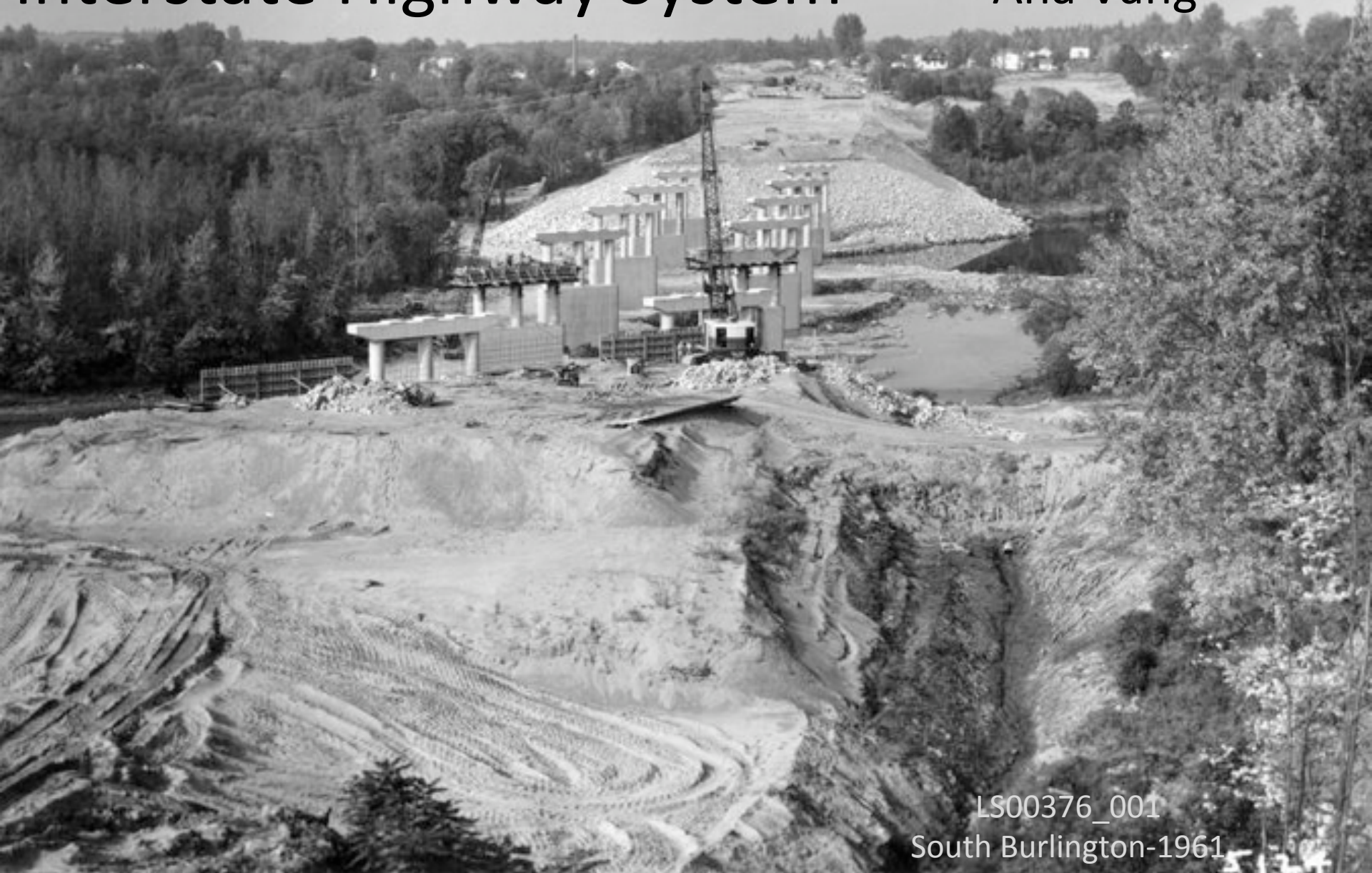


The Hydrologic Impacts of the Vermont Interstate Highway System

Ana Vang



LS00376_001
South Burlington-1961

Outline

- Project Goals
- Interstate History
- Vermont Interstate
- Build-out and Impervious Surface
- Vermont's Exits and Study Site Selection
- Aerial and Ground Based Rephotography
- Summer 2012 Fieldwork
- Hydraulic Modeling

Landscape Change Program

- Funded by NEH
- Documents change in Vermont
- Interstate photos
- Summer team of 4



The screenshot shows the top section of the website. On the left is a logo for the 'LANDSCAPE CHANGE PROGRAM' inside a tilted rectangular frame. To its right is the text 'See Vermont as it was 200 YEARS AGO' in a serif font, followed by 'A digital archive of historic and current photo pairs, educational resources, and more!' in a smaller sans-serif font. Below this is a navigation bar with links: 'home search submit learn about members' followed by a search input field and a 'quick image search' button. On the right side of the banner are two small landscape photos. Below the banner is a large heading 'We've Made TIME TRAVEL Possible.' followed by a paragraph of text and two side-by-side photos of the Vermont State House in Montpelier, one in black and white (1874) and one in color (2000). At the bottom of the banner is the text 'Enter the website and see how VERMONT has changed!'.

LANDSCAPE CHANGE PROGRAM

See Vermont as it was
200 YEARS AGO
A digital archive of historic and current photo pairs, educational resources, and more!

home search submit learn about members quick image search [Advanced Search](#)
[Map/Keyword Search](#)

We've Made TIME TRAVEL Possible.

The Landscape Change Program, at the University of Vermont, is a virtual collection of images that documents 200 years of Vermont's changing face. We have thousands of views of Vermont as it was and as it is, online and free to everyone.

Left: The State House, Montpelier (1874 and 2000). 1874 photo courtesy of the Vermont Historical Society, photo VHS-96.

Enter the website and see how VERMONT has changed!

Goals

Determine how the building of the interstate has changed the hydrology of Vermont

Hypothesis: I will test whether construction of the interstate and the associated build-out increased the amount of impermeable surface sufficient to change peak flow and run off volume, and if so whether I can relate this to changes in stream planform, incision depth, and bed material.

