Replat of Lot 10 - Brownwood Estates

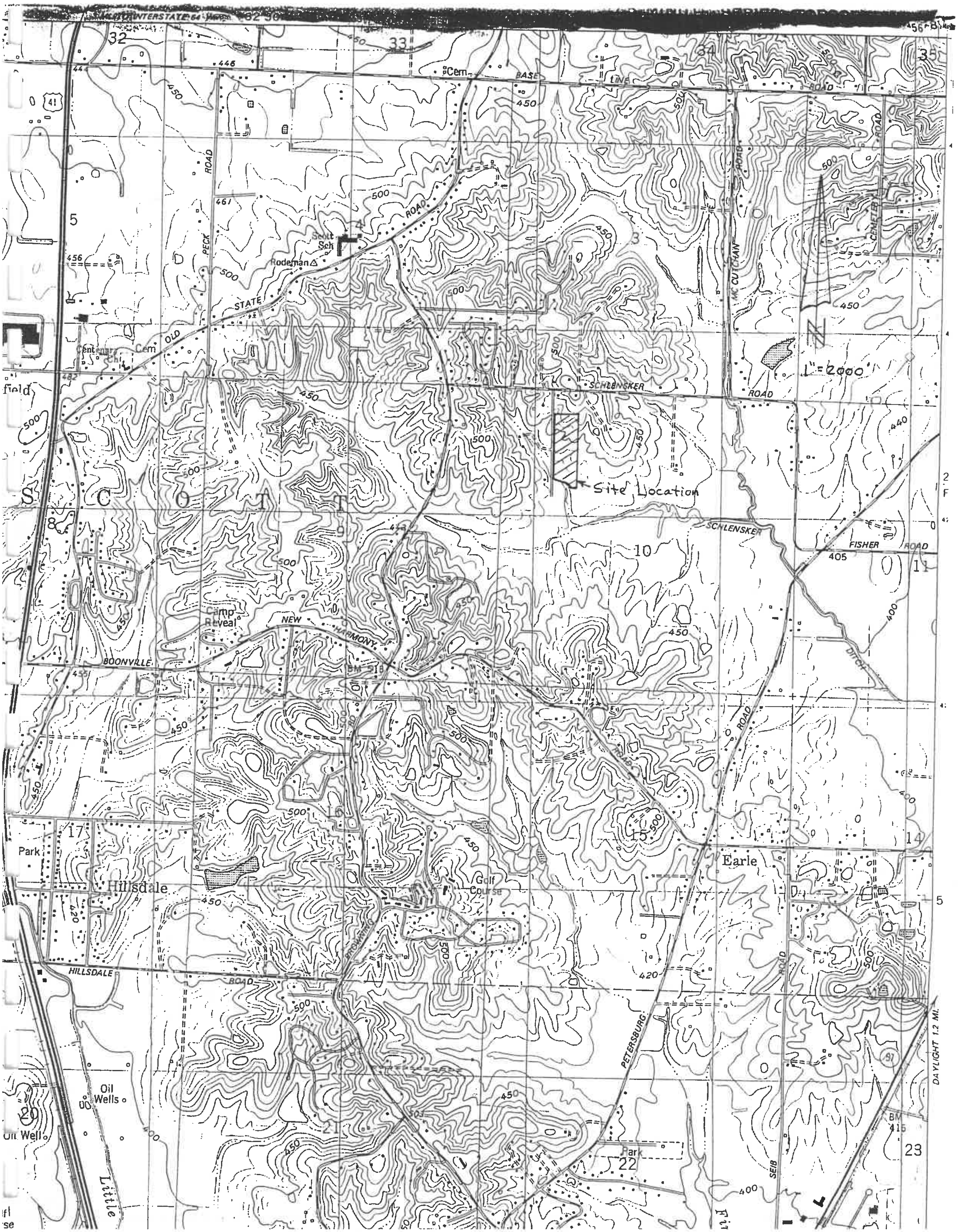
The site is located on Brownwood Lane, approximately 400 feet south of Schlensker Road and 1900 feet east of Browning Road, in Scott Township in northeast Vanderburgh County.

The site contains 11.98 acres, comprised mainly of pasture or meadow and woodland on rolling ground. Part of the site drains south and west, directly into a tributary of Schlensker Ditch. The remaining portion drains south into a ditch on the south side of Brownwood Lane, and then west into the Schlensker Ditch tributary. The soil types present include Bartle silt loam (Ba), Hosmer silt loam (HoB2, HoC3), Stendal silt loam (St) and Zanesville silt loam (ZaC3).

