56th Avenue, Quebec Street to Havana Street
Structural Selection Report

56TH AVENUE BRIDGE OVER HAUL ROAD
(Structure No. D-20-MB-790)

Prepared for:

City and County of Denver

in partnership with

US Department of Transportation
Federal Highway Administration

Colorado Department of Transportation

Prepared by:

URS Corporation
Denver, Colorado

Written by:
Chengyu Li, P.E., Ph.D.

August 2008

Contents

Tables

Figures

EXECUTIVE SUMMARY

Project Description

This project is proposed to reconstruct a portion of 56th Avenue from Quebec Street to Havana Street from its existing two lanes to six lanes with median separation and multi-use paths on both sides throughout the limits. The project requires the construction of additional lanes at the 56th Avenue Bridge over Haul Road (Structure No. D-20-MB-790) and widening of the 56th Avenue Bridge over the Havana Interceptor (Structure No. D-20-MB-785) west of Havana Street. This selection report is for the **56th Avenue Bridge over the Haul Road**.

Purpose of the Report

This report presents the structure type selection process for the construction of additional lanes at the 56th Avenue Bridge over the Haul Road. The objective of the study is to evaluate feasible structure alternatives for the site and identify one that will best meet the overall requirements for the project.

Structure Selection Process

The criteria for comparing and evaluating the structural alternatives include considering different span arrangements, foundations, superstructure types, aesthetic considerations, constructability, construction cost, maintenance, and durability specifically to this project. The final selection is based on the overall consideration of all elements mentioned above and their importance for this particular site and bridge.

Structure Recommendations

Based on the following discussion, using the existing bridge for eastbound traffic, and constructing a new precast prestressed concrete BT54 girder bridge for the westbound traffic is recommended for the project.

Since the existing bridge is too narrow to accommodate the new lanes and adjacent multi-use path, either a new pedestrian bridge to carry the multi-use path over the haul road or an at-grade path that would cross the haul road at-grade is required. A prefabricated truss bridge is recommended if the pedestrian bridge option is selected.

1.0 PROJECT INFORMATION AND DESIGN FEATURES

1.1 Roadway Design Features

This project is proposed to reconstruct a portion of 56th Avenue from Quebec Street to Havana Street (see Figure 1). As shown on Figure 2, the proposed 56th Avenue roadway typical section consists of three through lanes in each direction, a 28-foot raised median, and a 10-foot multi-use path on each side.

56th Avenue crosses a haul road that is currently used for transporting recycled materials from the old Stapleton Airport. The haul road will remain in use for the ongoing construction of the Stapleton Redevelopment project. The Haul Road may ultimately become part of a multi-use trail system, retaining a grade-separated crossing of 56th Avenue. For this analysis, it was assumed that the haul road would remain at its current location and configuration. Existing vertical clearances over the haul road (approximately 15 feet) would be maintained (at a minimum).

Two general options were identified for providing the required number of lanes on 56th Avenue at the bridge over the haul road:

1. Construct two new bridges to carry EB and WB traffic, respectively.

2. Retain the existing bridge (Structure No. D-20-MB-790) to serve eastbound (EB) traffic on 56th Avenue. Since the existing bridge is too narrow to accommodate the new lanes and adjacent multi-use path, this option would include either a new pedestrian bridge to carry the multi-use path over the haul road or an at-grade path that would cross the haul road at-grade.

Figure 3 shows the proposed configuration for the alternative to replace the existing bridge with new EB and WB bridges. With a design speed of 45 mph, the Colorado Department of Transportation requires that multi-use paths on bridges be separated from vehicle traffic using traffic barriers. As shown on the figure, it is recommended that the multi-use paths be placed on each side of the bridge deck and separated from traffic with a Type 7 Bridge Rail. Both the EB and WB bridges will include three traffic lanes (with lane widths of 13 feet, 12 feet, and 14 feet) a 10-foot multi-use path, a Bridge Rail Type 10M, a Bridge Rail Type 7, and one 1-foot curb with chain link fence for a total out-to-out width of 53 feet.

Figure 4 shows the option of retaining the existing bridge, and constructing a new bridge for WB traffic. The option of a pedestrian bridge for the multi-path on the south side of 56th Avenue is also shown on this figure.

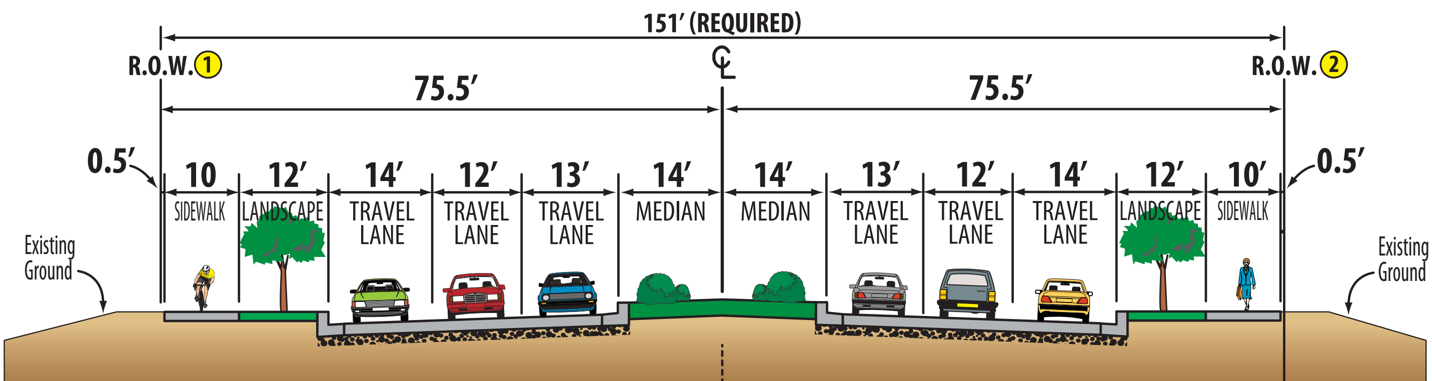
Data Source: URS Corporation

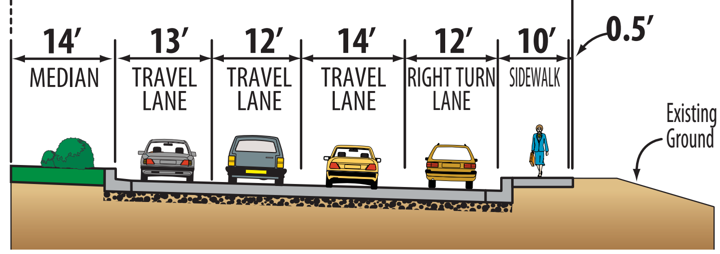
56th Avenue Structural Selection Report
Quebec Street to Havana Street

