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CENTRAL BROWARD EAST-WEST TRANSIT STUDY

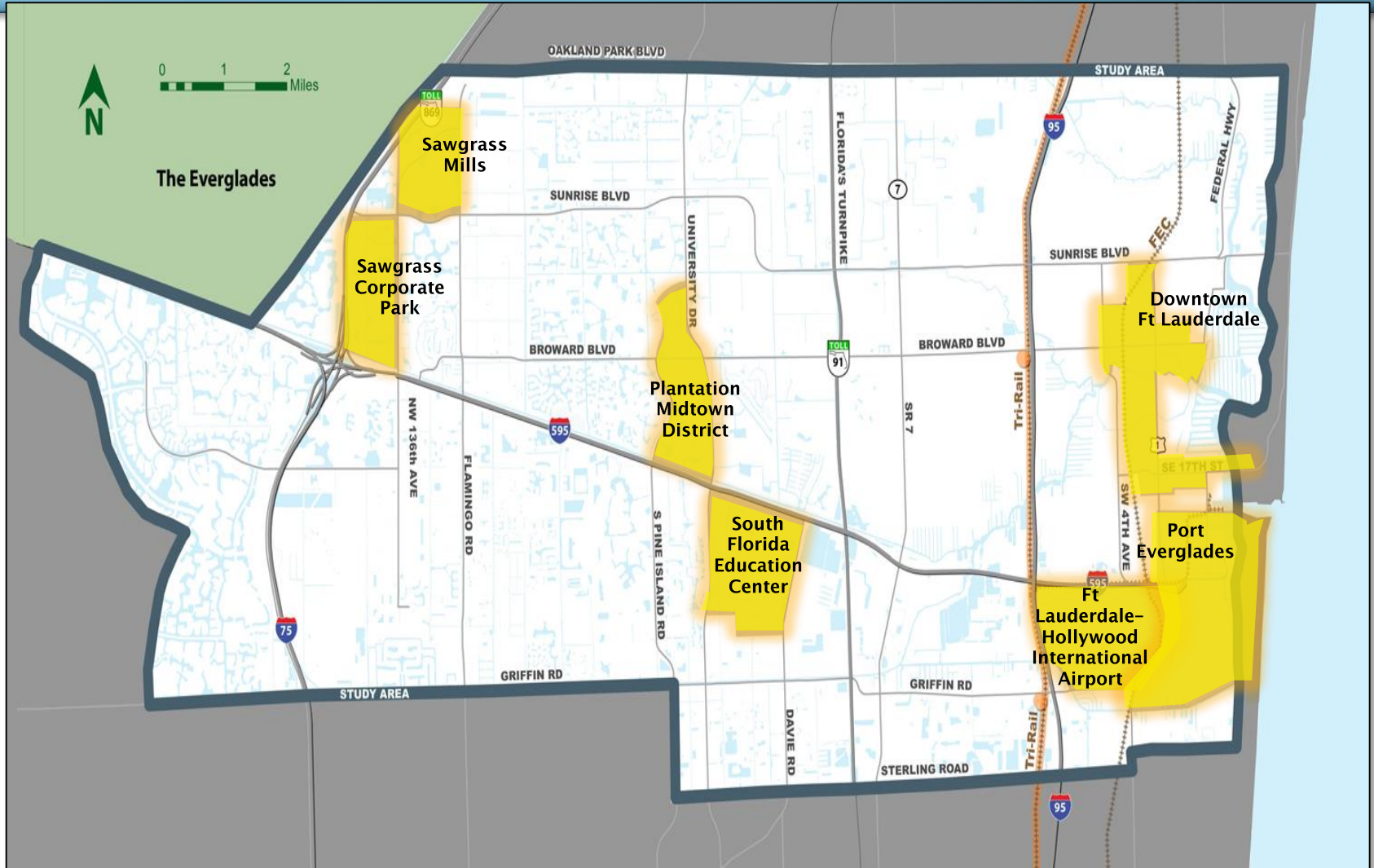
CENTRAL BROWARD



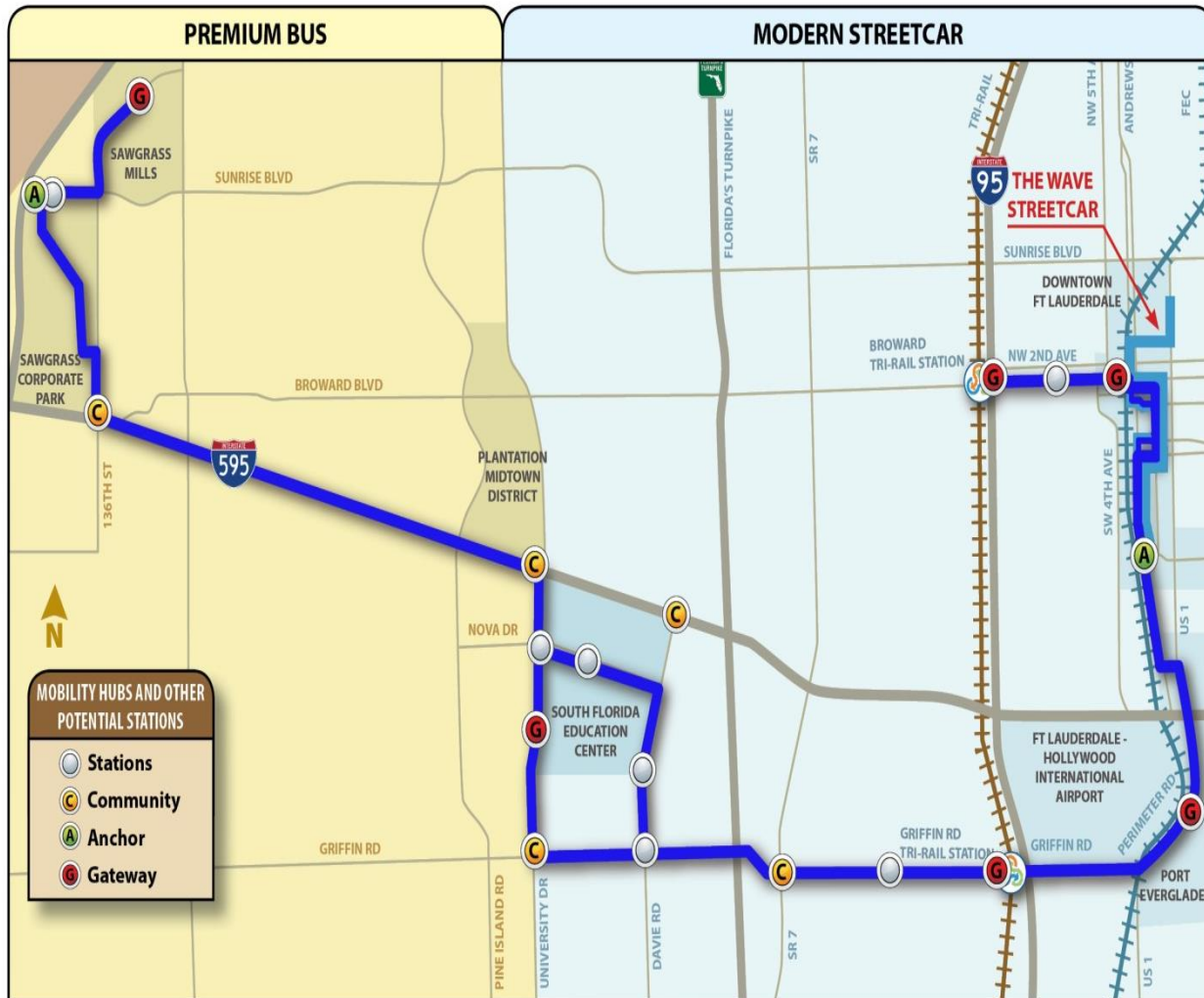
TRANSIT STUDY



Central Broward Transit Study Area

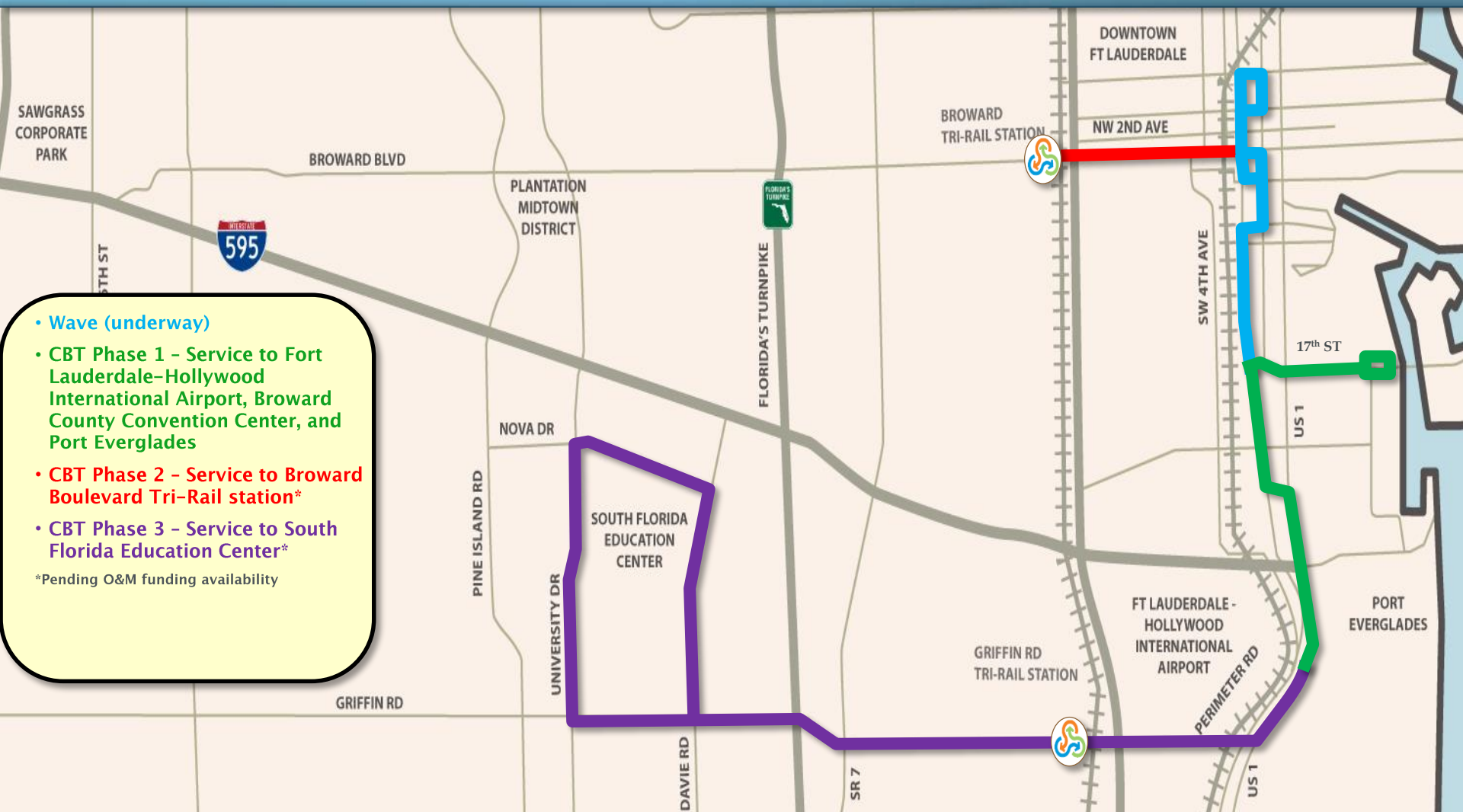


Locally Preferred Alternative



- At-grade within existing right-of-way
- Mixed traffic with some exclusive sections
- 25 miles = 13 miles of streetcar + 12 miles of premium bus
- 17 stations (excluding Wave): 14 streetcar + 3 bus

Central Broward Transit Phasing & Integration with Wave



- Wave (underway)
- CBT Phase 1 - Service to Fort Lauderdale-Hollywood International Airport, Broward County Convention Center, and Port Everglades
- CBT Phase 2 - Service to Broward Boulevard Tri-Rail station*
- CBT Phase 3 - Service to South Florida Education Center*

*Pending O&M funding availability

WAVE Streetcar



- Currently in design phase
- Modern Streetcar Vehicles
- Mixed Traffic Operations
- 14 Stations



Central Broward Transit Phase 1



- Currently in Project Development with FTA
- At-grade within existing right-of-way
- Mixed traffic with some exclusive sections
- ~ 4.5 miles of streetcar
- 6 stations (excluding Wave)



FDOT - District IV

Streetcar/Urban Rail – Design & Construction

January 26, 2016



APPROACHING SIGNAL



Streetcar

Electric vehicle - Less noise than a diesel bus

BOARDING



Streetcar Stop
Typical boarding

SPECIAL SIGNAL



Streetcar - Transition

Streetcar with a special transit only phase to change lanes

MIXED TRAFFIC OPERATIONS



Operating In Mixed Traffic
Streetcar and cars sharing lane

TURNING



Streetcars Turning

They stop just like a car and wait for the signal to turn green

ON-STREET PARKING



Streetcar in Mixed Traffic

Leaving a stop

DUAL SIDE BOARDING



Streetcar Stop

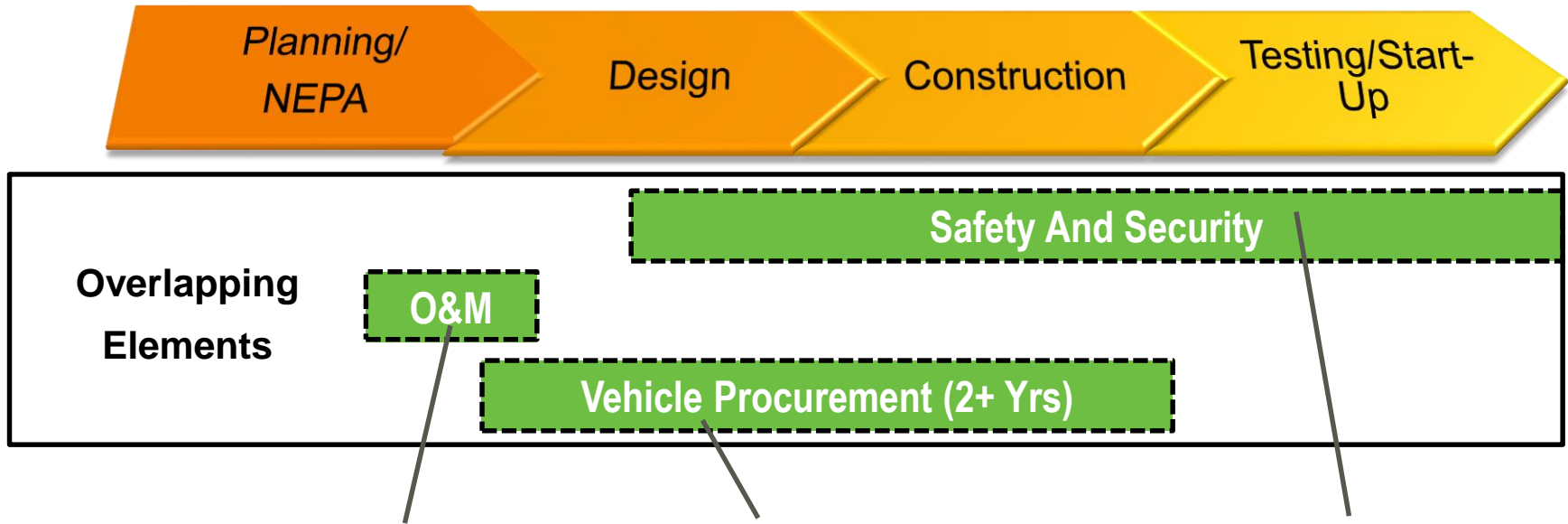
Vehicles can board from either side

COMMITTED & EXPLORING STREETCAR CITIES (January 2016)



Source: Community Streetcar Coalition (Updated by HDR 2016)

PROJECT LIFE CYCLE (Phases)

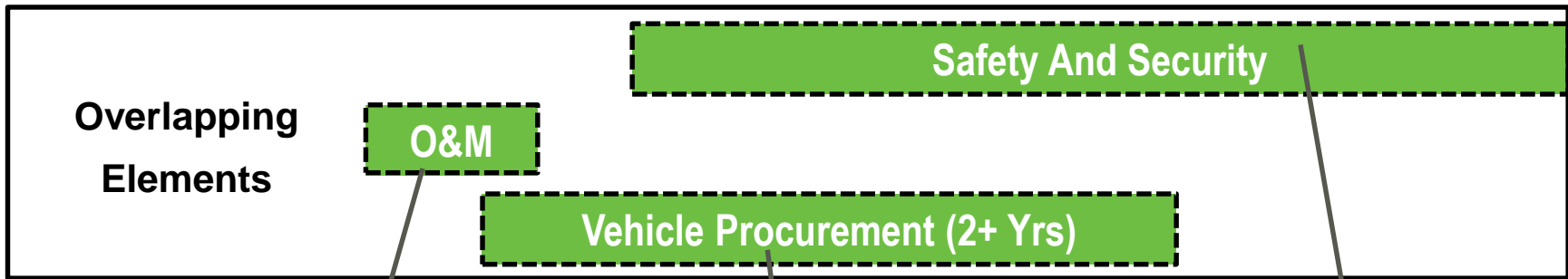


Preferences/Likes?
Equipment/Tools?
Yard/Bldg. Layout?
Operating Procedures?

Platform Interface?
Maintenance?
Special Trackwork?

SSMP?
SSCP?
TVA?
PHA?
SSRC?

PROJECT LIFE CYCLE (Phases)



Preferences/Likes?
 Equipment/Tools?
 Yard/Bldg. Layout?
 Operating Procedures?

Platform Interface?
 Maintenance?
 Special Trackwork?

SSMP?
 SSCP?
 TVA?
 PHA?
 SSRC?

Desired Start

Late Start/Reality?



DESIGN AND CONSTRUCTION OF STREETCAR ELEMENTS

DESIGN CRITERIA

- Purpose
 - Establish Design Standards and Policies for Streetcar Design
 - Provide a Uniform Design
 - Reference to Other Applicable Standards (Federal, State, County, Municipal, Utilities, etc.)
 - Standard Drawings



- Typical Design Criteria Table of Contents
 - General
 - Operations
 - Track Alignment and Vehicle Clearance
 - Urban Design
 - Civil
 - Utilities
 - Traffic
 - Special Trackwork
 - Structural
 - Vehicles
 - Maintenance and Operations Facility
 - Traction Power
 - Stray Current and Corrosion Control
 - Signal and Route Control
 - Communications
 - Fare Collection

DESIGN CRITERIA

- Purpose

- Establish Design Criteria
 - Streetcar Design
- Provide a Uniform Design
- Reference to Existing Design Criteria (Federal, State, County, Municipal, Utilities, etc.)
- Standard Drawings

Responsibilities

- Who signs-off/approves the initial criteria?
- Who is authorized to update and issue revisions?

