EXISTING DRAINAGE CONDITIONS

DESCRIPTION OF THE STUDY AREA

The Study Area is located in Northwest El Paso and comprises approximately 1,850 acres. It is near the Franklin Mountains and extends into the mountain and hillside district designations as shown on the Base Map, Figure 2-1.

Soils at the site are within the Delnorte-Canutio association, described as nearly level to steep soils that are shallow or very shallow over caliche or that are deep and gravelly throughout; mainly on and near foot slopes of the Franklin Mountains. Arroyos and alluvial fans are common near the foot slopes within this association.

BASIN CHARACTERISTICS

Floodplains

The Study Area is affected by storm water runoff generated from the Franklin Mountains. Several existing flow paths, arroyos, and ephemeral streams run through the site. The floodplains were analyzed and modeled by the Federal Emergency Management Agency (FEMA), and are shown on the Flood Insurance Rate Maps (FIRM). There are a total of six flow paths, shown on the FIRM(s) for the Site, Figure 4-11. Each of the flow paths/arroyos developed by FEMA show the 100-year and 500-year flood occurrences. The base flood elevations are also shown for the 100-year storm event. The flow paths and arroyos as designated by the FIRM of the FEMA are listed in the following tables.

Table 4-1 – Existing/Effective Flood Zones

SITE			
Name	**Panel**	**Community-Panel Number**	**Date**
Flow Path 38	17 of 52	480214 0017 C	February 5, 1986
Flow Path 38A	17 of 52	480214 0017 C	February 5, 1986
Flow Path 38B	17 of 52	480214 0017 C	February 5, 1986
Flow Path 39	17 of 52	480214 0017 C	February 5, 1986
Flow Path 39A	17 of 52	480214 0017 C	February 5, 1986
Flow Path 40	17 of 52 & 12 of 52	480214 0017 C & 480214 0012 C	February 5, 1986

These arroyos flow across alluvial deposits with poorly defined channels. Our review of site topography and site observations shows evidence of instability of the arroyo channels. This evidence is strongest in the southern reaches of Flow Path 38A at the proposed crossing of the Helen of Troy (Arterial 2) alignment. The flow path gets very wide and braided. This condition is known as an alluvial fan. In the case of a large storm water event in its natural condition, it is impossible to predict where storm water runoff would occur within the wide flood plain.

Flow Path 38A widens from its apex located approximately 5,300 feet east of the westerly property line to a maximum width of 3,000 feet near the western property line. This flow path uncertainty is aggravated by the absence of clear topographic confinement in the area (i.e., channel embankments). These site characteristics together, with the large volumes and velocity of runoff anticipated for Flow Path 38A, create a flood hazard that can only be mitigated by the use of a major structural flood control measure.

Watersheds and Sub-basins

The six flow paths crossing the Site are Flow Paths, 38, 38A, 38B, 39, 39A, and 40. The flow paths are generated from a series of watershed areas, which in turn are broken up into several sub-basins. The watershed areas and sub-basins for each respective flow path are shown on Figures 4-1, 4-3, and 4-5. Each contributing watershed area was analyzed using the United States Army Corps of Engineers' Graphical HEC-1 computer software model. All of the watershed areas and sub-basins were analyzed and modeled for the 100-year storm event. The watershed areas and their respective peak discharges (Q_{100}) along with the model flow charts are shown on Figures 4-2, 4-4, and 4-6.

Drainage Facilities

Storm water runoff naturally flows from the peak of the Franklin Mountains in a westerly direction towards U.S. Interstate Highway 10 (IH-10), down to the Rio Grande Valley. The majority of the existing drainage facilities are located beneath IH-10, Trans Mountain Road, and Resler Drive.

The existing drainage facilities serve several functions such as intercept, pass-through and detain/retain storm water runoff associated with the above mentioned flow paths. The facilities include bridge and culvert structures, reinforced concrete pipes (RCP), concrete lined channels, earthen channels, diversion dikes, storm drain systems and detention/retention basins.

The nearest major flood control detention structure is the Mulberry Dam, designed by the Corps of Engineers. The Mulberry Dam is located approximately 1-mile southwest of the Site. All of the existing drainage facilities, including the Mulberry Dam, along with their designations and sizes are shown on Figure 4-7.

DESCRIPTION OF PREVIOUS DRAINAGE STUDIES AND REGIONAL PLANS

Several plans and studies have been conducted on and near the subject site. The following table lists an inventory of existing plans and studies found for the area. They provide works detail and analysis of existing drainage and planning conditions for the area. These works also provide insight on possible constraints that may be encountered when planning the subject site.

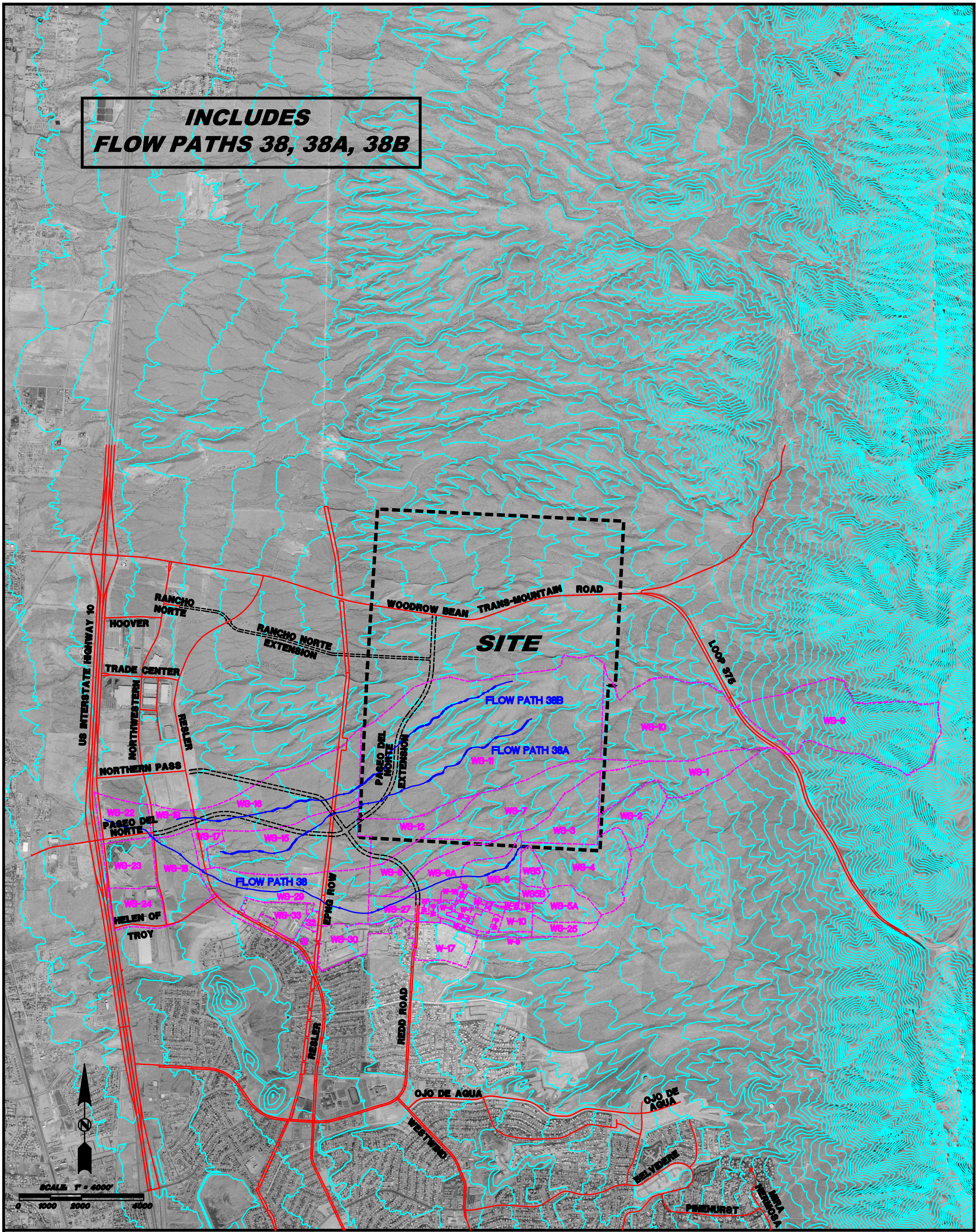

FIGURE 4-1
FLOWPATH 38 WATERSHED MAP

EL PASO WATER UTILITIES PUBLIC SERVICE BOARD

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WATERSHED LABEL	AREA (ac.)	Q(100) (cfs)
WS-1	103.81	218
WS-2	58.62	199
WS-3	76.94	303
WS-4	120.58	467
WS-5	17.66	77
WS-5A	42.18	168
WS-5B	10.37	49
WS-6	62.33	161
WS-6A	71.70	159

WATERSHED LABEL	AREA (ac.)	Q(100) (cfs)
WS-7	151.10	401
WS-8	61.44	216
WS-9	239.94	741
WS-10	256.96	643
WS-11	640.32	1454
WS-12	69.89	228
WS-15	182.78	518
WS-16	185.73	492
WS-17	17.15	94

WATERSHED LABEL	AREA (ac.)	Q(100) (cfs)
WS-18	86.46	386
WS-19	27.78	127
WS-22	49.86	223
WS-25	27.52	104
WS-27	26.62	139
WS-29	145.92	332
WS-30	51.90	131
WS-31	27.26	90
WS-32	6.78	18

WATERSHED LABEL	AREA (ac.)	Q(100) (cfs)
WS-33	35.39	93
W-1	2.02	9
W-2	3.33	7
W-3	6.78	12
W-4	14.98	25
W-5	4.42	11
W-6	4.16	12
W-7	6.08	14
W-8	3.78	7

WATERSHED LABEL	AREA (ac.)	Q(100) (cfs)
W-9	5.70	11
W-10	16.00	31
W-11	1.15	3
W-12	2.62	5
W-13	1.92	4
W-14	9.79	23
W-15	0.38	1
W-16	1.10	3
W-17	56.83	258