Interstate History

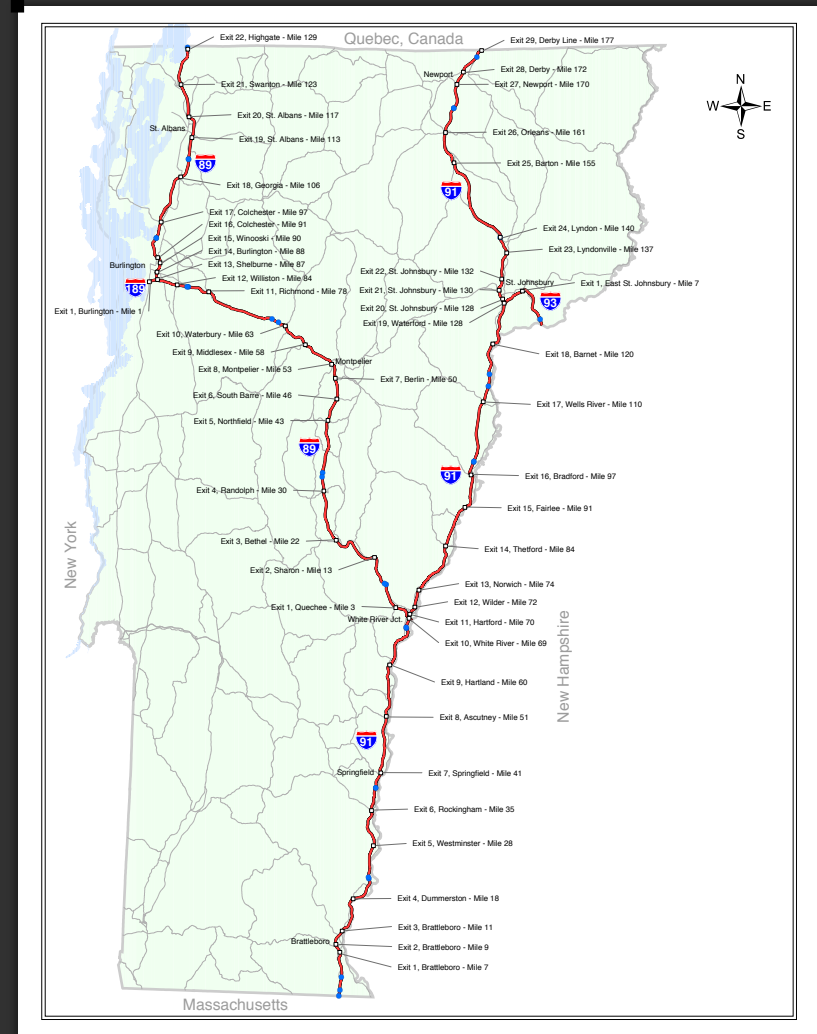
- Federal-Aid Highway and Highway Revenue Acts of 1956
 - 75440 km long
 - >170 km² paved area
 - 32 billion m³ moved
 - \$215 billion (2012)



Kaszynski, 2000; Missouri Department of Transportation, 2012; Obenberger and DeSimone, 2011

