University of New Mexico

Department of Civil Engineering

Car Wash Channel

Richard J. Heggen

March 11, 1997

A Report Prepared for the
Albuquerque Metropolitan Arroyo Flood Control Authority

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Introduction

The Car Wash Channel consists of:

An asphalt swale (175 cfs) along NM 528 in front of Octopus Car Wash,
The confluence of three CMP's (40 cfs total) crossing NM 528, and
A concrete trapezoidal channel (215 cfs) transitioning to and from a rectangular bridge crossing on the east.

The asphalt swale and CMP's terminate in a confluence basin of roughly 30x50x5 cubic feet. Outflow turns and enters the trapezoid. In general aspect, the confluence appears to be an ad-hoc intersection of the three conveyances, essentially what could be inexpensively fit into the alignment. Fig. 1 illustrates the configuration. Table 1 summarizes the conveyance geometrics and capacities.

Two sets of problems may exist at the confluence. Inflows are supercritical. While the trapezoidal outlet and downstream bridge crossing are of adequate capacity, inflow might fail to make the turn and overtop the confluence's south sideslope. This sideslope is reinforced with survey-designated crap-rap, a designation which may have acronymic meaning, or may simply be descriptive of mortared stones and rubble.

Apart from (but related to) hydraulic overtopping, the confluence is a sediment trap. The confluence floor is covered by approximately one foot of recent deposition. The CMP outlets are approximately half blocked. The reason for deposition is apparent: inflows from both the swale and the CMP's decelerate in the confluence and the suspended load settles. The sediment source appears to be upstream construction. Without maintenance, the CMP's will plug.

Problem Statement

The Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) authorized UNM to model the confluence to:

1) Analyze hydraulic conditions, and

2) Recommend confluence modifications as needed.

The Model

The study employed the UNM Civil Engineering/AMAFCA Open Channel Test Facility. The 50 foot articulated table served as a platform for a three-dimensional model constructed of sheet metal, wood, PVC pipe and plastic sheeting.

