FLOOD CONTROL DISTRICT OF MARICOPA COUNTY 1959

FLOOD CONTROL DISTRICT

OF

MARICOPA COUNTY

2801 WEST DURANGO STREET PHOENIX, ARIZONA 85009

RIO VERDE (SOUTH)

FLOOD DELINEATION STUDY

INTERIM HYDRAULIC REPORT

PARAMETER ESTIMATION

FCD CONTRACT NO. 93-07

JULY, 1994

Registered Professional Engineer (Civil) CERTIFICATE NO. 23969 FRANK EDWARD BROWN Date Signed 7/22/94 ARIZONA, U.S.A.

PREPARED BY:

McLAUGHLIN KMETTY ENGINEERS, LTD.
3501 N. 16TH STREET
PHOENIX, ARIZONA 85016
(602) 248-7702

Property of
Flood Control District of MC Library
Please Return to
2801 W. Durango
Phoenix, AZ 85009

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY 1959

FLOOD CONTROL DISTRICT

OF

MARICOPA COUNTY

2801 WEST DURANGO STREET PHOENIX, ARIZONA 85009

RIO VERDE (SOUTH)

FLOOD DELINEATION STUDY

INTERIM HYDRAULIC REPORT

PARAMETER ESTIMATION

FCD CONTRACT NO. 93-07

JULY, 1994

Registered Professional Engineer (Civil)
CERTIFICATE NO. 23969
FRANK EDWARD BROWN
Date Signed 7/22/94
ARIZONA, U.S.A.

PREPARED BY:

McLAUGHLIN KMETTY ENGINEERS, LTD.
3501 N. 16TH STREET
PHOENIX, ARIZONA 85016
(602) 248-7702

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RIO VERDE SOUTH FLOOD DELINEATION STUDY

TABLE OF CONTENTS

(Book 2 of 2)

Page

STUDY DOCUMENTATION ABSTRACT

SECTION 4: Hydraulic Analysis

4.1 Method Description

4.2 Parameter Estimation

4.2.1 Manning's n Value

4.2.1.1 Introduction

4.2.1.2 Methodology

4.2.1.3 n Value Determination
Base Roughness Value
Adjustment to Base value

4.2.2 Expansion and Contraction Coefficients

4.2.3 Hydraulic Jump/Drop Analysis

4.3 Cross-Section Description

4.3.1 Channel and Overbank

4.3.2 Bridge or Constriction

Registered Professional Engineer (Civil)
CERTIFICATE NO. 23969
FRANK EDWARD BROWN
Date Signed 7/22/94
ARIZONA, U.S.A.

SECTION 4: Hydraulic Analysis

4.1 Method Description

Introduction

This Interim Hydraulic Report presents the determination of the Manning's N value parameters to be utilized for the HEC-2 analyses. In addition, the same Manning's n values should be used in the HEC-1 model for channel routing analyses. This report is organized according to a draft copy of "ADWR-TDN, Suggested organization of information for ADWR-TDN 9/21 Technical Documents" dated June 9, 1994.

4.1 Method Description

There are 3 separate washes contained within the study area, and approximately 4.6 miles of floodplain will be delineated in Phase I. The floodplains are analyzed using the HEC-2 Water Surface Profiles Program. An enhanced version, developed by Dodson and Associates, June 1992, entitled ProHEC2 is used. ProHEC-2 is an enhancement of Version 4.6.2 of the standard U.S. Army Corps of Engineers Program dated May 1991 and allows for plotting capabilities using AutoCAD.

For Wash 9, the starting water surface elevation for the HEC-2 water surface profile program is obtained by the slope-area method to determine normal depth. The lower study limit for Wash 9 has been revised to occur at the Fort McDowell Indian Reservation Boundary. For Wash 11, the 100-year floodplain elevation in the Verde River is used for the starting water surface elevation. FIRM Panel #04013C1300E reports only a Zone A (no base flood elevations) for the Verde River, and a data request to FEMA via Flood Control District of Maricopa County (FCDMC) did not yield any water surface elevations. Therefore, a simple HEC-2 analysis is performed for the Verde River to determine the starting water surface elevation. For Wash 10, the HEC-2 analysis beings at the confluence with Wash 11.

The floodplains and floodways are prepared using the guidelines in the March 1993 edition of FEMA Document 34, Flood Insurance Study Guidelines and Specification for Study Contractors (FEMA 37) [3] and FIA Document 12, Appeals, Revisions, and Amendments to Flood Insurance Maps, January 1990 [4]. Floodways are initially determined using the equal conveyance encroachment method with the final analysis utilizing Encroachment Method 1 (specified encroachment station).

GET ORIGINAL BACK FROM FRANK

SECTION 4: Hydraulic Analysis

4.2 Parameter Estimation

4.2 Parameter Estimation

4.2.1 Manning's n Value

4.2.1.1 Introduction

The washes have been separated into reaches that have similar hydraulic characteristics, thus will have the same Manning's n roughness coefficient. Each reach has been identified with a two or three-character identifier. The identifier starts with the wash name which is a one or two digit number and the third character is the reach number; For example, 11B is Wash 11, Reach B.

The Exhibit 1 map entitled "Manning's n Value Map" shows reach limits, the location of photographs for a reach and n values. The density of vegetation has significant impact on the roughness coefficient. Vegetation within the floodplain has been identified to include the following:

Brittle Bush
Cactus - Barrel, Cholla, Prickly Pear, Saguaro
Catclaw
Creosote Bush
Desert Broom
Mesquite
Native Grasses
Ocotillo
Palo Verde Tree

Unless otherwise noted, the photographs are arranged in the following sequence:

1 Left Overbank looking upstream or downstream	2 Bed Material
3 Looking upstream or downstream at main channel	4 Right Overbank looking upstream or downstream

Photograph location and direction are shown on the enclosed Exhibit 1 map.

4.2.1.2 Methodology

Each reach was initially identified from the 1 inch = 200 feet semi-rectified aerial photographs. The discerning characteristics were channel size, apparent similarities in bed material, and vegetation. Each reach was photographed during the field reconnaissance phase at representative and accessible locations. The 1 inch = 200 feet topographic base maps were also taken to the field. Representatives from the Flood Control District assisted during one of the field reconnaissance visits.

