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**Flood Control District
Of
Maricopa County**

VALUE ENGINEERING

**McMICKEN DAM FISSURE RISK ZONE
REMEDATION PROJECT
PREFERRED ALTERNATIVE ANALYSIS**

March 25 & 26, 2003

**FINAL REPORT
APRIL 10, 2003**

Prepared by:

SiteTek
Financial Arts

Contract No. 2002C006
Assignment No. 2

**SUBJECT: MC MICKEN DAM FISSURE RISK ZONE
REMEDATION PROJECT
PREFERRED ALTERNATIVE ANALYSIS**

DATES: March 25 & 26, 2003

TEAM LEADER: John Pucetas – SiteTek Financial Arts

TEAM MEMBERS: Jon Benoist - ADWR
Larry Hansen – Sr. VP, AMEC
Chuck Gopperton – Hydrology / Hydraulics, Stantec
Ralph Weeks – Geologist, AMEC
George Sabol – Hydrology / Hydraulics, Stantec
Bobbie Ohler – Project Manager, FCDMC
Larry Lambert – Project Manager Dam Safety, FCDMC
Tom Renckly – Structure Branch Manager, FCDMC
Shiva Shivaswamy – Construction Manager, FCDMC
Mike Greenslade – Dam Safety Engineer, FCDMC
Bob Stevens – Environmental Planner, FCDMC
George Beckwith – Geotechnical Engineer, FCDMC

DESIGN PRESENTATION BY:

Ralph Weeks – Geologist, AMEC
Larry Hansen – Sr. VP, AMEC

DOCUMENTS USED: Alternatives Analysis Memorandum
Alternative Development and Initial Screening
McMicken Dam Fissure Risk Zone Remediation Project
Contract FCD 2002C011, Work Assignment No. 1
Prepared by: AMEC Earth & Environmental, Inc.
Dated: 20 December 2002

Alternatives Analysis Memorandum
Alternative Development and Secondary Screening
McMicken Dam Fissure Risk Zone Remediation Project
Contract FCD 2002C011, Work Assignment No. 1
Prepared by: AMEC Earth & Environmental, Inc.
Dated: 28 January 2003

Revised 15% Cost Estimate for Alternatives
Distributed at Workshop, March 26, 2003

Risk Analysis – McMicken Dam Fissure Risk Zone
Remediation Project, by reference during Workshop

Executive Summary:

Introduction:

- The Flood Control District of Maricopa County has commissioned SiteTek Financial Arts, Inc. to facilitate a Preferred Alternative Analysis Study for the McMicken Dam Fissure Zone Remediation Project. This is assignment number 2 under the On-Call Value Engineering Services Contract FCD 2002C006 dated June 10, 2002.
- This analysis is based on previous work completed by AMEC Earth & Environmental, Inc. and Stantec Consulting, Inc. Prior studies indicate that there is a high probability that earth fissures are present beneath portions of the McMicken Dam due to subsidence, consolidation and straining of the soils. Zones of High and Moderate Hazard have been identified with further geotechnical studies continuing. These fissures have caused concern for the stability of the dam and the need to develop remediation alternatives.
- Primary Project Objective: Mitigate fissure risk to maintain / improve the existing level of flood protection.
- A process of alternative development, initial and secondary screening has been completed by AMEC. Approximately 24 alternatives were developed with 8 alternatives selected during the initial screening and four alternatives initially identified from the secondary screening for the Preferred Alternative Analysis. Two general categories of alternatives were identified as follows:
 - Rehabilitation: modifications to prevent breaching of the dam due to seepage along or through an earth fissure
 - Abandonment / Segmentation: modifications to replace the function of the existing dam within the identified fissure risk zone of the dam

Component alternatives within each of these two categories included roller compacted concrete (RCC) or soil cement structures, earthen embankments and geomembrane materials to provide protection.

Preferred Alternative Process:

- This process has been documented by the Flood Control District of Maricopa County to be utilized as an analysis tool on capital projects. The Performance Criteria and Use of Evaluation Matrix document describes the process as follows:

A technique for identifying a proposed project's performance requirements, by determining the hierarchy of importance of its criteria elements, as they relate to the overall success of the project. It defines a baseline for project performance and expectations, that may include our project Partners, Customers and Stakeholders, in addition to our in-house Technical

Experts. The technique allows us to evaluate the effectiveness of various proposed planning or design alternatives and measure the aggregate effect of the alternatives relative to the project specific baseline performance expectations.”

Preferred Alternative Results:

Two separate matrices were completed to analyze the remediation of the High Hazard Zone (Stations 56+00 to 75+00) Matrix 1, and for the High & Moderate Zones combined (Stations 56+00 to 105+00) Matrix 2. This further analysis was completed in order to determine whether that additional scope would have any impact on the preferred alternative.

- Matrix 1: High Hazard Zone (Stations 56+00 to 75+00)
Preferred Alternative: 5C – R: RCC / Embankment Dam Extension with Upstream Diversions & Low Flow Channel
Estimated Cost: \$1,271,000
- Matrix 2: High & Moderate Hazard Zones (Stations 56+00 to 105+00)
Preferred Alternative: 5C – E / 3A: Embankment (Earthen) Dam Extension with Upstream Diversions & Low Flow Channel / Construct New Dam Section Upstream
Estimated Cost: \$2,637,000
- A further Sensitivity Analysis was conducted to determine whether the weightings given to the two risk criteria, Failure Consequences (10) and Possibility of Dam Failure (9) were over biasing the decision-making. The results of this analysis are as follows:
- Matrix 1 R: High Hazard Zone (Stations 56+00 to 75+00)
Preferred Alternative: 5C – E: Embankment (Earthen) Dam Extension with Upstream Diversions & Low Flow Channel
Estimated Cost: \$709,000
- Matrix 2 R: High & Moderate Zones (Stations 56+00 to 105+00)
Preferred Alternative: 5C – E / 3A: Embankment (Earthen) Dam Extension with Upstream Diversions & Low Flow Channel / Construct New Dam Section Upstream
Estimated Cost: \$2,637,000

Conclusions:

- The Preferred Alternative for the High Hazard Zone (Stations 56+00 to 75+00) is either Alternative 5C-R or 5C-E depending on the weighting of the Risk Criteria. Component structure selection of RCC vs. Earthen dam will be determined through budget development and value engineering.
- The Preferred Alternative for the High & Moderate Zones (Stations 56+00 to 105+00) is Alternative 5C – E / 3A regardless of the weighting of the Risk Criteria.

- The rankings were close for all of the alternatives considered and further analysis of the extent of the fissure zone is needed before a final alternative can be selected.
- Further value engineering of components including roller compacted concrete, soil cement, cement stabilized aggregate, cross section designs and the need for a geomembrane liner on the upstream face of the RCC may impact the total cost of the alternatives and possibly their final ranking.

Preferred Alternative Study Steps:

Study Objectives:

1. Select the preferred alternative - with consideration for construction issues / long-term monitoring
2. Identify major cost elements
3. Improve safety – manage risk
4. Identify follow-up issues – unknowns, assumptions
5. Establish a *logic trail* for alternative selection
6. Assure flexibility of the solution

Process Objective:

(Based on Performance Criteria and Use of Evaluation Matrix Standard provided by Flood Control District of Maricopa County)

“A technique for identifying a proposed project's performance requirements, by determining the hierarchy of importance of its criteria elements, as they relate to the overall success of the project. It defines a baseline for project performance and expectations, that may include our project Partners, Customers and Stakeholders, in addition to our in-house Technical Experts. The technique allows us to evaluate and rate a consultant's proposed level of effort (cost proposal) and provide a measurement tool for the effectiveness of various proposed planning or design alternatives and measure the aggregate effect of the alternatives relative to the project specific baseline performance expectations.”

- ✓ Step One - - Define Criteria
- ✓ Step Two - - Determine Hierarchy
- ✓ Step Three - - Identify Alternatives
- ✓ Step Four - - Evaluate Alternatives
- ✓ Step Five – Sensitivity Analysis

Step One – Define Criteria

Primary Project Objective:

Mitigate fissure risk to maintain / improve the existing level of flood protection.

Brainstorm Criteria:

1. Cost (initial)
2. Operating & Maintenance Cost (life-cycle)
3. Monitoring
4. Ease of repair
5. Protection against embankment piping
6. Risk (failure mode, consequences, dam safety risk, uncertainty)
7. Constructibility
8. Environmental Issues
9. Regulatory acceptance
10. QA / QC program (level of effort required during construction)
11. Long term reliability of components
12. Flood protection
13. Project Schedule – design and permitting, construction, funding
14. Compatibility
15. Flexibility
16. Ability to accommodate future changes
17. Aesthetics
18. Failure Consequences
19. Opportunities for additional benefits
20. Subsidence impacts
21. Ease of maintenance
22. Protect against embankment / foundation contact failure
23. Public involvement
24. Right-of-way
25. 404 Permitting
26. Recreation / Multi-use
27. Flood protection during construction

Criteria Refinement: Consolidation / Elimination / Definition

1. **Initial & Life-Cycle Costs** – including maintenance, repair and monitoring
2. **Probability of dam failure** – including protection against embankment piping, embankment / foundation failure, regulatory acceptance and reliability of components

3. Failure consequences

4. Constructibility – including QA / QC, variability of foundation conditions, construction modifications, flood protection during construction

5. Environmental impacts – need for 404 permit

6. Project schedule – including engineering and permitting timelines and funding availability

7. Flexibility – to accommodate future subsidence, future changes, multi-use & aesthetics and additional benefits

Step Two – Determine Hierarchy

Paired Comparison of Criteria

The following matrix is used to determine the relative importance of each of the criteria in relation to each other.

