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Arizona Biltmore Estates  
and the  
Arizona Canal  
Diversion Channel

from Cudia city wash to 16th street  
an examination by

**D.S. Gookin & Associates**

**May 3, 1982**



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ARIZONA BILTMORE ESTATES

and the

ARIZONA CANAL

DIVERSION CHANNEL

Cudia City Wash

to 16th Street

An examination by

W. S. GOOKIN & ASSOCIATES

May 3, 1982



An examination of the ACDC project from its inception  
near the Cudia City Wash to 16th Street.

INTRODUCTION:

The Firm of W. S. Gookin & Associates was retained by Rostland Management to review the situation of the ACDC project in relation to the Biltmore properties. Mr. Vern Schweigert has explained some of the concerns of the Biltmore Area property owners with respect to the ACDC project. Some of the concerns related to the esthetics, safety, and disruption of the project.

RECENT HISTORY:

In discussion with Mr. Schweigert and from a review of the correspondance, it is clear that the easement for the construction of the ACDC project was granted by the prior owners of the Biltmore Properties, Talley Industries. Talley owned a parcel of land that encompassed much more than the Biltmore Hotel itself.

The Talley ownership also encompassed a great deal of property lying on the north side of Lincoln Drive into the foothills north of the Biltmore and the

Wrigley Mansion. In prior years, the northern portions of the property had been maintained by the Biltmore as a scenic walkway that contained winding red sidewalks to prevent guests from becoming lost in the desert as well as numerous verandas along the red sidewalk for people to rest in the shade and enjoy the views overlooking Phoenix. Longtime Phoenix residents know this area as the "Red Sidewalk".

When Talley owned the property, negotiations were begun to allow zoning for the construction of a housing development in the "Red Sidewalk" area. At the time of the negotiations, the City of Phoenix was in the process of trying to firm up a Mountain Preserve. Proposals to put a housing development in the "Red Sidewalk" area were met with strong public resistance for a variety of reasons.

While the negotiations for the required zoning changes were being held, there were also in process, negotiations to acquire Rights-of-Way for the ACDC project. Talley got the zoning for the "Red Sidewalk" housing project and the City of Phoenix and Maricopa County Flood Control District got the easement for the ACDC Right-of-Way through the Biltmore Properties. Since no appreciable payment was received for the Right-of-Way, it has been assumed that the rezoning of

*This is an engineering report?*

the "Red Sidewalk" for a housing development was the payment for the Right of Way.

Shortly after all of this took place the current owners of the Biltmore bought the property. Rostland has no interest in the development of the "Red Sidewalk" area.

#### INVESTIGATIONS:

The Firm of W.S. Gookin & Associates reviewed the snaps and numerous documents furnished by Mr. Schweigert. We also reviewed the documents in our library with particular attention to flood flow analyses of the Cudia City Wash and adjacent areas. We made one trip to the grounds of the Arizona Biltmore Estates and traversed the highways surrounding the estates on several occasions.

#### Maricopa County Flood Control District;

The Firm of W. S. Gookin & Associates made contact with the Maricopa County Flood Control District and made an appointment with Mr. John Rodreguez of that office. Mr. Rodreguez represented that he was the most familiar with the ACDC project of those persons currently at the Flood Control District.

A meeting was held with Mr. Rodreguez at the

Flood Control Office in Phoenix. At the meeting Mr. Rodreguez was asked about the inception of the project and to see what plans and designs he had for the ACDC project. Mr Rodreguez was most cooperative during the contacts with him.

Mr. Rodreguez showed a series of aerial photographs that had graphic depictions of the proposed project displayed on them. These photos were in color and were display size and mounted on boards, having obviously been prepared for public presentations of the various features of the project. He also showed various architectural depictions of the possible typical appearance of the project. When asked about the fencing to be installed along the canal, he stated that the fence would be "about 10 feet tall with barbed wire along the top." He stated that the purpose of the fence was to keep people from falling into the canal as well as throwing in trash. No

The meeting at the Flood Control Office also yielded the names of the reports that were done in 1976. They had a copy of "Gila River Basin New River and Phoenix Streams Design Memorandum No. 3, General Design Memorandum--Phase I Plan Formulation--Main Report, March 1976" and "Gila River Basin New River and Phoenix Streams Design Memorandum No. 3, General

Design Memorandum-Phase I Plan Formulation, Appendixes, March 1976". Those were briefly examined at the time and a inquiry was made as to the whereabouts of the environmental documents, if any. Mr. Rodreguez searched his office and determined that the document was in the possession of "some attorneys" who were using it in relation to another matter. The Flood Control District did not have copies of any of the materials examined that could be borrowed, but they did make copies of a few pages that were of specific interest.

Mr. Rodreguez did provide the name and telephone number for the Army Corps of Engineers in Los Angeles. The name he gave was Mr. Nick Romanzov (213) 688-2754. This was important because discussions with Mr. Rodreguez made it quite clear that the Flood Control District was not involved in the design of the project and knew very little about current events in that regard.

U. S. Army Corps of Engineers;

This office made telephone inquiries of Mr. Nick Romanzov and learned that the desired reports were out of print, but that the reports should be available for inspection from the Phoenix office of the Corps. Upon contacting the Phoenix office of the Corps we were

allowed to borrow the two documents previously listed as well as the "Final Environmental Impact Statement, New River & Phoenix City Streams, Maricopa County, Arizona, March 1976". While the documents were borrowed, they were reproduced in their entirety with the exception of the colored plates that were copied in black and white. Additionally, the large maps were reduced due to the copying facilities available at the time.

