COLORADO
Department of Transportation

CENTRAL 70 PROJECT

Public Disclosure Administrative and Technical Proposal:
5280 CONNECTORS

5280 Connectors
Linking Communities

VOLUME 2 | Electronic Copy | Binder 8 of 8

TRANSPARENCY | RELIABILITY | ACCOUNTABILITY | INCLUSIVITY

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SECTION 2.2

ALTERNATIVE TECHNICAL CONCEPTS

SECTION 2.2.1

ATC 2.3 | COLORADO INTERCHANGE DDI

DATE: December 16, 2016

TO: 5280 Connectors

FROM: Anthony DeVito P.E. Central 70 Project Director
Nicholas Farber, Central 70 Project

SUBJECT: Central 70 - Detailed Alternative Technical Concept (ATC) Response
5280 Connectors - ATC No. 2.3

Dear Mr. Clark:

Your Team's ATC Submission Form for Detailed ATC 2.3 has been reviewed by the Procuring Authorities.

Detailed ATC 2.3 proposes to replace the tight diamond interchange at Colorado Blvd. with a diverging diamond interchange.

In accordance with the Instructions to Proposers ("ITP"), the Procuring Authorities will use reasonable efforts to provide a Proposer with the following written feedback on a ATC Submission within 15 Working Days following the later of (x) the date the relevant ATC Submission was submitted and (y) the One-on-One Meeting at which such submission is discussed. Below is the final response from the Procuring Authorities for your Detailed ATC:

☐ 1. unconditional approval;

☒ 2. conditional approval, subject to modifications and/or conditions;

☐ Re-submission required ☒ Re-submission not required

☐ 3. disapproval, with or without guidance that such ATC can be re-submitted under any circumstance;

☐ 4. notification that the incorporation of the proposed ATC in the Proposer's Proposal is already permitted under the terms of the RFP, and therefore does not qualify as an ATC (and will not be treated as such for purposes of Section 3.4 of Part C of the ITP).

☐ 5. subject to compliance with the confidentiality requirements set out in Section 3.4 of Part C of the ITP, the Procuring Authorities are considering amending (for the benefit of all Proposers) the terms of the RFP that are the subject-matter of the proposed ATC.

The ATC is conditionally approved.

Conditions of approval:

1. The Developer shall be solely responsible for obtaining any additional approvals (i.e., Environmental Approvals, IAR modification approval) required for this ATC. This includes the necessary public outreach, as solely determined by the Department, needed for the concept. All costs or schedule impacts associated with such approvals are the responsibility of the Developer.

2. The Developer shall coordinate with the City of Denver regarding operations of the 48th and Colorado intersection. This shall include, but may not be limited to, modeling the operations of the intersection and providing mitigation concepts should the operations not be suitable.
3. The Developer shall coordinate with the City of Denver regarding access to the 40th and Colorado area. This shall include, but may not be limited to, developing concepts that would improve access to this area.

The approval of this Detailed ATC by the Procuring Authorities does not constitute an approval of specific drafting modifications to the RFP necessary to incorporate this ATC into the Project Agreement pursuant to Section 7.2.1.c of Part C of the ITP, which modifications shall be agreed by the Procuring Authorities and the Proposer (each acting reasonably) following issuance of a Notice of Award to such Proposer.

ANNEX 3: ALTERNATIVE TECHNICAL CONCEPT SUBMISSION FORM

Proposer Name: 5280 Connectors
Date: November 8, 2016

Central 70 Project RFP: ATC Submission No. 2.3

A. Background Information

1. Type of Submission

☐ Conceptual ATC

☒ Detailed ATC

2. Prior Submission(s)

☐ None (initial submission of ATC)

☐ Previously Submitted as Conceptual ATC

☒ Previously Submitted as Detailed ATC

3. Explanation of Reason for Resubmission

Response to ATC 2.2 Comments and Technical 1:1 Meeting on 10/27/16

4. Request for Discussion at One-on-One Meeting

☒ Meeting Requested

☐ Meeting Not Requested

B. <u>General ATC Submission Requirements</u>

1. Overview Description

This information has not been amended since the submission of the previous version of this ATC

5280 Connectors proposes to replace the Colorado Boulevard “tight diamond” interchange shown in the draft RFP design with a Diverging Diamond Interchange (DDI).

2. Relevant RFP Requirements

This information has not been amended since the submission of the previous version of this ATC

Schedule 10, Section 9.4.2 I-70 Mainline Interchanges, Part b. Steele/Vasquez and Colorado Boulevards Interchanges and Ramp Reconstruction.

Schedule 10, Section 11.5.1.f Traffic Signal Design, Part xvi. Colorado Boulevard and 46th Avenue North and South of I-70.

3. Rationale

This information has not been amended since the submission of the previous version of this ATC

The DDI would be incorporated in lieu of the RFP “tight diamond” interchange at Colorado Blvd. The DDI provides an interchange similar in operation and magnitude to that of the RFP and the existing condition. The DDI provides for improved traffic operations and reduced construction time.

4. Impacts

This information has not been amended since the submission of the previous version of this ATC

<u>Community</u>:

- Grades within the interchange proper are less than 3%. (See Exhibit 1). This will provide for an improved vertical geometry in setting up curb ramps, and pedestrian pathways with less than 5% grades (See Exhibit 2).

<u>Traffic</u>:

- Provides unobstructed U-turns for I-70 and collector-distributor traffic.
- Improved synchronized rate of traffic flows to the I-70 on-ramps, providing for a natural ramp metering effect.
- The overall Level of Service (LOS) is improved from the RFP LOS C to the DDI LOS B. Refer to the attached DDI Traffic Analysis Memo for a more detailed discussion of traffic operations. (See Exhibit 1 and Traffic Analysis Memo).
- Drivers accessing adjacent properties and businesses will be managed in advance of the Colorado Boulevard interchange via guide signing. For example, traffic destined for the Safeway Warehouse facility on EB I-70 will be directed to exit at the I-70 EB Steele/Vasquez off-ramp to the 46th Ave South Frontage Road, which travels under the I-70 EB Colorado Boulevard off-ramp and Colorado Boulevard to meet with the I-70 EB Colorado Boulevard on-ramp. Local traffic on Colorado Boulevard will be directed to local businesses by means of supplemental signage outside and within the interchange area.
- Braided ramps proposed for the DDI west interchange ramp crossings at 46th Avenue EB and WB reduce the weaving issues for drivers. (See Exhibit 1 for geometry and the Traffic Analysis Memo).

Safety:

- Crossover intersection geometry and alignment helps reduce occurrence for broadside accidents. (See Exhibit 1)
- Pedestrians only need to cross one direction of traffic for all crossing movements. (See Exhibit 1)

Constructability:

- The DDI reduces the size and configuration of the bridge over I-70 which improves construction phasing by allowing the erection of the proposed Colorado Boulevard bridges over the existing I-70 profile without impacting the vertical clearance of Colorado Boulevard over I-70 and the existing Colorado Boulevard Bridge. (See Exhibit 1 & 2)

Operation & Maintenance:

- Snow removal for the DDI will require additional plowing equipment to remove snow deposited on left shoulders of intersection crossings. This has been accomplished with a bucket loader or smaller truck plows working behind main plowing echelon depending on depth of snow removal.

5. Cost and Benefit Analysis

This information has not been amended since the submission of the previous version of this ATC

At the Conceptual ATC level the DDI was considered to result in an approximate zero change in cost with an additional bridge deck area for ramps offset by reduced pavement area. Further detailed design of interchange roadway profile has resulted increased wall area due to Colorado Boulevard Bridge phasing considerations over I-70.

The Diverging Diamond Interchange is estimated to result in a $2.5 Million Dollar Increase in Construction costs.

6. Schedule Analysis

This information has not been amended since the submission of the previous version of this ATC

Schedule impacts are not anticipated with revised intersection configuration. New Bridges can be constructed outside existing structures without impacting traffic, accelerating bridge construction that is offset by additional roadway construction durations

7. Conceptual Drawings

This information has been amended since the submission of the previous version of this ATC

Exhibits included with this ATC 2.2 submittal:

- Exhibit 1 - Interchange Concept Plan -No Change
- Exhibit 2 - Traffic Analysis Memo -No Change
- Exhibit 3 - Detailed Engineering Plans -No Change

New Exhibits

- Exhibit 4 – Guide Sign Roll Plot

8. Past Use

This information has been amended since the submission of the previous version of this ATC

The Diverging Diamond Interchange has been constructed on three previous CDOT projects

- US 36 & McCaslin Blvd, -Superior, CO
- I-25 & Fillmore St.- Colorado Springs, CO
- I-70 & I-70B Grand Junction, CO
- Missouri's Experience with a Diverging Diamond Interchange Lessons Learned, MODOT

  https://library.modot.mo.gov/rdt/reports/unnumbrd/or10021rpt.pdf

9. Additional Information

This information has been amended since the submission of the previous version of this ATC

Roadway Geometry:

Detailed horizontal centerline and vertical profiles for Colorado Boulevard the interchange ramps and 46th Avenue EB and WB are include in the attached exhibits. All of the profiles meet the requirements of the Roadway Design Criteria Attachment A (See Exhibit 4).

Traffic Analysis:

A more in depth regional Traffic Analysis has been included as part of analysis to include Steele, Monroe and Cook St. intersections with 46th Ave. N&S showing the effects of movements that have been eliminated and intersection impacts on effected routes (see Exhibit 3).

Response to Comments from Technical 1:1 Meeting held 10/27/16 at the City and County of Denver Public Works Office (Webb Building) and the ATC 2.2 Response from the Owner sent on 10/18/16:

1. Additional 46th Ave Frontage Roadway Traffic to I-70 Eastbound Exit Ramp at Steele Intersection

RFP baseline traffic volumes indicated that 214 vehicles were taking the I-70 Eastbound Exit Ramp to make the through movement of the intersection at Steele St to continue eastbound on 46th Ave South Frontage Road. The DDI separates the frontage road through movements that were going through signalized intersections as part of the RFP tight diamond design. The traffic volumes that have been separated by the DDI design are now required to get off at the I-70 Eastbound Exit Ramp at Steele Street, instead of the I-70 Eastbound Exit Ramp at Colorado Boulevard. The DDI increases the I-70 Eastbound Exit Ramp at Steele St. from 214 to 236 vehicles.

2. Impacts to queues for the eastbound I-70 off ramp at Steele Street.

The additional traffic will have a minor impact on the queues, but the ramp as design is more than adequate to accommodate the demand. The measured geometric length of the dual left turn lanes is +350 feet. The VISSIM modeled impacts for this turning movement queue length was measured at 300 feet in the 2035 PM peak.

3. DDI affects on adjacent intersection performance

It is almost certain that the impacts of the project as a whole on the adjacent intersections, more specifically Colorado & 48th Ave, will far exceed the nuances of the rerouted DDI traffic. Namely improved mobility along I-70 and at interchanges east and west of Colorado are likely to cause some traffic to divert from these intersections.

4. Permanent Overhead Guide Sign Evaluation (See attached guide sign exhibit)

I-70 Eastbound vehicles that were destined for Dahlia Street are rerouted with guide signs as follows:

1) Steele Street eastbound exit ramp to 46th Ave South frontage road.
2) Continue eastbound on 46th Ave South frontage road underneath the braided ramp for I-70 eastbound exit ramp at Colorado Blvd.
3) Continue eastbound on 46th Ave South frontage road underneath Colorado Blvd until 46th Ave South frontage road turns into Stapleton Drive South frontage road.
4) Continue eastbound on Stapleton Drive South frontage road until it intersects Dahlia.

I-70 Westbound vehicles that were destined for Steele St are rerouted with guide signs as follows:

1) Colorado Blvd westbound exit ramp to Stapleton Drive North frontage road.
2) Continue westbound on Stapleton Drive North frontage road underneath Colorado Blvd until it turns into 46th Ave North frontage road.
3) Continue westbound on 46th Ave North frontage road underneath I-70 westbound entrance ramp from Colorado Blvd.
4) Continue westbound on 46th Ave North frontage road until it intersects Steele Street.

5. Diversion of RFP Drainage to the West:

With the change in interchange type, the pond areas designed in the RFP east of the Colorado interchange are removed, reduced in size or relocated, and the Smith Road drainage flows are diverted to the west instead of being diverted to the RFP ponds and conveyed north of I-70 as shown in the RFP. 5280 Connectors submitted ATC 17.0, requesting the culvert diversion of the existing Smith Road drainage that would have been conveyed to the ponds east of the tight diamond interchange in the RFP design, to the Owner on July 13, 2016. The Owner responded, initially on 8/4/2016 and then lastly on 8/31/2016, with a “notification that the inclusion of the proposed ATC in the Proposer’s Proposal is already permitted under the terms of the RFP, and therefore does not qualify as an ATC (and will not be treated as such for purposes of Section 3.4 of Part C of the ITP; or”.

6. Compatibility of DDI with Future Second Cover:

The second cover requirements as described in the Addendum #5 of the PA are not precluded with any part of this ATC design.

7. HDR Designed Diverging Diamond Interchange References:

McCaslin Blvd / US 36

Joliette Woodson
Public Works Engineering/Civil Eng III
749 Main St
Louisville, CO 80027
(303) 335 4603

Kurt Kowar
Director of Public Works
749 Main St
Louisville, CO 80027
(303) 335 4601

I-25 and Fillmore St. Interchange
www.codot.gov/projects/i25fillmore

Kathleen Krager
Transportation Manager
Public Works Department
City of Colorado Springs
30 S Nevada Avenue, Suite 401
Colorado Springs CO 80903
(719) 385-7628

Mark Andrew
CDOT R2 Program Engineer
1480 Quail Lake Loop, Suite A
Colorado Springs, CO 80906
(719) 227-3201

College Drive \ I-25

Mark Wingate
WyDOT- Systems Planning Engineer
5300Hop Blvd.
Cheyenne, WY 82009
(307) 777-4375

8. Turning Movements into RW-104 "Eagle Claw" Property:

The RFP roadway plans shows some "tea-cup handle" geometry for the East 46th Ave southbound to eastbound movement so that vehicles heading to the "Eagle Claw" property can enter the property from the southwest corner of the property before the Local Access Road turns into a one-way westbound to northbound movement.

The ATC roadway plans provide similar geometry for this movement, allowing for a WB-67 (AASHTO 2011) to enter the property. The WB-67 can still maneuver through the existing gate in the southwest corner.

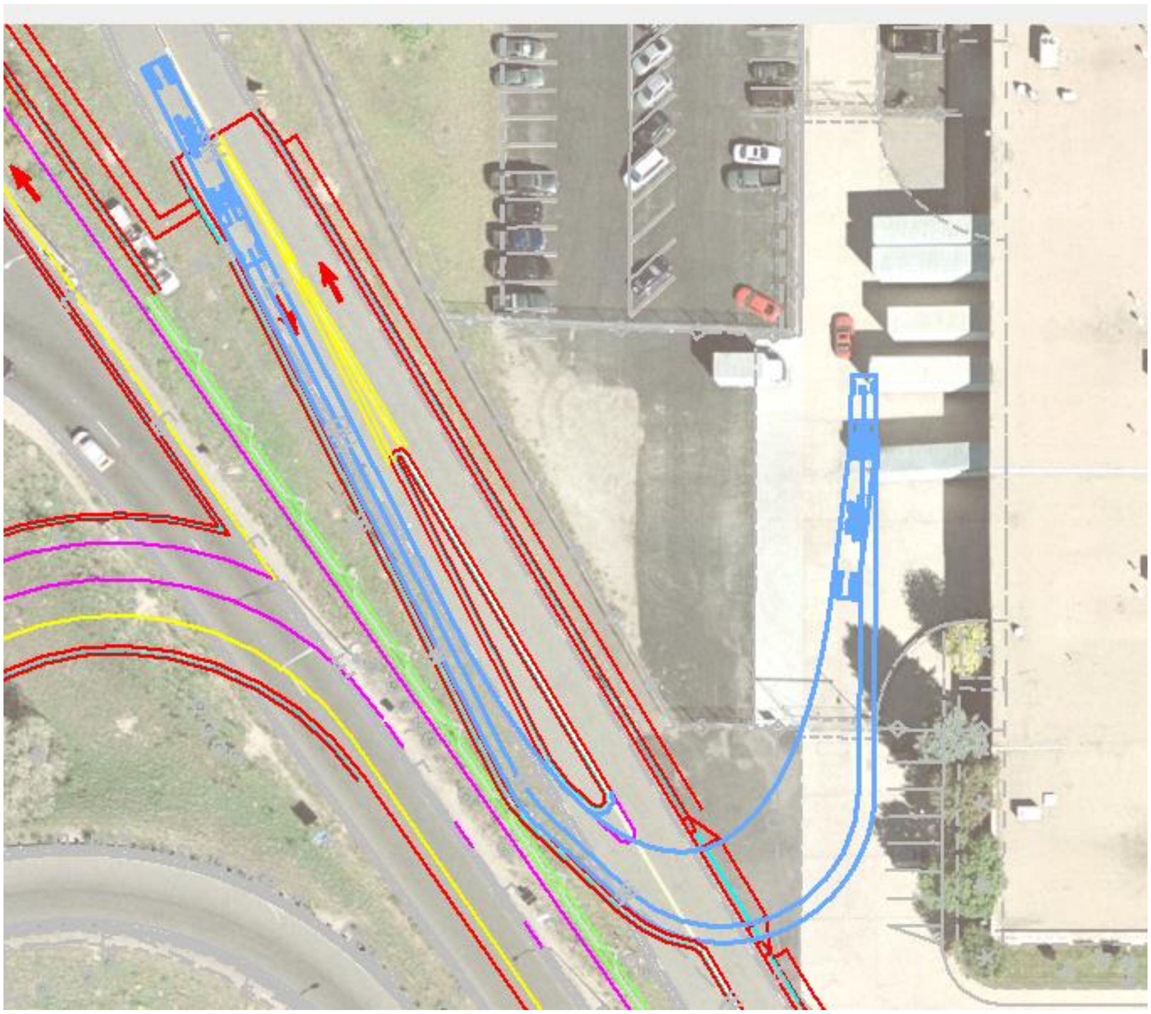


Figure 1 – WB-67 Truck Turning Movement into "Eagle Claw" Property

5280 Connectors is current working to develop a workable solution regarding the set-up of the local access road and access into the "Eagle Claw" property.

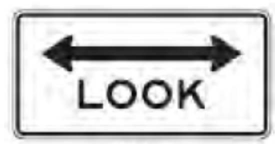
1) The RFP geometry provides for the access into the "Eagle Claw" property and can be modified slightly to allow for WB-67 turnaround movements from southbound to northbound along East 46th Ave.
    a. The ATC "tea-cup handle" geometry design does not allow for a WB-67 turnaround movement. The ATC allows for a SU40 turnaround movement as long as the movement can encroach onto the "Eagle Claw" property to make this movement.

b. If the ATC is implemented and a turnaround is required, we believe that a cul-de-sac could be provided near the northern entrance of the "Eagle Claw" property, but would require additional property take to "Eagle Claw". The additional property required is not identified as a location where existing parking or access is provided

9. <u>Pedestrian Movements:</u>

Pedestrians will only need to negotiate a crossing with one-way traffic movements at the crossover intersections. However, traffic will be approaching the intersections from the opposite direction that pedestrians may not expect. The excerpt below is from the Missouri Department of Transportation document: "Missouri's Experience with a Diverging Diamond Interchange Lessons Learned". Special considerations can be made during final design to account for this situation.

> Pedestrians may encounter a situation in which traffic approaches from the opposite direction than is expected. People are accustomed to look "left–right-left" before crossing the street; therefore, this condition may need special consideration. Signalization may help the issue. However, it does not necessarily prevent pedestrians from making mistakes and may adversely affect traffic capacity. Signs or pavement markings instructing a pedestrian to look right or left may be helpful to alert pedestrians of oncoming traffic from an unexpected direction.



R15-8

C. Detailed ATC Requirements

1. Risks

This information has not been amended since the submission of the previous version of this ATC

Implementation of this ATC does not present any additional risks to the Procuring Authorities, CDOT, the State or third parties. No new risks associated with environmental clearances or environmental re-evaluation are anticipated.

2. Handback

This information has not been amended since the submission of the previous version of this ATC

No additional handback requirements are anticipated.

3. Right-of-Way

This information has been amended since the submission of the previous version of this ATC

Additional ROW is not currently required for the DDI interchange beyond the RFP (Tight Diamond) ROW. As shown on the attached exhibits, the DDI interchange fits within the available RFP ROW footprint.

Variations in the Design of 46th Ave. North Entrance and turn-around at "Eagle Claw" Property may have impacts on ROW Parcel No. RW-104 currently identified for partial acquisition.

4. List of Required Approvals

This information has not been amended since the submission of the previous version of this ATC

It is anticipated that the following third party and Governmental Approvals may be required for the implementation of this ATC:

- Reevaluation of environmental decision from CDOT and FHWA and associated approvals from environmental resource agencies.
- Request for modification to the Interchange Access Request (IAR) from FHWA.
- Concept and design approval from City and County of Denver.

We do not anticipate any additional Design Exceptions for the implantation of this ATC.

5. Proposed Drafting Revisions

This information has not been amended since the submission of the previous version of this ATC

The following sections of the Project Agreement will require amendment (see attached proposed modifications):

- Schedule 10, Section 9.4.2 I 70 Mainline Interchanges, Part b. Steele/Vasquez and Colorado Boulevards Interchanges and Ramp Reconstruction.
- Schedule 10, Section 11.5.1.f Traffic Signal Design, Part xvi. Colorado Boulevard and 46th Avenue North and South of I-70.

9.4.2. I-70 Mainline Interchanges

b. Steele Street/Vasquez and Colorado Boulevards, Interchanges and Ramp Reconstruction

i. The existing Steele Street/Vasquez and Colorado Boulevard interchanges shall be reconstructed to allow for lowering the I-70 Mainline below the roadways. Ramp connectivity to Steele Street/Vasquez and Colorado Boulevard from the I-70 Mainline shall be designed and constructed as a ~~split diamond~~Diverging Diamond interchange with supplemental ramp connections on the west side of Colorado Boulevard. Specifically, ramp connectivity shall be provided for the following movements:

A. Westbound entrance ramp from Steele Street/Vasquez Boulevard;

B. Eastbound exit ramp to Steele Street/Vasquez Boulevard;

C. Westbound entrance slip ramp from Colorado Boulevard;

D. Eastbound exit slip ramp to Colorado Boulevard;

E. Westbound exit ramp to Colorado Boulevard; and

F. Eastbound entrance ramp from Colorado Boulevard.

ii. The Developer shall construct the ramps and ramp connections described above in accordance with the following criteria:

A. The Steele Street/Vasquez Boulevard westbound entrance ramp shall have a two receiving-lane terminal connection from Steele Street/Vasquez Boulevard transitioning to a single lane acceleration and single lane entrance to I-70;

B. The Steele Street/Vasquez Boulevard eastbound exit ramp shall have a single-lane ramp with single-lane exit and deceleration lane. A four-lane connection that includes dual left-turn lanes, a thru lane, and a thru/right lane shall be provided to Steele Street/Vasquez Boulevard;

C. The Steele Street/Vasquez Boulevard westbound 46th Avenue connection shall have a four-lane connection that includes dual left-turn lanes, a thru lane, and a thru/right lane provided;

D. The Steele Street/Vasquez Boulevard eastbound 46th Avenue connection shall have a two receiving-lane connection provided;

E. The Colorado Boulevard westbound entrance ramp shall have a two-lane terminal connection from Colorado Boulevard transitioning to a single lane acceleration and single lane entrance to I-70. Two receiving lanes shall also be provided at the terminal connection for 46th Avenue;

F. The Colorado Boulevard eastbound exit ramp shall have a single-lane ramp with single-lane exit and deceleration lane. A four-lane ramp terminal connection that includes a left-turn lane, a thru/left lane, a thru/right lane and a right turn lane shall be provided to Colorado Boulevard;

11.4.3. Existing Pavement Marking

Prior to the issuance of NTP 2, the Developer shall submit an inventory of all existing striping within the Site including approaches, in MicroStation and Excel format, to the Department for Information.

11.5. Traffic Signalization

11.5.1. Traffic Signal Design

a. Traffic signals on Local Agency Roadways shall comply with the Local Agency Standards at time of the Setting Date and as outlined in Project Special Provisions, Appendix A to this Section 11;

b. Traffic signalization design shall include traffic signal mast arm type poles, pedestal poles, pole footing/caisson locations and sizes, mast arm lengths, traffic signal heads, countdown pedestrian signal heads, signal head placement and alignment, controller cabinet(s), power disconnect and meter, signal phasing, lighting/luminaires, conduits, pull boxes, non-invasive vehicle detection, pedestrian push buttons, emergency vehicle preemption, Railroad signal preemption design, Americans with Disabilities Act (ADA) compliant curb ramps, signal timing plan, and signing as required;

c. All traffic signals shall be interconnected with 2 inch conduit and 12 strand single mode fiber optic cable between signal cabinets at each location. New traffic signal installations require an electric meter pedestal cabinet and base for the traffic signal. The electrical meter will be furnished by Xcel Energy. The Developer shall install the electric meter cabinet and pedestal base;

d. All ramp meters shall be interconnected with a 2 inch conduit and 12 stand single mode fiber optic cable to the local signal cabinet at each ramp termini;

e. Traffic signal pole locations shall be staked and Accepted by the Department and the CCD before construction;

f. Identified locations of traffic signalization:

i. Brighton Boulevard and 46th Avenue (North and South of I-70);

ii. Brighton Boulevard and 47th Avenue;

iii. Brighton Boulevard and UPRR Pepsi Lead Crossing (Northbound);

iv. York Street and 46th Avenue (North and South of I-70);

v. York Street and 47th Avenue with pre-signal at Railroad crossing;

vi. Josephine Street and 46th Avenue (North and South of I-70);

vii. Josephine Street and 45th Avenue;

viii. Columbine Street and 46th Avenue (North and South of I-70);

ix. Clayton Street and 46th Avenue (North and South of I-70);

x. Fillmore Street and 46th Avenue (North and South of I-70);

xi. Steele Street and 45th Avenue;

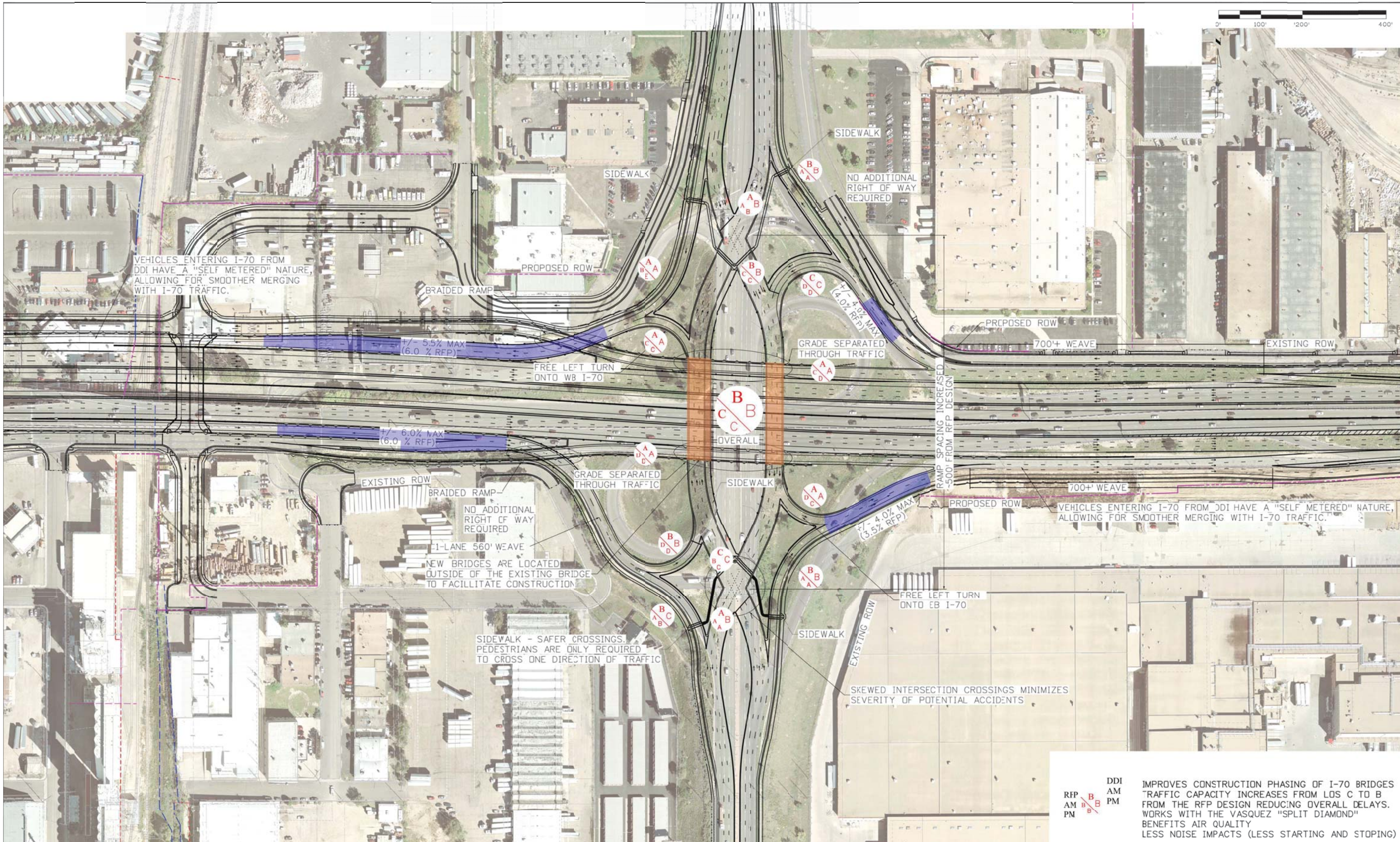
xii. Steele Street/Vasquez Boulevard and 46th Avenue (North and South of I-70);

xiii. Vasquez Boulevard and 48th Avenue;

xiv. Cook Street and 46th Avenue (North and South of I-70);

xv. Monroe Street and 46th Avenue with pre-signal at Railroad crossings North and South of I-70);

xvi. ~~Colorado Boulevard and 46th Avenue (North and South of I-70);~~



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Print Date: 9/13/2016
File Name: ATC2.2_Plan02_I-70_RollPlot.dgn
Horiz. Scale: 1:100 Vert. Scale: As Noted

EXHIBIT 1

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation

CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 2.2
DDI AT COLORADO BLVD

Designer:		Structure Numbers	
Detailer:			
Sheet Subset:		Subset Sheets:	of

Memo

Date:	Thursday, September 01, 2016
Project:	Central 70
To:	Michael Balash, Darren Hymas, Steve McQuilkin
From:	Jeremy Jackson
Subject:	Colorado Blvd DDI ATC 2.2

Introduction

The Colorado Boulevard DDI ATC traffic analysis was revised to include an updated design for the DDI (see Figure 1) and to expand the study area in order to evaluate intersection operations on 46th Avenue N and 46th Avenue S between Colorado Boulevard and Steele Street as a result of rerouting traffic due to the access limitations of the DDI.

Methodology

As with the previous ATC traffic analysis, the proposed DDI was analyzed using microsimulation due to the limitations that Synchro software has with modeling DDIs. Because of the unique geometry of the DDI and the ROW constraints, certain movements will need to be rerouted. The previous model was expanded to evaluate the impacts of rerouting traffic and included the Steele Street, Monroe Street and Cook Street intersections on 46th Avenue N and 46th Avenue S. For the purposes of this revised analysis, only the PM peak hour volumes were modeled and analyzed, as they were significantly higher than the AM peak hour volumes. The 2035 PM peak hour volumes for the DDI and the nearby ramp and frontage road merge/diverge locations are provided in Figure 2.

Figure 1 – Revised DDI Design

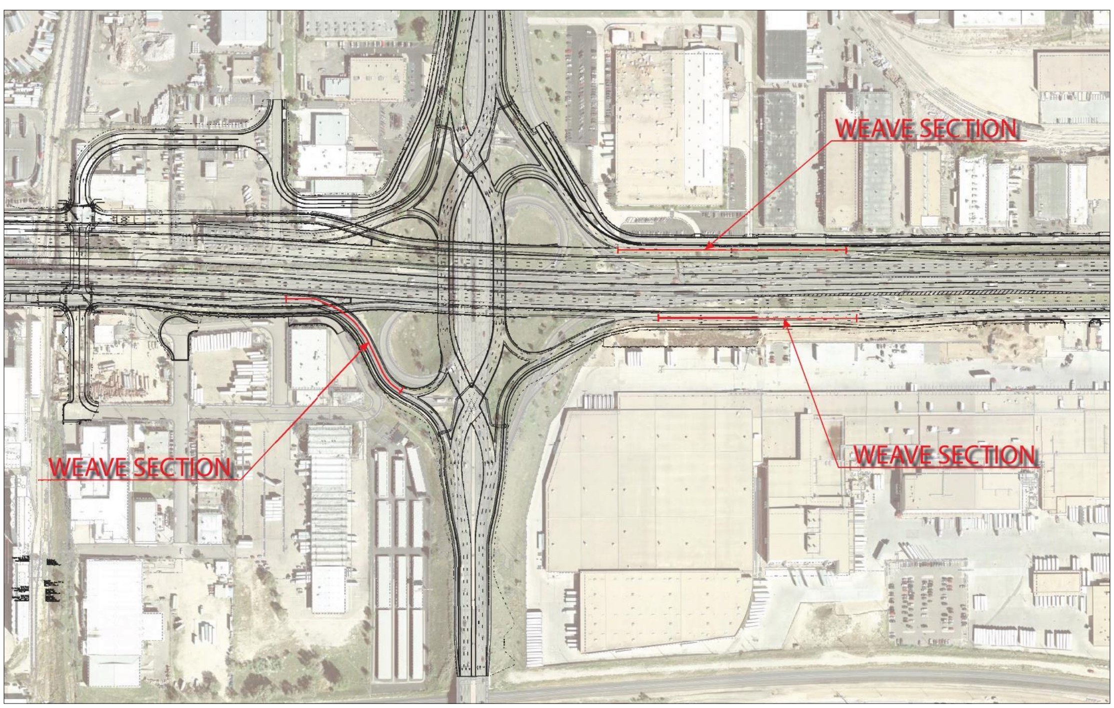
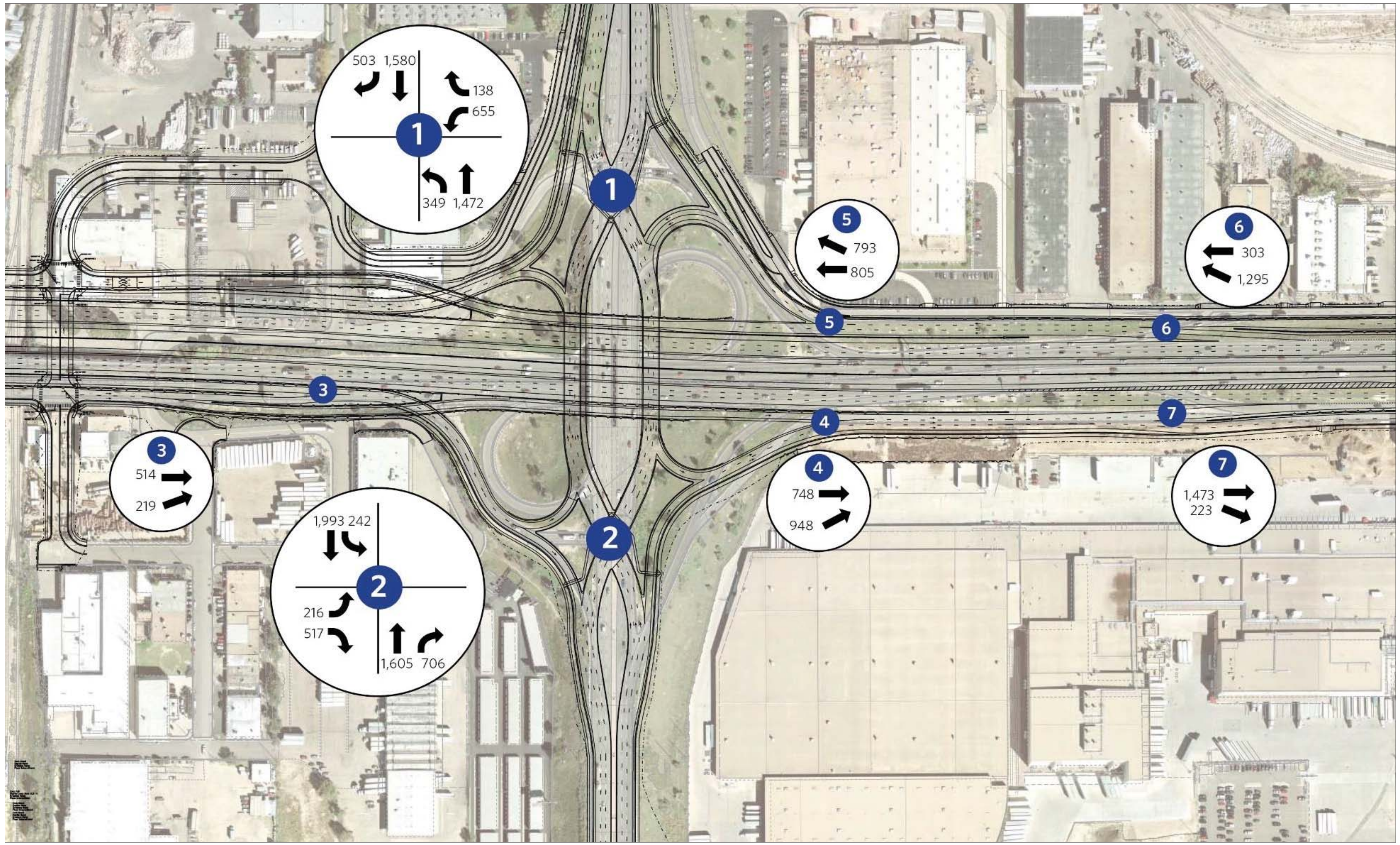


EXHIBIT 2

Figure 2 – 2035 PM Peak Hour Volumes



Access Limitations

As previously discussed, the ATC design has access limitations due to the unique geometry of the DDI. Several movements that are allowed in the Baseline RFP will need to be rerouted in the ATC design. In total, there are five movements that are rerouted in the ATC design as compared to the Baseline RFP design (see Figure 3 and Figure 4). These rerouted movements include the following:

1. *I-70 eastbound to frontage road eastbound*
2. *I-70 eastbound to frontage road westbound*
3. *Colorado Boulevard southbound to frontage road westbound*
4. *Frontage road westbound to I-70 westbound*
5. *Colorado Boulevard northbound to frontage road westbound*

Figure 3 – Rerouted Movements for ATC DDI Design

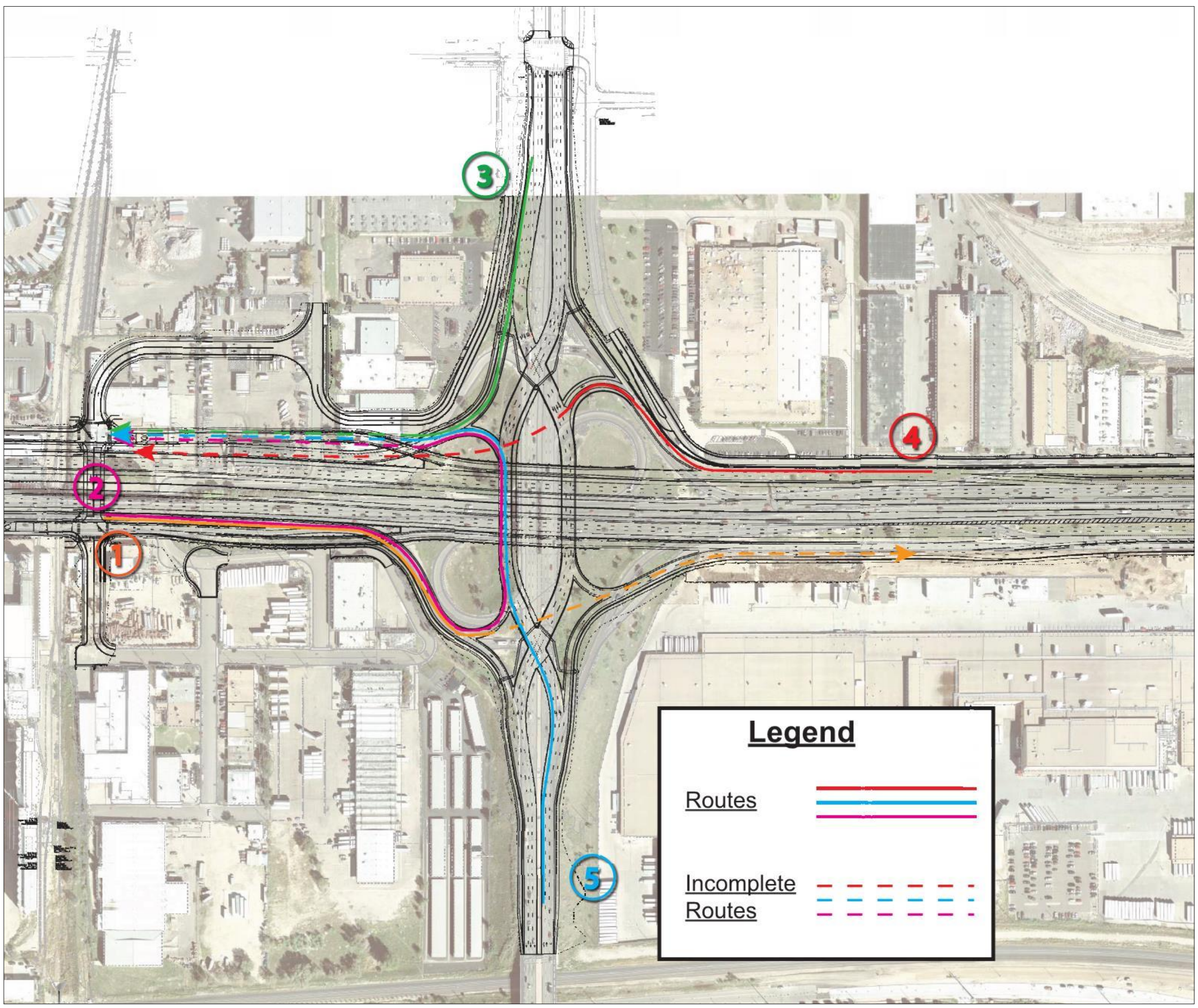
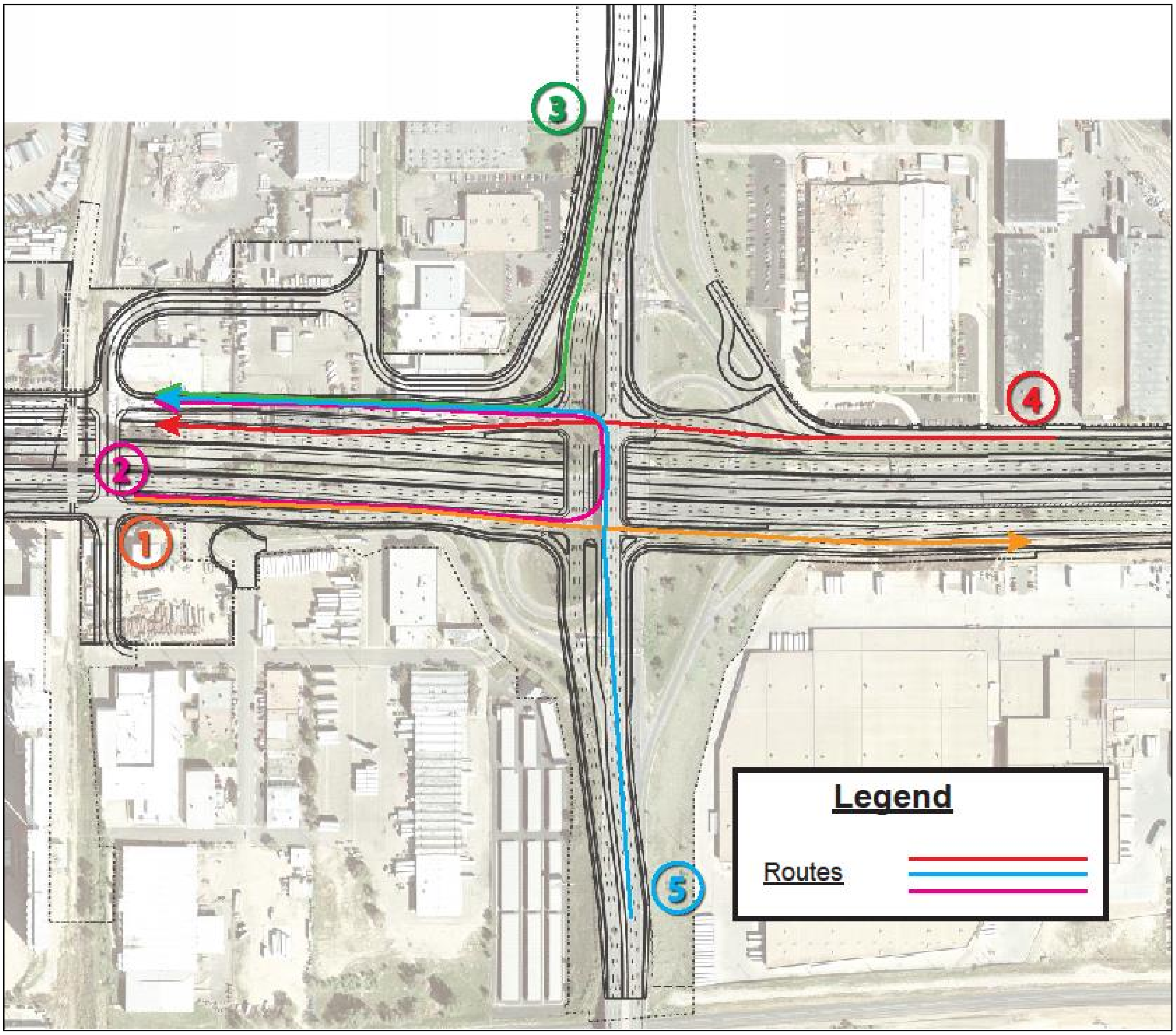


Figure 4 – Rerouted Movements as allowed in the Baseline RFP Design



The following is a more detailed description of the rerouted movements and how they will provide access to the surrounding network:

1. *I-70 eastbound to frontage road eastbound*
   - Traffic will exit at Steele Street and head eastbound on the frontage road, passing underneath Colorado Boulevard to return to the frontage road.

2. *I-70 eastbound to frontage road westbound*
   - Traffic will exit at Steele Street and head eastbound to Cook Street or Monroe Street. Given that this movement is essentially a U-turn movement, it is likely more of a direct route for traffic to use the off-ramp at Steele Street.

3. *Colorado Boulevard southbound to frontage road westbound*
    - Traffic will turn right onto 48th Avenue in order to return to the frontage road via 46th Avenue.

4. *Frontage road westbound to I-70 westbound*
    - Traffic will remain westbound on the frontage road, pass underneath Colorado Boulevard, and use the on-ramp at Steele Street.

5. *Colorado Boulevard northbound to frontage road westbound*
    - Traffic will turn left onto 48th Avenue in order to return to the frontage road via 46th Avenue.

For analysis purposes it is assumed that the Colorado Boulevard to westbound frontage road movements (#3 and #5) are low volume movements that service local businesses along the frontage road. Traffic destined for areas beyond the frontage road (Steele Street or Vasquez Boulevard) will likely use alternate routes other than 48th Avenue, i.e. 40th Avenue, Vasquez Boulevard, etc. This low volume of additional traffic at 48th Avenue will have little to no impact on intersection operations.

Because these impacts are assumed to be negligible, and that the I-70 East corridor does not include any improvements at the intersection, 48th Avenue was not included in the revised ATC analysis. The heaviest volumes of rerouted traffic are on the frontage road and the analysis focused on the impacts to the frontage road and Steele Street intersections.

Analysis Results

A summary of the PM peak hour intersection operations for the ATC design is provided in Table 1. As shown in Table 1, the ATC design provides acceptable operations at all study area intersections (LOS C or better). These results include the rerouted traffic movements described above. Detailed operational results for each intersection, including modeled volumes and delay by movement, and maximum approach queue lengths are provided in the Appendix.

Table 1 – PM Peak Hour Intersection Operations Summary

Intersection	*ATC Design*	
	Delay	LOS
Colorado Blvd. & I-70 EB Ramps	18.2	B
Colorado Blvd. & I-70 WB Ramps	14.5	B
Steele St. & 46th Ave. S	21.1	C
Steele St. & 46th Ave. N	23.0	C
Cook St. & 46th Ave. S	12.3	B
Cook St. & 46th Ave. N	9.1	A
Monroe St. & 46th Ave. S	9.2	A
Monroe St. & 46th Ave. N	14.7	B

LOS

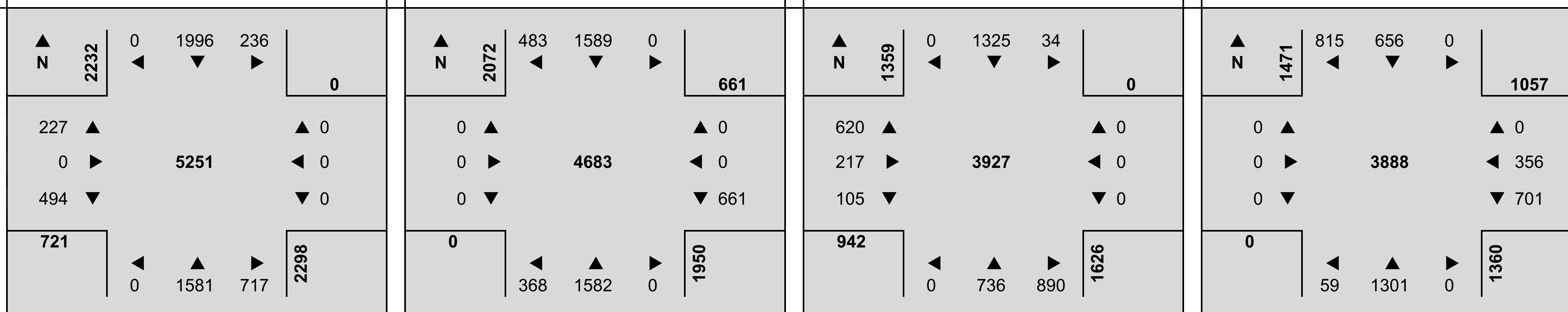
A
B
C
D
E
F

EXHIBIT 2

Appendix: Detailed Intersection Operations

DDI PM	100 Colorado Blvd. & I-70 EB Ramps			200 Colorado Blvd. & I-70 WB Ramps			300 Steele St. & 46th Ave. S			400 Steele St. & 46th Ave. N		
VISSIM RESULTS MVMNT	DELAY	LOS	QUEUE	DELAY	LOS	QUEUE	DELAY	LOS	QUEUE	DELAY	LOS	QUEUE
ALL	18.2	B	498	14.5	B	673	21.1	C	779	23.0	C	574
NBL	0.0	A	0	2.7	A	372	0.0	A	0	46.5	D	338
NBT	28.6	C	498	21.8	C	709	23.5	C	779	9.0	A	338
NBR	10.1	B	303	0.0	A	0	17.3	B	220	0.0	A	0
EBL	15.5	B	221	0.0	A	0	40.8	D	306	0.0	A	0
EBT	0.0	A	0	0.0	A	0	41.9	D	198	0.0	A	0
EBR	22.3	C	408	0.0	A	0	19.8	B	134	0.0	A	0
SBL	2.1	A	24	0.0	A	0	48.8	D	336	0.0	A	0
SBT	14.0	B	332	16.2	B	307	8.9	A	336	27.8	C	347
SBR	0.0	A	0	5.8	A	138	0.0	A	0	12.3	B	372
WBL	0.0	A	0	24.3	C	224	0.0	A	0	41.2	D	574
WBT	0.0	A	0	0.0	A	0	0.0	A	0	36.5	D	200
WBR	0.0	A	0	0.0	A	0	0.0	A	0	0.0	A	97

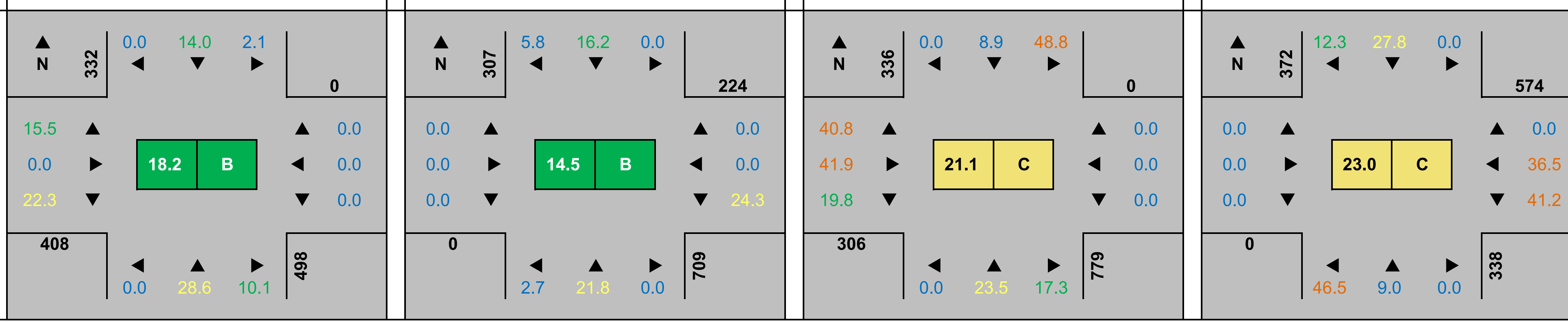
INTERSECTION TURNING MOVEMENT DIAGRAM



AVERAGE DELAY

LOS

MAX APPROACH QUEUE LENGTH

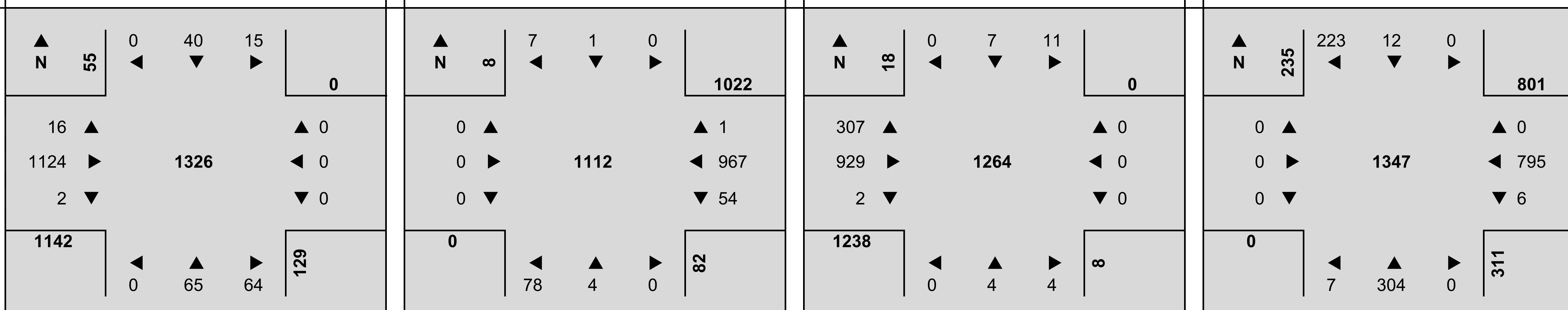


LOS
A
B
C
D
E
F

EXHIBIT 2

DDI PM	500 Cook St. & 46th Ave. S				600 Cook St. & 46th Ave. N				700 Monroe St. & 46th Ave. S				800 Monroe St. & 46th Ave. N			
VISSIM RESULTS	MVMNT	DELAY	LOS	QUEUE	MVMNT	DELAY	LOS	QUEUE	MVMNT	DELAY	LOS	QUEUE	MVMNT	DELAY	LOS	QUEUE
	ALL	12.3	B	257	ALL	9.1	A	499	ALL	9.2	A	444	ALL	14.7	B	409
	NBL	0.0	A	0	NBL	25.8	C	125	NBL	0.0	A	0	NBL	23.3	C	294
	NBT	23.7	C	145	NBT	30.7	C	125	NBT	16.1	B	24	NBT	20.6	C	294
	NBR	11.8	B	156	NBR	0.0	A	0	NBR	5.8	A	44	NBR	0.0	A	0
	EBL	6.4	A	246	EBL	0.0	A	0	EBL	9.6	A	409	EBL	0.0	A	0
	EBT	11.4	B	246	EBT	0.0	A	0	EBT	8.9	A	409	EBT	0.0	A	0
	EBR	4.9	A	257	EBR	0.0	A	0	EBR	8.3	A	444	EBR	0.0	A	0
	SBL	24.2	C	111	SBL	0.0	A	0	SBL	19.8	B	47	SBL	0.0	A	0
	SBT	18.4	B	111	SBT	4.8	A	22	SBT	5.2	A	47	SBT	17.1	B	95
	SBR	0.0	A	0	SBR	4.6	A	31	SBR	0.0	A	0	SBR	6.6	A	130
	WBL	0.0	A	0	WBL	7.8	A	499	WBL	0.0	A	0	WBL	10.0	A	370
	WBT	0.0	A	0	WBT	7.7	A	499	WBT	0.0	A	0	WBT	14.6	B	370
	WBR	0.0	A	0	WBR	37.3	D	499	WBR	0.0	A	0	WBR	0.0	A	409

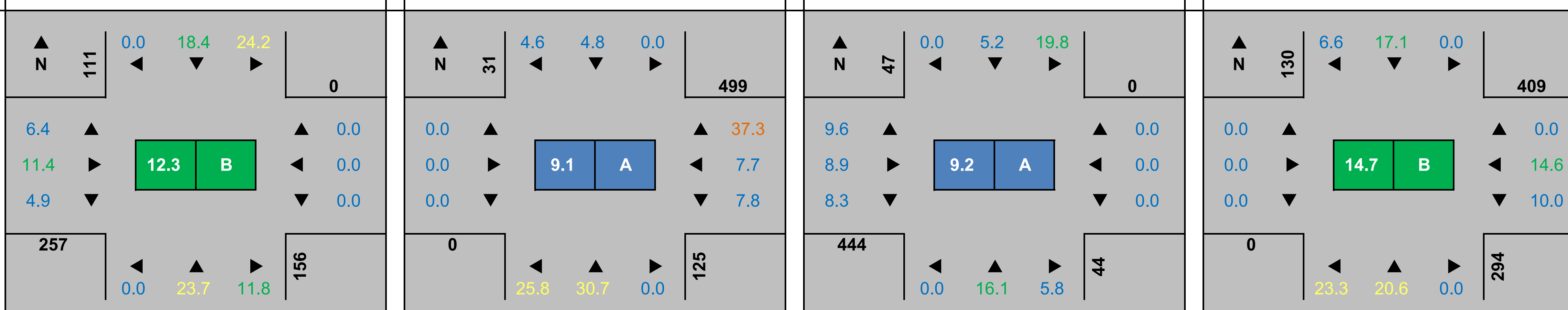
INTERSECTION TURNING MOVEMENT DIAGRAM



AVERAGE DELAY

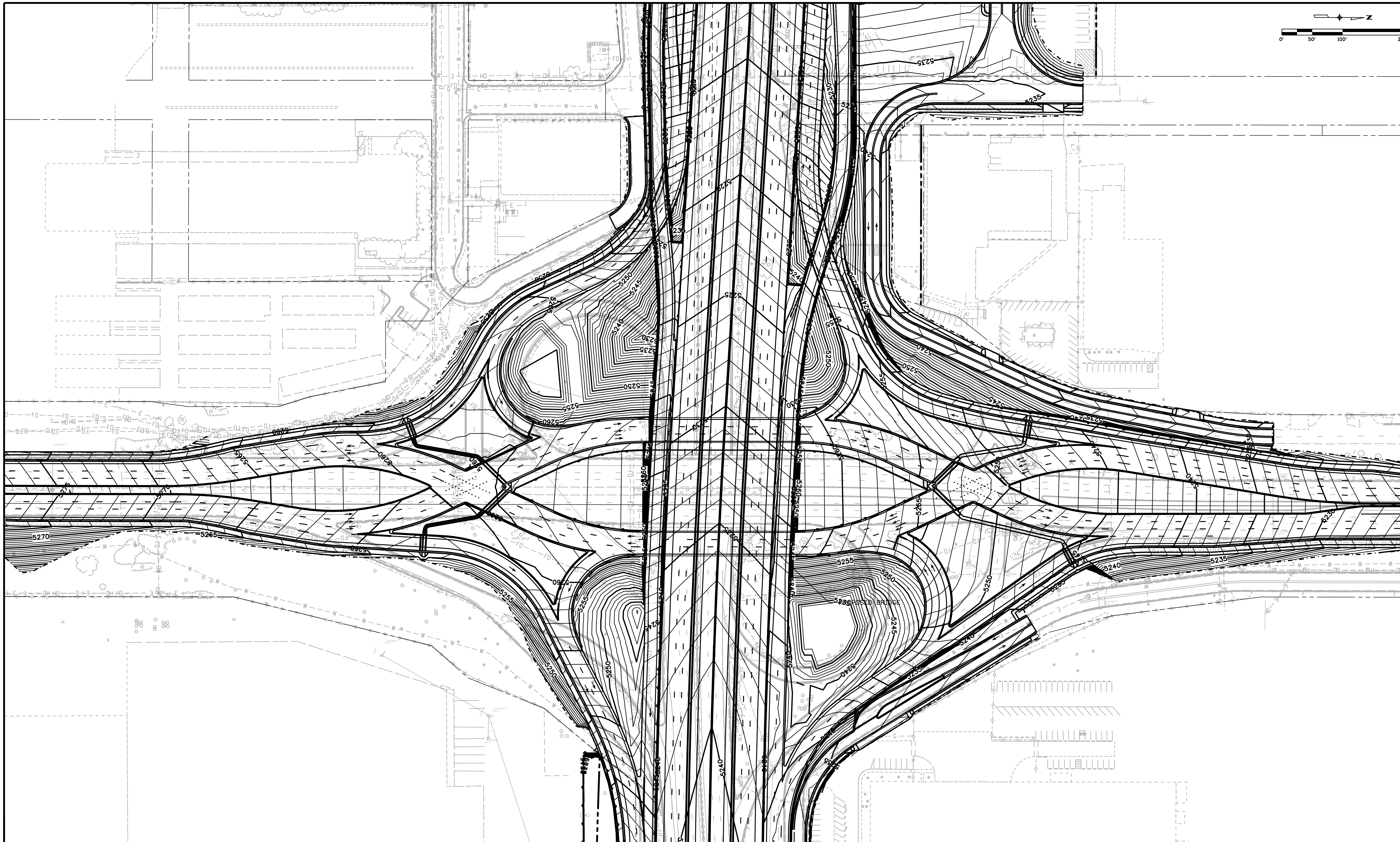
LOS

MAX APPROACH QUEUE LENGTH



LOS
A
B
C
D
E
F

EXHIBIT 2



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Print Date: 8/24/2016
File Name: ATC2.0_GradingPlan01_DDI-Colorado_Exhibit.dgn
Horiz. Scale: 1:150 Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

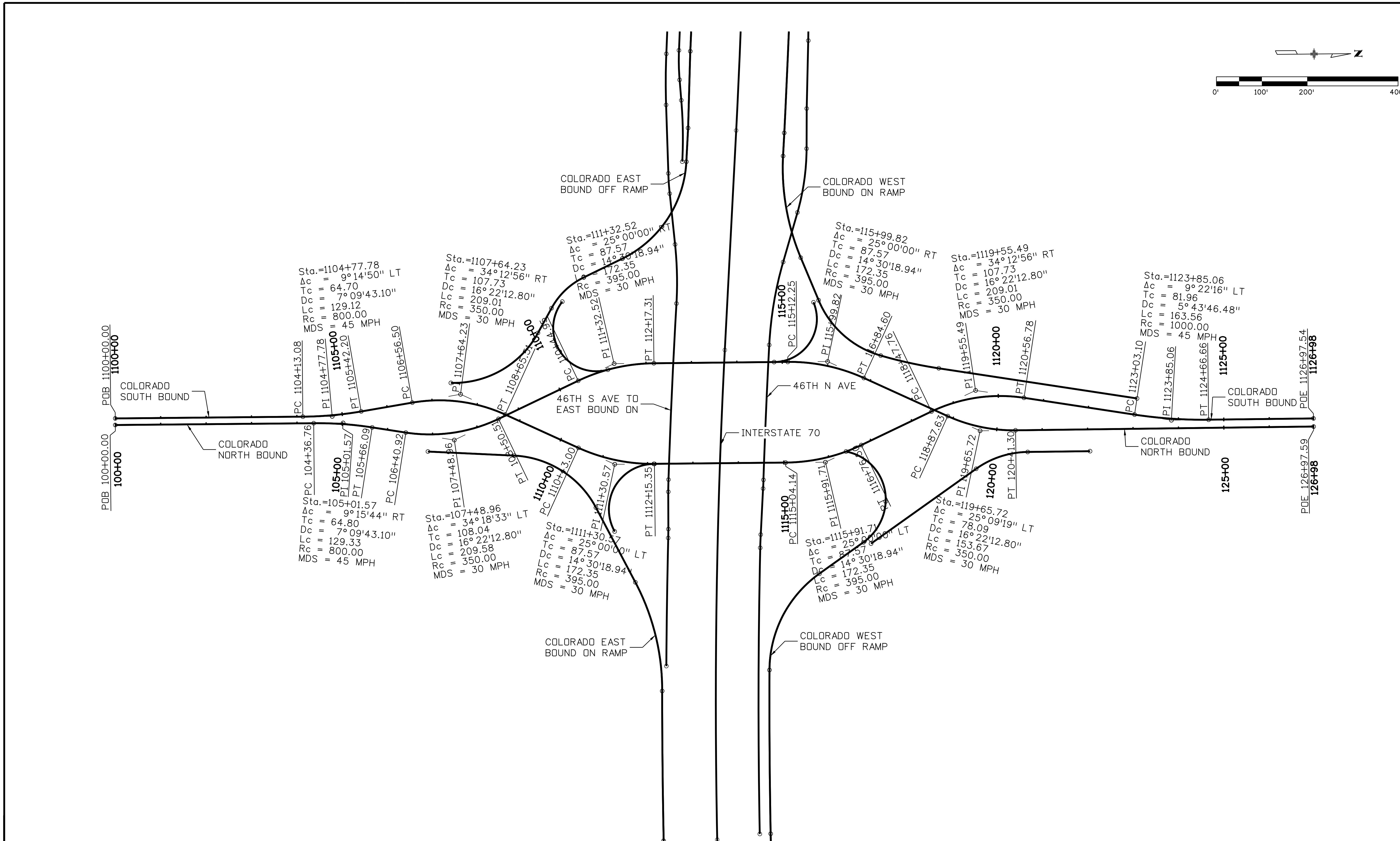
Colorado Department of Transportation

Region 1

COLORADO HPTE

I-70 EAST ATC 2.2
DDI AT COLORADO BLVD
GRADING PLAN

Designer:		Structure Numbers	
Detailer:			
Sheet Subset:		Subset Sheets:	1 of 1



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IN PROGRESS - NOT FOR FINAL ESTIMATE

Print Date: 8/30/2016
File Name: 13599DES_HCL-RD-DDI1.dgn
Horiz. Scale: 1:200.588 Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

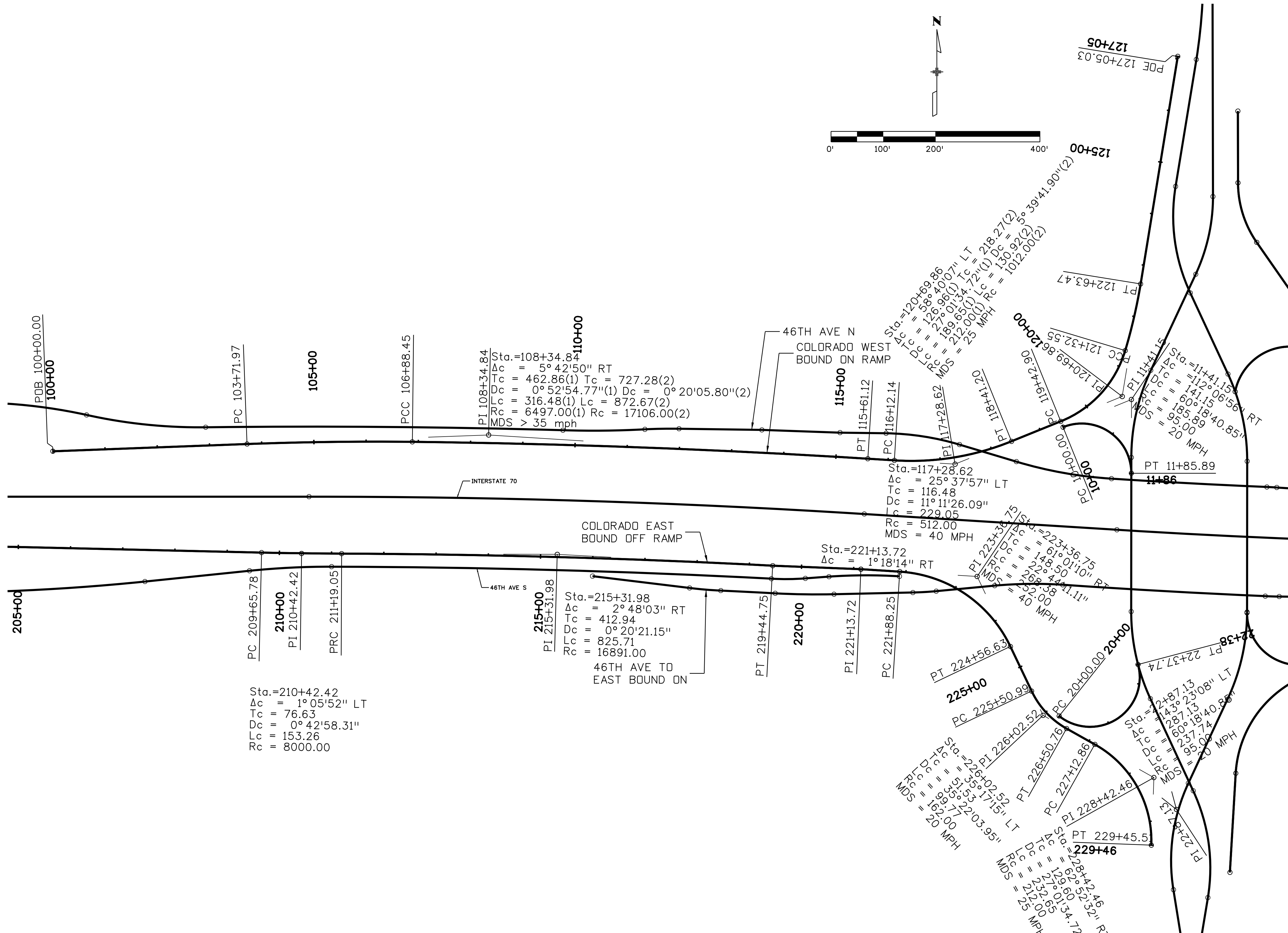
HDR

Colorado Department of Transportation
CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 2.2
COLORADO DDI
ALIGNMENT DATA

Designer:	DH	Structure Numbers	.
Detailer:	BJS		.
Sheet Subset:	.	Subset Sheets:	1 of 5



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Horiz. Scale: 1:200.588 Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation

CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 2.2
COLORADO DDI
ALIGNMENT DATA

Designer:	DH	Structure Numbers	.
Detailer:	BJS		.
Sheet Subset:	.	Subset Sheets:	2 of 5

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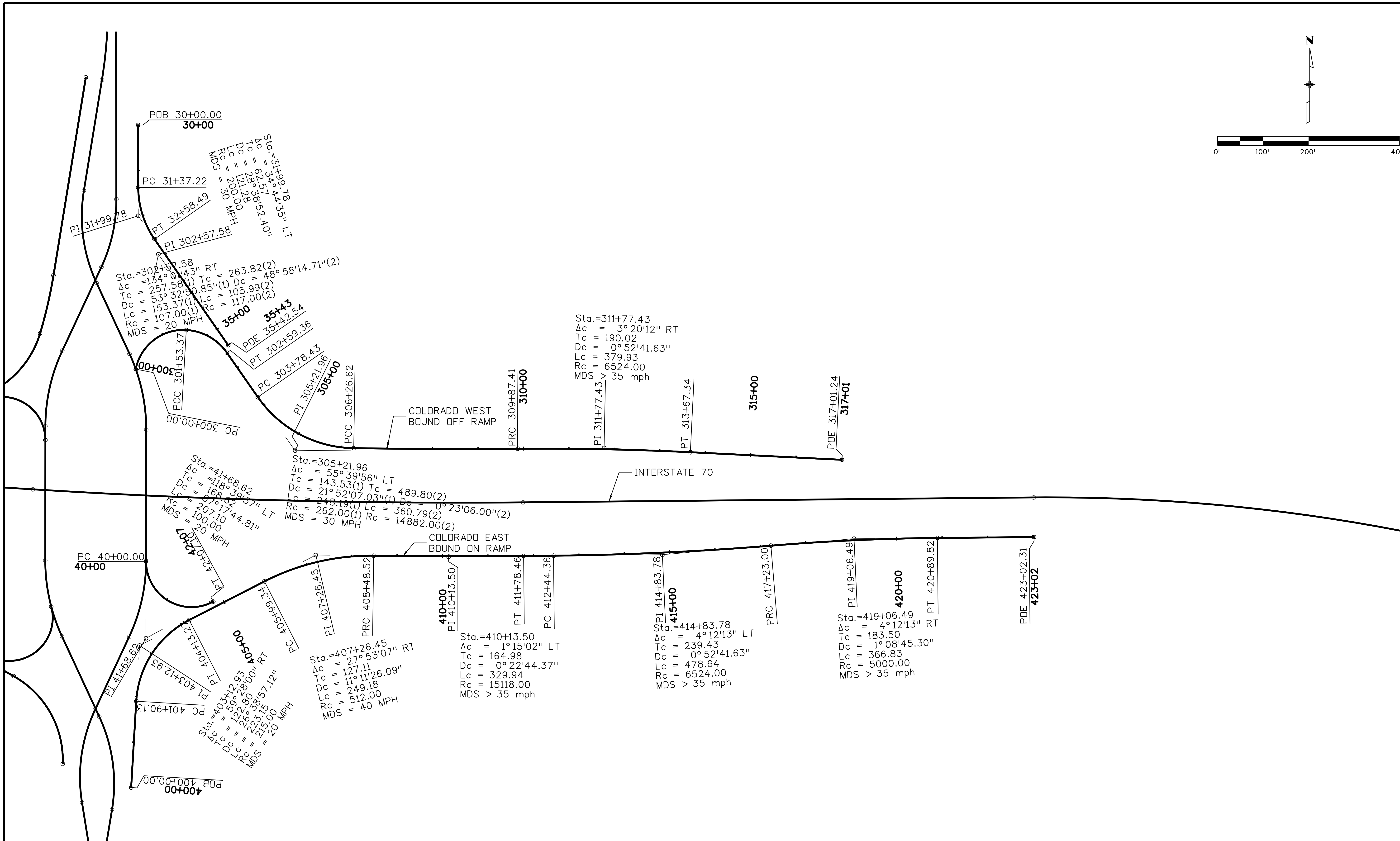

IN PROGRESS - NOT FOR FINAL ESTIMATE

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Horiz. Scale: 1:200.588	Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation

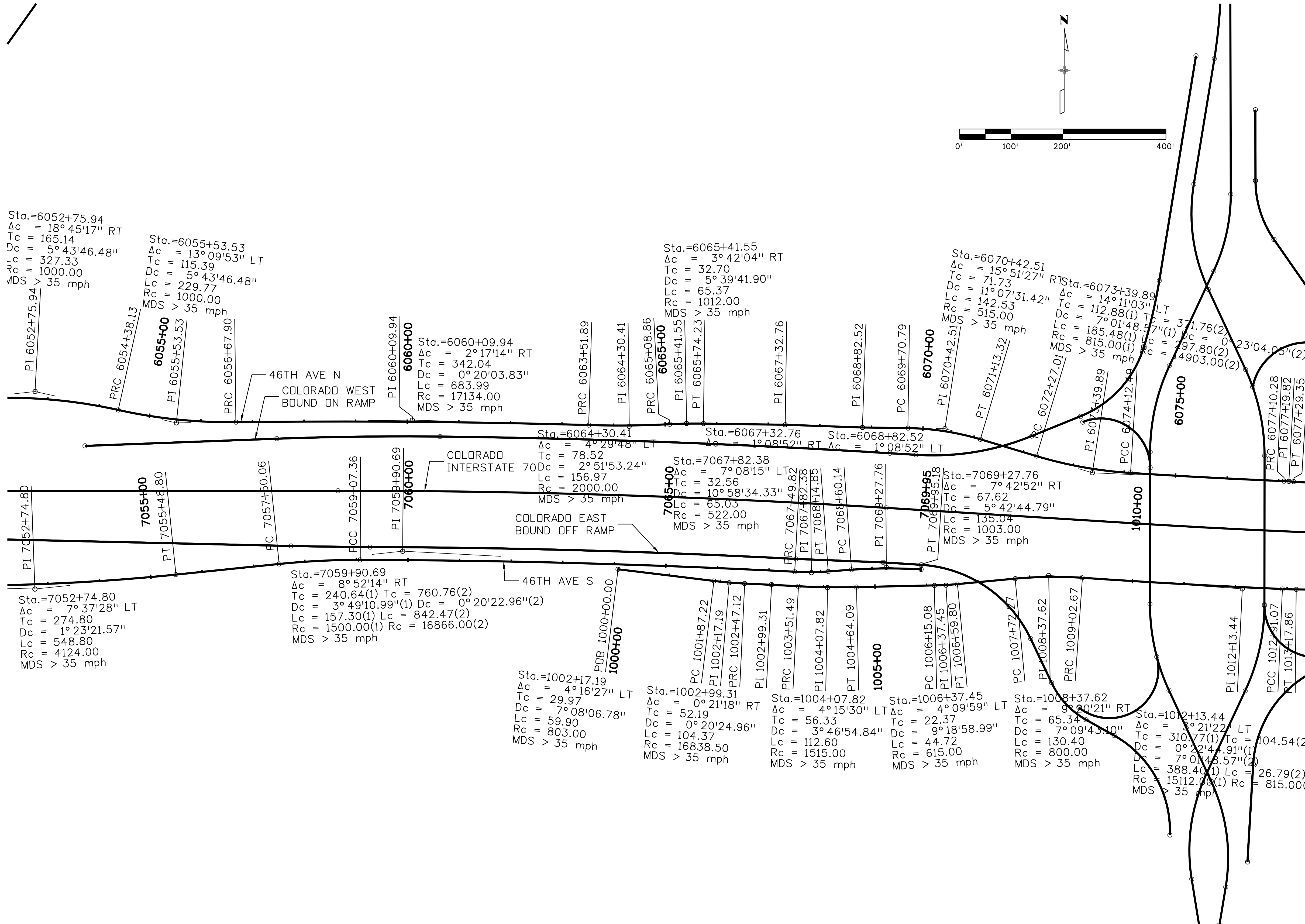
CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 2.2
COLORADO DDI
ALIGNMENT DATA

Designer:	DH	Structure Numbers	.
Detailer:	BJS		.
Sheet Subset:	.	Subset Sheets:	3 of 5

COLORADO WEST BOUND OFF RAMP



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Horiz. Scale: 1:200.588	Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation

CDOT CO Region 1

COLORADO HPTE

I-70 EAST ATC 2.2
COLORADO DDI
ALIGNMENT DATA

Designer:	DH	Structure Numbers	.
Detailer:	BJS		.
Sheet Subset:	.	Subset Sheets:	4 of 5

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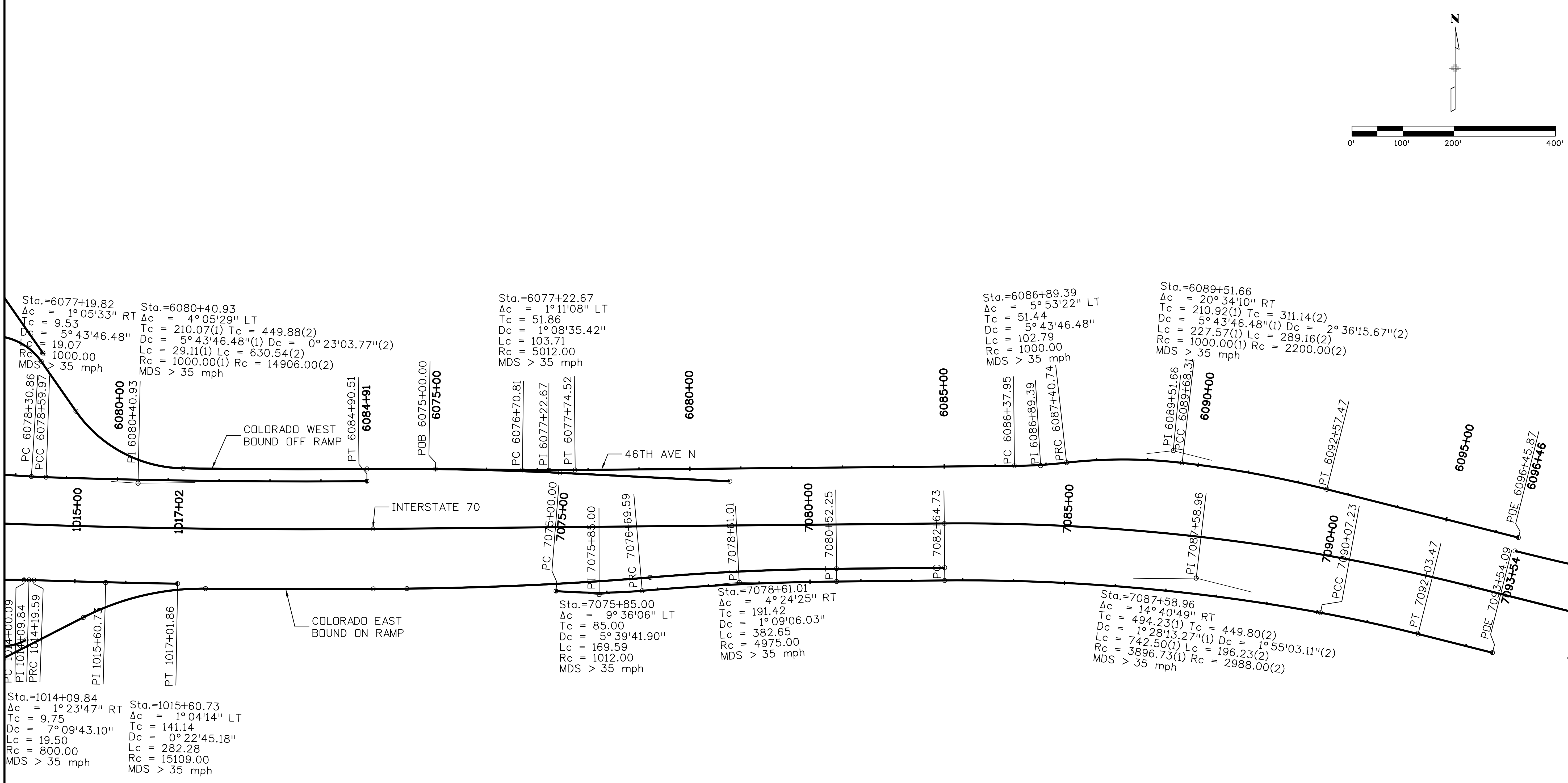

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Horiz. Scale: 1:200.588 Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation

CDOT CO Region 1

COLORADO HPTE

I-70 EAST ATC 2.1
COLORADO DDI
ALIGNMENT DATA

Designer: DH	Structure Numbers	.	
Detailer: BJS		.	
Sheet Subset: .	Subset Sheets:	5 of	5

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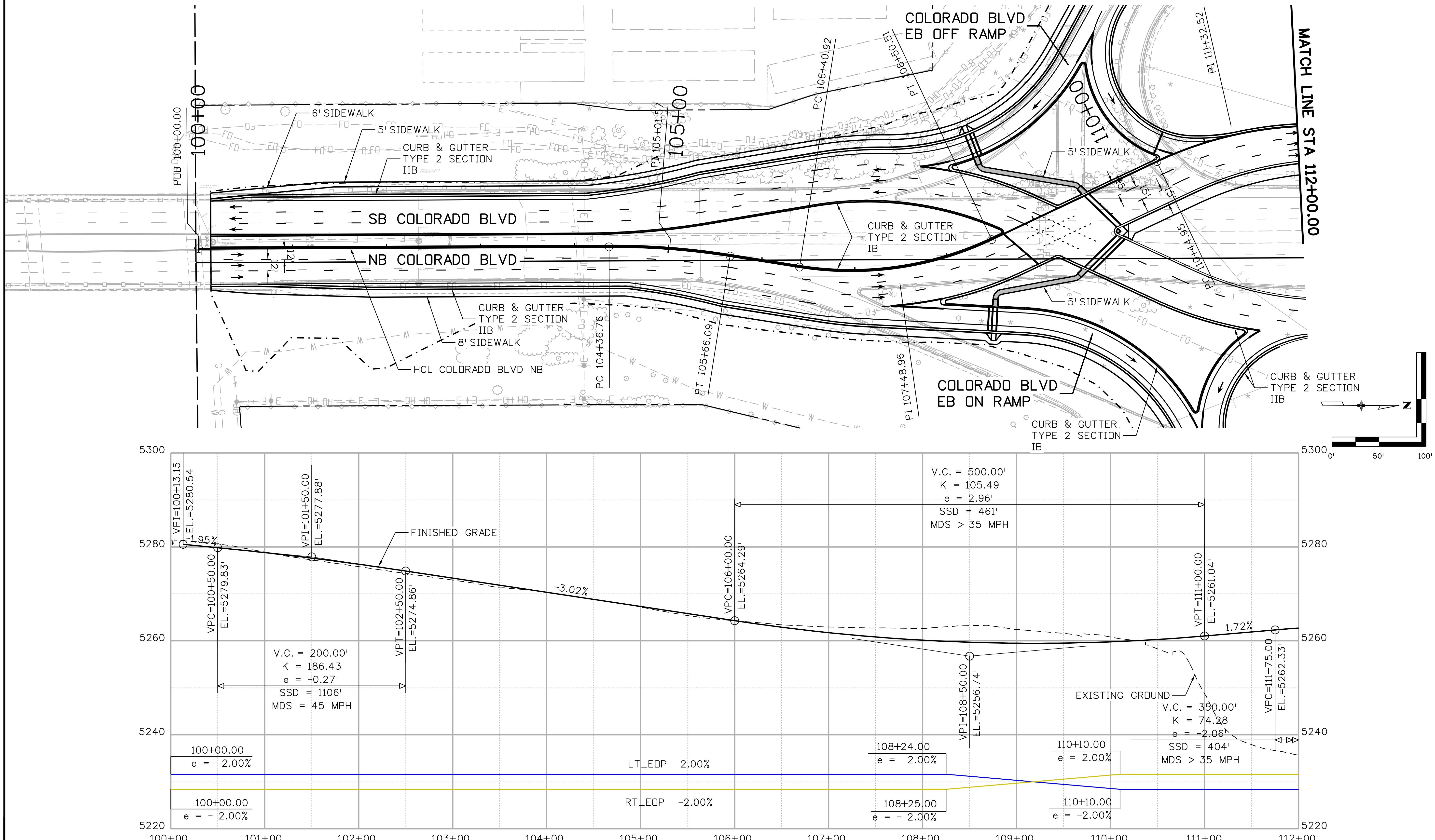

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Horiz. Scale: 1:100.294 Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

Colorado Department of Transportation
Region 1

I-70 EAST ATC 2.2
NB COLORADO BLVD
STA 100+00 TO STA 112+00

Designer:	D.HYMAS	Structure Numbers	
Detailer:	M.MARSHALL		
Sheet Subset:	ROADWAY	Subset Sheets:	1 of 20

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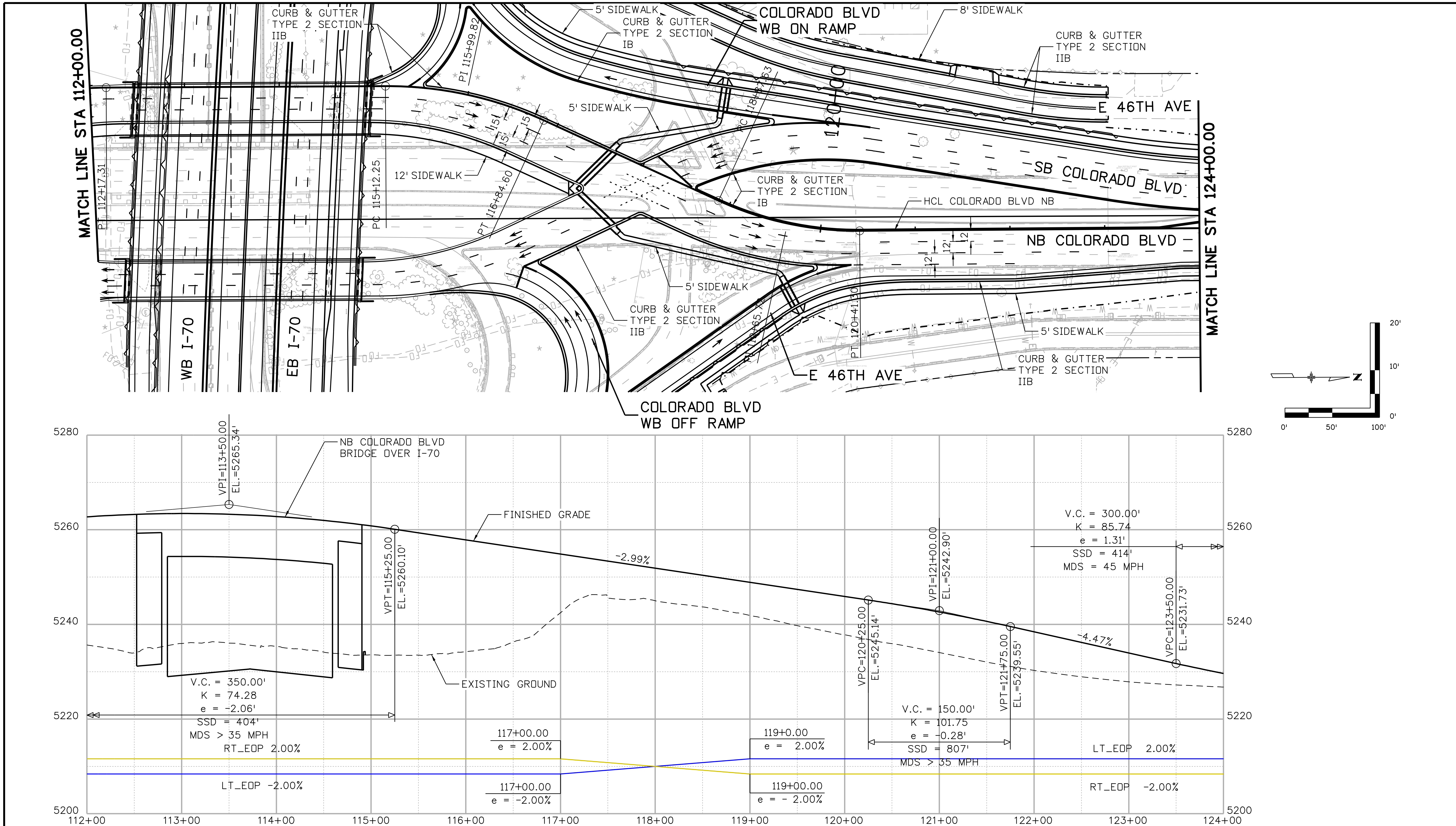

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Horiz. Scale: 1:100.294 Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation

CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 2.2
NB COLORADO BLVD
STA 112+00 TO STA 124+00

Designer:	D.HYMAS	Structure Numbers	
Detailer:	M.MARSHALL		
Sheet Subset:	ROADWAY	Subset Sheets:	2 of 20

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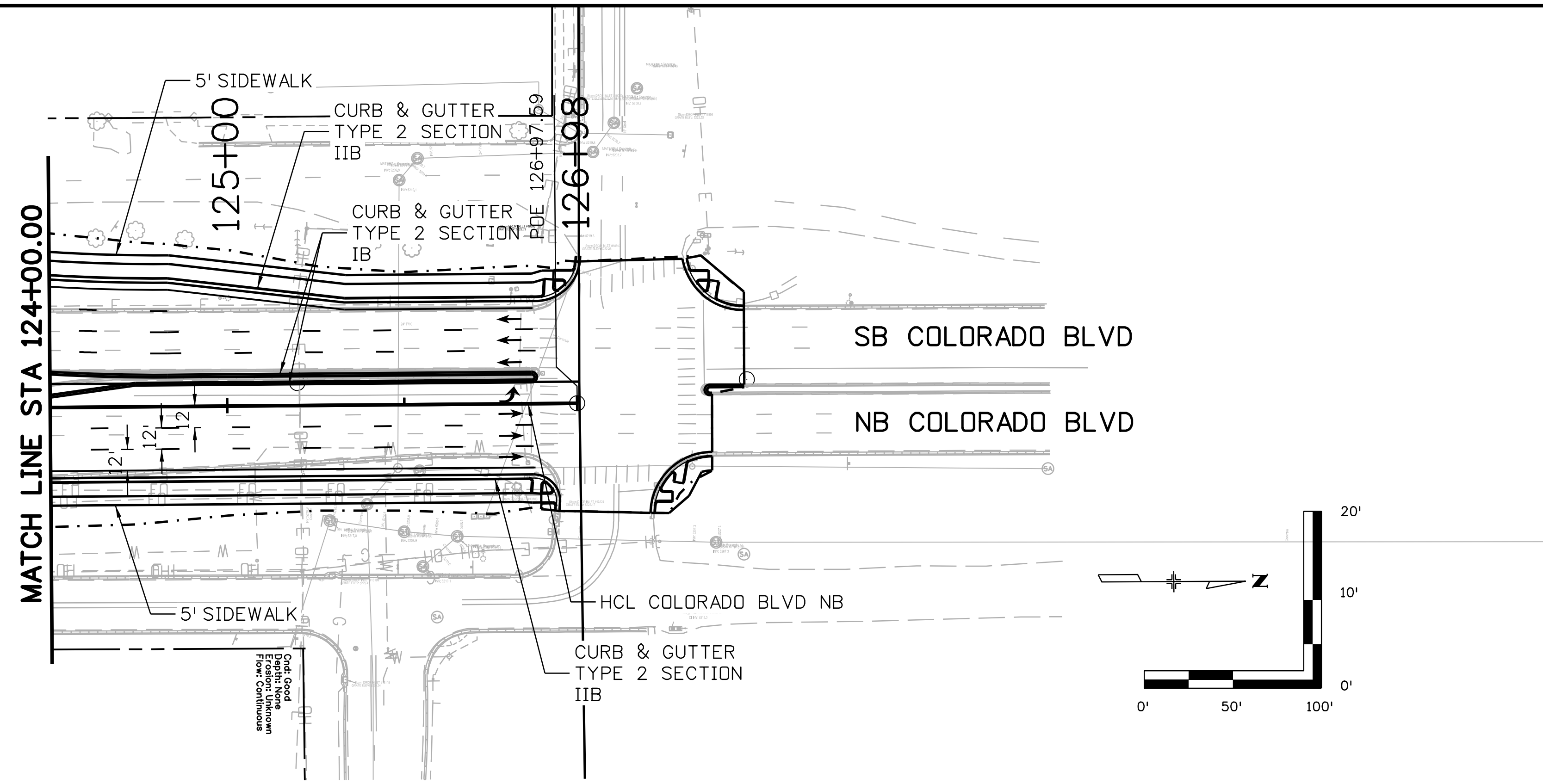

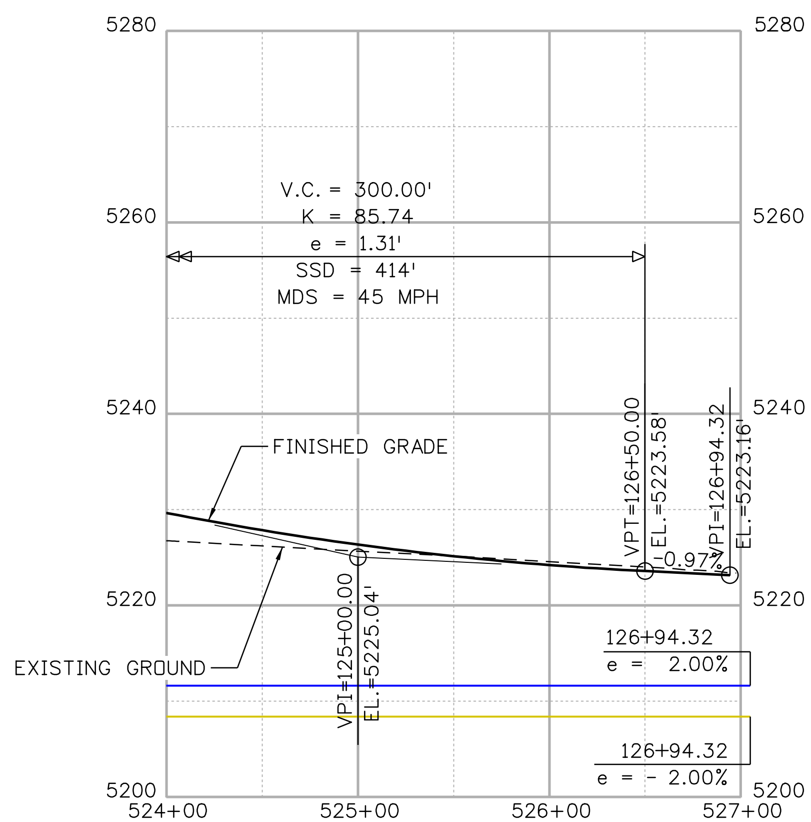

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Horiz. Scale: 1:100.294 Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation

Region 1

COLORADO HPTE

I-70 EAST ATC 2.2
NB COLORADO BLVD
STA 124+00 TO STA 126+98

Designer:	D.HYMAS	Structure Numbers	
Detailer:	M.MARSHALL		
Sheet Subset:	ROADWAY	Subset Sheets:	3 of 20

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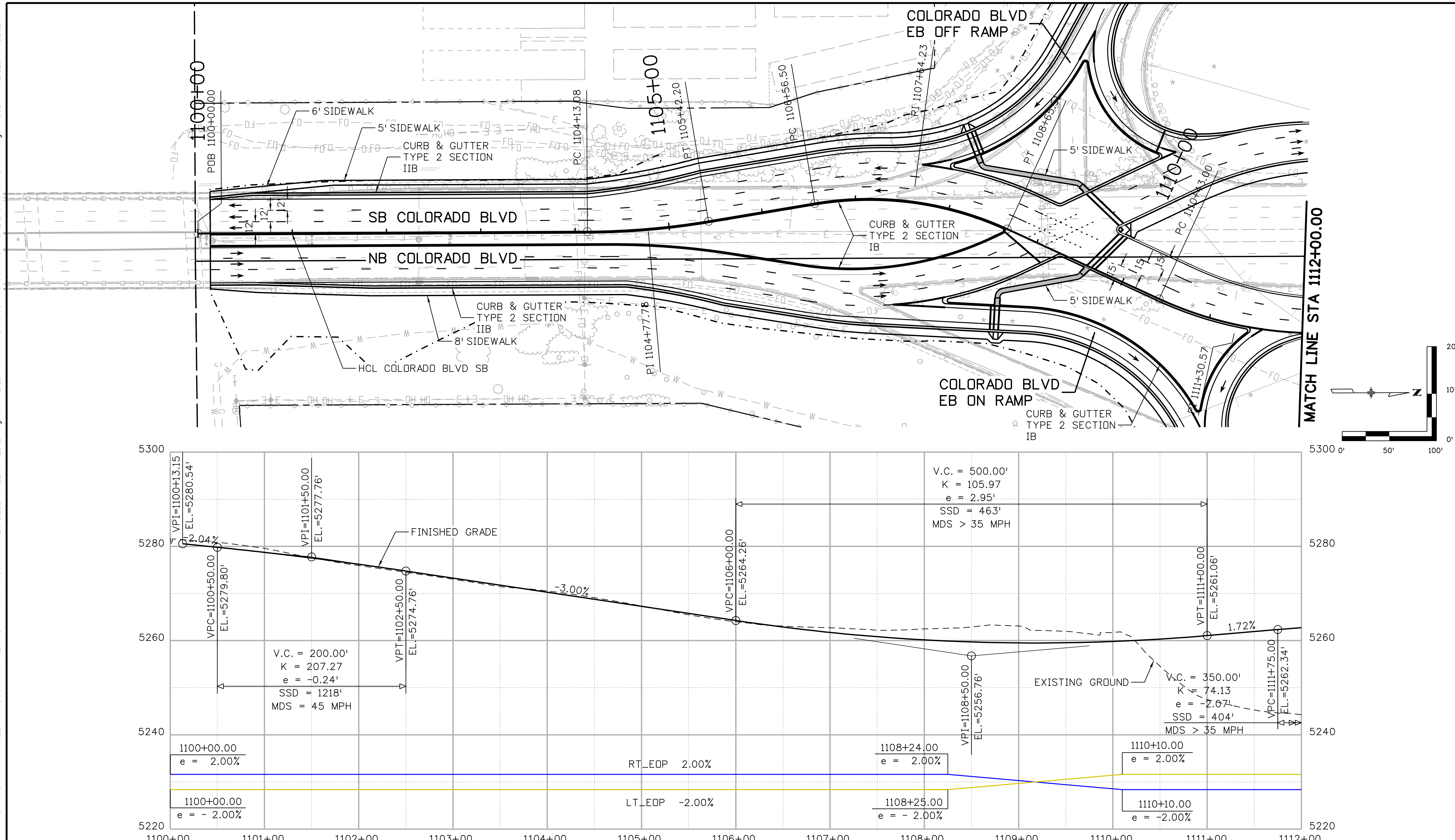

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Horiz. Scale: 1:100.294	Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors
Linking I-70 Communities

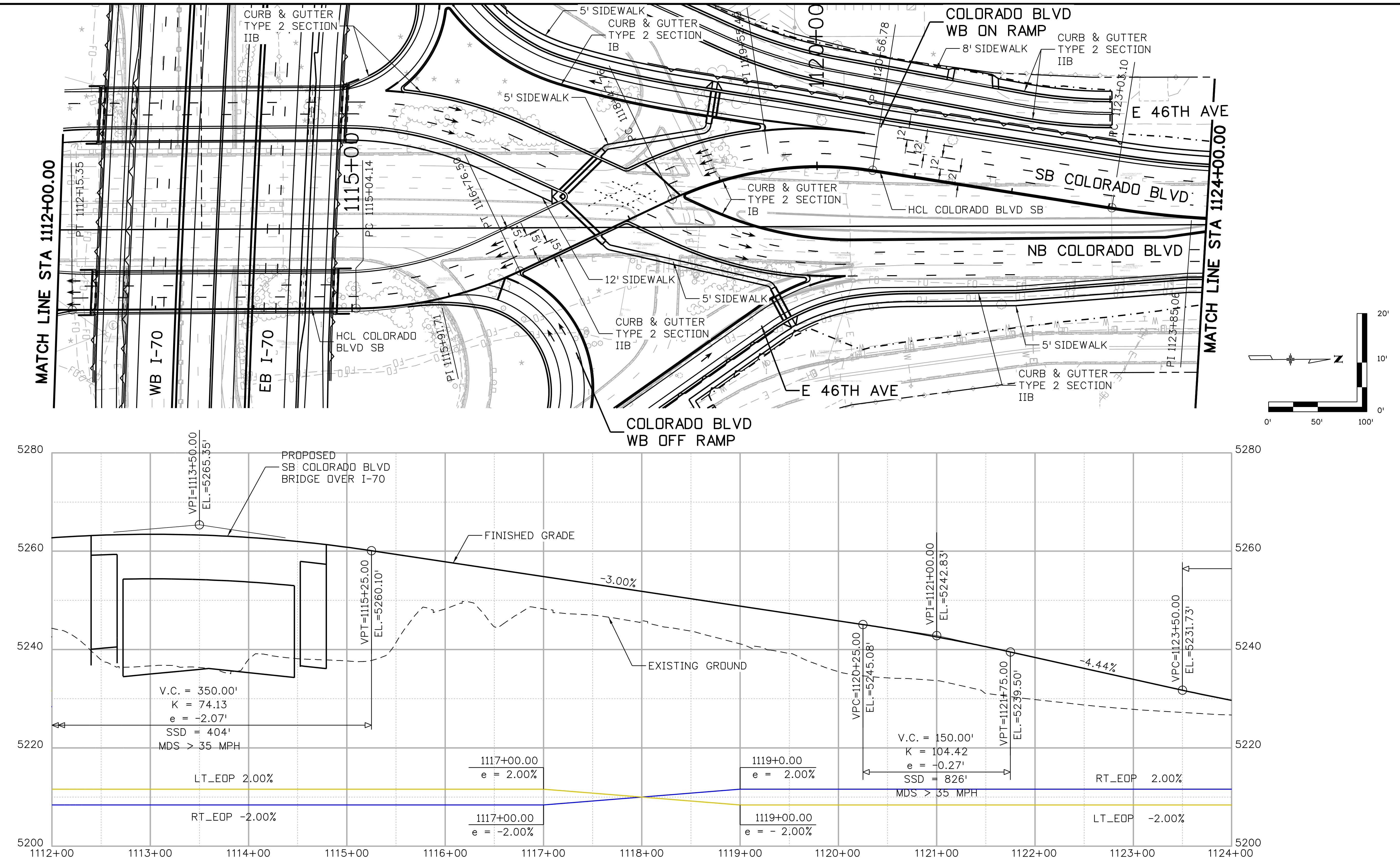
HDR

Colorado Department of Transportation
Region 1

COLORADO HPTE

I-70 EAST ATC 2.2
SB COLORADO BLVD
STA 1100+00 TO STA 1112+00

Designer:	D.HYMAS	Structure Numbers	
Detailer:	M.MARSHALL		
Sheet Subset:	ROADWAY	Subset Sheets:	4 of 20



IN PROGRESS - NOT FOR FINAL ESTIMATE

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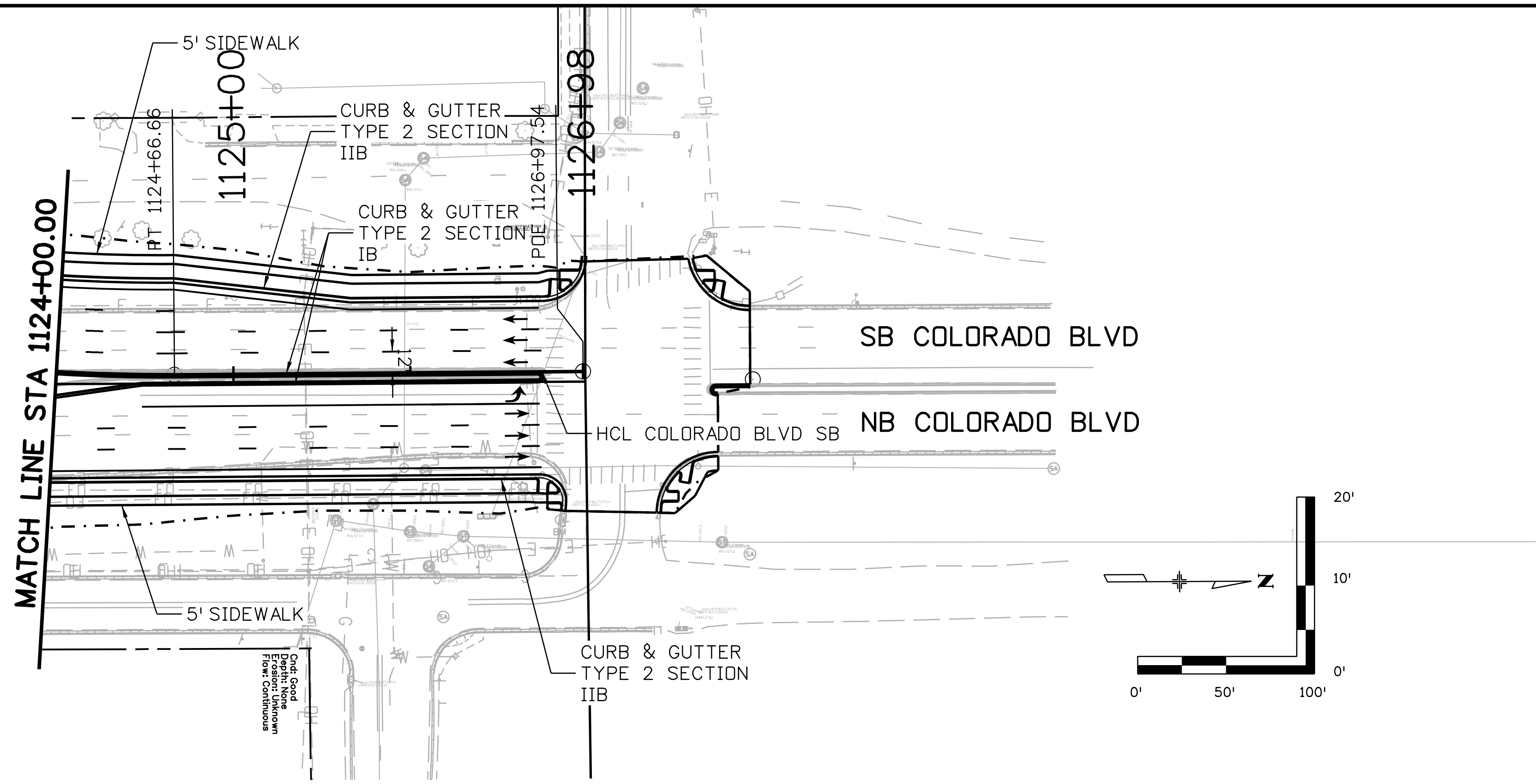
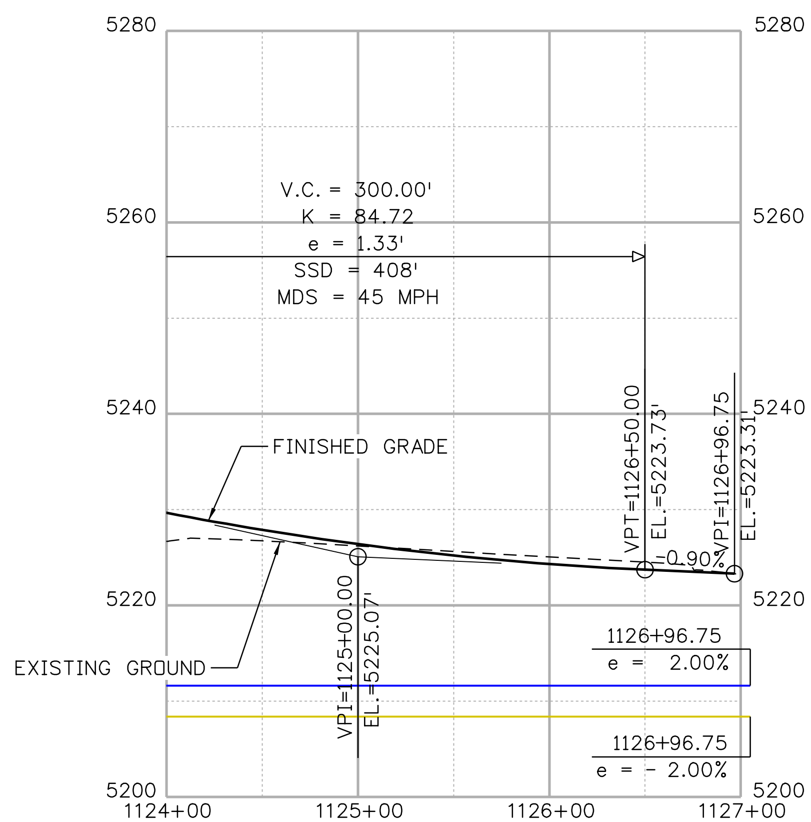
Print Date: 8/30/2016
File Name: ATC 2.1_13599DES_PnP-RD-71.dgn
Horiz. Scale: 1:100.294 Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities
HDR
Colorado Department of Transportation
Region 1
COLORADO HPTE

I-70 EAST ATC 2.2 SB COLORADO BLVD STA 1112+00 TO STA 1124+00			
Designer:	D.HYMAS	Structure Numbers	
Detailer:	M.MARSHALL		
Sheet Subset:	ROADWAY	Subset Sheets:	5 of 20





IN PROGRESS - NOT FOR FINAL ESTIMATE

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Horiz. Scale: 1:100.294	Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

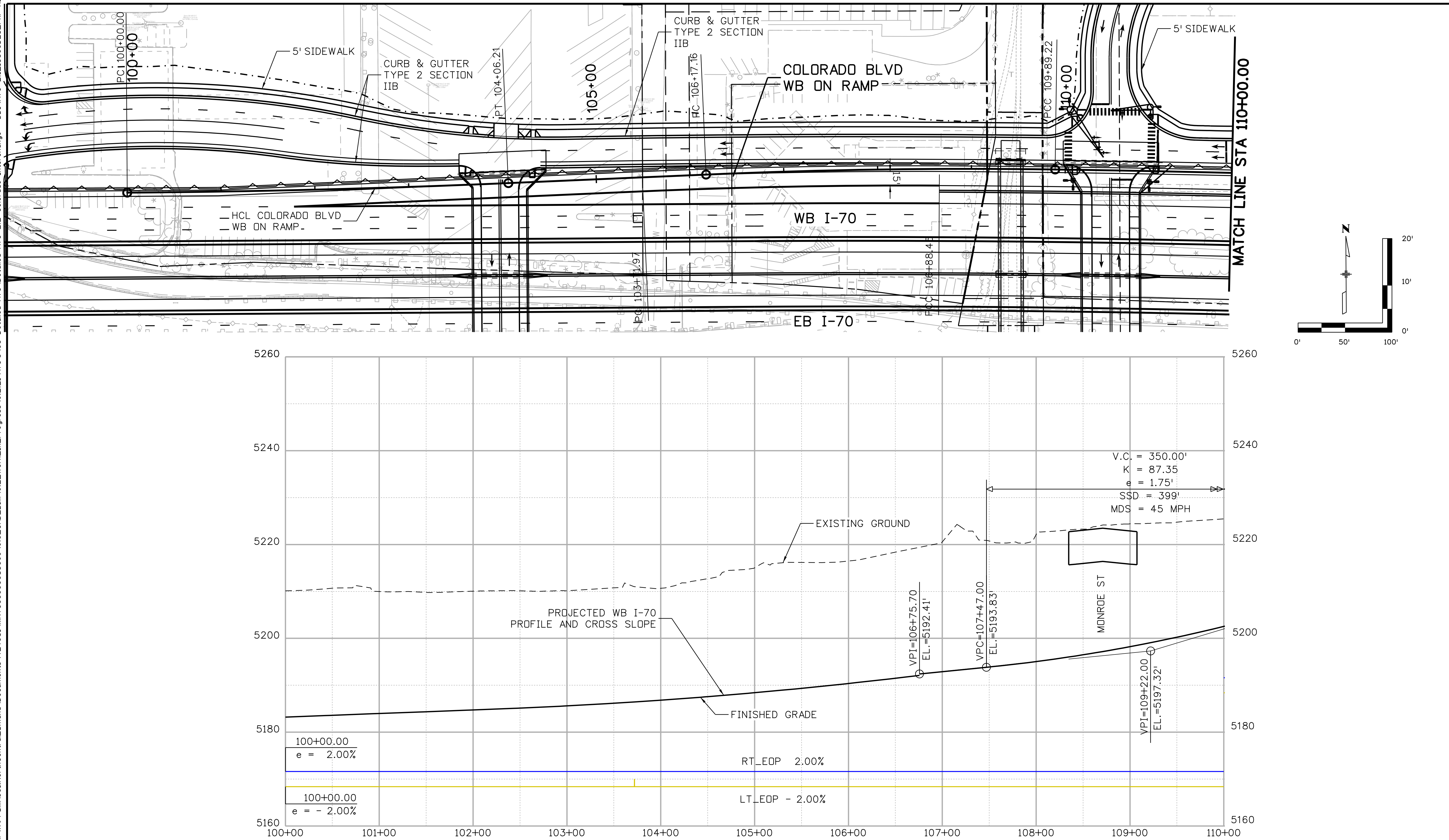
Colorado Department of Transportation

Region 1

COLORADO HPTE

I-70 EAST ATC 2.2
SB COLORADO BLVD
STA 1124+00 TO STA 1126+98

Designer:	D.HYMAS	Structure Numbers	
Detailer:	M.MARSHALL		
Sheet Subset:	ROADWAY	Subset Sheets:	6 of 20



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Print Date: 8/30/2016
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Horiz. Scale: 1:100.294 Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

