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# CONCEPTUAL STUDY
# AN ALTERNATIVE TO ACDC

March 29, 1983

prc

PRC Toups Corporation

A Planning Research Company

A118.927

# CONCEPTUAL STUDY
# AN ALTERNATIVE TO ACDC

March 29, 1983

Prepared For:

ARIZONA BILTMORE ESTATES VILLAGE ASSOCIATION
2423 EAST MARSHALL AVENUE
PHOENIX, ARIZONA 85016

Prepared by:

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FILE COPY

6 April 1983

Flood Control District of Maricopa County
3335 West Durango Street
Phoenix, Arizona
Attn: Mr. D. Sagromoso, Manager

Re: Alternative Flood Control in Reach 4 of the Arizona Canal Diversion Channel

Dear Mr. Sagromoso:

At the request of our client, Arizona Biltmore Estates Village Association we have undertaken a conceptual study for determining the most cost effective alternative to provide flood protection at the east end of the reach. The attached report sets out an alternative which, at a conceptual stage, has a potential for providing protection from the 100-year return frequency flood event. In addition, the alternative would substantially reduce capital costs to the Arizona Canal Diversion Channel; materially enhance the esthetics of the area through the elimination of an open channel; and reduce the taxpayer's future debt financing obligation.

Before we proceed any further with our study we, on behalf of our client, wish to have the District's concurrance in the technical and economic feasibility of the proposed alternative. We are aware that work towards making the ACDC a reality is currently underway and that, therefore, time to affect modifications in concept and design is critical. We are most willing to accomodate your needs in facilitating a conceptual review in whatever way may best assist the review process.

In order to keep our client informed regarding the project's status may we expect to receive your review comments by April 29th? If that date is impossible to meet please tell us when we may expect to hear from you.

Sincerely,

**PRC TOUPS, A Division of**
**PRC Engineering, Inc.**

Edward A. Adair, P.E.
Vice President

EAD/sk
enclosure

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## SCOPE OF STUDY

The purpose of this report is to investigate an alternative solution for flood protection in the eastern study reach of the Arizona Canal Diversion Channel (ACDC) from 24th Street to 40th Street. The scope of this report is to evaluate the alternative on a conceptual basis.

## GENERAL BACKGROUND

The U.S. Army Corps of Engineers has considered providing a concrete lined rectangular channel to intercept and convey flood flows from the drainage area of about 7.7 square miles in the two mile long study reach of ACDC (See Plat 1). The concrete lined channel is designed to carry the 100-year frequency flood flows ranging from 6900 cfs at its upstream end near the Cudia City Wash to about 8400 cfs at 24th Street.

An alternative method of protection has been studied from a conceptual level of effort which can reduce the capital cost as well as the aesthetic impact while providing a flood protection from the 100-year frequency storm.

## ALTERNATIVE EVALUATION

### General

In the alternative evaluation, two detention basins are considered (Plate 2). These basins will collect and detain flood flows from the 100-year frequency storm. A large size storm drain is provided at the discharges of each basin so that the basin size can be minimized. The storm drain will extend along the north side of existing Arizona Canal to discharge into the proposed ACDC

immediately west of 24th Street. The storm drain is sized so that it can be placed within the Salt River Project (SRP) right-of-way. The attenuation of the flood peak achieved as a result of detention will reduce the design peaks in the ACDC throughout its remaining eight mile reach west of 24th Street. Consequently, downsizing of ACDC will be possible for the eight mile reach, resulting in capital cost reduction. Comparison of capital costs between an open channel design and the alternative appear to show a significant reduction of 5.7 million dollars with the alternative. The attenuation of the flood peak through the basin alternative also has the potential effect of reducing capital costs an additional 17.5 million between 24th Street and Skunk Creek.

Cudia City Wash Basin

The first basin comprised of about 39 acres is located on the southwest side of the intersection of 40th Street and Stanford Drive and would be located on the parcel which is presently being used by the North Phoenix Country Day School. This basin would have an average depth of 27 feet and would collect and detain flood flows from the Cudia City Wash. A large ungated outlet in the form of a 72 inch reinforced concrete pipe would be provided to continuously drain the basin during and after the storm event. The outflow from the 72 inch pipe would then be discharged into a ten-foot by eight-foot concrete box conduit which will run along the north side of the Arizona Canal 3430 lineal feet westerly to 33rd Street.

