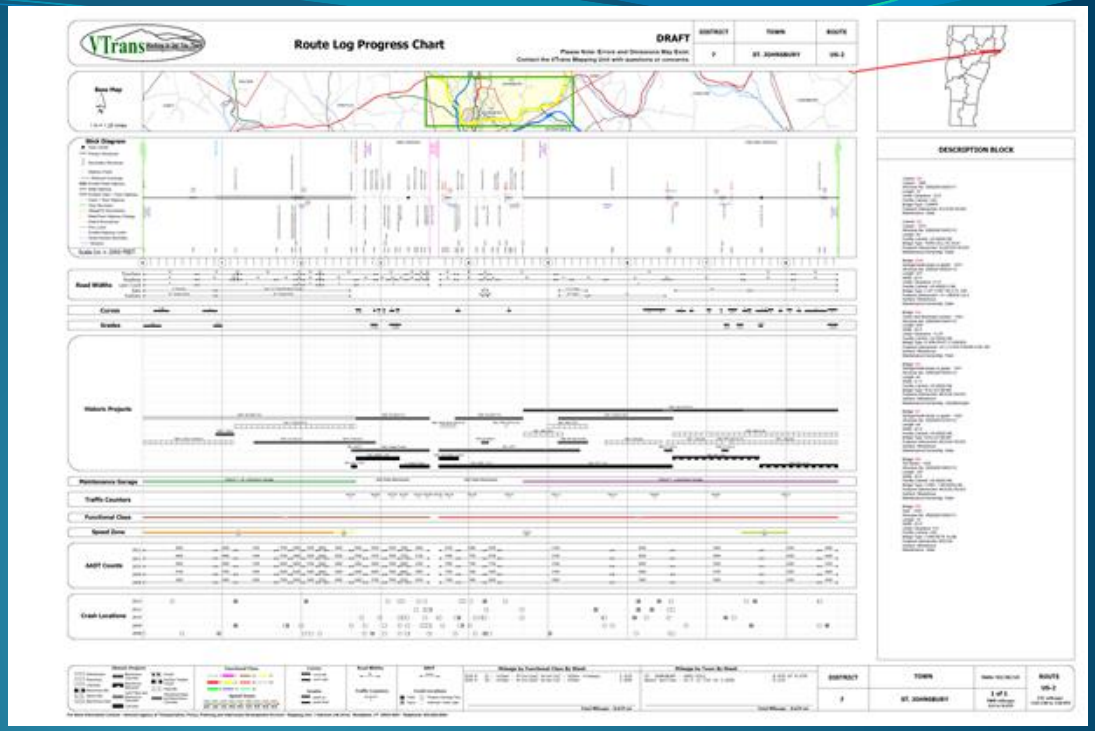
Vermont Route Logs



Python-driven Map Automation with Straight Line Diagrams

Kerry Alley

Esri DevSummit 2014

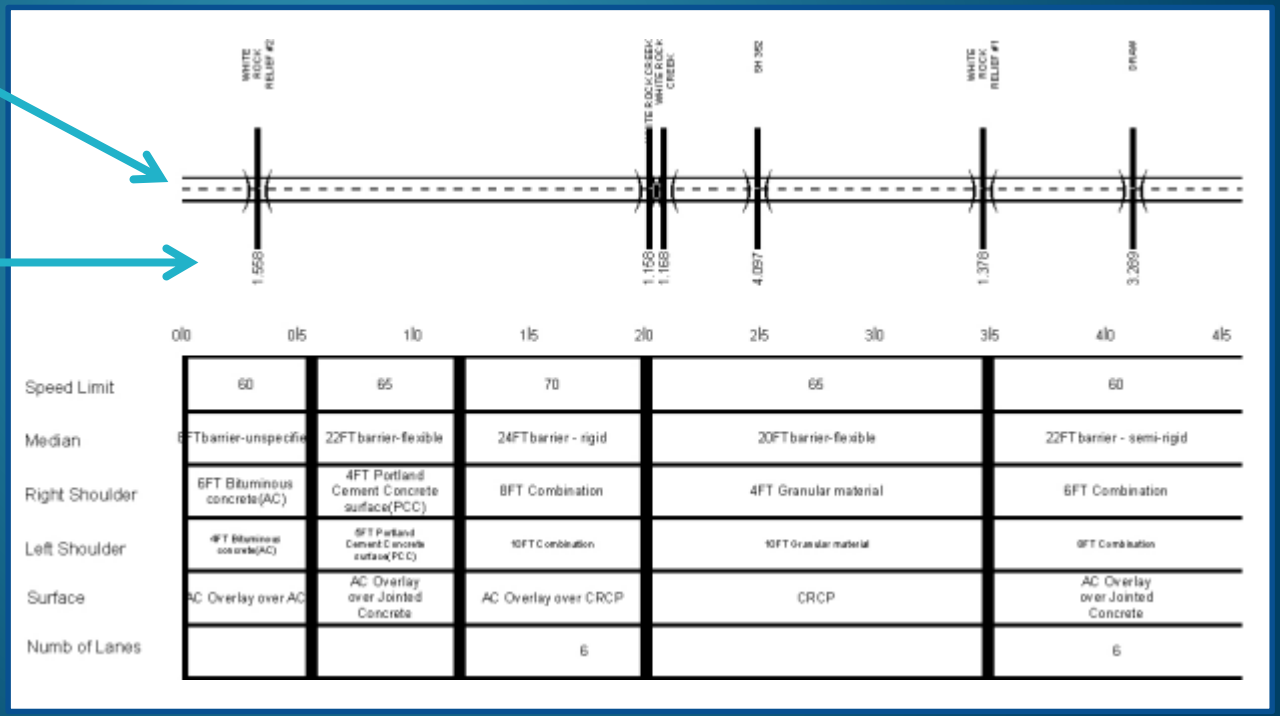
VERMONT
AGENCY OF TRANSPORTATION

Straight Line Diagram

Straight-line view of route

Measures

Additional data



Speed Limit	60	65	70	65	60
Median	6FT barrier-unspecified	22FT barrier-flexible	24FT barrier - rigid	20FT barrier-flexible	22FT barrier - semi-rigid
Right Shoulder	6FT Bituminous concrete(AC)	4FT Portland Cement Concrete surface(PCC)	8FT Combination	4FT Granular material	6FT Combination
Left Shoulder	4FT Bituminous concrete(AC)	5FT Portland Cement Concrete surface(PCC)	10FT Combination	10FT Granular material	6FT Combination
Surface	AC Overlay over AC	AC Overlay over Jointed Concrete	AC Overlay over CRCP	CRCP	AC Overlay over Jointed Concrete
Numb of Lanes			6		6

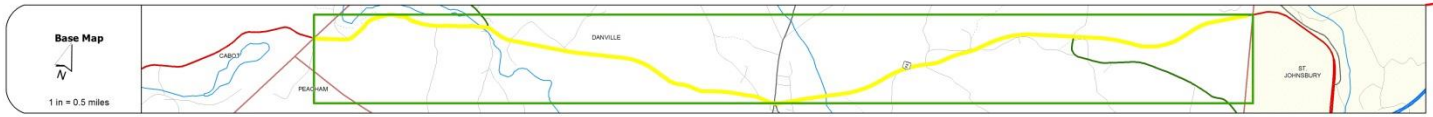
(Image from Esri ArcGIS Help pages)