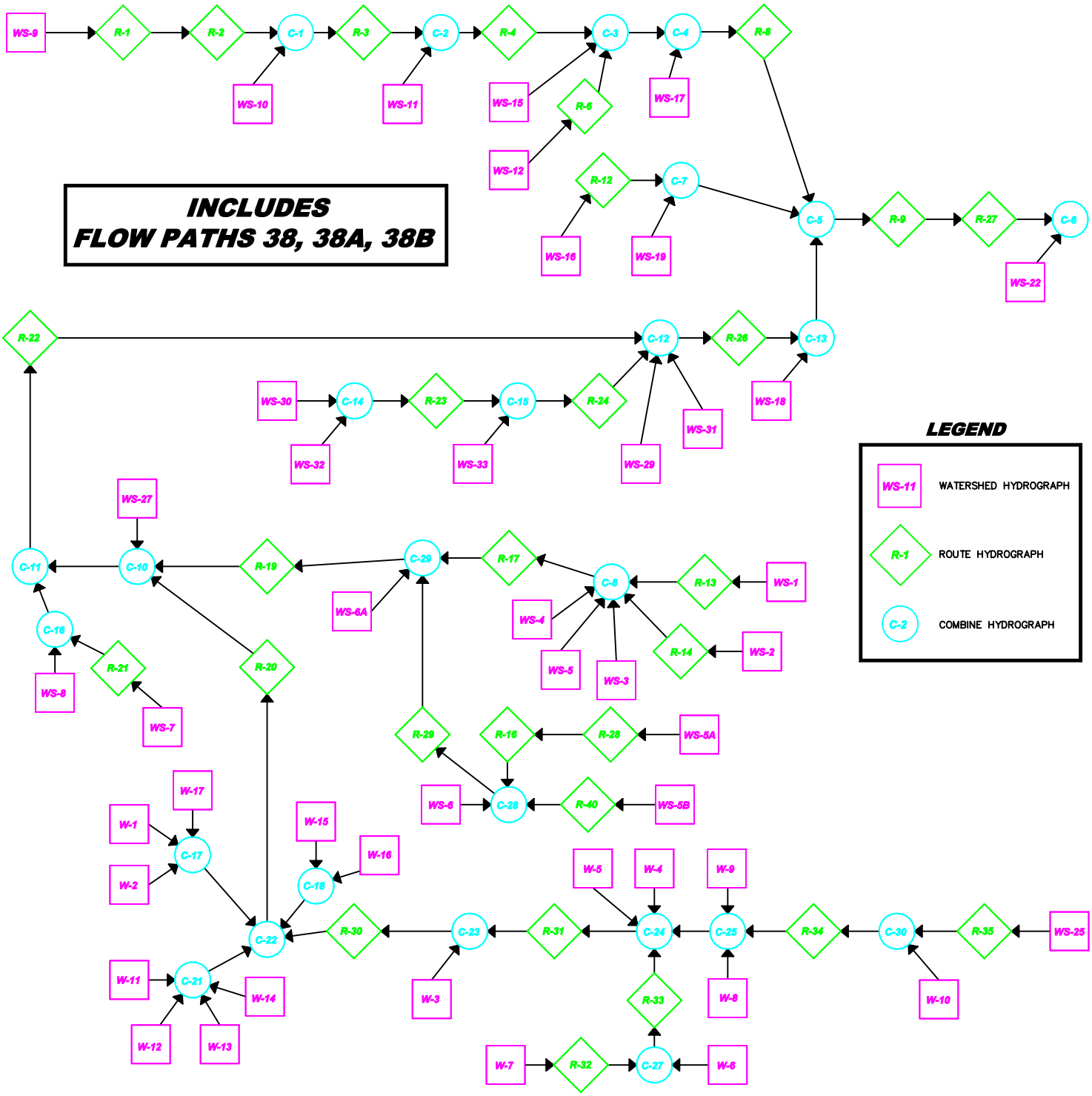

FIGURE 4-2
FLOWPATH 38 WATERSHED DATA

EL PASO WATER UTILITIES PUBLIC SERVICE BOARD
WESTSIDE MASTER PLAN
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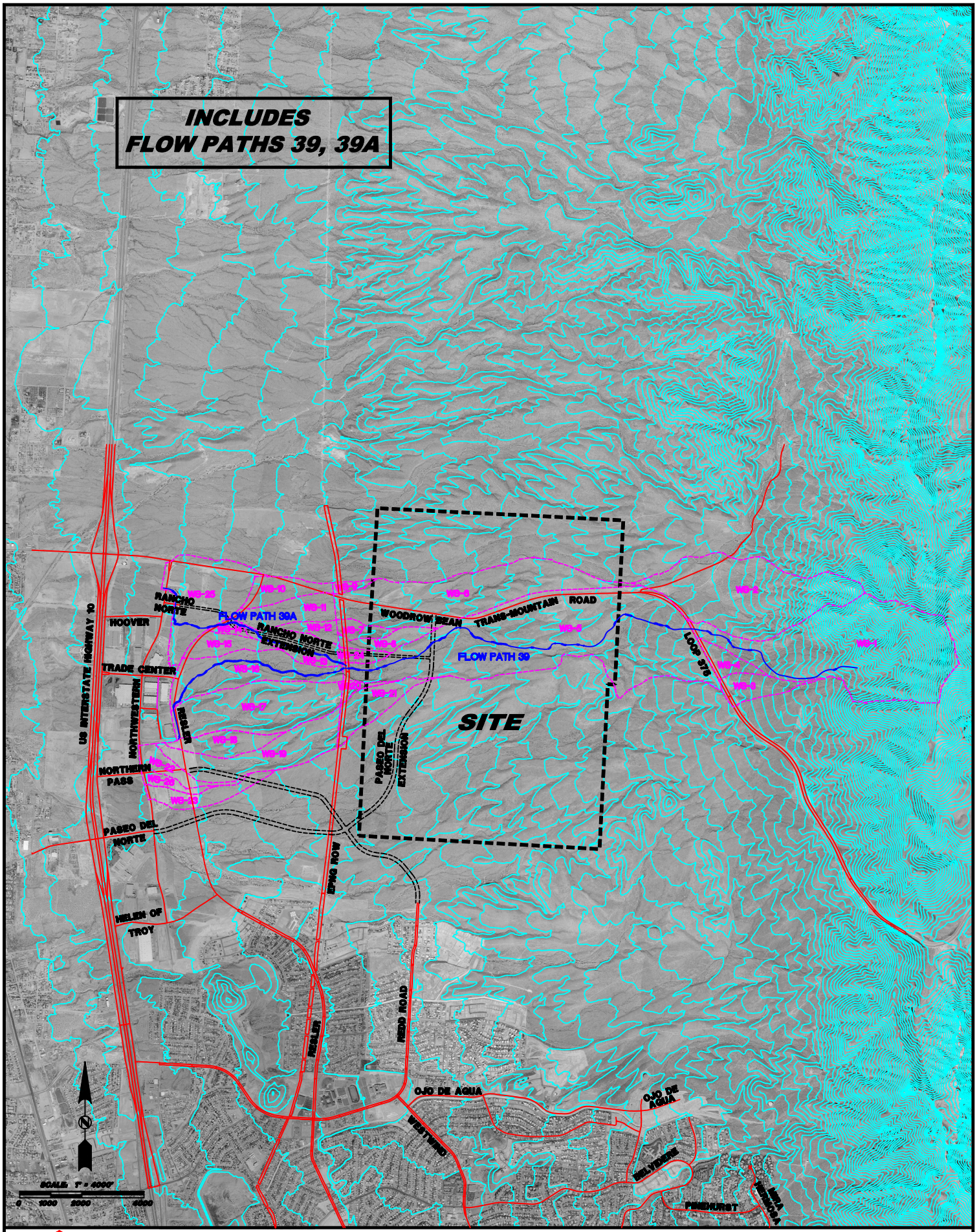

FIGURE 4-3

FLOWPATH 39 WATERSHED MAP

EL PASO WATER UTILITIES PUBLIC SERVICE BOARD

WESTSIDE MASTER PLAN

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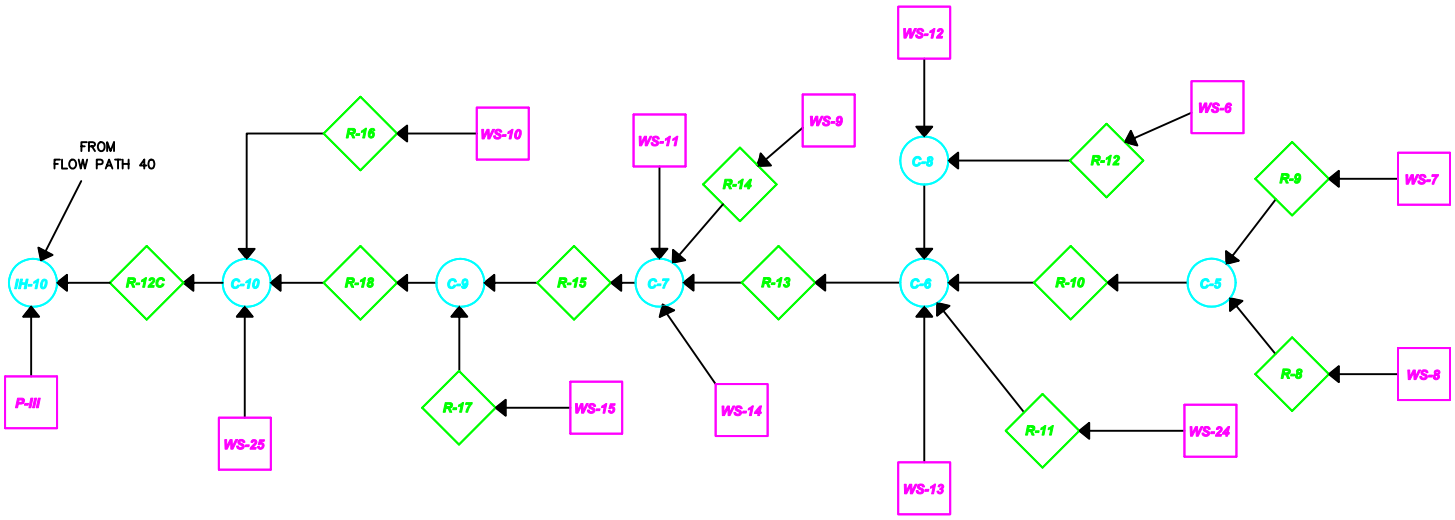
WATERSHED LABEL	AREA (ac.)	Q(100) (cfs)
WS-1	373.88	735
WS-2	268.29	626
WS-3	38.79	125
WS-4	25.98	81
WS-5	537.84	882
WS-6	236.00	263
WS-7	14.46	63
WS-8	29.70	71
WS-9	8.26	34

