SECTION 3 - HYDROLOGIC ANALYSIS

For Incorporation Into
Eastern Canal Floodplain Delineation Study
Technical Data Notebook

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Date Signed 5-30-97
Arizona, U.S.A.

May 1997

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3.1 METHOD DESCRIPTION

The project consists of approximately 5.5 miles of floodplain delineation for the Eastern Canal from Baseline Road to Hermosa Vista Drive located in the City of Mesa in Township 1 North, Range 6 East of the Gila and Salt River Base and Meridian. This requires the development of approximately 12 square miles of watershed hydrology. The large array version of the US Army Corps of Engineers HEC-1 computer program, obtained from the Flood Control District of Maricopa County (FCDMC), was used to develop the hydrologic model.

The FCDMC *Drainage Design Manual for Maricopa County, Arizona, Volumes I and II,* were used to develop discharges, means of conveyance, and retention volumes for this project. Peak discharges were calculated for the 10-year, 6-hour storm; the 100-year, 6-hour storm; and the 100-year, 24-hour storm. Specific issues regarding design approach were directed to the Hydrologic and Development Sections of the FCDMC.

Drainage areas were initially delineated by hand on 1"=200' scale detailed topographic maps with 2-foot contours. Subsequently, the areas were delineated in AutoCAD using aerial mapped topography. Drainage areas were calculated using AutoCAD and checked by planimeter on hard copies of the 1"=200' scale detailed topographic maps. The drainage areas were then transposed onto the digital soils maps and the percentages of soil types for each area computed using AutoCAD. City of Mesa zoning maps were digitized into AutoCAD and the percentages of land use computed for each drainage area. Water course lengths and slopes were measured on the 200-scale detailed topographic maps.

Design discharges were computed using the HEC-1 computer model. The hydrologic variables entered into the program were computed using procedures described in the FCDMC *Drainage Design Manual for Maricopa County, Arizona, Volume I, Hydrology (Hydrology),* and entered into the FCDMC Drainage Design Menu System (DDMS). The Green and Ampt Loss parameters were calculated using the DDMS. Precipitation data was taken from the FCDMC *Hydrology* and entered into the PREFRE and the MCUHP1 program options within DDMS.

Hydrologic routing of excess rainfall was achieved using the Clark Unit Hydrograph method, as recommended by the FCDMC. The required input parameters for the Clark Unit Hydrograph method, time of concentration, and storage coefficient were calculated using the procedures outlined in the FCDMC *Hydrology*. A time-area relation provided in the FCDMC manual was used.

The Normal-Depth Routing procedure was used for flood routing of hydrographs from one concentration point to another. Routed hydrographs were then combined with the next downstream hydrograph. Reservoir routing was achieved using the storage routing procedure. Storm drain routing was accomplished using the time-lag procedure (the RT card within HEC-1).

3.2 PARAMETER ESTIMATION

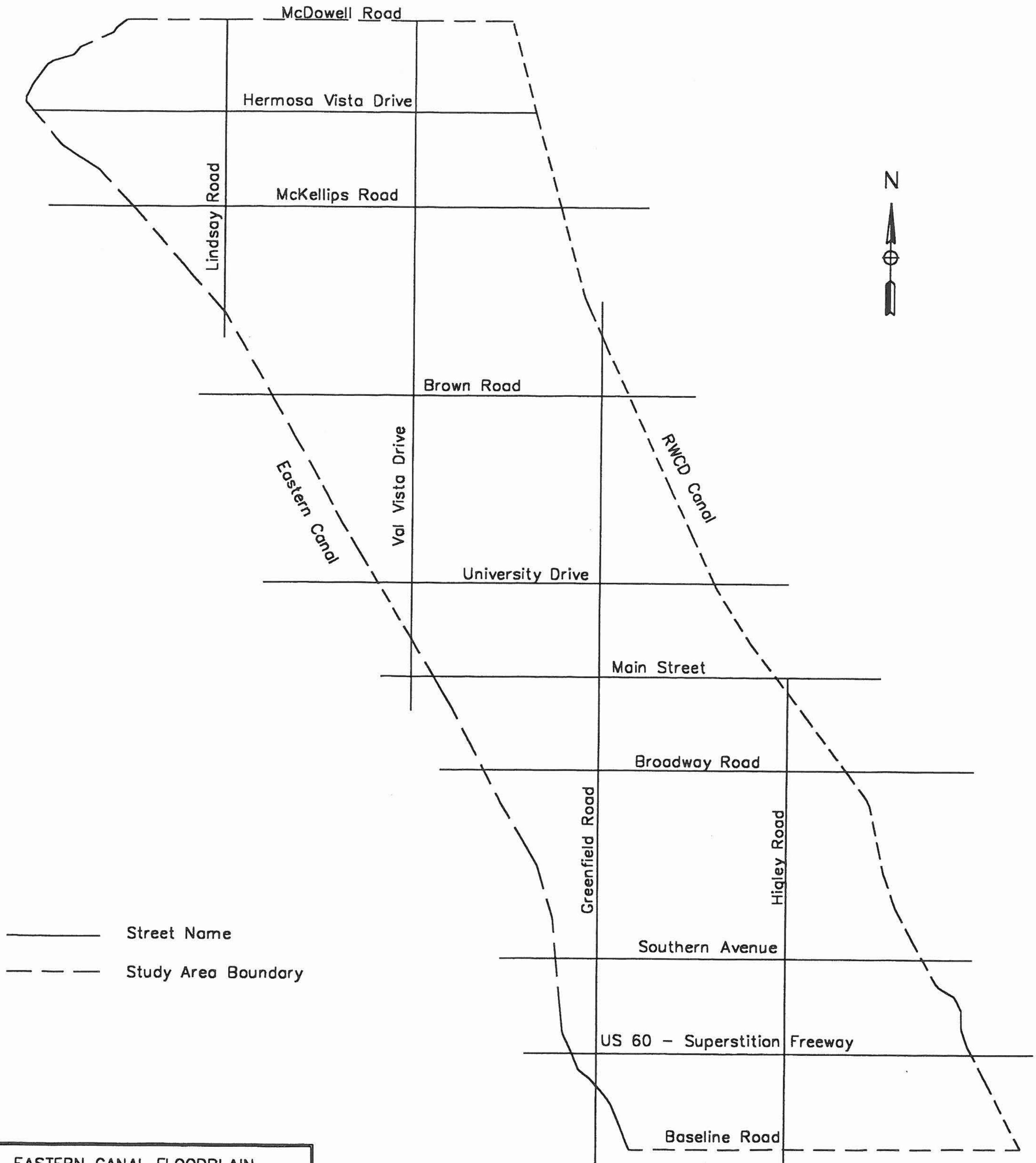
3.2.1 Drainage Area Boundaries

The project watershed is located in the City of Mesa, Arizona, in the eastern portion of Maricopa County. The watershed is bound by the Eastern Canal on the west, Roosevelt Canal on the east, Baseline Road on the south, and Hermosa Vista Drive on the north. While the study area is bound by Hermosa Vista Drive, contributing areas are bound by McDowell Road to the north. The total contributing area for the project is approximately 12 square miles. The project limits are shown in Figure 1, Study Area Boundary.

The watershed is predominantly developed residential lands of varied lot sizes. Agricultural areas as well as undeveloped lands are also located within the study area. US 60 passes through the southern end of the study area in an east-west alignment. A grid network of collector, major collector, and arterial streets channel the flow to the west.

The delineation of drainage sub-basins within the project watershed was accomplished using a 1"=200' scale, 2-foot contour interval topographic map, provided by Michael Baker Jr., Inc. Documents used for sub-basins within the contributing area north of Hermosa Vista Drive included a US Geological Survey (USGS) 7.5-minute quadrangle map for Buckhorn, AZ., with 10-foot contours, as well as aerial photographs.

The watershed was divided into 153 sub-basins which were numbered from 1 to 168, excluding numbers 7, 14, 72, 75, 78, 95, 109, 117, 119, 126, 127, 140, 145, 154, and 167, which were eliminated during the modeling process. Detention basins within the study area were identified by the sub-basin in which they are located and the sheet number of the topographic map on which the sub-basin is shown (e.g., Detention Basin 1B4 is within Sub-basin 4 shown on Sheet 1 of 5 of the topographic maps). Refer to Table 1 in Section 3.2.2.1 for a summary of the drainage sub-basins.



EASTERN CANAL FLOODPLAIN DELINEATION

FIGURE 3.1 – STUDY AREA BOUNDARY

PRIMATECH ENGINEERS
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Project No. :			MFC001
Date :	May 1997	Drawn by :	WVH

3.2.2 Physical Parameters

3.2.2.1 Sub-basin Parameters

Drainage Sub-basins

The watershed and sub-basin boundaries were delineated in AutoCAD using 2-foot contours. The drainage area delineations are shown with the study area topography on Exhibit 1 - Drainage Basin Map. The individual sub-basin areas and the watershed total area are presented in Table 1. There are 153 sub-basins which comprise the 12.147-square-mile watershed area. The sub-basin areas range between 16 acres (0.025 square mile) to 97.28 acres (0.152 square mile).

Flow path length (L), flow path slope (S), and basin resistance coefficient (K_b) were calculated for the individual drainage sub-basins. These parameters are included in Table 1 with the sub-basin areas. These basin parameters used for the Clark Unit Hydrograph calculations are described in Section 3.2.2.3. The flow path length and slope were measured from the topographic maps. The basin resistance coefficient was calculated following the procedure outlined in the FCDMC *Hydrology*.

Soil Types

Soil types for the study area were obtained from Soil Conservation Service, *Soil Survey, Eastern Maricopa and Northern Pinal Counties Area, Arizona (Nov., 1974).* Table 2 summarizes the soil types within the watershed area. Exhibit 2 - Soil Type Map shows the soil types with the drainage area delineations. The fraction of each soil type within each sub-basin is summarized in Table 3.

