Structural Assessment Key to Returning Historic Union Depot to an Active Transportation Hub

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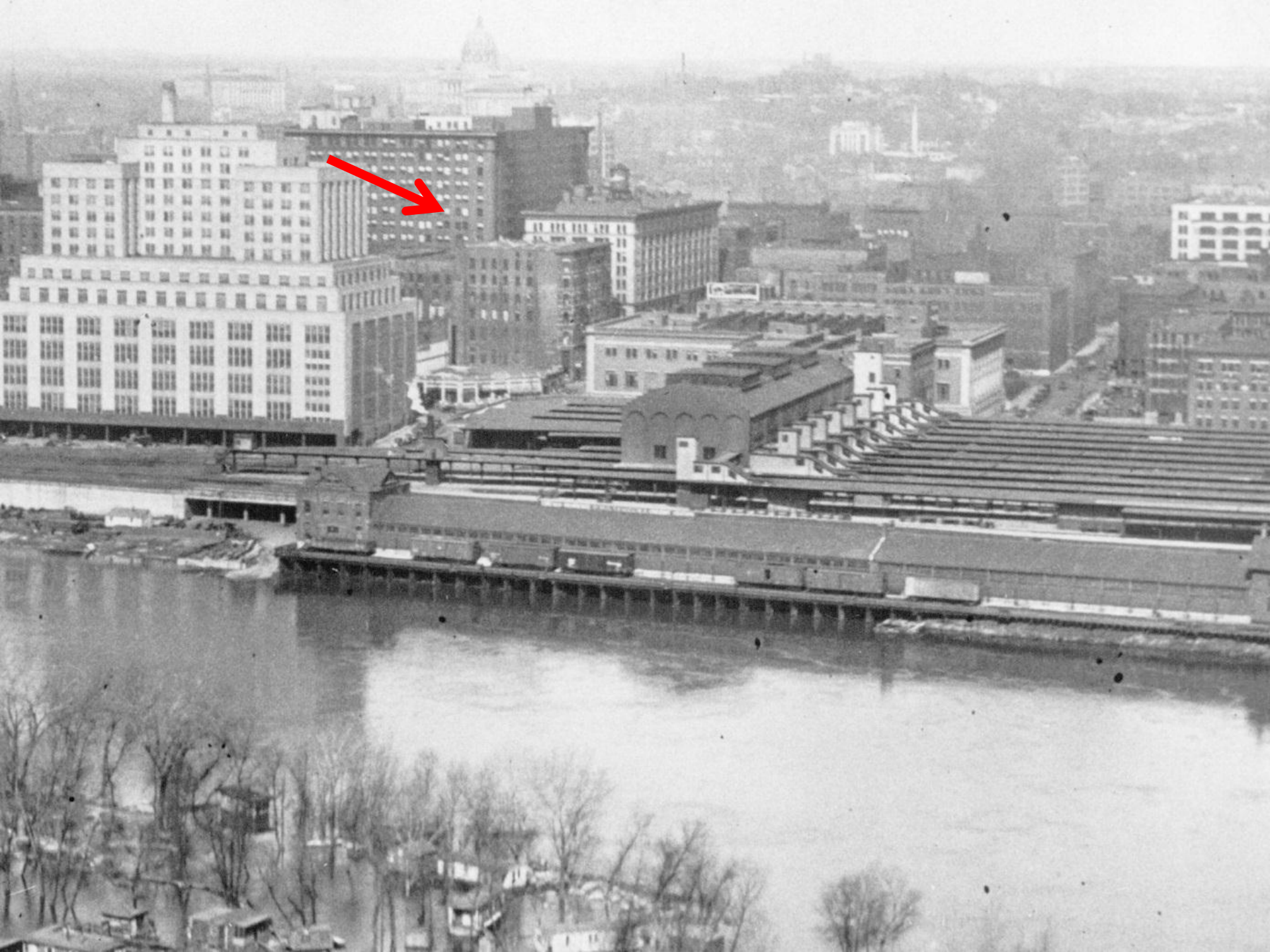
ICRI INTERNATIONAL CONCRETE REPAIR INSTITUTE

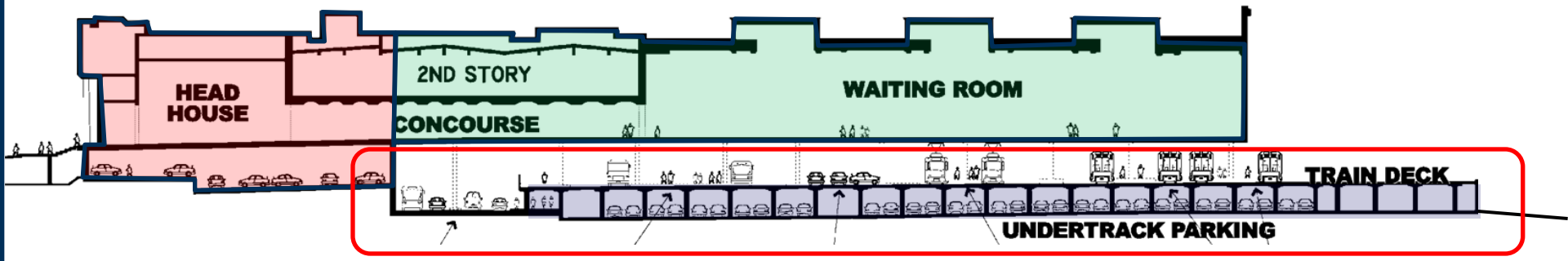
Presentation Outline

- History
- Rehabilitation Project Description
- Concrete Structure Assessment
- Concrete Repair Summary

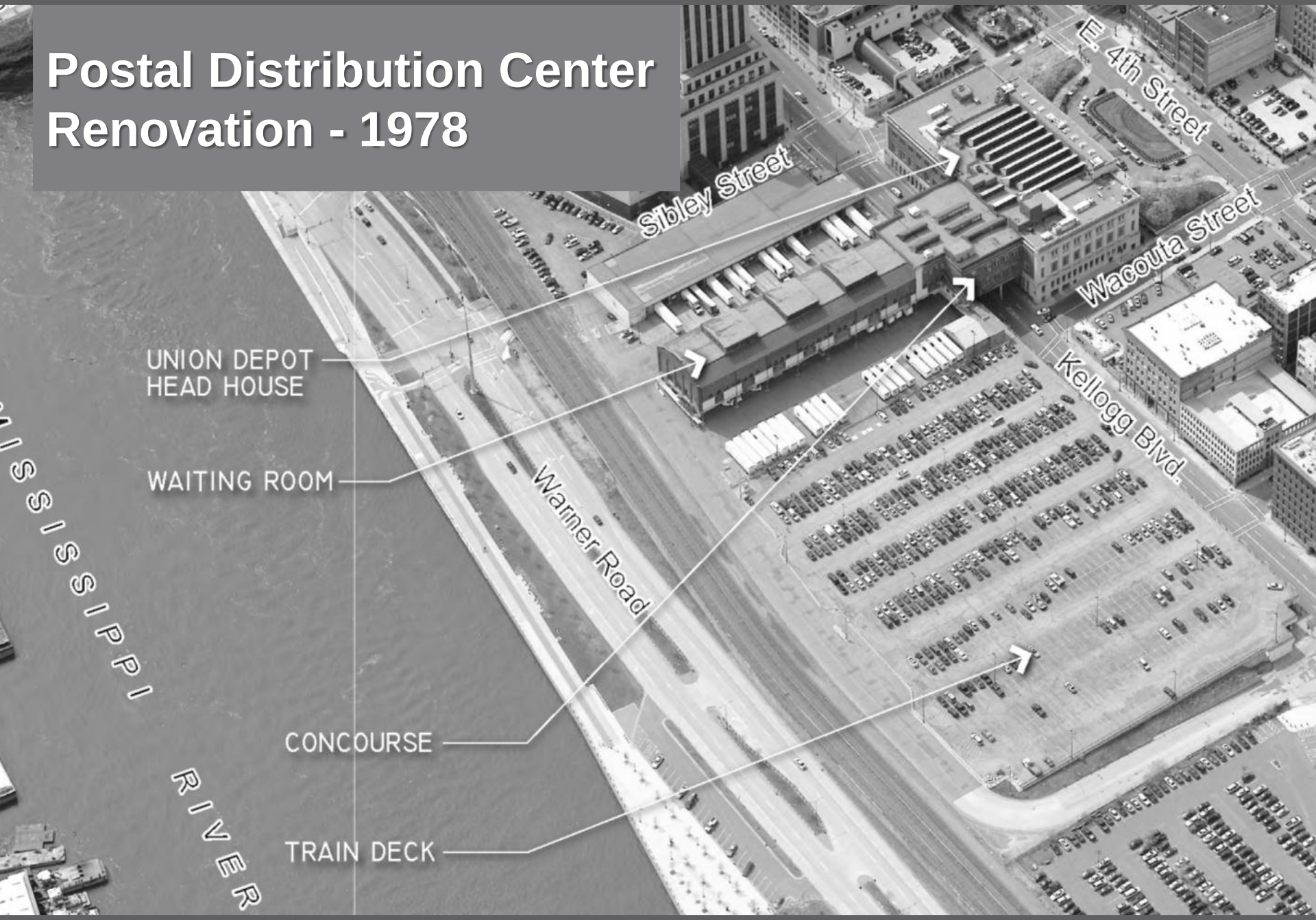
History

- Constructed: 1917-1926
- Train Service Ended: 1971
- National Register of Historic Places: 1974
- Converted to Postal Distribution Center: 1978
- Concrete Deck Repairs & Waterproofing: 1991
- Multimodal Transportation Hub: 2012