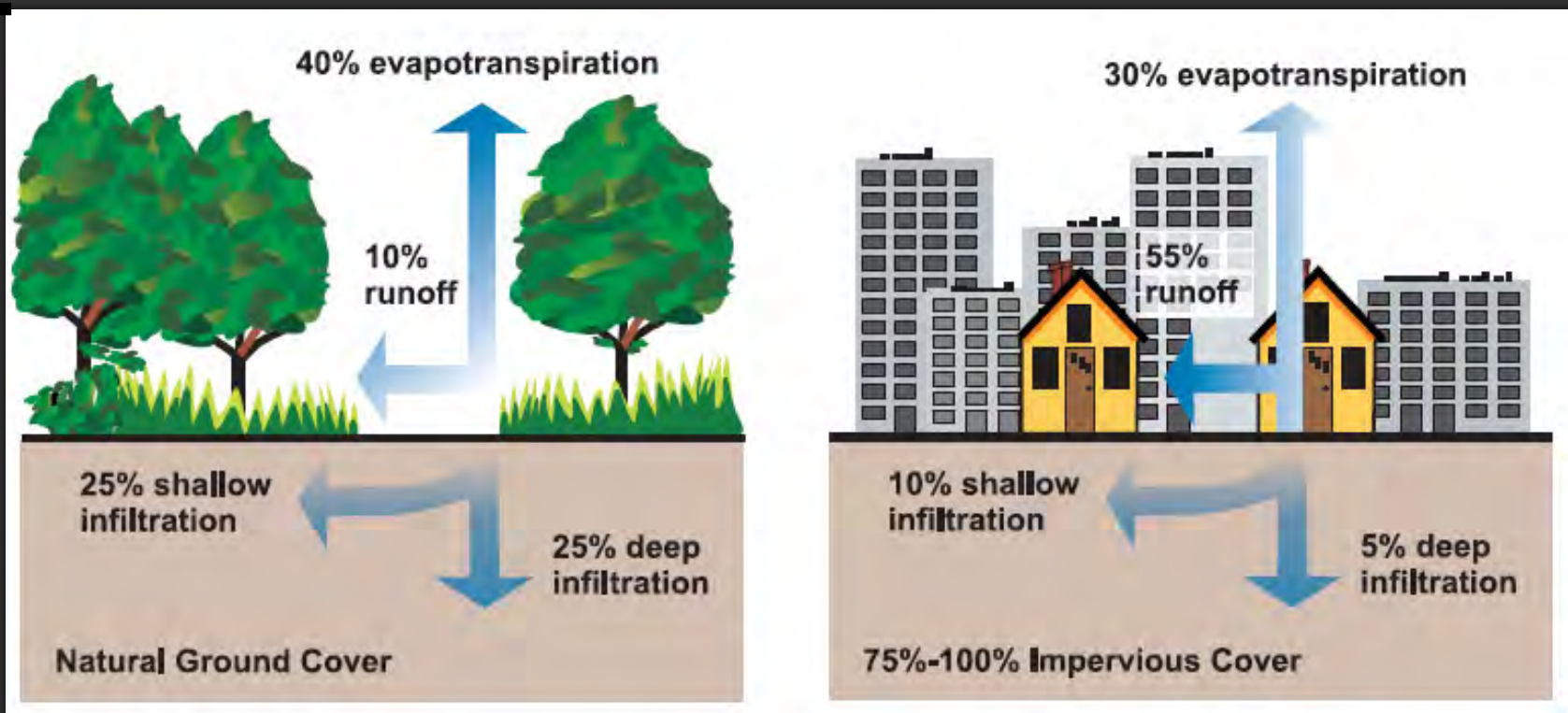
Vermont Interstate System

- Constructed from 1958-1983
- 516 km long
- 12 km² area
- 53 exits

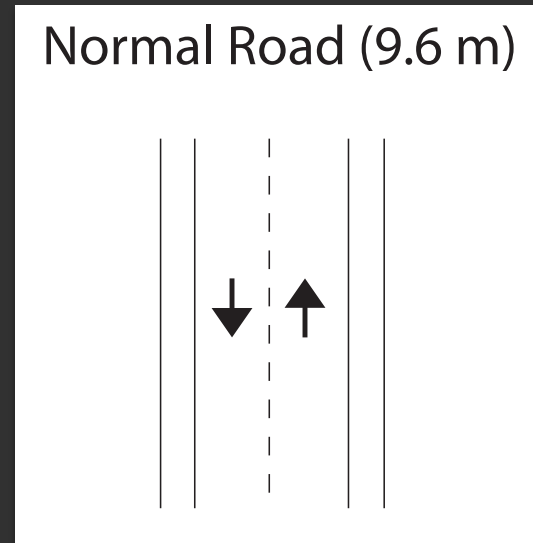
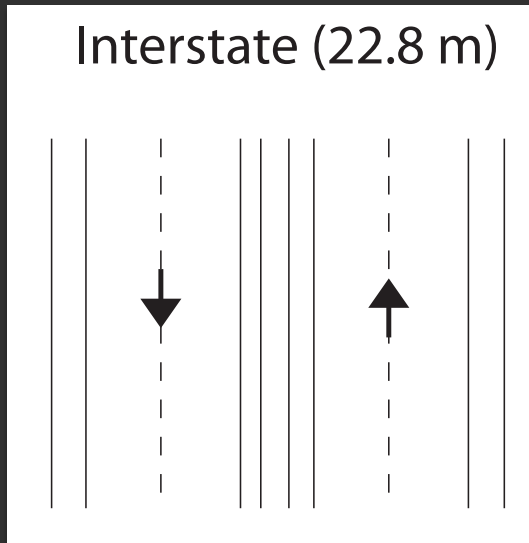


Smith, 2006; Vermont Department of Highways, 1965;
Vermont Agency of Transportation, 2012

Impervious Surface



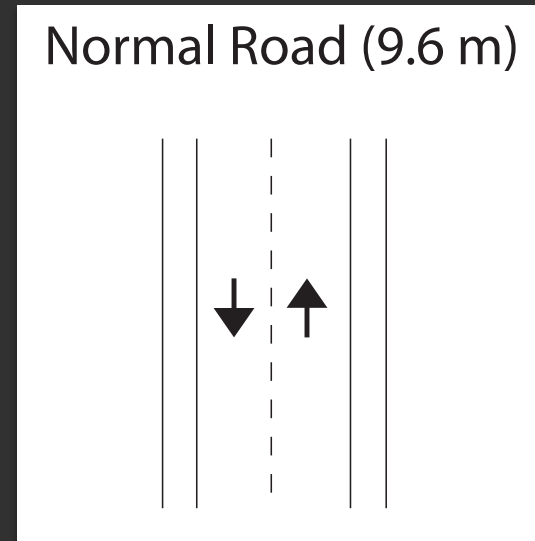
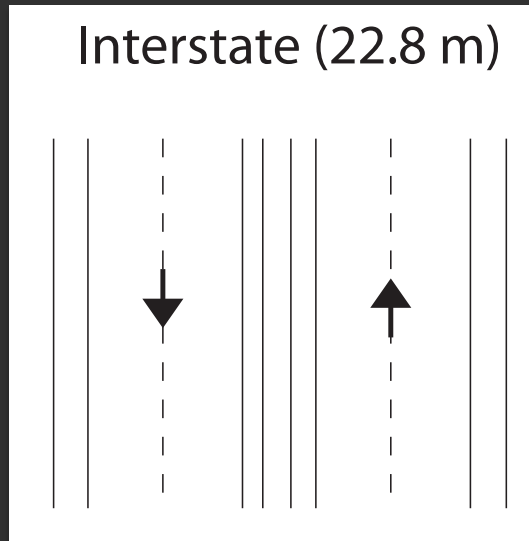
Vermont's Impervious Surface



Interstate: 516 km
Area/km: 22,800 m²
Total Area: 11.8 km²

Paved Road: 10,878 km
Area/km: 9600 m²
Total Area: 92.2 km²

Vermont's Impervious Surface



Interstate: 516 km
Area/km: 22,800 m²
Total Area: 11.8 km²

Paved Road: 10,878 km
Area/km: 9600 m²
Total Area: 92.2 km²

The interstate is 4.5% of paved roads by length but 10% by area

Interstate Build-Out

- Catalyzed build-out
- Increased impervious surface



Why do we care?

Changes in:

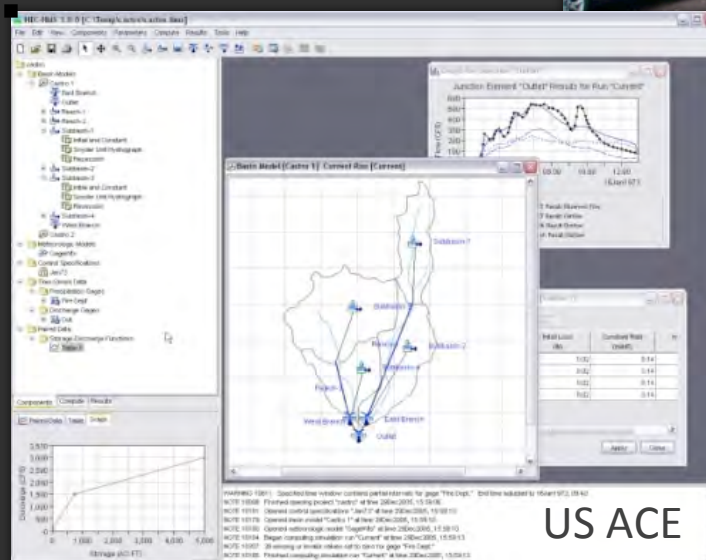
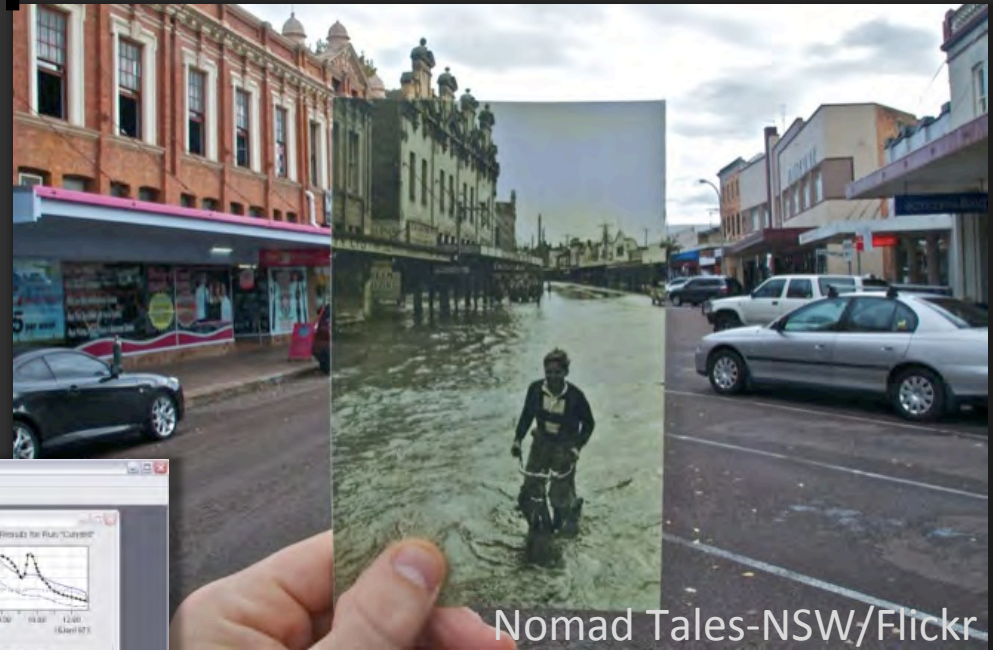
- Flow paths
- Flood peak
- Stream morphology
- Water quality
- Ground water recharge



