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CONCEPT DESIGN ALTERNATIVES
CHANNEL COVERS
ARIZONA CANAL DIVERSION CHANNEL (REACH 3)

CONTRACT NO. DACW09-87-C-0043

MODIFICATION NO. P0001

FEBRUARY 23, 1988

MATHEWS KESSLER & ASSOCIATES, INC.
3333 N. 44TH STREET, SUITE 100
PHOENIX, ARIZONA 85018
(602) 840-0575

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Rec'd from Dennis Siewert of SRP 1-11-89

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TABLE OF CONTENTS

- CONCEPT REPORT
- APPENDIX I - COST SUMMARY AND UNIT COST
- APPENDIX II - CROSS-SECTIONS

CONCEPT REPORT

CHANNEL COVER DESIGN ALTERNATIVES

ARIZONA CANAL DIVERSION CHANNEL, PHOENIX, ARIZONA

1. PURPOSE: This study is to evaluate alternative design concepts which would allow future decks to be placed over concrete channel walls at various locations along the Arizona Canal Diversion Channel to allow for commercial construction over the channel. This study provides:

a. The concept design including concept sketches.
b. Estimates of costs.
c. Impact on design schedules.
d. A narrative comparing two (or more) alternative plans.

2. CONCEPTS: The alternatives specifically addressed in this study include an open channel with standard design walls and invert. This section is labled Alternative A in attached tables. The standard channel design was altered to provide strengthened walls and invert (footings) such that a future deck system could be placed on top of the walls without further significant structural modifications. This concept is labeled Alternative B on the attached Cost Summary sheets. Also requested was a system that would allow a future deck system to be installed independent of the channel structure; i.e., a structure that would bridge the entire channel structure without using that structure for any of the deck support. This concept is labeled Alternative C on the attached Cost Summary sheets.

We have (although not requested) also included for consideration and comparison two cast-in-place box culvert sections in lieu of an open channel section with future cover to be installed. The sections considered were a double 30' X 21' box and a single 40' X 21' box. These concepts are labeled Alternative D on the attached Cost Summary sheets.

4. COST SUMMARY (Con't):

ALTERNATIVE COST COMPARISONS

ALTERNATIVE	24TH ST. 40' WIDTH CLR SPAN 460' DECK	7TH ST. 50' WIDTH CLR SPAN 260' DECK	CENTRAL AVE. 60' WIDTH CLR SPAN 120' DECK	19TH AVE. 60' WIDTH CLR SPAN 165' DECK	19TH AVE. 60' WIDTH CLR SPAN 180' DECK	TOTAL
A. Standard Rect. Channel	$ 399,740	$ 235,560	$ 113,040	$ 155,430	$ 169,560	$1,073,330
B. Strengthen Channel with Future Deck Construction						
Walls & Invert	$ 463,220	$ 271,440	$ 128,400	$ 176,550	$ 192,600	$1,232,210
Deck	$ 299,000	$ 243,880	$ 144,000	$ 198,000	$ 216,000	$1,100,880
Total:	$ 762,220	$ 515,320	$ 272,400	$ 374,550	$ 408,600	$2,333,090
Cost Diff (Present)	$ 63,480	$ 35,880	$ 15,360	$ 21,120	$ 23,040	$ 158,880
Cost Diff (Future)	$ 299,000	$ 243,880	$ 144,000	$ 198,000	$ 216,000	$1,100,880
Cost Diff (Total)	$ 362,480	$ 279,760	$ 159,360	$ 219,120	$ 239,040	$1,259,760
C. Channel with Independent Future Deck and Caissons						
Total:	$1,173,920	$ 771,940	$ 423,240	$ 581,955	$ 634,860	$3,585,915
Cost Diff (Present)	$ -0-	$ -0-	$ -0-	$ -0-	$ -0-	$ -0-
Cost Diff (Future)	$ 774,180	$ 536,380	$ 310,200	$ 426,525	$ 465,300	$2,512,585
Cost Diff (Total)	$ 774,180	$ 536,380	$ 310,200	$ 426,525	$ 465,300	$2,512,585
D. Cast-in-Place Concrete Box Culvert						
Total:	$ 850,080	N/A	$ 220,080	N/A	N/A	$1,070,160
Cost Diff (Present)	$ 450,340	N/A	$ 107,040	N/A	N/A	$ 557,380
Cost Diff (Future)	$ -0-	N/A	$ -0-	N/A	N/A	$ -0-
Cost Diff (Total)	$ 450,340	N/A	$ 107,040	N/A	N/A	$ 557,380

For each of the alternative design concepts, because of the different locations along the channel, it was necessary to consider alternative channel widths of 40', 50' and 60'. For cost and hydraulic capacity reasons the 50' cast-in-place box culvert was not considered to be a viable alternative and was not included. To provide a clear span over the channel, it was necessary to increase the spans to 49', 59' and 69' respectively for the previously mentioned channel widths. This clear span length would provide for clearing the toe of the retaining wall footing for drilling caissons. Location maps of the deck areas studied are attached along with the cost comparison tables.

3. APPROACH: The design criteria for the decks or box culverts provided for H-20 loading and a 2 ft. earth cover to provide a suitable base for vegetative growth. Additional earth cover did not seem to be necessary or desirable at any of the locations under consideration. In all cases the cost figures provided are for only concrete and reinforcing steel for comparative purposes. It is assumed that all other costs related to construction such as clearing and grubbing, excavation, structural backfill, etc. will remain the same for all channel options.

The Benchmark (Alternative A) against which all other concepts would be compared, is the rectangular concrete section up to 22' in height and from 40' to 60' in width. This section was designed and the estimated cost of construction was calculated.

To provide additional strength to support prestressed box beams for Alternative B, steel and concrete were increased in the Alternative A design.

The clear span concept (Alternative C) for putting a deck over the Benchmark channel section includes the use of drilled caissons with cast-in-place beams between caissons supporting prestressed concrete box beams forming the deck. This approach requires a much longer clear span, therefore much larger box beams and very costly drilling for caisson placement.

Due to the very significant costs of installing a deck over the Benchmark channel section, it was considered desirable to also provide a comparable cast-in-place concrete box culvert(s) as Alternative D to be considered. The use of this concept was acceptable only in the 40' (single) and 60' (twin 30') channel sections due to hydraulic and cost considerations, therefore, the 50' section was not included for consideration.

As requested, we also calculated deflections probable in the deck sections. Deflections calculated in the designed box beam covers used were:

70' Span with 4k/ft. load	0.706"
60' Span with 4.5k/ft. load	0.65"
50' Span with 5k/ft. load	0.61"
40' Span with 5.8k/ft. load	0.55"

The relative costs are easily seen from the attached cost summary on the next page. Of course the sequence of expenditures is different as is the potential source of funding.

Other things considered in evaluating alternative decks included the concern of restricting inflows to the channel in deck areas and the possibility of delaying the project by extending the design phase. A thorough review of the various specific sites of the decks indicated that the decks are of such an insignificant relative size and in such locations that inflow considerations are manageable with only minor design modifications.

It is not anticipated that the inclusion of designing a deck to cover a channel section nor extending the 60' box culvert section would increase the current schedule for the design of Reach 3 nor should it have any impact on the schedule of Reach 4.