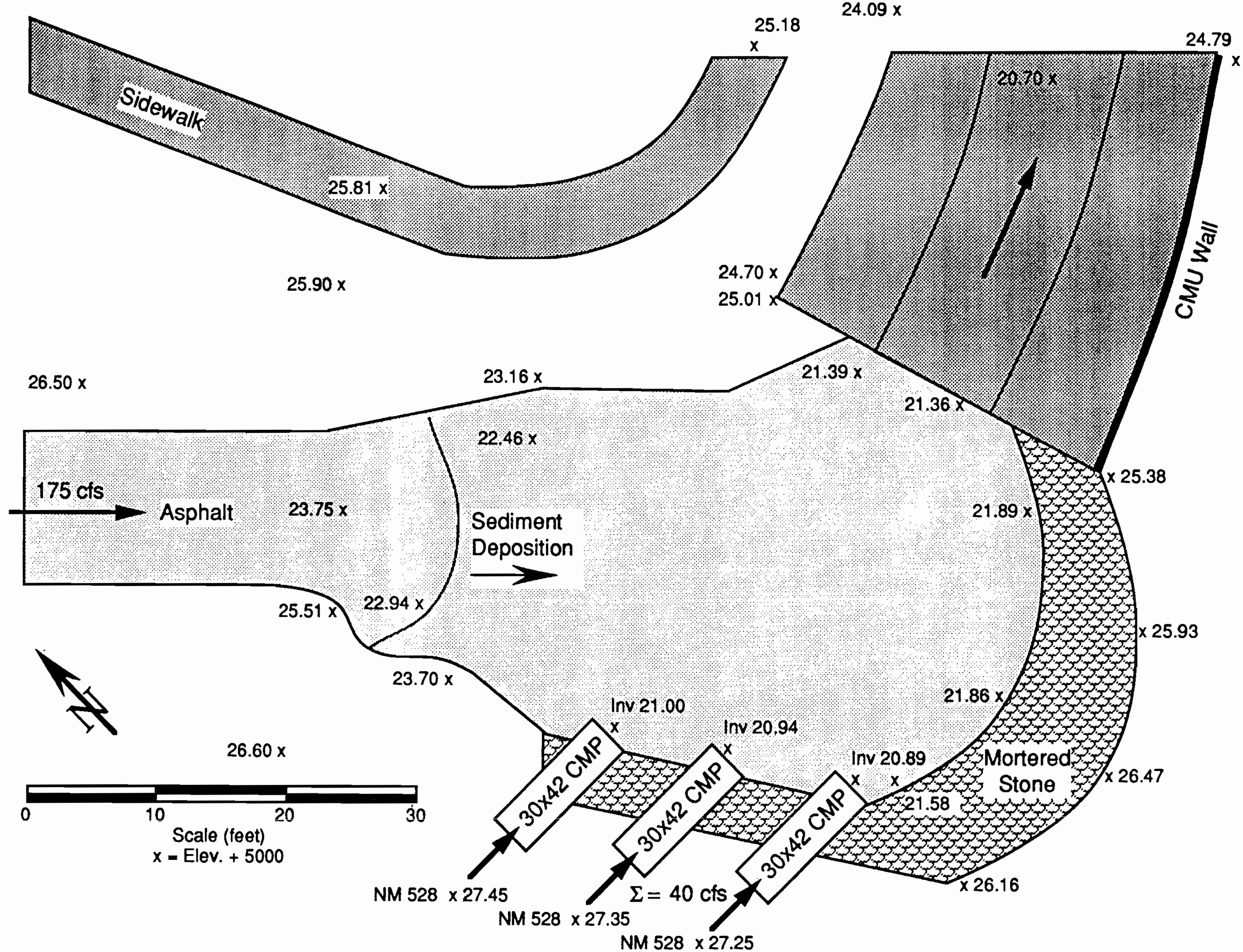


Figure 1. Configuration 1

Channel	Asphalt Swale			NM 528 Culverts			Car Wash Bridge			AMAFCA		
Shape	Parabolic			Squash Pipe			Rectangle			Trapazoid		
	w	12	ft.	3 -	30 in. x 42 in.		b	10	ft.	b	10	ft.
	h	1.5	ft.	3 -	36 in. (for analysis)		h	4	ft.	h	3.5	ft.
										Z	2	
Slope	Elev 28.81-26.42	0.0191			0.00444			0.0122			0.0122	
	Elev 26.42-25.32	0.0611										
	Elev 25.32-23.75	0.0357										
n		0.020		CMP	0.013			0.012			0.012	
				Sediment	0.025							
Design		175	cfs		40	cfs (total)		215	cfs		215	cfs
yn	Elev 28.81-26.42	1.79	ft.		1.13	ft. (open pipe)		1.45	ft.		1.25	ft.
	Elev 26.42-25.32	1.36	ft.									
	Elev 25.32-23.75	1.55	ft.									
Froude	Elev 28.81-26.42	1.81			1.06	(open pipe)		2.17			2.37	
	Elev 26.42-25.32	3.11										
	Elev 25.32-23.75	2.42										
yc		2.40	ft.		1.16	ft. (open pipe)		2.43	ft.		2.10	ft.
Capacity	Elev 28.81-26.42	68	cfs		135	cfs (total) open pipe		454	cfs (inlet limited)		1430	cfs
	Elev 26.42-25.32	215	cfs		33	cfs (total) half blocked						
	Elev 25.32-23.75	165	cfs									

Table 1. Capacities

Plastic sheeting lined a wooden confluence basin. Wire mesh on the plastic simulated the roughness. The model terminated with the confluence outlet. The downstream bridge transition does not limit flow leaving the confluence, as indicated in Table 1.

The 30x42-inch CMP's were modeled with round pipe, dimensionally equivalent to 36-inch diameter. (Unless noted otherwise, all dimensions in this report refer to the prototype, not the model.) As the CMP's have ample capacity, ignoring the squash makes negligible hydraulic difference. The reality of half of the pipe cross-section being lost to sediment overrides any error of geometric simplification, in any case.

To better use the lab space, the model was reversed left-to-right from the prototype. Directions in this report refer to the prototype.

The swale model discharge was measured by a pressure differential Annubar Flow Sensor, model GCR25 in the primary pump piping. The CMP model discharge was measured by a McChrometer propeller meter in the auxiliary pump piping.

Geometric similitude was 1:8. The inertial-gravity force ratio was the same for both model and prototype, making Froude numbers equal.

Experiments

Two confluence configurations were modeled. Configuration 1 is the existing structure.

Configuration 2 extends the CMP's roughly 20 feet and pulls the right (south) sideslope out to reduce the "belly" of the confluence. Fig. 2 illustrates the Configuration 2 layout.

Table 2 summarizes the experiments.