WATERSHED LABEL	AREA (ac.)	Q(100) (cfs)
WS-10	40.77	101
WS-11	56.19	113
WS-12	19.40	61
WS-13	49.92	96
WS-14	10.24	52
WS-15	35.26	80
WS-16	119.68	150
WS-17	169.41	232
WS-18	45.44	88

WATERSHED LABEL	AREA (ac.)	Q(100) (cfs)
WS-19	119.04	113
WS-20	9.41	40
WS-21	55.10	158
WS-22	30.52	54
WS-23	41.39	78
WS-24	13.70	47
WS-25	142.08	238
WS-26	16.46	45
P-III	36.42	144



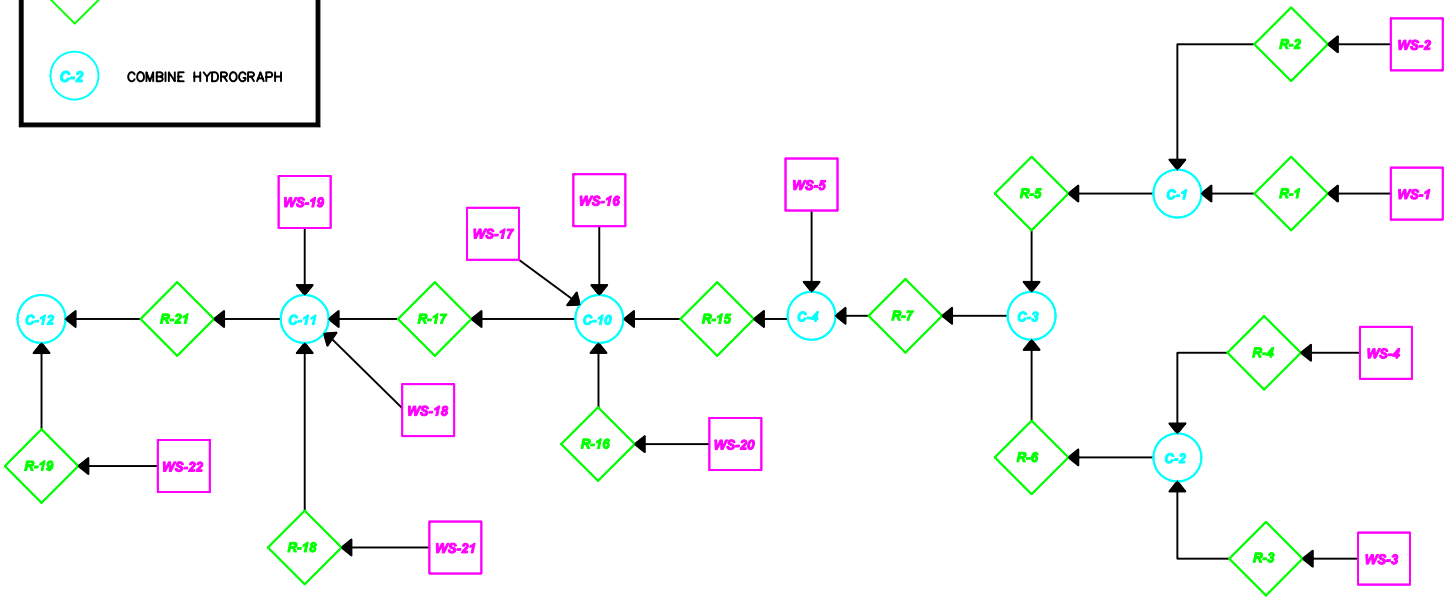
LEGEND

WS-11 WATERSHED HYDROGRAPH

R-1 ROUTE HYDROGRAPH

C-2 COMBINE HYDROGRAPH

FLOW PATH 39A



FLOW PATH 39

FIGURE 4-4

FLOWPATH 39 WATERSHED DATA

EL PASO WATER UTILITIES PUBLIC SERVICE BOARD

WESTSIDE MASTER PLAN

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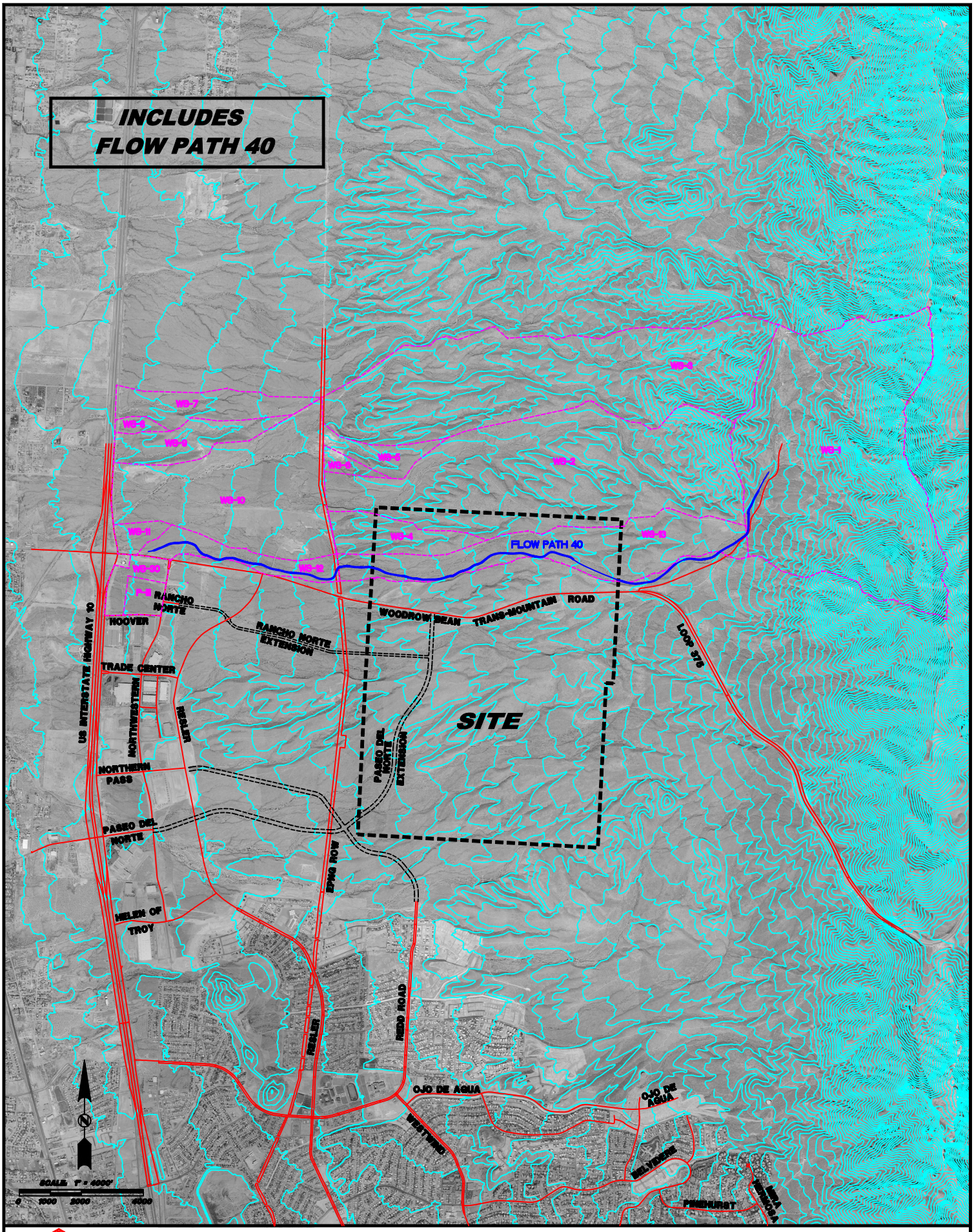

FIGURE 4-5
FLOWPATH 40 WATERSHED MAP

EL PASO WATER UTILITIES PUBLIC SERVICE BOARD

WESTSIDE MASTER PLAN

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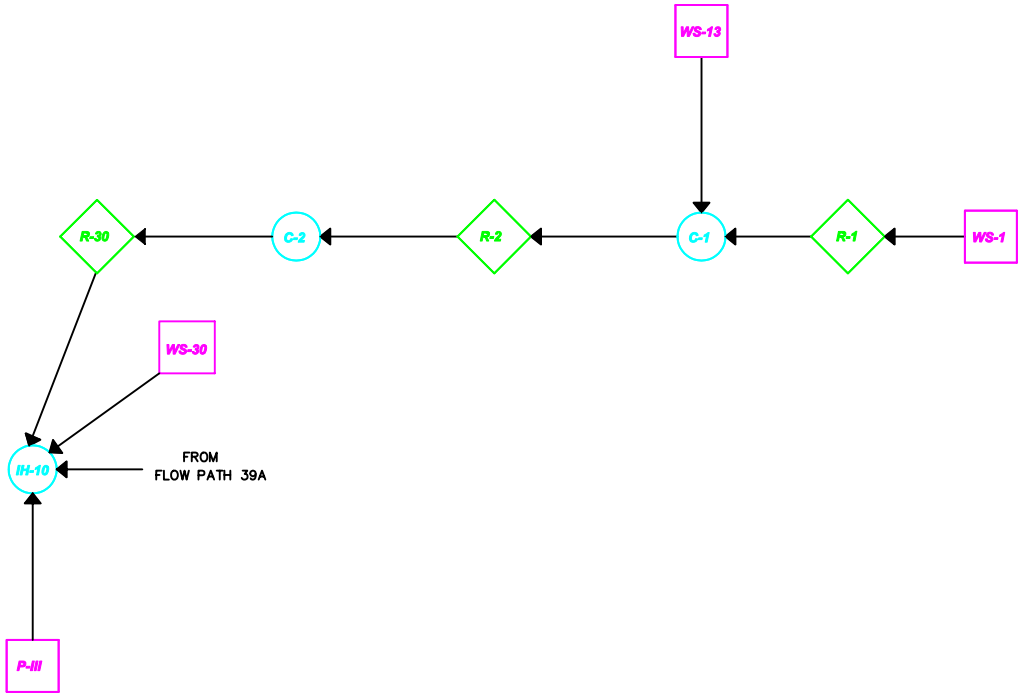
WATERSHED LABEL	AREA (ac.)	Q(100) (cfs)
P–III	36.416	144
WS–1	1132.99	1642
WS–4	108.41	193
WS–12	121.41	139
WS–13	400.24	254
WS–30	42.05	150



