FINAL EXHIBIT LIST PAGE NUMBERS NOT YET DETERMINED**

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1 DEC DESIGN STANDARDS FOR WASTEWATER TREATMENT WORKS 1988 32

2 DEIS APPENDIX 8 - TABLE 1 - BIG INDIAN

3 DEIS EXHIBIT 8 TABLE 1 - WILDACRES 8

4 SPEDES PERMIT - PLATEAU SEWAGE WORKS CORPORATION

5 "RESORT MATRIX BELLEAYRE RESORT COMPARISON PROPERTIES SEPTEMBER 2003"

6 MEMORANDUM DATED 5-20-04 FROM CRAIG SEYMOUR

7 "SCOPING DOCUMENT FOR PROPOSED RESORT

8 "NYS 2004 SECTION 303(D) LIST JANUARY 28, 2004 12

9 HYDROCAD FLOW CHART

9A HYDROCAD STORMWATER QUANTITY MODEL 24

9B WINSLAMM WATER QUALITY MODEL 24

9C WINSLAMM SOURCE LOADING AND MANAGEMENT MODEL 24

FINAL EXHIBIT LIST PAGE NUMBERS NOT YET ~~DETERMINED**~~

10	WRITING ON THE BACK OF FULL SIZE 9A BY JOSEPH J. DAMRATH	28
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12	8 1/2 BY 11 COLOR PHOTOGRAPH "CROSSROADS VENTURES, WATERCOURSE MAPPING ON WILDACRES SITE, TOWN OF SHANDAKEN, ULSTER COUNTY AND TOWN OF MIDDLETOWN, DELAWARE COUNTY	49
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28	LIST OF PESTICIDES PERMITTED FOR USE ON PP8-11 OF THE WILDACRES DRAFT SPDES PERMIT & PG 18 OF THE BIG INDIAN SPDES PERMIT FOR WHICH CERTIFIED ANALYTICAL METHODS DO NOT CURRENTLY EXIST	
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NYC Ex 5

Resort Matrix
Bellayre Resort Comparison Properties
September, 2003

Name	Location	Opened	Major Renovation	Nearest Metro Area	Distance (In Miles)	Population 50 Miles	Population 100 Miles	Primary Home	Owned Not Rented	Owned Rented	Hotel Roms	Time Shares 1/4	Time Shares 1/6	Time Shares Week	Golf Holes	Skiing Area
Belleayre Resort	Catskill Park, NY	2010		New York City	140	778,435	13,482,993	21			400	330			36	Yes
Northstar Village	Lake Tahoe, CA	1972	2003	San Francisco	200	613,234	2,978,285	150	950	380	0	0	0	20	18	Yes
Old Greenwood	Lake Tahoe, CA	2003		San Francisco	200	613,234	2,978,285	99	0	0	0	0	0	0	18 (36)	Yes
Mountain Creek Village	Vernon, NJ	2003		New York City	60	14,566,311	28,674,329	0	0	306	0	0	0	0	0 (216)	Yes
Snowshoe Mountain	Snowshoe, WV		1998	Charleston	80	202,245	2,320,720	0	0	360	0	0	0	0	18	Yes
Keystone	Keystone, CO	1970	1994	Denver	73	602,812	3,806,604	40	250	1,000	255	16	0	0	36	Yes
Steamboat Grand (ASC)	Steamboat Springs, CO	2000		Denver	160	39,337	933,258	0	0	0	0	0	0	327	0 (18)	Yes
Westin Resort and Spa	Whistler, BC	2000		Vancouver	75	35,565*	1,986,965*	0	0	419	0	0	0	0	54	Yes
Roaring Fork Club	Basalt, CO	1999	2000	Aspen	15	120,565	501,204	0	50	0	0	18	12	0	18	No
Blue Mountain Village	Collingwood, ON	1970	2003	Toronto	150	377,050*	11,895,000*	0	50	600	93	0	0	0	18 (18)	Yes
Fairmont Chateau Whistler	Whistler, BC	1989	1997	Vancouver	75	35,565*	1,986,965*	0	0	0	550	0	0	0	18	Yes
Sheraton Steamboat	Steamboat Springs, CO	1964	1998	Denver	160	39,337	933,258	0	0	45	222	0	0	0	18	Yes
Deerhurst Resort	Huntsville, ON	1895	2000	Toronto	170	377,050*	11,895,000*	0	0	0	370	0	0	20	36	Yes
Mount Shasta Resort	Mount Shasta, CA	1993		Sacramento	220	90,635	669,186	0	0	0	65	0	0	0	18	Yes
Grand Traverse Resort & Spa	Acme, MI	1980		Grand Rapids	142	312,632	908,253	212	0	228	426	0	0	0	54	Yes
Boyne Highlands	Harbor Springs, MI	1962	2002	Grand Rapids	190	178,274	579,978	15	30	130	175	3	7	0	72	Yes
Killington Resort Villages	Killington, VT	1950s		Boston	150	498,013	3,841,384	0	200	350	0	200	0	0	18	Yes
Mount Snow	West Dover, VT	1949		Boston	100	1,147,018	8,730,441	0	0	75	92	200	0	0	18	Yes
Mirror Lake Inn	Lake Placid, NY	1926	1988	Albany	141	347,409	1,420,310	0	0	0	128	0	0	0	0 (72)	Yes
Turnberry Isle Resort and Club	Avenura, FL	1972		Miami	18	4,757,742	5,662,345	0	0	0	395	0	0	0	36	No
Sun Valley Resort	Ketchum, ID	1936		Boise	152	25,590	478,997	0	0	0	510	0	0	0	18	Yes
Destination Kohler	Kohler, WI	1981		Milwaukee	56	1,434,697	4,634,637	288	0	111	357	0	0	0	72	No

Name	Location	Conference Facilities Rooms	Conference Facilities SF	Health Spa/ Recreation	Dining Facilities	Contact	Phone Number	Notes
Belleayre Resort	Catskill Park, NY		Yes	Yes	11			
Northstar Village	Lake Tahoe, CA	12	19,700	Yes	4	Terry Viehmann	800-466-6784	Plans to expand to 3,000 housing units and a hotel by 2015 ; East West Partners building new village
Old Greenwood	Lake Tahoe, CA	0	0	Yes	1			Access to all of Lake Tahoe Resort Properties (Northstar)
Mountain Creek Village	Vernon, NJ	3	5,000	Yes	2	Intrawest		Townhousees open this year. Condons in 2004
Snowshoe Mountain	Snowshoe, WV	7	14,000	Yes	4	Intrawest		Plans to extend to 1,200 units over next 15 years, plans to expand skiing, plans to move into region
Keystone	Keystone, CO	53	100,000	Yes	30	Phyllis Hughes	970-496-4123	
Steamboat Grand (ASC)	Steamboat Springs, CO	6	18,500	Yes	3		970-871-5500	An RCI property
Westin Resort and Spa	Whistler, BC	17	18,000	Yes	2	Monica Hayes	604-935-4309	8,100 SF ballroom
Roaring Fork Club	Basalt, CO	2	1,500	Yes	1	Leslie	970-927-6046	30 lodge units are 1/4 and 1/6 time-share, 1/6 share for the suites (12)
Blue Mountain Village	Collingwood, ON	23	33,000	Yes	6	Chris	705-445-0231	x6220 ; All together 800 housing units, golf course and 4-Star hotel by 2010
Fairmont Chateau Whistler	Whistler, BC	10	25,000	Yes	2		604-938-8000	12,000 SF ballroom
Sheraton Steamboat	Steamboat Springs, CO	12	19,800	Yes	2	Christine	970-879-7980	10,000 outdoor meeting space for summer
Deerhurst Resort	Huntsville, ON	32	30,000	Yes	3	Brenda MacPhee	705-789-7113	x4210
Mount Shasta Resort	Mount Shasta, CA	2	4,000	Yes	2		800-958-3363	
Grand Traverse Resort & Spa	Acme, MI	34	49,000	Yes	3	Mike DiAugustino	231-938-3781	Nicklaus Course opened in late 1985; Player course opened in 1999; 20,000 largest ballroom
Boyne Highlands	Harbor Springs, MI	19	30,700	Yes	3	Steve Matthews	231-439-4034	
Killington Resort Villages	Killington, VT	17	41,800	Yes	1	Kim Jackson	802-422-6237	
Mount Snow	West Dover, VT	4	14,550	Yes	4		802-464-3333	
Mirror Lake Inn	Lake Placid, NY	4	5,700	Yes	2		518-523-2544	
Turnberry Isle Resort and Club	Avenura, FL	22	48,500	Yes	5	Carmen Ackermar	305-933-6500	117-slip marina
Sun Valley Resort	Ketchum, ID	17	26,000	Yes	19	Jack Sibbach	208-622-2183	
Destination Kohler	Kohler, WI	22	35,000	Yes	10	Kay Miller	920-457-8000	111 condos in 3 dev.; 288 houses in 8 dev; no more than 20,000 people

6

Cty Exh # 6

MEMORANDUM

To: Kate Demong, Kurt Reike, Hilary Meltzer
NYCDEP

From: Craig Seymour & Jeff Donohoe

Date: May 20, 2004

Subject: Review and Comments on Appendix 27 of Crossroads DEIS

Per your request we have analyzed the information provided in Appendix 27 of the Crossroads DEIS entitled Economic Evaluation, Belleayre Resort at Catskill Park, prepared by HVS Consulting Services, Inc. and dated September 11, 2002, in order to calculate the *total* Internal Rate of Return (IRR) for the development as a whole. As you may recall, HVS treated the hotels/golf courses and the detached housing units (timeshares) as separate entities for their calculation of the IRR. They concluded that both hotels and golf courses were required in order to generate a sufficient return on investment (approximately 14.7%) to make the project feasible. Anything less resulted in an uncompetitive return, based on a comparison to published standards from industry surveys of luxury hotel portfolios.

The individual resorts (Big Indian or Wildacres) by themselves generated IRR's of 8.4% and 10.7% respectively. On the other hand, the detached housing (timeshare units at Big Indian and the interval ownership units at Wildacres) generated substantial IRR's of 41.6% and 33.5% respectively. HVS stated that "it is our understanding that IRR's for timeshare investments are generally perceived as attractive once they exceed 25%.". They also indicated that the detached housing units would not be feasible without the associated golf resorts. They then concluded "the proposed resort represents and attractive investment opportunity only when considered collectively, in its entirety."

Assuming that the methodology and source data utilized by HVS in their analysis is correct, then the resulting cash flows from the various project components can be combined to generate an estimated IRR for the project as a whole. RKG performed these calculations, using the same methodology used by HVS to derive the IRR for each alternative. The results of three combined alternatives are shown below:

Combined Alternatives	IRR
Full build-out of both resorts (hotels and golf) plus both detached housing complexes (Big Indian & Wildwood) – **DEIS scenario**	23.2%
Big Indian only – Resort plus timeshare units	22.2%
Wildacres only – Resort plus interval ownership units	19.0%

These IRR's are well above the minimum threshold HVS indicated was required for luxury hotels but somewhat less than their stated minimum for timeshare units alone. Because of the inherent risk associated with resort development, relatively high investment returns are likely to be required by investors in the project.

It is important to note that the Internal Rate of Return (also referred to as the discount rate) is the calculated percentage return on the cash flows from a project *before financing*. For comparison purposes, IRR's for various real estate investments held by major institutional investors during the fourth quarter of 2003 are as follows:

Investment Type	IRR range	IRR Average
Regional Malls	8.5% - 12%	10.46%
Central Business District Office Buildings	9% - 12.25%	10.60%
Warehouses	8.5% - 11%	9.88%
Apartments	9% - 12.5%	10.22%
Source: The Appraisal Institute, Chicago, IL; *Valuation Magazine*, First Quarter 2004, p.27.		

Thus, the returns reported in the DEIS for the entire project are approximately twice that for typical investment-grade real estate.

Typically, development projects of this type are financed using a variety of loans from private commercial banks. Since interest rates are relatively fixed (or vary slightly over the term of the loan), the return on the developer's equity after debt service can be significantly greater. For example, if 75% of a project's cost is financed by a bank at 8%, and the project's IRR is 20%, then the return on the developer's equity (25% of the cost) is approximately 56%.

7

City Exh #7

Section 5.0 ALTERNATIVES

- SEQRA requires consideration of alternatives to the proposed actions. The DEIS shall discuss the alternatives presented below. Alternatives shall be prepared in sufficient detail so that impacts can be compared to those of the proposed action. An alternative shall consider a reduced project scale and its effect on the viability of the project. A detailed explanation shall be provided of why a particular alternative may not be feasible.

5.1 Alternative Locations

- The DEIS shall discuss alternative locations that were examined for the project.

5.2 Alternative Use of the Site

- The DEIS shall address potential alternative uses that could occur on the site and how they relate to current local land use regulations.

5.3 Alternative Layouts

- Design alternatives considered shall include a discussion of a different mix of resort components and various layouts of the selected components including golf facilities.
- The DEIS shall discuss alternative layouts that consists of one golf course and one hotel complex. This discussion shall examine such an alternative in both the "east" and "west" areas of the project and separation of these two project elements by "east" versus "west" locations.
- The DEIS shall discuss land development limitations such as zoning and steep slopes, etc. that affect resort component layout, design and reorganization.

5.4 Alternative Water Supply

- This DEIS section shall identify different technologies considered for water supply, including the potential to connect to municipal services.

5.5 Alternative Wastewater Disposal

- This DEIS section shall identify different technologies considered for sewage disposal including the potential to connect to municipal services.
- Alternative technologies and designs to reduce wastewater loadings of various pollutants to receiving waters shall be examined and the level of these reductions quantified.

5.6 Alternative Site Access

- Alternative access locations on existing roads as well as internal site access shall be addressed in this section of the DEIS.

5.7 Alternative Golf Course Management Practices

- The DEIS shall assess alternative golf course management practices that could eliminate or reduce the need for pesticide and fertilizer use.

Alternative Stormwater Management Practices

- The DEIS shall assess innovative methods of design for the project as a whole to reduce stormwater runoff from the sponsor's development plan. Emphasis shall be on the reduction of impervious surfaces and examine changes that would be needed to achieve substantial reductions. The potential benefits to surface water quality shall be determined for a range of reductions that shall be analyzed for comparison to the sponsor's development plan.

9 No-Action Alternative

- The no action alternative shall describe impacts of leaving the lands in their present state.

8

MY City Ex 8

Part 1 - Individual Waterbody Segments with Impairments Requiring TMDL Development (con't)

Water Index Number	Waterbody Name (WI/PWL ID)	County	Type	Class	Cause/Pollutant	Source	Year
	Mohawk River Drainage Basin (con't)						
H-240 (portion 12b)	**Utica Harbor (1201-0228)**	Oneida	Bay	C	**Floatables**	CSOs, Urban, Ind/Munic	2004
					Pathogens	CSOs, Urban, Ind/Munic	2004
					D.O./Oxygen Demand	CSOs, Urban, Ind/Munic	2004
H-240- 11-P496/P498	Ann Lee (Shakers) Pond, Stump Pond (1201-0096) [3, 4]	Albany	Lake	C	Phosphorus	Urban Runoff	1998
H-240- 22-P519	**Collins Lake (1201-0077)**	Schenectady	Lake	B	**Phosphorus**	Urban Runoff	2004
H-240- 82- 63	**Cobleskill Creek, Lower, and tribs (1202-0019)**	Schoharie	River	C	**Pathogens**	On-Site WTS	2004
H-240- 82- 63-19-9-P589	**Engleville Pond (1202-0009)**	Schoharie	Lake	A	**Phosphorus**	Agriculture	2004
H-240- 82-104-P629	**Summit Lake (1202-0014)**	Schoharie	Lake	B	**Phosphorus**	On-Site WTS	2004
H-240- 82-P638a	Schoharie Reservoir (1202-0012)	Greene	Lake(R)	AA(TS)	Silt/Sediment	Erosion, Construction	1998
H-240-187-	**Steele Creek tribs (1201-0197)**	Herkimer	River	A(TS)	**Phosphorus**	Agric, Stream Erosion	2004
					Silt/Sediment	Agric, Stream Erosion	2004
H-240-211,214	**Ballou, Nail Creeks (1201-0203)**	Oneida	River	C	**D.O./Oxygen Demand**	CSOs, Urban Runoff	2004
					Phosphorus	CSOs, Urban Runoff	2004
H-240-227	**Ninemile Creek, Lower, and tribs (1201-0014)**	Oneida	River	B(T)	**Pathogens**	On-Site WTS	2004
	Lower Hudson River Drainage Basin						
H- 4	Saw Mill River (1301-0007)	Westchester	River	various	Floatables	Urban Runoff	1998
H- 31-P44-24-P89-10-P93	Peach Lake (1302-0004)	Westchester	Lake	B	Pathogens	On-site WTS	2002
					Phosphorus	On-site WTS	1998
H- 55- 8-P175	Oscawana Lake (1301-0035)	Putnam	Lake	A	Phosphorus	On-site WTS, Urban	2002
H- 95-10-P345g	Hillside Lake (1304-0001)	Dutchess	Lake	B	Phosphorus	On-site WTS	2002
H-171-P848	Ashokan Reservoir (1307-0004)	Ulster	Lake(R)	AA(T)	Silt/Sediment	Streambank Erosion	2002
H-171-P848-	Esopus Creek, Upp (1307-0007) [5]	Ulster	River	A(T)	Silt/Sediment	Streambank Erosion	1998
H-202-P8f	* Sleepy Hollow Lake (1301-0059)	Greene	Lake	A	Silt/Sediment	Streambank Erosion	2002
H-204- 2- 7-P24	Kinderhook Lake (1310-0002)	Columbia	Lake	B	Phosphorus	Agric, On-site WTS	2002
H-235-11-P377	Snyders Lake (1301-0043)	Rensselaer	Lake	B	Phosphorus	Oxygen Dem/Sed.	2002

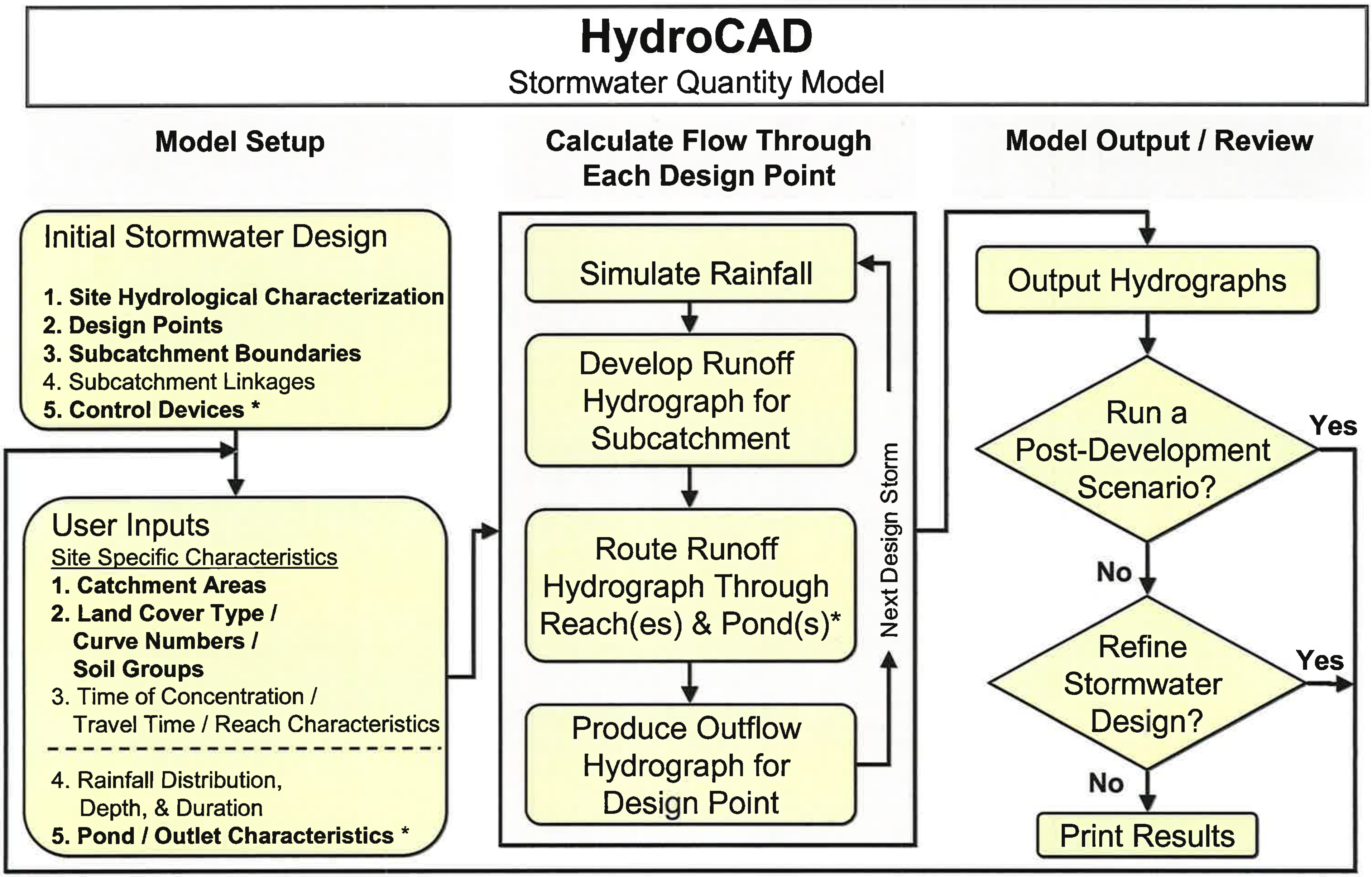
[3] This waterbody listing includes Ann Lee Pond, which was previously listed as a separate lake segment with WI/PWL ID 1201-0083.

[4] This segment was previously listed in Part 3 - *Waterbodies Requiring Re-Assessment* in the 2002 Section 303(d) List. Re-Assessed in the *Mohawk River Basin Waterbody Inventory and Priority Waterbodies List,* April 2003.

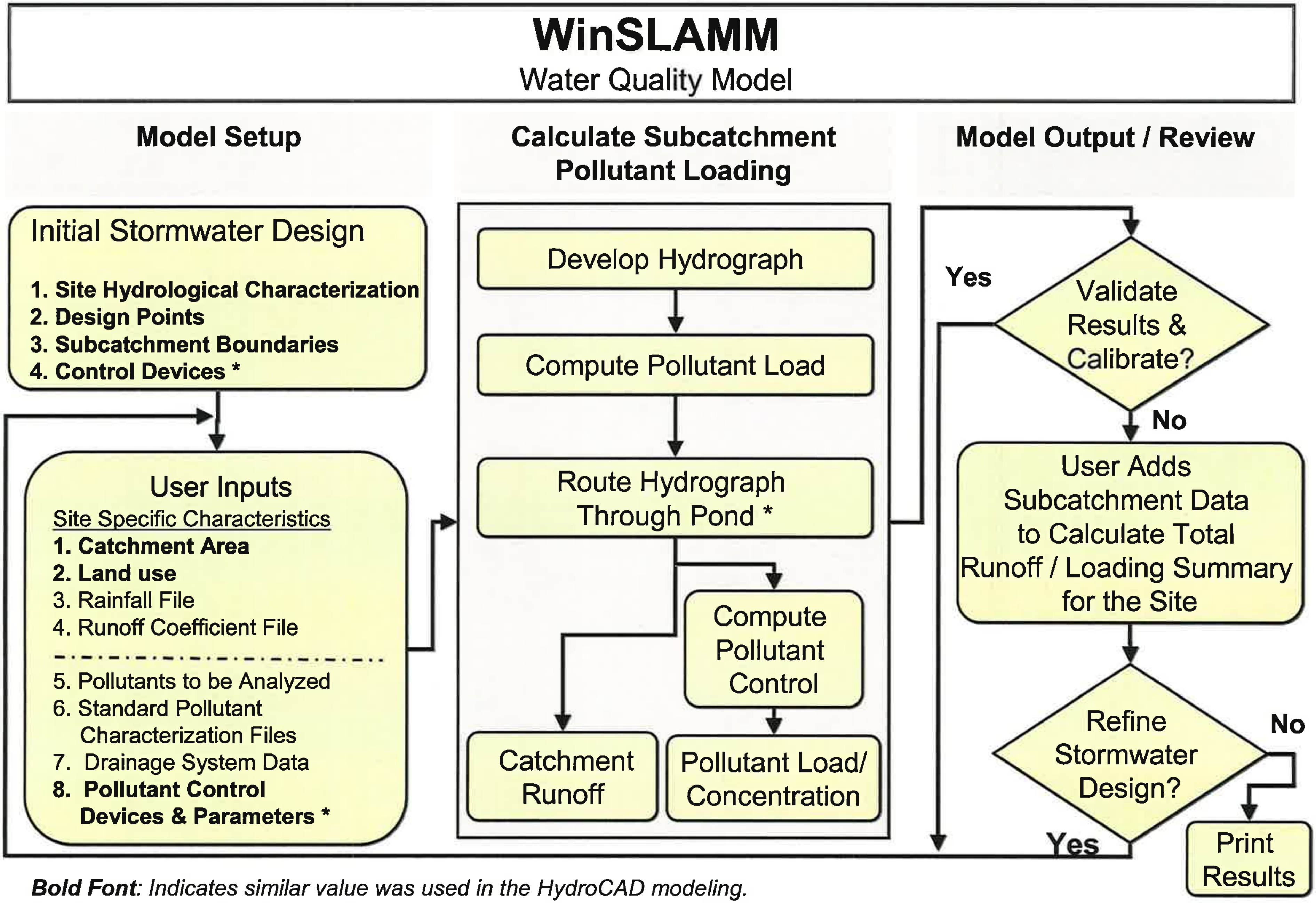
[5] This TMDL will be developed in conjunction with the Schoharie Reservoir TMDL.

