

Empire Laboratories, Inc.

MATERIALS AND FOUNDATION ENGINEERS

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December 1, 1981

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JCR Engineering
211 West Myrtle
Fort Collins, Colorado 80521

Attention: Mr. Joe Roesser

Re: Cimarron Plaza P.U.D.
Pavement Design
ELI Project No. 4629-81

Gentlemen:

We are pleased to present our Report of a Pavement Design prepared for the Cimarron Plaza P.U.D., Fort Collins, Colorado. The objectives of this investigation were to (1) develop criteria for determining the pavement design at the site and (2) develop recommendations for the pavement structure to be used in the proposed streets.

The field investigation, carried out on November 24, 1981, consisted of hand-digging, logging, and sampling one (1) test pit. The test pit was located approximately three hundred fifty (350) feet west and two hundred forty-five (245) feet south of the intersection of West Drake Road and South Shields Street. Atterberg limits, soil classification, and Hveem stabilometer test data were determined on the sample. A summary of test results along with a curve showing this data is included on pages 3 through 5. The sample was obtained at a depth of one (1) to two (2) feet below present grades. The material encountered at this depth consists of a moderately plastic sandy silty clay. A one (1) foot layer of silty topsoil overlies the clay.

The group index of the upper soil encountered at the site was 8.2. The Hveem stabilometer test was performed in our laboratory and an "R" value of 4 has been determined for this material. Using this "R" value as criteria for pavement design and design procedures in accordance with the Design Criteria and Standards for Streets for the City of Fort Collins dated September 1981, the following pavement thicknesses are recommended at the site.



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JCR Engineering
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Cul-de-sacs -

Select Subbase	7"
Select Aggregate Base Course	4"
Asphaltic Concrete	<u>2"</u>
Total Pavement Thickness	13"

Local Streets

Select Subbase	7"
Select Aggregate Base Course	4"
Asphaltic Concrete	<u>2½"</u>
Total Pavement Thickness	13½"

All street subgrade and all fill placement should be done in accordance with City of Fort Collins specifications. All subbase, base course, and asphaltic concrete shall meet City of Fort Collins specifications and should be placed in accordance with these specifications.

If you have any questions regarding the above recommendations, please do not hesitate to call us.

Very truly yours,

EMPIRE LABORATORIES, INC.



Neil R. Sherrod
Senior Engineering Geologist

Reviewed by:



Chester C. Smith, P.E.
President

clc



HVEEM STABILOMETER DATA

Boring No. Depth (Ft.)	Compaction Pressure (PSI)	Density (PCF)	Moisture (%)	Expansion Pressure (PSI)	Horizontal Pressure (PSI)*	Sample Height (In.)	Uncorrected R-Value	Corrected R-Value**
1 @ 1.0-2.0'	120	101.1	24.2	.12	145	2.55	4.9	4.9
	0	93.8	28.1	----	143	2.47	4.7	4.7
	0	89.8	30.7	----	146	2.47	3.8	3.8