FIGURE 1
56th Avenue Bridge over Haul Road
Vicinity Map

URS
DENVER THE MILE HIGH CITY

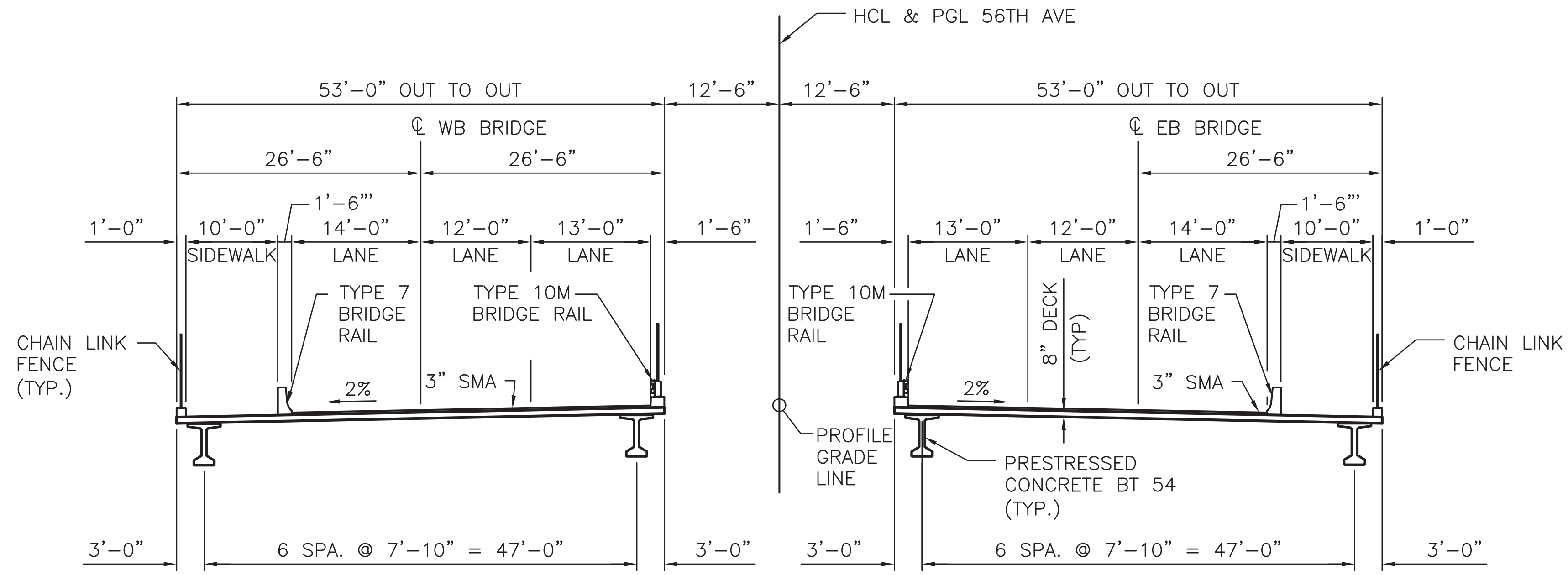
DESIGN CONCEPT: WIDEN TO 6 LANES
SPRUCE ST. TO HAVANA ST.
TYPICAL SECTION, LOOKING EAST



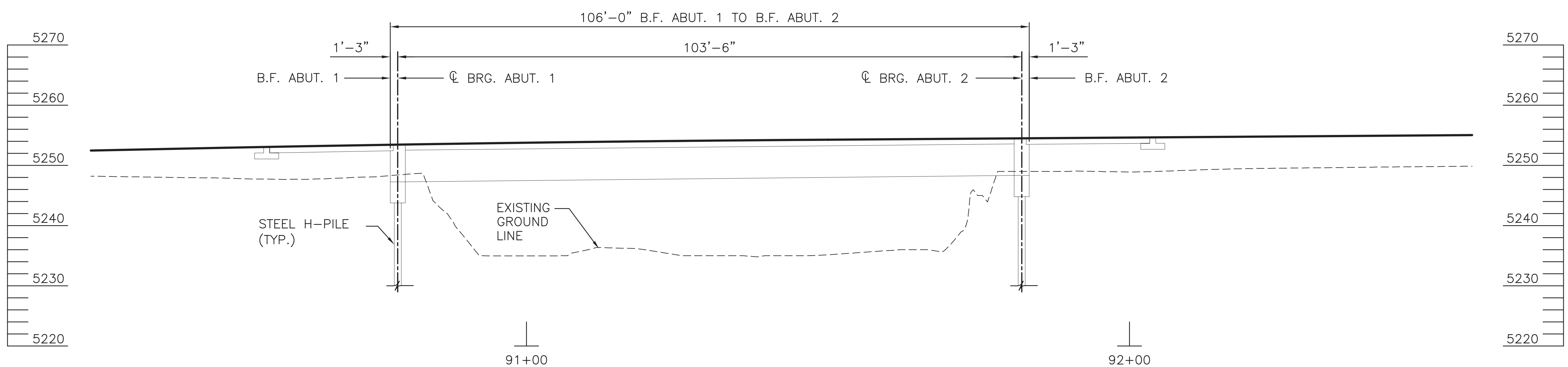


1. 50.5′ of additional ROW required on north side of 56th Avenue, east of Valentia St.to proposed Central Park Blvd. 10.5′ of additional ROW required on north side, Central Park Blvd. to Havana St.
2. 0.5′ of additional ROW required on south side of 56th Avenue, Valentia St. to Havana St.