5. SUMMARY AND CONCLUSIONS:

The study indicates that the single most economical means of providing deck area over the 60' channel is to construct a cast-in-place concrete box culvert. A strengthened concrete channel with prestressed concrete box beam deck installed is the most economical option for the 40' channel. The cost tables included herein indicate that the cost differential for these two options is far less than the future costs of the independent deck option. Obviously, selection of either of these alternatives precludes the huge future expenditure of installing a clear span deck.

If a nominal initial expense for channel modification is acceptable, Alternative B, which would allow the installation of a deck sometime in the future, becomes a viable alternative at an additional initial cost of less than $140 per foot. However, the future cost for adding this deck still varies between $650 and $1,200 per linear foot.

Alternative C incurs no additional initial costs since the channel is installed without alterations however, the future addition of independently supported deck and support structure will cost between $1,683 and $2,585 per linear foot. By casual observation, it can be seen that this method of covering exceeds the total cost of a box culvert or channel and cover provided in the other alternatives.

No costs are provided for the 50' cast-in-place concrete box culvert since it has been established by the Corps staff that this approach is unacceptable from a hydraulic view point. Also the 60' box culvert option is unacceptable in the vicinity of 19th Avenue for the same reason.

40 FOOT WIDTH

COST PER LINEAR FOOT

ALTERNATIVE	ORIGINAL COST	FUTURE COST	TOTAL COST
A. Benchmark Rectangular Channel	$ 869	$ -0-	$ 869
B. Benchmark Channel with Deck Added Later on Strengthened Walls			
Walls & Invert	$ 1,007	$ -0-	$ 1,007
Deck	$ -0-	$ 650	$ 650
Total:	$ 1,007	$ 650	$ 1,657
Cost Differential (B-A)	$ 138	$ 650	$ 788
C. Spanning Over Benchmark Channel with Drilled Caissons for Support			
Walls & Invert	$ 869	$ -0-	$ 869
Beams & Caissons	$ -0-	$ 1,683	$ 1,683
Total:	$ 869	$ 1,683	$ 2,552
Cost Differential (C-A)	$ -0-	$ 1,683	$ 1,683
D. Cast-in-Place Concrete Box Culvert	$ 1,848	$ -0-	$ 1,848
Cost Differential (D-A)	$ 979	$ -0-	$ 979

UNIT COST BREAKDOWN TO BE PROVIDED SEPARATELY

APPENDIX II

50 FOOT WIDTH

COST PER LINEAR FOOT

ALTERNATIVE	ORIGINAL COST	FUTURE COST	TOTAL COST
A. Benchmark Rectangular Channel	$ 906	$ -0-	$ 906
B. Benchmark Channel with Deck Added Later on Strengthened Walls			
Walls & Invert	$ 1,044	$ -0-	$ 1,044
Deck	$ -0-	$ 938	$ 938
Total:	$ 1,044	$ 938	$ 1,982
Cost Differential (B-A)	$ 138	$ 938	$ 1,076
C. Spanning Over Benchmark Channel with Drilled Caissons for Support			
Walls & Invert	$ 906	$ -0-	$ 906
Beams & Caissons	$ -0-	$ 2,063	$ 2,063
Total:	$ 906	$ 2,063	$ 2,969
Cost Differential (C-A)	$ -0-	$ 2,063	$ 2,063

60 FOOT WIDTH

COST PER LINEAR FOOT

ALTERNATIVE	ORIGINAL COST	FUTURE COST	TOTAL COST
A. Benchmark Rectangular Channel	$ 942	$ -0-	$ 942
B. Benchmark Channel with Deck Added Later on Strengthened Walls			
Walls & Invert	$ 1,070	$ -0-	$ 1,070
Deck	$ -0-	$ 1,200	$ 1,200
Total:	$ 1,070	$ 1,200	$ 2,270
Cost Differential (B-A)	$ 128	$ 1,200	$ 1,328
C. Spanning Over Benchmark Channel with Drilled Caissons for Support			
Walls & Invert	$ 942	$ -0-	$ 942
Beams & Caissons	$ -0-	$ 2,585	$ 2,585
Total:	$ 942	$ 2,585	$ 3,527
Cost Differential (C-A)	$ -0-	$ 2,585	$ 2,585
D. Cast-in-Place Concrete Box Culvert	$ 1,834	$ -0-	$ 1,834
Cost Differential (D-A)	$ 892	$ -0-	$ 892

UNIT COST BREAKDOWN TO BE PROVIDED SEPARATELY

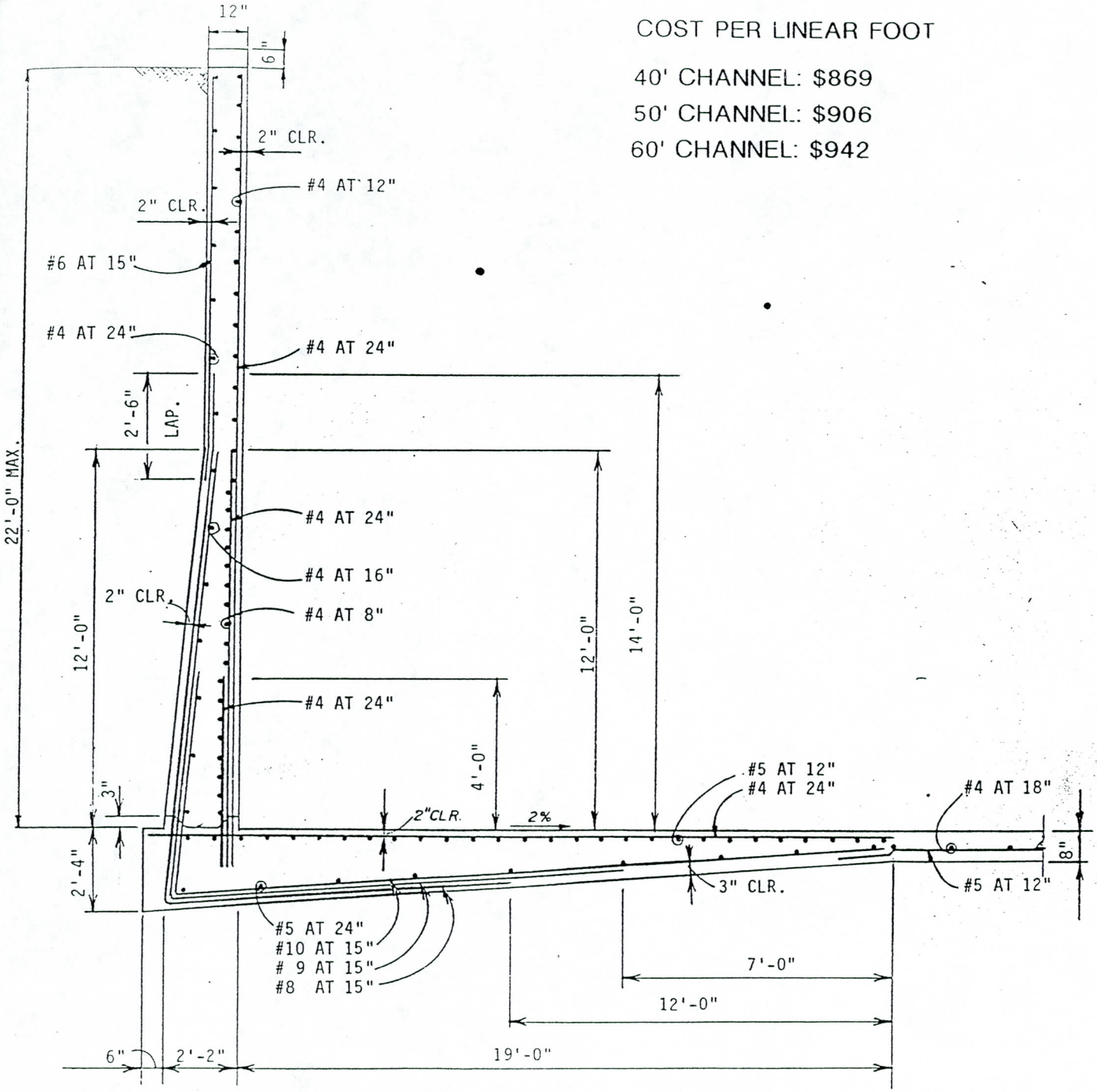
PLUMMER HASAN & ASSOCIATES CONSULTING ENGINEERS, INC.	ARIZONA CANAL DIVERSION CHANNEL PHOENIX, ARIZONA & VICINITY	JOB NO. DATE 1/11/88 BY EMP	SHT. NO. OF D4