* At 160 psi vertical pressure

** $100 - 100 / ((2.5/D)(160/P_h - 1) + 1)$

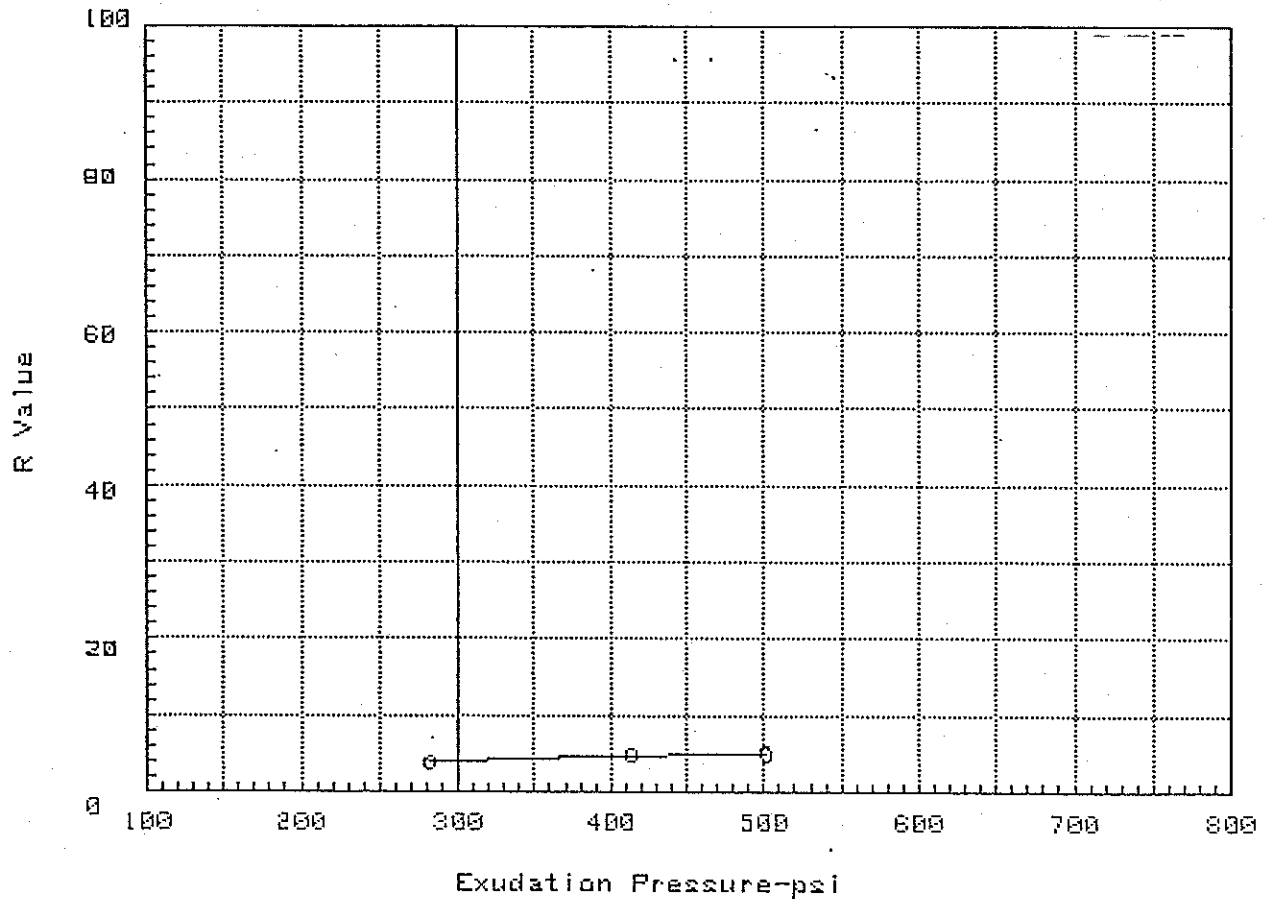
STABILOMETER TEST RESULTS

Client J.C.R. ENGINEERING

Project CIMARRON PLAZA P.U.D.

Boring 1 Depth 1.0-2.0

R Value at 300 psi exudation 4.0



SUMMARY OF TEST RESULTS

Atterberg Summary

Liquid Limit	33.4
Plastic Limit	22.2
Plasticity Index	11.2
% Passing 200	79.7
Group Index	8.2

Classification

Unified	CL
AASHTO	A-6(8)

THG
8-9-85

PRELIMINARY DRAINAGE ANALYSIS
FOR
ARROWSTONE DEVELOPMENT CORP.
CIMARRON PLAZA P.U.D.

The proposed Cimarron Plaza P.U.D. is a commercial development by Arrowstone Development Corporation. It consists of approximately 4.5 acres located in the NE 1/4 of Section 27, T7N, R69W of the 6th P.M. in Fort Collins, Colorado.

The site is bounded on the south and west by the Cimarron West Development. It is bounded on the north and east by Drake Road and Shields Street respectively. These streets have been improved in recent years and include curb and gutter and sidewalk improvements. A disheveled residence and outbuildings currently occupy the site with miscellaneous vegetation. The site slopes gently to the northeast.

The project will be comprised of two drainage basins. No offsite flows from Cimarron West are anticipated. Basin calculations for determination of stormwater detention are included herein and summarized below.