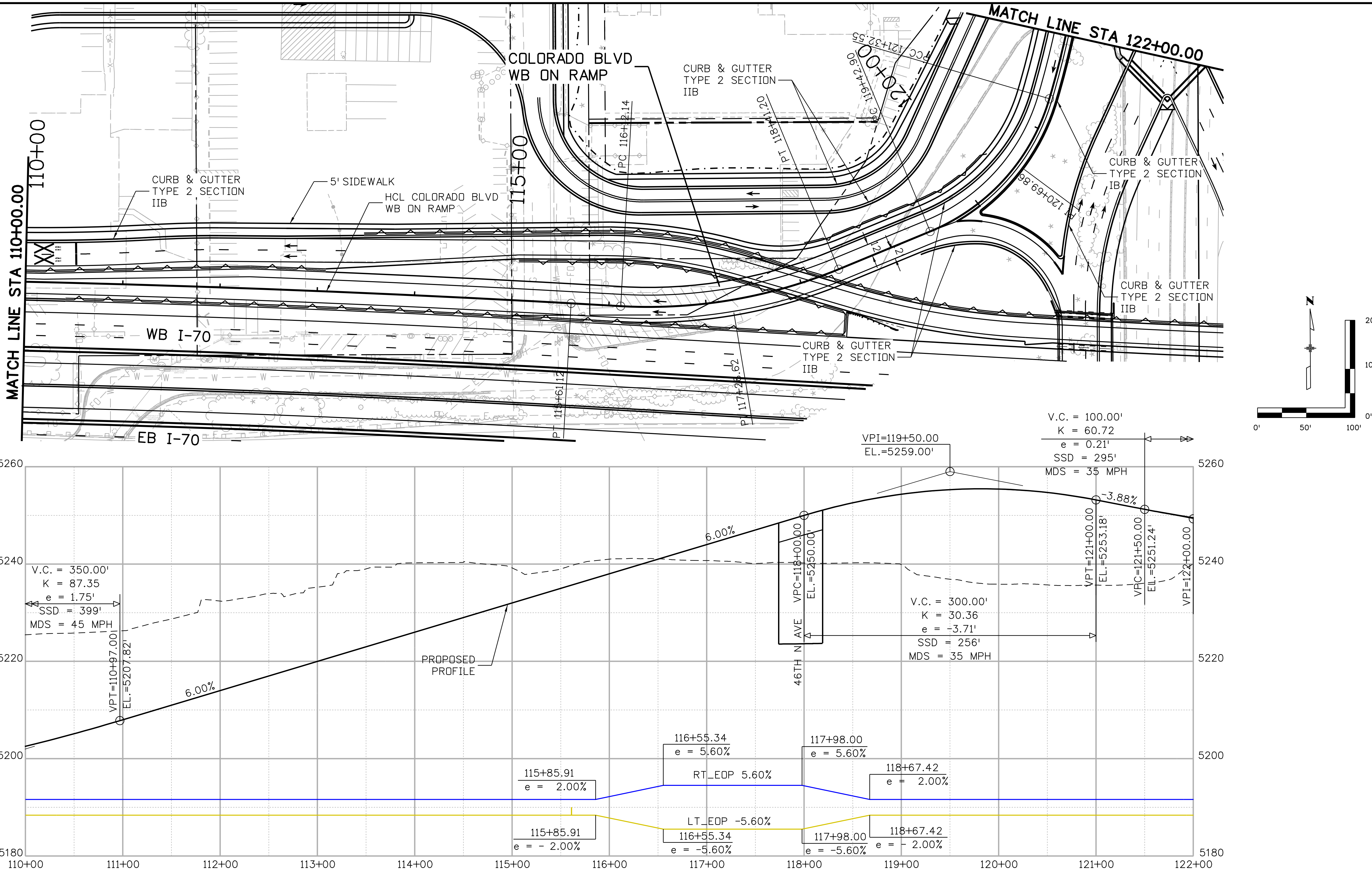
Colorado Department of Transportation
CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 2.2
COLORADO BLVD WB ON RAMP
STA 100+00 TO STA 110+00

Designer:	D.HYMAS	Structure Numbers	
Detailer:	M.MARSHALL		
Sheet Subset:	ROADWAY	Subset Sheets:	7 of 20

BSMAKA 2:29:21 PM pw:\\PWAPPOMA001:NorthCentral_Omaha\Documents\424981\MKTG00000083066\6.0_CAD_BIM\6.2_Work_In_Progress\6.2.21 ATC's\03 Detailed ATC\Detailed ATC 2.2 Colorado Interchange - DDI\ATC 2.1_13599DES_PnP-RD-74.dgn



IN PROGRESS - NOT FOR FINAL ESTIMATE

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Horiz. Scale: 1:100.294 Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

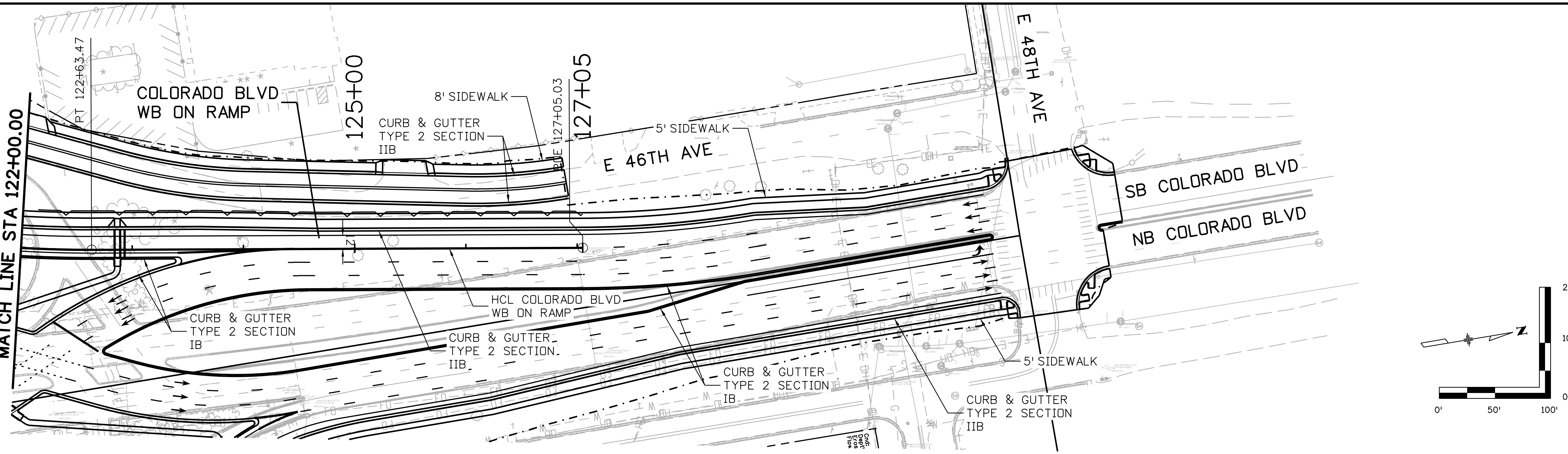
Colorado Department of Transportation

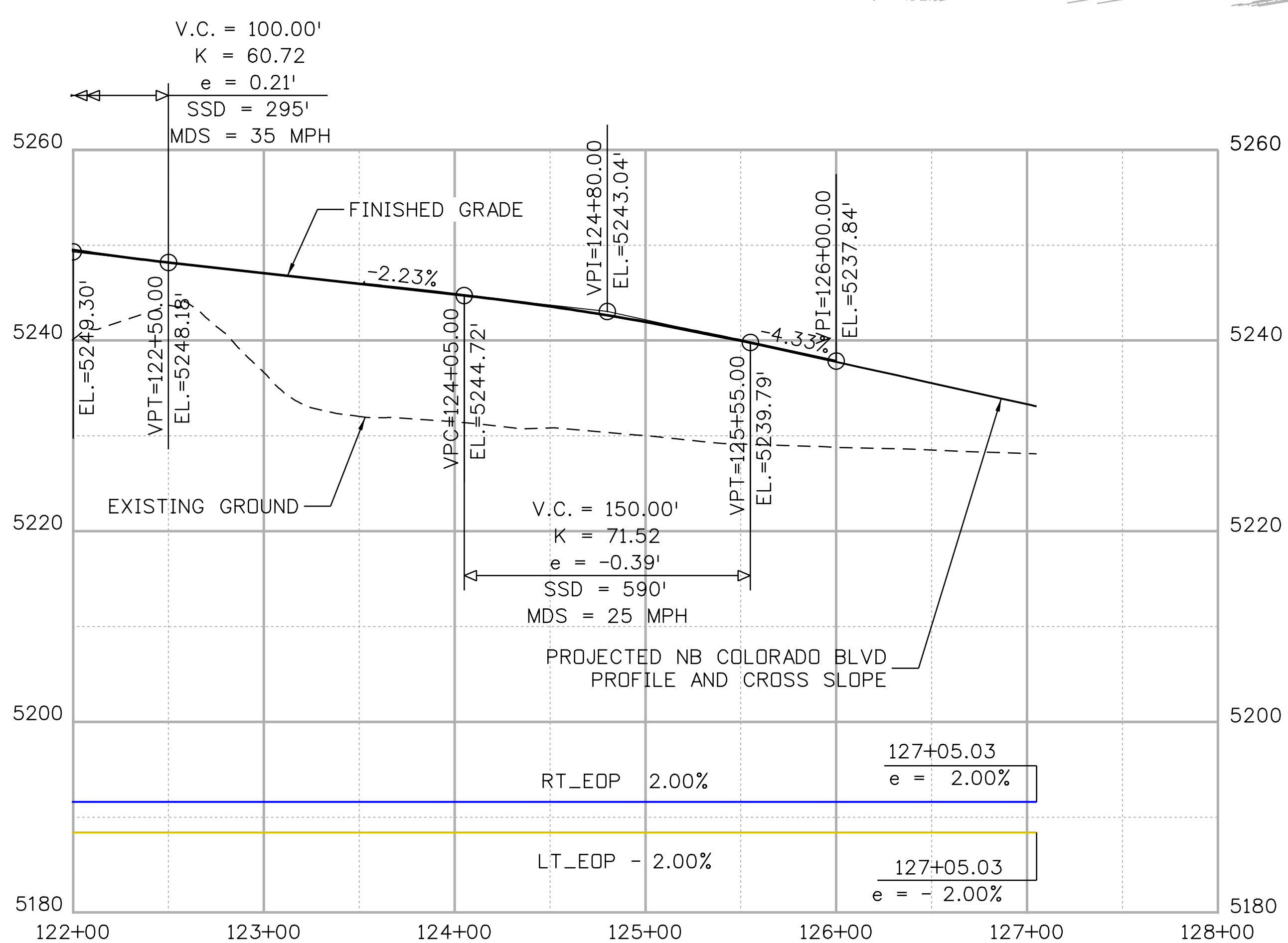
Region 1

COLORADO HPTE

I-70 EAST ATC 2.2
COLORADO BLVD WB ON RAMP
STA 112+00 TO STA 122+00.00

Designer:	D.HYMAS	Structure Numbers	
Detailer:	M.MARSHALL		
Sheet Subset:	ROADWAY	Subset Sheets:	8 of 20





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Horiz. Scale: 1:100.294 Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation
CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 2.2 COLORADO BLVD WB ON RAMP STA 122+00 TO STA 122+00.00	
Designer: D.HYMAS	Structure Numbers
Detailer: M.MARSHALL	
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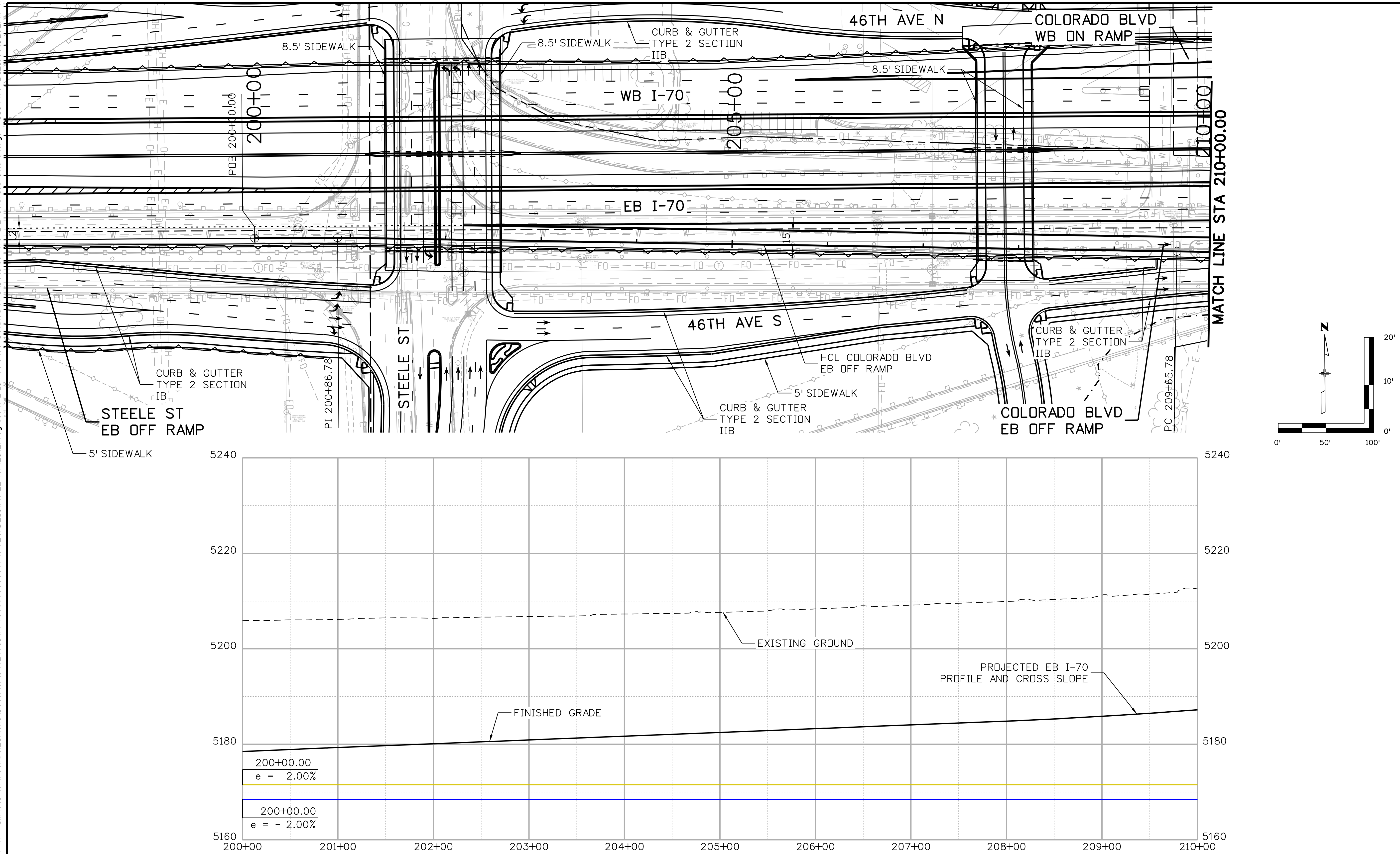

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File Name: ATC 2.1_13599DES_PnP-RD-76.dgn
Horiz. Scale: 1:100.294 Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors
Linking I-70 Communities

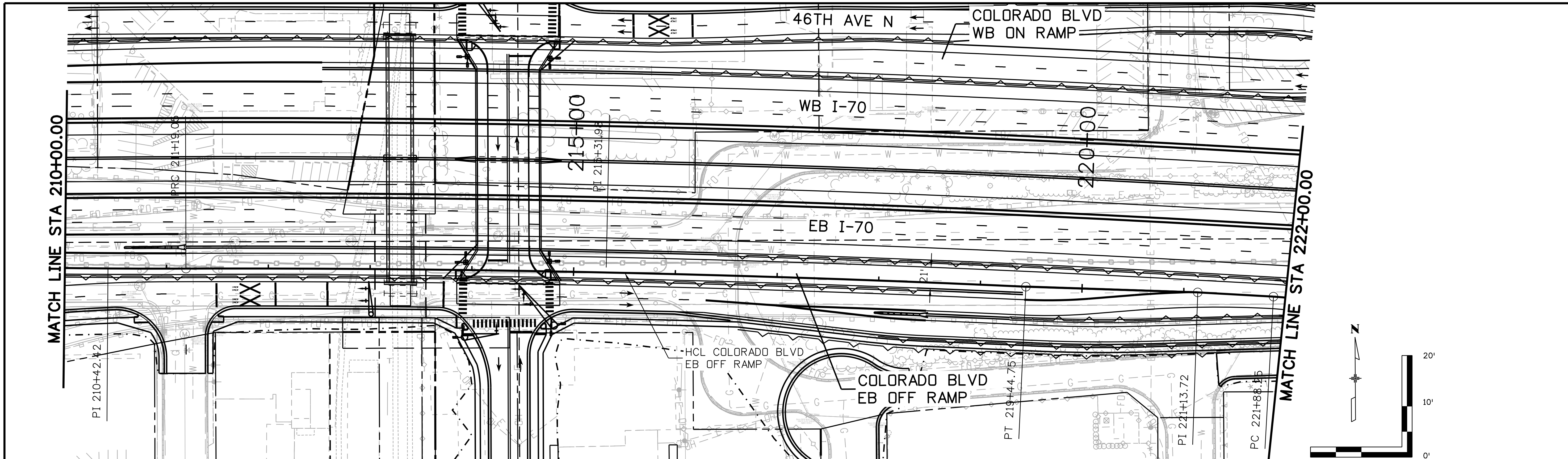
HDR

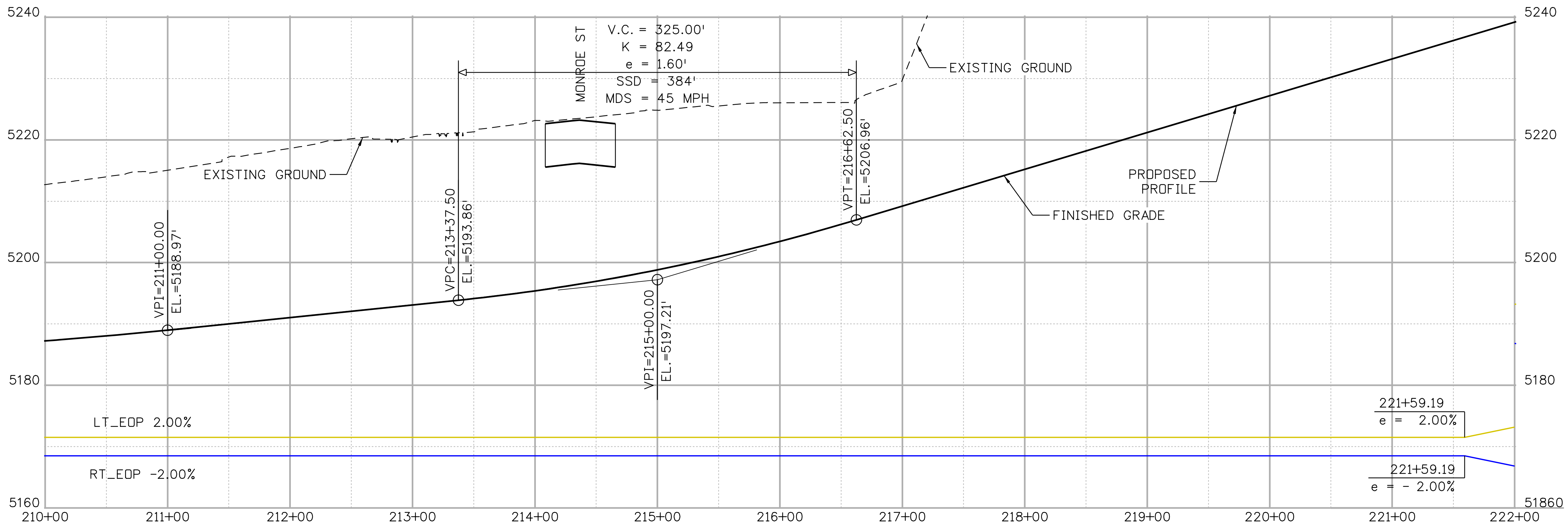
Colorado Department of Transportation
Region 1

COLORADO HPTE

I-70 EAST ATC 2.2
COLORADO BLVD EB OFF RAMP
STA 200+00 TO STA 210+00

Designer:	D.HYMAS	Structure Numbers	
Detailer:	M.MARSHALL		
Sheet Subset:	ROADWAY	Subset Sheets:	10 of 20





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Print Date: 8/30/2016
File Name: ATC 2.1_13599DES_PnP-RD-77.dgn
Horiz. Scale: 1:100.294 Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation
CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 2.2
COLORADO BLVD EB OFF RAMP
STA 210+00 TO STA 222+00

Designer:	D.HYMAS	Structure Numbers	
Detailer:	M.MARSHALL		
Sheet Subset:	ROADWAY	Subset Sheets:	11 of 20

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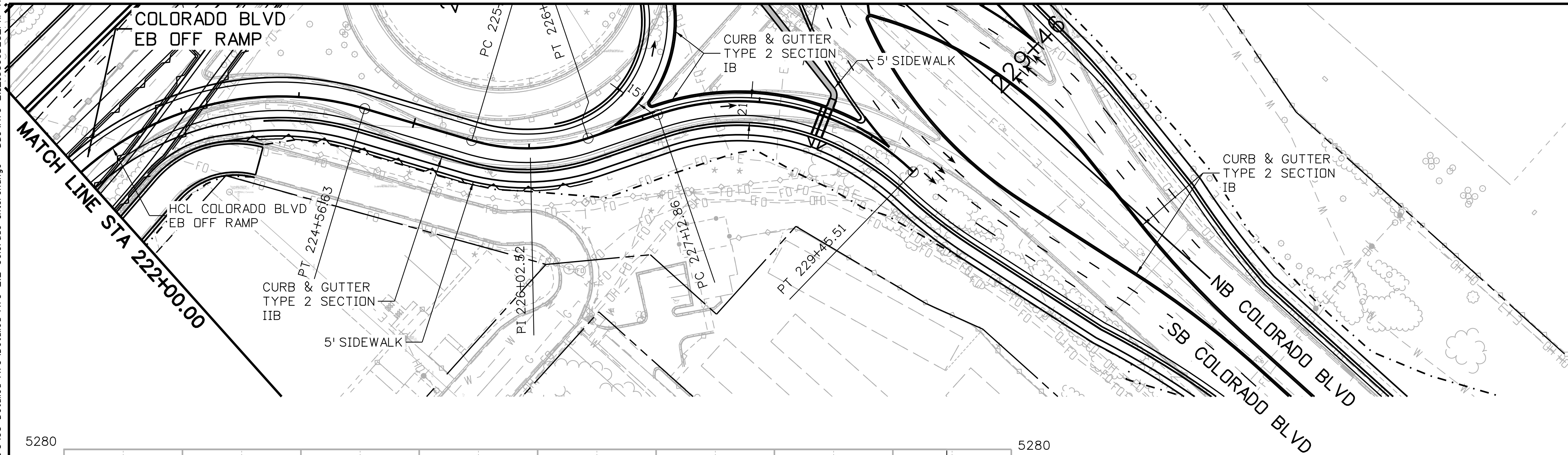

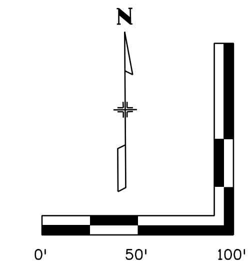

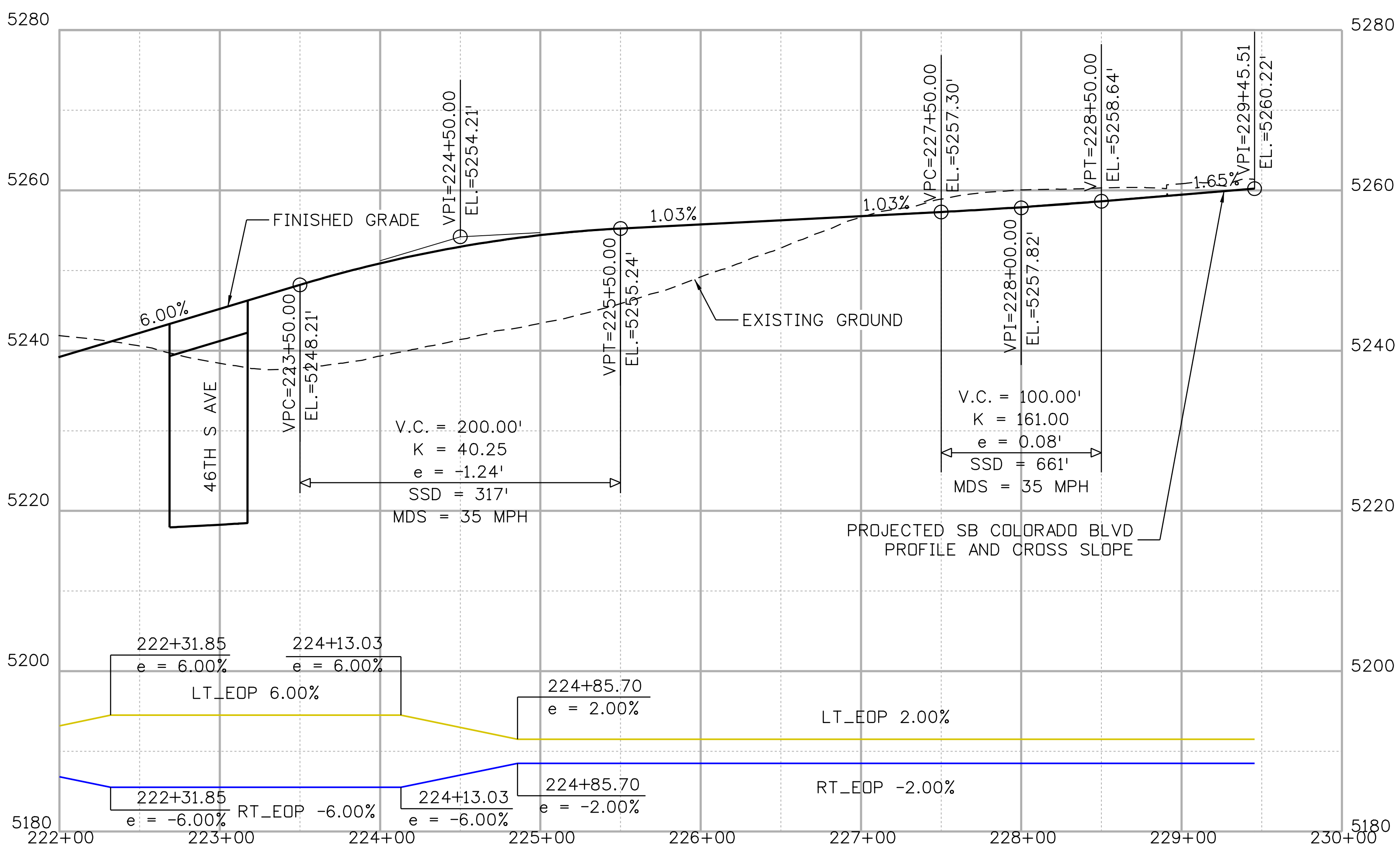

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Horiz. Scale: 1:100.294	Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation

CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 2.2
COLORADO BLVD OFF RAMP
STA 222+00 TO STA 229+45.51

Designer:	D.HYMAS	Structure Numbers	
Detailer:	M.MARSHALL		
Sheet Subset:	ROADWAY	Subset Sheets:	12 of 20

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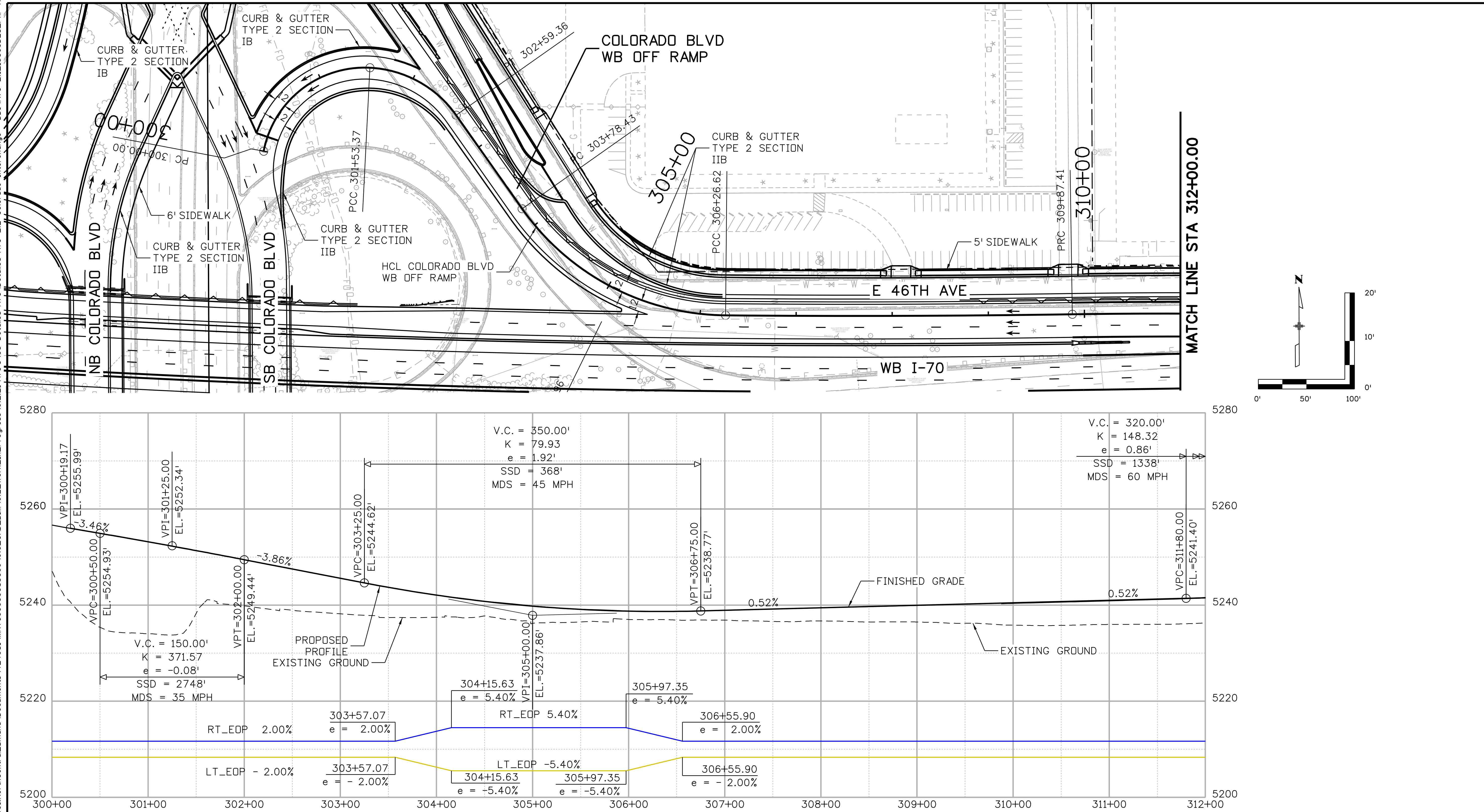

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Horiz. Scale: 1:100.294 Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

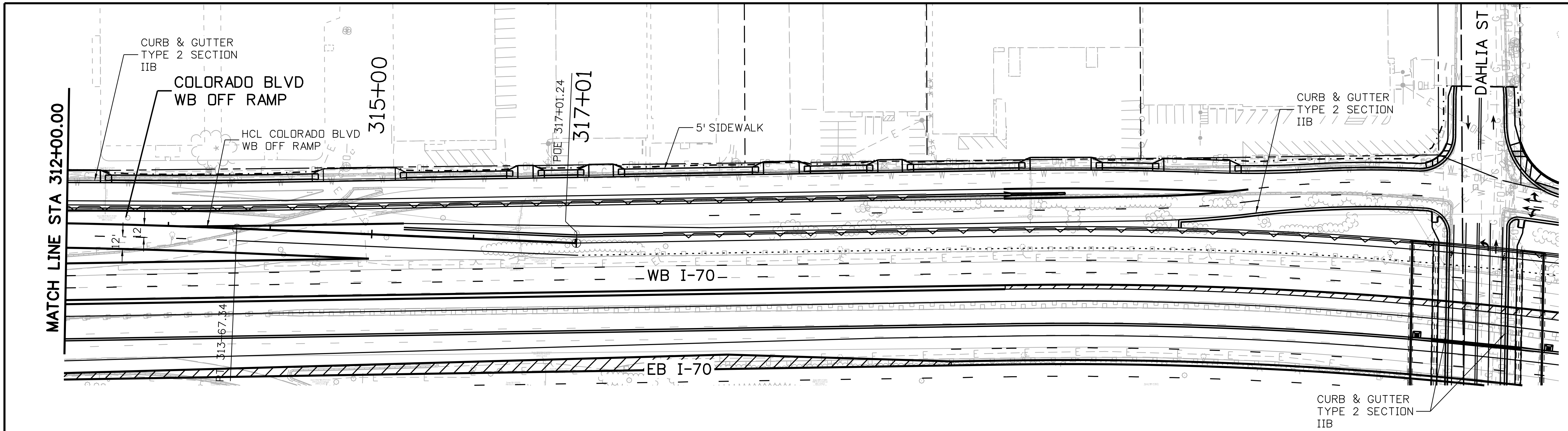
Colorado Department of Transportation

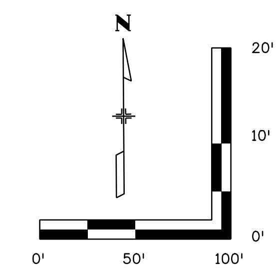
CDOT Region 1

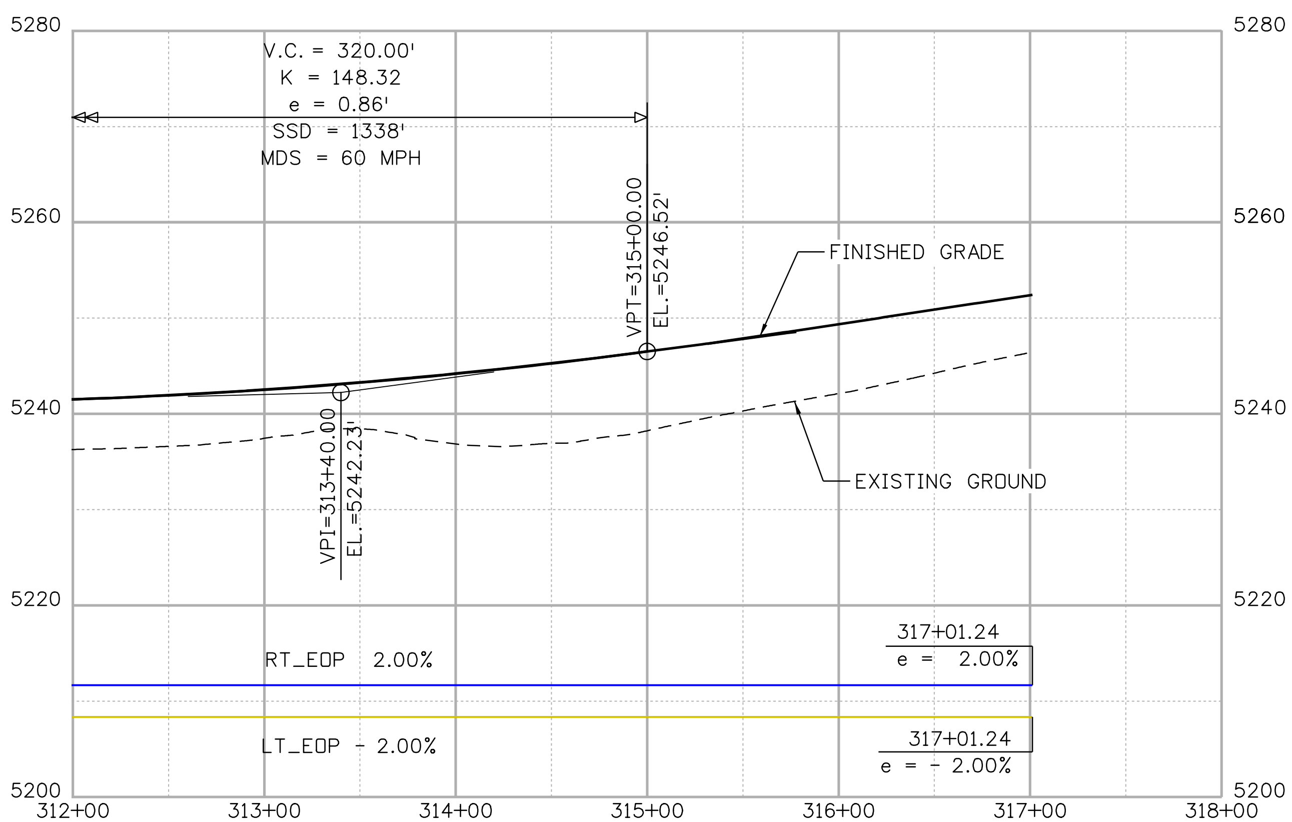
COLORADO HPTE

I-70 EAST ATC 2.2
COLORADO BLVD WB OFF RAMP
STA 300+00 TO STA 312+00

Designer:	D.HYMAS	Structure Numbers	
Detailer:	M.MARSHALL		
Sheet Subset:	ROADWAY	Subset Sheets:	13 of 20







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Print Date: 8/30/2016
File Name: ATC 2.1_13599DES_PnP-RD-80.dgn
Horiz. Scale: 1:100.294 Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation
CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 2.2
COLORADO BLVD WB OFF RAMP
STA 312+00 TO STA 316+22.46

Designer:	D.HYMAS	Structure Numbers	
Detailer:	M.MARSHALL		
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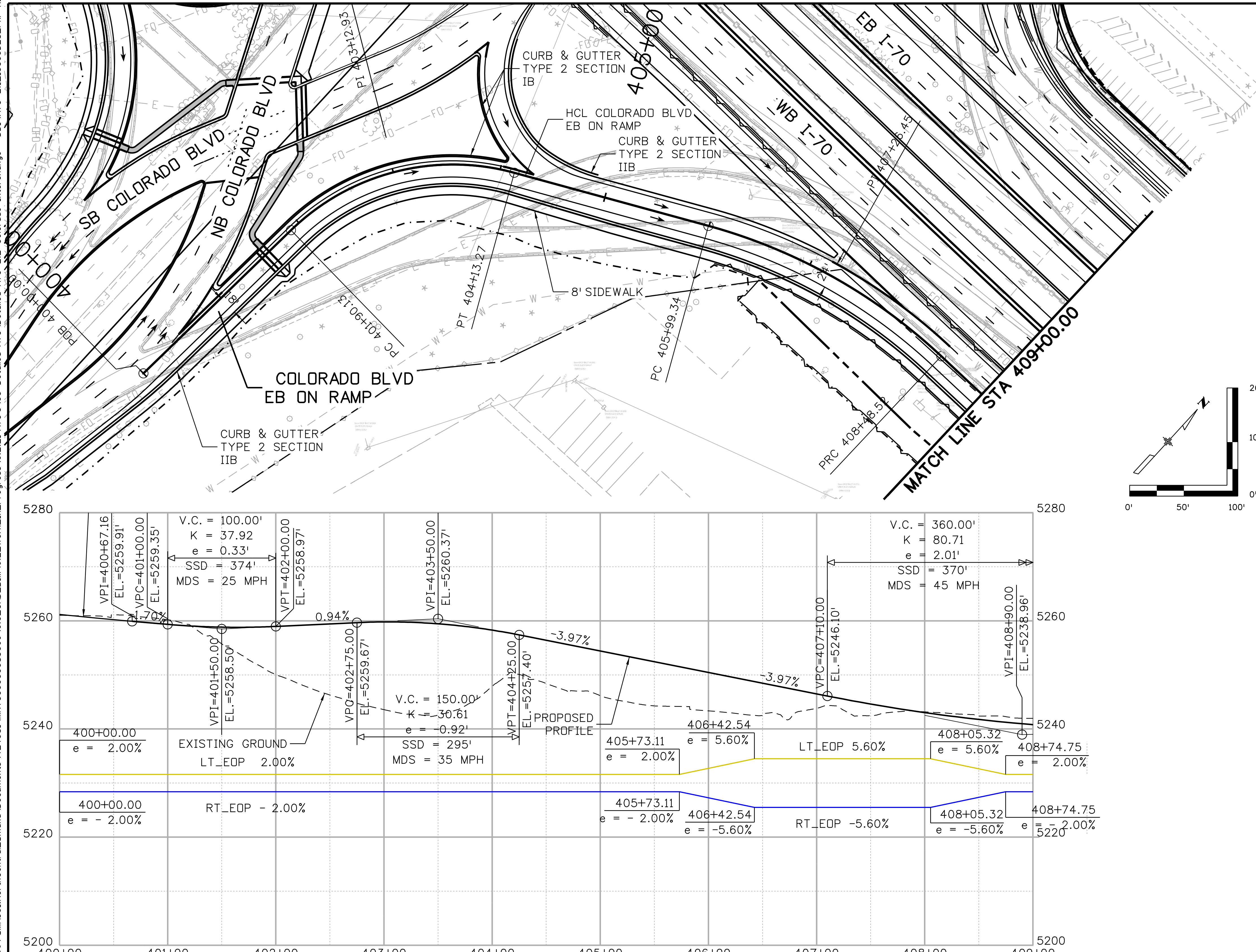

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Print Date: 8/30/2016	
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Horiz. Scale: 1:100.294	Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation

CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 2.2
COLORADO BLVD EB ON RAMP
STA 400+00 TO STA 412+17.47

Designer:	D.HYMAS	Structure Numbers	
Detailer:	M.MARSHALL		
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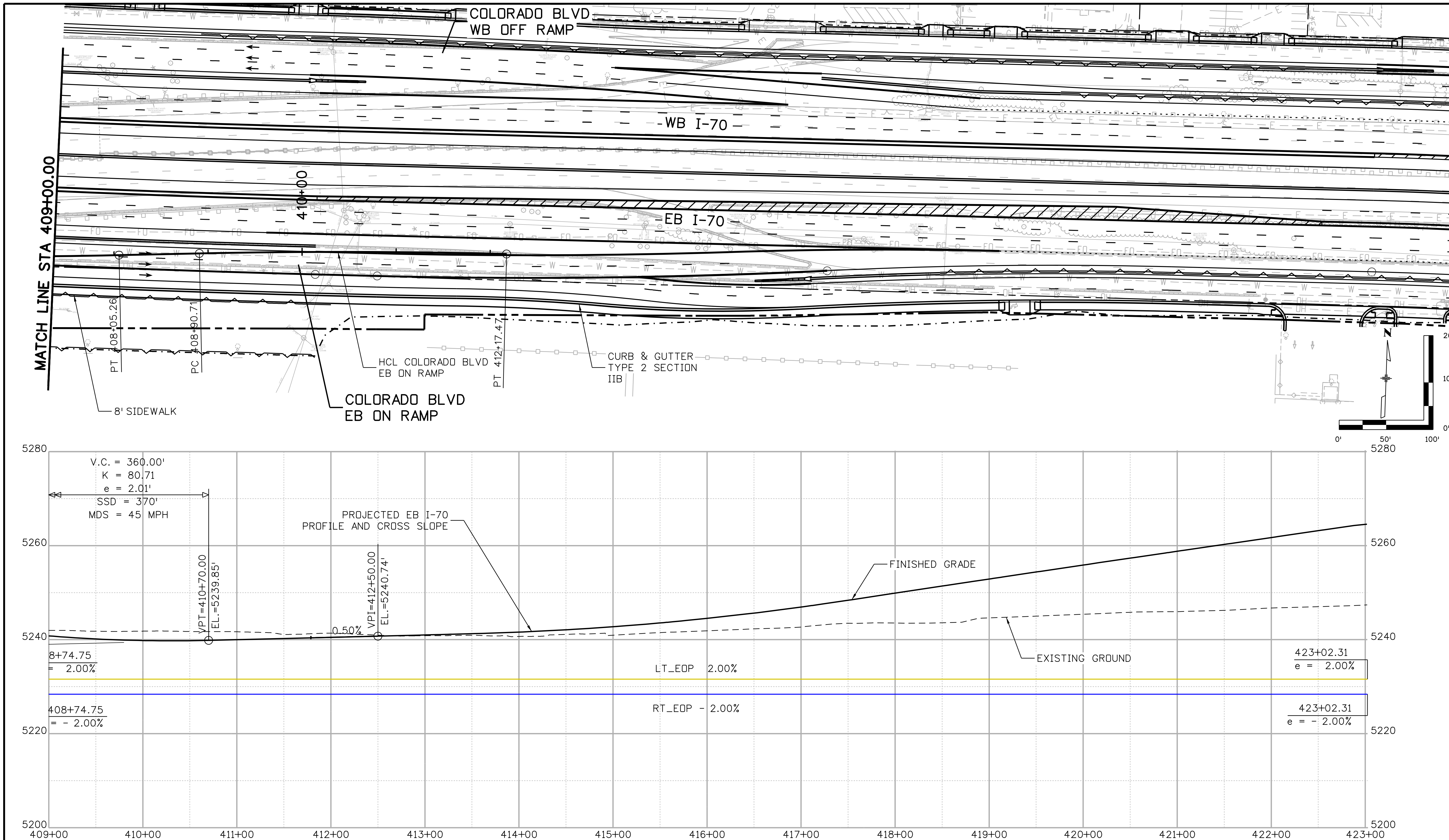

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EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation
Region 1

COLORADO HPTE

I-70 EAST ATC 2.2
COLORADO BLVD EB ON RAMP
STA 409+00 TO END

Designer:	D.HYMAS	Structure Numbers	
Detailer:	M.MARSHALL		
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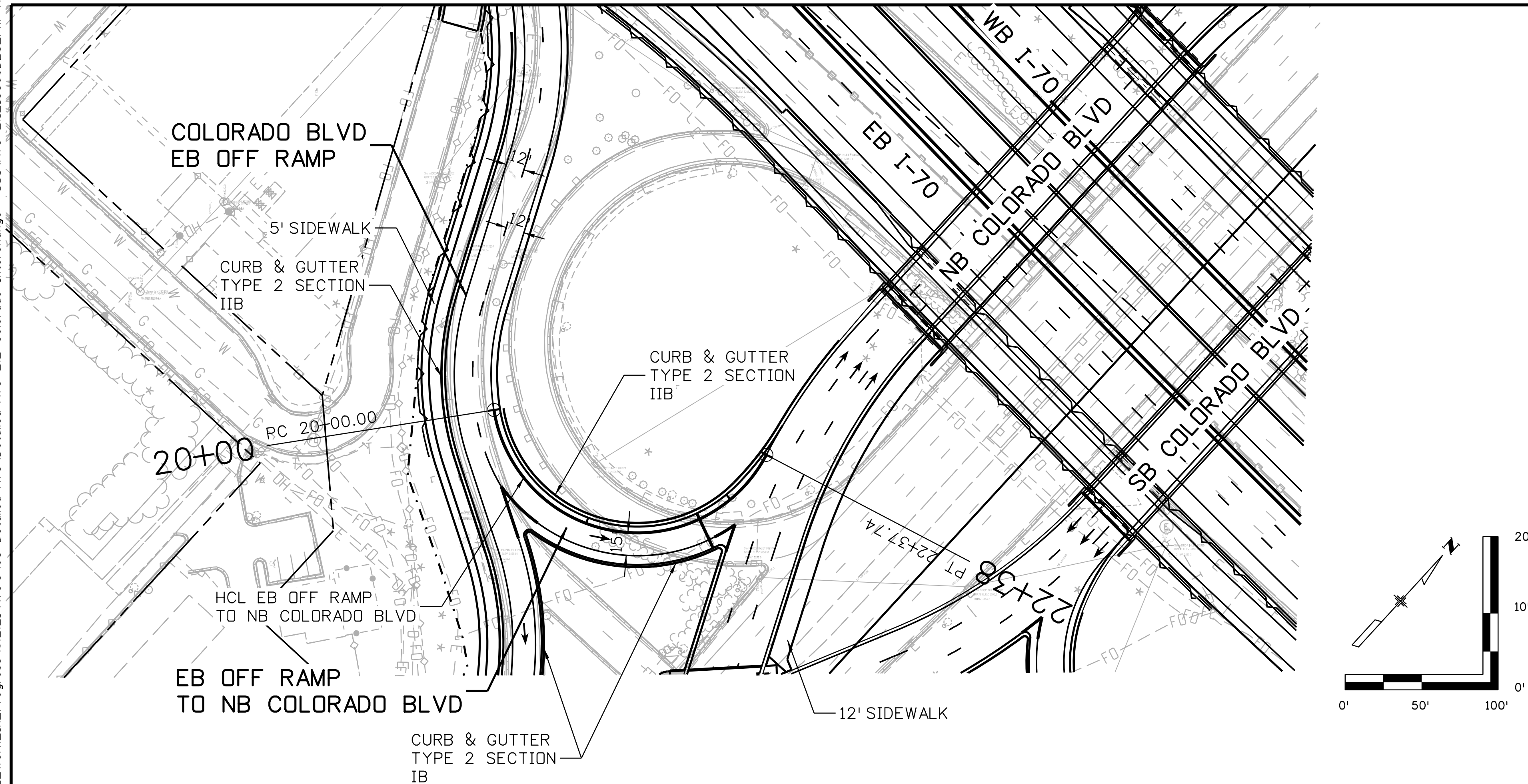

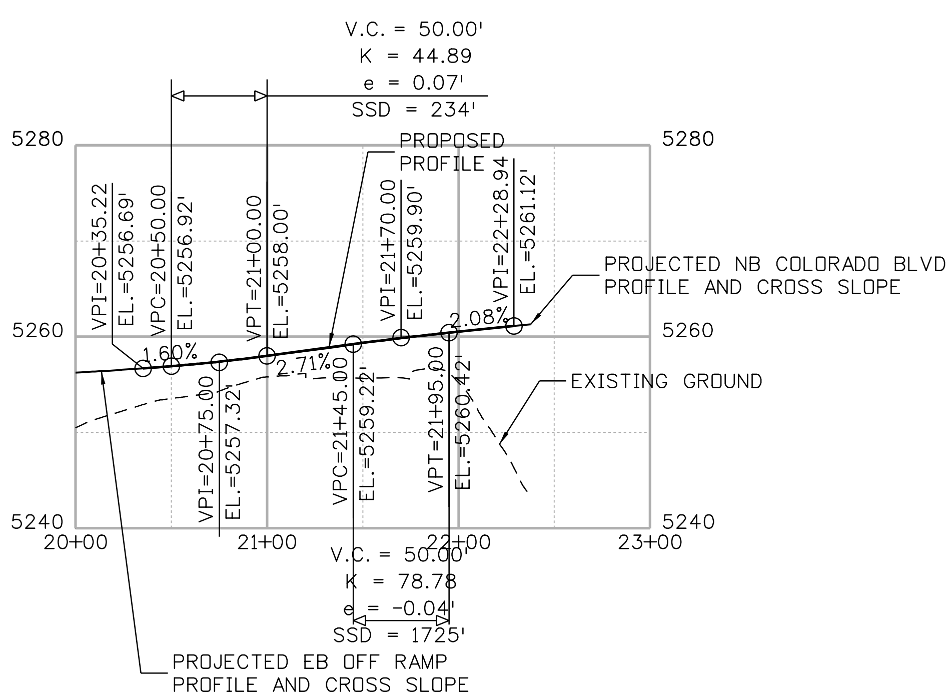

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File Name: ATC 2.1_13599DES_PnP-RD-83.dgn	
Horiz. Scale: 1:100.294	Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation

Region 1

COLORADO HPTE

I-70 EAST ATC 2.2
EB OFF RAMP TO NB COLORADO
STA 400+00 TO STA 412+17.47

Designer:	D.HYMAS	Structure Numbers	
Detailer:	M.MARSHALL		
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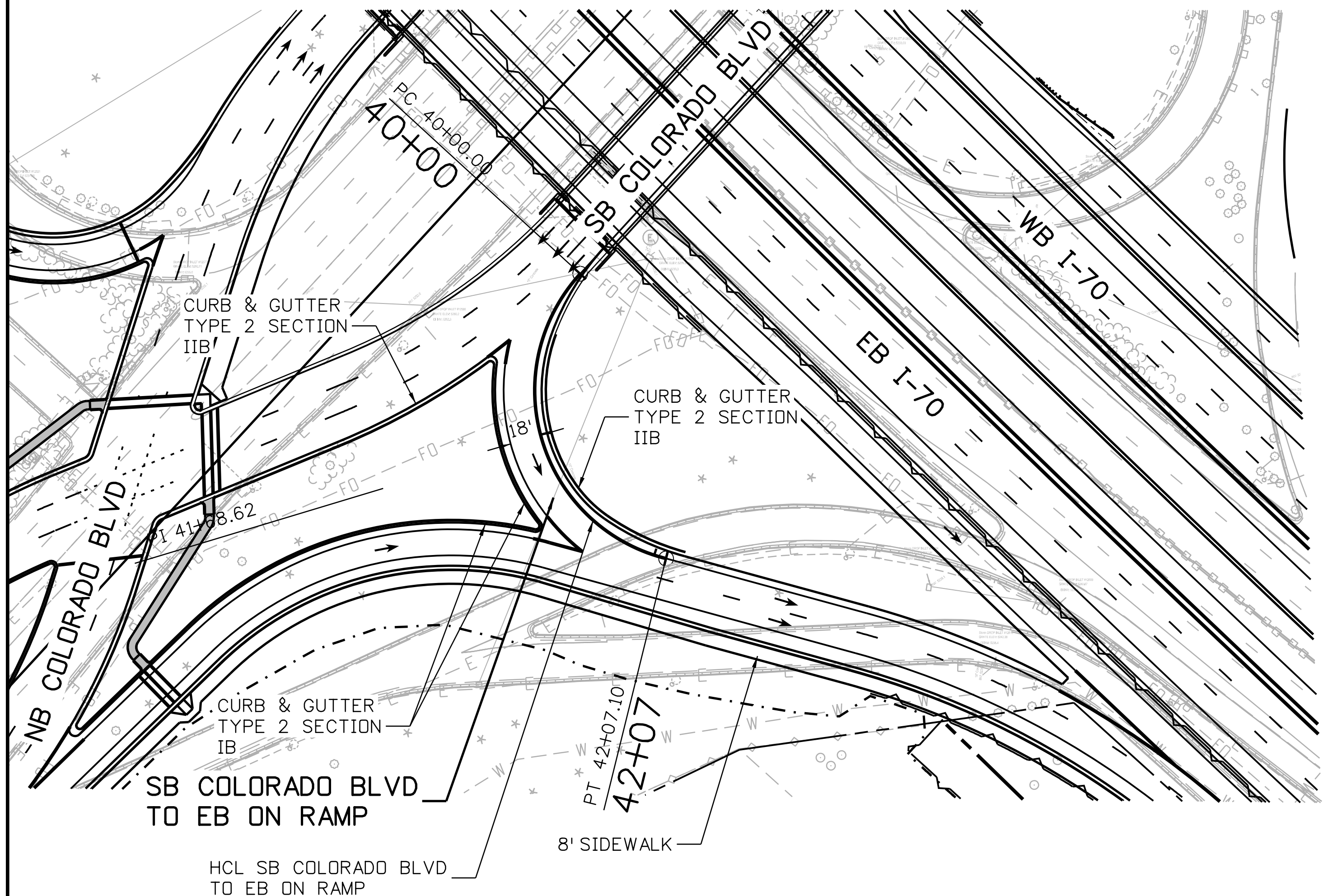

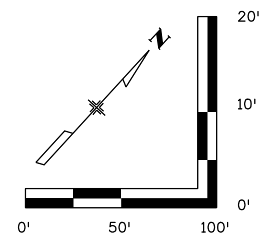

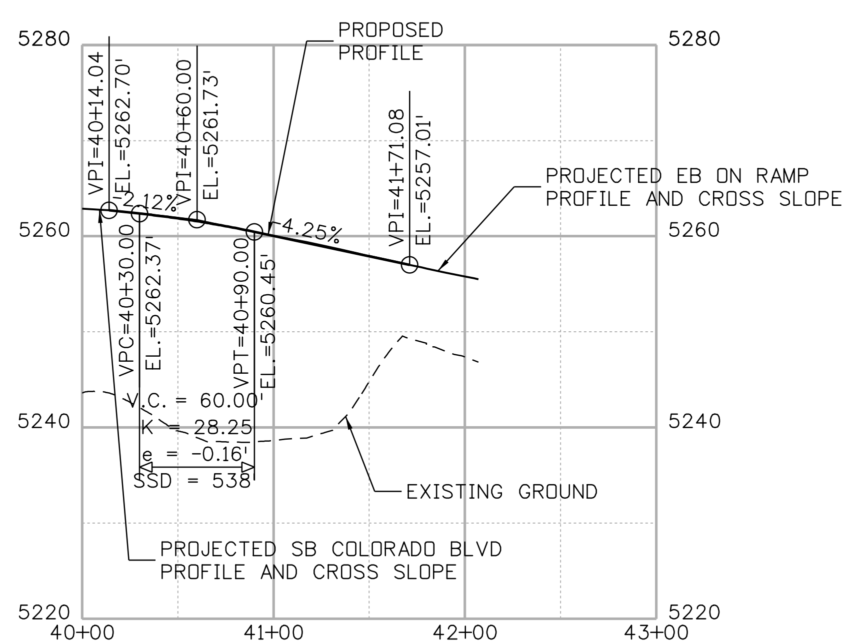

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Horiz. Scale: 1:100.303	Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation

Region 1

COLORADO HPTE

I-70 EAST ATC 2.2 COLORADO BLVD SB TO EB ON RAMP STA 40+00 TO STA 42+07.10			
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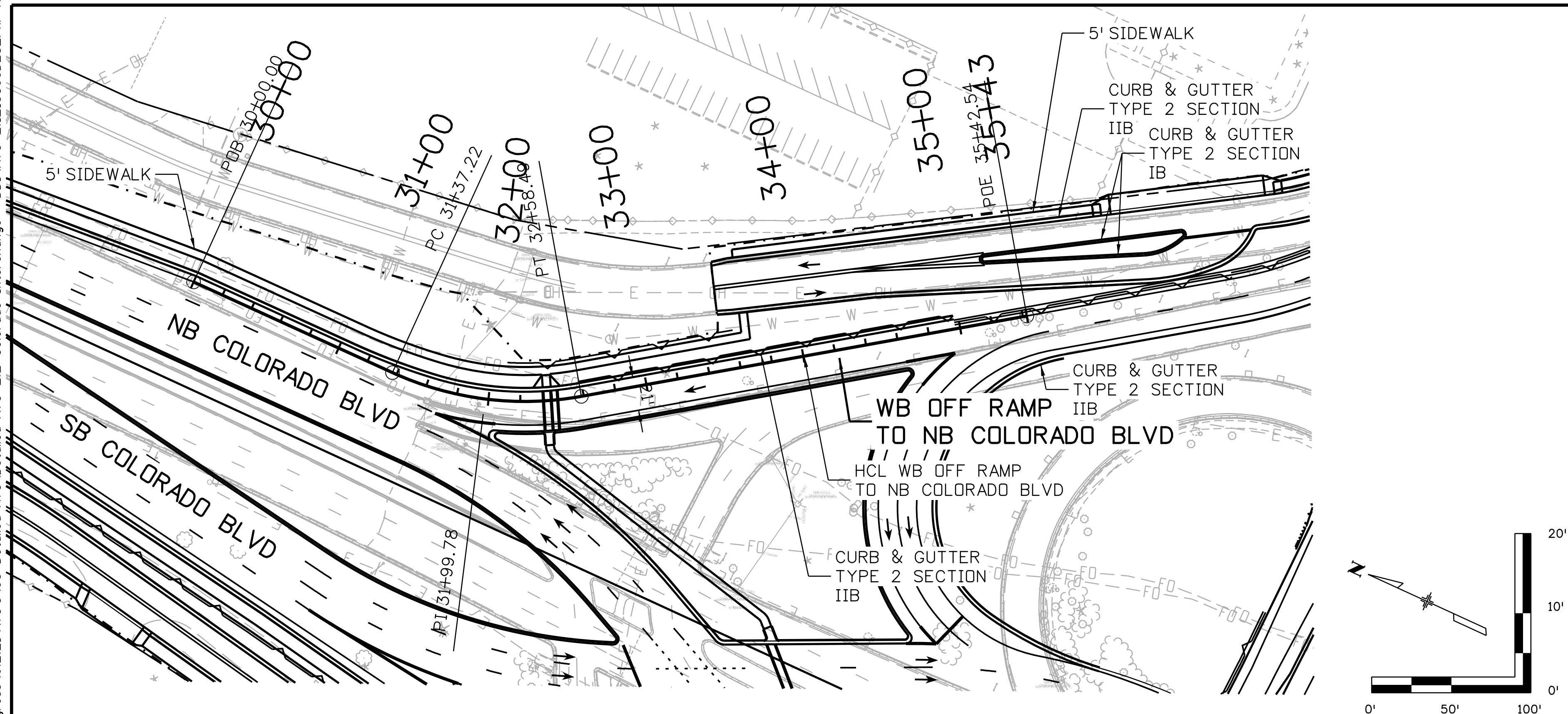
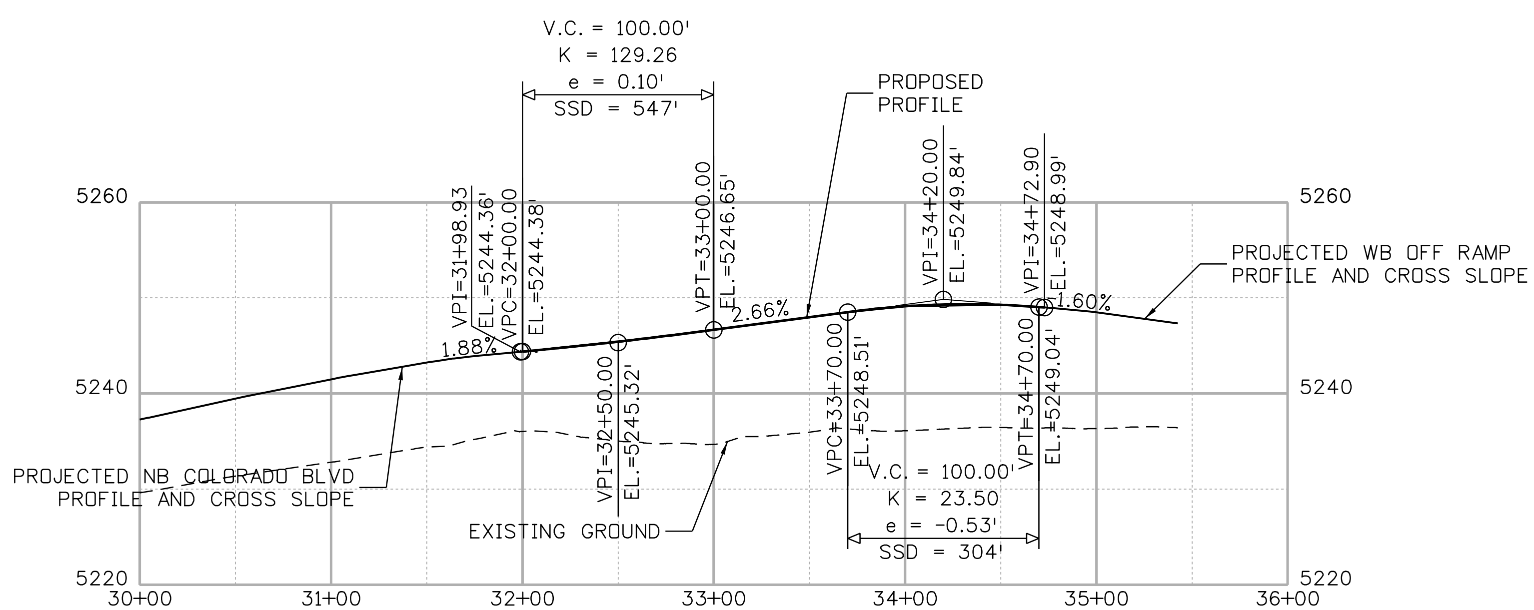
Detailer:	M.MARSHALL		.
Sheet Subset:	.	Subset Sheets:	. of





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Horiz. Scale: 1:100.294	Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation
Region 1

COLORADO HPTE

I-70 EAST ATC 2.1
WB OFF TO NB COLORADO BLVD
STA 30+00 TO STA 35+42.54

Designer:	D.HYMAS	Structure Numbers	
Detailer:	M.MARSHALL		
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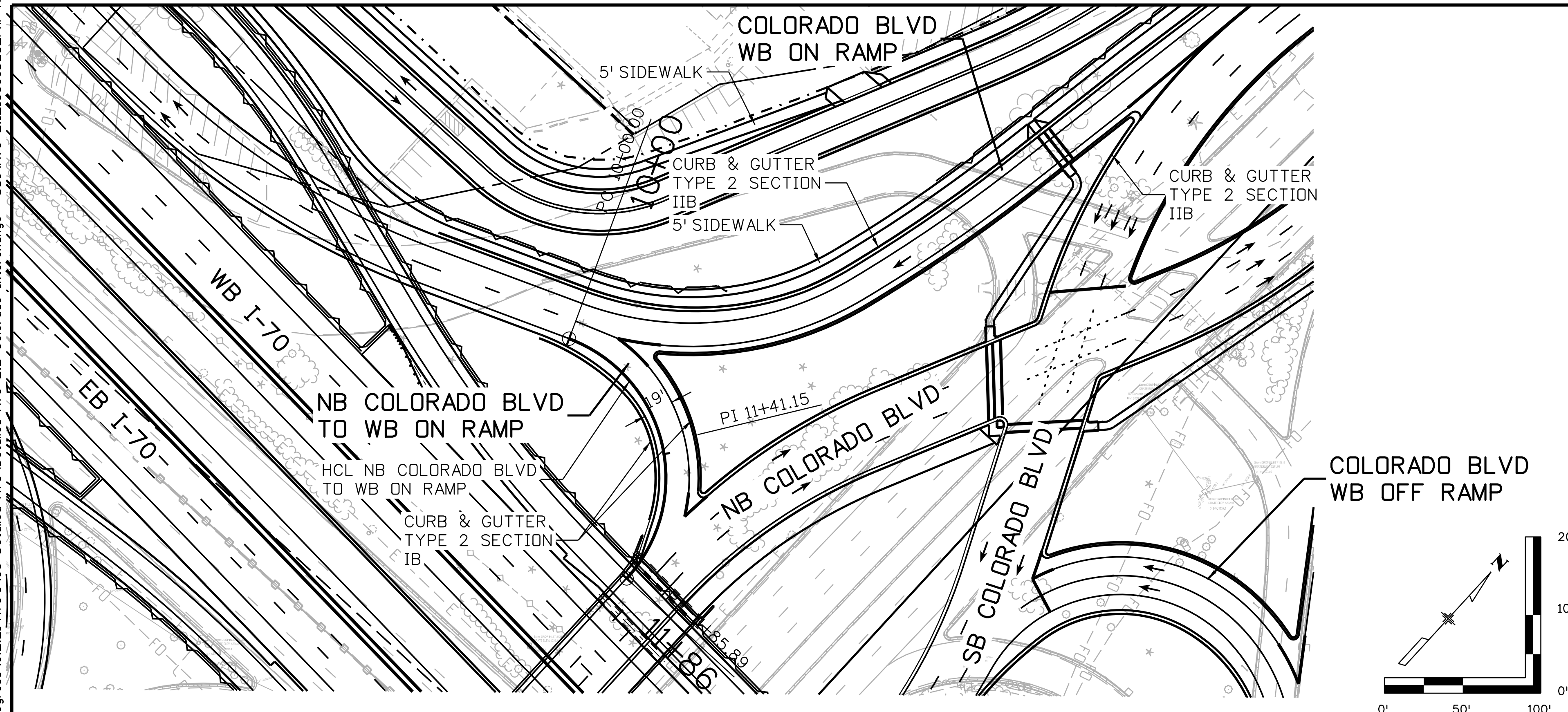

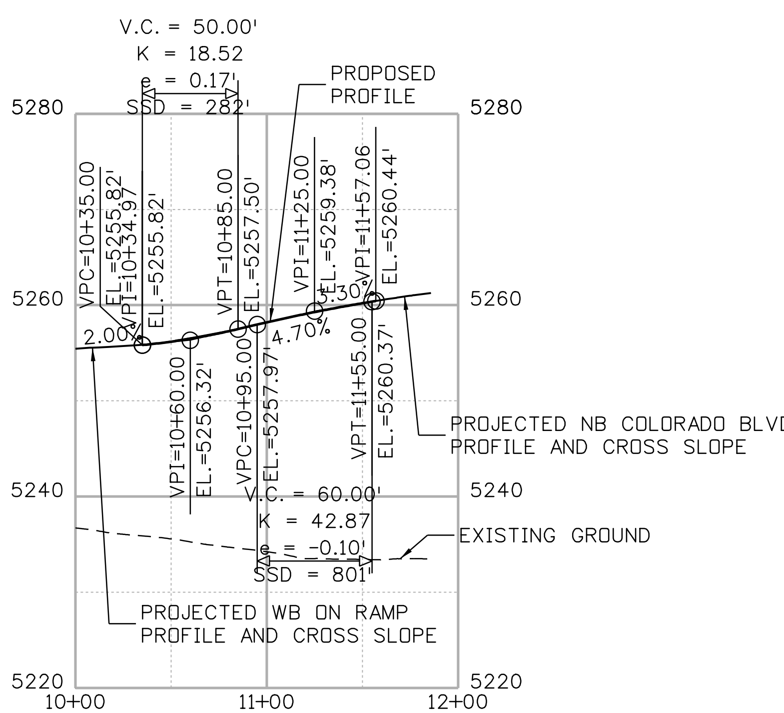

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Print Date: 8/30/2016
File Name: ATC 2.1_13599DES_PnP-RD-86.dgn
Horiz. Scale: 1:100.294 Vert. Scale: As Noted

EXHIBIT 3

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation
CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 2.1
COLORADO BLVD NB TO WB ON RAMP

Designer:	D.HYMAS	Structure Numbers	
Detailer:	M.MARSHALL		
Sheet Subset:	ROADWAY	Subset Sheets:	20 of 20

Print Date: 11/7/2016
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Horiz. Scale: 1:200 Vert. Scale: As Noted

5280 Connectors
Linking I-70 Communities

Colorado Department of Transportation
Region 1

COLORADO HPTE

I-70 CENTRAL AREAS 02, 03 & 04 GUIDE SIGN ROLL PLOT			
Designer:	STEWART, D	Structure Numbers	
Detailer:	ISLAM, S		
Sheet Subset:	GUIDE	Subset Sheets:	01 of 01

IN PROGRESS - NOT FOR FINAL ESTIMATE

SECTION 2.2.2

ATC 4.2 | STORM SEWER DIVERSION

Central 70

DATE: October 18, 2016

TO: 5280 Connectors

FROM: Anthony DeVito P.E. Central 70 Project Director
Nicholas Farber, Central 70 Project

SUBJECT: Central 70 - Detailed Alternative Technical Concept (ATC) Response
5280 Connectors - ATC No. 4.2

Dear Mr. Clark:

Your Team's ATC Submission Form for Detailed ATC 4.2 was reviewed by the Procuring Authorities prior to the September One-on-One Meetings and an initial response was sent to you on September 23, 2016. As discussed during the August One-on-One Meeting, the Procuring Authorities committed to provide a final response to your Detailed ATC.

Detailed ATC 4.2 proposes to eliminate the storm drain structure at York Street and divert south of I-70.

In accordance with the Instructions to Proposers ("ITP"), the Procuring Authorities will use reasonable efforts to provide a Proposer with the following written feedback on a ATC Submission within 15 Working Days following the later of (x) the date the relevant ATC Submission was submitted and (y) the One-on-One Meeting at which such submission is discussed. Below is the final response from the Procuring Authorities for your Detailed ATC:

☐ 1. unconditional approval;

☒ 2. conditional approval, subject to modifications and/or conditions;

☐ Re-submission required ☒ Re-submission not required

☐ 3. disapproval, with or without guidance that such ATC can be re-submitted under any circumstance;

☐ 4. notification that the incorporation of the proposed ATC in the Proposer's Proposal is already permitted under the terms of the RFP, and therefore does not qualify as an ATC (and will not be treated as such for purposes of Section 3.4 of Part C of the ITP).

Following our discussions at the September One-on-One Meeting, the Procuring Authorities have not changed their initial response to your above mentioned Detailed ATC Submission. The ATC is approved with the following conditions:

Conditions of Approval:

1. As set forth in the Project Agreement, the Developer shall:
    a. be responsible for any additional Environmental Approvals required for the ATC
    b. be responsible to obtain any Additional Right-of-Way required for the ATC
    c. be responsible to obtain any required Railroad Permits required for the ATC

2. The Procuring Authorities reserve the right to require resubmittal of this ATC in the future in order to address changes necessitated by any subsequent modifications to the RFP drainage requirements.

The approval of this Detailed ATC by the Procuring Authorities does not constitute an approval of specific drafting modifications to the RFP necessary to incorporate this ATC into the Project Agreement pursuant to Section 7.2.1.c of Part C of the ITP, which modifications shall be agreed by the Procuring Authorities and the Proposer (each acting reasonably) following issuance of a Notice of Award to such Proposer.

ANNEX 3: ALTERNATIVE TECHNICAL CONCEPT SUBMISSION FORM

Proposer Name: 5280 Connectors
Date: August 25, 2016

Central 70 Project RFP: ATC Submission No. 4.2

A. Background Information

1. Type of Submission

☐ Conceptual ATC

☒ Detailed ATC

2. Prior Submission(s)

☐ None (initial submission of ATC)

☐ Previously Submitted as Conceptual ATC

☒ Previously Submitted as Detailed ATC

3. Explanation of Reason for Resubmission

Conceptual ATC #4.0 was approved to be submitted as detailed ATC. Detailed ATC #4.1 was Conditionally Approved with Re-submission required with Cross Sections (including existing and proposed infrastructure) along the alignment where the box culvert is located additional exhibit showing cross sections following submittal of detailed ATC.

4. Request for Discussion at One-on-One Meeting

☒ Meeting Requested

☐ Meeting Not Requested

B. General ATC Submission Requirements

1. Overview Description

"This information has not been amended since the submission of the previous version of this ATC"

5280 Connectors proposes to eliminate the 72-inch storm drain utility structure and pipe at York Street from south to north, over I-70, to an east to west drainage flow into the RFP proposed Offsite Drainage System. The diversion of the existing flows in the York Street storm drain, south of I-70, to the proposed Offsite Drainage System can be accommodated with minor upsizing. The elimination of an overhead structure and drainage pipe over I-70 greatly reduces the addition of a drainage hazard and maintenance of this exposed service line from South of the right-of-way to North of I-70

This revised drainage concept continues to use the historic flow capacity in the existing storm drain in York Street, north of I-70 Mainline. However, it provides a more efficient drainage solution by eliminating the storm drainage structure and associated 72-inch storm drain pipe over the Lowered Section Historic flow capacity is maintained by connection of the proposed 46th Avenue North storm drain system to the continuation of the existing York Street drainage system north of I-70.

2. Relevant RFP Requirements

"This information has not been amended since the submission of the previous version of this ATC"

Project Agreement Schedule 10, *Section 8.4.9.f Storm Drain over the Lowered Section near York Street* requires that the Developer continue to use historic flow capacity in the existing storm drain in York Street, north of the I-70 Mainline, with a structure over the Lowered Section.

3. Rationale

"This information has not been amended since the submission of the previous version of this ATC"

The structure that would carry the 72-inch storm drain across I-70 Mainline controls the roadway vertical profile. The storm drain causes the roadway profile to be lower than required for passing beneath York Street due to additional vertical clearance requirements for utility bridges.

Eliminating the storm drainage over the Lowered Section will prevent freeze/ thaw exposure, reducing operation and maintenance risks. Eliminating the storm drain structure also improves safety through roadway section by improving vertical clearances and reduces flooding risks in the Lowered Section.

Diverting York Street storm water flow will use the proposed Off-Site Drainage outflow capacity to the south of I-70. This will provide additional capacity in the existing 72-inch storm drain north of I-70, providing capacity for storm water relief to local areas that are subject to flooding.

The RFP design shows a 7-by-6-foot Concrete Box Culvert (CBC) for the Offsite Drainage System between Brighton Boulevard and York Street. Diversion of the existing 72-inch storm drain in York Street can be accommodated by upsizing the CBC to a 7-by-8-foot CBC. InRoads analysis for the 7-by-6-foot CBC shows a capacity of 467.3695 cubic feet per second (cfs) for the proposed 7by-8-foot CBC shows a capacity of 686.2141 cfs and provides an increased capacity of 218.8 cfs.

4. Impacts

“This information has not been amended since the submission of the previous version of this ATC”

Eliminating the proposed storm bridge structure across the Lowered Section will improve aesthetics and providing the traveling public unobstructed sight lines by eliminating the utility bridge structure and keeping storm drainage underground. Removing the pipe crossing from the Lowered Section will also reduce risks to I-70 Mainline from damage to the storm pipe that could overwhelm the Onsite Drainage System during a major event. Eliminating the proposed storm bridge will also reduce construction impacts including eliminating an additional storm drain crossing of the UPRR, north of I-70 and eliminates placement of a large diameter storm drain along 46th Avenue North (west of York Street) and along Race Street*.*

5. Cost and Benefit Analysis

“This information has not been amended since the submission of the previous version of this ATC”

Diverting the Storm Drainage Flow at York Street is anticipated to result in a $2.5 Million Dollar Savings to the Project. This is reflected in the elimination of Storm Bridge offset by increase in the Offsite Drainage size between York Street and Brighton Avenue. Additional savings have been realized in the additional elimination of the 72-inch proposed storm line to the west located on the north side of I-70.

Eliminating the Storm Bridge in conjunction with changes to additional roadway vertical control points will also result in additional cost benefits to the roadway profile. A final cost of these net changes is considered to be a very significant cost benefit once they can be realized in a combined design.

6. Schedule Analysis

“This information has not been amended since the submission of the previous version of this ATC”

Eliminating the Storm Bridge at York Street is estimated to benefit the Project Schedule by reducing storm drainage relocation work in York Street for bridge construction. This will result in estimated one month reduction to the Project Schedule based on Conceptual Phasing Plan for Construction.

7. Conceptual Drawings

“This information has been amended since the submission of the previous version of this ATC”

See attached Plan and Profile Exhibits of Drainage Plan Revision and added Cross Section Plan.

8. Past Use

“This information has not been amended since the submission of the previous version of this ATC”

Storm drainage design is typically optimized by outfall requirements using detention as means to control outflow. Buried underground storm drains are preferred to exposed storm pipes to avoid issues with freezing in winter climate areas.

9. Additional Information

n/a

C. Detailed ATC Requirements

1. Risks

"This information has not been amended since the submission of the previous version of this ATC"

The diversion of the Offsite drainage basin, including the flows of the existing 72-inch storm drain in York Street is feasible, but does increase the design discharge between York Street and Brighton Avenue. A larger culvert crossing at UPRR poses minor constructability risks.

Additional risk is associated with the potential Globeville Outfall Project. The City of Denver's Early Action Drainage Project (Globeville Outfall) raises the elevation of the Brighton East Pond outfall approximately five feet. This increase could require additional culvert size to offset reduced slope. However, the reduction in Offsite flow may allow for an overall reduction in culvert size. The higher outfall will also require a rise in the culvert profile. Clearance under the UPRR tracks is an additional risk associated with the higher Brighton East Pond outfall.

2. Handback

"This information has not been amended since the submission of the previous version of this ATC"

This ATC does not propose any changes in handback procedures and or handback requirements.

3. Right-of-Way

"This information has not been amended since the submission of the previous version of this ATC"

No additional right-of-way is required to accommodate this ATC. The width of the box culvert is unchanged from the RFP design and additional capacity is being provided by increased box height.

4. List of Required Approvals

"This information has not been amended since the submission of the previous version of this ATC"

This ATC does not modify the list of required approvals. Required or likely required approvals are expected from City and County of Denver, UPRR and CDOT.

5. Proposed Drafting Revisions

"This information has not been amended since the submission of the previous version of this ATC"

The following sections of the Project Agreement will require amendment (see attached proposed modifications):

- Project Agreement Schedule 10, Section 8.4.9.f Storm Drainage over the Lowered Section near York Street.

f. Storm Drain over the Lowered Section near York Street

The Developer shall ~~continue to utilize the historic flow~~maintain ~~capacity~~ drainage flows ~~in~~ of the existing storm drain in York Street, ~~north of the I-70 Mainline, with a structure over the Lowered Section~~.

g. Sand Creek

The Developer shall design and reconstruct the overflow channel for Sand Creek adjacent to the south side of the I-270 flyover. The Developer shall coordinate with CCD, UDFCD and Local Agency floodplain administrator.

h. Groundwater

The Developer shall provide the necessary analysis and design for temporary dewatering during construction and permanent treatment of groundwater for the Site. Additional information regarding groundwater conditions and requirements is included in Schedule 17 Environmental Requirements.

i. Cover

The Developer shall design, construct and install the necessary drainage infrastructure required to drain the Cover and protect the Lowered Section between Columbine Street to Clayton Street from the 100 year event. Additional information and requirements regarding the Cover are included in Schedule 10, Section 12 Cover MEP System.

j. Micro Tunneling and Pipe Jacking

Micro tunneling or pipe jacking shall be permitted in areas where open cut installation of Storm Drains and Cross Drains is prohibitive. The use of rectangular pipe is prohibited. The Developer shall:

i. Consider the use of steel, concrete, or centrifugally cast fiberglass-reinforced, polymer mortar pipe. Pipe material shall be submitted by the Developer to the Department for Acceptance;

ii. Submit to the Department, for Acceptance, the materials, means, and methods of installation, including but not limited to the following:

A. Plan and profile with all Utilities shown and labeled with appropriate Utility ID number. All clearances between Storm Drains or Cross Drains and Utilities shall be clearly labeled;

B. Jack and boring pit locations;

C. Excavation Material Management Plan;

D. Traffic Control Plan;

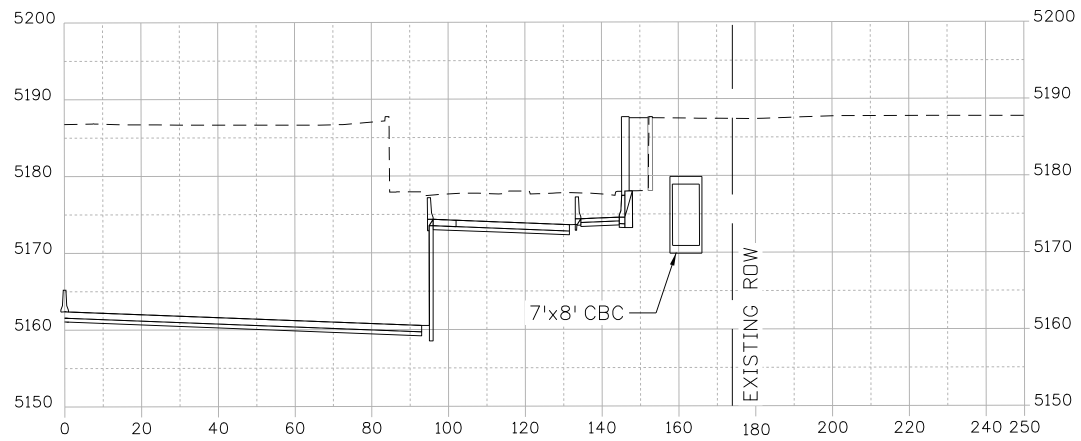
E. Dewatering Plan; and

F. Quality Control Plan.

8.5. Construction Requirements

8.5.1. The Developer shall be aware that the Project is within two large existing flood-prone basins; the Montclair Basin and Park Hill Basin. The Developer shall be responsible for protecting and preserving public and private property from damage resulting directly or indirectly from stormwater runoff along or adjacent to the Site during construction of all improvements, including upstream and downstream properties.

8.5.2. The Developer is advised to coordinate with Local Agencies, including but not limited to the UDFCD, for flows that affect drainage within the Site. The Developer shall evaluate construction methods and staging during the design phase and include provisions to maintain positive drainage at all times during construction.



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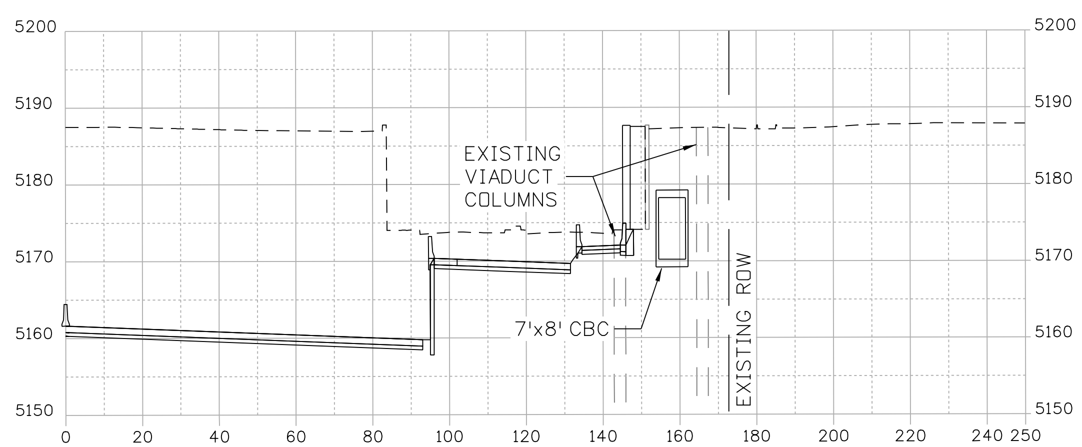

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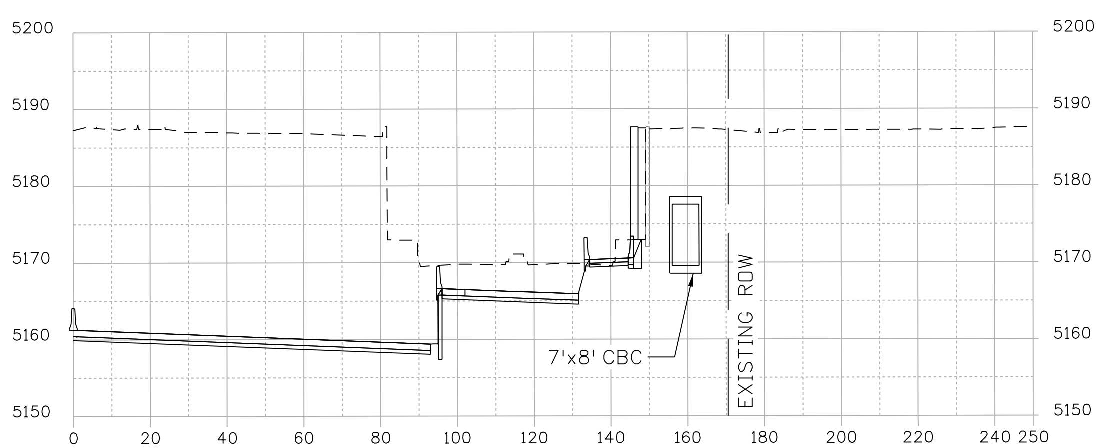

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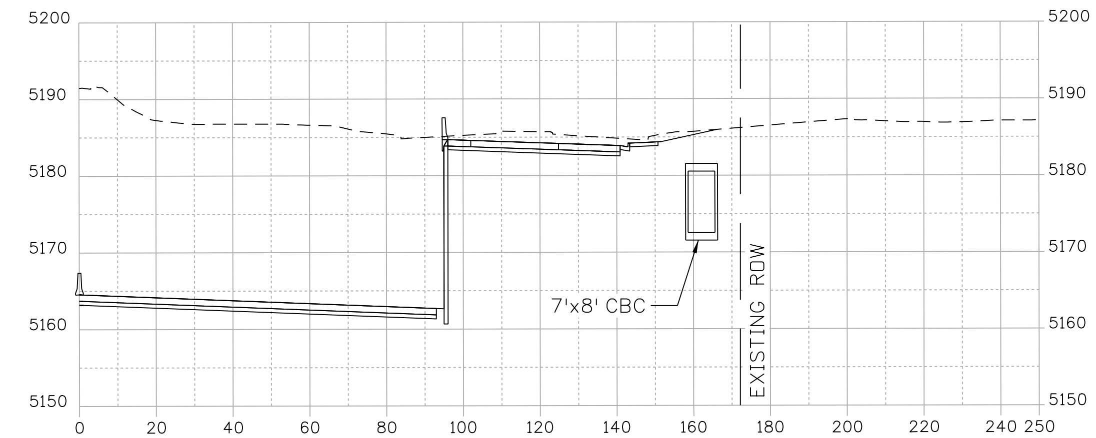

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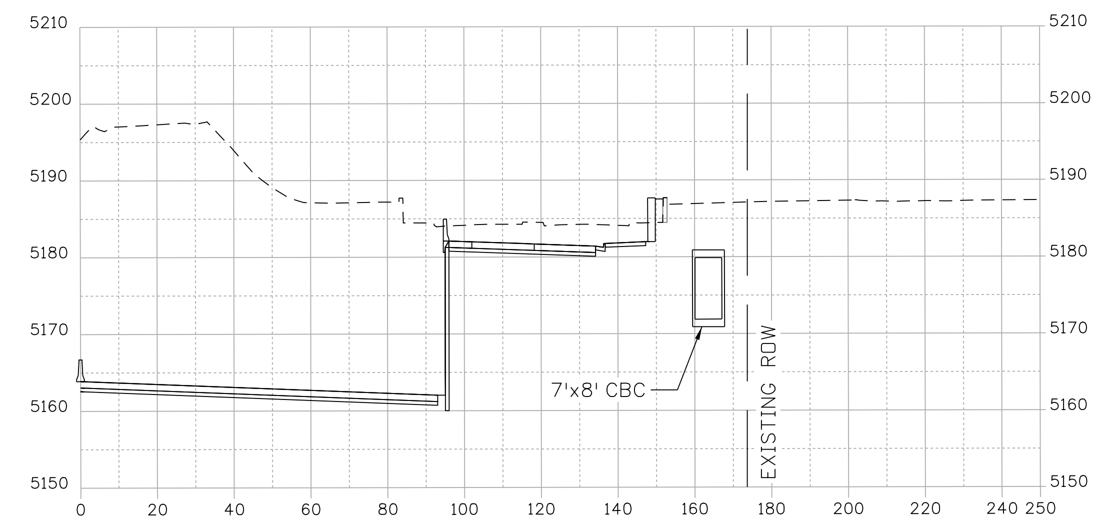

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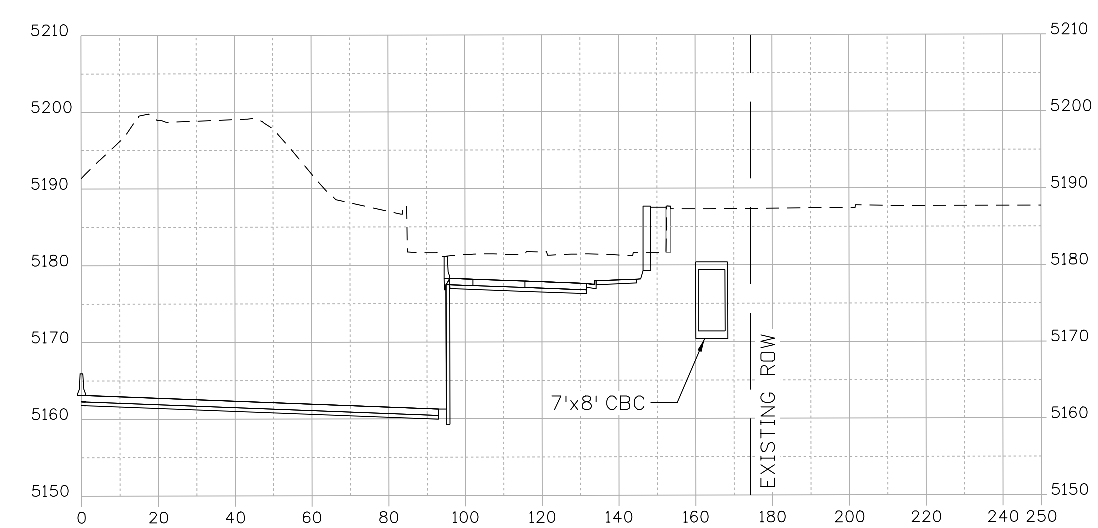

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5280 Connectors
Linking I-70 Communities

Colorado Department of Transportation
Region 1

ATC4.2
CROSS SECTIONS
STA 2020+00 TO 2025+00

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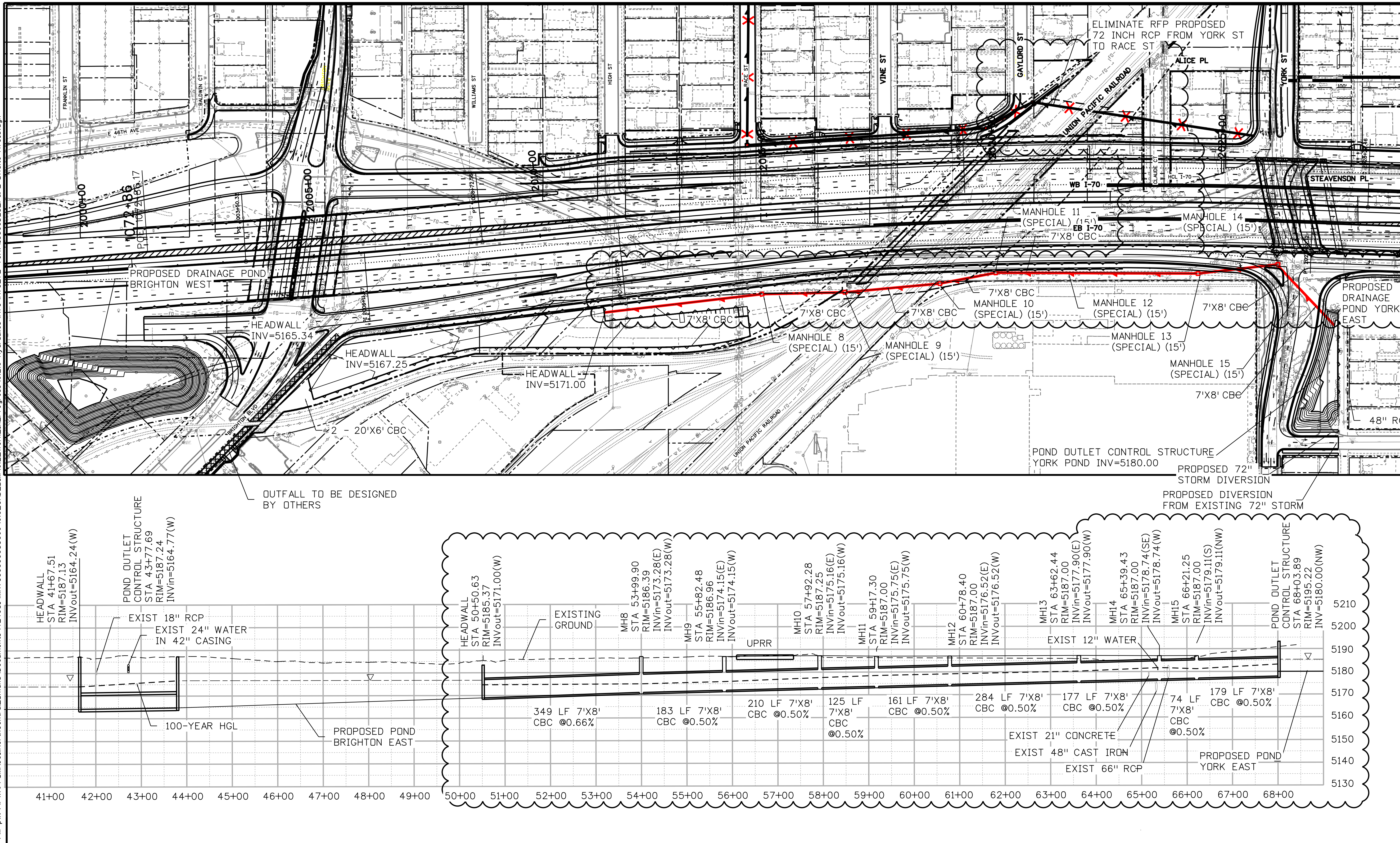

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5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation
Region 1

COLORADO HPTE

CENTRAL 70 ATC 4.1
OFFSITE DRAINAGE AT YORK ST

Designer:		Structure Numbers	
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SECTION 2.2.3

ATC 7.2 | SANITARY SEWER GRAVITY LINE

Central 70

DATE: November 15, 2016

TO: 5280 Connectors

FROM: Anthony DeVito P.E. Central 70 Project Director
Nicholas Farber, Central 70 Project

SUBJECT: Central 70 - Detailed Alternative Technical Concept (ATC) Response
5280 Connectors - ATC No. 7.2

Dear Mr. Clark:

Your Team's ATC Submission Form for Detailed ATC 7.2 has been reviewed by the Procuring Authorities.

Detailed ATC 7.2 proposes to relocate the existing 48-inch sanitary sewer line at York Street Bridge through a gravity sewer that passes under the I-70 viaduct from 44th Avenue to 46th Avenue.

In accordance with the Instructions to Proposers ("ITP"), the Procuring Authorities will use reasonable efforts to provide a Proposer with the following written feedback on a ATC Submission within 15 Working Days following the later of (x) the date the relevant ATC Submission was submitted and (y) the One-on-One Meeting at which such submission is discussed. Below is the final response from the Procuring Authorities for your Detailed ATC:

☐ 1. unconditional approval;

☒ 2. conditional approval, subject to modifications and/or conditions;

☐ Re-submission required ☒ Re-submission not required

☐ 3. disapproval, with or without guidance that such ATC can be re-submitted under any circumstance;

☐ 4. notification that the incorporation of the proposed ATC in the Proposer's Proposal is already permitted under the terms of the RFP, and therefore does not qualify as an ATC (and will not be treated as such for purposes of Section 3.4 of Part C of the ITP).

The ATC is conditionally approved.

Conditions of approval:

1. As set forth in the Project Agreement, the Developer shall:
   a. be responsible for any additional Environmental Approvals required for the ATC
   b. be responsible to obtain any Additional Right-of-Way required for the ATC
   c. be responsible to obtain any required Railroad Permits required for the ATC
   d. ensure that all Utility Work results in Utilities being located in a manner to allow future Utility maintenance to be performed by the relevant Utility Owner.

The approval of this Detailed ATC by the Procuring Authorities does not constitute an approval of specific drafting modifications to the RFP necessary to incorporate this ATC into the Project Agreement pursuant to Section 7.2.1.c of Part C of the ITP, which modifications shall be agreed by the Procuring Authorities and the Proposer (each acting reasonably) following issuance of a Notice of Award to such Proposer.

ANNEX 3: ALTERNATIVE TECHNICAL CONCEPT SUBMISSION FORM

Proposer Name: 5280 Connectors
Date: October 21, 2008

Central 70 Project RFP: ATC Submission No. 7.2

A. Background Information

1. Type of Submission

☐ Conceptual ATC

☒ Detailed ATC

2. Prior Submission(s)

☐ None (initial submission of ATC)

☐ Previously Submitted as Conceptual ATC

☒ Previously Submitted as Detailed ATC

3. Explanation of Reason for Resubmission

Additional Engineering review to address identified items regarding:

(a) Cross Sections for length of sewer alignment

(b) Updated Plan & Profiles showing infrastructure and Stock Show Underpass

(c) Details of impacts to the National Wester Stock Show Properties

(d) Updated vertical profile clearance dimensions

(e) Revised sanitary sewer slope profile of 0.08 to 1.3% and minimum pipe size of 30”

4. Request for Discussion at One-on-One Meeting

☐ Meeting Requested

☒ Meeting Not Requested

B. General ATC Submission Requirements

1. Overview Description

This information has been amended since the submission of the previous ATC.

5280 Connectors proposes to relocate the existing 48-inch sanitary sewer line at York Street Bridge through a gravity sewer that passes under the I-70 viaduct from 44th Avenue to 46th Avenue.

The elevation of the proposed sanitary sewer utility bridge at York Street Bridge inhibits raising the I-70 profile to reduce the management and disposal of the contaminated groundwater and soils in the project area.

As show on Exhibit, the proposed gravity sewer would:

1. Begin on the existing 48-inch brick sewer at the southeast corner of the York Street/ I-70 intersection
2. Flow west under the south sidewalk of the UPRR overpass to the west side of the new RR overpass.
3. Turn south to pass through the retaining wall to a manhole on the east side of the southeast detention basin for Brighton Boulevard
4. Then flow west and pass under the Brighton Boulevard southeast and southwest detention basins to 44th Street
5. Turn north at 44th Street and pass through the I-70 viaduct to a manhole on the west side of East 46th Avenue
6. Turn west and connect to the Delgany Interceptor Sewer 880 feet west of East 46th Avenue.

The required 30-inch pipe will accommodate the slope and a maximum flow capacity of 11.6 cfs cubic feet per second (cfs). Refer to Table 1 on Sheet No. 4 of Exhibit for a summary of the pipe sizes, flow capacities, and other detailed information. We will provide a 4.5-foot minimum cover under the sidewalk section and install a majority of the 30-inch pipe at depths of 22 to 24 feet with a maximum depth of 28 feet. We will connect the proposed gravity sewer line to the Delgany Sewer approximately 4.0 feet above the existing invert.

2. Relevant RFP Requirements

This information has not been amended since the submission of the previous ATC.

Project Agreement Schedule 10, Section 4.2.12.b requires Utility Relocations to be performed by the Developer for any existing Utilities shall be designed and constructed to provide service at least equal to that provided by the existing Utility, unless the Utility Owner approves a lesser replacement.

3. Rationale

This information has not been amended since the submission of the previous ATC.

Installation of gravity sewer to connect with the Delgany interceptor would maintain gravity flow, eliminating the need to construct a utility bridge that may be susceptible to damage from a traffic accident resulting in a sewage spill unacceptable to CDPHE and EPA. Life-cycle maintenance costs for the overhead bridge are also eliminated while improving visual impacts of exposed infrastructure to the community.

4. Impacts

This information has not been amended since the submission of the previous ATC.

The proposed utility bridge presents concerns via potential accidental damage to the pier structure where the sewage line may break, resulting in a spill that would be unacceptable to CDPHE, EPA, and the public. A result would likely be a road closure until a temporary by-pass could be constructed to facilitate repairs.

Construction of permanent bypass sanitary sewer and manholes will allow for unimpeded flows and eliminate the need for a utility bridge.

5. Cost and Benefit Analysis

This information has not been amended since the submission of the previous ATC.

Relocating the sanitary sewer line will result in little to no construction cost benefit. Removing the sanitary sewer bridge will significantly reduce unquantified risks by raising the I-70 Mainline profile through this location, as well as a significant savings in O&M lifecycle costs, with an overall net savings to the project of approximately $0.5 Million Dollars.

6. Schedule Analysis

This information has not been amended since the submission of the previous ATC.

A preliminary review of the conceptual schedule indicates that implementing this ATC will reduce the project duration by three months. This is accomplished by accelerating utility relocations at York Street controlled by the construction of the new utility structure over the new I-70 and phasing of the I-70 viaduct demolition.

7. Conceptual Drawings

This information has been amended since the submission of the previous ATC.

See Attached Exhibits of Plan, Profile, Typical Roadway Section and hydraulic calculations for proposed sanitary alignment.

8. Past Use

This information has not been amended since the submission of the previous ATC.

Gravity sewers are the most common and economical way to transport wastewater and the preferred option of City of Denver Wastewater.

9. Additional Information

This information has been amended since the submission of the previous ATC.

Alternative methods for relocation of Sanitary Sewer line at York Street were not considered desirable by the Utility- City of Denver Wastewater. Gravity sewer relocations were indicated as their preferred design.

5280 Connectors met with Metro Wastewater Reclamation District to confirm the viability of proposed connection to the Delgany Interceptor System on May 10, 2016 to confirm the accommodation of up to an additional 10cfs from the redirected Denver sanitary line and tie-in connection.

In the response to ATC 7.1 dated July 21, 2016, the additional items requested have been incorporated into the documents included herewith. A copy of said letter along with the narrative response to Item 3 (Impact to National Western Stock Show properties) are included at the end of this document.

C. Detailed ATC Requirements

1. Risks

This information has not been amended since the submission of the previous ATC.

Denver Wastewater Management must approve the proposed sanitary sewer relocation to divert flows from south of York St. via. the relocated sewer alignment.

New underground utility work will be required west of Brighton Blvd to tie-in west of 44th Ave in areas not previously identified for utility relocation work

2. Handback

This information has not been amended since the submission of the previous ATC.

Handback requirements for the Sanitary Sewer Bridge are not required with elimination of the utility bridge.

3. Right-of-Way

This information has not been amended since the submission of the previous ATC.

No additional ROW is required to accommodate this ATC. A permitted easement for the relocated sanitary line in CDOT's ROW will be required for the proposed alignment.

4. List of Required Approvals

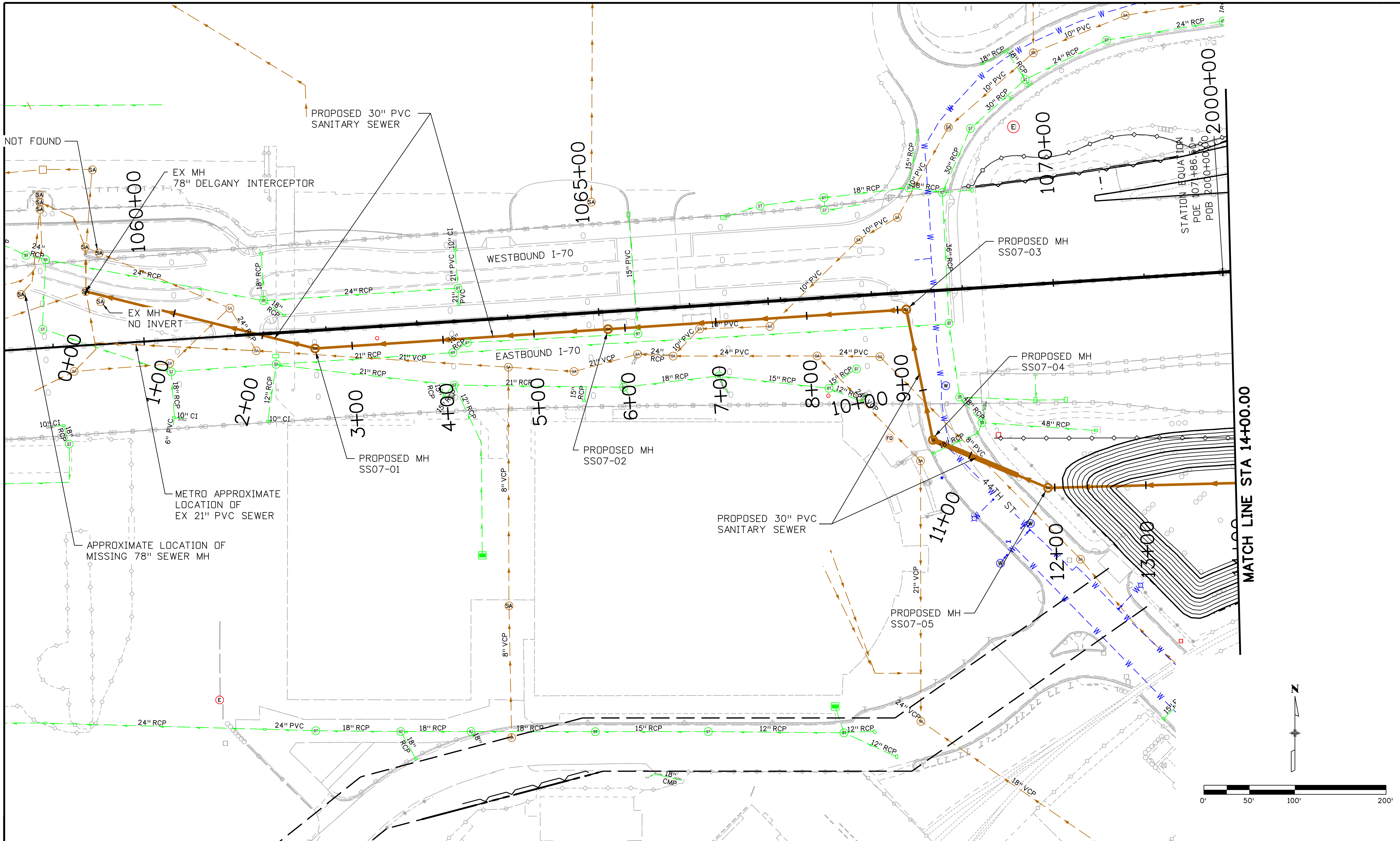
This information has not been amended since the submission of the previous ATC.

This ATC does not modify the list of required approvals. Required or likely required approvals are:
City and County of Denver Wastewater- Sewer Line Relocation Plan
Metro Wastewater Reclamation District- New Sanitary Connection
CDOT- Permitted Utility Easement

5. Proposed Drafting Revisions

This information has not been amended since the submission of the previous ATC.

This ATC does not create additional inconsistencies with the RFP requirements.



