MASTER DRAINAGE DEVELOPMENT PLAN
DEFENSE OFFICE PARK

MDDP Copy

AND

FINAL DRAINAGE REPORT
NORTHCOM BUSINESS CENTER SUBDIVISION

April 7, 2008

Revised
June 6, 2008

Revised
February 10, 2009

Revised
March 6, 2009

Prepared for

PARAGON PROPERTIES

Oliver E. Watts, Consulting Engineer, Inc.
Colorado Springs, Colorado

OLIVER E. WATTS, PE-LS
OLIVER E. WATTS, CONSULTING ENGINEER, INC.
CIVIL ENGINEERING AND SURVEYING
614 ELKTON DRIVE
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March 6, 2009

City Engineering Division
30 South Nevada Ave
Suite 702
Colorado Springs, CO 80903

ATTN: *Steve Kuehster*

SUBJECT: Master Plan and First Filing Drainage Plan and Report
Northcom Business Park Subdivision

Transmitted herewith for your review and approval is the drainage plan and report for the Northcom Business Park Subdivision to accompany the submittal of the first filing plat. This report will also serve as the master drainage plan for the area known as the Defense Office Park as approved for a concept plan. This report has been revised in accordance with your comments of April 29, 2008, our meeting of May, 2008 and your comments of February 3, 2009 and March 4, 2009.

Please contact me if I may provide any further information.

Oliver E. Watts, Consulting Engineer, Inc.

BY: _____
Oliver E. Watts, President

Encl:
CDOT 'acceptance' letter
Drainage Report 5 pages
Computations 20 pages
FEMA Panel No. 08041C0753 F
SCS Soils Map and Interpretation Sheet
Backup Information, 9 sheets
Area Drainage Map, Dwg 05-3717-05A
Existing Drainage Conditions, Dwg 05-3717-24A
Drainage Plan, Dwg 05-3717-24

1. ENGINEER'S STATEMENT:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the City for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

Oliver E. Watts, Consulting Engineer, Inc.

Oliver E. Watts Colo. PE-LS No. 9853

2. DEVELOPER'S STATEMENT:

The developer has read and will comply with all of the requirements specified in this drainage report.

Paragon Properties

By: _____
Doug Dragoo
P.O. Box 5061
Carefree, AZ 85377

3. CITY OF COLORADO SPRINGS:

Filed in accordance with Section 7-7-906 of the Code of the City of Colorado Springs, 2001, as amended.

_____ 5/5/09
for City Engineer date

Conditions:
1. The Engineer is responsible to provide acceptance of this report/plan from the Colorado Department of Transportation (CDOT), since this site's outfall is Troy Hill Road, a CDOT facility.
2. Platting of the Northcom Business Center Subdivision requires a recorded document to reserve the land needed for the private multi use detention shown in Basin I.

STATE OF COLORADO

DEPARTMENT OF TRANSPORTATION

Region 2 – Access
P.O. Box 536
Pueblo, Colorado 81002
Phone (719) 546-5403
Fax (719) 546-5414

April 20, 2009

SH 21
City of CS

Mike Schultz
City of Colorado Springs Development Services
30 S. Nevada Ave., Suite 404
PO Box 1575, Mail Code 440
Colorado Springs, CO 80901-1575

RE: Northcom Business Center Subdivision
Drainage Plans and Report - Revised

Dear Mike:

The Colorado Department of Transportation Hydraulics Unit has reviewed the revised drainage plans and report dated March 6, 2009 for the proposed Northcom Business Center Subdivision consisting of 1 lot on 7.06 acres zoned PIP-2/AO-CAD/APZ1 (Planned Industrial Park with Airport Overlay-Commercial Airport District and Accident Potential Zone) located at 110 Troy Hill Road. Their comments follow;

- The proposed development located adjacent to Troy Hill Road appears to meet Water Quality Standards and release developed flows at or below historic rates.

- In future drainage reports, it is respectfully requested that the table included are formatted for easier reading and clarity. (The table under B. Proposed Master Plan Condition)

The Department is also in receipt of a revised Traffic Impact Study (TIA) dated April 15, 2009. This study has been transmitted for review. Additional comments will be forthcoming upon completion of that review. If you have any questions, please contact me in Pueblo at (719) 546-5407.

Sincerely,

Valerie Sword

Valerie Sword
Access Manager

4. LOCATION AND DESCRIPTION:

The Defense Office Park Development lies on the Southwest corner of Platte Avenue and Powers Boulevard in Section 13, T.14S., R.66W., as shown on the enclosed drainage plan. The total area shown within the sketch plan is 38.88 acres, all within the Sand Creek drainage basin. A sketch plan for this has been approved, along with a Master Drainage Report that accompanied it. The first filing will be known as Northcom Business Center Subdivision, Lot 1 is 7.06 acres, Tract A, the detention pond is 0.50 acres, and total acreage is 7.56.

5. FLOOD PLAIN STATEMENT:

This subdivision is not within the limits of a flood plain or flood hazard area, according to FEMA map panel number 08041C0 F, dated March 17, 1997, a copy of which is enclosed for reference. A LOMR was approved effective May 23, 2007 (055-08-0368P) in which Powers was relocated to the West from the original location shown on the panel and the channel tributary improved.

6. METHOD AND CRITERIA:

The method used for all computations is that specified in the City-County Drainage Criteria Manual, using the rational method for areas of the size of the subdivision. All computations are enclosed for reference and review.
The local USDA/SCS office has mapped the soils in the subdivision. A soils map and interpretation sheet are enclosed for reference. All soils in this area are of hydrologic groups "B".

7. DESCRIPTION OF RUNOFF:

A. Existing Drainage Conditions:

1. Drainage Inflows (Offsite).

Basin A comprises an undeveloped State DOT parcel that is used primarily as a storage site for CDOT maintenance and shaved asphalt that is effectively 30% impervious. An inflow of 11.6 cfs / 26.1 cfs (5-year / 100-year runoffs) exists. This is well within the capacity of the existing East Bijou Street. Basin B is an existing equipment rental parcel that will runoff into Troy Hill Road with 8.4 cfs / 16.8 cfs. The existing 8' x 4' CBC culvert across Platte Avenue Shown on the Area Drainage Map will be abandoned in accordance with the drainage report for the Patriot Park Development. Platte Avenue and Powers Boulevard will not drain into the development due to existing roadside ditches, curb and gutter and storm sewer in place. There are no other inflows.

2. Westerly Troy Hill Road.

The westerly half of the Troy Hill Road right of way will drain southerly along and within the roadway as shown on the Existing Drainage Conditions map. Existing 8" curb and gutter will contain the runoff. The existing conditions will not change under further development Basins H1 through H5 are computed and the total runoff is within the allowable capacity of the roadway as follows:

Basin	Total Runoff - 5 yr / 100 yr	Street Runoff - 5 yr / 100 yr	Capacity
H1	6.7 / 11.7	6.7 / 11.7	16.9 / 96.4
H2	7.6 / 13.8	7.6 / 13.8	18.4 / 104
H3	8.2 / 15.1	8.2 / 15.1	13.0 / 144
H4	8.7 / 15.5	8.7 / 15.5	13.0 / 144
H5	9.3 / 16.9	9.3 / 16.9	20.6 / 144

3. Development Area: The existing development area has historically been used for storage of construction equipment, landscape businesses, RV and trailer sales and associated commercial uses, but well below the development potential of the site. The area is partially paved with gravel and has recently been cleared of the buildings shown within the boundary, but remains essentially 30% impervious. Runoff is into Troy Hill Road which carries it to the South in both the existing paved surface within the 8" curb and gutter section, and in a "borrow ditch" within the adjacent easterly right of way area.
Basis B runoff will be contained within the paved section on a slope of 2.5%. The existing runoff of 8.4 cfs / 16.8 cfs is well within the capacity of 20.5 cfs / 117 cfs of the road section. Basins C through I will runoff into the grassed borrow area which has ample capacity for the existing runoff with velocities that are stable and non erosive. Computations are enclosed for the non-uniform existing configuration, based on detailed field surveys, and may be summarized as follows:

Basin	Location	Runoff 5-yr/100-yr	Slope %	5-yr depth -ft	5- yr width -ft	5-year velocity fps-
E	60+54 North	29.5 / 66.4	1.99	1.14	12.75	4.07
F	56+82 North	40.1 / 86.2	1.99	1.23	15.2	4.29
G	52+37 North	46.5 / 99.5	1.75	1.32	16.72	4.22
I	47+60 North	55.3 / 118	1.46	1.80	13.19	4.66
Outfall	43+52 North	61.1 / 130	1.54	1.49	19.06	4.30

Existing culvers exist across Bijou Street, existing driveways, and Pikes Peak Avenue. All of these will be removed as development progresses and storm sewer is installed as described below. None of these culvert crossings are considered adequate in the long term and are subject to overtopping under existing conditions.

B. Proposed Master Plan Conditions

1. Drainage Inflows:

Even though Basins A and B are not part of the master plan at this time, the development potential exceeds the existing use. The property may also be purchased by this developer; therefore the runoff is computed based on anticipated full use, with a 70% impervious cover. The runoffs will be combined with downstream basins described below.

2. Internal Runoff:

Basin lines are taken to correspond to anticipated building sites shown on the development plan, which are subject to change, but which are convenient for runoff computations. Runoff will be routed southwesterly in accordance with existing topography into Troy Hill Road, as intercepted by proposed access roadways into the development. Basin limits were constructed to conform to these proposed driveways, recognizing that detailed drainage plans will be required at the development plan and platting stages. Private roadways are allowed to run to the depth of curb, with catch basins provided where driveways intersect with Troy Hill Road. The details of individual basis runoffs are shown in the computations and the below tabulations. The Troy Hill Road surface runoff is limited in accordance with its designation as an "Industrial Commercial Collector" by the City, and then supplemented as necessary with storm sewer. The outfall of the storm sewer has been designated by the City to be the Sand Creek Tributary shown on the area drainage map. Details of the design are summarized as follows:

Basin	Total Runoff 5 yr / 100 yr	Street Runoff 5 yr / 100 yr	Capacity	Pipe Runoff -cfs	Catch Basin and Pipe Min S
A	29.6 / 53.9	29.6 / 53.9	/ 69.6	-0-	N/A
B	11.8 / 22.0	11.8 / 22.0	20.5 / 117	-0-	N/A
C	35.3 / 64.4	35.3 / 64.4 8.2 / 37.8	14.8 / 84 14.8 / 84	-0- 27.1	2-5' CAP = 15.5 24" RCP S=1.44%
D	76.1 / 139	43.2 / 80.6 11.0 / 73.9	73.9 / 73.9 16.9 / 96.4	65.1	2-6' CAP= 19 36" RCP S=0.99%
E	99.3 / 182	15.2 / 97.9	18.4 / 104	84.1	6' CAP =19 36" RCP S=1.6%
F	118 / 223	10 / 115	13.0 / 144	108.3	8' CAP=24.2 48" RCP S=0.57%
G	141 / 261	8.5 / 128	13.0 / 144	132.5	8' CAP=24.2 48"RCP S=0.85%
I	159 / 294	3.0 / 138	13.0 / 144	156	8' CAP=24.2 48"RCP S=1.18%

SAND CREEK CHANNEL

C. Detention Ponds.

Detention ponds will be constructed as each portion of the development is graded, with a capacity of 1800 CF per acre of grading. As each plat is submitted, these ponds will be converted to Water Quality Detention ponds. The anticipated locations of these ponds are shown on the Master Drainage Development Plan, and detailed designs will be prepared at the time of development plan submittal for each site. At that time, the extent of the proposed storm sewer will be determined, based on an analysis of proposed versus historic flow conditions. As shown on the drainage plan, an erosion control pond will be installed above the first filing when this area is graded and a combined pond will be provided as the outfall of the first filing as discussed below. Said area is being platted as Tract A for Filing 1.