COST PER LINEAR FOOT

40' CHANNEL: $869

50' CHANNEL: $906

60' CHANNEL: $942



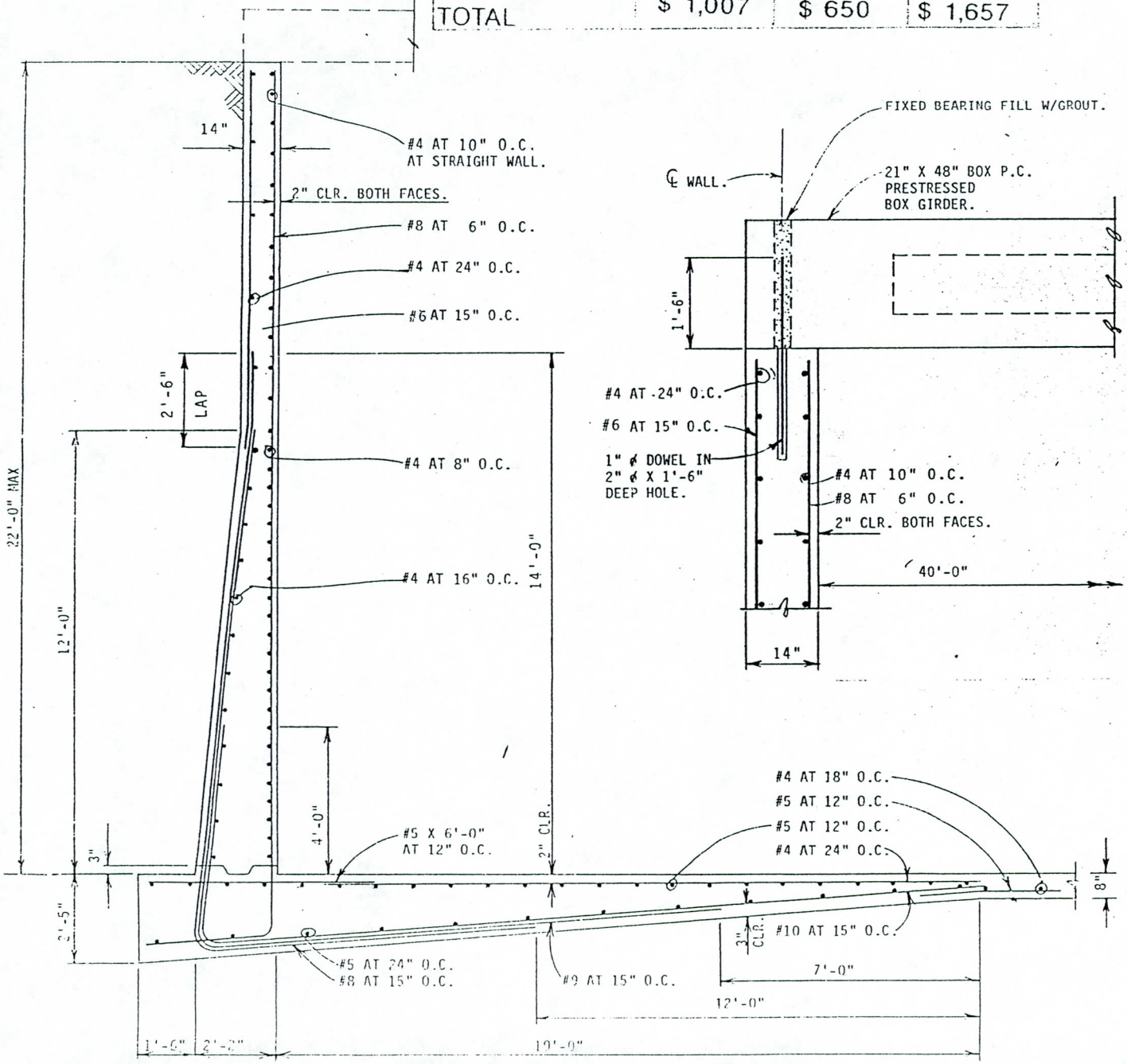
ALTERNATIVE A

22'-0" DEEP CHANNEL

PLUMMER HASAN & ASSOCIATES CONSULTING ENGINEERS, INC.	ARIZONA CANAL DIVERSION CHANNEL PHOENIX, ARIZONA & VICINITY	JOB NO. DATE 1/11/88 BY EMP	SHT. NO. OF D5

