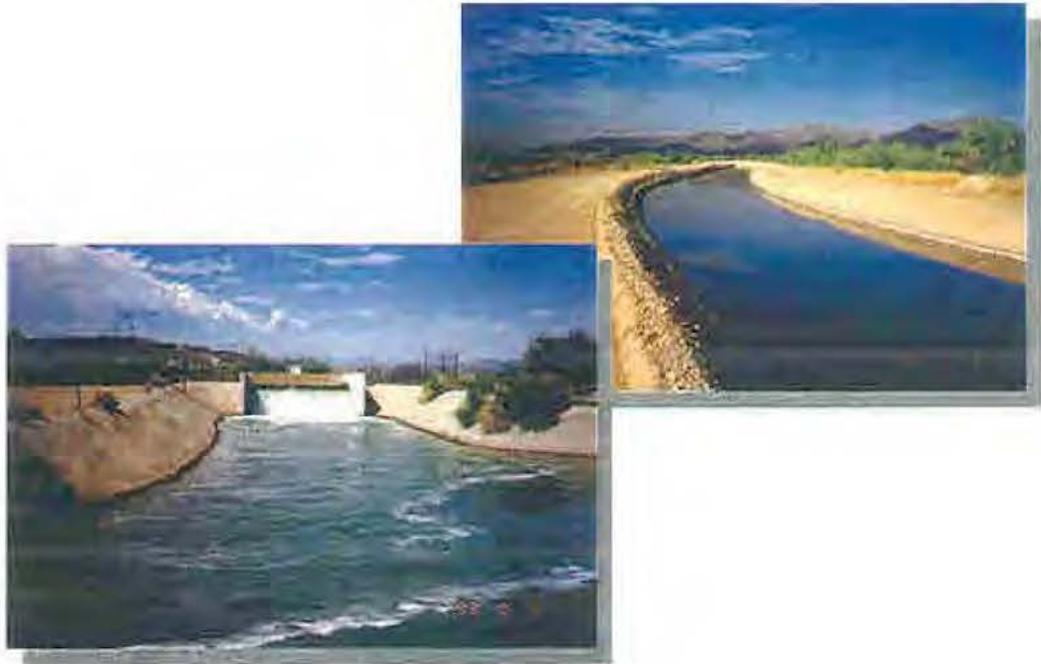


BEARDSLEY CANAL CAPACITY STUDY PHASE 2



PREPARED FOR
USBR/WESTCAPS



BY



Navigant

**BOOKMAN-EDMONSTON
ENGINEERING, INC.**

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October 8, 1999

Mr. Tom Wotring
U.S. Bureau of Reclamation
2222 West Dunlap Avenue
Suite 100
Phoenix, AZ 85021

Attention: PXAO-8012

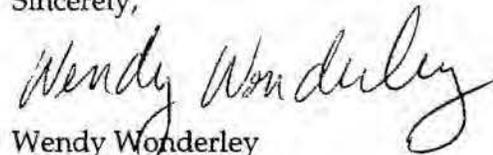
Subject: Phase 2 Report

Dear Tom:

This letter transmits the final report for the West Salt River Valley Water Management Study, Beardsley Canal Capacity Study, Phase 2. The report is entitled *Beardsley Canal Capacity Study - Phase 2*.

It has been a pleasure working with Marvin Murray, Warren Greenwell, and other USBR staff, as well as Harold Thomas, the WESTCAPS group, and the Maricopa Water District people. We look forward to your guidance in developing Phase 3.

Sincerely,



Wendy Wonderley
Project Manager

Enclosures

cc: Harold Thomas
Jim Sweeney

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BEARDSLEY CANAL CAPACITY STUDY PHASE 2



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USBR/WESTCAPS



BY



Navigant
CONSULTING, INC.

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EXECUTIVE SUMMARY

Section 10 - 11

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EXECUTIVE SUMMARY

The Beardsley Canal, owned and operated by Maricopa County Municipal Water Conservation District No. 1 (Maricopa Water District or MWD), is one of several options that WESTCAPS is considering for conveying CAP water to its members. The Beardsley Canal is approximately 33 miles long and has an initial reach capacity of approximately 300 cfs. The canal was constructed in the early 1930s and is primarily a shotcrete-lined, trapezoidal-shaped canal with varying cross-section dimensions. No as-built drawings are available for the canal, and actual flow capacity by reach was unknown due to the age of the canal and structures and the modifications that have been made over the years.

WESTCAPS, with cooperation from MWD, contracted with Navigant Consulting, Inc. (NCI, formerly Bookman-Edmonston Engineering, Inc.) to determine the current capacity of the Beardsley Canal as well as the capacity currently used by MWD in Phase 1 of the Beardsley Canal Capacity Study.

In this second phase of the study (Phase 2), NCI was asked to determine, on an appraisal-level, the cost of canal modifications which would be necessary to improve the capacity to five pre-determined flow regimes. These flow regimes are 50,000, 100,000, 150,000, 200,000, and 300,000 acre-feet per year, in addition to the volume currently delivered to MWD users. Five reaches of the canal were determined for the study of each flow regime. They are:

- From Camp Dyer Diversion to the CAP Inlet;
- From the CAP Inlet to Grand Avenue;
- From Grand Avenue to Cactus Road;
- From Cactus Road to Camelback Road; and
- From Camelback Road to the end of the canal (Thomas Road).

Each flow regime was converted to a constant flow rate considering MWD peak month deliveries (as experienced in July 1995). These values are presented in Table ES-1.

The modifications for each structure were determined through HEC-RAS hydraulic models for each flow regime. Costs of modifications are summarized for each reach and for each flow in Table ES-2.

Capital Cost of Improvements

The costs of capital improvements for each of five reaches and five flow regimes of the Beardsley Canal are displayed in Table ES-2. No capital improvements would be required to deliver an additional 50,000 acre-feet per year to WESTCAPS members at Cactus Road. Approximately \$5 to \$6 million in capital improvements would provide for the delivery of 200,000 acre-feet per year to Cactus Road, or for the delivery of 100,000 acre-feet to Camelback Road.

Table ES-1
Flow Rates for Delivery Quantities
By Canal Reach at Peak MWD Demands (1995)

Canal Reach	50,000 af	100,000 af	150,000 af	200,000 af	300,000 af
Reach 1 - Lake Pleasant to CAP Inlet	285 cfs 185 Mgd	370cfs 240 Mgd	455 cfs 295 Mgd	535 cfs 345 Mgd	705 cfs 455 Mgd
Reach 2 - CAP Inlet to Grand Ave.	285 cfs 185 Mgd	365 cfs 235 Mgd	450 cfs 290 Mgd	530 cfs 340 Mgd	700 cfs 450 Mgd
Reach 3 - Grand Ave. to Cactus Rd.	275 cfs 175 Mgd	355 cfs 230 Mgd	440 cfs 285 Mgd	520 cfs 335 Mgd	690 cfs 445 Mgd
Reach 4- Cactus Rd. to Camelback Rd.	170 cfs 110 Mgd	255 cfs 165 Mgd	340 cfs 220 Mgd	420 cfs 270 Mgd	590 cfs 380 Mgd
Reach 5 - Camelback to Thomas Rd.	105 cfs 70 Mgd	185 cfs 120 Mgd	270 cfs 175 Mgd	350 cfs 225 Mgd	520 cfs 335 Mgd

Table ES-2
Beardsley Canal Capacity Study - Phase 2
Capital Costs of Improvements to Achieve Minimum Delivery Requirements⁽¹⁾

Canal Reach	50,000 af	100,000 af	150,000 af	200,000 af	300,000 af
Reach 1 - Lake Pleasant to CAP Inlet	\$0	\$0	\$934,000	\$1,140,000	\$12,721,000
Reach 2 - CAP Inlet to Grand Ave.	\$0	\$13,000	\$30,000	\$2,785,000	\$27,168,000
Reach 3 - Grand Ave. to Cactus Rd.	\$0	\$326,000	\$871,000	\$1,187,000	\$12,769,000
Reach 4- Cactus Rd. to Camelback Rd.	\$4,805,000	\$5,314,000	\$7,495,000	\$7,854,000	\$9,782,000
Reach 5 - Camelback to Thomas Rd.	\$1,697,000	\$1,814,000	\$2,330,000	\$2,442,000	\$3,084,000
Total Cost	\$6,502,000	\$7,467,000	\$11,660,000	\$15,408,000	\$65,524,000

⁽¹⁾With 1995 MWD peak use, costs include 20 percent for contingencies; 15 percent for engineering and administration. All costs are in 1999 dollars. The current 9/99 construction cost index is listed at 6117 based on year 1913 (Engineering News Record). Right-of-way costs are not included.

Study Need and Background

A coalition of West Valley CAP Subcontractors (WESTCAPS) is investigating potential ways for its members to put Central Arizona Project (CAP) water supplies to use. WESTCAPS and the U.S. Bureau of Reclamation (USBR) are working cooperatively under an in-kind cost-share agreement to evaluate regional water resources and facilities to efficiently use CAP water.

The Beardsley Canal, owned and operated by Maricopa County Municipal Water Conservation District No. 1 (Maricopa Water District or MWD), is one of several options that WESTCAPS is considering for conveying CAP water to its members. The Beardsley Canal is approximately 33 miles long and has an initial reach capacity of approximately 400 cfs. The canal was constructed in the early 1930s and is primarily a shotcrete-lined, trapezoidal-shaped canal with varying cross-section dimensions.

Prior to this study, Navigant Consulting, Inc. (hereinafter NCI) (formerly known as Bookman-Edmonston Engineering, Inc.) conducted a canal capacity study, the results of which are detailed in *Maricopa Water District Beardsley Canal and Associated Delivery System, Hydraulic Capacity Analysis, An Evaluation and Assessment Report, Phase 1*, for the U.S. Bureau of Reclamation and WESTCAPS, May 14, 1999. In the interest of convenience, this shall be referred to as the Phase 1 Report.

Scope of Work

The scope of this Phase 2 study is to provide estimates of canal capacity, which could be made available for CAP and other water users, if certain physical improvements were made to the Beardsley Canal using the information and insights obtained from Phase 1.

Phase 2 of the Beardsley Canal Capacity Study seeks to meet the following goal:

- To determine approximately how much it would cost to move various volumes of CAP and other water to several points on the Beardsley Canal without impacting MWD operations.

This goal was met through seven tasks:

- Task 1 - Preliminary evaluation of canal capacity constraints
- Task 2 - Report results of Task 1 to USBR and WESTCAPS
- Task 3 - Preliminary cost estimates
- Task 4 - Estimate monthly available increased flow capacity
- Task 5 - Coordination meetings
- Task 6 - Draft and final Phase 2 reports
- Task 7 - Project management.

Deliverables

The deliverable for Tasks 1 and 2 was presented at the WESTCAPS Technical Committee meeting on July 9, 1999 and the WESTCAPS Planning Assumptions Work Group meeting on July 23, 1999. The deliverables for Tasks 3, 4, and 6 are incorporated into the Phase 2 report, which was presented in draft form at the September 10, 1999 WESTCAPS Technical Committee meeting and will be presented in final form at the October 8, 1999 WESTCAPS Technical Committee meeting. There is no deliverable for Task 5. The deliverables for Task 7 were included with the monthly invoicing to the USBR.

WESTCAPS Mission Statement

WESTCAPS is a coalition of CAP subcontractors most of whom serve drinking water to communities in the west Salt River Valley. It is WESTCAPS' mission to develop workable alternatives for its members in order to provide their customers with a cost effective, sustainable, reliable, and high quality water supply through partnerships and cooperative efforts in regional water resource planning and management, emphasizing CAP utilization.

WESTCAPS Members

WESTCAPS members are the following: Arizona State Land Department, Arizona Water Company, Town of Buckeye, Citizens Utilities Company, City of Glendale, City of Goodyear, Litchfield Park Water Service Company, City of Peoria, City of Phoenix, Sunrise and West End Water Companies, City of Surprise, and West Maricopa Combine.

Contracting Arrangements

NCI (as Bookman-Edmonston Engineering, Inc.) was issued Delivery Order No. 990341CD011 entitled Beardsley Canal Capacity Study - Phase 2 - Contract No. 1425-96-CA-20-0341C entitled Architectural-Engineering Services for the Bureau of Reclamation, Mid-Pacific Region on June 4, 1999 by the Bureau of Reclamation.

Acknowledgments

B-E acknowledges the assistance of the MWD staff, who generously gave of their time and expertise.

Description

One of the goals of Phase 2 is to develop a tool to aid WESTCAPS in determining the viability of transporting CAP and other water in the Beardsley Canal without impacting MWD water demands. MWD water demand figures were obtained from the work performed in Phase 1, which is summarized in *Maricopa Water District Beardsley Canal and Associated Delivery System Hydraulic Capacity Analysis, An Evaluation and Assessment Report* (prepared for USBR and WESTCAPS, May 14, 1999, Bookman-Edmonston Engineering, Inc.).

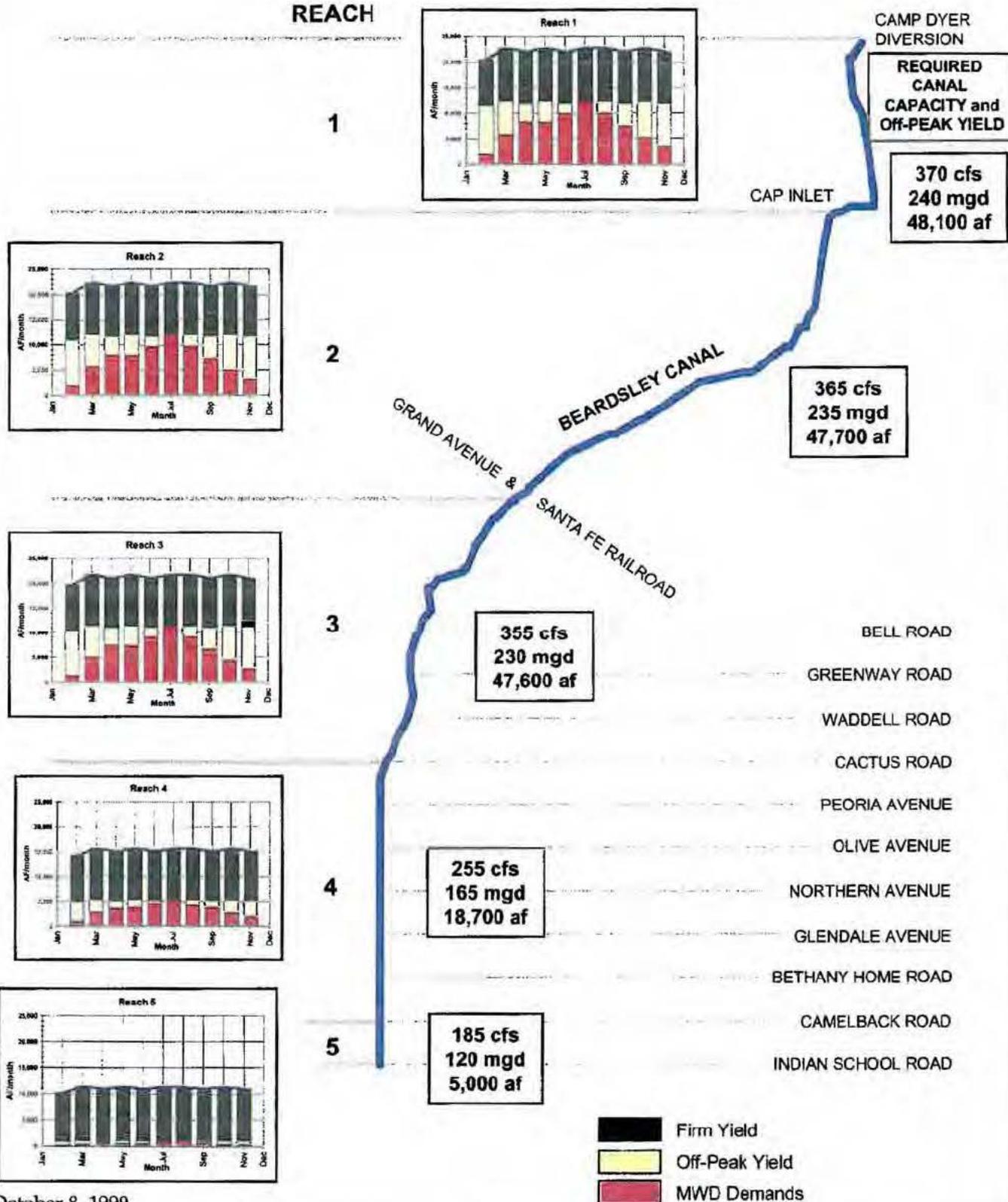
Evaluation of Constant Flow Rates

The capacity constraints of the Beardsley Canal were analyzed when carrying high MWD demands (as experienced in 1995) plus each of five quantities of water: 50,000, 100,000, 150,000, 200,000, and 300,000 acre-feet per year. The constraints in five separate reaches of the canal were evaluated for each of the five flow regimes. These volumes, transformed into flow rates for each reach, are displayed in Table 2-1. A flow regime contains varying flows in different canal reaches as the flow required by MWD demand changes. The flow required by MWD demands was determined using the Canal Capacity Model developed in Phase 1. The rates assume constant demand at peak MWD demands, as shown in Figure 2-1. For example, a 1995 MWD peak demand (plus conveyance losses) for Reach 1 of 12,000 acre-feet during July translates into a flow rate of 201 cfs, as determined in Phase 1. To this flow was added the constant demand of 50,000 acre-feet over a 10-month operating period (5,000 acre-feet per month or 81.3 cfs). Therefore, the constant demand on the canal (MWD plus non-MWD demand) for this reach is then 282.3 cfs, which was rounded up to 285 cfs.

Table 2-1
Flow Rates for Delivery Quantities
By Canal Reach at Peak MWD Demands (1995)

Canal Reach	50,000 af	100,000 af	150,000 af	200,000 af	300,000 af
Reach 1 - Lake Pleasant to CAP Inlet	285 cfs 185 Mgd	370cfs 240 Mgd	455 cfs 295 Mgd	535 cfs 345 Mgd	705 cfs 455 Mgd
Reach 2 - CAP Inlet to Grand Ave.	285 cfs 185 Mgd	365 cfs 235 Mgd	450 cfs 290 Mgd	530 cfs 340 Mgd	700 cfs 450 Mgd
Reach 3 - Grand Ave. to Cactus Rd.	275 cfs 175 Mgd	355 cfs 230 Mgd	440 cfs 285 Mgd	520 cfs 335 Mgd	690 cfs 445 Mgd

REACH



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	Prepared for USBW/WESTCAPS	Beardsley Canal Capacity Study - Phase II Capacity Required to Yield 100,000 af (Firm and Off-Peak Yield [for High MWD Canal Demand Year (1995)])	Figure 2-1
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Reach 4 - Cactus Rd. to Camelback Rd.	170 cfs 110 Mgd	255 cfs 165 Mgd	340 cfs 220 Mgd	420 cfs 270 Mgd	590 cfs 380 Mgd
Reach 5 - Camelback to Thomas Rd.	105 cfs 70 Mgd	185 cfs 120 Mgd	270 cfs 175 Mgd	350 cfs 225 Mgd	520 cfs 335 Mgd

Any reduction in conveyance losses as a result of canal improvements was not considered in the evaluation of modeled flow rates.