FLOW PATH 40

LEGEND

WS-11 WATERSHED HYDROGRAPH

R-1 ROUTE HYDROGRAPH

C-2 COMBINE HYDROGRAPH

FIGURE 4-6
FLOWPATH 40 WATERSHED DATA

EL PASO WATER UTILITIES PUBLIC SERVICE BOARD

WESTSIDE MASTER PLAN

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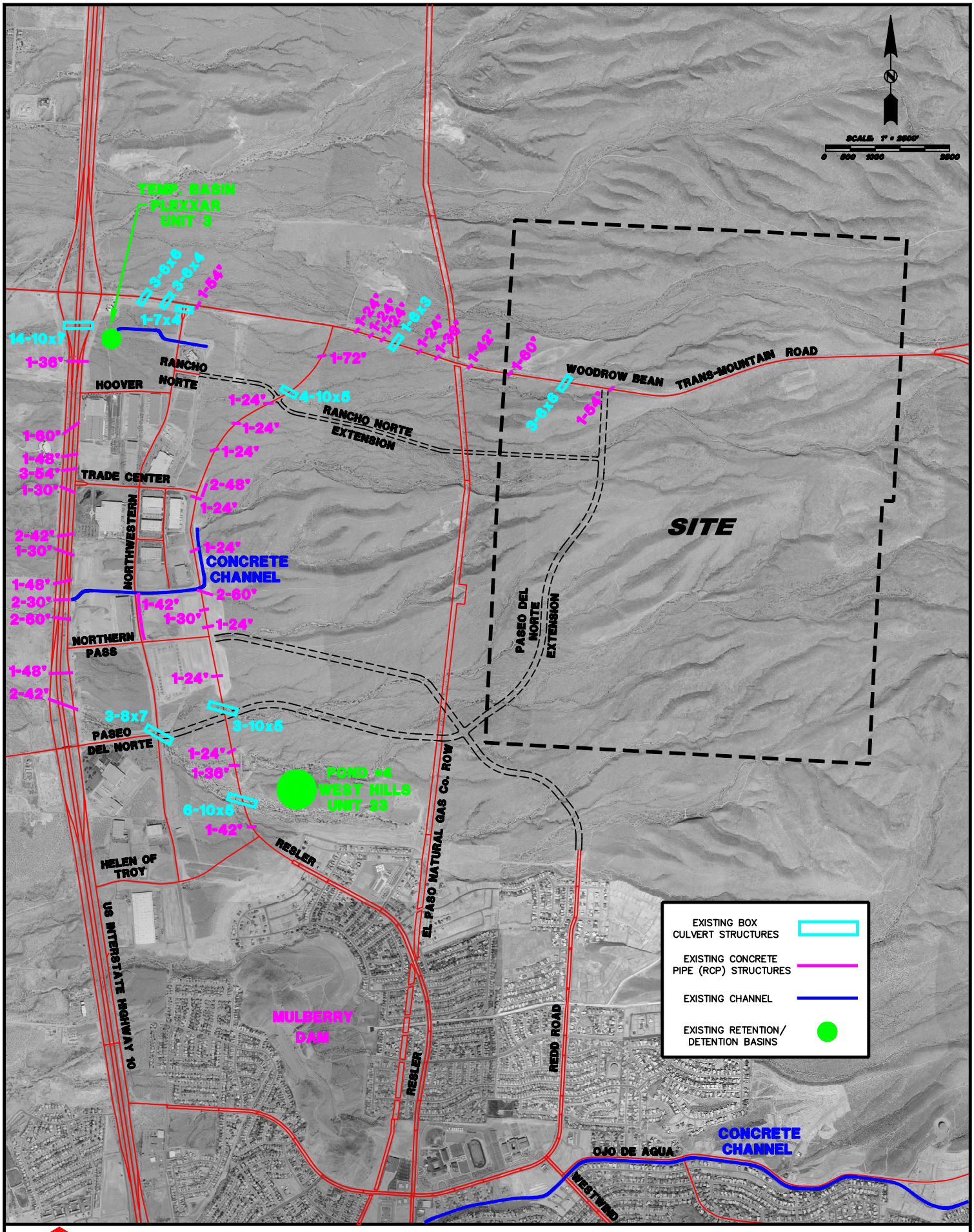

EXISTING BOX CULVERT STRUCTURES

EXISTING CONCRETE PIPE (RCP) STRUCTURES

EXISTING CHANNEL

EXISTING RETENTION/ DETENTION BASINS

FIGURE 4-7
EXISTING DRAINAGE STRUCTURES

EL PASO WATER UTILITIES PUBLIC SERVICE BOARD

WESTSIDE MASTER PLAN

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Table 4-2 – Inventory for Existing Plans & Studies

Name of Plan/Study	Prepared For/By	Year
EPWU/Artcraft Land Use Plan & Development Analysis	EPWU	November 5, 1996
Proposed Land Sales Policies & Procedures	EPWU	October 16, 2002
Soil Resources of El Paso	EPWU	September 2000
The Plan for El Paso	City of El Paso	April 27, 1999
Franklin Mountains State Park Management Plan	El Paso County	May 1994
Artcraft Area Utilities & Land Use Concept Plan	EPWU	February 1996
El Paso Water Utilities Future Reservoir Sites For El Paso's Northwest & Northeast Area	EPWU	June 12, 1998
Northwest Reuse Planning Update	EPWU	September 2002
Amended Rancho Las Lomas Concept Plan	Colony Development	August 20, 2003
Coates/Johannsen Master Drainage Study	City of El Paso	December 26, 1989
Mowad Street & Drainage Improvements	City of El Paso	March 28, 1990
Northwest Elementary/Middle Schools Feasibility Study	EPISD	August 2002

STUDY AREA HYDROLOGIC ANALYSIS

The following tables summarize the study criteria used for developing and analyzing the existing watershed areas and their respective peak runoff values.

Table 4-3 – Hydrologic Criteria

Method/Parameter	Criteria
Storm Frequency	100-Year
Hydrologic Analysis	U.S. Army Corps of Engineers Visual HEC-1 Hydrology Program
Source of Rainfall Depth	U.S. Department of Commerce Technical Paper No. 40
Source of Rainfall Distribution	Synthetic
Hydrograph Development Method	Snyder
Loss Rate Method	Initial/Uniform
Source of Soils Information	SCS Soil Survey
Source of Land Use Information	City Base Maps
Channel Routing Method	Modified Pouls

Table 4-4 – El Paso Rainfall Data (in inches depth)

Return Period	Duration							
	5-min	15-min	1-hr	2-hr	3-hr	6-hr	12-hr	24-hr
100-yr	0.61	1.19	1.95	2.35	2.50	2.95	3.45	3.90

Table 4-5 – Losses and Loss Rates

Land Use	Description	% Impervious	Initial Loss	Uniform Loss
M	Mountain	0	0.50	0.25
F	Alluvial Fan	0	0.80	0.40
U1	Light Density Residential	20	0.65	0.32
U2	Medium Density Residential	40	0.50	0.25
U3	High Density Residential	60	0.32	0.16
U4	Business/Commercial	90	0.10	0.05
U5	Light Industrial	90	0.10	0.05

The watershed areas for flow paths 38, 38A, 38B, 39, 39A and 40 were delineated using topographic mapping dated 1996. The 1996 map was chosen for these flow paths for consistency with previously approved FEMA studies of the area. All of the contributing watershed areas for each respective flow paths/arroyos, upstream of the intersection with IH-10, are shown in Figures 4-1, 4-3, and 4-5. The results computed from the model correspond to the results indicated in the City of El Paso's Flood Insurance Study (FIS), Volume 1 of 5.

STUDY AREA HYDRAULIC ANALYSIS

Hydraulic analyses were conducted for all six Site flow paths to reflect recent changes in topography and developments in the area. The Corps of Engineers' HEC-RAS computer software was used for the analyses. The essential computational procedure for HEC-RAS is based on the result of the one-dimensional energy equation. Energy losses are calculated by friction (Manning's equation) and contraction/expansion (coefficient multiplied by the change in velocity head). The momentum equation is utilized in circumstances where the water surface profile is quickly varied. These circumstances include mixed flow regimen results (i.e. hydraulic jumps), hydraulics of bridges, and calculating profiles at river confluences (stream junctions).

Numerous cross-sections were taken across streams to determine current existing water surface elevations for each respective flow path and were compared to the elevations analyzed by FEMA. Results of the comparisons are detailed in the following section.

SPECIAL FLOOD HAZARD AREAS

The majority of the results computed from the model are similar in nature to the results indicated in the FIRM(s), when comparing their Figures for flow paths 38, 38A, 38B and 39. However, our analysis revealed some differences when comparing the results for flow paths 39A and 40. The differences stem from current development constructed near IH-10, which altered the original directional flows for paths 39A and 40. Originally, flow path 39A flowed independently of 40 and was directed under IH-10 via a 36" RCP, located near the entrance of the Trans Mountain Road off ramp. Flow path 40 flowed under IH-10 via a 14-10' x 7' multiple box culvert (MBC), located approximately 65-feet north of the 36" RCP, also under the Trans Mountain Road off ramp. Both structures can be seen on Figure 4-7.

Our analysis revealed that the new development re-directed and combined flow path 39A with 40. Both paths now combine near IH-10 and flow under the existing 14-10' x 7' MBC. The computed Special Flood Hazard Areas along with the HEC-RAS cross-section identifications are shown on Figures 4-8, 4-9, and 4-10. Figure 4-11 shows all of the Special Flood Hazard Areas for the Site.