Manning's roughness coefficients were estimated using the methodology contained in the USGS report on Manning's Roughness Coefficients [1]. Chow's book, Open Channel Hydraulics [2] was also consulted for background on the USGS methodology and photographs of typical channels showing different n values. The basic methodology is to select a base value of Manning's n for the bed material, and then add adjustments for irregularity, obstructions, vegetation and variations in channel cross-section. If sufficient channel meander is present, a multiplier is applied to the n value enumeration.

A plastic grid is shown in many of the photographs. The outside measures 1.5 feet square. The inside grid measures 1.0 feet square, with 1 inch grids.

4.2.1.3 n Value Determination

Base Roughness Value

The base n value for bed material roughness was selected utilizing a photograph of the grid on the bed material. The dimensions of the grid allowed determination of the size of the bed material. Within the study area, bed material ranged from sandy gravel to riprap, which has an n value range of 0.024 to 0.050. Two reaches are lined with riprap for erosion protection. Throughout the study area, n values for the main channel ranged from 0.030 to 0.050.

Adjustments to Base Value

Based upon field reconnaissance data and the photographs, adjustments were added to the base roughness value. Where washes had a low-flow channel, the side slopes were generally moderately eroded.

Obstructions varied from stumps or fallen trees to block walls in backyards. Vegetation was found mainly outside of the low flow channel. In some instances, the low-flow channel had some trees or bushes growing in it. In general, the channel cross section size and side slope varied gradually. A portion of each wash traverses through established golf courses, with a turf n value of 0.030. There were no washes that had enough meander to warrant an adjustment. Overbank n values ranged from 0.020 to 0.070.

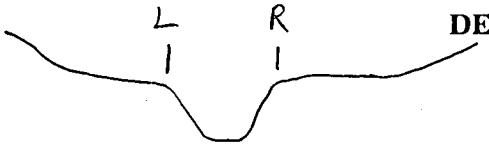
4.2.1.3 References:

1. U.S. Geological Survey, Water Resources Division, April, 1991, *Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona.*

2. V.T. Chow, *Open Channel Hydraulics,* McGraw-Hill, 1959.

3. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study Guidelines and Specifications for Study Contractors, (FEMA 37), March 1993.

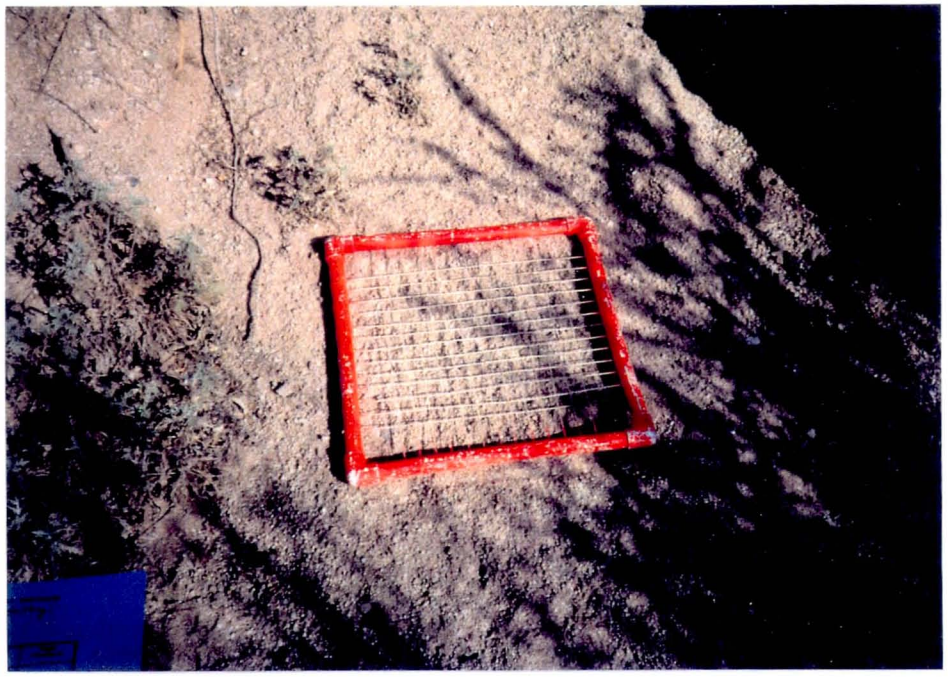
4. Flood Insurance Administration, Appeals, Revisions and Amendments to Flood Insurance Maps, (FIA Document 12), January 1990.

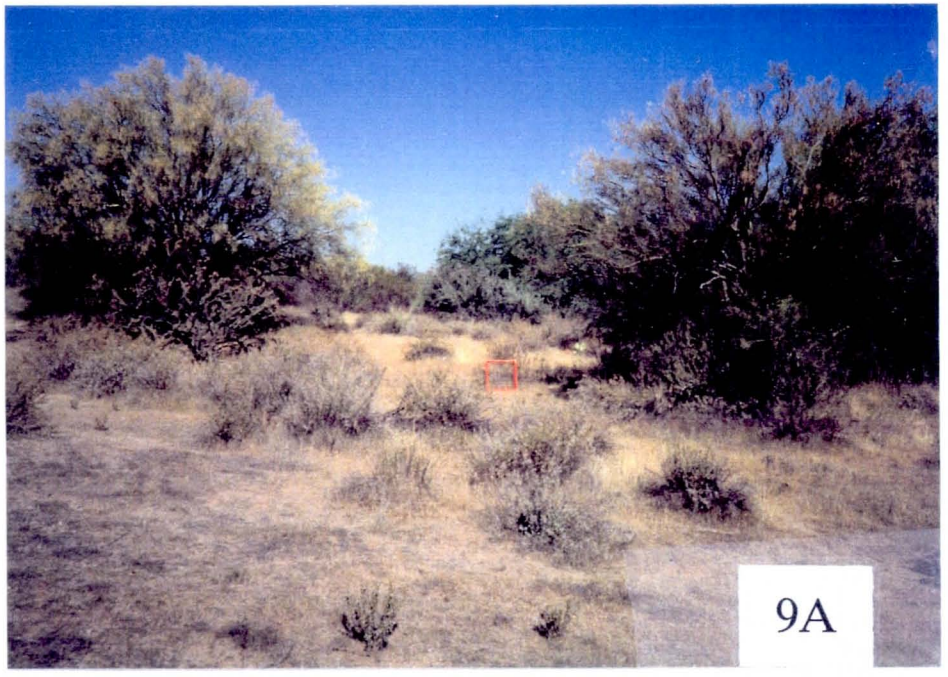


DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS BY FCDMC METHOD

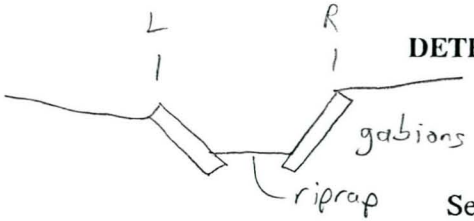
Project: Rio Verde South Flood Delineation Study
Stream: Wash 9
Location: Reach 9A
Photo No.: 9A – 1, 2, 3, 4
Section Description: Incised channel in natural desert. LOB brush, Palo Verde + mesquite trees, Short grass cover. ROB same as LOB.

