

You Sank My Nitrogen!

NEMO's Quest For Coastal Watershed Protection and Restoration



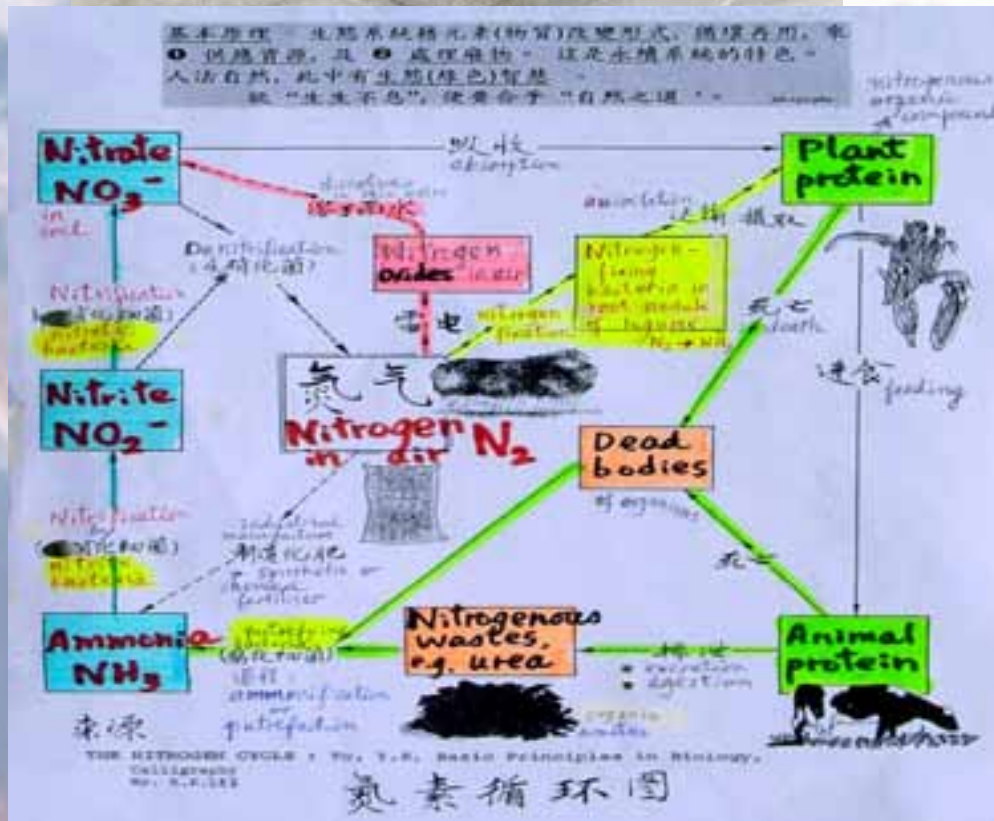
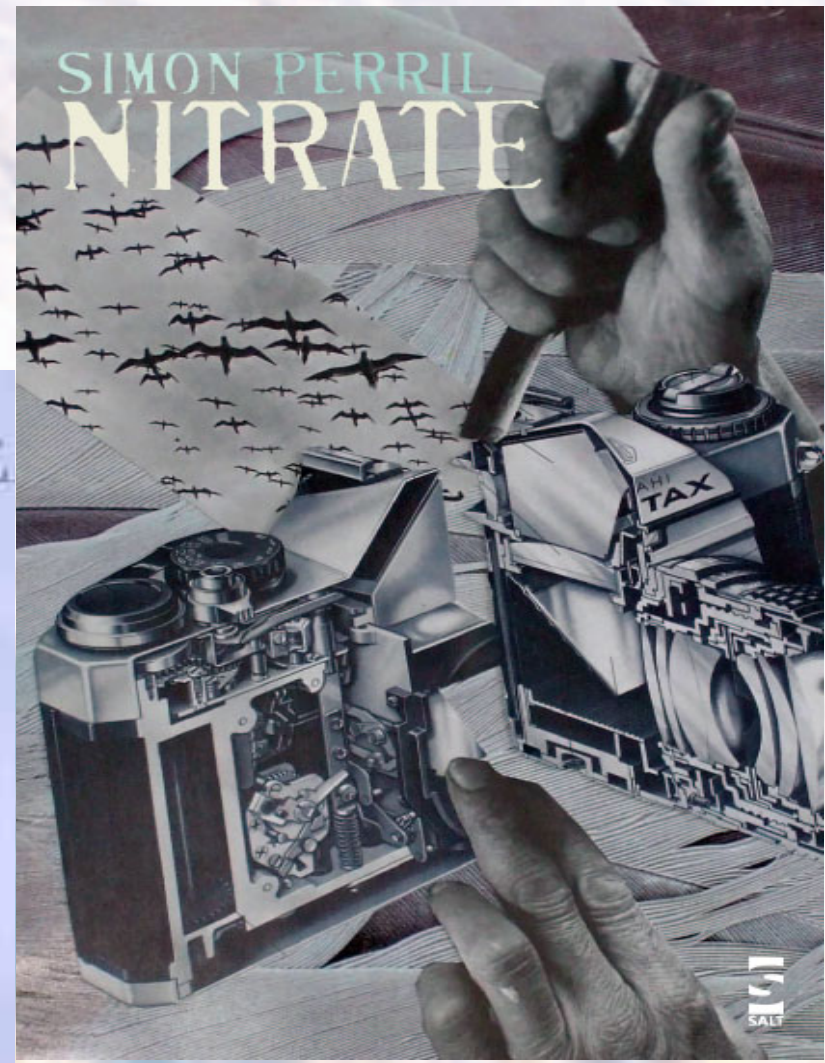
A. Gold, D.Q. Kellogg, M. Shimizu, E. Wentz, K. Addy, and C. Arnold
NEMO U-007
Portland, Maine
September 29, 2010

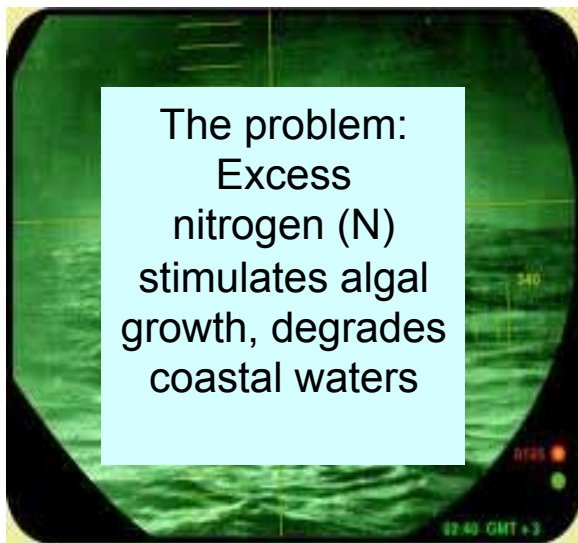


THE
UNIVERSITY
OF RHODE ISLAND



Can NEMO Crack the Nitrate Code?