Criteria Scoring Matrix

Criteria:	Preference											
	A or	B	A or	C	A or	D	A or	E	A or	F	A or	G
A. Initial & Life Cycle Costs		3		3	2		2		2		2	
B. Probability of Dam Failure	B or	C	B or	D	B or	E	B or	F	B or	G		
		3		4		4		4		4		
C. Failure Consequences	C or	D	C or	E	C or	F	C or	G				
		4		4		4		4				
D. Constructibility	D or	E	D or	F	D or	G						
		1		1		2		3				
E. Environmental Impacts	E or	F	E or	G								
		2		3								
F. Flexibility	F or	G										
		2										
G. Project Schedule												

How Important: Major Preference = 4, Medium Preference = 3, Minor Preference = 2, No Preference Each = 1

Analysis Matrix

Criteria	A	B	C	D	E	F	G
Raw Score	6	19	22	1	1	4	10
Weight	3	9	10	1	1	2	5

Based on the paired comparison and weighted analysis the following is a summary of the hierarchy of the evaluation criteria. (with 10 as the highest and 1 the lowest)

- C. Failure Consequences - 10
- B. Probability of Dam Failure - 9
- G. Project Schedule - 5

- A. Initial & Life-Cycle Costs - 3
- F. Flexibility - 2
- E. Environmental Impacts – 1
- G. Constructibility - 1

Performance Criteria Measurements

In order to assess how each of the alternatives meets the criteria, a performance range of 1 – 5 has been established for each of the criteria with 1 being Poor and 5 Excellent.

1. Initial and Life-Cycle Costs

- 5. Very low initial cost / moderate maintenance cost
- 4. Low initial cost / moderate maintenance cost
- 3. Medium initial cost / low maintenance cost
- 2. Medium initial cost / moderate maintenance cost
- 1. High initial cost / moderate maintenance cost

2. Probability of Dam Failure

- 5. Very low
- 4. Low
- 3. Moderate
- 2. Significant
- 1. High

3. Failure Consequences

(assuming full build out downstream)

- 5. Insignificant / no Population At Risk (PAR)
- 4. Low economic loss / no PAR
- 3. Moderate economic loss / no PAR
- 2. Major economic loss / no PAR
- 1. Major economic loss / some PAR

4. Constructibility

5. No difficulty
4. Minor difficulty
3. Significant difficulty
2. Major difficulty
1. High degree of difficulty

5. Environmental Impacts

5. No impact
4. Some mitigation
3. Significant mitigation
2. Major mitigation
1. Complete EIS possibility

6. Flexibility

5. Highly flexible
4. Very flexible
3. Moderate
2. Low
1. Inflexible

7. Project Schedule

(rank based on anticipated duration of engineering, permitting and construction schedule with 5 being the shortest schedule and 1 the longest)

Step Two – Identify Alternatives

The following list of alternatives with associated preliminary cost estimates has been identified for further analysis based on the Alternative Development and Initial Screening of 20 December 2002 and the Alternative Development and Secondary Screening dated 28 January 2003.

In order to address the immediate needs of this project and also anticipate future alternatives for the remaining portions of the dam, two sets of alternatives were developed. Matrix 1 addresses the immediate need in the identified High Hazard zone from Stations 56+00 to 75+00. Matrix 2 addresses both the high and moderate hazard zone (Stations 56+00 to 105+00). The alternatives with associated preliminary construction costs are as follows:

Matrix 1 – Stations 56+00 to 75+00		
Alternative Description		Cost (\$1000s)
3A	Construct New Earthen Embankment Dam Section Upstream with Geomembrane Liner	\$1,225
5C-R	Construct RCC Dam Extension with Upstream Diversions & Low Flow Channel	\$1,271
5C-E	Construct Earthen Embankment Dam Extension with Geomembrane Liner and Construct Upstream Diversions & Low Flow Channel	\$709
3E	Construct New RCC Dam Section Upstream	\$2,356

Matrix 2 – Stations 56+00 to 105+00		
Alternative Description		Cost (\$1000s)
3A	Construct New Earthen Embankment Dam Section Upstream with Geomembrane Liner	\$3,153
5C-R / 3A	Construct RCC/Embankment Dam Extension with Upstream Diversions & Low Flow Channel (Sta. 56+00 to Sta. 75+00) and Construct New Earthen Embankment Dam Section Upstream (Sta. 75+00 to Sta. 105+00)	\$3,199
5C-E / 3A	Construct Earthen Embankment Dam Extension with Upstream Diversions & Low Flow Channel (Sta. 56+00 to Sta. 75+00) and Construct New Earthen Embankment Dam Section Upstream (Sta. 75+00 to Sta. 105+00)	\$2,637
5C-R / 3E	Construct RCC Dam Extension with Upstream Diversions & Low Flow Channel (Sta. 56+00 to Sta. 75+00) and Construct New RCC Dam Section Upstream (Sta. 75+00 to Sta. 105+00)	\$5,132
3E	Construct New RCC Dam Section Upstream	\$6,397

Step Four – Evaluate Alternatives

Matrix 1 – Stations 56+00 to 75+00

Criteria Scoring Matrix

Criteria:	Preference											
	A or	B	A or	C	A or	D	A or	E	A or	F	A or	G
A. Initial & Life Cycle Costs		3		3	2		2		2		2	
B. Probability of Dam Failure	B or	C	B or	D	B or	E	B or	F	B or	G		
		3		4		4		4		4		
C. Failure Consequences	C or	D	C or	E	C or	F	C or	G				
		4		4		4		4				
D. Constructibility	D or	E	D or	F	D or	G						
	1	1		2		3						
E. Environmental Impacts	E or	F	E or	G								
		2		3								
F. Flexibility	F or	G										
		2										
G. Project Schedule												

How Important: Major Preference = 4, Medium Preference = 3, Minor Preference = 2, No Preference Each = 1

Analysis Matrix

Criteria	A		B		C		D		E		F		G		Total
	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	
Alternatives:	Score	W. S.	Score	W. S.	Score	W. S.	Score	W. S.	Score	W. S.	Score	W. S.	Score	W. S.	
1. 3A	3	9	4	36	2	20	4	4	4	4	4	8	3	15	96
2. 5C - R	2	6	5	45	3	30	5	5	4	4	3	6	3	15	111
3. 5C-E	5	15	4	36	2	20	4	4	4	4	3	6	4	20	105
4. 3E	1	3	5	45	3	30	5	5	4	4	4	8	2	10	105

Score: See attached Performance Measurements for Criteria

Preferred Alternative:

5C – R: Construct RCC Dam Extension with Upstream Diversions & Low Flow Channel

Matrix 2 – Stations 56+00 to 105+00

Criteria Scoring Matrix

Criteria:	Preference											
	A or	B	A or	C	A or	D	A or	E	A or	F	A or	G
A. Initial & Life Cycle Costs		3		3		2		2		2		2
B. Probability of Dam Failure		3		4		4		4		4		4
C. Failure Consequences		4		4		4		4		4		4
D. Constructibility		1		1		2		3				
E. Environmental Impacts		2		3								
F. Flexibility		2										
G. Project Schedule												

How Important: Major Preference = 4, Medium Preference = 3, Minor Preference = 2, No Preference Each = 1

Analysis Matrix

Criteria	A		B		C		D		E		F		G		Total
	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	
1. 3A	4	12	4	36	2	20	4	4	4	4	4	8	3	15	99
2. 5C-R / 3A	4	12	4	36	2	20	4	4	4	4	3	6	2	10	92
3. 5C-E / 3A	5	15	4	36	2	20	4	4	4	4	3	6	4	20	105
4. 5C-R / 3E	2	6	5	45	3	30	5	5	4	4	3	6	1	5	101
5. 3E	1	3	5	45	3	30	5	5	4	4	4	8	1	5	100

Score: See attached Performance Measurements for Criteria

Preferred Alternative:

5C – E / 3A: Construct Earthen Embankment Dam Extension with Upstream Diversions & Low Flow Channel (Sta. 56+00 to Sta. 75+00) and Construct New Earthen Embankment Dam Section Upstream (Sta. 75+00 to Sta. 105+00)

Step Five – Sensitivity Analysis

The team questioned whether the weightings given to the two risk criteria, Failure Consequences (10) and Possibility of Dam Failure (9) were over biasing the decision making. In order to test this question, a revised matrix was developed with each of these criteria being given a weight of 5 each.