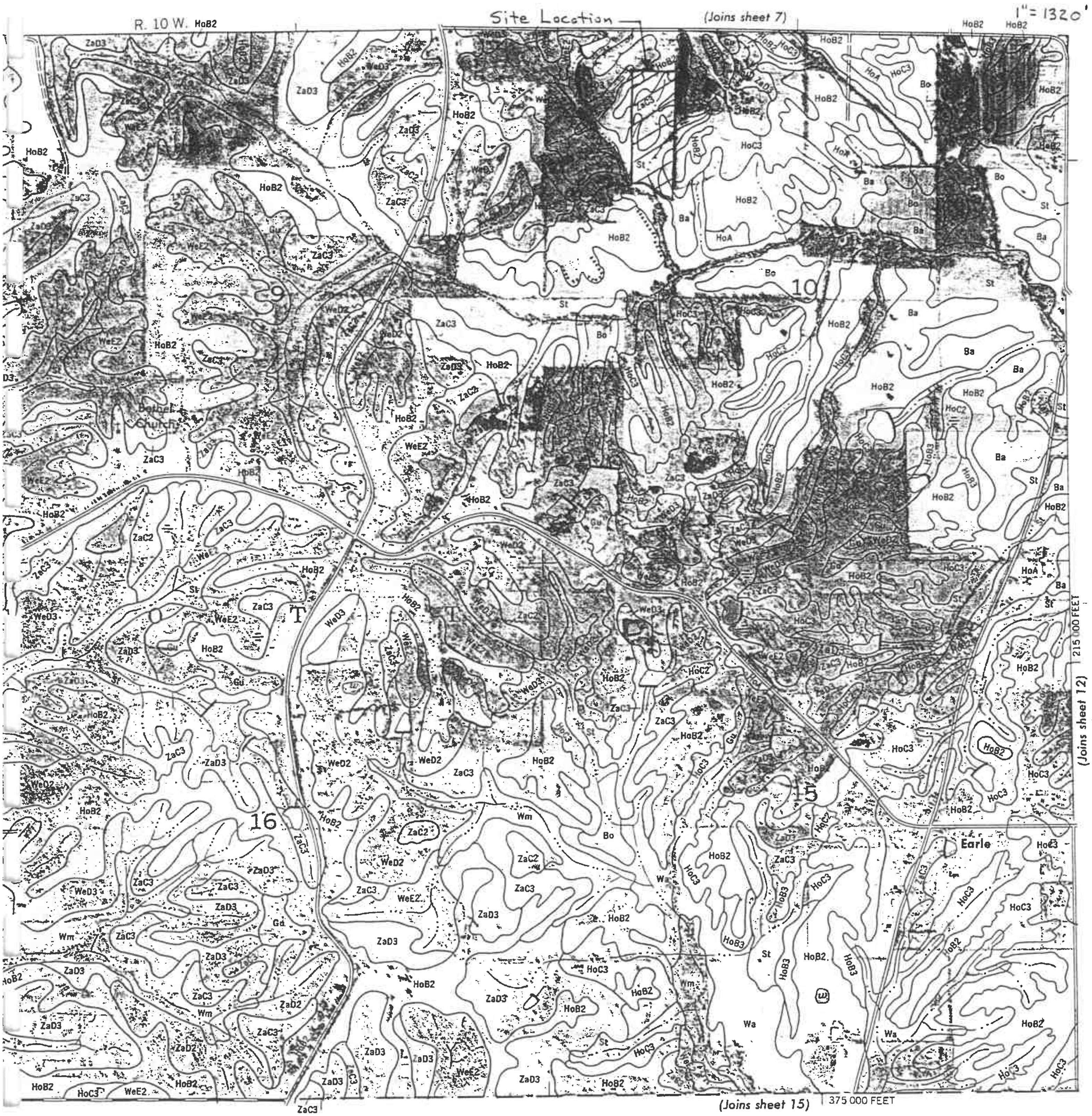
The site is divided into four lots, of which Lots 1, 2 and 4 are available for construction. Lot 3 presently contains a residence and garage and will not be developed any further at this time. The expected construction on Lots 1, 2 and 4 will produce a slight increase in peak runoff. The pre-development peak runoff for the three lots, which total 7.50 acres, is approximately 13 cfs and the post-development peak runoff rate increases to 16.4 cfs.