The three documents total over a thousand pages and concerned more than just the ACDC project. The ACDC project is a part of the "New River and Phoenix City Streams" project of the U. S. Army Corps of Engineers. The various aspects of this overall project are:

Arizona Canal Diversion Channel (ACDC)

Cave Buttes Dam

Adobe Dam

New River Dam

Skunk Creek, New and Agua Fria Rivers

Reading the portions of the reports that relate to the ACDC project raised many more questions than it answered. In an attempt to get these questions answered, Mr. Romanzov was again called in Los Angeles. At that time, he was asked about the

supporting data for some of the assertions and statements made in the reports and appendixes.

Mr. Romanzov said that the supporting data for the entire project was in the files of the Corps in Los Angeles and that we were welcome to come look at the data. When asked if the data could be sent to the Arizona Office of the Corps, he said that this could not be done; if we wanted to see the data we would have to come to Los Angeles to see it. Mr. Romanzov asked us to identify with greater specificity the subject areas for which we wanted to see supporting materials. He stated that if we wanted to come look at the materials we would need to make an appointment to be sure that the people who had worked on the project were going to be available.

During this conversation he was told that we were particularly interested in seeing the studies of the alternate routes mentioned in the various reports and the supporting data for their rejection. He was also advised that we were interested in the historic and aesthetics sections of the Environmental Impact Statement. It was made clear during the conversation that the focus of interest was in the ACDC project from its inception near the Cudia City wash to 16th Street.

It was decided to travel to Los Angeles to view the documents in the files of the Corps. Mr. Romanzov was called to set up an appointment. During that conversation he said that the meeting could tentatively be set up for Monday, April 19, but that he would not be able to confirm that date till Friday April 16. On Thursday April 15 he called back to change the date to Wednesday April 21. Mr. Romanzov also stated that he would need a letter at that time stating what questions we had so that they could specifically be answered.

A letter of questions was prepared, a copy of which is attached, and hand delivered by Mr. Scudder Gookin, P.E. on April 21.

Upon his arrival at the Corps of Engineers office in Los Angeles at approximately 9 A.M. Mr. Romanzov met Mr. Scudder Gookin, P.E. and expressed a desire to get the meeting over as soon as possible because he and his staff had another scheduled at another location at 11:30 the same morning. He said that any unanswered questions would be answered by mail.

The meeting that followed was a procession of various people who were currently in charge of the various aspects of the project. It was clear from

remarks made that few of the people at the meeting were actually involved in the preparation of the 1976 reports. Many of those in attendance were not in the Los Angeles office at the time of preparation of the report.

The first people that were met were Mr. Romanzov, Mr. Cliff Ford, P.E. and Mr. Vance Carson. These gentlemen were involved in the design of the project. Unfortunately the availability of the people was not in the order of the questions set forth in the letter and a considerable amount of hopping around was done during the meeting. In addition to the persons mentioned above, there were various other persons in and out of the meeting who were introduced as being interested in aspects including hydrology, archeology, environmental, and landscape design. At the meeting the only documentation offered in response for Mr. Gookin's questions was a copy of a document titled "Gila River Basin New River and Phoenix City Streams Arizona, Design Memorandum No. 2, Hydrology, Part 2, 1982". Mr. Gookin was given copy of document number 17 of that report and a further discussion of this will follow later in this report.

At the end of the meeting at 11:30 A.M. Mr. Gookin was told that his questions would be responded

to in writing "soon". Mr. Romanzov also said that he "owed" Rostland management a meeting and that it would be held in early May of this year jointly with the Flood Control District and Mr. Dave Burris of the City of Phoenix.

To date a written response to the questions posed has not been received by this office. In addition to the questions raised in the letter there were others raised. The following is a listing of the questions discussed, the answers received at the time and comments, thereon:

12 DAYS!

QUESTION:

Where are the engineering data, criteria and computations for the standard project flood and the 100 year flood for the tributaries from 16th Street to and including the Cudia City Wash.

RESPONSE:

A copy of the most recent hydrology report was provided with the understanding that it is not yet public and is subject to review. When told that some of our Firm's studies showed the 100 year flood on Cudia City Wash to be about 7200 cfs instead of 6800 cfs the response was that the difference was small due to a possible difference in method. Mr. Gookin was also told that Mr. John R. Erickson had computed a 100

year flow higher than 6800 cfs.

DISCUSSION:

During discussions the Hydrologist commented that the differences between the 6800 cfs and the 7200 cfs were "minor". Mr. Gookin suggested that 400 cfs is not minor if it is going through your property.

An examination of the Hydrology report Mr. Gookin was given does not yield the type of information that was requested. The computations are not shown and the methodology discussed is suspect to say the least. The figures generated are based on a generalized percentage breakdown of the differences between a 100 year, Standard Project Flow, etc. for the Tucson gage and the Youngtown Gage. There is no analysis of the appropriateness of this approach. Given the lack of provided documentation underlying the report we could not recommend relying on it for specific property protection. The normal procedure for computation of 100 year floods is to utilize data that is site specific. Percentage extropolations is not an accepted methology for analyzing the flood flows. Two common techniques are available for this.

The first is known as the SCS method (SCS stands for Soil Conservation Service) which is the procedure utilized by this office where appropriate and is the

accepted standard by the State of Arizona for flood design. The second technique that would be acceptable is the HEC-1 computer program designed by the Army Corps of Engineers.

The utilization of a percentage extropolation to compute the design flood bases upon the relation for the Tucson gage and the Youngtown gage is unusual and questionable. This is particularly true in light of the comment that the Corps is presently still running the sedimentation analysis to determine the effects of sediment on the flows to be expected. The Corps assured Mr. Gookin that the design freeboard in the channel would take care of this problem. Based upon our computations, the increase in depth as a result of the increased flows that a proper analysis shows is 0.5 feet.