Increased impervious area = Landscape change

How do we study changes and test hypothesis?

- Rephotography
- Fieldwork
- Hydraulic Modeling



How do we study changes and test hypothesis?



Ground Based Rephotography

How do we study changes and test hypothesis?

1927



Aerial Rephotography

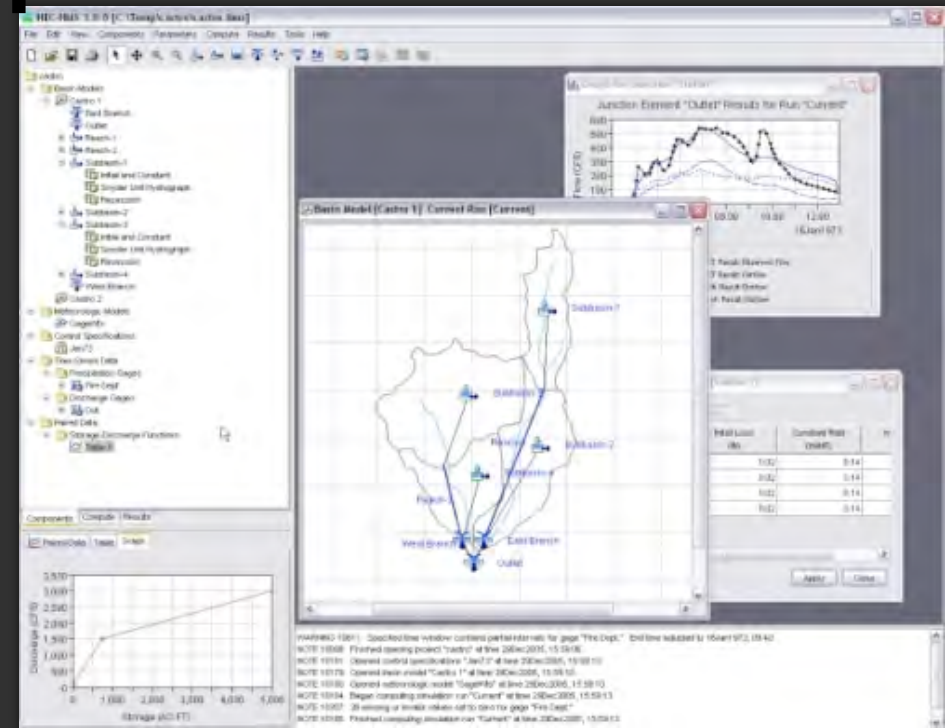
2004



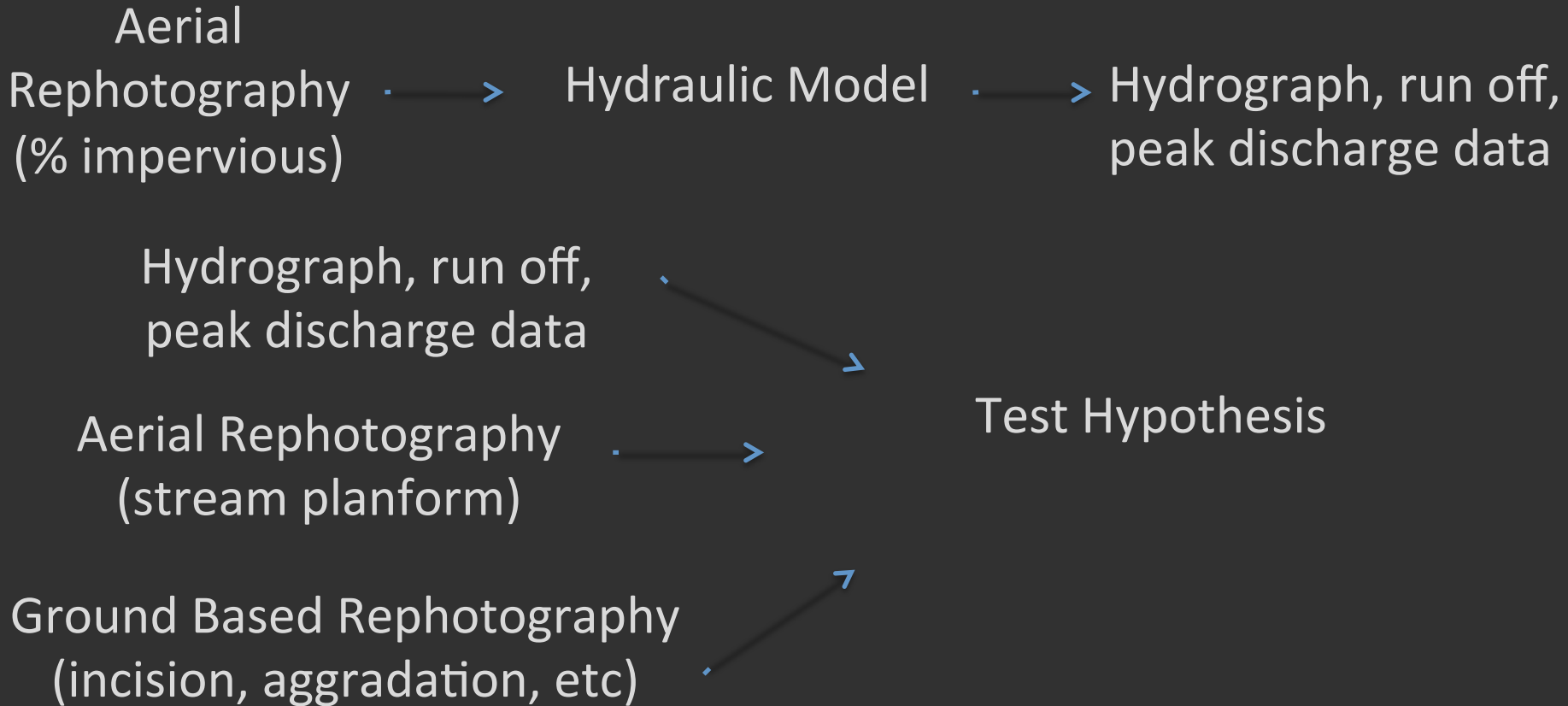
How do we study changes and test hypothesis?

