A CULVERT DESIGN STUDY
FOR
GENEVA COMPANY

FOR
ACCESS TO PT. LOT 18
DUES SUBDIVISION

UNION TOWNSHIP
BUTLER COUNTY, OHIO

A
CULVERT DESIGN STUDY
FOR
GENEVA INVESTMENT CO.

1/20/94

SUBMITTED BY:
DAN E. ANTENEN
OHIO REG. ENGR. #21804
Dan E. Antenen
1/20/94

GENEVA ACCESS CULVERT STUDY

EXHIBIT A — PROPERTY LOCATION

EXHIBIT B — GENEVA ACCESS CULVERT LOCATION

EXHIBIT C — DRAINAGE AREA
- C-1 — Location
- C-2 — Sub-area divisions
- C-3 — Location of major tributary points and significant culverts.
- C-4 — Elevations & sizes of ex'g culverts

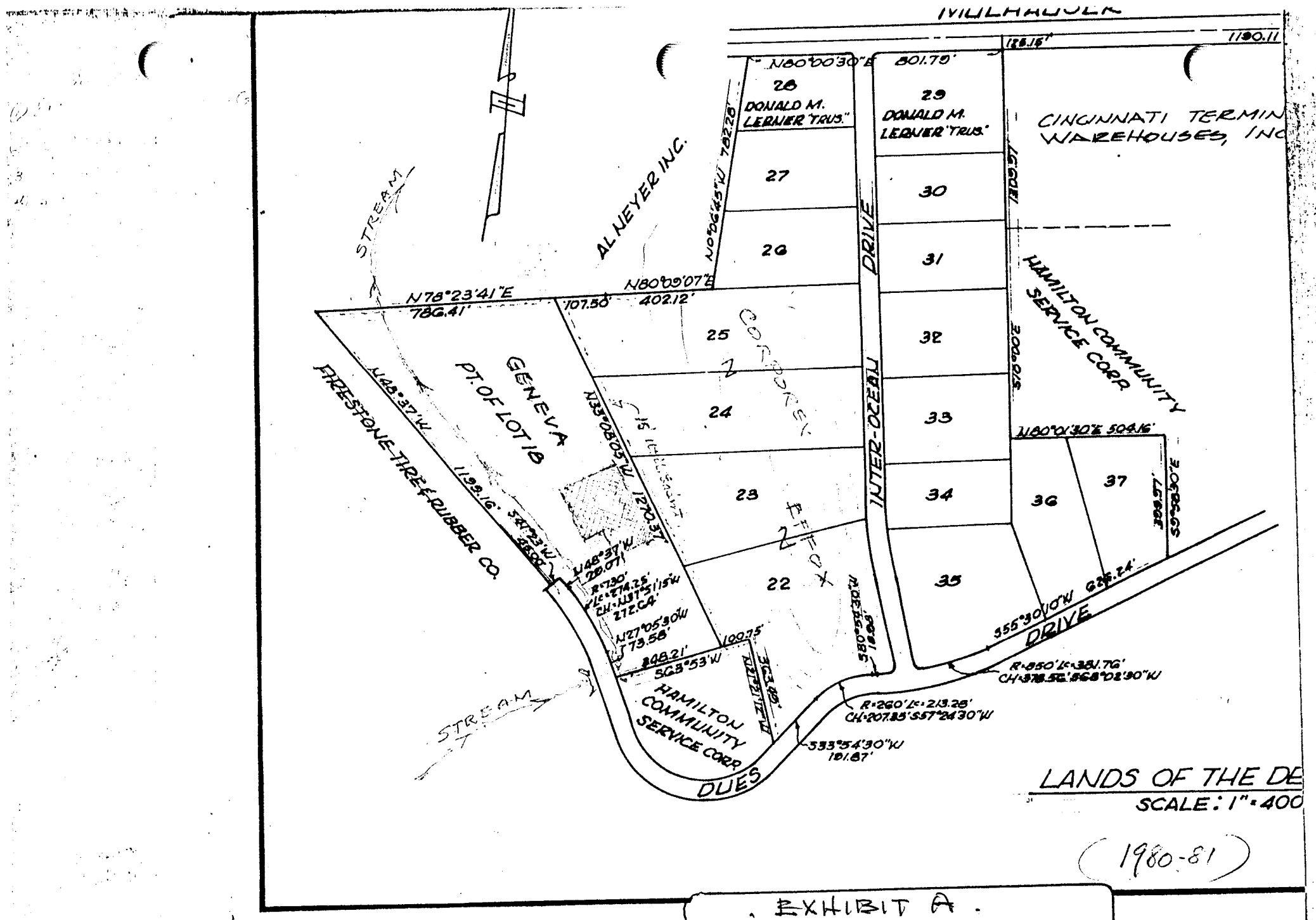
EXHIBIT D — TOTAL DISCHARGE BY TAB. HYDROGRAPH METH

(Computer Sheets)
- Sub-area selection and summary -
- T_c & T_t thru Sub-area Computation -
- Sub-area contrib'n & total disch'g at outlet

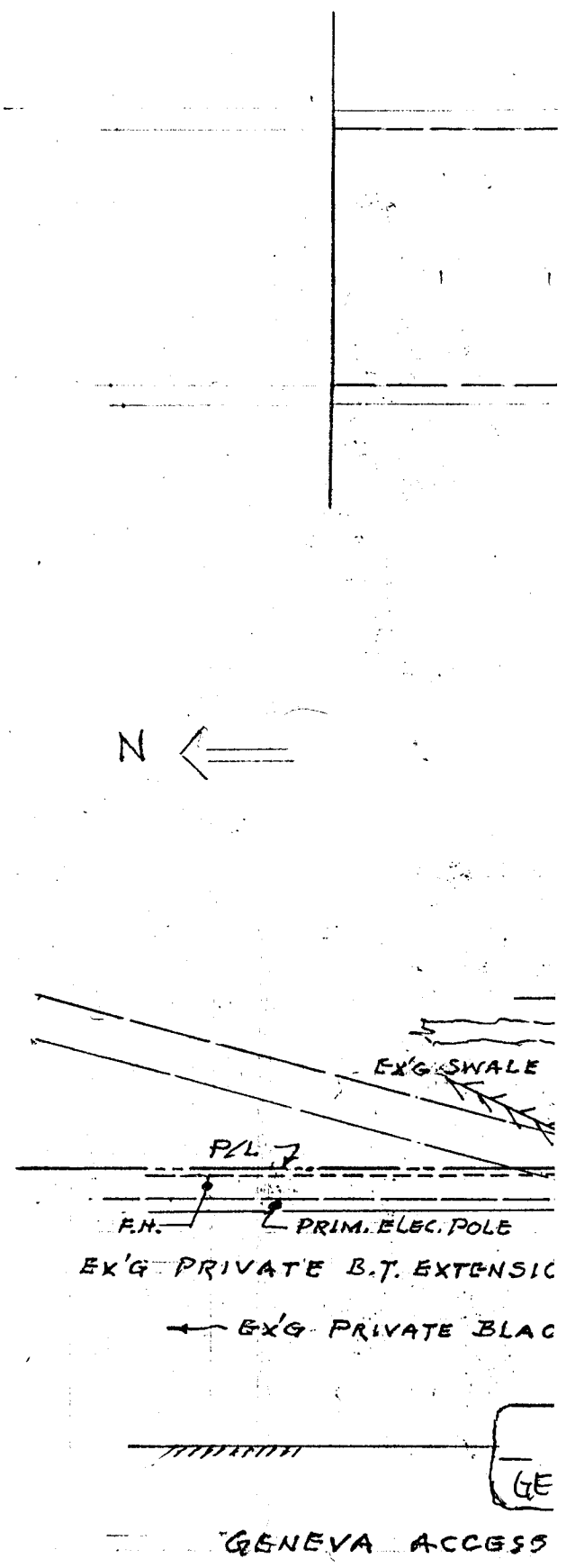
EXHIBIT E — CULVERT SELECTION FOR SITE "C"
- E-1 — Comparison of existing culvert capacities
- E-2 — Estimates of stream high water flow slope and allowable head losses.
- E-3 — Flows moderated by ex'g conditions
- E-4 — Selection of proposed Geneva Access culvert.

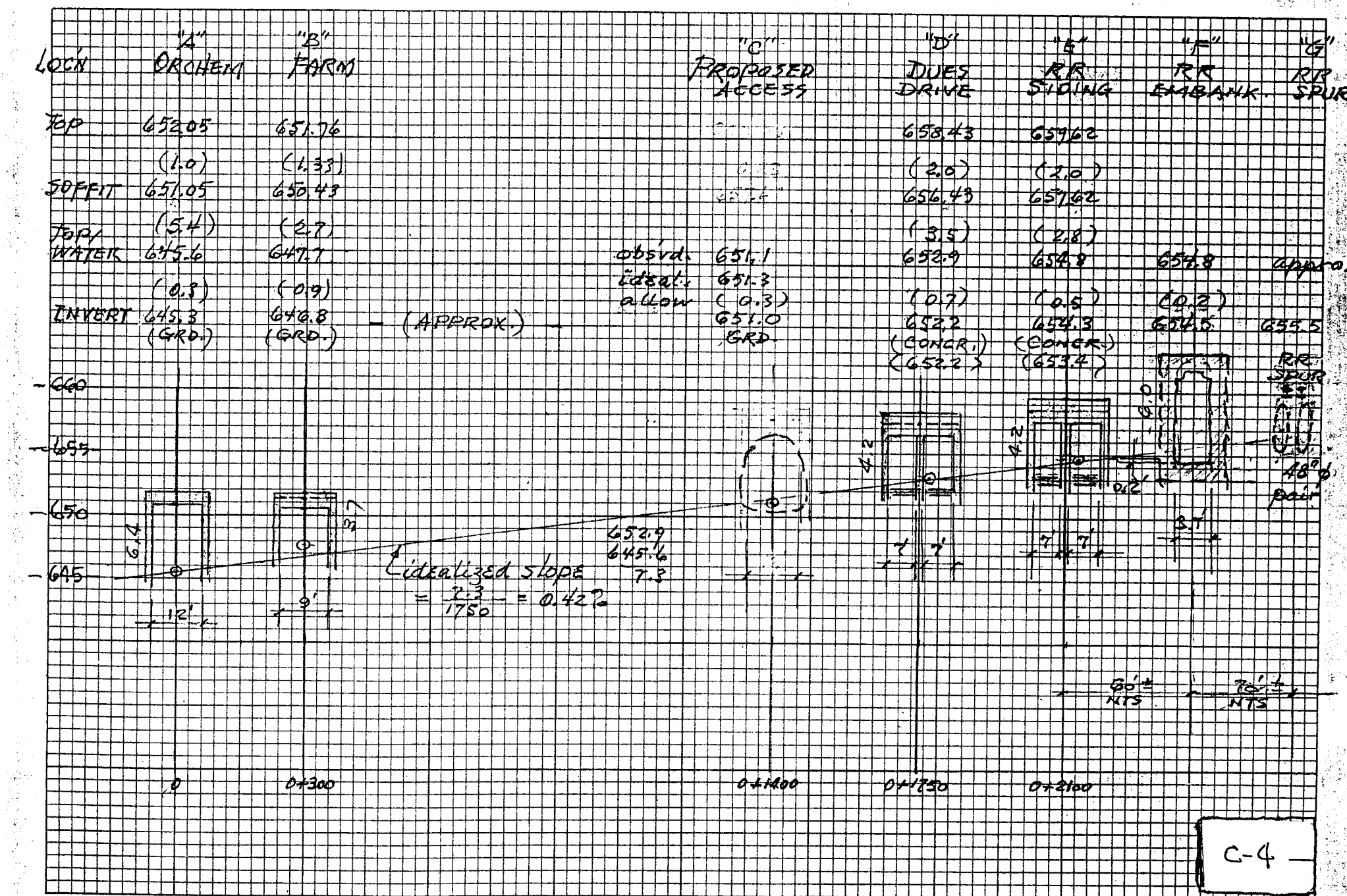
EXHIBIT ( ) (SPECIFICATION SHEET) not provided
( ) (CONSTRUCTION DETAILS) not provided

GENEVA COMPANY LS
c/o DAN E. ANTENEN
1391 NEW LONDON RD
HAMILTON, OH, 45013
tel. 868-1288



. EXHIBIT A .
PROPERTY LOCATION


N
EX'G SWALE
P/L 7
F.H.
PRIM. ELEC. POLE
EX'G PRIVATE B.T. EXTENSIC
EX'G PRIVATE BLAC
GE
GENEVA ACCESS



C-4

PLOTTED FROM SURVEY NOTES OF 11/28/93 (STRUCTURES) AND 12/22/93 (ELEVATIONS)

⊙ = WATER LEVEL

TR-55 CURVE NUMBER COMPUTATION VERSION 1.11

:t : GENEVA ACCESS User: DAN Date: 01-15-94
County : Butler State: OH Checked: ____ Date: _____
Subtitle: Culvert Study
Subarea : 1

