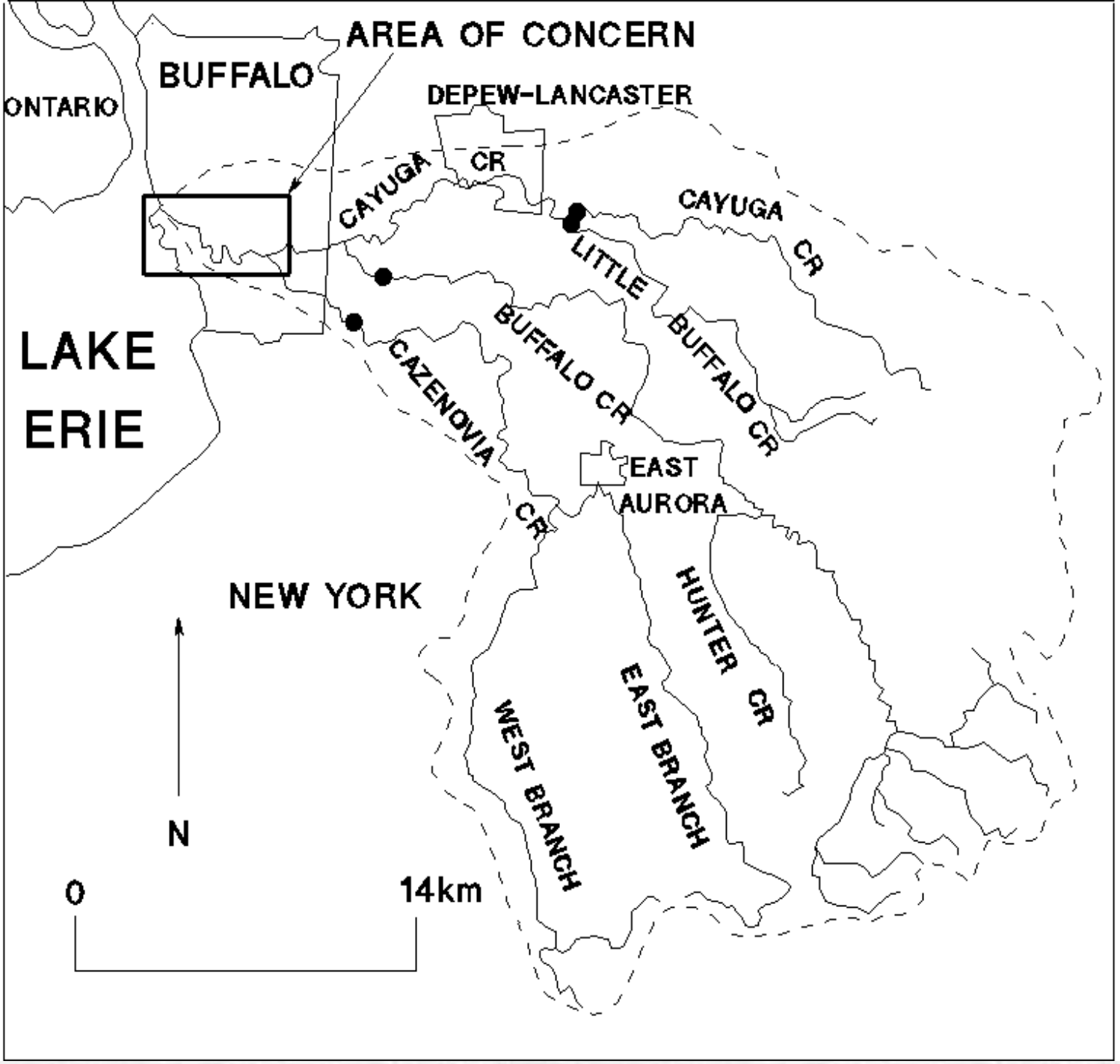
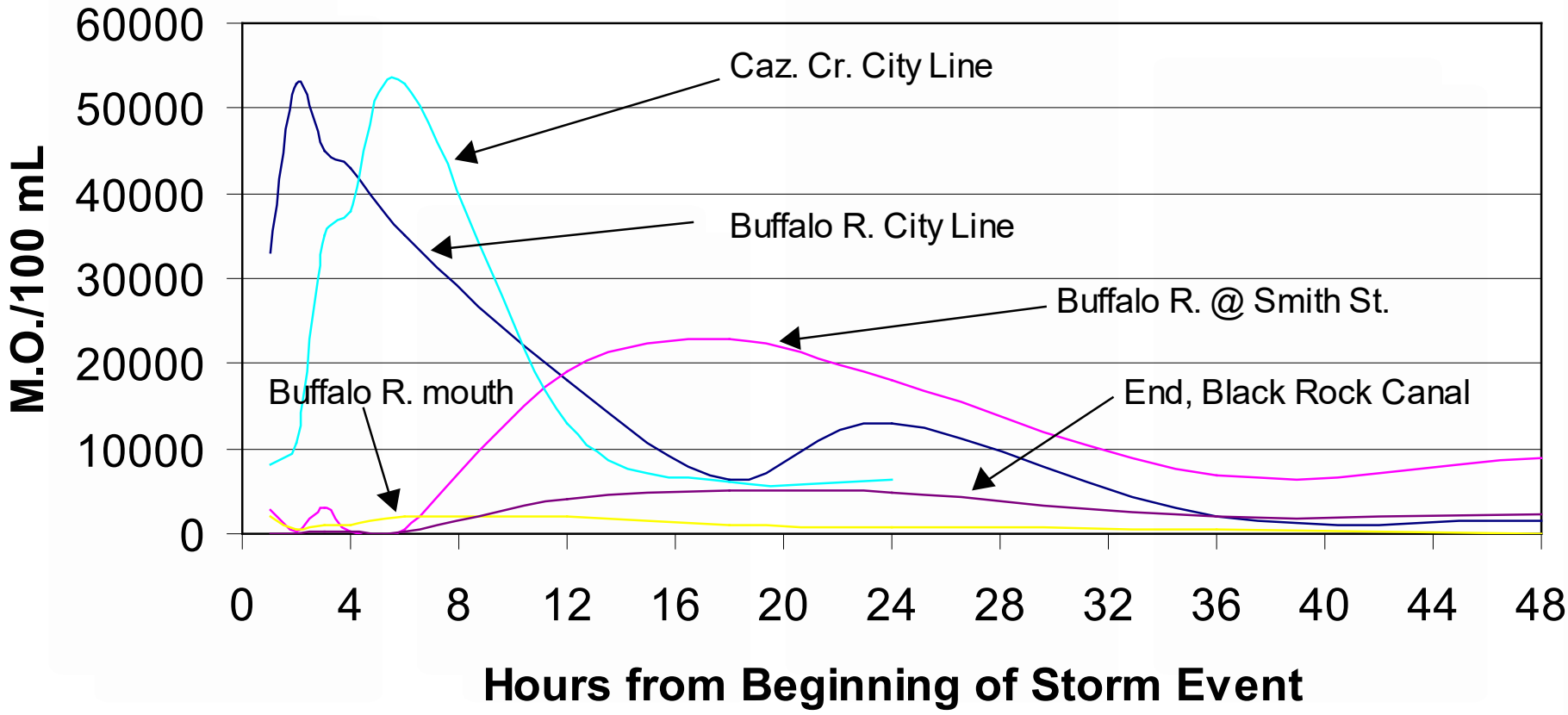
Septic System Pollution Prevention BMPs: Development of Public Outreach Approaches, Assessment, and Decision-making Tools for Local Government