HEC-HMS

- Inputs
 - Drainage area
 - % Impervious
 - Precipitation
- Outputs
 - Hydrograph data
 - Time to peak discharge
 - Runoff contribution



How does this all work together?



I will test whether construction of the interstate and the associated build-out increased the amount of impermeable surface sufficient to change peak flow and run off volume, and if so whether I can relate this to changes in stream planform, incision depth, and bed material.

Work Completed

- Photo processing
- Interstate exit classification
- Site selection

Vermont Interstate Photos

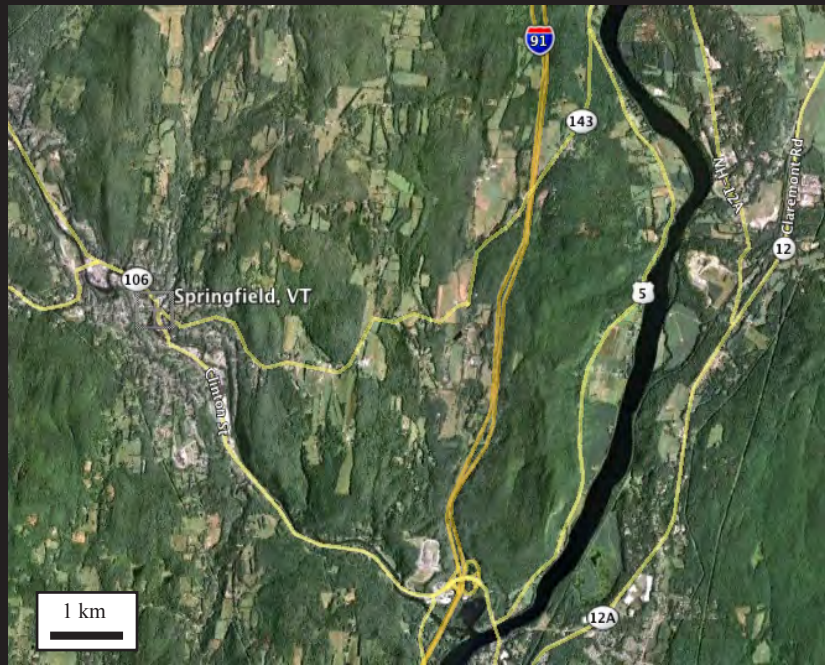
- 50,000 images
- >13,000 Public Interstate Images
- >36,000 Interstate Collection

The screenshot displays the Vermont Landscape Change Program website. At the top, a banner reads "See Vermont as it was 200 YEARS AGO" and "A digital archive of historic and current photo pairs, educational resources, and more!". Below the banner is a search bar with the text "home search submit learn about members" and "quick image search". To the right of the search bar are links for "Advanced Search" and "Map/Keyword Search".

The search results page shows "You searched for: each image in database, aotn. Here are the results:". Below this are tabs for "Refine Search", "Distribution", "Image Details", "List", and "Thumbnails". The results are displayed in a grid of 8 items, each with a thumbnail image, a set of icons, a unique ID, a title, and a location/year.

Image ID	Title	Location/Year
LS38605	Aerial of Houses	Manchester, 1960
LS21991	"Cheever Florist" and House	Berlin, 1959
LS22452	"Danger Highway Construction" Sign with Garbage on Ground	Moretown, 1959
LS07851	"Y" In Rural Road	Rutland, 1959
LS39722	\$50 Fine for Throwing Trash on Highways	Windsor, 1961
LS39723	\$50 Fine for Throwing Trash on Highways	Windsor, 1961
LS42264	100B Road Work	Moretown, 1963
LS46498	12 Maplewood Terrace in Hartford	Hartford, 1966

What do Vermont's exits look like?



Undeveloped/Basic Services

What do Vermont's exits look like?



Commercial

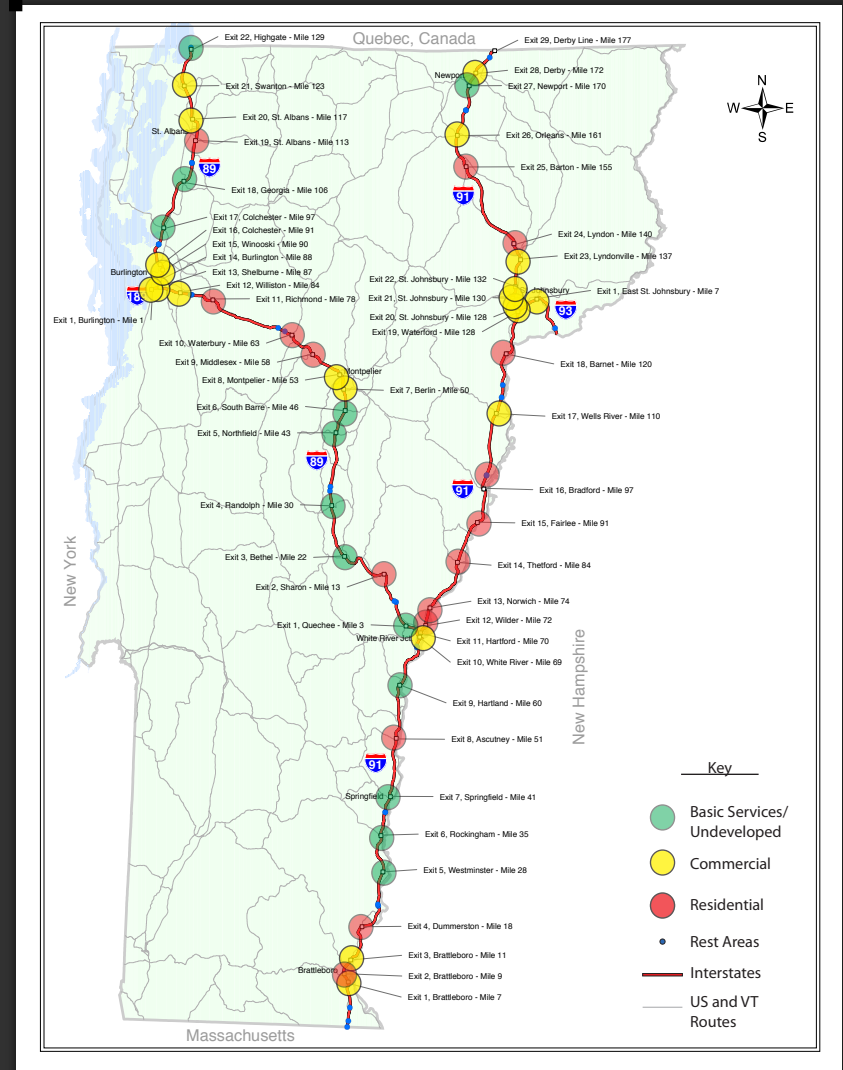
What do Vermont's exits look like?



