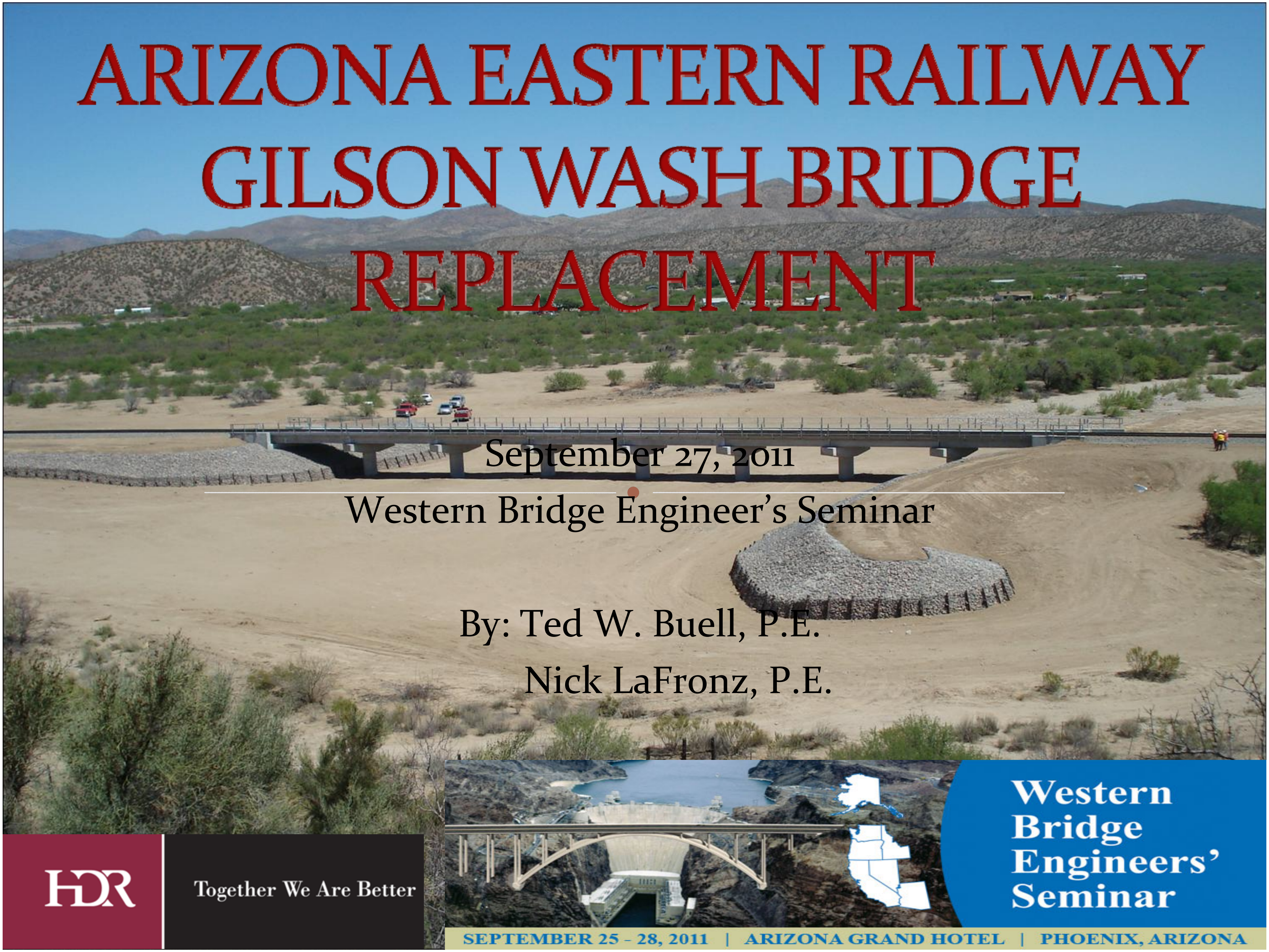
ARIZONA EASTERN RAILWAY GILSON WASH BRIDGE REPLACEMENT

September 27, 2011

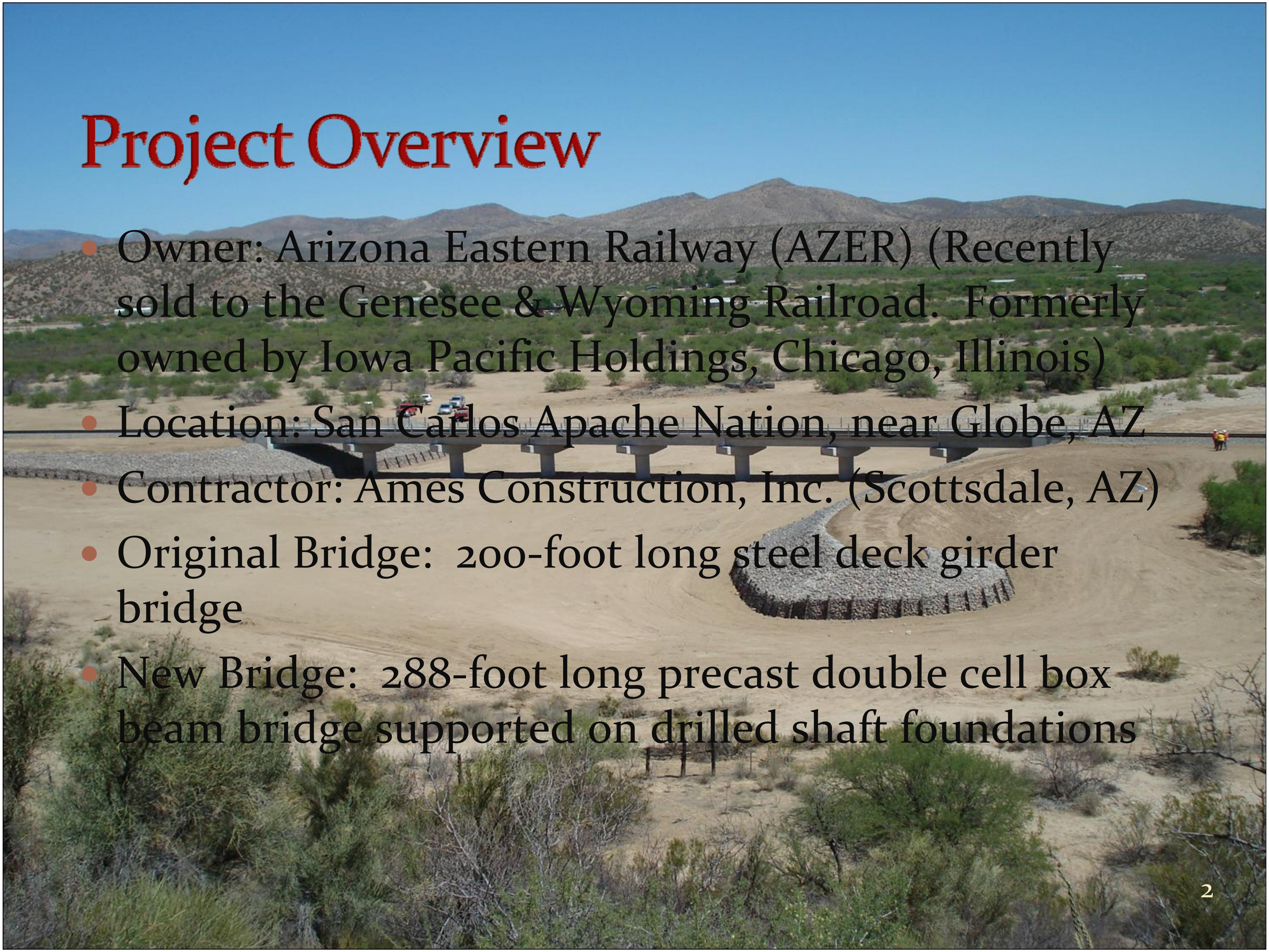
Western Bridge Engineer's Seminar

By: Ted W. Buell, P.E.

Nick LaFronz, P.E.



Project Overview



- Owner: Arizona Eastern Railway (AZER) (Recently sold to the Genesee & Wyoming Railroad. Formerly owned by Iowa Pacific Holdings, Chicago, Illinois)
- Location: San Carlos Apache Nation, near Globe, AZ
- Contractor: Ames Construction, Inc. (Scottsdale, AZ)
- Original Bridge: 200-foot long steel deck girder bridge
- New Bridge: 288-foot long precast double cell box beam bridge supported on drilled shaft foundations

Background of Project

Flash flood on January 28, 2008

Scour undermined east abutment

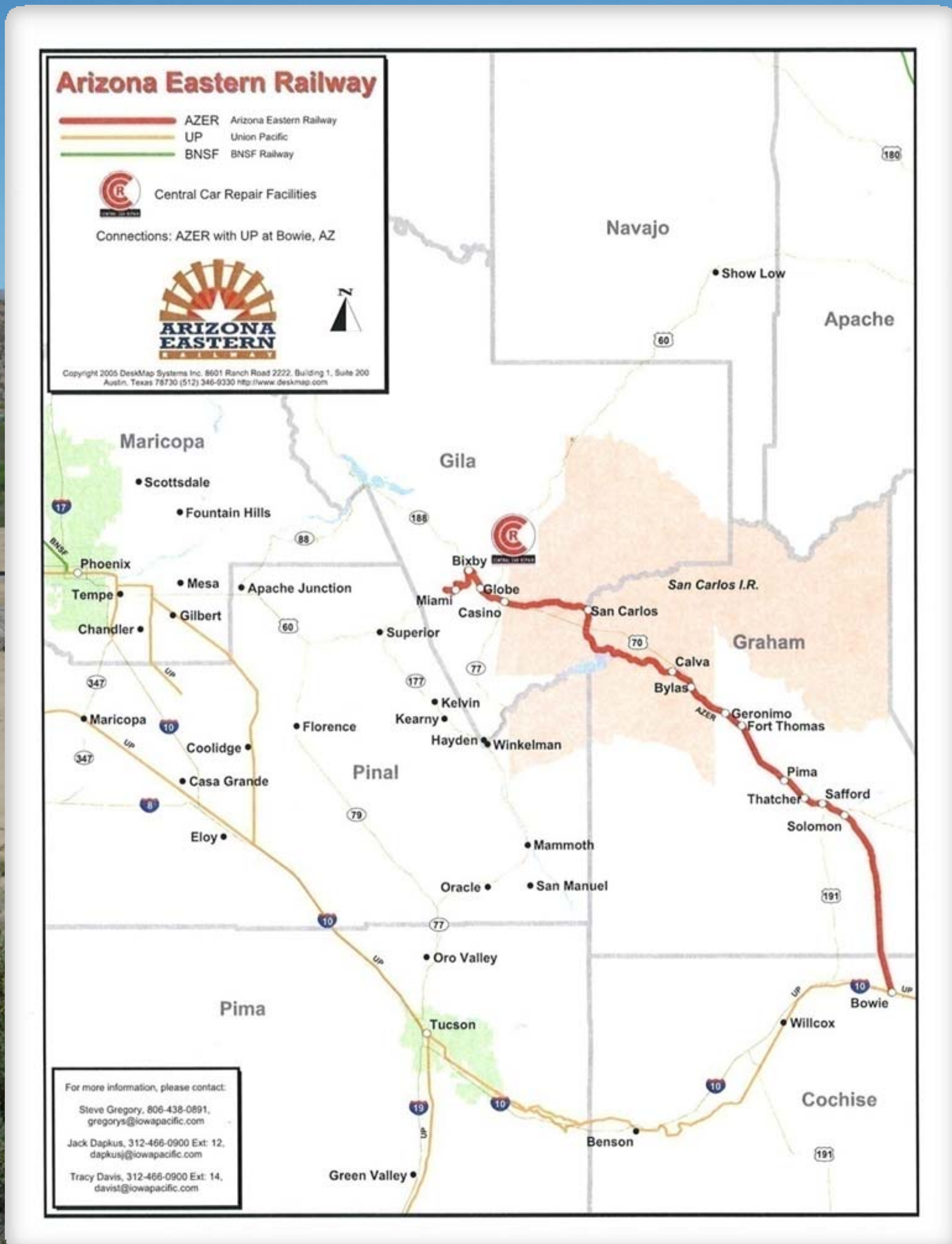
Diesel fuel spilled and locomotives burned on bridge

Bridge superstructure and locomotives destroyed due to heat from the fire

Background of Project

Background of Project

Arizona Eastern Railway



135 miles of track built in 1885

Transport copper, acid, and other copper processing materials between Miami, AZ and the UPRR line at Bowie, AZ.

