Stormwater Division

MEMORANDUM

DATE: March 13, 2010

TO: Michael J. Gillis, Virginia Correctional Enterprises Document Management Services

FROM: Jo Anna Ripley, Stormwater

PO: 270712

RE: Files Approved for Scanning

General File ID or BMP ID: YC013

PIN: 2310400045

Subdivision, Tract, Business or Owner Name (if known): Toano Woods

Property Description: Lot 45 Section 1

Site Address: 3652 Toano Woods Road

(For internal use only) **Box** 23 **Drawer:** 9

Agreements: (in file as of scan date) **N** **Book or Doc#:** **Page:**

Comments

WATERSHED	YC	MAINTENANCE PLAN	No	CTRL STRUC DESC	CMP Riser
BMP ID NO	013	SITE AREA acre	48	CTRL STRUC SIZE inches	48
PLAN NO	S-99-87	LAND USE	SF Residential	OTLT BARRL DESC	CMP Barrel
TAX PARCEL	(23-01)(04-46)	old BMP TYP	Wet Pond	OTLT BARRL SIZE inch	24
PIN NO	2310400046	JCC BMP CODE			
CONSTRUCTION DATE	1/1/1990	POINT VALUE	10	EMERG SPILLWAY	Yes
PROJECT NAME	Toano Woods Subdivision			DESIGN HW ELEV	69.42
FACILITY LOCATION	Back (south) of 3656 Toano Woods Road			PERM POOL ELE	65.0
CITY-STATE	Williamsburg, Va. 23168	SVC DRAIN AREA acres	40.5	2-YR OUTFLOW cfs	20.06
CURRENT OWNER	Toano Woods Assoc. LTD Partnership			10-YR OUTFLOW cfs	42.93
OWNER ADDRESS	P.O. Box 147			REC DRAWING	Yes
OWNER ADDRESS 2		SERVICE AREA DESCRI	SF Lots & Roads and 21 ac. Offsite		
CITY-STATE-ZIP CODE	Toano, Va. 23168	IMPERV AREA acres	7.00	CONSTR CERTI	No
OWNER PHONE		RECV STREAM	UT of Yarmouth Creek		
MAINT AGREEMENT	Yes	EXT DET-WQ-CTRL	Yes	LAST INSP DATE	4/2/2001
EMERG ACTION PLAN	No	WTR QUAL VOL acre-ft	3.67	INTERNAL RATING	2
		CHAN PROT CTRL	No	MISC/COMMENTS	
		CHAN PROT VOL acre-ft	0	Emb situated @ Ron Molrine 3617 Marlbrook & Greg Schneck 3656 Toano Woods Rd.	
		SW/FLOOD CONTROL	Yes		
		GEOTECH REPORT	Yes		

Get Last BMP No

Return to Menu

YC013

JAMES CITY COUNTY ENVIRONMENTAL DIVISION
FISH KILL - INVESTIGATION REPORT

Date: 08/26/04
By: Scott J. Thomas, P.E.
Location: Toano Woods Subdivision
BMP ID Code: YC 013

Summary:

The Environmental Division received a call from Mr. Karl Ruhlin (3487 Toano Woods Road, Lot 44 Section 1) on Wednesday August 25th to report a massive fish kill at a lake/BMP that he lives next to in Toano Woods (map attached). It was conveyed that the County ordinances for water quality only pertain to new development and there are no specific ordinances related to waterway pollution or contamination yet; however, in the next few years we may have an illicit discharge ordinance.

Mr. Ruhlin stated that he first noticed the fish kill on Friday August 20th when bigger fish started dying until Sunday August 22nd when all of the smaller species succumbed. It was decided to immediately investigate the situation to respond to the property owner request and for file information, even though this was not our formal compliance area. A meeting was set for Thursday August 26th 2004 at 3:45 pm.

Prior to the field meeting, general information was compiled and the "asbuilt" file for the BMP was reviewed. The subject BMP was constructed around 1988 as part of the approval for County plan SP-99-87, which pre-dates Chesapeake Bay Preservation regulations; therefore, it was assumed the BMP was a flood control and temporary sediment basin feature. The size of the normal pool is about ¾ of an acre and the basin serves a drainage area of about 40.5 acres. Site conditions are typical rural subdivision with the drainage area being mainly 1/3 to ½ acre single family lots, wooded areas and paved (shoulder and ditch) roadway. The basin is typical older wet pond design, with a 48-inch diameter coated CMP riser and 24-inch barrel with riser crest holding normal pool. Also, although of minor risk, County Mosquito Control was contacted to check recent sprays at this location. Mosquito spraying has been performed at this location for many years, and the pond permanent pool is well beyond a no spray zone of 100 feet. Spray operations at the subject location were most recently performed in this subdivision on Friday August 13th, one week prior to the reported incident, and on August 23rd, several days following the reported incident. Therefore, it was determined that mosquito spraying had no direct relation to the incident. Also, the area is served a public sewer system, not septic drainfield systems.

In researching local rain gage information, although an unusually rainy July and August occurred, no significant rainfall occurred within four days of the incident date of August 20th. A 1.33-inch storm event occurred on Saturday August 21st 2004, which was a day in-between the fish kill weekend.

Upon initial visit to the site, the drainage area tributary to the basin was investigated for any signs of dumping of deletrious material which could have caused harm to the normal pool. None was found. The meeting with Mr. Ruhlin then commenced. We walked along the shoreline and observed both large and small dead fish. The primary inflow location to the BMP was investigated. Although the pipe end sections at two outfalls were misplaced and some erosion was evident, this was not found to be related to the incident.

Some orange colored algae (iron oxidizing bacteria/fungus) was present in the flow channel between the pipe outfalls and the normal pool of the basin; however, it was not determined to be unusual as compared to many other wetland and low-lying areas of the County.

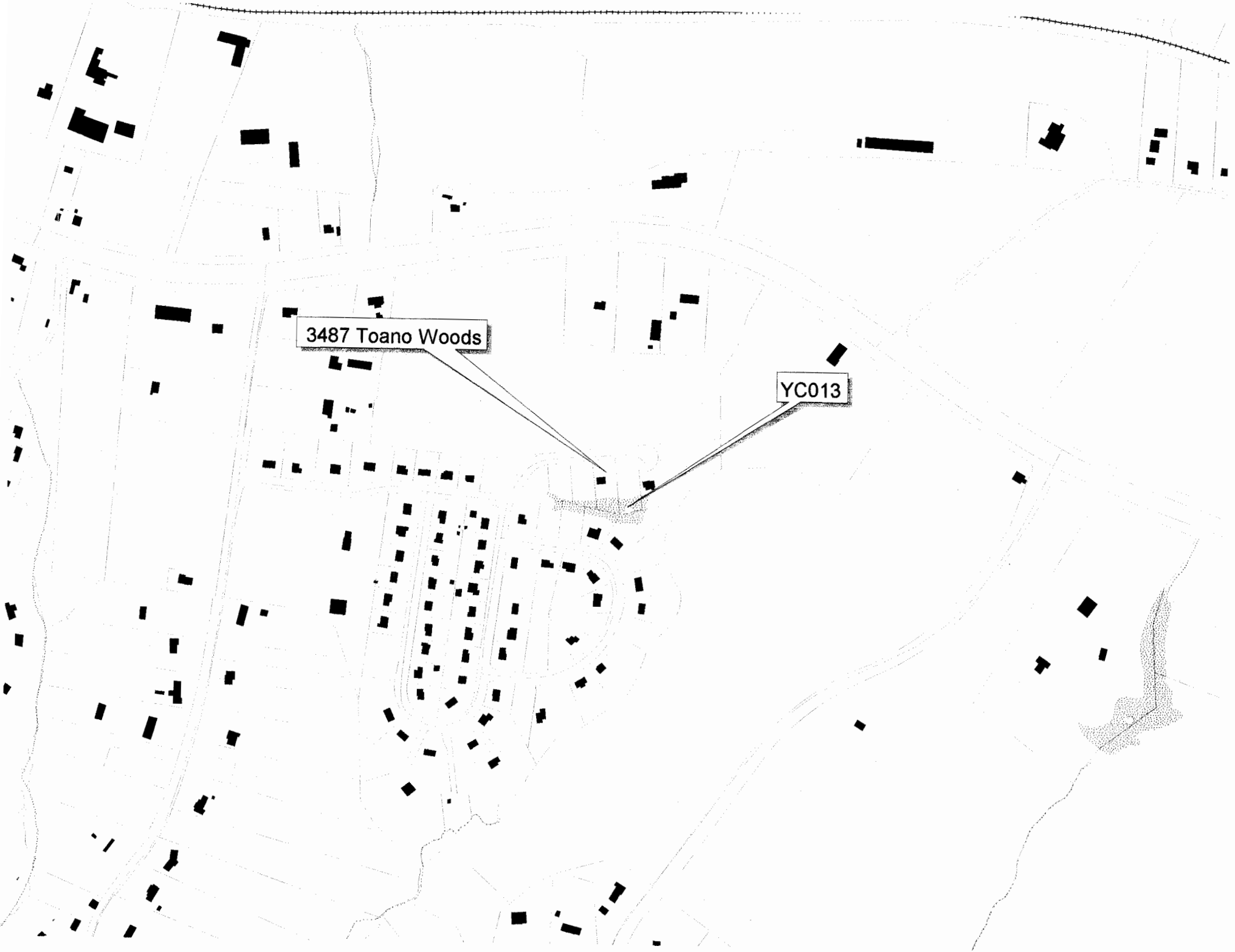
The normal pool appeared stagnant and had signs of algae on about 10 percent of the normal pool surface. The condition of the pool water was quite turbid, with an apparent high suspended solid content. There was also a slight oil-sheen appearance at the upper reach of the pond which extended to along the north shore. The BMP riser, barrel and outlet on the downstream side of the dam was observed. Although weathered, the system appeared to be intact and functional as the rainfall which occurred on Saturday (8/21) was drawn down to permanent pool (riser crest) level and only traces of outflow was observed through the barrel into the downstream wetlands.

Both pond shorelines were walked extensively to look for any signs of suspicious activities. Although many dead fish were found, there were no signs of pollution activity from nearby residents nor signs of leaking sanitary sewer connections or mains.

In summary, no distinct cause of the fish kill was found. No evidence was found to indicate an induced cause for the kill, only natural causes perhaps due to a high level of suspended solids or due to inversion of pond cold-warm water layers which started a chain reaction of low oxygen levels. Also, although not perceived by the naked eye at the time of the field investigation, the digital photographs a distinct sheen, perhaps an oily substance at the west end of the normal pool which traverses along the north shoreline, perhaps indicative of the dumping of used oil into waterways tributary of the basin. Oil dumping was not confirmed or denied as a cause, only noted based on review of photographs taken during the field visit.

A follow-up call was made to the Williamsburg Regional office of the Virginia Game & Inlands Fisheries (253-7072) to report the incident. A representative (Chris) discussed the situation with me and reported that he was aware of a call made to them in that area and Virginia DEQ was contacted. It appeared the GIF would not take any action on the matter as it was a private pond with no vested interest (such as a stocking program).

Scott J. Thomas, P.E.
Senior Engineer
September 7, 2004


3487 Toano Woods
YC013

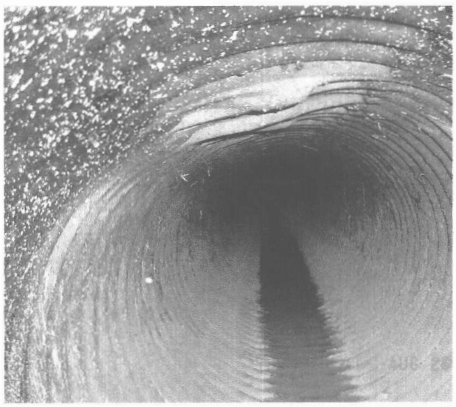
ıal Pool – High Turbidity

North Shore-Large
Dead Fish

Large Dead Fish

ɔre – Smaller Dead Fish

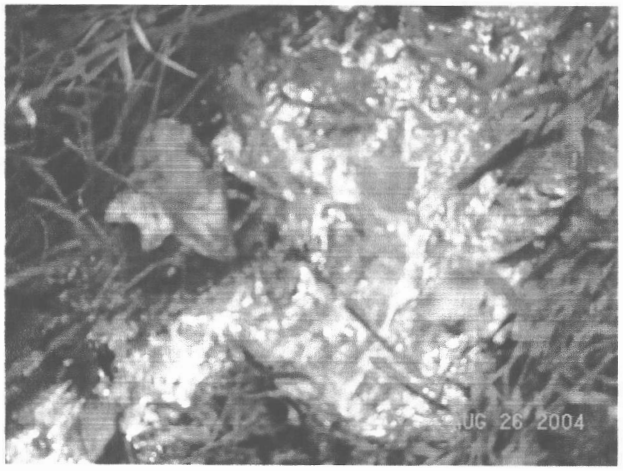
South Shore – Smaller Dead Fish



Inside Barrel Through Dam

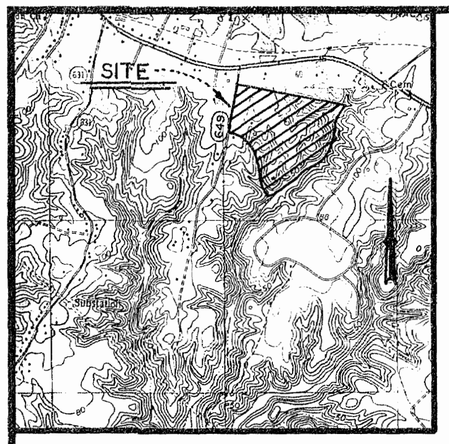
Inflow Pipe – West of Dam
(cracked and eroded)

Surface Sheen – west end and
along north shore



Surface Sheen - Inflow runoff at
west end of pool

Orange – Algae at inflow runoff
west end of pool



VICINITY MAP
SCALE: 1"=2000'

SOURCE OF TITLE

TITLE TO THE LAND SHOWN HEREON WAS GRANTED TO TOANO WOODS ASSOCIATES, LIMITED PARTNERSHIP FROM NORMAN AND HAZEL SAWYER BY DEED DATED 3/28/88 AND RECORDED IN DEED BOOK 386, PAGE 353 AND PAGE 355 AT THE CLERK OF THE CIRCUIT COURT'S OFFICE IN THE WILLIAMSBURG/JAMES CITY COUNTY COURTHOUSE AS REQUIRED BY LAW.

REFERENCES:

DEED BOOK 129, PAGE 682
PLAT BOOK 24, PAGE 47
PLAT BOOK 37, PAGE 11

CONSERVATION EASEMENT; THE FOLLOWING ACTIVITIES ARE PROHIBITED WITHIN THIS EASEMENT; STRUCTURES OF ANY KIND, REMOVAL OF VEGETATION, SOIL DISTURBANCE OF ANY KIND; SEE DEED OF EASEMENT, DEEDBOOK _____, PAGE _____ FOR FURTHER INFORMATION.

DEVELOPMENT NOTES

1. PROPERTY IS ZONED "R-1", LIMITED RESIDENTIAL
2. PROPERTY IS SHOWN ON TAX MAP # (22-2) AND (23-1).
3. TOTAL AREA OF SUBDIVISION: 47.92 acres
   AREA OF LOTS: 45.26 acres
   AREA OF R/W: 2.66 acres
4. MINIMUM LOT SIZE: 15,000 SF
5. AVERAGE LOT SIZE: 0.58 acres
6. BUILDING SETBACK REQUIREMENTS: (R-1)
   FRONT: 35'
   REAR: 35'
   SIDE: 15'
7. LOTS ARE TO BE SERVED BY PUBLIC WATER SYSTEM AND PUBLIC SEWER SYSTEM.
8. ALL UTILITIES TO BE PLACED UNDERGROUND.
9. DEVELOPER:
   TOANO WOODS ASSOCIATES, LIMITED PARTNERSHIP
   P. O. BOX 147
   TOANO, VIRGINIA 23168
10. THE STREETS AND ROADS SHOWN HEREON AND ON SHEET NO. 2 AND NO. 3 SHALL BE CONSTRUCTED TO VDOT STANDARDS AND ARE HEREBY OFFERED FOR DEDICATION TO THE COUNTY OF JAMES CITY AND/OR VDOT FOR INCLUSION INTO THEIR SECONDARY ROAD SYSTEM.
11. "UTILITY" EASEMENTS SHOWN ARE HEREBY DEDICATED TO THE JAMES CITY SERVICE AUTHORITY FOR THE PUBLIC USE.
12. "DRAINAGE" EASEMENTS AS SHOWN ARE HERBY DEDICATED TO THE VIRGINIA DEPT. OF TRANSPORTATION. ALL OTHER UTILITIES OR COMPANIES SHALL SECURE EASEMENTS BY SEPARATE INSTRUMENTS AND/OR PLATS.
13. A 10' DRAINAGE, SLOPE, AND UTILITY EASEMENT IS DEDICATED ALONG THE FRONT OF ALL LOTS.
14. **PROPERTY CORNERS SET BY SPEARMAN & ASSOC., INC., WILLIAMSBURG, VIRGINIA.**

CERTIFICATE OF NOTARIZATION

STATE OF VIRGINIA

CITY-~~COUNTY~~ OF Williamsburg I, Diane R Graft A NOTARY PUBLIC IN AND FOR THE CITY-COUNTY AND STATE AFORSAID, DO HEREBY CERTIFY THAT THE PERSONS WHOSE NAMES ARE SIGNED TO THE FOREGOING WRITING HAVE ACKNOWLEDGED THE SAME BEFORE ME IN THE CITY-COUNTY AFORESAID. GIVEN UNDER MY NAME THIS 4th DAY OF March 19 91.
MY COMMISSION EXPIRES March 31, 1994.

Diane R Graft
(SIGNATURE)

OWNER'S CERTIFICATE

THE SUBDIVISION OF LAND SHOWN ON THIS PLAT AND KNOWN AS "TOANO WOODS, SECTION I" IS WITH THE FREE CONSENT AND IN ACCORDANCE WITH THE DESIRE OF THE UNDERSIGNED OWNERS, PROPRIETORS, AND/OR TRUSTEES.

3/4/91 — Walter L. Scruggs, G.P.
DATE — NAME

3-4-91 — Walter J. Scruggs, G.P.
DATE — NAME

CERTIFICATE OF APPROVAL:

THIS SUBDIVISION IS APPROVED BY THE UNDERSIGNED IN ACCORDANCE WITH EXISTING REGULATIONS AND MAY BE COMMITTED TO RECORD.

SUBDIVISION AGENT OF JAMES CITY COUNTY:

SIGNED: _____ DATE: _____

VIRGINIA DEPARTMENT OF HEALTH:

SIGNED: James H. Bowles DATE: 3-5-91

VIRGINIA DEPARTMENT OF TRANSPORTATION:

SIGNED: J. N. Hall DATE: 3-5-91

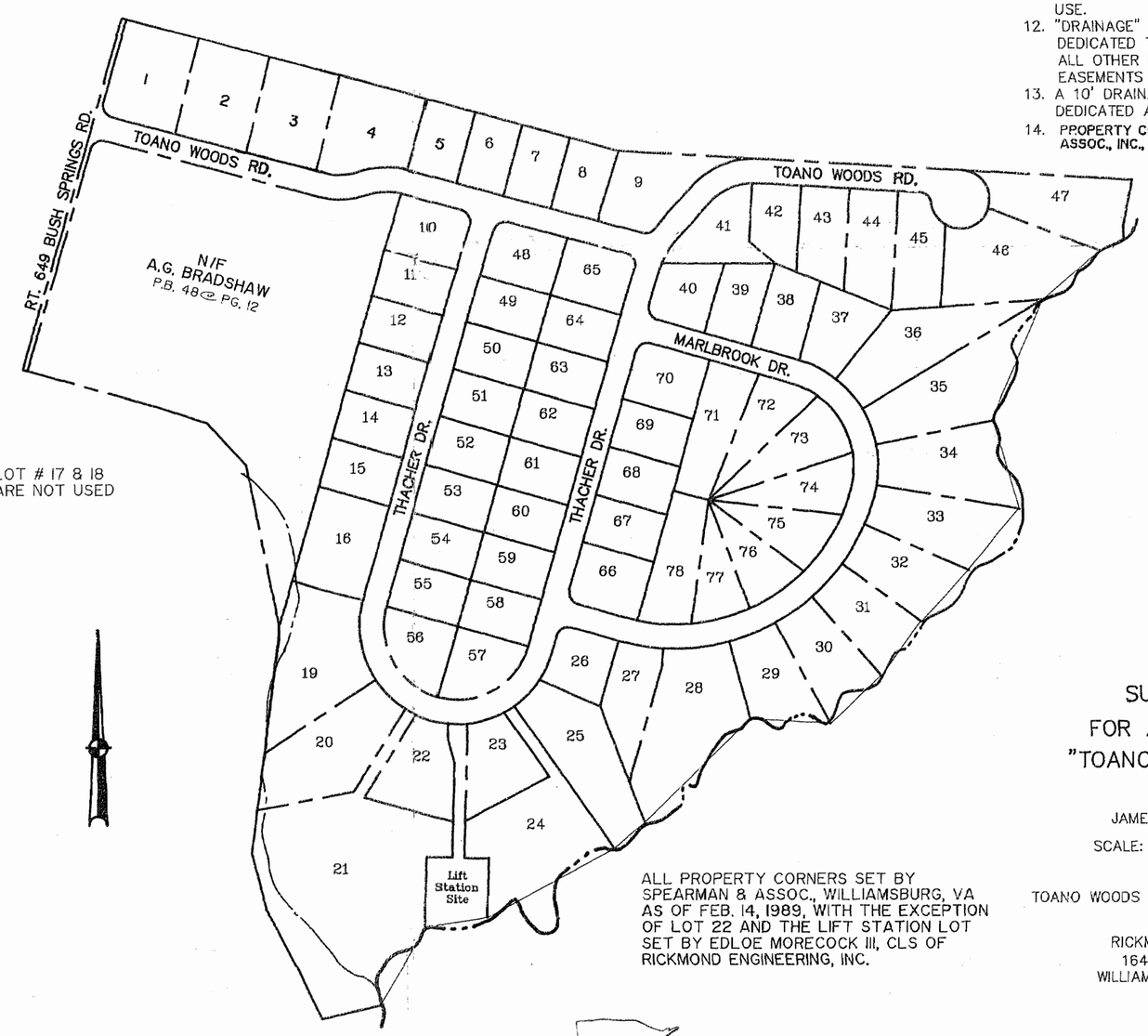
ENGINEER OR SURVEYOR'S CERTIFICATE

I HEREBY CERTIFY THAT TO THE BEST OF KNOWLEDGE OR BELIEF, THIS PLAT COMPLIES WITH ALL OF THE REQUIREMENTS OF THE BOARD OF SUPERVISORS AND ORDINANCES OF THE COUNTY OF JAMES CITY, VIRGINIA, REGARDING THE PLATTING OF SUBDIVISIONS WITHIN THE COUNTY.

3-5-91 — Ralph C. Simmons
DATE — NAME

COMMONWEALTH OF VIRGINIA
RALPH C. SIMMONS
No.018289
PROFESSIONAL ENGINEER

LOT # 17 & 18 ARE NOT USED



ALL PROPERTY CORNERS SET BY SPEARMAN & ASSOC., WILLIAMSBURG, VA AS OF FEB. 14, 1989, WITH THE EXCEPTION OF LOT 22 AND THE LIFT STATION LOT SET BY EDLOE MORECOCK III, CLS OF RICKMOND ENGINEERING, INC.

RECEIVED
AUG 1991
PLANNING DEPARTMENT

SUBDIVISION PLAT FOR A SUBDIVISION BEING "TOANO WOODS"

LOCATED
JAMES CITY COUNTY, VIRGINIA
SCALE: 1"=200' DATE" 2/25/91
OWNER/DEVELOPER
TOANO WOODS ASSOCIATES, LIMITED PARTNERSHIP
PREPARED BY
RICKMOND ENGINEERING, INC.
1643-C MERRIMAC TRAIL
WILLIAMSBURG, VIRGINIA 23185

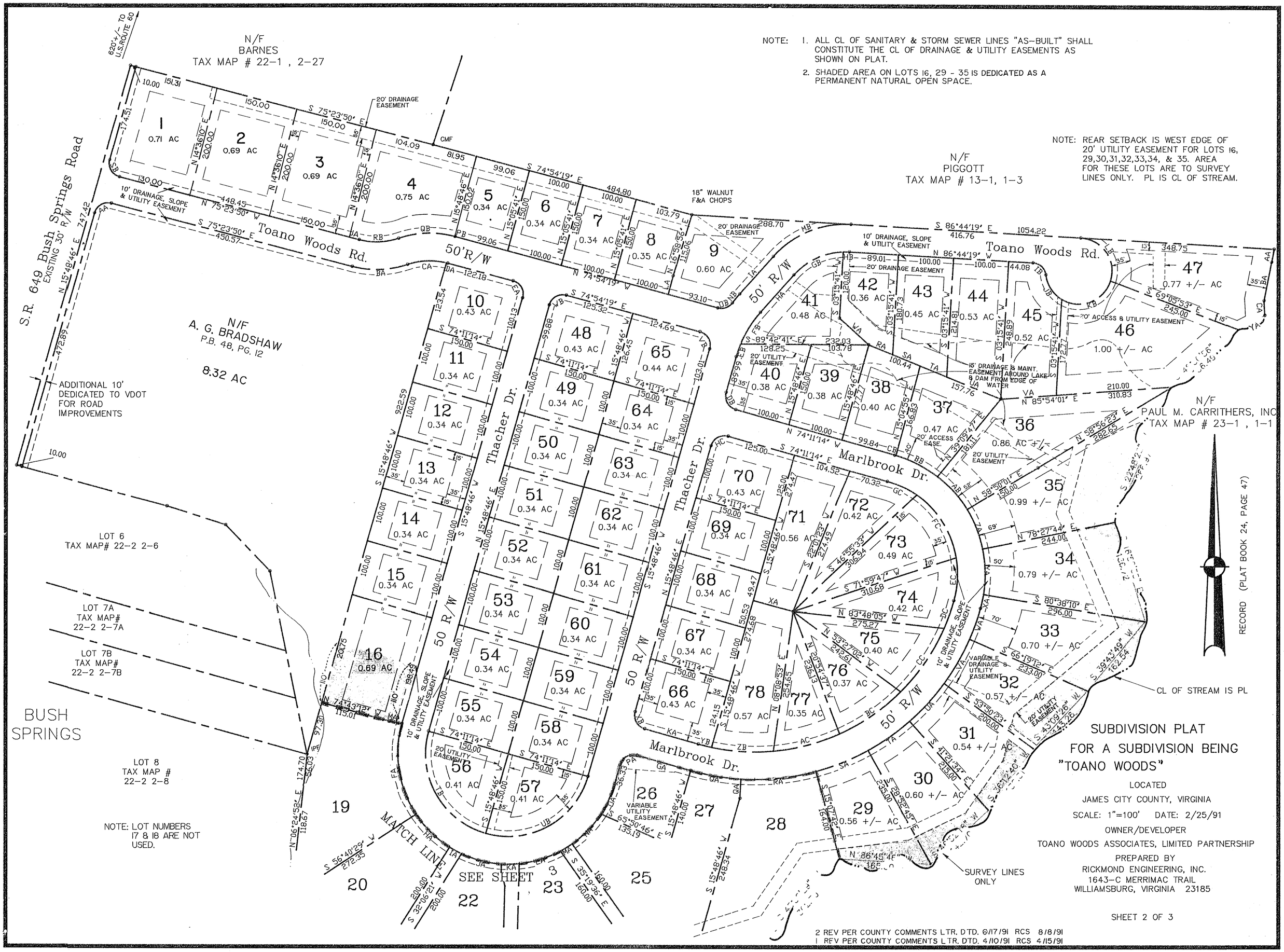
SHEET 1 OF 3

2 REV. PER COUNTY COMMENTS LTR. DTD. 6/17/91 RCS 8/8/91.
1 REV. PER COUNTY COMMENTS LTR. DTD. 4/10/91 RCS 4/15/91

NOTE: 1. ALL CL OF SANITARY & STORM SEWER LINES "AS-BUILT" SHALL CONSTITUTE THE CL OF DRAINAGE & UTILITY EASEMENTS AS SHOWN ON PLAT.

2. SHADED AREA ON LOTS 16, 29 - 35 IS DEDICATED AS A PERMANENT NATURAL OPEN SPACE.

NOTE: REAR SETBACK IS WEST EDGE OF 20' UTILITY EASEMENT FOR LOTS 16, 29,30,31,32,33,34, & 35. AREA FOR THESE LOTS ARE TO SURVEY LINES ONLY. PL IS CL OF STREAM.



SUBDIVISION PLAT
FOR A SUBDIVISION BEING
"TOANO WOODS"

LOCATED
JAMES CITY COUNTY, VIRGINIA
SCALE: 1"=100' DATE: 2/25/91
OWNER/DEVELOPER
TOANO WOODS ASSOCIATES, LIMITED PARTNERSHIP
PREPARED BY
RICKMOND ENGINEERING, INC.
1643-C MERRIMAC TRAIL
WILLIAMSBURG, VIRGINIA 23185

SHEET 2 OF 3

2 REV PER COUNTY COMMENTS LTR. DTD. 6/17/91 RCS 8/8/91
1 REV PER COUNTY COMMENTS LTR. DTD. 4/10/91 RCS 4/15/91

CURVE DATA

LABEL	RADIUS	ANGLE	CHORD	CHORD BEARING	TANGENT	ARC LENGTH
AA	25.00	088°47'25"	34.98	N60°12'28"E	24.47	38.74
BA	175.00	033°19'04"	100.33	N87°56'38"E	52.36	101.76
CA	125.00	032°39'37"	70.29	N87°36'55"E	36.62	71.25
DA	125.00	001°08'57"	2.50	S75°28'46"E	1.25	2.50
EA	25.00	090°43'05"	35.57	S29°32'47"E	25.31	39.58
FA	200.00	49°08'16"	166.32	S81°14'37"E	91.44	171.52
HA	200.00	024°34'08"	85.10	S45°36'35"E	43.55	85.76
IA	200.00	007°10'14"	25.01	S61°28'46"E	12.53	25.02
JA	200.00	019°11'43"	66.69	N74°39'45"W	33.82	67.00
KA	200.00	011°28'18"	39.98	N89°59'46"W	20.09	40.04
LA	200.00	022°25'27"	77.77	N73°03'21"E	39.64	78.27
MA	200.00	007°10'14"	25.01	N58°15'31"E	12.53	25.02
NA	200.00	021°41'11"	75.24	N43°49'48"E	38.30	75.69
OA	200.00	017°10'27"	59.72	N24°23'59"E	30.20	59.94
PA	25.00	090°00'00"	35.35	N60°48'46"E	25.00	39.26
QA	425.00	012°28'49"	92.39	S80°25'39"E	46.47	92.57
RA	425.00	018°27'39"	136.34	N84°06'07"E	69.06	136.93
SA	425.00	013°45'04"	101.75	N67°59'46"E	51.24	102.00
TA	425.00	012°28'49"	92.39	N54°52'50"E	46.47	92.57
UA	425.00	012°28'49"	92.39	N42°24'01"E	46.47	92.57
VA	425.00	012°28'49"	92.39	N29°55'12"E	46.47	92.57
WA	425.00	007°52'02"	58.31	N19°44'47"E	29.22	58.35
XA	225.00	006°26'55"	25.31	N12°35'18"E	12.67	25.32
YA	225.00	020°54'06"	81.62	N01°05'13"W	41.50	82.08
ZA	225.00	019°37'43"	76.70	N21°21'07"W	38.92	77.08
AB	225.00	020°48'46"	81.28	N41°34'22"W	41.32	81.73
BB	225.00	021°39'56"	84.57	N62°48'43"W	43.05	85.08
CB	225.00	000°32'33"	2.13	N73°54'58"W	1.06	2.13
DB	25.00	090°00'00"	35.35	N29°11'14"W	25.00	39.26

CURVE DATA

LABEL	RADIUS	ANGLE	CHORD	CHORD BEARING	TANGENT	ARC LENGTH
EB	203.13	006°46'56"	24.03	N19°12'13"E	12.03	24.04
FB	203.13	019°08'09"	67.52	N32°09'46"E	34.24	67.84
GB	125.00	046°29'14"	98.66	N64°58'27"E	53.68	101.41
HB	125.00	005°02'36"	11.00	S89°15'37"E	5.50	11.00
IB	25.00	079°50'09"	32.08	S46°49'15"E	20.91	34.83
JB	60.00	052°17'10"	52.87	S33°02'45"E	29.44	54.75
KB	60.00	103°24'11"	94.17	N69°06'34"E	75.97	108.28
LB	60.00	104°08'47"	94.65	N34°39'56"W	77.00	109.06
MB	175.00	051°31'51"	152.14	S67°29'46"W	84.46	157.39
NB	253.13	004°47'34"	21.16	S39°20'03"W	10.59	21.17
OB	25.00	068°09'24"	28.01	S71°00'59"W	16.91	29.73
PB	175.00	000°36'56"	1.88	N75°12'47"W	0.94	1.88
QB	175.00	033°11'38"	99.97	S87°52'56"W	52.15	101.38
RB	125.00	033°19'04"	71.66	S87°56'38"W	37.40	72.68
SB	25.00	091°12'35"	35.72	N29°47'32"W	25.53	39.79
TB	150.00	090°00'00"	212.13	S29°11'14"E	150.00	235.61
UB	150.00	090°00'00"	212.13	N60°48'46"E	150.00	235.61
VB	25.00	090°43'05"	35.57	N29°32'47"W	25.31	39.58
WB	25.00	089°16'55"	35.13	S60°27'13"W	24.68	38.95
XB	25.00	090°00'00"	35.35	S29°11'14"E	25.00	39.26
YB	375.00	003°50'44"	25.16	S76°06'36"E	12.58	25.16
ZB	375.00	017°04'53"	111.38	S86°34'25"E	56.31	111.79
AC	375.00	019°05'55"	124.42	N75°20'11"E	63.08	125.00
BC	375.00	020°37'35"	134.27	N55°28'26"E	68.23	135.00
CC	375.00	021°23'26"	139.18	N34°27'55"E	70.82	140.00
DC	375.00	007°57'27"	52.03	N19°47'29"E	26.08	52.08
EC	175.00	025°23'01"	76.89	N03°07'15"E	39.41	77.52
FC	175.00	045°03'28"	134.10	N32°05'59"W	72.59	137.62
GC	175.00	019°33'31"	59.44	N64°24'29"W	30.16	59.73
HC	25.00	090°00'00"	35.35	S60°48'46"W	25.00	39.26

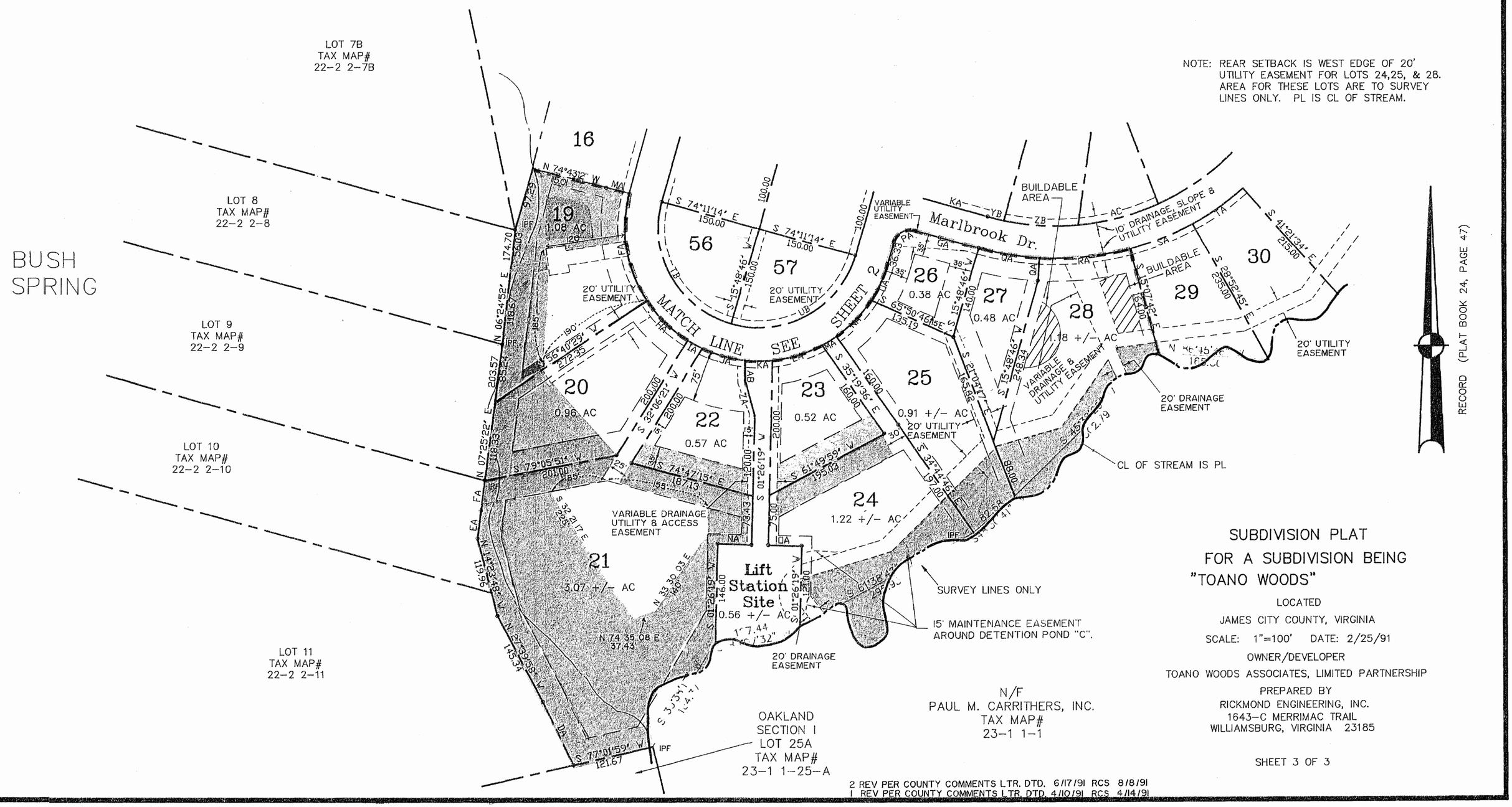
LINE DATA

AA	S 10°54'37" W	23.81
BA	S 10°54'37" W	71.36
CA	S 03°21'06" E	26.42
DA	N 25°40'58" W	105.26
EA	N 06°56'22" E	41.89
FA	N 07°25'22" E	46.10
GA	S 74°11'14" E	99.84
HA	N 41°43'50" E	91.03
IA	S 41°43'50" W	91.03
JA	N 75°23'50" W	18.45
KA	S 74°11'14" E	99.84
LA	N 15°05'41" E	35.00
MA	N 77°45'37" W	35.05
NA	N 88°33'41" W	50.00
OA	S 88°33'41" E	50.00
QA	S 03°19'57" W	35.00
RA	S 67°55'13" E	46.92
SA	S 67°55'13" E	53.52
TA	S 67°55'13" E	52.12
UA	S 67°55'13" E	105.64
VA	N 85°54'01" E	100.83
WA	S 47°40'18" E	71.58
XA	S 75°23'50" E	74.84
YA	S 65°39'24" W	58.29
ZA	N 15° 06' 27" W	52.67'
AB	N 01° 26' 19" E	30.07'

NOTE :

1. ALL ℄ OF SANITARY & STORM SEWER LINES " AS-BUILT " SHALL CONSTITUTE THE ℄ OF DRAINAGE & UTILITY EASEMENTS AS SHOWN ON PLAT.
2. SHADED AREA ON LOTS 19,20,21,24,25,28,22,23 DEDICATED AS A PERMANENT NATURAL OPEN SPACE.

NOTE: REAR SETBACK IS WEST EDGE OF 20' UTILITY EASEMENT FOR LOTS 24,25, & 28. AREA FOR THESE LOTS ARE TO SURVEY LINES ONLY. PL IS CL OF STREAM.

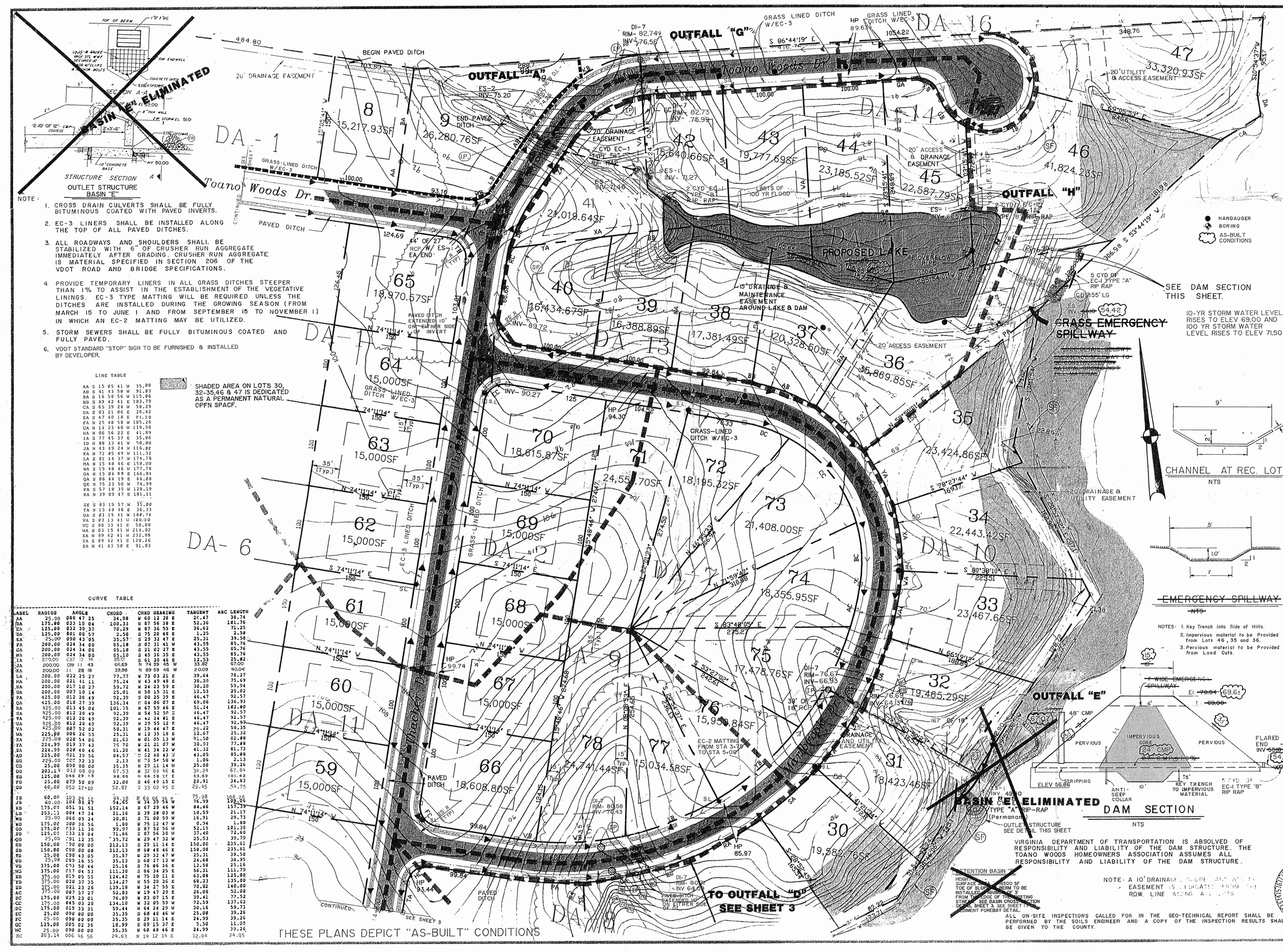


SUBDIVISION PLAT
FOR A SUBDIVISION BEING
"TOANO WOODS"

LOCATED
JAMES CITY COUNTY, VIRGINIA
SCALE: 1"=100' DATE: 2/25/91
OWNER/DEVELOPER
TOANO WOODS ASSOCIATES, LIMITED PARTNERSHIP
PREPARED BY
RICKMOND ENGINEERING, INC.
1643-C MERRIMAC TRAIL
WILLIAMSBURG, VIRGINIA 23185

SHEET 3 OF 3

2 REV PER COUNTY COMMENTS LTR. DTD. 6/17/91 RCS 8/8/91
1 REV PER COUNTY COMMENTS LTR. DTD. 4/10/91 RCS 4/14/91



NOTE:

1. CROSS DRAIN CULVERTS SHALL BE FULLY BITUMINOUS COATED WITH PAVED INVERTS.
2. EC-3 LINERS SHALL BE INSTALLED ALONG THE TOP OF ALL PAVED DITCHES.
3. ALL ROADWAYS AND SHOULDERS SHALL BE STABILIZED WITH 6" OF CRUSHER RUN AGGREGATE IMMEDIATELY AFTER GRADING. CRUSHER RUN AGGREGATE IS MATERIAL SPECIFIED IN SECTION 206 OF THE VDOT ROAD AND BRIDGE SPECIFICATIONS.
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5. STORM SEWERS SHALL BE FULLY BITUMINOUS COATED AND FULLY PAVED.
6. VDOT STANDARD "STOP" SIGN TO BE FURNISHED & INSTALLED BY DEVELOPER.

SHADED AREA ON LOTS 30, 32-35,46 & 47 IS DEDICATED AS A PERMANENT NATURAL OPEN SPACE.

LINE TABLE

AA	S 15 05 41 W	35.00
AB	S 41 43 50 W	91.03
BA	S 16 58 56 W	115.06
BB	S 89 42 41 E	103.79
CA	S 65 39 24 W	58.29
DA	S 03 21 06 E	26.42
EA	S 47 40 18 E	71.59
FA	N 25 40 58 W	105.26
GA	N 14 23 48 W	119.96
HA	N 06 56 22 E	41.89
IA	S 77 45 37 E	35.06
JA	N 88 33 41 W	50.00
JA	N 43 49 24 W	116.82
KA	N 72 05 49 W	111.32
LA	S 81 14 37 W	174.78
MA	N 15 48 46 E	158.00
NA	S 15 48 46 W	177.78
OA	N 15 04 55 E	166.84
QE	N 75 23 50 W	74.99
PA	S 57 18 35 W	128.19
RA	N 39 09 47 E	181.11
SE	S 03 19 57 W	35.00
TA	N 15 48 46 E	36.33
UA	S 03 15 41 W	188.74
VA	S 03 15 41 W	180.00
VC	S 88 33 41 E	50.00
WA	S 03 15 41 W	214.82
XA	N 89 42 41 W	232.05
YA	S 89 42 41 E	128.26
ZA	N 41 43 50 E	91.03

CURVE TABLE

LABEL	RADIUS	ANGLE	CHORD	CHRD BEARING	TANGENT	ARC LENGTH
AA	25.00	080 47 25	34.98	W 60 12 28 E	24.47	38.74
BA	175.00	033 19 04	100.33	N 87 56 38 E	52.36	101.76
CA	125.00	032 39 37	70.29	W 87 36 55 E	36.62	71.25
DA	125.00	001 00 57	2.50	S 75 20 48 E	1.25	2.50
EA	25.00	090 43 05	35.57	S 29 32 47 E	25.31	39.58
FA	200.00	024 34 00	85.18	S 82 31 41 W	43.55	85.76
GA	200.00	024 34 00	85.18	S 21 02 27 E	43.55	85.76
HA	200.00	024 34 00	85.18	S 45 36 35 E	43.55	85.76
IA	20.00	087 32 14	26.72	S 61 20 46 E	12.53	25.82
JA	200.00	09 11 43	66.69	N 74 39 45 W	33.82	67.00
KA	200.00	11 28 18	39.98	N 89 59 46 W	20.09	40.04
LA	200.00	022 25 27	77.77	W 73 03 21 E	39.64	78.27
MA	200.00	021 11 11	75.24	W 43 49 48 E	38.30	75.69
NA	200.00	017 10 27	59.72	W 24 23 59 E	30.20	59.94
OA	200.00	007 10 14	25.01	N 58 15 31 E	12.53	25.02
PA	425.00	012 28 49	92.39	S 00 25 39 E	46.47	92.57
QA	425.00	018 27 39	136.34	N 04 06 07 E	69.06	136.93
RA	425.00	013 45 04	101.75	N 67 59 46 E	51.24	102.00
SA	425.00	012 28 49	92.39	W 54 54 50 E	46.47	92.57
TA	425.00	012 28 49	92.39	N 42 24 01 E	46.47	92.57
UA	425.00	012 28 49	92.39	N 29 55 12 E	46.47	92.57
VA	425.00	007 53 52	58.31	N 19 14 47 E	29.22	58.35
WA	225.00	006 26 55	25.31	N 12 35 18 E	12.67	25.32
XA	225.00	020 54 06	81.62	W 01 05 13 W	41.50	82.08
YA	224.99	019 37 43	76.70	W 21 21 07 W	38.91	77.48
ZA	224.99	020 48 46	81.28	N 41 34 22 W	41.32	81.73
AB	225.00	021 39 56	84.57	N 52 40 43 W	43.05	85.08
BB	225.00	000 32 13	2.13	N 73 54 58 W	1.06	2.13
CB	25.00	090 00 00	35.35	N 29 11 14 W	25.00	39.26
DB	203.14	019 08 09	67.53	W 32 09 46 E	38.24	67.84
EB	125.00	046 29 18	98.66	N 64 58 27 E	53.69	101.42
FB	25.00	079 50 09	32.00	S 46 49 15 E	20.91	34.83
GB	60.00	052 17 10	52.87	S 33 02 45 E	29.45	54.75
IB	60.00	103 29 13	94.18	N 69 06 38 E	75.98	108.28
JB	60.00	104 00 47	94.65	N 34 39 56 W	76.99	109.96
KB	175.00	051 31 51	152.14	S 67 29 46 W	84.46	157.79
LB	253.13	004 47 34	21.16	S 39 28 03 W	10.59	21.17
MB	25.00	060 09 24	20.01	S 71 00 59 W	16.91	29.73
NB	175.00	000 36 56	1.88	W 75 12 47 W	0.94	1.88
OB	175.00	033 11 30	99.97	S 87 52 56 W	52.15	101.30
PB	125.00	033 19 04	71.66	S 87 56 38 W	37.40	72.60
QB	25.00	091 12 26	35.72	S 29 47 32 W	25.53	39.79
RB	150.00	090 00 00	212.13	S 29 11 14 E	150.00	235.61
SB	150.00	090 00 00	212.13	N 60 48 46 E	150.00	235.61
TB	25.00	090 43 05	35.57	S 29 32 47 W	25.31	39.58
UB	25.00	089 16 55	35.13	S 60 27 13 W	24.68	38.95
VB	375.00	013 50 44	25.16	S 76 06 36 E	12.50	25.16
WB	375.00	017 04 53	111.30	S 86 34 25 E	56.31	111.79
XB	375.00	019 05 55	124.42	N 75 20 11 E	63.00	125.00
YB	375.00	020 37 35	134.27	W 55 20 26 E	68.23	135.00
ZB	375.00	021 23 26	139.18	W 34 27 55 E	70.82	140.00
AC	375.00	007 57 27	52.03	W 19 47 29 E	26.08	52.08
BC	175.00	025 23 01	76.89	W 03 07 15 E	39.41	77.52
CC	175.00	045 03 28	134.10	W 32 05 50 W	72.59	137.62
DC	175.00	019 33 31	59.44	N 64 24 29 W	30.16	59.73
EC	25.00	090 00 00	35.35	S 68 48 46 W	25.00	39.26
FC	25.00	090 00 00	35.35	S 29 11 14 E	24.99	39.26
GC	125.00	005 02 36	10.99	S 09 15 37 E	5.50	11.05
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Rickmond Engineering, Inc.
Civil Engineering
Environmental Engineering
Land Development Planning
7243 Richmond Road
Williamsburg, Virginia 23188
(804) 565-1717 FAX (804) 565-1746

Designed by	Drawn by	Approved by	Scale	Date	Job No.
KMJ	RJH	RCS	1"=50'	10/7/98	98188

No.	By	Revision	Date	App.
12	DPB	REV. PER COUNTY COMMENTS LTR. DTD. 4/10/91	RCS 4/16/91	
11	DPB	REV PER COUNTY COMMENTS LTR DTD 9/28/90	RCS 2/7/91	
10	DPB	REV FOR RESUBMITTAL KMJ REV PER ENGINEER	DCR 9-4-90	
9	DPB	Rev. per Engineer	DCR 7-25-90	
8	DPB	Rev. per Vertical Comments D.E.C.	DCR 10-17-89	
7	BMc	Rev. per County Comments	DCR 10-13-89	
6	BMc	Rev. as per Developer	DCR 1-4-89	
5	BMc	Rev. per County Comments Ltr. Dtd. 7-20-88	DCR 8-9-88	
4	KMJ	REV PER WRITTEN COMMENTS FROM DEC DTD 5-26-88	DCR 7-5-88	
3	BMc	Rev. per County Comments Ltr. Dtd. 4-29-88	DCR 5-6-88	
2	BMc	Rev. per County Comments Ltr. Dtd 11-3-87	DCR 3-1-88	
1	BMc	Rev. per County Comments Ltr. Dtd. 10-13-87	DCR 10-5-87	
No.	By	Revision	Date	App.