It should be noted that there is potentially more capacity for wheeling in the Beardsley Canal in the shoulder months than this developed constant flow. Figure 2-1 illustrates the volume of capacity which could be available on a non-firm basis.

Preliminary Evaluation of Canal Capacity Constraints

A preliminary evaluation of these flow rates was conducted to assess the potential modifications required to the Beardsley Canal. With the exception of the lower reach and the largest flow regime, replacing the canal with a larger canal would not meet the goals of this study. A preliminary evaluation of these flow regimes yielded the following basic understanding of changes to the Beardsley Canal which would be necessary to maintain the modified flow regimes, as summarized in Table 2-2.

Table 2-2
Results of Preliminary Evaluation Showing
General Modifications to the Beardsley Canal for Each Flow Regime

Canal Reach	50,000 af	100,000 af	150,000 af	200,000 af	300,000 af
Reach 1 - Lake Pleasant to CAP Inlet	No Modifications	No Modifications	Replace Structures & Minor Canal Modifications	Replace Structures & Minor Canal Modifications	Replace Structures, Major Canal Modifications
Reach 2 - CAP Inlet to Grand Ave.	No Modifications	Possibly Replace Structures	Possibly Replace Structures	Replace Structures & Minor Canal Modifications	Replace Structures, Major Canal Modifications
Reach 3 - Grand Ave. to Cactus Rd.	No Modifications	Possibly Replace Structures	Replace Structures, Major Canal Modifications	Replace Structures, Major Canal Modifications	Replace Structures, Major Canal Modifications
Reach 4 - Cactus Rd. to Camelback Rd.	Possibly Replace Structures	Replace Structures, Major Canal Modifications	Replace Structures, Major Canal Modifications	Replace Structures, Major Canal Modifications	Replace Structures, Major Canal Modifications

Reach 5 - Camelback to Thomas Rd.	Possibly Replace Structures	Replace Structures, Major Canal Modifications	Replace Structures, Major Canal Modifications	Replace Structures, Major Canal Modifications	Replace Structures, Major Canal Modifications
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These preliminary results were presented to the WESTCAPS Technical Committee on July 9, 1999 for discussion. The proposed flow regimes were more thoroughly discussed and approved for further study by WESTCAPS on July 23, 1999 and were the same set of flow regimes originally specified for Phase 2.

Modeling Approach

Separate appraisal-level hydraulic models for the Beardsley Canal were constructed to evaluate the effects of the five flow regimes. The base for these models was the HEC-RAS model constructed for the Phase 1 Beardsley Canal Capacity Study, which in turn was based on a 1998 field survey of the Beardsley Canal.

Given a flow regime and canal geometry, HEC-RAS will determine the corresponding water surface. (Please see Appendix B of the Phase 1 Report for a detailed description of the Phase 1 HEC-RAS model of the Beardsley Canal). The water surface is then compared with the canal lining height to determine if the six inches of freeboard have been maintained or compromised. In addition, flow velocities through the canal and structures are checked for conformance to maximum allowable velocities.

Iterative model runs for each flow regime were made to evaluate the size and placement of new structures, the effects of removing unnecessary structures, and the effects of enlarging and relining appropriate reaches of the canal. The volumes of earthwork required to enlarge the canal were computed in HEC-RAS.

A separate model using HEC-RAS output was developed to compute the area of increased lining or relining necessary in order to provide a sufficiently-sized canal for the flow regime plus six inches of freeboard. In all cases, the canal lining was specified to be at least five feet deep.

Every effort was made to utilize the existing configuration of the canal in order to reduce excavation or replacement costs. Flow restrictions were identified during each model iteration and "fixed" in the model until the specified flow regime passed through the canal. This approach identified only necessary retrofits while minimizing costs.

One exception to this modeling approach was the 300,000 acre-foot per year flow regime. Replacing almost the entire canal was the intent for this flow regime. Only a few existing structures are large enough to carry these flow rates.

Criteria for Canal and Structure Modifications

The appraisal-level cost estimates required to modify the Beardsley Canal are based on several assumptions and criteria of canal design, including the following:

- Average velocity in canal equal to or less than eight feet per second;
- Canal freeboard equals at least six inches;
- Minimum canal lined depth equals five feet;
- Ability to deliver water to all existing MWD turnouts was maintained;
- Manning's "n" value of newly lined canal equals 1.15;
- Canal modification costs are based on 1999 cost of labor and materials; and
- The appraisal level costs include 20 percent for contingencies and 15 percent for administration and engineering.

Modifications to the canal fall into three general categories: (1) increasing lining height within the existing prism; (2) enlarging and relining the canal; and (3) modifying or replacing canal structures such as siphons and gates.

Raising Canal Lining

Raising the canal lining without otherwise modifying the geometry of the canal prism was considered in areas where flow would overtop (or come to within six inches of) the existing canal lining. Raising the canal lining was only considered in reaches where there was sufficient existing or excavated bank upon which to place the raised lining. The raised canal lining height incorporated the standard six inches of freeboard.

Raising the canal lining is a cost-effective solution for increasing canal capacity and is preferable to modifying the canal geometry where feasible.

Enlarging the Canal by Modifying the Canal Geometry

In reaches where raising the lining produced insufficient results, the canal prism itself was modified. The modification could be deepening, widening, altering the side slopes, or any combination thereof. Figure 2-2 provides an example of these types of modifications. In Reaches 4 and 5, the canal prism was modified due to the flow velocity being too high for the current configuration. In these lower reaches, the flow velocity exceeded eight feet per second, indicating drop structures and low slope canal segments as a replacement to the existing configuration.

The appraisal-level evaluation of the required modifications indicated that Reaches 4 and 5 for the 50,000 acre-foot flow regime would require significant modifications to the canal. The preliminary evaluation showed that the canal prism can hold the required flow rate, however, the flow velocities exceed recommended design velocities. NCI recommends that a series of vertical and inclined drops be installed to lower these velocities. It should be noted that MWD has, for some time, operated the canal at these

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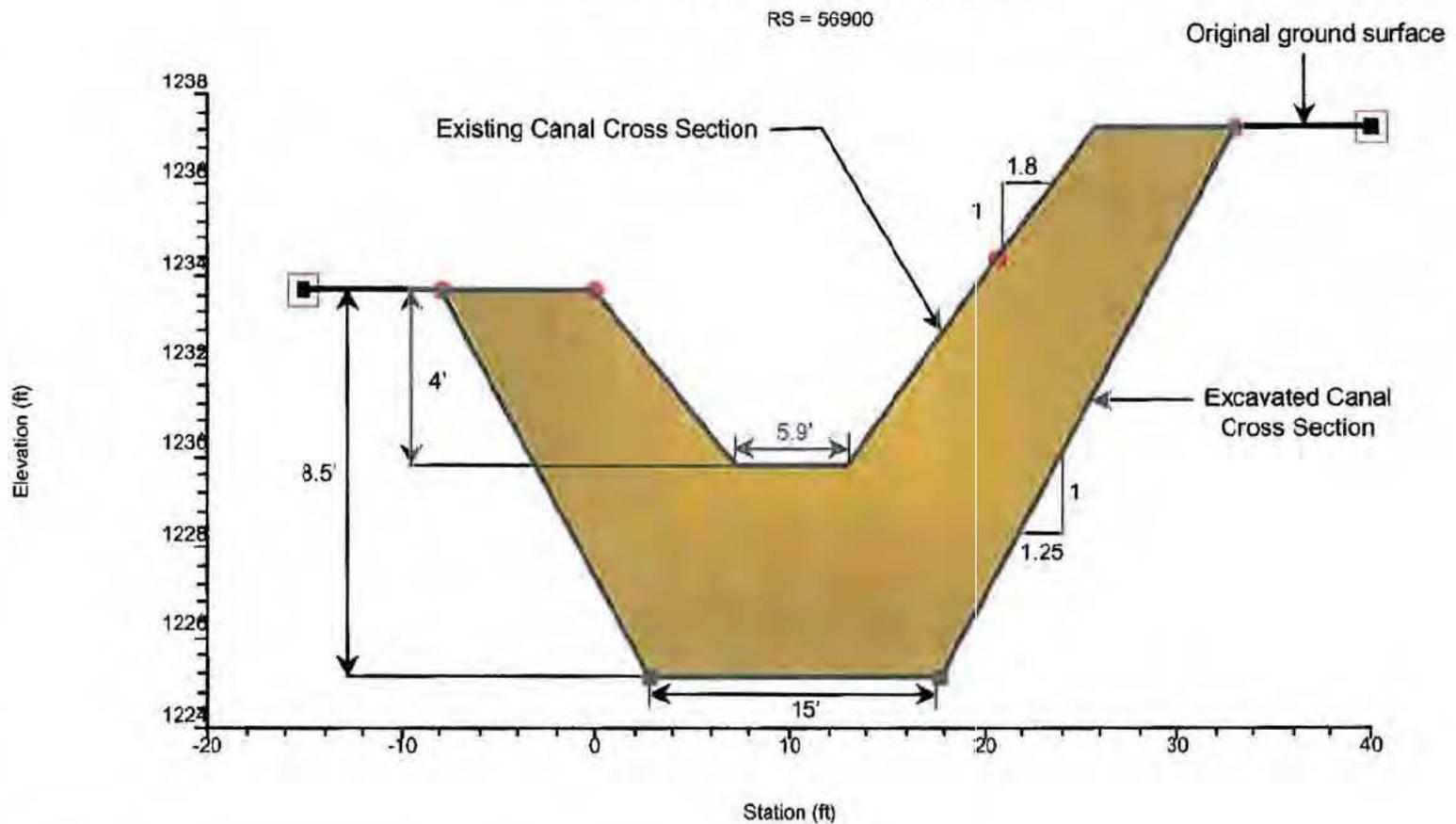
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FIGURE 2-2

Beardsley Canal Capacity Study - Phase 2
EXAMPLE OF CANAL PRISM EXCAVATION FOR 200,000 af/yr FLOW
Reach 4, Cactus Rd. to Camelback Rd.

Existing and Excavated Canal Cross Section



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flow velocities and may choose to increase the volume delivered through this reach with only minimum modifications to the canal structures.

Replacing Structures

Structures which either cause the canal to overtop its banks or which have unacceptably high flow velocities will be replaced with a structure which meets hydraulic requirements and allows good canal operational practices. The hydraulic requirements allow the water to pass through the canal with a minimum of six inches of freeboard at an acceptable average velocity. Structures which allow good canal operational practices maintain or reduce current canal operating expenses and have a long operational life. Standardization of canal structures and the potential for future remote control were also factors in determining structure replacements. Table 2-3 provides the general structure replacement criteria. Figure 2-3 displays an example of replacing an existing culvert with a larger box culvert.

**Table 2-3
Canal Structure Replacement Criteria**

Structure Type	Maximum Flow Velocity (ft/s)	Replacement Structure
Reinforced Concrete Pipe/Box	10	Larger Reinforced Concrete Pipe or Box
Corrugated Metal Pipe	5	Reinforced Concrete Pipe or Box
Check Board Gate	NA	Radial Gate (>200 cfs) or Mechanical Sluice Gate (<200 cfs)
Flumes	10	Reinforced Concrete Pipe Siphon

Removing Structures

Since the Beardsley Canal was constructed, several flood control structures have been installed which have changed the area's drainage pattern. Maricopa County floodplain maps of the area were reviewed, and it was determined that McMicken Dam and White Tanks Number 3 flood retention structures have made several canal siphons obsolete. In such cases, it was assumed that the siphon would be removed only if it did not adequately convey a given flow. In other words, if the siphon could carry the flow without exceeding maximum flow velocities or causing the canal to overtop, the structure was left in place (to avoid the structure removal cost). When the structure did not adequately pass the given flow or interfered with other modifications, such as installing check-drops, its removal was specified.

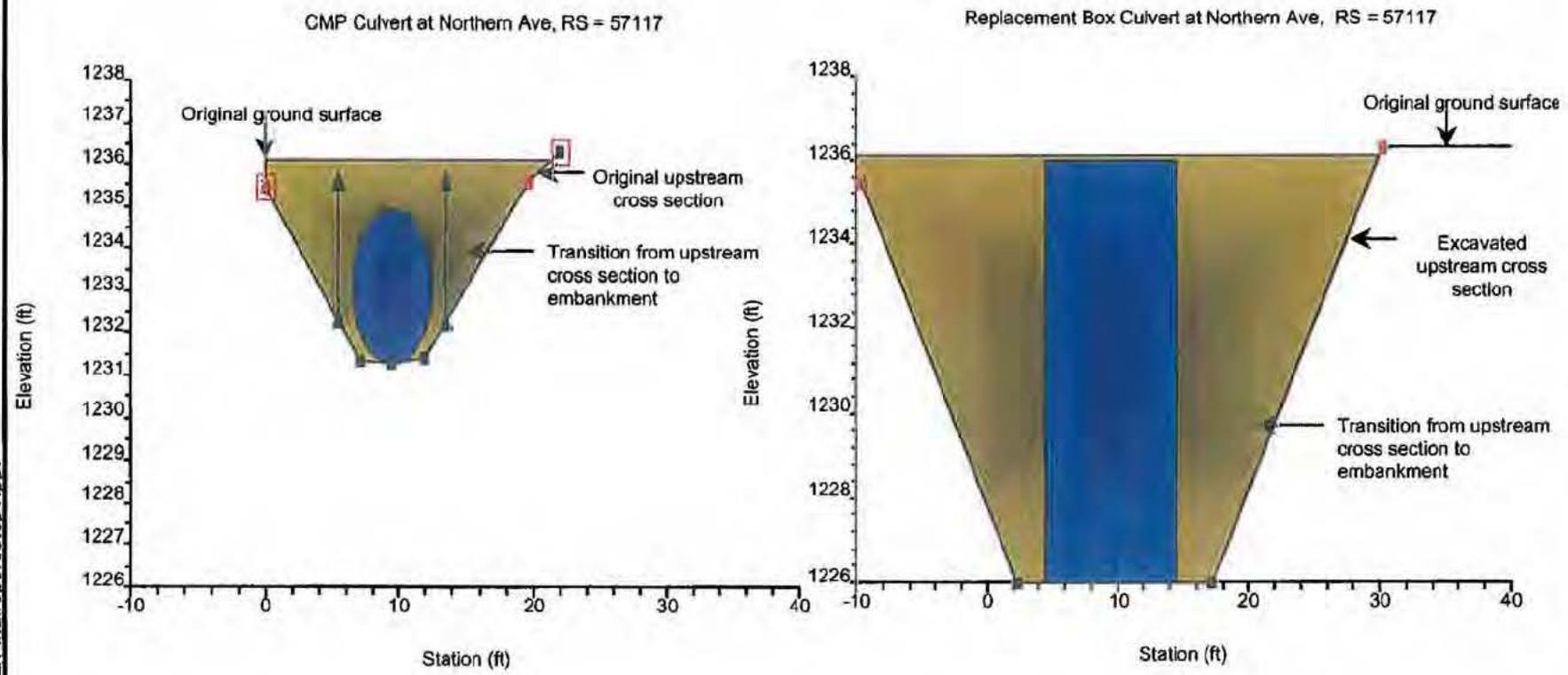
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FIGURE 2-3
 Beardsley Canal Capacity Study - Phase 2
 EXAMPLE CUT AND RETROFIT FOR 200,000 af/yr FLOW
 Reach 4, Cactus Rd. to Camelback Rd.



Flow velocity exceeding 5 ft/s and overtopping existing 6' x 3.6' elliptical CMP culvert

Culvert replaced with 10' x 10' concrete box culvert

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Adding Structures

The drainage pattern changes mentioned above also indicated that a canal siphon is likely needed in the area above Olive Avenue. This siphon, at a size appropriate for the specified flow regime, was added to each cost estimate.

Due to the changes in drainage patterns caused by the CAP canal, an additional siphon above Grand Avenue may also be necessary. A siphon for this area was not specified in the cost estimates since floodplain maps of this area were not available.

In some instances, flood water is allowed to flow into some reaches of the Beardsley Canal. If these occasional inflows are undesirable contributions to WESTCAPS members, the flood flows will need to be routed under or over the Beardsley Canal.

It is recommended that a comprehensive cross-drainage study of the Beardsley Canal be undertaken prior to the removal or addition of any siphons on the Beardsley Canal. Such a study was beyond the scope of this report. Costs which may be incurred from altering drainage across the Beardsley Canal were not included in this report.

Cost of Modifications

Canal modification costs were based on the quantities of various materials, such as volume of earthwork, lining area, and volume of concrete. The unit costs specified are for the materials listed in Appendix A. All costs are based on recent construction costs provided in bid sheets on other recent canal construction projects.

Appraisal-level costs for contingencies, engineering and administration (20 percent and 15 percent of capital costs, respectively) were also added. Costs for right of way were not included in the capital costs at this time. MWD currently owns the right of way for the Beardsley Canal and has leases for other utility easements within this space. WESTCAPS will standardize the right-of-way costs for all WESTCAPS' alternatives under consideration at a later time. The permanent and temporary right-of-way areas for each reach are listed in Section 3.

Canal Improvements

Canal improvements required to deliver the five flow regimes through each segment of the Beardsley Canal are outlined in Figures 3-1 through 3-5. A more detailed list of canal and structural modifications is included in Appendix A.