D. Internal Runoffs – First Filing:

The first filing encompasses the easterly portion of Basin G, and the access roadway from Troy Hill Road, as shown on the Drainage Plan for the first filing. All runoff will be routed to the Southwest corner of the subdivision by the grading shown on the drainage plan. The interim section for Troy Hill Road will be used above the access roadway to concentrate the runoff in the proposed 48" RCP at a minimum slope of 0.57%. The access road will act as the outfall point for Basin F to the north (20.8 cfs/ 39.3 cfs) where it will be intercepted by an 8' D-10R catch basin and routed to the outfall storm sewer. Internal runoff from the subdivision area, Basin G (22.4 cfs / 42.4 cfs) will be intercepted by an 8'D-10R catch basin and routed into a private detention pond that will serve as an erosion control pond during construction and as a water quality pond for the subdivision and the unplatted lot lying to the west.

Detention pond computations are enclosed in accordance with Volume 2 of the DCM. This is an extended detention pond. As shown in these computations the required water quality storage is 11,979 CF and the erosion control storage is 17,982 CF. The storage required to provide detention necessary to lower the peak 100-year runoff (42.4 cfs) to below the historic value (21.0 cfs) is 17,537 CF. This demonstrates the staging benefit of the water quality pond in this case. The schematic details of this pond (fore bay, main pond, etc.) are shown on the plan and the final details

will be provided with the Grading and Erosion Control plan when it is submitted.

E. Drainage Outfall.

As shown on the Area Drainage Map and summarized above, the storm sewer for the master plan area will extend to the existing Sand Creek Tributary Channel. The existing Troy Hill Road right of way should be sufficient for this installation. The developer will construct the Troy Hill outfall (48"RCP) from Defense Com Point to the Sand Creek tributary with the development of the Northcom Business Center. As the remaining parcels develop along Troy Hill Road they will be required to construct the remaining portions of the Troy Hill outfall to connect to this 48" RCP section.

8. COST ESTIMATE: All storm sewer facilities are public, but are non-reimbursable under the Sand Creek Drainage Basin Study. The detention pond is private.

A. Public Facilities:

Item No.	Description	Quantity	Unit Cost	Cost
1	8' D-10R catch basin	3 ea	4500.00	13,500.00
6	48" RCP	1130 LF	120.00	135,600.00
	Subtotal Construction Cost			$ 149,100.00
	Engineering & Contingency @ 15%			22,365.00
	Total Estimated Cost			**$ 171,465.00**

B. Private Facilities:

Item No.	Description	Quantity	Unit Cost	Cost
1	Detention Pond Excavation	1684 CY	$ 4.00	$ 6,736.00
2	24" PVC Outlet & Riser	44 LF	30.00	1,320.00
3	Interior bays and channels	LS	1500.00	1,500.00
	Subtotal Construction Cost			$ 9,556.00
	Engineering		15%	1,433.40
	Total Estimated Cost			**$10,989.40**

9. FEES: 2009 Sand Creek Basin Fees:

All of the 7.06 acre proposed Lot 1 is currently unplatted.

Drainage Fees: 7.06 acres @ $9,493.00 per acre = **$ 67,020.58**

Bridge Fees: 7.06 acres @ $ 596.00 per acre = **$ 4,207.76**

Pond Land Fee: 7.06 acres @ $1,070.00 per acre = **$7,554.20**

Pond Fac. Fee: 7.06 acres @ $2,881.00 per acre = **$ 20,339.86**

No fees are due for the 0.50 Tract A, the detention pond as is was previously platted as Lot 14, Block 1 Frazier's Garden Acres.

MAJOR BASIN	SUB BASIN	AREA		BASIN		Tc MIN	I		SOIL GRP	DEV. TYPE	C		FLOW		RETURN PERIOD	
		PLANIM READ	ACRES	LENGTH	HEIGHT								qp	qp		
SAND CREEK	G	COGO		300	6	11			B	COMM	0.75	0.80			5	100
Developed				+900	V=2	+7.5										
			9.99			18.5	3.0	5.3					22.4	42.4		
	I	COGO		300	6	11			B	COMM	0.75	0.80				
				+1000	V=2	+8.3										
			9.97			19.3	3.0	5.2					22.4	41.5		
Developed and	H1		1.77	1250	V=2.6	8	4.5	7.5	B	44/60	0.84	0.88	6.7	11.7		
Historic	+H2		0.54	+540	V=2.6	+3.5										
	H1+H2		2.31			11.5	3.9	6.8					7.6	13.8		
	+H3		0.42	+400	V=3.0	+2.2										
	H1-H3		2.73			13.7	3.6	6.3					8.2	15.1		
	+H4		0.42	+400	V=2.3	+2.9										
	H1-H4		3.15			16.6	3.3	5.6					8.7	15.1		
	+H5		0.54	+450	V=10.5	+0.7										
	H1-H5		3.639			17.3	3.0	5.2					9.3	16.9		
	B+C			+570	V=3.7	+2.6			B	COMM	0.75	0.80				
	TOTAL		13.87			15.6	3.4	5.8					35.3	64.4		
	A+D			+430	V=2.0	+4										
	TOTAL		15.99			13	3.6	6.3					43.2	80.6		
	A-D		29.86			15.6	3.4	5.8					76.1	139		
	+E		11.53	+540	V=9.2	+1.0										
	A-E		41.39			16.6	3.2	5.5					99.3	182		
	+F		9.26	+400	V=11.9	+0.6										
	A-F		50.65			17.2	3.1	5.5					118	223		
	+G		9.99	+400	V=8.6	+0.8										
	A-G		60.64			18	3.1	5.4					141	262		
	+I		9.97	+450	V=10.5	+0.7										
	A-I		70.61			19	3.0	5.2					15.9	294		

HYDROLOGICAL COMPUTATION – BASIC DATA

PROJ: DEFENSE OFFICE PARK BY: O.E. WATTS

RATIONAL METHOD DATE: 10-4-06, 11-29-06, 2-10-09

OLIVER E. WATTS, CONSULTING ENGINEER, INC.
614 ELKTON DRIVE COLORADO SPRINGS, CO 80907

STREET	LOCATION	DISTANCE	ELEVATION & SLOPE	TOTAL RUNOFF	STREET FLOW / CAPACITY	PIPE FLOW	TYPE PIPE, CATCH BASIN & SLOPE %
PRIVATE Developed	A		1%	29.6/53.9	/69.6		D=0.50 T=30 V=2.0
TROY HILL	B		2.5%	11.8/22.0	11.8/20.5 22.0/117		D=0.41 T=15. V=3.7
	C		1.3%	35.3/64.4	35.3/14.8 64.4/84		2- 5' D-1OR'S CAP =15.5 EA
		200			8.2/14.8 37.8/84	27.1	24"RCP S=1.44% MIN
PRIVATE	D		1%	43.2/80.6	43.2/73.9 80.6/73.9		D=0.56 T=40 V=1.9
TROY HILL	D		1.7%	76.1/139			2-6'D-1OR/S CAP = 19 EA = 38
	540				11.0/16.9 73.9/96.4	65.1	36"RCP S=0.95% MIN. V=9.2
	E		2.0%	99.3/182			6'D=10 R CAP =19
		400			15.2/18.4 97.9/104	84.1	36" RCP S=1.6% MIN. V=11.9
	F		1.0%	118/223			8'D-1OR CAP = 24.2
		400			10/13.0 115/144	108.3	48"RCP S=0.57%MIN V=8.6
	G		1%	141/261			8'D-10R CAP =24.2
		400			8.5/13.0 128/144	132.5	48"RCP S=0.85%MIN. V=10.5
	I		2.5%	159/294			8'D-10R CAP=24.2
		330	4%		3.0/13.0 138/144	132	48"RCP S=1.18% MIN, V=12.4
	CHANNEL						
Historic and Developed	H1		1.6%	6.7/11.7	6.7/16.4		D=0.37 T=13.8 V=2.6
	H2		2.0%	7.6/13.8	7.6/16.4		D=0.37 T=13.9 V=3.0
	H3		1%	8.2/15.1	8.2/13.0		D=0.42' T=16.7' V=2.3
	H4		1%	8.7/13.0	8.7\13.0		D=0.43' T=17.1' V=2.4
	H5		2.5%	9.3/16.9	9.3/20.6		OK

MAJOR BASIN	SUB BASIN	AREA		BASIN		Tc MIN	I		SOIL GRP	DEV. TYPE	C		FLOW		RETURN PERIOD	
		PLANIM READ	ACRES	LENGTH	HEIGHT								qp	qp		
SAND CREEK	A	COGO		300	5	20			B	30%	0.40	0.50			5	100
Historic				+700	V=1.5	8										
			11.61			28	2.5	4.5					11.6	26.1		
	B			300	3	15			B	65%	060	0.70				
				+400	V=4	+2										
			4.36			17	3.2	5.5					11.8	22.0		
	C			300	9	17			B	30%	0.40	0.50				
				+750	V=1.5	+8										
			9.51			25	2.6	4.6					9.9	21.9		
	D			300	6	20										
				+350	V=1.5	+4										
			4.38			24	2.7	4.7					4.7	10.0		
	E			300	6	20										
				+900	V=1.5	+10										
			11.53			30	2.3	4.2					10.6	24.2		
	F			300	6	20										
				+900	V=1.5	+10										
			9.26			30	2.3	4.2					8.5	19.4		
	E+F			+300	V=1.5	+3										
			20.79			33	2.2	3.9					18.3	40.5		

HYDROLOGICAL COMPUTATION – BASIC DATA
PROJ: DEFENSE OFFICE PARK BY: O.E. WATTS
RATIONAL METHOD DATE: 2-9-09

OLIVER E. WATTS, CONSULTING ENGINEER, INC.
614 ELKTON DRIVE COLORADO SPRINGS, CO 80907

hAJOR BASIN	SUB BASIN	AREA		BASIN		Tc MIN	I		SOIL GRP	DEV. TYPE	C		FLOW		RETURN PERIOD	
		PLANIM READ	ACRES	LENGTH	HEIGHT								qp	qp		
SAND CREEK	G	COGO		300	6	20			B	30%	0.40	0.50			5	100
Historic				+900	V=1.5	+10										
			9.99			30	2.5	4.2					9.2	21.0		
	I	COGO		300	6	20										
				+1000	V=1.5	+11										
			9.97			31	2.3	4.0					9.2	19.9		
	B+C			+570	V=3.3	+3										
	TOTAL		13.87			20	2.9	5.2	B	MIX	0.463	0.563	18.6	40.6		
	A+D			+350	V-4.66	+2										
	TOTAL		15.99			30	2.3	4.2	B	30%	0.40	0.50	14.7	33.6		
	A-D			+350	V=2.6	+2										
	TOTAL		29.86			30	2.3	4.2	B	MIX	0.429	0.529	29.5	66.4		
	A+E			+520	V=4.07	+2										
	TOTAL		41.39			32	2.3	4.0	B	MIX	0.421	0.521	40.1	86.2		
	A-F			+400	V=4.39	+1.5										
	TOTAL		50.65			33.5	2.2	3.8	B	MIX	0.417	0.517	46.5	99.5		
	A-G			+405	V=4.22	+1.6										
	TOTAL		60.64			35	2.2	3.8	B	MIX	0.414	0.514	55.3	118		
	A-I			+470	V=4.66	+1.7										
	TOTAL		70.61			37	2.1	3.6	B	MIX	0.412	0.512	61.1	130		

