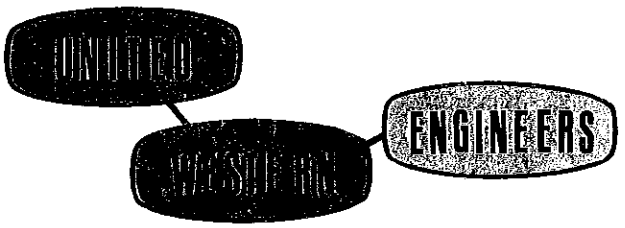

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MASTER DRAINAGE PLAN

DRENNAN INDUSTRIAL CENTER

See drennan dwl #1 for drainage plan

OLIVER E. WATTS PE-LS
CONSULTING ENGINEER
300 GARDEN OF THE GODS ROAD
SUITE NO. 103
COLORADO SPRINGS, COLORADO 80907
303-593-0173

May 18, 1982

City of Colorado Springs
Department of Public Works
Engineering Division
P.O. Box 1575
Colorado Springs, CO 80901

SUBJECT: Drennan Industrial Center, Filing No. 1
Drainage Revision

Gentlemen

This will confirm the agreements I understand were reached in your meeting with Allan Miller and the Stresscon representative last week concerning the drainage inlet to be placed on the south side of the Peterson Field channel.

The inlet is to be a 6-inch thick reinforced concrete trapezoidal section, B=8', Z=12:1, D=1'-0", to extend a minimum of 10 feet behind the lip of the channel lining, and to have a minimum one-foot cutoff collar placed all around the termination. I understand that the channel lining has been placed and a blockout provided to conform to this configuration.

12
5/24/82
See attached drawing for detail section & plan.

The inlet is to be private, and maintained by ~~Stresscon,~~ who will also perform the necessary grading to convey the runoff safely to the inlet. Construction is to be performed by the developer. As shown on the revised drainage plan, which is being resubmitted herewith, this inlet will replace the storm sewer previously proposed to run along the railroad right-of-way.

Enclosed please find our April 26, 1982 submittal and your reply of May 3, 1982.

Respectfully Submitted

Oliver E. Watts
Consulting Engineer

OK Allen R. Miller
5/24/82

Encl
cc: Allan Miller

OLIVER E. WATTS PE-LS
CONSULTING ENGINEER
300 GARDEN OF THE GODS ROAD
SUITE NO. 103
COLORADO SPRINGS, COLORADO 80907

April 26, 1982

City of Colorado Springs
Department of Public Works
Engineering Division
18 South Nevada Street
Colorado Springs, CO 80903

SUBJECT: Drennan Industrial Center Filing Number One
Drainage Revision

Gentlemen

Enclosed is a drawing and computations related to a requested revision in subject subdivision drainage report, which is submitted for your review and approval. Because of the grading of the Stresscon site, it is not possible to route the cross lot drainage to the previously proposed storm sewer along the west boundary. Rather, it is now proposed that an inlet into the City channel be provided.

The developer proposes that the channel lining on the left (South) side be raised across a drop structure and continued at an added height until past the proposed inlet, which would sheet over the lining into the channel, and be contained by dikes on either side. The enclosed computations show that the 5-year runoff of 23.4 cfs would not overtop a one foot deep inlet 8 feet long. Some acceptable provision to prevent undermining the lining lip should be provided.

