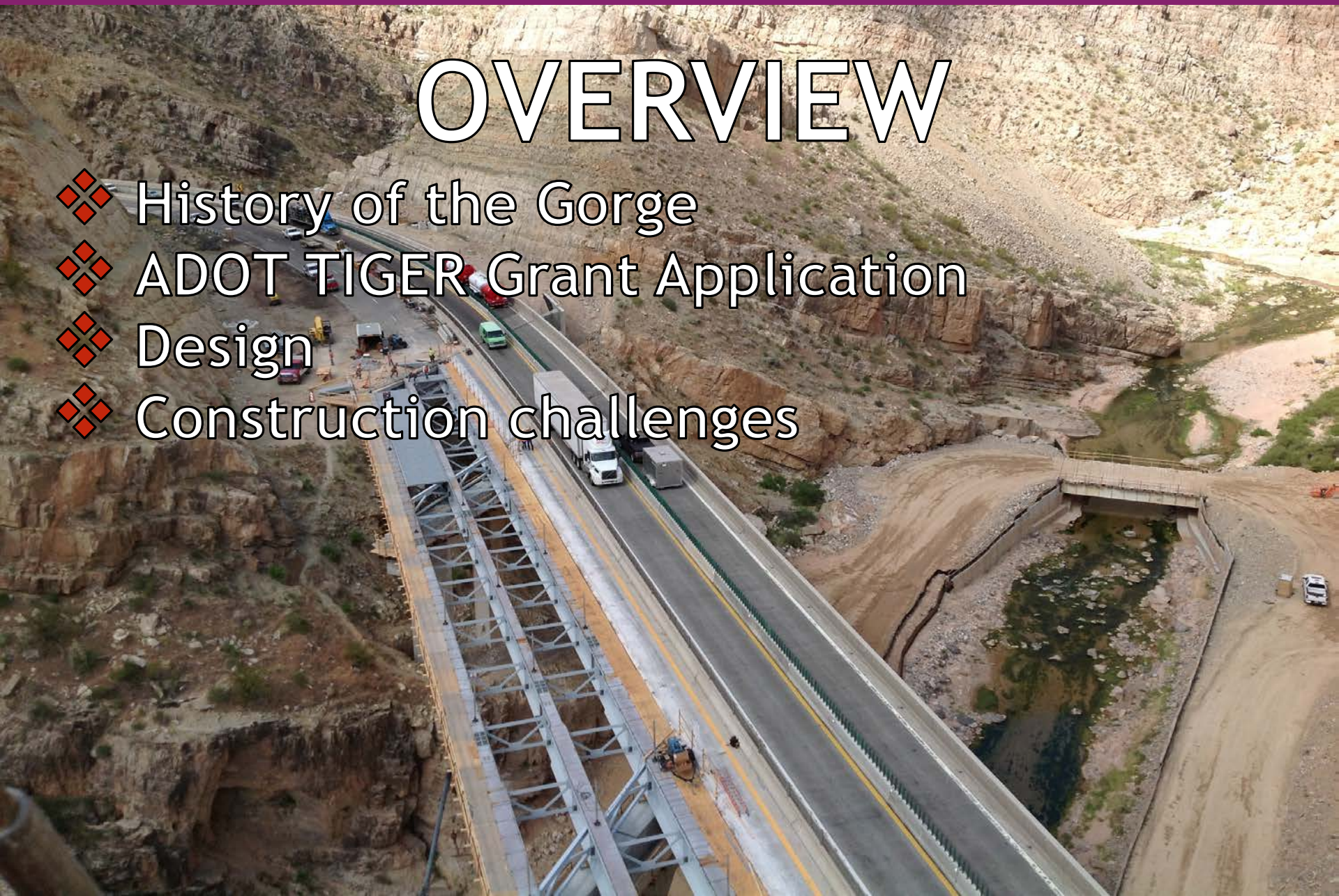
Acquiring and Implementing TIGER Grant funding for I-15 Virgin River Bridge #6 Superstructure Replacement

Rafael Davis

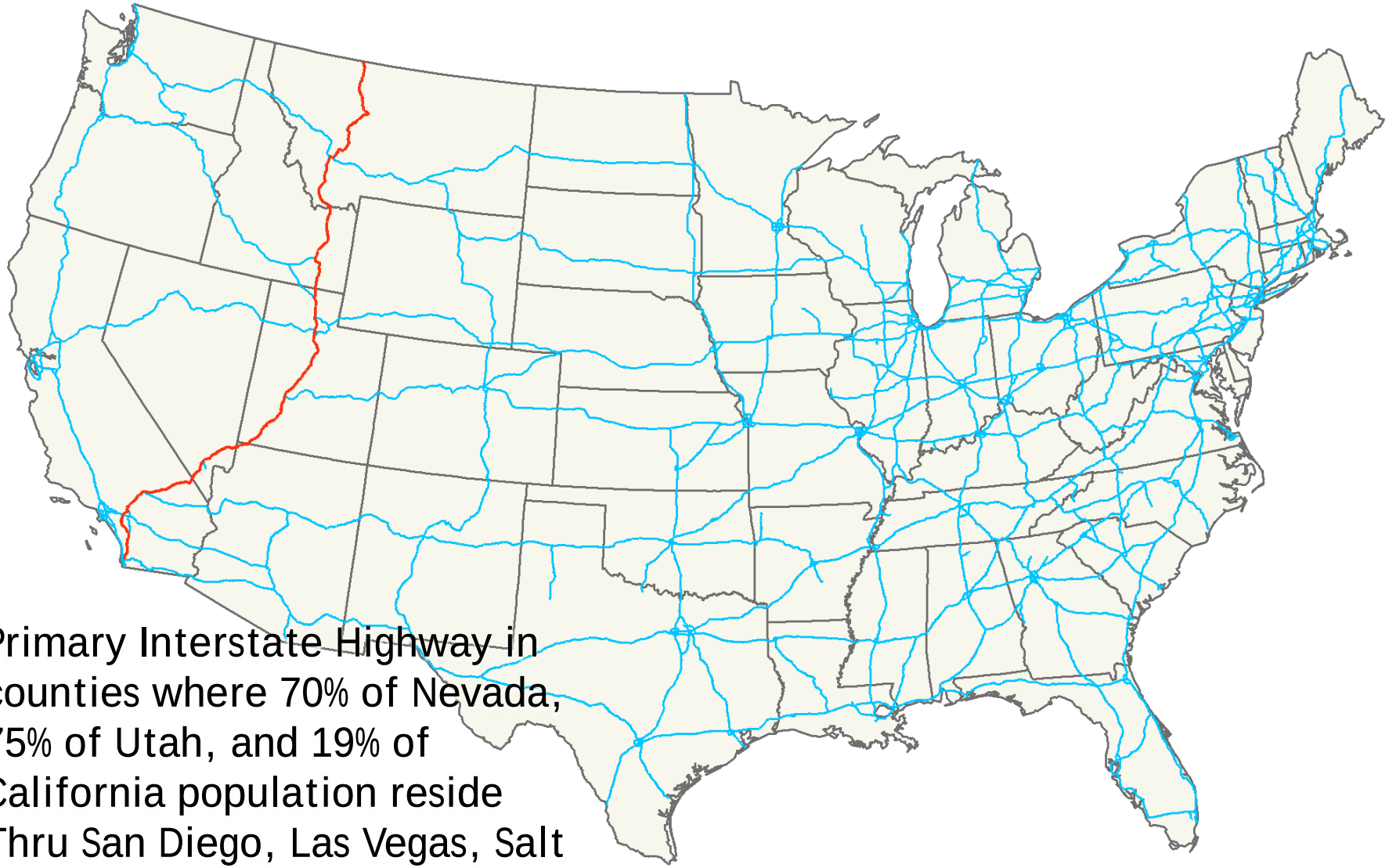
Senior Bridge Engineer with ADOT Bridge Design Group

OVERVIEW

- History of the Gorge
- ADOT TIGER Grant Application
- Design
- Construction challenges



Where is I15?



- Primary Interstate Highway in counties where 70% of Nevada, 75% of Utah, and 19% of California population reside
- Thru San Diego, Las Vegas, Salt Lake City Utah, Idaho, and Montana

Bridge Group

Where is I15 in AZ?

Bridge 6, #1619
I-15, MP 15.58

- Most AZ residents don't know it exists.
- Known as AZ strip it is 29.43 miles long
- 308 Residents of Littlefield AZ need to leave state to go anywhere
- Designated as a "Nationally and Exceptionally Significant Feature of the Federal Interstate Highway System"
- Part of CANAMEX

Bridge Group

What is CANAMEX?

Established under NAFTA
Identified as a "High Priority" Corridor in the

- *Intermodal Surface Transportation Efficiency Act of 1991*
- *1995 National Highway System Design Act*
- *Transportation Equity Act of the 21st Century 1998*

- NAFTA Treaty establishes highway be upgraded to 4 lanes its entire length

Bridge Group

What is VRG?

- *500Million year old Rugged Gorge*
- *Tributary of Colorado River system that carved Zion and the Gorge*
- *Limestone Cliffs over 500ft*
- *Habitat for three federally protected species*
- *One of a few perennial rivers in Arizona*

Bridge Group

1829 Old Spanish Trail

Important trade route between New Mexico and California.
Pack horse route Armijo Route cut thru four corners and St. George. Followed Colorado river to the Virgin river thru the Gorge. Established 1829 by Antonio Armijo
Main Route established in 1830 went far north avoided canyon country and joined the Armijo trail at present day Littlefield at Virgin River.