K.N. Irvine, N. Brown, and M. Perrelli
Department of Geography and Planning
Buffalo State, State University of New York


AREA OF CONCERN
BUFFALO
ONTARIO
DEPEW-LANCASTER
CAYUGA CR
CAYUGA CR
LITTLE BUFFALO CR
BUFFALO CR
CAZENOVIA CR
LAKE ERIE
EAST AURORA
NEW YORK
HUNTER CR
EAST BRANCH
WEST BRANCH
N
0
14km


694
Chris

Fecal Coliform Levels, Event 2, August 23-25, 2000



Objectives of Study

- Deliver and assess an evening workshop program that provided information on appropriate septic system construction and maintenance
- Apply computer-oriented tools (GIS, water quality modeling) to help county personnel identify problem source-areas and evaluate potential impact of septic remediation on receiving water quality

Delivery of Workshops

- One workshop held on 11/19/02, Sardinia
  - 60 attendees; 24 surveys completed
- Second workshop held on 4/23/03, Eden
  - 110 attendees; 48 surveys completed
- Workshops were advertised in local newspapers as well as the *Buffalo News*

Delivery of Workshops

General format for the evening:

- Soil characteristics (USDA NRCS)
- Environmental considerations (Erie County Health Department or Ecology and Environment, Inc.)
- Septic system design considerations (Erie County Health Department)
- Septic system maintenance issues (Private Septic System Company)

Delivery of Workshops

- Handout material provided by Cornell Cooperative Extension
- Ample time for question and answer period
- Entire evening approximately 2 hours

Assessment of Workshops

- Questionnaire was developed to help assess workshop delivery and effectiveness
- Each family attending a workshop was asked to complete questionnaire and submit it at the end of the evening
- Two previous workshops were sponsored by Erie County Water Quality Committee and a questionnaire was mailed to these attendees

