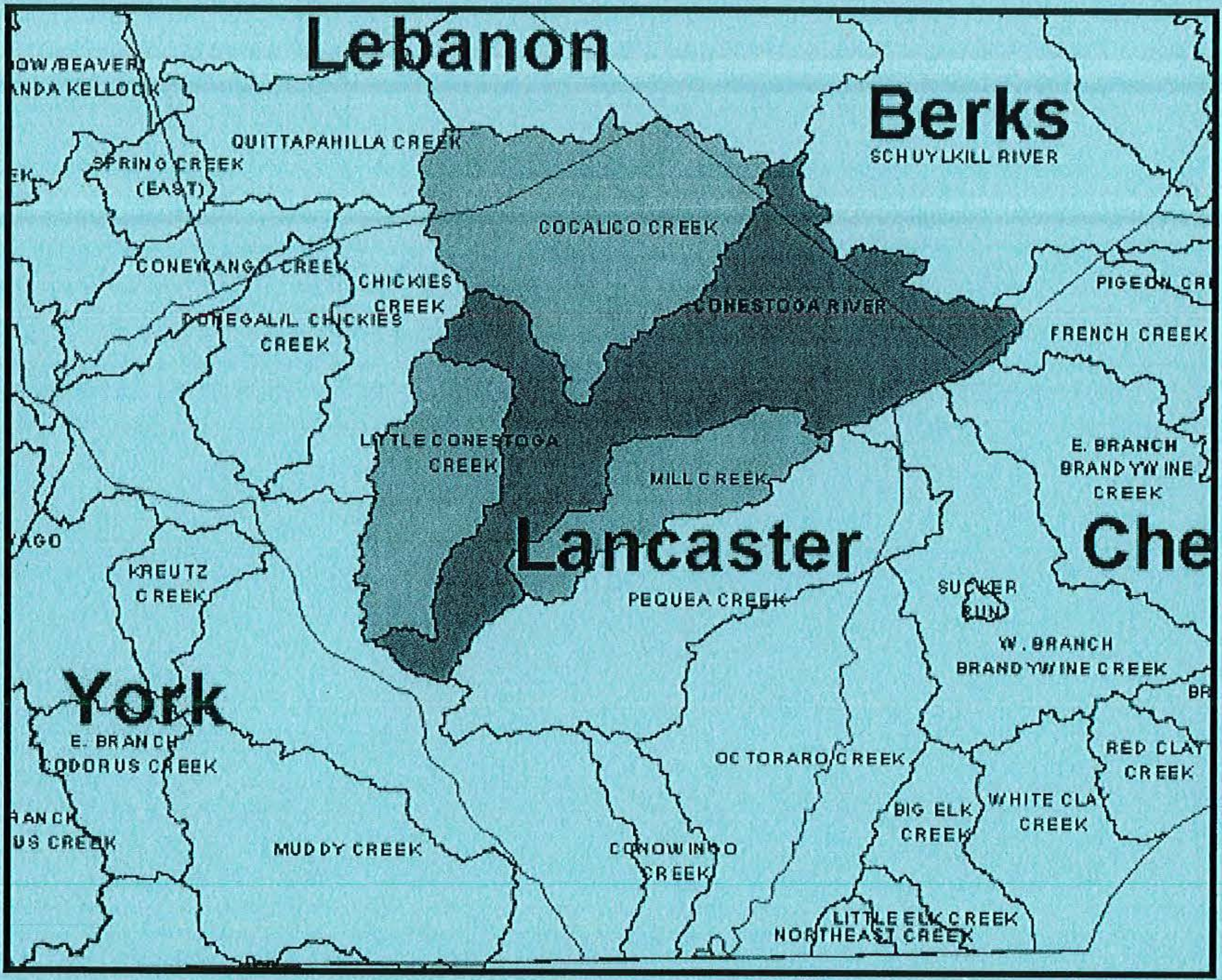
CONESTOGA RIVER
ACT 167
STORM WATER MANAGEMENT PLAN

VOLUME I - EXECUTIVE SUMMARY



LANCASTER COUNTY, PENNSYLVANIA
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PREPARED FOR:

LANCASTER COUNTY COMMISSIONERS
50 NORTH DUKE STREET
LANCASTER, PA 17602

VOLUME I - PLAN CONTENTS

I. INTRODUCTION

The Conestoga River Watershed is located in the central portion of Lancaster County and parts of Berks and Chester Counties. The Conestoga River drains three other State designated watersheds - Mill, Little Conestoga, and Cocalico Creeks.

Portions of this watershed are developed, but vast areas are still undeveloped with a potential for extensive growth under existing zoning. Extensive commercial/industrial growth can result in accelerated storm water runoff which has the potential of causing flooding and erosion problems for property owners along Conestoga River. Stream water quality can also become degraded as impervious areas grow throughout the watershed.

In past years, storm water control was viewed only on a site-specific basis. Recently, local perspectives and policies have changed, with the realization that proper storm water management can only be accomplished by evaluating the comprehensive picture (i.e. by analyzing what adverse impacts a development located in a watershed's headwaters may have on flooding downstream). Proper storm water management improves the overall quality of the receiving streams.

The Conestoga River Watershed Storm Water Management Plan, prepared under the Pennsylvania Storm Water Management Act, will enable continued development to occur within the Watershed, utilizing both structural and nonstructural measures to properly manage storm water runoff in the watershed.

II. ACT 167

The Pennsylvania General Assembly, recognizing the adverse effects of inadequate management of excessive rates and volumes of storm water runoff resulting from development, approved the Storm Water Management Act, P.L. 864, No. 167, October 4, 1978. Act 167 provides for the regulation of land and water use for flood control and storm water management purposes.

There is increased sentiment statewide, as well as local recognition, that a sound and effective Act 167 Plan should be a diversified multiple-purpose plan. This plan should address the full range of hydrologic consequences resulting from development instead of simply focusing on controlling site-specific peak flow, without consideration of tributary timing, flow volume reduction, base flow augmentation, water quality control and ecological protection.

III. CONESTOGA RIVER WATERSHED CHARACTERISTICS

The base data used to model the watershed came mostly from the Lancaster County GIS database. The information for Berks and Chester Counties came from the Berks and Chester County GIS databases, and USGS information for Pennsylvania obtained from the Internet.