9

STORMWATER MANAGEMENT MODELS



Bold Font: *Indicates a similar input to WinSLAMM model.*
** Indicates a post-development feature.*



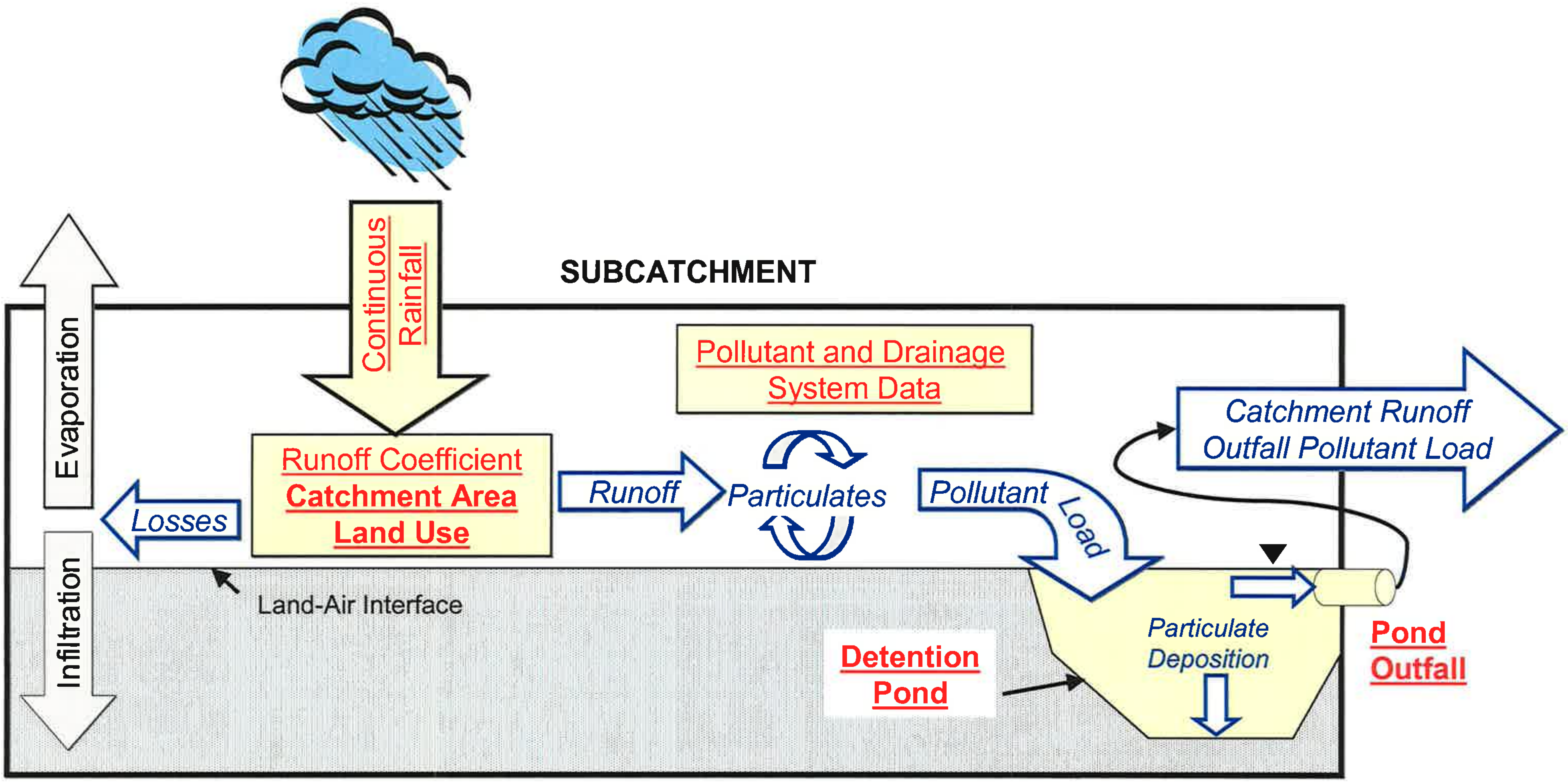
***Bold Font**: Indicates similar value was used in the HydroCAD modeling.*

** Indicates a post-development feature*

NYC 9(C)

WinSLAMM

Source Loading and Management Model



Bold Font: *Indicates value was obtained from HydroCAD modeling.*
Underlined text: Indicates a user input or user selection.
Blue italicized arrows: Indicates a WinSLAMM calculated valu.
Note: Arrows not to scale.

10

11

Ex 11

Crossroads Ventures, Watercourse Mapping on Big Indian Site, (T) Shandaken, Ulster County

NYCDEP GIS/GPS Data:

- Culvert Locations as Mapped by NYCDEP, January to April, 2004
- Washout Locations as Mapped by NYCDEP, January to April, 2004
- NYCDEP Hydrology Sampling Locations as Mapped by NYCDEP
- Selected Wetland Flag Locations as Marked by Crossroads Ventures Wetland Consultant
- Watercourses as Mapped by NYCDEP, January to April, 2004
- Streams (USGS Blueline and SCS Blackline)
- Approximate Wetland Boundary as Flagged by Crossroads Ventures Wetland Consultant
- Basin Boundary
- Parcel Boundaries

Data Obtained from LA Group:

- Proposed Buildings
- Golf Fairway and Other Disturbed Areas
- Golf Green
- Subdivision Clearing
- Pavement
- Proposed Lakes

Culverts, Wetland flag locations, and watercourses were mapped in the field by NYCDEP personnel using a Trimble XR Pro GPS Unit. Post processing was completed with base station data provided by the Delaware County Planning Department. Mapping was completed during January to April of 2004.

Base Imagery - NYSDOS Leaf-off, 1994-1999 Color-Infrared

DEP

Projection: UTM
Datum: NAD 83
Zone: 18
Units: Meters

N
W E
S

NOTE: GIS data are approximate according to their scale and resolution. They may be subject to error and are not a substitute for on site inspection or survey.

400 0 400 800 Feet

NOTE: Scale Is Approximate

12

Ex. 12

Crossroads Ventures, Watercourse Mapping on Wildacres Site, (T) Shandaken, Ulster County and (T) Middletown, Delaware County

NYCDEP GIS/GPS Data:

- Culvert Locations as Mapped by NYCDEP, January to April, 2004
- Selected Wetland Flag Locations as Marked by Crossroads Ventures Wetland Consultant
- Watercourses as Mapped by NYCDEP, January to April, 2004
- Streams (USGS Bluelines and SCS Blacklines)
- Approximate Wetland Boundary as Flagged by Crossroads Ventures Wetland Consultant
- Basin Boundary
- Parcel Boundaries

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- Proposed Buildings
- Golf Fairways and Other Disturbed Areas
- Golf Green
- Subdivision Clearing
- Pavement
- Proposed Lakes

Projection: UTM
Datum: NAD 83
Zone: 18
Units: Meters

NOTE: GIS data are approximate according to their scale and resolution. They may be subject to error and are not a substitute for on site inspection or survey.

400 0 400 800 Feet

NOTE: Scale is Approximate

13

THE CITY OF NEW YORK
LAW DEPARTMENT
100 CHURCH STREET
NEW YORK, N.Y. 10007-2601

MICHAEL A. CARDOZO
Corporation Counsel

DANIEL GREENE
Phone: (212) 788-1568
Fax: (212) 788-1619
E-mail: dgreene@law.nyc.gov

September 2, 2004

See enclosed service list

Re: City Exhibit 13

Counsel:

Enclosed with this letter is a color copy of City Exhibit 13. If you have any questions or need any additional exhibits, please do not hesitate to contact me.

Sincerely yours,

Daniel Greene

Service List

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Whiteman, Osterman & Hanna
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Young, Sommer, Ward, Ritzenberg, Baker & Moore
Executive Woods Office
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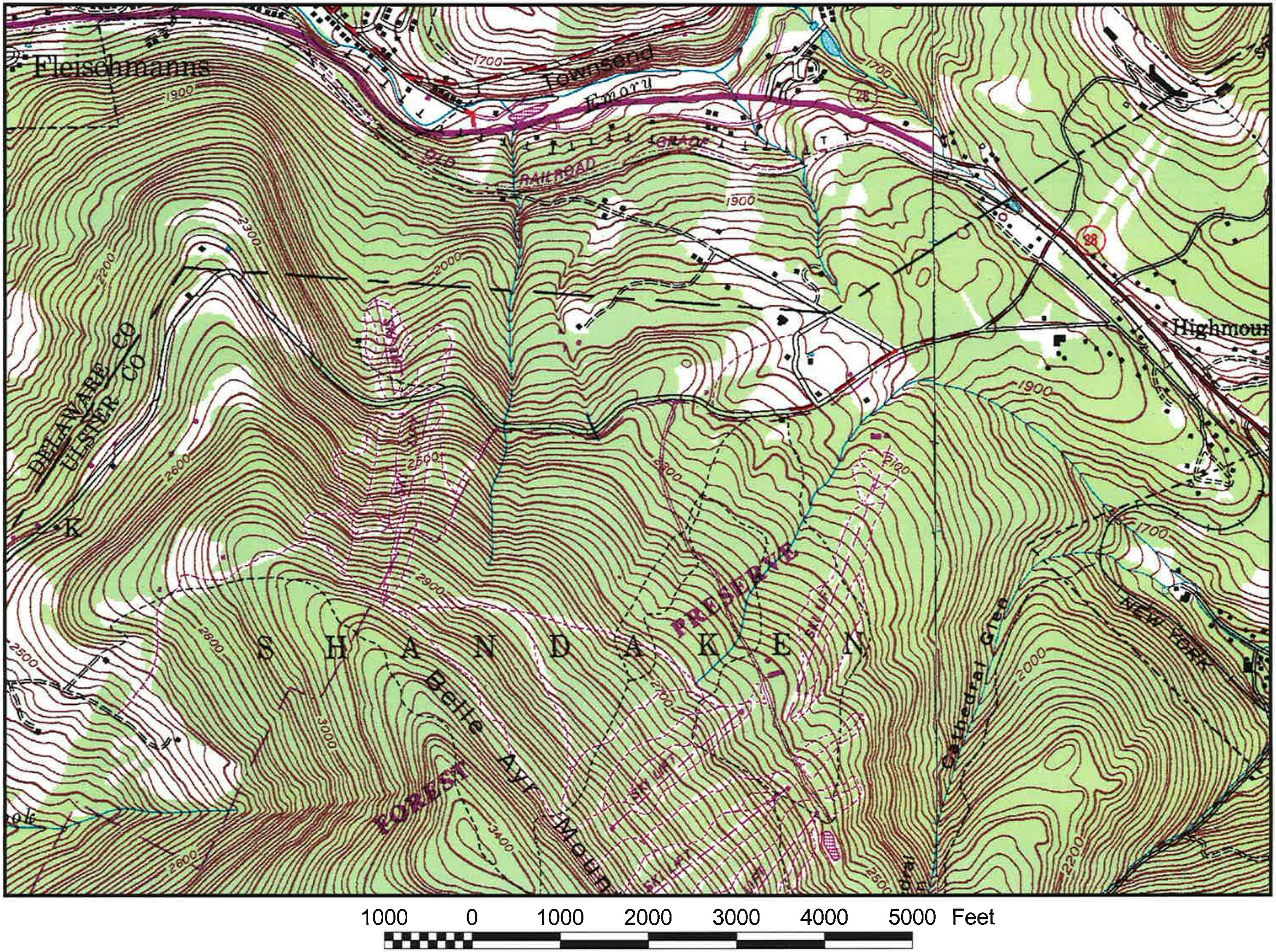
14

City Ex 14



Fleischmanns
Townsend
Emory
RAILROAD
GRADE
DELAWARE CO
ULSTER CO
K
S H A N D A K E N
PRESERVE
FOREST
Belle Ayr Moun
Highmoun
Cathedral Glen
NEW YORK
1700
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1000 0 1000 2000 3000 4000 5000 Feet

15

DEP Ex. 15

Chapter 4: Unified Stormwater Sizing Criteria

Section 4.1 Introduction

This chapter presents a unified approach for sizing SMPs in the State of New York to meet pollutant removal goals, reduce channel erosion, prevent overbank flooding, and help control extreme floods. For a summary, please consult Table 4.1 below. The remaining sections describe the four sizing criteria in detail and present guidance on how to properly compute and apply the required storage volumes.

Table 4.1 New York Stormwater Sizing Criteria	
Water Quality (WQ_v)	**90% Rule:** $WQ_v = [(P)(R_v)(A)]\ /12$ Rv = 0.05+0.009(I) I = Impervious Cover (Percent) Minimum Rv = 0.2 P = 90% Rainfall Event Number (See Figure 4.1) A = site area in acres
Channel Protection (Cp_v)	**Default Criterion:** Cp_v = 24 hour extended detention of post-developed 1-year, 24-hour storm event. **Option for Sites Larger than 50 Acres:** Distributed Runoff Control - geomorphic assessment to determine the bankfull channel characteristics and thresholds for channel stability and bedload movement.
Overbank Flood (Q_p)	Control the peak discharge from the 10-year storm to 10-year predevelopment rates.
Extreme Storm (Q_f)	Control the peak discharge from the 100-year storm to 100-year predevelopment rates. Safely pass the 100-year storm event.
Note: *The local review authority may waive channel protection, overbank flood, and extreme storm requirements in some instances. Guidance is provided in this chapter.*	

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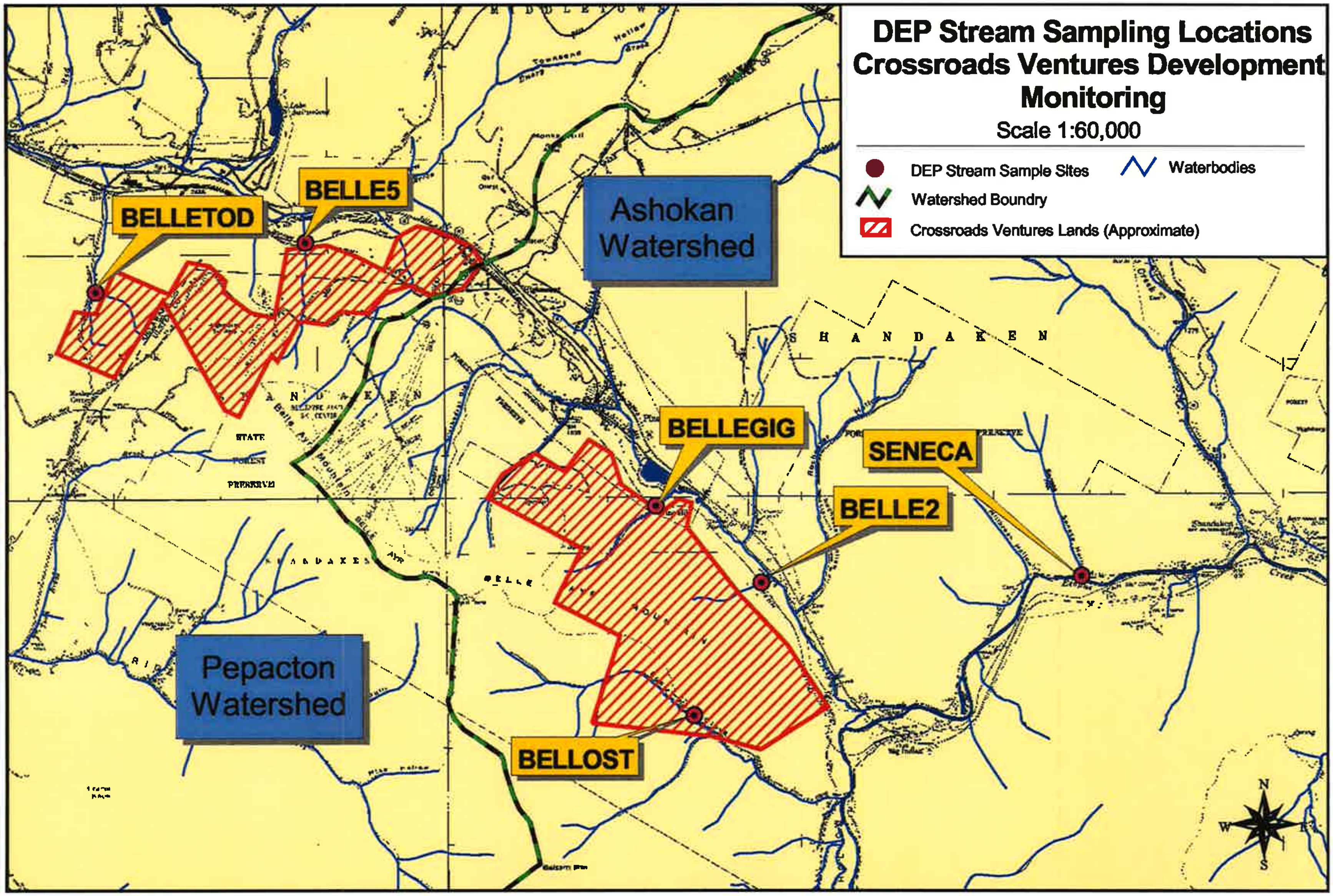
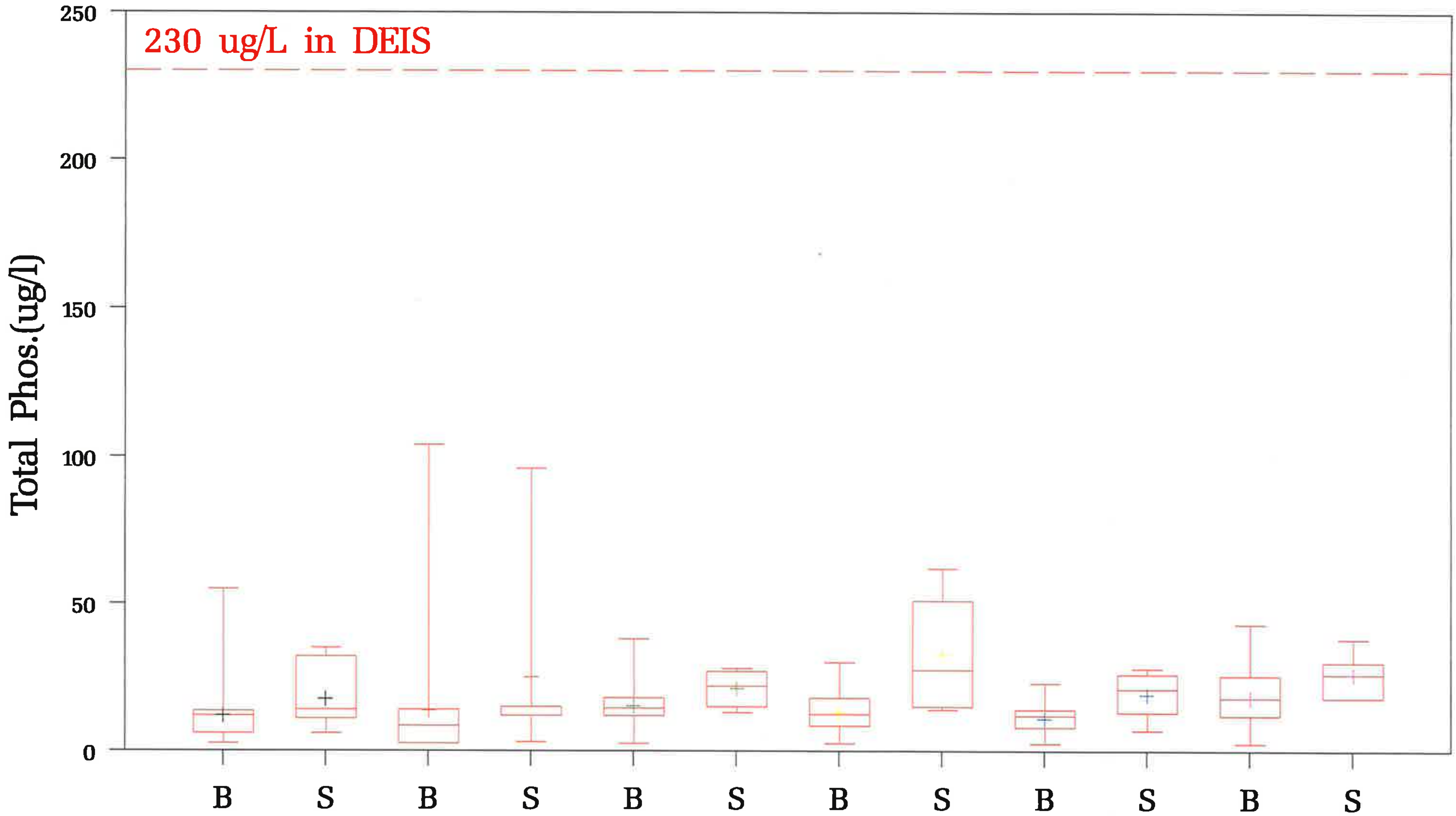


Figure 1 DEP water quality monitoring locations of tributaries draining Belleayre Mountain.

17

Belleayre Mtn. tributary Total Phosphorus Data Aug. 2000 – Sep. 2001

City Ex 17

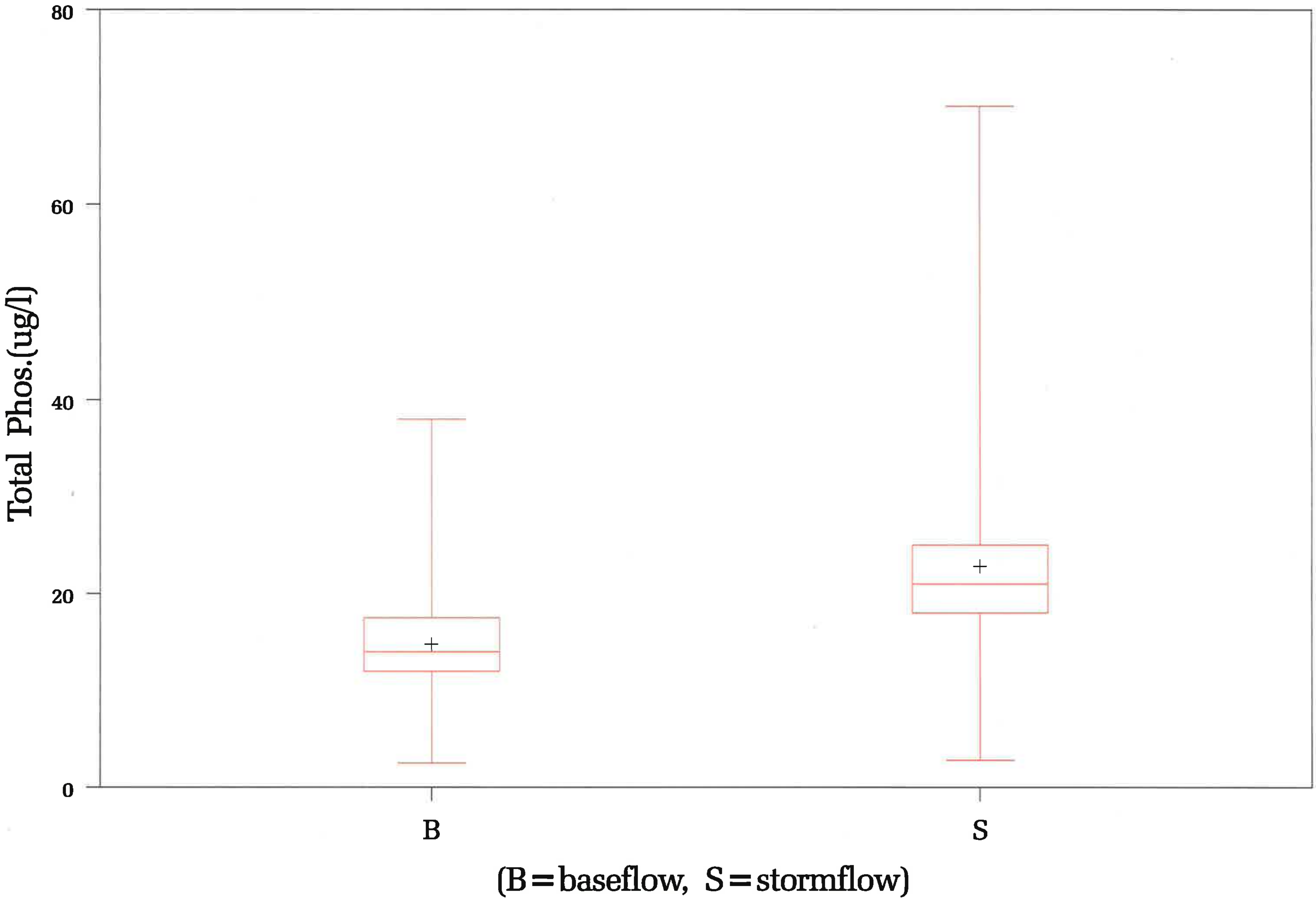


Group Sizes: Min n=6 Max n=44

Site
+++ BELLE2
+++ BELLE5
+++ BELLEGIG
+++ BELLETOD
+++ BELLOST
+++ SENECA

18

Giggle Hollow Total Phosphorus Data Aug. 2000 – Dec. 2003

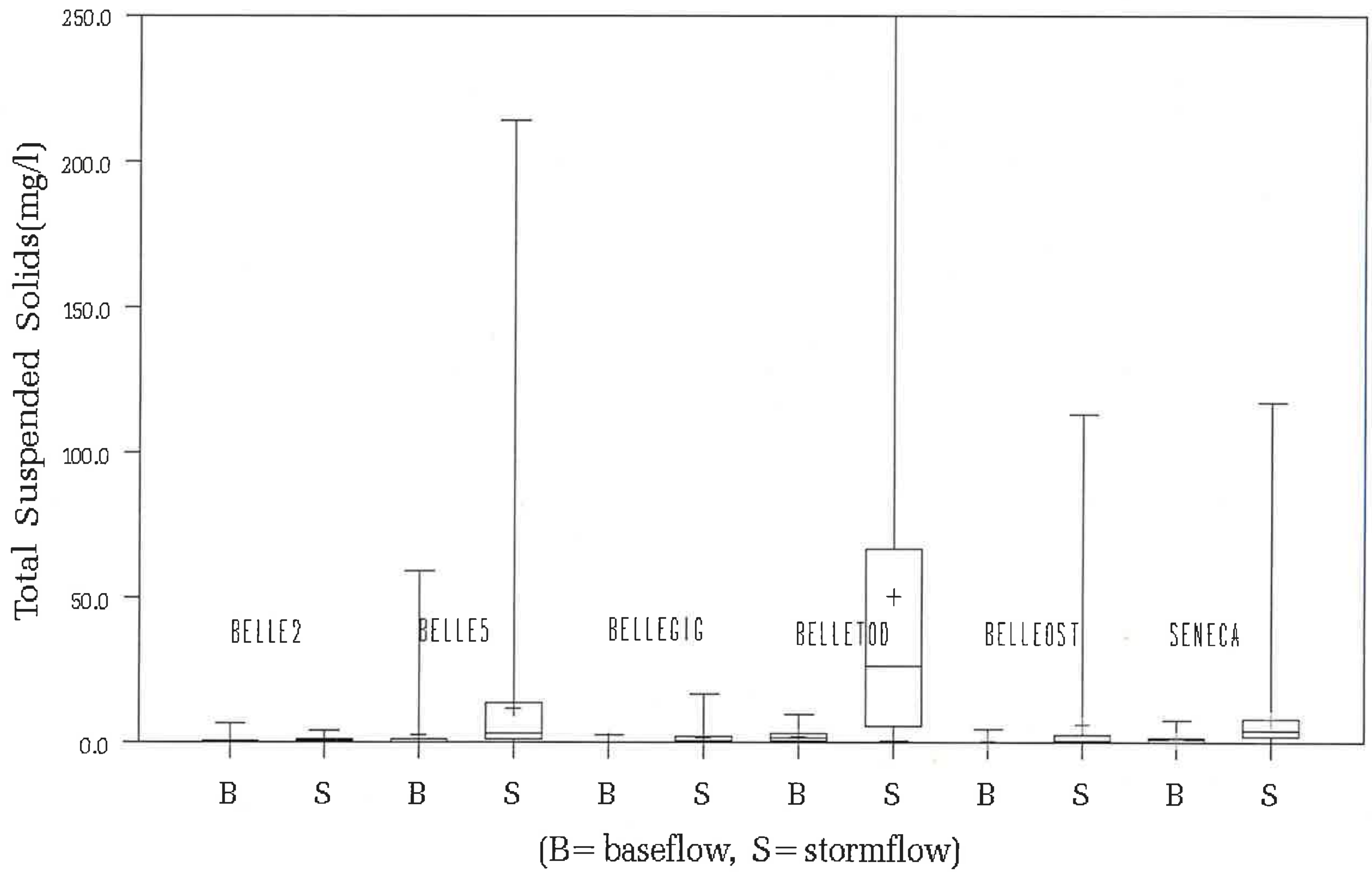


Group Sizes: Min n=84 Max n=193

19

City Ex 7

Belleayre Mtn. tributary Total Suspended Solids Data Aug. 2000 — Dec. 2003



Group Sizes: Min n=12 Max n=207

Site +++ BELLE2 +++ BELLE5 +++ BELLEGIG
+++ BELLETOD +++ BELLOST +++ SENECA

20

TABLE 1. Runoff observed for five monitoring stations on Belleayre Mountain as measured by NYCDEP for the period of 15 Mar 2002 thru 30 Nov 2002. Note: BELLE 2, an additional station on Belleayre Mountain, does not have a continuous stage record and therefore is not included in this table.