Channel Conditions		Manning's n Adjustment		Left Overbank 3/4" gravel	Channel Coarse gravel	Right Overbank gravel
Channel Material		nb		0.030	0.028	0.030
	Cobble		.030 - .050			
	Boulder		.040 - .070			
Degree of Irregularity	Smooth	n1	.000	0.0		0.0
	Minor		.001 - .005			
	Moderate		.006 - .010		0.010	
	Severe		.011 - .020			
Effects of Obstruction	Negligible	n2	.000 - .004		0.0	
	Minor		.005 - .015	0.010		0.010
	Appreciable		.020 - .030			
	Severe		.040 - .060			
Vegetation	Small	n3	.002 - .010		0.005	
	Medium		.010 - .025	0.025		0.025
	Large		.025 - .050			
	Very Large		.050 - .100			
Variations in Channel Cross Sections	Gradual	n4	.000	0.0		0.0
	Occ. Alt.		.001 - .005		0.002	
	Freq. Alt.		.010 - .015			
Degree of Meandering	Minor	m	1.00	1.0	1.0	1.0
	Appreciable		1.15			
	Severe		1.30			
n = (nb+n1+n2+n3+n4)m				0.065	0.045	0.065





9A



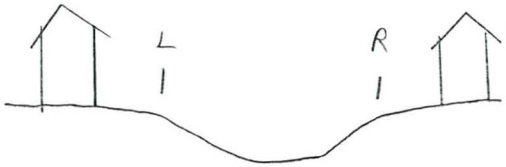
DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS BY FCDMC METHOD

Project: Rio Verde South Flood Delineation Study
Stream: Wash 9
Location: Reach 9B
Photo No.: 9B - 1, 2, 3, 4
Section Description: rip-rap lined channel, LOB is pavement, ROB is desert or golf course

Channel Conditions		Manning's n Adjustment		Left Overbank pavement	Channel d_{50} = 9"	Right Overbank
Channel Material		nb		0.020	0.045	0.030
	Cobble		.030 - .050			
d_{50} = 9"	Boulder		.040 - .070			
Degree of Irregularity	Smooth	n1	.000	0.0	0.0	0.0
	Minor		.001 - .005			
	Moderate		.006 - .010			
	Severe		.011 - .020			
Effects of Obstruction	Negligible	n2	.000 - .004	0.0	0.0	
	Minor		.005 - .015			0.010
	Appreciable		.020 - .030			
	Severe		.040 - .060			
Vegetation	Small	n3	.002 - .010	0.0	0.0	
	Medium		.010 - .025			0.025
	Large		.025 - .050			
	Very Large		.050 - .100			
Variations in Channel Cross Sections	Gradual	n4	.000	0.0	0.0	0.0
	Occ. Alt.		.001 - .005			
	Freq. Alt.		.010 - .015			
Degree of Meandering	Minor	m	1.00	1.0	1.0	1.0
	Appreciable		1.15			
	Severe		1.30			
n = (nb+n1+n2+n3+n4)m				0.020	0.045	0.065

desert ROB
0.030 golf course ROB

9B

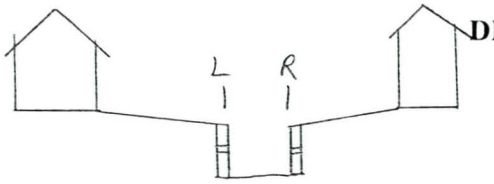


DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS BY FCDMC METHOD

Project: Rio Verde South Flood Delineation Study
Stream: Wash 9
Location: Reach 9C
Photo No.: 9C - 1, 3, 4
Section Description: channel in golf course, LOB is turf, ROB is landscaped backyards, or desert

Channel Conditions		Manning's n Adjustment		Left Overbank	Channel	Right Overbank — landscaped backyards
Channel Material	turf	nb		0.030	0.030	gravel 0.028
	Cobble		.030 - .050			
	Boulder		.040 - .070			
Degree of Irregularity	Smooth	n1	.000	0.0	0.0	0.0
	Minor		.001 - .005			
	Moderate		.006 - .010			
	Severe		.011 - .020			
Effects of Obstruction	Negligible	n2	.000 - .004	0.0	0.0	0.015
	Minor		.005 - .015			
	Appreciable		.020 - .030			
	Severe		.040 - .060			
Vegetation	Small	n3	.002 - .010	0.0	0.0	
	Medium		.010 - .025			0.012
	Large		.025 - .050			
	Very Large		.050 - .100			
Variations in Channel Cross Sections	Gradual	n4	.000	0.0	0.0	0.0
	Occ. Alt.		.001 - .005			
	Freq. Alt.		.010 - .015			
Degree of Meandering	Minor	m	1.00	1.0	1.0	
	Appreciable		1.15			
	Severe		1.30			
n = (nb+n1+n2+n3+n4)m				0.030	0.030	0.055 — same for desert in vacant lots.

9C



DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS BY FCDMC METHOD

Project: Rio Verde South Flood Delineation Study
Stream: Wash 9
Location: Reach 9D
Photo No.: 9D - 1, 2, 3, 4
Section Description: railroad-tie lined main channel, LOB residential backyards, ROB is backyards, with block walls.