Degraded eelgrass

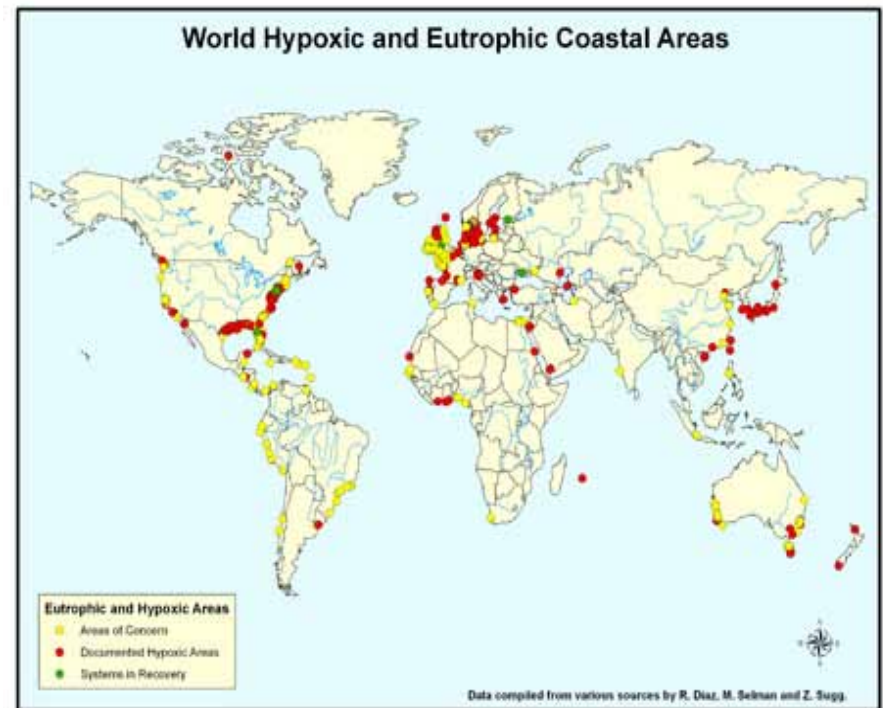


Nuisance seaweed replaces eelgrass



Greenwich Bay, RI 2006

Dead zones
with low oxygen
generate fish
kills which is a
global
problem



Local Watersheds Generate High N Loading



1 acre impervious Cover
(Atmospheric Deposition)

=



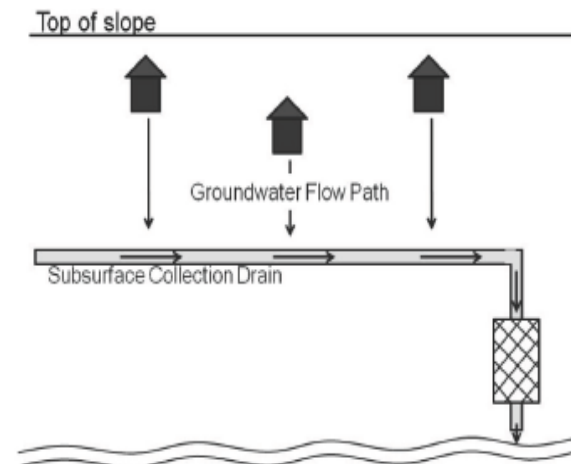
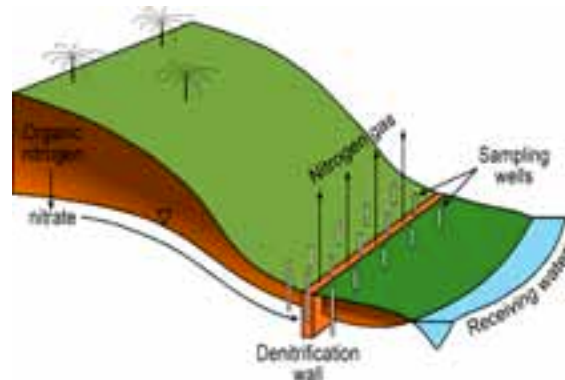
10 dogs

=



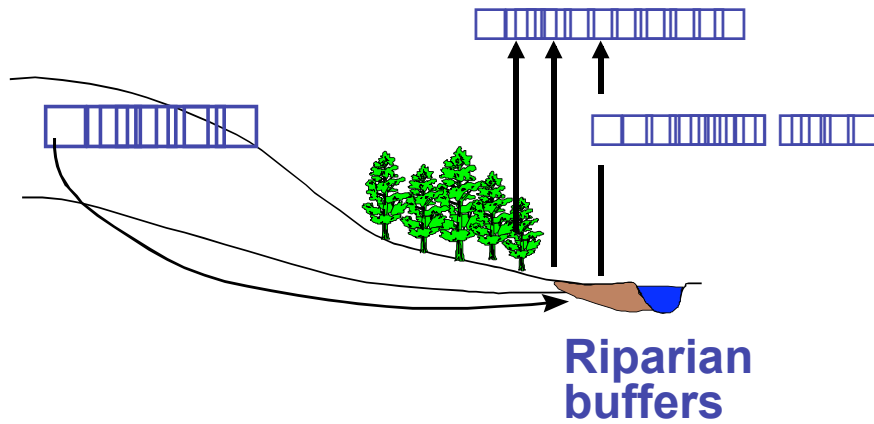
1 home

Where to target investments in source controls?



(Adapted from Gold et al., 1990; Jemison and Fox, 1994;
Howarth et al., 2000; Bernhardt, et al., 2008; Ohio State Extension)

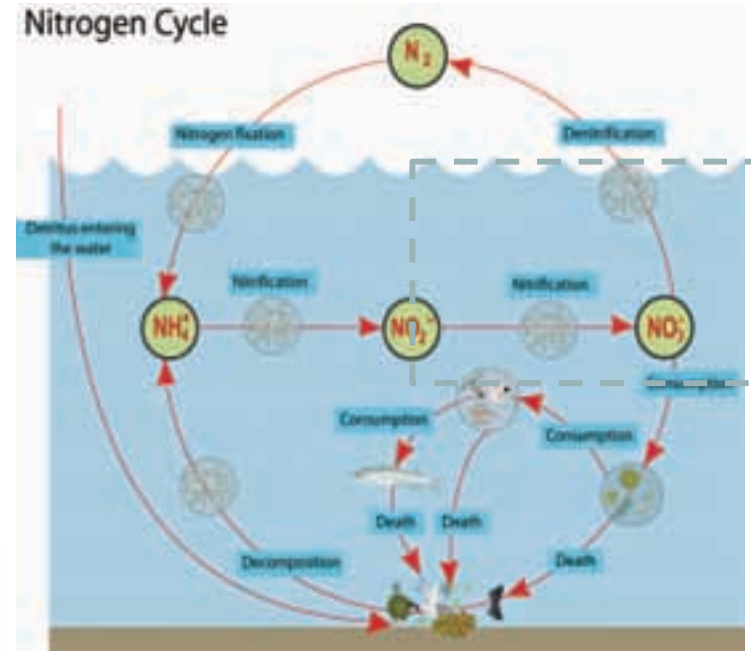
N Removal can occur through denitrification within “hotspots”, i.e., localized watershed sinks



Headwater Streams: Hyporheic Zone



Lakes and Ponds



Challenges & THE Quest

Can we use our research, spatial data and GIS tools to guide local management of watershed N:

- Where to **target source controls**?
 - **Alternative septic systems**
 - **Storm water bioreactors**

Where to **protect and restore**?

- Informed restoration of stream buffers
- Prioritize protection (Conservancies)
- Enhance regulations



Mission Objective

Assist local communities to enhance watershed health and reduce N export using a model based on:

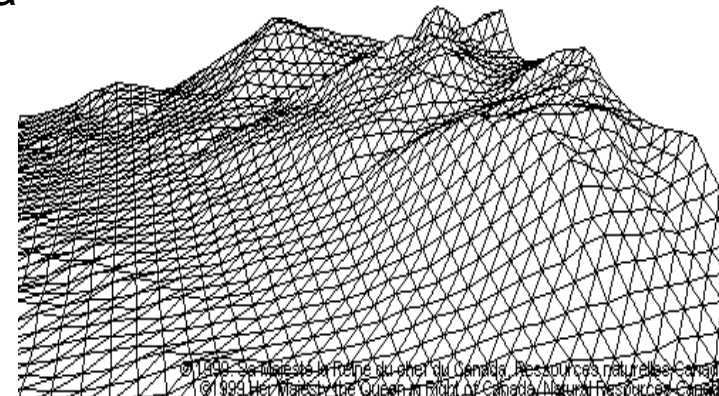
- Widely available geospatial data
- Current findings from peer reviewed literature
- USGS stream gauging data
- Locally based data on selected stream attributes
- Best professional judgment



Tricks and Tools:

Widely available high resolution data

- SSURGO county scale digital soil surveys (1:24,000)
 - Soil wetness (hydric riparian soils)
 - Geomorphology
- Land use
 - 1995 Anderson Level III (1:24,000)
- USGS discharge estimates
 - Normalized by catchment area (discharge/a
- Digital topography & hydrography (1:24,000)
 - Watershed & recharge boundaries
 - Stream network



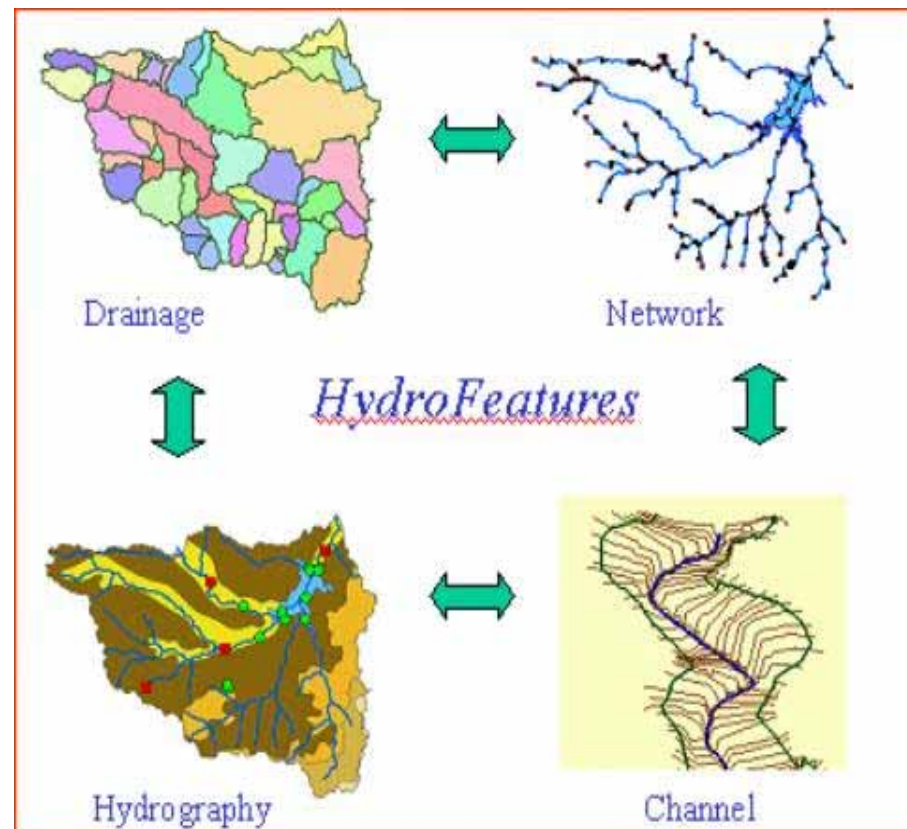
© 1999 - Les données de la carte ont été fournies par le Service canadien de l'information géographique.
© 1999 - Les données de la carte ont été fournies par le Service canadien de l'information géographique.

Flowpath Processing: ArcHydro

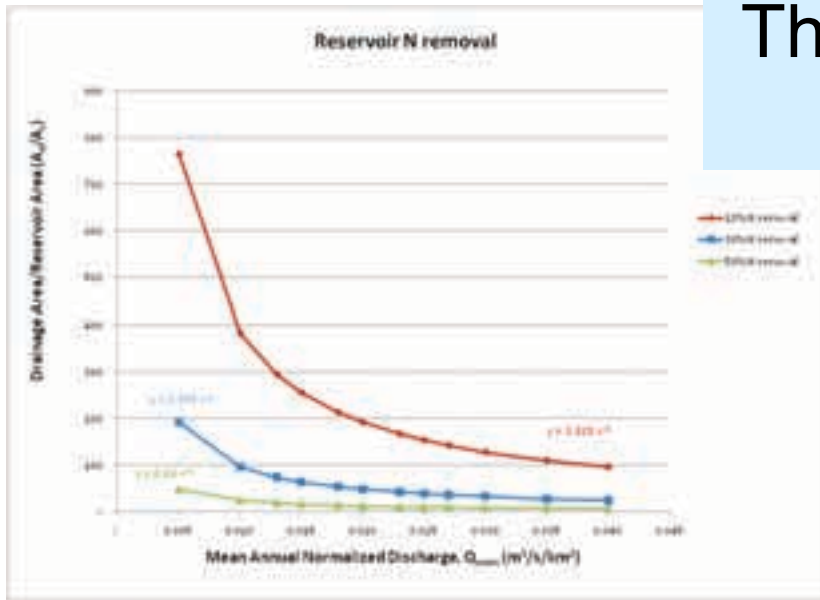
Flow direction & accumulation grids
based on digital elevation models (DEMs)

Allows:

- particle tracking from any source to outlet
- auto-delineation of subcatchment for any point in defined outlet
- (i.e., drainage point)



The Science behind those ever elusive N sinks



From Alexander et al. (2007),

$$N \text{ Removal (\%)} = 1 - \exp(-\theta_{S1} * D^{\theta_{S2}} * T) * 100$$

where,

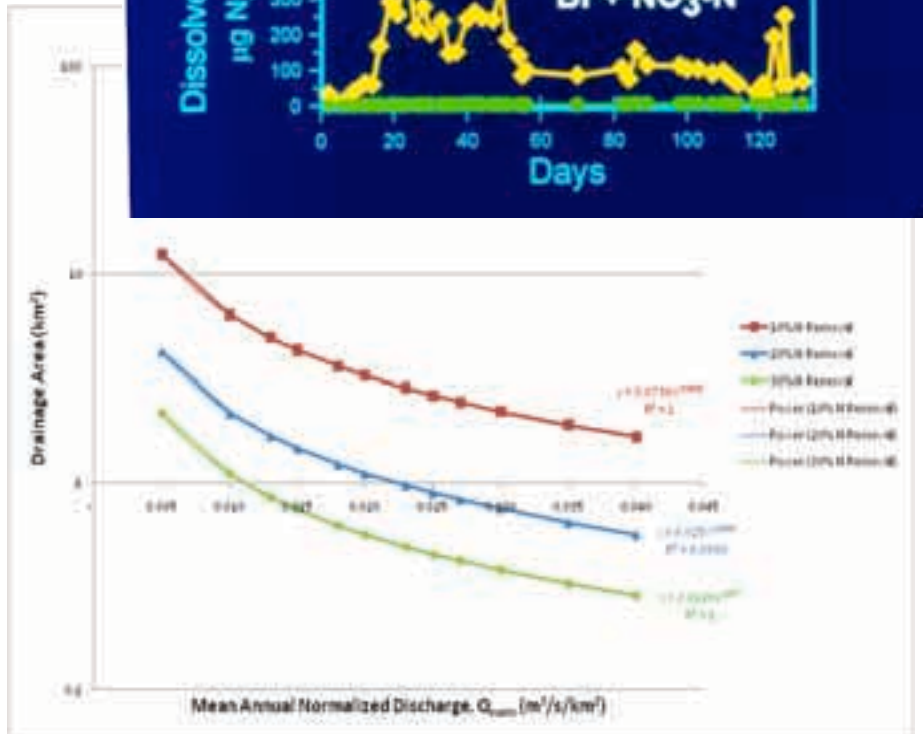
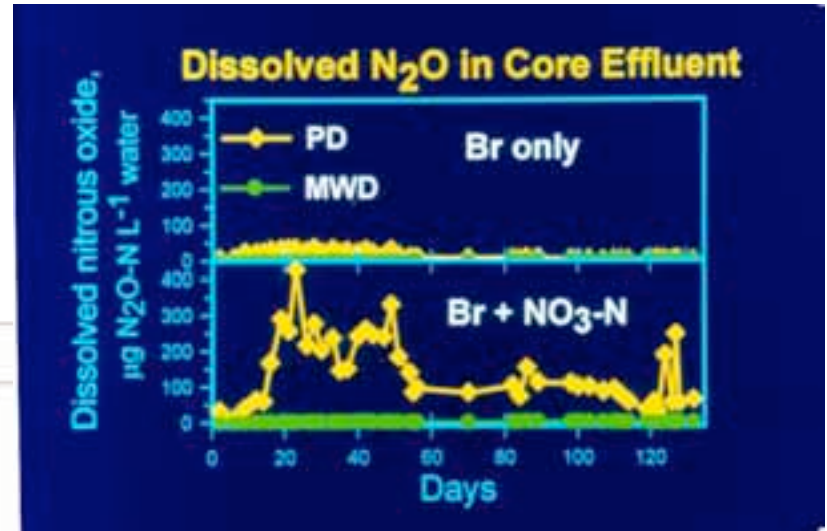
$$\theta_{S1} = 0.0513 [m^{-1} d^{-1}]$$

$$\theta_{S2} = -1.319$$

D = stream depth (m)

T = time of travel (d) = retention

time in reach



??????