Source: URS Corporation



TYPICAL SECTION



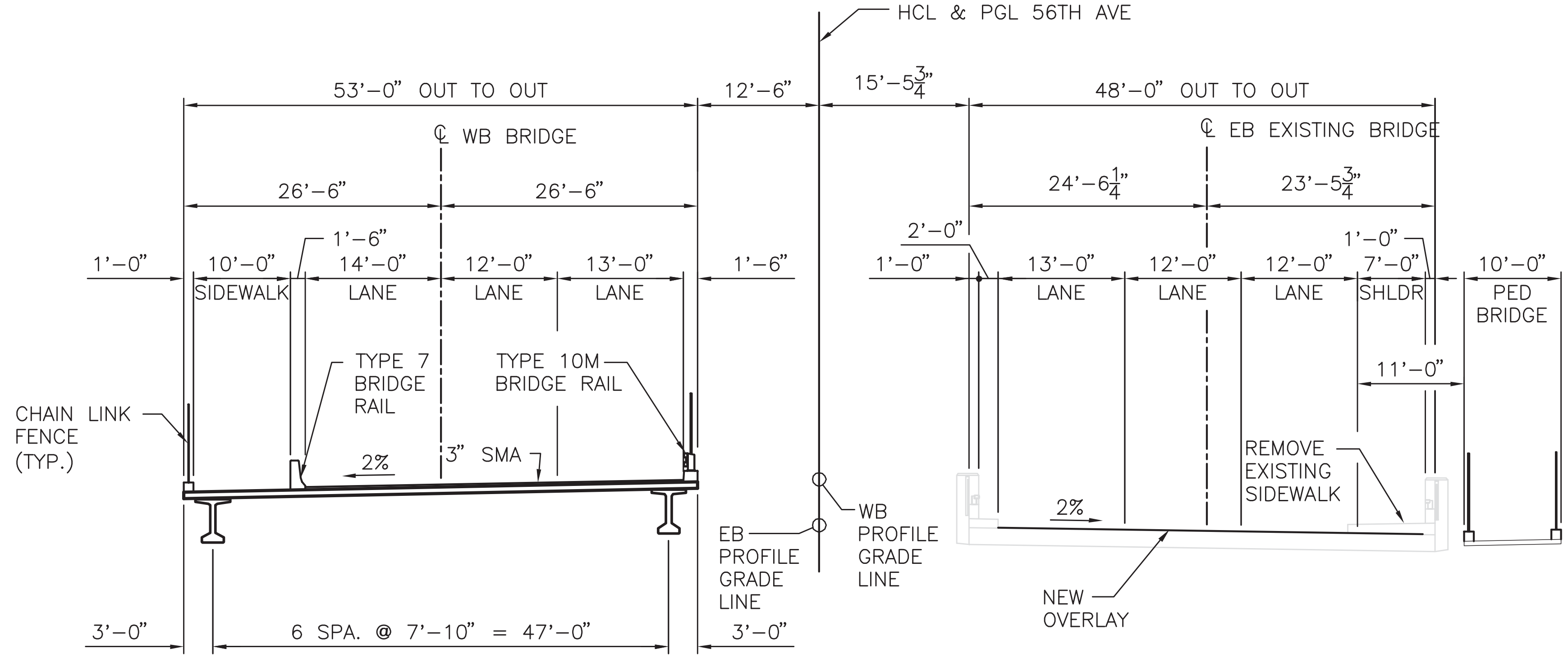
SECTION

Data Source: URS Corporation

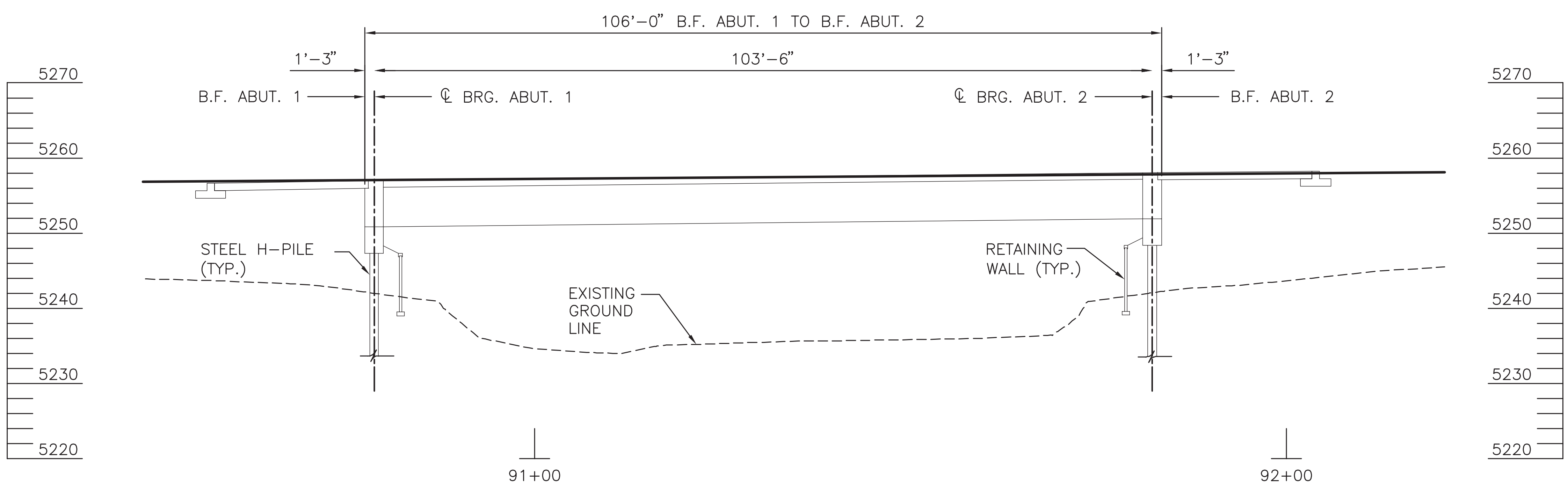
56th Avenue Structural Selection Report
Quebec Street to Havana Street

FIGURE 3
Typical Bridge Section with Two New Bridges

URS
DENVER THE MILE HIGH CITY



TYPICAL SECTION



WB NEW BRIDGE SECTION

Data Source: URS Corporation

56th Avenue Structural Selection Report
Quebec Street to Havana Street

FIGURE 4
Typical Section with Existing Bridge for EB and a New Bridge for WB

1.2 Existing Structure

The existing 56th Avenue Bridge over Haul Road (Structure No. D-20-MB-790) is a three-span post-tensioned slab bridge built in 1995. The span lengths are 24.5 feet, 53 feet, and 24.5 feet, respectively. The bridge is 48 feet wide. The bridge deck profile is located on a tangent with a 0.7% grade. The two-column piers are supported on two caissons. The bridge has two cantilever end spans with no support at each end (see Figure 5).

The bridge has a sufficiency rating of 91.8 reported in the 2006 Structure Inspection and Inventory Report. The report also reports 47.2 tons for inventory load rating and 89.7 tons for operating load rating, respectively. However, the report recommended urgent repair to stabilize abutments as to not allow movement in cantilevered sections. It stated that abutments are monolithic with cantilevered slab and have settled up to one inch. Up to one inch deflection is visible at the ends of the cantilevered slabs when large trucks pass over.

URS performed a field observation on the bridge. It was observed that the bridge vibrated and bounced severely under normal traffic due to lack of supports at the ends. The repetitive deflection has caused significant damage to the joints at both ends.