STATION	Q (CFS)	AREA (HA)	PRECIP (IN)	RUNOFF (IN)	RC
BELLE5	0.265	62.16	34	10.71	0.32
BELLEGIG	1.151	147.63	34	19.59	0.58
BELLETOD	0.685	334.11	34	5.15	0.15
BELLOST	2.126	437.71	34	12.21	0.36
SENECA	0.845	181.30	34	11.71	0.34
AVERAGE	**1.014**	**232.58**	**34**	**11.88**	**0.35**

Precipitation data were obtained from the NYSDEC gauging station on Belleayre Mountain.

MC 20

21

PRINCIPLES OF SURFACE WATER QUALITY MODELING AND CONTROL

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MC 21

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4. How credible is the water quality model projection of expected responses due to the WLA, that is, what is the "accuracy" of the model calculations and how should the level of the analysis be reflected, if at all, in the WLA?

From a water quality point of view, the basic relationship between waste load input and the resulting response is given by a mathematical model of the water system. The development and applications of such a water quality model in the specific context of a WLA involves a variety of considerations including the specifications of parameters and model conditions. This relationship between input and the resulting water quality response is the principal focus of this book. Thus, the overall issues of WLA are recognized and indeed are not minimized. It is crucial, however, that the principles of water quality modeling be understood and such understanding begins with the major steps and elements of modeling.

Figure 1.4 shows the principal components of a mathematical modeling framework. The upper two steps enclosed with the dashed lines, namely, "theoretical construct" and "numerical specification" constitute what is considered a mathematical model. This is to distinguish the simple writing of equations for a model from the equally difficult task of assigning a set of representative numbers to inputs and parameters. Following this initial model specification are the steps of (a) model calibration, that is, the first "tuning" of model output to observed data and (b) the step of model verification, that is, the use of the calibrated model on a different set of water quality data. This verification data set should presumably represent a condition under a sufficiently perturbed condition (i.e., high flows, decreased temperature, changed waste input) to provide an adequate test for the model. Upon the completion of this verification or auditing step, the model would be considered verified [Fig. 1.4(a)].

The following definitions are therefore offered:

Model. A theoretical construct, together with assignment of numerical values to model parameters, incorporating some prior observations drawn from field and laboratory data, and relating external inputs or forcing functions to system variable responses.

Model Calibration. The first stage testing or tuning of a model to a set of field data, preferably a set of field data not used in the original model construction; such tuning to include a consistent and rational set of theoretically defensible parameters and inputs.

Model Verification. Subsequent testing of a calibrated model to additional field data preferably under different external conditions to further examine model validity.

The calibrated model, it should be noted, is not simply a curve-fitting exercise, but should reflect wherever possible more fundamental theoretical constructs and parameters. Thus, models that have widely varying coefficients to merely "fit" the observed data are not considered calibrated models.

22

The Source Loading and Management Model (SLAMM)

A Water Quality Management Planning Model for
Urban Stormwater Runoff

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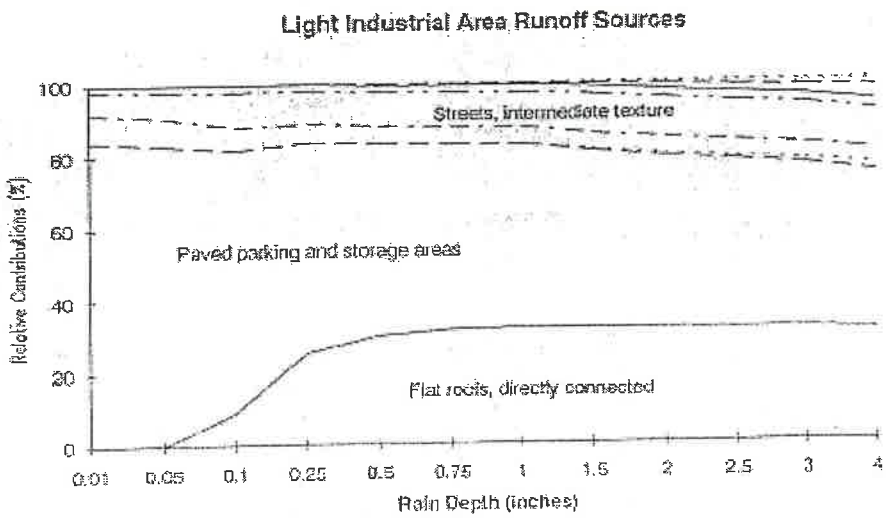
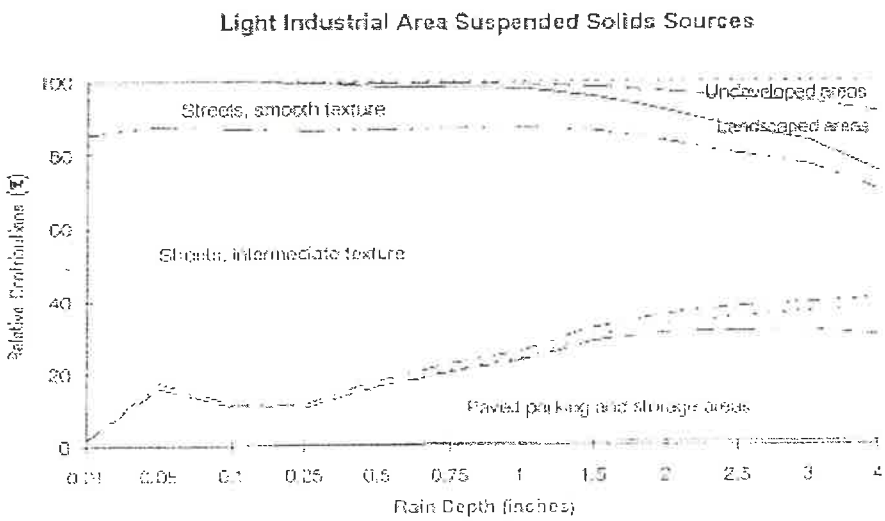
NYC 22





WinSLAMM Calibration Procedures

The calibration and verification procedures of WinSLAMM are similar to the procedures needed to calibrate and verify any stormwater quality model. Local data should be collected, including stormwater outfall quality and quantity data and watershed information. Numerous individual rainfall-runoff events need to be sampled (using flow-weighted composite sampling). The best scenario is to collect all calibration information from one watershed and then verify the model using independent observations from another watershed. Another common approach is to collect calibration information for a series of events from one watershed, and then verify the calibrated model using additional data from other storms from the same watershed.

WinSLAMM has typically been calibrated and verified using a combination of approaches. The initial effort for the full implementation of WinSLAMM (as reported by Pitt 1987) used data from three years of monitoring of eight watersheds in Milwaukee and data from one year of monitoring two additional watersheds in Toronto. These data represented a broad range of land uses (residential, commercial, and industrial uses), a wide range of hydraulic complexity (from having mostly connected impervious areas to having much landscaped areas and grass drainages), and widely varying rain conditions (from 0.01 to over 3 inches). The data was supplemented with source area data collected elsewhere (as referenced later) and with small-scale washoff tests conducted in Toronto. These data (from several hundred independent rainfall-runoff events) enabled the basic processes contained within WinSLAMM to be rigorously tested and allowed for a comprehensive set of initial calibration conditions to be developed. With additional site-specific data, these calibration conditions should be modified to consider specific situations not contained in the initial data set. This has been especially important for organic toxicants and for source areas not well represented in the initial data set.

This section describes a general approach to calibrate WinSLAMM and describes the data sources for the additional parameter files used in WinSLAMM. The order for calibrating WinSLAMM is:

1) Runoff quantity
2) Annual suspended solids loading (and event mean concentration)
3) Event suspended solids loadings and concentrations
4) Annual total pollutant loadings (and event mean concentrations)
5) Partitioning of pollutants between particulate and filterable phases
6) Variations in pollutant concentrations

It is very important that the user start with runoff quantity and be completely satisfied with the calibration of each step before proceeding to the next step. Much wasted effort will occur if one skips around in the order of the calibration.

Runoff Coefficients

The mandatory *.RSV file contains volumetric runoff coefficients (the ratio of runoff quantity to rain quantity: Rv) for each surface type for various rain depths. The runoff coefficients were calculated using general impervious and pervious area models. These models were then calibrated based on extensive Toronto data and were then verified using additional independent Toronto data, along with numerous Milwaukee data for a wide variety of land development and rain conditions. However, WinSLAMM was designed to allow the use of alternative runoff models, as desired. Alternative runoff coefficients for each source area type can be calculated using other models and saved under other runoff volume file names.

The *.RSV file must be calibrated before any of the other parameter files are examined. After this file is modified, as needed, the suspended solids files must be calibrated. Finally, the file describing the other pollutants is examined and modified last.

Initial Data Sources

The RUNOFF.RSV file contains the verified runoff coefficients, based on the small storm hydrology model described in:

R. Pitt. *Small Storm Urban Flow and Particulate Washoff Contributions to Outfall Discharges*. Ph.D. Dissertation, Civil and Environmental Engineering Department, University of Wisconsin, Madison, WI, November 1987.

This file was developed using data from eight study sites in Milwaukee (having generally clayey soils) and two study sites in Toronto (having generally sandy soils). The published data are contained in the following reports:

Bannerman, R., K. Baun, M. Bohn, P.E. Hughes, and D.A. Graczyk. *Evaluation of Urban Nonpoint Source Pollution Management in Milwaukee County, Wisconsin*, Vol. I. Grant No. P005432-01-5, PB 84-114164. US Environmental Protection Agency, Water Planning Division, November 1983.

R. Pitt and J. McLean. *Humber River Pilot Watershed Project.* Ontario Ministry of the Environment, Toronto, Canada, December 1984.

Calibration Steps

The runoff file should be modified based on correctly collected rainfall and runoff data. It is very important that adequate QA/QC procedures be used to insure the accuracy and suitability of the data. Common problems are associated with unrepresentative rainfall data (too few rain gauges and not correctly located in the watershed), incorrect rain gauge calibrations, poor flow monitoring conditions (surcharged flows, relying on Manning's equation for V and Q, poor conditions at the monitoring location), etc. The use of a calibrated flume or simultaneous use of velocity and depth sensors is preferred, for example. Other common errors are associated with inaccurate descriptions of the watershed (incorrect area, amount of impervious areas, understanding of drainage efficiency, soil characteristics, etc.).

Few people appreciate the inherent errors associated with measuring rainfall and runoff. Most monitoring programs are probably no more than ± 25% accurate for each event. It is very demanding to obtain rainfall and runoff data that is only 10% in error. This is most evident when highly paved areas (such as shopping centers or strip commercial areas) are monitored and the volumetric runoff coefficients are examined. For these areas, it is not uncommon for many of the events to have Rv values greater than 1.0 (implying more runoff than rainfall). Similar errors occur with other sites, but are not as obvious.

The first calibration steps are therefore associated with observing the watershed and rainfall - runoff data, followed by changing the RUNOFF.RSV file, as necessary:

1. Confirm that the watershed areas and development characteristics are correctly described. Urban drainage areas generally follow the topographic divide, but it is not unusual for storm drainage to cross-over surface topographic divides for a block, or more. If the area is very large (hundreds to thousands of acres), these deviations will tend to cancel out, with minimal detrimental effect. However, for calibration and verification studies, the drainage area should be as precisely defined as possible, especially for small drainage areas (tens to hundreds of acres). Therefore, confirm all storm drainage locations and storm drain inlets affecting the outfall monitoring location. For each inlet, identify the precise watershed divide, if at all possible. This includes examining all buildings located close to the divide and determining where the actual divide is located, including splitting roofs or paved areas, as necessary.

Another important aspect is correctly identifying the development characteristics for the watershed area. The most important attribute that affects runoff quantity (and quality) is the drainage efficiency of the area. This includes understanding where the paved areas drain. Are they directly connected to the storm drainage system, or do they drain across substantial distances of unpaved areas before reaching the drainage system? Each type of paved area (roofs, parking/storage areas, play grounds, driveways, sidewalks, etc.) needs to be divided to "directly-connected" and "disconnected" portions, usually through site investigations. Streets are assumed to be directly connected, as they are adjacent to the drainage system. Be careful of roof drains that are to lawns, but only provide a few feet of overland flow before paved areas. These are effectively directly connected areas. Similar problems arise with relatively large paved or roof areas that drain to relatively small unpaved areas (especially in multi-family residential, commercial and industrial areas). Other factors affecting drainage efficiency is the presence of grass swales, or other types of stormwater management devices (dry or wet ponds, porous pavements, infiltration areas, etc.) that may occur in the area. These need to be carefully described and considered in the calibration and verification process.

2. Calculate the Rv for each event and observe the pattern. Plot rainfall depth vs. runoff depth and plot Rv vs. rainfall depth. The Rv values should be small for small rains and steadily increase as the rains increase. The Rv differences will not be great for mostly directly connected impervious areas (either paved or roofed areas), but the trend should be quite dramatic for areas having substantial unpaved areas, if a wide range of rains were monitored. The Rv values should look reasonable for moderate rains (0.25 to 0.5 inch rains): about 0.3 for medium density residential areas, about 0.8+ for commercial areas, etc. If the Rv values all appear to be too small or too large, suspect an error in the drainage area, or an error in the rainfall or flow monitoring calibrations. If several individual events look strange and the others appear to follow a reasonable trend, then investigate specific circumstances for the odd events. Unusual

rain intensities, snow/icing problems, debris at flow monitoring station, etc. are all transient problems that may periodically occur. If the unusual conditions cannot be explained, then a decision will have to be made concerning eliminating the data, or keeping it in the data set.

3. Hopefully, data from several watersheds are available for the calibration and verification process. If so, start with data from the simplest area (mostly directly connected paved areas and roofs, with little unpaved areas). This area probably represents commercial roofs and parking/storage areas alone. Therefore, these areas will be calibrated first, before moving on to more complex areas. The most complex areas, such as typical residential areas having large expanses of landscaped areas and most of the roofs being disconnected from the drainage areas, should be examined last.

4. Carefully prepare the WinSLAMM input file describing the watershed area and a rain file for the specific rains that occurred during the monitoring period. If rains occurred during the monitoring period that were not monitored, they must also be included in the rain file. It would be a good idea to include rains for about a month preceding the first monitored event because WinSLAMM is a quasi-continuous model and some preceding time is needed to reach equilibrium conditions before the first monitored event. It will also be helpful to prepare another special rain file to be used in determining the relative sources of runoff (and pollutants). This rain file (could be named SOURCE.RAN) should include about 12 rains spaced about two weeks apart, containing the following rain depths (sorted from small to large rains) and durations (modify durations based on typical durations for these rain depths for the area of interest):

0.01 inches	3 hours
0.05	7
0.10	8
0.25	10
0.50	12
0.75	14
1.0	14
1.5	14
2.0	14
2.5	14
3.0	14
4.0	14

5. Run the created watershed file for the two rain files, without any additional pollutants selected, using the available RUNOFF.RSV file and using the outfall total (at least) output option for the actual rains and the source area, by rains, output option for the source rain file. Compare the predicted runoff depths (in inches) with the measured runoff depths (in inches) for the monitored events by creating a scatter plot of observed vs. predicted runoff values. Calculate the percentage runoff depth errors: 100 x (observed-predicted)/observed, and plot these against the observed rain depths. The desired pattern for the observed vs. predicted runoff depth plot is a 45 degree line, with little deviation. The desired pattern for the residual error plot is an even, narrow band over the range of observed rain depths, centered on the zero residual error horizontal line. Also calculate the sum of the observed and predicted runoff depths for all monitored events. The percentage difference in the sum of depths should be small.

If you are satis fied with these analyses, then no changes are to be made to the RUNOFF.RSV file. However, some improvement is usually possible. The overall sum runoff error indicated the general severity of the problem, but other information needs to be used to identify which source areas for which rains need to have their Rv values modified.

The model run using the SOURCE.RAN file is important in directing where the changes should be made. This run contains the percentage contribution of runoff for each rain, for each source area. This shows where WinSLAMM is generating the runoff for the different rain depths. It is doubtful if the monitored events cover the wide range of rains contained in this special rain file. Therefore, only look at the range of predicted data covering the actual monitored rains.

If a constant percentage bias occurs (unlikely) over the range of events monitored, then modify the Rv values in the RUNOFF.RSV file for the contributing source areas for the range of rains monitored. However, the residual error plot probably shows a bias, with some portions of the rain distribution having greater problems than others. It is therefore possible to divide the residual error plot into different rain depth ranges, corresponding to different amounts of correction needed. Each rain depth range also has different source contributions. Therefore, Rv corrections can be made to each source area for different rain ranges. It is probably best to start with the smallest rains where the directly connected impervious areas have the greatest influence, then go to the largest rains where runoff from the soil dominates. It is possible to create a simple series of simultaneous equations to solve for the changes to be concurrently made, but manual changes are typically adequate. After the changes are made, it is necessary to plot the new Rv values for each source area against rain depth and to smooth the resulting relationships to remove any discontinuities. After these smoothing changes are made, then re-run the program using the new *.RSV file and review the results. It may be necessary to repeat this process a few times to become satisfied that no further improvements are possible or necessary.

6. The above process is difficult if only one watershed is available for study and if the watershed area has much disconnected paved/roof areas. The preferred approach would be to start by evaluating an area having all directly connected impervious areas and making the basic changes in the Rv values for each source area and rain, as needed. Another area (preferably similar in character) having disconnected impervious areas would then be used to verify (or change) the coefficients in the RUNOFF.RSV that reduces the Rv values if the impervious areas are disconnected. The ten different watersheds used in preparing the initial RUNOFF.RSV file allowed this more rigorous approach.

Assuming the RUNOFF.RSV file Rv values are acceptable, the disconnection coefficients can be adjusted in a similar manner using the above described residual analysis: the runoff residual errors are plotted against rain depth and changes are made to the disconnection coefficients to minimize the total and individual errors.

Particulate Solids Concentrations

The mandatory *.PSC file describes the particulate residue (suspended solids) concentrations for each source area (except for roads and freeway lanes, which are included in the build-up and washoff algorithms of WinSLAMM) and land use, for several rain categories. The PART.PSC file was developed and verified using source area data mostly from Toronto, Milwaukee and Birmingham during specific field tests.

SLAMM uses another file (*.PRR) to calibrate the source predictions to outfall observations because the *.PSC file contains suspended solids data for only some of the source areas, while the streets and highway lanes are directly predicted. The mandatory delivery.PRR file accounts for the deposition of particulate pollutants in the storm drainage system, before the outfall, or before outfall controls. The DELIVERY.PRR file was originally calibrated for swales, curb and gutters, undeveloped roadsides, or combinations of drainage conditions.

Initial Data Sources

The following list shows the major published sources of the particulate residue (suspended solids) data used in developing the original PART.PSC and DELIVERY.PRR files:

Bannerman, R., K. Baun, M. Bohn, P.E. Hughes, and D.A. Graczyk. *Evaluation of Urban Nonpoint Source Pollution Management in Milwaukee County, Wisconsin*, Vol. I. Grant No. P005432-01-5, PB 84-114164. US Environmental Protection Agency, Water Planning Division, November 1983. SS and pollutants from streets, commercial roofs and parking areas - Milwaukee

R. Pitt and G. Shawley. *Demonstration of Nonpoint Pollution Management on Castro Valley Creek*. Environmental Protection Agency, Water Planning Division, Washington, D.C., June 1981. SS and pollutants from many source areas - Castro Valley, CA

R. Pitt. *Urban Bacteria Sources and Control in the Lower Rideau River Watershed*, Ottawa, Ontario. Ontario Ministry of the Environment, May 1982. SS and some pollutants from some source areas - Ottawa

Pitt, R. and M. Bozeman. *Sources of Urban Runoff Pollution and Its Effects on an Urban Creek*. EPA-600/S2-82-090, U.S. Environmental Protection Agency, Cincinnati, Ohio, December 1982. SS and pollutants from many source areas - San Jose, CA

R. Pitt and J. McLean. *Humber River Pilot Watershed Project*. Ontario Ministry of the Environment, Toronto, Canada, December 1984. SS and pollutants from many source areas - Toronto

Shelley, P.E. and D.R. Gaboury. "Estimation of Pollution from Highway Runoff - Initial Results," *Conference on Urban Runoff Quality - Impact and Quality Enhancement Technology*, Henniker, New Hampshire, Edited by B. Urbonas and L.A. Roesner, Proceedings published by the American Society of Civil Engineering, New York, June 1986. SS and pollutants from highways - nationwide

Calibration Steps

The suspended solids files can only be examined and modified after the runoff file is acceptable. The *.PSC file contains suspended solids concentrations (in mg/L) for each source area and land use for different rains, except for the street areas that use explicit accumulation and washoff algorithms based on land use, street texture, and rain conditions. Highway paved lane and shoulder areas also have explicit algorithms that calculate accumulation and washoff of suspended solids based on traffic volume and rains. Both of these areas have a great deal of research information available, allowing these direct calculations. Unfortunately, other source areas have little research data available to allow direct predictions of suspended solids runoff concentrations. This file is therefore used to account for the "first-flush" effects observed at specific source areas. Concentrations of suspended solids at the very beginning of rains at some paved areas (especially paved parking areas) are much greater than later in the same rain. This variation is highly dependent on rain energy and SLAMM uses a similar relationship to describe suspended solids variations for different rain depths. These data are based on observed conditions at the source areas. Runoff from some source areas (especially roofs and landscaped areas) typically do not indicate major concentration changes for different rains.

The first calibration steps are associated with QA/QC checks and observing trends in predicted vs. observed outfall suspended solids concentrations, and then making needed changes:

1. This step is used if local source area data for suspended solids is available. If this data is not available, then start with the PART.PSC file and step 2.

The first step is to look at the data and see if it seems reasonable. The collected source area suspended solids concentrations need to be divided into separate categories for each source area and land use. These categories should be tested to determine if the categories are significantly different from each other. The easiest way to visualize these relationships is by using grouped boxed plots, sorted by median concentrations. If the boxes are offset by at least the 25% and 75% values, then they are generally significantly different at the 95% confidence level. What is likely, however, is that the groups show a gradual trend, with extreme groups different from each other and the other central groups showing generally overlapping distributions. The extreme groups may be roof runoff (for the low concentrations) and landscaped area runoff (for the high concentrations). The other groups (parking areas, streets, walks, etc.) area probably have more closely related suspended solids concentrations.

A two-way ANOVA test can be conducted to determine if there is any significant difference between the source area categories or between the land use categories. The test also determines if the combination of source area and land use combined affects the categories. ANOVA doesn't specifically identify which sets of data are different from any other. A multiple comparison procedure (such as the Bonferroni *t*-test) can be used to identify significant differences between all cells in the 2-way matrix if the ANOVA finds that a significance difference exists. Both of these tests are parametric tests and require that the data be normally distributed. It may therefore be necessary to perform a log-transformation on the raw suspended solids data. These tests will identify differences in sample groupings, but similarities (to combine data) are probably more important to know. The grouped box plots, again, will be most helpful, in addition to possibly conducting a cluster analysis to identify natural groupings of the data.