??????

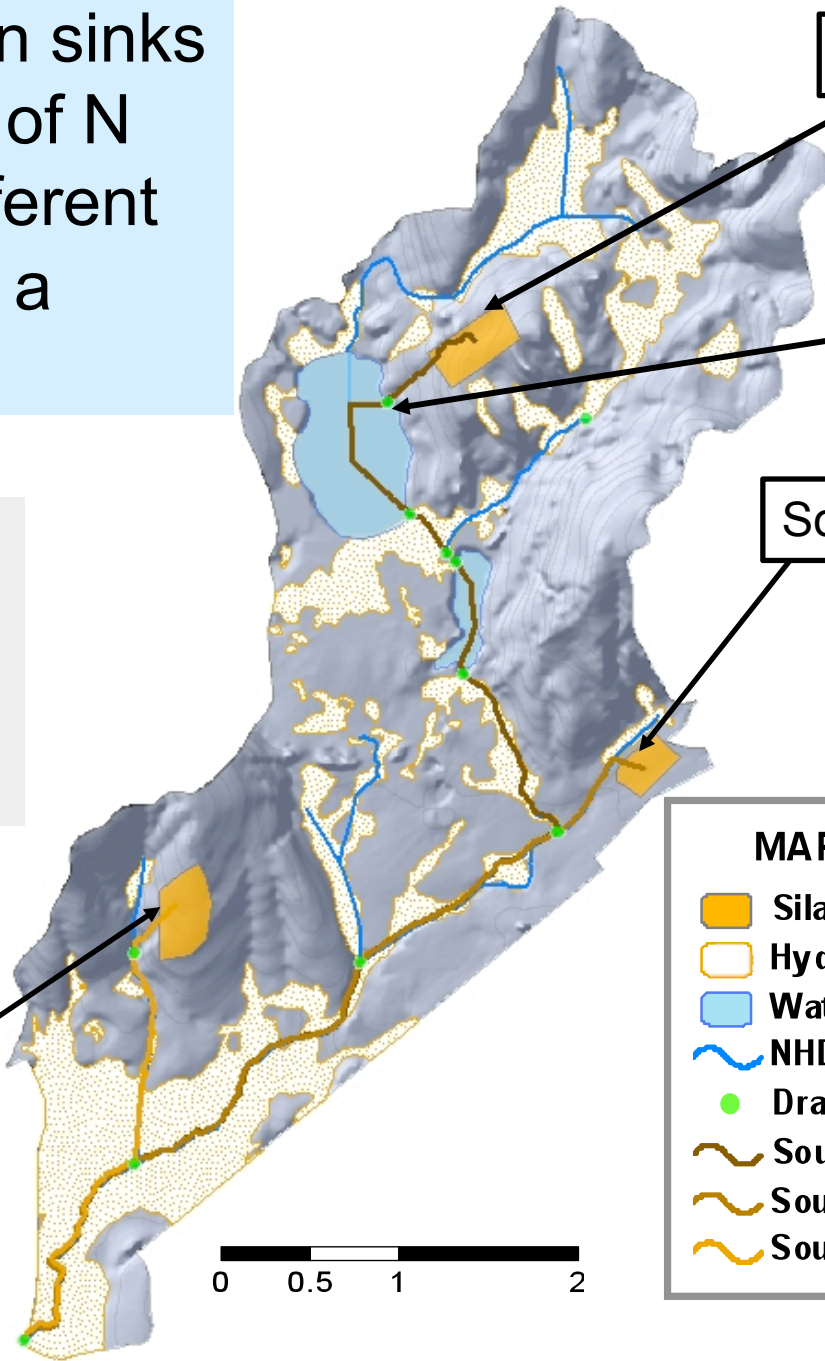
How do denitrification sinks affect the delivery of N from sources in different locations within a catchment?

Example:
Chickasheen Catchment,
Southern New England
(1740 Ha)

N source:
Silage corn on well-drained soil



Source C



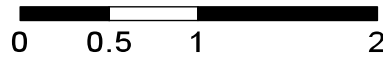
Source A

Drainage Point

Source B

MAP LEGEND

- Silage Corn
- Hydric Soils
- Waterbodies
- NHD Streams
- Drainage Points
- Source A Flowpath
- Source B Flowpath
- Source C Flowpath