HYDROLOGICAL COMPUTATION – BASIC DATA
PROJ: DEFENSE OFFICE PARK BY: O.E. WATTS
RATIONAL METHOD DATE: 2-9-09

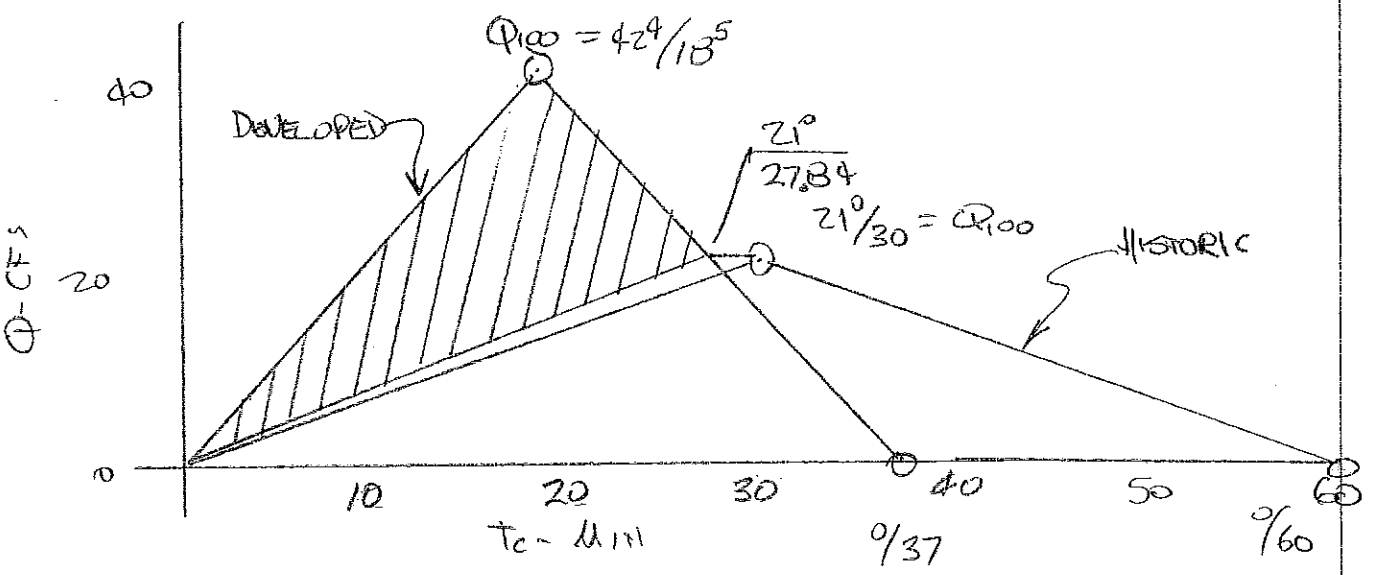
OLIVER E. WATTS, CONSULTING ENGINEER, INC.
614 ELKTON DRIVE COLORADO SPRINGS, CO 80907

STREET	LOCATION	DISTANCE	ELEVATION & SLOPE	TOTAL RUNOFF	STREET FLOW / CAPACITY	PIPE FLOW	TYPE PIPE, CATCH BASIN & SLOPE %
PRIVATE Historic	A		1%	11.6/26.1	/69.6		D=0.47, T19.1 V=2.6
TROY HILL	B		2.5%	8.4/16.8	8.4/20.5 16.8/117		D=0.36 T=13.8. V=3.3
	C		1.3%	29.5/66.4			D=0.49, T=20, V=1.51
	D-G						NATURAL CHANNELS
							SEE ATTACHED SHEETS

STREET AND STORM SEWER CALCULATIONS
PROJECT: DEFENSE OFFICE PARK
BY: O.E. WATTS DATE: 2-9-09

OLIVER E. WATTS, CONSULTING ENGINEER, INC.
614 ELKTON DRIVE COLORADO SPRINGS, CO 80907

TO LOWER PEAK TO HISTORIC (BASIN 5)



REQ'D STORAGE: 21.0 × 27.84 × 60 / 2 = 17,537 CF

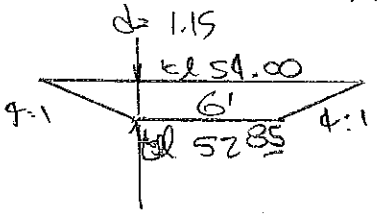
EROSION CONTROL 9.99 Ac × 1800 = 17,982 CF

POND STORAGE B = 66' Z = 4:1

WS El		A-SF	V-CF		DESIGN WS
6150	d=0	4356	0		
			11,080		
6152	d=2	6724	11,080	17,982 CF @ el 52.85	
			16,328		
6154	d=4	9604	27,408	17,537 CF @ el 52.79	

Water Quality: 0.275 AF = 11,979 CF @ WS 52.1'
See ATTN Sheets

SPILLWAY



$Fr = \frac{V}{\sqrt{gd}} = 1$

$V = \sqrt{gd} = 6.09$

A = 12.19 SF Cap = 74.2 CFS >> 42.4 OK

RISER PIPE Top 24" PVC el 52.85 d = 2.8'

See SB-1 : SB2 06772 IN² (RIM) Use 3 Rows 9/16" Ø

Design Procedure Form: Extended Detention Basin (EDB) - Sedimentation Facility

Designer: O.E. WATTS
Company: OLIVER E. WATTS, CE, INC.
Date: February 9, 2009
Project: NORCOM OFFICE PARK
Location: BASIN G WATER QUALITY POND

1. Basin Storage Volume	
A) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	I_a = 70.00 i = 0.70
B) Contributing Watershed Area (Area)	Area = 9.99 acres
C) Water Quality Capture Volume (WQCV) (WQCV =1.0 * (0.91 * I^3 - 1.19 * I^2 + 0.78 * I))	WQCV = 0.28 watershed inches
D) Design Volume: Vol = (WQCV / 12) * Area * 1.2	Vol = 0.275 acre-feet 11,979 ≈
2. Outlet Works	
A) Outlet Type (Check One)	____ Orifice Plate XX Perforated Riser Pipe ____ Other: ____
B) Depth at Outlet Above Lowest Perforation (H)	H = 2.11 feet
C) Required Maximum Outlet Area per Row, (A_o)	A_o = 0.54 square inches
D) Perforation Dimensions **(enter one only)**: i) Circular Perforation Diameter **OR** ii) 2" Height Rectangular Perforation Width	D = 0.5625 inches, **OR** W = ____ inches
E) Number of Columns (nc, See Table 6a-1 For Maximum)	nc = 3 number
F) Actual Design Outlet Area per Row (A_o)	A_o = 0.75 square inches
G) Number of Rows (nr)	nr = 6 number
H) Total Outlet Area (A_{ot})	A_{ot} = 4.72 square inches
3. Trash Rack	
A) Needed Open Area: A_t = 0.5 * (Figure 7 Value) * A_{ot}	A_t = 169 square inches
B) Type of Outlet Opening (Check One)	X ≤ 2" Diameter **Round** ____ 2" High **Rectangular** ____ Other: ____
C) For 2", or Smaller, **Round Opening** (Ref.: Figure 6a):	
i) Width of Trash Rack and Concrete Opening (W_{conc}) from Table 6a-1	W_{conc} = 9 inches
ii) Height of Trash Rack Screen (H_{TR})	H_{TR} = ____ inches

Design Procedure Form: Extended Detention Basin (EDB) - Sedimentation Facility

Designer: O.E. WATTS
Company: OLIVER E. WATTS, CE, INC.
Date: February 9, 2009
Project: NORCOM OFFICE PARK
Location: BASIN G WATER QUALITY POND

iii) Type of Screen (Based on Depth H), Describe if "Other"	_____ S.S. #93 VEE Wire (US Filter) _____ Other: _____
iv) Screen Opening Slot Dimension, Describe if "Other"	_____ 0.139" (US Filter) _____ Other: _____
v) Spacing of Support Rod (O.C.) Type and Size of Support Rod (Ref.: Table 6a-2)	_____ inches _____
vi) Type and Size of Holding Frame (Ref.: Table 6a-2)	_____
D) For 2" High **Rectangular Opening** (Refer to Figure 6b):	
I) Width of Rectangular Opening (W)	W = _____ inches
ii) Width of Perforated Plate Opening (W_{conc} = W + 12")	W_{conc} = _____ inches
iii) Width of Trashrack Opening ($W_{opening}$) from Table 6b-1	$W_{opening}$ = _____ inches
iv) Height of Trash Rack Screen (H_{TR})	H_{TR} = _____ inches
v) Type of Screen (based on depth H) (Describe if "Other")	_____ Klemp™ KPP Series Aluminum _____ Other: _____
vi) Cross-bar Spacing (Based on Table 6b-1, Klemp™ KPP Grating). Describe if "Other"	_____ inches _____ Other: _____
vii) Minimum Bearing Bar Size (Klemp™ Series, Table 6b-2) (Based on depth of WQCV surcharge)	_____
4. Detention Basin length to width ratio	_____ (L/W)
5 Pre-sedimentation Forebay Basin - Enter design values	
A) Volume (5 to 10% of the Design Volume in 1D)	_____ acre-feet
B) Surface Area	_____ acres
C) Connector Pipe Diameter (Size to drain this volume in 5-minutes under inlet control)	_____ inches
D) Paved/Hard Bottom and Sides	_____ yes/no

Design Procedure Form: Extended Detention Basin (EDB) - Sedimentation Facility

Designer: O.E. WATTS
Company: OLIVER E. WATTS, CE, INC.
Date: February 9, 2009
Project: NORCOM OFFICE PARK
Location: BASIN G WATER QUALITY POND

6. Two-Stage Design	
A) Top Stage (D_{WQ} = 2' Minimum)	D_{WQ} = _____ feet Storage= _____ acre-feet
B) Bottom Stage (D_{BS} = D_{WQ} + 1.5' Minimum, D_{WQ} + 3.0' Maximum, Storage = 5% to 15% of Total WQCV)	D_{BS} = _____ feet Storage= _____ acre-feet Surf. Area= _____ acres
C) Micro Pool (Minimum Depth = the Larger of 0.5 * Top Stage Depth or 2.5 Feet)	Depth= _____ feet Storage= _____ acre-feet Surf. Area= _____ acres
D) Total Volume: Vol_{tot} = Storage from 5A + 6A + 6B Must be ≥ Design Volume in 1D	Vol_{tot} = _____ acre-feet
7. Basin Side Slopes (Z, horizontal distance per unit vertical) Minimum Z = 3, Flatter Preferred	Z = _____ (horizontal/vertical)
8. Dam Embankment Side Slopes (Z, horizontal distance) per unit vertical) Minimum Z = 3, Flatter Preferred	Z = _____ (horizontal/vertical)
9. Vegetation (Check the method or describe "Other")	_____ Native Grass _____ Irrigated Turf Grass _____ Other: _____

Notes: _____

Worksheet for Irregular Section - 1 60+54 No

Project Description	
Flow Element:	Irregular Section
Friction Method:	Manning Formula
Solve For:	Normal Depth