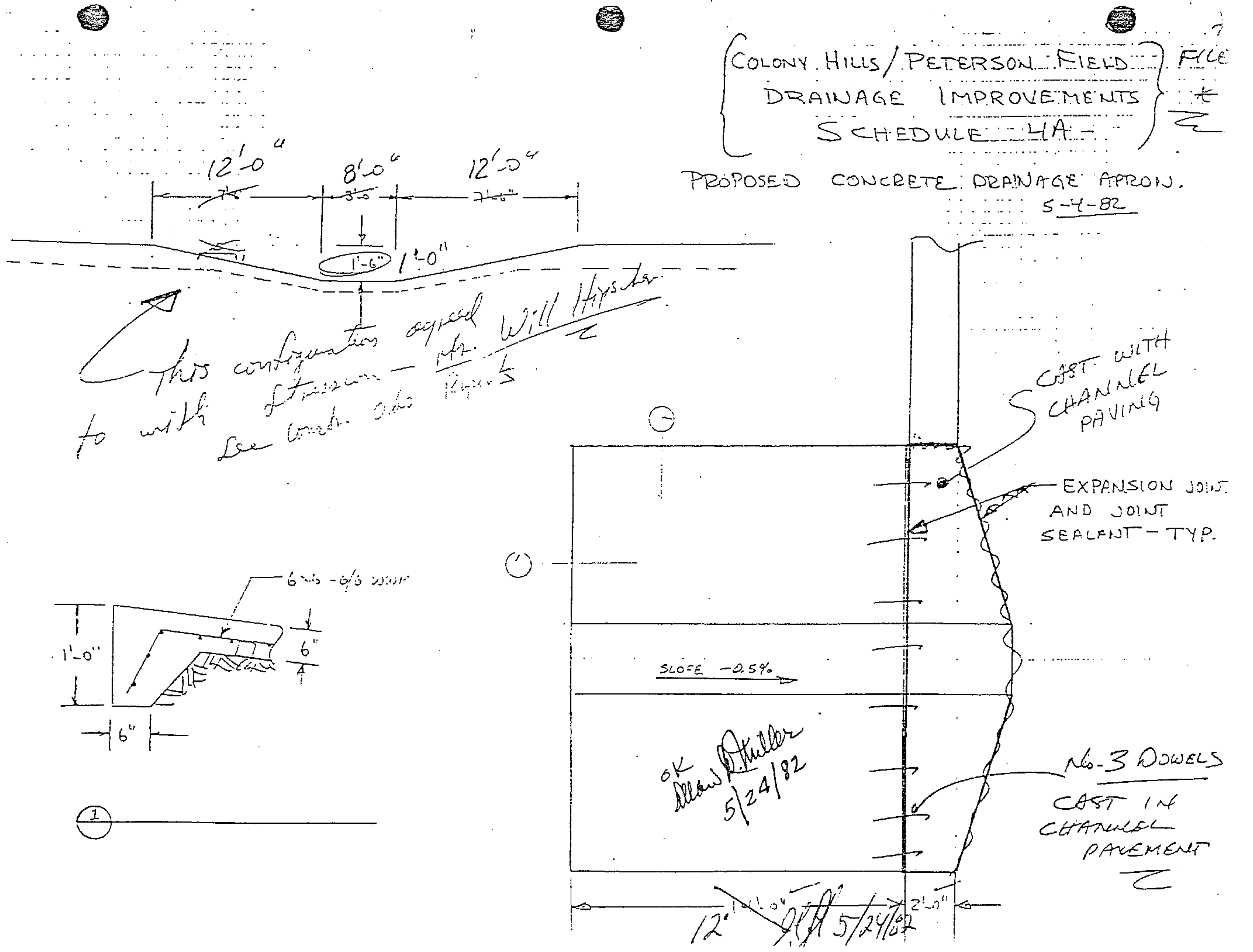
The inlet proper would be a private facility but would be constructed as part of the channel lining now in progress, and the developer intends that the necessary changes be incorporated into the City contract.