1.3 Foundation Alternatives

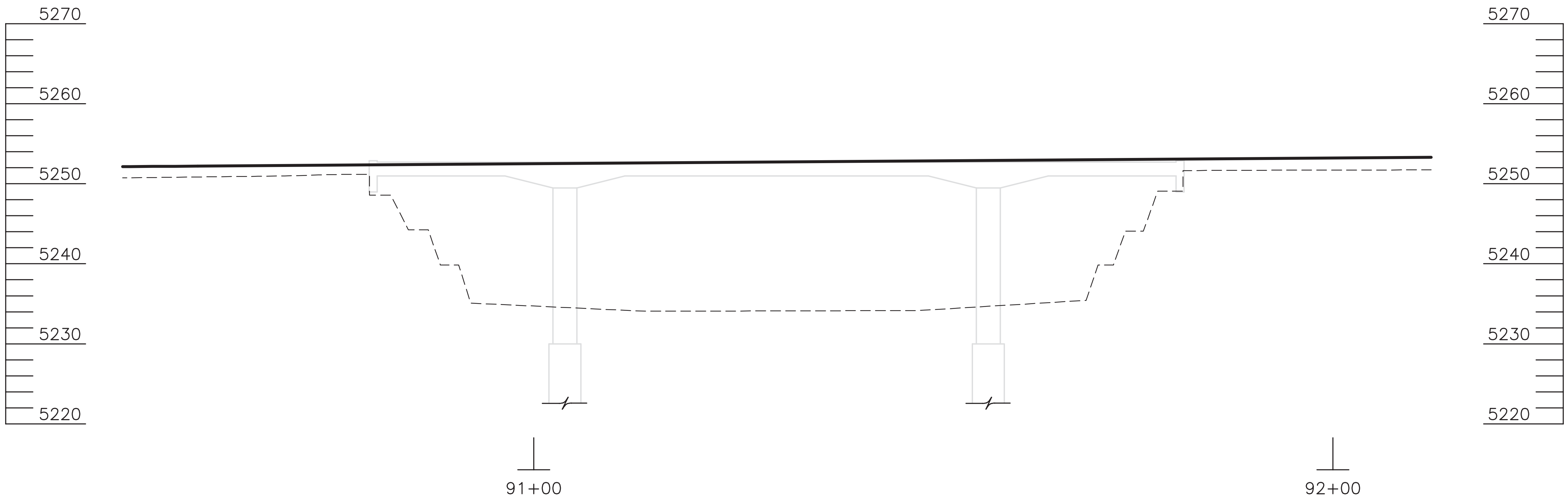
URS Corporation subcontracted with Geocal to perform the preliminary geotechnical investigation. Two borings were made at the bridge location. The final site investigation and site report will be completed after the preliminary design is approved. The possible foundations for this site include steel H-piles and drilled caissons. The geotechnical recommendation for the original alignment is in support of steel piles at abutments and drilled caissons at piers.

1.4 Utilities

The removal and relocation of utilities along 56th Avenue will be addressed in the utility plan. The utilities at or adjacent to the bridge are to be either relocated or remain in service during the construction. URS has contracted with Merrick & Company to perform utility research and take responsibility for coordinating utility work with the utility companies.

1.5 Structure Layout

As discussed in the existing structure section, the recommendation is to either use the existing bridge for eastbound traffic and construct a new bridge for westbound traffic or replace the existing bridge with a new EB bridge and construct a new WB bridge. The existing 56th Avenue Bridge has three spans with a total length of 102 feet. There are no additional requirements to increase the cross section of the Haul Road; therefore, the current length can be maintained. A single span bridge is suitable for this length. A two-span bridge can also be constructed, but with a pier in the middle of the Haul Road, it would not be a good option and will not be considered. A three-span bridge will not be economical due to the additional cost to construct piers. The bridge will have approximately a zero degree skew. Layouts for the two alternatives are shown on Figures 6 and 7.