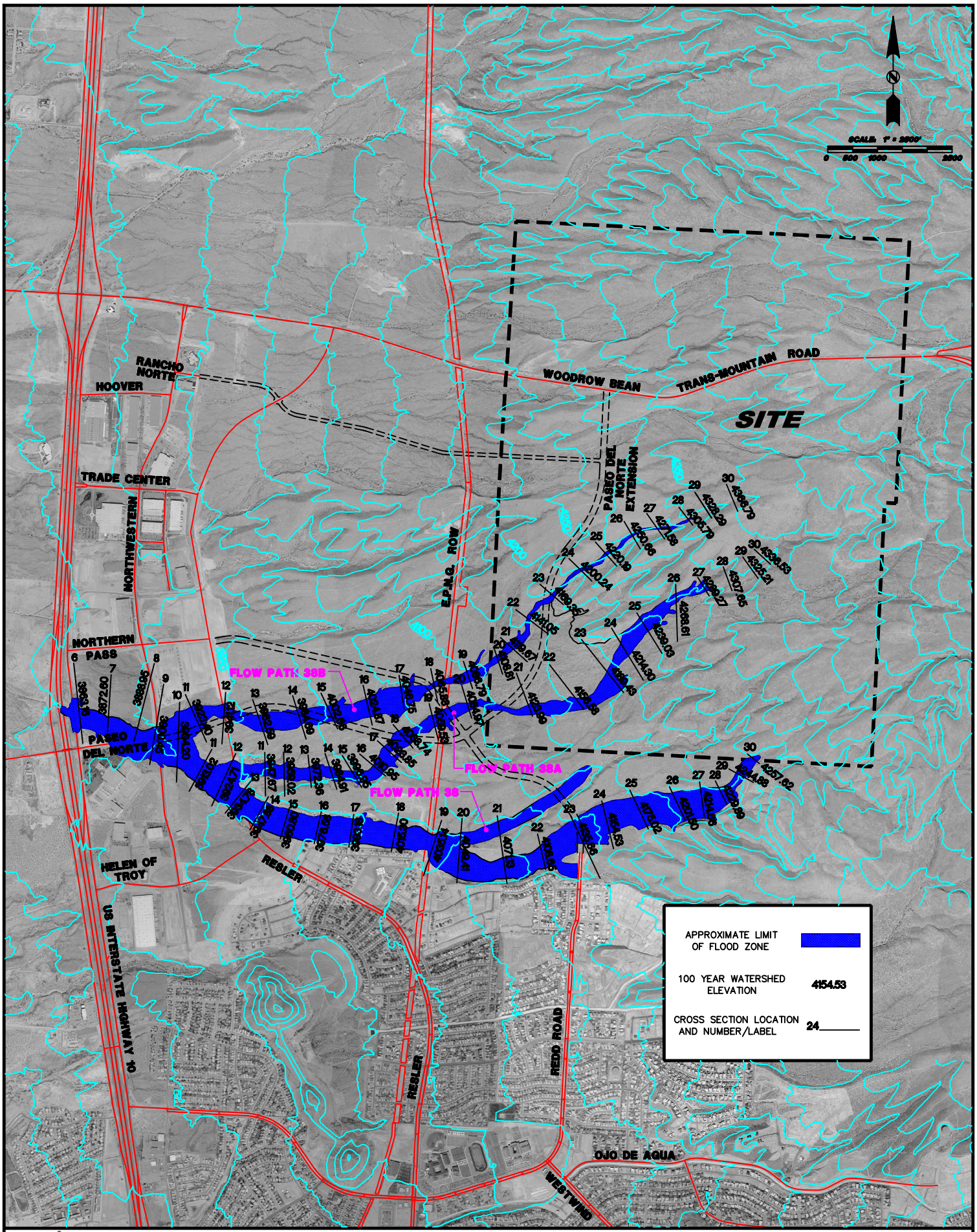

FIGURE 4-8
EFFECTIVE FLOOD ZONES (FP38)

EL PASO WATER UTILITIES PUBLIC SERVICE BOARD

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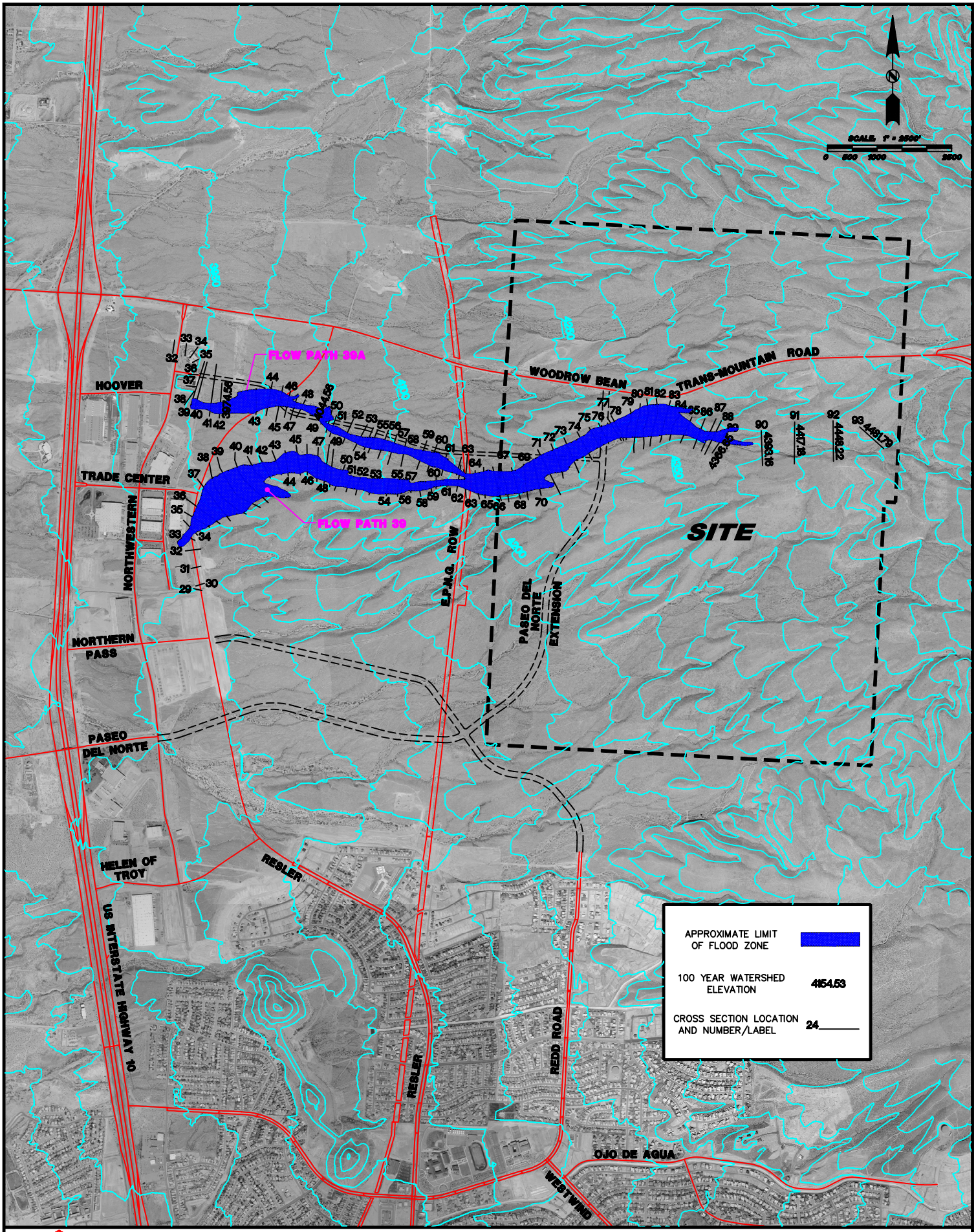

FIGURE 4-9
EFFECTIVE FLOOD ZONES (FP39)

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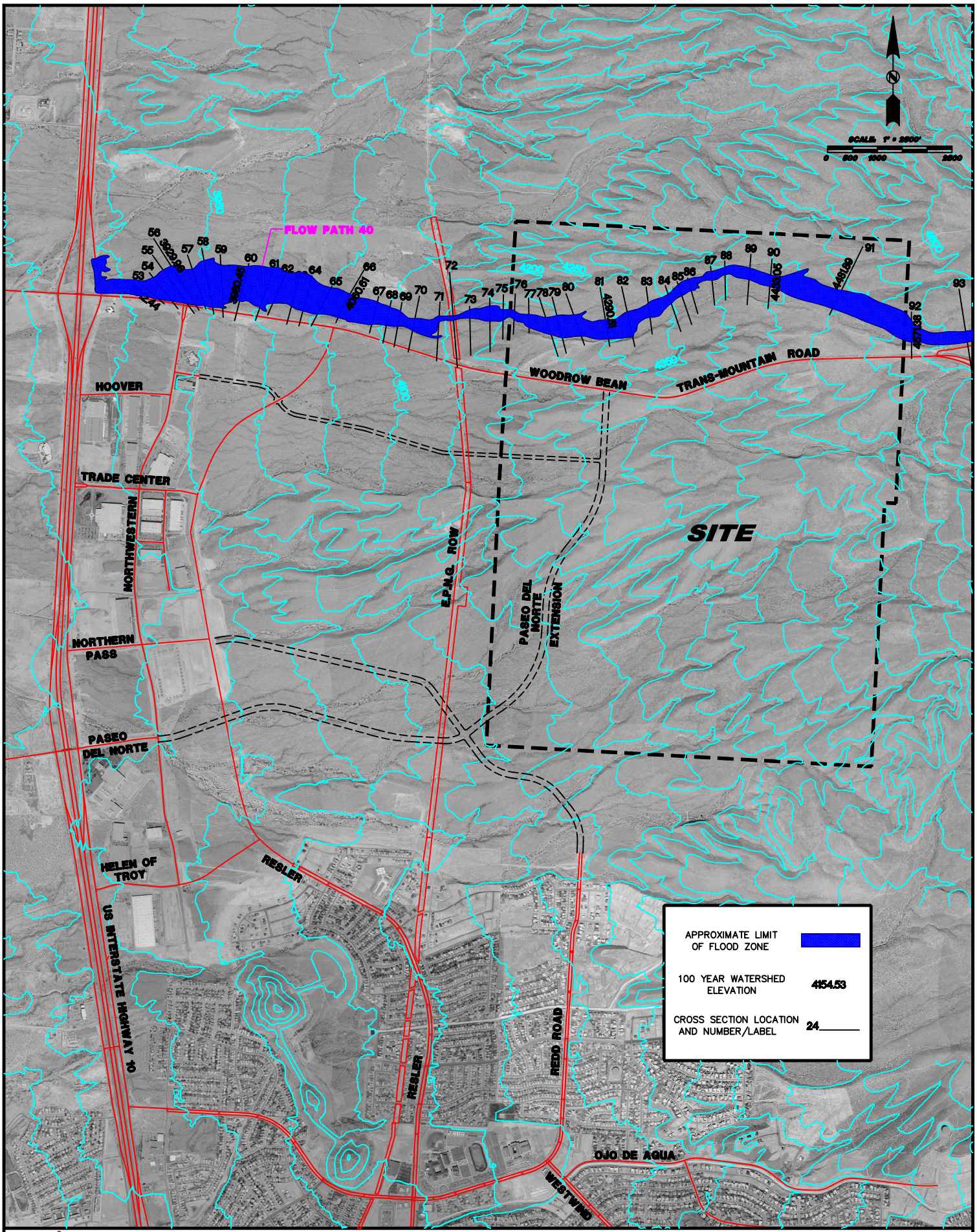