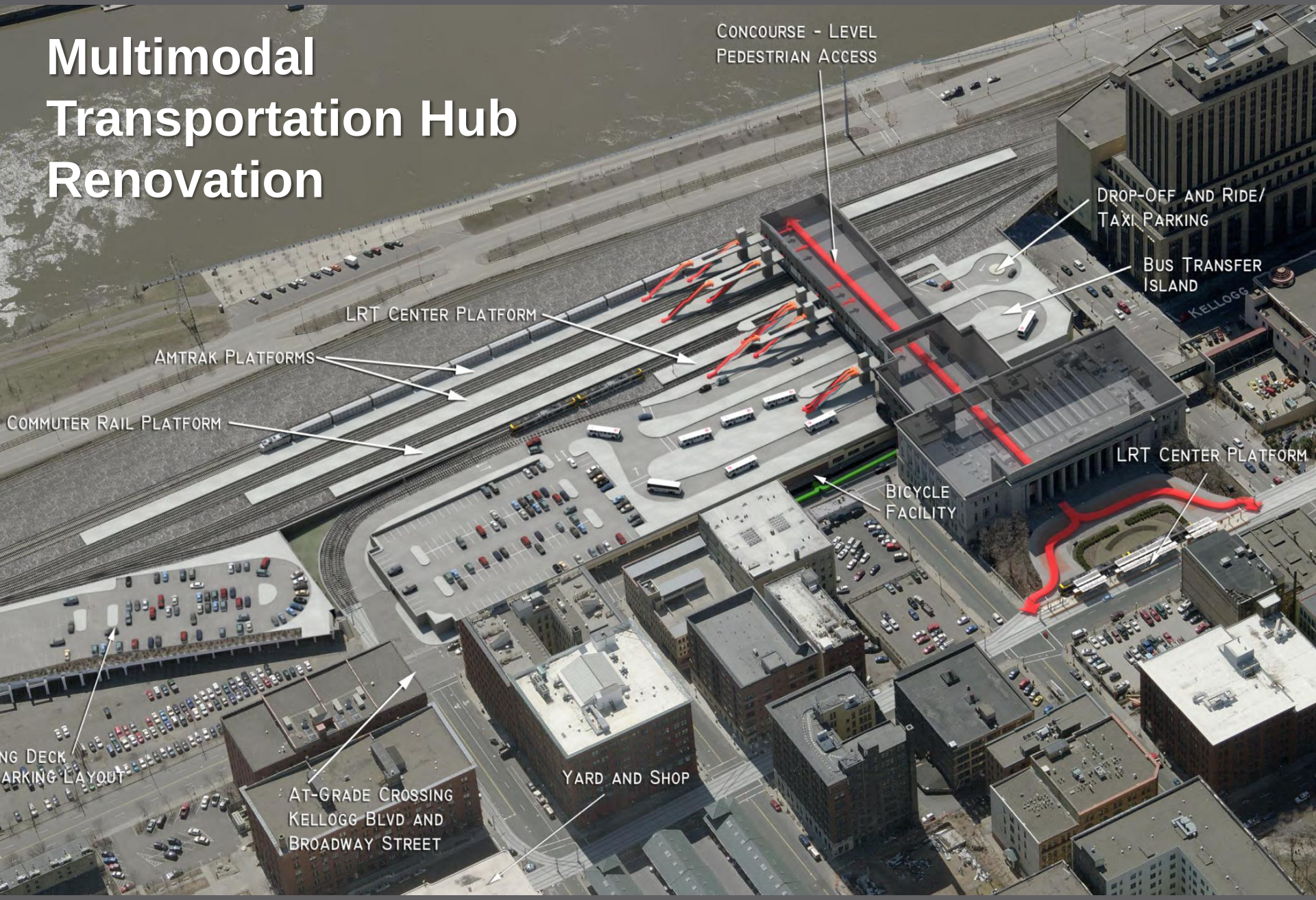



HEAD
HOUSE
2ND STORY
CONCOURSE
WAITING ROOM
TRAIN DECK
UNDERTRACK PARKING

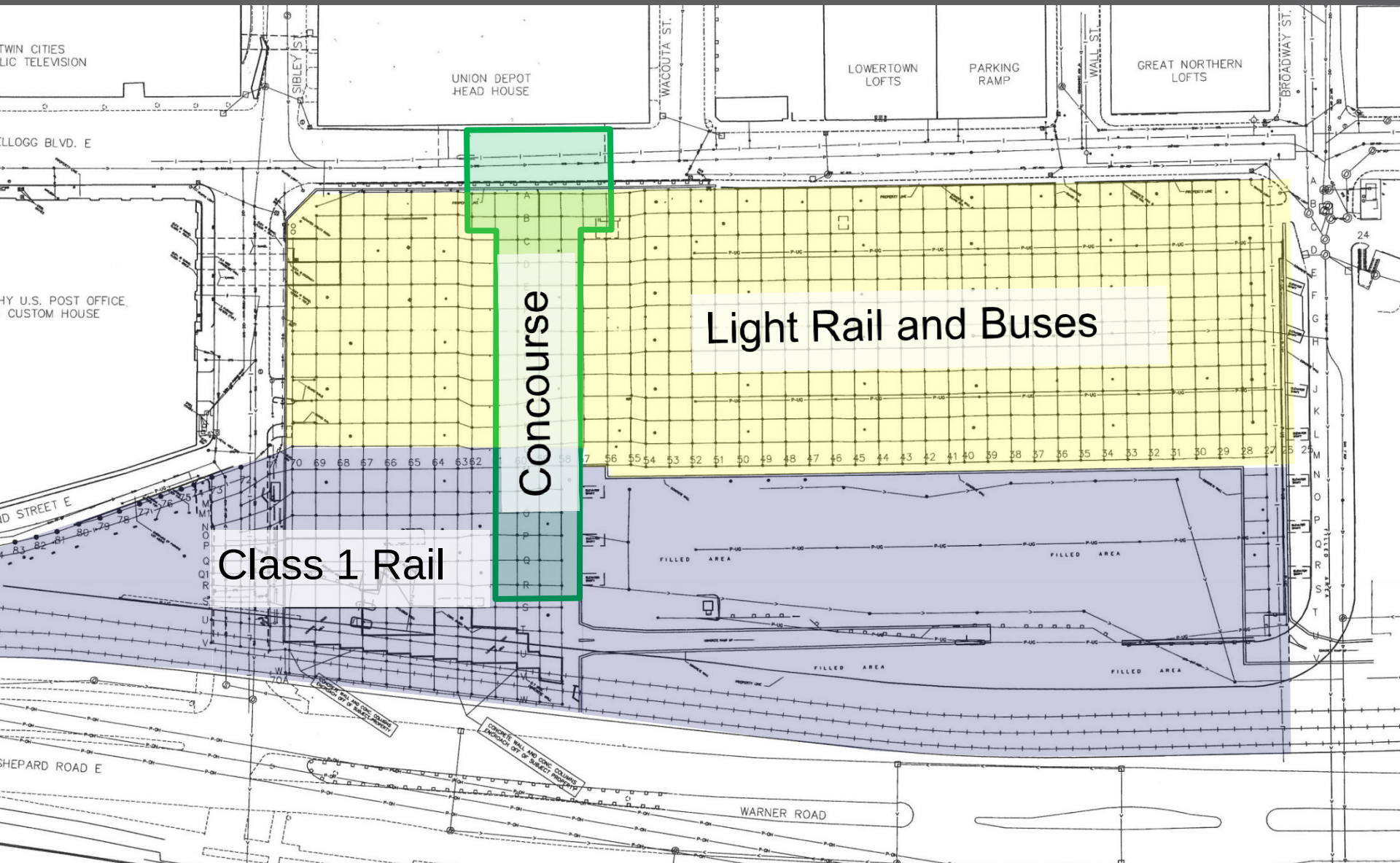
Postal Distribution Center Renovation - 1978