Channel Conditions		Manning's n Adjustment		Left Overbank gravel	Channel Sandy gravel	Right Overbank gravel	Right Overbank
Channel Material		nb		0.030	0.024	0.030	0.030
	Cobble		.030 - .050				
	Boulder		.040 - .070				
Degree of Irregularity	Smooth	n1	.000	0.0	0.0	0.0	0.0
	Minor		.001 - .005				
	Moderate		.006 - .010				
	Severe		.011 - .020				
Effects of Obstruction	Negligible	n2	.000 - .004		0.0		
	Minor		.005 - .015	0.010			0.010
	Appreciable		.020 - .030				
	Severe		.040 - .060			0.060	
Vegetation	Small	n3	.002 - .010		0.006		
	Medium		.010 - .025	0.025		0.020	0.025
	Large		.025 - .050				
	Very Large		.050 - .100				
Variations in Channel Cross Sections	Gradual	n4	.000	0.0	0.0	0.0	0.0
	Occ. Alt.		.001 - .005				
	Freq. Alt.		.010 - .015				
Degree of Meandering	Minor	m	1.00	1.0	1.0		1.0
	Appreciable		1.15				
	Severe		1.30				
n = (nb+n1+n2+n3+n4)m				0.065	0.030	0.110	0.065
				with walls in yards			without walls

9D

DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS BY FCDMC METHOD

Project: Rio Verde South Flood Delineation Study
Stream: Wash 10
Location: Reach 10A
Photo No.: 10A - 1,2,3,4
Section Description: Sandy gravel bottom, LOB is grass, brush and some cactii. ROB Same as LOB

Channel Conditions		Manning's n Adjustment		Left Overbank	Channel	Right Overbank
Channel Material	gravel + 1-3" rock	nb		0.030	0.030	0.030
	Cobble		.030 - .050			
	Boulder		.040 - .070			
Degree of Irregularity	Smooth	n1	.000	0.0		0.0
	Minor		.001 - .005		0.003	
	Moderate		.006 - .010			
	Severe		.011 - .020			
Effects of Obstruction	Negligible	n2	.000 - .004		0.003	
	Minor		.005 - .015	0.015		0.015
	Appreciable		.020 - .030			
	Severe		.040 - .060			
Vegetation	Small	n3	.002 - .010		0.006	
	Medium		.010 - .025	0.025		0.025
	Large		.025 - .050			
	Very Large		.050 - .100			
Variations in Channel Cross Sections	Gradual	n4	.000	0.0		0.0
	Occ. Alt.		.001 - .005		0.003	
	Freq. Alt.		.010 - .015			
Degree of Meandering	Minor	m	1.00	1.0	1.0	1.0
	Appreciable		1.15			
	Severe		1.30			
n = (nb+n1+n2+n3+n4)m				0.070	0.045	0.070

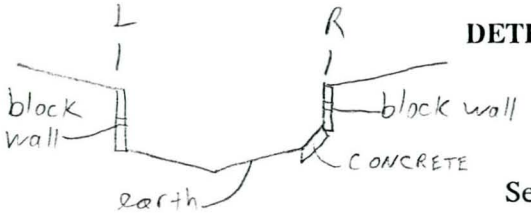
10A

DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS BY FCDMC METHOD

See 10A dwg

Project: Rio Verde South Flood Delineation Study
Stream: Wash 10
Location: Reach 10A where hardpan exists in channel
Photo No.: See Reach 10A description.
Section Description: Some Hardpan is from Forest Road to 950' downstream. Average is 20% of bottom has hardpan.

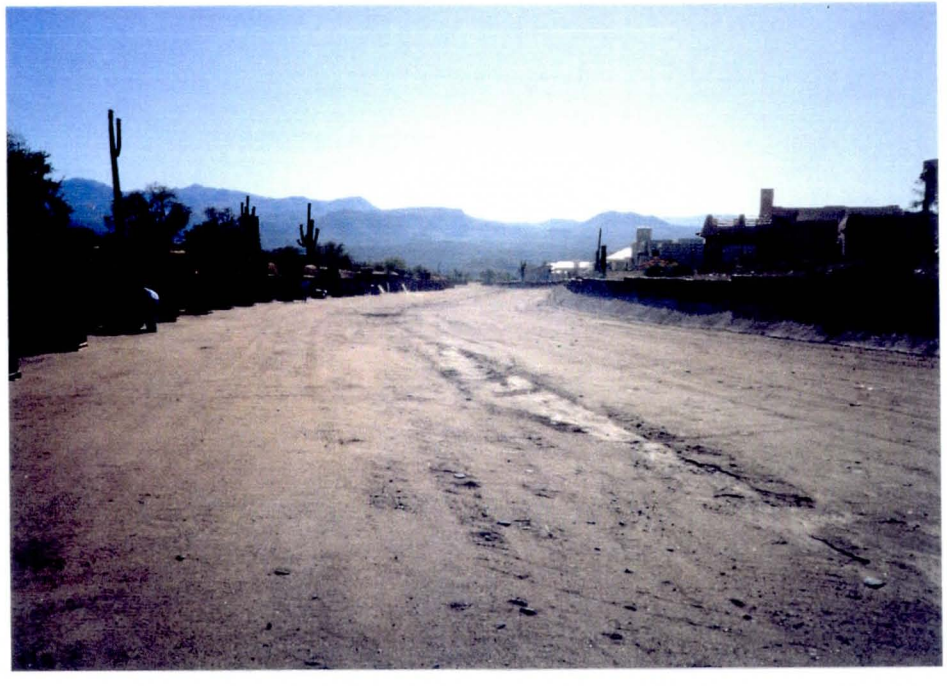
Channel Conditions		Manning's n Adjustment		Left Overbank	Channel hardpan	Right Overbank
Channel Material		nb			0.020	
	Cobble		.030 - .050			
	Boulder		.040 - .070			
Degree of Irregularity	Smooth	n1	.000			
	Minor		.001 - .005		0.003	
	Moderate		.006 - .010			
	Severe		.011 - .020			
Effects of Obstruction	Negligible	n2	.000 - .004		0.003	
	Minor		.005 - .015			
	Appreciable		.020 - .030			
	Severe		.040 - .060			
Vegetation	Small	n3	.002 - .010		0.007	
	Medium		.010 - .025			
	Large		.025 - .050			
	Very Large		.050 - .100			
Variations in Channel Cross Sections	Gradual	n4	.000			
	Occ. Alt.		.001 - .005		0.003	
	Freq. Alt.		.010 - .015			
Degree of Meandering	Minor	m	1.00		1.0	
	Appreciable		1.15			
	Severe		1.30			
n = (nb+n1+n2+n3+n4)m				See 10A	0.036	See 10A