Combine the data into fewer groupings (such as all paved parking areas for commercial and industrial areas, another group for all roofs, regardless of land use, and another for all landscaped area runoff). The data in each of these new groups should be plotted as suspended solids concentrations vs. rain depth. The resulting suspended solids concentrations for each rain depth should be included in the construction of a new *.PSC file, duplicating values for all land uses and source areas that were combined based on the statistical tests. If all land uses and source areas are not included in the local monitoring data, then data (unmodified) from elsewhere (including the existing PART.PSC file) can be used with caution.

2. Run the watershed description SLAMM file prepared previously, using the DELIVERY.PRR file, the calibrated *.RSV file and the two rain files (one containing the monitored events and the other being the source.RAN file) without any additional pollutants selected. Select the output option giving results for each rain, by source area. Compare the predicted to the observed suspended solids concentrations for the monitored events by creating a scatter plot of observed vs. predicted runoff values. Calculate the percentage suspended solids concentration errors: 100 x (observed-predicted)/observed, and plot these against the observed suspended solids concentrations and against rain depth for the monitored events. The residual patterns desired are as described above for the runoff calibration. Also calculate the sum of the observed and predicted suspended solids loadings (in lbs) for all monitored events. The percentage difference in the sum of loadings should be small and will indicate the general magnitude of the changes needed. It is likely that the largest discrepancies in suspended solids concentrations will be associated with small rain depths (SLAMM will probably over-estimate the concentrations), while the differences for the larger rains will be smaller.

The calibration of WinSLAMM for the suspended solids concentrations and loadings will mostly be accomplished by modifying the DELIVERY.PRR file. This file accounts for the reduction of suspended solids concentrations for small rains because of deposition of these solids along the drainage path, from the source area (where the *.PSC associated concentrations were measured) to the outfall. Grass swales, undeveloped roadsides, and flat curbs and gutters have relatively slow runoff velocities and lower carrying capacities of sediment than flows in steeper areas and smoother gutters. The differences are most pronounced for the smaller rains than for larger rains where the velocities are all much greater, corresponding to much greater sediment carrying capacities.

Since the *.PRR file adjusts the delivery of the suspended solids for the whole watershed combined (for the drainage system type) the SOURCE.RAN file results won't be helpful in making changes to this files. However, if changes need to be made to the *.PSC file, the results from the model run using this rain file will be very helpful. This run contains the percentage contribution of suspended solids for each rain, for each source area. This shows where SLAMM is generating the suspended solids for the different rain depths. Again, only look at the range of predicted data covering the actual monitored rains.

If a constant percentage bias occurs (unlikely) over the range of events monitored, then modify all of the delivery fractions by the same amount. However, the residual error plot probably shows a bias, with some portions of the rain distribution having greater problems than others. As with the runoff calibration, it is possible to divide the residual error plot into different rain depth ranges, corresponding to different amounts of correction needed for suspended solids loads. Each rain depth range also has different source contributions. Therefore, the delivery corrections can be made to each source area for different rain ranges. After the changes are made, it is necessary to plot the new delivery values for each rain depth and to smooth the resulting relationships to remove any discontinuities. After these smoothing changes are made, re-run the program using the new *.PRR file and review the results. It may be necessary to repeat this process a few times to become satisfied that no further improvements are possible.

Pollutant Concentrations

The optional pollutant.PPD file describes the particulate pollutant strengths related to particulate residue and describes the filterable pollutant concentrations for each source area for each land use. This file is not needed if only runoff volume and particulate residue calculations are desired. This file also contains the COV values for each pollutant for Monte Carlo simulation in SLAMM. The POLL.PPD file was developed and verified using source area data from Toronto, Milwaukee and Birmingham during specific field tests. The following list shows the major published sources of the pollutant characteristic data used in developing this file:

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NYC 23

SOIL SURVEY OF
Ulster County, New York

K. RADNER

United States Department of Agriculture
Soil Conservation Service
in cooperation with
Cornell University Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1968-73. Soil names and descriptions were approved in 1974. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1974. This survey was made cooperatively by the Soil Conservation Service and the Cornell University Agricultural Experiment Station. It is part of the technical assistance furnished to the Ulster County Soil and Water Conservation District. Part of the funding for this survey was provided by the Ulster County Legislature and the Palisades Interstate Park Commission through the Ulster County Soil and Water Conservation District and the Ulster County Planning Board. Also providing financial aid were the U.S. Department of Housing and Urban Development and the New York State Office of Planning Services.

Soil maps in this survey may be copied without permission, but any enlargement of these maps can cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

Cover: The Ashokan Reservoir is in the foreground, and the Catskill Mountains are in the background. Arnot, Oquaga, and Lackawanna soils are extensive in the mountains. Stones in the foreground help to control wave action erosion.

The slight seasonal wetness, slope, and slow permeability in the fragipan and substratum are limitations for many community development uses. Effluent from some septic tank absorption fields seeps to the surface in this soil. Absorption fields should be much larger than those commonly installed because of the slow permeability in the fragipan. In areas where public sewers are available, this soil is only moderately limited for residential housing. Foundation drains and exterior coatings on the walls of basements are needed. Erosion is a hazard during construction. A vegetative cover maintained on the site during construction helps prevent erosion. Capability subclass IIIe.

LCD—Lackawanna and Swartswood very bouldery soils, moderately steep. This map unit consists of deep, well drained soils on valley walls and ridgesides on glaciated uplands. These very bouldery soils formed in glacial till. Slope ranges from 15 to 25 percent. Most areas are long and narrow or irregular in shape and are about 20 to 700 acres in size.

Both soils are rarely in the same area. Areas generally consist of Lackawanna very bouldery soils or of Swartswood very bouldery soils. Lackawanna soils are mainly in the Catskill Mountains, and the Swartswood soils are in the Shawangunk Mountains and on the plateau adjacent to the Catskill Mountains. Because slopes and boulders are dominant in these soils and determine their use, these soils are not shown separately on the soil map.

Typically, the surface layer of the Lackawanna soil is dark reddish brown, very bouldery silt loam 3 inches thick under forest litter and humus. The upper part of the subsoil extends to a depth of about 17 inches. It is friable, reddish brown gravelly silt loam. The lower part of the subsoil extends to a depth of about 49 inches. It is a very firm and brittle, dark reddish brown gravelly loam fragipan. The substratum is dusky red gravelly loam that extends to a depth of about 80 inches.

Typically, the surface layer of the Swartswood soil is very dark grayish brown, very bouldery fine sandy loam about 4 inches thick. The upper part of the subsoil extends to a depth of about 33 inches. It is friable, strong brown gravelly sandy loam. The lower part of the subsoil extends to a depth of 60 inches. It is a very firm and brittle, olive brown gravelly sandy loam fragipan.

Included with these soils in mapping are areas of Oquaga and Lordstown soils that have bedrock within a depth of 20 to 40 inches; areas of moderately well drained Wellsboro and Wurtsboro soils that are near seeps and drainageways; some areas of Valois soils that are on the lower parts of valley walls where the glacial waters reworked the till and dense underlying glacial till is below a depth of 4 feet; and some areas on the lower slopes, mainly in the Esopus Creek Valley, of a soil that is similar to the Valois soil but has more clay than is typical. Most of the included soils have slopes of 25 to 35 percent. A few areas that were cleared for crops are nonbouldery. Also included are some areas of extremely bouldery soils that are too small to be mapped separately.

Free water is generally above the fragipan in these soils for brief periods late in fall, in winter, and early in spring. Because the fragipan is so dense, roots cannot easily penetrate it, so they are mainly confined to the 17- to 36-inch zone above the fragipan. Available water capacity of this zone is low to moderate in the Lackawanna soils and is very low to moderate in the Swartswood soils. Permeability is moderate above the fragipan in both soils, is slow in the fragipan and substratum of the Lackawanna soils, and is slow or moderately slow in the fragipan and substratum of the Swartswood soils. Runoff is very rapid. Boulders are dominantly 2 to 6 feet across and 1 to 2 feet thick, but many are smaller and a few are larger. Distance between boulders is quite variable, but it is generally 5 to 30 feet. Boulders cover 0.1 to 3 percent of the surface. In unlimed areas, reaction of the Lackawanna soils is very strongly acid or strongly acid in the surface layer. Reaction of the Swartswood soils is extremely acid to strongly acid in the surface layer.

Most of the acreage of these soils is used for woodland and wildlife habitat. These soils are well suited to these uses. They have poor potential for farming and for urban and most recreational uses.

A few areas of these soils are used for permanent pasture and hay. Pasture is generally unimproved and brushy. Boulders hinder fertilizing and mowing, and must be removed before the soils can be cultivated. If the soils are cultivated, the hazard of erosion is very severe. Contour farming, use of cover crops, crop rotation, minimum tillage, and good fertilization help to control erosion. These measures also help to conserve moisture and promote good tilth.

Woodland productivity is moderately high. Boulders cause difficulty in machine planting of tree seedlings. Logging roads and skid trails need to be well laid out and need to be protected from erosion with drainage dips or water bars.

Slope, boulders, slight seasonal wetness, and slow or moderately slow permeability in the fragipan and substratum are limitations for urban and recreational uses. The hazard of erosion is severe during construction. Trench absorption fields are difficult to lay out and construct. Controlling the downhill flow of effluent is a serious concern. Many areas have potential for use as paths and trails. Paths and trails need to be protected from erosion and established across the slope wherever possible. Capability subclass VIIs.

LCF—Lackawanna and Swartswood very bouldery soils, very steep. This map unit consists of deep, well drained soils on valley walls and V-shaped ravines in glaciated uplands. These very bouldery soils formed in glacial till. Slope ranges from 35 to 70 percent. Most areas are long and narrow in shape and are 10 to 100 acres in size.

Both soils are rarely in the same area. Areas generally consist of Lackawanna very bouldery soils or of Swartswood very bouldery soils. Lackawanna soils are mainly in the Catskill Mountains, and the Swartswood soils are in the Shawangunk Mountains and on the plateau adjacent to the Catskill Mountains. Because slopes and boulders are dominant in these soils and determine their use, these soils are not shown separately on the soil map.

Typically, the surface layer of the Lackawanna soil is dark reddish brown, very bouldery silt loam 3 inches thick under the forest litter and humus. The upper part of the subsoil extends to a depth of about 28 inches. It is friable, reddish brown gravelly silt loam. The lower part of the subsoil extends to a depth of about 49 inches. It is a very firm and brittle, dark reddish brown gravelly loam fragipan. The substratum is dusky red gravelly loam that extends to a depth of about 80 inches.

Typically, the surface layer of the Swartswood soil is very dark grayish brown, very bouldery, fine sandy loam about 3 inches thick. The upper part of the subsoil extends to a depth of about 29 inches. It is friable, strong brown gravelly sandy loam. The lower part of the subsoil extends to a depth of about 50 inches. It is a very firm and brittle, olive brown gravelly sandy loam fragipan. The substratum to a depth of about 60 inches is dark yellowish brown gravelly sandy loam.

Included with these soils in mapping are areas of Valois soils that formed in glacial till and colluvium from a higher elevation and some areas of Lordstown and Oquaga soils that have bedrock at a depth of 20 to 40 inches. Also included are a few areas of extremely bouldery soils and small areas of eroded soils.

Free water generally is present above the fragipan in these soils for brief periods late in fall, in winter, and early in spring. Because the fragipan is so dense, roots cannot easily penetrate it, so they are mostly confined to the 17- to 36-inch zone above the fragipan. Available water capacity of this zone is low to moderate in the Lackawanna soils and is very low to moderate in the Swartswood soils. Permeability is moderate above the fragipan in both soils, is slow in the fragipan and substratum of the Lackawanna soils, and is slow or moderately slow in the fragipan and substratum of the Swartswood soils. Runoff is very rapid. In some areas, streams have undercut the very steep soils and have caused sections to slump and form escarpments. Boulders cover 0.1 to 3 percent of the surface of these soils and are spaced about 5 to 30 feet apart. They are mainly 1 to 4 feet thick and 2 to 10 feet across, but some are smaller. In unlimed areas, reaction of the Lackawanna soils is very strongly acid or strongly acid in the surface layer. Swartswood soils are extremely acid to strongly acid in the surface layer.

Most of the acreage of these soils is used for woodland and for wildlife habitat. The steepness of the slope and surface boulders prevent most uses other than woodland, recreation, and wildlife habitat. In some areas, these soils are scenic spots and have potential for recreational use.

Woodland productivity is moderately high. Slope and boulders present equipment limitations. Logging roads and skid trails need to be well designed and to be protected from erosion by drainage dips or water bars.

The very steep slope and surface boulders cause difficulty in construction for urban uses. The hazard of erosion is high when vegetation is removed. Trails in recreational areas need to be protected from erosion by drainage dips and need to be established across the slope wherever possible. Capability subclass VIIs.

LEE—Lackawanna and Swartswood extremely bouldery soils, steep. This map unit consists of deep, well drained soils that are mainly on valley walls or on the ridgesides below rock ledges in glaciated uplands. These extremely bouldery soils formed in glacial till. Slope ranges from 25 to 35 percent. Areas are long and narrow or irregular in shape and are 25 to 300 acres in size.

Most areas consist entirely of Lackawanna extremely bouldery soils or of Swartswood extremely bouldery soils. A few areas consist of both soils. Boulders and slope dominate the capabilities of this unit so much that the difference between the Lackawanna and Swartswood soils is relatively unimportant. Lackawanna soils are mainly in the Catskill Mountains, and the Swartswood soils are in the Shawangunk Mountains and on the plateau adjacent to the Catskill Mountains.

Typically, the surface layer of the Lackawanna soil is dark reddish brown, extremely bouldery silt loam 3 inches thick under the forest litter and humus. The upper part of the subsoil extends to a depth of about 23 inches. It is friable, reddish brown gravelly silt loam. The lower part of the subsoil extends to a depth of about 49 inches. It is a very firm and brittle, dark reddish brown gravelly loam fragipan. The substratum is dusky red gravelly loam that extends to a depth of about 80 inches.

Typically, the surface layer of the Swartswood soil is very dark grayish brown, extremely bouldery, fine sandy loam about 4 inches thick. The upper part of the subsoil extends to a depth of 29 inches. It is friable, strong brown gravelly sandy loam. The lower part of the subsoil extends to a depth of 55 inches. It is a very firm and brittle, olive brown gravelly sandy loam fragipan. The substratum to a depth of about 60 inches is dark yellowish brown gravelly sandy loam.

Included with these soils in mapping are Valois soils in glacial drainageways and on fans. A few areas of extremely bouldery Bath soils are included in the eastern part of the county. Moderately well drained Wellsboro and Wurtsboro soils are near seeps and drainageways. Most included soils have slopes of 15 to 25 percent. Some spots are included that are too small to be low, and plants wilt quickly during dry periods. Permeability is moderate. Runoff is very rapid. Boulders are dominantly 2 to 4 feet thick and 2 to 10 feet across, but some are smaller and a few are larger. They are spaced about 2.5 to 5 feet apart. In many areas they occur as rock rubble at the base of vertical cliffs or bedrock escarpments. Reaction is extremely acid to medium acid throughout the Arnot soils.

The very steep slopes, shallow depth to bedrock, boulders, and high percentage of exposed bedrock severely affect all uses. Most of the acreage of this unit is used for wildlife habitat. Some areas have potential for lookout points from the higher escarpments.

Vegetation is very sparse. Seedling mortality is high because of droughtiness.

Construction for urban and recreational developments is extremely difficult. Capability subclass VIIIs.

SaB—Schoharie silt loam, 3 to 8 percent slopes. This deep, gently sloping moderately well drained and well drained soil formed in lake-laid deposits of clay and silt. It is mainly moderately well drained. This soil is on low knolls and on ridgetops on dissected lake plains and other landforms that are mantled with lake sediment. Slopes are slightly convex. Most areas are long and narrow or irregular in shape and are 5 to 40 acres in size.

Typically, the surface layer is brown silt loam about 8 inches thick. The subsurface layer is leached, reddish brown silty clay loam about 2 inches thick. The subsoil extends to a depth of about 36 inches. It is firm and very firm, reddish brown silty clay and has mottles below a depth of 15 inches. The substratum to a depth of about 50 inches is mottled, reddish brown, varved silty clay and silty clay loam.

Included with this soil in mapping are small areas of somewhat poorly drained Odessa and Raynham soils in slight depressions and along drainageways. A few areas are included between Kerhonkson and Wawarsing in the Rondout Creek Valley and between Olive Bridge and Big Indian in the Esopus Creek Valley that have 6 to 35 inches of gravelly loam outwash, similar to the surface layer and upper part of the subsoil in Castile soils, over the lake sediment. Also included are narrow strips of Cayuga, Mardin, and Wellsboro soils that are in lake sediment less than 40 inches thick over glacial till; a few areas near Olive Bridge that have a surface layer of gravelly loam or gravelly silt loam; and small areas of Williamson soils that are more silty than this Schoharie soil.

This soil has a perched seasonal high water table at a depth of 18 to 36 inches in spring and in other excessively wet periods. Roots are mainly confined to the upper 20 to 30 inches, but a few extend below this depth. Available water capacity in the root zone is moderate to high. Permeability is moderately slow in the surface layer and is slow or very slow in the subsoil and substratum. This soil becomes puddled and cloddy if it is cultivated when wet. Runoff is medium. In unlimed areas, reaction is medium acid to neutral in the surface layer and is medium acid to mildly alkaline in the subsoil.

Most of the acreage of this soil is used for crops, pasture, and woodland. This soil has good potential for farming and for some recreational uses, but it has limited potential for urban development.

This soil is better suited to crops and pasture that support dairy farms and beef cattle farms than to most other uses. Seasonal wetness, slow permeability, and high content of clay and silt in the subsoil limit the suitability of this soil for special crops and fruit crops. Seasonal wetness delays planting in some years. This soil needs to be cultivated at the proper moisture condition because it is sticky when wet and hard when dry. Hard clods and a crusty surface form if the soil is cultivated when wet. Planting when this soil is very dry generally results in poor seed germination. The hazard of erosion is severe in cultivated areas that are not protected. Standard management practices, for example, contour farming, minimum tillage, use of cover crops, incorporating crop residue into the soil, crop rotation, good fertilization, and pasturing and harvesting at the proper moisture condition help to control erosion, improve tilth, and maintain the content of organic matter. Random drainage of the included wet spots is beneficial in some fields.

Woodland productivity is high. Machine planting of tree seedlings is practical on this soil.

The perched seasonal high water table, low strength, and slow and very slow permeability in the subsoil and substratum are limitations for urban uses. This soil is better suited to buildings without basements than to those with basements. Spread footings, foundation drains, and protective coatings on the exterior walls of basements are needed. The subbase of roads needs to be thicker than that commonly used. Effluent from many septic tank absorption fields seeps to the surface in this soil. Therefore, the absorption field needs to be much larger than those commonly installed. A vegetative cover maintained on the site during construction helps prevent erosion. Capability subclass IIe.

SaC—Schoharie silt loam, 8 to 15 percent slopes. This deep, moderately well drained and well drained, sloping soil formed in lake-laid deposits of clay and silt. It is mainly on dissected lake plains and other landforms that are mantled with lake sediment. Slopes are short and convex. Areas are long and narrow or irregular in shape and are 5 to 50 acres in size.

Typically, the surface layer is brown silt loam about 8 inches thick. The subsurface layer is leached, reddish brown silty clay loam about 2 inches thick. The subsoil extends to a depth of about 36 inches. It is firm and very firm, reddish brown silty clay and has mottles below a depth of 15 inches. The substratum to a depth of about

50 inches is mottled, reddish brown, varved silty clay and silty clay loam.

Included with this soil in mapping are narrow strips of somewhat poorly drained Odessa and Raynham soils that are in low-lying areas near drainageways; small areas on the upper part of many slopes of an eroded soil that has a surface layer of silty clay loam; and a few areas between Kerhonkson and Wawarsing in the Rondout Creek Valley and between Olive Bridge and Big Indian in the Esopus Creek Valley that have 6 to 35 inches of gravelly loam outwash, similar to the surface layer and upper part of the subsoil in Chenango soils, over the lake sediment. Also included are narrow strips of Cayuga, Wellsboro, and Mardin soils on the upper part of slopes where the lake sediment is less than 40 inches thick over glacial till and narrow strips of a soil that is similar to the Schoharie soil but has bedrock at a depth of 20 to 40 inches.

This soil has a perched seasonal high water table at a depth of 18 to 36 inches in spring and in other excessively wet periods. Roots are mainly confined to the upper 20 to 30 inches of the soil, but a few extend below this depth. Available water capacity in the root zone is moderate to high. Permeability is moderately slow in the surface layer and is slow or very slow in the subsoil and substratum. This soil becomes puddled and cloddy if it is cultivated when wet. Runoff is rapid. In unlimed areas, reaction is medium acid to neutral in the surface layer and is medium acid to mildly alkaline in the subsoil.

Most of the acreage of this soil is used for crops, pasture, and woodland. This soil has fair potential for farming, but it has limited potential for urban developments. It has potential for woodland and for some recreational uses, such as paths and trails.

This soil is suited to cultivated crops, but it is best suited to hay and pasture. Slope causes some difficulty in farming. Seasonal wetness, high content of clay and silt in the subsoil, and slow or very slow permeability also limit the suitability of this soil for special crops and fruit crops. If this soil is intensively used for intertilled crops, erosion is a major hazard. If proper management and conservation measures are practiced, intertilled crops can be grown, but the cropping system needs to include a high proportion of sod-forming crops and pasture. This soil needs to be cultivated at the proper moisture condition because it is sticky when wet and fairly hard when dry. Hard clods and a crusty surface forms if the soil is cultivated when wet. Planting when this soil is very dry generally results in poor seed germination. Standard management practices, for example, minimum tillage, use of cover crops, incorporating crop residue into the soil, contour farming, good fertilization, and pasturing and harvesting at the proper moisture condition, help to control erosion, improve tilth, and maintain the content of organic matter. The shallow waterways that cross some areas need special attention; some need permanent sod cover to control erosion, and others need drainage for wet spots.

Woodland productivity is high. Machine planting of tree seedlings is practical on this soil.

The perched seasonal high water table, low strength, slope, and slow or very slow permeability in the subsoil and substratum are limitations for most urban and recreational uses. Effluent from many septic tank absorption fields seeps to the surface in this soil. Therefore, the absorption field needs to be much larger than those commonly installed. Spread footings are needed because of low strength of the soil. Foundation drains and protective coatings on the exterior walls of basements are needed. Cut slopes are subject to slippage. The subbase of roads need to be thicker than that commonly used. The hazard of erosion is severe during construction. A vegetative cover maintained on the site during construction helps prevent erosion. Trails in recreational areas need to be protected from erosion and established across the slope wherever possible. In some areas, this soil is a suitable site for ponds. Capability subclass IIIe.

Sc—Scio silt loam. This deep, nearly level, moderately well drained soil formed in gravel-free, water-deposited material that is high in content of silt and very fine sand. It is mainly on stream terraces above the present flood plains, but a few areas are on glacial outwash terraces. Slope ranges from 0 to 2 percent. Most areas are oblong or long and narrow in shape and are 5 to 40 acres in size.

Typically, the surface layer is dark brown silt loam about 10 inches thick. The upper part of the subsoil to a depth of about 19 inches is friable, yellowish brown silt loam and has mottles below a depth of 14 inches. The lower part of the subsoil to a depth of about 35 inches is friable, mottled, brown and strong brown silt loam. The substratum to a depth of about 55 inches is mottled, brown silt loam in the upper part and mottled, reddish brown fine sandy loam in the lower part.

Included with this soil in mapping are narrow strips of Raynham soils that are wetter than this Scio soil and are in depressions; narrow strips of Unadilla soils that are drier and on slight rises; and a few areas of a soil that is similar to the Scio soil that has a somewhat higher reaction. Also included, in the Wallkill and Shawangunk Kill Valleys, are a few areas of soils that have stratified sand and gravel at a depth of 20 to 40 inches.

This soil mainly is on glacial outwash and stream terraces that are not subject to flooding. Some areas are on low stream terraces that are subject to flooding during periods of higher than normal rainfall. This soil has a seasonal high water table at a depth of 18 to 24 inches in spring and in other excessively wet periods. Roots are mainly confined to a depth of 18 to 24 inches, depending on the depth to the seasonal high water table. Available water capacity of this zone is moderate. Permeability is moderate in the surface layer and subsoil and is rapid to ıat can tolerate dryness are better suited than most ther crops. Flat stone fragments hinder tillage and har-esting. The hazard of erosion and loss of moisture ırough runoff are moderate concerns. Conserving mois-ıre, improving tilth, and maintaining the content of or-anic matter are needed. Such practices as minimum lage, use of cover crops, incorporating crop residue to the soil, crop rotation, and tillage at the proper oisture condition can be used. The use of lime and rtilizers is also important in management.

Woodland productivity is poor. Machine planting of ee seedlings is practical on this soil. Seedling mortality high because of droughtiness of the soil.

The shallow depth to bedrock severely limits most ımmunity development. Effluent from septic tank ab-ırption fields seeps over the bedrock and comes to the ırface at rock outcrop or in very shallow areas. A vege-tive cover maintained on the site helps to prevent osion. This soil has potential for some recreational es, even though the shallow depth to bedrock and/flat one fragments can present hazards for some uses. ıpability subclass IIIe.

