STRUCTURAL PRESERVATION SYSTEMS

DETERIORATED SLUICEWAY AT A DELAYED COKING UNIT AND AN INNOVATIVE T/A REPAIR SOLUTION

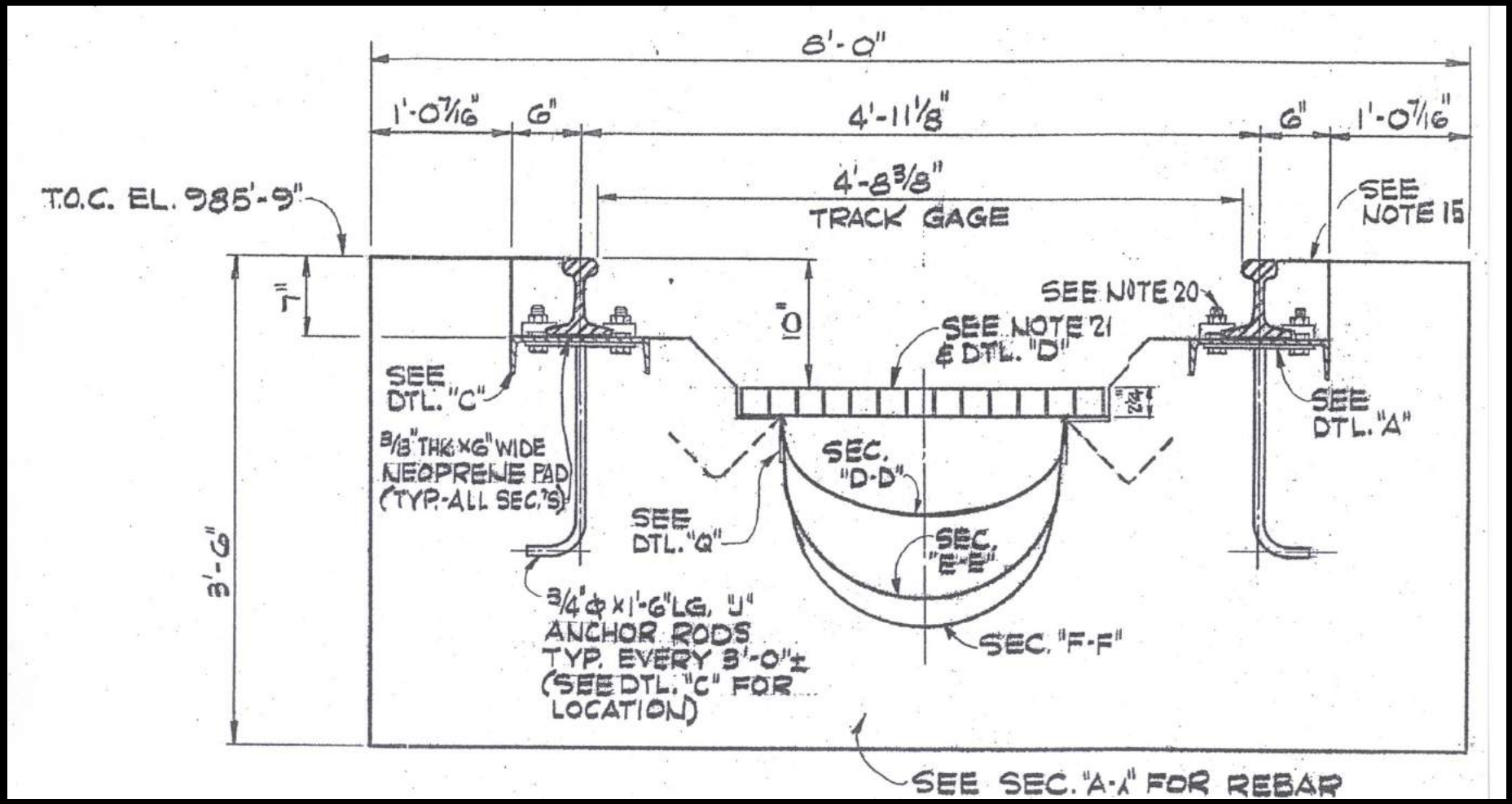
Repairing the Repair

Background

- Delayed Coker Unit is reported to be 1940's vintage
- Sluiceway directs hot process fluids assisted by high-pressure water jets
- Hydrocarbon based products exceeding boiling point of water

Background

- Type II PC concrete
- Structural Steel Hot Dip Galvanized
- Exposed concrete surfaces intended to be protected with epoxy coating
- Railroad track gage width = 56-3/8 in.