Assessment of Workshops

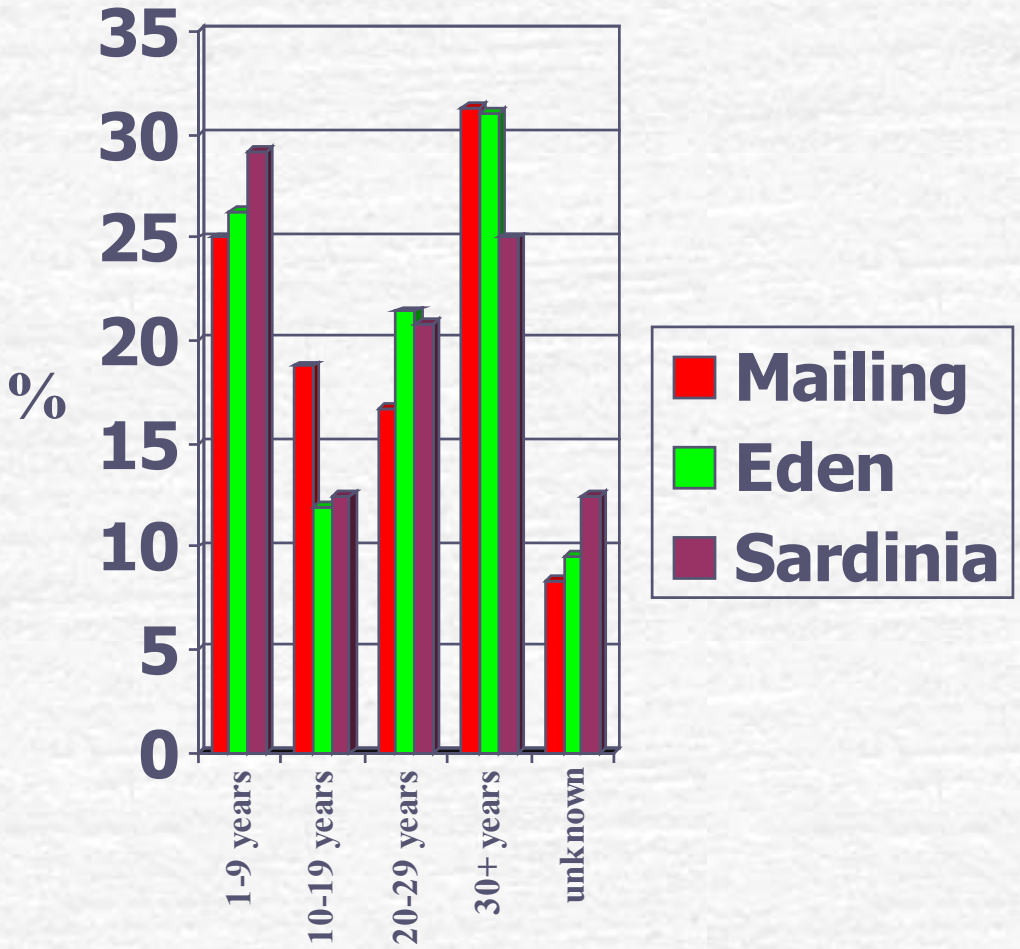
- Questionnaire was divided into four sections:
  - Basic information about individual system
  - General information about the workshop
  - Maintenance information about individual systems
  - Information about system failure

Assessment of Workshops

- Questionnaires returned:

  - Sardinia, n = 24
  - Eden, n = 48
  - Mailings for previous workshops, n = 48 (55% return rate)
  - Total response for questionnaire, n = 120

Assessment Results - System Age



- For each of the workshop sites, 25-33% of the homes had septic systems older than 30 years, while generally 25% of homes had septic systems between 1 and 9 years old

Assessment Results

- For each of the workshop sites 75-98% of respondents could locate their system and 29-58% had sketches of their system
- For each of the workshop sites 54-85% pumped system every 3-5 years

Assessment Results

- Majority of attendees practice some type of septic BMPs
- Most common BMP practiced was “safe disposal of substances (e.g. don’t put grease, oil, antifreeze, or other non-biodegradable substances down sink or toilet)”
- Least common BMP practiced was “protection of absorption field”, followed closely by “not placing additives in tank to accelerate settling or decomposition”