Culverts have been sized for the expected driveways on Lots 1, 2 and 4, in the approximate locations shown on the drainage plan. Although the final locations may vary from those depicted, the size of each culvert will remain the same. Each culvert was designed to safely handle the peak flow rate from a 25 year storm event, with the headwater depth assumed to be 12 inches above the top of the inside of the culvert.

No detention is required for this site.



Site Location
1"=2000'
N
S C O T T
BASE LINE ROAD
PECK ROAD
OLD STATE ROAD
Scott Sch
Rodeman
Centenary Ch
Cem
SCHLENSKER ROAD
FISHER ROAD
MC CUTCHAN ROAD
CEMETERY ROAD
Camp Reveal
NEW HARMONY
BOONVILLE
HILLSDALE ROAD
Hillsdale
Park
Golf Course
Earle
PETERSBURG
SEIB ROAD
DITCH
Oil Wells
Oil Well
Little
DAYLIGHT 1.2 MI.



1" = 1320'
R. 10 W.
Site Location
(Joins sheet 7)
9
10
Bethel Church
T
16
15
Earle
(Joins sheet 12)
215 000 FEET
(Joins sheet 15)
375 000 FEET

PIPE FLOW: For a pipe flowing full, but not under pressure, Manning's Equation (Equation 4.6) may be used to calculate the flowrate. As soon as a depth of water develops above the pipe the flowrate must be calculated using a modified form of the Manning equation and must include entrance and exit losses. Equation 6.10 is used to calculate the flowrate under these conditions,

$$Q = A\left[\frac{h}{\frac{K_e + K_o}{2g} + \frac{2.87n^2L}{D^{4/3}}}\right]^{1/2} \quad (6.10)$$

where Q = flowrate in cfs,
K_e = entrance loss coefficient (given in Table 6.3),
K_o = outlet loss coefficient (usually taken as 1.0),
D = pipe diameter (ft),
n = Manning's roughness coefficient (Table 4.2),
L = length of pipe (ft) (Equation assumes a free jet @ exit),
h = Height of water surface above center of pipe opening (ft).

All of the equations presented may be used to calculate the flowrate Q. Often the flowrate is known and the orifice opening, weir size or pipe diameter are the parameters actually required. In these cases the equations are rearranged to solve for the unknown variable. When the computed result does not correspond to a commercially available pipe size, the type of opening, discharge coefficient, or pipe roughness are varied to obtain a readily available pipe of proper size.

Table 6.3

Value of K_e (entrance losses)
(Portland Cement Association)

Type of Entrance	K_e
Concrete pipe in headwall	
Socket or beveled entrance	0.19
Rounded lip	0.10
Square edge	0.43
Concrete pipe projecting, square edge	0.46
Corrugated metal pipe in headwall, square edge	0.43

the water travels toward the watershed outlet. These phases generally are overland flow including flow over spoil and through forest litter, shallow channel flow toward larger channels, and flow in open channels, both natural and improved. The travel time in these various flow phases depends on the length of travel and the flow velocity.

Flow velocity for overland flow and shallow channel flow can be estimated using results such as those of Izzard (1946) or from Figure 2.34. Flow velocity for open channels can be estimated from Manning's equation assuming the channel is flowing full. Once the velocity in each flow segment is determined, the time of concentration is determined from