Capital Cost of Improvements

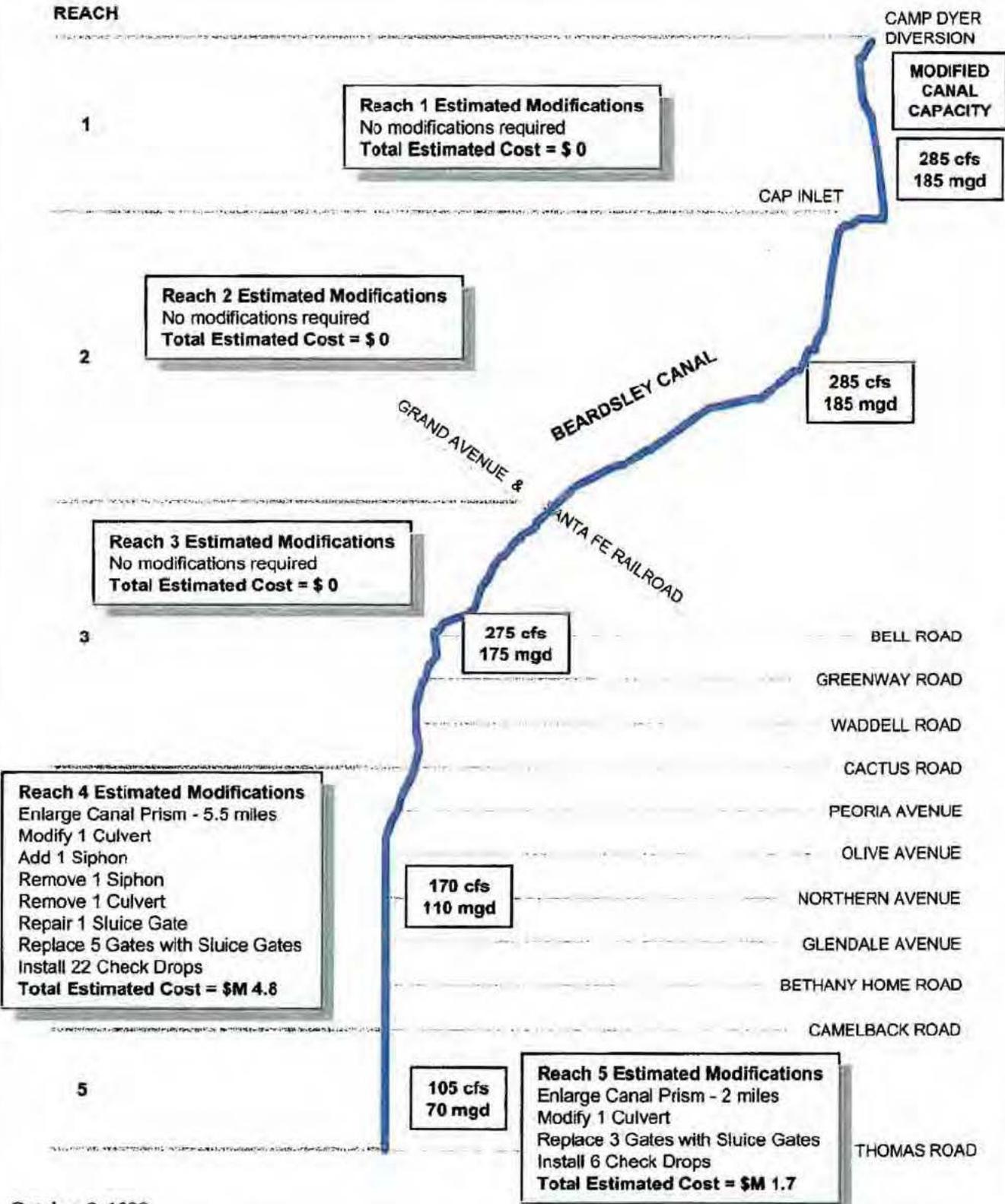
The costs of capital improvements for each of five reaches and five flow regimes (Table 3-1) of the Beardsley Canal are displayed in Table 3-2. No capital improvements would be required to deliver an additional 50,000 acre-feet per year to WESTCAPS members at Cactus Road. Approximately \$5 to \$6 million in capital improvements would provide for the delivery of 200,000 acre-feet per year to Cactus Road, or for the delivery of 100,000 acre-feet to Camelback Road. Table 3-2 may be used as a tool to estimate the improvement costs required to move varying amounts of water through the Beardsley Canal.

Figure 3-6 illustrates the use of Table 3-2. In this example, the required canal capacity is reduced by 50,000 acre-feet per year at each turnout location. This has the effect of lowering the costs for the successive reaches. The cost and capacity for each reach is highlighted on the example table within Figure 3-6.

Table 3-1
Flow Rates for Delivery Quantities
By Canal Reach at Peak MWD Demands (1995)

Canal Reach	50,000 af	100,000 af	150,000 af	200,000 af	300,000 af
Reach 1 - Lake Pleasant to CAP Inlet	285 cfs 185 Mgd	370cfs 240 Mgd	455 cfs 295 Mgd	535 cfs 345 Mgd	705 cfs 455 Mgd
Reach 2 - CAP Inlet to Grand Ave.	285 cfs 185 Mgd	365 cfs 235 Mgd	450 cfs 290 Mgd	530 cfs 340 Mgd	700 cfs 450 Mgd
Reach 3 - Grand Ave. to Cactus Rd.	275 cfs 175 Mgd	355 cfs 230 Mgd	440 cfs 285 Mgd	520 cfs 335 Mgd	690 cfs 445 Mgd
Reach 4- Cactus Rd. to Camelback Rd.	170 cfs 110 Mgd	255 cfs 165 Mgd	340 cfs 220 Mgd	420 cfs 270 Mgd	590 cfs 380 Mgd
Reach 5 - Camelback to Thomas Rd.	105 cfs 70 Mgd	185 cfs 120 Mgd	270 cfs 175 Mgd	350 cfs 225 Mgd	520 cfs 335 Mgd

REACH



October 8, 1999

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<p>Prepared by Navigant Bookman-Edmonston ENGINEERING, INC.</p>	<p>Prepared for USBW/WESTCAPS </p>	<p>Beardsley Canal Capacity Study - Phase 2 Summary of Modifications Required for 50,000 afa Increased Flow</p>	<p>Figure 3-1</p>
---	---	---	-------------------

REACH

1

Reach 1 Estimated Modifications
 No modifications required
 Total Estimated Cost = \$M 0

CAMP DYER DIVERSION

MODIFIED CANAL CAPACITY

370 cfs
240 mgd

CAP INLET

Reach 2 Estimated Modifications
 Raise Lining - 0.3 miles
 Total Estimated Cost = \$M 0.01

2

GRAND AVENUE & BEARDSLEY CANAL
 SANTA FE RAILROAD

365 cfs
235 mgd

Reach 3 Estimated Modifications
 Enlarge Canal Prism - <0.1 mile
 Raise Lining - 3 miles
 Install 1 Siphon
 Total Estimated Cost = \$M 0.3

3

355 cfs
230 mgd

BELL ROAD

GREENWAY ROAD

WADDELL ROAD

CACTUS ROAD

PEORIA AVENUE

OLIVE AVENUE

Reach 4 Estimated Modifications
 Enlarge Canal Prism - 5.5 miles
 Replace 3 Siphons/Culverts
 Add 1 Siphon
 Remove 3 Siphons/Culverts
 Replace 4 Gates with Radial Gates
 Replace 1 Gate with Sluice Gate
 Install 22 Check Drops
 Total Estimated Cost = \$M 5.3

4

255 cfs
165 mgd

NORTHERN AVENUE

GLENDALE AVENUE

BETHANY HOME ROAD

CAMELBACK ROAD

INDIAN SCHOOL ROAD

OSBORN ROAD

THOMAS ROAD

Reach 5 Estimated Modifications
 Enlarge Canal Prism - 2 miles
 Modify 1 Culvert
 Replace 3 Gates with Sluice Gates
 Install 6 Check Drops
 Total Estimated Cost = \$M 1.8

5

185 cfs
120 mgd

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Beardsley Canal Capacity Study - Phase 2
 Summary of Modifications Required for
 100,000 afa Increased Flow

Figure 3-2

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REACH

CAMP DYER DIVERSION

Reach 1 Estimated Modifications
 Enlarge Canal Prism - <1 mile
 Replace 1 Flume with Siphon
 Total Estimated Cost = \$M 0.9

MODIFIED CANAL CAPACITY

455 cfs
295 mgd

1

CAP INLET

Reach 2 Estimated Modifications
 Enlarge Canal Prism - <0.1 mile
 Raise Lining - 0.6 mile
 Modify 1 Check Structure
 Total Estimated Cost = \$M 0.03

2

450 cfs
290 mgd

GRAND AVENUE &
BEARDSLEY CANAL
 SANTA FE RAILROAD

Reach 3 Estimated Modifications
 Enlarge Canal Prism - 0.4 miles
 Raise Lining - 3 miles
 Modify Canal Under 1 Bridge
 Install 1 Siphon
 Total Estimated Cost = \$M 0.9

3

440 cfs
285 mgd

BELL ROAD

GREENWAY ROAD

WADDELL ROAD

CACTUS ROAD

PEORIA AVENUE

OLIVE AVENUE

Reach 4 Estimated Modifications
 Enlarge Canal Prism - 6.0 miles
 Replace 3 Siphons/Culverts
 Add 1 Siphon
 Remove 4 Siphons/Culverts
 Replace 5 Gates with Radial Gates
 Install 22 Check Drops
 Total Estimated Cost = \$M 7.5

4

340 cfs
220 mgd

NORTHERN AVENUE

GLENDALE AVENUE

BETHANY HOME ROAD

CAMELBACK ROAD

INDIAN SCHOOL ROAD

Reach 5 Estimated Modifications
 Enlarge Canal Prism - 2.0 miles
 Modify 1 Culvert
 Replace 3 Gates with Radial Gates
 Install 6 Check Drops
 Total Estimated Cost = \$M 2.3

5

270 cfs
175 mgd

OSBORN ROAD

THOMAS ROAD

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Beardsley Canal Capacity Study - Phase 2
 Summary of Modifications Required for
 150,000 afa Increased Flow

Figure 3-3

REACH

①

Reach 1 Estimated Modifications
 Enlarge Canal Prism - < 1 mile
 Replace 1 Flume with Siphon
Total Estimated Cost = \$M 1.1

CAMP DYER DIVERSION

MODIFIED CANAL CAPACITY

535 cfs
345 mgd

CAP INLET

Reach 2 Estimated Modifications
 Enlarge Canal Prism - 2.8 miles
 Raise Lining - 1.7 miles
 Modify 1 Check Structure
Total Estimated Cost = \$M 2.8

②

530 cfs
340 mgd

GRAND AVENUE &
BEARDSLEY CANAL
SANTA FE RAILROAD

Reach 3 Estimated Modifications
 Enlarge Canal Prism - 0.4 miles
 Raise Lining - 4 mile
 Modify Canal Under 1 Bridge
 Remove 1 Siphon
 Install 1 Siphon
Total Estimated Cost = \$M 1.2

③

520 cfs
335 mgd

BELL ROAD

GREENWAY ROAD

WADDELL ROAD

CACTUS ROAD

PEORIA AVENUE

OLIVE AVENUE

Reach 4 Estimated Modifications
 Enlarge Canal Prism - 6 miles
 Modify 3 Siphons/Culverts
 Add 1 Siphon
 Remove 4 Siphons/Culverts
 Replace 5 Gates with Radial Gates
 Install 22 Check Drops
Total Estimated Cost = \$M 7.9

④

420 cfs
270 mgd

NORTHERN AVENUE

GLENDALE AVENUE

BETHANY HOME ROAD

CAMELBACK ROAD

INDIAN SCHOOL ROAD

Reach 5 Estimated Modifications
 Enlarge Canal Prism - 2 miles
 Modify 1 Siphon/Culvert
 Replace 3 Gates with Radial Gates
 Install 6 Check Drops
Total Estimated Cost = \$M 2.4

⑤

350 cfs
225 mgd

OSBORN ROAD

THOMAS ROAD

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Beardsley Canal Capacity Study - Phase 2
Summary of Modifications Required for
200,000 afa Increased Flow

Figure 3-4

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REACH

1

Reach 1 Estimated Modifications
 Enlarge Canal Prism - 4.7 miles
 Replace 1 Flume with Siphon
 Modify Canal Under 2 Bridges
Total Estimated Cost = \$M 12.7

CAMP DYER DIVERSION

MODIFIED CANAL CAPACITY

705 cfs
455 mgd

CAP INLET

Reach 2 Estimated Modifications
 Enlarge Canal Prism - 11.7 miles
 Replace 3 Flumes with Siphons
 Modify 1 Bridge
 Modify 1 Culvert
 Replace 1 Measuring Weir
Total Estimated Cost = \$M 27.2

2

700 cfs
450 mgd

GRAND AVENUE &
BEARDSLEY CANAL
 SANTA FE RAILROAD

Reach 3 Estimated Modifications
 Enlarge Canal Prism - 7.4 miles
 Modify 1 Bridge
 Modify Canal Under 1 Bridge
 Remove 1 Siphon
 Replace 4 Gates with Radial Gates
Total Estimated Cost = \$M 12.8

3

690 cfs
445 mgd

BELL ROAD

GREENWAY ROAD

WADDELL ROAD

CACTUS ROAD

PEORIA AVENUE

OLIVE AVENUE

Reach 4 Estimated Modifications
 Enlarge Canal Prism - 6 miles
 Modify 3 Siphons/Culverts
 Add 1 Siphon
 Remove 4 Siphons/Culverts
 Replace 6 Gates with Radial Gates
 Replace 1 Measuring Weir
 Install 22 Check Drops
Total Estimated Cost = \$M 9.9

4

590 cfs
380 mgd

NORTHERN AVENUE

GLENDALE AVENUE

BETHANY HOME ROAD

CAMELBACK ROAD

INDIAN SCHOOL ROAD

OSBORN ROAD

THOMAS ROAD

Reach 5 Estimated Modifications
 Enlarge Canal Prism - 2 miles
 Modify 1 Culvert
 Replace 3 Gates with Radial Gates
 Install 6 Check Drops
Total Estimated Cost = \$M 3.1

5

520 cfs
335 mgd

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Beardsley Canal Capacity Study - Phase 2
Summary of Modifications Required for
300,000 afa Increased Flow

Figure 3-5

Table 3-2
Beardsley Canal Capacity Study - Phase 2
Capital Costs of Improvements to Achieve Minimum Delivery Requirements⁽¹⁾

Canal Reach	50,000 af	100,000 af	150,000 af	200,000 af	300,000 af
Reach 1 - Lake Pleasant to CAP Inlet	\$0	\$0	\$934,000	\$1,140,000	\$12,721,000
Reach 2 - CAP Inlet to Grand Ave.	\$0	\$13,000	\$30,000	\$2,785,000	\$27,168,000
Reach 3 - Grand Ave. to Cactus Rd.	\$0	\$326,000	\$871,000	\$1,187,000	\$12,769,000
Reach 4 - Cactus Rd. to Camelback Rd.	\$4,805,000	\$5,314,000	\$7,495,000	\$7,854,000	\$9,782,000
Reach 5 - Camelback to Thomas Rd.	\$1,697,000	\$1,814,000	\$2,330,000	\$2,442,000	\$3,084,000
Total Cost	\$6,502,000	\$7,467,000	\$11,660,000	\$15,408,000	\$65,524,000

⁽¹⁾With 1995 MWD peak use, costs include 20 percent for contingencies; 15 percent for engineering and administration. All costs are in 1999 dollars. The current 9/99 construction cost index is listed at 6117 based on year 1913 (Engineering News Record). Right-of-way costs are not included.

Figures 3-7 through 3-11 show reach-by-reach graphs of the improvement costs versus resulting flow.

Reach 4 and 5 - Additional Options

Additional options were examined for conveying 50,000 acre-feet per year through Reaches 4 and 5 (Cactus Road to Thomas Road). The options considered include operating the canal with the current high velocities through this segment. Although it is recommended to install vertical and inclined drops, it should be noted that MWD is not dissatisfied with operating these canal reaches with the high flow velocities. The modifications for this option involve replacing five gates, removing one culvert and replacing one siphon and one culvert. The Reach 4 canal geometry can typically carry the increased flow, however, much of the Reach 5 canal must be enlarged. Costs for these options are displayed in Table 3-3.

Other options considered include installing a pipe parallel to the Beardsley Canal through Reaches 4 and 5, and through Reach 5 only. This pipe would carry only the 50,000 acre-feet per year flow to WESTCAPS members (55 mgd, 85 cfs) and not MWD irrigation water. A slightly larger pipe (45-inch diameter vs. 42-inch diameter) would be

Beardsley Canal Capacity Study - Phase 2
Capital Costs of Improvements to Achieve Minimum Delivery Requirements⁽¹⁾
 \$ in Millions

Canal Reach	50,000 af	100,000 af	150,000 af	200,000 af	300,000 af
Reach 1 - Lake Pleasant to CAP Inlet	\$ -	\$ -	\$ 0.9	\$ 1.1	\$ 12.7
Reach 2 - CAP Inlet to Grand Ave	\$ -	\$ 0.01	\$ 0.03	\$ 2.8	\$ 27.2
Reach 3 - Grand Ave. to Cactus Rd.	\$ -	\$ 0.3	\$ 0.9	\$ 1.9	\$ 12.8
Reach 4 - Cactus Rd. to Camelback Rd.	\$ 4.8	\$ 5.3	\$ 7.5	\$ 7.9	\$ 9.8
Reach 5 - Camelback to Thomas Rd.	\$ 1.7	\$ 1.8	\$ 2.3	\$ 2.4	\$ 3.1

⁽¹⁾With 1995 MWD peak use, costs include 20% for contingencies, 15% for engineering and administration. All costs are in 1999 dollars. The current 9/99 construction cost index is listed at 6117 based on year 1913 (Engineering News Record). Right-of-way costs are not included.