8'-0"
1'-0 7/16"
6"
4'-11 1/8"
6"
1'-0 7/16"
4'-8 3/8"
TRACK GAGE
T.O.C. EL. 985'-9"
SEE NOTE 15
7"
10"
SEE NOTE 20
SEE NOTE 21 & DTL. "D"
SEE DTL. "C"
SEE DTL. "A"
3/8" THK x 6" WIDE NEOPRENE PAD (TYP. ALL SEC.'S)
SEC. "D-D"
SEE DTL. "Q"
SEC. "E-E"
3'-6"
3/4" ϕ x 1'-6" LG. "J" ANCHOR RODS TYP. EVERY 3'-0"± (SEE DTL. "C" FOR LOCATION)
SEC. "F-F"
SEE SEC. "A-A" FOR REBAR

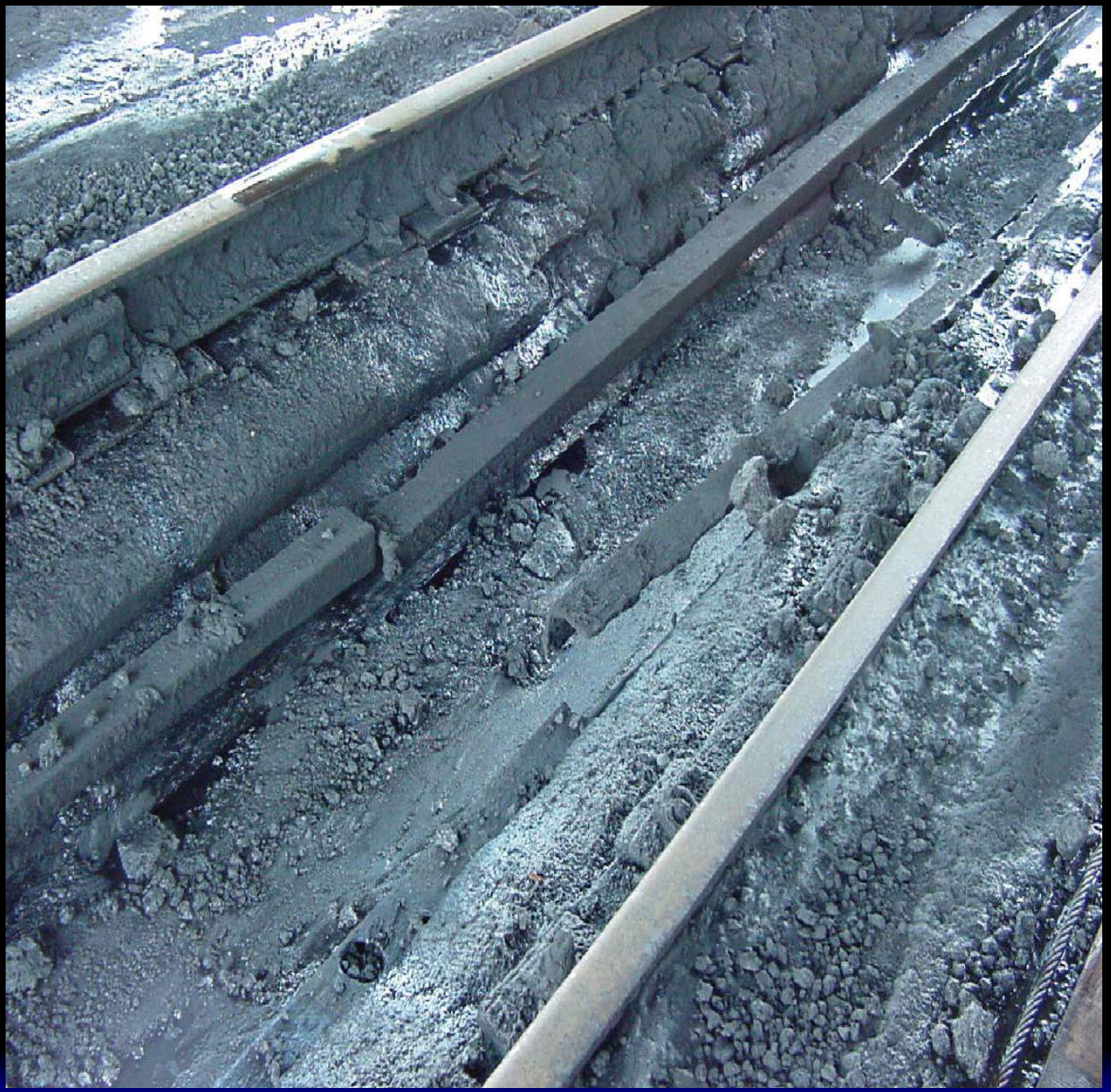
Condition Survey

- **Field Investigation**
  - Visual Inspection
  - Acoustic Impact Testing
  - Rebound Hammer Testing
  - Sample Extraction
- **Laboratory Tests**
  - pH Testing and Carbonation Depth Determination
  - Chloride Ion (Cl^-) Content
  - Compressive Strength Testing