<u>BASIN</u>	<u>ALLOWABLE DISCHARGE RATE</u>	<u>DETENTION VOL.</u>
A	0.85 cfs	31577
B	0.27 cfs	8604

Detention storage will be facilitated in parking areas. The majority of the site will drain into the parking area in the northeast corner of the site, from there runoff will outfall.

The southeast portion of the site will be detained in the southeast parking area and will surface outfall into the curb & gutter in Shields Street.

RBD, Inc.
Stan A. Myers
Stan A. Myers, P.E.



FINAL REPORT MUST ADDRESS:

1. How release is to be controlled w/ sizing calc.
2. Depths of ponding for 10 & 100 yr. storms.
3. Pipe velocities (must > 2 fps, e.g. self scouring)
4. Consequences of outlet pipe not functioning
→ where does water go? ~~will~~ Do "inadvertent" spillways exist?

AS WELL AS "USUAL" ITEMS.
See comments on drainage plan too.

DATE: 8-1-85
 PROJECT: CIMARRON LAZA
 JOB NUMBER: 108-017
 DESIGN ENGINEER: STAN MYERS

BASIN DESIGNATION = A

DETERMINE EXISTING Q FOR ⁽²⁾ YEAR STORM

HISTORIC RUNOFF COEFFICIENT .2
 BASIN SLOPE: .7 PERCENT
 BASIN LENGTH 650 FEET
 AREA: 3.56 ACRES

HIST TC = $1.87 * (1.1 - (1 - \frac{1}{650})^{.2}) * \text{SQRRROOT}$ * .2
 = 48.31959 MINUTES .7 ^ 1/3

HISTORIC RAINFALL INTENSITY: 1.186969 INCHES/HOUR
 HISTORIC OUTFALL: $.8451221$ CUBIC FEET PER SECOND

DETERMINATION OF DETENTION POND VOLUME FOR DEVELOPED CONDITIONS

DEVELOPED STORM: 100 YEAR STORM
 DEVELOPED RUNOFF COEFFICIENT .85

CCFAC = .85 * 1.25 * 3.56
 = 3.7825

DURATION MIN	GROSS VOL. CU. FT.	OUTFLOW VOL. CU. FT.	DETENTION VOL. CU. FT.
5	9740.16	253.5366	9486.623
10	14994.72	507.0732	14487.65
15	19095.84	760.6098	18335.23
30	26400.96	1521.22	24879.74
45	31719.6	2281.829	29437.77
60	33449.76	3042.439	30407.32
90	36141.12	4563.659	31577.46
120	36910.08	6084.879	30825.2
180	39985.92	9127.318	30858.6
360	44599.68	18254.64	26345.05

REQUIRED DETENTION VOLUME IS 31577.46 CU. FT. OR
 .7249188 ACRE FEET

DATE: 8-1-85
 PROJECT: CIMARRON PLAZA
 JOB NUMBER: 108-017
 DESIGN ENGINEER: STAN MYERS

BASIN DESIGNATION = B

DETERMINE EXISTING Q FOR ⁽²⁾ YEAR STORM

HISTORIC RUNOFF COEFFICIENT .2
 BASIN SLOPE: ^(.8) PERCENT
 BASIN LENGTH 440 FEET
 AREA: .99 ACRES

HIST TC = $1.87 * (1.1 - (1 / 440)^{.2}) * \text{SQRT}(440)$ * .2
 = 38.02608 MINUTES ^ 1/3

HISTORIC RAINFALL INTENSITY: 1.352986 INCHES/HOUR
 HISTORIC OUTFALL: .2678912 CUBIC FEET PER SECOND

DETERMINATION OF DETENTION POND VOLUME FOR DEVELOPED CONDITIONS

DEVELOPED STORM: 100 YEAR STORM
 DEVELOPED RUNOFF COEFFICIENT .85

CCFAC = .85 * 1.25 * .99
 = 1.051875

DURATION MIN	GROSS VOL. CU. FT.	OUTFLOW VOL. CU. FT.	DETENTION VOL. CU. FT.
5	2708.64	80.36735	2628.273
10	4169.88	160.7347	4009.145
15	5310.36	241.102	5069.258
30	7341.84	482.2041	6859.636
45	8820.901	723.3061	8097.594
60	9302.04	964.4081	8337.632
90	10050.48	1446.612	8603.868
120	10264.32	1928.816	8335.504
180	11119.68	2893.225	8226.455
360	12402.72	5786.449	6616.271