Land Use Types

Land use types for the study area were obtained from zoning maps issued by the City of Mesa, Community Development & Planning Department (July, 1996). Table 4 summarizes the City of Mesa land use types within the watershed area and the corresponding Maricopa County equivalent land use category, as presented in the FCDMC *Hydrology*. Exhibit 3 - Land Use Map shows the land use types with the drainage area delineations. The fraction of each land use type within each sub-basin is summarized in Table 5.

Table 1
Sub-basin Parameters

MFC001					Date:	May-97
calculations by:		WVH				
checked by:		RHF				
Drainage Area #	Area (mi^2)	L (mi)	S (ft / mi)	Land Type	Kb	
1	0.041	0.244	19.2	A	0.031	
2	0.117	0.662	18.4	A	0.028	
3	0.062	0.395	23.0	A	0.030	
4	0.093	0.608	19.7	A	0.029	
5	0.146	0.639	25.0	A	0.028	
6	0.065	0.443	23.9	A	0.030	
8	0.037	0.298	28.2	B	0.061	
9	0.067	0.415	34.2	B	0.058	
10	0.082	0.523	21.2	B	0.056	
11	0.063	0.491	20.8	A	0.030	
12	0.131	0.653	24.3	B	0.054	
13	0.183	0.909	27.3	B	0.052	
15	0.141	0.770	29.4	A	0.028	
16	0.100	0.452	27.0	B	0.055	
17	0.100	0.787	35.7	A	0.029	
18	0.108	0.634	39.0	A	0.028	
19	0.069	0.418	31.1	B	0.057	
20	0.149	0.662	35.5	B	0.053	
21	0.060	0.520	27.9	B	0.058	
22	0.053	0.369	26.3	B	0.059	
23	0.090	0.634	28.1	B	0.056	
24	0.097	0.616	28.1	B	0.055	
25	0.109	0.588	29.8	B	0.055	
26	0.165	0.705	33.1	B	0.053	
27	0.050	0.341	22.3	B	0.059	
28	0.050	0.358	24.9	B	0.058	
29	0.063	0.378	28.9	B	0.058	
30	0.063	0.381	30.5	B	0.058	
31	0.030	0.313	25.3	A	0.032	
32	0.033	0.283	31.1	B	0.062	
33	0.062	0.537	33.5	B	0.058	
34	0.065	0.540	32.4	B	0.058	
35	0.062	0.526	32.9	B	0.058	
36	0.071	0.514	31.3	B	0.057	
37	0.069	0.455	28.2	A	0.030	
38	0.049	0.361	42.7	A	0.031	
39	0.074	0.446	36.3	A	0.030	
40	0.055	0.398	31.4	A	0.030	
41	0.031	0.267	37.5	B	0.062	
42	0.073	0.682	21.1	A	0.030	
43	0.062	0.483	24.9	A	0.030	
44	0.112	0.625	20.8	A	0.028	
45	0.067	0.543	36.5	B	0.058	
46	0.058	0.568	32.4	B	0.058	
47	0.048	0.426	23.2	A	0.031	
48	0.123	0.616	27.1	B	0.054	
49	0.131	0.676	28.5	A	0.028	
50	0.071	0.599	33.2	B	0.057	

Table 1
Sub-basin Parameters

MFC001					Date:	May-97
calculations by:		WVH				
checked by:		RHF				
Drainage Area #	Area (mi^2)	L (mi)	S (ft / mi)	Land Type	Kb	
51	0.057	0.514	39.3	A	0.030	
52	0.085	0.415	40.7	A	0.029	
53	0.042	0.403	34.7	A	0.031	
54	0.060	0.395	40.3	A	0.030	
55	0.070	0.341	30.5	A	0.030	
56	0.049	0.420	43.8	B	0.059	
57	0.058	0.349	23.2	B	0.058	
58	0.075	0.560	37.0	A	0.030	
59	0.082	0.443	49.6	B	0.056	
60	0.136	0.568	24.1	A	0.028	
61	0.071	0.389	45.7	B	0.057	
62	0.025	0.293	30.8	B	0.063	
63	0.122	0.625	21.4	B	0.054	
64	0.061	0.491	23.8	A	0.030	
65	0.081	0.474	31.6	B	0.056	
66	0.068	0.366	32.7	B	0.057	
67	0.069	0.676	30.3	A	0.030	
68	0.053	0.619	22.9	A	0.030	
69	0.075	0.568	34.7	A	0.030	
70	0.055	0.540	36.9	A	0.030	
71	0.101	0.594	32.7	A	0.029	
73	0.059	0.349	34.3	A	0.030	
74	0.064	0.338	34.3	A	0.030	
76	0.132	0.682	39.2	A	0.028	
77	0.137	1.182	22.0	B	0.053	
79	0.120	0.548	36.1	B	0.054	
80	0.108	0.455	31.5	A	0.029	
81	0.054	0.531	40.7	B	0.059	
82	0.047	0.460	34.8	B	0.060	
83	0.035	0.435	32.7	A	0.032	
84	0.047	0.341	8.8	A	0.031	
85	0.121	0.560	28.6	B	0.054	
86	0.095	0.517	25.7	A	0.029	
87	0.055	0.443	27.5	A	0.030	
88	0.084	0.616	35.7	A	0.029	
89	0.067	0.690	40.8	B	0.058	
90	0.092	0.634	37.9	A	0.029	
91	0.079	0.358	34.4	B	0.057	
92	0.074	0.636	18.9	A	0.030	
93	0.048	0.460	50.0	A	0.031	
94	0.102	0.517	20.7	A	0.029	
96	0.069	0.423	15.8	B	0.057	
97	0.043	0.278	14.4	B	0.060	
98	0.045	0.347	28.9	A	0.031	
99	0.075	0.449	32.5	B	0.057	
100	0.052	0.577	30.3	A	0.031	

Table 1
Sub-basin Parameters

MFC001						Date:	May-97
calculations by:		WVH					
checked by:		RHF					
Drainage Area #	Area (mi^2)	L (mi)	S (ft / mi)	Land Type	Kb		
101	0.087	0.628	30.9	B	0.056		
102	0.097	0.682	23.5	A	0.029		
103	0.09	0.625	27.5	A	0.029		
104	0.073	0.54	29.6	A	0.03		
105	0.036	0.428	29.9	A	0.031		
106	0.067	0.537	22.3	B	0.058		
107	0.154	0.563	26.7	B	0.053		
108	0.099	0.642	25.4	A	0.029		
110	0.072	0.42	25.7	A	0.03		
111	0.056	0.395	28.4	A	0.03		
112	0.044	0.358	29.9	B	0.06		
113	0.092	0.705	23.0	A	0.029		
114	0.080	0.631	25.4	A	0.029		
115	0.042	0.341	29.3	A	0.031		
116	0.140	0.631	27.3	A	0.028		
118	0.158	0.767	31.7	A	0.027		
120	0.057	0.34	30.0	B	0.059		
121	0.040	0.364	22.0	B	0.061		
122	0.093	0.469	24.7	B	0.056		
123	0.103	0.542	33.2	B	0.055		
124	0.072	0.57	38.6	B	0.057		
125	0.101	0.7	37.2	A	0.029		
128	0.114	0.662	29.3	B	0.054		
129	0.116	0.588	30.6	B	0.054		
130	0.087	0.537	24.2	B	0.056		
131	0.051	0.349	13.7	A	0.031		
132	0.093	0.537	22.3	B	0.056		
133	0.051	0.489	18.4	B	0.059		
134	0.101	0.511	35.2	B	0.055		
135	0.105	0.645	24.8	B	0.055		
136	0.066	0.406	29.5	B	0.058		
137	0.032	0.517	75.4	B	0.062		
138	0.073	0.557	27.5	B	0.057		
139	0.098	0.54	27.8	B	0.055		
141	0.038	0.324	30.9	B	0.061		
142	0.084	0.375	32.0	B	0.056		
143	0.093	0.622	38.6	B	0.056		
144	0.069	0.491	36.6	B	0.057		
146	0.044	0.509	83.2	B	0.06		
147	0.084	0.599	33.4	B	0.056		
148	0.047	0.483	41.4	B	0.06		
149	0.087	0.767	39.1	B	0.056		
150	0.096	0.594	40.4	B	0.055		

Table 1
Sub-basin Parameters

MFC001					Date:	May-97
calculations by:		WVH				
checked by:		RHF				
Drainage Area #	Area (mi^2)	L (mi)	S (ft / mi)	Land Type	Kb	
151	0.022	0.278	37.7	A	0.033	
152	0.040	0.489	26.4	B	0.061	
153	0.039	0.349	24.9	B	0.061	
155	0.043	0.313	38.1	A	0.031	
156	0.129	0.568	18.1	A	0.028	
157	0.152	0.758	17.8	A	0.028	
158	0.089	0.455	13.9	A	0.029	
159	0.076	0.758	13.7	A	0.029	
160	0.078	0.568	19.9	A	0.029	
161	0.088	0.606	5.6	A	0.029	
162	0.137	0.653	24.0	A	0.028	
163	0.152	0.758	18.1	A	0.028	
164	0.091	0.464	35.3	B	0.056	
165	0.097	0.653	25.7	B	0.055	
166	0.081	0.786	24.2	B	0.056	
168	0.051	0.474	24.7	B	0.059	

Total Drainage area (mi^2)
12.146

TABLE 2
SOIL TYPE DESCRIPTIONS

Mapping Symbol	Mapping Unit
PnA	Pinal gravelly loam, 0 to 1% slopes
Po	Pinal loam, moderately deep variant
PnC	Pinal gravelly loam, 1 to 3% slopes
AnA	Antho sandy loam, 0 to 1% slopes
LaA	Laveen loam, 0 to 1% slopes
Gm	Gilman loam
Co	Contine clay loam
Es	Estrella loam
Mv	Mohall loam
RIA	Rillito gravelly loam, 0 to 1% slopes
Ru	Rough broken sand
Mo	Mohall sandy loam