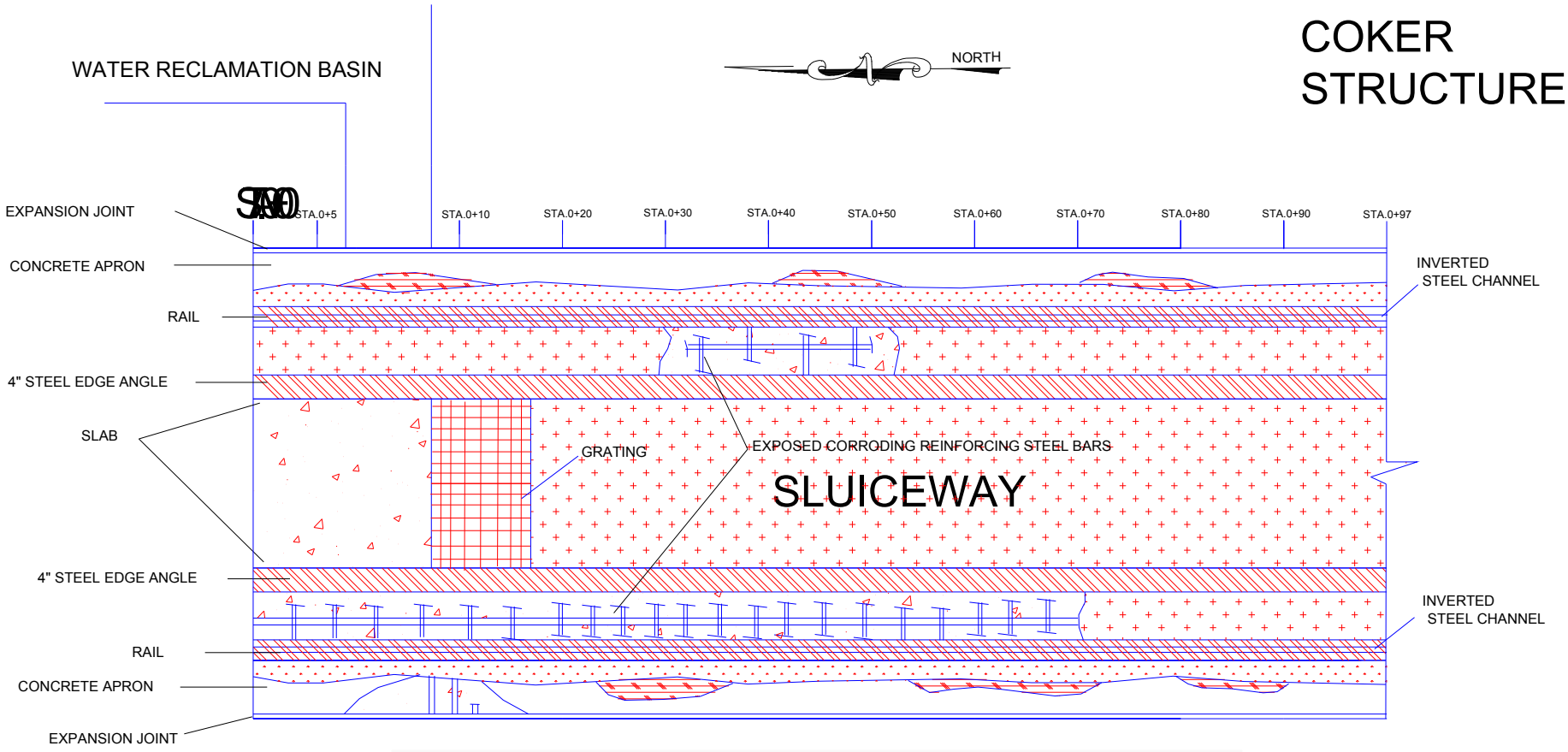
Field Investigation

Visual Inspection

- Documentation of observed deterioration in the form of cracks, delaminations, spalls, etc.
- Physical measurements for comparison of as-design details

