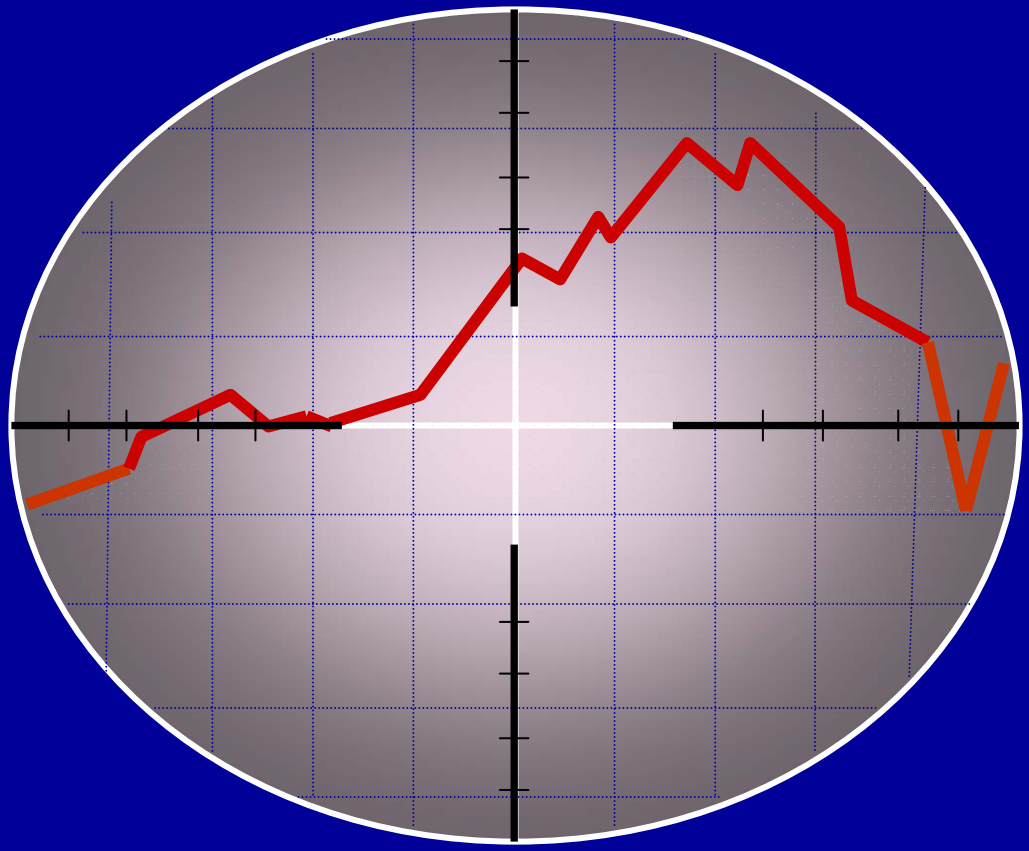
Enhancing Surveillance Data via GIS-related Jurisdictional Morbidity Reassignment

2nd Annual PHIN Stakeholders Conference

May 25, 2004



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Overview

- STD Morbidity Re-assignment
- Case report Visualization
- Confidentiality

Division of HIV/STD

GIS Use in Virginia's Division of HIV/STD

- For STDs (CT, GC, syphilis):
  - Geocoding
    - Address correction
    - Morbidity assignment
  - Mapping
    - Routine Surveillance
      - Trend analysis
    - Case visualization
      - Rapid response/Outbreaks
  - Spatial analysis / research applications
    - Satscan, spatial linear regression

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Practical Tools

Geocoding

- Centrus
  - GeoStan
- ArcView
  - StreetMap
- MapPoint
- GeoCoder
- MapInfo
  - MapMarker

Mapping

- ArcView
  - ArcMap
  - StreetMap
  - ArcPublisher
- MapInfo
- Maptitude

PC Specifications: 40GB HD, 1024MB RAM, 3.2GHz Processor, monitor resolution, video card

Geocoding

- **matching an address to latitudinal & longitudinal coordinates**
  - **Example:**
    - **Address:** 920 W Grace St
      Richmond, VA 23220
    - **Latitude:** 37.550164
    - **Longitude:** -77.451723
- **Input addresses are matched against a postal or geocoding database**

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Input File

saved as a text file from Excel

Name	Street	City	County	St	Zip
A Movable Feast	1318 E Cary St	Richmond	Richmond City	VA	23219
Azalea Food Market & Deli	211 Azalea Ave.	Richmond	Richmond City	VA	23227
Blimpie	13969 Raised Anter	Midlothian	Richmond City	VA	23112
Bogey's Bagels	13520 Midlothian Trnpk	Midlothian	Richmond City	VA	23113
Boychiks Deli	4024-B Cox Rd	Richmond	Richmond City	VA	23233
Café 1602	1602 Rolling Hill Dr	Richmond	Richmond City	VA	23229
Carla's Kitchen	920 W Grace St	Richmond	Richmond City	VA	23220

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Command Prompt

```
Microsoft Windows 2000 [Version 5.00.2195]
(C) Copyright 1985-2000 Microsoft Corp.

C:\>d:

D:\>cd centrus\geolib\32bit

D:\CENTRUS\GEOLIB\32BIT>rungeo

D:\CENTRUS\GEOLIB\32BIT>geocoder ..\data\temp.fmt ..\data\Richmond_Delis.prn ..\
data\Richmond_Delis_out.txt

Geocoder, version 3.02.01.H
Initializing...

Primary GSD Data:              Loaded   Version: 16.0   Release Date: 10/15/2003
Geocode Precision:             Standard
Supplemental GSD Data:         Loaded
eLOT/Z4Change Data:            Not Loaded
State Intersection Data:       Not Loaded
ZIPMove Data:                  Loaded
GSU Data:                      Loaded
EWS Data:                      Not Loaded

Processing...

Records:
 Examined: 47, Processed: 47, Matched: 41, Geocoded: 46, Skipped: 0
Processing Complete.

D:\CENTRUS\GEOLIB\32BIT>
```

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Name	Street	City	County	St	Zip
A Movable Feast	1318 E Cary St	Richmond	Richmond City	VA	23219
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Carla's Kitchen	920 W Grace St	Richmond	Richmond City	VA	23220

Street_new	City_new	St	Zip_new	Longitude	Latitude	Census Block	FIPS	County_new	Code
1318 E CARY ST	RICHMOND	VA	23219-4155	-77.432889	37.534887	517600305001095	51760	RICHMOND CITY	S80 AS0
211 AZALEA AVE	RICHMOND	VA	23227-3621	-77.424351	37.602463	510872008043000	51087	HENRICO	S80 AS0
13969 RAISED ANTLER CIR	MIDLOTHIAN	VA	23112-2005	-77.663853	37.402642	510411010061024	51041	CHESTERFIELD	S80 AS0
13520 MIDLOTHIAN TPKE	MIDLOTHIAN	VA	23113-4214	-77.649450	37.503059	510411009151016	51041	CHESTERFIELD	S80 AS0
4024-B COX RD	RICHMOND	VA	23233	-77.619700	37.624400	51087200115	51087	HENRICO	E022ZC5X
1602 ROLLING HILLS DR	RICHMOND	VA	23229-5012	-77.546885	37.601315	510872001043022	51087	HENRICO	S80 AS0
920 W GRACE ST	RICHMOND	VA	23220-4125	-77.451723	37.550164	517600403001003	51760	RICHMOND CITY	S80 AS0