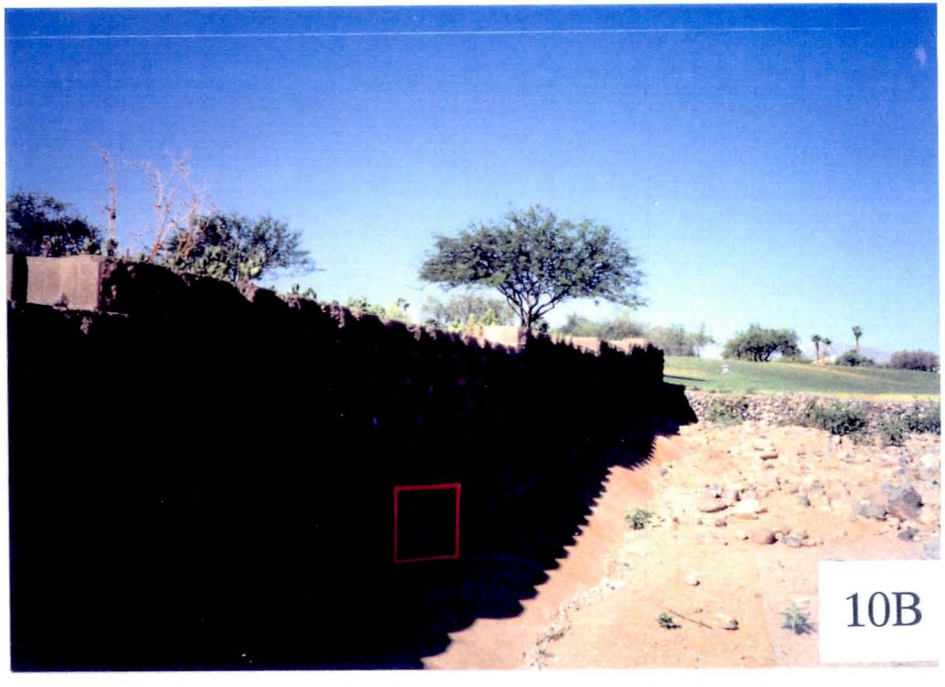


DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS BY FCDMC METHOD

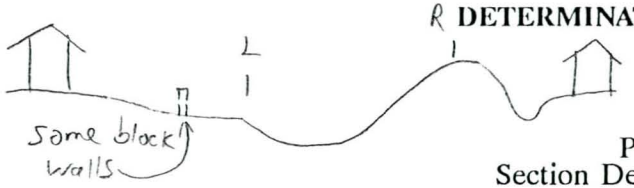
Project: Rio Verde South Flood Delineation Study
Stream: Wash 10
Location: Reach 10B (channelized)
Photo No.: 10B - 1, 2, 3, 4
Section Description: Channelized earth lined channel, RoB is landscaped back yards, LoB is natural desert (Soon to be developed).

Channel Conditions		Manning's n Adjustment		Left Overbank gravel	Channel Sandy gravel	Right Overbank gravel
Channel Material		nb		0.030	0.024	0.030
	Cobble		.030 - .050			
	Boulder		.040 - .070			
Degree of Irregularity	Smooth	n1	.000	0.0	0.0	0.0
	Minor		.001 - .005			
	Moderate		.006 - .010			
	Severe		.011 - .020			
Effects of Obstruction	Negligible	n2	.000 - .004		0.0	
	Minor		.005 - .015	0.010		0.010
	Appreciable		.020 - .030			
	Severe		.040 - .060			
Vegetation	Small	n3	.002 - .010		0.006	
	Medium		.010 - .025	0.015		0.010
	Large		.025 - .050			
	Very Large		.050 - .100			
Variations in Channel Cross Sections	Gradual	n4	.000	0.0	0.0	0.0
	Occ. Alt.		.001 - .005			
	Freq. Alt.		.010 - .015			
Degree of Meandering	Minor	m	1.00	1.0	1.0	1.0
	Appreciable		1.15			
	Severe		1.30			
n = (nb+n1+n2+n3+n4)m				0.055	0.030	0.050





10B

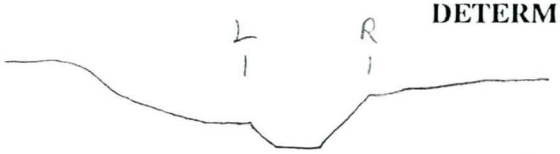


R DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS BY FCDMC METHOD

Project: Rio Verde South Flood Delineation Study
Stream: Wash 10
Location: Reach 10C
Photo No.: 10C - 1, 2, 3, 4
Section Description: turf main channel, LOB and ROB is landscaped back yards. Some landscaping is natural desert

Channel Conditions		Manning's n Adjustment		Left Overbank Coarse gravel	Channel turf	Right Overbank Coarse gravel
Channel Material		nb		0.030	0.030	0.030
	Cobble		.030 - .050			
	Boulder		.040 - .070			
Degree of Irregularity	Smooth	n1	.000	0.0	0.0	0.0
	Minor		.001 - .005			
	Moderate		.006 - .010			
	Severe		.011 - .020			
Effects of Obstruction	Negligible	n2	.000 - .004		0.0	
	Minor		.005 - .015			
	Appreciable		.020 - .030	0.010		0.010
	Severe		.040 - .060			
Vegetation	Small	n3	.002 - .010		0.0	
	Medium		.010 - .025	0.025		0.025
	Large		.025 - .050			
	Very Large		.050 - .100			
Variations in Channel Cross Sections	Gradual	n4	.000	0.0	0.0	0.0
	Occ. Alt.		.001 - .005			
	Freq. Alt.		.010 - .015			
Degree of Meandering	Minor	m	1.00	1.0	1.0	1.0
	Appreciable		1.15			
	Severe		1.30			
n = (nb+n1+n2+n3+n4)m				0.065	0.030	0.065

10C



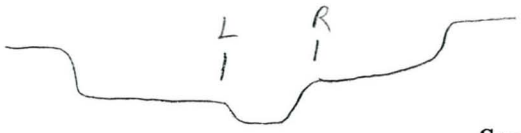
DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS BY FCDMC METHOD

Project: Rio Verde South Flood Delineation Study
Stream: Wash 10
Location: Reach 10 D
Photo No.: 10D - 1, 2, 3, 4
Section Description: Coarse gravel channel, riprap on Right channel slope occupies 450 LF of this reach. LOB is desert brush, mesquite, Palo Verde + Saguaro. ROB has less trees than LOB.