FIGURE 4-10
EFFECTIVE FLOOD ZONES (FP40)

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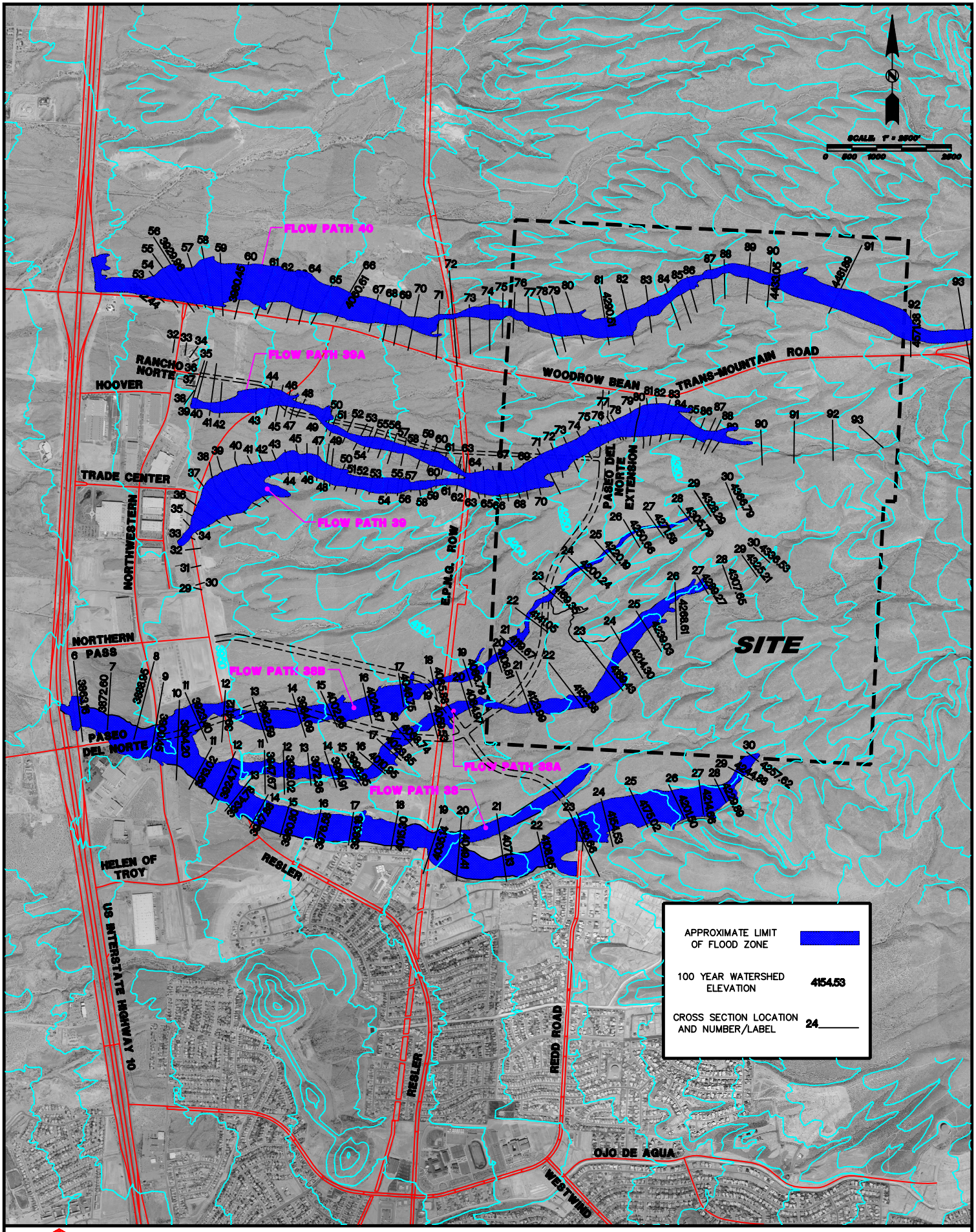

FIGURE 4-11
AREA EFFECTIVE FLOOD ZONES

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PROPOSED DRAINAGE IMPROVEMENTS

The proposed drainage improvements of the Site conform to the land uses and current policies of the City of El Paso for new developments and incorporate the needs and concerns received from the project stakeholders.

DESCRIPTION OF THE STUDY AREA

As previously mentioned the Site is located within the foothills of the Franklin Mountains and receives large amounts of runoff during storm events. Considering this and stakeholder concerns we have proposed to leave the majority of the arroyos in their natural state. Flow Paths 38B, 39, and 40 are left in their natural condition up to the intersection with Paseo Del Norte Drive. Flow Path 38A is left in its natural condition up to the intersection with Helen of Troy Drive. Northern and southern portions of Flow Path 38A west of Helen of Troy are also left undisturbed and classified as open space. The flow path portions left in their natural condition follow the effective flood zone designations of the FIRM.

Flow Paths 38B, 39 and 40 would then be conveyed through a concrete lined channel which ties into the Rancho Las Lomas development. Flow Path 38A would be conveyed through a hybrid channel up to Paseo Del Norte Drive. The hybrid channel would capture flow in the vicinity of its topographic apex, before it spreads as sheet flood. The hybrid channel also captures flow generated from the adjacent northern and southern open spaces. The remainder would be conveyed through a concrete lined channel.

Currently the City of El Paso Subdivision Design Standards consists solely of concrete lined channels for open-channel conveyance. We are proposing to implement a hybrid channel within the Land Study Area. The hybrid channel would consist of using alternate materials for conveyance of storm water minimizing the use of concrete.

The hybrid channel would implement soil stabilization features that would withstand storm water runoff velocities and promote a natural looking appearance. Along with a more aesthetically pleasing channel, there is opportunity to include recreational amenities. Some amenities include hike/bike trails, which connect to the natural trail system. Park areas would also be constructed throughout the reach of the hybrid channel. The hybrid channel creates a recreational atmosphere that is conducive to both family and competitive outdoor activities.

Aside from natural arroyos and channelization for storm water control the plan includes several park/ponds to detain additional storm runoff form the proposed development. Park/ponds serve a dual use and are very practical for the El Paso region, due to the low amount of annual precipitation. All proposed drainage improvements for the Site are shown in Figure 4-12.

BASIN CHARACTERISTICS

Watersheds and Sub-basins

Each contributing watershed area was analyzed using the United States Army Corps of Engineers' Graphical HEC-1 computer software model. All of the watershed areas and sub-