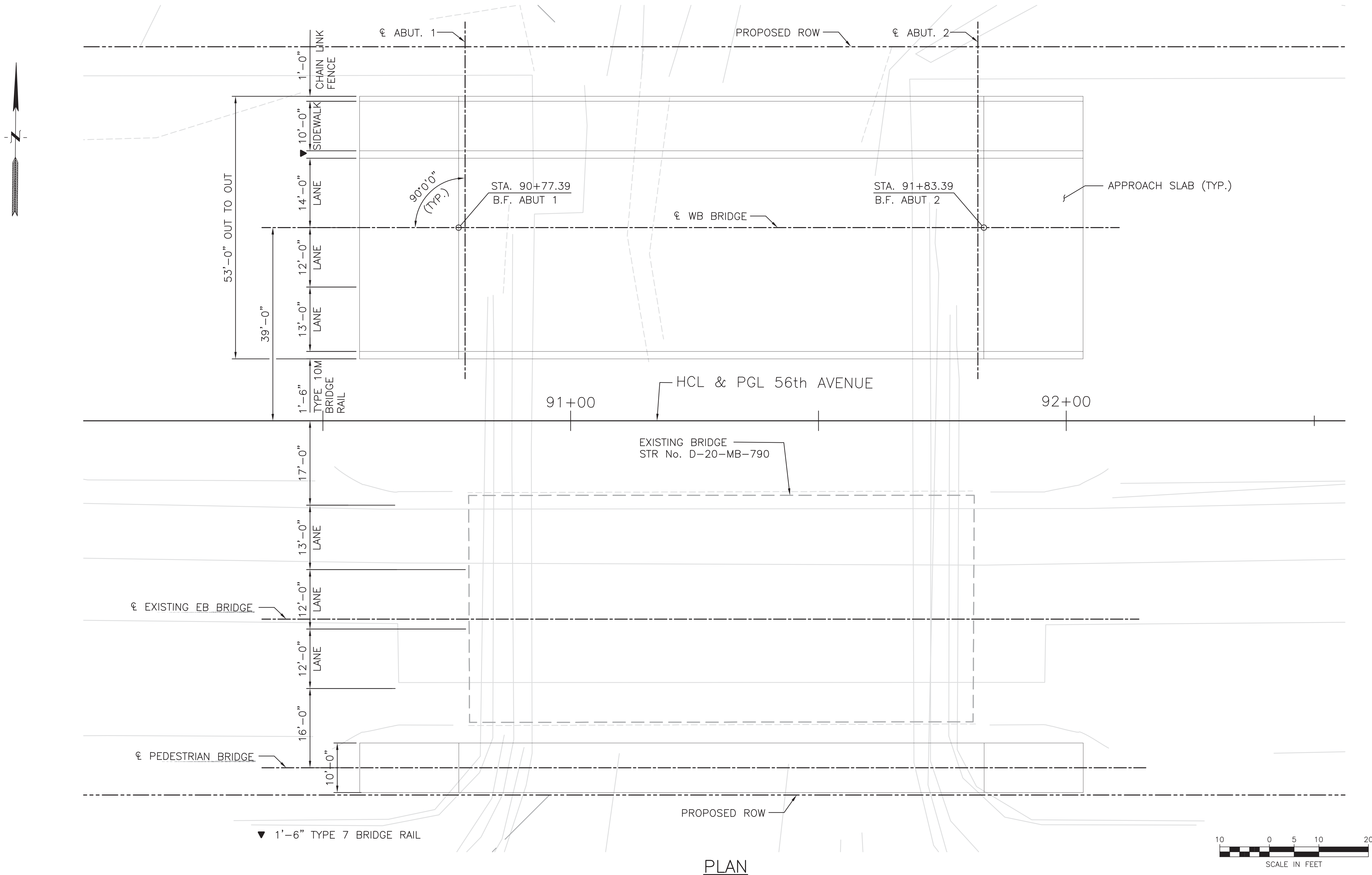
EB EXISTING BRIDGE SECTION

Data Source: URS Corporation

56th Avenue
Structural Selection Report
Quebec Street to Havana Street

FIGURE 5
Existing Bridge Typical Section

URS
DENVER
THE MILE HIGH CITY

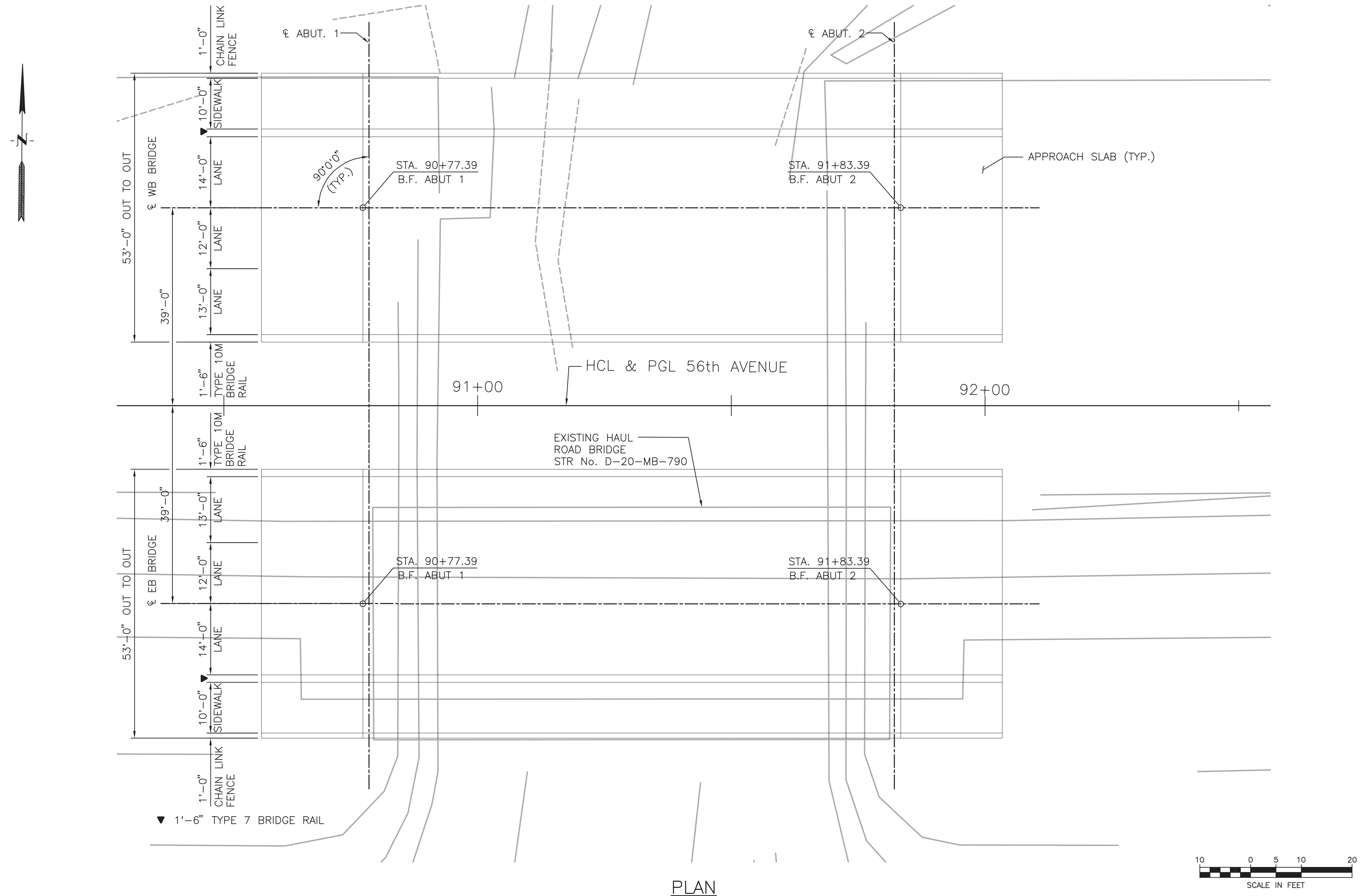


Data Source: URS Corporation

56th Avenue Structural Selection Report
Quebec Street to Havana Street

FIGURE 6
General Bridge Layout with Existing Bridge for EB and a New Bridge for WB

URS
DENVER THE MILE HIGH CITY



56th Avenue Structural Selection Report
Quebec Street to Havana Street

FIGURE 7
General Bridge Layout with Two New Bridges

URS
DENVER THE MILE HIGH CITY

For a single-span bridge, suitable superstructure types include precast prestressed concrete Bulb Tee (BT) girders, precast prestressed concrete box girders, and steel plate girders.

1.6 Structure Design Criteria

Design Specifications for Structures

Current AASHTO LRFD Bridge Design Specifications

Current CDOT Bridge Design Manual, Memos, and Bridge Detailing Manual

Live Loads: HL-93 Design Truck or Tandem, and Design Lane Load

Dead Load: Assumes 60 lbs per square foot for bridge deck overlay

Construction Specifications

Current Colorado Department of Transportation Standard Specifications for Road and Bridge Construction

Loading

The bridge will be designed with a concrete deck overlaid with a waterproofing membrane in combination with three inches of asphalt initially and an additional two inches in the future. The minimum deck thickness will be eight inches (not including overlay). The Bridge Barriers shall be Type 7 and Type 10M.

Design Method

Load and Resistant Factor Design (LRFD) method will be used in the design of all structural elements, except where only Service Load Design Method provisions are given.

Materials

Cast-in-Place Reinforced Concrete

Concrete Class B: $f'_c = 3{,}000$ psi

Concrete Class D: $f'_c = 4{,}500$ psi

Concrete Class S: $f'_c = 5{,}000$ psi

Reinforcing Steel: $f_y = 60{,}000$ psi

Precast/Prestressed Concrete

Initial Strength: f'_{ci} = 6,500 psi

Final Strength: f'_c = 8,500 psi

Prestressing Strands: ASTM A416, Grade 270, 0.6”, uncoated, 7 wire, low relaxation

Structural Steel

Steel plate girders: ASTM A 709 Grade 50W: f_y = 50,000 psi

Secondary members: ASTM A 709 Grade 36: f_y = 36,000 psi

Steel H Piles: ASTM A 572 Grade 50: f_y = 50,000 psi

All bolts: shall be high strength, unless otherwise noted.

Deck Forms

Precast panel deck forms are proposed.

Approach Slab

A standard CDOT approach slab will be utilized at each bridge end.