COVER DESCRIPTION		Hydrologic Soil Group A	B	C	D
			Sq miles (CN)		
OTHER AGRICULTURAL LANDS					
Woods	good	-	.13(55)	-	-
Total Area (by Hydrologic Soil Group)			.13		

SUBAREA: 1 TOTAL DRAINAGE AREA: .13 Sq miles WEIGHTED CURVE NUMBER:55

EXHIBIT D
BATCH OF COMPUTER SHEETS

TR-55 CURVE NUMBER COMPUTATION VERSION 1.11

t : GENEVA ACCESS User: DAN Date: 01-15-94
County : Butler State: OH Checked: ____ Date: _____
Subtitle: Culvert Study
Subarea : 2

COVER DESCRIPTION	Hydrologic Soil Group A	B	C	D
		Sq miles (CN)		
OTHER AGRICULTURAL LANDS				
Brush - brush, weed, grass mix good	-	.07(48)	-	-
Total Area (by Hydrologic Soil Group)		.07		

SUBAREA: 2 TOTAL DRAINAGE AREA: .07 Sq miles WEIGHTED CURVE NUMBER:48

TR-55 CURVE NUMBER COMPUTATION VERSION 1.11

t : GENEVA ACCESS User: DAN Date: 01-15-94
County : Butler State: OH Checked: ____ Date: _____
Subtitle: Culvert Study
Subarea : 3

COVER DESCRIPTION	Hydrologic Soil Group A	B	C	D
		Sq miles (CN)		
FULLY DEVELOPED URBAN AREAS (Veg Estab.)				
Open space (Lawns,parks etc.)				
Good condition; grass cover > 75%	-	.09(61)	-	-
Impervious Areas				
Paved parking lots, roofs, driveways	-	.03(98)	-	-
Total Area (by Hydrologic Soil Group)		.12		
		====		

SUBAREA: 3 TOTAL DRAINAGE AREA: .12 Sq miles WEIGHTED CURVE NUMBER:70

TR-55 CURVE NUMBER COMPUTATION VERSION 1.11

t : GENEVA ACCESS User: DAN Date: 01-15-94
County : Butler State: OH Checked: ____ Date: _____
Subtitle: Culvert Study
Subarea : 4

COVER DESCRIPTION		Hydrologic Soil Group A	B	C	D
			Sq miles (CN)		
FULLY DEVELOPED URBAN AREAS (Veg Estab.)					
Urban Districts	Avg % imperv				
Commercial & business	85	-	.04(92)	-	-
Total Area (by Hydrologic Soil Group)			.04		

SUBAREA: 4 TOTAL DRAINAGE AREA: .04 Sq miles WEIGHTED CURVE NUMBER:92

TR-55 CURVE NUMBER COMPUTATION VERSION 1.11

t : GENEVA ACCESS User: DAN Date: 01-15-94
County : Butler State: OH Checked: ____ Date: _____
Subtitle: Culvert Study
Subarea : 5

COVER DESCRIPTION	Hydrologic Soil Group A	B	C	D
		Sq miles (CN)		
OTHER AGRICULTURAL LANDS				
Brush - brush, weed, grass mix good	-	.07(48)	-	-
Total Area (by Hydrologic Soil Group)		.07		

SUBAREA: 5 TOTAL DRAINAGE AREA: .07 Sq miles WEIGHTED CURVE NUMBER:48

TR-55 CURVE NUMBER COMPUTATION VERSION 1.11

t : GENEVA ACCESS User: DAN Date: 01-15-94
County : Butler State: OH Checked: ____ Date: _____
Subtitle: Culvert Study
Subarea : 6

COVER DESCRIPTION	Hydrologic Soil Group A	B	C	D
		Sq miles (CN)		
OTHER AGRICULTURAL LANDS				
Brush - brush, weed, grass mix good	-	.04(48)	-	-
Total Area (by Hydrologic Soil Group)		.04		

SUBAREA: 6 TOTAL DRAINAGE AREA: .04 Sq miles WEIGHTED CURVE NUMBER:48

TR-55 CURVE NUMBER COMPUTATION VERSION 1.11

:t : GENEVA ACCESS User: DAN Date: 01-15-94
County : Butler State: OH Checked: ____ Date: _____
Subtitle: Culvert Study
Subarea : 7

COVER DESCRIPTION	Hydrologic Soil Group A	B	C	D
		Sq miles (CN)		
FULLY DEVELOPED URBAN AREAS (Veg Estab.)				
Open space (Lawns,parks etc.)				
Good condition; grass cover > 75%	-	.02(61)	-	-
Impervious Areas				
Paved parking lots, roofs, driveways	-	.02(98)	-	-
OTHER AGRICULTURAL LANDS				
Brush - brush, weed, grass mix good	-	.02(48)	-	-
Total Area (by Hydrologic Soil Group)		.06		

SUBAREA: 7 TOTAL DRAINAGE AREA: .06 Sq miles WEIGHTED CURVE NUMBER:69

TR-55 CURVE NUMBER COMPUTATION VERSION 1.11

ct : GENEVA ACCESS User: DAN Date: 01-15-94
County : Butler State: OH Checked: ____ Date: _____
Subtitle: Culvert Study
Subarea : 8

COVER DESCRIPTION		Hydrologic Soil Group A	B	C	D
			Sq miles (CN)		
FULLY DEVELOPED URBAN AREAS (Veg Estab.)					
Urban Districts	Avg % imperv				
Industrial	72	-	.09(88)	-	-
Total Area (by Hydrologic Soil Group)			.09		

SUBAREA: 8 TOTAL DRAINAGE AREA: .09 Sq miles WEIGHTED CURVE NUMBER:88

TR-55 CURVE NUMBER COMPUTATION VERSION 1.11

:t : GENEVA ACCESS User: DAN Date: 01-15-94
County : Butler State: OH Checked: ____ Date: _____
Subtitle: Culvert Study
Subarea : 9

COVER DESCRIPTION	Hydrologic Soil Group A	B	C	D
		Sq miles (CN)		
FULLY DEVELOPED URBAN AREAS (Veg Estab.)				
Open space (Lawns,parks etc.)				
Good condition; grass cover > 75%	-	.015(61)	-	-
OTHER AGRICULTURAL LANDS				
Brush - brush, weed, grass mix good	-	.055(48)	-	-
Total Area (by Hydrologic Soil Group)		.07		

SUBAREA: 9 TOTAL DRAINAGE AREA: .07 Sq miles WEIGHTED CURVE NUMBER:51

TR-55 CURVE NUMBER COMPUTATION VERSION 1.11

:t : GENEVA ACCESS User: DAN Date: 01-15-94
County : Butler State: OH Checked: ____ Date: _____
Subtitle: Culvert Study
Subarea : 10

COVER DESCRIPTION	Hydrologic Soil Group A	B	C	D
		Sq miles (CN)		
FULLY DEVELOPED URBAN AREAS (Veg Estab.)				
Open space (Lawns,parks etc.)				
Fair condition; grass cover 50% to 75%	-	.005(69)	-	-
Streets and roads				
Paved; curbs and storm sewers	-	.005(98)	-	-
OTHER AGRICULTURAL LANDS				
Brush - brush, weed, grass mix fair	-	.02(56)	-	-
Total Area (by Hydrologic Soil Group)		.03		

SUBAREA: 10 TOTAL DRAINAGE AREA: .03 Sq miles WEIGHTED CURVE NUMBER:65

TR-55 RUNOFF CURVE NUMBER COMPUTATION VERSION 1.11

User DANz >>>>> Identification Data <<<<< Date 01-15-94

Project GENEVA ACCESSzzzzzzzzzzzzzzzz County Butlerzzzzzzzzzzzzz State OH

Subtitle Culvert Studyzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz

>>>>> Subarea Selection and Summary <<<<<

Area Units (Acres,SqMi,Percent) S	Subareas	Accum. Sq miles	Weighted CN
Select appropriate Area	# 1 1zzzzz	0.130	55
Units (A,S, or P above).	# 2 2zzzzz	0.070	48
Then place cursor on line	# 3 3zzzzz	0.120	70
for desired subarea. Key	# 4 4zzzzz	0.040	92
in name, if blank, and	# 5 5zzzzz	0.070	48
press PgDn to bring up	# 6 6zzzzz	0.040	48
first land use-CN screen.	# 7 7zzzzz	0.060	69
Use PgUp and PgDn to	# 8 8zzzzz	0.090 0.62	88
loop through the land uses	# 9 9zzzzz	0.070	51
and F8 to return here.	#10 10zzzz z	0.030 0.72	65

F1Help F2Print F3Load F4Save F5DOS F6Zero

TR-55 Tc and Tt THRU SUBAREA COMPUTATION VERSION 1.11

:t : GENEVA ACCESS User: DAN Date: 01-15-94
County : Butler State: OH Checked: ___ Date: _____
Subtitle: Culvert Study

---------- Subarea #1 - 1 ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.88	300	.10	i					0.831
Shallow Concent'd		1000	.10	u					0.054
Open Channel		1000	.04		.08	48	24		0.047

Time of Concentration = 0.93*
=====

---------- Subarea #2 - 2 ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.88	300	.017	f					0.644
Shallow Concent'd		1100	.014	u					0.160

Time of Concentration = 0.80*
=====

---------- Subarea #3 - 3 ----------

Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.88	300	.04	e					0.297
Shallow Concent'd		300	.033	u					0.028
Shallow Concent'd		300	.033	p					0.023
Open Channel		1000	.025		.08	2	1		0.059

Time of Concentration = 0.41*
=====

Open Channel		1000	.025		.08	2	1		0.059

Travel Time = 0.06*
=====

* - Generated for use by TABULAR method

TR-55 Tc and Tt THRU SUBAREA COMPUTATION VERSION 1.11

:t : GENEVA ACCESS User: DAN Date: 01-15-94
County : Butler State: OH Checked: ____ Date: _____
Subtitle: Culvert Study

---------- Subarea #4 - 4 ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.88	300	.05	e					0.272
Open Channel		600	.05		.08	2	1		0.025
								Time of Concentration =	0.30*
									=====
Open Channel		600	.05		.08	2	1		0.025
								Travel Time =	0.03*
									=====

---------- Subarea #5 - 5 ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.88	300	.033	f					0.494
Shallow Concent'd		300	.033	u					0.028
Open Channel		2300	.014		.08	2	1		0.183
								Time of Concentration =	0.71*
									=====
Open Channel		2300	.014		.08	2	1		0.183
								Travel Time =	0.18*
									=====

---------- Subarea #6 - 6 ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.88	200	.067	f					0.269
Shallow Concent'd		200	.10	u					0.011
								Time of Concentration =	0.28*
									=====

---------- Subarea #7 - 7 ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.88	300	.04	f					0.458
Shallow Concent'd		300	.033	p					0.023
Open Channel		1400	.02		.08	2	1		0.093
								Time of Concentration =	0.57*
									=====
Open Channel		1400	.02		.08	2	1		0.093
								Travel Time =	0.09*
									=====

* - Generated for use by TABULAR method

TR-55 Tc and Tt THRU SUBAREA COMPUTATION VERSION 1.11

:t : GENEVA ACCESS User: DAN Date: 01-15-94
County : Butler State: OH Checked: ___ Date: _____
Subtitle: Culvert Study

---------- Subarea #8 - 8 ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.88	200	.05	f					0.303
Shallow Concent'd		1000	.05	p					0.061
Open Channel		1500	.02		.08	2	1		0.100
								Time of Concentration =	0.46*
									=====
Open Channel		1500	.02		.08	2	1		0.100
								Travel Time =	0.10*
									=====

---------- Subarea #9 - 9 ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.88	300	.033	e					0.321
Shallow Concent'd		800	.005	u					0.195
Open Channel		2700	.0003		.08	2	1		1.465
								Time of Concentration =	1.98*
									=====

---------- Subarea #10 - 10 ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.88	300	.1	i					0.831
Shallow Concent'd		800	.075	p					0.040
Open Channel		600	.0083		.08	2	1		0.062
								Time of Concentration =	0.93*
									=====
Open Channel		600	.0083		.08	2	1		0.062
								Travel Time =	0.06*
									=====

--- Sheet Flow Surface Codes ---

A Smooth Surface
B Fallow (No Res.)
C Cultivated < 20 % Res.
D Cultivated > 20 % Res.
E Grass-Range, Short
F Grass, Dense
G Grass, Burmuda
H Woods, Light
I Woods, Dense