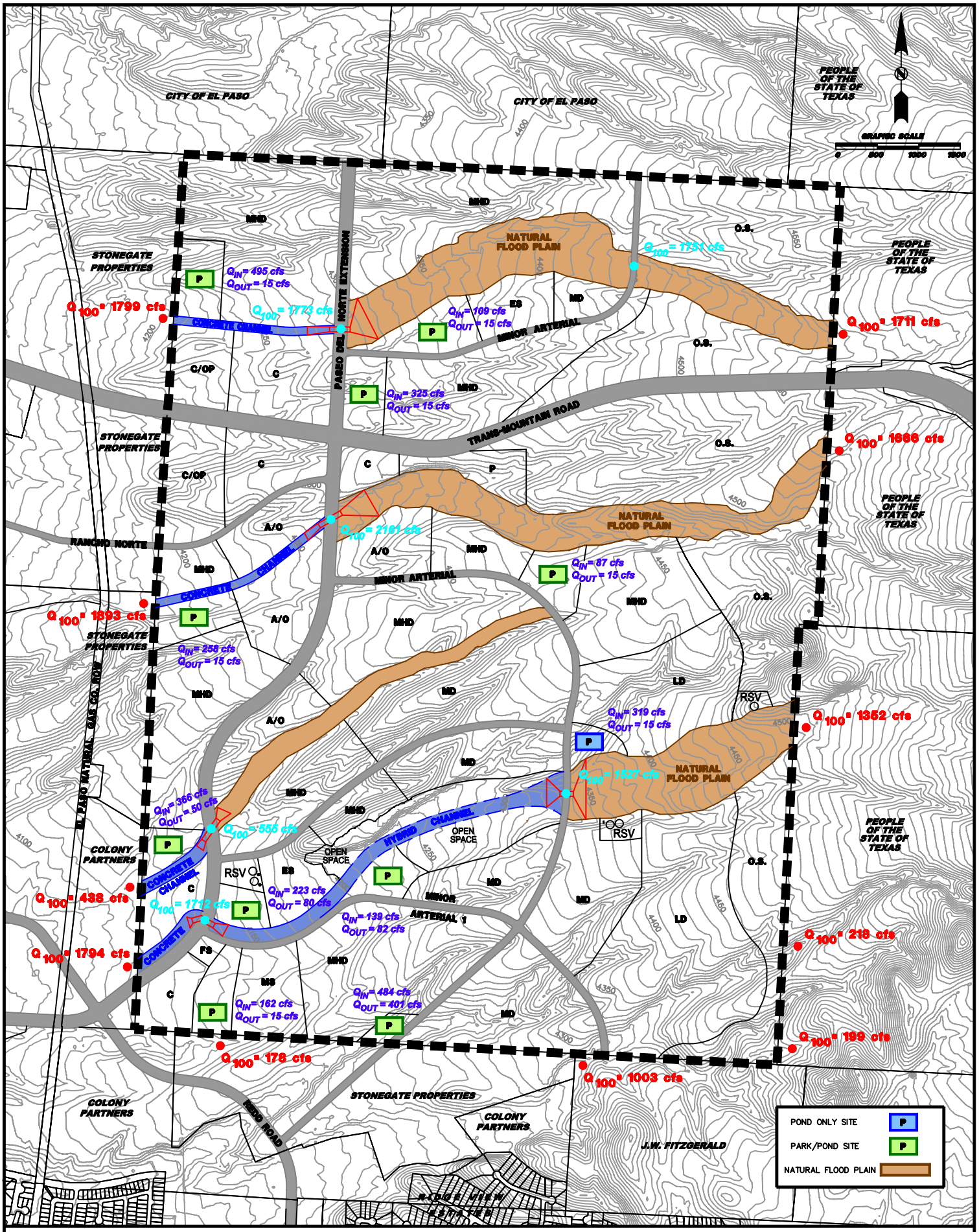

FIGURE 4-12
PROPOSED DRAINAGE IMPROVEMENTS

EL PASO WATER UTILITIES PUBLIC SERVICE BOARD

WESTSIDE MASTER PLAN

PREPARED BY: MORENO CARDENAS INC. JUNE 2005

basins were analyzed and modeled for the 100-year storm event. The watershed areas and their respective peak discharges (Q_{100}) along with the model flow charts are shown on Figures 4-13, 4-14 and 4-15.

Additional runoff from the proposed development would be detained within the proposed park/pond areas. Storm water runoff would be released in a controlled manner to assure that none of the historical flows are exceeded in the flow paths.

The developed flows are dependent on land use. The watershed areas would have to be re-analyzed if any proposed land use is changed. Further analysis would be required upon the design phase of the site.

Drainage Facilities

Several proposed drainage facilities would be required in order to control storm water runoff generated from the Franklin Mountains. As mentioned above some facilities include channels and park/ponds. In addition, culverts and bridge spans would also be required. Culvert crossings would be developed at points where the arroyos intersect Paseo Del Norte Drive and any proposed minor arterials. A bridge span would be required at the intersection of the proposed minor arterial intersecting Flow Path 40. The proposed drainage facilities are shown in Figure 4-12. The uses of culverts for crossings are recommended due to their lower construction cost when compared to bridge spans.

Figure 4-12 also shows the flow rate expected (Q_{IN}) and the flow rate exiting (Q_{OUT}) each of our respective park/ponds (detention basins). Further analysis would be required during the design phase for proper sizing, configuration and location of drainage appurtenances.

STUDY AREA HYDROLOGIC ANALYSIS

The same study criteria was used for our proposed analysis on watershed areas and their peak runoff values as shown in Tables 4-3, 4-4 and 4-5. The watershed area delineations are based on the topographic mapping dated 1996 and were analyzed based on their respective land use designations. All 100-year peak runoff values are shown in Figure 4-14. The peak runoff values leaving the property are shown for comparison to the existing values. None of the storm water peak discharge values leaving the property exceed the existing condition.

STUDY AREA HYDRAULIC ANALYSIS

All concrete lined channels and culverts were analyzed by the HEC-RAS computer model. Sufficient right-of-way was provided to allow flexibility upon design of each respective channel, including the hybrid type. Storm sewer systems would be designed and analyzed by each development and is not part of this study. The size and configuration of channels is conceptual and would require further study at the time of their design.

Ponding area locations were determined based on available topographic information and our observations of existing conditions. The ponding areas were analyzed to detain the majority of

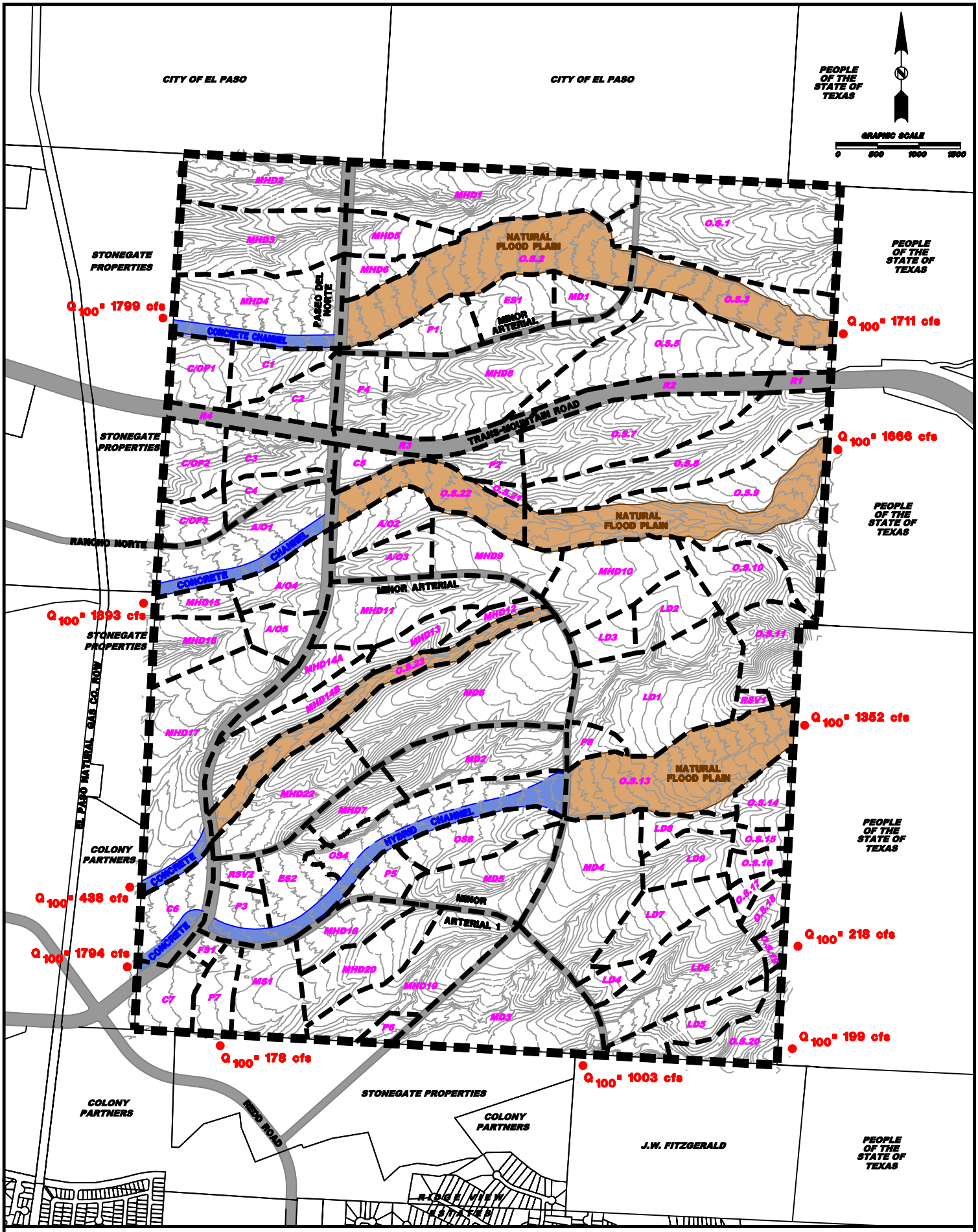

FIGURE 4-13
PROPOSED WATERSHED MAP

EL PASO WATER UTILITIES PUBLIC SERVICE BOARD

WESTSIDE MASTER PLAN

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WATERSHED ID	AREA (ac.)	Q100 (cfs)
A/O 1	32.95	127
A/O 2	13.28	52
A/O 3	11.86	47
A/O 4	16.87	66
A/O 5	10.65	42
C 1	13.14	52
C 2	12.60	50
C 3	14.27	57
C 4	8.56	34
C 5	7.00	28
C 6	21.26	82
C 7	12.6	49
C/OP 1	13.87	55
C/OP 2	15.29	61
C/OP 3	9.73	39

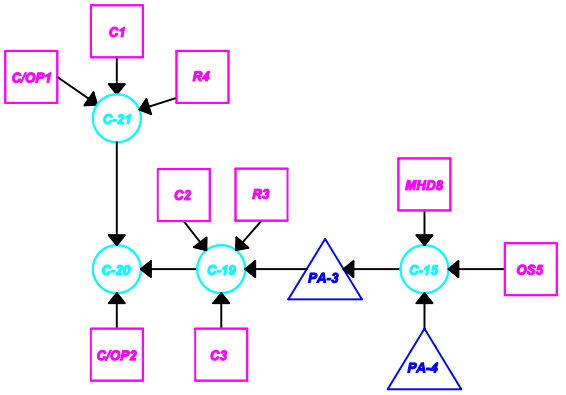
WATERSHED ID	AREA (ac.)	Q100 (cfs)
ES 1	15.00	58
ES 2	15.00	58
MS 1	20	80
FS 1	2.00	8
R 1	3.92	16
R 2	14.40	54
R 3	10.76	
R 4	8.94	36
P 1	14.66	32
P 2	9.22	20
P 3	6.50	23
P 4	39	10.3
P 5	8	20
P 6	3	11
P 7	10	38

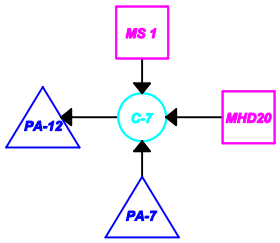
WATERSHED ID	AREA (ac.)	Q100 (cfs)
P 8	5.1	18
MD 1	8.36	29
MD 2	27.20	68
MD 3	48.73	135
MD 4	44.16	124
MD 5	23.1	58
MD 6	61.13	160
LD 1	50.3	121
LD 2	14.42	45
LD 3	8.36	25
LD 4	6.97	22
LD 5	14.73	44
LD 6	42.20	102
LD 7	19.30	54
LD 8	7.30	22
LD 9	12.73	40