It's normal and "OK" to update the criteria

Criteria Table of Contents

Clearance and Vehicle Clearance

○ Civil

○ Utilities

Additional Resources

- TCRP 155 – Track Design Handbook for LRT
- AREMA Chapter 12, Part 8

These are a good resource but keep in mind they are only a guide and also may have differing interpretations of the same information

○ Stray Current and Corrosion Control

○ Signal and Route Control

○ Communications




○ Fare Collection

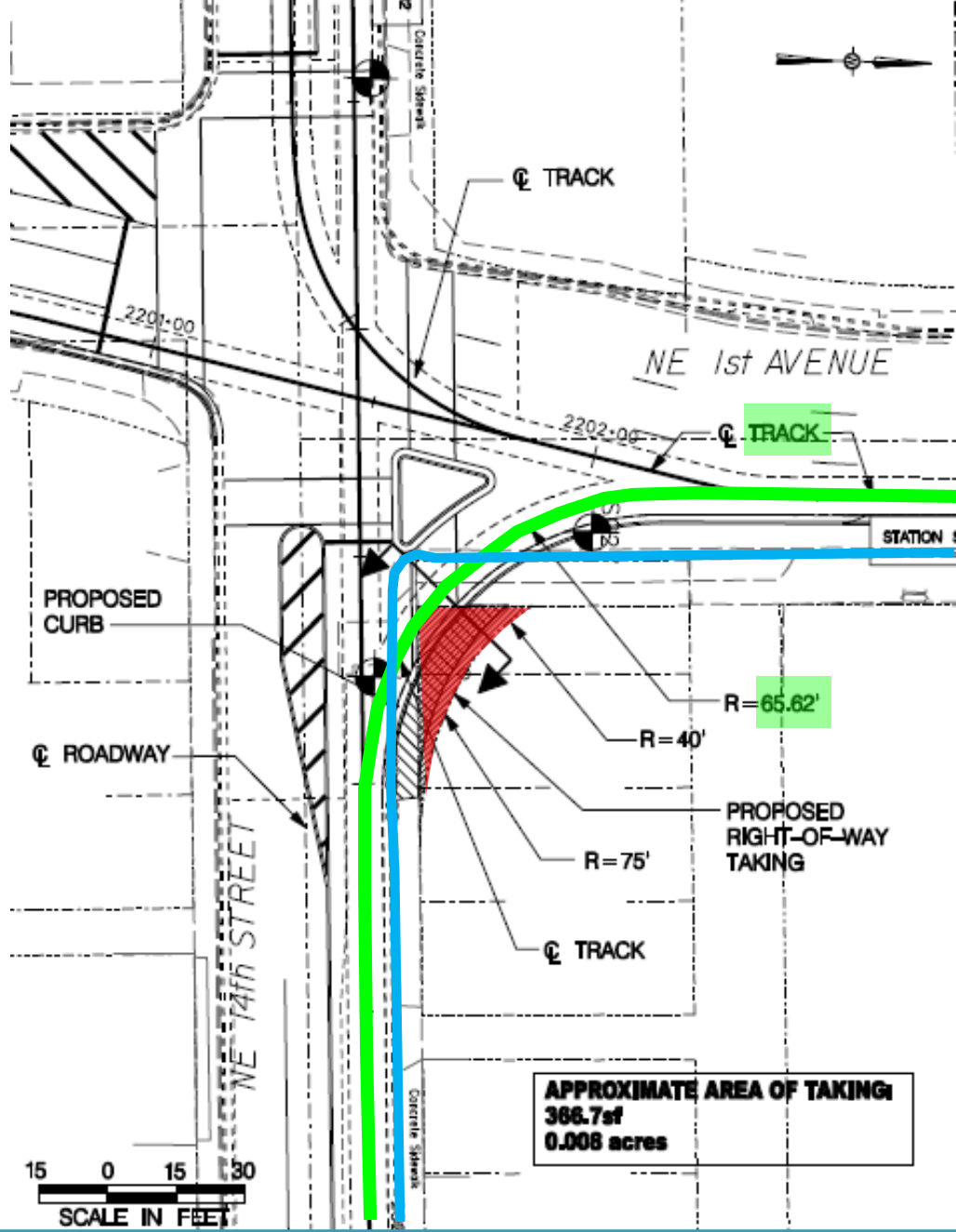




RIGHT-OF-WAY NEEDS – Maintenance Facility

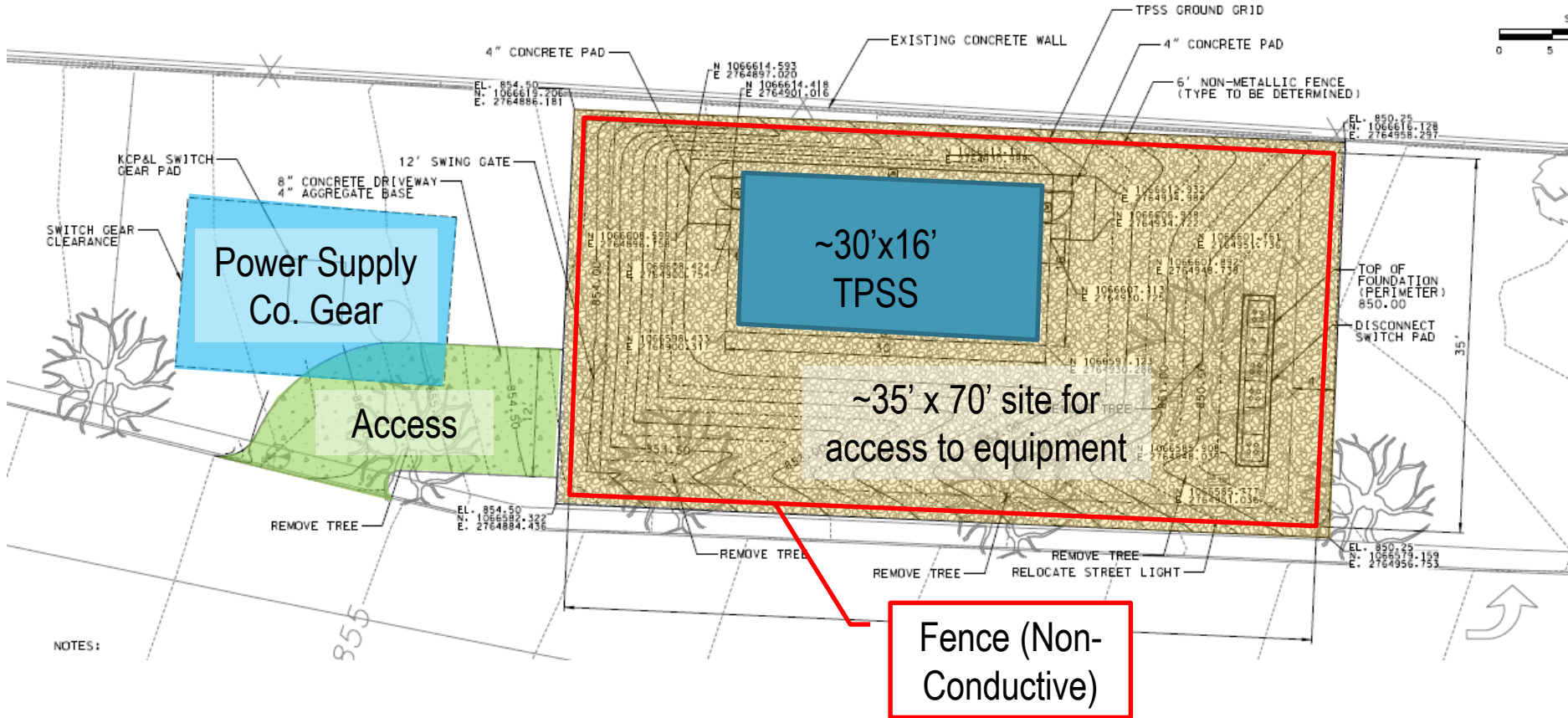
RIGHT-OF-WAY NEEDS – Corner Clips

-  EXISTING CURB
-  TRACK CENTERLINE
-  RIGHT-OF-WAY TAKE



RIGHT-OF-WAY NEEDS – TPSS (Substation)

INTERSTATE 670



NOTES:

855



UTILITIES

UTILITIES – Start With the End in Mind



UTILITIES – Defines “Permit” Envelope & Access Rules

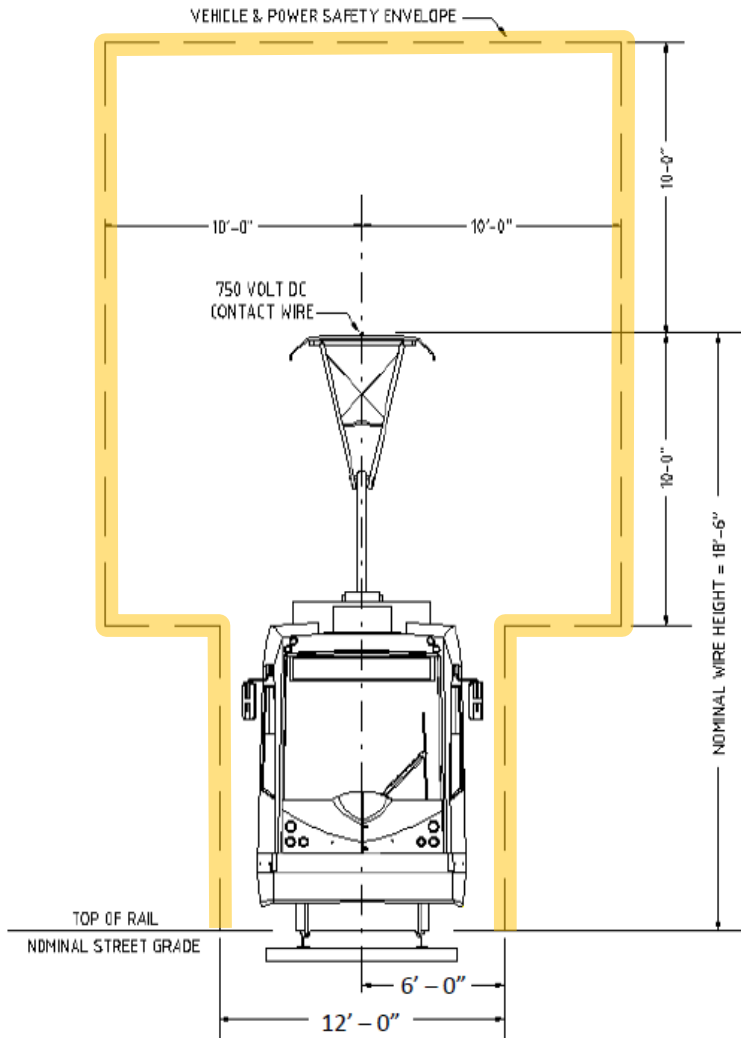


FIGURE ONE – VEHICLE and POWER ENVELOPE

Permit Requirements

- Notice to Obtain Permit - “example”
 - 12 Hour – Non-Revenue Access
 - 48 Hour – Revenue Service Access
 - Immediate – Emergency Shutdown
- Working Around the Streetcar - Requirements
 - Flaggers
 - Track Access Training

For a sample – “Google” “KC Streetcar Regulations Manual”

UTILITIES – Composite Drawings & Engaging Utilities

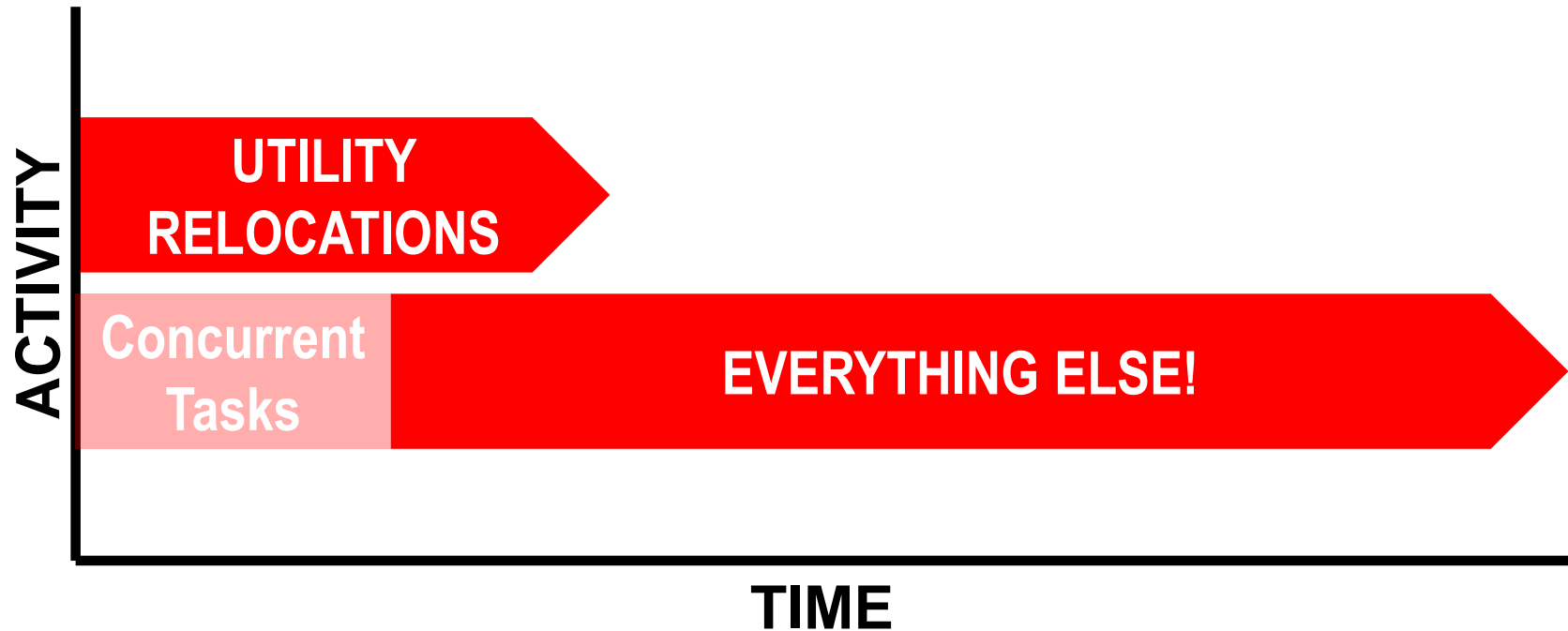
Lessons Learned

- Make PDF Layered – Utilities can turn on or off other utilities when reviewing their potential conflicts
- Public First - Do NOT show until you have public utility relocations designs completed and proposed locations shown.
- Show Track Alignment – Include dimensions to track from curb or similar object so Utility has a reference point.

You are Now Ready to Engage the Utility Companies



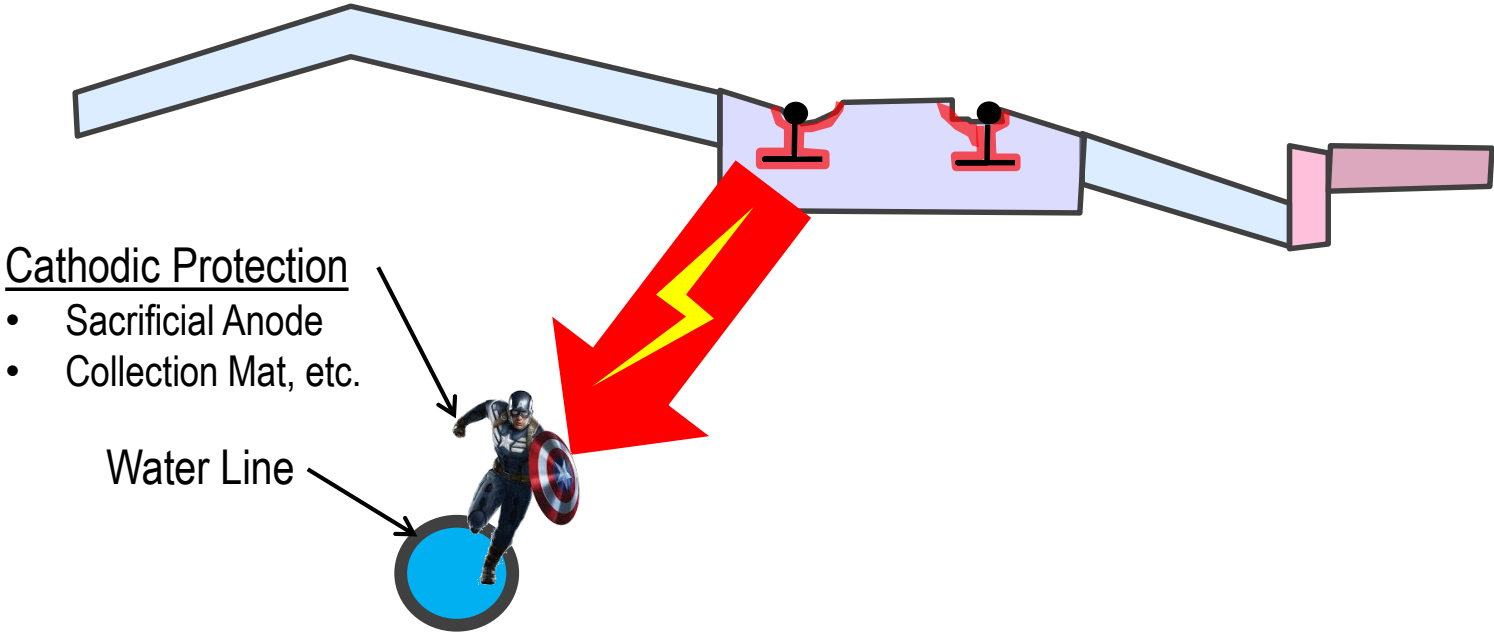
UTILITIES – Critical Path – ALWAYS!



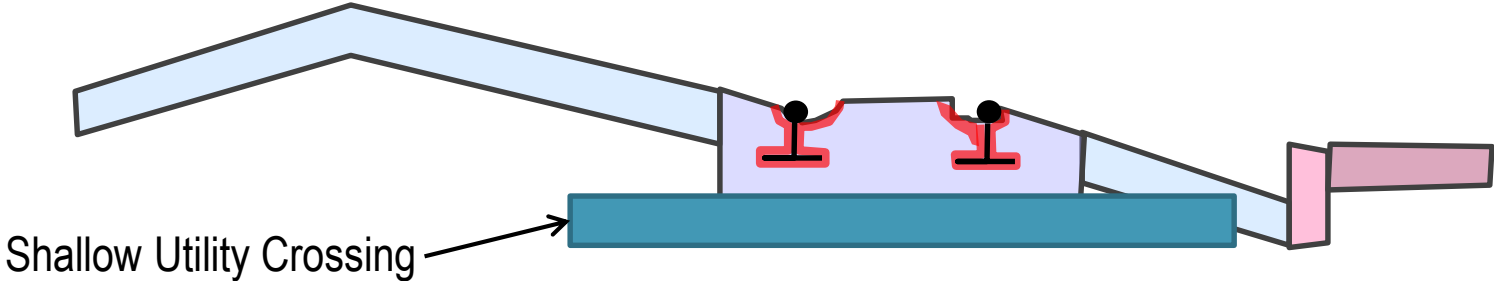
Are there any concurrent tasks?