--- Shallow Concentrated --- --- Surface Codes ---

P Paved
U Unpaved

Generated for use by TABULAR method

TR-55 Tc AND Tt THRU SUBAREA COMPUTATION VERSION 1.11

User DANz >>>>> Identification Data <<<<< Date 01-15-94

Project GENEVA ACCESS County Butlerzzzzzzzzzzzzzz State OH

Subtitle Culvert Study

>>>>> Subarea Selection and Summary<<<<<

	Subareas	Tc	Tt thru Subarea
Place cursor on line for	# 1 1	0.93	
desired subarea. Key in	# 2 2zzzzz	0.80	
name, if blank, and press	# 3 3zzzzz	0.41	0.06
PgDn to bring up Tc data	# 4 4zzzzz	0.30	0.03
entry screen. Use PgUp	# 5 5zzzzz	0.71	0.18
and PgDn to toggle between	# 6 6zzzzz	0.28	
Tc and Tt entry screens	# 7 7zzzzz	0.57	0.09
or F8 to return here.	# 8 8zzzzz	0.46	0.10
	# 9 9zzzzz	1.98	
	#10 10zzzz z	0.93	0.06

F1Help F2Print F3Load F4Save F5DOS F6Zero

EXHIBIT D
BATCH OF COMPUTER SHEETS

TR-55 TABULAR HYDROGRAPH METHOD VERSION 1.11

GENEVA ACCESS Butler,OH DAN 01-15-94
Culvert Study

>>>>> Subarea Data <<<<<

Subarea Name	Drainage Area (sq mi)	Runoff Curve Number	Time of Concen- tration (hrs)	Travel Thru Subarea (hrs)	Downstream Subarea Name	24-Hour Rain (in)	
1zzzzz	.13zz *	55 *	.93z *	zzzz	4zzzzz	4.8z	
2zzzzz	.07zz *	48 *	.8zz *	zzzz	3zzzzz	4.8z	
3zzzzz	.12zz *	70 *	.41z *	.06z *	8zzzzz	4.8z	
4zzzzz	.04zz *	92 *	.3zz *	.03z *	5zzzzz	4.8z	
z	.07zz *	48 *	.71z *	.18z *	zzzzzz	4.8z	
6zzzzz	.04zz *	48 *	.28z *	zzzz	7zzzzz	4.8z	
7zzzzz	.06zz *	69 *	.57z *	.09z *	8zzzzz	4.8z	
8zzzzz	.09zz *	88 *	.46z *	.1zz *	zzzzzz	4.8z	
9zzzzz	.07zz *	51 *	1.98 *	zzzz	zzzzzz	4.8z	
10zzzz	.03zz *	65 *	.93z *	.06z *	zzzzzz	4.8z	z

F1Help F2Print F3Load F4Save F5DOS F6Zero F7Compute F9RCN F10TCTT

TR-55 TABULAR HYDROGRAPH METHOD VERSION 1.11

User DAN >>>>> Identification Data <<<<< Date 01-19-94

Project GENEVA ACCESS County Butlerzzzzzzzzzzzzzz State OH

Subtitle Culvert Study at Access to Propertyzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz

>>>>> Basic Watershed Data <<<<<

Rainfall-Type (I,IA,II,III) II

Rainfall Frequency 25zz years

If constant rainfall over entire watershed, 24-Hour Rain 4.8z in.
(If rainfall varies by subarea enter on next screen.)

Interpolate hydrograph tables based on Ia/P ratio Y
(Enter Y for yes and N for no) z

F1Help F2Print F3Load F4Save F5DOS F6Zero F7Compute F9RCN F10TCTT

TR-55 TABULAR HYDROGRAPH METHOD VERSION 1.11

SUBAREA CONTRIBUTIONS AND TOTAL DISCHARGE (CFS) AT OUTLET

	Time									
Subarea	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8
1	0	0	0	0	1	2	5	9	14	19
2	0	0	0	0	0	1	2	3	5	6
3	9	16	32	60	92	112	106	88	67	51
4	8	13	24	45	74	91	84	66	48	35
5	0	0	0	0	1	3	5	7	8	8
6	0	0	0	1	3	5	6	6	5	4
7	3	5	9	17	30	41	48	46	40	32
8	18	29	53	96	146	166	159	126	93	71
9	0	0	0	0	0	0	1	1	2	2
10	1	1	1	2	3	5	8	11	13	14
TOTAL	39	64	119	221	350	426	424	363	295	242

Esc exit compute process is spy earlier
time Display
later

TOTAL DISCHARGE TO "C"
IS BY WAY OF "E" & "F"

GENEVA ACCESS — Comparison of Existing Culverts "G", "E", "D", "B", "A"

1/20/94
Culvert Calcs.
Sht. 1 of 4

Assume all flowing full, both ends submerged, H = Δ surface elevations, ft.
K_e = Entry loss coeff.
n = roughness coeff.
L = Length of culvert, ft.
R = A/P = flow cross-section / wetted perimeter, ft.
Flow Q = AV = Area × Vel. = cfs.

$$V = \sqrt{\frac{H}{\frac{(1+K_e)}{2g} + \frac{n^2 L}{2.21 R^{4/3}}}}$$

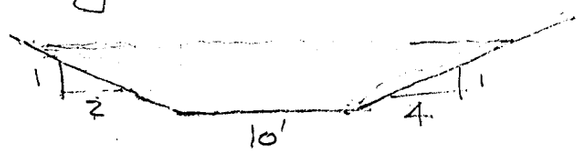
Culvert	H	A	P	R	$1+K_e$	$\frac{1+K_e}{2g}$	n	L	$R^{4/3}$	$\frac{n^2 L}{2.21 R^{4/3}}$	V^2	V	Q	REMARKS
"G"	1.5	2(12.6)	2(12.6)	1.0	1.50	0.023	.024	40	1.	0.010	45.5	6.75	170.	See Sht. 3
"E"	1.5	2(29.4)	2(22.4)	1.31	1.50	0.023	.013	20	1.43	0.001	62.5	7.91	465.	clogged 25% now
"D"	1.5	2(29.4)	2(22.4)	1.31	1.50	0.023	.013	40	1.43	0.002	60.0	7.75	455.	clogged 25% now
"B"	1.5	32.4	25.4	1.28	1.50	0.023	.025	10	1.39	0.002	60.0	7.75	251.	debris @ 1' over soffit
"A"	1.5	76.8	36.8	2.09	1.50	0.023	.013	60	2.67	0.002	60.0	7.75	595.	new culvert clean!
										add'l areas contribution			100.±	
													495	

E-1

GENEVA ACCESS.

1/20/94
Culvert Calcs.
Sht. 2 of 4

What general water surface slope would accommodate a flow of 426 cfs in an earthen channel of the following approx. configuration?:



$$V = \frac{(1.49) R^{2/3} S^{1/2}}{n}$$

$$\sqrt{S} = \frac{n V}{(1.49) R^{2/3}}$$

Trial Depth	A	P	R	n	V	$R^{2/3}$	$\sqrt{S}$	S
5'	125	41.8	3.0	0.05	3.4	2.08	.0549	0.003
5'				0.04			.0439	0.002
5'				0.03			.0329	0.001
4.5'	106	38.6	2.75	0.05	4.02	1.96	.0688	0.005
4.5'				0.04			.0550	0.003
4.5'				0.03			.0413	0.002

Comment

The general slope of the stream bed was determined by survey (see Exhibit) to be approx — 0.0042.

If stream flow demand is — 0.0020

Balance avail. for head losses = 0.0022

Length of waterway = 2100 ft.

Head avail. for 5 culverts = 4.62 ft.

Avg. available per culvert = 0.92

Say 1. ft.

Since pipe flow velocities are $\sim \sqrt{H}$, capacities calculated on sht. 1 can be reworked by $\sqrt{\frac{1}{1.5}} = \sqrt{.67} = 0.82 \times$ calc. values

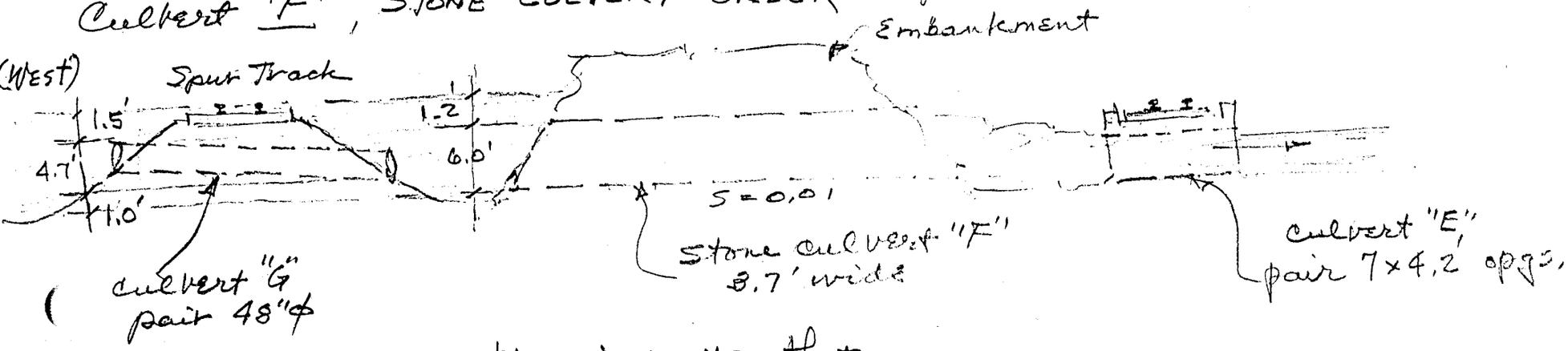
("G" head is not involved) "E" ÷ "D" ÷ 460 cfs.

× 0.82

377 cfs. probable exemplary culvert flow.

E-2

Culvert "F", STONE CULVERT UNDER B & O RR.



Washout of ballast and ties indicates that in recent hydrologic time the spur track was topped. Since the track is nearly level, culvert capacity at moment of topping was as per calc. on sht. E-1 = 170 cfs.

Flow thru "F":
Practically pipe flow, but reduce to $H_{\text{above opg}} = (1 + K_e)\frac{v^2}{2g}$

If $K_e = 0.5$,
$v = 6.5\sqrt{H}$

H	v	A	Q
1.2	7.1	22.2	158 cfs
2.2	9.6		214
3.2	11.6		258
4.2	13.3		296

Range of max. expectations based on ponding upstream of B&O (C&O) RR culvert

1/20/94
Culvert Calcs.
Sht. 4 of 4

· See TABULAR HYDROGRAPH EXHIBITS

Max. discharge expected at culvert location = 426 cfs.

max. upstream elev. = use 657.5 − (350 × .002) = 656.8 (0.7)

min downstream elev. = use Orchem soffit plus 1 ft. plus (1400' × .002)
= 651.1 + 1.00 + 2.80 = 654.8

avg. base el. = 650.7

(not flowing full except just inside entry, entrance shape to reduce $K_e = 0.3$)

rough estimate, $v \doteq \sqrt{\frac{2gH}{1+K_e}} \doteq \sqrt{\frac{(64.4)(2)}{1.3}} \doteq \sqrt{99} \doteq 9.95$ fps, a little high, $\Delta H = 2'$

reducing vel. to a lower value;
if $H = 1.5$ $v \doteq \sqrt{\frac{1.5}{2}} \times 9.95 \doteq 8.6$ fps.

Area req'd $= \frac{426}{8.6} = 49.5$ □' @ 4.6' of flow

Armco 10'-8" × 6'-11" − 5"×1" Pipe Arch should about meet this requir (Equiv φ = 9'-0" φ)

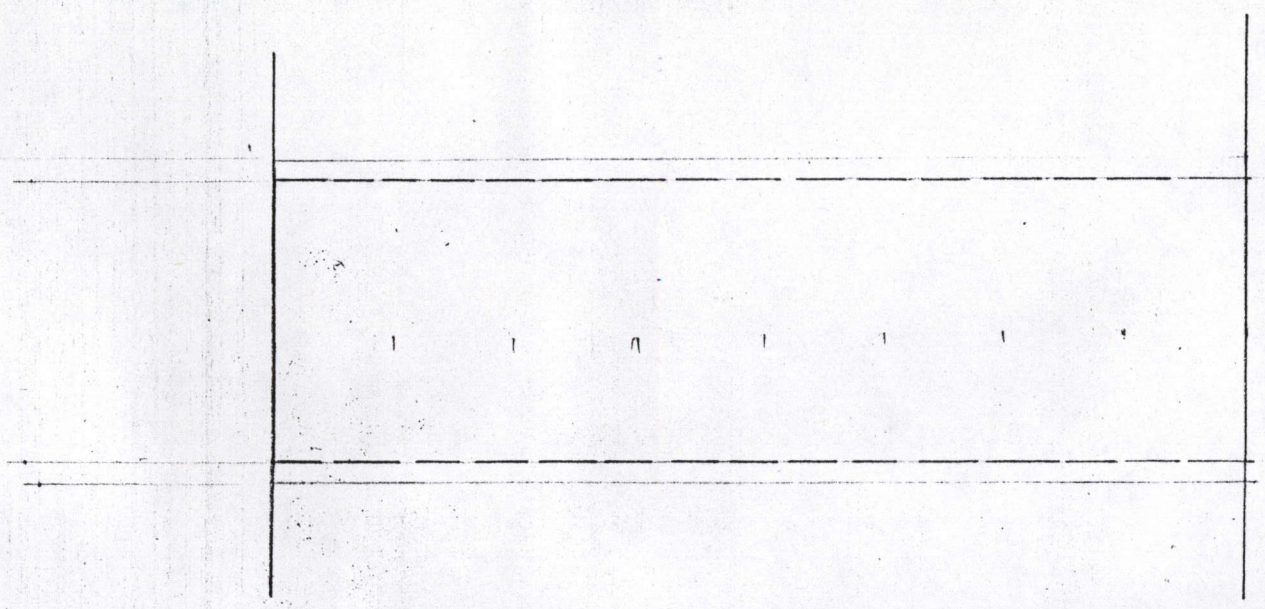
Have possibility of setting access road elev. w/ 27" of cover?