A. Drainage Area

The Conestoga River Watershed covers an area from the Susquehanna River at Safe Harbor in the southwest to Berks and Chester Counties in the northeast. The watershed is contained in thirty-three (33) municipalities. Twenty-five of these municipalities are in Lancaster County. The Conestoga River watershed drains an area of approximately 215 total square miles (188 square miles are in Lancaster County, 25 are in Berks County and 2 square miles are in Chester County). A list of the municipalities and Counties in the watershed are shown below, by County.

Lancaster County

Adamstown Borough
Akron Borough
Brecknock Township
Caernarvon Township
Conestoga Township
Earl Township
East Cocalico Township
East Earl Township
East Lampeter Township
Elizabeth Township
Ephrata Township
Lancaster City
Lancaster Township
Lititz Borough
Manheim Township
Manor Township
Millersville Borough
New Holland Borough
Penn Township
Pequea Township
Terre Hill Borough
Upper Leacock Township
Warwick Township
West Earl Township
West Lampeter Township

Berks County

Brecknock Township
Caernarvon Township
New Morgan Boro
Robeson Township
Spring Township

Chester County

Elverson Borough
Honeybrook Township
West Nantmeal Township

The municipalities are ranked by area as follows;

Municipality	County	Square Miles	% of Total
Brecknock Township	Lancaster	25.03	11.65
Caernarvon Township	Lancaster	22.53	10.49
East Earl Township	Lancaster	18.50	8.61
West Earl Township	Lancaster	16.21	7.55
Earl Township	Lancaster	14.51	6.76
Manheim Township	Lancaster	14.30	6.66
Warwick Township	Lancaster	10.20	4.75
Brecknock Township	Berks	9.01	4.19
Caernarvon Township	Berks	8.71	4.05
Upper Leacock Township	Lancaster	8.10	3.77
East Lampeter Township	Lancaster	7.81	3.64
Conestoga Township	Lancaster	7.10	3.31
Lancaster City	Lancaster	6.00	2.79
Pequea Township	Lancaster	5.62	2.62
Ephrata Township	Lancaster	5.50	2.56
East Cocalico Township	Lancaster	5.44	2.53
Manor Township	Lancaster	4.83	2.25
Lancaster Township	Lancaster	4.20	1.96
Penn Township	Lancaster	4.10	1.91
Spring Township	Berks	3.50	1.63
New Morgan Borough	Berks	2.93	1.36
Lititz Borough	Lancaster	2.30	1.07
Millersville Borough	Lancaster	1.40	0.65
Adamstown Borough	Lancaster	1.31	0.61
Honeybrook Township	Chester	1.20	0.56
West Lampeter Township	Lancaster	0.97	0.45
New Holland Borough	Lancaster	0.60	0.28
West Nantmeal Township	Chester	0.54	0.25
Elverson Borough	Chester	0.53	0.25
Robeson Township	Berks	0.50	0.23
Elizabeth Township	Lancaster	0.46	0.21
Terre Hill Borough	Lancaster	0.46	0.21
Akron Borough	Lancaster	0.40	0.19
Total		214.80	100

The Conestoga River begins in the hills of Caernarvon Township, Berks County, and flows southwestward to the Susquehanna River. The first major tributary, Muddy Creek, meets the Conestoga River north of Hinkletown in Earl Township. Muddy Creek has two significant tributaries, Black Creek and Little Muddy Creek. Black Creek starts in the hills of Brecknock Township and flows parallel to the Conestoga River until it meets Muddy Creek above Terre Hill. Muddy Creek begins in the hills of Brecknock Township, Berks County, and runs parallel to Black Creek until it cuts South above Frysville. Before Muddy Creek cuts south, it is joined by Little Muddy Creek which drains Spring Township in Berks County.

The Conestoga River is next joined from the South by Groff Creek which flows West from Earl Township and New Holland Borough into the Conestoga River near Brownstown. The Cocalico Creek, a State Designated Watershed, joins the Conestoga River below Brownstown. West of that point, the river is joined by Lititz Run. Lititz Run flows through Lititz Borough below the confluence of Santo Domingo Creek and Hubers Run. As the Conestoga River flows toward the City of Lancaster it is joined by Landis Run, which drains part of Manheim Township, and Stauffer Run, which drains part of East Lampeter Township.

The Conestoga River continues to meander southwesterly along the southern side of Lancaster City. The South Sewage Treatment Plant at Engleside is a major discharge point. Mill Creek, a State Designated Watershed, joins the Conestoga River below Lancaster. Stehman Run, the next named tributary, runs West from New Danville into the river at Rockhill. A short distance downstream, Little Conestoga Creek, a State Designated Watershed, joins the river from the North. Witmer Run in Manor Township joins the Conestoga River just before it empties into the Susquehanna River near Safe Harbor Dam.

The named tributaries of the Conestoga River are:

Witmer Run
Little Conestoga Creek *
Stehman Run
Stauffer Run
Mill Creek *
Santo Domingo Creek
Hubers Run
Lititz Run
Cocalico Creek *
Groff Creek
Muddy Creek
Little Muddy Creek
Black Creek

*This tributary is a State Designated Watershed

B. Land Use

The available GIS landuse data for the watershed shows that existing land use is approximately 55% agricultural, 23% woodland / wetland / water, 14% residential development / village, 4% commercial / industrial, and 4% open space / brush / weeds / grass.

The upland area of the Conestoga River Watershed has a significant amount of woodland and is relatively undeveloped. Much of the woodland is part of the State Game Land System and will not be developed. The privately held woodland is currently under development pressure to provide dwellings in a forested locale.

The central portion of the watershed is a broad limestone plain with rich farmland. This area will remain largely agricultural but some development is expected here as well. The lower third of the watershed is characterized by the urban / industrial usage. Lancaster, Manheim and East Lampeter Townships, and Lancaster City are all heavily developed.

The lowest portions of the watershed in Pequea, Conestoga and Manor Townships are largely agricultural with potential for development.