ARD—Arnot-Lordstown-Rock outcrop complex, oderately steep. This map unit consists of shallow, mewhat excessively drained and moderately well ained Arnot soils; moderately deep, well drained Lord-ıwn soils; and exposed bedrock. These very bouldery ils formed in glacial till. The relief is affected by bed-ck. The surface generally has a stairstep appearance. e Arnot soils are on narrow benches and on the upper rt of slopes where the till mantle is 10 to 20 inches ck. The Lordstown soils are at the base of slopes and the wider benches where the till mantle is 20 to 40 hes thick. Sandstone and siltstone bedrock outcrops generally on the risers between benches. Slope ıges from 15 to 25 percent. Areas on the Shawangunk ıuntains are broad and irregular in shape and are 15 more than 300 acres in size. Those on the plateau iacent to the Catskill Mountains are long and narrow in ape and are 15 to 150 acres in size.

This unit is made up of about 35 percent Arnot very ıldery silt loam and very bouldery loam, 30 percent rdstown very bouldery silt loam and very bouldery m, 20 percent Rock outcrop, and 15 percent other ls. These soils and the Rock outcrop are in such an icate pattern that they are not shown separately on soil map.

Typically, the surface layer of the Arnot soil in a oded area is very dark grayish brown, very bouldery loam about 2 inches thick. The subsoil extends to a oth of 14 inches. It is friable, yellowish brown, very ınnery loam. Thick-bedded gray sandstone and silt-ne bedrock is below a depth of about 14 inches. Typically, the surface layer of the Lordstown soil is k brown, very bouldery silt loam 4 inches thick. The ble, yellowish brown subsoil extends to a depth of 32 inches. It is channery silt loam in the upper part and channery loam in the lower part. Thick-bedded gray sandstone and siltstone bedrock is at a depth of about 32 inches.

Included with this unit in mapping are Swartswood, Bath, Valois, and Hoosic soils that are intermingled with the Lordstown soils where the soil mantle is deep to bedrock; small areas of Tuller and Scriba soils that are in seeps and along drainageways; many areas of soils that have slopes of 25 to 35 percent; and some areas of soils on narrow benches that have slopes of 3 to 15 percent. Some included areas are nonbouldery, and a few areas have small spots of quarry rubble. Also includ-ed are large areas of soils that are similar to the Arnot and Lordstown soils but have a gravelly loam to gravelly sandy loam subsoil where the bedrock is quartz pebble conglomerate and sandstone.

The Arnot soil can have free water above the bedrock for periods in spring and after heavy rains. The root zone consists of 10 to 20 inches of well aerated soil over bedrock. A few roots penetrate fractures in the bedrock in some areas. Available water capacity is very low, and plants wilt quickly during dry periods.

Free water is occasionally above the bedrock for brief periods in the Lordstown soils after very rainy periods, but it is generally below a depth of 6 feet. The root zone consists of 20 to 40 inches of soil over bedrock. Availa-ble water capacity is low to moderate.

Permeability is moderate in both soils. Runoff is very rapid. Boulders are mainly 2 to 6 feet across and 1 to 2 feet thick, but many are smaller and a few are larger. Distance between boulders varies but is generally 5 to 30 feet. Boulders cover 0.1 to 3 percent of the surface of these soils. In unlimed areas, the Arnot soils are extremely acid to medium acid in the surface layer and subsoil. The surface layer and the subsoil of the Lord-stown soils are very strongly acid or strongly acid.

Most areas of this map unit are used for woodland and for wildlife habitat. The unit has poor potential for farm-ing and for urban uses, but has potential for some recre-ational uses, such as hiking.

Slope, rock outcrops, boulders, and moderately deep and shallow depth to bedrock are very severe limitations for farming. Some areas can be used for unimproved pasture.

Woodland productivity is poor on the Arnot soils and moderately high on the Lordstown soils. New plantations are difficult to establish. Drainage dips or water bars are needed to protect logging roads and skid trails from erosion.

The moderate and shallow depth to bedrock, slope, rock outcrops, and boulders make construction for urban and recreational uses extremely difficult. A few esthetic homesites are available but sites for sewage disposal are very limiting. The hazard of erosion is severe where vegetation is removed. Establishing trails in recreational areas across the slope wherever possible helps to protect them from erosion. Capability subclass VIIs.

ARF—Arnot-Oquaga-Rock outcrop complex, very steep. This map unit consists of a shallow, somewhat excessively drained and moderately well drained Arnot soils; moderately deep, well drained excessively drained Oquaga soils; and exposed bedrock. The Arnot soil is mainly in the somewhat excessivly drained part and the Oquaga soil is in the excessively drained part of the drainage range for their respective series. These very bouldery soils formed in glacial till over sandstone, siltstone, and shale bedrock on hillsides, valleysides, and mountains. The Arnot soil is intermingled with the Rock outcrop throughout the unit, but is mainly on back slopes. The Oquaga soil is near the base of slopes. Slope ranges from 35 to 70 percent. Areas of this unit on mountainsides are irregular in shape and are 25 to 500 acres in size. Areas in other positions are long and narrow in shape and are 15 to 150 acres in size.

This unit is made up of about 40 percent Arnot very bouldery silt loam, 30 percent Oquaga very bouldery silt loam, about 20 percent Rock outcrop, and 10 percent other soils. These soils and the Rock outcrop are in such an intricate pattern that they are not shown separately on the soil map.

Typically, the subsoil of the Arnot soil is directly under the forest litter and humus. The subsoil extends to a depth of 14 inches. It is friable, brown, very bouldery silt loam in the upper 3 inches and friable, brown, very channery silt loam in the lower 11 inches. Dusty red, fractured shale bedrock is at a depth of 14 inches.

Typically, the subsoil of the Oquaga soil in a wooded area is directly under the forest litter and humus. The subsoil extends to a depth of 26 inches. It is very friable, strong brown, very bouldery silt loam in the upper 5 inches and friable and very friable, yellowish red, very channery loam in the lower 21 inches. Olive gray sandstone bedrock is at a depth of 26 inches.

Included with this unit in mapping are Valois, Swartswood, Lackawanna, and Bath soils that are intermingled with the Oquaga soils at the base of slopes where soil depth is more than 40 inches. In the Shawangunk Mountains and on the plateau adjacent to the Catskill Mountains, the Oquaga position in this unit is made up of Lordstown soil. Also included are small spots of quarry rubble and small nonbouldery areas.

The Arnot soil can have free water above the bedrock for brief periods in spring and after heavy rain. The root zone consists of 10 to 20 inches of well aerated soil material over bedrock. A few roots penetrate fractures in the bedrock in some areas. Available water capacity is very low, and plants wilt quickly during dry periods.

Free water is occasionally above the bedrock for brief periods in the Oquaga soil after very rainy periods, but it is generally below a depth of 6 feet. The root zone consists of 20 to 40 inches of soil over bedrock. Available water capacity is low to moderate.

Permeability is moderate in both soils. Runoff is very rapid. Boulders are dominantly 2 to 6 feet across and 1 to 2 feet thick, but many are smaller and a few are larger. Distance between boulders varies, but it is generally 5 to 30 feet. Boulders cover 0.1 to 3 percent of the surface of these soils. Reaction is extremely acid to medium acid throughout both soils.

Most areas of this map unit are used for woodland and for wildlife habitat. Very steep slopes, rock outcrops, surface boulders, and moderate and shallow depth to bedrock prevent most uses other than woodland and wildlife habitat. Some areas are scenic spots and have potential for recreational developments.

Woodland productivity is poor on the Arnot soil and moderately high on the Oquaga soil. Logging and establishing new plantations are very difficult. Good design and drainage dips or water bars can be used to help protect logging roads and skid trails from erosion.

Construction for urban and recreational developments is extremely difficult. The hazard of erosion is very high in areas where vegetation is removed. Some of the higher areas have development potential as lookout points. Establishing trails across slope in recreational areas helps protect the soils from erosion. Capability subclass VIIs.

At—Atherton silt loam. This deep, nearly level, poorly drained and very poorly drained soil formed in glacial outwash. It is on flats or in depressions on glacial outwash terraces, stream terraces, and kame-and-kettle topography. It receives a large amount of runoff and seepage from adjacent soils. Slope ranges from 0 to 2 percent. Most areas are long and narrow or oval in shape and are 5 to 80 acres in size.

Typically, the surface layer is very dark gray silt loam 7 inches thick. The subsoil extends to a depth of 27 inches. The upper 6 inches is friable, mottled, gray silt loam; the next 6 inches is firm, mottled, gray, silty clay loam; the next 9 inches is firm, mottled, brown, gravelly loam; and the lower 6 inches is friable, mottled, brown gravelly sandy loam. The substratum to a depth of 65 inches is stratified gray sand, gravel, and very gravelly sandy loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Red Hook and Raynham soils that dry out earlier in spring than this Atherton soil. In a few broader depressions are small areas of Lamson soils that formed in water-sorted sands and Canandaigua soils that formed in lacustrine deposits of silt, very fine sand, and clay. Also included are small areas of soils that have a surface layer of mucky silt loam and gravelly silt loam.

In undrained areas of this soil, water is on or near the surface late in fall, in winter, and early in spring. Roots are mainly confined to the upper 10 to 15 inches of the helps to prevent erosion. Most areas have potential for paths and trails even though small stones and included Rock outcrops interfere with this use. Capability subclass VIs.

ORD—Oquaga-Arnot-Rock outcrop complex, moderately steep. This map unit consists of a moderately deep, well drained and excessively drained Oquaga soil; a shallow, somewhat excessively drained and moderately well drained Arnot soil; and small areas of exposed bedrock. These very bouldery soils formed in reddish glacial till over sandstone, siltstone, and shale bedrock in the Catskill Mountains and their foothills. Relief is affected by bedrock. These soils mainly are on a series of benches that have a stairstep appearance. The Oquaga soil is on benches and at the base of slopes where the till mantle is 20 to 40 inches thick. The Arnot soil is on narrow benches, slope breaks, and mountaintops where the till mantle is 10 to 20 inches thick. The risers between benches are generally made up of sandstone and siltstone bedrock. Slope ranges from 15 to 25 percent. Areas on mountainsides and foothills are broad or irregular in shape and are 40 to 300 acres in size. Those on mountaintops are long and narrow in shape and are 40 to 150 acres in size.

This unit is made up of about 35 percent Oquaga very bouldery silt loam, 30 percent Arnot very bouldery silt loam, 15 percent Rock outcrop, and 20 percent other soils. These soils and the Rock outcrop form such an intricate pattern that they are not shown separately on the soil map.

Typically, the subsoil of the Oquaga soil in a wooded area is directly under the forest litter and humus. The subsoil is very friable, strong brown very bouldery silt loam in the upper 5 inches and very friable and friable, yellowish red channery loam in the lower 20 inches. The substratum to a depth of about 32 inches is reddish brown very gravelly loam. Olive gray sandstone bedrock is at a depth of about 32 inches.

Typically, the subsoil of the Arnot soil in a wooded area is directly under the forest litter and humus. The subsoil is friable, brown very bouldery silt loam in the upper 3 inches and friable, reddish brown very channery silt loam in the lower 14 inches. Dusty red, fractured shale bedrock is at a depth of about 17 inches.

Included with this unit in mapping are Valois, Lackawanna, and Swartswood soils that are intermingled with the Oquaga soils at the base of slopes; small spots of Fuller and Morris soils that are in seeps; and areas of soils that have slopes of 25 to 35 percent and narrow benches that have slopes of 3 to 15 percent. Also included are a few areas of nonbouldery soils and narrow strips of Tunkhannock soils along streams in narrow valleys.

Free water is above the bedrock in the Oquaga soil for brief periods after very rainy periods, but it is generally below a depth of 6 feet. The root zone consists of the 20 to 40 inches of soil over the bedrock. Available water capacity is low to moderate.

The Arnot soil has free water above the bedrock for brief periods in spring and after heavy rain. The root zone consists of 10 to 20 inches of well aerated soil material over bedrock. A few roots penetrate fractures in the bedrock in some areas. Available water capacity is very low, and plants wilt quickly during dry periods.

Permeability is moderate in both soils. Runoff is very rapid. Boulders are mainly 2 to 6 feet across and 1 to 2 feet thick, but many are smaller and a few are larger. Distance between boulders is quite variable, but is generally 5 to 30 feet. Boulders cover about 0.1 to 3 percent of the surface of these soils. In unlimed areas, reaction is extremely acid to medium acid throughout both soils.

Most of the acreage of these soils and the Rock outcrop is used for woodland and for wildlife habitat to which it is suited. The unit has poor potential for farming and for urban uses, but it has potential for hiking.

The slope, outcrops, boulders, and moderate and shallow depth to bedrock are very severe limitations for farming. Fertilizing and mowing pasture are difficult.

Woodland productivity is moderately high on the Oquaga soil and poor on the Arnot soil. New plantations are difficult to establish. Logging roads and skid trails need drainage dips or water bars to protect them from erosion.

The moderately deep and shallow depth to bedrock, slope, outcrops, and boulders make construction for urban and recreational uses extremely difficult. Esthetic homesites are in some areas, but sites for sewage disposal can be very limiting. The hazard of erosion is high when vegetation is removed. Trails in recreational areas need to be protected from erosion and established across the slope wherever possible. Capability subclass VIIs.

Pa—Palms muck. This deep, nearly level to depressional, very poorly drained soil formed in 16 to 50 inches of well decomposed organic deposits over loamy mineral material. It is in basins that were formerly glacial lakes or ponds. Slope is generally less than 2 percent. Small areas generally are round, and larger areas are more irregular in shape. Areas are 5 to 100 acres in size.

Typically, the surface layer is very dark brown muck about 7 inches thick. The subsurface layer consists of slightly sticky and slightly plastic, very dark brown muck 37 inches thick. The mineral substratum to a depth of about 56 inches is dark gray sandy clay loam.

Included with this soil in mapping are small areas of Carlisle soils that are near the center of large basins; small areas of Palms Muck, bedrock variant soils, that are near shallow soils; and areas of Lyons, Canandaigua, Menlo, Atherton, Wayland, Madalin, and Lamson soils that formed in mineral material and are around the margins of areas and on very slight rises. Also included is an area of soil on the Wallkill Correctional Facility Farm that

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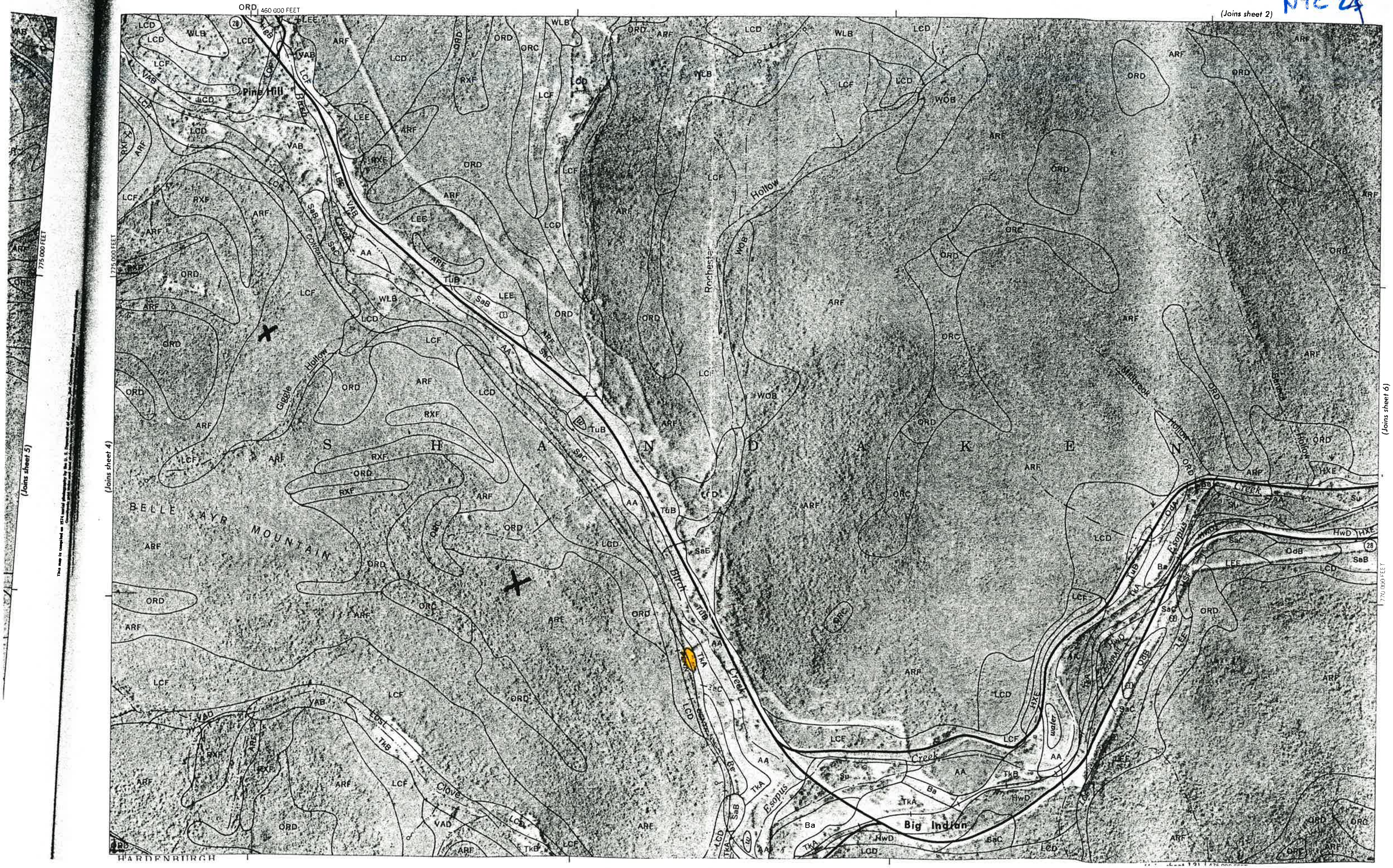

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City Ex 26

NEW YORK

Guidelines for Urban Erosion and Sediment Control

BASIC PRINCIPLES OF EROSION AND SEDIMENT CONTROL

The Erosion and Sedimentation Processes

The standards, specifications and planning guidelines presented in this document are intended to be utilized when development activities change the natural topography and vegetative cover of an area. It is necessary to formulate and implement erosion and sediment control plans with urban land development because such development can increase erosion and sediment problems. To understand how erosion and sediment rates are increased requires an understanding of the processes themselves.

Soil erosion is the removal of soil by water, wind, ice, or gravity. This document deals primarily with the types of soil erosion caused by rainfall and surface runoff. Raindrops strike the soil surface at a velocity of approximately 25-30 feet per second and can cause splash erosion. Raindrop erosion causes particles of soil to be detached from the soil mass and splash into the air. After the soil particles are dislodged, they can be transported by surface runoff, which results when the soil becomes too saturated to absorb falling rain or when the rain falls at an intensity greater than the rate at which the water can enter the soil. Scouring of the exposed soil surface by runoff can cause further erosion. Runoff can become concentrated into rivulets or well defined channels up to several inches deep. This advanced stage is called rill erosion. If rills and grooves remain unrepaired, they may develop into gullies when more concentrated runoff flows downslope.

Sediment deposition occurs when the rate of surface flow is insufficient for the transport of soil particles. The heavier particles, such as sand and gravel, transport less readily than the lighter silt and clay particles. Previously deposited sediment may be suspended by runoff from another storm and transported farther downslope. In this way, sediment is carried intermittently downstream from its upland point of origin.

Factors That Influence Erosion

The erosion potential of a site is determined by five factors; soil erodibility, vegetative cover, topography, climate and season. Although the factors are interrelated as determinants of erosion potential, they are discussed separately for easy understanding.

1. **Soil Erodibility** - The vulnerability of a soil to erosion is known as erodibility. The soil structure, texture, and percentage of organic matter influence its erodibility. The most erodible soils generally contain high proportions of silt and very fine sand. The presence of clay or organic matter tends to decrease soil erodibility. Clays are sticky and tend to bind soil particles together. Organic matter helps to maintain stable soil structure (aggregates).

2. **Vegetative Cover** - Vegetation protects soil from the erosive forces of raindrop impact and runoff scour in several ways. Vegetation (top growth) shields the soil surface from raindrop impact while the root mass holds soil particles in place. Grass buffer strips can be used to filter sediment from the surface runoff. Grasses also slow the velocity of runoff, and help maintain the infiltration capacity of a soil. The establishment and maintenance of vegetation are the most important factors in minimizing erosion during development.

3. **Topography** - Slope length and steepness greatly influence both the volume and velocity of surface runoff. Long slopes deliver more runoff to the base of slopes and steep slopes increase runoff velocity. Both conditions enhance the potential for erosion to occur.

4. **Climate** - Climate also affects erosion potential in an area. Rainfall characteristics such as frequency, intensity, and duration directly influence the amount of runoff that is generated. As the frequency of rainfall increases, water has less chance to drain through the soil between storms. The soil will remain saturated for longer periods of time and stormwater runoff volume may be potentially greater. Therefore, erosion risks are high where rainfall is frequent, intense, or lengthy.

5. **Season** - Seasonal variation in temperature and rainfall defines periods of high erosion potential during the year. A high erosion potential may exist in the spring when the surface soil first thaws and the ground underneath remains frozen. A low intensity rainfall may cause substantial erosion because the frozen subsoil prevents water infiltration. In addition the erosion potential increases during the summer months due to more frequent, high intensity rainfall.

STANDARD AND SPECIFICATIONS FOR LEVEL SPREADER

Definition

A non-erosive outlet for concentrated runoff constructed to disperse flow uniformly across the a slope.

Purpose

To convert concentrated flow to sheet flow and release it uniformly over a stabilized area.

Conditions Where Practice Applies

Where sediment-free storm runoff can be released in sheet flow down a stabilized slope without causing erosion; where a level lip can be constructed without filling; where the area below the level lip is uniform with a slope of 10% or less and the runoff will not re-concentrate after release; and where no traffic will be allowed over spreader.

Design Criteria

The design capacity shall be determined by estimating the peak flow from the 10 year storm. The drainage area shall be restricted to limit the maximum flows into the spreader to 30 cfs. The level spreader shall have the following minimum dimensions:

Design Flow (cfs)	Minimum Entrance Width (ft.)	Depth (ft.)	End Width (ft.)	Length (ft.)
0-10	10	0.5	3	10
10-20	16	0.6	3	20
20-30	24	0.7	3	30

A transition section 20 feet in length shall be constructed from the width of the diversion or channel to the width of the spreader to ensure uniform outflow. This last transition section will blend the diversion grade to zero grade at the beginning of the spreader.

Construct the level lip in undisturbed soil to a uniform height and zero grade over the length of the spreader. Protect the lip with an erosion resistant material or mat to prevent erosion and allow vegetation to become established.

The outlet area should be a generally smooth, well vegetated area no steeper than 10 percent.

See figure 5A.5 on page 5A.12 for details.

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The City of New York
Department of Environmental Protection

71 Smith Avenue
Kingston, New York
12401

Joel A. Miele Sr., P.E.
Commissioner

Bureau of Water Supply

Michael A. Principe, Ph.D.
Acting Deputy Commissioner

Tel (914) 340-7500
Fax (914) 340-7504

September 22, 2000

Arthur Rashap
Project Manager
Crossroads Ventures, LLC
P.O. Box 267
Andrew Lane Road
Mt. Tremper, NY 12457

Re: Request for Information on Monitoring Program at Belleayre Resort

Dear Mr. Rashap:

This letter is to respond to your letter of September 18, 2000 concerning DEP's monitoring program at the Belleayre Resort site. In the letter you seek the type of "information (that) is being collected that would be relevant to the studies we are undertaking for the DEIS now being prepared" and in which you express interest "in viewing one or two of the monitoring operations" that DEP is undertaking for the Belleayre Resort project.

Concerning the latter, please contact David VanValkenburg, Research Assistant (914 773-4474), who is managing the monitoring operation for the Belleayre Resort project. Mr. VanValkenburg will be pleased to arrange to meet with you, Kevin Franke or other Crossroads representatives to view these operations.

Concerning "information (that) is being collected that would be relevant to the studies we are undertaking for the DEIS now being prepared", in addition to laying out the objectives and methods proposed to monitor and assess stream impacts, the draft "Quality Assurance Project Plan for Monitoring of Tributaries Draining Properties of the Proposed Crossroads Ventures Development on Belleayre" (the QAPP), transmitted to you on July 10, 2000, details the type of information that is being collected in the program. Sections 7.2.2 through 7.3.3 identify this information and Table 3 on pages 11 and 12 lists the sampling frequency for each parameter.

While DEP is very interested to and will make information gathered in this monitoring program available, I want to re-iterate comments I made at the meeting with DEC of August 29, 2000 in New Paltz. DEP's monitoring program at Crossroads was not designed to provide information for the DEIS. At the meeting we discussed the fact that since DEP's monitoring program runs on a separate schedule from the DEIS, Crossroads Ventures should be implementing its own monitoring program to feed into the DEIS. By doing so, the DEIS will not be dependent on activities beyond Crossroads Ventures' control. Per the milestones in Table 1 of the QAPP, DEP is planning in July 2001 (barring unforseen events) to review the provisional baseline data collected so far. Again, DEP plans on sharing the product of that review with Crossroads Ventures.

I hope that the information provided here is helpful and that you do contact Mr. VanValkenburg to arrange to see the monitoring effort. If you have additional questions concerning the monitoring effort or if I can provide any other assistance, please feel free to call (845 6340-7533) or write.