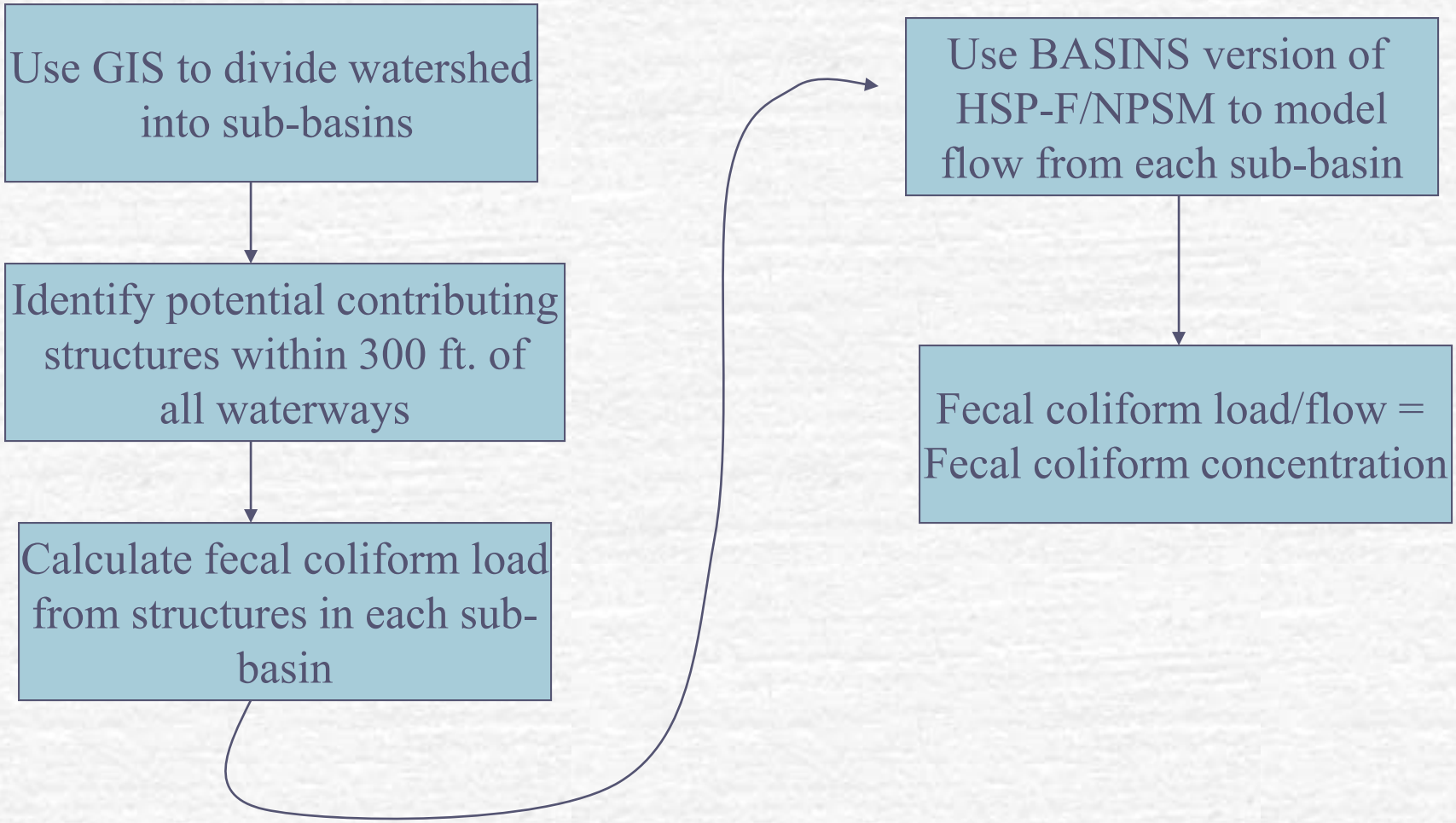
Assessment Results

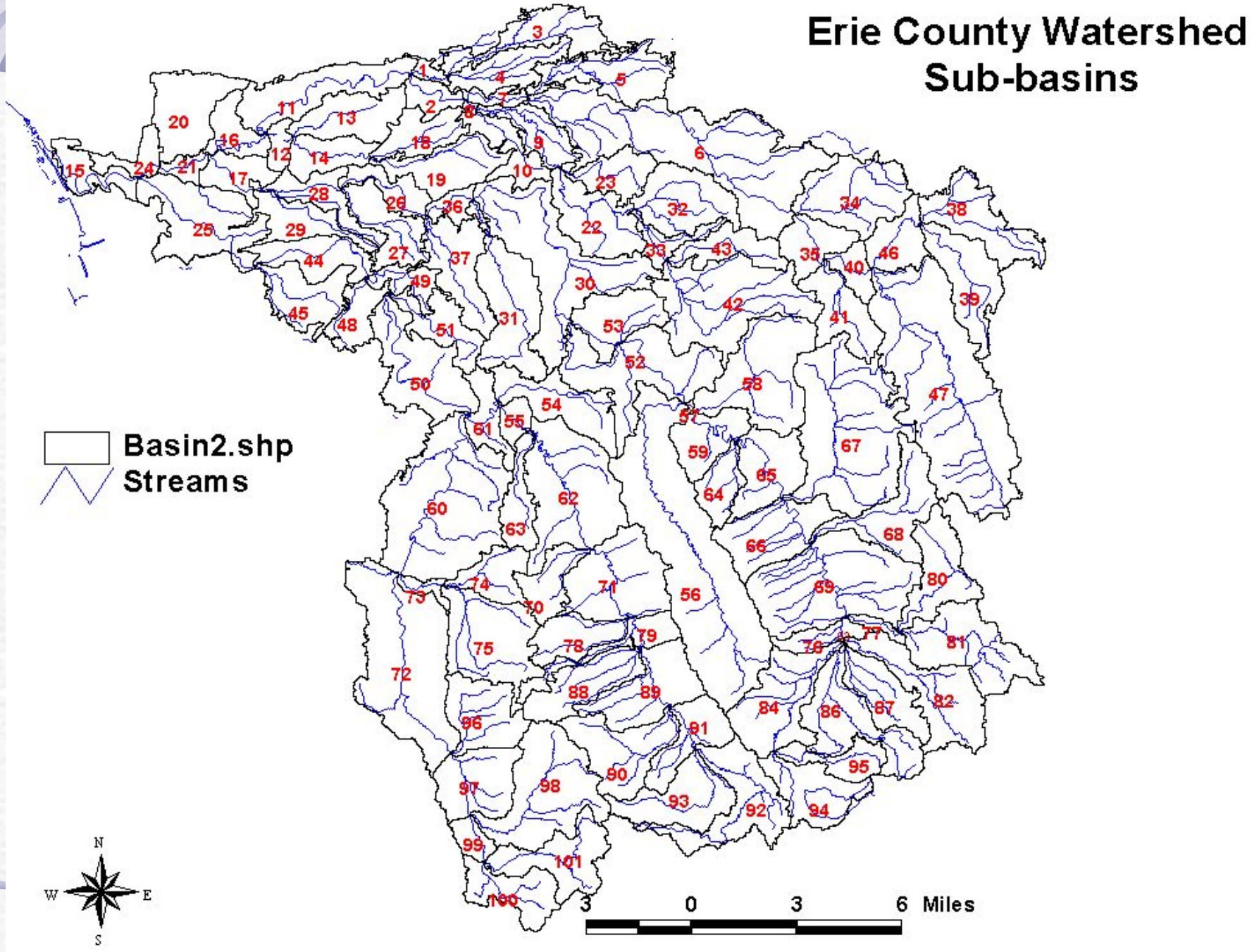
- Unanimously, people found information on operation and maintenance of septic system as being most valuable
- Soils information generally was seen as least valuable, except to a couple of respondents who were looking to build a new home and septic system
- Information on environmental impacts of septic systems was voted as second least valuable, after the soils information