C. Topography

The watershed topography ranges from the moderate hills ringing the eastern side of the watershed, to the farmland of the central region, to the hills and valleys of the southwestern part. The highest point in the watershed is on a hill near the State Game Lands No. 52 at 1044-feet. The lowest point is on the Susquehanna River at 170-feet. The Conestoga River flows for a distance of approximately 65.3 miles with an average slope of about 0.25%. The lower reaches are characterized by slopes of about 0.08%, with meandering of the streambed and numerous horseshoe bends.

D. Soils

The majority of the soils in the watershed are of the B and C hydrologic soil group. The watershed consists of 66% B soils, 33% C soils, and 1% D soils. There do not appear to be any A type soils in the watershed, although there may be small, isolated locations where A soils do exist in the watershed.

The Conestoga River Watershed consists of the following General Soil Units:

Manor-Chester-Glenelg

Nearly level to very steep, well drained soils on broad ridgetops and side slopes. These soils were formed in residuum from mica schist, quartzite and gneiss. The unit is about 32% Manor soils, 30% Chester soils, 23% Glenelg soils, and 15% soils of minor extent.

Duffield-Hagerstown

Nearly level to steep, well-drained soils in undulating, broad valleys. These soils were formed in residuum from limestone. The unit is about 42% Duffield soils, 40% Hagerstown soils, and 18% soils of minor extent.

Ungers-Bucks-Lansdale

Nearly level to very steep, well-drained soils on ridges, side slopes and foot slopes. These soils were formed in residuum from Triassic siltstone, conglomerate, shale and sandstone. The unit is about 34% Ungers soils, 19% Bucks soils, 13% Lansdale soils and 34% of minor extent.

Bedington

Nearly level to moderately steep, well-drained soils on dissected ridgetops and side slopes. These soils were formed in residuum from acid shale. The unit is about 75% Bedington soils and 25% soils of minor extent.

Letort-Pequea-Conestoga

Nearly level to very steep, well-drained soils on side slopes of ridges. These soils were formed in residuum from graphitic and micaceous limestone and schist. The unit is about 27% Letort soils, 17% Pequea soils, 17% Conestoga soils, and 39% soils of minor extent.

Clymer-Chester

Nearly level to very steep, well-drained soils on broad ridges. These soils were formed in residuum from sandstone, mica schist, and quartzite. The unit is about 64% Clymer soils, 23% Chester soils, and 13% soils of minor extent.

E. Geology

Approximately 60% of the Conestoga River Watershed is underlain by carbonate rock, namely limestone and dolomite. Sinkhole activity is common in these areas. Rapid infiltration of storm water runoff into the groundwater system at sinkholes and sinking streams can cause a significant reduction in streamflow and flood peaks at downstream locations. The most prevalent area of this activity is in the western part of the watershed. Sinkhole activity is also found in other areas of the watershed.

The four main areas *not* underlain by carbonate bedrock are located in the Lititz area, in the Berks and Northeastern Lancaster County, in the Welsh Mountain area, and a small area at the very bottom (South end) of the watershed. Everywhere else, in a broad band across the middle of the watershed, is limestone.

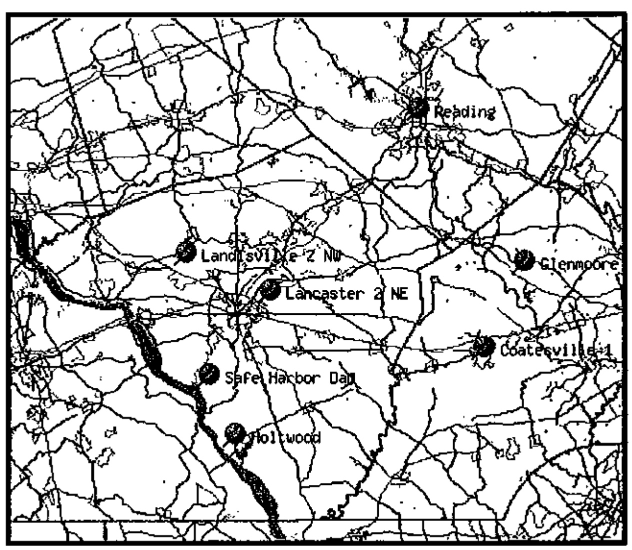
IV. WATERSHED TECHNICAL ANALYSIS - MODELING

An initial step in the preparation of this Storm Water Management Plan was the identification of the storm water runoff simulation model to be utilized. A model comparison yielded the decision that TR-20 would be utilized for the Conestoga River Act 167 plan.

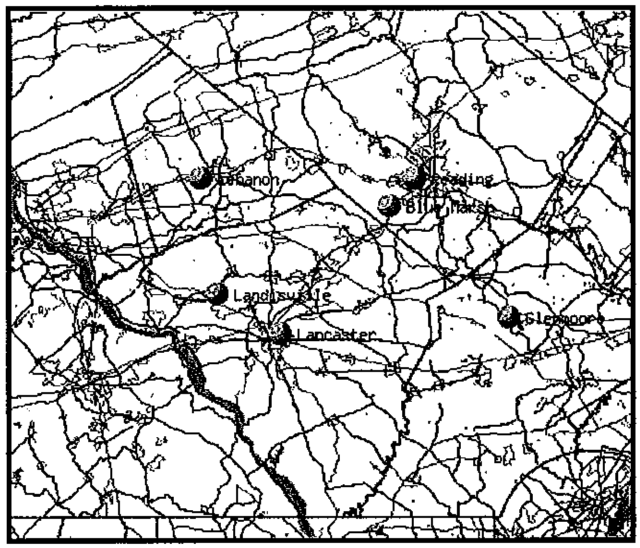
The County developed a "tool" (a computer program) which runs TR20 and allows the modification of the hydrological model for this watershed to be adjusted between existing and future development by subwatershed and to adjust the model beyond the existing zoning and look at a total build out scenario.