Temporary Crossing

Twelve 96" diameter CMPs

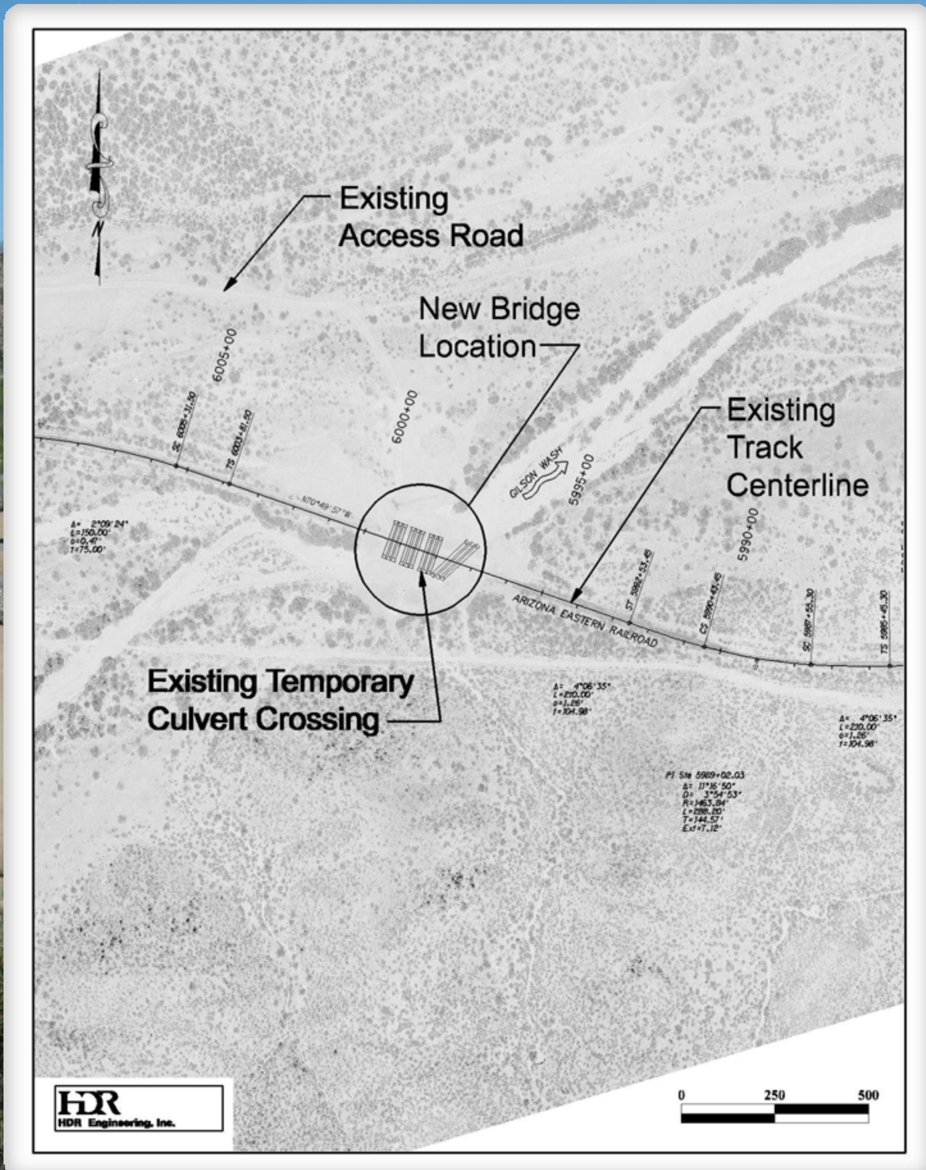
12,000 cubic yards of fill

Trains were back in service within one week of the derailment!

Grouted riprap armoring

Emergency permit was obtained from the Corps of Engineers

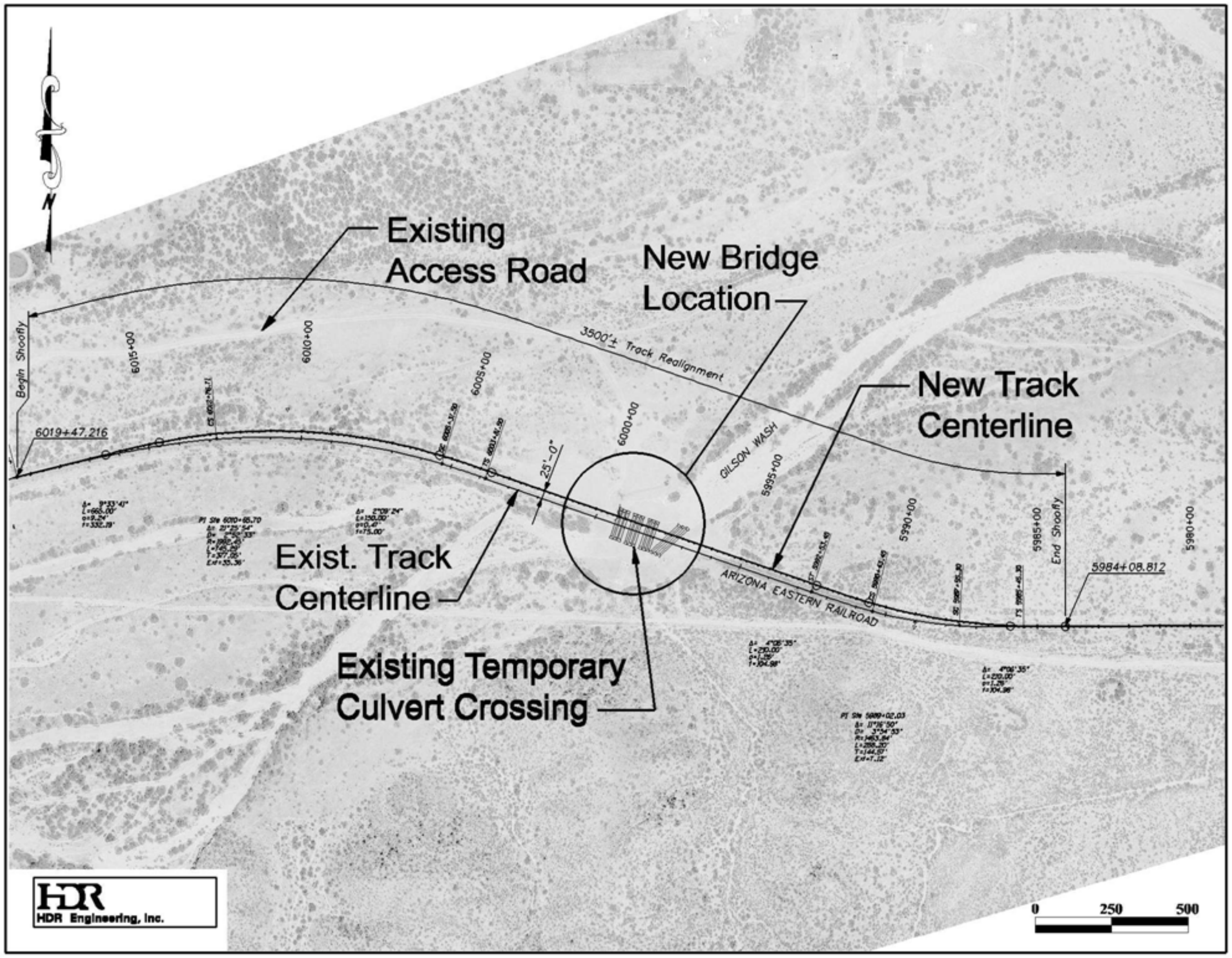
Hydraulic capacity is less than a 10-year storm event



Bridge Design Criteria:

- Arema 2008 Cooper E-80
- Q50 to pass below low chord (20,600 cfs)
- Q100 to pass below railroad subgrade (29,000 cfs)
- Variable scour depth (22 feet to 42 feet)

Track Alignment:



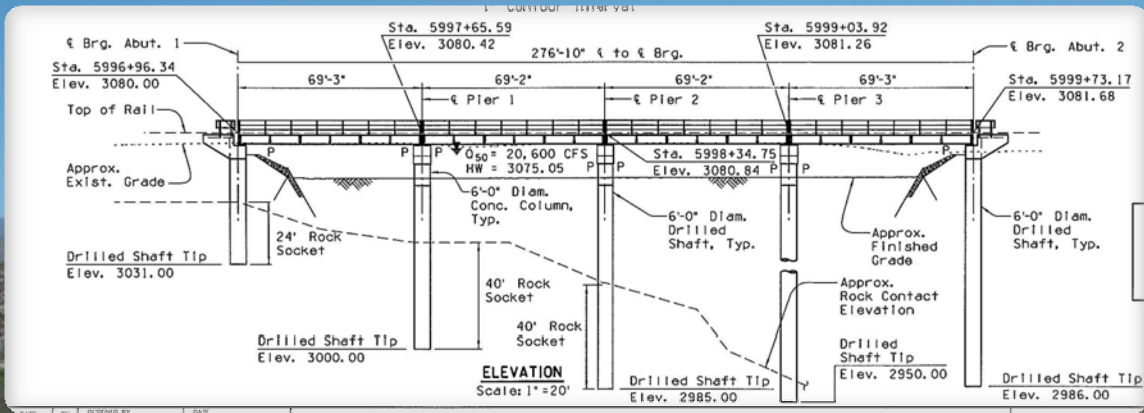
Alternatives:

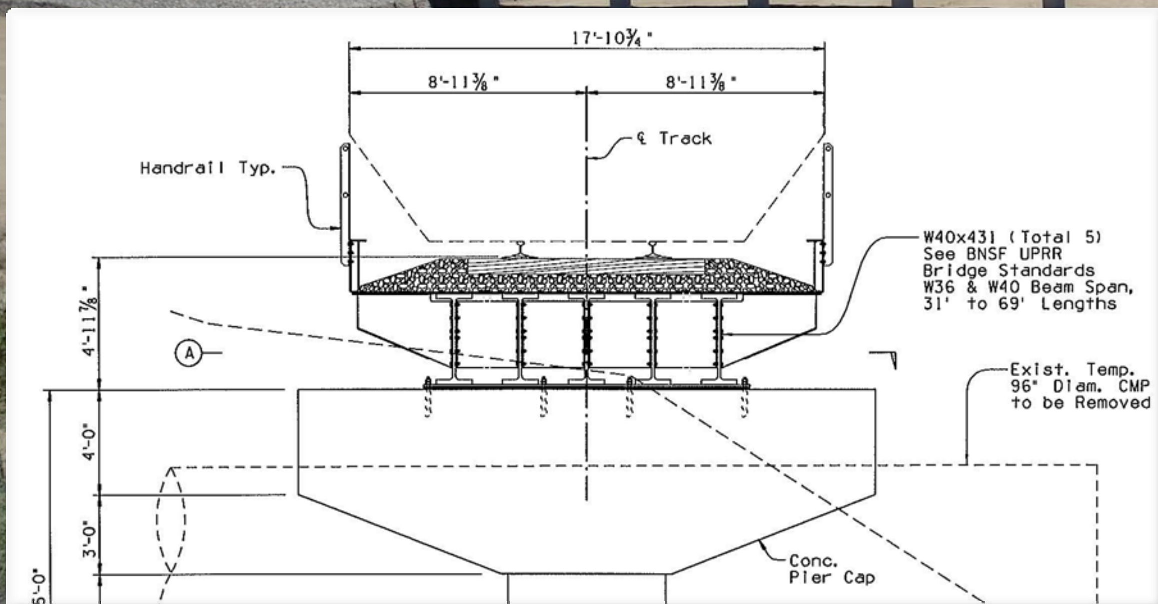
- Construct new bridge on same alignment (difficult due to track raise)
- Re-align track & construct new bridge adjacent to existing track. (must stay within 100' right-of-way)(preferred)
- Shoring required to maintain rail traffic