- Public Utility Relocations
- Procurement and Submittals
- Weld Rail
- Pole Foundations

UTILITIES – Stray Current, a “FUZZY” Science



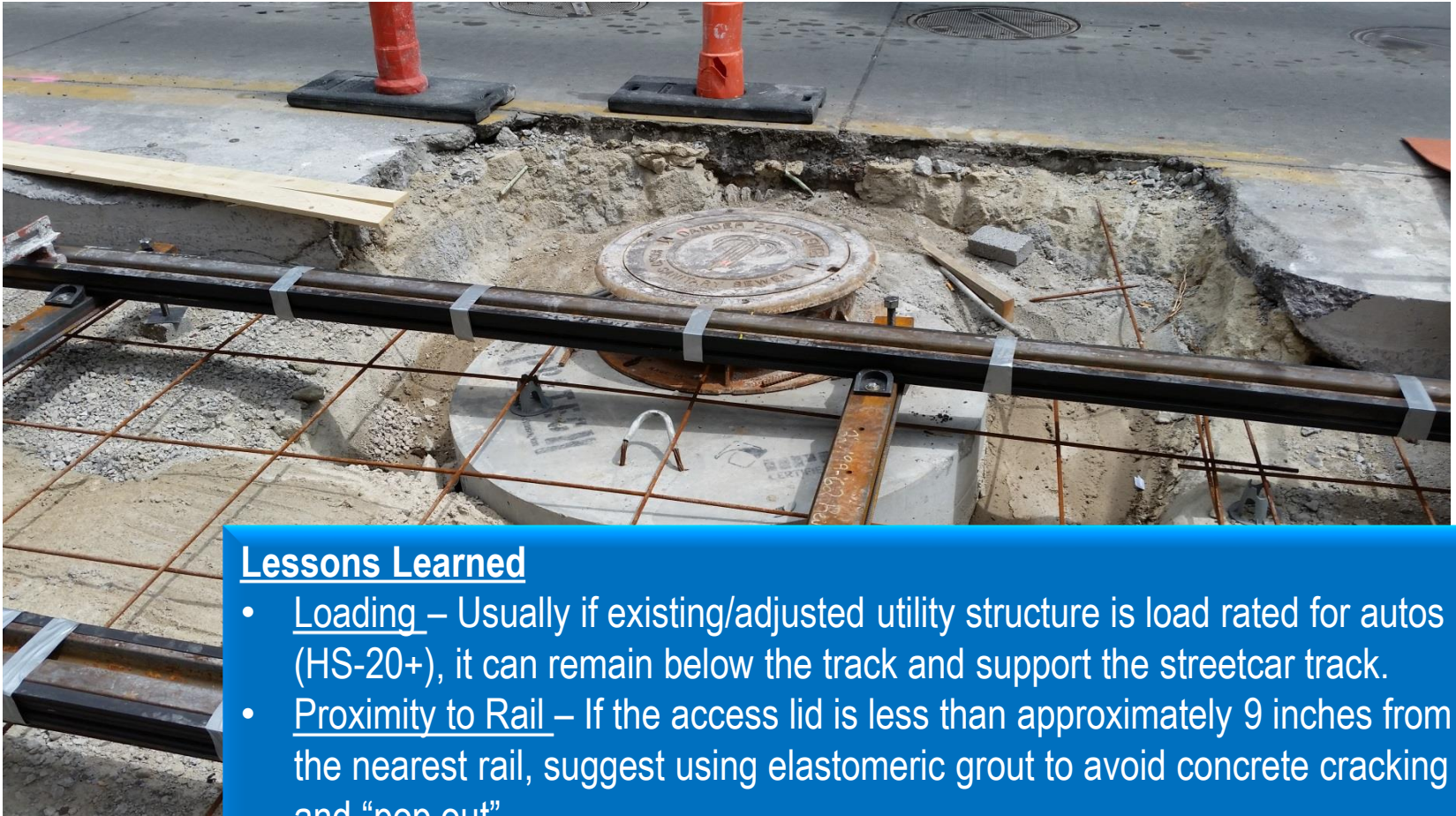
UTILITIES – Shallow Crossings



UTILITIES – Vaults, Manholes, etc.



UTILITIES – Vaults, Manholes, etc.



Lessons Learned

- Loading – Usually if existing/adjusted utility structure is load rated for autos (HS-20+), it can remain below the track and support the streetcar track.
- Proximity to Rail – If the access lid is less than approximately 9 inches from the nearest rail, suggest using elastomeric grout to avoid concrete cracking and “pop out”

There are typically several of these situations on every project. It's ok to leave in place, just evaluate each one as they are all a little different.



TRACK

TRACK – Rail Options, Types



Girder Rail



Tee Rail



Block Rail

TRACK – Rail Options, Applicability

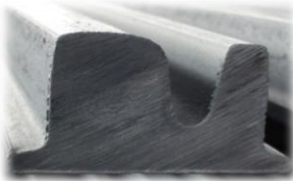
Embedded



Ballasted

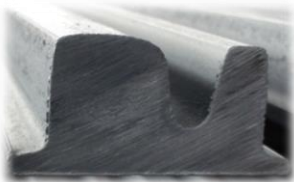
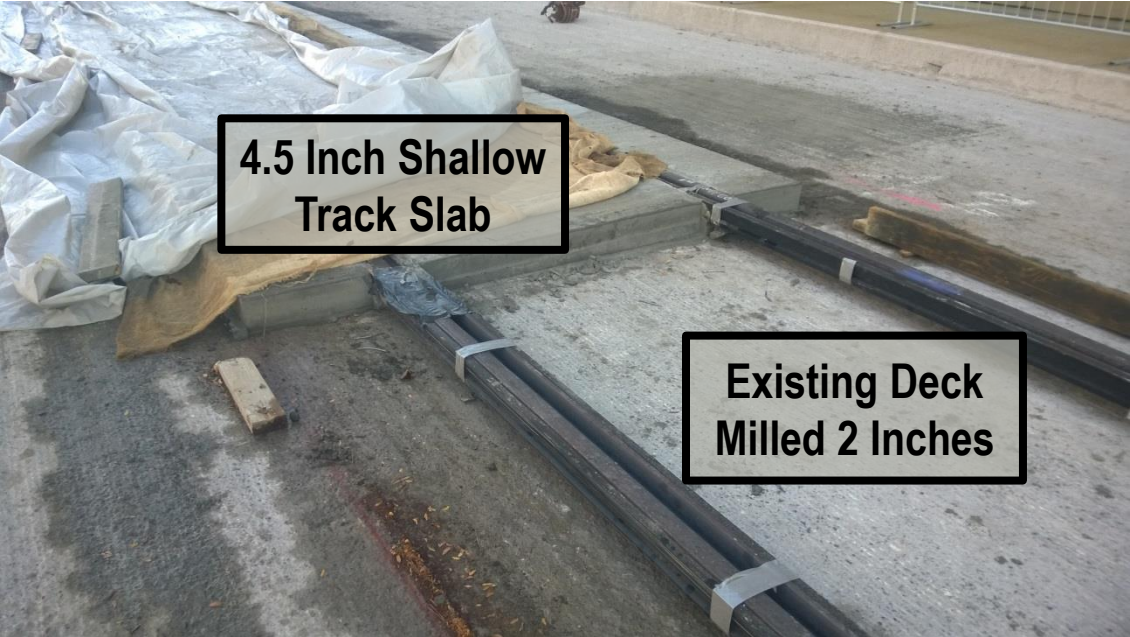


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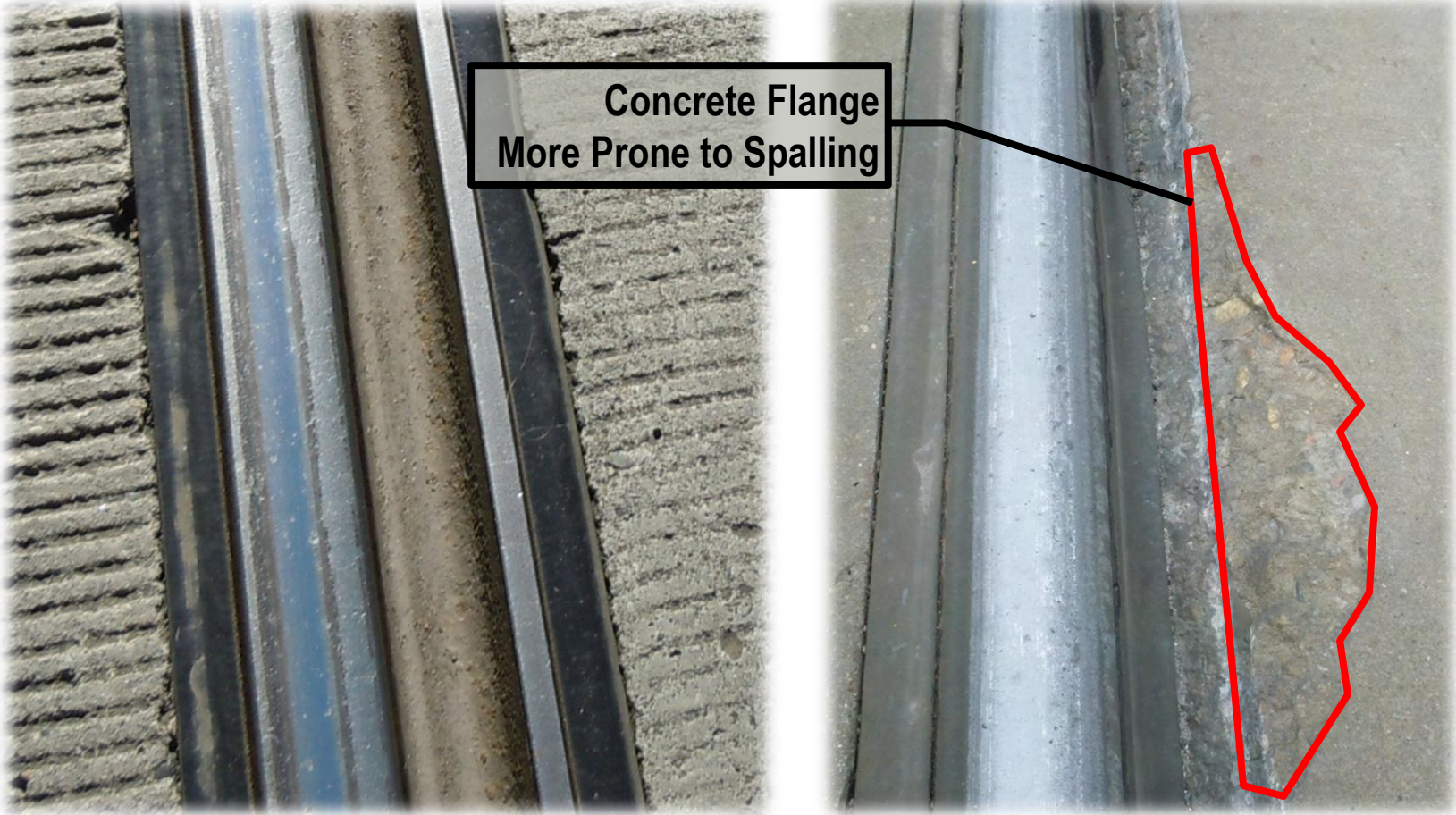


TRACK – Rail Options, Existing Bridges

Shallow Slab Embedded on Structure



TRACK – Rail Options, Durability



TRACK – Rail Options, Narrow Tired Vehicles



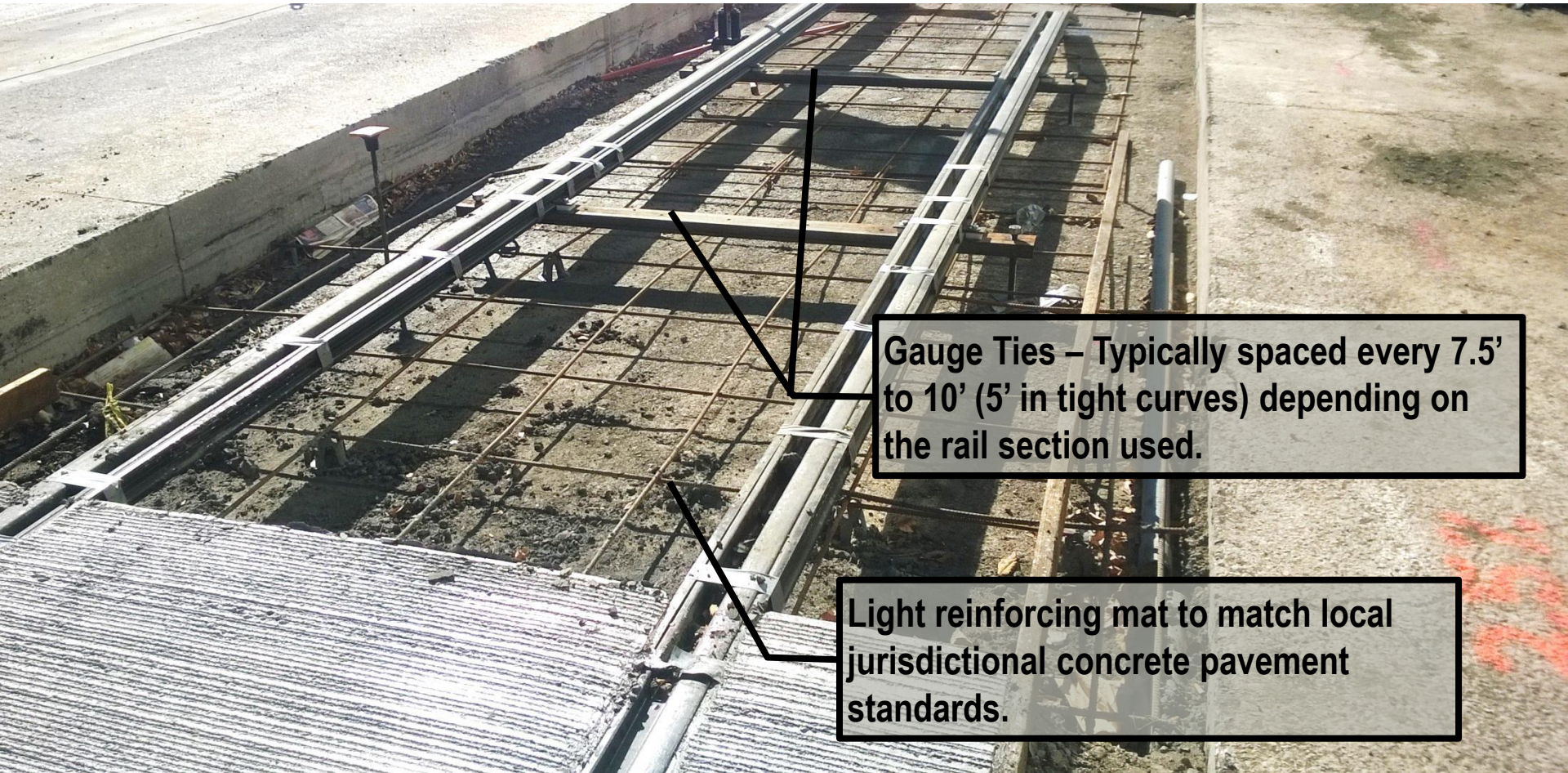
TRACK – Storing Rail



TRACK – Welding Rail



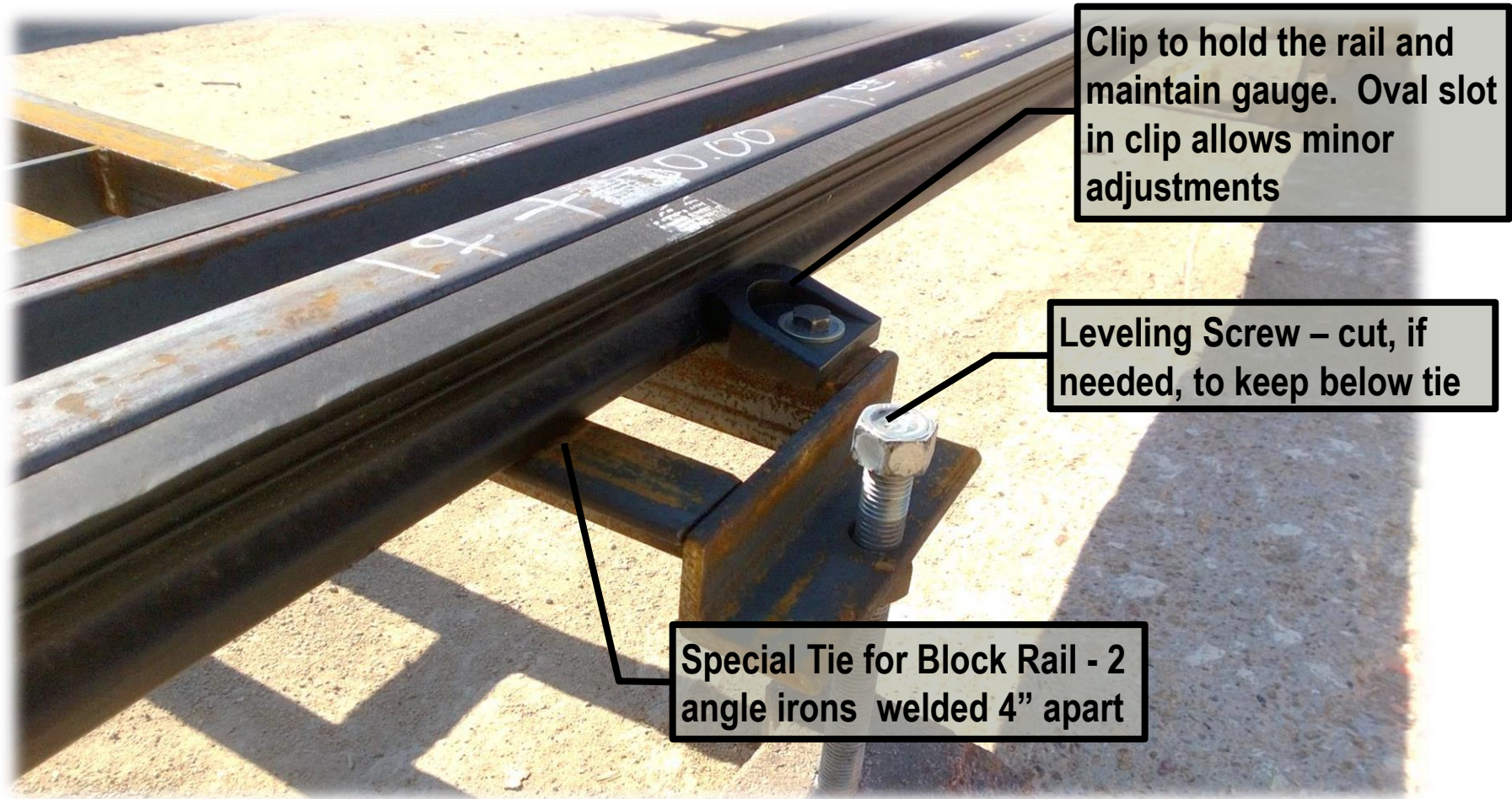
TRACK INSTALLATION – Typical CIP Track Construction



Gauge Ties – Typically spaced every 7.5' to 10' (5' in tight curves) depending on the rail section used.

Light reinforcing mat to match local jurisdictional concrete pavement standards.