In order to model a watershed with confidence and reliability, the chosen computer model must be checked against actual field data or actual storm events. We used several sources to check the model, as follows;

- Tropical Storm Agnes, June 1972 - Using hourly rainfall from the National Climate Data Center (NCDC) for seven stations, including Lancaster, Holtwood, Safe Harbor, Reading, and Coatesville, we were able determine that Agnes crossed the watershed at about 8 mph moving from Southwest to Northeast. Running the watershed model with the actual rainfall obtained from NCDC for the Lancaster rain gauge produced a peak flow of 48,200 cfs. <u>This was within 4% of the 50,300 cfs which was calculated to have passed at the USGS stream guage at the Lancaster City water intake</u>. Antecedent Moisture Condition 1 (AMC 1) was assumed in carbonate areas due to the dry conditions 6 months prior to Agnes, and the normal conditions 1 month prior to Agnes. 24 hour rainfall was 6.54 inches, total rainfall was 8.4 inches (both at Lancaster). The NCDC 24 hour rainfall on June 22, 1972 was relatively uniform in the rain gauges surrounding the watershed. The rainfall varied among the stations by less than 0.5", with 6.8" at Reading, 6.54" at Lancaster, and 7.07 at Landisville.



- Hurricane Floyd, September 17, 1999 - Using hourly rainfall from the National Climate Data Center (NCDC) for six stations, including Blue Marsh Lake, Glenmoore, Lancaster, Landisville, Lebanon, and Reading, we were able determine that Floyd crossed the watershed at about 8 mph moving from Southwest to Northeast. Running the watershed model with the actual rainfall obtained from Millersville University produced a peak flow of 23,200 cfs. <u>This was within 32% of the 17,600 cfs which was measured at the USGS stream guage at the Lancaster City water intake</u>. AMC 1 was assumed in carbonate areas. 24 hour rainfall was 5.14 inches at Millersville. The rainfall was relatively non-uniform across the watershed according to the NCDC data (not used in the model). The NCDC 24 hour rainfall was 5.90" at Reading, 6.30" at Lancaster, and 4.60 at Lebanon. The 1.7 inch variance in rainfall in the rain guages surrounding the watershed may be responsible for the discrepancy between the model results and actual flows.



The Agnes and Floyd storms occurred in 1972 and 1999 respectively. Since then, Lancaster Emergency Management Agency has placed rain and stream gauges throughout Lancaster County. There have been several rainfalls of 3 or so inches - this is at the lower limit of our ability to model the runoff using TR20.

- Rain event of September 23, 2003 - Using continuous rainfall data from Lancaster Emergency Management Agency (LEMA) gauges in various locations throughout the County, we could determine no noticeable pattern of motion of the storm across the watershed, so none was used in the model. Running the watershed model with the actual rainfall obtained from the LEMA gauges produced a peak flow of 8,550 cfs. <u>This was within 18% of the 10,400 cfs which was measured at the USGS stream gauge at the Lancaster City water intake</u>. AMC 2 was assumed in all areas due to the normal soil moisture conditions 6 months prior to September 23, and the wet conditions 1 month prior to September 23 (rainfall was twice the normal amount). 24 hour rainfall was approximately 3 inches averaged among 4 LEMA rain gauges across the watershed.

In the future, we hope to collect enough data from the LEMA guages to continue to check the accuracy of the model.

Since our worst results were within 30% of actual flows, we feel confident that we have an acceptably accurate model of the Conestoga River watershed for the purposes of preparing an watershed study under Act 167.

There were no significant structures to include in the watershed computer model.

V. STANDARDS AND CRITERIA FOR THE CONTROL OF STORM WATER RUNOFF

1. <u>"Match Pre-existing Hydrograph"</u>
   Developers and/or landowners are encouraged to provide infiltration facilities or utilize other techniques so that the post-development hydrograph will match the pre-existing hydrograph for the site.

2. <u>Groundwater Recharge Standard</u>
   Recharging rainfall into the ground replenishes the groundwater that, in turn, provides baseflow to streams, a process that keeps streams flowing during the dryer summer months and maintains groundwater levels. Storm water management measures such as porous pavement with underground infiltration beds and infiltration/recharge structures or Best Management Practices (BMPs) can be designed to promote groundwater recharge.

3. <u>Water Quality Standard</u>
   Pollutants accumulate on impervious surfaces between rainfall events or during dry weather. Pollutant concentrations in runoff from developed land tends to be greatest at the beginning of the storm event, or the "first flush" of runoff. It has been found that eighty to ninety percent of rainfall events are 1.2" or less, storms that essentially simulate this "first flush". The majority of the nonpoint source pollutants, therefore, are being washed into streams during the smaller storms. Capturing this first flush and/or smaller storms will allow the storm water to be detained and will allow pollutants to settle, thus allowing a "cleaner" outflow.

4. <u>Description of Performance Standard Districts</u>
   If, after development, the existing hydrograph can not be matched using infiltration, a reduction in the post developed peak flow will be required because of the increased volume of runoff. It was found during the watershed study that a variable release rate scenario based on each subarea's position in the watershed, provided results which were not significantly different (within 5 percent) than the existing flows for each subarea. A map of the release rates is included as an insert in Volume II - Plan Contents.

5. <u>Sub-Regional (Combined Site) Storage</u>
   A municipality and/or two or more developers developing sites adjacent to each other could pool their resources to provide for a

community, or regional, storm water storage facility in the most hydrologically advantageous location.

6. "No Harm Option"
For any proposed development, the developer has the option of using a less restrictive runoff control if the developer can prove that "no harm" would be caused by discharging at a higher runoff rate than that specified by the Plan.