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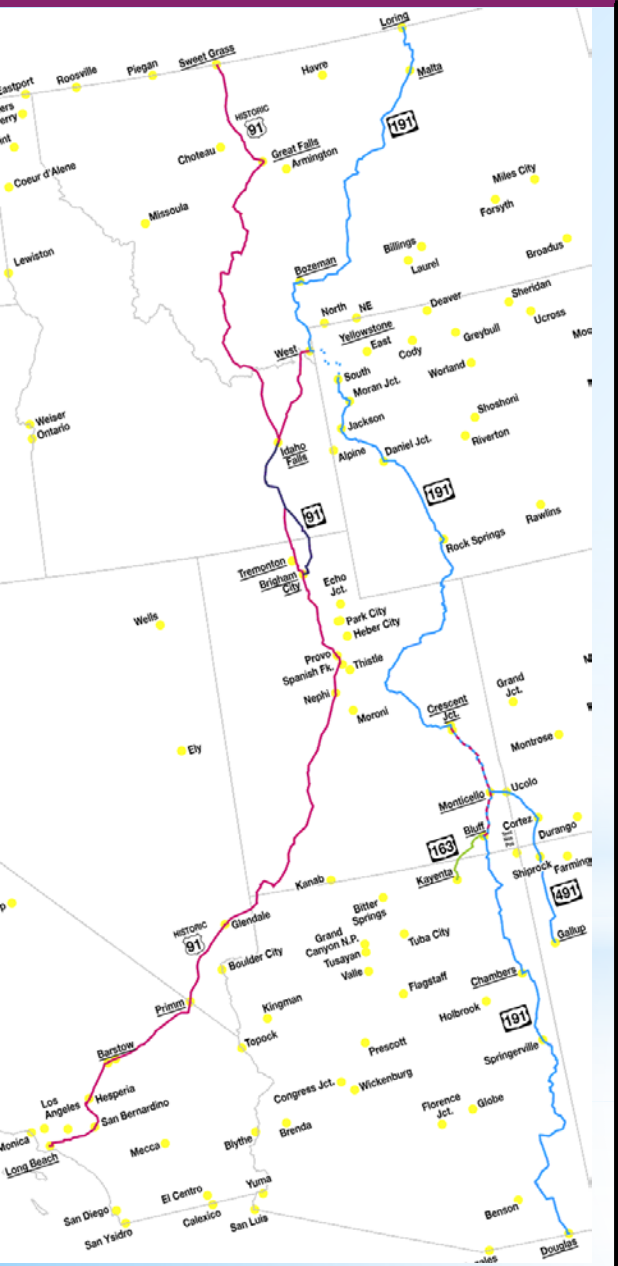
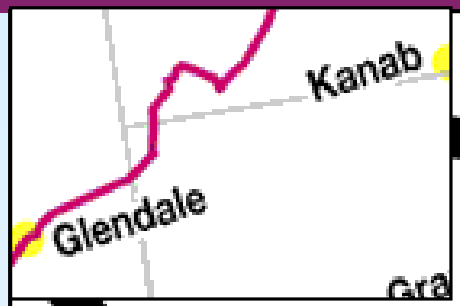
1926 US 91 Highway





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Why is I-15 thru the gorge?

- *US 91 up Utah Hill was dangerous for vehicles at the time climbing 3,000ft from Littlefield AZ*

- *Largest city outside of Salt Lake area*
- *Highway was huge to St. George economy*
- *Utah lent their federal funding to Arizona*

1939 “Super Highway”

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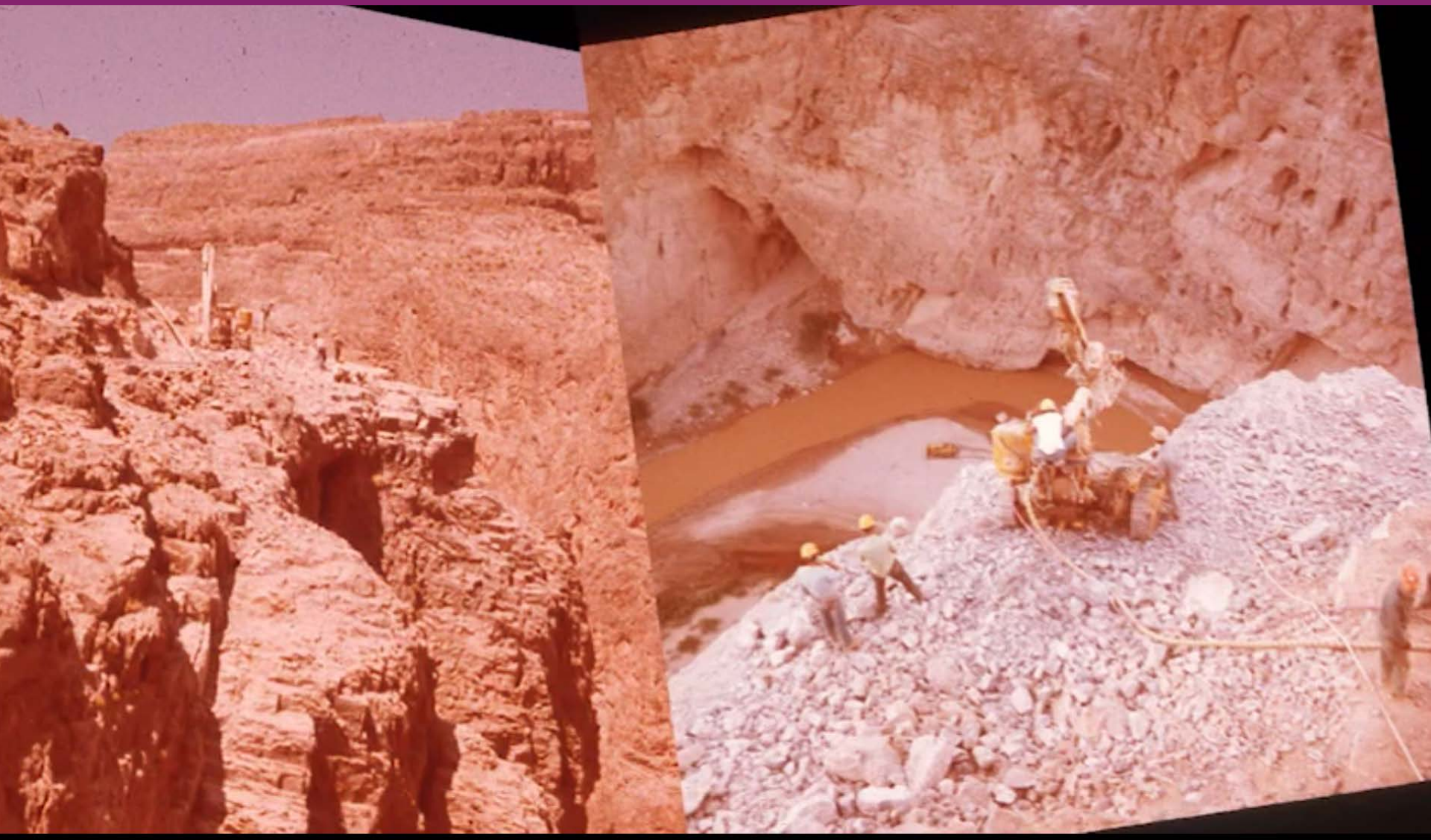
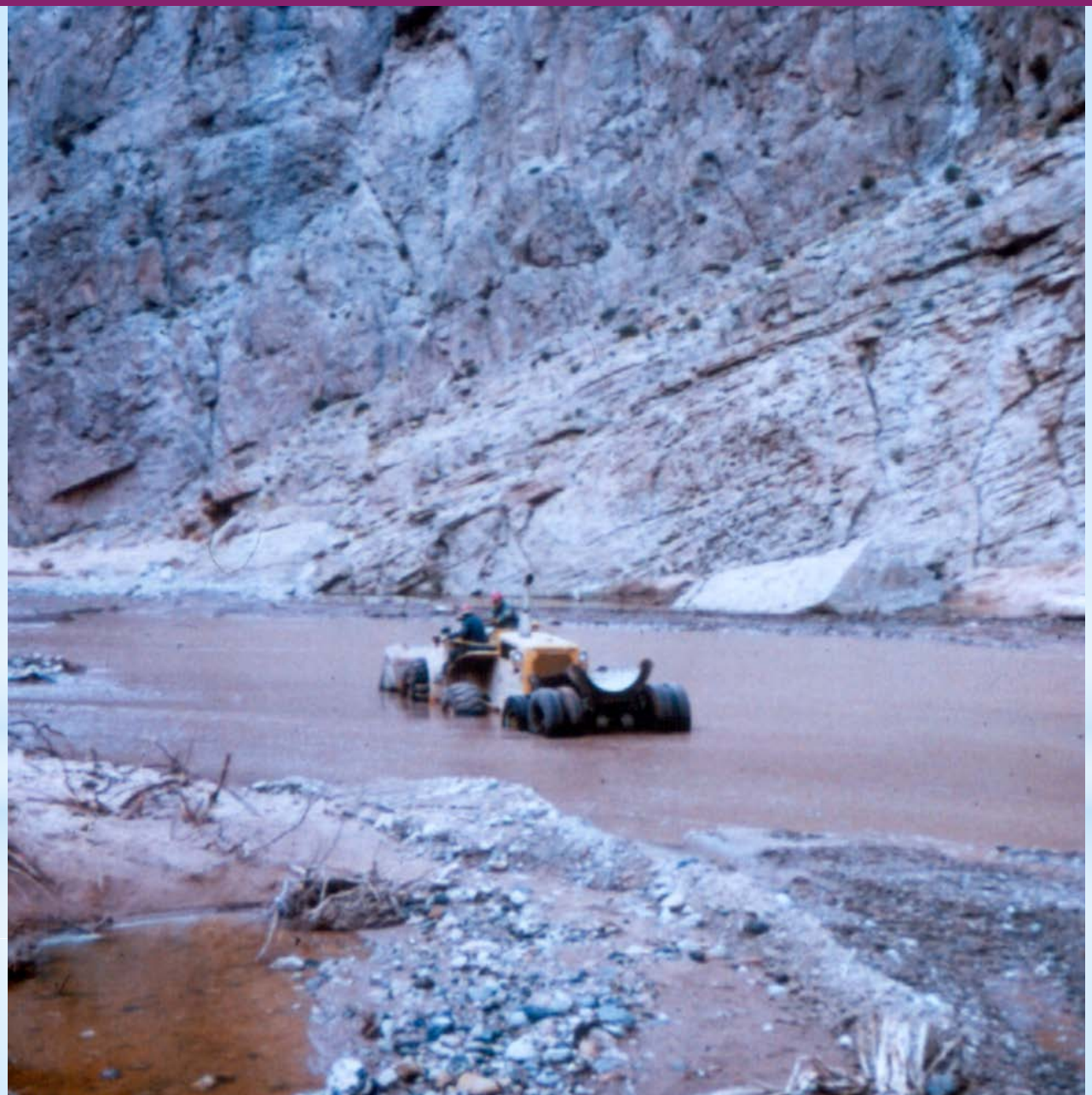
Super Highway