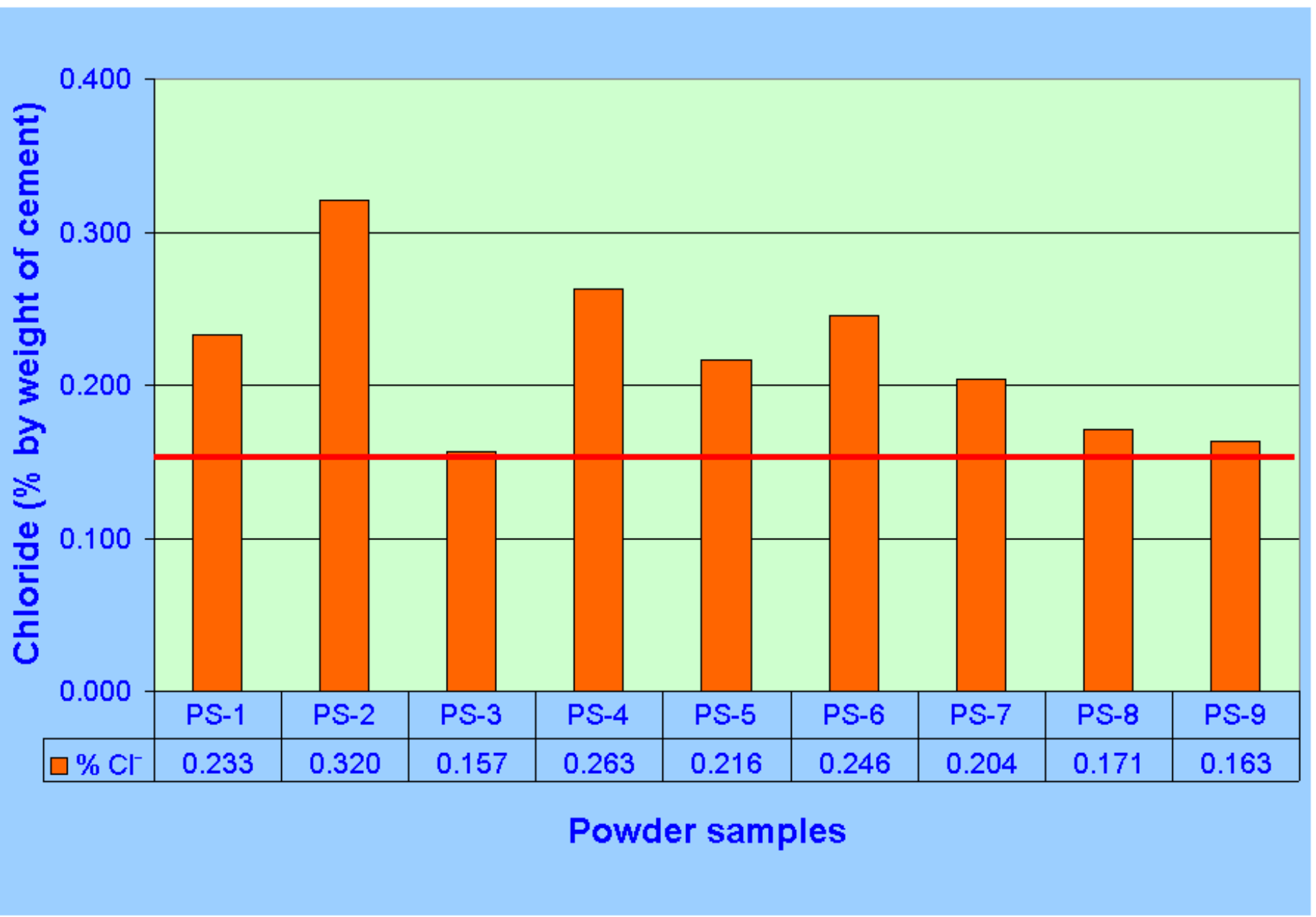


Non-Destructive and Semi-Destructive Testing (NDT & SDT) techniques provide insight to assemble an accurate assessment