Respectfully Submitted

Oliver E. Watts
Consulting Engineer

Encl

cc: Allan Miller w/ encl

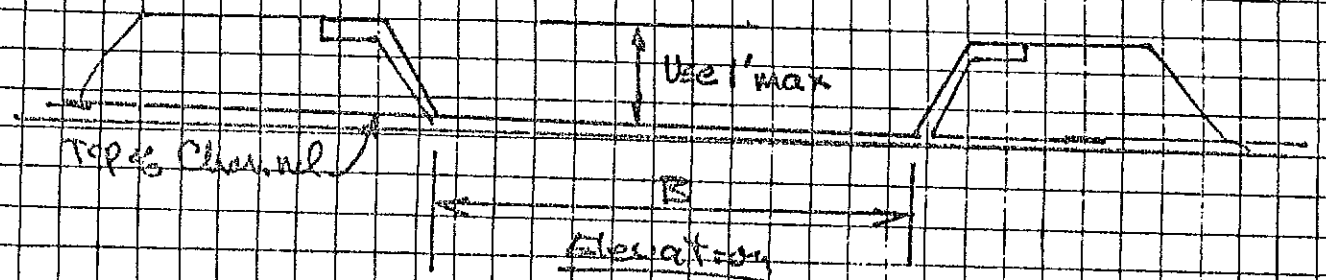


COLONY HILLS / PETERSON FIELD
DRAINAGE IMPROVEMENTS
SCHEDULE 4A
FILE
PROPOSED CONCRETE DRAINAGE APRON.
5-4-82
12'-0"
8'-0"
12'-0"
1'-6"
1'-0"
6x6 - 6/6 WWF
1'-0"
6"
6"
CAST WITH CHANNEL PAVING
EXPANSION JOINT AND JOINT SEALANT – TYP.
SLOPE -0.5%
No-3 DOWELS CAST IN CHANNEL PAVEMENT
OK 5/24/82
12'
2'-0"
5/24/82

Oliver E. Watts
CONSULTING ENGINEER

Project Drennan Ind Center Page 1 of 1
Calc. by OEW date 9-26-82
Checked by _____ date _____

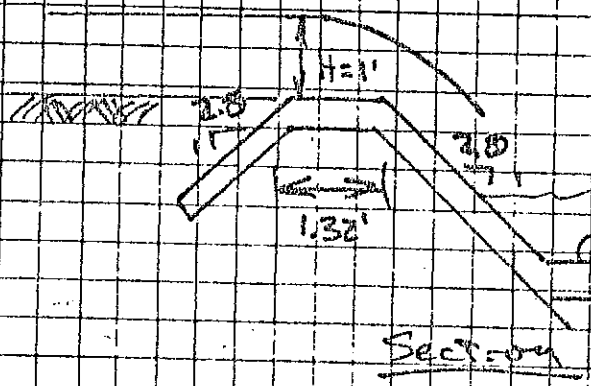
Revised Stream Inlet



Assume Critical Depth of flow over weir

$$Q = C_L H^{3/2}$$

See p 5-49 King
Table 5-9
C = 2.98



perimeter, no. of ft

$$23.4 \text{ cfs} = Q = 2.98 \times B_x \, 1^{3/2}$$

$$B = 7.85' \quad \text{Use } 8'$$

$$H = \left(\frac{23.4}{2.98 \times 8}\right)^{2/3} = 0.99' \text{ max}$$

UNITED WESTERN ENGINEERS

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Suite 104
3709 East Platte Avenue
Colorado Springs, Colo. 80909

(303)596-3222

August 31, 1976

Mr. Dewitt Miller
Director of Public Works
City of Colorado Springs
Colorado Springs, Colorado

Subject: Master Drainage Plan
Drennan Industrial Center

Dear Deke:

Transmitted herewith is subject drainage plan for your review and approval.

Please contact me if I may answer any questions.

Respectfully submitted,

UNITED WESTERN ENGINEERS

Oliver E. Watts
Engineer Director

OEW/nb

Enclosure

DRENNAN INDUSTRIAL CENTER

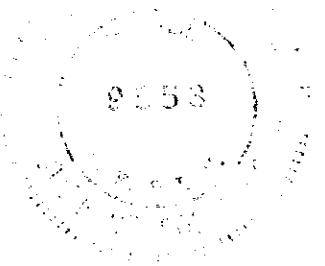
MASTER DRAINAGE PLAN

CERTIFICATIONS AND APPROVALS

Registered Engineer

I, Oliver E. Watts, a registered engineer in the State of Colorado, hereby certify that the attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. I further certify that said drainage report is in accordance with all City of Colorado Springs Ordinances and specifications and criteria.