Bldg. 3'-2"x8'-2" (vertical) from Public Works and CGA

RALPH C. SIMMONS No. 018288 PROFESSIONAL ENGINEER COMMONWEALTH OF VIRGINIA

TOANO WOODS SUBDIVISION

SUBDIVISION PLAN

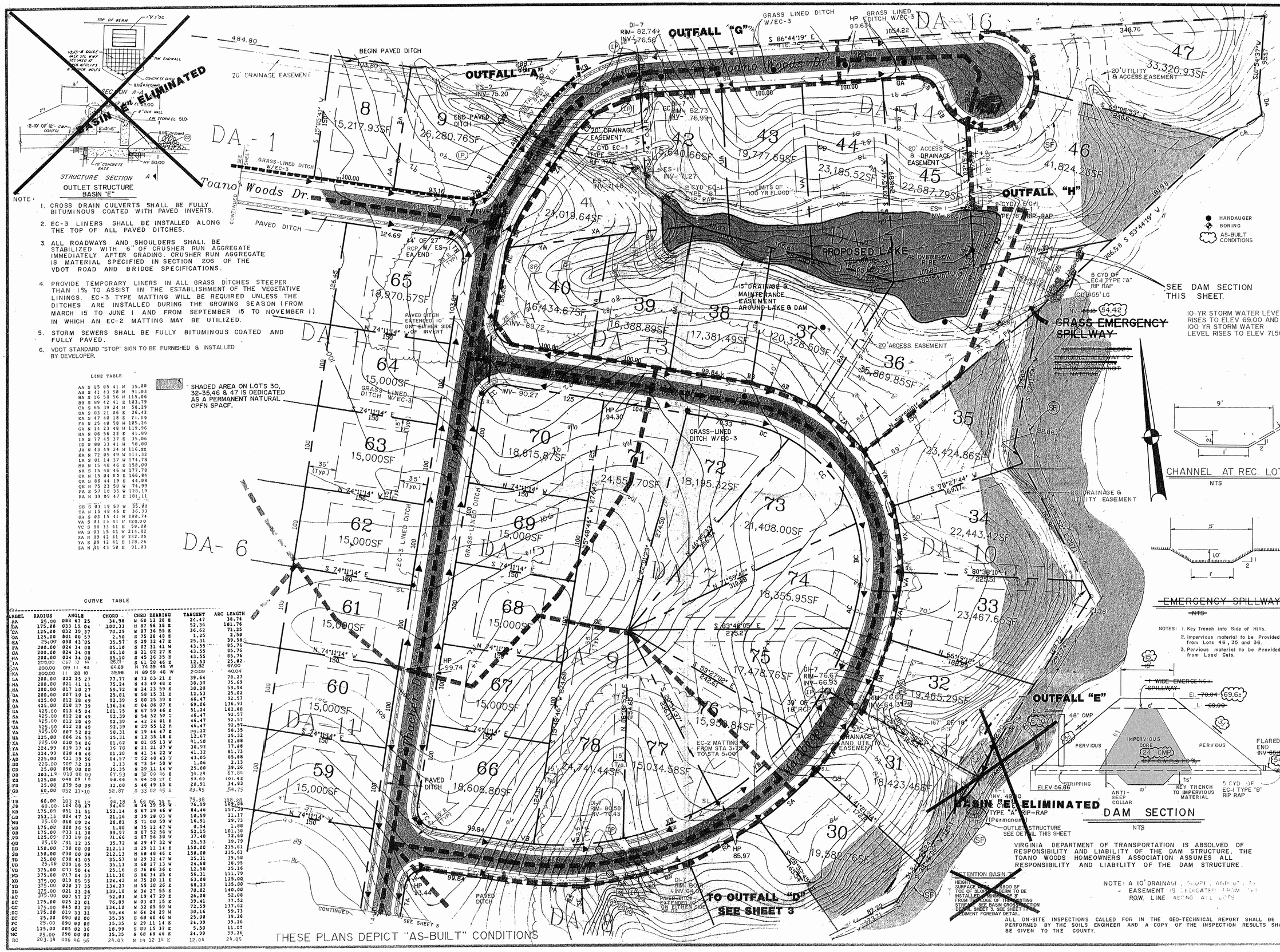
RETENTION POND "AS-BUILT"

JAMES CITY COUNTY, VIRGINIA

RECEIVED JUN 24 2000

98188

2



NOTE:

1. CROSS DRAIN CULVERTS SHALL BE FULLY BITUMINOUS COATED WITH PAVED INVERTS.
2. EC-3 LINERS SHALL BE INSTALLED ALONG THE TOP OF ALL PAVED DITCHES.
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NA	S 15 48 46	W	177.78		
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QB	N 75 23 50	W	74.99		
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RC	203.14	006 46 56	24.03	N 19 12 14 E	12.04	24.05

VIRGINIA DEPARTMENT OF TRANSPORTATION IS ABSOLVED OF RESPONSIBILITY AND LIABILITY OF THE DAM STRUCTURE. THE TOANO WOODS HOMEOWNERS ASSOCIATION ASSUMES ALL RESPONSIBILITY AND LIABILITY OF THE DAM STRUCTURE.

NOTE: A 10' DRAINAGE, SLOPE, AND UTILITY EASEMENT IS DEDICATED FROM THE R.O.W. LINE ALONG ALL LOTS

ALL ON-SITE INSPECTIONS CALLED FOR IN THE GEO-TECHNICAL REPORT SHALL BE PERFORMED BY THE SOILS ENGINEER AND A COPY OF THE INSPECTION RESULTS SHALL BE GIVEN TO THE COUNTY.

App	Date	Revision
DCR	10-17-88	Rev. per Engineer
DCR	1-13-89	Rev. per Verbal Comments D.E.C.
DCR	1-4-89	Rev. as per Developer
DCR	8-9-88	Rev. per County Comments Ltr. Dtd. 7-20-88
DCR	7-5-88	REV. PER WRITTEN COMMENTS FROM DEC DTD 5-26-88
DCR	5-6-88	Rev. per County Comments Ltr. Dtd. 4-29-88
DCR	3-1-88	Rev. per County Comments Ltr Dtd 11-3-87
DCR	10-5-87	As per Comments Verbal From Public Works and CESA
App.	Date	Revision

8 DPB REV FOR RESUBMITTAL
9 DPB REV PER COUNTY

Rickmond Engineering, Inc.
Civil Engineering
Environmental Engineering
Land Development Planning
7455-F Merrimac Trail
Williamsburg, VA 23185
(804) 565-1776 or 565-1782

Designed by	Drawn by	Approved by	Scale	Date	Job No.
RMJ	RJH	RCS	1" = 50'	10/7/88	98188

10 DPB REV PER COUNTY COMMENTS LTR DTD 5/28/91 RCS 6/6/91
9 RMJ REV PER COUNTY COMMENTS LTR DTD 3/27/91 RCS 4/11/91
10 DPB REV PER COUNTY COMMENTS LTR DTD 9/28/90 RCS 11/9/90
11 DPB REV PER COUNTY COMMENTS LTR DTD 4/10/91 RCS 4/11/91

COMMONWEALTH OF VIRGINIA
RALPH C. SIMMONS
No. 016288
PROFESSIONAL ENGINEER

TOANO WOODS SUBDIVISION

SUBDIVISION PLAN

RETENTION POND "AS-BUILT"

JAMES CITY COUNTY VIRGINIA

Job No. 98188 Sheet No. 2

MEMORANDUM

Date: March 7, 2002

To: File

From: Darryl E. Cook, Environmental Director DEC

Subject: Toano Woods

The Toano Woods dam has been corrected to an acceptable condition to allow for the release of the project surety. The remaining issue to be resolved was the raising of the top of the dam to eliminate the sag in the dam profile that caused the low point of the dam to be in the middle of the embankment.

The original request was to raise the top of the dam to an assumed elevation of 71, which is an elevation one foot higher than the top of the sewer manhole on the north end of the dam. The dam was raised by the contractor but upon completion, it was determined that the top was raised to elevation 70 rather than 71. An analysis was conducted to determine if this was acceptable. The calculations performed indicated that the 100-year storm would be passed safely through the dam but not with the normal freeboard required in most structures. However during Hurricane Floyd, the elevation of the water in the pond did not rise more than about 2 feet much less than the 4 feet available in the pond before it would flow over the northern portion of the dam. In addition, the elevation of exposed foundation of the house on lot 46 is at about elevation 70.7. Raising the top of the dam to elevation 71 would increase the chance that water could rise to an elevation that would impact the structure. Therefore, in view of the performance of the pond during Floyd and the fact that an adjacent structure might be impacted if the top of the dam were raised any higher, the elevation of 70 is an acceptable height for the dam. Water will flow around the north end of the dam before it would be overtopped during a storm event.

BY: SAT DATE: 2-13-02 SHEET ___ OF ___

CHKD: ___ DATE: ___ PROJECT NO.

APRVD: ___ DATE: ___ TOANO WOODS SWM FAC.

DEVELOPMENT MANAGEMENT

101-E MOUNTS BAY ROAD, P.O. BOX 8784, WILLIAMSBURG, VIRGINIA 23187-8784
(757) 253-6671 Fax: (757) 253-6850 E-MAIL: devtman@james-city.va.us

CODE COMPLIANCE (757) 253-6626 codecomp@james-city.va.us
ENVIRONMENTAL DIVISION (757) 253-6670 environ@james-city.va.us
PLANNING (757) 253-6685 planning@james-city.va.us
COUNTY ENGINEER (757) 253-6678
INTEGRATED PEST MANAGEMENT (757) 253-2620

POND PACK VERSION 6.0

SCS UNIT HYDROGRAPH

DA = 40.5 AC
CN = 78
T_c = 0.9 hrs. (54 minutes)

DAM DATA

Riser: Crest 65.0; 48" ϕ
Barrel: 24" ϕ CMP; INV OUT. 54.4; 100' @ 1.16%
ES: CONTRACTED, ~~CREST~~ BW 20.0; CREST 69.0; COEFF 3.1

ELEV	AREA AC.	Volume (AC-FT)	Cum VOL (AC-FT)
65.0	0.6198	0.00	0.00
66.0	0.6887	0.654	0.654
67.0	0.7576	0.723	1.377
68.0	0.8322	0.795	2.171
69.0	0.9091	0.870	3.042
70.0	0.9757	0.942	3.984

BASE MODEL	IN	OUT	WSEL
2-YEAR	33.51 CFS	20.06	66.92
10-YEAR	78.27 CFS	42.93	69.12
25-YEAR	90.64 CFS	58.88	69.48
100-YEAR	124.12 CFS VOL.	DAM OVERTOPS	

ADJUST ES TO
CREST EL. 69.20
BW 28.0

DAM OVERTOPS 100-YR.

Lower Emergency Spwy to 68.5 - 10 year - 68.85 100 yr - 69.59

CRP

Concrete Pipe & Products Company, Inc.

TOANO WOODS DAM 2/11/02 DEC

Field Check on Raising Top of DAM

Use torpedo level

BS - Manhole - assume elev 70

BS ~~at~~ # + 3.0

HI 73.0

	73.0 BS	Elev
45' from MH	3.4	69.6
60' from MH	3.2	69.8
75' from MH	3.3	69.7
90' from MH	3.10	69.9
115	3.05	69.95
130	3.05	69.95
30'	4.1	68.9
12'	3.9	69.1
45'	4.0	69.0

TOANO WOODS DAM

9/13/00

BS - Manhole 3.51
Assume elev -70
73.51

	HI	-	ELEV
	73.43 ~~73.57~~		
Water Surface	73.43	8.43	65.0
0 10' behind MH		3.53	69.9
10 adj to MH		3.72	69.71
20		4.30	69.13
30		4.50	68.93
40		4.36	69.07
50		4.45	68.98
60		4.73	68.7
70		4.83	68.60
80		4.71	68.72
105		4.36	69.07
130		3.75	69.68
155		3.20	70.23
180 - returns to natural grade		2.48	70.95
205		2.0	71.43
-10		3.56	69.87
-20		3.55	69.88
-30		2.91	70.52
House - foundation		2.73	70.7
prop line - 54' from MH		4.81	68.62

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Natural ground is from MH & back —

TOANO WOODS DAM

2/12/02

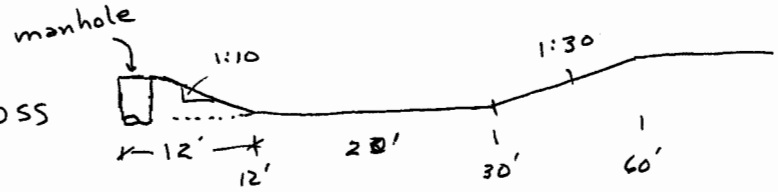
Evaluation of As-Built Info.

Top of Dam raised to elevation 69.8 to 70.0

Emergency Spillway crested on left-side of dam Looking downstream.

E.S. - elev - 69 ±

bottom width = 20' w/ 1:20 SS



Capacity of 40' spway @ 0.7' depth = 48 cfs

Riser elev. 65.0 - 48"

Emergency 69

Top of Dam 69.8

Q riser - 120 cfs @69

Q_{100} - 123 cfs

Q_{barrel} - H = 69 - 55.5 = 13.5' - 24"

length = 100'

Q = 40.5 × .89 = 36 cfs

100' long Inv elev = 54.4

Slope = 1.6%

STAGE	SURFACE A		STORAGE
65	27,000	0.62	0
66	30,000	0.69	0.65
67	33,000	0.75	1.37
68	36250	0.83	2.16
69	39,600	0.91	3.03
70	42,500	1.0	3.97

Q_i = 123.1

V_t = 18.2

V_s = 3.03 > 0.167 ⇒ $\frac{Q_o}{Q_i}$ = 0.8

Q_o = 36 cfs

Q_o = .8 × 123 = 98 cfs

G. U.S. Navy

There was no status report on activities from the U.S. Navy.

H. Local Programs

Mr. Noyes indicated that the meeting of the Area III Soil and Water Conservation Districts would be held on April 19, 2001

The RSMC members generally discussed the current budget process and any potential increases in SWM fees. Only VB indicated an intent to raise fees for the next Fiscal Year.

Mr. Bernick indicated that the DEQ Public Hearing on the new wetlands regulations would be held on April 5, 2001 in Chesapeake. He indicated that the VB Comprehensive Plan would be reviewed by the CBLA Board for consistency on March 19, 2001. The Stumpy Lake purchase is being finalized. City Council has reacted positively to the VB Outdoors Plan and is considering a bond referendum of roughly %50 - 75 Million to finance open space acquisition.

Ms. Bennett reminded attendees of the Watershed Conference on March 12 and 13, 2001. She also pointed out that York County had recently sent out notices concerning the CBPA septic tank pumpout requirement to a portion of the County. They had achieved nearly 90% compliance with the pumpout requirement.

11. Other Matters

There were no other matters for discussion.

TOANO Woods

Top of dam - 69.6

(our survey shows it varying from 68.6 to 70.2

As-built calcs - 10 year - elev 69.00
100 year - 71.50 } on plan

calcs - 100 year - 72.78

RCN = 78
t_c = 0.92

Riser - 67.07 -

our survey - Water line = 65.0

Storage calcs go from 67.07 to 69.6

Original Design

Top of Dam - 74.0

Riser - 68.0

Outlet - 56.0

Emergency - 71.0

Reservoir Report

English

Reservoir No. 1 - SEDIMENT BASIN/BMP

Pond Data

Pond storage is based on known contour areas

Stage / Storage Table

Stage ft	Elevation ft	Contour area sqft	Incr. Storage cuft	Total storage cuft
0.00	73.50	457	0	0
0.50	74.00	694	288	288
1.50	75.00	1,189	942	1,229
2.50	76.00	1,708	1,449	2,678
3.50	77.00	2,252	1,980	4,658
4.50	78.00	2,822	2,537	7,195
5.50	79.00	3,417	3,120	10,314

Culvert / Orifice Structures

	[A]	[B]	[C]	[D]
Rise in	= 6.0	2.0	0.0	0.0
Span in	= 6.0	2.0	0.0	0.0
No. Barrels	= 1	1	0	0
Invert El. ft	= 70.50	73.50	0.00	0.00
Length ft	= 50.0	0.0	0.0	0.0
Slope %	= 1.00	0.00	0.00	0.00
N-Value	= .013	.013	.000	.000
Orif. Coeff.	= 0.60	0.60	0.00	0.00
Multi-Stage	= -----	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len ft	= 12.7	0.0	0.0	0.0
Crest El. ft	= 76.00	0.00	0.00	0.00
Weir Coeff.	= 3.08	0.00	0.00	0.00
Eqn. Exp.	= 1.50	0.00	0.00	0.00
Multi-Stage	= Yes	No	No	No

Tailwater Elevation = 0.00 ft

Note: All outflows have been analyzed under inlet and outlet control.

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	Clv D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Discharge cfs
0.00	0	73.50	1.18	0.00	---	---	0.00	---	---	---	0.00
0.50	288	74.00	1.27	0.07	---	---	0.00	---	---	---	0.07
1.50	1,229	75.00	1.44	0.13	---	---	0.00	---	---	---	0.13
2.50	2,678	76.00	1.59	0.16	---	---	0.00	---	---	---	0.16
3.50	4,658	77.00	1.73	0.00	---	---	38.99	---	---	---	1.73
4.50	7,195	78.00	1.86	0.00	---	---	110.29	---	---	---	1.86
5.50	10,314	79.00	1.98	0.00	---	---	202.61	---	---	---	1.98

Toano Wds

Original Design -

Top Dam 71.67

100-year	71.15	- RCN 70	- original	
w/ Computer	69.93	- RCN 70	No	
w/ Computer	71.42	- " 78		
w/ computer w/ Ests	69.94	- RCN 78 LC Soils		10' wide ES @ 69.0

- Sense

Build up to 71 -

ES @ 69.3

20' wide

Keep HW @ 70

James City County Environmental Division
Stormwater Management / BMP Inspection Report
Detention and Retention Pond Facilities

Database Inventory No. (if known): _____

Name of Facility: TORNO WOODS POND BMP No.: _____ Date: 9/14/00

Location: _____

Name of Owner: _____

Inspector: _____

Type of Facility: _____

Weather Conditions: Warm, Sunny, Dry

If an inspection item is not applicable, mark NA, otherwise mark the appropriate column.

O.K. - The item checked is in adequate condition and the maintenance program is currently satisfactory.
Routine - The item checked requires attention, but does not present an immediate threat to the function of the BMP.
Urgent - The item checked requires immediate attention to keep the BMP operational and prevent damage to the facility.

Provide an explanation and details in the comment column, if routine or urgent are marked.

Facility Item	O.K.	Routine	Urgent	Comments
Embankments and Side Slopes:				
Grass Height	X			Good grass cover + maintenance
Vegetated Condition			X	Much woody vegetation on downstream +
Weed Growth			X	upstream faces - needs to be removed by cutting flush.
Erosion	X			
Trash & Debris	X			
Seepage		X		Some seepage noted to the south of the outfall pipe (25' away). Needs to be watched for changes.
Fencing or Benches				Non present or required
Constructed Wetlands (Interior Landscaped & Planted) Areas:				
Vegetated Conditions	NA			
Trash & Debris				
Floatables				
Erosion				
Sediment				
Dead Plant				
Aesthetics				
Other				

Facility Item	O.K.	Routine	Urgent	Comments
Water Pools ❒ Permanent Pool (Retention Basin) ❒ Shallow Marsh (Detention Basin)				
Shoreline Erosion				
Algae		X		
Trash & Debris				
Sediment				
Aesthetics				
Other				
Inflow Stuctures (Describe Locations):				
Condition of Structure				
Erosion				
Trash and Debris				
Sediment				
Aesthetics				
Other				
Principal Flow Control Structure - Intake, Riser, etc. (Describe Location):				
Condition of Structure				
Corrosion				
Trash and Debris				
Sediment				
Aesthetics				
Other				
Principal Outlet Structure - Barrel, Conduit, etc. :				
Condition of Structure	X			
Settlement	X			None observed
Trash & Debris	X			
Sediment	X			
Erosion	X			Minor erosion - plunge pool ~~bene~~ downstream of riprap protection - no problem, monitor
Other				
Emergency Spillway (Overflow):				
Vegetation				
Lining				
Erosion				
Trash & Debris				
Other				

Facility Item	O.K.	Routine	Urgent	Comments
Nuisance Type Conditions:				
Mosquito Breeding				
Animal Burrows				
Graffiti				
Other				
Surrounding Perimeter Conditions:				
Land Uses				
Vegetation				
Trash & Debris				
Aesthetics				
Access /Maintenance Roads or Paths				
Other				

Remarks:

Overall Environmental Division Internal Rating: _____

Signature: _____ **Date:** _____

Title: _____

SWMProg\BMP\CoInspProg\DetRet.wpd

DAM SAFETY PROGRAM

DEPARTMENT OF CONSERVATION & RECREATION

Division of Dam Safety
203 Governor Street, Suite 402
Richmond, Virginia 23219-2094

OWNER'S ANNUAL INSPECTION FORM

Name of Dam _____ Inventory Number _____

Name of Reservoir _____ County/City _____

Owner's Name _____ Hazard Class I, II, III or IV _____

Address _____ Inspected by _____

_____ Date _____

Telephone (___)_____

DIRECTIONS: MARK "X" in YES, NO or N/A COLUMN

ITEM	YES	NO	N/A	REMARKS
1. GENERAL CONDITIONS				
A. Alterations to dam?				
B. Development in downstream flood plain?				
C. Grass cover adequate? (embankment & spillway)				
D. Settlements, misalignment, or cracks?				
E. Recent high water marks?				Elevation:
2. UPSTREAM SLOPE				
A. Erosion?				
B. Trees?				
C. Rodent holes?				
D. Cracks, settlement, or bulges?				
E. Adequate and sound riprap?				
3. INTAKE STRUCTURE ☐ Concrete ☐ Metal				Water Surface Elevation:
A. Spalling, cracking, scaling?				
B. Exposed reinforcement?				
C. Corrosion present?				
D. Coating adequate?				
E. Leakage?				
F. Trash rack adequate?				
G. Obstacles to inlet?				
H. Drawdown operative? ☐ Closed ☐ Open				
4. ABUTMENT CONTACTS				
A. Erosion, cracks or slides?				
B. Seepage?				Estimated GPM:
5. EMERGENCY SPILLWAY				
A. Obstructions?				
B. Erosion?				
C. Rodent holes?				
6. DOWNSTREAM SLOPE				
A. Erosion?				
B. Trees?				
C. Rodent holes?				

ITEM	YES	NO	N/A	REMARKS
D. Cracks, settlements or bulges?				
E. Drains or wells flowing?				Estimated GPM:
F. Seepage or boils?				Estimated GPM:
7. CONDUIT AND OUTLET ☐ Concrete ☐ Metal				Tail water elevation and flow:
A. Spalling, cracking, scaling?				
B. Exposed reinforcement?				
C. Joints displaced or offset?				
D. Joint material lost?				
E. Leakage?				
F. Earth erosion?				
G. Conduit misaligned?				
H. Outlet channel obstructed?				
8. STILLING BASIN				
A. Spalling, cracking, scaling?				
B. Exposed reinforcement?				
C. Joints displaced or offset?				
D. Joint material lost?				
E. Joints leak?				
F. Rock adequate?				
G. Dissipators deteriorating?				
H. Dissipators clean of debris?				
9. CONCRETE SPILLWAY				
A. Spalling, cracking, scaling?				
B. Exposed reinforcement?				
C. Joints displaced or offset?				
D. Joint material lost?				
E. Leakage?				
F. Dissipators deteriorating?				
G. Dissipators clean of debris?				
H. Earth erosion?				
I. Outlet channel eroding?				
10. GATES				
A. Floodgates broken, bent?				
B. Floodgates eroded or rusted?				
C. Floodgates operational?				
11. RESERVOIR				
A. Development?				
B. Slides or erosion on banks?				
C. Reservoir managed?				
12. INSTRUMENTS				
A. Is structure instrumented?				
B. Monitoring performed?				
13. SHOULD DAM BE INSPECTED BY ENGINEER?				
14. REEVALUATE HAZARD CLASSIFICATION				
15. IS EMERGENCY ACTION PLAN CURRENT?				
REMARKS:				

Tozno Wds

RCN = 78 T_c = 0.9 hr DA = 40.5 ac

P = 8.0 Runoff = $\frac{5.4'' \times 40.5}{12''/ft}$ = 18.225 acft

I_a = .564

$q_u = 150 \frac{cfs}{mi^2 \cdot in} \times 5.4\ in \times \frac{40.5}{640} = 51.2$ cfs

170 × 5.4 × 58 cfs

Q_i = 52 cfs
Q_o = 36 cfs > 0.69 => $\frac{V_s}{V_r}$ = 0.21

V_r = 18.2

V_s = (0.21)(18.2) = 3.8 acft

$V_{s\ req}$ = 3.8 acft

$V_{s\ prov}$ = 3.0 acft

Original Q_{100} - 63 cfs

with a subcommittee prior to further Committee discussion. The subcommittee will consist of Ms. James-Webb and Messrs. Bernick and Noyes. Mr. Brown agreed to work with the HRPDC staff in developing the strawman.

7. Chesapeake Bay Program Watershed Management Plan Task Force

Because Ms. Ring was unable to attend the meeting, Mr. Brown provided an overview of the activities of the CBP Watershed Management Plan Task Force. The Task Force had met on February 26, 2001. Mr. Brown distributed copies of a presentation on the work of the Task Force and a draft of recommended plan components. The plan content and requirements were discussed at great length with considerable concern expressed about the role of local governments in the watershed planning process. Based on the discussion, the Committee recommended that:

- Any watershed plan must be adopted by the local governing body as an element of its comprehensive plan.
- All proposals for grant funding for plan preparation should be reviewed and endorsed by the locality. In the case of multiple proposals affecting more than one watershed(s) in a locality, the local governing body should prioritize the proposals.
- Any proposal for a watershed plan should receive written endorsement by the affected Soil and Water Conservation District.
- Where proposals and/or plans affect federal lands, the cognizant federal agency should be involved.
- The C2K commitments to prepare wetlands plans should be incorporated into the watershed planning process.

The HRPDC staff was requested to advise Ms. Ring of the Committee's position on the watershed plans.

8. General Assembly Report

Mr. Carlock briefly reviewed the status of a number of wetlands, Chesapeake Bay and stormwater/erosion and sediment control bills and studies acted upon by the General Assembly.

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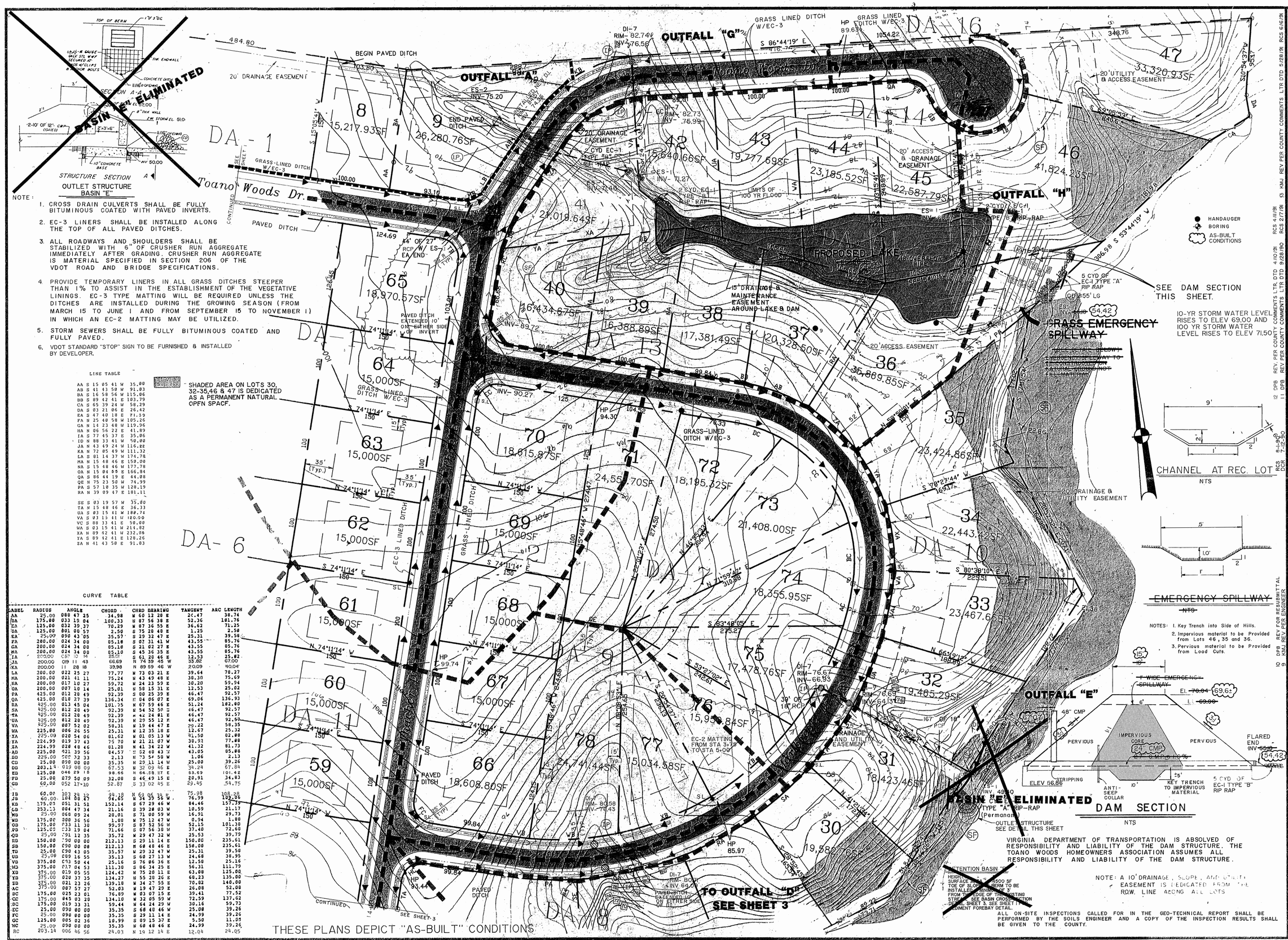

NOTE:

1. CROSS DRAIN CULVERTS SHALL BE FULLY BITUMINOUS COATED WITH PAVED INVERTS.
2. EC-3 LINERS SHALL BE INSTALLED ALONG THE TOP OF ALL PAVED DITCHES.
3. ALL ROADWAYS AND SHOULDERS SHALL BE STABILIZED WITH 6" OF CRUSHER RUN AGGREGATE IMMEDIATELY AFTER GRADING. CRUSHER RUN AGGREGATE IS MATERIAL SPECIFIED IN SECTION 206 OF THE VDOT ROAD AND BRIDGE SPECIFICATIONS.
4. PROVIDE TEMPORARY LINERS IN ALL GRASS DITCHES STEEPER THAN 1% TO ASSIST IN THE ESTABLISHMENT OF THE VEGETATIVE LININGS. EC-3 TYPE MATTING WILL BE REQUIRED UNLESS THE DITCHES ARE INSTALLED DURING THE GROWING SEASON (FROM MARCH 15 TO JUNE 1 AND FROM SEPTEMBER 15 TO NOVEMBER 1) IN WHICH AN EC-2 MATTING MAY BE UTILIZED.
5. STORM SEWERS SHALL BE FULLY BITUMINOUS COATED AND FULLY PAVED.
6. VDOT STANDARD "STOP" SIGN TO BE FURNISHED & INSTALLED BY DEVELOPER.

SHADED AREA ON LOTS 30, 32-35,46 & 47 IS DEDICATED AS A PERMANENT NATURAL OPEN SPACE.

LINE TABLE

AA	S	15 05 41	W	35.00
AB	S	41 43 50	W	91.03
BA	S	16 58 56	W	115.06
BB	S	89 42 41	E	103.79
CA	S	65 39 24	W	58.29
DA	S	03 21 06	E	26.42
EA	S	47 40 18	E	71.59
FA	N	25 40 58	W	105.26
GA	N	14 23 48	W	119.96
HA	N	06 56 22	E	41.89
IA	S	77 45 37	E	35.06
JA	N	88 33 41	W	50.00
KA	N	43 49 24	W	116.02
LA	N	72 05 49	W	111.32
MA	S	01 14 37	W	174.78
NA	N	15 48 46	E	150.00
OA	N	15 48 46	W	177.78
PA	N	15 04 59	E	166.84
QA	S	86 44 19	E	44.08
QB	N	75 23 50	W	74.99
RA	S	57 18 35	W	128.19
RB	N	39 09 47	E	181.11
SB	S	03 19 57	W	35.00
TA	N	15 48 46	E	36.33
UA	S	03 15 41	W	180.74
VA	S	03 15 41	W	120.00
VC	S	88 33 41	E	50.00
WA	S	03 15 41	W	214.82
XA	N	89 42 41	W	232.06
YA	S	89 42 41	E	128.26
ZA	N	41 43 50	E	91.03

CURVE TABLE

LABEL	RADIUS	ANGLE	CHORD	CHRD BEARING	TANGENT	ARC LENGTH
AA	25.00	080 47 25	34.98	N 60 12 20 E	24.47	38.74
BA	175.00	033 12 04	100.33	N 87 56 38 E	52.36	101.76
CA	125.00	032 39 37	70.29	N 87 56 55 E	36.62	71.25
DA	125.00	001 00 57	2.50	S 75 20 40 E	1.25	2.50
EA	25.00	090 43 05	35.57	S 29 32 47 E	25.31	39.58
FA	200.00	024 34 00	85.18	S 02 11 41 W	43.55	85.76
GA	200.00	024 34 00	85.18	S 21 02 27 E	43.55	85.76
HA	200.00	024 34 00	85.18	S 45 36 35 E	43.55	85.76
IA	200.00	087 10 34	28.07	S 61 39 46 E	12.53	25.02
JA	200.00	019 11 43	66.69	N 74 59 45 W	33.82	67.00
KA	200.00	11 28 18	39.98	N 89 59 46 W	20.09	40.04
LA	200.00	022 25 27	77.77	N 73 03 21 E	39.64	78.27
MA	200.00	021 41 11	75.24	N 43 49 48 E	38.30	75.69
NA	200.00	017 10 27	59.72	N 24 23 53 E	30.20	59.94
OA	200.00	007 10 34	25.01	N 58 15 31 E	12.53	25.02
PA	425.00	012 28 49	92.39	S 00 25 39 E	46.47	92.57
QA	425.00	018 27 39	136.34	N 04 06 07 E	69.06	136.93
RA	425.00	013 45 04	101.75	N 67 59 46 E	51.24	102.00
SA	425.00	012 28 49	92.39	N 54 52 50 E	46.47	92.57
TA	425.00	012 28 49	92.39	N 42 24 01 E	46.47	92.57
UA	425.00	012 28 49	92.39	N 29 55 12 E	46.47	92.57
VA	425.00	007 52 02	58.31	N 19 44 47 E	29.22	58.35
WA	225.00	006 26 55	25.31	N 12 35 18 E	12.67	25.32
XA	225.00	020 54 06	81.62	N 01 05 13 W	41.50	82.08
YA	224.99	019 37 43	76.70	N 21 21 07 W	38.93	77.08
ZA	224.99	020 40 46	81.28	N 41 34 22 W	41.32	81.73
AB	225.00	021 39 56	84.57	N 62 40 43 W	43.05	85.08
BB	225.00	000 32 33	2.13	N 73 54 50 W	1.06	2.13
CB	25.00	090 00 00	35.35	N 29 11 14 W	25.00	39.26
DB	203.14	019 00 09	67.53	N 32 09 46 E	34.24	67.84
EB	125.00	046 29 18	98.66	N 64 28 37 E	53.69	101.42
FB	25.00	079 50 09	32.00	S 46 49 15 E	20.91	34.83
GB	60.00	052 17 10	52.87	S 33 02 45 E	28.45	54.75
IB	60.00	103 [illegible] 35	[illegible]	N 52 [illegible] 06 E	75.98	108.28
JB	60.00	104 00 35	94.28	N 54 59 36 W	76.99	109.96
KB	175.00	051 31 51	152.14	S 67 29 46 W	84.46	157.39
LB	253.13	004 47 34	21.16	S 39 28 03 W	10.59	21.17
MB	25.00	068 09 24	28.01	S 71 00 59 W	16.91	29.73
NB	175.00	000 36 56	1.80	N 75 12 47 W	0.94	1.80
OB	175.00	033 11 30	99.97	S 87 52 56 W	52.15	101.38
PB	125.00	033 19 04	71.66	S 87 56 30 W	37.40	72.60
QB	25.00	091 12 35	35.72	N 29 47 32 W	25.53	39.79
RB	150.00	090 00 00	212.13	S 29 11 14 E	150.00	235.61
SB	150.00	090 00 00	212.13	N 60 48 46 E	150.00	235.61
TB	25.00	090 43 05	35.57	N 29 32 47 W	25.31	39.58
UB	25.00	089 16 55	35.13	S 60 27 13 W	24.68	38.95
VB	375.00	043 50 44	25.16	S 76 06 36 E	12.58	25.16
WB	375.00	017 04 53	111.30	S 86 34 25 E	56.31	111.79
XB	375.00	019 07 29	124.42	S 75 20 11 E	63.00	125.00
YB	375.00	020 37 35	134.27	N 55 20 26 E	68.23	135.00
ZB	375.00	021 23 26	139.18	N 34 27 55 E	70.02	140.00
AC	375.00	007 52 27	52.03	N 19 07 29 E	26.08	52.08
BC	175.00	025 23 01	76.09	N 03 07 15 E	39.41	77.52
CC	175.00	045 03 29	134.10	N 32 05 59 W	72.59	137.62
DC	175.00	019 43 31	59.44	N 64 24 29 W	30.16	59.73
EC	25.00	090 00 00	35.35	S 68 48 46 W	25.00	39.26
FC	25.00	090 00 00	35.35	S 29 11 14 E	24.99	39.26
GC	125.00	005 02 36	10.99	S 09 15 37 E	5.50	11.05
HC	25.00	090 00 00	35.35	N 60 48 46 E	24.99	39.26
RC	203.14	006 46 56	24.03	N 19 12 14 E	12.04	24.05

VIRGINIA DEPARTMENT OF TRANSPORTATION IS ABSOLVED OF RESPONSIBILITY AND LIABILITY OF THE DAM STRUCTURE. THE TOANO WOODS HOMEOWNERS ASSOCIATION ASSUMES ALL RESPONSIBILITY AND LIABILITY OF THE DAM STRUCTURE.

NOTE: A 10' DRAINAGE, SLOPE, AND UTILITY EASEMENT IS DEDICATED FROM THE R.O.W. LINE ALONG ALL LOTS

ALL ON-SITE INSPECTIONS CALLED FOR IN THE GEO-TECHNICAL REPORT SHALL BE PERFORMED BY THE SOILS ENGINEER AND A COPY OF THE INSPECTION RESULTS SHALL BE GIVEN TO THE COUNTY.

Revision	Date	By
8 DPB Rev. per Engineer	10-17-89	DCR
7 BMC Rev. per Verbal Comments D.E.C.	1-13-89	DCR
6 BMC Rev. as per Developer	1-4-89	DCR
5 BMC Rev. per County Comments Ltr. Dtd. 7-20-88	8-9-88	DCR
4 KMJ REV PER WRITTEN COMMENTS FROM DEC DTD 5-26-88	7-5-88	DCR
3 BMC Rev. per County Comments Ltr. Dtd. 4-29-88	5-6-88	DCR
2 BMC Rev. per County Comments Ltr. Dtd 11-3-87	3-1-88	DCR
1 BMC As per Comments (Verbal) from Public Works and CESA 10-2-87	10-5-87	DCR
No. 4y	Date	App.

10 DPB REV FOR RESUBMITTAL
9 KMJ REV PER ENGINEER
12 DPB REV. PER COUNTY COMMENTS LTR. DTD 4/10/91 RCS 4/11/91
11 DPB REV PER COUNTY COMMENTS LTR DTD 9/28/90 RCS 2/7/91
13 KMJ REV PER COUNTY COMMENTS LTR DTD 5/28/91 RCS 6/6/91

Rickmond Engineering, Inc.
Civil Engineering
Environmental Engineering
Land Development Planning
Williamsburg VA 23185
(804) 229-9[illegible]

Designed by KMJ | Drawn by RJH | Approved by RCS | Scale 1" = 50' | Date 10/7/88 | Job No. 98188

COMMONWEALTH OF VIRGINIA
RALPH C. SIMMONS
No. 018288
PROFESSIONAL ENGINEER

TOANO WOODS SUBDIVISION

SUBDIVISION PLAN

RETENTION POND "AS-BUILT"

JAMES CITY COUNTY VIRGINIA

Job Number 98188 | Sheet No. 2

YC 013

Letter of Transmittal	Date/Time: 6/16/99
Rickmond Engineering, Inc. 1643 Merrimac Trail Williamsburg, Virginia 23185 (757) 229-1776 • Fax (757) 229-4683 e-mail: rickmond @tni.net www.rickmond.com	Project #: 98188 Project Title: Toano Woods BMP "As-Built"

To: James City County Environmental Division

Address: P.O. Box 8784

City/State/Zip: Williamsburg, Va. 23187

Attn: Darryl Cook

RECEIVED JUN 1999 ENVIRONMENTAL DIVISION

We are sending you (X) Attached ( ) Under Separate cover

The following items:
( ) Shop Drawings ( ) Prints ( ) Samples ( ) Specifications ( ) Copy of Letter ( ) Change Order
( ) Other

Copies	Date	# of Pages	Description
2	6/16/99	—	Drainage Calculations
1	1/12/99	1	Initialized Comment Letter
			YC 013

These are transmitted as checked below:

(X) For Approval ( ) For Your Use ( ) As Requested ( ) For Review and Comment
( ) Other

Remarks: FILE: TOANO Woods

Copy to: _____ Signed: Kenneth Jenkins

J:\REI\FORMS\OFFICE\TRANSMIT.FRM

Letter of Transmittal	Date/Time: 1/11/01
Rickmond Engineering, Inc. 1643 Merrimac Trail Williamsburg, VA 23185 Phone: 757-229-1776 Fax: 757-229-4683 Email: rei@rickmond.com www.rickmond.com	Project #: 98188 Project Title: Toano Woods "As Built" Retention Pond

To: James City County Environmental Division

Address: P.O. Box 8784

City/State/Zip: Williamsburg, Va. 23187

Attn: Darryl Cook

Phone No.:

JAN 2001 RECEIVED ENVIRONMENTAL DIVISION

We are sending you (X) Attached ( ) Under Separate Cover _____

The following items:

( ) Shop Drawings ( ) Prints ( ) Samples ( ) Specifications ( ) Copy of Letter
( ) Change Order (X) Other Calculations

Copies	Date	# of Pages	Description
1	11/29/00	—	"As-Built" Calculations

These are transmitted as checked below:

(X) For Approval ( ) For Your Use ( ) As Requested ( ) For Review and Comment
( ) Other _____

Remarks:

Copy to:

Signed: Kenneth Jenkins

Toano Woods Pond

"As-Built" Drainage Calculations

November 29, 2000

Rickmond

ENGINEERING, INC.

COMMONWEALTH OF VIRGINIA
K.M. JENKINS II
No.022872
3/16/01
PROFESSIONAL ENGINEER

Project No. 98188

1643 Merrimac Trail
Williamsburg, VA 23185
Phone: 757-229-1776
Fax: 757-229-4683
rei@rickmond.com

Vint Hill • P.O.Box 861647
Warrenton, VA 20187
Phone: 540-349-7730
Fax: 540-349-7731
rickmond@citizen.infi.net

www.rickmond.com

Preface

The following drainage calculations pertain to the "as-built" conditions of the Toano Woods BMP Pond located in James City County, Virginia.

Currently, the dam is constructed in a sag condition. The dam elevation at natural grade at the north end is approximately Elev. 70.0 and Elev. 71.0 at the south end, with Elev. 68.6 in the middle. This is an unacceptable profile for a dam and will need to be repaired. The top of the dam should be filled to Elev. 71.0 from the south end to within 20' of the north end. The remaining 20' should be an emergency spillway at Elev. 69.3. With these improvements, the 100-year storm rises to Elev. 69.42.

```
1*******************************     PONDOPT
*******************************
 *******************************   Version 1.83
*******************************
 ******************   COMPUTER-AIDED HYDROLOGY & HYDRAULICS
******************
```

PROJECT: TOANO WOODS
User: Rickmond Engineering
Date: 11/29/2000 Wednesday
Time: 09:37:31
Output: TWP100.OUT

SOLUTION FOR 1 STORMS.