TRACK INSTALLATION – How Ties Work



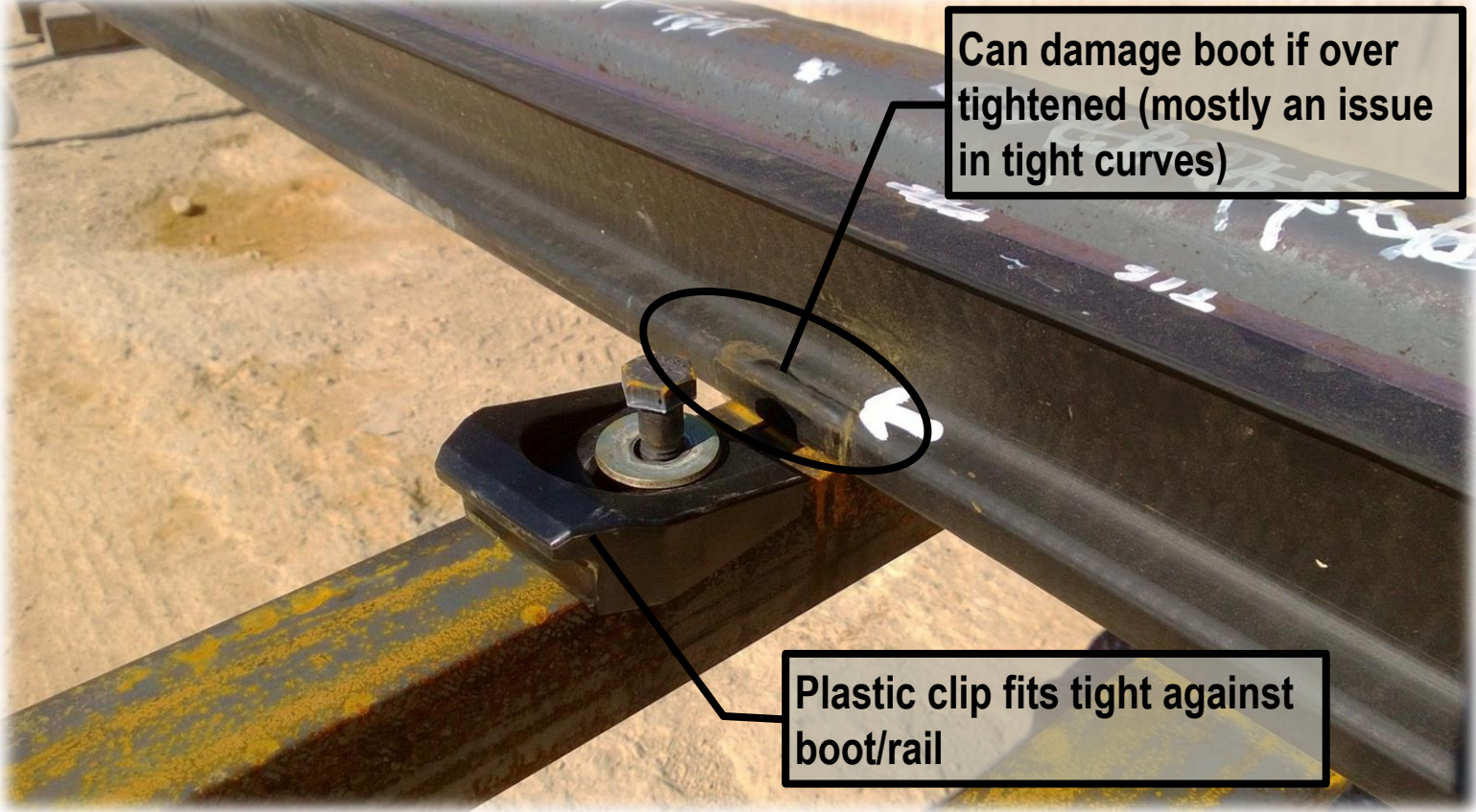
TRACK INSTALLATION – The Pour



3' rebar pieces placed over ties
(with unique block rail tie only)

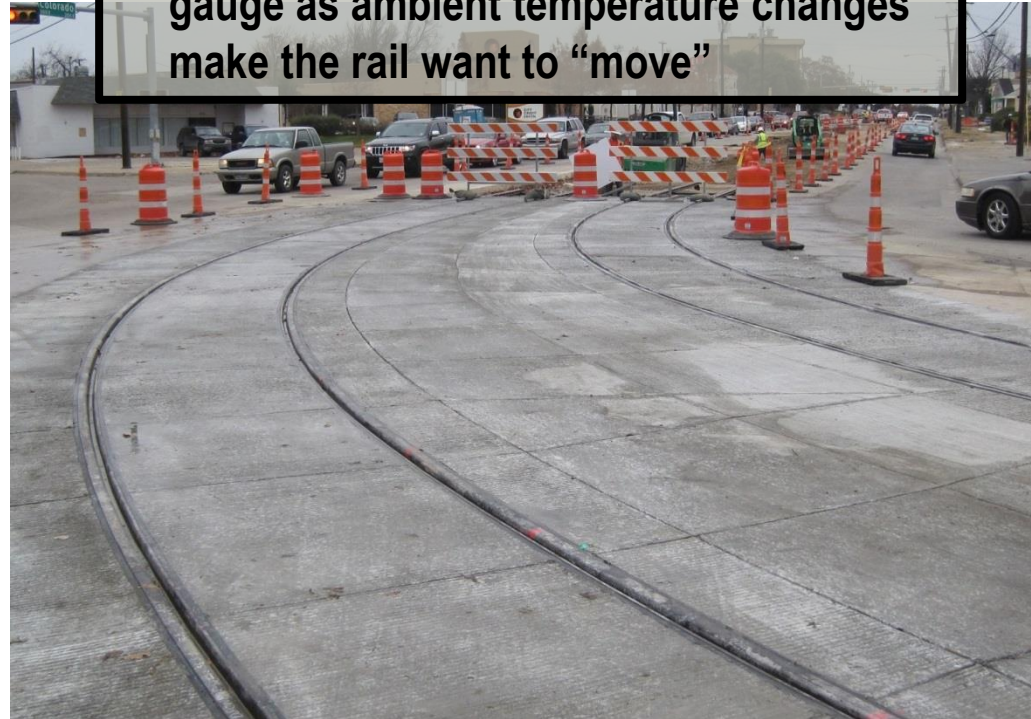
Wide tape placed over rail and
top lip of boot to prevent
concrete to get between boot and
rail during concrete pour

TRACK INSTALLATION - Clips



TRACK INSTALLATION - Pre-Curved Rail

- Applies to Curves < 400 feet
- Decrease tie spacing to 5 feet
- More challenging to maintain line and gauge as ambient temperature changes make the rail want to “move”

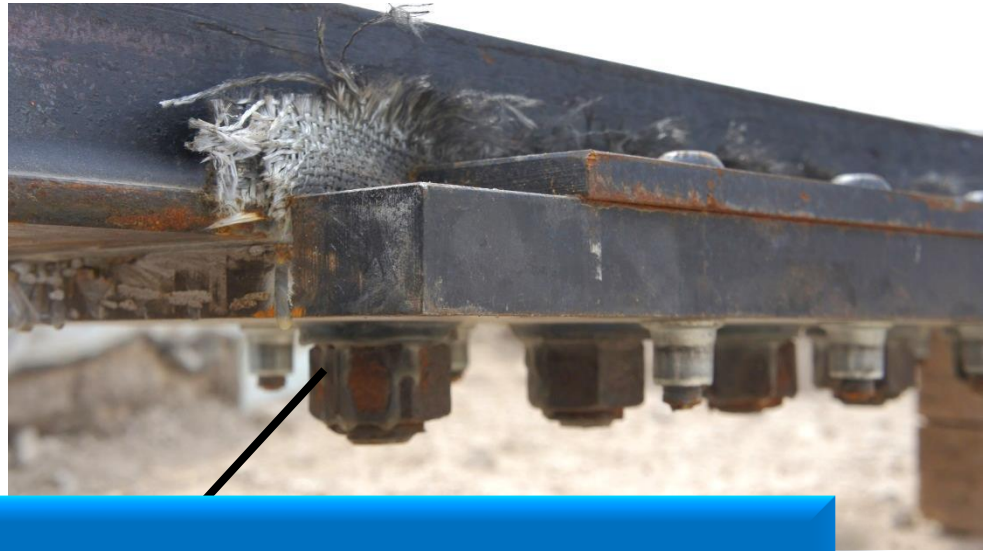


Support bar to hold line during concrete pour

TRACK INSTALLATION – Maintaining Access



TRACK INSTALLATION – Insulated Joints

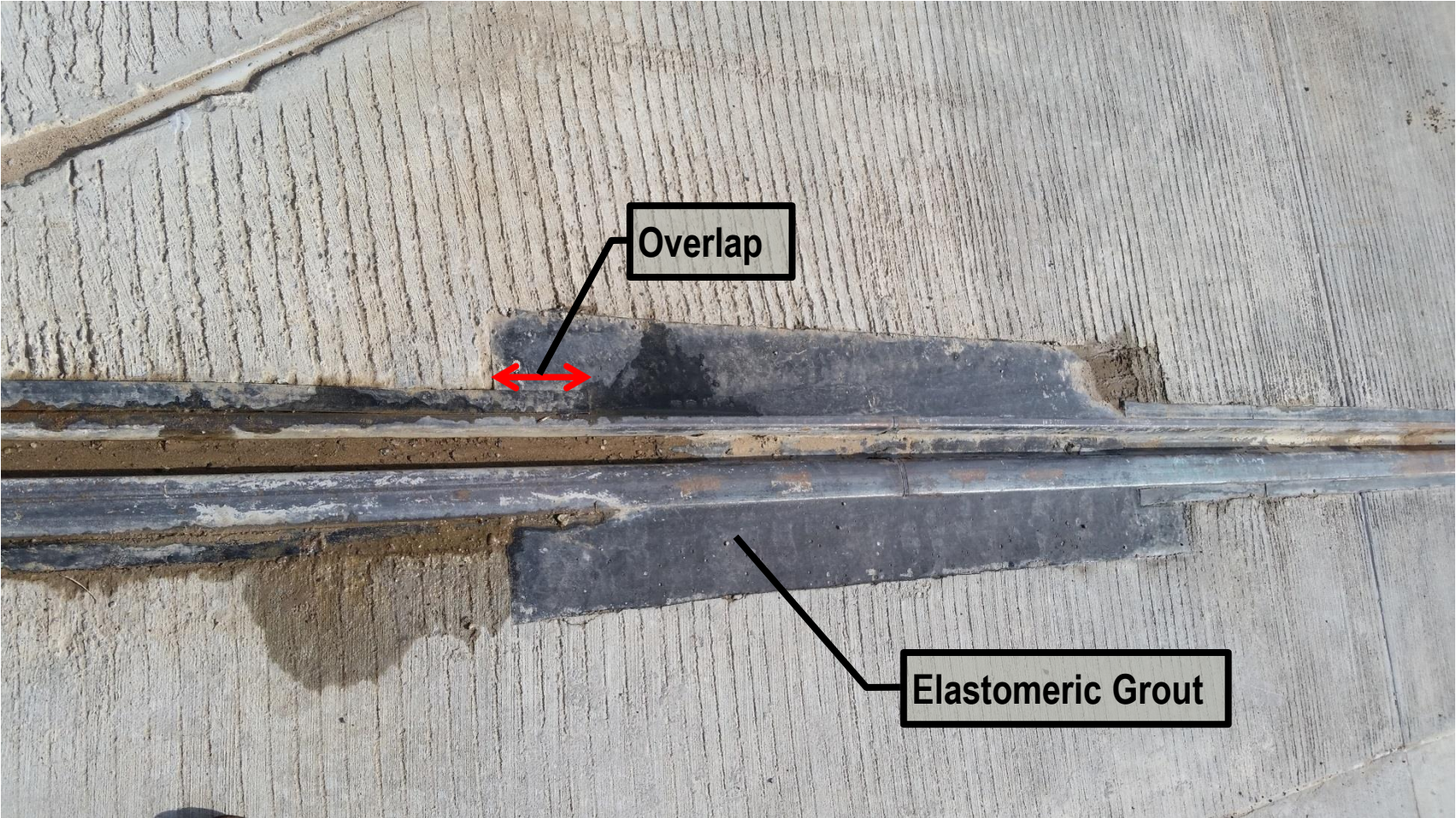


Key Points

- Use – Sometimes used for signal system (“Track Circuits”) or when trying to isolate segments electrically from one another

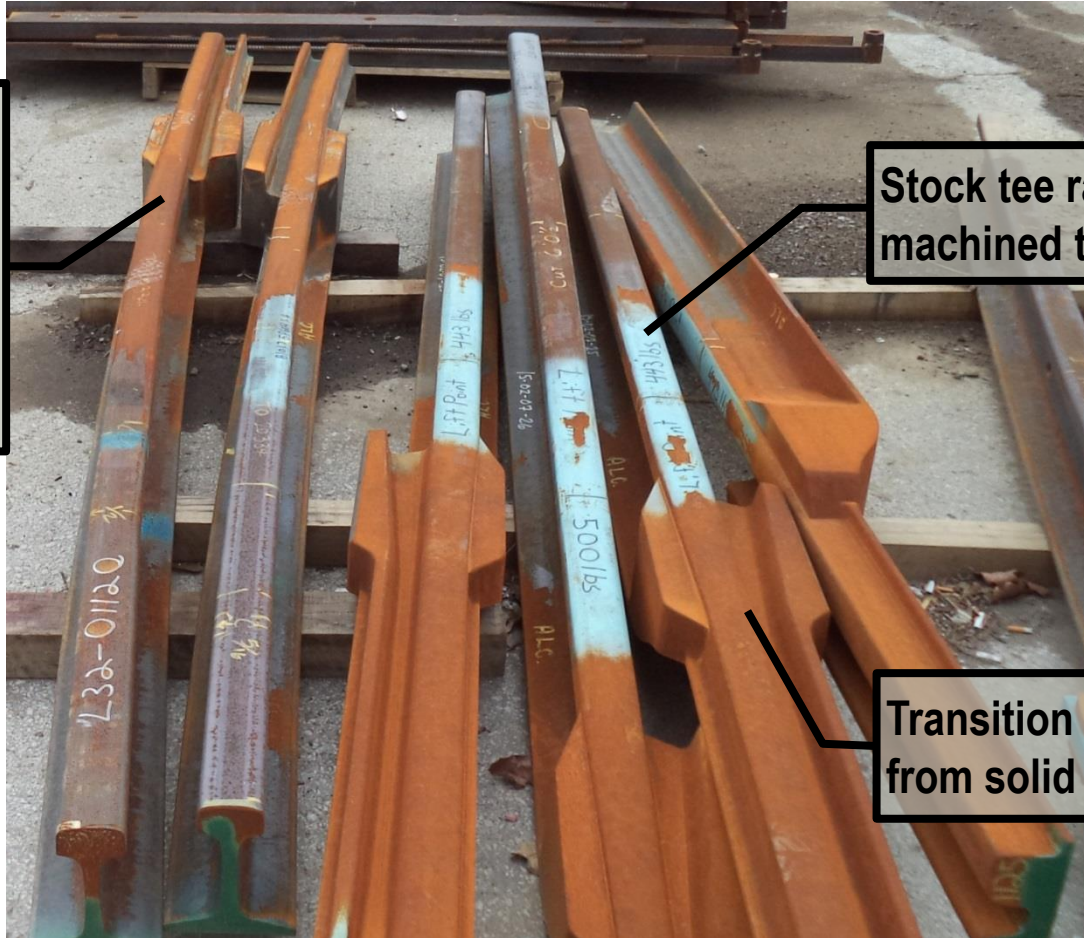
During Construction, resistivity tests are done prior to and after pouring the elastomeric grout verifying electrical separation at the IJ.

TRACK INSTALLATION – Insulated Joints



TRACK INSTALLATION – Transition Rails

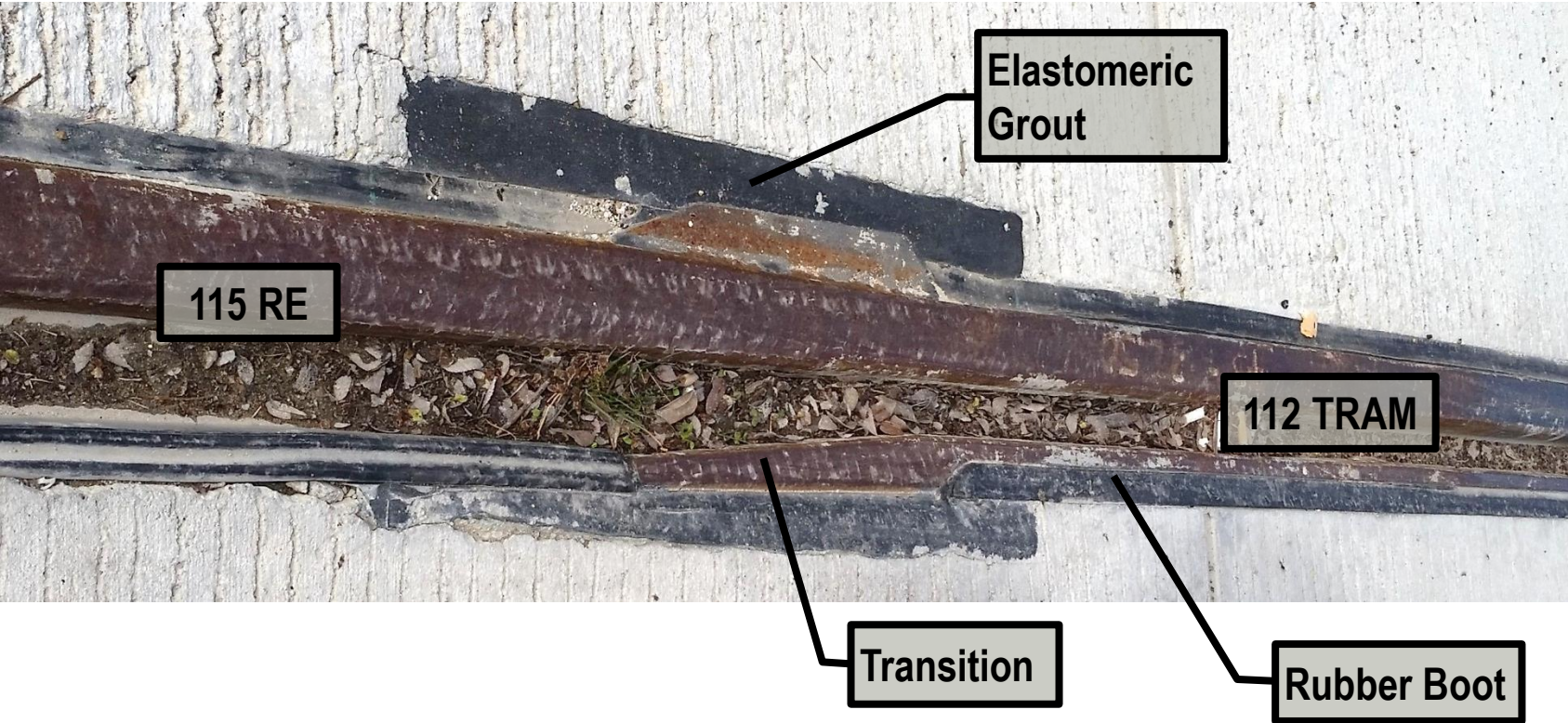
Curved transitions are also possible – used in KCMO at the end of a turnout



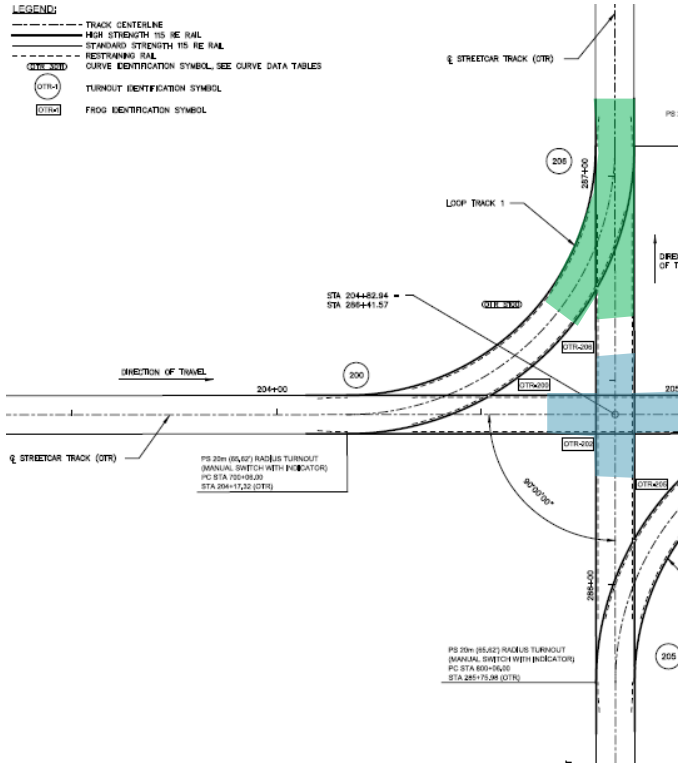
Stock tee rail welded to end of machined transition

Transition piece machined from solid piece of steel

TRACK INSTALLATION – Insulated Joints



TRACK - Special Trackwork





Responsibilities

- Designer – Provide Geometry, Style and Performance Measures/Specs.
- Contractor – Solicit Bids from Suppliers, Handling, Storage and Installation.
- Manufacturer – Detailed Design to submit to designer for approval. Also commonly responsible for encapsulation for stray current protection.