Table 3
Sub-basin Soil Types

MFC001						date:	May-97
calculations by:		WVH					
checked by:		RHF		Soil Types (mi²)			
Drainage Area #	Area (mi²)		PnA	Po	LaA	Mv	
1	0.041			0.037	0.004		
2	0.117		0.027	0.008	0.082		
3	0.062		0.034	0.001	0.027		
4	0.093		0.027	0.033	0.033		
5	0.146		0.047	0.055	0.044		
6	0.065		0.016	0.033	0.016		
8	0.037		0.018	0.019			
9	0.067		0.018	0.037	0.012		
10	0.082		0.021	0.044	0.017		
11	0.063		0.031	0.025	0.007		
12	0.131		0.056	0.044	0.031		
13	0.183		0.015	0.039	0.129		
15	0.141		0.001	0.009	0.131		
16	0.100				0.100		
17	0.100				0.100		
18	0.108				0.108		
19	0.069				0.069		
20	0.149				0.149		
21	0.060		0.015		0.045		
22	0.053		0.024	0.005	0.024		
23	0.090		0.008	0.031	0.051		
24	0.097			0.012	0.085		
25	0.109		0.023	0.065	0.021		
26	0.165		0.032	0.049	0.016	0.068	
27	0.050					0.050	
28	0.050				0.006	0.044	
29	0.063				0.035	0.028	
30	0.063					0.063	
31	0.030					0.030	
32	0.033					0.033	
33	0.062				0.001	0.061	
34	0.065				0.006	0.059	
35	0.062					0.062	
36	0.071					0.071	
37	0.069				0.038	0.031	
38	0.049				0.001	0.048	
39	0.074					0.074	
40	0.055					0.055	
41	0.031					0.031	
42	0.073					0.073	
43	0.062					0.062	
44	0.112					0.112	
45	0.067					0.067	
46	0.058					0.058	
47	0.048					0.048	
48	0.123					0.123	
49	0.131					0.131	
50	0.071					0.071	

Table 3
Sub-basin Soil Types

MFC001						date:	May-97
calculations by:	WVH						
checked by:	RHF		Soil Types (mi^2)				
Drainage Area #	Area (mi^2)	Mo	Mv	Co	Gm	Es	
51	0.057		0.057				
52	0.085		0.070		0.015		
53	0.042		0.042				
54	0.060		0.058		0.002		
55	0.070		0.070				
56	0.049		0.041		0.008		
57	0.058		0.058				
58	0.075		0.075				
59	0.083		0.040		0.043		
60	0.136		0.044	0.092			
61	0.071		0.049	0.022			
62	0.025			0.025			
63	0.122			0.122			
64	0.061			0.061			
65	0.081			0.081			
66	0.068			0.063		0.005	
67	0.069		0.004	0.065			
68	0.053		0.015	0.038			
69	0.075	0.003	0.007	0.065			
70	0.055		0.055				
71	0.101		0.075	0.026			
73	0.059		0.003	0.025		0.031	
74	0.064			0.025		0.039	
76	0.132		0.037		0.085	0.010	
77	0.137				0.068	0.069	
79	0.120			0.088	0.008	0.024	
80	0.108				0.108		
81	0.054	0.002	0.003	0.019	0.030		
82	0.047	0.008	0.011	0.006	0.022		
83	0.035				0.035		
84	0.047	0.002	0.035	0.010			
85	0.121	0.012	0.104	0.005			
86	0.095	0.001	0.060		0.034		
87	0.055	0.004	0.049			0.002	
88	0.084		0.008		0.034	0.042	
89	0.067		0.048			0.019	
90	0.092		0.059			0.033	
91	0.079	0.026	0.005			0.048	
92	0.074	0.022	0.052				
93	0.048		0.048				
94	0.102		0.101		0.001		
96	0.069		0.014		0.055		
97	0.043				0.043		
98	0.045		0.045				
99	0.075		0.075				
100	0.052		0.052				

Table 3
Sub-basin Soil Types

MFC001						date:	May-97
calculations by:		WVH					
checked by:		RHF		Soil Types			
				(mi^2)			
Drainage	Area						
Area #	(mi^2)		Gm	Mv	AnA	Es	
101	0.087		0.011	0.076			
102	0.097		0.097				
103	0.090		0.090				
104	0.073		0.072		0.001		
105	0.036			0.036			
106	0.067		0.004	0.063			
107	0.154		0.137		0.017		
108	0.099		0.068		0.031		
110	0.072		0.025	0.046		0.001	
111	0.056		0.034	0.022			
112	0.044		0.026	0.018			
113	0.092		0.046	0.046			
114	0.080		0.065	0.015			
115	0.042		0.042				
116	0.140		0.139		0.001		
118	0.158		0.112		0.046		
120	0.057		0.057				
121	0.040		0.040				
122	0.093		0.093				
123	0.103		0.103				
124	0.072		0.057		0.015		
125	0.101		0.101				
128	0.114		0.104	0.010			
129	0.116		0.059	0.057			
130	0.087		0.001		0.082	0.004	
131	0.051		0.051				
132	0.093		0.080		0.013		
133	0.051		0.026		0.025		
134	0.101		0.080		0.021		
135	0.105		0.059			0.046	
136	0.066		0.066				
137	0.032		0.032				
138	0.073		0.046		0.027		
139	0.098		0.001	0.027	0.070		
141	0.038		0.021	0.017			
142	0.084		0.001	0.036	0.047		
143	0.093		0.093				
144	0.069		0.069				
146	0.044		0.041		0.003		
147	0.084		0.048	0.006	0.030		
148	0.047		0.043		0.004		
149	0.087		0.052	0.021	0.014		
150	0.096		0.018	0.063	0.015		

Table 3
Sub-basin Soil Types

MFC001 date: May-97
calculations by: WVH
checked by: RHF

Drainage Area #	Area (mi^2)		Soil Types (mi^2) Po	PnA	LaA	Mv	PnC	RIA	Ru
151	0.022		0.006	0.008	0.008				
152	0.040				0.040				
153	0.039		0.001	0.037	0.001				
155	0.043					0.043			
156	0.129		0.022	0.002	0.105				
157	0.152		0.048	0.054	0.050				
158	0.089		0.027	0.024	0.038				
159	0.076		0.005	0.026	0.045				
160	0.078			0.053	0.025				
161	0.088			0.039	0.049				
162	0.137		0.037	0.086	0.014				
163	0.152		0.001	0.051	0.100				
164	0.091		0.069	0.005				0.017	
165	0.097		0.009	0.008	0.032		0.048		
166	0.081		0.023	0.041	0.002		0.006	0.006	0.003
168	0.051		0.010	0.014	0.027				

TABLE 4
LAND USE DESCRIPTIONS

Maricopa County Land Use Category	City of Mesa Zoning Unit	City of Mesa Description
Agriculture	AG	Agriculture
Low Density Residential	RI-90	Single Residence
Medium Density Residential	RI-35 RI-15	Single Residence Single Residence
Multiple Family Residence	RI-9 RI-7	Single Residence Single Residence
Industrial	M-1	Limited Industrial
Commercial	C-2 C-3 OS	Limited Commercial General Commercial Office-Services

Table 5
Sub-basin Land Use Types

MFC001									date:	May-97
calculations by:		WVH								
checked by:		RHF				Land Use				
						(mi^2)				
Drainage	Area		AG	C-2,C-3.O-S	R-2, R-3	R1-7,R1-9	R1-15, R1-35	R1-43	M-1	
Area #	(mi^2)		AG	Comm	M-F-R	M-D-R	L-D-R	V-L-D-R	Ind	
1	0.041					0.033	0.008			
2	0.117					0.083	0.034			
3	0.062			0.006	0.036	0.020				
4	0.093					0.093				
5	0.146					0.145	0.001			
6	0.065			0.001	0.041	0.023				
8	0.037			0.004	0.019	0.014				
9	0.067			0.015	0.034			0.018		
10	0.082			0.026			0.010	0.046		
11	0.063			0.063						
12	0.131						0.131			
13	0.183		0.074				0.109			
15	0.141						0.141			
16	0.100						0.100			
17	0.100						0.100			
18	0.108						0.108			
19	0.069						0.069			
20	0.149						0.149			
21	0.060		0.060							
22	0.053			0.009				0.044		
23	0.090		0.090							
24	0.097		0.097							
25	0.109		0.003				0.106			
26	0.165		0.165							
27	0.050		0.050							
28	0.050		0.050							
29	0.063		0.063							
30	0.063		0.063							
31	0.030						0.030			
32	0.033		0.033							
33	0.062		0.047				0.015			
34	0.065		0.048				0.017			
35	0.062		0.030				0.032			
36	0.071		0.053				0.018			
37	0.069						0.069			
38	0.049						0.049			
39	0.074						0.074			
40	0.055						0.055			
41	0.031						0.031			
42	0.073						0.073			
43	0.062						0.062			
44	0.112						0.112			
45	0.067						0.067			
46	0.058						0.058			
47	0.048						0.048			
48	0.123		0.123							
49	0.131					0.131				
50	0.071		0.071							