TIME INCREMENT: .100 Hours

STORM NUMBER	HYDROGRAPH IN FILE:
1	TW100.DAT

TAILWATER STAGE (ft)	STORM NUMBER	PEAK INFLOW (cfs)	ALLOWABLE PEAK DISCHARGE (cfs)	DURATION (min)	RUNOFF VOLUME (ft3)
50.000	1	101.495	N/A	1794.00	.6570E+06

```
1*******************************     PONDOPT
*******************************
 *******************************   Version 1.83
*******************************
 ******************   COMPUTER-AIDED HYDROLOGY & HYDRAULICS
******************
```

PROJECT: TOANO WOODS
User: Rickmond Engineering
Date: 11/29/2000 Wednesday
Time: 09:37:31
Output: TWP100.OUT

Stage-Area-Discharge
Filename: TWPOND.DAT

```
          TAILWATER STAGE:   50.000 feet.
            INITIAL STAGE:   65.000 feet.

 ==================   STAGE-STORAGE-DISCHARGE RELATIONSHIP
===================

 <<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<   STORM  1
>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
```

STAGE (ft)	STORAGE VOLUME (ac-ft)	DISCHARGE (cfs)
65.000	.0000	.0000
66.000	.6588	34.61
67.000	1.382	36.34
68.000	2.177	38.01
69.000	3.047	39.68
70.000	3.998	89.63
71.000	5.037	268.0

```
1*******************************     PONDOPT
*******************************
 *******************************   Version 1.83
*******************************
 ******************   COMPUTER-AIDED HYDROLOGY & HYDRAULICS
******************

 PROJECT: TOANO WOODS
    User: Rickmond Engineering
    Date: 11/29/2000 Wednesday
    Time: 09:37:31
  Output: TWP100.OUT


          TAILWATER STAGE:   50.000 feet.
            INITIAL STAGE:   65.000 feet.

 <<<<<<<<<<<<<<<<<<<<<   ROUTING RESULTS FOR STORM  1
>>>>>>>>>>>>>>>>>>>>>

     MAXIMUM ELEVATION:    69.42     feet.
        MAXIMUM INFLOW:    101.5     cfs.
       MAXIMUM OUTFLOW:    60.81     cfs.
       MAXIMUM STORAGE:    3.450     acre-feet.

      CONTINUITY ERROR:    -.520E-06 percent.
```

POND

TIME (min)	INFLOW RATE (cfs)	OUTFLOW RATE (cfs)	SURFACE ELEVATION (ft)
0	.000	.000	

65.000				
	6	.000	.000	|
65.000				
	12	.000	.000	|
65.000				
	18	.000	.000	|
65.000				
	24	.000	.000	|
65.000				
	30	.000	.000	|
65.000				
	36	.000	.000	|
65.000				
	42	.000	.000	|
65.000				
	48	.000	.000	|
65.000				
	54	.000	.000	|
65.000				
	60	.000	.000	|
65.000				
	66	.000	.000	|
65.000				
	72	.000	.000	|
65.000				
	78	.000	.000	|
65.000				
	84	.000	.000	|
65.000				
	90	.000	.000	|
65.000				
	96	.000	.000	|
65.000				
	102	.000	.000	|
65.000				
	108	.000	.000	|
65.000				
	114	.000	.000	|
65.000				
	120	.000	.000	|
65.000				
	126	.000	.000	|
65.000				
	132	.000	.000	|
65.000				
	138	.000	.000	|
65.000				
	144	.000	.000	|
65.000				
	150	.000	.000	|
65.000				
	156	.000	.000	|
65.000				
	162	.000	.000	|
65.000				
	168	.000	.000	|
65.000				
	174	.000	.000	|
65.000				
	180	.000	.000	|

65.000				
	186	.000	.000	
65.000				
	192	.000	.000	
65.000				
	198	.000	.000	
65.000				
	204	.000	.000	
65.000				
	210	.000	.000	
65.000				
	216	.000	.000	
65.000				
	222	.000	.000	
65.000				
	228	.000	.000	
65.000				
	234	.000	.000	
65.000				
	240	.000	.000	
65.000				
	246	.000	.000	
65.000				
	252	.000	.000	
65.000				
	258	.000	.000	
65.000				
	264	.000	.000	
65.000				
	270	.000	.000	
65.000				
	276	.000	.000	
65.000				
	282	.000	.000	
65.000				
	288	.000	.000	
65.000				
	294	.000	.000	
65.000				
	300	.000	.000	
65.000				
	306	.000	.000	
65.000				
	312	.000	.000	
65.000				
	318	.000	.000	
65.000				
	324	.000	.000	
65.000				
	330	.000	.000	
65.000				
	336	.000	.000	
65.000				
	342	.000	.000	
65.000				
	348	.000	.000	
65.000				
	354	.000	.000	
65.000				
	360	.000	.000	

65.000				
	366	.000	.000	|
65.000				
	372	.000	.000	|
65.000				
	378	.000	.000	|
65.000				
	384	.000	.000	|
65.000				
	390	.000	.000	|
65.000				
	396	.000	.000	|
65.000				
	402	.000	.000	|
65.000				
	408	.000	.000	|
65.000				
	414	.000	.000	|
65.000				
	420	.000	.000	|
65.000				
	426	.000	.000	|
65.000				
	432	.000	.000	|
65.000				
	438	.000	.000	|
65.000				
	444	.000	.000	|
65.000				
	450	.000	.000	|
65.000				
	456	.001	.000	|
65.000				
	462	.005	.001	|
65.000				
	468	.013	.004	|
65.000				
	474	.026	.010	|
65.000				
	480	.047	.019	|
65.001				
	486	.075	.034	|
65.001				
	492	.111	.055	|
65.002				
	498	.155	.083	|
65.002				
	504	.206	.118	|
65.003				
	510	.265	.160	|
65.005				
	516	.329	.209	|
65.006				
	522	.397	.264	|
65.008				
	528	.470	.324	|
65.009				
	534	.547	.390	|
65.011				
	540	.627	.460	|

65.013				
	546	.711	.535	|
65.015				
	552	.799	.613	|
65.018				
	558	.893	.696	|
65.020				
	564	.994	.785	|
65.023				
	570	1.101	.879	|
65.025				
	576	1.213	.978	|
65.028				
	582	1.330	1.083	|
65.031				
	588	1.455	1.193	|
65.034				
	594	1.586	1.310	|
65.038				
	600	1.722	1.433	|
65.041				
	606	1.868	1.562	|
65.045				
	612	2.028	1.700	|
65.049				
	618	2.211	1.850	|
65.053				
	624	2.418	2.016	|
65.058				
	630	2.645	2.200	|
65.064				
	636	2.897	2.404	|
65.069				
	642	3.177	2.629	|
65.076				
	648	3.502	2.883	|
65.083				
	654	3.872	3.170	|
65.092				
	660	4.275	3.492	|
65.101				
	666	4.734	3.853	|
65.111				
	672	5.267	4.262	|
65.123				
	678	5.917	4.737	|
65.137				
	684	6.693	5.296	|
65.153				
	690	7.564	5.950	|
65.172				
	696	8.787	6.744	|
65.195				
	702	10.623	7.800	|
65.225				
	708	14.345	9.471	|
65.274				
	714	22.112	12.595	|
65.364				
	720	36.054	18.477	|

65.534				
	726	54.828	28.097	
65.812				
	732	75.499	34.978	
66.213				
	738	92.518	35.937	
66.767				
	744	101.391	37.036	
67.417				
	750	101.495	38.133	
68.074				
	756	95.299	39.082	
68.642				
	762	85.408	44.402	
69.095				
	768	73.533	56.914	
69.345				
	774	62.157	60.813	
69.423				
	780	52.886	59.639	
69.400				
	786	45.628	55.935	
69.325				
	792	39.681	51.197	
69.231				
	798	34.528	46.169	
69.130				
	804	30.262	41.255	
69.032				
	810	26.795	39.549	
68.922				
	816	23.958	39.326	
68.788				
	822	21.648	39.066	
68.632				
	828	19.713	38.777	
68.459				
	834	18.053	38.464	
68.272				
	840	16.646	38.132	
68.073				
	846	15.476	37.763	
67.852				
	852	14.543	37.371	
67.618				
	858	13.818	36.972	
67.378				
	864	13.232	36.568	
67.137				
	870	12.667	36.137	
66.883				
	876	12.132	35.673	
66.614				
	882	11.647	35.208	
66.346				
	888	11.210	34.743	
66.077				
	894	10.789	28.559	
65.825				
	900	10.391	22.148	

65.640				
	906	9.995	17.883	
65.517				
	912	9.608	15.000	
65.433				
	918	9.234	13.010	
65.376				
	924	8.874	11.599	
65.335				
	930	8.531	10.565	
65.305				
	936	8.205	9.781	
65.283				
	942	7.899	9.164	
65.265				
	948	7.614	8.662	
65.250				
	954	7.352	8.242	
65.238				
	960	7.113	7.882	
65.228				
	966	6.897	7.569	
65.219				
	972	6.705	7.295	
65.211				
	978	6.537	7.054	
65.204				
	984	6.391	6.844	
65.198				
	990	6.265	6.660	
65.192				
	996	6.156	6.499	
65.188				
	1002	6.062	6.360	
65.184				
	1008	5.978	6.239	
65.180				
	1014	5.903	6.132	
65.177				
	1020	5.835	6.038	
65.174				
	1026	5.772	5.955	
65.172				
	1032	5.712	5.879	
65.170				
	1038	5.656	5.809	
65.168				
	1044	5.602	5.745	
65.166				
	1050	5.550	5.685	
65.164				
	1056	5.499	5.627	
65.163				
	1062	5.449	5.573	
65.161				
	1068	5.399	5.520	
65.159				
	1074	5.350	5.468	
65.158				
	1080	5.302	5.417	

65.157			
	1086	5.254	5.367
65.155			
	1092	5.206	5.318
65.154			
	1098	5.158	5.270
65.152			
	1104	5.110	5.221
65.151			
	1110	5.062	5.173
65.149			
	1116	5.015	5.125
65.148			
	1122	4.967	5.077
65.147			
	1128	4.919	5.029
65.145			
	1134	4.871	4.981
65.144			
	1140	4.823	4.934
65.143			
	1146	4.776	4.886
65.141			
	1152	4.728	4.838
65.140			
	1158	4.680	4.790
65.138			
	1164	4.632	4.742
65.137			
	1170	4.584	4.694
65.136			
	1176	4.536	4.646
65.134			
	1182	4.488	4.599
65.133			
	1188	4.440	4.551
65.131			
	1194	4.392	4.503
65.130			
	1200	4.344	4.455
65.129			
	1206	4.296	4.407
65.127			
	1212	4.248	4.359
65.126			
	1218	4.200	4.311
65.125			
	1224	4.152	4.263
65.123			
	1230	4.105	4.215
65.122			
	1236	4.057	4.167
65.120			
	1242	4.011	4.120
65.119			
	1248	3.965	4.073
65.118			
	1254	3.919	4.026
65.116			
	1260	3.875	3.980

65.115	1266	3.831	3.935	|
65.114	1272	3.789	3.890	|
65.112	1278	3.747	3.847	|
65.111	1284	3.707	3.804	|
65.110	1290	3.668	3.762	|
65.109	1296	3.629	3.722	|
65.108	1302	3.592	3.682	|
65.106	1308	3.557	3.644	|
65.105	1314	3.522	3.607	|
65.104	1320	3.489	3.570	|
65.103	1326	3.457	3.536	|
65.102	1332	3.425	3.502	|
65.101	1338	3.396	3.469	|
65.100	1344	3.367	3.438	|
65.099	1350	3.340	3.408	|
65.098	1356	3.313	3.379	|
65.098	1362	3.289	3.351	|
65.097	1368	3.265	3.324	|
65.096	1374	3.242	3.299	|
65.095	1380	3.221	3.275	|
65.095	1386	3.201	3.252	|
65.094	1392	3.182	3.231	|
65.093	1398	3.164	3.210	|
65.093	1404	3.148	3.191	|
65.092	1410	3.133	3.173	|
65.092	1416	3.119	3.156	|
65.091	1422	3.106	3.141	|
65.091	1428	3.095	3.126	|
65.090	1434	3.085	3.113	|
65.090	1440	3.076	3.102	|

65.090				
	1446	3.037	3.085	
65.089				
	1452	2.940	3.051	
65.088				
	1458	2.752	2.978	
65.086				
	1464	2.465	2.846	
65.082				
	1470	2.106	2.646	
65.076				
	1476	1.726	2.386	
65.069				
	1482	1.367	2.086	
65.060				
	1488	1.051	1.773	
65.051				
	1494	.794	1.470	
65.042				
	1500	.601	1.194	
65.035				
	1506	.458	.957	
65.028				
	1512	.351	.760	
65.022				
	1518	.266	.599	
65.017				
	1524	.202	.469	
65.014				
	1530	.153	.365	
65.011				
	1536	.116	.283	
65.008				
	1542	.088	.218	
65.006				
	1548	.066	.168	
65.005				
	1554	.050	.129	
65.004				
	1560	.037	.098	
65.003				
	1566	.028	.075	
65.002				
	1572	.020	.057	
65.002				
	1578	.015	.043	
65.001				
	1584	.010	.032	
65.001				
	1590	.007	.024	
65.001				
	1596	.004	.017	
65.000				
	1602	.002	.012	
65.000				
	1608	.001	.008	
65.000				
	1614	.000	.005	
65.000				
	1620	.000	.003	

```
65.000
         1626                .000                .002                |
65.000
         1632                .000                .001                |
65.000
         1638                .000                .001                |
65.000
         1644                .000                .001                |
65.000
         1650                .000                .000                |
65.000
1*******************************     PONDOPT
*******************************
 *******************************   Version 1.83
*******************************
 ******************   COMPUTER-AIDED HYDROLOGY & HYDRAULICS
*******************

 PROJECT: TOANO WOODS
    User: Rickmond Engineering
    Date: 11/29/2000 Wednesday
    Time: 09:37:31
  Output: TWP100.OUT
```

ROUTING SUMMARY ----------
SIMULATION MODE ----------
FOR THE ABOVE CASE ----------

STORM NUMBER	PEAK STAGE (ft)	PEAK STORAGE (ac-ft)	PEAK INFLOW (cfs)	PEAK OUTFLOW (cfs)
1	69.423	3.45	101.495	60.813

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TOANO WOODS BMP
"AS-BUILT" DRAINAGE
CALCULATIONS

June 16,1999

Rickmond

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Phone: 757-229-1776
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e-mail: rickmond@tni.net
www.rickmond.com

COMMONWEALTH OF VIRGINIA
K.M. Jenkins II
K.M. JENKINS II
No.022872
6/16/99
PROFESSIONAL ENGINEER

Project No. 98188

Preface

The following drainage calculations pertain to the "as-built" conditions of the Toano Woods BMP Pond located in James City County, Virginia.

The outlet structure of the existing pond is not adequate to pass the 100 year post-development storm without overtopping the dam. The top of the dam is at elevation 69.6 and the 100 year storm rises to elevation 72.78. Therefore the emergency spillway shown on the plans is required.

100 YEAR HYDROGRAPH

```
1*******************************     SCSHYDRO
*******************************
 *******************************   Version 3.21
*******************************
 ******************   COMPUTER-AIDED HYDROLOGY & HYDRAULICS
******************

 PROJECT: TOANO WOODS
    User: Rickmond Engineering
    Date: 06/16/1999 Wednesday
    Time: 12:53:23
   Input: TW100.IN
  Output: TW100.OUT



 ============================   PROGRAM EXECUTION
============================


                         NUMBER OF STORMS TO BE MODELED    :     1
                         NUMBER OF CHANNELS                :     0
                         NUMBER OF SUBAREAS                :     1
                         UPSTREAM HYDROGRAPHS ENTER AT     :     0
LOCATIONS
                         NUMBER OF TIME STEPS              :   300
                         COMPUTATIONAL TIME INCREMENT      :  .100 Hours

 NOTE:   The DURATION of the final computed hydrograph(s) for this
watershed
         system will be 30.000 hours.



 ========================   UNIT HYDROGRAPH METHODOLOGY
========================


 The SCS DIMENSIONLESS UNIT HYDROGRAPH is used in all runoff
computations.
 The peak rate factor (PRF) for all unit hydrographs is 484 (U.S.
Customary
 units) or 2.08356 (Metric units).
1*******************************     SCSHYDRO
*******************************
 *******************************   Version 3.21
*******************************
 ******************   COMPUTER-AIDED HYDROLOGY & HYDRAULICS
******************

 PROJECT: TOANO WOODS
    User: Rickmond Engineering
```

Date: 06/16/1999 Wednesday
Time: 12:53:23
Input: TW100.IN
Output: TW100.OUT

========== SUBAREA DATA
==========

SUBAREA ID NO	AREA (mi2)	TIME OF CONCENTRATION (hrs)	CURVE NUMBER	BASEFLOW (cfs)	DOWNSTREAM CHANNELS
1	.0633	.920	78.00	.0	

Composite Watershed Curve Number = 78.00
Minimum Subarea Time of Concentration = .920 hours.

1********** SCSHYDRO
****
********** Version 3.21
****
********** COMPUTER-AIDED HYDROLOGY & HYDRAULICS
****

PROJECT: TOANO WOODS
User: Rickmond Engineering
Date: 06/16/1999 Wednesday
Time: 12:53:23
Input: TW100.IN
Output: TW100.OUT

RETURN PERIOD (yrs): 100

========== RAINFALL HYETOGRAPH INFORMATION
==========

RAINFALL HYETOGRAPH: SCS TYPE II
RAINFALL DURATION: 24.00 Hours
RAINFALL DEPTH: 8.00 Inches

RAINFALL HYETOGRAPH,
SCS TYPE II
Time (Hours), Total Depth (Inches):

.000,	.00	2.000,	.18	4.000,	.38	6.000,	.64
7.000,	.78	8.000,	.96	8.500,	1.06	9.000,	1.18
9.500,	1.30	9.750,	1.38	10.000,	1.45	10.500,	1.63
11.000,	1.88	11.500,	2.26	11.750,	2.86	12.000,	5.30
12.500,	5.88	13.000,	6.18	13.500,	6.39	14.000,	6.56
16.000,	7.04	20.000,	7.62	24.000,	8.00		

```
1*******************************     SCSHYDRO
*******************************
 *******************************   Version 3.21
*******************************
 ******************   COMPUTER-AIDED HYDROLOGY & HYDRAULICS
******************

 PROJECT: TOANO WOODS
   Input: TW100.IN
  Output: TW100.OUT
                                                          RETURN PERIOD
(yrs):    100

    SUBAREA     1       SUBAREA     1       SUBAREA     1       SUBAREA
1


     AREA (square miles)          :        .0633
     TIME OF CONCENTRATION (hrs):        .92
     RUNOFF CURVE NUMBER          :      78.00
     BASEFLOW (cfs)               :        .00
     DOWNSTREAM CHANNELS          :

                                   SUBAREA RUNOFF (cfs)

 TIME:      +.00    +.10    +.20    +.30    +.40    +.50    +.60    +.70    +.80
+.90
 (hrs)      hrs     hrs     hrs     hrs     hrs     hrs     hrs     hrs     hrs
hrs
 _______  ______  ______  ______  ______  ______  ______  ______  ______  ______
______  |
   .00 |     .00     .00     .00     .00     .00     .00     .00     .00     .00
.00
  1.00 |     .00     .00     .00     .00     .00     .00     .00     .00     .00
.00
  2.00 |     .00     .00     .00     .00     .00     .00     .00     .00     .00
.00
  3.00 |     .00     .00     .00     .00     .00     .00     .00     .00     .00
.00
  4.00 |     .00     .00     .00     .00     .00     .00     .00     .00     .00
.00
  5.00 |     .00     .00     .00     .00     .00     .00     .00     .00     .01
.02
  6.00 |     .04     .06     .09     .12     .16     .21     .25     .30     .35
.40
  7.00 |     .45     .51     .56     .63     .70     .77     .85     .93    1.01
1.09
  8.00 |    1.17    1.24    1.32    1.41    1.51    1.61    1.73    1.84    1.96
2.08
  9.00 |    2.20    2.32    2.44    2.58    2.73    2.88    3.04    3.20    3.38
3.56
 10.00 |    3.75    3.95    4.17    4.43    4.72    5.04    5.40    5.79    6.24
6.76
 11.00 |    7.32    7.95    8.68    9.56   10.61   11.78   13.40   15.82   20.64
30.40
 12.00 |   47.42   69.91   94.17  113.64  123.15  122.22  113.91  101.36   86.72
72.89
 13.00 |   61.71   52.97   45.84   39.69   34.63   30.53   27.18   24.47   22.20
```

```
20.26
 14.00 |   18.63  17.27  16.20  15.36  14.67  14.01  13.39  12.84  12.34
11.87
 15.00 |   11.42  10.98  10.55  10.13   9.73   9.35   8.99   8.65   8.33
8.04
 16.00 |    7.78   7.54   7.33   7.14   6.98   6.84   6.72   6.61   6.52
6.44
 17.00 |    6.36   6.29   6.22   6.16   6.10   6.04   5.98   5.93   5.87
5.82
 18.00 |    5.76   5.71   5.66   5.60   5.55   5.50   5.44   5.39   5.34
5.28
 19.00 |    5.23   5.18   5.13   5.07   5.02   4.97   4.91   4.86   4.81
4.76
 20.00 |    4.70   4.65   4.60   4.54   4.49   4.44   4.39   4.34   4.29
4.24
 21.00 |    4.19   4.14   4.09   4.05   4.00   3.96   3.92   3.88   3.84
3.80
 22.00 |    3.76   3.73   3.70   3.66   3.63   3.60   3.57   3.55   3.52
3.49
 23.00 |    3.47   3.45   3.43   3.41   3.39   3.37   3.36   3.35   3.33
3.32
 24.00 |    3.31   3.27   3.16   2.96   2.65   2.27   1.86   1.47   1.13
.85
 25.00 |     .65    .49    .38    .29    .22    .16    .12    .09    .07
.05
 26.00 |     .04    .03    .02    .02    .01    .01    .00    .00    .00
.00
 27.00 |     .00    .00    .00    .00    .00    .00    .00    .00    .00
.00
 28.00 |     .00    .00    .00    .00    .00    .00    .00    .00    .00
.00
 29.00 |     .00    .00    .00    .00    .00    .00    .00    .00    .00
.00

                     PEAK RUNOFF (cfs):      123.15
                    TIME TO PEAK (hrs):       12.40
1*******************************     SCSHYDRO
*******************************
 *******************************   Version 3.21
*******************************
 ******************   COMPUTER-AIDED HYDROLOGY & HYDRAULICS
******************

 PROJECT: TOANO WOODS
    User: Rickmond Engineering
    Date: 06/16/1999 Wednesday
    Time: 12:53:23
   Input: TW100.IN
  Output: TW100.OUT
                                                          RETURN PERIOD
(yrs):    100

 ==========================   DOWNSTREAM HYDROGRAPH
==========================

                                   DISCHARGE (cfs)
```

TIME: (hrs)	+.00 hrs	+.10 hrs	+.20 hrs	+.30 hrs	+.40 hrs	+.50 hrs	+.60 hrs	+.70 hrs	+.80 hrs	+.90 hrs
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
1.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
2.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
4.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
5.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.02
6.00	.04	.06	.09	.12	.16	.21	.25	.30	.35	.40
7.00	.45	.51	.56	.63	.70	.77	.85	.93	1.01	1.09
8.00	1.17	1.24	1.32	1.41	1.51	1.61	1.73	1.84	1.96	2.08
9.00	2.20	2.32	2.44	2.58	2.73	2.88	3.04	3.20	3.38	3.56
10.00	3.75	3.95	4.17	4.43	4.72	5.04	5.40	5.79	6.24	6.76
11.00	7.32	7.95	8.68	9.56	10.61	11.78	13.40	15.82	20.64	30.40
12.00	47.42	69.91	94.17	113.64	123.15	122.22	113.91	101.36	86.72	72.89
13.00	61.71	52.97	45.84	39.69	34.63	30.53	27.18	24.47	22.20	20.26
14.00	18.63	17.27	16.20	15.36	14.67	14.01	13.39	12.84	12.34	11.87
15.00	11.42	10.98	10.55	10.13	9.73	9.35	8.99	8.65	8.33	8.04
16.00	7.78	7.54	7.33	7.14	6.98	6.84	6.72	6.61	6.52	6.44
17.00	6.36	6.29	6.22	6.16	6.10	6.04	5.98	5.93	5.87	5.82
18.00	5.76	5.71	5.66	5.60	5.55	5.50	5.44	5.39	5.34	5.28
19.00	5.23	5.18	5.13	5.07	5.02	4.97	4.91	4.86	4.81	4.76
20.00	4.70	4.65	4.60	4.54	4.49	4.44	4.39	4.34	4.29	4.24
21.00	4.19	4.14	4.09	4.05	4.00	3.96	3.92	3.88	3.84	3.80
22.00	3.76	3.73	3.70	3.66	3.63	3.60	3.57	3.55	3.52	3.49
23.00	3.47	3.45	3.43	3.41	3.39	3.37	3.36	3.35	3.33	3.32
24.00	3.31	3.27	3.16	2.96	2.65	2.27	1.86	1.47	1.13	.85
25.00	.65	.49	.38	.29	.22	.16	.12	.09	.07	.05
26.00	.04	.03	.02	.02	.01	.01	.00	.00	.00	.00

```
 27.00 |     .00    .00    .00    .00    .00    .00    .00    .00    .00
.00
 28.00 |     .00    .00    .00    .00    .00    .00    .00    .00    .00
.00
 29.00 |     .00    .00    .00    .00    .00    .00    .00    .00    .00
.00

                    PEAK DISCHARGE (cfs):     123.15
                      TIME TO PEAK (hrs):      12.40
 Hydrograph Saved In: TW100.DAT

1*******************************     SCSHYDRO
*******************************
 *******************************   Version 3.21
*******************************
 ******************   COMPUTER-AIDED HYDROLOGY & HYDRAULICS
*******************

 PROJECT: TOANO WOODS
    User: Rickmond Engineering
    Date: 06/16/1999 Wednesday
    Time: 12:53:23
   Input: TW100.IN
  Output: TW100.OUT
                                                          RETURN PERIOD
(yrs):    100


 ============================   HYDROLOGIC SUMMARY
============================
 =====================   Volumes, Losses, and Discharges
=====================


 SCS TYPE II  Hyetograph.
 SCS DIMENSIONLESS UNIT HYDROGRAPH was used.
 APPLIED RAINFALL DEPTH (inches):  8.00


                VOLUME OF                                |
                 RAINFALL      VOLUME OF    RAINFALL     |     PEAK
PEAK
                 APPLIED        RUNOFF       LOSSES      |   DISCHARGE
DISCHARGE
                 (ac-ft)        (ac-ft)     (percent)    |    (cfs)
(cfs/ac)
                ___________   ___________   __________   |  ___________
___________
                                                         |
                                                         |
 SUBAREA    1   27.008        18.214         32.56      |     123.154
3.040
                                                         |
                                                         |
                                                         |
 TOTAL                                                   |
 WATERSHED      27.008        18.214         32.56      |     123.154
3.040
```

TOTAL WATERSHED AREA (square miles):	.0633
TOTAL VOLUME OF DISCHARGE LEAVING WATERSHED (ac-ft):	18.2139
COMPOSITE WATERSHED CURVE NUMBER:	78.00
MINIMUM SUBAREA TIME OF CONCENTRATION:	.920

hours.

NOTE: "VOLUME OF RUNOFF" includes surface runoff only; baseflows are not included in this summation. The "TOTAL VOLUME OF DISCHARGE LEAVING WATERSHED" includes all baseflows.

1

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www.rickmond.com

JOB 98188
SHEET NO. ____ OF ____
CALCULATED BY KMJ DATE 6/16/99
CHECKED BY ____ DATE ____
SCALE ____

STAGE - STORAGE

ELEV (ft)	ΔELEV (ft)	SURFACE AREA (sf)	STORAGE (sf)	ACCUM. STORAGE (sf)
67.07		33,000		0
	.93		33,590	
68.0		36,250		33,590
	1.0		39,925	
69.0		39,600		73,515
	.6		24,630	
69.6		42,500		98,145

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JOB 98188
SHEET NO. ____ OF ____
CALCULATED BY KMJ DATE 6/16/99
CHECKED BY ____ DATE ____
SCALE ____

OUTLET BARREL

85' of 24" CMP @ 1.0% n=.024

Q	d_n	d_c	v_n	R	H	h_o	LS_o	HW	HW ELEV
0	—	—	—	—	—	—	—	—	55.27
5	.89	.79	3.70	.47	1.14	1.40	.85	1.69	56.96
10	1.37	1.13	4.35	.59	1.28	1.57	.85	2.00	57.27
15	2.00	2.00	4.78	.50	1.80	2.00	.85	2.95	58.22
20	2.00	2.00	6.37	.50	3.19	2.00	.85	4.34	59.61
25	2.00	2.00	7.96	.50	4.99	2.00	.85	6.14	61.41
30	2.00	2.00	9.55	.50	7.19	2.00	.85	8.34	63.61
35	2.00	2.00	11.15	.50	9.78	2.00	.85	10.93	66.20
40	2.00	2.00	12.74	.50	12.77	2.00	.85	13.92	69.19
45	2.00	2.00	14.33	.50	16.17	2.00	.85	17.32	72.59

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JOB 98188
SHEET NO. _____ OF _____
CALCULATED BY KMJ DATE 6/16/99
CHECKED BY _____ DATE _____
SCALE _____

OUTLET RISER

48" CMP RISER

$Q = 9.739 D_r H^{3/2}$

ELEV	H	Q
67.07	0	0
68.0	.93	34.94
69.0	1.93	104.45
69.6	2.53	156.77

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JOB 98188
SHEET NO. ____ OF ____
CALCULATED BY KMJ DATE 6/16/99
CHECKED BY ____ DATE ____
SCALE ____

STAGE - STORAGE - DISCHARGE

ELEV (ft)	STORAGE (ac-ft)	DISCHARGE (cfs)
67.07	.758	0
68.00	.832	34.94
69.00	.909	39.68
69.60	.976	40.60

100-YR STORM ROUTING

```
1*******************************     PONDOPT
*******************************
 *******************************   Version 1.83
*******************************
 ******************   COMPUTER-AIDED HYDROLOGY & HYDRAULICS
******************

 PROJECT: TOANO WOODS
    User: Rickmond Engineering
    Date: 06/16/1999 Wednesday
    Time: 13:01:34
  Output: TWP100.OUT


 SOLUTION FOR  1  STORMS.


 TIME INCREMENT:   .100  Hours


 STORM
 NUMBER   HYDROGRAPH IN FILE:
 ______   ___________________________________________________________

   1      TW100.DAT
```

TAILWATER STAGE (ft)	STORM NUMBER	PEAK INFLOW (cfs)	ALLOWABLE PEAK DISCHARGE (cfs)	DURATION (min)	RUNOFF VOLUME (ft3)
50.000	1	123.154	N/A	1794.00	.7934E+06

```
1*******************************     PONDOPT
*******************************
 *******************************   Version 1.83
*******************************
 ******************   COMPUTER-AIDED HYDROLOGY & HYDRAULICS
******************

 PROJECT: TOANO WOODS
    User: Rickmond Engineering
    Date: 06/16/1999 Wednesday
    Time: 13:01:34
  Output: TWP100.OUT


 Stage-Area-Discharge
 Filename: TWPOND.DAT
```

TAILWATER STAGE: 50.000 feet.
INITIAL STAGE: 67.070 feet.

========== STAGE-STORAGE-DISCHARGE RELATIONSHIP
==========

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<< STORM 1
>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

STAGE (ft)	STORAGE VOLUME (ac-ft)	DISCHARGE (cfs)
67.070	.0000	.0000
68.000	.7391	34.94
69.000	1.609	39.68
69.600	2.175	40.60

1********** PONDOPT
****
********** Version 1.83
****
********** COMPUTER-AIDED HYDROLOGY & HYDRAULICS
****

PROJECT: TOANO WOODS
User: Rickmond Engineering
Date: 06/16/1999 Wednesday
Time: 13:01:34
Output: TWP100.OUT

TAILWATER STAGE: 50.000 feet.
INITIAL STAGE: 67.070 feet.

<<<<<<<<<<<<<<<<<<<<<< ROUTING RESULTS FOR STORM 1
>>>>>>>>>>>>>>>>>>>>>>

MAXIMUM ELEVATION: 72.78 feet.
MAXIMUM INFLOW: 123.2 cfs.
MAXIMUM OUTFLOW: 45.47 cfs.
MAXIMUM STORAGE: 5.171 acre-feet.

CONTINUITY ERROR: .834E-05 percent.

POND

TIME (min)	INFLOW RATE (cfs)	OUTFLOW RATE (cfs)	SURFACE ELEVATION (ft)
0	.000	.000	67.070
6	.000	.000	67.070
12	.000	.000	67.070

67.070	18	.000	.000	
67.070	24	.000	.000	
67.070	30	.000	.000	
67.070	36	.000	.000	
67.070	42	.000	.000	
67.070	48	.000	.000	
67.070	54	.000	.000	
67.070	60	.000	.000	
67.070	66	.000	.000	
67.070	72	.000	.000	
67.070	78	.000	.000	
67.070	84	.000	.000	
67.070	90	.000	.000	
67.070	96	.000	.000	
67.070	102	.000	.000	
67.070	108	.000	.000	
67.070	114	.000	.000	
67.070	120	.000	.000	
67.070	126	.000	.000	
67.070	132	.000	.000	
67.070	138	.000	.000	
67.070	144	.000	.000	
67.070	150	.000	.000	
67.070	156	.000	.000	
67.070	162	.000	.000	
67.070	168	.000	.000	
67.070	174	.000	.000	
67.070	180	.000	.000	
67.070	186	.000	.000	
67.070	192	.000	.000	
67.070	198	.000	.000	

67.070				
	204	.000	.000	|
67.070				
	210	.000	.000	|
67.070				
	216	.000	.000	|
67.070				
	222	.000	.000	|
67.070				
	228	.000	.000	|
67.070				
	234	.000	.000	|
67.070				
	240	.000	.000	|
67.070				
	246	.000	.000	|
67.070				
	252	.000	.000	|
67.070				
	258	.000	.000	|
67.070				
	264	.000	.000	|
67.070				
	270	.000	.000	|
67.070				
	276	.000	.000	|
67.070				
	282	.000	.000	|
67.070				
	288	.000	.000	|
67.070				
	294	.000	.000	|
67.070				
	300	.000	.000	|
67.070				
	306	.000	.000	|
67.070				
	312	.000	.000	|
67.070				
	318	.000	.000	|
67.070				
	324	.000	.000	|
67.070				
	330	.000	.000	|
67.070				
	336	.001	.000	|
67.070				
	342	.004	.001	|
67.070				
	348	.011	.003	|
67.070				
	354	.022	.008	|
67.070				
	360	.039	.015	|
67.070				
	366	.062	.027	|
67.071				
	372	.090	.043	|
67.071				
	378	.125	.064	|
67.072				

67.072	384	.164	.090	|
67.073	390	.208	.122	|
67.074	396	.254	.157	|
67.075	402	.303	.197	|
67.076	408	.353	.240	|
67.078	414	.404	.285	|
67.079	420	.455	.332	|
67.080	426	.507	.381	|
67.081	432	.564	.432	|
67.083	438	.627	.485	|
67.084	444	.697	.543	|
67.086	450	.773	.606	|
67.088	456	.853	.674	|
67.090	462	.934	.746	|
67.092	468	1.014	.820	|
67.094	474	1.092	.896	|
67.096	480	1.166	.972	|
67.098	486	1.242	1.048	|
67.100	492	1.321	1.124	|
67.102	498	1.409	1.203	|
67.104	504	1.507	1.286	|
67.107	510	1.613	1.376	|
67.109	516	1.725	1.472	|
67.112	522	1.840	1.573	|
67.115	528	1.958	1.680	|
67.118	534	2.077	1.790	|
67.121	540	2.196	1.903	|
67.124	546	2.317	2.019	|
67.127	552	2.443	2.137	|
67.130	558	2.579	2.259	|
	564	2.725	2.388	|

67.134			
	570	2.878	2.523
67.137			
	576	3.038	2.665
67.141			
	582	3.203	2.814
67.145			
	588	3.378	2.970
67.149			
	594	3.561	3.133
67.153			
	600	3.748	3.303
67.158			
	606	3.948	3.481
67.163			
	612	4.169	3.670
67.168			
	618	4.425	3.875
67.173			
	624	4.719	4.103
67.179			
	630	5.041	4.357
67.186			
	636	5.395	4.638
67.193			
	642	5.789	4.950
67.202			
	648	6.245	5.299
67.211			
	654	6.763	5.693
67.222			
	660	7.323	6.134
67.233			
	666	7.951	6.625
67.246			
	672	8.679	7.177
67.261			
	678	9.562	7.813
67.278			
	684	10.611	8.556
67.298			
	690	11.777	9.418
67.321			
	696	13.401	10.455
67.348			
	702	15.818	11.813
67.384			
	708	20.641	13.910
67.440			
	714	30.403	17.705
67.541			
	720	47.420	24.637
67.726			
	726	69.908	35.050
68.023			
	732	94.174	37.119
68.460			
	738	113.641	39.795
69.075			
	744	123.154	40.845
69.760			

	750	122.222	41.938	
70.473				
	756	113.907	42.955	
71.136				
	762	101.363	43.819	
71.700				
	768	86.717	44.490	
72.137				
	774	72.894	44.962	
72.445				
	780	61.707	45.260	
72.639				
	786	52.974	45.422	
72.745				
	792	45.839	45.475	
72.779				
	798	39.695	45.439	
72.756				
	804	34.631	45.328	
72.684				
	810	30.526	45.158	
72.573				
	816	27.181	44.940	
72.430				
	822	24.465	44.685	
72.264				
	828	22.199	44.399	
72.078				
	834	20.263	44.090	
71.876				
	840	18.629	43.761	
71.661				
	846	17.275	43.416	
71.437				
	852	16.196	43.060	
71.204				
	858	15.357	42.695	
70.966				
	864	14.674	42.325	
70.725				
	870	14.014	41.952	
70.481				
	876	13.394	41.574	
70.235				
	882	12.837	41.194	
69.987				
	888	12.340	40.812	
69.738				
	894	11.865	40.428	
69.488				
	900	11.421	40.044	
69.237				
	906	10.979	39.610	
68.985				
	912	10.547	38.340	
68.717				
	918	10.131	37.107	
68.457				
	924	9.732	35.910	
68.205				
	930	9.350	33.526	

67.962				
	936	8.989	25.565	
67.750				
	942	8.649	20.092	
67.605				
	948	8.335	16.300	
67.504				
	954	8.045	13.649	
67.433				
	960	7.780	11.774	
67.383				
	966	7.540	10.429	
67.348				
	972	7.328	9.450	
67.322				
	978	7.141	8.726	
67.302				
	984	6.979	8.182	
67.288				
	990	6.840	7.766	
67.277				
	996	6.719	7.443	
67.268				
	1002	6.614	7.189	
67.261				
	1008	6.520	6.986	
67.256				
	1014	6.437	6.820	
67.252				
	1020	6.360	6.682	
67.248				
	1026	6.290	6.565	
67.245				
	1032	6.223	6.464	
67.242				
	1038	6.160	6.375	
67.240				
	1044	6.100	6.295	
67.238				
	1050	6.041	6.222	
67.236				
	1056	5.984	6.153	
67.234				
	1062	5.928	6.089	
67.232				
	1068	5.873	6.027	
67.230				
	1074	5.818	5.968	
67.229				
	1080	5.764	5.910	
67.227				
	1086	5.710	5.853	
67.226				
	1092	5.657	5.798	
67.224				
	1098	5.603	5.743	
67.223				
	1104	5.550	5.689	
67.221				
	1110	5.497	5.635	
67.220				

67.219	1116	5.444	5.581	|
67.217	1122	5.391	5.527	|
67.216	1128	5.338	5.474	|
67.214	1134	5.285	5.421	|
67.213	1140	5.232	5.368	|
67.211	1146	5.179	5.315	|
67.210	1152	5.126	5.262	|
67.209	1158	5.073	5.209	|
67.207	1164	5.020	5.156	|
67.206	1170	4.967	5.103	|
67.204	1176	4.915	5.050	|
67.203	1182	4.862	4.997	|
67.202	1188	4.809	4.944	|
67.200	1194	4.756	4.891	|
67.199	1200	4.703	4.838	|
67.197	1206	4.650	4.785	|
67.196	1212	4.597	4.733	|
67.195	1218	4.545	4.680	|
67.193	1224	4.492	4.627	|
67.192	1230	4.440	4.574	|
67.190	1236	4.388	4.522	|
67.189	1242	4.337	4.470	|
67.188	1248	4.286	4.418	|
67.186	1254	4.236	4.367	|
67.185	1260	4.188	4.316	|
67.184	1266	4.140	4.266	|
67.182	1272	4.093	4.217	|
67.181	1278	4.048	4.170	|
67.180	1284	4.004	4.123	|
67.179	1290	3.961	4.077	|
	1296	3.919	4.032	|

67.177				
	1302	3.879	3.988	|
67.176				
	1308	3.839	3.946	|
67.175				
	1314	3.802	3.905	|
67.174				
	1320	3.765	3.865	|
67.173				
	1326	3.730	3.827	|
67.172				
	1332	3.696	3.789	|
67.171				
	1338	3.663	3.753	|
67.170				
	1344	3.632	3.719	|
67.169				
	1350	3.602	3.685	|
67.168				
	1356	3.573	3.653	|
67.167				
	1362	3.546	3.623	|
67.166				
	1368	3.520	3.593	|
67.166				
	1374	3.495	3.565	|
67.165				
	1380	3.471	3.538	|
67.164				
	1386	3.450	3.513	|
67.164				
	1392	3.429	3.489	|
67.163				
	1398	3.409	3.466	|
67.162				
	1404	3.391	3.445	|
67.162				
	1410	3.375	3.424	|
67.161				
	1416	3.359	3.406	|
67.161				
	1422	3.345	3.388	|
67.160				
	1428	3.333	3.372	|
67.160				
	1434	3.321	3.357	|
67.159				
	1440	3.311	3.344	|
67.159				
	1446	3.269	3.326	|
67.159				
	1452	3.164	3.290	|
67.158				
	1458	2.962	3.216	|
67.156				
	1464	2.653	3.083	|
67.152				
	1470	2.266	2.879	|
67.147				
	1476	1.857	2.612	|
67.140				

1482	1.471	2.302	67.131
1488	1.130	1.975	67.123
1494	.854	1.654	67.114
1500	.647	1.358	67.106
1506	.493	1.101	67.099
1512	.377	.883	67.094
1518	.287	.703	67.089
1524	.218	.556	67.085
1530	.165	.437	67.082
1536	.125	.341	67.079
1542	.094	.265	67.077
1548	.071	.206	67.075
1554	.054	.159	67.074
1560	.040	.122	67.073
1566	.030	.094	67.072
1572	.022	.072	67.072
1578	.016	.054	67.071
1584	.011	.041	67.071
1590	.007	.031	67.071
1596	.004	.022	67.071
1602	.002	.016	67.070
1608	.001	.011	67.070
1614	.000	.008	67.070
1620	.000	.005	67.070
1626	.000	.003	67.070
1632	.000	.002	67.070
1638	.000	.002	67.070
1644	.000	.001	67.070
1650	.000	.001	67.070
1656	.000	.000	67.070

1********** PONDOPT

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*******************************
 *******************************   Version 1.83
*******************************
 ******************   COMPUTER-AIDED HYDROLOGY & HYDRAULICS
*******************