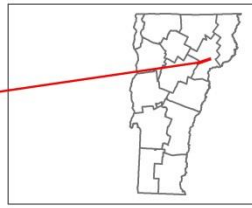
Route Log Progress Chart

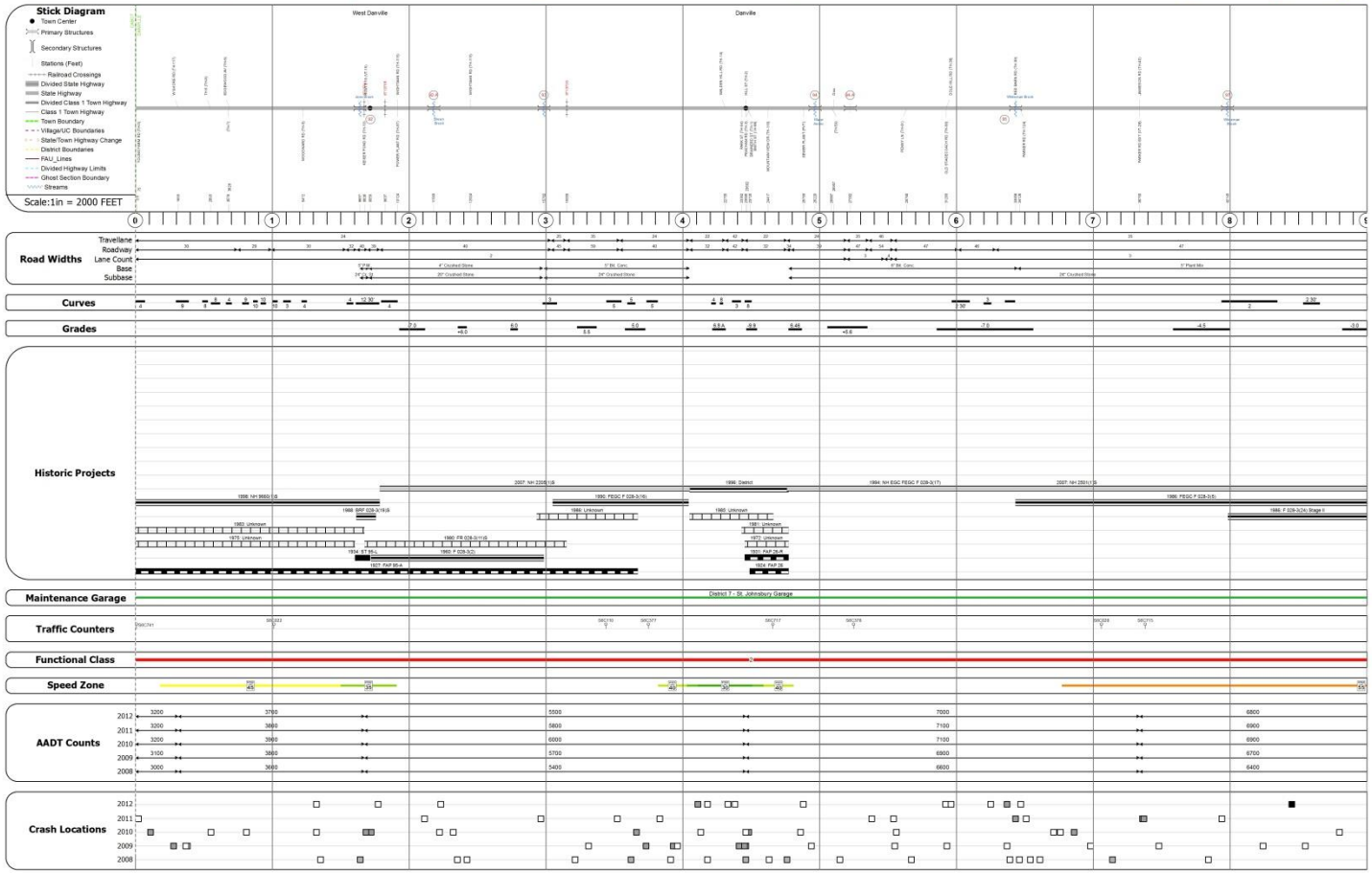
DRAFT

Please Note: Errors and Omissions May Exist.
Contact the VTrans Mapping Unit with questions or concerns.

DISTRICT	TOWN	ROUTE
7	DANVILLE	US-2







DESCRIPTION BLOCK

Bridge 92:
Stringer/multi-beam or girder - 1934
Structure No. 3000280092A03032
Length: 74'
Width: 35.0'
Facility Carried: US 00002 ML
Bridge Type: ROLLED BEAM
Features Intersected: JOES BROOK
Surface: Bituminous
Maintenance/Ownership: State

Culvert 92-A:
Culvert - 1960
Structure No. 3000280092A03031
Length: 8'
Under Clearance: 9.0'
Facility Carried: US2
Bridge Type: CGMPP
Features Intersected: BROOK
Maintenance: State

Culvert 93:
Culvert - 1958
Structure No. 3000280093O3031
Length: 7'
Under Clearance: 5.0'
Facility Carried: US2
Bridge Type: CGMPPA
Features Intersected: BROWN BROOK
Maintenance: State

Culvert 94:
Culvert - 1994
Structure No. 3000280094O3031
Length: 11'
Under Clearance: 7.25'
Facility Carried: US2
Bridge Type: CGMPPA
Features Intersected: WATER ANDRIC BROOK
Maintenance: State

Culvert 94-A:
Culvert - 1994
Structure No. 3000280094A03031
Length: 12'
Under Clearance: 14.0'
Facility Carried: US2
Bridge Type: RC BOX CULVERT
Features Intersected: CATTLE PASS
Maintenance: State

Culvert 95:
Culvert - 1986
Structure No. 3000280095O3031
Length: 9'
Under Clearance: 7.5'
Facility Carried: US2
Bridge Type: CGMPP
Features Intersected: WHITEMAN BROOK
Maintenance: State

Culvert 97:
Culvert - 1986
Structure No. 3000280097O3031
Length: 12'
Under Clearance: 12.0'
Facility Carried: US2
Bridge Type: CGMPP
Features Intersected: WHITEMAN BK
Maintenance: State

Historic Projects: Retreatment, Resurface, Unknown, Bituminous Mix, Skinny Mix, Bituminous Seal; Bituminous Concrete, Bituminous Macadam, Cold Plane and Bituminous Concrete, Reclaimed Base and Bituminous Concrete, Concrete; Gravel, Surface Treated Gravel, Plant Mix

Functional Class: 1, 2, 6, 7, 8, 11, 12, 14, 16, 17, 19

Speed Zones: 25, 30, 35, 40, 45, 50, 55, 60, 65

Curves: curve left, curve right

Grades: grade up, grade down

Road Widths

Traffic Counters

AADT (count)

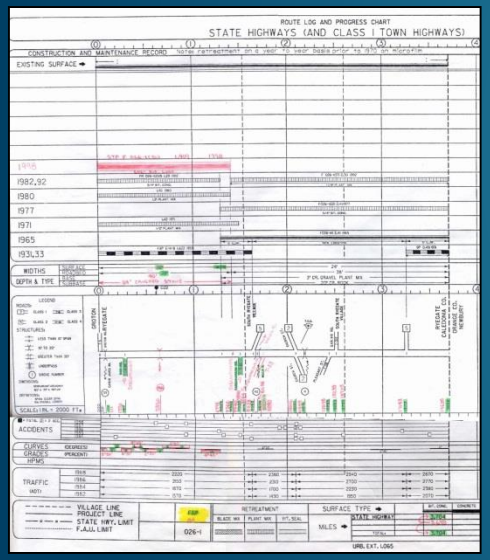
Crash Locations: Fatal, Injury, Property Damage Only, Unknown Crash Type

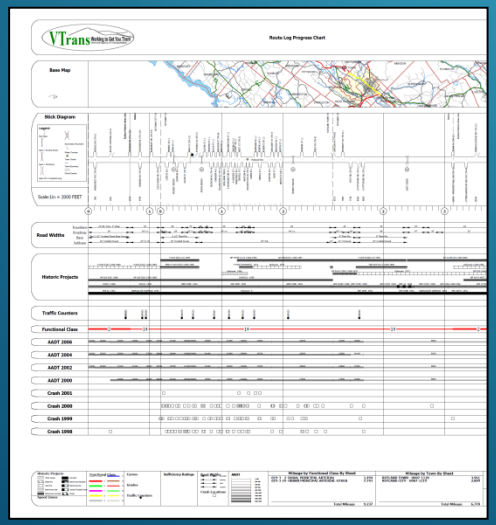
Mileage by Functional Class By Sheet		Mileage by Town By Sheet	
028-3 2 - Rural - Principal Arterial	9.000	DANVILLE - u002-0303	9.0 of 9.059
Total Mileage: 9.000 mi		Total Mileage: 9.0 mi	

DISTRICT	TOWN	Date: 03/05/14	ROUTE
7	DANVILLE	1 of 2 TWN mileage: 0.0 to 9.0	US-2 ETE mileage: 101.279 to 110.338

For More Information Contact - Vermont Agency of Transportation, Policy, Planning and Intermodal Development Division - Mapping Unit, 1 National Life Drive, Montpelier, VT 05633-5001 Telephone: 802-828-2600.

Route Logs at VTrans





- 1950's
  - The first Logs were drawn by hand
  - Developed during the building of the Interstate System
- 1980's
  - Logs converted to CADD using Intergraph software
- 1990's
  - The Route Log System becomes defunct & Master series maintained with hand markups
- 2006-2010
  - Contractor developed ArcGIS/VBA system. Also an online version. Most users still preferred CADD w/ markups.