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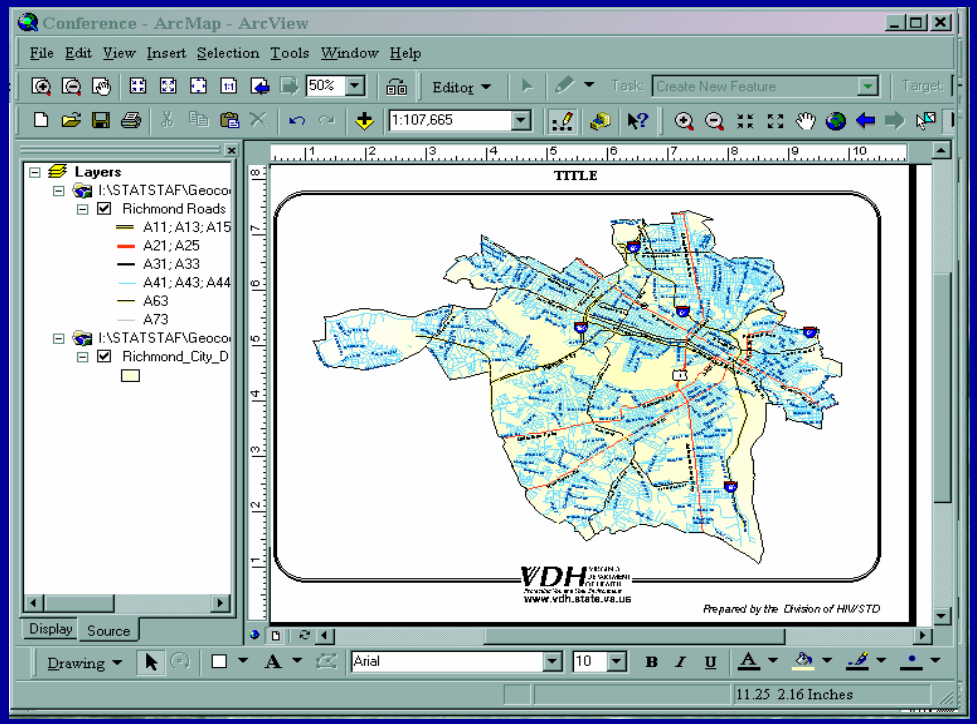
Mapping Geocoded Addresses

- Save the geocoded data as a .dbf file
- Create a new map file in mapping software



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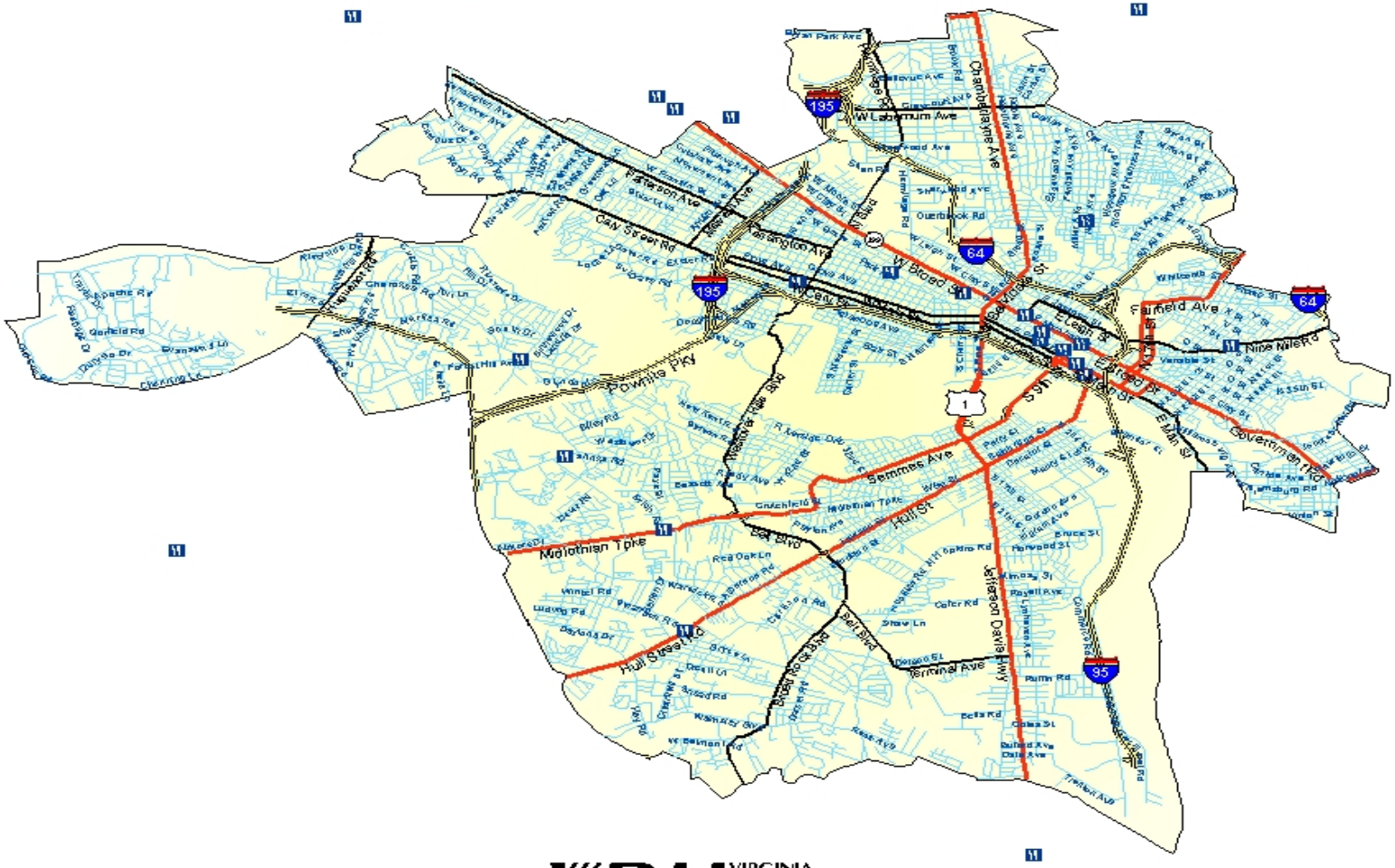
Richmond Area Delis