Multimodal Transportation Hub Renovation



Transportation Hub Renovation Loadings



Structural Assessment

Two Fronts

Concrete Superstructure

↓

250,000 SF Deck

↓

600 Columns

Timber Pile Foundations

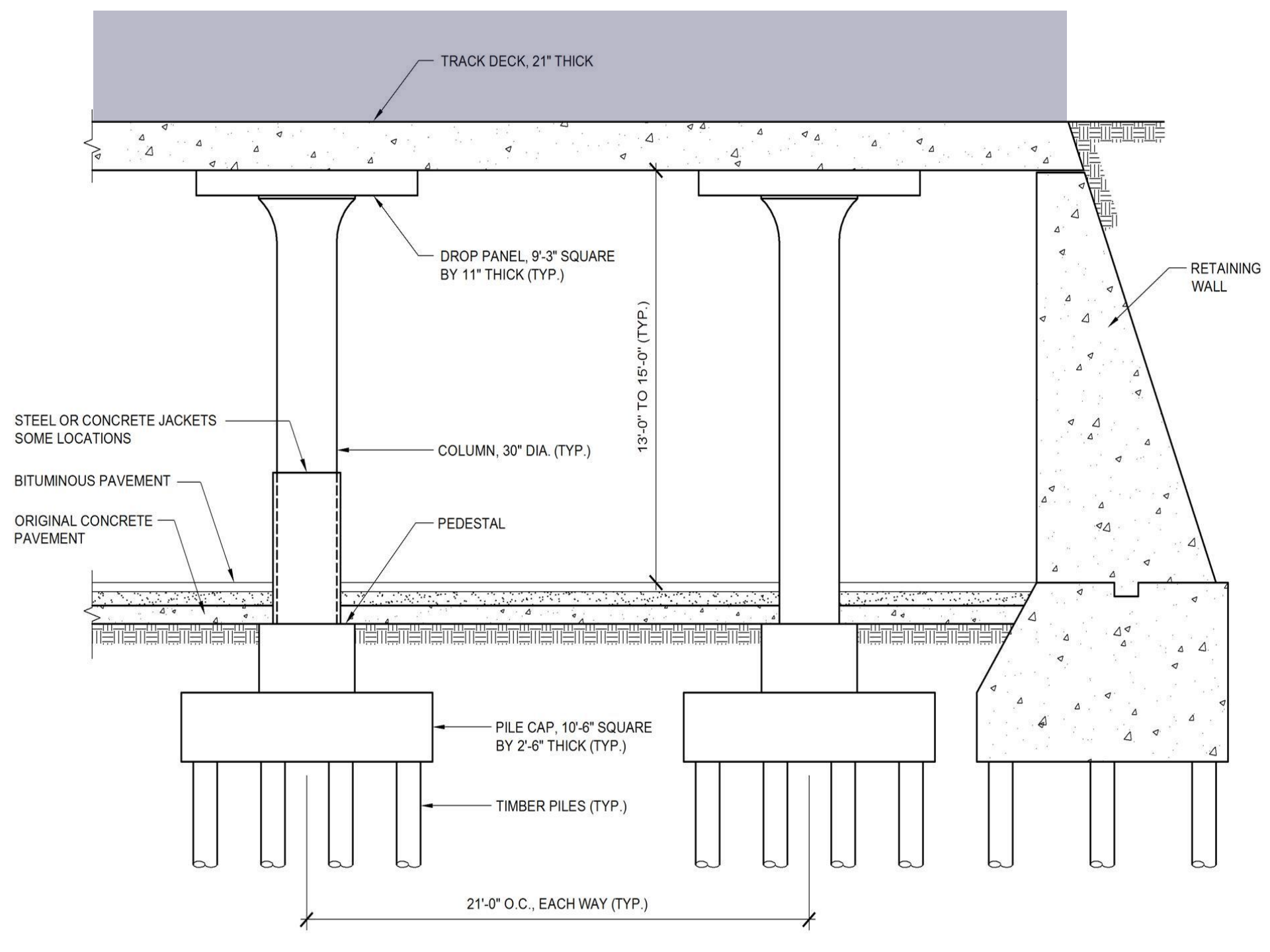
↓

600 Concrete Pile Caps

↓

9,000 Timber Piles


Concrete Superstructure


TRACK DECK, 21" THICK
DROP PANEL, 9'-3" SQUARE
BY 11" THICK (TYP.)
13'-0" TO 15'-0" (TYP.)
RETAINING
WALL
STEEL OR CONCRETE JACKETS
SOME LOCATIONS
COLUMN, 30" DIA. (TYP.)
BITUMINOUS PAVEMENT
ORIGINAL CONCRETE
PAVEMENT
PEDESTAL
PILE CAP, 10'-6" SQUARE
BY 2'-6" THICK (TYP.)
TIMBER PILES (TYP.)
21'-0" O.C., EACH WAY (TYP.)

Concrete Assessment Objectives

- Determine overall condition of structure
- Assess structural adequacy for intended use
- Develop repair strategies
- Estimate repair quantities
- Evaluate anticipated future performance over 50-year service life

Accomplish above with limited investigation and in context that overall project is design-build with project GMP and structural repair budget already established.

Concrete Assessment Scope

- Field Investigation
  - Visual examination
  - Study areas/Field testing
  - Additional delamination survey
- Laboratory testing and materials evaluation
- Structural analysis and load rating
- Repair strategy development and repair quantity estimates

Field Investigation

1. 100% Visual Examination of Deck Underside

- Documented concrete condition in every bay
  - Types of deterioration, degrees of each, visual quantities of each
  - 100% visual mapping of deterioration
- Visual condition rating for all bays (0 to 4, with 4 being worst)

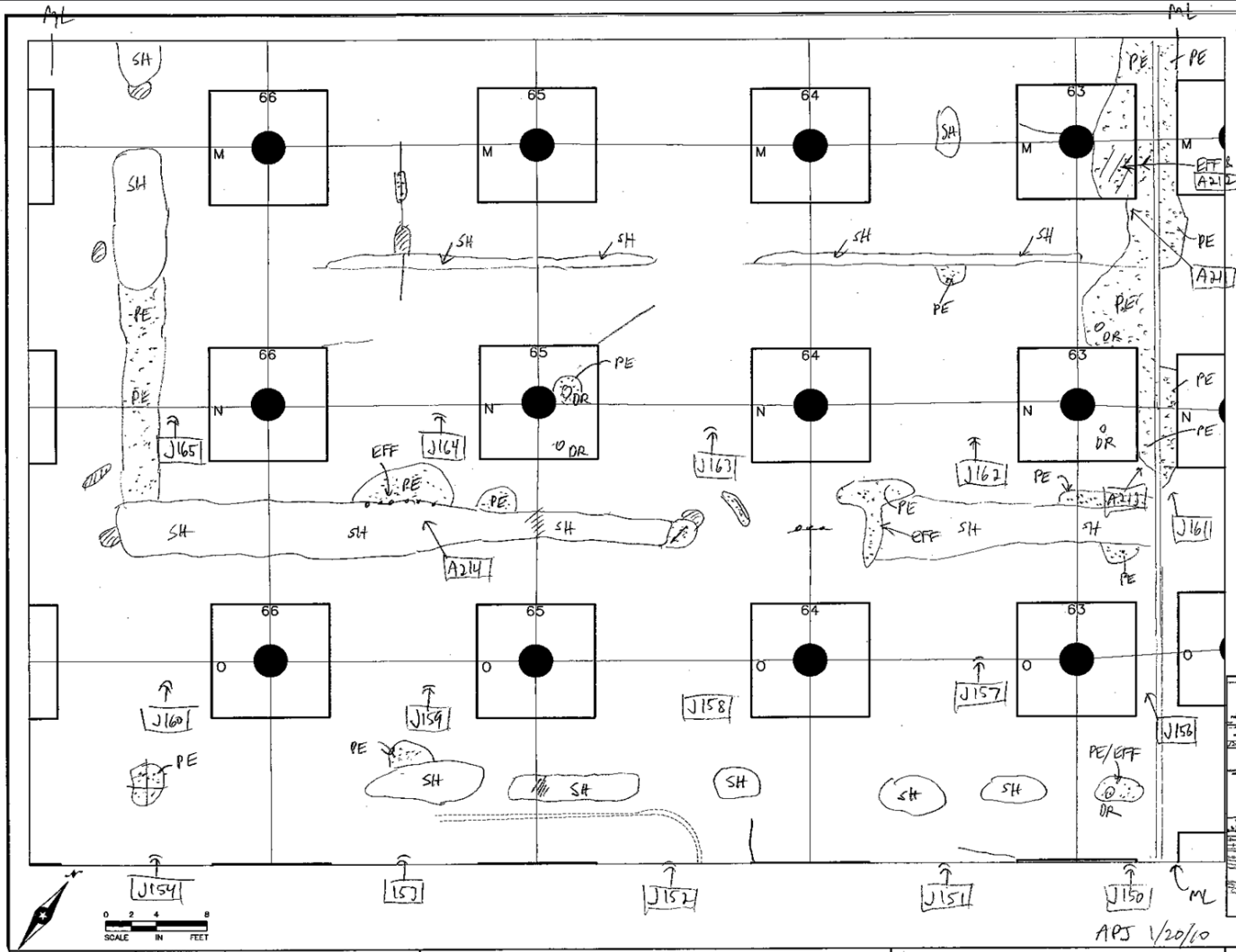
Train Deck Underside

Along Construction Joints

Along Expansion Joints

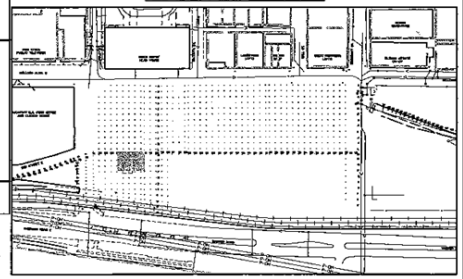
Along Expansion Joints

At Exposed Edges



COLUMN ID:	CONDITION NOTES:
M66	SJ
M65	SJ
M64	SJ
M63	SJ
N66	SJ
N65	SJ, PE - 1SF @ DRAIN
N64	SJ
N63	SJ
O66	SJ
O65	SJ, D - 2SF
O64	SJ
O63	SJ

OVERALL KEY PLAN:



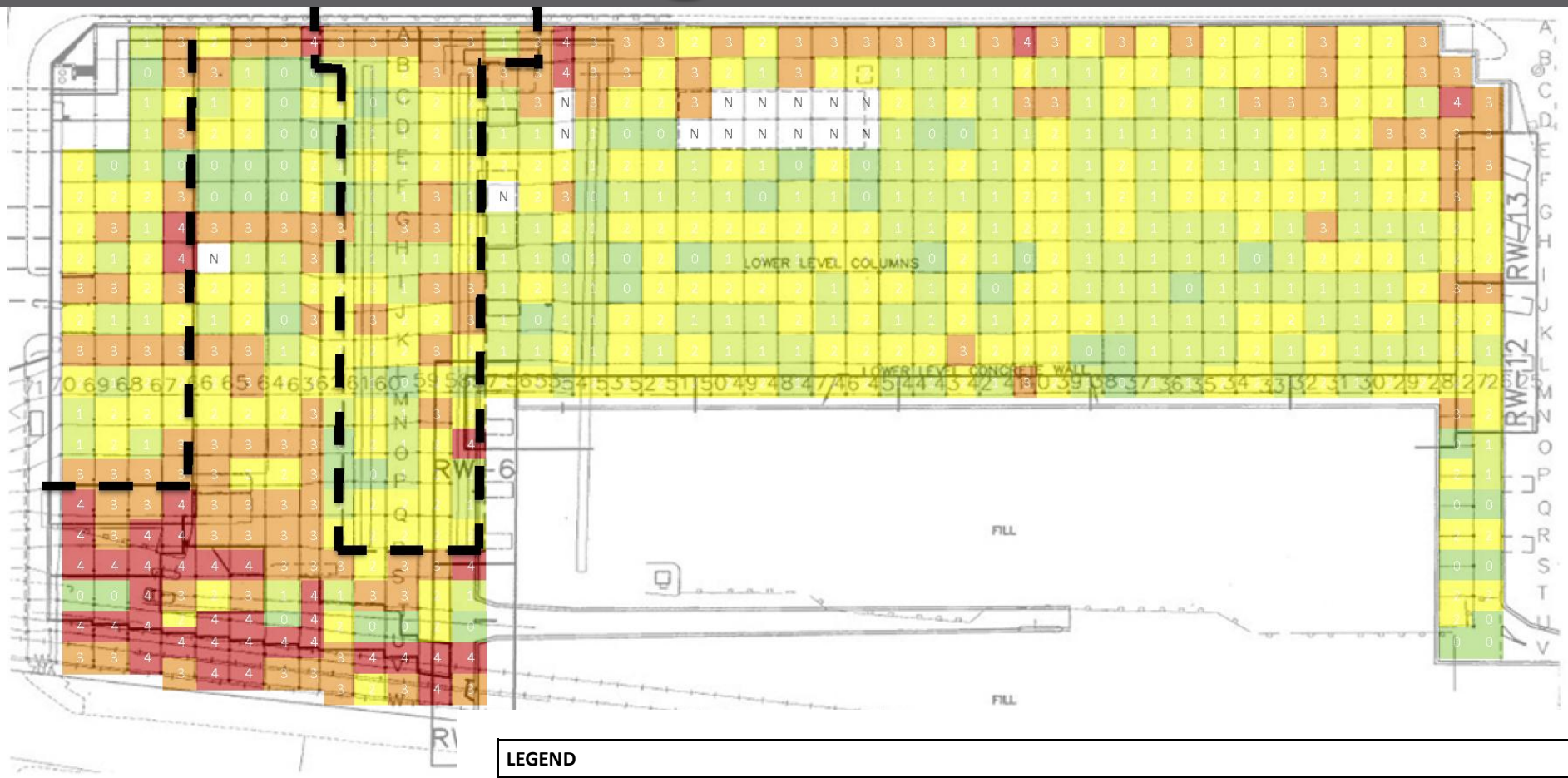
APJ 1/20/10

DESIGN FILE: 31810714	REV. NO.	BY	DATE	REVISIONS DESCRIPTION
DRAWN BY: JMB / DESIGN BY: MM				
CHKED. BY: / DWG. NAME: MMUD-EX01				
DATE: 12/29/09				

MINNESOTA'S UNION DEPOT
LOWER LEVEL COLUMNS
N.W. PLAN
CONDITION SURVEY

SHEET NO.
GL-47

Visual Rating-Deck Underside



LEGEND

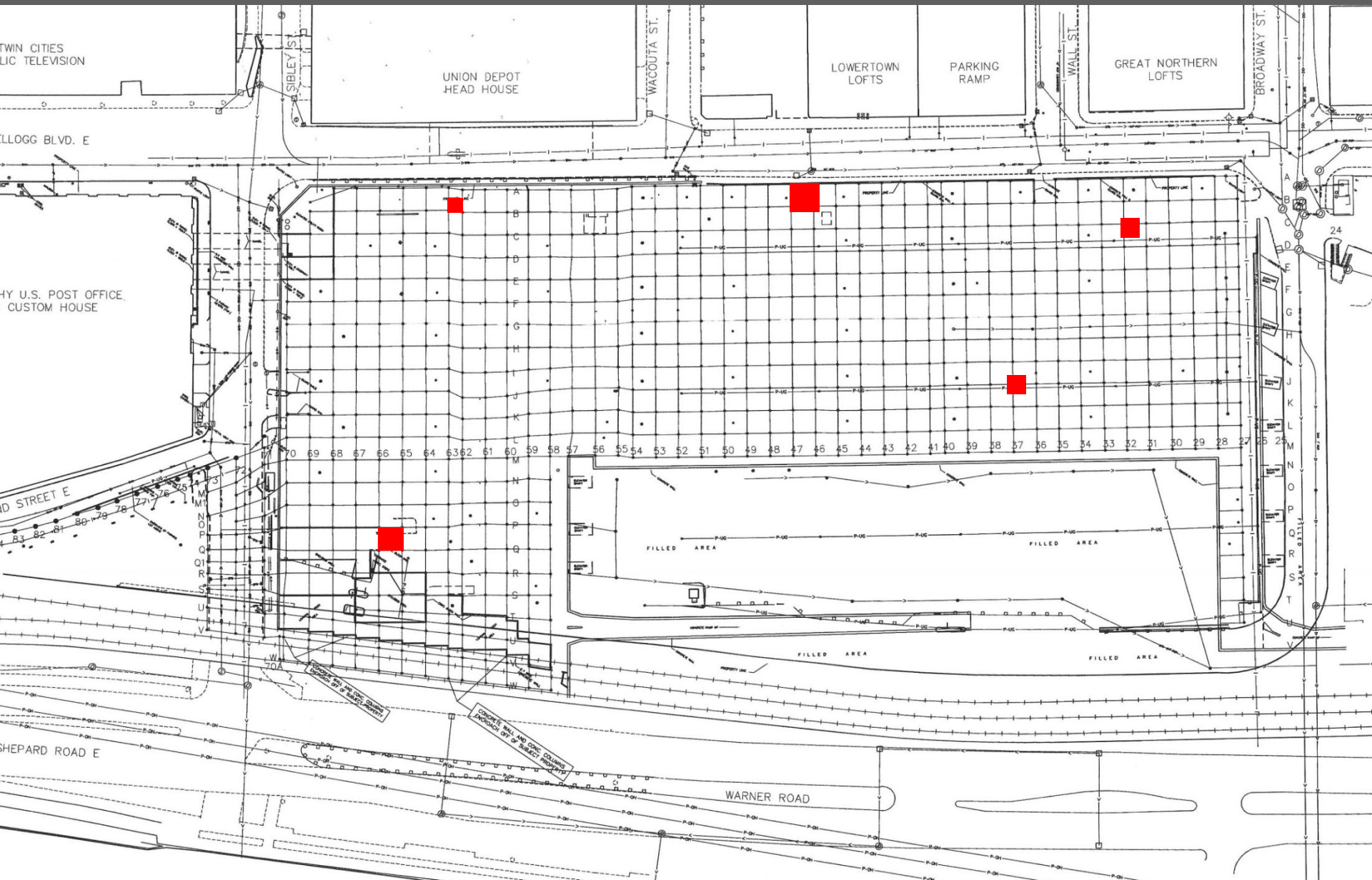
- 0 - 0 - No deterioration - Essentially no deterioration or previous repairs present on deck underside
- 1 - 1 - Minor deterioration - Localized deterioration and previous repairs (less than 15 square ft) present on deck underside
- 2 - 2 - Moderate deterioration - Moderate deterioration and previous repairs greater than 15 square ft and/or minor efflorescence and/or a drain present on deck underside
- 3 - 3 - Severe deterioration - Widespread deterioration and previous repairs exceeding 100 square ft and/or moderate efflorescence present on deck underside
- 4 - 4 - Very severe deterioration - Widespread deterioration with extensive previous repairs and extensive spalling with severe efflorescence on deck underside
- N - Did not inspect

Field Investigation

2A. Study Areas for Detailed Examination of Concrete:

- Selected based on underside visual survey
- Include range of conditions present
- Spatial distribution across site
- Typical and key atypical features
  - Previous shotcrete repairs
  - Construction joints
  - Expansion joints