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5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation

CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 7.2
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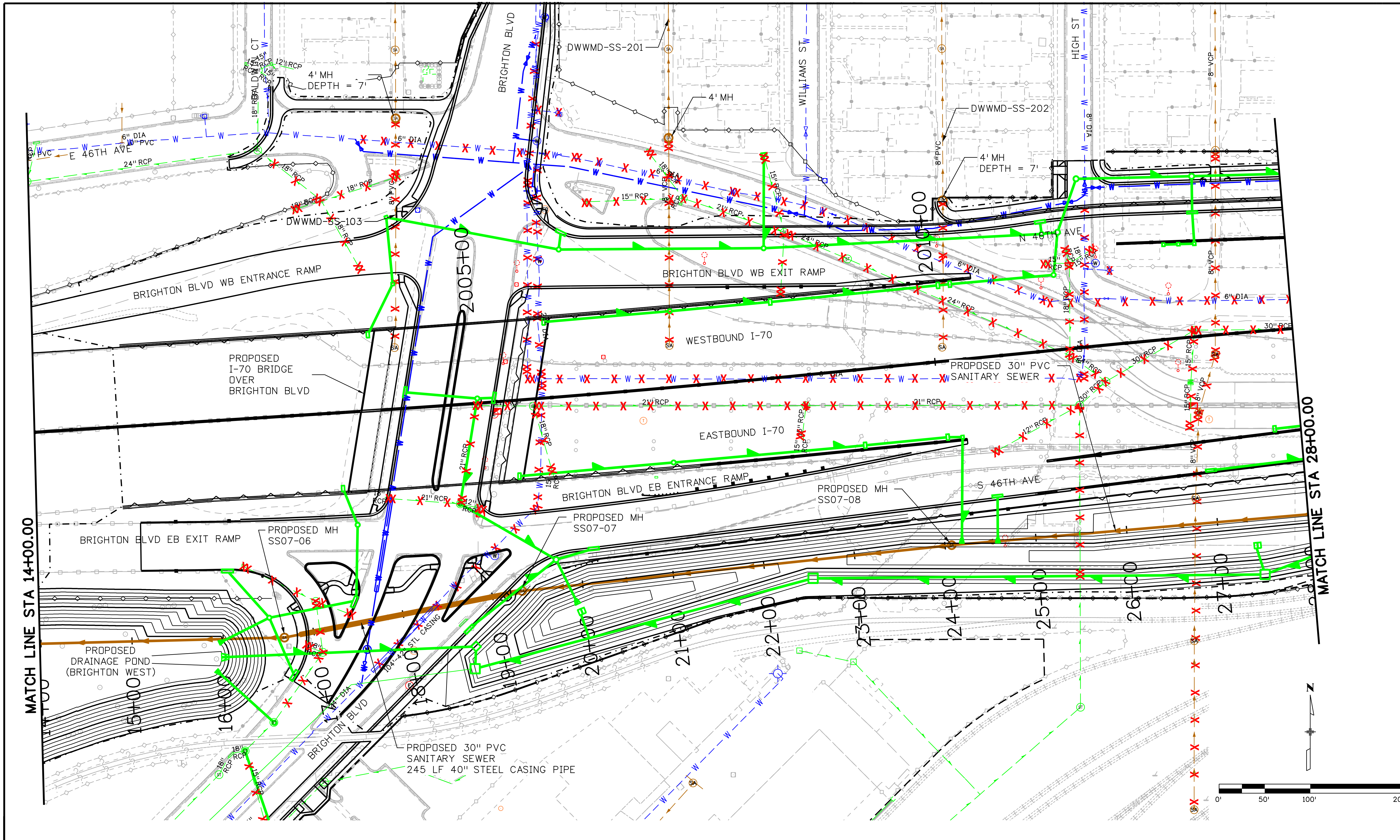

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5280 Connectors Linking I-70 Communities

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Colorado Department of Transportation
CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 7.2
PROPOSED SANITARY SEWER SS07
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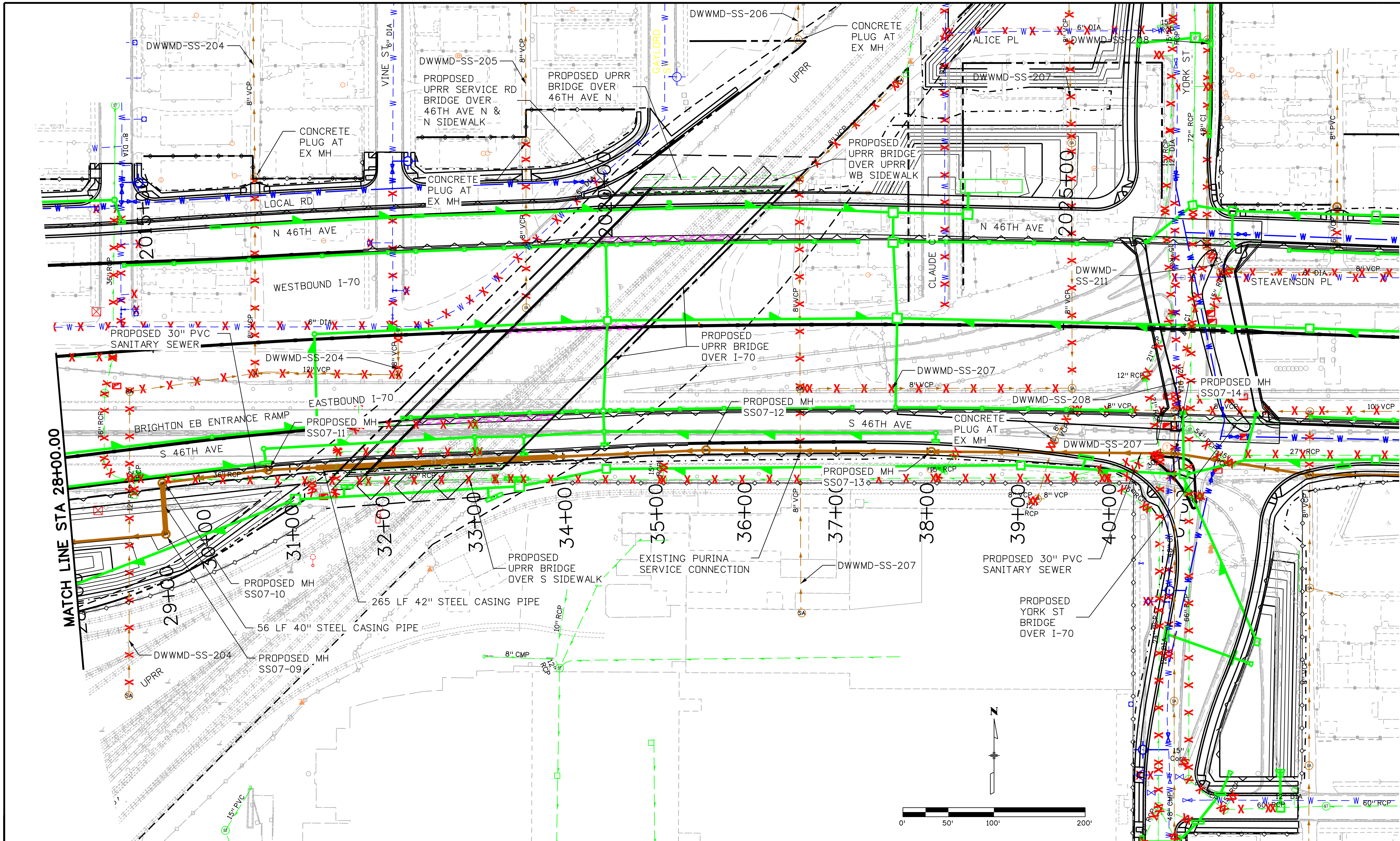

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5280 Connectors Linking I-70 Communities

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CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 7.2
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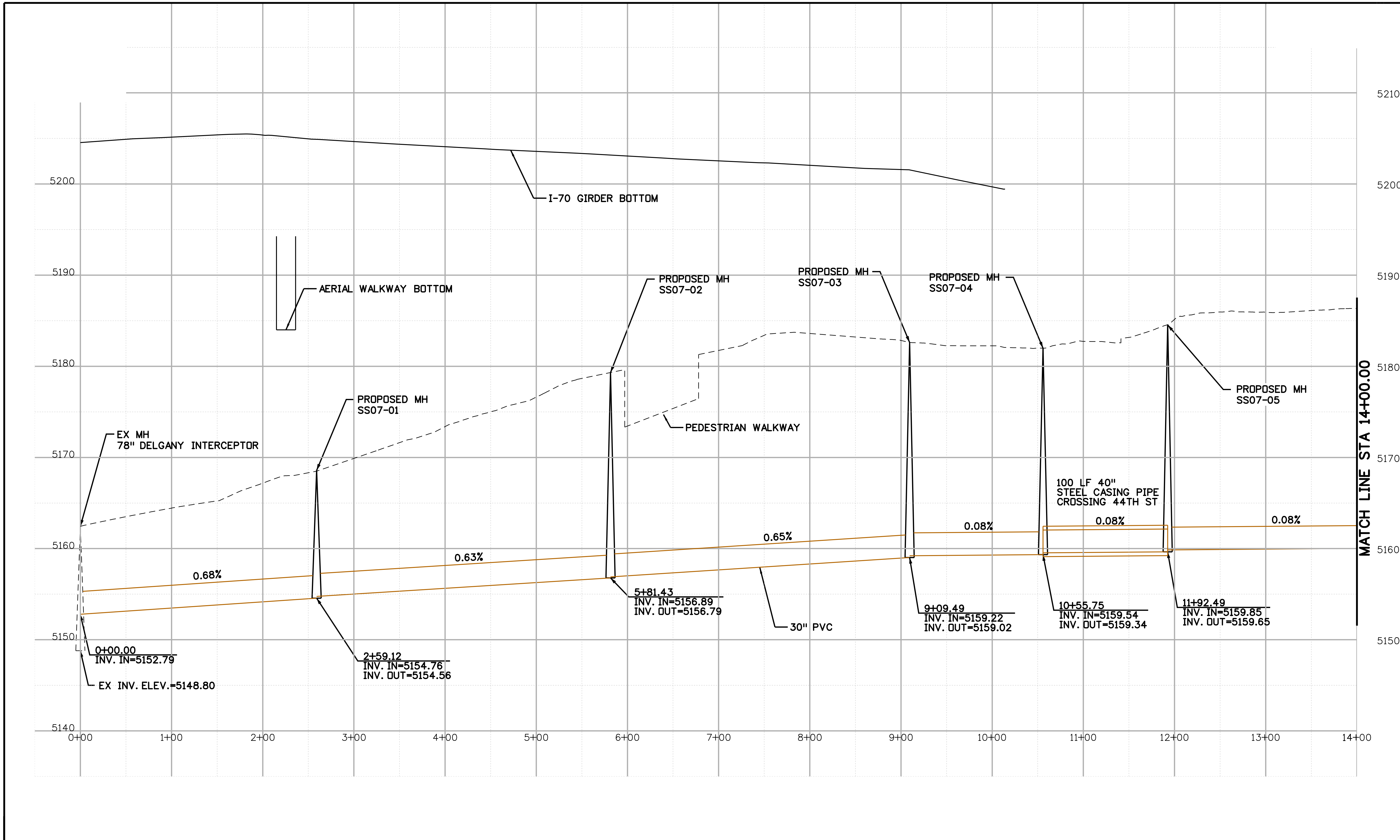

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5280 Connectors
Linking I-70 Communities

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Colorado Department of Transportation
Region 1

COLORADO HPTE

I-70 EAST ATC 7.2
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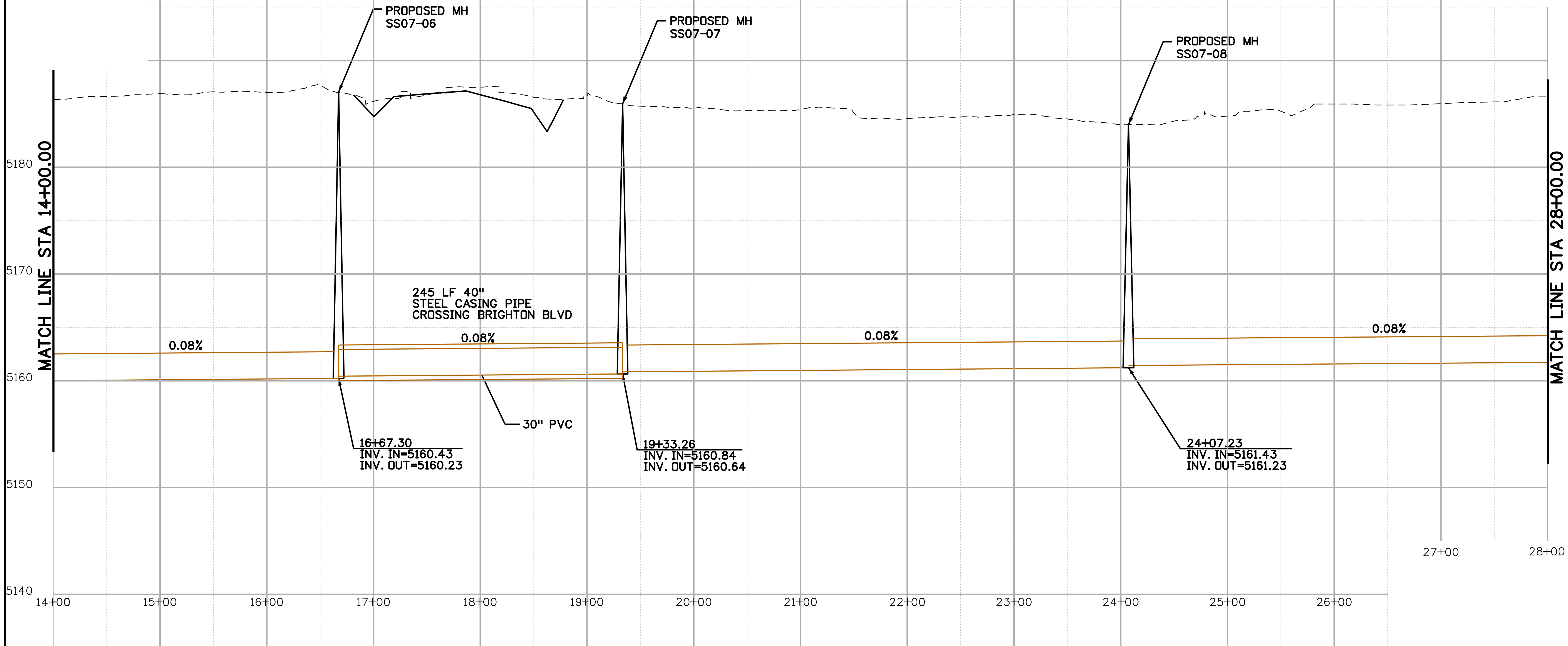

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5280 Connectors Linking I-70 Communities

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Colorado Department of Transportation

CDOT CO Region 1

COLORADO HPTE

I-70 EAST ATC 7.2
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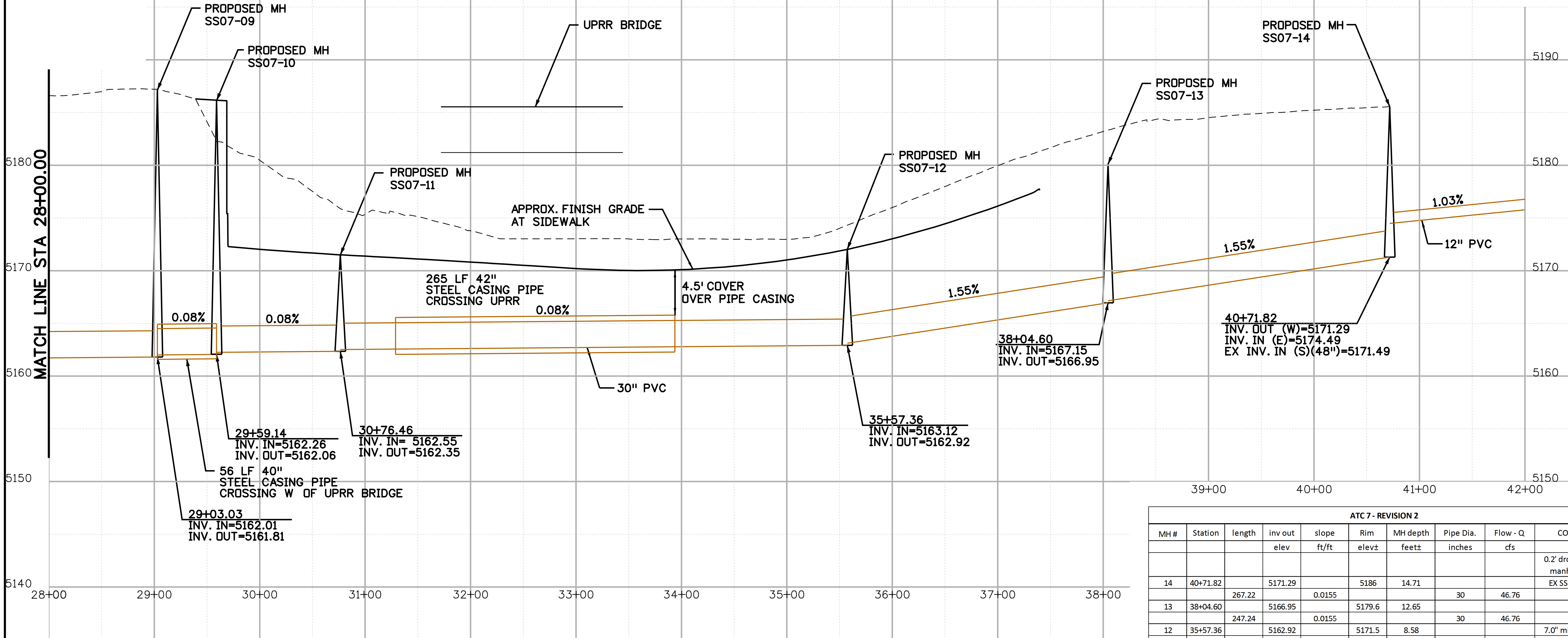

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MH #	Station	length	inv out	slope	Rim	MH depth	Pipe Dia.	Flow - Q	COMMENT
			elev	ft/ft	elev±	feet±	inches	cfs	
									0.2' drop across all manholes UNO
14	40+71.82		5171.29		5186	14.71			EX SS at York St.
		267.22		0.0155			30	46.76	
13	38+04.60		5166.95		5179.6	12.65			
		247.24		0.0155			30	46.76	
12	35+57.36		5162.92		5171.5	8.58			7.0" min. to invert
		480.90		0.0008			30	22.46	
11	30+76.46		5162.35		5169.5	7.15			7.0" min. to invert
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9	29+03.03		5161.81		5182	20.19			
		495.80		0.0008			30	11.6	
8	24+07.23		5161.23		5178	16.77			pond bottom
		473.97		0.0008			30	11.6	
7	19+33.26		5160.64		5188	27.36			
		265.96		0.0008			30	11.6	
6	16+67.30		5160.23		5188	27.77			
		474.81		0.0008	5173	13.35	30	11.6	pond bottom
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		328.06		0.0065			30	33.07	
2	5+81.43		5156.79		5175	18.21			0.1' manhole drop
		322.31		0.0063			30	32.3	
1	2+59.12		5154.56		5170	15.44			
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5280 Connectors
Linking I-70 Communities

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Colorado Department of Transportation
CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 7.2
PROPOSED SANITARY SEWER SS07
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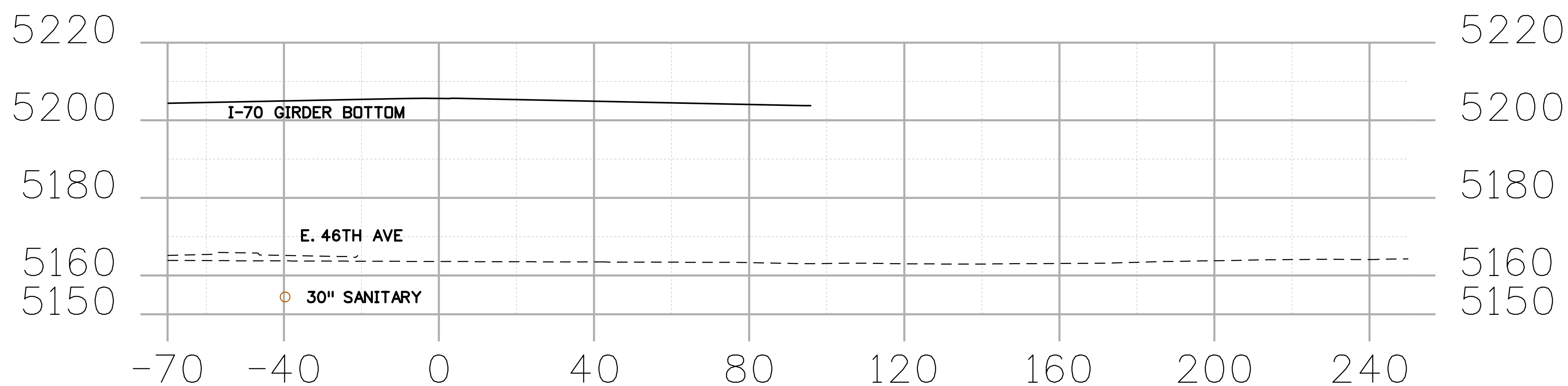

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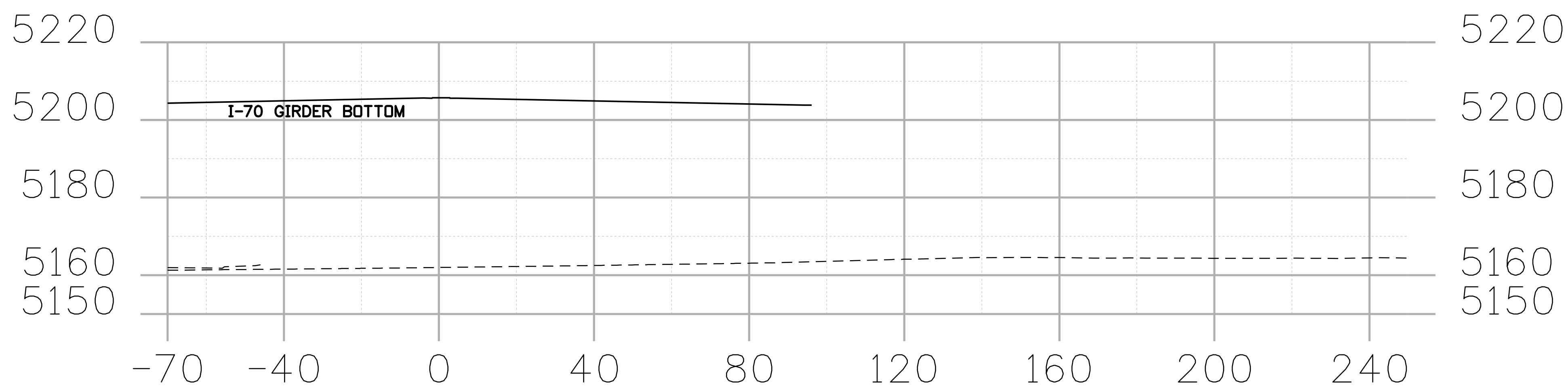

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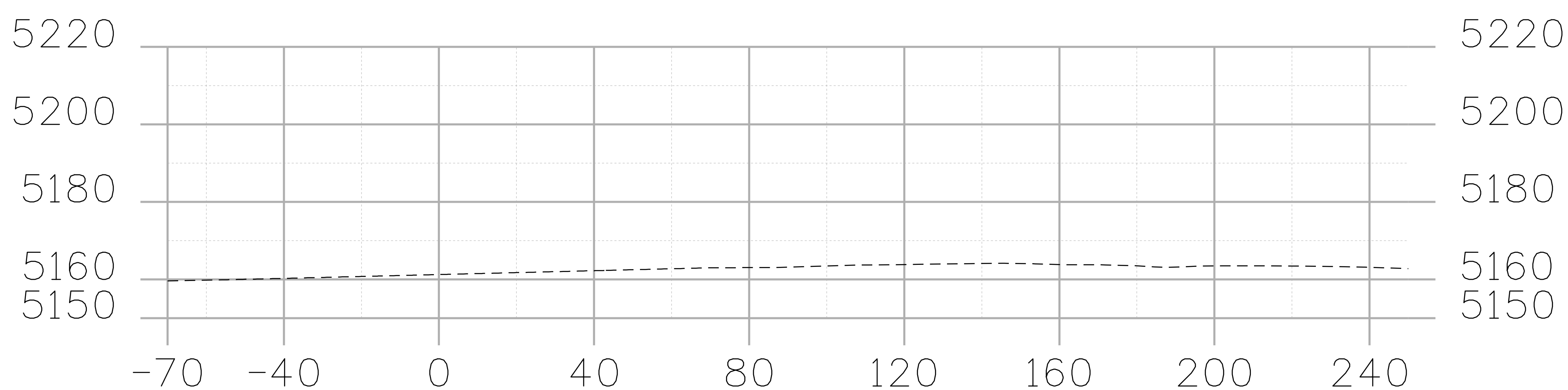

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5280 Connectors Linking I-70 Communities

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Colorado Department of Transportation
CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 7.2
SS07 CROSS SECTIONS
STA 1058+50 TO STA 1060+00

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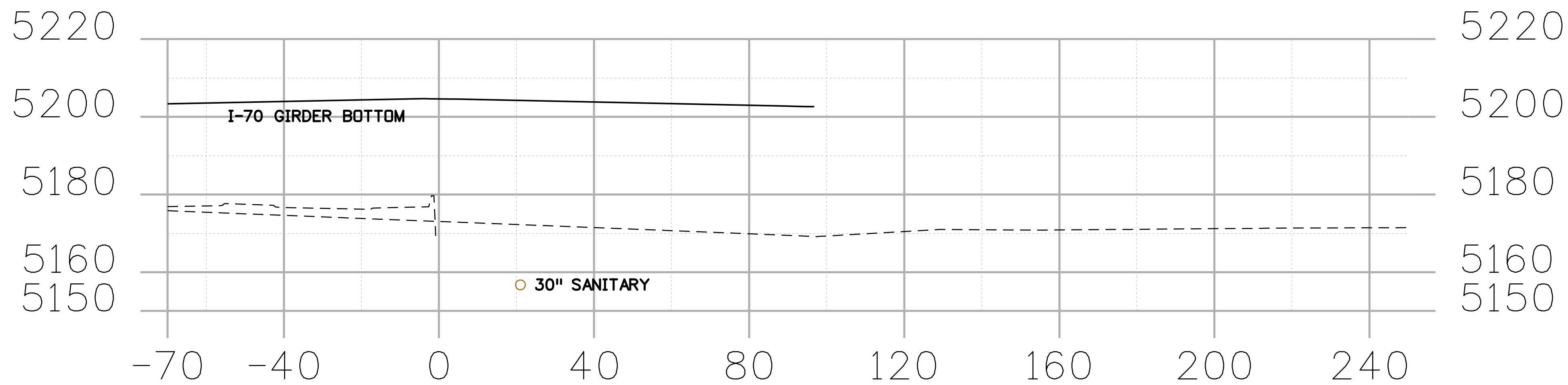

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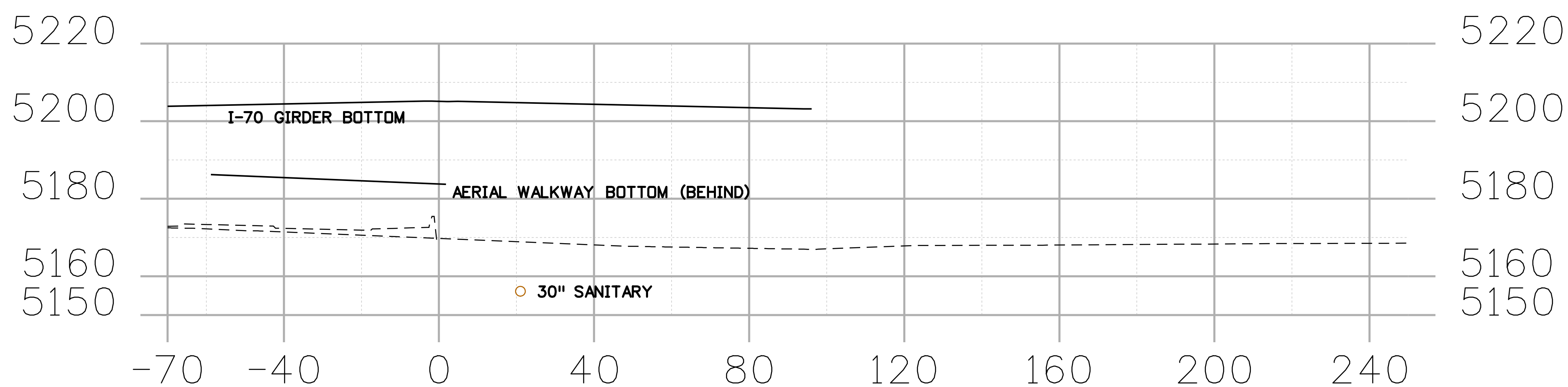

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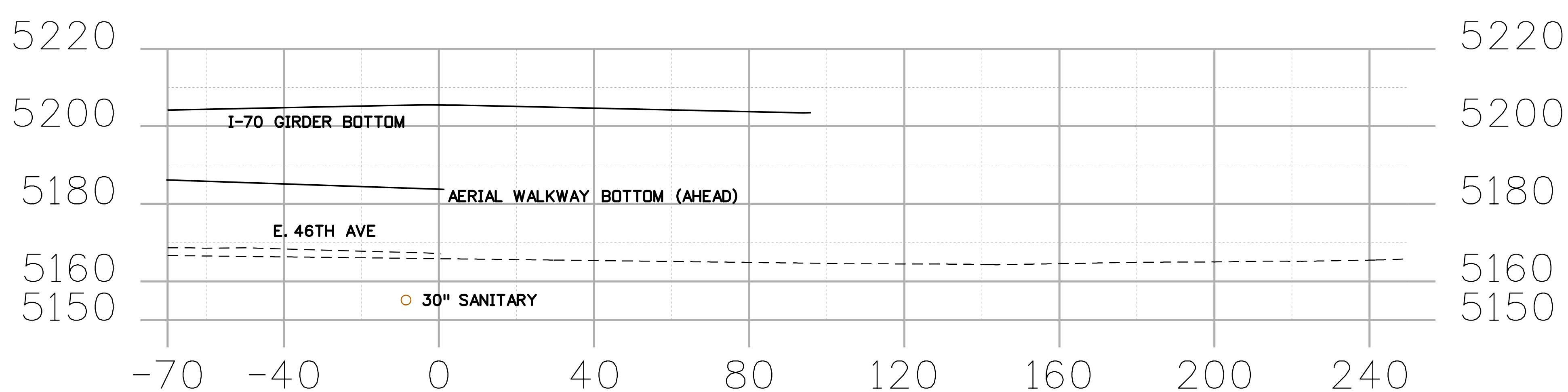

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5280 Connectors Linking I-70 Communities

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Region 1

COLORADO HPTE

I-70 EAST ATC 7.2
SS07 CROSS SECTIONS
STA 1061+00 TO STA 1063+00

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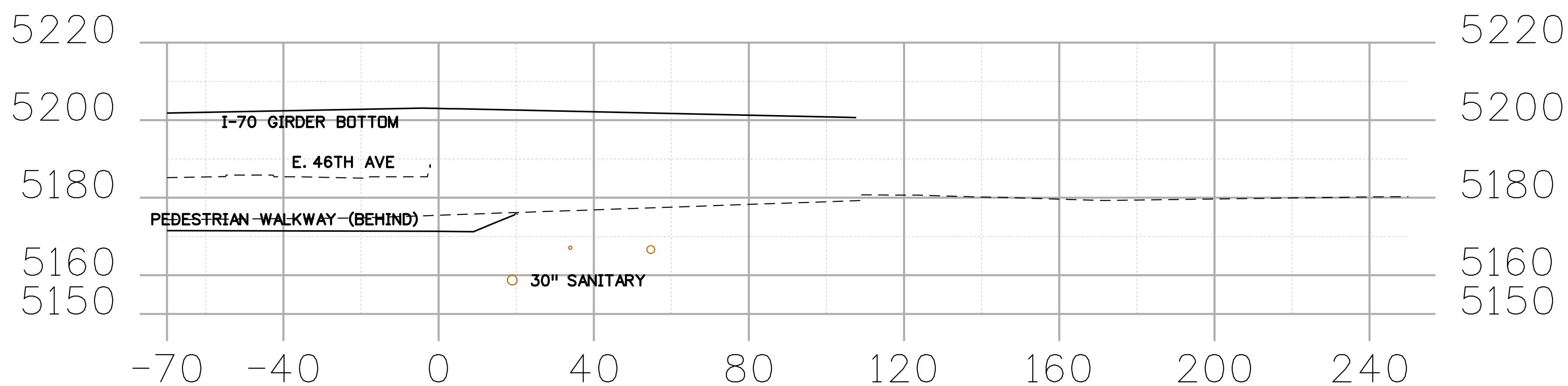

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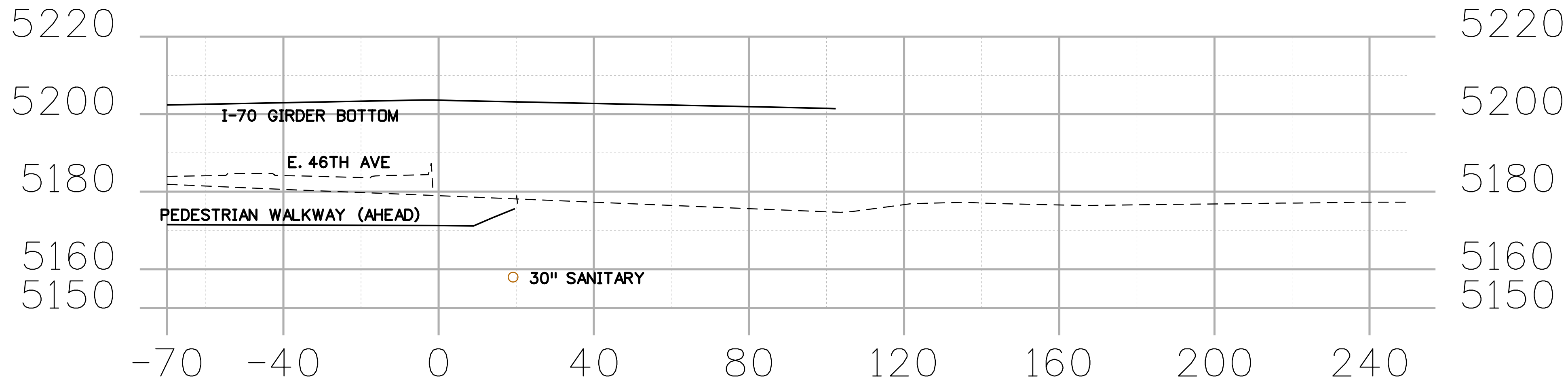

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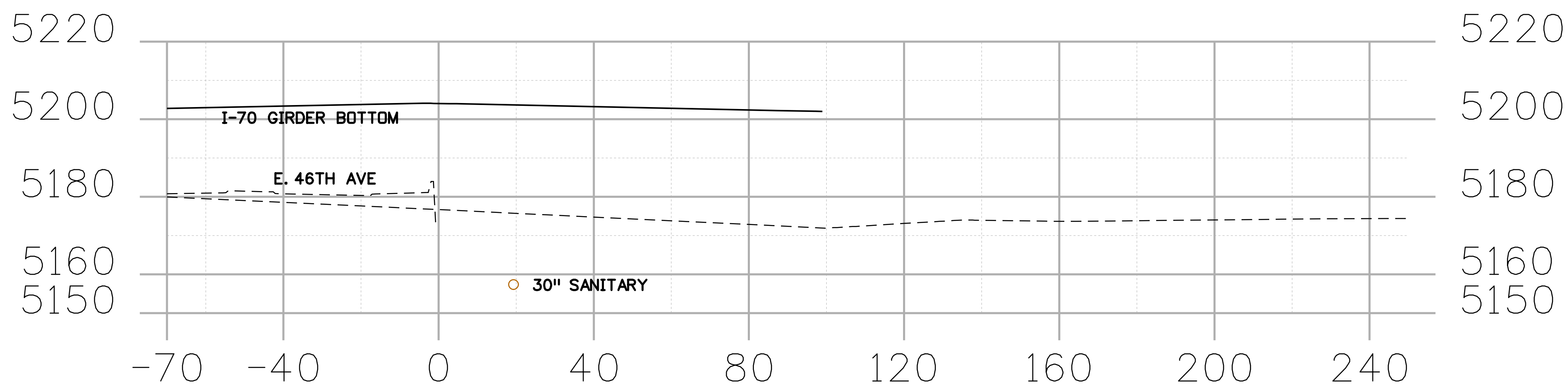

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5280 Connectors Linking I-70 Communities
HDR
Colorado Department of Transportation
Region 1
COLORADO HPTE

I-70 EAST ATC 7.2
SS07 CROSS SECTIONS
STA 1064+00 TO STA 1066+00

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Detailer:	G. CICOFF		
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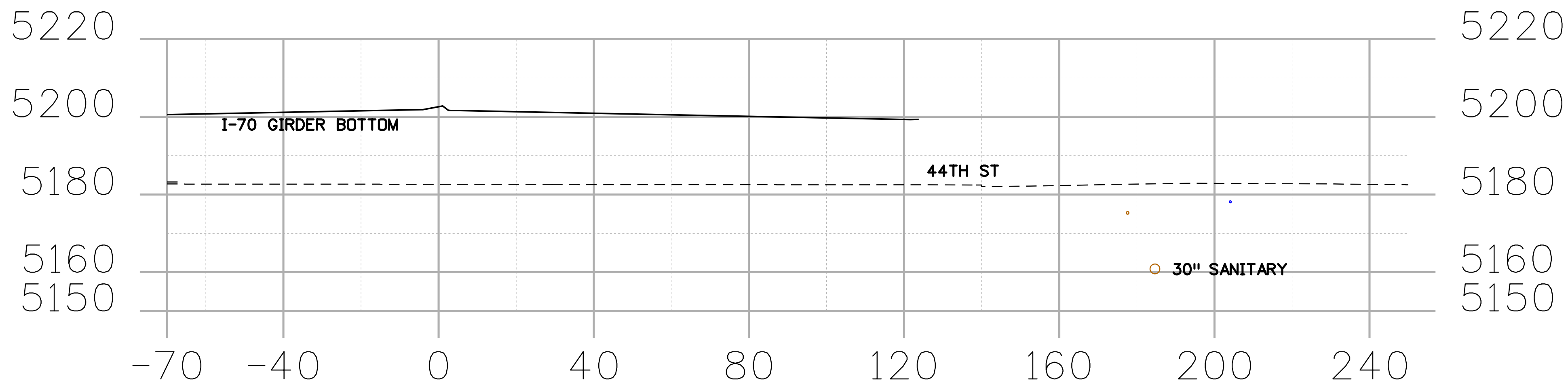

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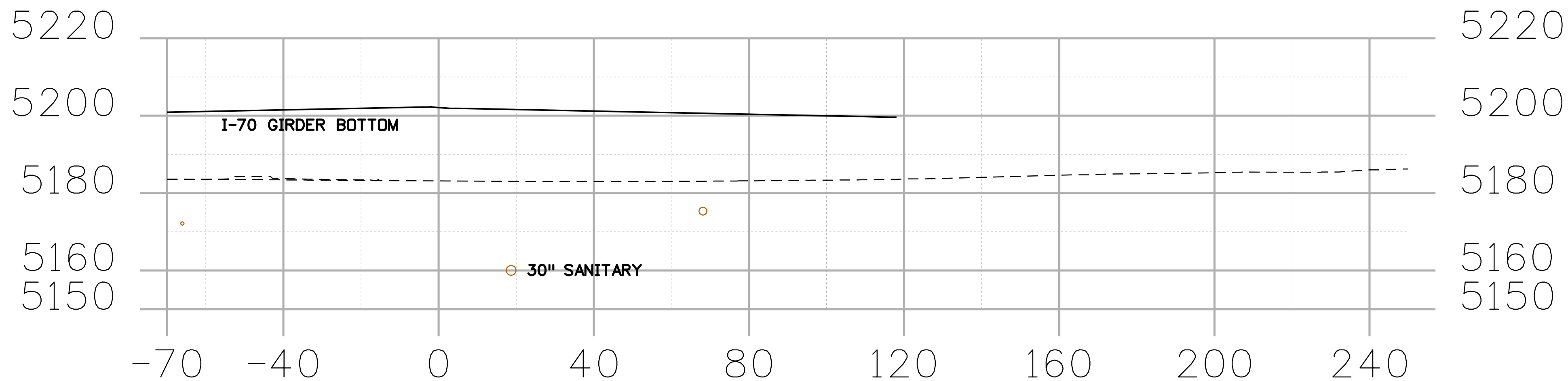

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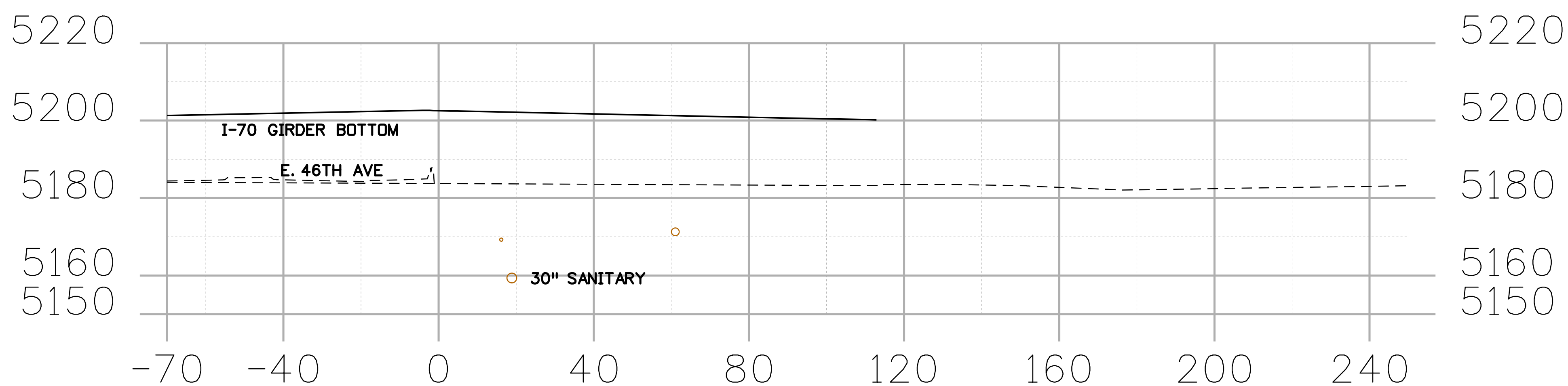

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5280 Connectors Linking I-70 Communities

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CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 7.2
SS07 CROSS SECTIONS
STA 1067+00 TO STA 1069+00

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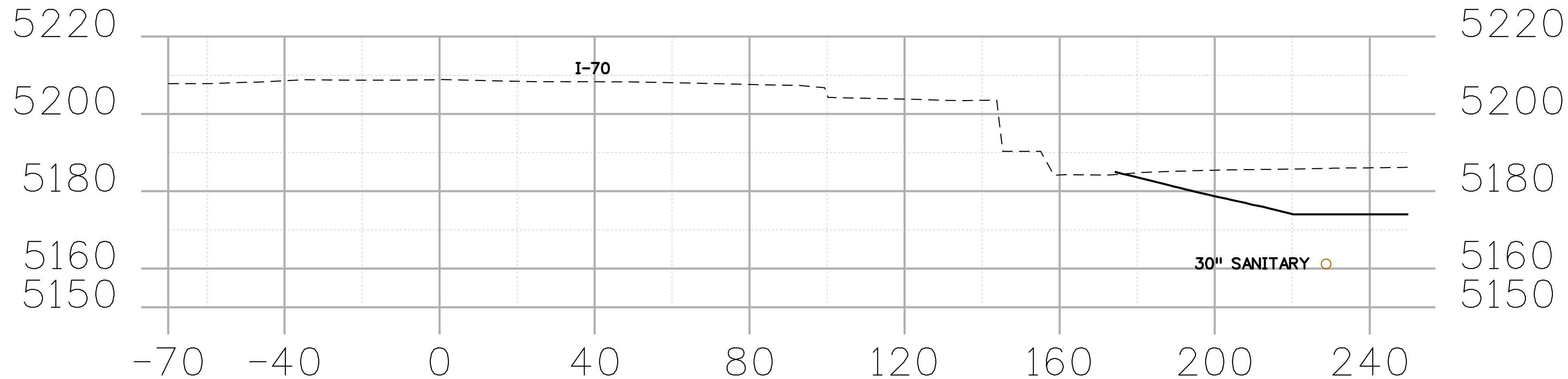

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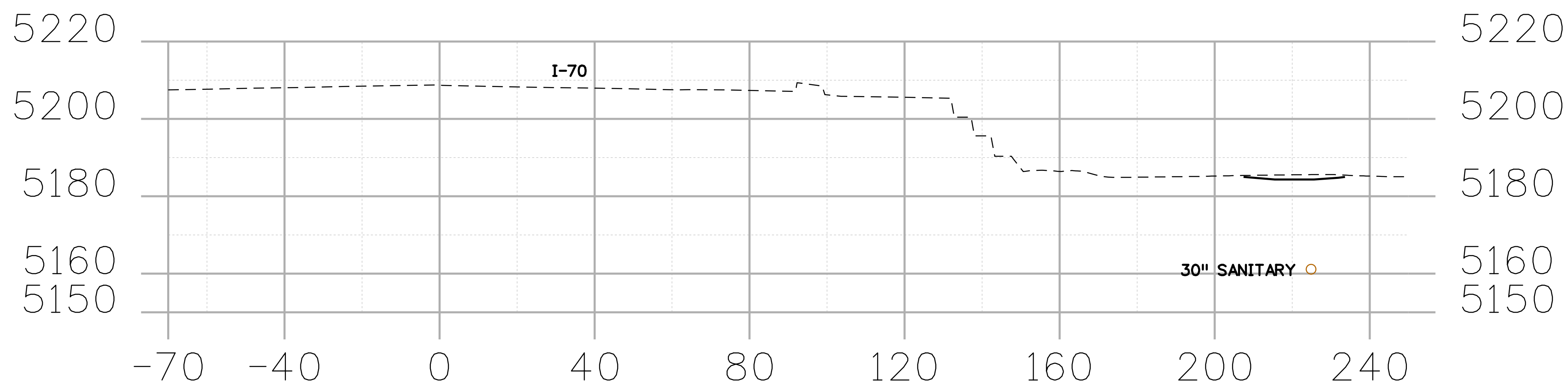

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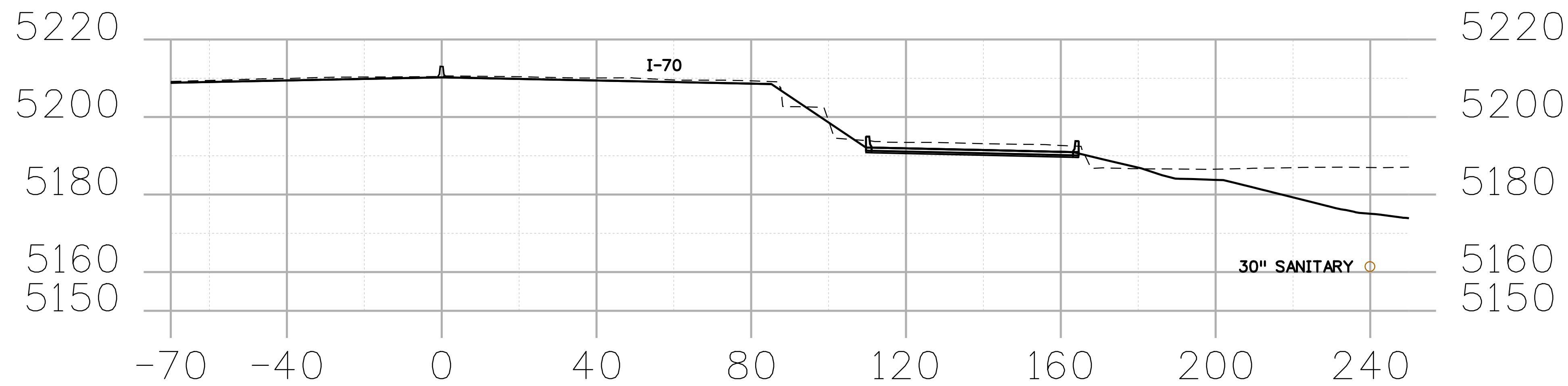

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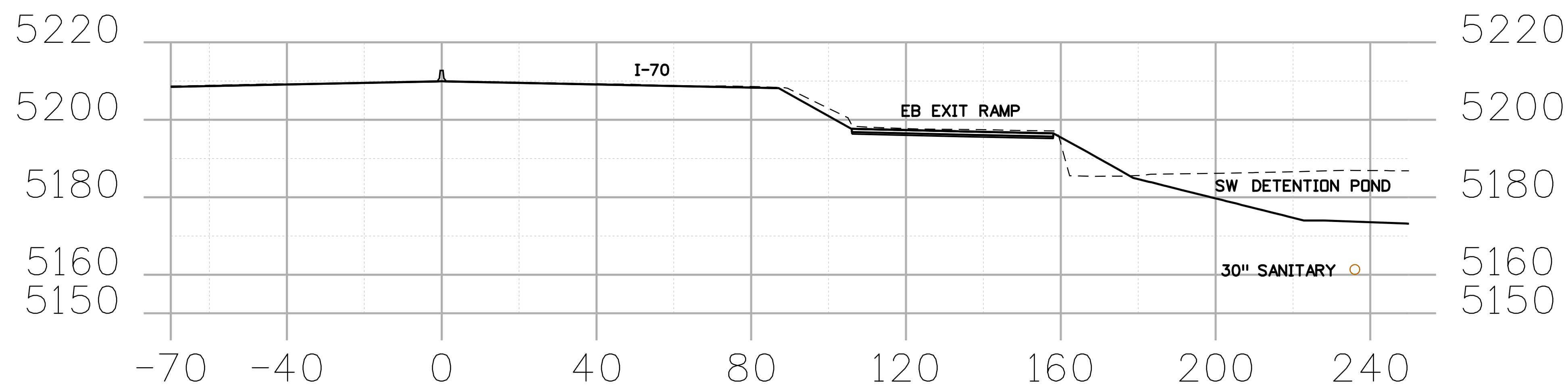

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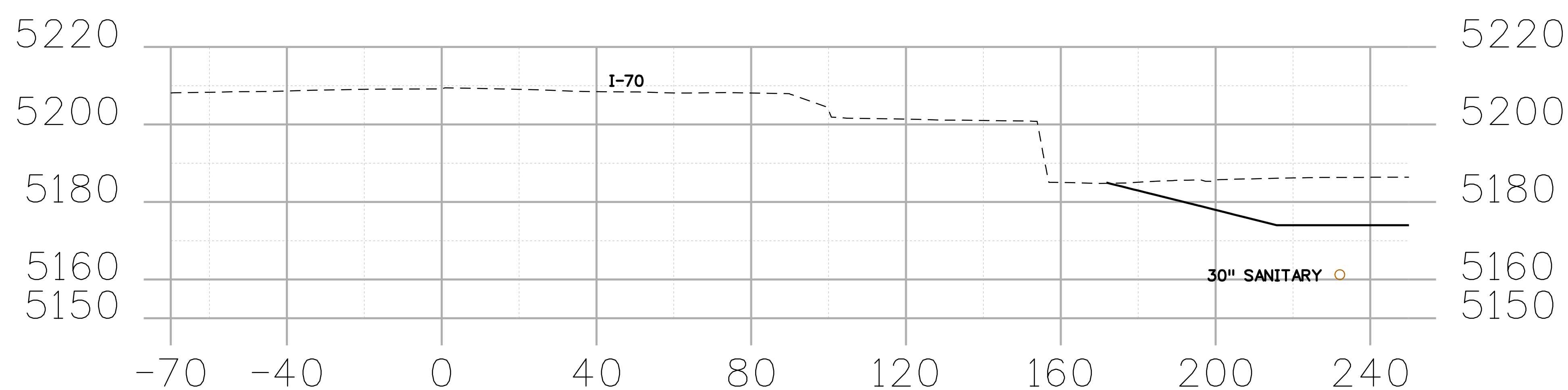

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5280 Connectors Linking I-70 Communities

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CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 7.2
SS07 CROSS SECTIONS
STA 2000+00 TO STA 2002+00

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Detailer:	G. CICOFF		
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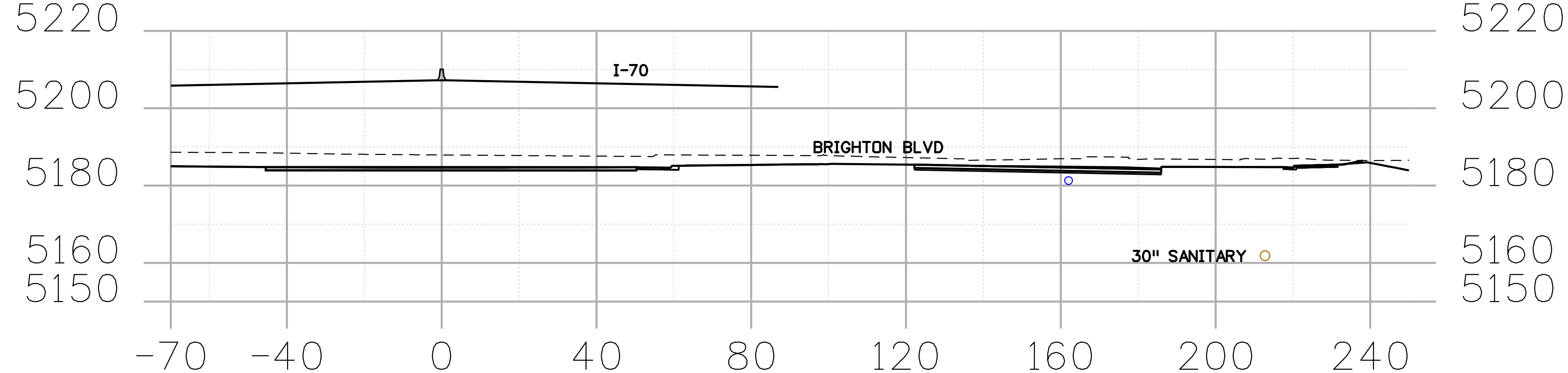

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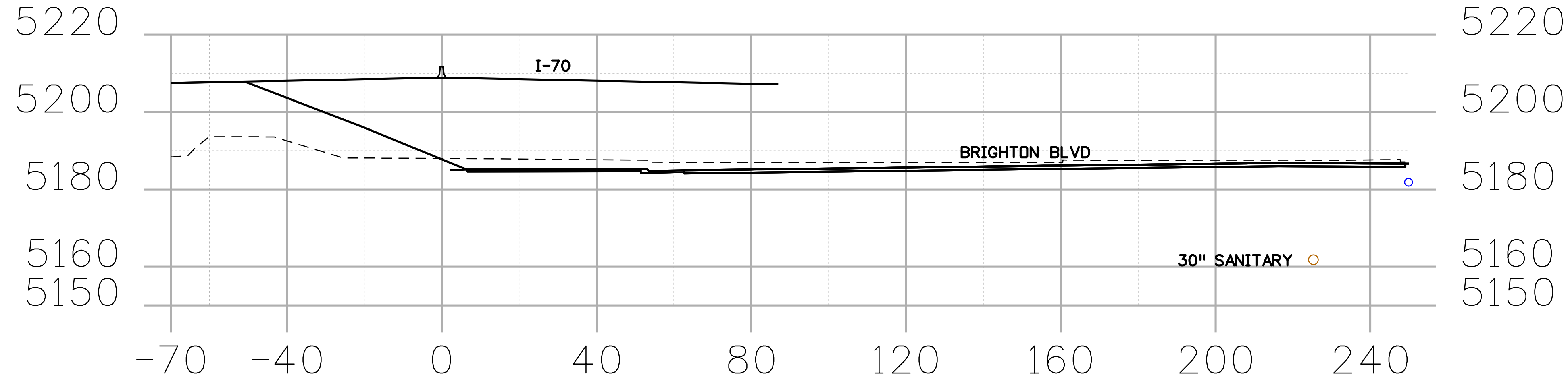

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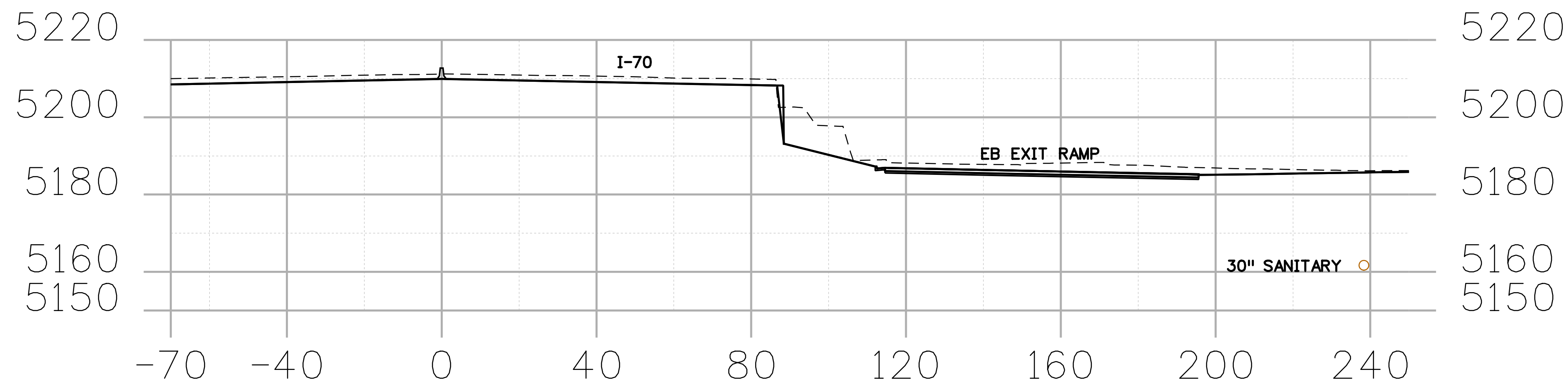

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5280 Connectors Linking I-70 Communities

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I-70 EAST ATC 7.2
SS07 CROSS SECTIONS
STA 2003+00 TO STA 2005+00

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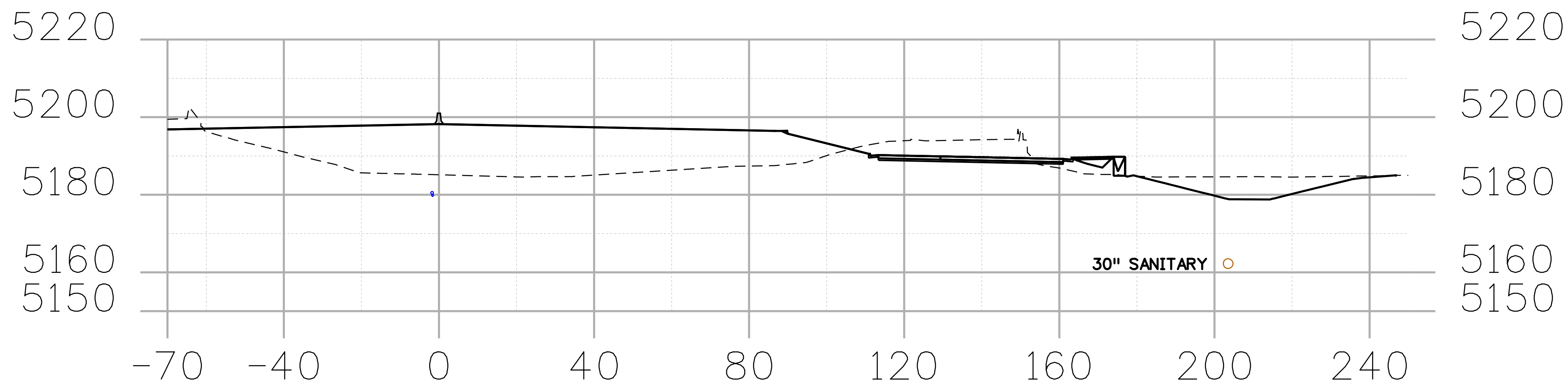

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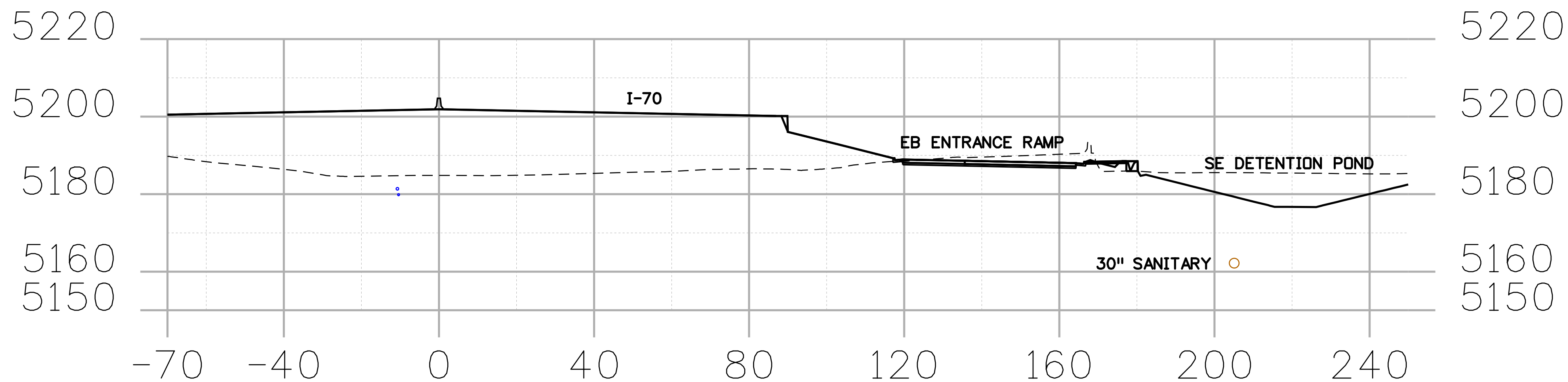

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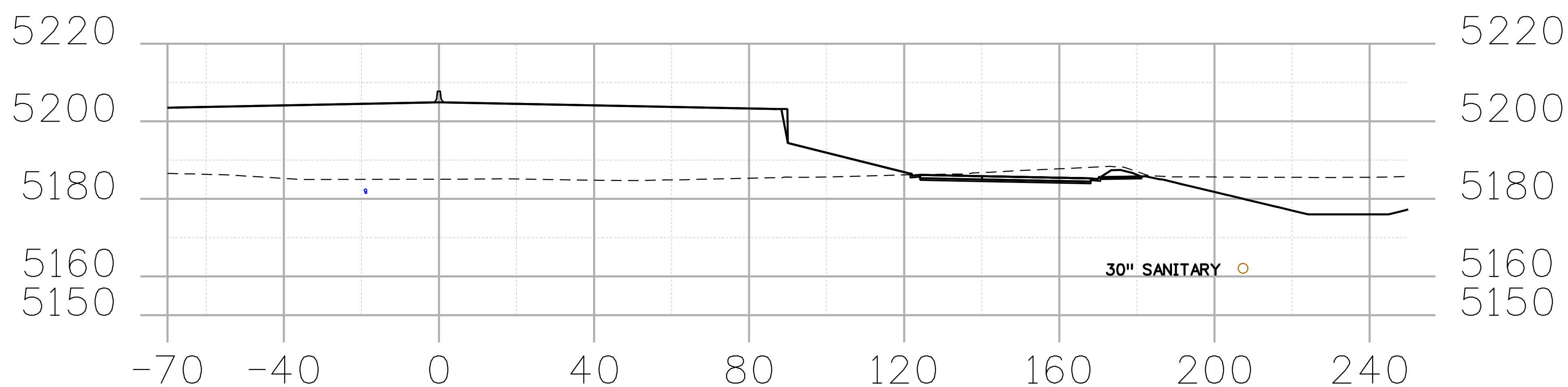

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5280 Connectors Linking I-70 Communities

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I-70 EAST ATC 7.2
SS07 CROSS SECTIONS
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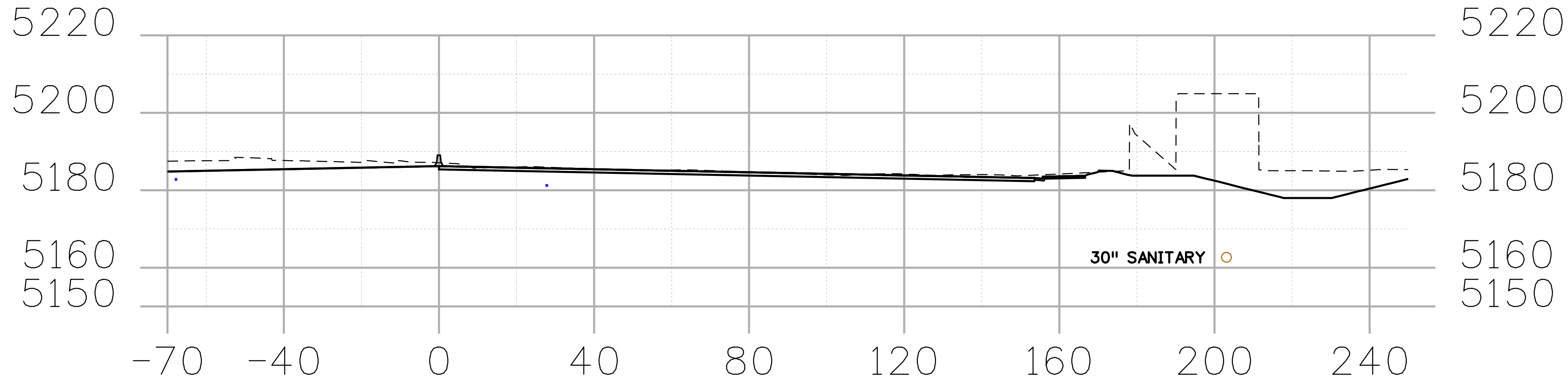

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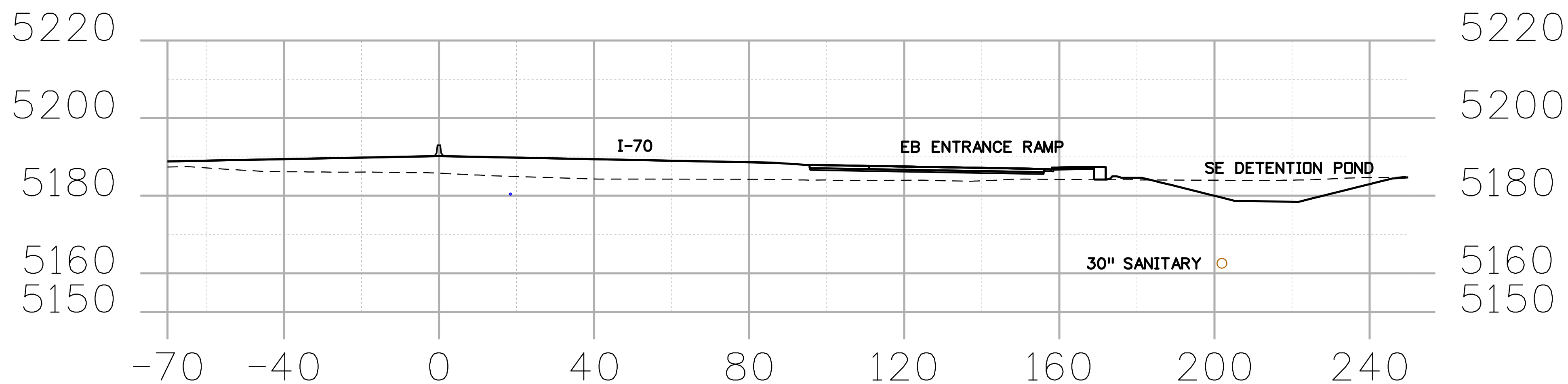

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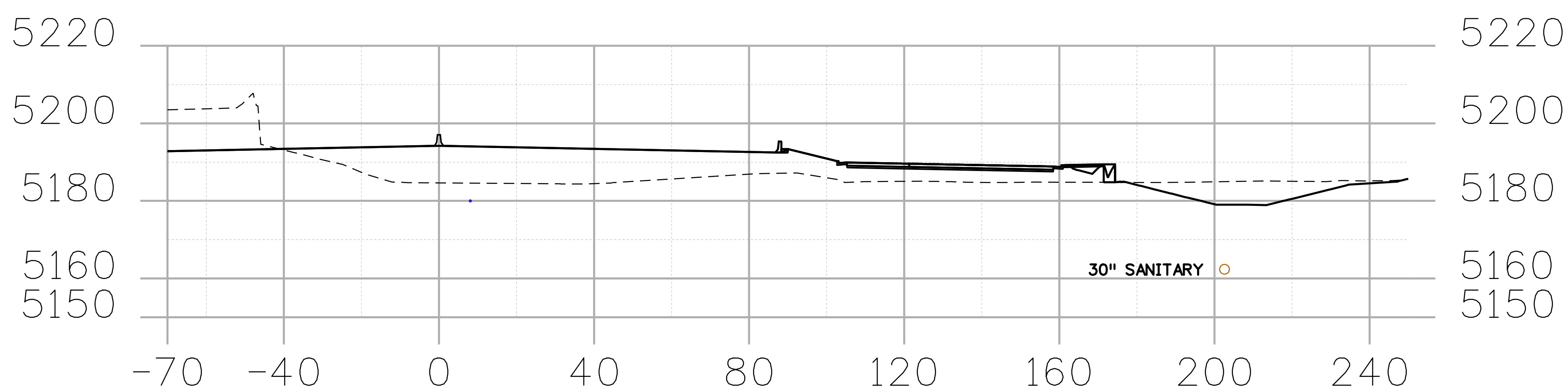

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5280 Connectors Linking I-70 Communities

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I-70 EAST ATC 7.2
SS07 CROSS SECTIONS
STA 2009+00 TO STA 2011+00

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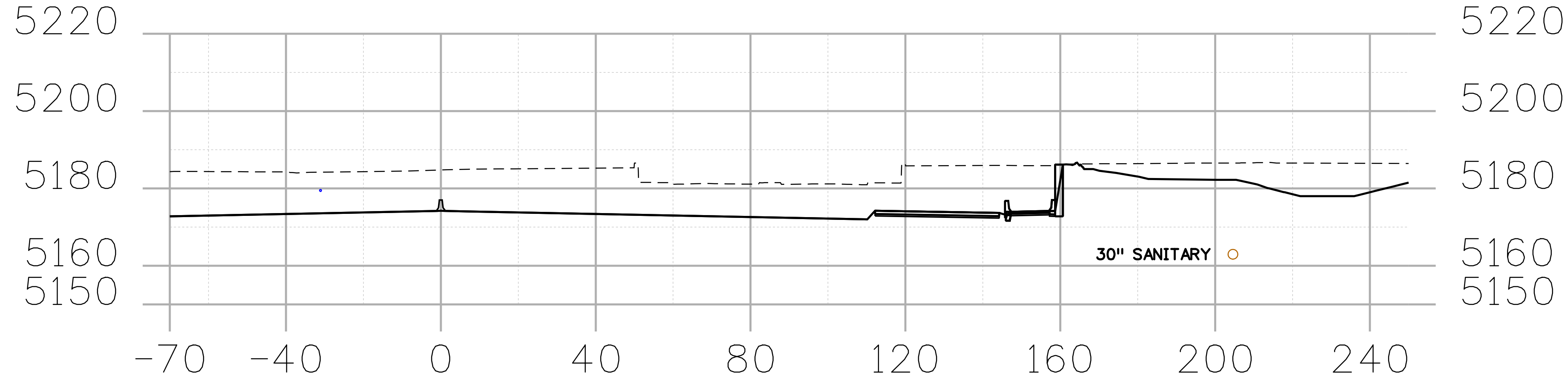

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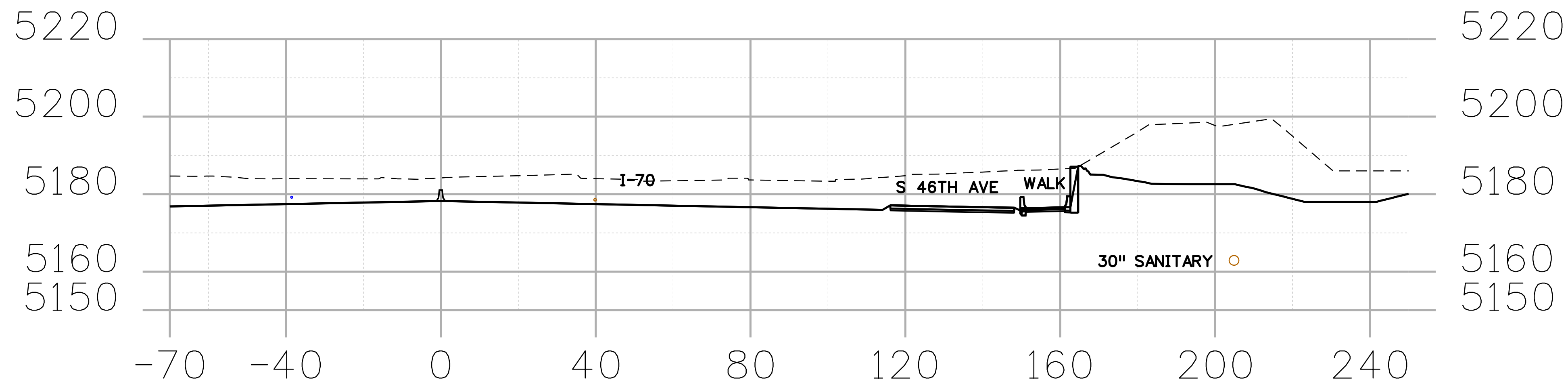

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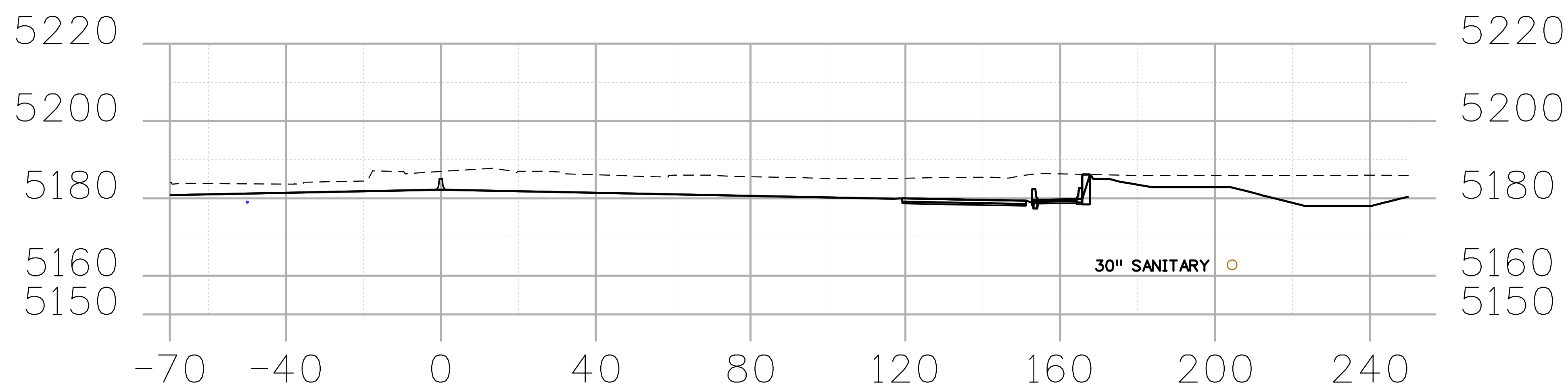

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5280 Connectors Linking I-70 Communities

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I-70 EAST ATC 7.2 SS07 CROSS SECTIONS STA 2012+00 TO STA 2014+00			
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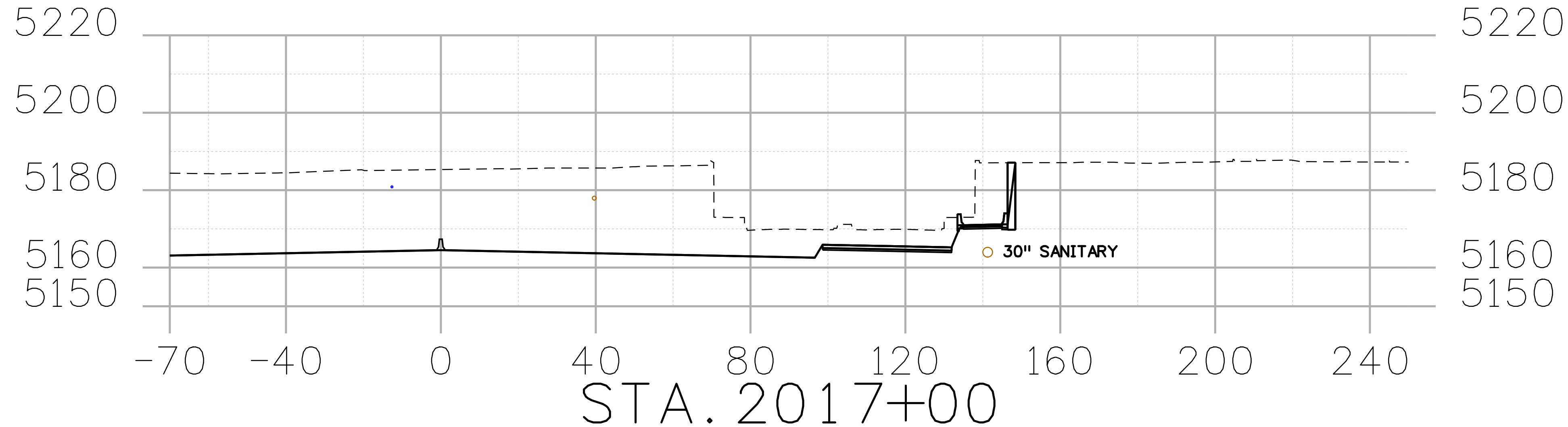

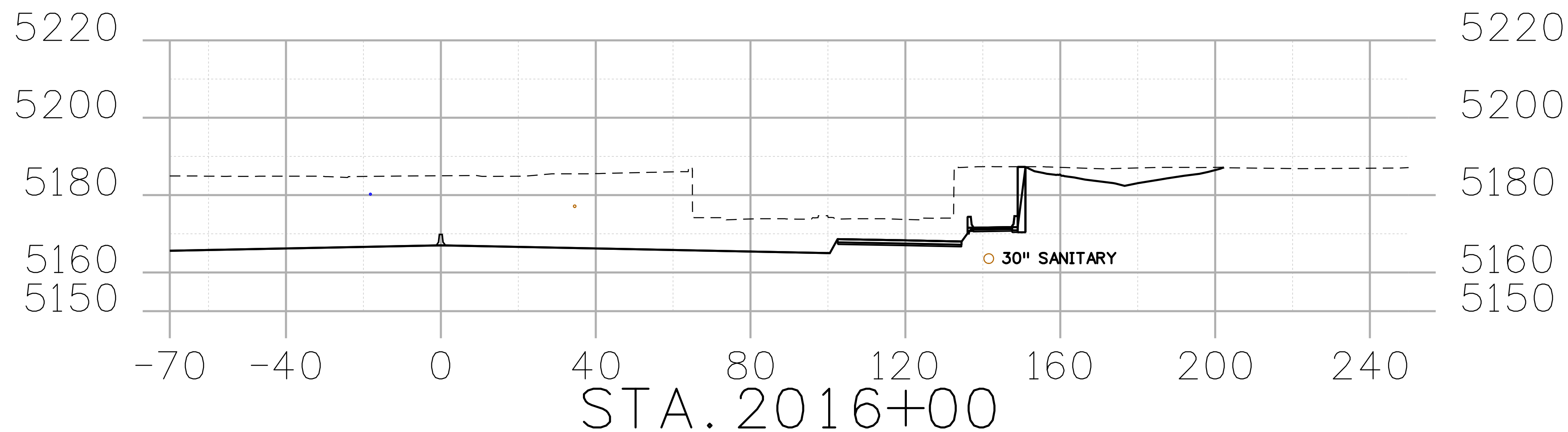

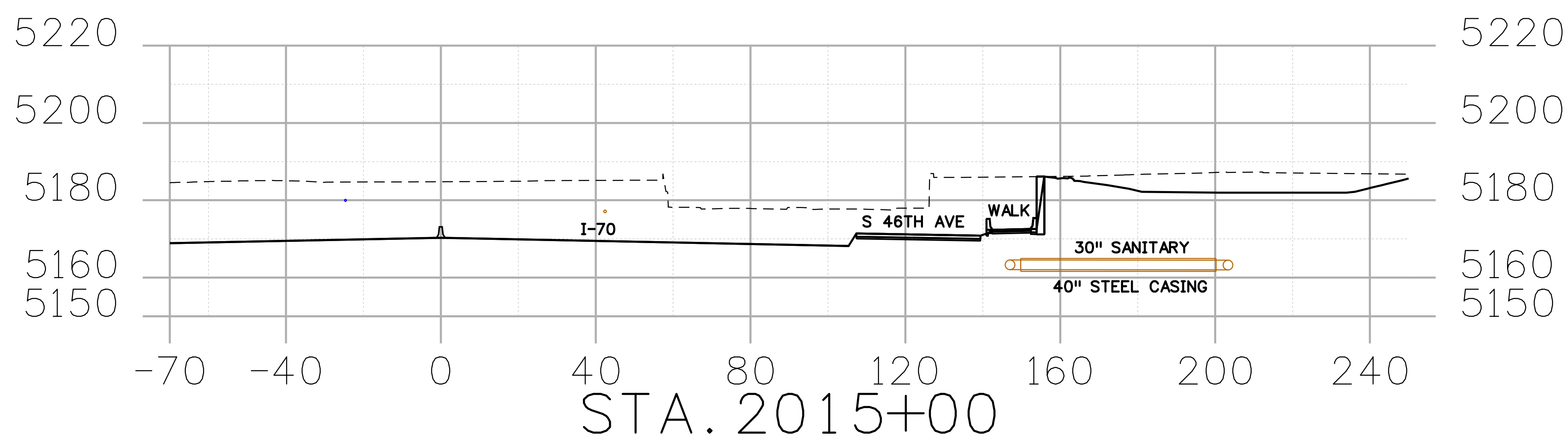

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5280 Connectors Linking I-70 Communities

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COLORADO HPTE

I-70 EAST ATC 7.2
SS07 CROSS SECTIONS
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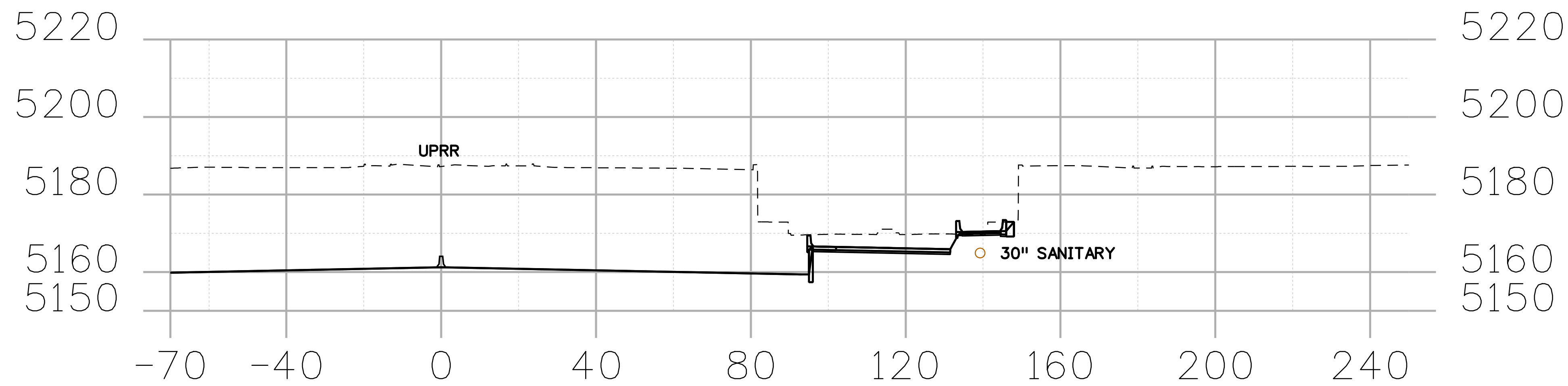

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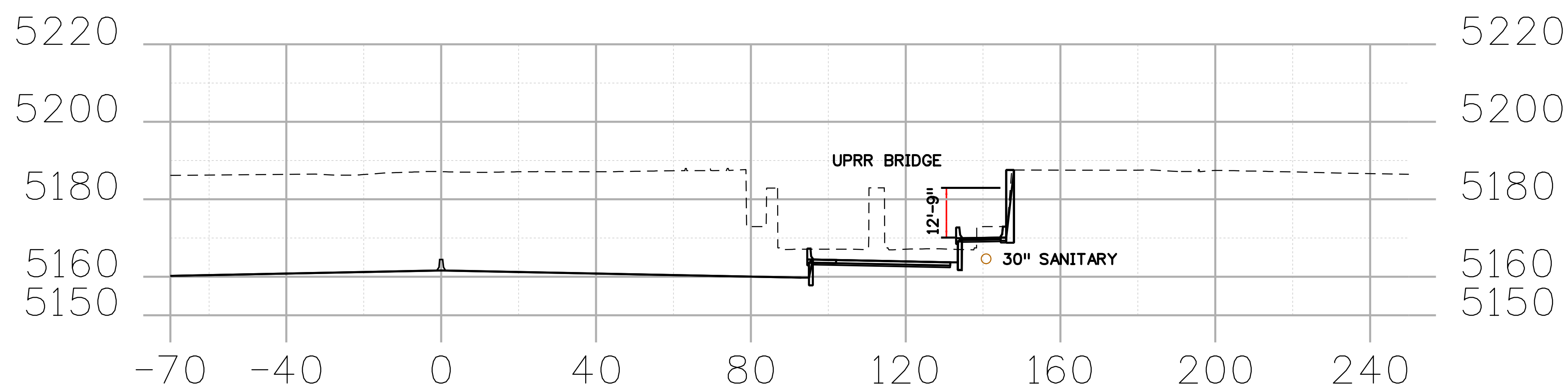

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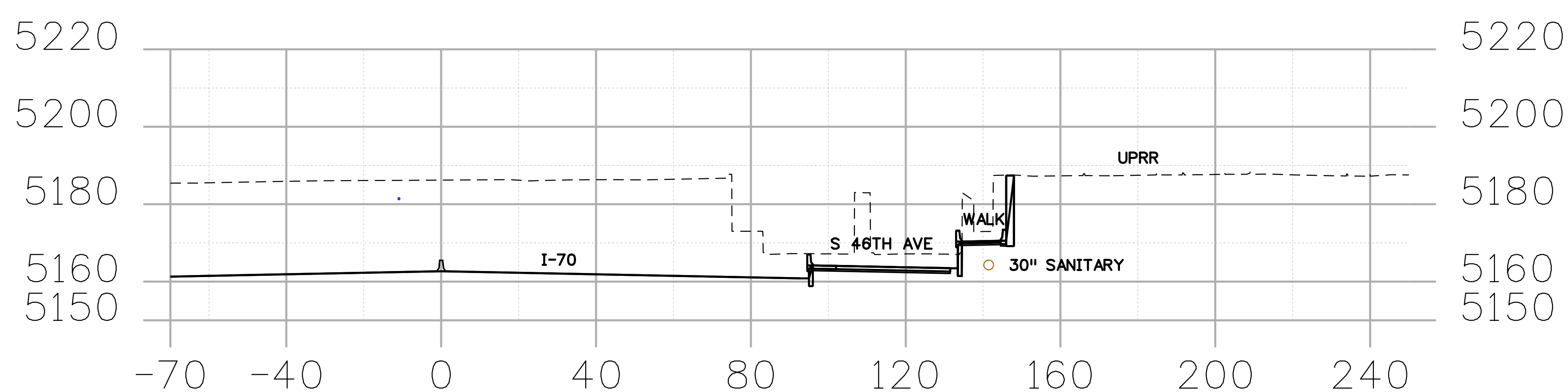

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5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation
Region 1

COLORADO HPTE

I-70 EAST ATC 7.2
SS07 CROSS SECTIONS
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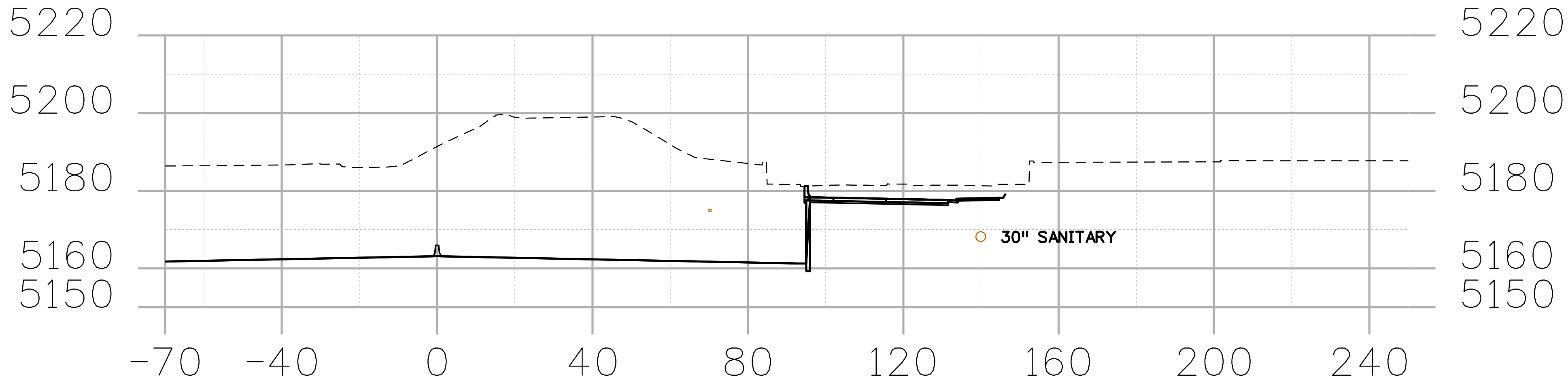

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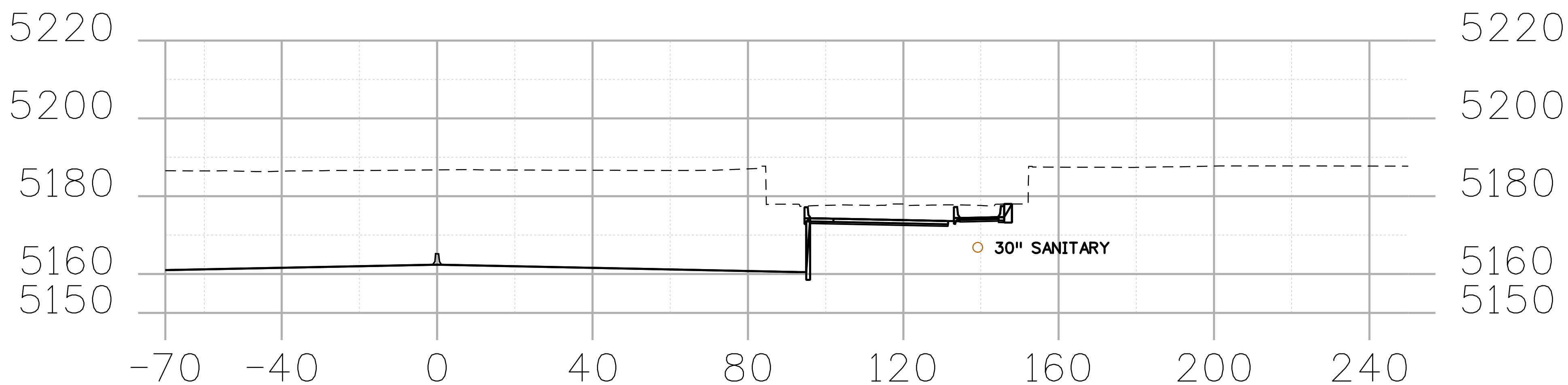

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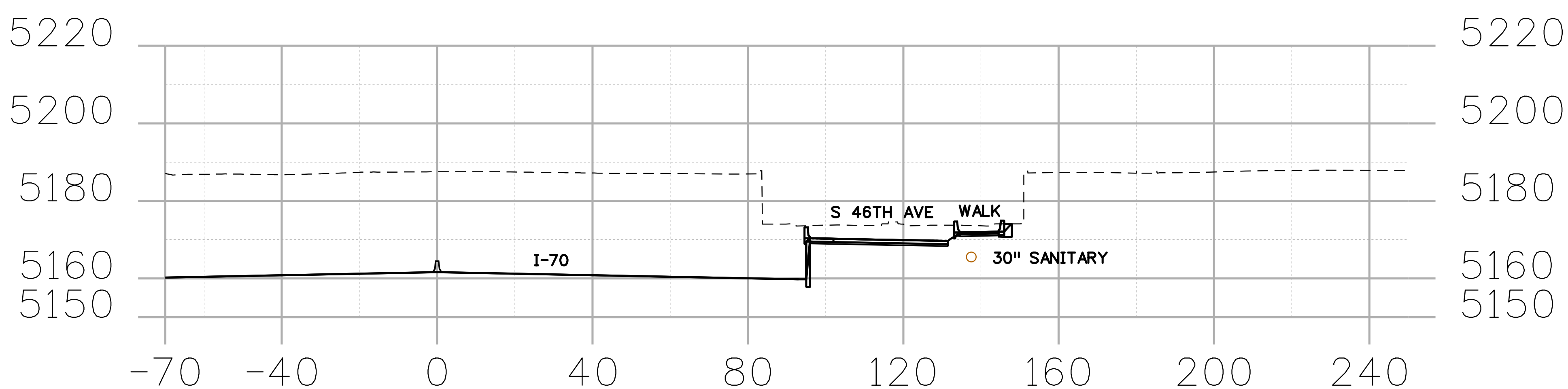

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5280 Connectors Linking I-70 Communities

Colorado Department of Transportation
Region 1

I-70 EAST ATC 7.2
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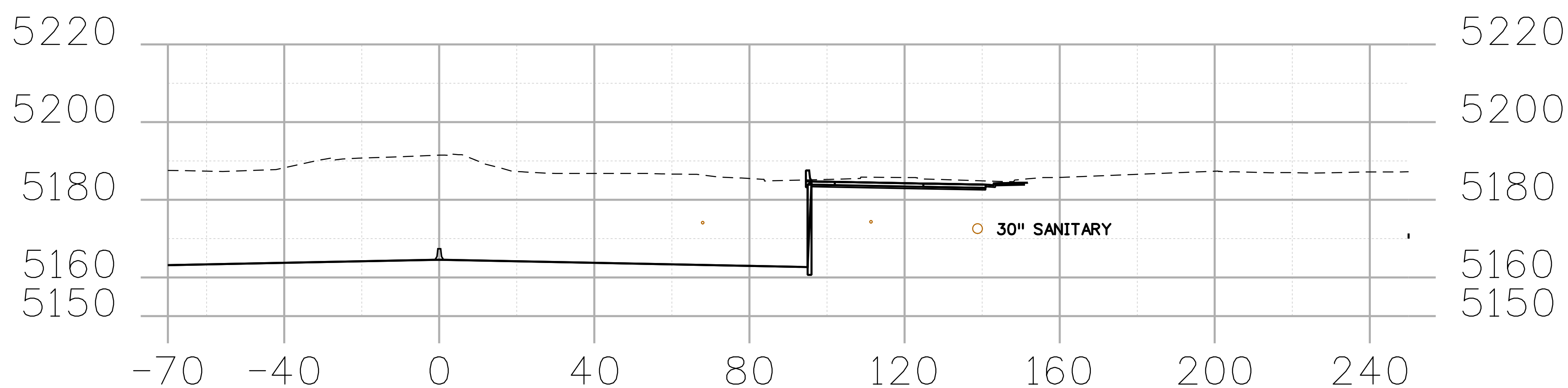

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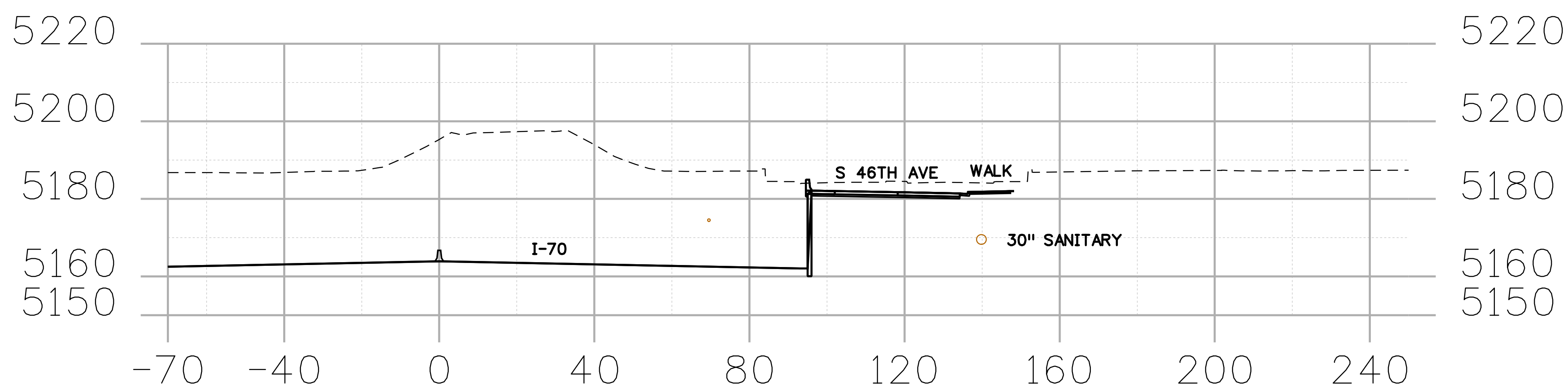

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5280 Connectors Linking I-70 Communities

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I-70 EAST ATC 7.2
SS07 CROSS SECTIONS
STA 2024+00 TO STA 2025+00

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SECTION 2.2.4

ATC 10.2 | ELIMINATION OF PCC JOINT SEALING

2.2 ALTERNATIVE TECHNICAL CONCEPTS

2.2.4 ATC 10.2 | ELIMINATION OF PCC JOINT SEALING

As stated in Form B (Confidential Contents Index), this section has been redacted in accordance with Section 1.5 of the RFP and C.R.S. § 24-72-204.

SECTION 2.2.5

ATC 20.0 | LOWER DESIGN SPEED FOR QUEBEC WB OFF RAMP FROM 45MPH TO 35MPH

DATE: August 31, 2016

TO: 5280 Connectors

FROM: Anthony DeVito P.E. Central 70 Project Director
Nicholas Farber, Central 70 Project

SUBJECT: Central 70 - Conceptual Alternative Technical Concept (ATC) Response
5280 Connectors - ATC No. 20.0

Dear Mr. Clark:

Your Team's ATC Submission Form for Conceptual ATC 20.0 was reviewed by the Procuring Authorities prior to the August One-on-One Meetings and an initial response was sent to you on August 4, 2016. As discussed during the August One-on-One Meeting, the Procuring Authorities committed to provide a final response to your Conceptual ATC. The ATC proposes to lower the design speed for the Quebec St. westbound exit ramp from 45 mph to 35 mph.

In accordance with the Instructions to Proposers ("ITP"), the Procuring Authorities will use reasonable efforts to provide a Proposer with the following written feedback on a ATC Submission within 15 Working Days following the later of (x) the date the relevant ATC Submission was submitted and (y) the One-on-One Meeting at which such submission is discussed. Below is the final response from the Procuring Authorities for your Conceptual ATC:

☒ 1. unconditional approval and waiver of requirement for re-submission as a Detailed ATC;

☐ 2. unconditional approval for re-submission as a Detailed ATC;

☐ 3. conditional approval for re-submission as a Detailed ATC, subject to modifications and/or conditions;

☐ 4. disapproval, with or without guidance that such ATC can be re-submitted under any circumstance;

☐ 5. notification that the inclusion of the proposed ATC in the Proposer's Proposal is already permitted under the terms of the RFP, and therefore does not qualify as an ATC (and will not be treated as such for purposes of Section 3.4 of Part C of the ITP; or

☐ 6. subject to compliance with the confidentiality requirements set out in Section 3.4 of Part C of the ITP, the Procuring Authorities are considering amending (for the benefit of all Proposers) the terms of the RFP that are the subject-matter of the proposed ATC.

Following our discussions at the One-on-One Meeting, the Procuring Authorities <u>have not</u> changed their initial response to your above mentioned Conceptual ATC Submission.

The approval of this Conceptual ATC by the Procuring Authorities does not constitute an approval of specific drafting modifications to the RFP necessary to incorporate this ATC into the Project Agreement pursuant to

Section 7.2.1.c of Part C of the ITP, which modifications shall be agreed by the Procuring Authorities and the Proposer (each acting reasonably) following issuance of a Notice of Award to such Proposer.

ANNEX 3: ALTERNATIVE TECHNICAL CONCEPT SUBMISSION FORM

Proposer Name: 5280 Constructors
Date: July 14, 2016

Central 70 Project RFP: ATC Submission No. 20.0

A. Background Information

1. Type of Submission

☒ Conceptual ATC

☐ Detailed ATC

2. Prior Submission(s)

☒ None (initial submission of ATC)

☐ Previously Submitted as Conceptual ATC

☐ Previously Submitted as Detailed ATC

3. Explanation of Reason for Resubmission

n/a

4. Request for Discussion at One-on-One Meeting

☒ Meeting Requested

☐ Meeting Not Requested[1]

[1] In accordance with Section 3.2.1 of Part C, the Procuring Authorities may nevertheless require a Proposer to present an ATC Submission at a One-on-One Meeting.

B. General ATC Submission Requirements

1. Overview Description

We propose to lower the design speed for the Quebec St. Westbound Exit Ramp due to geometric design refinement from 45 mph to 35 mph. With the current design speed of 45 mph, we are not able to tie in the WB off-ramp profile with the proposed Quebec Street due to vertical profile issues. This change will allow more flexibility with the WB off-ramp profile and the I-70 mainline profile, allowing the construction of a single span bridge for I-70 over Quebec. This will provide improved maintenance of traffic with reduced impacts to the traveling public without the need to widen the existing Sand Creek Bridge.

2. Relevant RFP Requirements

The Project Agreement Schedule 10- Section 9 Appendix A of the Roadway Design Criteria calls for the design speed for the Quebec Street Westbound Exit Ramp to be 45 mph.

3. Rationale

The design of the Quebec Street WB off-ramp provided in the Schedule 10B Reference Documents does not meet the Appendix A Design Criteria for 45 mph design speed due to substandard K value. We propose to reduce the ramp roadway design criteria to 35 mph. With a 45 mph design speed, it is not possible to raise the I-70 profile to accommodate a single span bridge unless the gore point of the Quebec WB off-ramp is moved east onto the Sand Creek Bridge, thus requiring a widening of the bridge. Without the need to construct a pier in the median of Quebec, the single span bridge will greatly improve maintenance of traffic operations at Quebec St. The single span bridge will also provide improved sight distance, operations, visibility and aesthetics for the permanent condition. In the Ultimate Configuration of the Quebec St. Interchange will include a new WB off-ramp bridge over Sand Creek. Therefore the proposed 35 mph ramp design speed would be an interim condition.

4. Impacts

A design speed change to 35 mph at the Quebec St. westbound exit ramp, would allow construction of the ramp to occur without any effect on the Sand Creek Bridge to the east. This change would also allow for the ramp to tie in from the I-70 mainline to Quebec Street providing for a single span I-70 structure over Quebec St. Both construction cost and schedule are benefited while having a lesser impact on the traveling impact.

5. Cost and Benefit Analysis

Decreasing the design speed at the Quebec westbound off ramp from 45 mph to 35 mph will result in a cost savings of $1.2 Million Dollars due to reduced bridge phasing construction costs and reduced ramp reconstruction work.

6. Schedule Analysis

Lowering the design speed at the Quebec Street westbound exit ramp to 35 mph is estimated to benefit the Project Schedule by eliminating the construction of a pier at the I-70 mainline structure over Quebec Street. This will result in an estimated 3 month reduction to the Project Schedule based on Conceptual Phasing Plan for Construction.

7. Conceptual Drawings

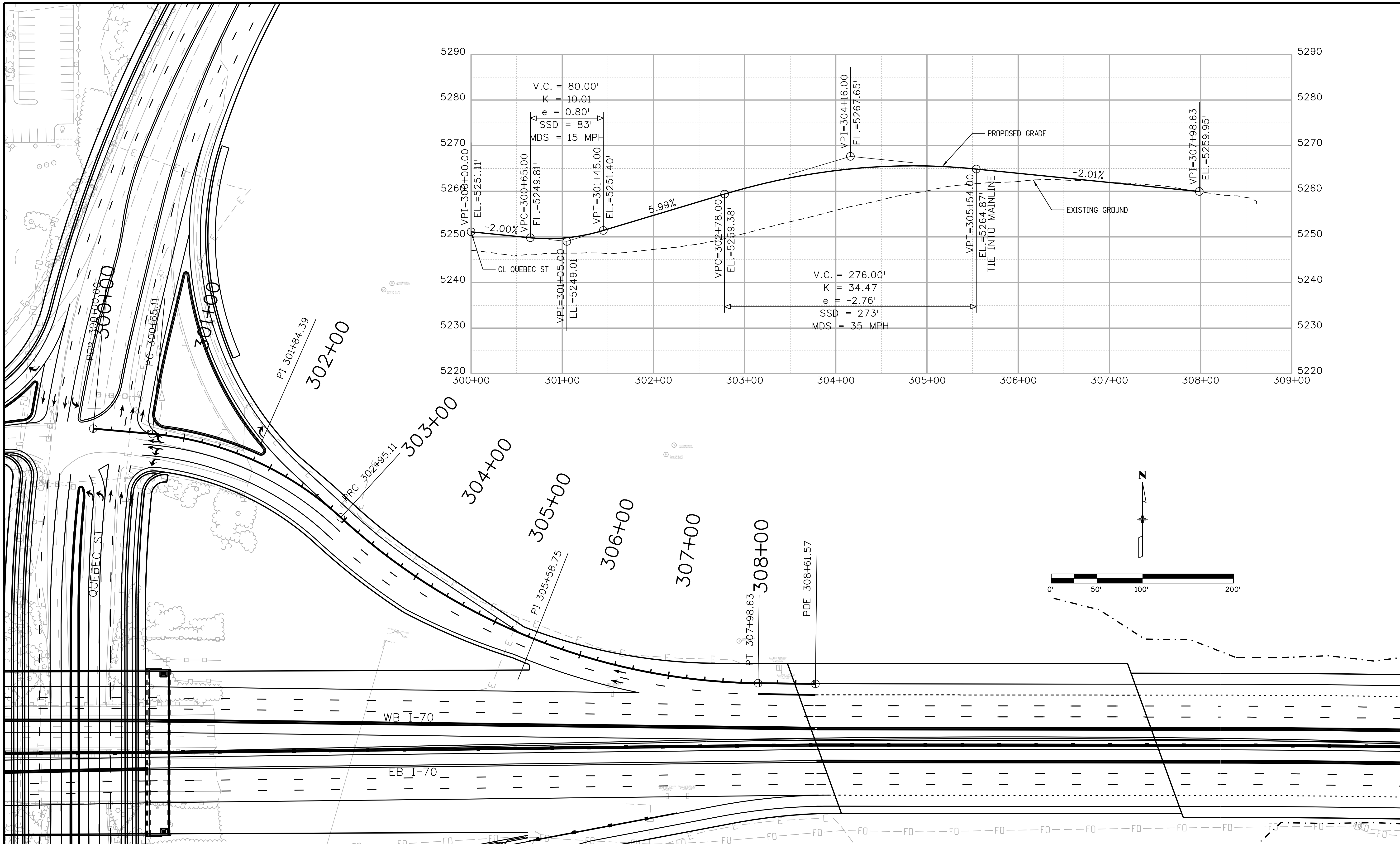
See attached Plan and Profile of the Quebec Street westbound exit ramp.

8. Past Use

N/A

9. Additional Information

N/A



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5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation

CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 20.0
QUEBEC ST WB OFF RAMP
35 MPH PROFILE

Designer:		Structure Numbers	
Detailer:			
Sheet Subset:		Subset Sheets:	1 of 1

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SECTION 2.2.6

ATC 25.2 | YORK STREET STORM DRAIN CONNECTION

Central 70

DATE: March 3, 2017

TO: 5280 Connectors

FROM: Anthony DeVito P.E. Central 70 Project Director
Nicholas Farber, Central 70 Project

SUBJECT: Central 70 - Detailed Alternative Technical Concept (ATC) Response
5280 Connectors - ATC No. 25.2

Dear Mr. Clark:

Your Team's ATC Submission Form for Detailed ATC 25.2 was reviewed by the Procuring Authorities prior to the February One-on-One Meetings and an initial response was sent to you on February 10, 2017. As discussed during the February One-on-One Meeting, the Procuring Authorities committed to provide a final response to your Detailed ATC.

Detailed ATC 25.2 proposes an alternative drainage outfall solution for the Onsite Outfall System.

In accordance with the Instructions to Proposers ("ITP"), the Procuring Authorities will use reasonable efforts to provide a Proposer with the following written feedback on a ATC Submission within 15 Working Days following the later of (x) the date the relevant ATC Submission was submitted and (y) the One-on-One Meeting at which such submission is discussed. Below is the final response from the Procuring Authorities for your Detailed ATC:

☐ 1. unconditional approval;

☒ 2. conditional approval, subject to modifications and/or conditions;

☐ Re-submission required ☒ Re-submission not required

☐ 3. disapproval, with or without guidance that such ATC can be re-submitted under any circumstance;

☐ 4. notification that the incorporation of the proposed ATC in the Proposer's Proposal is already permitted under the terms of the RFP, and therefore does not qualify as an ATC (and will not be treated as such for purposes of Section 3.4 of Part C of the ITP).

☐ 5. subject to compliance with the confidentiality requirements set out in Section 3.4 of Part C of the ITP, the Procuring Authorities are considering amending (for the benefit of all Proposers) the terms of the RFP that are the subject-matter of the proposed ATC.

Following our discussions at the One-on-One Meeting, the Procuring Authorities <u>have not</u> changed their initial response to your above mentioned Detailed ATC Submission. The ATC is approved with the following conditions:

Conditions of approval:

1. The Developer shall be responsible for any additional Utility Work required to implement this ATC.

The approval of this Detailed ATC by the Procuring Authorities does not constitute an approval of specific drafting modifications to the RFP necessary to incorporate this ATC into the Project Agreement pursuant to

Section 7.2.1.c of Part C of the ITP, which modifications shall be agreed by the Procuring Authorities and the Proposer (each acting reasonably) following issuance of a Notice of Award to such Proposer.

ANNEX 3: ALTERNATIVE TECHNICAL CONCEPT SUBMISSION FORM

Proposer Name: 5280 Constructors
Date: January 24, 2017

Central 70 Project RFP: ATC Submission No. 25.2[1]

A. Background Information

1. Type of Submission

☐ Conceptual ATC

☒ Detailed ATC

2. Prior Submission(s)

☐ None (initial submission of ATC)

☒ Previously Submitted as Conceptual ATC

☐ Previously Submitted as Detailed ATC

3. Explanation of Reason for Resubmission

ATC 25.1 received conditional approval with Re-submission required. The response included, "The resubmission shall address the following item:

1. *Provide a no adverse impact analysis for the existing 72" pipe in York Street. The analysis shall compare the reference design to the ATC. As part of the analysis, provide the storm event that would fill the existing 72" pipe as well as the 5 year and 100 year flow conditions for both the reference design and if the ATC is implemented."*

ATC Design has been verified to confirm No Adverse Impact.

4. Request for Discussion at One-on-One Meeting

☒ Meeting Requested

☐ Meeting Not Requested[2]

[1] Proposers to complete in accordance with instruction (2) to the Annex.
[2] In accordance with Section 3.2.1 of Part C, the Procuring Authorities may nevertheless require a Proposer to present an ATC Submission at a One-on-One Meeting.

B. General ATC Submission Requirements

1. Overview Description

This information has not been amended since the submission of the previous version of this ATC.

5280 Connectors proposes an alternative drainage outfall solution for the Onsite Outfall System. The *Draft Master Plan Drainage Report and Draft Master Plan Water Quality Report* provide a concept for the Onsite drainage design which includes a new outfall system to convey I-70 stormwater flow directly to the South Platte River from a point northwest of the York St. and I-70 intersection. Due to the elevation of the lowered I-70 profile, the concept Onsite drainage design includes a micro tunnel outfall pipe to an offsite detention pond and pump station.

Under existing conditions, I-70 drains to the existing Denver storm drain system with flows toward York Street and 47th Ave (see attached Drainage Basin Plan Exhibit). An existing 72 inch storm drain in York St. carries flows from the south to north side of I-70, turning west at 47th Ave. and increasing to a 78 inch pipe. Our proposed ATC 4.0 would divert flow in the existing 72 inch storm drain south of I-70 at York St. into the Offsite drainage system. This diversion would eliminate all flow from the existing 72 inch storm drain on the north side of I-70 and allow for additional capacity.

Our alternative drainage concept will utilize a new stormwater pump station situated in the remaining York St. remnant parcel to the north of the proposed 46th Ave. North. The proposed pump station would lift and discharge stormwater from the Onsite collection system into a proposed water quality pond. This stormwater would then discharge into the existing Denver storm drain system 72" pipe, flowing west at the intersection of York St. and 47th Ave. (see attached Pump Station Plan).

2. Relevant RFP Requirements

This information has not been amended since the submission of the previous version of this ATC.

The Project Agreement Schedule 10, *Section 8.3.2.b states "The Developer shall coordinate all drainage related issues with affected Governmental Authorities", requiring* City and County of Denver Wastewater Department coordination.

The Project Agreement Schedule 10, *Section 8.4.5.a states "The use of pump stations shall be permitted where stormwater removal by gravity is not economically feasible, as Approved by the Department."* The change in pump station provides offsite outfall for stormwater at reduced cost when compared to the RFP designed onsite outfall to the South Platte River.

This alternative drainage concept incorporates changes in flows from ATC No. 4 and relocating the stormwater pump station location. Historic drainage lows are maintained with modifications to contributory areas. The concept plan for the Onsite Outfall System design is provided as an information Reference Document. Due the changes with this alternative drainage design concept, the location of the pump station and connection to the existing drainage system require coordination and approval elements.

3. Rationale

This information has not been amended since the submission of the previous version of this ATC.

Discharge of the I-70 Onsite runoff can be accommodated in the existing Denver storm drain at York Street with the diversion of flow as a result of ATC No 4. A pump station would lift stormwater from the lowered section to a water quality pond located immediately north of I-70. The grading of the water quality pond could be designed to accommodate the future 47th Ave Grade Separation Project. A pump station is included in the Concept Design located at the downstream end of the system to lift stormwater flow into the South Platte River. By moving the pump station to the upstream end of the system, I-70 stormwater can follow historical flow paths and discharge to the South Platte River using existing storm drains. The connectivity of the CDOT storm drain system to the Denver storm drain system at York is similar to other storm drain connections throughout the project including Colorado Blvd., Forest St., Grape St., Monaco St., Havana St. and Carson St., all of which maintain historic flow paths.

The York Street 72 inch storm drain, north of I-70, has zero flow due to ATC No. 4, York Street Diversion. By eliminating contributing flow to the system with ATC 4.0, the freed capacity of the York Street storm drain can provide sufficient capacity for the Onsite Drainage System outfall.

The proposed pump station would be capable of discharging approximately 90 cfs vs. smaller conceptual design pump station with capacity of 10 cfs, which also require significant detention volume and was located at the outfall. The proposed pump station would be designed to accommodate the 100-year runoff and meet the other requirements for pump stations shown in the RFP.

Elimination of the concept outfall tunnel system would:

- Eliminate construction drainage impacts north of 47th Ave.
- Provides a more efficient drainage system
- Maintains historic drainage flow paths

The existing York Street 72 inch storm drain provides the following:

- Adequate capacity to accept discharge of the proposed I-70 Onsite system
- Adequate capacity to accept the proposed 46th Ave North runoff
- A full flow, pipe capacity of approximately 408 cubic feet per second (cfs)

System	**Capacity (cfs)**	**Requirement**	**Additional Available Capacity (cfs)**
RFP On Site System	116 (updated based on Addendum #5)	Separate system. Flow in existing York Street maintained north of I-70.	0
Proposed ATC: Connection to York Street Storm Drain (using 100% full pipe capacity)	408 (updated to tie into existing 72" at Alice Pl)	Provides capture and conveyance of the 100-year runoff from CDOT onsite system and 100-year runoff from 46th Ave N system. Total peak discharge approximately 246 cfs	162
Proposed ATC: (using Denver design criteria of 80% full pipe capacity)	326	Same as above	80

This scenario provides a more efficient drainage solution by eliminating the storm drainage system flows from the existing York Street alignment north of I-70 as well as eliminating significant offsite drainage infrastructure from I-70 North ROW limit to the Platte River. Additionally, the overall drainage basin flowing to the existing storm drain at York Street and 47th Ave is greatly reduced in post-project conditions.

4. Impacts

This information has not been amended since the submission of the previous version of this ATC.

Eliminating the concept Onsite outfall micro tunnel, would reduce impacts to the community north of I-70. These impacts would have occurred with the construction related infrastructure such as large access shaft openings at the two turns in 49th St., manholes, existing utility relocations, dewatering, and ROW for the offsite water storage pond. Impacts to other parties such as RTD, UPRR and BNSF along the proposed micro tunnel route are also eliminated by construction of the York St. pump station and connection to the York Street storm drain.

The proposed pump station and connectivity to the existing York Street 72 inch storm drain would also provide O&M personnel access to all features of the Onsite outfall system, including pump station and water quality pond, from within CDOT ROW. Maintenance operations are also improved by eliminating sedimentation removal from 4,600 ft. section of deep outfall pipe that could not be serviced using conventional vacuum excavation pipe cleaning and require placing personnel in deep confined space areas.

The acquired properties north of I-70, west of York Street, and southeast of the UPRR would be used for the location of the pump station, associated maintenance access and a proposed water quality pond. These improvements would be limited to the area south of Alice Place and north of the proposed 46th Ave. These improvements would not impact the future CCD grade separation project.

5. Cost and Benefit Analysis

This information has not been amended since the submission of the previous version of this ATC.

Eliminating the concept Onsite storm drain system outfall with proposed stormwater pump station and discharge connection at York St. is estimated to result in a $12.0 Million Dollar savings to the Project. This is reflected in the elimination of micro tunnel and related infrastructure necessary between the I-70 and concept outfall at the South Platte River.

6. Schedule Analysis

This information has not been amended since the submission of the previous version of this ATC.

Eliminating the Onsite drain system outfall to the South Platte River via micro tunnel and constructing the York St. pump station would have similar schedule completion dates. The net effect to the project schedule would be no impact to the Project Schedule based on Conceptual Phasing Plan for Construction.

7. Conceptual Drawings

This information has not been amended since the submission of the previous version of this ATC.

See attached:

- Exhibit 1 Site Plan Layout
- Exhibit 2 Pre/ Post Project Drainage Basin
- Exhibit 3 – Conceptual Stormwater Pump Station

8. Past Use

This information has not been amended since the submission of the previous version of this ATC.

Storm water pump stations have been successfully used by CDOT to capture and convey stormwater flows from the roadway to adjacent outfall locations at certain roadway areas where gravity stormwater drainage is not feasible due to site topography and ROW constraints. These pump stations can be sized for continued use of the roadway during storm events and continuity of traffic flow in areas that cannot be otherwise drained via gravity connections.

- I-25 & Alameda Ave. Pump Station, CDOT Region 6, Denver, CO

9. Additional Information

This information has been amended since the submission of the previous version of this ATC.

Conceptual ATC 25.0 was approved to be submitted as detailed ATC. CDOT requested additional information regarding:

1. *47th Ave. Grade Separation Project and modified design to not preclude the grade separation project.*

   Exhibit 1 shows a preliminary site plan for the pump station and water quality pond that do not impact the future grade separation project.

2. *Detailed comparison of the CDOT and CCD flow areas for existing and proposed conditions.*

   Exhibit 2 shows that the existing Montclair Basin urban overflow flows south to north under I-70 and inundates York Street. Using available FLO-2D models for the Montclair Basin, approximately 1,224 cfs flows in York Street between 46th Ave and 47th Ave during the 100-year storm event. The existing 72" RCP has a full flow capacity of 408 cfs and flows underneath York Street between 46th Ave and 47th Ave.

   In proposed conditions, all flows south of I-70 are diverted to adequate outfalls south of I-70. The existing 72" RCP in York Street has no flow immediately north of I-70. The project proposes to connect the proposed 46th Ave N storm drain to the existing York Street 72" RCP at the intersection of York Street and 46th Ave N. The 100-year discharge of the 46th Ave N. storm drain system is approximately 156 cfs.

   The proposed CDOT on-site storm drain system captures and collects approximately 90 cfs from the lowered section of I-70 during the 100-year storm event. The project proposes to connect the CDOT on-site water quality pond to the existing 72" RCP in York Street. The total project flows introduced to the existing 72" RCP in York Street is approximately 246 cfs. This is 978 cfs less than existing conditions. This is 162 cfs less than the total pipe capacity of the existing 72" RCP in York Street. In proposed conditions, the existing storm drain system has the capacity to convey the 10o-yr flows for this area.

3. *Volume available for water quality with justification that MS4 requirements can be met.*

   The preliminary design of the proposed water quality pond includes approximately 1.66 acre-feet of storage for permanent water quality capture volume. That is sufficient to treat up to 40 acres of impervious surface from the lowered section of I-70. The preliminary design includes accommodation of the grade separation project, access ramp and other requirements of Section 8.

4. *Additional detail on the proposed larger pumps.*

   Exhibit 3 shows a preliminary pump station design to accommodate the collected flows in the lowered section of I-70. Four 200 HP, vertical turbine pumps are provided to accommodate the 100-year peak flows and requirements of Section 8. One pump is provided for maintenance and replacement. Each pump has a capacity of approximately 30 cfs and designed to lift the stormwater runoff from the wet well to the water quality pond. To improve maintenance and reduce wear on the larger pumps, two smaller pumps are also provided to allow complete drainage of the wet well and discharge smaller runoff events. The structure is watertight to eliminate groundwater intrusion. The site allows for parking, storage and maintenance access. The pump station design accommodates Section 8 requirements.

Detailed ATC# 25.1 was Conditionally approved with Resubmission required showing no adverse impacts for the existing 72" pipe in York St.

The reference design includes a split flow condition for the 46th Ave South storm drain, with inflow from a proposed 84" pipe and an 18" pipe entering Water Quality Feature #8. The outflow is divided between a 72" pipe (storm drain bridge) and a 30" pipe connecting to the offsite drainage system south of I-70. The Draft Central 70 Offsite Outfall System Drainage Map, dated 1/6/2017 shows a design flow of 310 cfs for the 72" pipe bridge. The Reference Plans do not include any additional inflows into this 72" pipe before the connection to the existing CCD 72" pipe in York Street.

The ATC design eliminates the 72" storm drain bridge and discharges the I-70 on-site storm drain system and the 46th Street North storm drain system to the existing 72" pipe at York Street. Comparison of Reference Design and ATC flows are shown in Table 1.

Table 1: Pipe Flows at York Street Connection

	Reference Design (cfs)	ATC Design Flow (cfs)	Difference (cfs)
5-Year Flow	152	142	-10
100-Year Flow	310	286	-24
Pipe Capacity	328	328	0
Storm Event Capacity	~100-year	>100-year	

Reference files did not include 5-year flows for this area. Due to the insignificance of the 5-year flow and the 100-year capacity of the existing system, 5-year flows were estimated based on IDF Curve and C value reductions.

The ATC decreases the 100-year flow by 24 cfs. The Reference Design 100-year flows of 310 cfs are 18 cfs less than the pipe capacity. The existing storm drain provides capacity for the Reference Design 100-year flows to be conveyed underground. However, excess capacity over the 100-year event is minimal. The existing storm drain provides capacity for more than the ATC Design 100-year flows. The existing pipe provides an additional 42 cfs of capacity over the ATC 100-year design.

This ATC provides no adverse impacts to the existing York Street 72" pipe or downstream system. This ATC provides a flow reduction to the existing CCD storm drain at York Street, a more efficient drainage solution, reduces impacts and improves drainage conditions north of I-70.

List of Analysis

- Rational method hydrologic analysis (within InRoads) of proposed 46th Ave N system
- CUHP hydrologic analysis of I-70 on-site system
- InRoads hydraulic analysis of existing 72" pipe
- CulvertMaster Pipe capacity estimations
- IDF Curve and C value adjustment to estimate 5-yr flows

C. Detailed ATC Requirements

1. Risks

This information has not been amended since the submission of the previous version of this ATC.

The proposed drainage connection in York St. will require coordination with the City and County of Denver Wastewater Authority. The Proposed Pump Station will require excavation below the existing groundwater table outside of the identified roadway section. Construction will need to be watertight to prevent groundwater intrusion into pump station.

2. Handback

This information has not been amended since the submission of the previous version of this ATC.

The pump station that will be transferred back will include larger capacity pumps and eliminated maintenance and cleaning of On-Site Outfall pipe from Lowered Section to Outfall at the South Platte River.

3. Right-of-Way

This information has not been amended since the submission of the previous version of this ATC.

No additional right of way is required with use of existing property acquisitions not identified for future use.