Matrix 1R – Stations 56+00 to 75+00

Criteria Scoring Matrix

Criteria:	Preference											
	A or	B	A or	C	A or	D	A or	E	A or	F	A or	G
A. Initial & Life Cycle Costs		3		3	2		2		2			2
B. Probability of Dam Failure	B or	C	B or	D	B or	E	B or	F	B or	G		
		3		4		4		4		4		
C. Failure Consequences	C or	D	C or	E	C or	F	C or	G				
		4		4		4		4				
D. Constructibility	D or	E	D or	F	D or	G						
	1	1		2		3						
E. Environmental Impacts	E or	F	E or	G								
		2		3								
F. Flexibility	F or	G										
		2										
G. Project Schedule												

How Important: Major Preference = 4, Medium Preference = 3, Minor Preference = 2, No Preference Each = 1

Analysis Matrix

Criteria	A		B		C		D		E		F		G		Total
	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	
Alternatives:	Score	W. S.	Score	W. S.	Score	W. S.	Score	W. S.	Score	W. S.	Score	W. S.	Score	W. S.	
1. 3A	3	9	4	20	2	10	4	4	4	4	4	8	3	15	70
2. 5C -R	2	6	5	25	3	15	5	5	4	4	3	6	3	15	76
3. 5C-E	5	15	4	20	2	10	4	4	4	4	3	6	4	20	79
4. 3E	1	3	5	25	3	15	5	5	4	4	4	8	2	10	70

Score: See attached Performance Measurements for Criteria

Preferred Alternative: 5C – E: Construct Earthen Embankment Dam Extension with Upstream Diversions & Low Flow Channel

Matrix 2R – Stations 56+00 to 105+00

Criteria Scoring Matrix

Criteria:	Preference											
	A or	B	A or	C	A or	D	A or	E	A or	F	A or	G
A. Initial & Life Cycle Costs		3		3	2		2		2			2
B. Probability of Dam Failure	B or	C	B or	D	B or	E	B or	F	B or	G		
C. Failure Consequences	C or	D	C or	E	C or	F	C or	G				
D. Constructibility	D or	E	D or	F	D or	G						
E. Environmental Impacts	E or	F	E or	G								
F. Flexibility	F or	G										
G. Project Schedule												

How Important: Major Preference = 4, Medium Preference = 3, Minor Preference = 2, No Preference Each = 1

Analysis Matrix

Criteria	A		B		C		D		E		F		G		Total
	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	Raw Score	Weight	
Alternatives:	Score	W. S.	Score	W. S.	Score	W. S.	Score	W. S.	Score	W. S.	Score	W. S.	Score	W. S.	
1. 3A	4	12	4	20	2	10	4	4	4	4	4	8	3	15	73
2. 5C-R / 3A	4	12	4	20	2	10	4	4	4	4	3	6	2	10	66
3. 5C-E / 3A	5	15	4	20	2	10	4	4	4	4	3	6	4	20	79
4. 5C-R / 3E	2	6	5	25	3	15	5	5	4	4	3	6	1	5	66
5. 3E	1	3	5	25	3	15	5	5	4	4	4	8	1	5	65

Score: See attached Performance Measurements for Criteria

Preferred Alternative:

5C – E / 3A: Construct Earthen Embankment Dam Extension with Upstream Diversions & Low Flow Channel (Sta. 56+00 to Sta. 75+00) and Construct New Earthen Embankment Dam Section Upstream (Sta. 75+00 to Sta. 105+00)

Additional Discussion

The following topics were discussed at the end of the workshop:

Waterfall Wash

- Evaluate the proposed solution for Waterfall Wash based on the 3A Alternative acknowledging that I may have a negative impact on the 5C alternatives.

RCC vs. Soil Cement (regarding all R options)

- It is the engineer's intent to utilize the native material to process a material that may be a hybrid that is closer to soil cement than roller compacted concrete,
- Additional testing of existing soils will need to be completed in order to determine grain size distribution to develop a specification for either soil cement, RCC or cement stabilized alluvium design.

Potential VE Suggestions for Structure Components

1. Delete geomembrane at the face of the RCC in Alternative 5C cross section
2. Evaluate erosion potential of the foundation soils to determine if cutoff depths can be reduced in depth, and/or if one cutoff can be deleted.
3. Modify shape/size of RCC and/or soil cement cross section for dam.
4. Determine ending station for RCC
5. For dam extension, determine where change in construction details can be made (single vs. double foundation cutoff).
6. Evaluate soils from the impoundment area for suitability in the use of RCC, soil cement, or CAA stabilized aggregate.
7. Identify borrow area – location, quantity, and method of borrow pit excavation will affect cost, permitting, aesthetics, etc.

Appendix

1. Attendance List
2. Preferred Alternative Study Agenda
3. Summary of Cost Estimates (Revised)
4. Concept Drawings & Sections
 - a. Alternative 3A – High Risk Zone
 - b. Alternative 3A – Moderate Risk Zone
 - c. Alternative 5C – RCC Dam Extension
 - d. Alternative 5C – Dam Extension
 - e. Alternative 5C – Diversion Channel Locations

ATTENDANCE LIST

Preferred Alternative & Value Engineering Workshop



Project: **Mc Micken Dam Fissure Risk Zone Remediation Project**

Location: **Phoenix, Arizona**

Date: **March 25 & 26, 2003**

PARTICIPANTS:

Name:	Job Function:	Organization/Address:	Phone/ Fax/ e-mail:
John Pucetas	Facilitator	SiteTek Financial Arts, Inc.	480-836-0594
		16010 Aspen Drive	480-836-0596
		Fountain Hills, AZ 85268	sitetek@earthlink.net
Jon Benoist		ADWR	602-417-2400 x-7191
		500 N. 3rd Street	
		Phoenix, AZ 85004	jmbenoist@adwr.state.az.us
Larry Lambert	Project Manager Dam Safety	Flood Control District	602-372-6110
		2801 W. Durango	602-506-8561
		Phoenix, AZ 85009	lkl@mail.maricopa.gov
Larry Hansen		AMEC Earth & Environmental, Inc.	
		3232 W. Virginia Ave.	
		Phoenix, AZ 85009	lawrence.hansen@amec.com
Tom Renckly	Structures Management Dam Safety	Flood Control District	602-506-8610
		2801 W. Durango	602-506-8561
		Phoenix, AZ 85009	trr@mail.maricopa.gov
Shiva Shivaswamy	Construction Manager	Flood Control District	602-506-4726
		2801 W. Durango	602-506-8561
		Phoenix, AZ 85009	hns@mail.maricopa.gov
Mike Greenslade	Dam Safety Engineer	Flood Control District	602-506-5426
		2801 W. Durango	602-506-8561
		Phoenix, AZ 85009	mdg@mail.maricopa.gov
Bob Stevens	Environmental Planner	Flood Control District	
		2801 W. Durango	
		Phoenix, AZ 85009	rbs@mail.maricopa.gov
Chuck Gopperton	Project Engineer Hydrology / Hydraulics	Stantec Consulting	602-707-4637
		8211 S. 48th Street	602-431-9562
		Phoenix, AZ 85044	cgopperton@stantec.com

ATTENDANCE LIST

Preferred Alternative & Value Engineering Workshop



Project: **Mc Micken Dam Fissure Risk Zone Remediation Project**

Location: **Phoenix, Arizona**

Date: **March 25 & 26, 2003**

PARTICIPANTS:

Name:	Job Function:	Organization/Address:	Phone/ Fax/ e-mail:
Ralph Weeks	Geologist	AMEC Earth & Environmental, Inc.	602-272-6848
		3232 W. Virginia Ave.	602-272-7239
		Phoenix, AZ 85009	ralph.weeks@amec.com
George Sabol	Hydrology / Hydraulics	Stantec Consulting	602-707-4635
		8211 S. 48th Street	602-431-9562
		Phoenix, AZ 85044	gsabol@stantec.com
George H. Beckwith	Geotechnical Engineer	Flood Control District	602-506-4603
		2801 W. Durango	
		Phoenix, AZ 85009	ghbeckwith@aol.com
Bobby Ohler	Project Manager	Flood Control District	
		2801 W. Durango	
		Phoenix, AZ 85009	

**PREFERRED ALTERNATIVE STUDY AGENDA
McMICKEN DAM FISSURE ZONE REMEDIATION**

March 24 – 25 , 2003

Flood Control District of Maricopa County
2801 West Durango Street, Phoenix
Operations Building Conference Room

DAY 1 – March 24, 2003

- 8:00 a.m. **INTRODUCTION TO STUDY**
(by VE Team Leader, John Pucetas, AIA, CVS)
- Welcome & Opening Remarks
 Team Member Introductions
 Objectives of Study
- 8:30 **PROJECT BRIEFING**
(by Stantec, FCDMC)
- Project Background
 Identification & Presentation of Alternatives
- 10:00 **BREAK**
- 10:15 **METHODOLOGY: PERFORMANCE CRITERIA & EVALUATION**
MATRIX
- Sample Matrix
 - Criteria Development
 - Paired Comparison
 - Performance Measures
- 11:00 **DEVELOP PERFORMANCE CRITERIA**
- Brainstorm Criteria
 Consolidation / Elimination
 Criteria Definition
- 12:00 **LUNCH**
- 1:00 **WEIGHTING PERFORMANCE CRITERIA**
- Paired Comparison
 Total Raw Scores
 Assign Weighting Factor (Normalize Scores)
- 3:00 **PERFORMANCE MEASUREMENTS FOR CRITERIA**

Definition of Performance Range from Poor (1) to Excellent (5)

5:00 ADJOURN

DAY 2 – March 25, 2003

8:00 a.m ALTERNATIVES ANALYSIS
Evaluation of Alternatives vs. Performance Criteria

10:00 BREAK

10:15 FINAL SCORING & RANKING
Sensitivity Analysis
Finalize Preferred Alternative