Table 5
Sub-basin Land Use Types

MFC001									date:	May-97
calculations by:		WVH								
checked by:		RHF				Land Use				
						(mi²)				
Drainage	Area		AG	C-2,C-3.O-S	R-2, R-3	R1-7,R1-9	R1-15, R1-35	R1-43	M-1	
Area #	(mi²)		AG	Comm	M-F-R	M-D-R	L-D-R	V-L-D-R	Ind	
51	0.057		0.045				0.012			
52	0.085		0.045				0.04			
53	0.042						0.042			
54	0.060						0.06			
55	0.070						0.07			
56	0.049						0.049			
57	0.058					0.011	0.047			
58	0.075					0.075				
59	0.082		0.056		0.026					
60	0.136			0.136						
61	0.071			0.033	0.003	0.035				
62	0.025				0.025					
63	0.122				0.122					
64	0.061			0.019	0.042					
65	0.081				0.081					
66	0.068			0.021	0.047					
67	0.069			0.047	0.022					
68	0.053				0.053					
69	0.075			0.007	0.068					
70	0.055					0.055				
71	0.101			0.015	0.086					
73	0.059			0.022	0.037					
74	0.064			0.018	0.046					
76	0.132			0.022	0.11					
77	0.137				0.137					
79	0.120			0.071	0.049					
80	0.108			0.007	0.101					
81	0.054		0.003	0.041	0.01					
82	0.047				0.047					
83	0.035			0.035						
84	0.047			0.009	0.038					
85	0.121		0.049	0.025	0.038		0.009			
86	0.095				0.095					
87	0.055				0.055					
88	0.084			0.006	0.078					
89	0.067				0.067					
90	0.092				0.092					
91	0.079				0.079					
92	0.074			0.012	0.013	0.049				
93	0.048			0.001	0.015	0.032				
94	0.102					0.1		0.002		
96	0.069							0.069		
97	0.043			0.034				0.009		
98	0.045			0.007	0.038					
99	0.075				0.075					
100	0.052				0.052					

Table 5
Sub-basin Land Use Types

MFC001									date:	May-97
calculations by:		WVH								
checked by:		RHF				Land Use				
						(mi^2)				
Drainage	Area		AG	C-2,C-3.O-S	R-2, R-3	R1-7,R1-9	R1-15, R1-35	R1-43	M-1	
Area #	(mi^2)		AG	Comm	M-F-R	M-D-R	L-D-R	V-L-D-R	Ind	
101	0.087				0.087					
102	0.097				0.097					
103	0.090				0.090					
104	0.073			0.002	0.071					
105	0.036				0.036					
106	0.067				0.067					
107	0.154				0.154					
108	0.099			0.017	0.082					
110	0.072			0.006	0.066					
111	0.056				0.056					
112	0.044		0.009	0.013	0.022					
113	0.092		0.015			0.077				
114	0.080					0.080				
115	0.042		0.022			0.020				
116	0.140					0.140				
118	0.158			0.051		0.107				
120	0.057		0.057							
121	0.040			0.040						
122	0.093						0.058	0.035		
123	0.103			0.021		0.011	0.071			
124	0.072		0.053			0.019				
125	0.101					0.099	0.002			
128	0.114		0.018	0.012		0.081	0.003			
129	0.116						0.067		0.049	
130	0.087		0.056						0.031	
131	0.051			0.007			0.044			
132	0.093			0.017		0.076				
133	0.051					0.051				
134	0.101		0.061			0.040				
135	0.105		0.097	0.006					0.002	
136	0.066		0.012			0.043			0.011	
137	0.032					0.032				
138	0.073		0.036			0.037				
139	0.098		0.098							
141	0.038		0.027			0.011				
142	0.084		0.084							
143	0.093				0.008	0.083	0.002			
144	0.069			0.013	0.017	0.039				
146	0.044					0.044				
147	0.084		0.027			0.057				
148	0.047		0.038			0.009				
149	0.087		0.087							
150	0.096		0.072	0.021			0.003			

Table 5
Sub-basin Land Use Types

MFC001									date:	May-97
calculations by:		WVH								
checked by:		RHF				Land Use				
						(mi^2)				
Drainage	Area		AG	C-2,C-3.O-S	R-2, R-3	R1-7,R1-9	R1-15, R1-35	R1-43	M-1	
Area #	(mi^2)		AG	Comm	M-F-R	M-D-R	L-D-R	V-L-D-R	Ind	
151	0.022						0.022			
152	0.040						0.040			
153	0.039					0.039				
155	0.043			0.006	0.014		0.023			
156	0.129						0.129			
157	0.152						0.152			
158	0.089						0.089			
159	0.076						0.076			
160	0.078						0.078			
161	0.088					0.082	0.006			
162	0.137					0.133	0.004			
163	0.152					0.138	0.014			
164	0.091					0.020	0.071			
165	0.097					0.016	0.081			
166	0.081					0.029	0.052			
168	0.051			0.009				0.042		

3.2.2.2 Green and Ampt Parameters

Rainfall losses were estimated using the Green and Ampt infiltration method. This method is based on the assumption that rainfall loss is a two-part process. Initially, all rainfall is lost until the accumulated rainfall value equals the initial abstraction value (IA). The initial abstraction value is dependent upon land use and soil cover. The second phase of loss is infiltration.

The Green and Ampt equation is based upon three infiltration parameters, hydraulic conductivity at natural saturation (XKSAT), wetting front capillary suction (PSIF), and volumetric soil moisture deficit (DTHETA). These infiltration parameters are functions of soil characteristics, ground surface characteristics, and land management practices.

In addition to the three infiltration parameters, the HEC-1 application of the Green and Ampt method requires the input of an initial abstraction (IA) parameter and the impervious percentage of the sub-basin (RTIMP).

3.2.2.3 Clark Unit Hydrograph Parameters

The Clark Unit Hydrograph method was used to produce storm discharge hydrographs at sub-basin concentration points. This method involves three parameters: time of concentration (T_c), a storage coefficient (R), and a graphical time-area relation.

The time of concentration is described as the travel time for a flood wave to move from the most hydraulically distant point in the watershed to the concentration point. The FCDMC *Hydrology*, provides an empirical equation for calculating T_c. This equation is based upon the average rainfall intensity (*I*) and the following sub-basin characteristics described in Section 3.2.2.1: the length of the flow path (L), a representative watershed resistance coefficient (K_b), and the slope of the watercourse (S).

The storage coefficient represents the effect that temporary storage within the watershed has on the hydrograph. The manual also provides the equation for estimating R in Maricopa County. This equation is based upon T_c, the drainage area, and the length of the flow path.

The time-area relation provides the cumulative area of the watershed that is contributing runoff to the outlet at a given time. The FCDMC *Hydrology* provides values for three synthetic dimensionless time-area relations for the Clark Unit Hydrograph method. One time-area relation provided applies to urban watersheds. The second time-area relation provided in the manual applies to natural, undeveloped watersheds, and the third time-area relation is manually input by the user. The time-area relation for urban watersheds was used for most sub-basins within the study area, with the exception of agricultural area to which the natural watershed time-area relation was applied.

3.2.2.4 Reach Routing Parameters

The Normal-Depth Routing procedure was used for flood routing of hydrographs. This method uses the Modified Puls procedure with storage and discharge information calculated by HEC-1 from the channel characteristics entered on the RC, RX, and RY cards.

The routing cross-sections were developed using several different methods. The different types of channels considered were street cross-sections, well defined channels, and poorly defined overland flow.

Street sections were classified based upon City of Mesa standard street types. All street sections within a range of width were similarly typed and an equivalent street section was developed for that type. The equivalent section was determined by calculating the hydraulic radius of the typical street section and calculating a rectangular channel with an equal hydraulic radius and similar width.

For well defined channels, a cross-section was taken and its dimensions obtained through interpolation of contour line on the topographic map.

For poorly defined overland flow, a cross-section was taken at approximately uniform sections and a trapezoidal shape was approximated. The cross-section was given a large width to hold a shallow flow.

Values used for Manning's 'n' are as follows. A value of n=0.016 was used for street sections with n=0.013 for the overbanks (sidewalks). For earthen channels, a value of n=0.027 was used. For shotcrete channels, a value of n=0.022 was used. A value of n=0.055 was used for poorly defined overland flow channels.

Infiltration or percolation within routing sections was not considered due to most of the channel sections being impervious (either street sections or shotcrete channels).

3.2.2.5 Storage Routing Parameters

Reservoir storage routing was performed at existing retention basins. Retention basin sizes were calculated using the 1"=200' scale detailed topographic maps. Storage volumes were calculated for different elevations using the conic method presented in the Section 3.6.6 of the HEC-1 manual. The HEC-1 cards were then encoded with storage-elevation information.

3.2.2.6 HEC-1 Model Set-Up

The five Green and Ampt loss rate parameters described in Section 3.2.2.2 were calculated using the Sub-basin Preparation portion of the FCDMC Drainage Design Menu System for HEC-1 input. This portion of the menu system prompts the user to enter a data set for each sub-basin. The data entered includes the sub-basin identifier, the location within Maricopa County (Aguilla-Carefree area, central area, or eastern area) and the sub-basin size. Next, soil types are entered with the corresponding areal size within the sub-basin. Using this information, the program calculates the percentage of each soil type within the sub-basin. Similarly, the area for each land use type present within the sub-basin is entered into the Land Use Table and the program calculates the percentage of the sub-basin for each land use type. With this information, the program calculates the IA, DTHETA, PSIF, XKSAT, and RTIMP for input into the HEC-1 LG card.

The Maricopa County Unit Hydrograph Procedure 1 (MCUHP-1) was used to calculate the T_c and R parameters and build the HEC-1 input file for the Clark Unit Hygrograph. To achieve this, the program first prompts for the input of several rainfall parameters. Then, the basin characteristics of area, flow path length resistance coefficient (Kb), and slope are entered. The Green and Ampt parameters, as described in Section 3.2.2.2, are also entered. The program then prompts for the selection of the time-area relation, either urban or natural basin synthetic relation or a manually input relation. The program then provides a HEC-1 input file which contains the appropriate Clark input (UC and UA cards).

The output from the MCUHP1 program was edited and assembled according to Exhibit 4 - HEC-1 Flow Schematic. This exhibit was developed to logically describe the sequence of the HEC-1 model. It depicts the order of hydrograph generation, reach routing, hydrograph combination, and storage routing. The HEC-1 simulation is completed at the concentration point located at the watershed outlet located at the southwest corner of the study area.