Table 2. Experiments

Experiment	Configuration	Discharge (cfs) Swale	Discharge (cfs) CMP's
1	1	175	0
2	1	0	40
3	1	175	40
4	2	175	0
5	2	0	40
6	2	175	40

Depths were recorded along the confluence walls.

Results

Table 3 summarizes experimental results, the critical value being maximum water surface elevation where swale inflow hits the opposite (south) sideslope of the confluence. This high-water location is between the spot elevations 25.38 and 25.93 on the right side of Fig. 1. Elevation datum is 5000 feet. Table 3 elevations represent mean high water. Occasional instabilities deviate the water

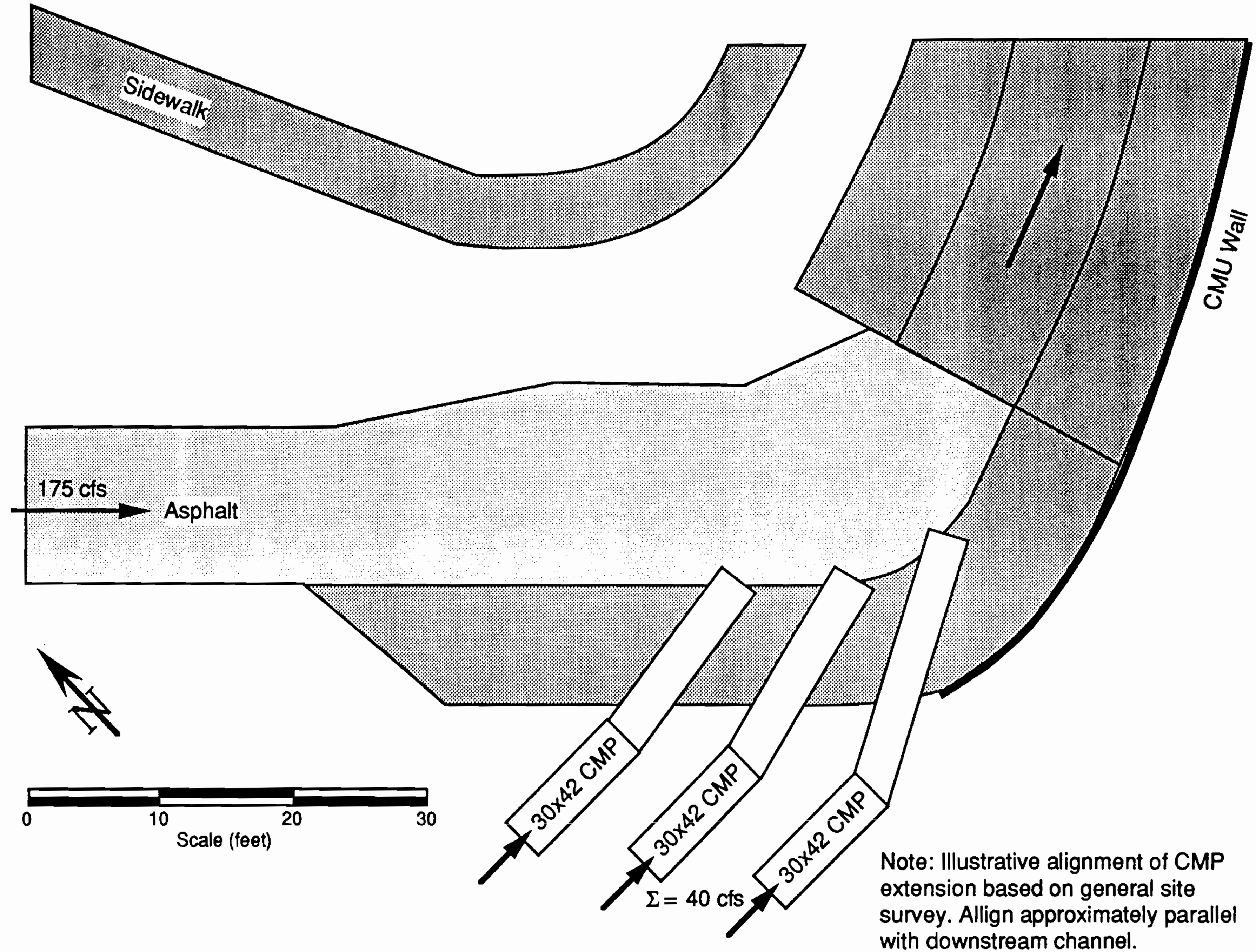


Figure 2. Configuration 2

surface approximately ± 0.5 feet. Additional water surface elevations are shown in the appended data.