 PROJECT: TOANO WOODS
    User: Rickmond Engineering
    Date: 06/16/1999 Wednesday
    Time: 13:01:34
  Output: TWP100.OUT
```

ROUTING SUMMARY ----------
SIMULATION MODE ----------
FOR THE ABOVE CASE ----------

STORM NUMBER	PEAK STAGE (ft)	PEAK STORAGE (ac-ft)	PEAK INFLOW (cfs)	PEAK OUTFLOW (cfs)
1	72.779	5.17	123.154	45.475

Rickmond Engineering, Inc.
1643 Merrimac Trail
Williamsburg, VA 23185
Phone: 757-229-1776
Fax: 757-229-4683
e-mail: rickmond@tni.net
www.rickmond.com

FILE - TOANO WOODS

Letter of Transmittal	Date/Time: 9/8/98
Rickmond Engineering, Inc. 1643 Merrimac Trail Williamsburg, Virginia 23185 (757) 229-1776 • Fax (757) 229-4683	Project #: 98188
	Project Title: Toano Woods Revised BMP Calcs

To: James City County Environmental Division

Address: P.O. Box 8784

City/State/Zip: Williamsburg, Va. 23187

Attn: Darryl Cook

RECEIVED SEP 1998 PLANNING DEPARTMENT

We are sending you (X) Attached ( ) Under Separate cover

The following items:
( ) Shop Drawings ( ) Prints ( ) Samples ( ) Specifications ( ) Copy of Letter ( ) Change Order
(X) Other Calculations

Copies	Date	# of Pages	Description
1	10/4/90	8	Original BMP Calculations
1	9/8/98	3	Revised BMP Calculations

These are transmitted as checked below:

(X) For Approval ( ) For Your Use ( ) As Requested ( ) For Review and Comment
( ) Other

Remarks: Revised BMP Calculations per your meeting w/ Ralph Simmons on 9/4/98

Copy to:

Signed: Kenneth Jenkins

A:\TRANSMIT.FRM

Toano Woods

BMP Calculations

Rickmond Engineering, Inc.
1643 Merrimac Trail, Suite C
Williamsburg, VA 23185

Project No. ~~90221~~ 98188

Revised 9/8/98

COMMONWEALTH OF VIRGINIA
K.M. JENKINS II
No.022872
9/8/98
PROFESSIONAL ENGINEER

Table of Contents

	Page
Introduction	i
Determine Design of Existing Wet Pond	1
Area in Permanent Natural Open Space	2
BMP Worksheet	3
~~Drainage Area Map~~	~~4~~
~~Design of Dry Pond for Outfall "C"~~	~~5~~

Introduction

The following BMP Calculations pertain to Toano Woods Subdivision located in James City County, Virginia. Toano Woods consists of 74 lots located on 47.92 acres with 2.66 acres of R/W.

To achieve a 10 point BMP an existing Wet Pond ~~(Design 7)~~ 10 Pt. BMP is used, ~~a proposed Dry Pond (Design 4) is installed at the end of outfall "C",~~ and Permanent Natural Open Space is dedicated on the Rec Lot, Lots 19-21, 24-25, 28-35, and 46.

RICKMOND ENGINEERING, INC.
1643C MERRIMAC TRAIL
WILLIAMSBURG, VA 23185
(804)229-1776 or (804)898-4149
FAX NUMBER (804)220-9370

JOB 90221
SHEET NO. 1 OF
CALCULATED BY HMJ DATE 10/4/90
CHECKED BY RCS DATE 2/28/91
SCALE

1) Determine Design of Existing Wet Pond for BMP Worksheet:

a) Serves 19.34 Ac onsite and 21.14 AC offsite or 84% of site
Total Area of Toano Woods = 47.92 Ac.
Total Area used for Calcs = 47.92 ac − 5.85 ac = 42.07 ac
Try Design 7 10 Point Wet Pond
RV = 0.05 + .009(I)
I = (1.65 Ac) + (5.34 AC) = 6.96 ac = 36% (on site)
Road; Imp Area 1/3 Ac. Lots
(off site is pervious)

RV = 0.05 + .009(36) = .37
Permanent Vol Reqd = (1.0)(.37)(.5 in/area)(19.34 ac)(43,560 sf)(1 ft / 12 in)
= ~~51,950 cf~~ 130,000 cf
Permanent Vol ~~Reqd~~ Prov. = (.4)(Surface Area)(depth)
= (.4)(40,000 sf)(10 ft)
= 160,000 cf
Area in S.B. and D&U Easements = 24.44 Ac.
Area available for "Conservation Easement"
outside side & rear setback = 12.96 Ac

Existing Wet Pond is Design 7 ← 10 Pt Wet Pond

RICKMOND ENGINEERING, INC.
1643C MERRIMAC TRAIL
WILLIAMSBURG, VA 23185
(804)229-1776 or (804)898-4149
FAX NUMBER (804)220-9370

JOB 90221
SHEET NO. 2 OF
CALCULATED BY KMJ DATE 10/4/90
CHECKED BY KMJ DATE 9/8/98
SCALE

Lot #		Area Dedicated as "Permanent Natural Open Space"
16		17,500sf
19		27,880sf
20		18,450sf
21	* 90,175	~~97,000~~sf
24	* 10,700	~~17,175~~sf
25		4,635sf
23		5,775sf
28		8,680sf
29		6,400sf
30		6,250sf
31		5,800sf
32		8,375sf
33		9,600sf
34		12,250sf
35		16,150sf
22		6,125sf
		268,045sf (6.15ac)
		254,745sf (5.85ac)

* Used in calculation on Page 1, This number does include front yard setback

TABLE 3

WORKSHEET FOR BMP POINT SYSTEM

A. STRUCTURAL BMP POINT ALLOCATION

BMP	BMP Points		Fraction of Site Served by BMP		Weighted BMP Points
Existing Wet Pond ~~(#7)~~	~~9~~ 10	x	~~.89~~ .962	=	~~7.56~~ 9.62
~~Proposed Pond 6 Only Pond (#4)~~	~~9~~	x	~~.13~~	=	~~1.17~~
		x		=	
		x		=	

TOTAL WEIGHTED STRUCTURAL BMP POINTS: ~~8.73~~ 9.62

B. NATURAL OPEN SPACE CREDIT

	Fraction of Site (6.15 ac)		Natural Open Space Credit (0.1 per 1%)		Points for Natural Open Space
Permanent Natural Open Space	.128	x	10	=	1.28

C. TOTAL WEIGHTED POINTS

9.62 ~~8.73~~	+	1.28	=	~~10.01~~ 10.90
Structural BMP Points		Natural Open Space Points		TOTAL

Toano Woods

BMP Calculations

Rickmond Engineering, Inc.
1643 Merrimac Trail, Suite C
Williamsburg, VA 23185

Project No. 90221

Table of Contents

	Page
Introduction	i
Determine Design of Existing Wet Pond	1
Area in Permanent Natural Open Space	2
BMP Worksheet	3
Drainage Area Map	4
Design of Dry Pond for Outfall "C"	5

Introduction

The following BMP Calculations pertain to Toano Woods Subdivision located in James City County, Virginia. Toano Woods consists of 74 lots located on 47.92 acres with 2.66 acres of R/W.

To achieve a 10 point BMP an existing Wet Pond (Design 7) is used, a proposed Dry Pond (Design 4) is installed at the end of outfall "C", and Permanent Natural Open Space is dedicated on the Rec Lot, Lots 19-21, 24-25, 28-35, and 46.

RICKMOND ENGINEERING, INC.
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FAX NUMBER (804)220-9370

JOB 90221
SHEET NO 1 OF
CALCULATED BY KMJ DATE 10/4/90
CHECKED BY RCS DATE 2/28/91
SCALE

1) Determine Design of Existing Wet Pond for BMP Worksheet:

a) Serves 19.34 Ac onsite and 21.14 AC offsite or 84% of site
Total Area of Toano Woods = 47.92 Ac.

Try Design 7
RV = 0.05 + .009(I)
I = (1.65 Ac) + (5.34 AC) = 6.96 ac = 36% (on site)
Road — Imp Area 1/3 Ac. Lots
(off site is pervious)

RV = 0.05 + .009(36) = .37
Permanent Vol Reqd = (4)(.37)(.5 in/acre)(19.34 ac)(43,560 sf)(1 ft / 12 in)
= 51,950 cf
Permanent Vol Reqd = (.4)(Surface Area)(depth)
= (.4)(40,000 sf)(10 ft)
= 160,000 cf
Area in S.B. and O&U Easements = 24.44 Ac.
Area available for "Conservation Easement"
Outside side & rear setback = 12.96 Ac

Existing Wet Pond is Design 7 ←

LOT 16 = .345, .342, .356 = .348

LOTS 29-31 = .309, .317, .302 = .309

Lots 32-35 = 1.021, 1.021, 1.021 = 1.021

Lots 19-22 = 3.40, 3.42, 3.40 = 3.401

LOTS 23 & 24 = .298, .306, .288 = .297

LOTS 24-28 = .789, .776, .786 = .784

LOT 28 = .049, .043, .039 = .044

6.204 ac.

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JOB 90221
SHEET NO. 2 OF
CALCULATED BY KMJ DATE 10/4/90
CHECKED BY DATE
SCALE

Lot #	Area Dedicated as "Permanent Natural Open Space"
16	17,500 sf
19	27,880 sf
20	18,450 sf
21	97,000 sf
24	17,175 sf
25	4,635 sf
23	5,775 sf
28	8,680 sf
29	6,400 sf
30	6,250 sf
31	5,800 sf
32	8,375 sf
33	9,600 sf
34	12,250 sf
35	16,150 sf
22	6,125 sf
	268,045 sf (6.15 Ac)

TABLE 3

WORKSHEET FOR BMP POINT SYSTEM

A. STRUCTURAL BMP POINT ALLOCATION

BMP	BMP Points		Fraction of Site Served by BMP		Weighted BMP Points
Existing Wet Pond (#7)	9	x	.84	=	7.56
Proposed Pond C Dry Pond (#4)	9	x	.13	=	1.17
		x		=	
		x		=	

TOTAL WEIGHTED STRUCTURAL BMP POINTS: 8.73

B. NATURAL OPEN SPACE CREDIT

	Fraction of Site (6.15 Ac)		Natural Open Space Credit (0.1 per 1%)		Points for Natural Open Space
Permanent Natural Open Space	12.8%	x	0.1	=	1.28

C. TOTAL WEIGHTED POINTS

8.73	+	1.28	=	10.01
Structural BMP Points		Natural Open Space Points		TOTAL

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JOB 90221
SHEET NO. 5 OF
CALCULATED BY KMJ DATE 10/4/90
CHECKED BY DATE
SCALE

Size Proposed Pond at Outfall "C"

Pond C (Design 4)

Total Area = 6.19 Ac.
Imp Area = (.73 Ac) + (1.64 Ac) = 2.37 = 38%
R/W 1/3 Ac Lots

RV = .05 + .009 (38)
RV = .39

Storage Vol. Reqd = (.39)(1 in/ac)(6.19 Ac)(43,560)(1 ft / 12 in)

= 8,763 sf

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JOB 90221
SHEET NO. 6 OF
CALCULATED BY KMJ DATE 2/7/91
CHECKED BY DATE
SCALE

Size Orifice For Dry Pond "C"

Storage Volume Required = 8763 cf

Determine Q_o to release 8763 cf over 24hr period:

$$Q_o = \frac{8763\ cf}{24hr} \cdot \frac{1hr}{60min} \cdot \frac{1min}{60s} = .10\ cfs$$

Size Orifice to release Q_o at .10 cfs:
$h = 1.25''$

$$Q_o = CA\sqrt{2gh}$$

$$.10 = .60(A)\sqrt{2(32.2)(1.25)}$$

$$A = \pi r^2 = .019\ ft^2$$

$r = .077' = .92''$ Use $1\frac{3}{4}''$ diameter orifice

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JOB 90221
SHEET NO. 7 OF
CALCULATED BY KMJ DATE 2/7/91
CHECKED BY DATE
SCALE

CULVERT DESIGN
Outlet Pipe
Dry Pond "C"

c= .44
A= 6.89 Ac.

OVERLAND FLOW

L= 400 ft.
S= 2.5 %
Tc= 15 min.

CHANNEL FLOW

H= 36 ft.
L= 900 ft.
Tc= 5 min.

Tc= 20 min

i_{10}= 4.5 in/hr

Q=CAi=(.44)(6.89 Ac.)(4.5 in/hr)

Q= 13.64 cfs
L= 25 ft.
S= 0.5 %
HW= 2 ft.

Inv_i=
Inv_o=

INLET CONTROL Use 3-12" CMP Q=4.55cfs

D= 12 in. or 1.0 ft.

HW/D= 1.9

HW=(1.0 ft.)(1.9)= 1.9 ft. < 2.0 ft. OK

RICKMOND ENGINEERING, INC.
1643 C Merrimac Trail
WILLIAMSBURG, VIRGINIA 23185
(804) 229-1776
(804) 875-1785

JOB 90221
SHEET NO. 8 OF
CALCULATED BY KMJ DATE 2/7/91
CHECKED BY DATE
SCALE

OUTLET CONTROL

$d_c = 1.0$

$h_o = \frac{d_c + D}{2} = \frac{1.0 + 1.0}{2} = 1.0$

$S_oL = (.005)(25) = .13$

$d_n = 1.0$

$\frac{d}{D} = 1.0$ $\frac{r}{D} = .25$ P.E. Manual Pg 3-43

$R = .25$

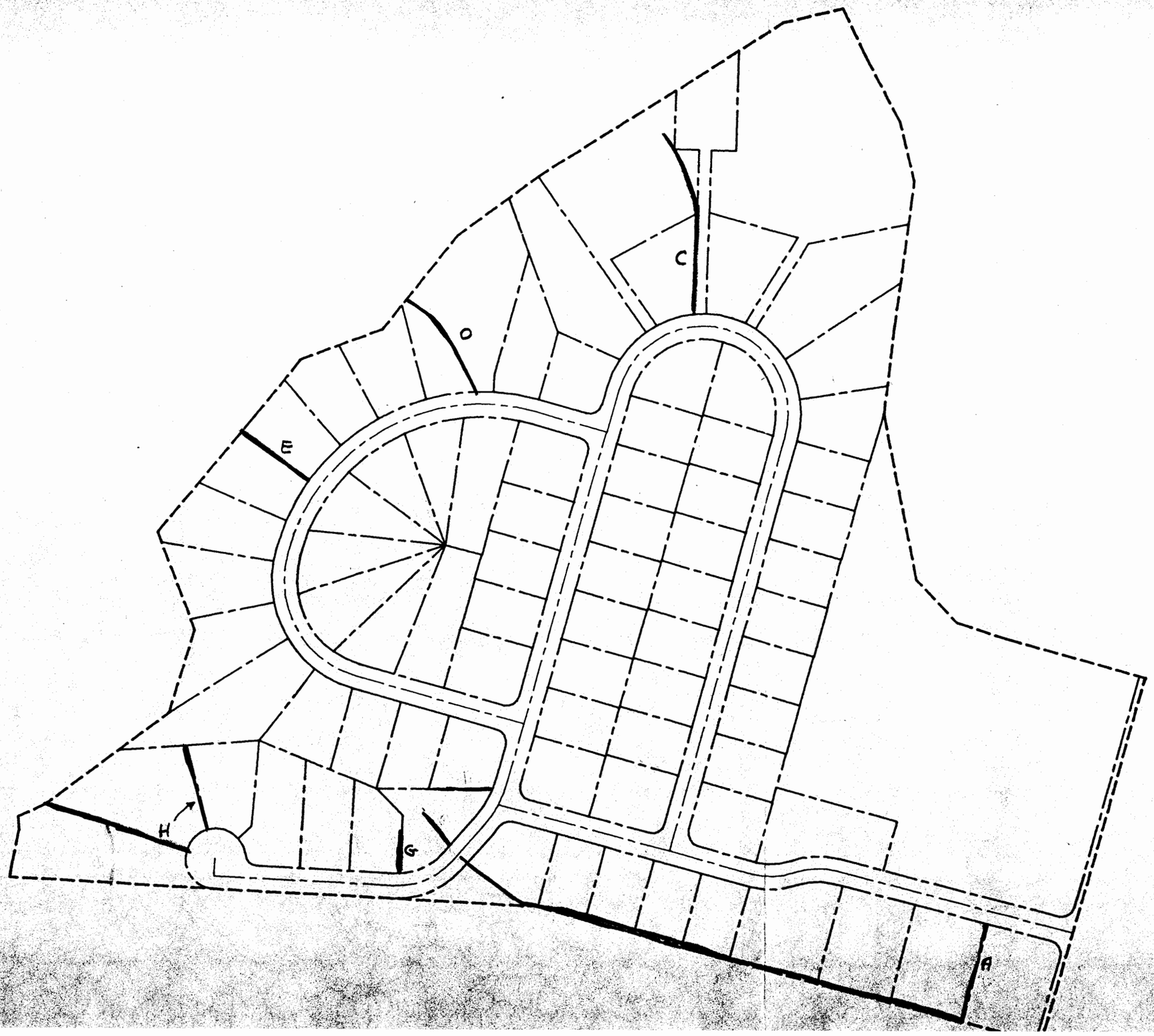
$v = 1.73$ fps

$H = (1 + k_e + \frac{29n^2L}{R^{4/3}})\frac{v^2}{2g} = .19$

$HW = H + h_o - S_oL = 1.06' < 2.0'$

Inlet Control Governs

Outfall



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JOB: Toano Woods
SHEET NO. 65 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

Total Flow Retained by Dam

Overland Flow

L = 750'
S = .53%
Tc = 28 min

Channel Flow

L = 900'
H = 18'
Tc = 6.5 min

$T_c = 28 + 6.5 = 34.5$ min

$i_{10} = 3.4$

Runoff Coefficient (C)

	A	C	CA
Residential	31.08	.40	12.43
Roadway	1.28	.85	1.09
Pasture	.69	.25	.17
			13.69

$Q_i = CAi = (13.69)(3.4) = 46.55$ cfs C = .41

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JOB: Toano Woods
SHEET NO. 66 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

Size of Vertical Discharge Pipe

$$Q = \frac{2}{3} b \sqrt{2g}\,(H)^{3/2} \qquad Q = 46.55$$

$$b = \frac{3Q}{2\sqrt{2g}\,(H)^{3/2}} = \frac{3(46.55)}{2(\sqrt{2(32.3)})(1)^{3/2}} = \frac{139.65}{16.05}$$

$$b = 8.7 \text{ ft}$$

$$b = 2\pi r$$

$$r = \frac{8.7}{2\pi} = 1.38 \text{ ft}$$

Use $r = 2.0$ ft for discharge pipe

	Q_{in}	Q_{out}	D_r	D_{rel}	h_o
Q_2	14.5	35.2	18.1	1.2	0.7
Q_{10}	35.1	48.1	35.0	2.4	1.5
Q_{100}	66.7	35.2	65.4	3.9	2.7
				↳ .9' in S.S.	
Q_{50}	48.1	65.2	48.5	3.2	2.1

$$Q_w = 9.739\, D_r H^{3/2}$$

$$\therefore D_r = \frac{Q_w}{9.739\,(H)^{3/2}}$$

$$= \frac{46.55}{9.739\,(1)^{3/2}} = 4.78$$

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JOB: Toano Woods
SHEET NO. 67 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

Size of Horizontal Discharge Pipe

Q = 46.55
L = 85'
S = 2.8%
HW = 11 ft

Steel pipe, n = .012

Inlet Control:

D = 27 in or 2.25 ft

HW/D = 3.0 HW = (2.25 ft)(3.0) = 6.75' OK

Determine Outlet Velocity

Full Flow = 50 cfs
Full Flow Velocity = 12.5

$\frac{Q_{10}}{Q_{Full}} = \frac{46.55}{50.0} = .93$

$\frac{V_{10}}{V_{Full}} = 1.14$

$V_{10} = (1.14)(12.5) = 14.25$ fps

Use 27-inch diameter steel pipe with allowable HW = 11 ft, and actual HW = 6.75 ft, and maximum outlet velocity of 14.25 fps

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JOB Toano Woods
SHEET NO. 68 OF
CALCULATED BY DATE
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SCALE

Drainage Area V

Run-off Coefficient (C)

	A	C	CA
Residential	4.72	.40	1.89
Roadway	.33	.85	.28
	5.05		2.07

$C = 2.07 / 5.05 = .41$

Overland Flow

$L = 275'$
$S = 10\%$
$T_c = 12$ min

Channel Flow
NA

$T_c = 12$ min

$i_{10} = 5.6$

∴ Flow In (Q_i)

$Q_i = CAi = 2.07(5.6) = 11.6$ cfs

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JOB 87157
SHEET NO. 69 OF
CALCULATED BY KMJ DATE 5/4/88
CHECKED BY DATE
SCALE

Design of Sediment Trap for
Outfall "C"

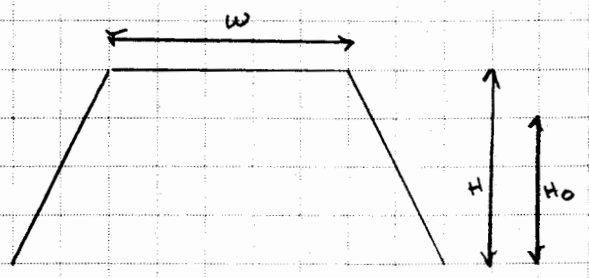
$V = .4(A)(D)$ Disturbed Area = 2.25 Ac

$V = (2.25)(67\,yd^3) = 151\,yd^3 = 4{,}077\,ft^3$

$d = 4'$

$4{,}077 < (4ft)(.4)(2625)$

$4{,}077\,cf < 4{,}200\,cf$ OK



H = 5.0'
H_o = 4.0'
w = 4.5'
L = 13.5'

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JOB 87157
SHEET NO. 70 OF
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CHECKED BY DATE
SCALE

Design of Sediment Trap for
Outfall "D"

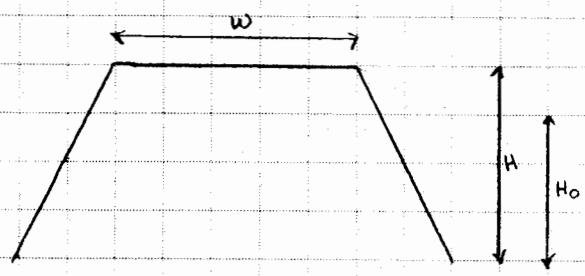
$V = .4(A)(D)$ Disturbed Area = .70 Ac

$V = (.70)(67 yd^3/Ac) = 47 cyd = 1269 cf$

$d = 3'$

$1269 cf < (.4)(3)(2000 sf)$

$1269 cf < 2400 cf$



$H = 4'$
$H_o = 3'$
$W = 3'$
$L = 4.5'$

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JOB 87167
SHEET NO. 71 OF
CALCULATED BY KMJ DATE 5/4/88
CHECKED BY DATE
SCALE

Design of Sediment Trap for
Outfall "E"

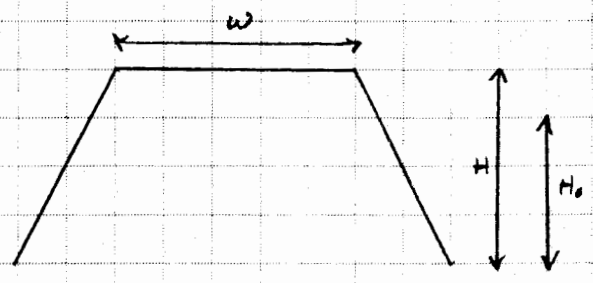
$V = .4(A)(D)$ Disturbed Area = .90 Ac

$V = (67\,yd^3)(.90) = 61\ yd^3 = 1647\ ft^3$

$D = 4'$

$1647\,ft^3 < (.4)(4\,ft)(1050\,ft^2)$

$1647\,ft^3 < 1680\,ft^3$ OK



H = 5.0'
H_o = 4.0'
W = 4.5'
L = 5.5'

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JOB 87157
SHEET NO. 72 OF
CALCULATED BY KMJ DATE 8/7/90
CHECKED BY DATE
SCALE

CULVERT DESIGN

Driveway Culvert
Pipes
Lots 61-65, 68-70
See Sheet 24
"Worst Case"

c= ____

A= ____ Ac.

OVERLAND FLOW

L= ____ ft.

S= ____ %

Tc= ____ min.

CHANNEL FLOW

H= ____ ft.

L= ____ ft.

Tc= ____ min.

Tc= ____ min

i_{10}= ____ in/hr

Q=CAi=(____)(____ Ac.)(____ in/hr)

Q= 6.70 cfs

L= 12 ft.

S= 2.32 %

HW= 2.1 ft.

Inv_i=

Inv_o=

$Q_{full} = \frac{1.49}{n} R^{2/3} S^{1/2} A =$

INLET CONTROL

18" CMP

D= 18 in. or 1.5 ft.

HW/D= 1.15

HW=(1.5 ft.)(1.15)= 1.73 ft. < 2.1 ft.

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JOB 87167
SHEET NO. 73 OF
CALCULATED BY KMJ DATE 8/7/90
CHECKED BY DATE
SCALE

OUTLET CONTROL

$d_c = 1.3$

$h_o = \frac{d_o + D}{2} = \frac{1.3 + 1.5}{2} = 1.4$

$S_o L = (.0232)(12) = .28$

$\frac{Q_{10}}{Q_{full}} = ____ =$

$d_n = (____)(____) = 1.0$

$\frac{d}{D} = .67$ $\frac{r}{D} = .2917$ P.E. Manual Pg 3-43

$R = .44$

$v = \frac{1.49}{n} R^{2/3} S^{1/2} = 5.45$

$H = (1 + k_e + \frac{29 n^2 L}{R^{4/3}}) \frac{v^2}{2g} = .83$

$HW = H + h_o - S_o L = 1.95$

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JOB 87157
SHEET NO. 74 OF
CALCULATED BY KMJ DATE 8/7/90
CHECKED BY DATE
SCALE

CULVERT DESIGN
Driveway Culvert
Pipes
Lots 71-78
See sheet 29
"Worst Case"

c= ____

A= ____ Ac.

OVERLAND FLOW

L= ____ ft.

S= ____ %

Tc= ____ min.

CHANNEL FLOW

H= ____ ft.

L= ____ ft.

Tc= ____ min.

Tc= ____ min

i_{10}= ____ in/hr

Q=CAi=(____)(____ Ac.)(____ in/hr)

Q= 6.25 cfs

L= 12 ft.

S= 2.45 %

HW= 2.1 ft.

Inv_i=

Inv_o=

$$Q_{full} = \frac{1.49 R^{2/3} S^{1/2} A}{n} =$$

INLET CONTROL

18" CMP

D= 18 in. or 1.5 ft.

HW/D= 1.08

HW=(1.5 ft.)(1.08)= 1.62 ft. < 2.1 ft.

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JOB 87157
SHEET NO. 75 OF
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CHECKED BY DATE
SCALE

OUTLET CONTROL

$d_c = 1.22$

$h_o = \frac{d_c + D}{2} = \frac{1.22 + 1.50}{2} = 1.36$

$S_o L = (.0245)(12) = .29$

$\frac{Q_{10}}{Q_{full}} = ____ =$

$d_n = (____)(____) = .95$

$\frac{d}{D} = .63$ $\frac{r}{D} = .2839$ P.E. Manual Pg 3-43

$R = .43$

$v = \frac{1.49}{n} R^{2/3} S^{1/2} = 5.52$

$H = (1 + k_e + \frac{29 n^2 L}{R^{4/3}}) \frac{v^2}{2g} = .86$

$HW = H + h_o - S_o L = 1.93$

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JOB 87157
SHEET NO. 76 OF
CALCULATED BY KWJ DATE 8/7/90
CHECKED BY DATE
SCALE

CULVERT DESIGN

Driveway Culvert Pipes

Lots 1-9, Rec Lot, 42-47
"Worst Case"

c= .90
A= .69 Ac.

OVERLAND FLOW

L= — ft.
S= — %
Tc= — min.

CHANNEL FLOW

H= 17.5 ft.
L= 1200 ft.
Tc= 10 min.

Tc= 10 min

i_{10}= 6.0 in/hr

Q=CAi=(.90)(.69 Ac.)(6.0 in/hr)

Q= 3.73 cfs
L= 12 ft.
S= .0323%
HW= 2.1 ft.

Inv_i=
Inv_o=

$Q_{full} = \frac{1.49 R^{2/3} S^{1/2} A}{n}$ =

INLET CONTROL

15" CMP

D= 15 in. or 1.25 ft.

HW/D= .94

HW=(1.25 ft.)(.94)=1.18 ft. < 2.1 ft.

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JOB 87157
SHEET NO. 77 OF
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SCALE

OUTLET CONTROL

$d_c = 1.0$

$h_o = \frac{d_c + D}{2} = \frac{1.0 + 1.25}{2} = 1.13$

$S_o L = (.0323)(12) = .39$

$\frac{Q_{10}}{Q_{full}} = ____ =$

$d_n = (____)(____) = .70$

$\frac{d}{D} = .56$ $\frac{r}{D} = .2676$ P.E. Manual Pg 3-43

$R = .33$

$v = \frac{1.49}{n} R^{2/3} S^{1/2} = 5.31$

$H = (1 + k_e + \frac{29 n^2 L}{R^{4/3}}) \frac{v^2}{2g} = .91$

$HW = H + h_o - S_o L = 1.65$

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JOB 87157
SHEET NO. 78 OF
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CHECKED BY DATE
SCALE

CULVERT DESIGN

Driveway Culvert
Pipes
Lots 10 - 25, 48 - 60, 66, 67
See Sheet 23
"Worst Case"

c= ____

A= ____ Ac.

OVERLAND FLOW

L= ____ ft.

S= ____ %

Tc= ____ min.

CHANNEL FLOW

H= ____ ft.

L= ____ ft.

Tc= ____ min.

Tc= ____ min

i_{10}= ____ in/hr

Q=CAi=(____)(____ Ac.)(____ in/hr)

Q= 4.03 cfs

L= 12 ft.

S= .0303 %

HW= 2.1 ft.

Inv_i=

Inv_o=

$Q_{full} = \frac{1.49}{n} R^{2/3} S^{1/2} A =$

INLET CONTROL

15" CMP

D= 15 in. or 1.25 ft.

HW/D= 1.1

HW=(1.25 ft.)(1.1)= 1.38 ft. < 2.1 ft.

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SCALE

OUTLET CONTROL

d_c = 1.0

$h_o = \frac{d_c + D}{2} = \frac{1.0 + 1.25}{2} = 1.13$

$S_oL = (.0303)(12) = .36$

$\frac{Q_{10}}{Q_{full}} = ____ =$

$d_n = (____)(____) = .75$

$\frac{d}{D} = .60$ $\frac{r}{D} = .2776$ P.E. Manual Pg 3-43

R = .35

$v = \frac{1.49}{n} R^{2/3} S^{1/2} = 5.35$

$H = (1 + k_e + \frac{29n^2L}{R^{4/3}}) \frac{v^2}{2g} = .89$

$HW = H + h_o - S_oL = 1.66$

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SHEET NO. 80 OF
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CHECKED BY DATE
SCALE

CULVERT DESIGN

Driveway Culvert
Pipes
Lots 26-40

c= .90
A= .34 Ac.

OVERLAND FLOW

L= — ft.
S= — %
Tc= — min.

CHANNEL FLOW

H= 12 ft.
L= 600 ft.
Tc= 5 min.

Tc= 5 min

i_{10}= 7.0 in/hr

Q=CAi=(.90)(.33 Ac.)(7.0 in/hr)

Q= 2.08 cfs
L= 12 ft.
S= 2.45 %
HW= 2.1 ft.

Inv_i=
Inv_o=

$$Q_{full} = \frac{1.49}{n} R^{2/3} S^{1/2} A =$$

INLET CONTROL

15" CMP

D= 15 in. or 1.25 ft.

HW/D= .7

HW=(1.25 ft.)(.7)=.88 ft. < 2.1 ft.

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JOB 87157
SHEET NO. 81 OF
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CHECKED BY DATE
SCALE

OUTLET CONTROL

$d_c = .72$

$h_o = \frac{d_c + D}{2} = \frac{.72 + 1.25}{2} = .99$

$S_oL = (.0245)(12) = .29$

$\frac{Q_{10}}{Q_{full}} = ____ =$

$d_n = .54$

$\frac{d}{D} = .43$ $\frac{r}{D} = .2257$ P.E. Manual Pg 3-43

$R = .28$

$v = \frac{1.49}{n} R^{2/3} S^{1/2} = 4.14$

$H = (1 + k_e + \frac{29 n^2 L}{R^{4/3}}) \frac{v^2}{2g} = .61$

$HW = H + h_o - S_oL = 1.31$

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JOB

SHEET NO. OF

CALCULATED BY DATE

CHECKED BY DATE

SCALE

REDESIGN OF EMERGENCY SPILLWAY

TOANO WOODS

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JOB 8715
SHEET NO. 1 OF
CALCULATED BY KWJ DATE 3/26/90
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SCALE

Runoff to Pond

DA-____

CA = 13.69 from Town Woods Drainage Calculations

c=____
A=____Ac.

OVERLAND FLOW

L=750 ft.
S=0.53 %
Tc=28 min.

CHANNEL FLOW

H=13 ft.
L=700 ft.
Tc=6.5 min.

Tc=34.5 min.

i_{50}=4.3 in/hr i_{100} = 4.6

Q=CAi=(____)(____Ac.)(____in/hr)

Q_{50}=58.87 cfs

Q_{100} = 62.97 cfs

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JOB 87157
SHEET NO. 2 OF
CALCULATED BY RMJ DATE 3/26/90
CHECKED BY DATE
SCALE

Determine Q for 48" Riser with 3.4' of head

Elev Rim of Riser = 70.60
Elev Lowest Pt Dam = 74.00

$h = 3.4'$

$Q = 9.739\, D_r\, H^{3/2}$

$Q = 9.739(4')(2.4)^{3/2}$ h=2.4' to allow 1' of freeboard

$Q = 144.84$ cfs

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JOB 8715
SHEET NO. 3 OF
CALCULATED BY HMJ DATE 3/26/90
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SCALE

CULVERT DESIGN
27" Barrel
at Dam

c= ____

A= ____ Ac.

OVERLAND FLOW

L= ____ ft.

S= ____ %

Tc= ____ min.

CHANNEL FLOW

H= ____ ft.

L= ____ ft.

Tc= ____ min.

Tc= ____ min

i_{10}= ____ in/hr

Q=CAi=(____)(____ Ac.)(____ in/hr)

Q= 62.97 cfs

L= 105 ft.

S= 1.6 %

HW= 15 ft.

Inv_i = 57.68

Inv_o = 56.00

$$Q_{full} = \frac{1.49}{n} R^{2/3} S^{1/2} A =$$

INLET CONTROL

D= 27 in. or 2.25 ft.

HW/D= 7.75

HW=(2.25 ft.)(7.75)= 17.44 ft.> 15 ft.

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JOB 87157
SHEET NO. 4 OF
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SCALE

OUTLET CONTROL

$d_c = 2.25$

$h_o = \frac{d_o + D}{2} = \frac{2.25 + 2.25}{2} = 2.25$

$S_o L = (.016)(105) = 1.68$

$\frac{Q_{10}}{Q_{full}} = ____ =$

$d_n = (____)(____) = 2.25$

$\frac{d}{D} = 1.0$ $\frac{r}{D} = .25$ P.E. Manual Pg 3-43

$R = .56$

$v = \frac{1.49}{n} R^{2/3} S^{1/2} = \frac{Q}{A} = 15.83$

$H = (1 + k_e + \frac{29 n^2 L}{R^{4/3}}) \frac{v^2}{2g} = 20.59$

$HW = H + h_o - S_o L = 21.16' > 15'$

27" Barrel does not pass 100 yr Storm w/o Emergency Spillway

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JOB 8711
SHEET NO. 5 OF
CALCULATED BY KMJ DATE 3/26/90
CHECKED BY DATE
SCALE

CULVERT DESIGN

Determine Capacity of 27" CMP with h=15'

c=_____

A=_____Ac.

OVERLAND FLOW

L=_____ft.

S=_____%

Tc=____min.

CHANNEL FLOW

H=_____ft.

L=_____ft.

Tc=____min.

Tc=____min

i_{10}=_____in/hr

Q=CAi=(_____)(_____Ac.)(_____in/hr)

Q= 50.0 cfs

L= 105 ft.

S= 1.60 %

HW= 15 ft.

Inv_i = 57.68

Inv_o = 56.00

$$Q_{full} = \frac{1.49}{n} R^{2/3} S^{1/2} A =$$

INLET CONTROL

D= 27 in. or 2.25 ft.

HW/D= 4.5

HW=(2.25 ft.)(4.5)= 10.13 ft. < 15 ft.

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JOB 8715
SHEET NO. 6 OF
CALCULATED BY KMJ DATE 3/26/90
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SCALE

OUTLET CONTROL

$d_c = 2.25$

$h_o = \frac{d_c + D}{2} = \frac{2.25 + 2.25}{2} = 2.25$

$S_oL = (.016)(105) = 1.68$

$\frac{Q_{10}}{Q_{full}} = _____ =$

$d_n = (____)(____) = 2.25$

$\frac{d}{D} = 1.0$ $\frac{r}{D} = .25$ P.E. Manual Pg 3-43

$R = .56$

$v = \frac{1.49}{n} R^{2/3} S^{1/2} = 12.56$

$H = (1 + k_e + \frac{29 n^2 L}{R^{4/3}}) \frac{v^2}{2g} = 12.96$

$HW = H + h_o - S_oL = 13.53'$

RICKMOND ENGINEERING, INC.
1643 C Merrimac Trail
WILLIAMSBURG, VIRGINIA 23185
(804) 229-1776
(804) 875-1785

JOB 8715
SHEET NO. 7 OF
CALCULATED BY KMJ DATE 3/26/90
CHECKED BY DATE
SCALE

Size Emergency Spillway:

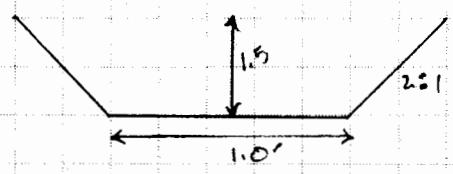
Q = 63.00 cfs - 50.00 cfs = 13.0 cfs

Added 7/11/90 KMJ

Design Emergency Spillway:

Use Grass Spillway -
side slope 2:1

b = 1.0' S = 33% d = 0.5'



$A = bd + zd^2 = (1)(1.5) + (2)(1.5)^2 = 6.0$
R = .78

$V \times R = (3)(.78) = 2.34$

n = .089 (class B)
n = .052 (class C)

Check Q: $Q = \frac{1.49}{n} R^{2/3} S^{1/2} A = \frac{1.49}{.089} (.78)^{2/3} (.33)^{1/2} 6$

Q = 48.85 cfs

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INTEGRATED PEST MANAGEMENT
(757) 259-4116

April 17, 2001

Mr. Greg Schneck
3656 Toano Woods Road
Toano, Va. 23168

Re: Toano Woods Subdivision
Stormwater Management Facility (YC 013)

Dear Mr. Schneck:

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Sincerely,

Darryl E Cook

Darryl E. Cook, P.E.
Environmental Director

Enclosures

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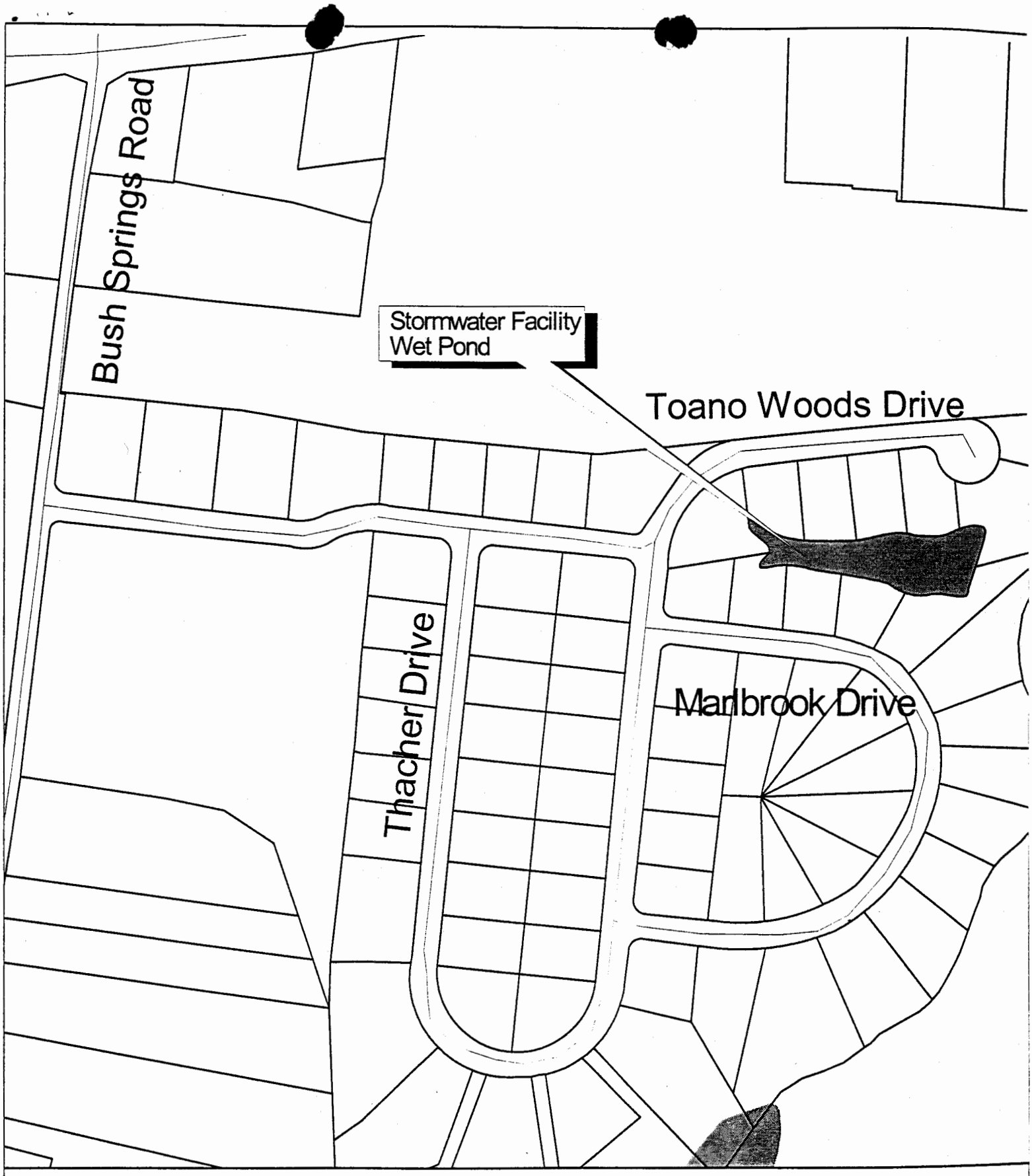

Toano Woods Subdivision
Location of Stormwater Facility

100 0 100 200 300 400 500 Feet

N

Howard Hankins -
592-3216

DEVELOPMENT MANAGEMENT

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(757) 259-4116

April 17, 2001

Mr. Ronald Molrine 566-1911
3617 Marlbrook Drive
Toano, VA. 23168

Re: Toano Woods Subdivision
Stormwater Management Facility (YC 013)

Dear Mr. Molrine:

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Sincerely,

Darryl E Cook

Darryl E. Cook, P.E.
Environmental Director

Enclosures

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James City County Environmental Division
Stormwater Management / BMP Inspection Report
Detention and Retention Pond Facilities

Database Inventory No. (if known): YC-013

Name of Facility: TOANO Woods BMP No.: 1 of 1 Date: 4/2/01

Location: Toano Woods Subdivision between Toano Wds Dr. & Marlbrook Dr.

Name of Owner: Individual Property Owners (2 own dam - Greg Schnick,

Inspector: DECook

Type of Facility: Wet Retention Pond

Weather Conditions: Overcast, 50's

If an inspection item is not applicable, mark NA, otherwise mark the appropriate column.

O.K. - The item checked is in adequate condition and the maintenance program is currently satisfactory.
Routine - The item checked requires attention, but does not present an immediate threat to the function of the BMP.
Urgent - The item checked requires immediate attention to keep the BMP operational and prevent damage to the facility.

Provide an explanation and details in the comment column, if routine or urgent are marked.

Facility Item	O.K.	Routine	Urgent	Comments
Embankments and Side Slopes: TALL DAM				
Grass Height	X			
Vegetation Condition		X		Need to remove trees on interior face of
Tree Growth			X	dam @ water edge
Erosion	X			
Trash & Debris	X			Minor accumulation of leaves near the spillway
Seepage	X			A few areas @ base of dam - just watch for change in color or flow rate
Fencing or Benches				NA