Input Data		
Channel Slope:	0.01990	ft/ft
Discharge:	29.50	ft³/s

Options	
Current Roughness Weighted Meth	ImprovedLotters
Open Channel Weighted Roughnes	ImprovedLotters
Closed Channel Weighted Roughne	Hortons

Results		
Roughness Coefficient:	0.035	
Water Surface Elevation:	68.95	ft
Elevation Range:	67.81 to 72.75 ft	
Flow Area:	7.25	ft²
Wetted Perimeter:	12.96	ft
Top Width:	12.75	ft
Normal Depth:	1.14	ft
Critical Depth:	1.11	ft
Critical Slope:	0.02217	ft/ft
Velocity:	4.07	ft/s
Velocity Head:	0.26	ft
Specific Energy:	1.39	ft
Froude Number:	0.95	
Flow Type:	Subcritical	

Segment Roughness

Start Station	End Station	Roughness Coefficient
(0+37, 69.80)	(0+88, 72.75)	0.035

Section Geometry

Station	Elevation
0+37	69.80
0+50	67.81

60+59 N

2/3

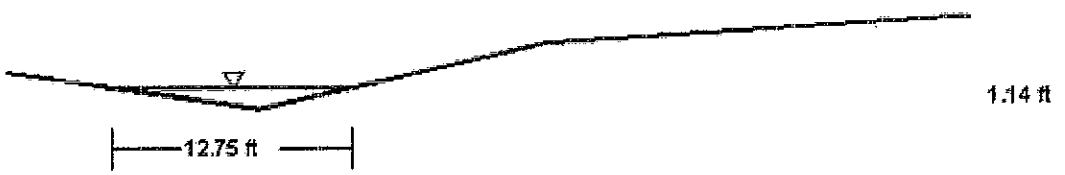
Worksheet for Irregular Section - 1

Station	Elevation
0+66	71.30
0+88	72.75

NORCOM 60+54 NORTH
Cross Section for Irregular Section - 1

Project Description		
Flow Element:	Irregular Section	
Friction Method:	Manning Formula	
Solve For:	Normal Depth	

Section Data		
Roughness Coefficient:	0.035	
Channel Slope:	0.01990	ft/ft
Normal Depth:	1.14	ft
Elevation Range:	67.81 to 72.75 ft	
Discharge:	29.50	ft^3/s



V: 1
H: 1

Worksheet for Irregular Section - 1 S6482 Mo

Project Description	
Flow Element:	Irregular Section
Friction Method:	Manning Formula
Solve For:	Normal Depth

Input Data		
Channel Slope:	0.01990	ft/ft
Discharge:	40.10	ft³/s

Options	
Current Roughness Weighted Meth	ImprovedLotters
Open Channel Weighted Roughnes	ImprovedLotters
Closed Channel Weighted Roughne	Hortons

Results		
Roughness Coefficient:	0.035	
Water Surface Elevation:	61.98	ft
Elevation Range:	60.75 to 63.45 ft	
Flow Area:	9.35	ft²
Wetted Perimeter:	15.43	ft
Top Width:	15.20	ft
Normal Depth:	1.23	ft
Critical Depth:	1.21	ft
Critical Slope:	0.02152	ft/ft
Velocity:	4.29	ft/s
Velocity Head:	0.29	ft
Specific Energy:	1.52	ft
Froude Number:	0.96	
Flow Type:	Subcritical	

Segment Roughness

Start Station	End Station	Roughness Coefficient
(0+39, 62.24)	(0+90, 63.42)	0.035

Section Geometry

Station	Elevation
0+39	62.24
0+52	60.75

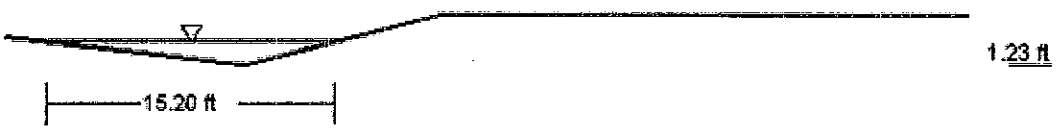
Worksheet for Irregular Section - 1

Station	Elevation
0+62	63.45
0+90	63.42

NORCOM 56+82 NORTH
Cross Section for Irregular Section - 1

Project Description		
Flow Element:	Irregular Section	
Friction Method:	Manning Formula	
Solve For:	Normal Depth	

Section Data		
Roughness Coefficient:	0.035	
Channel Slope:	0.01990	ft/ft
Normal Depth:	1.23	ft
Elevation Range:	60.75 to 63.45 ft	
Discharge:	40.10	ft^3/s



V: 1
H: 1

Worksheet for Irregular Section - 1 52+37 b

Project Description	
Flow Element:	Irregular Section
Friction Method:	Manning Formula
Solve For:	Normal Depth

Input Data		
Channel Slope:	0.01750	ft/ft
Discharge:	46.50	ft³/s

Options	
Current Roughness Weighted Meth	ImprovedLotters
Open Channel Weighted Roughnes	ImprovedLotters
Closed Channel Weighted Roughne	Hortons

Results		
Roughness Coefficient:	0.035	
Water Surface Elevation:	56.35	ft
Elevation Range:	55.03 to 57.78 ft	
Flow Area:	11.03	ft²
Wetted Perimeter:	16.94	ft
Top Width:	16.72	ft
Normal Depth:	1.32	ft
Critical Depth:	1.27	ft
Critical Slope:	0.02112	ft/ft
Velocity:	4.22	ft/s
Velocity Head:	0.28	ft
Specific Energy:	1.60	ft
Froude Number:	0.92	
Flow Type:	Subcritical	

Segment Roughness

Start Station	End Station	Roughness Coefficient
(0+42, 57.78)	(0+96, 57.17)	0.035

Section Geometry

Station	Elevation
0+42	57.78
0+47	57.28

Worksheet for Irregular Section - 1

Station	Elevation
0+58	55.03
0+70	56.52
0+96	57.17

NORCOM 52+37 NORTH
Cross Section for Irregular Section - 1

Project Description	
Flow Element:	Irregular Section
Friction Method:	Manning Formula
Solve For:	Normal Depth

Section Data		
Roughness Coefficient:	0.035	
Channel Slope:	0.01750	ft/ft
Normal Depth:	1.32	ft
Elevation Range:	55.03 to 57.78 ft	
Discharge:	46.50	ft^3/s

V: 1
H: 1

Worksheet for Irregular Section - 1 47+60 Lb

Project Description	
Flow Element:	Irregular Section
Friction Method:	Manning Formula
Solve For:	Normal Depth

Input Data		
Channel Slope:	0.01460	ft/ft
Discharge:	55.30	ft³/s

Options	
Current Roughness Weighted Meth	ImprovedLotters
Open Channel Weighted Roughnes	ImprovedLotters
Closed Channel Weighted Roughne	Hortons

Results		
Roughness Coefficient:	0.035	
Water Surface Elevation:	48.77	ft
Elevation Range:	46.97 to 54.77 ft	
Flow Area:	11.86	ft²
Wetted Perimeter:	13.70	ft
Top Width:	13.19	ft
Normal Depth:	1.80	ft
Critical Depth:	1.70	ft
Critical Slope:	0.01982	ft/ft
Velocity:	4.66	ft/s
Velocity Head:	0.34	ft
Specific Energy:	2.14	ft
Froude Number:	0.87	
Flow Type:	Subcritical	

Segment Roughness

Start Station	End Station	Roughness Coefficient
(0+31, 54.77)	(0+85, 50.51)	0.035

Section Geometry

Station	Elevation
0+31	54.77
0+35	54.52

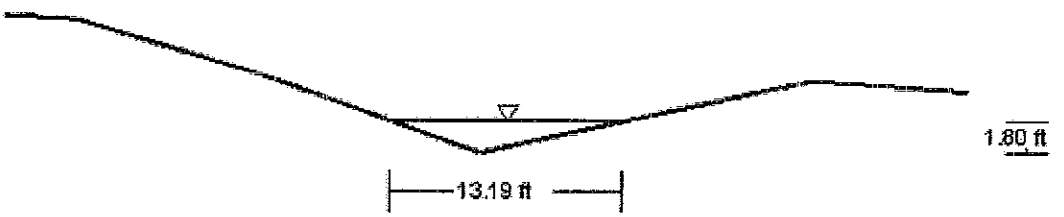
Worksheet for Irregular Section - 1

Station	Elevation
0+46	51.18
0+58	46.97
0+77	51.11
0+85	50.51

NORCOM 47+60 NORTH
Cross Section for Irregular Section - 1

Project Description		
Flow Element:	Irregular Section	
Friction Method:	Manning Formula	
Solve For:	Normal Depth	

Section Data		
Roughness Coefficient:	0.035	
Channel Slope:	0.01460	ft/ft
Normal Depth:	1.80	ft
Elevation Range:	46.97 to 54.77 ft	
Discharge:	55.30	ft³/s



V: 1
H: 1

Worksheet for Irregular Section - 1

Project Description	
Flow Element:	Irregular Section
Friction Method:	Manning Formula
Solve For:	Normal Depth

Input Data		
Channel Slope:	0.01540	ft/ft
Discharge:	61.10	ft³/s

Options	
Current Roughness Weighted Methc	ImprovedLotters
Open Channel Weighted Roughnes:	ImprovedLotters
Closed Channel Weighted Roughne	Hortons

Results		
Roughness Coefficient:	0.035	
Water Surface Elevation:	42.41	ft
Elevation Range:	40.92 to 51.51 ft	
Flow Area:	14.21	ft²
Wetted Perimeter:	19.29	ft
Top Width:	19.06	ft
Normal Depth:	1.49	ft
Critical Depth:	1.42	ft
Critical Slope:	0.02036	ft/ft
Velocity:	4.30	ft/s
Velocity Head:	0.29	ft
Specific Energy:	1.78	ft
Froude Number:	0.88	
Flow Type:	Subcritical	

Segment Roughness

Start Station	End Station	Roughness Coefficient
(0+10, 51.51)	(0+90, 44.08)	0.035

Section Geometry

Station	Elevation
0+10	51.51
0+15	51.08

Worksheet for Irregular Section - 1

Station	Elevation
0+33	47.16
0+45	43.74
0+64	40.92
0+80	43.64
0+90	44.08

NORCOM 43+52 NORTH
Cross Section for Irregular Section - 1

Project Description		
Flow Element:	Irregular Section	
Friction Method:	Manning Formula	
Solve For:	Normal Depth	

Section Data		
Roughness Coefficient:	0.035	
Channel Slope:	0.01540	ft/ft
Normal Depth:	1.49	ft
Elevation Range:	40.92 to 51.51 ft	
Discharge:	61.10	ft³/s

V: 1
H: 1

LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

ZONE A No base flood elevations determined.

ZONE AE Base flood elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE A99 To be protected from 100-year flood by Federal flood protection system under construction; no base elevations determined.

ZONE V Coastal flood with velocity hazard (wave action); no base flood elevations determined.

ZONE VE Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

ZONE X Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

ZONE X Areas determined to be outside 500-year floodplain.

ZONE D Areas in which flood hazards are undetermined.

UNDEVELOPED COASTAL BARRIERS

d — Identified 1990 — Otherwise Protected Areas

Barrier areas are normally located within or adjacent to Special Flood Hazard Areas.

Flood Boundary

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

513 — Base Flood Elevation Line, Elevation in Feet. See Map Index for Elevation Datum.

(D) — Cross Section Line

(EL 987) — Base Flood Elevation in Feet Where Uniform Within Zone. See Map Index for Elevation Datum

RM7 × — Elevation Reference Mark

• M2 — River Mile

30", 32°22'30" — Horizontal Coordinates Based on North American Datum of 1927 (NAD 27) Projection.