REQUIRED DETENTION VOLUME IS 8603.868 CU. FT. OR
 .1975176 ACRE FEET

DATE: 8/24/85
 PROJECT: FT. COLLINS RETAIL CENTER
 JOB NUMBER: 105-001
 DESIGN ENGINEER: STAN MYERS

BASIN DESIGNATION = A

DETERMINE EXISTING Q FOR 2 YEAR STORM
 =====

HISTORIC RUNOFF COEFFICIENT .2
 BASIN SLOPE: 1 PERCENT
 BASIN LENGTH 600 FEET
 AREA: 10.63 ACRES
 HIST TC = $1.87 * (1.1 - (1 / 600)^{.2}) * SQRT(600)$ = 41.22492 * 1 MINUTES ^ 1/3
 HISTORIC RAINFALL INTENSITY: 1.310335 INCHES/HOUR
 HISTORIC OUTFALL: 2.785771 CUBIC FEET PER SECOND

DETERMINATION OF DETENTION POND VOLUME FOR DEVELOPED CONDITIONS
 =====

DEVELOPED STORM: 100 YEAR STORM
 DEVELOPED RUNOFF COEFFICIENT .85

CCFAC = .85 * 1.25 * 10.63
 = 11.29438

DURATION MIN	GROSS VOL. CU. FT.	OUTFLOW VOL. CU. FT.	DETENTION VOL. CU. FT.
5	29083.68	835.7313	28247.95
10	44773.56	1671.463	43102.1
15	57019.32	2507.194	54512.13
30	78832.08	5014.388	73817.69
45	94713.3	7521.582	87191.72
60	99879.49	10028.78	89850.71
90	107915.8	15043.16	92872.59
120	110211.9	20057.55	90154.3
180	119396.2	30086.33	89309.84
360	133172.6	60172.65	72999.99

REQUIRED DETENTION VOLUME IS 92872.59 CU. FT. OR
 2.132062 ACRE FEET

DATE: 10/3/85
 PROJECT: FORT COLLIN RETAIL CENTER
 JOB NUMBER: 105-001
 DESIGN ENGINEER: STAN MYERS

BASIN DESIGNATION = B

DETERMINE EXISTING Q FOR 2 YEAR STORM

HISTORIC RUNOFF COEFFICIENT .2
 BASIN SLOPE: .66 PERCENT
 BASIN LENGTH 350 FEET
 AREA: 3.35 ACRES

HIST TC = $1.87 * (1.1 - (1 * .2)) * \text{SQRRROOT}(350)$ = 36.15847 MINUTES
 HISTORIC OUTFLOW IS SUPERCEDED BY: 2.91 CUBIC FEET PER SECOND

DETERMINATION OF DETENTION POND VOLUME FOR DEVELOPED CONDITIONS

DEVELOPED STORM: 100 YEAR STORM
 DEVELOPED RUNOFF COEFFICIENT .85

CCFAC = .85 * 1.25 * 3.35 = 3.559375

DURATION MIN	GROSS VOL. CU. FT.	OUTFLOW VOL. CU. FT.	DETENTION VOL. CU. FT.
5	9165.599	873	8292.6
10	14110.2	1746	12364.2
15	17969.4	2619	15350.4
30	24843.6	5238	19605.6
45	29848.5	7857	21991.5
60	31476.6	10476	21000.6
90	34009.2	15714	18295.2
120	34732.8	20952	13780.8
180	37627.2	31428	6199.199
360	41968.8	62856	-20887.2

REQUIRED DETENTION VOLUME IS 21991.5 CU. FT. OR
 .5048554 ACRE FEET

DATE: 10/3/85
 PROJECT: FORT COLLINS RETAIL CENTER
 JOB NUMBER: 105-001
 DESIGN ENGINEER: STAN MYERS

BASIN DESIGNATION = C

DETERMINE EXISTING Q FOR 2 YEAR STORM

HISTORIC RUNOFF COEFFICIENT .2
 BASIN SLOPE: .7 PERCENT
 BASIN LENGTH 210 FEET
 AREA: .46 ACRES

HIST TC = $1.87 * (1.1 - (1 / 210)^{.7})$ * SQRRROOT = 27.46478 MINUTES
 HISTORIC OUTFLOW IS SUPERCEDED BY: .88 CUBIC FEET PER SECOND