WESTCAPS FLOW, COST TO MODIFY CANAL

CAMP DYER DIVERSION

CAP INLET

**200,000 af
\$1.1 million**

**200,000 af
\$2.8 million**

BEARDSLEY CANAL

GRAND AVENUE

SANTA FE RAILROAD

Turnout 50,000 af to WESTCAPS members

**150,000 af
\$0.9 million**

BELL ROAD

GREENWAY ROAD

WADDELL ROAD

CACTUS ROAD

Turnout 50,000 af to WESTCAPS members

PEORIA AVENUE

OLIVE AVENUE

**100,000 af
\$5.3 million**

NORTHERN AVENUE

GLENDALE AVENUE

BETHANY HOME ROAD

CAMELBACK ROAD

Turnout 50,000 af to WESTCAPS members

INDIAN SCHOOL ROAD

OSBORN ROAD

**50,000 af
\$1.7 million**

THOMAS ROAD

50,000 af to WESTCAPS members

Total Cost = \$11.8 million

October 8, 1999

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Beardsley Canal Capacity Study - Phase 2
Example Showing Capital Improvement
Costs for Multiple WESTCAPS Turnouts

Figure 3-6

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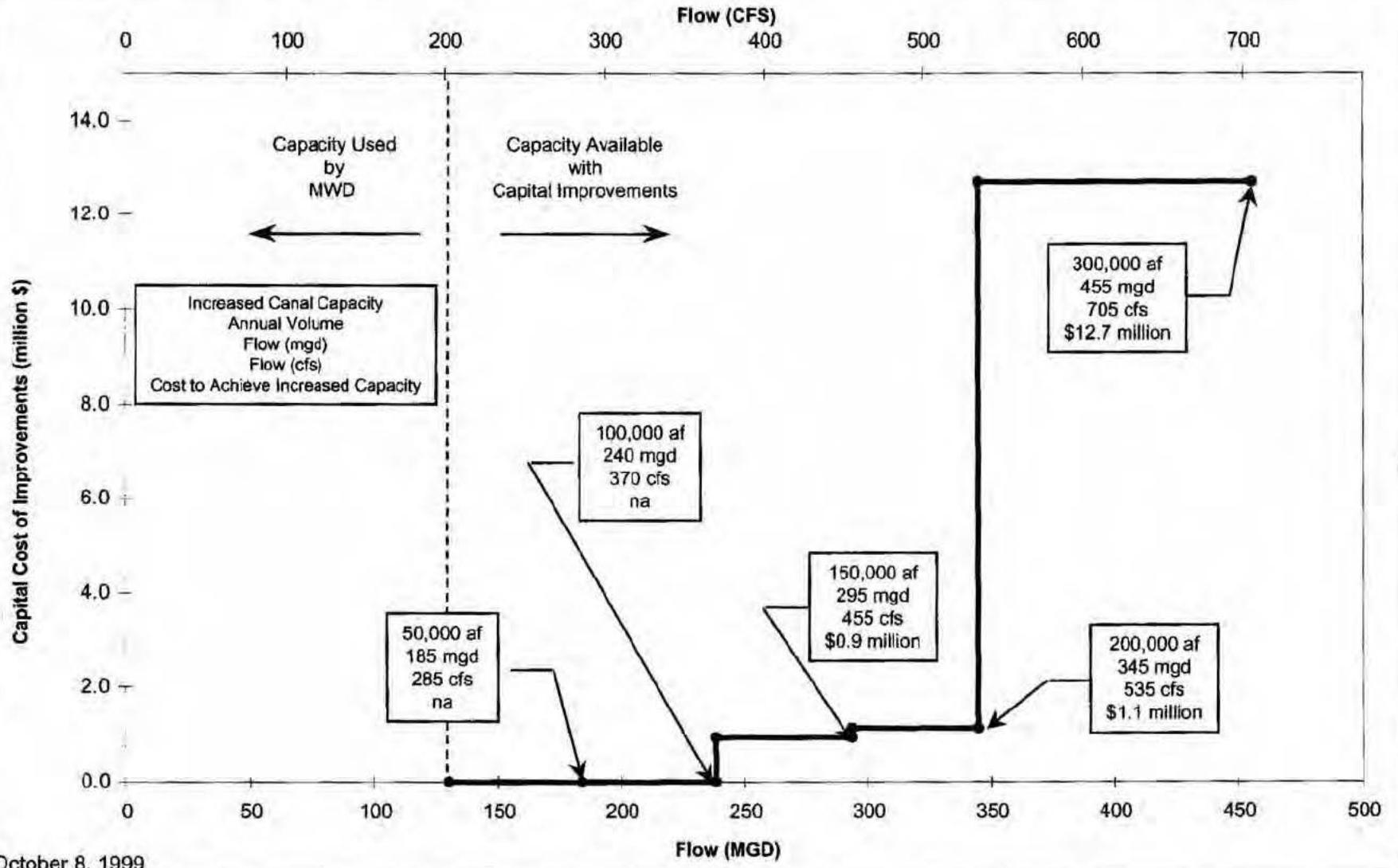


FIGURE 3-7

Beardsley Canal Capacity Study - Phase 2

ESTIMATED CAPITAL COSTS FOR INCREASED CANAL CAPACITY

Reach 1, Lake Pleasant to CAP Inlet



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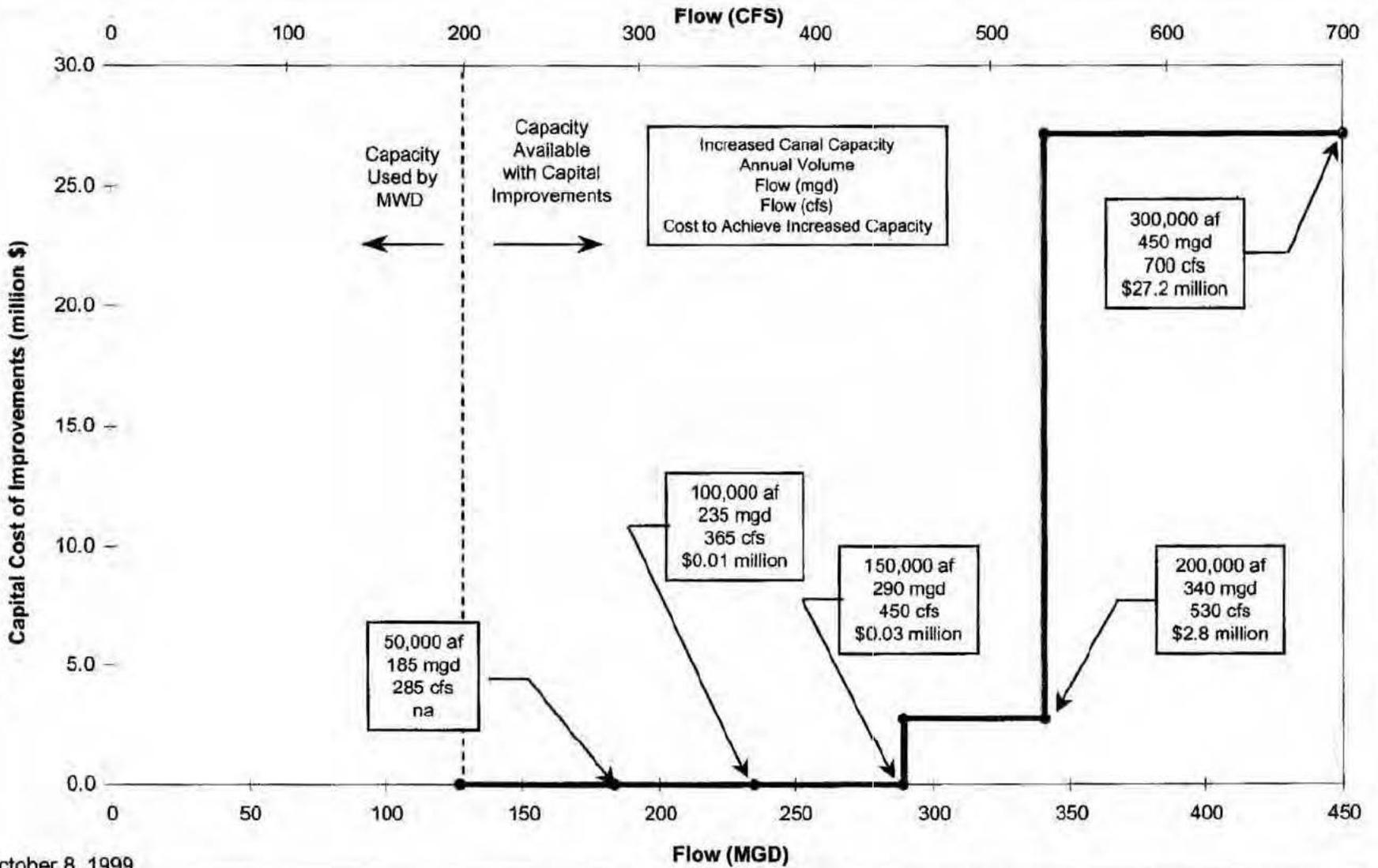


FIGURE 3-8

Beardsley Canal Capacity Study - Phase 2

ESTIMATED CAPITAL COSTS FOR INCREASED CANAL CAPACITY

Reach 2, CAP Inlet to Grand Avenue



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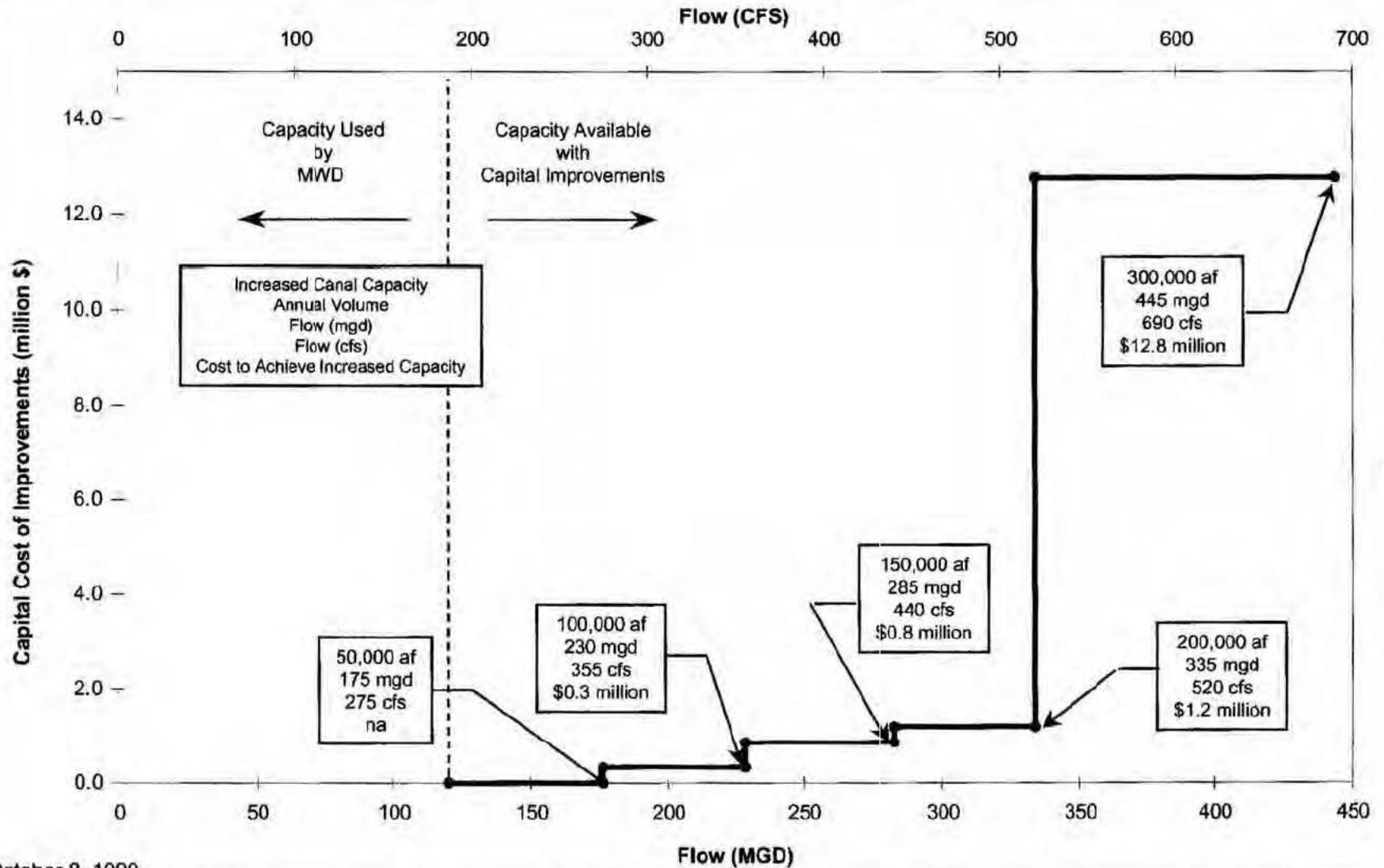


FIGURE 3-9

Beardsley Canal Capacity Study - Phase 2

ESTIMATED CAPITAL COSTS FOR INCREASED CANAL CAPACITY

Reach 3, Grand Avenue to Cactus Road



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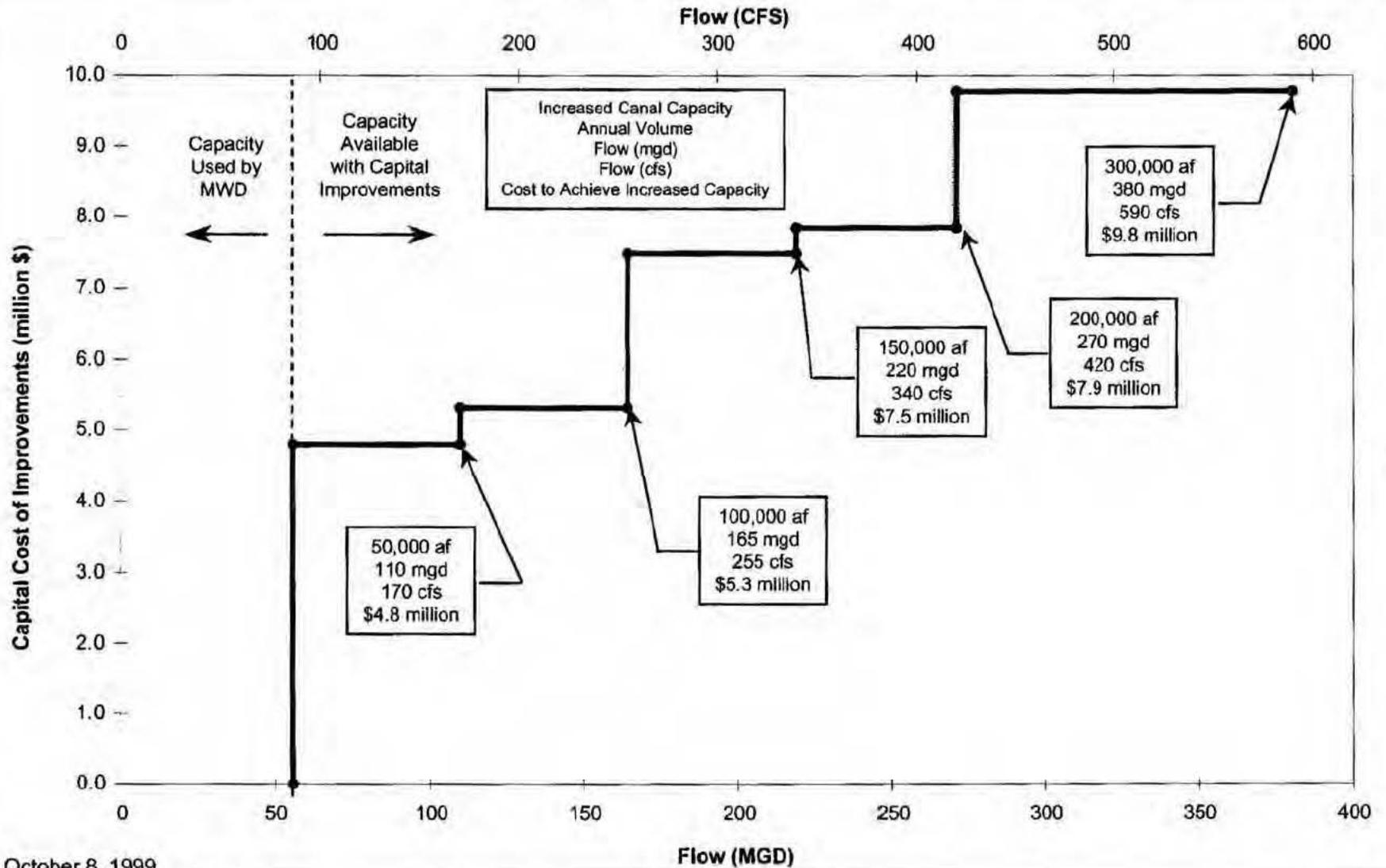


FIGURE 3-10

Beardsley Canal Capacity Study - Phase 2

ESTIMATED CAPITAL COSTS FOR INCREASED CANAL CAPACITY

Reach 4, Cactus Road to Camelback Road



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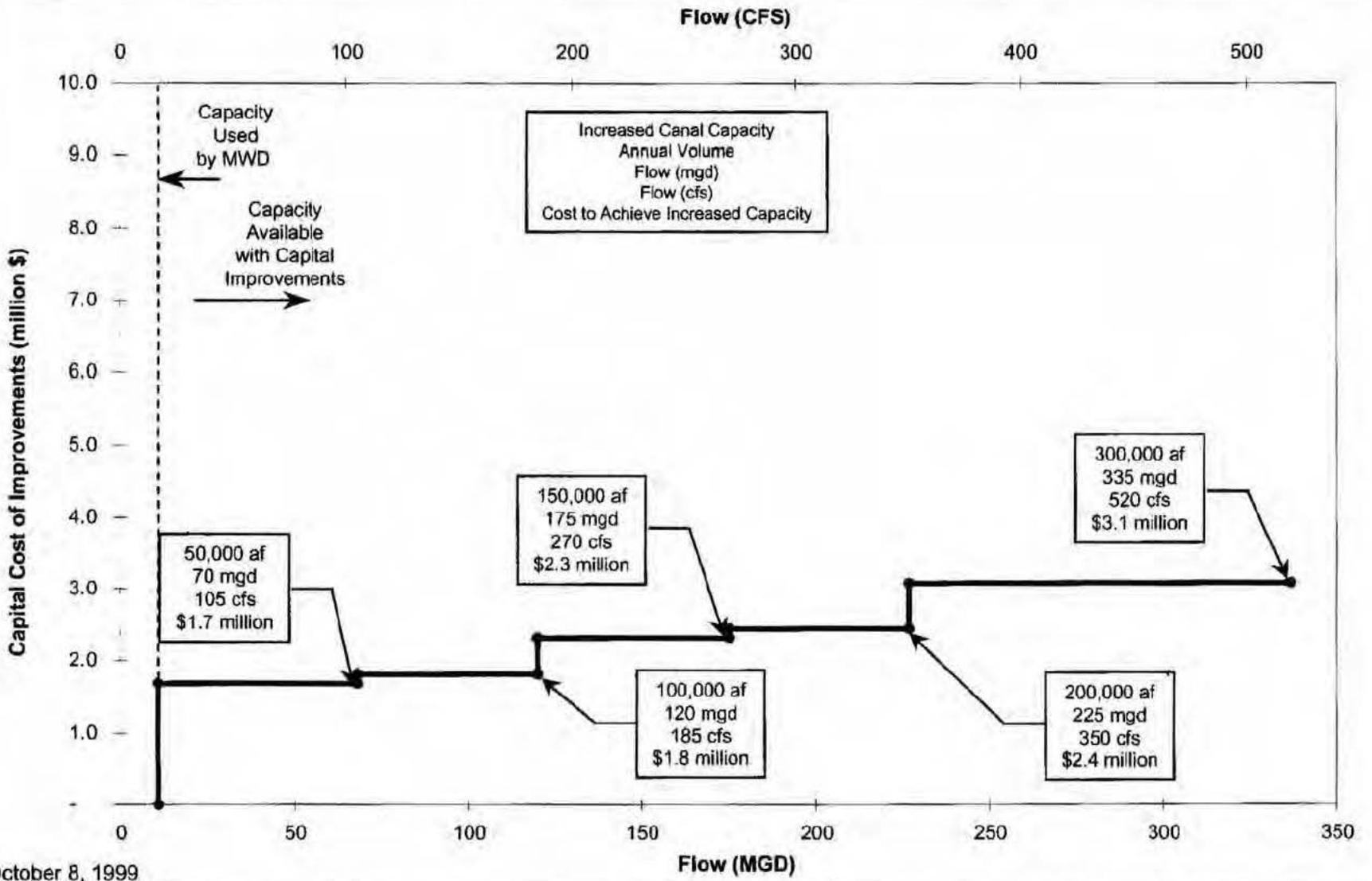


FIGURE 3-11

Beardsley Canal Capacity Study - Phase 2

ESTIMATED CAPITAL COSTS FOR INCREASED CANAL CAPACITY

Reach 5, Camelback Road to Thomas Road (Canal End)



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October 8, 1999

required if the water is only conveyed through Reach 5, since the vertical drop per foot of travel is smaller in this reach.