Sincerely,

Jeffrey D. Graf
Program Manager
West of Hudson Community Planning

xc: Stern, Olson, VanValkenburg, Drake, Buchman
Kevin Franke, LA Group

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City DEP Ex. 28

Pesticides permitted for use on pp.8-11 of the Wildacres draft SPDES permit and p.18 of the Big Indian SPDES permit for which certified analytical methods do not currently exist.

pesticide	CAS No.
acephate	30560-19-1
dithiopyr	97886-45-8
ethofumesate	26225-79-6
fenoxaprop	66441-23-4
flutalonil	66332-96-5
fosetyl-Al	39148-24-8
glyphosate	1071-83-6
halosulfuron	100784-20-1
mefenoxam	0630-17-0
MSMA	2163-80-6
prodiamine	290991-21-2
propamocarb	24579-73-5
propiconazole	60207-90-1
triclopyr	55335-06-3
trifloxystrobin	141517-21-7
vinclozolin	50471-44-8

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Response to Specific Comments: Data Inaccuracies

Table 2-1 as presented in Chapter 2 of App. 26 of DEIS

Table 2-1
Population and Household Trends and Projections

	1990	2000	1990-2000 percent growth	2005	2000-2005 percent growth
Population					
Delaware County	47,225	48,055	1.8	45,504	-5.3
Greene County	44,739	48,195	7.7	49,729	3.2
Ulster County	165,304	177,749	7.5	167,687	5.7
Tri-County	257,268	273,999	6.5	262,920	-4
Study Area	10,472	10,552	0.8	10,570	0.2
Study Area as a percent of Tri-County Area	4.1	3.9	-5.4	4	4.4
Households					
Delaware County	17,646	19,270	9.2	17,627	-0.2
Greene County	16,596	18,256	10	18,741	3.8
Ulster County	[illegible]	67,499	11	63,380	1.5
Tri-County	95,049	105,025	10.5	99,748	1.6
Study Area	4,339	4,454	2.7	4,520	1.5
Study Area as a percent of Tri-County Area	4.6	4.2	-7.1	4.5	-0.1

Source: U.S. Census 2000; study area population and projected populations from Claritas, Inc., December 2000; Allee King Rosen & Fleming, Inc., December 2000.

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Response to Specific Comments: Data Inaccuracies

Table 2-1 with updated Claritas data

Table 2-1
Population and Household Trends and Projections

	1990	2000	1990-2000 percent growth	2003	2008	2000-2008 percent growth
Population						
Delaware County	47,225	48,055	1.8	48,219	48,442	0.8%
Greene County	44,739	48,195	7.7	48,880	49,934	3.6%
Ulster County	165,304	177,749	7.5	181,459	187,095	5.3%
Tri-County	257,268	273,999	6.5	278,558	285,471	4.2%
Study Area	12,092	13,475	11.4	13,827	14,370	6.6%
Study Area as a percent of Tri-County Area	4.7%	4.9%	4.6%	5.0%	5.0%	2.4%
Households						
Delaware County	17,646	19,270	9.2	19,700	20,365	5.7%
Greene County	16,596	18,256	10	18,794	19,689	7.8%
Ulster County	60,807	67,499	11	69,948	73,953	9.6%
Tri-County	95,049	105,025	10.5	108,442	114,007	8.6%
Study Area	5,005	5,769	15.3	6,006	6,385	10.7%
Study Area as a percent of Tri-County Area	5.3%	5.5%	4.3%	5.5%	5.6%	2.0%

Source: U.S. Census 2000; study area population and projected populations from Claritas, Inc., March 2004; AKRF, Inc., March 2004.

Study Area did show growth versus being flat in the DEIS analysis

Table 3
Potentially Developable Land on the NYS Route 28 Corridor
Primary Study Area Towns

	Undeveloped Parcels			Potentially Subdividable Parcels		
	# Parcels	Total Acres	Acreage with Slopes Less Than 20%	# Parcels	Total Acres	Acreage with Slopes Less Than 20%
Andes	90	1,566	910	30	1,360	473
Middletown	211	2,422	1,172	23	1,922	850
Shandaken	293	2,007	955	34	1,076	459
Olive	95	379	298	11	174	119
Total	**689**	**6,374**	**3,335**	**98**	**4,532**	**1,901**
Potentially Available for Development [1]					**4,042**	**1,411**

[1] Represents the total acres less 5 acres for each of the 98 existing houses
Source: Property assessment database records and RKG Associates, Inc.

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City DEP Ex. 30

Calculation of Export Coefficients for Tributaries on Belleayre Mountain

An analysis by the Water Quality Impact Assessment Group, WMS, DWQC

In anticipation of a proposed land use change on Belleayre Mountain, the Water Quality Impact Assessment group (WQIA) of the DEP Bureau of Water Supply's Division of Drinking Water Quality Control (DWQC) implemented a monitoring program of perennial tributaries draining the Mountain to document changes in water quality and quantity characteristics. During the environmental review process of the proposed project, DWQC staff noted that some of the baseline environmental characteristics as described in the Draft Environmental Impact Statement for the Resort on Belleayre Mountain (DEIS) did not comport with the data being gathered and reported from the monitored tributaries. DWQC staff have composed the following estimate of current export coefficients for total phosphorus (TP) and total suspended solids (TSS) from the tributaries, based on WQIA's monitoring data.

Tributary monitoring program

DWQC initiated the monitoring of five Belleayre Mountain tributaries and a control site ("SENECA") in late August 2000 after review and approval of a Quality Assurance Project Plan by the Division Chief and the Quality Assurance Officer. As part of the agreement granting access to property owned by the Developer of the proposed resort, Crossroads Ventures, water quality data collected were shared with the Developer annually. Table 1 lists some basic information regarding the tributaries, and Figure 1 is a map illustrating their locations.

Table 1. List of tributaries being sampled

Tributary	Waters Index Number, stream class	Site Code	Pre-development Watershed Area (mi^2)	Stream Slope[1]	Aspect
Lost Clove	H 171-53, B(T)	BELLOST	1.69	13.52%	E
unnamed trib. near E15	not listed	BELLE2	0.19	26.79%	NE
Giggle Hollow	H 171-52-3, B(T)	BELLEGIG	0.57	18.96%	NE
Unnamed trib. near Wild Acres Hotel	D-70-80-12-2, B	BELLE5	0.24	21.81%	N
Trib. near Todd Mtn. Road	D-70-80-10, B(T)	BELLETOD	1.29	11.42%	N

[1] Stream slope is calculated as the change in elevation divided by the stream length from the origin to the sample point.

Tributary	Waters Index Number, stream class	Site Code	Pre-development Watershed Area (mi^2)	Stream Slope[1]	Aspect
Seneca Hollow (control stream)	H 171-51, D	SENECA	0.7	19.64%	S

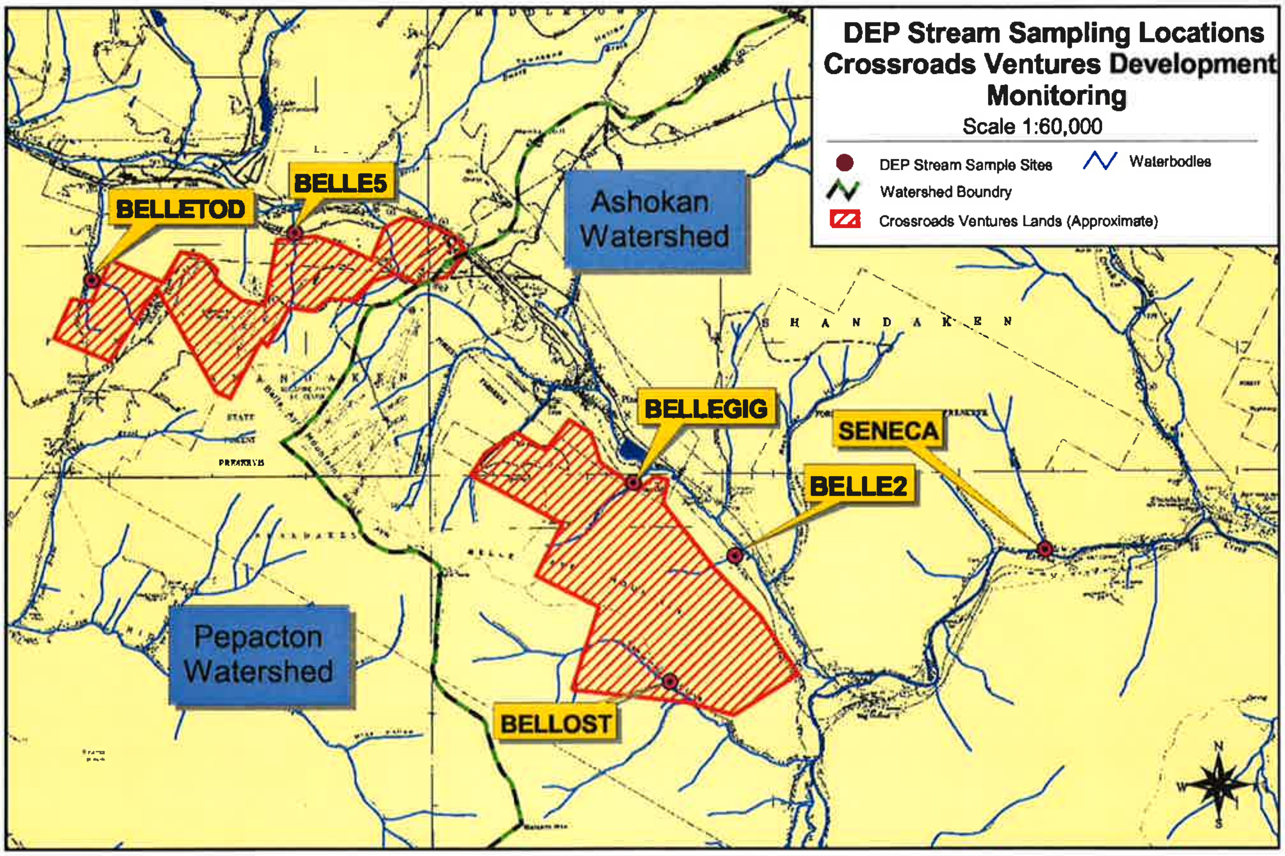

Figure 1. Map showing locations of sampling sites of the Belleayre Mountain tributary monitoring program.

The stream flow data record for the tributaries began in the spring and fall of 2001 with the installation of staff gages, pressure transducers, and the development of stage/discharge rating curves. Pressure transducers provide 15-minute interval stage (water depth) readings which are converted to discharge in cubic feet per second. The 96 15-minute interval readings are averaged to derive a mean daily discharge value for the site which is then recorded in the DWQC data set for this program. Given the difficulty accessing BELLE2, this site has not been instrumented. Because water quantity data is not available from BELLE2, it is excluded from the export coefficient analysis.

Water quality sampling during storm events using automated sampling and precipitation recording equipment was underway at four sites in 2002, and storm sampling at a fifth site, BELLETOD began in 2003.

<u>Derivation of Export coefficients</u>

The basic process for determining export coefficients is as follows.

First, pollutant loads are calculated by multiplying the concentration of a given pollutant (e.g., TP) by the volume of water carrying that concentration over a specified period of time. As explained below, both the concentrations and the volumes are derived from the WQIA data. Below are the algorithms for calculating TP and TSS loads in kilograms per day.

Step 1: Convert daily discharge to compatible units:
Q_{cfs} x 28.317 = $Q_{\text{liters per second}}$

Step 2: Calculate nutrient or sediment export:

$$\frac{[Q]\,liters}{second} \times \frac{86400\,\text{sec.}}{day} \times \frac{[TP]\,\mu g}{liter} \times \frac{kg}{10^9\,\mu g} = [L_{TP}]\,{}^{kg\,TP}/_{day}$$

Where the above equation reduces to:
$[Q]_{\text{cfs}}$ x $[C_{TP}]$ µg/L x 0.0024465888 = $[L_{TP}]$ kg TP / day
$[Q]_{\text{cfs}}$ x $[C_{TSS}]$ mg/L x 2.4465888 = $[L_{TSS}]$ kg TSS / day

Export coefficients are the pollutant load divided by the contributing area. In this exercise, daily discharge data and periodic sampling data are used to estimate export coefficients for five sampling sites in units of kilograms per hectare per year[2] (kg/ha/yr).

Step 3: Calculate an export coefficient in kilograms per hectare per year:

$$\frac{\dfrac{kg}{day} \times \dfrac{275\,days}{year}}{watershed\ area\,(hectares)} = kg\,/\,hectare\,/\,year$$

<u>Data used to calculate export coefficients</u>

As mentioned above, daily discharge data begin in late 2001, so a complete annual record only exists for 2002 and 2003. In order to generate coefficients that could be used in the WinSLAMM model in the DEIS, since WinSLAMM does not simulate loads during

[2] As noted below, for consistency with the analysis in the DEIS, we have used the period March – November as the "year."

frozen conditions, calculations in this analysis estimated loads and export coefficients using only data from March – November.

For several reasons, only the 2002 data were used to calculate export coefficients in this analysis. First, a heavy storm in late October 2003 altered stream stage/discharge relationships, so discharge is not available for November 2003. Moreover, the precipitation in 2002 was both more typical of the region and more similar to the data used in the DEIS than the precipitation in 2003. The DEIS used a precipitation quantity of 32 inches for its runs of WinSLAMM based upon the March – November 1993 precipitation value recorded at the DEP monitoring station in Tannersville (Appendix 10A, pdf p. 10 and p. 24). A review of precipitation data at the Arkville, N.Y. monitoring station found 31.41 inches of rain recorded in the March-November period for 1993, and 38.27 inches and 48.81 inches for the same months in 2002 and 2003, respectively.

Given the very high precipitation and resulting high stream discharges in 2003, the closer agreement between the 2002 rainfall quantity and the 1993 reference year quantity, as well as the incomplete discharge record for 2003, only 2002 discharge and water quality data were used to calculate the export coefficients reported here, and those data are attached as Appendices A and B, respectively.

DWQC has traditionally made intensive sampling of individual storm events part of its stream monitoring program due in part to the higher pollutant concentrations typically observed in storm water. The storm event data collected at Belleayre Mountain in 2002, as well as a single event collected in 2003, are set forth in Appendix C.

Regression analyses of flow and concentration relationships over the entire data set collected for the tributaries monitored at Belleayre Mountain generally found weak and unreliable relationships, although such regressions between flow and concentrations in the intensive storm sample data were stronger. However, statistical tests of central tendencies between the distributions of base flow and storm flow concentrations at each site indicated significant differences, so a decision was made to stratify storm flows from base flows for the purpose of estimating loads and export. To identify the dates of these two types of flow regimes, the precipitation record for the Arkville rain monitoring station for 2002 and 2003 was reviewed, and if 0.5" or more precipitation had fallen over the previous 48 hour period, the date was coded "S" in the "FLOWCODE" column of Data Appendix A to indicate a storm flow condition on that date. By identifying individual dates likely to be influenced by storm events, WQIA was able to make use of the available daily discharge data.

As described above, mean daily flow data are available for every date of interest in 2002. To provide corresponding concentration values for those dates on which no actual sample data are available, two separate methods of data substitution were employed. (1) For all base flow dates with no actual sample data, a flow-weighted mean concentration calculated from samples collected during base flow periods at each site was entered. (2) For storm flow dates with no actual sample data, separate flow-weighted mean values during storm events at each site were calculated from intensive time-series sampling using the data provided in Appendix C. The flow-weighted means for each storm at each site were averaged by site and used for storm flow dates with no actual sample data. These values are shown in Tables 2 and 3. As mentioned above, any time-series samples in the raw data which were collected within in a single date were averaged to arrive at single concentrations values for that date. If concentration data were available from samples collected during storms for any given date, the data were not substituted. Also, for both analytes, values below detection were considered to be present at one-half the detection limit. Note that the water quality data in Appendix B include averaged (where more than one sample existed for a given date) and converted (where analytes concentrations were below the analytical detection limit) values, not the actual raw data.

Table 2. Flow-weighted TP concentrations (µg/L) from time-series storm event sampling and average values used to substitute for storm dates with no actual sample data.

Storm date (precip)	BELLE5	BELLEGIG	BELLOST	BELLTOD*	SENECA
7/23/02 (0.63")	n.d.	47.8	20.9		40.7
9/27/02 (1.43")	21.1	29.4	18.3		56.2
10/16/02 (1.41")	26.1	23.6	47.4		60.1
Avg. conc.	**23.6**	**33.6**	**28.8**	**105.1**	**52.3**

*Only one storm event is available for BELLETOD, sampled on October 15, 2003.

Table 3. Flow-weighted TSS concentrations (mg/L) from time-series storm event sampling and average values used to substitute for storm dates with no actual sample data.

Storm date (precip)	BELLE5	BELLEGIG	BELLOST	BELLTOD*	SENECA
7/23/02 (0.63")	n.d.	3.39	2.36		8.57
9/27/02 (1.43")	1.58	2.19	2.99		20.24
10/16/02 (1.41")	16.93	3.11	34.69		22.58
Avg. conc.	**9.25**	**2.90**	**13.35**	**32.87**	**17.13**

*Only one storm event is available for BELLETOD, sampled on October 15, 2003.

Export coefficients based on data from the site

DWQC's daily discharge data (Appendix A) combined with actual water quality sample data (Appendix B), with values substituted for dates with no sampling data as described above, were used to calculate daily loads. Daily loads were converted into annual export mass values, and the results are presented in Tables 5 and 6 below. Export values from individual monitoring sites are presented as area-weighted means to derive estimates for the Pepacton watershed and Ashokan watershed sides of Belleayre Mountain separately, since the project plans land use changes on both sides. SENECA, the control site for this program and which is not located on Belleayre Mountain (see Figure 1), was not included in these calculations. All five sites were also combined into a single area-weighted average export value.

Since all sites used in this study monitor watersheds with predominantly forest land cover, the calculated export values are representative of export from forested watersheds in the Catskill Region. The overall mean TP export of 0.046 kg/ha/yr confirms the value of 0.05 kg/ha/yr used by DEP in the Phase II TMDL calculations (DEP 1999, p.21) for TP export from forested watersheds.

The coefficients presented here, based on sampling data gathered in accordance with an approved Quality Assurance Project Plan, and calculated using a relatively average period of precipitation, should be considered more accurate than literature values calculated from areas other than forested watersheds in the Catskill Mountain region for the purpose of examining the impact of land use changes to the forested watersheds that are affected by the proposed Belleayre Resort.

Table 5. Base flow ("B") and storm flow ("S") TP concentrations (µg/L) substituted for base flow and storm flow dates with no sample data, and resulting export coefficients by site, area-weighted mean export for sites within a particular basin (not including Seneca), and area-weighted mean export overall.

Site (area in hectares)	TP (µg/L)	TP export (kg/ha/yr)	Basin mean. TP export (kg/ha/yr)	Overall mean TP export (kg/ha/yr)
BELLETOD (334.109)	B: 9.4 S: 105.1	0.034	Pepacton: 0.033	0.046
BELLE5 (62.160)	B: 4.8 S: 23.6	0.024		
SENECA (181.299)	B: 12.4 S: 52.3	0.054		
BELLEGIG (147.629)	B: 13.1 S: 33.6	0.084	Ashokan: 0.052	
BELLOST (437.708)	B: 9.7 S: 28.8	0.042		

Table 6. Base flow ("B") and storm flow ("S") TSS concentrations (mg/L) substituted for base flow and storm flow dates with no sample data, and resulting export coefficients by site, area-weighted mean export for sites within a particular basin (not including Seneca), and area-weighted mean export overall.

Site (area in hectares)	TSS (mg/L)	TSS export (kg/ha/yr)	Basin mean. TSS export (kg/ha/yr)	Overall mean TSS export (kg/ha/yr)
BELLETOD (334.109)	B: 2.35 S: 32.87	10.052	Pepacton: 9.396	7.640
BELLE5 (62.160)	B: 0.26 S: 9.25	5.868		
SENECA (181.299)	B: 0.54 S: 17.13	8.070		
BELLEGIG (147.629)	B: 0.28 S: 2.90	3.512	Ashokan: 6.319	
BELLOST (437.708)	B: 0.28 S: 13.35	7.266		

<u>Reference:</u>

NYCDEP. March 1999. Methodology for Calculating Phase II Total Maximum Daily Loads (TMDLs) of Phosphorus for New York City Drinking Water Reservoirs. 34pp.

Appendix A. Discharge data for site BELLE5

Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode
3/1/2002	0.221468		4/16/2002	0.399610		6/1/2002	0.281000	
3/2/2002	0.221741		4/17/2002	0.374466		6/2/2002	0.269000	
3/3/2002	0.389816		4/18/2002	0.349184		6/3/2002	0.257000	
3/4/2002	0.329700		4/19/2002	0.356220		6/4/2002	0.245000	
3/5/2002	0.249298		4/20/2002	0.322344		6/5/2002	0.233461	S
3/6/2002	0.283023		4/21/2002	0.285799		6/6/2002	0.425148	S
3/7/2002	0.244382		4/22/2002	0.250520		6/7/2002	1.186478	S
3/8/2002	0.239737		4/23/2002	0.246725		6/8/2002	0.968524	
3/9/2002	0.239074		4/24/2002	0.242760		6/9/2002	0.723517	
3/10/2002	0.467849		4/25/2002	0.244649		6/10/2002	0.557934	
3/11/2002	0.417301		4/26/2002	0.243095		6/11/2002	0.461839	
3/12/2002	0.400318		4/27/2002	0.240855		6/12/2002	0.446438	
3/13/2002	0.339653		4/28/2002	0.406192	S	6/13/2002	0.381249	
3/14/2002	0.250377		4/29/2002	0.693224	S	6/14/2002	0.381572	
3/15/2002	0.245565		4/30/2002	0.682281	S	6/15/2002	0.359966	S
3/16/2002	0.291956		5/1/2002	0.681600		6/16/2002	0.448586	S
3/17/2002	0.246893		5/2/2002	0.653556		6/17/2002	0.412063	
3/18/2002	0.246386		5/3/2002	0.610969		6/18/2002	0.341653	
3/19/2002	0.245666		5/4/2002	0.569563		6/19/2002	0.249795	
3/20/2002	0.245052		5/5/2002	0.474207		6/20/2002	0.242990	
3/21/2002	0.242043		5/6/2002	0.375745		6/21/2002	0.239547	
3/22/2002	0.237439		5/7/2002	0.330589		6/22/2002	0.233854	
3/23/2002	0.235467		5/8/2002	0.300132		6/23/2002	0.237923	
3/24/2002	0.229508		5/9/2002	0.249555		6/24/2002	0.230893	
3/25/2002	0.228782		5/10/2002	0.247064		6/25/2002	0.225781	
3/26/2002	0.234783	S	5/11/2002	0.242290		6/26/2002	0.221127	
3/27/2002	0.686499	S	5/12/2002	0.244347		6/27/2002	0.215772	
3/28/2002	0.594462		5/13/2002	0.521774	S	6/28/2002	0.209614	
3/29/2002	0.586122		5/14/2002	0.806245	S	6/29/2002	0.200325	
3/30/2002	0.874742		5/15/2002	0.631217		6/30/2002	0.176682	
3/31/2002	0.873829		5/16/2002	0.593077		7/1/2002	0.136790	
4/1/2002	0.910596		5/17/2002	0.530998	S	7/2/2002	0.080019	
4/2/2002	0.799250		5/18/2002	0.680611	S	7/3/2002	0.050779	
4/3/2002	0.711131		5/19/2002	0.636526		7/4/2002	0.030300	
4/4/2002	0.628898		5/20/2002	0.631336		7/5/2002	0.015066	
4/5/2002	0.549194		5/21/2002	0.573015		7/6/2002	0.008330	
4/6/2002	0.513007		5/22/2002	0.513596		7/7/2002	0.004685	
4/7/2002	0.441562		5/23/2002	0.466368		7/8/2002	0.003402	
4/8/2002	0.409910		5/24/2002	0.412925		7/9/2002	0.004321	
4/9/2002	0.366209		5/25/2002	0.353114		7/10/2002	0.001647	
4/10/2002	0.353557		5/26/2002	0.336102		7/11/2002	0.001000	
4/11/2002	0.290791		5/27/2002	0.341000		7/12/2002	0.000000	
4/12/2002	0.286396		5/28/2002	0.329000		7/13/2002	0.000000	
4/13/2002	0.307227		5/29/2002	0.317000		7/14/2002	0.001000	
4/14/2002	0.323783	S	5/30/2002	0.305000		7/15/2002	0.000928	
4/15/2002	0.418893	S	5/31/2002	0.293000	S	7/16/2002	0.001000	

Appendix A. Discharge data for site BELLE5

Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode
7/17/2002	0.000000		9/1/2002	0.000000		10/17/2002	1.839567	S
7/18/2002	0.000000		9/2/2002	0.000000		10/18/2002	1.129072	
7/19/2002	0.001020	S	9/3/2002	0.000000	S	10/19/2002	0.774105	
7/20/2002	0.000000	S	9/4/2002	0.008461	S	10/20/2002	0.571766	
7/21/2002	0.000000	S	9/5/2002	0.000000		10/21/2002	0.451370	
7/22/2002	0.000000	S	9/6/2002	0.000000		10/22/2002	0.381120	
7/23/2002	0.001962		9/7/2002	0.000000		10/23/2002	0.321113	
7/24/2002	0.000000		9/8/2002	0.000000		10/24/2002	0.247727	
7/25/2002	0.000000		9/9/2002	0.000000		10/25/2002	0.242886	S
7/26/2002	0.000000		9/10/2002	0.000000		10/26/2002	0.334765	
7/27/2002	0.000000		9/11/2002	0.000000		10/27/2002	0.246505	
7/28/2002	0.000953		9/12/2002	0.000000		10/28/2002	0.243152	
7/29/2002	0.001000		9/13/2002	0.000000		10/29/2002	0.239276	
7/30/2002	0.000000		9/14/2002	0.000000		10/30/2002	0.237011	
7/31/2002	0.000000		9/15/2002	0.000000	S	10/31/2002	0.232541	
8/1/2002	0.000000		9/16/2002	0.000000	S	11/1/2002	0.229407	
8/2/2002	0.000000		9/17/2002	0.000000		11/2/2002	0.228353	
8/3/2002	0.000000		9/18/2002	0.000000		11/3/2002	0.223713	
8/4/2002	0.000000	S	9/19/2002	0.000000		11/4/2002	0.221728	
8/5/2002	0.000000	S	9/20/2002	0.000000		11/5/2002	0.220048	
8/6/2002	0.000000		9/21/2002	0.000000		11/6/2002	0.241305	
8/7/2002	0.000000		9/22/2002	0.000000	S	11/7/2002	0.233486	
8/8/2002	0.000000		9/23/2002	0.000000	S	11/8/2002	0.227979	
8/9/2002	0.000000		9/24/2002	0.000000		11/9/2002	0.229366	
8/10/2002	0.000000		9/25/2002	0.000000		11/10/2002	0.232212	
8/11/2002	0.000000		9/26/2002	0.000000	S	11/11/2002	0.233859	
8/12/2002	0.000000		9/27/2002	0.001584	S	11/12/2002	0.238408	S
8/13/2002	0.000000		9/28/2002	0.022535	S	11/13/2002	0.300537	S
8/14/2002	0.000000		9/29/2002	0.000000		11/14/2002	0.241198	
8/15/2002	0.000000		9/30/2002	0.000000		11/15/2002	0.287033	
8/16/2002	0.000000		10/1/2002	0.000000		11/16/2002	0.287671	S
8/17/2002	0.000000		10/2/2002	0.000000		11/17/2002	0.850601	S
8/18/2002	0.000000		10/3/2002	0.000000		11/18/2002	0.890768	S
8/19/2002	0.000000		10/4/2002	0.000000		11/19/2002	0.699606	
8/20/2002	0.000000		10/5/2002	0.000000		11/20/2002	0.623031	
8/21/2002	0.000000		10/6/2002	0.000000		11/21/2002	0.596831	
8/22/2002	0.000000		10/7/2002	0.000000		11/22/2002	0.805234	
8/23/2002	0.000000		10/8/2002	0.000000		11/23/2002	0.968598	
8/24/2002	0.000000		10/9/2002	0.000000	S	11/24/2002	0.777721	
8/25/2002	0.000000		10/10/2002	0.000000	S	11/25/2002	0.664322	
8/26/2002	0.000000		10/11/2002	0.001763	S	11/26/2002	0.577898	
8/27/2002	0.000000		10/12/2002	1.496294	S	11/27/2002	0.520100	
8/28/2002	0.000000		10/13/2002	0.993382		11/28/2002	0.452195	
8/29/2002	0.001831	S	10/14/2002	0.535683		11/29/2002	0.427390	
8/30/2002	0.000000	S	10/15/2002	0.355483	S	11/30/2002	0.384664	
8/31/2002	0.000000		10/16/2002	1.021569	S			