APPENDIX A PRESENT VERSUS FUTURE FLOWS 100 Year Storm of 24-hour Duration						
Subarea	Individual Area (s.m.)	Individual Flow (cfs)	Cumulative Area (s.m.)	Cumulative Existing Flow (cfs)	Cumul. Future Flow (100% rel. rate)	Cumul. Future Flow (variable rel. rate)
(MC1) * 1	0.83	820	0.83	820	**903	410
(MC2) * 2	1.23	1,216	2.06	1,578	**1,715	964
(MC3) * 3	1.58	641	3.64	1,349	**2,112	1,031
4	1.37	2,967	2.85	3,358	**5,459	1,472
5	1.63	2,452	1.63	2,452	**3,214	736
6	1.50	1,949	3.13	3,820	**5,563	1,325
(MC4) * 7	1.75	918	11.54	5,178	**8,500	3,612
(MC5) * 8	0.96	1,708	15.63	7,646	**12,544	4,999
(MC6) * 9	1.13	1,821	16.76	7,183	**11,817	5,049
(MC7) * 10	1.12	2,042	17.88	7,258	**11,893	5,141
(MC8) * 11	0.97	1,697	18.85	7,354	**11,985	5,217
12	0.94	1,015	0.94	1,015	**1,103	508
13	1.38	1,583	2.32	1,610	**1,981	912
14	1.48	1,574	1.48	1,574	**2,740	472
(MC9) * 15	1.28	882	20.13	7,308	**11,850	5,272
(MC10) * 16	1.29	2,406	21.42	7,217	**11,571	5,524
(MC11) * 17	0.98	1,531	22.4	7,296	**11,634	5,897
(MC12) * 18	0.98	1,714	23.38	7,365	**11,707	6,352
19	0.80	1,472	0.8	1,472	1,418	1,418
20	1.30	2,166	1.3	2,166	**2,403	1,083
21	0.92	557	3.02	3,958	**4,175	2,940
(MC14) * 22	1.63	2,280	35.56	11,279	**12,698	8,178
23	1.69	2,669	1.69	2,669	2,669	2,669
24	1.39	1,848	3.08	4,461	4,461	4,461
25	1.31	945	5.49	5,635	5,657	5,657
26	1.10	1,307	1.1	1,307	1,307	1,307
27	0.82	1,372	0.82	1,372	1,372	1,372
(MC25) * 28	1.46	1,095	124.95	27,773	**30,044	26,226
29	0.98	1,634	3.3	2,439	**2,811	2,049
(MC3) * 30	1.22	725	27.62	7,348	**11,275	6,242
(MC15) * 31	1.87	2,233	37.43	10,783	**12,149	8,088
32	1.40	1,866	1.4	1,866	1,866	1,866
33	1.39	641	1.39	641	**785	321
34	1.35	1,090	2.75	2,384	2,395	2,395
(MC16) * 35	1.42	829	42.99	10,472	**11,820	8,325
(MC17) * 36	1.21	1,013	44.2	10,503	**11,855	8,783

Subarea	Individual Area (s.m.)	Individual Flow (cfs)	Cumulative Area (s.m.)	Cumulative Existing Flow (cfs)	Cumul. Future Flow (100% rel. rate)	Cumul. Future Flow (variable rel. rate)
(MC18) * 37	1.00	914	45.2	10,547	**11,891	8,815
(MC19) * 38	0.98	828	46.18	10,373	**11,841	8,608
39	0.79	1,039	0.79	1,039	**1,377	520
40	1.25	1,402	2.04	1,744	**1,981	1,709
41	1.47	1,151	1.47	1,151	**1,228	576
42	1.26	782	2.73	1,343	**1,427	1,134
43	0.95	941	0.95	941	959	959
(MC20) * 44	1.43	834	50.6	10,055	**11,898	8,544
45	0.87	1,474	0.87	1,474	1,474	1,474
(MC21) * 46	1.48	1,128	55.68	9,758	**11,958	8,544
47	1.53	1,346	1.53	1,346	1,359	1,359
48	0.98	871	3.48	2,445	2,462	2,462
49	1.14	949	1.14	949	976	976
50	0.81	1,497	0.81	1,497	1,508	1,508
51	1.01	1,761	3.1	3,716	**3,908	2,161
52	1.28	2,157	2.09	2,660	2,764	1,692
53	1.29	2,491	4.39	3,737	**4,016	2,733
54	1.27	1,804	5.66	3,837	**4,356	3,360
55	0.88	1,462	0.88	1,462	**1,819	439
56	0.94	1,396	1.82	1,570	1,648	871
57	1.38	2,112	8.86	5,474	**6,045	4,591
58	2.02	3,047	10.88	6,740	**7,465	6,005
59	1.06	1,839	11.94	7,421	**8,247	6,745
60	1.08	1,555	1.08	1,555	**2,065	467
61	1.13	1,640	13.07	7,023	**7,736	6,740
62	1.04	1,516	15.19	7,540	**8,412	7,095
63	1.11	1,664	16.3	7,368	**8,232	6,897
64	0.95	1,554	0.95	1,554	**2,136	466
65	1.04	1,429	1.99	2,050	2,070	1,224
66	1.00	1,049	1	1,049	**1,330	525
67	0.66	898	3.65	2,819	**3,340	1,906
68	0.83	1,545	0.83	1,545	**1,971	464
69	1.71	2,813	6.19	3,484	**4,486	2,923
70	0.94	1,348	7.13	3,331	**4,095	2,967
71	1.50	1,770	14.69	10,281	**11,961	6,649
72	1.16	1,313	1.16	1,313	**1,585	657
73	0.83	1,364	0.83	1,364	1,430	682
74	1.65	2,722	3.64	5,353	**5,955	2,779
75	0.97	1,594	0.97	1,594	1,611	1,611
76	1.45	2,617	6.06	7,266	**8,160	4,292
77	1.03	1,312	15.72	9,673	**11,302	6,715