Table 3. Water surface elevations.

Experiment	Water Surface Elevation (ft)
1	24.0
2	22.5
3	24.2
4	24.0
5	22.3
6	24.5

Discussion

Configuration 1 Eddy

Configuration 1 conveys the discharge without hydraulic problem, but creates a large eddy in the south end of the confluence. The eddy behaves as a sediment extractor, a canal desilting structure developed in India, but not what is needed here. Deposition is significant and contributes to CMP blockage. Unless the introduction of upstream sediment can be precluded, Configuration 1 appears to be a self-burying basin.

Configuration 2 Hydraulics

Confluence 2 resembles a sharp channel bend with a relatively small discharge addition aligned with the downstream channel. While this configuration might be unsatisfactory for major channels, it functions adequately in this situation.

Configuration 2 Sedimentation

Configuration 2 maintains a more consistent channel width than that of Configuration 1. The narrowing minimizes eddying along south sideslope, significantly reducing the Configuration 1 propensity for sediment accumulation.

Configuration 2 Alignment

While the Configuration 2 model adequately simulates the hydraulics, its final shaping requires a design-level survey. The existing CMP alignment is not parallel with the outflow channel and the three pipes span approximately 20 feet, twice the 10-foot downstream bed width. Fig. 2 suggests the type of redirection needed, but necessary adjustments are left to the final design.

Configuration 2 Sideslope

While a concrete sideslope is anticipated, any erosion-resistant treatment is adequate. The modeled sideslope was 2:1, but this can be steepened as desired. There is no reason to reconstruct the left sideslope.

Configuration 2 CMU Wall Extension

The existing 20-inch CMU extension provides freeboard above the right (outside) trapezoidal wall, but does not extend up the curve. Configuration 1, with its larger basin, experiences minimal wave action across the pond surface and has little propensity for waves to override the south sideslope. The CMU wall is prudent, but not absolutely necessary

The existing sideslope height contains the wave action for Configuration 2, but freeboard is minimal. Configuration 2 superelevation may ride higher on the south bank because the channel is narrower. For this reason, the CMU extension illustrated in Fig. 2 is recommended. The existing 20-inch wall height (approximate elevation 26.90) appears to be reasonable.

Downstream Deposition

The Octopus Car Wash staff digs out the channel downstream of the bridge on occasion. Recent cleaning is evident. The model does not address sediment transport in this reach. There is no assurance that confluence reconstruction will eliminate downstream problems. Downstream deposition may thus merit additional review.

Conclusions

1) The existing confluence is satisfactory for a clean channel.
2) The confluence is filling with sediment, plugging the CMP outlets.
3) For a more-maintainable structure, the confluence should be reconstructed to streamline the discharge. Configuration 2 suggests a layout for such improvement.

Notes:

1. Multiply model distances by 8 to get prototype distances.
2. Multiply model velocities by 2.83 to get prototype velocities.
3. Multiply model discharges by 181.02 to get prototype discharges.

PROJECT DESCRIPTION

The project entails construction of a new building structure on a vacant lot. There is joint access between the proposed commercial site to the west and this site. A deceleration lane and driveway shall be constructed on NM 528 for both sites. Detailed drawings for the driveway, deceleration lane, and drainage channel reconstruction shall be submitted at a later date for DRC review.

DRAINAGE MANAGEMENT PLAN

EXISTING SITE CONDITIONS

The site is currently vacant with typical westside vegetation covering the ground. The soils are also typical of westside silty sands. The existing storm runoff drains overland from west to east and continues offsite to a detention pond then into the Cabezon Drain. SAD 223 analyzed this area and defined the allowable discharge to the Cabezon Drain. Offsite flows do not impact site.

PROPOSED CONDITIONS

The grading and drainage plan proposes to drain the developed storm runoff overland from west to east to a detention pond in the northeastern corner of the property. The detention pond is designed to recieve all developed flows from the commercial site to the west. The developed flow from the adjacent site will also be directed overland to the detention pond. The allowable storm runoff from this site is Q=2.31cfs per acre of developed property in Tract C-3-A. Construction will include a paved parking lot and landscaped area. AHYMO was used and fully developed conditions were assumed to calculate and obtain the developed flows and the results were utilized to obtain the pond size and routing.