DETERMINATION OF DETENTION POND VOLUME FOR DEVELOPED CONDITIONS

DEVELOPED STORM: 100 YEAR STORM
 DEVELOPED RUNOFF COEFFICIENT .85

CCFAC = .85 * 1.25 * .46
 = .48875

DURATION MIN	GROSS VOL. CU. FT.	OUTFLOW VOL. CU. FT.	DETENTION VOL. CU. FT.
5	1258.56	264	994.5601
10	1937.52	528	1409.52
15	2467.44	792	1675.44
30	3411.36	1584	1827.36
45	4098.6	2376	1722.6
60	4322.16	3168	1154.16
90	4669.92	4752	-82.08008
120	4769.281	6336	-1566.72
180	5166.72	9504	-4337.28
360	5762.88	19008	-13245.12

REQUIRED DETENTION VOLUME IS 1827.36 CU. FT. OR
 4.195042E-02 ACRE FEET

DATE: 10/3/85
 PROJECT: FORT COLLINS RETAIL CENTER
 JOB NUMBER: 105-001
 DESIGN ENGINEER: STAN MYERS

BASIN DESIGNATION = D

DETERMINE EXISTING Q FOR 2 YEAR STORM

HISTORIC RUNOFF COEFFICIENT .2
 BASIN SLOPE: .7 PERCENT
 BASIN LENGTH 200 FEET
 AREA: .68 ACRES

HIST TC = $1.87 * (1.1 - (1 * .2)) * SQRT(200)$ = 26.80288 MINUTES

HISTORIC OUTFLOW IS SUPERCEDED BY: .11 CUBIC FEET PER SECOND

DETERMINATION OF DETENTION POND VOLUME FOR DEVELOPED CONDITIONS

DEVELOPED STORM: 100 YEAR STORM
 DEVELOPED RUNOFF COEFFICIENT .85

CCFAC = .85 * 1.25 * .68 = .7225

DURATION MIN	GROSS VOL. CU. FT.	OUTFLOW VOL. CU. FT.	DETENTION VOL. CU. FT.
5	1860.48	33	1827.48
10	2864.16	66	2798.16
15	3647.52	99	3548.52
30	5042.88	198	4844.88
45	6058.8	297	5761.8
60	6389.281	396	5993.281
90	6903.36	594	6309.36
120	7050.24	792	6258.24
180	7637.761	1188	6449.761
360	8519.04	2376	6143.04

REQUIRED DETENTION VOLUME IS 6449.761 CU. FT. OR
 .1480661 ACRE FEET



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CLIENT SULLIVAN / INC JOB NO. 142 001
 PROJECT ... CALCULATIONS FOR ...
 MADE BY ... DATE ... CHECKED BY ... DATE ... SHEET ... OF ...