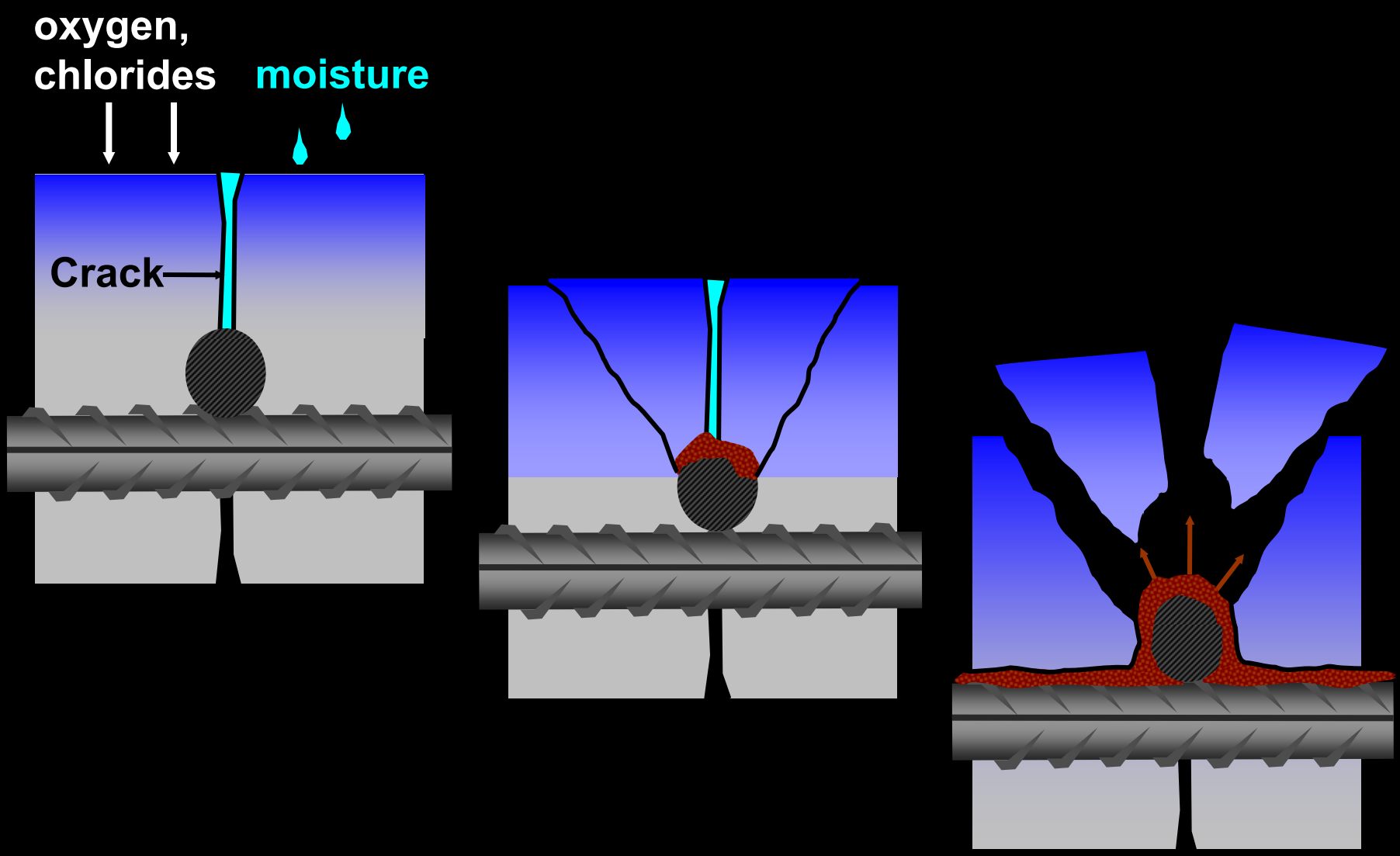


Partial Plan View of Sluiceway

Laboratory Tests


Chloride (% by weight of cement)
0.400
0.300
0.200
0.100
0.000
PS-1
PS-2
PS-3
PS-4
PS-5
PS-6
PS-7
PS-8
PS-9
% Cl⁻
0.233
0.320
0.157
0.263
0.216
0.246
0.204
0.171
0.163
Powder samples

Chloride-Induced Corrosion



Compressive Strength Testing

- Drilled core compression test report
- Certified third party laboratory
- 6,410 to 8,720 psi
- Based on ACI guidelines, average compressive strength exceeds 9,000 psi

Findings and Recommendations

Deterioration

- Cracking
- Delamination
- Eroded Surfaces
- Spalling
- Existing Concrete Repairs