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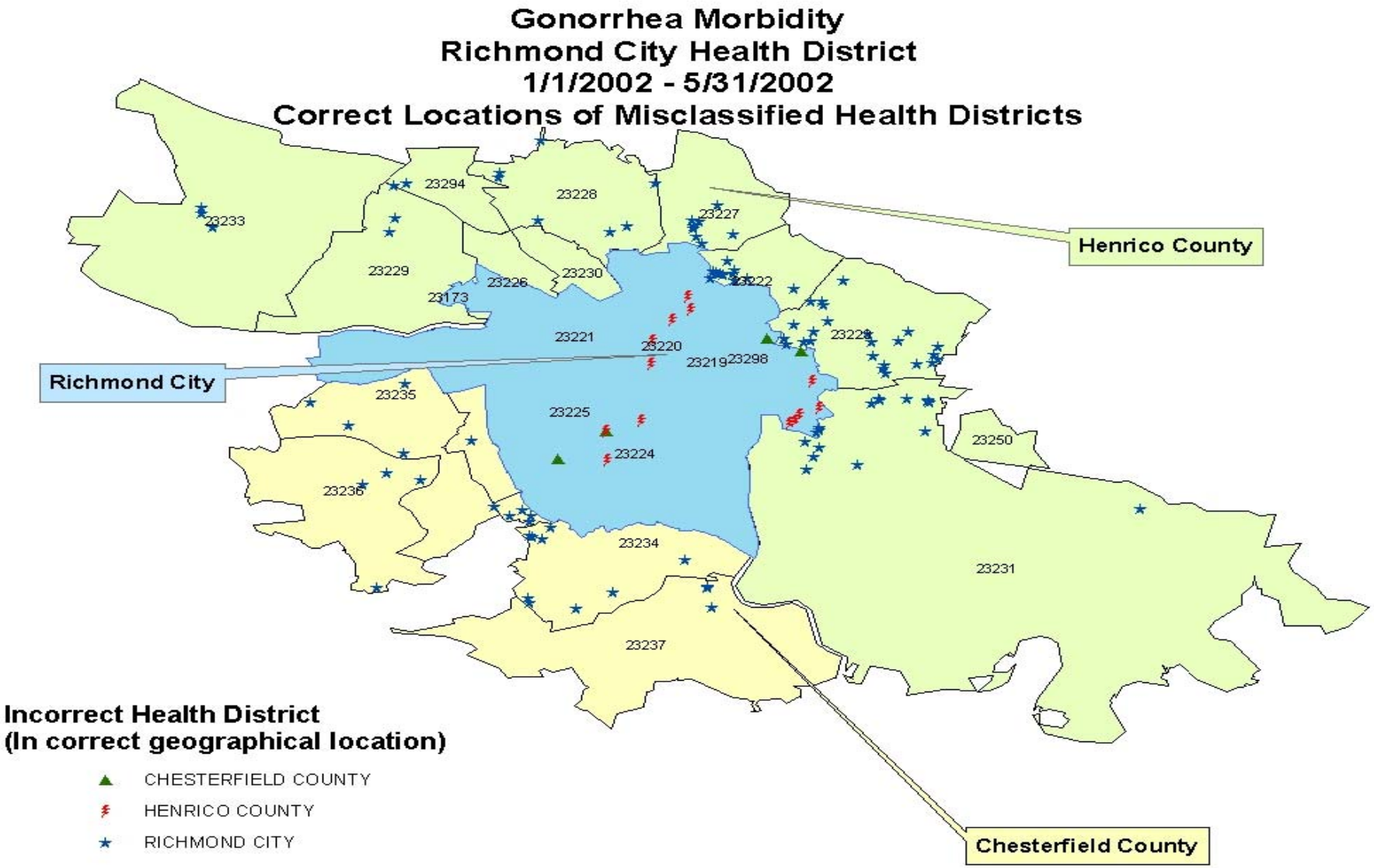
Correcting Morbidity Assignments



2002 Morbidity Re-assignments

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Virginia Morbidity Corrections

- CY2002
  - 2,404 total cases reassigned (46.2/wk)
    - Richmond: -703
    - Henrico County: +510
    - Chesterfield County: +220
- CY2003
  - 2,547 total cases reassigned (50.9/wk)
    - Richmond: -749
    - Henrico County: +528
    - Chesterfield County: +220

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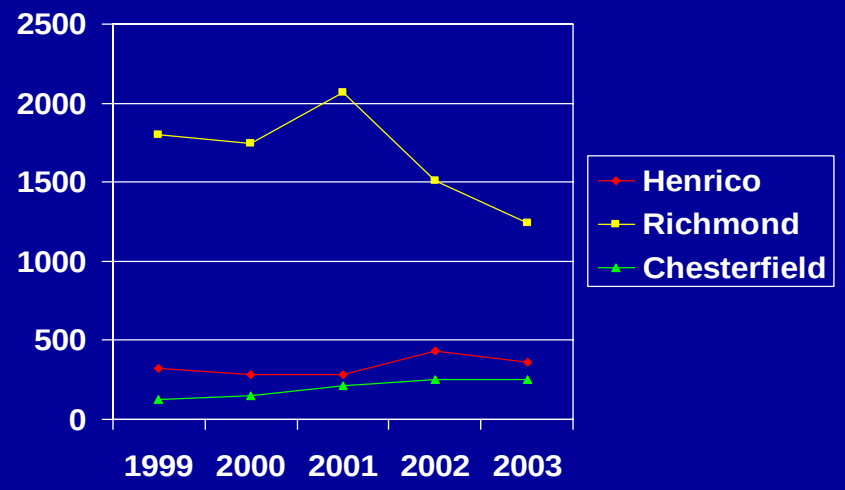
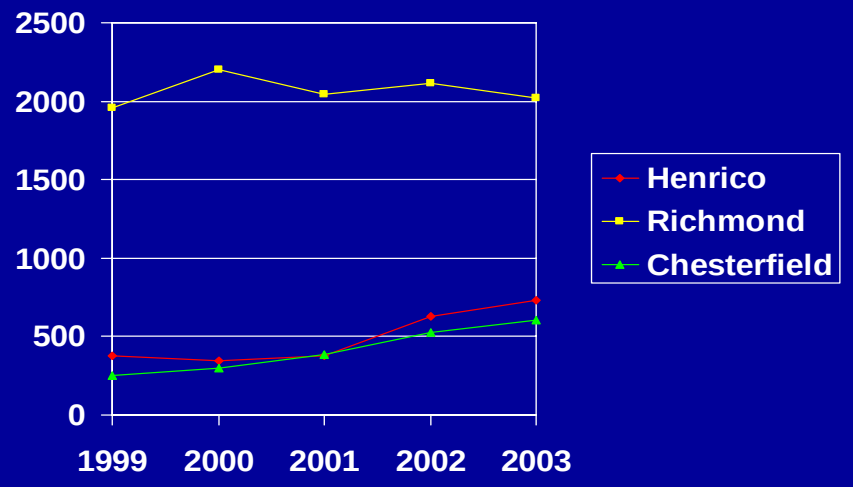
Richmond Metro Re-assignments

Gonorrhea



Chlamydia



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Richmond National Ranking (Rates per 100,000)

GONORRHEA - Richmond			
YEAR	RANK	RATE*	# OF CASES
1992	1	1805.9	3667
1993	6	991.4	2029
1994	2	1280.7	2621
1995	2	1195.8	2371
1996	3	876.0	1737
1997	7	739.4	1466
1998	5	793.7	1527
1999	2	940.9	1827
2000	1	923.6	1752
2001	1	1066.3	2109
2002	2	761.9	1507
2002	1	912.1	1806

CHLAMYDIA – Richmond			
YEAR	RANK	RATE*	# OF CASES
1992	NOT AVAILABLE		
1993	NOT AVAILABLE		
1994	NOT AVAILABLE		
1995	NOT AVAILABLE		
1996	NOT AVAILABLE		
1997	1	1100.0	2181
1998	4	841.5	1619
1999	1	1015.6	1972
2000	1	1175.5	2230
2001	1	1052.6	2082
2002	2	1065.8	2108
2002	1	1273.7	2522

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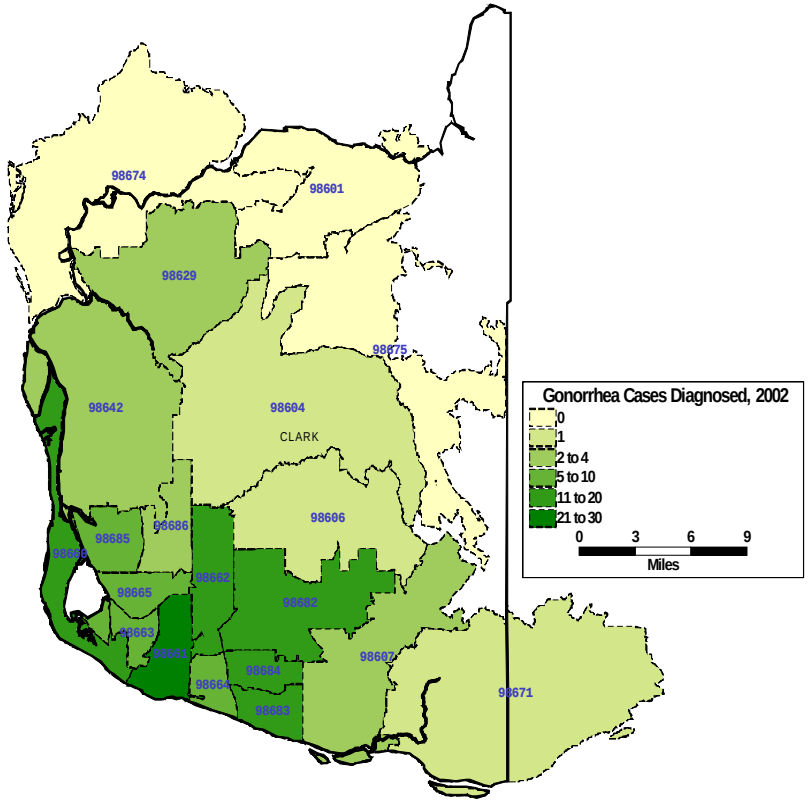
Gonorrhea cases and incidence rate per 100,000 for Washington State 1993 through 2002.