Cudia City Wash Basin - Summary:

| | |
|---|---|
| Drainage Area | 5.23 Square Miles |
| 100-Year 24-Hour Precipitation | 4 Inches |
| Runoff Curve Number | 91 |
| Runoff | 3.0025" |
| Runoff Volume | 840 AcFt |
| Estimated Outflow from 10' x 8' box | 500 cfs |
| Required Detention Volume | 500 AcFt |
| Freeboard | 1.5 Feet |
| Basin depths (varies) | 17.5 to 40 feet |
| Basin drain time | 1 Day (Maximum) |
| Basin Size | 39 Acres |

35th Street Wash Basin

The second basin comprised of about eleven acres would be located on the west side of 35th Street and about 1200 feet north of Standford Drive. This basin would collect flood flows from three unnamed tributaries draining about 1.5 square miles of watershed. Three inlets would be provided to intercept flood flows from these tributaries. The basin having an average depth of 22 feet would detain about 130 acre feet of runoff during the 100-year storm event. An ungated 60 inch reinforced concrete pipe would be provided to continuously drain the basin. The pipe would connect to the ten-foot by eight-foot concrete box conduit which comes from the Cudia City Wash Basin at 33rd Street and the Arizona Canal. From the junction at 33rd Street and the Arizona Canal, the box would be enlarged to a ten-foot by ten-foot size and extended westerly 6780 lineal feet adjacent to and parallel with the Arizona Canal to the ACDC now having its eastern terminus located west of 24th Street.

35th Street Wash Basin - Summary:

| | |
|---|---|
| Drainage Area | 1.5 Square Miles |
| 100-Year 24-Hour Precipitation | 4 Inches |
| Runoff Curve Number (Wtd.) | 88.3 |
| Runoff | 2.98" |
| Runoff Volume | 234 AcFt |
| Estimated outflow from 60" RCP | 250 cfs |
| Required detention volume | 130 AcFt |
| Freeboard | 1.5 feet |
| Basin depths (varies) | 15 to 32 feet |
| Basin drain time | 1 Day (Maximum) |
| Basin Size | 11 Acres |

Biltmore Storm Drain

In the watershed of about one square mile which directly affects the Arizona Biltmore Estates, there are a series of existing flood retarding elements including detention basins, lakes and drainage channels which compose the Biltmore flood protection system. This flood protection system was sized to reduce flood flows which occur from a ten-year two-hour storm event and are therefore, presently undersized to effectively contain the 100-year 24-hour storm event. Our preliminary examination of these elements lead us to the conclusion that enlarging these facilities would not be cost-effective. In this alternative, precast concrete boxes were considered to convey the 100-year flood flows from the Biltmore property discharging into the ACDC west of 24th Street.

Presently, storm flow from about .36 square miles concentrates in the retention basin located immediately north of the Arizona Canal and east of Biltmore Hotel tennis courts. In the alternative, an inlet structure would be provided to intercept the 100-year flood outflow from the exiting retention basin. The intercepted flow would then be carried by a second ten-foot by ten-foot concrete box conduit laid parallel to the box conduit coming from the 35th Street and Cudia City detention basins as discussed earlier in this report. The second box conduit will also terminate at the ACDC west of 24th Street.

A major portion of the Biltmore watershed drains through a tributary wash which terminates immediately west of the Biltmore Hotel and north of the Arizona Canal. A third box conduit (ten-foot by ten-foot) would intercept flows from this tributary through an inlet structure. The box would be extended about 1750 lineal feet to the ACDC west of 24th Street.

Biltmore Storm Drain - Summary:

| | |
|---|---|
| Drainage Area (Varies) | 0.4 to 1.0 Square Mile |
| 100-Year 24-Hour Precipitation | 4 Inches |
| Runoff Curve Number | 91 |
| Runoff Peaks (Varies) | 800 to 1400 cfs |
| Storm Drain Size | 1. 10 x 10 Pre-cast box |
| | 2. 10 x 10 Pre-cast box |

## CONCLUSIONS AND RECOMMENDATIONS

An alternative solution of flood protection for the eastern reach of Arizona Canal Diversion Channel (ACDC) was investigated in this conceptual study. Based upon this study, the following conclusions are drawn:

1. The alternative to ACDC is feasible in the study reach. This alternative consists of a combination of detention basins and a two-mile long storm drain system as shown on Plate 2. It will require an estimated 50 acres of land which includes two existing residential homes and the North Phoenix Country Day School property. The cost of this alternative is estimated to be 25.2 million dollars based upon 1982 land values and construction prices as compared to Corp's present estimate of 31 million dollars for the same reach. For more detailed cost estimates, reference should be made to the Appendix.