$$t_c = \sum_{i=1}^{n} \frac{L_i}{V_i} \tag{2.56}$$

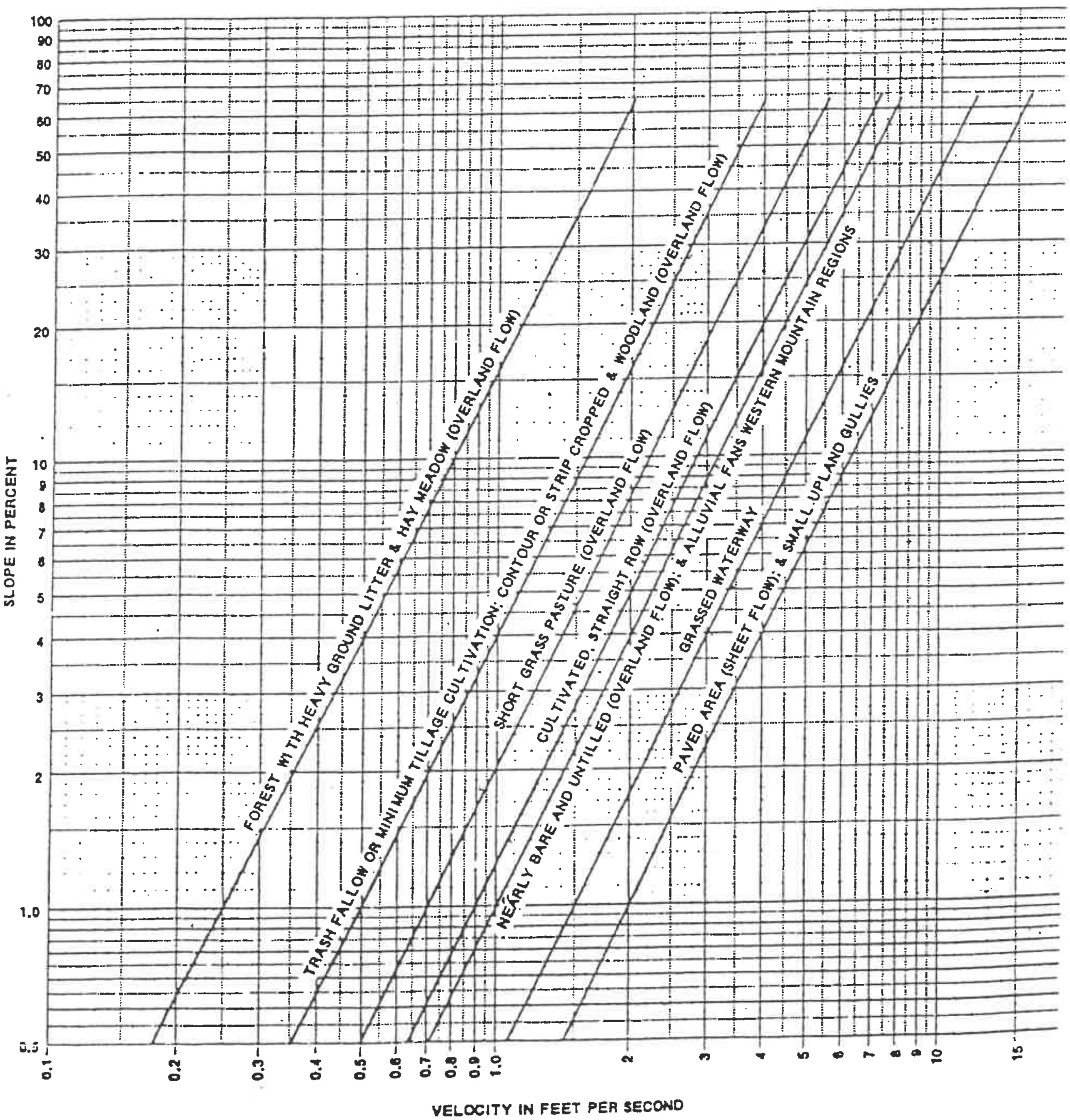


Figure 2.34. Velocities for upland method of estimating t_c.

Replat of Lot 10 - Brownwood Estates

Peak Flow Rates - Lots 1, 2, 3 & 4

Assumptions for developed conditions - 108,900 S.F. total

House, garage, etc	- 5,500 S.F.	(5.05 %)
Driveway	- 5,000 S.F.	(4.59 %)
Lawn/Meadow	- remaining	(90.36 %)

Lot 1 - 2.50 Ac. Woods, meadow, 5-10%

Undeveloped C = 0.36

" N = 0.40

L = 330' H = 14' S = 0.0424

$$t_c = 0.827 \left[\frac{(0.40)(330)}{(0.0424)^{1/2}} \right]^{0.467} = 16.91 \text{ min.}$$

I(25) = 4.856 in./hr.

Undev. Q(25) = (0.36)(4.856)(2.50) = 4.37 cfs

Developed C (wt'd)

= (0.96)(0.0505 + 0.0459) + (0.40)(0.9036)

= 0.454

Dev. Q(25) = (0.454)(4.856)(2.50) = 5.51 cfs

Lot 2 - 2.50 Ac. Woods, meadow, 5-10%

Undeveloped C = 0.36

" N = 0.40

L = 450' H = 23' S = 0.0511

$$t_c = 0.827 \left[\frac{(0.40)(450)}{(0.0511)^{1/2}} \right]^{0.467} = 18.72 \text{ min.}$$

Replat of Lot 10 - Brownwood Estates

Lot 2 cont'd

I(25) = 4.689 in./hr.