Subarea	Individual Area (s.m.)	Individual Flow (cfs)	Cumulative Area (s.m.)	Cumulative Existing Flow (cfs)	Cumul. Future Flow (100% rel. rate)	Cumul. Future Flow (variable rel. rate)
78	0.69	1,138	16.41	9,085	**10,665	6,651
79	1.55	1,929	1.55	1,929	1,965	965
80	1.48	1,698	3.03	1,999	2,073	1,811
81	1.70	1,793	1.7	1,793	1,807	1,807
82	1.78	2,199	3.48	3,394	3,420	3,420
83	0.83	1,484	9.12	5,868	5,974	5,854
84	1.37	2,374	10.49	5,841	5,951	5,806
85	0.72	1,474	0.72	1,474	1,543	737
86	0.76	1,135	11.97	6,077	6,194	6,092
87	0.92	1,318	0.92	1,318	1,371	659
88	1.23	2,366	1.23	2,366	2,412	2,412
89	1.09	1,274	2.32	3,069	3,190	2,489
90	1.39	1,914	32.09	14,639	**16,156	12,554
91	1.23	2,111	1.23	2,111	**2,248	1,056
92	1.89	1,978	51.51	21,219	**23,483	18,777
93	1.87	1,076	53.38	19,737	**21,807	18,031
94	1.39	2,719	1.39	2,719	2,801	2,801
95	0.94	2,057	0.94	2,057	2,154	1,029
96	1.28	2,582	1.28	2,582	**3,172	1,291
(MC22) * 97	1.38	1,658	119.77	28,184	**30,460	26,435
(MC23) * 98	1.17	1,052	120.94	28,201	**30,479	26,464
99	1.49	2,716	1.49	2,716	**2,882	1,358
(MC24) * 100	1.06	719	122	27,920	**30,193	26,281
101	1.41	1,343	1.41	1,343	**1,566	672
(MC26) * 102	1.13	658	126.08	27,253	**29,514	25,860
(MC27) * 103	1.40	893	142.07	27,469	**29,701	26,206
104	1.17	864	1.17	864	864	864
105	1.41	854	1.41	854	883	883
106	1.49	1,254	5.02	2,784	2,868	2,626
107	1.31	1,059	6.33	2,336	2,440	2,239
108	1.55	883	1.55	883	**986	442
109	1.56	911	3.11	1,202	**1,294	1,169
110	1.68	1,085	1.68	1,085	**1,172	814
111	0.85	461	2.53	1,359	**1,442	1,123
112	1.21	776	10.65	3,261	**3,462	3,007
113	1.05	1,696	1.05	1,696	1,735	1,735
114	1.28	1,987	1.28	1,987	1,981	1,981
115	1.42	1,924	3.62	4,828	4,998	3,325
116	1.49	907	2.43	1,349	1,404	971
117	0.93	985	4.44	2,233	2,308	1,864
118	0.94	1,235	5.38	3,073	3,155	2,972

Subarea	Individual Area (s.m.)	Individual Flow (cfs)	Cumulative Area (s.m.)	Cumulative Existing Flow (cfs)	Cumul. Future Flow (100% rel. rate)	Cumul. Future Flow (variable rel. rate)
119	0.91	1,167	0.91	1,167	**1,276	584
120	1.34	898	13.25	9,267	**9,731	7,306
121	1.71	2,200	14.96	8,492	**8,950	6,948
122	1.36	1,738	1.36	1,738	**1,936	869
Cocalico Creek drains into Subarea 123, Area = 140.19 square miles						
(MC28) * 123	0.77	468	284.08	50,394	**53,454	50,067
124	1.08	810	17.4	8,604	**9,121	7,915
125	1.60	2,028	1.6	2,028	**2,603	1,014
126	0.92	597	0.92	597	615	615
127	1.70	955	4.22	3,026	**3,651	1,937
(MC29) * 128	1.19	939	306.89	51,674	**54,720	51,296
129	0.95	806	2.12	1,304	1,304	1,304
(MC30) * 130	1.28	1,137	308.17	51,508	**54,550	51,180
131	0.78	789	2.14	1,572	**1,718	1,475
132	1.00	1,032	1	1,032	1,022	1,022
(MC31) * 133	1.31	1,211	312.62	51,091	**54,157	50,899
134	1.35	967	2.33	1,157	**2,260	817
135	1.44	1,331	3.77	2,168	**3,331	1,495
136	1.02	1,278	1.02	1,278	**1,742	639
137	0.95	1,093	1.97	1,886	**2,477	1,199
138	1.52	1,097	1.52	1,097	**1,153	823
139	1.34	1,072	2.86	1,870	**2,139	1,618
140	1.07	655	1.07	655	**801	491
141	1.33	1,305	5.26	2,838	**3,330	2,948
(MC32) * 142	1.01	753	317.4	50,919	**54,028	50,826
143	1.02	1,532	1.02	1,532	**1,659	766
144	0.94	1,063	1.96	2,149	**2,316	1,699
(MC33) * 145	1.24	1,183	327.83	51,094	**54,237	51,073
(MC34) * 146	1.54	1,381	329.37	51,136	**54,287	51,125
(MC35) * 147	1.14	471	330.51	50,863	**54,040	50,925
(MC36) * 148	1.46	574	331.97	49,835	**53,042	50,112
149	0.70	1,502	0.7	1,502	1,502	1,502
150	0.87	1,665	1.57	3,167	3,198	3,198
151	0.74	754	0.74	754	**898	769
(MC37) * 152	0.82	464	335.1	49,564	**52,797	49,924
153	1.13	730	1.13	730	**812	731
Mill Creek drains into Subarea 154, Area = 57.40 square miles						
(MC38) * 154	1.21	675	394.84	51,887	**55,165	52,201
(MC39) * 155	1.07	664	395.91	51,656	**54,916	51,982
156	0.74	344	0.74	344	**523	344
(MC40) * 157	1.29	548	397.94	51,445	**54,699	51,791

Subarea	Individual Area (s.m.)	Individual Flow (cfs)	Cumulative Area (s.m.)	Cumulative Existing Flow (cfs)	Cumul. Future Flow (100% rel. rate)	Cumul. Future Flow (variable rel. rate)
(MC41) * 158	1.04	556	398.98	51,379	**54,641	51,737
(MC42) * 159	1.62	855	400.6	51,069	**54,343	51,476
(MC43) * 160	1.22	560	401.82	50,402	**53,688	50,903
161	1.67	680	1.67	680	703	703
162	0.82	424	0.82	424	424	424
163	1.41	618	1.41	618	641	641
164	1.10	469	3.59	1,001	1,015	1,015
165	1.10	914	5.72	3,250	3,295	6,295
166	1.00	525	1	525	**718	529
167	1.36	1,229	1.36	1,229	**1,316	922
Little Conestoga Creek drains into Subarea 168, Area = 66.17 square miles						
(MC44) * 168	1.48	535	475.47	52,282	**55,360	52,403
169	0.70	1,219	0.7	1,219	1,241	1,241
170	1.40	501	2.1	1,407	1,471	1,471
171	0.66	945	0.66	945	**1,055	938
172	0.98	1,382	0.98	1,382	**1,697	1,401
(MC45) * 173	1.14	1,282	480.35	52,237	**55,316	52,364
183	0.94	800	0.94	800	800	800
184	0.98	584	0.98	584	**1,330	292
185	1.01	786	4.63	5,244	5,462	3,710
186	1.08	766	1.08	766	775	775
187	0.99	1,001	11.91	9,443	9,876	7,217
188	0.97	1,036	0.97	1,036	1,036	1,036

Note: These flows were developed for storm water planning purposes and are not considered regulatory under PaDEP, Chapter 105 for permitting of structures.