Assessment Results

- For each of the workshop sites, 54-83% of respondents had no plans to replace their system
- Cost of replacement was a determining factor and for those who responded, the range of desirable subsidy was $2,200-$3,650 (or for those who responded as a percent of cost, the range was 50-100%)
- For the each of the workshop sites, 19-35% of respondents had noticed at least one sign of a failing system

Source Area and Water Quality Impact Assessment




Erie County Watershed
Sub-basins
Basin2.shp
Streams
N
W
E
S
3
0
3
6 Miles

Structure Identification

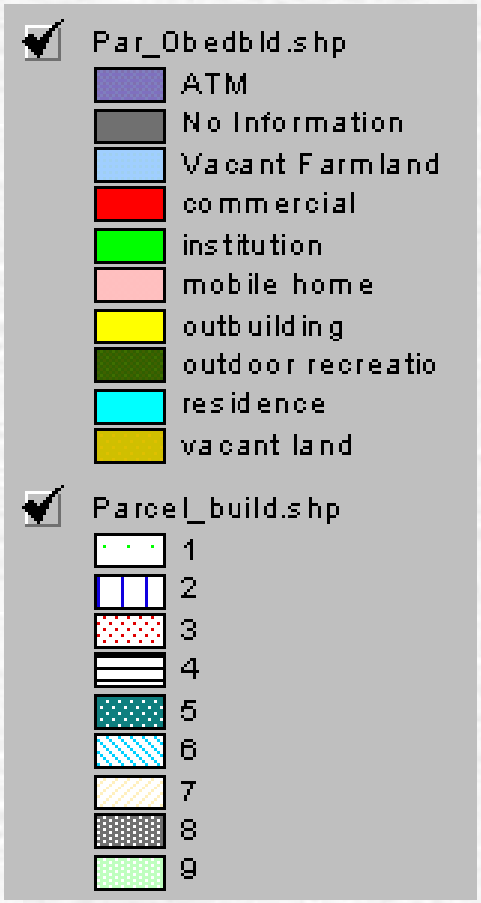
Structures having a septic system within a 300 ft. buffer of all waterways were mapped using ArcView 3.2.

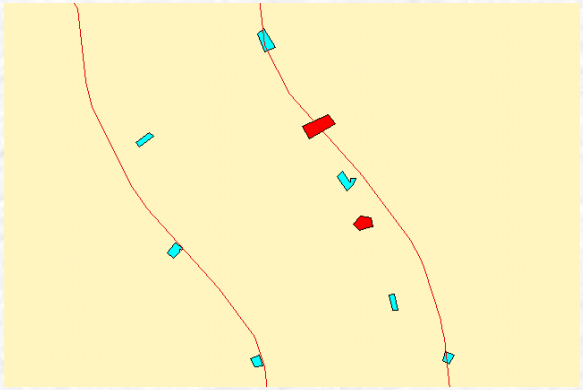
The type of structure was identified according to the zoning classification provided Erie County.