COST PER LINEAR FOOT

	ORIGINAL COST	FUTURE COST	TOTAL
INVERT WALLS	$ 1,007	0	$ 1,007
DECK	0	$ 650	$ 650
TOTAL	$ 1,007	$ 650	$ 1,657



ALTERNATIVE - B

40'-0" WIDE CHANNEL WITH DECK ADDED LATER

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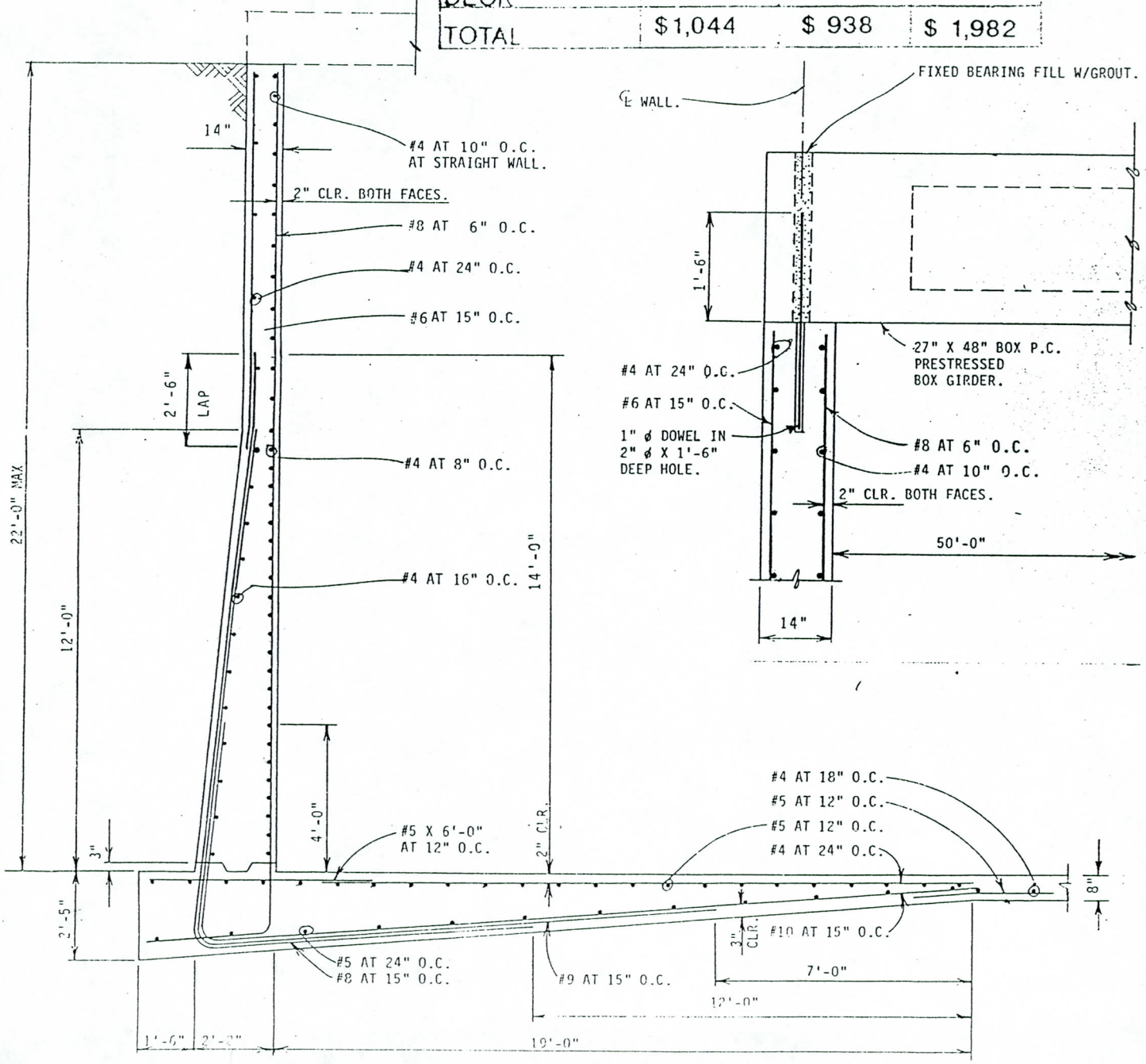
COST PER LINEAR FOOT

	ORIGINAL COST	FUTURE COST	TOTAL
INVERT WALLS	$ 1,044	0	$ 1,044
DECK	0	$ 938	$ 938
TOTAL	$1,044	$ 938	$ 1,982



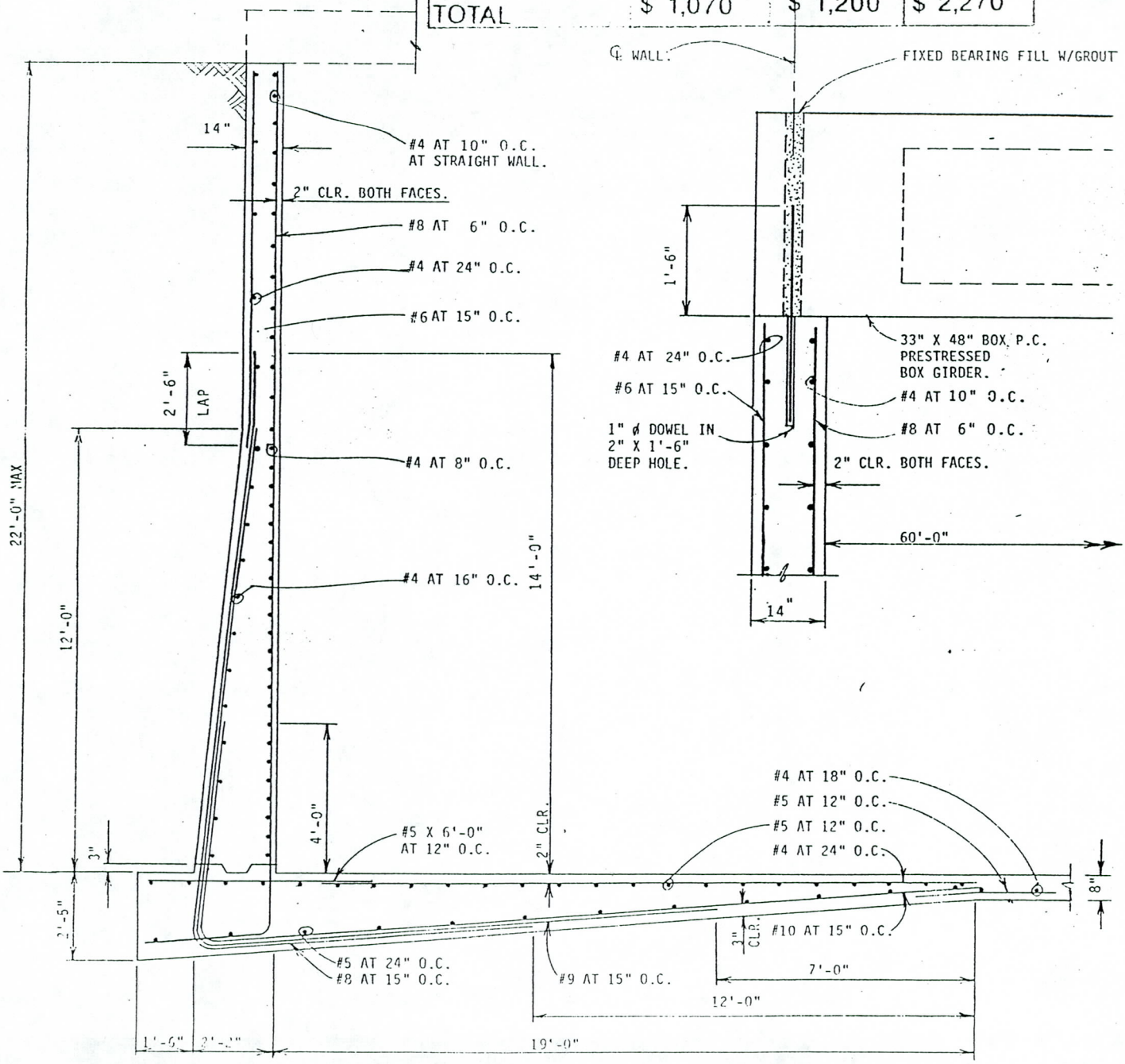
ALTERNATIVE - B

50'-0" WIDE CHANNEL WITH DECK ADDED LATER

PLUMMER HASAN & ASSOCIATES CONSULTING ENGINEERS, INC.	ARIZONA CANAL DIVERSION CHANNEL PHOENIX, ARIZONA & VICINITY	JOB NO. DATE 1/11/88 BY EMP	SHT. NO. OF D7