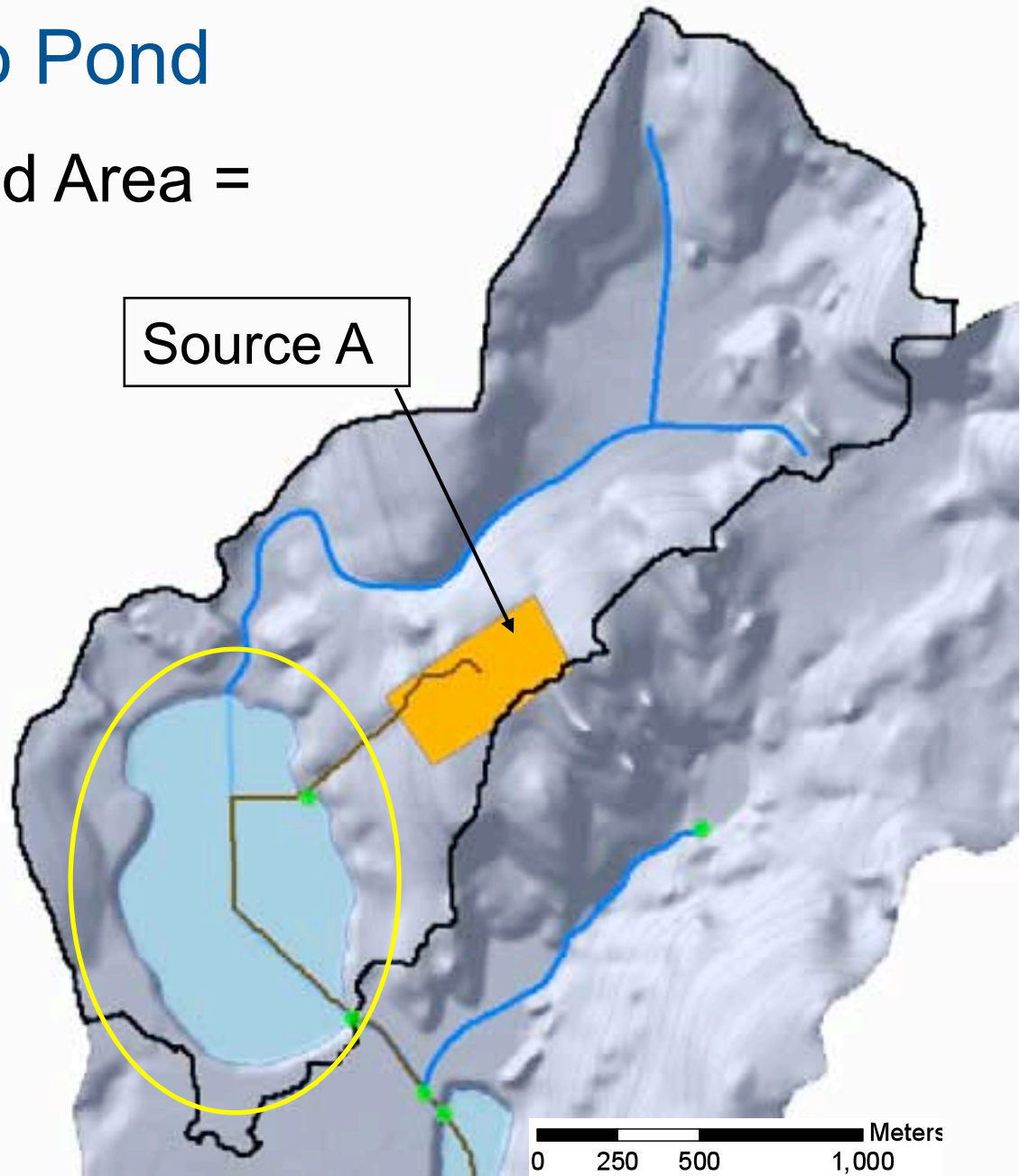
Example: Yawgoo Pond

Drainage Area/Pond Area =
6.3

N retention
in pond =
68% of N
entering pond

MAP LEGEND

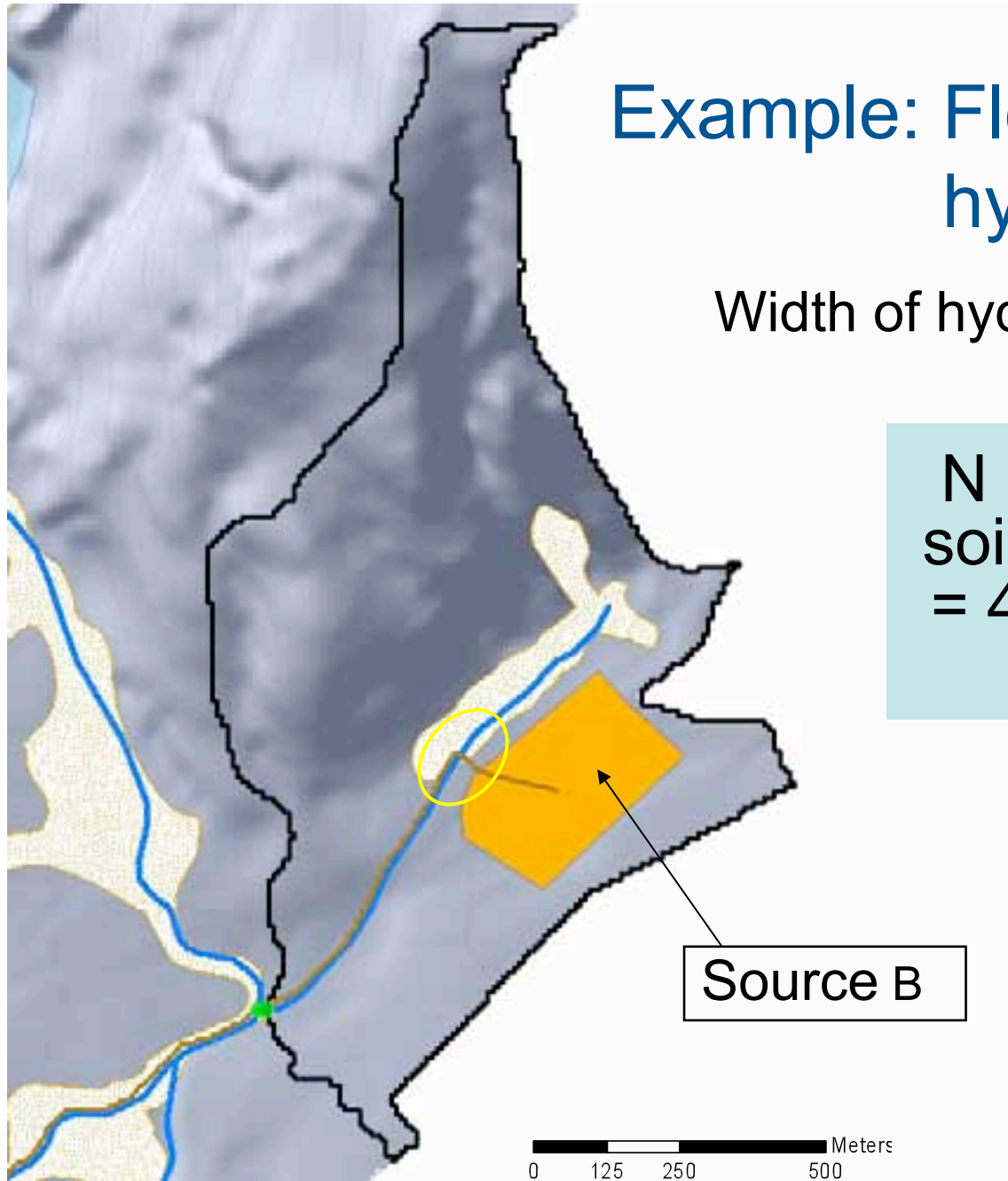
-  Silage Corn
-  Hydric Soils
-  Waterbodies
-  NHD Streams
-  Drainage Points
-  Source A Flowpath
-  Source B Flowpath
-  Source C Flowpath



Example: Flow path crosses hydric riparian zone

Width of hydric soils in riparian zone
= 12 m

N removal in hydric soils in riparian zone
= 40% of N entering riparian zone



MAP LEGEND

- Silage Corn
- Hydric Soils
- Waterbodies
- NHD Streams
- Drainage Points
- Source A Flowpath
- Source B Flowpath
- Source C Flowpath

Example: Flow path along first order stream

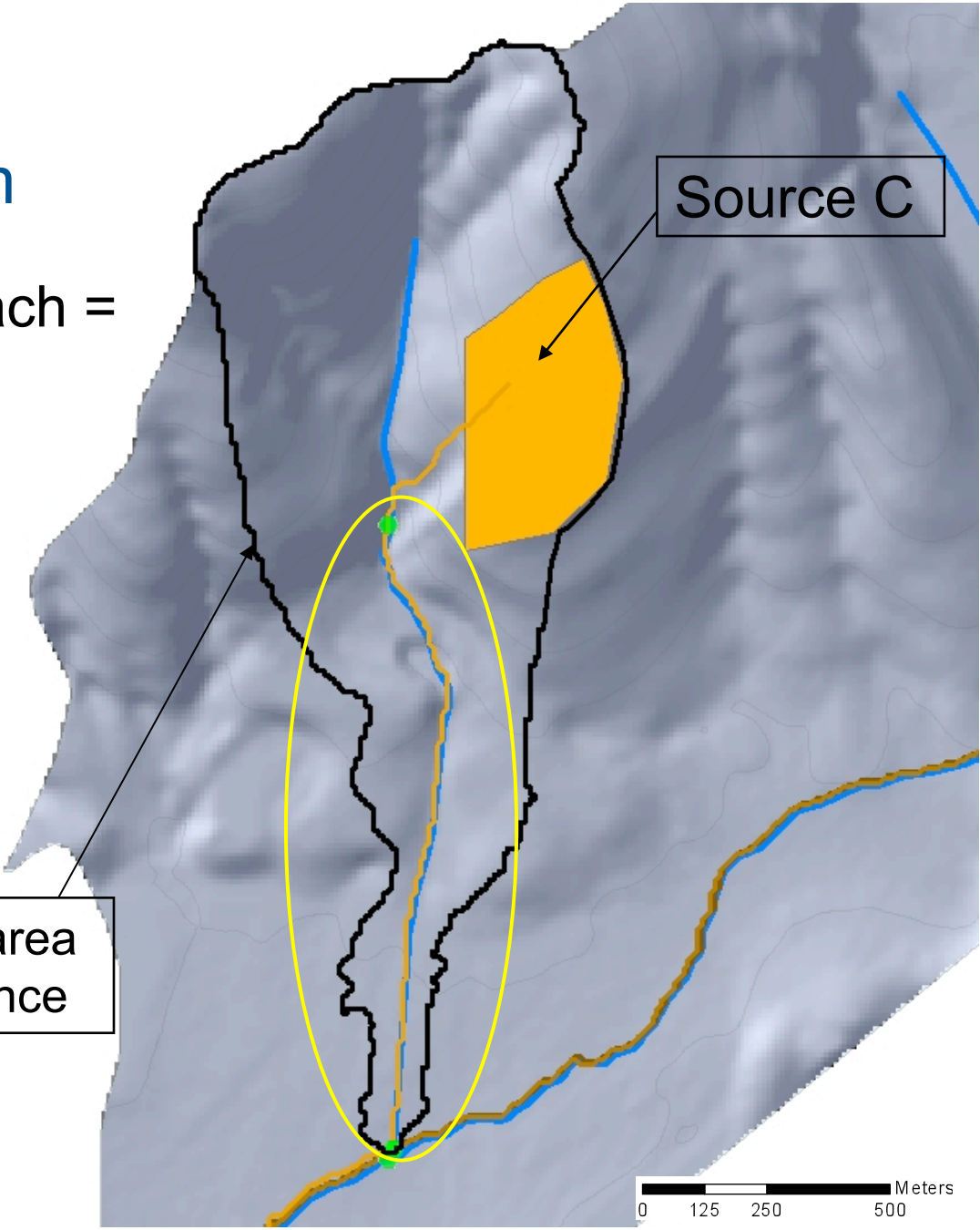
Time of travel in stream reach =
3.3 hrs (0.14 days)
Depth: 0.1 m