Vertical Clearances

Minimum vertical clearance over the Haul Road shall be equal to or larger than the existing vertical clearance.

Deflection

Live load deflection is limited to less than 1/800 span length.

2.0 STRUCTURE SELECTION

This chapter discusses the selection criteria used and compares the structural selection elements between the alternatives. The purpose of the report is to identify which structural alternatives best meet the requirements. The following items were established as guidelines to evaluate each structure type as a suitable replacement alternative.

The issues concerning each of the evaluating criteria as they relate to each superstructure type are summarized in Table 2-1. The first two alternatives assume the existing structure would be retained for use by eastbound traffic with a new structure for westbound traffic. The remaining three alternatives assumed the replacement of the existing bridge and the construction of a new adjacent structure.

Table 2-1
Summary of 56th Avenue Bridge Over Haul Road
Structure Type Evaluation

Criteria	Use of Existing Bridge for EB and a New BT54 Girder Bridge for WB	Use of Existing Bridge for EB and a New Similar Bridge for WB	Precast Prestressed Concrete BT Girder	Precast Prestressed Concrete Box Girder	Steel Plate Girder
Aesthetic	New WB Bridge is higher than the existing EB Bridge	Fits overall concept	Fits overall concept	Fits overall concept, provides better appearance than BT and I girders	Fits overall concept
Constructability	Rapid girder erection for WB bridge	Long construction period for cast-in-place post-tensioned slab bridge	Rapid girder erection, fits two stage construction	Rapid girder erection, fits two stage construction	Rapid girder erection, but more complicated than precast concrete, fits two stage construction
Construction Cost	$825,000	$1,155,000	$1,058,000	$1,148,000	$1,187,000
Maintenance & Durability	Low maintenance and inspection	Low maintenance and inspection	Low maintenance and inspection	Low maintenance and inspection	Moderate maintenance and inspection
Foundation	Steel H piles or drilled concrete caissons, integral abutments	Steel H piles or drilled concrete caissons, integral abutments	Steel H piles or drilled concrete caissons, integral abutments	Steel H piles or drilled concrete caissons, integral abutments	Steel H piles or drilled concrete caissons, integral abutments

2.1 Use of Existing Bridge for Eastbound

As discussed in Section 1.2, the existing bridge has a sufficiency rating of 91.8, an inventory load rating of 47.2-tons and an operating load rating of 89.7 tons, respectively. Therefore, it is possible to utilize the existing bridge for the eastbound traffic. A new overlay is required to create the proposed slope on the existing bridge.

The existing bridge has two cantilever end spans without support at each end. Due to lack of support at each abutment, it was noticed that the bridge deflects in the magnitude of approximately one inch under large trucks. The repetitive deflection has caused significant damage to the joints at both ends. In order to utilize the existing bridge, extensive repair is required. The recommendation is to modify the abutment at each end to support the superstructure. The repair will include the following steps:

- Excavate to the bottom of proposed abutment
- Install steel H piles
- Cast new abutment cap and backwall
- Install new elastomeric pad under the backwall
- Backfill abutment
- Cast new approach slab

The existing post-tensioned slab superstructure was originally designed for cantilever condition. Due to the addition of abutment support at each end, the superstructure is converted to simple support. The superstructure will need to be evaluated for the simply supported condition.

A bridge layout for the option of using the existing bridge for eastbound traffic, a new bridge for the westbound traffic and a pedestrian bridge for the eastbound pedestrian traffic is shown on Figure 6. For the new westbound bridge, there are two alternatives, including (1) a similar post-tensioned slab structure and (2) a new girder type bridge with a raised profile to maintain the existing clearance over the haul road. A comparison of the two alternatives is shown on Table 2-1. Constructing a post-tensioned slab structure, similar to the existing bridge, will allow the same profile on 56th Avenue as the existing bridge to be maintain, with the same vertical clearance as the existing bridge. However, post-tensioned slab bridge will generally cost more and require longer construction time due to falsework and cast-in-place concrete curing than that of precast concrete bridges. A new girder type bridge will have a deeper superstructure than that of the existing post-tensioned slab and require raising the profile to provide the same vertical clearance. A new girder type bridge will cost less than a post-tensioned slab bridge.

Estimates of probable construction cost for a post-tension slab structure versus a girder structure is given in Table 2-2 and Table 2-3.

Since the existing bridge is too narrow to accommodate the new lanes and adjacent multi-use path, either a new pedestrian bridge to carry the multi-use path over the haul road or an at-grade path that would cross the haul road at-grade is required. A prefabricated truss bridge is recommended if the pedestrian bridge option is selected.

2.2 Superstructure Types for New Structure

Based on the historic structure type usage, general knowledge of the bridge site and previously listed considerations, feasible structure alternatives to be investigated for a new bridge include Precast Prestressed Concrete BT Girders, Precast Concrete Box Girders, and Steel Plate Girders for a single-span.

A Precast Concrete BT Girder Bridge provides an economic solution for a single-span layout. BT54 and BT63 girders are suitable for the span length. BT54 girders are preferable for a shallower superstructure depth compared to BT64 girders.

A Precast Concrete Box Girder Bridge also provides an economic solution for the single-span layout. 42-inch deep box girders are suitable for the design span.

Steel plate girders are also suitable for the span length. However, historically these bridges are more expensive than concrete bridges.

With a cast-in-place concrete bridge, either conventional reinforced or post-tensioned girders can be used. However, the amount of shoring and falsework required for construction is a definite disadvantage and would restrict the traffic flow on the Haul Road. Cast-in-place concrete bridge will require curing time for concrete, resulting in longer construction time. Therefore, cast-in-place concrete bridges are eliminated from further evaluation.

Based on the above discussion, further studies will be concentrated on the comparison between the precast concrete BT girders, precast concrete box girders, and steel plate girder.

2.3 Aesthetic Design

There have been no specific aesthetic requirements identified to date. Standard CDOT details are acceptable for bridge rails.

2.4 Constructability

Precast concrete girders can be prefabricated and then erected on site, resulting in high quality control and fast construction. Steel plate girders can be fabricated in the shop and erected on site. Steel plate girders are lighter than concrete girders, therefore easer to erect than concrete box girders. However, the fabrication and field install of steel plate girders are more complicated than that of precast concrete girders.

2.5 Construction Cost

Construction costs are one of the most important factors in the structure type selections. Conceptual costs for the five alternatives, including using the existing bridge for the eastbound traffic with a new similar post-tensioned slab bridge for the westbound traffic and a new pedestrian bridge for the eastbound pedestrian traffic, using the existing bridge for the eastbound traffic with a new BT54 girder bridge for the westbound traffic and a new pedestrian bridge for the eastbound pedestrian traffic, precast prestressed concrete BT girder bridges for both EB and WB, precast prestressed concrete box girder bridges for both EB and WB, and steel plate girder bridges for both EB and WB, are shown in Tables 2-2, 2-3, 2-4, 2-5 and 2-6, respectively.