Rugged construction

Handwork to start



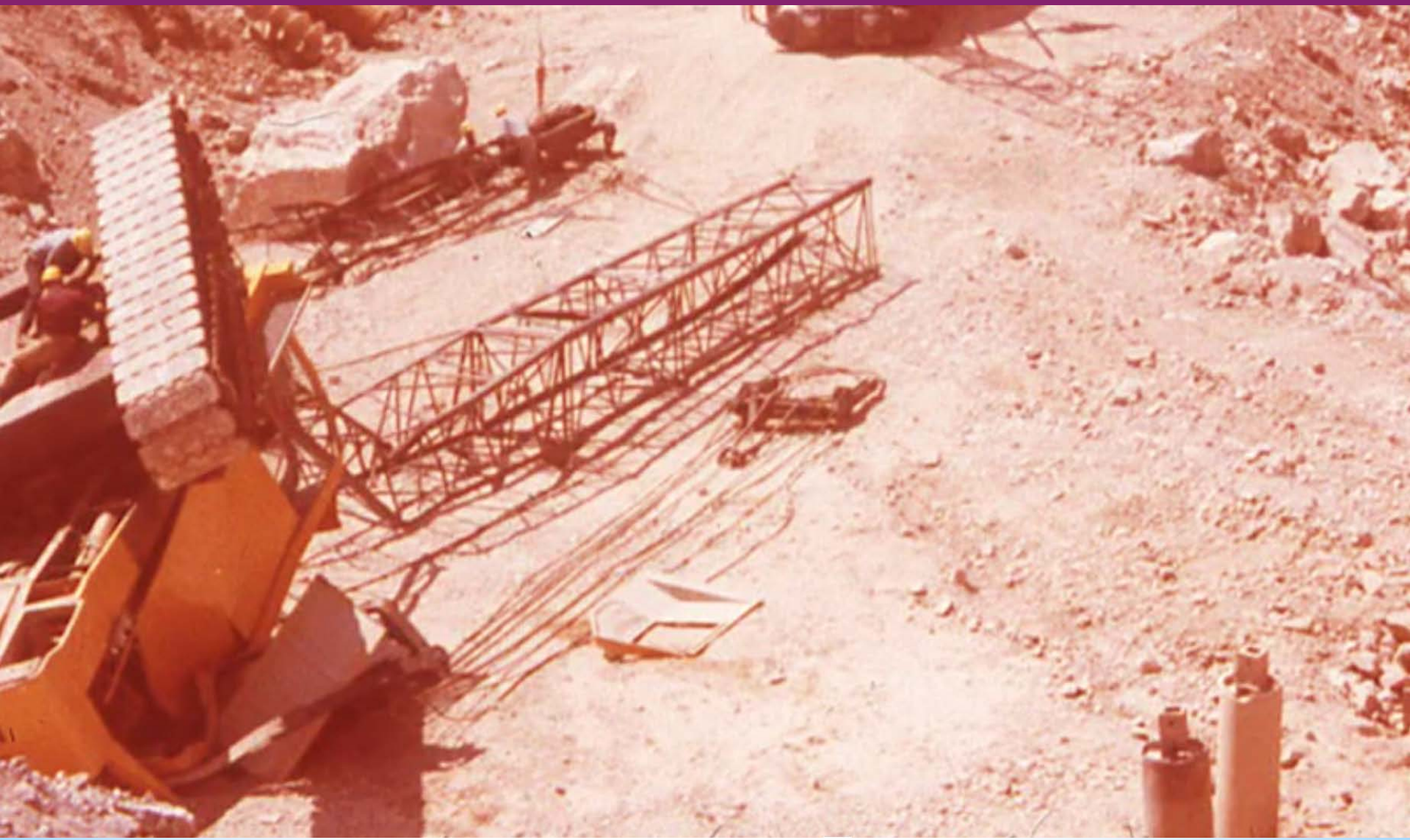
Swamp buggy



Flash Floods

Tight Jobsite

Many Accidents



Bridge Group

Never perfect

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Before and After

"Most Scenic Highway in AZ"

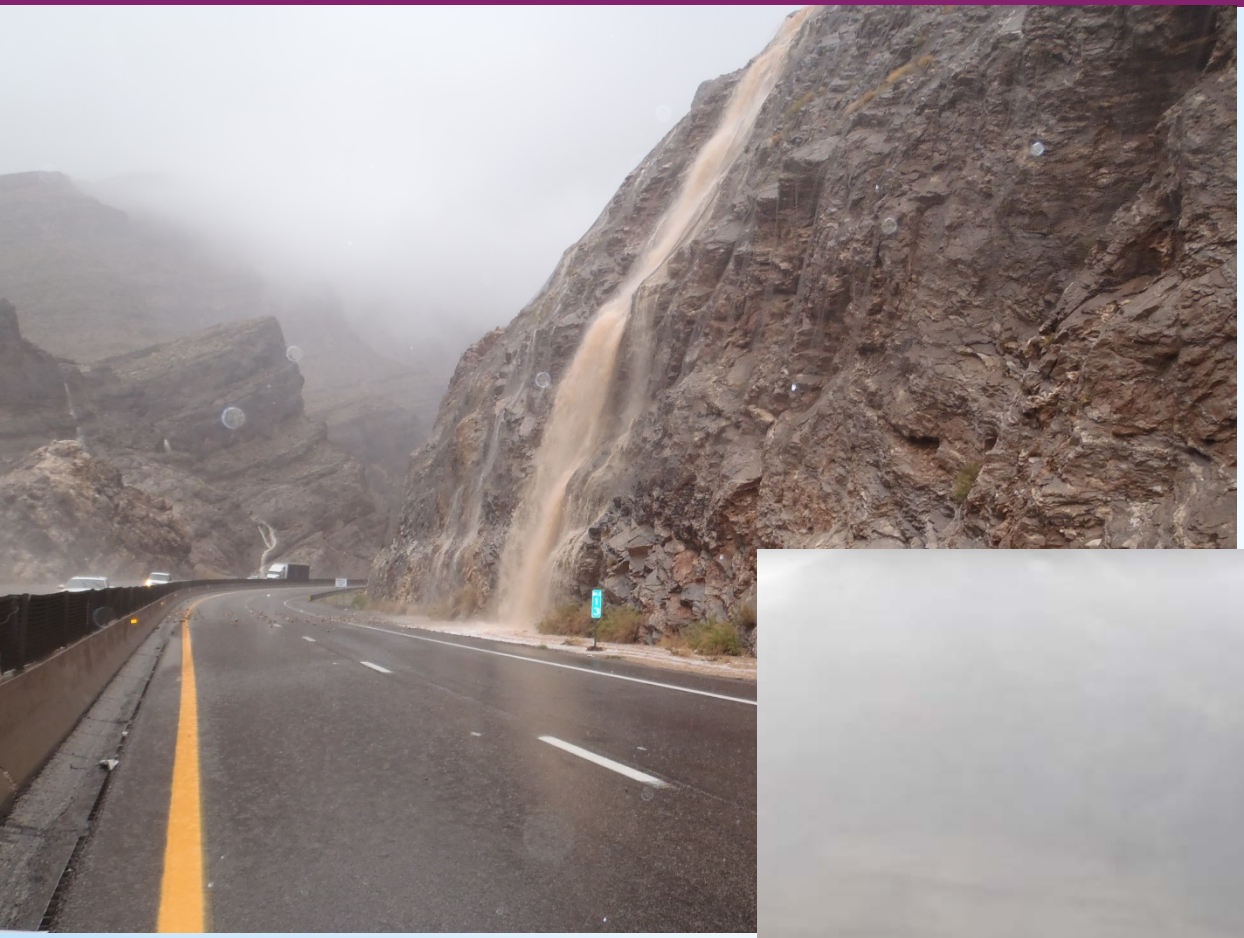
- **Most expensive Rural Interstate per mile in History at the time**
- **7 Bridges**
- **3.2 miles thru Gorge**
- **$50million per mile adjusted for inflation**
- **Construction from 1964 and 1973**

Bridge Group

Today's Gorge

Bridge Group

Today's Gorge



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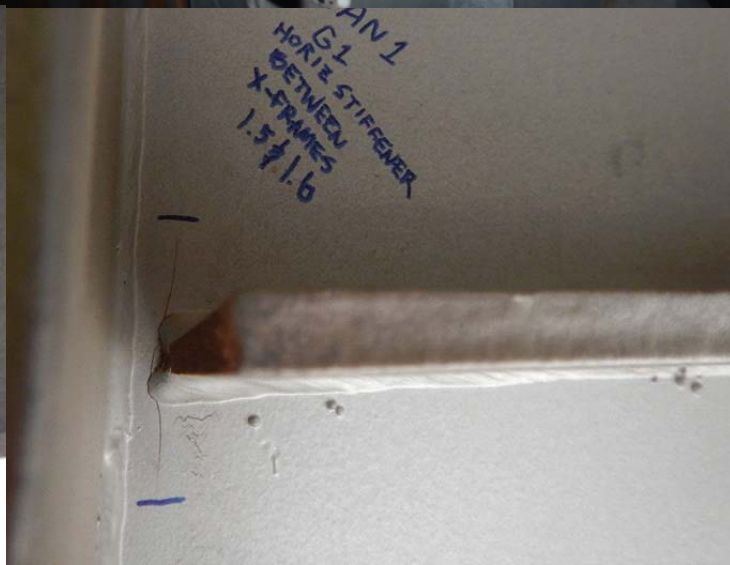
4 Fracture Critical Bridges

Frequent Repairs



Bridge Rehabilitation

Bridge	Year	Project #	Structure items ($)	Traffic control, mobility etc. ($)	15% Contingencies ($)	Project development and CE ($)	Total per project ($)
Bridge #1	1999	H5177 01C	22,673	12,460	5,270	8,783	49,186
Bridge #2	1999	H5177 01C	8,010	12,460	3,071	5,118	28,658
Bridge #2	2007	H6938 01C	183,344	200,105	57,517	95,862	536,829
Bridge #3	1999	H4532 01C	457,746	339,264	119,552	199,253	1,115,814
Bridge #3	2007	H6938 01C	178,612	200,105	56,808	94,679	530,204
Bridge #4	2002	H6029 01C	120,154	234,710	53,230	88,716	496,810
Bridge #4	2007	H6938 01C	74,976	200,105	41,262	68,770	385,113
Bridge #5 NB	1999	H5177 01C	32,530	12,460	6,749	11,248	62,986
Bridge #5 NB	2002	H6029 01C	87,602	234,710	48,347	80,578	451,237
Bridge #5 NB	2004	H5844 01C	29,965	200,000	34,495	57,491	321,951
Bridge #5 NB	2007	H6938 01C	143,772	200,105	51,582	85,969	481,428
Bridge #5 SB	1999	H5177 01C	56,774	12,460	10,385	17,309	96,928
Bridge #5 SB	2007	H6938 01C	63,854	200,105	39,594	65,990	369,543
Bridge #5 SB	2002	H6029 01C	87,602	234,710	48,347	80,578	451,237
Bridge #6	1999	H5177 01C	20,100	12,460	4,884	8,140	45,584
Bridge #6	2002	H6029 01C	239,514	234,710	71,134	118,556	663,914
Bridge #6	2007	H6938 01C	190,308	200,105	58,562	97,603	546,578
Bridge #7	1998	H4532 01C	223,715	339,264	84,447	140,745	788,171
Bridge #7	1999	H5177 01C	33,951	12,460	6,962	11,603	64,975
Bridge #7	2004	H5844 01C	334,190	200,000	80,129	133,548	747,866
Bridge #7	2007	H6938 01C	1,808,174	200,105	301,242	502,070	2,811,591
						Total	$11,046,601