Development Goals & Priorities

- Reproduce CADD version's layout and functionality
- Automated
- Easily generate logs with current data
- Minimize need to independently maintain/update data displayed on logs
- Evolvable… user needs and data change
- Low cost

Development Goals & Priorities

- Reproduce CADD version's layout and functionality
- Automated
- Easily generate logs with current data
- Minimize need to independently maintain/update data displayed on logs
- Evolvable… user needs and data change
- Low cost

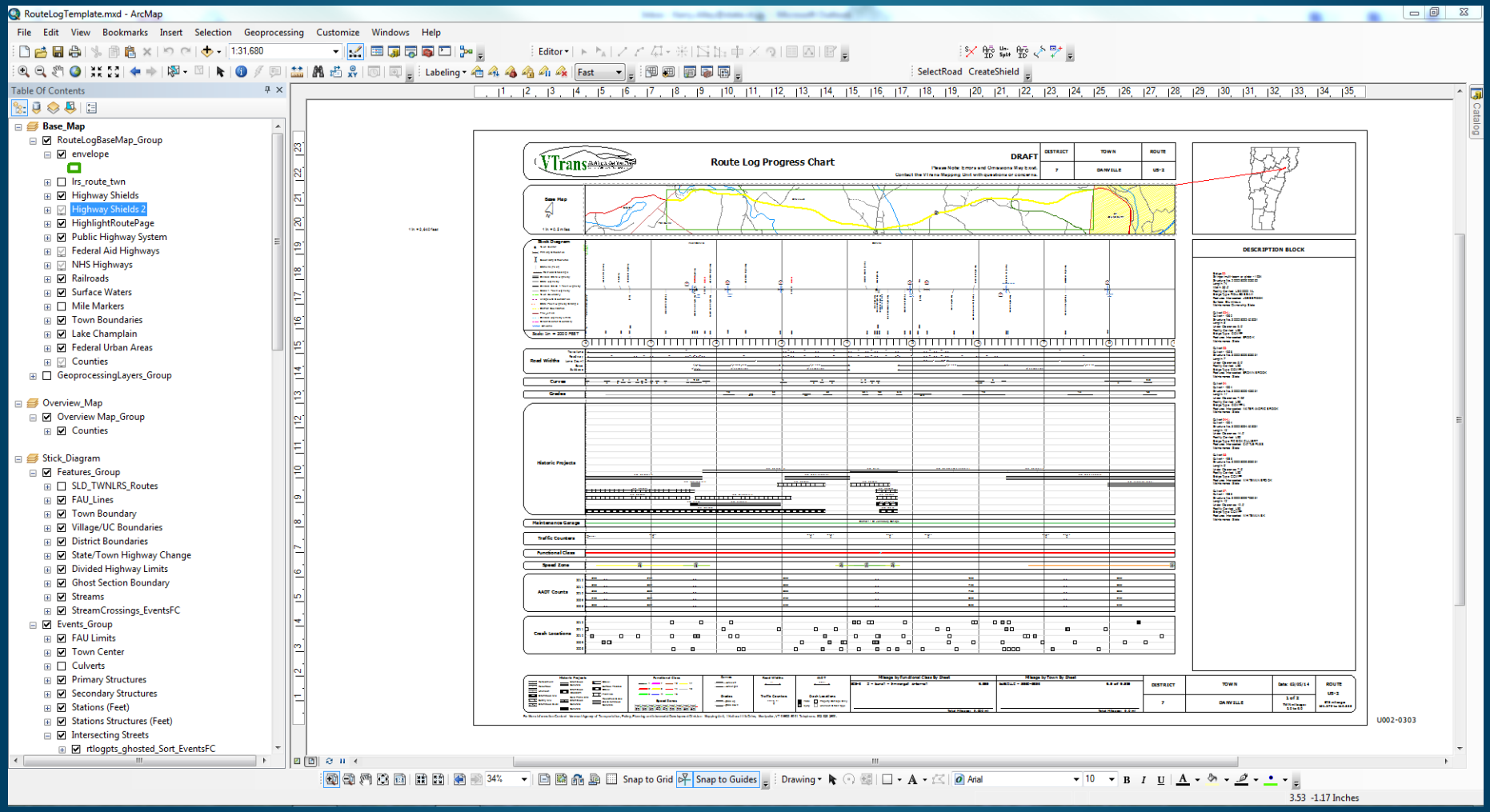
Solution: Python/arcpy

Key Components

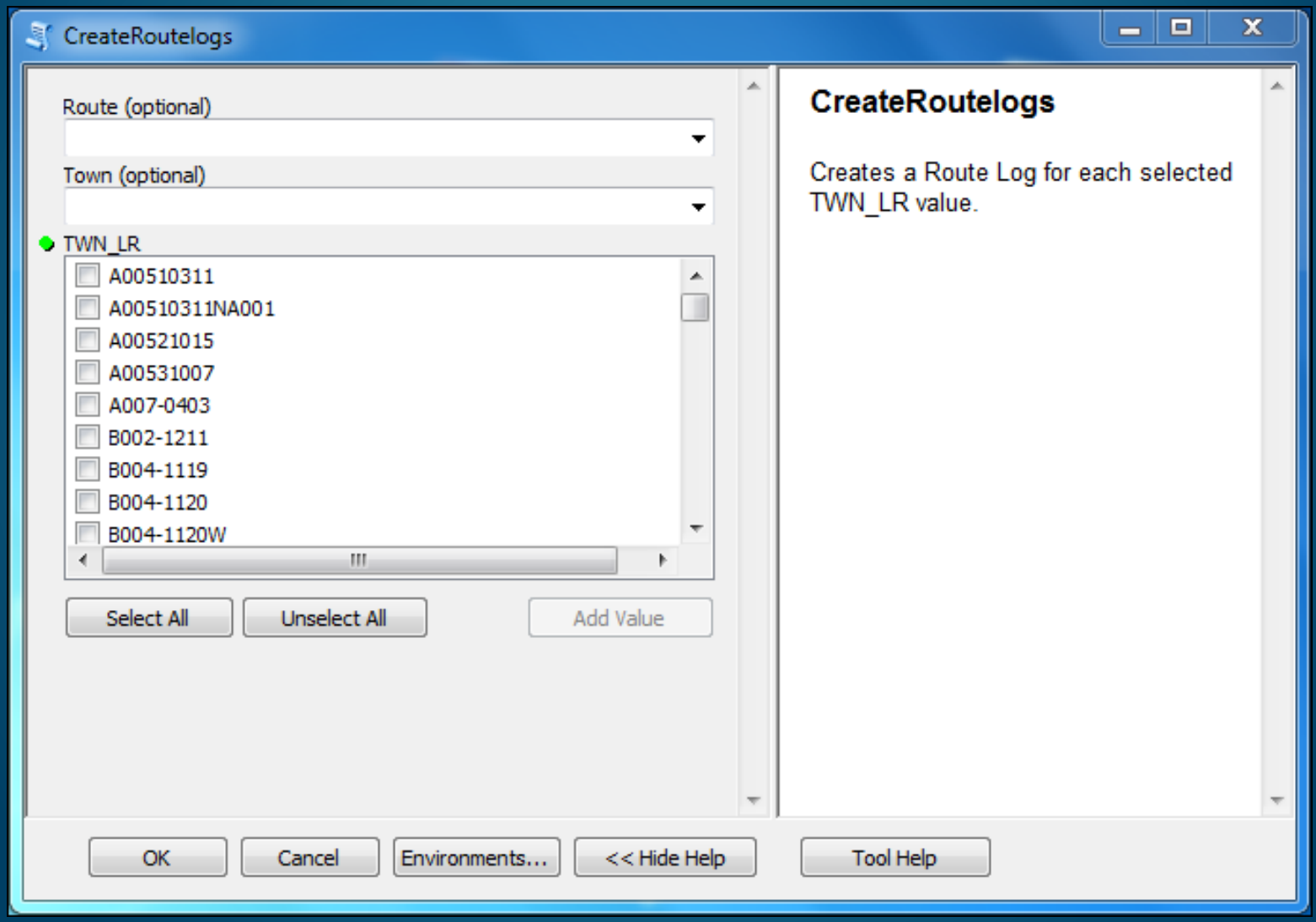
- Data
  - 46 datasets: feature classes and event tables from SDE & file geodatabases, shape files, Excel tables
- Map Document Template ← Easy to modify!
  - 14 data frames
  - 90 layers (not including group layers)
  - 187 layout elements (75 text, 84 graphic…)
- Python Scripts & Script Tool
  - Data preprocessing
  - Map automation