Bridge Superstructure Alternatives:

Steel Through Girder

- Relocate Through Girder Bridge from Separ, New Mexico (Built in 1974)
- 3 main spans of 93 feet = 279 feet (Fits nicely between existing culverts)
- Skew = 20 degrees in wrong direction!
- Paved Cross-over detour would be required to maintain traffic on I-10
- Too Expensive @ 21% higher than preferred alternative

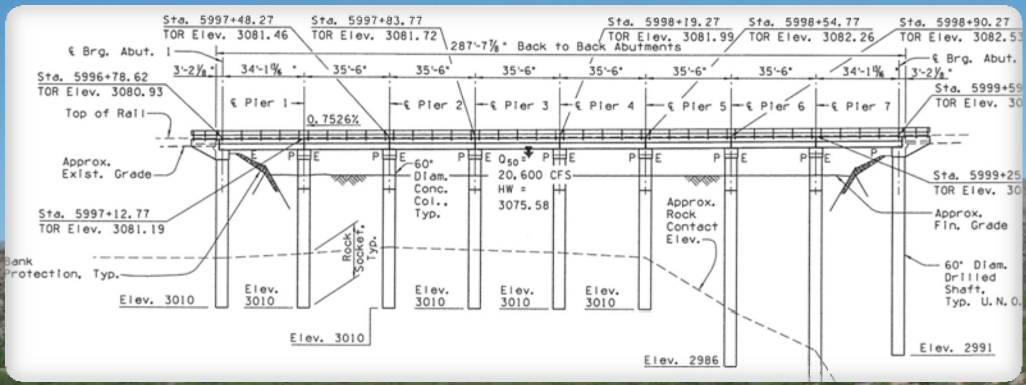


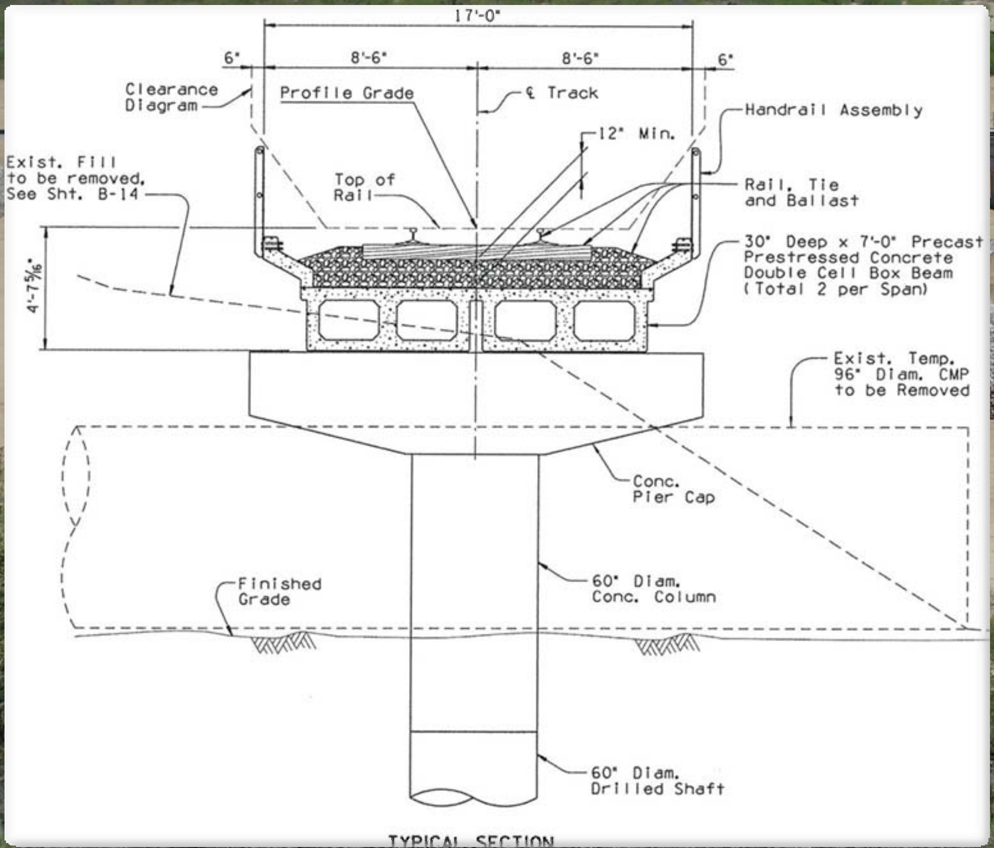


Bridge Superstructure Alternatives:

Steel Deck Girder

- W40 x 431
- 4 spans of 69 feet = 277 feet
- Skew = 30 degrees
- Too Expensive @ 40% more than preferred alternative





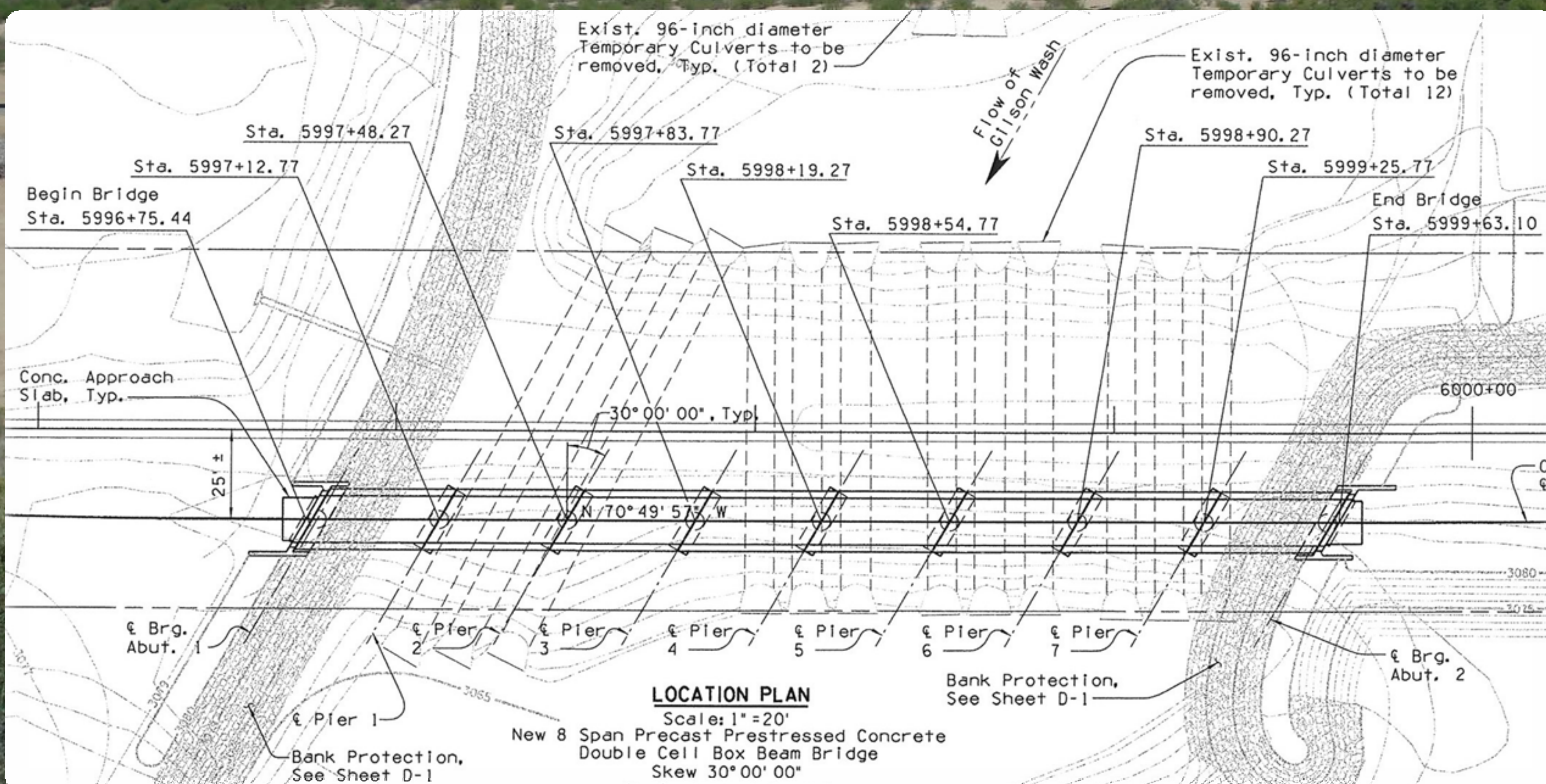
Selected Bridge Alternative:

Precast Double Cell Box Beams

- 30-inch deep x 7 feet wide
- 8 spans @ 35'-6" feet = 288 feet
- Skew = 30 degrees
- Simple to construct
- Least costly @ $2.0M (Ames Construction Bid Price) (~$7,000/Track Foot, not including track, ballast & OTM)

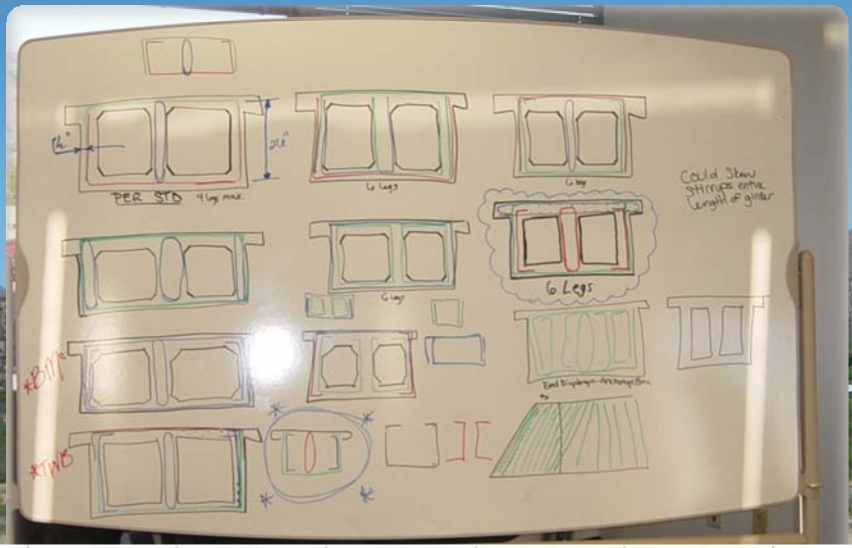
Design Challenges:

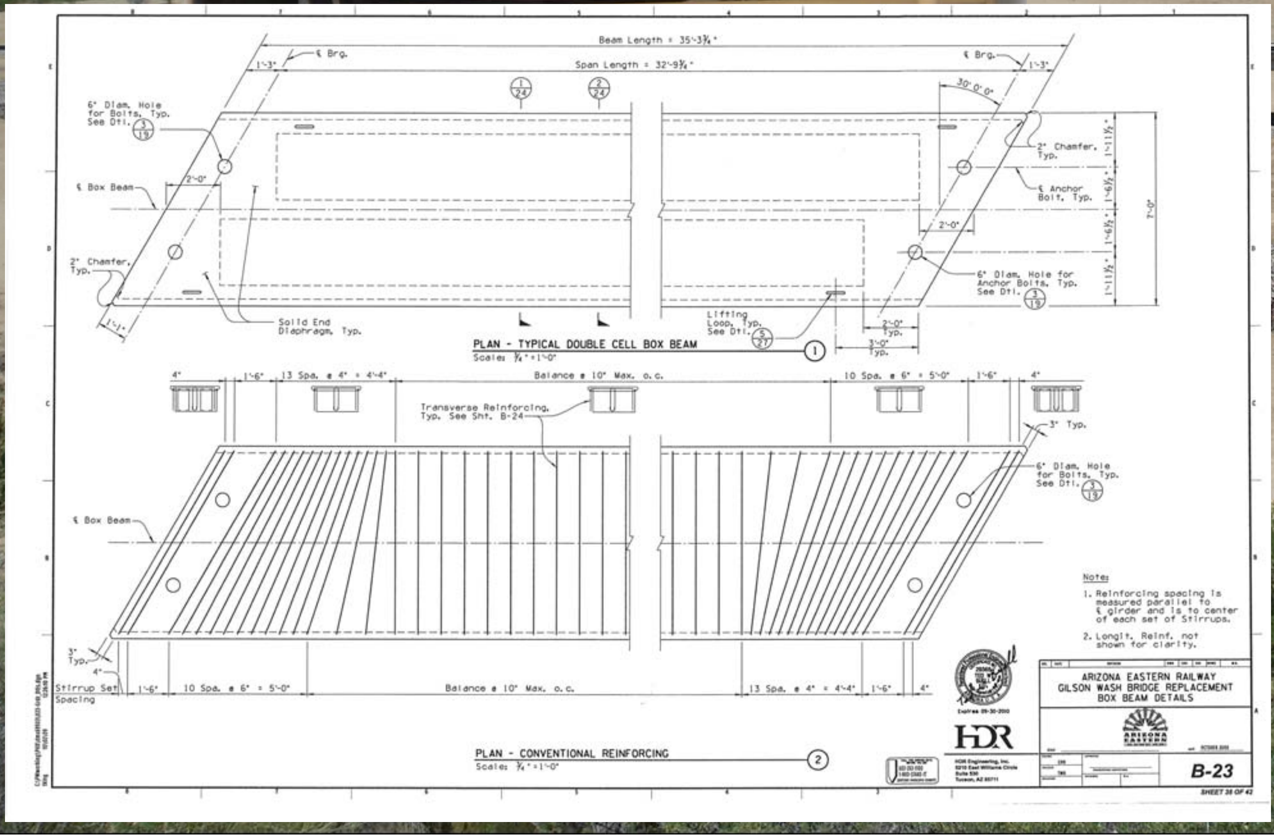
- 30° skew
- Variable pier stiffness & scour
- Potential for rocking
- Maintaining rail traffic & water flow during construction

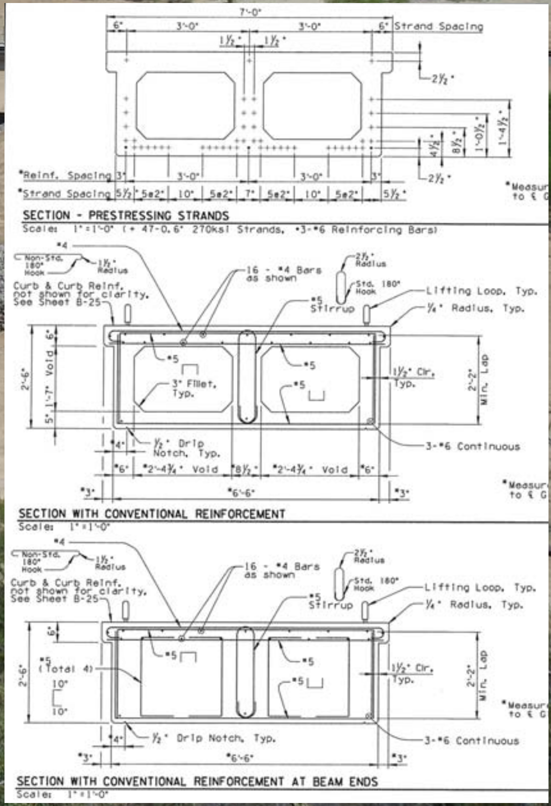


Design Challenges:

30° skew
(Recommended Max Skew = 15° per AREMA)