3.2.3 Statistical Parameters

The statistical parameters used for this study are based upon information obtained from the FCDMC *Hydrology.*

3.2.4 Precipitation

3.2.4.1 Rainfall Depth

The design storms studied for this hydrologic analysis are the 10-year, 6-hour, 100-year, 6-hour, and 100-year, 24-hour storms. The rainfall depth-duration-frequency statistics for use in Maricopa County are described in the FCDMC *Hydrology*. This section of the manual contains isopluvial maps for Maricopa County which have been taken from the NOAA Precipitation-Frequency Atlas of the Western United States. The project watershed area was located on the isopluvial maps and the rainfall depth was determined for the 2-, 5-, 10-, 25-, 50-, and 100-year frequencies, 6-hour and 24-hour duration storms.

With these values, the FCDMC PREFRE program developed a line of best fit to the points read from the isopluvial maps. The program then recalculated the frequency-duration depths for the project watershed area based upon the best fit relationship. Point rainfall depths calculated using PREFRE for the study watershed area are listed in Table 6. The point rainfall depth calculated for the 10-year, 6-hour storm is 1.88 inches, the 100-year, 6-hour depth is 2.96 inches, and the 100-year, 24-hour depth is 3.39 inches.

3.2.4.2 Depth-Area Reduction Factors

The point rainfall depth represents the value that is expected to occur at a point in the watershed for a specific frequency-duration storm event. This point depth is converted to an areally-averaged rainfall that is expected to fall over the entire watershed by multiplying the point rainfall depth by a depth-area reduction factor.

The factors for the 6-hour storm used by Maricopa County are from the depth-area reduction curve developed by the US Army Corps of Engineers for a historical 1954 Queen Creek storm. The depth area reduction factors corresponding to this curve are presented in Table 2.2 of the FCDMC *Hydrology* and reproduced in Table 7 of this report.

The factors for the 24-hour storm used by Maricopa County are from the NWS HYDRO-40. These depth area reduction factors are given in Table 2.1a of the FCDMC *Hydrology* and presented in Table 8 of this report.

Based upon the size of the watershed entered into the FCDMC DDMS, the program determined the appropriate reduction factor and applied it to the point rainfall depths to obtain the areally-averaged depths. The 6-hour reduction factor applied is 0.934. The 24-hour reduction factor applied is also 0.934. These factors are multiplied by the appropriate point rainfall depth for each of the three design frequency-duration storms in Table 9.

3.2.4.3 Rainfall Distributions

The MCUHP1 program within the FCDMC DDMS was used to convert the rainfall depths into the appropriate storm pattern based upon the drainage area size. The 6-hour and the 24-hour storm distributions have been encoded in the FCDMC MCUHP programs.

Maricopa County uses five patterns of dimensionless 6-hour storm distributions. The patterns are dependent upon drainage area size. The FCDMC Hydrology manual provides a figure to determine which pattern is appropriate based upon drainage area size. For the 6-hour storm, the program used Pattern No. 2.84. This pattern distribution is listed in Table 10.

For the 24-hour storm distribution, Maricopa County recommends the use of the SCS Type II distribution, which is presented in Table 11.

TABLE 6
POINT RAINFALL VALUES

POINT VALUES (Inches)							
Return Period							
Duration	***2-YR***	***5-YR***	***10-YR***	***25-YR***	***50-YR***	***100-YR***	***500-YR***
5-MIN	.30	.40	.48	.58	.66	.74	.92
10-MIN	.44	.61	.73	.88	1.01	1.13	1.41
15-MIN	.54	.77	.92	1.13	1.29	1.45	1.82
30-MIN	.72	1.03	1.24	1.52	1.74	1.96	2.47
1-HR	.87	1.27	1.53	1.90	2.18	2.45	3.09
2-HR	.95	1.37	1.65	2.04	2.33	2.63	3.31
3-HR	1.00	1.44	1.73	2.13	2.44	2.74	3.45
6-HR	1.10	1.56	1.88	2.30	2.64	2.96	3.72
12-HR	1.19	1.69	2.02	2.47	2.83	3.18	3.98
24-HR	1.28	1.81	2.16	2.64	3.02	3.39	4.25

TABLE 7
DEPTH-AREA REDUCTION FACTORS FOR 6-HOUR DURATION RAINFALL

Area Square Miles	*Ratio to Point Rainfall*
0	1.0
1	0.987
5	0.96
10	0.94
20	0.91
30	0.89
40	0.87
50	0.86
100	0.80
200	0.72
300	0.66
400	0.61
500	0.57

TABLE 8
DEPTH-AREA REDUCTION FACTORS FOR 24-HOUR DURATION RAINFALL

Area Square Miles	*Ratio to Point Rainfall*
0	1.0
10	0.94
20	0.91
30	0.90
40	0.88
50	0.87
60	0.86
70	0.856
80	0.855
90	0.846
100	0.842
110	0.838
120	0.834
130	0.833
140	0.829
150	0.825
200	0.817
300	0.80
400	0.79
500	0.78

TABLE 9
AREALLY-AVERAGED RAINFALL VALUES

Design Storm	Point Rainfall Value	Depth-Area Reduction Factor	Drainage Area Average Rainfall Value
10-year 6-hour	1.88	0.934	1.756
100-year 6-hour	2.96	0.934	2.765
100-year 24-hour	3.39	0.934	3.166

TABLE 10
6-HOUR DISTRIBUTION

Time (Hrs)	*Pattern 2.84 (Fraction Rainfall Depth)*
0:00	0.0
0:15	0.014
0:30	0.019
0:45	0.029
1:00	0.046
1:15	0.060
1:30	0.072
1:45	0.085
2:00	0.099
2:15	0.112
2:30	0.127
2:45	0.143
3:00	0.166
3:15	0.212
3:30	0.295
3:45	0.469
4:00	0.674
4:15	0.803
4:30	0.873
4:45	0.916
5:00	0.947
5:15	0.960
5:30	0.973
5:45	0.987
6:00	1.000

TABLE 11
SCS 24-HOUR DISTRIBUTION
TYPE II

Time (Hrs)	Fraction of Rainfall Depth	Time (Hrs)	Fraction of Rainfall Depth	Time (Hrs)	Fraction of Rainfall Depth	Time (Hrs)	Fraction of Rainfall Depth
0:00	0.000	6:15	0.085	12:15	0.707	18:15	0.926
0:15	0.002	6:30	0.090	12:30	0.735	18:30	0.930
0:30	0.005	6:45	0.095	12:45	0.758	18:45	0.934
0:45	0.008	7:00	0.100	13:00	0.776	19:00	0.938
1:00	0.011	7:15	0.105	13:15	0.791	19:15	0.942
1:15	0.014	7:30	0.110	13:30	0.804	19:30	0.946
1:30	0.017	7:45	0.115	13:45	0.815	19:45	0.950
1:45	0.020	8:00	0.120	14:00	0.825	20:00	0.953
2:00	0.023	8:15	0.126	14:15	0.834	20:15	0.956
2:15	0.026	8:30	0.133	14:30	0.842	20:30	0.959
2:30	0.029	8:45	0.144	14:45	0.849	20:45	0.962
2:45	0.032	9:00	0.147	15:00	0.856	21:00	0.965
3:00	0.035	9:15	0.155	15:15	0.863	21:15	0.968
3:15	0.038	9:30	0.163	15:30	0.869	21:30	0.971
3:30	0.041	9:45	0.172	15:45	0.875	21:45	0.974
3:45	0.044	10:00	0.181	16:00	0.881	22:00	0.977
4:00	0.048	10:15	0.191	16:15	0.887	22:15	0.980
4:15	0.052	10:30	0.203	16:30	0.893	22:30	0.983
4:30	0.056	10:45	0.218	16:45	0.898	22:45	0.986
4:45	0.060	11:00	0.236	17:00	0.903	23:00	0.898
5:00	0.064	11:15	0.257	17:15	0.908	23:15	0.992
5:15	0.068	11:30	0.283	17:30	0.913	23:30	0.995
5:30	0.072	11:45	0.387	17:45	0.918	23:45	0.998
5:45	0.076	12:00	0.663	18:00	0.922	24:00	1.000
6:00	0.080						

3.2.5 Gage Data

There is no stream flow gage data available from the FCDMC or City of Mesa for the study area. The FCDMC does have historical precipitation data for the area but there is no historical stage data for model calibration.

3.3 CALIBRATION

Calibration of the HEC-1 models for this study was not performed due to the lack of historical storm and runoff data.

3.4.1 Storm Drain Diversions

The storm drain system was modeled using diversion cards within HEC-1. Flows which were considered to be diverted through a storm drain to a detention basin in another drainage area were handled as follows.

Using invert elevations for manholes along the storm drain and pipe sizes provided by the City of Mesa, the capacity for each segment of pipe was calculated. The Chezy-Manning equation was applied assuming full flowing pipes with a Manning coefficient of n=0.013. The slope was calculated using the change in invert elevations between manholes for the length of the pipe. The maximum amount of flow that could be intercepted by the storm drain was determined to be the capacity of the pipe between the last catch basin in an area and the outfall from the area. These values are calculated in Table 12, Summary of Storm Drain Diversion Data. The amount of flow intercepted by a storm drain in a drainage area was determined by multiplying the limiting flow in the storm drain system by the ratio of the sub-basin area to the area contributing to the storm drain. These values are summarized in Table 12 and Table 13, Summary of Storm Drain Intercepted Flows. This is best represented through the following example.

Maps supplied by the City of Mesa indicate a storm drain which runs beneath Greenfield Road beginning in Sub-basin Area 41 and through all intermediate sub-areas until it outlets to the detention basin in Sub-area 128. Storm drain records from the City of Mesa show that this is a 24-inch RCP from its first catch basin located north of Brown Road until it reaches University Drive where it transitions to a 42-inch RGRCP. Pipe lengths and invert elevations between manholes were obtained from City records and the slope of the pipe segments were calculated. Application of the Chezy-Manning equation yielded a limiting flow through each pipe segment. The assumption was made that flow through the limiting section of pipe would be at capacity.