} Modification requires some Confidence with programming

Map Document



Script Tool


CreateRoutelogs
Route (optional)
Town (optional)
TWN_LR
A00510311
A00510311NA001
A00521015
A00531007
A007-0403
B002-1211
B004-1119
B004-1120
B004-1120W
Select All
Unselect All
Add Value
CreateRoutelogs
Creates a Route Log for each selected TWN_LR value.
OK
Cancel
Environments...
<< Hide Help
Tool Help

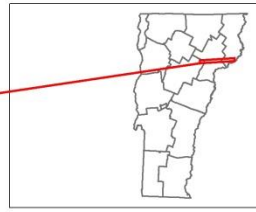
VTrans Working to Get You There — Vermont Agency of Transportation

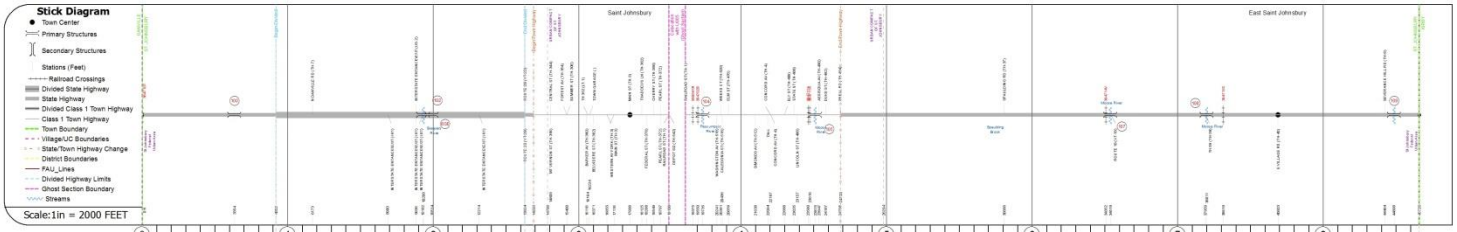
Route Log Progress Chart

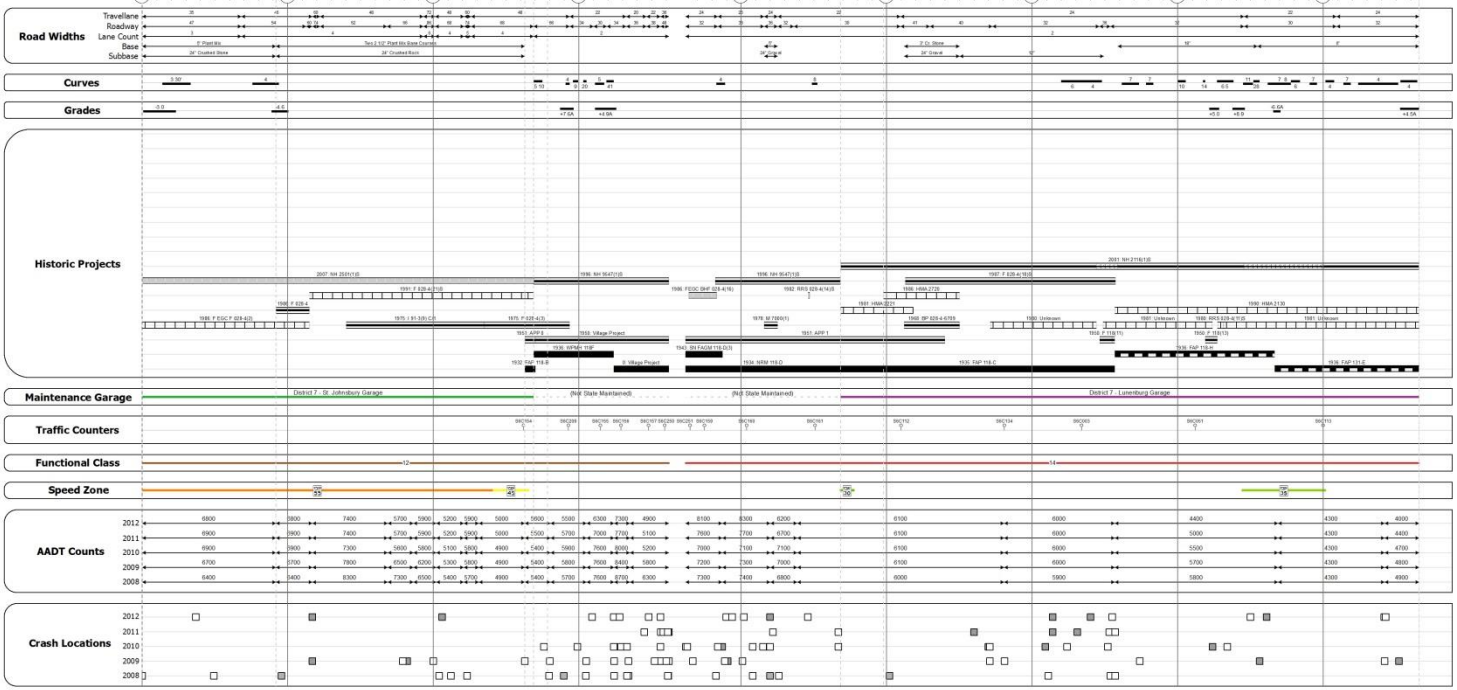
DRAFT

Please Note: Errors and Omissions May Exist.
Contact the VTrans Mapping Unit with questions or concerns.

DISTRICT	TOWN	ROUTE
7	ST. JOHNSBURY	US-2







DESCRIPTION BLOCK

Culvert 100:
Culvert - 1986
Structure No. 300028010003111
Length: 10'
Under Clearance: 10.0'
Facility Carried: US2
Bridge Type: CGMPP
Features Intersected: ACCESS ROAD
Maintenance: State

Culvert 102:
Culvert - 1975
Structure No. 2000280102033112
Length: 56'
Facility Carried: US 00002 ML
Bridge Type: TWIN CELL RC BOX
Features Intersected: SLEEPER RIVER
Maintenance/Ownership: State

Bridge 103E:
Stringer/multi-beam or girder - 1975
Structure No. 2000281036O3112
Length: 327'
Width: 42.6'
Under Clearance: 21.0'
Facility Carried: US 00002 E ML
Bridge Type: 2 SP CONT WLD PL GIR
Features Intersected: I 91 UNDER US 2
Surface: Bituminous
Maintenance/Ownership: State

Bridge 104:
Girder and floorbeam system - 1943
Structure No. 2000280104O3112
Length: 890'
Width: 38.6'
Under Clearance: 13.25'
Facility Carried: US 00002 ML
Bridge Type: 8 SPN RIVET 2 GIRDER
Features Intersected: US 2 OVER PSR/MC/CRL RR
Surface: Bituminous
Maintenance/Ownership: Town

Bridge 105:
Stringer/multi-beam or girder - 1931
Structure No. 2000280105O3112
Length: 64'
Width: 41.5'
Facility Carried: US 00002 ML
Bridge Type: ROLLED BEAM
Features Intersected: MOOSE RIVER
Surface: Bituminous
Maintenance/Ownership: City/Municipal

Bridge 107:
Stringer/multi-beam or girder - 1929
Structure No. 2000280107O3112
Length: 64'
Width: 42.0'
Facility Carried: US 00002 ML
Bridge Type: ROLLED BEAM
Features Intersected: MOOSE RIVER
Surface: Bituminous
Maintenance/Ownership: State

Bridge 108:
Tee Beam - 1929
Structure No. 2000280108O3112
Length: 103'
Width: 30.0'
Facility Carried: US 00002 ML
Bridge Type: CONC T-BEAM/SLAB
Features Intersected: MOOSE RIVER
Surface: Bituminous
Maintenance/Ownership: State

Bridge 109:
Slab - 1929
Structure No. 300028010903111
Length: 18'
Width: 25.0'
Under Clearance: 8.0'
Facility Carried: US2
Bridge Type: CONCRETE SLAB
Features Intersected: BROOK
Surface: Bituminous
Maintenance: State

Historic Projects: Retreatment, Resurface, Unknown, Bituminous Mix, Skinny Mix, Bituminous Seal; Bituminous Concrete, Bituminous Macadam, Cold Plane and Bituminous Concrete, Concrete; Gravel, Surface Treated Gravel, Plant Mix, Reclaimed Base and Bituminous Concrete

Functional Class: 1, 2, 6, 7, 8, 11, 12, 14, 16, 17, 19

Speed Zones: 25, 30, 35, 40, 45, 50, 55, 60, 65*

Curves: curve left, curve right

Grades: grade up, grade down

Road Widths: (ft)

Traffic Counters: (counter ID)

AADT: (count)