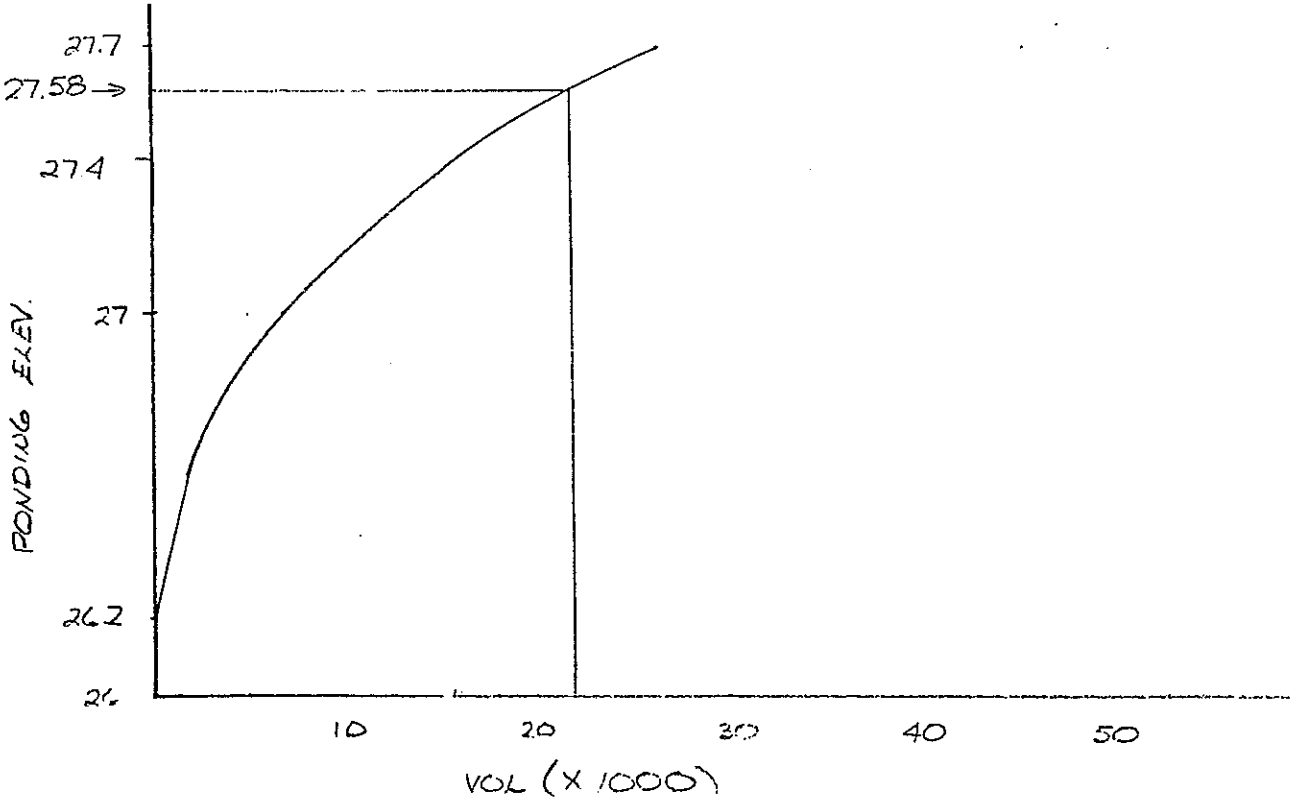
175.017 TOTAL AREA

EL	AREA	VOL
26.20	0	
27.00	17026	6894
27.40	26364	8840
-27.70	15436	10860
		<u>26594 cf</u>