TIGER Grant

Transportation Investment Generating Economic Recovery

* Merit based competitive Discretionary Grants
* $4.1 Billion TIGER funds in 7 rounds since 2009
* 6,000 applications requesting $124 Billion
* Program has historically achieved 3.5 co-investment dollars for every TIGER dollar invested
* Results in $18.45 Billion in total construction spending

June 2012 ADOT TIGER

What TIGER wants

* Project would be difficult to fund otherwise
* Strong partnership, Multi-jurisdictional cooperation
* Leverage non-federal resources with a strong match(min 20%)
* Timeline for success
* Presents a clear story and project impact
* Innovative delivery methods
* Cost Benefit analysis
* TIGER Website provides lots of information and training on application process
* <u>Measures 5 Long term benefits</u>

1. Safety
2. economic competiveness
3. state of good repair
4. quality of life
5. environmental sustainability

Bridge Group

ADOT TIGER Application

Long-term outcomes	Benefit categories	Description	Monetized	Quantified	Qualitative
State of Good Repair	Pavement Maintenance	Pavement maintenance savings by not diverting traffic to a longer detour route	$17.8	25.1 million VMT per year	
	Maintenance and Operating Cost Savings	Savings in costs associated with longer-term maintenance and operation of deficient bridge superstructure			Represents a savings on the cost side of the BCA
Economic Competitiveness	Fuel Savings	More circuitous detour routes increase travel distance and fuel consumption.	$188.6	4.6 million gallons per year	
	Vehicle Operating Cost Savings	Reductions in monetary costs from longer detour routes for trucks	$154.4	25.1 million VMT per year	
	Travel Time Savings	Time savings associated with reduced detour mileage	$132.9	0.4 million VHT per year	
Livability	Maintain Critical Transportation Corridor	Freight and congestion benefits to keeping freight trucks on a dedicated freight corridor			Limits truck congestion in small communities
Environmental Sustainability	Emissions Reduction	Reductions in pollutants and green house gases due to fewer trucks using longer more circuitous routes	$22.9	46,300 tons GHG per year	
Safety	Accident Reduction	Reductions in property losses and injuries and deaths due to fewer truck traffic diversions	$1.2	0.4 accidents per year	

ADOT TIGER Application

Table 7 | Benefit-Cost Results for 7% and 3% Discount Rate - Bridge #6

7% Discount Rate			3% Discount Rate	
BENEFITS	Millions of 2012$		BENEFITS	Millions of 2012$
Emissions Benefits	9.9		Emissions Benefits	9.9
Time Savings	55.5		Time Savings	55.5
Accidents	0.2		Accidents	0.2
Highway Maintenance Savings	5.9		Highway Maintenance Savings	5.9
Vehicle Operating and Maintenance	51.3		Vehicle Operating and Maintenance	51.3
Fuel Costs	58.6		Fuel Costs	58.6
TOTAL BENEFITS	181.0		TOTAL BENEFITS	181.0
PV of Total Benefits	125.7		PV of Total Benefits	154.1
COSTS			COSTS	
Maintenance Costs	0.1		Maintenance Costs	0.1
Capital Costs	27.0		Capital Costs	27.0
TOTAL COSTS	27.1		TOTAL COSTS	27.1
PV of Total Costs	22.0		PV of Total Costs	23.7
Net Present Value (NPV)	103.8		Net Present Value (NPV)	130.4
Benefit-Cost Ratio (BCR)	5.7		Benefit-Cost Ratio (BCR)	6.5

ADOT TIGER Application

Table 8 | Benefit-Cost Results for 7% and 3% Discount Rate – Rehabilitation of System of Virgin River Bridges

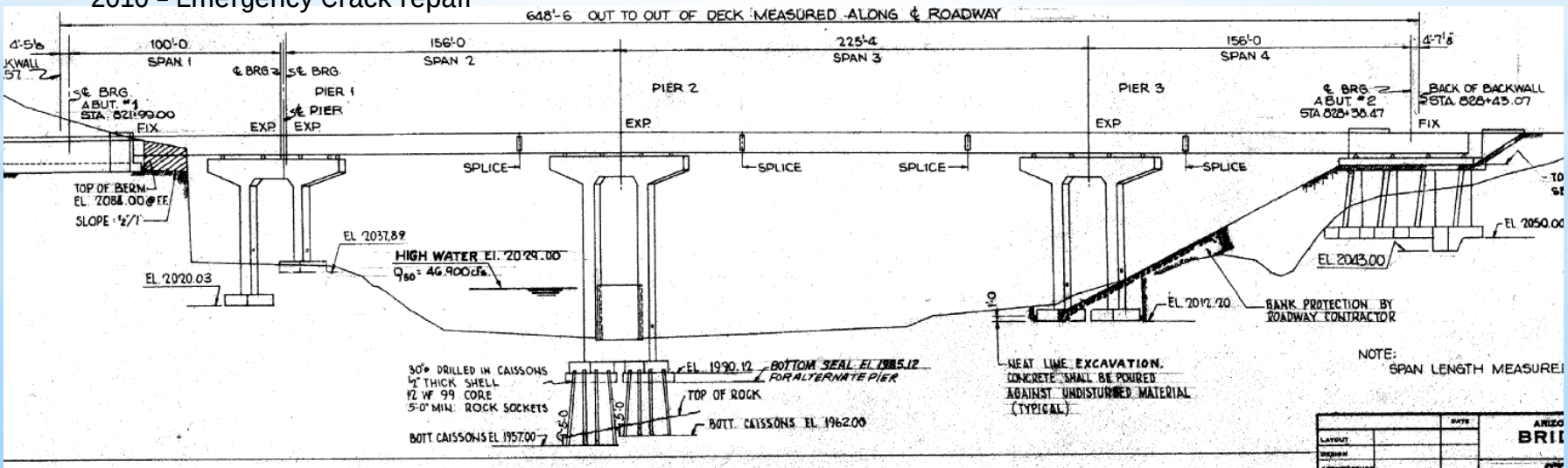
7% Discount Rate			3% Discount Rate	
BENEFITS	**Millions of 2012$**		**BENEFITS**	**Millions of 2012$**
Emissions Benefits	68.9		Emissions Benefits	68.9
Time Savings	668.3		Time Savings	668.3
Accidents	5.1		Accidents	5.1
Highway Maintenance Savings	56.5		Highway Maintenance Savings	56.5
Vehicle Operating and Maintenance	490.4		Vehicle Operating and Maintenance	490.4
Fuel Costs	615.0		Fuel Costs	615.0
TOTAL BENEFITS	1,904.0		TOTAL BENEFITS	1,904.0
PV of Total Benefits	594.0		PV of Total Benefits	1,088.0
COSTS			COSTS	
Maintenance Costs	2.9		Maintenance Costs	2.9
Capital Costs	27.0		Capital Costs	27.0
TOTAL COSTS	29.9		TOTAL COSTS	29.9
PV of Total Costs	70.5		PV of Total Costs	96.1
Net Present Value (NPV)	523.5		Net Present Value (NPV)	991.9
Benefit-Cost Ratio (BCR)	8.4		Benefit-Cost Ratio (BCR)	11.3

CHALLENGES OF SPENDING GRANT

* Advanced Schedule
* Complex Geometry and Phasing
* Contractor coordination and Negotiating GMP
* Strict Environmental regulations

Existing Bridge Data

* 4 Spans-100ft simple and 3 span continuous 156ft, 225ft, and 156ft
* Spread footings on rock, Pier 2 is on two spread caps with 4-30” caissons each
* Four-9ft deep steel plate girders 17’-4” O.C.
* S45.0 Sufficiency Rating with Poor (4.0) Superstructure Rating
* Pinned at Abutments with piers on high rocker bearings, Pier 1 has fingered expansion joint
* GEOMETRY
  * Superelevation transition on bridge
  * Horizontal spiral in span 1
  * Vertical curve that terminates on bridge
  * 45 degree skew
  * 2-12ft lanes with 3’-0” inside shoulder and 2’-9” outside shoulder
* REHABILITATION PROJECTS
  * 1999 – Cross-Frame and Gusset Plate Retrofit
  * 2002 – MSMC overlay of SB deck
  * 2007 – Replaced Barriers
  * 2010 – Emergency Crack repair



NEPA Process

3 LEVELS OF ENVIRONMENTAL DOCUMENTATION

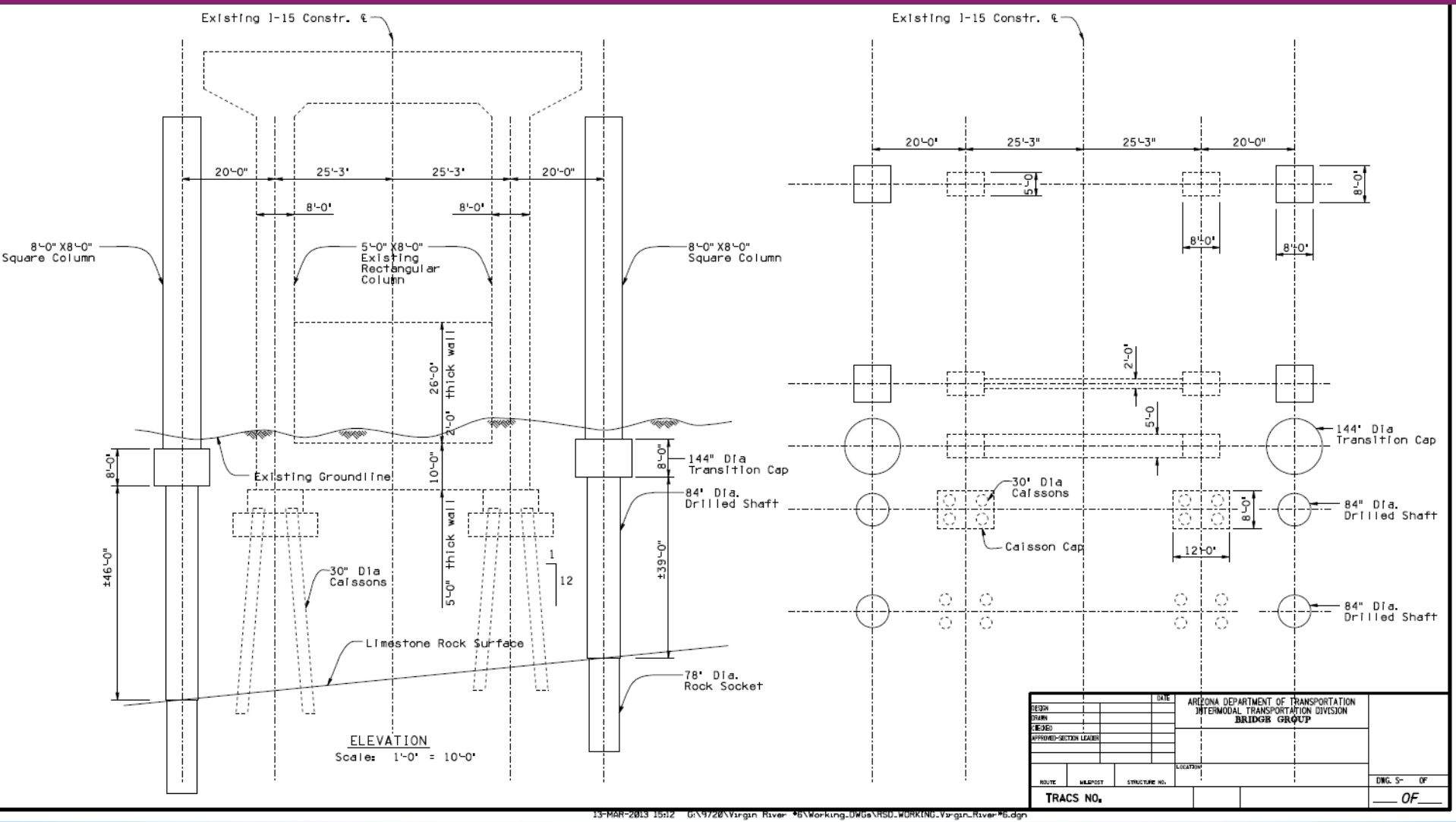
1. Categorical Exclusion
   * Does not have a significant effect on the quality of the human environment
   * Agencies develop a list of CEs specific to their operations
   * Based on an Agency's experience with a particular kind of action and its environmental effects
2. Environmental Assessment
   * Actions where the significance of environmental effect is not known
   * Decisional - determines further action