Appendix A. Discharge data for site BELLEGIG

Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode
3/1/2002	0.916535		4/16/2002	1.486062		6/1/2002	0.970660	
3/2/2002	0.877010		4/17/2002	1.637297		6/2/2002	0.909741	
3/3/2002	1.010099		4/18/2002	1.695403		6/3/2002	0.972411	
3/4/2002	1.153867		4/19/2002	1.697892		6/4/2002	0.925868	
3/5/2002	1.393154		4/20/2002	1.685015		6/5/2002	0.951385	S
3/6/2002	1.430516		4/21/2002	1.614093		6/6/2002	1.079218	S
3/7/2002	1.413666		4/22/2002	1.501796		6/7/2002	1.776921	S
3/8/2002	1.326537		4/23/2002	1.390695		6/8/2002	2.628403	
3/9/2002	1.293437		4/24/2002	1.268713		6/9/2002	2.695905	
3/10/2002	1.579582		4/25/2002	1.211183		6/10/2002	2.465876	
3/11/2002	1.835114		4/26/2002	1.154280		6/11/2002	2.243086	
3/12/2002	2.020972		4/27/2002	1.073672		6/12/2002	2.093938	
3/13/2002	1.989439		4/28/2002	1.156276	S	6/13/2002	1.892940	
3/14/2002	1.883831		4/29/2002	1.580455	S	6/14/2002	1.818245	
3/15/2002	1.762903		4/30/2002	2.349112	S	6/15/2002	1.779978	S
3/16/2002	1.731590		5/1/2002	2.701676		6/16/2002	1.765205	S
3/17/2002	1.626596		5/2/2002	2.740786		6/17/2002	1.706672	
3/18/2002	1.622657		5/3/2002	2.561153		6/18/2002	1.685741	
3/19/2002	1.630231		5/4/2002	2.298276		6/19/2002	1.602499	
3/20/2002	1.620580		5/5/2002	2.103668		6/20/2002	1.550266	
3/21/2002	1.574943		5/6/2002	1.880230		6/21/2002	1.426043	
3/22/2002	1.530203		5/7/2002	1.642964		6/22/2002	1.274753	
3/23/2002	1.447558		5/8/2002	1.632905		6/23/2002	1.165633	
3/24/2002	1.397074		5/9/2002	1.508615		6/24/2002	1.043347	
3/25/2002	1.310717		5/10/2002	1.388794		6/25/2002	0.959974	
3/26/2002	1.364532	S	5/11/2002	1.233387		6/26/2002	0.828794	
3/27/2002	1.873480	S	5/12/2002	1.189565		6/27/2002	0.732708	
3/28/2002	2.406415		5/13/2002	1.324702	S	6/28/2002	0.647856	
3/29/2002	2.711535		5/14/2002	1.739131	S	6/29/2002	0.572703	
3/30/2002	2.936423		5/15/2002	2.597813		6/30/2002	0.511817	
3/31/2002	3.616481		5/16/2002	2.748187		7/1/2002	0.488106	
4/1/2002	4.067099		5/17/2002	2.624677	S	7/2/2002	0.460269	
4/2/2002	3.673176		5/18/2002	2.613650	S	7/3/2002	0.413499	
4/3/2002	3.194991		5/19/2002	2.399570		7/4/2002	0.392288	
4/4/2002	2.805961		5/20/2002	2.354428		7/5/2002	0.363547	
4/5/2002	2.505059		5/21/2002	2.332395		7/6/2002	0.327465	
4/6/2002	2.255878		5/22/2002	2.237506		7/7/2002	0.273028	
4/7/2002	2.048454		5/23/2002	2.074321		7/8/2002	0.256267	
4/8/2002	1.859603		5/24/2002	1.894143		7/9/2002	0.228076	
4/9/2002	1.709452		5/25/2002	1.656495		7/10/2002	0.260771	
4/10/2002	1.603998		5/26/2002	1.478740		7/11/2002	0.241158	
4/11/2002	1.502553		5/27/2002	1.329369		7/12/2002	0.218985	
4/12/2002	1.402225		5/28/2002	1.218407		7/13/2002	0.204847	
4/13/2002	1.351955		5/29/2002	1.136020		7/14/2002	0.199101	
4/14/2002	1.350327	S	5/30/2002	1.082425		7/15/2002	0.189018	
4/15/2002	1.396809	S	5/31/2002	1.040658	S	7/16/2002	0.163581	

Appendix A. Discharge data for site BELLEGIG

Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode
7/17/2002	0.166279		9/1/2002	0.042688		10/17/2002	6.645016	S
7/18/2002	0.153801		9/2/2002	0.041595		10/18/2002	4.995365	
7/19/2002	0.167435	S	9/3/2002	0.040254	S	10/19/2002	3.646723	
7/20/2002	0.153503	S	9/4/2002	0.078127	S	10/20/2002	2.956896	
7/21/2002	0.131952	S	9/5/2002	0.059966		10/21/2002	2.460859	
7/22/2002	0.090487	S	9/6/2002	0.043923		10/22/2002	2.041972	
7/23/2002	0.125812		9/7/2002	0.041855		10/23/2002	1.761693	
7/24/2002	0.092070		9/8/2002	0.040096		10/24/2002	1.526013	
7/25/2002	0.087287		9/9/2002	0.037826		10/25/2002	1.333092	S
7/26/2002	0.084427		9/10/2002	0.032725		10/26/2002	1.322436	
7/27/2002	0.082619		9/11/2002	0.026165		10/27/2002	1.240134	
7/28/2002	0.082689		9/12/2002	0.021870		10/28/2002	1.180566	
7/29/2002	0.081233		9/13/2002	0.020551		10/29/2002	1.156589	
7/30/2002	0.078431		9/14/2002	0.018394		10/30/2002	1.115384	
7/31/2002	0.075757		9/15/2002	0.026539	S	10/31/2002	1.067826	
8/1/2002	0.072495		9/16/2002	0.040126	S	11/1/2002	1.013384	
8/2/2002	0.074076		9/17/2002	0.034593		11/2/2002	0.992101	
8/3/2002	0.070938		9/18/2002	0.027691		11/3/2002	0.937284	
8/4/2002	0.067986	S	9/19/2002	0.022475		11/4/2002	0.868610	
8/5/2002	0.071375	S	9/20/2002	0.018497		11/5/2002	0.818775	
8/6/2002	0.067143		9/21/2002	0.015569		11/6/2002	0.866200	
8/7/2002	0.065127		9/22/2002	0.041240	S	11/7/2002	0.849711	
8/8/2002	0.062082		9/23/2002	0.042600	S	11/8/2002	0.816616	
8/9/2002	0.059504		9/24/2002	0.036351		11/9/2002	0.804192	
8/10/2002	0.057102		9/25/2002	0.032324		11/10/2002	0.865259	
8/11/2002	0.054991		9/26/2002	0.031568	S	11/11/2002	0.970253	
8/12/2002	0.052263		9/27/2002	0.078278	S	11/12/2002	1.069438	S
8/13/2002	0.049624		9/28/2002	0.210681	S	11/13/2002	1.258616	S
8/14/2002	0.047468		9/29/2002	0.137905		11/14/2002	1.378293	
8/15/2002	0.043894		9/30/2002	0.083540		11/15/2002	1.469295	
8/16/2002	0.043831		10/1/2002	0.077874		11/16/2002	1.498857	S
8/17/2002	0.043674		10/2/2002	0.075817		11/17/2002	2.056337	S
8/18/2002	0.042512		10/3/2002	0.076317		11/18/2002	3.017252	S
8/19/2002	0.041261		10/4/2002	0.076922		11/19/2002	3.522401	
8/20/2002	0.041046		10/5/2002	0.087303		11/20/2002	3.262934	
8/21/2002	0.039574		10/6/2002	0.087470		11/21/2002	2.955630	
8/22/2002	0.038763		10/7/2002	0.086550		11/22/2002	2.874274	
8/23/2002	0.038219		10/8/2002	0.086454		11/23/2002	3.205891	
8/24/2002	0.044597		10/9/2002	0.087050	S	11/24/2002	3.436963	
8/25/2002	0.043616		10/10/2002	0.087591	S	11/25/2002	3.122703	
8/26/2002	0.040945		10/11/2002	0.158892	S	11/26/2002	2.756175	
8/27/2002	0.038329		10/12/2002	1.768533	S	11/27/2002	2.393098	
8/28/2002	0.034892		10/13/2002	3.172683		11/28/2002	2.031909	
8/29/2002	0.066166	S	10/14/2002	2.463305		11/29/2002	1.798311	
8/30/2002	0.069646	S	10/15/2002	2.022411	S	11/30/2002	1.613117	
8/31/2002	0.047536		10/16/2002	2.683084	S			

Appendix A. Discharge data for site BELLETOD

Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode
3/1/2002	0.633153		4/16/2002	0.802294		6/1/2002	0.793378	
3/2/2002	0.607772		4/17/2002	0.966893		6/2/2002	0.715428	
3/3/2002	0.812768		4/18/2002	0.965040		6/3/2002	0.676350	
3/4/2002	0.737180		4/19/2002	0.984787		6/4/2002	0.598559	
3/5/2002	0.734789		4/20/2002	0.957716		6/5/2002	0.638127	S
3/6/2002	0.766045		4/21/2002	0.924921		6/6/2002	1.027223	S
3/7/2002	0.777562		4/22/2002	0.881380		6/7/2002	2.024448	S
3/8/2002	0.769195		4/23/2002	0.816426		6/8/2002	2.063925	
3/9/2002	0.766845		4/24/2002	0.756381		6/9/2002	1.812807	
3/10/2002	1.009287		4/25/2002	0.795342		6/10/2002	1.560403	
3/11/2002	0.886692		4/26/2002	0.745903		6/11/2002	1.374534	
3/12/2002	0.913077		4/27/2002	0.676350		6/12/2002	1.415897	
3/13/2002	0.927807		4/28/2002	0.921262	S	6/13/2002	1.227134	
3/14/2002	0.914448		4/29/2002	1.122230	S	6/14/2002	1.183534	
3/15/2002	0.888506		4/30/2002	1.375074	S	6/15/2002	1.114036	S
3/16/2002	0.966707		5/1/2002	1.541629		6/16/2002	1.218749	S
3/17/2002	0.902866		5/2/2002	1.613667		6/17/2002	1.054339	
3/18/2002	0.893080		5/3/2002	1.512340		6/18/2002	0.978488	
3/19/2002	0.867929		5/4/2002	1.398977		6/19/2002	0.935289	
3/20/2002	0.878935		5/5/2002	1.296796		6/20/2002	0.845158	
3/21/2002	0.899971		5/6/2002	1.223761		6/21/2002	0.778693	
3/22/2002	0.863666		5/7/2002	1.131895		6/22/2002	0.738899	
3/23/2002	0.824778		5/8/2002	1.031915		6/23/2002	0.801361	
3/24/2002	0.801746		5/9/2002	0.981852		6/24/2002	0.684810	
3/25/2002	0.765832		5/10/2002	0.888740		6/25/2002	0.619121	
3/26/2002	0.942079	S	5/11/2002	0.813376		6/26/2002	0.573050	
3/27/2002	1.685364	S	5/12/2002	0.837747		6/27/2002	0.516480	
3/28/2002	1.720916		5/13/2002	1.180097	S	6/28/2002	0.448333	
3/29/2002	1.731685		5/14/2002	1.540360	S	6/29/2002	0.385960	
3/30/2002	1.819649		5/15/2002	1.672165		6/30/2002	0.338489	
3/31/2002	1.783177		5/16/2002	1.645601		7/1/2002	0.291694	
4/1/2002	1.868131		5/17/2002	1.571211	S	7/2/2002	0.243103	
4/2/2002	1.715344		5/18/2002	2.006569	S	7/3/2002	0.194100	
4/3/2002	1.689620		5/19/2002	1.843737		7/4/2002	0.160753	
4/4/2002	1.571083		5/20/2002	1.818197		7/5/2002	0.131297	
4/5/2002	1.467348		5/21/2002	1.791127		7/6/2002	0.110228	
4/6/2002	1.351889		5/22/2002	1.689155		7/7/2002	0.087298	
4/7/2002	1.219965		5/23/2002	1.596174		7/8/2002	0.069367	
4/8/2002	1.137774		5/24/2002	1.482536		7/9/2002	0.067103	
4/9/2002	1.058062		5/25/2002	1.287446		7/10/2002	0.050929	
4/10/2002	1.096356		5/26/2002	1.179467		7/11/2002	0.037099	
4/11/2002	0.993749		5/27/2002	1.057932		7/12/2002	0.022881	
4/12/2002	0.919585		5/28/2002	0.968252		7/13/2002	0.015504	
4/13/2002	0.865911		5/29/2002	0.863781		7/14/2002	0.009969	
4/14/2002	0.858328	S	5/30/2002	0.791526		7/15/2002	0.006407	
4/15/2002	0.955262	S	5/31/2002	0.874059	S	7/16/2002	0.003635	

Appendix A. Discharge data for site BELLETOD

Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode
7/17/2002	0.001885		9/1/2002	0.000000		10/17/2002	2.080714	S
7/18/2002	0.000717		9/2/2002	0.000000		10/18/2002	1.623298	
7/19/2002	0.009021	S	9/3/2002	0.000000	S	10/19/2002	1.458512	
7/20/2002	0.002363	S	9/4/2002	0.048268	S	10/20/2002	1.318004	
7/21/2002	0.000349	S	9/5/2002	0.001000		10/21/2002	1.136373	
7/22/2002	0.001000	S	9/6/2002	0.000000		10/22/2002	1.017520	
7/23/2002	0.005773		9/7/2002	0.000000		10/23/2002	0.907085	
7/24/2002	0.001903		9/8/2002	0.000000		10/24/2002	0.804579	
7/25/2002	0.001000		9/9/2002	0.000000		10/25/2002	0.745431	S
7/26/2002	0.001000		9/10/2002	0.000000		10/26/2002	0.858271	
7/27/2002	0.001000		9/11/2002	0.000000		10/27/2002	0.757227	
7/28/2002	0.001000		9/12/2002	0.000000		10/28/2002	0.708151	
7/29/2002	0.000242		9/13/2002	0.000000		10/29/2002	0.658903	
7/30/2002	0.001000		9/14/2002	0.000000		10/30/2002	0.634855	
7/31/2002	0.001000		9/15/2002	0.000000	S	10/31/2002	0.594418	
8/1/2002	0.001000		9/16/2002	0.000000	S	11/1/2002	0.573494	
8/2/2002	0.001000		9/17/2002	0.000000		11/2/2002	0.548541	
8/3/2002	0.001000		9/18/2002	0.000000		11/3/2002	0.510477	
8/4/2002	0.001000	S	9/19/2002	0.000000		11/4/2002	0.504315	
8/5/2002	0.001000	S	9/20/2002	0.000000		11/5/2002	0.486870	
8/6/2002	0.001000		9/21/2002	0.000000		11/6/2002	0.655548	
8/7/2002	0.001000		9/22/2002	0.001000	S	11/7/2002	0.497892	
8/8/2002	0.000000		9/23/2002	0.001000	S	11/8/2002	0.493946	
8/9/2002	0.000000		9/24/2002	0.000000		11/9/2002	0.505257	
8/10/2002	0.000000		9/25/2002	0.000000		11/10/2002	0.532675	
8/11/2002	0.000000		9/26/2002	0.000000	S	11/11/2002	0.555910	
8/12/2002	0.000000		9/27/2002	0.001000	S	11/12/2002	0.703687	S
8/13/2002	0.000000		9/28/2002	0.028052	S	11/13/2002	0.858665	S
8/14/2002	0.000000		9/29/2002	0.001000		11/14/2002	0.829231	
8/15/2002	0.000000		9/30/2002	0.001000		11/15/2002	0.833649	
8/16/2002	0.000000		10/1/2002	0.000000		11/16/2002	0.920839	S
8/17/2002	0.000000		10/2/2002	0.000000		11/17/2002	1.830085	S
8/18/2002	0.000000		10/3/2002	0.000000		11/18/2002	2.127851	S
8/19/2002	0.000000		10/4/2002	0.000000		11/19/2002	2.121301	
8/20/2002	0.000000		10/5/2002	0.001000		11/20/2002	2.031746	
8/21/2002	0.000000		10/6/2002	0.001000		11/21/2002	1.968563	
8/22/2002	0.000000		10/7/2002	0.000000		11/22/2002	2.257920	
8/23/2002	0.000000		10/8/2002	0.000000		11/23/2002	2.482276	
8/24/2002	0.001000		10/9/2002	0.000000	S	11/24/2002	2.389922	
8/25/2002	0.001000		10/10/2002	0.000000	S	11/25/2002	2.170093	
8/26/2002	0.000000		10/11/2002	0.001000	S	11/26/2002	1.963407	
8/27/2002	0.000000		10/12/2002	0.440784	S	11/27/2002	1.818022	
8/28/2002	0.000000		10/13/2002	0.105040		11/28/2002	1.651393	
8/29/2002	0.001000	S	10/14/2002	0.123285		11/29/2002	1.551595	
8/30/2002	0.001000	S	10/15/2002	0.148227	S	11/30/2002	1.469545	
8/31/2002	0.000000		10/16/2002	1.190003	S			

Appendix A. Discharge for BELLOST

Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode
3/1/2002	2.505096		4/16/2002	2.749331		6/1/2002	2.026888	
3/2/2002	2.417392		4/17/2002	2.897751		6/2/2002	1.833395	
3/3/2002	3.493164		4/18/2002	2.904151		6/3/2002	1.660171	
3/4/2002	3.598068		4/19/2002	2.881241		6/4/2002	1.508487	
3/5/2002	3.919724		4/20/2002	2.701519		6/5/2002	1.606730	S
3/6/2002	4.047862		4/21/2002	2.539686		6/6/2002	2.328150	S
3/7/2002	3.936390		4/22/2002	2.408182		6/7/2002	4.131965	S
3/8/2002	3.703896		4/23/2002	2.257861		6/8/2002	4.520445	
3/9/2002	3.700570		4/24/2002	2.072589		6/9/2002	4.438651	
3/10/2002	5.149754		4/25/2002	2.089801		6/10/2002	4.048762	
3/11/2002	3.717383		4/26/2002	1.990558		6/11/2002	3.724961	
3/12/2002	3.759812		4/27/2002	1.831585		6/12/2002	3.506883	
3/13/2002	3.586913		4/28/2002	2.389743	S	6/13/2002	3.193456	
3/14/2002	3.453006		4/29/2002	3.826720	S	6/14/2002	3.069771	
3/15/2002	3.249191		4/30/2002	4.604029	S	6/15/2002	2.932121	S
3/16/2002	3.245119		5/1/2002	4.717519		6/16/2002	3.022916	S
3/17/2002	2.928731		5/2/2002	4.922944		6/17/2002	2.942835	
3/18/2002	2.891001		5/3/2002	5.253804		6/18/2002	2.793055	
3/19/2002	2.838789		5/4/2002	4.932394		6/19/2002	2.542399	
3/20/2002	2.786744		5/5/2002	4.573457		6/20/2002	2.405521	
3/21/2002	2.717828		5/6/2002	4.265035		6/21/2002	2.211377	
3/22/2002	2.524951		5/7/2002	3.987853		6/22/2002	2.119766	
3/23/2002	2.328808		5/8/2002	3.571775		6/23/2002	2.018603	
3/24/2002	2.243409		5/9/2002	3.225526		6/24/2002	1.885575	
3/25/2002	2.103100		5/10/2002	2.947662		6/25/2002	1.691302	
3/26/2002	2.228667	S	5/11/2002	2.632853		6/26/2002	1.616098	
3/27/2002	4.044958	S	5/12/2002	2.514301		6/27/2002	1.551498	
3/28/2002	4.373230		5/13/2002	3.112872	S	6/28/2002	1.380977	
3/29/2002	4.285452		5/14/2002	4.116243	S	6/29/2002	1.300272	
3/30/2002	5.083613		5/15/2002	4.608432		6/30/2002	1.135353	
3/31/2002	5.635254		5/16/2002	4.588315		7/1/2002	1.093779	
4/1/2002	5.703448		5/17/2002	4.437823	S	7/2/2002	1.007585	
4/2/2002	5.172282		5/18/2002	4.685626	S	7/3/2002	0.912782	
4/3/2002	4.919294		5/19/2002	4.491320		7/4/2002	0.854121	
4/4/2002	4.394654		5/20/2002	4.489242		7/5/2002	0.731062	
4/5/2002	3.951267		5/21/2002	4.401461		7/6/2002	0.631834	
4/6/2002	3.611874		5/22/2002	4.292402		7/7/2002	0.537105	
4/7/2002	2.771687		5/23/2002	4.054771		7/8/2002	0.449917	
4/8/2002	3.009396		5/24/2002	3.801825		7/9/2002	0.411810	
4/9/2002	2.624272		5/25/2002	3.430142		7/10/2002	0.360295	
4/10/2002	2.229314		5/26/2002	3.176546		7/11/2002	0.269169	
4/11/2002	2.019540		5/27/2002	2.901128		7/12/2002	0.241953	
4/12/2002	1.818325		5/28/2002	2.650219		7/13/2002	0.234000	
4/13/2002	2.121515		5/29/2002	2.428508		7/14/2002	0.224648	
4/14/2002	2.192526	S	5/30/2002	2.216058		7/15/2002	0.218663	
4/15/2002	2.546640	S	5/31/2002	2.182560	S	7/16/2002	0.215190	

Appendix A. Discharge for BELLOST

Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode
7/17/2002	0.210752		9/1/2002	0.108927		10/17/2002	12.380448	S
7/18/2002	0.203723		9/2/2002	0.091620		10/18/2002	8.161748	
7/19/2002	0.211845	S	9/3/2002	0.087773	S	10/19/2002	6.229733	
7/20/2002	0.213771	S	9/4/2002	0.125122	S	10/20/2002	4.760717	
7/21/2002	0.207002	S	9/5/2002	0.123741		10/21/2002	3.836049	
7/22/2002	0.193473	S	9/6/2002	0.104150		10/22/2002	3.323430	
7/23/2002	0.198898		9/7/2002	0.089632		10/23/2002	2.940826	
7/24/2002	0.194745		9/8/2002	0.078759		10/24/2002	2.605847	
7/25/2002	0.190622		9/9/2002	0.073215		10/25/2002	2.367052	S
7/26/2002	0.180049		9/10/2002	0.058889		10/26/2002	2.726058	
7/27/2002	0.174708		9/11/2002	0.045902		10/27/2002	2.619047	
7/28/2002	0.170569		9/12/2002	0.038223		10/28/2002	2.383220	
7/29/2002	0.178728		9/13/2002	0.036381		10/29/2002	2.255031	
7/30/2002	0.170522		9/14/2002	0.033903		10/30/2002	2.098050	
7/31/2002	0.168313		9/15/2002	0.036301	S	10/31/2002	1.970543	
8/1/2002	0.158598		9/16/2002	0.077512	S	11/1/2002	1.900897	
8/2/2002	0.153578		9/17/2002	0.072200		11/2/2002	1.742169	
8/3/2002	0.150337		9/18/2002	0.062503		11/3/2002	1.607797	
8/4/2002	0.141619	S	9/19/2002	0.051484		11/4/2002	1.474747	
8/5/2002	0.151753	S	9/20/2002	0.046942		11/5/2002	1.414367	
8/6/2002	0.136773		9/21/2002	0.036658		11/6/2002	1.740301	
8/7/2002	0.125490		9/22/2002	0.079550	S	11/7/2002	1.764368	
8/8/2002	0.118982		9/23/2002	0.082281	S	11/8/2002	1.712589	
8/9/2002	0.112139		9/24/2002	0.070584		11/9/2002	1.941685	
8/10/2002	0.105201		9/25/2002	0.064247		11/10/2002	2.179283	
8/11/2002	0.097646		9/26/2002	0.061935	S	11/11/2002	2.485971	
8/12/2002	0.089875		9/27/2002	0.162598	S	11/12/2002	2.748387	S
8/13/2002	0.084988		9/28/2002	0.291750	S	11/13/2002	3.623940	S
8/14/2002	0.077739		9/29/2002	0.250655		11/14/2002	3.695974	
8/15/2002	0.074611		9/30/2002	0.208927		11/15/2002	3.686958	
8/16/2002	0.072356		10/1/2002	0.185249		11/16/2002	3.561482	S
8/17/2002	0.072961		10/2/2002	0.170007		11/17/2002	5.948979	S
8/18/2002	0.073979		10/3/2002	0.164427		11/18/2002	8.454746	S
8/19/2002	0.068306		10/4/2002	0.156502		11/19/2002	8.045018	
8/20/2002	0.062588		10/5/2002	0.186735		11/20/2002	7.257168	
8/21/2002	0.056819		10/6/2002	0.186922		11/21/2002	6.986057	
8/22/2002	0.052952		10/7/2002	0.186558		11/22/2002	7.961617	
8/23/2002	0.051244		10/8/2002	0.175469		11/23/2002	10.120632	
8/24/2002	0.077300		10/9/2002	0.171849	S	11/24/2002	9.067432	
8/25/2002	0.088067		10/10/2002	0.170712	S	11/25/2002	7.764452	
8/26/2002	0.079732		10/11/2002	0.211981	S	11/26/2002	6.648095	
8/27/2002	0.069577		10/12/2002	0.749519	S	11/27/2002	5.690044	
8/28/2002	0.055848		10/13/2002	0.749665		11/28/2002	4.778614	
8/29/2002	0.138028	S	10/14/2002	0.659066		11/29/2002	4.193207	
8/30/2002	0.176434	S	10/15/2002	0.591965	S	11/30/2002	3.759886	
8/31/2002	0.136112		10/16/2002	0.816685	S			