4. List of Required Approvals

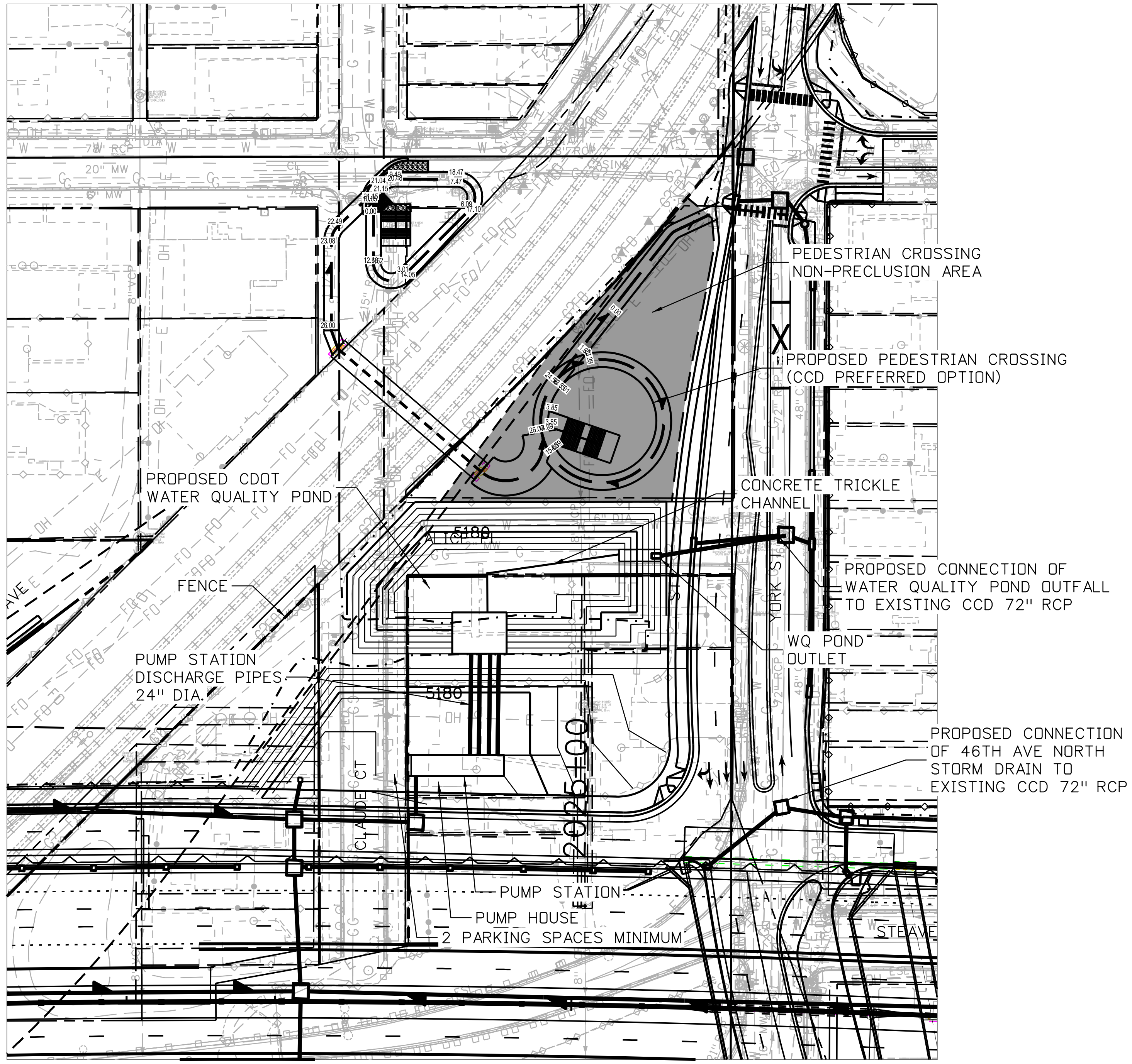
This information has not been amended since the submission of the previous version of this ATC.

City and County of Denver Wastewater Authority Approval is anticipated

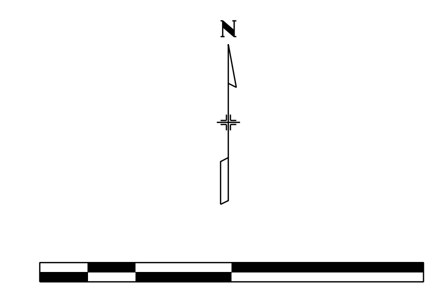
5. Proposed Drafting Revisions

This information has not been amended since the submission of the previous version of this ATC.

n/a



YORK POND PLAN VIEW



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5280 Connectors Linking I-70 Communities

Colorado Department of Transportation
Region 1

I-70 EAST ATC 25.2 EXHIBIT 1 SITE PLAN			
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Detailer:	XXXXXXXX		X-XX-XX
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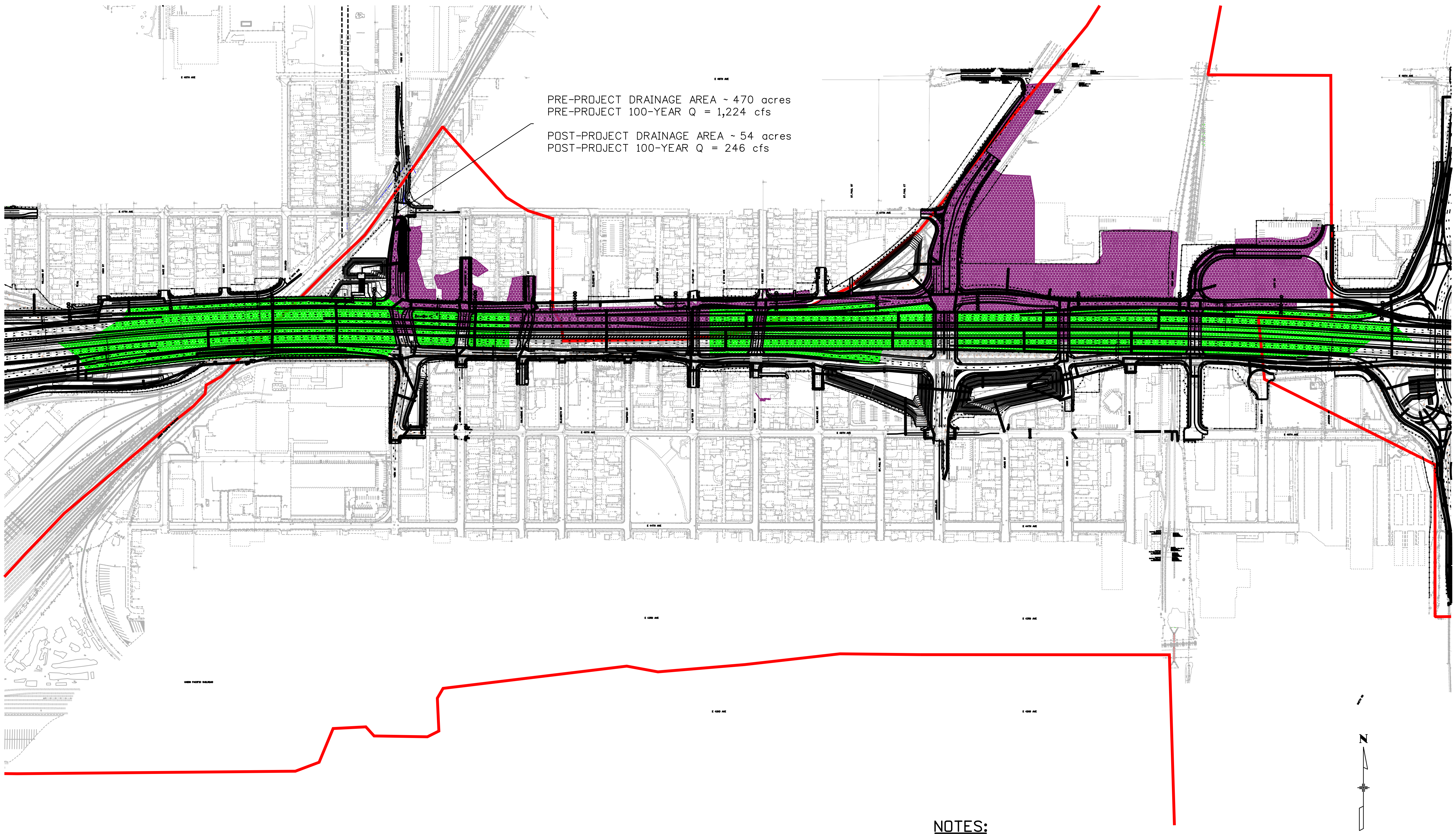

46TH NORTH DRAINAGE SYSTEM BASIN AREA
DRAINAGE AREA = 27 ACRES

PROPOSED I-70 SYSTEM DRAINAGE BASIN AREA
DRAINAGE AREA = 27 ACRES

CCD MASTER PLAN DRAINAGE AREA
DRAINAGE AREA = 470 ACRES

NOTES:

ADDITIONAL DETAILS ON PRE-PROJECT FLOWS FOR THIS LOCATION CAN BE FOUND IN THE MATT DOCUMENTS AND MONTCLAIR OSP REPORT. PORTIONS OF THE MONTCLAIR BASIN OVERFLOW AND DRAIN THROUGH THIS AREA.

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5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation
CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 25.2
EXHIBIT 2
PRE/POST PROJECT DRAINAGE BASIN

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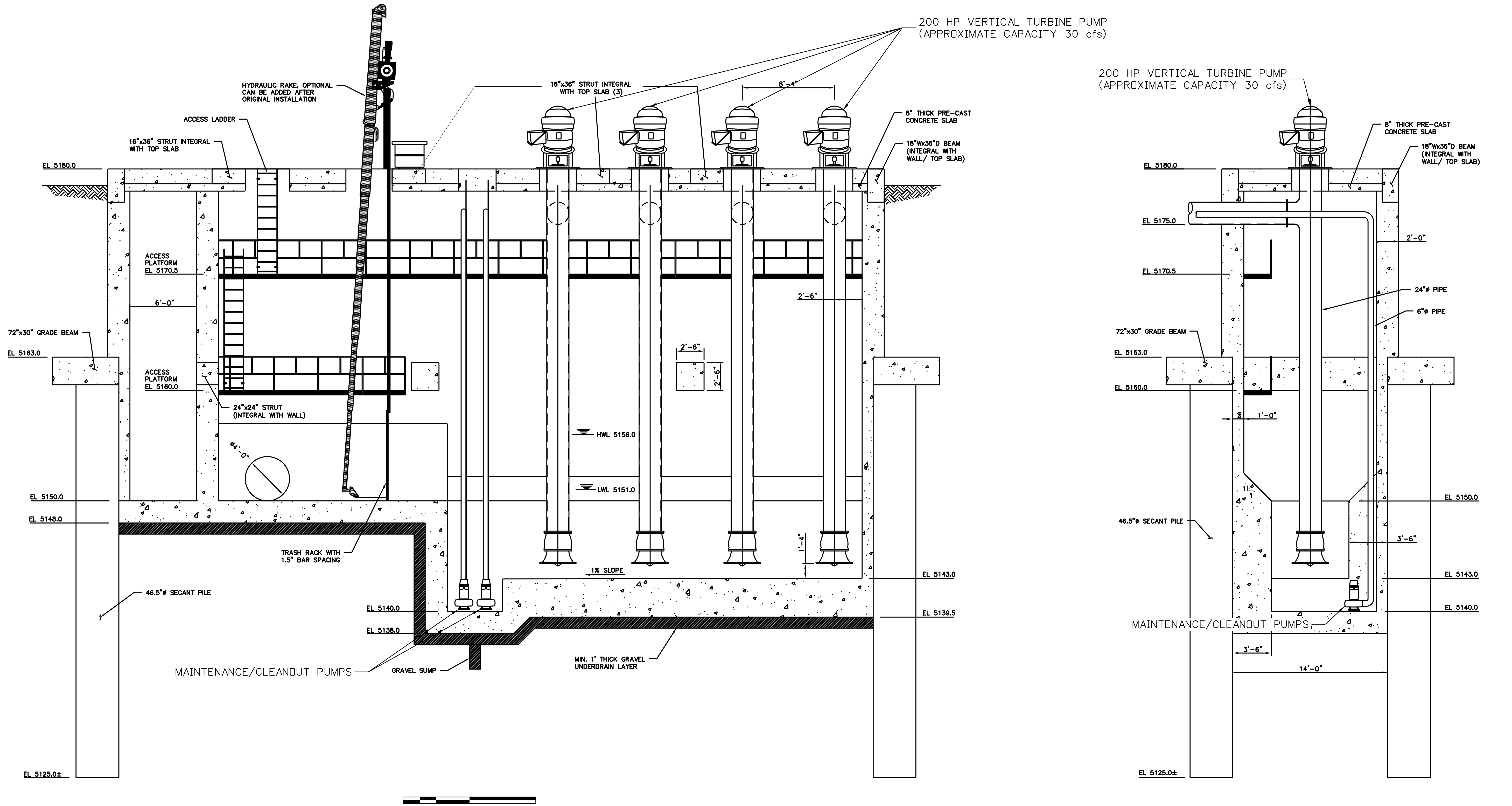

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5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation
CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 25.2
EXHIBIT 3-CONCEPTUAL STORMWATER PUMP STATION

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SECTION 2.2.7

ATC 27.1 | ELIMINATING INTERMEDIATE DIAPHRAGMS FOR PC GIRDERS

Central 70

DATE: December 16, 2016

TO: 5280 Connectors

FROM: Anthony DeVito P.E. Central 70 Project Director
Nicholas Farber, Central 70 Project

SUBJECT: Central 70 - Detailed Alternative Technical Concept (ATC) Response
5280 Connectors - ATC No. 27.1

Dear Mr. Clark:

Your Team's ATC Submission Form for Detailed ATC 27.1 was reviewed by the Procuring Authorities prior to the December One-on-One Meetings and an initial response was sent to you on December 1, 2016. As discussed during the December One-on-One Meeting, the Procuring Authorities committed to provide a final response to your Detailed ATC.

Detailed ATC 27.1 proposes to eliminate permanent intermediate diaphragms used with precast concrete girders.

In accordance with the Instructions to Proposers ("ITP"), the Procuring Authorities will use reasonable efforts to provide a Proposer with the following written feedback on a ATC Submission within 15 Working Days following the later of (x) the date the relevant ATC Submission was submitted and (y) the One-on-One Meeting at which such submission is discussed. Below is the final response from the Procuring Authorities for your Detailed ATC:

☒ 1. unconditional approval;

☐ 2. conditional approval, subject to modifications and/or conditions;

☐ Re-submission required ☐ Re-submission not required

☐ 3. disapproval, with or without guidance that such ATC can be re-submitted under any circumstance;

☐ 4. notification that the incorporation of the proposed ATC in the Proposer's Proposal is already permitted under the terms of the RFP, and therefore does not qualify as an ATC (and will not be treated as such for purposes of Section 3.4 of Part C of the ITP).

☐ 5. subject to compliance with the confidentiality requirements set out in Section 3.4 of Part C of the ITP, the Procuring Authorities are considering amending (for the benefit of all Proposers) the terms of the RFP that are the subject-matter of the proposed ATC.

Following our discussions at the One-on-One Meeting, the Procuring Authorities <u>have not</u> changed their initial response to your above mentioned Detailed ATC Submission. The ATC is unconditionally approved.

The approval of this Detailed ATC by the Procuring Authorities does not constitute an approval of specific drafting modifications to the RFP necessary to incorporate this ATC into the Project Agreement pursuant to Section 7.2.1.c of Part C of the ITP, which modifications shall be agreed by the Procuring Authorities and the Proposer (each acting reasonably) following issuance of a Notice of Award to such Proposer.

ANNEX 3: ALTERNATIVE TECHNICAL CONCEPT SUBMISSION FORM

Proposer Name: 5280 Connectors
Date: November 1, 2016

Central 70 Project RFP: ATC Submission No. 27.1

A. Background Information

1. Type of Submission

☐ Conceptual ATC

☒ Detailed ATC

2. Prior Submission(s)

☐ None (initial submission of ATC)

☒ Previously Submitted as Conceptual ATC

☐ Previously Submitted as Detailed ATC

3. Explanation of Reason for Resubmission

Resubmission as Detailed ATC with reference example details.

4. Request for Discussion at One-on-One Meeting

☒ Meeting Requested

☐ Meeting Not Requested

B. General ATC Submission Requirements

1. Overview Description

This information has been amended since the submission of the previous version of this ATC.

5280 Connectors proposes to eliminate Permanent Intermediate Diaphragms used with Precast Concrete Girders. Intermediate Metal Diaphragms are primarily used to stabilize the precast girders during erection. However, after a concrete deck has been placed and reached its required strength, the intermediate diaphragms have no structural value. During construction, 5280 Connectors will Design install temporary girder bracing as the responsible party for ensuring girder stabilization.

2. Relevant RFP Requirements

This information has not been amended since the submission of the previous version of this ATC.

Project Agreement Schedule 10, Section 13.2 Applicable Standards and Software, Section 13.2.1 Last Sentence "The CDOT bridge design and policy manual should be followed"

CDOT Bridge Design Manual, Subsection 9.1, C40

CDOT Standard Worksheet B-618-DF

3. Rationale

This information has not been amended since the submission of the previous version of this ATC.

Historically, galvanized metal diaphragms have been used during installations of precast girders. Although the diaphragms do not provide a structural value once the bridge deck has reached strength, they remain in place and become maintenance items for routine bridge inspections. Other means of temporary stabilization are available that are less costly having no maintenance requirements.

4. Impacts

This information has not been amended since the submission of the previous version of this ATC.

Reduces future impacts to traffic during Bridge Inspections

5. Cost and Benefit Analysis

This information has not been amended since the submission of the previous version of this ATC.

The deletion of permanent intermediate diaphragms is estimated to save roughly $0.5 Million Dollars. This saving is realized in costs for permanent metal galvanizing and material reuse. Labor costs are roughly the same if installing permanent or temporary diaphragms. No cost is recognized here for the operation and maintenance period but minor savings may be seen as the diaphragms are a small part of the required bridge inspections.

6. Schedule Analysis

This information has not been amended since the submission of the previous version of this ATC.

No schedule saving is anticipated from the deletion of permanent intermediate diaphragms.

7. Conceptual Drawings

This information has been amended since the submission of the previous version of this ATC.

See Exhibit 1: I-4 Ultimate- Area 3 Project #432193-1-52-01 Girder Bracing – Bridge 331 Sections and Detail for sample Temporary bracing detail for Precast Girders for use until bridge deck is complete. Once deck is cured, temporary bracing is removed.

8. Past Use

This information has been amended since the submission of the previous version of this ATC.

Permanent intermediate diaphragms were substituted with temporary girder diaphragms on pervious projects including:

- I-25 TREX Project – Narrows Segment, CDOT Denver, CO
- I-4 Ultimate Project – FDOT Maintland, FA
- Perryville Road Overpass Project, ADOT, Perryville, AZ

9. Additional Information

Not Applicable

C. Detailed ATC Requirements

1. Risks

Contractor to ensure girder stability during construction and inspect temporary bracing as part of daily girder inspection until deck is complete and bracing is removed.

2. Handback

Reduced maintenance and inspection of steel diaphragm members at bridge locations.

3. Right-of-Way

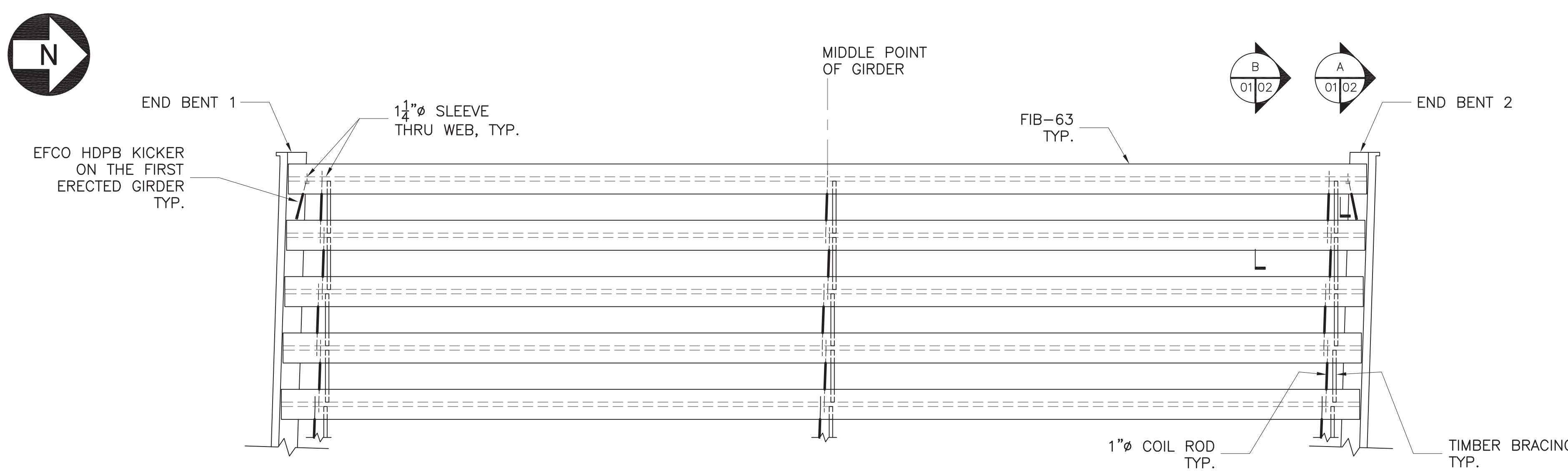
Not Applicable

4. List of Required Approvals

Girder Temporary Bracing to be included in Overhead Girder Erection Plan submission to the Authority for Record Purposes and addressed in Safety Girder Erection Plan Conference in accordance with CDOT Project Special Provisions- Revision to Section 107: Performance of Safety Critical Work.

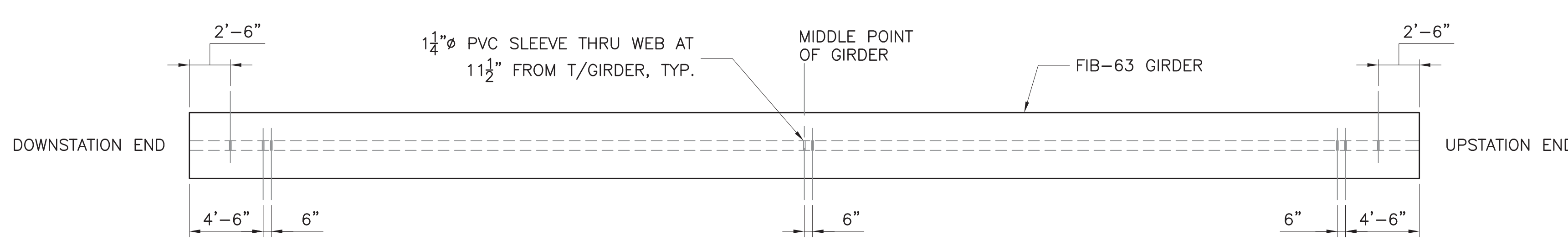
5. Proposed Drafting Revisions

Not Applicable



GIRDER BRACING – BRIDGE 331
PARTIAL PLAN

0 16' 32' 48'



PVC INSERT PLAN
N.T.S.

NOTES:

1.) THE SCREED WHEEL LOADS ARE BASED ON BIDWELL 4800 SCREED MACHINE WITH 6 WHEELS AT EACH END, MAX 1800 LBS WHEEL LOAD.
2.) THE BRACINGS ARE DESIGNED PER THE LOADS PROVIDED ON PROJECT DRAWINGS.
3.) THE CONSTRUCTION LOADS SHALL NOT EXCEED THE ASSUMED LOADS SHOWN ON PROJECT PLANS.
4.) TEMPORARY ANCHORING SHALL BE INSTALLED ON ONE OF THE FIB GIRDERS ERECTED WITHIN THE FIRST SHIFT OF GIRDER ERECTIONS, AND INSTALL THE TEMPORARY BRACINGS BETWEEN ERECTED GIRDERS WITH THE ERECTION.
5.) ALL TIMBER STRUTS SHALL BE PERPENDICULAR TO THE GIRDERS.
6.) THE TEMPORARY BRACINGS SHALL STAY IN PLACE UNTIL THE BRIDGE DECK IS COMPLETED, AND THE CONCRETE HAS GAINED MIN 2500 PSI COMPRESSIVE STRENGTH.
7.) ALL BOLT HOLES IN BEAMS AND ABUTMENTS SHALL BE PREFORMED AND FILLED AFTER USE.

MATERIALS:

- STEEL HSS: A500, GRADE 46
- COIL RODS: DAYTON B-12 COIL RODS OR EQUAL
- COIL NUTS ON ¾"ø COIL RODS: DAYTON B-13 NUT OR EQUAL
- COIL NUTS ON 1"ø COIL RODS: DAYTON B-25 OR EQUAL
- COUPLERS: DAYTON D-32 COUPLERS
- TIMBER STRUTS: SOUTHERN PINE NO. 2
- STANDARD WASHER ON RODS: ASTM A572, GRADE 50 OR BETTER
- KICKERS: EFCO ADJUSTABLE HDPB WITH ¾"ø A325 CONNECTION BOLTS
- ANCHORS: POWERS ¾"ø WEDGE-BOLT W/ 5½" EMBEDMENT AND MIN 12" EDGE DISTANCE, INSTALLED PER MANUFACTURER'S SPECIFICATIONS

APPROVED FOR CONSTRUCTION
BY SKANSKA SE ENGINEERING DEPT

REV.	DATE	DESIGN	DRAWN	REMARKS
0	07/29/16	JXZ	DER	FOR CONSTRUCTION
A	07/28/16	JXZ	DER	FOR REVIEW

SGL CONSTRUCTORS
MAITLAND, FLORIDA

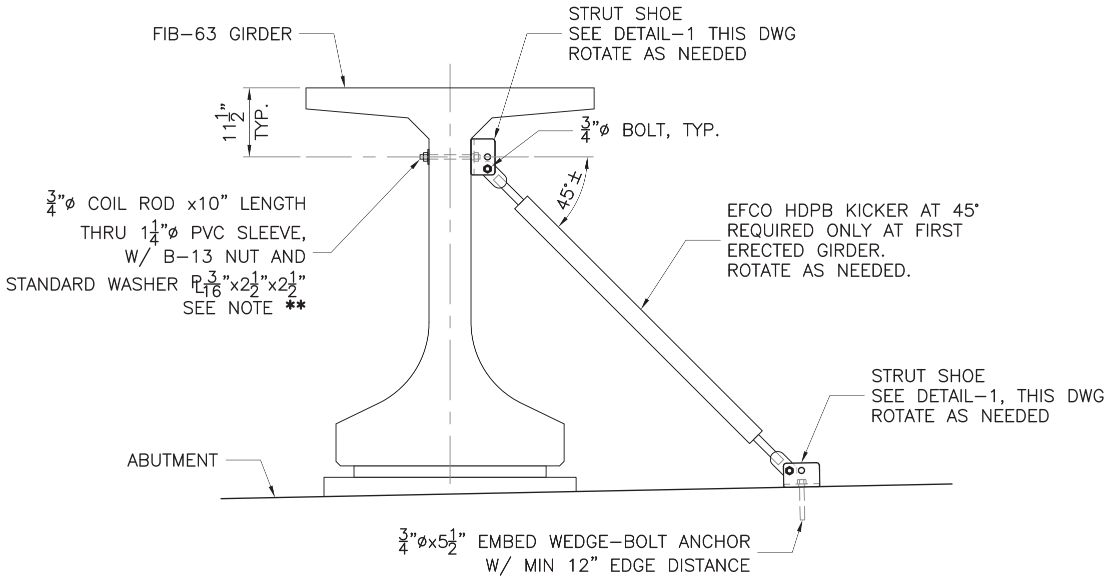
I-4 ULTIMATE – AREA 3
PROJECT #432193-1-52-01
GIRDER BRACING – BRIDGE 331
PLAN AND NOTES

Skanska USA
Civil Southeast Engineering Department
295 Bendix Rd. - Virginia Beach, VA 23452
Phone: 757-420-4140

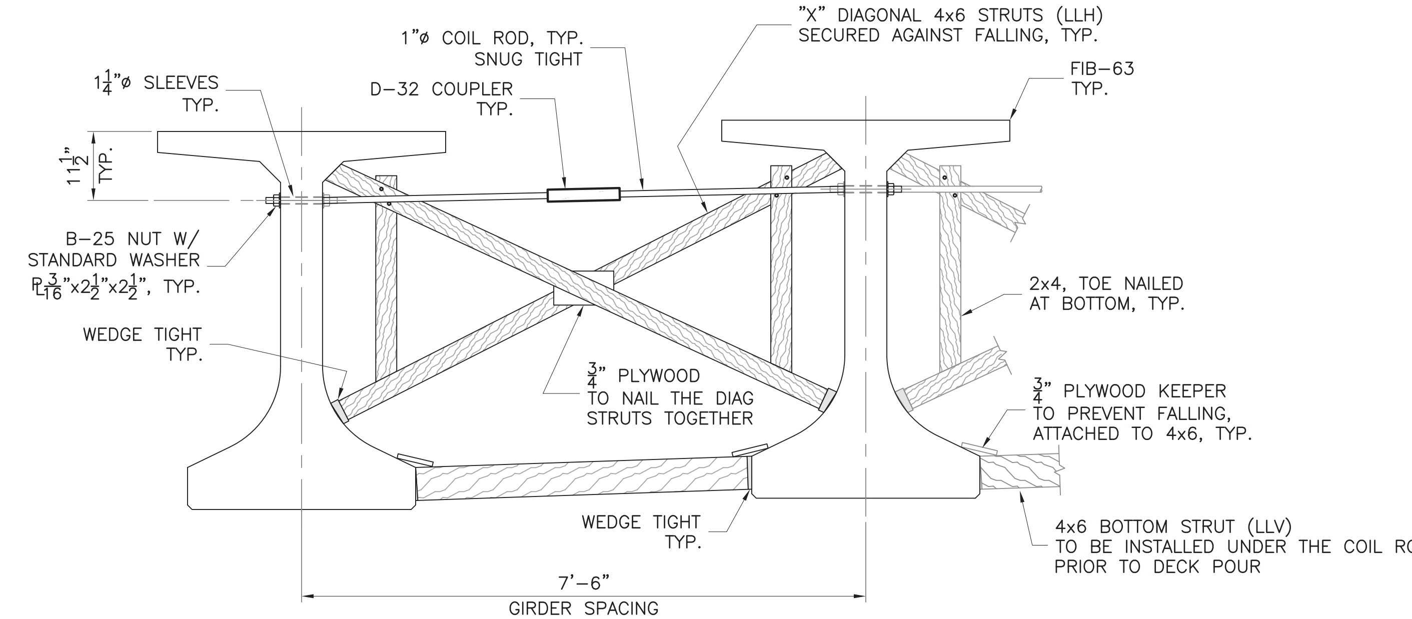
SCALE	JOB	DRAWING NUMBER	Approved
AS NOTED	04-2298	04-2298-A3-GE-331-01	JBH

NOTES:
1.) SEE DWG: A3-GE-331-01 FOR NOTES AND SPECIFICATIONS.

** KICKER SLEEVES LOCATED 2'-6" FROM EACH END OF GIRDER. SEE DWG: A3-GE-331-01 FOR CROSS TIE-ROD SLEEVE LOCATIONS.

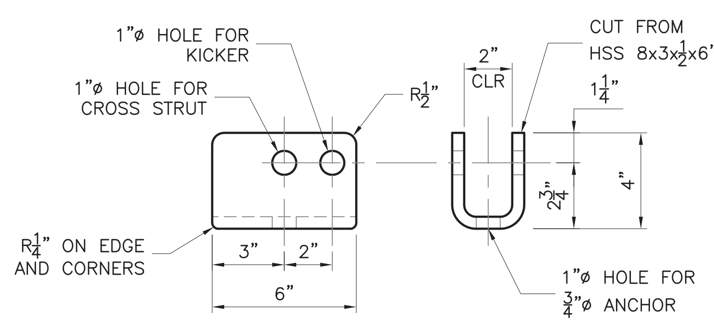


SECTION A-A
DWG: A3-GE-331-01
N.T.S.



SECTION B-B
DWG: A3-GE-331-01
N.T.S.

NOTE: COIL RODS AND TIMBER BRACING REQUIRED AT ENDS AND MIDDLE OF SPAN.



DETAIL-1
DWG: A3-GE-331-02
0 4" 8" 1'

APPROVED FOR CONSTRUCTION
BY SKANSKA SE ENGINEERING DEPT

REV.	DATE	DESIGN	DRAWN	REMARKS
0	07/29/16	JXZ	DER	FOR CONSTRUCTION
A	07/28/16	JXZ	DER	FOR REVIEW

SGL CONSTRUCTORS
MAITLAND, FLORIDA

I-4 ULTIMATE - AREA 3
PROJECT #432193-1-52-01
GIRDER BRACING - BRIDGE 331
SECTIONS AND DETAIL

Skanska USA
Civil Southeast Engineering Department
295 Bendix Rd. - Virginia Beach, VA 23452
Phone: 757-420-4140

SCALE	JOB	DRAWING NUMBER	Approved
AS NOTED	04-2298	04-2298-A3-GE-331-02	JBH

SECTION 2.2.8

ATC 28.0 | TUNNEL LIGHTING ELECTRICAL DRIVERS

Central 70

DATE: October 18, 2016

TO: 5280 Connectors

FROM: Anthony DeVito P.E. Central 70 Project Director
Nicholas Farber, Central 70 Project

SUBJECT: Central 70 - Conceptual Alternative Technical Concept (ATC) Response
5280 Connectors - ATC No. 28.0

Dear Mr. Clark:

Your Team's ATC Submission Form for Conceptual ATC 28.0 has been reviewed by the Procuring Authorities. The ATC proposes an alternate lighting power distribution concept for the I-70 roadway lighting under the Cover.

In accordance with the Instructions to Proposers ("ITP"), the Procuring Authorities will use reasonable efforts to provide a Proposer with the following written feedback on a ATC Submission within 15 Working Days following the later of (x) the date the relevant ATC Submission was submitted and (y) the One-on-One Meeting at which such submission is discussed. Below is the final response from the Procuring Authorities for your Conceptual ATC:

☒ 1. unconditional approval and waiver of requirement for re-submission as a Detailed ATC;

☐ 2. unconditional approval for re-submission as a Detailed ATC;

☐ 3. conditional approval for re-submission as a Detailed ATC, subject to modifications and/or conditions;

☐ 4. disapproval, with or without guidance that such ATC can be re-submitted under any circumstance;

☐ 5. notification that the inclusion of the proposed ATC in the Proposer's Proposal is already permitted under the terms of the RFP, and therefore does not qualify as an ATC (and will not be treated as such for purposes of Section 3.4 of Part C of the ITP; or

☐ 6. subject to compliance with the confidentiality requirements set out in Section 3.4 of Part C of the ITP, the Procuring Authorities are considering amending (for the benefit of all Proposers) the terms of the RFP that are the subject-matter of the proposed ATC.

The approval of this Conceptual ATC by the Procuring Authorities does not constitute an approval of specific drafting modifications to the RFP necessary to incorporate this ATC into the Project Agreement pursuant to Section 7.2.1.c of Part C of the ITP, which modifications shall be agreed by the Procuring Authorities and the Proposer (each acting reasonably) following issuance of a Notice of Award to such Proposer.

ANNEX 3: ALTERNATIVE TECHNICAL CONCEPT SUBMISSION FORM

Proposer Name: 5280 Connectors
Date: September 1, 2016

Central 70 Project RFP: ATC Submission No. 28.0

A. Background Information

1. Type of Submission

☒ Conceptual ATC

☐ Detailed ATC

2. Prior Submission(s)

☒ None (initial submission of ATC)

☐ Previously Submitted as Conceptual ATC

☐ Previously Submitted as Detailed ATC

3. Explanation of Reason for Resubmission

n/a

4. Request for Discussion at One-on-One Meeting

☒ Meeting Requested

☐ Meeting Not Requested

B. General ATC Submission Requirements

1. Overview Description

5280 Connectors proposes an alternate lighting power distribution concept for I-70 roadway lighting under the Cover. The Project Agreement includes technical requirements for lighting drivers to be housed in separate enclosures. This can be optimized using current available technology, generally accepted practices and design methods. Lighting drivers would be relocated from a separate panel enclosure and placed within the fixture. This approach will reduce cost and shorten our schedule for the lighting installation and commissioning.

2. Relevant RFP Requirements

Schedule 10 Section 12.18.6 (f) specifies:

"The lighting fixtures will have symmetrical optics and be fixed to the structural soffit of the underside of the Cover. The fixtures shall be in rows or multiple rows aligned with the center line of the lanes. The spacing between the fixtures will be chosen to avoid flicker, noting that continuous line is preferable. The fixtures shall consist only of the LEDs and their optical lens housed within a sealed IP66 enclosure capable of being pressure hosed. The fixtures are to be connected to the electrical distribution panels (EDPs) via specially constructed cables that have IP66 connectors. The EDPs are to house the LED drivers in fire rated enclosures. The fixtures are to be supplied by two separated electrical supplies providing interleaved circuits so that alternate fixtures are fed from the same supply."

3. Rationale

The rationale for installing the drivers for the LED lights in the fixtures would reduce exposed conduit runs and eliminate exposed driver boxes surface mounted to the Cover walls. Another benefit of reducing the amount of conduit attached to walls and girders, greatly reducing impacts to other electrical and Fire Life Safety (FLS) systems while accommodating future ITS and electrical systems upgrades at these locations.

A significant number of light driver enclosures would be required at the portal areas, resulting in multiple enclosures mounted to walls with a significant visual impact, resulting in a tunnel retrofit appearance. By combining drivers into the overhead lighting fixtures above, enclosures would be hidden from view in the ceiling soffit.

4. Impacts

By moving the Drivers from the separate EDP to the LED fixtures, this greatly reduces the exposure to third party damage and eliminates any maintenance of the conduits running from the EDP's to the LED fixtures.

Historically, LED lighting drivers have been found to require little maintenance and fail about 1% of the time. Maintenance on light drivers would have minimal impact to the traveling public due to their low failure occurrence and could be easily maintained during maintenance of light fixtures.

5. Cost and Benefit Analysis

The cost savings of relocating the light drivers and placing them in the fixtures is a savings of $1.1 Million Dollars.

Placing the drivers in the LED fixtures also simplifies the commissioning and the integration of the lighting system and reduces the amount of conduit that penetrates the Cover structural section and waterproofing.

6. Schedule Analysis

By optimizing the LED Lights with the drivers in the fixtures, the procurement & installation schedule is estimated to save three months on lighting duration. This would have an estimated one month reduction to the Project Schedule based upon preliminary schedule assumptions.

7. Conceptual Drawings

Lighting Power Distribution Concept Design drawing markup attached.

8. Past Use

LED luminaires in tunnels are a relatively new lighting power distribution concept. The following tunnels have the LED drivers incorporated into the luminaire:

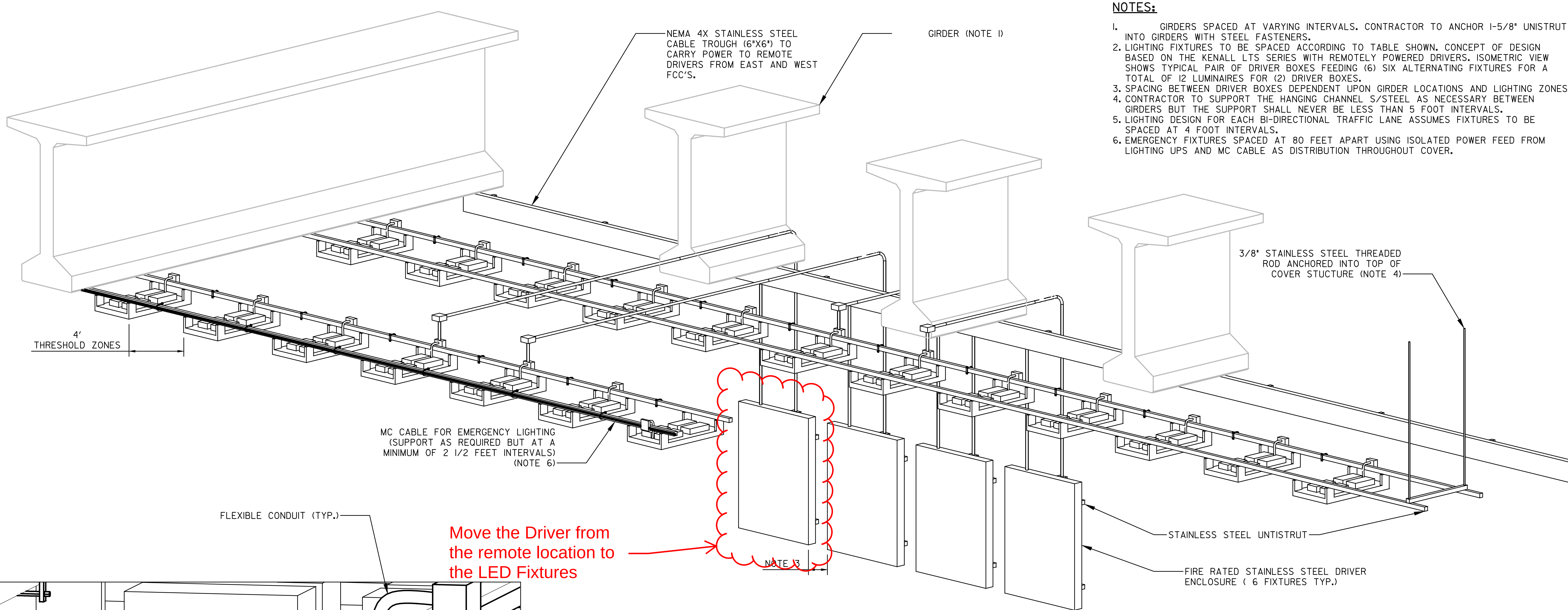
- Hugh L. Carey (Brooklyn- Battery) Tunnel, Brooklyn, New York
- Queens Midtown Tunnel, Queens, New York
- Lytle Tunnel, Cincinnati, Ohio

9. Additional Information

N/A

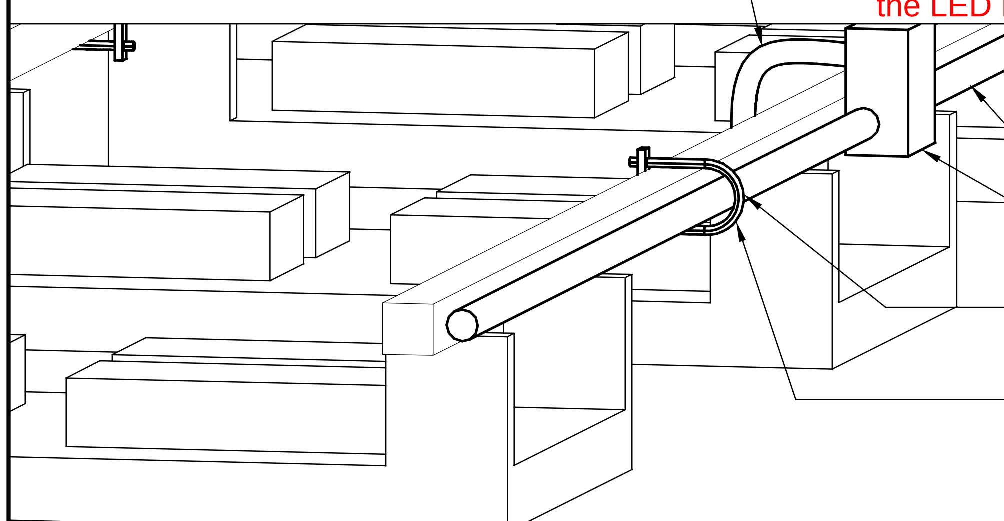
NOTES:

1. GIRDERS SPACED AT VARYING INTERVALS. CONTRACTOR TO ANCHOR 1-5/8" UNISTRUT INTO GIRDERS WITH STEEL FASTENERS.
2. LIGHTING FIXTURES TO BE SPACED ACCORDING TO TABLE SHOWN. CONCEPT OF DESIGN BASED ON THE KENALL LTS SERIES WITH REMOTELY POWERED DRIVERS. ISOMETRIC VIEW SHOWS TYPICAL PAIR OF DRIVER BOXES FEEDING (6) SIX ALTERNATING FIXTURES FOR A TOTAL OF 12 LUMINAIRES FOR (2) DRIVER BOXES.
3. SPACING BETWEEN DRIVER BOXES DEPENDENT UPON GIRDER LOCATIONS AND LIGHTING ZONES.
4. CONTRACTOR TO SUPPORT THE HANGING CHANNEL S/STEEL AS NECESSARY BETWEEN GIRDERS BUT THE SUPPORT SHALL NEVER BE LESS THAN 5 FOOT INTERVALS.
5. LIGHTING DESIGN FOR EACH BI-DIRECTIONAL TRAFFIC LANE ASSUMES FIXTURES TO BE SPACED AT 4 FOOT INTERVALS.
6. EMERGENCY FIXTURES SPACED AT 80 FEET APART USING ISOLATED POWER FEED FROM LIGHTING UPS AND MC CABLE AS DISTRIBUTION THROUGHOUT COVER.



COVER LIGHTING POWER DISTRIBUTION CONCEPT DESIGN

SCALE: NTS



ISOMETRIC VIEW 2

SCALE: NTS

LIGHTING SCHEDULE

LABEL	LUMINAIRE LUMENS	LLF	DESCRIPTION
LTS-B2-C-SM--5N-8-384L-50K7-DC	56509	0.7	LUXTRAN SUPPLEMENTAL

CALCULATION SUMMARY

LABEL	UNITS	AVG	LENGTH (FT)	SPACING BETWEEN FIXTURES	DIM %
THRESHOLD 1	CD/SQ.M	317	356	4	100
THRESHOLD 2	CD/SQ.M	236	176	4	80
TRANSITION 1	CD/SQ.M	117	264	10	100
TRANSITION 2	CD/SQ.M	57	204	20	100
EMERGENCY	CD/SQ.M	14	1000	80	100

IN PROGRESS – NOT FOR FINAL ESTIMATE

Quantities			Detail			Design		
Quantities By / Checked By	INITIAL	DATE	Detailed By / Checked By	INITIAL	DATE	Designed By / Checked By	INITIAL	DATE
							RRU / TK	7.26.16 / 7.26.16

Print Date: 8/16/2016 10:14 AM

File Name: E015.DWG

Staff Bridge Branch – Unit 0226 Unit Leader DDG

Sheet Revisions

Date:	Comments	Init.

Colorado Department of Transportation

CDOT CO

2000 South Holly Street
Denver, CO 80222
Phone: 303-757-9295 FAX: 303-757-9963

Region 1 JKE

As Constructed

No Revisions:

Revised:

Void:

LIGHTING POWER DISTRIBUTION CONCEPT DESIGN

Designer: CML

Detailer:

Sheet Subset:

Structure Numbers

Subset Sheets: of

Project No./Code

18999

C4701 124

Sheet Number E015

$PLOT_INFO$

SECTION 2.2.9

ATC 29.1 | VASQUEZ EB DMS

Central 70

DATE: December 16, 2016

TO: 5280 Connectors

FROM: Anthony DeVito P.E. Central 70 Project Director
Nicholas Farber, Central 70 Project

SUBJECT: Central 70 - Detailed Alternative Technical Concept (ATC) Response
5280 Connectors - ATC No. 29.1

Dear Mr. Clark:

Your Team's ATC Submission Form for Detailed ATC 29.1 was reviewed by the Procuring Authorities prior to the December One-on-One Meetings and an initial response was sent to you on December 1, 2016. As discussed during the December One-on-One Meeting, the Procuring Authorities committed to provide a final response to your Detailed ATC.

Detailed ATC 29.1 proposes to combine the eastbound DMS between the Covered section and Vasquez Blvd. with the proposed Colorado Blvd. exit sign at STA 2052+00.

In accordance with the Instructions to Proposers ("ITP"), the Procuring Authorities will use reasonable efforts to provide a Proposer with the following written feedback on a ATC Submission within 15 Working Days following the later of (x) the date the relevant ATC Submission was submitted and (y) the One-on-One Meeting at which such submission is discussed. Below is the final response from the Procuring Authorities for your Detailed ATC:

☒ 1. unconditional approval;

☐ 2. conditional approval, subject to modifications and/or conditions;

☐ Re-submission required ☐ Re-submission not required

☐ 3. disapproval, with or without guidance that such ATC can be re-submitted under any circumstance;

☐ 4. notification that the incorporation of the proposed ATC in the Proposer's Proposal is already permitted under the terms of the RFP, and therefore does not qualify as an ATC (and will not be treated as such for purposes of Section 3.4 of Part C of the ITP).

☐ 5. subject to compliance with the confidentiality requirements set out in Section 3.4 of Part C of the ITP, the Procuring Authorities are considering amending (for the benefit of all Proposers) the terms of the RFP that are the subject-matter of the proposed ATC.

Following our discussions at the One-on-One Meeting, the Procuring Authorities have not changed their initial response to your above mentioned Detailed ATC Submission. The ATC is unconditionally approved.

The approval of this Detailed ATC by the Procuring Authorities does not constitute an approval of specific drafting modifications to the RFP necessary to incorporate this ATC into the Project Agreement pursuant to Section 7.2.1.c of Part C of the ITP, which modifications shall be agreed by the Procuring Authorities and the Proposer (each acting reasonably) following issuance of a Notice of Award to such Proposer.

ANNEX 3: ALTERNATIVE TECHNICAL CONCEPT SUBMISSION FORM

Proposer Name: 5280 Connectors
Date: November 4, 2016

Central 70 Project RFP: ATC Submission No. 29.1[1]

A. Background Information

1. Type of Submission

☐ Conceptual ATC

☒ Detailed ATC

2. Prior Submission(s)

☐ None (initial submission of ATC)

☒ Previously Submitted as Conceptual ATC

☐ Previously Submitted as Detailed ATC

3. Explanation of Reason for Resubmission

Resubmission as Detailed ATC with Plan view of combined signage.

4. Request for Discussion at One-on-One Meeting

☒ Meeting Requested

☐ Meeting Not Requested[2]

[1] Proposers to complete in accordance with instruction (2) to the Annex.
[2] In accordance with Section 3.2.1 of Part C, the Procuring Authorities may nevertheless require a Proposer to present an ATC Submission at a One-on-One Meeting.

B. General ATC Submission Requirements

1. Overview Description

This information has not been amended since the submission of the previous version of this ATC.

5280 Connectors proposes an Alternated Technical Concept to combine the eastbound full size Dynamic Message Sign (DMS) between the Covered section and Vasquez Boulevard with the proposed Colorado Boulevard exit sign at STA 2052+00.

2. Relevant RFP Requirements

This information has not been amended since the submission of the previous version of this ATC.

The Project Agreement, Schedule 10, Section 3.8.7.a.i.B.II specifies that an "eastbound full color DMS shall be installed" "between the Cover and Vasquez Blvd."

The Project Agreement, Schedule 10, Section 3.8.7.a.ii specifies that DMS "shall be mounted on a sign bridge and co-located with static guide signs wherever possible."

The Project Agreement, Schedule 10, Section 3.8.7.a.ii specifies that DMS "shall be centered over the General Purpose Lanes but be visible to all Users."

The Project Agreement, Schedule 10, Section 3.8.7.a.ii specifies that "where ROW permits, an 8 feet wide paved area shall be provided outside of the shoulder, for maintenance access" and that "the sign bridge shall have a locked, secured ladder and walkway so that maintenance personnel can maintain every portion of the sign bridge without the use of a bucket truck."

The Project Agreement, Schedule 10, Section 3.8.7.a.ii specifies that "the sign bridge handle shall not prevent the static sign messages from being clearly read and shall be OSHA compliant."

The Project Agreement, Schedule 10, Section 11.3.1.m specifies that "walkways shall not be permitted on overhead guide sign structures."

3. Rationale

This information has not been amended since the submission of the previous version of this ATC.

The Project Agreement requires that a full size DMS be located in between the Cover and Vasquez Boulevard for I-70 eastbound. Given that the distance between the Cover and Vasquez Boulevard is less than 1,200 feet, as well as the presence of the Fillmore Street Bridge overpass, the location at which a DMS can be correctly placed is limited. Furthermore, static signage requires that a sign structure be placed at STA 2052+00 to provide drivers with information regarding the Colorado Boulevard exit. As such, to maintain adequate sign spacing distances and to avoid line-of-sight obstructions from the Fillmore Street overpass, the DMS is proposed to be co-located with the Colorado Boulevard exit sign at STA 2052+00.

The Colorado Boulevard exit sign is required to be placed over the right-most lane to indicate to drivers that this is an exit only lane. Furthermore, the DMS is required to be centered over the general purpose lanes. Attachment 1 shows a preliminary signing elevation at this location.

To allow maintenance personnel access to the DMS, this ATC proposes that the required ladder and walkway extend from the I-70 median instead of the outside shoulder.

4. Impacts

This information has not been amended since the submission of the previous version of this ATC.

The impacts of relocating the access ladder and walkway from the outside shoulder to the I-70 median are that maintenance personnel will have to access the DMS from the median at this particular location in the Project.

5. Cost and Benefit Analysis

This information has not been amended since the submission of the previous version of this ATC.

The cost benefit of consolidating these two structures is estimated at $0.15 Million Dollars as a result of eliminating DMS sign bridge and foundations.

The benefits of relocating the access ladder and walkway from the outside shoulder to the I-70 median will provide drivers with an unobstructed view of the Colorado Boulevard exit sign.

6. Schedule Analysis

This information has not been amended since the submission of the previous version of this ATC.

There will be no impacts to the schedule.

7. Conceptual Drawings

This information has been amended since the submission of the previous version of this ATC.

Vasquez Blvd. EB DMS Median Access Plan shows a preliminary elevation of the overhead sign structure, static signing, and electronic signing at STA 2052+00 in the eastbound direction.

A Plan view of the Static Roadway signage is show with distances from adjacent Bridge structures.

8. Past Use

This information has not been amended since the submission of the previous version of this ATC.

N/A

9. Additional Information

This information has not been amended since the submission of the previous version of this ATC.

N/A

Detailed ATC Requirements

1. Risks

Consolidation of signage is contingent on Approval of ATC #30 for Median access to DMS. Without median access, an alternative walkway connection would be required to pass the roadway Guide signage on the left side of the structure for outside shoulder access.

2. Handback

There will be reduction of one sign bridge structure for handback requirements.

3. Right-of-Way

Not Applicable

4. List of Required Approvals

ATC #30 Median Access to DMS

5. Proposed Drafting Revisions

See proposed modifications to the Project Agreement, Schedule 10, Section 11.3.1.m specifies that "walkways shall not be permitted on overhead guide sign structures."

e. The Developer shall submit sign layouts for all special signs of any size to the Department for Acceptance;

f. During the Construction Period the Developer shall re-set the existing permanent signs on the I-70 Mainline that display the LOGOS. The Developer shall coordinate with the contractor responsible for managing the LOGOS program for the correct placement of these signs. Contact information for the LOGOS program can be found at www.colorado.interstatelogos.com. At the end of the Construction Period these signs shall be incorporated into the Permanent Signing Plan at the direction of the LOGOS program manager following the Approval from the Department;

g. The Developer shall coordinate with the Regional Transportation District (RTD) to replace wayfinding signs for RTD stops and stations in and outside the Site. If existing wayfinding signs require removal, alternative equivalent signs shall be replaced, as directed by RTD;

h. Mile markers are required for the entire length of the Project and shall be displayed every 0.1 mile. In addition, delineators are required. Mile markers and delineators shall be installed in accordance with the Construction Standards;

i. Signing designs shall include details of size, legend and locations of ground-mounted and overhead signs, dimensions of Class III sign supports, layouts/dimensions of all special signs, and structural and foundation requirements. Details to be submitted shall include structure cross sections, display signing mounting, hangers, equipment, control boxes, conduits, holes, hand holes, vertical clearances, the Right-of-Way (ROW) line, Utility conflicts, panel sizes, tolling attachments, all Intelligent Transportation Systems (ITS) attachments, Active Traffic Management (ATM) elements, cabinets, conduit locations, caisson foundation sizes and depths, shoulder, General Purpose Lane and Tolled Express Lane widths, correct sign placement over each lane, direction, barrier protection type, station and offset, etc. Refer to Schedule 10, Section 13 Structures for requirements and coordination;

j. Where CDOT sign structure standards cannot be met, the Developer shall submit alternative designs, such as custom designed monotube sign structures and foundations, for Approval. Permanent signage on Bridges shall not be hung from or be attached to the face of Bridge superstructures. Existing signs attached to Bridge superstructures shall be removed and replaced with monotube sign bridges or cantilever structures with new signs. Refer to Schedule 10, Section 13 Structures for requirements and coordination;

k. The Developer shall mount all overhead signs along the I-70 Mainline with a minimum vertical clearance of 17.5 feet and a maximum of 18.5 feet measured from the roadway surface under the sign panels and/or electronic signs to the bottom of the Variable Message Sign (VMS), Variable Toll Message Sign (VTMS), lane use signal (LUS) or guide sign (whichever is lowest). Structure cross sections shall be submitted and display signing mounting, hangers, equipment, control boxes, conduits, holes, hand holes, vertical clearances and all dimensions. Refer to Schedule 10, Section 3 ITS and Tolling Equipment for requirements and coordination;

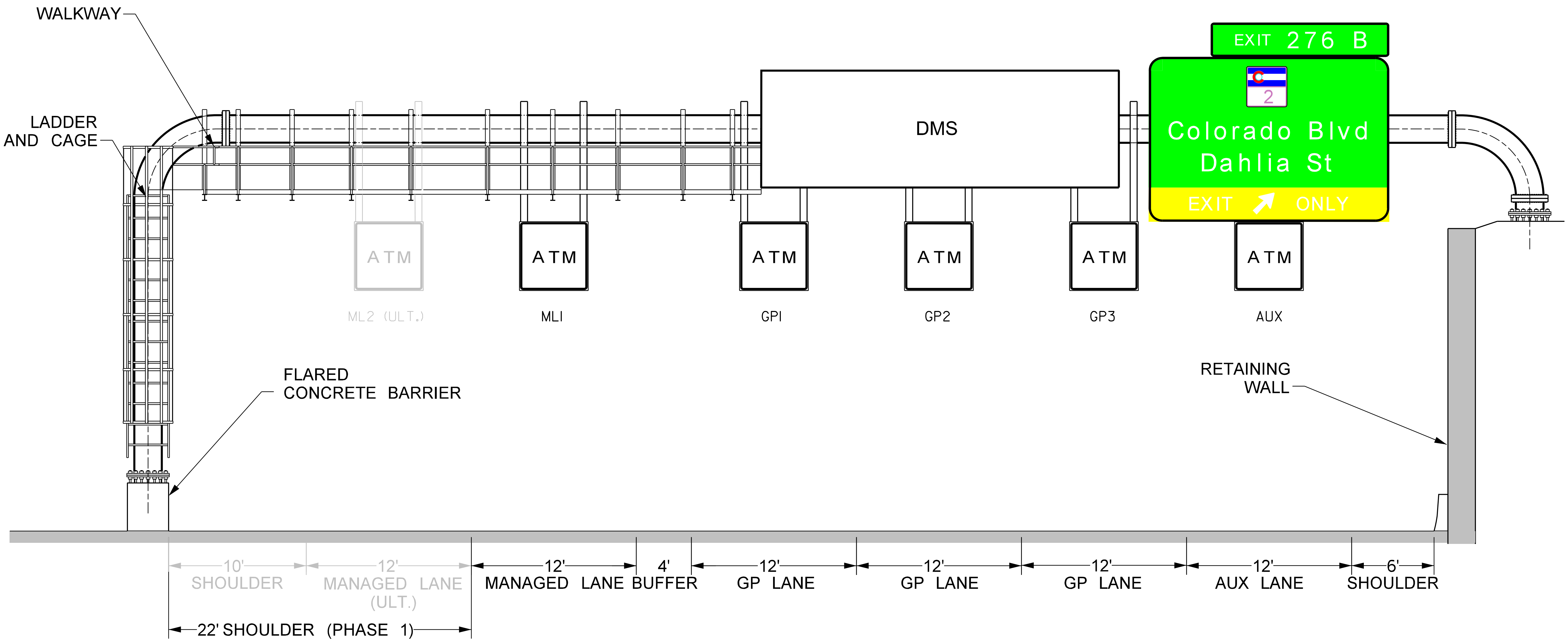
l. Sign lighting on overhead guide signs shall not be permitted; and

m. ~~Unless stated otherwise,~~ DMS walkways shall ~~not~~ be permitted on overhead guide sign structures if they do not obstruct view of signage~~.~~

11.3.2. Signing Materials

a. The materials for sign posts for each class of sign shall comply with the respective requirements of the Construction Standards. The use of wood posts for mounting ground signs is not permitted and all Class I and Class II sign posts shall use schedule 80 in lieu of schedule 40 material;

STATION: 2052+00 EASTBOUND



Print Date: 11/1/2016	
File Name: EB Vasquez DMS	
Horiz. Scale: 1:8.33333	Vert. Scale: As Noted

5280 Connectors Linking I-70 Communities

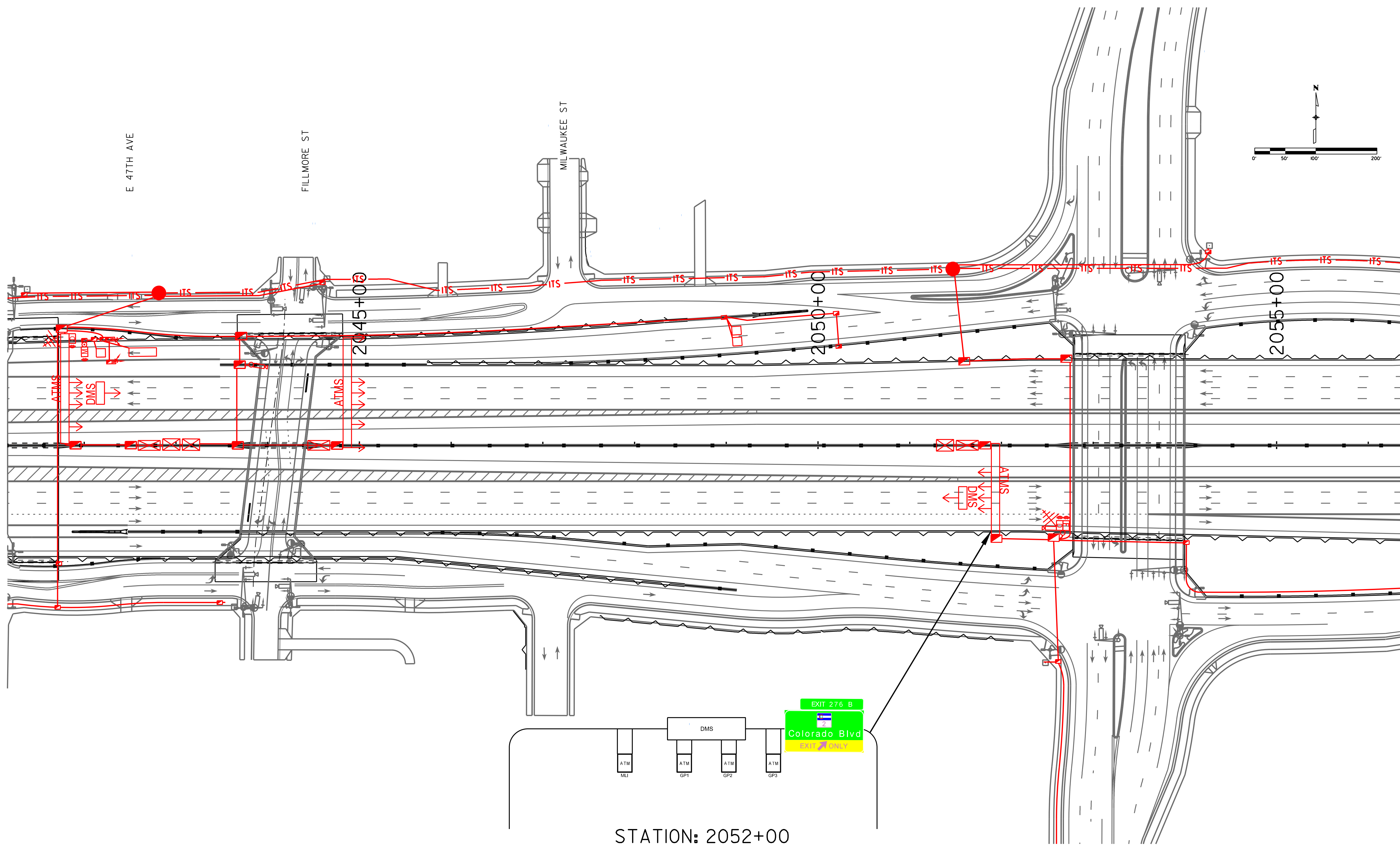
Colorado Department of Transportation

Region 1

COLORADO HPTE

I-70 EAST ATC 29.1
VASQUEZ BLVD EB DMS
MEDIAN ACCESS

Designer:	Structure Numbers	
Detailer:		
Sheet Subset:	Subset Sheets: 1 of 2	



steve.simmons 11:55:55 AM pw:\\PWAPPOMA001:NorthCentral_Omaha\Documents\Colorado_Dept_of_Transportation_R1\CDOT_I_70_E_LID_D_B\6.0_CAD_BIM\6.2_Work_in_Progress\6.2.11 Traffic_ITS_S&S_Signals\Working\JChan\Vasques DMS Plan

Print Date: 11/2/2016
File Name: Vasques DMS Plan
Horiz. Scale: 100 Vert. Scale: As Noted

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation
Region 1

COLORADO HPTE

I-70 EAST ATC 29.1
VASQUEZ BLVD EB DMS
MEDIAN ACCESS

Designer:	Structure Numbers
Detailer:	
Sheet Subset:	Subset Sheets: 2 of 2

SECTION 2.2.10

ATC 30.1 | DMS MEDIAN ACCESS

Central 70

DATE: December 16, 2016

TO: 5280 Connectors

FROM: Anthony DeVito P.E. Central 70 Project Director
Nichola Farber, Central 70 Project

SUBJECT: Central 70 - Detailed Alternative Technical Concept (ATC) Response
5280 Connectors - ATC No. 30.1

Dear Mr. Clark:

Your Team's ATC Submission Form for Detailed ATC 30.1 was reviewed by the Procuring Authorities prior to the December One-on-One Meetings and an initial response was sent to you on December 1, 2016. As discussed during the December One-on-One Meeting, the Procuring Authorities committed to provide a final response to your Detailed ATC.

Detailed ATC 30.1 proposes to provide maintenance access to the DMS in the Lowered Section via a ladder and walkway from the median of I-70, instead of the outside shoulder.

In accordance with the Instructions to Proposers ("ITP"), the Procuring Authorities will use reasonable efforts to provide a Proposer with the following written feedback on a ATC Submission within 15 Working Days following the later of (x) the date the relevant ATC Submission was submitted and (y) the One-on-One Meeting at which such submission is discussed. Below is the final response from the Procuring Authorities for your Detailed ATC:

☒ 1. unconditional approval;

☐ 2. conditional approval, subject to modifications and/or conditions;

☐ Re-submission required ☐ Re-submission not required

☐ 3. disapproval, with or without guidance that such ATC can be re-submitted under any circumstance;

☐ 4. notification that the incorporation of the proposed ATC in the Proposer's Proposal is already permitted under the terms of the RFP, and therefore does not qualify as an ATC (and will not be treated as such for purposes of Section 3.4 of Part C of the ITP).

☐ 5. subject to compliance with the confidentiality requirements set out in Section 3.4 of Part C of the ITP, the Procuring Authorities are considering amending (for the benefit of all Proposers) the terms of the RFP that are the subject-matter of the proposed ATC.

Following our discussions at the One-on-One Meeting, the Procuring Authorities have not changed their initial response to your above mentioned Detailed ATC Submission. The ATC is unconditionally approved.

The approval of this Detailed ATC by the Procuring Authorities does not constitute an approval of specific drafting modifications to the RFP necessary to incorporate this ATC into the Project Agreement pursuant to Section 7.2.1.c of Part C of the ITP, which modifications shall be agreed by the Procuring Authorities and the Proposer (each acting reasonably) following issuance of a Notice of Award to such Proposer.

ANNEX 3: ALTERNATIVE TECHNICAL CONCEPT SUBMISSION FORM

Proposer Name: 5280 Connectors
Date: November 4, 2016

Central 70 Project RFP: ATC Submission No. 30.1

A. Background Information

1. Type of Submission

☐ Conceptual ATC

☒ Detailed ATC

2. Prior Submission(s)

☐ None (initial submission of ATC)

☒ Previously Submitted as Conceptual ATC

☐ Previously Submitted as Detailed ATC

3. Explanation of Reason for Resubmission

Resubmission with identified Structure cross Sections showing sign structures

4. Request for Discussion at One-on-One Meeting

☒ Meeting Requested

☐ Meeting Not Requested[1]

[1] In accordance with Section 3.2.1 of Part C, the Procuring Authorities may nevertheless require a Proposer to present an ATC Submission at a One-on-One Meeting.

B. General ATC Submission Requirements

1. Overview Description

This information has not been amended since the submission of the previous version of this ATC.

5280 Connectors proposes an Alternated Technical Concept to provide maintenance personnel with Dynamic Message Sign (DMS) access in the Lowered Section from Colorado to Brighton Blvd. via a ladder and walkway from the median of I-70, instead of the outside shoulder.

2. Relevant RFP Requirements

This information has been amended since the submission of the previous version of this ATC.

The Project Agreement, Schedule 10, Section 3.8.11.a.ii specifies that “where ROW permits, an 8 feet wide paved area shall be provided outside of the shoulder, for maintenance access” and that “the sign bridge shall have a locked, secured ladder and walkway so that maintenance personnel can maintain every portion of the sign bridge without the use of a bucket truck.”

3. Rationale

This information has not been amended since the submission of the previous version of this ATC.

To allow maintenance personnel access to the DMS structures, this ATC proposes that the required ladder and walkway extend from the I-70 median instead of the outside shoulder. The equipment cabinets for the nearby intelligent transportation systems (ITS) devices are proposed to be located in the median, allowing maintenance personnel the ability to access both the cabinets and the DMS itself from the same location.

In the Phase 1 configuration, there will be a single managed lane at this location, resulting in an inside shoulder width of 22 feet. In the Ultimate configuration where there will be two managed lanes at this location, the inside shoulder width will be 10 feet. In either case, there is sufficient space for maintenance personnel to park their vehicles and access without the need for a lane closure.

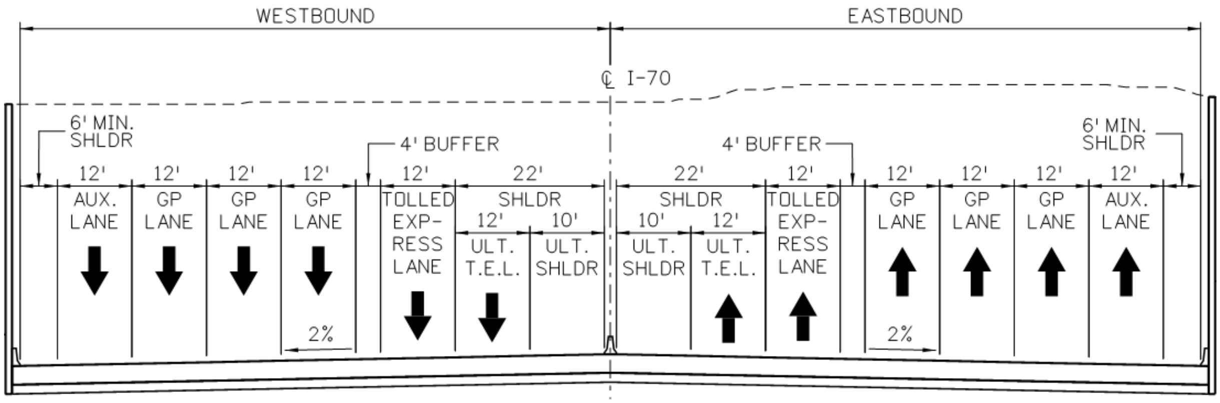


Figure 1 - STA 2052+00 Cross Section

4. Impacts

This information has not been amended since the submission of the previous version of this ATC.

The impacts of relocating the access ladder and walkway from the outside shoulder to the I-70 median are that maintenance personnel will have to access the DMS from the median. All other full size DMS locations within the Project outside of the Lowered section will be accessible from the outside shoulder.

5. Cost and Benefit Analysis

This information has not been amended since the submission of the previous version of this ATC.

There is no estimated cost saving from relocating the DMS access from the outside roadway shoulder to the median.

The benefits of relocating the DMS access ladder and walkway from the outside shoulder to the I-70 median include safer access for maintenance personnel and removal of sign access from the outside wall unauthorized individuals.

6. Schedule Analysis

This information has not been amended since the submission of the previous version of this ATC.

There will be no impacts to the schedule.

7. Conceptual Drawings

This information has been amended since the submission of the previous version of this ATC.

Median Access DMS Plans at Station 2031+65 EB and 2021+50 WB shows preliminary elevation of the overhead sign structure, and electronic DMS for access requirements.

8. Past Use

This information has not been amended since the submission of the previous version of this ATC.

N/A

9. Additional Information

This information has not been amended since the submission of the previous version of this ATC.

N/A

<u>Detailed ATC Requirements</u>

1. Risks

The risk of unauthorized access to the sign structure DMS access is minimized by restricting access from the outside wall. Access can now only be gained from the restricted interstate median. Walkway would not obscure sign visibility but would limit future signage on west side of the structure.

2. Handback

There are no changes in handback requirements.

3. Right-of-Way

Not Applicable

4. List of Required Approvals

No additional Approvals are anticipated with access change.

5. Proposed Drafting Revisions

See proposed modifications to the Project Agreement, Schedule 10, Section 3.8.7.a.ii

See proposed modifications to the Project Agreement, Schedule 10, Section 11.3.1.m specifies that "walkways shall not be permitted on overhead guide sign structures."

e. The Developer shall submit sign layouts for all special signs of any size to the Department for Acceptance;

f. During the Construction Period the Developer shall re-set the existing permanent signs on the I-70 Mainline that display the LOGOS. The Developer shall coordinate with the contractor responsible for managing the LOGOS program for the correct placement of these signs. Contact information for the LOGOS program can be found at www.colorado.interstatelogos.com. At the end of the Construction Period these signs shall be incorporated into the Permanent Signing Plan at the direction of the LOGOS program manager following the Approval from the Department;

g. The Developer shall coordinate with the Regional Transportation District (RTD) to replace wayfinding signs for RTD stops and stations in and outside the Site. If existing wayfinding signs require removal, alternative equivalent signs shall be replaced, as directed by RTD;

h. Mile markers are required for the entire length of the Project and shall be displayed every 0.1 mile. In addition, delineators are required. Mile markers and delineators shall be installed in accordance with the Construction Standards;

i. Signing designs shall include details of size, legend and locations of ground-mounted and overhead signs, dimensions of Class III sign supports, layouts/dimensions of all special signs, and structural and foundation requirements. Details to be submitted shall include structure cross sections, display signing mounting, hangers, equipment, control boxes, conduits, holes, hand holes, vertical clearances, the Right-of-Way (ROW) line, Utility conflicts, panel sizes, tolling attachments, all Intelligent Transportation Systems (ITS) attachments, Active Traffic Management (ATM) elements, cabinets, conduit locations, caisson foundation sizes and depths, shoulder, General Purpose Lane and Tolled Express Lane widths, correct sign placement over each lane, direction, barrier protection type, station and offset, etc. Refer to Schedule 10, Section 13 Structures for requirements and coordination;

j. Where CDOT sign structure standards cannot be met, the Developer shall submit alternative designs, such as custom designed monotube sign structures and foundations, for Approval. Permanent signage on Bridges shall not be hung from or be attached to the face of Bridge superstructures. Existing signs attached to Bridge superstructures shall be removed and replaced with monotube sign bridges or cantilever structures with new signs. Refer to Schedule 10, Section 13 Structures for requirements and coordination;

k. The Developer shall mount all overhead signs along the I-70 Mainline with a minimum vertical clearance of 17.5 feet and a maximum of 18.5 feet measured from the roadway surface under the sign panels and/or electronic signs to the bottom of the Variable Message Sign (VMS), Variable Toll Message Sign (VTMS), lane use signal (LUS) or guide sign (whichever is lowest). Structure cross sections shall be submitted and display signing mounting, hangers, equipment, control boxes, conduits, holes, hand holes, vertical clearances and all dimensions. Refer to Schedule 10, Section 3 ITS and Tolling Equipment for requirements and coordination;

l. Sign lighting on overhead guide signs shall not be permitted; and

m. ~~Unless stated otherwise,~~ DMS walkways shall ~~not~~ be permitted on overhead guide sign structures if they do not obstruct view of signage~~.~~

11.3.2. Signing Materials

a. The materials for sign posts for each class of sign shall comply with the respective requirements of the Construction Standards. The use of wood posts for mounting ground signs is not permitted and all Class I and Class II sign posts shall use schedule 80 in lieu of schedule 40 material;

a. Design Requirements

i. The DMS's are large dynamic displays that are used for a wide range of purposes, including providing driver information regarding weather advisories, travel times, amber alerts, toll information, construction, and incident notifications. The Developer shall design a complete DMS system. Final sign locations may need to be adjusted due to roadway geometry, conflicts with other signs or Cover requirements. Final locations of all DMS shall be Approved by the Department.

A. Westbound full color DMS shall be installed at the following approximate locations:

(I) 0.4 miles east of Airport Blvd

(II) 0.5 miles west of Peoria St

(III) Between Havana St and in advance of the I-270 off ramp

(IV) 0.8 miles east of Colorado Blvd

B. Eastbound full color DMS shall be installed (or, in the case of (ii), replaced) at the following approximate locations:

(I) Between I-25 and Brighton Blvd

(II) In advance of Washington St (at the same location as the current DMS). This DMS shall be over the entering ramp lanes.

(III) Between the Cover and Vasquez Blvd

(IV) 0.9 miles east of Colorado Blvd

(V) Between the Central Park Blvd EB on-ramp and Havana St

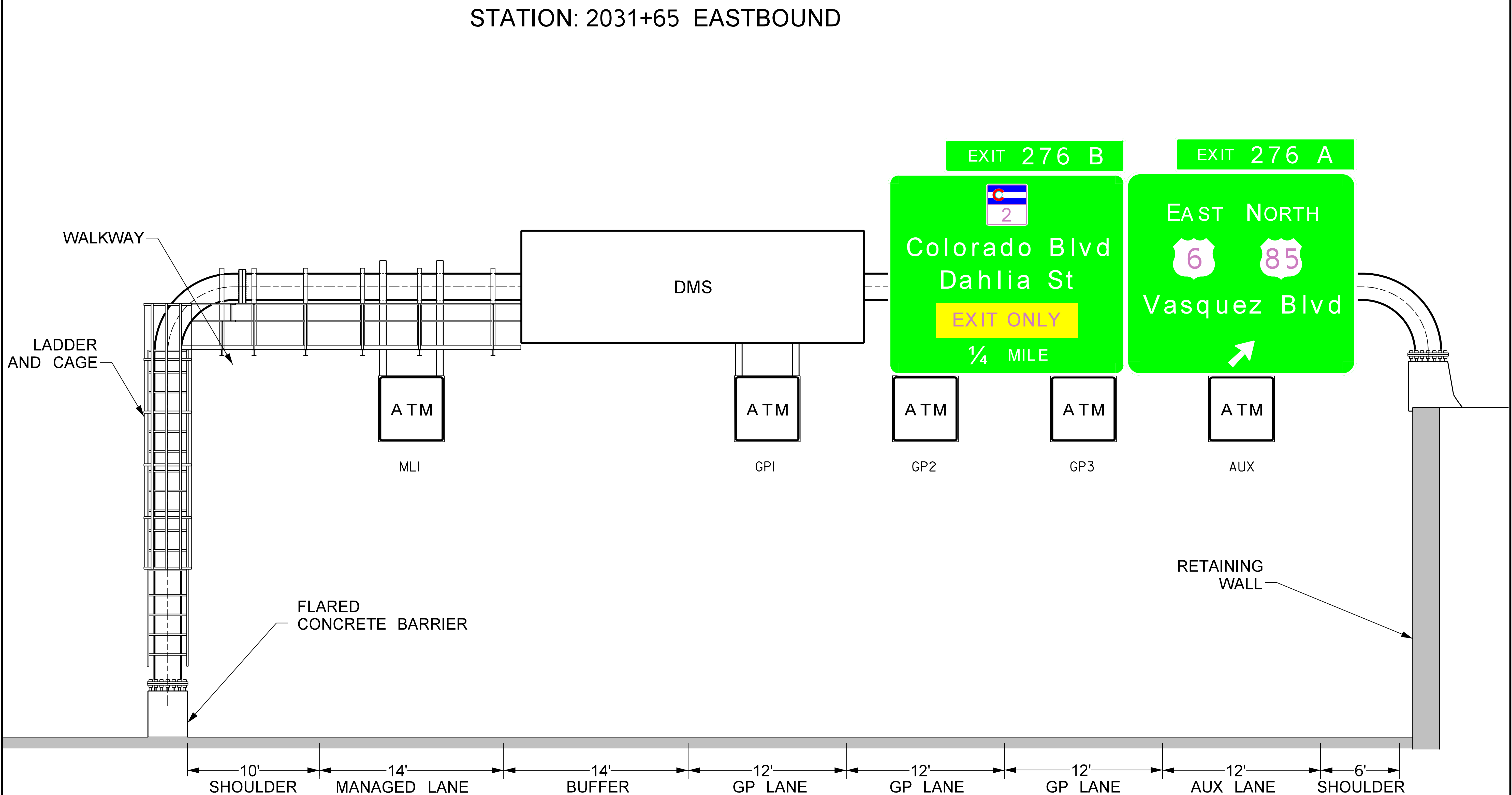
C. A new Amber DMS with dimensions of 18 feet (width) by 8.5 feet (height) by 4 feet (depth) with an allowable variation of plus or minus 7-inches shall be installed at the I-70 EB to I-25 off-ramp to replace the existing DMS; and

D. See Schedule 10, Section 12 Cover MEP System for additional requirements regarding the DMS required for the Cover.

ii. New DMSs shall be mounted on a sign bridge and co-located with the static guide signs wherever possible. They shall be centered over the General Purpose Lanes but be visible to all Users. Where ROW permits, an 8 feet wide paved area shall be provided, outside of the shoulder, for maintenance access or from roadway median where outside shoulder is not sufficient. The sign bridge shall have a locked, secured ladder and walkway so that maintenance personnel can maintain every portion of the sign bridge without the use of a bucket truck. The walkway shall be mesh with a maximum diameter of ½-inch to prevent dropped tools and debris from falling onto the travelled way. In addition, the walkway shall be Occupational Safety and Health Administration (OSHA) compliant with side rails and toe kicks. The Developer shall submit a structural design for each DMS structure in accordance with the requirements of Schedule 10, Section 13 Structures. The sign bridge handle shall not prevent the static sign messages from being clearly read and shall be OSHA compliant; and

iii. The Developer shall furnish, install, integrate, and test all new DMS signs and any and all associated equipment necessary to achieve a fully-functioning system. The new DMS signs shall be designed based on the following material requirements, at a minimum:

A. The sign shall utilize light emitting diode (LED) displays;



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5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation

CDOT CO Region 1

COLORADO HPTE

I-70 EAST ATC 30.1
MEDIAN ACCESS DMS

Designer:		Structure Numbers	
Detailer:			
Sheet Subset:		Subset Sheets: 1 of 3	

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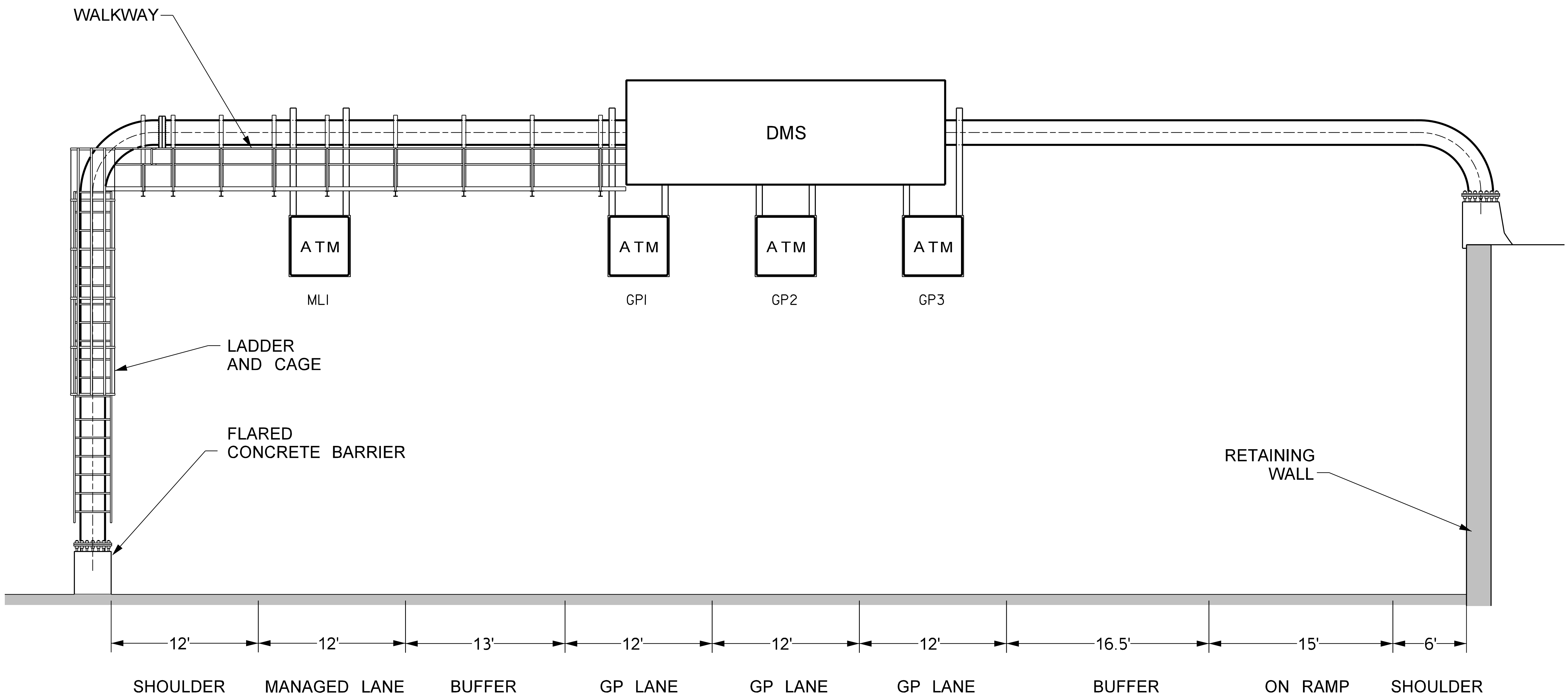
STATION: 2042+00 WESTBOUND



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5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation

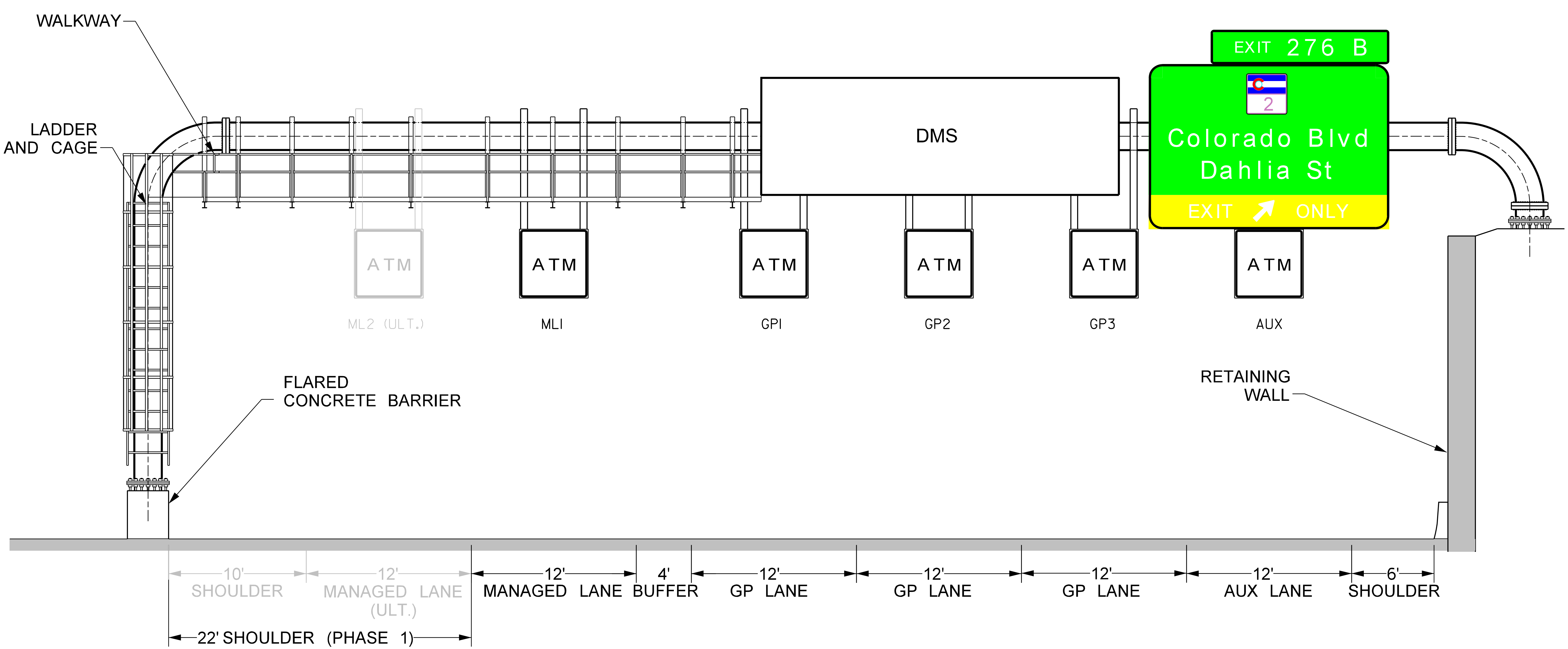
Region 1

COLORADO HPTE

I-70 EAST ATC 30.1
MEDIAN ACCESS DMS

Designer:		Structure Numbers	
Detailer:			
Sheet Subset:		Subset Sheets: 2 of 3	

STATION: 2052+00 EASTBOUND



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Print Date: 11/1/2016
File Name: 2052+00 EB DMS
Horiz. Scale: 8.33333 Vert. Scale: As Noted

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation
CDOT Region 1

COLORADO HPTE

I-70 EAST ATC 30.1
MEDIAN ACCESS DMS

Designer:		Structure Numbers	
Detailer:			
Sheet Subset:		Subset Sheets: 3 of 3	

SECTION 2.2.11

ATC 31.2 | COVER BUILDINGS CONFIGURATION

Central 70

DATE: March 28, 2017

TO: 5280 Connectors

FROM: Anthony DeVito P.E. Central 70 Project Director
Nicholas Farber, Central 70 Project

SUBJECT: Central 70 - Detailed Alternative Technical Concept (ATC) Response
5280 Connectors - ATC No. 31.2

Dear Mr. Clark:

Your Team's ATC Submission Form for Detailed ATC 31.2 has been reviewed by the Procuring Authorities.

Detailed ATC 31.2 proposes to locate the plant and service rooms off the Cover landscape area to an adjacent ROW parcel.

In accordance with the Instructions to Proposers ("ITP"), the Procuring Authorities will use reasonable efforts to provide a Proposer with the following written feedback on a ATC Submission within 15 Working Days following the later of (x) the date the relevant ATC Submission was submitted and (y) the One-on-One Meeting at which such submission is discussed. Below is the final response from the Procuring Authorities for your Detailed ATC:

☐ 1. unconditional approval;

☒ 2. conditional approval, subject to modifications and/or conditions;

☐ Re-submission required ☒ Re-submission not required

☐ 3. disapproval, with or without guidance that such ATC can be re-submitted under any circumstance;

☐ 4. notification that the incorporation of the proposed ATC in the Proposer's Proposal is already permitted under the terms of the RFP, and therefore does not qualify as an ATC (and will not be treated as such for purposes of Section 3.4 of Part C of the ITP).

☐ 5. subject to compliance with the confidentiality requirements set out in Section 3.4 of Part C of the ITP, the Procuring Authorities are considering amending (for the benefit of all Proposers) the terms of the RFP that are the subject-matter of the proposed ATC.

The ATC is approved with the following conditions:

Conditions of approval:

1. The Developer shall:
   a. be solely responsible for any additional Environmental Approvals required to implement the ATC;
   b. be solely responsible to obtain any Additional Right-of-Way required to implement the ATC; and

c. be solely responsible to obtain any Governmental Approvals, including from the City of Denver, required to implement the ATC.

The approval of this Detailed ATC by the Procuring Authorities does not constitute an approval of specific drafting modifications to the RFP necessary to incorporate this ATC into the Project Agreement pursuant to Section 7.2.1.c of Part C of the ITP, which modifications shall be agreed by the Procuring Authorities and the Proposer (each acting reasonably) following issuance of a Notice of Award to such Proposer.

ANNEX 3: ALTERNATIVE TECHNICAL CONCEPT SUBMISSION FORM

Proposer Name: 5280 Connectors
Date: March 6, 2017

Central 70 Project RFP: ATC Submission No. 31.2

A. Background Information

1. Type of Submission

☐ Conceptual ATC

☒ Detailed ATC

2. Prior Submission(s)

☐ None (initial submission of ATC)

☒ Previously Submitted as Conceptual ATC

☐ Previously Submitted as Detailed ATC

3. Explanation of Reason for Resubmission

A Service Building Layout Plan has been provided for the proposed Plant and Facility Room location with Building Architectural Elevations showing facility detail for incorporation into the neighborhood character.

4. Request for Discussion at One-on-One Meeting

☒ Meeting Requested

☐ Meeting Not Requested

B. General ATC Submission Requirements

1. Overview Description

This information has been amended since the submission of the previous version of this ATC.

We propose to locate the Plant and Service Rooms Facilities from atop the Cover landscape area Maintenance Buildings (Site Keynote #5.6) on the 10B.10.14.01 I-70 Cover Plan Drawings, to an adjacent ROW parcel (AP-52) along 46th Ave. North. This will allow 5280 Connectors to comply with Section 12.16 of the Project Agreement for housing necessary Fire Life Safety Equipment which cannot be accommodated by the the two Maintenance Building locations.

This will provide a single central location for the Plant and Service Room facilities and provide direct access to operations and maintenance personnel. Consolidating plant and service equipment into a central location will reduce the number of total locations needed and eliminate the facility buildings on the Cover area.

The building footprint is roughly 64 ft. x 55 ft., two stories tall with enclosed exterior generator and house required control systems for the Cover Mechanical, Electrical and Plumbing (MEP) in accordance with RFP requirements. A preliminary floor plan of equipment has been shown identifying the necessary space proofing requirements and code requirements for necessary access.

2. Relevant RFP Requirements

This information has not been amended since the submission of the previous version of this ATC.

<u>12.16 Plant Rooms and Service Buildings</u>

"The Developer shall provide suitable plant rooms to house switchgear, control equipment and associated equipment meeting Local Agency building codes and standards.

Plant rooms and other Cover facilities, including the CCMS, shall have secure access utilizing the same building monitoring and access control system that CDOT uses on its node buildings; refer to Schedule 10, Section 3 – ITS and Tolling Equipment: Traffic Management System Building specification for requirements.

The I-70 Cover in Schedule 10B Contract Drawings indicate locations (labelled 'Maintenance Building') and footprints on the Cover for two service buildings (one at each bookend). The Developer (i) is required to construct any such buildings that it requires in accordance with its design at such locations, (ii) is not permitted to construct such buildings using a greater footprint than indicated in such plans unless Approved by the Department to be larger and (iii) notwithstanding (ii), shall minimize the sizes of such buildings by locating certain plant rooms and equipment in separate facilities located within remaining ROW areas in the vicinity of the Cover or in Additional ROW areas."

3. Rationale

This information has been amended since the submission of the previous version of this ATC.

The Cover conceptual geometry design and the limited space restrictions for the maintenance buildings as stated on the covered lid per the I-70 Cover Plans in Schedule 10B contract drawings provided, the plant and Service rooms do not have numerous location options on the Cover.

Moving the Plant and Service Rooms to alternate location from the Cover to Right of Way Parcel No. AP-52 at Josephine St. and 46th Ave N. will allow 5280 Connectors to comply with Section 12.16 of the Project Agreement. In addition, it will also benefit aesthetically by allowing the maintenance buildings to remain the required size, and it will eliminate addition equipment placement on the cover section that would interfere with the landscaping. With the Plant and Service Rooms located at one location on a parcel off the Cover will have a positive impact on the maintenance of these systems as well.

4. Impacts

This information has not been amended since the submission of the previous version of this ATC.

The relocation of the Cover Plant and Service facilities to a single Fire Control Center location off the Cover will place equipment on a remnant residential Right-of-Way Parcel that is included in the Project acquisition. This will place project equipment outside areas that have not previously identified for impact. The remnant Parcel AP-52 would be occupied with building facility location to house equipment. The new facility would front Josephine St, and 46th Ave with local alley behind.

By locating the Cover Plant and Service Facilities off the Cover, this will increase the available space for landscaping enhancements and increase square footage of usable park size. In addition, removing the Maintenance Buildings from the Cover will also provide increased aesthetic benefit by removing large building structures. This will open sight lines into the park and decrease vertical profile view at portals. User security will also be increased by eliminating darkened shaded and corner areas around the building exteriors.

5. Cost and Benefit Analysis

This information has not been amended since the submission of the previous version of this ATC.

The cost impact of shifting the layout of the Plant and Service rooms off the Cover provides an estimated savings of approximately $1.0 Million Dollars. This savings is due to the efficiencies of housing all the system equipment into one location. A single location for systems would also reduce maintenance costs and provide within a secured location with restricted access.

6. Schedule Analysis

This information has not been amended since the submission of the previous version of this ATC.

Impacts on schedule are very minimum since some elements like the Fire Main manual wheel valve and the hose connections to supplement the Fixed Fire Suppression (FFS) system still need to be install as part of the Cover Mechanical Electrical Plumbing (MEP) system, however the construction of the Plant and Service Room Facility will be removed from the Project schedule critical path, since the future building will be located off the Cover in adjacent parcel. This will allow for earlier testing and commissioning of electrical system and plant equipment.

7. Conceptual Drawings

This information has not been amended since the submission of the previous version of this ATC.

Please see attached the conceptual drawings

- Service Building- Layout Plan
- Service Building- Architectural Elevations

8. Past Use

This information has not been amended since the submission of the previous version of this ATC.

N/A

9. Additional Information

This information has not been amended since the submission of the previous version of this ATC.

The Local Control Facilities have been relocated near the entry portal of each bore at the roadway level. In performing space proofing analysis of Plant Rooms and Service Equipment, we believe there is insufficient space in the “Maintenance Buildings” footprint locations provided on the I-70 Cover Plans to meet the requirements.

There is limited additional ROW on the south side of the alignment to locate the additional equipment requirements for the Eastbound tunnel and have identified an additional ROW parcel on the north side of alignment best suited to house all the Plant Rooms and Service Equipment in a single location.

This provides maximum efficiency of locating all the Plant Rooms together in a single location by minimizing footprint on the lid. The benefits and advantages of commissioning, integration and interface of all electrical and mechanical components in one location include: facilitate and expedite Cover testing and integration phase, facilitate the communication links between cover lid on-site equipment components and operational system, and reduce the timeframe to find and resolve any potential or future failure within the Cover MEP system.

C. Detailed ATC Requirements

1. Risks

The proposed consolidated facility will locate the Cover Service Building in Alternate ROW site location than has been previously identified in I-70 Cover Plans for Maintenance Facility Buildings. Proposed locations will be located in residential location that will be subject to review by the City of Denver Building Code requirements and approvals.

2. Handback

The consolidated control facility Service Building will reduce handback requirements with a single plant room control facility location from the two portal cover locations. Additional redundancy is provided with a single location as well as reduced handback structural inspections with standard building construction vs. locating Buildings on Cover structure.

3. Right-of-Way

No additional right of way is required with use of existing property acquisitions not identified for future use.

4. List of Required Approvals

City and County of Denver Approval and review by Development/ Building Department is anticipated.

5. Proposed Drafting Revisions

Modification the the Project Agreement Schedule 10- Section 12.16 is required (see attached drafting revisions).

12.16. Plant Rooms and Service Buildings

The Developer shall provide suitable plant rooms to house switchgear, control equipment and associated equipment meeting Local Agency building codes and standards.

Plant rooms and other Cover facilities, including the CCMS, shall have secure access utilizing the same building monitoring and access control system that CDOT uses on its node buildings; refer to Schedule 10, Section 3 – ITS and Tolling Equipment: Traffic Management System Building specification for requirements.

The I-70 Cover Plans in Schedule 10B Contract Drawings indicate locations (labelled ‘Maintenance Building’) and footprints on the Cover for two service buildings (one at each bookend). The Developer (i) is required to construct any such buildings that it requires in accordance with its design~~ at such locations~~, (ii) is not permitted to construct such buildings using a greater footprint than indicated in such plans unless Approved by the Department to be larger and (iii) notwithstanding (ii), shall minimize the sizes of such buildings by locating ~~certain~~ plant rooms and equipment in a separate facilitie~~s~~ located within remaining ROW areas in the vicinity of the Cover or in Additional ROW areas.

12.17. Command Control and Monitoring System

12.17.1. Scope

a. The Developer shall design and install a CCMS to provide a comprehensive fault monitoring and management facility for all electrical and mechanical systems installed in the Cover as well as to facilitate the operation and management of the roadway in the Cover and its approaches. The CCMS design shall include provisions to integrate the Project ITS and the Cover ITS described in this Section as necessary to support the CCMS and to enable the CCMS to interface with the operation and management for the I-70 Mainline as a whole as well as either side of the Cover and the associated ramp management systems.

b. The CCMS shall include the ability to monitor the status of the Cover MEP System and provide facilities to:

i. Over-ride the automatic operation of the CVS;

ii. Over-ride the automatic operation of the drainage system;

iii. Over-ride the automatic operation of the electricity distribution system;

iv. Over-ride the automatic operation of the lighting system;

v. Over-ride the automatic operation of the Emergency way finding signs;

vi. Over-ride the automatic operation of the FFFS;

vii. Control the operation of the radio rebroadcast systems;

viii. Control the operation of the voice alarm and public address system;

ix. Monitor the status of the fire main system;

x. Monitor the status and manage alarms from the AID system;

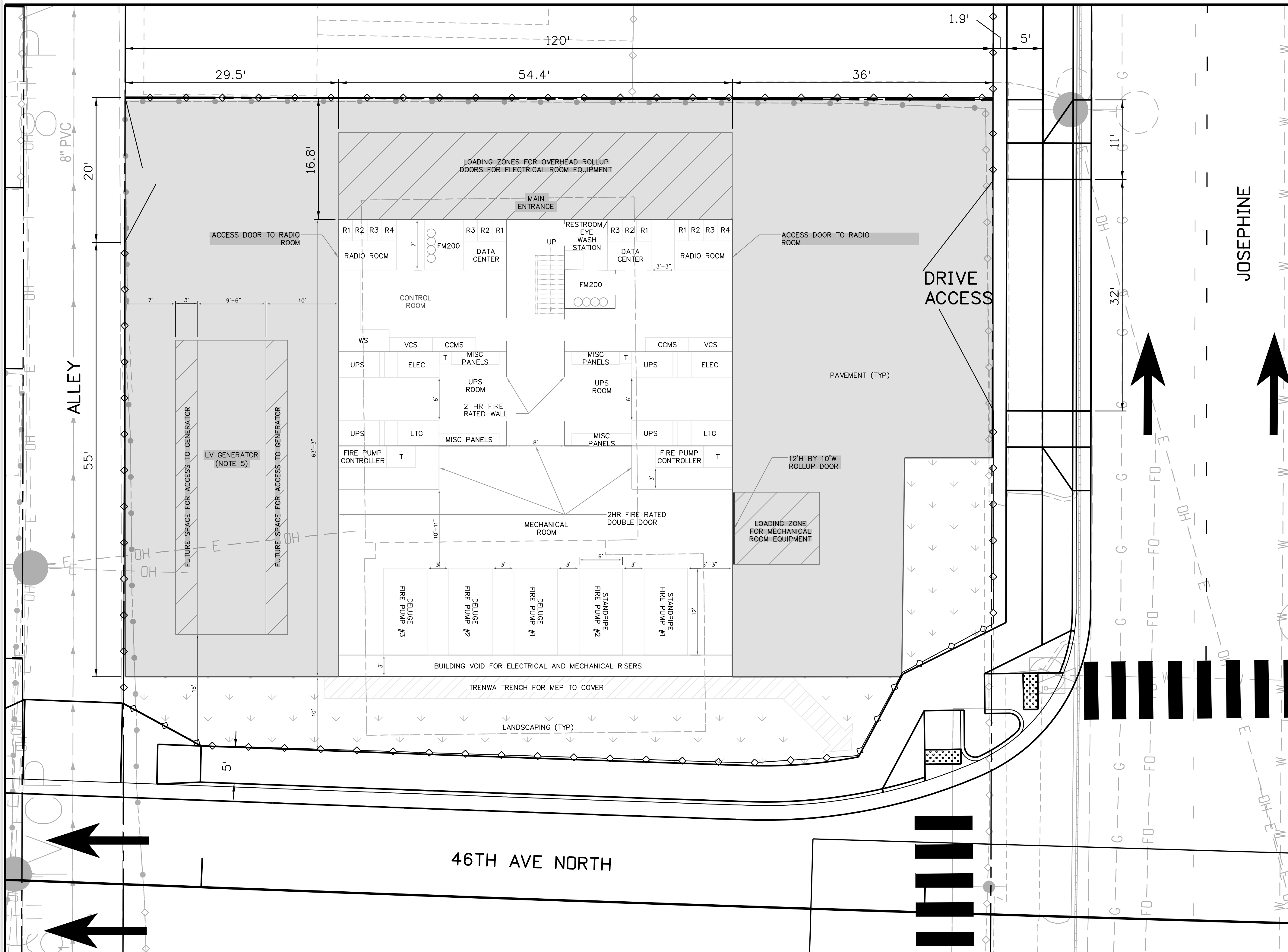
xi. Monitor the status and manage alarms from the Fire Detection system;

xii. Monitor the status and manage alarms from the cross bore doors;

xiii. Monitor Plant Room systems including heating, ventilation, and air conditioning (HVAC), lighting, intruder alarm, fire alarm, FFFS etc.;

xiv. Monitor the status and manage alarms from all environmental and other sensors;

xv. Monitor the status of the power distribution system; and

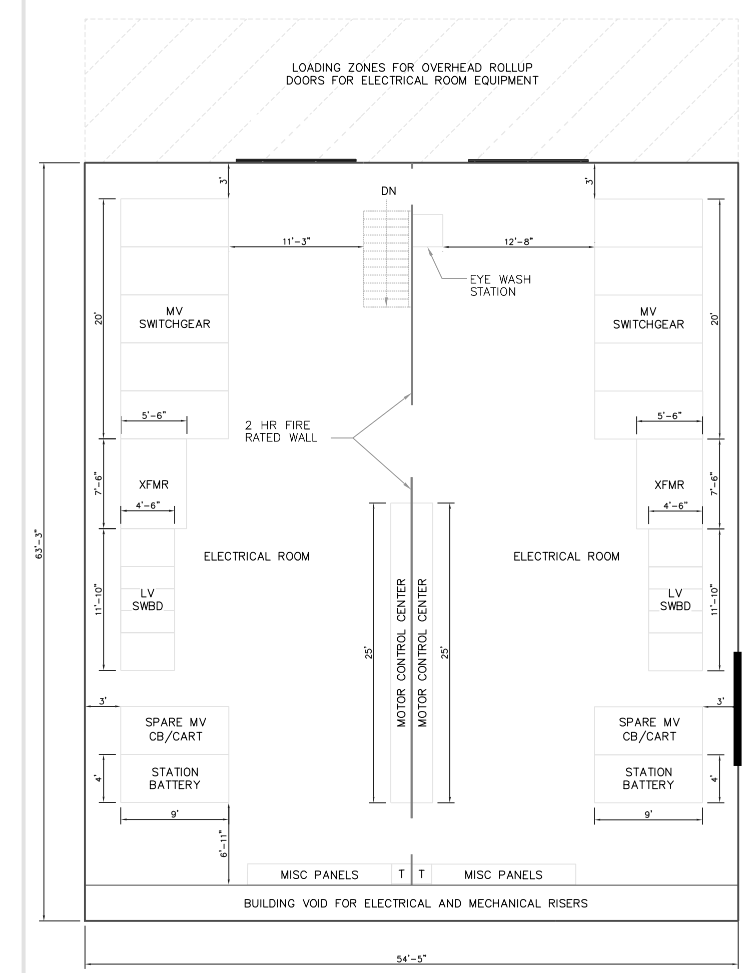


GROUND LEVEL

SCALE: 1/16" = 1'-0"

NOTES:

1. FIRE CONTROL CENTER LAYOUT IS BASED ON A CONCEPTUAL DESIGN APPROACH TO ESTIMATE THE SPACE REQUIREMENTS NEEDED IN TOTAL SQUARE FOOTAGE (SF). THE SQUARE FOOTAGE OF THE BUILDING IS APPROXIMATELY 4705 SF PLUS 591 SF FOR THE GENERATOR SET.
2. AN ARCHITECT WILL DEVELOP THIS SPACE PROOFING LAYOUT INTO A BUILDING.
3. ELECTRICAL SERVICES IN THIS LAYOUT ARE NOT ILLUSTRATED.
4. HEIGHT OF BUILDING SHOULD BE 12FT FIRST FLOOR AND 16FT 2ND FLOOR HEIGHT ABOVE FINISHED FLOOR AT THE MINIMUM IN THE ELECTRICAL ROOMS.
5. LV GENERATOR SIZED TO INCLUDE SOUND ENCLOSURE WITH INTERNAL SILENCER AND SUBBASE FUEL TANK.



SECOND LEVEL

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Print Date: 3/6/2017
File Name: ATC 31.2_Plan.dgn
Horiz. Scale: 1:16 Vert. Scale: As Noted

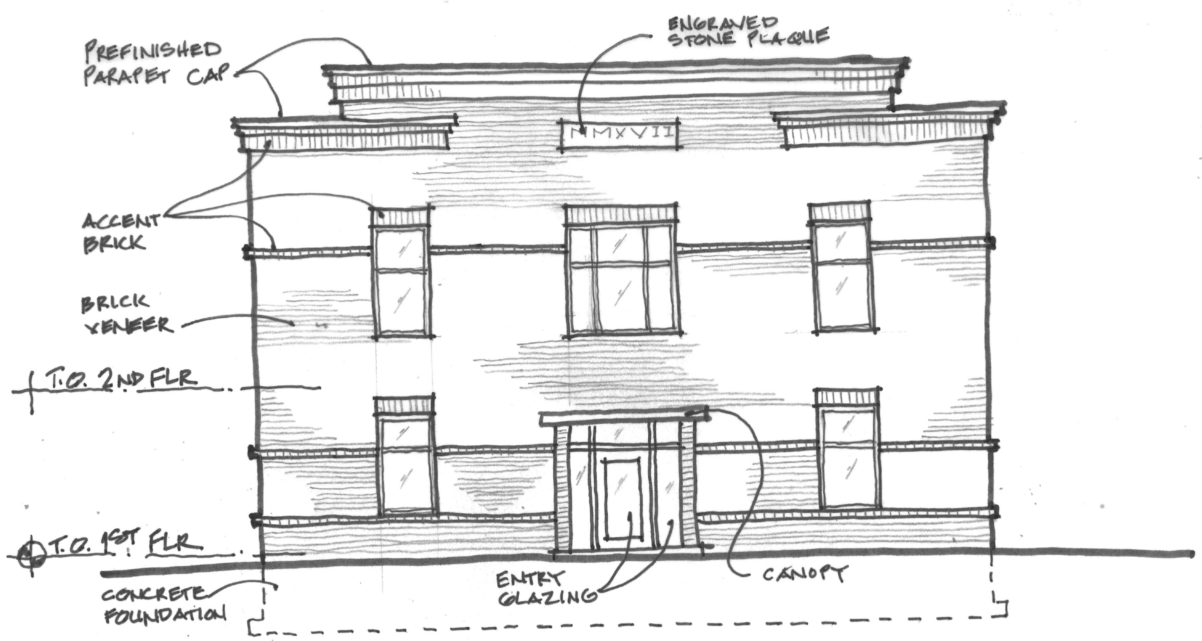
5280 Connectors Linking I-70 Communities

HDR

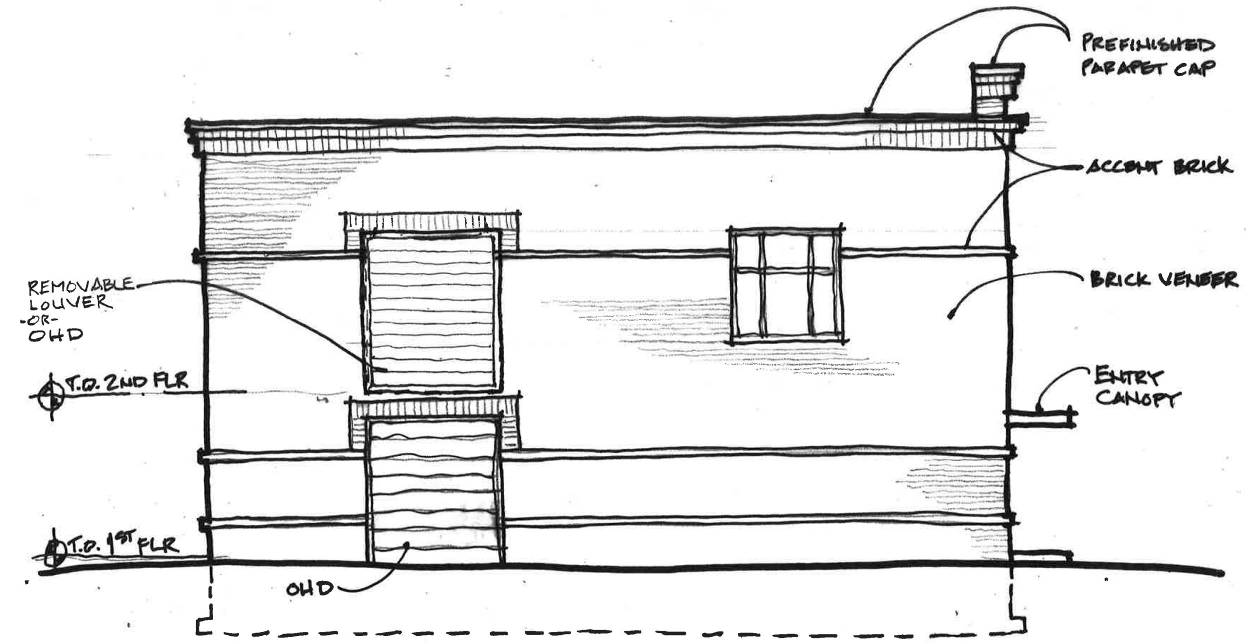
Colorado Department of Transportation
CDOT Region 1
COLORADO HPTE

I-70 ATC 31.2
SERVICE BUILDING
LAYOUT PLAN

Designer:
Detailer:
Sheet Subset:
Structure Numbers
Subset Sheets: 1 of 2



SERVICE BUILDING - ENTRY
NTS



SERVICE BUILDING - SIDE
NTS

Print Date: 3/3/2017	
File Name: ATC 31.2_Elevation.dgn	
Horiz. Scale: 1:300	Vert. Scale: As Noted

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation

CO CDOT

Region 1

COLORADO HPTE

I-70 ATC 31.2
SERVICE BUILDING
ARCHITECTURAL ELEVATION

Designer:		Structure Numbers	
Detailer:			
Sheet Subset:		Subset Sheets:	2 of 2

SECTION 2.2.12

ATC 32.0 | PRECAST CONCRETE FIB GIRDERS (FLORIDA I-BEAMS)

Central 70

DATE: October 18, 2016

TO: 5280 Connectors

FROM: Anthony DeVito P.E. Central 70 Project Director
Nicholas Farber, Central 70 Project

SUBJECT: Central 70 - Conceptual Alternative Technical Concept (ATC) Response
5280 Connectors - ATC No. 32.0

Dear Mr. Clark:

Your Team's ATC Submission Form for Conceptual ATC 32.0 was reviewed by the Procuring Authorities prior to the September One-on-One Meetings and an initial response was sent to you on September 23, 2016. As discussed during the September One-on-One Meeting, the Procuring Authorities committed to provide a final response to your Conceptual ATC. The ATC proposes the use of the Florida I-Beam precast pre-stressed girders.

In accordance with the Instructions to Proposers ("ITP"), the Procuring Authorities will use reasonable efforts to provide a Proposer with the following written feedback on a ATC Submission within 15 Working Days following the later of (x) the date the relevant ATC Submission was submitted and (y) the One-on-One Meeting at which such submission is discussed. Below is the final response from the Procuring Authorities for your Conceptual ATC:

☒ 1. unconditional approval and waiver of requirement for re-submission as a Detailed ATC;

☐ 2. unconditional approval for re-submission as a Detailed ATC;

☐ 3. conditional approval for re-submission as a Detailed ATC, subject to modifications and/or conditions;

☐ 4. disapproval, with or without guidance that such ATC can be re-submitted under any circumstance;

☐ 5. notification that the inclusion of the proposed ATC in the Proposer's Proposal is already permitted under the terms of the RFP, and therefore does not qualify as an ATC (and will not be treated as such for purposes of Section 3.4 of Part C of the ITP; or

☐ 6. subject to compliance with the confidentiality requirements set out in Section 3.4 of Part C of the ITP, the Procuring Authorities are considering amending (for the benefit of all Proposers) the terms of the RFP that are the subject-matter of the proposed ATC.

Following our discussions at the September One-on-One Meeting, the Procuring Authorities <u>have not</u> changed their initial response to your above mentioned Conceptual ATC Submission.

The approval of this Conceptual ATC by the Procuring Authorities does not constitute an approval of specific drafting modifications to the RFP necessary to incorporate this ATC into the Project Agreement pursuant to Section 7.2.1.c of Part C of the ITP, which modifications shall be agreed by the Procuring Authorities and the Proposer (each acting reasonably) following issuance of a Notice of Award to such Proposer.

ANNEX 3: ALTERNATIVE TECHNICAL CONCEPT SUBMISSION FORM

Proposer Name: 5280 Connectors
Date: September 7, 2016

Central 70 Project RFP: ATC Submission No. 32.0

A. Background Information

1. Type of Submission

☒ Conceptual ATC

☐ Detailed ATC

2. Prior Submission(s)

☒ None (initial submission of ATC)

☐ Previously Submitted as Conceptual ATC

☐ Previously Submitted as Detailed ATC

3. Explanation of Reason for Resubmission

N/A

4. Request for Discussion at One-on-One Meeting

☒ Meeting Requested

☐ Meeting Not Requested

B. General ATC Submission Requirements

1. Overview Description

5280 Connectors proposes the use of Alternative Design Concept Florida Department of Transportation (FDOT) Florida I-Beam (FIB) precast prestressed girders for the bridges shown in the following table. These girders are a more efficient superstructure type, allowing for reduced superstructure depth and/or decreased number of girder lines in most of the bridges as compared to a Colorado BT girder.