QUESTION:

What are the design criteria and hydraulics coefficients considered in the design of the channel, particularly in the vicinity of the Biltmore properties?

RESPONSE:

Mr. Gookin was told that the entire channel was designed using a complex backwater analysis. The Manning's N factor considered in this analysis was

0.014. Mr. Gookin was also told that the Corps is in the process of recalculating all of the hydrology to account for sedimentation and that the final designs would encompass all changes resulting from the newest calculations.

DISCUSSION:

A backwater analysis is a computation of the upstream water surface profiles based on estimates of the physical parameters of a channel. The Corps people at the meeting said that a complete backwater analysis of the entire channel of the ACDC was being performed to include all proposed structures, stilling basins, piers, sedimentation, etc. This is an undertaking that is so mathematically large that only the largest computers available have sufficient capacity and speed to complete.

When Mr. Gookin questioned the wisdom of using a roughness factor of 0.014 to allow for possible future degradation of the channel he was told that many Corps channels have been measured with an N factor of 0.011 (smoother than 0.014), and that the use of 0.014 was quite conservative. This firm believes that the recommendations given in the "Civil Engineering Handbook" by L. C. Urquhart and published by Mc Graw-Hill would be more realistic for a project that will

be in use as long as this one will particularly because there will inevitably be some deterioration in the smoothness of the channel from the anticipated high velocity flows. Urquhart recommends on page 323 that the values for good concrete lined channels should be 0.014 and that fair channel should be 0.016.

A second authority as to value of Mannings Roughness Factor is "Open Channel Hydraulics by Ven Te Chow, Phd. dated 1959". In these tables, it is indicated that for a float finish concrete channel, a value of .016 would be reasonable as the ditch ages.

Our experience in Central Arizona has been that concrete surfaces deteriorate with age and that it is prudent to design to the rougher 0.016 resulting in a larger channel to account for future surface deterioration. The Corps assured Mr. Gookin that the planed freeboard in the channel will handle this. However, the significance of the variation is considerable. Based on our computations, from .014 to .016, this would increase the depth approximately 1.9 feet. When this variance is taken into account and the earlier variance for the flows is added, it becomes apparent that the freeboard in the channel is inadequate.

This is not surprising since the freeboard is

inadequate for a channel of this magnitude, even if the other factors had been properly evaluated. The Bureau of Reclamation in "General Requirements and Design Computations by A. J. Aisenbray, Jr." indicates that for an irrigation structure of this size, the freeboard for the hard surface lining should be 2.6 feet instead of the 2 feet recommended by the Corps. Since these Bureau of Reclamation freeboards are for trapezoidal ditches and the envisioned ditch is rectangular, that figure should be increased even further. In addition, based on the Bureau of Reclamation Criteria, the total freeboard lined and unlined for a trapezoidal channel should be 5.3 feet. The plans and profiles contained in Design Memorandum No. 3 show a total design freeboard of approximately 2 feet. The freeboard recommended by Bureau of Reclamation is a minimum when applied to a flood channel. Unlike the irrigation system where the flows can be controlled and shut off if necessary to allow modification or cleaning of the ditches when the freeboard proves inadequate, a flood cannot be turned off to allow necessary repairs and then turned back on again for the duration of the flood.

The inadequate freeboard is acerbated by the current intention of covering the ditch, this could

lead to a catastrophic failure of the carrying capacity of the system. Many people who do not work in hydrology do not realize that a covered conduit flowing partially full can convey significantly more water than a covered conduit flowing full. The reason for this is that once the water reaches the top of the conduit, the wetted perimeter of the conduit is suddenly increased by the amount of the covering. This causes a sudden and substantial increase in the friction which causes a sudden and substantial decrease in the carrying capacity of the conduit. Thus, once the conduit fills, the carrying capacity is significantly reduced. This will cause a portion of the normal flows to leave the diversion channel and flow through the Biltmore in addition to those flows that were not designed for.

QUESTION:

What is the justification for the protection against a 100 year event instead of a Standard Project Flood.

RESPONSE:

The first response given to this question was that the decision was made solely on the basis of economics. Almost immediately the response was changed to say that it was based on a variety of factors

including cost and the size of the right of way required.

DISCUSSION:

Normal procedure in a flood study requires that a careful and detailed economic analysis be made to determine the optimal design flood and the economic desirability for the project. It was apparent in the meeting that either this had not been done or that the Corps did not wish to release it.

QUESTION:

What assurance can the Corps give that no water will enter the Biltmore Property on the North side of the ACDC project that would not presently occur.

RESPONSE:

This matter has not been examined but the Corps will respond. Mr. Gookin was assured that this matter would be handled in final design.

DISCUSSION:

Under present conditions the Cudia City Wash has no recorded history of reaching the Arizona Biltmore. If the design flow capacity of the ACDC is exceeded we know of no proposed measure to prevent flooding outside the ACDC right of way.

While we are not attorneys and a legal opinion should probably be sought to confirm this, it has been

our experience that under Arizona laws, any man-made change in the natural flow patterns must not leave any owner of land who is not involved in that action, liable to flooding worse than that which would have occurred in the prior state.

The Corps of Engineers is admitting in this project, that it is importing flood waters for floods in excess of a 100 year frequency that cannot be handled by its system and will therefore, flood this area. Aquisition of flood easement only grants the Corps the right to handle water within that easement.

Further discussions with the Corps people relating to the recent installation of retention basins on the golf course showed that they have not been taken into account in any of the designs to date. Discussions were also held regarding the adequacy and the purpose of the retention basins on the golf course. It was pointed out by Mr. Gookin that there may be confusion as to the retention basin function. Specifically whether or not the basins were intended to take care of inflow from the Cudia City wash instead of local drainage. The Corps expressed doubt that the facilities would handle more than a 10 year storm. Although the drainage area controlled by these basins was apparently unclean. Clearly, the drainage

retention effect of the golf course was not intended to handle Cudia City Wash floods. Therefore, the Corps probably erred in the evaluation of the effectiveness of the golf course retention.