Oliver E. Watts
Colorado P.E. --- L.S. No. 9853



Owner or developer of the site

"The developer has read and will comply with all of the requirements specified in this drainage report as approved by the City Engineer."

United Western Engineers & Land Surveyors, Inc.

By Allan D. Miller Allan D. Miller, individually

Title president

Approved:

City of Colorado, Department of Public Works

D. Jeffries
City Engineer

2/23/78
Date

Railroad is to worry about the R.R. culvert.

See letter ——

1. Description of Location

a. The Drennan Industrial Center is located as shown on the enclosed map, in the S 1/2 Section 34, Township 14 South Range 66 West of the 6th P.M., in the City of Colorado Springs. It is located at the northeast corner of the intersection of Drennan Road and the Santa Fe Railroad tracks.

b. The total area enclosed by the development is 115.690 acres.

c. 6.82 acres lies within the Sand Creek Drainage Basin, while the remaining 108.87 acres lies within the Peterson Field Basin as recently prescribed by the City, but not approved by Council. This plan is in full compliance with the Master Drainage Studies of both basins.

d. The natural drainage is defined by the topography on the enclosed map, as follows:

The existing Johnson Ditch now intercepts all but major quantities of inflow to the development in the Peterson Field Basin.

The existing 24-inch CMP, under the railroad tracks accomodates all runoff within the Peterson Field Basin at the present time.

Both of the above routings are to be changed as later described, as required by the proposed Peterson Field Master Drainage Report.

The existing 100 year flood plain for Sand Creek is shown on the enclosed map. It may be seen that the two basins are well defined within the development but presently cannot be separated to the west of the railroad.

2. Method of Computations

a. Computations

All interior drainage is computed by the SCS synthetic hydrograph method as prescribed by the City of Colorado Springs, using a storm of two inch intensity, duration of one hour.

Greenbelt design flows are taken from the master drainage reports prescribed by the City.

Enclosed are all applicable computations.

b. Soils

Three soils types are found within the development as mapped by the local SCS office, and are shown on the enclosed map. Descriptions are as follows:

XAO Sandy Alluvial: A coarse textured, stratified soil material ranging from sand to sandy loam with gravel and cobble along Sand Creek. Hydrologic group "B".

R5 Tructon Series: A deep, dark sandy loam falling within hydrologic group "B".

R7 Blakeland Series: A deep, dark, coarse textured soil ranging from sandy loam at the surface to loamy sand. Hydrologic group "A".

3. External Water Entering The Subdivision

a. 4330 CFS will enter the development in the major Peterson Field greenbelt, as shown on the enclosed map.

b. 18.5 CFS will enter along the proposed extension of Astrozon Boulevard.

c. 10,940 CFS enters the development on Sand Creek, according to the Master Plan. The SCS flood plain limits shown on the enclosed map demonstrate that existing structures are adequate to contain their projected runoff for existing and 1990 conditions in the basin.

4. Flow Through The Subdivision

All runoff above Astrozon Boulevard is routed by it to the greenbelt system. Runoff within the development below Astrozon is routed to small ditches and then to the greenbelt. Undeveloped land along the railroad is allowed to drain to the existing 24-inch CMP. Drennan Road will route runoff across the railroad on the surface.

5. Outfall Points

It should be noted that the flood plain for Sand Creek encompasses all outfall points for the development.

The Sand Creek structures are more than adequate for the design flows as shown on the enclosed plan, according to the SCS flood plain study.

A future culvert by others across the Santa Fe Tracks will accomodate the greenbelt as proposed herein. It will need to be a double 10' x 8' RCB x 75' instead of the 4-10' x 6' RCB x 45' specified in the master report.

The existing 24" CMP on the railroad will easily accomodate the 3.6 CFS to the west of the development.