   Conclusion:
   * Finding of No Significant Impact (FONSI)
   * Significant Impacts – EIS Required
3. Environmental Impact Statement (EIS)
   * "Major Federal Action" that would significantly affect the environment
   * Projects financed, assisted, conducted, regulated or approved by Federal Agencies
   * For "gray areas" agencies should conduct an EIS rather than to risk the delay and expense of protracted litigation
   * Examples include a new, controlled-access freeway or a highway project of four or more lanes on a new location
   * Concludes with a Record of Decision (ROD)

Section 7 Consultation U.S.F.W.S.

* ***"No effect"*** means there will be no impacts, positive or negative, to listed or proposed resources. Generally, this means no listed resources will be exposed to action and its environmental consequences. Concurrence from the Service is not required.
* ***"May affect, but not likely to adversely affect"*** means that all effects are beneficial, insignificant, or discountable. Beneficial effects have contemporaneous positive effects without any adverse effects to the species or habitat. Insignificant effects relate to the size of the impact and include those effects that are undetectable, not measurable, or cannot be evaluated. Discountable effects are those extremely unlikely to occur. These determinations require written concurrence from the Service.
* ***"May affect, and is likely to adversely affect"*** means that listed resources are likely to be exposed to the action or its environmental consequences and will respond in a negative manner to the exposure.

WORKING DRAWINGS



Working Drawings used to get Geotech, Environmental, and Hydraulics Engineers started prior to the 60% submittal.

SCOUR: "Erodibility Index Method"

3.6.2 Summary of Scour Analyses

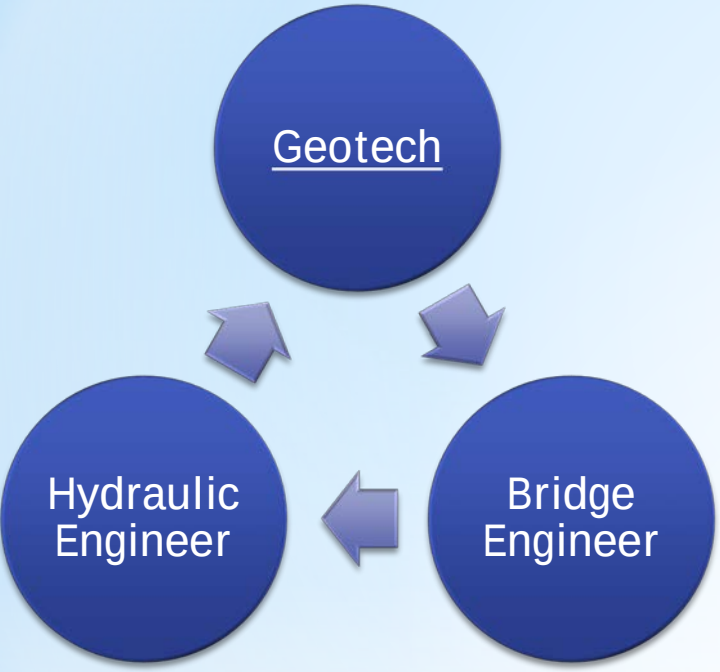
The results of the scour analysis are presented in Table 2. Note that the foundations of Piers #1 and #3 are spread footings on rock, so a scour evaluation was not performed.

Table 3: Results of Scour Analyses

	Pier #2		
	50-year	**100-year**	**500-year**
Peak Discharge	**31,060 cfs**	**39,510 cfs**	**68,800 cfs**
Hydraulic Conditions			
Water Surface Elevation	2023.01	2025.07	2029.63
Hydraulic Depth (ft)	14.48	16.54	21.09
Velocity (fps)	28.00	29.43	36.06
Elevations			
Assumed Bed Elevation	2008.37	2008.37	2008.37
Pile Cap Bottom Elevation	1990.12	1990.12	1990.12
Pile Cap Top Elevation	1995.12	1995.12	1995.12
Scour Calculation Results			
Pier Stem Scour Depth(ft)	36.6	38.0	42.9
Pile Cap Scour Depth(ft)	8.7	8.7	8.9
Pile Group Scour Depth(ft)	3.93	4.92	8.31
Total Scour Depth(ft)	**49.1**	**51.6**	**60.1**
Scour hole bottom elevation	**1959.23**	**1956.74**	**1948.31**

Note: Scour is limited by bedrock elevations of 1968.00 feet (downstream side of bridge) to 1988.00 feet (upstream side of bridge).

SCOUR: "Erodibility Index Method"



$$K_h = M_s \left(\frac{RQD}{J_n} \right) J_s \left(\frac{J_r}{J_a} \right)$$

where:

K_h	=	Erodibility Index
M_s	=	intact rock mass strength parameter
RQD	=	rock quality designation
J_n	=	rock joint set number
J_s	=	relative orientation parameter
J_r	=	joint roughness number
J_a	=	joint alteration number

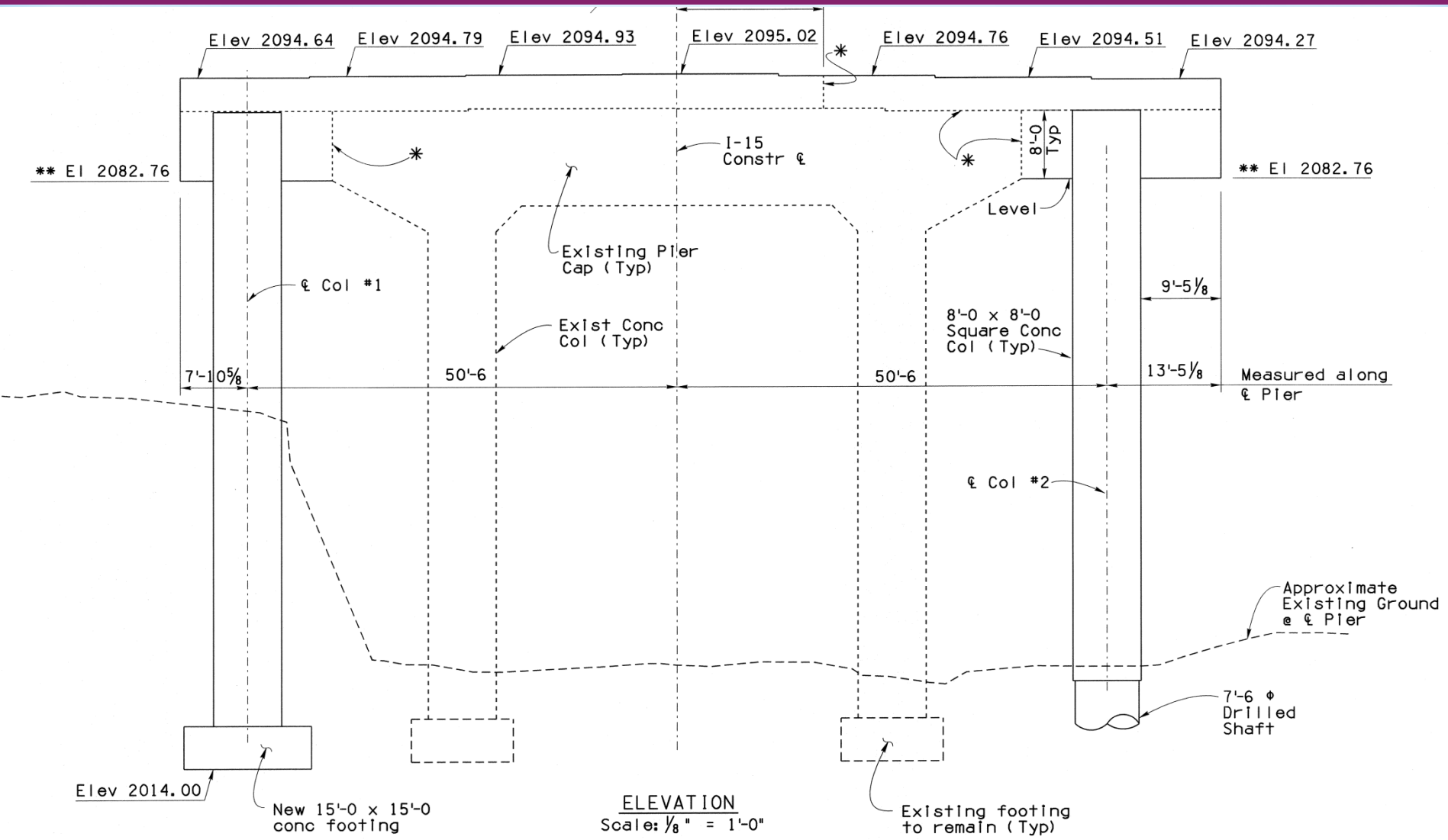
Table 6-2: Erodibility Index

Data Source	Unconfined Compressive Strength							Erodibility Index	Critical Stream Power (P_{crit})
	(lb/in²)	M_s	RQD	J_n	J_s	J_r	J_a	K_h	(kW/m²)
Pier 2	5,400	35	78	3.3	0.77	1.5	2.00	472.0	101.3
Pier 3	5,400	35	61	3.34	0.77	1.5	2.00	369.2	84.2