Deck Study Areas




TAKEUCHI

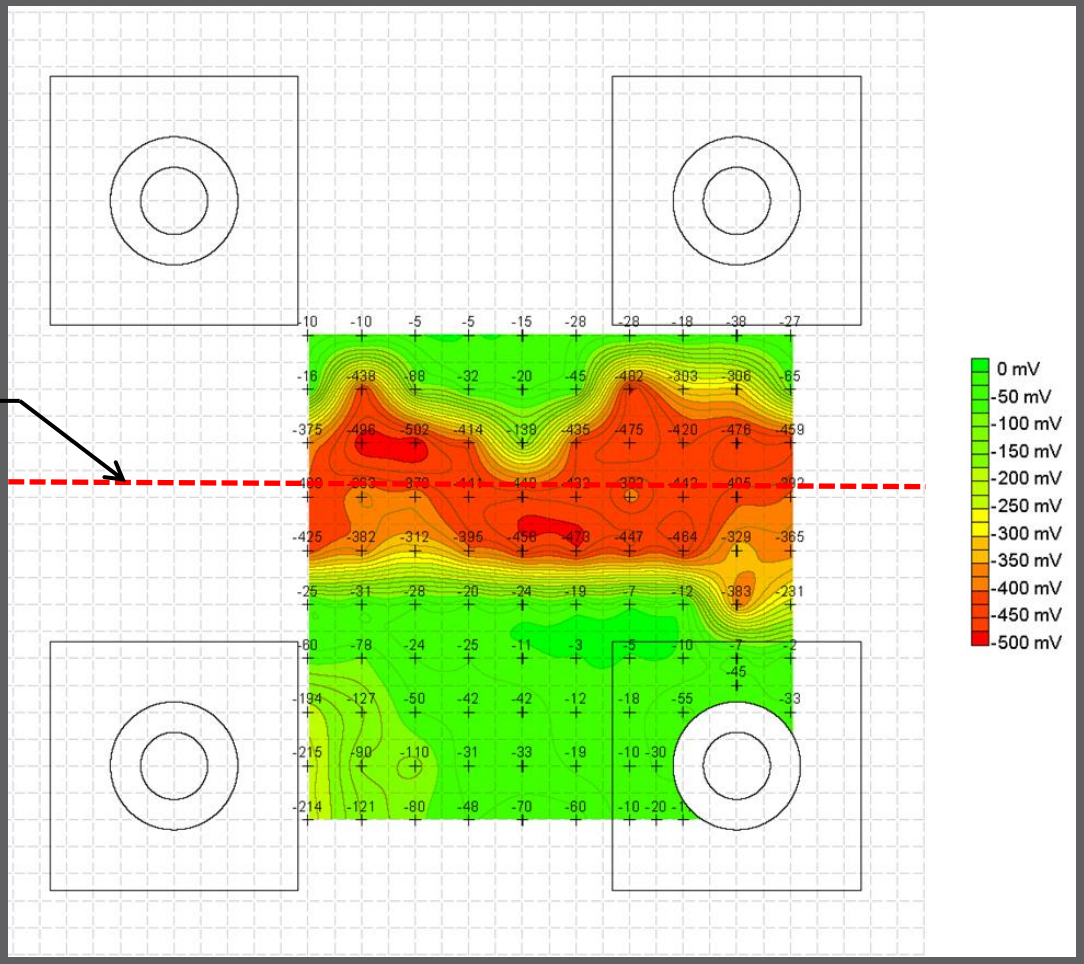
Field Investigation

2B. Field Testing At Each Deck Study Area:

- Delamination survey, close-up condition survey
- Reinforcing steel survey
- Half-cell potential survey, corrosion rate testing
- Depth of carbonation testing
- Excavation openings to examine reinforcement
- Concrete core and rebar sample removal

Half-cell Potential Testing

Construction Joint



Field Investigation

3. Additional Sounding of Representative Areas

- Include range of visual ratings
- Previous shotcrete repairs
- Expansion joints
- Construction joints
- Cracks

Proved beneficial in estimating extent of deterioration and repair quantities

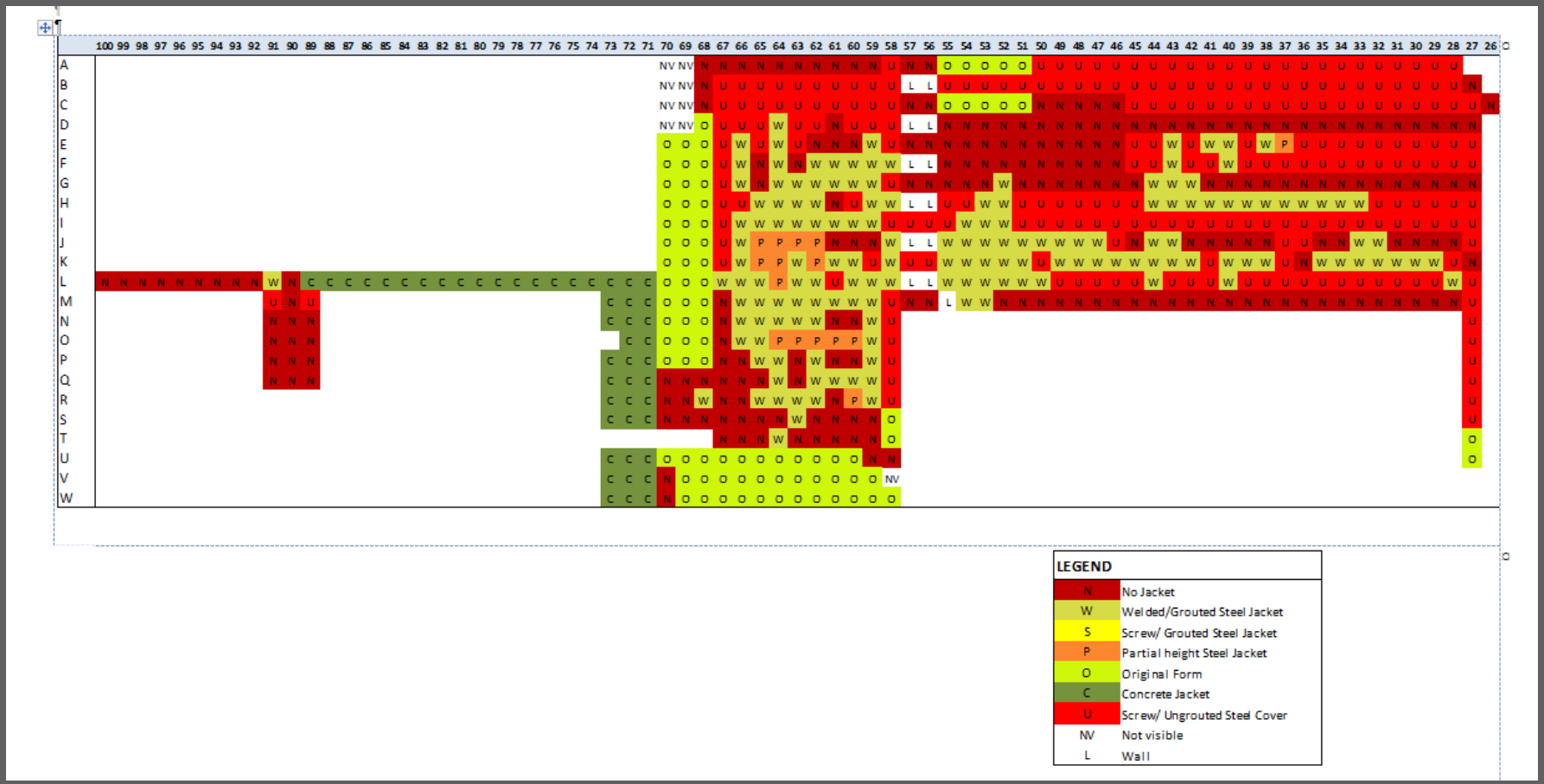
Field Investigation

4. Columns

- Visual survey
- Limited hammer sounding
- Document different jackets and covers
- Investigation openings to expose rebar
- Investigation pits down to pile caps
- Field testing
- Sample extraction