Drennan Road will route 10.3 CFS across the railroad, where it will contribute to the Sand Creek Flood Plain.

6. Internal Design Computations

a. Streets

Name	Area	Width	Curb	Slope	Runoff	Capacity
Astrozon	A & B	60/80	vert.	0.67%	28.5cfs	30.0cfs
Astrozon	D	60/80	vert.	0.50%	16.2cfs	30.0cfs
Drennan	H	44/60	vert	1.5%	10.3cfs	52.2cfs

b. Concrete Channels n=0.015

Location	Size b x d	Slope %	Runoff CFS	Velocity -fps-	Freeboard -Ft-
Greenbelt	10x9.2	1.18	4330	29.4	1.0
Greenbelt	10x8.8	1.44	4330	31.6	1.0
E + F1	4x2	0.75	60.6	8.5	0.7
G	2x2	1.1	23.4	7.7	1.0

c. Curve Superelevations

R-ft	Normal d -ft-	Outside d -ft-	Added Super -ft-
300	8.2	9.4	0.3
300	7.8	9.1	0.4

d. RCB Designs (To Be Built By Others)

Location	Size	Pier Width -ft-	Incoming Depth -ft-	Inside Depth -ft-
Astrozon	2-10'x7'	0.50	6.24	6.63
AT & SF	2-10'x7'	1.00	6.11	6.91

e. Transition Lengths

Location	Length Required -ft-	Length Provided -ft-
To Pinehurst*	6.40	10.00
d=9.2 to d=8.8	2.30	5.00
Astrozon*	16.75	20.00
AT & SF*	15.17	16.00

*By Others

7. Cost Estimate

a. Sand Creek Facilities

As demonstrated by the flood plain report by SCS and on-site inspections, the existing facilities are fully adequate and no new ones are required.

b. Peterson Field Facilities

Item	Quantity	Unit Cost	Cost
10' x 9.2' concrete channel	2090 LF	46.88	97,982.14
4' 2' concrete channel	690 LF	12.55	8,659.50
2' x 2' concrete channel	200 LF	10.25	2,050.00
Subtotal:			$108,688.64
Engineering and Contingencies @5%			5,434.43
			$114,123.07

Per acre cost for 108.87 acres----------$1,048.25

8. Fees

a. Peterson Field Drainage Fees (1976-Proposed)
108.87 acres @$1003.00=$109,196.61
The developer will put up credit as he plats for $1,048.25/acre.

b. Peterson Field Bridge Fees (1976-Proposed)
108.87 acre @$106.00=$11,540.22
The developer will put this up in cash as he plats.

c. Sand Creek Drainage Fees (1976)
6.82 acres @$~~1,705~~1,579.00=$10,768.78
The developer will put this up in cash as he plats.

d. Total Fees:----------$131,505.61
Net fees per acre (115.690)-------$1,136.71

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Project DREXMAN IND CENTER Page 1 of 1

Calc. by DEWATT date 8-19-76

Checked by _____ date _____

Culvert & Channel Calculations $d/b = 1$ $z = 1$ $K = 1.93 = \frac{Qn}{b^{8/3} S^{1/2}}$ $n = 0.015$

$A = 2b^2$

AREA	LOCATION & DISTANCE	ELEV & S %	S 1/2	Q 50	b 8/3	b	S F AREA	USE DITCH	V-FS CULVERT ETC.	FB TIME HRS
E+F1	E	34.0								
	690'	0.754%	0.0868	60.6	5.425	1.885	7.11	4'x 2'	8.5	0.7'
	channel 25+40	28.8								
G	End Ditch	31.0								
	200'	0.011	0.1049	23.4	1.739	1.229	3.02	2'x 2'	7.7	1.0'
	channel 25+40	28.8								