2. A reduction in the flood peak will result for the entire reach of ACDC, thus making possible the structural downsizing of the entire ACDC.

3. Improvement costs are estimated to be reduced by 17.4 million dollars (1982 pricing) for the reach west of 24th Street and extending to Skunk Creek.

4. The estimated savings using the alternative is summarized below:

| REACH | ACDC | ALTERNATE | COST DIFFERENCE |
|---|---|---|---|
| Eastern Reach<br>ACDC East of 24th Street | 31,000,000 | 25,223,000 | 5,777,000 |
| Western Reach<br>ACDC West of 24th Street | 130,837,000[a] | 113,343,000[a] | 17,494,000[a] |
| TOTAL | 161,837,000 | 138,566,000 | $23,211,000 |

a. Does not include reduced cost of right-of-way, utilities, bridges, etc.

## AVAILABLE DATA AND REFERENCES

For the purpose of this conceptual study, the following references were cited:


1. U.S. Army Corps of Engineers," Gila River Basin, New River and Phoenix City Streams, Arizona, Design Memorandum No. 3, General Design Memorandum - Phase 1, Plan Formulation." March 1976.

2. U.S. Department of Agriculture, Soil Conservation Service, "Arizona General Soil Map", Portland, Oregon, December 1975.

3. U.S. Department of Agriculture, Soil Conservation Service, "Urban Hydrology for Small Watersheds", Technical Release No. 55, January 1975.

4. U.S. Department of Commerce, National Weather Service, "Precipitation Frequency Atlas of the Western United States", Volume VII - Arizona 1973.

5. City of Phoenix, "Storm Drain Design Manual, Subdivision Drainage Design." October 1972.

6. Arizona Department of Transportation, "Hydrologic Design for Highway Drainage in Arizona", Phoenix, Arizona, December 1968.

7. City of Phoenix, "Quarter Section Maps."

## APPENDIX

Cost Analysis

Cost Summary

Cudia City Wash Basin including Outlet Drain

35th Street Wash Basin including Outlet Drain

Biltmore Storm Drain

ACDC Cost Reduction West of 24th Street

PLATE 1 Location and Drainage Area Map

PLATE 2 ACDC Alternative, Eastern Reach

## COST ANALYSIS

A conceptual cost analysis is prepared for the alternative studied so that a cost comparison can be made with the planned Arizona Canal Diversion Channel for the study reach. The analysis is based on the 1982 price index and only includes major elements of the flood control improvements. It is also assumed that the storm drain facility which runs parallel to Arizona Canal will be contained within the Arizona Canal right-of-way limits. Consequently, no right of way acquisition cost is considered for placing the drain facility along the Arizona Canal.

Cost Summary (1982 Price)

| | ACDC Present Estimates By Corps | Alternative To ACDC | Cost Reduction |
|---|---|---|---|
| Eastern Reach ACDC East of 24th Street: | | | |
| Cudia City Wash Basin | | 15,877,200 | |
| 35th St. Wash Basin | | 4,879,000 | |
| Biltmore Storm Drain | | 4,467,000 | |
| | $ 31,000,000[a] | $ 25,223,200 | $ 5,776,800 |
| Western Reach ACDC West of 24th Street: | | | |
| | $ 130,837,000[b] | $ 113,343,000[b] | $17,494,000[b] |
| | | | $23,270,800 |

a. Prorated based on Corps 1982 Estimate of 53.4 million dollars for the ACDC - Cudia City Wash to Dreamy Draw.

b. Does not include reduced costs of right-of-way, utilities, bridges, etc.