Table 3-3
Beardsley Canal Capacity Study - Phase 2
Additional Options for Conveying 50,000 afa through Reach 4 and 5
Capital Costs of Improvements to Achieve Minimum Delivery Requirements⁽¹⁾

Canal Reach	Canal with Drop Structures	Canal w/out Drop Structures	Pipeline for Reach 4 and 5	Pipeline for Reach 5 Only
Reach 4 - Cactus Rd. to Camelback Rd.	\$4,085,000	\$645,000	\$ 8,606,000	Use Canal Cost
Reach 5 - Camelback to Thomas Rd.	\$1,697,000	\$814,000	\$ 2,944,000	\$ 3,345,000
Total Cost	\$6,502,000	\$1,551,000	\$11,550,000	\$3,990,000 w/out Drops \$7,430,000 with Drops

⁽¹⁾With 1995 MWD peak use, costs include 20 percent for contingencies; 15 percent for engineering and administration. All costs are in 1999 dollars. The current 9/99 construction cost index is listed at 6117 based on year 1913 (Engineering News Record). Right-of-way costs are not included.

Right of Way

Standardized right-of-way costs for WESTCAPS alternatives have not yet been fully developed and were not included with the cost estimates above. MWD currently holds a 139-foot wide right of way for the Beardsley Canal from the Camp Dyer Diversion to ½ mile south of Cactus Road. The remaining right of way south of Cactus Road is 75 feet wide. It was assumed that the 139-foot wide right of way would be sufficient for canal construction and no temporary right of way would be required. For the lower reach, it was assumed that an additional 70 feet of temporary right of way would be required for construction purposes.

Table 3-5
Beardsley Canal Capacity Study
Canal Right of Way

Canal Reach	Length (ft)	ROW Width (ft)	Area (acres)	Additional Construction ROW (ft)	Area (acres)
Reach 1 - Lake Pleasant to CAP Inlet	26,959	139	86.0	0	0
Reach 2 - CAP Inlet to Grand Ave.	60,322	139	192.5	0	0
Reach 3 - Grand Ave. to Cactus	39,349	139	125.6	0	0

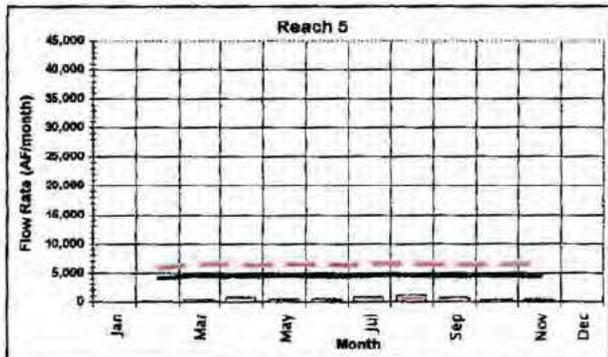
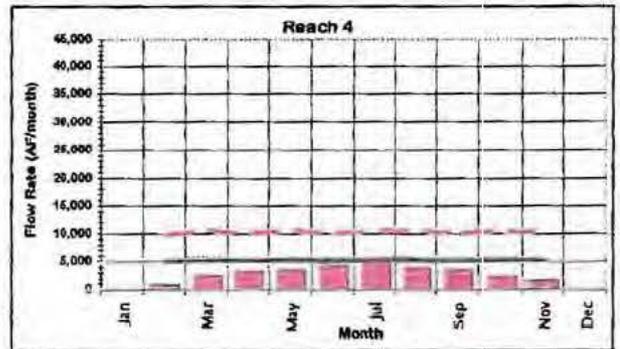
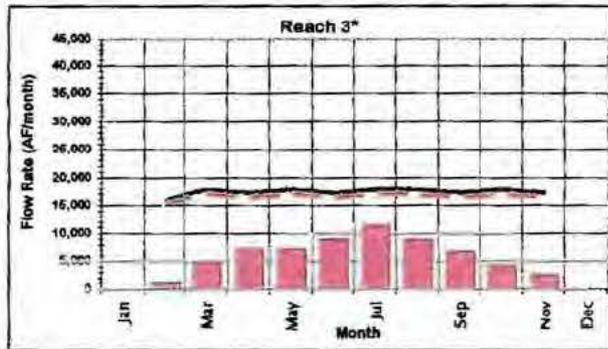
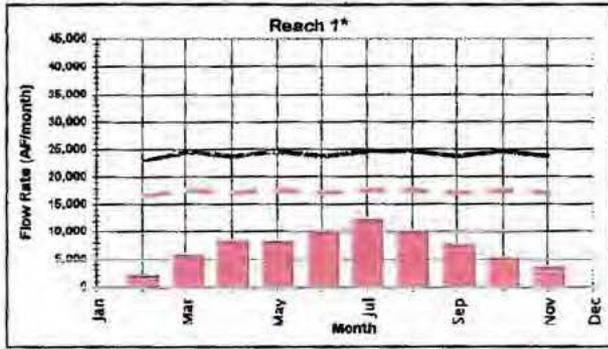
Reach 4 - Cactus Rd. to Camelback Rd.	26,490	75	45.6	70	84.8
Reach 5 - Camelback to Thomas Rd.	15,753	75	21.1	70	50.4

Volumetric Increase in Canal Capacity

The increased capacity available to transport water through the Beardsley Canal at each of the five flow regimes, for each reach, is shown in Figures 3-12 through 3-16. The constant flow values used in this analysis allow for full delivery of the five flow volumes (50,000 through 300,000 acre-feet) at peak MWD demands. Additional delivery capacity may be available during off-peak months as shown in the following figures. For example, improving Reach 4 to carry a constant 50,000 acre-feet of water (Figure 3-11) would actually yield capacity to carry nearly 70,000 acre-feet of water, given the 1995 MWD demand schedule used here. Note that the capacities for each reach displayed in Figures 3-12 through 3-16 are independent of the other reaches. The minimum reach capacity must be considered when calculating the volume of flow through the entire canal.

For some reaches and flow regimes, the canal improvements may reduce conveyance losses, further enhancing the delivery capability of the canal. Calculating the potential reduction in conveyance losses was beyond this scope of work.

Figure 3-12
Beardsley Canal Capacity Study - Phase 2
Volumetric Increase in Capacity Compared to Existing Canal Capacity
and Current MWD Demands for 50,000 af/year Minimum Delivery



Excess Capacity by Reach and Month Improved Canal Capacity Compared to 1995 MWD Demands					
	Reach 1*	Reach 2*	Reach 3*	Reach 4	Reach 5
Jan	0	0	0	0	0
Feb	14,300	13,900	13,900	18,800	5,600
Mar	11,600	11,900	11,900	7,700	6,100
Apr	8,600	8,900	8,900	15,600	5,500
May	9,200	9,500	9,500	15,700	6,000
Jun	7,000	7,300	7,300	15,500	5,800
Jul	5,100	5,400	5,400	15,200	5,600
Aug	7,500	7,800	7,800	15,300	5,400
Sep	9,400	9,700	9,600	15,400	5,600
Oct	12,200	12,500	12,500	7,800	6,100
Nov	13,400	13,700	13,600	18,200	5,900
Dec	0	0	0	0	0
Total	98,300	100,600	100,400	69,200	57,600

*Current canal capacity exceeds the minimum delivery requirement, no improvements are necessary.

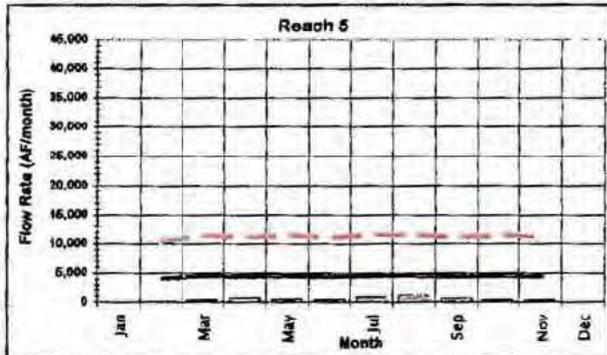
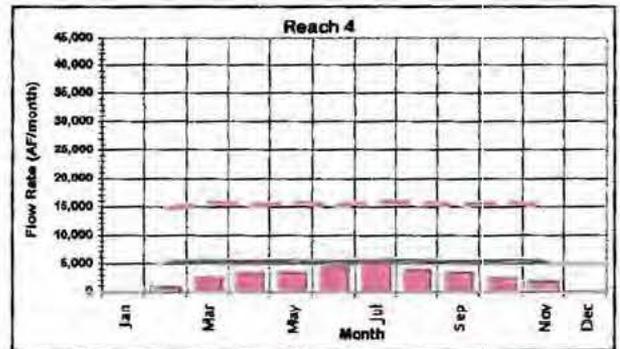
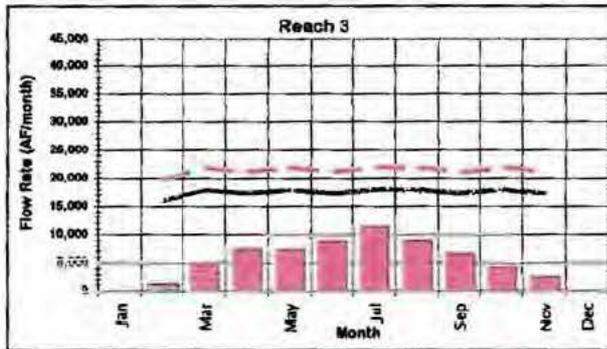
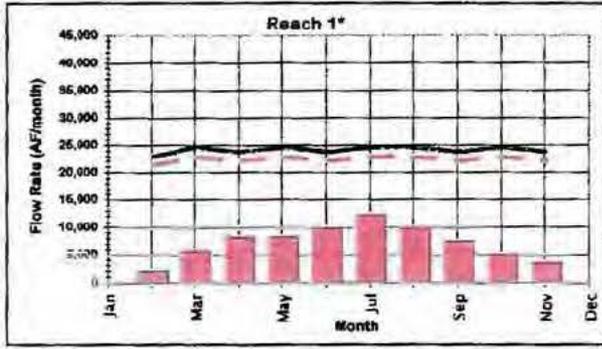
Legend:

- 1995 MWD Demands (acre-feet/month)
- Current Canal Capacity (acre-feet/month)
- Improved Canal Capacity (acre-feet/month)

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Figure 3-13

Beardsley Canal Capacity Study - Phase 2
Volumetric Increase in Capacity Compared to Existing Canal Capacity
and Current MWD Demands for 100,000 acre-year Minimum Delivery



Excess Capacity by Reach and Month
Improved Canal Capacity Compared to 1995 MWD Demands

	Reach 1*	Reach 2	Reach 3	Reach 4	Reach 5
Jan	0	0	0	0	0
Feb	19,100	18,400	18,400	13,700	10,100
Mar	16,800	16,800	16,800	13,000	11,000
Apr	13,700	13,700	13,600	11,700	10,300
May	14,500	14,400	14,400	12,000	10,900
Jun	12,000	12,000	12,000	10,600	10,600
Jul	10,300	10,300	10,300	10,400	10,600
Aug	12,700	12,700	12,700	11,600	10,300
Sep	14,400	14,400	14,400	11,500	10,400
Oct	17,500	17,500	17,400	13,100	11,000
Nov	18,500	18,500	18,400	13,200	10,700
Dec	0	0	0	0	0
Total	149,500	148,700	148,400	120,800	105,900

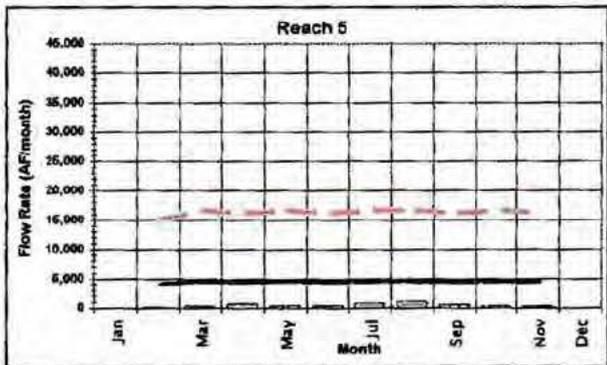
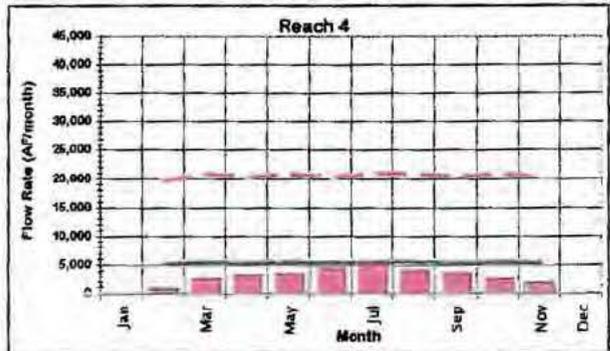
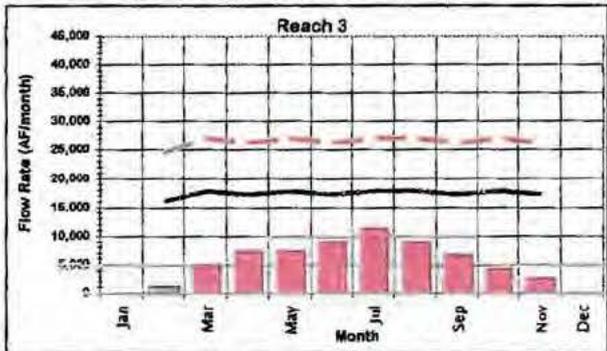
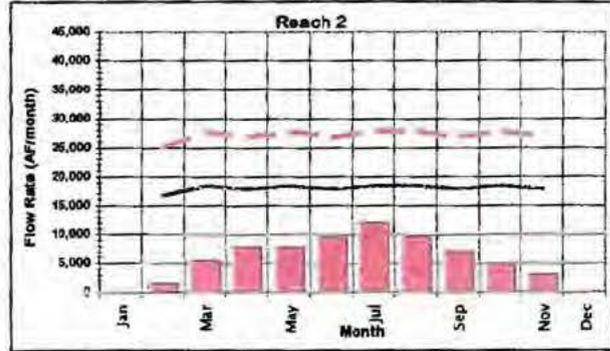
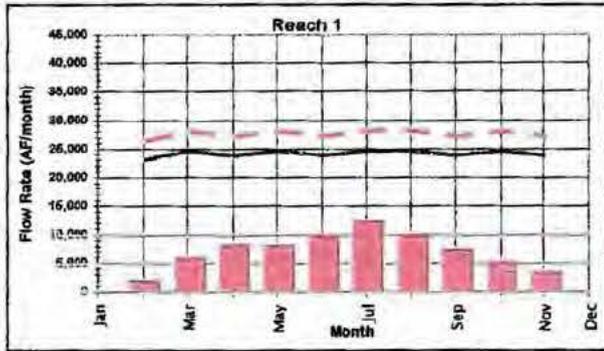
*Current canal capacity exceeds the minimum delivery requirement, no improvements are necessary.

Legend:

- 1995 MWD Demands (acre-feet/month)
- Current Canal Capacity (acre-feet/month)
- Improved Canal Capacity (acre-feet/month)

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Figure 3-14
Beardsley Canal Capacity Study - Phase 2
 Volumetric Increase in Capacity Compared to Existing Canal Capacity
 and Current MWD Demands for 150,000 af/year Minimum Delivery



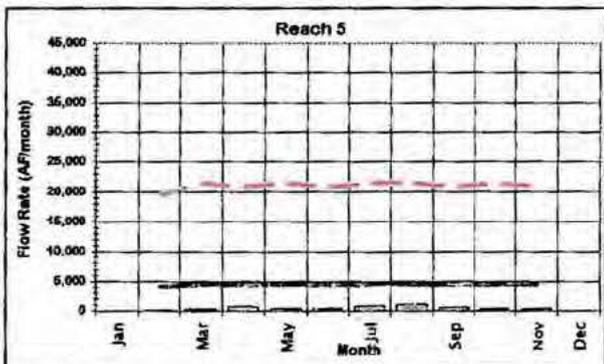
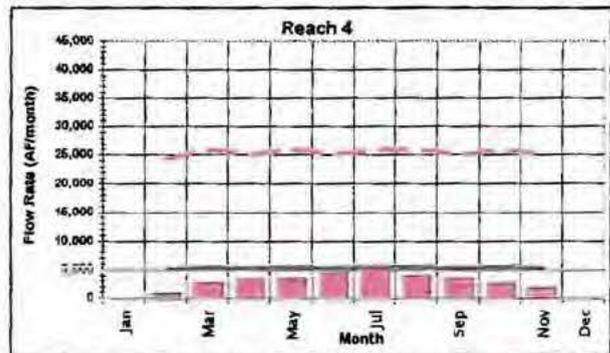
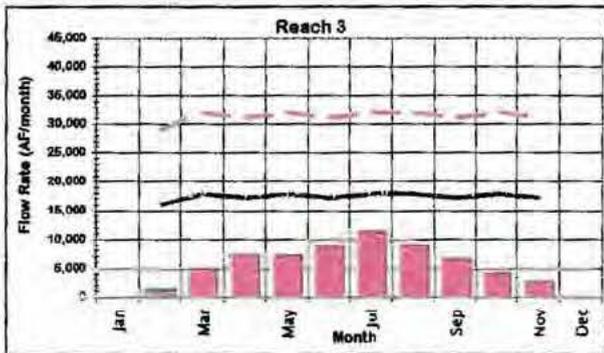
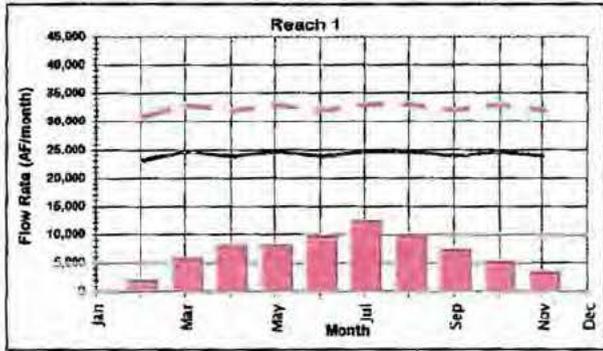
	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5
Jan	0	0	0	0	0
Feb	24,000	23,100	23,100	18,600	14,800
Mar	22,100	22,000	22,000	18,200	16,200
Apr	18,700	18,700	18,700	16,700	15,400
May	19,700	19,700	19,700	17,200	16,100
Jun	17,100	17,100	17,100	15,600	15,600
Jul	15,600	15,600	15,500	15,600	15,800
Aug	18,000	17,900	17,900	16,800	15,500
Sep	19,500	19,500	19,400	16,500	15,400
Oct	22,700	22,700	22,600	18,300	16,200
Nov	23,500	23,500	23,500	18,300	15,700
Dec	0	0	0	0	0
Total	200,900	199,800	199,500	171,800	156,700