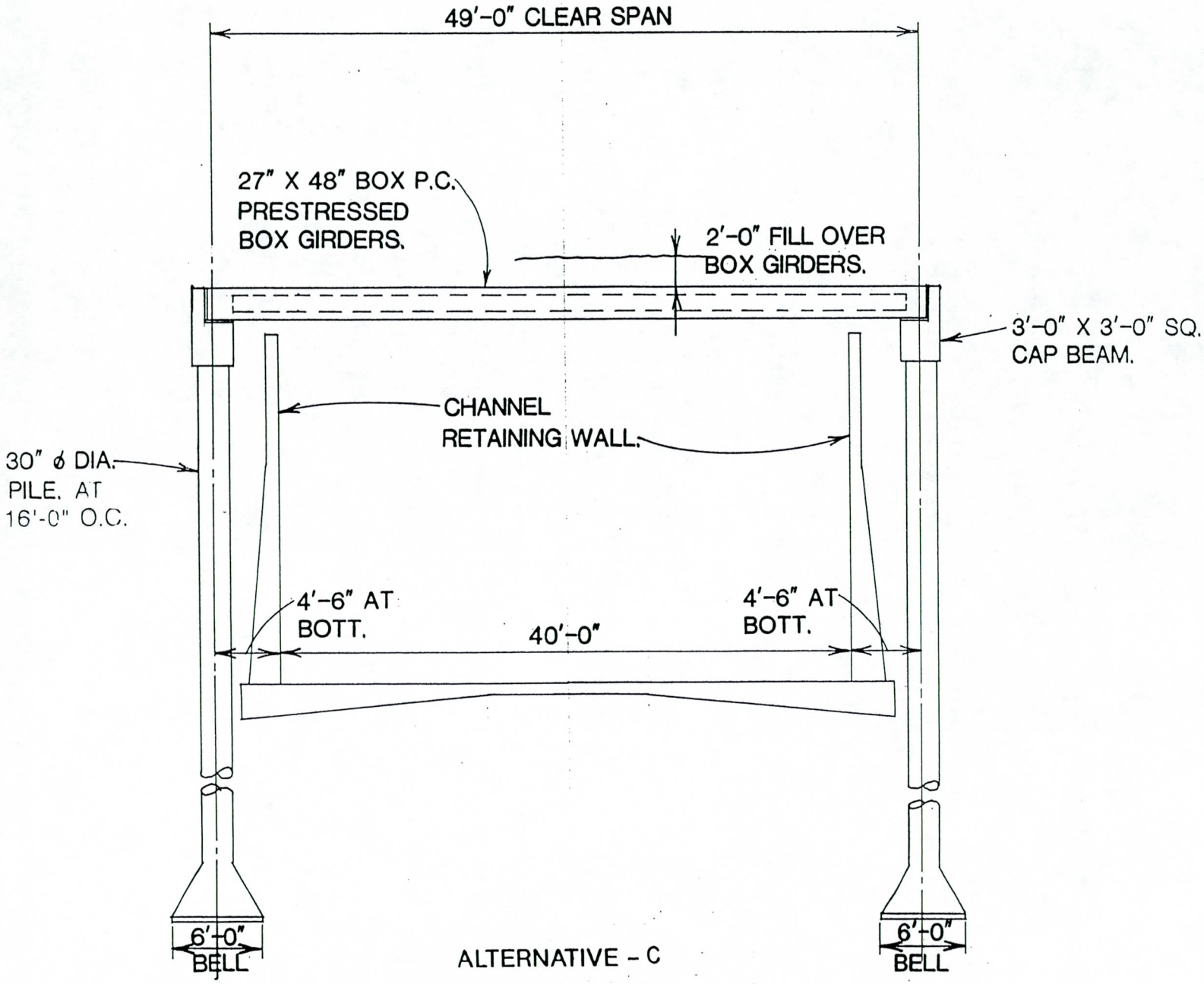
COST PER LINEAR FOOT

	ORIGINAL COST	FUTURE COST	TOTAL
INVERT WALLS	$ 1,070	0	$ 1,070
DECK	0	$ 1,200	$ 1,200
TOTAL	$ 1,070	$ 1,200	$ 2,270



ALTERNATIVE - B

60'-0" WIDE CHANNEL WITH DECK ADDED LATER



ALTERNATIVE - C

40'-0" WIDE CHANNEL

COST PER LINEAR FOOT: $2,552

PLUMMER HASAN & ASSOCIATES
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DATE 1/11/88
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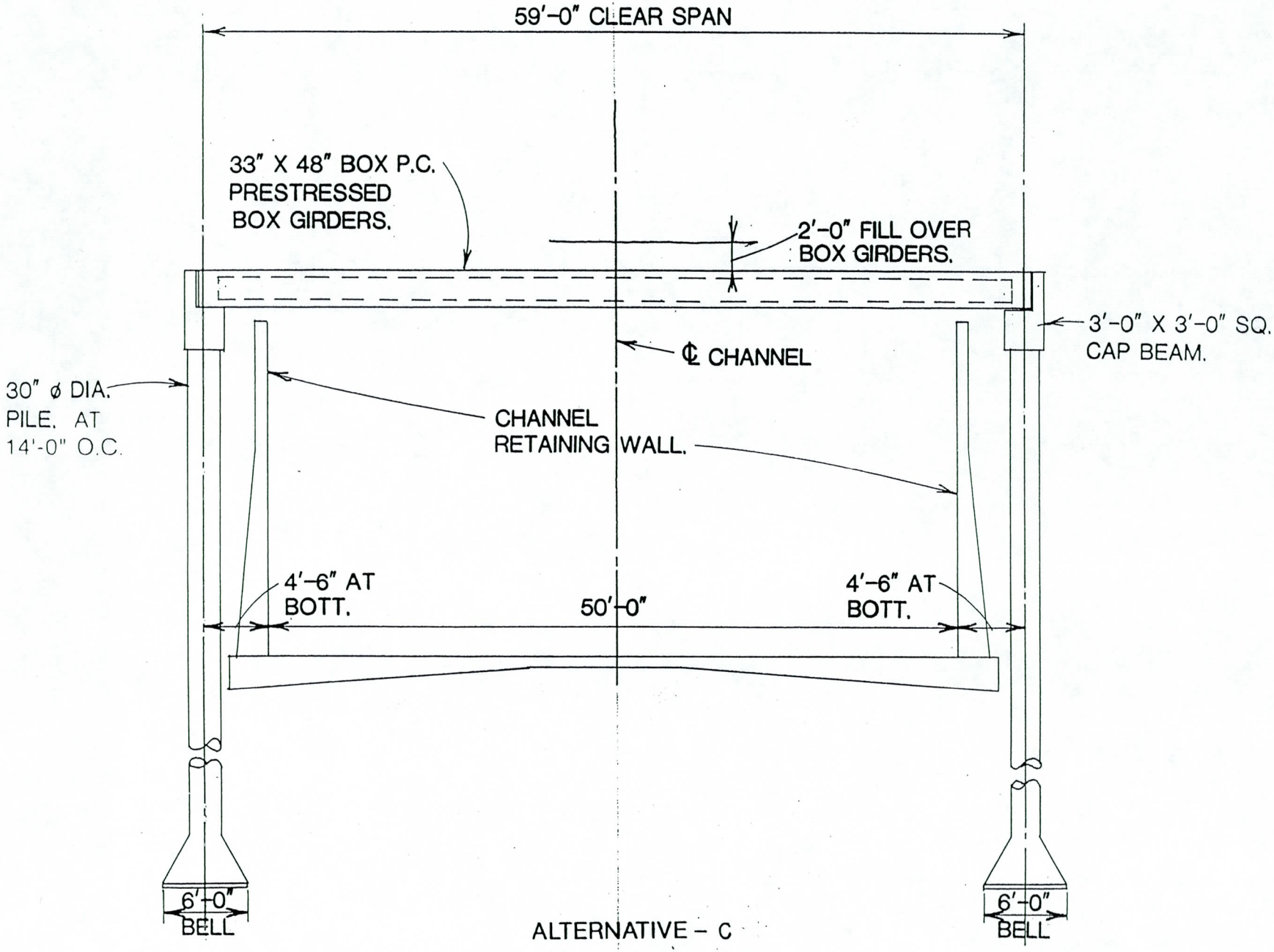