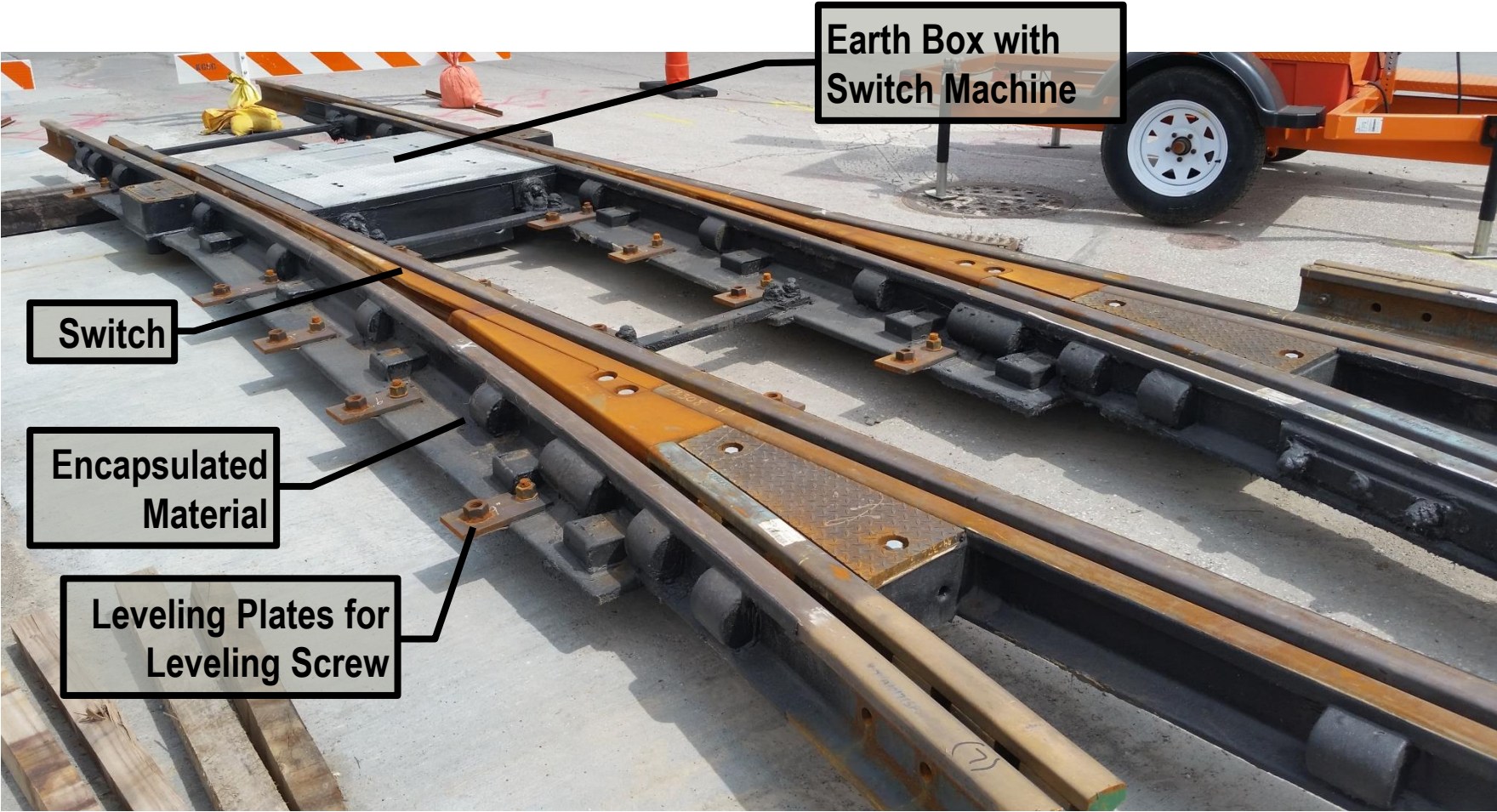
Use STANDARD Designs to reduce costs and Lead Times

Special Trackwork

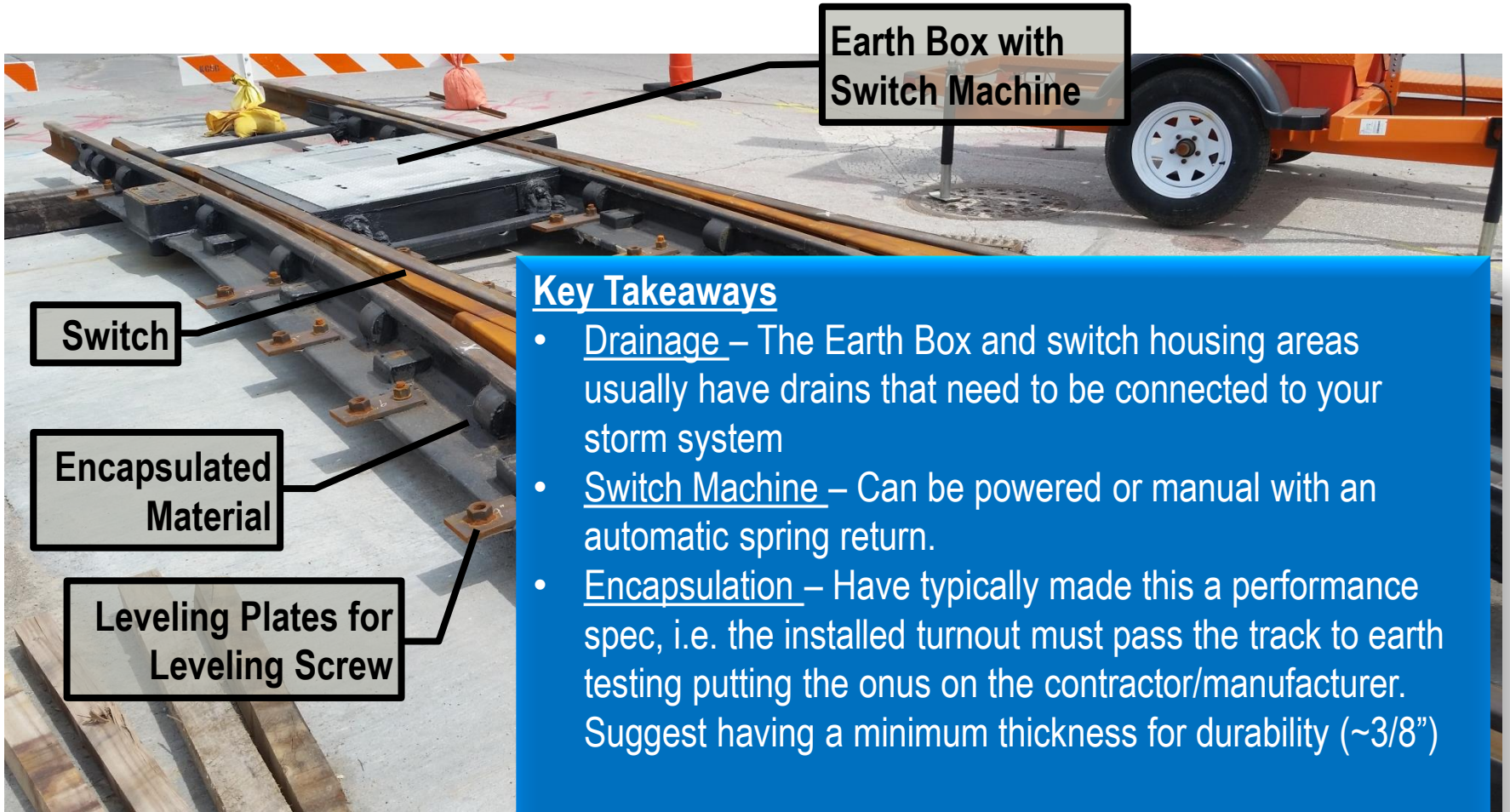
- Turnouts 
- Diamonds 



TRACK – Special Trackwork



TRACK – Special Trackwork



Key Takeaways

- Drainage – The Earth Box and switch housing areas usually have drains that need to be connected to your storm system
- Switch Machine – Can be powered or manual with an automatic spring return.
- Encapsulation – Have typically made this a performance spec, i.e. the installed turnout must pass the track to earth testing putting the onus on the contractor/mufacturer. Suggest having a minimum thickness for durability (~3/8")

Consider ordering spare parts at the same time

TRACK – Important Vehicle Parameters, Wheel Profile

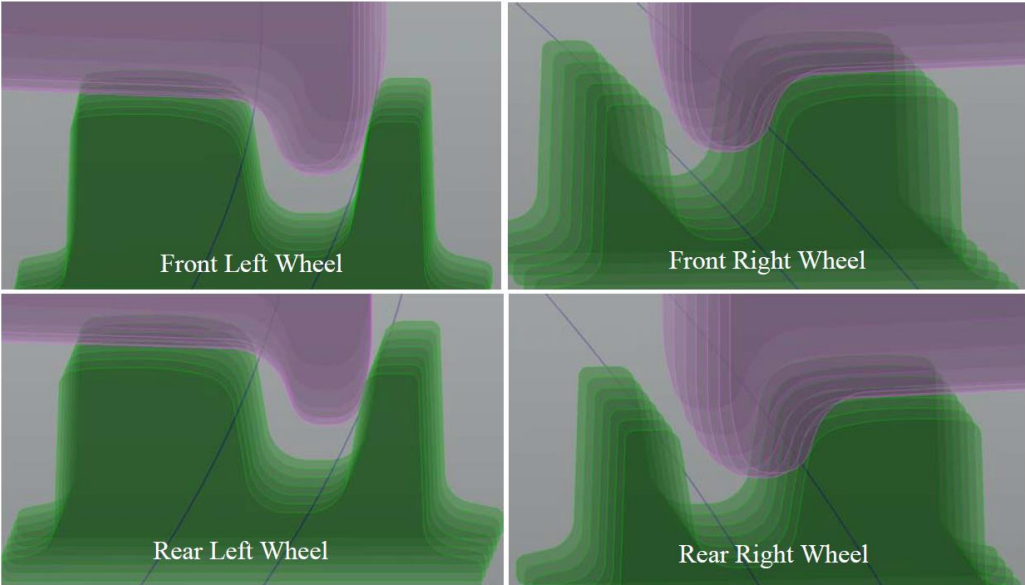
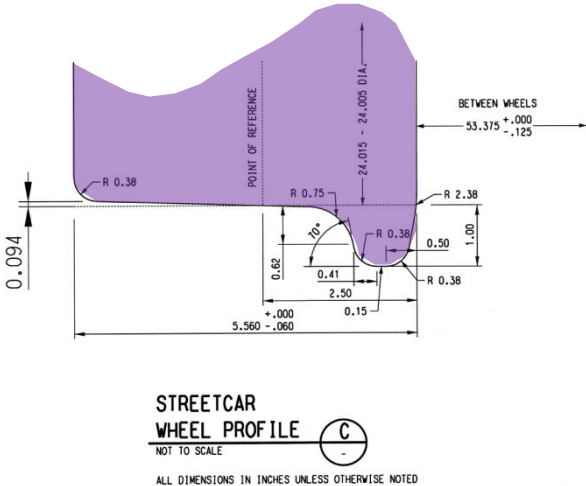


Figure 5: Wheels of truck in 65.56' radius curve, 56" rail gauge

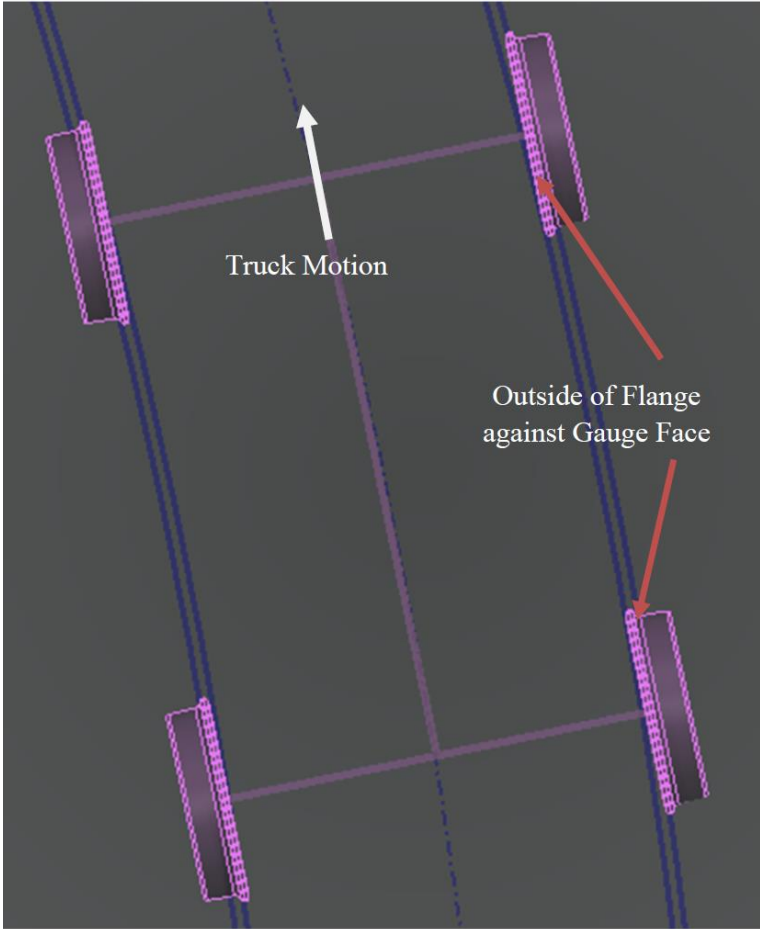
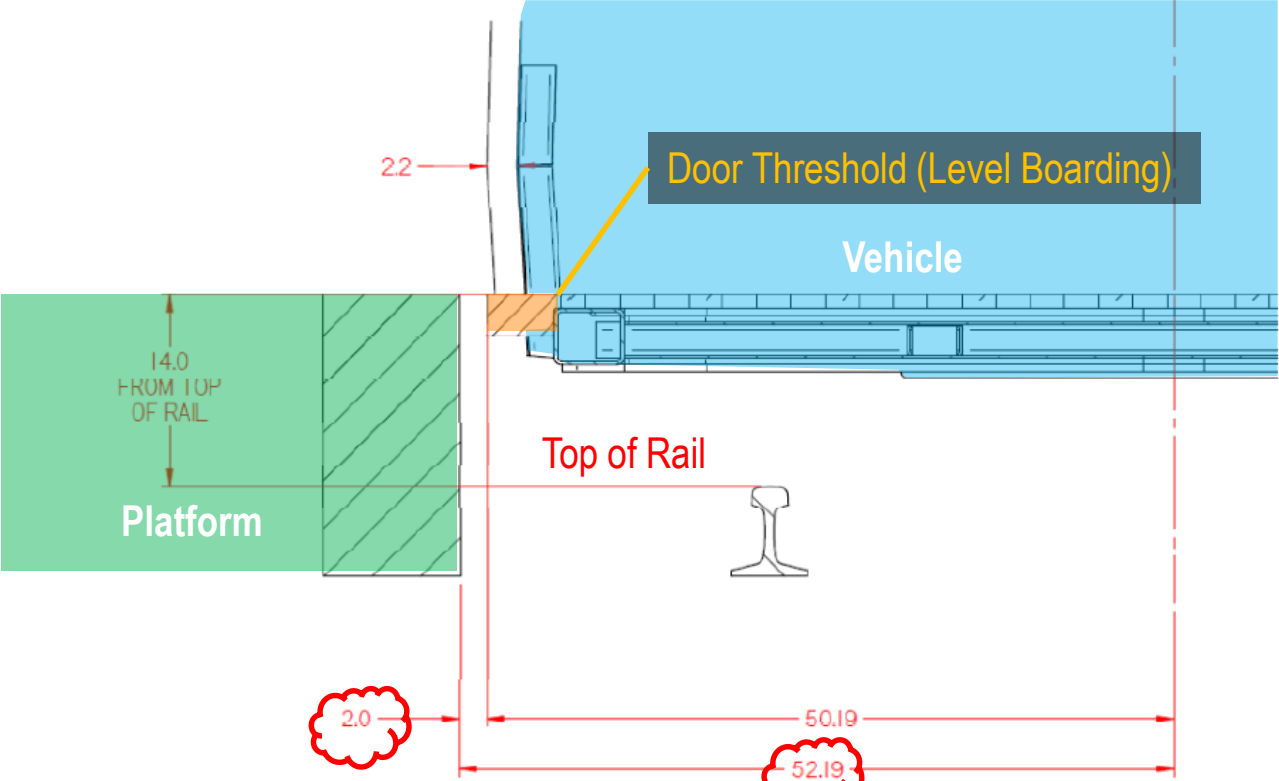


Figure 4: Curve Check Situation

TRACK – Important Vehicle Parameters, Platform Offset

Attachment D – Streetcar Centerline to Platform Offset (in)

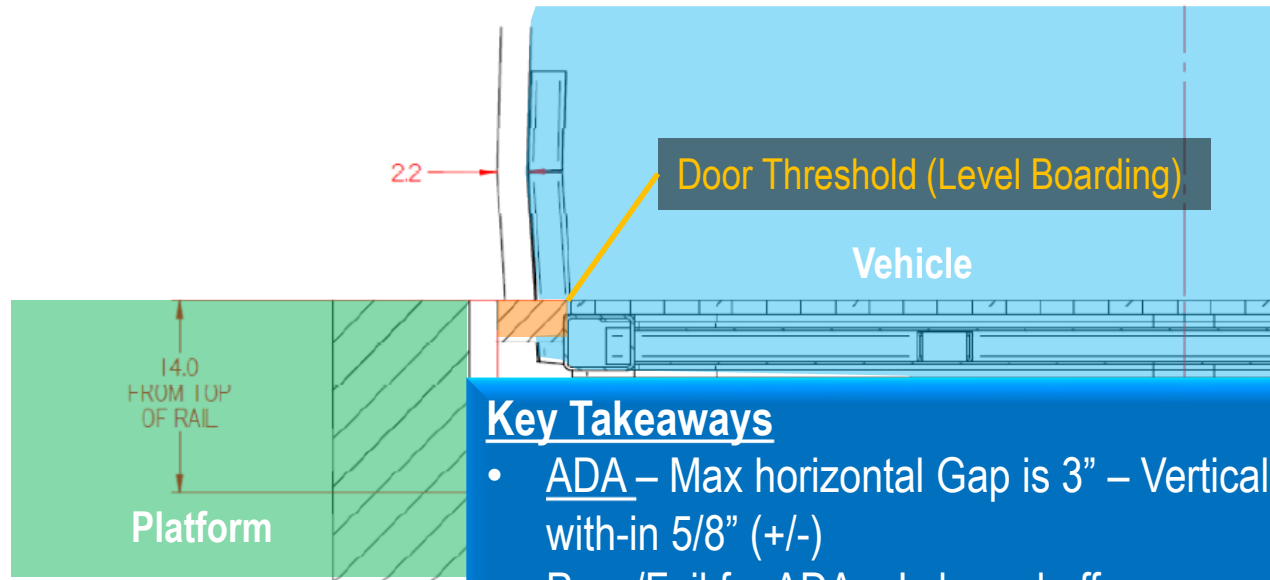


2" – Nominal Gap between Door threshold and Platform Edge

52.19" – Vehicle manufacturers recommended distance from Centerline of Track to Platform

TRACK – Important Vehicle Parameters, Platform Offset

Attachment D – Streetcar Centerline to Platform Offset (in)



2" – Nominal Gap
between Door threshold
and Platform Edge

Key Takeaways

- ADA – Max horizontal Gap is 3" – Vertical gap must be with-in 5/8" (+/-)
- Pass/Fail for ADA – Is based off measurements with an actual vehicle during testing.
- Tolerances - Must have tighter tolerances for platform to track then other Civil elements.