POND IN DISCOUNT TIRE SITE

ELEVATION	AREA	VOLUME (FT^3)	STORAGE (ACRE-FEET)	OUTFLOW (cfs)	PIPE SIZE (INCHES)
26.00	3752.50			0.00	15
		4150	0.095271		
27.00	4547.50			3.92	
		5164.25	0.118555		
28.00	5781.00			7.51	
		TOTAL	0.213826		

POND VOLUME REQUIRED 3,594 FT^3
POND VOLUME PROVIDED 9,315 FT^3
MAXIMUM WATER SURFACE ELEVATION 26.87

SEE ATTACHED SHEETS FOR AHYMO RESULTS.

D. Mark Goodwin & Associates, P.A.
Consulting Engineers and Surveyors

PROJECT Discount Tire
SUBJECT Drainage
BY RM DATE 3 Apr 97
CHECKED ______ DATE ______
SHEET 1 OF 1

Area

A = 0.9600 Acres = 0.0015 sq. miles.

Rainfall

1 hr = 1.87" 6 hr = 2.20" 24 hr = 2.66"

Land Treatments

Type "A" = 0.00%
Type "B" = 20.00%
Type "C" = 11.00%
Type "D" = 69.00%

AHYMO Results

Q_{PK} = 3.60 cfs Vol_{PK} = 0.1276 Acre-Feet

Combined Discharge

Midas Muffler

Q_{PK} = 3.15 cfs Vol_{PK} = 0.1148 Acre-Feet

Discount Tire

Q_{PK} = 3.60 cfs Vol_{PK} = 0.1276 Acre-Feet

Q_T = 6.75 cfs Vol_T = 0.2423 Acre-Feet

Allowable Discharge

Q = 2.31 cfs Per Acre Granted By SAD 223 For Tract C-3-A

Total Area Of Both Commercial Site

A = Midas + Discount Tire
= (0.7892 + 0.96) Acres
A = 1.7492 Acres

$Q_{ALLOWABLE}$ = 1.7492 Acres * 2.31

Q_A = 4.04 cfs

D. Mark Goodwin & Associates, P.A.
Consulting Engineers and Surveyors

PROJECT Discount - 528
SUBJECT Drainage
BY MG DATE 11/6/96
CHECKED ______ DATE ______
SHEET 1 OF ____

This project entails development of a 0.97 Ac. portion of the overall 4.93 Ac Tract C-3-A.

Per SAD 223 and Tract C-3-B report (attached), allowable discharge rate for C-3-A is 11.4 cfs = 2.31 cfs per Ac.

Allowable Rate this Project = 2.24 cfs

Area = 0.97 Ac.

Precip. Zone 1 P_1 = 1.87 in P_6 = 2.20 P_{24} = 2.66

LAND Treatments:

Treatment A = 0
Treatment B = 20%
Treatment C = 11%
Treatment D = 69%

Per Attached AHYMO

Q_{100} = 3.60 cfs
Vol. = 5489 cu Ft. } We will need to Pond

We will discharge via orifice to Tract C-3-C which is the inlet to the Cabazon Channel

D. Mark Goodwin & Associates, P.A.
Consulting Engineers and Surveyors

PROJECT Discount - 528
SUBJECT Drainage
BY MG DATE 11/6/96
CHECKED ______ DATE ______
SHEET 4 OF ____

Using the Orifice Eqn :

$Q = CA\sqrt{2gH}$

$C = 0.6$

$A(8") = 0.35$

H	Q	Vol.
0	0	0
0.5	1.19	2025
1.0	1.69	3037
1.5	2.06	5750
2.0	2.38	8125

Per Attached Routing :

Q(peak w/8") = 1.3 cfs o.k.

Max H_2O Surface = 27.57 o.k.

Emergency spillway inlet will act as weir:

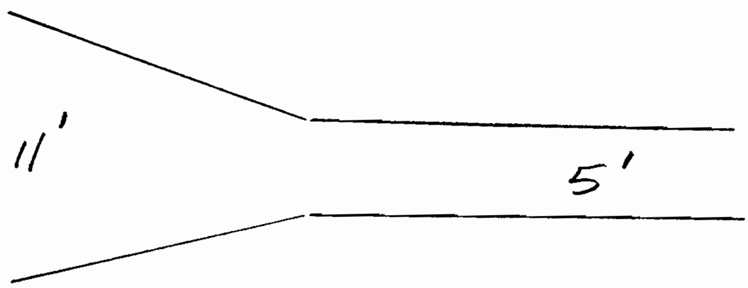
$Q = CLH^{3/2}$

$H = 6''$

$Q = 11$ (Total allowable from all of C-3-A)