ALTERNATIVE – C

50'-0: WIDE CHANNEL

COST PER LINEAR FOOT: $2,969

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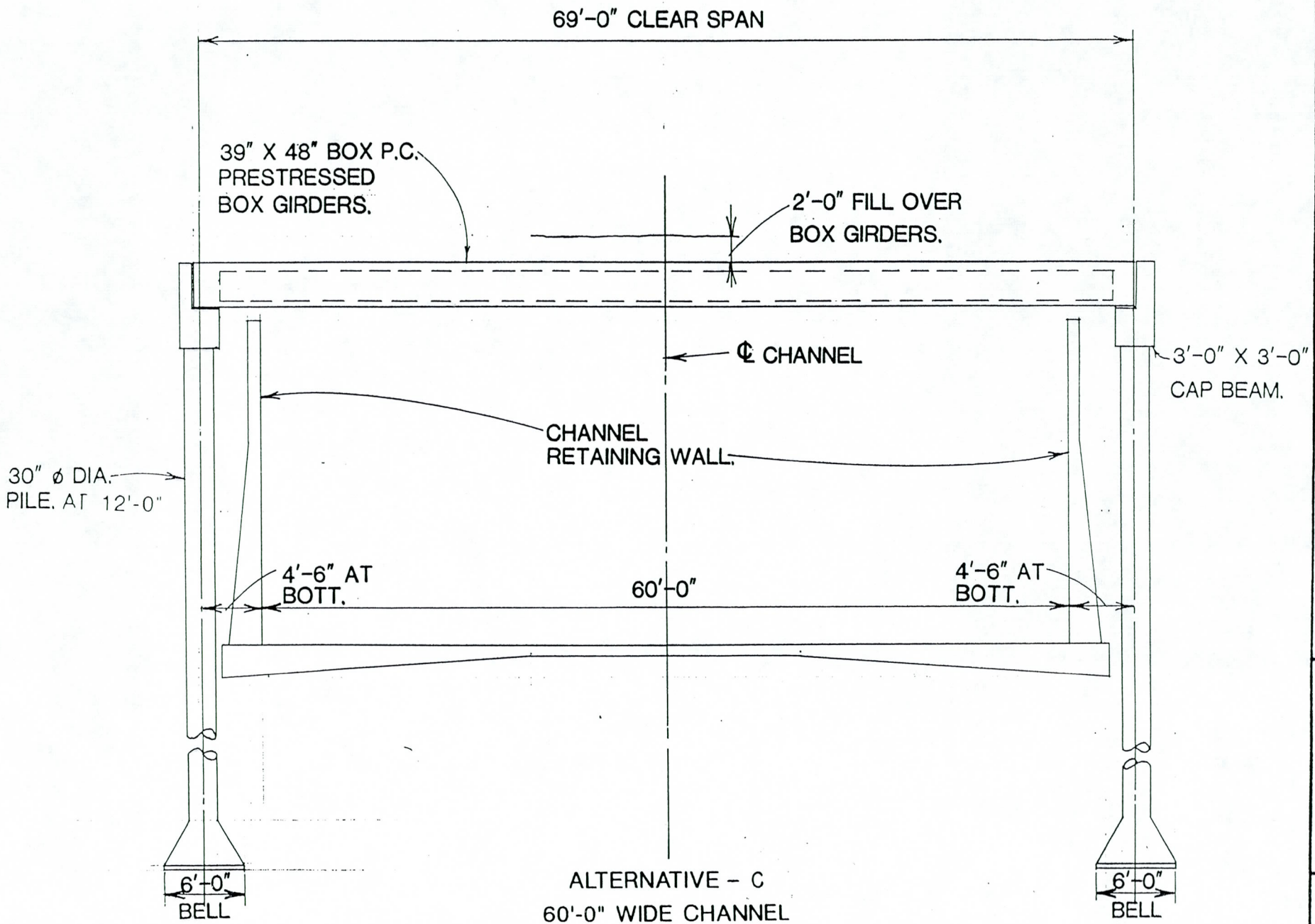

ALTERNATIVE – C
60'-0" WIDE CHANNEL
COST PER LINEAR FOOT $3,527

PLUMMER HASAN & ASSOCIATES
CONSULTING ENGINEERS, INC.