Residential

What do Vermont's exits look like?

- Undeveloped/Basic Services: 14
- Commercial: 21
- Residential: 16



Site Selection

Town	Current Development	Change in Development
Barton*	Residential	Little change
Bethel*	Undeveloped/Basic	Little change
Brattleboro	Commercial (Exit 1)	Little change
Brattleboro	Residential (Exit 2)	Little change
Brattleboro	Commercial (Exit 3)	Drastic change
Burlington	Commercial	Drastic change
Dummerston*	Residential	Little change
Lyndonville*	Commercial	Little change
Montpelier*	Commercial	Little change
Orleans	Commercial	Little change
Richmond*	Residential	Some change
Sharon	Residential	Little change
Springfield*	Undeveloped/Basic	Little change
St. Albans	Residential (Exit 19)	Some change
St. Albans*	Commercial (Exit 20)	Drastic change
Thetford*	Residential	Some change
Waterbury	Residential	Little change
Westminster	Undeveloped/Basic	Little change
White River Junction	Commercial	N/A
Williston*	Commercial	Drastic change
Winooski*	Commercial	Drastic change
Georgia	Undeveloped/Basic	Some change
Hartford*	Commercial	Some change
Vermont	-	-

*Indicates chosen field site

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Williston*	Commercial	Drastic change
Winooski*	Commercial	Drastic change
Georgia	Undeveloped/Basic	Some change
Hartford*	Commercial	Some change
Vermont	-	-

*Indicates chosen field site

Site Selection

Basic Services/Undeveloped:

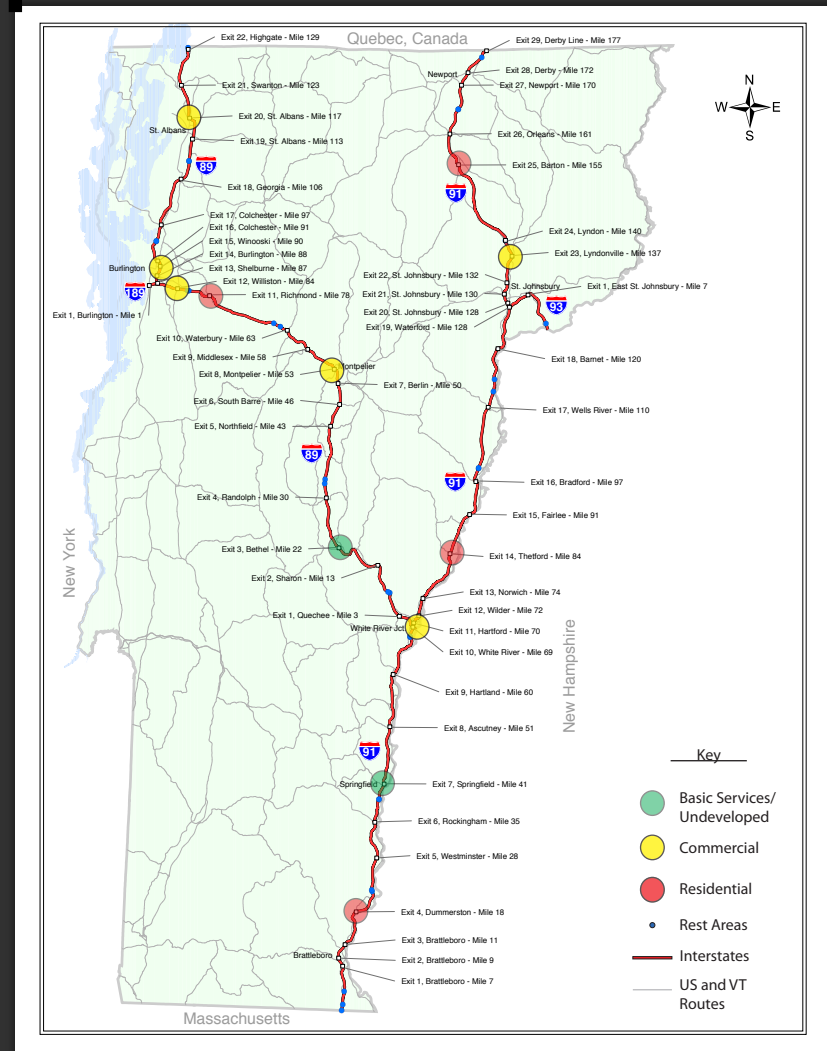
- Bethel
- Springfield

Commercial:

- Hartford
- Lyndonville
- Montpelier
- St. Albans
- Williston
- Winooski

Residential

- Barton
- Dummerston
- Richmond



Summer/Fall Work

- Ground based rephotography
- Fieldwork
- Final study site selection
- Aerial rephotography
- Hydraulic modeling

Ground Based Rephotography



Ground Based Rephotography

LS00376 - Interstate 89, South Burlington (1961-1964)