Mr. Gookin also pointed out that depending on the final design of the ACDC, overflow from the ACDC could impinge on the capacity of the Biltmore's retention basins. He also pointed out that there was a certification by an Arizona Professional Engineer concerning the capacity and that the Biltmore was entitled to rely on that until some one shows to the contrary. Mr. Gookin was assured that this matter would be taken care of in the final design.

QUESTION:

What measures are being taken to handle the proposed 11 to 12 feet per second proposed flood velocities.

RESPONSE

Mr. Gookin was assured this problem would be handled in the final design of the project. He was told that the Corps presently has numerous projects in California that exceed 40 feet per second (approx 30 mph) in various portions. The Corps presently envisions linings 10 to 12 inches thick reinforced with double rows of re-bar.

DISCUSSION:

It is most important when velocities of this type are to be encountered, that failures or overtopping MUST be prevented or tremendous damage will result. This concept was discussed at great lengths with the Corps by Mr. Gookin

QUESTION:

The 1976 reports mention alternates to the Eastern extension of the ACDC canal having been considered and rejected on the basis of costs. Recognizing that the Corps doesn't have a final cost on the ACDC computed please show the documentation and work to support the discarding of the other routes.

RESPONSE:

It's too bad you weren't here a couple of months ago. At that time our files relating to that matter were discarded to the dump.

DISCUSSION:

Further questioning concerning this disposal yielded the information that the materials had been loaded into a dumpster and sent where ever the rest of the refuse from the building goes. Mr. Gookin specifically asked if any of the material had been sent to the Federal Records Center as many other if not all Government offices do, and he was told that

they were not. We believe this destruction of Federal Records probably violates Federal rules and/or statutes, but an attorney would have to be consulted in this matter. The Corps now claims to have nothing to support the present route in its files.

Since the time the Corps of Engineers performed the economic studies, they have incorporated significant variations to correct certain objectionable aspects of the initial design. These changes, however, will be expensive and in fact, the final cost of the system is apparently not known. To select one of several alternatives on the basis of a cost comparison, discard all known data except for the selected alternatives, and then proceed to make significant and expensive modifications in the selected alternatives without giving reconsideration to the discarded alternatives.

QUESTION:

Please show what documentation there is to support the contention concerning minimal aesthetic impact in the Environmental Impact Statement.

RESPONSE:

Mr. Gookin was assured that these matters will be handled in the final design. Attractive "typical" architectural renderings of landscape was presented.

Mr. Romanzov said the Corps has determined that on the basis of severance damage, the decision had been made to cover the channel in front of the hotel without cost to the Biltmore. This cover will be sufficient to handle the vehicular loadings of the parking lot that will remain on top of it. All fences on the open portions will be 5 or 6 feet tall and will be recessed 2 or 3 feet from the natural ground surface since they will be mounted to the top of the channel wall. The corps is looking to the Biltmore for input on the matter of landscaping.

DISCUSSION:

The Corps seems genuinely eager to work with the property owners in the matter of aesthetics. The original question of the minimal impact still does not seem to be answered.

QUESTION:

What consideration was given to the Arizona Biltmore and the Wrigley Mansion as Arizona Landmarks.

RESPONSE:

Neither of those facilities is in the National Register of Historical Places and as such no consideration was given in the original design. The Corps is aware of the local significance and wants to work with the property owners and neighbors to solve

this problem in the final design. Mr. Gookin was assured that the original bridges belonging to the Biltmore across the Arizona Canal would be untouched.

DISCUSSION:

The Corps appears to have a genuine concern for the historic landmarks involved whether or not they are listed in the historic register.

QUESTION:

Has the Corps or the Flood Control District been issued an NPDES discharge permit for this project.

RESPONSE:

No one at the meeting specifically knew if such a permit had been acquired but the Corps will respond.

DISCUSSION:

Inquiry with the Arizona Department of Health Services indicates that no such permit has been applied for or issued. Under current rules such a permit is probably required, but no one has raised the issue concerning the ACDC yet.

Visits to the site have been made and it is obvious that construction of the proposed ACDC project will result in considerable disruption to the surrounding area both during and after construction. The existing retention basins on the golf courses obviously represent a very substantial expense on the

part of the owner. This is evident from the extent, depth and careful attention to contouring and landscaping.

The Arizona Biltmore is a beautiful resort by any standard. It is listed in most tour guides as among the finest in the world. Having been built in the 1920's following a Frank Lloyd Wright design adjacent to the world famous Wrigley Mansion, it has been a prominent Phoenix landmark since it was built. It has always been known for its manicured lawns and gardens as well as its immaculate upkeep. Because of this longstanding appearance the surrounding residential developments are also some of the most expensive in Arizona because of the desirable location.

The existing Arizona Canal in the vicinity of the Biltmore is lined with large trees and gives the appearance of a slow moving stream that is full of water most of the year. Since the canal was in place when the Resort and the Mansion were built it is an addition to the overall effect. The canal is presently lined, but due to being full most of the time does not give the appearance of a cold concrete channel.

The disruption that will be occurring if the ACDC is built will include a total interruption of traffic across the canal at various points during the

construction. There will also be the loss of parking in the front of the Hotel until construction is complete. The construction adjacent to the front door of the Hotel will undoubtedly have an adverse effect on business, assuming that the patrons of the Biltmore are particularly sensitive to noise, dust, and inconvenience.

REMARKS:

In light of the fact that the ACDC has already had an environment impact study, there are too many items that are not available for review. The standard answer of "that is being taken care of in final design" has been overworked in this case.