Challenge: Different jacket types around column bases

Column Jacket Types



Column Bases

Column Bases

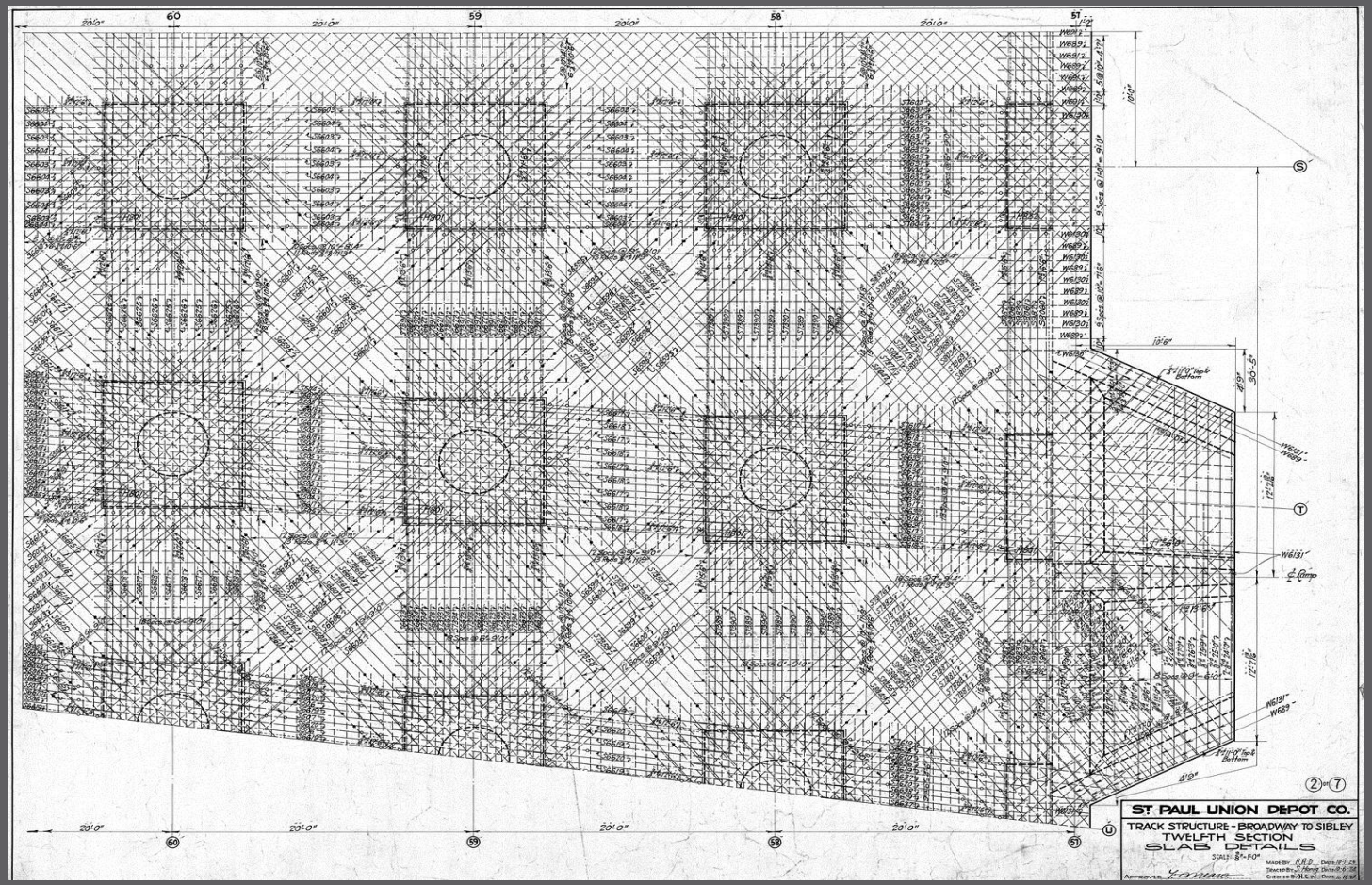
Laboratory Analysis

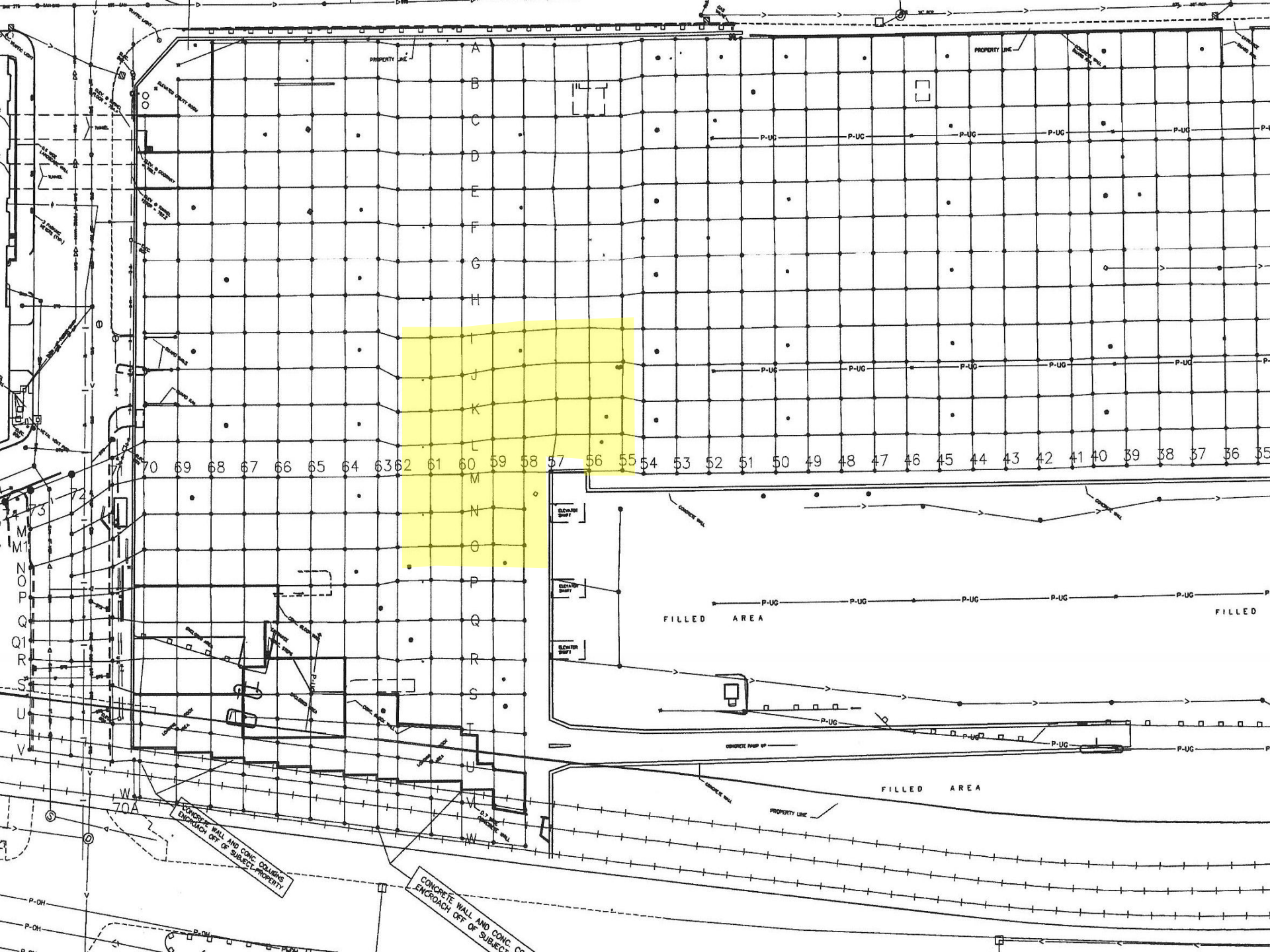
Deck and Columns

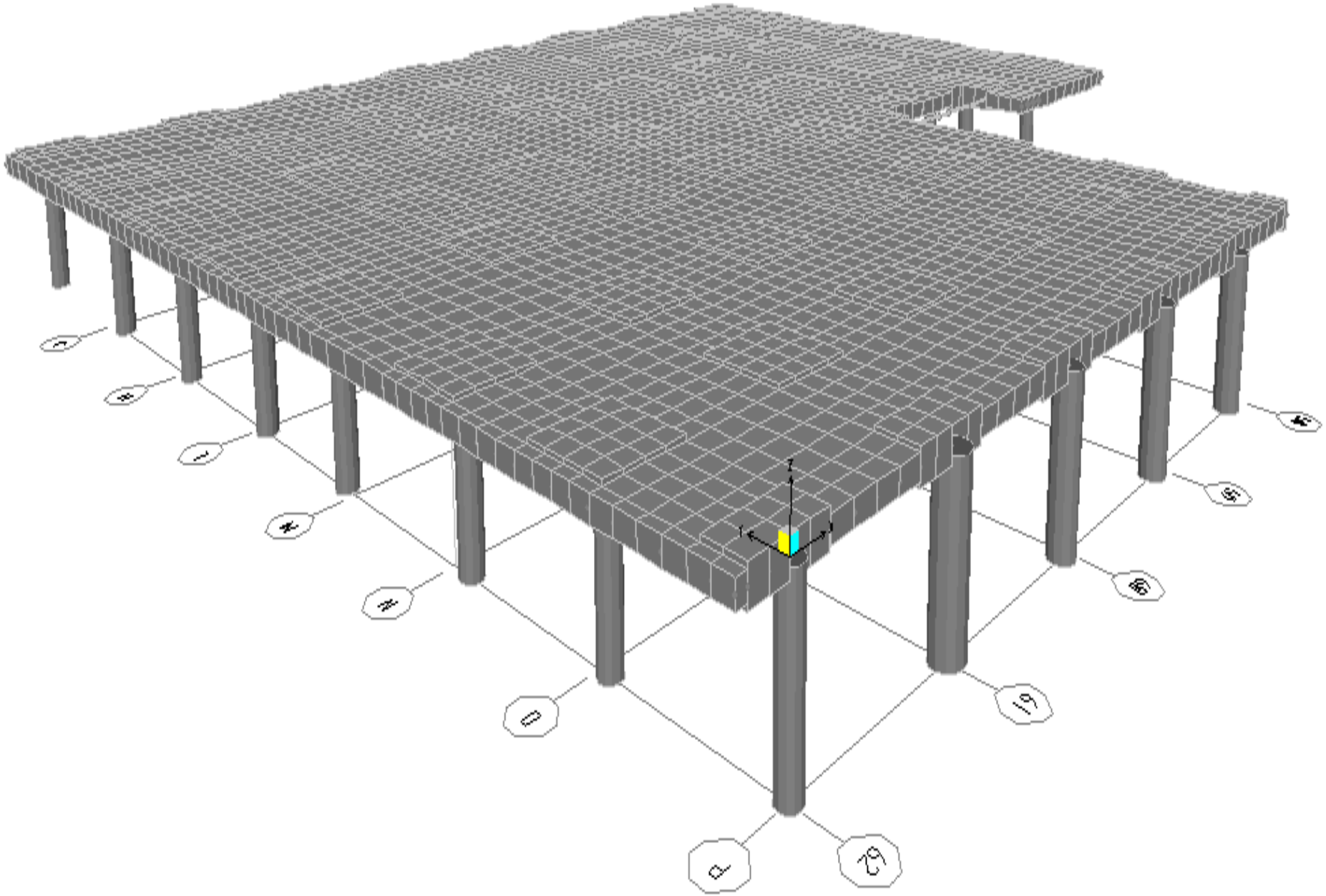
- Compressive strength tests
- Carbonation depth
- Chloride content testing
- Petrographic examination
- Reinforcing steel strength testing