650.7
7.0 rise
2.25 cover
659.95 ± El. road surface

Barely ok −

Max. grade up to ℄ arch from ℄ intersn = 4%:
.04 × 40' = 1.60'
658.3
659.9

(Put culvert pipe on a slope of 0.0042)



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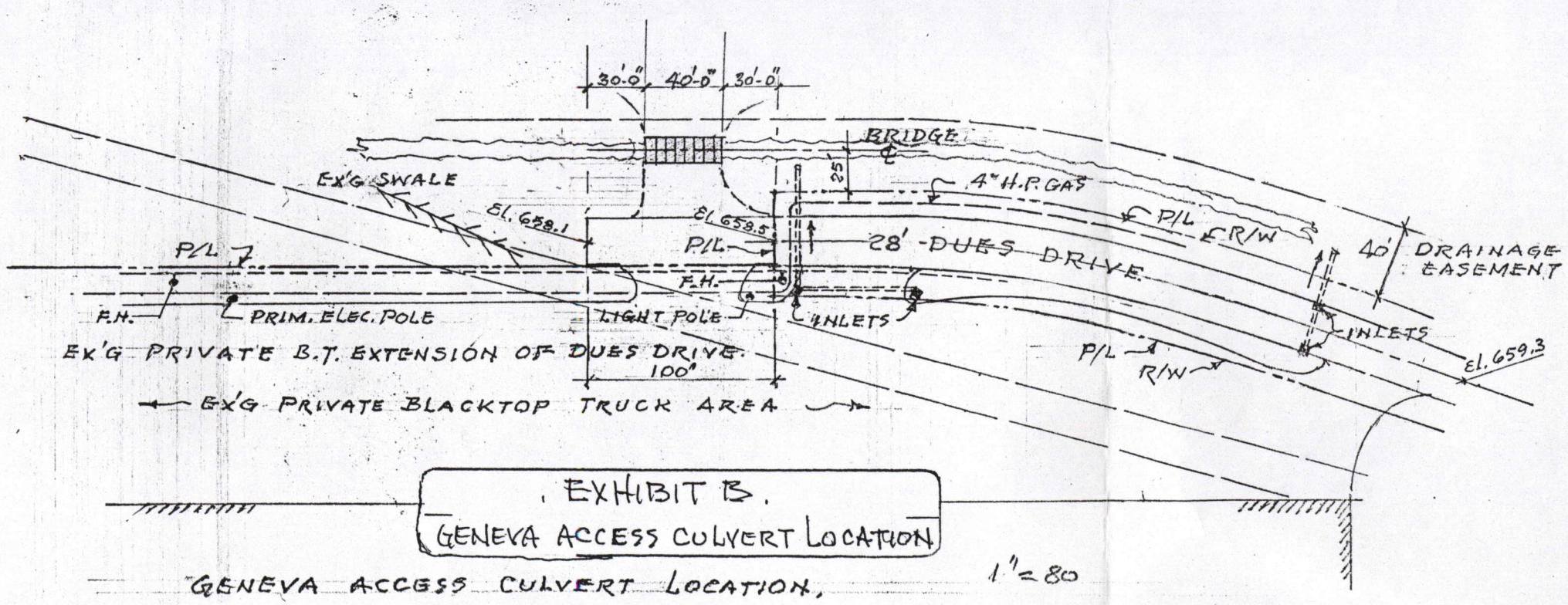
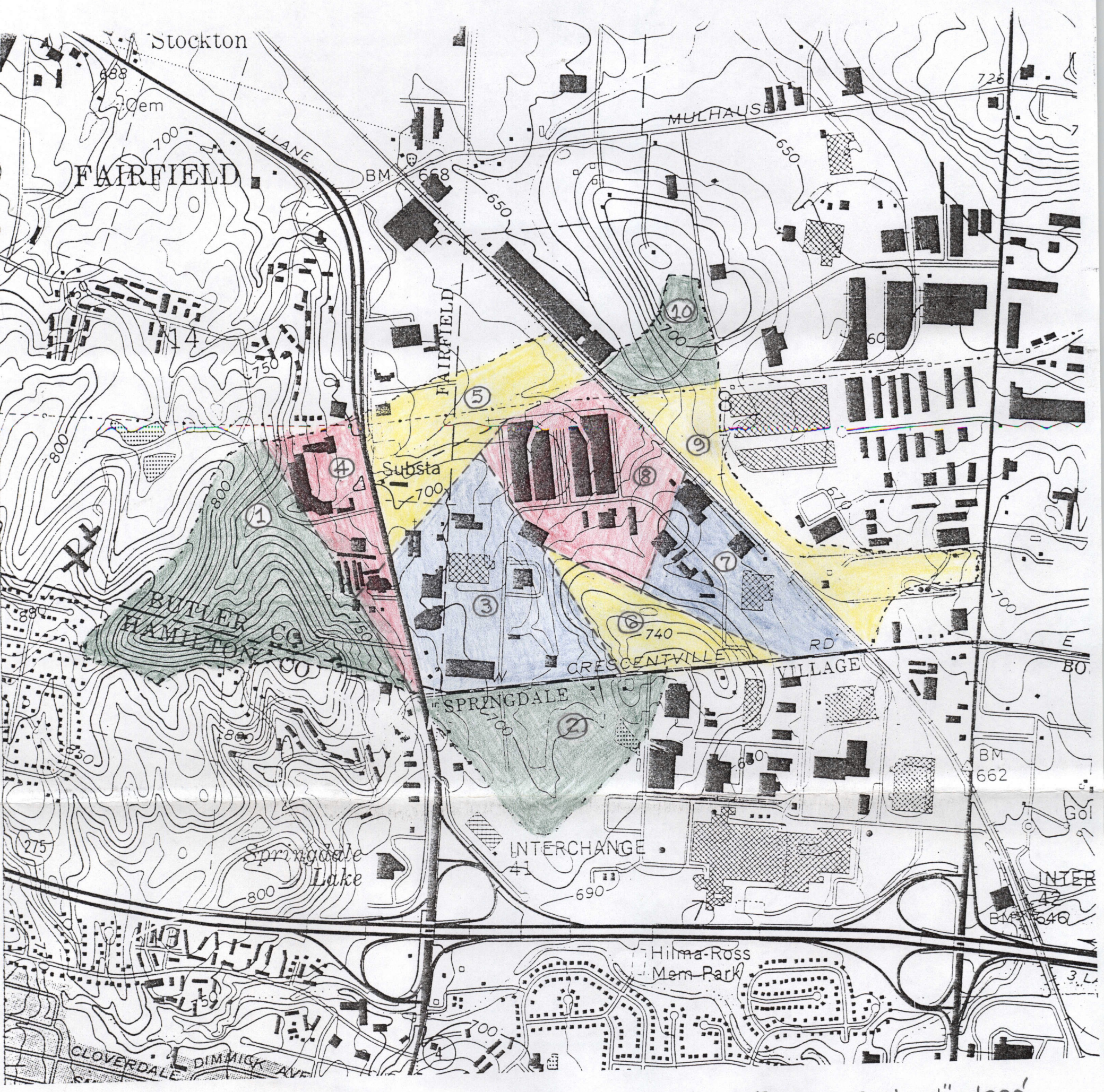


EXHIBIT B.
GENEVA ACCESS CULVERT LOCATION

GENEVA ACCESS CULVERT LOCATION, 1" = 80

1/20/94


Hamilton
Port Union
Rialto
Stockton
FAIRFIELD
Crescentville
SPRINGDALE
FOREST PARK
SPRINGFIELD
Glendale
Golf Course
Substation
Trailer Park
Tri-County Shopping Center
Arrowhead Golf Club
Pumping Sta
Water Tank
Heritage Hill Sch
Hilma-Ross Mem Park
Springdale Lake
Forest Dale Ch
Old St Marys Cem
Glenmary Mission Sch
OAK HILL CEMETERY
GLENDALE Park
Princeton Jr High Sch
Princeton High Sch
St Gabriels Sch
Glenview Sch
Cameron Park Sch
Bethany Sch
St Edmunds Camp
Filtration Plant
Substa
INTERCHANGE 16 AND 43
INTERCHANGE 42
INTERCHANGE 41
INTERCHANGE 15
INTERCHANGE 44
BUTLER CO
HAMILTON CO
MIDDLETOWN 20 MI.
HAMILTON (P.O.) 7 MI.
3.8 MI. TO U.S. 127
(GREENHILLS)
470 000 FEET
17'30"
LOCATION MAP FOR
GENEVA ACCESS
DRAINAGE AREA SHOWN IN YELLOW
C-1



APPROX. SCALE 1" = 1000'

ENLARGEMENT OF U.S.G.S. 1987 PHOTOREVISION
OF 1984 SURFACE FEATURES
GLENDALE, OHIO QUADRANGLE

C-2

TR-55 TABULAR DISCHARGE METHOD VERSION 1.11

Project : geneva bldg, drives genevabb User: dan Date: 01-31-94
County : butler State: oh Checked: ____ Date: _____
Subtitle:

Total watershed area: 0.005 sq mi Rainfall type: II Frequency: 25 years

---------- Subareas ----------

	bldg	drives	lawn
Area(sq mi)	0.00*	0.00*	0.00*
Rainfall(in)	4.8	4.8	4.8
Curve number	98*	98*	69*
Runoff(in)	4.56	4.56	1.81

TR-55 TABULAR HYDROGRAPH METHOD VERSION 1.11

SUBAREA CONTRIBUTIONS AND TOTAL DISCHARGE (CFS) AT OUTLET

	Time									
Subarea	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5
bldg	0	0	0	3	6	9	6	2	1	1
drives	0	0	0	3	6	9	6	2	1	1
lawn	0	0	0	0	1	1	1	1	0	0
TOTAL	0	0	0	6	13	19	13	5	2	2

File GENEVABB

~~Esc exit compute process~~ i s p l a y e a r l i e r
t i m e D i s p l a y
l a t e r t i m e

TR-55 TABULAR DISCHARGE METHOD VERSION 1.11

GENEVA 2C

Project : GENEVA ACCESS User: DAN Date: 01-19-94
County : Butler State: OH Checked: ____ Date: _____
Subtitle: Culvert Study

Total watershed area: 0.720 sq mi Rainfall type: II Frequency: 25 years

	Subareas				
	1	2	3	4	5
Area(sq mi)	0.13*	0.07*	0.12*	0.04*	0.07*
Rainfall(in)	4.8	4.8	4.8	4.8	4.8
		48*	70*	92*	48*

TR-55 TABULAR HYDROGRAPH METHOD VERSION 1.11

SUBAREA CONTRIBUTIONS AND TOTAL DISCHARGE (CFS) AT OUTLET

	Time									
Subarea	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8
1	0	0	0	0	1	2	5	9	14	19
2	0	0	0	0	0	1	2	3	5	6
3	9	16	32	60	92	112	106	88	67	51
4	8	13	24	45	74	91	84	66	48	35
5	0	0	0	0	1	3	5	7	8	8
6	0	0	0	1	3	5	6	6	5	4
7	3	5	9	17	30	41	48	46	40	32
8	18	29	53	96	146	166	159	126	93	71
9	0	0	0	0	0	0	1	1	2	2
10	1	1	1	2	3	5	8	11	13	14
TOTAL	39	64	119	221	350	426	424	363	295	242

File GENEVA 2C

Esc exit compute process is play earlier time later time Display

TR-55 Tc and Tt THRU SUBAREA COMPUTATION VERSION 1.11

Project : GENEVA ACCESS User: DAN Date: 01-19-94
County : Butler State: OH Checked: ____ Date: _____
Subtitle: Culvert Study

---------- Subarea #8 - 8 ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.88	200	.05	f					0.303
Shallow Concent'd		1000	.05	p					0.061
Open Channel		1500	.02		.08	2	1		0.100
								Time of Concentration =	0.46*
									=====
Open Channel		1500	.02		.08	2	1		0.100
								Travel Time =	0.10*
									=====