N removed in stream reach = 17% of N entering at top of reach

MAP LEGEND

- Silage Corn
- Hydric Soils
- Waterbodies
- NHD Streams
- Drainage Points
- Source A Flowpath
- Source B Flowpath
- Source C Flowpath

Drainage area to confluence



YOUR Portal to the World of N Sinks

Nitro7Sim

An Environmental Spatial Decision Support System



Home

Explain

Explore

Examples

Examine

Version A

Version B

References

Building a sustainable future depends on the decisions we make today.

The goal of this project is to develop an environmental spatial decision support system for local watershed managers.

They will use it to evaluate the extent and location of Nitrogen sources and sinks within specific stream reach ecosystems. This tool will permit decision makers and landowners to target best managements practices to effectively minimize nitrogen impacts on their watersheds. The tool will provide guidance to protect critical areas, optimize site selection, and recommend necessary nitrogen interventions. It will support decisions at both the household and regional scales.



This tool is divided into sections that can be accessed using the tabs on the left hand side of the screen.

Explain - Information about nitrogen best management practices

Explore - An exploratory map showing the study area and relevant data

Examples - Handdooded examples of the simulation (not created yet)

Examine - The simulation is accessed in this section

References - Relevant works cited for the production of this tool

Nitro7Sim

Version A

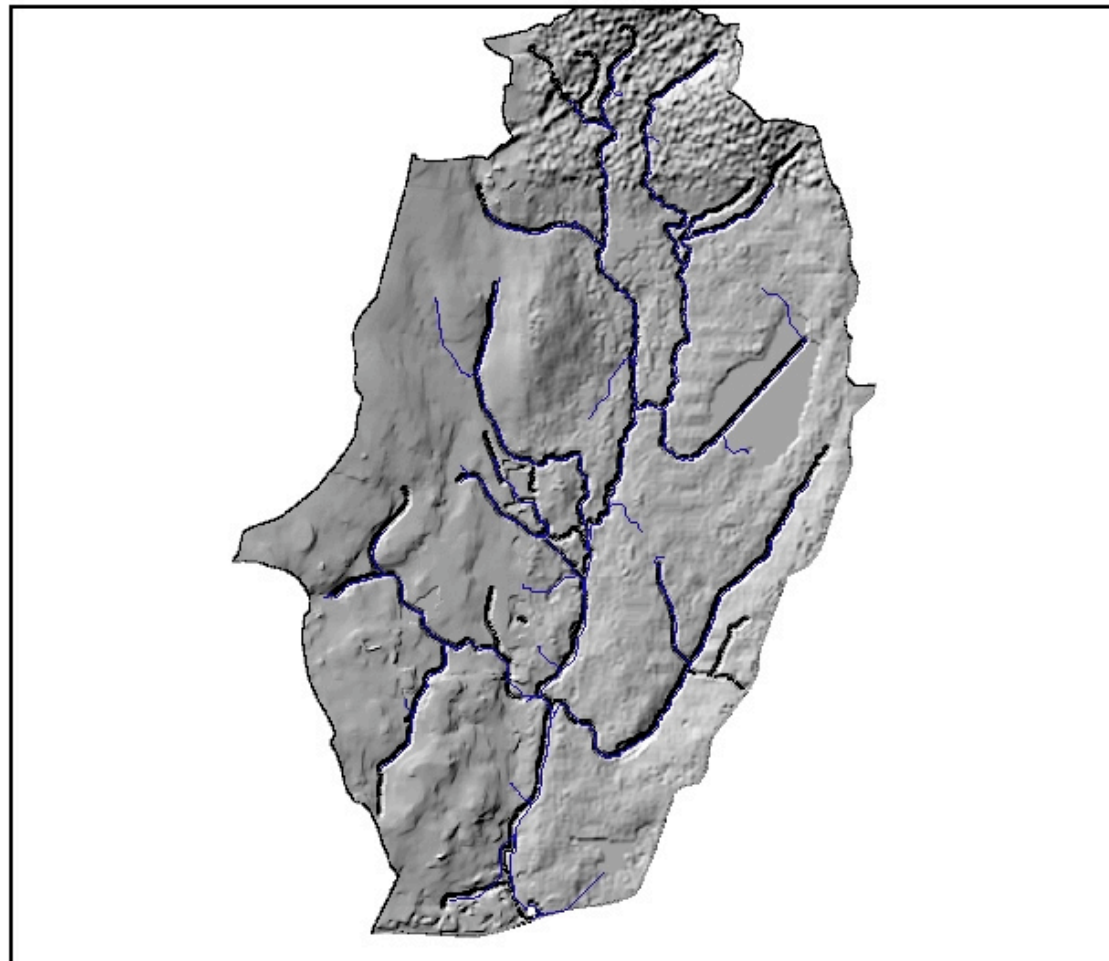
1. Enter Development size: 100 Acres

2. Select Development Type:

Medium Density Residential ▼

3. Select Development Location using image below (click on image):

Version A:
Locating your
target



Version A: Target Details

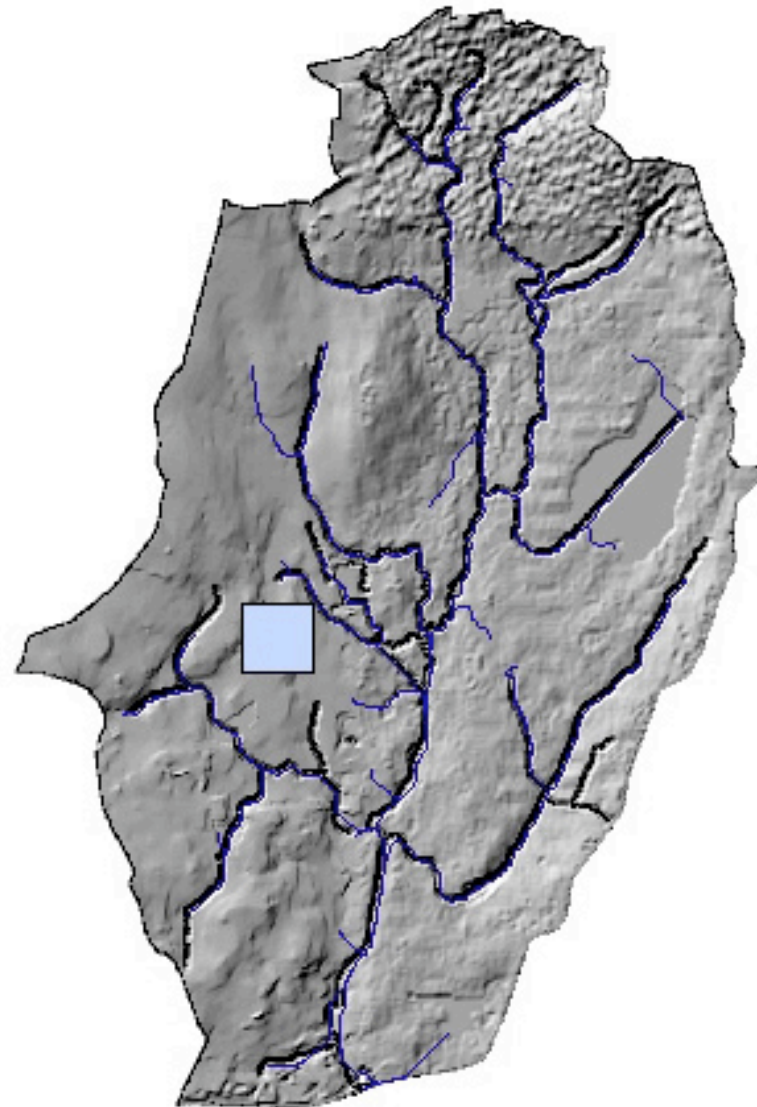
Development
Size: 100 acres

Development
Type: Med. Dens.
Residential

Nitrogen Load
at Development: 4170 lb/yr

Nitrogen load
at end of system
(sensitive areas): 3915 lb/yr

Nitrogen Impact
Rating: Medium



Version A: Alternate Target Details
-fewer casualties expected

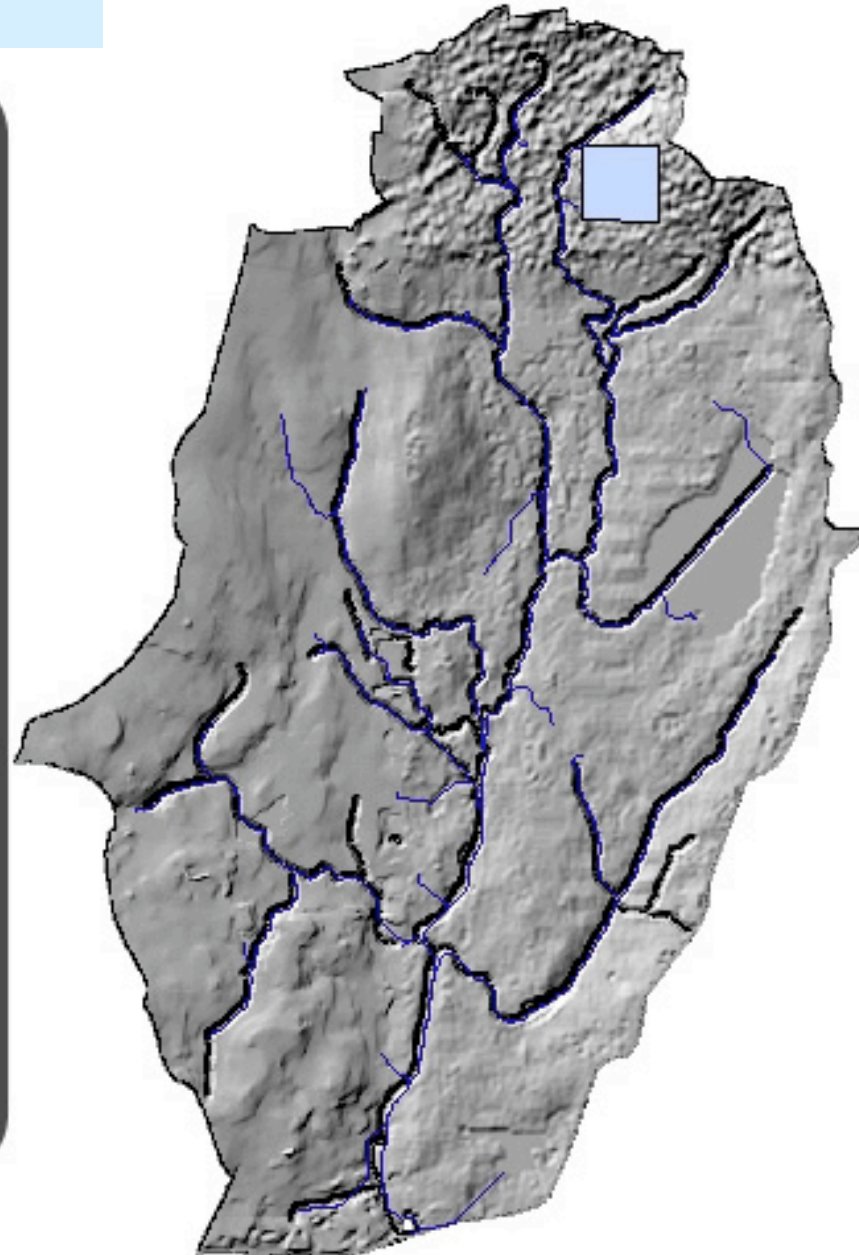
Development
Size: 100 acres

Development
Type: Med. Dens.
Residential

Nitrogen Load
at Development: 4170 lb/yr

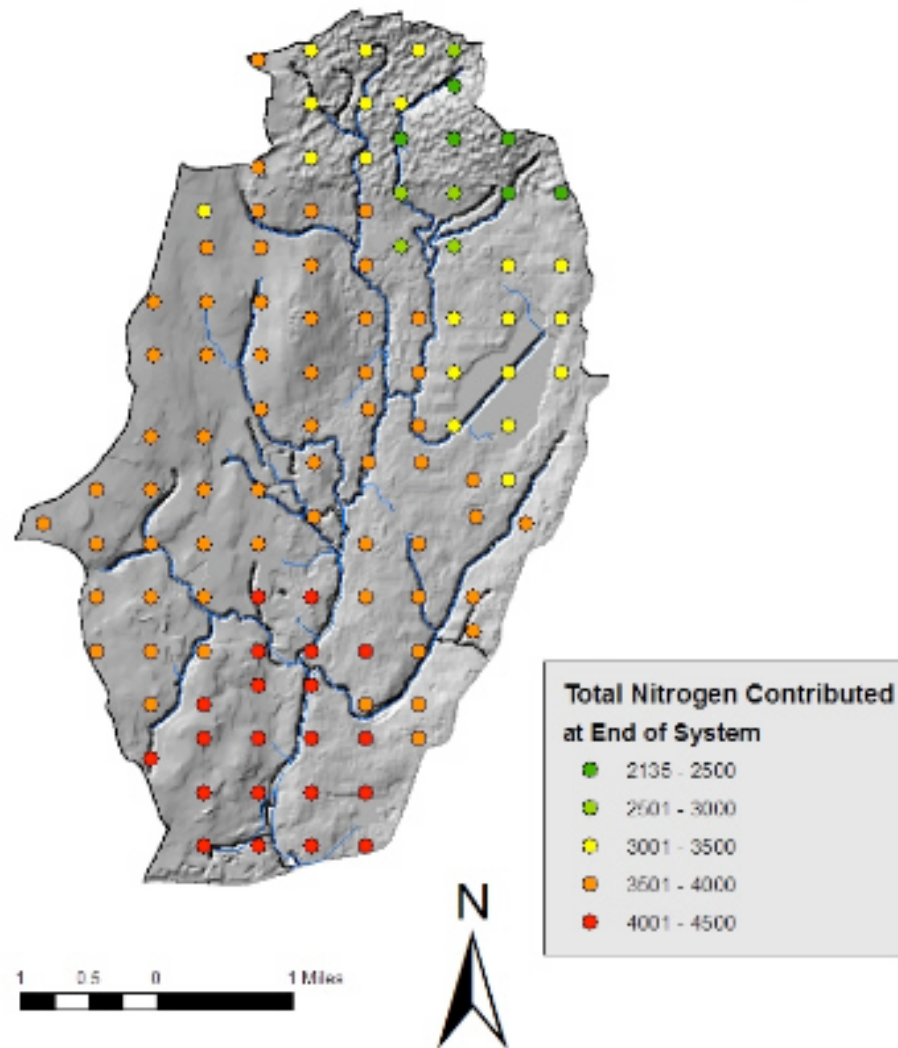
Nitrogen load
at end of system
(sensitive areas): 2224 lb/yr