Channel Conditions		Manning's n Adjustment		Left Overbank gravel	Channel coarse gravel	Right Overbank gravel
Channel Material		nb		0.030	0.028	0.030
	Cobble		.030 - .050			
	Boulder		.040 - .070			
Degree of Irregularity	Smooth	n1	.000	0.0		0.0
	Minor		.001 - .005			
	Moderate		.006 - .010		0.010	
	Severe		.011 - .020			
Effects of Obstruction	Negligible	n2	.000 - .004			
	Minor		.005 - .015			
	Appreciable		.020 - .030	0.010		0.010
	Severe		.040 - .060			
Vegetation	Small	n3	.002 - .010		0.005	
	Medium		.010 - .025	0.025		0.015
	Large		.025 - .050			
	Very Large		.050 - .100			
Variations in Channel Cross Sections	Gradual	n4	.000	0.0		0.0
	Occ. Alt.		.001 - .005		0.002	
	Freq. Alt.		.010 - .015			
Degree of Meandering	Minor	m	1.00	1.0		1.0
	Appreciable		1.15			
	Severe		1.30			
n = (nb+n1+n2+n3+n4)m				0.065	0.045	0.055

10D

DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS BY FCDMC METHOD

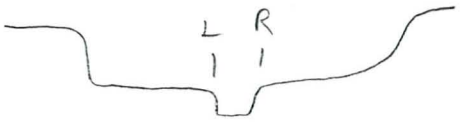


Project: Rio Verde South Flood Delineation Study
Stream: Wash 11
Location: Reach 11A
Photo No.: 11A - 1, 2, 3, 4
Section Description: wide sandy bottom, steep side slopes. LOB grass + mesquite trees. ROB same as LOB.

Channel Conditions		Manning's n Adjustment		Left Overbank clay	Channel coarse gravel	Right Overbank clay
Channel Material		nb		0.020	0.028	0.020
	Cobble		.030 - .050			
	Boulder		.040 - .070			
Degree of Irregularity	Smooth	n1	.000	0.0		0.0
	Minor		.001 - .005			
	Moderate		.006 - .010		0.006	
	Severe		.011 - .020			
Effects of Obstruction	Negligible	n2	.000 - .004		0.002	
	Minor		.005 - .015	0.015		0.015
	Appreciable		.020 - .030			
	Severe		.040 - .060			
Vegetation	Small	n3	.002 - .010		0.005	
	Medium		.010 - .025	0.025		0.025
	Large		.025 - .050			
	Very Large		.050 - .100			
Variations in Channel Cross Sections	Gradual	n4	.000	0.0		0.0
	Occ. Alt.		.001 - .005		0.001	
	Freq. Alt.		.010 - .015			
Degree of Meandering	Minor	m	1.00	1.0	1.0	1.0
	Appreciable		1.15			
	Severe		1.30			
n = (nb+n1+n2+n3+n4)m				0.060	0.042	0.060

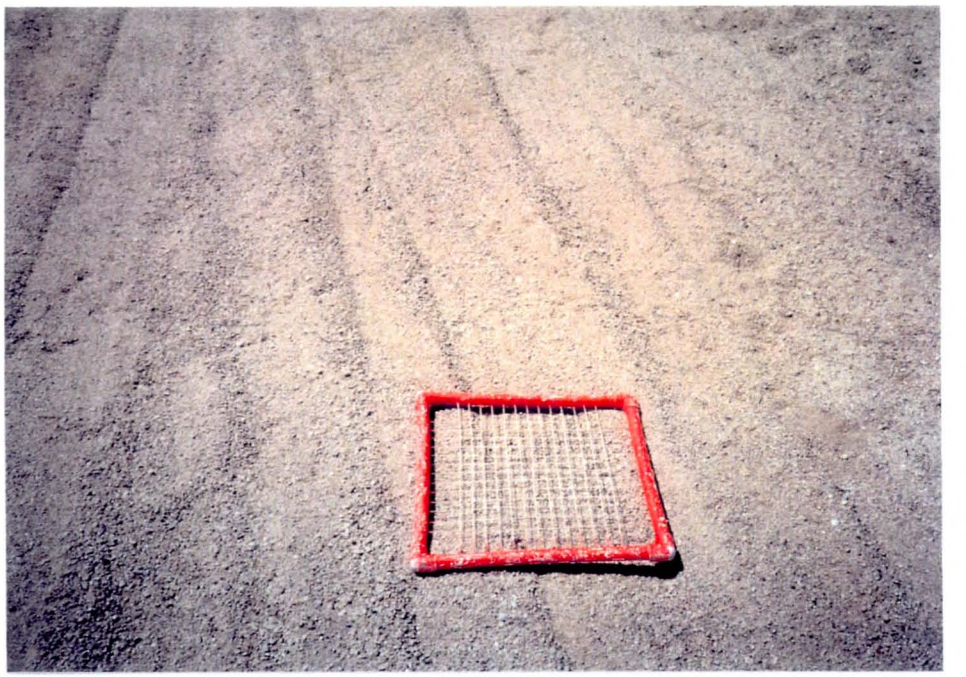
11A

DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS BY FCDMC METHOD

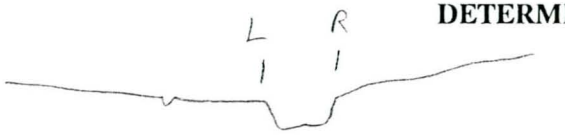


Project: Rio Verde South Flood Delineation Study
Stream: Wash 11
Location: Reach 11B
Photo No.: 11B - 1, 2, 3, 4
Section Description: wide sandy bottom, steep side slopes. LOB is grass, brush, cactus + trees. ROB same as LOB

Channel Conditions		Manning's n Adjustment		Left Overbank clay	Channel coarse gravel	Right Overbank clay
Channel Material		nb		0.020	0.028	0.020
	Cobble		.030 - .050			
	Boulder		.040 - .070			
Degree of Irregularity	Smooth	n1	.000	0.0		0.0
	Minor		.001 - .005			
	Moderate		.006 - .010		0.006	
	Severe		.011 - .020			
Effects of Obstruction	Negligible	n2	.000 - .004		0.002	
	Minor		.005 - .015	0.015		0.015
	Appreciable		.020 - .030			
	Severe		.040 - .060			
Vegetation	Small	n3	.002 - .010		0.005	
	Medium		.010 - .025			
	Large		.025 - .050	0.030		0.030
	Very Large		.050 - .100			
Variations in Channel Cross Sections	Gradual	n4	.000	0.0		0.0
	Occ. Alt.		.001 - .005		0.001	
	Freq. Alt.		.010 - .015			
Degree of Meandering	Minor	m	1.00	1.0	1.0	1.0
	Appreciable		1.15			
	Severe		1.30			
n = (nb+n1+n2+n3+n4)m				0.065	0.042	0.065



11B



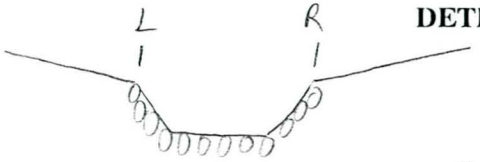
DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS BY FCDMC METHOD

Project: Rio Verde South Flood Delineation Study
Stream: Wash
Location: Reach 11C
Photo No.: 10A-1,2,3,4 (see description)
Section Description: Same as Reach 10A 2400 ft some mesquite and Palo Verde trees growing along channel bottom.