This should be provided by the vehicle manufacturer and verified by the track/civil engineers

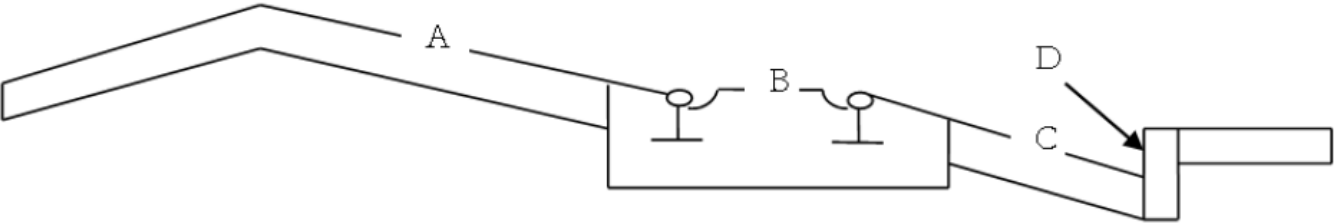


CIVIL

CIVIL ROADWAY - Xslope

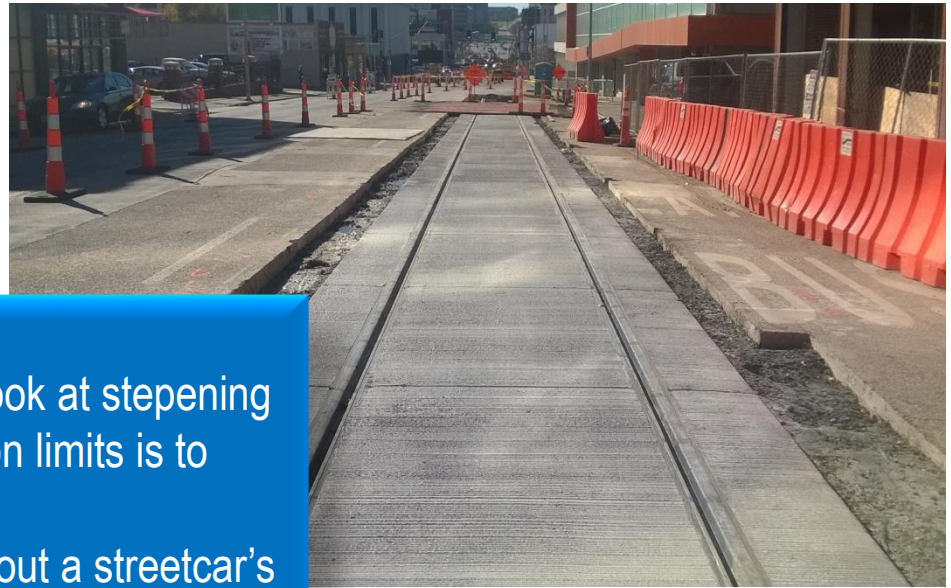


Travel Lane Shared Lane Parking Lane Sidewalk



	Desirable	Maximum	Minimum
A	2%	5% or Match Existing	1% or Match Existing
B	0%	1%	0%
C	2-4%	7% or Match Existing	1% or Match Existing
D	6-8 inches	10 inches	4 inches

CIVIL ROADWAY - Xslope



Key Takeaways

- Minimize Cost – A primary reason why we look at steepening cross slopes and minimizing the construction limits is to save costs.
- Civil is Civil – There is nothing “magical” about a streetcar’s Civil work. It’s the same as a roadway project just phased different and typically more “piece meal”.

A good municipal Engineer/Inspector already knows 90% of what they need for this scope element, a little training to fill in the streetcar specific gaps is all that’s needed.

Sidewalk

	Desirable	Maximum	Minimum
A	2%	5% or Match Existing	1% or Match Existing
B	0%	1%	0%
C	2-4%	7% or Match Existing	1% or Match Existing
D	6-8 inches	10 inches	4 inches

CIVIL – 90 degree turns

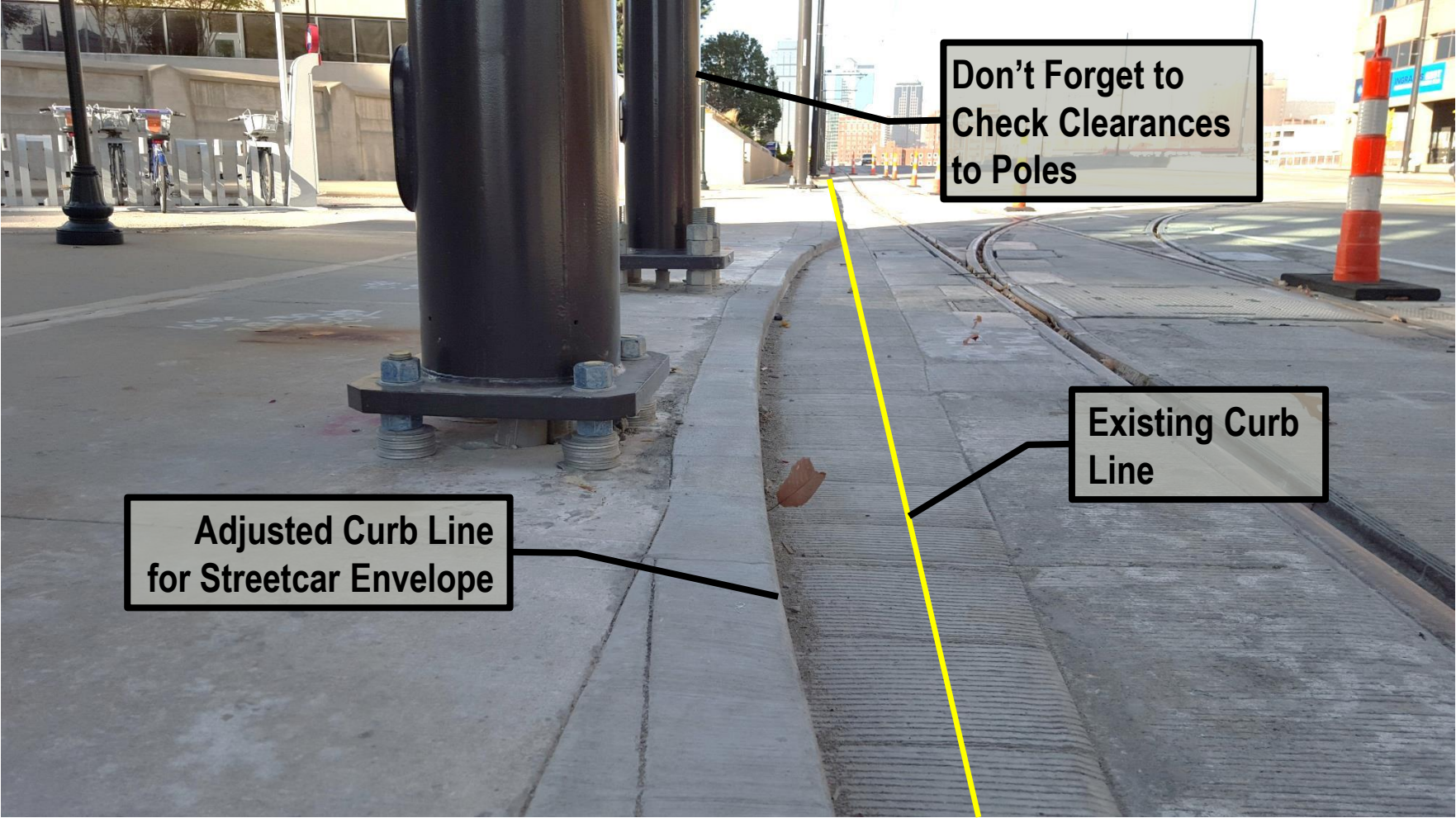


CIVIL – Drainage

- Track Drains
 - Located at Low Points Along the Track Slab (Only where adjacent pavement does not already drain away from the track)
 - Located Upstream All Special Trackwork
 - Connect into Existing Drainage System
- Typically No Change to Impervious Area Except for at Maintenance and Operations Facility
- Consider Water Recycling at Wash Bay in Maintenance and Operations Facility



CIVIL – Dynamic Envelope of Streetcar Vehicle



**Adjusted Curb Line
for Streetcar Envelope**

**Don't Forget to
Check Clearances
to Poles**

**Existing Curb
Line**

CIVIL - Pavement Markings and Signage



Parking Lane Markings



Bicycle Lane Markings



Crosswalk Markings



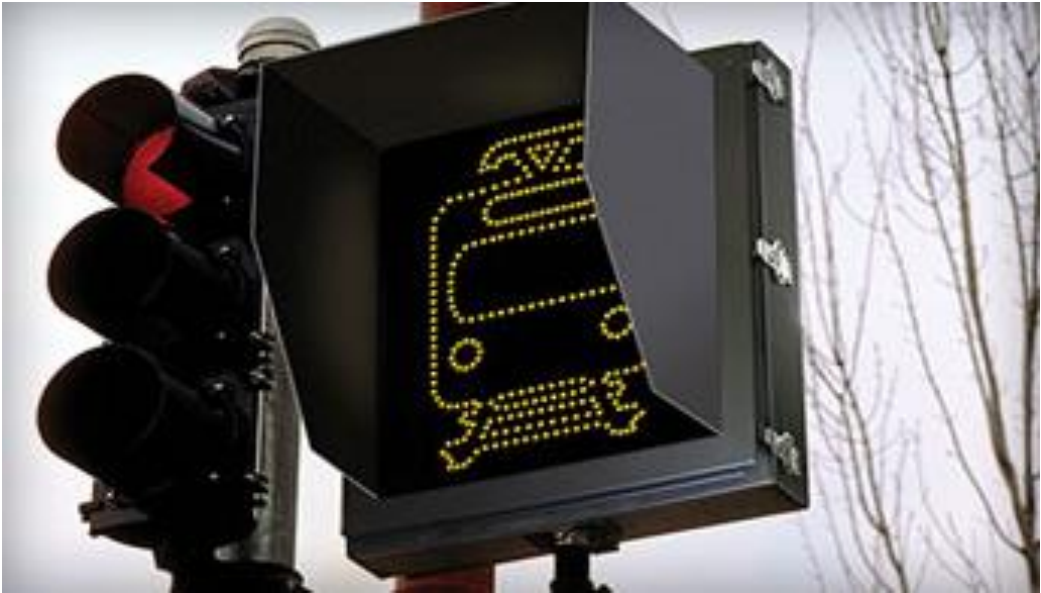
Warning Sign

CIVIL - Parking



Photo: San Francisco Examiner

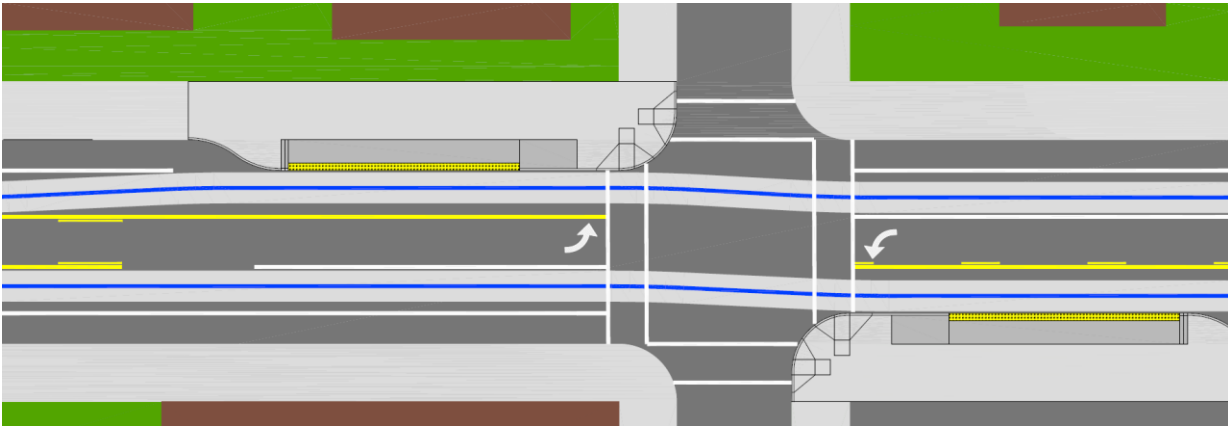
CIVIL – Blank Out Signs





STATION STOPS

STATION STOPS – Types, Curb Extension



STATION STOPS – Types, Median



STATION STOPS – ADA Requirements



Near Level Boarding (Bridge Plate)



Tactile Warning Strip

STATION STOPS – ADA Requirements

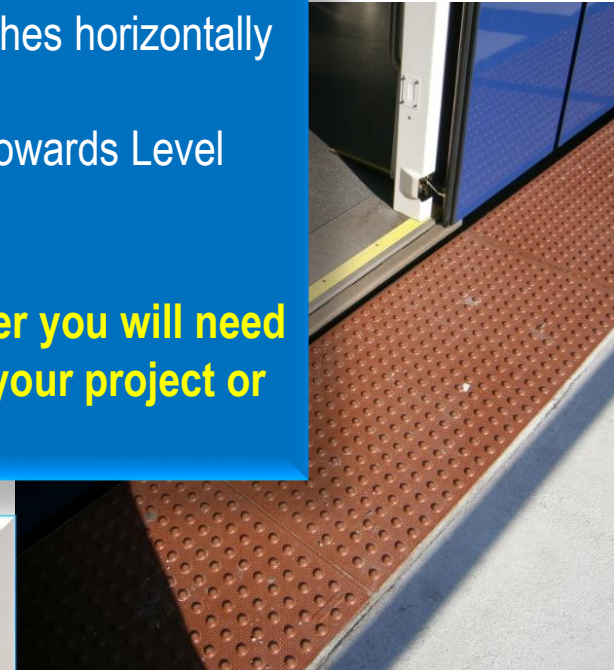
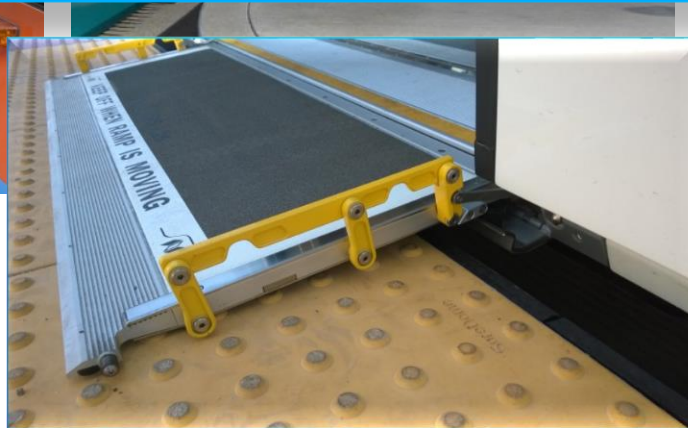
Key Takeaways

- Mind the “Gap” – Per ADA, the max horizontal and vertical gap for level boarding is no more than 3 inches horizontally and +/- 5/8” vertically.
- Industry Trends – The Industry is trending towards Level boarding for new start systems.

If considering near level boarding, remember you will need to go through “equivalent facilitation” for your project or add edge protection.