MAJOR BASIN	SUB BASIN	AREA Planim. Read	AREA MILE	BASIN LENGTH	BASIN HEIGHT	Tc	DITCH Soils ~~LENGTH~~	DITCH Curve* ~~SLOPE~~	V	TPO	FLOW Q	FLOW qp	Tb
PETE FIELD	J	—	2.94^{-3}	840	11	0.310	B	79		0.686	0.52	1.1	
SAND CREEK	A	4.67	6.70^{-3}	920	22	0.105	B	92		0.563	1.24	7.1	
PETE FIELD	E+F1	39.48				0.190	ΣE (B)	92					
		9.97	Add	690	3	(+) 0.149	F1 (B)	92					
		49.45	0.0710			0.339	B	92		0.703	1.24	60.6	
	F2	12.58	0.0180	1380	23	0.165	B	92		0.600	1.24	18.0	

HYDROLOGIC COMPUTATION – BASIC DATA

PROJ: DIC

By: OEO

Date: 8-19

UNITED WESTERN ENGINEERS
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Suite 200
4525 Northpark Drive
Colorado Springs, Colo. 80907

$T_c = \left(\frac{11.9L^3}{H}\right)^{.385}$ $T_p = .5 + 0.6T_c$ $q_p = \frac{484AQ}{T_p}$ D= 1in I = 2"

MAJOR BASIN	SUB BASIN	1"=200' AREA Planim. Read	MILE	BASIN LENGTH	BASIN HEIGHT	Tc	DITCH SOILS ~~LENGTH~~	DITCH CURVE # ~~SLOPE~~	V	TPO	FLOW Q	FLOW qp	Tb
PETE FIELD	A WELOW	10.20					A	89					
		4.79					B	92					
		14.99	0.0215	1390	17	0.187	ΣA	90		0.612	1.09	18.5	
	A+B	14.99					ΣA	90					
		7.55					A	89					
		4.98	Add	1280	14	+0.183	B	92					
		27.52	0.0395			0.370	ΣA+B	90		0.722	1.09	28.9	
	C	3.48	4.99^{-3}	520	20	0.056	A	89		0.534	1.03	4.7	
	D	14.34	0.0206	1520	14	0.223	A	89		0.634	1.03	16.2	
	E	39.48	0.0566	1880	40	0.190	B	92		0.614	1.24	55.3	
	~~F~~	~~22.55~~	~~0.0324~~	~~1380~~	~~23~~	~~0.165~~	~~B~~	~~92~~		~~0.600~~	~~1.24~~	~~32.5~~	
	G	5.55					A	89					
		12.94					B	92					
		18.49	0.0265	1600	16	0.225	ΣG	91		0.635	1.16	23.4	
	H	8.66	0.0124	1280	19	0.163	A	89		0.598	1.03	10.3	
	I	5.94	8.52^{-3}	1260	20	0.156	B	79		0.594	0.52	3.6	

HYDROLOGIC COMPUTATION – BASIC DATA

PROJ: DEENNAN IND. CENTER By: DEWITT Date: 8-19-76

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4525 Northpark Drive
Colorado Springs, Colo. 80907

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Project DRENNAN IND. PARK Page 1 of 4

Calc. by O.E. WATTS date 8-17-76

Checked by _____ date _____

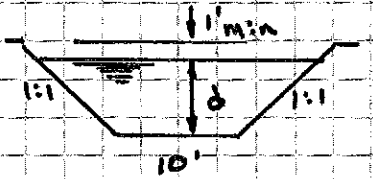
MAIN GREEN BELT DESIGN

Prelim Design $b/d = 1$ $z = 1$ $K = 1.93 = \frac{Q_n}{b^{8/3} S^{1/2}}$ $A = zb^2$

$n = 0.015$

Sta	GG El & S	$S^{1/2}$	Q	$b^{8/3}$	b	A	Use b
0+00	64.0						
	0.011842	0.10882	4330	309.25	8.58	147.49	10'
7+60	55.0						
	0.014375	0.11990	4330	280.68	8.28	137.15	10'
23+60	32.0						