Interior Landscaping/Planted Areas: ☐ None ☐ Constructed Wetland/Shallow Marsh ☐ Naturally Established Vegetation				
Vegetated Conditions		X		Need to remove vegetation leaning over the water before it falls in & creates
Trash & Debris	X			problems - snags and erosion
Floating Material	X			
Erosion	X			
Sediment	X			
Dead Plant	X			
Aesthetics	X			
Other				

Facility Item	O.K.	Routine	Urgent	Comments
Water Pools ☐ Permanent Pool (Retention Basin) ☐ Shallow Marsh (Detention Basin) ☐ None (Detention Basin)				
Shoreline Erosion	X			
Algae	X			Does get algae blooms in summer
Trash & Debris	X			
Sediment	X			
Aesthetics	X			
Other				May want to consider an aerator to improve habitat for fish
Inflow Stuctures (Describe Locations):				
Condition of Structure		X		Paved ditch broken + failed on pipe bet 41+42 and end of pipe on 41
Erosion			X	Outfall of pipe bet. lots 41+42 being undermined
Trash and Debris	X			
Sediment		X		Upper end of pond filling in - minor issue
Aesthetics	X			
Other				
Principal Flow Control Structure - Intake, Riser, etc. (Describe Location):				
Condition of Structure		X		Remove debris from top of grate on riser
Corrosion	X			Minor discoloration below the water line on anti-vortex device
Trash and Debris		X		
Sediment	X			
Aesthetics	X			
Other				Exercise the drain to make sure it is in operating condition
Principal Outlet Structure - Barrel, Conduit, etc. :				
Condition of Structure	X			Good condition - Bit Coated CMP - Coating
Settlement	X			worn away on invert of pipe - minor rust showing
Trash & Debris	X			
Sediment	X			
Erosion	X			Outfall in Good Condition, Stable
Other				
Emergency Spillway (Overflow):				
Vegetation	NA			
Lining				
Erosion				
Trash & Debris				
Other				

Em. Spillway not installed - suggest building up top of dam to create overflow area on northeast end of dam

Facility Item	O.K.	Routine	Urgent	Comments
Nuisance Type Conditions:				
Mosquito Breeding	X			
Animal Burrows	X			
Graffiti	X			
Other				
Surrounding Perimeter Conditions:				
Land Uses	X			
Vegetation		X		May want to remove leaning debris
Trash & Debris	X			
Aesthetics	X			
Access /Maintenance Roads or Paths		X		Access easements not cleared - good access to dam between lots 35/36
Other				

Remarks:

- Erosion problem between lots 41 & 42 starting @ road - inlet clogged
- Outfall of both pipe systems entering pond need attention - one failed w/ flared end section being undermined
- Upper end of pond great location for forebay
- Pond was built about 12 years ago
- Hurricane Floyd did not overtop or inundate the top of the anti-vortex device.

Overall Environmental Division Internal Rating: 2

Signature: Darryl E Cook **Date:** 4/2/01

Title: Environmental Director

SWMProg\BMP\CoInspProg\DetRet.wpd

Stormwater Management Facility Maintenance Plan for Toano Woods

(Note: This is a Typical Maintenance Plan for a Wet (Retention) Pond facility. For general use by the dam owners and the surrounding pond property owners who are responsible for operation, maintenance and inspection of the stormwater facility when no other specifically approved maintenance plans are available. This is provided as a courtesy by the Environmental Division of James City County for informational purposes only. This plan addresses normal structural and stormwater runoff control aspects of the facility. It does not address landscaping, cosmetic, or ornamental features associated with the facility nor does it replace any specific recommendations offered by a registered professional.)

Maintenance Plan (Retention Pond BMP's)

A maintenance program is required to ensure the Stormwater Management (SWM) pond facility functions as designed and to provide for reasonable aesthetic conditions. Proper maintenance is encouraged to prevent the introduction of debris and sediment into the SWM facility itself, its principal inflow and outflow control structures and downstream waterways. Following facility installation, acceptance and establishment of vegetation in disturbed areas, inspections for sediment buildups should be performed at least quarterly. It is anticipated that under normal conditions, sediment removal could be required once every 5 to 10 years. If other construction or related land-disturbing activities are performed upland of the facility, adequate protection measures should be implemented and inspection frequencies increased to at least once weekly.

The designated party should inspect the SWM structure after each significant rainfall event or the following working day if a weekend or holiday occurs. A significant rainfall for this structure is defined as one (1) inch or more of gauged rainfall within a 24 hour period. Once per year (more or less) a representative of the County may jointly inspect the structure with an owners' representative. Appropriate action should be taken to ensure appropriate maintenance. Keys to locked access points or structures shall be made available to the County upon request and adequate notice should be given to nearby residences of inspection activities that may take place.

Facility Description:

The wet pond is located in the northeast portion of the subdivision and serves an onsite and offsite drainage area of approximately 40 acres. The facility was constructed before adoption of the Chesapeake Bay Ordinance and was built to address only runoff quantity not water quality requirements. However, as this pond is a wet facility with a substantially sized permanent pool, it does provide significant water quality benefits for the receiving waters. It has a surface area of just under one acre and a maximum depth of about 10 feet providing about 3.5 acre feet of permanent storage. The normal pool elevation is elevation 65.0 and the top of the dam is at approximately elevation 70. The pond will contain water during non-rainfall events and will temporarily receive and store more water above the normal pool during rainfall events. Typically, stored stormwater should drawdown to the normal pool elevation within 24 hours after a storm event. The facility contains a 48-inch diameter riser structure connected to a 24-inch pipe (barrel) that is through the dam structure. The total dam height is about 15 feet.

Inspection and Maintenance of the Facility should consist of the following Additional Measures:

1. Inspect for sediment buildup by visual observation and a physical determination of sediment depth within pond's storage area. If sediment has accumulated significantly within the pond bottom, removal is required. At the same time, or at least once per year, clean pretreatment devices, the riser bottom and outlet pipes of accumulated sediments. Dispose of sediments removed from the facility at an acceptable disposal area.

(Note: Typically the cleanout elevation is 10 to 25 percent of the design Water Quality Volume or normal pool volume.)

2. Perform maintenance mowing of pond grasses at least twice each year. Grasses such as tall fescue should be mowed in early summer after emergence of the heads on cool season grasses and in late fall to prevent seeds of annual weeds from maturing. Mowing of legumes can be less frequent. Trees, shrubs and woody vegetation are not be permitted to grow on any part of pond embankment that was constructed using engineered (compacted) fills. For aesthetic purposes, the dam may be mowed on a more frequent basis.

3. Perform soil sampling on stabilized pond soil areas at least once every 4 years. Soil sampling and testing should be performed a qualified independent soil testing laboratory such as VPI&SU. Apply additional lime and fertilizer in accordance with test recommendations.

4. In stabilized pond areas, if vegetation covers less than 40 % of soil surfaces, lime, fertilize and seed in accordance with recommendations for new seedings. If vegetation covers more than 40 % but less than 70 % of soil surfaces, lime, fertilize and over seed in accordance with current seeding recommendations of the Virginia Erosion and Sediment Control Handbook (VESCH).

5. Perform quarterly inspections of the riser section and crest spillway for the observance of collected trash and debris. Immediately remove any trash or debris that prevents the movement of water or that accumulates on the top of the anti-vortex device grate. Remove any trash and litter downstream and at storm drain or channel inflow locations to maintain the integrity of the structure and provide an attractive appearance.

6. Perform yearly structural inspections of the facility for damage. Structural inspection shall be performed on the concrete riser, anti-vortex and trash rack cap, trash rack, orifices/weirs, outlet barrel and pond embankment. Exposed metal surfaces shall be painted to minimize rust damage or replaced if rust damage is irreversible. If damage is evident, further investigation by a registered professional engineer may be required to assess the integrity of the structure.

7. Perform quarterly inspections of graded side slopes of the facility for signs of animal/rodent borrows or slope erosion. Immediately perform necessary repairs, refilling or reseeding.

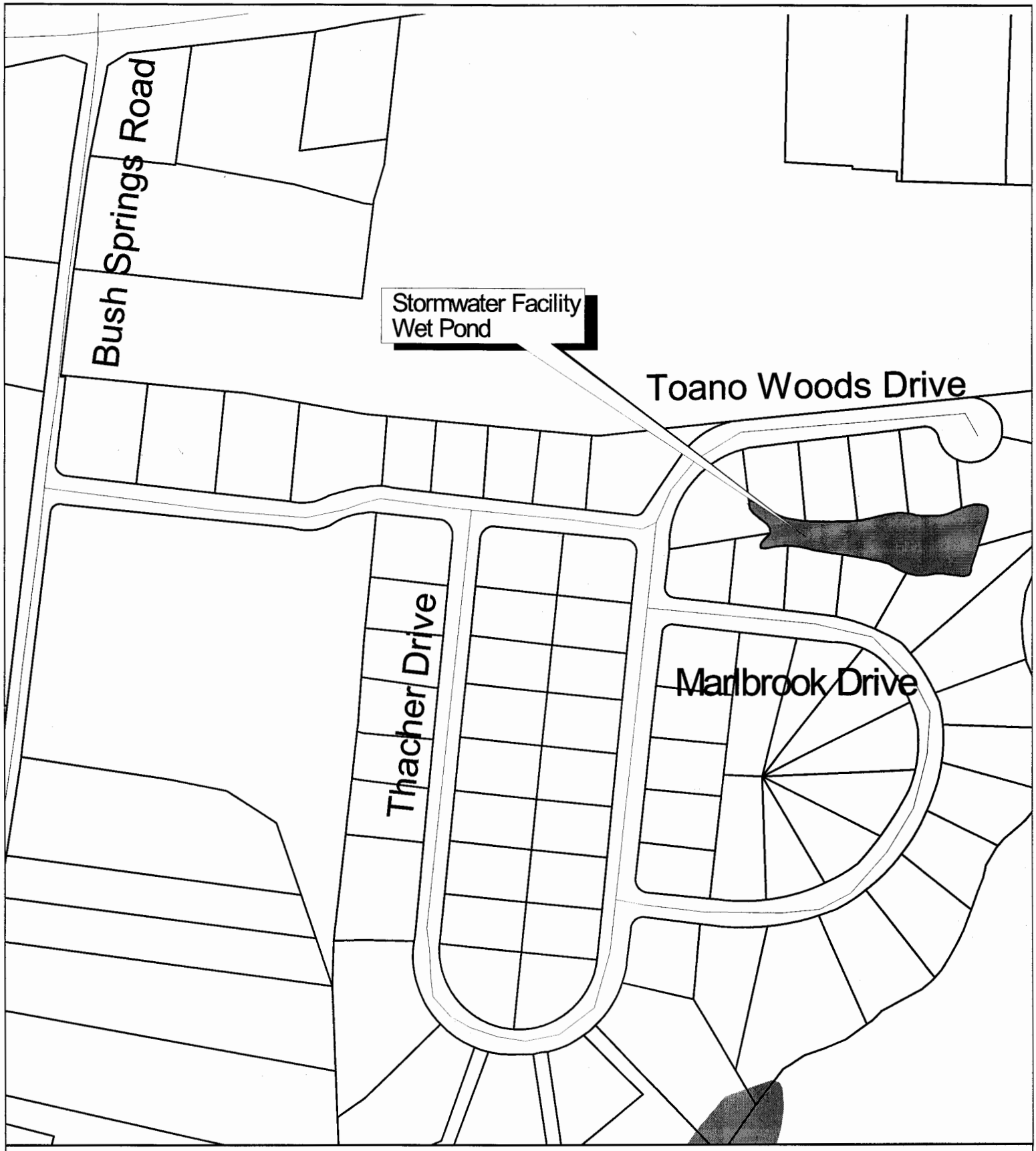
8. Perform yearly observations of perimeter areas surrounding the facility to ensure changes in land use, topography or access have not occurred and do not affect the operation, maintenance, access or safety features as provided for the facility. Appropriate action is required to ensure adequacy and to provide a clear, safe passage for maintenance vehicles to the embankment and principal flow control structures.

9. Inspect and exercise pond drain valves, if provided, on a regular basis.

10. Record Keeping. Keep reasonable, accurate written records of inspections and maintenance activities performed for the facility at all times. Records shall document routine maintenance and/or repairs performed.

11. The facility shall not accept additional drainage or be modified in any way without prior consent or approval by the Environmental Division of James City County.

(End)



Toano Woods Subdivision
Location of Stormwater Facility

100 0 100 200 300 400 500 Feet

N

General Landscaping Guidance for All Stormwater Management BMP's

- ❒ *Trees, shrubs and/or any type of woody vegetation are not allowed on the embankment.*
- ❒ *Keep trees and shrubs at least 15 feet away from the toe of constructed fill slopes.*
- ❒ *Keep trees or shrubs having long taproot systems away from earthen dams or subsurface drains.*
- ❒ *Keep trees and shrubs at least 25 feet away from perforated pipes.*
- ❒ *Keep trees and shrubs at least 25 feet away from principal flow control structures.*
- ❒ *Keep vegetation at least 15 feet from low flow orifice openings.*
- ❒ *Clean trash and debris as necessary from the facility and principal control structures. Only trained or authorized personnel should enter confined spaces or structural components of the facility.*
- ❒ *Keep herbaceous (not woody) embankment plantings limited to ten (10) inches in height.*
- ❒ *Maintain erosion control mats, blankets and fabrics in channels to reduce erosion potential.*
- ❒ *Sod channels that are not stabilized with erosion control mats.*
- ❒ *Keep emergency spillways stabilized with plant material that can withstand strong flows. Root material should be fibrous and substantial but lacking a taproot.*
- ❒ *Seed and mulch bare, exposed or formed erosion gullies. Divert surface runoff from any reseeded and mulched areas until stabilized.*
- ❒ *Check water tolerances of existing native plant materials prior to inundation of pond areas.*
- ❒ *Stabilize aquatic and safety benches with emergent wetland plant species and wet-seed mixes.*
- ❒ *Keep access to embankments or flow control structures free of trees or shrubs. Ensure areas that are planted adjacent to access routes can withstand compaction, damage or vibration that may occur due to passing vehicles or heavy equipment.*
- ❒ *To reduce thermal warming effects, shade inflow and outflow channels as well as southern exposures to the greatest extent possible.*
- ❒ *Avoid plantings that require routine or intensive chemical applications such as turf, etc.*
- ❒ *Use salt tolerant plants if excessive amounts of deicing salt are anticipated in inflow runoff.*
- ❒ *Soil test perimeter areas periodically to determine if soil amendments are necessary. Contact the local Virginia Cooperative Extension for assistance.*
- ❒ *Use native plant species which adapt to local soil and weather conditions over exotic or foreign species.*
- ❒ *Decrease or minimize areas where turf is used. Use low maintenance ground cover to absorb runoff where possible.*
- ❒ *Plant stream and normal pool buffers with trees, shrubs, ornamental grasses and herbaceous material where possible to stabilize banks, provide shade and provide for water quality enhancement.*
- ❒ *Use selective or strategic plantings to minimize access to deeper pools or steeper slopes.*
- ❒ *If warranted, provide educational signs around the perimeter of the facility to indicate that it is a Stormwater Management Area or to designate planting, maintenance or mowing zones.*
- ❒ *Avoid the overuse of any one type of plant material and material with weeds or invasive components.*
- ❒ *Preserve existing, native vegetation to the greatest extent possible unless it deters from structural aspects of the facility.*
- ❒ *Aesthetics and cosmetic characteristics should be a prime consideration. Strive to maintain a natural, scenic character for the BMP that blends well with the community theme, physical location and surrounding land uses and provides for screening, but yet maintains the structural aspects of the facility such as riser pipes, outlet barrels, spillways, trash racks, inlets, inflow channels, etc. Be certain original or enhanced landscaping does not encroach upon public or private roadways, sidewalks, trails or emergency vehicle access routes.*
- ❒ *Refer to the approved design or construction plan for the BMP. Some approved plans provide site specific information related to operation, inspection and maintenance. Please note, however, this is a current requirement of the Environmental Division for stormwater management plans and this information may not necessarily be found on all plans, especially for older facilities. Contact the Environmental Division at **757-253-6670** for additional information.*

BILLBOARD
BILLBOARD
Richmond
Road
West
Panel Pn 11-30
3/26/86
TT-395
ABANDONED
See (23-1)(1-3)
OLIVE BRANCH
CHRISTIAN CHURCH
See
(13-3) (1-3)
OLIVE BRANCH
CHRISTIAN CHURCH
Toano Woods Drive
Toano Woods Drive
Morlbrook Drive
Thacher Drive
Thacher Drive
RECREATION
PROPOSED
POND EL 68'
NOT RECORDED
RMA-H
SWAMP FOREST
PASTURE
CROP
HARDWOODS
SCRUB
RIPRAP
BMP

Atec Associates, Inc.

Consulting Geotechnical & Materials Engineers

Toano Woods Dam Investigation
Toano, Virginia
ATEC Job No. 26-84898/83327

Prepared For:

Rickmond Engineering
1643 Merrimac Trail
Williamsburg, Virginia 23185

Attn: Ralph Simmons

ATEC Associates of Virginia, Inc.
11840 Canon Boulevard, Suite 100
Newport News, Virginia 23606-3811
(804) 873-0116

July 21, 1988

Rickmond Engineering
1643 Merrimac Trail
Williamsburg, Virginia 23185

Attn: Ralph Simmons

Re: Toano Woods Dam Investigation
Toano, Virginia
ATEC Job No. 26-84898/83327

Dear Mr. Simmons:

Please find enclosed the results of our handauger and soil test borings and laboratory tests conducted at the site of the referenced project. Also included is an explanation of these results with respect to the design of the proposed dam. The data contained herein is intended to assist in the design and construction phases of the earth fill dam.

SAMPLING AND TESTING SUMMARY

A total of nine (9) handauger borings were performed along the half circle inscribed by Roads "B" and "C" from Lot 36 to Lot 45. The purpose of these handauger borings was to ascertain the suitability of the shallower soils of the roadway cuts for use in construction of the proposed dam. Handauger sampling locations are shown on the sketch included in the Appendix of this report. The handaugers were extended to a depth of 4 ft except for HA-8 and HA-9 which were extended to a depth of 8 ft.

The results of the handauger borings indicate the soils along the roadway cuts will consist primarily of Silty, fine SANDS (SM). Silt content of these soils generally ranged between 20 and 40% by weight. In order to ascertain the suitability of these soils for use as fill in the dam construction, two permeabilities were performed on bulk samples typical of the less Silty and more Silty soils encountered. The results of these tests indicated the less Silty Sand (BS-1 with 18.3% passing a No. 200 sieve) had a permeability of 1.37 X 10(-4) cm/sec. The more Silty Sand (BS-2 with 32.4% passing a No. 200 sieve) demonstrated a permeability of about 2.43 X 10(-5) cm/sec. These permeabilities represent values obtained with the soil compacted to a dry density of at least 95% of the soil's Standard Proctor maximum dry density.

We would therefore expect the permeability range of 10(-4) to 10(-5) cm/sec to be reasonable for use in the design of the dam's shell assuming roadway excavated material were used.

In addition to the handauger borings two soil test borings were performed in the proposed location of the dam. Boring 1 (B-1) was performed on the south shoulder of the dam about 10 ft above the existing creek. B-2 was performed in the flat area of the creek bed.

Based on estimates made using the gradation analysis, it appears the soils of B-1 would have the following ranges of permeability:

0-4 ft (SM)	10(-4) to 10(-5)cm/sec
4-8.5 ft (ML)	10(-6) to 10(-7)cm/sec
8.5 to 14 ft (SM)	10(-3) to 10(-4)cm/sec
14 to 30 ft (SP)	10(0) to 10(-3) cm/sec

The results of B-2 conducted in the creek bed indicate that soils which are considered unsuitable for support of the proposed dam may extend as deep as about 4 or 5 ft below the surface. These consisted of relatively clean to Silty, fine SANDS (SP-SM) in a very loose state and containing considerable amounts of organic material. These soils are alluvial deposits and would not only possess high permeability characteristics, but in their loose state would provide poor bearing support for the earthwork. We would recommend that these materials be removed from below the base of the dam and be replaced with a more suitable, well compacted fill.

The soils encountered below a depth of about 4 or 5 ft in B-2 consisted of medium dense, Silty to relatively clean SANDS (SM-SP) of medium density. These should provide acceptable support for the earthwork fill. They are, however, relatively permeable. Based on the gradation analysis of sample 2-4 (8.5 to 10 ft below the surface) a permeability of .5 X 10(0) appears reasonable.

It should be noted that the permeabilities provided by the permeability tests are representative of the soils in their compacted condition. Permeability estimates based on gradation analysis are more typical of soils in their natural condition, a state which would generally result in higher permeabilities than the same soil in a compacted, disturbed condition.

DESIGN REVIEW

A sketch of the proposed dam section as submitted to this office has been included in the Appendix of this report. A review of the design was conducted in order to compare the proposed dimensioning to generally accepted dimensioning criteria. This review concerns geotechnical considerations only and does not comment on the suitability of the design with regard to project runoff, emergency flow capacities, rip rap, or piping.

The following is a summary of the review considerations:

1) Maximum embankment slopes for small, zoned, earthfill dams employing a Sand shell and Clay or Silt core:

Suggested upstream - 2:1	Provided upstream - 3:1
Suggested downstream - 2:1	Provided downstream - 3:1

2) Minimum core width at base on a pervious (Sand) foundation:

Suggested - 36 ft Provided - 32 ft (acceptable)

3) Minimum core width at waterline:

Suggested - 10 to 12 ft Provided - 12 ft

4) Maximum core slope (pervious foundation):

Suggested - 1:1 Provided - 1:1

5) Minimum crest width:

Suggested - 13 ft Provided - 24 ft ?

6) Minimum freeboard with fetch less than 1 mile:

Suggested - 3 ft Provided - 3 ft

7) Additional recommended criterion not included on plans: Maximum slope of the natural hillsides against which the dam shoulders will rest should be 1:1. These slopes should be uniform from toe to crest.

Based on the results of our geotechnical investigation, the proposed dam section appears to be suitably dimensioned.

GENERAL CONSTRUCTION PROCEDURES AND RECOMMENDATIONS

1. It appears that the Silty, fine SANDS (SM) encountered in the handauger borings performed along the roadways will be acceptable for use as shell fill material. They are not considered acceptable for use in the impervious core. Material considered acceptable for use in the core was encountered in B-1 between depths of about 4 and 8.5 ft and was also noted exposed in the erosion surface of the hillsides adjacent to the dam's shoulders. This material was classified as a reddish brown, fine Sandy, Clayey SILT (ML-CL).

2. All topsoil, organics, or otherwise undesirable materials should be removed from the full width of the dam's shell and core. The Soils Engineer should be called on to observe the subgrade and ascertain the suitability of the soils exposed at the dam's base. Any unsuitable materials noted should be removed and replaced with a competent, well compacted fill. The Soils Engineer should also be called on to observe the base of the key trench which is to be constructed below the core. Based on the results of B-2 conducted in the creek's flatlands, excavation of at least 5 ft and possibly more below existing grades will be necessary to remove organic, excessively porous, or unstable materials. Backfilling of overexcavation in this area should be accomplished using compacted core fill.

3. Natural hillsides against which the shoulders of the dam will rest should be thoroughly stripped and graded for a maximum slope of 1:1. These natural soils to a depth of at least 12 inches should then be scarified so as to minimize the potential for seepage planes to form between the embankment fill and the undisturbed, natural soils.

4. Initial fill lifts should be placed under conditions which are sufficiently dry to facilitate adequate compaction using maximum 8 inch thick lifts. Where necessary, temporary drainage trenches, sump hole pumping, etc., should be employed to remove free or standing water from the subgrade. Thick "bridge" lifts should not be used to initiate the fill placement.

5. All fill should be compacted over flat surfaces using heavy compaction equipment. For the cohesive core fill a sheepsfoot roller should be used for compaction. Compaction should be accomplished by making a minimum of ten (10) passes and should continue until the soils have been brought to a dry density of at least 95% of the soil's Standard Proctor maximum dry density (ASTM D 698). As a general rule, the Soils should be compacted just dry (1 or 2%) of optimum moisture.

6. Where wheeled vehicles traffic the dam during fill placement, their tracks should be reworked prior to placement of the next lift. Care should be excercised to see that the full design width of the dam receives the adequate compactive effort. The rolling operation of each lift should also extend up the slopes of the natural hillside 2 or 3 ft to help provide blending of the fill and natural soils at their interface.

7. Fill should be placed in maximum 8 inch loose lifts. A Soils Technician under the direction of a qualified Soils Engineer should perform field density tests on each lift to determine whether adequate compaction is being attained. As a minimum, 1 test per 1500 square ft per lift should be performed. Areas failing to meet compaction requirements should be reworked and retested prior to placement of subsequent lifts.

INVESTIGATIVE SCOPE

The findings of this report were developed from the information obtained in the test borings which depict subsurface conditions only at these specific locations and at the particular time designated on the logs. Soil conditions at other locations may differ from conditions encountered at these boring locations. Also the passage of time may result in a change in the soil conditions at these boring locations.

The nature and extent of variations between the borings may not become evident until the course of construction. If variations then appear evident, it will be necessary for a re-evaluation of the recommendations of this report to be made after performing on-site observations during the construction period and noting the characteristics of any variation.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied. This company is not responsible for the conclusions, opinions or recommendations made by others based on these data.

We wish to remind you that we will store the soil samples for 30 days after which time they will be discarded unless you request otherwise.