* MC denotes those Subareas on the Main Channel of the Conestoga River. The accompanying number signifies the position on the Main Channel that the Subarea occupies, with 1 being at the top of the watershed, and 45 being at the bottom.

** Future flow more than 5% in excess of present flow.

APPENDIX B

MUNICIPALITY QUESTIONNAIRE RESULTS

Specific Problems

BRECKNOCK TWP., LANCASTER COUNTY

Critical stream and street flooding, soil washoff, and storm water pollution problems in every storm. Caused by too large an increase in uncontrolled runoff, drainage system being too small and must be corrected, obstructions in the system that need to be removed, and lack of maintenance of drainage ways. Results in possible loss of life due to flooded roads, some areas of the Township being completely cut off from access to any road. Damage to property is usually minor.

Farming practices and development has upset the normal flows of water runoff to the point where storm water problems are everywhere in the Township.

1. Areas of major stream flooding (crops and properties under water).
2. Areas of flooded roads which require "High Water" and "Road Closed" signs in every storm.
3. Areas of soil washoff and stream pollution mostly as a result of farming practices.

CAERNARVON TWP., BERKS COUNTY

Critical stream flooding with resultant street flooding in certain areas. Damage to private and public property (yards, and streets) consisting of erosion and sedimentation.

A. Mill Road South of Valley Road, street flooding at least twice a year. Caused by drainage system that is too small and needs to be replaced.
B. Willow Glen Road – flooding at least twice a year. Caused by drainage system that is too small and needs to be replaced. Caused by runoff from farm fields and airport runway.

CONESTOGA TWP., LANCASTER COUNTY

Critical street flooding. Damage to private and public property (homes, yards, and streets) in every storm. Caused by drainage system being too small, obstructions in system that need to be removed, and lack of maintenance of drainage ways.

4. Orchard Hills Development (Supervisors have approved work to correct problem).
5. Kendig Road at Elm Street, low spot in the road floods.

EARL TWP., LANCASTER COUNTY

6. Cabin Road near Township line – flooding more than once a year due to overflowing stream banks.
7. Rt. 322, West of Martindale Road – flooding more than once a year due to overflowing stream banks.

EAST EARL TWP., LANCASTER COUNTY

Critical stream and street flooding, soil washoff, and storm water pollution problems in major flood events. Caused by too large an increase in uncontrolled runoff.

8. Areas of roadway flooding.
9. Roadway flooding on Pa. Route 897 caused by runoff from Welsh Mountain and farm fields.

EAST LAMPETER TWP., LANCASTER COUNTY

Critical stream and street flooding, and storm water pollution problems more than one time per year. Caused by too large an increase in uncontrolled runoff, runoff from upstream municipalities, and drainage system(s) too small that needs to be corrected. Results in damage to commercial and residential property.

10. Millcross Road.
11. Eastwood Village.
12. Pitney Road.
13. Greenfield Road at railroad underpass.

EPHRATA TWP., LANCASTER COUNTY

Moderate stream and street flooding and soil washoff problems. Minor storm water pollution problems. Problems result in road closings.

14. Fryeville Road / Newswanger Road Intersection – flooding from small stream more than once per year. Caused by drainage system that is too small and needs to be replaced.
15. Fryeville Road / Fry's Road, flooding from two small streams & Muddy Crk. in major flood events.

LANCASTER CITY, LANCASTER COUNTY

Minor street flooding and storm water pollution problems. Minor combined sewer overflow problems. Caused by drainage system being too small and needing to be replaced. Results in road closings / disruption of transportation system more than once per year.

16. North Plum Street at railroad underpass.
17. Wabank Road 70' West of Hershey Avenue.
18. New Holland Avenue at railroad overpass (East of Rose Street).
19. Chesapeake and Broad Streets.

LITITZ BORO., LANCASTER COUNTY

Potential problems with stream and street flooding in heavy storms more than once per year. Caused by Caused by uncontrolled runoff from upstream municipalities. Results in property damage to public park and business.

20. Lititz Springs Park.
21. Lititz Run during heavy storms.

MILLERSVILLE BORO., LANCASTER COUNTY

Moderate stream and street flooding and soil washoff problems caused by drainage system being to small and corrections need to be made.

22. Oak Ridge Drive – street flooding more than once per year.
23. Barbara Street at East College Avenue – street flooding and soil washoff more than once per year.
24. Creek Drive – stream flooding in major events.

UPPER LEACOCK TWP., LANCASTER COUNTY

Critical stream and street flooding, soil washoff, and storm water pollution problems more than one time per year. Caused by too large an increase in uncontrolled runoff and overwhelmed or clogged inlet grates. Results in road closures.

25. Snake Hill Road at Conestoga River (stream/street flooding).
26. Mondale Road at Conestoga River (stream/street flooding).
27. Creek Hill and Hartman Station Roads (soil washoff).

WARWICK TWP., LANCASTER COUNTY

Some stream flooding more than one time per year, caused by drainage system being too small and corrections need to be made. Results in road closures.

28. Lititz Run Road culvert – flooding across cartway.
29. Millport Road Bridge – flooding across cartway.

WEST EARL TWP., LANCASTER COUNTY

Critical stream and street flooding, and soil washoff problems more than one time per year. Results in loss of life, loss of vital services, private and public (to parkland) property damage.

30. Cabin road.
31. North Farmersville Road.
32. Turtle Road (100 Block).
33. South State Street, Talmage (Conestoga River).
34. South State Street, Talmage (Groff Creek).
35. South Fairmount and Sawmill Roads.
36. South Farmersville Road.
37. Sheaffer's School Road.

WEST EARL TWP., LANCASTER COUNTY

Critical stream and street flooding, and soil washoff problems.