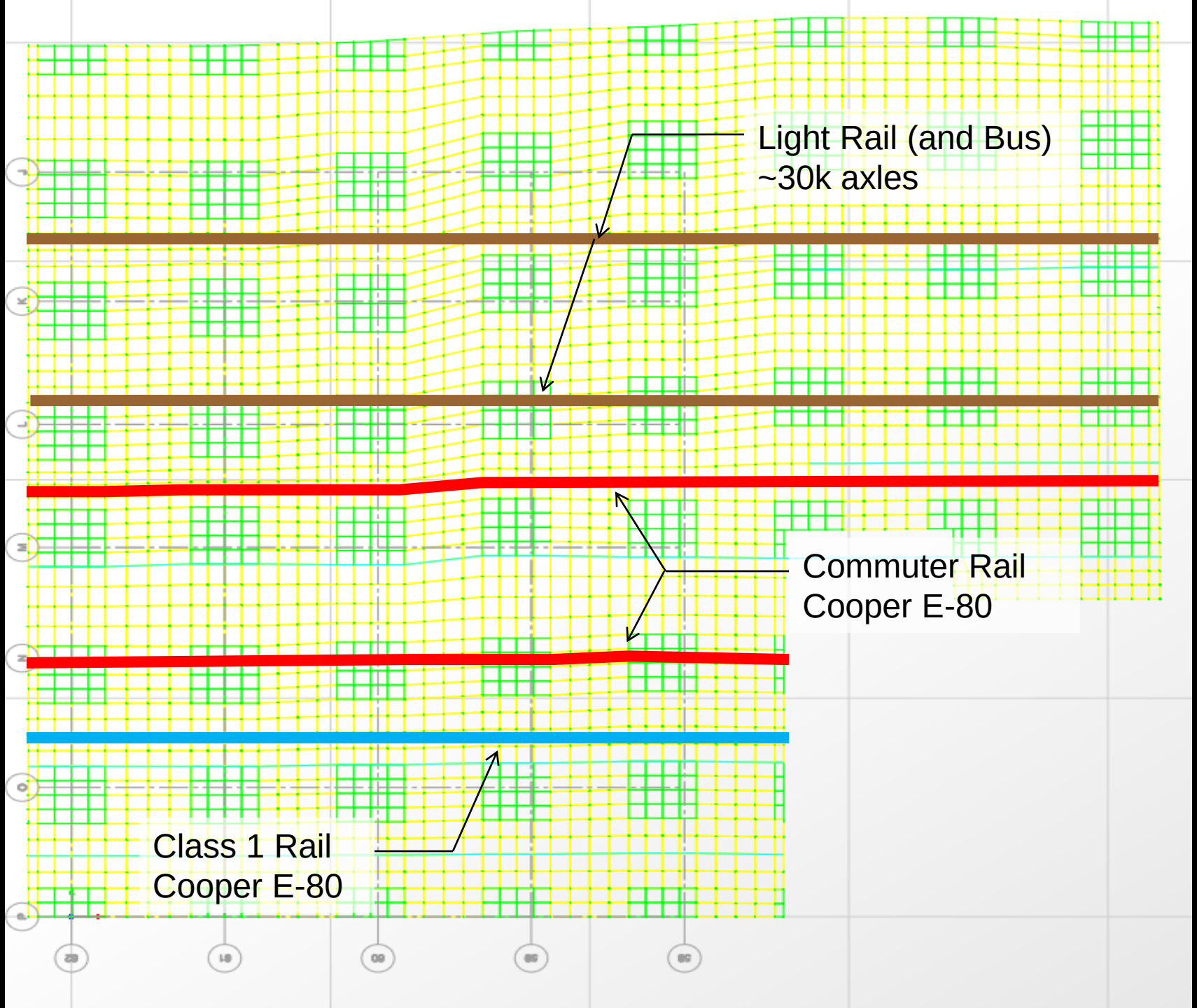
Data used for strength evaluation, durability assessment, and repair strategy development

Structural Review & Load Rating




PROPERTY LINE
P-UG
FILLED AREA
CONCRETE WALL AND CONC. COLUMNS ENCROACH OFF OF SUBJECT PROPERTY
CONCRETE WALL AND CONC. ENCROACH OFF OF SUBJECT
P-OH

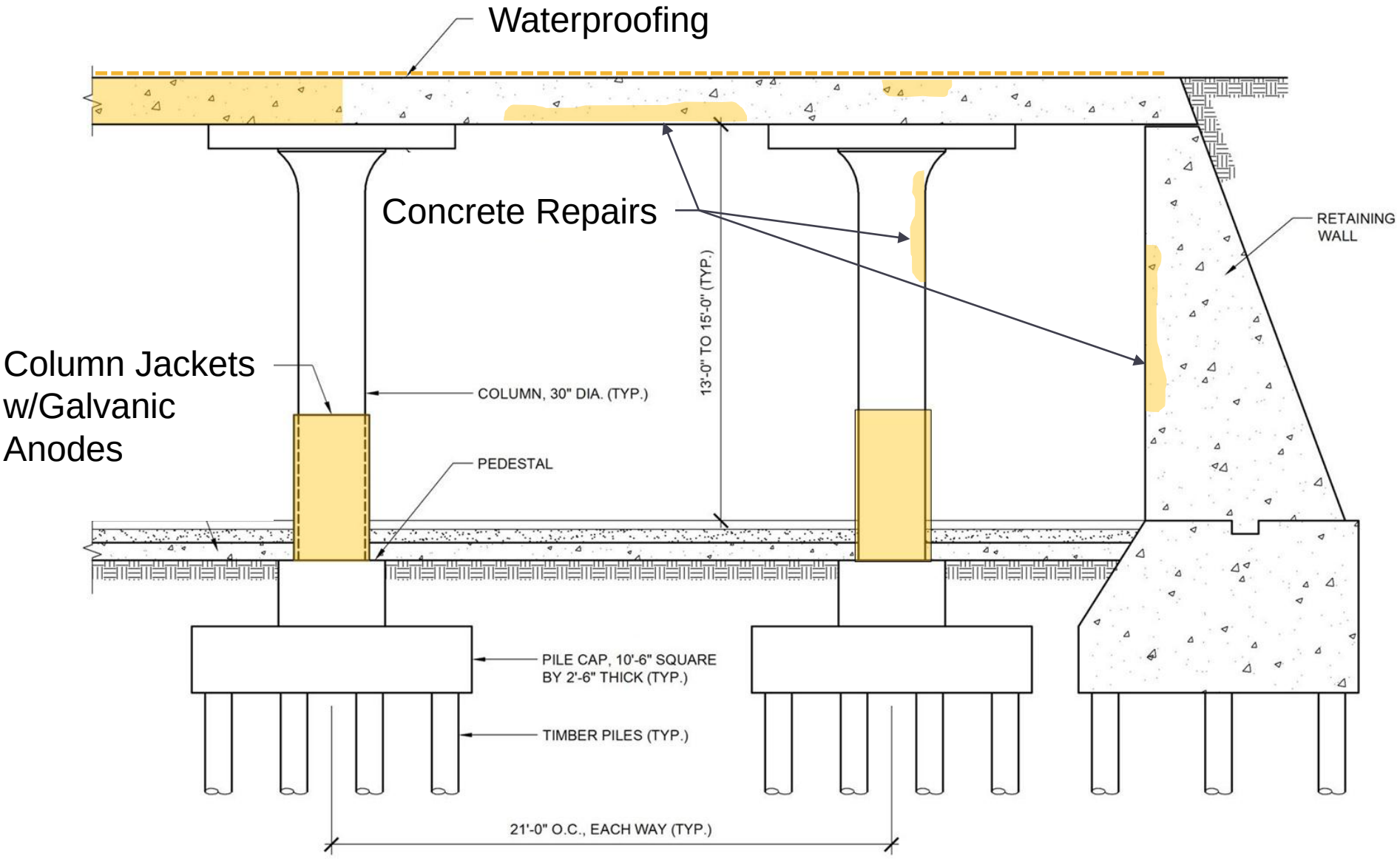

Z
Y
X


Light Rail (and Bus)
~30k axles
Commuter Rail
Cooper E-80
Class 1 Rail
Cooper E-80