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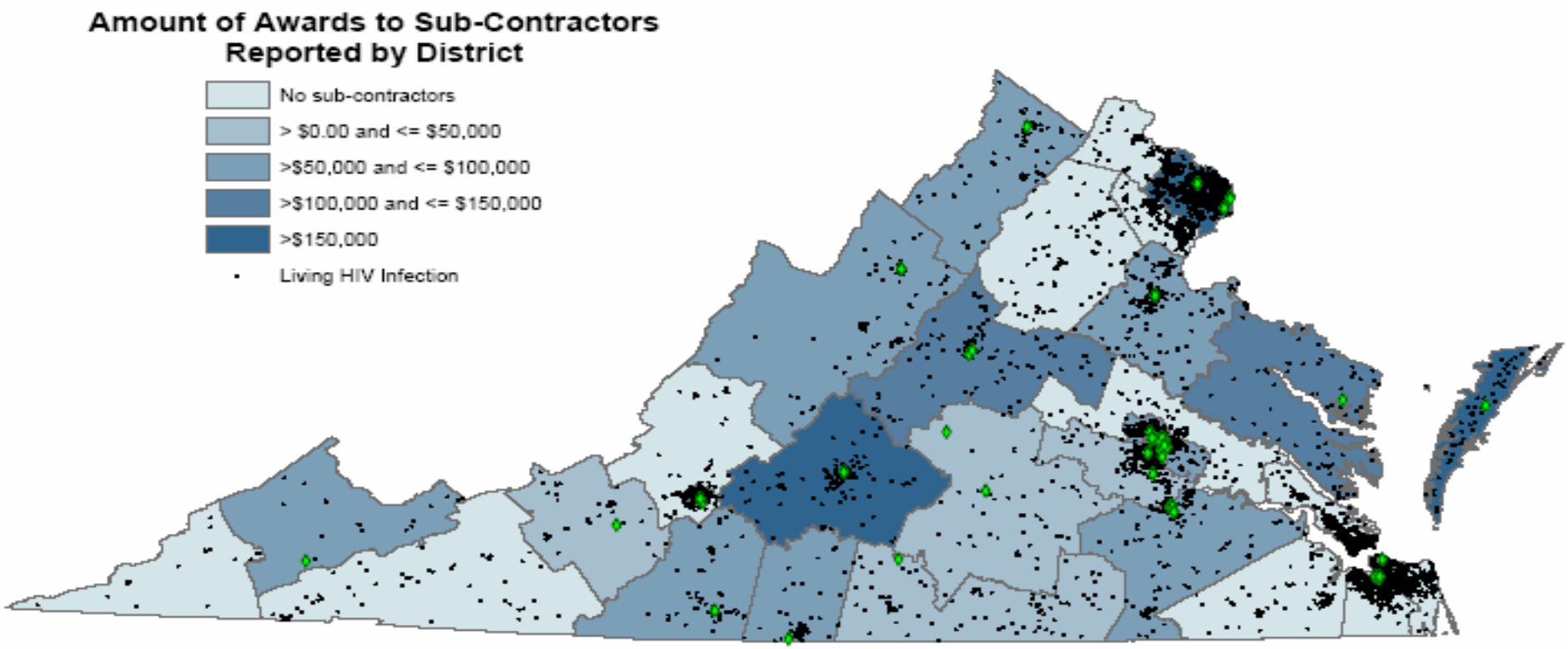
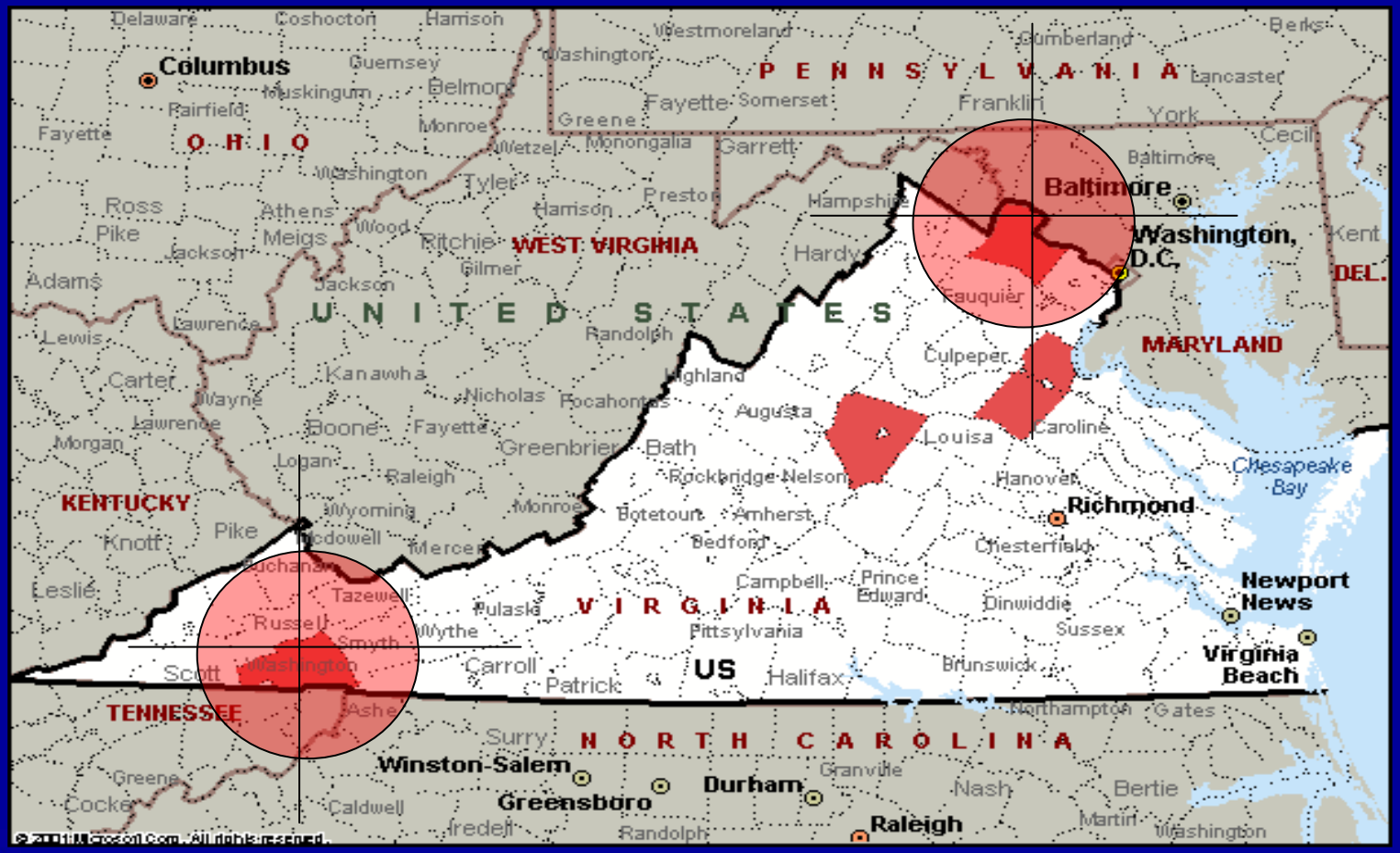
2003 Ryan White Sub-Contractors
Living HIV Infection (HIV and AIDS Unduplicated*)



* Virginia regulations require reporting of HIV and AIDS separately; therefore, an individual may be reported once as an HIV case and once as an AIDS case. This table presents the total number of people who have either HIV or AIDS. People reported as both an HIV case and an AIDS case are counted only once.