12:00 LUNCH

1:00 OPTIMIZATION OF PREFERRED ALTERNATIVE
Identification of Design Options

2:00 CONDUCT “MINI-VE” ON DESIGN OPTIONS
Advantages / Disadvantages
Constructability Issues
Maintenance Issues
Quantify Cost Impacts (if possible)

4:00 WRAP UP
Schedule for Draft & Final Report
Comments / Suggestions

5:00 ADJOURN

SUMMARY OF COST ESTIMATES

Alternative Description	Cost (\$1000s)
3A Construct New Dam Section US High Hazard Zone Stations 56+00 to 75+00	1,225
3A Construct New Dam Section US Moderate Hazard Zone Stations 75+00 to 105+00	1,928
5C RCC/Embankment Dam Extension with US Diversions & Low Flow Channel	1,271
5C Embankment Dam Extension with US Diversions & Low Flow Channel	709
3E Construct New RCC Dam Section US High Hazard Zone Stations 56+00 to 75+00	2,536
3A 3E Construct New RCC Dam Section US Moderate Hazard Zone Stations 75+00 to 105+00	3,861

Flood Control District of Maricopa County
 McMicken Dam FRZR Project
 Cost Estimates for Alternatives 3A (High Risk)

Estimated Structure/Modification Length (ft):

1900

ALT 3A (high)

Earthwork			Estimated Unit Cost (2002)	Sectional Area/Length	UNIT	Estimated Cost (\$)	Sectional Area/Length	UNIT	Estimated Cost (\$)	Sectional Area/Length	UNIT	Estimated Cost (\$)
A	Clear and Grub Sloped Surface	SY	\$ 0.10		LF	\$ -		LF	\$ -	117	LF	\$ 2,470
B	Excavation of Trenches (15 feet hard dig)	LF	\$ 3.50		No.	\$ -		No.	\$ -	2	No.	\$ 13,300
C	Provide and Place Flowable Fill	CY	\$ 35.00		SF	\$ -		SF	\$ -	60	SF	\$ 147,778
D	Mass Excavation	CY	\$ 0.75		SF	\$ -		SF	\$ -	970	SF	\$ 51,194
E	Mass Excavation of Slopes	CY	\$ 0.90		SF	\$ -		SF	\$ -	100	SF	\$ 6,333
F	Grading of Slopes	SY	\$ 0.64		LF	\$ -		LF	\$ -		LF	\$ -
G	Random Compacted Backfill	CY	\$ 1.25		SF	\$ -		SF	\$ -		SF	\$ -
H	Fill and Compact Fine Grained Buttress Material (over liner)	CY	\$ 2.75		SF	\$ -		SF	\$ -	272	SF	\$ 52,637
I	Fill and Compact Fine Grained Buttress Material (mass)	CY	\$ 2.00							1555	SF	\$ 220,259
J	Excavate Downstream Slope to 1:1	CY	\$ 1.25		SF	\$ -		SF	\$ -		SF	\$ -
K	RCC Section Downstream	CY	\$ 55.00		SF	\$ -		SF	\$ -		SF	\$ -
K.1	Cement (10% by weight)	TON	\$ 100.00			\$ -			\$ -			\$ -
L	Soil Cement Structure	CY	\$ 35.00		SF	\$ -		SF	\$ -		SF	\$ -
L.1	Cement (7% by weight)	TON	\$ 100.00			\$ -			\$ -			\$ -
Liner Materials			Estimated Unit Cost (2002)		UNIT	Estimated Cost (\$)		UNIT	Estimated Cost (\$)		UNIT	Estimated Cost (\$)
M	80 mil HDPE, 20 oz. NW Geotextile Supply and Install (v)	SF	\$ 2.00		LF	\$ -		LF	\$ -	30	LF	\$ 114,000
	80 mil HDPE, 20 oz. NW Geotextile Supply and Install (h)	SF	\$ 0.90		LF	\$ -		LF	\$ -	135		\$ 230,850
CONSTRUCTION SUBTOTAL:						\$ -		\$ -		\$ 838,822		
	Environmental Mitigation	AC	\$ 10,000.00		AC	\$ -		AC	\$ -	0	AC	\$ -
	Design and Construction Engineering	LS	15%			\$ -			\$ -			\$ 125,823
	Construction Staking and As-Builts	LS	2%			\$ -			\$ -			\$ 16,776
	Construction water & dust control	LS	1%			\$ -			\$ -			\$ 8,388
	Construction inspection & testing	LS	5%			\$ -			\$ -			\$ 41,941
	Mobilization	LS	3%			\$ -			\$ -			\$ 25,165
MOBILIZATION, PERMITS AND ENGINEERING SUBTOTAL:						\$ -		\$ -		\$ 218,094		
CONTINGENCY			20%			\$ -			\$ -			\$ 167,764
TOTAL						\$ -		\$ -		ALT 3A (high)	\$ 1,224,680	

**Flood Control District of Maricopa County
McMicken Dam FRZR Project
Cost Estimates for Alternatives 3A (Moderate Risk)**

Estimated Structure/Modification Length (ft):

3000

ALT 3A (moderate)

Earthwork			Estimated Unit Cost (2002)	Sectional Area/Length	UNIT	Estimated Cost (\$)	Sectional Area/Length	UNIT	Estimated Cost (\$)	Sectional Area/Length	UNIT	Estimated Cost (\$)
A	Clear and Grub Sloped Surface	SY	\$ 0.10		LF	\$ -		LF	\$ -	115	LF	\$ 3,833
B	Excavation of Trenches (15 feet hard dig)	LF	\$ 3.50		No.	\$ -		No.	\$ -	2	No.	\$ 21,000
C	Provide and Place Flowable Fill	CY	\$ 35.00		SF	\$ -		SF	\$ -	60	SF	\$ 233,333
D	Mass Excavation	CY	\$ 0.75		SF	\$ -		SF	\$ -	960	SF	\$ 80,000
E	Mass Excavation of Slopes	CY	\$ 0.90		SF	\$ -		SF	\$ -	100	SF	\$ 10,000
F	Grading of Slopes	SY	\$ 0.64		LF	\$ -		LF	\$ -		LF	\$ -
G	Random Compacted Backfill	CY	\$ 1.25		SF	\$ -		SF	\$ -		SF	\$ -
H	Fill and Compact Fine Grained Butress Material (over liner)	CY	\$ 2.75		SF	\$ -		SF	\$ -	265	SF	\$ 80,972
I	Fill and Compact Fine Grained Butress Material (mass)	CY	\$ 2.00							1560	SF	\$ 346,667
J	Excavate Downstream Slope to 1:1	CY	\$ 1.25		SF	\$ -		SF	\$ -		SF	\$ -
K	RCC Section Downstream	CY	\$ 55.00		SF	\$ -		SF	\$ -		SF	\$ -
K.1	Cement (10% by weight)	TON	\$ 100.00			\$ -			\$ -			\$ -
L	Soil Cement Structure	CY	\$ 35.00		SF	\$ -		SF	\$ -		SF	\$ -
L.1	Cement (7% by weight)	TON	\$ 100.00			\$ -			\$ -			\$ -
Liner Materials			Estimated Unit Cost (2002)									
M	80 mil HDPE, 20 oz. NW Geotextile Supply and Install (v)	SF	\$ 2.00		LF	\$ -		LF	\$ -	30	LF	\$ 180,000
	80 mil HDPE, 20 oz. NW Geotextile Supply and Install (h)	SF	\$ 0.90		LF	\$ -		LF	\$ -	135	LF	\$ 364,500
CONSTRUCTION SUBTOTAL:						\$ -		\$ -		\$ 1,320,306		
	Environmental Mitigation	AC	\$ 10,000.00		AC	\$ -		AC	\$ -	0	AC	\$ -
	Design and Construction Engineering	LS	15%			\$ -			\$ -			\$ 198,046
	Construction Staking and As-Builts	LS	2%			\$ -			\$ -			\$ 26,406
	Construction water & dust control	LS	1%			\$ -			\$ -			\$ 13,203
	Construction inspection & testing	LS	5%			\$ -			\$ -			\$ 66,015
	Mobilization	LS	3%			\$ -			\$ -			\$ 39,609
MOBILIZATION, PERMITS AND ENGINEERING SUBTOTAL:						\$ -		\$ -		\$ 343,279		
CONTINGENCY			20%			\$ -			\$ -			\$ 264,061
TOTAL						\$ -		\$ -		ALT 3A (moderate)		\$ 1,927,646

