



Keeping Stormwater Where it Falls

November 2003

GILE TRACT: A Rough Hydrologic Analysis

An engineer did not do the following analysis¹; it is simply intended to illustrate some of the components of a hydrological analysis. The resulting numbers show the effect of impervious surfaces on run off and peak stormwater flows. There are many assumptions (see below), some of which may be incorrect. The error may be considerable; however, once you start the process, the results are all derived from your starting assumptions – different assumptions, different results. Most engineers will use one of the spreadsheet programs to help with the computation of runoff, and indeed you too can download this from the NRCS website².

The method used here is based on TR-55, a tool for small watersheds. Other models exist (in fact the LID hydrology manual has slightly different assumptions).

Rainfall for Grafton County:

- 2-year storm: 2.7” total rainfall in 24 hours
- 10-year storm: 4.2” total rainfall in 24 hours
- 100-year storm: 5.9” total rainfall in 24 hours

Soils:

Soils in most of Gile tract are considered Cardigan–Kearsarge, hydrologic soil group “B” (moderate drainage). See separate sheet on soils for more detail.

Curve Numbers³:

Curve Number (CN) for a site is determined by the hydrologic soil group (HSG), the cover type, treatment (only for agricultural uses), hydrologic condition (ex. Canopy, lawn density, amount of cover, surface roughness), and antecedent runoff condition (ARC -previously soaked or not). Another factor is whether impervious areas outlet directly to the drainage system (connected) or whether the flow spreads over pervious areas before entering the drainage system (unconnected).

Here are some typical curve numbers for the HSG and various conditions/cover:

	HSG A	HSG B	HSG C	HSG D
Impervious Area	98	98	98	98
Open Space (lawn) poor condition	68	69	86	89
Meadow	30	58	71	78
Woods				
Poor condition	45	66	77	83
Fair condition	36	60	73	79
Good condition	30	55	70	77

¹ Doug McIlroy, November 4, 2003

² <http://www.wcc.nrcs.usda.gov/hydro/index.html> Part of the USDA’s Natural Resources Conservation Service (NRCS) website on water and erosion issues. The site has technical papers to help user assess run-off from small sites, such as TR-55, and the WinTR-55 software to assist in this analysis.

³ NRCS TR-55 tables 2-2a, 2-2c

Assumptions for Gile-tract analysis:

- After-development conditions are **worst-case**: no detention facilities.
- Though the soil for the site is hydrologic group “B” (see separate soils sheet), after development the disturbed soils will probably be compacted, downgrading soils to “C” hydrologic group.
- Areas were computed by counting squares as an estimate (GIS can do better, faster).
- Developed areas are modeled as 1/8 acre housing (65% impervious, or about 4.5 acres of total 7 acres)⁴.
- Development reaches⁵ are assumed to be storm drains, arbitrarily modeled as smooth channels, with 1’ bottom (2’ on entrance road) and 1:1 side slopes.
- The landfill's contribution to flow is dubiously modeled. The receiving ravine carries this flow as subsurface concentrated. Since that's not a recognized kind of reach, the ravine was instead modeled as a broad channel of maximum roughness. The result is overestimated flow. To compensate, the area of the landfill was arbitrarily understated by 50%. However, as the condition of much of the ravine does not change, this modeling flaw should not materially affect the predicted *change* in runoff due to development.

Impervious area estimate from November 2002 proposal:

The following analysis uses a conventional estimate of total impervious area, about 65% of developed subareas, or 4.5 acres.

ASIDE: However, a very rough estimate from the proposal’s layout yields the following numbers for the paved surfaces and building footprints:

Buildings 75,468 sf

Pavement

Parking (estimate) (102 spaces) x (8’ x 18’) = 14,688 sf

Roads (estimate) (1971’ roadway total length) x (24’ width) = 47,314 sf

Total impervious area: 137,470 sf (~3.2 acres), **not** counting the disturbed area, sidewalks, etc.

This analysis Covers:

- The proposed 7-acre development tract
- All land uphill of it
- Land extending downhill to Route 120
- Buck Road, and medical-office parking

Data for the worksheets (produced by TR-55 spreadsheet program for Windows)

NOTE: the proposed area has two natural drainage patterns: one, a shallow ravine (depression) that traverses the western edge of proposed 7-acre parcel, running in northward direction. The other is drainage easterly, towards Rt 120 and small stream. To make runoff estimates you must determine the contributing watershed, which is approximately 17.7 acres for this project.

⁴ from the proposal, one can estimate buildings to take about

⁵ A “reach” is a portion of a sub-watershed – here, a part of the proposed layout that will drain into a road swale, pipe or other channel (natural or man-made)

Input data for WESTERN WATERSHED:

<i>Subareas</i>	Acres	Discharge to
(1) Ravine west: steep rocky slope, good woods.	6.1	West outlet (before development)
(1A) Reserved: no development but runoff	5.8	Culvert
(1B) Targeted: to be developed	0.4	Foot of ravine
(2) Landfill: bare, unconsolidated.	0.6	Ravine
(3) Summit: rocky terrain, good woods.	1.7	Culvert
(4) Ravine east: rocky terrain, good woods.		
(4A) upper development	1.2	Top west
(4B) central development	0.9	Bot west
(4C) lower (northern) development	0.6	West outlet

Reaches

Top west: stub road, 2' storm drain

West cir: west side of central loop road, 2' drain

Bot west: lower side of central loop, 2' drain

Ravine: from dump to culvert (see note)

Culvert: from ravine crossing downhill

Northwest tail: stub west of ravine (ignored in analysis)

Top center: road drain between Top east & Top west (ignored in analysis)

West outlet: medical center driveway

Input data for EASTERN WATERSHED (slopes generally northeast towards Route 120 and Mink Brook)

<i>Subareas</i>	Acres	Discharge to
(6) Front: rocky terrain, good woods	6.6	East outlet (before)
(6A) Reserved: no development, but runoff will be intercepted by development	0.8	Top east
(6B) Targeted: entrance to development	3.9	Entrance
(6C) Targeted: lower (northern) development	0.9	East outlet
(6D) Targeted: central development	0.9	Bot east

Reaches

Top east: road stub 2' storm drain

East cir: east side of central loop road 2' drain

Bot east: lower side of central loop, 2' drain

Entrance: long winding road, 3' drain

East outlet: junction of Buck Road and Route 120

RESULTS OF ANALYSIS

Extract from TR-55 results.

Full report gives similar data for every reach and subarea.
Also times of peak runoff and charts flow versus time.

East Outlet

Condition	Rainfall Amount (in)	Runoff Amount (in)	Peak Flow (cfs)
2-yr storm	2.7		
Current		0.0	0.0
Developed		0.501	10.89
10-yr storm	4.2		
Current		0.268	5.06
Developed		1.333	23.75
100-yr storm	5.9		
Current		1.054	13.50
Developed		2.529	39.23

West Outlet

Condition	Rainfall Amount (in)	Runoff Amount (in)	Peak Flow (cfs)
2-yr storm	2.7		
Current		0.011	1.64
Developed		0.236	9.98
10-yr storm	4.2		
Current		0.275	9.20
Developed		0.671	23.03
100-yr storm	5.9		
Current		1.021	22.60
Developed		1.514	42.38