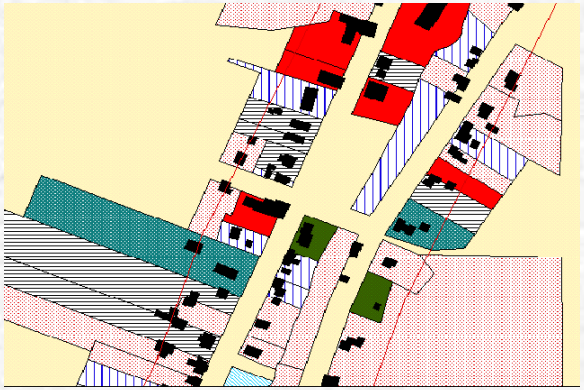
Structures outside of Erie County and those in Erie County that were built after the GIS layers had been created were identified and digitized using 1995 digital orthoquads.

Footprint Classification

- Residence (1,2,3,…. Bedrooms)
- Commercial/Industrial
- Institutional
- Vacant Land
- Farm Land
- Outdoor Recreation
- Outbuilding- Garage,shed,etc.
- Mobile Homes
- Sewage Treatment
- ATM/Phone Booths
- Vacant Farmland







Septic System Discharge Rates

Septic system discharge rates were calculated for each structure that did not have a SPDES permit. Data for calculations were obtained from the *Onsite Wastewater Treatment Systems Manuals* (U.S. EPA, 1980; 2002) and other literature.

- Residential, Mobile Homes – 45 gpd/person
- Commercial, Institutional (excluding Hospitals and Laundry Mats), Outdoor Recreation - 300gpd
- Hospitals and Laundry Mats - 3000gpd
- Outbuildings, Vacant Land, ATM/Phone booths- 0 gpd
- SPDES-permitted discharge rates were used for the individual major dischargers

Septic System Discharge Per Day

The total discharge per day for each non-permitted structure was then calculated.

For Residential and Mobile Homes with zoning information available, (i.e. # of bedrooms per house):

$$Q = 45gpd \times 1.5 \text{ persons} \times \#\text{ of bedrooms}$$

For Residential and Mobile Homes without zoning information, census block data for average number of persons per household were used.

$$Q = 45gpd \times \text{census data } \#\text{ of persons}$$

Septic System Discharge, Cont'd

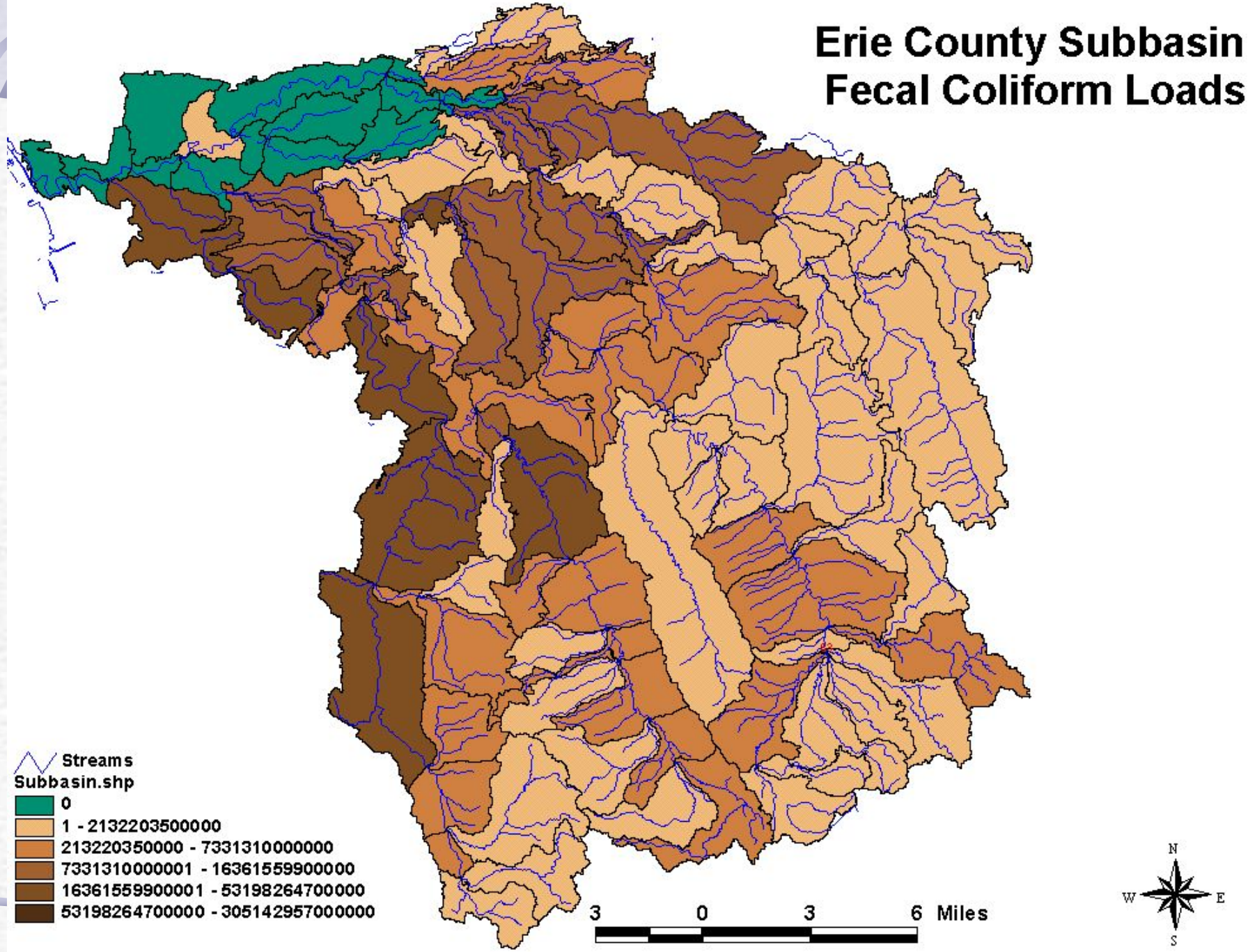
For each sub-basin a total septic system discharge was calculated by summing the discharge from each structure within the 300 ft. buffer.