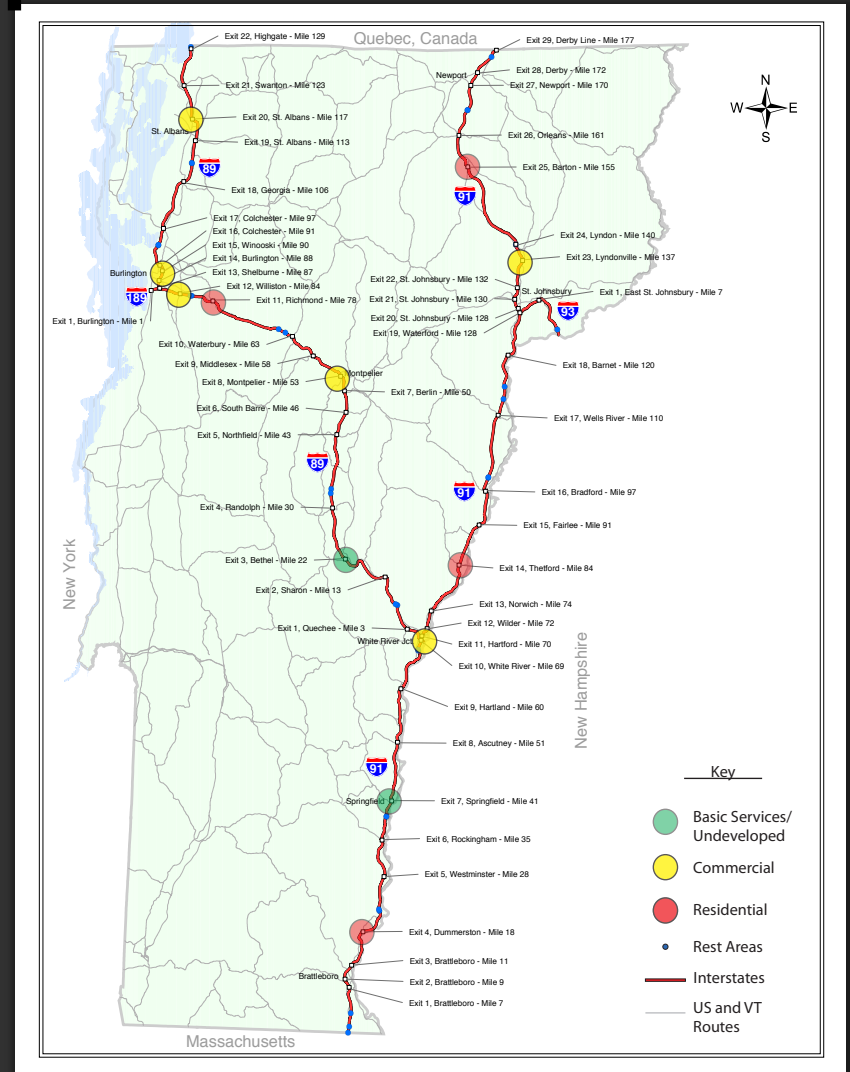
Fieldwork

- Rephotography
 - Bridge piers
 - Near slopes
 - Drainage
- Walking stretches of river with air photos in hand
 - Scour
 - Aggradation

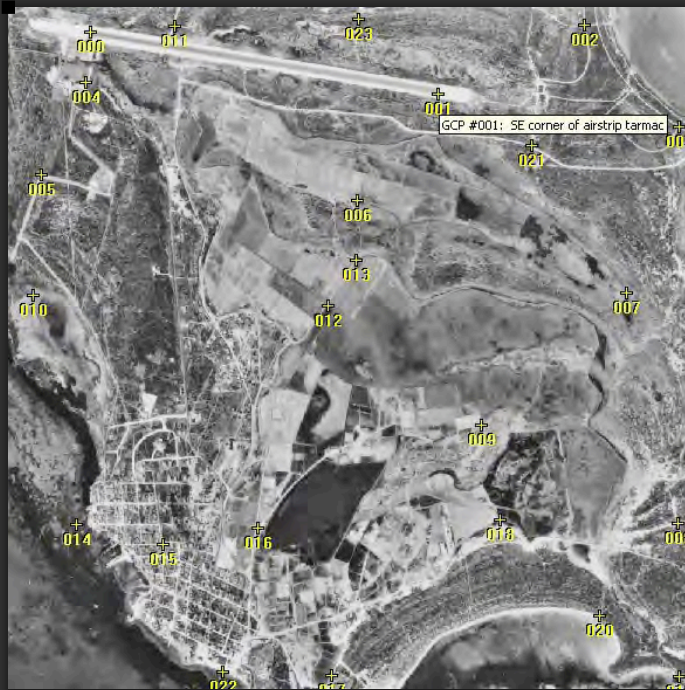


Final Study Sites

- 4 Sites
- Spectrum of variables
- Placement within watershed



Aerial Rephotography



Aerial Photo Availability

Bailey Howe Map Library

Year	Coverage	Type	Source Scale
1937	Most of Chittenden County	Panchromatic	1:20,000
1939-1942	Fragmentary Coverage of Vermont	Panchromatic	-
1962	Statewide	Panchromatic	1:18,000
1962	Select Town Centers	Panchromatic	1:6,000
1968	Central and Southern Vermont	Panchromatic	1:24,000
1974	Northern Half of the State	Panchromatic	1:20,000
	Southern Half of the State	Panchromatic	1:62,500
1977	Statewide	CIR	1:80,000
1980	Statewide	Panchromatic	1:40,000
1988	Most of Chittenden County	Panchromatic	1:7,800