The U. S. Army Corps of Engineers has destroyed much of the underlying supporting data and computations. With the information that the Corps has released it is impossible to do a reasonable analysis of what they have done, or what they propose to do. The Flood Control District is looking to the Corps for all of the technical information so they obviously have the same problem.

It is patently obvious from the fact with two paralleling canals, i.e. Arizona and ACDC with the ACDC having a bottom or invert at least 10 feet lower than the bottom of the Arizona Canal, a failure in the

Arizona Canal would be very apt to discharge the Arizona Canal into the ACDC, thereby immeasurably increasing the leverage to the Biltmore.

There are some underlying flaws in the project that appear to be insolvable without damage to the surrounding area. These flaws are:

1). The ACDC is apparently under design for a 100 year flood even when freeboard is taken into account.

2). The design freeboard is inadequate for the size flows envisioned.

3). The ACDC should be designed for a Standard Project Flood and not a 100 year flood.

4). The existing Right of Way is not large enough to accomodate a channel for a Standard Project Flood.

5). Flood water that never before came into the Biltmore area will be introduced by this project probably in violation of Arizona law.

6). The effects of this project on surface water quality are unknown.

7). No consideration has been given to the consequences of a channel failure, which could result in the collapse of the Arizona Canal.

8). Failure of the ACDC channel would undoubtedly result in considerable damage outside of the right-of-way.

9). Inadequate economic analysis of the design flood and of alternative routes makes the particular choice appear arbitrary.

CONCEPTUAL STUDY  
AN ALTERNATIVE TO ACDC

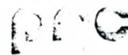
March 29, 1983

Prepared For:

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

Prepared by:

PRC TOUPS,  
A DIVISION OF PRC ENGINEERING, INC.  
4131 NORTH 24th STREET  
SUITE 110  
PHOENIX, ARIZONA 85016  
(602) 954-9191



Planning Research Corporation

PRC Toups  
Division of PRC Engineering  
4131 North 24th Street  
Phoenix, AZ 85016  
602-954-9191

FLOOD CONTROL DISTRICT  
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William R. Mills, Jr., P.E., President; David M. Wood, Executive Vice President;  
Cooper Roberts, P.E., Vice President; John W. Stansel, A.I.A., Associate Vice President;  
Ashok C. Patel, P.E., Associate Vice President; Edward A. Adair, Associate Vice President

6 April 1983

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

4	CH ENG	HYDRO
3	ASST	LMgt
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1	ENGR	DESTROY
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REMARKS		

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 concurrence 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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## APPENDIX

Cost Analysis -

Cost Summary

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    35th Street Wash Basin including Outlet Drain

    Biltmore Storm Drain

ACDC Western Reach, Cost Reduction Estimates

PLATE 1 Location and Drainage Area Map

PLATE 2 ACDC Alternative, Eastern Reach

## 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 ACDC East of 24th Street	31,000,000	25,223,000	5,777,000
Western Reach ACDC West of 24th Street	<u>130,837,000<sup>a</sup></u>	<u>113,343,000<sup>a</sup></u>	<u>17,494,000<sup>a</sup></u>
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)

	<u>ACDC Present Estimates By Corps</u>	<u>Alternative To ACDC</u>	<u>Cost Reduction</u>
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	
	<u>\$ 31,000,000<sup>a</sup></u>	<u>\$ 25,223,200</u>	<u>\$ 5,776,800</u>
Western Reach ACDC West of 24th Street:			
	<u>\$ 130,837,000<sup>b</sup></u>	<u>\$ 113,343,000<sup>b</sup></u>	<u>\$17,494,000<sup>b</sup></u>
			<u>\$23,270,800</u>

- 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	<u>1,114,750</u>

Subtotal \$ 8,624,200

Right of Way costs:

Land	39	Ac.	50,000	\$ 1,950,000
Buildings	83,000	S.F.	41.00	<u>3,403,000</u>

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	<u>1,132,000</u>

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	<u>600,000</u>

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	<u>1,995,000</u>

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:

<u>ACDC Reach</u>	<u>ACDC Present Estimates by Corps (1976 Price)</u>	<u>Alternate ACDC reduced cross-section (1976 Price)</u>	<u>Reduced Cost (1976 Price)</u>
24th Street to Dreamy Draw	7,030,000 <sup>a</sup>	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	<u>14,600,000</u>	<u>13,299,000</u>	<u>1,301,000</u>
	\$ 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