Crash Locations: Fatal, Injury, Property Damage Only, Unknown Crash Type

Mileage by Functional Class By Sheet

028-4	12 - Urban - Principal Arterial - Other Freeway	3.619	
028-4	14 - Urban - Principal Arterial - Other	5.040	
		Total Mileage:	8.659 mi

Mileage by Town By Sheet

ST. JOHNSBURY - U002-0311	8.659 of 8.659	
Ghost Section - US-5 (1.714 to 1.828)	0.114	
	Total Mileage:	8.659 mi

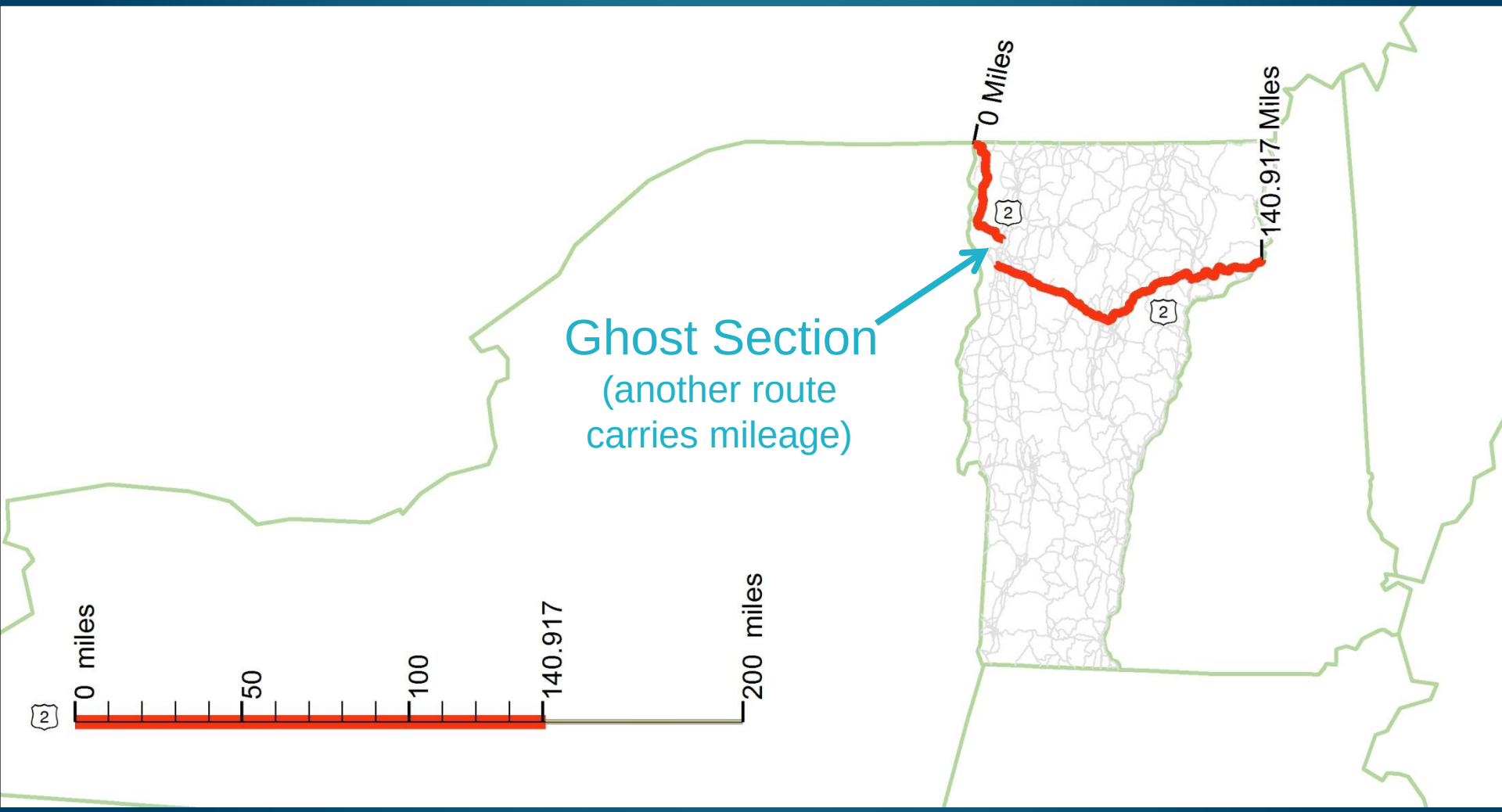
DISTRICT	TOWN	Date: 02/27/14	ROUTE
7	ST. JOHNSBURY	1 of 1 TWN mileage: 0.0 to 8.659	US-2 ETE mileage: 110.338 to 118.997

For More Information Contact - Vermont Agency of Transportation, Policy, Planning and Intermodal Development Division - Mapping Unit, 1 National Life Drive, Montpelier, VT 05633-5001 Telephone: 802-828-2600.

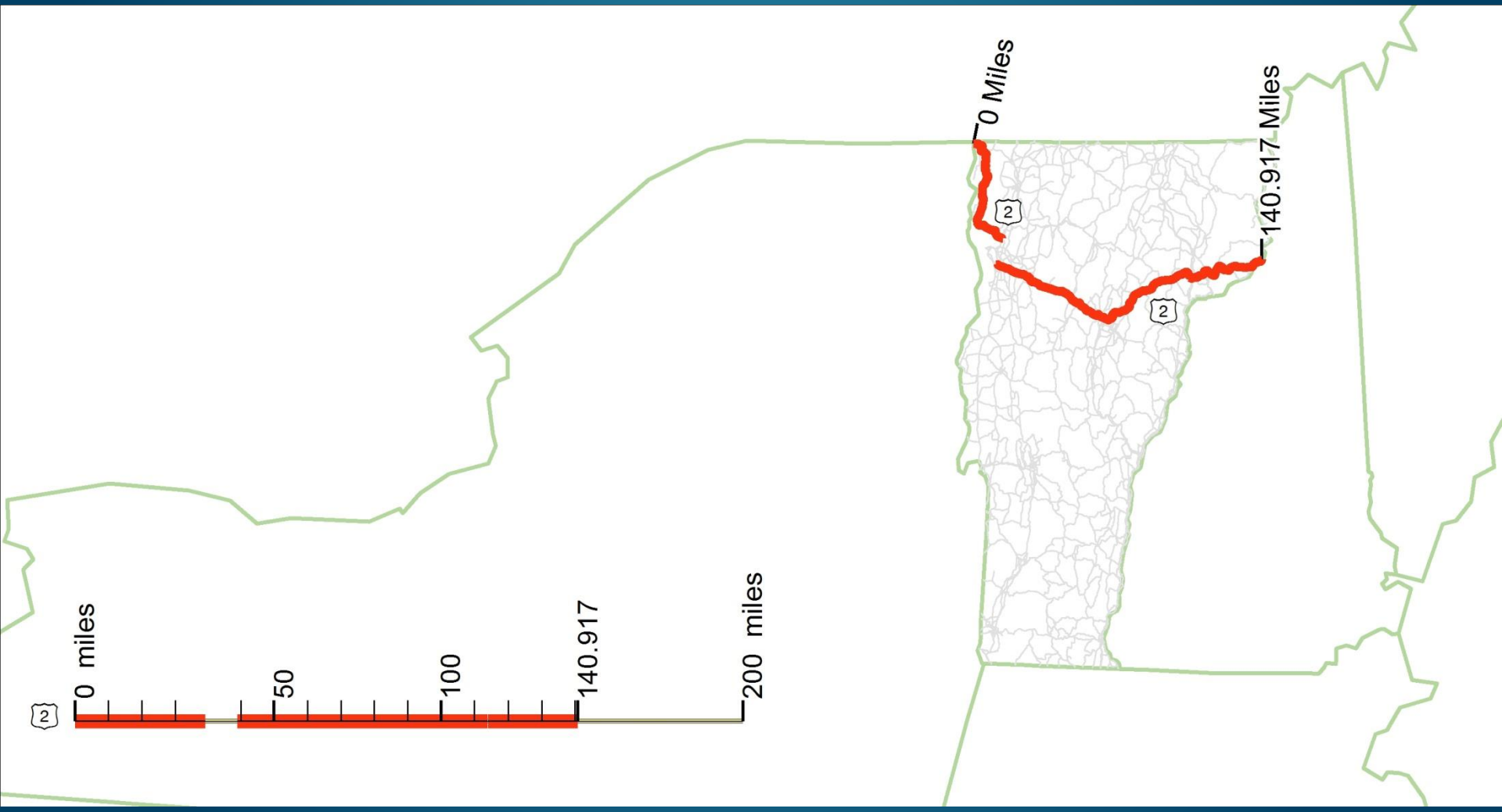
Automation Script

- Set Base Map
  - new extent, rotation, highlight target route
- Update layer definition queries
- Update text elements
  - header & footer info, bridge descriptions, total & functional class mileage statistics
- Update SLD data frame extents
- Behind the scenes:
  - Data driven: read data attributes, calculate values, build strings
  - Some built-in redundancy for QA/QC purposes
  - Isolated segments of divided highway treated differently