Location	Structure Number
UPRR Service Road over I-70	E-17-AEX
York Street over I-70	E-17-AEY
Josephine Street over I-70	E-17-AEZ
Fillmore Street over I-70	E-17-AEN
Steele St / Vasquez Blvd over I-70	E-17-AEO
Cook Street over I-70	E-17-AEP
Monroe Street over I-70	E-17-AFC
Colorado Blvd over I-70	E-17-AFD
I-70 over Dahlia Street	E-17-AFF / E-17-AFG
I-70 over Holly Street	E-17-AFH / E-17-AFI
I-70 over Monaco Street	E-17-AFJ / E-17-AFK
I-70 and N. Stapleton Dr. over Denver RIRR	E-17-ADT / E-17-AFN / E-17-AFO
I-70 Quebec Exit Ramp over Denver RIRR	E-17-ADU
I-70 over Quebec Street	E-17-AFQ / E-17-AFR
I-70 over Peoria Street	E-17-AFT / E-17-AFU
Cover	E-17-AEL

2. Relevant RFP Requirements

Project Agreement, Schedule 10 Section 13.5.4.a, specifies:

> *"Bridge types are not restricted to those historically used by the Department. The Developer may propose other types and components and submit to the Department for Approval. The Department will make its assessments by taking into account, among other factors, as to whether the type has been accepted for general use by other transportation authorities and the Developer has demonstrated that the design of the bridge type and components will perform well under the Project's environmental conditions, including frequent freeze-thaw cycles, anti-icing and de-icing. Bridge types are not restricted to those historically used by the Department."*

3. Rationale

This alternate girder type will replace the girder types shown in the RFP plans. The FIB shape can accommodate more prestressing strands than a comparable Colorado Bulb Tee (BT) girder, allowing for shallower girder depths and/or wider girder spacing for a given span length. FIB girders typically use only straight prestressing strands, with some strands debonded at the ends to relieve tensile stress at the top of the girder, whereas Colorado BT girders typically use harped strands to achieve this objective. This girder type has been accepted for general use by other transportation authorities and will perform well under the Project's environmental conditions, including freeze-thaw cycles, anti-icing and de-icing. The

FIB girders have more concrete cover on the bottom prestressing strands than the BT girders and include top prestressing strands to reduce the potential for cracking on the top of the girder.

4. Impacts

The precast girder type will not have any direct effects on environmental, social or economic impact, nor on community, traffic, operations and maintenance. FIB girders will not differ in durability or long-term maintenance requirements from Colorado BT girders but will be faster to construct.

5. Cost and Benefit Analysis

A preliminary analysis was performed for each bridge location for the FIB girder layout and a reduction in superstructure depth occurred at almost every location. The estimated cost savings for FIB girders is estimated at over $2.0 Million including bridge and cover superstructure and reduced excavation, walls and dewatering in the lowered section, and reduced embankment and walls east of Colorado Blvd.

6. Schedule Analysis

The anticipated benefits to the Project Schedule associated with bridge girder type is estimated at less than one month reduction with reduced number of girders. There is also anticipated Project Schedule savings in reduced associated items based on reduction in quantities that have not been fully calculated.

7. Conceptual Drawings

Attached are FDOT Standard Details for a FIB 63” girders and a Span Chart using Standard Loading that would be a typical girder type on the Project.

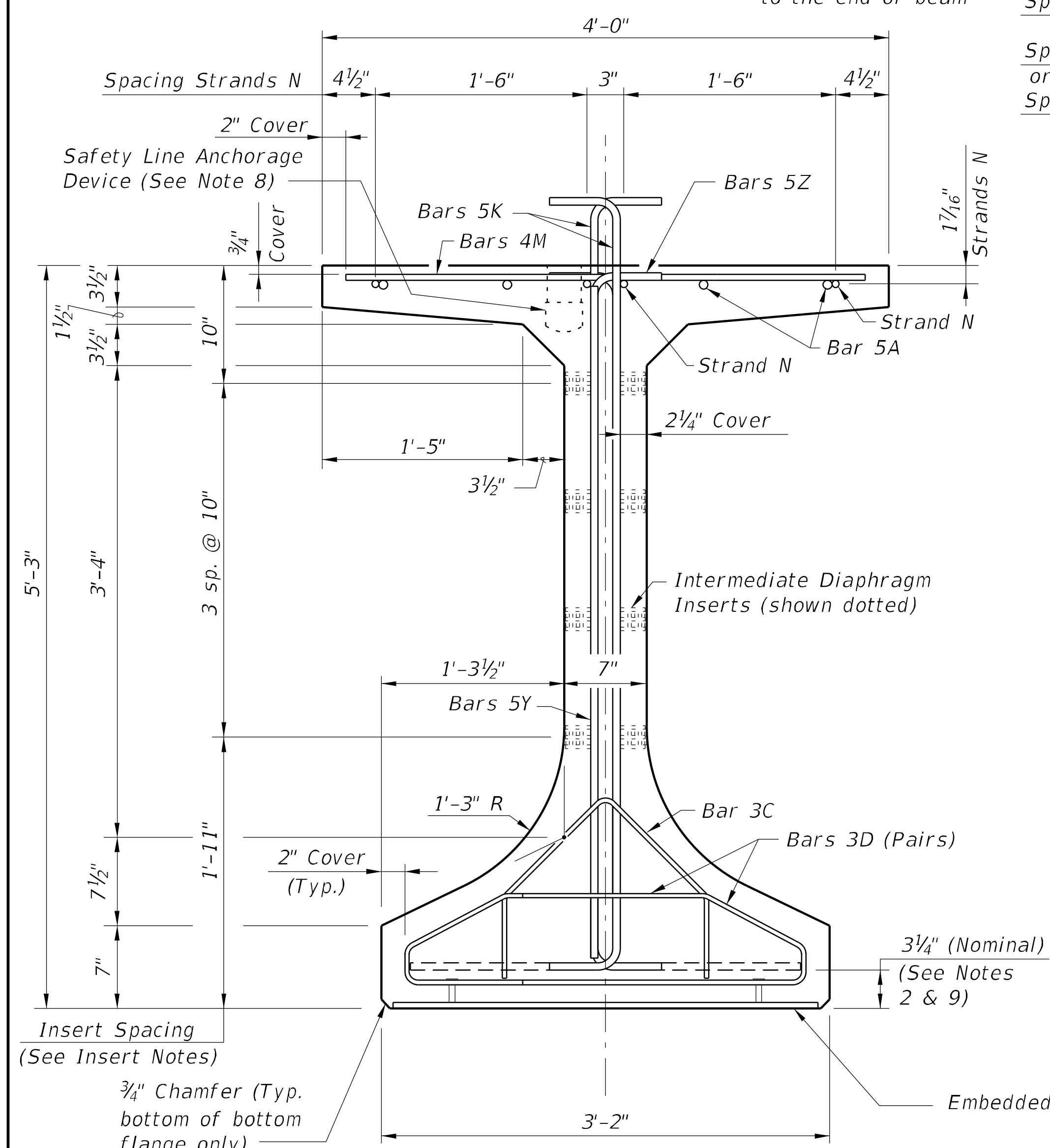
8. Past Use

FIB girders have been used successfully on many recent and ongoing bridge projects throughout the State of Florida. They are the Florida Department of Transportation’s standard prestressed beams, and are used instead of traditional AASHTO girder sections or bulb T-beams. Additional State DOT projects that have utilized FIB girders include:

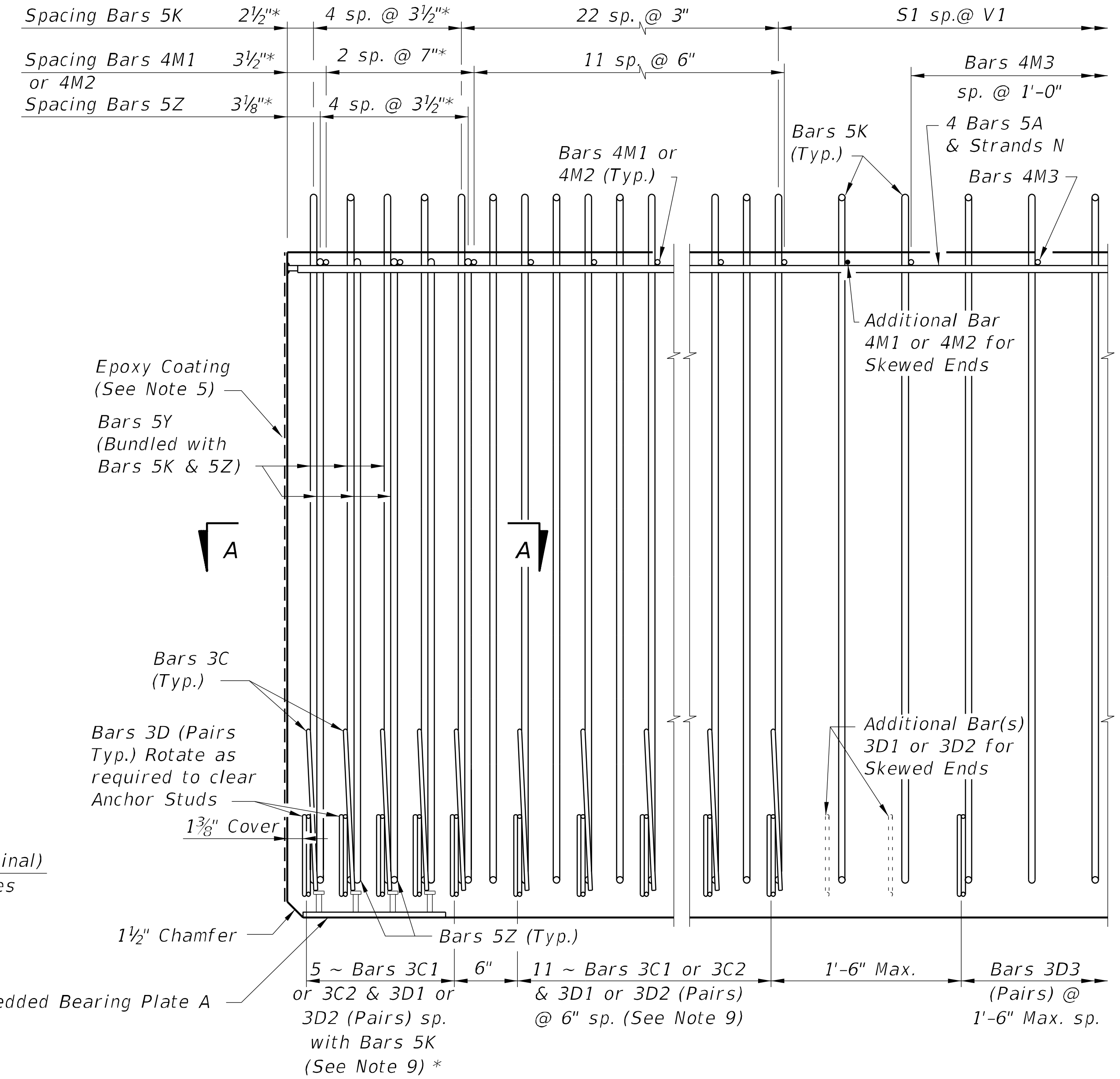
- T-285/ SR400 Interchange- GDOT, Atlanta, GA
- I-26 Port Access Rd- SCDOT, Charleston, SC

9. Additional Information

N/A



END VIEW



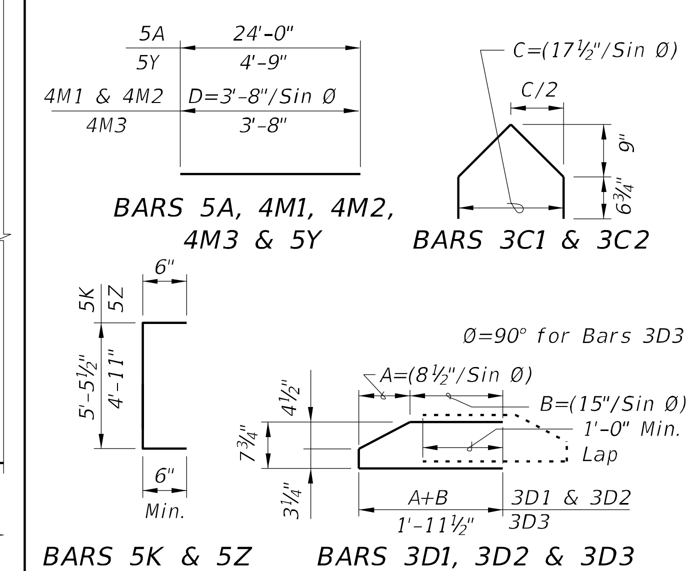
ELEVATION AT END OF BEAM
(Flanges Not Shown For Clarity)
(End 1 Shown, End 2 Similar)

CONVENTIONAL REINFORCING BAR BENDING DETAILS

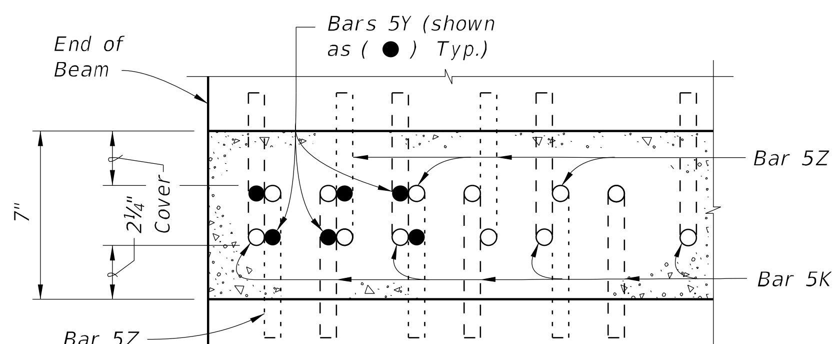
BILL OF REINFORCING STEEL

MARK	NOTE NUMBERS	SIZE	NUMBER REQUIRED	LENGTH (NOTE 1)
A	—	5	8	24'-0"
C1	9, 10 & 11	3	16 (End 1)	Varies
C2	9, 10 & 11	3	16 (End 2)	Varies
D1	9, 10, 11 & 14	3	32 (End 1)	Varies
D2	9, 10, 11 & 14	3	32 (End 2)	Varies
D3	9 & 14	3	See Table	4'-3"
K	2, 9, 11 & 13	5	See Table	6'-5"
M1	9 & 10	4	14 (End 1)	Varies
M2	9 & 10	4	14 (End 2)	Varies
M3	9	4	See Table	3'-8"
N	3 & 4	⅜" Ø Strand	4	Dim. L
Y	9 & 11	5	12	4'-9"
Z	2, 9, 11 & 13	5	10	5'-11"

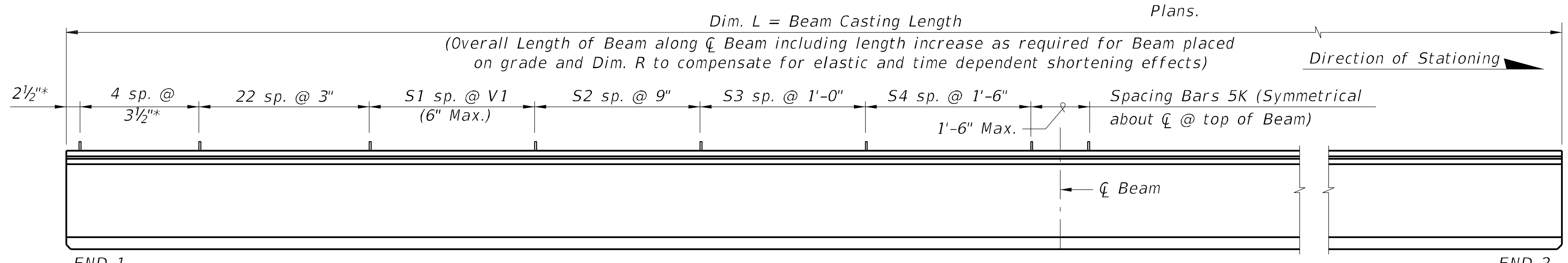
BENDING DIAGRAMS (See Note 1)



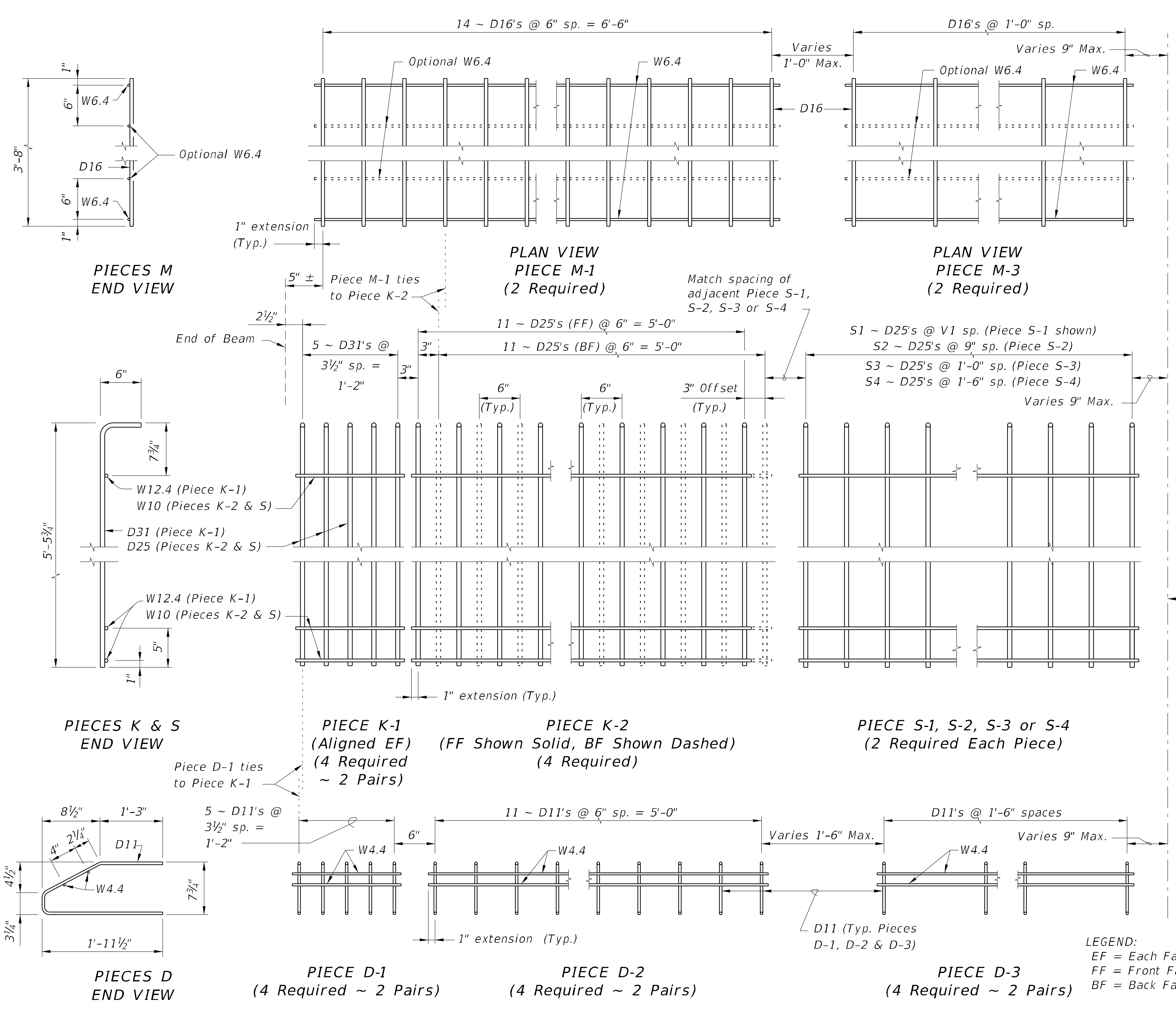
NOTES:
A. Work this Index with Index No. 20010 - Typical Florida-I Beam Details and Notes and the Florida-I Beam - Table of Beam Variables in Structures Plans.
B. For referenced notes, see Index No. 20010.
C. For Dimensions A, B, C, D, L, R & V1 and number of spaces S1 thru S4, see Florida-I Beam - Table of Beam Variables in Structures Plans.

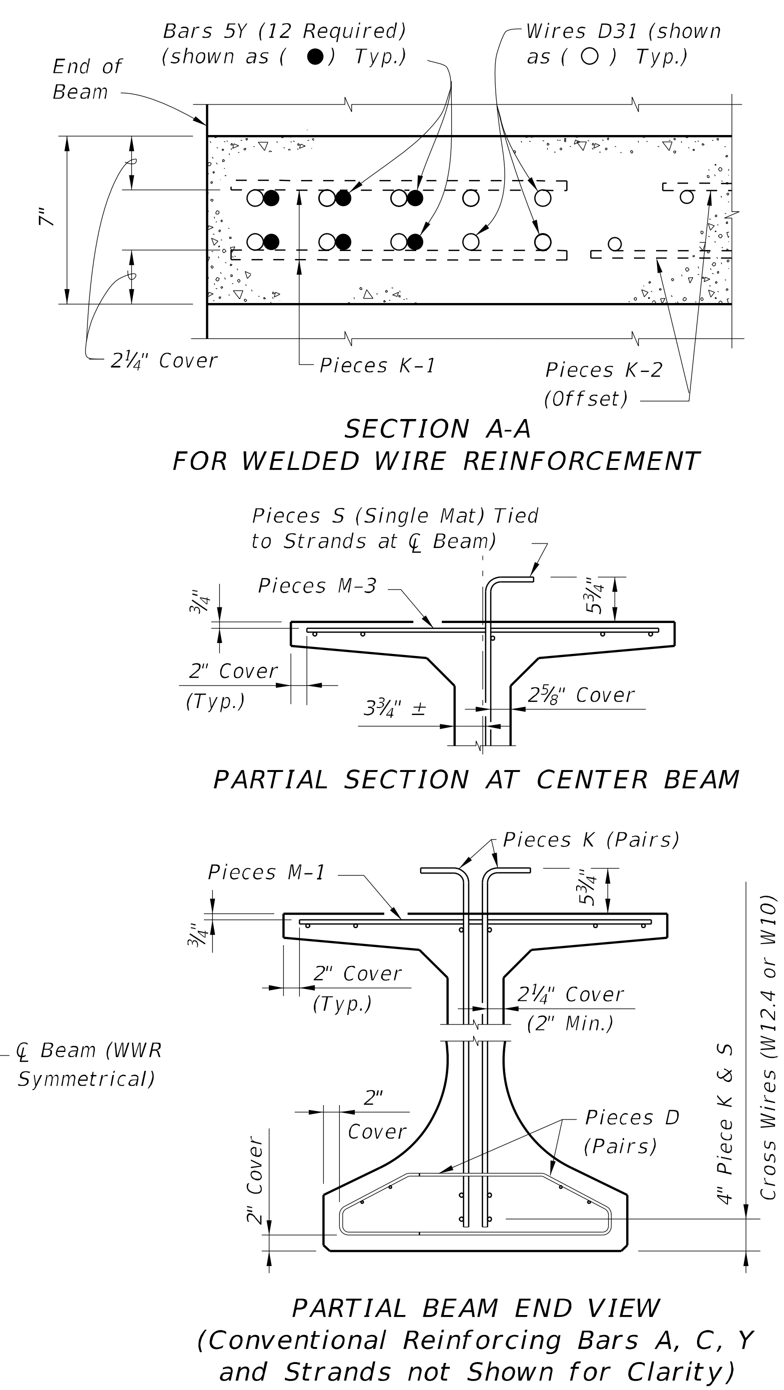


SECTION A-A FOR CONVENTIONAL REINFORCING
(Showing Bars 5K, 5Y & 5Z Only)



ELEVATION





LEGEND:
EF = Each Face
FF = Front Face
BF = Back Face

NOTES:
a. See Sheet 1 for placement details & Table of Beam Variables in Structures Plans for variables S1, S2, S3, S4 & V1.
b. Place Conventional Reinforcement Bars 5A & 3C as shown on Sheet 1. Place additional Bars 5Y as shown in Section A-A for Welded Wire Reinforcement. Bars 5Z will not be used with the WWR Option.
c. Pieces may be fabricated in multiple length sections.
d. For beams with skewed end conditions, Pieces D-1, D-2 & M-1 shall not be used; Conventional Reinforcement Bars D1, D2, C1, C2, M1 & M2 shall be used. See Index No. 20010 Skew Details and Note 9 for placement details. Shift Pieces K & Bars 5Y to accommodate skewed end conditions and align with Bars C and D.

1:20:13 PM 12/17/2015

LAST REVISION	REVISION	DESCRIPTION:	FDOT FY 2016-17 DESIGN STANDARDS	FLORIDA-I 63 BEAM - STANDARD DETAILS	INDEX NO.	SHEET NO.
07/01/10					20063	2 of 2

SECTION 2.2.13

ATC 36.0 | DRAINAGE CCD STORM INTERCEPTOR PIPES AT FOREST AND GRAPE ST.

Central 70

DATE:	October 18, 2016
TO:	5280 Connectors
FROM:	Anthony DeVito P.E. Central 70 Project Director Nicholas Farber, Central 70 Project
SUBJECT:	**Central 70 - Conceptual Alternative Technical Concept (ATC) Response** **5280 Connectors - ATC No. 36.0**

Dear Mr. Clark:

Your Team's ATC Submission Form for Conceptual ATC 36.0 was reviewed by the Procuring Authorities prior to the September One-on-One Meetings and an initial response was sent to you on September 23, 2016. As discussed during the September One-on-One Meeting, the Procuring Authorities committed to provide a final response to your Conceptual ATC. The ATC proposes to utilize existing drainage interceptor pipes at Forest and Grape St. to convey storm water flow from the south to north side of I-70.

In accordance with the Instructions to Proposers ("ITP"), the Procuring Authorities will use reasonable efforts to provide a Proposer with the following written feedback on a ATC Submission within 15 Working Days following the later of (x) the date the relevant ATC Submission was submitted and (y) the One-on-One Meeting at which such submission is discussed. Below is the final response from the Procuring Authorities for your Conceptual ATC:

☐ 1. unconditional approval and waiver of requirement for re-submission as a Detailed ATC;

☐ 2. unconditional approval for re-submission as a Detailed ATC;

☐ 3. conditional approval for re-submission as a Detailed ATC, subject to modifications and/or conditions;

☐ 4. disapproval, with or without guidance that such ATC can be re-submitted under any circumstance;

☐ 5. notification that the inclusion of the proposed ATC in the Proposer's Proposal is already permitted under the terms of the RFP, and therefore does not qualify as an ATC (and will not be treated as such for purposes of Section 3.4 of Part C of the ITP; or

☐ 6. subject to compliance with the confidentiality requirements set out in Section 3.4 of Part C of the ITP, the Procuring Authorities are considering amending (for the benefit of all Proposers) the terms of the RFP that are the subject-matter of the proposed ATC.

Following our discussions at the September One-on-One Meeting, the Procuring Authorities have not changed their initial response to your above mentioned Conceptual ATC Submission.

On the basis that the ATC submitted contains sufficient information for the Procuring Authorities to make a determination whether or not to approve the relevant ATC for incorporation in your Proposal, consistent with

Section 3.1.2.a. of Part C of the ITP, the Procuring Authorities hereby waive the requirement for re-submission as a Detailed ATC and approve the ATC subject to the following conditions.

Conditions of approval:

1. 5280 shall inspect the Forest Street and Grape Street interceptor pipes.
2. 5280 shall submit a report detailing the condition of the storm sewer crossing to the Procuring Authorities for Approval. The report shall include recommended maintenance work that needs to take place on the pipes.
3. 5280 shall undertake and be responsible for any costs associated with required maintenance work on the pipes. If the results of the inspection show that the existing condition of the pipes has sufficiently degraded, as determined at the sole discretion of the Procuring Authorities, 5280 shall be responsible for replacing the pipes in their entirety.
4. The existing interceptor pipes, including any repairs, shall meet the handback requirements at the end of the Term.

The approval of this Conceptual ATC by the Procuring Authorities does not constitute an approval of specific drafting modifications to the RFP necessary to incorporate this ATC into the Project Agreement pursuant to Section 7.2.1.c of Part C of the ITP, which modifications shall be agreed by the Procuring Authorities and the Proposer (each acting reasonably) following issuance of a Notice of Award to such Proposer.

ANNEX 3: ALTERNATIVE TECHNICAL CONCEPT SUBMISSION FORM

Proposer Name: 5280 Connectors
Date: September 8, 2016

Central 70 Project RFP: ATC Submission No. 36.0

A. Background Information

1. Type of Submission

☒ Conceptual ATC

☐ Detailed ATC

2. Prior Submission(s)

☒ None (initial submission of ATC)

☐ Previously Submitted as Conceptual ATC

☐ Previously Submitted as Detailed ATC

3. Explanation of Reason for Resubmission

n/a

4. Request for Discussion at One-on-One Meeting

☒ Meeting Requested

☐ Meeting Not Requested

B. General ATC Submission Requirements

1. Overview Description

5280 Connectors proposes an Alternate Drainage Technical Concept to utilize existing drainage interceptor pipes at Forest and Grape St. to convey stormwater flow from the south to north side of I-70. The existing 108" RCP in Forest St. between North & South Stapleton Dr. would remain in place to carry flow. The 60" RCP east of Grape St. will also remain in place to service existing flow with new capacity provided by a new proposed storm drain crossing at Holly St.

2. Relevant RFP Requirements

Removals and Abandonment of Existing Drainage in the Project Agreement- Schedule 10, Section 8.4.4.a.ii calls for

"Existing Cross Drains, Storm Drains, embankment protectors and drainage appurtenances Brighton Boulevard and Sand Creek shall be removed in their entirety and replaced with drainage features designed for the Project. The limits of removal shall be limited to I-70 Mainline, CDOT Roadways, 46th Avenue North, 46th Avenue South, Stapleton Drive North and Stapleton Drive South."

3. Rationale

The existing 108" storm drain interceptor in Forest St. has sufficient capacity to handle proposed drainage flow and was recently constructed in 2008. The existing pipe is located at 30ft below existing Stapleton Dr. and 43 ft below I-70. A new pipe would need to be installed via a bored installation to avoid disruption to I-70 at a parallel alignment. The existing 108" storm pipe was constructed with Class 5 RCP Jacking Pipe with additional wall thickness vs. standard RCP for bored installation. Standard RCP pipe has been shown to have a shown to have a service life of over 100yrs based upon % slope and soil pH (American Concrete Pipe Association- *Precast Concrete Pipe Durability* Resource #02-713, July, 2016).

The existing CCD 60" storm drain east of Grape St. would be utilized to convey existing stormwater. A new parallel storm drain crossing proposed at Holly St. would convey flows from Stapleton Dr. South to the north. By providing a new drainage conveyance from the south side of I-70 to the existing interceptor to the north, sufficient drainage capacity can be achieved without disturbing the existing 60" pipe.

4. Impacts

Impacts to traffic and local businesses will be reduced by maintaining the existing 108" RCP in Forest due to impacts associated with deep bored pipe installation. Maintaining the existing 60" RCP near Grape St. can be augmented with smaller storm drain pipe at Holly St. with reduced impact from replacing with larger 78" pipe.

5. Cost and Benefit Analysis

The estimated Cost benefit of this change is estimated at $3.9 Million dollars due to saving in elimination of two large diameter bores.

6. Schedule Analysis

The schedule benefit of eliminating the two borings is not anticipated to have an overall effect on the Project Schedule with work completed off-line and not directly impacting anticipated critical path.

7. Conceptual Drawings

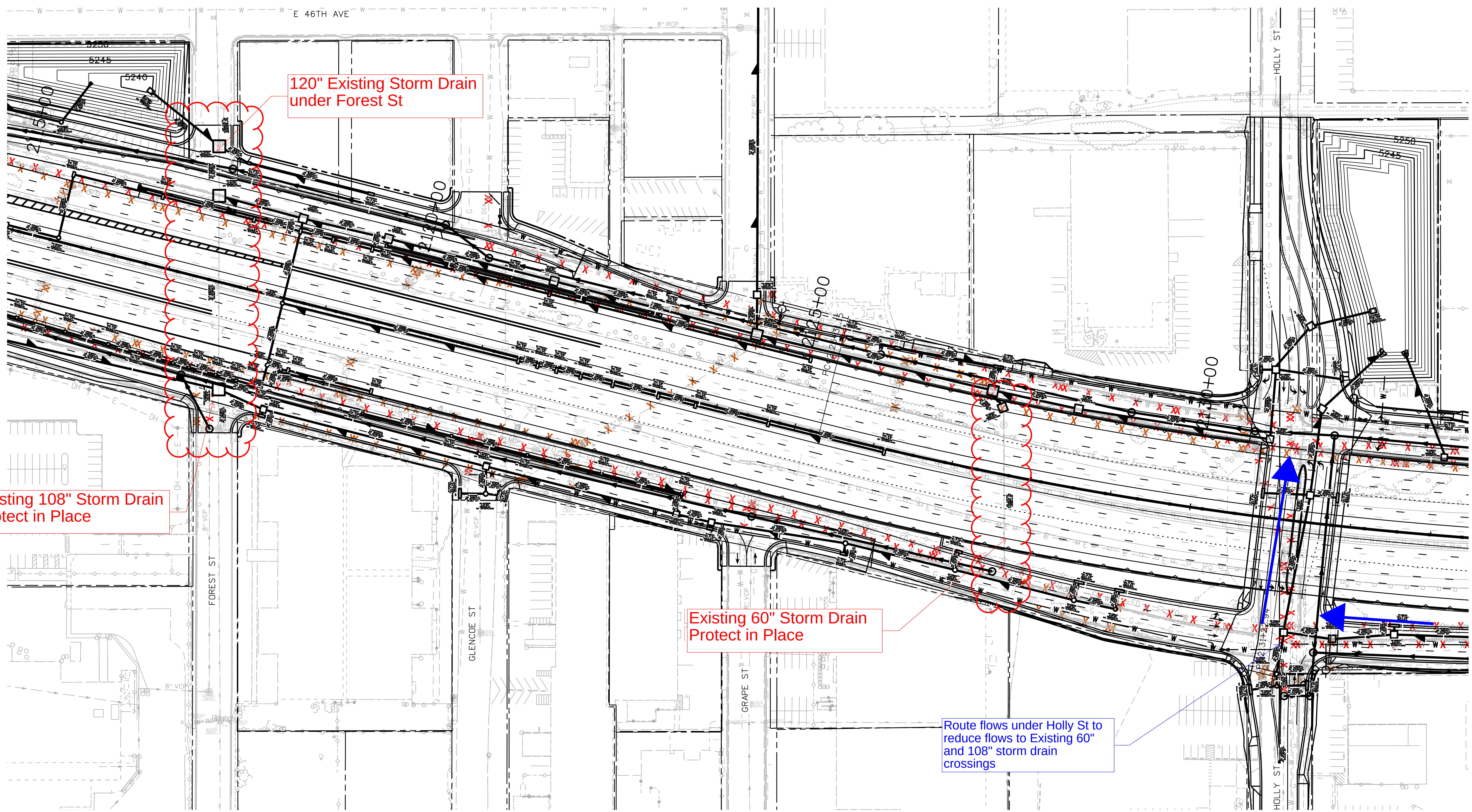
See attached Storm Interceptor Pipes at Forest & Grape St. Plan.

8. Past Use

Existing 3rd Party Utilities are commonly left in place if determined to not be in conflict with the proposed design.

9. Additional Information

n/a



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Print Date: 8/25/2016	
File Name: ATC_Border.dgn	
Horiz. Scale: 1:300	Vert. Scale: As Noted

5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation

CDOT CO Region 1

COLORADO HPTE

I-70 EAST ATC 36.0

Strom Interceptor Pipes at Forest & Grape St.

Designer:		Structure Numbers	
Detailer:			
Sheet Subset:		Subset Sheets:	1 of 1

SECTION 2.2.14

ATC 37.2 | NORTH STEELE VASQUEZ INTERCHANGE (RAMP AND FRONTAGE ROAD CONNECTION)

DATE: March 3, 2017

TO: 5280 Connectors

FROM: Anthony DeVito P.E. Central 70 Project Director
Nicholas Farber, Central 70 Project

SUBJECT: Central 70 - Detailed Alternative Technical Concept (ATC) Response
5280 Connectors - ATC No. 37.2

Dear Mr. Clark:

Your Team's ATC Submission Form for Detailed ATC 37.2 was reviewed by the Procuring Authorities prior to the February One-on-One Meetings and an initial response was sent to you on February 9, 2017. As discussed during the February One-on-One Meeting, the Procuring Authorities committed to provide a final response to your Detailed ATC.

Detailed ATC 37.2 proposes to remove the slip ramp that connects the Steele/Vasquez westbound on ramp to 46th Ave North and reconfigure the Steele/Vasquez and 46th Ave North intersection to maintain access to 46th Ave North.

In accordance with the Instructions to Proposers ("ITP"), the Procuring Authorities will use reasonable efforts to provide a Proposer with the following written feedback on a ATC Submission within 15 Working Days following the later of (x) the date the relevant ATC Submission was submitted and (y) the One-on-One Meeting at which such submission is discussed. Below is the final response from the Procuring Authorities for your Detailed ATC:

☐ 1. unconditional approval;

☒ 2. conditional approval, subject to modifications and/or conditions;

☐ Re-submission required ☒ Re-submission not required

☐ 3. disapproval, with or without guidance that such ATC can be re-submitted under any circumstance;

☐ 4. notification that the incorporation of the proposed ATC in the Proposer's Proposal is already permitted under the terms of the RFP, and therefore does not qualify as an ATC (and will not be treated as such for purposes of Section 3.4 of Part C of the ITP).

☐ 5. subject to compliance with the confidentiality requirements set out in Section 3.4 of Part C of the ITP, the Procuring Authorities are considering amending (for the benefit of all Proposers) the terms of the RFP that are the subject-matter of the proposed ATC.

Following our discussions at the One-on-One Meeting, the Procuring Authorities have not changed their initial response to your above mentioned Detailed ATC Submission. The Procuring Authorities have coordinated with the City of Denver regarding this ATC. The Procuring Authorities and the City of Denver agree the concept presented has merit but will require additional refinement during final design. The Developer will be required to address the below-listed conditions through final design.

Conditions of approval:

1. The Developer shall be solely responsible for obtaining City of Denver approval on the final design. The City of Denver has provided the following comments regarding the current design:
    a. As currently presented, the ATC would enable drivers to cut between the frontage road and the on-ramp over the gore points. This presents a new safety concern that must be addressed through final design.
2. The Procuring Authorities are updating some signing requirements in the Final RFP. The final design shall be compliant with the Final RFP requirements.

The approval of this Detailed ATC by the Procuring Authorities does not constitute an approval of specific drafting modifications to the RFP necessary to incorporate this ATC into the Project Agreement pursuant to Section 7.2.1.c of Part C of the ITP, which modifications shall be agreed by the Procuring Authorities and the Proposer (each acting reasonably) following issuance of a Notice of Award to such Proposer.

ANNEX 3: ALTERNATIVE TECHNICAL CONCEPT SUBMISSION FORM

Proposer Name: 5280 Connectors
Date: January 24, 2017

Central 70 Project RFP: ATC Submission No. 37.2

A. Background Information

1. Type of Submission

☐ Conceptual ATC

☒ Detailed ATC

2. Prior Submission(s)

☐ None (initial submission of ATC)

☒ Previously Submitted as Conceptual ATC

☐ Previously Submitted as Detailed ATC

3. Explanation of Reason for Resubmission

Resubmission of ATC with revised exhibits for traffic turning movements for both the northbound left turn movement and southbound right turn movement off Steele/ Vazquez.

Traffic analysis at the signal for the southbound right turn movement off Steele/ Vazquez and on to WB I-70 Ramp

4. Request for Discussion at One-on-One Meeting

☒ Meeting Requested

☐ Meeting Not Requested

B. General ATC Submission Requirements

1. Overview Description

This information has been amended since the submission of the previous version of this ATC.

5280 Connectors proposes an Alternative Technical Concept to remove the slip ramp that connects the Steele/Vasquez westbound on ramp to 46th Ave North and reconfigure the Steele/Vasquez and 46th Ave North intersection to maintain access to 46th Ave North. Relevant RFP Requirements

The Project Agreement Schedule 10, Section 9.4.3.b.xii states that:

North of the I-70 Mainline, Milwaukee Street shall connect to new 46th Avenue North, providing a right turn movement to westbound 46th Avenue. South of the I-70 Mainline, Milwaukee Street shall connect to the new 46th Avenue South with left and right turn movements provided to 46th Avenue. Sidewalk connections from Milwaukee Street to new 46th Avenue shall be provided.

The Project Agreement Schedule 10, Section 11.3.1.a states that:

Permanent signing shall include all necessary guide, warning, supplemental, tolling, informational, school zones, Railroad, and regulatory, etc., signs for the Project, including signing on adjacent Local Agency Roadways, arterials and highways outside the Site. These signs shall be required to be installed as new at the appropriate locations in coordination with the design and Accepted by the Department prior to installation.

2. Rationale

This information has not been amended since the submission of the previous version of this ATC.

The grade difference between existing Milwaukee St and the Milwaukee T-intersection at 46th Ave. North is approximately 10 feet. The grade difference is created mostly by providing a roadway connection between the I-70 westbound entrance ramp from Vasquez and the 46th Ave. North westbound movement. The grade difference would be mitigated by removing the slip ramp connection between 46th Ave. North and the Steele/Vasquez Westbound on ramp and extending the wall between these adjacent roads.

3. Impacts

This information has been amended since the submission of the previous version of this ATC.

5280 Connectors evaluated solutions for maintaining the connection between Milwaukee St and 46th Ave. North, where the grade differential would be mitigated by incorporating retaining walls onto and into the private property access points and along Milwaukee St. This solution requires additional ROW from residential property owners not previously identified.

The proposed ATC reconfigures the access for westbound traffic heading to 46th Ave. North west of Steele/Vasquez Street. Traffic planning to travel westbound on 46th Ave. North, from the northbound left at Steele/Vasquez Street, would set-up their trip from the outside left turn lane and diverge from the I-70 westbound on-ramp. Traffic planning to travel westbound on 46th Ave. North, from westbound 46th Ave North east of Steele/Vasquez Street, would set-up their trip from a proposed shared through/right turn lane and continue westbound. The shared through/right turn lane would be separated from the dual westbound through lanes heading onto I-70 westbound on-ramp. This allows for the lane separation of two different traffic speeds. Additionally, the proposed ATC design includes a painted gore that functions as a recovery zone.

Southbound traffic on Steele/Vasquez Street turning right to head westbound onto I-70 westbound on-ramp is generally unaffected and the level of service remains the same with a slight decrease in overall delay of the Steele/Vasquez & 46th Ave. North intersection.

4. Cost and Benefit Analysis

This information has not been amended since the submission of the previous version of this ATC.

Modifying the proposed Intersection is estimated to result in a very small cost benefit to the Project. This is reflected in reduced roadway area vs. additional walls and larger signal arm requirements.

5. Schedule Analysis

This information has not been amended since the submission of the previous version of this ATC.

The net effect of changing the intersection design is not anticipated to have an impact to the Project Schedule based on Conceptual Phasing Plan for Construction.

6. Conceptual Drawings

This information has been amended since the submission of the previous version of this ATC.

See attached Exhibits:

Milwaukee St. North Grade Differential Plan

Steele Intersection Node Evaluation

Steele Vasquez Truck Turning

Guide Signing Plan

7. Past Use

This information has been amended since the submission of the previous version of this ATC.

Split left turn lanes have been successfully used by CDOT in the following areas:

- Brighton Blvd NB to I-70 WB On Ramp/E 46th Ave
- University Blvd SB to E Exposition Ave/Bonnie Brae Blvd

8. Additional Information

Node Analysis for Steele/ Vasquez- North Interchange Operation for the Intersection configuration options.

C. Detailed ATC Requirements

1. Risks

Proposed Intersection Design eliminates the need for additional ROW or the Cull-de-Sacking of Milwaukee St. north of 46th Ave. The RFP design for this location does not accommodate the vertical geometric requirements of Milwaukee St. If proposed intersection was not to be approved, additional risks would need to be included for additional ROW and residential parcel acquisition if Milwaukee St. could not be dead-ended.

2. Handback

No changes in handback requirements will be required associated with this change in Intersection ATC.

3. Right-of-Way

No additional Right-of-Way will be required to implement this ATC.

4. List of Required Approvals

Approval by the City and County of Denver would be required as part of this ATC regarding the signalized intersection configuration.

No Design Exceptions are required.

5. Proposed Drafting Revisions

Project Agreement Section 9.4.2.c.iv specifies the Exclusive Right turn Movement that would require drafting modification (see proposed changes).

following the ramp meter stop bar, to a single lane entrance and acceleration lane;

F. The Colorado Boulevard eastbound exit ramp shall have a single-lane ramp with single-lane exit and deceleration lane. A four-lane ramp terminal connection that includes a left-turn lane, a thru/left lane, a thru/right lane and a right turn lane shall be provided to Colorado Boulevard;

G. The Colorado Boulevard westbound exit ramp shall have a single-lane exit transitioning to a combined ramp/Stapleton Drive North connection to Colorado Boulevard. A five-lane connection that includes dual left-turn lanes, a thru/left lane, a thru/right lane, and a right-turn lane shall be provided to Colorado Boulevard; and

H. The Colorado Boulevard eastbound entrance ramp shall provide a minimum 650 feet dual ramp meter queuing, as measured from the ramp meter stop bar to the cross street. The ramp shall transition, following the ramp meter stop bar, to a single lane entrance and acceleration lane.

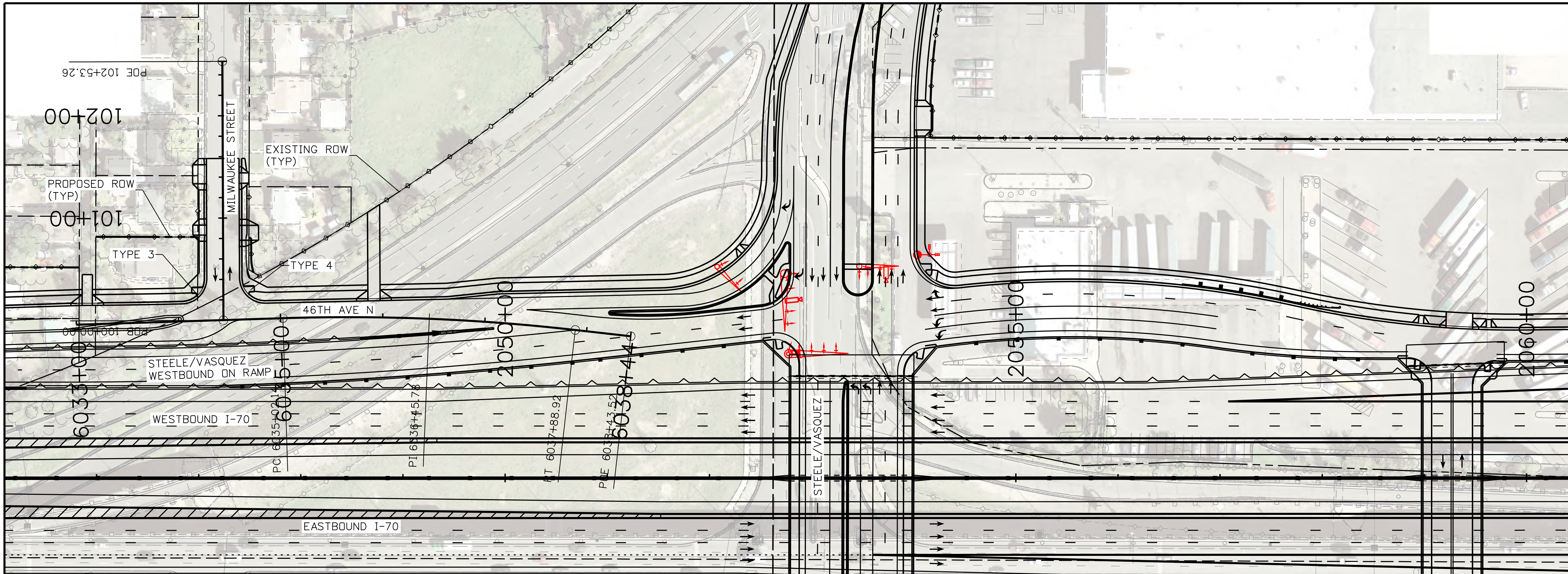
iii. Steele Street/Vasquez Boulevard shall be reconstructed to provide two thru lanes between 45th Avenue and 46th Avenue North, in both directions, and three thru lanes between 46th Avenue North and 48th Avenue, in both directions. The reconstruction shall also provide left and right turn movements for the new I-70 ramps and 46th Avenue. Dual-left turns shall be provided from Steele Street/Vasquez to the westbound entrance ramp, and a single left turn provided from Steele Street/Vasquez to eastbound 46th Avenue South. Construction shall include a right-in/right-out intersection at 47th Avenue.

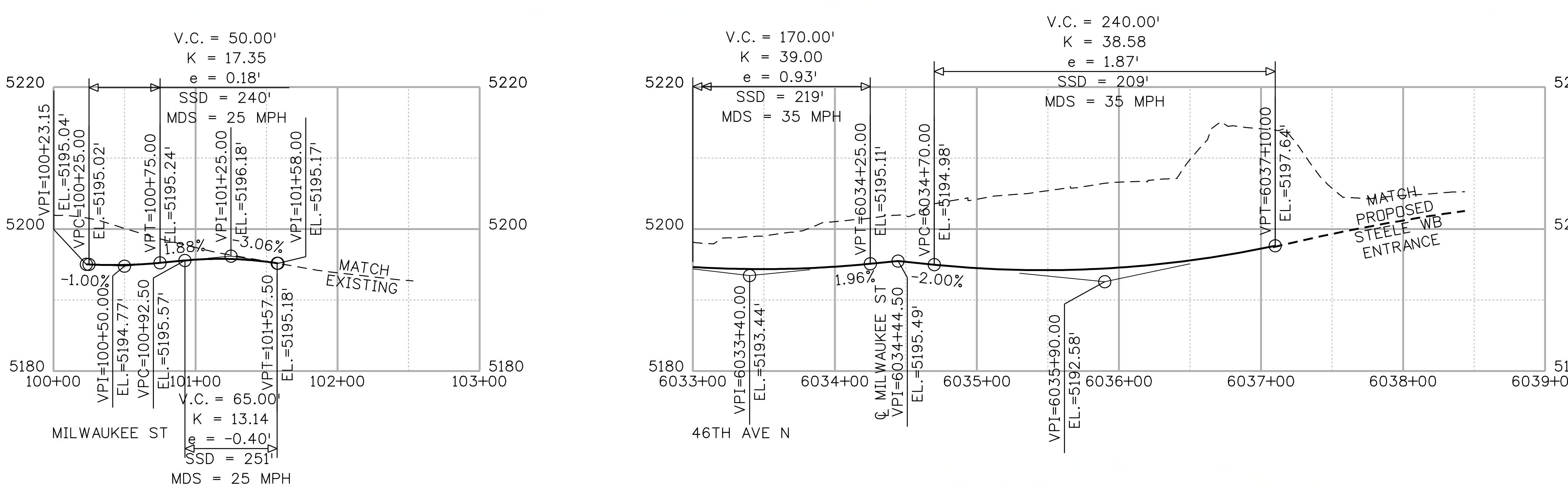
iv. A thru/right and exclusive right-turn shall be provided at the southbound Steele Street/Vasquez to westbound 46th Avenue~~/I-70 ramp~~. The leftmost lane of the dual right-turn shall be signal controlled. 46th Avenue/ramp terminals on the west side shall be aligned with the ramp terminals on the east side to provide for minimum two-lane thru traffic movements across the intersection.

v. Colorado Boulevard shall be reconstructed to provide three thru lanes, in both directions, and provide dual left and separate right turn movements to the I-70 ramps and new 46th Avenue. The limits of reconstruction on Colorado Boulevard shall extend from the north abutment of the existing bridge over UPRR and RTD to 48th Avenue. Sidewalk approaches, curb ramps and curb returns shall be provided on the south side of the intersection. The Colorado Boulevard and 48th Avenue intersection shall be reconstructed to meet the ADA requirements, as described in this Section 9.

vi. Dual right-turns shall be provided at the Colorado Boulevard intersections with 46th Avenue and Stapleton Drive. Free-flow right-turn movements shall be provided for all rightmost lanes of dual right-turns. The leftmost lanes of the dual right-turns shall be signal controlled. Both lanes of the dual right-turn from southbound Colorado Boulevard to westbound 46th Avenue/I-70 ramp shall be exclusive right turns. An auxiliary lane shall be provided southbound between 48th Avenue and 46th Avenue North, and northbound between the existing bridge over UPRR/RTD and 46th Avenue South. The 46th Avenue/ramp terminals on the west side shall be aligned with the Stapleton Drive/ramp terminals on the east side to provide for minimum two-lane thru traffic movements across the intersection.

vii. The Developer shall include raised medians to separate the southbound and northbound lanes of Steele Street/Vasquez and Colorado Boulevard within the general limits of the roadways' reconstruction. Sidewalks shall be provided on





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5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation
Region 1

HPTE

CENTRAL 70 ATC 37.2
MILWAUKEE ST. NORTH
RFP BASE DESIGN

Designer:
Detailer:
Sheet Subset:
Structure Numbers
Subset Sheets: 1 of 1

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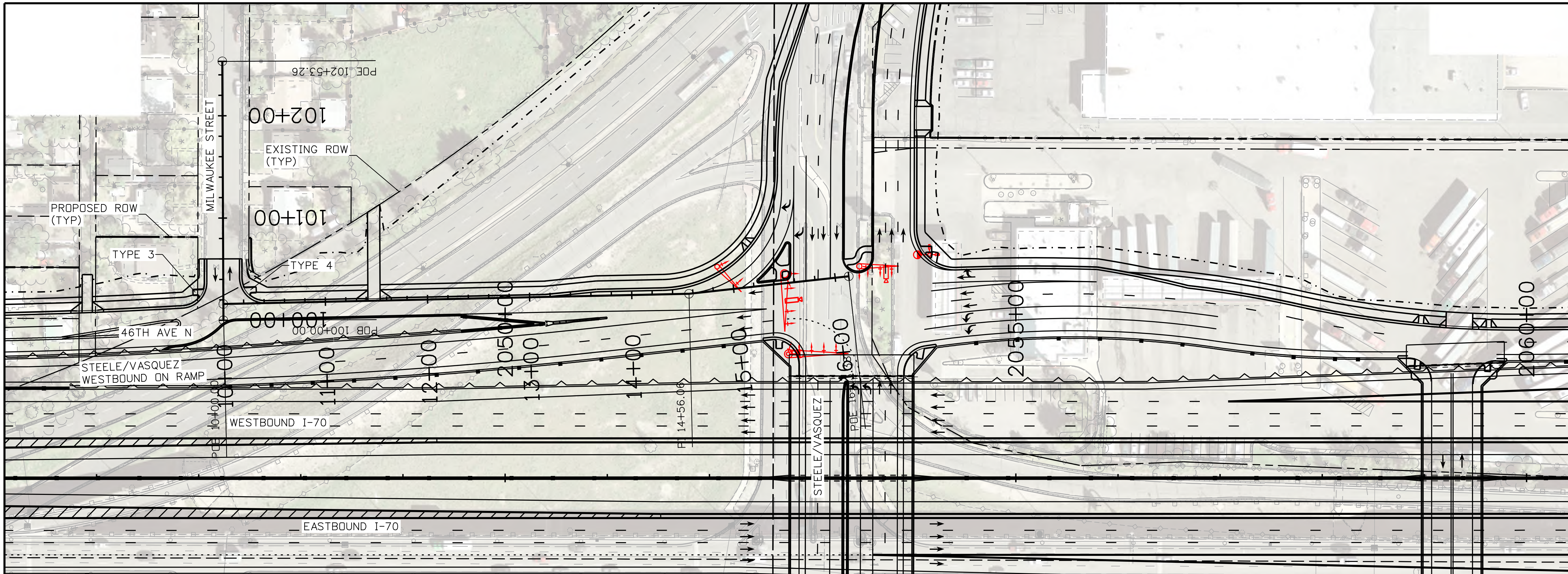

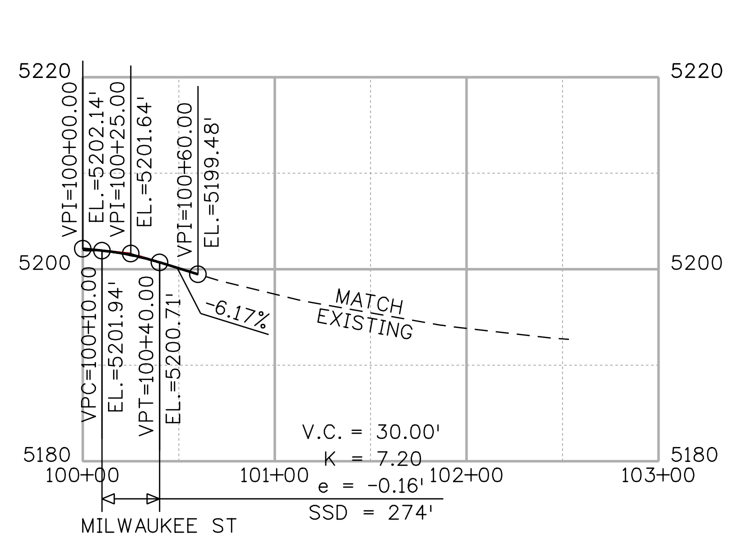

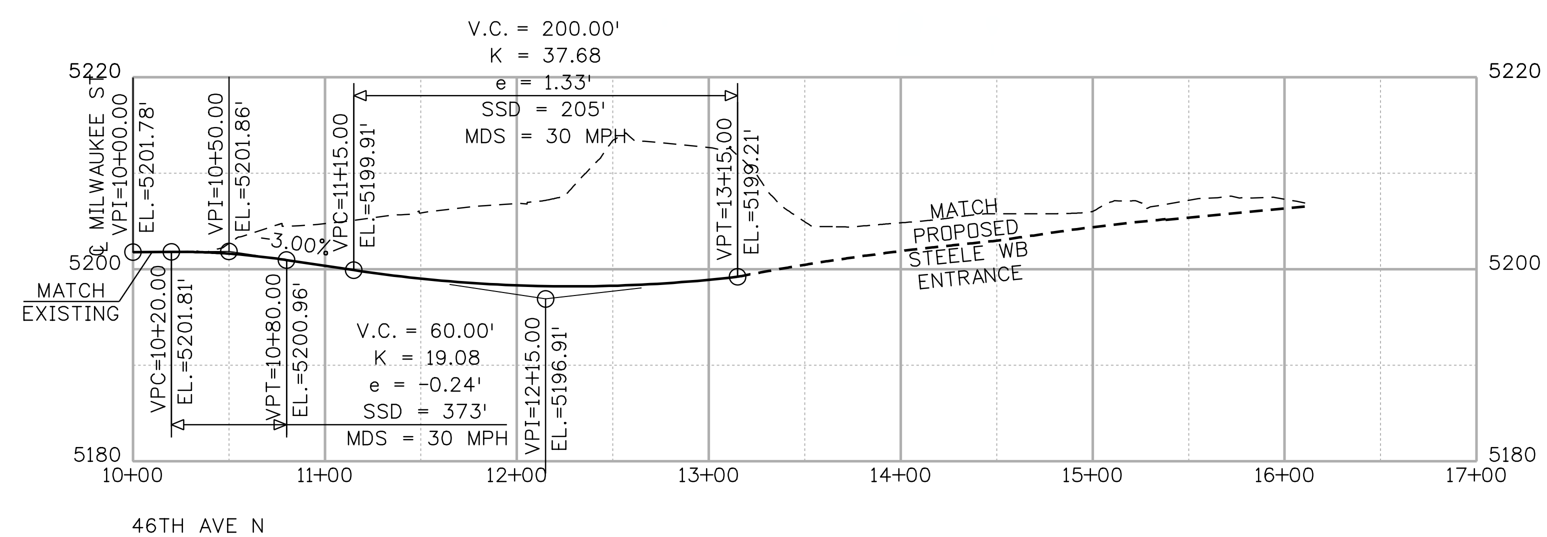

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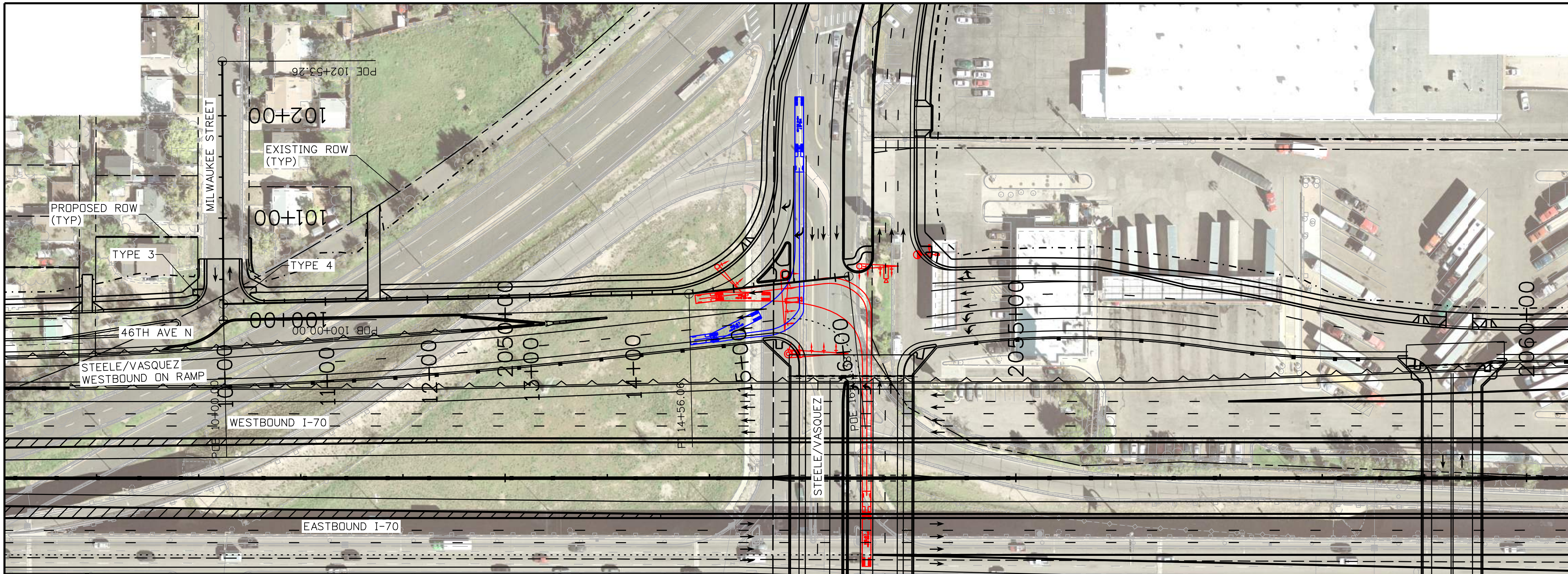
5280 Connectors Linking I-70 Communities

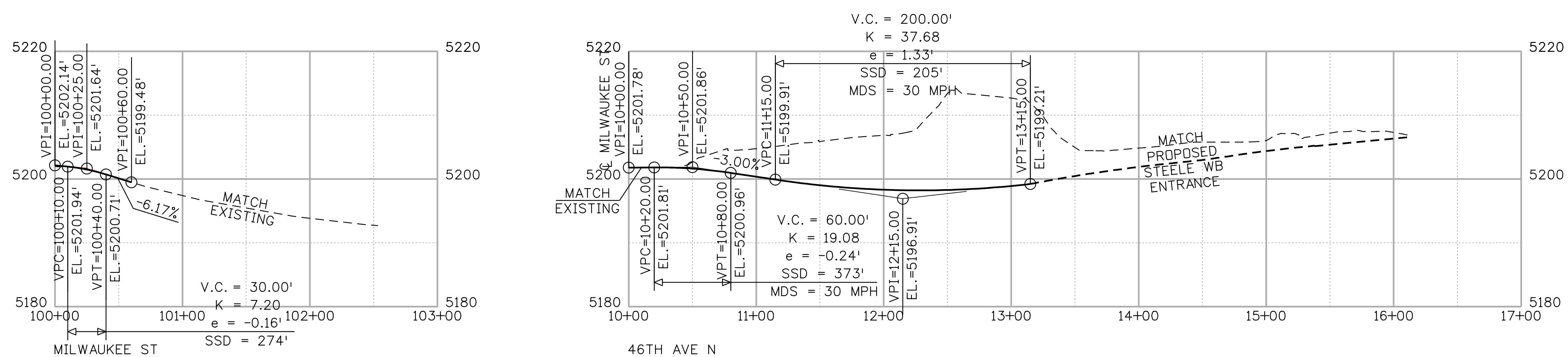
HDR

Colorado Department of Transportation
CDOT Region 1
COLORADO HPTE

CENTRAL 70 ATC 37.2
MILWAUKEE ST. NORTH
GRADE DIFFERENTIAL

Designer:		Structure Numbers	
Detailer:			
Sheet Subset:		Subset Sheets:	1 of 1





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5280 Connectors Linking I-70 Communities

HDR

Colorado Department of Transportation
Region 1

HPTE

CENTRAL 70 ATC 37.2
Steele/ Vasquez Truck Turning

Designer:		Structure Numbers	
Detailer:			
Sheet Subset:		Subset Sheets:	1 of 1

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Concept PM One Controller	RFP SIGNALIZED Steele N				RFP Colorado + ATC 37 SIGNALIZED Steele N				DDI Colorado + ATC 37 SIGNALIZED Steele N			
VISSIM RESULTS ATC EBOff Ramp Split Phase	MVMNT	DELAY	LOS	QUEUE	MVMNT	DELAY	LOS	QUEUE	MVMNT	DELAY	LOS	QUEUE
	ALL	24.5	C	641	ALL	23.5	C	689	ALL	21.9	C	689
	NBL	45.8	D	347	NBL	0.0	A	0	NBL	42.2	D	344
	NBT	12.9	B	347	NBT	10.0	A	344	NBT	9.3	A	575
	NBR	0.0	A	0	NBR	0.0	A	0	NBR	0.0	A	0
	EBL	0.0	A	0	EBL	0.0	A	0	EBL	0.0	A	0
	EBT	0.0	A	0	EBT	0.0	A	0	EBT	0.0	A	0
	EBR	0.0	A	0	EBR	0.0	A	0	EBR	0.0	A	0
	SBL	0.0	A	0	SBL	0.0	A	0	SBL	0.0	A	0
	SBT	35.6	D	537	SBT	35.7	D	575	SBT	28.1	C	604
	SBR	26.7	C	561	SBR	26.5	C	599	SBR	23.5	C	814
	WBL	40.5	D	592	WBL	40.5	D	604	WBL	41.0	D	112
	WBT	29.1	C	406	WBT	64.2	E	430	WBT	36.3	D	215
	WBR	22.4	C	302	WBR	13.1	B	112	WBR	0.0	A	0

INTERSECTION TURNING MOVEMENT DIAGRAM

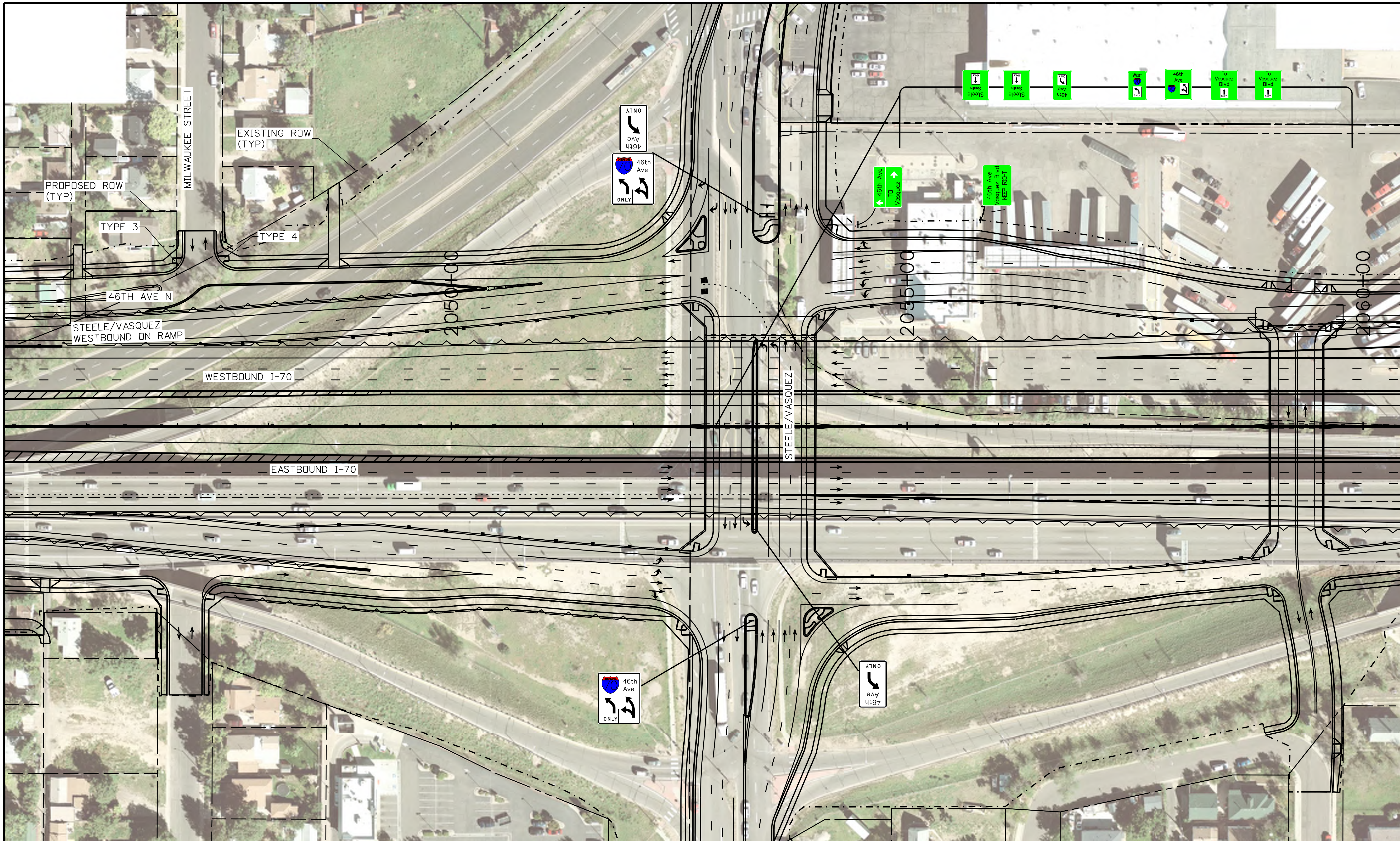
	RFP					RFP Colorado + ATC 37					DDI Colorado + ATC 37				
	▲ N 1468	802 ◄	666 ▼	0 ►	1156	▲ N 1462	802 ◄	660 ▼	0 ►	1161	▲ N 1473	817 ◄	656 ▼	0 ►	1038
	0 ▲				▲ 115	0 ▲				▲ 117	0 ▲				▲ 0
	0 ►		3794		◄ 319	0 ►		3686		◄ 318	0 ►		3873		◄ 342
	0 ▼				▼ 722	0 ▼				▼ 726	0 ▼				▼ 696
	0	◄ 39	▲ 1131	► 0	1170	0	◄ 0	▲ 1063	► 0	1063	0	◄ 59	▲ 1303	► 0	1362

AVERAGE DELAY

LOS

MAX APPROACH QUEUE LENGTH

	RFP					RFP Colorado + ATC 37					DDI Colorado + ATC 37				
	▲ N 561	26.7 ◄	35.6 ▼	0.0 ►	592	▲ N 599	26.5 ◄	35.7 ▼	0.0 ►	604	▲ N 814	23.5 ◄	28.1 ▼	0.0 ►	215
	0.0 ▲				▲ 22.4	0.0 ▲				▲ 13.1	0.0 ▲				▲ 0.0
	0.0 ►	24.5		C	◄ 29.1	0.0 ►	23.5		C	◄ 64.2	0.0 ►	21.9		C	◄ 36.3
	0.0 ▼				▼ 40.5	0.0 ▼				▼ 40.5	0.0 ▼				▼ 41.0
	0	◄ 45.8	▲ 12.9	► 0.0	347	0	◄ 0.0	▲ 10.0	► 0.0	344	0	◄ 42.2	▲ 9.3	► 0.0	575



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5280 Connectors Linking I-70 Communities
HDR
Colorado Department of Transportation
CDOT Region 1
COLORADO HPTE

CENTRAL 70 ATC 37.2
MILWAUKEE ST. NORTH
SIGNING PLAN

Designer:		Structure Numbers	
Detailer:			
Sheet Subset:		Subset Sheets: 1 of 1	

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SECTION 2.2.15

ATC 40.1 | HARMONIC ACTION OF STRUCTURE FOR LOADING

Central 70

DATE: March 28, 2017

TO: 5280 Connectors

FROM: Anthony DeVito P.E. Central 70 Project Director
Nichalas Farber, Central 70 Project

SUBJECT: Central 70 - Detailed Alternative Technical Concept (ATC) Response
5280 Connectors - ATC No. 40.1

Dear Mr. Clark:

Your Team's ATC Submission Form for Detailed ATC 40.1 has been reviewed by the Procuring Authorities.

Detailed ATC 40.1 proposes to utilize an acceleration based design in lieu of the natural frequency requirements found in the RFP.

In accordance with the Instructions to Proposers ("ITP"), the Procuring Authorities will use reasonable efforts to provide a Proposer with the following written feedback on a ATC Submission within 15 Working Days following the later of (x) the date the relevant ATC Submission was submitted and (y) the One-on-One Meeting at which such submission is discussed. Below is the final response from the Procuring Authorities for your Detailed ATC:

☒ 1. unconditional approval;

☐ 2. conditional approval, subject to modifications and/or conditions;

☐ Re-submission required ☐ Re-submission not required

☐ 3. disapproval, with or without guidance that such ATC can be re-submitted under any circumstance;

☐ 4. notification that the incorporation of the proposed ATC in the Proposer's Proposal is already permitted under the terms of the RFP, and therefore does not qualify as an ATC (and will not be treated as such for purposes of Section 3.4 of Part C of the ITP).

☐ 5. subject to compliance with the confidentiality requirements set out in Section 3.4 of Part C of the ITP, the Procuring Authorities are considering amending (for the benefit of all Proposers) the terms of the RFP that are the subject-matter of the proposed ATC.

The ATC is unconditionally approved.

The approval of this Detailed ATC by the Procuring Authorities does not constitute an approval of specific drafting modifications to the RFP necessary to incorporate this ATC into the Project Agreement pursuant to Section 7.2.1.c of Part C of the ITP, which modifications shall be agreed by the Procuring Authorities and the Proposer (each acting reasonably) following issuance of a Notice of Award to such Proposer.

ANNEX 3: ALTERNATIVE TECHNICAL CONCEPT SUBMISSION FORM

Proposer Name: 5280 Connectors
Date: March 9, 2017

Central 70 Project RFP: ATC Submission No. 40.1

A. Background Information

1. Type of Submission

☐ Conceptual ATC

☒ Detailed ATC

2. Prior Submission(s)

☐ None (initial submission of ATC)

☒ Previously Submitted as Conceptual ATC

☐ Previously Submitted as Detailed ATC

3. Explanation of Reason for Resubmission

Submission of detailed ATC request for to follow up Conceptual ATC #40.0 for the use of Acceleration Based Cover Harmonic Frequency Design requirements for Dynamic Loading.

4. Request for Discussion at One-on-One Meeting

☐ Meeting Requested

☒ Meeting Not Requested

B. General ATC Submission Requirements

1. Overview Description

This information has been amended since the submission of the previous version of this ATC.

5280 Connectors propose to utilize an acceleration based design criteria in lieu of the 3.0 Hz natural frequency requirement in the RFP Commercial Update on January 6, 2017, Schedule 10, Section 13.6.4 for the cover design. Acceleration based design is a more appropriate design approach for the intended purpose of achieving acceptable ranges of vibrations perceived by humans in this specific application. This approach is fully supported by the AISC Steel Design Guide 11, Vibrations of Steel-Framed Structural Systems Due to Human Activity, which provides acceleration limits for our exact intended use: sporting events and lively concerts. AISC Design Guide 11 is the most commonly recognized design guide for vibration analysis. While it is an AISC guide that is mainly for steel structures the vibration theory and design procedures are applicable to both concrete and steel structures.

Based on this guide, 5280 Connectors propose a peak acceleration limit of 7%g (7% of gravitational acceleration), which is supported by the guidelines in AISC Design Guide 11, chapter 5, for rhythmic activities such as dancing, lively concerts, and sporting events.

2. Relevant RFP Requirements

This information has not been amended since the submission of the previous version of this ATC.

Schedule 10 Section 13.6.4 Cover Design Loads

"a. The Developer's Cover structural design loading shall include:

> *ii Pedestrian loading shall be a minimum of 90 psf and shall consider dynamic loading. The dynamic loading shall include rhythmic excitation from lively concerts or sport events activities and shall consider forcing frequencies for first and second harmonic. The Cover fundamental natural frequency, f_n, shall not be less than the higher of (i) minimum required frequency determined from a rational analysis and (ii) 3.0 Hz."*

3. Rationale

This information has been amended since the submission of the previous version of this ATC.

5280 Connectors are in full agreement that accounting for dynamic loading due to rhythmic excitation on the Cover is a necessity, especially since there is an events lawn located on it. This is a very unique loading for a bridge type structure and making sure people on it feel safe is of paramount importance. The Cover structure is very similar to a pedestrian bridge and most of these structures are designed using the AASHTO LRFD *Guide Specification for the Design of Pedestrian Bridges*. This specification provides design provisions to limit vibrations and states that bridges with a fundamental vertical frequency of 3 hertz (Hz) or greater do not require further analysis. This minimum frequency limit, the same as that is specified in the RFP, provides a conservative approach that allows typical pedestrian bridges to forgo additional analysis to minimize bridge excitation from people walking or running over them. However, the Guide Specification does allow structures to have a fundamental vertical frequency of less than 3 Hz but requires an evaluation of the dynamic performance and states that the design should consider limits on acceleration and/or velocity but does not provide specifics on what the limits should be.

The AISC Steel Design Guide 11, *Vibrations of Steel-Framed Structural Systems Due to Human Activity*, Second Edition, does provide these specific limits and the 5280 Connector team deems them to be totally applicable for the Cover. The rationale behind this decision is based on the fact that what humans feel is high acceleration of a structure and not frequency, so achieving acceptable ranges of acceleration is a more direct way of accounting for user comfort than limiting the structure's frequency. Using frequency by itself also overlooks the beneficial effects of higher mass and higher levels of damping, as are present in this Cover structure. Finally, determining accelerations requires the performance of a dynamic analysis which is a more sophisticated way of assessing vibration effects in structures compared to a simple frequency check. The dynamic analysis provides more information than the simple frequency check and will help increase CDOT's confidence that the structure is designed appropriately.

There are many analytical procedures that have been developed in several countries that allow a structural designer to assess occupant comfort for a specific activity. Generally, these analytical tools require the calculation of the first natural frequency and the maximum amplitude of acceleration or velocity due to a reference excitation. An estimate of damping in the floor is also required. The response is compared to the tolerance limit for human comfort to determine whether the structure meets serviceability requirements. The same analysis can be used to assess how much additional force the structure will see due to these dynamic effects, though this will be minimal since the acceleration thresholds for human comfort are generally less than 10% of gravity.

The analytical tools proposed by the 5280 Connectors are presented in the AISC Steel Design Guide 11. They represent years of research and have been shown to yield useful predictions of the acceptability of vibration response of structures subject to human activity. The rationale, design approach, design criteria, and recommendations for the use of acceleration design are provided in the AISC Steel Design Guide 11 for vibration analysis.

Detailed Background:

A minimum value for fundamental natural vertical frequency of a structure is often used as a design criterion for bridge-type structures to reduce the chances of damaging vibrations or vibrations that cause discomfort for users. Bridge designed solely for strength will usually have a fundamental frequency in the range of 1 to 4 hertz. The higher the frequency, the less chance there is for human activities to cause resonant vibrations that lead to undesirably high accelerations, which cause user discomfort and possibly structural damage. This is because human activities such as walking, running, or dancing cause a periodic loading whose frequencies are in this 1 to 4 hertz range. The closer the frequency of the loading is to the fundamental frequency of the structure, the greater the vibration effects. So if a structure's frequency is at or above the higher end of this range, the less chance there is for vibration to cause problems. The frequency of a structure is directly proportional to its stiffness and inversely proportional to its mass (higher stiffness yields higher frequency, and higher mass yields lower frequency). However, frequency by itself is not an ideal design criterion, since people do not directly experience a structure's frequency – rather, they feel acceleration of the structure, and the higher the acceleration, the more likely they are to be uncomfortable.

Acceptance criterion used throughout the AISC Design Guide for a structure subject to human activities is whether or not the peak acceleration of a structure due to an excitation is less than the tolerance acceleration limit. This applies whether the excitation is due to people walking, running, or rhythmic excitation such as dancing, lively concerts or sporting events, or exercise (such as aerobics). While the fundamental natural frequency of the structural system is important, as it is used in the calculation of acceleration as well as determination of the acceleration acceptance criterion, it is not used in the AISC Design Guide as a criterion in and of itself to determine acceptance of a structure. The tolerance acceleration limit depends on the frequency of the vibration, as well as the activity the users themselves are engaged in. For structures with rhythmic activity (from lively concerts or sport events) a tolerance limit of 7% g is recommended (see Table 5-1 from the AISC Design Guide).

As stated above, mass lowers the fundamental natural frequency of the structure so as desired features including, landscaping, play equipment, and stone pavers are added the additional mass (weight) causes the frequency to decrease, making it harder to meet a minimum frequency criterion like the one specified in the RFP. Conversely, when looking at acceleration, the additional mass actually helps lower the peak acceleration felt by the people on the Cover. Also, the presence of the crowd as well as energy-dissipating mechanisms (like the compression of soil or other surfaces on the Cover) increases the damping of the system which also reduces the accelerations of the structures. The presence of these desirable features reduces accelerations and makes the people on the cover feel more comfortable. Therefore, using acceleration based design, 5280 Connector will not be concerned about adding weight to the Cover and can provide high quality design features such as normal weight soil, quality building material, heaver climbing rocks, etc. For example, 5280

Connectors are planning to use normal weight soil where acceleration controls the design. This will provide a better soil medium for trees and shrubs to grow in. It will also improve moisture retention which will minimize irrigation requirements. The structural capacity of the structure has been checked and all structural limit states are satisfied. The proposed added weight from normal weight soil and high quality building materials have been accounted for.

As described above, damping also helps reduce accelerations. The AISC Design Guide recommends a value of 6% for a steel building with a crowd of people engaged in rhythmic activities. However, because our structure will be constructed using concrete (concrete structures inherently provide more damping than steel) and because the presence of a waterproofing membrane, a drainage mat and significant soil depth over most of the Cover provides some compressibility, a damping value of up to 8% will be used. If additional damping is needed then tuned dampers can be added to help further reduce acceleration. Tuned dampers do not affect frequency so they are not an option if the design is based on a frequency limit.

Supporting Calculations:

Detailed calculations are provided in Attachment B for couple of typical sections on the Cover structure in the area of the events lawn. These calculations follow the approach given in section 7.4.4 of the AISC Design Guide, where a finite element model (using CSI Bridge software) is created and used to evaluate the vibration response of the structure by generating accelerations of the structure due to various forcing frequencies imposed by a given weight of pedestrians. In this analysis, a range of frequencies was used between 1 and 12 hertz, as suggested in the AISC Design Guide, specifically including all the modal frequencies of the structure. The weight of participants (w_p) used in the analysis is 1/3 of the 90 psf specified pedestrian load, or 30 psf. This loading represents about one person per 5 square feet, which is a recommended density for people at a lively concert or sporting event, engaged in rhythmic movement. Pedestrian densities higher than this, while possible, represent more static or slow moving crowds where people are unlikely to be able to generate significant rhythmic loading.

When looking at the results the maximum acceleration at the events lawn is under 7%. It is important to note that these accelerations are the peak accelerations experienced by users at a single location within a span (near the middle of the southern span) and are generated by people engaging in rhythmic movement on the south span only. When people engage in rhythmic movement in both spans the acceleration reduces by 40%. Also, as one moves towards the supporting walls, the acceleration drops towards zero, similar to the way deflection of the structure under static loads decreases. So only a fraction of the people on the Cover will experience this peak acceleration.

4. Impacts

This information has been amended since the submission of the previous version of this ATC.

The acceleration based design criteria from the AISC Design Guide is intended for the specific application of sporting events and lively concerts, therefore, has no detrimental impacts on the Cover or the use of its occupants.

5. Cost and Benefit Analysis

This information has been amended since the submission of the previous version of this ATC.

The cost benefit is estimated at $8.5 Million dollars due to reduced depth of girders, excavation volumes, wall square footage and type change, and groundwater treatment. It is estimated that accommodating the current 3.0 Hz requirement will require increasing the girder depth from 63 inches to 90 inches. This requires a lowering of the I-70 profile by 2.25 feet causing a similar increase in excavation depth below groundwater for a length of 1,200 feet. Additionally, providing this same structure depth for the second future Cover, which is required, will increase excavation for the mainline by up to 2.25 feet for over 3,100 feet.

6. Schedule Analysis

This information has been amended since the submission of the previous version of this ATC.

Schedule benefit is estimated at 6-9 months and is driven by reduced time for initial water drawdown, reduced excavation volumes, and utilization of a soil nail wall rather than secant walls.

7. Conceptual Drawings

This information has been amended since the submission of the previous version of this ATC.

Attachment B: ATC 40.1, Section B.3: Calculation Package (dated March 2, 2016) is included to provide technical support of dynamic loading design criteria and analysis.

8. Past Use

This information not been amended since the submission of the previous version of this ATC.

The evaluation of peak accelerations to assess a structure for vibrations caused by human activity is a commonly accepted approach across structure types and throughout the world. This is the design approach taken in the AISC Steel Design Guide 11 which is currently the most authoritative design guide in the United States for vibration design of facilities holding sporting events and lively concerts, authored by some of the foremost experts in vibrations of structures.

As mentioned above, the AASHTO *Guide Specifications for Design of Pedestrian Bridges* (section 6) mandates an evaluation of dynamic performance using acceleration or velocity limits. These specifications (section C6) also reference the technical guide to vibrational behavior of pedestrian bridges (footbridges) published by SETRA in France. In this guide, acceleration is also used as a primary criterion for assessing vibration and the comfort of the bridge's users. The AISC Design Guide also refers to the National Building Code of Canada for setting acceleration tolerance limits for both walking and rhythmic events, and to the document *Dynamic Performance Requirements for Permanent Grandstands Subject to Crowd Motion* published by the Institution of Structural Engineers in the UK for acceleration tolerance limits in sports and concert venues.

9. Additional Information

This information has been amended since the submission of the previous version of this ATC.

Resubmission of ATC request outlining Cover design criteria from February 14, 2017 Technical One-on One Meeting.

C. Detailed ATC Submission Requirements

1. Risks

There are no additional risks to the Procuring Authorities, CDOT, the State or third parties associated with implementation of this ATC.

2. Handback

There are no changes in handback procedures and/or Handback Requirements associated with this ATC.

3. Right-of-Way

No additional right-of-way is required to implement this ATC.

4. List of Required Approvals

There are no third party, Governmental Approvals or Design Exceptions required by this ATC.

5. Proposed Drafting Revisions

Revisions to the Final RFP are required to Schedule 10, Section 13.6.4 Cover Design Loads (see attached)

p. The protecting of bridge Elements and roadway/pedestrian areas from bird droppings shall be considered in the design. The Developer shall eliminate all potential pigeon roosting and nesting areas and/or install various control systems, such as plates, grating, nets, spikes, electric systems, and wires as Approved by the Department at bearing areas, abutment and pier caps, and areas above pedestrian traffic. Bird control and nest removal shall be taken into consideration when planning long-term maintenance.

13.6. Cover

13.6.1. The Developer shall be responsible for designing and constructing the structural Elements for the Cover and Swansea Elementary School outdoor areas, as such areas are described in Section 14 of this Schedule 10. The I-70 Cover Plans included in Schedule 10B, Contract Drawings (including the landscaping and aesthetic features reflected in such plans) constitute a preliminary 70% design of the Cover and Swansea Elementary School outdoor areas and have been preliminarily agreed upon by the City of Denver and the Department. The Developer shall be required to advance and complete such design of the structural Elements in accordance with the requirements of this Agreement.

13.6.2. The Cover shall meet all requirements as described in Schedule 10, Section 4 Utilities, Section 12 Cover MEP System, Section 14 Landscaping and Aesthetics, Section 16 ITS and Tolling Equipment, and Schedule 10B Contract Drawings.

13.6.3. The Developer shall construct a solid concrete pier wall that extends beyond both ends of the Cover a minimum distance of 130 feet, to prevent recirculation of pollution or smoke from the exit of one bore into the entrance of the other, meeting the requirements specified in Schedule 10, Section 12 Cover MEP System.

13.6.4. Cover Design Loads

a. The Developer's Cover structural design loading shall include:

i. All dead loads (i.e. soil, plantings, fields, utilities, barriers and fences, buildings, lighting, overlay, deck, girders and forms, fire protection, ventilation fans/equipment, and MEP requirements, etc.) specific to the final Cover design. The design loading shall be for fully mature trees.

ii. Pedestrian loading shall be a minimum of 90 psf and shall consider dynamic loading. The dynamic loading shall include rhythmic excitation from lively concerts or sport events activities and shall consider forcing frequencies for first and second harmonic. Within active use areas,~~ the Cover fundamental natural frequency, f_n, shall not be less than the higher of (i) minimum required frequency determined from a rational analysis and (ii) 3.0 Hz~~ a total peak acceleration shall be limited to 7.0%. Acceleration from the first and second harmonic shall be combined using the 1.5 power rule as defined in the AISC Steel Design Guide 11, second edition.

iii. Excluding locations of raised planters, Columbine Street and Clayton Street (the requirements for which streets are set out in Section 13.6.4.c), the vehicle live loading for the entirety of the Cover shall be an emergency vehicle equivalent to AASHTO H10 vehicle. The vehicle live loading for the Cover shall be a fire truck loading in accordance with The 2016 Amendments to the Building Code for the City and County of Denver. The location for the fire truck access and loading on the Cover is shown in the Fire Truck Loading Exhibit provided in the Reference Documents. The design shall provide physical barriers using bollards, walls and other measures that prohibit all other vehicle classes from access to locations on the Cover not designed accordingly. The design shall be coordinated with the Denver Fire Department for approval.

iv. Dead load reserve capacity of at least 25 psf shall be included in the structural design for future potential changed conditions that may occur over the design life of the Cover.

ATTACHMENT B

CENTRAL I-70 PROJECT
I-70 Partial Cover Structure

ATC 40.1, Section B.3.

Calculation Package

Brian J. Harris, Senior Bridge Engineer

March 2, 2017

Peak accelerations due to dynamic pedestrian loading on the cover

In order to evaluate the suitability of the superstructure design for dynamic pedestrian loading, the following calculations were developed using the AISC Design Guide 11: Vibrations of Steel-Framed Structural Systems Due to Human Activity (Second Edition). This guide uses the current best practices for evaluating vibration in structures, and uses a maximum peak vertical acceleration of the structure as the limiting criteria, as humans experience discomfort with higher accelerations, with the specific limit depending on the nature of the activity and the frequency of the vibration.

Two sections of the Cover structure were evaluated for these calculations (See Figure 1). One is in the central area of the events lawn (amphitheater), near station 2038+57.5, as it represents an area of the cover most likely to see large

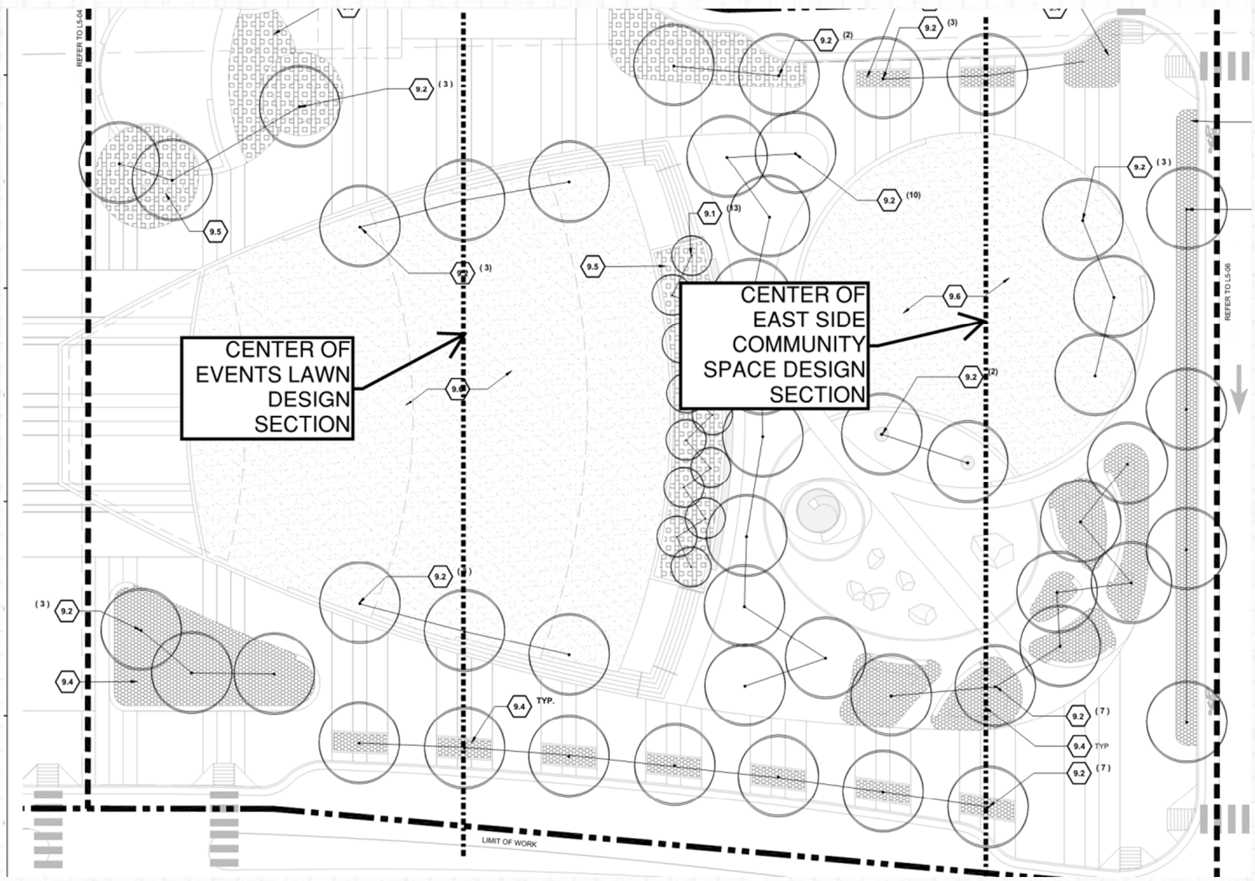


Figure 1 Design Sections on Cover

groups of pedestrians engaging in rhythmic activities that could cause vertical vibrations in the superstructure. It also has longer span lengths than the soccer field area to the west, which makes larger vibrations possible. The second area is just east of the events lawn, at the East Side Community Space (ESCS). This area on the Cover structure has slightly longer span lengths than the events lawn and also has the potential for rhythmic excitation due to pedestrians, so it is likely the worst case area for vibrations.

These sections of the cover are modeled in CSI Bridge as 3D finite element models using both frame and shell-type elements. A 30-foot representative width of superstructure was chosen for each section, centered on the 12” high planter boxes adjacent to the north and south edges of the cover superstructure. The superstructure for this analysis are FIB63 precast prestressed girders with an 8” thick concrete deck, girders spaced at 4.2’ o.c. typically, but with one 9’ girder space to accommodate a below deck soil planting depth for the trees (see Figure 2).

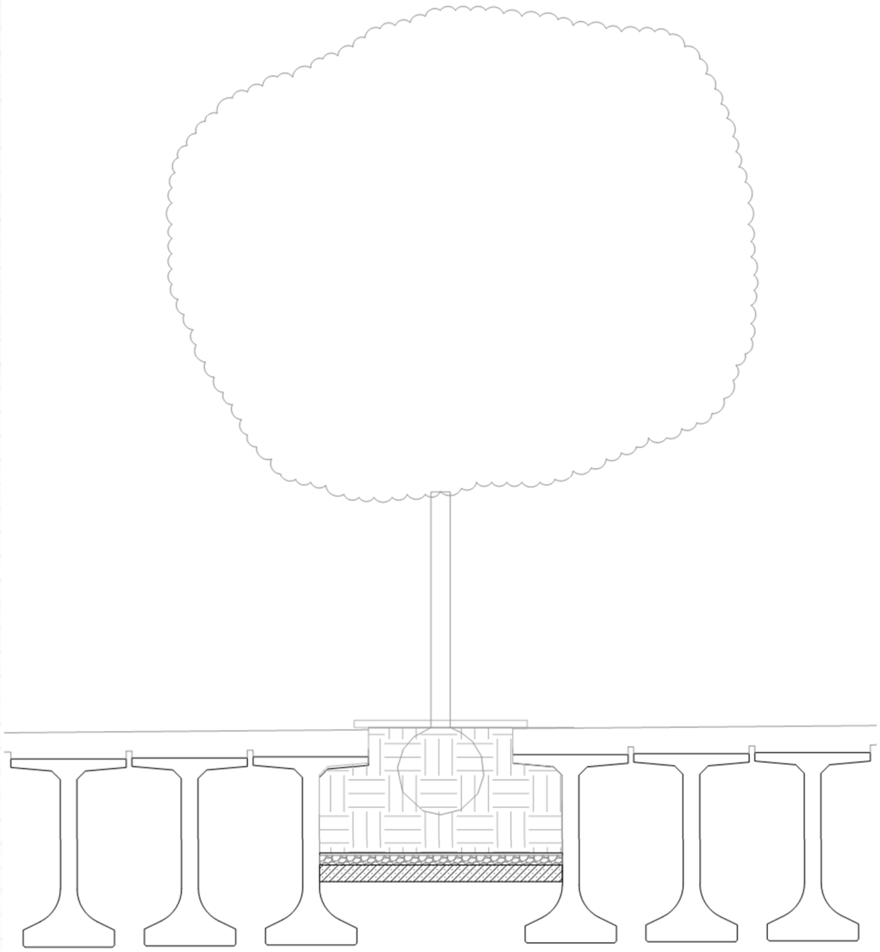


Figure 2: Superstructure Cross Section – 30' Width for Models

The approach given in section 7.4.4 of the AISC Design Guide is followed, for evaluation using a finite element model, for rhythmic activity on floors. For this analysis, a range of loading frequencies was used between 1 and 12 hertz, as suggested in the AISC Design Guide, specifically including all the modal frequencies of the structure. The weight of participants (w_p) used in the analysis is 1/3 of the 90 psf specified pedestrian load, or 30 psf. This loading represents about one person per 5 square feet, which is a recommended density for people at a lively concert or sporting event, engaged in rhythmic movement. Pedestrian densities higher than this, while possible, represent more static or slow moving crowds where people are unlikely to be able to generate significant dynamic loading.

Because of the fundamental vertical mode shape (see below) for this two-span continuous superstructure, there are two load cases checked for each model: forcing all of span one with a uniform 30 psf with no forcing in span 2, and forcing all of span two with a uniform 30 psf, with no forcing in span 1. Additionally, for comparison, the events space model also has a load case 3: forcing both spans simultaneously with a uniform 30 psf. In CSI Bridge, these load cases are implemented as Steady State analysis load cases, with a uniform steady state forcing function (uniform meaning no variation in peak amplitude of the loading as frequency changes).

Analysis is performed with damping (% of critical viscous damping) set at 8%. The AISC Design Guide recommends a value of 6% for a steel building with a crowd of people engaged in rhythmic activities. Because of the presence of soil over large portions of this area, and the fact that the superstructure is concrete and not steel, the higher damping value of 8% was used.

For each load case, the peak acceleration that comes out of the model for any forcing frequency less than 3 hz (3 hz being the upper limit on frequency of loading from rhythmic activities per the AISC Design Guide) is selected. This is the first harmonic. Then the acceleration at the second harmonic is identified (acceleration at the frequency 2 times the frequency of the first harmonic). These two accelerations (only the first and second harmonics are used here) are multiplied by the Fourier series parameters from AISC Design Guide table 7-4, then the accelerations for each harmonic are combined using AISC Design Guide equation 7-10 to obtain the peak acceleration.

Loading:

Because added mass (weight) helps reduce the accelerations, a conservative approach is taken to calculating the weights, except that a normal-to-heavy weight soil is assumed to be used in the planting areas (120 pcf / 0.120 kcf).

DC: Self-weight of girders and deck (at 150 pcf)

DW:

Miscellaneous above deck loads, including trees: 10 psf over entire deck area (50% of actual 20 psf used for strength design)

Miscellaneous below deck loads, including utilities and fire/life safety systems: 10 psf over entire deck area (50% of actual 20 psf used for strength design)

Future DW allowance: 0 psf (actual = 25 psf for strength design, which would not be conservative here)

Soil: Use 120 pcf weight soil

PLL: Use 30 psf for mass, and for forcing function amplitude (1/3rd of 90 psf used for strength design, in accordance with the AISC Design Guide recommendations)

Loading at paved areas:

75 psf paving + 10 psf misc above + 10 psf misc below = 95 psf

Loading at amphitheater turf:

1’ soil x 0.120 kcf + 10 psf misc above + 10 psf misc below = 140 psf

Loading at trees:

Below deck planter box:

Soil weight = [(8’x15’x4’) + (14.5”/12 x 15’ x 5’))] x .120 kcf = 68.5 k

Bottom slab = 7”/12 x 15’ x 8’-5” x 0.150 pcf = 11 k

End walls = 7”/12 x 37 ft2 x 0.150 kcf x 2 = 6.5 k

TOTAL = 86 k / (9’ x 15’) = 0.637 ksf over a 9’x15’ area

Above deck planter box, assume soil depth for shrub planting only around trees = 1.25’; assume concrete planter walls captured in misc. above deck loads:

1.25’ x 0.120 kcf = .150 ksf over 6’ x 16’ planter area (= 0.075 ksf above typical paved area loading)

Models

Figure 3 shows a 3D view of the CSI Bridge model at the events lawn, representing this 30’ wide strip of the Cover structure (model at the ESCS is similar). Frame elements are used for most components, with shell elements used for the deck slab.

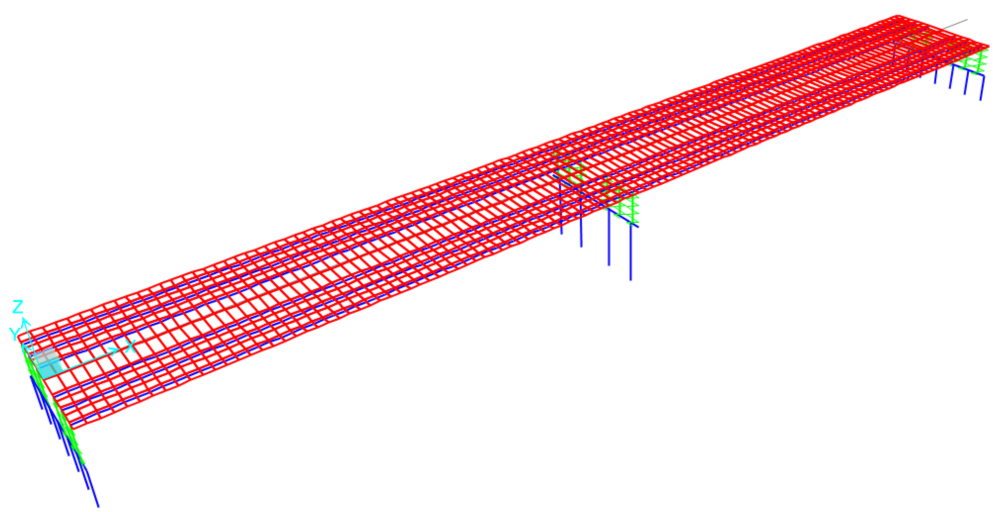


Figure 3: 3D Model View

For the events lawn model, the joints in each span showing the maximum deflection under uniform live load only in that span are shown in Figure 4, and these are the joints whose accelerations are monitored during the dynamic loading. Nearby joints are monitored for load case 3, as different nodes have the peak acceleration for that case. Similar joints

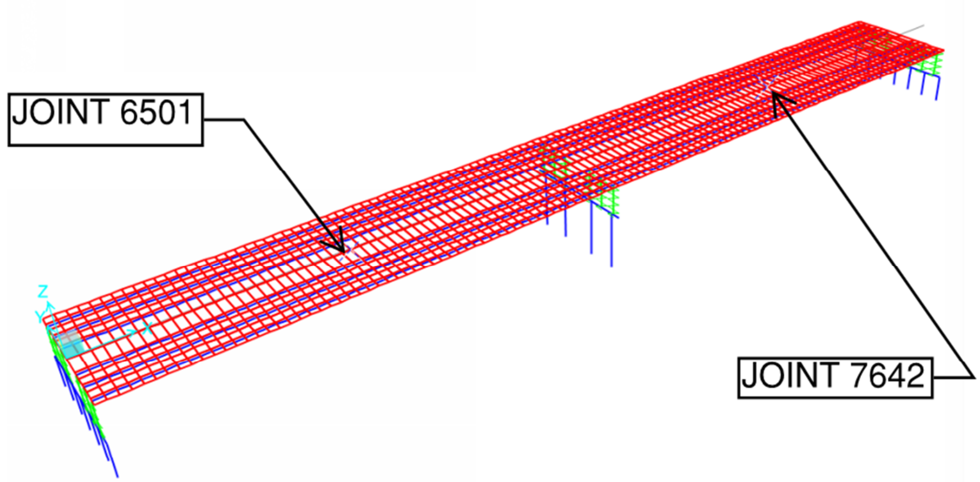


Figure 4: Monitored Joints in Each Span for the Events Lawn Model, For Load Cases 1 and 2

are monitored in the ESCS model.

Analysis Results:

The modal analysis results in mode 2 (see Figure 5) having the dominant frequency for vertical motion (the fundamental vertical natural frequency). This mode shape shows that the two spans synchronously move in opposite directions. This is why load cases 1 and 2, with loading in one span or the other, were developed for the dynamic analysis as described

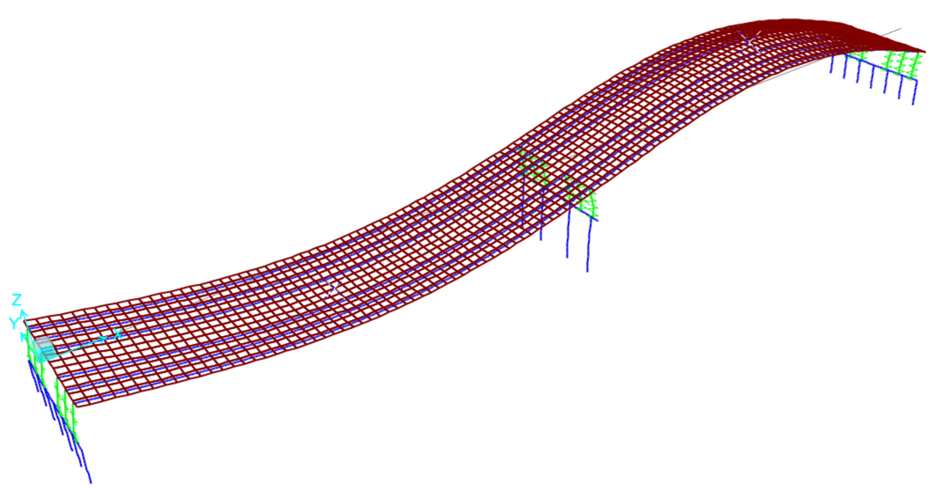


Figure 5: Mode Shape for Mode 2

above. The third case used in the events space model with both spans loaded simultaneously, corresponds to a higher mode.

Acceleration results taken at the monitored nodes are shown on the following pages, along with the frequency response function plot showing the response for all load cases, at both levels of damping. As expected due to the larger span length, load case 2 (uniform load forcing span 2 only) controls, and gives the higher peak acceleration.

For the events lawn model, the peak acceleration is 6.5%g, in span 2 under load case 2. For the ESCS model, the peak acceleration is 6.9%g, in span 2 under load case 2. These peak values are below the recommended maximum peak acceleration of 7%g for rhythmic activities given in table 5-1 of the AISC Design Guide. It is important to recognize two things about these results:

1) These accelerations are the maximum within each span – as you move away from the point of maximum accelerations (near mid-span of each span), the accelerations drop off towards zero at the supports, similar to the way deflections decrease. So only a small fraction of the people on the cover would experience these peak accelerations.
2) These accelerations are from load cases as described above, where the span in question is being fully forced (fully loaded with the 1 person per 5 square feet with all people in that span moving in rhythm together), while the adjacent span is not being forced at all (people there but not moving at all). This is highly unlikely to be the

case, given the layout of the amphitheater relative to the span arrangement. This is a conservative assumption for this analysis, and actual accelerations would be lower given that people would be moving in both spans, with the movement in one span reducing the movement in the adjacent span and vice-versa. For example, looking at load case 3 for the events lawn model, where both spans are being forced together, the peak acceleration is only 3.9%g, in span 1.