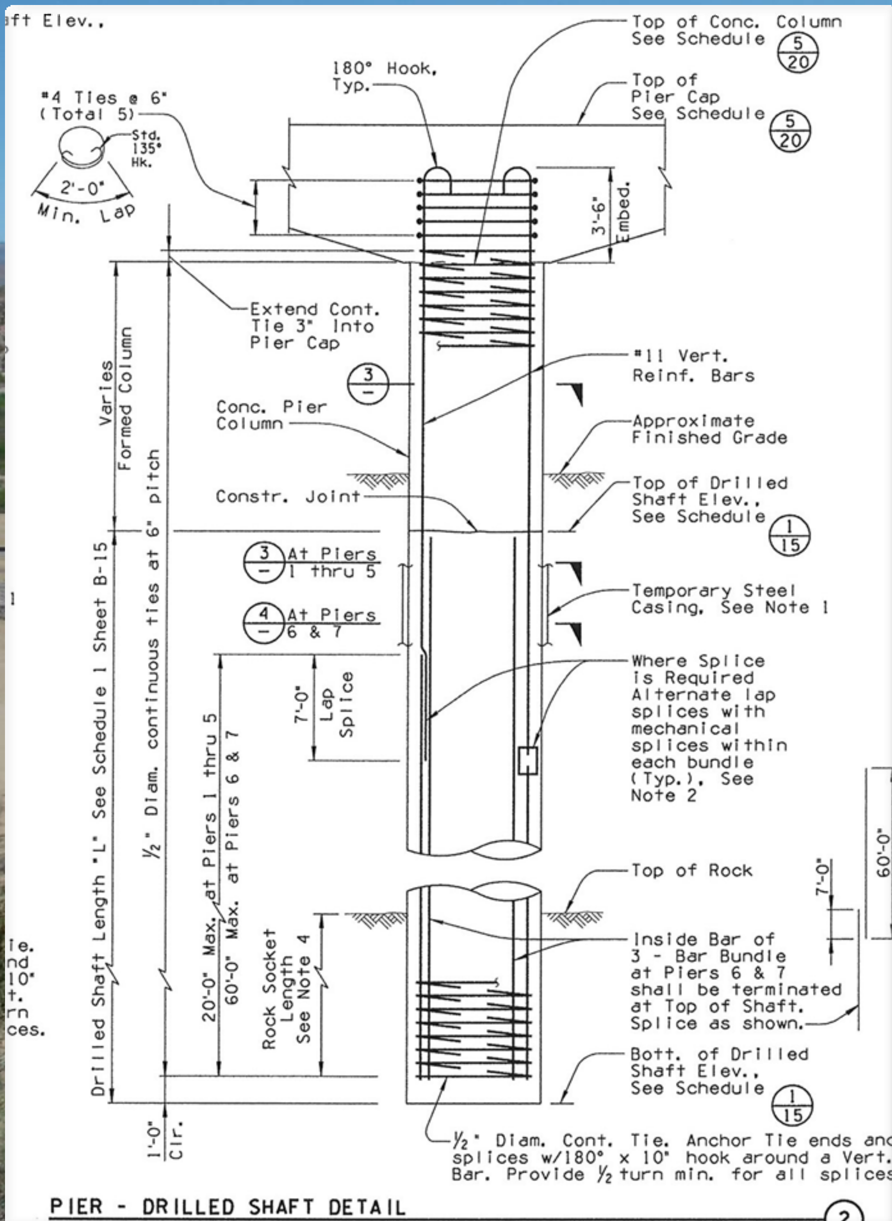


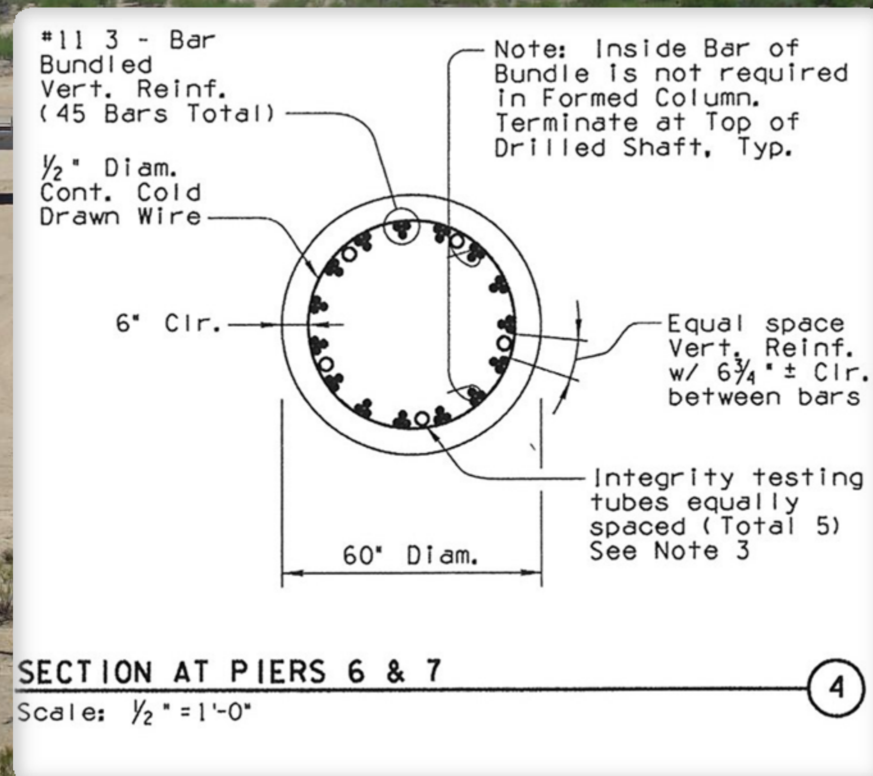


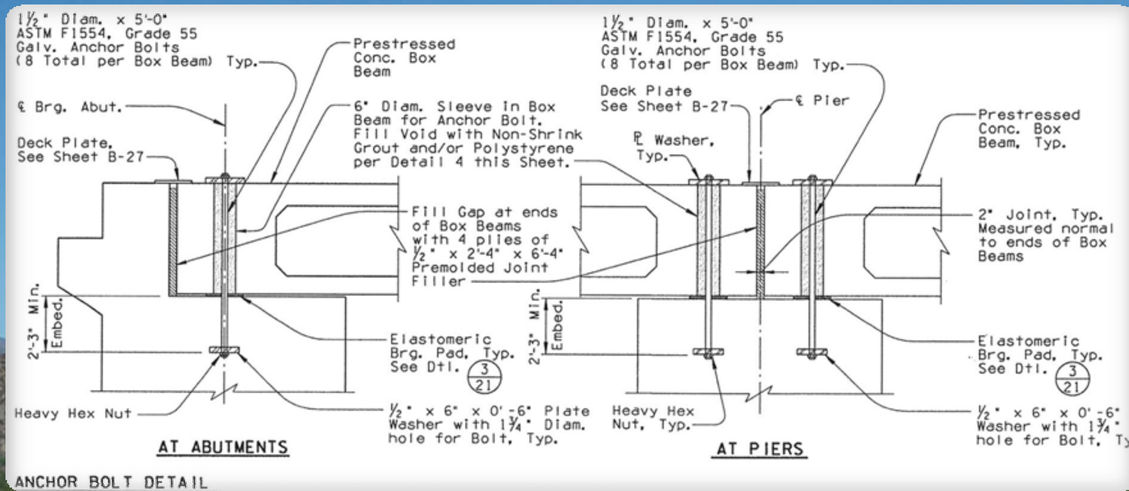


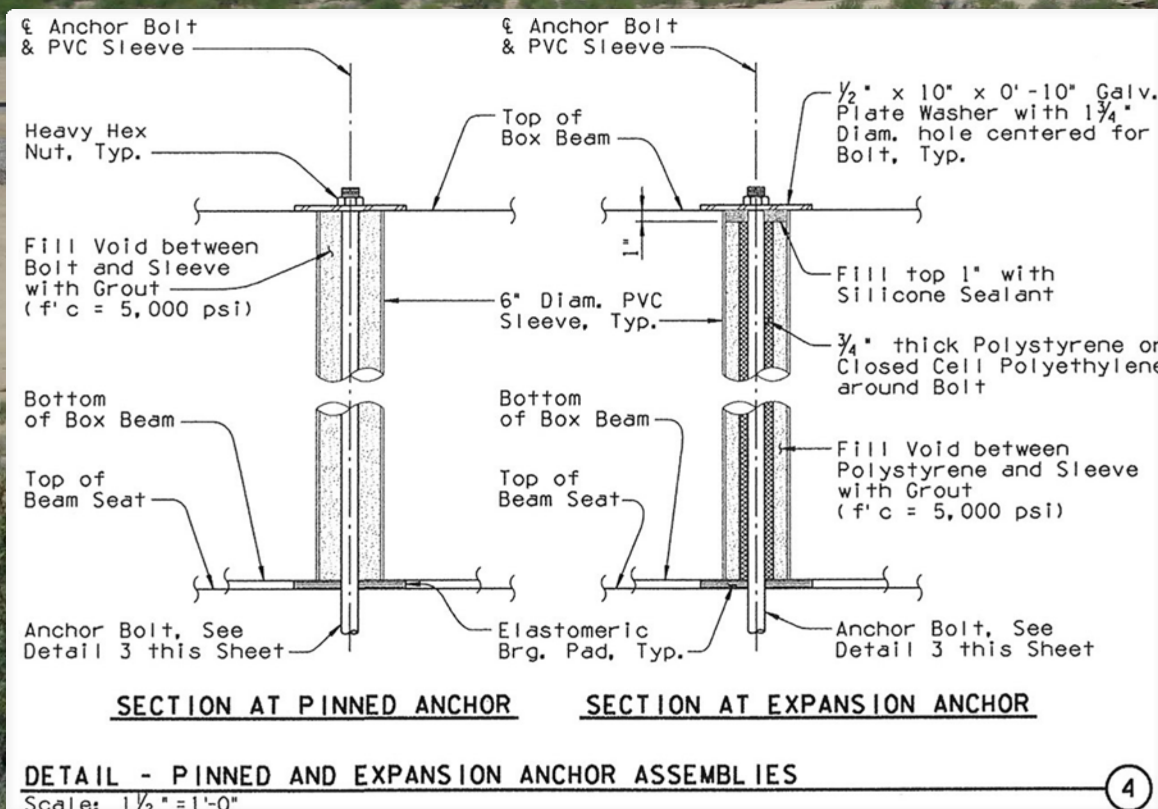
Design Challenges:

- Variable Pier Stiffness due to depth of rock





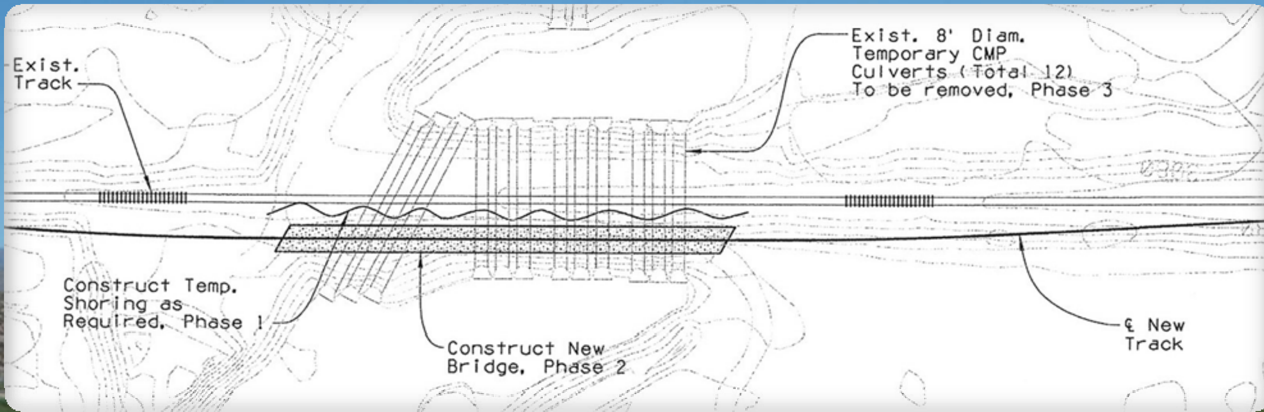




Design Challenges:

Potential for Rocking

- Mechanically anchored beams to substructure
- Specified shim placement to achieve full bearing
- Provided pinned & expansion connections

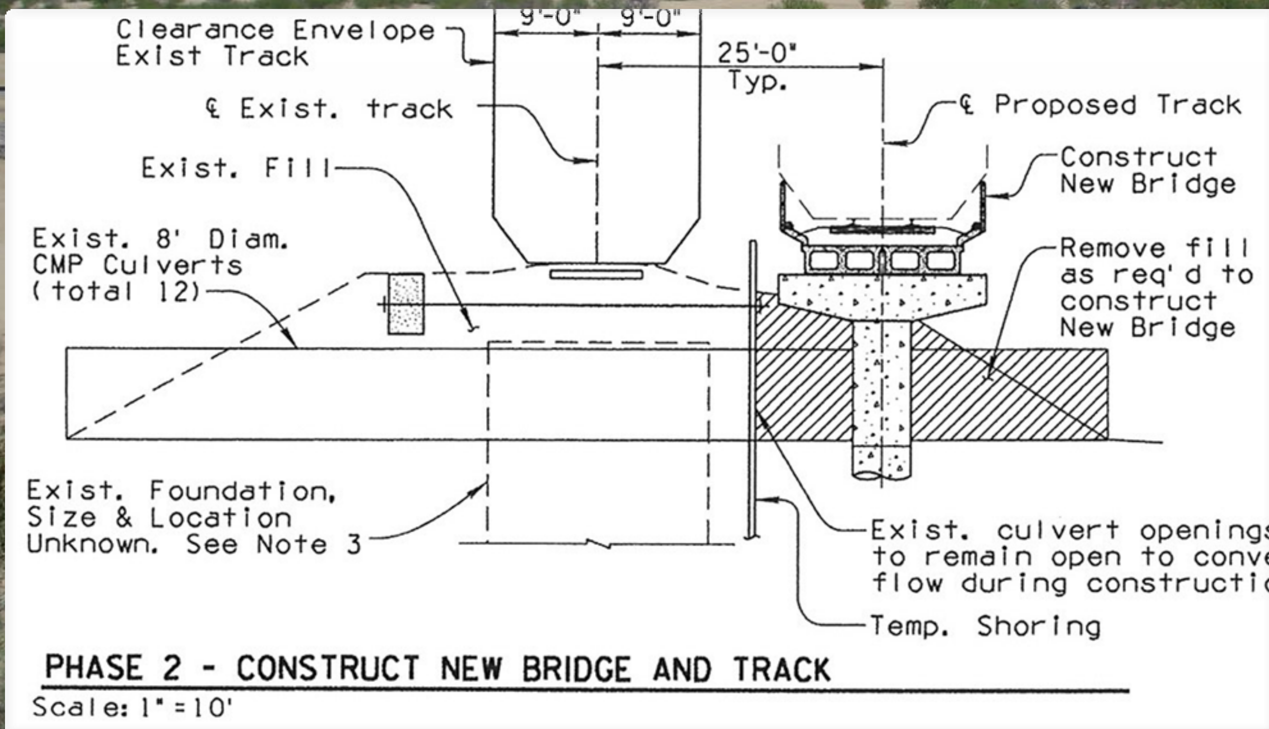


Construction Challenges:

Maintain rail traffic

Maintain flow through culverts

Provided temporary shoring while avoiding existing culverts



Geotechnical Investigation:

Site Geology

Channel, terrace & floodplain alluvium overlying weakly consolidated sedimentary rock (conglomerate, sandstone & siltstone).

Hill and cut-slope located north track-side, about 1,000 feet east of Gilson Wash

Geotechnical Investigation:

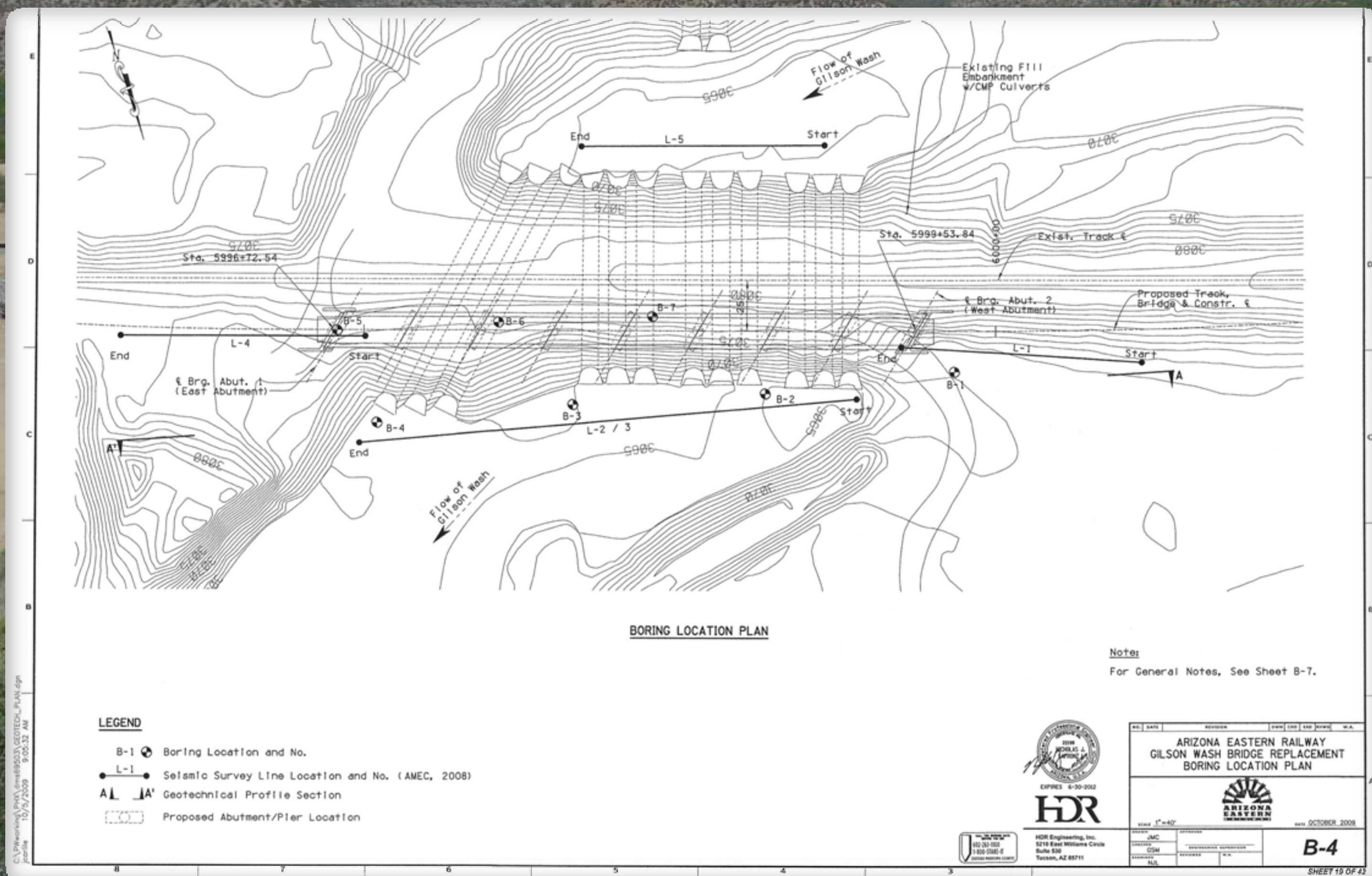
Site Geology

Moderately to highly weathered sedimentary rock (sandstone and conglomerate) in slope face about 1,000 feet east of Gilson Wash

Geotechnical Investigation:

Phase I - Seismic refraction & refraction microtremor (ReMi) surveys & four borings (based on Separ bridge span arrangement)

Phase II – three core borings atop temporary crossing



Phase I & Phase II investigations.