ARIZONA CANAL DIVERSION CHANNEL
PHOENIX, ARIZONA & VICINITY

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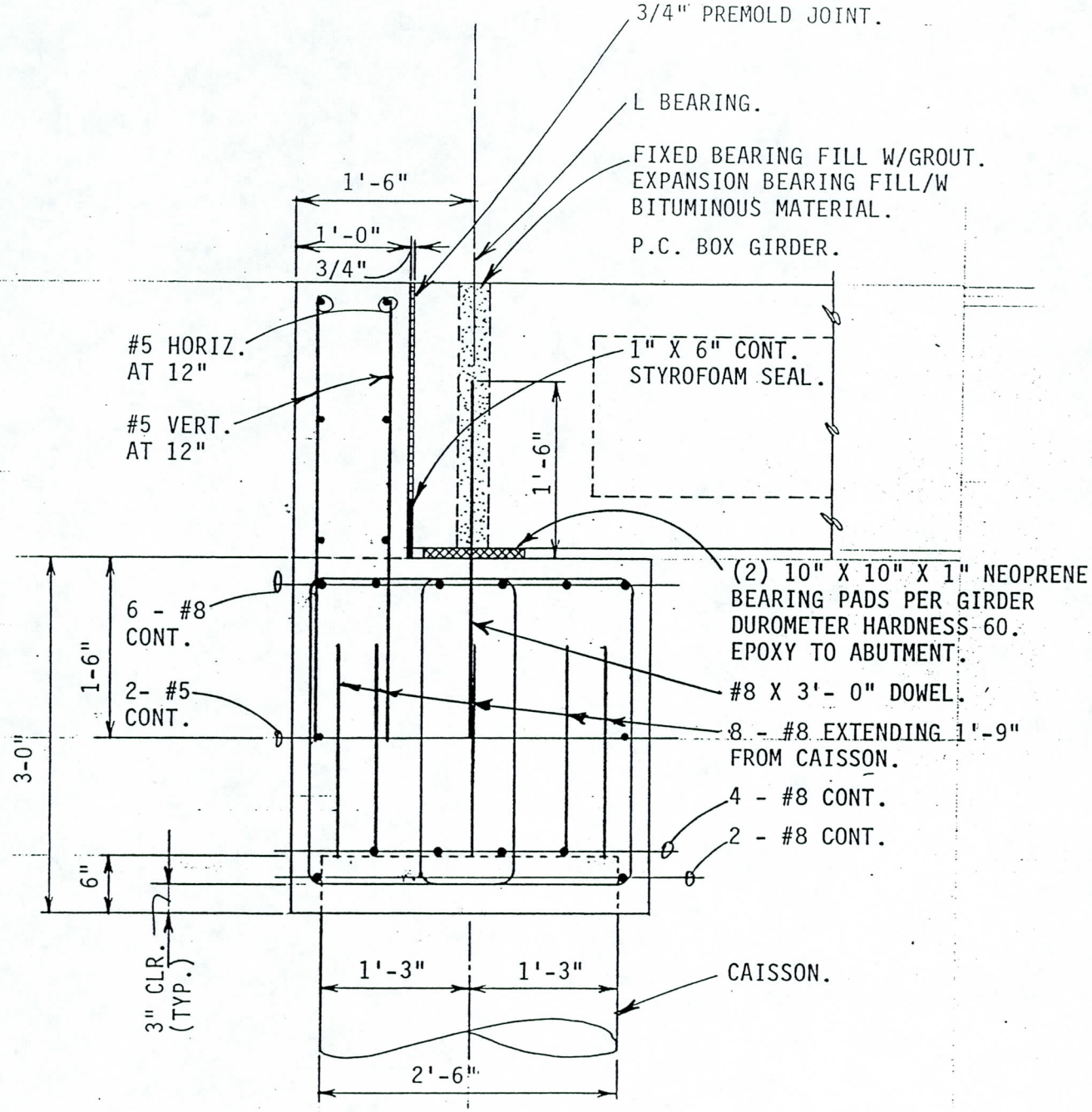

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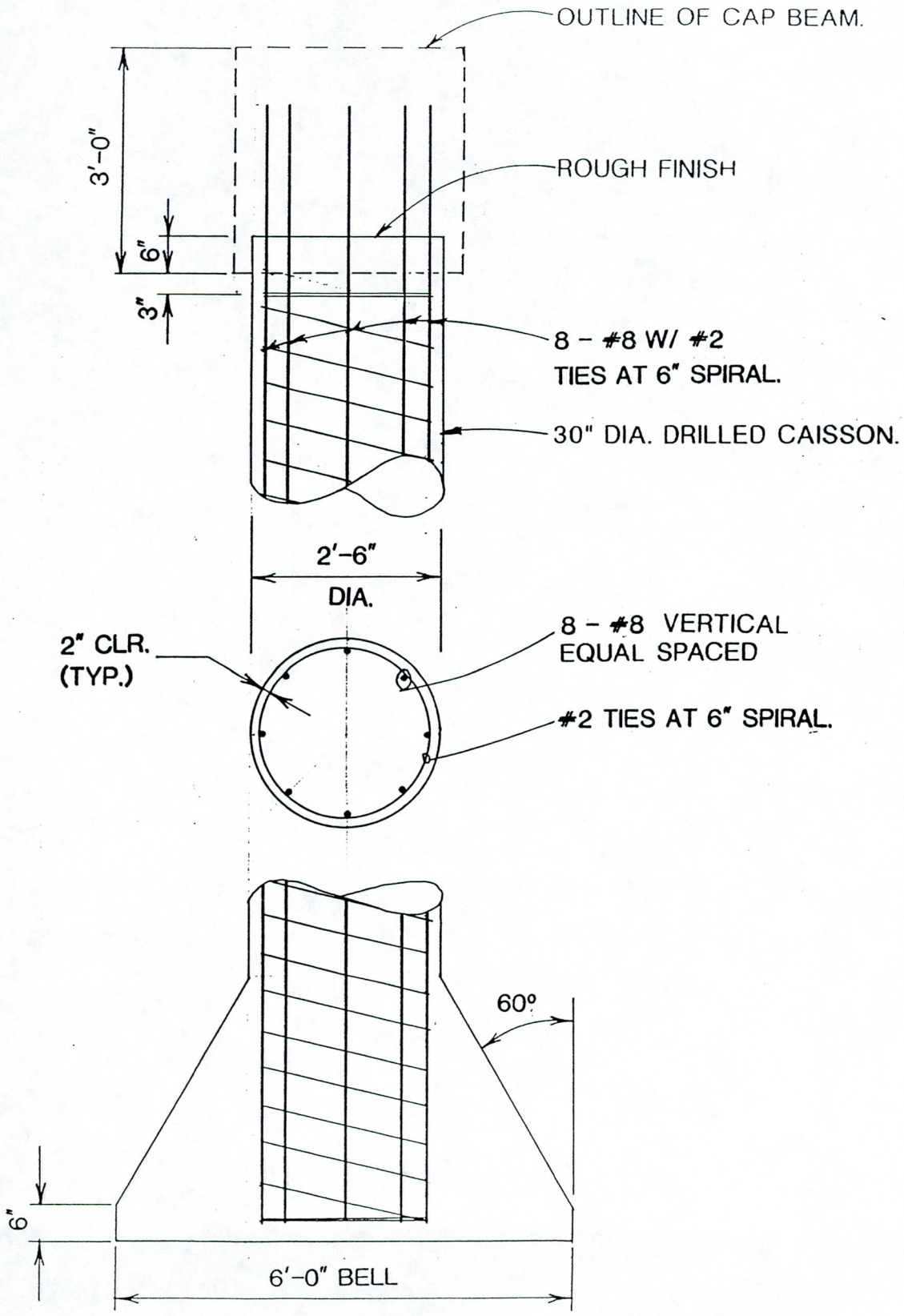