Legend:

- 1995 MWD Demands (acre-feet/month)
- Current Canal Capacity (acre-feet/month)
- Improved Canal Capacity (acre-feet/month)

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Figure 3-15
Beardsley Canal Capacity Study - Phase 2
Volumetric Increase in Capacity Compared to Existing Canal Capacity
and Current MWD Demands for 200,000 af/year Minimum Delivery



Excess Capacity by Reach and Month
Improved Canal Capacity Compared to 1995 MWD Demands

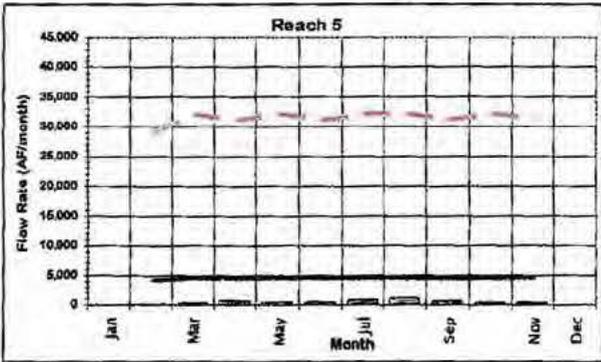
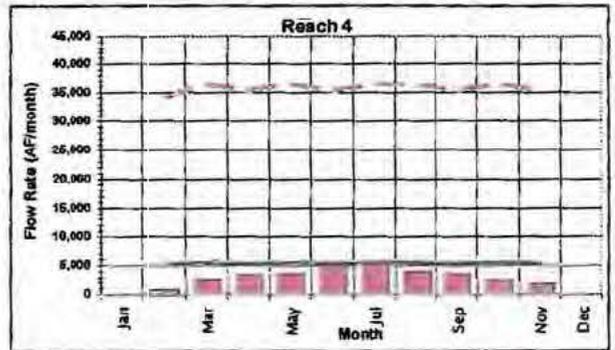
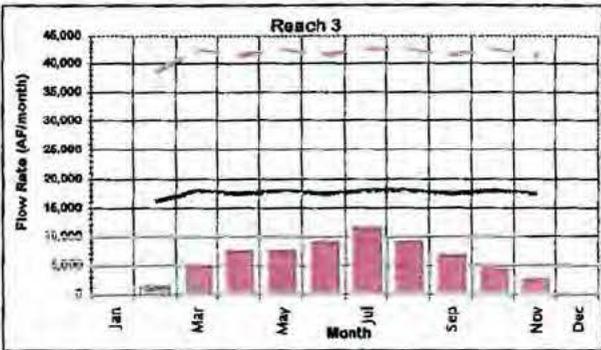
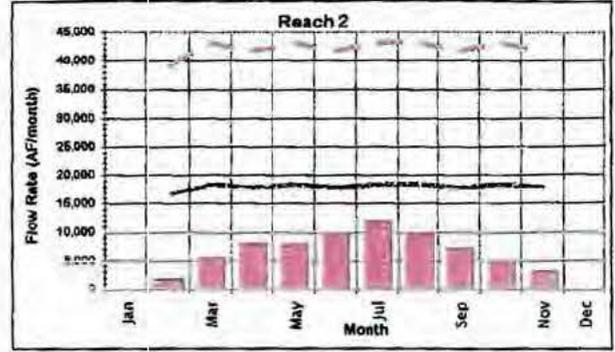
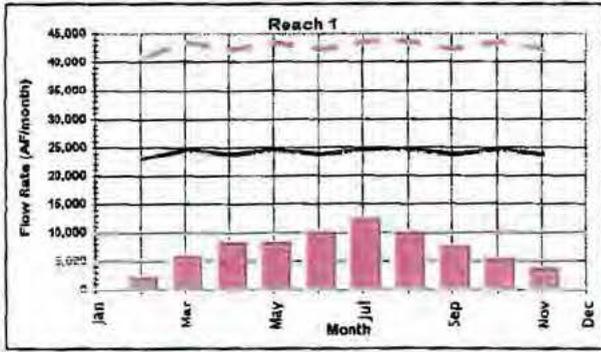
	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5
Jan	0	0	0	0	0
Feb	28,800	27,600	27,500	23,200	19,200
Mar	27,000	27,000	26,900	23,100	21,100
Apr	23,500	23,500	23,500	21,500	20,100
May	24,600	24,600	24,600	22,100	21,000
Jun	21,800	21,800	21,800	20,400	20,400
Jul	20,500	20,500	20,500	20,500	20,700
Aug	22,900	22,900	22,800	21,700	20,500
Sep	24,300	24,200	24,200	21,300	20,200
Oct	27,600	27,600	27,600	23,200	21,200
Nov	28,300	28,300	28,200	23,100	20,500
Dec	0	0	0	0	0
Total	249,100	248,000	247,600	220,100	204,900

Legend:

- 1995 MWD Demands (acre-feet/month)
- Current Canal Capacity (acre-feet/month)
- Improved Canal Capacity (acre-feet/month)

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Figure 3-16
Beardsley Canal Capacity Study - Phase 2
Volumetric Increase in Capacity Compared to Existing Canal Capacity
and Current MWD Demands for 300,000 af/year Minimum Delivery



	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5
Jan	0	0	0	0	0
Feb	38,400	37,000	37,000	33,000	28,700
Mar	37,400	37,400	37,400	33,600	31,600
Apr	33,600	33,600	33,600	31,600	30,200
May	35,100	35,000	35,000	32,500	31,500
Jun	32,000	32,000	31,900	30,500	30,500
Jul	30,900	30,900	30,900	31,000	31,200
Aug	33,300	33,300	33,300	32,100	30,900
Sep	34,400	34,400	34,300	31,400	30,300
Oct	38,100	38,100	38,000	33,700	31,600
Nov	38,400	38,400	38,300	33,200	30,600
Dec	0	0	0	0	0
Total	351,600	350,100	349,700	322,700	307,100

Legend:

- 1995 MWD Demands (acre-feet/month)
- Current Canal Capacity (acre-feet/month)
- Improved Canal Capacity (acre-feet/month)

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Canal Improvements

Canal improvements required to deliver the five flow regimes through the Beardsley Canal are provided in detail in Tables A-1 through A-5.

Canal modification costs are based on the quantities of various materials, such as volume of earthwork, lining area, and volume of concrete. The unit costs specified for the materials listed in the following table include the cost of all tasks and components required to complete the job. All costs are based on recent canal construction costs as reflected in bid tabulation sheets for other recent NCI projects.

- Canal excavation costs include costs of soil preparation and an incidental amount of blasting.
- Canal lining costs are for slip-formed concrete and include forming and finishing.
- The unit cost of concrete for formed structures such as box culverts includes the cost of the form, reinforcing steel, structural steel, and concrete.
- The costs of replacement gates include the cost of installing power and mechanical operators, but do not include costs for remote supervisory control.
- The costs of structure removal include the cost of demolition and disposal. Canal relining and soil preparation are included in the canal excavation and relining costs.
- Bridge replacement costs are based on an average cost per square foot for similar canal crossing bridges.
- Vertical and inclined drop unit costs include the cost of additional concrete and forming for the chutes, checks, and stilling pools.

Costs for the 300,000 acre-foot flow regime are to replace the entire canal, excluding the diversion works and some larger siphons.

**Table A-1
Estimated Capital Costs(1)
Modify Beardsley Canal to Deliver a Minimum of 50,000 acre-feet per year in Addition to MWD Demands**

	Station	Flow (cfs)	Description	Improvement Works	Quantity	Units	Unit Cost	Units	Cost
Canal Excavation									
Reach 1	200000-173041	285	Lake Pleasant to CAP Inlet	Excavate Rock, Soil Prep.	0 cu yards		\$ 12.00	cy	\$ -
Reach 2	172787-112465	285	CAP Inlet to Grand Ave	Excavate Rock, Soil Prep.	0 cu yards		\$ 12.00	cy	\$ -
Reach 3	112431-73082	275	Grand Ave to Cactus Rd.	Excavate, Soil Prep.	0 cu yards		\$ 5.00	cy	\$ -
Reach 4	73062-41275	170	Cactus Rd. to Camelback	Excavate, Soil Prep.	87,400 cu yards		\$ 5.00	cy	\$ 437,000
Reach 5	41274-30802	105	Camelback to Thomas Rd.	Excavate, Soil Prep.	32,000 cu yards		\$ 5.00	cy	\$ 160,000
Subtotal, Excavation					119,400 cu yards				\$ 597,000
Canal Lining - New Lining									
Reach 1	200000-173041	285	Lake Pleasant to CAP Inlet	Form placed & finished	0 sq. ft		\$ 2.50	sq. ft	\$ -
Reach 2	172787-112465	285	CAP Inlet to Grand Ave	Form placed & finished	0 sq. ft		\$ 2.50	sq. ft	\$ -
Reach 3	112431-73082	275	Grand Ave to Cactus Rd.	Form placed & finished	0 sq. ft		\$ 2.50	sq. ft	\$ -
Reach 4	73062-41275	170	Cactus Rd. to Camelback	Form placed & finished	581900 sq. ft		\$ 2.50	sq. ft	\$ 1,454,750
Reach 5	41274-30802	105	Camelback to Thomas Rd.	Form placed & finished	203500 sq. ft		\$ 2.50	sq. ft	\$ 508,750
Subtotal, New Lining					785,400 sq. ft				\$ 1,963,500
Canal Lining - Increase Existing Lining Height									
Reach 1	200000-173041	285	Lake Pleasant to CAP Inlet	Increase existing	0 sq. ft		\$ 2.50	sq. ft	\$ -
Reach 2	172787-112465	285	CAP Inlet to Grand Ave	Increase existing	0 sq. ft		\$ 2.50	sq. ft	\$ -
Reach 3	112431-73082	275	Grand Ave to Cactus Rd.	Increase existing	0 sq. ft		\$ 2.50	sq. ft	\$ -
Reach 4	73062-41275	170	Cactus Rd. to Camelback	Increase existing	0 sq. ft		\$ 2.50	sq. ft	\$ -
Reach 5	41274-30802	105	Camelback to Thomas Rd.	Increase existing	0 sq. ft		\$ 2.50	sq. ft	\$ -
Subtotal, New Lining					0 sq. ft				\$ -
Structures									
Bridges									
Reach 1	197473	285	Lake Rd.	Sufficient Capacity					
Reach 1	185472	285	Cowtown	Sufficient Capacity					
Reach 2	114520	285	163rd	Sufficient Capacity					
Reach 3	90563	275	Ball	Sufficient Capacity					
Reach 3	84479	275	Greenway	Sufficient Capacity					
Canal Box Culverts/Siphons									
Reach 2	141387	285	10x10 Siphon 1	Sufficient Capacity					
Reach 2	132048	285	10x10 Siphon 2	Sufficient Capacity					
Reach 2	127855	285	10x10 Siphon 3	Sufficient Capacity					
Reach 2	114282	285	8x18 - Grand Ave box culvert	Sufficient Capacity					
Reach 3	112430	275	10x10 Siphon TO#1	Sufficient Capacity					
Reach 3	109365	275	12x12 - McMicken Siphon	Sufficient Capacity					
Reach 3	96647	275	8x8 Siphon below TO#3	Sufficient Capacity					
Reach 4	70740	170	5x5 Siphon below TO#7	Sufficient Capacity					
Reach 4	65027	170	6x6 Siphon below TO#8	Sufficient Capacity					
Reach 4	64800	170	does not currently exist	Add Siphon	70 cu yds		\$ 700	cu yd	\$ 49,000
Reach 4	55206	170	5x5 Siphon below TO#10	Remove	1 each		\$ 20,000	each	\$ 20,000
Reach 4	46475	105	4.4x4.4 Siphon below TO#12	Sufficient Capacity					
Reach 5	36051	105	5.5x8 - Indian School box culvert	Enlarge, lower Culvert	30 cu yds		\$ 700	cu yd	\$ 21,000
CMP Culverts									
Reach 2	114443	285	Double Barrel 8' Dia-SFR	Sufficient Capacity					
Reach 4	67670	170	5' Dia at TO#8	Remove	1 each		\$ 20,000	each	\$ 20,000
Reach 4	62413	170	6' Dia at Olive Ave, TO#9	Sufficient Capacity					
Reach 4	57117	170	5' Dia at Northern Ave, TO#10	Enlarge, lower Culvert	30 cu yds		\$ 700	cu yd	\$ 21,000
Flumes									
Reach 1	175304.9	285	Flume #1 - Agua Fria	Sufficient Capacity					
Reach 2	157469	285	Flume #2 (pipe) 10'ID Steel	Sufficient Capacity					
Reach 2	154080	285	Flume #3 (pipe) 10' ID Steel	Sufficient Capacity					
Reach 2	147581	285	Flume #4 (pipe) 10' ID Steel	Sufficient Capacity					
Unchecked Lat. Turnout Gates									
Reach 2	168203	285	18' Bard TO	Sufficient Capacity					
Reach 2	112797	285	TO #1	Sufficient Capacity					
Reach 3	104988	275	TO#2	Sufficient Capacity					
Reach 3	93836	275	TO#3.5	Sufficient Capacity					
Reach 3	81772	275	TO#5.03	Sufficient Capacity					
Rect. Check Gates w. Turnouts									
Reach 3	101801	275	TO#3 Rec. Check & 36" gate	Sufficient Capacity					
Reach 3	90639	275	TO#4 Rec. Check & 48" gate	Sufficient Capacity					
Reach 3	79013	275	TO#6 Rec. Check & 42" gate	Sufficient Capacity					
Reach 4	73059	170	TO#7 Rec. Check & 48" gate	Sufficient Capacity, fix Inop. gates					
Reach 4	67647	170	TO#8, CMP % 24" gate	Replace w/ Sluice Gate	170	cfs Minimum	100000	each	100000
Reach 4	62366	170	TO#9, Rec. Check & 24" gate	Replace w/ Sluice Gate	170	cfs Minimum	100000	each	100000
Reach 4	57083	170	TO#10, Rec. Check & 48" gate	Replace w/ Sluice Gate	170	cfs Minimum	100000	each	100000
Reach 4	51802	170	TO#11, Rec. Check & 42" gate	Replace w/ Sluice Gate	170	cfs Minimum	100000	each	100000
Reach 4	46554	105	TO#12, Rec. Check & 24" gate	Replace w/ Sluice Gate	105	cfs Minimum	100000	each	100000
Reach 5	41274	105	TO#13, Rec. Check & 36" gate	Replace w/ Sluice Gate	105	cfs Minimum	100000	each	100000
Reach 5	38658	105	TO#13.5 Rec. Check & 24" gate	Replace w/ Sluice Gate	105	cfs Minimum	100000	each	100000
Reach 5	36011	105	TO#14, Rec. Check & 42" gate	Replace w/ Sluice Gate	105	cfs Minimum	100000	each	100000
Radial Check Gates									
Reach 2	127453	285	Radial 2-10' gates	Sufficient Capacity					
Reach 2	115009	285	Radial 2-10' gates	Sufficient Capacity					
Reach 3	84411	275	TO #5 Radial Gate-2 8' gates	Sufficient Capacity					
Mass. Weirs									
Reach 1	197651	285	Station 01	Sufficient Capacity					
Reach 2	172153	285	Station 05	Sufficient Capacity					
Reach 4	72160	170	Station 27-last station	Sufficient Capacity					
Inclined Drops/Check Drops									
Reach 4	70745	590	7' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	68898	590	6' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	67590	590	7' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	66460	590	12' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	65042	590	5' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	63511	590	11' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	62307	590	7' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	60785	590	12' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	60472	590	10' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	58352	590	10' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	57040	590	3' Drop	Install check, stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 4	56345	590	10' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	55679	590	4' Drop	Install check, stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 4	55216	590	6' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	52835	590	9' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	51795	590	10' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	50250	590	3' Drop	Install check, stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 4	49219	590	9' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	48005	590	7' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	46324	520	3' Drop	Install check, stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 4	44085	520	6' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	41769	520	5' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 5	39563	520	4' Drop	Install check, stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 5	38141	520	8' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 5	36755	520	6' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 5	35977	520	8' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 5	33449	520	4' Drop	Install check, stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 5	32880	520	7' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000

(1) Costs do not include 20% for contingencies and 15% for engineering and administration

Table A-2
Estimated Capital Costs(1)
Modify Beardley Canal to Deliver a Minimum of 100,000 acre-feet per year in Addition to MWD Demands