Undev. Q(25) = (0.36)(4.689)(2.50) = 4.22 cfs

Dev. C = 0.454

Dev. Q(25) = (0.454)(4.689)(2.50) = 5.32 cfs

Lot 4 - 2.50 Ac. Woods, meadow, 5-10 %

Undeveloped C = 0.36

" N = 0.40

L = 420' H = 32' S = 0.0762

$$t_c = 0.827 \left[\frac{(0.40)(420)}{(0.0762)^{1/2}} \right]^{0.467} = 16.51 \text{ min.}$$

I(25) = 4.893 in./hr.

Undev. Q(25) = (0.36)(4.893)(2.50) = 4.40 cfs

Dev. C = 0.454

Dev. Q(25) = (0.454)(4.893)(2.50) = 5.55 cfs

Lot 3 - 4.48 Ac Developed - house, garage, drive, lawn/meadow

House, garage, drive - 10,500 S.F. C = 0.92 N = 0.02

Lawn/Meadow - 184,649 S.F. C = 0.40 N = 0.40

Wt'd C = 0.428

Wt'd N = 0.380

L = 550' H = 37' S = 0.067

$$t_c = 0.827 \left[\frac{(0.380)(550)}{(0.067)^{1/2}} \right]^{0.467} = 18.84 \text{ min.}$$

Replat of Lot 10 - Brownwood Estates

Lot 3 cont'd

$I(25) = 4.678$ in./hr.

$Q(25) = (0.428)(4.678)(4.48) = 8.97$ cfs

Replat of Lot 10 - Brownwood Estates

Driveway Culverts - 25 Year Storm

Assume developed conditions

Lot 1 - Two Culverts

Structure 1-1 : Road ditch south side of Brownwood Lane

Watershed Area ≈ 6.5 Ac.

$C = 0.454 \qquad N = 0.363$

Time of concentration - sheet + shallow swale + road ditch

Sheet flow t_{c_1}

$L = 400' \qquad H = 30' \qquad S = 0.075$

$$t_{c_1} = 0.827\left[\frac{(0.363)(400)}{(0.075)^{1/2}}\right]^{0.467} = 15.48 \text{ min.}$$

Shallow swale t_{L_2} + Road ditch t_{L_3}

$L_2 = 500' \qquad S = 0.054 \qquad$ Avg. vel. = 3.5 fps

$L_3 = 625' \qquad S = 0.029 \qquad$ Avg. vel. = 3.4 fps

$$t_{L_2} = \frac{500}{(3.5)(60)} = 2.38 \text{ min.}$$

$$t_{L_3} = \frac{625}{(3.4)(60)} = 3.06 \text{ min.}$$

$t_c = 15.48 + 2.38 + 3.06 = 20.92$ min.

$I(25) = 4.486$ in/hr

$Q(25) = (0.454)(4.486)(6.5) = 13.2$ cfs

Culvert Sizing - RCP , $n = 0.011$

Assume headwater allowed 12" above top inside of pipe.

$$Q = A\left[\frac{h}{\frac{K_e + K_o}{2g} + \frac{2.87\,n^2 L}{D^{4/3}}}\right]^{1/2}$$

Eq. 6.10

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Replat of Lot 10 - Brownwood Estates

Lot 1 Culverts cont'd

$K_e = 0.50$ $n = 0.011$

$K_o = 1.00$ $L = 30'$

$g = 32.2\ ft/sec^2$ $h = 12'' + 1/2$ Dia.

For $D = 18''$

$Q = 13.6$ cfs > 13.2 cfs req'd

∴ Use 18" RCP @ 1ST location - Lot 1

(or equivalent)

Structure L-2: Drive crossing channel approx. 150' south of Brownwood Lane

Watershed Area = 15.4 Ac.

Woods - 7.7 Ac. $c = 0.36$ $N = 0.60$

Water - 0.4 Ac. $c = 1.0$ $N = 0$

Developed Lots - 7.3 Ac. $c = 0.454$ $N = 0.363$

Wt'd $c = 0.421$

Wt'd $N = 0.472$

Time of concentration - sheet + shallow swale

Sheet flow t_{c_1}

$L = 400'$ $H = 26'$ $S = 0.065$

$$t_{c_1} = 0.827\left[\frac{(0.472)(400)}{(0.065)^{1/2}}\right]^{0.467} = 18.10 \text{ min.}$$

Shallow swale t_{L_2}

$L_2 = 1320'$ $S = 0.043$ Avg. vel. = 3.2 fps

$$t_{L_2} = \frac{1320}{(3.2)(60)} = 6.88 \text{ min.}$$

$t_c = 18.10 + 6.88 = 24.98$ min.

$I(25) = 4.110$ in./hr.