Structural Review & Load Rating

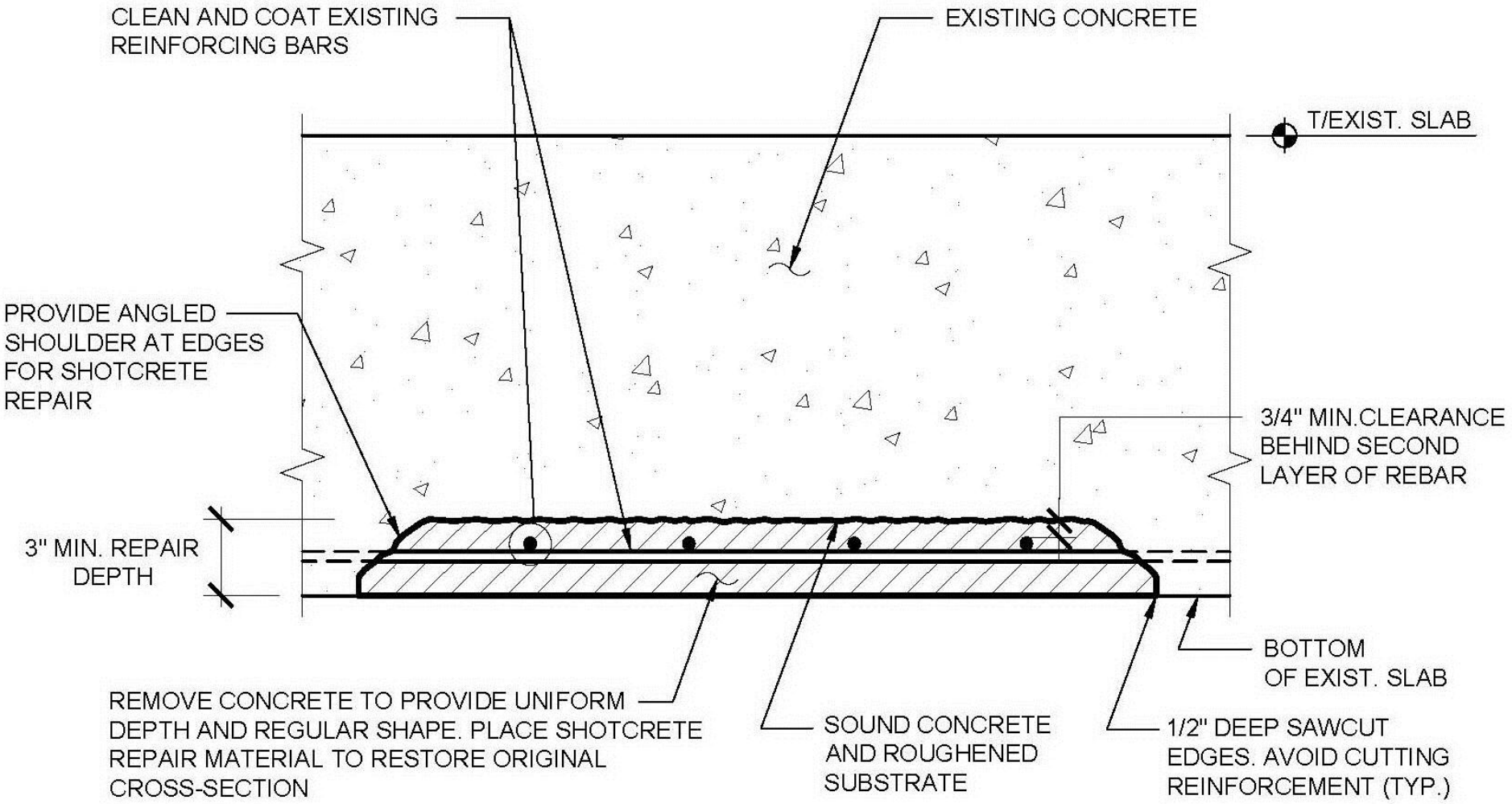
- Deck:
  - Not Cooper E-80, more like E-60
  - Adequate for Amtrak and Commuter Rail
- Columns:
  - Adequate strength
  - Reserve capacity
- No strengthening required

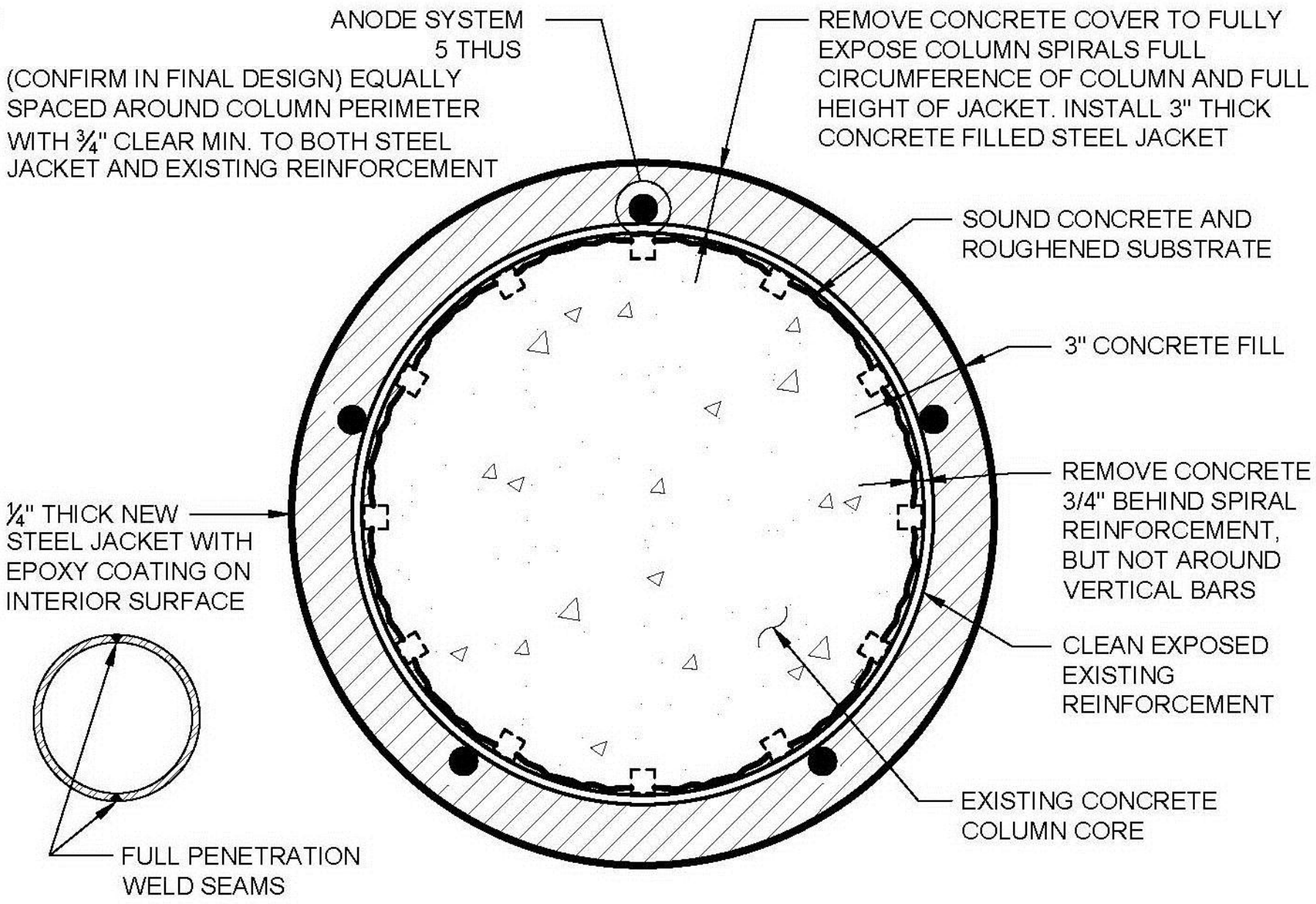
Concrete Repairs



Concrete Repairs

- *Desired Service Life: 50 years*
- Deck Topside:
  - Localized repairs and waterproofing
- Deck Underside:
  - Corrosion mitigation methods required for 50 years
  - Service life estimated at 15-20 years without mitigation
  - Maintenance repairs at 15-20 year frequency
- Columns:
  - Jackets w/galvanic corrosion protection


CLEAN AND COAT EXISTING REINFORCING BARS
EXISTING CONCRETE
T/EXIST. SLAB
PROVIDE ANGLED SHOULDER AT EDGES FOR SHOTCRETE REPAIR
3/4" MIN.CLEARANCE BEHIND SECOND LAYER OF REBAR
3" MIN. REPAIR DEPTH
BOTTOM OF EXIST. SLAB
REMOVE CONCRETE TO PROVIDE UNIFORM DEPTH AND REGULAR SHAPE. PLACE SHOTCRETE REPAIR MATERIAL TO RESTORE ORIGINAL CROSS-SECTION
SOUND CONCRETE AND ROUGHENED SUBSTRATE
1/2" DEEP SAWCUT EDGES. AVOID CUTTING REINFORCEMENT (TYP.)


ANODE SYSTEM
5 THUS
(CONFIRM IN FINAL DESIGN) EQUALLY SPACED AROUND COLUMN PERIMETER WITH ¾" CLEAR MIN. TO BOTH STEEL JACKET AND EXISTING REINFORCEMENT
REMOVE CONCRETE COVER TO FULLY EXPOSE COLUMN SPIRALS FULL CIRCUMFERENCE OF COLUMN AND FULL HEIGHT OF JACKET. INSTALL 3" THICK CONCRETE FILLED STEEL JACKET
SOUND CONCRETE AND ROUGHENED SUBSTRATE
3" CONCRETE FILL
REMOVE CONCRETE 3/4" BEHIND SPIRAL REINFORCEMENT, BUT NOT AROUND VERTICAL BARS
¼" THICK NEW STEEL JACKET WITH EPOXY COATING ON INTERIOR SURFACE
CLEAN EXPOSED EXISTING REINFORCEMENT
EXISTING CONCRETE COLUMN CORE
FULL PENETRATION WELD SEAMS

Repair Quantity Development

Deck Underside Concrete Repair Quantities

Estimated with algorithms that were based on:

- Visual rating
- Previous shotcrete repair area
- Visible spalls and delamination area
- Anticipated repair area growth
- *-->Actual quantities 95% of estimate*

Deck Topside: Conventional extrapolation

Deck Full Depth: Areas visually identified

Column Bases: 100% new jackets

Summary

Structural assessment methodology provided:

- Extent of deterioration and cause
- Reliable concrete repair quantity estimates
- Confidence repairs could be delivered within budget

Repair strategies engineered to:

- Restore structural integrity
- Enhance durability
- Preserve the structure

Historic Union Depot modernized to an active transportation hub for the next 50 years


Questions?