In the Greenfield storm drain, it was determined that approximately 11 cfs could pass through the section of storm drain south of Adobe Drive. The sub-basins contributing to the storm drain flow through this segment of pipe were Areas 41, 52, 54 and 56. The sum of these four areas is the total area contributing to the storm drain flow and is approximately 0.222 square mile. The ratio of each individual area to the total area multiplied by the limiting flow rate of 11 cfs is the amount of flow that was diverted through the storm drain from each area. For example:

> Area 41 = 0.03 sq. mi.
> Ratio to total area = (0.03/0.222) = 0.135
> Total flow intercepted = 0.135 x 11 cfs ≈ 1.5 cfs

Area 52 = 0.083 sq. mi.
Ratio to total area = (0.083/0.222) = 0.374
Total flow intercepted = 0.374 x 11 cfs ≈ 4.1 cfs

Area 54 = 0.057 sq. mi.
Ratio to total area = (0.057/0.222) = 0.257
Total flow intercepted = 0.257 x 11 cfs ≈ 2.8 cfs

Area 56 = 0.052 sq. mi.
Ratio to total area = (0.052/0.222) = 0.234
Total flow intercepted = 0.234 x 11 cfs ≈ 2.6 cfs

Engineering judgements were used to determine the final value of diverted flow to be used in the HEC-1 model. These judgements were based upon the number of catch basins within an area and the position of the catch basins with respect to their location along the flow path. The final values used are listed in Table 12.

After diverting flows from a drainage area through the storm drain system, the diverted flows were recovered and combined at the detention basins with the flow that had remained on the surface.

3.4.2 RT Card

The RT Record - Straddle / Stagger Routing was utilized to assist in modeling the diverted flows from the surface into the storm drain system. This method introduces a lag time into the model to minimize distortion of the computed hydrographs based upon travel time in the pipe. Table 14 summarizes the values computed for this record. The value input into the third field of the record is the number of ordinate steps for the hydrograph of the intercepted flow to be lagged when it is reintroduced to the system at an outflow point in another drainage basin. This value is the reach length divided by the velocity multiplied by the ordinate step value and converted into equivalent units. The RT card was chosen over Kinematic Wave routing for the storm drains since for full flowing pipes, the two methods result in essentially the same result. These values were spot checked using the Kinematic Wave routing by the FCDMC during the generation of the model.

3.4.3 Surface Diversions

For some drainage areas, a difficulty in modeling occurred when it was found that storm drain flow and overland flow conflicted. For instance, some drainage areas had a storm drain system which diverted flow to a detention basin located in an area that contributed surface flow to the initial drainage area. This modeling problem was resolved by first calculating the hydrograph for the area without the detention basin, then using diversion cards to divert the surface flow. The remaining flow intercepted by the storm drain was routed to the detention basin and combined with surface flow from the drainage area within which the detention basin is located. The surface flow from the initial drainage area was retrieved. The flows were then combined and routed to the next concentration point.

One such situation occurred in Areas 15 and 151. Local topography shows that surface runoff from Area 151 will reach its concentration point, flow through Area 15, and combine with surface flow from Area 15 at its concentration point. However, some rainfall from Area 15 will be intercepted by a catch basin and storm drain system and be diverted to the detention basin in Area 151.

To solve the modeling problem created by this situation, the surface flow from Area 15 was diverted using HEC-1 diversion cards and the flow intercepted by the storm drain was routed from Area 15 to Area 151. Then, the surface flow from Area 151 was recalled and combined with the recalled surface flow from Area 15 and routed normally through the rest of the model. A similar situation occurred within Areas 116 and 118.

Table 12
Summary of Storm Drain Diversion Data

MFC001			Storm Drain Diversion data						"n" value		by	Bil Haas
					Values for flow limiting pipe section				0.013		date	May-97
diversion area ID	return area ID	Map ID	Street	begin MH ID	invert el. (ft)	end MH ID	invert el. (ft)	length (ft)	pipe dia. (in)	Vel (ft / s)	Q_{max} (ft^3 / s)	$Q_{intercepted}$ (ft^3 / s)
2	4		N. 24th St.		1299.30		1297.86	600	30	4.1	20.1	
15	151		N. Glenview		1296.25		1296.00	165	30	3.3	16.0	
6	25											56
8	25											8
25	26	59B	Eastern Canal	2235	1283.70	2244	1283.16	2160	72	2.4	67.0	67
36	N / A	67B										10
27	N / A	59B	Eastern Canal	2348	1282.96	2349	1282.89	610	48	1.2	15.4	5
71	N / A											10
49	N / A											14
60	N / A											30
63	N / A											4
62	N / A											4
		69A	N. Val Vista Dr.	2273	1271.24	2037	1270.34	245	48	6.9	87.1	
41	59											2
52	59											3
54	59											2
56	59											2
59	76	76B	N. Greenfield Rd.	1746	1318.00	1743	1315.90	605	24	4.2	13.3	13
76	77	76B	N. Greenfield Rd.	1740	1313.80	1739	1308.85	326	24	8.9	27.9	28
77	79	77A	N. Greenfield Rd.	1842	1307.50	1843	1307.00	280	42	4.4	42.5	42
79	86											49
81	86											1
82	86											1
86	101											59
98	101											1
100	101											1
101	104	78B	N. Greenfield Rd.	1506	1272.53	1518.00	1271.52	820	54	4.3	69.0	69
114	115											8
115	116											16
116	118											20
118	108											28
108	104	78B	E. Southern Ave.	1539	1286.83	1540.00	1284.92	437	36	6.2	44.1	44
103	104											7
104	128	71C	S. Greenfield Rd	1446	1267.87	1447.00	1267.20	679	72	4.7	133.0	133

Table 13
Summary of Storm Drain Intercepted Flows

MFC001						
		Storm Drain Intercepted flows for Individual Areas				
Area ID	total drainage area (mi^2)	% of total system drainage area	System Q_{max} (cfs)	Q intercepted by % (cfs)	sub - System Q_{max} (cfs)	ID for sub basins which drain to the intercepting sub basin
			67			
6	1.64	83.7%		56		156, 157, 158, 159, 160, 161, 162
8	0.076	3.9%		3		153
25	0.244	12.4%		8		10 , 22
			15			
36	0.538	69.7%		10		33, 34, 35, 37, 38, 39, 40, 41
27	0.234	30.3%		5		30, 31, 32
			72			
71	0.639	30.9%		22		52, 54, 56, 58, 59, 70, 76
49	0.131	6.3%		5		
60	1.151	55.7%		40		42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 53, 55, 57, 155
63	0.122	5.9%		4		
62	0.025	1.2%		1		
			69			
41	0.031	1.9%		1		
52	0.085	5.3%		4		
54	0.06	3.7%		3		
56	0.049	3.0%		2		
59	0.082	5.1%		3	13	
76	0.132	8.2%		6	28	
77	0.137	8.5%		6	42	
79	0.263	16.2%		11		80, 83
81	0.054	3.3%		2		
82	0.047	2.9%		2		
86	0.472	29.2%		20		87, 88, 89, 90, 91
98	0.12	7.4%		5		99
101	0.087	5.4%		4	69	
			44			
114	0.08	15.4%		7		
115	0.042	8.1%		4		
116	0.14	27.0%		12	22	
118	0.158	30.4%		13		
108	0.099	19.1%		8	44	
			133			
101	1.619	70.4%		94	69	
108	0.519	22.6%		30	44	
103	0.09	3.9%		5		
104	0.073	3.2%		4	133	

Table 14
Summary of RT Card Values

MFC001			
Calculation of the number of ordinate steps to be used in field 3 of the RT card			
Area ID	velocity (ft / s)	reach length (ft)	field 3 value
6	2.4	2780	3.9
8	2.4	3695	5.1
25	2.4	3595	5.0
41	4.1	4561	3.7
52	4.1	3643	3.0
54	4.1	1212	1.0
56	4.1	440	0.4
59	4.2	1201	1.0
76	4.4	1080	0.8
77	4.4	1350	1.0
79	4.3	2520	2.0
81	4.3	2013	1.6
82	4.3	1230	1.0
86	4.3	2625	2.0
98	4.3	1973	1.5
100	4.3	800	0.6
101	4.3	2404	1.9
114	6.2	1470	0.8
115	6.2	1037	0.6
116	6.2	1060	0.6
118	6.2	2181	1.2
108	6.2	2890	1.6
103	4.7	466	0.3
104	4.7	2615	1.9

3.5 Final Results

The watershed hydrology for the Eastern Canal was developed using HEC-1 models for the 10-year, 6-hour, 100-year, 6-hour, and 100-year, 24-hour duration storms. The results of the peak flows at concentration points along the Eastern Canal are summarized in Table 15. Table 16 summarizes the peak 100-year discharges and describes their location along the Eastern Canal.

From Table 16, the peak flow for the watershed is the result of the 100-year, 6-hour storm and occurs where US 60 meets the Eastern Canal (Concentration Point 91). The discharge is 1,532 cfs for an 11.13-square-mile drainage area.

Evaluation of the peak discharges along the canal and the 10-foot artificial extensions used in the routing procedures indicate that the entire 100-year flow rates are not contained within the existing canal configuration. This is further validated by the preliminary HEC-2 study performed by AN West which indicated that the actual capacity of the canal is much less than the flow rates generated by the watershed. Therefore, it was determined jointly by the City of Mesa and the Flood Control District of Maricopa County to discontinue with modeling of the break-outs that occur along the canal and instead describe the flood plain based upon the elevation of the top of bank. However, the hydrology of this project can be used as a guide for future projects or improvements in the watershed.