We have appreciated the opportunity to be of service to you on this project and recommend that this report be included in your construction specifications. If we can be of any further assistance, such as providing our inspection services during construction, please contact this office.

Very truly yours,
ATEC ASSOCIATES OF VIRGINIA, INC.

Robert C Moss III

Robert C. Moss, III
Geotechnical Engineer

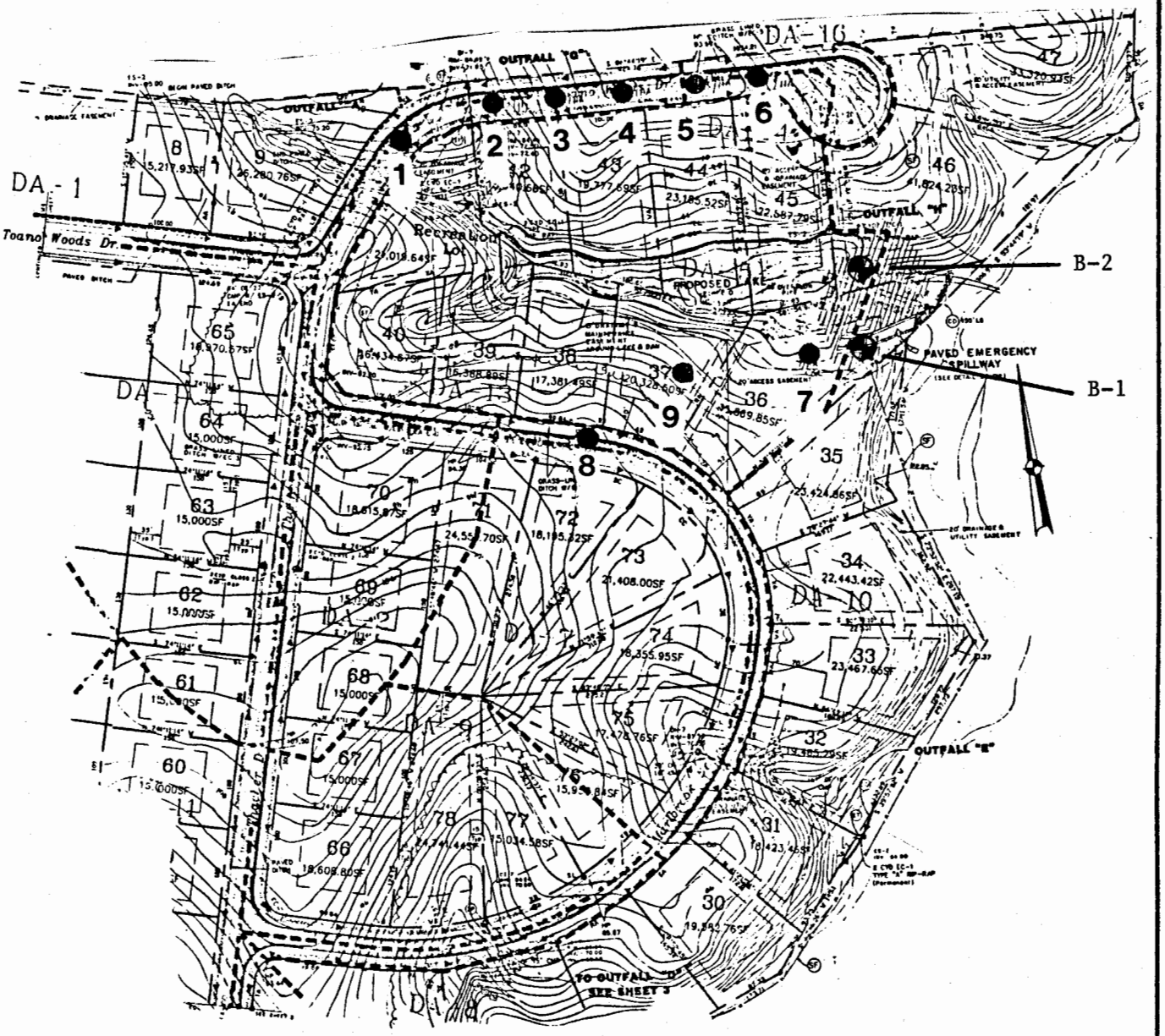
Copies (3) Client

APPENDIX

1. Field Sampling Location Sketch
2. Proposed Dam Section
3. Test Boring Logs (B-1, B-2)
4. Handauger Logs (HA-1 to HA-9)
5. Summary of Laboratory Test Data
6. Gradation Curves (HA Samples)
7. Proctor Curve (BS-1)
8. Gradation Curves (Bulk Samples)
9. Gradation Curves (B-1, B-2)

NOTE: Numbers 1 through 9 denote handauger locations.

B-1 and B-2 are Soil Boring locations.

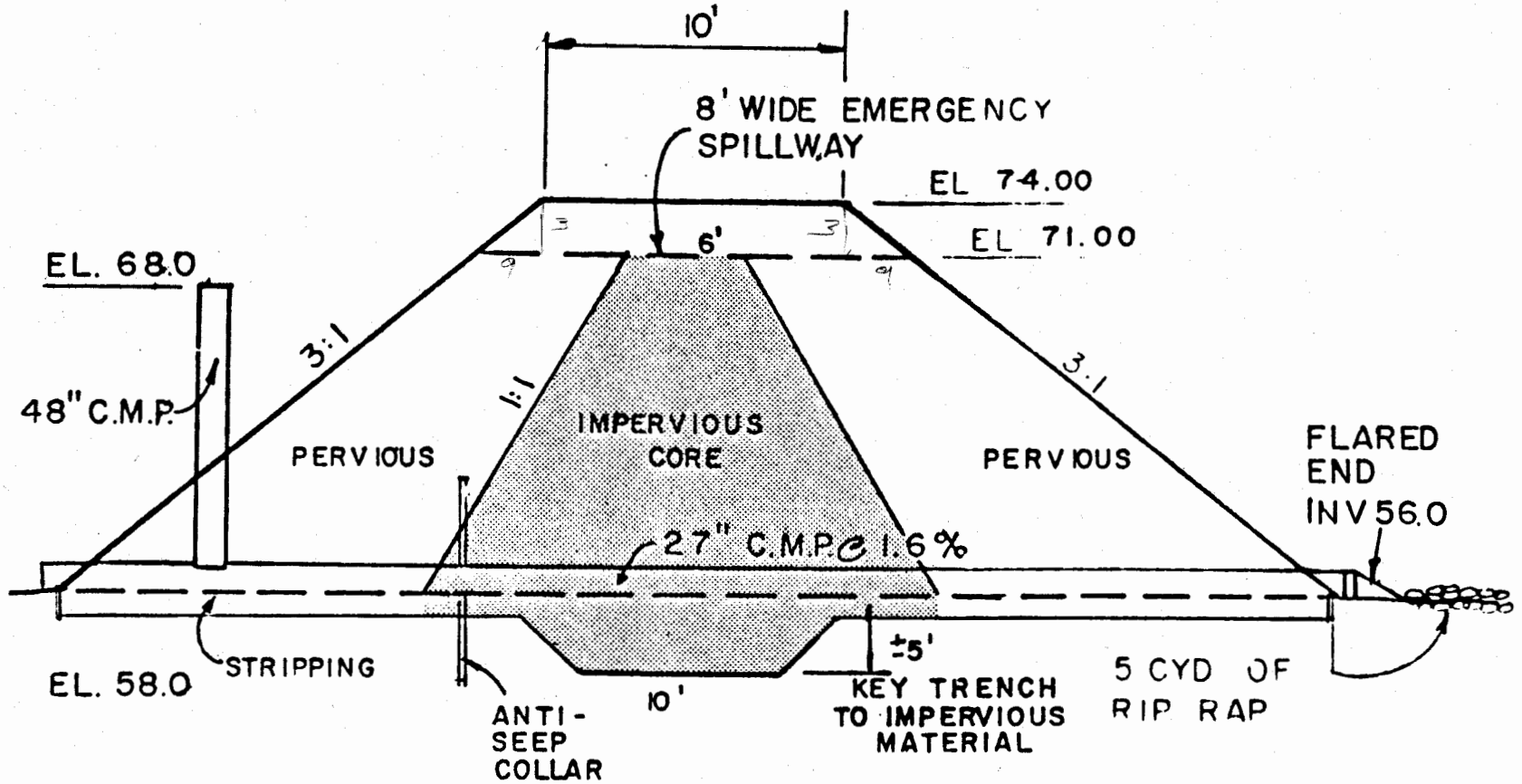


ATEC Associates
OF VIRGINIA, INC.

FIELD SAMPLING LOCATION SKETCH

Job Name: Toano Woods Dam Investigation
Job No: 26-84898
Client: Rickmond Engineering
Date: July 1988

NOTES: 1. Key Trench into Side of Hills.
2. Impervious material to be Provided from Lots 46, 35 and 36.
3. Pervious material to be Provided from Load Cuts.



DAM SECTION

NTS

ATEC Associates
OF VIRGINIA, INC.

Job Name: Toano Woods Dam Investigation
Job No: 26-84898/83327
Client: Rickmond Engineering
Date: July 88

ATEC Associates, Inc.

Consulting Geotechnical / Materials Engineers, and Environmental Scientists

LOG OF BORING NO. 1

CLIENT Rickmond Engineering
PROJECT NAME Toano Woods
PROJECT LOCATION Toano, Virginia
BORING LOCATION Dam Shoulder (South end)
FOREMAN Weaver
INSPECTOR Moss

JOB NO. 26-83327
DATE 23 June 88
BORING METHOD HSA
ROCK CORE DIA. ____ IN.
SHELBY TUBE DIA. ____ IN.

MATERIAL DESCRIPTION	STRATUM DEPTH, FT.	DEPTH, FT.	STD. PENETRATION SAMPLE NO.	BLOWS/6 IN. THREE 6 IN. INCREMENTS	RECOVERY, %	SHELBY TUBE NO.	BORING AND SAMPLING NOTES
Topsoil -3"							
Brownish tan, moist, loose, Silty, very fine SAND (SM)	2.0		1	4/4 4/6	22		
Dark brownish tan, moist, loose, Silty, very fine SAND (SM)	4.0		2	4/4 5/6	22		
Reddish brownish tan, moist, medium stiff, fine Sandy SILT (ML) trace fine Sand	8.5	5	3	4/3 4/6	18		
Light gray, moist, loose, Silty, fine SAND (SM) and marine shell fragments	14.0	10	4	4 7/7	18		
Tan, saturated, medium dense, fine SAND (SP) some marine shell fragments, trace Silt		15	5	4 6/5	18		
		20	6	9 12/14	18		
More Silty (SP-SM) with trace marine shell fragments from 24.5 ft		25	7	9 11/16	18		
	30.0	30	8	7 11/11	18		
Bottom of Test Boring 30.0 ft							* Cave in @ 18'

WATER LEVEL OBSERVATIONS
NOTED ON RODS 24 FT.
AT COMPLETION 16 FT.*
AFTER ____ HRS. ____ FT.

BORING METHOD
HSA — HOLLOW STEM AUGER
CFA — CONTINUOUS FLIGHT AUGER
DC — DRIVEN CASING
MD — MUD DRILLING
RC — ROCK CORING
CA — CASING ADVANCER

*THESE SHELBY TUBE SAMPLES OBTAINED IN AN AUXILIARY BORING DRILLED A FEW FEET FROM THIS BORING

ATEC Associates, Inc.

Consulting Geotechnical / Materials Engineers, and Environmental Scientists

LOG OF BORING NO. 2

CLIENT Rickmond Engineering
PROJECT NAME Toano Woods
PROJECT LOCATION Toano, Virginia
BORING LOCATION North center of Dam
FOREMAN Weaver
INSPECTOR Moss

JOB NO. 26-83327
DATE 25 June 88
BORING METHOD HSA
ROCK CORE DIA. ____ IN.
SHELBY TUBE DIA. ____ IN.

MATERIAL DESCRIPTION	STRATUM DEPTH, FT.	DEPTH, FT.	STD. PENETRATION SAMPLE NO.	STD. PENETRATION BLOWS/6 IN; THREE 6 IN. INCREMENTS	STD. PENETRATION RECOVERY, %	SHELBY TUBE NO.	BORING AND SAMPLING NOTES
Topsoil -3"							
Note 1	1.0		1	2/2	12		Note 1: Tan, very moist, very loose, Silty, very fine SAND (SM-SP) trace organics
Note 2	2.0			2/2			
Note 3	3.0		2	1/2	22		
Note 4	4.0			2/5			
Note 5	5.0		3	2/1	20		Note 2: Gray and tan, very moist, soft, fine Sandy CLAY (CL) trace organics
Grayish tan, saturated, very loose to medium dense, Silty, very fine SAND (SM-SP) trace marine shell fragments		5		2/2			
			4	5	18		Note 3: Grayish tan, very moist, very loose, fine SAND (SP) trace organics, trace Silt
		10		6/6			
	12.5						
Tan, saturated, loose, Silty, very fine SAND (SM-SP)			5	4	18		Note 4: Dark gray and black, very moist, loose, Silty, fine SAND (SM) some organics
		15		5/5			
More Silty (SM) from 17.5 ft			6	6	18		Note 5: Tan and gray, saturated, very soft, fine Sandy CLAY (CL) trace organics
	20.0	20		8/10			
Bottom of Test Boring 20.0 ft							* Cave in @ 9'

WATER LEVEL OBSERVATIONS
NOTED ON RODS 4 FT.
AT COMPLETION 7 FT. *
AFTER ____ HRS. ____ FT.

BORING METHOD
HSA — HOLLOW STEM AUGER
CFA — CONTINUOUS FLIGHT AUGER
DC — DRIVEN CASING
MD — MUD DRILLING
RC — ROCK CORING
CA — CASING ADVANCER

*THESE SHELBY TUBE SAMPLES OBTAINED IN AN AUXILIARY BORING DRILLED A FEW FEET FROM THIS BORING

ATEC Associates, Inc.

Consulting Geotechnical / Materials Engineers, and Environmental Scientists

LOG OF BORING NO. 1

CLIENT Rickmond Engineering
PROJECT NAME Toano Woods
PROJECT LOCATION Toano, Virginia
BORING LOCATION
FOREMAN Epps
INSPECTOR Moss

JOB NO. 26-84898
DATE June 8, 1988
BORING METHOD HA
ROCK CORE DIA. ____ IN.
SHELBY TUBE DIA. ____ IN.

MATERIAL DESCRIPTION SURFACE ELEVATION	STRATUM DEPTH, in.	DEPTH, FT.	STD. PENETRATION: SAMPLE NO.	STD. PENETRATION: BLOWS/6 IN; THREE 6 IN. INCREMENTS	STD. PENETRATION: RECOVERY, %	SHELBY TUBE NO.	BORING AND SAMPLING NOTES
Topsoil	2						
Tan, moist, Silty, fine SAND (SM) trace Clay		1					
	24	2					
Brown, moist, Silty fine SAND (SM) trace Clay (See gradation analysis)		3					
	48	4					
Bottom of handauger 4 ft		5					
		6					
		7					

WATER LEVEL OBSERVATIONS
NOTED ON RODS _____ FT.
AT COMPLETION _____ FT.
AFTER ____ HRS. _____ FT.

BORING METHOD
HSA — HOLLOW STEM AUGER
CFA — CONTINUOUS FLIGHT AUGER
DC — DRIVEN CASING
MD — MUD DRILLING
RC — ROCK CORING
CA — CASING ADVANCER

*THESE SHELBY TUBE SAMPLES OBTAINED IN AN AUXILIARY BORING DRILLED A FEW FEET FROM THIS BORING

ATEC Associates, Inc.

Consulting Geotechnical / Materials Engineers, and Environmental Scientists

LOG OF BORING NO. 2

CLIENT Rickmond Engineering
PROJECT NAME Toano Woods
PROJECT LOCATION Toano, Virginia
BORING LOCATION
FOREMAN Epps
INSPECTOR Moss

JOB NO. 26-84898
DATE June 8, 1988
BORING METHOD HA
ROCK CORE DIA. ____ IN.
SHELBY TUBE DIA. ____ IN.

MATERIAL DESCRIPTION SURFACE ELEVATION	STRATUM DEPTH, in.	DEPTH, FT.	STD. PENETRATION SAMPLE NO.	BLOWS/6 IN; THREE 6 IN. INCREMENTS	RECOVERY, %	SHELBY TUBE NO.	BORING AND SAMPLING NOTES
Topsoil	3						
Brown, moist, Silty, fine SAND (SM)		1					
		2					
		3					
	48	4					
Bottom of handauger 4 ft		5					
		6					
		7					

WATER LEVEL OBSERVATIONS
NOTED ON RODS _____ FT.
AT COMPLETION _____ FT.
AFTER ____ HRS. _____ FT.

BORING METHOD
HSA — HOLLOW STEM AUGER
CFA — CONTINUOUS FLIGHT AUGER
DC — DRIVEN CASING
MD — MUD DRILLING
RC — ROCK CORING
CA — CASING ADVANCER

*THESE SHELBY TUBE SAMPLES OBTAINED IN AN AUXILIARY BORING DRILLED A FEW FEET FROM THIS BORING

ATEC Associates, Inc.

Consulting Geotechnical / Materials Engineers, and Environmental Scientists

LOG OF BORING NO. 3

CLIENT Rickmond Engineering
PROJECT NAME Toano Woods
PROJECT LOCATION Toano, Virginia
BORING LOCATION
FOREMAN Epps
INSPECTOR Moss

JOB NO. 26-84898
DATE June 8, 1988
BORING METHOD HA
ROCK CORE DIA. ____ IN.
SHELBY TUBE DIA. ____ IN.

MATERIAL DESCRIPTION SURFACE ELEVATION	STRATUM DEPTH, in.	DEPTH, FT.	STD. PENETRATION: SAMPLE NO.	STD. PENETRATION: BLOWS/6 IN; THREE 6 IN. INCREMENTS	STD. PENETRATION: RECOVERY, %	SHELBY TUBE NO.	BORING AND SAMPLING NOTES
Topsoil	4						
Brown, moist, Silty, fine SAND (SM)		1 2 3					
	48	4					
Bottom of handauger 4 ft		5 6 7					

WATER LEVEL OBSERVATIONS
NOTED ON RODS _____ FT.
AT COMPLETION _____ FT.
AFTER ____ HRS. _____ FT.

BORING METHOD
HSA — HOLLOW STEM AUGER
CFA — CONTINUOUS FLIGHT AUGER
DC — DRIVEN CASING
MD — MUD DRILLING
RC — ROCK CORING
CA — CASING ADVANCER

*THESE SHELBY TUBE SAMPLES OBTAINED IN AN AUXILIARY BORING DRILLED A FEW FEET FROM THIS BORING

ATEC Associates, Inc.

Consulting Geotechnical / Materials Engineers, and Environmental Scientists

LOG OF BORING NO. 4

CLIENT Rickmond Engineering
PROJECT NAME Toano Woods
PROJECT LOCATION Toano, Virginia
BORING LOCATION
FOREMAN Epps
INSPECTOR Moss

JOB NO. 26-84898
DATE June 8, 1988
BORING METHOD HA
ROCK CORE DIA. ____ IN.
SHELBY TUBE DIA. ____ IN.

MATERIAL DESCRIPTION SURFACE ELEVATION	STRATUM DEPTH, in.	DEPTH, FT.	STD. PENETRATION: SAMPLE NO.	STD. PENETRATION: BLOWS/6 IN; THREE 6 IN. INCREMENTS	STD. PENETRATION: RECOVERY, %	SHELBY TUBE NO.	BORING AND SAMPLING NOTES
Topsoil	2						
Tan, moist, Silty, fine SAND (SM)	14	1					
Tan, moist, Silty, fine SAND (SM) trace Clay	48	2 3 4					
Bottom of handauger 4 ft		5 6 7					

WATER LEVEL OBSERVATIONS
NOTED ON RODS _____ FT.
AT COMPLETION _____ FT.
AFTER ____ HRS. _____ FT.

BORING METHOD
HSA — HOLLOW STEM AUGER
CFA — CONTINUOUS FLIGHT AUGER
DC — DRIVEN CASING
MD — MUD DRILLING
RC — ROCK CORING
CA — CASING ADVANCER

*THESE SHELBY TUBE SAMPLES OBTAINED IN AN AUXILIARY BORING DRILLED A FEW FEET FROM THIS BORING

ATEC Associates, Inc.

Consulting Geotechnical / Materials Engineers, and Environmental Scientists

LOG OF BORING NO. 5

CLIENT Rickmond Engineering
PROJECT NAME Toano Woods
PROJECT LOCATION Toano, Virginia
BORING LOCATION
FOREMAN Epps
INSPECTOR Moss

JOB NO. 26-84898
DATE June 8, 1988
BORING METHOD HA
ROCK CORE DIA. ____ IN.
SHELBY TUBE DIA. ____ IN.

MATERIAL DESCRIPTION SURFACE ELEVATION	STRATUM DEPTH, in.	DEPTH, FT.	STD. PENETRATION: SAMPLE NO.	STD. PENETRATION: BLOWS/6 IN; THREE 6 IN. INCREMENTS	STD. PENETRATION: RECOVERY, %	SHELBY TUBE NO.	BORING AND SAMPLING NOTES
Topsoil	5						
Brown, moist, Silty, fine SAND (SM) trace Clay		1					
		2					
		3					
	48	4					
Bottom of handauger 4 ft							
		5					
		6					
		7					

WATER LEVEL OBSERVATIONS
NOTED ON RODS _____ FT.
AT COMPLETION _____ FT.
AFTER ____ HRS. _____ FT.

BORING METHOD
HSA — HOLLOW STEM AUGER
CFA — CONTINUOUS FLIGHT AUGER
DC — DRIVEN CASING
MD — MUD DRILLING
RC — ROCK CORING
CA — CASING ADVANCER

*THESE SHELBY TUBE SAMPLES OBTAINED IN AN AUXILIARY BORING DRILLED A FEW FEET FROM THIS BORING

ATEC Associates, Inc.

Consulting Geotechnical / Materials Engineers, and Environmental Scientists

LOG OF BORING NO. 6

CLIENT Rickmond Engineering
PROJECT NAME Toano Woods
PROJECT LOCATION Toano, Virginia
BORING LOCATION
FOREMAN Epps
INSPECTOR Moss

JOB NO. 26-84898
DATE June 8, 1988
BORING METHOD HA
ROCK CORE DIA. ____ IN.
SHELBY TUBE DIA. ____ IN.

MATERIAL DESCRIPTION SURFACE ELEVATION	STRATUM DEPTH, in.	DEPTH, FT.	STD. PENETRATION: SAMPLE NO.	STD. PENETRATION: BLOWS/6 IN; THREE 6 IN. INCREMENTS	STD. PENETRATION: RECOVERY, %	SHELBY TUBE NO.	BORING AND SAMPLING NOTES
Topsoil	3						
Brown, moist, Silty, fine SAND (SM)		1					
		2					
(See gradation analysis)		3					
	48	4					
Bottom of handauger 4 ft		5					
		6					
		7					

WATER LEVEL OBSERVATIONS
NOTED ON RODS _____ FT.
AT COMPLETION _____ FT.
AFTER ____ HRS. _____ FT.

BORING METHOD
HSA — HOLLOW STEM AUGER
CFA — CONTINUOUS FLIGHT AUGER
DC — DRIVEN CASING
MD — MUD DRILLING
RC — ROCK CORING
CA — CASING ADVANCER

*THESE SHELBY TUBE SAMPLES OBTAINED IN AN AUXILIARY BORING DRILLED A FEW FEET FROM THIS BORING

ATEC Associates, Inc.

Consulting Geotechnical / Materials Engineers, and Environmental Scientists

LOG OF BORING NO. 7

CLIENT Rickmond Engineering
PROJECT NAME Toano Woods
PROJECT LOCATION Toano, Virginia
BORING LOCATION
FOREMAN Epps
INSPECTOR Moss

JOB NO. 26-84898
DATE June 8, 1988
BORING METHOD HA
ROCK CORE DIA. ____ IN.
SHELBY TUBE DIA. ____ IN.

MATERIAL DESCRIPTION SURFACE ELEVATION	STRATUM DEPTH, in.	DEPTH, FT.	STD. PENETRATION: SAMPLE NO.	STD. PENETRATION: BLOWS/6 IN; THREE 6 IN. INCREMENTS	STD. PENETRATION: RECOVERY, %	SHELBY TUBE NO.	BORING AND SAMPLING NOTES
Topsoil	2						
Tan, moist, Silty, fine SAND (SM)	12	1					
Brownish tan, moist, Silty, fine SAND (SM) trace to little Clay	48	2 3					
Bottom of handauger 4 ft		4 5 6 7					

WATER LEVEL OBSERVATIONS
NOTED ON RODS _____ FT.
AT COMPLETION _____ FT.
AFTER ____ HRS. _____ FT.

BORING METHOD
HSA — HOLLOW STEM AUGER
CFA — CONTINUOUS FLIGHT AUGER
DC — DRIVEN CASING
MD — MUD DRILLING
RC — ROCK CORING
CA — CASING ADVANCER

*THESE SHELBY TUBE SAMPLES OBTAINED IN AN AUXILIARY BORING DRILLED A FEW FEET FROM THIS BORING

ATEC Associates, Inc.

Consulting Geotechnical / Materials Engineers, and Environmental Scientists

LOG OF BORING NO. 8

CLIENT Rickmond Engineering
PROJECT NAME Toano Woods
PROJECT LOCATION Toano, Virginia
BORING LOCATION
FOREMAN Epps
INSPECTOR Moss

JOB NO. 26-84898
DATE June 8, 1988
BORING METHOD HA
ROCK CORE DIA. ____ IN.
SHELBY TUBE DIA. ____ IN.

MATERIAL DESCRIPTION SURFACE ELEVATION	STRATUM DEPTH, in.	DEPTH, FT.	STD. PENETRATION: SAMPLE NO.	STD. PENETRATION: BLOWS/6 IN; THREE 6 IN. INCREMENTS	RECOVERY, %	SHELBY TUBE NO.	BORING AND SAMPLING NOTES
Topsoil	3						
Brown, moist, Silty, fine SAND (SM) trace to little Clay		1					
		2					
(See gradation analysis)		3					
	48	4					
Tannish brown, moist, Silty, fine SAND (SM)		5					
		6					
		7					
Bottom of Handauger 8 ft	96						

WATER LEVEL OBSERVATIONS
NOTED ON RODS ____ FT.
AT COMPLETION ____ FT.
AFTER ____ HRS. ____ FT.

BORING METHOD
HSA — HOLLOW STEM AUGER
CFA — CONTINUOUS FLIGHT AUGER
DC — DRIVEN CASING
MD — MUD DRILLING
RC — ROCK CORING
CA — CASING ADVANCER

*THESE SHELBY TUBE SAMPLES OBTAINED IN AN AUXILIARY BORING DRILLED A FEW FEET FROM THIS BORING

ATEC Associates, Inc.

Consulting Geotechnical / Materials Engineers, and Environmental Scientists

LOG OF BORING NO. 9

CLIENT Rickmond Engineering
PROJECT NAME Toano Woods
PROJECT LOCATION Toano, Virginia
BORING LOCATION
FOREMAN Epps
INSPECTOR Moss

JOB NO. 26-84898
DATE June 8, 1988
BORING METHOD HA
ROCK CORE DIA. ____ IN.
SHELBY TUBE DIA. ____ IN.

MATERIAL DESCRIPTION SURFACE ELEVATION	STRATUM DEPTH, in.	DEPTH, ft	STD. PENETRATION: SAMPLE NO.	STD. PENETRATION: BLOWS/6 IN; THREE 6 IN. INCREMENTS	STD. PENETRATION: RECOVERY, %	SHELBY TUBE NO.	BORING AND SAMPLING NOTES
Topsoil	3						
Brown, moist, Silty, fine SAND (SM) trace to little Clay		1 2 3					
	48	4					
Brown, moist, Silty, fine SAND (SM)		5 6 7					
Bottom of handauger 8 ft	96						

WATER LEVEL OBSERVATIONS
NOTED ON RODS _____ FT.
AT COMPLETION _____ FT.
AFTER ____ HRS. _____ FT.

BORING METHOD
HSA — HOLLOW STEM AUGER
CFA — CONTINUOUS FLIGHT AUGER
DC — DRIVEN CASING
MD — MUD DRILLING
RC — ROCK CORING
CA — CASING ADVANCER

*THESE SHELBY TUBE SAMPLES OBTAINED IN AN AUXILIARY BORING DRILLED A FEW FEET FROM THIS BORING

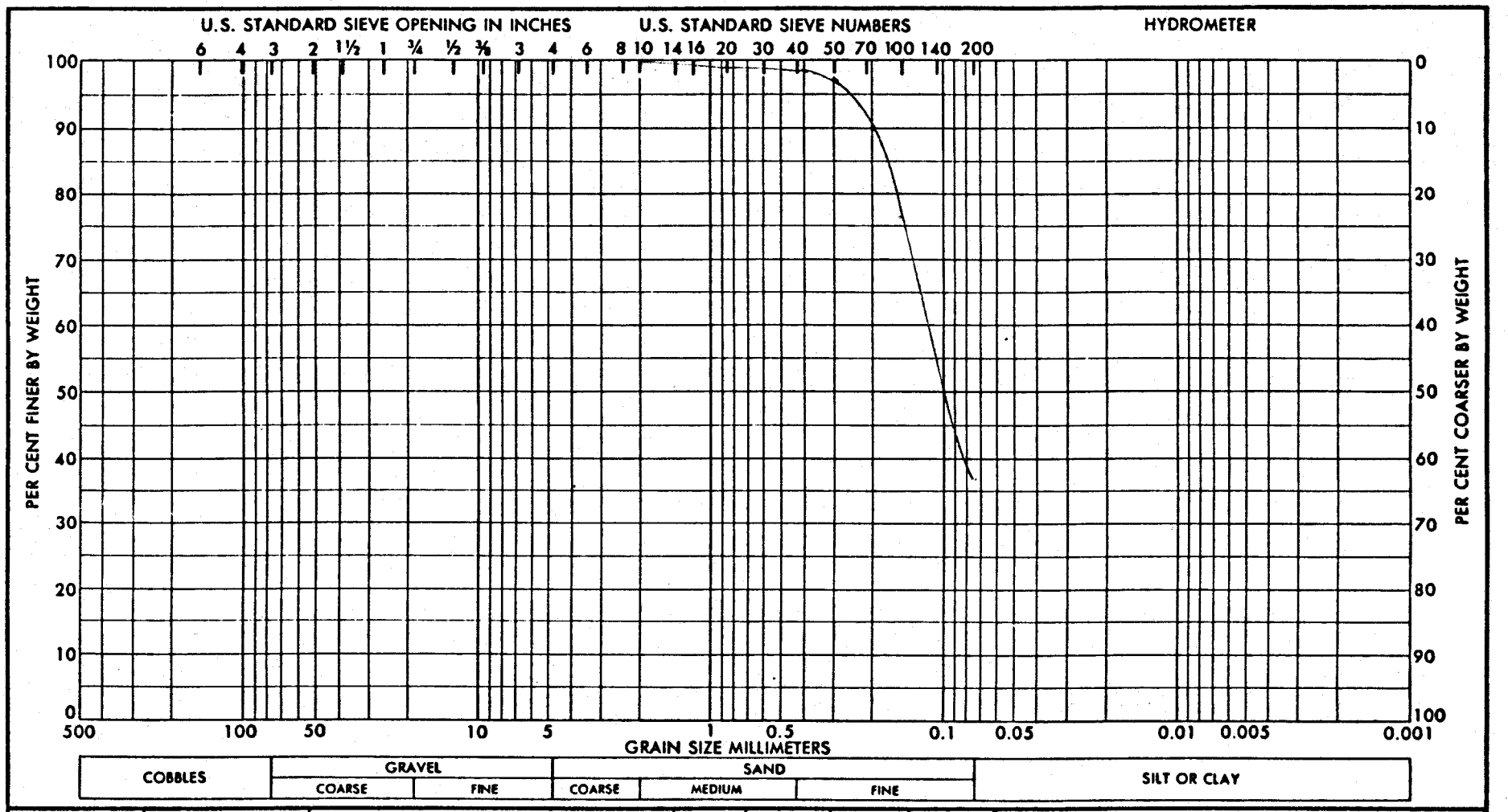
Project: Toano Woods
Client: Rickmond Engineering
Job # : 26-84898

SUMMARY OF LABORATORY TEST DATA

ATEC ASSOCIATES OF VIRGINIA, Inc.
11840 Canon Blvd. Suite 100
Newport News, Virginia 23606
(804)873-0116

Boring Number or Sampling Location	Sample Number	Sample Depth, in.	Unified Soil Classification Symbol	CLASSIFICATION PROPERTIES							PHYSICAL PROPERTIES					
											Compressive Strength, Qu		COMPACTION			
				Average Natural Moisture Content, %	Dry Unit Weight, pcf	Liquid Limit, %	Plastic Limit, %	Plasticity Index, %	% Passing #200 Sieve	Grain Size Data, Figure #	Compressive Strength, tsf	Strain at Failure, %	Maximum dry Density, pcf (Proctor type)	Optimum Moisture, %	CBR Value Soaked, at 0.1" Penetration	Permeability CM/Sec
HA*	1	2-24	SM						37.0	1						
HA	6	3-48	SM						28.2	2						
HA	8	3-48	SM-SC						41.1	3						
BS**	1	6-14	SM	(From HA-7)					18.3	4			108.4	12.1		$1.37(10)^{-4}$
BS	2	N/A	SM	(Composite sample)					32.4	5						$2.43(10)^{-5}$
1***	1	0'-2'	SM						38.9	6						
1	2	2'-4'	SM						36.9	7						
1	3	4'-6'	ML-CL						51.3	8						
1	4	8.5'-10'	SM						29.5	9						
2	4	8.5'-10'	SP-SM						8.1	10						

* Handauger Boring
** Bulk Sample
*** Soil Test Boring



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
HA-1	2"-24"	SM				
		Fig. 1				

GRADATION CURVES

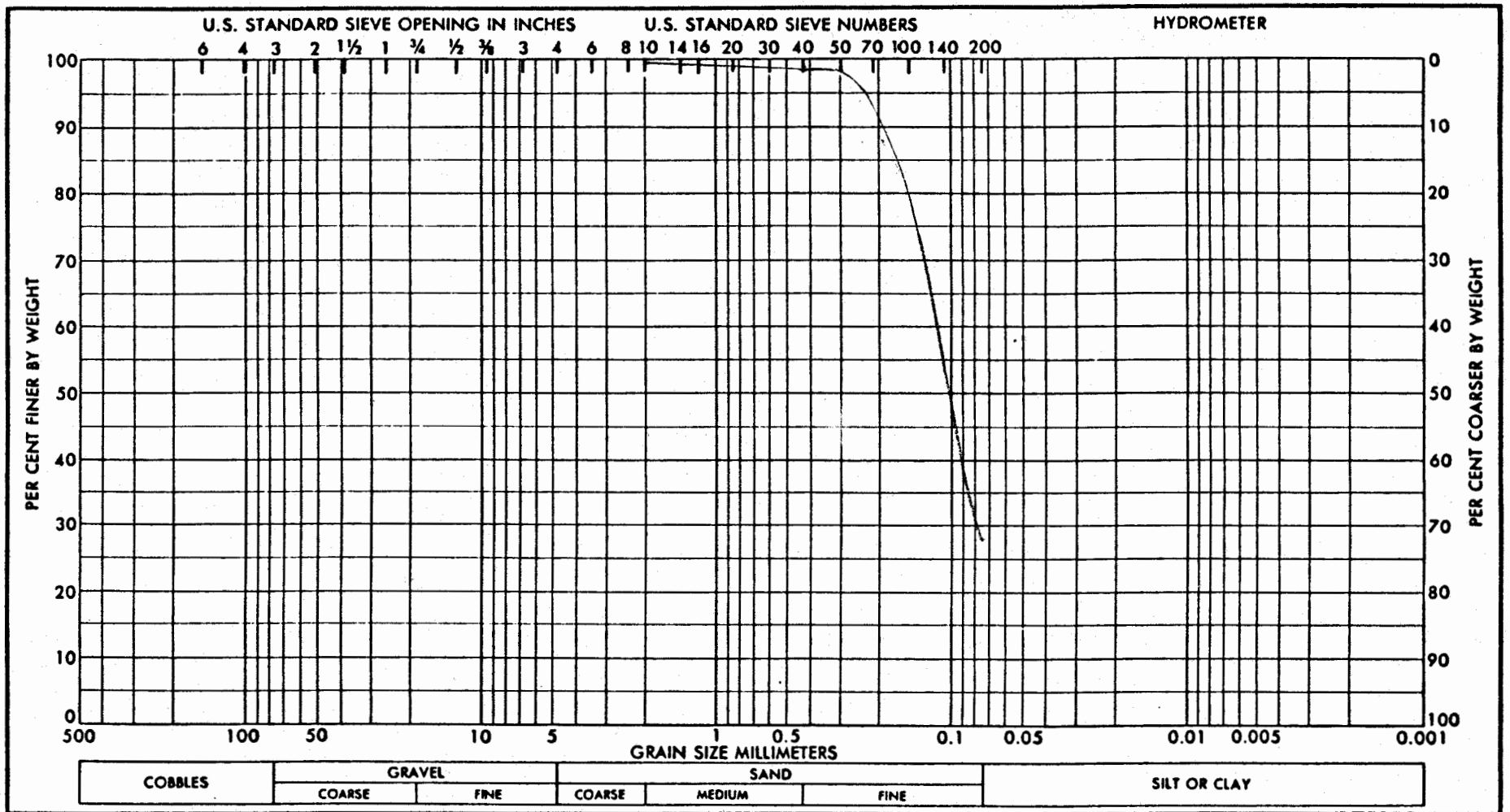
PROJECT Toano Woods

AREA Roadway

BORING NO.

DATE June 88

DRM 105



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
HA-6	3"-48"	SM				
		Fig. 2				

GRADATION CURVES

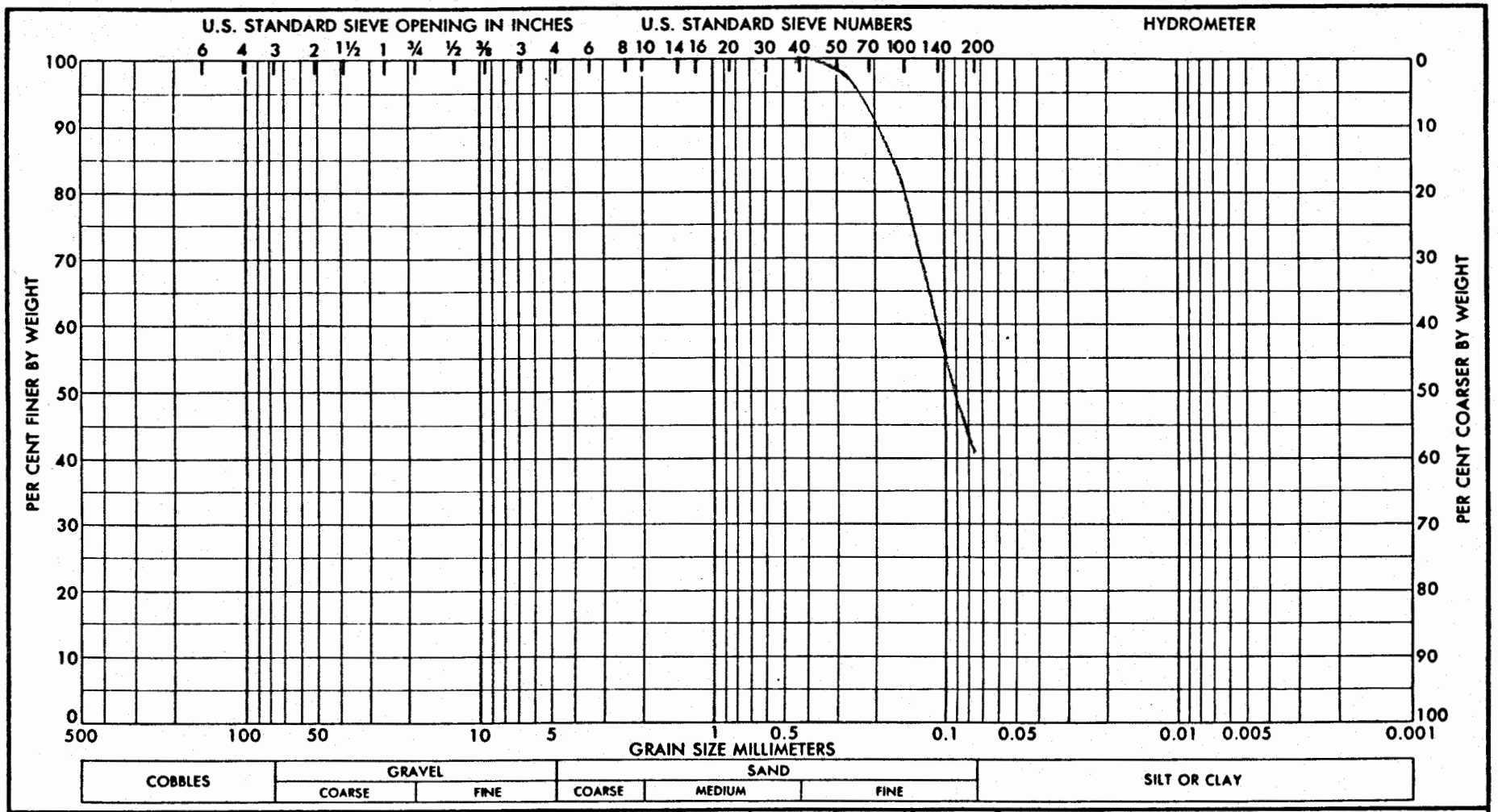
PROJECT Toano Woods

AREA Roadway

BORING NO.

DATE June 88

DRM 106



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
HA-8	3"-48"	SM-SC				

Fig. 3

GRADATION CURVES

PROJECT Toano Woods

AREA South shoulder of Dam

BORING NO.

DATE June 88

FORM 105

Atec Associates
Geotechnical and Materials Engineers
A subsidiary of American Testing and Engineering Corporation

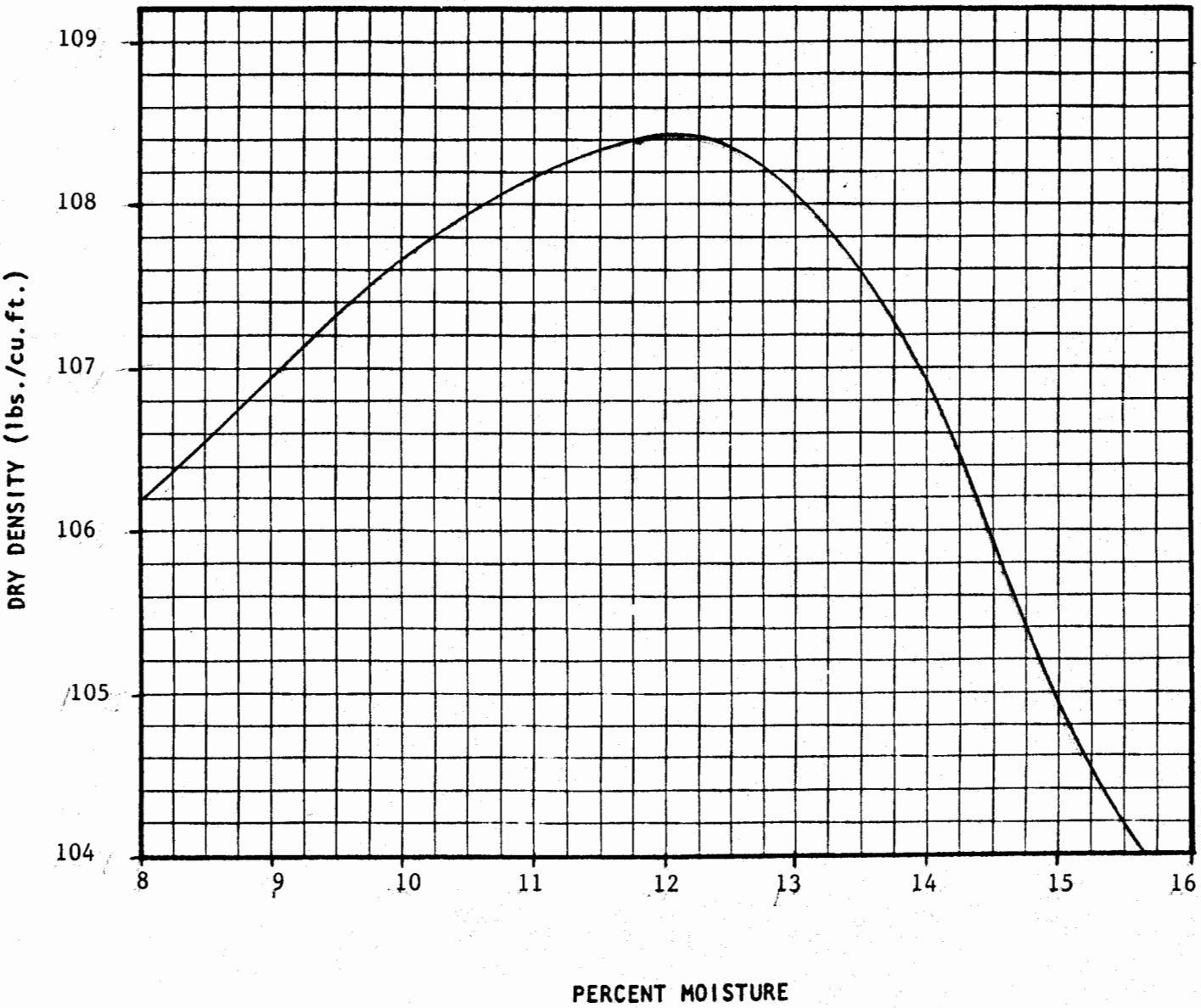
FOR Rickmond Engineering

PROJECT NUMBER 26-84898
DATE 6/13/88
TEST NUMBER BS-1
LOCATION Toano Woods

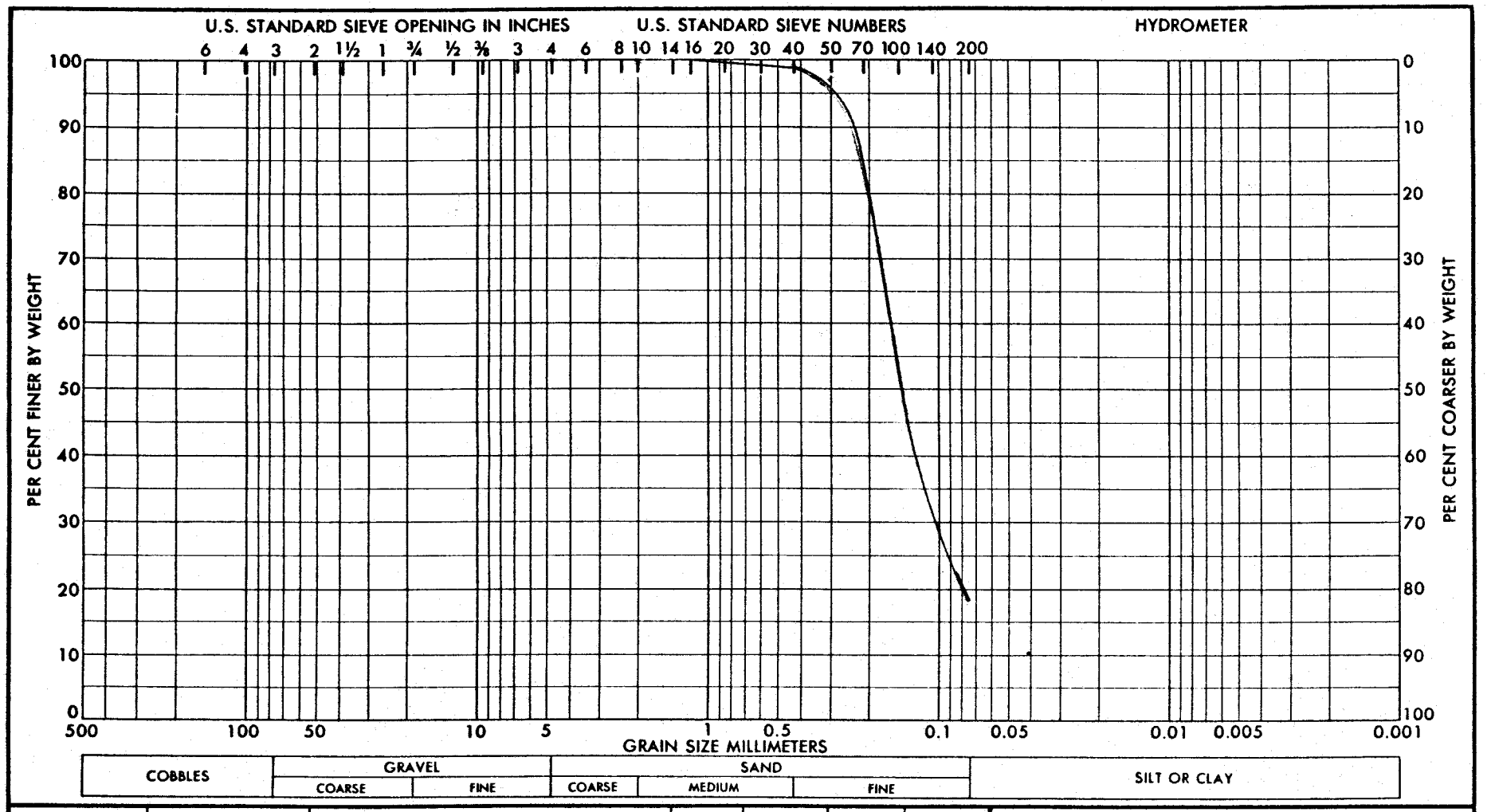
SAMPLE OBTAINED FROM: HA-7 6"-14"

TYPE OF MATERIAL Tan, Silty, fine SAND (SM) STANDARD PROCTOR x MODIFIED PROCTOR ____

DRY DENSITY (maximum) 108.4 lbs./cu.ft. 12.1 PERCENT MOISTURE (optimum)



FORM 101



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BS-1	6"-14"	Tan, Silty, fine SAND (SM)				
		Fig. 4				

GRADATION CURVES

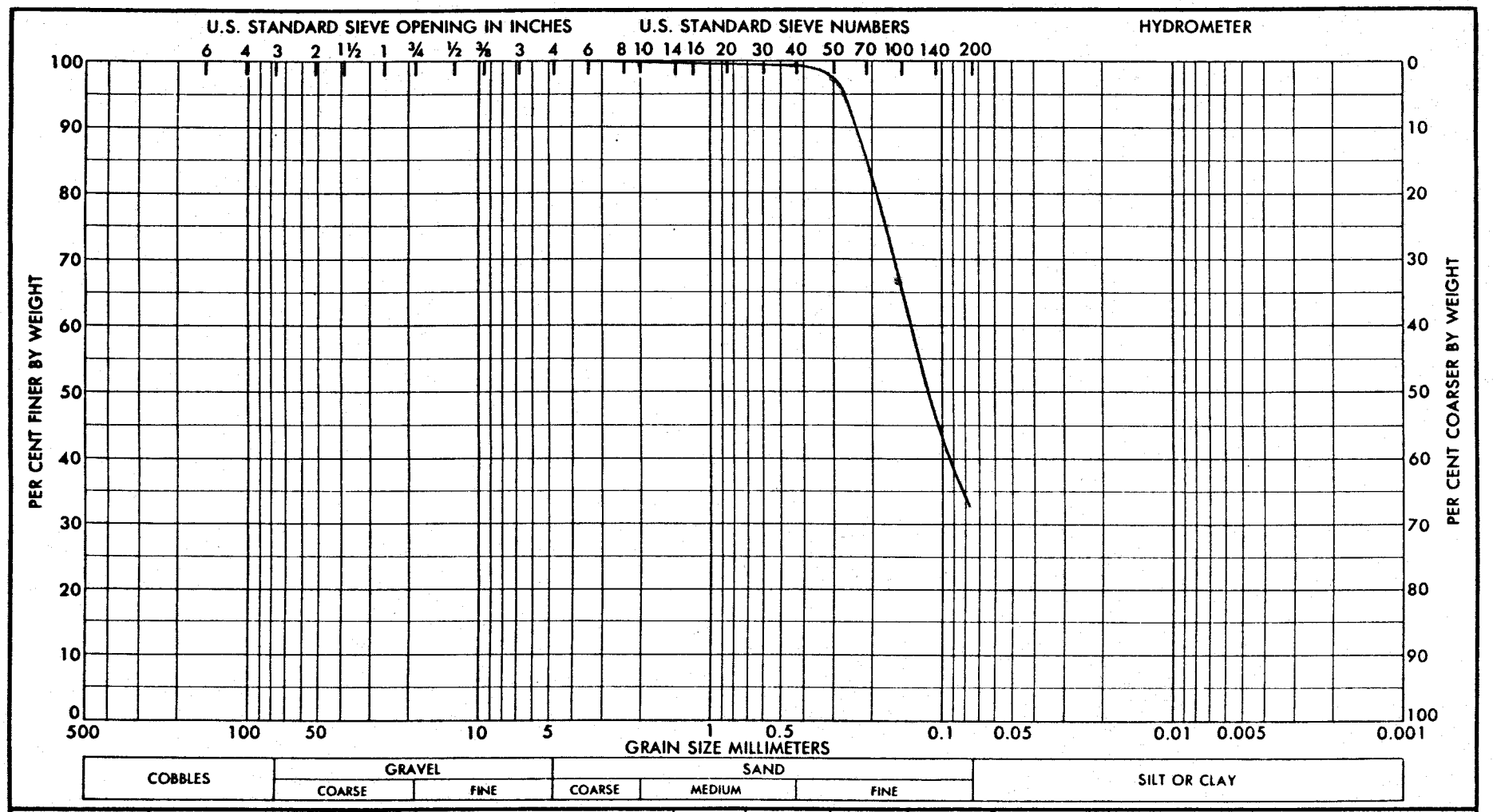
PROJECT Toano Woods

Rickmond Engineering

AREA

BORING NO. BS-1 @ HA-7

DATE 6/17/88



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BS-2	N/A	Orange, Silty, fine SAND (SM)	–			

Fig. 5

GRADATION CURVES

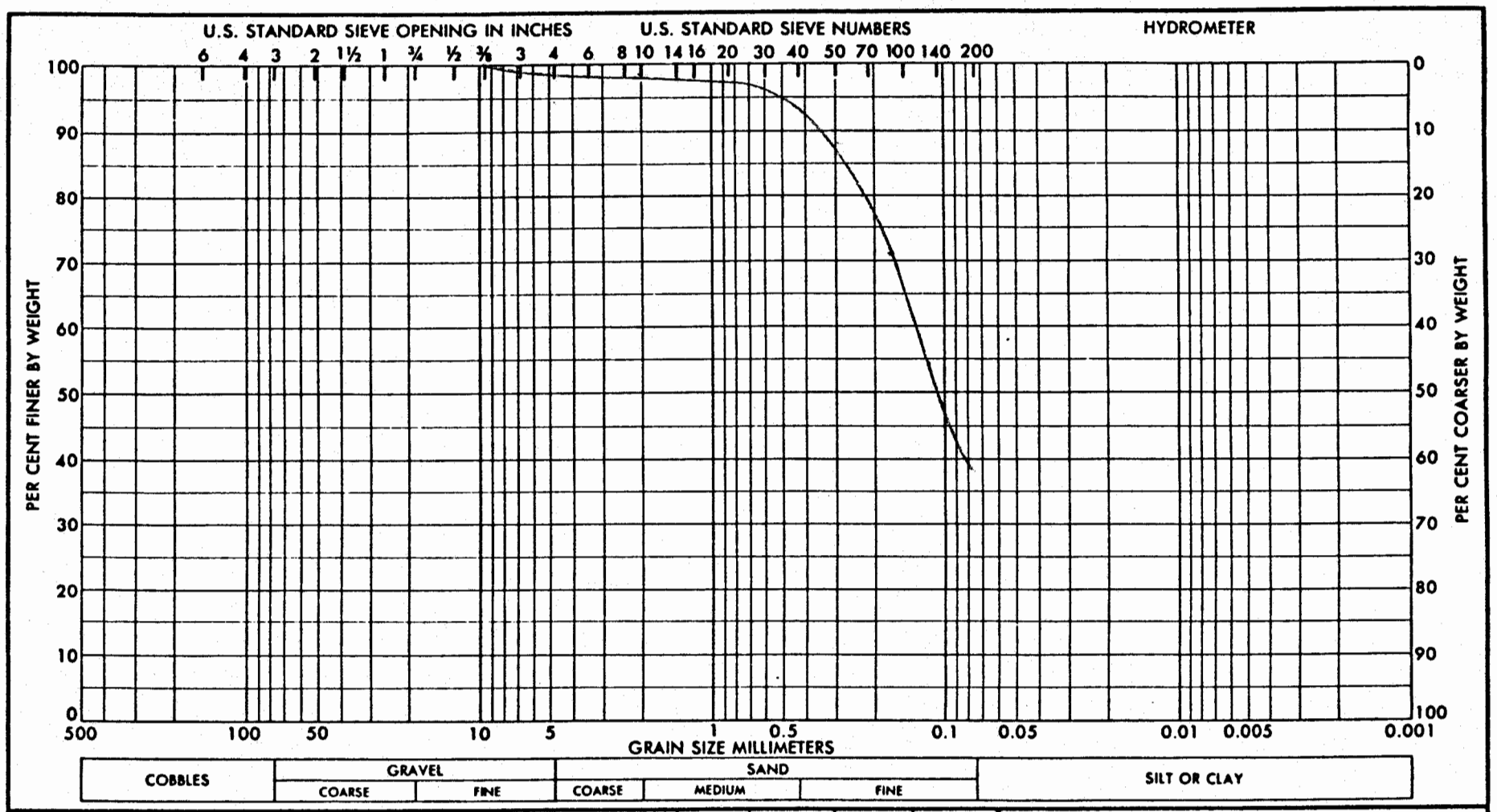
PROJECT Toano Woods

Rickmond Engineering

AREA

BORING NO. BS-2 (Composite sample)

DATE 6/17/88



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
1	0-2	SM				
		Fig. 6				

GRADATION CURVES

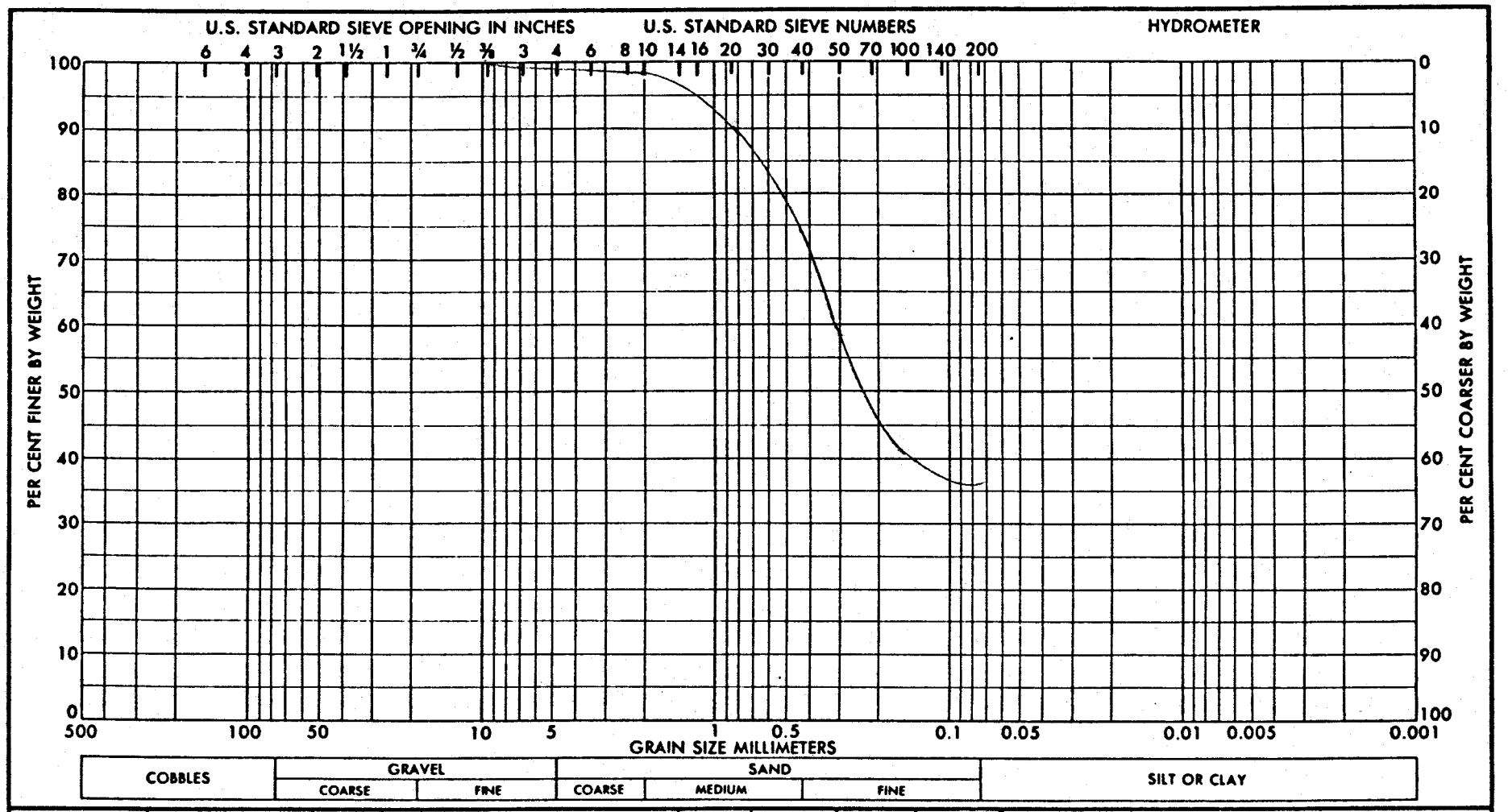
PROJECT Toano Woods

AREA

BORING NO. 1

DATE

FORM 105



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
2	2-4	SM				
		Fig. 7				

GRADATION CURVES

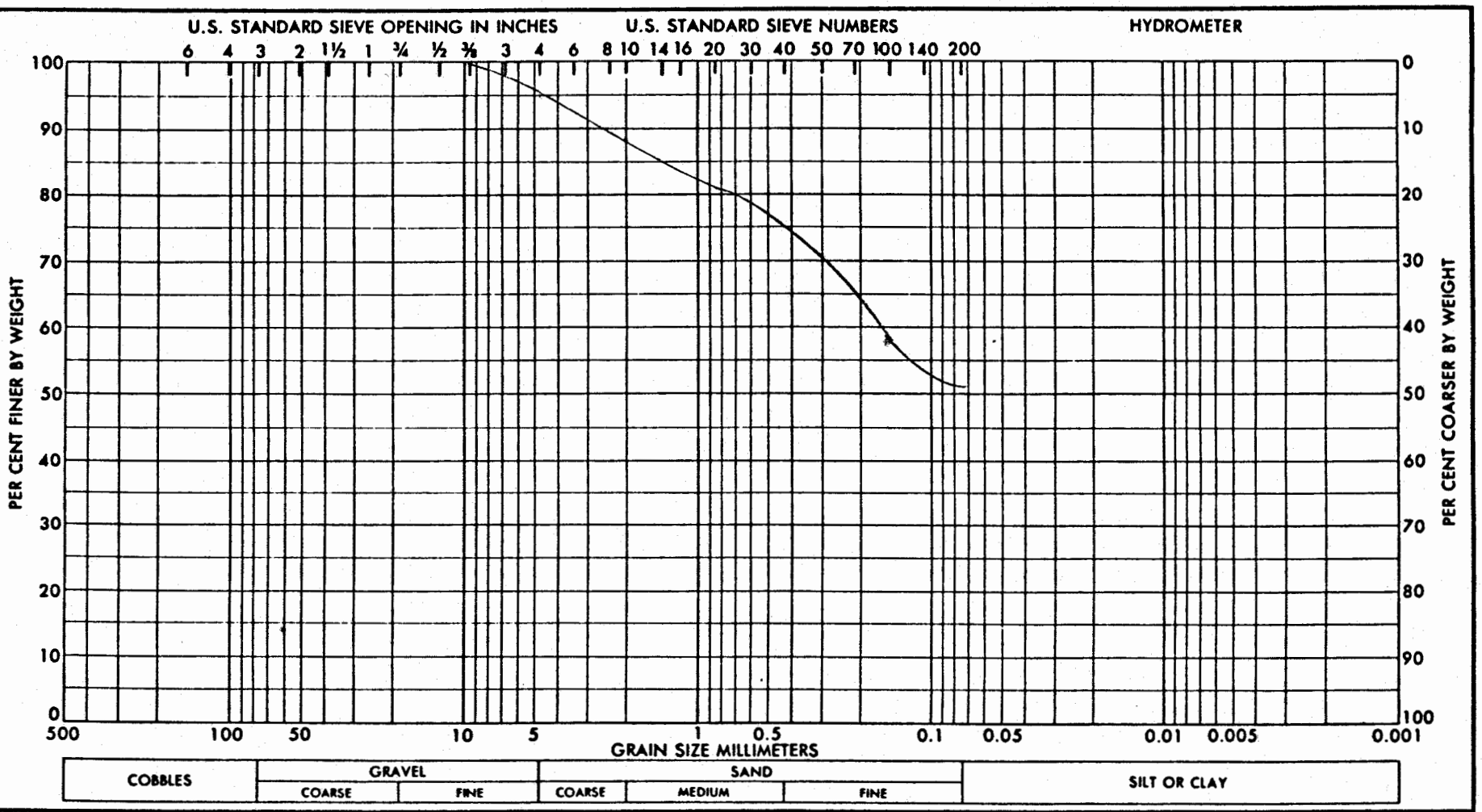
PROJECT Toano Woods

AREA

BORING NO. 1

DATE

FORM 105



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
3	4-6	ML-CL				
		Fig. 8				

GRADATION CURVES

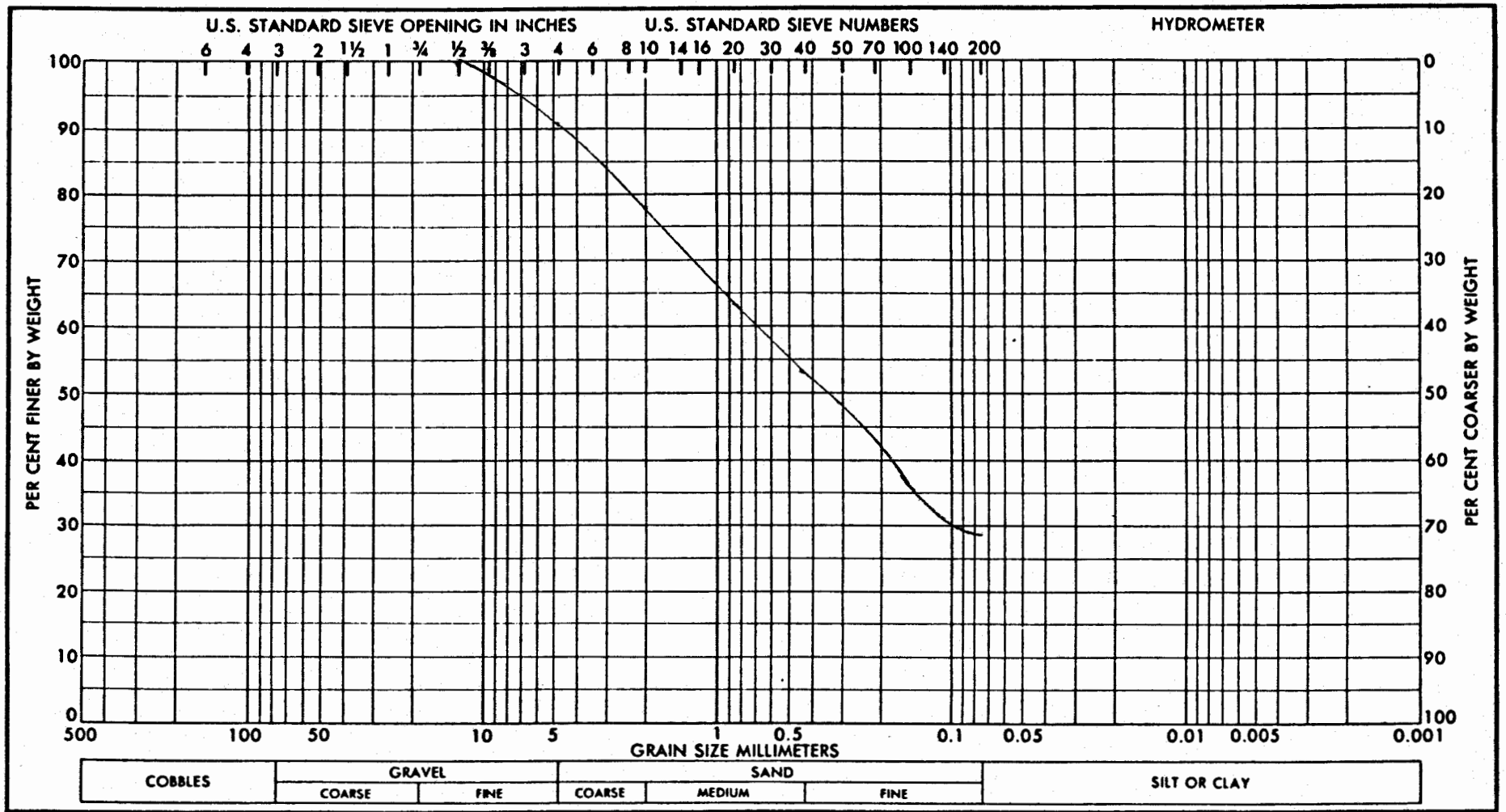
PROJECT Toano Woods

AREA

BORING NO. I

DATE

FORM 105



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
4	8-10	SM				
		Fig. 9				

GRADATION CURVES

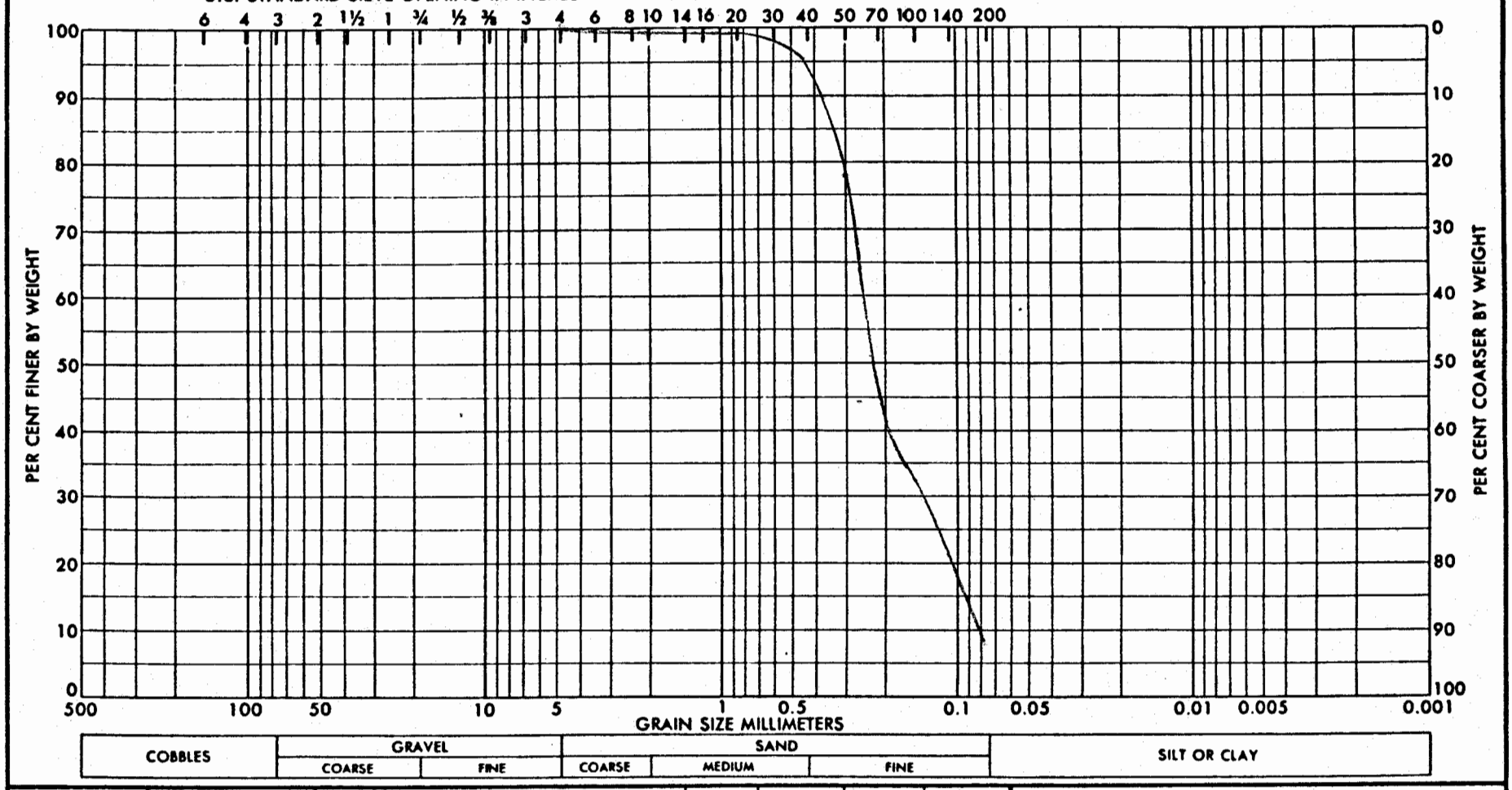
PROJECT Toano Woods

AREA

BORING NO. 1

DATE

FORM 105



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
4	8-10	SP-SM				
		Fig. 10				

GRADATION CURVES

PROJECT Toano Woods

AREA

BORING NO. 2

DATE

FORM 105

FIELD CLASSIFICATION SYSTEM FOR SOIL EXPLORATION

NON COHESIVE SOILS
(Silt, Sand, Gravel and Combinations)

Density

Very Loose	- 5 blows/ft. or less
Loose	- 6 to 10 blows/ft.
Medium Dense	-11 to 30 blows/ft.
Dense	-31 to 50 blows/ft.
Very Dense	-51 blows/ft. or more

Relative Proportions

Descriptive Term	Percent
Trace	1 -10
Little	11-20
Some	21-35
And	36-50

Particle Size Identification

Boulders	-8 inch diameter or more	
Cobbles	-3 to 8 inch diameter	
Gravel	-Coarse	-1 to 3 inch
	Medium	-½ to 1 inch
	Fine	-¼ to ½ inch
Sand	-Coarse	2.00mm to ¼ inch (dia. of pencil lead)
	Medium	0.42 to 2.00mm (dia. of broom straw)
	Fine	0.074 to 0.42mm (Dia. of human hair)
Silt		0.074 to 0.002mm (Cannot see particles)

COHESIVE SOILS
(Clay, Silt and Combinations)

Consistency

Very Soft	- 3 blows/ft. or less
Soft	- 4 to 5 blows/ft.
Medium Stiff	- 6 to 10 blows/ft.
Stiff	-11 to 15 blows/ft.
Very Stiff	-16 top 30 blows/ft.
Hard	-31 blows/ft. or more

Plasticity

Degree of Plasticity	Plasticity Index
None to slight	0- 4
Slight	5- 7
Medium	8-22
High to Very High	over 22

Classification on logs are made by visual inspection of samples.

Standard Penetration Test — Driving a 2.0" O.D., 1-3/8" I.D., sampler a distance of 1.0 foot into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 inches. It is customary for ATEC to drive the spoon 6.0 inches to seat into undisturbed soil, then perform the test. The number of hammer blows for seating the spoon and making the test are recorded for each 6.0 inches of penetration on the drill log (Example — 6/8/9). The standard penetration test result can be obtained by adding the last two figures (i.e. 8+ 9 = 17 blows/ft.). (ASTM D-1586-67)

Strata Changes — In the column "Soil Descriptions" on the drill log the horizontal lines represent strata changes. A solid line (_____) represents an actually observed change, a dashed line (_ _ _ _) represents an estimated change.

Ground Water observations were made at the times indicated. Porosity of soil strata, weather conditions, site topography, etc., may cause changes in the water levels indicated on the logs.

Adjoining
Property Owner

GREGORY J. SCHNECK
HISTORIAN - ANTHROPOLOGIST

3656 TOANO WOODS ROAD
TOANO, VA 23168-9060
(757) 566-8550

~~*EMAIL: g1schneck@AOL.COM*~~

Weds AM

COPY

A. Concerns that need to be addressed related to drainage include but are not limited to the following:

1. Because of the poor soils and topographic limitations, erosion and sediment control may require that this project be constructed with a curb and gutter system rather than an open drainage system.

2. Drainage outfalls shall be pipe and combined to the extent possible to reduce disturbed areas and eliminate potential erosion problems. Specifically, Outfall B drainage shall be conveyed to Outfall C, Outfall D drainage shall be conveyed to Outfall E and conveyed to the proposed lake, and Outfall G drainage shall be conveyed to Outfall F.

3. If for some reason Outfall B is not eliminated, provide riprap at the end of the paved ditch.

4. Extend the paved ditch for Outfall C to the stream and provide riprap at the end.

5. If for some reason Outfall E cannot be eliminated, extend this paved ditch outfall to Elevation 50.

6. If an open ditch system is retained, recalculate paved ditch requirements using a velocity of 2.5 fps.

B. Concerning sewer problems, the proposed gravity sewer system with a lift station will cause additional erosion and sediment control problems and may be changed to a grinder pump system. If for some reason the system remains a gravity system, silt fence will be required on the downslope side of the proposed sewer line extending from the lift station site to the proposed dam site as well as other additional erosion and sediment control measures.

C. The following items shall be addressed relating to the proposed dam:

1. Maintenance standards shall be developed for the proposed dam with one of the conditions being that no trees shall be allowed on the embankment. These maintenance standards and a means to ensure that they are implemented shall be incorporated into the subdivision covenants, a Homeowners Association Agreement or some other suitable document to be reviewed and approved by the County Attorney.

2. Provide a 40-foot rock check dam in lieu of a portion of the silt fence shown below the proposed dam.

RICKMOND ENGINEERING INC.
1643C MERRIMAC TRAIL
WILLIAMSBURG, VA 23185
(804) 229-1776

LETTER OF TRANSMITTAL

DATE 10/4/90	JOB NO 90221
ATTENTION Darryl Cook	
RE: Toano Woods	

TO JCC Code Compliance

RECEIVED 10-4-90

WE ARE SENDING YOU [X] ATTACHED [ ] UNDER SEPARATE COVER VIA _____
THE FOLLOWING ITEMS:
[ ] SHOP DRAWINGS [ ] PRINTS [ ] PLANS [ ] SAMPLES
[ ] SPECIFICATIONS [ ] COPY OF LETTER [ ] CHANGE ORDER
[X] Calculations

COPIES	DATE	NO.	DESCRIPTION
1	10/4/90	3	BMP Calculations

THESE ARE TRANSMITTED AS CHECKED BELOW:

[X] FOR APPROVAL [ ] APPROVED AS SUBMITTED [ ] RESUBMIT ___ COPIES FOR APPROVAL
[ ] FOR YOUR USE [ ] APPROVED AS NOTED [ ] SUBMIT ___ COPIES FOR DISTRIBUTION
[ ] AS REQUESTED [ ] RETURNED FOR CORRECTIONS [ ] RETURN ___ CORRECTED PRINTS
[ ] FOR REVIEW AND COMMENT [ ] _____
[ ] FOR BIDS DUE _____ 19___ [ ] PRINTS RETURNED AFTER LOAN TO US

REMARKS Revised calculations including offsite area draining onto our property

COPY TO _____ SIGNED Kenneth Jenkins

Erosion Control Plan Review Comments
Plan No. S-99-87. Toano Woods

1. Surety must be provided for the Land Disturbing Permit and Siltation Agreement.

2. A Subdivision Agreement, with surety, must be executed with the County prior to recording lots.

3. Water and sewer inspection fees must be paid prior to the issuance of a Land Disturbing Permit.

See 4 on attached sheet.

a. Specify the amount of riprap to be provided at the end of each drainage pipe.

b. Provide paved ditch on Toano Woods Drive from the end of Culvert B on the right side of the road and Station 8+75 on the left side to the intersection with Thacher Drive.

c. The type of pipe provided is corrugated metal ~~pipe~~ rather than concrete pipe. VDOT ~~may not allow this~~ must verify that this is acceptable to him.

7. Extend silt fence across Lot 16 and Lot 19 on Thacher Drive to connect to the existing silt fence shown.

8. Provide a silt trap at the end of Outfalls C, D and E.

redo

~~9. Provide temporary liners in all grass ditches steeper than 1% slope.~~

d) ~~10.~~ Pave the ~~ditch~~ roadside ditch from the end of Culvert I on Thacher Drive to the inlet of Culvert A.

e) ~~11.~~ Provide temporary liners, such as polyethylene sheets, in all ditches that are to receive paved ditch until the permanent lining is installed.

f) ~~12.~~ Adjust the direction of the pipe from Outfall A to discharge into the low point of the swale at the lake's edge.

13. Relocate the streetlight shown between Lots 3 and 4 to between Lots 4 and 5. Relocate the light between Lots 11 and 12 to between Lots 12 and 13. Relocate the light between Lots 52 and 53 to between Lots 53 and 54. Relocate the light on Lot 56 to between Lots 18 and 19. Add a streetlight between Lots 22 and 23. Relocate the light between Lots 77 and 78 to between Lots 76 and 77. Add a light between Lots 61 and 62.