Septic System Bacteria Load Calculations

For each sub-basin a bacteria load was calculated using appropriate bacteria levels for raw septic discharge, obtained from the *Onsite Wastewater Treatment Systems Manuals* (U.S. EPA, 1980; 2002):

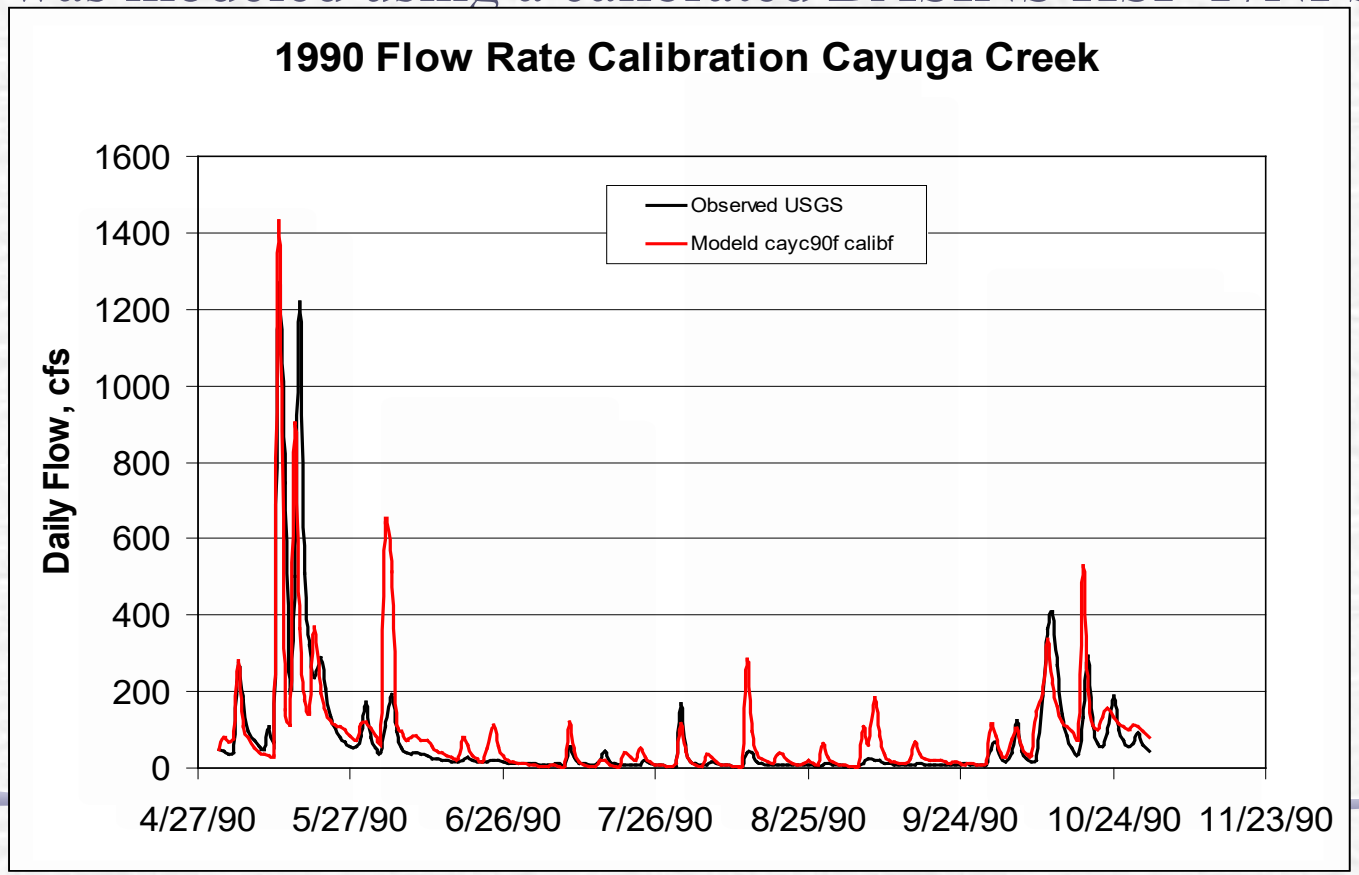
1.) 1×10^8 cfu x Sub-basin's Total Septic System Discharge, Q = Bacteria Load, L, assuming no treatment (0% efficiency).