$Q(25) = (0.421)(4.110)(15.4) = 26.6$ cfs

Replat of Lot 10 - Brownwood Estates

Lot 1 Culverts cont'd

Culvert Sizing - RCP, $n = 0.011$, $L = 30'$

Assume 12" HW above top inside of pipe

Using Eq. 6.10 & $L = 30'$

For $D = 24"$

$Q = 26.8$ cfs > 26.6 cfs req'd

∴ Use 24" RCP @ 2ND location - Lot 1

(or equivalent)

Lot 2 - Two Culverts

Structure 2-1 : Road ditch south side of Brownwood Lane

Watershed Area = 6.3 Ac.

$C = 0.454$ $N = 0.363$

Time of Concentration - sheet + shallow swale + road ditch

Sheet flow t_{c_1}

$L = 400'$ $H = 30'$ $S = 0.075$.

$t_{c_1} = 15.48$ min.

Shallow swale t_{L_2} + Road ditch t_{L_3}

$L_2 = 500'$ $S = 0.054$ Avg. vel. = 3.5 fps

$L_3 = 400'$ $S = 0.033$ Avg. vel. = 3.7 fps

$$t_{L_2} = \frac{500}{(3.5)(60)} = 2.38 \text{ min.}$$

$$t_{L_3} = \frac{400}{(3.7)(60)} = 1.80 \text{ min.}$$

$t_c = 15.48 + 2.38 + 1.80 = 19.66$ min.

$I(25) = 4.602$ in./hr.

$Q(25) = (0.454)(4.602)(6.3) = 13.2$ cfs

Replat of Lot 10 – Brownwood Estates

Lot 2 Culverts cont'd

Culvert Sizing – RCP, $n = 0.011$, $L = 30'$

Assume 12" HW above top inside of pipe

Using Eq. 6.10 & $L = 30'$

For $D = 18"$

$Q = 13.6$ cfs > 13.2 cfs req'd

∴ Use 18" RCP @ 1st location – Lot 2
(or equivalent)

Structure 2-2 : Drive crossing channel approx. 120' south of Brownwood Lane

Watershed Area = 13.5 Ac.

Woods	– 7.7 Ac.	$C = 0.36$	$N = 0.60$
Water	– 0.4 Ac.	$C = 1.0$	$N = 0$
Developed Lots	– 5.4 Ac.	$C = 0.454$	$N = 0.363$

Wt'd $C = 0.417$

Wt'd $N = 0.487$

Time of concentration – sheet + shallow swale

Sheet flow t_{c_1}

$L = 400'$ $H = 26'$ $S = 0.065$

$$t_{c_1} = 0.827 \left[\frac{(0.487)(400)}{(0.065)^{1/2}} \right]^{0.467} = 18.36 \text{ min.}$$

Shallow swale t_{c_2}

$L_2 = 1100'$ $S = 0.045$ Avg. vel. = 3.2 fps

$$t_{c_2} = \frac{1100}{(3.2)(60)} = 5.73 \text{ min.}$$

$t_c = 18.36 + 5.73 = 24.09$ min.

$I(25) = 4.192$ in./hr.

$Q(25) = (0.417)(4.192)(13.5) = 23.6$ cfs

Replat of Lot 10 - Brownwood Estates

Lot 2 Culverts cont'd

Culvert Sizing - RCP, n = 0.011, L ≈ 30'

Assume 12" HW above top inside of pipe

Using Eq. 6.10 & L = 30'

For D = 24"

Q = 26.8 cfs > 23.6 cfs req'd

∴ Use 24" RCP @ 2ND location - Lot 2

(or equivalent)

Lot 4 - One Culvert

Structure 4-1 : Road ditch south side of Brownwood Lane

Watershed Area = 2.3 Ac.

$C = 0.454$ $N = 0.363$

Time of concentration - sheet flow t_c

$L = 500'$ $H = 43'$ $S = 0.086$

$$t_c = 0.827 \left[\frac{(0.363)(500)}{(0.086)^{1/2}} \right]^{0.467} = 16.64 \text{ min.}$$

$I(25) = 4.881$ in./hr.

$Q(25) = (0.454)(4.881)(2.3) = 5.1$ cfs

Culvert Sizing - RCP, n = 0.011, L = 30'

Assume 12" HW above top inside of pipe

Using Eq. 6.10 & L = 30'

For D = 12"

Q = 5.2 cfs > 5.1 cfs req'd

∴ Use 12" RCP @ Road - Lot 4