Geotechnical Investigation:

Seismic Refraction & ReMi Surveys – measured both compression & shear wave velocities of subsurface materials

Phase I investigation: seismic survey line in active channel

Geotechnical Investigation:

Test Borings

Phase I investigation: Rotary-percussion drilling of Boring B-2 on downstream side of temporary crossing

Geotechnical Investigation:

Test Borings

Phase I investigation: Rotary-percussion drilling of Boring B-4 on downstream side of temporary crossing

Geotechnical Investigation:

Test Borings

HQ-size triple-tube core drilling of sedimentary rock during Phase II investigation, from atop temporary crossing

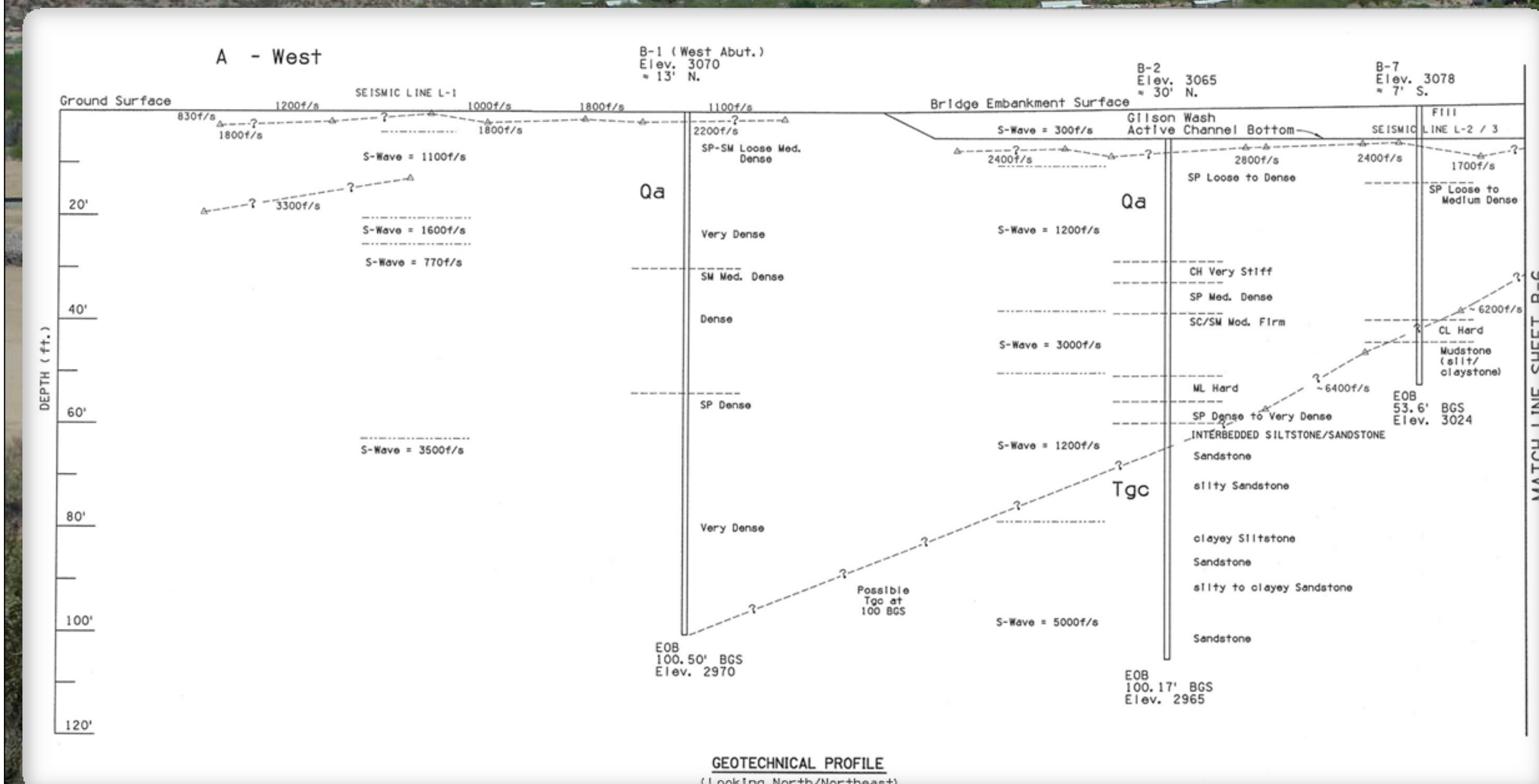
Geotechnical Investigation:

Test Borings

Core samples of rock from Boring B-6, 40.5 to 49.5 feet bgs.

Geotechnical Investigation:

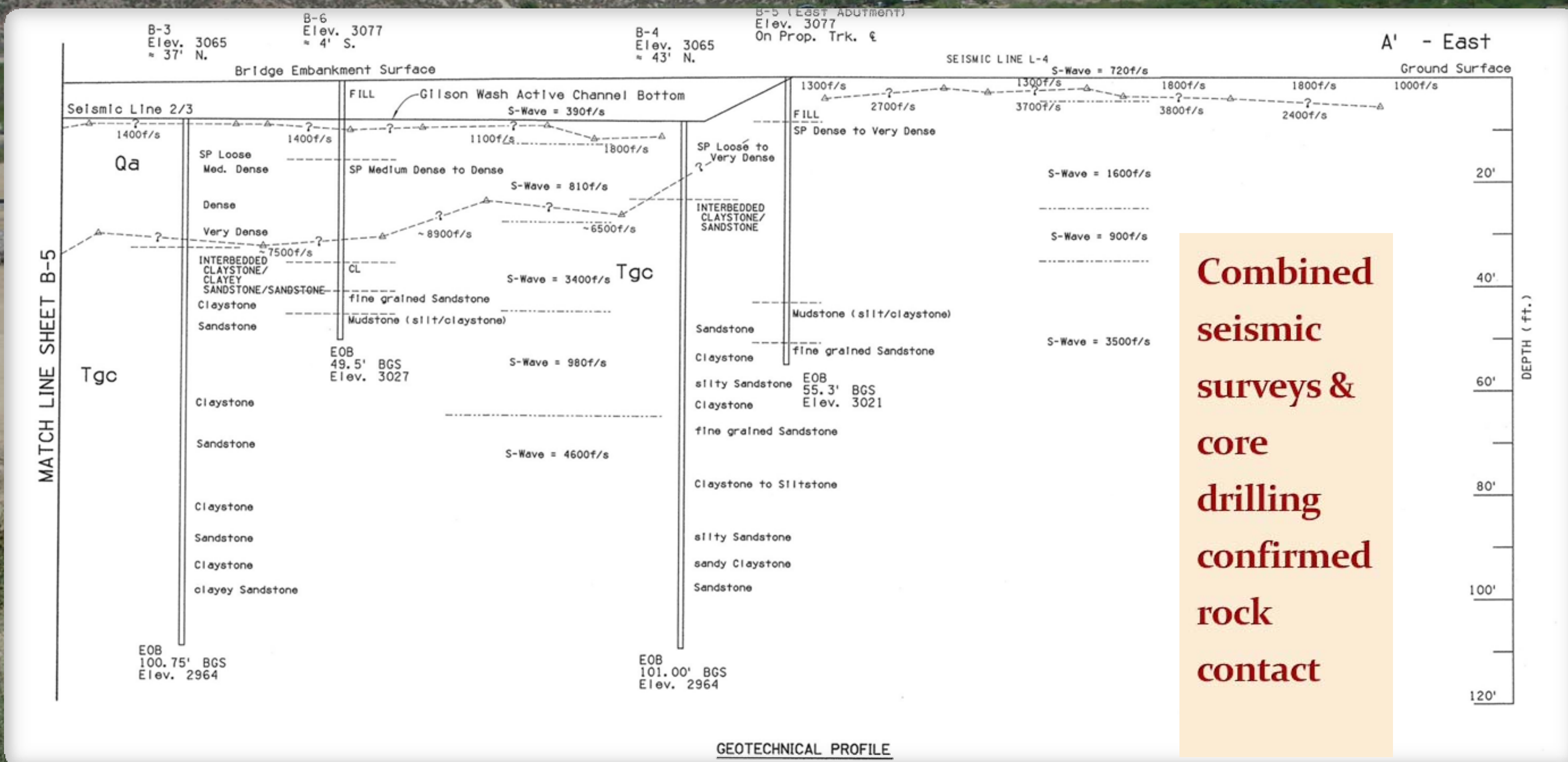
Geotechnical profile with boring & seismic survey results



Sloping rock contact of variable depth underlies the wash alluvium along the bridge length

Geotechnical Investigation:

Geotechnical profile with boring & seismic survey results

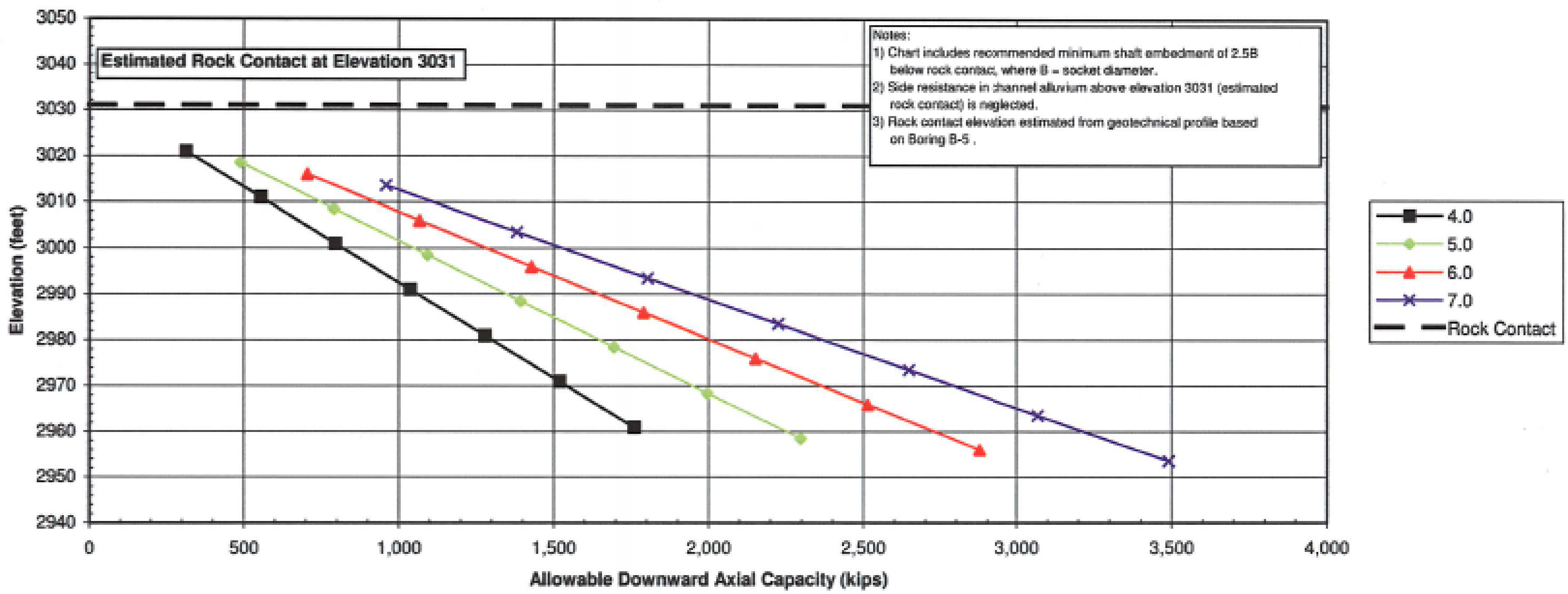


Combined seismic surveys & core drilling confirmed rock contact

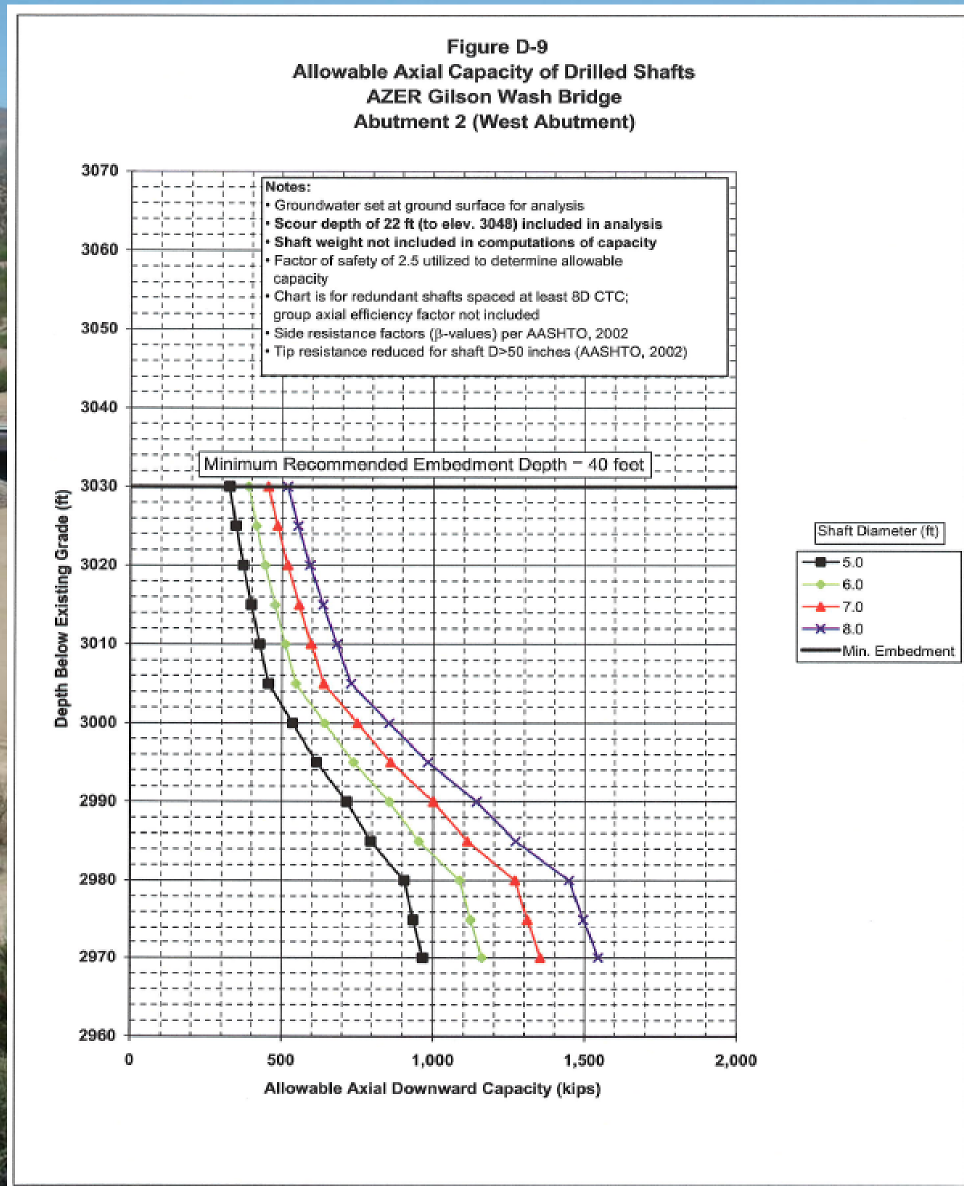
Foundation Design:

Drilled shaft rock socket capacity chart – Abutment 1 (east)

Figure D-1
AZER Gilson Wash Bridge
Alternative 3 (8-span) - Abutment 1 (East Abutment)
Allowable Axial Capacity of Drilled Shaft Rock Sockets
AASHTO Method (AASHTO, 2002)



Foundation Design:
Drilled shaft capacity chart – Abutment 2 (west)



Construction Schedule

- Construction began in September 2010
- Track realignment September through December
- Temporary shoring November, 2010
- Drilled shafts December 2010 (2 week duration)
- Precast box beams set on January 26 & 27, 2011
- Ballast & track placed February, 2011 (1 weekend)
- Bank protection – February to May, 2011
- Re-seeding June, 2011

Temporary Shoring

Due to rock depth, piles were driven to varying depths

Temporary Shoring

Rail traffic was not affected by bridge construction

Drilled shaft construction in rock & soil

5'-0" diameter , length varies from 50 ft to 91 ft
Rock socket lengths vary from 0 ft to 26 ft
Drilling Contractor: Case Foundation Co.

Drilled Shaft Construction

Rock contact elevation was within a few feet of the predicted elevation except at two of the shafts

Drilled Shaft Construction

Drilled Shaft Integrity Testing

Cross-hole sonic logging and gamma density logging in each shaft

Precast Double-Cell Box Beams

Manufactured by Coreslab Structures, Albuquerque, New Mexico

Precast Double-Cell Box Beams

Sloped curbs are cast at the precast plant after the beams are cast

Precast Double-Cell Box Beams

30° skew on ends with solid diaphragms

Standard UPRR box beams without end diaphragms on left of both photos.
Skewed beams on right of both photos

Pier Caps in Place Ready for Box Beams

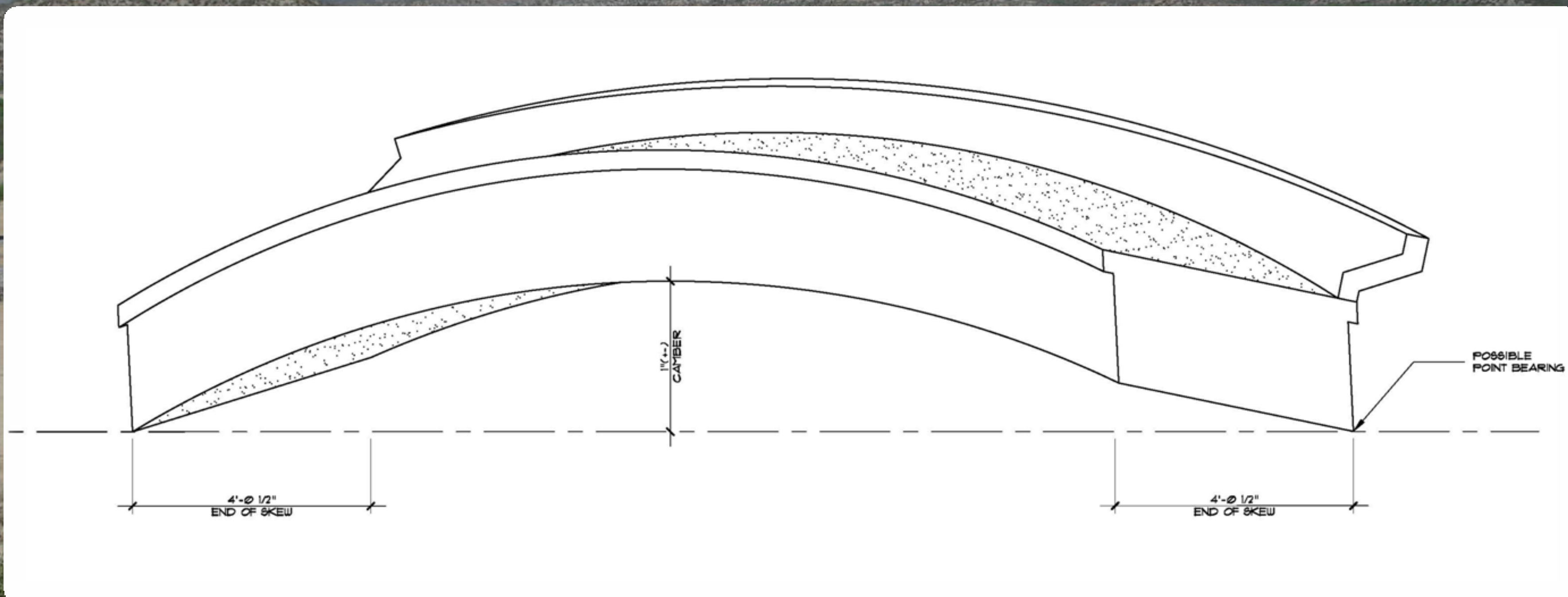
Bearing pads in place with holes for anchor bolts

The presence of the temporary crossing culvert fill was actually beneficial for this phase

Setting of the First Box Beam

Gap Between Bearing Pad and Bottom of Box Beam (1/4" to 3/4")

Precast Double-Cell Box Beams - Skewed Ends with Camber



Sketch provided by Coreslab Structures

Underside of the box beams and tops of pier caps were relatively flat

As-built survey elevations of the tops of the pier caps closely matched the contract drawings

Applied thick layer of High Strength Grout instead of steel shims to achieve full bearing along the full length of the bearing pads

Four corners of adjacent box beams at centerline pier

Four corners of adjacent box beams at centerline pier

Deck joint cover plate over sloped curbs

Completion of Box Beam Erection

Once box beams are erected, the bridge is accessible. No deck forming or cast-in-place deck is required