Table 15
Summary of Discharges
Along the Eastern Canal

MFC001 — Mesa Flood Plain Delineation Study — Date: May-97

STATION	Drainage Area (mi^2)	100-year 24-hr PEAK FLOW cfs	100-year 24-hr Q / A (cfs / mi2)	100-year 6-hr PEAK FLOW cfs	100-year 6-hr Q / A (cfs / mi2)	10-year 6-hr PEAK FLOW cfs	10-year 6-hr Q / A (cfs / mi2)	100-yr Critical Duration	Critical Q_{100} cfs
CP3	0.46	273	593.5	225	489.1	78	169.6	24-hr	273
CP4	0.67	333	723.9	297	645.7	76	165.2	24-hr	333
CP17	2.45	240	521.7	217	471.7	106	230.4	24-hr	240
CP18	2.52	218	473.9	219	476.1	105	228.3	6-hr	219
CP20	2.57	216	469.6	223	484.8	106	230.4	6-hr	223
CP21	2.81	323	702.2	305	663.0	147	319.6	24-hr	323
CP37	4.48	637	1384.8	540	1173.9	98	213.0	24-hr	637
CP38	4.55	703	1528.3	615	1337.0	155	337.0	24-hr	703
CP39	4.65	692	1504.3	609	1323.9	150	326.1	24-hr	692
CP43	5.25	791	1719.6	691	1502.2	156	339.1	24-hr	791
CP44	5.3	781	1697.8	689	1497.8	119	258.7	24-hr	781
CP45	5.49	774	1682.6	687	1493.5	120	260.9	24-hr	774
CP53	6.36	767	1667.4	702	1526.1	160	347.8	24-hr	767
CP54	6.49	726	1578.3	667	1450.0	176	382.6	24-hr	726
CP56	7.22	1004	2182.6	896	1947.8	463	1006.5	24-hr	1004
CP57	7.29	1032	2243.5	946	2056.5	490	1065.2	24-hr	1032
CP58	7.34	1032	2243.5	967	2102.2	499	1084.8	24-hr	1032
CP68	8.16	1293	2810.9	1231	2676.1	539	1171.7	24-hr	1293
CP69	8.23	1326	2882.6	1265	2750.0	554	1204.3	24-hr	1326
CP70	8.28	1342	2917.4	1286	2795.7	562	1221.7	24-hr	1342
CP77	9.09	1487	3232.6	1435	3119.6	616	1339.1	24-hr	1487
CP78	9.25	1108	2408.7	1304	2834.8	115	250.0	6-hr	1304
CP79	9.3	1097	2384.8	1302	2830.4	111	241.3	6-hr	1302
CP85	10.11	1081	2350.0	1350	2934.8	107	232.6	6-hr	1350
CP91	11.13	1206	2621.7	1532	3330.4	289	628.3	6-hr	1532
CP92	11.25	869	1889.1	950	2065.2	33	71.7	6-hr	950
CP97	12.15	897	1950.0	1009	2193.5	59	128.3	6-hr	1009

Table 16
Summary of 100-year Discharges
Along the Eastern Canal

MFC001	Mesa Flood Plain Delineation Study			Date
				May-97
STATION	Location	Drainage area (mi^2)	Q_{100} cfs	
CP3	N. Rose	0.46	273	
CP4	N. Almond Cir.	0.67	333	
CP17	E. McKellips Rd.	2.45	240	
CP18	E. Ivyglen Cir.	2.52	219	
CP20	N. Lindsay Rd.	2.57	223	
CP21	N. Lindsay Rd.	2.81	323	
CP37	E. Brown Rd.	4.48	637	
CP38	E. Fox St.	4.55	703	
CP39	E. Fairfield	4.65	692	
CP43	E. Adobe St.	5.25	791	
CP44	E. Dartmouth St.	5.3	781	
CP45	E. Covina Cir	5.49	774	
CP53	N. Val Vista Dr.	6.36	767	
CP54	Alpha St.	6.49	726	
CP56	E. Main St.	7.22	1004	
CP57	E. Alder Ave.	7.29	1032	
CP58	E. Balsam Ave.	7.34	1032	
CP68	E. Capri Ave.	8.16	1293	
CP69	E. Carol Cir.	8.23	1326	
CP70	E. Catalina Cir.	8.28	1342	
CP77	E. Pueblo Ave.	9.09	1487	
CP78	E. Emelita Ave.	9.25	1304	
CP79	E. Southern Ave.	9.3	1302	
CP85	E. Hampton Cir.	10.11	1350	
CP91	US 60 - Superstition Freeway	11.13	1532	
CP92	1400' N. Of E. Baseline Rd.	11.25	950	
CP97	E. Baseline Rd.	12.15	1009	

3.6 FINAL MODELING RESULTS ON DISKETTE

HEC-1 models were developed for the 10-year, 6-hour storm and the 100-year, 6-hour and 24-hour storms for the Eastern Canal study drainage area. The following table describes the models included on the diskette.

TABLE 17
HEC-1 MODELS

Input File	*Description*
REV_10_6.DAT	Eastern Canal HEC-1 Model for 10-year, 6-hour storm with storm drain diversions
REV100_6.DAT	Eastern Canal HEC-1 Model for 100-year, 6-hour storm with storm drain diversions
REV10024.DAT	Eastern Canal HEC-1 Model for 100-year, 24-hour storm with storm drain diversions

LIST OF REFERENCES

1. Aerial Mapping Company, Inc., Topographic Maps, Scale 1"=200', 2' contour intervals, 1996.

2. Arizona Department of Water Resources, "Instructions for Organizing and Submitting Technical Documentation for Flood Studies," Engineering Division, August 1991, revised September 1991.

3. City of Mesa, Land Use Map for Study Area, not dated.

4. City of Mesa, Zoning Maps, Community Development and Planning Department, revised July 1996.

5. City of Mesa Geosystem, Storm Drain, Retention Basins and Mains Map, Engineering Division, copyright 1988 & 1996, plot compilation August 13, 1996.

6. Flood Control District of Maricopa County, "Hydrologic Design Manual for Maricopa County, Arizona," September 1, 1990.

7. Franzoy-Corey Engineering Company, "Flood Insurance Study, Gilbert-Chandler Area, Maricopa County, Arizona," Prepared for the Flood Control District of Maricopa County, draft October 1989, revised July 1990, revised September 1990.

8. Soil Conservation Service, "Soil Survey Eastern Maricopa and Northern Pinal Counties Area, Arizona," November 1974.

9. US Army Corps of Engineers, "HEC-1 Flood Hydrograph Package, User's Manual and Computer Program," Hydrologic Engineering Center, September 1990.

10. US Geological Survey, 7.5-minute Quadrangle Map for Buckhorn, Arizona, 1956, photo revised 1982.

11. US Geological Survey, 7.5-minute Quadrangle Map for Mesa, Arizona, 1952, photo revised 1982.

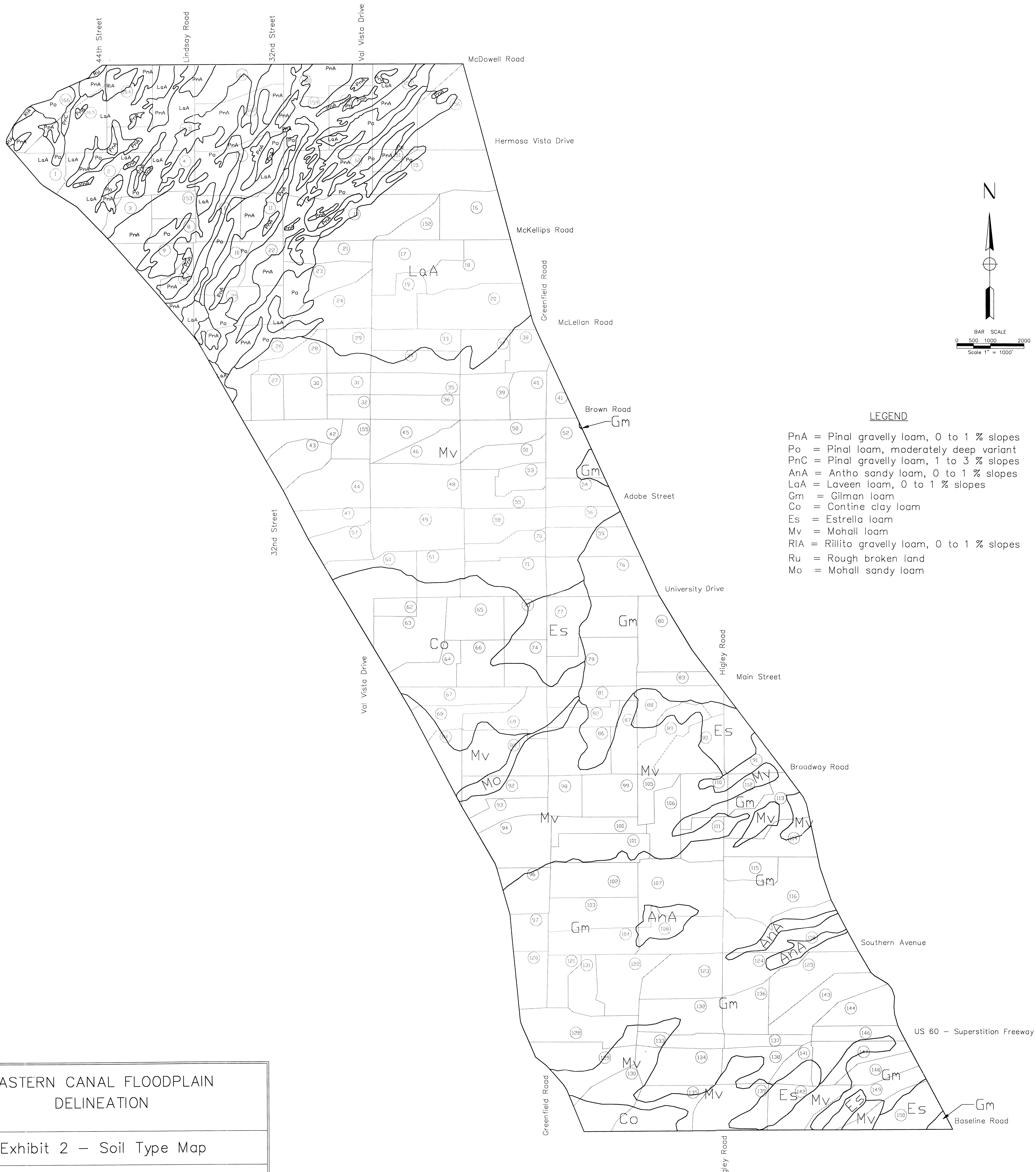
EASTERN CANAL FLOODPLAIN DELINEATION

Exhibit 1 – Drainage Basin Map

PRIMATECH ENGINEERS
2929 N. 44th St. Phoenix, AZ 85018

Project No. :	MFC001
Date : May 1997	Drawn by : WVH

NOTE:
Topography for northernmost portion of watershed was not included in the aerial mapping provided. This area was delineated using the USGS 7.5-minute Quadrangle map for Buckhorn, Az.