**Flood Control District of Maricopa County
McMicken Dam FRZR Project
Cost Estimates for Alternatives 5C-RCC Structure**

			5C-RCC	800	5C-Emb	700
			Sectional Area/Length	UNIT Estimated Cost (\$)	Sectional Area/Length	UNIT Estimated Cost (\$)
Earthwork						
A	Clear and Grub Sloped Surface	SY	73	LF \$ 649	55	LF \$ 428
B	Excavation of Trenches (15 feet hard dig)	LF	2	No. \$ 5,600	1	No. \$ 2,450
C	Provide and Place Flowable Fill	CY	60	SF \$ 62,222	30	SF \$ 27,222
D	Mass Excavation	CY	323	SF \$ 7,178	308	SF \$ 5,989
E	Mass Excavation of Slopes	CY	100	SF \$ 2,667	100	SF \$ 2,333
F	Grading of Slopes	SY		LF \$ -		LF \$ -
G	Random Compacted Backfill	CY	716	SF \$ 26,519	685	SF \$ 22,199
H	Fill and Compact Fine Grained Butress Material (over liner)	CY		SF \$ -		SF \$ -
I	Fill and Compact Fine Grained Butress Material (mass)	CY		SF \$ -		SF \$ -
J	Excavate Downstream Slope to 1:1	CY		SF \$ -		SF \$ -
K	RCC Section Downstream	CY	320	SF \$ 521,481		SF \$ -
L	Soil Cement Structure	CY		SF \$ -		SF \$ -
Liner Materials						
M	80 mil HDPE, 20 oz. NW Geotextile Supply and Install (v)	SF	50	LF \$ 80,000	15	LF \$ 21,000
	80 mil HDPE, 20 oz. NW Geotextile Supply and Install (h)	SF		LF \$ -		LF \$ -
CONSTRUCTION SUBTOTAL:						\$ 787,937
	Environmental Mitigation	AC			3	AC \$ 30,000
	Design and Construction Engineering	LS				\$ 118,191
	Construction Staking and As-Builts	LS				\$ 15,759
	Construction water & dust control	LS				\$ 7,879
	Construction inspection & Testing	LS				\$ 39,397
	Mobilization	LS				\$ 23,638
MOBILIZATION, PERMITS AND ENGINEERING SUBTOTAL:						\$ 234,864
CONTINGENCY			20%			\$ 157,587
TOTAL						5C \$ 1,180,388

**Flood Control District of Maricopa County
McMicken Dam FRZR Project
Cost Estimates for Alternatives 5C-Embankment**

			5C-Embankment		800		700			
	Earthwork	UNIT	Estimated Unit Cost (2002)	Sectional Area/Length	UNIT	Estimated Cost (\$)	Sectional Area/Length	UNIT	Estimated Cost (\$)	
A	Clear and Grub Sloped Surface	SY	\$ 0.10	94.5	LF	\$ 840	55	LF	\$ 428	
B	Excavation of Trenches (15 feet hard dig)	LF	\$ 3.50	2	No.	\$ 5,600	1	No.	\$ 2,450	
C	Provide and Place Flowable Fill	CY	\$ 35.00	60	SF	\$ 62,222	30	SF	\$ 27,222	
D	Mass Excavation	CY	\$ 0.75	745	SF	\$ 16,556	308	SF	\$ 5,989	
E	Mass Excavation of Slopes	CY	\$ 0.90	100	SF	\$ 2,667	100	SF	\$ 2,333	
F	Grading of Slopes	SY	\$ 0.64		LF	\$ -		LF	\$ -	
G	Random Compacted Backfill	CY	\$ 1.25		SF	\$ -	685	SF	\$ 22,199	
H	Fill and Compact Fine Grained Butress Material (over liner)	CY	\$ 2.75	216	SF	\$ 17,600		SF	\$ -	
I	Fill and Compact Fine Grained Butress Material (mass)	CY	\$ 2.00	1142	SF	\$ 67,674		SF	\$ -	
J	Excavate Downstream Slope to 1:1	CY	\$ 1.25		SF	\$ -		SF	\$ -	
K	RCC Section Downstream	CY	\$ 55.00		SF	\$ -		SF	\$ -	
L	Soil Cement Structure	CY	\$ 35.00		SF	\$ -		SF	\$ -	
			Estimated Unit Cost (2002)							
			Liner Materials							
M	80 mil HDPE, 20 oz. NW Geotextile Supply and Install (v)	SF	\$ 2.00	30	LF	\$ 48,000	15	LF	\$ 21,000	
	80 mil HDPE, 20 oz. NW Geotextile Supply and Install (h)	SF	\$ 0.90	139	LF	\$ 100,080	0	LF	\$ -	
CONSTRUCTION SUBTOTAL:									\$ 402,860	
	Environmental Mitigation	AC	\$ 10,000.00				3	AC	\$ 30,000	
	Design and Construction Engineering	LS	15%						\$ 60,429	
	Construction Staking and As-Builts	LS	2%						\$ 8,057	
	Construction water & dust control	LS	1%						\$ 4,029	
	Construction inspection & Testing	LS	5%						\$ 20,143	
	Mobilization	LS	3%						\$ 12,086	
MOBILIZATION, PERMITS AND ENGINEERING SUBTOTAL:									\$ 134,744	
CONTINGENCY			20%							\$ 80,572
TOTAL									5C \$ 618,175	

Flood Control District of Maricopa County
 McMicken Dam FRZR Project
 Cost Estimates for Alternatives 3E-RCC Structure (Moderate Risk)

				3E-RCC (Mod)		3000		
	UNIT	Estimated Unit Cost (2002)	Sectional Area/Length	UNIT	Estimated Cost (\$)	Sectional Area/Length	UNIT	Estimated Cost (\$)
Earthwork								
A	Clear and Grub Sloped Surface	SY	\$ 0.10	LF	\$ -	90	LF	\$ 3,000
B	Excavation of Trenches (15 feet hard dig)	LF	\$ 3.50	No.	\$ -	2	No.	\$ 21,000
C	Provide and Place Flowable Fill	CY	\$ 35.00	SF	\$ -	30	SF	\$ 116,667
D	Mass Excavation	CY	\$ 0.75	SF	\$ -	350	SF	\$ 29,167
E	Mass Excavation of Slopes	CY	\$ 0.90	SF	\$ -	100	SF	\$ 10,000
F	Grading of Slopes	SY	\$ 0.64	LF	\$ -		LF	\$ -
G	Random Compacted Backfill	CY	\$ 1.25	SF	\$ -		SF	\$ -
H	Fill and Compact Fine Grained Buttress Material (over liner)	CY	\$ 2.75	SF	\$ -		SF	\$ -
I	Fill and Compact Fine Grained Buttress Material (mass)	CY	\$ 2.00	SF	\$ -		SF	\$ -
J	Excavate Downstream Slope to 1:1	CY	\$ 1.25	SF	\$ -		SF	\$ -
K	RCC Section Downstream	CY	\$ 55.00	SF	\$ -	345	SF	\$ 2,108,333
L	Soil Cement Structure	CY	\$ 35.00	SF	\$ -		SF	\$ -
Liner Materials								
M	80 mil HDPE, 20 oz. NW Geotextile Supply and Install (v)	SF	\$ 2.00	LF	\$ -	56	LF	\$ 336,000
	80 mil HDPE, 20 oz. NW Geotextile Supply and Install (h)	SF	\$ 0.90	LF	\$ -		LF	\$ -
CONSTRUCTION SUBTOTAL:								\$ 2,624,167
Environmental Mitigation	AC	\$ 10,000.00				3	AC	\$ 30,000
Design and Construction Engineering	LS	15%						\$ 393,625
Construction Staking and As-Builts	LS	2%						\$ 52,483
Construction water & dust control	LS	1%						\$ 26,242
Construction inspection & Testing	LS	5%						\$ 131,208
Mobilization	LS	3%						\$ 78,725
MOBILIZATION, PERMITS AND ENGINEERING SUBTOTAL:								\$ 712,283
CONTINGENCY								\$ 524,833
TOTAL								3E \$ 3,861,283

**Flood Control District of Maricopa County
McMicken Dam FRZR Project**

Alternative 5C - Segment Dam
Reconnaissance Level Design

Engineers Estimate
Prepared March 20, 2003

DESCRIPTION	QTY	UNIT	UNIT PRICE	AMOUNT
Excavation, Channel, Low Flow	2900	CY	\$2.00	\$5,800
Excavation, Channel, Low Level Drain	5600	CY	\$2.00	\$11,200
Embankment, Channel Berm	300	CY	\$4.00	\$1,200
Riprap, Dumped	250	CY	\$35.00	\$8,750
Pipe, 36 inch RGRCP, Class V	120	LF	\$75.00	\$9,000
Sand Diaphragm	440	CY	\$30.00	\$13,200
Filter Fabric	440	SY	\$2.00	\$880
Headwall, 36 inch	2	EA	\$2,000.00	\$4,000
Hydroseed	385600	SF	\$0.05	\$19,280
CONSTRUCTION SUBTOTAL				\$55,110
Design and Construction Engineering	15%	LS	\$8,267	\$8,267
Construction Staking and As-Builts	2%	LS	\$1,102	\$1,102
Construction water & dust control	1%	LS	\$551	\$551
Construction inspection, testing, quality control	5%	LS	\$2,756	\$2,756
NPDES/SWPPP Permit	1	LS	\$10,000	\$10,000
Mobilization	3%	LS	\$1,653	\$1,653
MOBILIZATION, PERMITS AND ENGINEERING SUBTOTAL				\$24,329
20%		CONTINGENCY		\$11,022
Right of Way	0	SF	\$0.50	\$0
TOTAL				\$90,500

Notes:

1. Doesn't include construction of dam extensions
2. Doesn't include dam rehabilitation or lowering of dam

**Flood Control District of Maricopa County
McMicken Dam FRZR Project**

Alternative 5C - Segment Dam
Reconnaissance Level Design

Engineers Estimate Details
Prepared March 20, 2003

Prepared by: cvg

Checked by:

Revisions

Excavation, Channel, Low Flow

added

Length	Bot width	Top width	Avg depth	Avg area	side slope	Excavation
800	8.00	40.00	4.00	96.00	4 :1	2,900

Total excavation 2,900 cubic yards

Embankment, Channel Berm

assume 10% of excavation quantity 300.00 cubic yards

added

Excavation, Channel, Low Level Drain

added

Length	Bot width	Top width	Avg depth	Avg area	side slope	Excavation
1,800	20.00	36.00	2.00	56.00	4 :1	3,800
400	20.00	48.00	3.50	119.00	4 :1	1,800

Total excavation 5,600 cubic yards

Riprap, Dumped

location	number	length	width	thickness	quant riprap
low flow channel	2	30	30	2	130
pipe inlet	2	20	20	2	60
pipe outlet	2	20	20	2	60
total					250

added

Pipe, 36 inch RGRCP, Class V

Length 120 ft 1 each

shortened

Sand Diaphragm

location	Length	Width	Height	Area	Total Volume (CY)
outlet pipe	120	10.0	10.0	100.00	440

shortened

**Flood Control District of Maricopa County
McMicken Dam FRZR Project**

Alternative 5C - Segment Dam
Reconnaissance Level Design

Engineers Estimate Details
Prepared March 20, 2003

Prepared by: cvg

Checked by:

Revisions

Filter Fabric

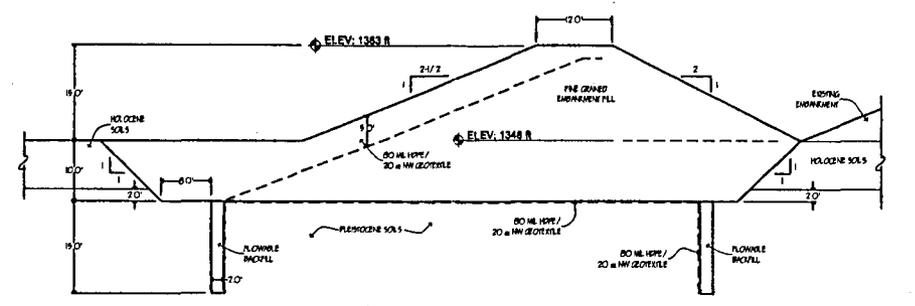
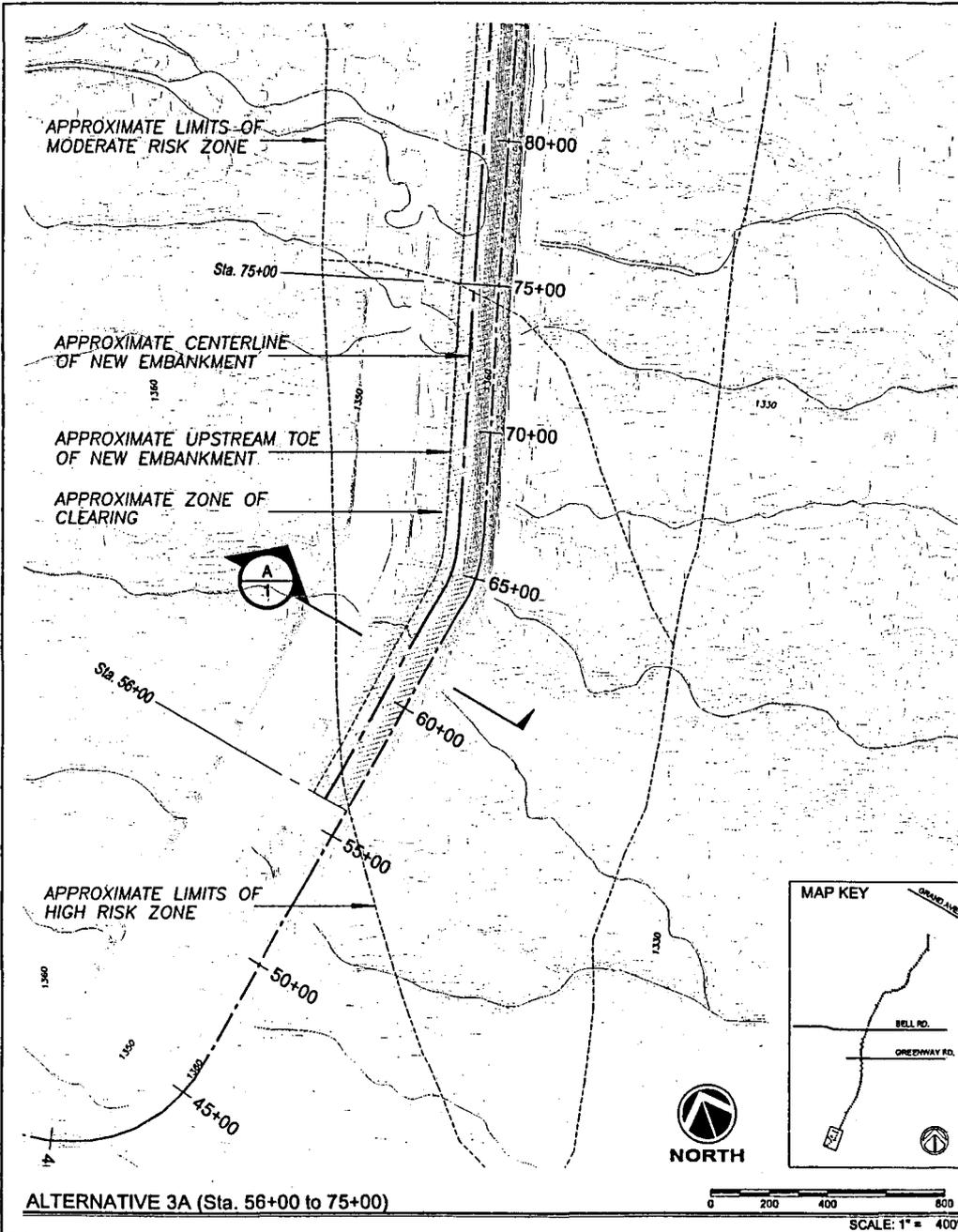
location	length	width	number	Area (sf)	
low flow channel	34	34	2	2312	added
headwalls	20	20	4	1,600	
Total				3,912	sf
				440	sy

Headwall, 36 inch

2 ea

Hydroseed

location	length	width	number	Area	
low level drain channel	1800	36	1	259200	added
low level drain channel	400	48	1	76800	added
low flow channel	800	60	1	48000	added
around headwalls	20	20	4	1,600	
Total				385,600	square feet



ALTERNATIVE 3A - NEW UPSTREAM EMBANKMENT

0 10 20 40
SCALE: 1" = 20'