Final Size



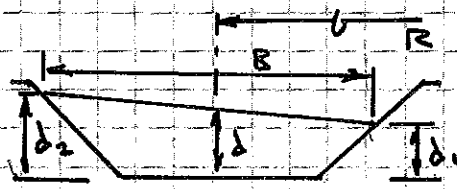
$Q = \frac{1.486}{0.015} A R^{2/3} S^{1/2}$

$A = 10d + d^2$ $wp = 10 + 2\sqrt{2}\,d$

nearest 0.1'

Reach	d	A	wp	R	Q	V	Use d	FB
0-7+60	8.2	149.24		4.50	4385	29.38	9.2	1.0
	8.1	146.61	32.91	4.465	4279			
7+60-	7.8	138.84		4.33	4381	31.56	8.8	1.0
end	7.7	136.29	31.78	4.289	4273			

Curve Super's



$d_2 - d_1 = \frac{V^2 B}{G R}$

$d_2 = d_1 \frac{d_2 - d_1}{2}$

PC Sta	R	d	B	V	$d_2 - d_1$	d_2	Use d_2	Added FB
0+00	300'	8.2	26.4	29.38	2.36	9.38	9.5	0.3
9+69	300'	7.8	25.6	31.56	2.64	9.12	9.2	0.4

UNITED WESTERN ENGINEERS

Project Drennan Ind. PK

Calc. by OEW date 8-18

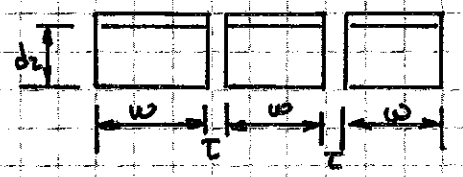
Checked by _____ date _____

RCB Designs

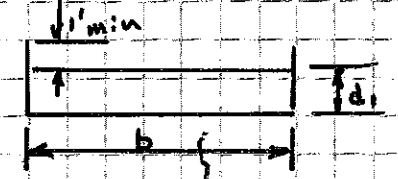
$$x = \frac{\Sigma w}{b}$$

$$Q = \frac{1.486}{0.013} A R^{2/3} S^{1/2}$$

LA Manual DB 9.3



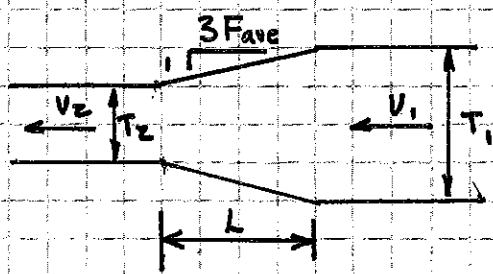
Box



Inlet-Outlet

Loc	Q	S	box	d_1	A_1	wp	Q	$v_1^2/2g$	$d_1/h^2/2g$	$y = d_2/d_1$	d_2	
11+52	4330	1.4375%	2-9x7.5	6.0	111.00	30.5	3599					
			t=0.5	7.0	129.50	32.5	4460					
			b=18.5	6.85	126.72	32.2	4329	18.122	0.378	1.073	7.35	
			k=0.973									
			2-10x7	6.0	123.00	32.5	4093					
			t=0.5	6.3	129.15	33.1	4386					
			b=20.5	6.24	127.92	32.98	4328	17.774	0.351	1.064	6.63	← 2-10x7 Pier=6"
			k=0.976									
26+50	4330	1.4325%	2-10x7	6.0	126.00	33.00	4218					
			t=1.0	6.2	130.20	33.40	4419					
			b=21.0	6.11	128.81	33.22	4328	17.675	0.346	1.131	6.91	← 2-10x7 Pier=12"
			k=0.952									