NOTES

...is for use in administering the National Flood Insurance Program. ...ot necessarily identify all areas subject to flooding, particularly from ...nage sources of small size, or all planimetric features outside ...ood Hazard Areas.

...base flood elevations apply only landward of 0.0 NGVD, and include ...cts of wave action, these elevations may also differ significantly ...ose developed by the National Weather Service for hurricane ... planning.

...PRODUCTS TO THIS PANEL.

...fer to the FLOOD INSURANCE RATE MAP EFFECTIVE DATE shown ... this map to determine when actuarial rates apply to structures in ...nes where elevations or depths have been established.

...determine if flood insurance is available, contact an insurance agent or ...the National Flood Insurance Program at (800) 638-6620.

APPROXIMATE SCALE IN FEET

500 0 500

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 753 OF 1300

(SEE MAP INDEX FOR PANELS NOT PRINTED)

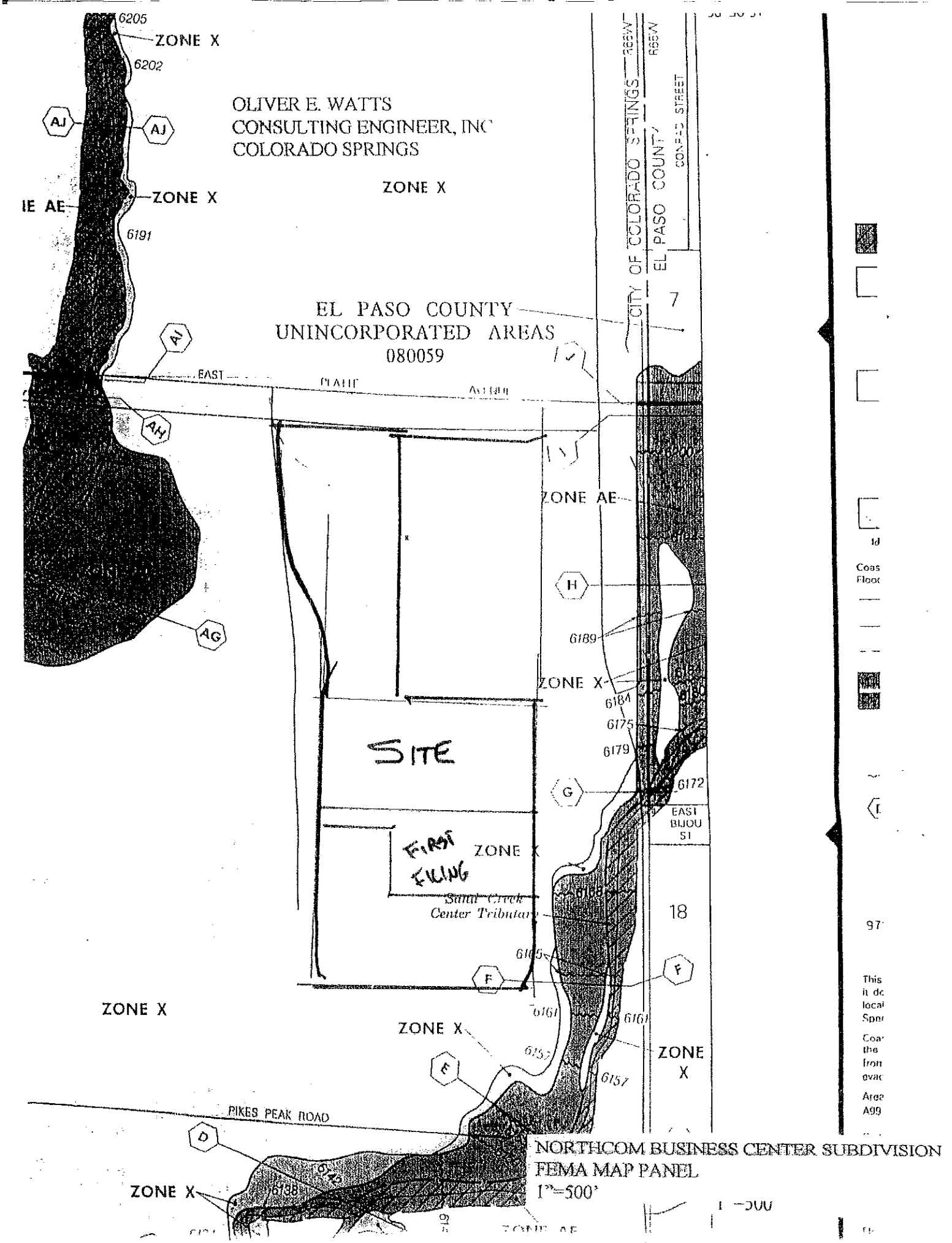
CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0753	F
EL PASO COUNTY, UNINCORPORATED AREAS	080059	0753	F

MAP NUMBER 08041C0753 F

EFFECTIVE DATE: MARCH 17, 1997

Federal Emergency Management Agency


OLIVER E. WATTS
CONSULTING ENGINEER, INC
COLORADO SPRINGS
EL PASO COUNTY
UNINCORPORATED AREAS
080059
CITY OF COLORADO SPRINGS
EL PASO COUNTY
CONFED STREET
EAST BIJOU ST
PIKES PEAK ROAD
ZONE X
ZONE AE
SITE
FIRST FILING
Sand Creek
Center Tributary
6205
6202
6191
6189
6184
6175
6179
6172
6165
6161
6157
6138
AJ
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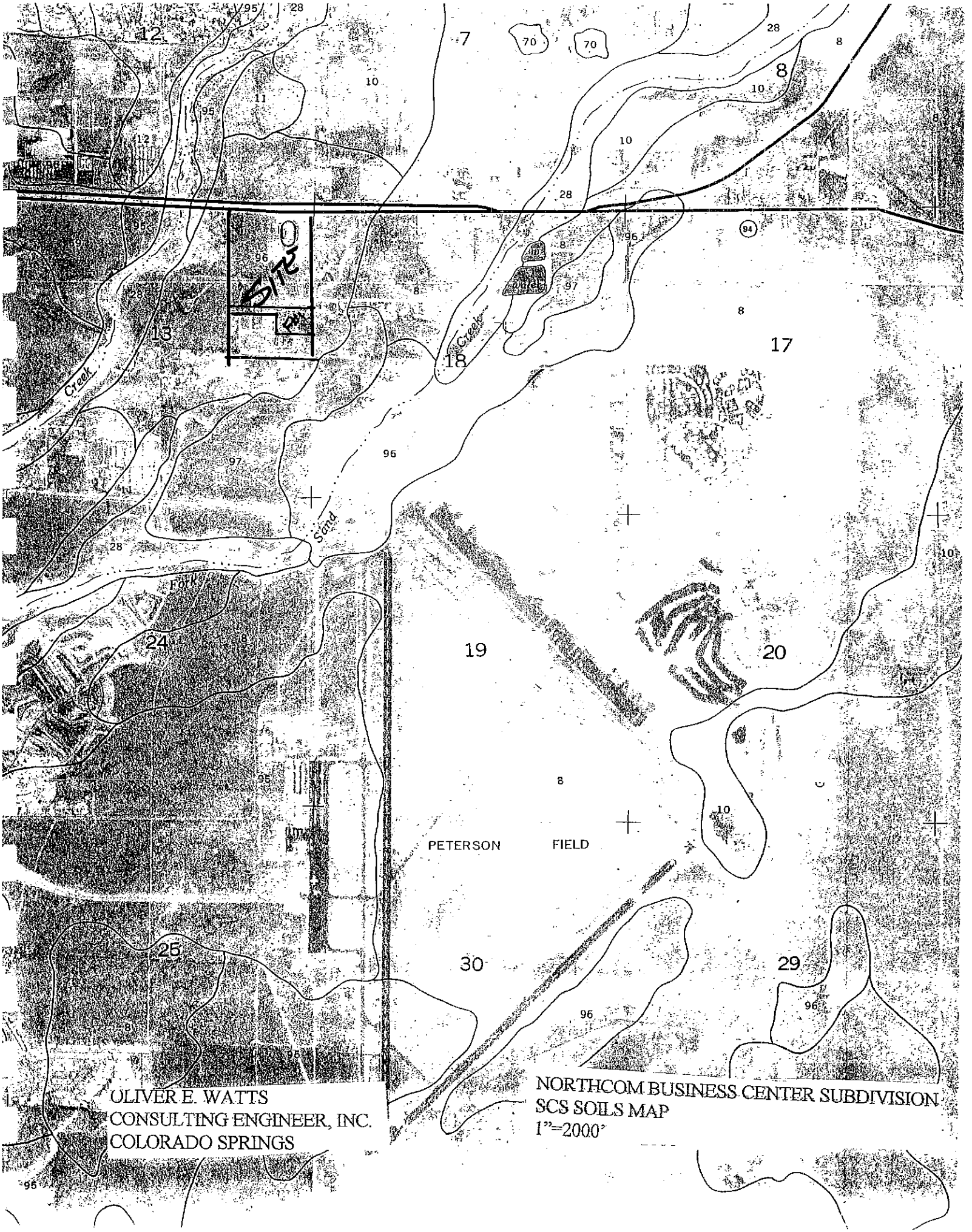
D
7
18
NORTHCOM BUSINESS CENTER SUBDIVISION
FEMA MAP PANEL
1"=500'



OLIVER E. WATTS
CONSULTING ENGINEER, INC.
COLORADO SPRINGS

NORTHCOM BUSINESS CENTER SUBDIVISION
SCS SOILS MAP
1"=2000'

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Hardness	
					In		
Tomah:							
[1]92, [1]93:							
Tomah part-----	B	None----------	---	---	>60	---	Moderate.
Crowfoot part--	B	None----------	---	---	>60	---	Moderate.
Travessilla:							
[1]94:							
Travessilla part----------	D	None----------	---	---	6-20	Hard	Low.
Rock outcrop part----------	D	---	---	---	---	---	---
Truckton:							
95, 96, 97-------	B	None----------	---	---	>60	---	Moderate.
[1]98:							
Truckton part--	B	None----------	---	---	>60	---	Moderate.
Blakeland part-	A	None----------	---	---	>60	---	Low.
[1]99, [1]100:							
Truckton part--	B	None----------	---	---	>60	---	Moderate.
Bresser part---	B	None----------	---	---	>60	---	Low.
Ustic Torrifluvents:							
101----------	B	Occasional----	Very brief----	Mar-Aug	>60	---	Moderate.
Valent:							
102, 103---------	A	None----------	---	---	>60	---	Low.
Vona:							
104, 105---------	B	None----------	---	---	>60	---	Moderate.
Wigton:							
106----------	A	None----------	---	---	>60	---	Low.
Wiley:							
107, 108---------	B	None----------	---	---	>60	---	Low.
Yoder:							
109, 110---------	B	None----------	---	---	>60	---	Low.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior characteristics of the map unit.