Near Level Boarding (Bridge Plate)



Tactile Warning Strip



14" Level Boarding – ADA Door(s) Location

Sloped from 14" to 7" – At least one side <5%

Lower Platform for Bus loading and using their deployable ADA Ramp

STATION STOPS – Amenities



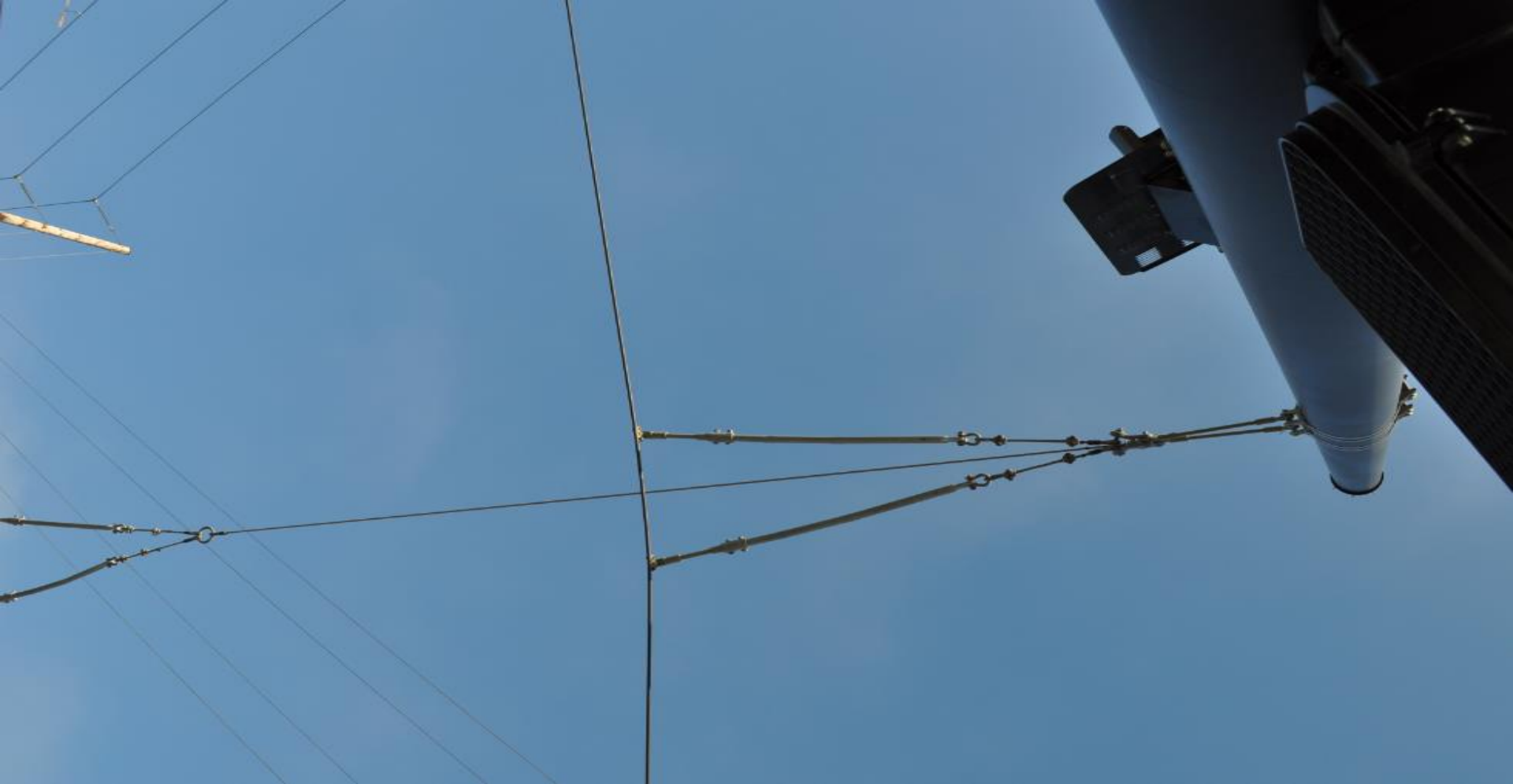
Art in Transit



History in Transit



Ticket Vending Machine (TVM)



SYSTEMS

SYSTEMS - Overhead Contact System (OCS)

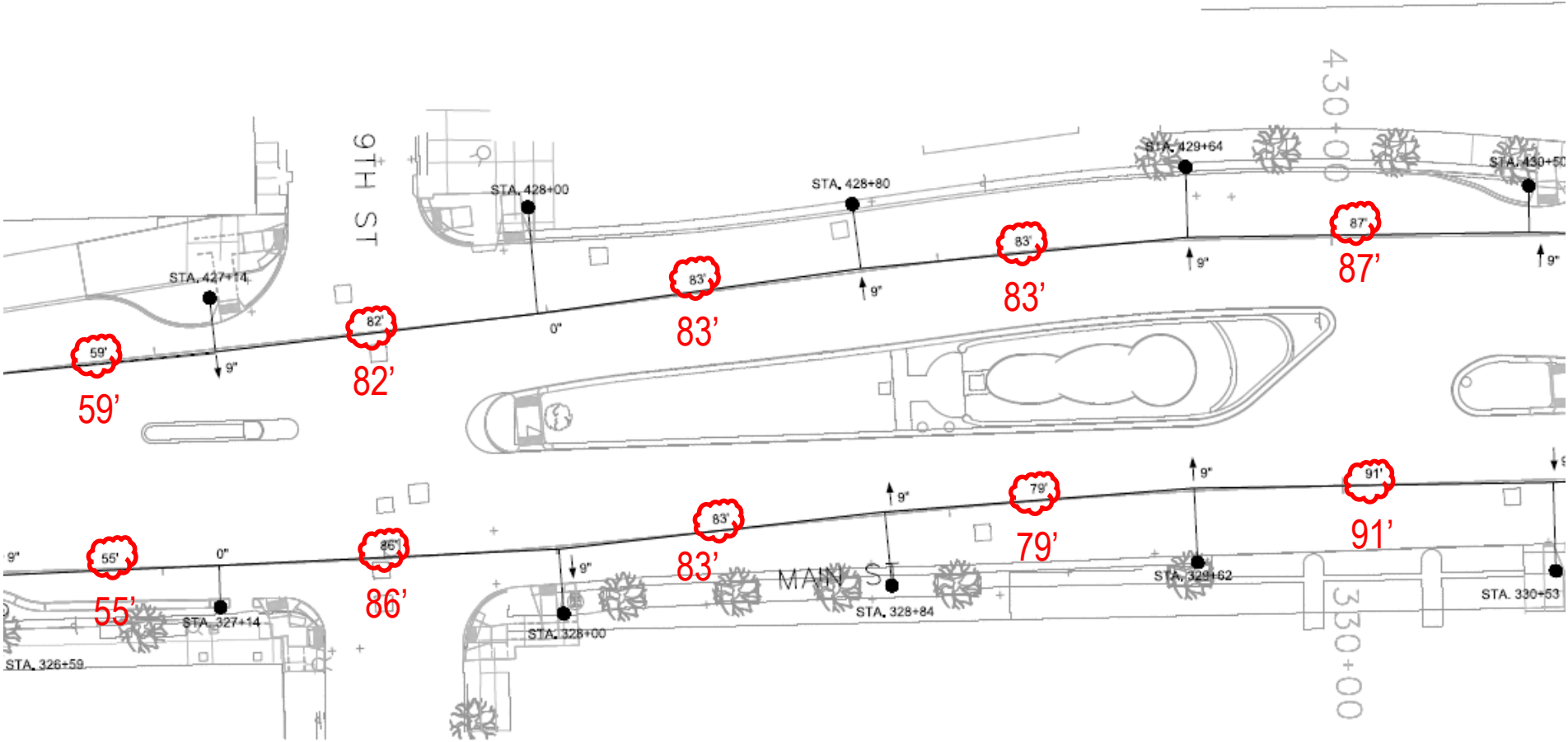


OCS Cantilever with Pole



OCS at Curved Track

SYSTEMS – OCS Pole Spacing

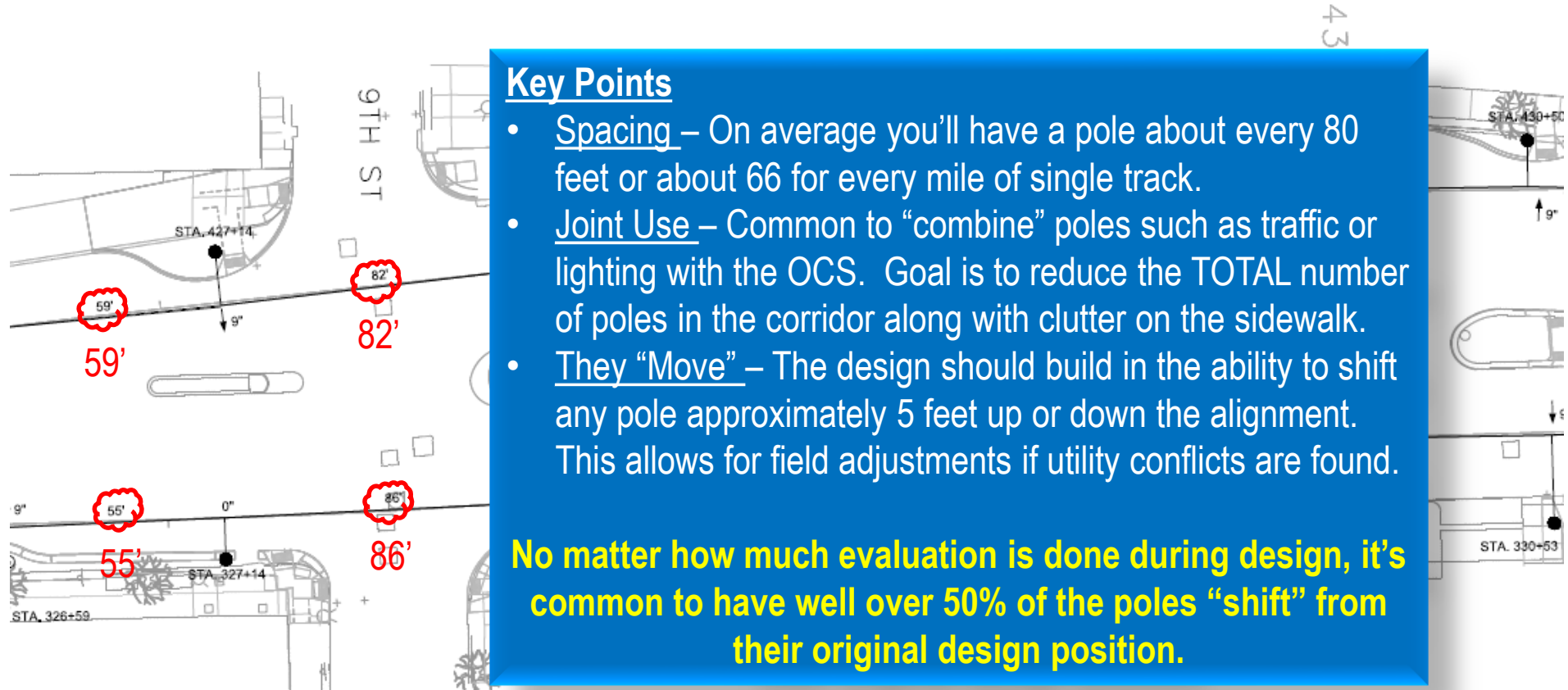


SYSTEMS – OCS Pole Spacing

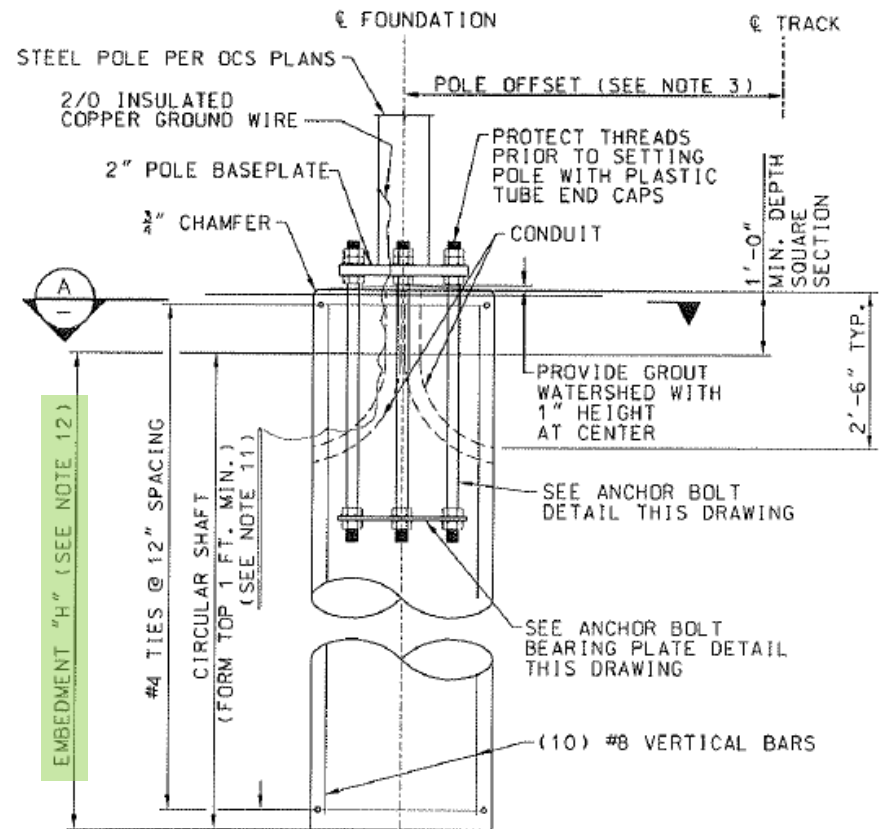
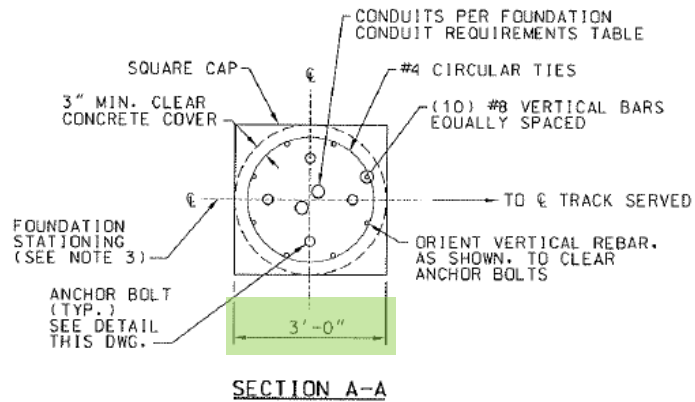
Key Points

- Spacing – On average you'll have a pole about every 80 feet or about 66 for every mile of single track.
- Joint Use – Common to “combine” poles such as traffic or lighting with the OCS. Goal is to reduce the TOTAL number of poles in the corridor along with clutter on the sidewalk.
- They “Move” – The design should build in the ability to shift any pole approximately 5 feet up or down the alignment. This allows for field adjustments if utility conflicts are found.

No matter how much evaluation is done during design, it's common to have well over 50% of the poles “shift” from their original design position.



SYSTEMS – OCS Pole Foundations

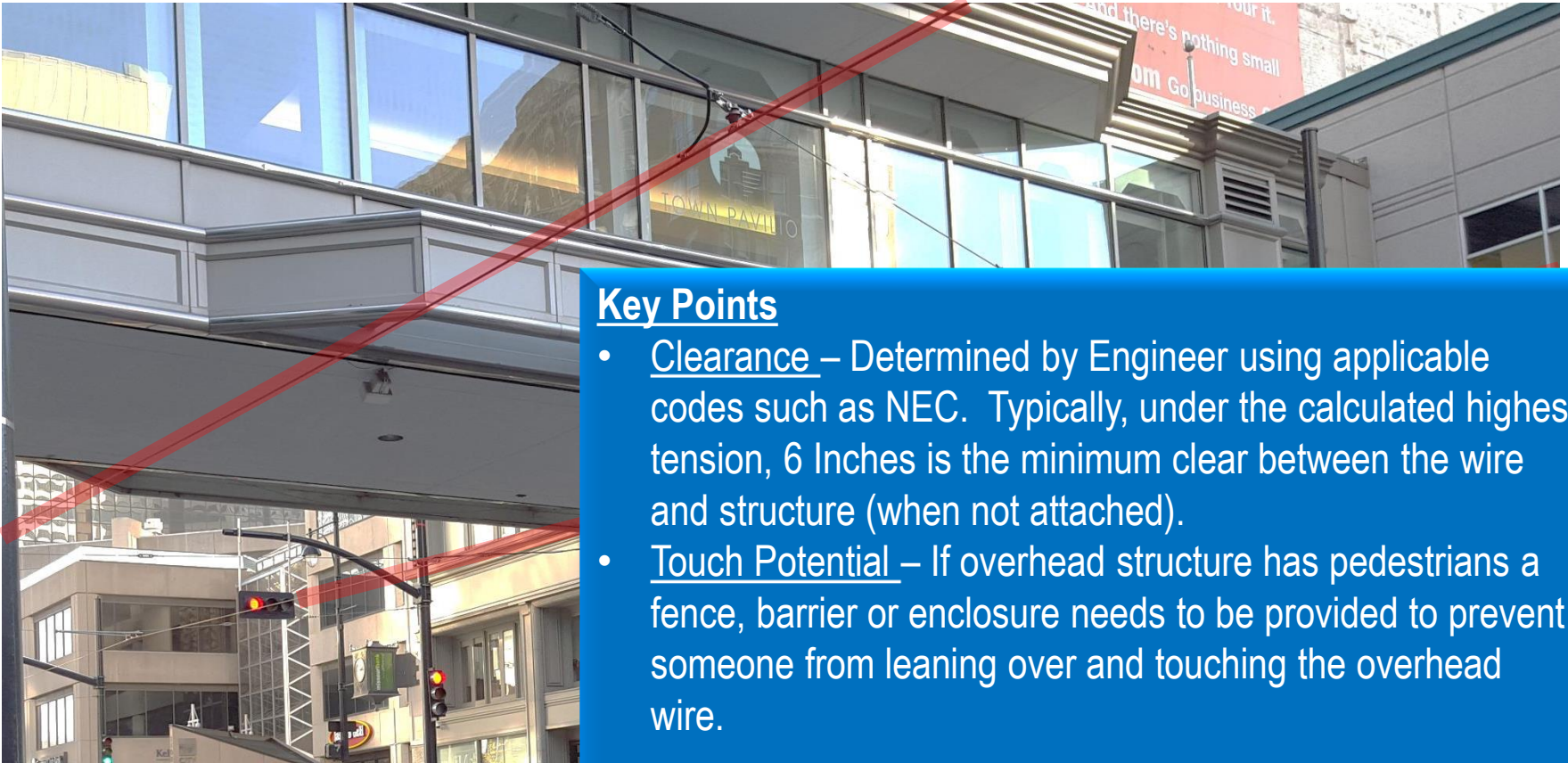


FOUNDATION REFERENCE	"A"	"B"	"C"	"D"	"E"	"F"	"G"	EMBEDMENT "H"	MAX. MOMENT FT-K
F1	1.5	60	10	9 1/2	69.5	15	10.60	11'-0"	29
F2	2	60	10	9 1/2	69.5	16	11.31	14'-0"	47
F3	2	60	11 1/2	11	71.5	17	12.0	18'-0"	112
F4	2.5	60	13	13 1/2	73	20	14.14	24'-0"	195