Table 6-3: Stream Power Summary

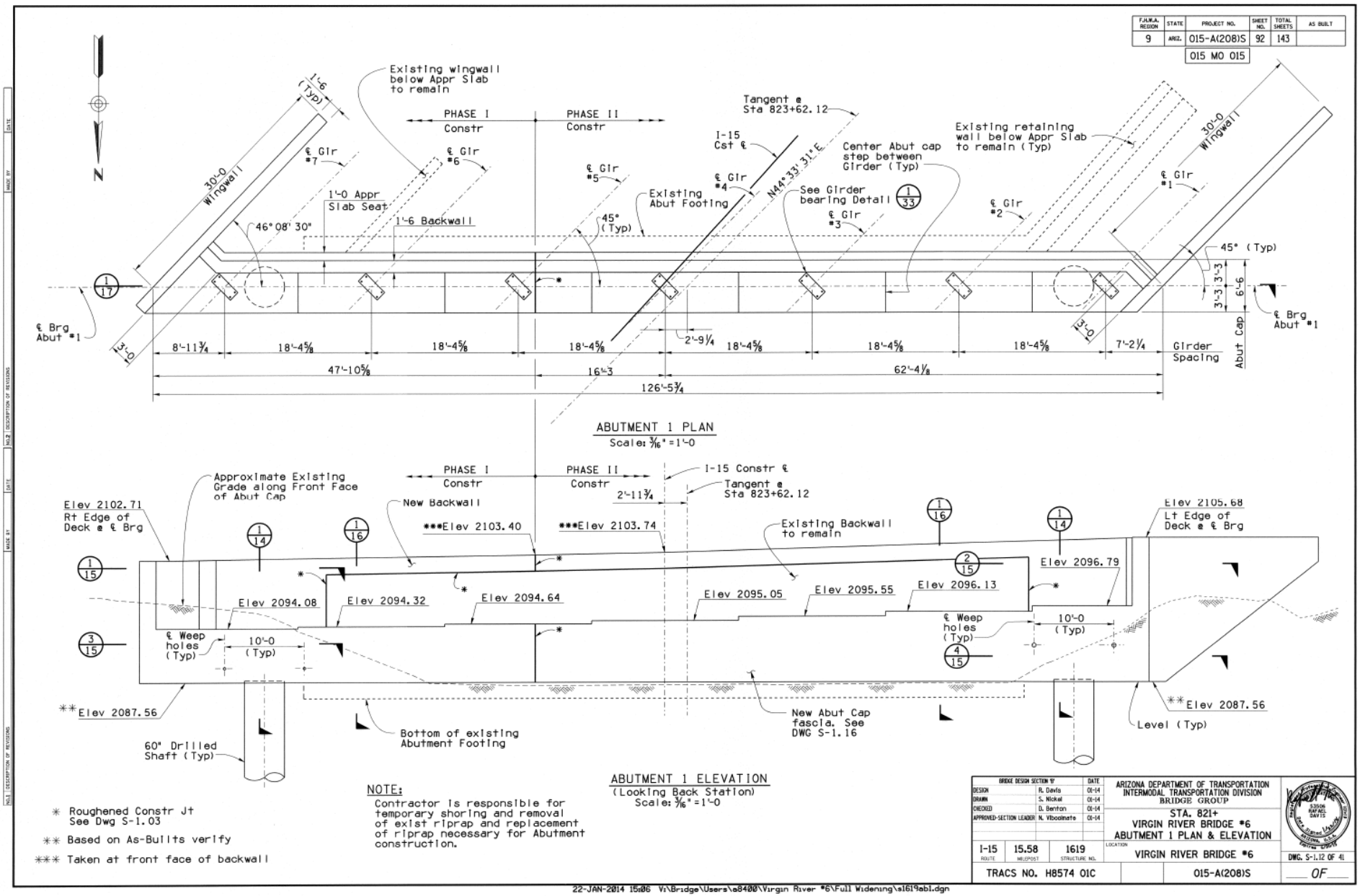
Storm Event	γ (lb/ft³)	q (ft²/sec)	Sf (%)	P_{design} (lb-ft/sec/ft²)	P_{design} (kW/m²)
100-Year	62.4	252.3	0.27	43.1	0.6
500-Year	62.4	417.0	0.27	71.3	1.0

PIER 3 ROCK EXCAVATION



Cutting existing ground line from InRoads surface file helped Contractor show ICE team costs associated with rock excavation

Bridge Group ABUT 1



* Roughened Constr Jt See Dwg S-1.03

** Based on As-Builts verify

*** Taken at front face of backwall

NOTE:
Contractor is responsible for temporary shoring and removal of exist riprap and replacement of riprap necessary for Abutment construction.

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
9	ARIZ.	015-A(208)S	92	143	
		015 MO 015			

BRIDGE DESIGN SECTION 'B'		DATE
DESIGN	R. Davis	01-14
DRAWN	S. Nickel	01-14
CHECKED	D. Benton	01-14
APPROVED-SECTION LEADER	N. Viboolnate	01-14

ARIZONA DEPARTMENT OF TRANSPORTATION
INTERMODAL TRANSPORTATION DIVISION
BRIDGE GROUP

STA. 821+
VIRGIN RIVER BRIDGE #6
ABUTMENT 1 PLAN & ELEVATION

I-15	15.58	1619	LOCATION: VIRGIN RIVER BRIDGE #6
ROUTE	MILEPOST	STRUCTURE NO.	

TRACS NO. H8574 01C | 015-A(208)S | DWG. S-1.12 OF 41 | OF

22-JAN-2014 15:06 V:\Bridge\Users\a8400\Virgin River #6\Full Widening\s1619abl.dgn

Bridge Group

PRE-CONSTRUCTION

* Acquired permit to excavate talus pile to find good material in ROW
* Equipment access
* Drill rig pads

Bridge Group

TEMPORARY BRIDGE

Bridge Group

SEPTEMBER FLOODS

Bridge Group

SEPTEMBER FLOODS

* Flooding damaged jobsite twice in September
* CMAR Contract had allowances for flood damage

BORINGS VARIED FROM REAL CONDITION

CMAR Contract had allowances for drilled shaft length

DIFFICULT ACCESS FOR DRILL RIGS

Bridge Group

CONSTRUCTION ENGINEERING

INNOVATIVE CONSTRUCTION

Containment system developed to keep slurry and concrete out of water

Old Rockfall fence used to keep rock scaling boulders from jumping highway

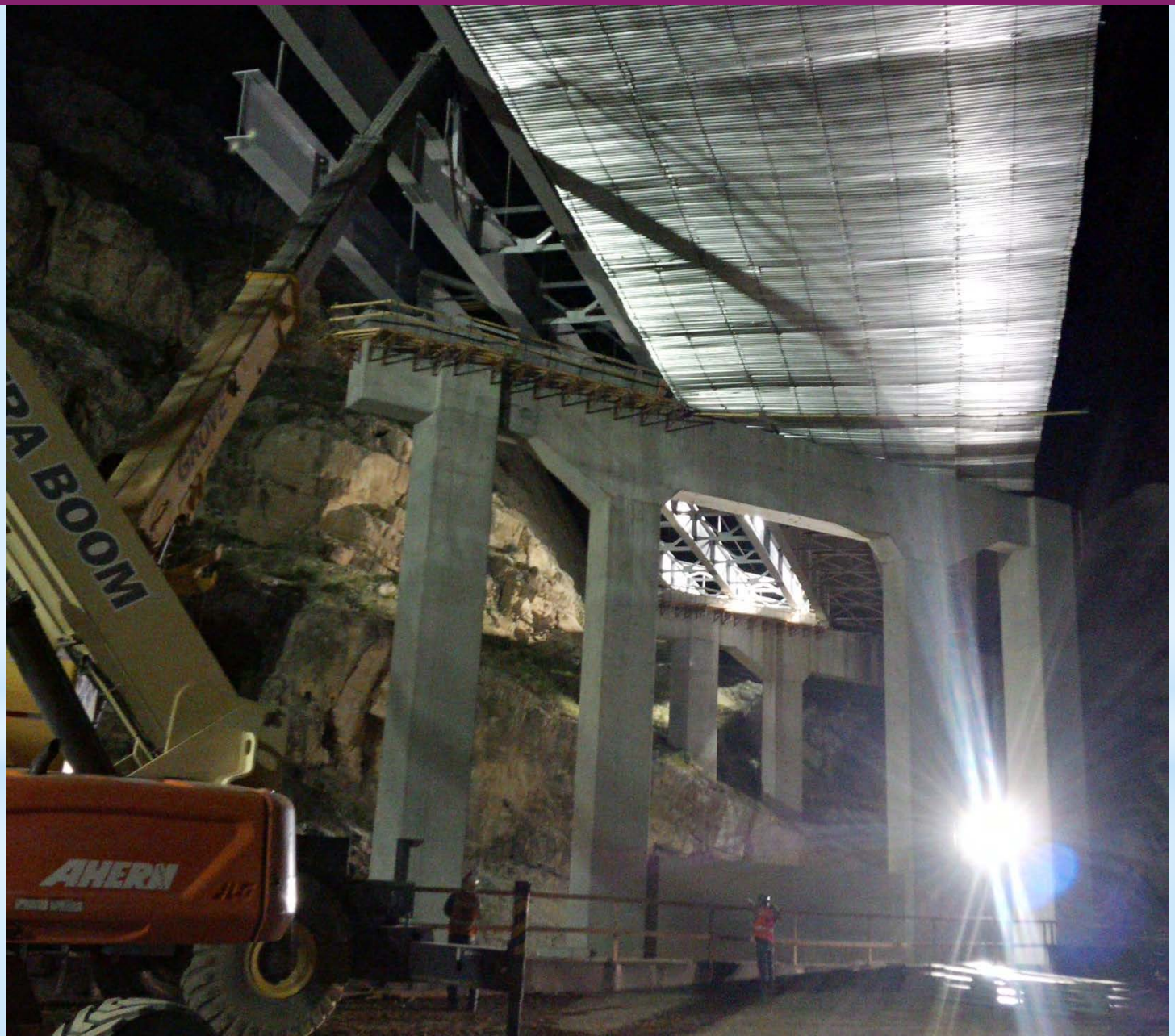
DPS used rolling stops to create breaks to scale cliffs