The estimated cost is approximately $825,000 for use of the existing bridge for EB with a new BT54 bridge for WB and a new pedestrian bridge, $1.15 million for use of existing bridge for EB with a new post-tensioned slab bridge for WB and a new pedestrian bridge, $1.06 million for two precast prestressed concrete BT 54 girder bridges, $1.15 million for two precast prestressed concrete box girder bridges and $1.19 million for two steel plate girder bridges. The conceptual costs for the alternatives were developed based on the preliminary quantities and the unit prices used in Colorado Department of Transportation 2007 Cost Data Book. This study found that using the existing bridge for the EB traffic, a new BT54 girder bridge for the WB traffic and a new pedestrian bridge for the eastbound pedestrian traffic has the lowest cost of the five alternatives.

2.6 Maintenance and Durability

Selected materials and structure components must exhibit high durability to provide longevity of the bridge. A precast prestressed concrete BT Girder Bridge requires minimum maintenance and possesses long durability. A painted steel plate girder bridge requires routine maintenance and repaints. Weathering steel can be used to eliminate the paint requirement.

Table 2-2
Summary of Quantities and Preliminary Cost Estimate
Use of Existing Bridge for EB and a New BT54 Girder Bridge for WB

Item	Description	Unit	Quantity	Unit Price	Cost
REPAIR EXISTING BRIDGE					
206	Structure Excavation	CY	418	$15.00	$6,270
206	Structure Backfill (Class 1)	CY	418	$28.50	$11,913
206	Mechanical Reinforcement of Soil	CY	350	$15.00	$5,250
403	Stone Matrix Asphalt (3 Inch)	Ton	130	$65.00	$8,450
502	Steel Piling (HP 12 x 84)	LF	450	$60.00	$27,000
515	Waterproofing (Membrane)	SY	550	$10.00	$5,500
518	Bridge Expansion Device	LF	96	$150.00	$14,400
601	Concrete Class D	CY	84	$600.00	$50,400
601	Reinforced Steel (Epoxy Coated)	LB	10000	$1.00	$10,000
	Subtotal Cost				**$139,183**
PEDESTRIAN BRIDGE					
	Prefabricated Truss	EA	1	$122,400.00	$122,400
206	Structure Backfill (Class 1)	CY	20	$28.50	$570
502	Steel Piling (HP 12 x 84)	LF	180	$60.00	$10,800
601	Concrete Class D	CY	20	$600.00	$12,000
601	Reinforced Steel (Epoxy Coated)	LB	2000	$1.00	$2,000
	Subtotal Cost				**$147,770**
NEW EB BT54 GIRDER BRIDGE					
206	Structure Excavation	CY	305	$15.00	$4,575
206	Structure Backfill (Class 1)	CY	175	$28.50	$4,988
206	Structure Backfill (Class 2)	CY	130	$13.00	$1,690
206	Mechanical Reinforcement of Soil	CY	175	$15.00	$2,625
403	Stone Matrix Asphalt (3 Inch)	Ton	85	$65.00	$5,525
502	Steel Piling (HP 12 x 84)	LF	540	$60.00	$32,400
515	Waterproofing (Membrane)	SY	313	$10.00	$3,130
518	Bridge Expansion Device	LF	106	$150.00	$15,900
601	Concrete Class D	CY	250	$600.00	$150,000
601	Structural Concrete Coating	SY	325	$10.00	$3,250
601	Reinforced Steel (Epoxy Coated)	LB	53400	$1.00	$53,400
606	Bridge Rail Type 10M (Special)	LF	106	$160.00	$16,960
606	Bridge Rail Type 7	LF	106	$85.00	$9,010
607	Fence Chain Link (72 Inch)	LF	106	$20.00	$2,120
618	Prestressed Concrete I (BT 54)	LF	731	$170.00	$124,270
	Subtotal Cost				**$429,843**
		Total Cost			**$716,796**
		Contingency (15%)			**$107,519**
		Total			**$824,315**
		Cost per SF			**$73.36**

Table 2-3
Summary of Quantities and Preliminary Cost Estimate
Use of Existing Bridge for EB and a New Post-Tensioned Slab Bridge for WB

Item	Description	Unit	Quantity	Unit Price	Cost
REPAIR EXISTING BRIDGE					
206	Structure Excavation	CY	418	$15.00	$6,270
206	Structure Backfill (Class 1)	CY	418	$28.50	$11,913
206	Mechanical Reinforcement of Soil	CY	350	$15.00	$5,250
403	Stone Matrix Asphalt (3 Inch)	Ton	130	$65.00	$8,450
502	Steel Piling (HP 12 x 84)	LF	450	$60.00	$27,000
515	Waterproofing (Membrane)	SY	550	$10.00	$5,500
518	Bridge Expansion Device	LF	96	$150.00	$14,400
601	Concrete Class D	CY	84	$600.00	$50,400
601	Reinforced Steel (Epoxy Coated)	LB	10000	$1.00	$10,000
	Subtotal Cost				**$139,183**
PEDESTRIAN BRIDGE					
	Prefabricated Truss	EA	1	$122,400.00	$122,400
206	Structure Backfill (Class 1)	CY	20	$28.50	$570
502	Steel Piling (HP 12 x 84)	LF	180	$60.00	$10,800
601	Concrete Class D	CY	20	$600.00	$12,000
601	Reinforced Steel (Epoxy Coated)	LB	2000	$1.00	$2,000
	Subtotal Cost				**$147,770**
NEW EB POST-TENSIONED SLAB BRIDGE					
206	Structure Excavation	CY	268	$15.00	$4,020
206	Structure Backfill (Class 1)	CY	268	$28.50	$7,638
206	Structure Backfill (Class 2)	CY	0	$13.00	$0
206	Mechanical Reinforcement of Soil	CY	268	$15.00	$4,020
403	Stone Matrix Asphalt (3 Inch)	Ton	130	$65.00	$8,450
502	Steel Piling (HP 12 x 84)	LF	450	$60.00	$27,000
503	Drilled Caisson (48 Inch)	LF	280	$500.00	$140,000
515	Waterproofing (Membrane)	SY	805	$10.00	$8,050
518	Bridge Expansion Device	LF	106	$150.00	$15,900
601	Concrete Class D	CY	151	$600.00	$90,600
601	Concrete Class S	CY	342	$750.00	$256,500
601	Structural Concrete Coating	SY	502	$10.00	$5,020
601	Reinforced Steel (Epoxy Coated)	LB	50000	$1.00	$50,000
606	Bridge Rail Type 10M (Special)	LF	106	$160.00	$16,960
606	Bridge Rail Type 7	LF	106	$85.00	$9,010
607	Fence Chain Link (72 Inch)	LF	106	$20.00	$2,120
618	Prestressed Concrete Box (Depth 32" Through 48")	MKFT	1435	$50.00	$71,750
	Subtotal Cost				**$717,038**
		Total Cost			**$1,003,991**
		Contingency (15%)			**$150,599**
		Total			**$1,154,590**
		Cost per SF			**$106.79**