SYSTEMS OCS – Under Bridge/Skyway



SYSTEMS OCS – Under Bridge/Skyway

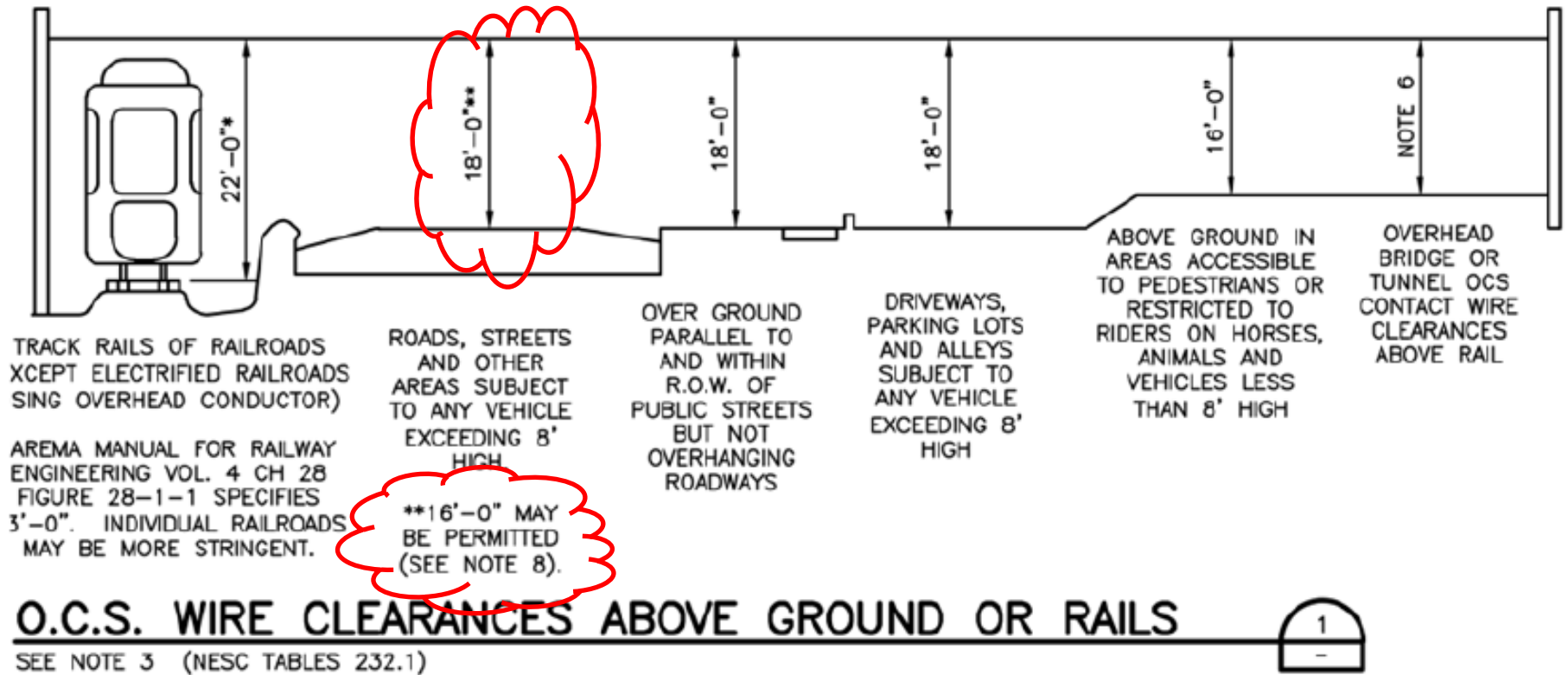


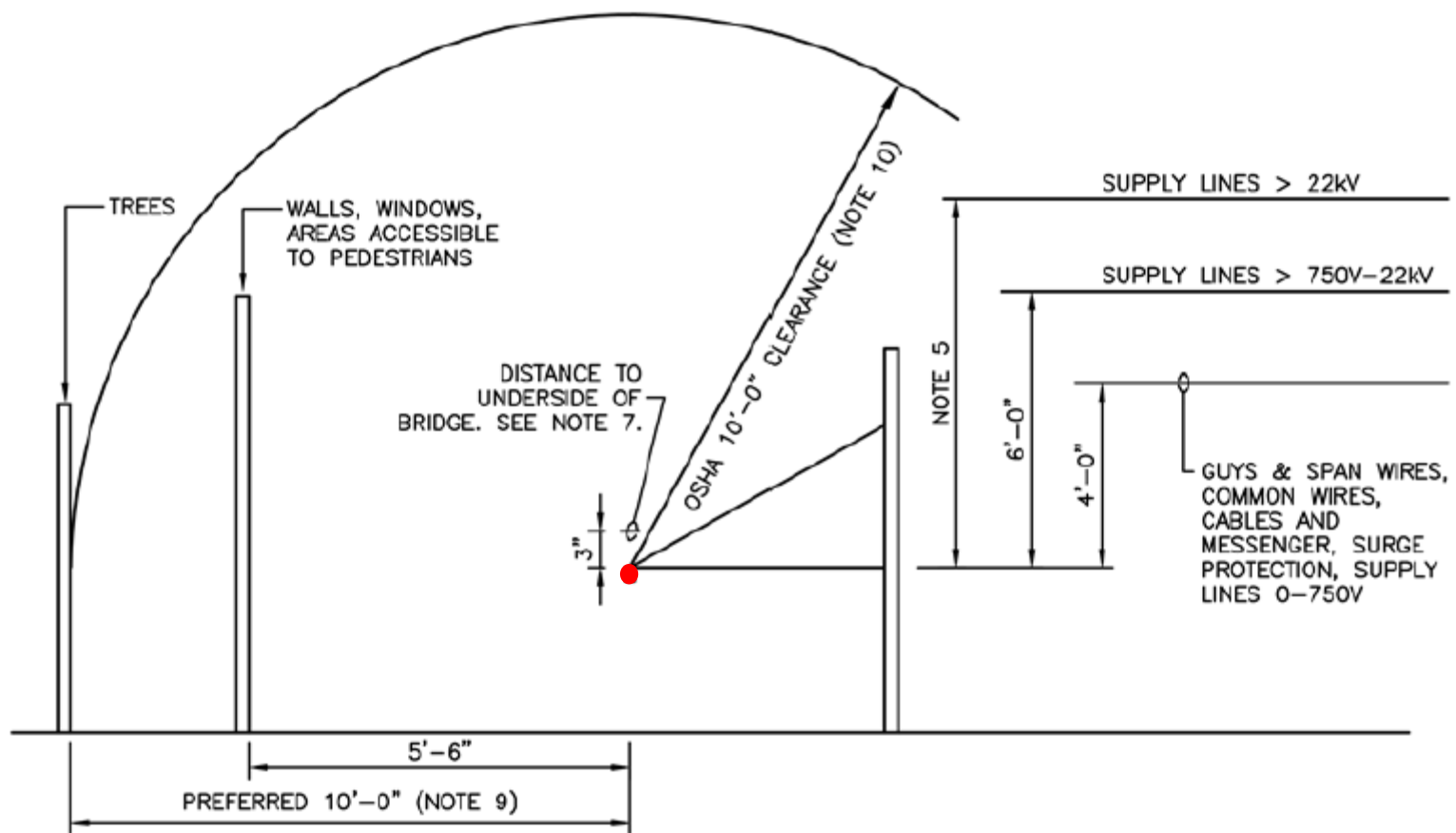
Key Points

- Clearance – Determined by Engineer using applicable codes such as NEC. Typically, under the calculated highest tension, 6 Inches is the minimum clear between the wire and structure (when not attached).
- Touch Potential – If overhead structure has pedestrians a fence, barrier or enclosure needs to be provided to prevent someone from leaning over and touching the overhead wire.

Remember to “LOOK UP” there are a lot of things competing for the same airspace as the OCS

SYSTEMS OCS – Under Bridge/Skyway





VERTICAL & HORIZONTAL CLEARANCES FROM O.C.S CONDUCTOR

SEE NOTE 4 (NESC TABLES 233.1 & 234.1)

NOTES:

1. ALL CLEARANCES SHALL COMPLY WITH THE NATIONAL ELECTRICAL SAFETY CODE.
2. ALL CLEARANCES ARE MINIMUM VALUES.

SYSTEMS - Traction Power



TPSS Integrated within Public Space



Typical TPSS



TPSS Beneath Bridge

SYSTEMS - Traction Power



TPSS Integrated within Public Space

Key Points

- Space needed – Recall previous slide showing approximately 35' x 70' for substation, access and power supplier's switch gear. Can be less but access needs to be accommodated.
- Spacing – Typically need one substation every ½ to 1 mile along the route. Determined by a TPSS Load Flow Model.
- Power Source – Need to coordinate primary power supply with local utility. It can impact the size of the substation to accommodate gear to transform voltage.

There is a lot more than just the building unit, think of access, grounding grid, outside switch gear and security (fences) that may be needed

SYSTEMS - Vehicles



Modern Articulated Vehicle



Heritage Vehicle

SYSTEMS - Vehicles





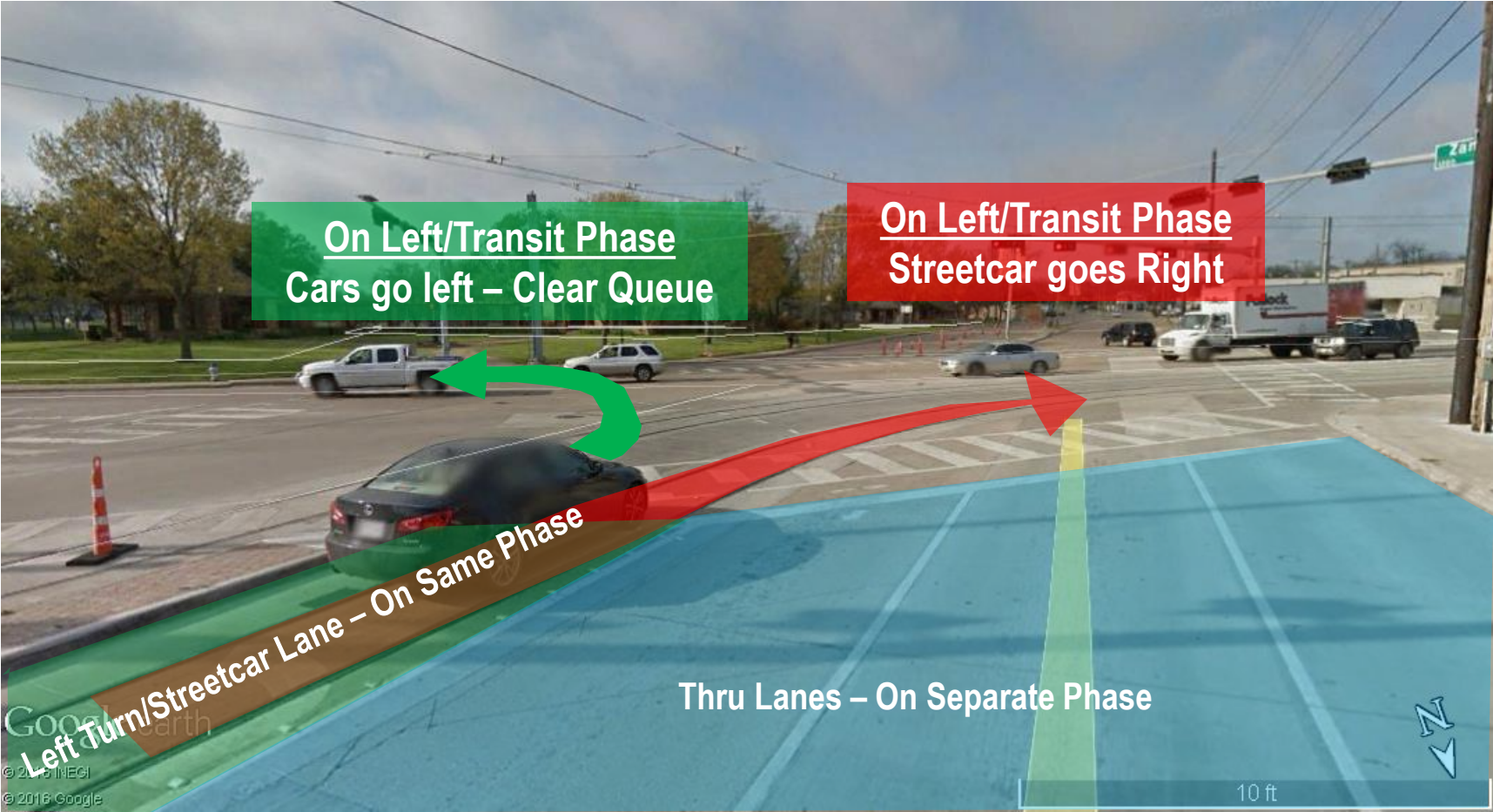
TRAFFIC

TRAFFIC – Streetcar Turning Movements

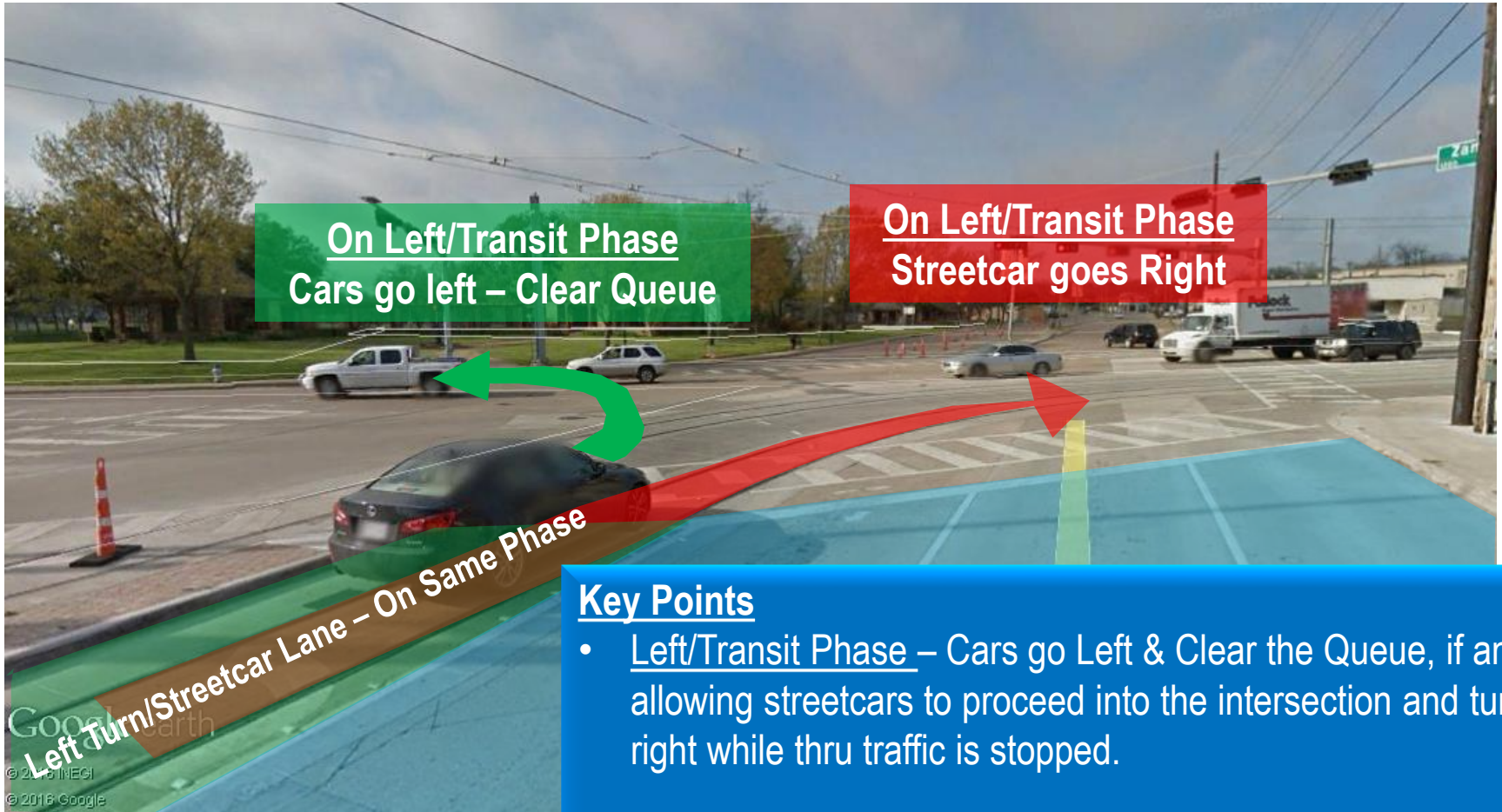
- Left Turn from Right Lane (Visa versa)
- Lane Switching
- Shared Left-Turn Lane
- Streetcar Lane Width



TRAFFIC - Streetcar Turning Right from LT Turn Lane



TRAFFIC - Streetcar Turning Right from LT Turn Lane



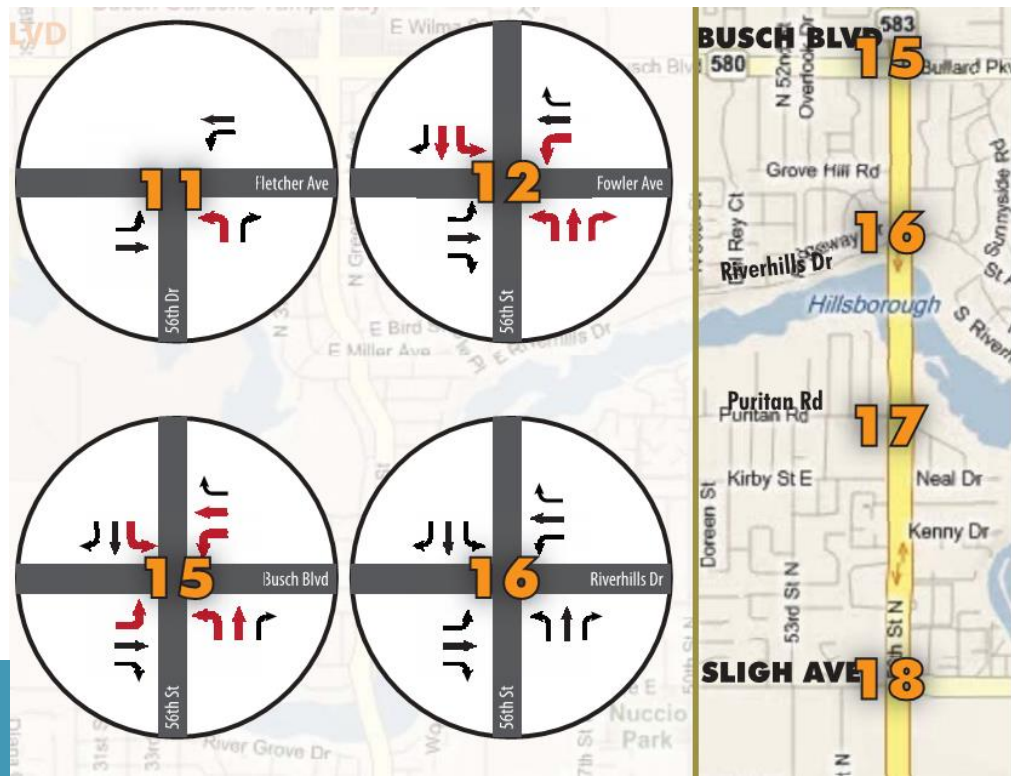
TRAFFIC – Train Signal Equipment





TRAFFIC - Analysis VISSIM vs. Synchro

- What is the current stage of planning and design?
- Do you want to understand Intersection LOS, Issues with Queuing or Weave, or Travel Time?
- Does the model need to be for the entire project or at key locations?
- VISSIM can model Transit Signal Priority, but do you want to understand benefits or location restrictions?



TRAFFIC – Transit Signal Priority (TSP)

- Active TSP
- Technology
 - Radio/GPS
 - Infrared (IR)
 - RFID Readers
- Integrated with Signals (Add-On Module)



Vehicle Systems





MAINTENANCE AND OPERATIONS FACILITY

MAINTENANCE AND OPERATIONS FACILITY

- Vehicle Storage in Yard During Non-Revenue Service
- Light Maintenance Bay
- Heavy Maintenance Bay with Pit and Overhead Walkway
- Wash Bay to Clean Vehicles
- Operations and Control Center



MAINTENANCE AND OPERATIONS FACILITY



MOF Entrance from Street



MOF Beneath Interstate



MOF Building Entrance

MAINTENANCE AND OPERATIONS FACILITY



Overhead Maintenance



Narrow Maintenance Pit



Wide Maintenance Pit

MAINTENANCE OF RAIL INFRASTRUCTURE

- Clear Delineation of Inventory and Responsible Persons in Charge Should be Set Prior to Passenger Service and Any MOU's Executed for Maintenance
 - Some Maintenance Performed by DOT;
 - Other Performed by Operation Maintenance Contractor (OMC).

Item	Maintained by	Notes
Streets	DOT	Same as typical roadway
Track Drains	DOT	Additional to keep gauge section from fouling
Flangeway	Both	In addition to standard maintenance
Switch Machine & Turnouts	OMC	Weekly
OCS Poles	OMC	In addition to standard maintenance
OCS Poles w/Streetlights or Signals	Both	Requires special training
Wayfinding Signs	Both	In addition to standard maintenance
Platforms	Both	In addition to standard maintenance

Thanks!

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Florida Department of Transportation, D4

Office of Modal Development – Rail Administration



FDOT - District IV

Streetcar/Urban Rail – Design & Construction

January 26, 2016