Events Lawn Model

Load Case 1 (Span 1), 8% Damping FIB63

Peak Accel = 3.13% (%g)

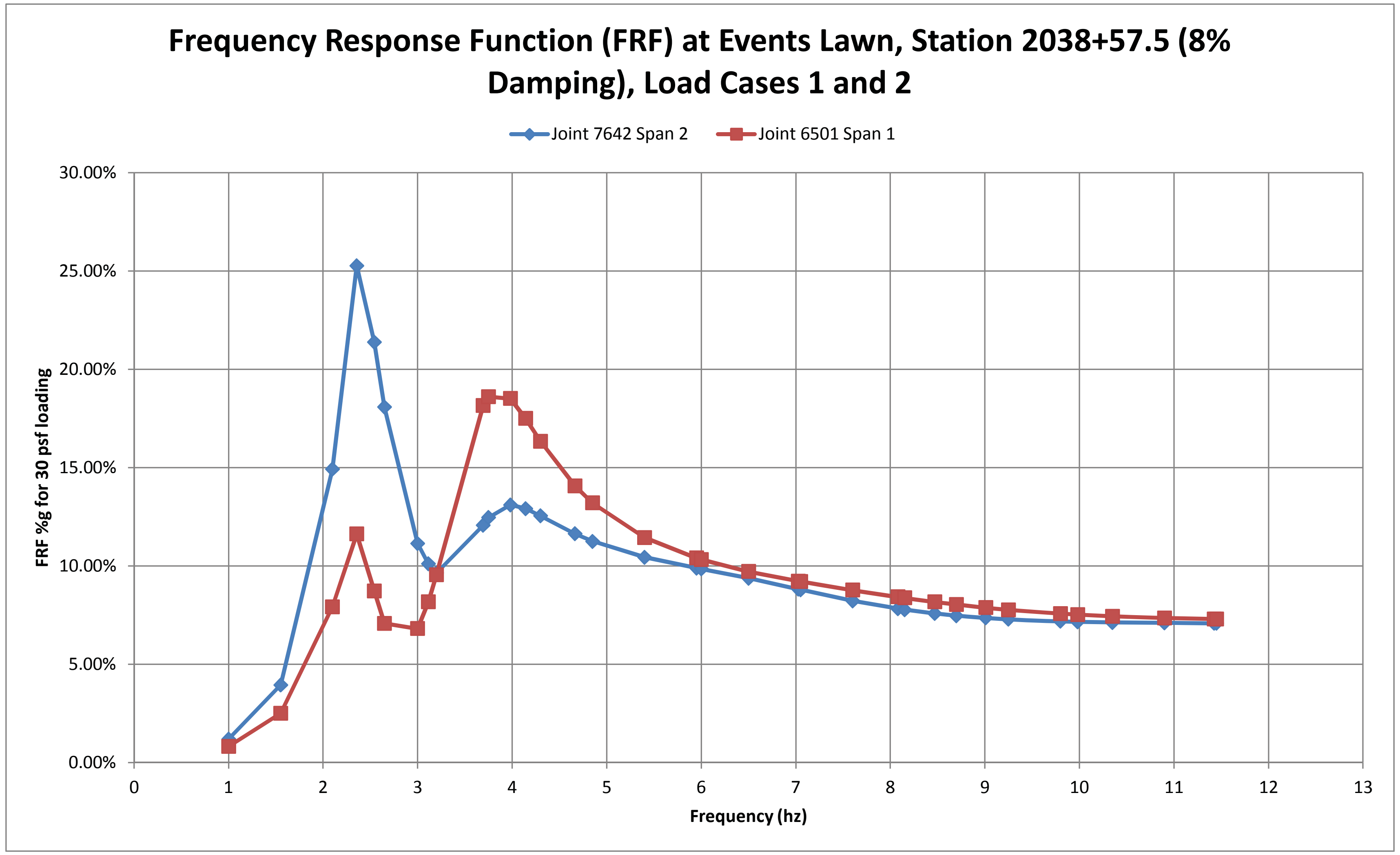
TABLE: Joint Accelerations - Absolute													
Joint	**OutputCase**	**CaseType**	**StepType**	**StepNum**	**U1**	**U2**	**U3**	**R1**	**R2**	**R3**	FRF	FRF(f_{step}) * α_1	
Text	Text	Text	Text	Unitless	ft/sec2	ft/sec2	ft/sec2	rad/sec2	rad/sec2	rad/sec2	**%g**	**%g**	
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	1	0.0089	7.508E-09	0.2648	2.507E-08	0.0001463	3.559E-10	0.82%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	1.55	0.0373	6.874E-09	0.808	7.274E-08	0.0002386	1.088E-09	2.51%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	2.1	0.2367	1.671E-07	2.5498	0.000000197	0.00199	3.472E-09	7.92%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	2.3545	0.5925	5.479E-07	3.7419	2.616E-07	0.007546	5.062E-09	11.62%	2.91%	1st harmonic
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	2.542755	0.5422	6.925E-07	2.8105	0.000000236	0.009956	3.478E-09	8.73%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	2.65	0.3892	7.268E-07	2.2771	2.536E-07	0.011	2.656E-09	7.07%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	3	0.1096	8.478E-07	2.1931	4.244E-07	0.014	2.985E-09	6.81%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	3.111739	0.0774	8.354E-07	2.6295	4.784E-07	0.016	4.099E-09	8.17%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	3.2	0.0594	7.969E-07	3.0756	5.154E-07	0.018	5.244E-09	9.55%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	3.690669	0.0066	7.708E-07	5.8448	7.533E-07	0.029	1.118E-08	18.15%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	3.75	0.0061	8.065E-07	5.9903	7.661E-07	0.03	1.129E-08	18.60%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	3.982105	0.0144	9.397E-07	5.9616	7.534E-07	0.029	9.862E-09	18.51%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	4.14192	0.0185	9.812E-07	5.6347	7.159E-07	0.027	7.966E-09	17.50%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	4.3	0.021	9.712E-07	5.2629	6.783E-07	0.026	6.153E-09	16.34%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	4.664759	0.024	8.407E-07	4.5313	6.139E-07	0.023	3.737E-09	14.07%	0.70%	2nd harmonic
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	4.85	0.0249	7.653E-07	4.252	5.912E-07	0.022	3.348E-09	13.20%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	5.4	0.027	6.101E-07	3.685	5.401E-07	0.02	3.028E-09	11.44%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	5.95	0.029	5.331E-07	3.3492	5.056E-07	0.02	2.76E-09	10.40%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	6	0.0291	5.283E-07	3.3255	5.031E-07	0.02	2.733E-09	10.33%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	6.5	0.031	4.902E-07	3.1284	4.809E-07	0.021	2.438E-09	9.72%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	7.025528	0.0329	4.633E-07	2.9703	4.567E-07	0.022	2.09E-09	9.22%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	7.05	0.033	4.623E-07	2.9637	4.553E-07	0.022	2.074E-09	9.20%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	7.6	0.035	4.416E-07	2.8233	4.189E-07	0.024	1.747E-09	8.77%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	8.079573	0.0366	4.274E-07	2.712	3.753E-07	0.025	1.615E-09	8.42%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	8.15	0.0368	4.256E-07	2.6966	3.681E-07	0.025	1.613E-09	8.37%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	8.470168	0.0379	4.183E-07	2.6303	3.339E-07	0.026	1.652E-09	8.17%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	8.7	0.0386	0.000000414	2.5871	3.084E-07	0.027	1.717E-09	8.03%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	9.010064	0.0396	4.092E-07	2.5352	2.744E-07	0.027	1.823E-09	7.87%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	9.25	0.0403	4.061E-07	2.5003	2.494E-07	0.028	1.905E-09	7.76%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	9.8	0.0417	4.003E-07	2.4371	2.006E-07	0.03	2.049E-09	7.57%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	9.982472	0.0422	3.986E-07	2.4208	1.883E-07	0.03	2.081E-09	7.52%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	10.35	0.0429	3.953E-07	2.394	0.000000171	0.031	2.127E-09	7.43%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	10.9	0.0436	3.901E-07	2.366	1.657E-07	0.033	2.173E-09	7.35%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	11.425327	0.0439	0.000000385	2.3489	1.801E-07	0.034	2.224E-09	7.29%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	11.45	0.0439	3.847E-07	2.3483	1.811E-07	0.034	2.227E-09	7.29%		
6501	Span1_SteadyState-8%	LinSteady	Mag at Freq	12	0.0437	3.793E-07	2.337	2.083E-07	0.035	2.322E-09	7.26%		

Events Lawn Model

Load Case 2 (Span 2), 8% Damping FIB63

Peak Accel = 6.44% (%g)

TABLE: Joint Accelerations - Absolute													
Joint	**OutputCase**	**CaseType**	**StepType**	**StepNum**	**U1**	**U2**	**U3**	**R1**	**R2**	**R3**	FRF	FRF(f_{step}) * α_1	
Text	Text	Text	Text	Unitless	ft/sec2	ft/sec2	ft/sec2	rad/sec2	rad/sec2	rad/sec2	**%g**	**%g**	
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	1	0.0107	8.669E-09	0.384	3.256E-08	0.00008267	4.532E-10	1.19%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	1.55	0.048	7.363E-09	1.273	1.044E-07	0.00007358	1.54E-09	3.95%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	2.1	0.345	2.712E-07	4.8045	3.533E-07	0.002074	6.157E-09	14.92%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	2.3545	0.937	8.957E-07	8.1404	0.00000054	0.006782	1.091E-08	25.28%	6.32%	1st harmonic
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	2.542755	0.9227	0.000001161	6.885	4.334E-07	0.008096	9.349E-09	21.38%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	2.65	0.6947	0.000001243	5.8236	3.847E-07	0.008118	7.948E-09	18.09%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	3	0.2381	0.00000158	3.5906	5.246E-07	0.01	4.453E-09	11.15%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	3.111739	0.183	0.000001602	3.2558	5.913E-07	0.011	3.261E-09	10.11%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	3.2	0.152	0.000001556	3.1062	6.203E-07	0.012	2.329E-09	9.65%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	3.690669	0.0556	0.000001265	3.8862	6.973E-07	0.019	2.981E-09	12.07%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	3.75	0.0477	0.000001241	4.0136	7.102E-07	0.019	3.41E-09	12.46%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	3.982105	0.024	0.000001098	4.2194	7.357E-07	0.018	4.84E-09	13.10%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	4.14192	0.0151	9.862E-07	4.1605	7.352E-07	0.017	5.401E-09	12.92%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	4.3	0.0113	0.000000892	4.0403	7.295E-07	0.016	5.61E-09	12.55%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	4.664759	0.0121	7.278E-07	3.7473	7.209E-07	0.014	5.451E-09	11.64%	0.58%	2nd harmonic
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	4.85	0.0135	6.639E-07	3.6249	7.217E-07	0.013	5.287E-09	11.26%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	5.4	0.0171	5.477E-07	3.3641	0.000000734	0.012	4.906E-09	10.45%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	5.95	0.02	4.964E-07	3.1866	7.483E-07	0.012	4.668E-09	9.90%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	6	0.0203	4.931E-07	3.1718	0.000000749	0.012	4.649E-09	9.85%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	6.5	0.0224	4.634E-07	3.019	7.432E-07	0.012	4.435E-09	9.38%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	7.025528	0.0242	4.341E-07	2.8409	7.013E-07	0.012	4.134E-09	8.82%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	7.05	0.0242	4.327E-07	2.8324	6.984E-07	0.012	4.117E-09	8.80%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	7.6	0.0256	4.046E-07	2.6497	6.173E-07	0.013	3.732E-09	8.23%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	8.079573	0.0264	3.855E-07	2.5206	5.332E-07	0.013	3.433E-09	7.83%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	8.15	0.0265	3.832E-07	2.5048	5.207E-07	0.013	3.398E-09	7.78%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	8.470168	0.0268	3.745E-07	2.4424	4.645E-07	0.013	3.278E-09	7.59%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	8.7	0.027	3.697E-07	2.4069	4.256E-07	0.013	3.232E-09	7.47%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	9.010064	0.027	3.648E-07	2.3696	3.757E-07	0.013	3.214E-09	7.36%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	9.25	0.0269	3.619E-07	2.3476	3.393E-07	0.013	3.224E-09	7.29%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	9.8	0.0264	3.571E-07	2.3142	2.639E-07	0.013	3.267E-09	7.19%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	9.982472	0.0262	3.558E-07	2.3069	2.415E-07	0.013	3.277E-09	7.16%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	10.35	0.0256	3.532E-07	2.2963	2.008E-07	0.013	3.28E-09	7.13%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	10.9	0.0245	3.494E-07	2.2867	1.532E-07	0.013	3.236E-09	7.10%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	11.425327	0.0235	3.455E-07	2.2809	1.291E-07	0.013	3.154E-09	7.08%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	11.45	0.0234	3.453E-07	2.2807	1.286E-07	0.013	3.15E-09	7.08%		
7642	Span2_SteadyState-8%	LinSteady	Mag at Freq	12	0.0223	0.000000341	2.2755	1.332E-07	0.012	3.043E-09	7.07%		

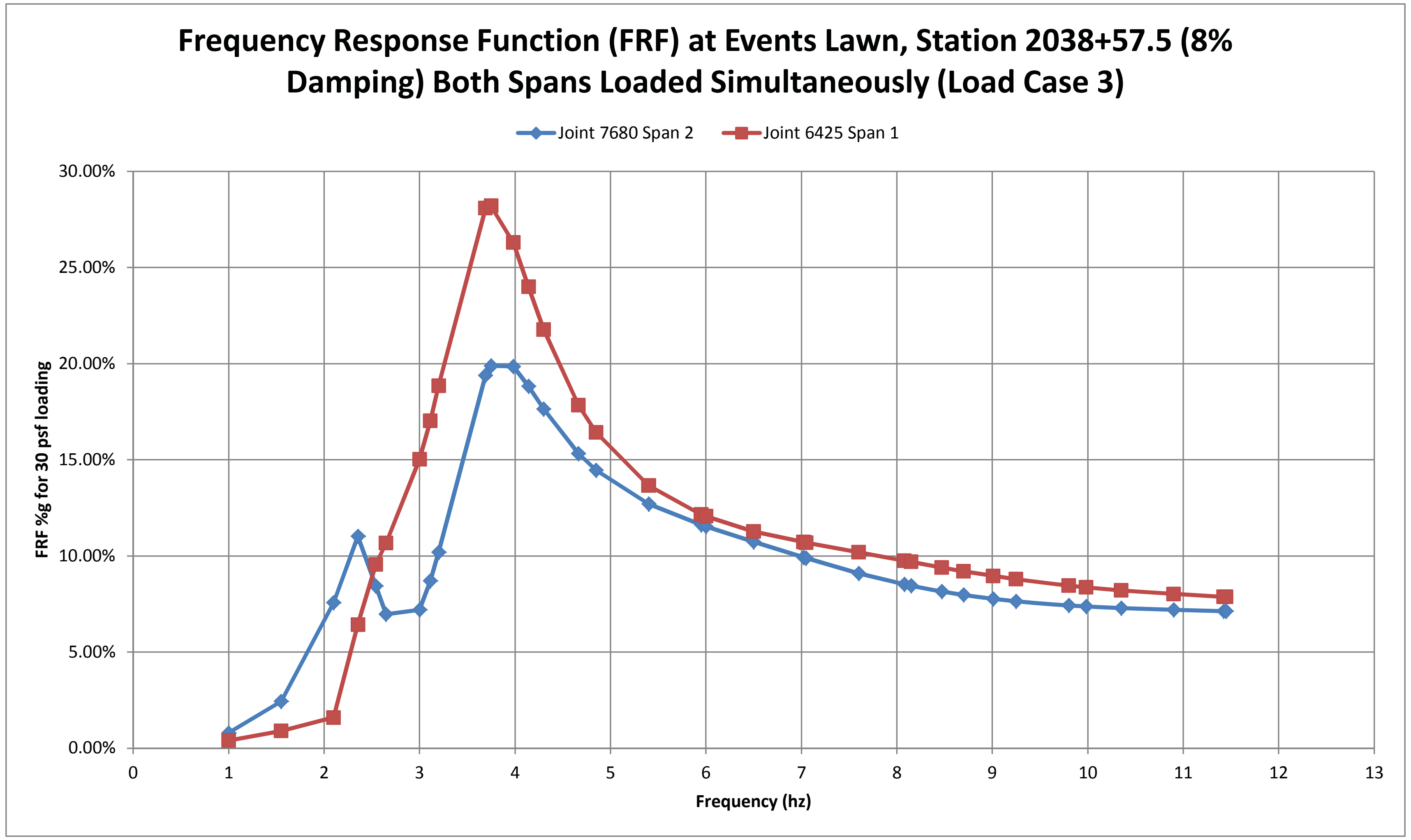

Frequency Response Function (FRF) at Events Lawn, Station 2038+57.5 (8% Damping), Load Cases 1 and 2
Joint 7642 Span 2
Joint 6501 Span 1
FRF %g for 30 psf loading
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Frequency (hz)

Events Lawn Model

Load Case 3 (Both Spans Forced), Span 2 Results, 8% Damping FIB63

Peak Accel = **3.02%** **(%g)**

TABLE: Joint Accelerations - Absolute													
Joint	**OutputCase**	**CaseType**	**StepType**	**StepNum**	**U1**	**U2**	**U3**	**R1**	**R2**	**R3**	FRF	FRF(f_{step}) * α_1
Text	Text	Text	Text	Unitless	ft/sec2	ft/sec2	ft/sec2	rad/sec2	rad/sec2	rad/sec2	**%g**	**%g**
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	1	0.002	2.368E-08	0.2572	2.649E-08	0.00006299	4.429E-10	0.80%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	1.55	0.0104	5.605E-08	0.7827	7.869E-08	0.0002655	1.303E-09	2.43%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	2.1	0.1	1.042E-07	2.4379	2.205E-07	0.004369	3.732E-09	7.57%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	2.3545	0.3262	4.267E-07	3.5492	2.993E-07	0.012	5.041E-09	11.02%	2.76%
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	2.542755	0.3765	6.584E-07	2.7179	2.695E-07	0.014	3.716E-09	8.44%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	2.65	0.3131	7.498E-07	2.2445	2.827E-07	0.014	3.292E-09	6.97%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	3	0.156	0.000001089	2.3198	4.748E-07	0.015	4.681E-09	7.20%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	3.111739	0.1373	0.000001183	2.8007	5.514E-07	0.016	5.614E-09	8.70%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	3.2	0.1278	0.000001247	3.2816	6.132E-07	0.017	6.469E-09	10.19%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	3.690669	0.0985	0.000001669	6.2456	0.000001032	0.021	1.282E-08	19.40%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	3.75	0.0938	0.000001668	6.4044	0.000001064	0.021	1.359E-08	19.89%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	3.982105	0.0739	0.000001487	6.3934	0.000001106	0.019	1.578E-08	19.86%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	4.14192	0.062	0.000001306	6.0603	0.00000109	0.016	1.621E-08	18.82%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	4.3	0.0528	0.000001155	5.6795	0.000001064	0.014	1.592E-08	17.64%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	4.664759	0.0396	9.115E-07	4.9344	0.000001014	0.011	1.431E-08	15.32%	0.77%
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	4.85	0.0357	8.188E-07	4.6533	9.993E-07	0.009447	1.353E-08	14.45%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	5.4	0.0299	0.000000652	4.089	9.786E-07	0.007022	1.187E-08	12.70%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	5.95	0.0282	5.853E-07	3.7405	0.000000973	0.00563	1.082E-08	11.62%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	6	0.0282	5.812E-07	3.7137	9.724E-07	0.005533	1.074E-08	11.53%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	6.5	0.0283	5.471E-07	3.4598	9.542E-07	0.004728	9.951E-09	10.74%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	7.025528	0.0292	5.152E-07	3.1984	8.996E-07	0.004043	9.037E-09	9.93%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	7.05	0.0292	5.138E-07	3.1863	8.961E-07	0.004014	8.992E-09	9.90%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	7.6	0.0305	4.839E-07	2.9305	8.008E-07	0.003583	7.966E-09	9.10%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	8.079573	0.0319	4.642E-07	2.745	7.042E-07	0.004054	7.235E-09	8.52%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	8.15	0.0321	4.619E-07	2.7213	6.898E-07	0.004221	7.155E-09	8.45%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	8.470168	0.0331	4.533E-07	2.6253	6.253E-07	0.005264	6.915E-09	8.15%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	8.7	0.0337	4.488E-07	2.5674	5.805E-07	0.006248	6.867E-09	7.97%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	9.010064	0.0345	4.445E-07	2.5024	5.228E-07	0.007794	6.946E-09	7.77%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	9.25	0.0351	4.422E-07	2.4612	4.806E-07	0.009107	7.091E-09	7.64%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	9.8	0.0361	0.000000439	2.3908	3.928E-07	0.012	7.552E-09	7.42%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	9.982472	0.0363	4.382E-07	2.3734	3.664E-07	0.013	7.714E-09	7.37%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	10.35	0.0368	4.367E-07	2.3453	3.177E-07	0.016	8.022E-09	7.28%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	10.9	0.0373	4.344E-07	2.3158	2.562E-07	0.019	8.411E-09	7.19%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	11.425327	0.0377	4.317E-07	2.2968	2.122E-07	0.022	8.698E-09	7.13%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	11.45	0.0377	4.315E-07	2.296	2.105E-07	0.022	8.709E-09	7.13%	
7680	Span1&2_SteadyState-8%	LinSteady	Mag at Freq	12	0.038	4.282E-07	2.2814	1.849E-07	0.025	8.936E-09	7.09%	


Frequency Response Function (FRF) at Events Lawn, Station 2038+57.5 (8% Damping) Both Spans Loaded Simultaneously (Load Case 3)
Joint 7680 Span 2
Joint 6425 Span 1
FRF %g for 30 psf loading
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Frequency (hz)

East Side Community Space Model

Load Case 1 (Span 1), 8% Damping FIB63

Peak Accel =	**3.61%**	**(%g)**

TABLE: Joint Accelerations - Absolute

Joint	**OutputCase**	**CaseType**	**StepType**	**StepNum**	**U1**	**U2**	**U3**	**R1**	**R2**	**R3**	FRF	FRF(f_{step}) * α_1	
Text	Text	Text	Text	Unitless	ft/sec2	ft/sec2	ft/sec2	rad/sec2	rad/sec2	rad/sec2	**%g**	**%g**	
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	1	0.0099	0.00001105	0.301	0.000005038	0.0001571	1.485E-07	0.93%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	1.55	0.0411	0.0001434	0.9289	0.00006279	0.000175	0.00000154	2.88%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	2.1	0.2601	0.0023	3.0307	0.0009271	0.002996	0.00001628	9.41%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	2.339338	0.6052	0.0075	4.3624	0.002951	0.009351	0.00004141	13.55%	3.39%	1st harmonic
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	2.563556	0.5349	0.0121	2.961	0.004562	0.012	0.00004976	9.20%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	2.65	0.4124	0.0142	2.493	0.00525	0.012	0.00005209	7.74%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	3	0.1169	0.0274	2.4004	0.009269	0.015	0.00009396	7.45%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	3.025665	0.1077	0.0283	2.495	0.009507	0.016	0.0001001	7.75%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	3.2	0.0643	0.0325	3.3767	0.01	0.019	0.0001479	10.49%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	3.643078	0.0202	0.0329	6.0295	0.009223	0.026	0.0002701	18.73%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	3.75	0.0159	0.0305	6.2524	0.008433	0.026	0.0002791	19.42%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	3.938796	0.0122	0.0244	6.1322	0.006764	0.024	0.0002617	19.04%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	4.067163	0.0115	0.0197	5.85	0.00564	0.022	0.0002327	18.17%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	4.3	0.0116	0.0122	5.2662	0.003941	0.019	0.0001699	16.35%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	4.54469	0.0124	0.0067	4.7366	0.002696	0.017	0.0001133	14.71%	0.74%	2nd harmonic
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	4.85	0.0134	0.003	4.239	0.001695	0.015	0.00006826	13.16%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	5.4	0.0151	0.0008113	3.6628	0.0007889	0.013	0.00003464	11.38%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	5.95	0.0164	0.0003052	3.3231	0.000427	0.012	0.00002329	10.32%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	6	0.0165	0.0002839	3.2998	0.0004066	0.012	0.00002266	10.25%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	6.5	0.0178	0.0001535	3.1199	0.0002617	0.012	0.000018	9.69%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	7.05	0.0193	0.00009002	3.0085	0.0001733	0.012	0.00001491	9.34%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	7.36343	0.0202	0.00007121	2.9743	0.0001402	0.012	0.00001366	9.24%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	7.6	0.021	0.00006355	2.9583	0.0001205	0.013	0.00001287	9.19%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	8.15	0.0228	0.00006281	2.941	0.00008725	0.013	0.00001142	9.13%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	8.254768	0.0232	0.00006436	2.9396	0.00008241	0.013	0.00001119	9.13%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	8.298146	0.0233	0.00006509	2.9391	0.00008051	0.013	0.00001109	9.13%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	8.7	0.0245	0.0000728	2.9361	0.00006558	0.014	0.00001026	9.12%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	8.728736	0.0246	0.00007337	2.9359	0.00006467	0.014	0.0000102	9.12%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	9.25	0.0259	0.00008243	2.9325	0.00005094	0.015	0.000009184	9.11%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	9.591073	0.0265	0.00008665	2.9291	0.00004419	0.015	0.000008544	9.10%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	9.8	0.0267	0.00008851	2.9264	0.0000407	0.015	0.000008161	9.09%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	10.35	0.027	0.00009118	2.9178	0.00003334	0.016	0.000007205	9.06%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	10.9	0.0267	0.00009134	2.9072	0.0000279	0.016	0.000006342	9.03%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	10.910536	0.0266	0.00009132	2.907	0.00002781	0.016	0.000006326	9.03%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	11.45	0.0259	0.00008982	2.8954	0.00002376	0.016	0.000005581	8.99%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	11.844043	0.0251	0.00008802	2.8863	0.00002137	0.016	0.000005098	8.96%		
507	Span1_SteadyState-8%	LinSteady	Mag at Freq	12	0.0247	0.00008718	2.8825	0.00002052	0.016	0.00000492	8.95%		

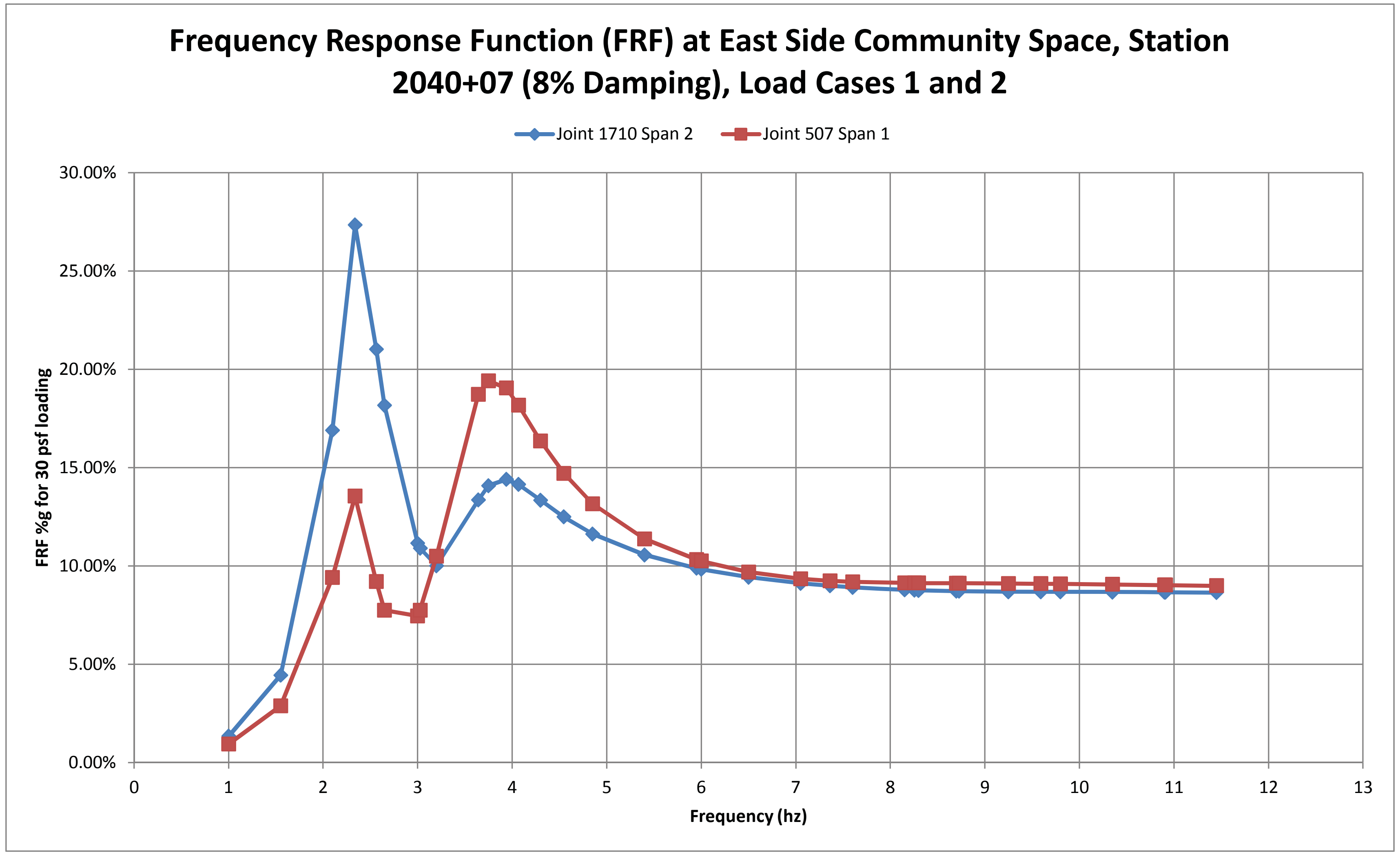
East Side Community Space Model

Load Case 2 (Span 2), 8% Damping FIB63

Peak Accel = 6.96% (%g)

TABLE: Joint Accelerations - Absolute

Joint	OutputCase	CaseType	StepType	StepNum	U1	U2	U3	R1	R2	R3	FRF	FRF(f_{step}) * α_1	
Text	Text	Text	Text	Unitless	ft/sec2	ft/sec2	ft/sec2	rad/sec2	rad/sec2	rad/sec2	%g	%g	
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	1	0.0117	0.0001143	0.4327	0.00008816	0.0001433	4.129E-07	1.34%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	1.55	0.0518	0.0011	1.4317	0.0007887	0.0003235	3.332E-06	4.45%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	2.1	0.3657	0.0113	5.4446	0.006833	0.001233	2.531E-05	16.91%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	2.339338	0.9168	0.0288	8.8079	0.016	0.00523	0.0000553	27.35%	6.84%	1st harmonic
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	2.563556	0.8874	0.035	6.7688	0.017	0.007413	5.328E-05	21.02%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	2.65	0.7133	0.0364	5.8522	0.017	0.007691	4.966E-05	18.17%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	3	0.2497	0.0403	3.5966	0.016	0.011	4.291E-05	11.17%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	3.025665	0.2342	0.0401	3.5125	0.015	0.012	4.254E-05	10.91%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	3.2	0.1592	0.0369	3.223	0.013	0.015	4.372E-05	10.01%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	3.643078	0.0664	0.0365	4.3016	0.012	0.024	0.0001223	13.36%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	3.75	0.0529	0.0354	4.5358	0.013	0.025	0.0001544	14.09%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	3.938796	0.0375	0.031	4.6391	0.014	0.025	0.0002012	14.41%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	4.067163	0.0324	0.0279	4.5561	0.014	0.024	0.0002194	14.15%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	4.3	0.0294	0.0235	4.2984	0.014	0.022	0.0002295	13.35%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	4.54469	0.0295	0.0193	4.0242	0.012	0.021	0.0002288	12.50%	0.62%	2nd harmonic
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	4.85	0.0306	0.0142	3.7452	0.011	0.02	0.0002285	11.63%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	5.4	0.0334	0.0083	3.4002	0.007833	0.02	0.0002365	10.56%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	5.95	0.0366	0.0063	3.1824	0.006358	0.021	0.0002547	9.88%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	6	0.0369	0.0062	3.1668	0.006282	0.021	0.0002567	9.83%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	6.5	0.04	0.0056	3.0372	0.005952	0.023	0.0002799	9.43%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	7.05	0.0434	0.0053	2.9376	0.006318	0.024	0.0003083	9.12%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	7.36343	0.0451	0.0051	2.8961	0.006761	0.025	0.0003242	8.99%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	7.6	0.0462	0.005	2.8709	0.007176	0.026	0.0003356	8.92%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	8.15	0.0481	0.0046	2.8299	0.008324	0.028	0.0003579	8.79%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	8.254768	0.0483	0.0045	2.8245	0.008565	0.028	0.0003614	8.77%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	8.298146	0.0484	0.0045	2.8225	0.008666	0.028	0.0003628	8.77%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	8.7	0.0487	0.0041	2.8084	0.009643	0.029	0.0003733	8.72%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	8.728736	0.0487	0.0041	2.8077	0.009715	0.029	0.000374	8.72%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	9.25	0.0482	0.0035	2.7993	0.011	0.029	0.0003819	8.69%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	9.591073	0.0474	0.0032	2.7968	0.012	0.029	0.0003841	8.69%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	9.8	0.0469	0.003	2.7959	0.013	0.029	0.0003846	8.68%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	10.35	0.0451	0.0024	2.7939	0.014	0.029	0.0003829	8.68%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	10.9	0.0432	0.0018	2.7908	0.015	0.029	0.0003785	8.67%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	10.910536	0.0432	0.0018	2.7907	0.015	0.029	0.0003784	8.67%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	11.45	0.0414	0.0013	2.7853	0.017	0.028	0.0003727	8.65%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	11.844043	0.0401	0.0009755	2.7796	0.018	0.028	0.0003682	8.63%		
1710	Span2_SteadyState-8%	LinSteady	Mag at Freq	12	0.0396	0.0008738	2.7769	0.018	0.028	0.0003665	8.62%		


Frequency Response Function (FRF) at East Side Community Space, Station 2040+07 (8% Damping), Load Cases 1 and 2
Joint 1710 Span 2
Joint 507 Span 1
FRF %g for 30 psf loading
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Frequency (hz)

SECTION 2.2.16

ATC 41.1 | REDUCED PORTAL ARCHITECTURAL REQUIREMENTS

Central 70

DATE: March 28, 2017

TO: 5280 Connectors

FROM: Anthony DeVito P.E. Central 70 Project Director
Nicholas Farber, Central 70 Project

SUBJECT: Central 70 - Detailed Alternative Technical Concept (ATC) Response
5280 Connectors - ATC No. 41.1

Dear Mr. Clark:

Your Team's ATC Submission Form for Detailed ATC 41.1 has been reviewed by the Procuring Authorities.

Detailed ATC 41.1 proposes to make minor change to the finish grading shown in the I-70 Cover Plans document found in Schedule 10B.

In accordance with the Instructions to Proposers ("ITP"), the Procuring Authorities will use reasonable efforts to provide a Proposer with the following written feedback on a ATC Submission within 15 Working Days following the later of (x) the date the relevant ATC Submission was submitted and (y) the One-on-One Meeting at which such submission is discussed. Below is the final response from the Procuring Authorities for your Detailed ATC:

☒ 1. unconditional approval;

☐ 2. conditional approval, subject to modifications and/or conditions;

☐ Re-submission required ☐ Re-submission not required

☐ 3. disapproval, with or without guidance that such ATC can be re-submitted under any circumstance;

☐ 4. notification that the incorporation of the proposed ATC in the Proposer's Proposal is already permitted under the terms of the RFP, and therefore does not qualify as an ATC (and will not be treated as such for purposes of Section 3.4 of Part C of the ITP).

☐ 5. subject to compliance with the confidentiality requirements set out in Section 3.4 of Part C of the ITP, the Procuring Authorities are considering amending (for the benefit of all Proposers) the terms of the RFP that are the subject-matter of the proposed ATC.

The ATC is unconditionally approved.

The approval of this Detailed ATC by the Procuring Authorities does not constitute an approval of specific drafting modifications to the RFP necessary to incorporate this ATC into the Project Agreement pursuant to Section 7.2.1.c of Part C of the ITP, which modifications shall be agreed by the Procuring Authorities and the Proposer (each acting reasonably) following issuance of a Notice of Award to such Proposer.

ANNEX 3: ALTERNATIVE TECHNICAL CONCEPT SUBMISSION FORM

Proposer Name: 5280 Connectors
Date: March 10, 2017

Central 70 Project RFP: ATC Submission No. 41.1

A. Background Information

1. Type of Submission

☐ Conceptual ATC

☒ Detailed ATC

2. Prior Submission(s)

☐ None (initial submission of ATC)

☒ Previously Submitted as Conceptual ATC

☐ Previously Submitted as Detailed ATC

3. Explanation of Reason for Resubmission

Resubmission for clarity and limited request information related to Cover Extension surface grading and vertical step dimensions.

4. Request for Discussion at One-on-One Meeting

☒ Meeting Requested

☐ Meeting Not Requested

B. General ATC Submission Requirements

1. Overview Description

This information has been amended since the submission of the previous version of this ATC.

The Contract Drawings Document: I-70 Cover Plans (#10B.10.14.01) architectural sections at the Columbine and Clayton St. Portal Entrances (Cover Extensions) reference Structure Plans No. 29.10.13.01 for the superstructure step depth dimensions. Meeting the finished grades shown in the I-70 Cover Plans with an alternative superstructure type to satisfy the required design criteria is challenging without requiring lowering the I-70 roadway profile.

5280 Connectors propose minor changes in the design of the I-70 Cover Plans Doc# 10B.10.14.01 Portal Entrance finish grading. The purpose of the changes is to meet the intent of the I-70 Cover Plans while providing some relief in minimizing the lowering of the I-70 roadway profile below. The following are the proposed changes:

1) Columbine Street Cover Extension, South:
   a. The vertical step in the Cover Portal structure is 2'-7" larger (4'-5" vs. 1'-10") than shown in the Cover Plans. This results in higher surface finished grade (1'-0" higher within the westernmost 35' of the Cover Extension) than shown in the Cover Plans.
2) Clayton Street Cover Extension, North:
   a. The vertical step in the Cover Portal structure is 0'-6" larger (4'-0" vs. 3'-6") than shown in the Cover Plans. This results in higher surface finished grade (6" higher within the easternmost 35' of the Cover Extension) than shown in the Cover Plans.

2. Relevant RFP Requirements

This information has been amended since the submission of the previous version of this ATC.

The Project Agreement Schedule 10, Section 14.2 Applicable Standards and Drawings lists:

c. I-70 Cover Plans included in Schedule 10B Contract Drawings

Specific relevant RFP requirements from this list of standards and drawings include items shown in the I-70 Cover Plans included in the Schedule 10B Contract Drawings.

3. Rationale

This information has been amended since the submission of the previous version of this ATC.

The rationale behind raising the finished grading and changing the height of the steps in the structure at the Cover extensions is to provide a design that satisfies the structural loading requirements, accommodates the jet fans for fire and life safety and an equivalent design to the I-70 Cover Plans Doc #10B.10.14.01. This minimizes the excavation for the I-70 roadway by accommodating a deeper girder size and minimizing the lowering of the roadway profile and groundwater impact.

4. Impacts

This information has been amended since the submission of the previous version of this ATC.

There are minor impacts to the topography on the top of Cover at the Cover extensions. However, the intent of the Cover Plans remains intact, with no change in functionality, and minor changes in appearance. The change in the height of the steps in the structure would not be noticeable to users.

5. Cost and Benefit Analysis

This information has been amended since the submission of the previous version of this ATC.

The cost benefit is estimated at up to $25.0 Million dollars due to reduced excavation volumes, wall square footage and structure type change, and groundwater treatment vs. an alternative Portal Superstructure design to accommodate the I-70 Cover Plans Architectural requirements. It is estimated that accommodating the finished ground contour elevations at the Cover extensions as shown in the Contract Drawings would increase the I-70 excavation depth by as much as 1.0 feet for a length of 1,200 feet.

6. Schedule Analysis

This information has not been amended since the submission of the previous version of this ATC.

Schedule benefit is estimated at 6-9 months and is driven by increased schedule for alternative Cast-in-place Cover Superstructure alternative along with increased excavation and wall construction.

7. Conceptual Drawings

This information has been amended since the submission of the previous version of this ATC.

Columbine and Clayton Street Cover Extension typical sections are provided.

8. Past Use

This information has been amended since the submission of the previous version of this ATC.

n/a

9. Additional Information

This information has not been amended since the submission of the previous version of this ATC.

n/a

C. <u>Detailed ATC Submission Requirements</u>

1. Risks

There are no additional risks to the Procuring Authorities, CDOT, the State or third parties associated with implementation of this ATC.

2. Handback

There are no changes in handback procedures and/or Handback Requirements associated with this ATC.

3. Right-of-Way

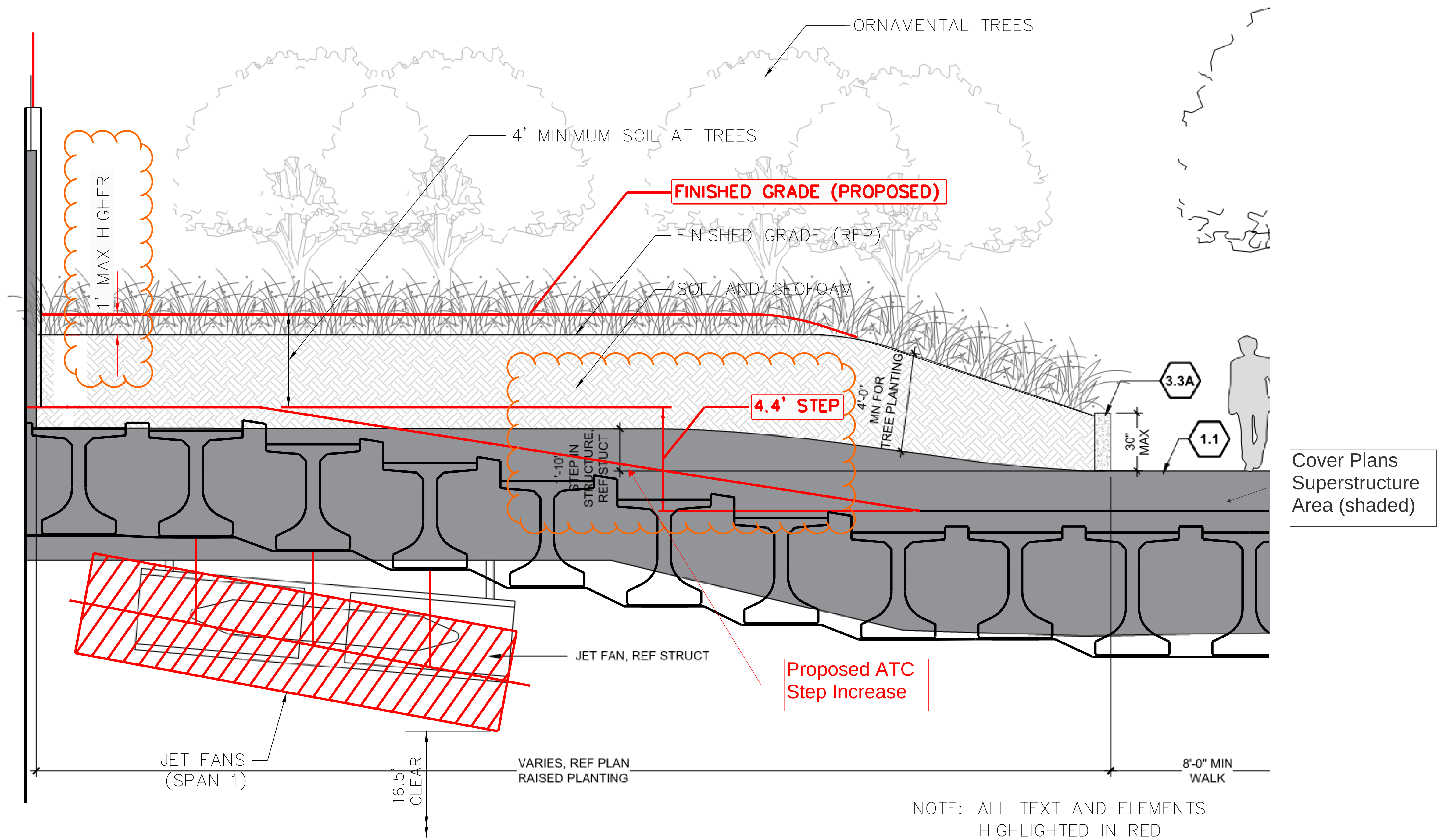
No additional right-of-way is required to implement this ATC.

4. List of Required Approvals

The proposed minor changes in Contour grading are not considered to require third party, Governmental Approvals or Design Exceptions required by this ATC.

5. Proposed Drafting Revisions

Revisions to the I-70 Cover Plan Contract Drawings 10B.10.14.01 are required for the Columbine and Clayton St. Cover Extenuations for the vertical dimension step at the Portal ends as shown in ATC 41.1 Exhibits.



NOTE: ALL TEXT AND ELEMENTS HIGHLIGHTED IN RED ARE PROPOSED CHANGES TO THE CONTRACT DRAWINGS.

2 COLUMBINE STREET COVER EXTENSION, SOUTH

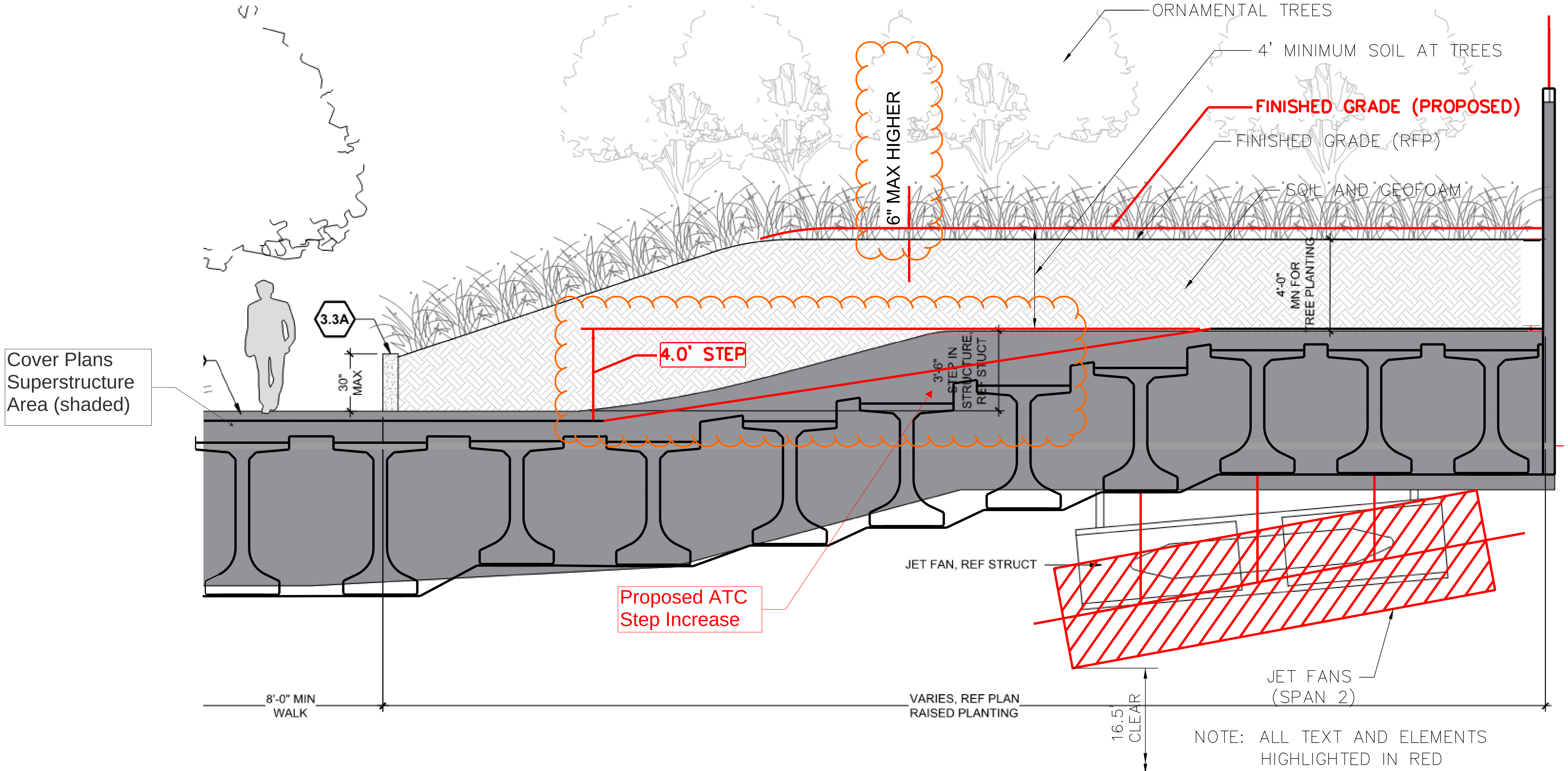
MSCHWAB 10:52:11 AM pw:\\PWAPPOMA001:NorthCentral_Omaha\Documents\Colorado_Dept_of_Transportation_R1\CDOT_I_70_E_LID_D_B\6.0_CAD_BIM\6.2_Work_In_Progress\6.2.21 ATCs\03 Detailed ATC\Detailed ATC 41 Cover - Portal Contours\ATC_41.

Print Date: 3/10/2017
File Name: ATC_41.1_ColumbineACAD Sheet 1 of 2
Vert. Scale: As Noted

5280 Connectors Linking I-70 Communities
HDR
Colorado Department of Transportation
Region 1
COLORADO HPTE

I-70 EAST ATC 41.1
Cover Plan Exhibit

Designer:		Structure Numbers	
Detailer:			
Sheet Subset:		Subset Sheets:	1 of 2



3 CLAYTON STREET COVER EXTENSION, NORTH

NOTE: ALL TEXT AND ELEMENTS HIGHLIGHTED IN RED ARE PROPOSED CHANGES TO THE CONTRACT DRAWINGS.

Print Date: 3/10/2017
File Name: ATC_41.1_ClaytonACAD Sheet 2 of 2
Vert. Scale: As Noted

5280 Connectors Linking I-70 Communities

Colorado Department of Transportation
Region 1

COLORADO HPTE

I-70 EAST ATC 41.1
Cover Plan Exhibit

Designer:		Structure Numbers	
Detailer:			
Sheet Subset:		Subset Sheets:	2 of 2

SECTION 2.2.17

ATC 42.0 | T-WALL BACKFILL

Central 70

DATE: April 14, 2017

TO: 5280 Connectors

FROM: Anthony DeVito, P.E. Central 70 Project Director
Keith Stefanik, P.E. Central 70 Deputy Director of Project Delivery

SUBJECT: Central 70 - Detailed Alternative Technical Concept (ATC) Response
5280 Connectors - ATC No. 42.0

Dear Mr. Clark:

Your Team's ATC Submission Form for Detailed ATC 42.0 was reviewed by the Procuring Authorities prior to the April One-on-One Meetings and an initial response was sent to you on April 7, 2017. As discussed during the April One-on-One Meeting, the Procuring Authorities committed to provide a final response to your Detailed ATC.

Detailed ATC 42.0 proposes the use of the Neel Company Precast T-Wall System and its own select backfill requirements and installation specifications.

In accordance with the Instructions to Proposers ("ITP"), the Procuring Authorities will use reasonable efforts to provide a Proposer with the following written feedback on a ATC Submission within 15 Working Days following the later of (x) the date the relevant ATC Submission was submitted and (y) the One-on-One Meeting at which such submission is discussed. Below is the final response from the Procuring Authorities for your Detailed ATC:

☐ 1. unconditional approval;

☒ 2. conditional approval, subject to modifications and/or conditions;

☐ Re-submission required ☒ Re-submission not required

☐ 3. disapproval, with or without guidance that such ATC can be re-submitted under any circumstance;

☐ 4. notification that the incorporation of the proposed ATC in the Proposer's Proposal is already permitted under the terms of the RFP, and therefore does not qualify as an ATC (and will not be treated as such for purposes of Section 3.4 of Part C of the ITP).

☐ 5. subject to compliance with the confidentiality requirements set out in Section 3.4 of Part C of the ITP, the Procuring Authorities are considering amending (for the benefit of all Proposers) the terms of the RFP that are the subject-matter of the proposed ATC.

Following our discussions at the One-on-One Meeting, the Procuring Authorities have not changed their initial response to your above mentioned Detailed ATC Submission. The ATC is approved with the following conditions:

Conditions of approval:

1. The project specific material specifications for the use of T-Walls shall be submitted to the Department for Approval.

The approval of this Detailed ATC by the Procuring Authorities does not constitute an approval of specific drafting modifications to the RFP necessary to incorporate this ATC into the Project Agreement pursuant to Section 7.2.1.c of Part C of the ITP, which modifications shall be agreed by the Procuring Authorities and the Proposer (each acting reasonably) following issuance of a Notice of Award to such Proposer.

ANNEX 3: ALTERNATIVE TECHNICAL CONCEPT SUBMISSION FORM

Proposer Name: 5280 Connectors
Date: March 23, 2017

Central 70 Project RFP: ATC Submission No. 42.0

A. Background Information

1. Type of Submission

☐ Conceptual ATC

☒ Detailed ATC

2. Prior Submission(s)

☒ None (initial submission of ATC)

☐ Previously Submitted as Conceptual ATC

☐ Previously Submitted as Detailed ATC

3. Explanation of Reason for Resubmission

n/a

4. Request for Discussion at One-on-One Meeting

☒ Meeting Requested

☐ Meeting Not Requested

B. General ATC Submission Requirements

1. Overview Description

5280 Connectors proposes the use of the Neel Company Precast T-Wall System with its own select backfill requirements and installation specifications. Neel Company T-Wall is a proprietary design, and more versatile in their backfill requirement, accommodating more on-site material, reducing the amount of waste excavation leaving the project.

2. Relevant RFP Requirements

No proposed changes to the Project Agreement. All changes are associated with the following CDOT standard specifications:

Current Specifications

703.08 Structure Backfill Material
(a) Class I Structure Backfill Gradation

Sieve Size	*% Passing*
2 inch	*100*
No. 4	*30-100*
No. 50	*10-60*
No. 200	*5-20*

Proposed Changes for T-Walls

Granular Backfill Gradation

Sieve Size	*% Passing*
3 inch	*100*
¾ inch	*20-100*
No. 200	*0-25*

Current lift thickness specification
Backfill shall consist of approved materials uniformly distributed in layers brought up equally on all sides of the structure. Each layer of backfill shall not exceed 6 inches before compacting to the required density and before successive layers are placed….

Proposed lift thickness change
The backfill lift should be uniform in thickness, not to exceed 12 inches and compacted within the limits shown on the plans and as approved by The Neel Company.

CDOT Section 504.06 thru 504.27
*These specifications are for Mechanically Stabilized Earth (MSE) Retaining Walls which we believe are **not relevant** in the construction of T-Walls due to its proprietary wall design. However a similar set of project specifications must be created for use of the T-Walls and submitted for approval. These specifications are also attached and incorporate the T-Wall Construction Manual by reference and can be provided if requested by the Authority. Additionally, full construction standard details similar to those referenced via the link to the Pennsylvania Dept. of Transportation can be provided if requested*.

3. Rationale

The use of the Neel Company T-Wall product will give CDOT the following benefits:

- *Reduction in the amount of wall excavation for the "typical" MSE straps, hence reducing the amount of material hauled off the project.*
- *Will allow increased quantities of "contaminated" material to remain on site*
- *Will reduce the amount of temporary support of excavation for MOT by using the "inverted" T-Wall design*

MSE Walls and CDOT gravity walls require Class1 Structural Backfill which is currently in excess of 400,000 CY. 5280 Connectors would have to purchase this material, and incur additional cost to haul off the wall excavation.

4. Impacts

Reuse of project materials is considered Resource Allocation, which is a positive impact for environmental, economic, traffic and safety. Using as much of the on-site excavation as possible saves on hauling it to a landfill, dump fees, energy to create and haul Class 1 to the project. Additionally, significantly fewer trucks hauling in and out of the project lessens traffic issues and creates a safer project.

5. Cost and Benefit Analysis

Revising the specification results in an estimated $7.48M in savings to the project.

6. Schedule Analysis

There are no recognizable schedule savings in using T-Walls when compared to MSE Walls.

7. Conceptual Drawings

See attached:

- *Comparison of Select Backfill…….CDOT vs. Proposed T-Wall standard specifications*
- *Typical 20 foot high inverted T-Wall Section*
- *T-Wall Special Provisions – March 2017*
- *Completed project pictures*

8. Past Use

T-Walls have been successfully used and are included on approved wall lists for:

- Pennsylvania DOT and are an approve product for use; visit;
  http://www.dot.state.pa.us/public/Bureaus/BOPD/Bridge/NewProducts/drawings/NP60.pdf

- New York DOT, detailed as Fill Type Retaining Wall, Prefabricated System, “Open Top Face”
  https://www.dot.ny.gov/divisions/engineering/technical-services/technical-services-repository/alme/pages/modwall-1.html

- Florida DOT
  http://www2.dot.state.fl.us/specificationsestimates/productevaluation/qpl/QPLItems.aspx?QPLTitle=Specification%20548%20Retaining%20Wall%20Systems&QPLDesc=Retaining%20Wall%20System&QPLNum=S548

- Illinois DOT
  http://www.idot.illinois.gov/Assets/uploads/files/Doing-Business/Specialty-Lists/Highways/Bridges/PMR%20Wall%20System%20QPL%20Package.pdf

9. Additional Information

N/A

C. Detailed ATC Submission Requirements

1. **Risks**

   There are no additional risks to the Procuring Authorities, CDOT, the State or third parties associated with implementation of this ATC

2. **Handback**

   There are no changes in handback procedures and/or Handback Requirements associated with this ATC

3. **Right-of-Way**

   No additional right-of-way is required to implement this ATC

4. **List of Required Approvals**

   There are no third party, Governmental Approvals or Design Exceptions required by this ATC

5. **Proposed Drafting Revisions**

   There are no revisions to the project specific document, only the referenced CDOT standard specifications

Comparison of Select Backfill
CDOT MSE Specifications vs. T-WALL Standard Specifications

CDOT (Revision of Section 504, February 3, 2011)

CDOT Class 1 Structure Backfill gradation:

Sieve Size	% Passing
2 inch	**100**
No. 4	30-100
No. 50	10-60
No. 200	***5-20***

504.08 Backfill. Unless otherwise specified on the plans, wall backfill material in the reinforced structure backfill zone and the associated trapezoidal retained structure backfill zone shall conform to the requirements for **Structure Backfill (Class 1) of Section 206**. For reinforcement tensile stress and associated pullout, a friction angle of 34 degrees shall be assumed for Structure Backfill (Class 1). ***Structure Backfill (Class 1) shall be considered to be non-aggressive soil for corrosion and durability computations.*** All reinforcing elements shall be designed to ensure a minimum design life of 75 years for permanent structures.

504.19 Excavation and Backfill. The reinforced structure backfill zone and the retained structure backfill zone portion immediately behind the wall as defined on the plans shall be Structure Backfill (Class 1). ***Recycled asphalt, recycled concrete and flow-fill material shall not be substituted for Structure Backfill (Class 1).***

Per Section 206:
Each layer of backfill ***shall not exceed 6 inches*** before compacting to the required density and before successive layers are placed.

T-WALL® Retaining Wall System Standard Specifications

SELECT BACKFILL BETWEEN STEMS:
Shall be one or more of the following materials:

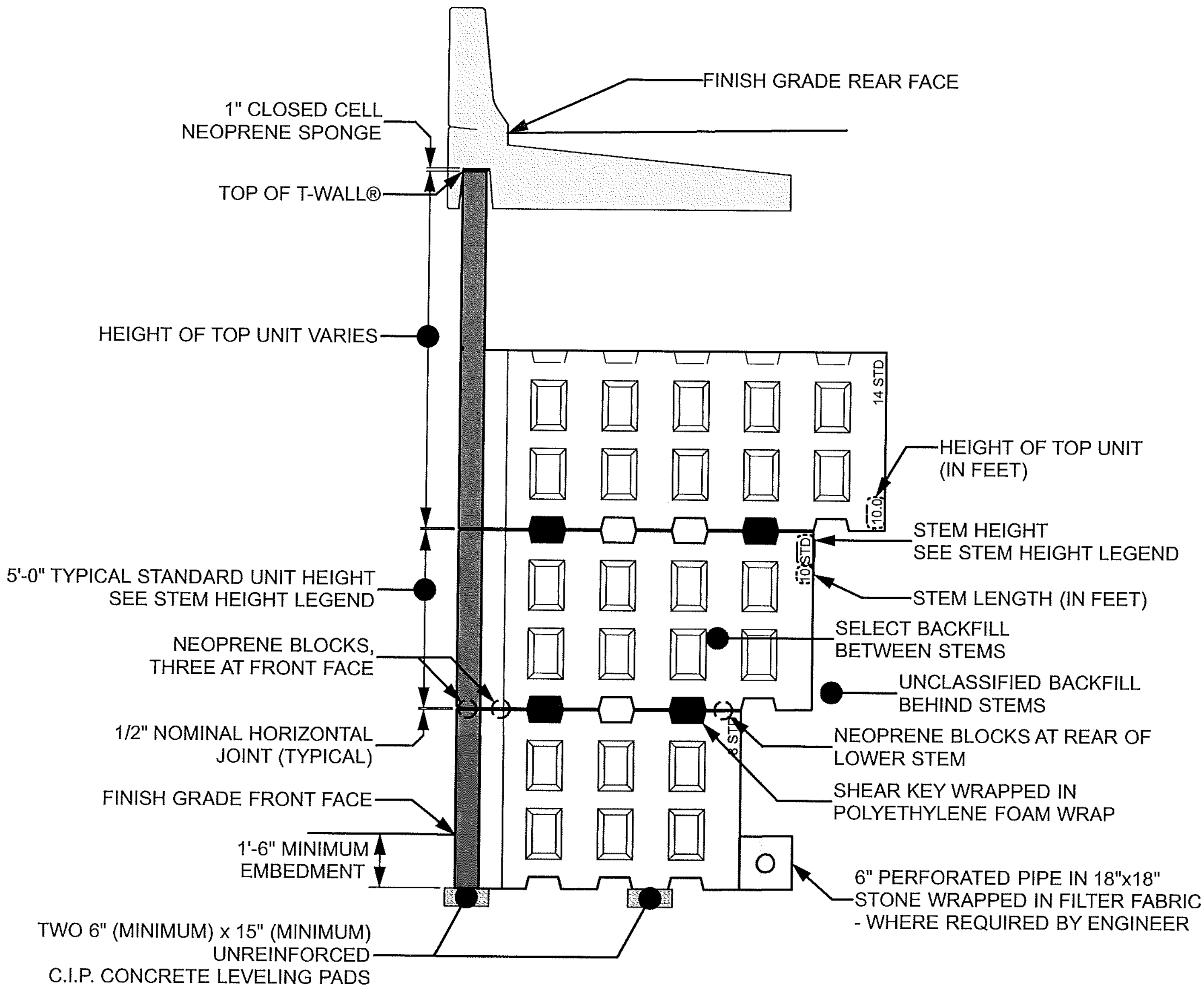
- Crushed or Natural Stone
- Crushed or Uncrushed Gravel
- Crushed Limestone
- Crushed Sandstone
- Coarse Aggregate
- **Recycled Concrete**
- **Slag**
- Angle of Internal Friction – 34°
- Density – 100 pcf to 120 pcf
- **25% Maximum Passing #200 Sieve**
- **100% Passing 3" Sieve**
- 95% Standard Compaction (ASTM D698)

Note: Backfill materials from native soil over 15% passing thru No. 200 sieve can be used if positive drainage behind the wall is provided. Both the backfill material and the drainage must be approved by The Neel Company on a project specific basis.

Per Section 4.9
The backfill lift should be uniform in thickness, ***not to exceed 12 inches*** and compacted within the limits shown on the Plans.

THE NEEL COMPANY
8328-D TRAFORD LANE • SPRINGFIELD, VA 22152
PH: (703) 913-7858 • FX: (703) 913-7859 • WEB: www.neelco.com

TNC PROJECT NO: TW4672



MAX. BEARING PRESSURE

STRENGTH I : 5500 psf
SERVICE : 3500 psf

STEM HEIGHT LEGEND

- STANDARD UNITS:
  - **STD** = 5'-0" STEM HEIGHT
  - **TQR** = 3'-9" STEM HEIGHT
  - **HLF** = 2'-6" STEM HEIGHT

PRELIMINARY
NOT FOR CONSTRUCTION
16-Feb-17

TYPICAL 20FT HIGH INVERTED T-WALL SECTION
CENTRAL 70
DENVER, CO

T-WALL® RETAINING WALL SYSTEM

DATE:	16-Feb-17
DRAWN:	ACS
SHEET:	1

T-WALL® Retaining Wall System – 5.0' x 7.5' Units

1.0 Description

This work shall consist of the design, manufacture and construction of a T-WALL® structure in accordance with this specification and in close conformity with the lines, grades, design, and dimensions shown in the Contract Documents & Plans.

The Contractor shall make arrangements to acquire the T-WALL® design, precast reinforced concrete units, shear keys and joint materials from The Neel Company (TNC), 8328-D Traford Lane, Springfield, Virginia 22152, (703-913-7858).

2.0 Design

2.1. Primary Design References
AASHTO LRFD Bridge Design Specifications, 6th Edition.

2.2. Foundation Analysis
A geotechnical investigation, bearing capacity, settlement and the global stability analysis for the T-WALL design is included in the contract geotechnical report. The T-WALL design shall be in accordance with the soil and foundation parameters specified in the contract documents. A geotechnical report is on file and available for review.

2.3. Submittals

2.3.1. Contractor shall submit XX sets of the T-WALL stability calculations and the shop drawings sealed by a Professional Engineer licensed to practice in the State where the retaining wall is constructed.

2.3.2. The Rankine stability analysis for overturning, sliding and pullout shall be used for the T-WALL design.

2.3.3. Shop Drawings shall show details, dimensions and cross sections necessary to construct the wall including:

a. The retaining wall plan, layout and wall elevations
b. Typical wall sections
c. Types, locations and properties of all drainage materials, utilities, appurtenances and any special installation requirements as shown in the contract drawings
d. T-WALL unit-reinforcing diagrams and rebar schedules, special hardware requirements and dimensioning for custom cast pieces including but not limited to bevels, sloped tops, penetrations, and framing for culvert pipes.

3.0 Materials

3.1. Precast Concrete Units

The T-WALL units shall be manufactured in an NPCA, PCI or DOT certified precast concrete plant. A quality control plan shall be submitted by the precaster and approved prior to start of production.

The concrete mix design shall be Self-Consolidating Concrete (SCC) with a minimum compressive strength of 5,000 psi at 28 days. The mix design shall be submitted and approved by the Engineer prior to the manufacture of any units.

3.1.1. Testing and Inspection

Acceptability of the concrete for the precast units will be determined on the basis of compression tests, certifications and visual inspection. The concrete strength requirements for the precast units shall be considered satisfied regardless of curing age when compression test results indicate that the concrete strength will conform to 28-day specifications. The Supplier shall furnish facilities and perform all necessary sampling and testing in an expeditious and satisfactory manner.

3.1.2. Casting

The units shall be cast in steel forms with dimensional tolerances that will assure the production of uniform units.

3.1.3. Curing

The curing method shall be as submitted and approved in the quality control plan.

3.1.4. Removal of Forms

The units shall remain in place until they can be removed from the form without damage to the unit.

3.1.5. Marking of Precast Units:

Clearly and permanently mark each precast unit on the butt end of the stem with the unit type, the date of manufacture, the lot number if applicable, and the trademark "T-WALL®".

3.1.6. T-WALL® Unit Finish and Tolerances

- Steel Form Finish - Unit Tolerances - all dimensions shall be within ±1/4 inch.
- Architectural Form Liner Finish – shall be as called for on the Contract drawings.
- Front Face Tolerance - length and height of front face shall be within ±1/4 inch.
- Surface Finish - all honeycomb or open texture shall be properly repaired.

3.1.7. Rejection of Precast Components

Precast concrete wall components not meeting the quality standards of this Section and referenced Specifications will be repaired or rejected. In addition, any of the following defects may be sufficient cause for rejection if not satisfactorily repaired:

Defects that indicate unsatisfactory molding
Defects indicating honeycombed or open texture concrete
Defects in the physical characteristics

3.1.8. Handling, Storage and Shipping

All units shall be handled, stored, and shipped in such a manner as to avoid chipping, cracking, fracturing and excessive bending stresses.

3.1.9. Reinforcing Steel

Must meet the requirements of ASTM A 615 grade 60
Rebar finish shall comply with project specifications

The minimum concrete cover for the reinforcing steel shall be in accordance with the referenced specifications.

Primary Reinforcement	2 inches
Stirrups, ties	1-1/2 inches

Rebar cage fabrication by welding is not permitted and is cause for rejection

3.2. Joint Materials

a. Horizontal Joints

Rubber blocks with a minimum durometer of 60 placed as shown in the approved T-WALL drawings.

A 12-inch width of geotextile fabric such as Mirafi 1120N or approved equal shall be tacked on the back face to cover the horizontal joints.

b. Vertical Joints

A 12-inch width of geotextile fabric such as Mirafi 1120N or approved equal shall be placed against the back face and held in place by the backfill to cover the vertical joints.

c. Shear Keys

Precast shear keys shall be made of the same concrete mix as the T-WALL® units and cured in the same manner. The shear keys are to be wrapped with a closed cell polyethylene foam material (shear key wrap) to fit snugly into the T-WALL® stem keyways.

3.3. Select Granular Backfill

Backfill between the T-WALL® Units may be one of the following locally available materials and must be submitted and approved prior to installation:

- Crushed or Natural Stone
- Crushed or Uncrushed Gravel
- Crushed Limestone
- Crushed Sandstone
- Coarse Aggregate
- Recycled Concrete
- Slag

The general gradation requirement of the select backfill material is:

Sieve Size	Percent Passing
3 inch	100
3/4 inch	20-100
No. 200	0-25

General Design Parameters

Minimum Angle of Internal Friction 30°
Unit Weight (density) 120 pcf or as specified
Compaction - 95% of Standard Proctor ASTM D-698 (AASHTO T-99)

If the locally available material meets the gradation and angle of internal friction requirements stated above, but not the unit weight, the wall design may be modified to reflect the actual properties of the available material.

3.4. Unclassified Backfill

Minimum Angle of Internal Friction	30°
Unit Weight (density)	120 pcf or as specified
Compaction -	95% of Standard Proctor, ASTM D-698 (AASHTO T-99)

3.5. Leveling Pad Concrete

The leveling pad concrete shall have a nominal compressive strength of 2,500 psi at 28-days. Under normal circumstances the leveling pad strength is considered acceptable for placement of the T-WALL® units after 24 hours.

No rebar is required in the cast-in-place leveling pad.

4.0 Construction Requirements

In accordance with the ***T-WALL® Retaining Wall System Construction Manual.***

Excavation and backfill construction requirements in accordance with these specifications and *CDOT Specification 206.03.*

4.1. Examination

Verify locations of utilities and existing structures prior to excavation.

Examine the Project site and evaluate conditions where the T-WALL® retaining wall will be constructed. Notify the proper supervising authority in writing of any conditions that may interfere with the proper construction of the T-WALL® wall or delay completion.

Promptly notify the wall design engineer of site conditions, which may affect wall performance, soil conditions observed other than those assumed, or other conditions that may require a reevaluation of the wall design.

4.2. Excavation

Contractor shall excavate to the lines and grades shown on the construction drawings. The foundation for the T-WALL® structure shall be excavated and graded level for a width equal to or exceeding the length of the T-WALL® stem using the top of the leveling pad as the grade elevation or grade to the appropriate slope for a battered wall. The contractor shall be careful not to disturb base beyond the lines indicated and shall be responsible for slope stability and protection of the open excavation.

Over-excavated areas shall be filled with suitable base or backfill material as approved by the Engineer and compacted to 95% modified proctor.

4.3. Foundation Preparation

Foundation soil shall be evaluated by a Geotechnical Engineer retained by the contractor or Owner to ensure that the bearing soils meet or exceed the design conditions and assumptions in the geotechnical report and the approved T-WALL design.

Compact the graded area with an appropriate roller weighting a minimum of 8 tons by at least 3 passes or as otherwise directed by the Engineer. Remove and replace any soft or loose foundation soils to insure that there is adequate bearing capacity as directed by the Geotechnical Engineer or the Owner's engineer. The soil foundation shall be approved by the Owner or certified by the Engineer prior to installation of the T-WALL®.

4.4. Leveling Pads

At each unit foundation level, two concrete leveling pads shall be provided as shown on the Plans. Leveling pads shall be level within ±1/4 inch per 15 feet and shall not exceed a 1/4" overall over 100 feet. Leveling pads that do not meet this requirement shall be repaired or replaced as directed by the Engineer at no additional cost.

4.5. Wall Drainage

A wall drainage system shall be installed as required in the contract drawings.

Contractor shall verify that an overall site drainage analysis has been performed during design or prior to start of T-WALL construction to ensure that area runoff is controlled and directed away from the retaining wall.

Contractor shall be responsible for the stability of all excavated slopes and shall assure that surface runoff is diverted away from the wall during construction. The contractor is responsible for providing dewatering of excavated areas in order to maintain dry working conditions during construction of the wall.

4.6. Wall Erection

In accordance with the *T-WALL® Retaining Wall System Construction Manual,* tolerance and alignment shall be as follows:

1. Horizontal joint openings between panels shall be 1/2-inch ±3/8 inch.
2. Vertical joint openings between panels shall be 1/2-inch ±3/8 inch.
3. Vertical tolerance (plumbness) as the wall is constructed shall not exceed ±3/4 inch when measured with a 10-foot straight edge and shall not exceed 3/4" overall.
4. Horizontal alignment tolerance as the wall is constructed shall not exceed ± 3/4 inch when measured with a 15-foot straight edge and shall not exceed 3/4" overall.

4.7. Repairs

Repairs to the units in the field are possible only with a pre-approved repair procedure and prior permission of the Owner and The Neel Company.

4.8. Field Quality Control

If not provided by the Owner, the contractor shall employ the services of an independent engineering firm to monitor soil testing and perform daily quality assurance and inspection for wall construction and soils work. Contractor shall provide any quality control testing or inspection not provided by the Owner.

Field Quality Assurance shall include but not be limited to the foundation inspection prior to wall construction, frequent backfill compaction testing, verification of backfill soil parameters and compliance with approved T-WALL® Shop Drawings, T-WALL Construction Manual and Project Specifications.

Contractor shall be responsible for proper installation, inspection and quality control of all T-WALL® components and appurtenant materials.

4.9. Backfill Placement

Backfill placement shall closely follow the erection of each course of T-WALL® units. The backfill lift should be uniform in thickness, not to exceed 12 inches and compacted within the limits shown on the Plans. Each lift shall be compacted to at least 95% of maximum laboratory dry density in accordance with ASTM D-698. Placement and compaction of the backfill shall be accomplished without displacement of the T-WALL® units.

Conduct sampling and testing for both select and unclassified backfill in accordance with the project QA/QC plan.

4.10. Cleaning

After completion of wall installation, remove construction debris and restore any adjacent finished areas affected by wall construction to their pre-construction state.

Wash the wall face to remove soiling and stains. Do not use acid or detergents that may "burn" or discolor face.

4.10. Staining, Sealing or Coatings

If otherwise specified or noted in the contract drawings, field apply stain , sealer or coatings within the limits shown in the contract drawings and in accordance with manufacturers recommended procedures.

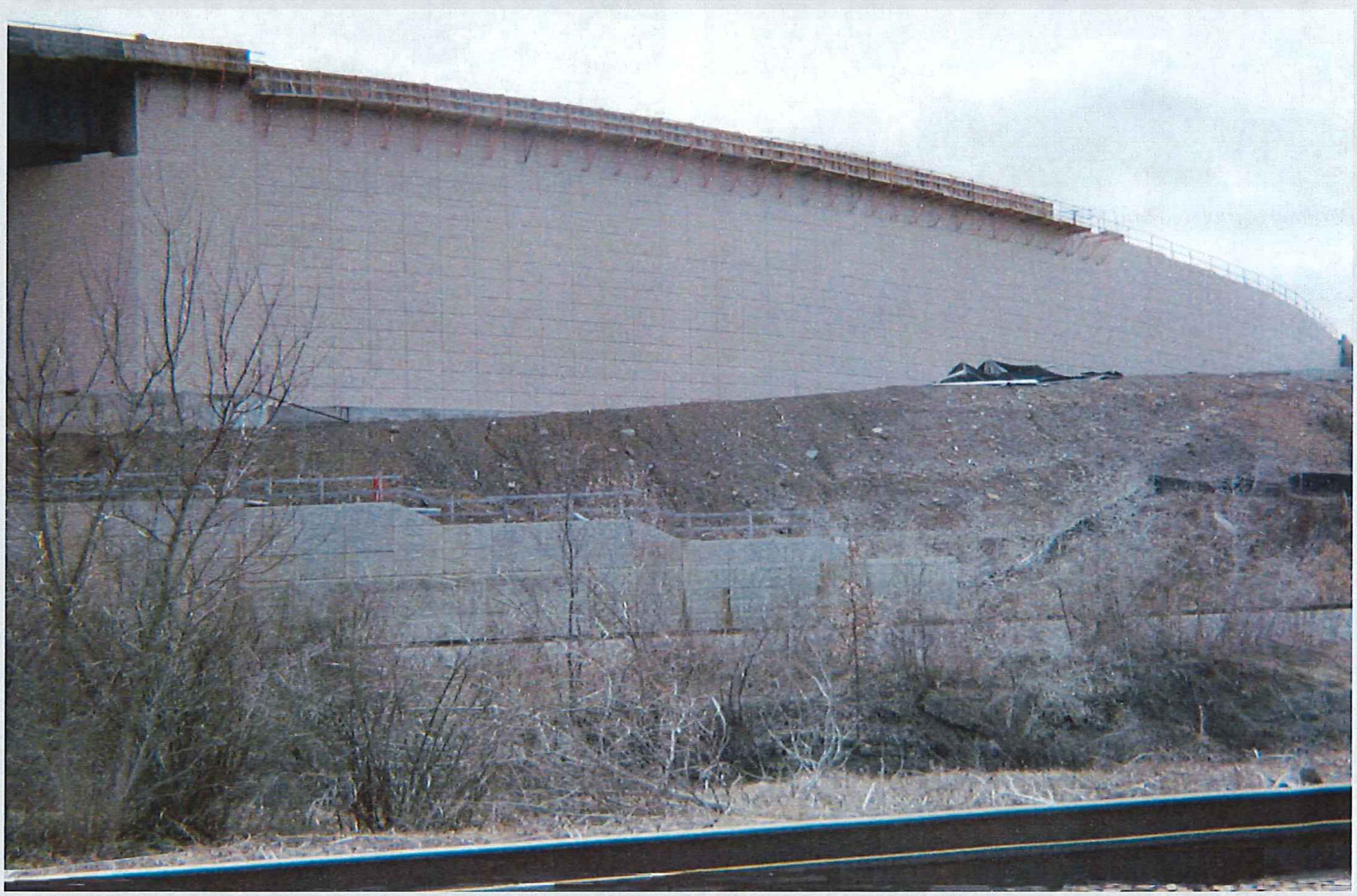
END OF SECTION

T-WALL®
THE NEEL COMPANY

MAIN ST. BRIDGE REPLACEMENT & CRASH WALL
BUTLER, PA

The **T-WALL® Retaining Wall System** was approved as an alternate for a 42' high bridge approach and buttress railroad crash wall. **T-WALL®** reduced the 'as-designed' excavation for this project by over 40% - eliminating the need for temporary shoring and lane closures. The railroad crash wall was first constructed with **T-WALL®** and then a CIP face was applied to the front.

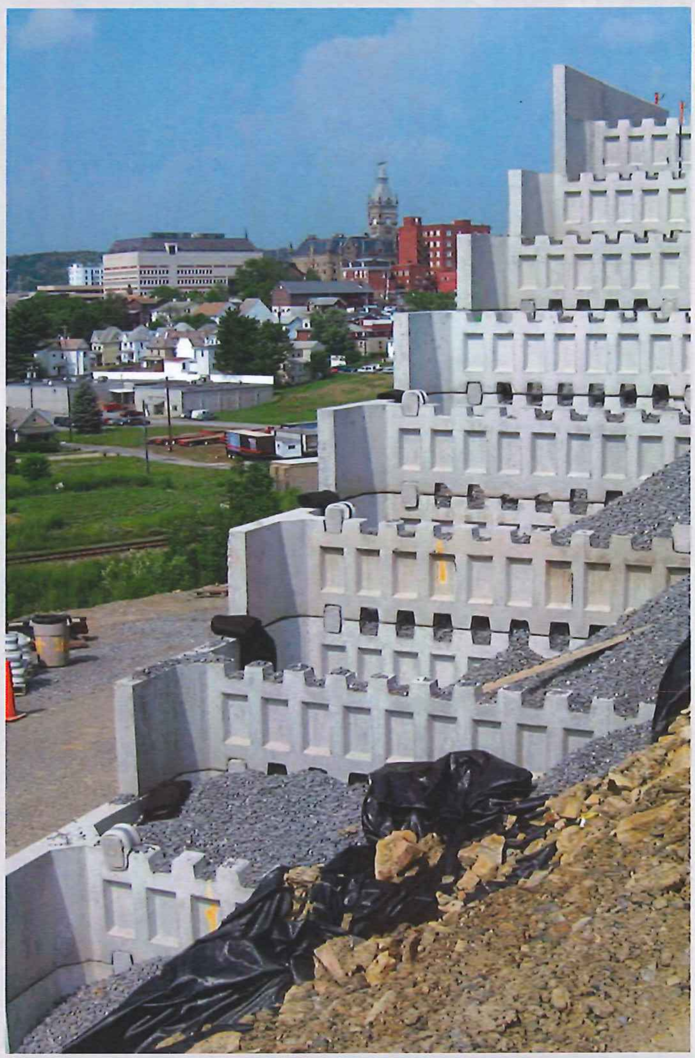
Completed walls (left & below)



T-WALL® *units being lowered into place*

Crash wall and partially completed bridge approach

Partially completed bridge approach



Partially completed bridge approach

Partially completed bridge approach

SECTION 2.2.18

ATC 44.0 | TUNNEL FIBER GLASS CONDUIT

Central 70

DATE: April 14, 2017

TO: 5280 Connectors

FROM: Anthony DeVito, P.E. Central 70 Project Director
Keith Stefanik, P.E. Central 70 Deputy Director of Project Delivery

SUBJECT: Central 70 - Detailed Alternative Technical Concept (ATC) Response
5280 Connectors - ATC No. 44.0

Dear Mr. Clark:

Your Team's ATC Submission Form for Detailed ATC 44.0 was reviewed by the Procuring Authorities prior to the April One-on-One Meetings and an initial response was sent to you on April 7, 2017. As discussed during the April One-on-One Meeting, the Procuring Authorities committed to provide a final response to your Detailed ATC.

Detailed ATC 44.0 proposes to use phenolic fiberglass conduit in place of stainless steel conduit inside the bores of the Cover for all exposed conduits.

In accordance with the Instructions to Proposers ("ITP"), the Procuring Authorities will use reasonable efforts to provide a Proposer with the following written feedback on a ATC Submission within 15 Working Days following the later of (x) the date the relevant ATC Submission was submitted and (y) the One-on-One Meeting at which such submission is discussed. Below is the final response from the Procuring Authorities for your Detailed ATC:

☒ 1. unconditional approval;

☐ 2. conditional approval, subject to modifications and/or conditions;

☐ Re-submission required ☐ Re-submission not required

☐ 3. disapproval, with or without guidance that such ATC can be re-submitted under any circumstance;

☐ 4. notification that the incorporation of the proposed ATC in the Proposer's Proposal is already permitted under the terms of the RFP, and therefore does not qualify as an ATC (and will not be treated as such for purposes of Section 3.4 of Part C of the ITP).

☐ 5. subject to compliance with the confidentiality requirements set out in Section 3.4 of Part C of the ITP, the Procuring Authorities are considering amending (for the benefit of all Proposers) the terms of the RFP that are the subject-matter of the proposed ATC.

Following our discussions at the One-on-One Meeting, the Procuring Authorities <u>have not</u> changed their initial response to your above mentioned Detailed ATC Submission. The ATC is unconditionally approved.

The approval of this Detailed ATC by the Procuring Authorities does not constitute an approval of specific drafting modifications to the RFP necessary to incorporate this ATC into the Project Agreement pursuant to Section 7.2.1.c of Part C of the ITP, which modifications shall be agreed by the Procuring Authorities and the Proposer (each acting reasonably) following issuance of a Notice of Award to such Proposer.

ANNEX 3: ALTERNATIVE TECHNICAL CONCEPT SUBMISSION FORM

Proposer Name: 5280 Connectors
Date: March 27, 2017

Central 70 Project RFP: ATC Submission No. 44.0

A. Background Information

1. Type of Submission

☐ Conceptual ATC

☒ Detailed ATC

2. Prior Submission(s)

☒ None (initial submission of ATC)

☐ Previously Submitted as Conceptual ATC

☐ Previously Submitted as Detailed ATC

3. Explanation of Reason for Resubmission

n/a

4. Request for Discussion at One-on-One Meeting

☒ Meeting Requested

☐ Meeting Not Requested

B. General ATC Submission Requirements

1. Overview Description

5280 Connectors proposes the alternative to use surface-mounted phenolic fiberglass conduit in place of stainless steel conduit inside the bores of the Cover for all exposed conduits.

2. Relevant RFP Requirements

The Project Agreement Schedule 10, Section 12.3.2 states that: *"All cable Management systems (CMS) i.e. trunking, trays, conduit, brackets, enclosures etc. for equipment and ancillary items inside the bores of the Cover (including on the Portals and on the cross bore escape doors) shall be manufactured from grade 316L stainless steel.*

NFPA502-12.1.2: "Emergency circuits installed in a road tunnel and ancillary areas shall remain functional for a period of not less than 1 hour, for the anticipated fire condition, by one of the following methods:

(1) Fire-resistive cables shall be certified or listed as having been tested in a totally enclosed furnace using the ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, time-temperature curve and which demonstrate functionality for no less than 2 hours as described in the ANSI/UL 2196, *Standard for Tests for Fire Resistive Cables*, test standards and as follows:
   a. Fire-resistive cables are tested as a complete system of conductors, cables, and raceways as applicable, using a sample no shorter than 3.0m (9.84ft).
   b. Fire-resistive cables intended for installation in a raceway are tested in the type of raceway in which they are intended to be installed.
   c. Each fire-resistive cable system has installation instructions that outline the test procedure, and only the components stated in the test report are acceptable for actual installations.

(2) Using circuits embedded in concrete that are protected by a 2-hour fire barrier system in accordance with UL 1724, *Outline of Investigation for Fire Tests for Electrical Circuit Protective Systems* (The insulation for cables or conductors shall be thermoset and shall be suitable to maintain functionality at the temperature within the embedded conduit or fire barrier system.)

(3) By the routing of the cable system external to the roadway

(4) Using diversity in system routing as approved, such as separate redundant or multiple circuits separated by a 1-hour fire barrier, so that a single fire or emergency event will not lead to a failure of the system."

3. Rationale

According to section 12.3.2 all Cable Management System (CMS) inside the bores should be 316 stainless steel. The design of the I-70 Cover shall be carried out in compliance with the 2014 edition of NFPA 502, Standard for Road Tunnels, and Other Limited Access Highways.

Due to economic considerations and constructability constraints within the Cover, the most readily constructible means to comply with NFPA 502 Section 12.1.2 for emergency circuits is to provide a complete system of fire resistive conductors, cables and raceways that follow Method 1 outlined above, in compliance with ANSI/UL 2196 test standards and procedures.

In recent years, Phenolic Fiberglass Conduit has been used widely throughout the US in both road and rail tunnel applications as a durable, cost-effective, corrosion resistant and fire-rated alternative to metallic conduit. Phenolic Fiberglass is also a Low-Smoke, Zero-Halogen (LSZH) material, and complies with the NFPA-502 requirement for the emittance of acid gas when burned (NFPA-502:12.3.2.1). The 2014 edition of NFPA 502 does not specifically include for the installation of non-metallic conduits, surface-mounted in

Road Tunnels. It does however allow the engineer to support installation with sufficient technical data in order to demonstrate the equivalence or superiority properties including quality, fire resistance, effectiveness, durability and safety.

4. Impacts

Phenolic Fiberglass conduit is a UL-2196 compliant, LSZH material that is well suited to challenging road tunnel environments. It is highly corrosion resistant, and not subject to corrosion due to dissimilar metals. The relative cost and ease of installation of phenolic fiberglass also facilitate future system modifications.

5. Cost and Benefit Analysis

The benefits of Phenolic Fiberglass Conduit include a reduction in both material and installation costs when compared to stainless steel. It has high temperature rating, combustion resistance, tensile and mechanical strength, stability, and chemical resistance.

Phenolic Fiberglass material is approximately 50% lower in cost than Stainless Steel and since it's such a much lighter material labor installation cost is also considerably lower than stainless steel.

Replacing the stainless steel conduit material for the Phenolic Fiberglass conduit will result in approximate $ 2.0 Million Dollars savings to the Project.

6. Schedule Analysis

The net effect to the installation of Phenolic conduit would have approximately 1 month reduction to the Project Schedule based on Conceptual Phasing Plan for Construction.

7. Conceptual Drawings

- Champion Flame Shield Phelonic Conduit - Data Sheet
- Champion-RHW-UL2196-White-Paper-Rev-1
- UL2196: The Next Generation Fire Resistive Cables and Phenolic Conduit (Champion Fiberglass)
- FRE Type XW BreathSaver Phenolic Conduit with Lifeline Type RHW-2 Two-Hour Fire Resistive Cables

8. Past Use

List of North American Tunnel Locations with Phenolic Fiberglass Conduit Installations:

1. Elizabeth River Tunnels (East & West) – Portsmouth, VA
2. Mt. Lebanon Tunnel – Mt. Lebanon, PA
3. Sunset Tunnel (SFMTA) – San Francisco, CA
4. Queens Midtown Tunnel (QTM-TBTA) – New York, NY
5. Massachusetts Bay Transit Authority (MBTA) – Boston, MA
6. SR99 – Seattle, WA
7. Seattle Sound Transit – Seattle, WA
8. Bay Area Rapid Transit – San Francisco, CA
9. Toronto Transit Commission (TTC) – Toronto, Canada
10. Société des Transport de Montreal (STM) – Montreal, Canada

9. Additional Information

N/A

C. Detailed ATC Requirements

1. Risks

No additional risks to the Procuring Authorities, CDOT or the State, subject to the AHJ approval.

2. Handback

No proposed changes in handback procedures

3. Right-of-Way

No Additional Right-of-Way expected to be required to implement the ATC

4. List of Required Approvals

Subject to the AHJ approval. No Design Exceptions

5. Proposed Drafting Revisions

Final RFP - Project Agreement -Section 12.3.2. "All cable management systems (CMS) i.e. trunking, trays, conduit, brackets, enclosures etc. for equipment and ancillary items inside the bores of the Cover (including on the Portals and on the cross bore escape doors) shall be manufactured from grade 316L stainless steel."

Revision to RFP Schedule10, Section 12.3.2 attached

functional coordination and integration of all the individual systems. The Developer's Construction Work shall include all necessary incidental Activities, services and actions required to deliver a fully functional system that meets the requirements of the Project Agreement.

12.1.7. The Developer shall carry out an engineering analysis as required by NFPA 502, demonstrating full compliance with all requirements of this Section 12, and document such in a Fire System Performance Report submitted to the Department for Acceptance.

12.1.8. All equipment mounted in the Cover shall be mounted in such a way that it meets all design standards both in normal and Emergency use. This shall include measures such as mounting equipment outside of vertical clearance requirements on the Cover walls adjacent to I-70 Mainline or recessing all low-level equipment to not protrude into the horizontal clearance requirements.

12.1.9. The Developer shall provide emergency exit doors near each entry Portal to each bore and at a minimum one additional emergency exit door located within the Cover (spaced equally), which exit doors shall be for Fire Department use and meet the requirements of the National Fire Protection Association (NFPA) standard 502 subsection 716.5 and the subject requirements provided herein.

12.2. Applicable Standards

12.2.1. The Cover MEP System shall be designed to comply with the Construction Standards. The requirements of the NFPA standard 502 and associated standards and specifications apply to the Cover and the Lowered Section on the approaches to the Cover. The Construction Work for the Cover is classified as *Category C* for fire protection and fire life safety purposes.

12.2.2. The requirements of the NFPA standard 502 and associated standards and specifications apply to the entire length of the Lowered Section, the limits being between Brighton Blvd. and Dahlia Street.

12.2.3. The Developer shall design, install, test, commission and put into operation the Cover MEP System in accordance with the Construction Standards and the requirements specified in this Section 12. The extent of the Cover MEP System shall include the whole of the Cover (including I-70 Mainline, Portals etc.), immediate approaches, all associated plant/equipment rooms and spaces, yards, interconnecting spaces (including pipes, ducts, cabling etc.), local and remote control centers etc., unless stated otherwise.

12.3. Durability

12.3.1. All equipment used in the Cover MEP System shall be protected against temperature range and atmospheric corrosion, including saline atmospheres. Materials used shall not be susceptible to mold growth, or attack by vermin or other life forms. All components shall have a minimum design life of 20 years.

12.3.2. All cable management systems (CMS) i.e. trunking, trays, conduit, brackets, enclosures etc. for equipment and ancillary items inside the bores of the Cover (including on the Portals and on the cross bore escape doors) shall be manufactured from grade 316L stainless steel, phenolic fiberglass or similar material in compliance with requirements of NFPA 502-12.1.2~~.~~

12.3.3. Enclosures shall have minimum penetration protection rating of IP66K in accordance with IEC 60529.

12.3.4. Enclosures shall have an impact resistance of IK09 in accordance with EN62262. Durable finishes shall be provided to all materials to resist mechanical stress due to moisture, traffic exhaust fumes, cover washers brush, cleaning detergents, etc.

12.3.5. Enclosures shall be designed to be free draining so that water does not 'pond' on any surfaces.

12.4. Pipework

12.4.1. The Developer shall use pipe work with anchor joints avoiding the use of concrete anchor or thrust blocks. However, additional anchoring or restraint shall be provided to the pipe work where

CHAMPION FIBERGLASS®

Do More.®

CHAMPION FLAME SHIELD®

PHENOLIC CONDUIT

MADE IN THE U.S.A.

ISO 9001:2008 CERTIFIED

Champion Fiberglass, Inc. is the leading manufacturer of fiberglass conduit, Flame Shield and bridge hangers for electrical and mechanical markets.

Champion Fiberglass began production of epoxy fiberglass conduit and fittings in 1988. The company has the most advanced production facilities for manufacturing fiberglass conduit in North America. A well-trained and highly efficient work force utilizes proprietary high-speed winding equipment and high temperature curing ovens to ensure consistent production standards to produce the highest quality fiberglass conduit on the market.

In 1989, Champion Fiberglass developed the first conduit from epoxy resins that had flame resistance and low smoke characteristics, meeting the most stringent codes and specifications. Today this conduit system has been integrated into the **CHAMPION DUCT**® system and is **UL** and **CSA listed** for both below and above ground use.

Another milestone evolved in 2006 when Champion Fiberglass completed development of a Phenolic Conduit System, **FLAME SHIELD**®. It is now the number one choice conduit for subways, including tunnels and stations. **FLAME SHIELD** conforms to the **NFPA 130** requirements, including the 2010 edition.

In 2008, **CHAMPION FLAME SHIELD**® (XW Type fiberglass conduit) was allowed for use in **Class I Div 2** installations, per the **National Electrical Code** (NEC). This was accomplished by Champion Fiberglass after having worked with UL and NEC on this issue for many years.

Champion Fiberglass is an **ISO 9001:2008 Certified Company**. We offer our customers innovative solutions with the highest quality products and customer service available in our industry. Our headquarters and manufacturing are located in Spring, Texas.

UL® LISTED

NFPA® MEMBER

NEMA® Member

CONTENTS

CHAMPION FLAME SHIELD®

CHAMPION FIBERGLASS

6400 Spring Stuebner Rd Spring, TX 77389 Main: 281.655.8900 Fax: 281.257.2523

» info@championfiberglass.com » championfiberglass.com

INTRODUCTION

Champion Fiberglass's comprehensive line of phenolic conduit, **FLAME SHIELD®** is the number one choice of surface mounted conduit for transit and passenger rail systems including subway tunnels and stations. **FLAME SHIELD** conforms to the latest **NFPA 130** requirements.

The **FLAME SHIELD** conduit system provides for improved system longevity and relief from stray eddy current issues common with some transit systems. It is a system that handles the damp, cold environments found in subterranean transit and rail systems while providing a low coefficient of thermal expansion. **FLAME SHIELD** is a non-metallic system tested and proven to handle the elevated conduit temperature requirements of **NFPA 130** and **NFPA 502**. It does this while maintaining low smoke density and without release of toxic gases.

FLAME SHIELD is manufactured without generating formaldehyde or residual corrosive by-products. In addition, this lightweight and cost effective system is easy on the maintenance crew.

FLAME SHIELD is an engineered product by the industry's foremost manufacturer of Reinforced Thermosetting Resin Conduit (RTRC), Champion Fiberglass, an **ISO 9001:2008 Certified Company**.

Important differences between... CHAMPION DUCT® vs. FLAME SHIELD®

A key difference between **CHAMPION DUCT** fiberglass conduit (RTRC) and **FLAME SHIELD** phenolic conduit is that phenolic conduit meets the elevated temperatures requirements of exposed conduits by **NFPA 130** and **ASTM E136**. This allows **FLAME SHIELD** to be in compliance when surface mounted. Fiberglass conduit (RTRC) is in compliance when encased in concrete. In addition, **FLAME SHIELD** has met the increased temperature and duration demands of **NFPA 502**.

To meet the requirements of **NFPA 130** and **502**, Champion has developed a phenolic conduit adhesive system that maintains the integrity of the conduit system. If those standards are not required, Champion's epoxy adhesive system is available.

Another important difference between fiberglass conduit (RTRC) and phenolic conduit is the low flame spread and low smoke characteristics of **FLAME SHIELD.** This allows **FLAME SHIELD** to be used in applications requiring these low numbers.

Due to the physical properties of phenolic conduit, **FLAME SHIELD** is not field bendable for elbows or offsets. Field bending is allowed for **CHAMPION DUCT** (RTRC) by **NFPA 70** (National Electric Code).

Phenolic **FLAME SHIELD** SW (Standard Wall) and MW (Medium Wall) conduits are not **UL** listed due to their physical properties. Phenolic **FLAME SHIELD** XW is **UL** listed and approved.

CHAMPION FIBERGLASS®
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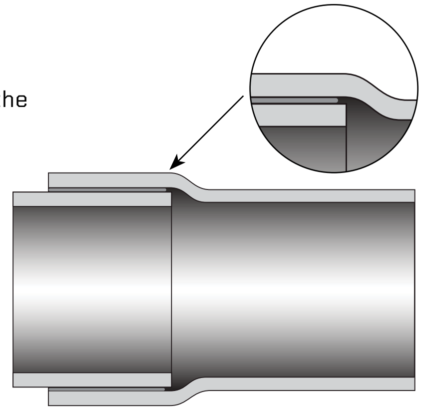
ADHESIVE JOINT

The Adhesive Joint is the straight socket joint combined with the appropriate adhesive. The adhesive is applied to the spigot end of the conduit. Please select an adhesive from page 34.



EXPANSION JOINTS

We recommend that expansion fittings should be provided to compensate for thermal expansion and contraction where the length change is expected to be ¼ inch ***(6 mm)*** or greater in a straight run between securely mounted items such as boxes, cabinets, elbows, or other conduit terminations.

Expansion Characteristics of Flame Shield (Phenolic Conduit)
Coefficient of Thermal Expansion = 5.1 x 10^{-6} in/in/°F (9.27 x 10^{-6} mm/mm/°C)

Temperature Change (°F)	Length Change (in/100 ft)	Temperature Change (°F)	Length Change (in/100 ft)
5	0.03	105	0.64
10	0.06	110	0.67
15	0.09	115	0.70
20	0.12	120	0.73
25	0.15	125	0.77
30	0.18	130	0.80
35	0.21	135	0.83
40	0.24	140	0.86
45	0.28	145	0.89
50	0.31	150	0.92
55	0.34	155	0.95
60	0.37	160	0.98
65	0.40	165	1.01
70	0.43	170	1.04
75	0.46	175	1.07
80	0.49	180	1.10
85	0.52	185	1.13
90	0.55	190	1.16
95	0.58	195	1.19
100	0.61	200	1.22

Temperature Change (°C)	Length Change (mm/m)
5	0.05
10	0.09
15	0.14
20	0.19
25	0.23
30	0.28
35	0.32
40	0.37
45	0.42
50	0.46
55	0.51
60	0.56
65	0.60
70	0.65
75	0.70
80	0.74
85	0.79
90	0.83
95	0.88
100	0.93

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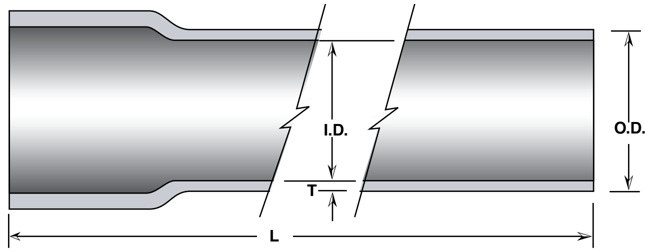

STRAIGHT SOCKET JOINT (IPS)

Nominal. Size	Item No.	Outside Diameter Average	Outside Diameter Tolerance	Min. Inside Diameter	Nominal Wall Thickness* (T)	Length* (L)	Weight lbs/ft	Weight kg/m
Type SW (Standard Wall) Inches ***(Metric)***								
¾ ***(19)***	07E-SW-10S	1.050 ***(27)***	+0.028 ***(0.7)*** -0.018 ***(0.4)***	0.910 ***(23)***	.070 ***(2)***	10 ft ***(3m)***	.17	***(0.25)***
1 ***(25)***	10E-SW-10S	1.315 ***(33)***	+0.028 ***(0.7)*** -0.018 ***(0.4)***	1.175 ***(30)***	.070 ***(2)***	10 ft ***(3m)***	.19	***(0.28)***
1¼ ***(32)***	12E-SW-20-S	1.660 ***(42)***	+0.028 ***(0.7)*** -0.018 ***(0.4)***	1.520 ***(39)***	.070 ***(2)***	20 ft ***(6.1m)***	.23	***(0.34)***
1½ ***(38)***	15E-SW-20-S	1.900 ***(48)***	+0.028 ***(0.7)*** -0.018 ***(0.4)***	1.760 ***(45)***	.070 ***(2)***	20 ft ***(6.1m)***	.33	***(0.49)***
2 ***(51)***	20E-SW-20-S	2.375 ***(60)***	+0.028 ***(0.7)*** -0.018 ***(0.4)***	2.235 ***(57)***	.070 ***(2)***	20 ft ***(6.1m)***	.38	***(0.57)***
2½ ***(64)***	25E-SW-20-S	2.875 ***(73)***	+0.028 ***(0.7)*** -0.018 ***(0.4)***	2.740 ***(69)***	.070 ***(2)***	20 ft ***(6.1m)***	.46	***(0.68)***
3 ***(76)***	30E-SW-20-S	3.500 ***(89)***	+0.028 ***(0.7)*** -0.018 ***(0.4)***	3.360 ***(85)***	.070 ***(2)***	20 ft ***(6.1m)***	.60	***(0.89)***
4 ***(102)***	40E-SW-20-S	4.460 ***(113)***	+0.028 ***(0.7)*** -0.018 ***(0.4)***	4.320 ***(110)***	.070 ***(2)***	20 ft ***(6.1m)***	.72	***(1.07)***
Type MW (Medium Wall) Inches ***(Metric)***								
5 ***(127)***	50E-MW-20-S	5.572 ***(142)***	+0.034 ***(0.9)*** -0.028 ***(0.7)***	5.380 ***(137)***	.096 ***(2)***	20 ft ***(6.1m)***	1.20	***(1.79)***
6 ***(152)***	60E-MW-20-S	6.627 ***(168)***	+0.034 ***(0.9)*** -0.028 ***(0.7)***	6.435 ***(163)***	.096 ***(2)***	20 ft ***(6.1m)***	1.42	***(2.11)***
8 ***(203)***	80E-MW-20-S	8.620 ***(219)***	+0.034 ***(0.9)*** -0.028 ***(0.7)***	8.400 ***(213)***	.110 ***(3)***	20 ft ***(6.1m)***	2.14	***(3.20)***
Type HW (Heavy Wall) Inches ***(Metric)***								
4 ***(102)***	40E-HW-20-S	4.512 ***(115)***	+0.028 ***(0.7)*** -0.022 ***(0.6)***	4.320 ***(110)***	.096 ***(2)***	20 ft ***(6.1m)***	0.97	***(1.44)***
5 ***(127)***	50E-HW-20-S	5.600 ***(142)***	+0.034 ***(0.9)*** -0.028 ***(0.7)***	5.380 ***(137)***	.110 ***(3)***	20 ft ***(6.1m)***	1.32	***(1.96)***
6 ***(152)***	60E-HW-20-S	6.655 ***(169)***	+0.034 ***(0.9)*** -0.028 ***(0.7)***	6.435 ***(163)***	.110 ***(3)***	20 ft ***(6.1m)***	1.63	***(2.43)***
8 ***(203)***	80E-HW-20-S	8.650 ***(220)***	+0.034 ***(0.9)*** -0.028 ***(0.7)***	8.400 ***(213)***	.125 ***(3)***	20 ft ***(6.1m)***	2.43	***(3.62)***

*Note: 10 ft **(3.05 m)** lengths available.*

** Actual wall thickness is that required to meet the performance requirements for specifications. Other wall thicknesses are available by special request.*

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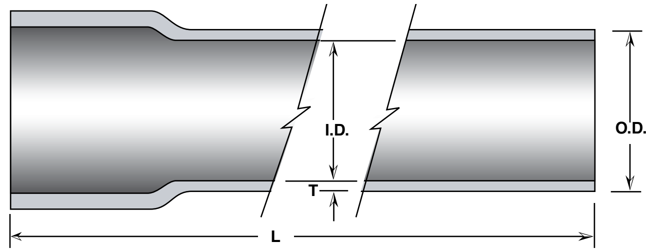
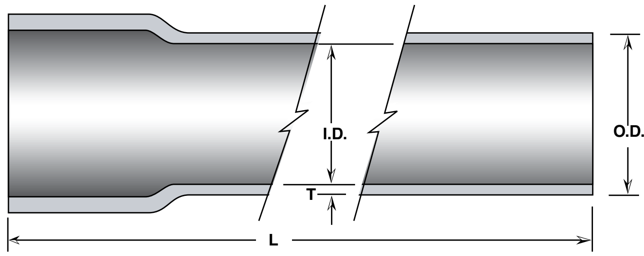


STRAIGHT SOCKET JOINT (ID)

Nominal. Size	Item No.	Outside Diameter Average	Outside Diameter Tolerance	Min. Inside Diameter	Nominal Wall Thickness* (T)	Length** (L)	Weight lbs/ft	Weight kg/m
Type SW (Standard Wall) Inches ***(Metric)***								
2 ***(51)***	20F-SW-20-S	2.140 ***(54)***	+0.028 ***(0.7)*** -0.018 ***(0.4)***	2.000 ***(51)***	.070 ***(2)***	20 ft ***(6.1m)***	0.34	***(0.51)***
2½ ***(64)***	25F-SW-20-S	2.640 ***(67)***	+0.028 ***(0.7)*** -0.018 ***(0.4)***	2.500 ***(64)***	.070 ***(2)***	20 ft ***(6.1m)***	0.42	***(0.63)***
3 ***(76)***	30F-SW-20-S	3.140 ***(80)***	+0.028 ***(0.7)*** -0.018 ***(0.4)***	3.000 ***(76)***	.070 ***(2)***	20 ft ***(6.1m)***	0.48	***(0.72)***
3½ ***(89)***	35F-SW-20-S	3.640 ***(92)***	+0.028 ***(0.7)*** -0.018 ***(0.4)***	3.500 ***(89)***	.070 ***(2)***	20 ft ***(6.1m)***	0.60	***(0.89)***
4 ***(102)***	40F-SW-20-S	4.140 ***(105)***	+0.028 ***(0.7)*** -0.018 ***(0.4)***	4.000 ***(101)***	.070 ***(2)***	20 ft ***(6.1m)***	0.69	***(1.03)***
4½ ***(114)***	45F-SW-20-S	4.640 ***(118)***	+0.028 ***(0.7)*** -0.018 ***(0.4)***	4.500 ***(114)***	.070 ***(2)***	20 ft ***(6.1m)***	0.75	***(1.12)***
Type MW (Medium Wall) Inches ***(Metric)***								
5 ***(127)***	50F-MW-20-S	5.192 ***(131)***	+0.034 ***(0.9)*** -0.028 ***(0.7)***	5.000 ***(127)***	.096 ***(2)***	20 ft ***(6.1m)***	1.13	***(1.68)***
6 ***(152)***	60F-MW-20-S	6.192 ***(157)***	+0.034 ***(0.9)*** -0.028 ***(0.7)***	6.000 ***(152)***	.096 ***(2)***	20 ft ***(6.1m)***	1.35	***(2.01)***
8 ***(203)***	80F-MW-20-S	8.220 ***(209)***	+0.028 ***(0.7)*** -0.018 ***(0.4)***	8.000 ***(203)***	.110 ***(3)***	20 ft ***(6.1m)***	2.13	***(3.17)***
10 ***(254)***	100F-MW-20-S	10.312 ***(262)***	+0.034 ***(0.9)*** -0.028 ***(0.7)***	10.000 ***(254)***	.156 ***(4)***	20 ft ***(6.1m)***	3.65	***(5.43)***
12 ***(305)***	120F-MW-20-S	12.312 ***(313)***	+0.034 ***(0.9)*** -0.028 ***(0.7)***	12.000 ***(305)***	.156 ***(4)***	20 ft ***(6.1m)***	4.37	***(6.50)***
Type HW (Heavy Wall) Inches ***(Metric)***								
4 ***(102)***	40F-HW-20-S	4.192 ***(106)***	+0.028 ***(0.7)*** -0.022 ***(0.6)***	4.000 ***(101)***	.096 ***(2)***	20 ft ***(6.1m)***	0.92	***(1.37)***
4½ ***(114)***	45F-HW-20-S	4.692 ***(119)***	+0.028 ***(0.7)*** -0.022 ***(0.6)***	4.500 ***(114)***	.096 ***(2)***	20 ft ***(6.1m)***	1.04	***(1.55)***
5 ***(127)***	50F-HW-20-S	5.220 ***(132)***	+0.034 ***(0.9)*** -0.028 ***(0.7)***	5.000 ***(127)***	.110 ***(3)***	20 ft ***(6.1m)***	1.30	***(1.92)***
6 ***(152)***	60F-HW-20-S	6.220 ***(158)***	+0.034 ***(0.9)*** -0.028 ***(0.7)***	6.000 ***(152)***	.110 ***(3)***	20 ft ***(6.1m)***	1.58	***(2.35)***
8 ***(203)***	80F-HW-20-S	8.250 ***(210)***	+0.028 ***(0.7)*** -0.018 ***(0.4)***	8.000 ***(203)***	.125 ***(3)***	20 ft ***(6.1m)***	2.42	***(3.60)***
10 ***(254)***	100F-HW-20-S	10.376 ***(264)***	+0.034 ***(0.9)*** -0.028 ***(0.7)***	10.000 ***(254)***	.188 ***(5)***	20 ft ***(6.1m)***	4.50	***(6.70)***
12 ***(305)***	120F-HW-20-S	12.376 ***(314)***	+0.034 ***(0.9)*** -0.028 ***(0.7)***	12.000 ***(305)***	.188 ***(5)***	20 ft ***(6.1m)***	5.38	***(8.01)***

*Note: 10 ft **(3.05 m)** lengths available.*

** Actual wall thickness is that required to meet the performance requirements for specifications. Other wall thicknesses are available by special request.*



STRAIGHT SOCKET JOINT (XW)

Type XW (Xtra Wall) Inches ***(Metric)***

Nominal Size		Item No.	Outside Diameter Average		Tolerance		Min. Inside Diameter		Nominal Wall Thickness* (T)		Length (L)		Weight lbs/ft	kg/m
¾	***(19)***	07E-XW-10S	1.410	***(36)***	+0.056 -0.036	***(1.4)*** ***(0.9)***	0.910	***(23)***	.25	***(6)***	10 ft	***(3m)***	.61	***(.91)***
1	***(25)***	10E-XW-10S	1.675	***(43)***	+0.056 -0.036	***(1.4)*** ***(0.9)***	1.175	***(30)***	.25	***(6)***	10 ft	***(3m)***	.68	***(1.01)***
1¼	***(32)***	12E-XW-20-S	2.020	***(51)***	+0.056 -0.036	***(1.4)*** ***(0.9)***	1.520	***(39)***	.25	***(6)***	20 ft	***(6.1m)***	.82	***(1.22)***
1½	***(38)***	15E-XW-20-S	2.260	***(57)***	+0.056 -0.036	***(1.4)*** ***(0.9)***	1.760	***(45)***	.25	***(6)***	20 ft	***(6.1m)***	1.18	***(1.76)***
2	***(51)***	20F-XW-20-S	2.500	***(64)***	+0.056 -0.036	***(1.4)*** ***(0.9)***	2.000	***(51)***	.25	***(6)***	20 ft	***(6.1m)***	1.26	***(1.88)***
2½	***(64)***	25F-XW-20-S	3.000	***(76)***	+0.056 -0.036	***(1.4)*** ***(0.9)***	2.500	***(64)***	.25	***(6)***	20 ft	***(6.1m)***	1.54	***(2.29)***
3	***(76)***	30F-XW-20-S	3.500	***(89)***	+0.056 -0.036	***(1.4)*** ***(0.9)***	3.000	***(76)***	.25	***(6)***	20 ft	***(6.1m)***	1.82	***(2.71)***
3½	***(89)***	35F-XW-20-S	4.000	***(102)***	-0.036 +0.056	***(1.4)*** ***(0.9)***	3.500	***(89)***	.25	***(6)***	20 ft	***(6.1m)***	2.10	***(3.13)***
4	***(102)***	40F-XW-20-S	4.500	***(114)***	+0.056 -0.036	***(1.4)*** ***(0.9)***	4.000	***(102)***	.25	***(6)***	20 ft	***(6.1m)***	2.38	***(3.54)***
5	***(127)***	50F-XW-20-S	5.500	***(140)***	+0.056 -0.036	***(1.4)*** ***(0.9)***	5.000	***(127)***	.25	***(6)***	20 ft	***(6.1m)***	2.94	***(4.38)***
6	***(152)***	60F-XW-20-S	6.500	***(165)***	+0.056 -0.036	***(1.4)*** ***(0.9)***	6.000	***(152)***	.25	***(6)***	20 ft	***(6.1m)***	3.50	***(5.21)***
8**	***(203)***	80E-XW-20-S	8.900	***(226)***	+0.056 -0.036	***(1.4)*** ***(0.9)***	8.400	***(213)***	.25	***(6)***	20 ft	***(6.1m)***	4.80	***(7.14)***
10	***(254)***	100F-XW-20-S	10.500	***(267)***	+0.056 -0.036	***(1.4)*** ***(0.9)***	10.000	***(254)***	.25	***(6)***	20 ft	***(6.1m)***	5.74	***(8.54)***
12	***(305)***	120F-XW-20-S	12.500	***(318)***	+0.056 -0.036	***(1.4)*** ***(0.9)***	12.000	***(305)***	.25	***(6)***	20 ft	***(6.1m)***	6.86	***(10.21)***

Note: 10 ft. ***(3.05 m)*** *lengths available for 1¼" nominal size and larger.*

** Actual wall thickness is that required to meet the performance requirements for specifications. Other wall thicknesses are available by special request.*

*** XW type conduit is also available with an inside diameter of 8.000 (203). Please contact our factory for further information.*

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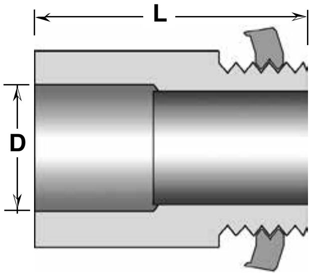


BOX CONNECTOR

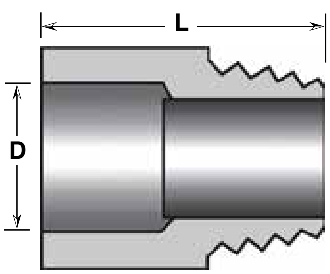
(Straight Threads)

A box connector creates a separable termination into a box. This connector has straight threads (NPS) and is supplied with a locknut. O-ring supplied upon request.

Nominal Size	Type	IPS Item No.	D	L	Weight lbs	kg
¾	SW	07E-SW-30	1.06 (27)	3 (76)	0.11	(.05)
1	SW	10E-SW-30	1.32 (34)	3 (76)	0.22	(.10)
1¼	SW	12E-SW-30	1.67 (42)	3 (76)	0.25	(.12)
1½	SW	15E-SW-30	1.91 (49)	3 (76)	0.29	(.13)
2	SW	20E-SW-30	2.40 (61)	5 (127)	0.85	(.39)
3	SW	30E-SW-30	3.52 (89)	5 (127)	1.28	(.58)
4	SW	40E-SW-30	4.47 (114)	5 (127)	2.09	(.95)
4	HW	40E-HW-30	4.52 (115)	5 (127)	2.09	(.95)
5	MW	50E-MW-30	5.59 (142)	5 (127)	2.75	(1.25)
5	HW	50E-HW-30	5.63 (143)	5 (127)	2.75	(1.25)
6	MW	60E-MW-30	6.66 (169)	5 (127)	2.97	(1.35)
6	HW	60E-HW-30	6.69 (170)	5 (127)	2.97	(1.35)

Nominal Size	Type	ID Item No.	D	L	Weight lbs	kg
2	SW	20F-SW-30	2.16 (55)	5 (127)	0.85	(.39)
2½	SW	25F-SW-30	2.66 (68)	5 (127)	0.94	(.43)
3	SW	30F-SW-30	3.16 (80)	5 (127)	1.28	(.58)
3½	SW	35F-SW-30	3.66 (93)	5 (127)	1.77	(.80)
4	SW	40F-SW-30	4.16 (106)	5 (127)	2.09	(.95)
4	HW	40F-HW-30	4.20 (107)	5 (127)	2.09	(.95)
4½	SW	45F-SW-30	4.66 (118)	5 (127)	2.40	(1.08)
4½	HW	45F-HW-30	4.70 (119)	5 (127)	2.40	(1.08)
5	MW	50F-MW-30	5.20 (132)	5 (127)	2.75	(1.25)
5	HW	50F-HW-30	5.24 (133)	5 (127)	2.75	(1.25)
6	MW	60F-MW-30	6.20 (157)	5 (127)	2.97	(1.35)
6	HW	60F-HW-30	6.24 (158)	5 (127)	2.97	(1.35)

Nominal Size	Type	Item No.	D	L	Weight lbs	kg
¾	XW	07E-XW-30	1.44 (36)	3 (76)	0.11	(0.05)
1	XW	10E-XW-30	1.70 (43)	3 (76)	0.22	(0.10)
1¼	XW	12E-XW-30	2.05 (52)	3 (76)	0.35	(0.16)
1½	XW	15E-XW-30	2.29 (58)	3 (76)	0.49	(0.22)
2	XW	20F-XW-30	2.52 (64)	5 (127)	0.85	(0.39)
3	XW	30F-XW-30	3.52 (89)	5 (127)	1.28	(0.58)
4	XW	40F-XW-30	4.52 (115)	7 (165)	2.09	(0.95)
5	XW	50F-XW-30	5.52 (140)	7 (165)	2.75	(1.25)
6	XW	60F-XW-30	6.52 (166)	7 (165)	2.97	(1.35)



MALE ADAPTER

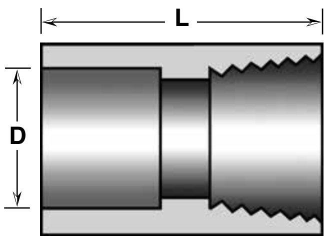
(Tapered Threads)

Male adapters with tapered threads (NPT) are generally used for joining to female threads of rigid steel, Myers type hubs or terminating into precast iron boxes with female thread entrances.

Nominal Size	Type	IPS Item No.	D	L	Weight lbs	kg
¾	SW	07E-SW-33	1.06 (27)	3 (76)	0.08	(.04)
1	SW	10E-SW-33	1.32 (34)	3 (76)	0.08	(.04)
1¼	SW	12E-SW-33	1.67 (42)	3 (76)	0.15	(.07)
1½	SW	15E-SW-33	1.91 (49)	3 (76)	0.15	(.07)
2	SW	20E-SW-33	2.40 (61)	5 (127)	0.44	(.20)
3	SW	30E-SW-33	3.52 (89)	5 (127)	0.64	(.29)
4	SW	40E-SW-33	4.47 (114)	5 (127)	0.93	(.42)
4	HW	40E-HW-33	4.52 (115)	5 (127)	0.97	(.44)
5	MW	50E-MW-33	5.59 (142)	5 (127)	1.30	(.59)
5	HW	50E-HW-33	5.63 (143)	5 (127)	1.15	(.52)
6	MW	60E-MW-33	6.66 (169)	5 (127)	1.70	(.77)
6	HW	60E-HW-33	6.69 (170)	5 (127)	1.40	(.64)

Nominal Size	Type	ID Item No.	D	L	Weight lbs	kg
2	SW	20F-SW-33	2.16 (55)	5 (127)	0.43	(.20)
2½	SW	25F-SW-33	2.66 (68)	5 (127)	0.62	(.28)
3	SW	30F-SW-33	3.16 (80)	5 (127)	0.76	(.35)
3½	SW	35F-SW-33	3.66 (93)	5 (127)	0.86	(.39)
4	SW	40F-SW-33	4.16 (106)	5 (127)	1.02	(.46)
4	HW	40F-HW-33	4.20 (107)	5 (127)	0.95	(.43)
4½	SW	45F-SW-33	4.66 (118)	5 (127)	1.22	(.55)
4½	HW	45F-HW-33	4.70 (119)	5 (127)	1.15	(.52)
5	MW	50F-MW-33	5.20 (132)	5 (127)	1.30	(.59)
5	HW	50F-HW-33	5.24 (133)	5 (127)	1.18	(.54)
6	MW	60F-MW-33	6.20 (157)	5 (127)	1.40	(.64)
6	HW	60F-HW-33	6.24 (158)	5 (127)	1.30	(.59)

Nominal Size	Type	Item No.	D	L	Weight lbs	kg
¾	XW	07E-XW-33	1.44 (36)	3 (76)	0.09	(0.04)
1	XW	10E-XW-33	1.70 (43)	3 (76)	0.19	(0.09)
1¼	XW	12E-XW-33	2.05 (52)	3 (76)	0.24	(0.11)
1½	XW	15E-XW-33	2.29 (58)	3 (76)	0.35	(0.16)
2	XW	20F-XW-33	2.52 (64)	5 (127)	0.69	(0.31)
2½	XW	25F-XW-33	3.03 (77)	5 (127)	0.85	(0.38)
3	XW	30F-XW-33	3.52 (89)	5 (127)	1.00	(0.45)
3½	XW	35F-XW-33	4.03 (102)	5 (127)	1.28	(0.58)
4	XW	40F-XW-33	4.52 (115)	7 (178)	1.56	(0.71)
5	XW	50F-XW-33	5.52 (140)	7 (178)	2.08	(0.94)
6	XW	60F-XW-33	6.52 (166)	7 (178)	2.47	(1.12)



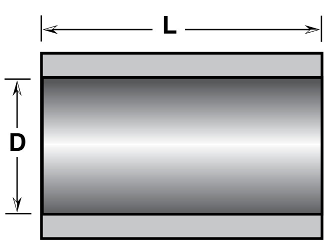
FEMALE TERMINAL ADAPTER

This adapter is generally used for joining phenolic conduit with galvanized rigid steel (GRS) conduit. It has the same threads as GRS conduit and can easily be attached to GRS conduit.