Table 2-4
Summary of Quantities and Preliminary Cost Estimate
Precast Prestressed Concrete BT54 Girder Bridge

Item	Description	Unit	Quantity	Unit Price	Cost
202	Removal of Bridge	EA	1	$60,000.00	$60,000
206	Structure Excavation	CY	610	$15.00	$9,150
206	Structure Backfill (Class 1)	CY	350	$28.50	$9,975
206	Structure Backfill (Class 2)	CY	260	$13.00	$3,380
206	Mechanical Reinforcement of Soil	CY	350	$15.00	$5,250
403	Stone Matrix Asphalt (3 Inch)	Ton	170	$65.00	$11,050
502	Steel Piling (HP 12 x 84)	LF	1080	$60.00	$64,800
515	Waterproofing (Membrane)	SY	625	$10.00	$6,250
518	Bridge Expansion Device	LF	212	$150.00	$31,800
601	Concrete Class D	CY	500	$600.00	$300,000
601	Structural Concrete Coating	SY	650	$10.00	$6,500
601	Reinforced Steel (Epoxy Coated)	LB	106773	$1.00	$106,773
606	Bridge Rail Type 10M (Special)	LF	212	$160.00	$33,920
606	Bridge Rail Type 7	LF	212	$85.00	$18,020
607	Fence Chain Link (72 Inch)	LF	212	$20.00	$4,240
618	Prestressed Concrete I (BT 54)	LF	1462	$170.00	$248,540
		Total Cost			**$919,648**
		Contingency (15%)			**$137,947**
		Total			**$1,057,595**
		Cost per SF			**$94.13**

Table 2-5
Summary of Quantities and Preliminary Cost Estimate
Precast Prestressed Concrete Box Girder Bridge

Item	Description	Unit	Quantity	Unit Price	Cost
202	Removal of Bridge	EA	1	$60,000	$60,000
206	Structure Excavation	CY	610	$15.00	$9,150
206	Structure Backfill (Class 1)	CY	350	$28.50	$9,975
206	Structure Backfill (Class 2)	CY	260	$13.00	$3,380
206	Mechanical Reinforcement of Soil	CY	350	$15.00	$5,250
403	Stone Matrix Asphalt (3 Inch)	Ton	170	$65.00	$11,050
502	Steel Piling (HP 12 x 84)	LF	1080	$60.00	$64,800
515	Waterproofing (Membrane)	SY	625	$10.00	$6,250
518	Bridge Expansion Device	LF	212	$150.00	$31,800
601	Concrete Class D	CY	500	$600.00	$300,000
601	Structural Concrete Coating	SY	650	$10.00	$6,500
601	Reinforced Steel (Epoxy Coated)	LB	106773	$1.00	$106,773
606	Bridge Rail Type 10M (Special)	LF	212	$160.00	$33,920
606	Bridge Rail Type 7	LF	212	$85.00	$18,020
607	Fence Chain Link (72 Inch)	LF	212	$20.00	$4,240
618	Prestressed Concrete Box (Depth 32" Through 48")	SF	5940	$55.00	$326,700
		Total Cost			**$997,808**
		Contingency (15%)			**$149,671**
		Total			**$1,147,479**
		Cost per SF			**$102.13**

Table 2-6
Summary of Quantities and Preliminary Cost Estimate
Steel Plate Girder Bridge

Item	Description	Unit	Quantity	Unit Price	Cost
202	Removal of Bridge	EA	1	$60,000	$60,000
206	Structure Excavation	CY	610	$15.00	$9,150
206	Structure Backfill (Class 1)	CY	350	$28.50	$9,975
206	Structure Backfill (Class 2)	CY	260	$13.00	$3,380
206	Mechanical Reinforcement of Soil	CY	350	$15.00	$5,250
403	Stone Matrix Asphalt (3 Inch)	Ton	170	$65.00	$11,050
502	Steel Piling (HP 12 x 84)	LF	1080	$60.00	$64,800
515	Waterproofing (Membrane)	SY	625	$10.00	$6,250
518	Bridge Expansion Device	LF	212	$150.00	$31,800
601	Concrete Class D	CY	500	$600.00	$300,000
601	Structural Concrete Coating	SY	650	$10.00	$6,500
601	Reinforced Steel (Epoxy Coated)	LB	106773	$1.00	$106,773
606	Bridge Rail Type 10M (Special)	LF	424	$160.00	$33,920
606	Bridge Rail Type 10M (Special)	LF	424	$85.00	$18,020
607	Fence Chain Link (72 Inch)	LF	424	$20.00	$4,240
509	Structural Steel	LB	430000	$1.00	$430,000
		Total Cost			**$1,031,958**
		Contingency (15%)			**$153,045**
		Total			**$1,186,752**
		Cost per SF			**$105.62**

3.0 CONSTRUCTION PHASING

A two-stage construction sequence is proposed to maintain traffic on 56th Avenue during bridge construction. The first stage is to construct the westbound bridge. In this stage, all traffic in both directions will remain on the existing bridge in the existing two lanes. In Phase 2 construction, all the traffic will be shifted to the new westbound bridge in one lane in each direction while the modifications to (or replacement of) the eastbound bridge are constructed.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The proposed widening of 56th Avenue will require two structures, eastbound and westbound over the existing haul road. To maintain the existing haul cross section, the westbound bridge will be approximately 106 feet long and 53 feet wide. The required profile must provide minimum vertical clearance over Haul Road at least equal to the existing available vertical clearance.

Five alternatives were studied in detail, including:

- Use of the existing bridge for the eastbound traffic, a new similar post-tensioned slab bridge for the westbound traffic.
- Use of the existing bridge for the eastbound traffic, a new BT54 girder bridge for the westbound traffic.
- Two new precast prestressed concrete BT girder bridges
- Two new precast prestressed concrete box girder bridges
- Two new steel plate girder bridges

Use of the existing bridge for the eastbound traffic, a new BT54 girder bridge for the westbound traffic is the most economical and can be easily constructed.

Based on the criteria discussed above, use of existing bridge with modifications to the abutments for the eastbound traffic, and a new precast prestressed concrete BT54 girder bridge for the westbound traffic, and a new pedestrian bridge for the eastbound pedestrian traffic is recommended for the project.

Since the existing bridge is too narrow (48 feet wide) to accommodate the new lanes and adjacent multi-use path, either a new pedestrian bridge to carry the multi-use path over the haul road or an at-grade path that would cross the haul road at-grade is required. A prefabricated truss bridge is recommended if the pedestrian bridge option is selected.

With a pedestrian bridge, the estimated total cost for this alternative is $825,000.