4D Modeling

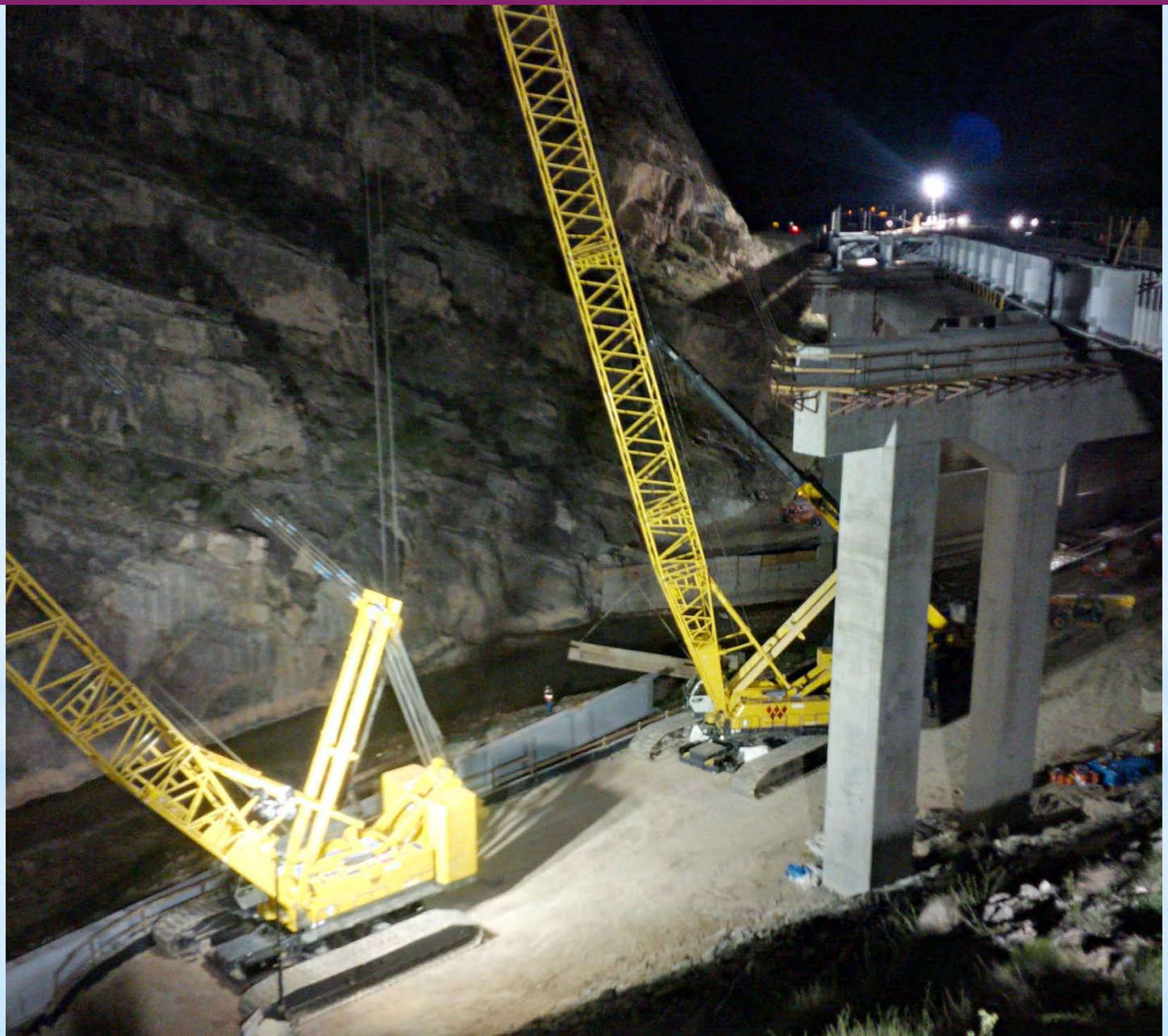
* Bracing for first girder
  * Against existing bridge
  * Lift in pairs
  * Shoring
  * 2nd smaller crane
* Geometry and conflicts
* Sequence of girder lifts

GIRDER PLACEMENT

GIRDER PLACEMENT



GIRDER PLACEMENT



GIRDER PLACEMENT

DECK POUR REQUIRED SLOWING OF TRAFFIC TO 25MPH TO REDUCE LIVE LOAD VIBRATION

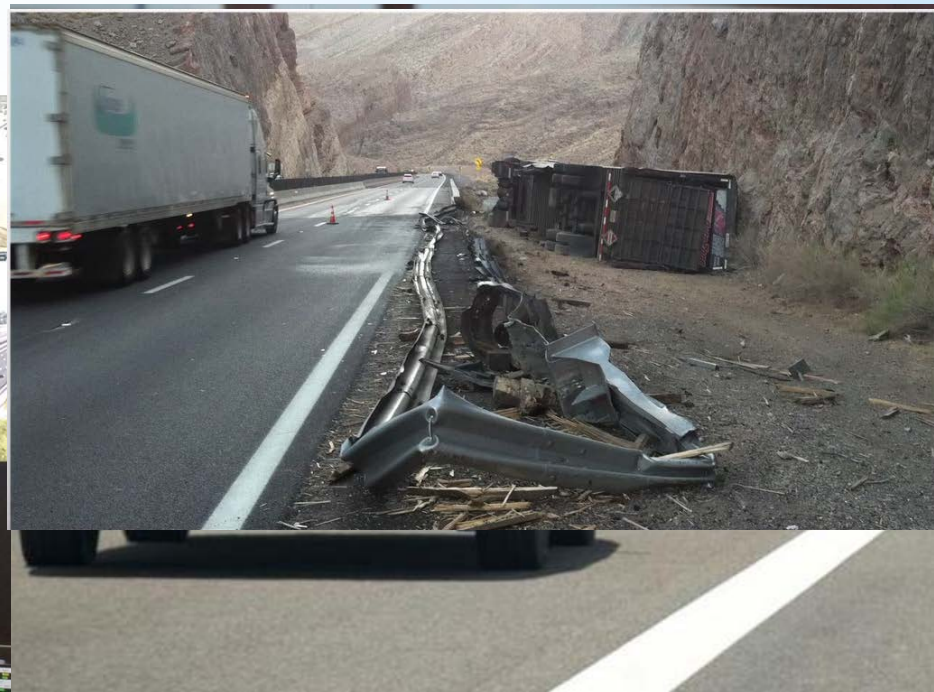
ARIZONA DEPARTMENT OF PUBLIC SAFETY IS INVALUABLE TO PROJECT SUCCESS

EXHIBIT A

DPS Reimbursement Rate Schedule

Hourly Rate	$44.00
Vehicle Idle Time	$9.97
Vehicle Mileage Rate (50 miles)	$2.78
Subtotal	$56.75
15% Markup (Prime & Broker)	$8.51
Total Hourly Rate	$65.26

- ADOT and DPS have a strong partnership
- Share funding and work together to meet the needs of the public and many agencies
- DPS is an elite 1,600 enforcement unit
- DPS provided rolling closures for girder placement, rock scaling, and concrete trucks
- Intergovernmental Agreement allows for seamless payment of services



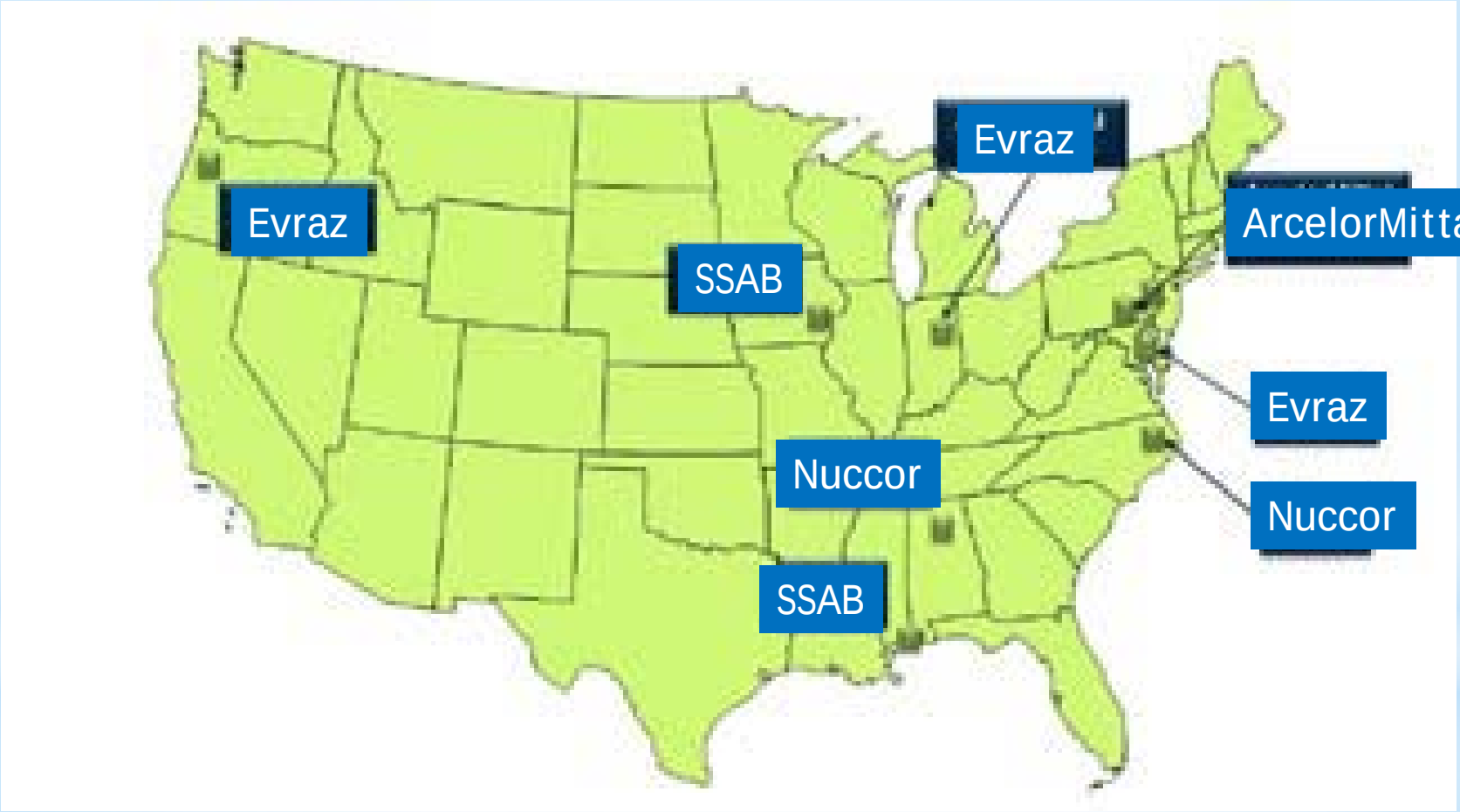
IMPROVED PAINT SYSTEM

* **Prime Coat** – **Organic** zinc epoxy with pigment primarily consisting of zinc dust.
* **Intermediate Coat** – Epoxy formulated without using any heavy metal materials listed in the Resource Conservation and Recovery Act (RCRA) regulations for toxic characteristics.
* **Finish Coat** – Aliphatic polyurethane, formulated without using any heavy metal materials listed in the RCRA regulations for toxic characteristics.