---------- Subarea #9 - 9 ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.88	300	.033	e					0.321
Shallow Concent'd		800	.005	u					0.195
Open Channel		2700	.0003		.08	2	1		1.465
								Time of Concentration =	1.98*
									=====

---------- Subarea #10 - 10 ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.88	300	.1	i					0.831
Shallow Concent'd		800	.075	p					0.040
Open Channel		600	.0083		.08	2	1		0.062
								Time of Concentration =	0.93*
									=====
Open Channel		600	.0083		.08	2	1		0.062
								Travel Time =	0.06*
									=====

--- Sheet Flow Surface Codes ---

A Smooth Surface
B Fallow (No Res.)
C Cultivated < 20 % Res.
D Cultivated > 20 % Res.
E Grass-Range, Short
F Grass, Dense
G Grass, Burmuda
H Woods, Light
I Woods, Dense

--- Shallow Concentrated --- Surface Codes ---

P Paved
U Unpaved

* - Generated for use by TABULAR method

TR-55 TABULAR DISCHARGE METHOD VERSION 1.11

Project : geneva bldg site dich genevabs User: dan Date: 01-31-94
County : butler State: oh Checked: ___ Date: _____
Subtitle: compare site runoff time to calculated hydrograph of geneva 2c

Total watershed area: 0.005 sq mi Rainfall type: II Frequency: 25 years

---------- Subareas ----------

	hill
Area(sq mi)	0.00*
Rainfall(in)	4.8
Curve number	57*
Runoff(in)	1.00

TR-55 TABULAR HYDROGRAPH METHOD VERSION 1.11

SUBAREA CONTRIBUTIONS AND TOTAL DISCHARGE (CFS) AT OUTLET

	Time									
Subarea	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8
hill	0	0	0	1	1	2	2	2	1	1

File GENEVABS

TR-55 Tc and Tt THRU SUBAREA COMPUTATION VERSION 1.11

Project : geneva bldg site dich genevabs User: dan Date: 01-31-94
County : butler State: oh Checked: ____ Date: _____
Subtitle: compare site runoff time to calculated hydrograph of geneva 2c

---------- Subarea #1 - hill ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.88	75	0.13	i					0.247
Sheet		130	0.06	h					0.300
Shallow Concent'd		175	0.03	u					0.017

Time of Concentration = 0.56*
=====

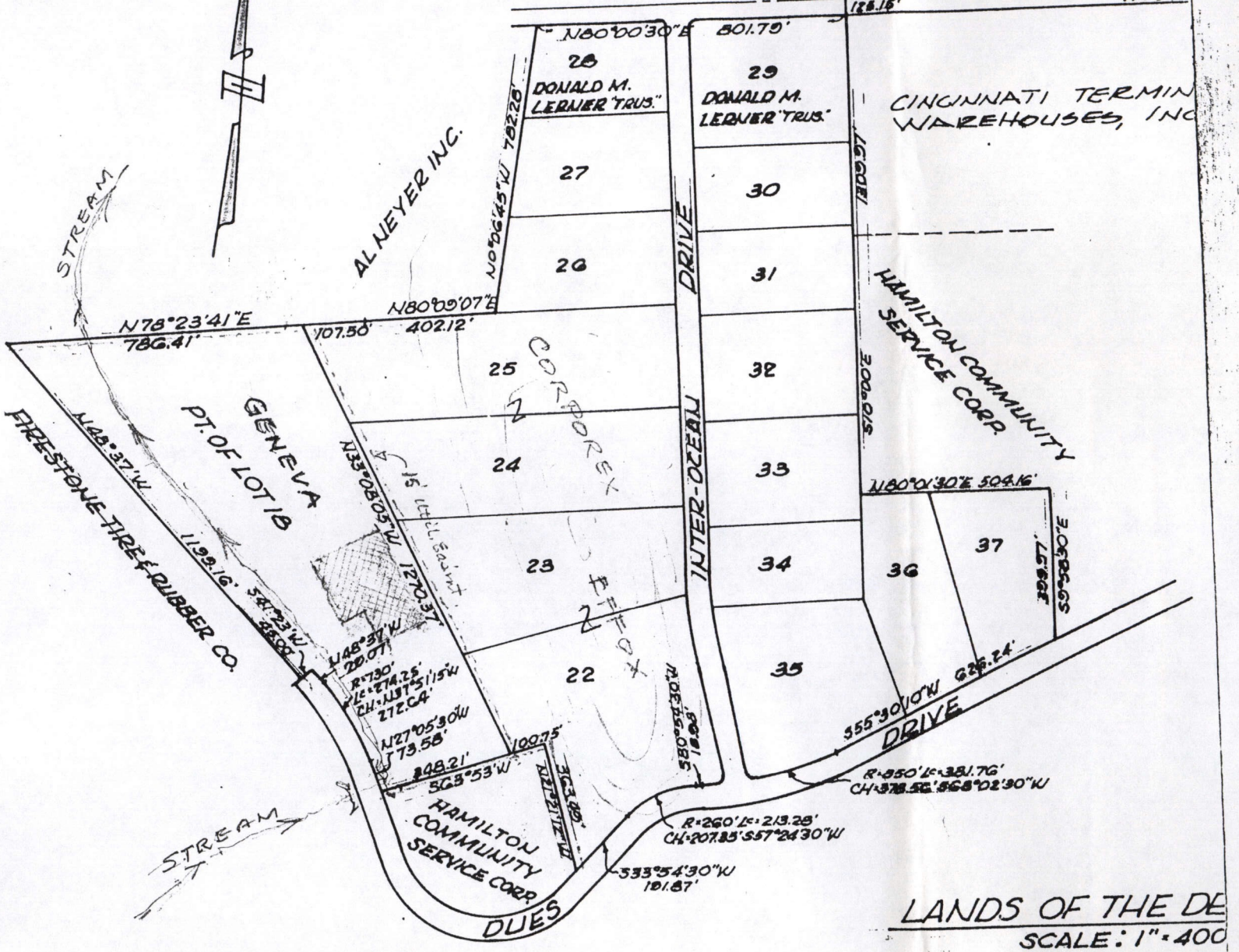
--- Sheet Flow Surface Codes ---

A Smooth Surface
B Fallow (No Res.)
C Cultivated < 20 % Res.
D Cultivated > 20 % Res.
E Grass-Range, Short
F Grass, Dense
G Grass, Burmuda
H Woods, Light
I Woods, Dense

--- Shallow Concentrated --- --- Surface Codes ---

P Paved
U Unpaved

* - Generated for use by TABULAR method

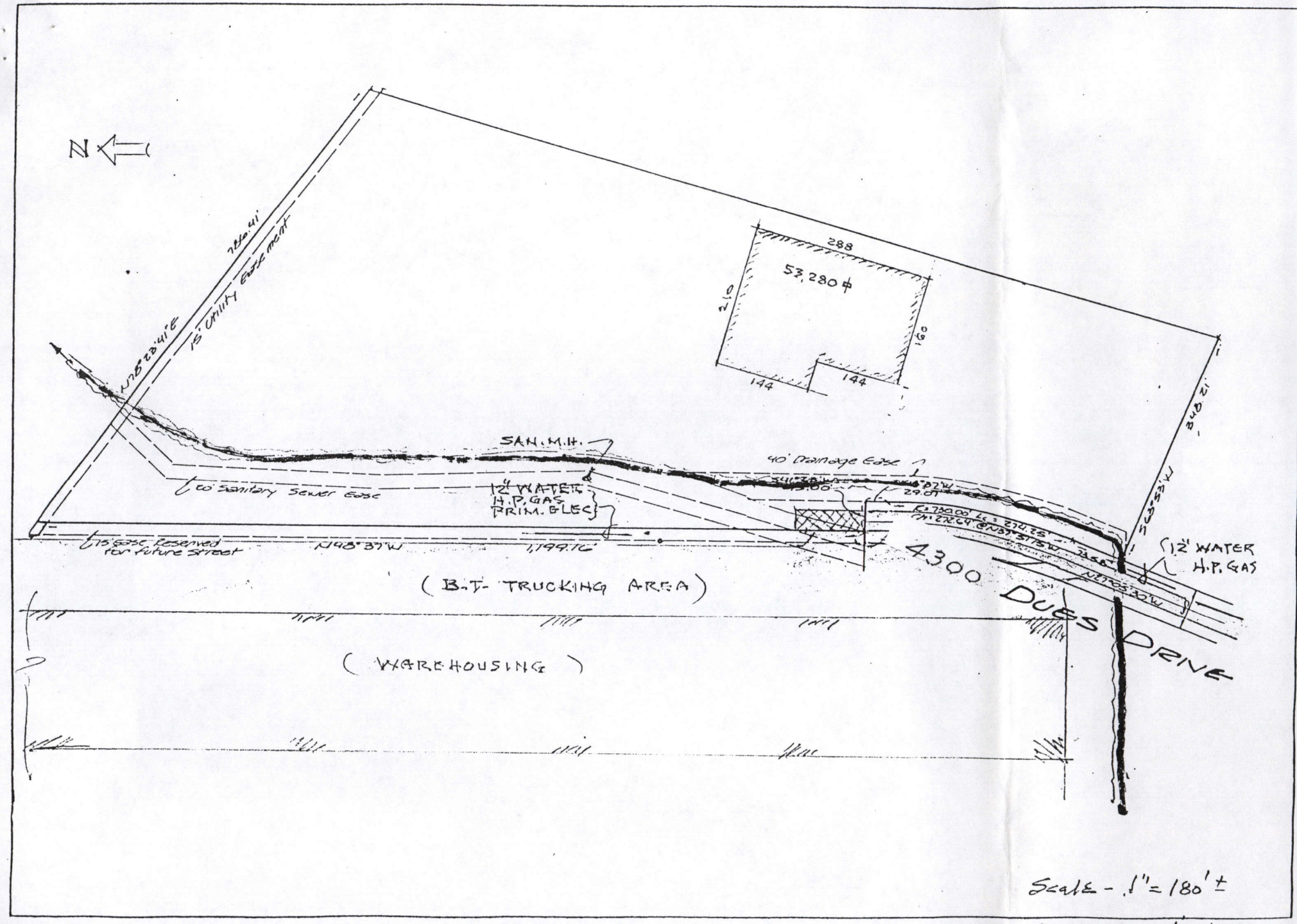


LANDS OF THE DE

SCALE: 1" = 400

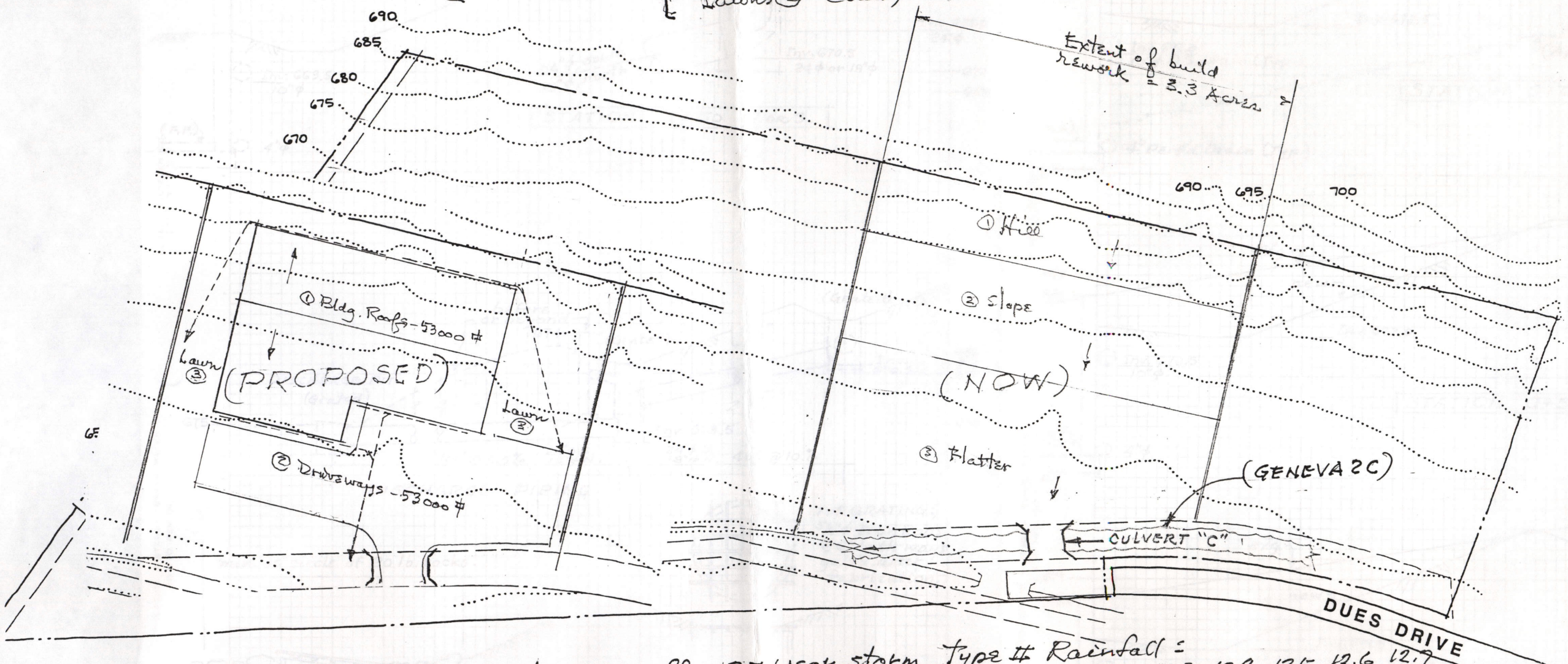
(1980-81)