Strategic Surveillance Monitoring



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Highlights

- **Benefits**
  - **Standardizes surveillance monitoring: *"What is normal for a given week?"***
  - **Uses data from 5 yrs. vs. 1 yr. Frequency distributions**
  - **Easy-to-read map**
  - **Adjusts according to disease**
- **Limitations**
  - **Computations more complex**
  - **Higher sensitivity (too many targets?)**
  - **Not an outbreak detection method**

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What is Normal for Week 2 of 2004?

2002 | 2003

Wk 1	Wk 2	Wk 3	Wk 4	Wk5-52	Wk 1	Wk 2	Wk 3	Wk 4
10	6	5	7		12	9	4	2

Step 1: Apply 3-week averaging window

Wk 1	Wk 2	Wk 3	Wk 4	Wk5-52	Wk 1	Wk 2	Wk 3	Wk 4
10	6	5	7		12	9	4	2

Step 2: Historical Average of Week 2 = (10 + 6 + 5 +12 + 9 + 4)/6 = **7.6**

Wk 1	Wk 2	Wk 3	Wk 4	Wk5-52	Wk 1	Wk 2	Wk 3	Wk 4
10	6	5	7		12	9	4	2

Repeat (Week 3): Historical Average of Week 3 = (6 + 5 + 7 + 9 + 4 + 2)/6 = **5.5**

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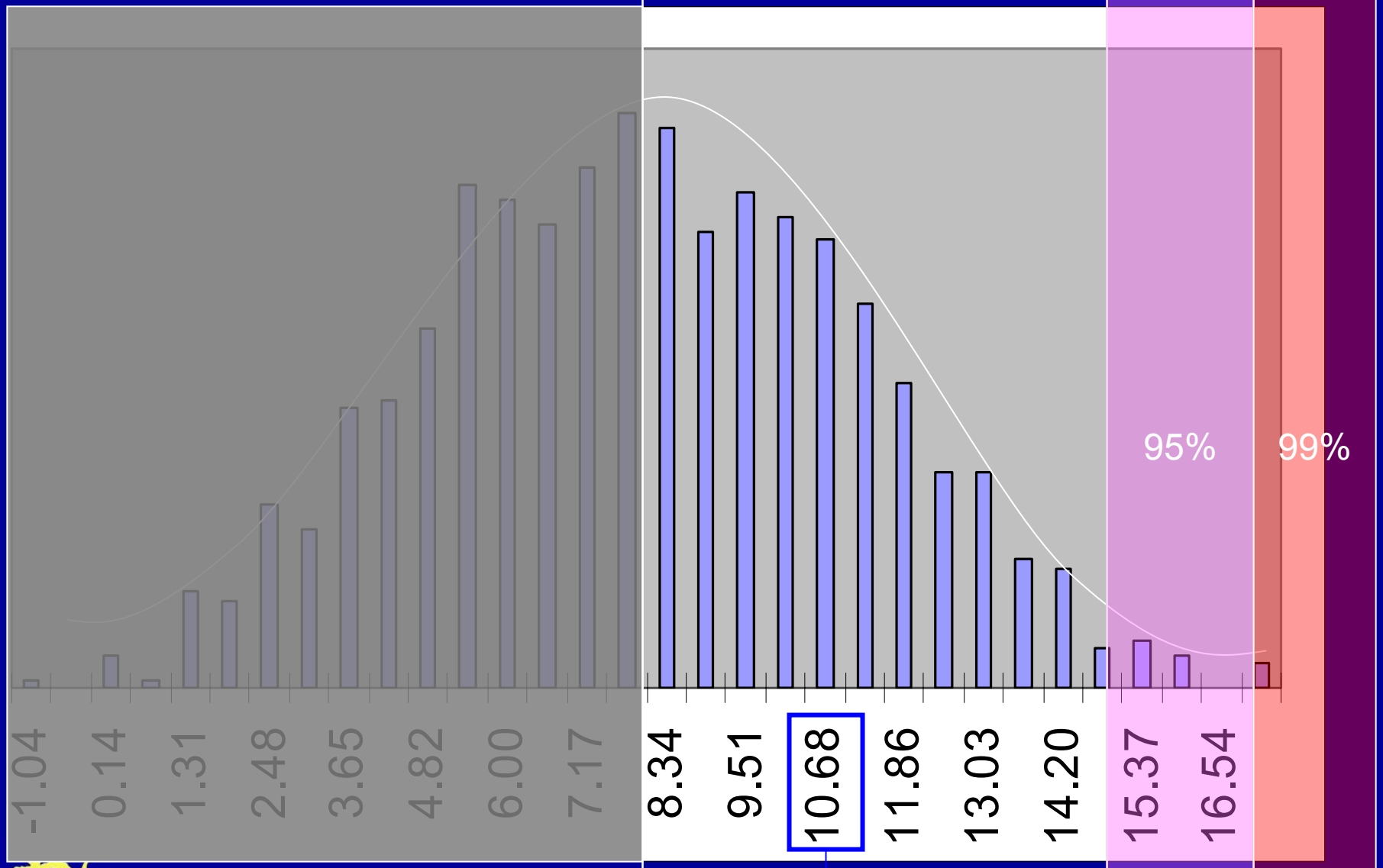
Average (Week 2) = 7.6



Wk 2 (2003) = 10 cases
= No Targeting

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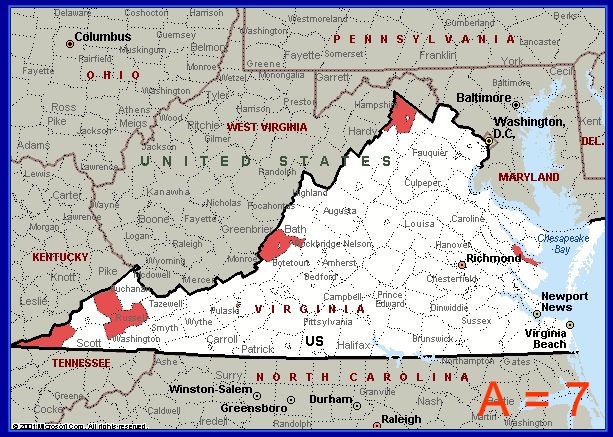
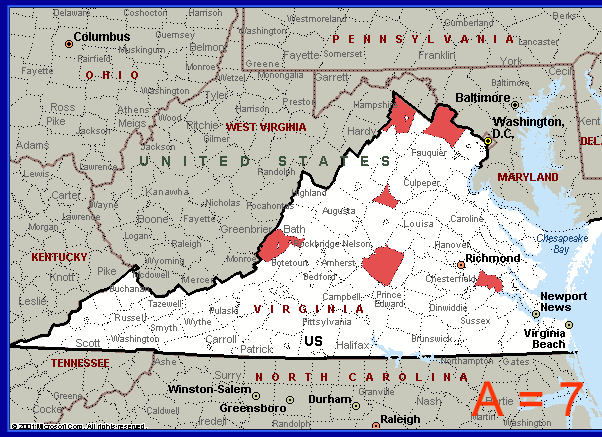
99% + 5 week averaging window