DEC/lwo
3884c

— Backslope & shoulder stabilization comment
— Preconstruction conference w/ owner, engineer cont & county, prior to is. Prior to the preconst. mtg the contractor shall submit a narrative plan
— Phasing plan
— Inlet protection detail
— Refer to previous dam comment & SW (over)

— sewer thru dam. geotech comments

RICKMOND ENGINEERING, INC.
1643C MERRIMAC TRAIL
WILLIAMSBURG, VA 23185
(804)229-1776 or (804)898-4149
FAX NUMBER (804)220-9370

JOB 90221
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____
SCALE _____

Lot #	Marsh in S.B.	25% Slope in S.B.
9		2,100
17		700
18	7,825	2,900
19	5,250	9,475
20	3,525	7,375
21	16,200	50,650
22		1,375
23		500
24	8,725	13,350
25	3,150	6,325
26	9,800	
28	5,500	19,475
29		5,950
30		4,250
31		2,950
32		3,875
33		3,225
34		300
35		2,500
36		650
37		1,000
39		1,450
40		450
RL		2,400
42		2,000
45		900
46	1,225	2,375
47		4,550
	61,200 = 1.41	153,050 = 3.51 Ac.

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JOB
SHEET NO. OF
CALCULATED BY DATE
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1) Determine Design Wet Pond:

a) Serves 19.34 Ac or 34% of site

Try Design 7

RV = 0.05 + .009(I)

I = (1.65 Ac) + (5.34 Ac) = 6.96 ac. = 36%
Road — Imp Area 1/3 Lots

RV = 0.05 + .009(34) = .36

Permanent Vol Reqd = (4)(.36)(.5 in/acre)(19.34 ac)(43,560 sf)(1 ft / 12 in)
= 50,547 cf

Permanent Vol Reqd = (.4)(Surface Area)(depth)
= (.4)(40,000 sf)(10 ft)
= 160,000 cf

Area in S.B. and D&U Easements = 24.44 Ac.

Area available for "Conservation Easement" = 12.96 Ac

Total Area = 56.25 Ac.

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JOB
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SCALE

Size Proposed Ponds at Outfalls C, D, E

Pond C (Design 4)

Total Area = 6.19 Ac
Imp. Area = (.73 Ac) + (1.64 Ac) = 2.37 = 38%
R/W 1/3 lots

RV = .05 + .009(38)
RV = .39
Storage Vol Reqd = (.39)(1in/ac)(6.19ac)(43,560 sf)$\left(\frac{1 ft}{12 in}\right)$

= 8,763 cf (6' x 38' x 38')

Pond D (Design 4)

Total Area = 2.81 Ac
Imp Area = (.33 Ac) + (.74 Ac) = 1.07 Ac. = 38%
R/W 1/3 Lots

RV = .05 + .009(38)
RV = .39
Storage Vol Reqd = (.39)(1in/ac)(2.81 Ac)(43,560)$\left(\frac{1 ft}{12 in}\right)$

= 3,978 cf (4' x 32' x 32')

Pond E Design (4)

Total Area = 2.81 Ac
Imp Area = (.38 Ac) + (.73 Ac) = 1.11 Ac = 40%
R/W 1/3 lots

RV = .05 + .009(40)
RV = .41
Storage Vol Reqd = (.41)(1in/ac)(2.81 Ac)(43,560)$\left(\frac{1 ft}{12 in}\right)$

= 4,182 cf (4' x 32' x 32')

Toano Woods

Drainage Calculations

Rickmond Engineering, Inc.
1643 Merrimac Trail, Suite C
Williamsburg, VA 23185

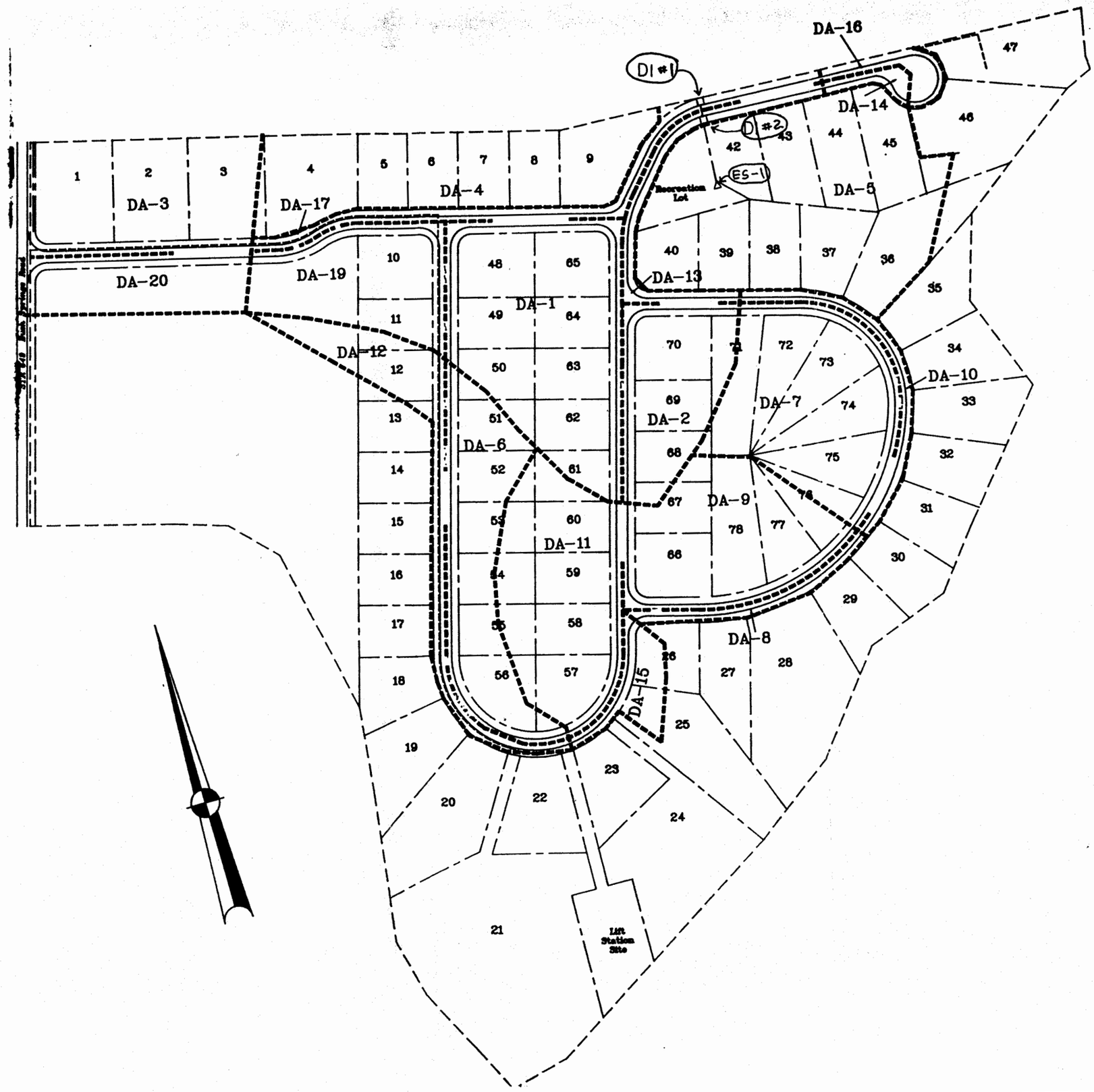
Project No. 90221

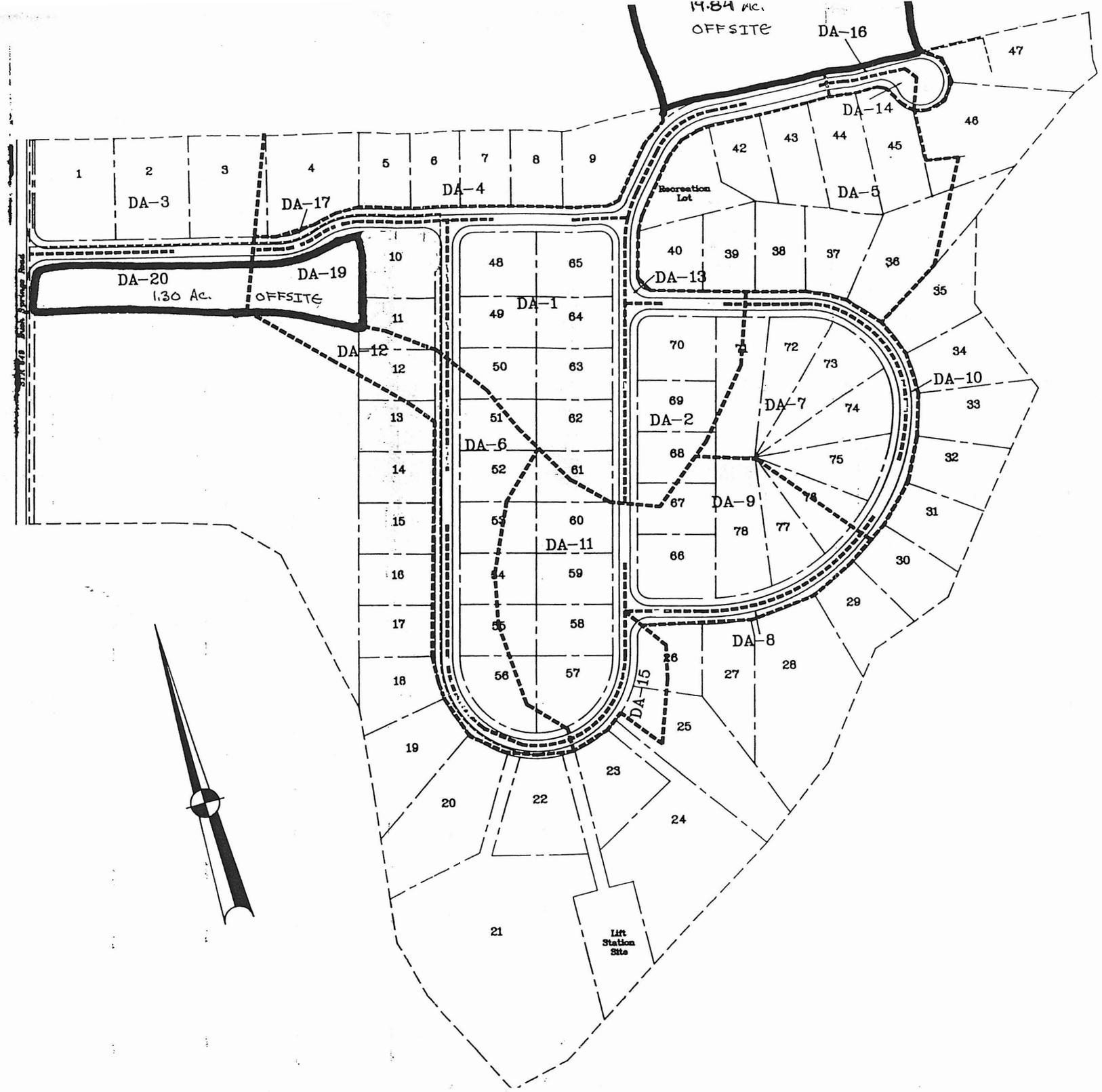
Table of Contents

	Page
Description	1
Drainage Structure Map	2
DA to DI#1 (Toano Woods Dr. Sta 25+25, North Side)	3
DA to DI#2 (Toano Woods Dr. Sta 25+25, South Side)	4
Combined DA's (@ DI#2)	4
Check Inlet Capacity DI#1	6
Check Inlet Capacity DI#2	7
Storm Sewer Design	8
Hydraulic Calculation Sheet	9
Conclusion	10

Description

The following drainage calculations pertain to the storm sewer structure located at Sta 25+25 on Toano Woods Drive. The system consists of two (2) DI-7 with connecting 24" RCP pipe and an ES-1 which discharges into an existing wet pond.


DA-16
DI #1
DI #2
DA-14
DA-5
ES-1
Recreation Lot
DA-3
DA-17
DA-4
DA-20
DA-19
DA-13
DA-1
DA-12
DA-10
DA-7
DA-2
DA-6
DA-9
DA-11
DA-8
DA-15
Lift Station Site


14.84 Ac.
OFFSITE
DA-16
DA-14
DA-5
DA-4
DA-3
DA-17
DA-19
OFFSITE
DA-20
1.30 Ac.
DA-13
DA-1
DA-12
DA-10
DA-7
DA-2
DA-6
DA-9
DA-11
DA-8
DA-15
Recreation Lot
Lift Station Site

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JOB 90281
SHEET NO. 3 OF
CALCULATED BY KMJ DATE 2/22/91
CHECKED BY RCS DATE 2/28/91
SCALE

DI at 25+25 (DI#1)
on Toano Woods
Dr. North Side

DA-1, 17, 19, 20, offsite Woods

c=.37
A=9.79 Ac.

	c	A	CA
Road	.90	1.01	.90
Lots	.40	6.28	2.51
Woods	.10	2.50	.25
		9.79	3.66

$\tilde{C} = \frac{\Sigma CA}{\Sigma A} = \frac{3.66}{9.79}$

$= .37$

OVERLAND FLOW

L=360 ft.
S=4.44 %
Tc=18 min.

CHANNEL FLOW

H=6.25 ft.
L=365 ft.
Tc=3.5 min.

Tc=21.5 min.

i_{10}=4.4 in/hr

Q=CAi=(.37)(9.79 Ac.)(4.4 in/hr)(C_f)

C_f for storms 25 yr+
(VDOT Manual Pg. 1-11)

Q=15.94 cfs

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JOB 90221
SHEET NO. 4 OF
CALCULATED BY KMJ DATE 2/22/91
CHECKED BY RCS DATE 2/28/91
SCALE

OI at 25+25 (DI#2)
on Toano Woods
On South Side

DA-2.13

c=.48
A=2.16 Ac.

	C	A	CA
Road	.90	.36	.32
Lots	.40	1.80	.72
		2.16	1.04

$\tilde{C} = \frac{\Sigma CA}{\Sigma A} = \frac{1.04}{2.16}$

$= 0.48$

OVERLAND FLOW

L=300 ft.
S=7.67 %
Tc=12 min.

CHANNEL FLOW

H=8 ft.
L=450 ft.
Tc=4 min.

Tc=16 min.

i_{10}=5.0 in/hr

Q=CAi=(.48)(2.16 Ac.)(5.0 in/hr)(C_f)

C_f for storms 25 yr+
(VDOT Manual Pg. 1-11)

Q=5.18 cfs

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JOB 90221
SHEET NO. 5 OF
CALCULATED BY KMS DATE 2/22/91
CHECKED BY RCB DATE 2/28/91
SCALE

From DI at Sta 25+25
on Toano Woods Drive
South Side to ES-1

DA-____

c= .39
A= 11.95 Ac.

OVERLAND FLOW

L= 360 ft.
S= 4.44 %
Tc= 18 min.

CHANNEL FLOW

H= 6.25 ft.
L= 365 ft.
Tc= 3.5 min.

Tc= 21.5 min.

i_{10}= 4.4 in/hr

Q=CAi=(.39)(11.95 Ac.)(4.4 in/hr)(C_f)

C_f for storms 25 yr+
(VDOT Manual Pg. 1-11)

Q= 20.51 cfs

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JOB 90221
SHEET NO. 6 OF
CALCULATED BY KMJ DATE 2/22/91
CHECKED BY RCS DATE 2/28/91
SCALE

Check Inlet Capacity
of DI at Sta 25+25
on Toano Woods Dr.
North Side

Std VDOT DI-1
$L = 2.5'$
$W = 2.5'$
$Q = 15.94$ cfs

$P = 2(W+L) = 2(2.5+2.5) = 10'$

From Chart 14: $d = .68$ inlet operates as weir

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JOB 90221
SHEET NO. 7 OF
CALCULATED BY KMT DATE 2/22/91
CHECKED BY RCS DATE 2/28/91
SCALE

Check Inlet Capacity
of DI at Sta 25+25
on Toano Woods Dr.
South Side

Std VDOT DI-1
L = 2.5'
W = 2.5'
Q = 5.18 cfs

P = 2(W+L) = 2(2.5+2.5) = 10'

From Chart 14: d = .32 Inlet operates as weir

STORM SEWER DESIGN

MH From	MH To	Area Ac.	C	A×C	Total Section A.R.	Total Trunk A.R.	Inten. In/Hr	Q CFS	Length of Pipe	Size Pipe In	Slope Ft/Ft	Fall in Feet	M.H. Drop	Invert Up Stream	Invert Down Stream	Actual Cap. CFS	Vel FPS
1	2	9.79	.37	3.62			4.4	15.94	39	24	.0146	.57	—	76.56	75.99	23.68	8.13
2	ES-1	11.95	.39	4.66			4.4	20.51	103	24	.0458	4.72	—	75.99	71.27	41.95	13.36

HYDRAULIC CALCULATION SHEET

M.H.	Inv.	D	W.S.	RIM	A	K	V	Q	$\frac{V^2}{2g}$	E.G.	S_f	$\frac{S_{f_1}+S_{f_2}}{2}$	L	h_f	h_b	h_j	h_{mh}
ES-1	71.27	30"	72.27		3.14	.0066	13.36	20.51	2.77	75.04	.0458		103	4.72			
2	75.99	30"	76.99	82.73	3.14	.0066	8.13	15.94	1.03	78.02	.0146		39	.57			.05
1	76.56	30"	77.61	82.74													

Conclusion

These calculations verify that the DI inlet and pipes are sized correctly to handle the expected stormwater runoff and that the cause of the continual overflowing of the DI structures is due to a build-up of silt in the pipes and debris around the inlet grate. Both these problems have been viewed during numerous visits to the site.

We recommend DI inlet and pipes be cleaned and inlet protection used until site is stabilized.

98188

DEVELOPMENT MANAGEMENT

101-E Mounts Bay Road, P.O. Box 8784, Williamsburg, Virginia 23187-8784
(757) 253-6671 Fax: (757) 253-6850 E-mail: devmgmt@james-city.va.us

Code Compliance (757) 253-6626 codecomp@james-city.va.us
Environmental Division (757) 253-6670 environ@james-city.va.us
Planning (757) 253-6685 planning@james-city.va.us
County Engineer (757) 253-6678
Integrated Pest Management (757) 253-2620

January 12, 1999

Mr. Kenneth Jenkins
Rickmond Engineering, Inc.
1643 Merrimac Trail
Williamsburg, VA 23185

RE: Toano Woods BMP As-built Drawings

Dear Mr. Jenkins:

We have completed review of the as-built drawings submitted by you for the above referenced subdivision. The following items need to be addressed to bring the structure into conformance with the approved plan and to allow release of the remaining project surety.

KWJ 1. Install an emergency spillway as required by the design. Given that the original location of the spillway is now on a constucted lot, it may be necessary to install it on the north side of the dam. Developer

KWJ 2. Install a flared end section on the outfall pipe or place additional riprap at the outfall to protect against erosion and undercutting. Developer

KWJ 3. Provide calculations to demonstrate the 24-inch barrel is adequate. Provided. Emergency Spillway is required.

KWJ 4. The existing trash rack is leaning and needs to be straightened. Also, install a solid cover on top of the trash rack with 5/8-inch holes drilled through in accordance with the erosion control handbook (VESCH). Developer

KWJ 5. Remove all trees growing on the dam and restabilize with a permanent grass. Developer

If you have any questions regarding these items, please feel free to call me at 253-6673.

Sincerely,

Darryl E Cook

Darryl E. Cook, P.E.
Environmental Director

DEVELOPMENT MANAGEMENT

101-E MOUNTS BAY ROAD, P.O. BOX 8784, WILLIAMSBURG, VIRGINIA 23187-8784
(757) 253-6671 Fax: (757) 253-6850 E-MAIL: devtman@james-city.va.us

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environ@james-city.va.us

PLANNING
(757) 253-6685
planning@james-city.va.us

COUNTY ENGINEER
(757) 253-6678

INTEGRATED PEST MANAGEMENT
(757) 253-2620

January 12, 1999

Mr. Kenneth Jenkins
Rickmond Engineering, Inc.
1643 Merrimac Trail
Williamsburg, VA 23185

RE: Toano Woods BMP As-built Drawings

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1. Install an emergency spillway as required by the design. Given that the original location of the spillway is now on a constucted lot, it may be necessary to install it on the north side of the dam.

2. Install a flared end section on the outfall pipe or place additional riprap at the outfall to protect against erosion and undercutting.

3. Provide calculations to demonstrate the 24-inch barrel is adequate.

4. The existing trash rack is leaning and needs to be straightened. Also, install a solid cover on top of the trash rack with 5/8-inch holes drilled through in accordance with the erosion control handbook (VESCH).

5. Remove all trees growing on the dam and restabilize with a permanent grass.

If you have any questions regarding these items, please feel free to call me at 253-6673.

Sincerely,

Darryl E Cook

Darryl E. Cook, P.E.
Environmental Director

DEVELOPMENT MANAGEMENT

101-E MOUNTS BAY ROAD, P.O. BOX 8784, WILLIAMSBURG, VIRGINIA 23187-8784
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planning@james-city.va.us

COUNTY ENGINEER
(757) 253-6678

INTEGRATED PEST MANAGEMENT
(757) 253-2620

Mr. Jack Scruggs
Toano Woods Associates
PO Box 147
Toano, VA 23168

Re: Toano Woods

Dear Mr. Scruggs:

The purpose of this letter is to inform you that the required Inspection/ Maintenance Agreement for the BMP located in the above referenced project has not been executed with James City County. The notification of the this requirement was transmitted to you through your authorized agent, the design engineer, during the plan review process.

During a recent phone conversation with Pat Menichino of our office, you indicated that the individual property owners whose land is contiguous with the BMP are responsible for the BMP's perpetual maintenance. In order to assist us in determining the assignment of long term maintenance responsibilities, please provide us with the legal documents which reference the individual property owners' BMP obligations.

James City County will continue to hold the existing surety until an acceptable Inspection/ Maintenance Agreement is executed.

If you would like to discuss this matter please contact me at 253-6670.

Sincerely;

Darryl E Cook

Darryl Cook
Environmental Director

TOANO WOODS

STORM DRAINAGE CALCULATIONS

Revised 3/90 KMJ
Revised 1/13/89 KMJ
Revised 1/5/89 KMJ
Revised 3/14/88 KMJ

JOB 87157

RICKMOND ENGINEERING, INC.
1643 C Merrimac Trail
WILLIAMSBURG, VIRGINIA 23185
(804) 229-1776
(804) 875-1785

JOB _____
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE _____
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SCALE _____

TABLE OF CONTENTS

PAGE	
1	PRE-DEVELOPMENT
3	POST-DEVELOPMENT
4	CULVERT DESIGN
8	PAVED DITCHES
11	GRASS DITCHES
15	TOANO WOODS DR. DITCHES
22	THACHER DR. DITCHES
28	MARLBROOK DR. DITCHES
30	OUTFALL A
42	OUTFALL C
49	OUTFALL D
53	OUTFALL E
57	OUTFALL G
60	OUTFALL H
65	DAM DESIGN
69	SEDIMENT TRAPS

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1643 Merrimac Trail
WILLIAMSBURG, VIRGINIA 23185
(804) 229-1776

JOB TOANO WOODS
SHEET NO. 1 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

Pre-Developement

DRAINAGE AREA "2"

	C	A	CA
WOODLANDS (STEEP)	.25	75.66	18.92
PASTURE	.25		
ROOF	.90	.05	.045
		75.71	18.97

PRORATED $C = \Sigma CA / \Sigma A = .25$

Overland Flow:

$L = 1000'$
$S = 2.0\%$
$T_c = 25.5$ min

Channel Flow:

$L = 2840'$
$H = 40'$
$T_c = 19$ min

$T_c = 44.5$ min

$i_{10} = 2.7$

∴ Flow In (Q_i):

$Q_i = CAi = (18.97)(2.7) = 51.22$ cfs

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WILLIAMSBURG, VIRGINIA 23185
(804) 229-1776

JOB TOANO WOODS
SHEET NO. 2 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

Pre-Developement

DRAINAGE AREA "1"

	C	A	CA
PASTURE	.25	8.67	2.17

Find "i":

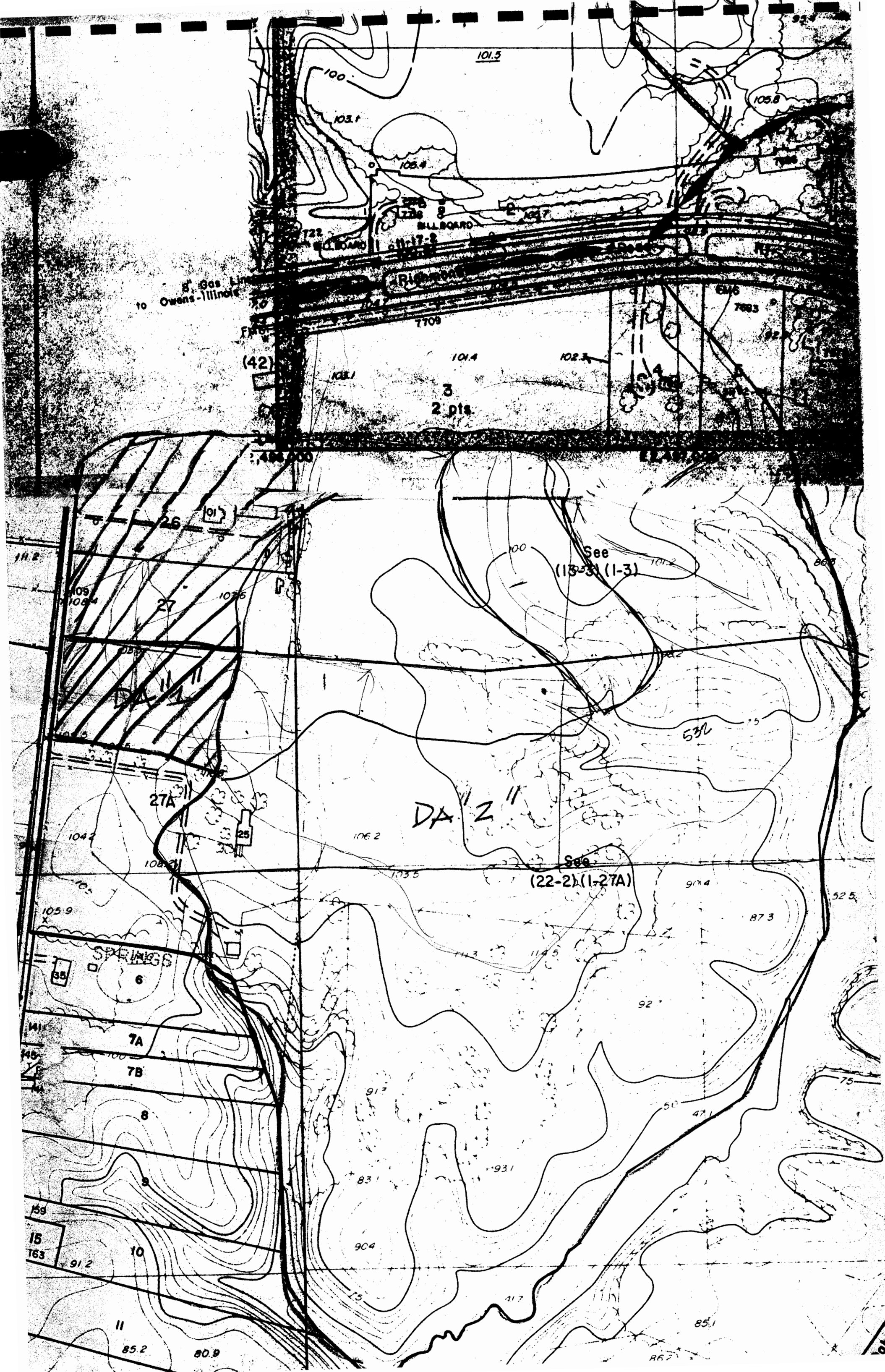
Overland Flow:

$L = 425'$
$S = 3.1\%$
$T_c = 24$ min

$i_{10} = 4.0$

∴ Flow In (Q_i):

$Q_i = CAi = (4)(2.17) = 8.7$ cfs


101.5
100
103.1
105.8
105.4
BILLBOARD
8" Gas Line
to Owens-Illinois
7709
101.4
102.3
(42)
3
2 pts.
26
101
See
(13-33) (1-3)
27
DA 1
27A
25
DA 2
See
(22-2) (1-27A)
SPRINGS
35
6
7A
7B
8
9
15
10
11
85.2
80.9
87.3
92
91.3
93.1
83.1
90.4
85.1

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(804) 229-1776

JOB Toano Woods
SHEET NO. 3 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

Post-Developement - DA-2
Total

	C	A	CA
Residential	.40	75.71	30.28

Find i:

Overland Flow:

L = 1000'
S = 2.0%
Tc = 25.5 min

Channel Flow:

L = 2840
H = 40'
Tc = 19 min

Tc = 44.5 min

i10 = 2.7

∴ Flow In (Qi):

Qi = CAi = 30.28 (2.7) = 81.8 CFS

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(804) 229-1776

JOB 87157
SHEET NO. 4 OF
CALCULATED BY KMJ DATE 1/4/89
CHECKED BY DATE
SCALE

CULVERT DESIGN

Thacher Dr
Sta 0+20
OA - 19,20

c= .40
A= 2.70 Ac.

OVERLAND FLOW

L= 110 ft.
S= 0.5 %
Tc= 18 min.

CHANNEL FLOW

H= 7.0 ft.
L= 800 ft.
Tc= 8 min.

Tc= 26 min

i_{10}= 3.9 in/hr

Q=CAi=(.40)(2.70 Ac.)(3.9 in/hr)

Q= 4.21 cfs
L= 60 ft.
S= 2.62 %
HW= 2.0 ft.

$$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A$$

$$Q = \frac{1.49}{.021}\left(\frac{1.23}{3.93}\right)^{2/3}(.0262)^{1/2}(1.23)$$

Q= 6.49 cfs > 4.21 cfs OK

INLET CONTROL

D= 15 in. or 1.25 ft.

HW/D= 1.02 HW=(1.25 ft.)(1.02)=1.28 ft. < 2.0 ft. OK

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JOB Toano Woods
SHEET NO. 5 OF
CALCULATED BY DATE
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SCALE

Culvert Design
Marlbrook Dr.
Sta 14+15
DA-2

$Q_{10} = 3.05$ cfs
$L = 60'$
$S = .01$ ft/ft
$HW = 2.0$ ft
$TW = 0$
Circular CMP Culvert with a projecting entrance, $n = .012$

Inlet Control:

$D = 15$-in or 1.25 ft

$HW/D = .83$ $HW = (.83)(1.25) = 1.04$ ft OK

Determine Outlet Velocity:

Full Flow = 7.0 cfs
Full Flow Velocity = 5.6 fps

$$\frac{Q_{10}}{Q_{Full}} = \frac{3.05}{7.0} = .44$$

$$\frac{V_{10}}{V_{Full}} = .96$$

$V_{10} = .96(5.6) = 5.4$ fps

Use 15-inch diameter CMP pipe with allowable HW = 2.0 ft, actual HW = 1.04 ft, and maximum outlet velocity of 5.4 fps.

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JOB Toano Woods
SHEET NO. 6 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

Culvert Design
Toano Woods Dr
Sta 11+60
DA-1

Q = 7.0 cfs + 6.7 cfs = 13.7 cfs
L = 60 ft
S = .01 ft
HW = 2.0 ft
TW = 0
Circular CMP Culvert with a projecting entrance, n = 0.012

Inlet Control:

D = 18 in or 1.5 ft

HW/D = 2.3 HW = (2.3)(1.5) = 3.5 ft NG

Try D = 21 in or 1.75 ft

HW/D = 1.4 HW = (1.4)(1.75) = 2.45 NG

Try D = 24 in or 2.0 ft

HW/D = 1.05 HW = (1.05)(2.0) = 2.1 ft NG

Try D = 27 in or 2.25 ft

HW/D = .85 HW = (2.25)(.85) = 1.91 OK

PRODUCT 204-1 NEBS Inc. Groton, Mass. 01471

RICKMOND ENGINEERING, INC.
1643 Merrimac Trail
WILLIAMSBURG, VIRGINIA 23185
(804) 229-1776

JOB Toano Woods
SHEET NO. 7 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

Culvert Design
Toano Woods
Sta. 11+60
OA-1

Determine Outlet Velocity:

Full Flow = 33 cfs
Full Flow Velocity = 8.7 fps

$\frac{Q_{10}}{Q_{Full}} = \frac{13.7}{33.0} = .42$

$\frac{V_{10}}{V_{Full}} = .95$

$V_{10} = .95(8.7) = 8.3$ fps

Use 27-inch diameter CMP pipe with allowable HW = 2.0 ft, actual HW = 1.91 ft, and maximum outlet velocity of 8.3 fps

PRODUCT 204-1 NEBS Inc., Groton, Mass. 01471

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JOB: Toano Woods
SHEET NO. 8 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

Paved Ditches
"Worst Case"
Thacher Dr.

$Q = 4.75$ cfs
$S = 4.98\%$

Try $T = 4$ ft
$d = 1$ ft

$$R = \frac{zd}{2\sqrt{z^2+1}} = \frac{(2)(1)}{2\sqrt{5}} = .45 \text{ ft}$$

$n = .012$

$A = 2 \text{ ft}^2$

$$Q = \frac{1.49}{n}(R)^{2/3}(S^{1/2})A = \frac{1.49}{.012}(.45)^{2/3}(.0498)^{1/2}2 = 32.5 \text{ cfs}$$

$Q = 32.5$ cfs > 4.75 cfs OK

$$V = \frac{Q}{A} = \frac{32.5}{2} = 16.3 \text{ fps}$$

Use Vee channel, concrete; 4ft top width, 1ft depth

* Comment: Calculated for "worst case" and since it was satisfied by design all cases will be satisfied.

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JOB: Toano Woods
SHEET NO. 9 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

Paved Ditch
"Worst Case"
Toano Woods Dr

Q = 6.6 cfs
S = 3.30%

Try T = 4ft
d = 1ft

$$R = \frac{Td}{2\sqrt{Z^2+1}} = \frac{(2)(1)}{2\sqrt{5}} = .45 ft^2$$

n = .012

A = 2ft

$$Q = \frac{1.49}{n}(R)^{2/3}(S)^{1/2}A = \frac{1.49}{.012}(.45)^{2/3}(.033)^{1/2}2 = 26.4 cfs$$

Q = 26.4 cfs > 6.6 cfs OK

$$V = \frac{Q}{A} = \frac{26.4}{2} = 13.2 fps$$

Use Vee channel, concrete; 4ft top width, 1ft depth

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JOB: Toano Woods
SHEET NO. 10 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

Paved Ditch
"Worst Case"
Thacher Dr.

$Q = 4.03 cfs$
$S = 3.37\%$

Try $T = 4ft$
$d = 1ft$

$$R = \frac{zd}{2\sqrt{z^2+1}} = \frac{(2)(1)}{2\sqrt{5}} = .45ft$$

$n = .012$

$A = 2ft^2$

$$Q = \frac{1.49}{n}(R)^{2/3}(S)^{1/2}A = \frac{1.49}{.012}(.45)^{2/3}(.0337)^{1/2}\,2 = 26.7cfs$$

$Q = 26.7cfs > 4.03cfs$ OK

$$V = \frac{26.7cfs}{2cf} = 13.4fps$$

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JOB Toano Woods
SHEET NO. 11 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

Grass-lined Ditches

"Worst Case
Toano Woods Dr.

$Q = 8.82$ cfs
$S = 1.46\%$

Try $T = 6$ ft Bermuda grass
$d = 1.5$ ft

Permissible Velocity = 6 fps from E+SC Handbook, Table 5-17

$A = zd^2 = (2)(1.5)^2$

$A = 4.5 ft^2$

$R = \frac{zd}{2\sqrt{z^2+1}} = \frac{(2)(1.5)}{2\sqrt{5}} = .67 ft$

Use Table 5-19 + 5-20 to determine n, Assume Retardance Class B for calculating capacity + Retardance class C for velocity.

$V \times R = (6 fps)(.67 ft) = 4.02$

$n = .069$ (for class B)
$n = .042$ (for class C)

$n = .03 \rightarrow V = 3.7$ - need temp lining
$n = .05 \rightarrow V = 2.5$

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JOB Toano Woods
SHEET NO. 12 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

check Q + V:

$$Q = \frac{1.49}{n}(R)^{2/3}(S)^{1/2}A = \frac{1.49}{.069}(.67)^{2/3}(.0146)^{1/2}(4.5\,ft^2) = 9.25\,cfs$$

$Q = 9.25\,cfs > 8.82\,cfs$ OK

$$V = \frac{1.49}{n}(R)^{2/3}(S)^{1/2} = \frac{1.49}{.042}(.67)^{2/3}(.0146)^{1/2} = 3.28\,fps$$

$V = 3.28\,fps < 6.0\,fps$ OK

Use Vee channel, lined with Bermuda grass; 6 ft top width, 1.5 ft depth

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JOB: Toano Woods
SHEET NO. 13 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

Grass-lined Ditches
"Worst Case"
Marlbrook Dr.

$Q = 6.25$ cfs
$S = 2.45\%$

Try $T = 6$ ft Bermuda grass
$d = 1.5$ ft

Permissible Velocity = 6fps from E+SC Handbook, Table 5-17

$A = zd^2 = (2)(1.5)^2$

$A = 4.5 ft^2$

$R = \frac{zd}{2\sqrt{z^2+1}} = \frac{(2)(1.5)}{2\sqrt{5}} = .67 ft$

Use Table 5-19 + 5-20 to determine n

$V \times R = (6fps)(.67ft) = 4.02$

$n = .069$ (for class B)
$n = .042$ (for class C)

$n = .03$ $D = .87$ $V = 4.1$
$n = .05$ $D = 1.05$ $V = 2.8$ - temp line

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JOB Toano Woods
SHEET NO. 14 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

Check Q + V:

$$Q = \frac{1.49}{n}(R)^{2/3}(S)^{1/2}A = \frac{1.49}{.069}(.67)^{2/3}(.0245)^{1/2}(4.5) = 11.63\text{cfs}$$

$Q = 11.63\text{cfs} > 6.25\text{cfs}$

$$V = \frac{1.49}{n}(R)^{2/3}(S)^{1/2} = \frac{1.49}{.042}(.67)^{2/3}(.0245)^{1/2} = 4.25\text{fps}$$

$V = 4.25 < 6.0\text{fps}$ OK

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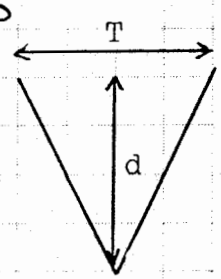
JOB 87157
SHEET NO. 15 OF
CALCULATED BY KMS DATE 1/4/89
CHECKED BY DATE
SCALE

V-DITCH DESIGN

Toano Woods Dr
Sta 0+00 - 5+00
South Side



Q= 4.50 cfs
S= 0.5 %
L= 500 ft.

T= 6 ft.
d= 1.5 ft.

$R = \frac{zd}{2(z^2+1)^{1/2}} = \frac{(2)(1.5\text{ ft.})}{2(5)^{1/2}} = .68$ ft.

n= _____

$A = zd^2 = (2)(1.5\text{ ft.})^2 = 4.5$ ft.^{2}

$V \times R = 6 \times .68 = 4.08$

n=.067 (class B)
n=.041 (class C)

Check Q:

$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A = \frac{1.49}{.067}(.68)^{2/3}(.005)^{1/2}(4.5) = 5.46\text{cfs} > 4.5\text{cfs}$ OK

Check V:

$AR^{2/3} = \frac{Qn}{1.49 S^{1/2}} = \frac{(4.5)(.041)}{1.49(.005)^{1/2}} = 1.75$

d= 1.25 A= 3.13 R= .56 $AR^{2/3}$ = 2.12
d= 1.15 A= 2.65 R= .51 $AR^{2/3}$ = 1.69

$V = \frac{Q}{A} = \frac{4.50}{2.65} = 1.70\text{fps} < 2.5\text{fps}$ OK

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JOB 87157
SHEET NO. 16 OF
CALCULATED BY KMJ DATE 1/4/89
CHECKED BY DATE
SCALE

Toano Woods Dr.
Roadside Ditch
Sta 5+00 - 8+00

DA- 19

c= .40
A= 2.70 Ac.

OVERLAND FLOW

L= 110 ft.
S= 0.5 % — slope on profile - 1.46
Tc= 18 min.

CHANNEL FLOW

H= 7.0 ft.
L= 800 ft.
Tc= 8 min.

Tc= 26 min.

i_{10}= 3.9 in/hr

Q=CAi=(.40)(2.70 Ac.)(3.9 in/hr)

Q= 4.21 cfs

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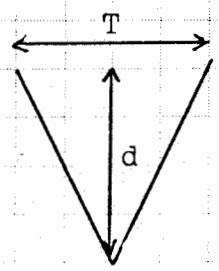
JOB 87157
SHEET NO. 17 OF
CALCULATED BY KMS DATE 1/4/89
CHECKED BY DATE
SCALE

V-DITCH DESIGN

Toano Woods Dr.
Sta 5+00 - 8+00
South Side



Q= 4.21 cfs
S= 1.46 %
L= 300 ft.

T= 6 ft.
d= 1.5 ft.

$R = \frac{zd}{2(z^2+1)^{1/2}} = \frac{(2)(1.5 \text{ ft.})}{2(6)^{1/2}} = .68 \text{ ft.}$

n= ____

$A = zd^2 = (2)(1.5 \text{ ft.})^2 = 4.5 \text{ ft.}^2$

$V \times R = 6 \times .68 = 4.08$

n= .067 (class B)
n= .041 (class C)

n= .03 V= 3.1 D= .83
n= .05 V= 2.1

Check Q:

$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A = \frac{1.49}{.067} (.68)^{2/3} (.0146)^{1/2} (4.5) = 9.25 \text{ cfs} > 4.21 \text{ cfs}$ OK

Check V:

$AR^{2/3} = \frac{Qn}{1.49 S^{1/2}} = \frac{(4.21)(.041)}{1.49(.0146)^{1/2}} = .96$

d= .90 A= 1.62 R= .40 $AR^{2/3}$= .88
d= .95 A= 1.81 R= .42 $AR^{2/3}$ = 1.02
A= 1.70

$V = \frac{Q}{A} = \frac{4.21}{1.70} = 2.48 \text{ fps} < 2.5 \text{ fps}$ OK

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JOB 87157
SHEET NO. 18 OF
CALCULATED BY KMJ DATE 1/4/89
CHECKED BY DATE
SCALE

Toano Woods Dr.
Roadside Ditch
Sta 8+00 - 12+00

DA- 1.19

c= .40
A= 5.83 Ac.

OVERLAND FLOW

L= 110 ft.
S= 0.5 %
Tc= 18 min.

CHANNEL FLOW

H= 18 ft.
L= 1200 ft.
Tc= 9 min.

Tc= 27 min.

i_{10}= 3.8 in/hr

Q=CAi=(.40)(5.83 Ac.)(3.8 in/hr)

Q= 8.86 cfs

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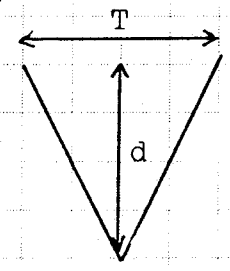
JOB 8757
SHEET NO. 19 OF
CALCULATED BY KMJ DATE 1/4/89
CHECKED BY DATE
SCALE

V-DITCH DESIGN

Toano Woods Dr.
Sta 8+00 - 12+00
South Side



Q= 8.86 cfs
S= 3.23 %
L= 400 ft.

T= 4 ft.
d= 1 ft.

$R = \frac{zd}{2(z^2+1)^{1/2}} = \frac{(2)(1\ ft.)}{2(5)^{1/2}} = .45\ ft.$

n= .015 Paved Ditch

$A = zd^2 = (2)(1\ ft.)^2 = 2\ ft.^2$

Check Q:

$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A = \frac{1.49}{.015} (.45)^{2/3} (.0323)^{1/2} 2 = 20.91\ cfs > 8.86\ cfs$ OK

Check V:

$AR^{2/3} = \frac{Qn}{1.49 S^{1/2}} = \frac{(8.86)(.015)}{(1.49)(.0323)^{1/2}} = .50$

d=.70	A=.98	R=.31	$AR^{2/3}$=.45
d=.75	A=1.13	R=.34	$AR^{2/3}$=.55
	A=1.05		

$V = \frac{Q}{A} = \frac{8.86}{1.05} = 8.44\ fps$ Use paved ditch

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JOB 87157
SHEET NO. 20 OF
CALCULATED BY KMJ DATE 1/5/88
CHECKED BY DATE
SCALE

Toano Woods Dr
Sta 8+00 - 12+00
North Side

DA- 17

c= .45
A= .49 Ac.

OVERLAND FLOW

L= — ft.
S= — %
Tc= — min.

CHANNEL FLOW

H= 18 ft.
L= 850 ft.
Tc= 6.5 min.

Tc= 6.5 min.

i_{10}= 6.8 in/hr

Q=CAi=(.45)(.49 Ac.)(6.8 in/hr)

Q= 1.50 cfs

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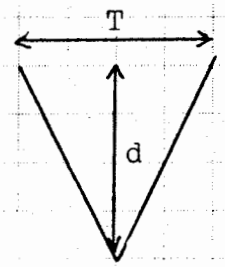
JOB 87157
SHEET NO. 21 OF
CALCULATED BY KMJ DATE 1/5/88
CHECKED BY DATE
SCALE

V-DITCH DESIGN

Toano Woods Dr.
Sta 8+00 - 12+00
Northside



Q= 1.50 cfs
S= 3.23 %
L= 400 ft.

T= 6 ft.
d= 1.5 ft.

$R = \frac{zd}{2(z^2+1)^{1/2}} = \frac{(2)(1.5 \text{ ft.})}{2(5)^{1/2}} = .68 \text{ ft.}$

n= _____

$A = zd^2 = (2)(1.5 \text{ ft.})^2 = 4.5 \text{ ft.}^2$

$V \times R = 6 \times .68 = 4.08$

n = .05 V = 2.2 D = .6
n = .03 V = 3.3 D = .5

n = .067 (class B)