Appendix A. Discharge for site SENECA

Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode
3/1/2002	0.346172		4/16/2002	0.736000		6/1/2002	0.726440	
3/2/2002	0.319455		4/17/2002	0.741026		6/2/2002	0.654782	
3/3/2002	0.524627		4/18/2002	0.793049		6/3/2002	0.595476	
3/4/2002	0.448235		4/19/2002	0.865009		6/4/2002	0.544575	
3/5/2002	0.451595		4/20/2002	0.909280		6/5/2002	0.569155	S
3/6/2002	0.556477		4/21/2002	0.896236		6/6/2002	0.737471	S
3/7/2002	0.635513		4/22/2002	0.877992		6/7/2002	1.199745	S
3/8/2002	0.648233		4/23/2002	0.831911		6/8/2002	1.721704	
3/9/2002	0.654849		4/24/2002	0.773641		6/9/2002	2.068218	
3/10/2002	0.872689		4/25/2002	0.755652		6/10/2002	2.025717	
3/11/2002	0.827267		4/26/2002	0.712489		6/11/2002	1.734601	
3/12/2002	1.007011		4/27/2002	0.658428		6/12/2002	1.515741	
3/13/2002	1.123145		4/28/2002	0.842479	S	6/13/2002	1.258441	
3/14/2002	1.111466		4/29/2002	1.232849	S	6/14/2002	1.128385	
3/15/2002	1.042865		4/30/2002	1.973367	S	6/15/2002	1.038690	S
3/16/2002	1.022415		5/1/2002	2.486732		6/16/2002	0.993682	S
3/17/2002	0.878079		5/2/2002	2.625321		6/17/2002	0.915050	
3/18/2002	0.792529		5/3/2002	2.488028		6/18/2002	0.919994	
3/19/2002	0.775957		5/4/2002	2.217339		6/19/2002	0.899284	
3/20/2002	0.776941		5/5/2002	2.008593		6/20/2002	0.860303	
3/21/2002	0.840089		5/6/2002	1.775048		6/21/2002	0.808002	
3/22/2002	0.848204		5/7/2002	1.564969		6/22/2002	0.741405	
3/23/2002	0.816810		5/8/2002	1.347282		6/23/2002	0.706852	
3/24/2002	0.839838		5/9/2002	1.220435		6/24/2002	0.644380	
3/25/2002	0.839461		5/10/2002	1.100508		6/25/2002	0.585730	
3/26/2002	1.023547	S	5/11/2002	0.966254		6/26/2002	0.515195	
3/27/2002	2.606748	S	5/12/2002	0.915813		6/27/2002	0.460029	
3/28/2002	3.762265		5/13/2002	1.158555	S	6/28/2002	0.405621	
3/29/2002	3.878320		5/14/2002	1.614901	S	6/29/2002	0.344836	
3/30/2002	3.532630		5/15/2002	2.461607		6/30/2002	0.314376	
3/31/2002	3.160842		5/16/2002	2.826664		7/1/2002	0.278410	
4/1/2002	2.892747		5/17/2002	2.769581	S	7/2/2002	0.243405	
4/2/2002	2.443530		5/18/2002	2.832523	S	7/3/2002	0.206933	
4/3/2002	2.125782		5/19/2002	2.451240		7/4/2002	0.183286	
4/4/2002	1.774404		5/20/2002	2.326316		7/5/2002	0.170231	
4/5/2002	1.492621		5/21/2002	2.355292		7/6/2002	0.156889	
4/6/2002	1.318593		5/22/2002	2.166857		7/7/2002	0.144748	
4/7/2002	1.162694		5/23/2002	1.928606		7/8/2002	0.129875	
4/8/2002	1.058050		5/24/2002	1.679681		7/9/2002	0.121011	
4/9/2002	0.970369		5/25/2002	1.405131		7/10/2002	0.112923	
4/10/2002	0.890824		5/26/2002	1.224109		7/11/2002	0.103532	
4/11/2002	0.814969		5/27/2002	1.071148		7/12/2002	0.099541	
4/12/2002	0.685513		5/28/2002	0.949415		7/13/2002	0.093251	
4/13/2002	0.744481		5/29/2002	0.839796		7/14/2002	0.087615	
4/14/2002	0.726888	S	5/30/2002	0.772504		7/15/2002	0.081857	
4/15/2002	0.796536	S	5/31/2002	0.778595	S	7/16/2002	0.073904	

Appendix A. Discharge for site SENECA

Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode	Date	Discharge (cfs)	Flowcode
7/17/2002	0.067096		9/1/2002	0.028880		10/17/2002	4.122702	S
7/18/2002	0.061975		9/2/2002	0.025745		10/18/2002	3.796652	
7/19/2002	0.068773	S	9/3/2002	0.021520	S	10/19/2002	3.034253	
7/20/2002	0.064396	S	9/4/2002	0.064305	S	10/20/2002	2.229021	
7/21/2002	0.056239	S	9/5/2002	0.027982		10/21/2002	1.615168	
7/22/2002	0.053033	S	9/6/2002	0.021206		10/22/2002	1.194875	
7/23/2002	0.062032		9/7/2002	0.018563		10/23/2002	0.958366	
7/24/2002	0.056294		9/8/2002	0.017109		10/24/2002	0.792107	
7/25/2002	0.049255		9/9/2002	0.015271		10/25/2002	0.670817	S
7/26/2002	0.048542		9/10/2002	0.013678		10/26/2002	0.722442	
7/27/2002	0.053092		9/11/2002	0.014035		10/27/2002	0.623888	
7/28/2002	0.056739		9/12/2002	0.011191		10/28/2002	0.527804	
7/29/2002	0.062608		9/13/2002	0.011560		10/29/2002	0.481686	
7/30/2002	0.049774		9/14/2002	0.010660		10/30/2002	0.473449	
7/31/2002	0.045127		9/15/2002	0.017858	S	10/31/2002	0.458574	
8/1/2002	0.045114		9/16/2002	0.035320	S	11/1/2002	0.462804	
8/2/2002	0.053225		9/17/2002	0.016354		11/2/2002	0.433288	
8/3/2002	0.049704		9/18/2002	0.011978		11/3/2002	0.409727	
8/4/2002	0.037242	S	9/19/2002	0.010456		11/4/2002	0.370164	
8/5/2002	0.044001	S	9/20/2002	0.008430		11/5/2002	0.348546	
8/6/2002	0.033417		9/21/2002	0.007567		11/6/2002	0.444413	
8/7/2002	0.058027		9/22/2002	0.048727	S	11/7/2002	0.399033	
8/8/2002	0.036855		9/23/2002	0.019345	S	11/8/2002	0.357260	
8/9/2002	0.030731		9/24/2002	0.010704		11/9/2002	0.345893	
8/10/2002	0.021869		9/25/2002	0.008352		11/10/2002	0.369774	
8/11/2002	0.022000		9/26/2002	0.009776	S	11/11/2002	0.443778	
8/12/2002	0.045634		9/27/2002	0.081617	S	11/12/2002	0.541311	S
8/13/2002	0.026136		9/28/2002	0.107061	S	11/13/2002	0.621317	S
8/14/2002	0.023646		9/29/2002	0.036628		11/14/2002	0.605370	
8/15/2002	0.028170		9/30/2002	0.021630		11/15/2002	0.667141	
8/16/2002	0.014153		10/1/2002	0.017097		11/16/2002	0.777761	S
8/17/2002	0.010741		10/2/2002	0.015210		11/17/2002	1.634222	S
8/18/2002	0.009237		10/3/2002	0.017097		11/18/2002	2.497225	S
8/19/2002	0.007025		10/4/2002	0.016638		11/19/2002	3.359503	
8/20/2002	0.010293		10/5/2002	0.022854		11/20/2002	3.439083	
8/21/2002	0.008273		10/6/2002	0.017176		11/21/2002	3.230961	
8/22/2002	0.010143		10/7/2002	0.016229		11/22/2002	3.347747	
8/23/2002	0.012018		10/8/2002	0.012365		11/23/2002	3.722140	
8/24/2002	0.036867		10/9/2002	0.012057	S	11/24/2002	3.839718	
8/25/2002	0.025692		10/10/2002	0.012398	S	11/25/2002	3.523043	
8/26/2002	0.019782		10/11/2002	0.059983	S	11/26/2002	2.860616	
8/27/2002	0.017573		10/12/2002	0.829254	S	11/27/2002	2.295440	
8/28/2002	0.015348		10/13/2002	0.686832		11/28/2002	1.844528	
8/29/2002	0.084405	S	10/14/2002	0.774700		11/29/2002	1.528544	
8/30/2002	0.042740	S	10/15/2002	0.866124	S	11/30/2002	1.304922	
8/31/2002	0.029874		10/16/2002	1.669939	S			

Data Appendix B. Water quality data

Sample Date	SITE	Total Phosphorus (μg/L)	Total Suspended Solids (mg/L)
3/12/2002	BELLE5	3.0	0.25
3/26/2002	BELLE5	4.0	0.25
4/9/2002	BELLE5	3.0	0.20
4/23/2002	BELLE5	3.0	0.25
4/28/2002	BELLE5	11.3	3.23
4/29/2002	BELLE5	7.3	0.74
5/7/2002	BELLE5	6.0	0.30
5/21/2002	BELLE5	8.0	0.25
6/4/2002	BELLE5	3.0	0.25
6/18/2002	BELLE5	3.0	0.25
7/1/2002	BELLE5	10.0	0.25
7/16/2002	BELLE5	13.0	0.25
9/27/2002	BELLE5	31.5	5.20
9/28/2002	BELLE5	12.9	0.29
10/15/2002	BELLE5	3.0	0.30
10/16/2002	BELLE5	23.3	14.77
10/17/2002	BELLE5	6.8	4.94
11/12/2002	BELLE5	3.0	0.25
3/12/2002	BELLEGIG	9.0	0.25
3/26/2002	BELLEGIG	11.4	0.42
3/27/2002	BELLEGIG	11.9	0.56
4/9/2002	BELLEGIG	11.0	0.25
4/23/2002	BELLEGIG	12.0	0.25
5/7/2002	BELLEGIG	14.0	0.25
5/21/2002	BELLEGIG	15.0	0.25
6/4/2002	BELLEGIG	15.0	0.25
6/18/2002	BELLEGIG	12.0	0.25
7/1/2002	BELLEGIG	16.0	0.25
7/16/2002	BELLEGIG	23.0	0.25
7/23/2002	BELLEGIG	41.2	2.77
7/30/2002	BELLEGIG	16.0	0.25
8/13/2002	BELLEGIG	20.0	0.25
8/27/2002	BELLEGIG	22.0	0.60
9/10/2002	BELLEGIG	18.0	0.25
9/15/2002	BELLEGIG	26.6	0.77
9/16/2002	BELLEGIG	30.6	3.50
9/22/2002	BELLEGIG	25.0	1.53
9/24/2002	BELLEGIG	20.0	0.25
9/26/2002	BELLEGIG	20.8	1.14
9/27/2002	BELLEGIG	22.7	0.75
9/28/2002	BELLEGIG	21.7	
10/15/2002	BELLEGIG	16.0	0.30
10/16/2002	BELLEGIG	23.4	2.77
10/17/2002	BELLEGIG	21.5	3.04
11/12/2002	BELLEGIG	11.0	0.25
3/12/2002	BELLETOD	8.0	0.60
3/26/2002	BELLETOD	11.0	2.40
4/9/2002	BELLETOD	3.0	1.40
4/23/2002	BELLETOD	8.0	1.80
5/7/2002	BELLETOD	11.0	3.00

Sample Date	SITE	Total Phosphorus (μg/L)	Total Suspended Solids (mg/L)
5/21/2002	BELLETOD	12.0	2.20
6/4/2002	BELLETOD	11.0	3.60
6/18/2002	BELLETOD	10.0	3.60
7/1/2002	BELLETOD	14.0	4.40
7/16/2002	BELLETOD	18.0	1.00
7/30/2002	BELLETOD	11.0	0.25
10/15/2002	BELLETOD	12.0	1.60
11/12/2002	BELLETOD	3.0	0.80
3/12/2002	BELLOST	6.0	0.25
4/9/2002	BELLOST	9.0	0.25
4/23/2002	BELLOST	9.0	0.25
5/7/2002	BELLOST	11.0	0.25
5/21/2002	BELLOST	12.0	0.25
6/4/2002	BELLOST	12.0	0.25
6/18/2002	BELLOST	8.0	0.25
7/1/2002	BELLOST	10.0	0.25
7/16/2002	BELLOST	13.0	0.25
7/23/2002	BELLOST	20.6	2.27
7/30/2002	BELLOST	12.0	0.25
8/13/2002	BELLOST	12.0	0.25
8/27/2002	BELLOST	15.0	3.20
9/10/2002	BELLOST	10.0	1.20
9/24/2002	BELLOST	12.0	0.25
3/26/2002	BELLOST	8.0	0.25
9/22/2002	BELLOST	23.0	13.31
9/26/2002	BELLOST	13.0	0.80
9/27/2002	BELLOST	16.5	1.82
9/28/2002	BELLOST	17.1	1.49
10/15/2002	BELLOST	12.0	0.30
10/16/2002	BELLOST	44.5	33.53
10/17/2002	BELLOST	13.3	5.67
11/12/2002	BELLOST	8.0	0.25
3/12/2002	SENECA	8.0	0.25
3/26/2002	SENECA	16.6	5.00
3/27/2002	SENECA	15.9	2.17
4/9/2002	SENECA	9.0	0.25
4/23/2002	SENECA	10.0	0.25
4/28/2002	SENECA	15.5	1.79
4/29/2002	SENECA	13.4	1.20
5/7/2002	SENECA	11.0	0.60
5/21/2002	SENECA	14.0	0.25
6/4/2002	SENECA	16.0	0.60
6/18/2002	SENECA	13.0	1.20
7/1/2002	SENECA	18.0	0.80
7/16/2002	SENECA	23.0	1.20
7/23/2002	SENECA	41.2	8.80
7/30/2002	SENECA	25.0	1.80
8/13/2002	SENECA	27.0	1.20
8/27/2002	SENECA	29.0	0.80
9/10/2002	SENECA	26.0	0.80

Data Appendix B. Water quality data

Sample Date	SITE	Total Phosphorus (μg/L)	Total Suspended Solids (mg/L)
9/16/2002	SENECA	45.9	
9/22/2002	SENECA	42.3	7.78
9/24/2002	SENECA	27.0	0.80
9/27/2002	SENECA	40.9	9.65
9/28/2002	SENECA	29.8	5.61
10/15/2002	SENECA	19.0	1.30
10/16/2002	SENECA	56.1	19.75
10/17/2002	SENECA	22.2	3.20
11/12/2002	SENECA	22.0	0.60

Appendix C. Intensive storm event sample data

Sample Date	SITE	Flow (cfs)	Total Phosphorus (µg/L)	Total Suspended Solids (mg/L)
9/27/2002	BELLE5	0.086	22	6.2
9/27/2002	BELLE5	0.538	41	4.2
9/27/2002	BELLE5	0.347	16	0.6
9/27/2002	BELLE5	0.24	16	0.25
9/27/2002	BELLE5	0.225	14	0.25
9/27/2002	BELLE5	0.207	12	0.25
9/27/2002	BELLE5	0.18	12	0.25
9/27/2002	BELLE5	0.134	10	0.25
9/27/2002	BELLE5	0.076	10	0.25
9/27/2002	BELLE5	0.045	13	0.25
10/16/2002	BELLE5	0.414	3	0.25
10/16/2002	BELLE5	1.23	11	3.4
10/16/2002	BELLE5	1.894	14	8.4
10/16/2002	BELLE5	2.254	25	16.2
10/16/2002	BELLE5	2.365	23	13.6
10/16/2002	BELLE5	2.48	23	15.4
10/16/2002	BELLE5	2.597	56	40.6
10/16/2002	BELLE5	2.597	43	33.2
10/16/2002	BELLE5	2.717	27	15.8
10/16/2002	BELLE5	2.609	17	11.4
10/16/2002	BELLE5	2.609	14	4.2
7/23/2002	BELLEGIG	0.087	18	0.2
7/23/2002	BELLEGIG	0.197	59	13.8
7/23/2002	BELLEGIG	0.382	70	6.6
7/23/2002	BELLEGIG	0.328	60	1.6
7/23/2002	BELLEGIG	0.237	40	1
7/23/2002	BELLEGIG	0.182	35	0.6
7/23/2002	BELLEGIG	0.166	31	0.25
7/23/2002	BELLEGIG	0.144	28	0.6
7/23/2002	BELLEGIG	0.13	30	0.25
9/27/2002	BELLEGIG	0.045	19	0.25
9/27/2002	BELLEGIG	0.046	20	0.25
9/27/2002	BELLEGIG	0.048	21	0.6
9/27/2002	BELLEGIG	0.053	21	0.9
9/27/2002	BELLEGIG	0.066	24	0.8
9/27/2002	BELLEGIG	0.073	21	0.6
9/27/2002	BELLEGIG	0.075	21	0.25
9/27/2002	BELLEGIG	0.075	23	0.6
9/27/2002	BELLEGIG	0.075	20	0.25
9/27/2002	BELLEGIG	0.075	20	0.25
9/27/2002	BELLEGIG	0.079	20	0.25
9/27/2002	BELLEGIG	0.08	20	0.25
9/27/2002	BELLEGIG	0.078	20	0.25
9/27/2002	BELLEGIG	0.073	19	0.25
9/27/2002	BELLEGIG	0.07	22	0.25
9/27/2002	BELLEGIG	0.077	20	0.25
9/27/2002	BELLEGIG	0.087	19	0.25

Appendix C. Intensive storm event sample data

Sample Date	SITE	Flow (cfs)	Total Phosphorus (µg/L)	Total Suspended Solids (mg/L)
9/27/2002	BELLEGIG	0.088	19	0.25
9/27/2002	BELLEGIG	0.088	26	0.5
9/27/2002	BELLEGIG	0.09	22	0.25
9/27/2002	BELLEGIG	0.122	21	0.25
9/27/2002	BELLEGIG	0.522	55	8.6
9/27/2002	BELLEGIG	0.406	29	1
10/16/2002	BELLEGIG	1.837	21	0.8
10/16/2002	BELLEGIG	2.349	22	1
10/16/2002	BELLEGIG	2.648	23	1.2
10/16/2002	BELLEGIG	3.187	22	1.2
10/16/2002	BELLEGIG	3.564	25	2
10/16/2002	BELLEGIG	3.889	23	3.2
10/16/2002	BELLEGIG	4.129	26	5.4
10/16/2002	BELLEGIG	4.879	28	4.8
10/16/2002	BELLEGIG	5.082	24	3.4
10/16/2002	BELLEGIG	5.398	23	4.4
10/16/2002	BELLEGIG	5.616	22	3
10/16/2002	BELLEGIG	5.506	22	2.8
7/23/2002	BELLOST	0.213	16	2
7/23/2002	BELLOST	0.238	19	1.8
7/23/2002	BELLOST	0.229	45	13.6
7/23/2002	BELLOST	0.219	20	1.3
7/23/2002	BELLOST	0.219	21	0.7
7/23/2002	BELLOST	0.214	20	0.25
7/23/2002	BELLOST	0.21	16	0.25
7/23/2002	BELLOST	0.21	14	0.25
7/23/2002	BELLOST	0.205	14	0.25
9/27/2002	BELLOST	0.077	14	0.6
9/27/2002	BELLOST	0.08	13	0.25
9/27/2002	BELLOST	0.082	14	2
9/27/2002	BELLOST	0.09	13	0.35
9/27/2002	BELLOST	0.108	14	0.25
9/27/2002	BELLOST	0.107	13	0.25
9/27/2002	BELLOST	0.107	14	0.25
9/27/2002	BELLOST	0.11	12	0.25
9/27/2002	BELLOST	0.116	13	0.25
9/27/2002	BELLOST	0.119	13	0.25
9/27/2002	BELLOST	0.121	14	0.25
9/27/2002	BELLOST	0.137	14	0.25
9/27/2002	BELLOST	0.134	26	5.4
9/27/2002	BELLOST	0.131	16	0.25
9/27/2002	BELLOST	0.131	16	0.25
9/27/2002	BELLOST	0.132	16	0.25
9/27/2002	BELLOST	0.15	13	0.6
9/27/2002	BELLOST	0.162	16	0.25
9/27/2002	BELLOST	0.167	15	0.25
9/27/2002	BELLOST	0.167	15	0.6

Appendix C. Intensive storm event sample data

Sample Date	SITE	Flow (cfs)	Total Phosphorus (μg/L)	Total Suspended Solids (mg/L)
9/27/2002	BELLOST	0.18	16	0.8
9/27/2002	BELLOST	0.249	23	5.4
9/27/2002	BELLOST	0.298	41	20.6
9/27/2002	BELLOST	0.295	21	3.7
10/16/2002	BELLOST	0.548	14	0.25
10/16/2002	BELLOST	0.608	16	1.2
10/16/2002	BELLOST	0.704	19	2.3
10/16/2002	BELLOST	0.816	26	17.9
10/16/2002	BELLOST	0.583	44	49.6
10/16/2002	BELLOST	0.61	45	49.4
10/16/2002	BELLOST	0.731	66	70.7
10/16/2002	BELLOST	0.826	69	73.5
10/16/2002	BELLOST	0.919	47	52.3
10/16/2002	BELLOST	0.953	106	31.9
10/16/2002	BELLOST	0.929	38	19.8
7/23/2002	SENECA	0.055	47	10
7/23/2002	SENECA	0.083	66	27.2
7/23/2002	SENECA	0.084	41	7.4
7/23/2002	SENECA	0.101	41	8.6
7/23/2002	SENECA	0.105	38	7.2
7/23/2002	SENECA	0.11	36	6
7/23/2002	SENECA	0.101	36	5.2
7/23/2002	SENECA	0.084	34	4
7/23/2002	SENECA	0.076	32	3.6
9/27/2002	SENECA	0.02	34	3.6
9/27/2002	SENECA	0.033	37	5.4
9/27/2002	SENECA	0.042	38	5.8
9/27/2002	SENECA	0.065	58	15.8
9/27/2002	SENECA	0.072	40	6.8
9/27/2002	SENECA	0.079	37	5.4
9/27/2002	SENECA	0.083	37	5.4
9/27/2002	SENECA	0.082	39	13.2
9/27/2002	SENECA	0.082	39	4.8
9/27/2002	SENECA	0.09	38	5
9/27/2002	SENECA	0.086	36	4.6
9/27/2002	SENECA	0.078	34	3.8
9/27/2002	SENECA	0.072	30	3
9/27/2002	SENECA	0.065	31	2.4
9/27/2002	SENECA	0.065	27	7.8
9/27/2002	SENECA	0.079	28	2.6
9/27/2002	SENECA	0.091	26	3.4
9/27/2002	SENECA	0.095	28	3.2
9/27/2002	SENECA	0.079	26	2.6
9/27/2002	SENECA	0.083	26	2.2
9/27/2002	SENECA	0.328	127	66.8
9/27/2002	SENECA	0.582	76	35.6
9/27/2002	SENECA	0.349	48	12.7

Appendix C. Intensive storm event sample data

Sample Date	SITE	Flow (cfs)	Total Phosphorus ($\mu g/L$)	Total Suspended Solids (mg/L)
10/16/2002	SENECA	0.896	26	1.2
10/16/2002	SENECA	1.035	32	5
10/16/2002	SENECA	1.575	51	14.6
10/16/2002	SENECA	2.096	51	15.4
10/16/2002	SENECA	2.593	56	20.4
10/16/2002	SENECA	3.601	140	61.8
10/16/2002	SENECA	4.08	75	35
10/16/2002	SENECA	4.452	72	31.5
10/16/2002	SENECA	4.917	61	25.4
10/16/2002	SENECA	4.592	44	13.7
10/16/2002	SENECA	4.285	35	7.4
10/16/2002	SENECA	4.065	30	5.6
10/15/2003	BELLETOD	1.091	89	36.8
10/15/2003	BELLETOD	1.619	149	58.3
10/15/2003	BELLETOD	2.151	152	94
10/15/2003	BELLETOD	2.042	162	38
10/15/2003	BELLETOD	2	129	21.5
10/15/2003	BELLETOD	2.143	111	18.7
10/15/2003	BELLETOD	1.861	54	8.5
10/15/2003	BELLETOD	1.781	42	6.7
10/15/2003	BELLETOD	1.453	20	3.7