Oct. 5th

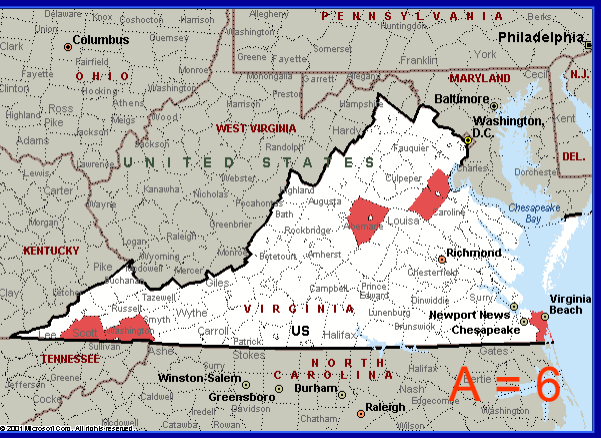
Oct. 13th

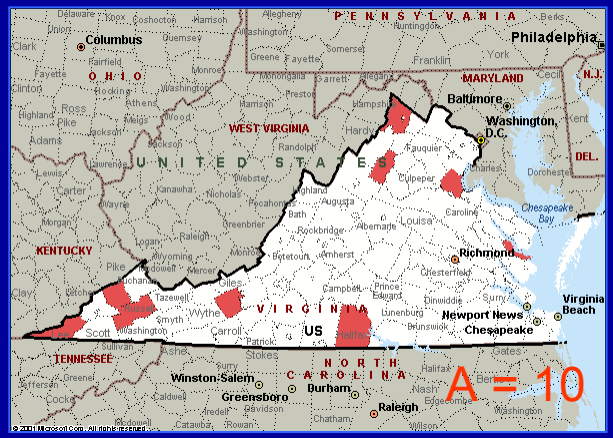


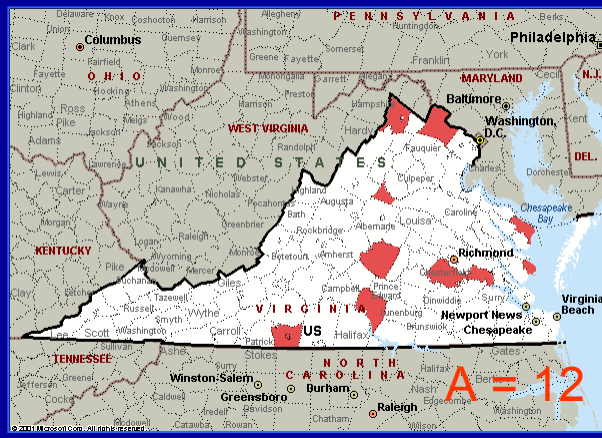
Oct. 19th



99% + 3 week averaging window







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Confidentiality

"a picture's worth a thousand ~~words~~ NAMES"

- GIS is fairly new to STD surveillance
- Technology has outpaced confidentiality standards
- Is geocoded and/or mapped data easily identifiable?
  - Use of rates, ranges, etc.
  - Randomization of points, offsets
- Need to establish guidance for users and recipients
  - Data sharing agreements

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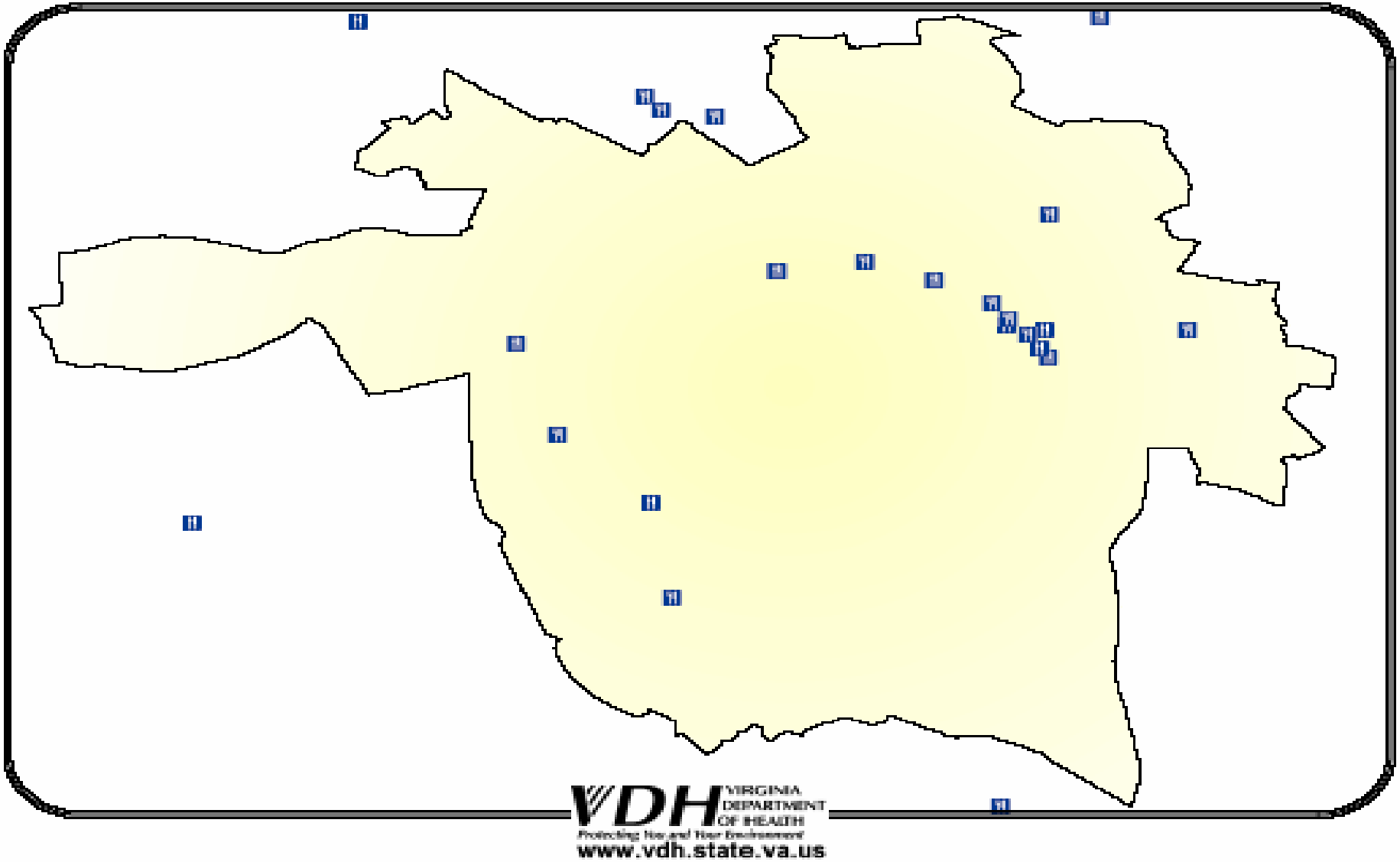