Deterioration Mechanisms

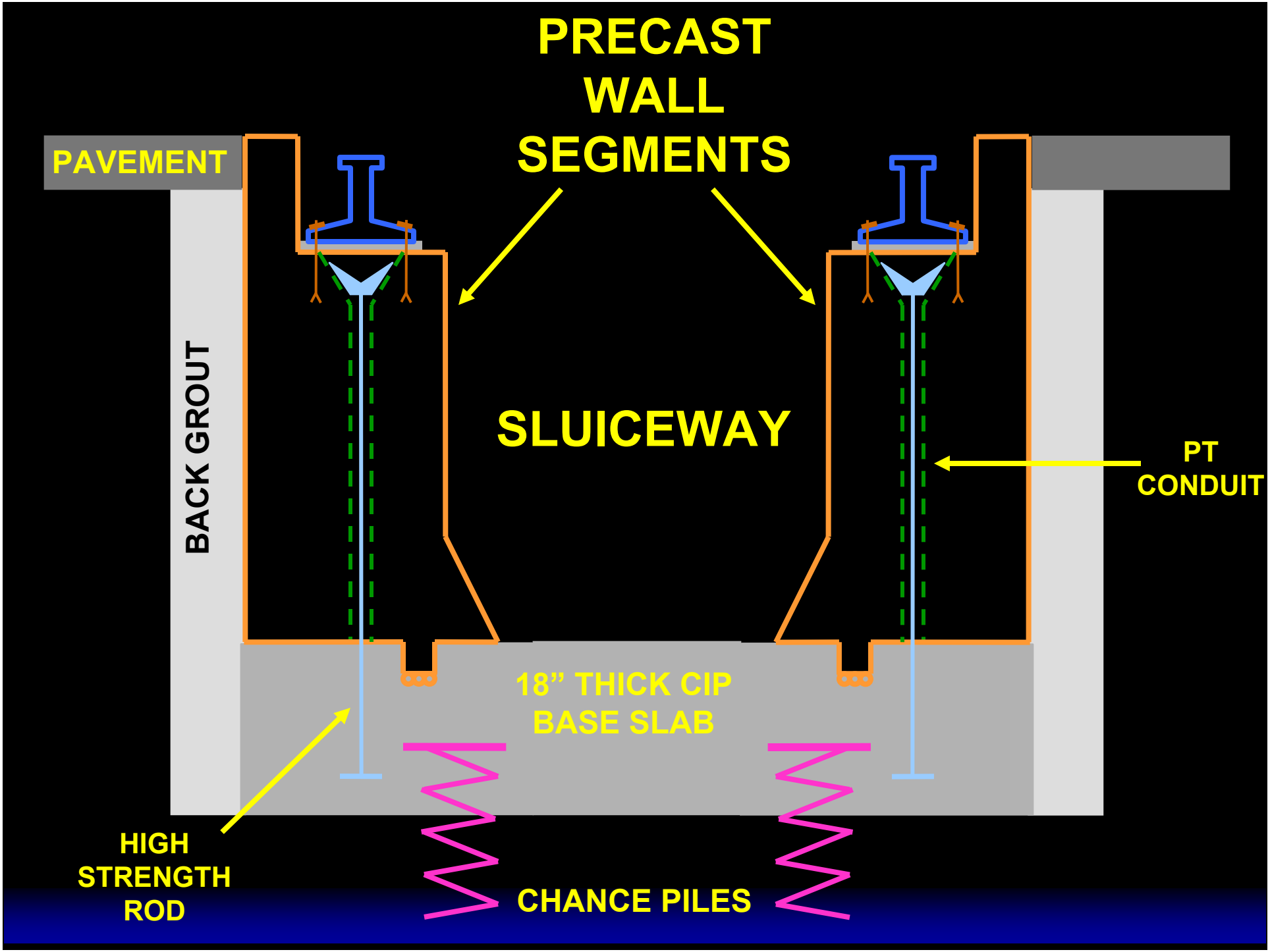
- Thermal Shock
- Erosion
- Corrosion

Railroad Track

- Warped and distorted railroad rail
- Broken and/or missing railroad clips and shims
- Dislodged tie plates with missing or dislodged neoprene bearing pads
- Exposed inverted structural steel channel members due to concrete spalling

Minimize potential for train car derailment by installing spreader bars at regular intervals

Conceptual Repair Schematic


PRECAST
WALL
SEGMENTS
PAVEMENT
BACK GROUT
SLUICEWAY
PT
CONDUIT
18” THICK CIP
BASE SLAB
HIGH
STRENGTH
ROD
CHANCE PILES

Materials of Construction

- Corrosion Resistance
- Moderate Refractory Properties
- Concrete Mix Design Toughness
- Rapid “Out-gassing” of Mix
- Segmental & P-T Construction Sequencing

Pre-T/A Planning & Design

- To Implement a Fast-Track Repair Requires Extensive Preplanning and Incorporation of Proven Construction Technology

Pre-T/A Planning & Design

- The Project Required Rapid Removal and Replacement of the Existing Sluiceway Within a 28 Day “Window of Opportunity”
- The Sluiceway was Critical Path for the Majority of the T/A Schedule

Pre-T/A Planning & Design

- The Planned Repair Approach was to Perform as Much Work as Possible Prior to the Outage and Then Implement Proven Precast Segmental Concrete Construction Along with Rapid Setting Construction Materials

Precast Concrete Block Segment Fabrication

- Standard Precast Concrete Design with High Performance Concrete Materials

Precast Concrete Block Segment Fabrication