Channel Conditions		Manning's n Adjustment		Left Overbank	Channel	Right Overbank
Channel Material	gravel + 1-3" rock	nb		0.030	0.030	0.030
	Cobble		.030 - .050			
	Boulder		.040 - .070			
Degree of Irregularity	Smooth	n1	.000	0.0		0.0
	Minor		.001 - .005		0.003	
	Moderate		.006 - .010			
	Severe		.011 - .020			
Effects of Obstruction	Negligible	n2	.000 - .004		0.003	
	Minor		.005 - .015	0.015		0.015
	Appreciable		.020 - .030			
	Severe		.040 - .060			
Vegetation	Small	n3	.002 - .010			
	Medium		.010 - .025	0.025	0.011	0.025
	Large		.025 - .050			
	Very Large		.050 - .100			
Variations in Channel Cross Sections	Gradual	n4	.000	0.0		0.0
	Occ. Alt.		.001 - .005		0.003	
	Freq. Alt.		.010 - .015			
Degree of Meandering	Minor	m	1.00	1.0	1.0	1.0
	Appreciable		1.15			
	Severe		1.30			
n = (nb+n1+n2+n3+n4)m				0.070	0.050	0.070

NOTE: NO ADDITIONAL PHOTOGRAPHS FOR REACH 11C

THE PHOTOGRAPHS FOR REACH 10A ARE APPLICABLE

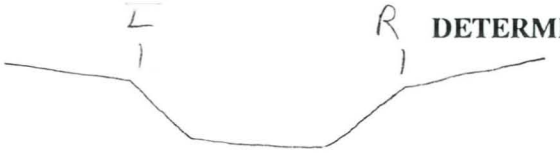


DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS BY FCDMC METHOD

Project: Rio Verde South Flood Delineation Study
Stream: Wash 11
Location: Reach 11D
Photo No.: 11D-1, 2, 3, 4
Section Description: Rip rap lined main channel, natural desert overbanks. LOB is brush and Palo Verde Trees. ROB same as LOB

Channel Conditions		Manning's n Adjustment		Left Overbank gravel	Channel d_{50} = 12"	Right Overbank gravel
Channel Material		nb		0.030	0.050	0.030
	Cobble		.030 - .050			
	Boulder		.040 - .070			
Degree of Irregularity	Smooth	n1	.000	0.0	0.0	0.0
	Minor		.001 - .005			
	Moderate		.006 - .010			
	Severe		.011 - .020			
Effects of Obstruction	Negligible	n2	.000 - .004		0.0	
	Minor		.005 - .015	0.015		0.015
	Appreciable		.020 - .030			
	Severe		.040 - .060			
Vegetation	Small	n3	.002 - .010		0.0	
	Medium		.010 - .025	0.025		0.025
	Large		.025 - .050			
	Very Large		.050 - .100			
Variations in Channel Cross Sections	Gradual	n4	.000	0.0	0.0	0.0
	Occ. Alt.		.001 - .005			
	Freq. Alt.		.010 - .015			
Degree of Meandering	Minor	m	1.00	1.0	1.0	1.0
	Appreciable		1.15			
	Severe		1.30			
n = (nb+n1+n2+n3+n4)m				0.070	0.050	0.070

11D



DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS BY FCDMC METHOD

Project: Rio Verde South Flood Delineation Study
Stream: Wash 11
Location: Reach 11E (channelized)
Photo No.: 11E - 1, 3, 4
Section Description: Sandy gravel bottom, LOB desert brush and Palo Verde + mesquite trees. ROB same as LOB. In some areas LOB + ROB in turf but use desert as majority.

Channel Conditions		Manning's n Adjustment		Left Overbank gravel	Channel Sandy gravel	Right Overbank gravel
Channel Material		nb		0.030	0.024	0.030
	Cobble		.030 - .050			
	Boulder		.040 - .070			
Degree of Irregularity	Smooth	n1	.000	0.0	0.0	0.0
	Minor		.001 - .005			
	Moderate		.006 - .010			
	Severe		.011 - .020			
Effects of Obstruction	Negligible	n2	.000 - .004	0.015	0.0	0.015
	Minor		.005 - .015			
	Appreciable		.020 - .030			
	Severe		.040 - .060			
Vegetation	Small	n3	.002 - .010		0.006	
	Medium		.010 - .025	0.025		0.025
	Large		.025 - .050			
	Very Large		.050 - .100			
Variations in Channel Cross Sections	Gradual	n4	.000	0.0	0.0	0.0
	Occ. Alt.		.001 - .005			
	Freq. Alt.		.010 - .015			
Degree of Meandering	Minor	m	1.00	1.0	1.0	1.0
	Appreciable		1.15			
	Severe		1.30			
n = (nb+n1+n2+n3+n4)m				0.070	0.030	0.070