$L = 11'$

Then spillway will operate as open channel @ $S = 7\% \pm$



Box Culvert

$Q = 160$ cfs (from SAD 223)

$b = 10'$

slope $= 1\%$

$n = 0.015$

$D = 1.20'$

$V = 12$ fps

Froude = 1.60
Freeboard = 1.57'
Box H = 2.77' use 3'

Roadside Channel

Q = 160 cfs
Sideslope = 2:1
Slope = 9/225 = 4.0%
n = 0.015   b = 10'
D = 0.75'
V = 8.6 fps
F = 1.25
Freeboard = 1.15'
D = 1.85' use 2'

HEC-RAS Plan: Plan 01 Reach: NM528

River Sta.	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
155	160.00	42.13	44.56	44.56	45.00	0.003682	5.35	29.93	35.15	1.02
150	160.00	39.22	41.00	41.76	43.76	0.025982	13.32	12.01	15.29	2.65
145	160.00	35.06	37.01	38.02	40.65	0.026841	15.31	10.45	10.72	2.73
140	160.00	32.67	34.09	34.56	36.09	0.039091	11.34	14.11	31.77	3.00
135	160.00	28.81	30.34	30.87	32.51	0.017653	12.31	18.15	47.98	2.26
130	160.00	26.42	27.36	27.73	28.88	0.054905	13.84	20.25	49.05	3.56
125	160.00	23.75	25.40	26.04	27.24	0.016111	10.90	14.68	17.85	2.12
120	160.00	21.48	22.00	22.60	25.94	0.122162	15.92	10.05	31.96	5.00
115	160.00	21.36	23.29		23.39	0.000519	2.65	60.46	46.19	0.41
110	160.00	20.99	22.63	22.63	23.31	0.003195	6.62	24.15	17.94	1.01
107.5	160.00	20.70	22.24	22.45	23.18	0.005033	7.80	20.51	16.90	1.25
105	160.00	19.99	21.28	21.77	22.84	0.010424	10.01	15.99	15.77	1.75
100	160.00	19.24	20.92	21.69	22.34	0.006822	9.55	16.75	9.98	1.30

HEC-RAS Plan: Plan 01 Reach: NM528

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
155	160.00	42.13	44.56	44.56	45.00	0.003682	5.35	29.93	35.15	1.02
150	160.00	39.22	41.09	41.76	43.33	0.020151	12.02	13.31	16.35	2.35
145	160.00	35.06	37.02	38.02	40.55	0.025775	15.08	10.61	10.81	2.68
140	160.00	32.67	34.10	34.56	36.05	0.037926	11.21	14.27	31.95	2.96
136	160.00	30.55	32.19	32.74	33.99	0.018749	10.76	14.87	20.75	2.24
134	160.00	29.00	29.57	30.25	32.60	0.044969	13.96	11.46	20.03	3.25
133	Culvert									
132	160.00	28.80	30.04	30.04	30.67	0.003587	6.36	25.17	20.26	1.00
130	160.00	26.42	27.73	27.73	28.07	0.006945	6.58	40.34	55.73	1.36
125	160.00	23.75	25.40	26.04	27.24	0.016106	10.90	14.68	17.85	2.12
120	160.00	21.48	22.02	22.60	25.48	0.098991	14.93	10.72	32.07	4.55
115	160.00	21.36	23.28	22.61	23.39	0.000524	2.65	60.28	46.16	0.41
110	160.00	20.99	22.63	22.63	23.31	0.003195	6.62	24.15	17.94	1.01
107.5	160.00	20.70	22.24	22.45	23.18	0.004984	7.77	20.59	16.92	1.24
105	160.00	19.99	21.29	21.77	22.81	0.010072	9.89	16.18	15.84	1.72
100	160.00	19.24	20.94	21.70	22.33	0.006593	9.45	16.94	9.99	1.28