Nominal Size	Type	IPS Item No.	D	L	Weight lbs	kg
¾	SW	07E-SW-32	1.06 *(27)*	3 *(76)*	0.07	*(0.03)*
1	SW	10E-SW-32	1.32 *(34)*	3 *(76)*	0.13	*(0.06)*
1¼	SW	12E-SW-32	1.67 *(42)*	3 *(76)*	0.18	*(0.08)*
1½	SW	15E-SW-32	1.91 *(49)*	3 *(76)*	0.21	*(0.10)*
2	SW	20E-SW-32	2.40 *(61)*	5 *(127)*	0.47	*(0.21)*
3	SW	30E-SW-32	3.52 *(89)*	5 *(127)*	0.80	*(0.36)*
4	SW	40E-SW-32	4.47 *(114)*	5 *(127)*	1.05	*(0.48)*
4	HW	40E-HW-32	4.52 *(115)*	5 *(127)*	1.00	*(0.45)*
5	MW	50E-MW-32	5.59 *(142)*	5 *(127)*	1.05	*(0.48)*
5	HW	50E-HW-32	5.63 *(143)*	5 *(127)*	1.00	*(0.45)*
6	MW	60E-MW-32	6.66 *(169)*	5 *(127)*	1.10	*(0.50)*
6	HW	60E-HW-32	6.69 *(170)*	5 *(127)*	1.05	*(0.48)*

Nominal Size	Type	ID Item No.	D	L	Weight lbs	kg
2	SW	20F-SW-32	2.16 *(55)*	5 *(127)*	0.75	*(0.34)*
2½	SW	25F-SW-32	2.66 *(55)*	5 *(127)*	1.00	*(0.45)*
3	SW	30F-SW-32	3.16 *(80)*	5 *(127)*	1.08	*(0.49)*
3½	SW	35F-SW-32	3.66 *(93)*	5 *(127)*	1.18	*(0.54)*
4	SW	40F-SW-32	4.16 *(106)*	5 *(127)*	1.25	*(0.57)*
4	HW	40F-HW-32	4.20 *(107)*	5 *(127)*	1.08	*(0.49)*
4½	SW	45F-SW-32	4.66 *(118)*	5 *(127)*	1.50	*(0.68)*
4½	HW	45F-HW-32	4.70 *(119)*	5 *(127)*	1.40	*(0.64)*
5	MW	50F-MW-32	5.20 *(132)*	5 *(127)*	1.75	*(0.80)*
5	HW	50F-HW-32	5.24 *(133)*	5 *(127)*	1.65	*(0.75)*
6	MW	60F-MW-32	6.20 *(157)*	5 *(127)*	2.00	*(0.91)*
6	HW	60F-HW-32	6.24 *(158)*	5 *(127)*	1.83	*(0.83)*

Nominal Size	Type	Item No.	D	L	Weight lbs	kg
¾	XW	07E-XW-32	1.44 *(36)*	3 *(76)*	0.30	*(0.14)*
1	XW	10E-XW-32	1.70 *(43)*	3 *(76)*	0.38	*(0.17)*
1¼	XW	12E-XW-32	2.05 *(52)*	3 *(76)*	0.45	*(0.20)*
1½	XW	15E-XW-32	2.29 *(58)*	3 *(76)*	0.60	*(0.27)*
2	XW	20F-XW-32	2.52 *(64)*	5 *(127)*	1.20	*(0.55)*
2½	XW	25F-XW-32	3.03 *(77)*	5 *(127)*	0.85	*(0.38)*
3	XW	30F-XW-32	3.52 *(89)*	5 *(127)*	1.40	*(0.64)*
3½	XW	35F-XW-32	4.03 *(102)*	5 *(127)*	1.28	*(0.58)*
4	XW	40F-XW-32	4.52 *(115)*	7 *(178)*	2.08	*(0.94)*
5	XW	50F-XW-32	5.52 *(140)*	7 *(178)*	2.60	*(1.18)*
6	XW	60F-XW-32	6.52 *(166)*	7 *(178)*	3.51	*(1.59)*



SLEEVE COUPLING

Nominal Size	Type	IPS Item No.	D	L	Weight lbs	kg
¾	SW	07E-SW-42	1.06 *(27)*	6 *(152)*	0.06	*(0.03)*
1	SW	10E-SW-42	1.32 *(34)*	6 *(152)*	0.08	*(0.04)*
1¼	SW	12E-SW-42	1.67 *(42)*	6 *(152)*	0.10	*(0.05)*
1½	SW	15E-SW-42	1.91 *(49)*	6 *(152)*	0.11	*(0.05)*
2	SW	20E-SW-42	2.40 *(61)*	6 *(152)*	0.20	*(0.09)*
3	SW	30E-SW-42	3.52 *(89)*	6 *(152)*	0.30	*(0.14)*
4	SW	40E-SW-42	4.47 *(114)*	6 *(152)*	0.36	*(0.16)*
4	HW	40E-HW-42	4.52 *(115)*	6 *(152)*	0.50	*(0.23)*
5	MW	50E-MW-42	5.59 *(142)*	6 *(152)*	0.60	*(0.27)*
5	HW	50E-HW-42	5.63 *(143)*	6 *(152)*	0.70	*(0.32)*
6	MW	60E-MW-42	6.66 *(169)*	6 *(152)*	0.80	*(0.36)*
6	HW	60E-HW-42	6.69 *(170)*	6 *(152)*	0.90	*(0.41)*

Nominal Size	Type	ID Item No.	D	L	Weight lbs	kg
2	SW	20F-SW-42	2.16 *(55)*	6 *(152)*	0.17	*(0.08)*
2½	SW	25F-SW-42	2.66 *(68)*	6 *(152)*	0.21	*(0.10)*
3	SW	30F-SW-42	3.16 *(80)*	6 *(152)*	0.24	*(0.11)*
3½	SW	35F-SW-42	3.66 *(93)*	6 *(152)*	0.32	*(0.15)*
4	SW	40F-SW-42	4.16 *(106)*	6 *(152)*	0.35	*(0.16)*
4	HW	40F-HW-42	4.20 *(107)*	6 *(152)*	0.46	*(0.21)*
4½	SW	45F-SW-42	4.66 *(118)*	6 *(152)*	0.38	*(0.17)*
4½	HW	45F-HW-42	4.70 *(119)*	6 *(152)*	0.54	*(0.25)*
5	MW	50F-MW-42	5.20 *(132)*	6 *(152)*	0.60	*(0.27)*
5	HW	50F-HW-42	5.24 *(133)*	6 *(152)*	0.70	*(0.32)*
6	MW	60F-MW-42	6.20 *(157)*	6 *(152)*	0.83	*(0.38)*
6	HW	60F-HW-42	6.24 *(158)*	6 *(152)*	1.15	*(0.52)*

Nominal Size	Type	Item No.	D	L	Weight lbs	kg
¾	XW	07E-XW-42	1.44 *(36)*	6 *(152)*	0.22	*(0.10)*
1	XW	10E-XW-42	1.70 *(43)*	6 *(152)*	0.29	*(0.13)*
1¼	XW	12E-XW-42	2.05 *(52)*	6 *(152)*	0.36	*(0.16)*
1½	XW	15E-XW-42	2.29 *(58)*	6 *(152)*	0.39	*(0.18)*
2	XW	20F-XW-42	2.52 *(64)*	6 *(152)*	0.53	*(0.24)*
2½	XW	25F-XW-42	3.03 *(77)*	6 *(152)*	0.77	*(0.35)*
3	XW	30F-XW-42	3.52 *(89)*	6 *(152)*	0.75	*(0.34)*
3½	XW	35F-XW-42	4.03 *(102)*	6 *(152)*	1.12	*(0.51)*
4	XW	40F-XW-42	4.52 *(115)*	10 *(254)*	1.50	*(0.68)*
5	XW	50F-XW-42	5.52 *(140)*	10 *(254)*	2.08	*(0.94)*
6	XW	60F-XW-42	6.52 *(166)*	10 *(254)*	2.50	*(1.13)*

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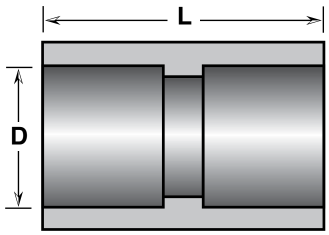
Nominal Size	Type	IPS Item No.	D	L	Weight lbs	kg
¾	SW	07E-SW-40	1.06 ***(27)***	6 ***(152)***	0.07	***(0.03)***
1	SW	10E-SW-40	1.32 ***(34)***	6 ***(152)***	0.08	***(0.04)***
1¼	SW	12E-SW-40	1.67 ***(42)***	6 ***(152)***	0.09	***(0.04)***
1½	SW	15E-SW-40	1.91 ***(49)***	6 ***(152)***	0.11	***(0.05)***
2	SW	20E-SW-40	2.40 ***(61)***	6 ***(152)***	0.20	***(0.10)***
3	SW	30E-SW-40	3.52 ***(89)***	6 ***(152)***	0.30	***(0.14)***
4	SW	40E-SW-40	4.47 ***(114)***	6 ***(152)***	0.43	***(0.20)***
4	HW	40E-HW-40	4.52 ***(115)***	6 ***(152)***	0.58	***(0.26)***
5	MW	50E-MW-40	5.59 ***(142)***	6 ***(152)***	0.70	***(0.31)***
5	HW	50E-HW-40	5.63 ***(143)***	6 ***(152)***	0.90	***(0.41)***
6	MW	60E-MW-40	6.66 ***(169)***	6 ***(152)***	0.85	***(0.39)***
6	HW	60E-HW-40	6.69 ***(170)***	6 ***(152)***	0.95	***(0.43)***



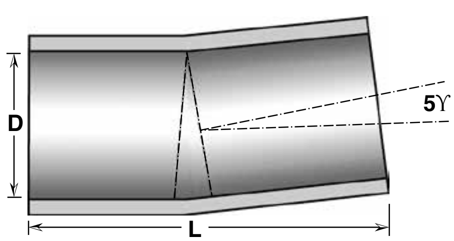
Nominal Size	Type	ID Item No.	D	L	Weight lbs	kg
2	SW	20F-SW-40	2.16 ***(55)***	6 ***(152)***	0.20	***(0.09)***
2½	SW	25F-SW-40	2.66 ***(68)***	6 ***(152)***	0.25	***(0.11)***
3	SW	30F-SW-40	3.16 ***(80)***	6 ***(152)***	0.30	***(0.14)***
3½	SW	35F-SW-40	3.66 ***(93)***	6 ***(152)***	0.35	***(0.16)***
4	SW	40F-SW-40	4.16 ***(106)***	6 ***(152)***	0.40	***(0.18)***
4	HW	40F-HW-40	4.20 ***(107)***	6 ***(152)***	0.54	***(0.25)***
4½	SW	45F-SW-40	4.66 ***(118)***	6 ***(152)***	0.45	***(0.20)***
4½	HW	45F-HW-40	4.70 ***(119)***	6 ***(152)***	0.60	***(0.27)***
5	MW	50F-MW-40	5.20 ***(132)***	6 ***(152)***	0.68	***(0.31)***
5	HW	50F-HW-40	5.24 ***(133)***	6 ***(152)***	0.80	***(0.36)***
6	MW	60F-MW-40	6.20 ***(157)***	6 ***(152)***	0.80	***(0.36)***
6	HW	60F-HW-40	6.24 ***(158)***	6 ***(152)***	0.92	***(0.42)***

STOP COUPLING

Stop coupling is sometimes referred to as a double bell coupling.

Nominal Size	Type	Item No.	D	L	Weight lbs	kg
¾	XW	07E-XW-40	1.44 ***(36)***	6 ***(152)***	0.22	***(0.10)***
1	XW	10E-XW-40	1.70 ***(43)***	6 ***(152)***	0.29	***(0.13)***
1¼	XW	12E-XW-40	2.05 ***(52)***	6 ***(152)***	0.36	***(0.16)***
1½	XW	15E-XW-40	2.29 ***(58)***	6 ***(152)***	0.39	***(0.18)***
2	XW	20F-XW-40	2.52 ***(64)***	6 ***(152)***	0.65	***(0.29)***
2½	XW	25F-XW-40	3.03 ***(77)***	6 ***(152)***	0.77	***(0.35)***
3	XW	30F-XW-40	3.52 ***(89)***	6 ***(152)***	0.95	***(0.43)***
3½	XW	35F-XW-40	4.03 ***(102)***	6 ***(152)***	1.12	***(0.51)***
4	XW	40F-XW-40	4.52 ***(115)***	10 ***(254)***	2.00	***(0.91)***
5	XW	50F-XW-40	5.52 ***(140)***	10 ***(254)***	2.50	***(1.13)***
6	XW	60F-XW-40	6.52 ***(166)***	10 ***(254)***	2.90	***(1.32)***

Nominal Size	Type	IPS Item No.	D	L	Weight lbs	kg
¾	SW	07E-SW-44	1.06 ***(27)***	6 ***(152)***	0.07	***(0.03)***
1	SW	10E-SW-44	1.32 ***(34)***	6 ***(152)***	0.09	***(0.04)***
1¼	SW	12E-SW-44	1.67 ***(42)***	6 ***(152)***	0.11	***(0.05)***
1½	SW	15E-SW-44	1.91 ***(49)***	6 ***(165)***	0.13	***(0.06)***
2	SW	20E-SW-44	2.40 ***(61)***	6 ***(152)***	0.22	***(0.10)***
3	SW	30E-SW-44	3.52 ***(89)***	6 ***(152)***	0.32	***(0.46)***
4	SW	40E-SW-44	4.47 ***(114)***	6 ***(152)***	0.40	***(0.18)***
4	HW	40E-HW-44	4.52 ***(115)***	6 ***(152)***	0.60	***(0.27)***
5	MW	50E-MW-44	5.59 ***(142)***	6 ***(152)***	0.65	***(0.30)***
5	HW	50E-HW-44	5.63 ***(143)***	6 ***(152)***	0.75	***(0.34)***
6	MW	60E-MW-44	6.66 ***(169)***	6 ***(152)***	0.85	***(0.39)***
6	HW	60E-HW-44	6.69 ***(170)***	6 ***(152)***	0.95	***(0.43)***

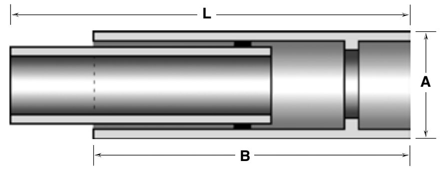


Nominal Size	Type	ID Item No.	D	L	Weight lbs	kg
2	SW	20F-SW-44	2.16 ***(55)***	6 ***(152)***	0.18	***(0.08)***
2½	SW	25F-SW-44	2.66 ***(68)***	6 ***(152)***	0.22	***(0.10)***
3	SW	30F-SW-44	3.16 ***(80)***	6 ***(152)***	0.25	***(0.11)***
3½	SW	35F-SW-44	3.66 ***(93)***	6 ***(152)***	0.32	***(0.15)***
4	SW	40F-SW-44	4.16 ***(106)***	6 ***(152)***	0.36	***(0.16)***
4	HW	40F-HW-44	4.20 ***(107)***	6 ***(152)***	0.48	***(0.22)***
4½	SW	45F-SW-44	4.66 ***(118)***	6 ***(152)***	0.40	***(0.18)***
4½	HW	45F-HW-44	4.70 ***(119)***	6 ***(152)***	0.56	***(0.25)***
5	MW	50F-MW-44	5.20 ***(132)***	6 ***(152)***	0.63	***(0.29)***
5	HW	50F-HW-44	5.24 ***(133)***	6 ***(152)***	0.73	***(0.33)***
6	MW	60F-MW-44	6.20 ***(157)***	6 ***(152)***	0.85	***(0.39)***
6	HW	60F-HW-44	6.24 ***(158)***	6 ***(152)***	1.20	***(0.55)***

5° DOUBLE BELL COUPLING

Other angles can also be manufactured, such as 2.5° etc. Please contact factory for consultation.

Nominal Size	Type	Item No.	D	L	Weight lbs	kg
¾	XW	07E-XW-44	1.44 ***(36)***	6 ***(152)***	0.22	***(0.10)***
1	XW	10E-XW-44	1.70 ***(43)***	6 ***(152)***	0.29	***(0.13)***
1¼	XW	12E-XW-44	2.05 ***(52)***	6 ***(152)***	0.36	***(0.16)***
1½	XW	15E-XW-44	2.29 ***(58)***	6 ***(152)***	0.39	***(0.18)***
2	XW	20F-XW-44	2.52 ***(64)***	6 ***(152)***	0.55	***(0.25)***
2½	XW	25F-XW-44	3.03 ***(77)***	6 ***(152)***	0.77	***(0.35)***
3	XW	30F-XW-44	3.52 ***(89)***	6 ***(152)***	0.89	***(0.40)***
3½	XW	35F-XW-44	4.03 ***(102)***	6 ***(152)***	1.02	***(0.51)***
4	XW	40F-XW-44	4.52 ***(115)***	10 ***(254)***	1.53	***(0.67)***
5	XW	50F-XW-44	5.52 ***(140)***	10 ***(254)***	2.17	***(0.98)***
6	XW	60F-XW-44	6.52 ***(166)***	10 ***(254)***	2.55	***(1.16)***



SINGLE EXPANSION JOINT SOCKET X SPIGOT WITH O-RING

Installation of Expansion Joints:

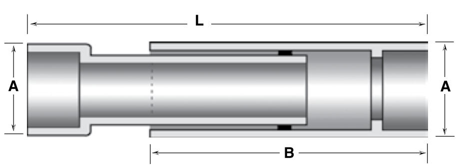
- When the duct is shorter than 100 ft., no Expansion Joint needed
- When the duct is between 100 ft. up to 300 ft., install one Expansion Joint at the mid point
- If the duct is longer than 300 ft., install one Expansion Joint every 300 ft. apart

Note: All Expansion Joints have a yellow line on the nipple end of the joint for proper installation.

Nominal Size	Type	IPS Item No.	A	B	L - Min	L - Max	Weight lbs (kg)
¾	SW	07E-SW-36	1.20 (30)	12 (305)	15 (381)	23 (584)	0.39 (0.18)
1	SW	10E-SW-36	1.46 (37)	12 (305)	15 (381)	23 (584)	0.44 (0.20)
1¼	SW	12E-SW-36	1.81 (46)	12 (305)	15 (381)	23 (584)	0.53 (0.24)
1½	SW	15E-SW-36	2.04 (52)	12 (305)	15 (381)	23 (584)	0.76 (0.35)
2	SW	20E-SW-36	2.54 (65)	12 (305)	15 (381)	23 (584)	0.87 (0.40)
3	SW	30E-SW-36	3.66 (93)	12 (305)	15 (381)	23 (584)	1.38 (0.63)
4	SW	40E-SW-36	4.61 (117)	12 (305)	15 (381)	23 (584)	1.66 (0.75)
4	HW	40E-HW-36	4.69 (119)	12 (305)	15 (381)	23 (584)	2.23 (1.01)
5	MW	50E-MW-36	5.79 (147)	12 (305)	15 (381)	23 (584)	2.76 (1.25)
5	HW	50E-HW-36	5.85 (149)	12 (305)	15 (381)	23 (584)	2.99 (1.36)
6	MW	60E-MW-36	6.85 (174)	12 (305)	15 (381)	23 (584)	3.27 (1.49)
6	HW	60E-HW-36	6.91 (176)	12 (305)	15 (381)	23 (584)	3.75 (1.70)

Nominal Size	Type	ID Item No.	A	B	L - Min	L - Max	Weight lbs (kg)
2	SW	20F-SW-36	2.30 (58)	12 (305)	15 (381)	23 (584)	0.78 (0.35)
2½	SW	25F-SW-36	2.80 (71)	12 (305)	15 (381)	23 (584)	0.97 (0.44)
3	SW	30F-SW-36	3.30 (84)	12 (305)	15 (381)	23 (584)	1.10 (0.50)
3½	SW	35F-SW-36	3.80 (96)	12 (305)	15 (381)	23 (584)	1.38 (0.63)
4	SW	40F-SW-36	4.30 (109)	12 (305)	15 (381)	23 (584)	1.59 (0.72)
4	HW	40F-HW-36	4.39 (111)	12 (305)	15 (381)	23 (584)	2.12 (0.96)
4½	SW	45F-SW-36	4.80 (122)	12 (305)	15 (381)	23 (584)	1.73 (0.79)
4½	HW	45F-HW-36	4.89 (124)	12 (305)	15 (381)	23 (584)	2.39 (1.09)
5	MW	50F-MW-36	5.39 (137)	12 (305)	15 (381)	23 (584)	2.60 (1.18)
5	HW	50F-HW-36	5.42 (138)	12 (305)	15 (381)	23 (584)	3.04 (1.38)
6	MW	60F-MW-36	6.39 (162)	12 (305)	15 (381)	23 (584)	3.11 (1.41)
6	HW	60F-HW-36	6.42 (163)	12 (305)	15 (381)	23 (584)	3.63 (1.65)

Nominal Size	Type	Item No.	A	B	L - Min	L - Max	Weight lbs (kg)
¾	XW	07E-XW-36	1.94 (54)	12 (305)	15 (381)	23 (584)	1.40 (0.64)
1	XW	10E-XW-36	2.20 (61)	12 (305)	15 (381)	23 (584)	1.57 (0.71)
1¼	XW	12E-XW-36	2.55 (65)	12 (305)	15 (381)	23 (584)	1.89 (0.86)
1½	XW	15E-XW-36	2.79 (71)	12 (305)	15 (381)	23 (584)	2.72 (1.23)
2	XW	20F-XW-36	3.00 (76)	12 (305)	15 (381)	23 (584)	2.90 (1.32)
2½	XW	25F-XW-36	3.53 (90)	12 (305)	15 (381)	23 (584)	3.56 (1.61)
3	XW	30F-XW-36	4.00 (102)	12 (305)	15 (381)	23 (584)	4.19 (1.90)
3½	XW	35F-XW-36	4.53 (115)	12 (305)	15 (381)	23 (584)	4.83 (2.19)
4	XW	40F-XW-36	5.00 (127)	14 (356)	19 (482)	27 (686)	6.42 (2.92)
5	XW	50F-XW-36	6.00 (152)	14 (356)	19 (482)	27 (686)	7.94 (3.60)
6	XW	60F-XW-36	7.00 (178)	14 (356)	19 (482)	27 (686)	10.06 (4.57)



SINGLE EXPANSION JOINT SOCKET X SOCKET WITH O-RING

Installation of Expansion Joints:

- When the duct is shorter than 100 ft., no Expansion Joint needed
- When the duct is between 100 ft. up to 300 ft., install one Expansion Joint at the mid point
- If the duct is longer than 300 ft., install one Expansion Joint every 300 ft. apart

Note: All Expansion Joints have a yellow line on the nipple end of the joint for proper installation.

Nominal Size	Type	IPS Item No.	A	B	L - Min	L - Max	Weight lbs (kg)
¾	SW	07E-SW-37	1.20 (30)	12 (305)	18 (457)	26 (660)	0.49 (0.22)
1	SW	10E-SW-37	1.46 (37)	12 (305)	18 (457)	26 (660)	0.55 (0.25)
1¼	SW	12E-SW-37	1.81 (46)	12 (305)	18 (457)	26 (660)	0.66 (0.30)
1½	SW	15E-SW-37	2.04 (52)	12 (305)	18 (457)	26 (660)	0.76 (0.35)
2	SW	20E-SW-37	2.54 (65)	12 (305)	18 (457)	26 (660)	1.09 (0.50)
3	SW	30E-SW-37	3.66 (93)	12 (305)	18 (457)	26 (660)	1.73 (0.79)
4	SW	40E-SW-37	4.61 (117)	12 (305)	18 (457)	26 (660)	2.07 (0.94)
4	HW	40E-HW-37	4.69 (119)	12 (305)	18 (457)	26 (660)	2.79 (1.27)
5	MW	50E-MW-37	5.79 (147)	12 (305)	18 (457)	26 (660)	3.45 (1.57)
5	HW	50E-HW-37	5.85 (149)	12 (305)	18 (457)	26 (660)	3.74 (1.70)
6	MW	60E-MW-37	6.85 (174)	12 (305)	18 (457)	26 (660)	4.08 (1.85)
6	HW	60E-HW-37	6.91 (176)	12 (305)	18 (457)	26 (660)	4.69 (2.13)

Nominal Size	Type	ID Item No.	A	B	L - Min	L - Max	Weight lbs (kg)
2	SW	20F-SW-37	2.30 (58)	12 (305)	18 (457)	26 (660)	0.98 (0.45)
2½	SW	25F-SW-37	2.80 (71)	12 (305)	18 (457)	26 (660)	1.21 (0.55)
3	SW	30F-SW-37	3.30 (84)	12 (305)	18 (457)	26 (660)	1.38 (0.63)
3½	SW	35F-SW-37	3.80 (96)	12 (305)	18 (457)	26 (660)	1.73 (0.79)
4	SW	40F-SW-37	4.30 (109)	12 (305)	18 (457)	26 (660)	1.98 (0.90)
4	HW	40F-HW-37	4.39 (111)	12 (305)	18 (457)	26 (660)	2.65 (1.20)
4½	SW	45F-SW-37	4.80 (122)	12 (305)	18 (457)	26 (660)	2.16 (0.98)
4½	HW	45F-HW-37	4.89 (124)	12 (305)	18 (457)	26 (660)	2.99 (1.36)
5	MW	50F-MW-37	5.39 (137)	12 (305)	18 (457)	26 (660)	3.25 (1.48)
5	HW	50F-HW-37	5.42 (138)	12 (305)	18 (457)	26 (660)	3.80 (1.73)
6	MW	60F-MW-37	6.39 (162)	12 (305)	18 (457)	26 (660)	3.88 (1.76)
6	HW	60F-HW-37	6.42 (163)	12 (305)	18 (457)	26 (660)	4.54 (2.06)

Nominal Size	Type	Item No.	A	B	L - Min	L - Max	Weight lbs (kg)
¾	XW	07E-XW-37	1.94 (54)	12 (305)	15 (381)	23 (584)	1.76 (0.80)
1	XW	10E-XW-37	2.20 (61)	12 (305)	15 (381)	23 (584)	1.97 (0.89)
1¼	XW	12E-XW-37	2.55 (65)	12 (305)	15 (381)	23 (584)	2.35 (1.07)
1½	XW	15E-XW-37	2.79 (71)	12 (305)	15 (381)	23 (584)	2.72 (1.23)
2	XW	20F-XW-37	3.00 (76)	12 (305)	18 (457)	26 (660)	3.62 (1.64)
3	XW	30F-XW-37	4.00 (102)	12 (305)	18 (457)	26 (660)	5.23 (2.37)
4	XW	40F-XW-37	5.00 (127)	14 (356)	22 (559)	32 (812)	7.89 (3.58)
5	XW	50F-XW-37	6.00 (152)	14 (356)	22 (559)	32 (812)	9.75 (4.43)
6	XW	60F-XW-37	7.00 (178)	14 (356)	22 (559)	32 (812)	12.08 (5.48)
8	XW	80E-XW-37	9.42 (239)	14 (356)	22 (559)	32 (812)	16.56 (7.52)

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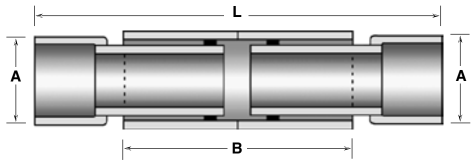


DOUBLE EXPANSION JOINT WITH O-RING

Double expansion joint is sometimes referred to as back-to-back expansion joint.

Installation of Expansion Joints:

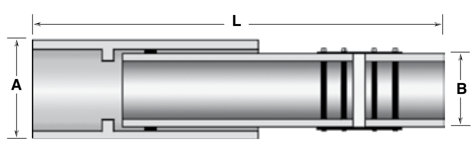
- When the duct is shorter than 100 ft., no Expansion Joint needed
- When the duct is between 100 ft. up to 300 ft., install one Expansion Joint at the mid point
- If the duct is longer than 300 ft., install one Expansion Joint every 300 ft. apart

Note: All Expansion Joints have a yellow line on the nipple end of the joint for proper installation.

Nominal							Weight	
Size	Type	IPS Item No.	A	B	L - Min	L - Max	lbs	kg
¾	SW	07E-SW-39	1.20 (30)	17 (432)	29 (737)	45 (1143)	0.84	(0.38)
1	SW	10E-SW-39	1.46 (37)	17 (432)	29 (737)	45 (1143)	0.94	(0.43)
1¼	SW	12E-SW-39	1.81 (46)	17 (432)	29 (737)	45 (1143)	1.14	(0.52)
1½	SW	15E-SW-39	2.04 (52)	17 (432)	29 (737)	45 (1143)	1.63	(0.74)
2	SW	20E-SW-39	2.54 (65)	17 (432)	29 (737)	45 (1143)	1.88	(0.85)
3	SW	30E-SW-39	3.66 (93)	17 (432)	29 (737)	45 (1143)	2.97	(1.35)
4	SW	40E-SW-39	4.61 (117)	17 (432)	29 (737)	45 (1143)	3.56	(1.62)
4	HW	40E-HW-39	4.69 (119)	17 (432)	29 (737)	45 (1143)	4.80	(2.18)
5	MW	50E-MW-39	5.79 (147)	17 (432)	29 (737)	45 (1143)	5.94	(2.70)
5	HW	50E-HW-39	5.85 (149)	17 (432)	29 (737)	45 (1143)	6.44	(2.92)
6	MW	60E-MW-39	6.85 (174)	17 (432)	29 (737)	45 (1143)	7.03	(3.19)
6	HW	60E-HW-39	6.91 (176)	17 (432)	29 (737)	45 (1143)	8.07	(3.66)

Nominal							Weight	
Size	Type	ID Item No.	A	B	L - Min	L - Max	lbs	kg
2	SW	20F-SW-39	2.30 (58)	17 (432)	29 (737)	45 (1143)	1.68	(0.76)
2½	SW	25F-SW-39	2.80 (71)	17 (432)	29 (737)	45 (1143)	2.08	(0.94)
3	SW	30F-SW-39	3.30 (84)	17 (432)	29 (737)	45 (1143)	2.38	(1.08)
3½	SW	35F-SW-39	3.80 (96)	17 (432)	29 (737)	45 (1143)	2.97	(1.35)
4	SW	40F-SW-39	4.30 (109)	17 (432)	29 (737)	45 (1143)	3.42	(1.55)
4	HW	40F-HW-39	4.39 (111)	17 (432)	29 (737)	45 (1143)	4.55	(2.07)
4½	SW	45F-SW-39	4.80 (122)	17 (432)	29 (737)	45 (1143)	3.71	(1.68)
4½	HW	45F-HW-39	4.89 (124)	17 (432)	29 (737)	45 (1143)	5.15	(2.34)
5	MW	50F-MW-39	5.39 (137)	17 (432)	29 (737)	45 (1143)	5.59	(2.54)
5	HW	50F-HW-39	5.42 (138)	17 (432)	29 (737)	45 (1143)	6.53	(2.97)
6	MW	60F-MW-39	6.39 (162)	17 (432)	29 (737)	45 (1143)	6.68	(3.03)
6	HW	60F-HW-39	6.42 (163)	17 (432)	29 (737)	45 (1143)	7.82	(3.55)

Nominal							Weight	
Size	Type	Item No.	A	B	L - Min	L - Max	lbs	kg
¾	XW	07E-XW-39	1.94 (54)	17 (432)	29 (737)	45 (1143)	3.01	(1.37)
1	XW	10E-XW-39	2.20 (61)	17 (432)	29 (737)	45 (1143)	3.36	(1.53)
1¼	XW	12E-XW-39	2.55 (65)	17 (432)	29 (737)	45 (1143)	4.06	(1.84)
1½	XW	15E-XW-39	2.79 (71)	17 (432)	29 (737)	45 (1143)	5.83	(2.65)
2	XW	20F-XW-39	3.00 (76)	17 (432)	29 (737)	45 (1143)	6.24	(2.83)
2½	XW	25F-XW-39	3.53 (90)	17 (432)	29 (737)	45 (1143)	7.63	(3.46)
3	XW	30F-XW-39	4.00 (102)	17 (432)	29 (737)	45 (1143)	9.01	(4.09)
3½	XW	35F-XW-39	4.53 (115)	17 (432)	29 (737)	45 (1143)	10.42	(4.72)
4	XW	40F-XW-39	5.00 (127)	17 (432)	29 (737)	45 (1143)	11.78	(5.35)
5	XW	50F-XW-39	6.00 (152)	17 (432)	29 (737)	45 (1143)	14.55	(6.61)
6	XW	60F-XW-39	7.00 (178)	17 (432)	29 (737)	45 (1143)	19.25	(8.74)



ALIGNMENT/EXPANSION FITTING, WITH O-RINGS

Alignment/Expansion fitting is sometimes referred to as an Expansion/Deflection joint.

(The clamps holding the rubber sleeve connecting the two nipples are made from stainless steel for corrosion protection.)

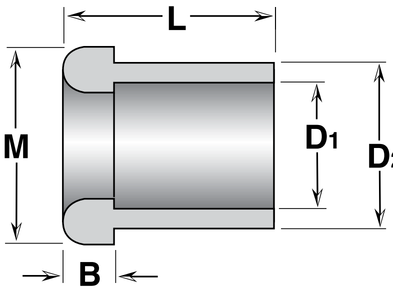
Same instructions & note as above

Nominal							Weight	
Size	Type	IPS Item No.	A	B	L - Min	L - Max	lbs	kg
¾	SW	07E-SW-31	1.20 (30)	1.1 (27)	37 (940)	51 (1295)	1.19	(0.54)
1	SW	10E-SW-31	1.46 (37)	1.3 (34)	37 (940)	51 (1295)	1.33	(0.60)
1¼	SW	12E-SW-31	1.81 (46)	1.7 (42)	37 (940)	51 (1295)	1.61	(0.73)
1½	SW	15E-SW-31	2.04 (52)	1.9 (49)	37 (940)	51 (1295)	2.31	(1.05)
2	SW	20E-SW-31	2.54 (65)	2.4 (61)	37 (940)	51 (1295)	2.66	(1.21)
3	SW	30E-SW-31	3.66 (93)	3.5 (89)	37 (940)	51 (1295)	4.20	(1.91)
4	SW	40E-SW-31	4.61 (117)	4.5 (114)	37 (940)	51 (1295)	5.04	(2.29)
4	HW	40E-HW-31	4.69 (119)	4.5 (115)	37 (940)	51 (1295)	6.79	(3.08)
5	MW	50E-MW-31	5.79 (147)	5.6 (142)	37 (940)	51 (1295)	8.40	(3.81)
5	HW	50E-HW-31	5.85 (149)	5.6 (143)	37 (940)	51 (1295)	9.10	(4.13)
6	MW	60E-MW-31	6.85 (174)	6.6 (167)	37 (940)	51 (1295)	9.94	(4.51)
6	HW	60E-HW-31	6.91 (176)	6.6 (168)	37 (940)	51 (1295)	11.41	(5.18)

Nominal							Weight	
Size	Type	ID Item No.	A	B	L - Min	L - Max	lbs	kg
2	SW	20F-SW-31	2.30 (58)	2.2 (55)	37 (940)	51 (1295)	2.38	(1.08)
2½	SW	25F-SW-31	2.80 (71)	2.7 (68)	37 (940)	51 (1295)	2.94	(1.34)
3	SW	30F-SW-31	3.30 (84)	3.2 (80)	37 (940)	51 (1295)	3.36	(1.53)
3½	SW	35F-SW-31	3.80 (96)	3.7 (93)	37 (940)	51 (1295)	4.20	(1.97)
4	SW	40F-SW-31	4.30 (109)	4.2 (106)	37 (940)	51 (1295)	4.83	(2.19)
4	HW	40F-HW-31	4.39 (111)	4.2 (107)	37 (940)	51 (1295)	6.44	(2.92)
4½	SW	45F-SW-31	4.80 (122)	4.7 (118)	37 (940)	51 (1295)	5.25	(2.38)
4½	HW	45F-HW-31	4.89 (124)	4.7 (119)	37 (940)	51 (1295)	7.28	(3.31)
5	MW	50F-MW-31	5.39 (137)	5.2 (132)	37 (940)	51 (1295)	7.91	(3.59)
5	HW	50F-HW-31	5.42 (138)	5.2 (133)	37 (940)	51 (1295)	9.24	(4.20)
6	MW	60F-MW-31	6.39 (162)	6.2 (157)	37 (940)	51 (1295)	9.45	(4.29)
6	HW	60F-HW-31	6.42 (163)	6.2 (158)	37 (940)	51 (1295)	11.06	(5.02)

Nominal							Weight	
Size	Type	Item No.	A	B	L - Min	L - Max	lbs	kg
¾	XW	07E-XW-31	1.94 (54)	1.410 (36)	37 (940)	51 (1295)	4.27	(1.94)
1	XW	10E-XW-31	2.20 (61)	1.675 (43)	37 (940)	51 (1295)	4.76	(2.16)
1¼	XW	12E-XW-31	2.55 (65)	2.020 (51)	37 (940)	51 (1295)	5.74	(2.60)
1½	XW	15E-XW-31	2.79 (71)	2.260 (57)	37 (940)	51 (1295)	8.26	(3.75)
2	XW	20F-XW-31	3.00 (76)	2.500 (64)	37 (940)	51 (1295)	8.82	(4.00)
2½	XW	25F-XW-31	3.53 (90)	3.000 (76)	37 (940)	51 (1295)	10.78	(4.89)
3	XW	30F-XW-31	4.00 (102)	3.500 (89)	37 (940)	51 (1295)	12.74	(5.78)
3½	XW	35F-XW-31	4.53 (115)	4.000 (102)	37 (940)	51 (1295)	14.70	(6.67)
4	XW	40F-XW-31	5.00 (127)	4.500 (114)	37 (940)	51 (1295)	16.66	(7.56)
5	XW	50F-XW-31	6.00 (152)	5.500 (140)	37 (940)	51 (1295)	20.58	(9.34)
6	XW	60F-XW-31	7.00 (178)	6.500 (165)	37 (940)	51 (1295)	24.50	(11.12)

Nominal Size	Type	IPS Item No.	D1	D2	L	M	Weight lbs	kg
¾	SW	07E-SW-29	1.06 (27)	1.20 (30)	1.60 (41)	1.50 (38)	0.10	(0.05)
1	SW	10E-SW-29	1.32 (34)	1.46 (37)	1.60 (41)	1.80 (46)	0.10	(0.05)
1¼	SW	12E-SW-29	1.67 (42)	1.81 (46)	1.60 (41)	2.20 (56)	0.15	(0.07)
1½	SW	15E-SW-29	1.91 (49)	2.04 (52)	1.60 (41)	2.40 (61)	0.20	(0.09)
2	SW	20E-SW-29	2.40 (61)	2.54 (61)	3.00 (76)	2.94 (75)	0.40	(0.18)
3	SW	30E-SW-29	3.52 (89)	3.66 (93)	3.00 (76)	4.06 (103)	0.45	(0.20)
4	SW	40E-SW-29	4.47 (114)	4.61 (117)	3.00 (76)	5.01 (127)	0.80	(0.36)
4	HW	40E-HW-29	4.52 (115)	4.69 (119)	3.00 (76)	5.09 (129)	0.85	(0.38)
5	MW	50E-MW-29	5.59 (142)	5.79 (147)	3.00 (76)	6.19 (157)	0.95	(0.43)
5	HW	50E-HW-29	5.63 (143)	5.85 (149)	3.00 (76)	6.25 (159)	1.00	(0.45)
6	MW	60E-MW-29	6.66 (169)	6.79 (172)	3.00 (76)	7.19 (183)	1.10	(0.50)
6	HW	60E-HW-29	6.69 (170)	6.85 (174)	3.00 (76)	7.25 (184)	1.15	(0.52)

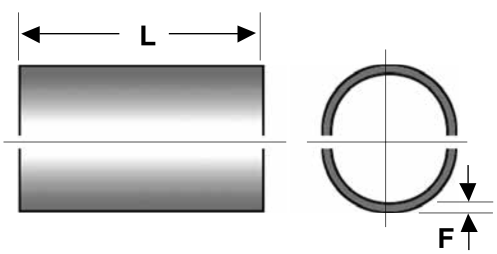


Nominal Size	Type	ID Item No.	D1	D2	L	M	Weight lbs	kg
2	SW	20F-SW-29	2.16 (55)	2.30 (58)	3.00 (76)	2.70 (69)	0.40	(0.18)
2½	SW	25F-SW-29	2.66 (68)	2.80 (71)	3.00 (76)	3.20 (81)	0.45	(0.20)
3	SW	30F-SW-29	3.16 (80)	3.30 (84)	3.00 (76)	3.70 (94)	0.55	(0.25)
3½	SW	35F-SW-29	3.66 (93)	3.80 (96)	3.00 (76)	4.20 (107)	0.60	(0.27)
4	SW	40F-SW-29	4.16 (106)	4.30 (109)	3.00 (76)	4.70 (119)	0.78	(0.35)
4	HW	40F-HW-29	4.20 (107)	4.39 (111)	3.00 (76)	4.79 (122)	0.95	(0.43)
4½	SW	45F-SW-29	4.66 (118)	4.80 (122)	3.00 (76)	5.20 (132)	0.85	(0.38)
4½	HW	45F-HW-29	4.70 (119)	4.89 (124)	3.00 (76)	5.29 (134)	0.90	(0.41)
5	MW	50F-MW-29	5.20 (132)	5.39 (137)	3.00 (76)	5.79 (147)	0.85	(0.39)
5	HW	50F-HW-29	5.24 (133)	5.42 (138)	3.00 (76)	5.82 (148)	0.87	(0.40)
6	MW	60F-MW-29	6.20 (157)	6.39 (162)	3.00 (76)	6.79 (172)	1.15	(0.52)
6	HW	60F-HW-29	6.24 (158)	6.42 (163)	3.00 (76)	6.82 (173)	1.25	(0.57)

END BELLS-SOCKET TYPE

End bells are used for creating a permanent termination into a box as well as having a smooth surface that the cable can be pulled over.

Nominal Size	Type	Item No.	D1	D2	L	M	Weight lbs	kg
¾	XW	07E-XW-29	1.44 (36)	1.935 (54)	1.60 (45)	2.48 (63)	0.63	(0.28)
1	XW	10E-XW-29	1.70 (43)	2.200 (61)	1.60 (45)	2.70 (68)	0.70	(0.32)
1¼	XW	12E-XW-29	2.05 (52)	2.545 (65)	1.60 (45)	3.11 (79)	0.85	(0.38)
1½	XW	15E-XW-29	2.29 (58)	2.785 (71)	1.60 (45)	3.35 (85)	1.22	(0.55)
2	XW	20F-XW-29	2.52 (64)	3.02 (76)	3.00 (76)	3.62 (92)	1.30	(0.59)
2½	XW	25F-XW-29	3.03 (77)	3.525 (90)	3.00 (76)	4.22 (107)	1.59	(0.72)
3	XW	30F-XW-29	3.52 (89)	4.02 (102)	3.00 (76)	4.62 (117)	1.90	(0.86)
3½	XW	35F-XW-29	4.03 (102)	4.525 (115)	3.00 (76)	5.48 (139)	2.17	(0.98)
4	XW	40F-XW-29	4.52 (115)	5.02 (128)	5.00 (127)	5.62 (143)	2.40	(1.09)
5	XW	50F-XW-29	5.52 (140)	6.02 (153)	5.00 (127)	6.62 (168)	2.42	(1.10)
6	XW	60F-XW-29	6.52 (166)	7.02 (178)	5.00 (127)	7.62 (194)	2.50	(1.13)



Side View End View

Nominal Size	Type	IPS Item No.	ID Item No.	F	L	Weight lbs	kg
¾	SW	07E-SW-28	—	0.25 (6)	3.0 (76)	0.18	(0.08)
1	SW	10E-SW-28	—	0.25 (6)	3.0 (76)	0.21	(0.10)
1¼	SW	12E-SW-28	—	0.25 (6)	3.0 (76)	0.26	(0.12)
1½	SW	15E-SW-28	—	0.25 (6)	3.0 (76)	0.36	(0.16)
2	SW	20E-SW-28	20F-SW-28	0.25 (6)	3.0 (76)	0.42	(0.19)
2½	SW	25E-SW-28	25F-SW-28	0.25 (6)	3.0 (76)	0.48	(0.22)
3	SW	30E-SW-28	30F-SW-28	0.25 (6)	3.0 (76)	0.67	(0.30)
3½	SW	—	35F-SW-28	0.25 (6)	3.0 (76)	0.76	(0.34)
4	SW	40E-SW-28	40F-SW-28	0.25 (6)	3.0 (76)	0.80	(0.36)
4	HW	40E-HW-28	40F-HW-28	0.25 (6)	3.0 (76)	0.80	(0.36)
4½	SW	—	45F-SW-28	0.25 (6)	3.0 (76)	0.91	(0.41)
4½	HW	—	45F-HW-28	0.25 (6)	3.0 (76)	0.91	(0.41)
5	MW	50E-MW-28	50F-MW-28	0.25 (6)	3.0 (76)	1.06	(0.48)
5	HW	50E-HW-28	50F-HW-28	0.25 (6)	3.0 (76)	1.06	(0.48)
6	MW	60E-MW-28	60F-MW-28	0.25 (6)	3.0 (76)	1.15	(0.52)
6	HW	60E-HW-28	60F-HW-28	0.25 (6)	3.0 (76)	1.15	(0.52)

SPLIT ANCHOR RINGS

Split anchor rings are supplied in pairs and are used to create fixed points. The split anchor rings are placed around the support system, close to the mid point between two expansion joints. One pair of split anchor rings is placed on each side of the support system. Split anchor rings are bonded to the outside of the conduit with FLAME SHIELD® Mix.

Nominal Size	Type	Item No.	F	L	Weight lbs	kg
¾	XW	07E-XW-28	0.25 (6)	3 (76)	0.25	(0.11)
1	XW	10E-XW-28	0.25 (6)	3 (76)	0.28	(0.13)
1¼	XW	12E-XW-28	0.25 (6)	3 (76)	0.34	(0.15)
1½	XW	15E-XW-28	0.25 (6)	3 (76)	0.49	(0.22)
2	XW	20F-XW-28	0.25 (6)	3 (76)	0.52	(0.24)
2½	XW	25F-XW-28	0.25 (6)	3 (76)	0.64	(0.29)
3	XW	30F-XW-28	0.25 (6)	3 (76)	0.80	(0.36)
3½	XW	35F-XW-28	0.25 (6)	3 (76)	0.87	(0.39)
4	XW	40F-XW-28	0.25 (6)	3 (76)	0.98	(0.44)
5	XW	50F-XW-28	0.25 (6)	3 (76)	1.15	(0.52)
6	XW	60F-XW-28	0.25 (6)	3 (76)	1.25	(0.57)

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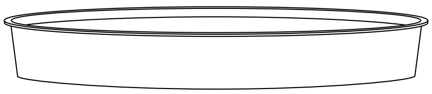
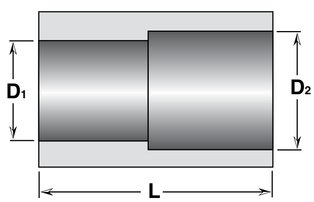


THERMOPLASTIC PLUG

Nominal Size	Type	IPS Item No.	ID Item No.	Weight lbs	kg
¾	SW	07C-SW-26	—	0.01	***(0.005)***
1	SW	10C-SW-26	—	0.01	***(0.005)***
1¼	SW	12C-SW-26	—	0.01	***(0.005)***
1½	SW	15C-SW-26	—	0.01	***(0.005)***
2	SW	20C-SW-26	20D-SW-26	0.01	***(0.005)***
2½	SW	25C-SW-26	25D-SW-26	0.01	***(0.005)***
3	SW	30C-SW-26	30D-SW-26	0.03	***(0.014)***
3½	SW	—	35D-SW-26	0.03	***(0.014)***
4	SW	40C-SW-26	40D-SW-26	0.03	***(0.014)***
4	HW	40C-HW-26	40D-HW-26	0.03	***(0.014)***
4½	SW	—	45D-SW-26	0.05	***(0.023)***
4½	HW	—	45D-HW-26	0.05	***(0.023)***
5	MW	50C-MW-26	50D-MW-26	0.06	***(0.027)***
5	HW	50C-HW-26	50D-HW-26	0.06	***(0.027)***
6	MW	60C-MW-26	60D-MW-26	0.07	***(0.032)***
6	HW	60C-HW-26	60D-HW-26	0.07	***(0.032)***

Nominal Size	Type	Item No.	Weight lbs	kg
¾	XW	07C-XW-26	0.01	***(0.005)***
1	XW	10C-XW-26	0.01	***(0.005)***
1¼	XW	12C-XW-26	0.01	***(0.005)***
1½	XW	15C-XW-26	0.01	***(0.005)***
2	XW	20D-XW-26	0.01	***(0.005)***
2½	XW	25D-XW-26	0.01	***(0.005)***
3	XW	30D-XW-26	0.03	***(0.014)***
3½	XW	35D-XW-26	0.03	***(0.014)***
4	XW	40D-XW-26	0.03	***(0.014)***
5	XW	50D-XW-26	0.06	***(0.027)***
6	XW	60D-XW-26	0.07	***(0.032)***

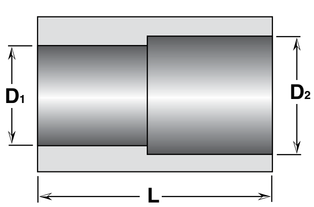


REDUCING ADAPTER

Transition adapter from ID/tubular phenolic conduit to IPS type.

Nominal Size	Type	Item No.	D1	D2	L	Weight lbs	kg
2	SW	20F-SW-27	2.16 ***(55)***	2.40 ***(61)***	6 ***(152)***	0.30	***(0.14)***
3	SW	30F-SW-27	3.16 ***(80)***	3.52 ***(89)***	6 ***(152)***	0.50	***(0.23)***
4	SW	40F-SW-27	4.16 ***(106)***	4.47 ***(114)***	6 ***(152)***	0.60	***(0.27)***
4	HW	40F-HW-27	4.20 ***(107)***	4.52 ***(115)***	6 ***(152)***	0.70	***(0.32)***
5	MW	50F-MW-27	5.20 ***(132)***	5.59 ***(142)***	6 ***(152)***	0.90	***(0.41)***
5	HW	50F-HW-27	5.24 ***(133)***	5.63 ***(143)***	6 ***(152)***	1.00	***(0.45)***
6	MW	60F-MW-27	6.20 ***(157)***	6.66 ***(169)***	6 ***(152)***	1.10	***(0.50)***
6	HW	60F-HW-27	6.24 ***(158)***	6.69 ***(170)***	6 ***(152)***	1.20	***(0.55)***

Note: These are just examples of some reducing adapters. Contact Champion Fiberglass directly for other reducers.

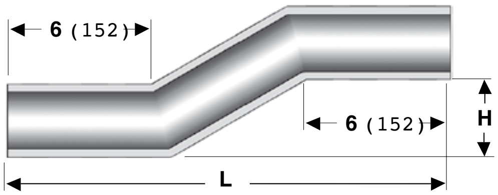


REDUCING ADAPTER

This adapter is used for transition between different diameters of IPS phenolic conduit.

Nominal Size	IPS Item No.	D1	D2	L	Weight lbs	kg
1 SW - ¾ SW	10E-SW-25-07E-SW	1.06 ***(27)***	1.32 ***(34)***	4 ***(101)***	0.35	***(0.16)***
1¼ SW - ¾ SW	12E-SW-25-07E-SW	1.06 ***(27)***	1.67 ***(42)***	4 ***(101)***	0.45	***(0.20)***
1¼ SW - 1 SW	12E-SW-25-10E-SW	1.32 ***(34)***	1.67 ***(42)***	4 ***(101)***	0.40	***(0.18)***
1½ SW - ¾ SW	15E-SW-25-07E-SW	1.06 ***(27)***	1.91 ***(48)***	4 ***(101)***	0.38	***(0.17)***
1½ SW - 1 SW	15E-SW-25-10E-SW	1.32 ***(34)***	1.91 ***(48)***	4 ***(101)***	0.40	***(0.18)***
1½ SW - 1¼ SW	15E-SW-25-12E-SW	1.67 ***(42)***	1.91 ***(48)***	6 ***(152)***	0.37	***(0.17)***
2 SW - ¾ SW	20E-SW-25-07E-SW	1.06 ***(27)***	2.40 ***(61)***	6 ***(152)***	0.60	***(0.27)***
2 SW - 1 SW	20E-SW-25-10E-SW	1.32 ***(34)***	2.40 ***(61)***	6 ***(152)***	0.55	***(0.25)***
2 SW - 1¼ SW	20E-SW-25-12E-SW	1.67 ***(42)***	2.40 ***(61)***	6 ***(152)***	0.50	***(0.23)***
2 SW - 1½ SW	20E-SW-25-15E-SW	1.91 ***(48)***	2.40 ***(61)***	6 ***(152)***	0.47	***(0.21)***
3 SW - 2 SW	30E-SW-25-20E-SW	2.40 ***(61)***	3.52 ***(89)***	6 ***(152)***	0.65	***(0.32)***
4 SW - 2 SW	40E-SW-25-20E-SW	2.40 ***(61)***	4.47 ***(113)***	6 ***(152)***	0.80	***(0.36)***
4 SW - 3 SW	40E-SW-25-30E-SW	3.52 ***(89)***	4.47 ***(113)***	6 ***(152)***	0.90	***(0.41)***
5 MW - 3 SW	50E-MW-25-30E-SW	3.52 ***(89)***	5.59 ***(142)***	6 ***(152)***	1.30	***(0.59)***
5 MW - 4 SW	50E-MW-25-40E-SW	4.47 ***(114)***	5.59 ***(142)***	6 ***(152)***	0.85	***(0.39)***
6 MW - 4 SW	60E-MW-25-40E-SW	4.47 ***(114)***	6.61 ***(166)***	6 ***(152)***	1.70	***(0.77)***
6 MW - 5 MW	60E-MW-25-50E-MW	5.59 ***(142)***	6.61 ***(166)***	6 ***(152)***	1.90	***(0.86)***

Note: These are just examples of some reducing adapters. Contact Champion Fiberglass directly for other reducers.

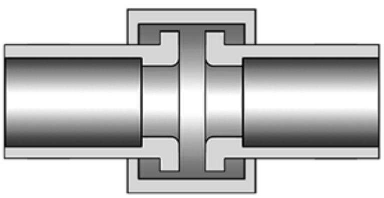


OFFSET BEND

When manufacturing offset bends, the vertical offset dimension, H and the horizontal offset dimension, L, need to be specified.

All offset bends are supplied with 6" ***(152mm)*** straight ends. (Item numbers for offset bends end with the suffix - 47)

Contact your local sales representative or Champion Fiberglass directly for information.



WOBBLE COUPLING

Wobble couplings are used for minor vertical and horizontal offsets for above ground installations. (Item numbers for wobble couplings end with the suffix - 48)

For further information regarding dimensions, etc., please contact your local sales representative or Champion Fiberglass directly.

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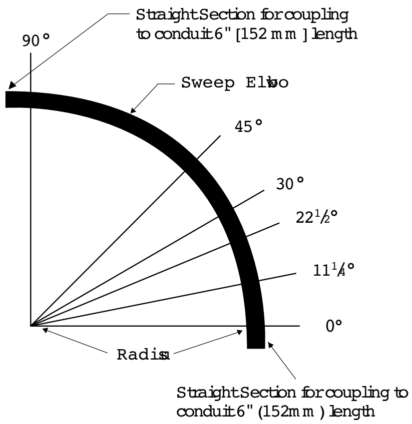
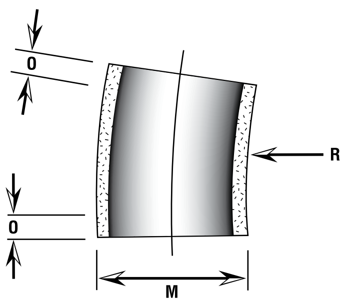


ELBOWS

Radii listed are available and larger radii can be supplied. Contact your local representative for more information. All bends are supplied with plain ends. To enhance installation, bends can be supplied with one or two bonded on couplings. Please specify if such an arrangement is required.

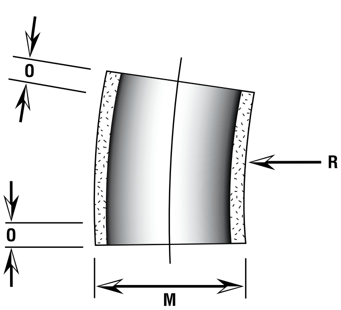


11¼° X 12"

Nominal Size	Type	IPS Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	SW	07E-SW-50-P	1.05 ***(27)***	6 ***(152)***	12 ***(305)***	0.20	***(0.09)***
1	SW	10E-SW-50-P	1.32 ***(33)***	6 ***(152)***	12 ***(305)***	0.22	***(0.10)***
1¼	SW	12E-SW-50-P	1.66 ***(42)***	6 ***(152)***	12 ***(305)***	0.27	***(0.12)***
1½	SW	15E-SW-50-P	1.90 ***(48)***	6 ***(152)***	12 ***(305)***	0.39	***(0.18)***
2	SW	20E-SW-50-P	2.37 ***(60)***	6 ***(152)***	12 ***(305)***	0.44	***(0.20)***
2½	SW	25E-SW-50-P	2.88 ***(73)***	6 ***(152)***	12 ***(305)***	0.54	***(0.25)***

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
2	SW	20F-SW-50-P	2.14 ***(54)***	6 ***(152)***	12 ***(305)***	0.40	***(0.18)***
2½	SW	25F-SW-50-P	2.64 ***(67)***	6 ***(152)***	12 ***(305)***	0.49	***(0.22)***

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	XW	07E-XW-50-P	1.41 ***(36)***	6 ***(152)***	12 ***(305)***	0.71	***(0.32)***
1	XW	10E-XW-50-P	1.68 ***(43)***	6 ***(152)***	12 ***(305)***	0.79	***(0.36)***
1¼	XW	12E-XW-50-P	2.02 ***(51)***	6 ***(152)***	12 ***(305)***	0.96	***(0.43)***
1½	XW	15E-XW-50-P	2.26 ***(57)***	6 ***(152)***	12 ***(305)***	1.38	***(0.63)***
2	XW	20F-XW-50-P	2.50 ***(63)***	6 ***(152)***	12 ***(305)***	1.47	***(0.67)***
2½	XW	25F-XW-50-P	3.00 ***(76)***	6 ***(152)***	12 ***(305)***	1.80	***(0.82)***
3	XW	30F-XW-50-P	3.50 ***(89)***	6 ***(152)***	12 ***(305)***	2.18	***(0.99)***
3½	XW	35F-XW-50-P	4.00 ***(102)***	6 ***(152)***	12 ***(305)***	2.45	***(1.11)***



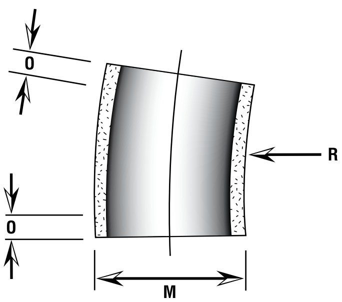
11¼° X 24"

Nominal Size	Type	IPS Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	SW	07E-SW-51-P	1.05 ***(27)***	6 ***(152)***	24 ***(610)***	0.24	***(0.11)***
1	SW	10E-SW-51-P	1.32 ***(33)***	6 ***(152)***	24 ***(610)***	0.27	***(0.12)***
1¼	SW	12E-SW-51-P	1.66 ***(42)***	6 ***(152)***	24 ***(610)***	0.33	***(0.15)***
1½	SW	15E-SW-51-P	1.90 ***(48)***	6 ***(152)***	24 ***(610)***	0.47	***(0.21)***
2	SW	20E-SW-51-P	2.37 ***(60)***	6 ***(152)***	24 ***(610)***	0.54	***(0.25)***
2½	SW	25E-SW-51-P	2.88 ***(73)***	6 ***(152)***	24 ***(610)***	0.65	***(0.30)***
3	SW	30E-SW-51-P	3.50 ***(89)***	6 ***(152)***	24 ***(610)***	0.85	***(0.38)***
4	SW	40E-SW-51-P	4.46 ***(113)***	6 ***(152)***	24 ***(610)***	1.02	***(0.46)***
4	HW	40E-HW-51-P	4.51 ***(114)***	6 ***(152)***	24 ***(610)***	1.37	***(0.61)***

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
2	SW	20F-SW-51-P	2.14 ***(54)***	6 ***(152)***	24 ***(610)***	0.48	***(0.22)***
2½	SW	25F-SW-51-P	2.64 ***(67)***	6 ***(152)***	24 ***(610)***	0.60	***(0.27)***
3	SW	30F-SW-51-P	3.14 ***(80)***	6 ***(152)***	24 ***(610)***	0.68	***(0.25)***
3½	SW	35F-SW-51-P	3.64 ***(92)***	6 ***(152)***	24 ***(610)***	0.86	***(0.39)***
4	SW	40F-SW-51-P	4.14 ***(105)***	6 ***(152)***	24 ***(610)***	0.98	***(0.45)***
4	HW	40F-HW-51-P	4.19 ***(106)***	6 ***(152)***	24 ***(610)***	1.48	***(0.67)***

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	XW	07E-XW-51-P	1.41 ***(36)***	6 ***(152)***	24 ***(610)***	0.87	***(0.39)***
1	XW	10E-XW-51-P	1.68 ***(43)***	6 ***(152)***	24 ***(610)***	0.97	***(0.44)***
1¼	XW	12E-XW-51-P	2.02 ***(51)***	6 ***(152)***	24 ***(610)***	1.16	***(0.53)***
1½	XW	15E-XW-51-P	2.26 ***(57)***	6 ***(152)***	24 ***(610)***	1.68	***(0.76)***
2	XW	20F-XW-51-P	2.50 ***(63)***	6 ***(152)***	24 ***(610)***	1.79	***(0.81)***
2½	XW	25F-XW-51-P	3.00 ***(76)***	6 ***(152)***	24 ***(610)***	2.19	***(0.99)***
3	XW	30F-XW-51-P	3.50 ***(89)***	6 ***(152)***	24 ***(610)***	2.58	***(1.17)***
3½	XW	35F-XW-51-P	4.00 ***(102)***	6 ***(152)***	24 ***(610)***	2.98	***(1.35)***
4	XW	40F-XW-51-P	4.50 ***(114)***	6 ***(152)***	24 ***(610)***	3.38	***(1.53)***

PHENOLIC ELBOWS

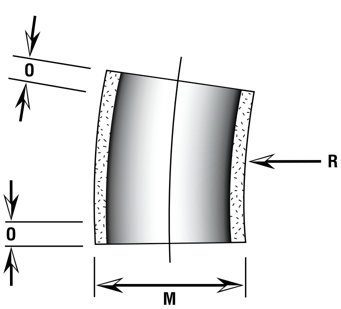


11¼° X 36"

Nominal Size	Type	IPS Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	SW	07E-SW-52-P	1.05 (27)	6 (152)	36 (914)	0.27	(0.12)
1	SW	10E-SW-52-P	1.32 (33)	6 (152)	36 (914)	0.30	(0.14)
1¼	SW	12E-SW-52-P	1.66 (42)	6 (152)	36 (914)	0.36	(0.16)
1½	SW	15E-SW-52-P	1.90 (48)	6 (152)	36 (914)	0.52	(0.24)
2	SW	20E-SW-52-P	2.37 (60)	6 (152)	36 (914)	0.60	(0.27)
2½	SW	25E-SW-52-P	2.88 (73)	6 (152)	36 (914)	0.73	(0.33)
3	SW	30E-SW-52-P	3.50 (89)	6 (152)	36 (914)	0.95	(0.43)
4	SW	40E-SW-52-P	4.46 (113)	6 (152)	36 (914)	1.14	(0.52)
4	HW	40E-HW-52-P	4.51 (114)	6 (152)	36 (914)	1.54	(0.70)
5	MW	50E-MW-52-P	5.57 (141)	6 (152)	36 (914)	1.90	(0.86)
5	HW	50E-HW-52-P	5.60 (152)	6 (152)	36 (914)	2.10	(0.95)
6	MW	60E-MW-52-P	6.63 (168)	6 (152)	36 (914)	2.25	(1.02)
6	HW	60E-HW-52-P	6.66 (169)	6 (152)	36 (914)	2.59	(1.17)

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
2	SW	20F-SW-52-P	2.14 (54)	6 (152)	36 (914)	0.54	(0.25)
2½	SW	25F-SW-52-P	2.64 (67)	6 (152)	36 (914)	0.67	(0.30)
3	SW	30F-SW-52-P	3.14 (80)	6 (152)	36 (914)	0.76	(0.35)
3½	SW	35F-SW-52-P	3.64 (92)	6 (152)	36 (914)	0.95	(0.43)
4	SW	40F-SW-52-P	4.14 (105)	6 (152)	36 (914)	1.09	(0.50)
4	HW	40F-HW-52-P	4.19 (106)	6 (152)	36 (914)	1.46	(0.66)
4½	SW	45F-SW-52-P	4.64 (117)	6 (152)	36 (914)	1.19	(0.54)
4½	HW	45F-HW-52-P	4.69 (118)	6 (152)	36 (914)	1.65	(0.75)
5	MW	50F-MW-52-P	5.19 (132)	6 (152)	36 (914)	1.78	(0.81)
5	HW	50F-HW-52-P	5.22 (132)	6 (152)	36 (914)	2.05	(0.93)
6	MW	60F-MW-52-P	6.19 (157)	6 (152)	36 (914)	2.13	(0.97)
6	HW	60F-HW-52-P	6.22 (158)	6 (152)	36 (914)	2.50	(1.00)

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	XW	07E-XW-52-P	1.41 (36)	6 (152)	36 (914)	0.97	(0.44)
1	XW	10E-XW-52-P	1.68 (43)	6 (152)	36 (914)	1.08	(0.49)
1¼	XW	12E-XW-52-P	2.02 (51)	6 (152)	36 (914)	1.30	(0.59)
1½	XW	15E-XW-52-P	2.26 (57)	6 (152)	36 (914)	1.87	(0.85)
2	XW	20F-XW-52-P	2.50 (64)	6 (152)	36 (914)	2.00	(0.91)
2½	XW	25F-XW-52-P	3.00 (76)	6 (152)	36 (914)	2.44	(1.11)
3	XW	30F-XW-52-P	3.50 (89)	6 (152)	36 (914)	2.88	(1.31)
3½	XW	35F-XW-52-P	4.00 (102)	6 (152)	36 (914)	3.33	(1.51)
4	XW	40F-XW-52-P	4.50 (114)	6 (152)	36 (914)	3.77	(3.77)
5	XW	50F-XW-52-P	5.50 (140)	6 (152)	36 (914)	4.64	(2.11)
6	XW	60F-XW-52-P	6.50 (165)	6 (152)	36 (914)	5.53	(2.51)



11¼° X 48"

Nominal Size	Type	IPS Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	SW	07E-SW-53-P	1.05 (27)	6 (152)	48 (1,219)	0.31	(0.14)
1	SW	10E-SW-53-P	1.32 (33)	6 (152)	48 (1,219)	0.35	(0.16)
1¼	SW	12E-SW-53-P	1.66 (42)	6 (152)	48 (1,219)	0.42	(0.19)
1½	SW	15E-SW-53-P	1.90 (48)	6 (152)	48 (1,219)	0.61	(0.28)
2	SW	20E-SW-53-P	2.37 (60)	6 (152)	48 (1,219)	0.70	(0.32)
2½	SW	25E-SW-53-P	2.88 (73)	6 (152)	48 (1,219)	0.84	(0.38)
3	SW	30E-SW-53-P	3.50 (89)	6 (152)	48 (1,219)	1.10	(0.50)
4	SW	40E-SW-53-P	4.46 (113)	6 (152)	48 (1,219)	1.32	(0.60)
4	HW	40E-HW-53-P	4.51 (114)	6 (152)	48 (1,219)	1.78	(0.81)
5	MW	50E-MW-53-P	5.57 (141)	6 (152)	48 (1,219)	2.20	(1.00)
5	HW	50E-HW-53-P	5.60 (142)	6 (152)	48 (1,219)	2.38	(1.08)
6	MW	60E-MW-53-P	6.63 (168)	6 (152)	60 (1,524)	2.60	(1.18)
6	HW	60E-HW-53-P	6.66 (169)	6 (152)	60 (1,524)	2.98	(1.35)

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
2	SW	20F-SW-53-P	2.14 (54)	6 (152)	48 (1,219)	0.62	(0.36)
2½	SW	25F-SW-53-P	2.64 (67)	6 (152)	48 (1,219)	0.77	(0.45)
3	SW	30F-SW-53-P	3.14 (80)	6 (152)	48 (1,219)	0.88	(0.55)
3½	SW	35F-SW-53-P	3.64 (92)	6 (152)	48 (1,219)	1.10	(0.55)
4	SW	40F-SW-53-P	4.14 (105)	6 (152)	48 (1,219)	1.27	(0.64)
4	HW	40F-HW-53-P	4.19 (106)	6 (152)	48 (1,219)	1.69	(0.86)
4½	SW	45F-SW-53-P	4.64 (117)	6 (152)	48 (1,219)	1.38	(0.73)
4½	HW	45F-HW-53-P	4.69 (118)	6 (152)	48 (1,219)	1.91	(0.95)
5	MW	50F-MW-53-P	5.19 (132)	6 (152)	48 (1,219)	2.07	(1.14)
5	HW	50F-HW-53-P	5.22 (133)	6 (152)	48 (1,219)	2.42	(1.27)
6	MW	60F-MW-53-P	6.19 (157)	6 (152)	48 (1,219)	3.34	(1.52)
6	HW	60F-HW-53-P	6.22 (158)	6 (152)	48 (1,219)	4.36	(1.98)

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	XW	07E-XW-53-P	1.41 (36)	6 (152)	48 (1,219)	1.09	(0.50)
1	XW	10E-XW-53-P	1.68 (43)	6 (152)	48 (1,219)	1.21	(0.55)
1¼	XW	12E-XW-53-P	2.02 (51)	6 (152)	48 (1,219)	1.46	(0.66)
1½	XW	15E-XW-53-P	2.26 (57)	6 (152)	48 (1,219)	2.11	(0.95)
2	XW	20F-XW-53-P	2.50 (64)	6 (152)	48 (1,219)	2.29	(1.04)
2½	XW	25F-XW-53-P	3.00 (76)	6 (152)	48 (1,219)	2.83	(1.29)
3	XW	30F-XW-53-P	3.50 (89)	6 (152)	48 (1,219)	3.34	(1.51)
3½	XW	35F-XW-53-P	4.00 (102)	6 (152)	48 (1,219)	3.86	(1.75)
4	XW	40F-XW-53-P	4.50 (114)	6 (152)	48 (1,219)	4.38	(1.99)
5	XW	50F-XW-53-P	5.50 (140)	6 (152)	48 (1,219)	5.41	(2.46)
6	XW	60F-XW-53-P	6.50 (165)	6 (152)	48 (1,219)	6.44	(2.92)

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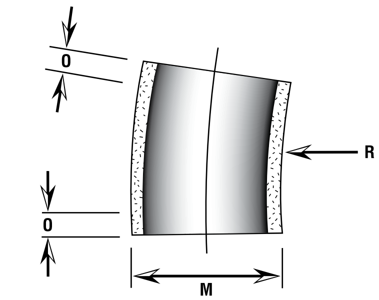
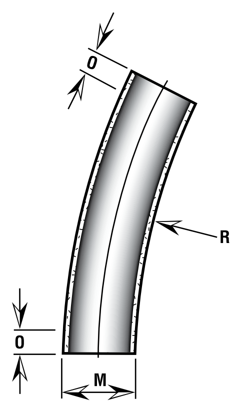


11¼° X 60"

Nominal Size	Type	IPS Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	SW	07E-SW-54-P	1.05 *(27)*	6 *(152)*	60 *(1,524)*	0.34	*(0.15)*
1	SW	10E-SW-54-P	1.32 *(33)*	6 *(152)*	60 *(1,524)*	0.38	*(0.17)*
1¼	SW	12E-SW-54-P	1.66 *(42)*	6 *(152)*	60 *(1,524)*	0.46	*(0.21)*
1½	SW	15E-SW-54-P	1.90 *(48)*	6 *(152)*	60 *(1,524)*	0.66	*(0.30)*
2	SW	20E-SW-54-P	2.37 *(60)*	6 *(152)*	60 *(1,524)*	0.76	*(0.35)*
2½	SW	25E-SW-54-P	2.88 *(73)*	6 *(152)*	60 *(1,524)*	0.92	*(0.42)*
3	SW	30E-SW-54-P	3.50 *(89)*	6 *(152)*	60 *(1,524)*	1.20	*(0.55)*
4	SW	40E-SW-54-P	4.46 *(113)*	6 *(152)*	60 *(1,524)*	1.44	*(0.65)*
4	HW	40E-HW-54-P	4.51 *(115)*	6 *(152)*	60 *(1,524)*	1.94	*(0.88)*
5	MW	50E-MW-54-P	5.57 *(141)*	6 *(152)*	60 *(1,524)*	2.40	*(1.09)*
5	HW	50E-HW-54-P	5.60 *(142)*	6 *(152)*	60 *(1,524)*	2.60	*(1.18)*
6	MW	60E-MW-54-P	6.63 *(168)*	6 *(152)*	60 *(1,524)*	2.84	*(1.29)*
6	HW	60E-HW-54-P	6.66 *(169)*	6 *(152)*	60 *(1,524)*	3.26	*(1.48)*

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
2	SW	20F-SW-54-P	2.14 *(54)*	6 *(152)*	60 *(1,524)*	0.68	*(0.31)*
2½	SW	25F-SW-54-P	2.64 *(67)*	6 *(152)*	60 *(1,524)*	0.84	*(0.38)*
3	SW	30F-SW-54-P	3.14 *(80)*	6 *(152)*	60 *(1,524)*	0.96	*(0.44)*
3½	SW	35F-SW-54-P	3.64 *(92)*	6 *(152)*	60 *(1,524)*	1.20	*(0.55)*
4	SW	40F-SW-54-P	4.14 *(105)*	6 *(152)*	60 *(1,524)*	1.38	*(0.63)*
4	HW	40F-HW-54-P	4.19 *(106)*	6 *(152)*	60 *(1,524)*	1.84	*(0.83)*
4½	SW	45F-SW-54-P	4.64 *(117)*	6 *(152)*	60 *(1,524)*	1.50	*(0.68)*
4½	HW	45F-HW-54-P	4.69 *(118)*	6 *(152)*	60 *(1,524)*	2.08	*(0.94)*
5	MW	50F-MW-54-P	5.19 *(132)*	6 *(152)*	60 *(1,524)*	2.26	*(1.03)*
5	HW	50F-HW-54-P	5.22 *(132)*	6 *(152)*	60 *(1,524)*	2.64	*(1.20)*
6	MW	60F-MW-54-P	6.19 *(157)*	6 *(152)*	60 *(1,524)*	2.70	*(1.23)*
6	HW	60F-HW-54-P	6.22 *(158)*	6 *(152)*	60 *(1,524)*	3.16	*(1.44)*

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	XW	07E-XW-54-P	1.41 *(36)*	6 *(152)*	60 *(1,524)*	1.21	*(0.55)*
1	XW	10E-XW-54-P	1.68 *(43)*	6 *(152)*	60 *(1,524)*	1.35	*(0.61)*
1¼	XW	12E-XW-54-P	2.02 *(51)*	6 *(152)*	60 *(1,524)*	1.62	*(0.73)*
1½	XW	15E-XW-54-P	2.26 *(57)*	6 *(152)*	60 *(1,524)*	2.34	*(1.05)*
2	XW	20F-XW-54-P	2.50 *(65)*	6 *(152)*	60 *(1,524)*	2.52	*(1.44)*
2½	XW	25F-XW-54-P	3.00 *(76)*	6 *(152)*	60 *(1,524)*	3.08	*(1.40)*
3	XW	30F-XW-54-P	3.50 *(89)*	6 *(152)*	60 *(1,524)*	3.64	*(1.65)*
3½	XW	35F-XW-54-P	4.00 *(102)*	6 *(152)*	60 *(1,524)*	4.20	*(1.91)*
4	XW	40F-XW-54-P	4.50 *(114)*	6 *(152)*	60 *(1,524)*	4.76	*(2.16)*
5	XW	50F-XW-54-P	5.50 *(140)*	6 *(152)*	60 *(1,524)*	5.88	*(2.67)*
6	XW	60F-XW-54-P	6.50 *(165)*	6 *(152)*	60 *(1,524)*	7.00	*(3.18)*



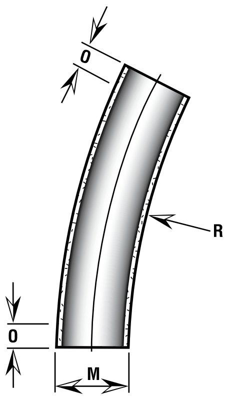
22½° X 12"

Nominal Size	Type	IPS Item No.	M	O-Tangent (min.)	R-Radius (min.)	Weight lbs	kg
¾	SW	07E-SW-60-P	1.05 *(27)*	6 *(152)*	12 *(305)*	0.24	*(0.11)*
1	SW	10E-SW-60-P	1.32 *(33)*	6 *(152)*	12 *(305)*	0.27	*(0.12)*
1¼	SW	12E-SW-60-P	1.66 *(42)*	6 *(152)*	12 *(305)*	0.33	*(0.15)*
1½	SW	15E-SW-60-P	1.90 *(48)*	6 *(152)*	12 *(305)*	0.47	*(0.21)*
2	SW	20E-SW-60-P	2.37 *(60)*	6 *(152)*	12 *(305)*	0.54	*(0.25)*
2½	SW	25E-SW-60-P	2.88 *(73)*	6 *(152)*	12 *(305)*	0.65	*(0.30)*

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
2	SW	20F-SW-60-P	2.14 *(54)*	6 *(152)*	12 *(305)*	0.48	*(0.22)*
2½	SW	25F-SW-60-P	2.64 *(67)*	6 *(152)*	12 *(305)*	0.60	*(0.27)*

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	XW	07E-XW-60-P	1.41 *(36)*	6 *(152)*	12 *(305)*	0.87	*(0.39)*
1	XW	10E-XW-60-P	1.68 *(43)*	6 *(152)*	12 *(305)*	0.97	*(0.44)*
1¼	XW	12E-XW-60-P	2.02 *(51)*	6 *(152)*	12 *(305)*	1.16	*(0.53)*
1½	XW	15E-XW-60-P	2.26 *(57)*	6 *(152)*	12 *(305)*	1.68	*(0.76)*
2	XW	20F-XW-60-P	2.50 *(63)*	6 *(152)*	12 *(305)*	1.79	*(0.81)*
2½	XW	25F-XW-60-P	3.00 *(76)*	6 *(152)*	12 *(305)*	2.19	*(0.99)*
3	XW	30F-XW-60-P	3.50 *(89)*	6 *(152)*	12 *(305)*	2.58	*(1.17)*
3½	XW	35F-XW-60-P	4.00 *(102)*	6 *(152)*	12 *(305)*	2.98	*(1.35)*

PHENOLIC ELBOWS

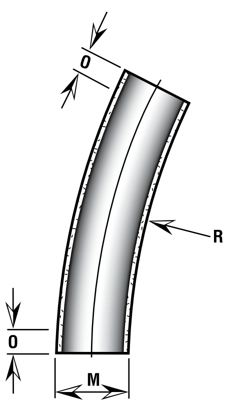


22½° X 24"

Nominal Size	Type	IPS Item No.	M	O-Tangent (min.)	R-Radius (min.)	Weight lbs kg
¾	SW	07E-SW-61-P	1.05 (27)	6 (152)	24 (610)	0.30 (0.14)
1	SW	10E-SW-61-P	1.32 (33)	6 (152)	24 (610)	0.33 (0.15)
1¼	SW	12E-SW-61-P	1.66 (42)	6 (152)	24 (610)	0.40 (0.18)
1½	SW	15E-SW-61-P	1.90 (48)	6 (152)	24 (610)	0.58 (0.26)
2	SW	20E-SW-61-P	2.37 (60)	6 (152)	24 (610)	0.67 (0.30)
2½	SW	25E-SW-61-P	2.88 (73)	6 (152)	24 (610)	0.81 (0.37)
3	SW	30E-SW-61-P	3.50 (89)	6 (152)	24 (610)	1.06 (0.48)
4	SW	40E-SW-61-P	4.46 (113)	6 (152)	24 (610)	1.27 (0.58)
4	HW	40E-HW-61-P	4.51 (114)	6 (152)	24 (610)	1.71 (0.78)

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs kg
2	SW	20F-SW-61-P	2.14 (54)	6 (152)	24 (610)	0.60 (0.27)
2½	SW	25F-SW-61-P	2.64 (67)	6 (152)	24 (610)	0.74 (0.34)
3	SW	30F-SW-61-P	3.14 (80)	6 (152)	24 (610)	0.85 (0.38)
3½	SW	35F-SW-61-P	3.64 (92)	6 (152)	24 (610)	1.06 (0.48)
4	SW	40F-SW-61-P	4.14 (105)	6 (152)	24 (610)	1.22 (0.55)
4	HW	40F-HW-61-P	4.19 (106)	6 (152)	24 (610)	1.62 (0.74)

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs kg
¾	XW	07E-XW-61-P	1.41 (36)	6 (152)	24 (610)	1.07 (0.48)
1	XW	10E-XW-61-P	1.68 (43)	6 (152)	24 (610)	1.19 (0.54)
1¼	XW	12E-XW-61-P	2.02 (51)	6 (152)	24 (610)	1.44 (0.65)
1½	XW	15E-XW-61-P	2.26 (57)	6 (152)	24 (610)	2.07 (0.94)
2	XW	20F-XW-61-P	2.50 (65)	6 (152)	24 (610)	2.21 (1.00)
2½	XW	25F-XW-61-P	3.00 (76)	6 (152)	24 (610)	2.70 (1.23)
3	XW	30F-XW-61-P	3.50 (89)	6 (152)	24 (610)	3.32 (1.51)
3½	XW	35F-XW-61-P	4.00 (102)	6 (152)	24 (610)	3.83 (1.74)
4	XW	40F-XW-61-P	4.50 (114)	6 (152)	24 (610)	4.34 (1.97)



22½° X 36"

Nominal Size	Type	IPS Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs kg
¾	SW	07E-SW-62-P	1.05 (27)	6 (152)	36 (914)	0.35 (0.16)
1	SW	10E-SW-62-P	1.32 (33)	6 (152)	36 (914)	0.40 (0.18)
1¼	SW	12E-SW-62-P	1.66 (42)	6 (152)	36 (914)	0.48 (0.22)
1½	SW	15E-SW-62-P	1.90 (48)	6 (152)	36 (914)	0.69 (0.31)
2	SW	20E-SW-62-P	2.37 (60)	6 (152)	36 (914)	0.79 (0.36)
2½	SW	25E-SW-62-P	2.88 (73)	6 (152)	36 (914)	0.96 (0.44)
3	SW	30E-SW-62-P	3.50 (89)	6 (152)	36 (914)	1.25 (0.57)
4	SW	40E-SW-62-P	4.46 (113)	6 (152)	36 (914)	1.50 (0.68)
4	HW	40E-HW-62-P	4.51 (114)	6 (152)	36 (914)	2.02 (0.91)
5	MW	50E-MW-62-P	5.57 (141)	6 (152)	36 (914)	2.50 (1.14)
5	HW	50E-HW-62-P	5.60 (152)	6 (152)	36 (914)	2.75 (1.25)
6	MW	60E-MW-62-P	6.63 (168)	6 (152)	36 (914)	2.96 (1.34)
6	HW	60E-HW-62-P	6.66 (169)	6 (152)	36 (914)	3.40 (1.54)

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs kg
2	SW	20F-SW-62-P	2.14 (54)	6 (152)	36 (914)	0.71 (0.32)
2½	SW	25F-SW-62-P	2.64 (67)	6 (152)	36 (914)	0.88 (0.40)
3	SW	30F-SW-62-P	3.14 (80)	6 (152)	36 (914)	1.00 (0.45)
3½	SW	35F-SW-62-P	3.64 (92)	6 (152)	36 (914)	1.25 (0.57)
4	SW	40F-SW-62-P	4.14 (105)	6 (152)	36 (914)	1.44 (0.65)
4	HW	40F-HW-62-P	4.19 (106)	6 (152)	36 (914)	1.92 (0.87)
4½	SW	45F-SW-62-P	4.64 (117)	6 (152)	36 (914)	1.56 (0.71)
4½	HW	45F-HW-62-P	4.69 (118)	6 (152)	36 (914)	2.17 (0.99)
5	MW	50F-MW-62-P	5.19 (132)	6 (152)	36 (914)	2.36 (1.07)
5	HW	50F-HW-62-P	5.22 (132)	6 (152)	36 (914)	2.71 (1.23)
6	MW	60F-MW-62-P	6.19 (157)	6 (152)	36 (914)	2.82 (1.28)
6	HW	60F-HW-62-P	6.22 (158)	6 (152)	36 (914)	3.30 (1.50)

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs kg
¾	XW	07E-XW-62-P	1.41 (36)	6 (152)	36 (914)	1.27 (0.58)
1	XW	10E-XW-62-P	1.68 (43)	6 (152)	36 (914)	1.42 (0.64)
1¼	XW	12E-XW-62-P	2.02 (51)	6 (152)	36 (914)	1.71 (0.77)
1½	XW	15E-XW-62-P	2.26 (57)	6 (152)	36 (914)	2.46 (1.12)
2	XW	20F-XW-62-P	2.50 (65)	6 (152)	36 (914)	2.63 (1.19)
2½	XW	25F-XW-62-P	3.00 (76)	6 (152)	36 (914)	3.21 (1.46)
3	XW	30F-XW-62-P	3.50 (89)	6 (152)	36 (914)	3.79 (1.72)
3½	XW	35F-XW-62-P	4.00 (102)	6 (152)	36 (914)	4.38 (1.99)
4	XW	40F-XW-62-P	4.50 (114)	6 (152)	36 (914)	4.96 (2.25)
5	XW	50F-XW-62-P	5.50 (140)	6 (152)	36 (914)	6.13 (2.78)
6	XW	60F-XW-62-P	6.50 (165)	6 (152)	36 (914)	7.29 (3.31)

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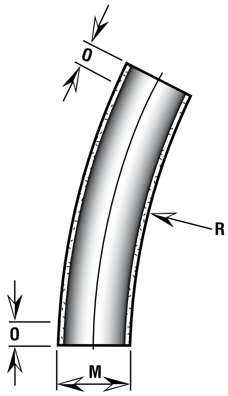
Nominal Size	Type	IPS Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	SW	07E-SW-63-P	1.05 *(27)*	6 *(152)*	48 *(1,219)*	0.43	*(0.20)*
1	SW	10E-SW-63-P	1.32 *(33)*	6 *(152)*	48 *(1,219)*	0.48	*(0.22)*
1¼	SW	12E-SW-63-P	1.66 *(42)*	6 *(152)*	48 *(1,219)*	0.58	*(0.26)*
1½	SW	15E-SW-63-P	1.90 *(48)*	6 *(152)*	48 *(1,219)*	0.83	*(0.38)*
2	SW	20E-SW-63-P	2.37 *(60)*	6 *(152)*	48 *(1,219)*	0.95	*(0.43)*
2½	SW	25E-SW-63-P	2.88 *(73)*	6 *(152)*	48 *(1,219)*	1.15	*(0.52)*
3	SW	30E-SW-63-P	3.50 *(89)*	6 *(152)*	48 *(1,219)*	1.50	*(0.68)*
4	SW	40E-SW-63-P	4.46 *(113)*	6 *(152)*	48 *(1,219)*	1.80	*(0.82)*
4	HW	40E-HW-63-P	4.51 *(114)*	6 *(152)*	48 *(1,219)*	2.43	*(1.10)*
5	MW	50E-MW-63-P	5.57 *(141)*	6 *(152)*	48 *(1,219)*	3.00	*(1.36)*
5	HW	50E-HW-63-P	5.60 *(142)*	6 *(152)*	48 *(1,219)*	3.25	*(1.48)*
6	MW	60E-MW-63-P	6.63 *(168)*	6 *(152)*	48 *(1,219)*	2.84	*(1.29)*
6	HW	60E-HW-63-P	6.66 *(170)*	6 *(152)*	48 *(1,219)*	3.26	*(1.48)*

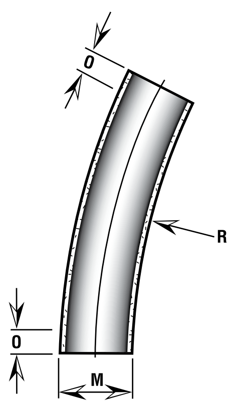


Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
2	SW	20F-SW-63-P	2.14 *(54)*	6 *(152)*	48 *(1,219)*	0.85	*(0.50)*
2½	SW	25F-SW-63-P	2.64 *(67)*	6 *(152)*	48 *(1,219)*	1.05	*(0.64)*
3	SW	30F-SW-63-P	3.14 *(80)*	6 *(152)*	48 *(1,219)*	1.20	*(0.77)*
3½	SW	35F-SW-63-P	3.64 *(92)*	6 *(152)*	48 *(1,219)*	1.50	*(0.77)*
4	SW	40F-SW-63-P	4.14 *(105)*	6 *(152)*	48 *(1,219)*	1.73	*(0.95)*
4	HW	40F-HW-63-P	4.19 *(106)*	6 *(152)*	48 *(1,219)*	2.30	*(1.23)*
4½	SW	45F-SW-63-P	4.64 *(117)*	6 *(152)*	48 *(1,219)*	1.88	*(1.73)*
4½	HW	45F-HW-63-P	4.69 *(118)*	6 *(152)*	48 *(1,219)*	2.60	*(2.00)*
5	MW	50F-MW-63-P	5.19 *(132)*	6 *(152)*	48 *(1,219)*	2.83	*(1.59)*
5	HW	50F-HW-63-P	5.22 *(133)*	6 *(152)*	48 *(1,219)*	3.30	*(1.86)*
6	MW	60F-MW-63-P	6.19 *(157)*	6 *(152)*	48 *(1,219)*	2.84	*(1.29)*
6	HW	60F-HW-63-P	6.22 *(158)*	6 *(152)*	48 *(1,219)*	3.26	*(1.48)*

22½° X 48"

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	XW	07E-XW-63-P	1.41 *(36)*	6 *152*	48 *(1,219)*	1.57	*(0.72)*
1	XW	10E-XW-63-P	1.68 *(43)*	6 *152*	48 *(1,219)*	1.75	*(0.80)*
1¼	XW	12E-XW-63-P	2.02 *(51)*	6 *152*	48 *(1,219)*	2.11	*(0.95)*
1½	XW	15E-XW-63-P	2.26 *(57)*	6 *152*	48 *(1,219)*	3.03	*(1.36)*
2	XW	20F-XW-63-P	2.50 *(65)*	6 *(152)*	48 *(1,219)*	3.15	*(1.43)*
2½	XW	25F-XW-63-P	3.00 *(76)*	6 *(152)*	48 *(1,219)*	3.85	*(1.75)*
3	XW	30F-XW-63-P	3.50 *(89)*	6 *(152)*	48 *(1,219)*	4.55	*(2.07)*
3½	XW	35F-XW-63-P	4.00 *(102)*	6 *(152)*	48 *(1,219)*	5.25	*(2.38)*
4	XW	40F-XW-63-P	4.50 *(114)*	6 *(152)*	48 *(1,219)*	5.95	*(2.70)*
5	XW	50F-XW-63-P	5.50 *(140)*	6 *(152)*	48 *(1,219)*	7.35	*(3.34)*
6	XW	60F-XW-63-P	6.50 *(165)*	6 *(152)*	48 *(1,219)*	8.75	*(3.97)*

Nominal Size	Type	IPS Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	SW	07E-SW-64-P	1.05 *(27)*	6 *(152)*	60 *(1,524)*	0.50	*(0.23)*
1	SW	10E-SW-64-P	1.32 *(33)*	6 *(152)*	60 *(1,524)*	0.55	*(0.25)*
1¼	SW	12E-SW-64-P	1.66 *(42)*	6 *(152)*	60 *(1,524)*	0.67	*(0.30)*
1½	SW	15E-SW-64-P	1.90 *(48)*	6 *(152)*	60 *(1,524)*	0.96	*(0.44)*
2	SW	20E-SW-64-P	2.37 *(60)*	6 *(152)*	60 *(1,524)*	1.11	*(0.50)*
2½	SW	25E-SW-64-P	2.88 *(73)*	6 *(152)*	60 *(1,524)*	1.34	*(0.61)*
3	SW	30E-SW-64-P	3.50 *(89)*	6 *(152)*	60 *(1,524)*	1.75	*(0.80)*
4	SW	40E-SW-64-P	4.46 *(113)*	6 *(152)*	60 *(1,524)*	2.10	*(0.95)*
4	HW	40E-HW-64-P	4.51 *(115)*	6 *(152)*	60 *(1,524)*	2.83	*(1.29)*
5	MW	50E-MW-64-P	5.57 *(141)*	6 *(152)*	60 *(1,524)*	3.50	*(1.59)*
5	HW	50E-HW-64-P	5.60 *(142)*	6 *(152)*	60 *(1,524)*	3.79	*(1.72)*
6	MW	60E-MW-64-P	6.63 *(168)*	6 *(152)*	60 *(1,524)*	4.14	*(1.88)*
6	HW	60E-HW-64-P	6.66 *(170)*	6 *(152)*	60 *(1,524)*	4.75	*(2.16)*

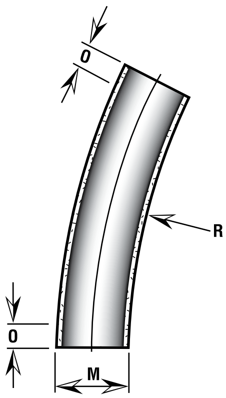


Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
2	SW	20F-SW-64-P	2.14 *(54)*	6 *(152)*	60 *(1,524)*	0.99	*(0.45)*
2½	SW	25F-SW-64-P	2.64 *(67)*	6 *(152)*	60 *(1,524)*	1.23	*(0.56)*
3	SW	30F-SW-64-P	3.14 *(80)*	6 *(152)*	60 *(1,524)*	1.40	*(0.64)*
3½	SW	35F-SW-64-P	3.64 *(92)*	6 *(152)*	60 *(1,524)*	1.75	*(0.80)*
4	SW	40F-SW-64-P	4.14 *(105)*	6 *(152)*	60 *(1,524)*	2.01	*(0.91)*
4	HW	40F-HW-64-P	4.19 *(106)*	6 *(152)*	60 *(1,524)*	2.68	*(1.22)*
4½	SW	45F-SW-64-P	4.64 *(117)*	6 *(152)*	60 *(1,524)*	2.19	*(0.99)*
4½	HW	45F-HW-64-P	4.69 *(118)*	6 *(152)*	60 *(1,524)*	3.03	*(1.38)*
5	MW	50F-MW-64-P	5.19 *(132)*	6 *(152)*	60 *(1,524)*	3.30	*(1.50)*
5	HW	50F-HW-64-P	5.22 *(132)*	6 *(152)*	60 *(1,524)*	3.85	*(1.75)*
6	MW	60F-MW-64-P	6.19 *(157)*	6 *(152)*	60 *(1,524)*	3.94	*(1.79)*
6	HW	60F-HW-64-P	6.22 *(158)*	6 *(152)*	60 *(1,524)*	4.61	*(2.09)*

22½° X 60"

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	XW	07E-XW-64-P	1.41 *(36)*	6 *(152)*	60 *(1,524)*	1.81	*(0.83)*
1	XW	10E-XW-64-P	1.68 *(43)*	6 *(152)*	60 *(1,524)*	2.01	*(0.92)*
1¼	XW	12E-XW-64-P	2.02 *(51)*	6 *(152)*	60 *(1,524)*	2.43	*(1.10)*
1½	XW	15E-XW-64-P	2.26 *(57)*	6 *(152)*	60 *(1,524)*	3.50	*(1.57)*
2	XW	20F-XW-64-P	2.50 *(65)*	6 *(152)*	60 *(1,524)*	3.68	*(1.67)*
3	XW	30F-XW-64-P	3.50 *(89)*	6 *(152)*	60 *(1,524)*	5.31	*(2.41)*
4	XW	40F-XW-64-P	4.50 *(114)*	6 *(152)*	60 *(1,524)*	6.94	*(3.15)*
5	XW	50F-XW-64-P	5.50 *(140)*	6 *(152)*	60 *(1,524)*	8.58	*(3.90)*
6	XW	60F-XW-64-P	6.50 *(165)*	6 *(152)*	60 *(1,524)*	10.21	*(4.64)*

PHENOLIC ELBOWS

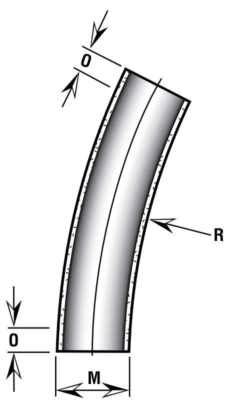


30° X 12"

Nominal Size	Nominal Type	IPS Item No.	M	O-Tangent (min.)	R-Radius (min.)	Weight lbs	Weight kg
¾	SW	07E-SW-70-P	1.05 *(27)*	6 *(152)*	12 *(305)*	0.27	*(0.12)*
1	SW	10E-SW-70-P	1.32 *(33)*	6 *(152)*	12 *(305)*	0.30	*(0.14)*
1¼	SW	12E-SW-70-P	1.66 *(42)*	6 *(152)*	12 *(305)*	0.36	*(0.16)*
1½	SW	15E-SW-70-P	1.90 *(48)*	6 *(152)*	12 *(305)*	0.52	*(0.24)*
2	SW	20E-SW-70-P	2.37 *(60)*	6 *(152)*	12 *(305)*	0.60	*(0.27)*
2½	SW	25E-SW-70-P	2.88 *(73)*	6 *(152)*	12 *(305)*	0.73	*(0.33)*

Nominal Size	Nominal Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	Weight kg
2	SW	20F-SW-70-P	2.14 *(54)*	6 *(152)*	12 *(305)*	0.54	*(0.25)*
2½	SW	25F-SW-70-P	2.64 *(67)*	6 *(152)*	12 *(305)*	0.67	*(0.30)*

Nominal Size	Nominal Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	Weight kg
¾	XW	07E-XW-70-P	1.41 *(36)*	6 *(152)*	12 *(305)*	0.97	*(0.44)*
1	XW	10E-XW-70-P	1.68 *(43)*	6 *(152)*	12 *(305)*	1.08	*(0.49)*
1¼	XW	12E-XW-70-P	2.02 *(51)*	6 *(152)*	12 *(305)*	1.30	*(0.59)*
1½	XW	15E-XW-70-P	2.26 *(57)*	6 *(152)*	12 *(305)*	1.87	*(0.85)*
2	XW	20F-XW-70-P	2.50 *(63)*	6 *(152)*	12 *(305)*	2.00	*(0.91)*
2½	XW	25F-XW-70-P	3.00 *(76)*	6 *(152)*	12 *(305)*	2.44	*(1.11)*
3	XW	30F-XW-70-P	3.50 *(89)*	6 *(152)*	12 *(305)*	2.89	*(1.31)*
3½	XW	35F-XW-70-P	4.00 *(102)*	6 *(152)*	12 *(305)*	3.33	*(1.51)*



30° X 24"

Nominal Size	Nominal Type	IPS Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	Weight kg
¾	SW	07E-SW-71-P	1.05 *(27)*	6 *(152)*	24 *(610)*	0.34	*(0.15)*
1	SW	10E-SW-71-P	1.32 *(33)*	6 *(152)*	24 *(610)*	0.38	*(0.17)*
1¼	SW	12E-SW-71-P	1.66 *(42)*	6 *(152)*	24 *(610)*	0.46	*(0.21)*
1½	SW	15E-SW-71-P	1.90 *(48)*	6 *(152)*	24 *(610)*	0.66	*(0.30)*
2	SW	20E-SW-71-P	2.37 *(60)*	6 *(152)*	24 *(610)*	0.76	*(0.35)*
2½	SW	25E-SW-71-P	2.88 *(73)*	6 *(152)*	24 *(610)*	0.92	*(0.42)*
3	SW	30E-SW-71-P	3.50 *(89)*	6 *(152)*	24 *(610)*	1.20	*(0.54)*
4	SW	40E-SW-71-P	4.46 *(113)*	6 *(152)*	24 *(610)*	1.44	*(0.65)*
4	HW	40E-HW-71-P	4.51 *(114)*	6 *(152)*	24 *(610)*	1.94	*(0.88)*

Nominal Size	Nominal Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	Weight kg
2	SW	20F-SW-71-P	2.14 *(54)*	6 *(152)*	24 *(610)*	0.68	*(0.31)*
2½	SW	25F-SW-71-P	2.64 *(67)*	6 *(152)*	24 *(610)*	0.84	*(0.38)*
3	SW	30F-SW-71-P	3.14 *(80)*	6 *(152)*	24 *(610)*	0.96	*(0.44)*
3½	SW	35F-SW-71-P	3.64 *(92)*	6 *(152)*	24 *(610)*	1.20	*(0.54)*
4	SW	40F-SW-71-P	4.14 *(105)*	6 *(152)*	24 *(610)*	1.38	*(0.63)*
4	HW	40F-HW-71-P	4.19 *(106)*	6 *(152)*	24 *(610)*	1.84	*(0.84)*

Nominal Size	Nominal Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	Weight kg
¾	XW	07E-XW-71-P	1.41 *(36)*	6 *(152)*	24 *(610)*	1.22	*(0.55)*
1	XW	10E-XW-71-P	1.68 *(43)*	6 *(152)*	24 *(610)*	1.36	*(0.62)*
1¼	XW	12E-XW-71-P	2.02 *(51)*	6 *(152)*	24 *(610)*	1.64	*(0.74)*
1½	XW	15E-XW-71-P	2.26 *(57)*	6 *(152)*	24 *(610)*	2.36	*(1.07)*
2	XW	20F-XW-71-P	2.50 *(65)*	6 *(152)*	24 *(610)*	2.52	*(1.14)*
2½	XW	25F-XW-71-P	3.00 *(76)*	6 *(152)*	24 *(610)*	3.08	*(1.40)*
3	XW	30F-XW-71-P	3.50 *(89)*	6 *(152)*	24 *(610)*	3.72	*(1.69)*
3½	XW	35F-XW-71-P	4.00 *(102)*	6 *(152)*	24 *(610)*	4.30	*(1.95)*
4	XW	40F-XW-71-P	4.50 *(114)*	6 *(152)*	24 *(610)*	4.87	*(2.21)*

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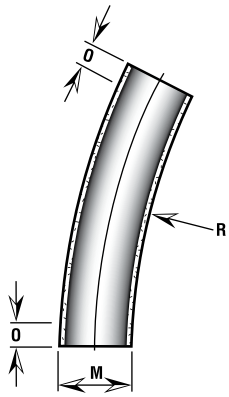
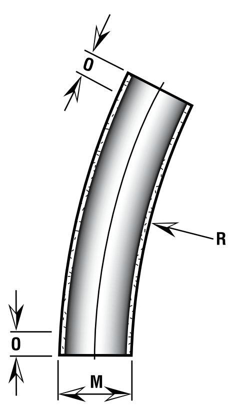


30° X 36"

Nominal Size	Type	IPS Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	SW	07E-SW-72-P	1.05 (27)	6 (152)	36 (914)	0.43	(0.15)
1	SW	10E-SW-72-P	1.32 (33)	6 (152)	36 (914)	0.48	(0.17)
1¼	SW	12E-SW-72-P	1.66 (42)	6 (152)	36 (914)	0.58	(0.21)
1½	SW	15E-SW-72-P	1.90 (48)	6 (152)	36 (914)	0.83	(0.30)
2	SW	20E-SW-72-P	2.37 (60)	6 (152)	36 (914)	0.95	(0.50)
2½	SW	25E-SW-72-P	2.88 (73)	6 (152)	36 (914)	1.15	(0.42)
3	SW	30E-SW-72-P	3.50 (89)	6 (152)	36 (914)	1.50	(0.77)
4	SW	40E-SW-72-P	4.46 (113)	6 (152)	36 (914)	1.80	(0.77)
4	HW	40E-HW-72-P	4.51 (115)	6 (152)	36 (914)	2.43	(0.95)
5	MW	50E-MW-72-P	5.57 (141)	6 (152)	36 (914)	3.00	(1.36)
5	HW	50E-HW-72-P	5.60 (152)	6 (152)	36 (914)	3.31	(1.50)
6	MW	60E-MW-72-P	6.63 (168)	6 (152)	36 (914)	3.56	(1.62)
6	HW	60E-HW-72-P	6.66 (169)	6 (152)	36 (914)	4.08	(1.85)

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
2	SW	20F-SW-72-P	2.14 (54)	6 (152)	36 (914)	0.85	(0.39)
2½	SW	25F-SW-72-P	2.64 (67)	6 (152)	36 (914)	1.05	(0.48)
3	SW	30F-SW-72-P	3.14 (80)	6 (152)	36 (914)	1.20	(0.55)
3½	SW	35F-SW-72-P	3.64 (92)	6 (152)	36 (914)	1.50	(0.68)
4	SW	40F-SW-72-P	4.14 (105)	6 (152)	36 (914)	1.73	(0.79)
4	HW	40F-HW-72-P	4.19 (106)	6 (152)	36 (914)	2.30	(1.04)
4½	SW	45F-SW-72-P	4.64 (117)	6 (152)	36 (914)	1.88	(0.85)
4½	HW	45F-HW-72-P	4.69 (118)	6 (152)	36 (914)	2.60	(1.18)
5	MW	50F-MW-72-P	5.19 (132)	6 (152)	36 (914)	2.83	(1.28)
5	HW	50F-HW-72-P	5.22 (132)	6 (152)	36 (914)	3.25	(1.48)
6	MW	60F-MW-72-P	6.19 (157)	6 (152)	36 (914)	3.38	(1.54)
6	HW	60F-HW-72-P	6.22 (158)	6 (152)	36 (914)	3.96	(1.80)

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	XW	07E-XW-72-P	1.41 (36)	6 (152)	36 (914)	1.52	(0.69)
1	XW	10E-XW-72-P	1.68 (43)	6 (152)	36 (914)	1.70	(0.77)
1¼	XW	12E-XW-72-P	2.02 (51)	6 (152)	36 (914)	2.05	(0.93)
1½	XW	15E-XW-72-P	2.26 (57)	6 (152)	36 (914)	2.95	(1.34)
2	XW	20F-XW-72-P	2.50 (65)	6 (152)	36 (914)	3.15	(1.43)
2½	XW	25F-XW-72-P	3.00 (76)	6 (152)	36 (914)	3.85	(1.75)
3	XW	30F-XW-72-P	3.50 (89)	6 (152)	36 (914)	4.55	(2.07)
3½	XW	35F-XW-72-P	4.00 (102)	6 (152)	36 (914)	5.25	(2.38)
4	XW	40F-XW-72-P	4.50 (114)	6 (152)	36 (914)	5.95	(2.70)
5	XW	50F-XW-72-P	5.50 (140)	6 (152)	36 (914)	7.35	(3.34)
6	XW	60F-XW-72-P	6.50 (165)	6 (152)	36 (914)	8.75	(3.97)



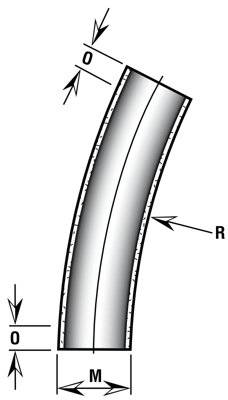
30° X 48"

Nominal Size	Type	IPS Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	SW	07E-SW-73-P	1.05 (27)	6 (152)	48 (1,219)	0.52	(0.24)
1	SW	10E-SW-73-P	1.32 (33)	6 (152)	48 (1,219)	0.59	(0.27)
1¼	SW	12E-SW-73-P	1.66 (42)	6 (152)	48 (1,219)	0.71	(0.32)
1½	SW	15E-SW-73-P	1.90 (48)	6 (152)	48 (1,219)	1.02	(0.46)
2	SW	20E-SW-73-P	2.37 (60)	6 (152)	48 (1,219)	1.17	(0.53)
2½	SW	25E-SW-73-P	2.88 (73)	6 (152)	48 (1,219)	1.42	(0.65)
3	SW	30E-SW-73-P	3.50 (89)	6 (152)	48 (1,219)	1.85	(0.84)
4	SW	40E-SW-73-P	4.46 (113)	6 (152)	48 (1,219)	2.22	(1.01)
4	HW	40E-HW-73-P	4.51 (114)	6 (152)	48 (1,219)	2.99	(1.36)
5	MW	50E-MW-73-P	5.57 (141)	6 (152)	48 (1,219)	3.70	(1.68)
5	HW	50E-HW-73-P	5.60 (142)	6 (152)	48 (1,219)	4.01	(1.82)
6	MW	60E-MW-73-P	6.63 (168)	6 (152)	48 (1,219)	4.38	(1.99)
6	HW	60E-HW-73-P	6.66 (169)	6 (152)	48 (1,219)	5.03	(2.28)

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
2	SW	20F-SW-73-P	2.14 (54)	6 (152)	48 (1,219)	1.05	(0.48)
2½	SW	25F-SW-73-P	2.64 (67)	6 (152)	48 (1,219)	1.30	(0.59)
3	SW	30F-SW-73-P	3.14 (80)	6 (152)	48 (1,219)	1.48	(0.67)
3½	SW	35F-SW-73-P	3.64 (92)	6 (152)	48 (1,219)	1.85	(0.84)
4	SW	40F-SW-73-P	4.14 (105)	6 (152)	48 (1,219)	2.13	(0.97)
4	HW	40F-HW-73-P	4.19 (106)	6 (152)	48 (1,219)	2.84	(1.29)
4½	SW	45F-SW-73-P	4.64 (117)	6 (152)	48 (1,219)	2.31	(1.05)
4½	HW	45F-HW-73-P	4.69 (118)	6 (152)	48 (1,219)	3.21	(1.46)
5	MW	50F-MW-73-P	5.19 (132)	6 (152)	48 (1,219)	3.48	(1.58)
5	HW	50F-HW-73-P	5.22 (133)	6 (152)	48 (1,219)	4.07	(1.85)
6	MW	60F-MW-73-P	6.19 (157)	6 (152)	48 (1,219)	4.16	(1.89)
6	HW	60F-HW-73-P	6.22 (158)	6 (152)	48 (1,219)	4.87	(2.21)

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	XW	07E-XW-73-P	1.41 (36)	6 (152)	48 (1,219)	1.89	(0.87)
1	XW	10E-XW-73-P	1.68 (43)	6 (152)	48 (1,219)	2.10	(0.96)
1¼	XW	12E-XW-73-P	2.02 (51)	6 (152)	48 (1,219)	2.54	(1.14)
1½	XW	15E-XW-73-P	2.26 (57)	6 (152)	48 (1,219)	3.65	(1.64)
2	XW	20F-XW-73-P	2.50 (65)	6 (152)	48 (1,219)	3.89	(1.77)
2½	XW	25F-XW-73-P	3.00 (76)	6 (152)	48 (1,219)	4.75	(2.16)
3	XW	30F-XW-73-P	3.50 (89)	6 (152)	48 (1,219)	5.61	(2.55)
3½	XW	35F-XW-73-P	4.00 (102)	6 (152)	48 (1,219)	6.47	(2.94)
4	XW	40F-XW-73-P	4.50 (114)	6 (152)	48 (1,219)	7.34	(3.33)
5	XW	50F-XW-73-P	5.50 (140)	6 (152)	48 (1,219)	9.07	(4.12)
6	XW	60F-XW-73-P	6.50 (165)	6 (152)	48 (1,219)	10.79	(4.90)

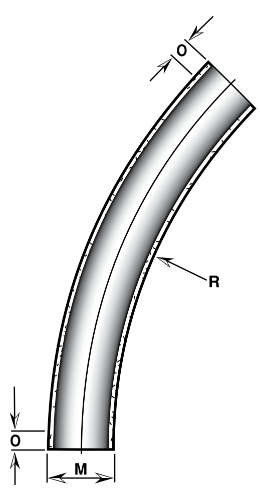
Nominal Size	Type	IPS Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	SW	07E-SW-74-P	1.05 *(27)*	6 *(152)*	60 *(1,524)*	0.61	*(0.28)*
1	SW	10E-SW-74-P	1.32 *(33)*	6 *(152)*	60 *(1,524)*	0.68	*(0.31)*
1¼	SW	12E-SW-74-P	1.66 *(42)*	6 *(152)*	60 *(1,524)*	0.82	*(0.37)*
1½	SW	15E-SW-74-P	1.90 *(48)*	6 *(152)*	60 *(1,524)*	1.18	*(0.54)*
2	SW	20E-SW-74-P	2.37 *(60)*	6 *(152)*	60 *(1,524)*	1.36	*(0.62)*
2½	SW	25E-SW-74-P	2.88 *(73)*	6 *(152)*	60 *(1,524)*	1.65	*(0.75)*
3	SW	30E-SW-74-P	3.50 *(89)*	6 *(152)*	60 *(1,524)*	2.15	*(0.98)*
4	SW	40E-SW-74-P	4.46 *(113)*	6 *(152)*	60 *(1,524)*	2.58	*(1.17)*
4	HW	40E-HW-74-P	4.51 *(115)*	6 *(152)*	60 *(1,524)*	3.48	*(1.58)*
5	MW	50E-MW-74-P	5.57 *(141)*	6 *(152)*	60 *(1,524)*	4.30	*(1.95)*
5	HW	50E-HW-74-P	5.60 *(142)*	6 *(152)*	60 *(1,524)*	4.66	*(2.12)*
6	MW	60E-MW-74-P	6.63 *(168)*	6 *(152)*	60 *(1,524)*	5.09	*(2.31)*
6	HW	60E-HW-74-P	6.66 *(169)*	6 *(152)*	60 *(1,524)*	5.84	*(2.65)*



Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
2	SW	20F-SW-74-P	2.14 *(54)*	6 *(152)*	60 *(1,524)*	1.22	*(0.55)*
2½	SW	25F-SW-74-P	2.64 *(67)*	6 *(152)*	60 *(1,524)*	1.51	*(0.69)*
3	SW	30F-SW-74-P	3.14 *(80)*	6 *(152)*	60 *(1,524)*	1.72	*(0.78)*
3½	SW	35F-SW-74-P	3.64 *(92)*	6 *(152)*	60 *(1,524)*	2.15	*(0.98)*
4	SW	40F-SW-74-P	4.14 *(105)*	6 *(152)*	60 *(1,524)*	2.47	*(1.12)*
4	HW	40F-HW-74-P	4.19 *(106)*	6 *(152)*	60 *(1,524)*	3.30	*(1.50)*
4½	SW	45F-SW-74-P	4.64 *(117)*	6 *(152)*	60 *(1,524)*	2.69	*(1.22)*
4½	HW	45F-HW-74-P	4.69 *(118)*	6 *(152)*	60 *(1,524)*	3.73	*(1.69)*
5	MW	50F-MW-74-P	5.19 *(132)*	6 *(152)*	60 *(1,524)*	4.05	*(1.84)*
5	HW	50F-HW-74-P	5.22 *(132)*	6 *(152)*	60 *(1,524)*	4.73	*(2.15)*
6	MW	60F-MW-74-P	6.19 *(157)*	6 *(152)*	60 *(1,524)*	4.84	*(2.20)*
6	HW	60F-HW-74-P	6.22 *(158)*	6 *(152)*	60 *(1,524)*	5.66	*(2.57)*

30° X 60"

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	XW	07E-XW-74-P	1.41 *(36)*	6 *(152)*	60 *(1,524)*	2.21	*(1.01)*
1	XW	10E-XW-74-P	1.68 *(43)*	6 *(152)*	60 *(1,524)*	2.46	*(1.12)*
1¼	XW	12E-XW-74-P	2.02 *(51)*	6 *(152)*	60 *(1,524)*	2.97	*(1.34)*
1½	XW	15E-XW-74-P	2.26 *(57)*	6 *(152)*	60 *(1,524)*	4.27	*(1.92)*
2	XW	20F-XW-74-P	2.50 *(65)*	6 *(152)*	60 *(1,524)*	4.52	*(2.05)*
3	XW	30F-XW-74-P	3.50 *(89)*	6 *(152)*	60 *(1,524)*	6.52	*(2.96)*
4	XW	40F-XW-74-P	4.50 *(114)*	6 *(152)*	60 *(1,524)*	8.53	*(3.87)*
5	XW	50F-XW-74-P	5.50 *(140)*	6 *(152)*	60 *(1,524)*	10.54	*(4.79)*
6	XW	60F-XW-74-P	6.50 *(165)*	6 *(152)*	60 *(1,524)*	12.55	*(5.70)*



Nominal Size	Type	IPS Item No.	M	O-Tangent (min.)	R-Radius (min.)	Weight lbs	kg
¾	SW	07E-SW-80-P	1.05 *(27)*	6 *(152)*	12 *(305)*	0.30	*(0.14)*
1	SW	10E-SW-80-P	1.32 *(33)*	6 *(152)*	12 *(305)*	0.33	*(0.15)*
1¼	SW	12E-SW-80-P	1.66 *(42)*	6 *(152)*	12 *(305)*	0.40	*(0.18)*
1½	SW	15E-SW-80-P	1.90 *(48)*	6 *(152)*	12 *(305)*	0.58	*(0.26)*
2	SW	20E-SW-80-P	2.37 *(60)*	6 *(152)*	12 *(305)*	0.67	*(0.30)*
2½	SW	25E-SW-80-P	2.88 *(73)*	6 *(152)*	12 *(305)*	0.81	*(0.37)*

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
2	SW	20F-SW-80-P	2.14 *(54)*	6 *(152)*	12 *(305)*	0.60	*(0.27)*
2½	SW	25F-SW-80-P	2.64 *(67)*	6 *(152)*	12 *(305)*	0.74	*(0.34)*

45° X 12"

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	XW	07E-XW-80-P	1.41 *(36)*	6 *(152)*	12 *(305)*	1.07	*(0.48)*
1	XW	10E-XW-80-P	1.68 *(43)*	6 *(152)*	12 *(305)*	1.19	*(0.54)*
1¼	XW	12E-XW-80-P	2.02 *(51)*	6 *(152)*	12 *(305)*	1.44	*(0.65)*
1½	XW	15E-XW-80-P	2.26 *(57)*	6 *(152)*	12 *(305)*	2.07	*(0.94)*
2	XW	20F-XW-80-P	2.50 *(63)*	6 *(152)*	12 *(305)*	2.21	*(1.00)*
2½	XW	25F-XW-80-P	3.00 *(76)*	6 *(152)*	12 *(305)*	2.70	*(1.22)*
3	XW	30F-XW-80-P	3.50 *(89)*	6 *(152)*	12 *(305)*	2.89	*(1.31)*
3½	XW	35F-XW-80-P	4.00 *(102)*	6 *(152)*	12 *(305)*	3.68	*(1.67)*

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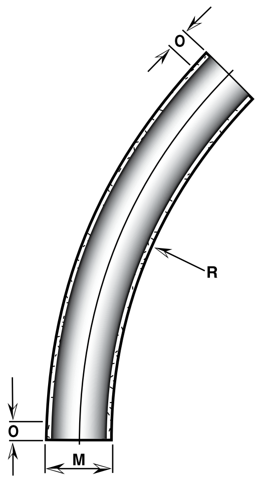
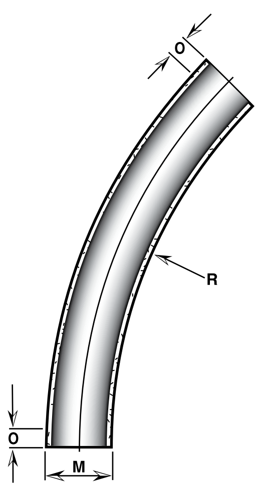


45° X 24"