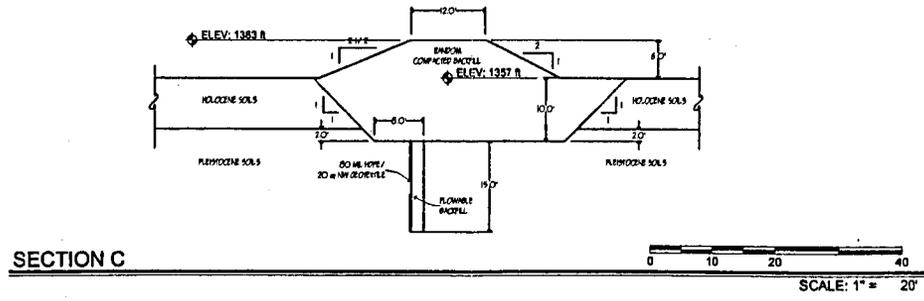
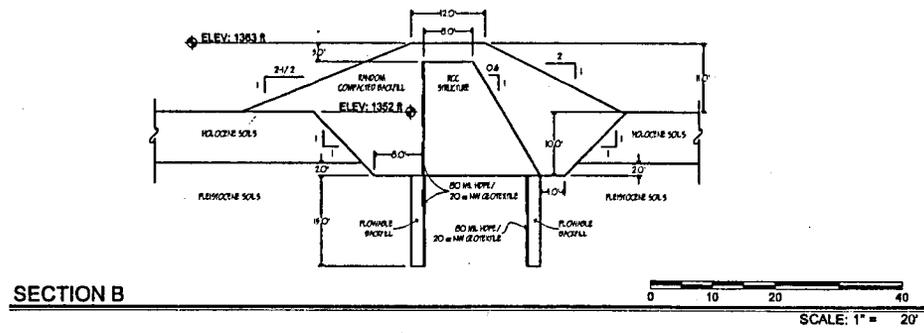
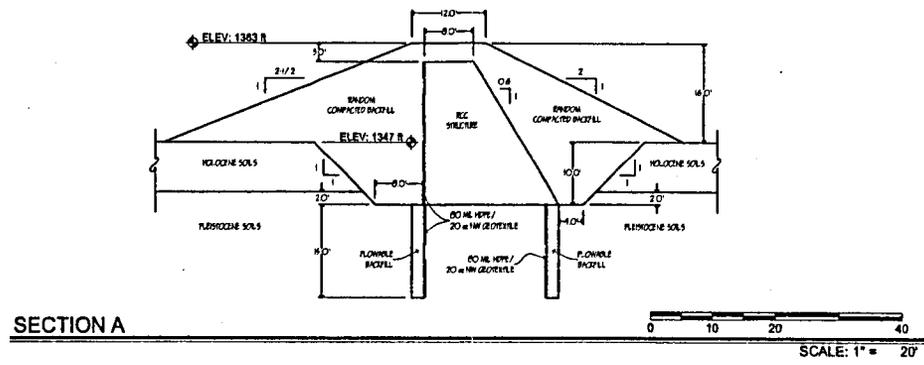
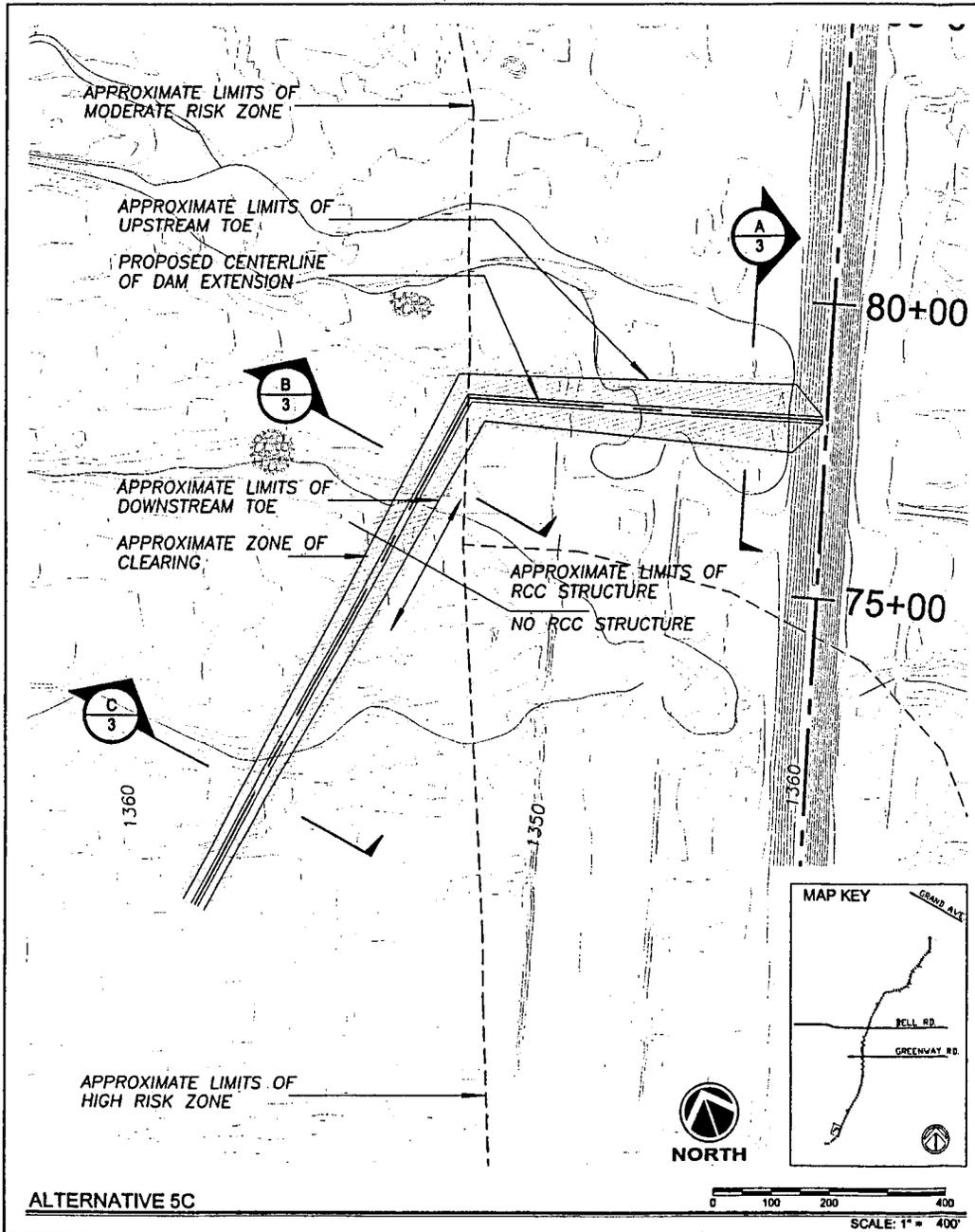
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 DRAWN: EHS
 DATE: MARCH 2003
 SCALE: AS SHOWN

ALTERNATIVE 3A - HIGH RISK ZONE
 Station 56+00 to 75+00

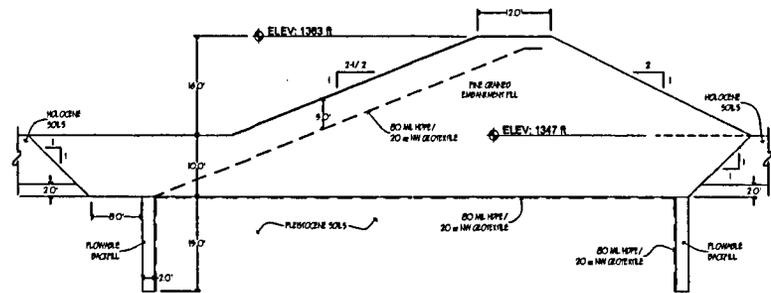
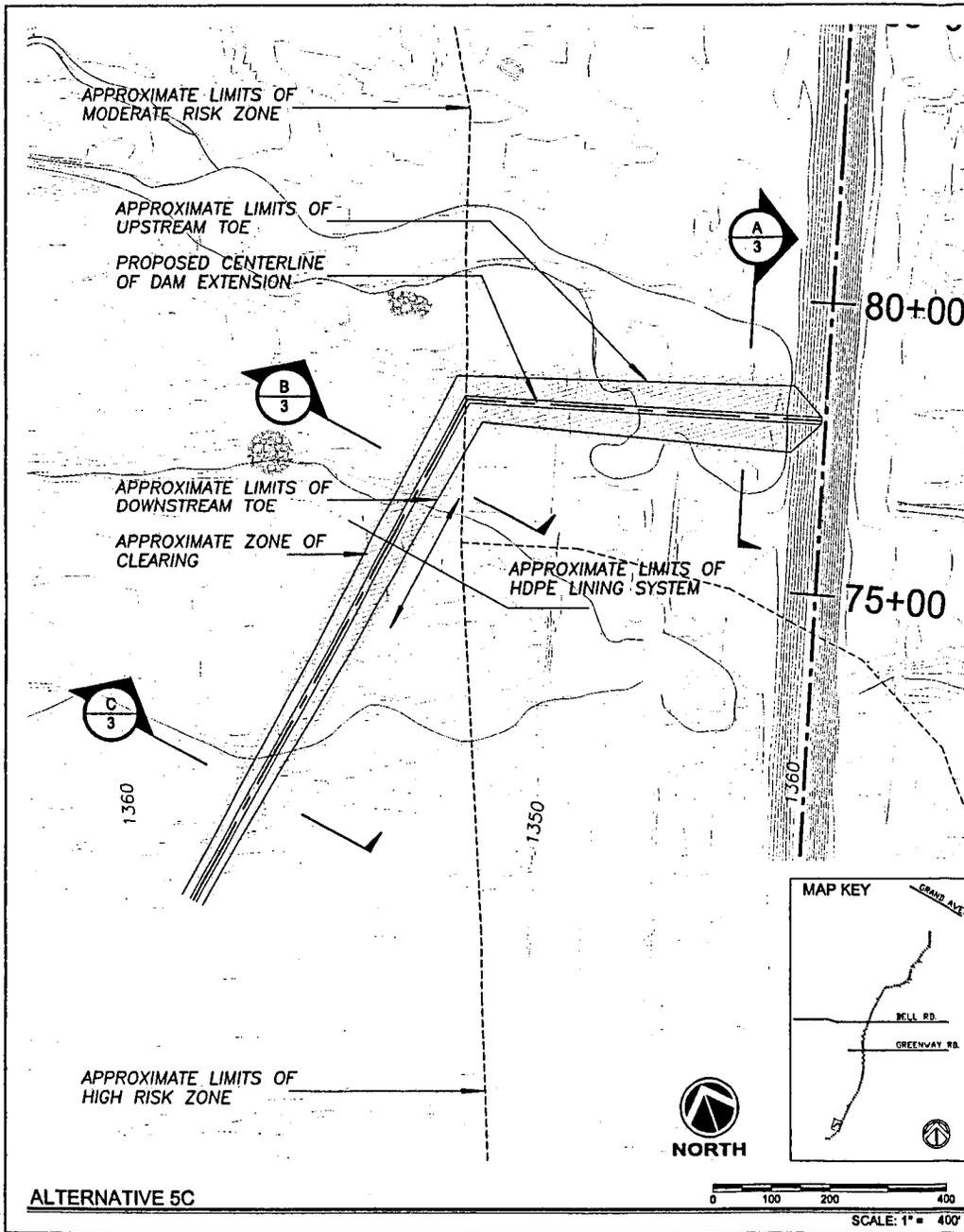
McMICKEN DAM FRZR PROJECT
 FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
 CONTRACT FCD 2002C011, WORK ASSIGNMENT NO. 1