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



# PRC Toups

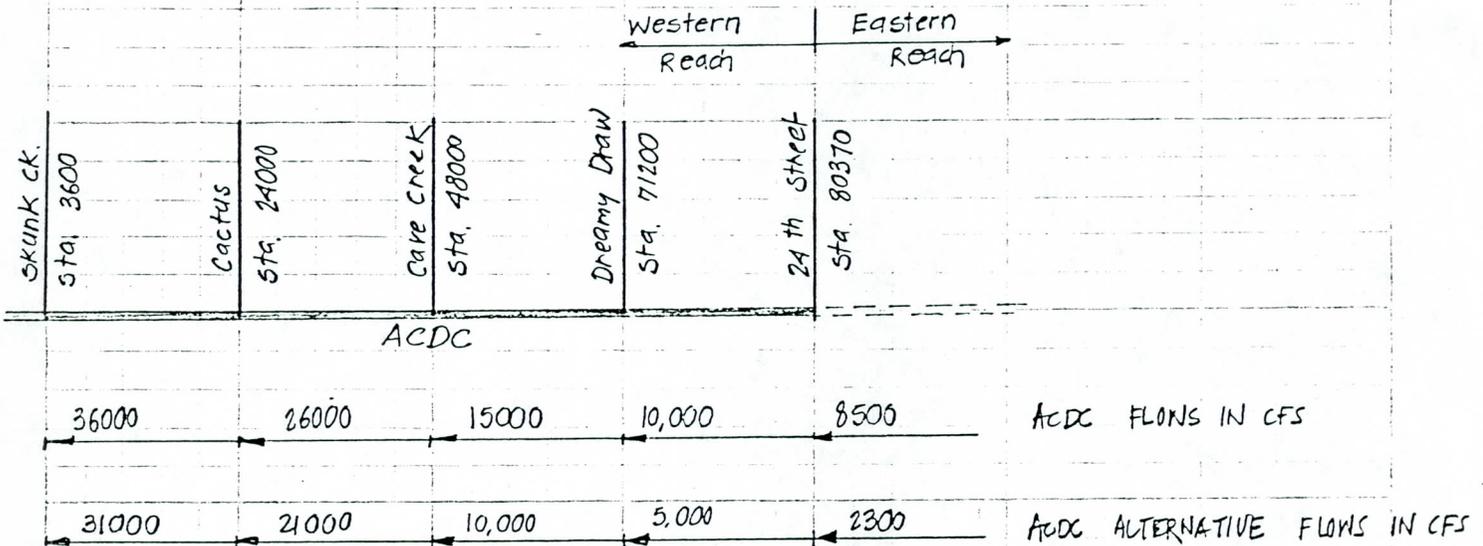
CONSULTING ENGINEERS AND PLANNERS

BY ATP DATE 3/21/83 CLIENT AEVA 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 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
	<b>\$ 58,600,000</b>	<b>\$ 50,764,800</b>	<b>\$ 7,835,200</b>
			Cost Reduction (1982 Price Index) = $7,835,200 \times 1.8606$ = \$14,478,000

\* Prorated based on length in ft.



# PRC Toups

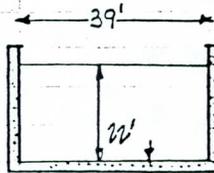
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BY \_\_\_\_\_ DATE \_\_\_\_\_ CLIENT \_\_\_\_\_ SHEET NO. 2 OF 7

CHECKED \_\_\_\_\_ DATE \_\_\_\_\_ JOB \_\_\_\_\_ JOB NO. \_\_\_\_\_

ACDC REACH FROM 24<sup>th</sup> ST TO DREAMY DRAW  
STA 80,370 STA 71200

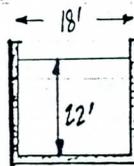
(i) ACDC - AVE. FLOW 9250 cfs  
V = 10.8 fps



Assume 12" thick

(ii) ACDC - ALTERNATIVE:

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



Reduction in concrete requirement for bottom slab:

$$= (39' - 18') \times 1' \text{ thick} \times (80,370 - 71,200) \text{ L.F.} \times \frac{1}{27} \frac{\text{c.f.}}{\text{c.f.}}$$
$$= 7132 \text{ c.f.}$$

Cost Reduction:

Ref. Table 9, A 8-22 (Ref. No. 1)

Estimate cost of Rein. Concrete:

$$\text{Vol: Concrete (invert) + Concrete (Walls)} = 66,700 \text{ c.f.} + 60,000 = 126,700 \text{ c.f.}$$

$$\text{Cost: Concrete (invert) + Concrete (Walls) + Port. Cement + Steel} \quad \$$$
$$= 1,867,600 + 2,760,000 + 1,430,000 + 3,800,000$$
$$= \$9,857,600$$

$$\therefore \text{Unit Cost} = \frac{\$9,857,600}{126,700 \text{ c.f.}} = \$77.80 / \text{c.f.}$$

$$\text{Reduction in concrete cost} = 7132 \text{ c.f.} @ \$77.80 / \text{c.f.} = \$554,900$$



# PRC Toups

CONSULTING ENGINEERS AND PLANNERS

BY \_\_\_\_\_ DATE \_\_\_\_\_ CLIENT \_\_\_\_\_ SHEET NO. 3 OF 7

CHECKED \_\_\_\_\_ DATE \_\_\_\_\_ JOB \_\_\_\_\_ JOB NO. \_\_\_\_\_

## Earth Work Reduction:

$$\text{Volume of Earthwork} = 21' \text{ width} \times 25' \text{ depth} \times 9170' \text{ length} \times \frac{1}{27} = 178,306 \text{ c.y.}$$

$$\begin{aligned} \text{Unit cost of earthwork} &= \text{Excavation cost} + \text{Excess excavated material} \\ &= \$1.60 + \$0.20 \\ &= \$1.80 \end{aligned}$$

compaction

$$\begin{aligned} \therefore \text{Reduction in earthwork cost} &= 178,306^{\text{c.y.}} \times \$1.80/\text{c.y.} \\ &= \$320,950 \end{aligned}$$

$$\begin{aligned} \text{Net reduction in cost} &= \$554,900 + 320,950 \\ &= \$875,850 \end{aligned}$$



# PRC Toups

CONSULTING ENGINEERS AND PLANNERS

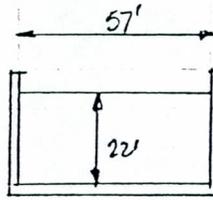
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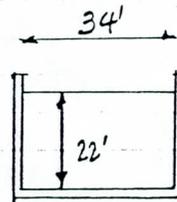
## ACDC REACH

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

(i) ACDC are. design Flow = 12,500 cfs  
V = 10 Fps ±



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



Reduction in concrete requirements (Top & bottom slabs):

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

Cost Reduction:

Conc. Bottom slab:  $77,800 \text{ c.y.} \times 0.4035 \times 28 \text{ \$/c.y.} = \$ 879,000$