Nitrogen Impact
Rating: Low



Version B:
The overall scenario

Saugatucket Watershed - Nitrogen Load from 100 acre Medium Density Residential Developments



Version B: Target Details

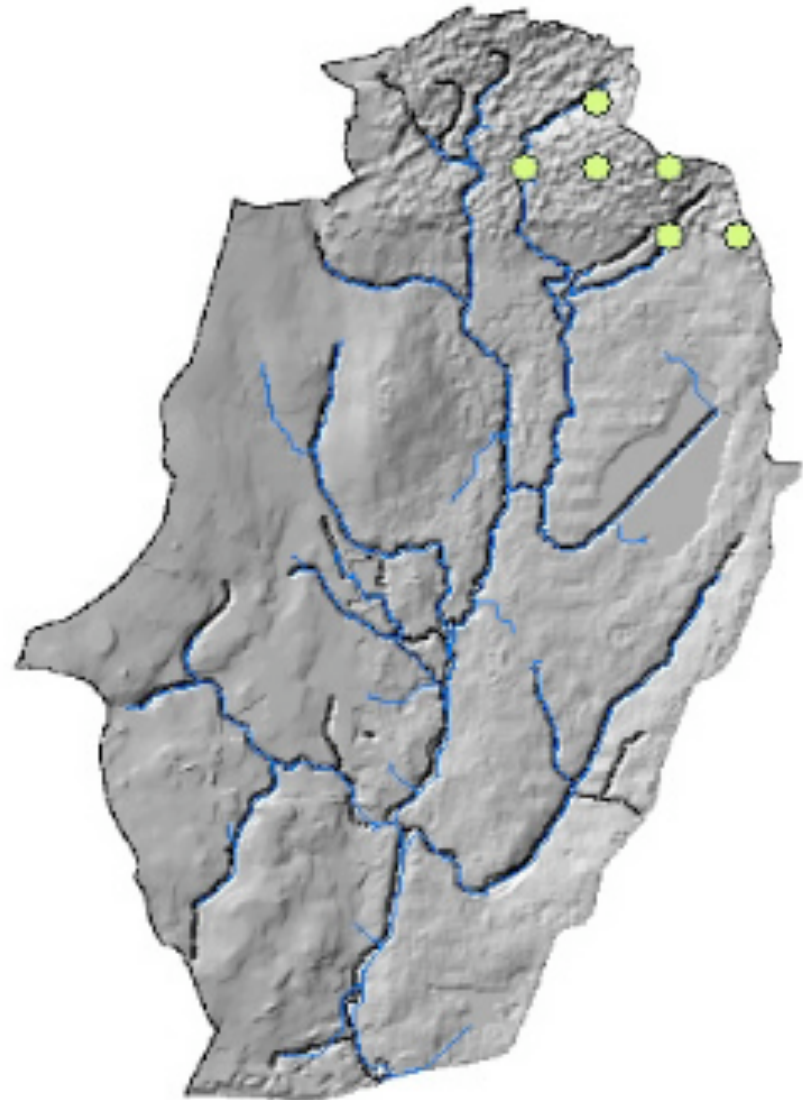
Development
Size: 100 acres

Development
Type: Medium
Dens. Res.

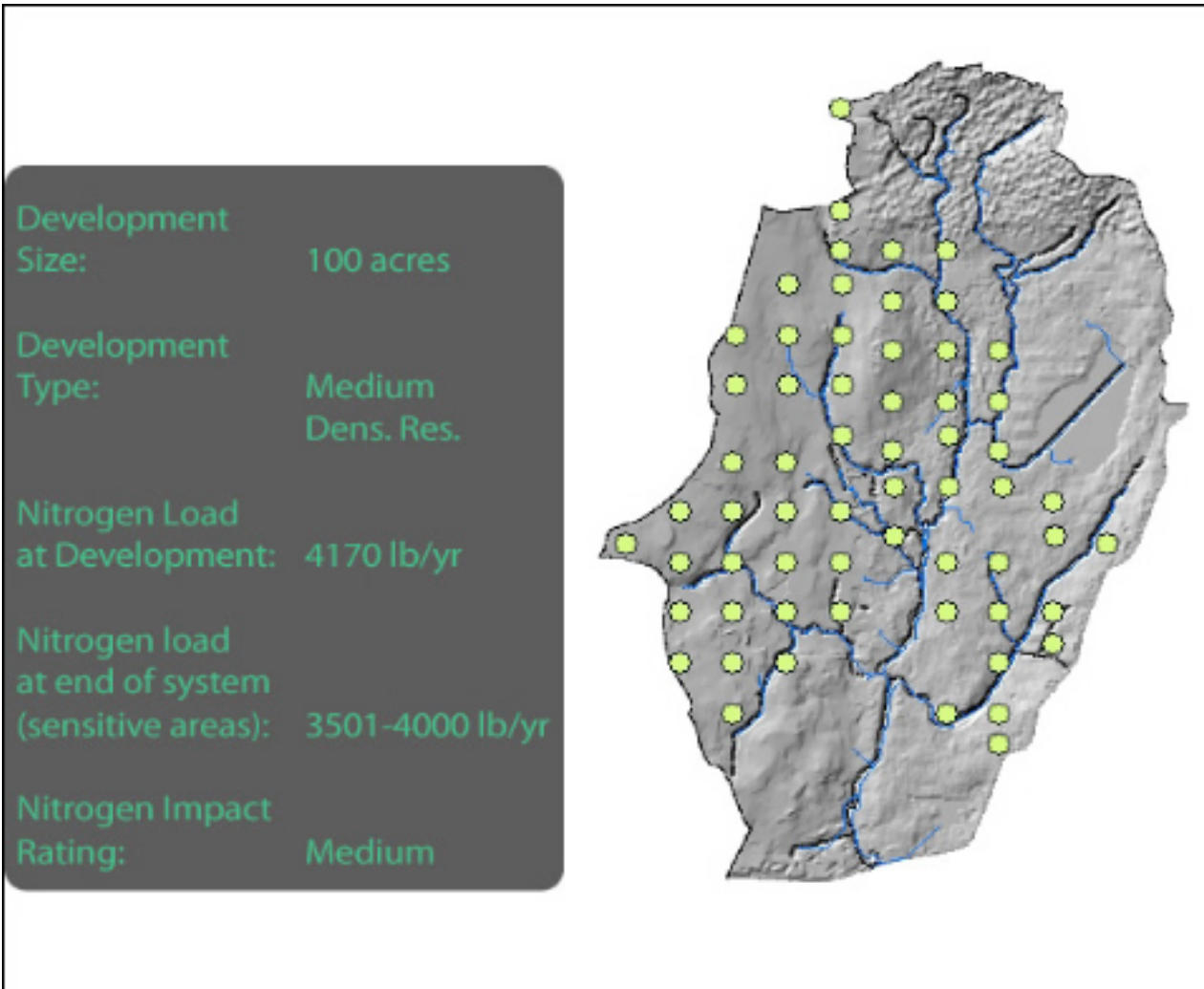
Nitrogen Load
at Development: 4170 lb/yr

Nitrogen load
at end of system
(sensitive areas): 2001-2500 lb/yr

Nitrogen Impact
Rating: Low



Version B: Alternate Target Details



Mission not quite complete. Next Steps: Nitro7Sim & the Sink Quest



- Map and Show Importance of Natural Sinks
- Develop hotlinks with information on each sink and source area
- Test Usability and Usefulness of System with NEMO (will you be an associate in cracking the N code?!) and NRCS
- Provide access and links to national databases