- Use of Metal Formwork and Inserts Assure Proper Alignment of Construction Details During Concrete Placement

Precast Concrete Block Segment Fabrication

- Using a Calcium Aluminate Based Cement Concrete with Stainless Steel Fibers, the Blocks were Placed & Consolidated

Precast Concrete Block Segment Fabrication

- Metal Formwork was Stripped Within 1 Day and the Blocks were Stored in a Cool Location W/O Moist Curing Provisions

Demolition of Existing Sluiceway

- Use of Hydraulic Diamond Wire Cutting Equipment to Remove Massive Subsurface Foundations

Demolition of Existing Sluiceway

- Low Overhead Clearance Hoe Ram Excavators Were Used to Remove Majority of Sluiceway Concrete

Install New Base Slab for Sluiceway

- Installation of a New Double Mat Reinforced 22-inch Thick Base Slab Overtop a Previously Placed Mud-Mat

Install New Base Slab for Sluiceway

- Concrete Placement Using a High-Early Strength Concrete Mix Conveyed via a Concrete Pump Truck

Placement of New Precast Concrete Segments

- Precast 10,500# Concrete Block Segments Placed Sequentially Using a Compact Carry-Deck Crane

Placement of New Precast Concrete Segments

- Drilling and Installation of PT Grouted Anchors Thru Sleeved Precast Blocks into CIP Structural Base Slab

Placement of New Precast Concrete Segments

- Torquing and Stressing PT Anchor Rods to Spec. To Assure Composite Behavior Between Block & Base Slab

Placement of New Precast Concrete Segments

- Precast Concrete Segments Installed and Prior to Joint Grouting, Waterproofing and Backfilling

Successful Project Performed Under Budget and 3 Days Ahead of Schedule