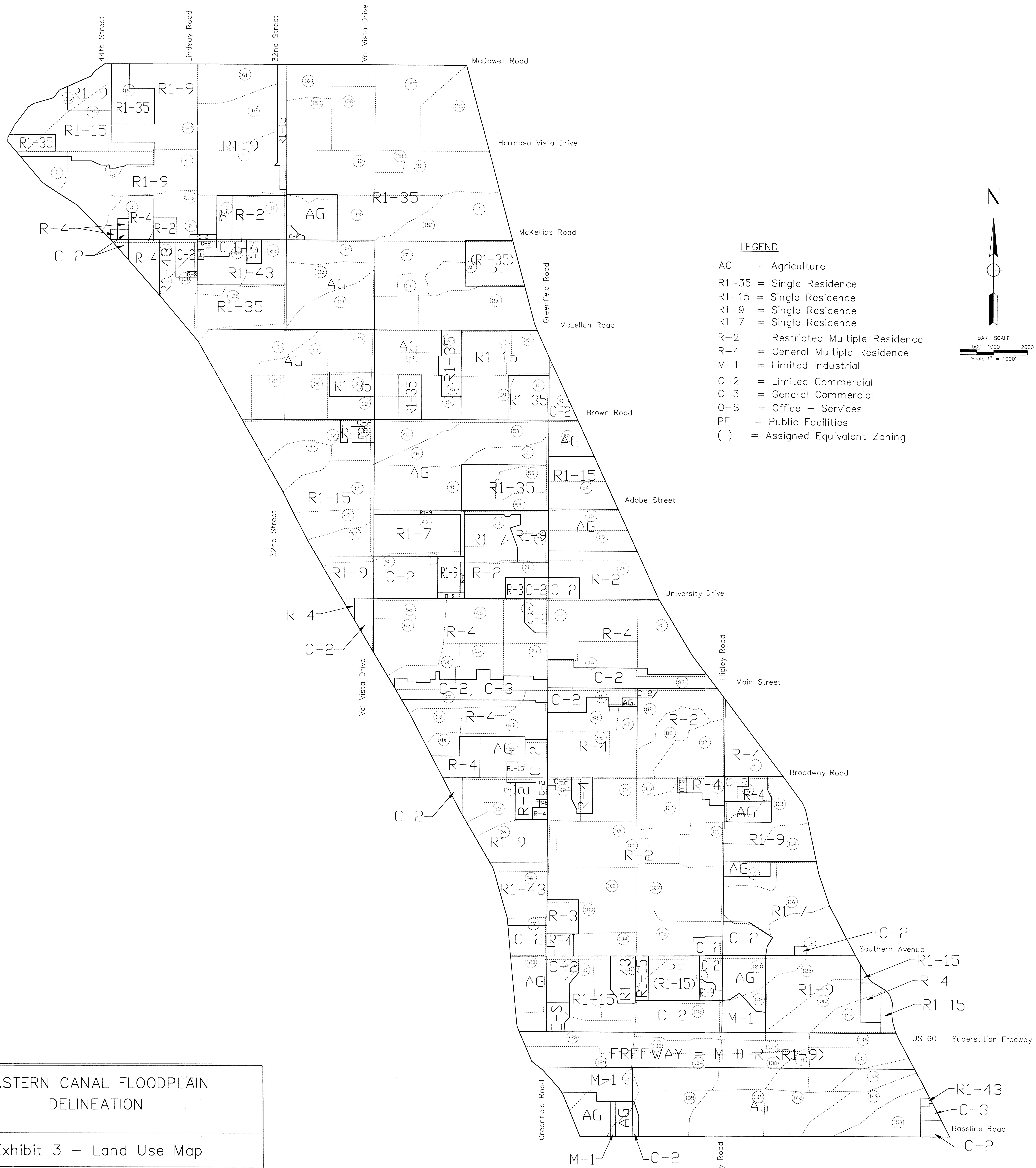


EASTERN CANAL FLOODPLAIN DELINEATION

Exhibit 2 – Soil Type Map

PRIMATECH ENGINEERS
2929 N. 44th St. Phoenix, AZ 85018

Project No. :	MFC001
Date : May 1997	Drawn by : WVH

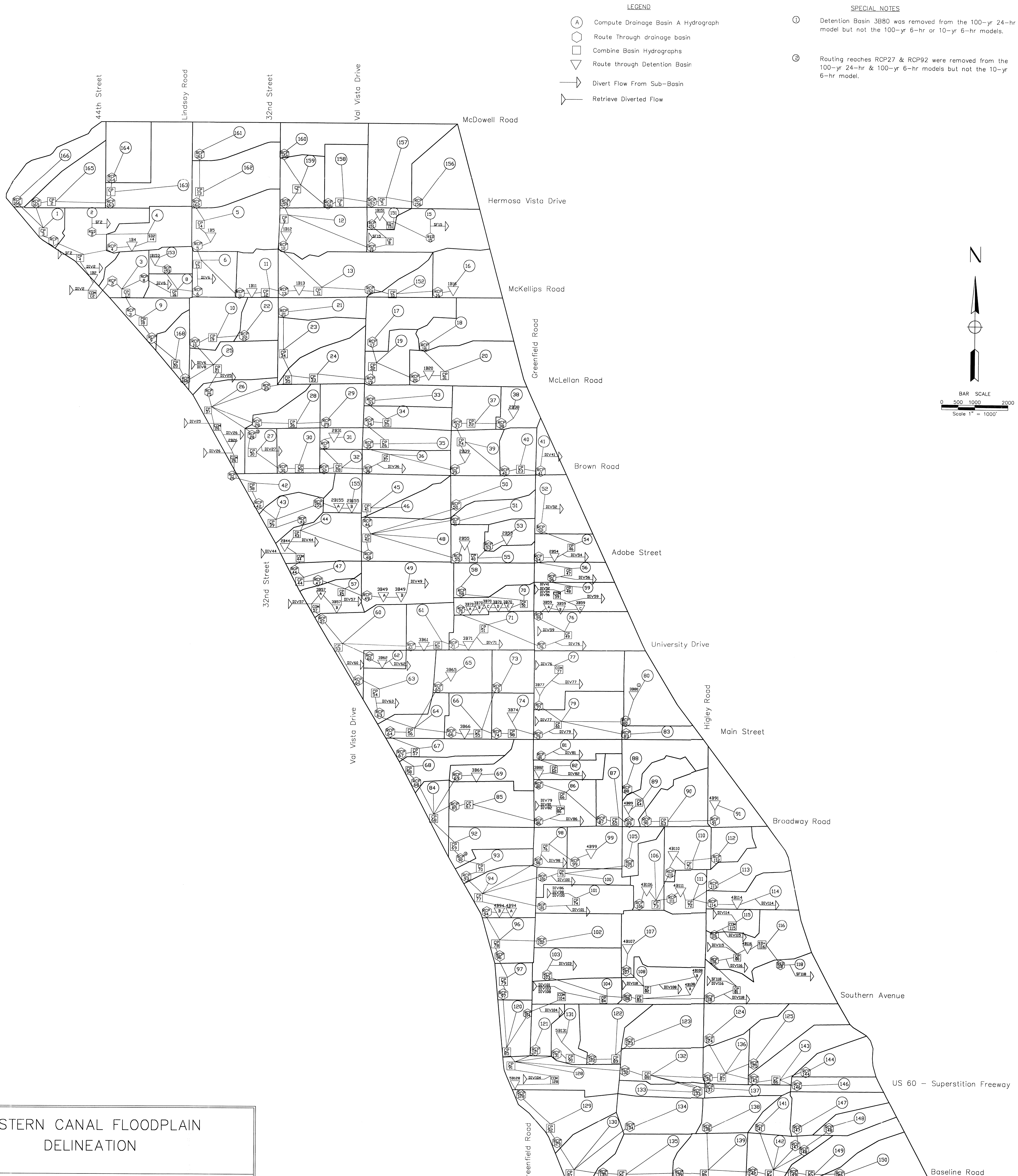


EASTERN CANAL FLOODPLAIN DELINEATION

Exhibit 3 – Land Use Map

PRIMATECH ENGINEERS
2929 N. 44th St. Phoenix, AZ 85018

Project No. :	MFC001
Date : May 1997	Drawn by : WVH



EASTERN CANAL FLOODPLAIN DELINEATION

Exhibit 4 – HEC-1 Flow Schematic

PRIMATECH ENGINEERS
2929 N. 44th St. Phoenix, AZ 85018

Project No. : MFC001

Date : May 1997 Drawn by : WVH