	Station	Flow (cfs)	Description	Improvement Works	Quantity	Units	Unit Cost	Units	Cost
Canal Excavation									
Reach 1	200000-173041	370	Lake Pleasant to CAP Inlet	Excavate Rock, Soil Prep.	0 cu yards		\$ 12.00	cy	\$ -
Reach 2	172787-112485	365	CAP Inlet to Grand Ave	Excavate Rock, Soil Prep.	0 cu yards		\$ 12.00	cy	\$ -
Reach 3	112431-73082	355	Grand Ave to Cactus Rd.	Excavate, Soil Prep.	600 cu yards		\$ 5.00	cy	\$ 3,000
Reach 4	73062-41275	255	Cactus Rd. to Camelback	Excavate, Soil Prep.	103,800 cu yards		\$ 5.00	cy	\$ 519,000
Reach 5	41274-30802	185	Camelback to Thomas Rd.	Excavate, Soil Prep.	35,400 cu yards		\$ 5.00	cy	\$ 177,000
			Subtotal, Excavation		139,800 cu yards				\$ 699,000
Canal Lining - New Lining									
Reach 1	200000-173041	370	Lake Pleasant to CAP Inlet	Form placed & finished	0 sq. ft		\$ 2.50	sq. ft	\$ -
Reach 2	172787-112485	365	CAP Inlet to Grand Ave	Form placed & finished	0 sq. ft		\$ 2.50	sq. ft	\$ -
Reach 3	112431-73082	355	Grand Ave to Cactus Rd.	Form placed & finished	3700 sq. ft		\$ 2.50	sq. ft	\$ 9,250
Reach 4	73062-41275	255	Cactus Rd. to Camelback	Form placed & finished	656500 sq. ft		\$ 2.50	sq. ft	\$ 1,641,250
Reach 5	41274-30802	185	Camelback to Thomas Rd.	Form placed & finished	233500 sq. ft		\$ 2.50	sq. ft	\$ 583,750
			Subtotal, New Lining		893,700 sq. ft				\$ 2,234,250
Canal Lining - Increase Existing Lining Height									
Reach 1	200000-173041	370	Lake Pleasant to CAP Inlet	Increase existing	0 sq. ft		\$ 2.50	sq. ft	\$ -
Reach 2	172787-112485	365	CAP Inlet to Grand Ave	Increase existing	803 sq. ft		\$ 2.50	sq. ft	\$ 2,007
Reach 3	112431-73082	355	Grand Ave to Cactus Rd.	Increase existing	11274 sq. ft		\$ 2.50	sq. ft	\$ 28,185
Reach 4	73062-41275	255	Cactus Rd. to Camelback	Increase existing	0 sq. ft		\$ 2.50	sq. ft	\$ -
Reach 5	41274-30802	185	Camelback to Thomas Rd.	Increase existing	0 sq. ft		\$ 2.50	sq. ft	\$ -
			Subtotal, New Lining		12,077 sq. ft				\$ 30,192
Structures									
Bridges									
Reach 1	197473	370	Lake Rd.	Sufficient Capacity					
Reach 1	185472	370	Cowtown	Sufficient Capacity					
Reach 2	114520	365	163rd	Sufficient Capacity					
Reach 3	90563	355	Bell	Replace with siphon	280 cu yds		\$ 700	cu yd	\$ 196,000
Reach 3	84479	355	Greenway	Enlarge canal under bridge	see excavation				
Canal Box Culverts/Siphons									
Reach 2	141387	365	10x10 Siphon 1	Sufficient Capacity					
Reach 2	132048	365	10x10 Siphon 2	Sufficient Capacity					
Reach 2	127855	365	10x10 Siphon 3	Sufficient Capacity					
Reach 2	114282	365	8x18 - Grand Ave box culvert	Sufficient Capacity					
Reach 3	112430	355	10x10 Siphon @ TO#1	Sufficient Capacity					
Reach 3	109365	355	12x12 - McMicken Siphon	Sufficient Capacity					
Reach 3	96647	355	8x8 Siphon below TO#3	Sufficient Capacity					
Reach 4	70740	255	5x5 Siphon below TO#7	Remove Siphon	1 each		\$ 20,000	each	\$ 20,000
Reach 4	65027	255	6x6 Siphon below TO#8	Sufficient Capacity					
Reach 4	64800	255	does not currently exist	Add Siphon	70 cu yds		\$ 700	cu yd	\$ 49,000
Reach 4	55206	255	5x5 Siphon below TO#10	Remove Siphon	1 each		\$ 20,000	each	\$ 20,000
Reach 4	46475	185	4.4x4.4 Siphon below TO#12	Enlarge Siphon	70 cu yds		\$ 700	cu yd	\$ 49,000
Reach 5	36051	185	5.5x8- Indian School box culvert	Enlarge, lower Culvert	20 cu yds		\$ 700	cu yd	\$ 14,000
CMP Culverts									
Reach 2	114443	365	Double Barrel @ 8' Dia-SFRR	Sufficient Capacity					
Reach 4	67670	255	5' Dia at TO#8	Remove	1 each		\$ 20,000	each	\$ 20,000
Reach 4	62413	255	6' Dia at Olive Ave, TO#9	Replace	45 cu yds		\$ 700	cu yd	\$ 31,500
Reach 4	57117	255	5' Dia at Northern Ave, TO#10	Replace	30 cu yds		\$ 700	cu yd	\$ 21,000
Flumes									
Reach 1	175304.9	370	Flume #1 - Agua Fria	Sufficient Capacity					
Reach 2	157469	365	Flume #2 (pipe) 10" ID Steel	Sufficient Capacity					
Reach 2	154080	365	Flume #3 (pipe) 10" ID Steel	Sufficient Capacity					
Reach 2	147581	365	Flume #4 (pipe) 10" ID Steel	Sufficient Capacity					
Unchecked Lat. Turnout Gates									
Reach 2	168203	365	18" Bard TO	Sufficient Capacity					
Reach 2	112797	365	TO #1	Sufficient Capacity					
Reach 3	104988	355	TO#2	Sufficient Capacity					
Reach 3	93836	355	TO#3.5	Sufficient Capacity					
Reach 3	81772	355	TO#5.03	Sufficient Capacity					
Rect. Check Gates w. Turnouts									
Reach 3	101801	355	TO#3 Rec. Check & 36" gate	Sufficient Capacity					
Reach 3	90639	355	TO#4 Rec. Check & 48" gate	Sufficient Capacity					
Reach 3	79013	355	TO#6 Rec. Check & 42" gate	Sufficient Capacity					
Reach 4	73059	255	TO#7 Rec. Check & 48" gate	Sufficient Capacity, fix inop. gates					
Reach 4	67647	255	TO#8, CMP & 24" gate	Replace w/ Radial	:255	cfs minimum	100000	each	\$ 100,000
Reach 4	62366	255	TO#9, Rec. Check & 24" gate	Replace w/ Radial	:255	cfs minimum	100000	each	\$ 100,000
Reach 4	57083	255	TO#10, Rec. Check & 48" gate	Replace w/ Radial	:255	cfs minimum	100000	each	\$ 100,000
Reach 4	51802	255	TO#11, Rec. Check & 42" gate	Replace w/ Radial	:255	cfs minimum	100000	each	\$ 100,000
Reach 4	46554	185	TO#12, Rec. Check & 24" gate	Replace w/ Sluice Gate	:185	cfs minimum	100000	each	\$ 100,000
Reach 5	41274	185	TO#13, Rec. Check & 36" gate	Replace w/ Sluice Gate	:185	cfs minimum	100000	each	\$ 100,000
Reach 5	38558	185	TO#13.5 Rec. Check & 24" gate	Replace w/ Sluice Gate	:185	cfs minimum	100000	each	\$ 100,000
Reach 5	36011	185	TO#14, Rec. Check & 42" gate	Replace w/ Sluice Gate	:185	cfs minimum	100000	each	\$ 100,000
Radial Check Gates									
Reach 2	127453	365	Radial 2-10' gates	Sufficient Capacity					
Reach 2	115009	365	Radial 2-10' gates	Sufficient Capacity					
Reach 3	84411	355	TO #5 Radial Gate-2 8' gates	Sufficient Capacity					
Meas. Weirs									
Reach 1	197651	370	Station 01	Sufficient Capacity					
Reach 2	172153	365	Station 05	Sufficient Capacity					
Reach 4	72160	255	Station 27-last station	Sufficient Capacity					
Inclined Drops/Check Drops									
Reach 4	70745	255	7' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	68898	255	6' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	67590	255	7' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	66460	255	12' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	65042	255	5' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	63511	255	11' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	62307	255	7' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	60785	255	12' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	60472	255	10' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	58352	255	10' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	57040	255	3' Drop	Install check, stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 4	56345	255	10 Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	55679	255	4' Drop	Install check, stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 4	55216	255	6' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	52835	255	9' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	51795	255	8' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	50250	255	4' Drop	Install check, stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 4	49219	255	9' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	48005	255	7' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	46324	185	3' Drop	Install check, stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 4	44085	185	6' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	41769	185	5' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 5	39563	185	4' Drop	Install check, stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 5	38141	185	8' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 5	36755	185	6' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 5	35977	185	8' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 5	33449	185	4' Drop	Install check, stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 5	32880	185	7' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000

(1) Costs do not include 20% for contingencies and 15% for engineering and administration

Table A-3
Estimated Capital Costs(1)
Modify Beardsley Canal to Deliver a Minimum of 150,000 acre-feet per year In Addition to MWD Demands

	Station	Flow (cfs)	Description	Improvement Works	Quantity	Units	Unit Cost	Units	Cost
Canal Excavation									
Reach 1	200000-173041	455	Lake Pleasant to CAP Inlet	Excavate Rock, Soil Prep.	6,000 cu yards		\$ 12.00 cy		\$ 72,000
Reach 2	172787-112465	450	CAP Inlet to Grand Ave	Excavate Rock, Soil Prep.	500 cu yards		\$ 12.00 cy		\$ 6,000
Reach 3	112431-73082	440	Grand Ave to Cactus Rd.	Excavate, Soil Prep.	2,500 cu yards		\$ 5.00 cy		\$ 12,500
Reach 4	73062-41275	340	Cactus Rd. to Camelback	Excavate, Soil Prep.	209,700 cu yards		\$ 5.00 cy		\$ 1,048,500
Reach 5	41274-30802	270	Camelback to Thomas Rd.	Excavate, Soil Prep.	62,400 cu yards		\$ 5.00 cy		\$ 312,000
			Subtotal, Excavation		281,100 cu yards				\$ 1,451,000
Canal Lining - New Lining									
Reach 1	200000-173041	455	Lake Pleasant to CAP Inlet	Form placed & finished	4400 sq. ft		\$ 2.50 sq. ft		\$ 11,000
Reach 2	172787-112465	450	CAP Inlet to Grand Ave	Form placed & finished	1200 sq. ft		\$ 2.50 sq. ft		\$ 3,000
Reach 3	112431-73082	440	Grand Ave to Cactus Rd.	Form placed & finished	79100 sq. ft		\$ 2.50 sq. ft		\$ 197,750
Reach 4	73062-41275	340	Cactus Rd. to Camelback	Form placed & finished	987700 sq. ft		\$ 2.50 sq. ft		\$ 2,469,250
Reach 5	41274-30802	270	Camelback to Thomas Rd.	Form placed & finished	329100 sq. ft		\$ 2.50 sq. ft		\$ 822,750
			Subtotal, New Lining		1,401,500 sq. ft				\$ 3,503,750
Canal Lining - Increase Existing Lining Height									
Reach 1	200000-173041	455	Lake Pleasant to CAP Inlet	Increase existing	0 sq. ft		\$ 2.50 sq. ft		\$ -
Reach 2	172787-112465	450	CAP Inlet to Grand Ave	Increase existing	2300 sq. ft		\$ 2.50 sq. ft		\$ 5,750
Reach 3	112431-73082	440	Grand Ave to Cactus Rd.	Increase existing	20000 sq. ft		\$ 2.50 sq. ft		\$ 50,000
Reach 4	73062-41275	340	Cactus Rd. to Camelback	Increase existing	1500 sq. ft		\$ 2.50 sq. ft		\$ 3,750
Reach 5	41274-30802	270	Camelback to Thomas Rd.	Increase existing	0 sq. ft		\$ 2.50 sq. ft		\$ -
			Subtotal, New Lining		23,800 feet2				\$ 59,500
Structures									
Bridges									
Reach 1	197473	455	Lake Rd.	Sufficient Capacity					
Reach 1	185472	455	Cowtown	Sufficient Capacity					
Reach 2	114520	450	163rd	Sufficient Capacity					
Reach 3	90563	440	Bell Rd.	Replace with siphon	530 cu yds		\$ 700 cu yd		\$ 371,000
Reach 3	84479	440	Greenway	Enlarge canal under bridge	see excavation				
Canal Box Culverts/Siphons									
Reach 2	141387	450	10x10 Siphon 1	Sufficient Capacity					
Reach 2	132048	450	10x10 Siphon 2	Sufficient Capacity					
Reach 2	127855	450	10x10 Siphon 3	Sufficient Capacity					
Reach 2	114282	450	8x18 - Grand Ave box culvert	Sufficient Capacity					
Reach 3	112430	440	10x10 Siphon TO#1	Sufficient Capacity					
Reach 3	109365	440	12x12 - McMicken Siphon	Sufficient Capacity					
Reach 3	96647	440	8x8 Siphon below TO#3	Sufficient Capacity			\$ 20,000 each		\$ -
Reach 4	70740	340	5x5 Siphon below TO#7	Remove Siphon	1 each		\$ 20,000 each		\$ 20,000
Reach 4	65027	340	6x6 Siphon below TO#8	Remove Siphon	1 each		\$ 20,000 each		\$ 20,000
Reach 4	64800	340	does not currently exist	Add Siphon	140 cu yds		\$ 700 cu yd		\$ 98,000
Reach 4	55206	340	5x5 Siphon below TO#10	Remove Siphon	1 each		\$ 20,000 each		\$ 20,000
Reach 4	46475	270	4.4x4.4 Siphon below TO#12	Enlarge Siphon	80 cu yds		\$ 700 cu yd		\$ 56,000
Reach 5	36051	270	5.5x8 - Indian School box culvert	Enlarge Culvert	20 cu yds		\$ 700 cu yd		\$ 14,000
CMP Culverts									
Reach 2	114443	450	Double Barrel 8' Dia-SFRR	Sufficient Capacity					
Reach 4	67670	340	5' Dia at TO#8	Remove	1 each		\$ 20,000 each		\$ 20,000
Reach 4	62413	340	6' Dia at Olive Ave, TO#9	Replace	100 cu yds		\$ 700 cu yd		\$ 70,000
Reach 4	57117	340	5' Dia at Northern Ave, TO#10	Replace	55 cu yds		\$ 700 cu yd		\$ 38,500
Flumes									
Reach 1	175304.9	455	Flume #1 - Agua Fria	Replace	1485 lin ft		\$ 400 ft		\$ 594,000
Reach 2	157469	450	Flume #2 (pipe) 10" ID Steel	Sufficient Capacity					
Reach 2	154080	450	Flume #3 (pipe) 10' ID Steel	Sufficient Capacity					
Reach 2	147581	450	Flume #4 (pipe) 10' ID Steel	Sufficient Capacity					
Unchecked Lat. Turnout Gates									
Reach 2	168203	450	18" Bard TO	Sufficient Capacity					
Reach 2	112797	450	TO #1	Modify Check Structure	10 cu yds		\$ 700 cu yd		\$ 7,000
Reach 3	104988	440	TO#2	Sufficient Capacity					
Reach 3	93836	440	TO#3.5	Sufficient Capacity					
Reach 3	81772	440	TO#5.03	Sufficient Capacity					
Rect. Check Gates w. Turnouts									
Reach 3	101801	440	TO#3 Rec. Check & 36" gate	Sufficient Capacity					
Reach 3	90639	440	TO#4 Rec. Check & 48" gate	Sufficient Capacity					
Reach 3	79013	440	TO#6 Rec. Check & 42" gate	Sufficient Capacity					
Reach 4	73059	340	TO#7 Rec. Check & 48" gate	Sufficient Capacity					
Reach 4	67647	340	TO#8, CMP & 24" gate	Replace w/ Radial	340	cfs minimum	120000 each		\$ 120,000
Reach 4	62366	340	TO#9, Rec. Check & 24" gate	Replace w/ Radial	340	cfs minimum	120000 each		\$ 120,000
Reach 4	57083	340	TO#10, Rec. Check & 48" gate	Replace w/ Radial	340	cfs minimum	120000 each		\$ 120,000
Reach 4	51802	340	TO#11, Rec. Check & 42" gate	Replace w/ Radial	340	cfs minimum	120000 each		\$ 120,000
Reach 4	46554	270	TO#12, Rec. Check & 24" gate	Replace w/ Radial	270	cfs minimum	100000 each		\$ 100,000
Reach 5	41274	270	TO#13, Rec. Check & 36" gate	Replace w/ Radial	270	cfs minimum	100000 each		\$ 100,000
Reach 5	38658	270	TO#13.5 Rec. Check & 24" gate	Replace w/ Radial	270	cfs minimum	100000 each		\$ 100,000
Reach 5	36011	270	TO#14, Rec. Check & 42" gate	Replace w/ Radial	270	cfs minimum	100000 each		\$ 100,000
Radial Check Gates									
Reach 2	127453	450	Radial 2-10' gates	Sufficient Capacity					
Reach 2	115009	450	Radial 2-10' gates	Sufficient Capacity					
Reach 3	84411	440	TO #5 Radial Gate-2 8' gates	Sufficient Capacity					
Meas. Weirs									
Reach 1	197651	455	Station 01	Sufficient Capacity					
Reach 2	172153	450	Station 05	Sufficient Capacity					
Reach 4	72160	340	Station 27-last station	Replace/enlarge	10	cu yds	\$ 700 cu yd		\$ 7,000
Inclined Drops/Check Drops									
Reach 4	70745	340	7' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 4	68898	340	6' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 4	67590	340	7' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 4	66460	340	12' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 4	65042	340	5' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 4	63511	340	11' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 4	62307	340	7' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 4	60785	340	12' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 4	60472	340	10' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 4	58352	340	10' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 4	57040	340	3' Drop	Install check, stilling pool	1	each	\$ 20,000 each		\$ 20,000
Reach 4	56345	340	10 Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 4	55679	340	4' Drop	Install check, stilling pool	1	each	\$ 20,000 each		\$ 20,000
Reach 4	55216	340	6' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 4	52835	340	9' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 4	51795	340	8' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 4	50250	340	4' Drop	Install check, stilling pool	1	each	\$ 20,000 each		\$ 20,000
Reach 4	49219	340	9' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 4	48005	340	7' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 4	46324	270	3' Drop	Install check, stilling pool	1	each	\$ 20,000 each		\$ 20,000
Reach 4	44085	270	6' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 4	41769	270	5' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 5	39563	270	4' Drop	Install check, stilling pool	1	each	\$ 20,000 each		\$ 20,000
Reach 5	38141	270	8' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 5	36755	270	6' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 5	35977	270	8' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000
Reach 5	33449	270	4' Drop	Install check, stilling pool	1	each	\$ 20,000 each		\$ 20,000
Reach 5	32880	270	7' Drop	Install check, stilling pool	1	each	\$ 50,000 each		\$ 50,000

(1) Costs do not include 20% for contingencies and 15% for engineering and administration

Table A-4
Estimated Capital Costs(1)
Modify Beardsley Canal to Deliver a Minimum of 200,000 acre-feet per year In Addition to MWD Demands