The cost estimate for various elements of the alternative is summarized below:

1. Cudia City Wash Basin including outlet drain:

| | | | | |
|---|---|---|---|---|
| **Construction costs:** | | | | |
| Excavation | 1,459,000 | C.Y. | $ 5.00 | $ 7,295,000 |
| Drop Structure | 1 | L.S. | | 100,000 |
| Fencing & Gates | 52.00 | L.F. | 7.00 | 36,400 |
| Landscaping | 78,000 | S.F. | .60 | 46,800 |
| 72" RCP Outlet Drain | 250 | L.F. | 125.00 | 31,250 |
| 1-10'x 8' Pre-Cast Concrete Box | 3,430 | L.F. | 325.00 | 1,114,750 |
| Subtotal | | | | $ 8,624,200 |
| **Right of Way costs:** | | | | |
| Land | 39 | Ac. | 50,000 | $ 1,950,000 |
| Buildings | 83,000 | S.F. | 41.00 | 3,403,000 |
| Subtotal | | | | $ 5,353,000 |
| TOTAL CONSTRUCTION AND RIGHT OF WAY | | | | $ 13,977,200 |
| CONTINGENCIES 10% | | | | 1,400,000 |
| ENGINEERING & ADMINISTRATIVE 5% OF CONSTRUCTION COST | | | | 500,000 |
| **TOTAL** | | | | **$ 15,877,200** |

2. 35th Street Wash Basin including Outlet Drain

| | | | | |
|---|---|---|---|---|
| **Construction costs:** | | | | |
| Excavation | 341,000 | C.Y. | $ 4 | $ 1,364,000 |
| Drop Structures | 1 | JOB L.S. | | 100,000 |
| Fencing and Gates | 3,600 | L.F. | 8.33 | 30,000 |
| Landscaping | 21,600 | S.F. | .60 | 13,000 |
| 60" RCP Outlet Drain | 600 | L.F. | 100.00 | 60,000 |
| 1-10'x 10' Pre-Cast Concrete Box | 2,830 | L.F. | 400.00 | 1,132,000 |
| Subtotal | | | | $ 2,699,000 |
| **Right of Way costs:** | | | | |
| Land | 11 | Ac. | 100,000 | 1,110,000 |
| Single Family Homes (Building Only) | 2 | EA. | 300,000 | 600,000 |
| Subtotal | | | | $ 1,710,000 |
| TOTAL CONSTRUCTION AND RIGHT OF WAY | | | | $ 4,409,000 |
| CONTINGENCIES 5% | | | | 220,000 |
| ENGINEERING & ADMINISTRATIVE 9% OF CONSTRUCTION COST | | | | 250,000 |
| **TOTAL** | | | | **$ 4,879,000** |

3. Biltmore Storm Drain

Construction costs:

| | | | | |
|---|---|---|---|---|
| 2 - 10' x 10' Pre-cast Concrete Boxes | 2,200 | L.F. | 760 | $ 1,672,000 |
| 3 - 10' x 10' Pre-cast Concrete Boxes | 1,750 | L.F. | 1,140 | 1,995,000 |
| Subtotal | | | | 3,667,000 |
| CONTINGENCIES 15% | | | | $ 500,000 |
| ENGINEERING AND ADMINISTRATIVE 7% OF CONSTRUCTION COST | | | | 250,000 |
| TOTAL | | | | $ 4,467,000 |

## ACDC COST REDUCTION - WESTERN REACH

The ACDC is presently designed to carry 8400 cfs Peak downstream from its location near 24th Street. With the proposed alternative in-place this value of peak discharge (8400 cfs) will be reduced to approximately 2200 cfs. As discussed earlier in this report, the reduction in peak will be achieved by detaining major flood flows in to the Cudia City Wash Basin and 35th Street Wash Basin. With the reduced flow, the present size of ACDC can therefore be downsized. The following tabulation indicates modified channel cost for the western reach of ACDC:

| ACDC Reach | ACDC Present Estimates by Corps (1976 Price) | Alternate ACDC reduced cross-section (1976 Price) | Reduced Cost (1976 Price) |
|---|---|---|---|
| 24th Street to Dreamy Draw | 7,030,000[a] | 6,154,100 | 875,900 |
| Dreamy Draw to Cave Creek Wash | 19,470,000 | 15,398,900 | 4,071,100 |
| Cave Creek Wash to Cactus Road | 17,500,000 | 15,912,800 | 1,587,200 |
| Cactus Road to Skunk Creek | 14,600,000 | 13,299,000 | 1,301,000 |
| | $ 58,600,000 | $50,764,800 | $7,835,200 |

Reduced cost (1982 Price index) = $ 7,835,200 x 1.8606
= $ 14,478,000

Reduced cost engineering, design, Supervision & Administration = $ 2,916,000

Total $ 17,494,000

a. Cost prorated from ACDC - 40th Street to Dreamy Draw based on length in feet.