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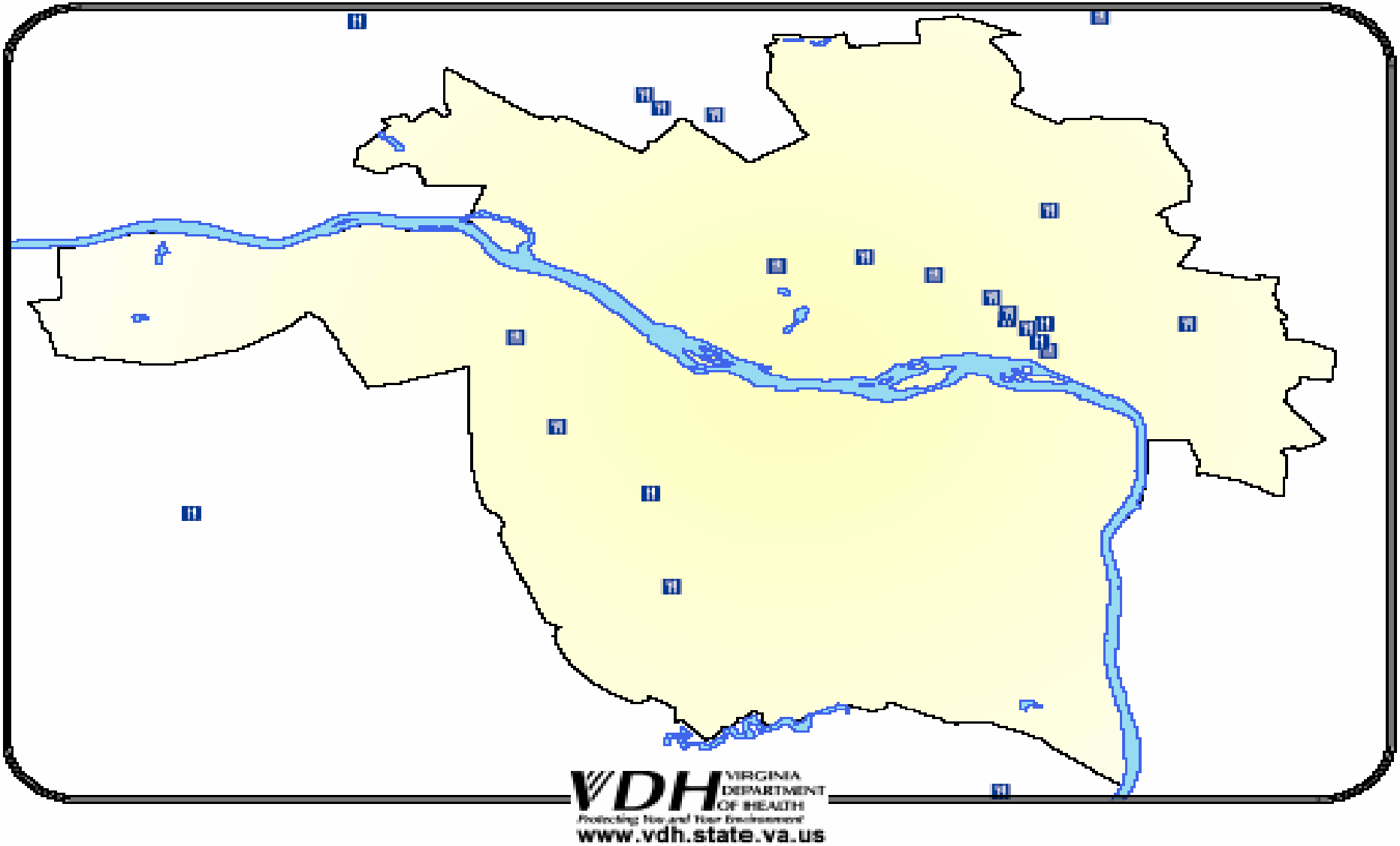

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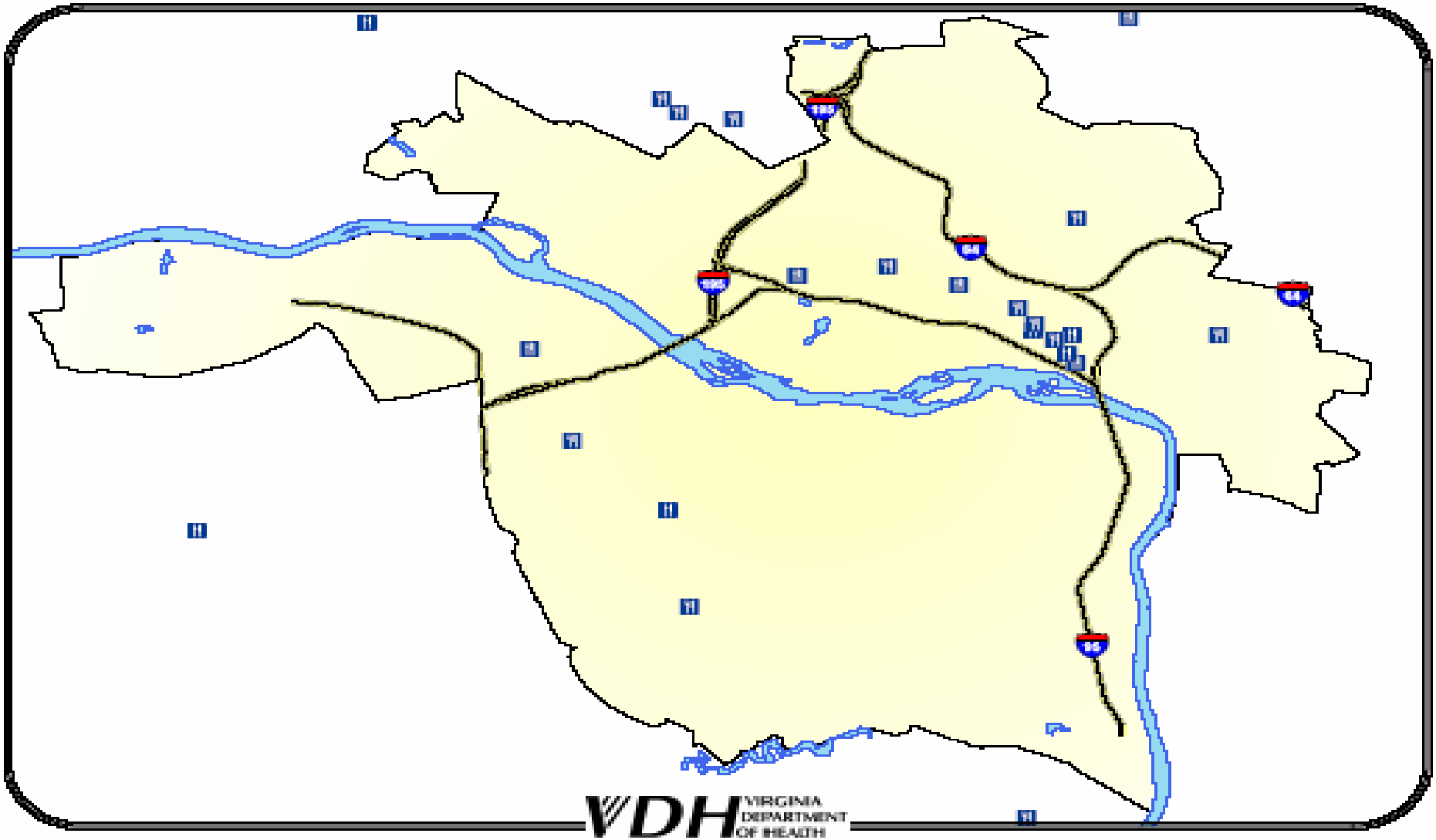