	Station	Flow (cfs)	Description	Improvement Works	Quantity	Units	Unit Cost	Units	Cost
Canal Excavation									
Reach 1	200000-173041	535	Lake Pleasant to CAP Inlet	Excavate Rock/Fill & Prep	6,000	cu yards	\$ 12.00	cy	\$ 72,000
Reach 2	172787-112465	530	CAP Inlet to Grand Ave	Excavate Rock/Fill & Prep	28,400	cu yards	\$ 12.00	cy	\$ 316,800
Reach 3	112431-73082	520	Grand Ave to Cactus Rd.	Excavate/Fill & Prep	4,100	cu yards	\$ 5.00	cy	\$ 20,500
Reach 4	73062-41275	420	Cactus Rd. to Camelback	Excavate/Fill & Prep	212,100	cu yards	\$ 5.00	cy	\$ 1,060,500
Reach 5	41274-30802	350	Camelback to Thomas Rd.	Excavate/Fill & Prep	62,400	cu yards	\$ 5.00	cy	\$ 312,000
			Subtotal, Excavation		311,000	cu yards			\$ 1,781,800
Canal Lining - New Lining									
Reach 1	200000-173041	535	Lake Pleasant to CAP Inlet	Form placed & finished	4600	sq. ft	\$ 2.50	sq. ft	\$ 11,500
Reach 2	172787-112465	530	CAP Inlet to Grand Ave	Form placed & finished	672200	sq. ft	\$ 2.50	sq. ft	\$ 1,680,500
Reach 3	112431-73082	520	Grand Ave to Cactus Rd.	Form placed & finished	87900	sq. ft	\$ 2.50	sq. ft	\$ 219,750
Reach 4	73062-41275	420	Cactus Rd. to Camelback	Form placed & finished	1000500	sq. ft	\$ 2.50	sq. ft	\$ 2,501,250
Reach 5	41274-30802	350	Camelback to Thomas Rd.	Form placed & finished	330800	sq. ft	\$ 2.50	sq. ft	\$ 827,000
			Subtotal, New Lining		2,096,000	feet ²			\$ 5,240,000
Canal Lining - Increase Existing Lining Height									
Reach 1	200000-173041	535	Lake Pleasant to CAP Inlet	Increase existing	0	sq. ft	\$ 2.50	sq. ft	\$ -
Reach 2	172787-112465	530	CAP Inlet to Grand Ave	Increase existing	5400	sq. ft	\$ 2.50	sq. ft	\$ 13,500
Reach 3	112431-73082	520	Grand Ave to Cactus Rd.	Increase existing	44000	sq. ft	\$ 2.50	sq. ft	\$ 110,000
Reach 4	73062-41275	420	Cactus Rd. to Camelback	Increase existing	0	sq. ft	\$ 2.50	sq. ft	\$ -
Reach 5	41274-30802	350	Camelback to Thomas Rd.	Increase existing	0	sq. ft	\$ 2.50	sq. ft	\$ -
			Subtotal, New Lining		49,400	sq. ft			\$ 123,500
Structures									
Bridges									
Reach 1	197473	535	Lake Rd.	Sufficient Capacity					
Reach 1	185472	535	Cowtown	Sufficient Capacity					
Reach 2	114520	520	163rd	Sufficient Capacity					
Reach 3	90563	420	Bell	Replace with siphon	700	cu yds	\$ 700	cu yd	\$ 490,000
Reach 3	84479	420	Greenway	Enlarge canal under bridge	see excavation				
Canal Box Culverts/Siphons									
Reach 2	141387	530	10x10 Siphon 1	Sufficient Capacity					
Reach 2	132048	530	10x10 Siphon 2	Sufficient Capacity					
Reach 2	127855	530	10x10 Siphon 3	Sufficient Capacity					
Reach 2	114282	530	8x18 - Grand Ave box culvert	Sufficient Capacity					
Reach 3	112430	520	10x10 Siphon TO#1	Sufficient Capacity					
Reach 3	109365	520	12x12 - McMicken Siphon	Sufficient Capacity					
Reach 3	96647	520	8x8 Siphon below TO#3	Remove Siphon	1	each	\$ 20,000	each	\$ 20,000
Reach 4	70740	420	5x5 Siphon below TO#7	Remove Siphon	1	each	\$ 20,000	each	\$ 20,000
Reach 4	65027	420	6x6 Siphon below TO#8	Remove Siphon	1	each	\$ 20,000	each	\$ 20,000
Reach 4	64800	420	does not currently exist	Add Siphon	200	cu yds	\$ 700	cu yd	\$ 140,000
Reach 4	55206	420	5x5 Siphon below TO#10	Remove Siphon	1	each	\$ 20,000	each	\$ 20,000
Reach 4	46475	350	4.4x4.4 Siphon below TO#12	Enlarge Siphon	98	cu yds	\$ 700	cu yd	\$ 68,600
Reach 5	36051	350	5.5x8 - Indian School box culvert	Enlarge, lower Culvert	22	cu yds	\$ 700	cu yd	\$ 15,400
CMP Culverts									
Reach 2	114443	530	Double Barrel @ 8' Dia-SFRF	Sufficient Capacity					
Reach 4	67670	420	5' Dia at TO#8	Remove	1	each	\$ 20,000	each	\$ 20,000
Reach 4	62413	420	6' Dia at Olive Ave, TO#9	Replace	120	cu yds	\$ 700	cu yd	\$ 84,000
Reach 4	57117	420	5' Dia at Northern Ave, TO#10	Replace	70	cu yds	\$ 700	cu yd	\$ 49,000
Flumes									
Reach 1	175304.9	535	Flume #1 - Agua Fria	Replace	1485	lin ft	\$ 500	ft	\$ 742,500
Reach 2	157469	530	Flume #2 (pipe) 10' ID Steel	Sufficient Capacity					
Reach 2	154080	530	Flume #3 (pipe) 10' ID Steel	Sufficient Capacity					
Reach 2	147581	530	Flume #4 (pipe) 10' ID Steel	Sufficient Capacity					
Unchecked Lat. Turnout Gates									
Reach 2	168203	530	18" Bard TO	Sufficient Capacity					
Reach 2	112797	530	TO #1	Modify Check Structure	10	cu yds	\$ 700	cu yd	\$ 7,000
Reach 3	104988	520	TO#2	Sufficient Capacity					
Reach 3	93838	520	TO#3.5	Sufficient Capacity					
Reach 3	81772	520	TO#5.03	Sufficient Capacity					
Rect. Check Gates w. Turnouts									
Reach 3	101801	520	TO#3 Rec. Check & 36" gate	Sufficient Capacity					
Reach 3	90639	520	TO#4 Rec. Check & 48" gate	Sufficient Capacity					
Reach 3	79013	520	TO#6 Rec. Check & 42" gate	Sufficient Capacity					
Reach 4	73059	420	TO#7 Rec. Check & 48" gate	Sufficient Capacity					
Reach 4	67647	420	TO#8, CMP & 24" gate	Replace w/ Radial	420	cfs minimum	150000	each	150000
Reach 4	62366	420	TO#9, Rec. Check & 24" gate	Replace w/ Radial	420	cfs minimum	150000	each	150000
Reach 4	57083	420	TO#10, Rec. Check & 48" gate	Replace w/ Radial	420	cfs minimum	150000	each	150000
Reach 4	51802	420	TO#11, Rec. Check & 42" gate	Replace w/ Radial	420	cfs minimum	150000	each	150000
Reach 4	46554	350	TO#12, Rec. Check & 24" gate	Replace w/ Radial	350	cfs minimum	125000	each	125000
Reach 5	41274	350	TO#13, Rec. Check & 36" gate	Replace w/ Radial	350	cfs minimum	125000	each	125000
Reach 5	38658	350	TO#13.5 Rec. Check & 24" gate	Replace w/ Radial	350	cfs minimum	125000	each	125000
Reach 5	36011	350	TO#14, Rec. Check & 42" gate	Replace w/ Radial	350	cfs minimum	125000	each	125000
Radial Check Gates									
Reach 2	127453	530	Radial 2-10' gates	Sufficient Capacity					
Reach 2	115009	530	Radial 2-10' gates	Sufficient Capacity					
Reach 3	84411	520	TO #5 Radial Gate-2 8' gates	Sufficient Capacity					
Meas. Weirs									
Reach 1	197651	535	Station 01	Sufficient Capacity					
Reach 2	172153	530	Station 05	Sufficient Capacity					
Reach 4	72160	420	Station 27-last station	Replace/enlarge	10	cu yds	\$ 300	ft	\$ 3,000
Inclined Drops/Check Drops									
Reach 4	70745	420	7' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	68898	420	6' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	67590	420	7' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	66460	420	12' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	65042	420	5' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	63511	420	11' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	62307	420	7' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	60785	420	12' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	60472	420	10' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	58352	420	10' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	57040	420	3' Drop	Install check,stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 4	56345	420	10' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	55679	420	4' Drop	Install check,stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 4	55216	420	6' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	52835	420	9' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	51795	420	8' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	50250	420	4' Drop	Install check,stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 4	49219	420	9' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	48005	420	7' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	46324	350	3' Drop	Install check,stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 4	44085	350	6' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	41769	350	5' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 5	39563	350	4' Drop	Install check,stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 5	38141	350	8' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 5	36755	350	6' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 5	35977	350	8' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 5	33449	350	4' Drop	Install check,stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 5	32880	350	7' Drop	Install check,stilling pool	1	each	\$ 50,000	each	\$ 50,000

(1) Costs do not include 20% for contingencies and 15% for engineering and administration

**Table A-5
Estimated Capital Costs(1)
Modify Beardsley Canal to Deliver a Minimum of 300,000 acre-feet per year in Addition to MWD Demands**

	Station	Flow (cfs)	Description of Existing Item	Improvement Works	Quantity	Units	Unit Cost	Units	Cost
Canal Excavation									
Reach 1	200000-173041	705	Lake Pleasant to CAP Inlet	Excavate Rock, Soil Prep.	221,800	cu yards	\$ 12.00	cy/rock	\$ 2,661,800
Reach 2	172787-112465	700	CAP Inlet to Grand Ave	Excavate Rock, Soil Prep.	261,400	cu yards	\$ 12.00	cy/rock	\$ 3,136,800
Reach 3	112431-73082	690	Grand Ave to Cactus Rd.	Excavate, Soil Prep.	135,300	cu yards	\$ 5.00	cy/normal	\$ 676,500
Reach 4	73062-41275	590	Cactus Rd. to Camelback	Excavate, Soil Prep.	296,600	cu yards	\$ 5.00	cy/normal	\$ 1,483,000
Reach 5	41274-30802	520	Camelback to Thomas Rd.	Excavate, Soil Prep.	88,400	cu yards	\$ 5.00	cy/normal	\$ 442,000
			Subtotal, Excavation		1,003,500	cu yards			\$ 8,399,900
Canal Lining - New Lining									
Reach 1	200000-173041	705	Lake Pleasant to CAP Inlet	Form placed & finished	2337600	sq. ft	\$ 2.50	sq. ft	\$ 5,844,000
Reach 2	172787-112465	700	CAP Inlet to Grand Ave	Form placed & finished	6085200	sq. ft	\$ 2.50	sq. ft	\$ 15,213,000
Reach 3	112431-73082	690	Grand Ave to Cactus Rd.	Form placed & finished	2870800	sq. ft	\$ 2.50	sq. ft	\$ 7,177,000
Reach 4	73062-41275	590	Cactus Rd. to Camelback	Form placed & finished	1176900	sq. ft	\$ 2.50	sq. ft	\$ 2,942,250
Reach 5	41274-30802	520	Camelback to Thomas Rd.	Form placed & finished	381400	sq. ft	\$ 2.50	sq. ft	\$ 953,500
			Subtotal, New Lining		12,851,900	feet2			\$ 32,129,750
Structures									
Bridges									
Reach 1	197473	705	Lake Rd.	Enlarge Canal Under Bridge	see excavation				
Reach 1	185472	705	Cowtown	Enlarge Canal Under Bridge	see excavation				
Reach 2	114520	700	163rd	Replace w/ siphon	75 ft		\$ 950	ft	\$ 71,250
Reach 3	90563	690	Bell	Raise/Replace Bridge	5840 sq. ft		\$ 65	sq. ft	\$ 379,800
Reach 3	84479	690	Greenway	Enlarge Canal Under Bridge	see excavation				
Canal Box Culverts/Siphons									
Reach 2	141387	700	10x10 Siphon 1	Sufficient Capacity					
Reach 2	132048	700	10x10 Siphon 2	Sufficient Capacity					
Reach 2	127855	700	10x10 Siphon 3	Sufficient Capacity					
Reach 2	114282	700	8x18 - Grand Ave box culvert	Sufficient Capacity					
Reach 3	112430	690	10x10 Siphon TO#1	Sufficient Capacity					
Reach 3	109365	690	12x12 - McMicken Siphon	Sufficient Capacity					
Reach 3	96647	690	8x8 Siphon below TO#3	Remove Siphon	1 each		\$ 20,000	each	\$ 20,000
Reach 4	70740	590	5x5 Siphon below TO#7	Remove Siphon	1 each		\$ 20,000	each	\$ 20,000
Reach 4	65027	590	6x6 Siphon below TO#8	Remove Siphon	1 each		\$ 20,000	each	\$ 20,000
Reach 4	64800	590	does not currently exist	Add Siphon	200 cu yds		\$ 700	cu yd	\$ 140,000
Reach 4	55206	590	5x5 Siphon below TO#10	Remove Siphon	1 each		\$ 20,000	each	\$ 20,000
Reach 4	46475	520	4.4x4.4 Siphon below TO#12	Enlarge, lower Culvert	200 cu yds		\$ 700	cu yd	\$ 140,000
Reach 5	36051	520	5.5x8 - Indian School box culvert	Enlarge, lower Culvert	85 cu yds		\$ 700	cu yd	\$ 59,500
CMP Culverts									
Reach 2	114443	700	Double Barrel 8' Dia-SFRR	Replace w/ pipe (Bore)	60 ft		\$ 5,400	ft	\$ 324,000
Reach 4	67670	590	5' Dia at TO#8	Remove	1 each		\$ 20,000	each	\$ 20,000
Reach 4	62413	590	6' Dia at Olive Ave, TO#9	Enlarge, lower Culvert	120 cu yds		\$ 700	cu yd	\$ 84,000
Reach 4	57117	590	5' Dia at Northern Ave, TO#10	Enlarge, lower Culvert	75 cu yds		\$ 700	cu yd	\$ 52,500
Flumes									
Reach 1	175304.9	705	Flume #1 - Agua Fria	Replace w/ Siphon	1485 lin ft		\$ 480	ft	\$ 712,800
Reach 2	157469	700	Flume #2 (pipe) 10'ID Steel	Replace w/ Siphon	600 lin ft		\$ 580	ft	\$ 348,000
Reach 2	154080	700	Flume #3 (pipe) 10' ID Steel	Replace w/ Siphon	540 lin ft		\$ 580	ft	\$ 313,200
Reach 2	147581	700	Flume #4 (pipe) 10' ID Steel	Replace w/ Siphon	460 lin ft		\$ 580	ft	\$ 266,800
Unchecked Lat. Turnout Gates									
Reach 2	168203	700	18" Bard TO	Sufficient Capacity					
Reach 2	112797	700	TO#1	Modify Check Structure	10 cu yds		\$ 700	cu yd	\$ 7,000
Reach 3	104988	690	TO#2	Sufficient Capacity					
Reach 3	93836	690	TO#3.5	Sufficient Capacity					
Reach 3	81772	690	TO#5.03	Sufficient Capacity					
Rect. Check Gates w. Turnouts									
Reach 3	101801	690	TO#3 Rec. Check & 36" gate	Replace w/ Radial	690	cfs minimu	\$ 250,000	each	\$ 250,000
Reach 3	90639	690	TO#4 Rec. Check & 48" gate	Replace w/ Radial	690	cfs minimu	\$ 250,000	each	\$ 250,000
Reach 3	79013	690	TO#6 Rec. Check & 42" gate	Replace w/ Radial	690	cfs minimu	\$ 250,000	each	\$ 250,000
Reach 4	73059	590	TO#7 Rec. Check & 48" gate	Replace w/ Radial	590	cfs minimu	\$ 200,000	each	\$ 200,000
Reach 4	67647	590	TO#8, CMP & 24" gate	Replace w/ Radial	590	cfs minimu	\$ 200,000	each	\$ 200,000
Reach 4	62366	590	TO#9, Rec. Check & 24" gate	Replace w/ Radial	590	cfs minimu	\$ 200,000	each	\$ 200,000
Reach 4	57083	590	TO#10, Rec. Check & 48" gate	Replace w/ Radial	590	cfs minimu	\$ 200,000	each	\$ 200,000
Reach 4	51802	590	TO#11, Rec. Check & 42" gate	Replace w/ Radial	590	cfs minimu	\$ 200,000	each	\$ 200,000
Reach 4	46554	520	TO#12, Rec. Check & 24" gate	Replace w/ Radial	520	cfs minimu	\$ 180,000	each	\$ 180,000
Reach 5	41274	520	TO#13, Rec. Check & 36" gate	Replace w/ Radial	520	cfs minimu	\$ 180,000	each	\$ 180,000
Reach 5	38658	520	TO#13.5 Rec. Check & 24" gate	Replace w/ Radial	520	cfs minimu	\$ 180,000	each	\$ 180,000
Reach 5	36011	520	TO#14, Rec. Check & 42" gate	Replace w/ Radial	520	cfs minimu	\$ 180,000	each	\$ 180,000
Radial Check Gates									
Reach 2	127453	700	Radial 2-10' gates	Sufficient Capacity					
Reach 2	115009	700	Radial 2-10' gates	Sufficient Capacity					
Reach 3	84411	690	TO #5 Radial Gate-2 8' gates	Replace w/ Radial	690	cfs minimu	\$ 250,000	each	\$ 250,000
Meas. Weirs									
Reach 1	197651	705	Station 01	Sufficient Capacity					
Reach 2	172153	700	Station 05	Replace	10	cu yds	\$ 700	cu yd	\$ 7,000
Reach 4	72160	590	Station 27-last station	Replace	10	cu yds	\$ 700	cu yd	\$ 7,000
Inclined Drops/Check Drops									
Reach 4	70745	590	7' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	68898	590	8' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	67590	590	7' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	66460	590	12' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	65042	590	5' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	63511	590	11' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	62307	590	7' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	60785	590	12' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	60472	590	10' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	58352	590	10' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	57040	590	3' Drop	Install check, stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 4	56345	590	10 Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	55679	590	4' Drop	Install check, stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 4	55216	590	8' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	52835	590	9' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	51795	590	8' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	50250	590	4' Drop	Install check, stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 4	49219	590	9' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	48005	590	7' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	46324	520	3' Drop	Install check, stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 4	44085	520	8' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 4	41769	520	5' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 5	39563	520	4' Drop	Install check, stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 5	38141	520	8' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 5	36755	520	6' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 5	35977	520	8' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000
Reach 5	33449	520	4' Drop	Install check, stilling pool	1	each	\$ 20,000	each	\$ 20,000
Reach 5	32880	520	7' Drop	Install check, stilling pool	1	each	\$ 50,000	each	\$ 50,000

(1) Costs do not include 20% for contingencies and 15% for engineering and administration