Conc. Top slab  $12,300 \text{ c.y.} \times 0.4035 \times 112 \text{ \$/c.y.} = 555,900$

$$\text{Portland cement \& steel} = \frac{\$ 1,624,000 + 5,300,000}{77,800 \text{ c.y.} + 54,000 \text{ c.y.} + 12,300 \text{ c.y.}} = \$ 48^{05} / \text{c.y. Conc.}$$

(Cement + steel) bottom slab =  $77,800 \times 0.4035 \times 48^{05} \text{ \$/c.y.} = \$ 1,508,400$

top slab =  $12,300 \times 0.4035 \times 48^{05} \text{ \$/c.y.} = 238,470$

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



# PRC Toups

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BY \_\_\_\_\_ DATE \_\_\_\_\_ CLIENT \_\_\_\_\_ SHEET NO. 5 OF 7

CHECKED \_\_\_\_\_ DATE \_\_\_\_\_ JOB \_\_\_\_\_ JOB NO. \_\_\_\_\_

## Earth Work Reduction:

$$\begin{aligned} \text{Volume of Earthwork} &= 23' \text{ width} \times 25' \text{ depth} \times 23,200 \text{ LF} \times \frac{1}{27} \frac{\text{CY}}{\text{CF}} \\ &= 494,074 \text{ c.y.} \end{aligned}$$

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

$$\therefore \text{Reduction in earthwork cost} = 494,074 \text{ c.y.} \times \$180 / \text{c.y.} = \$889,300$$

$$\begin{aligned} \text{net cost reduction} &= \$3,181,800 + 889,300 \\ &= \$4,071,100 \end{aligned}$$



# PRC Toups

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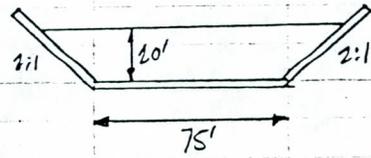
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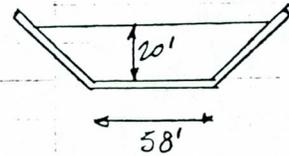
## ACDC REACH

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

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



(ii) ACDC Alternative Flow = 23,500 cfs



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

Cost Reduction:

$$\text{Conc. bottom slab} = 68,600 \text{ c.y.} \times 0.2267 \times 28 \frac{\$}{\text{c.y.}} = \$ 435,400$$

$$\text{Port. cement \& steel} = \frac{1,492,000 + 2,525,000}{68,600 \text{ c.y.} + 63,800} = \$ 30^{34} / \text{c.y.}$$

$$\text{(Cement + steel) bottom slab} = 68,600 \times 0.2267 \times 30^{34} \frac{\$}{\text{c.y.}} = \$ 471,800$$

$$\text{Total reduction in conc. cost} = \$ 907,200$$

Earth Work Reduction:

$$\text{Vol. of Earth work} = 17' \text{ width} \times 25' \text{ depth} \times 24000 \text{ L.F.} \times \frac{1}{27} \frac{\text{c.y.}}{\text{c.F.}} = 377,800 \text{ c.y.}$$

$$\therefore \text{Reduction in Earth work cost} = 377,800 \text{ c.y.} \times 180 / \text{c.y.} = \$ 680,040$$

$$\text{Net cost reduction} = \$ 1,587,200$$



PRC Troups

CONSULTING ENGINEERS AND PLANNERS

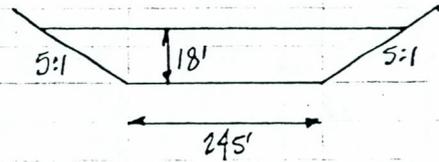
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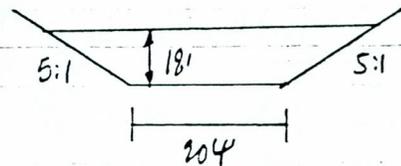
AzDC Reach

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

(i) AzDC org. design Flow = 34,000 cfs



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



Earthwork Reduction:

$$\begin{aligned} \text{Volume of Earthwork} &= (245 - 204) \times 21' \text{ depth} \times 20,400 \text{ L.F.} \times \frac{1}{27} \frac{\text{c.y.}}{\text{c.F.}} \\ &= 650,530 \text{ c.y.} \end{aligned}$$

$$\therefore \text{Reduction in Earthwork Cost} = 650,530 \text{ c.y.} \times 2 \$/\text{c.y.} = \$1,301,000$$