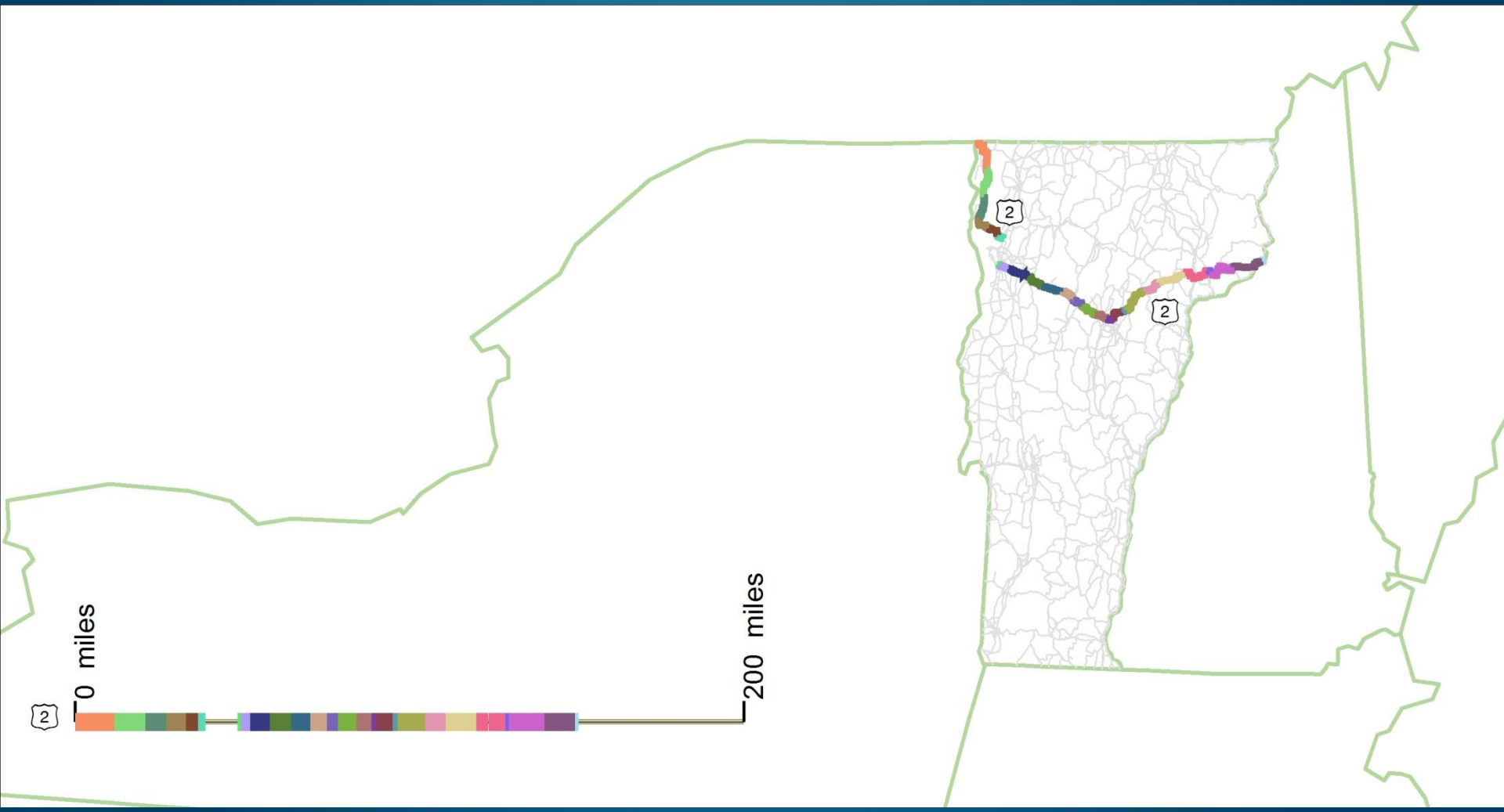
Route Feature Classes



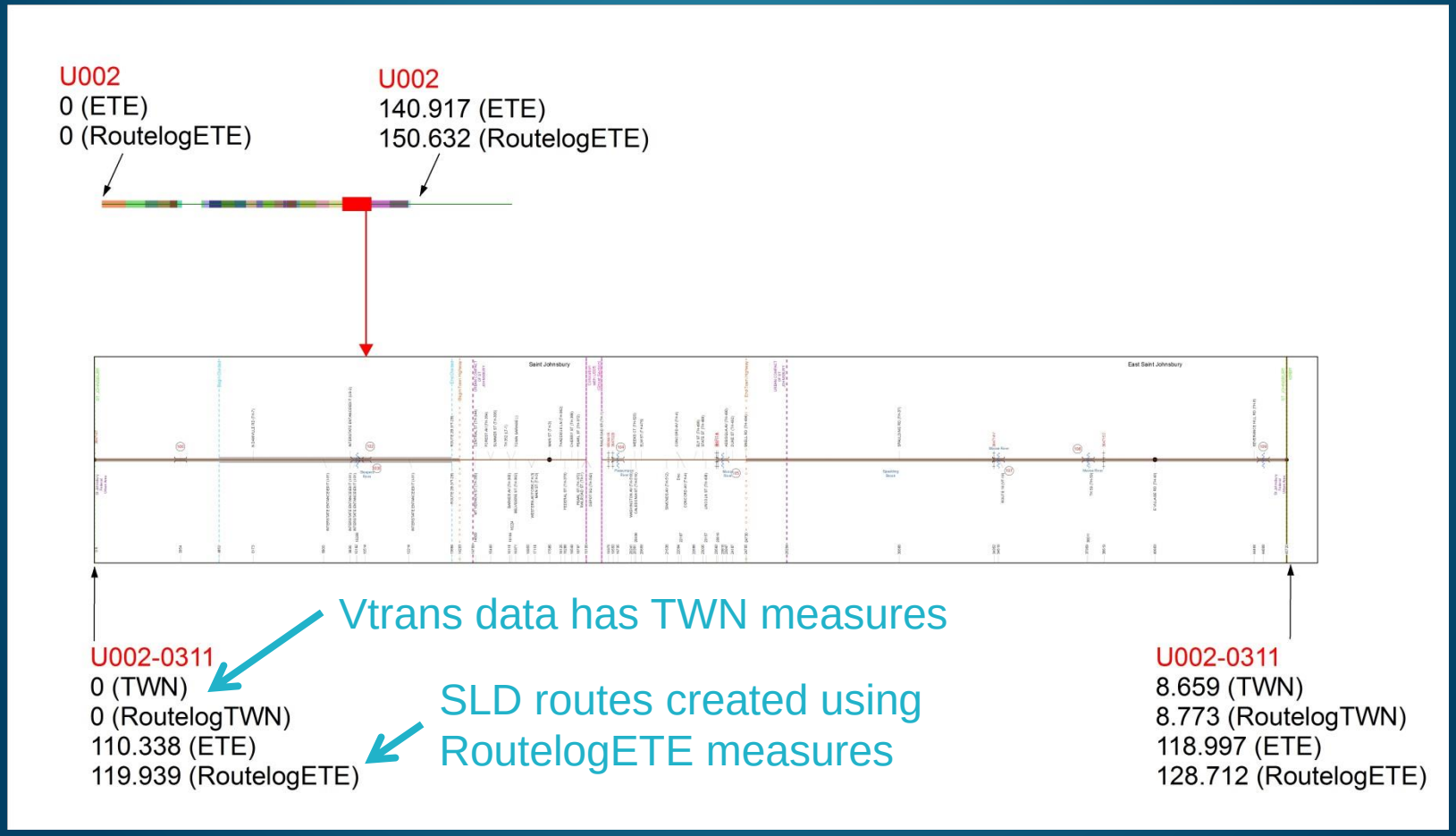
End-to-End Routes (ETE)



Town Routes (TWN)



ETE, TWN, and Routelog Mileages



Data Preprocessing Scripts

- Create local copies of all data in a file geodatabase
- Create Routelog LRS
  - Straight line geometries
  - Intermediate route feature class has RoutelogETE measures
  - Final route feature class has TWN measures
- Convert TWN event measures to RoutelogETE measures when necessary
  - 3 datasets: routes , functional class, and historic project tables
- Create boundary line features
  - (can’t use line symbology to represent points)
  - town, village, state/town ownership, etc.