EXHIBIT A.
PROPERTY LOCATION



GENEVA 2/10/94

SITE: BEFORE CONSTRUCTION	Hill ①	450×60	0.6	Wood, good	0.13	General building area discharge (GENEVABS)
	Slope ②	450×125	1.3	Wd. & Brush, good	0.06	
	Flatter ③	450×140	1.4	Dense grass	0.03	
SITE: AFTER CONSTRUCTION	Bldg. ①	53000 #	1.2	Imperv. {Roof #/ft. piping}		As proposed: bldg, drives, lawn (GENEVA BB)
	Drives ②	53000 #	1.2	Imperv. — .03 slopes		
	Lawns ③	(bal.)	0.7	Lawn, Fair — .03 slopes		

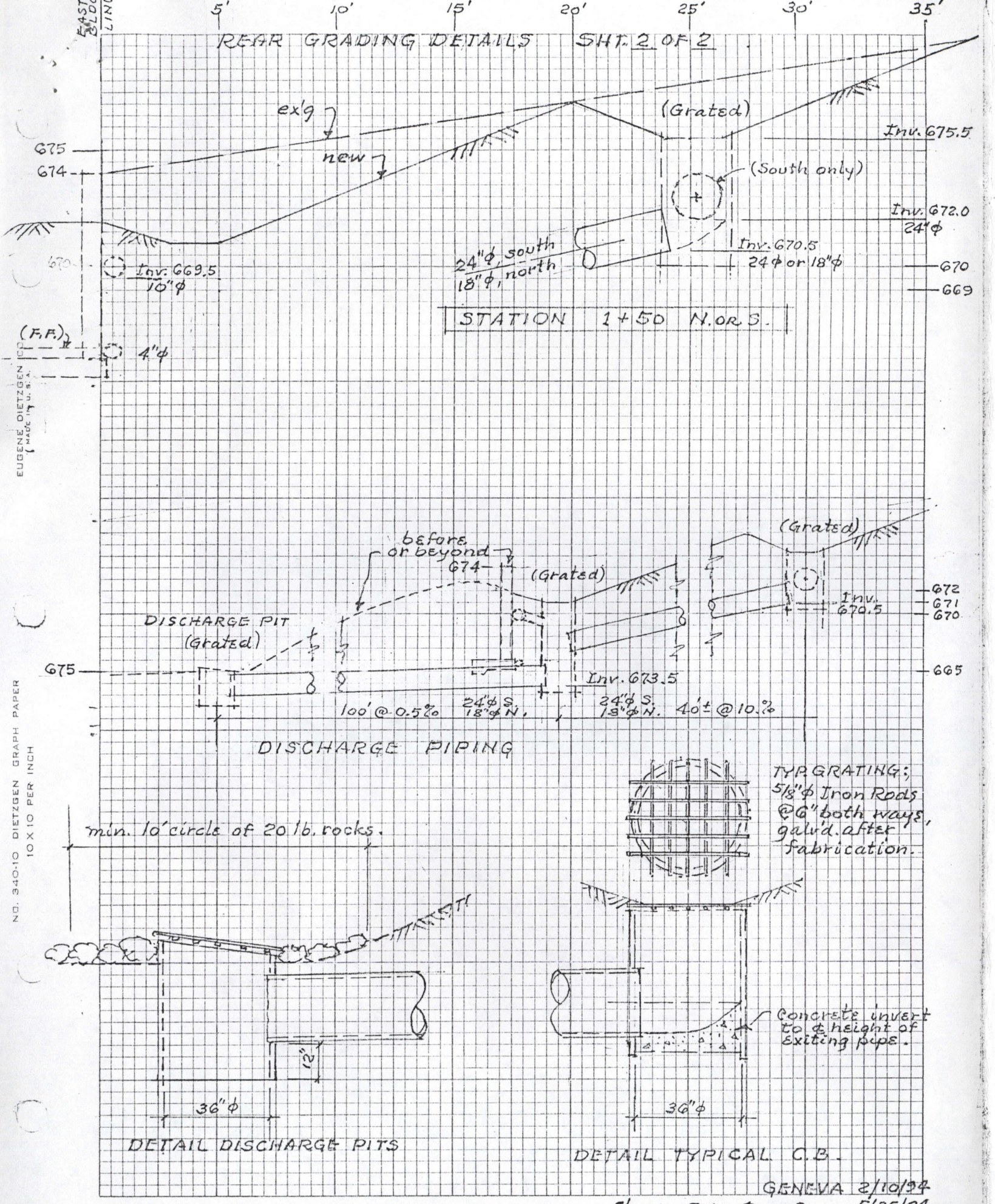


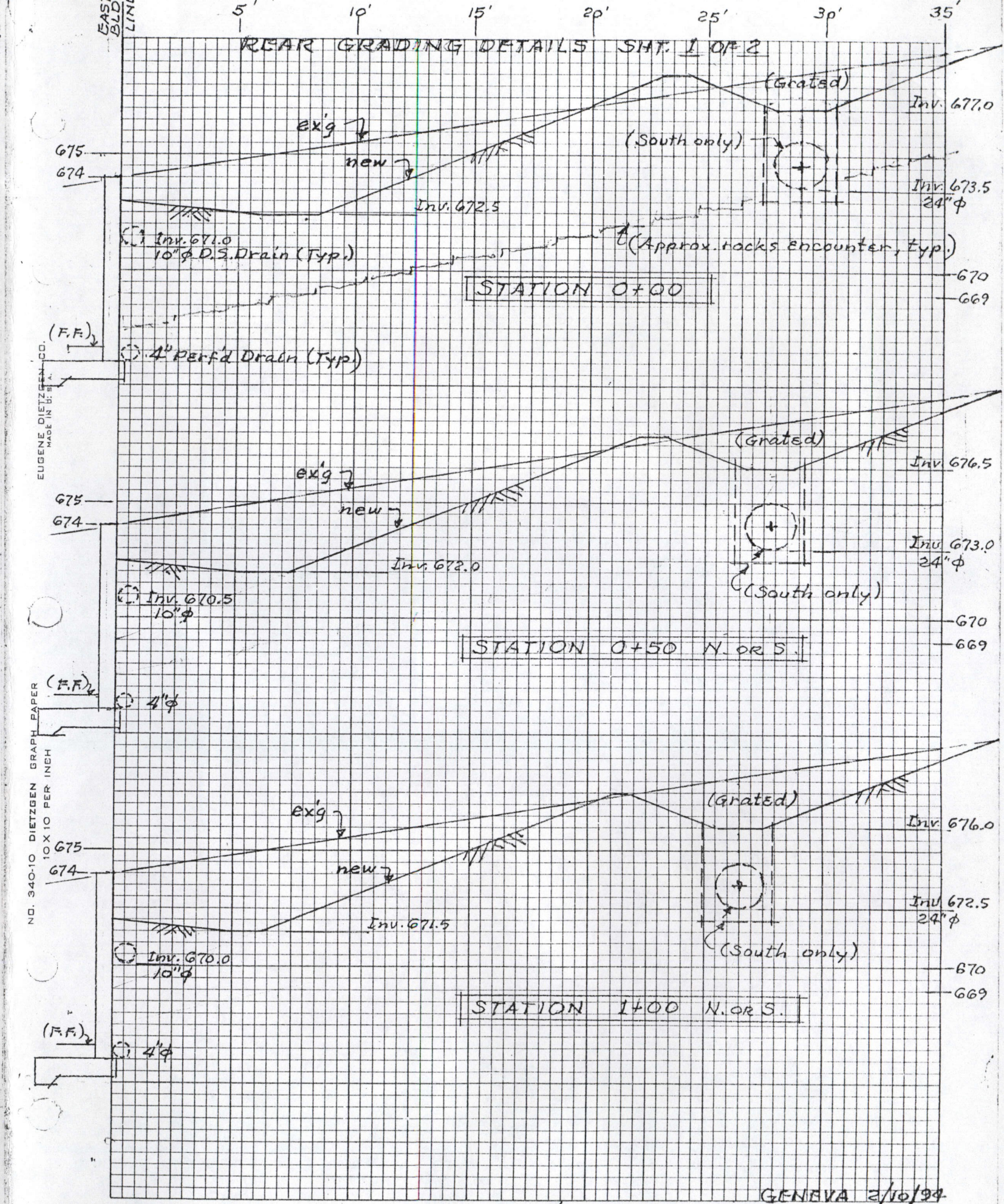
TR55 Summary of storm runoff, 25 year storm Type II Rainfall:

hrs.	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7
Peak discharge at culvert site from upstream File GENEVA2C — cfs.	39	64	119	221	359	426	424	363	295
Add Predevelopmt. site dischg. File GENEVABS — cfs.	0	0	0	1	1	2	2	2	1
totals				222	360	428	426	365	296
Repeat File GENEVA2C — cfs.	39	64	119	221	359	426	424	363	295
Add Postdevelop. site dischg. File GENEVABB — cfs	6	13	19	13	5	2			
totals				234	364	428			

CONCLUSION: NO RETENTION NECESSARY. Peak discharge is not increased.

8½×11 SHT.





TR-55 TABULAR DISCHARGE METHOD VERSION 1.11

Project : geneva bldg, drives genevabb User: dan Date: 01-31-94
County : butler State: oh Checked: ____ Date: _____
Subtitle:

Total watershed area: 0.005 sq mi Rainfall type: II Frequency: 25 years

---------- Subareas ----------

	bldg	drives	lawn
Area(sq mi)	0.00*	0.00*	0.00*
Rainfall(in)	4.8	4.8	4.8
Curve number	98*	98*	69*
Runoff(in)	4.56	4.56	1.81

TR-55 TABULAR HYDROGRAPH METHOD VERSION 1.11

SUBAREA CONTRIBUTIONS AND TOTAL DISCHARGE (CFS) AT OUTLET

	Time									
Subarea	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5
bldg	0	0	0	3	6	9	6	2	1	1
drives	0	0	0	3	6	9	6	2	1	1
lawn	0	0	0	0	1	1	1	1	0	0
TOTAL	0	0	0	6	13	19	13	5	2	2

File GENEVABB

~~Esc exit compute process~~ i s p l a y e a r l i e r
t i m e D i s p l a y
l a t e r t i m e

TR-55 TABULAR DISCHARGE METHOD VERSION 1.11

GENEVA 2C

Project : GENEVA ACCESS User: DAN Date: 01-19-94
County : Butler State: OH Checked: ____ Date: _____
Subtitle: Culvert Study

Total watershed area: 0.720 sq mi Rainfall type: II Frequency: 25 years

	Subareas				
	1	2	3	4	5
Area(sq mi)	0.13*	0.07*	0.12*	0.04*	0.07*
Rainfall(in)	4.8	4.8	4.8	4.8	4.8
		48*	70*	92*	48*

TR-55 TABULAR HYDROGRAPH METHOD VERSION 1.11

SUBAREA CONTRIBUTIONS AND TOTAL DISCHARGE (CFS) AT OUTLET

	Time									
Subarea	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8
1	0	0	0	0	1	2	5	9	14	19
2	0	0	0	0	0	1	2	3	5	6
3	9	16	32	60	92	112	106	88	67	51
4	8	13	24	45	74	91	84	66	48	35
5	0	0	0	0	1	3	5	7	8	8
6	0	0	0	1	3	5	6	6	5	4
7	3	5	9	17	30	41	48	46	40	32
8	18	29	53	96	146	166	159	126	93	71
9	0	0	0	0	0	0	1	1	2	2
10	1	1	1	2	3	5	8	11	13	14
TOTAL	39	64	119	221	350	426	424	363	295	242

File GENEVA 2C

Esc exit compute process i s p l a y e a r l i e r
t i m e D i s p l a y
l a t e r t i m e

TR-55 Tc and Tt THRU SUBAREA COMPUTATION VERSION 1.11

Project : GENEVA ACCESS User: DAN Date: 01-19-94
County : Butler State: OH Checked: ____ Date: _____
Subtitle: Culvert Study