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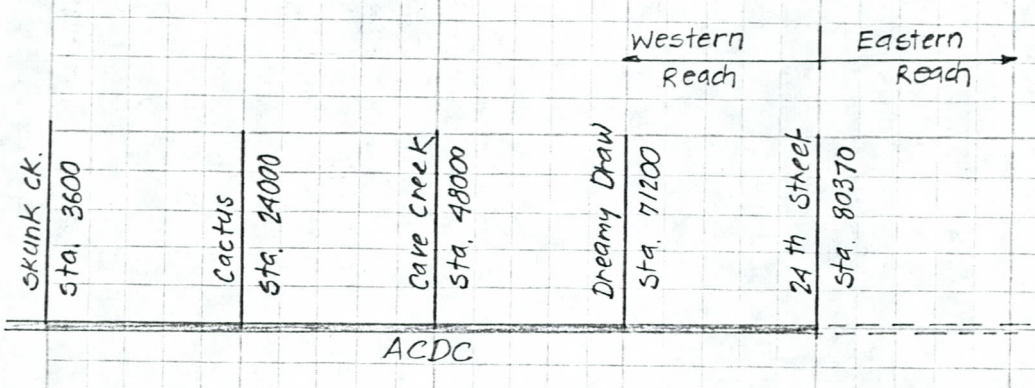
BY AZP DATE 3/21/83 CLIENT ABVA SHEET NO. 1 OF 7

CHECKED _____ DATE _____ JOB ACDC Alternative JOB NO. 603-900-3

## COST REDUCTION - ACDC WESTERN REACH

DESIGN FLOWS ACDC




channel Construction

SUMMARY OF Δ COSTS

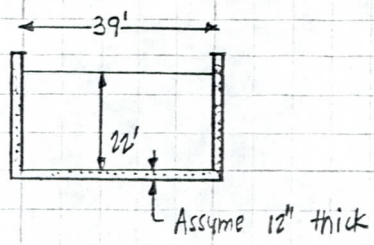
| Reach | ACDC Present Estimates by CORPS (1976 Price) | Alternative to ACDC (1976 Price) | Cost Reduction (1976 Price) |
|---|---|---|---|
| 24 St. to Dreamy Draw | 7,030,000 * | 6,154,100 | $ 875,900 |
| Dreamy Draw to Cave Creek | 19,470,000 | 15,398,900 | 4,071,100 |
| Cave Creek to Cactus | 17,500,000 | 15,912,800 | 1,587,200 |
| Cactus to Skunk Creek | 14,600,000 | 13,299,000 | 1,301,000 |
| | $58,600,000 | $50,764,800 | $7,835,200 |

Cost Reduction (1982 Price Index) = $7,835,200 X 1.8606
= $14,478,000

* Prorated based on length in ft.

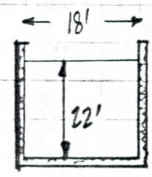
ACDC REACH FROM 24th ST TO DREAMY DRAW
STA 80,370 STA 71200

(i) ACDC - AVE. FLOW 9250 cfs
V = 10.8 fps




(ii) ACDC - ALTERNATIVE :

AVE FLOW = 9250 - 5000
= 4250 cfs
V = 10.8 fps




Reduction in concrete requirement for bottom slab :

$= (39' - 18') \times 1'$ thick $\times$ (80,370 - 71200) L.F. $\times \frac{1}{27}$ C.Y./C.F

= 7132 C.Y.

Cost Reduction :

Ref. Table 9, A 8-22

Estimate cost of Rein. Concrete :

vol: Concrete (invert) + Concrete (walls) = 66,700 C.Y. + 60,000 = 126,700 C.Y.

Cost: Concrete (invert) + Concrete (walls) + Port. cement + Steel
= 1,867,600 + 2,760,000 + 1,430,000 + 3,800,000 $
= $9,857,600

∴ Unit cost = $9,857,600 / 126,700 C.Y. = $77.80 / C.Y.

Reduction in concrete cost = 7132 C.Y. @ $77.80/C.Y. = $554,900

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BY _____ DATE _____ CLIENT _____ SHEET NO. 3 OF 7

CHECKED _____ DATE _____ JOB _____ JOB NO. _____

Earth work Reduction:

Volume of Earthwork = 21' width x 25' depth x 9170' length x $\frac{1}{27}$ = 178,306 C.Y.