Data Preprocessing Scripts

- Create station dataset, determine label offsets
- Determine intersection label offsets
- Transform historic crash locations to current LRS
- Create event layers (position features along the line routes using dynamic segmentation and TWN measures)
- Convert event layers to feature classes
- Dissolve roadwidth features for tidy rendering

Challenges/Solutions

- Incorporating diverse data sources
- Event Layer instability
- Portability
- Precise control over extents & scales
- Table formatting
- Label overposting
- Ghost sections

Project Management

Automation Scripts

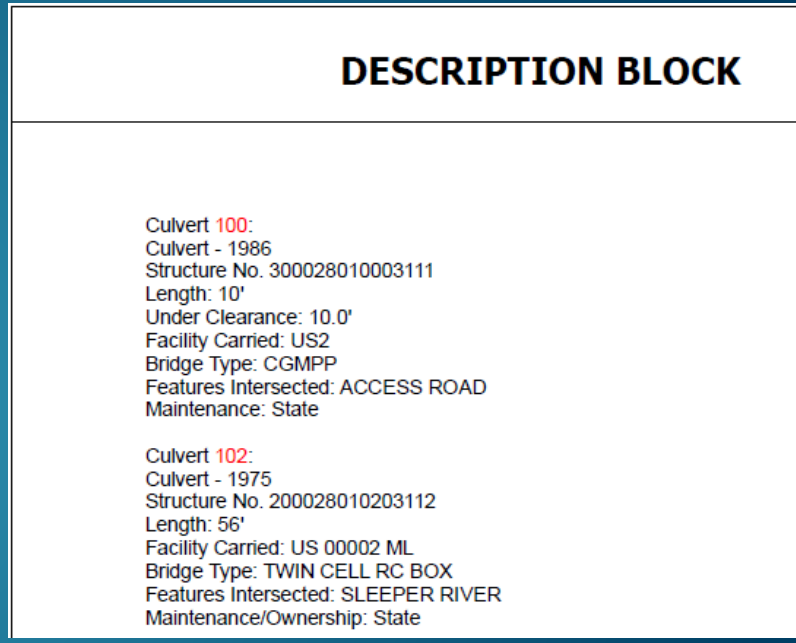
Data Preprocessing Scripts

Project Management

- Entire project within root folder
  - all data initially copied into LocalData.gdb
- MXD template has relative paths
  - no SDE connections in template
  - no event layers in template
- Event layers converted to feature classes
- Scripts have paths relative to root folder

Bridge Description Table

- Table is a single string assembled during automation
- String includes Python and ArcGIS formatting tags



DESCRIPTION BLOCK

Culvert 100:
Culvert - 1986
Structure No. 300028010003111
Length: 10'
Under Clearance: 10.0'
Facility Carried: US2
Bridge Type: CGMPP
Features Intersected: ACCESS ROAD
Maintenance: State

Culvert 102:
Culvert - 1975
Structure No. 200028010203112
Length: 56'
Facility Carried: US 00002 ML
Bridge Type: TWIN CELL RC BOX
Features Intersected: SLEEPER RIVER
Maintenance/Ownership: State

In Python:

```
BridgeDescriptionElm.text = '%s <CLR red = "255">'%struc_categ
    + label + '</CLR>: ' + '\r\n'
    + struc_type + ' - ' + str(yr_built) + '\r\n'
```

In ArcMap text element:

```
Culvert <CLR red = "255">100</CLR>:
Culvert - 1986
```

Mileage Summary Tables

Mileage by Functional Class By Sheet

028-4	12 - Urban - Principal Arterial - Other Freeway	3.619
028-4	14 - Urban - Principal Arterial - Other	5.040

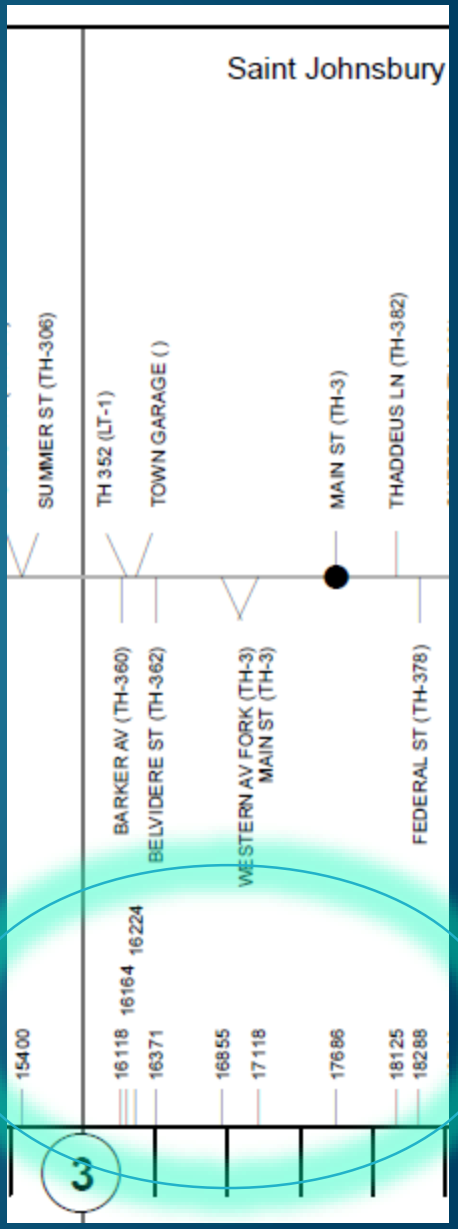
Total Mileage: 8.659 mi

- Split events at page breaks (another pre-processing script)
- Summary Statistics (Analysis) Tool
- Python strings with formatting
- Monospace font

```
FuncClassElm.text = []
For each row:
   FuncClassElm.text += '\n' + '{:<63}{:6}'.format('{:<8}{} -
   {}'.format(fcrtid, funcl, funclDict[int(funcl)]), length_str)
```