Anchor Bolts at Pinned and Expansion Ends

Expansion connection

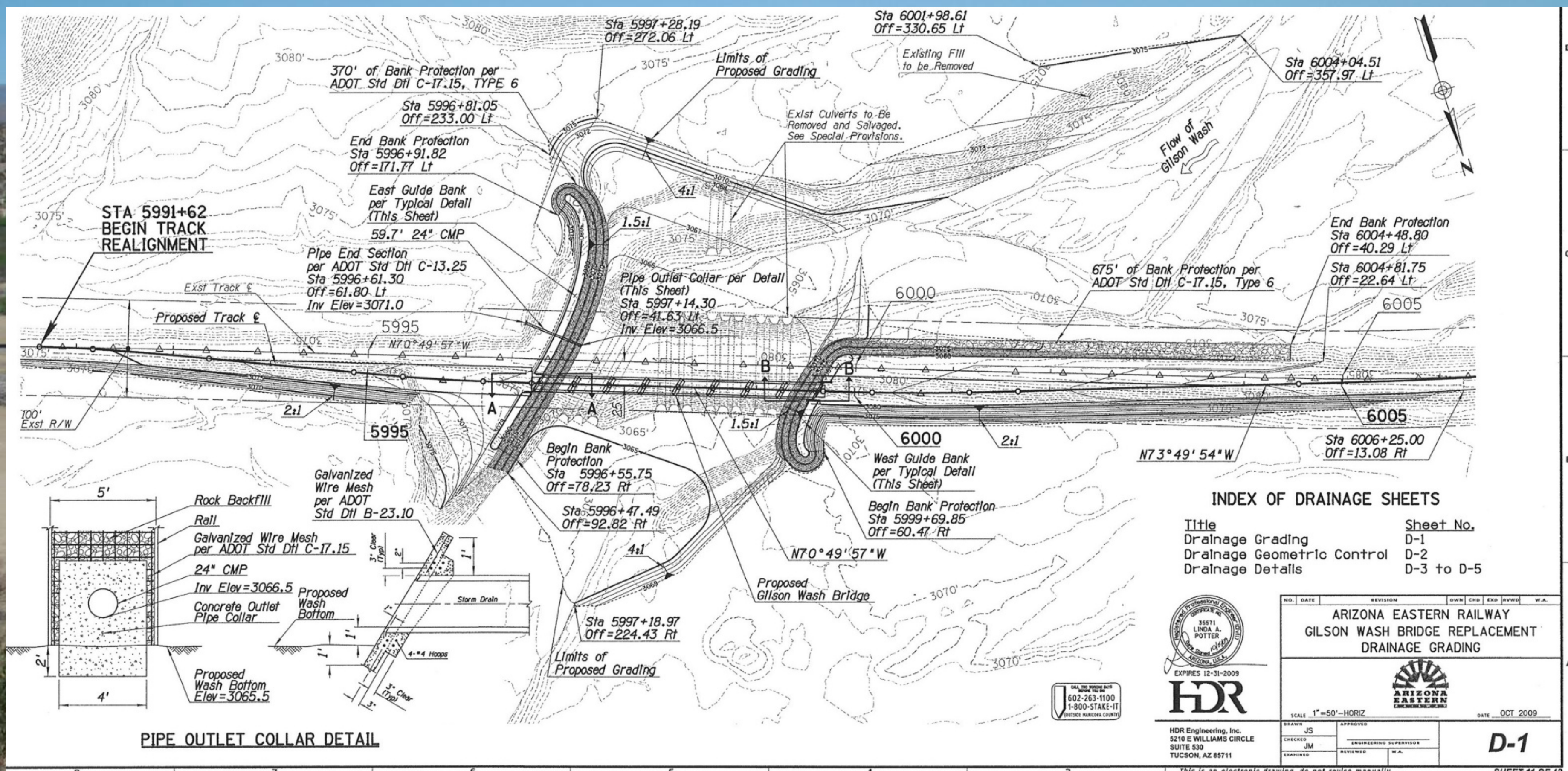
Pinned connection

Bridge ready for ballast with railing in place

Removal of Temporary Culvert Crossing and Existing Bridge Substructure

Existing foundations & CMP culverts were buried in the fill

Rail Bank Protection – ADOT C-17.15 Type 6

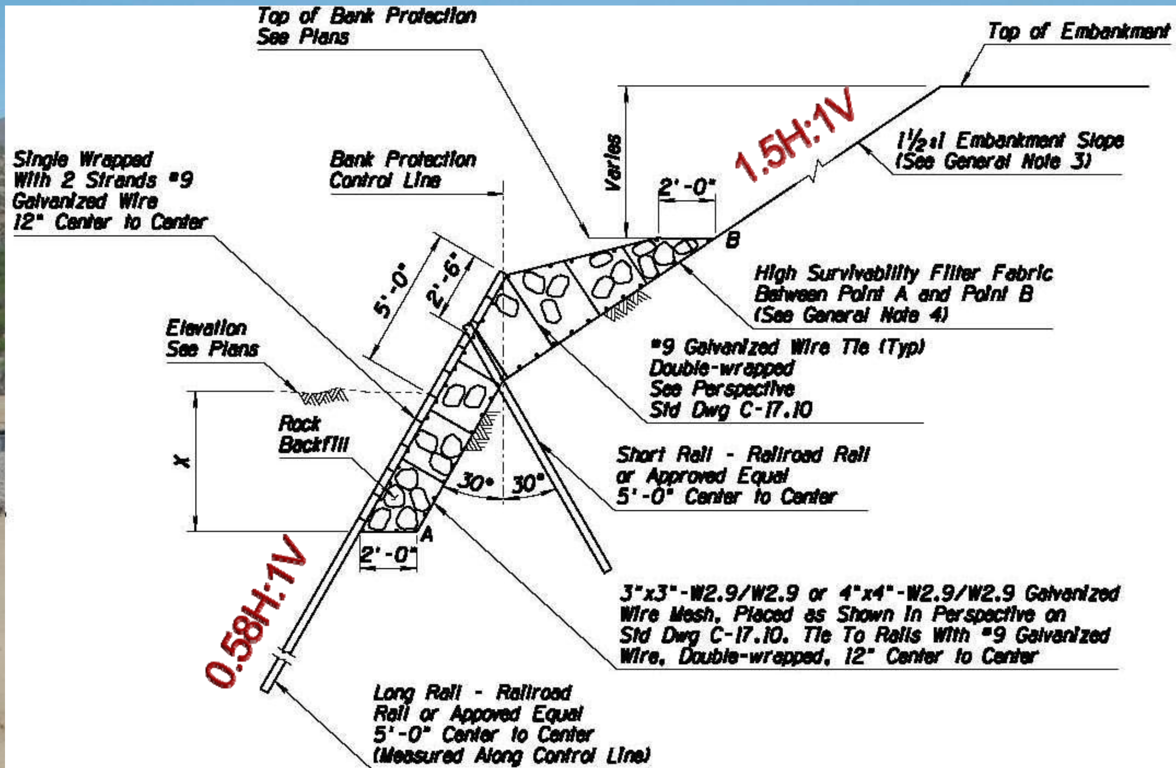


1,045 lineal feet of bank protection

Rail Bank Protection – ADOT C-17.15 Type 6

Depth of rip rap below grade = 10 feet

long rail = 28 feet, short rail = 16 feet

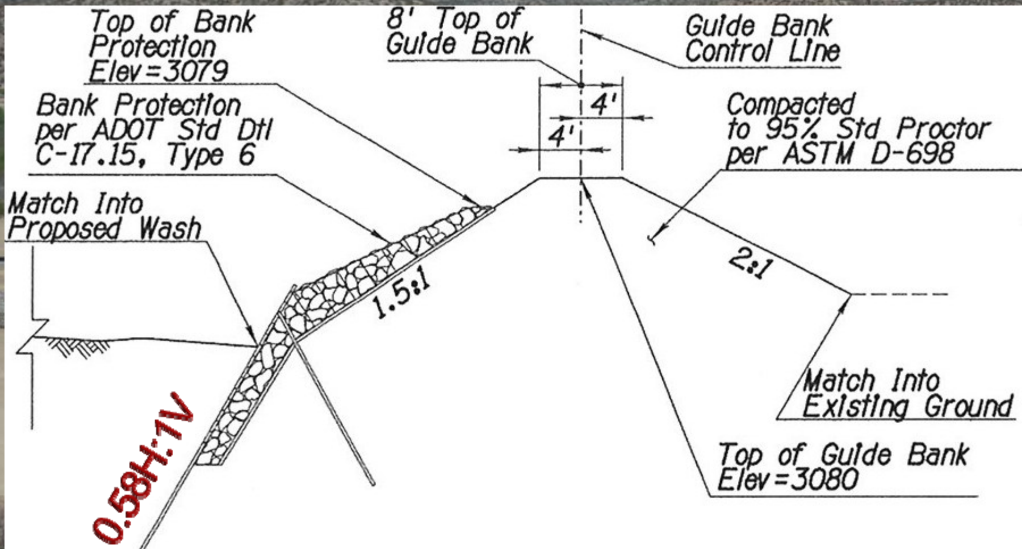


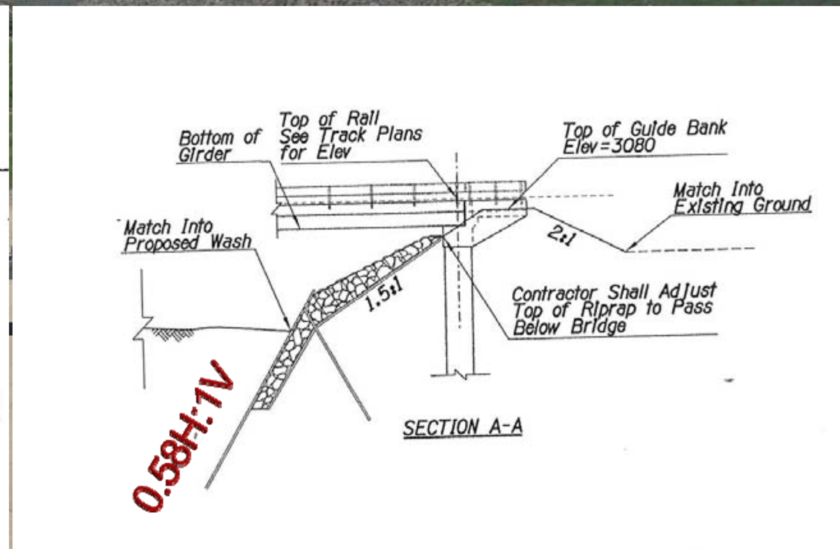
TYPICAL SECTION
See Perspective Std Dwg C-17.10

Type	X (Ft-In)	Minimum Rail Length (Ft)		Minimum Rail Weight (Lbs/Yd)
		Long Rail	Short Rail	
4	5-0	22	10	50
5	7-6	25	13	50
6	10-0	28	16	50

OSHA requires a 1.5H:1V max slope for Type C soils

Rail Bank Protection



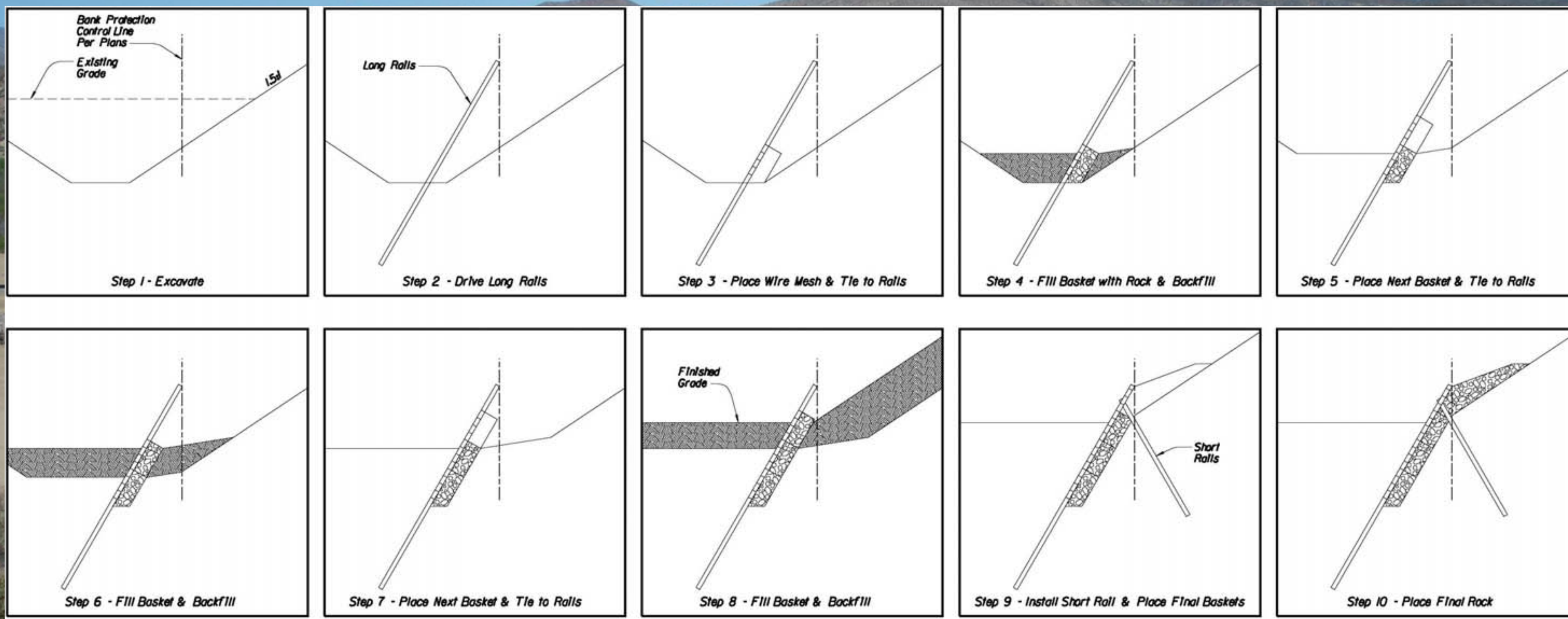


Rail bank at guide banks

Rail bank at abutments

Rail Bank Protection

Rail Bank Protection



Construction method to maintain 1.5:1 slopes

Rail Bank Protection

Installation of long rails on overexcavated slope (1.5H:1V)

Rail Bank Protection

Backfilling in front of bank protection
(short rails not yet installed)

Rail Bank Protection

Installation of long rails near abutments
(as you can see, there were headroom issues)

Rail Bank Protection

Backfilling behind bank protection with remote control compactor

Rail Bank Protection

Bank protection in progress with filter fabric and rock

Rail Bank Protection

Installing short rails

Rail Bank Protection

Placing rock on 1.5H:1V slope
(very time consuming due to flat slope)


Rail Bank Protection
Completed bank protection

Rail Bank Protection

Bank protection at abutments

Short rail to long rail connection

Rail Bank Protection

Completed bank protection

Completed Bridge

Completed Bridge


January
2008
February
2008


February
2008
May
2011


Thank you
Questions?