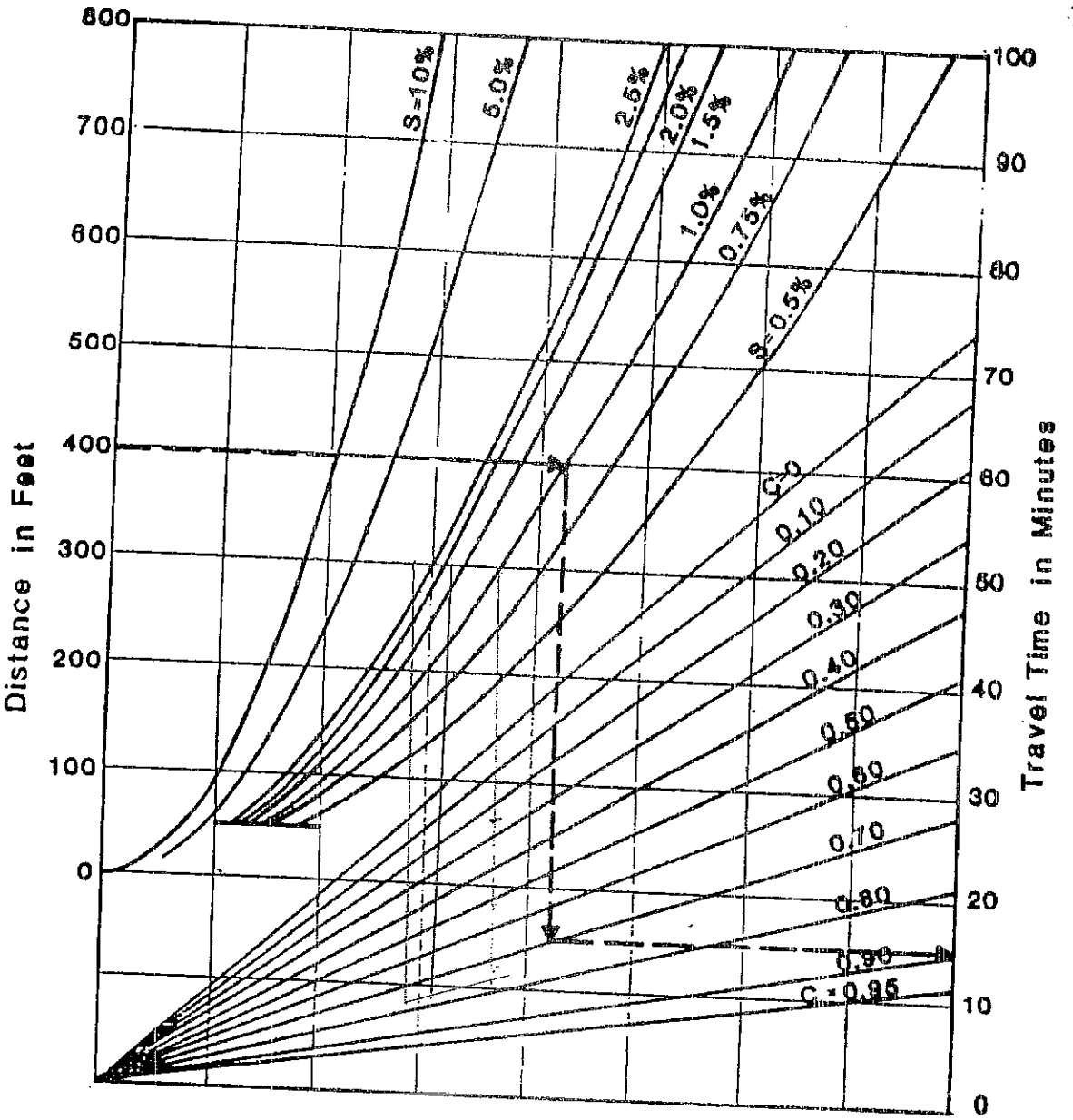
TABLE 5-1

RECOMMENDED AVERAGE RUNOFF COEFFICIENTS AND PERCENT IMPERVIOUS

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	"C" FREQUENCY 10 A&B*	"C" FREQUENCY 10 C&D*	"C" FREQUENCY 100 A&B*	"C" FREQUENCY 100 C&D*
Business					
Commercial Areas	95	0.90	0.90	0.90	0.90
Neighborhood Areas	70	0.75	0.75	0.80	0.80
Residential					
1/8 Acre or less	65	0.60	0.70	0.70	0.80
1/4 Acre	40	0.50	0.60	0.60	0.70
1/3 Acre	30	0.40	0.50	0.55	0.60
1/2 Acre	25	0.35	0.45	0.45	0.55
1 Acre	20	0.30	0.40	0.40	0.50
Industrial					
Light Areas	80	0.70	0.70	0.80	0.80
Heavy Areas	90	0.80	0.80	0.90	0.90
Parks and Cemeteries	7	0.30	0.35	0.55	0.60
Playgrounds	13	0.30	0.35	0.60	0.65
Railroad Yard Areas	40	0.50	0.55	0.60	0.65
Undeveloped Areas					
Historic Flow Analysis- Greenbelts, Agricultural	2	0.15	0.25	0.20	0.30
Pasture/Meadow	0	0.25	0.30	0.35	0.45
Forest	0	0.10	0.15	0.15	0.20
Exposed Rock	100	0.90	0.90	0.95	0.95
Offsite Flow Analysis (when land use not defined)	45	0.55	0.60	0.65	0.70
Streets					
Paved	100	0.90	0.90	0.95	0.95
Gravel	80	0.80	0.80	0.85	0.85
Drive and Walks	100	0.90	0.90	0.95	0.95
Roofs	90	0.90	0.90	0.95	0.95
Lawns	0	0.25	0.30	0.35	0.45

* Hydrologic Soil Group

9/30/90



REFERENCE : Wright – McLaughlin Engineers, Urban Storm Drainage Criteria Manual, Vol. 1, Denver Regional Council of Governments, Denver, Co. 1977

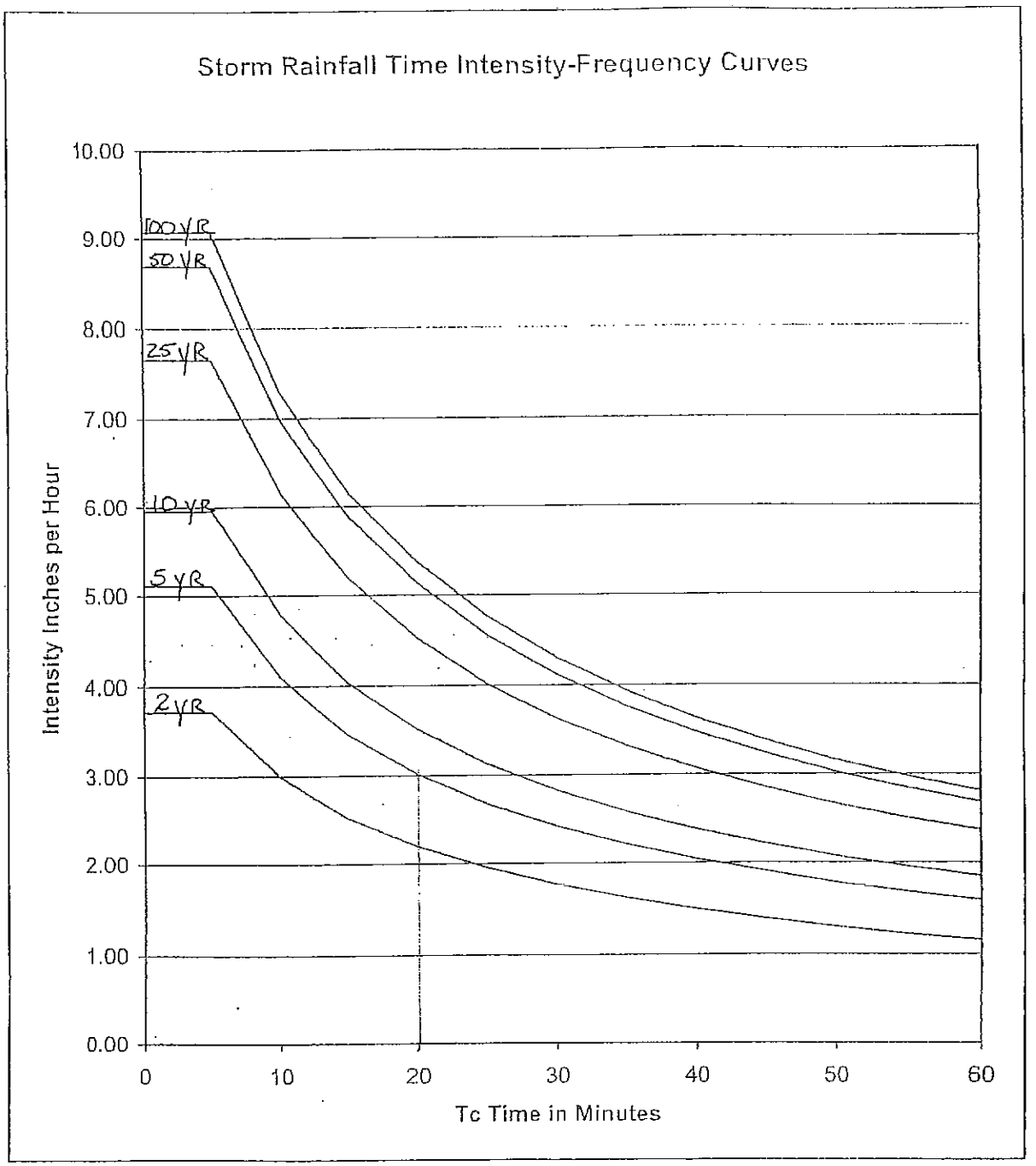
HDR Infrastructure, Inc.
A Centerra Company