38. West side of Lampeter Road between Wiker and Plymouth Avenue – major flooding more than once per year.

No Response

AKRON BORO., LANCASTER COUNTY
EAST COCALICO TWP., LANCASTER COUNTY
ELVERSON BORO., CHESTER COUNTY
LANCASTER TWP., LANCASTER COUNTY
MANHEIM TWP., LANCASTER COUNTY
MANOR TWP., LANCASTER COUNTY
SPRING TWP., LANCASTER COUNTY

No Problem Areas in the Conestoga River watershed

ADAMSTOWN BORO., LANCASTER COUNTY
ELIZABETH TWP., LANCASTER COUNTY
NEW MORGAN BORO., BERKS COUNTY
PENN TWP., LANCASTER COUNTY
PEQUEA TWP., LANCASTER COUNTY
ROBESON TWP., BERKS COUNTY
TERRE HILL BORO., LANCASTER COUNTY
WEST NANTMEAL TWP., CHESTER COUNTY

General Problems

BRECKNOCK TWP., BERKS COUNTY

Critical street flooding, soil washoff and stormwater pollution problems. Critical problems with aquifer recharge (i.e. not enough infiltration is being done) and potential groundwater pollution.

CAERNARVON TWP., LANCASTER COUNTY

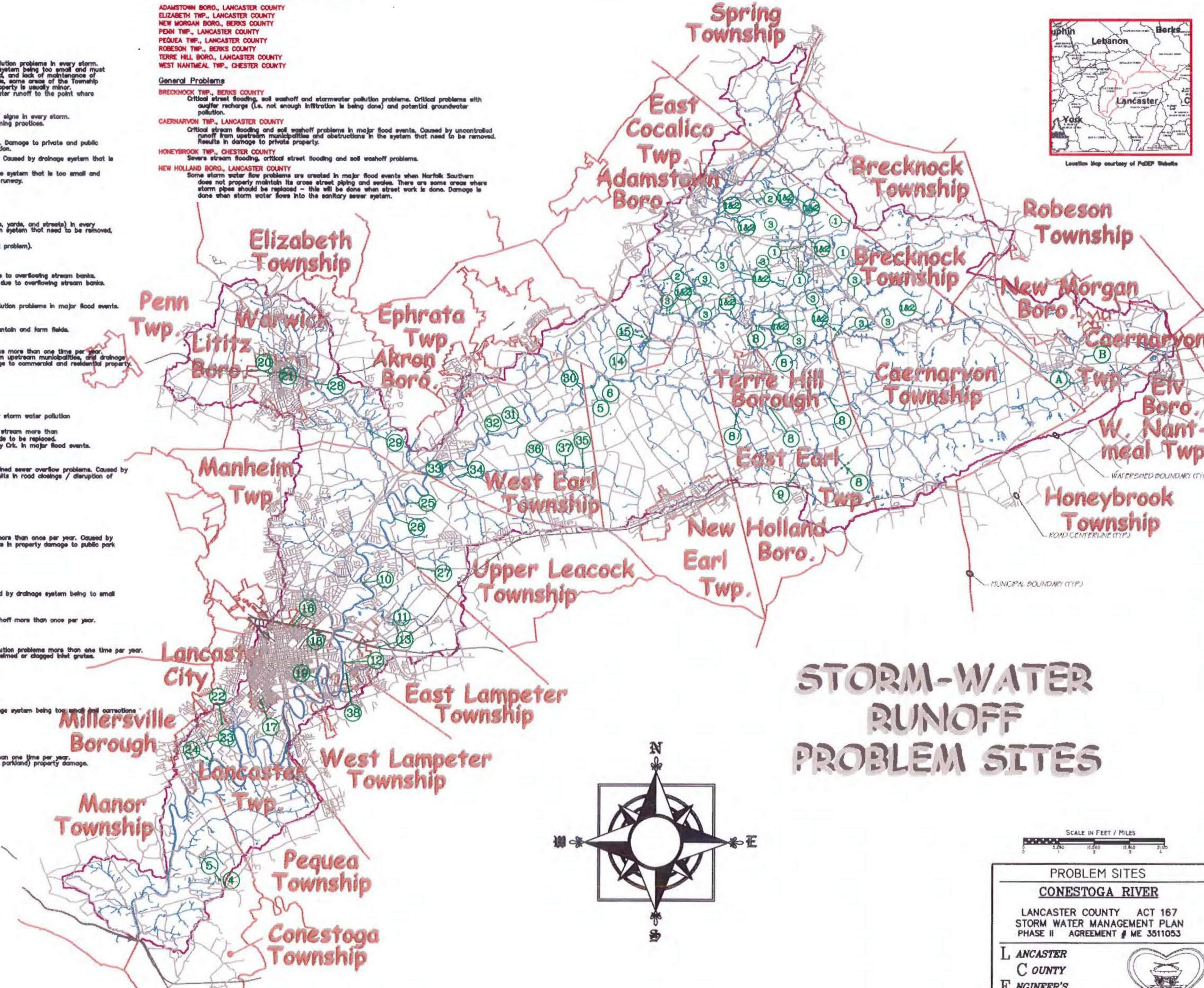
Critical stream flooding and soil washoff problems in major flood events. Caused by uncontrolled runoff from upstream municipalities and obstructions in the system that need to be removed. Results in damage to private property.

HONEYBROOK TWP., CHESTER COUNTY

Severe stream flooding, critical street flooding and soil washoff problems.

NEW HOLLAND BORO., LANCASTER COUNTY

Some storm water flow problems are created in major flood events when Norfolk Southern does not properly maintain its cross street piping and swales. There are some areas where storm pipes should be replaced – this will be done when street work is done. Damage is done when storm water flows into the sanitary sewer system.



STORM-WATER RUNOFF PROBLEM SITES

SCALE IN FEET / MILES

PROBLEM SITES

CONESTOGA RIVER

LANCASTER COUNTY ACT 167
STORM WATER MANAGEMENT PLAN
PHASE II AGREEMENT # ME 3511053

L ANCASTER
C OUNTY
E NGINEER'S
O FFICE

DATE	SCALE	DRAWN BY
JAN. 7, 2004	1" = 3 miles	ACW.