HEC-RAS   Plan: Plan 01   Reach: NM528

River Sta.	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
155	160.00	42.13	44.56	44.56	45.00	0 003682	5.35	29.93	35.15	1.02
150	160.00	39.22	41.00	41.76	43 76	0.025982	13.32	12.01	15 29	2.65
145	160.00	35.06	37.01	38 02	40.65	0.026841	15.31	10.45	10.72	2 73
140	160.00	32.67	34.09	34 56	36.10	0.039147	11.37	14.07	31.60	3.00
135	160.00	28.81	30.34	30 87	32.51	0.017694	12.32	18.12	47.93	2 26
130	160.00	26.42	27.36	27.73	28.88	0.054815	13.83	20.26	49.06	3.56
125	160.00	23.75	25.40	26.04	27.24	0.016104	10.90	14.68	17.85	2.12
120	160.00	21.47	21.80	22.48	26.13	0.264654	22.86	10.68	30 40	7 27
115	160.00	21.86	22.90	23 31	24.25	0.014997	11 05	19 71	21.36	2 07
110	160.00	25 99	27 21	27.21	27 54	0.003709	5.23	42.33	75 03	1 70
1075 ~~105~~	160 00	24.00	24.93	25 45	27.11	0 031957	12.01	14.50	31 44	2 83
105 ~~102.5~~	160.00	23 63	24.01	24 37	25 19	0.061134	8.68	18.43	29 84	1 95
100	160.00	25 00	24.06	24 06	24 57	0.014436	5.74	27.89	27 37	3 21

HEC-RAS Plan: Plan 01 Reach: NM528 12/27/96

River Sta.	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
155	160.00	42.13	44.57	44.57	45.00	0.003594	5.30	30.21	35.33	1.01
150	160.00	39.22	41.00	41.76	43.77	0.026066	13.34	11.99	15.27	2.65
145	160.00	35.06	37.01	38.02	40.63	0.026629	15.26	10.48	10.74	2.72
140	160.00	32.67	34.09	34.58	36.12	0.039707	11.44	13.98	31.43	3.02
135	160.00	28.81	30.36	30.65	31.44	0.025530	8.33	19.22	50.12	2.37
130	160.00	26.42	27.34	27.63	28.39	0.023535	8.21	19.49	48.11	2.27
125	160.00	23.75	25.41	26.05	27.20	0.015494	10.74	14.90	17.98	2.08
120	160.00	21.39	21.77	22.40	25.90	0.124513	16.32	9.81	30.37	5.06
115	160.00	21.86	22.70	23.19	24.35	0.016159	10.32	15.51	20.52	2.09
110	160.00	25.93	27.16	27.16	27.42	0.004214	4.11	38.94	75.02	2.25
105	160.00	24.00	24.90	25.39	27.00	0.040022	11.62	13.77	30.60	3.05
102.5	160.00	23.63	23.90	24.37	25.64	0.027612	10.58	15.12	28.41	2.56
100	160.00	25.00	23.72	24.06	24.77	0.009384	8.21	19.49	22.88	1.57

HEC-RAS Plan: Plan 01 Reach: NM528 12/26/96

River Sta.	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
155	160.00	42.13	44.57	44.57	45.00	0.003594	5.30	30.21	35.33	1.01
150	160.00	39.22	41.00	41.76	43.77	0.026066	13.34	11.99	15.27	2.65
145	160.00	35.06	37.01	38.02	40.63	0.026629	15.26	10.48	10.74	2.72
140	160.00	32.67	34.09	34.58	36.12	0.039707	11.44	13.98	31.43	3.02
136	160.00	30.55	32.18	32.76	34.04	0.019434	10.92	14.65	20.55	2.28
134	160.00	29.00	29.57	30.25	32.58	0.044363	13.90	11.51	20.03	3.23
133	Culvert									
132	160.00	28.80	30.04	30.04	30.67	0.003590	6.36	25.16	20.26	3.23
130	160.00	26.42	27.19	27.63	29.57	0.070089	12.37	12.94	39.16	3.79
125	160.00	23.75	25.33	26.05	27.48	0.019738	11.76	13.61	17.18	2.33
120	160.00	21.48	22.00	22.60	26.03	0.127051	16.12	9.93	31.94	5.09
115	160.00	21.36	22.21	22.61	23.75	0.030534	9.96	16.06	36.31	2.64
110	160.00	20.99	22.43	22.63	23.37	0.005096	7.76	20.61	17.20	1.25
107.5	160.00	20.70	22.16	22.44	23.23	0.006032	8.30	19.27	16.56	1.36
105	160.00	19.99	21.27	21.77	22.86	0.010716	10.10	15.84	15.72	1.77
100	160.00	19.24	20.91	21.62	22.35	0.006987	9.63	16.61	9.98	1.32