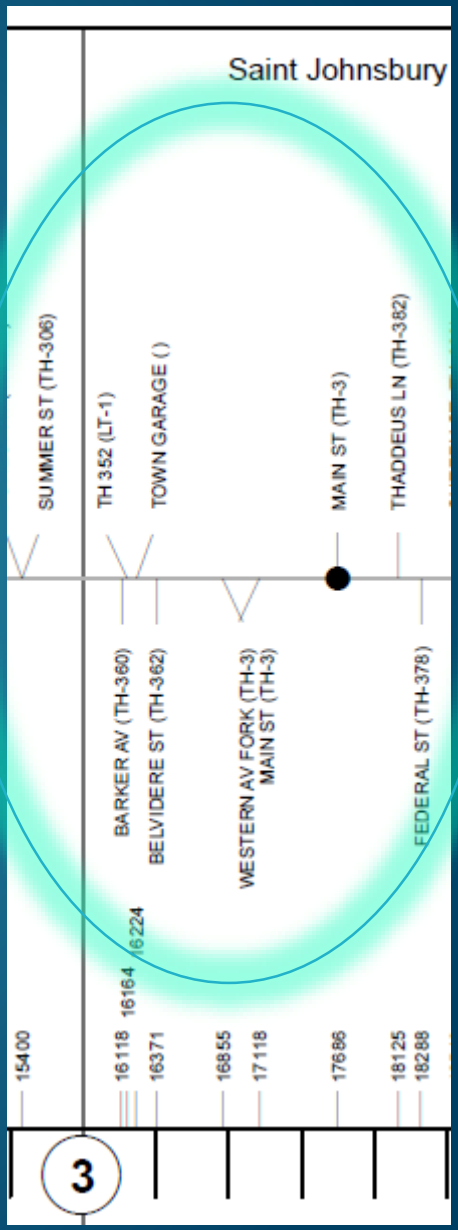
Station Labels

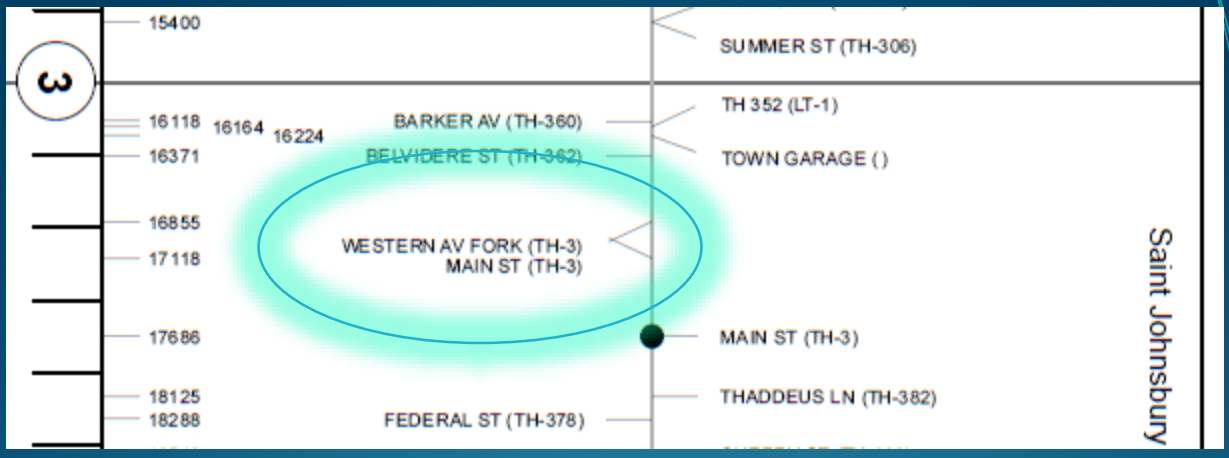
- Copy all stations data to one table
- Add “offset” field
- Define proximity cutoff
- Consider records L to R
- Is current label too close to nearest non-offset label to its left?
- If so, its offset = previous label’s offset + 1
- L to R order of labels strictly maintained



Intersection Labels

- Non-perpendicular intersection labels have offsets (if possible)
- Label have offsets to avoid labels to their left
- L to R order strictly maintained
- 36 label scenarios depending on:
  - Side of road
  - Previous intersection's angle
  - Previous intersection's offset type
  - Current intersection's angle
- 14 label classes





1st Label

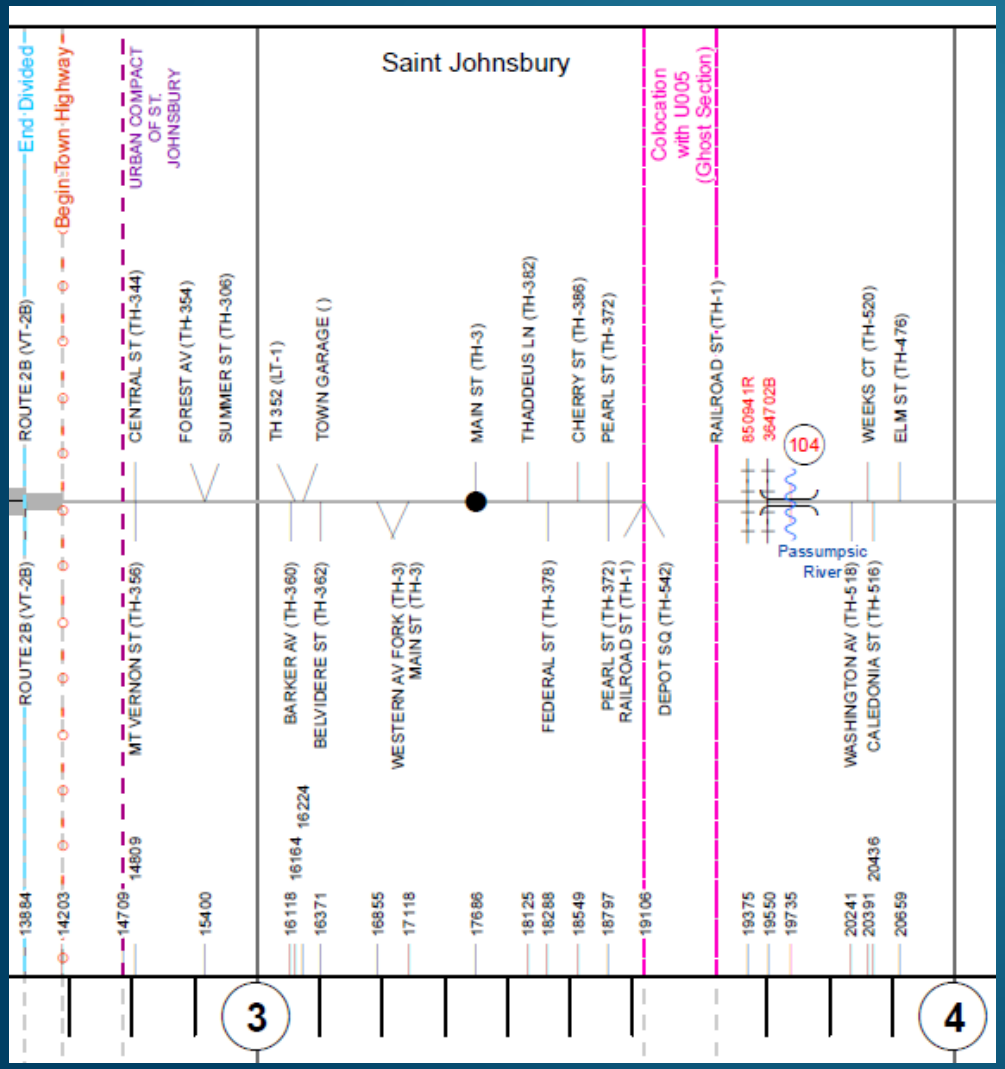
Right offset Left auto LO (not used)	Left offset Left auto LO (not used)
Right offset Left auto	Left offset Left auto
Right offset left auto UNDO	Left offset Left auto UNDO
Right	Left
Right offset Right auto UNDO (not used)	Left offset Right auto UNDO (not used)
Right offset Right auto	Left offset Right auto
Right offset Right auto RO	Left offset Right auto RO

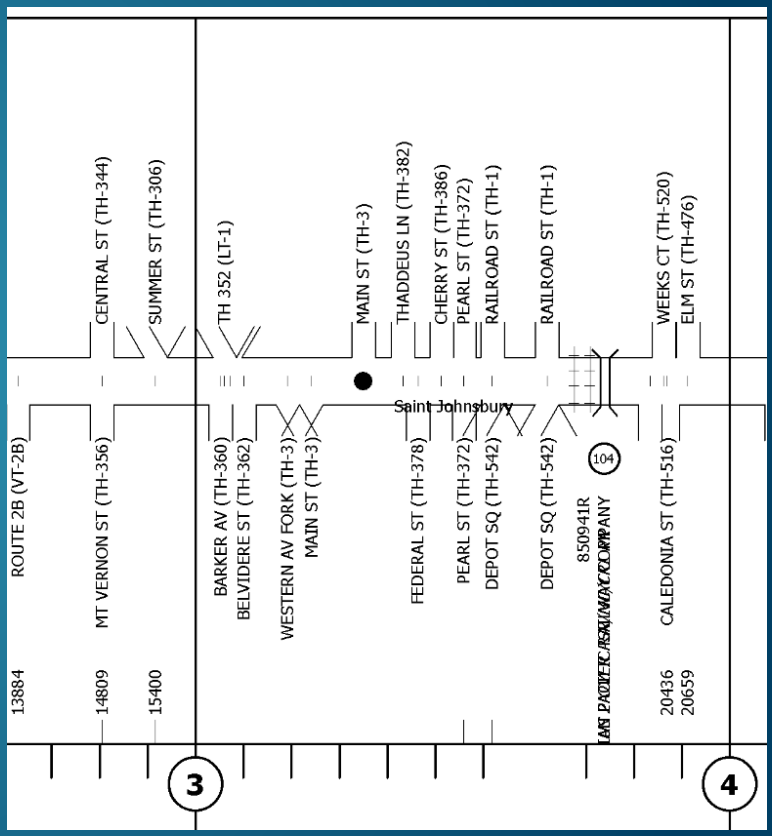
2nd Label

Right offset Left auto LO (not used)	Left offset Left auto LO (not used)
Right offset Left auto	Left offset Left auto
Right offset left auto UNDO	Left offset Left auto UNDO
Right	Left
Right offset Right auto UNDO (not used)	Left offset Right auto UNDO (not used)
Right offset Right auto	Left offset Right auto
Right offset Right auto RO	Left offset Right auto RO

Ghost Intersections

2014 Route Log





2008 Route Log

Thanks!

VTrans Mapping Unit:

- Johnathan Croft
- Michael Trunzo
- Sara Moulton
- Gary Smith
- David Narkewicz

Esri:

- Jeff Barrett
- Roads & Highways Team

VTrans Working to Get You There
Vermont Agency of Transportation

Contact:

Kerry.Alley@state.vt.us