Transition Lengths



$$Fr = \frac{V}{\sqrt{gd}}$$

$L = 1.5 \Delta T \, Fr_{ave}$

Sta @ Trans	b	d	T $\Sigma \Delta T$	V	Fr #. Fr_{ave}	L-req'd	L- use
0+00	10.00	8.40	28.6	28.73	1.747		
			2.4		1.777	6.40	10.00
0+10	10.00	8.20	26.4	29.38	1.808		
11+22 / 11+82	20.50	6.24	20.5	33.83	2.387		
			5.1		2.189	16.75	20.00
11+02 / 12+02	10.00	7.80	25.6	31.56	1.991		
26+13 / 26+88	21.00	6.11	21.00	33.73	2.405		
			4.6		2.198	15.17	16.00
25+97 / 27+09	10.00	7.80	25.60	31.56	1.991		
7+60	10.00	8.20	26.4	29.38	1.808		
			0.8		1.900	2.3	5.00
	10.00	7.80	25.6	31.56	1.991		

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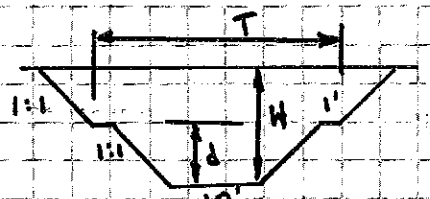
Project DIP

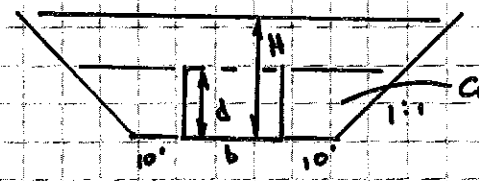
Calc. by DEW date 8-19

Checked by _____ date _____

Cost Estimate



Channel



Unit Prices

		Use T:	
Channel Exc:	$ 1.20 / cy	10x9.2	30
Structure Exc:	2.50 / cy	10x8.8	30
✓ BF:	3.50 / cy		
Channel Conc:	9.00 / sy		
Structure ✓:	$ 150.00 / cy		
✓ Steel:	0.18 / lb		

Station	Shape	Quantities Per Foot ×						Total Cost/ FT	Length	Cost
		Ch Exc	ST Exc	ST BF	Ch Conc	ST Conc	ST Steel			
3+58 PR	10x9.2 ✓	19.54 ~~13.54~~			4.225			61.47 ~~54.27~~	4	$ 245.89 ~~217.09~~
3+62	✓	✓			✓			✓ ~~54.27~~	17	949.85
3+79	✓	10.21 ~~8.21~~			✓			50.28	121	5900.75
5 ✓	✓	7.69 ~~7.02~~			✓			47.25	260	12285.00
7+60	✓	✓			✓			47.25	5	232.19
7+65	Trans. 10x8.8 ✓	7.28 ~~7.16~~			4.099			45.63	183	8625.61
9+48	✓	9.79 ~~7.53~~			✓			48.64	154	7490.56
11+02	✓	9.79 ~~7.53~~			✓			✓ 137.97	20	2759.35
11+22	Trans. 20.5x7 ✓		19.56	9.57		0.840	105	227.30		
	2-10x7		19.56	9.57		1.51	243	352.64	60	21158.10
11+82	20.5x7 ✓		19.56	9.57		0.840	105	227.30		
12+02	Trans. 10x8.8 ✓	9.27 ~~7.28~~			4.099			137.66 ~~48.02~~	20	2753.15
13+96	✓	7.28			✓			45.63	194	9083.76
18+60	✓	8.00			✓			46.49	464	21372.07
20+50	✓	8.75			✓			47.39	190	8918.70
23+56	✓	6.81			✓			45.06	306	14145.31

UNITED WESTERN ENGINEERS

Project PIP

Calc. by DEW date 8-19

Checked by _____ date _____

Station	Shape	Quant: Tons Per Foot						Total Cost/ Foot	Length	Cost
		ch Exc	ST Exc	ST BP	ch Conc	ST Conc	ST Steel			
23+56	10:8.3V	6.81			4.099			45.06	192	8732.45
25+48 ft	✓	7.51			✓			45.90		
Total									2190	$124,652.74 ←
Costs RCB + Transitions :									100	26,670.60
Developer Cost :									2090	* 97,982.14 ←