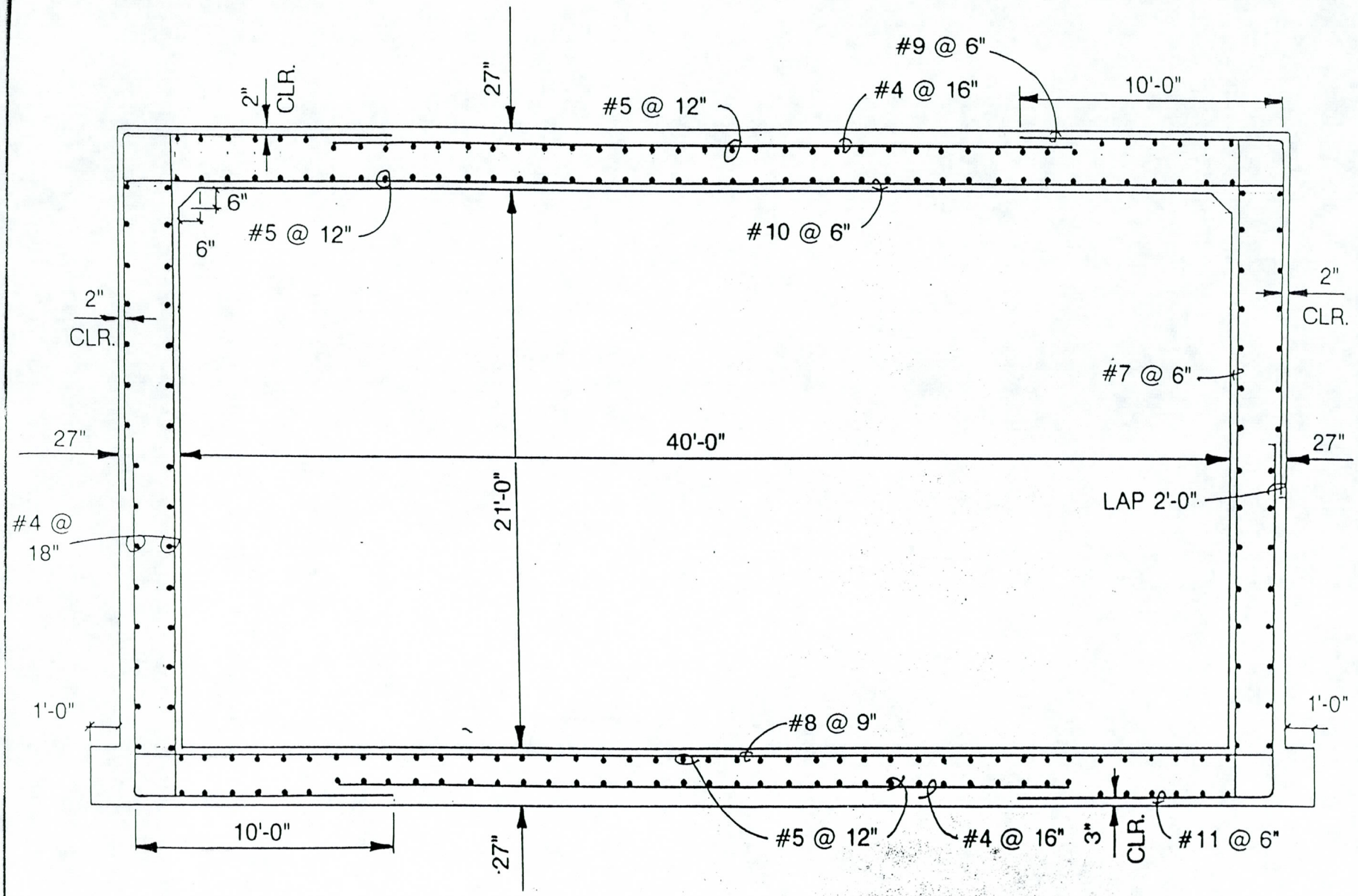

ALTERNATIVE - D

40'-0" BOX CULVERT

SCALE 3/16"=1'-0"

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ACDC

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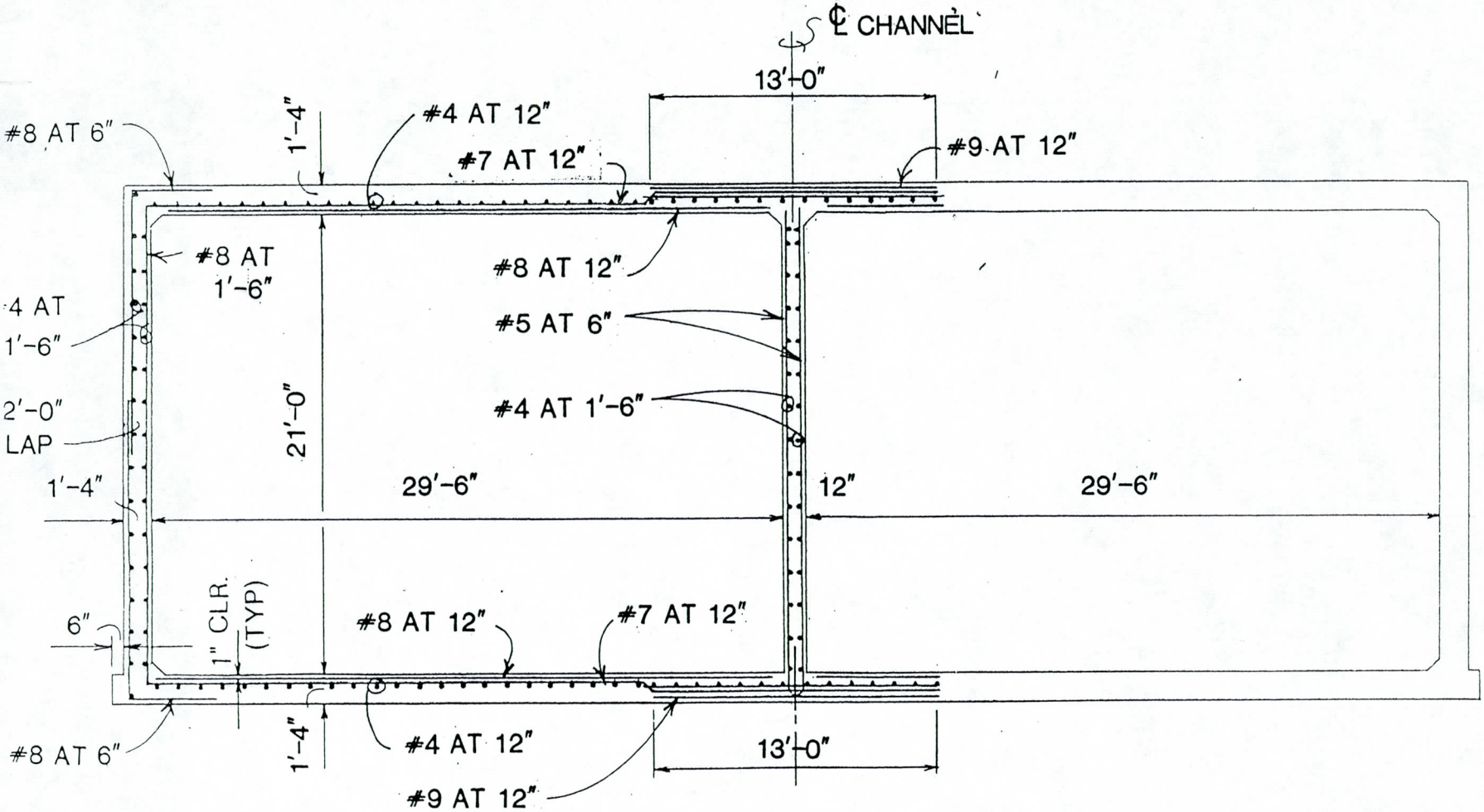
OF



ALTERNATIVE – D

60'-0" BOX CULVERT

COST PER LINEAR FOOT: $1,834

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ARIZONA CANAL DIVERSION
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PHOENIX, ARIZONA & VICINITY

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OF D3