**LEGEND**

-  DRAINAGE AREA BOUNDARY
-  DIRECTION OF FLOW

WESTERN REACH  
ACDC

EASTERN REACH  
ACDC

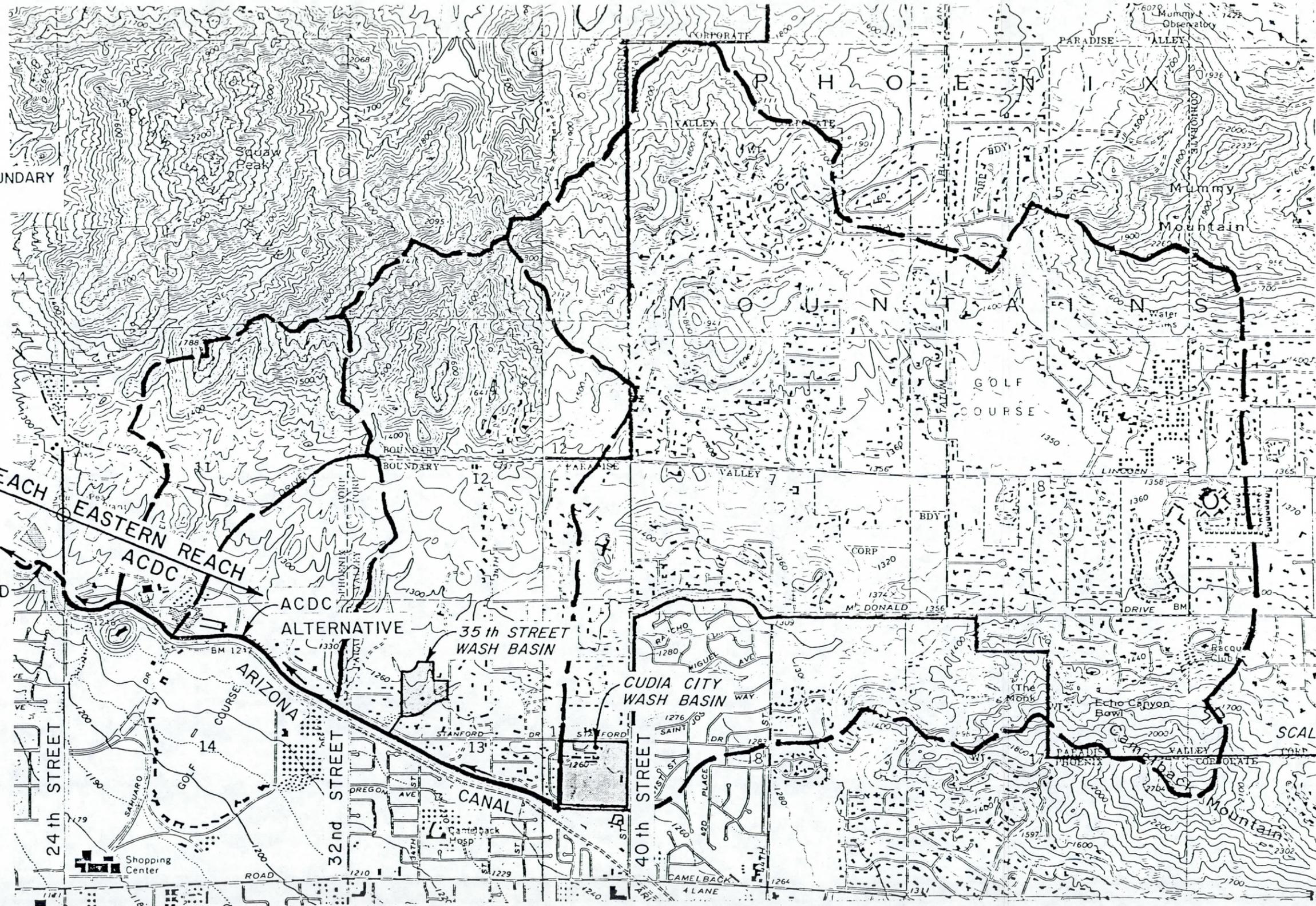
PROPOSED  
ACDC

ACDC  
ALTERNATIVE

35th STREET  
WASH BASIN

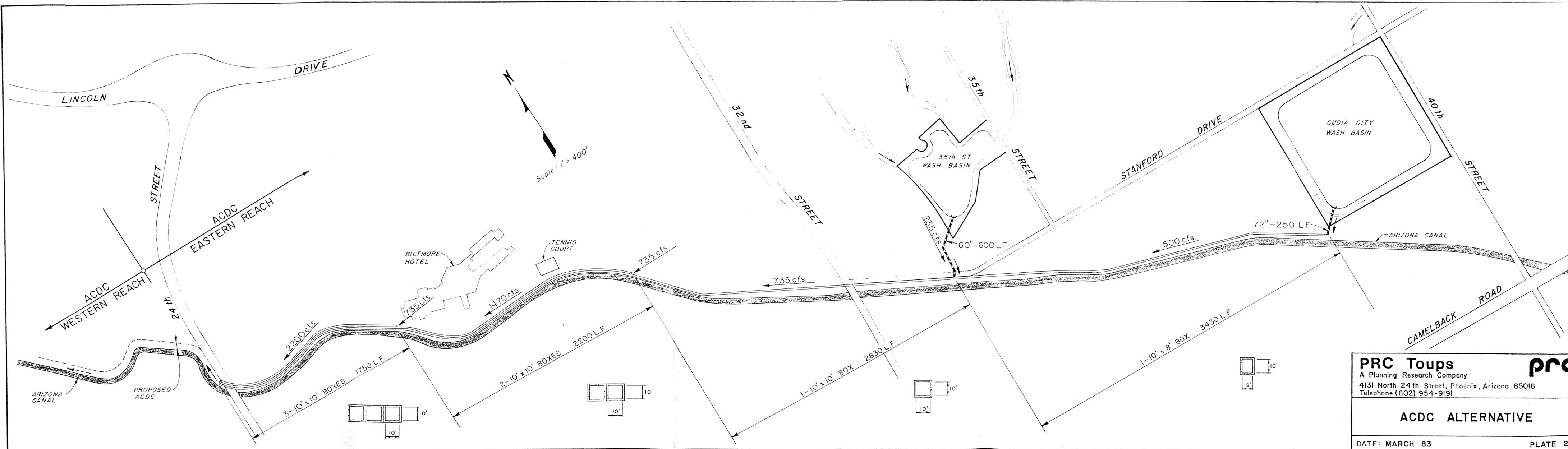
CUDIA CITY  
WASH BASIN

ARIZONA  
CANAL



SCALE: 1" = 2000'

**LOCATION AND DRAINAGE AREA MAP**



<p><b>PRC Toups</b>          A Planning Research Company          4131 North 24th Street, Phoenix, Arizona 85016          Telephone (602) 954-9191</p>		
<p><b>ACDC ALTERNATIVE</b></p>		
<p>DATE: MARCH 83</p>		<p>PLATE 2</p>