n = .041 (class C)

Check Q:

$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A = \frac{1.49}{.067} (.68)^{2/3} (.0323)^{1/2} (4.5) = 13.89 \text{cfs} > 1.50 \text{cfs}$ OK

Check V:

$AR^{2/3} = \frac{Qn}{1.49 S^{1/2}} = \frac{(1.50)(.041)}{1.49 (.0323)^{1/2}} = .23$

d = .5 A = .50 R = .22 $AR^{2/3}$ = .18
d = .55 A = .61 R = .25 $AR^{2/3}$ = .24

$V = \frac{Q}{A} = \frac{1.50}{.61} = 2.46 \text{fps}$ OK use grass-lined ditch

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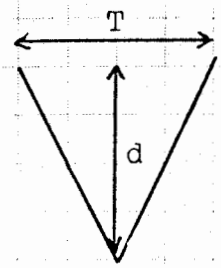
JOB: Toano Woods
SHEET NO. 22 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

V-DITCH DESIGN

Thacher Dr.
Sta 0+00-2+10



Q= 3.35 cfs
S= 0.50 %
L= ____ ft.

T= 6 ft.
d= 1.5 ft.

$$R = \frac{zd}{2(z^2+1)^{1/2}} = \frac{(2)(1.5\text{ ft.})}{2(5)^{1/2}} = .68\text{ ft.}$$

n= .05

$$A = zd^2 = (2)(1.5\text{ ft.})^2 = 4.5\text{ ft.}^2$$

$$AR^{2/3} = \frac{Qn}{1.49 S^{1/2}} = \frac{(3.35)(.05)}{1.49(0.005)^{1/2}} = 1.59$$

d=1.25 R=.56 A=3.13 $AR^{2/3}$=2.12
d=1.12 R=.50 A=2.51 $AR^{2/3}$=1.58

$$V = \frac{Q}{A} = \frac{3.35}{2.51} = 1.33\text{fps} < 6.0\text{fps}$$

Table 5-17 "Va E+S Control Handbook"

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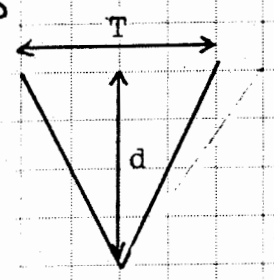
JOB 87157
SHEET NO. ____ OF ____
CALCULATED BY KMJ DATE 9/15/89
CHECKED BY ____ DATE ____
SCALE ____

V-DITCH DESIGN

Thacher Dr East Side
Sta 2+50 - 12+00
DA - 12



Q= 4.03 cfs DA-6
S= 3.03 %
L= ____ ft.

T= 6 ft.
d= 1.5 ft.

$R = \frac{zd}{2(z^2+1)^{1/2}} = \frac{(2)(1.5 \text{ ft.})}{2(5)^{1/2}} = .67$ ft.

n= ____

$A = zd^2 = (2)(1.5 \text{ ft.})^2 = 4.5 \text{ ft.}^2$

n = .03 D = .71 V = 4.0
n = .05 D = .86 V = 2.7

$V \times R = 5 \times .67 = 3.35$

n = .074 (class B)
n = .044 (class C)

Check Q:

$Q = \frac{1.49}{.074}(.67)^{2/3}(.028)^{1/2}\,4.5 = 11.59$

Check V:

$AR^{2/3} = \frac{Qn}{1.49 S^{1/2}} = \frac{(4.03)(.044)}{1.49(.0303)^{1/2}} = .68$

d = 1	A = 2	R = .45	$AR^{2/3}$ = 1.17
d = .9	A = 1.62	R = .40	$AR^{2/3}$ = .88
d = .82	A = 1.34	R = .37	$AR^{2/3}$ = .69

$V = \frac{Q}{A} = \frac{4.03}{1.34} = 3.00$ fps < 3.0 fps Use Grass Ditch

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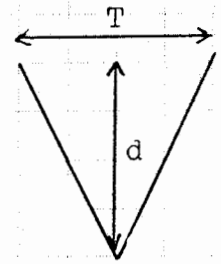
WILLIAMSBURG, VIRGINIA 23185
(804) 229-1776

JOB 87157
SHEET NO. 24 OF
CALCULATED BY KMJ DATE 1/13/89
CHECKED BY DATE
SCALE

V-DITCH DESIGN

Thacker Or.
Sta 11+00 - 22+00
West Side
DA-I



Q= 6.70 cfs
S= 2.32 %
L= 500 ft.

T= 6 ft.
d= 1.5 ft.

$R = \frac{zd}{2(z^2+1)^{1/2}} = \frac{(2)(1.5\text{ ft.})}{2(5)^{1/2}} = .67$ ft.

n= _____

N = .05 D = 1.1 V = 2.8
N = .03 D = .9 V = 4.1

$A = zd^2 = (2)(1.5\text{ ft.})^2 = 4.5\text{ ft.}^2$

$V \times R = 3.5 \times .67 = 2.35$

n = .088 (class B)
n = .052 (class C)

Check Q: $Q = \frac{1.49}{n} R^{2/3} S^{1/2} A = \frac{1.49}{.088}(.67)^{2/3}(.0232)^{1/2} A = 8.87\text{ cfs} > 6.70$ OK

Check V: $AR^{2/3} = \frac{Qn}{1.49 S^{1/2}} = \frac{(6.70)(.052)}{1.49(.0232)^{1/2}} = 1.54$

d = 1.25 A = 3.13 R = .56 $AR^{2/3} = 2.12$
d = 1.10 A = 2.42 R = .49 $AR^{2/3} = 1.50$

$V = \frac{Q}{A} = 2.77$ fps Use EC-3 lined ditch

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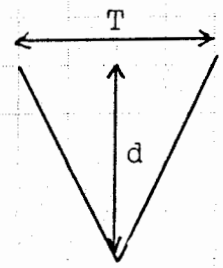
JOB 87157
SHEET NO. 25 OF
CALCULATED BY KMJ DATE 1/13/89
CHECKED BY DATE
SCALE

V-DITCH DESIGN

Thacher Or,
Sta 17+00 - 22+00
East Side
OA-2



Q= 3.05 cfs
S= 2.32 %
L= 500 ft.

T= 6 ft.
d= 1.5 ft.

$R = \frac{zd}{2(z^2+1)^{1/2}} = \frac{(2)(1.5\text{ ft.})}{2(5)^{1/2}} = .67\text{ ft.}$

n= _____

$A = zd^2 = (2)(1.5\text{ ft.})^2 = 4.5\text{ ft.}^2$

$V \times R = 3.5 \times .67 = 2.35$

n=.088 (class B)
n=.052 (class C)

Check Q:

$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A = \frac{1.49}{.088}(.67)^{2/3}(.0232)^{1/2}\,4.5 = 8.87\text{ cfs} > 3.05\text{ cfs}$ OK

Check V: $AR^{2/3} = \frac{Qn}{1.49 S^{1/2}} = \frac{3.05(.088)}{1.49(.0232)^{1/2}} = 1.18$

d=1 A=2 R=.45 $AR^{2/3} = 1.17$

$V = \frac{Q}{A} = \frac{3.05}{2} = 1.53\text{ fps}$ OK Grass-lined ditch

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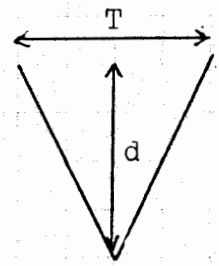
JOB 87157
SHEET NO. 26 OF
CALCULATED BY KMS DATE 1/13/89
CHECKED BY DATE
SCALE

V-DITCH DESIGN

2.5 Acre off site
Toano Woods OC
Sta 25+25 - 27+50



Q= 4.00 cfs
S= 3.20 %
L= 225 ft.

T= 6 ft.
d= 1.5 ft.

$R = \frac{zd}{2(z^2+1)^{1/2}} = \frac{(2)(1.5\ ft.)}{2(5)^{1/2}} = .67$ ft.

n= _____

$A = zd^2 = (2)(1.5\ ft.)^2 = 4.5$ ft.^{2}

V×R = 3.5×.67 = 2.35

n=.088 (class B)
n=.052 (class C)

Check Q:

$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A = \frac{1.49}{.088} (.67)^{2/3} (.032)^{1/2} 4.5 = 10.6$ cfs > 4.00 ok

Check V: $AR^{2/3} = \frac{Qn}{1.49 S^{1/2}} = \frac{(4.00)(.052)}{1.49(.032)^{1/2}} = .77$

d=.75	A= 1.13	R= .34	$AR^{2/3}$ = .54
d=.85	A= 1.45	R= .38	$AR^{2/3}$ = .76

$V = \frac{Q}{A} = \frac{4.00}{1.45} = 2.75$ fps use EC-3 lined ditch

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JOB Toano Woods
SHEET NO. 27 OF
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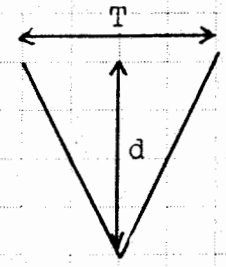
V-DITCH DESIGN

Toano Woods Dr.
Sta 27+50 - 29+50



Q= 1.04 cfs
S= 3.20 %
L= ____ ft.

T= 6 ft.
d= 1.5 ft.

$$R = \frac{zd}{2(z^2+1)^{1/2}} = \frac{(2)(1.5\text{ ft.})}{2(5)^{1/2}} = .68\text{ ft.}$$

n= .05

$$A = zd^2 = (2)(1.5\text{ ft.})^2 = 4.5\text{ ft.}^2$$

$$AR^{2/3} = \frac{Qn}{1.49\,S^{1/2}} = \frac{(1.04)(.05)}{1.49(.032)^{1/2}} = .20$$

d = .5 R = .22 A = .50 $AR^{2/3}$ = .18
d = .55 R = .25 A = .61 $AR^{2/3}$ = .24

$$V = \frac{Q}{A} = \frac{1.04}{.50} = 2.08\text{ fps} < 5.0\text{ fps}$$

Table 5-17 "Va E+S Control Handbook"

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DA- 8

c= .85
A= .26 Ac.

OVERLAND FLOW

L= — ft.
S= — %
Tc= — min.

CHANNEL FLOW

H= 10 ft.
L= 300 ft.
Tc= 2.5 min.

Tc= 2.5 min.

i_{10}= 7.2 in/hr

Q=CAi=(.85)(.26 Ac.)(7.2 in/hr)

Q= 1.59 cfs

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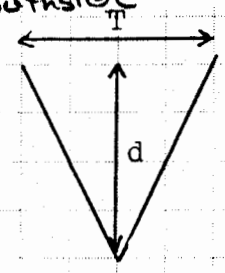
V-DITCH DESIGN

Marlbrook Dr.
Sta 0+00 - 4+50 Southside
DA-8



Q= 1.59 cfs
S= 4.83 %
L= ____ ft.

T= 6 ft.
d= 1.5 ft.

$R = \frac{zd}{2(z^2+1)^{1/2}} = \frac{(2)(1.5\text{ ft.})}{2(5)^{1/2}} = .67\text{ ft.}$

n= ____

$A = zd^2 = (2)(1.5\text{ ft.})^2 = 4.5\text{ ft.}^2$

n=.05 D=.46 V=3.8
n=.05 D=.55 V=2.5

$V \times R = 5 \times .67 = 3.35$

n=.074 (class B)
n=.044 (class C)

Check Q:

$Q = \frac{1.49}{.074}(.67)^{2/3}(.0483)^{1/2}\,4.5 = 15.23\text{ cfs}$

Check V:

$AR^{2/3} = \frac{Qn}{1.49S^{1/2}} = \frac{(1.59)(.044)}{1.49(.0483)^{1/2}} = .21$

d=.25	A=.13	R=.11	$AR^{2/3}$=.03
d=.5	A=0.5	R=.22	$AR^{2/3}$=.18
d=.52	A=.54	R=.23	$AR^{2/3}$=.20

$V = \frac{Q}{A} = \frac{1.59}{.54} = 2.94\text{ fps} < 3.0\text{ fps}$ Use Grass ditch

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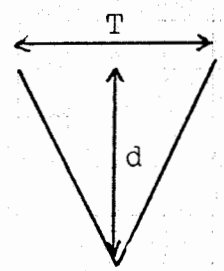
V-DITCH DESIGN

Road "C"
Sta 7+00 - 14+00



Q= 6.25 cfs
S= 2.45 %
L= ____ ft.

T= 6 ft.
d= 1.5 ft.

$R = \frac{zd}{2(z^2+1)^{1/2}} = \frac{(2)(1.5 \text{ ft.})}{2(5)^{1/2}} = .68 \text{ ft.}$

n= .05

$A = zd^2 = (2)(1.5 \text{ ft.})^2 = 4.5 \text{ ft.}^2$

$AR^{2/3} = \frac{Qn}{1.49 S^{1/2}} = \frac{(6.25)(.05)}{1.49(.0245)^{1/2}} = 1.34$

d = 1.07 R = .48 A = 2.29 $AR^{2/3}$ = 1.40

$V = \frac{Q}{A} = \frac{6.25}{2.29} = 2.73 > 6.0 \text{ fps}$

Table 5-17 "Va E+S Control Handbook

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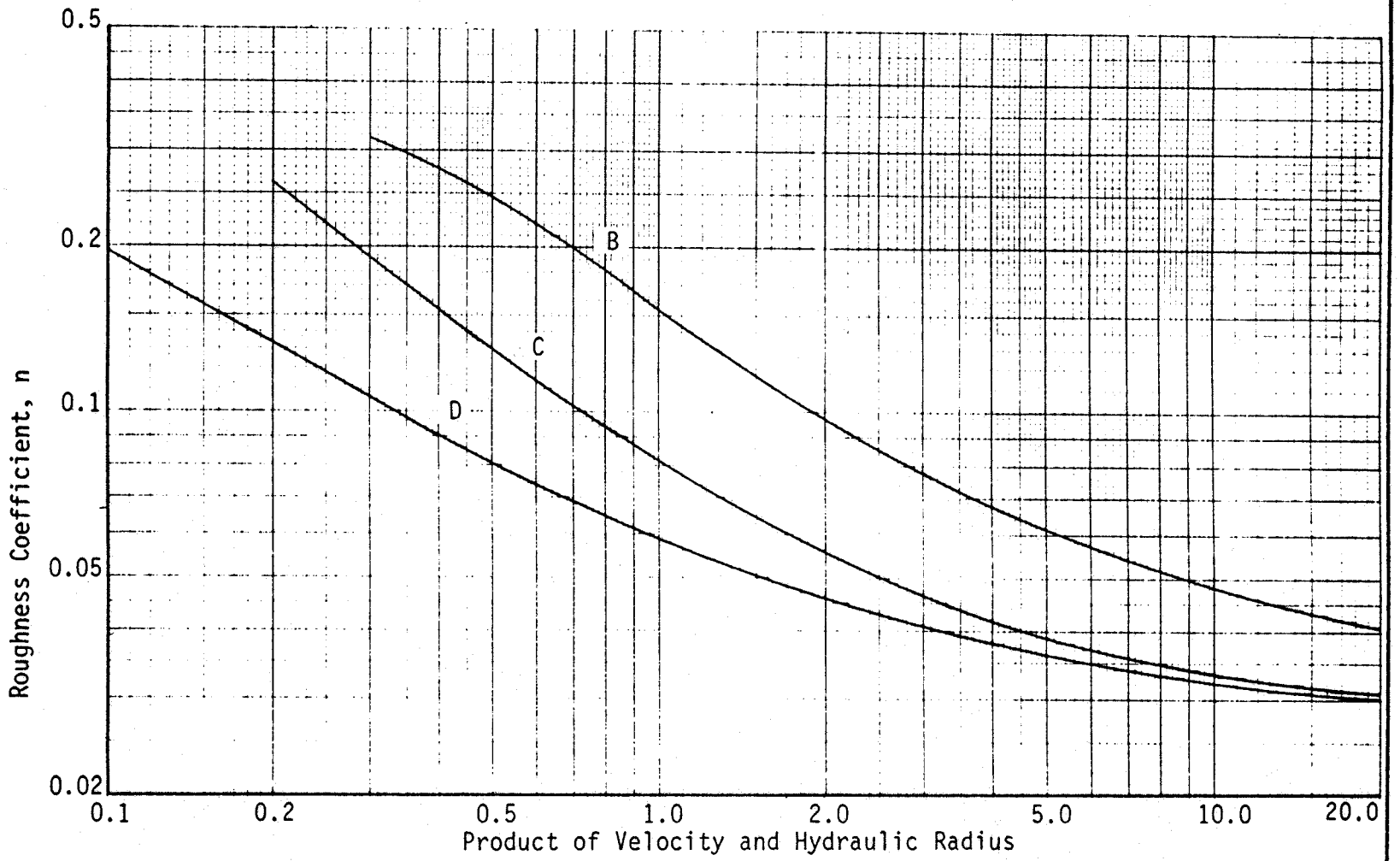

ROUGHNESS COEFFICIENT AS A FUNCTION OF v x R FOR VARIOUS RETARDANCE CLASSES

Source: USDA-SCS

Plate 5-20

Table 5-18

MANNINGS "n" FOR STRUCTURAL CHANNEL LININGS

Channel Lining	n Values Min.	Design	Max.
Asphaltic concrete, machine placed		0.014	
Asphalt, exposed prefabricated		0.015	
Concrete	0.012	0.015	0.018
Concrete, rubble	0.017		0.030
Metal, corrugated	0.021	0.024	0.026
Plastic	0.012		0.014
Shotcrete	0.016		0.017

Source: American Society of Civil Engineers

Table 5-19

RETARDANCE CLASSIFICATIONS

Retardance		Stand	Condition
B	Tall Fescue	Good	Unmowed - 18 inches
	Sericea Lespedeza	Good	Unmowed - 19 inches
	Grass-Legume Mixture	Good	Unmowed - 20 inches
	Small grains, mature	Good	Uncut - 19 inches
	Bermudagrass	Good	Tall - 12 inches
	Reed Canarygrass	Good	Mowed - 14 inches
C	Bermudagrass	Good	Mowed - 6 inches
	Redtop	Good	Headed - 18 inches
	Grass-Legume Mixture, summer	Good	Unmowed - 7 inches
	Kentucky Bluegrass	Good	Headed - 9 inches
	Small grains, mature	Poor	Uncut - 19 inches
	Tall Fescue	Good	Mowed - 6 inches
D	Bermudagrass	Good	Mowed - 25 inches
	Red Fescue	Good	Headed - 15 inches
	Grass-Legume Mixture, spring and fall	Good	Unmowed - 5 inches
	Sericea Lespedeza	Good	Mowed - 2 inches

Source: USDA-SCS

Table 5-17
PERMISSIBLE VELOCITIES FOR GRASS-LINED CHANNELS

Channel Slope	Lining	Permissible Velocity
0-5%	Bermudagrass	6 ft/sec
	Reed canarygrass Tall fescue Kentucky bluegrass	5 ft/sec
	Grass-legume mixture	4 ft/sec
	Red fescue Redtop Sericea lespedeza Annual lespedeza Small grains (temporary)	2.5 ft/sec
5-10%	Bermudagrass	5 ft/sec
	Reed canarygrass Tall fescue Kentucky bluegrass	4 ft/sec
	Grass-legume mixture	3 ft/sec
Greater than 10%	Bermudagrass	4 ft/sec
	Reed canarygrass Tall fescue Kentucky bluegrass	3 ft/sec

Source: USDA-SCS

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Outfall "A"
Drainage Area 2

Run-off Coefficient (C)

	A	C	CA
Residential	1.23	.40	.49
Roadway	.14	.85	.12
	1.37		.61

$C = .61/1.37 = .44$

Overland Flow

L = 375'
S = 4.0%
T_c = 15 min

Channel Flow

L = 145'
H = 9'
T_c = 1.0 min

T_c = 15 min + 1 min = 16 min or .27 hr

i_{10} = 5.0

∴ Flow In (Q_i)

$Q_i = CAi = .61(5.0) = 3.05$ cfs

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SHEET NO. 31 OF
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Drainage Area 3
(Drains to inlet Pipe at outfall "A")

Run-off Coefficient (c)

	A	C	CA
Residential	2.04	.40	.82
Roadway	.10	.85	.09
	2.14		.91

$c = .91/2.14 = .43$

Overland Flow

$L = 300'$
$S = 3.3\%$
$T_c = 14$ min

Channel Flow

$L = 200'$
$H = 2'$
$T_c = 2.5$ min

$T_c = 14 \text{ min} + 2.5 \text{ min} = 16.5 \text{ min}$

$i_{10} = 4.9$

∴ Flow In (Q_i)

$Q_i = CAi = .91(4.9) = 4.5$ cfs

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JOB Toano Woods
SHEET NO. 32 OF
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SCALE

DA- 13

c= .85
A= .49 Ac:

OVERLAND FLOW

L= N/A ft.
S= N/A %
Tc= N/A min.

CHANNEL FLOW

H= 22.5 ft.
L= 600 ft.
Tc= 4 min.

Tc= 4 min.

i_{10}= 7.2 in/hr

Q=CAi=(.85)(.49 Ac.)(7.2 in/hr)

Q= 3.00 cfs

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JOB 87157
SHEET NO. 33 OF
CALCULATED BY KMJ DATE 12/12/88
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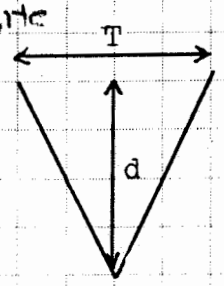
V-DITCH DESIGN

Outfall "A"
OA-3 + 8.4 Ac off-site

Sta 0+00 to
Sta 1+80

Q= 5.02 cfs
S= .50 %
L= 180 ft.

T= 6 ft.
d= 1.5 ft.



$$R = \frac{zd}{2(z^2+1)^{1/2}} = \frac{(2)(1.5\text{ ft.})}{2(5)^{1/2}} = .67\text{ ft.}$$

n= ____

$$A = zd^2 = (2)(1.5\text{ ft.})^2 = 4.5\text{ ft.}^2$$

$V \times R = 6 \times .67 = 4.02$

n = .068 (class B)
n = .042 (class C)

Check Q:

$$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A = \frac{1.49}{.068}(.67)^{2/3}(.005)^{1/2}\,4.5 = 5.33\text{ cfs} > 5.02\text{ cfs}$$ OK

Check V: $$AR^{2/3} = \frac{Qn}{1.49 S^{1/2}} = \frac{(5.02)(.042)}{1.49(.005)^{1/2}} = 2.00$$

d = 1.5	A = 4.5	R = .67	$AR^{2/3}$ = 3.44
d = 1.25	A = 3.13	R = .56	$AR^{2/3}$ = 2.12

$$V = \frac{Q}{A} = 1.60\text{ fps}$$ OK

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CULVERT DESIGN

Sta 1+80 to 6+00
Outfall "A"

c= .14
A= 10.54 Ac.

	C	A	
Lots	.3	2.14	.64
Pasture	.1	8.4	.84
			1.48

$c = \frac{1.48}{10.54}$

OVERLAND FLOW

L= 750 ft.
S= .53 %
Tc= 28 min.

CHANNEL FLOW

H= 18' ft.
L= 900 ft.
Tc= 6.5 min.

Tc= 34.5 min

i_{10} = 3.4 in/hr

Q=CAi=(.14)(10.54 Ac.)(3.4 in/hr)

Q= 5.02 cfs
L= 420 ft.
S= 0.85 %
HW= 2.5 ft.

$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A$

$5.02 = \frac{1.49}{.024}\left(\frac{1.77}{4.71}\right)^{2/3} (S)^{1/2} (1.77)$

$.046 = .519\ S^{1/2}$

S = 0.78% use 0.85%

INLET CONTROL

D= 18 in. or 1.5 ft.

HW/D= 1.85 HW=(1.50 ft.)(0.85)= 1.28 ft. < 2.5 ft.

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JOB 87167
SHEET NO. 35 OF
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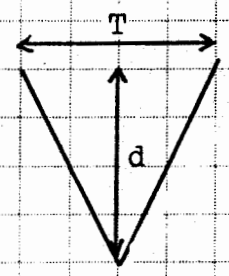
V-DITCH DESIGN

DA-3,4 + 8.4 Ac offsite
Sta 6+00 to 8+00
Outfall "A"



Q= 6.79 cfs
S= 2.97 %
L= 200 ft.

T= 6 ft.
d= 1.5 ft.

$R = \frac{zd}{2(z^2+1)^{1/2}} = \frac{(2)(1.5\text{ ft.})}{2(5)^{1/2}} = .67$ ft.

n= ____

$A = zd^2 = (2)(1.5\text{ ft.})^2 = 4.5$ ft.^{2}

V×R = 6 × .67 = 4.02

n= .068 (class B)
n= .0482 (class C)

Check Q:

$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A = \frac{1.49}{.068}(.67)^{2/3}(.0297)^{1/2} 4.5 = 18.00$ cfs OK

Check V:

$AR^{2/3} = \frac{Qn}{1.49 S^{1/2}} = \frac{(6.79)(.0482)}{1.49(.0297)^{1/2}} = 1.14$

d = 1.00 A = 2 R = .44 $AR^{2/3}$ = 1.15

$V = \frac{Q}{A} = \frac{6.79}{2.12} = 3.20$ fps use Jute Mesh lined Ditch

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JOB 5715T
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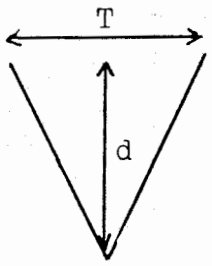
V-DITCH DESIGN

Sta 8+00 to 10+00
Outfall "A"



Q= 6.79 cfs
S= 8.90 %
L= 200 ft.

T= 4 ft.
d= 1.0 ft.

$R = \frac{zd}{2(z^2+1)^{1/2}} = \frac{(2)(1\ ft.)}{2(5)^{1/2}} = .45$ ft.

n= _____

$A = zd^2 = (2)(1\ ft.)^2 = 2$ ft.^{2}

n=.015 (paved ditch)

Check Q:

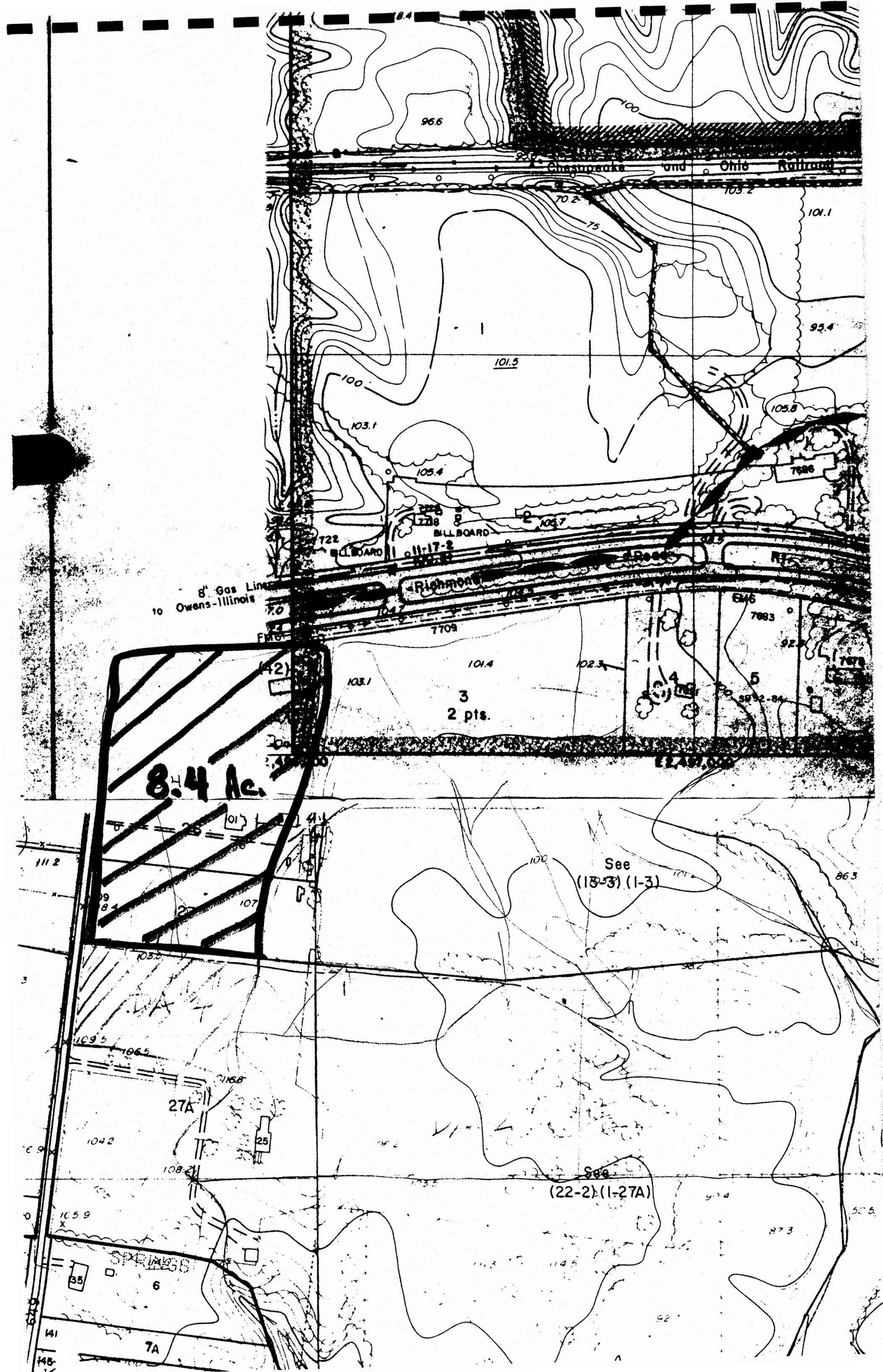
$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A = \frac{1.49}{.015}(.45^{2/3})(.089)^{1/2}\, 2 = 34.71$ cfs > 6.79 cfs OK

Check d:

$A = \frac{Q}{\frac{1.49}{n} R^{2/3} S^{1/2}} = \frac{6.79(.015)}{1.49(.089)^{1/2}} = .23$

d= .75 A= 1.13 R= .34 $AR^{2/3}$= .53
d= .50 A= .5 R= .22 $AR^{2/3}$= .18

$V = \frac{Q}{A} = \frac{6.79}{.5} = 13.6$ fps OK paved ditch


Chesapeake and Ohio Railroad
96.6
100
70.2
75
103.2
101.1
95.4
101.5
100
103.1
105.8
105.4
7686
BILLBOARD
722
8" Gas Line
to Owens-Illinois
Richmond
7709
7683
101.4
102.3
103.1
3
2 pts.
4
5
8.4 Ac.
See
(18-3) (1-3)
27A
25
108.2
See
(22-2) (1-27A)
35
6
7A

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JOB Toano Woods
SHEET NO. 38 OF
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SCALE

CULVERT DESIGN

Outfall "A"

OA 3, 4, 20 + 8.4 offsite Acres

c= .41

A= 16.32 Ac.

OVERLAND FLOW

L= 750 ft.

S= .53 %

Tc= 28 min.

CHANNEL FLOW

H= 18 ft.

L= 900 ft.

Tc= 6.5 min.

Tc= 34.5 min

i_{10}= 3.4 in/hr

Q=CAi=(.41)(16.32 Ac.)(3.4 in/hr)

Q= 22.75 cfs

L= 185 ft.

S= 1.62 %

HW= 10 ft.

INLET CONTROL

D= 30 in. or 2.5 ft.

HW/D= 1.3 HW=(2.5 ft.)(1.0)= 2.5 ft. < 10.0 ft.

Use 30" pipe

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JOB Toano Woods
SHEET NO. 39 OF
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OUTLET VELOCITY

FULL FLOW= 33 cfs

FULL FLOW VELOCITY= 8.2 fps

$$\frac{Q_{10}}{Q_{full}} = \frac{22.75}{33} = .69$$

$$\frac{V_{10}}{V_{full}} = 1.08$$

V_{10}=(1.08)(8.2 fps)= 8.90 fps

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JOB Toano Woods
SHEET NO. 42 OF
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SCALE

Design Outfall "C"
Drainage Area 11

Runoff Coefficient

	A	C	CA
Residential	1.56	.40	.62
Roof Opening	.20	.85	.17
	1.76		.79

$C = .79/1.76 = .45$

Overland Flow

$L = 200'$
$S = 3.0\%$
$T_c = 12$ min

Channel Flow

$L = 420$
$H = 20'$
$T_c = 2.5$ min

$T_c = 12 + 2.5 = 14.5$ min

$i_{10} = 5.1$

∴ Flow In (Q_i)

$Q_i = CAi = (.79)(5.1) = 4.03$ cfs

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Drainage Area 6

Run-off Coefficient (C)

	A	C	CA
Residential	2.10	.40	.84
Roadway	.14	.85	.12
	2.24		.96

$C = .96/2.24 = .43$

Overland Flow

L = 455
S = 4.4%
Tc = 15.50 min

Channel Flow

L = 235
H = 16'
Tc = 1.5 min

Tc = 15.50 + 1.50 = 17 min or .28 hr

$i_{10} = 4.95$

∴ Flow In (Qi)

$Q_i = CAi = .96(4.95) = 4.75$ cfs

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JOB Toano Woods
SHEET NO. 44 OF
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Drainage Area 12

Runoff Coefficient

	A	C	CA
Residential	.80	.40	.32
Roadway	.20	.85	.17
	1.00		.49

$C = .49/1.00 = .49$

Overland Flow

$L = 400'$
$S = 2.5\%$
$T_c = 16$ min

Channel Flow

$L = 600'$
$H = 28'$
$T_c = 3.5$ min

$T_c = 16 + 3.5 = 19.5$ min

$i_{10} = 4.5$

$Q_i = CAi = (.49)(4.5) = 2.21$ cfs

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SHEET NO. 45 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

Drainage Area 15

Runoff Coefficient (C)

	A		C
Residential	1.80		.72
[illegible]	.09		.08
	1.89		.80

$C = .80/1.89 = .42$

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JOB Tooano Woods
SHEET NO. 46 OF
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SCALE

Drainage Area 11, 15, 6, 12 (see attached "C")

Runoff Coefficient

	A	C	CA
Residential	6.26	.40	2.50
Roadway	.63	.85	.54
	6.89		3.04

$c = 3.04/6.89 = .44$

Overland Flow

L = 400'
S = 2.5%
T_c = 15 min

Channel Flow

L = 900'
H = 36'
T_c = 5 min

T_c = 20 min

i_{10} = 4.5"/hr

∴ Flow In (Qi)

Qi = (.44)(6.89)(4.5) = 13.64 cfs

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JOB Toano Woods
SHEET NO. 47 OF
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CHECKED BY DATE
SCALE

CULVERT DESIGN
Outfall "C"

c= .44
A= 6.89 Ac.

OVERLAND FLOW

L= 400 ft.
S= 2.5 %
Tc= 15 min.

CHANNEL FLOW

H= 900 ft.
L= 36 ft.
Tc= 5 min.

Tc= 20 min

i_{10}= 4.5 in/hr

Q=CAi=(.44)(6.89 Ac.)(4.5 in/hr)

Q= 13.64 cfs
L= 400 ft.
S= 6.23 %
HW= 2.5 ft.

INLET CONTROL

D= 24 in. or 2.0 ft.

HW/D= 1.1 HW=(2.0 ft.)(1.1)= 2.2 ft. < 2.5 ft.

Use 24" pipe

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JOB Toano Woods
SHEET NO. 48 OF
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SCALE

OUTLET VELOCITY

FULL FLOW= 90 cfs

FULL FLOW VELOCITY= 26.0 fps

$$\frac{Q_{10}}{Q_{full}} = \frac{13.64}{90} = .15$$

$$\frac{V_{10}}{V_{full}} = .74$$

V_{10}=(.74)(26.0 fps)= 19.24 fps

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SCALE

Outfall "D"

DA- 8

c= .85
A= .27 Ac.

OVERLAND FLOW

L= N/A ft.
S= N/A %
Tc= N/A min.

CHANNEL FLOW

H= 29.56 ft.
L= 275 ft.
Tc= 1.25 min.

Tc= 1.25 min.

i_{10}= 7.5 in/hr

Q=CAi=(.85)(.27 Ac.)(7.5 in/hr)

Q= 1.72 cfs

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SHEET NO. 30 OF
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CHECKED BY DATE
SCALE

Design Outfall "D"
Drainage 8,9

Runoff Coefficient (C)

	A	C	CA
Residential	1.94	.40	.78
Roadway	.52	.65	.44
	2.46		1.22

$C = 1.22/2.46 = .50$

Overland Flow

L = 250'
S = 14.0%
T_c = 10.25 min

Channel Flow

N/A

T_c = 10 min = 10.25 min

i_{10} = 6.0

∴ Flow In (Q_i)

$Q_i = CAi = (1.22)(6.0) = 7.32$ cfs

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JOB Toano Woods
SHEET NO. 51 OF
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SCALE

CULVERT DESIGN
Outfall "D"

c= .50
A= 2.46 Ac.

OVERLAND FLOW

L= 250 ft.
S= 14.0 %
Tc= 10.25 min.

CHANNEL FLOW

H= N/A ft.
L= N/A ft.
Tc= N/A min.

Tc= 10.25 min

i_{10}= 6.0 in/hr

Q=CAi=(.50)(2.46 Ac.)(6.0 in/hr)

Q= 7.32 cfs
L= 246 ft.
S= 9.51 %
HW= 10.0 ft.

INLET CONTROL

D= 18" in. or 1.50 ft.

HW/D= 1.2 HW=(1.50 ft.)(1.2)= 1.80 ft. < 10.0 ft.

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JOB Town Wharf
SHEET NO. 52 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

OUTLET VELOCITY

FULL FLOW= 42.0 cfs

FULL FLOW VELOCITY= 24.2 fps

$$\frac{Q_{10}}{Q_{full}} = \frac{7.32}{42.0} = .17$$

$$\frac{V_{10}}{V_{full}} = .73$$

V_{10}=(.73)(24.2 fps)= 17.7 fps

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JOB Towne Woods
SHEET NO. 52 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

Outfall "E"

DA- 10

c= .85
A= .43 Ac.

OVERLAND FLOW

L= NA ft.
S= NA %
Tc= NA min.

CHANNEL FLOW

H= 13.59 ft.
L= 585 ft.
Tc= 4.5 min.

Tc= 4.5 min.

i_{10}= 7.1 in/hr

Q=CAi=(.85)(.43 Ac.)(7.1 in/hr)

Q= 2.60 cfs

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JOB TOANO WOODS
SHEET NO. 54 OF
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CHECKED BY DATE
SCALE

(Outfall "E")

Drainage Area 7

Run-off Coefficient (C)

	A	C	CA
Residential	2.41	.40	.96
Roadway	.77	.85	.65
	3.18		1.61

$C = 1.61/3.18 = .51$

Overland Flow

L = 470'
S = 5.3
Tc = 15.25 min

Channel Flow

L = 125'
H = 13'
Tc = .25 min

Tc = 15.25 + .25 = 15.50 min or .26 hrs

i_{10} = 5.0

∴ Flow In (Q_i)

$Q_i = CAi = 1.61(5.0) = 8.05$ cfs

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JOB Tenna Woods
SHEET NO. 55 OF
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CHECKED BY DATE
SCALE

CULVERT DESIGN

Outfall "E"

c= .51
A= 3.18 Ac.

OVERLAND FLOW

L= 470 ft.
S= 5.3 %
Tc= 15.25 min.

CHANNEL FLOW

H= 125' ft.
L= 13 ft.
Tc= .25 min.

Tc= 15.5 min

i_{10}= 5.0 in/hr

Q=CAi=(.51)(3.18 Ac.)(5.0 in/hr)

Q= 8.05 cfs
L= 167 ft.
S= 9.52 %
HW= 10.0 ft.

INLET CONTROL

D= 18 in. or 1.5 ft.

HW/D= 1.25 HW=(1.50 ft.)(1.25)= 1.88 ft. < 10.0 ft.

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JOB Tour Woods
SHEET NO. 56 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

OUTLET VELOCITY

FULL FLOW= 42.0 cfs

FULL FLOW VELOCITY= 24.2 fps

$$\frac{Q_{10}}{Q_{full}} = \frac{8.05}{42.0} = .19$$

$$\frac{V_{10}}{V_{full}} = .77$$

V_{10}=(.77)(24.2 fps)= 18.6 fps

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JOB TOANO WOODS.
SHEET NO. 57 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

Design Outfall "G"
Drainage Area 1

Run-off Coefficient (C)

	A	C	CA
Residential	2.86	.40	1.14
Roadway	.27	.85	.23
	3.13		1.37

$C = 1.37/3.13 = .44$

Overland Flow

$L = 495'$
$S = 4.2\%$
$T_c = 16.25$ min

Channel Flow

$L = 45'$
$H = 1.0'$
$T_c = 1.25$ min

$T_c = 16.25$ min $+ 1.25$ min $= 17.50$ min or $.29$ hr

$i_{10} = 4.90$

∴ Flow In (Q_i)

$Q_i = CAi = 1.37(4.90) = 6.7$ cfs

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JOB Toano Woods
SHEET NO. 58 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

Drainage Area 19

Run-off Coefficient (C)

	A	C	CA
Residential	.71	.40	.28
Roadway	.16	.85	.14
Pasture	.69	.25	.17
	1.56		.59

$C = .59/1.56 = .38$

Overland Flow

$L = 400'$
$S = 3.0\%$
$T_c = 17.5$ min.

Channel Flow

$L = 50'$
$H = 1'$
$T_c = 1.5$ min

$T_c = 17.5$ min + 1.5 min = 19 min

$i_{10} = 4.6$

∴ Flow In (Q_i)

$Q_i = CAi = .59(4.6) = 2.7$ cfs

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JOB Town Woods
SHEET NO. 59 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

CULVERT DESIGN

Outfall "G"

DA - 1, 17, 19, 13

DA = 20, 19, 1,

1 - 3.13
19 - 1.56
offsite 2.5 & Town wds ID 25-27

from Ditch calcs
~~Q = 8.86~~ - TWs 12+00 South
Q = 1.5 " " North
culvert 17+60 Q = 13.7 Thacker 22+00 ~~East~~ West
DA - 1 ~~Q = 6.7~~
✓ Q = 4.00 Town Wds 25+25

19.2 cfs

c= .42
A= 5.84 Ac.

OVERLAND FLOW

L= 400 ft.
S= 4.5 %
Tc= 16 min.

CHANNEL FLOW

H= 4 ft.
L= 350 ft.
Tc= 4 min.

Tc= 20 min

i_{10}= 4.5 in/hr

Q=CAi=(.42)(5.84 Ac.)(4.5 in/hr)

Q= 11.04 cfs — too Low
L= 103 ft.
S= 2.8 %
HW= 7.0 ft.

INLET CONTROL

D= 24 in. or 2.0 ft.

HW/D= .90 HW=(2.0 ft.)(.9)= 1.8 ft. ≈ 7.0 ft.

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JOB: Tacoma Villas
SHEET NO. 60 OF
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CHECKED BY DATE
SCALE

DA- 14

c= .85
A= .15 Ac.

OVERLAND FLOW

L= N/A ft.
S= N/A %
Tc= N/A min.

CHANNEL FLOW

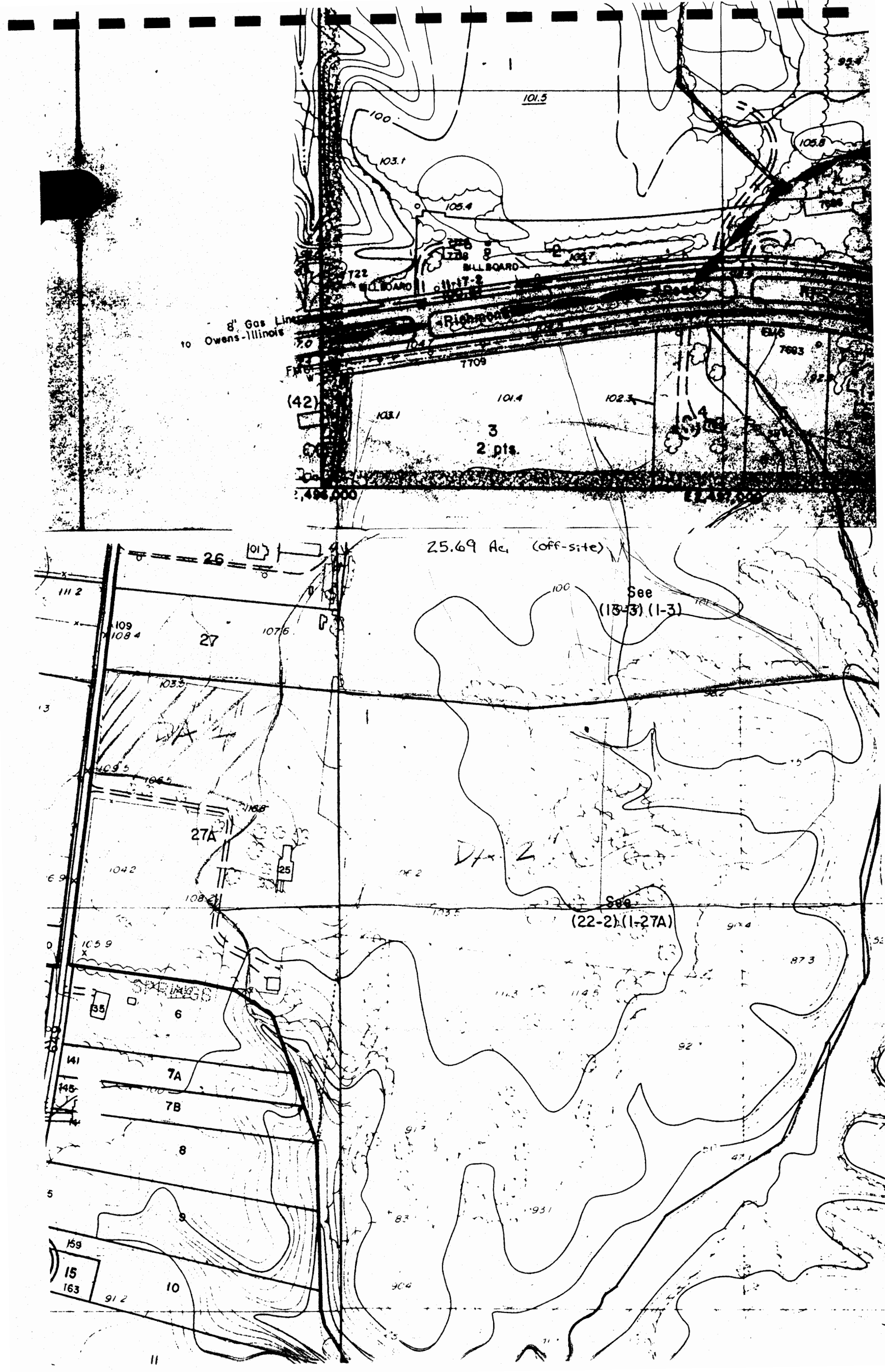
H= 5.4 ft.
L= 170 ft.
Tc= 2 min.

Tc= 2 min.

i_{10}= 7.4 in/hr

Q=CAi=(.85)(.15 Ac.)(7.4 in/hr)

Q= .94 cfs


8" Gas Line
to Owens-Illinois
Richmond
BILLBOARD
BILLBOARD
101.5
100
103.1
105.4
105.8
103.7
7709
101.4
102.3
103.1
3
2 pts.
(42)
25.69 Ac. (off-site)
See
(13-3) (1-3)
See
(22-2) (1-27A)
26
27
27A
25
35
6
7A
7B
8
9
10
15
163
141
145
159
STREET
DA 2
DA 2

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JOB [illegible]
SHEET NO. 62 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

DA- 16 2.5 offsite - Ac

c= .35
A= 2.77 Ac.

OVERLAND FLOW

L= 350 ft.
S= 2.9 %
Tc= 19 min.

CHANNEL FLOW

H= 10 ft.
L= 380 ft.
Tc= 3 min.

Tc= 22 min.

i_{10}= 4.1 in/hr

Q=CAi=(.35)(2.77 Ac.)(4.1 in/hr)

Q= 4.00 cfs

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JOB Toano Woods
SHEET NO. 62 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

CULVERT DESIGN
Outfall "H"

c= .38
A= 2.93 Ac.

OVERLAND FLOW

L= 350 ft.
S= 2.9 %
Tc= 19 min.

CHANNEL FLOW

H= 10 ft.
L= 380 ft.
Tc= 3 min.

Tc= 22 min

i_{10}= 4.1 in/hr

Q=CAi=(.38)(2.93 Ac.)(4.1 in/hr)

Q= 4.56 cfs
L= 105 ft.
S= 13.70%
HW= 2.5 ft.

INLET CONTROL

D= 12 in. or 1.0 ft.

HW/D= 2 HW=(1.0 ft.)(2)= 2.0 ft.< 6.0 ft.

PRODUCT 30-L3 NEBS Inc. Gardena, Mass. 01721

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JOB Toano Woods
SHEET NO. 64 OF
CALCULATED BY DATE
CHECKED BY DATE
SCALE

OUTLET VELOCITY

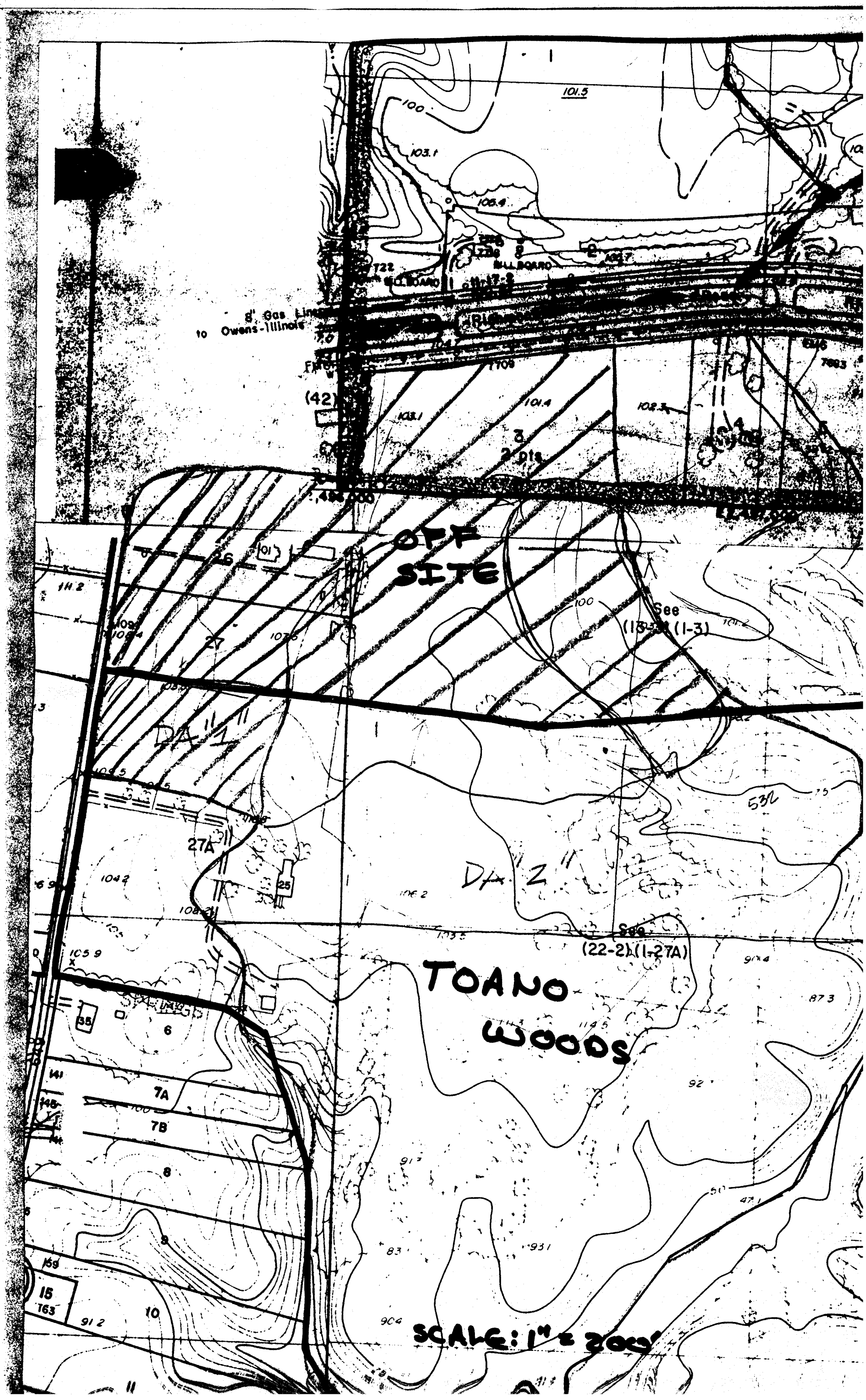
FULL FLOW= 15 cfs

FULL FLOW VELOCITY= 18.5 fps

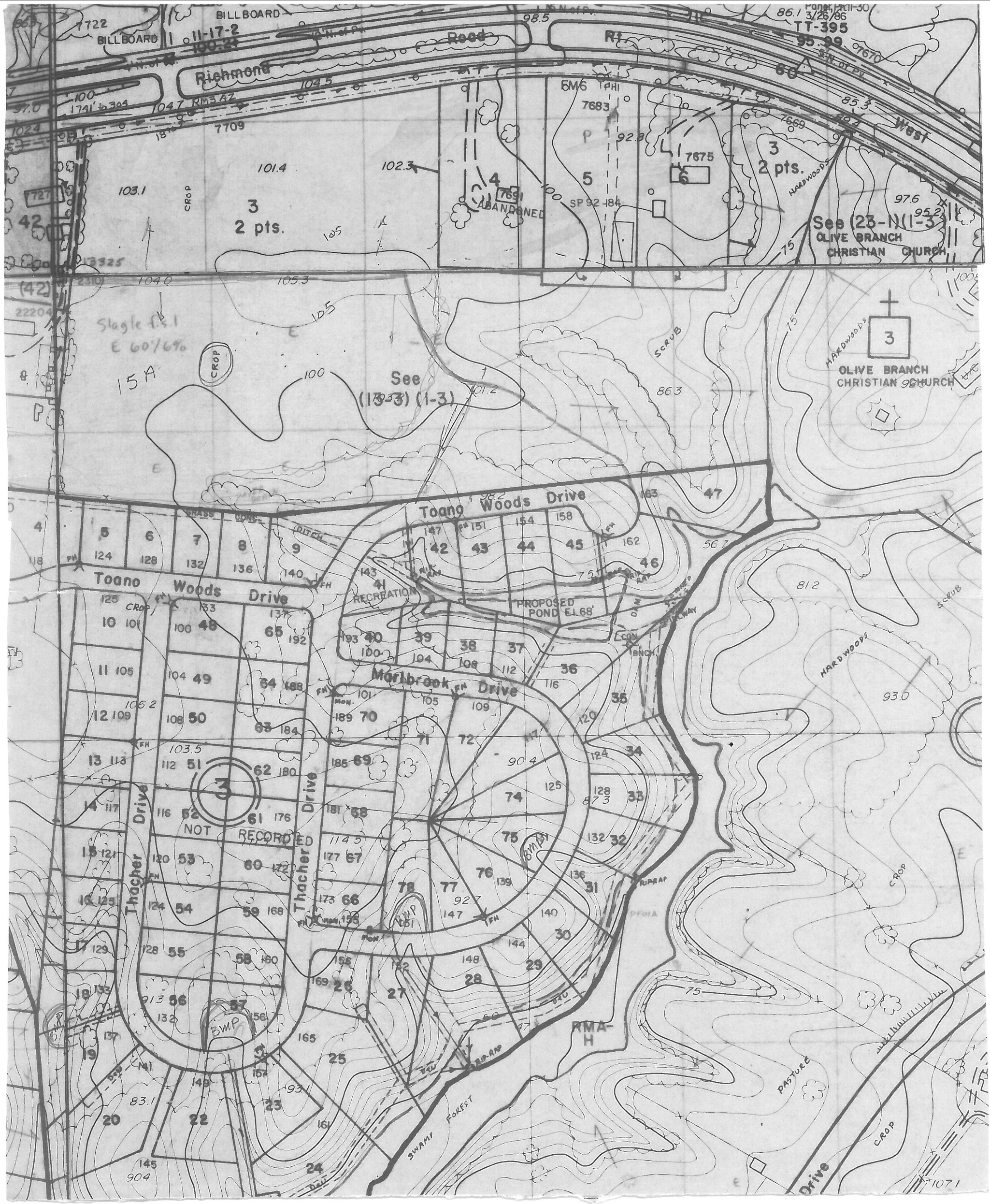
$$\frac{Q_{10}}{Q_{full}} = \frac{4.56}{15} = .30$$

$$\frac{V_{10}}{V_{full}} = .88$$

V_{10}=(.88)(18.5 fps)= 16.30 fps


101.5
100
103.1
106.4
BILLBOARD
g" Gas Line
to Owens-Illinois
(42)
101.4
102.3
OFF SITE
See (1-3)
DA 1
27A
25
DA 2
See (22-2)(1-27A)
TOANO WOODS
6
7A
7B
8
9
10
15
SCALE: 1" = 200'

8/26
3:45 pm
KARL RUTHIN


BILLBOARD
BILLBOARD
11-17-2
Richmond
Road
Rt
60
West
TT-395
95.99
3/26/86
3
2 pts.
CROP
ABANDONED
SP 92-184
See (23-1)(1-3)
OLIVE BRANCH
CHRISTIAN CHURCH
HARDWOODS
Slagle f.s.1
E 60/6%
15A
See
(13-3) (1-3)
SCRUB
Toano Woods Drive
RECREATION
PROPOSED
POND EL 68'
Marlbrook Drive
Thacher Drive
NOT RECORDED
BMP
RIPRAP
SWAMP FOREST
PASTURE
RMA-H