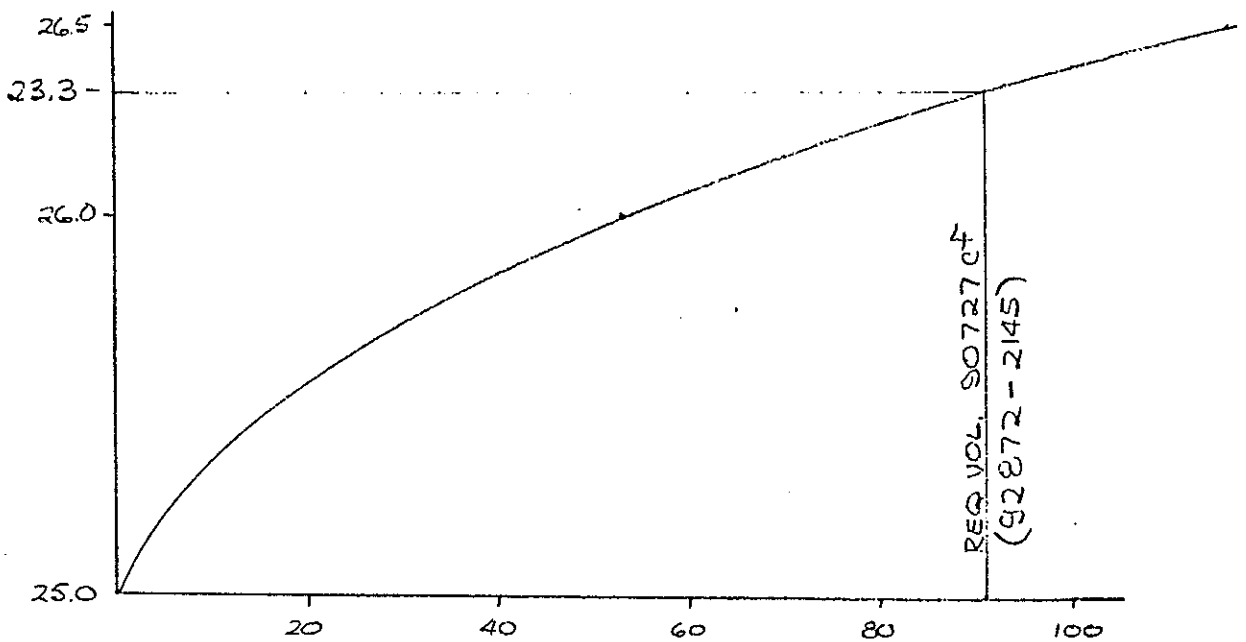
175.018 TOTAL AREA

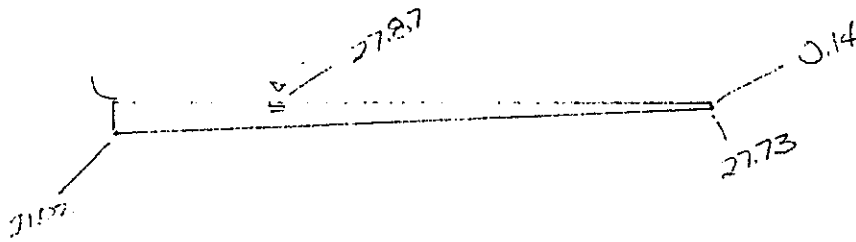
EL	AREA	
25.0	0	
26.0	105603	52802
26.5	147964	63392
		<u>116194</u>

NATIONAL CAR RETENTION AREA.



MAIN DETENTION





$$\frac{0.85 + 0.14}{2} \times 31 = 15.35'$$

$$\frac{15.35}{2} \times 170 = 1305 \text{ cF}$$

$$\frac{15.35}{2} \times 70 = \frac{537}{1842} \text{ cF}$$



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CLIENT SOIL WAVER JOB NO. 105-201
 PROJECT FORC CALCULATIONS FOR RAINFALL CAPACITY
 MADE BY JM DATE 10/13 CHECKED BY _____ DATE _____ SHEET _____ OF _____

BASIN E-1

EL	AREA	VOL
26.70	0	65
27.00	433	1080
27.50	2890	1159
27.80	7702	<u>2304</u>

BASIN E-2

26.80	0	110
27.00	1145	1028
27.30	5750	2152
27.70	10910	<u>4280</u>

TOTAL - 6594 cf

CALCS. BASED ON $Q = C \cdot A \cdot \sqrt{2gh}$ $C = 0.61$

h - FOUND BY TAKING CENTER OF PIPE ELEV FROM MAX. POND. ELEV OVER C.B.

BASIN AREAS	Q cfs	h	REQ'D A SQ FT	DIAM IN INCHES
OFFSITE FLOODS	0.82	6.78	0.064	3.43" = 3 ³ / ₈ "
A1-A3 + OFFSITE	10.97	6.78	0.861	12.56 = 12 ¹ / ₂ "
B2	0.35	1.2	0.065	3.5" =
B3	0.76	1.0	0.155	5.34 = 5 ³ / ₈ "
D ₁	0.05	0.9	0.011	1.4 ≈ 1 ¹ / ₂ "
D ₂	0.06	0.8	0.014	1.58 ≈ 1 ¹ / ₂ "

CURB OPENING DESIGN

BASED ON $Q = CLH^{3/2}$ $C = 3.32$ (BROADCRESTED WEIR)

BASIN B:

$H = 1.38 \rightarrow H^{3/2} = 1.62 \rightarrow L = Q / 5.382$

BASIN AREA	Q	L
B1	1.80	0.33' = 4"
B2	0.35	0.07' = 3/4"
B3	0.76	0.14 = 1 ¹ / ₂ "

BASIN C:

$H = 0.84' \rightarrow L = Q / 2.56 \rightarrow Q = 0.88 \therefore L = 0.356 = 4¹/₈"$

BASIN D

D1 $H = 1.0'$ $L = Q / 3.32$ $Q = 0.05 \therefore L = 1/8"$
D2 $H = 0.9'$ $L = Q / 2.83$ $Q = 0.06 \therefore L = 1/4"$