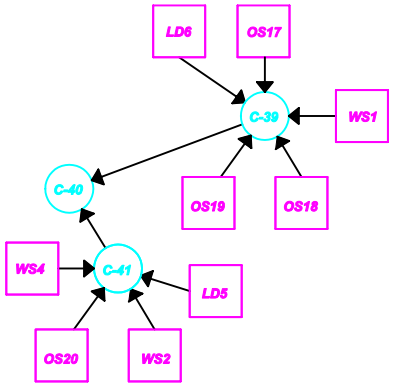
WATERSHED ID	AREA (ac.)	Q100 (cfs)
MHD 1	47.51	135
MHD 2	28.03	80
MHD 3	35.05	101
MHD 4	40.50	115
MHD 5	12.96	42
MHD 6	7.30	25
MHD 7	10.8	28
MHD 8	149	51.8
MHD 9	21.35	73
MHD 10	28.90	87
MHD 11	31.17	90
MHD 12	4.82	14
MHD 13	9.45	34
MHD 14A	9.24	31
MHD 14B	12.27	36
MHD 15	7.41	25

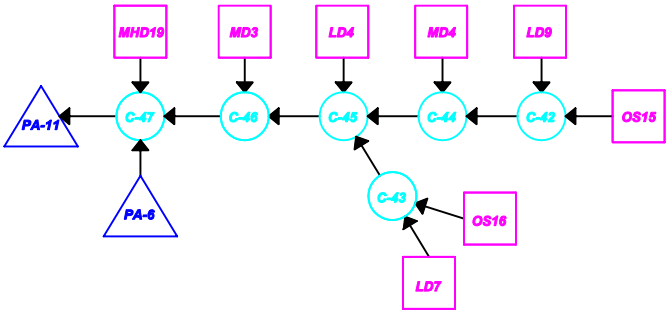
WATERSHED ID	AREA (ac.)	Q100 (cfs)
MHD 16	13.23	44
MHD 17	55.86	141
MHD 18	19.5	42
MHD 19	32.99	94
MHD 20	20.59	56
MHD 22	30.50	89
OS 1	66.97	250
OS 2	54.65	160
OS 3	31.38	115
OS 4	18.3	51
OS 5	145	49.2
OS 6	18.3	64
OS 7	40.20	150
OS 8	40.76	121
OS 9	71.07	203
OS 10	18.41	67

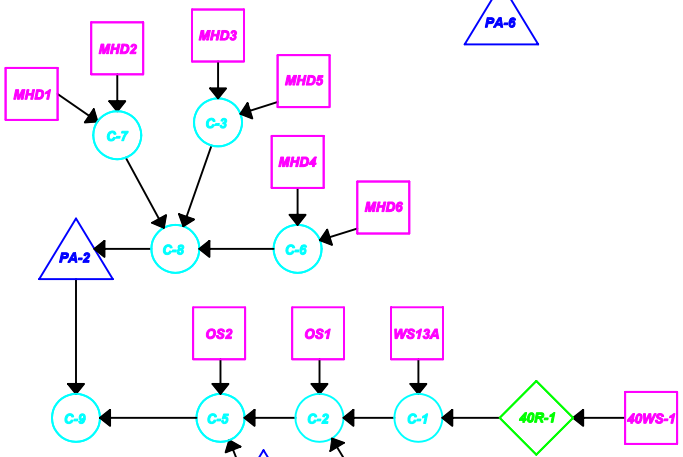
WATERSHED ID	AREA (ac.)	Q100 (cfs)
OS 11	16.60	49
OS 12	5.06	16
OS 13	50.98	184
OS 14	10.58	38
OS 15	4.07	22
OS 16	4.96	13
OS 17	3.49	10
OS 18	5.81	16
OS 19	2.96	10
OS 20	15.19	57
OS 21	2.05	8
OS 22	21.95	78
OS 23	21.45	58
RSV 1	3	11
RSV 2	4	15

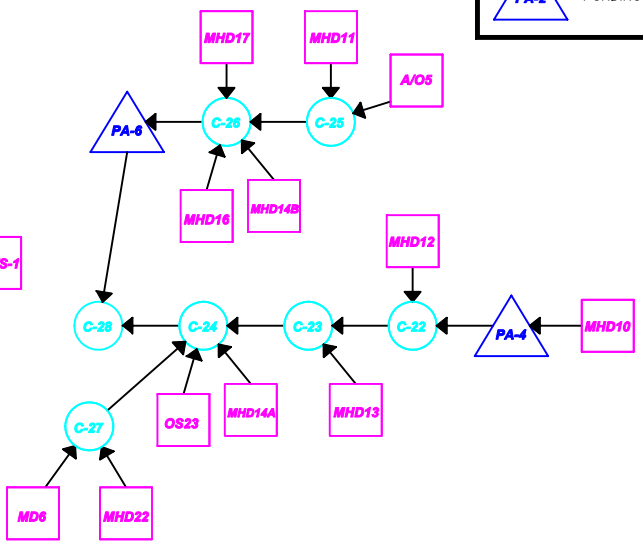












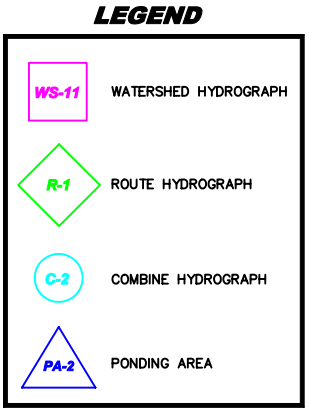


FIGURE 4-14
WATERSHED DATA

EL PASO WATER UTILITIES PUBLIC SERVICE BOARD
WESTSIDE MASTER PLAN
PREPARED BY: MORENO CARDENAS INC. JUNE 2005

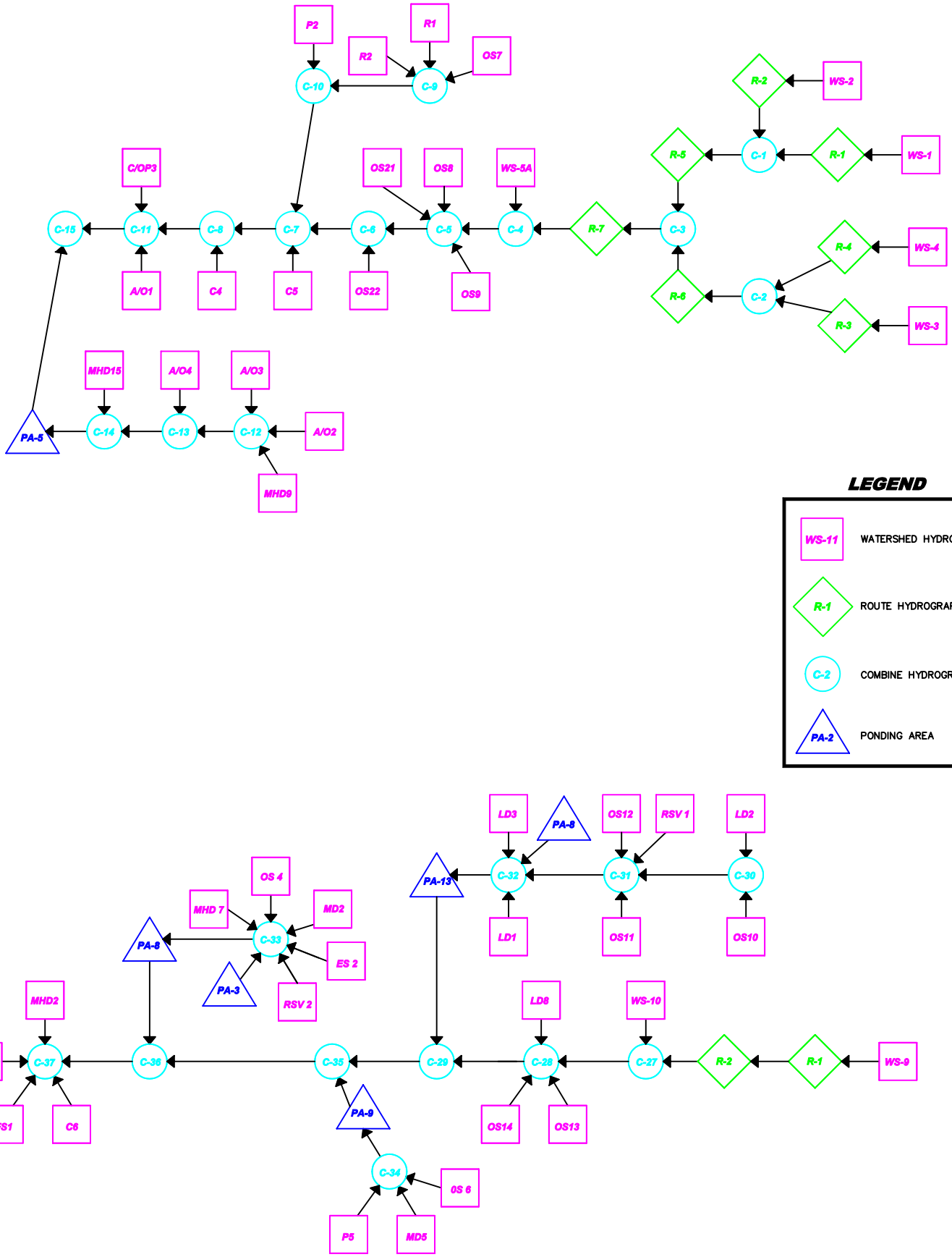


FIGURE 4-15
WATERSHED DATA

EL PASO WATER UTILITIES PUBLIC SERVICE BOARD

WESTSIDE MASTER PLAN

PREPARED BY: MORENO CARDENAS INC. JUNE 2005

the proposed runoff created by new development and maintain historic flows in existing arroyos or channels. The Land Use Map shows the proposed areas for park/ponds. These areas are for the combination of parks and ponds. However, ponding requirements shall require further analysis during the design phase for proper sizing, configuration and location.