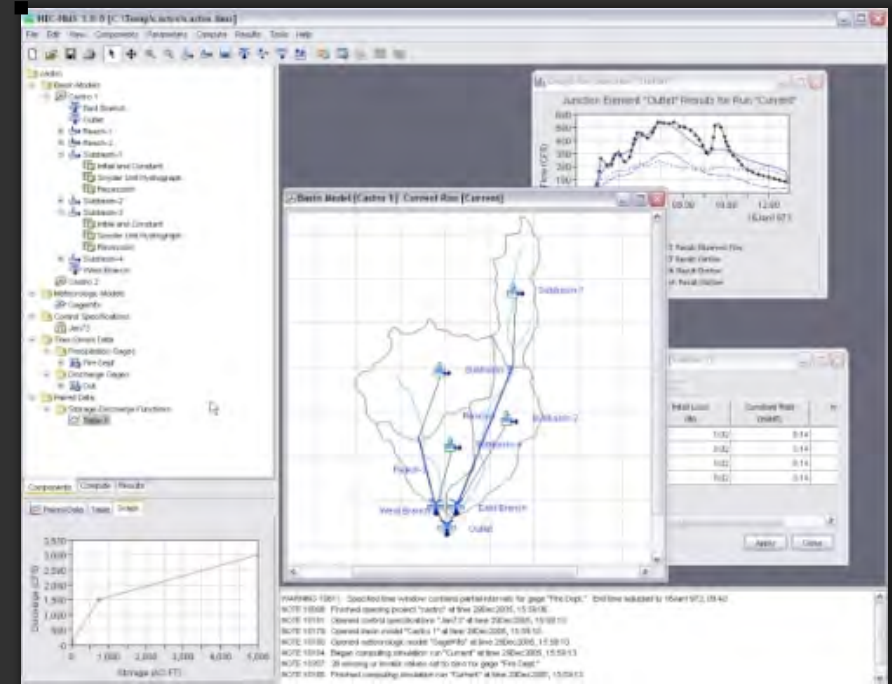
VCGI - Select Datasets

Year	Coverage	Type	Source Scale
2003	Statewide	Truecolor	1:40,000
2004	Most of Chittenden County	Truecolor	1:1,250
2004	Most of Chittenden County	Color IR	1:1,250
2004	Chittenden County	Panchromatic	1:1,250
2008	Statewide	Truecolor and Infared	1:40,000
2009	Statewide	Truecolor	1:40,000
2006-2010	Statewide	Panchromatic	1:5,000

Hydraulic modeling: HEC-HMS

Input:

- Delineate sub-basins
- Impervious % from aerial photos



Compare model outputs to field data

Thesis Outcomes

- Quantify amount impervious surface, over time, at 4 study sites of varying character
- Document current conditions in streams with summer fieldwork
- Document change in conditions with aerial and ground rephotography
- Model the effect of increased impervious on surface hydrology
- Attempt to link the amount and type of impervious change with channel change

Timeline

Timing	Task
Spring 2012	<ul style="list-style-type: none">-Contact local historical societies, town clerks, and listers-Determine method for quantifying imperviousness in historical photos
Summer 2012	<ul style="list-style-type: none">-Photograph and enter ground-based rephotography in LSC Database-Choose 4 final study sites-Learn to use HEC-HMS model
Fall 2012	<ul style="list-style-type: none">-Write introduction/methods-Rectify and analyze rephotographs-Rectify and analyze aerial photographs-Run HEC-HMS model for final study sites-Prepare and present progress report
Spring 2013	<ul style="list-style-type: none">-Finish running models-Compare model results to field data-Write results/conclusions and defend thesis

Questions?



Site Selection

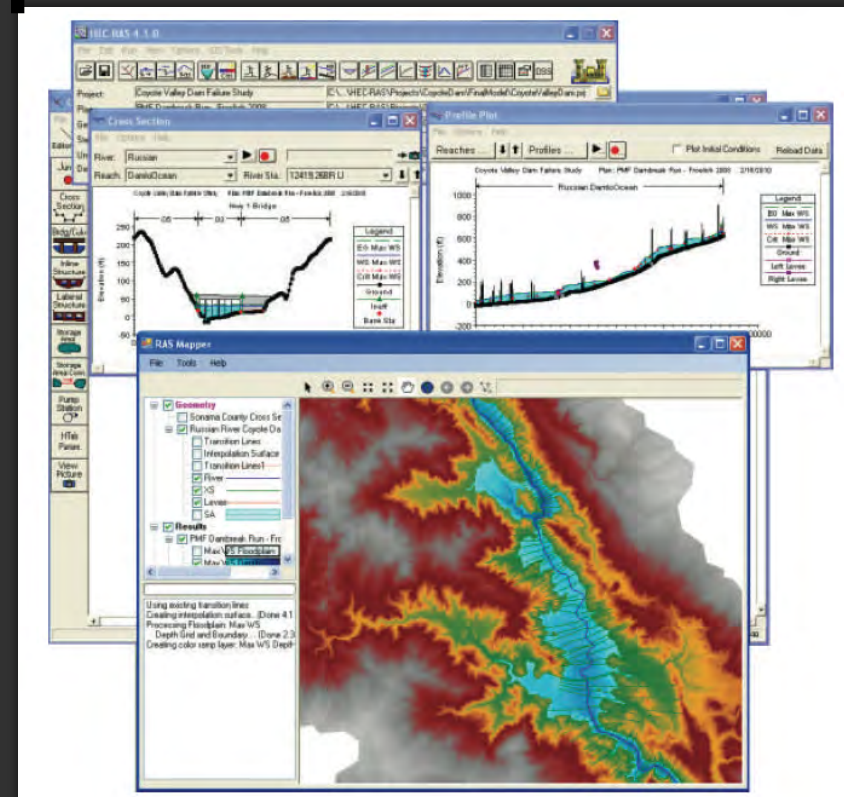
Town	Current Development	Mean Income	Change in Development
Barton*	Residential	43711	Little change
Bethel*	Undeveloped/Basic	54092	Little change
Brattleboro	Commercial (Exit 1)	53184	Little change
Brattleboro	Residential (Exit 2)	53184	Little change
Brattleboro	Commercial (Exit 3)	53184	Drastic change
Burlington	Commercial	56707	Drastic change
Dummerston*	Residential	79071	Little change
Lyndonville*	Commercial	37397	Little change
Montpelier*	Commercial	63892	Little change
Orleans	Commercial	36889	Little change
Richmond*	Residential	83703	Some change
Sharon	Residential	64034	Little change
Springfield*	Undeveloped/Basic	53392	Little change
St. Albans	Residential (Exit 19)	52557	Some change
St. Albans*	Commercial (Exit 20)	52557	Drastic change
Thetford*	Residential	81975	Some change
Waterbury	Residential	75150	Little change
Westminster	Undeveloped/Basic	63222	Little change
White River Junction	Commercial	48297	N/A
Williston*	Commercial	109121	Drastic change
Winooski*	Commercial	54001	Drastic change
Georgia	Undeveloped/Basic	80398	Some change
Hartford*	Commercial	64520	Some change
Vermont	-	78467	-

*Indicates chosen field site

Hydraulic modeling: HEC-RAS

Sediment transport/movable boundary computation

- Range of simulation times
- Simulate hydraulic sorting
- Estimate scour in floods
- Estimate sedimentation



Other slide ideas

- Expand on summer work
- Expand on modeling
- In summary
- Comments from presentation
 - Stream geomorphology, exp pics, list exactly what data I'm looking for. Go over how I'm surveying
 - Go over inputs and outputs of models
 - Go over method for quantifying impervious space
 - Break up writing thesis along the way
 - Data flow diagram for numerical inputs
 - Split up fieldwork slide