Unit cost of earth work = Excavation cost + Excess excavated material compaction

= \$ 1.60 + \$.20

= \$ 1.80

∴ Reduction in earthwork cost = 178,306 C.Y. x \$1.80/C.Y.

= \$ 320,950

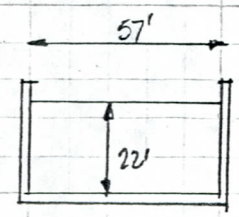
Net reduction in cost = \$ 554,900 + 320,950

= \$ 875,850

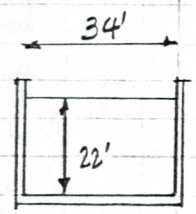
## ACDC REACH

Dreamy Draw (sta. 71200) to Cave Creek (sta. 48000)

(i) ACDC ave. design Flow = 12,500 cfs
V = 10 Fpst




(ii) ACDC Alternative Flow = 7,500 cfs
V = 10 Fpst




Reduction in concrete requirements (Top & bottom slabs):

$$= \frac{57' - 34'}{57} = 0.4035\ \%$$

Cost Reduction:

Conc. Bottom slab: 77,800 c.y. x 0.4035 x 28 \$/c.y. = \$879,000

Conc. Top slab 12,300 c.y. x 0.4035 x 112 \$/c.y. = 555,900

Portland cement & steel $= \dfrac{\$1,624,000 + 5,300,000}{77,800\ c.y. + 54,000\ c.y. + 12,300\ c.y.} = \$48.05/c.y.\ conc.$

(cement+steel) bottom slab = 77,800 x .4035 x 48.05 \$/c.y. = \$1,508,400
top slab = 12,300 x .4035 x 48.05 \$/c.y. = 238,470

Total Reduction in conc. cost = 879,000 + 555,900 + 1,508,400 + 238,470
= \$3,181,800

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Earth Work Reduction:

Volume of Earthwork = 23' width x 25' depth x 23,200 LF x $\frac{1}{27}$ $\frac{CY}{CF}$

= 494,074 c.y.

Unit cost of Earthwork = \$180 /c.y.

∴ Reduction in earthwork cost = 494,074 c.y. x \$180/c.y. = \$889,300

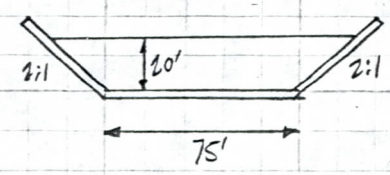
Net cost reduction = \$3,181,800 + 889,300

= \$4,071,100

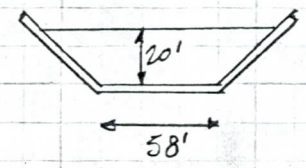
ACDC REACH

Cave Creek (Sta. 48000) to Cactus (Sta. 24000)

(i) ACDC. are. design Flow = 28,500 cfs




(ii) ACDC Alternative Flow = 23,500 cfs




Reduction in Concrete requirements = $\frac{75'-58'}{58'}$ = 0.2267 %

Cost Reduction:

Conc. bottom slab = 68,600 C.Y. X 0.2267 X 28 $/C.Y. = $ 435,400

Port. Cement & Steel = $\frac{1,492,000 + 2,525,000}{68,600 \text{ C.Y.} + 63,800}$ = $ 30.34 /C.Y.

(Cement + steel) bottom slab = 68,600 X .2267 X 30.34 $/C.Y. = $ 471,800

Total reduction in conc. cost = $ 907,200

Earth Work Reduction:

Vol. of Earth work = 17' width X 25' depth X 24000 L.F X $\frac{1}{27}$ $\frac{C.Y.}{C.F.}$ = 377,800 C.Y.