---------- Subarea #8 - 8 ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.88	200	.05	f					0.303
Shallow Concent'd		1000	.05	p					0.061
Open Channel		1500	.02		.08	2	1		0.100
								Time of Concentration =	0.46*
									=====
Open Channel		1500	.02		.08	2	1		0.100
								Travel Time =	0.10*
									=====

---------- Subarea #9 - 9 ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.88	300	.033	e					0.321
Shallow Concent'd		800	.005	u					0.195
Open Channel		2700	.0003		.08	2	1		1.465
								Time of Concentration =	1.98*
									=====

---------- Subarea #10 - 10 ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.88	300	.1	i					0.831
Shallow Concent'd		800	.075	p					0.040
Open Channel		600	.0083		.08	2	1		0.062
								Time of Concentration =	0.93*
									=====
Open Channel		600	.0083		.08	2	1		0.062
								Travel Time =	0.06*
									=====

--- Sheet Flow Surface Codes ---

A Smooth Surface
B Fallow (No Res.)
C Cultivated < 20 % Res.
D Cultivated > 20 % Res.
E Grass-Range, Short
F Grass, Dense
G Grass, Burmuda
H Woods, Light
I Woods, Dense

--- Shallow Concentrated --- Surface Codes ---

P Paved
U Unpaved

* - Generated for use by TABULAR method

TR-55 TABULAR DISCHARGE METHOD VERSION 1.11

Project : geneva bldg site dich genevabs User: dan Date: 01-31-94
County : butler State: oh Checked: ___ Date: _____
Subtitle: compare site runoff time to calculated hydrograph of geneva 2c

Total watershed area: 0.005 sq mi Rainfall type: II Frequency: 25 years

---------- Subareas ----------

	hill
Area(sq mi)	0.00*
Rainfall(in)	4.8
Curve number	57*
Runoff(in)	1.00

TR-55 TABULAR HYDROGRAPH METHOD VERSION 1.11

SUBAREA CONTRIBUTIONS AND TOTAL DISCHARGE (CFS) AT OUTLET

	Time									
Subarea	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8
hill	0	0	0	1	1	2	2	2	1	1

File GENEVABS

TR-55 Tc and Tt THRU SUBAREA COMPUTATION VERSION 1.11

Project : geneva bldg site dich genevabs User: dan Date: 01-31-94
County : butler State: oh Checked: ____ Date: _____
Subtitle: compare site runoff time to calculated hydrograph of geneva 2c

---------- Subarea #1 - hill ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.88	75	0.13	i					0.247
Sheet		130	0.06	h					0.300
Shallow Concent'd		175	0.03	u					0.017

Time of Concentration = 0.56*
=====

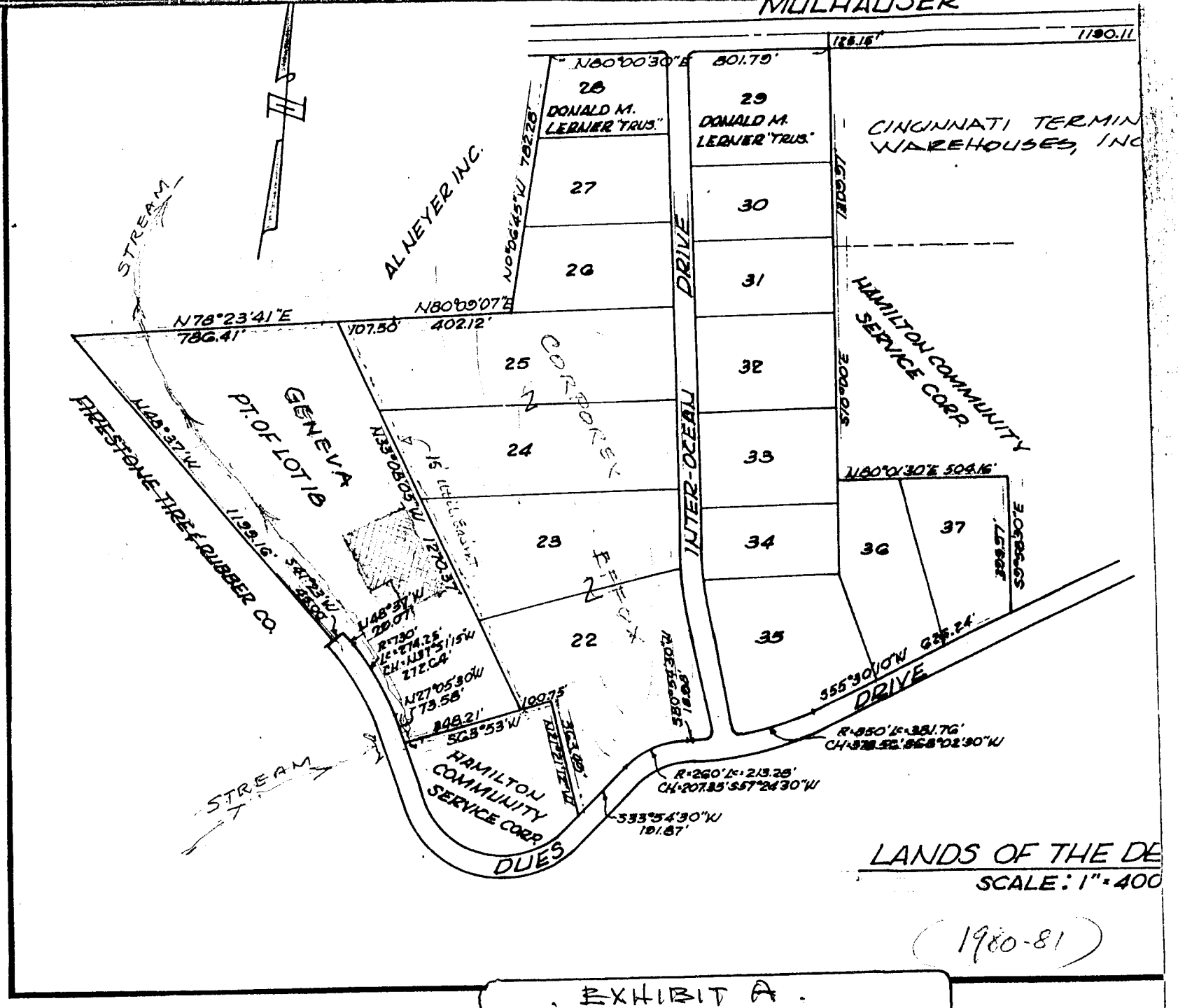
--- Sheet Flow Surface Codes ---

A Smooth Surface
B Fallow (No Res.)
C Cultivated < 20 % Res.
D Cultivated > 20 % Res.
E Grass-Range, Short
F Grass, Dense
G Grass, Burmuda
H Woods, Light
I Woods, Dense

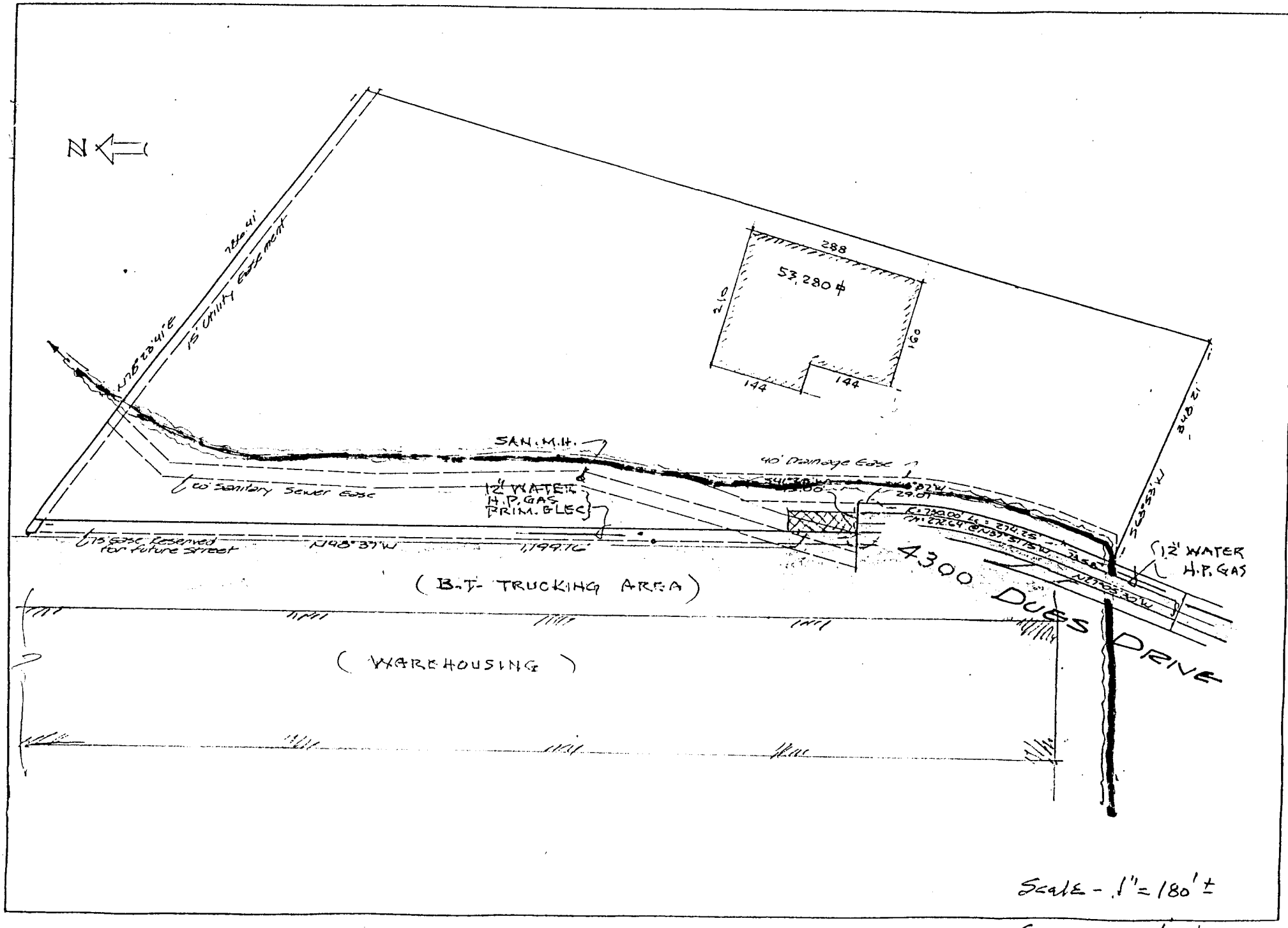
--- Shallow Concentrated --- --- Surface Codes ---