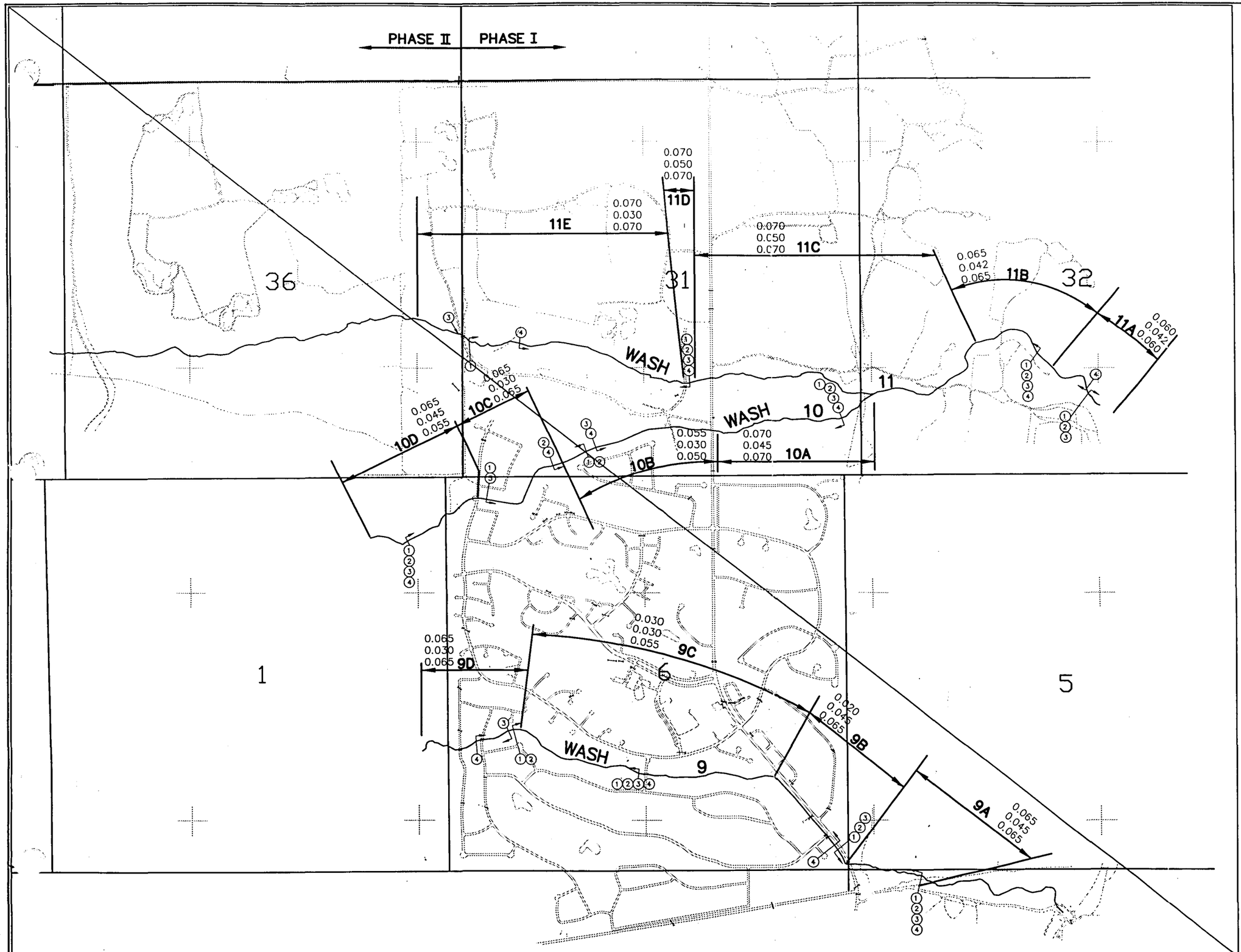
natural desert golf course = 0.030

natural desert golf course = 0.030

11E

JUST FOR COMPARISON.
BROOKS-HERSEY USED
0.035 FOR THE CHANNEL
DESIGN & 0.050 FOR THE
OVERBANKS.

11E photos



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF RIO VERDE SOUTH

F.C.D. CONTRACT NO. 93-07

LEGEND

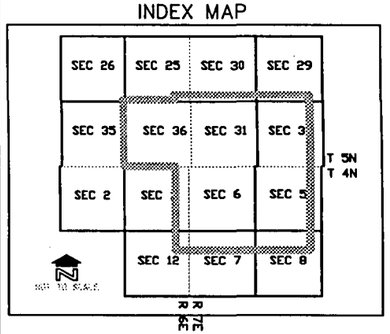
REACH LABEL	9A
PHOTO LOCATION AND DIRECTION	③
HYDRAULIC BASE LINE	
LEFT OVERBANK n VALUE	0.065
MAIN CHANNEL n VALUE	0.040
RIGHT OVERBANK n VALUE	0.055

NOTES

1. This map prepared from sheets 2 to 8, 1"=200', 2' C.I. maps.

Registered Professional Engineer (Civil) CERTIFICATE NO. 23969 FRANK EDWARD BROWN Date Signed 7/22/94 ARIZONA, U.S.A.

INDEX MAP



600 0' 1200

SCALE: 1"= 1200'

EXHIBIT 1

MANNINGS n VALUE MAP

McLAUGHLIN KMETTY ENGINEERS, Ltd.

	BY	DATE
DESIGN	FEB	7/94
DESIGN CHK.	MKE	7/94
PLANS	PJK	7/94
PLANS CHK.	FEB	7/94

SUBMITTED BY: DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET OF

SECTION 4: Hydraulic Analysis

4.3 Cross-Section Description

4.3 Cross Section Description

4.3.1 Channel and Overbank

Prior to obtaining GR records for exact location, the channel stations have been approximated from field reconnaissance data. The proposed location of channel bank stations are shown on a sketch contained on the roughness coefficient calculation sheet in Section 4.2. The letters "L" and "R" denote the location of the left and right channel bank stations, respectively. In general, the majority of washes have a low-flow channel, with vegetation outside of the low-flow channel. Some portions are channelized with railroad ties or block walls, with bank stations set at the top of wall.

4.3.2 Bridges or Constrictions

There is one golf cart bridge within the study area. Culverts at roadway crossings comprise the constrictions in the floodplain. There are 4 culverts along washes that will be analyzed using HEC-2. Culverts smaller than or equal to 36-inch round or equivalent will not be included in the floodplain model. The study wash culverts are multiple barrel concrete box culverts. All of these culverts probably will be overtopped during a 100-year storm. Most of the culverts appear to have been designed for overtopping. The culverts have the appearance of being stable from scour and from washing out during an overtopping event. The upper two culverts on Wash 9 have 1 to 1½ feet of sediment, which will be included in the HEC-2 model.

CULVERT PHOTOGRAPH KEY

1 Wash 9 3-4'x10'x48' CBC at Via Hermosa Looking Downstream at Inlet NOTE: The Golf Cart Bridge upstream of this culvert is expected to be above the 100-year flood.	2 Wash 9 2-4'x8'x36.6' CBC at Vado Court Looking Downstream at Inlet
3 Wash 9 2-4'x8'x34' CBC at Quail Haven Drive Looking Downstream at Inlet	4 Wash 11 4-4'x10'x38' CBC at Agua Verde Road Looking Downstream at Inlet