Septic systems have different treatment efficiencies, so the bacteria load calculated in 1.) was reduced by varying factors, 0% 50%, 90%, 95%, 99%, 99.5%, 99.9% efficiency.


Erie County Subbasin
Fecal Coliform Loads
Streams
Subbasin.shp
0
1 - 2132203500000
213220350000 - 7331310000000
7331310000001 - 16361559900000
16361559900001 - 53198264700000
53198264700000 - 305142957000000
3 0 3 6 Miles
N
W
E
S

From Load to Concentration

To convert the bacteria loads for each sub-basin into bacteria concentrations, the flow rate and total daily flow volume for each sub-basin was modeled using a calibrated BASINS HSP-F/NPSM model.



Days of Exceedence Averaged for Entire Watershed

Removal Efficiency	0%	50%	90%	95%	99%	99.5%	99.9%
# of Days of Exceedance	154	153	147	138	98	71	21
% Days of Exceedance	84	83	80	75	53	38	11

A Simplifying Assumption

In calculating our days of exceedance, we simply added the loads from each sub-basin and divided by flow.

We did not account for bacteria loss. This *will be done* using the BASINS model with a first order decay approach:

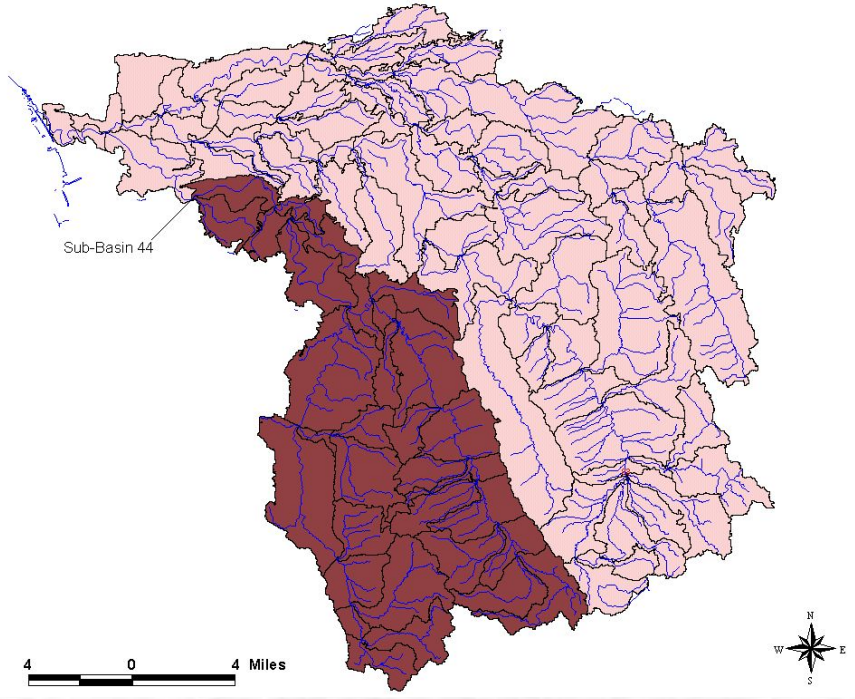
$$C_t = C_o e^{-kt}$$

As a check on our numbers shown today, we did this calculation for sub-basin 44.

Load Sum vs. First Order Decay, Sub-basin 44

Assuming the septic systems were 99.5% efficient, simply summing bacteria loads produced 116 days of exceedance, while accounting for the first order decay produced 106 days of exceedance.

The maximum concentration for the simple sum approach was 3,565 cfu/100 mL, while the maximum concentration for the first order decay was 2,780 cfu/100 mL.



Conclusions

Workshops were well-attended and generated many good questions.

Information on operation and maintenance of septic systems generally identified as being most valuable.

We will reduce the detail presented about soils characteristics.

While most people practice some form of septic system BMP and the majority of people had their systems pumped every 3-5 years, approximately one-third of the homes surveyed had systems that are 30+ years (high potential for failure).

Conclusions

GIS and BASINS modeling are useful tools to identify problem sub-basins, assess water quality under current conditions, and identify the level of septic treatment needed to meet water quality guidelines.

However, the data requirements for successful application are considerable.

The study provided information on the level of funding needed to conduct a demonstration project at a sub-basin scale to determine the benefits of efficiently functioning septic systems.

Acknowledgements

Erie County Water Quality Committee

Mary Rossi, Erie County, Environment and Planning

John Whitney, USDA, NRCS

Gene Degman, Erie County Health Department

Paul Fuhrmann, Ecology and Environment, Inc.

Dave Meyer, Meyer Septic System Service

James Rowell, Lakeshore Septic Service

Erica Somogye, Marlo Kovacs, Susan Kirkham, Buffalo State

Funding provided by New York State Water Resources Institute