P Paved
U Unpaved

* - Generated for use by TABULAR method



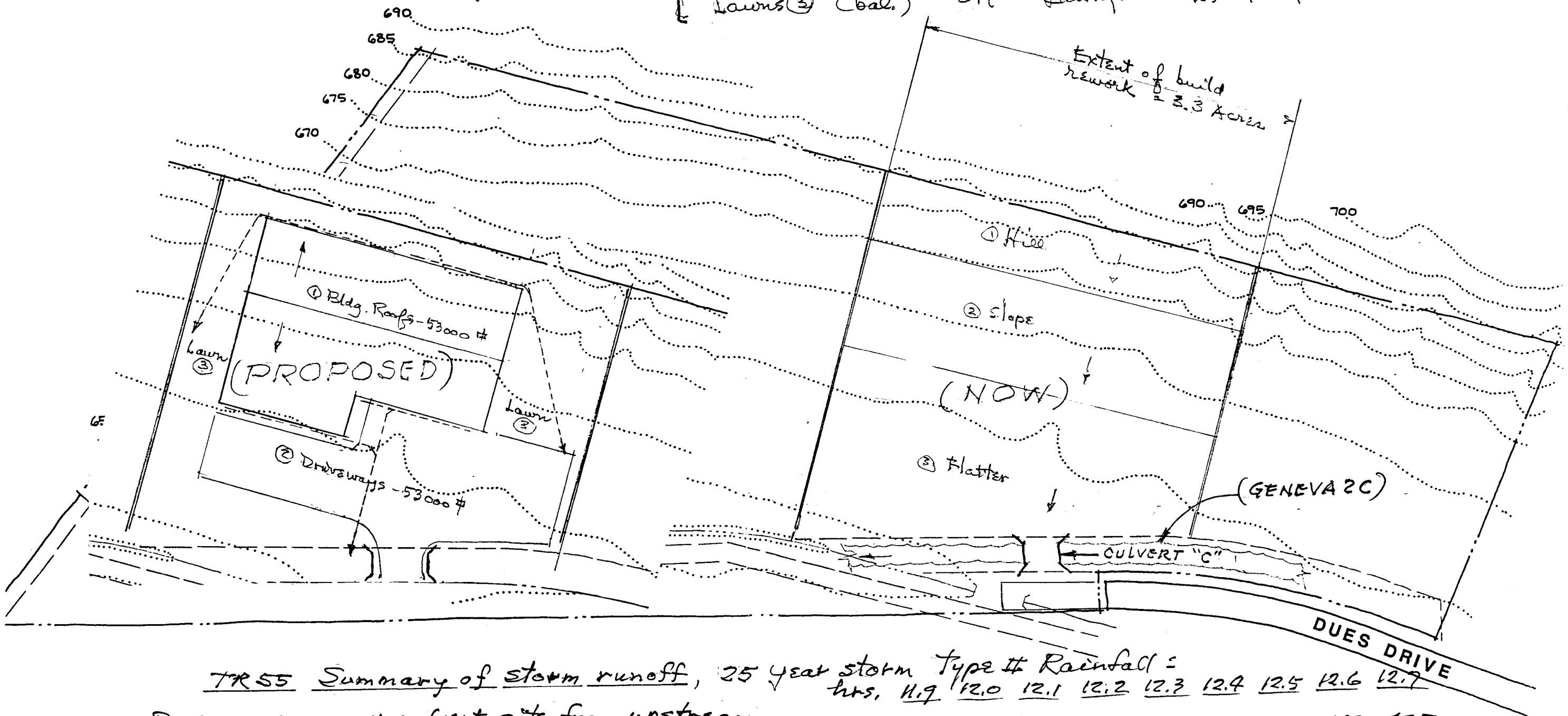
. EXHIBIT A .
PROPERTY LOCATION



GENEVA 2/10/94

1/31/74

		Subarea	Dim.	Acres	Descr.	Slope	
SITE	BEFORE CONSTRUCTION	Hill ①	450×60	0.6	Wood, good	0.13	General building site discharge (GENEVABS)
		Slope ②	450×125	1.3	Wd. & Brush, good	0.06	
		Flatter ③	450×140	1.4	Dense grass	0.03	
	AFTER CONSTRUCTION	Bldg. ①	53000 #	1.2	Impervious. Roof 1#/ft. piping		As proposed: bldg, driveway, lawn (GENEVA BB)
		Driveway ②	53000 #	1.2	Impervious — .03 slopes		
		Lawns ③	(bal.)	0.7	Lawn, Fair — .03 slopes		

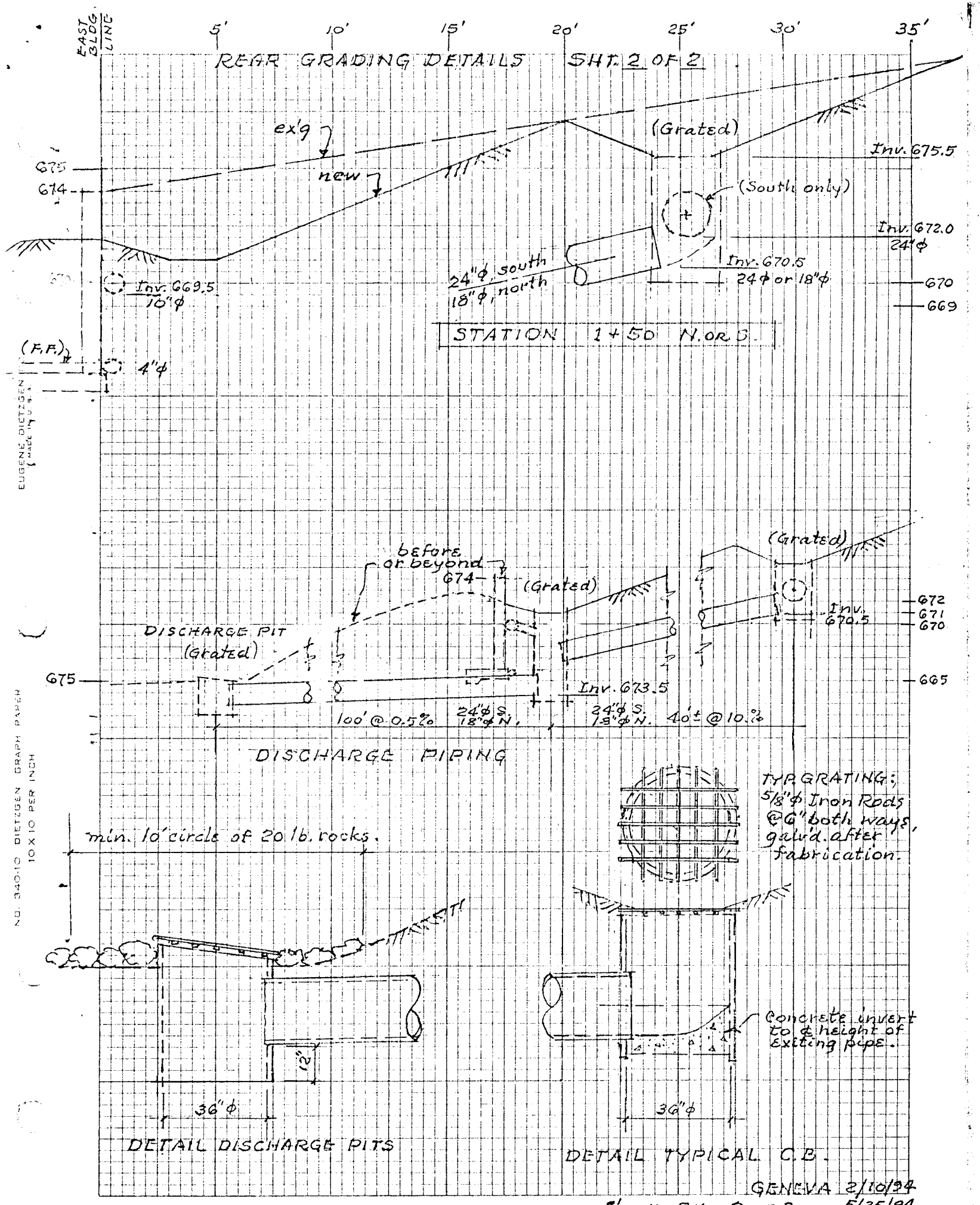


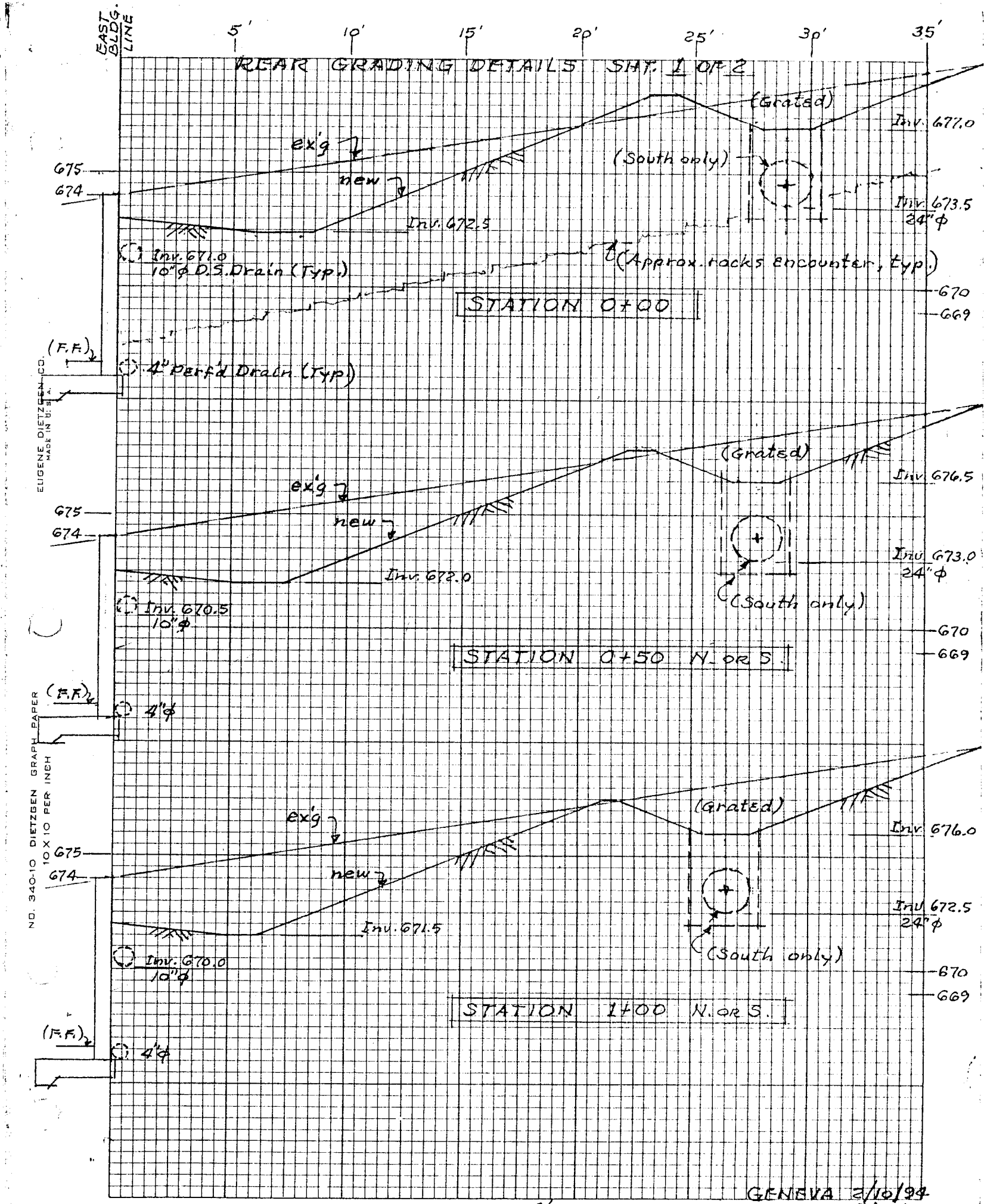
TR55 Summary of storm runoff, 25 year storm Type II Rainfall:

		hrs. 11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7
Peak discharge at culvert site from upstream File GENEVA2C	cfs.	39	64	119	221	359	426	424	363	295
Add Predevelopmt. site dischg. File GENEVABS =	cfs.	0	0	0	1	1	2	2	2	1
totals					222	360	428	426	365	296
Repeat File GENEVA2C	cfs.	39	64	119	221	359	426	424	363	295
Add Postdevelop. site dischg. File GENEVABB =	cfs	6	13	19	13	5	2			
totals					234	364	428			

Peak discharge is not increased.

CONCLUSION: NO RETENTION NECESSARY.


EAST BLDG. LINE
5'
10'
15'
20'
25'
30'
35'
REAR GRADING DETAILS SHT. 2 OF 2
ex'g
new
(Grated)
Inv. 675.5
(South only)
675
674
Inv. 672.0
24"φ
Inv. 670.5
24φ or 18"φ
24"φ south
18"φ, north
Inv. 669.5
10"φ
670
669
STATION 1+50 N. OR S.
(F.F.)
4"φ
before or beyond
674
(Grated)
DISCHARGE PIT
(Grated)
Inv. 670.5
672
671
670
675
Inv. 673.5
665
100' @ 0.5%
24"φ S.
18"φ N.
24"φ S.
18"φ N.
40± @ 10.%
DISCHARGE PIPING
TYP. GRATING;
5/8"φ Iron Rods
@6" both ways,
galv'd. after
fabrication.
min. 10' circle of 20 lb. rocks.
Concrete invert
to ℄ height of
exiting pipe.
12"
36"φ
36"φ
DETAIL DISCHARGE PITS
DETAIL TYPICAL C.B.
GENEVA 2/10/94
5/25/94
8½ × 11 SHT. 2 OF 2
EUGENE DIETZGEN CO. MADE IN U.S.A.
NO. 340-10 DIETZGEN GRAPH PAPER 10 X 10 PER INCH


EAST BLDG. LINE
5'
10'
15'
20'
25'
30'
35'
REAR GRADING DETAILS SHT. 1 OF 2
(Grated)
Inv. 677.0
ex'g
(South only)
675
674
new
Inv. 673.5
24"φ
Inv. 672.5
Inv. 671.0
10"φ D.S. Drain (Typ.)
(Approx. rocks encounter, typ.)
670
669
STATION 0+00
(F.F.)
4" Perf'd Drain (Typ.)
(Grated)
Inv. 676.5
ex'g
new
675
674
Inv. 673.0
24"φ
Inv. 672.0
(South only)
Inv. 670.5
10"φ
670
669
STATION 0+50 N. OR S.
(F.F.)
4"φ
(Grated)
ex'g
Inv. 676.0
675
674
new
Inv. 672.5
24"φ
Inv. 671.5
(South only)
Inv. 670.0
10"φ
670
669
STATION 1+00 N. OR S.
(F.F.)
4"φ
GENEVA 2/10/94
5/25/94
8½ × 11 SHT. 1 OF 2
EUGENE DIETZGEN CO. MADE IN U.S.A.
NO. 340-10 DIETZGEN GRAPH PAPER 10 X 10 PER INCH