The City of Colorado Springs / El Paso County
Drainage Criteria Manual

Overland Flow Curves

Date
OCT. 1987

Figure
5-2

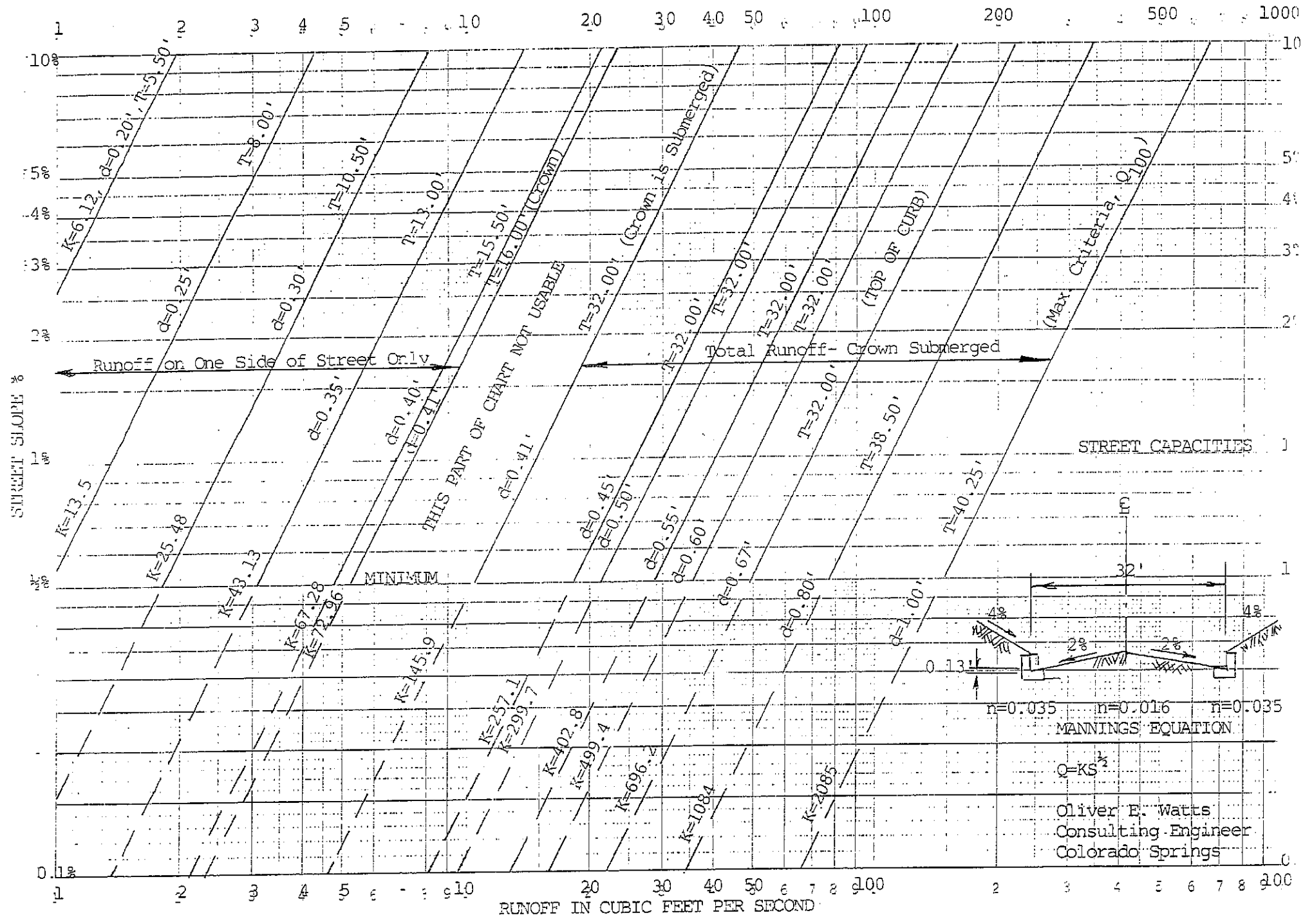


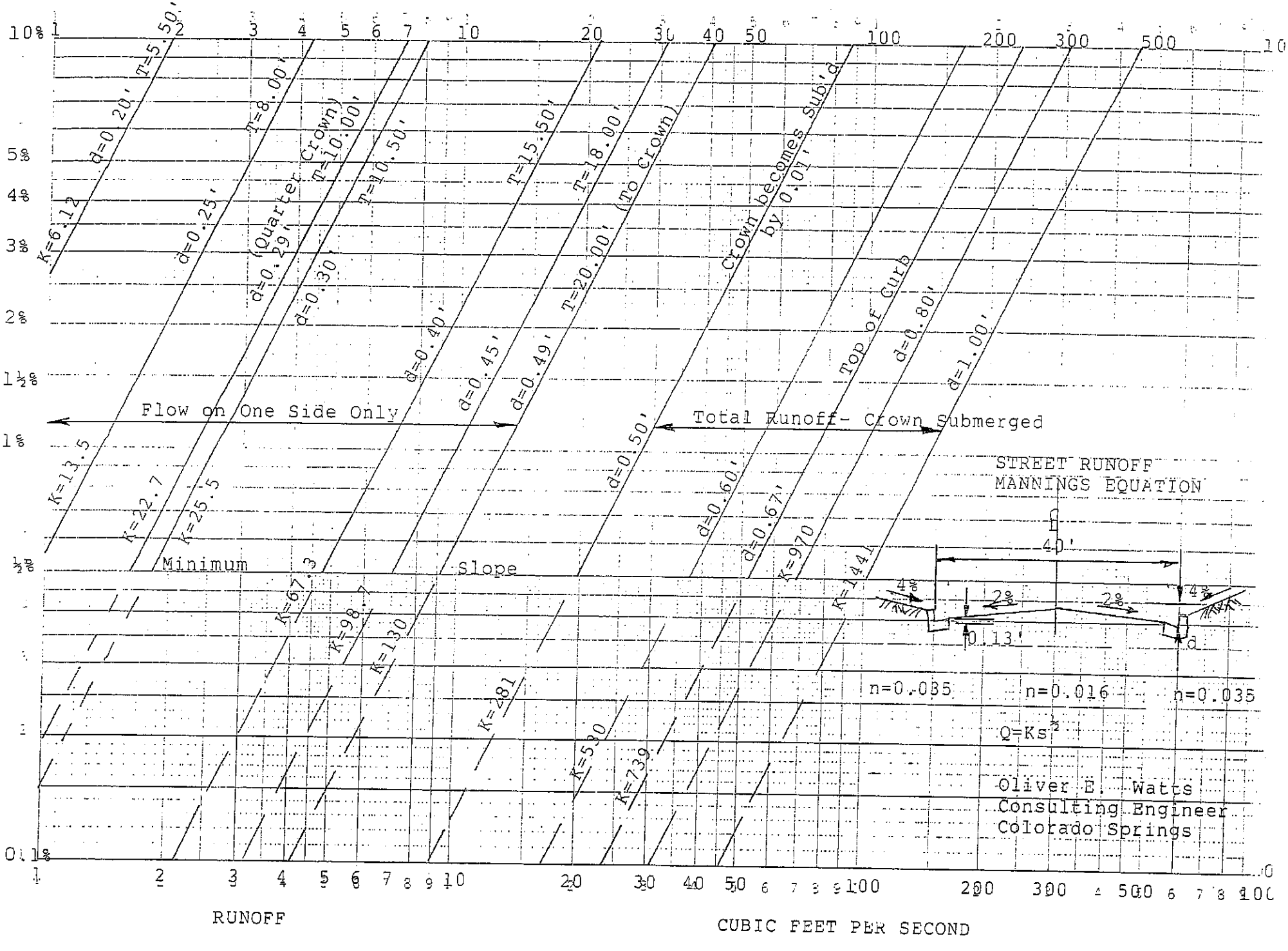
Rainfall Depth - Duration - Frequency Table derived from Rainfall Atlas III for Colorado
Resource: Guo, James C.Y., (2001) "Urban Storm Water Modeling", Chapter 5: Runoff Prediction for Small Catchment, published by Auraria Campus Book Company, University of Colorado at Denver, Denver, Colorado.

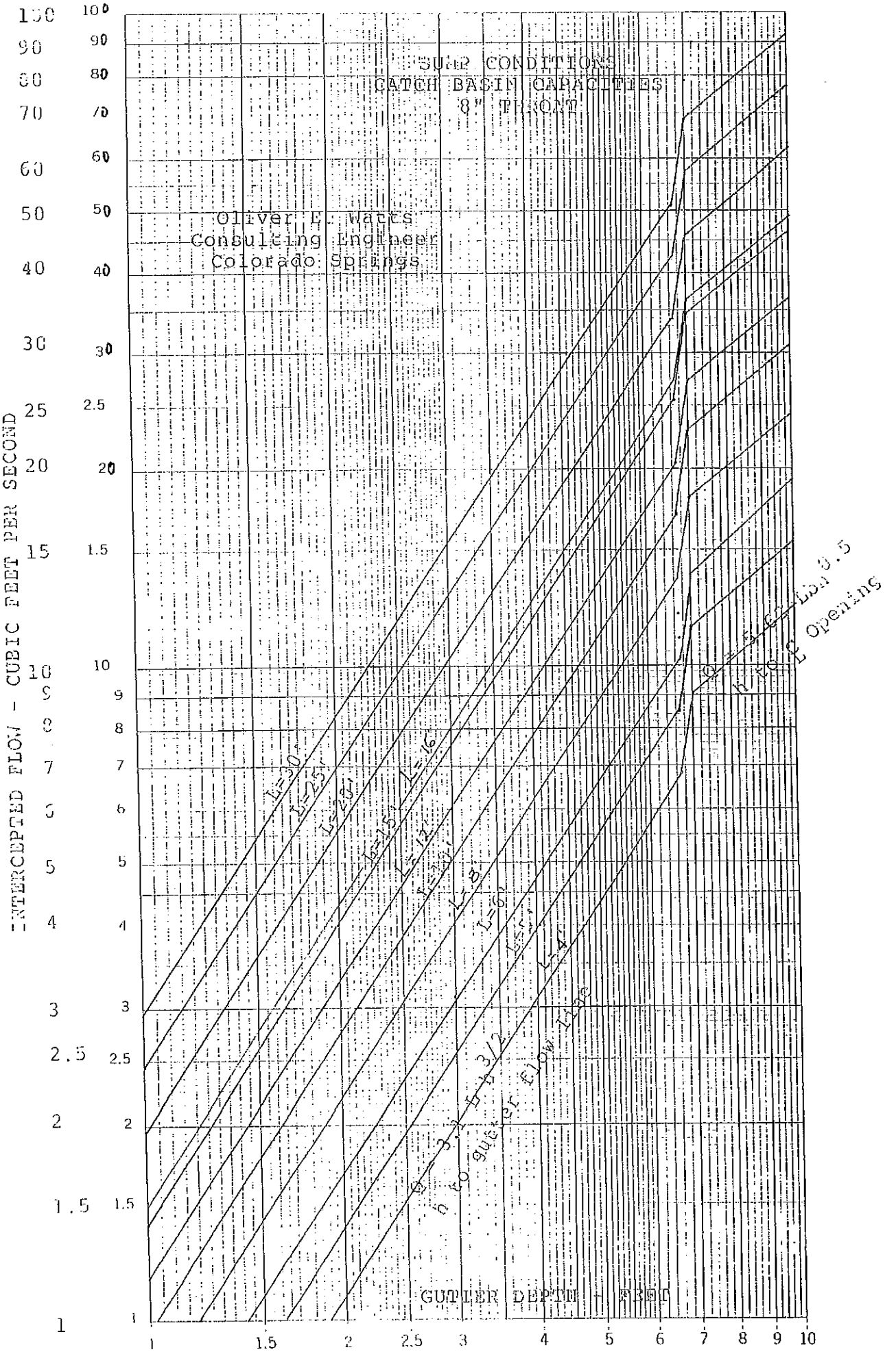
TABLE 6-1

Allowable Use of Roads and Streets

Street Classification	Use of Streets for Initial and Major Storms		Cross Flow In Streets For Initial and Major Storms	
	Initial Storm	Major Storm	Initial Storm	Major Storm
Hillside Residential (Less Than 32' F/C to F/C)	No curb over-topping, maximum street flow = 25 cfs, whichever is most limiting.	Same as Type A (Local/ Residential) below.	Same as Type A (Local/ Residential) below.	Same as Type A (Local/ Residential) below.
Type A (Local/Residential)	No curb overtopping, flow may spread to crown of street or top of curb, whichever is the most limiting.	Residential dwellings, public, commercial and industrial buildings shall not be inundated at the ground line. The depth of water at the gutter flow line shall not exceed 12 inches.	6 inches of depth in cross pan or gutter flow line	12 inches of depth at gutter flow line
Type A (Local with Roadside Ditch)	Flow must not encroach upon street shoulder area.	Residential dwellings, public, commercial and industrial buildings shall not be inundated at the ground line. The depth of flow shall not exceed 6 inches at the shoulder.	Requires culvert. Flow shall not encroach upon street shoulder.	Requires culvert, depth of flow shall not exceed 6 inches at the street shoulder.
Type B (Collector or Minor Arterial)	No curb over-topping. Flow spread must be limited to a maximum 20 foot spread from each curb face.	Same as Type A (Local/ Residential) above.	Where cross pans are allowed, depth of flow shall not exceed 6 inches at flow line	12 inches of depth at gutter flow line
Type B (Collector or Minor Arterial with Roadside Ditch)	Flow must not encroach upon street shoulder area.	Same as Type A (Local with Roadside Ditch) above.	Requires culvert. Flow shall not encroach upon street shoulder.	Requires culvert. Depth of flow shall not exceed 6 inches at the street shoulder.
Type C (Arterial)	No curb overtopping. Flow may encroach only onto one outside lane in each direction and must leave at least one 12 foot lane free of water in each direction.	Residential dwellings, public, commercial and industrial buildings shall not be inundated at the ground line. The depth of water shall not exceed 8 inches at the gutter flow line with no curb overtopping.	No allowable cross flow	No allowable cross flow
Type C (Arterial with Roadside Ditch)	Flow must not encroach upon street shoulder.	Residential dwellings, public, commercial and industrial buildings shall not be inundated at the ground line. Depth of flow shall not encroach upon street shoulder.	Requires culvert. Flow shall not encroach upon street shoulder.	Requires Culvert. Depth of flow shall not encroach upon street shoulder
Type D (Highway/Freeway)	No encroachment is allowed on any traffic lanes.	No encroachment on any traffic lanes.	No allowable cross flow	No allowable cross flow