NOTES:

1. Galvanized bolts, nuts, and washers difficult to prime for paint. Requires hand-wire brushing. Mechanical brushing polishes surface preventing friction surface needed.
2. Top flange doesn't need paint if encased in concrete. Paint on top flange prevents field installation of studs

Steel Plate Availability for Highway Bridges



	ArcelorMittal	Evraz	Nucor	SSAB
48	X	X		
54	X	X		
60	X	X		
66	X	X		
72	X	X	X	X
75	X		X	X
78	X	X	X	X
81	X		X	X
84	X	X	X	X
87	X			X
90	X	X	X	X
93	X		X	X
94	X		X	X
95	X		X	X
96	X	X	X	X
99	X		X	X
102	X	X	X	X
108	X	X	X	X
111	X		X	X
114	X	X	X	X
117	X		X	X
120	X	X	X	X
123	X		X	
126	X	X		
132	X	X		
138	X	X		

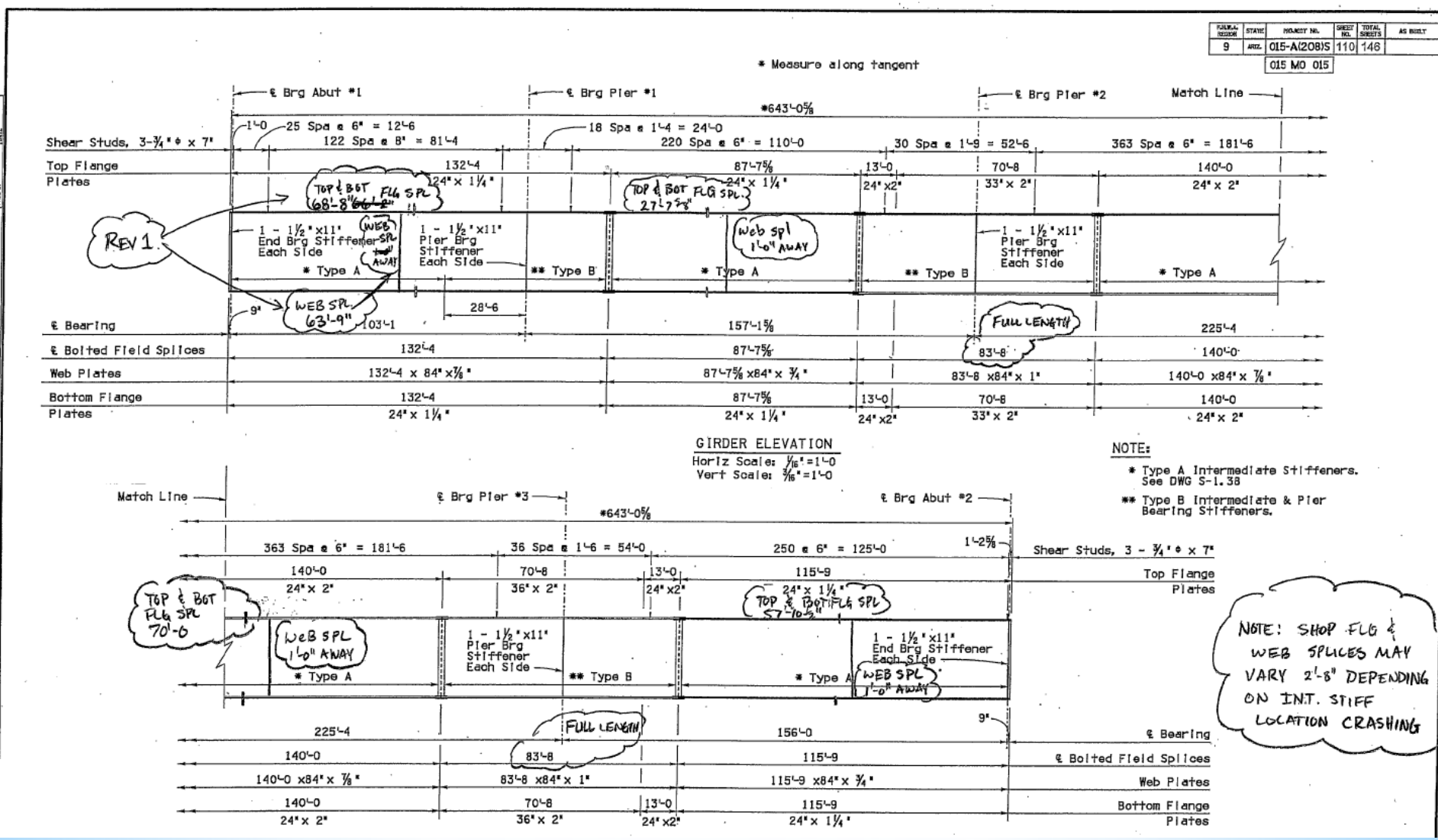
Table 3
Plate width availability by steel mill (in inches).

Increased price break after 2in thickness

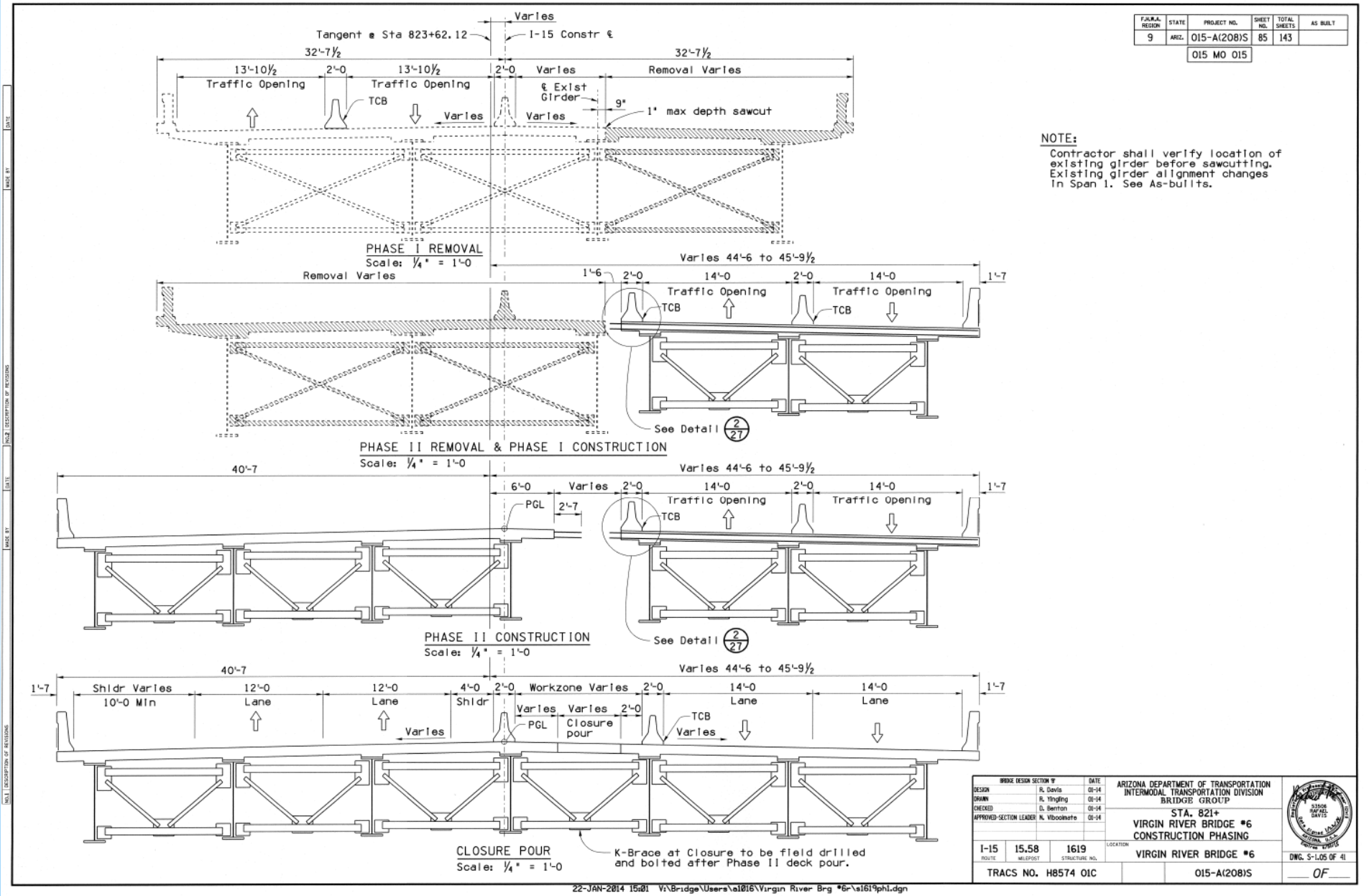
	Plate Width								
	72	78	84	90	96	102	108	114	120
⅜	972	972	972	972	972	972	972	972	750
½	972	972	972	972	972	972	972	972	750
9/16	972	972	972	972	972	972	972	972	972
⅝	972	972	972	972	972	972	972	972	972
¾	1,030	1,030	1,030	1,030	1,030	1,030	1,030	1,030	1,030
⅞	1,030	1,030	1,030	1,030	1,030	1,030	1,007	954	907
1	1,030	1,030	1,030	1,030	992	933	882	835	793
1¼	1,030	1,030	907	846	793	747	705	668	635
1½	1,030	1,030	756	705	661	622	588	557	529
1¾	1,030	1,030	648	604	567	533	504	477	453
2	937	937	567	529	496	467	441	418	397
2¼	833	833	504	470	441	415	392	371	353
2½	749	749	453	423	397	373	353	334	317
2¾	681	681	412	385	361	339	321	304	288
3	624	624	378	353	331	311	294	278	264

Table 4 Composite plate chart: Maximum length (in inches) for given plate thickness and width.

Welded Shop Splice Locations



Construction Phasing



F.A.H.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
9	ARIZ.	015-A(208)S	85	143	
		015 MO 015			

NOTE:
Contractor shall verify location of existing girder before sawcutting. Existing girder alignment changes in Span 1. See As-builts.

BRIDGE DESIGN SECTION 'B'		DATE
DESIGN	R. Davis	01-14
DRAWN	R. Yingling	01-14
CHECKED	D. Benton	01-14
APPROVED-SECTION LEADER	N. Viboolnate	01-14

ARIZONA DEPARTMENT OF TRANSPORTATION
INTERMODAL TRANSPORTATION DIVISION
BRIDGE GROUP

STA. 821+
VIRGIN RIVER BRIDGE #6
CONSTRUCTION PHASING

I-15	15.58	1619	VIRGIN RIVER BRIDGE #6
ROUTE	MILEPOST	STRUCTURE NO.	LOCATION

TRACS NO. H8574 01C | 015-A(208)S | DWG. S-1.05 OF 41

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QUESTIONS?