FIGURE
1

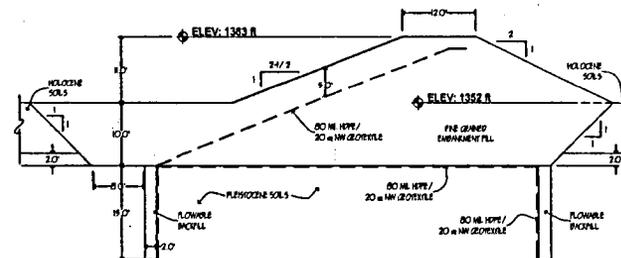
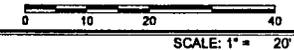




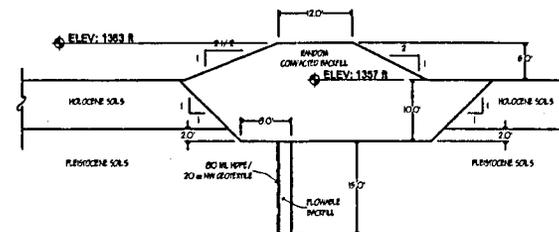
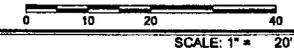
JOB NO. 2-117-001068	ALTERNATIVE 5C RCC DAM EXTENSION	FIGURE 3	
DESIGN: LAH	McMICKEN DAM FRZR PROJECT FLOOD CONTROL DISTRICT OF MARICOPA COUNTY CONTRACT FCD 2002CO11, WORK ASSIGNMENT NO. 1		
DRAWN: EHS			
DATE: MARCH 2003			
SCALE: AS SHOWN			



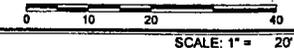
SECTION A



SECTION B



SECTION C



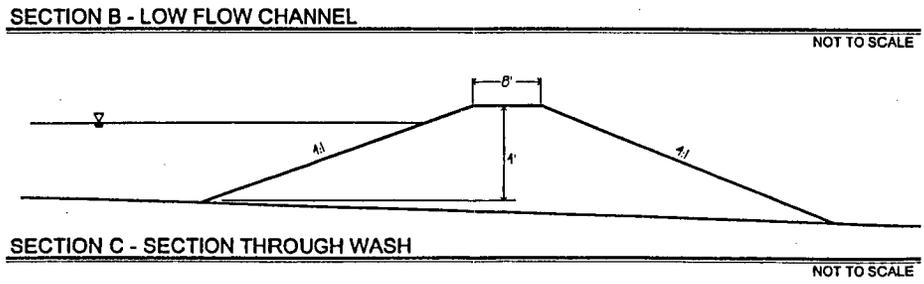
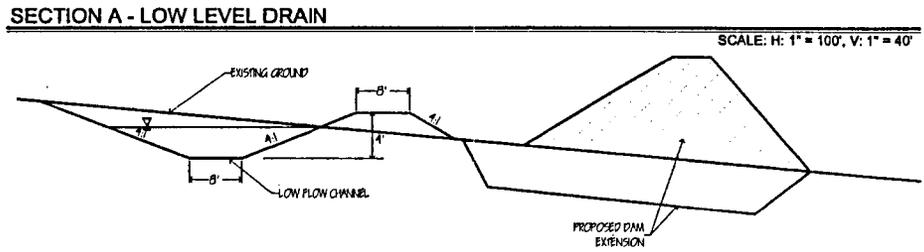
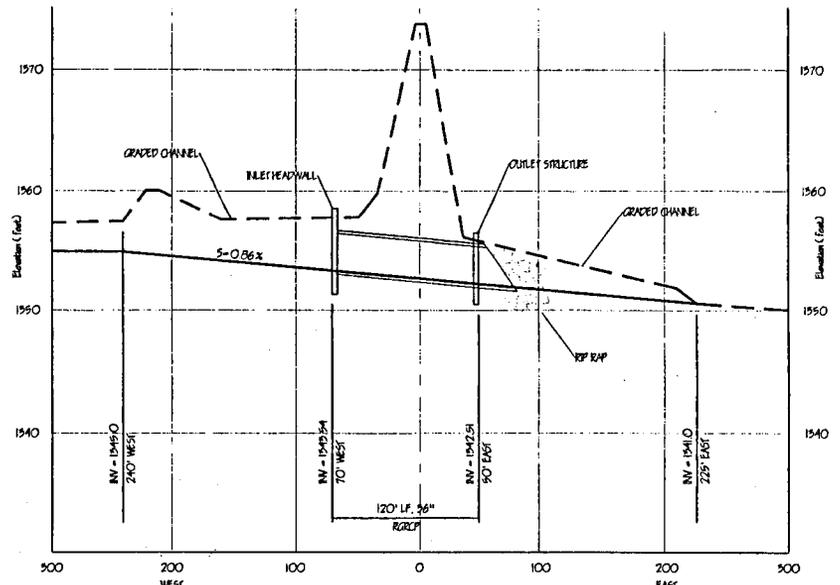
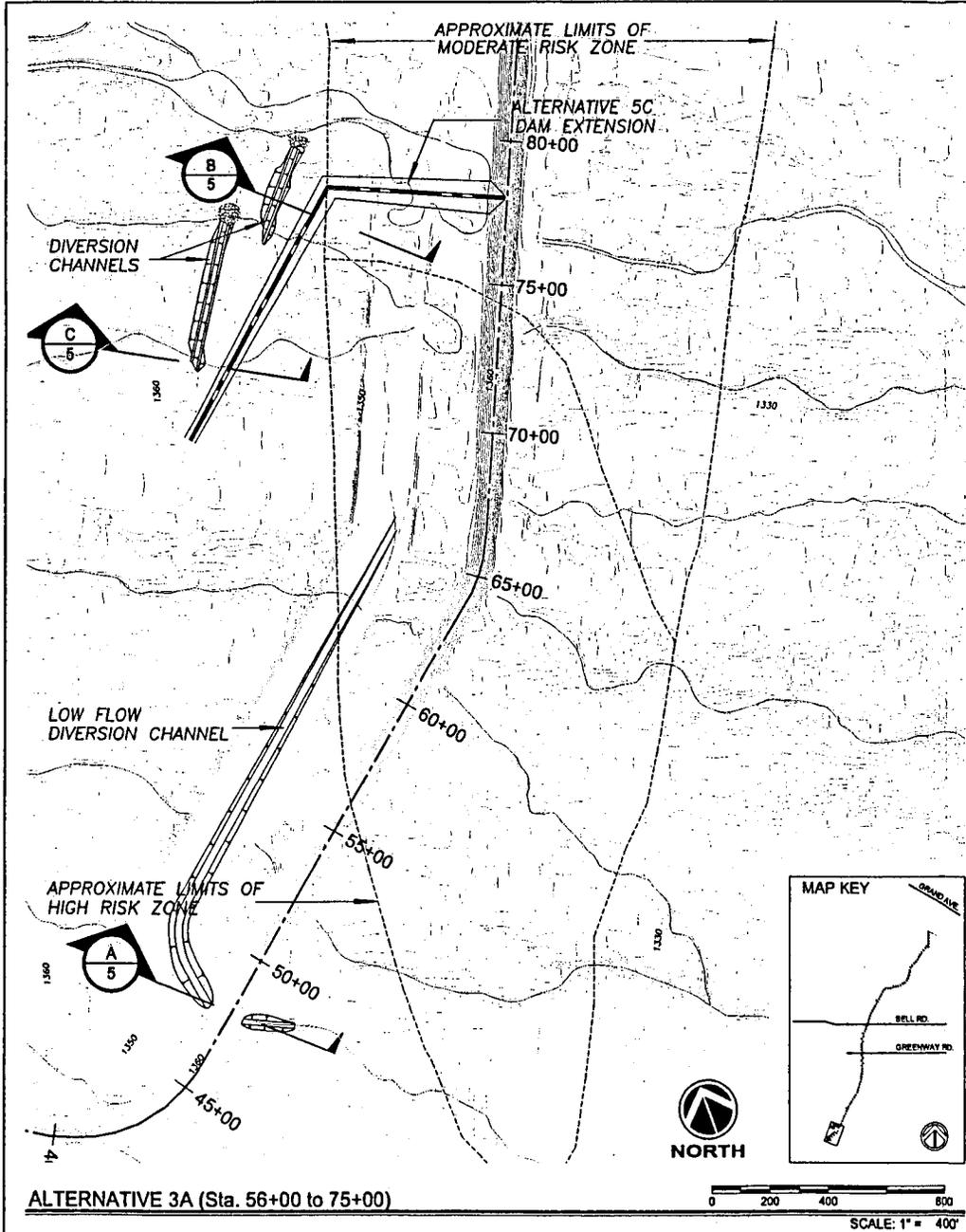
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 DATE: MARCH 2003
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ALTERNATIVE 5C
 DAM EXTENSION

McMICKEN DAM FRZR PROJECT
 FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
 CONTRACT FCD 2002CO11, WORK ASSIGNMENT NO. 1

FIGURE
 4





JOB NO. 2-117-001068	ALTERNATIVE 5C DIVERSION CHANNEL LOCATIONS		amec
DESIGN: LAH	McMICKEN DAM FRZR PROJECT FLOOD CONTROL DISTRICT OF MARICOPA COUNTY CONTRACT FCD 2002CO11, WORK ASSIGNMENT NO. 1		
DRAWN: EHS	DATE: MARCH 2003	SCALE: AS SHOWN	FIGURE 5