∴ Reduction in Earth work cost = 377,800 C.Y. X 1.80 /C.Y. = $ 680,040

Net cost Reduction = $ 1,587,200

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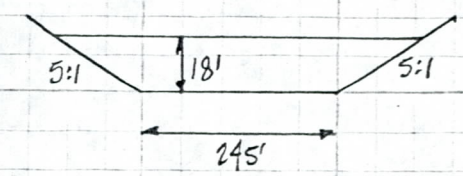
BY _____ DATE _____ CLIENT _____ SHEET NO. 7 OF 7

CHECKED _____ DATE _____ JOB _____ JOB NO. _____

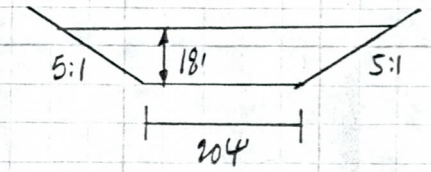
ACDC Reach

Cactus (Sta. 24000) to Skunk Creek (Sta. 3600)

(i) ACDC orr. design Flow = 34,000 cfs




(ii) ACDC Alt. Flow = 29,000 cfs

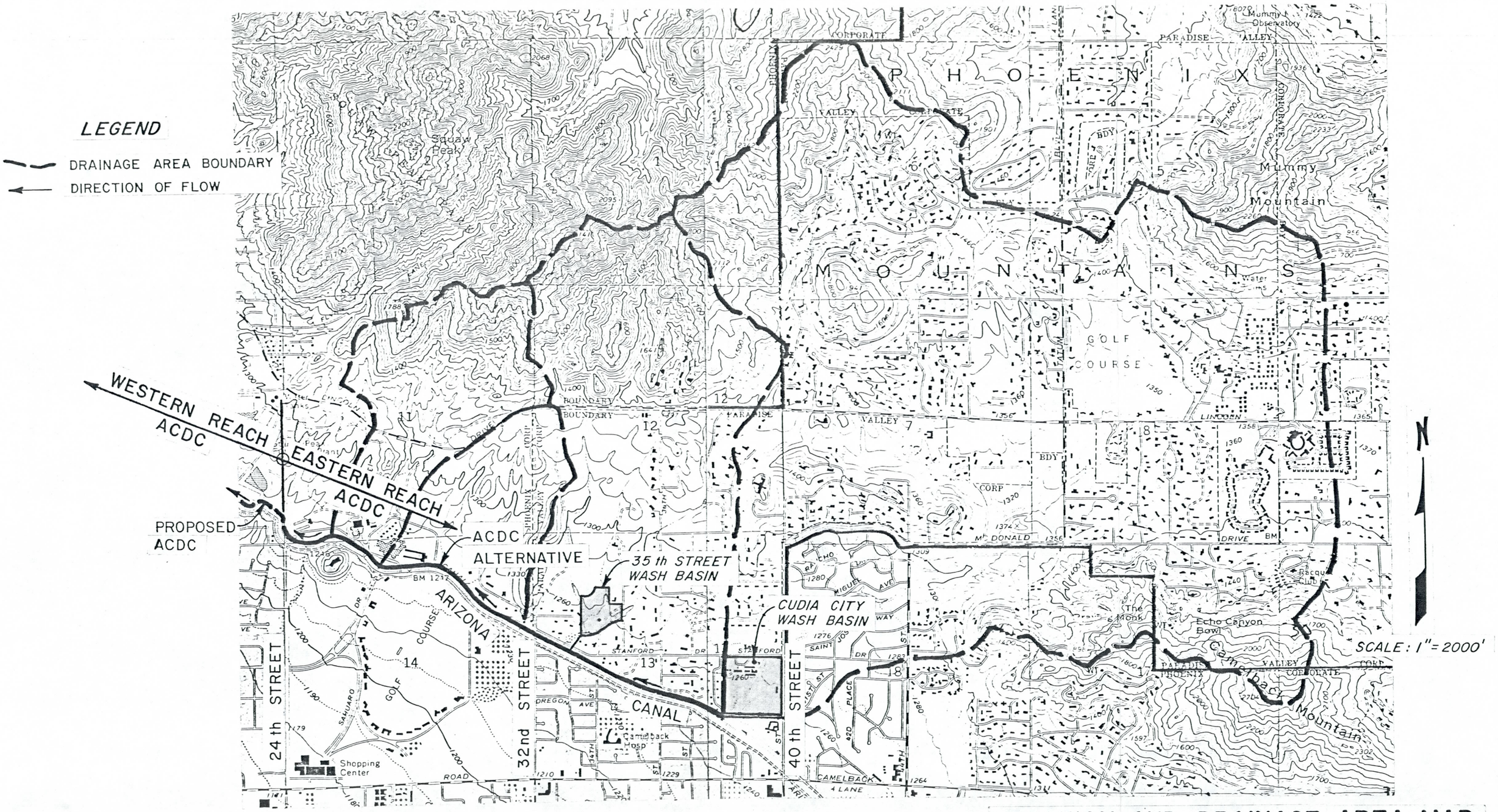



Earth work Reduction:

Volume of Earthwork = (245-204) x 21' depth x 20,400 L.F $\times \frac{1}{27} \frac{C.Y}{C.F}$

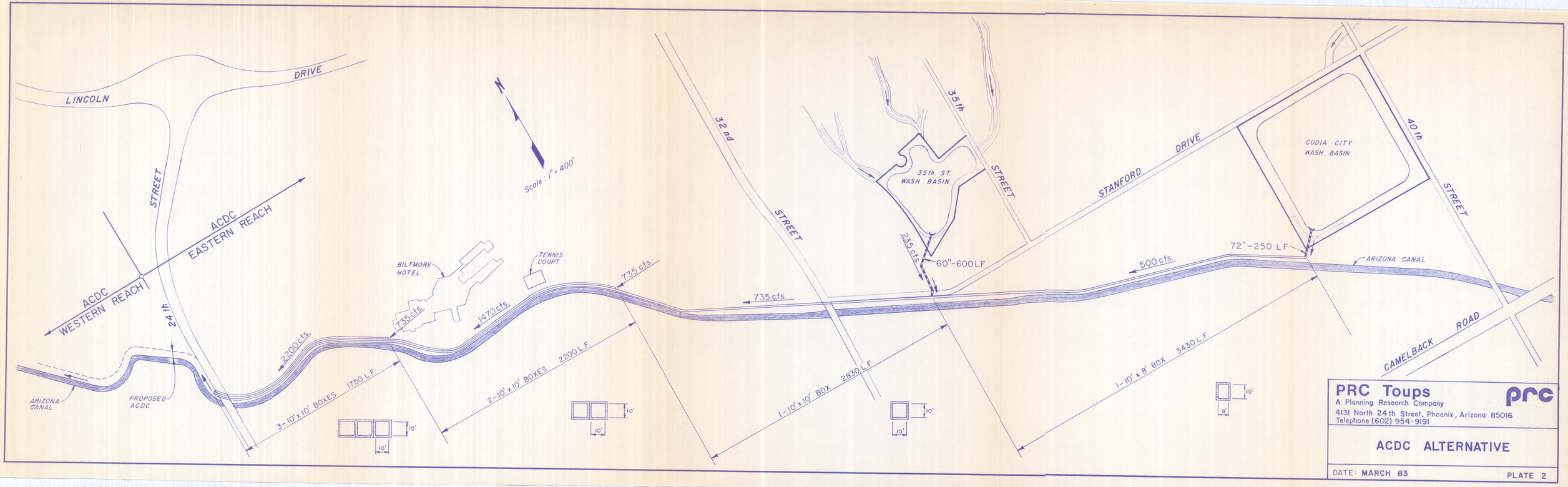
= 650,530 C.Y.

∴ Reduction in Earthwork Cost = 650,530 C.Y. x 2 \$/C.Y. = \$1,301,000




LOCATION AND DRAINAGE AREA MAP

PLATE I


LINCOLN
DRIVE
STREET
24th
ACDC
EASTERN REACH
ACDC
WESTERN REACH
N
Scale: 1" = 400'
BILTMORE HOTEL
TENNIS COURT
ARIZONA CANAL
PROPOSED ACDC
2200 cfs.
735 cfs.
1470 cfs.
735 cfs.
3-10' x 10' BOXES 1750 L.F.
2-10' x 10' BOXES 2200 L.F.
10'
10'
32nd
STREET
735 cfs.
1-10' x 10' BOX 2830 L.F.
35th
STREET
35th ST. WASH BASIN
235 cfs.
60"-600 LF
STANFORD DRIVE
500 cfs.
1-10' x 8' BOX 3430 L.F.
8'
CUDIA CITY WASH BASIN
40th
STREET
72"-250 LF
ARIZONA CANAL
CAMELBACK ROAD
PRC Toups
A Planning Research Company
4131 North 24th Street, Phoenix, Arizona 85016
Telephone (602) 954-9191
prc
ACDC ALTERNATIVE
DATE: MARCH 83
PLATE 2