Nominal Size	Type	IPS Item No.	M	O-Tangent (min.)	R-Radius (min.)	Weight lbs	Weight kg
¾	SW	07E-SW-81-P	1.05 *(27)*	6 *(152)*	24 *(610)*	0.43	*(0.20)*
1	SW	10E-SW-81-P	1.32 *(33)*	6 *(152)*	24 *(610)*	0.48	*(0.22)*
1¼	SW	12E-SW-81-P	1.66 *(42)*	6 *(152)*	24 *(610)*	0.58	*(0.26)*
1½	SW	15E-SW-81-P	1.90 *(48)*	6 *(152)*	24 *(610)*	0.83	*(0.38)*
2	SW	20E-SW-81-P	2.37 *(60)*	6 *(152)*	24 *(610)*	0.95	*(0.43)*
2½	SW	25E-SW-81-P	2.88 *(73)*	6 *(152)*	24 *(610)*	1.15	*(0.52)*
3	SW	30E-SW-81-P	3.50 *(89)*	6 *(152)*	24 *(610)*	1.96	*(0.89)*
4	SW	40E-SW-81-P	4.46 *(113)*	6 *(152)*	24 *(610)*	2.35	*(1.07)*
4	HW	40E-HW-81-P	4.51 *(114)*	6 *(152)*	24 *(610)*	3.17	*(1.44)*

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	Weight kg
2	SW	20F-SW-81-P	2.14 *(54)*	6 *(152)*	24 *(610)*	0.85	*(0.39)*
2½	SW	25F-SW-81-P	2.64 *(67)*	6 *(152)*	24 *(610)*	1.05	*(0.48)*
3	SW	30F-SW-81-P	3.14 *(80)*	6 *(152)*	24 *(610)*	1.57	*(0.71)*
3½	SW	35F-SW-81-P	3.64 *(92)*	6 *(152)*	24 *(610)*	1.96	*(0.89)*
4	SW	40F-SW-81-P	4.14 *(105)*	6 *(152)*	24 *(610)*	2.25	*(1.02)*
4	HW	40F-HW-81-P	4.19 *(106)*	6 *(152)*	24 *(610)*	3.00	*(1.36)*

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	Weight kg
¾	XW	07E-XW-81-P	1.41 *(36)*	6 *(152)*	24 *(610)*	1.52	*(0.69)*
1	XW	10E-XW-81-P	1.68 *(43)*	6 *(152)*	24 *(610)*	1.70	*(0.77)*
1¼	XW	12E-XW-81-P	2.02 *(51)*	6 *(152)*	24 *(610)*	2.05	*(0.93)*
1½	XW	15E-XW-81-P	2.26 *(57)*	6 *(152)*	24 *(610)*	2.95	*(1.34)*
2	XW	20F-XW-81-P	2.50 *(65)*	6 *(152)*	24 *(610)*	3.15	*(1.43)*
2½	XW	25F-XW-81-P	3.00 *(76)*	6 *(152)*	24 *(610)*	3.85	*(1.75)*
3	XW	30F-XW-81-P	3.50 *(89)*	6 *(152)*	24 *(610)*	4.55	*(2.07)*
3½	XW	35F-XW-81-P	4.00 *(102)*	6 *(152)*	24 *(610)*	5.24	*(2.38)*
4	XW	40F-XW-81-P	4.50 *(114)*	6 *(152)*	24 *(610)*	5.95	*(2.70)*



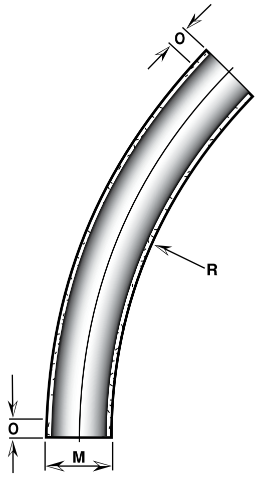
45° X 36"

Nominal Size	Type	IPS Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	Weight kg
¾	SW	07E-SW-82-P	1.05 *(27)*	6 *(152)*	36 *(914)*	0.57	*(0.26)*
1	SW	10E-SW-82-P	1.32 *(33)*	6 *(152)*	36 *(914)*	0.63	*(0.29)*
1¼	SW	12E-SW-82-P	1.66 *(42)*	6 *(152)*	36 *(914)*	0.77	*(0.35)*
1½	SW	15E-SW-82-P	1.90 *(48)*	6 *(152)*	36 *(914)*	1.10	*(0.50)*
2	SW	20E-SW-82-P	2.37 *(60)*	6 *(152)*	36 *(914)*	1.27	*(0.58)*
2½	SW	25E-SW-82-P	2.88 *(73)*	6 *(152)*	36 *(914)*	1.53	*(0.70)*
3	SW	30E-SW-82-P	3.50 *(89)*	6 *(152)*	36 *(914)*	2.00	*(0.91)*
4	SW	40E-SW-82-P	4.46 *(113)*	6 *(152)*	36 *(914)*	2.40	*(1.09)*
4	HW	40E-HW-82-P	4.50 *(114)*	6 *(152)*	36 *(914)*	3.23	*(1.47)*
5	MW	50E-MW-82-P	5.57 *(141)*	6 *(152)*	36 *(914)*	4.00	*(1.81)*
5	HW	50E-HW-82-P	5.60 *(152)*	6 *(152)*	36 *(914)*	4.39	*(2.00)*
6	MW	60E-MW-82-P	6.63 *(168)*	6 *(152)*	36 *(914)*	4.73	*(2.15)*
6	HW	60E-HW-82-P	6.66 *(169)*	6 *(152)*	36 *(914)*	5.43	*(2.46)*

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	Weight kg
2	SW	20F-SW-82-P	2.14 *(54)*	6 *(152)*	36 *(914)*	1.13	*(0.51)*
2½	SW	25F-SW-82-P	2.64 *(67)*	6 *(152)*	36 *(914)*	1.40	*(0.64)*
3	SW	30F-SW-82-P	3.14 *(80)*	6 *(152)*	36 *(914)*	1.60	*(0.73)*
3½	SW	35F-SW-82-P	3.64 *(92)*	6 *(152)*	36 *(914)*	2.00	*(0.91)*
4	SW	40F-SW-82-P	4.14 *(105)*	6 *(152)*	36 *(914)*	2.30	*(1.04)*
4	HW	40F-HW-82-P	4.19 *(106)*	6 *(152)*	36 *(914)*	3.07	*(1.39)*
4½	SW	45F-SW-82-P	4.64 *(117)*	6 *(152)*	36 *(914)*	3.65	*(1.66)*
4½	HW	45F-HW-82-P	4.69 *(118)*	6 *(152)*	36 *(914)*	4.00	*(1.82)*
5	MW	50F-MW-82-P	5.19 *(132)*	6 *(152)*	36 *(914)*	3.76	*(1.71)*
5	HW	50F-HW-82-P	5.22 *(132)*	6 *(152)*	36 *(914)*	4.33	*(1.96)*
6	MW	60F-MW-82-P	6.19 *(157)*	6 *(152)*	36 *(914)*	4.50	*(2.04)*
6	HW	60F-HW-82-P	6.22 *(158)*	6 *(152)*	36 *(914)*	5.26	*(2.39)*

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	Weight kg
¾	XW	07E-XW-82-P	1.41 *(36)*	6 *(152)*	36 *(914)*	2.03	*(0.92)*
1	XW	10E-XW-82-P	1.68 *(43)*	6 *(152)*	36 *(914)*	2.27	*(1.03)*
1¼	XW	12E-XW-82-P	2.02 *(51)*	6 *(152)*	36 *(914)*	2.73	*(1.24)*
1½	XW	15E-XW-82-P	2.26 *(57)*	6 *(152)*	36 *(914)*	3.93	*(1.78)*
2	XW	20F-XW-82-P	2.50 *(65)*	6 *(152)*	36 *(914)*	4.20	*(1.91)*
2½	XW	25F-XW-82-P	3.00 *(76)*	6 *(152)*	36 *(914)*	5.13	*(2.33)*
3	XW	30F-XW-82-P	3.50 *(89)*	6 *(152)*	36 *(914)*	6.07	*(2.76)*
3½	XW	35F-XW-82-P	4.00 *(102)*	6 *(152)*	36 *(914)*	6.99	*(3.18)*
4	XW	40F-XW-82-P	4.59 *(114)*	6 *(152)*	36 *(914)*	7.93	*(3.60)*
5	XW	50F-XW-82-P	5.50 *(140)*	6 *(152)*	36 *(914)*	9.79	*(4.44)*
6	XW	60F-XW-82-P	6.50 *(165)*	6 *(152)*	36 *(914)*	11.65	*(5.29)*

PHENOLIC ELBOWS

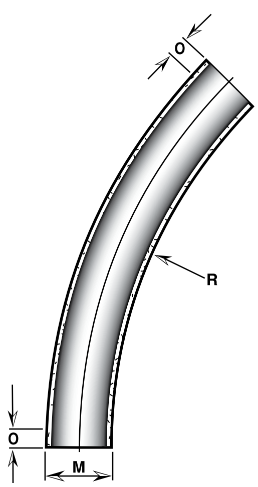


45° X 48"

Nominal Size	Type	IPS Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	SW	07E-SW-83-P	1.05 (27)	6 (152)	48 (1,219)	0.69	(0.31)
1	SW	10E-SW-83-P	1.32 (33)	6 (152)	48 (1,219)	0.78	(0.35)
1¼	SW	12E-SW-83-P	1.66 (42)	6 (152)	48 (1,219)	0.94	(0.43)
1½	SW	15E-SW-83-P	1.90 (48)	6 (152)	48 (1,219)	1.35	(0.61)
2	SW	20E-SW-83-P	2.37 (60)	6 (152)	48 (1,219)	1.55	(0.70)
2½	SW	25E-SW-83-P	2.88 (73)	6 (152)	48 (1,219)	1.88	(0.85)
3	SW	30E-SW-83-P	3.50 (89)	6 (152)	48 (1,219)	2.45	(1.11)
4	SW	40E-SW-83-P	4.46 (113)	6 (152)	48 (1,219)	2.94	(1.34)
4	HW	40E-HW-83-P	4.51 (114)	6 (152)	48 (1,219)	3.96	(1.80)
5	MW	50E-MW-83-P	5.57 (141)	6 (152)	48 (1,219)	4.90	(2.23)
5	HW	50E-HW-83-P	5.60 (142)	6 (152)	48 (1,219)	5.31	(2.41)
6	MW	60E-MW-83-P	6.63 (168)	6 (152)	48 (1,219)	5.80	(2.63)
6	HW	60E-HW-83-P	6.66 (169)	6 (152)	48 (1,219)	6.66	(3.02)

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
2	SW	20F-SW-83-P	2.14 (54)	6 (152)	48 (1,219)	1.39	(0.63)
2½	SW	25F-SW-83-P	2.64 (67)	6 (152)	48 (1,219)	1.72	(0.78)
3	SW	30F-SW-83-P	3.14 (80)	6 (152)	48 (1,219)	1.96	(0.89)
3½	SW	35F-SW-83-P	3.64 (92)	6 (152)	48 (1,219)	2.45	(1.11)
4	SW	40F-SW-83-P	4.14 (105)	6 (152)	48 (1,219)	2.82	(1.28)
4	HW	40F-HW-83-P	4.19 (106)	6 (152)	48 (1,219)	3.76	(1.71)
4½	SW	45F-SW-83-P	4.64 (117)	6 (152)	48 (1,219)	3.06	(1.39)
4½	HW	45F-HW-83-P	4.69 (118)	6 (152)	48 (1,219)	4.25	(1.93)
5	MW	50F-MW-83-P	5.19 (132)	6 (152)	48 (1,219)	4.61	(2.09)
5	HW	50F-HW-83-P	5.22 (133)	6 (152)	48 (1,219)	5.39	(2.45)
6	MW	60F-MW-83-P	6.19 (157)	6 (152)	48 (1,219)	5.51	(2.50)
6	HW	60F-HW-83-P	6.22 (158)	6 (152)	48 (1,219)	6.45	(2.93)

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	XW	07E-XW-83-P	1.41 (36)	6 (152)	48 (1,219)	2.53	(1.16)
1	XW	10E-XW-83-P	1.68 (43)	6 (152)	48 (1,219)	2.82	(1.28)
1¼	XW	12E-XW-83-P	2.02 (51)	6 (152)	48 (1,219)	3.40	(1.53)
1½	XW	15E-XW-83-P	2.26 (57)	6 (152)	48 (1,219)	4.89	(2.19)
2	XW	20F-XW-83-P	2.50 (65)	6 (152)	48 (1,219)	5.15	(2.34)
2½	XW	25F-XW-83-P	3.00 (76)	6 (152)	48 (1,219)	6.29	(2.85)
3	XW	30F-XW-83-P	3.50 (89)	6 (152)	48 (1,219)	7.43	(3.37)
3½	XW	35F-XW-83-P	4.00 (102)	6 (152)	48 (1,219)	8.57	(3.89)
4	XW	40F-XW-83-P	4.50 (114)	6 (152)	48 (1,219)	9.72	(4.41)
5	XW	50F-XW-83-P	5.50 (140)	6 (152)	48 (1,219)	12.01	(5.45)
6	XW	60F-XW-83-P	6.50 (165)	6 (152)	48 (1,219)	14.29	(6.49)

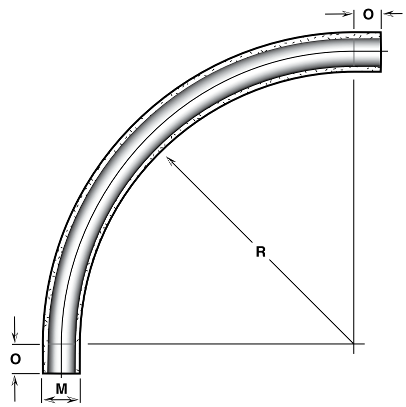


45° X 60"

Nominal Size	Type	IPS Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	SW	07E-SW-84-P	1.05 (27)	6 (152)	60 (1,524)	0.85	(0.39)
1	SW	10E-SW-84-P	1.32 (33)	6 (152)	60 (1,524)	0.95	(0.43)
1¼	SW	12E-SW-84-P	1.66 (42)	6 (152)	60 (1,524)	1.15	(0.52)
1½	SW	15E-SW-84-P	1.90 (48)	6 (152)	60 (1,524)	1.65	(0.75)
2	SW	20E-SW-84-P	2.37 (60)	6 (152)	60 (1,524)	1.90	(0.86)
2½	SW	25E-SW-84-P	2.88 (73)	6 (152)	60 (1,524)	2.30	(1.04)
3	SW	30E-SW-84-P	3.50 (89)	6 (152)	60 (1,524)	3.00	(1.36)
4	SW	40E-SW-84-P	4.46 (113)	6 (152)	60 (1,524)	3.60	(1.63)
4	HW	40E-HW-84-P	4.51 (115)	6 (152)	60 (1,524)	4.85	(2.20)
5	MW	50E-MW-84-P	5.57 (141)	6 (152)	60 (1,524)	6.00	(2.72)
5	HW	50E-HW-84-P	5.60 (142)	6 (152)	60 (1,524)	6.50	(2.95)
6	MW	60E-MW-84-P	6.63 (168)	6 (152)	60 (1,524)	7.10	(3.22)
6	HW	60E-HW-84-P	6.66 (169)	6 (152)	60 (1,524)	8.15	(3.70)

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
2	SW	20F-SW-84-P	2.14 (54)	6 (152)	60 (1,524)	1.70	(0.77)
2½	SW	25F-SW-84-P	2.64 (67)	6 (152)	60 (1,524)	2.10	(0.95)
3	SW	30F-SW-84-P	3.14 (80)	6 (152)	60 (1,524)	2.40	(1.09)
3½	SW	35F-SW-84-P	3.64 (92)	6 (152)	60 (1,524)	3.00	(1.36)
4	SW	40F-SW-84-P	4.14 (105)	6 (152)	60 (1,524)	3.45	(1.57)
4	HW	40F-HW-84-P	4.19 (106)	6 (152)	60 (1,524)	4.60	(2.09)
4½	SW	45F-SW-84-P	4.64 (117)	6 (152)	60 (1,524)	3.75	(1.70)
4½	HW	45F-HW-84-P	4.69 (118)	6 (152)	60 (1,524)	5.20	(2.36)
5	MW	50F-MW-84-P	5.19 (132)	6 (152)	60 (1,524)	5.65	(2.57)
5	HW	50F-HW-84-P	5.22 (132)	6 (152)	60 (1,524)	6.60	(3.00)
6	MW	60F-MW-84-P	6.19 (157)	6 (152)	60 (1,524)	6.75	(3.07)
6	HW	60F-HW-84-P	6.22 (158)	6 (152)	60 (1,524)	7.90	(3.59)

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	XW	07E-XW-84-P	1.41 (36)	6 (152)	60 (1,524)	3.01	(1.38)
1	XW	10E-XW-84-P	1.68 (43)	6 (152)	60 (1,524)	3.35	(1.53)
1¼	XW	12E-XW-84-P	2.02 (51)	6 (152)	60 (1,524)	4.04	(1.82)
1½	XW	15E-XW-84-P	2.26 (57)	6 (152)	60 (1,524)	5.81	(2.61)
2	XW	20F-XW-84-P	2.50 (65)	6 (152)	60 (1,524)	6.30	(2.86)
2½	XW	25F-XW-84-P	3.00 (76)	6 (152)	60 (1,524)	7.70	(3.50)
3	XW	30F-XW-84-P	3.50 (89)	6 (152)	60 (1,524)	9.10	(4.13)
3½	XW	35F-XW-84-P	4.00 (102)	6 (152)	60 (1,524)	10.50	(4.77)
4	XW	40F-XW-84-P	4.50 (114)	6 (152)	60 (1,524)	11.90	(5.40)
5	XW	50F-XW-84-P	5.50 (140)	6 (152)	60 (1,524)	14.70	(6.67)
6	XW	60F-XW-84-P	6.50 (165)	6 (152)	60 (1,524)	17.50	(7.94)

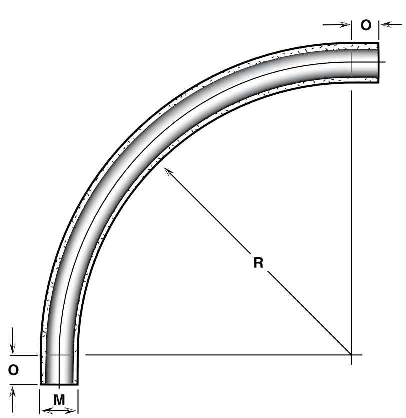


90° X 12"

Nominal Size	Type	IPS Item No.	M	O-Tangent (min.)	R-Radius (min.)	Weight lbs (kg)
¾	SW	07E-SW-90-P	1.05 (27)	6 (152)	12 (305)	0.43 (0.20)
1	SW	10E-SW-90-P	1.32 (33)	6 (152)	12 (305)	0.48 (0.22)
1¼	SW	12E-SW-90-P	1.66 (42)	6 (152)	12 (305)	0.58 (0.26)
1½	SW	15E-SW-90-P	1.90 (48)	6 (152)	12 (305)	0.83 (0.38)
2	SW	20E-SW-90-P	2.37 (60)	6 (152)	12 (305)	0.95 (0.43)
2½	SW	25E-SW-90-P	2.88 (73)	6 (152)	12 (305)	1.15 (0.52)

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs (kg)
2	SW	20F-SW-90-P	2.14 (54)	6 (152)	12 (305)	0.85 (0.39)
2½	SW	25F-SW-90-P	2.64 (67)	6 (152)	12 (305)	1.05 (0.48)

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs (kg)
¾	XW	07E-XW-90-P	1.41 (36)	6 (152)	12 (305)	1.52 (0.69)
1	XW	10E-XW-90-P	1.68 (43)	6 (152)	12 (305)	1.70 (0.77)
1¼	XW	12E-XW-90-P	2.02 (51)	6 (152)	12 (305)	2.05 (0.93)
1½	XW	15E-XW-90-P	2.26 (57)	6 (152)	12 (305)	2.95 (1.34)
2	XW	20F-XW-90-P	2.50 (63)	6 (152)	12 (305)	3.15 (1.43)
2½	XW	25F-XW-90-P	3.00 (76)	6 (152)	12 (305)	3.85 (1.75)
3	XW	30F-XW-90-P	3.50 (89)	6 (152)	12 (305)	4.55 (2.06)
3½	XW	35F-XW-90-P	4.00 (102)	6 (152)	12 (305)	5.25 (2.38)



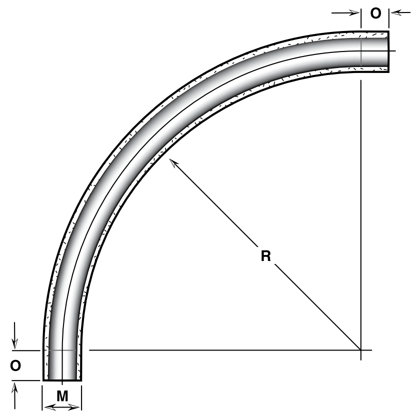
90° X 24"

Nominal Size	Type	IPS Item No.	M	O-Tangent (min.)	R-Radius (min.)	Weight lbs (kg)
¾	SW	07E-SW-91-P	1.05 (27)	6 (152)	24 (610)	0.71 (0.32)
1	SW	10E-SW-91-P	1.32 (33)	6 (152)	24 (610)	0.79 (0.36)
1¼	SW	12E-SW-91-P	1.66 (42)	6 (152)	24 (610)	0.96 (0.44)
1½	SW	15E-SW-91-P	1.90 (48)	6 (152)	24 (610)	1.38 (0.63)
2	SW	20E-SW-91-P	2.37 (60)	6 (152)	24 (610)	1.58 (0.72)
2½	SW	25E-SW-91-P	2.88 (73)	6 (152)	24 (610)	1.92 (0.87)
3	SW	30E-SW-91-P	3.50 (89)	6 (152)	24 (610)	2.50 (1.14)
4	SW	40E-SW-91-P	4.46 (113)	6 (152)	24 (610)	3.00 (1.36)
4	HW	40E-HW-91-P	4.51 (115)	6 (152)	24 (610)	4.04 (1.83)

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs (kg)
2	SW	20F-SW-91-P	2.14 (54)	6 (152)	24 (610)	1.42 (0.65)
2½	SW	25F-SW-91-P	2.64 (67)	6 (152)	24 (610)	1.75 (0.80)
3	SW	30F-SW-91-P	3.14 (80)	6 (152)	24 (610)	2.00 (0.91)
4	SW	40F-SW-91-P	4.14 (105)	6 (152)	24 (610)	2.88 (1.30)
4	HW	40F-HW-91-P	4.19 (106)	6 (152)	24 (610)	3.84 (1.74)

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs (kg)
¾	XW	07E-XW-91-P	1.41 (36)	6 (152)	24 (610)	2.54 (1.15)
1	XW	10E-XW-91-P	1.68 (43)	6 (152)	24 (610)	2.83 (1.29)
1¼	XW	12E-XW-91-P	2.02 (51)	6 (152)	24 (610)	3.42 (1.55)
1½	XW	15E-XW-91-P	2.26 (57)	6 (152)	24 (610)	4.92 (2.23)
2	XW	20F-XW-91-P	2.50 (65)	6 (152)	24 (610)	5.25 (2.38)
2½	XW	25F-XW-91-P	3.00 (76)	6 (152)	24 (610)	6.42 (2.92)
3	XW	30F-XW-91-P	3.50 (89)	6 (152)	24 (610)	7.58 (3.44)
3½	XW	35F-XW-91-P	4.00 (102)	6 (152)	24 (610)	8.76 (3.98)
4	XW	40F-XW-91-P	4.50 (114)	6 (152)	24 (610)	9.92 (4.50)

PHENOLIC ELBOWS

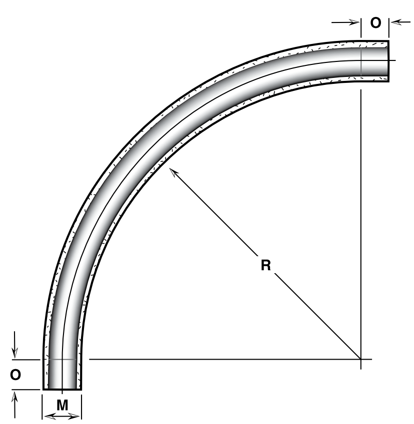


90° X 36"

Nominal Size	Type	IPS Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	SW	07E-SW-92-P	1.05 *(27)*	6 *(152)*	36 *(914)*	0.96	*(0.44)*
1	SW	10E-SW-92-P	1.32 *(33)*	6 *(152)*	36 *(914)*	1.08	*(0.49)*
1¼	SW	12E-SW-92-P	1.66 *(42)*	6 *(152)*	36 *(914)*	1.30	*(0.59)*
1½	SW	15E-SW-92-P	1.90 *(48)*	6 *(152)*	36 *(914)*	1.87	*(0.85)*
2	SW	20E-SW-92-P	2.37 *(60)*	6 *(152)*	36 *(914)*	2.15	*(0.98)*
2½	SW	25E-SW-92-P	2.88 *(73)*	6 *(152)*	36 *(914)*	2.61	*(1.19)*
3	SW	30E-SW-92-P	3.50 *(89)*	6 *(152)*	36 *(914)*	3.40	*(1.54)*
4	SW	40E-SW-92-P	4.46 *(113)*	6 *(152)*	36 *(914)*	4.08	*(1.85)*
4	HW	40E-HW-92-P	4.51 *(115)*	6 *(152)*	36 *(914)*	5.50	*(2.50)*
5	MW	50E-MW-92-P	5.57 *(141)*	6 *(152)*	36 *(914)*	6.85	*(3.08)*
5	HW	50E-HW-92-P	5.60 *(142)*	6 *(152)*	36 *(914)*	7.54	*(3.42)*
6	MW	60E-MW-92-P	6.63 *(168)*	6 *(152)*	36 *(914)*	8.11	*(3.65)*
6	HW	60E-HW-92-P	6.66 *(169)*	6 *(152)*	36 *(914)*	9.31	*(4.19)*

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
2	SW	20F-SW-92-P	2.14 *(54)*	6 *(152)*	36 *(914)*	1.93	*(1.14)*
2½	SW	25F-SW-92-P	2.64 *(67)*	6 *(152)*	36 *(914)*	2.38	*(1.36)*
3	SW	30F-SW-92-P	3.14 *(80)*	6 *(152)*	36 *(914)*	2.72	*(1.59)*
3½	SW	35F-SW-92-P	3.64 *(92)*	6 *(152)*	36 *(914)*	3.40	*(1.63)*
4	SW	40F-SW-92-P	4.14 *(105)*	6 *(152)*	36 *(914)*	3.91	*(1.68)*
4	HW	40F-HW-92-P	4.19 *(106)*	6 *(152)*	36 *(914)*	5.21	*(2.09)*
4½	SW	45F-SW-92-P	4.64 *(117)*	6 *(152)*	36 *(914)*	4.25	*(1.86)*
4½	HW	45F-HW-92-P	4.69 *(118)*	6 *(152)*	36 *(914)*	5.89	*(2.27)*
5	MW	50F-MW-92-P	5.19 *(132)*	6 *(152)*	36 *(914)*	6.45	*(2.90)*
5	HW	50F-HW-92-P	5.22 *(132)*	6 *(152)*	36 *(914)*	7.42	*(3.34)*
6	MW	60F-MW-92-P	6.19 *(157)*	6 *(152)*	36 *(914)*	7.71	*(3.47)*
6	HW	60F-HW-92-P	6.22 *(158)*	6 *(152)*	36 *(914)*	9.02	*(4.06)*

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	XW	07E-XW-92-P	1.41 *(36)*	6 *(152)*	36 *(914)*	3.46	*(1.57)*
1	XW	10E-XW-92-P	1.68 *(43)*	6 *(152)*	36 *(914)*	3.85	*(1.75)*
1¼	XW	12E-XW-92-P	2.02 *(51)*	6 *(152)*	36 *(914)*	4.65	*(2.11)*
1½	XW	15E-XW-92-P	2.26 *(57)*	6 *(152)*	36 *(914)*	6.69	*(3.04)*
2	XW	20F-XW-92-P	2.50 *(65)*	6 *(152)*	36 *(914)*	7.14	*(3.24)*
2½	XW	25F-XW-92-P	3.00 *(76)*	6 *(152)*	36 *(914)*	8.73	*(3.96)*
3	XW	30F-XW-92-P	3.50 *(89)*	6 *(152)*	36 *(914)*	10.31	*(4.68)*
3½	XW	35F-XW-92-P	4.00 *(102)*	6 *(152)*	36 *(914)*	11.90	*(5.40)*
4	XW	40F-XW-92-P	4.50 *(114)*	6 *(152)*	36 *(914)*	13.49	*(6.12)*
5	XW	50F-XW-92-P	5.50 *(140)*	6 *(152)*	36 *(914)*	16.79	*(7.56)*
6	XW	60F-XW-92-P	6.50 *(165)*	6 *(152)*	36 *(914)*	19.99	*(9.00)*



90° X 48"

Nominal Size	Type	IPS Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	SW	07E-SW-93-P	1.05 *(27)*	6 *(152)*	48 *(1,219)*	1.36	*(0.62)*
1	SW	10E-SW-93-P	1.32 *(33)*	6 *(152)*	48 *(1,219)*	1.52	*(0.69)*
1¼	SW	12E-SW-93-P	1.66 *(42)*	6 *(152)*	48 *(1,219)*	1.84	*(0.84)*
1½	SW	15E-SW-93-P	1.90 *(48)*	6 *(152)*	48 *(1,219)*	2.64	*(1.20)*
2	SW	20E-SW-93-P	2.37 *(60)*	6 *(152)*	48 *(1,219)*	3.04	*(1.38)*
2½	SW	25E-SW-93-P	2.88 *(73)*	6 *(152)*	48 *(1,219)*	3.68	*(1.67)*
3	SW	30E-SW-93-P	3.50 *(89)*	6 *(152)*	48 *(1,219)*	4.80	*(2.18)*
4	SW	40E-SW-93-P	4.46 *(113)*	6 *(152)*	48 *(1,219)*	5.76	*(2.62)*
4	HW	40E-HW-93-P	4.51 *(114)*	6 *(152)*	48 *(1,219)*	7.76	*(3.52)*
5	MW	50E-MW-93-P	5.57 *(141)*	6 *(152)*	48 *(1,219)*	9.60	*(4.36)*
5	HW	50E-HW-93-P	5.60 *(142)*	6 *(152)*	48 *(1,219)*	10.40	*(4.72)*
6	MW	60E-MW-93-P	6.63 *(168)*	6 *(152)*	48 *(1,219)*	11.52	*(5.23)*
6	HW	60E-HW-93-P	6.66 *(169)*	6 *(152)*	48 *(1,219)*	12.67	*(5.75)*

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
2	SW	20F-SW-93-P	2.14 *(54)*	6 *(152)*	48 *(1,219)*	2.72	*(1.24)*
2½	SW	25F-SW-93-P	2.64 *(67)*	6 *(152)*	48 *(1,219)*	3.36	*(1.53)*
3	SW	30F-SW-93-P	3.14 *(80)*	6 *(152)*	48 *(1,219)*	3.84	*(1.74)*
3½	SW	35F-SW-93-P	3.64 *(92)*	6 *(152)*	48 *(1,219)*	4.80	*(2.18)*
4	SW	40F-SW-93-P	4.14 *(105)*	6 *(152)*	48 *(1,219)*	5.52	*(2.51)*
4	HW	40F-HW-93-P	4.19 *(106)*	6 *(152)*	48 *(1,219)*	7.36	*(3.34)*
4½	SW	45F-SW-93-P	4.64 *(117)*	6 *(152)*	48 *(1,219)*	6.00	*(2.72)*
4½	HW	45F-HW-93-P	4.69 *(118)*	6 *(152)*	48 *(1,219)*	8.32	*(3.78)*
5	MW	50F-MW-93-P	5.19 *(132)*	6 *(152)*	48 *(1,219)*	9.04	*(4.10)*
5	HW	50F-HW-93-P	5.22 *(133)*	6 *(152)*	48 *(1,219)*	10.56	*(4.79)*
6	MW	60F-MW-93-P	6.19 *(157)*	6 *(152)*	48 *(1,219)*	10.85	*(4.92)*
6	HW	60F-HW-93-P	6.22 *(158)*	6 *(152)*	48 *(1,219)*	12.48	*(5.66)*

Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	XW	07E-XW-93-P	1.41 *(36)*	6 *(152)*	48 *(1,219)*	4.44	*(2.04)*
1	XW	10E-XW-93-P	1.68 *(43)*	6 *(152)*	48 *(1,219)*	4.95	*(2.26)*
1¼	XW	12E-XW-93-P	2.02 *(51)*	6 *(152)*	48 *(1,219)*	5.97	*(2.69)*
1½	XW	15E-XW-93-P	2.26 *(57)*	6 *(152)*	48 *(1,219)*	8.59	*(3.86)*
2	XW	20F-XW-93-P	2.50 *(65)*	6 *(152)*	48 *(1,219)*	10.08	*(4.58)*
2½	XW	25F-XW-93-P	3.00 *(76)*	6 *(152)*	48 *(1,219)*	12.32	*(5.59)*
3	XW	30F-XW-93-P	3.50 *(89)*	6 *(152)*	48 *(1,219)*	14.56	*(6.61)*
3½	XW	35F-XW-93-P	4.00 *(102)*	6 *(152)*	48 *(1,219)*	16.80	*(7.63)*
4	XW	40F-XW-93-P	4.50 *(114)*	6 *(152)*	48 *(1,219)*	19.04	*(8.64)*
5	XW	50F-XW-93-P	5.50 *(140)*	6 *(152)*	48 *(1,219)*	23.52	*(10.68)*
6	XW	60F-XW-93-P	6.50 *(165)*	6 *(152)*	48 *(1,219)*	28.00	*(12.71)*

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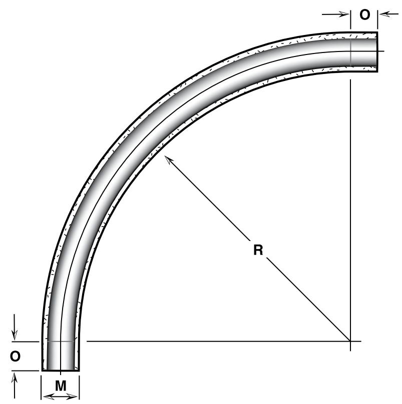
Nominal Size	Type	IPS Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	SW	07E-SW-94-P	1.05 *(27)*	6 *(152)*	60 *(1,524)*	1.50	*(0.68)*
1	SW	10E-SW-94-P	1.32 *(33)*	6 *(152)*	60 *(1,524)*	1.68	*(0.76)*
1¼	SW	12E-SW-94-P	1.66 *(42)*	6 *(152)*	60 *(1,524)*	2.03	*(0.92)*
1½	SW	15E-SW-94-P	1.90 *(48)*	6 *(152)*	60 *(1,524)*	2.92	*(1.33)*
2	SW	20E-SW-94-P	2.37 *(60)*	6 *(152)*	60 *(1,524)*	3.36	*(1.53)*
2½	SW	25E-SW-94-P	2.88 *(73)*	6 *(152)*	60 *(1,524)*	4.06	*(1.84)*
3	SW	30E-SW-94-P	3.50 *(89)*	6 *(152)*	60 *(1,524)*	5.30	*(2.41)*
4	SW	40E-SW-94-P	4.46 *(113)*	6 *(152)*	60 *(1,524)*	6.36	*(2.89)*
4	HW	40E-HW-94-P	4.51 *(115)*	6 *(152)*	60 *(1,524)*	8.57	*(3.89)*
5	MW	50E-MW-94-P	5.57 *(141)*	6 *(152)*	60 *(1,524)*	10.60	*(4.81)*
5	HW	50E-HW-94-P	5.60 *(142)*	6 *(152)*	60 *(1,524)*	11.48	*(5.21)*
6	MW	60E-MW-94-P	6.63 *(168)*	6 *(152)*	60 *(1,524)*	12.54	*(5.69)*
6	HW	60E-HW-94-P	6.66 *(169)*	6 *(152)*	60 *(1,524)*	14.40	*(6.54)*



90° X 60"

Nominal Size	Type	ID Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
2	SW	20F-SW-94-P	2.14 *(54)*	6 *(152)*	60 *(1,524)*	3.00	*(1.36)*
2½	SW	25F-SW-94-P	2.64 *(67)*	6 *(152)*	60 *(1,524)*	3.71	*(1.68)*
3	SW	30F-SW-94-P	3.14 *(80)*	6 *(152)*	60 *(1,524)*	4.24	*(1.93)*
3½	SW	35F-SW-94-P	3.64 *(92)*	6 *(152)*	60 *(1,524)*	5.30	*(2.41)*
4	SW	40F-SW-94-P	4.14 *(105)*	6 *(152)*	60 *(1,524)*	6.10	*(2.77)*
4	HW	40F-HW-94-P	4.19 *(106)*	6 *(152)*	60 *(1,524)*	8.13	*(3.69)*
4½	SW	45F-SW-94-P	4.64 *(117)*	6 *(152)*	60 *(1,524)*	6.63	*(3.01)*
4½	HW	45F-HW-94-P	4.69 *(118)*	6 *(152)*	60 *(1,524)*	9.19	*(4.17)*
5	MW	50F-MW-94-P	5.19 *(132)*	6 *(152)*	60 *(1,524)*	9.98	*(4.53)*
5	HW	50F-HW-94-P	5.22 *(132)*	6 *(152)*	60 *(1,524)*	11.66	*(5.29)*
6	MW	60F-MW-94-P	6.19 *(157)*	6 *(152)*	60 *(1,524)*	11.93	*(5.42)*
6	HW	60F-HW-94-P	6.22 *(158)*	6 *(152)*	60 *(1,524)*	13.96	*(6.34)*

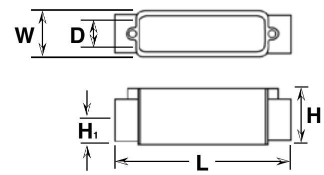
Nominal Size	Type	Item No.	M	O-Tangent (min)	R - Radius (min)	Weight lbs	kg
¾	XW	07E-XW-94-P	1.41 *(36)*	6 *(152)*	60 *(1,524)*	5.40	*(2.48)*
1	XW	10E-XW-94-P	1.68 *(43)*	6 *(152)*	60 *(1,524)*	6.02	*(2.74)*
1¼	XW	12E-XW-94-P	2.02 *(51)*	6 *(152)*	60 *(1,524)*	7.26	*(3.28)*
1½	XW	15E-XW-94-P	2.26 *(57)*	6 *(152)*	60 *(1,524)*	10.45	*(4.69)*
2	XW	20F-XW-94-P	2.50 *(65)*	6 *(152)*	60 *(1,524)*	11.13	*(5.05)*
2½	XW	25F-XW-94-P	3.00 *(76)*	6 *(152)*	60 *(1,524)*	13.61	*(6.18)*
3	XW	30F-XW-94-P	3.50 *(89)*	6 *(152)*	60 *(1,524)*	16.08	*(7.30)*
3½	XW	35F-XW-94-P	4.00 *(102)*	6 *(152)*	60 *(1,524)*	18.55	*(8.42)*
4	XW	40F-XW-94-P	4.50 *(114)*	6 *(152)*	60 *(1,524)*	21.02	*(9.54)*
5	XW	50F-XW-94-P	5.50 *(140)*	6 *(152)*	60 *(1,524)*	25.97	*(11.79)*
6	XW	60F-XW-94-P	6.50 *(165)*	6 *(152)*	60 *(1,524)*	30.92	*(14.04)*

Note: For different radii, degree and/or length for any elbows listed in this catalog, please contact your local sales rep. or the Champion Fiberglass office.

For technical information regarding fittings and elbows for 8", 10", and 12" conduit, please contact your local sales rep. or the Champion Fiberglass Spring, Texas office.

CONDUIT BODIES

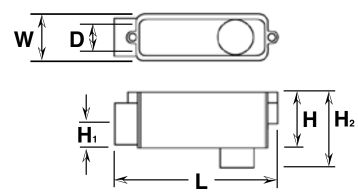
All conduit bodies are manufactured by compression molding for ultimate strength. The conduit bodies are made from phenolic resin with high glass content and meet the same flame and smoke standards as the conduit itself. Each conduit body is supplied with a high performance rubber gasket to provide a water tight seal between the cover and conduit body. All hardware is stainless steel.



TYPE C

Nominal Size	Type	IPS Item No. Aboveground	L inch (mm)	H inch (mm)	W inch (mm)	H_1 inch (mm)	D inch (mm)	Volume cu in (cm3)	Weight lbs (kg)
¾	SW	07E-SW-C	8.375 (213)	2.375 (60)	1.840 (47)	1.000 (25)	1.075 (27)	13.90 (228)	0.70 (0.32)
1	SW	10E-SW-C	8.375 (213)	2.375 (60)	1.840 (47)	1.000 (25)	1.340 (34)	13.90 (228)	0.70 (0.32)
1¼	SW	12E-SW-C	10.125 (257)	2.875 (73)	2.540 (64)	1.188 (30)	1.685 (43)	32.00 (524)	1.20 (0.54)
1½	SW	15E-SW-C	10.125 (257)	2.875 (73)	2.540 (64)	1.188 (30)	1.910 (48)	32.00 (524)	1.10 (0.50)
2	SW	20E-SW-C	13.375 (340)	4.000 (102)	3.040 (77)	1.812 (46)	2.390 (61)	70.75 (1160)	2.50 (1.13)
2½	SW	25F-SW-C	21.750 (552)	6.000 (152)	5.875 (149)	3.000 (76)	3.508 (89)	425.00 (6964)	4.24 (1.92)
3	SW	30E-SW-C	21.750 (552)	6.000 (152)	5.875 (149)	3.000 (76)	3.508 (89)	425.00 (6964)	4.24 (1.92)
4	SW	40E-SW-C	21.750 (552)	6.000 (152)	5.875 (149)	3.000 (76)	4.508 (114)	425.00 (6964)	4.24 (1.92)

Nominal Size	Type	IPS Item No. Aboveground	L inch (mm)	H inch (mm)	W inch (mm)	H_1 inch (mm)	D inch (mm)	Volume cu in (cm3)	Weight lbs (kg)
¾	XW	07E-XW-C	8.375 (213)	2.375 (60)	1.840 (47)	1.000 (25)	1.435 (36)	13.90 (228)	0.70 (0.32)
1	XW	10E-XW-C	8.375 (213)	2.375 (60)	1.840 (47)	1.000 (25)	1.700 (43)	13.90 (228)	0.70 (0.32)
1¼	XW	12E-XW-C	10.125 (257)	2.875 (73)	2.540 (64)	1.188 (30)	2.045 (52)	32.00 (524)	1.20 (0.54)
1½	XW	15E-XW-C	10.125 (257)	2.875 (73)	2.540 (64)	1.188 (30)	2.285 (58)	32.00 (524)	1.10 (0.50)
2	XW	20F-XW-C	13.375 (340)	4.000 (102)	3.040 (77)	1.812 (46)	2.520 (64)	70.75 (1160)	2.50 (1.13)
2½	XW	25F-XW-C	13.375 (340)	4.000 (102)	3.040 (77)	1.812 (46)	3.025 (77)	70.75 (1160)	2.50 (1.13)
3	XW	30F-XW-C	21.750 (552)	6.000 (152)	5.875 (149)	3.000 (76)	3.520 (89)	425.00 (6964)	4.24 (1.92)
3½	XW	35F-XW-C	21.750 (552)	6.000 (152)	5.875 (149)	3.000 (76)	4.025 (102)	425.00 (6964)	4.24 (1.92)
4	XW	40F-XW-C	21.750 (552)	6.000 (152)	5.875 (149)	3.000 (76)	4.520 (115)	425.00 (6964)	4.24 (1.92)



TYPE LB

Nominal Size	Type	IPS Item No. Aboveground	L inch (mm)	H inch (mm)	W inch (mm)	H_1 inch (mm)	H_2 inch (mm)	D inch (mm)	Volume cu in (cm^3)	Weight lbs (kg)
¾	SW	07E-SW-LB	7.375 (187)	2.375 (60)	1.840 (47)	1.000 (25)	3.900 (99)	1.075 (27)	13.90 (228)	0.70 (0.32)
1	SW	10E-SW-LB	7.375 (187)	2.375 (60)	1.840 (47)	1.000 (25)	3.900 (99)	1.340 (34)	13.90 (228)	0.70 (0.32)
1¼	SW	12E-SW-LB	9.000 (229)	2.875 (73)	2.540 (64)	1.188 (30)	4.875 (124)	1.685 (43)	32.00 (524)	1.20 (0.54)
1½	SW	15E-SW-LB	9.000 (229)	2.875 (73)	2.540 (64)	1.188 (30)	4.875 (124)	1.910 (48)	32.00 (524)	1.10 (0.50)
2	SW	20E-SW-LB	11.250 (286)	4.000 (102)	3.040 (77)	1.812 (46)	6.687 (170)	2.390 (61)	70.75 (1160)	2.50 (1.13)
2½	SW	25C-SW-LB	16.125 (410)	6.000 (152)	5.875 (149)	3.000 (76)	8.750 (222)	3.508 (89)	425.00 (6964)	4.24 (1.92)
3	SW	30E-SW-LB	16.125 (410)	6.000 (152)	5.875 (149)	3.000 (76)	8.750 (222)	3.508 (89)	425.00 (6964)	4.24 (1.92)
4	SW	40E-SW-LB	16.125 (410)	6.000 (152)	5.875 (149)	3.000 (76)	8.750 (222)	4.508 (114)	425.00 (6964)	4.24 (1.92)

Nominal Size	Type	IPS Item No. Aboveground	L inch (mm)	H inch (mm)	W inch (mm)	H_1 inch (mm)	H_2 inch (mm)	D inch (mm)	Volume cu in (cm^3)	Weight lbs (kg)
¾	XW	07E-XW-LB	7.375 (187)	2.375 (60)	1.840 (47)	1.000 (25)	3.900 (99)	1.435 (36)	13.90 (228)	0.70 (0.32)
1	XW	10E-XW-LB	7.375 (187)	2.375 (60)	1.840 (47)	1.000 (25)	3.900 (99)	1.700 (43)	13.90 (228)	0.70 (0.32)
1¼	XW	12E-XW-LB	9.000 (229)	2.875 (73)	2.540 (64)	1.188 (30)	4.875 (124)	2.045 (52)	32.00 (524)	1.20 (0.54)
1½	XW	15E-XW-LB	9.000 (229)	2.875 (73)	2.540 (64)	1.188 (30)	4.875 (124)	2.285 (58)	32.00 (524)	1.10 (0.50)
2	XW	20F-XW-LB	11.250 (286)	4.000 (102)	3.040 (77)	1.812 (46)	6.687 (170)	2.520 (64)	70.75 (1160)	2.50 (1.13)
2½	XW	25F-XW-LB	11.250 (286)	4.000 (102)	3.040 (77)	1.812 (46)	6.687 (170)	3.025 (77)	70.75 (1160)	2.50 (1.13)
3	XW	30F-XW-LB	16.125 (410)	6.000 (152)	5.875 (149)	3.000 (76)	8.750 (222)	3.520 (89)	425.00 (6964)	4.24 (1.92)
3½	XW	35F-XW-LB	16.125 (410)	6.000 (152)	5.875 (149)	3.000 (76)	8.750 (222)	4.025 (102)	425.00 (6964)	4.24 (1.92)
4	XW	40F-XW-LB	16.125 (410)	6.000 (152)	5.875 (149)	3.000 (76)	8.750 (222)	4.520 (115)	425.00 (6964)	4.24 (1.92)

CHAMPION FIBERGLASS®
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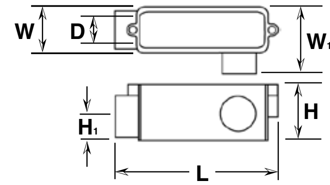
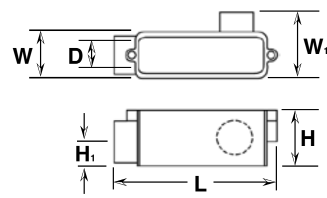
TYPE LL



Nominal Size	Type	IPS Item No. Aboveground	L inch *(mm)*	H inch *(mm)*	W inch *(mm)*	W_1 inch *(mm)*	H_1 inch *(mm)*	D inch *(mm)*	Volume cu in *(cm^3)*	Weight lbs *(kg)*
¾	SW	07E-SW-LL	7.375 *(187)*	2.375 *(60)*	1.840 *(47)*	3.500 *(89)*	1.000 *(25)*	1.075 *(27)*	13.90 *(228)*	0.70 *(0.32)*
1	SW	10E-SW-LL	7.375 *(187)*	2.375 *(60)*	1.840 *(47)*	3.500 *(89)*	1.000 *(25)*	1.340 *(34)*	13.90 *(228)*	0.70 *(0.32)*
1¼	SW	12E-SW-LL	9.000 *(229)*	2.875 *(73)*	2.540 *(64)*	4.500 *(114)*	1.188 *(30)*	1.685 *(43)*	32.00 *(524)*	1.20 *(0.54)*
1½	SW	15E-SW-LL	9.000 *(229)*	2.875 *(73)*	2.540 *(64)*	4.500 *(114)*	1.188 *(30)*	1.910 *(48)*	32.00 *(524)*	1.10 *(0.50)*
2	SW	20E-SW-LL	11.250 *(286)*	4.000 *(102)*	3.040 *(77)*	5.500 *(140)*	1.812 *(46)*	2.390 *(61)*	70.75 *(1160)*	2.50 *(1.13)*
2½	SW	25C-SW-LL	16.125 *(410)*	6.000 *(152)*	5.875 *(149)*	8.750 *(222)*	3.000 *(76)*	3.508 *(89)*	425.00 *(6964)*	4.24 *(1.92)*
3	SW	30E-SW-LL	16.125 *(410)*	6.000 *(152)*	5.875 *(149)*	8.750 *(222)*	3.000 *(76)*	3.508 *(89)*	425.00 *(6964)*	4.24 *(1.92)*
4	SW	40E-SW-LL	16.125 *(410)*	6.000 *(152)*	5.875 *(149)*	8.750 *(222)*	3.000 *(76)*	4.508 *(114)*	425.00 *(6964)*	4.24 *(1.92)*

Nominal Size	Type	IPS Item No. Aboveground	L inch *(mm)*	H inch *(mm)*	W inch *(mm)*	W_1 inch *(mm)*	H_1 inch *(mm)*	D inch *(mm)*	Volume cu in *(cm^3)*	Weight lbs *(kg)*
¾	XW	07E-XW-LL	7.375 *(187)*	2.375 *(60)*	1.840 *(47)*	3.500 *(89)*	1.000 *(25)*	1.435 *(36)*	13.90 *(228)*	0.70 *(0.32)*
1	XW	10E-XW-LL	7.375 *(187)*	2.375 *(60)*	1.840 *(47)*	3.500 *(89)*	1.000 *(25)*	1.700 *(43)*	13.90 *(228)*	0.70 *(0.32)*
1¼	XW	12E-XW-LL	9.000 *(229)*	2.875 *(73)*	2.540 *(64)*	4.500 *(114)*	1.188 *(30)*	2.045 *(52)*	32.00 *(524)*	1.20 *(0.54)*
1½	XW	15E-XW-LL	9.000 *(229)*	2.875 *(73)*	2.540 *(64)*	4.500 *(114)*	1.188 *(30)*	2.285 *(58)*	32.00 *(524)*	1.10 *(0.50)*
2	XW	20F-XW-LL	11.250 *(286)*	4.000 *(102)*	3.040 *(77)*	5.500 *(140)*	1.812 *(46)*	2.520 *(64)*	70.75 *(1160)*	2.50 *(1.13)*
2½	XW	25F-XW-LL	11.250 *(286)*	4.000 *(102)*	3.040 *(77)*	5.500 *(140)*	1.812 *(46)*	3.025 *(77)*	70.75 *(1160)*	2.50 *(1.13)*
3	XW	30F-XW-LL	16.125 *(410)*	6.000 *(152)*	5.875 *(149)*	8.750 *(222)*	3.000 *(76)*	3.520 *(89)*	425.00 *(6964)*	4.24 *(1.92)*
3½	XW	35F-XW-LL	16.125 *(410)*	6.000 *(152)*	5.875 *(149)*	8.750 *(222)*	3.000 *(76)*	4.025 *(102)*	425.00 *(6964)*	4.24 *(1.92)*
4	XW	40F-XW-LL	16.125 *(410)*	6.000 *(152)*	5.875 *(149)*	8.750 *(222)*	3.000 *(76)*	4.520 *(115)*	425.00 *(6964)*	4.24 *(1.92)*

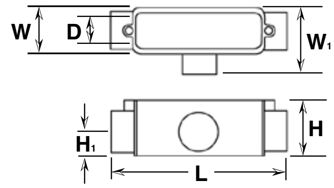
TYPE LR



Nominal Size	Type	IPS Item No. Aboveground	L inch *(mm)*	H inch *(mm)*	W inch *(mm)*	W_1 inch *(mm)*	H_1 inch *(mm)*	D inch *(mm)*	Volume cu in *(cm^3)*	Weight lbs *(kg)*
¾	SW	07E-SW-LR	7.375 *(187)*	2.375 *(60)*	1.840 *(47)*	3.500 *(89)*	1.000 *(25)*	1.075 *(27)*	13.90 *(228)*	0.70 *(0.32)*
1	SW	10E-SW-LR	7.375 *(187)*	2.375 *(60)*	1.840 *(47)*	3.500 *(89)*	1.000 *(25)*	1.340 *(34)*	13.90 *(228)*	0.70 *(0.32)*
1¼	SW	12E-SW-LR	9.000 *(229)*	2.875 *(73)*	2.540 *(64)*	4.500 *(114)*	1.188 *(30)*	1.685 *(43)*	32.00 *(524)*	1.20 *(0.54)*
1½	SW	15E-SW-LR	9.000 *(229)*	2.875 *(73)*	2.540 *(64)*	4.500 *(114)*	1.188 *(30)*	1.910 *(48)*	32.00 *(524)*	1.10 *(0.50)*
2	SW	20E-SW-LR	11.250 *(286)*	4.000 *(102)*	3.040 *(77)*	5.500 *(140)*	1.812 *(46)*	2.390 *(61)*	70.75 *(1160)*	2.50 *(1.13)*
2½	SW	25C-SW-LR	16.125 *(410)*	6.000 *(152)*	5.875 *(149)*	8.750 *(222)*	3.000 *(76)*	3.508 *(89)*	425.00 *(6964)*	4.24 *(1.92)*
3	SW	30E-SW-LR	16.125 *(410)*	6.000 *(152)*	5.875 *(149)*	8.750 *(222)*	3.000 *(76)*	3.508 *(89)*	425.00 *(6964)*	4.24 *(1.92)*
4	SW	40E-SW-LR	16.125 *(410)*	6.000 *(152)*	5.875 *(149)*	8.750 *(222)*	3.000 *(76)*	4.508 *(114)*	425.00 *(6964)*	4.24 *(1.92)*

Nominal Size	Type	IPS Item No. Aboveground	L inch *(mm)*	H inch *(mm)*	W inch *(mm)*	W_1 inch *(mm)*	H_1 inch *(mm)*	D inch *(mm)*	Volume cu in *(cm^3)*	Weight lbs *(kg)*
¾	XW	07E-XW-LR	7.375 *(187)*	2.375 *(60)*	1.840 *(47)*	3.500 *(89)*	1.000 *(25)*	1.435 *(36)*	13.90 *(228)*	0.70 *(0.32)*
1	XW	10E-XW-LR	7.375 *(187)*	2.375 *(60)*	1.840 *(47)*	3.500 *(89)*	1.000 *(25)*	1.700 *(43)*	13.90 *(228)*	0.70 *(0.32)*
1¼	XW	12E-XW-LR	9.000 *(229)*	2.875 *(73)*	2.540 *(64)*	4.500 *(114)*	1.188 *(30)*	2.045 *(52)*	32.00 *(524)*	1.20 *(0.54)*
1½	XW	15E-XW-LR	9.000 *(229)*	2.875 *(73)*	2.540 *(64)*	4.500 *(114)*	1.188 *(30)*	2.285 *(58)*	32.00 *(524)*	1.10 *(0.50)*
2	XW	20F-XW-LR	11.250 *(286)*	4.000 *(102)*	3.040 *(77)*	5.500 *(140)*	1.812 *(46)*	2.520 *(64)*	70.75 *(1160)*	2.50 *(1.13)*
2½	XW	25F-XW-LR	11.250 *(286)*	4.000 *(102)*	3.040 *(77)*	5.500 *(140)*	1.812 *(46)*	3.025 *(77)*	70.75 *(1160)*	2.50 *(1.13)*
3	XW	30F-XW-LR	16.125 *(410)*	6.000 *(152)*	5.875 *(149)*	8.750 *(222)*	3.000 *(76)*	3.520 *(89)*	425.00 *(6964)*	4.24 *(1.92)*
3½	XW	35F-XW-LR	16.125 *(410)*	6.000 *(152)*	5.875 *(149)*	8.750 *(222)*	3.000 *(76)*	4.025 *(102)*	425.00 *(6964)*	4.24 *(1.92)*
4	XW	40F-XW-LR	16.125 *(410)*	6.000 *(152)*	5.875 *(149)*	8.750 *(222)*	3.000 *(76)*	4.520 *(115)*	425.00 *(6964)*	4.24 *(1.92)*

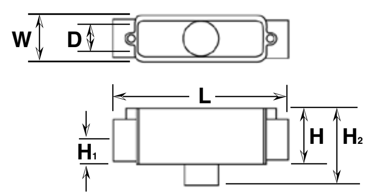
TYPE T



Nominal Size	Type	IPS Item No. Aboveground	L inch *(mm)*	H inch *(mm)*	W inch *(mm)*	W_1 inch *(mm)*	H_1 inch *(mm)*	D inch *(mm)*	Volume cu in *(cm³)*	Weight lbs *(kg)*
¾	SW	07E-SW-T	8.375 *(213)*	2.375 *(60)*	1.840 *(47)*	3.500 *(89)*	1.000 *(25)*	1.075 *(27)*	13.90 *(228)*	0.70 *(0.32)*
1	SW	10E-SW-T	8.375 *(213)*	2.375 *(60)*	1.840 *(47)*	3.500 *(89)*	1.000 *(25)*	1.340 *(34)*	13.90 *(228)*	0.70 *(0.32)*
1¼	SW	12E-SW-T	10.125 *(257)*	3.000 *(76)*	2.540 *(64)*	4.437 *(113)*	1.188 *(30)*	1.685 *(43)*	32.00 *(524)*	1.40 *(0.64)*
1½	SW	15E-SW-T	10.125 *(257)*	3.000 *(76)*	2.540 *(64)*	4.437 *(113)*	1.188 *(30)*	1.910 *(48)*	32.00 *(524)*	1.30 *(0.59)*
2	SW	20E-SW-T	13.375 *(340)*	4.000 *(102)*	3.040 *(77)*	5.500 *(140)*	1.812 *(46)*	2.390 *(61)*	70.75 *(1160)*	2.80 *(1.27)*
2½	SW	25C-SW-T	21.750 *(552)*	6.000 *(152)*	5.875 *(149)*	8.750 *(222)*	3.000 *(76)*	3.508 *(89)*	425.00 *(6964)*	4.24 *(1.92)*
3	SW	30E-SW-T	21.750 *(552)*	6.000 *(152)*	5.875 *(149)*	8.750 *(222)*	3.000 *(76)*	3.508 *(89)*	425.00 *(6964)*	4.24 *(1.92)*
4	SW	40E-SW-T	21.750 *(552)*	6.000 *(152)*	5.875 *(149)*	8.750 *(222)*	3.000 *(76)*	4.508 *(114)*	425.00 *(6964)*	4.24 *(1.92)*

Nominal Size	Type	IPS Item No. Aboveground	L inch *(mm)*	H inch *(mm)*	W inch *(mm)*	W_1 inch *(mm)*	H_1 inch *(mm)*	D inch *(mm)*	Volume cu in *(cm³)*	Weight lbs *(kg)*
¾	XW	07E-XW-T	8.375 *(213)*	2.375 *(60)*	1.840 *(47)*	3.500 *(89)*	1.000 *(25)*	1.435 *(36)*	13.90 *(228)*	0.70 *(0.32)*
1	XW	10E-XW-T	8.375 *(213)*	2.375 *(60)*	1.840 *(47)*	3.500 *(89)*	1.000 *(25)*	1.700 *(43)*	13.90 *(228)*	0.70 *(0.32)*
1¼	XW	12E-XW-T	10.125 *(257)*	3.000 *(76)*	2.540 *(64)*	4.437 *(113)*	1.188 *(30)*	2.045 *(52)*	32.00 *(524)*	1.40 *(0.64)*
1½	XW	15E-XW-T	10.125 *(257)*	3.000 *(76)*	2.540 *(64)*	4.437 *(113)*	1.188 *(30)*	2.285 *(58)*	32.00 *(524)*	1.30 *(0.59)*
2	XW	20F-XW-T	13.375 *(340)*	4.000 *(102)*	3.040 *(77)*	5.500 *(140)*	1.812 *(46)*	2.520 *(64)*	70.75 *(1160)*	2.80 *(1.27)*
2½	XW	25F-XW-T	13.375 *(340)*	4.000 *(102)*	3.040 *(77)*	5.500 *(140)*	1.812 *(46)*	3.025 *(77)*	70.75 *(1160)*	2.50 *(1.13)*
3	XW	30F-XW-T	21.750 *(552)*	6.000 *(152)*	5.875 *(149)*	8.750 *(222)*	3.000 *(76)*	3.520 *(89)*	425.00 *(6964)*	4.24 *(1.92)*
3½	XW	35F-XW-T	21.750 *(552)*	6.000 *(152)*	5.875 *(149)*	8.750 *(222)*	3.000 *(76)*	4.025 *(102)*	425.00 *(6964)*	4.24 *(1.92)*
4	XW	40F-XW-T	21.750 *(552)*	6.000 *(152)*	5.875 *(149)*	8.750 *(222)*	3.000 *(76)*	4.520 *(115)*	425.00 *(6964)*	4.24 *(1.92)*

TYPE TB



Nominal Size	Type	IPS Item No. Aboveground	L inch *(mm)*	H inch *(mm)*	W inch *(mm)*	H_1 inch *(mm)*	H_2 inch *(mm)*	D inch *(mm)*	Volume cu in *(cm³)*	Weight lbs *(kg)*
¾	SW	07E-SW-TB	8.375 *(213)*	2.375 *(60)*	1.840 *(47)*	1.000 *(25)*	3.900 *(99)*	1.075 *(27)*	13.90 *(228)*	0.70 *(0.32)*
1	SW	10E-SW-TB	8.375 *(213)*	2.375 *(60)*	1.840 *(47)*	1.000 *(25)*	3.900 *(99)*	1.340 *(34)*	13.90 *(228)*	0.70 *(0.32)*
1¼	SW	12E-SW-TB	10.125 *(257)*	3.000 *(76)*	2.540 *(64)*	1.188 *(30)*	4.875 *(124)*	1.685 *(43)*	32.00 *(524)*	1.40 *(0.64)*
1½	SW	15E-SW-TB	10.125 *(257)*	3.000 *(76)*	2.540 *(64)*	1.188 *(30)*	4.875 *(124)*	1.910 *(48)*	32.00 *(524)*	1.30 *(0.59)*
2	SW	20E-SW-TB	13.375 *(340)*	4.000 *(102)*	3.040 *(77)*	1.812 *(46)*	6.687 *(170)*	2.390 *(61)*	70.75 *(1160)*	2.80 *(1.27)*
2½	SW	25C-SW-TB	21.750 *(552)*	6.000 *(152)*	5.875 *(149)*	3.000 *(76)*	8.750 *(222)*	3.508 *(89)*	425.00 *(6964)*	4.24 *(1.92)*
3	SW	30E-SW-TB	21.750 *(552)*	6.000 *(152)*	5.875 *(149)*	3.000 *(76)*	8.750 *(222)*	3.508 *(89)*	425.00 *(6964)*	4.24 *(1.92)*
4	SW	40E-SW-TB	21.750 *(552)*	6.000 *(152)*	5.875 *(149)*	3.000 *(76)*	8.750 *(222)*	4.508 *(114)*	425.00 *(6964)*	4.24 *(1.92)*

Nominal Size	Type	IPS Item No. Aboveground	L inch *(mm)*	H inch *(mm)*	W inch *(mm)*	H_1 inch *(mm)*	H_2 inch *(mm)*	D inch *(mm)*	Volume cu in *(cm³)*	Weight lbs *(kg)*
¾	XW	07E-XW-TB	8.375 *(213)*	2.375 *(60)*	1.840 *(47)*	1.000 *(25)*	3.900 *(99)*	1.435 *(36)*	13.90 *(228)*	0.70 *(0.32)*
1	XW	10E-XW-TB	8.375 *(213)*	2.375 *(60)*	1.840 *(47)*	1.000 *(25)*	3.900 *(99)*	1.700 *(43)*	13.90 *(228)*	0.70 *(0.32)*
1¼	XW	12E-XW-TB	10.125 *(257)*	3.000 *(76)*	2.540 *(64)*	1.188 *(30)*	4.875 *(124)*	2.045 *(52)*	32.00 *(524)*	1.40 *(0.64)*
1½	XW	15E-XW-TB	10.125 *(257)*	3.000 *(76)*	2.540 *(64)*	1.188 *(30)*	4.875 *(124)*	2.285 *(58)*	32.00 *(524)*	1.30 *(0.59)*
2	XW	20F-XW-TB	13.375 *(340)*	4.000 *(102)*	3.040 *(77)*	1.812 *(46)*	6.687 *(170)*	2.520 *(64)*	70.75 *(1160)*	2.80 *(1.27)*
2½	XW	25F-XW-TB	13.375 *(340)*	4.000 *(102)*	3.040 *(77)*	1.812 *(46)*	6.687 *(170)*	3.025 *(77)*	70.75 *(1160)*	2.50 *(1.13)*
3	XW	30F-XW-TB	21.750 *(552)*	6.000 *(152)*	5.875 *(149)*	3.000 *(76)*	8.750 *(222)*	3.520 *(89)*	425.00 *(6964)*	4.24 *(1.92)*
3½	XW	35F-XW-TB	21.750 *(552)*	6.000 *(152)*	5.875 *(149)*	3.000 *(76)*	8.750 *(222)*	4.025 *(102)*	425.00 *(6964)*	4.24 *(1.92)*
4	XW	40F-XW-TB	21.750 *(552)*	6.000 *(152)*	5.875 *(149)*	3.000 *(76)*	8.750 *(222)*	4.520 *(115)*	425.00 *(6964)*	4.24 *(1.92)*

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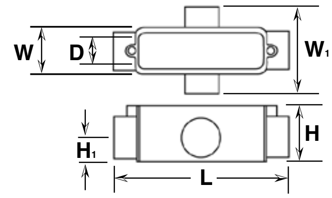

TYPE X

Nominal Size	Type	IPS Item No. Aboveground	L inch *(mm)*	H inch *(mm)*	W inch *(mm)*	W1 inch *(mm)*	H1 inch *(mm)*	D inch *(mm)*	Volume cu in *(cm³)*	Weight lbs *(kg)*
¾	SW	07E-SW-X	8.375 *(213)*	2.375 *(60)*	1.840 *(47)*	4.750 *(121)*	1.000 *(25)*	1.075 *(27)*	13.90 *(228)*	0.70 *(0.32)*
1	SW	10E-SW-X	8.375 *(213)*	2.375 *(60)*	1.840 *(47)*	4.750 *(121)*	1.000 *(25)*	1.340 *(34)*	13.90 *(228)*	0.70 *(0.32)*
1¼	SW	12E-SW-X	10.125 *(257)*	3.000 *(76)*	2.540 *(64)*	6.437 *(163)*	1.188 *(30)*	1.685 *(43)*	32.00 *(524)*	1.60 *(0.73)*
1½	SW	15E-SW-X	10.125 *(257)*	3.000 *(76)*	2.540 *(64)*	6.437 *(163)*	1.188 *(30)*	1.910 *(48)*	32.00 *(524)*	1.50 *(0.68)*
2	SW	20E-SW-X	13.375 *(340)*	4.000 *(102)*	3.040 *(77)*	7.188 *(182)*	1.812 *(46)*	2.390 *(61)*	70.75 *(1160)*	3.00 *(1.36)*
2½	SW	25C-SW-X	21.750 *(552)*	6.000 *(152)*	5.875 *(149)*	11.500 *(292)*	3.000 *(76)*	3.508 *(89)*	425.00 *(6964)*	4.24 *(1.92)*
3	SW	30E-SW-X	21.750 *(552)*	6.000 *(152)*	5.875 *(149)*	11.500 *(292)*	3.000 *(76)*	3.508 *(89)*	425.00 *(6964)*	4.24 *(1.92)*
4	SW	40E-SW-X	21.750 *(552)*	6.000 *(152)*	5.875 *(149)*	11.500 *(292)*	3.000 *(76)*	4.508 *(114)*	425.00 *(6964)*	4.24 *(1.92)*

Nominal Size	Type	IPS Item No. Aboveground	L inch *(mm)*	H inch *(mm)*	W inch *(mm)*	W1 inch *(mm)*	H1 inch *(mm)*	D inch *(mm)*	Volume cu in *(cm³)*	Weight lbs *(kg)*
¾	XW	07E-XW-X	8.375 *(213)*	2.375 *(60)*	1.840 *(47)*	4.750 *(121)*	1.000 *(25)*	1.435 *(36)*	13.90 *(228)*	0.70 *(0.32)*
1	XW	10E-XW-X	8.375 *(213)*	2.375 *(60)*	1.840 *(47)*	4.750 *(121)*	1.000 *(25)*	1.700 *(43)*	13.90 *(228)*	0.70 *(0.32)*
1¼	XW	12E-XW-X	10.125 *(257)*	3.000 *(76)*	2.540 *(64)*	6.437 *(163)*	1.188 *(30)*	2.045 *(52)*	32.00 *(524)*	1.60 *(0.73)*
1½	XW	15E-XW-X	10.125 *(257)*	3.000 *(76)*	2.540 *(64)*	6.437 *(163)*	1.188 *(30)*	2.285 *(58)*	32.00 *(524)*	1.50 *(0.68)*
2	XW	20F-XW-X	13.375 *(340)*	4.000 *(102)*	3.040 *(77)*	7.188 *(182)*	1.812 *(46)*	2.520 *(64)*	70.75 *(1160)*	3.00 *(1.36)*
2½	XW	25F-XW-X	13.375 *(340)*	4.000 *(102)*	3.040 *(77)*	7.188 *(182)*	1.812 *(46)*	3.025 *(77)*	70.75 *(1160)*	2.50 *(1.13)*
3	XW	30F-XW-X	21.750 *(552)*	6.000 *(152)*	5.875 *(149)*	11.500 *(292)*	3.000 *(76)*	3.520 *(89)*	425.00 *(6964)*	4.24 *(1.92)*
3½	XW	35F-XW-X	21.750 *(552)*	6.000 *(152)*	5.875 *(149)*	11.500 *(292)*	3.000 *(76)*	4.025 *(102)*	425.00 *(6964)*	4.24 *(1.92)*
4	XW	40F-XW-X	21.750 *(552)*	6.000 *(152)*	5.875 *(149)*	11.500 *(292)*	3.000 *(76)*	4.520 *(115)*	425.00 *(6964)*	4.24 *(1.92)*

CHAMPION FLAME SHIELD® MIX (PHENOLIC CONDUIT ADHESIVE)

Champion Fiberglass Flame Shield Mix is a single component, high temperature adhesive designed to permanently bond Champion Phenolic conduit, fittings and joints. The Flame Shield adhesive is used to permanently bond phenolic conduit joints that will be subjected to temperatures up to 1850°F for two hours or less. Flame Shield Mix is a water based adhesive that is environmentally safe, non-flammable and contains no volatile organic compounds.

Champion Flame Shield Mix is available in two sizes, a 16 oz. container or a 1 gallon container for larger applications.

Part Numbers:

- FM1670 – 16 oz. Container
- FM12870 – 1 Gallon Container

Estimated Number of Joints Per 16 oz. Container							
¾"	80 Joints	1½"	50 Joints	3"	30 Joints	5"	19 Joints
1"	68 Joints	2"	42 Joints	3½"	26 Joints	6"	16 Joints
1¼"	58 Joints	2½"	36 Joints	4"	22 Joints		

Estimated Number of Joints Per Gallon (128 oz.) Container							
¾"	640 Joints	1½"	400 Joints	3"	240 Joints	5"	152 Joints
1"	544 Joints	2"	336 Joints	3½"	208 Joints	6"	128 Joints
1¼"	464 Joints	2½"	288 Joints	4"	176 Joints		

GENERAL

- Conduit shall be phenolic fiberglass as manufactured by Champion Fiberglass, Inc. using the single circuit filament winding process.
- Conduit, elbows and fittings shall be manufactured from a phenol based resin and hardener with an appropriate E-glass roving manufactured by the same single circuit filament winding process. Resin shall be free of fillers.
- Conduit shall be supplied with either an integral wound bell and machined spigot or a bonded coupling and a machined spigot.
- Conduit, elbows, fittings, and adhesive are specified for use throughout a temperature range of -60°F ***(-51°C)*** to 1850°F ***(1010°C)***.
- Conduit, elbows, fittings, and adhesive shall be constructed of noncombustible materials in accordance with the requirements of ASTM E136.
- Conduit shall be wound on steel mandrels at a helix winding angle to the longitudinal axis appropriate to produce conduit that meets the physical requirements of this specification. Mandrels shall be straight and true so as to produce a non-tapered conduit. Tapering is allowed at the belled end.
- Conduit shall be free from all defects including indentations, delamination, pinholes, foreign inclusions, and resin-starved areas. The conduit shall be round. The bore of the conduit shall be smooth and uniform. All conduit ends shall be cut at right angles to the axis of the conduit.
- Conduit shall not be manufactured with a condensation reaction of phenol and formaldehyde. This is so that there is no residual formaldehyde or any corrosive by-products.

ELECTRICAL PROPERTIES

• Dielectric Strength	150 volts/mil. ***(5.9 kv/mm)***	ASTM D 149

PHYSICAL AND MECHANICAL PROPERTIES

• Tensile Strength (Axial)	7,000 psi ***(62 MPa)***	ASTM D 2105
• Modulus of Elasticity (4" conduit)	1.2 X 10^6 psi ***(8.3 GPa)***	ASTM D 2105
• Thermal Conductivity	1.67 BTU/(ft^2)(hr.)(°F/in) ***(0.24 mk/W)***	ASTM D 5930-01
• Specific Gravity	1.70-1.75	ASTM D 792
• Glass Content	70% ± 5%	API SPEC 15 LR
• Water Absorption	Less than 1.0%	ASTM D 570
• Barcol Hardness	70 ± 2	ASTM D2583
• Temperature Range	-60°F to +1850°F	ASTM E119 (1850°F 2 hours)
• Vertical Flame Test FT4	Passed	CSA 22.2

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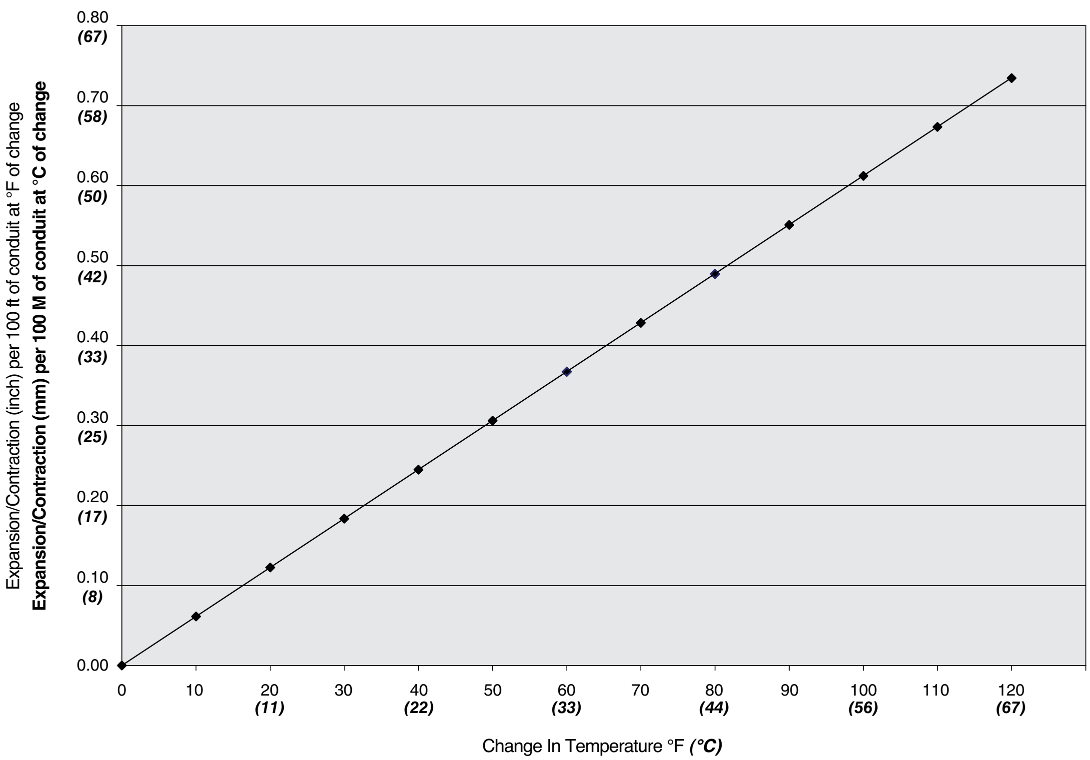
PHYSICAL AND MECHANICAL PROPERTIES (CONT.)

• Surface Flammability	<2	ASTM E162
• Tunnel Test, Flame Spread	<1	ASTM E84
• Tunnel Test, Smoke Density	<1	ASTM E84
• Smoke Density, D_{S4} min	<1	ASTM E662
• Smoke Density, D_{max} flaming	<30	ASTM E662
• Smoke Density, D_{max} non-flaming	<20	ASTM E662
• Coefficient of Thermal Expansion	5.1×10^{-6} in/in/°F ***(9.27 x 10^{-6} mm/mm/°C)***	ASTM D696



HEAT DEFLECTION

The minimum heat deflection temperature shall be 500°F ***(260°C)*** when tested at 264 psi in accordance with ASTM D 648.

TOXICITY

CHAMPION FLAME SHIELD® conduit does not contain any compounds that can release halogens - bromine or chlorine - when burning.

Gases	**Values (max P.P.M.)**
Hydrogen Chloride	0
Hydrogen Bromide	0
Hydrogen Cyanide	<1
Hydrogen Sulphide	0
Ammonia	0
Oxides of Nitrogen	<5
Carbon Dioxide	<10,500
Carbon Monoxide	<350

COLOR

Natural color is dark reddish brown, almost black.

DEFLECTION

Deflection is always determined at midspan.

The empirical formula for deflection is:

$$D = \frac{131 \cdot W \cdot L^4}{E(OD^4 - ID^4)}$$

Where:
- D = Midspan deflection (in.)
- OD = Outside diameter of conduit (in.)
- ID = Inside diameter of conduit (in.)
- E = Modulus of elasticity of conduit (psi), which is 1,200,000 for phenolic fiberglass conduit
- L = Distance between hangers (ft.)
- W = Total weight of cable and conduit (lbs/ft.)

It is recommended that midspan deflection never exceeds ⅝ inches *(16 mm)*.

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IMPACT RESISTANCE

The minimum impact resistance values for the conduit shall be as shown in the table below when tested in accordance with ASTM D2444.

Norminal Size	At 73.4°F *(23°C)* Impact Resistance lbs. ft. *(Nm)* SW	MW	HW	XW	At 32.4°F *(0°C)* Impact Resistance lbs. ft. *(Nm)* SW	MW	HW	XW
¾	8 ***(11)***	-- --	-- --	50 ***(68)***	8 ***(11)***	-- --	-- --	50 ***(68)***
1	12 ***(16)***	-- --	-- --	160 ***(215)***	12 ***(16)***	-- --	-- --	160 ***(215)***
1¼	12 ***(16)***	-- --	-- --	160 ***(215)***	12 ***(16)***	-- --	-- --	160 ***(215)***
1½	14 ***(19)***	-- --	-- --	175 ***(235)***	14 ***(19)***	-- --	-- --	175 ***(235)***
2	16 ***(22)***	-- --	-- --	200 ***(270)***	16 ***(22)***	-- --	-- --	200 ***(270)***
2½	19 ***(26)***	-- --	-- --	210 ***(285)***	19 ***(26)***	-- --	-- --	210 ***(285)***
3	22 ***(30)***	-- --	-- --	245 ***(330)***	22 ***(30)***	-- --	-- --	245 ***(330)***
3½	28 ***(38)***	-- --	-- --	300 ***(405)***	28 ***(38)***	-- --	-- --	300 ***(405)***
4	32 ***(43)***	-- --	40 ***(54)***	350 ***(470)***	32 ***(43)***	-- --	40 ***(54)***	350 ***(470)***
5	-- --	54 ***(73)***	60 ***(81)***	420 ***(565)***	-- --	54 ***(73)***	60 ***(81)***	420 ***(565)***
6	-- --	66 ***(89)***	72 ***(98)***	455 ***(615)***	-- --	66 ***(89)***	72 ***(98)***	455 ***(615)***

STIFFNESS

The minimum conduit stiffness at five percent deflection for all sizes of conduit shall not be less than the values given in table below when tested in accordance with ASTM D2412

Pipe Stiffness (PS) = (F/ΔY)								
Nominal Size	At 73.4°F *(23°C)* lbf/in² *(MPa)* SW	MW	HW	XW	At 32°F *(0°C)* lbf/in² *(MPa)* SW	MW	HW	XW
¾	270 ***(1.9)***	-- --	-- --	1,300 ***(9.1)***	270 ***(1.9)***	-- --	-- --	1,300 ***(9.1)***
1	220 ***(1.5)***	-- --	-- --	1,100 ***(7.7)***	220 ***(1.5)***	-- --	-- --	1,100 ***(7.7)***
1¼	175 ***(1.2)***	-- --	-- --	875 ***(6.1)***	175 ***(1.2)***	-- --	-- --	875 ***(6.1)***
1½	155 ***(1.1)***	-- --	-- --	775 ***(5.4)***	155 ***(1.1)***	-- --	-- --	775 ***(5.4)***
2	105 ***(0.70)***	-- --	-- --	525 ***(3.7)***	105 ***(0.70)***	-- --	-- --	525 ***(3.7)***
2½	65 ***(0.40)***	-- --	-- --	325 ***(2.3)***	65 ***(0.40)***	-- --	-- --	325 ***(2.3)***
3	45 ***(0.32)***	-- --	-- --	225 ***(1.6)***	45 ***(0.32)***	-- --	-- --	225 ***(1.6)***
3½	40 ***(0.28)***	-- --	-- --	200 ***(1.4)***	40 ***(0.28)***	-- --	-- --	200 ***(1.4)***
4	35 ***(0.24)***	-- --	50 ***(0.35)***	175 ***(1.2)***	35 ***(0.24)***	-- --	50 ***(0.35)***	175 ***(1.2)***
5	-- --	35 ***(0.24)***	38 ***(0.26)***	125 ***(0.88)***	-- --	35 ***(0.24)***	38 ***(0.26)***	125 ***(0.88)***
6	-- --	25 ***(0.18)***	28 ***(0.19)***	50 ***(0.35)***	-- --	25 ***(0.18)***	28 ***(0.19)***	50 ***(0.35)***

WIRE FILL

Maximum allowable percentage wire fill per Table 1, Chapter 9, National Electric Code 2008

IPS sizes					
			Percent of cross section of conduit & tubing for conductors		
Trade Size	Internal Diameter in *(mm)*	Total Area sq in *(sq mm)*	1 conductor 53% fill sq in *(sq mm)*	2 conductors 31% fill sq in *(sq mm)*	Over 2 conductors 40% fill sq in *(sq mm)*
¾ ***(19)***	0.910 ***(23)***	0.650 ***(419)***	0.345 ***(222)***	0.202 ***(130)***	0.260 ***(168)***
1 ***(25)***	1.175 ***(30)***	1.084 ***(699)***	0.574 ***(371)***	0.336 ***(217)***	0.434 ***(280)***
1¼ ***(32)***	1.520 ***(39)***	1.814 ***(1170)***	0.961 ***(620)***	0.562 ***(363)***	0.725 ***(468)***
1½ ***(38)***	1.760 ***(45)***	2.432 ***(1569)***	1.289 ***(831)***	0.754 ***(486)***	0.973 ***(628)***
2 ***(51)***	2.235 ***(57)***	3.921 ***(2530)***	2.078 ***(1341)***	1.216 ***(784)***	1.569 ***(1012)***
3 ***(76)***	3.360 ***(85)***	8.862 ***(5718)***	4.697 ***(3030)***	2.747 ***(1772)***	3.545 ***(2287)***
4 ***(102)***	4.320 ***(110)***	14.650 ***(9452)***	7.764 ***(5009)***	4.541 ***(2930)***	5.860 ***(3781)***
5 ***(127)***	5.380 ***(137)***	22.721 ***(14659)***	12.042 ***(7769)***	7.044 ***(4544)***	9.089 ***(5864)***
6 ***(152)***	6.380 ***(162)***	31.953 ***(20615)***	16.935 ***(10926)***	9.905 ***(6391)***	12.781 ***(8246)***

ID sizes					
			Percent of cross section of conduit & tubing for conductors		
Trade Size	Internal Diameter in *(mm)*	Total Area sq in *(sq mm)*	1 conductor 53% fill sq in *(sq mm)*	2 conductors 31% fill sq in *(sq mm)*	Over 2 conductors 40% fill sq in *(sq mm)*
2 ***(51)***	2.00 ***(51)***	3.140 ***(2026)***	1.664 ***(1074)***	0.973 ***(328)***	1.256 ***(810)***
2½ ***(64)***	2.500 ***(64)***	7.906 ***(3165)***	2.600 ***(1678)***	1.521 ***(981)***	1.963 ***(1266)***
3 ***(76)***	3.000 ***(76)***	7.065 ***(4558)***	3.744 ***(2416)***	2.190 ***(1413)***	2.826 ***(1823)***
3½ ***(89)***	3.500 ***(89)***	9.616 ***(6204)***	5.097 ***(3288)***	2.981 ***(1923)***	3.847 ***(2482)***
4 ***(102)***	4.000 ***(102)***	12.560 ***(8103)***	7.764 ***(5009)***	3.894 ***(2512)***	5.024 ***(3241)***
5 ***(127)***	5.000 ***(127)***	19.625 ***(12661)***	12.042 ***(7769)***	6.084 ***(3925)***	7.850 ***(5065)***
6 ***(152)***	6.000 ***(152)***	28.260 ***(18232)***	16.935 ***(10926)***	8.761 ***(5652)***	11.304 ***(7293)***

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CORROSION RESISTANCE GUIDE

The corrosion guidelines tests were performed by analyzing phenolic conduit coupons for 30 days in the chemical vapors at the temperature shown. It has been shown that **CHAMPION FLAME SHIELD®** can often be used for chemicals listed as "Not Recommended" (NR). Real cases often are limited to fumes, vapors and occasional splashes at the temperatures indicated.

This information is provided solely as a guide since it is impossible to anticipate all individual site conditions. For specific applications which are not covered in this guide (may require screening tests), consultation with Champion Fiberglass, Inc. is recommended.

Chemical	Concentration	Vapor °F	Vapor °C	Chemical	Concentration	Vapor °F	Vapor °C
Acetic Acid	All	140	***60***	Heavy Aromatic Naphtha (HAN)	100	150	***66***
Acetic Acid, Glacial	All	150	***66***	Hydrochloric Acid	37	120	***49***
Acetone	All	80	***27***	Hydrogen Chloride (Gas)	—	180	***82***
Aluminum Chloride	All	180	***82***	Hydrogen Sulfide (Gas)	—	180	***82***
Aluminum Hydroxide (1)	All	120	***49***	Isopropyl Alcohol	All	125	***52***
Aluminum Sulphate	All	250	***121***	Magnesium Hydroxide (1)	All	120	***49***
Ammonia Aqueous (1)	10%	NR	***NR***	Methyl Alcohol (Methanol)	100	125	***52***
Ammonium Bicarbonate (1)	All	150	***66***	Methyl Ethyl Ketone	100	80	***27***
Ammonium Chloride	All	150	***66***	Naphtha	All	(*)	***(*)***
Ammonium Hydroxide (1)	All	NR	***NR***	Nitric Acid	—	(*)	***(*)***
Ammonium Phosphate	All	150	***66***	Perchlorethylene	All	80	***27***
Benzene	100	150	***66***	Phenol (Carbolic Acid)	All	100	***38***
Benzyl Alcohol	100	125	***52***	Phosphoric Acid	All	150	***66***
Benzyl Chloride	All	150	***66***	Potassium Carbonate (1)	All	120	***49***
Calcium Chloride	All	150	***66***	Potassium Permanganate	All	150	***66***
Calcium Hydroxide (1)	All	120	***49***	Sodium Bicarbonate (1)	All	150	***66***
Calcium Hypochlorite	All	(*)	***(*)***	Sodium Carbonate (1)	All	150	***66***
Carbon Dioxide Gas	—	250	***121***	Sodium Chloride	All	150	***66***
Carbon Tetrachloride	100	150	***66***	Sodium Hydroxide (1)	All	(*)	***(*)***
Chlorine (Liquid)	All	NR	***NR***	Sodium Hypochlorite	All	250	***121***
Chlorobenzene	100	150	***66***	Sodium Sulfate	All	150	***66***
Chloroform	100	150	***66***	Sodium Tripolyphosphate	100	150	***66***
Chloroethylene	100	150	***66***	Styrene	All	150	***66***
Chlorotoluene	100	150	***66***	Sulfur Dioxide	All	NR	***NR***
Citric Acid	30	120	***49***	Sulfuric Acid	93	150	***66***
Ethyl Alcohol (Ethanol) (Denaturated)	100	150	***66***	Sulfurous Acid 25% min.	All	150	***66***
Ethylene Glycol	100	180	***82***	Toluene	100	150	***66***
Furfuryl Alcohol	100	125	***52***	Trichlorethylene	All	120	***49***
Glycol	100	180	***82***	Xylene	100	150	***66***

NR = Not Recommended   (*) - Contact Champion Fiberglass

(1) - All alkaline materials will attack phenolics to some extent. Resistance is dependent upon humidity of the environment. Material is conditionally recommended for continuous exposure to dry vapor only with occasional wetting. Duct system must be designed to eliminate condensation or pooling. If condensates can be expected from vapors, contact Champion Fiberglass.

Information in this table is based on data supplied by raw material suppliers and collected from many years of similar industrial applications.

Temperatures represent standard test conditions and are not minimums or maximums. **CHAMPION FLAME SHIELD®** products may be acceptable at other temperatures for some chemicals, but should be tested to determine specific suitability.

The recommendations or suggestions contained in this table are made without guarantee or representation as to results. We suggest that you evaluate these recommendations and suggestions in your own laboratory or field trial prior to use.

NFPA 130

Fixed Guideway Transit and Passenger Rail Systems

From Chapter 5, Stations

5.4 Wiring Requirements.

5.4.1 All wiring materials and installations within stations other than for traction power shall conform to requirements of NFPA 70 and, in addition, shall satisfy the requirements of 5.4.2 through 5.4.9.

5.4.2 Conduits, raceways, ducts, boxes, cabinets, and equipment enclosures shall be constructed of noncombustible materials in accordance with the requirements of ASTM E136

5.4.2.1 Other materials when encased in concrete shall be acceptable.

5.4.3 All conductors shall be insulated.

5.4.3.1 Ground wires installed in a metallic raceway shall be insulated.

5.4.3.2 Other ground wires shall be permitted to be bare.

5.4.4 All insulations shall conform to NFPA 70 and shall be moisture- and heat-resistant types carrying temperature ratings corresponding to either of the following conditions:

(1) 75°C (167°F) for listed fire-resistive cables

(2) 90°C (194°F) for all other application

From Chapter 6, Trainways

6.3.3 Wiring Requirements. *(See Section 5.4.)*

6.3.3.2 Underground (Subways).

6.3.3.2.1 All wiring materials and installations within trainways, other than for traction power, shall conform to the requirements of NFPA 70 and, in addition, shall satisfy the requirements of 6.3.3.2.2 through 6.3.3.2.9.

6.3.3.2.2 Conduits, raceways, ducts, boxes, cabinets, and equipment enclosures shall be constructed of noncombustible materials in accordance with the requirements of ASTM E136.

6.3.3.2.3 All conductors shall be insulated.

6.3.3.2.3.1 Ground wires installed in a metallic raceway shall be insulated.

6.3.3.2.3.2 Other ground wires shall be permitted to be bare.

6.3.3.2.4 All insulations shall conform to NFPA 70 and shall be moisture- and heat-resistant types carrying temperature ratings corresponding to either of the following conditions:

(1) 75°C (167°F) for listed fire-resistive cables

(2) 90°C (194°F) for all other application.

From Chapter 7, Emergency Ventilation System

7.7 Power and Wiring.

7.7.1 The design of the power for the emergency ventilation system shall comply with the requirements of Article 700 of NFPA 70.

7.7.1.1 Alternately, the design of the power for the emergency ventilation system shall be permitted to be based upon the results of the electrical reliability analysis as per 7.2.3(6) as approved.

7.7.2 All wiring materials and installations shall conform to the requirements of NFPA 70 and, in addition, shall satisfy the requirements of 7.7.3 through 7.7.8.

7.7.3 Conduits, raceways, ducts, boxes, cabinets, and equipment enclosures shall be constructed of noncombustible materials in accordance with the requirements of ASTM E136.

7.7.4 All conductors shall be insulated.

7.7.4.1 Ground wires installed in a metallic raceway shall be insulated.

7.7.4.2 Other ground wires shall be permitted to be bare.

7.7.4.3 All thicknesses of jackets shall conform to NFPA 70

7.7.5 All insulations shall conform to NFPA 70 and shall be moisture- and heat-resistant types carrying temperature ratings corresponding to either of the following conditions:

(1) 75°C (167°F) for listed fire-resistive cables

(2) 90°C (194°F) for all other application

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.6.3.3.2.6 and A.7.7.7

The trainway, although used for ventilation, should not be considered as an air plenum for purposes of mounting electrical appurtenances.

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LIMITED WARRANTY

This warranty covers any Champion Fiberglass, Inc. ("Champion") electrical conduit products ("Product").

Subject to the terms and conditions of this warranty, Champion warrants that the Product is free from defects in workmanship and materials for a period of one (1) year from the date of purchase. During the applicable terms of this warranty, and subject to the terms and conditions thereof, in the event that the Product is proven to be defective and the defect is not caused by any misuse or damage to the Product while in the possession of the user, Champion will remedy the failure or defect without charge to the user except for labor. The remedy will consist of repair or replacement of the Product and or defective part, at Champion's option. Repair will be made, at Champion's option, either at user's location or at a facility designated by Champion. Any replacement part provided under this warranty assumed as its warranty period only the unexpired term of this warranty, which is fixed when such part replaces a defective part. This warranty does not cover defects, failure or damages caused by normal wear and tear, act of God, accident, misuse or unreasonable use of the Product, lack of proper maintenance, fire, flood, or any circumstances or events beyond Champion's control.

Champion's sole obligation under this warranty is to repair or replace the product, as provided herein. Champion shall have no liability for any direct, incidental, special or consequential damages resulting from breach of this or any other warranty (no warranty being implied from this reference) on the product. Except to the extent prohibited by applicable law, any implied warranty, including without limitation, of merchantability or fitness for any particular purchase with respect to the product, is limited in duration to the term of this warranty. This warranty is in lieu of any other express warranties and of any other obligation on the part of Champion. Any other express warranties are expressly excluded and disclaimed. No Champion representative is authorized to give any warranty (other than this warranty) with respect to the product, and any such warranty given by a Champion representative shall not constitute a Champion warranty or be binding in any respect upon Champion.

Note: Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you. Some states do not allow limitation on how long an implied warranty lasts, so the above limitations may not apply to you.

To obtain performance of any obligation of Champion under this warranty, the user must provide proof of the date of purchase, notify Champion of any warranty claim at the following address:

CHAMPION FIBERGLASS, INC.
6400 Spring Stuebner Rd
Spring, TX 77389
Attention: Warranty Claims
Telephone: (281) 655-8900

Notify the nearest Champion authorized representative for inspection of the Product. For the name of the nearest authorized representative, refer to our web site: www.championfiberglass.com / Locate a Rep Tab / or you can contact our corporate offices for the appropriate Representative's contact information. Any written correspondence can be mailed to our corporate offices at the address above.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

NOTES

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» info@championfiberglass.com » championfiberglass.com

CERTIFICATE OF REGISTRATION

This is to certify that

Champion Fiberglass Inc.

6400 Spring Stuebner Rd., Spring, Texas 77389 USA

operates a

Quality Management System

which complies with the requirements of

ISO 9001:2008

for the following scope of registration

Manufacture of fiberglass conduit and fittings.

Certificate No.:	CERT-0065909	Original Certification Date:	November 6, 2009
File No.:	1058413	Current Certification Date:	November 5, 2012
Issue Date:	September 28, 2012	Certificate Expiry Date:	November 4, 2015

Chris Jouppi
President,
QMI-SAI Canada Limited

Guillaume Gignac, ing.f
Vice President, Corporate Operations, Accreditation & Quality
QMI-SAI Canada Limited

Certified System

ANAB ACCREDITED

ISO 9001

SAI GLOBAL
INFORM. INSPIRE. IMPROVE.

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CHAMPION FIBERGLASS®

UL2196: The Next Generation Fire Resistive Cables and Phenolic Conduit

Why the Electrical Industry is using RSCC VITAlink® 300 Cable and Champion Fiberglass Type XW Phenolic Conduit for Two-Hour Fire Rated Installations

Executive Summary

In June 2012, UL learned of compatibility issues when Classified Fire-Resistive Cables were installed in systems where zinc was used as in interior coating in steel conduits, raceways and other system components. At the high temperatures the zinc coating vaporizes and interacts with the copper conductor creating a brass alloy. Brass melts at a lower temperature which compromises the integrity of the electrical system causing pre-mature failure.

As a result, cable manufacturers were no longer authorized to place the UL trademark on the following products:

- UL Classified Fire Resistive Cable (FHJR)
- ULC Listed Fire Resistive Cable (FHJRC)
- UL Listed cable with "CI" suffix (Circuit Integrity)

UL2196 Cable Performance Testing Overview

The UL2196 test is designed to evaluate the performance of electrical circuit protective systems in severe fire events. UL2196 is designed to evaluate the functionality of electrical circuit systems when exposed to fire for 2 hours followed by the mechanical shock of a fire hose stream.

Project Systems Impacted:

- Fire Pump – Feeder/Controls
- Elevators
- Smoke control equipment
- Command center critical systems
- Pressurized stairway systems
- Smoke management systems
- Fire alarm systems
- Electrical Equipment Rooms – Feeders/Service
- Emergency Generators & Standby Power Systems

The Fiberglass Advantage

Being the demand for fiberglass conduit in the United States alone has been growing significantly over the last two decades—and is forecasted to increase further as project owners and engineers seek to serve long-term interests of their stakeholders, it made sense to consider investigating the use of fiberglass high temperature phenolic conduit as a solution to the zinc compatibility issue that plagued rigid metal conduit. When the UL findings became public, RSCC and Champion Fiberglass partnered together to examine, develop and create a cost-effective solution that would continue to function while being exposed to the severe fire requirements of UL2196.

The Fiberglass Advantage Detail
Champions Phenolic Fiberglass Type XW high temperature conduit doesn't have the problematic zinc compatibility issues of rigid steel conduit but it contains the zero smoke and zero halogen, high temperature physical properties that enable it and RSCC VITALink ® 300 RHW-2 cable to continue functioning during the UL2196 Cable Performance testing. Tests were conducted by UL in 2013 and 2014 resulting in UL issuing two VSR (Verification of Services) reports indicating that the system as described and installed in the UL VSR continues to function throughout the entire test. Both products, RSCC VITALink 300® and Champion Fiberglass Type XW Phenolic Flameshield conduit have their own independent product UL Listings. The UL2196 VSR is not a UL Listing or Certification. It is a system compatibility test which illustrates that both products, when installed together as outlined in the UL VSR, continue functioning the for the duration of the fire test and subsequent hose stream.

Project References
The following projects have utilized RSCC VITALink 300® and Champion Fiberglass Type XW Phenolic Flameshield conduit to resolve their 2 hour fire-resistive circuit requirements.

Elizabeth River Tunnels (East & West) – Portsmouth, VA
Contractor: Mass Electric Construction – Waltham, MA
Engineer: Parsons Brinkerhoff – Boston, MA



Mt. Lebanon Tunnel – Mt. Lebanon, PA
Contractor: Vantage Corporation – Carnegie, PA
Engineer: Gannett-Fleming – Pittsburgh, PA

Overall Impact on Project Economics
The RSCC VITALink® 300 Cable and Champion Fiberglass Type XW Phenolic Flameshield conduit impacts project economics in the following ways:

- Ensuring the facility or infrastructure will perform as designed well long-term
- Allowing engineers to draft more flexible, efficient and cost-effective designs
- Streamlining the project's implementation and ability to meet milestones
- Protecting project stakeholders from future safety risk and liability exposure

These various points illustrate the economic and operational impact that choosing the right cable and conduit combination for your 2 Hour Fire-Resistive electrical circuit protective systems will have.

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UL2196: THE NEXT GENERATION FIRE RESISTIVE CABLES AND PHENOLIC CONDUIT

Why the Electrical Industry is using RSCC VITAlink® 300 Cable and Champion Fiberglass Type XW Phenolic Conduit for Two-Hour Fire Rated Installations

Executive Summary

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These various points illustrate the economic and operational impact that choosing the right cable and conduit combination for your 2-hour fire-resistive electrical circuit protective systems will have.

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Manufacturer's Instructions for Lifeline® Power Cables

Lifeline® RHW-2 Two-Hour Fire Resistive Cables in XW BreathSaver® Phenolic Conduit

Technical Information Sheet #301H

BreathSaver is registered trademark of FRE composites

This Technical Information Sheet (TIS) covers Lifeline® RHW-2 or RW90 Cables: UL Certified and Listed Two Hour Fire Resistive Cable for use in BreathSaver® Phenolic Conduit

Applications

Lifeline® Power Cables have been qualified and listed to the demanding requirements of UL 2196, Tests for Fire Resistive Cables, and are UL Listed Type RHW-2 and RW90.

Lifeline® Power Cables meet various industry code requirements (NFPA 70, NFPA 101 and NFPA 130) for fire resistance according to UL Standard 2196 when selected and installed per applicable codes including federal, state, local and municipal rules, laws and regulations as well as Electrical Circuit Integrity System 25C (FHIT 25C) and TIS #301H - Manufacturer's Instructions. NFPA 502 can also be met when approved by an AHJ. Note that Authorities Having Jurisdiction (AHJ) should be consulted for approval prior to cable purchase and installation.

Requirements

1) Codes / Laws / Regulations

Selection and installation compliance is dependent on the applicable issue of any codes or addendums which covers the use of Lifeline® RHW-2 or RW90 Cables, Fire Resistive Cables.

2) UL Electrical Circuit Integrity System #25C (FHIT 25C)

The most current listing details and supporting information applicable to Lifeline® Cables' fire resistive rating classification can be obtained from UL's 'Online Certification Directory' website by searching for keyword: "FHIT 25C".

3) Manufacturer's Instructions – TIS #301H

All Lifeline® Cable products are covered by specific datasheets and supporting Technical Information Sheets that provide the user with information to properly select and install Lifeline® Cables in a reliable and trouble-free manner. Do not hesitate to contact your Lifeline® Cable representative should you have any questions.

Installation Parameters

1) Cable: Lifeline® RHW-2 or RW90

Code compliant cable certified as fire resistive per testing according to UL 2196 and listed in FHIT 25C. Fire resistive rating is two-hours in horizontal and vertical installations. Appropriate cable selection is required for systems requiring a fire resistive rating.

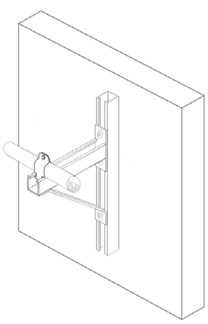
2) Conduit System

Code compliant conduit system which meets the following requirements:

a. Must be BreathSaver® Phenolic Conduit or other fire rated components (described in FHIT 25C) proven to meet the required fire resistance ratings (i.e two hours). No substitute components are allowed.

b. Conduit assemblies shall be secured to a fire rated structure comprised of steel or other fire rated components proven to meet the required fire resistance ratings (i.e. two hours).

Note: Installations where conduits run parallel to and extend away from the support structure require additional support. In such an installation, the horizontal support members shall be reinforced with a knee brace or equivalent. The drawing to the right shows an example installation with knee brace installed. The knee brace shall be secured to vertical and horizontal structural members using 3/8in. or larger steel bolts Recommended bracing material is steel at least ¼ inch thick with cross sectional area 0.3 in.² or greater.



c. Maximum support spacing shall be in accordance with National Electric Code article 355.30 with exception that spacing for conduit sizes 2½ and larger shall not exceed 5ft.

3) Conduit Sizing

Lifeline® RHW-2 or RW90 FHIT.25C datasheets provide cable diameters to calculate conduit fill which in lieu of the typical National Electrical Code requirements cannot exceed maximum fill level listed in datasheet and FHIT 25C.

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Draka

Lifeline® Power Cables: RHW-2 or RW90 Two-Hour Horizontal, Vertical Fire Resistive Cables in XW Breathsaver® Phenolic Conduit

UL 2196 Certified Fire Resistive Cable for Survivability in a Fire

Applications

Lifeline® fire resistive cables were designed to meet and have successfully passed the two hour fire rating certification test per UL 2196, *Standard for Tests for Fire Resistive Cables.*

Lifeline® Cables can be used in the following applications to provide survivability during a fire:

- Fire Pumps
- Emergency Feeder Cables
- Ventilating Fans
- Exit Lighting
- Elevators
- Tall Buildings
- Hospitals
- Transit
- Oil Refineries
- Drilling Platforms

Lifeline® Cables are preferred over Mineral Insulated (MI) cables, concrete encasement or the construction of fire rated assemblies based on the facts that Lifeline® Cables are less costly, easier to install, and readily available.

Fire resistive cables are required per NFPA 70, Articles 517, 695, 700, 708 and 760 as well as NFPA 72, NFPA 101, NFPA 130 and NFPA 502

c UL US LISTED

UL File E2268 Thermoset-Insulated Wire

RoHS COMPLIANT

lifeline

Specifications and Ratings

- Listed to UL 44, *Thermoset Insulated Wires and Cables*, as the following type:
  – RHW-2, 600 Volt, Rated 90ºC Dry/90ºC Wet
  – RW90, 600 Volt, Rated 90°C Dry/ 90°C Wet
- Classified to UL 2196, Standard for Tests for Fire Resistive Cables, for two-hours in horizontal (H) and vertical (V) installations.
- Electrical Circuit Integrity System (FHIT) No. 25C of the UL Fire Resistance Directory
- Sunlight Resistant
- FT4 Rated
- ST1
- IEEE 1202
- NFPA 70, NFPA 101, NFPA 130. NFPA 502 (when approved by AHJ)

Design Parameters

CONDUCTORS: Bare stranded copper, 8 AWG through 750kcmil

INSULATION: High Temperature Mica Tapes layer. Ceramifiable silicone, Low Smoke Zero Halogen (LSZH)

JACKET: Cross-linked polyolefin (XLPO), Low Smoke Zero Halogen

IDENTIFICATION:
DRAKA MA P/N (XXXXXX) #(X) AWG (X[MM2])LIFELINE c(UL)us E2268 RHW-2 OR RW90 600V FT4 ST1 VW1 FT1 2 HR HORIZONTAL 1 HR VERTICAL FIRE-RESISTIVE CABLE FOR USE IN ELECTRIC CIRCUIT INTEGRITY SYSTEM NO. 25B. OR 2 HR FIRE-RESISTIVE CABLE FOR USE IN ELECTRIC CIRCUIT INTEGRITY SYSTEM NO. 25C. SEE UL FIRE RESISTANCE DIRECTORY R19359 ([MM]/[YR]) [3FT]

Notes: [X] is the size of the cable in AWG or kcmil
[Y] is the size of the cable in mm^2
[#] is cable part number

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Lifeline® Power Cables: RHW-2 or RW90 Two-Hour Fire Resistive Cables

UL 2196 Certified Fire Resistive Cable for Survivability in a Fire

Lifeline® Power Cable

LIFELINE® Part Number	Conductor Size AWG /MCM	Number of Strands	Insulation Thickness in (mm)	Overall Diameter in (mm)	Approximate Weight lbs./Mft (kg/km)	Ampacity[1] 90°C Amps
G30064	8	7	0.060 (1.5)	0.31 (7.8)	84 (125)	55
G30065	6	7	0.075 (1.9)	0.37 (9.5)	129 (192)	75
G30066	4	7	0.075 (1.9)	0.42 (10.7)	185 (275)	95
G30067	3	7	0.075 (1.9)	0.45 (11.4)	224 (333)	115
G30068	2	7	0.075 (1.9)	0.48 (12.2)	269 (400)	130
G30069	1	19	0.100 (2.5)	0.57 (14.5)	364 (542)	145
G30070	1/0	19	0.100 (2.5)	0.61 (15.5)	441 (656)	170
G30071	2/0	19	0.100 (2.5)	0.65 (16.6)	535 (796)	195
G30072	3/0	19	0.100 (2.5)	0.70 (17.9)	656 (976)	225
G30073	4/0	19	0.100 (2.5)	0.76 (19.2)	803 (1195)	260
G30074	250	37	0.130 (3.3)	0.86 (21.9)	987 (1469)	290
G30075	350	37	0.130 (3.3)	0.97 (24.7)	1306 (1943)	350
G30076	500	37	0.130 (3.3)	1.10 (27.9)	1820 (2708)	430
G30077	600	61	0.145 (3.7)	1.21 (30.6)	2199 (3272)	475
G30078	750	61	0.145 (3.7)	1.31 (33.3)	2699 (4016)	535

[1] Ampacities are based on Table 310.15(B)(16) (formerly table 310.16) of the National Electrical Code (NFPA 70) for 3 current carrying conductors at 30°C ambient.
[2] With AHJ approval, a larger size conduit may be required if an EGC is used.

The above dimensions are approximate and subject to normal manufacturing tolerances. Information subject to change without notice.

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Lifeline® Power Cables: RHW-2 or RW90 Two-Hour Fire Resistive Cables

UL 2196 Certified Fire Resistive Cable for Survivability in a Fire

Conductor Size	Minimum Allowable XW BreathSaver® Conduit Size							
	Horizontal Installation - Number of Conductors				Vertical Installation - Number of Conductors			
	1	2	3	4	1	2	3	4
8	3/4	3/4	1	1	3/4	1	1-1/4	1-1/4
6	3/4	1	1-1/4	1-1/4	1	1-1/2	2-1/2	2-1/2
4	3/4	1	1-1/4	1-1/2	1-1/4	2	2-1/2	3
3	3/4	1-1/4	1-1/4	1-1/2	1-1/4	2	2-1/2	3
2	3/4	1-1/4	1-1/2	1-1/2	1-1/4	2-1/2	3	3
1	1	1-1/2	2	2-1/2	1-1/2	2-1/2	3-1/2	3-1/2
1/0	1	1-1/2	2-1/2	2-1/2	2	3	3-1/2	4
2/0	1-1/4	2	2-1/2	3	2	3	3-1/2	4
3/0	1-1/4	2	2-1/2	3	2-1/2	3-1/2	4	5
4/0	1-1/4	2-1/2	3	3	2-1/2	3-1/2	4	5
250	1-1/4	2-1/2	3	3	2-1/2	3-1/2	4	5
300	2	3	3-1/2	4	2-1/2	3-1/2	5	5
350	2	3	3-1/2	4	3	3-1/2	5	6
400	2	3	3-1/2	4	3	4	5	6
500	2-1/2	3	4	5	2-1/2	3-1/2	5	5
600	2-1/2	3-1/2	5	5	3	4	5	6
750	2-1/2	3-1/2	5	5	3	4	5	6

[1] Ampacities are based on Table 310.15(B)(16) (formerly table 310.16) of the National Electrical Code (NFPA 70) for 3 current carrying conductors at 30°C ambient.
[2] With AHJ approval, a larger size conduit may be required if an EGC is used.

The above dimensions are approximate and subject to normal manufacturing tolerances. Information subject to change without notice.

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FRE® SPECIFICATION FOR EXTRA HEAVY WALL BREATHSAVER® FOR CORROSION PROOF 2-HOUR RATED CABLE SYSTEM (UL 2196)

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Section 1: General

1.1 Description

This specification outlines the requirements for the design, construction and performance of the Extra Heavy Wall (XW) BreathSaver® rigid non-metallic fiberglass conduits and fittings.

1.2 Product application & use

Conduits and fittings are Class 1, Division 2 which can be subject to physical damage.

1.3 Materials

Conduits and fittings shall consist of continuous E or E-CR gla ss roving encapsulated in an internally steam cured, corrosion resistant phenolic resin system pigmented with UV inhibiting carbon black dispersed homogeneously manufactured for use at temperatures ranging from –40 °F (-40 °C) to 1850 °F (1010 °C). Resin system substitution shall not be permitted.

Phenolic resin system shall be impervious to a wide spectrum of chemicals and conduit shall contain by weight less than 0.2 % halog ens as chlorine and shall not contain other toxic materials in excess of trace levels limits compliant with OSHA requirements.

Section 2: General Requirements

2.1 Sizes & wall thicknesses

Conduits and fittings shall be manufactured with nominal wall thicknesses as outlined below:

IPS

Diameter in	Diameter mm	Wall thickness in	Wall thickness mm
1	27	0.250	6.4
8*	203	0.250	6.4

ID

Diameter in	Diameter mm	Wall thickness in	Wall thickness mm
2	53	0.250	6.4
3	78	0.250	6.4
4	103	0.250	6.4
5	129	0.250	6.4
6	155	0.250	6.4

2.2 Joining Method

Each length of conduit is supplied with an integral inside tapered bell on one end and spigot on the other end. All joints shall be adhesive bonded inside a tapered bell end of even socket depth through out the raceway. Adhesive shall be supplied by the manufacturer of the conduit and shall have a minimum joint pull out load of 1 000 lb. (454 kg) per inch diameter trade size.

2.3 Fittings

All fittings, adapters and elbows shall be constructed of the same filament wound materials as the conduit and shall have a socket depth and an inside tapered bell design consistent with the conduit.

Section 3: Requirements

3.1 Workmanship

Conduits and fittings shall be free from defects and commercially practicable in color, opacity, density and other physical properties. The exterior surface finish shall be smooth per acceptable industry practices.

3.2 Marking

Conduits and fittings shall be marked at least once with a suitable identifying mark printed on the outside of the product. Such marking shall contain:

(1) RTRC (2) for use -40 ºF (-40 °C) to 1850 ºF (1010 °C) (3) trade size (4) manufacturer's name or trademark (5) part number (6) degrees and radii (elbows only) (7) date of manufacture.

Section 4: Conduit system properties

4.1 Physical Properties

	Test Results	Test protocol
Glass Content	68% ± 3%	API 15LR
Specific Gravity	1.70 – 1.75 g/cm^3	ASTM D792
Barcol Hardness	50 ± 2	ASTM D2583
Water Absorption	< 1.5%	CSA C22.2 No. 2515
U.V. Resistance	> 3500 Hrs (Xenon Arc)	ASTM D570

4.2 Flame & Smoke Properties

	Test Results		Test protocol
Flame Spread	15	(Asbestos: 0) (Red Oak: 100)	ASTM E84
Flame Spread Index	2	(max: 35)	ASTM E162
Smoke Optical Density @ 4 minutes	2	(max: 200)	ASTM E662
Light Absorption	0%	(no smoke generated)	SAV 242
Emissions NO^2	2 ppm	(max: 100 ppm)	SMP 800C
Emissions SO^2	< 1 ppm	(max: 500 ppm)	SMP 800C
Emissions HCI	< 1 ppm	(max: 100 ppm)	SMP 800C
Emissions HF	< 1 ppm	(max: 100 ppm)	SMP 800C
Emissions HBr	< 1 ppm	(max: 100 ppm)	SMP 800C
Emissions HCN	< 1 ppm	(max: 100 ppm)	SMP 800C
Emissions CO	330 ppm	(max: 3 500ppm)	SMP 800C
Emissions CO^2	9 400 ppm	(max: 90 000ppm)	SMP 800C

4.3 Electrical Properties

	Test Results	Test protocol
Dielectric Strength	500 volts/mil (19.68 kV/mm)	ASTM D149
Dielectric Breakdown Voltage	29.7 kV	ASTM D149

4.4 Surface finish

Exterior (average)	<2000	microinches (50.8 micrometers)
Interior (average)	<250	microinches (6.4 micrometers)
Color		Black (standard)

4.5 Thermal Properties

	Test Results	Test protocol
Coefficient of Thermal Expansion	0.51 E-^{5} in./in./°F (0.927 E-^{5}m./m./°C)	ASTM D696
Thermal Conductivity	1.67 Btu.in/ft^2.h. °F (0.240W/ m.K)	ASTM D335
Thermal Resistivity	0.6°F. ft^2.h/Btu.in (4.17 mK/W)	ASTM D335 Heat
Deflection Temperature (HDT)	> 482 °F (> 250 °C)	ASTM D648

Section 5: Specification

Conduits and fittings are approved UL following tests made in laboratory by Underwriters Laboratories (UL file #E53373). Furthermore, products are superior in required expressed by the Standard NFPA 130. Class 1 fire rated (ASTM E84), NFPA 502 compliant, FT4 rated (CSA). Product identified in section 2.1 with "*" is not UL Listed.

Section 6: Manufacturers

Conduits and fittings shall be manufactured by FRE Composites. No substitute will be accepted.

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