STREET CAPACITIES
STREET SLOPE %
RUNOFF IN CUBIC FEET PER SECOND
Runoff on One Side of Street Only
Total Runoff- Crown Submerged
THIS PART OF CHART NOT USABLE
MINIMUM
(Max. Criteria, Q100)
(TOP OF CURB)
(Crown is Submerged)
K=6.12, d=0.20', T=5.50'
T=8.00'
T=10.50'
T=13.00'
T=15.50'
T=16.00' (Crown)
T=32.00'
T=38.50'
T=40.25'
d=0.25'
d=0.30'
d=0.35'
d=0.40'
d=0.41'
d=0.45'
d=0.50'
d=0.55'
d=0.60'
d=0.67'
d=0.80'
d=1.00'
K=13.5
K=25.48
K=43.13
K=67.28
K=72.96
K=145.9
K=237.1
K=299.7
K=402.8
K=499.4
K=696.2
K=1084
K=2085
32'
4%
2%
0.13'
n=0.035
n=0.016
n=0.035
MANNINGS EQUATION
Q=KS½
Oliver E. Watts
Consulting Engineer
Colorado Springs


STREET RUNOFF
MANNINGS EQUATION
Flow on One Side Only
Total Runoff- Crown Submerged
Minimum Slope
Top of Curb
Crown becomes Sub'd by 0.01'
(Quarter Crown)
(To crown)
d=0.20' T=5.50'
d=0.25' T=8.00'
d=0.29' n=10.00'
d=0.30' T=10.50'
d=0.40' T=15.50'
d=0.45' T=18.00'
d=0.49' T=20.00'
d=0.50'
d=0.60'
d=0.67'
d=0.80'
d=1.00'
K=6.12
K=13.5
K=22.7
K=25.5
K=67.3
K=98.7
K=130
K=181
K=530
K=739
K=970
K=1441
40'
4%
2%
2%
4%
0.13'
d
n=0.035
n=0.016
n=0.035
Q=Ks^½
Oliver E. Watts
Consulting Engineer
Colorado Springs
RUNOFF
CUBIC FEET PER SECOND


SUMP CONDITIONS
CATCH BASIN CAPACITIES
8" THICK
Oliver E. Watts
Consulting Engineer
Colorado Springs
INTERCEPTED FLOW - CUBIC FEET PER SECOND
GUTTER DEPTH - FEET
L=30'
L=25'
L=20'
L=15'
L=10'
L=8'
L=6'
L=4'
Q = 3.3 L h 3/2 Gutter Flow Inlets
Q = 5.4 A h 1/2 Depressed Curb Opening

$$Q=\frac{0.463}{n} D^{8/3} S^{1/2} \qquad Q=KS^{1/2}$$

AMETER -IN.-	AREA -FT2-	D 8/3 -FT-	K			
			N=0.010	N=0.013	N=0.024	N=0.026
2	0.02182	0.008413	0.3895	---	---	---
4	0.08727	0.053420	2.4733	---	---	---
6	0.19630	0.157500	7.2922	5.609	---	---
8	0.34910	0.339200	15.7050	12.081	---	---
10	0.54540	0.615000	28.4745	21.903	---	---
12	0.78540	1.000000	46.3000	35.615	---	---
15	1.22720	1.813100	83.9465	64.574	---	---
18	1.76710	2.948300	136.5100	105.000	56.88	52.50
21	2.40530	4.447400	205.9100	158.400	85.80	79.20
24	3.14160	6.349600	293.9900	226.140	122.49	113.07
27	3.97610	8.692700	402.4700	309.590	167.70	154.79
30	4.90870	11.512600	533.0300	410.030	222.10	205.02
33	5.93960	14.844100	---	528.680	---	---
36	7.06860	18.720800	866.7700	666.700	361.20	333.30
39	8.29580	23.175100	---	825.400	---	---
42	9.62110	28.238900	---	1005.000	544.80	502.50
48	12.56640	40.317500	---	1436.000	777.80	718.00
54	15.90430	55.195000	---	1966.000	1065.00	983.00
60	19.63500	73.100400	---	2604.000	1410.00	1302.00
66	23.75830	94.254200	---	3357.000	1818.00	1678.00
72	28.27430	118.869400	---	4234.000	2293.00	2117.00
78	33.18310	147.152900	---	5241.000	2839.00	2620.00
84	38.48450	179.306000	---	6386.000	3459.00	3193.00
90	44.17860	215.524500	---	7676.000	4158.00	3838.00
96	50.26550	256.000000	---	9118.000	4939.00	4559.00
108	63.61730	350.466600	---	12480.000	6761.00	6140.00
120	78.53980	464.158900	---	16530.000	8954.00	8265.00

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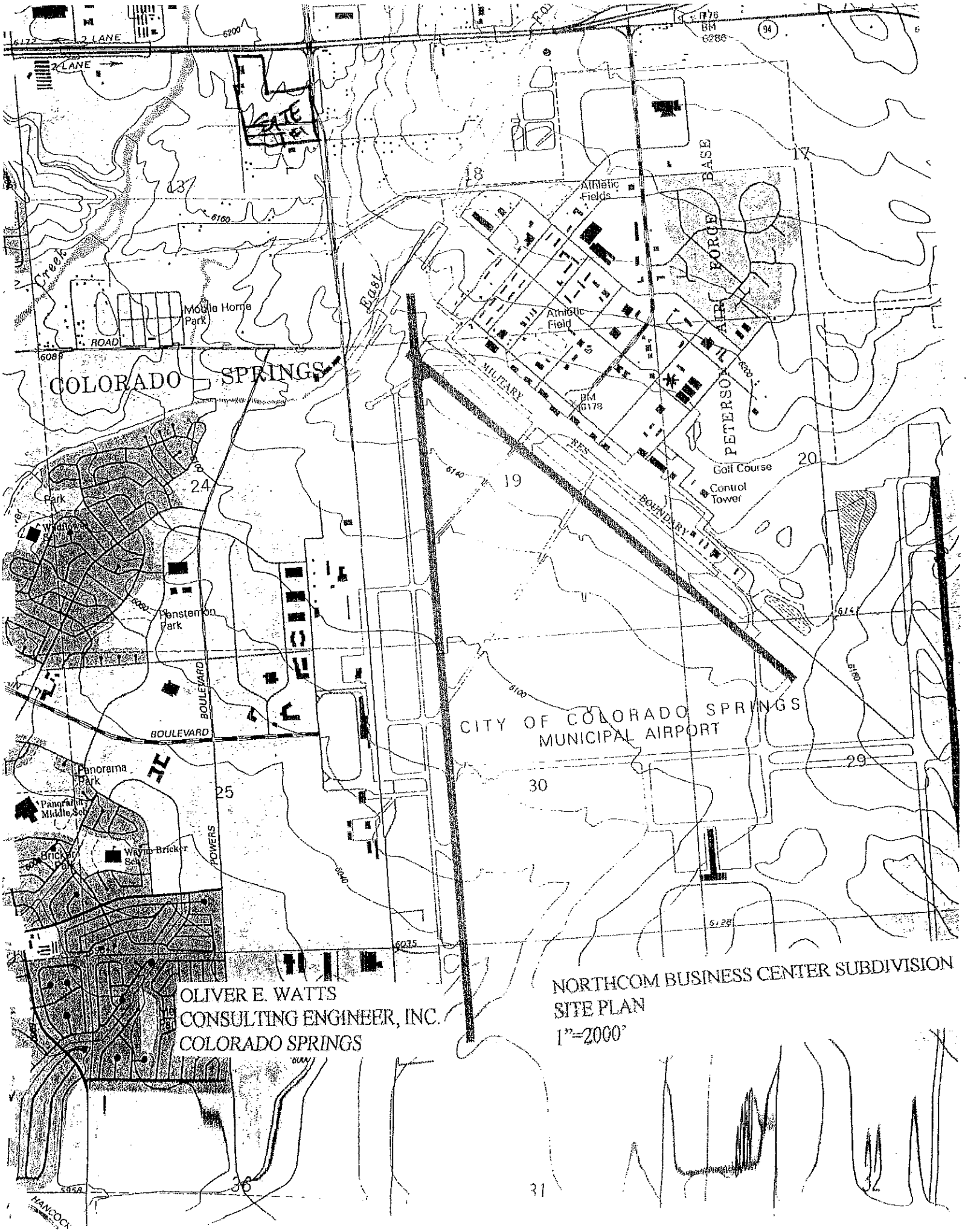
Consulting Enginee
Colorado Springs



OLIVER E. WATTS
CONSULTING ENGINEER, INC.
COLORADO SPRINGS

NORTHCOM BUSINESS CENTER SUBDIVISION
SITE PLAN
1"=2000'

300 0 300 600 900

Scale 1" = 300'

N

H5 H4 H3 H2 H1

48" RCP S=1.18% MIN.
48" RCP S=0.85% MIN.
48" RCP S=0.67% MIN.
36" RCP S=1.6% MIN.
36" RCP S=0.95% MIN.
24" RCP S=1.4% MIN.

9.3/16.9
8.7/15.5
8.2/15.
7.6/13.8
2-6'D-10R
6.7/11.
3.5/64.4
2-5'D-10R
153/212
141/262
8'D-10R
99.3/182
7.4/139
22.4/42.4
20.8/39.3
13.2/80.6
129.6/539
EXISTING RIPRAP INLET CHANNEL
EXIST. 8'X4' CBC TO BE ABANDONED PER PATRIOT PARK DRAINAGE
S PINYON BLVD
H PINYON BLVD
STEWART AVE
H POWERS BLVD
E PLATTE AVE

LEGEND:

10.5/20.4 RUNOFF IN CFS 5-YEAR/100-YEAR

A LIMIT OF DRAINAGE BASIN AND DESIGNATION

EXISTING STORM SEWER AS LABELED

PROPOSED STORM SEWER AS LABELED

LIMIT OF SOILS TYPE AND GROUP

DRAWN BY: O.E. WATTS DATE: 1-31-06 DWG. NO.: 05-3717-05A TOPOGRAPHY BY CITY FIMS	REVISIONS 11-29-06 CITY COMMENTS DEW	OLIVER E. WATTS CONSULTING ENGINEER COLORADO SPRINGS	PROJECT DEFENCE OFFICE PARK S13, T.14S., R.66W. 6TH P.M. COLORADO SPRINGS	SHT. NAME AREA DRAINAGE MAP	SHT. NO. 1 OF 1