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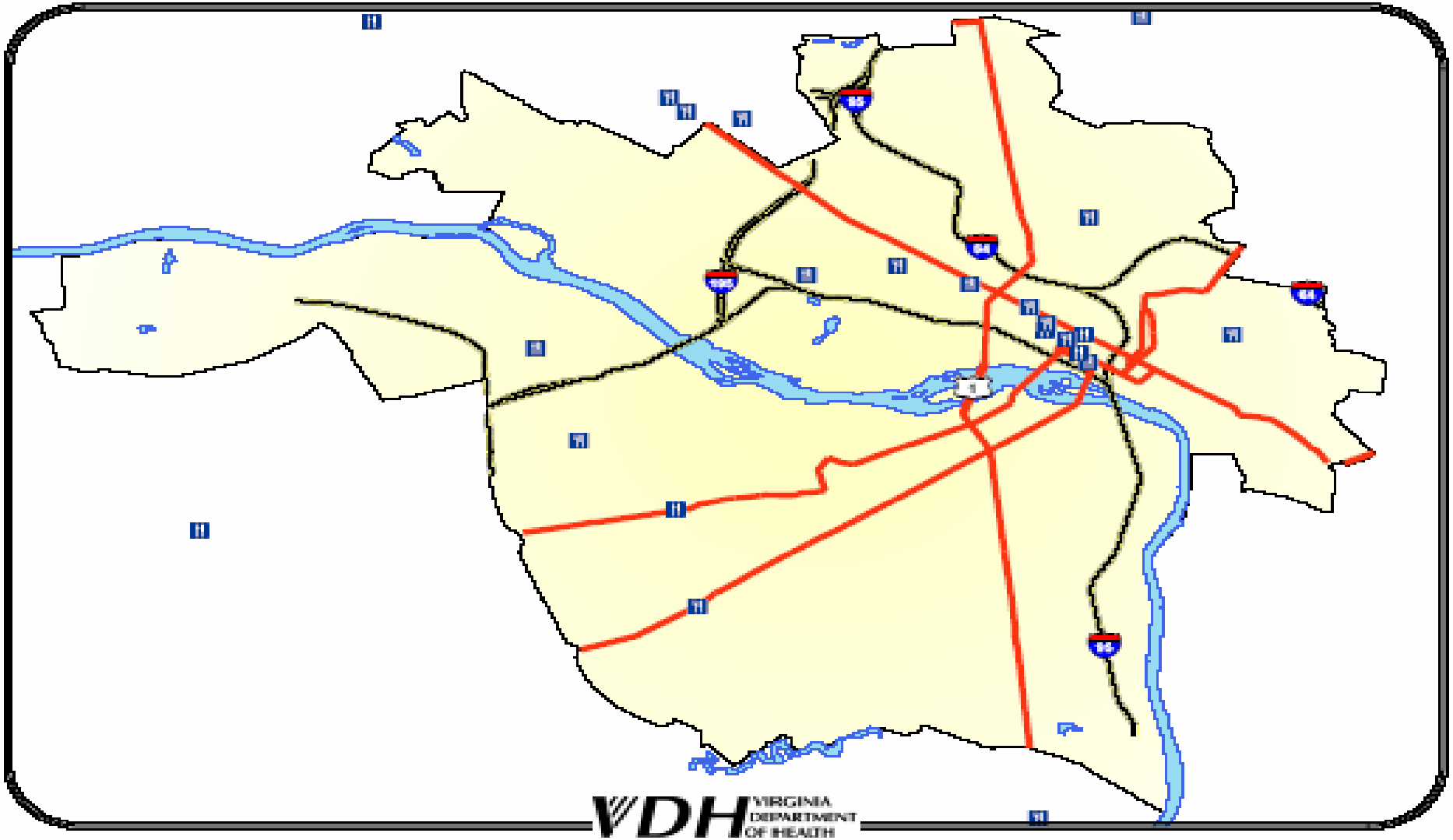

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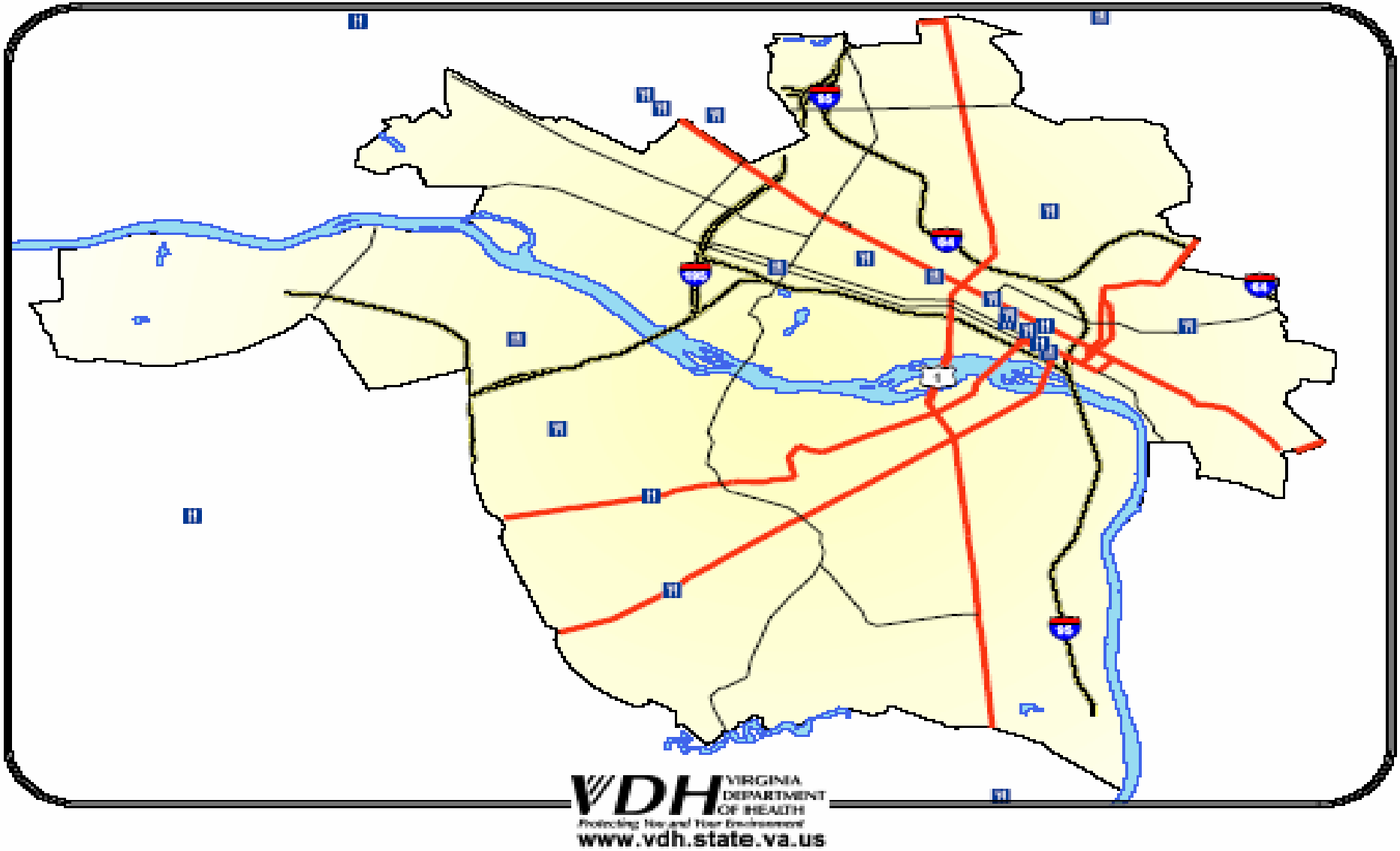

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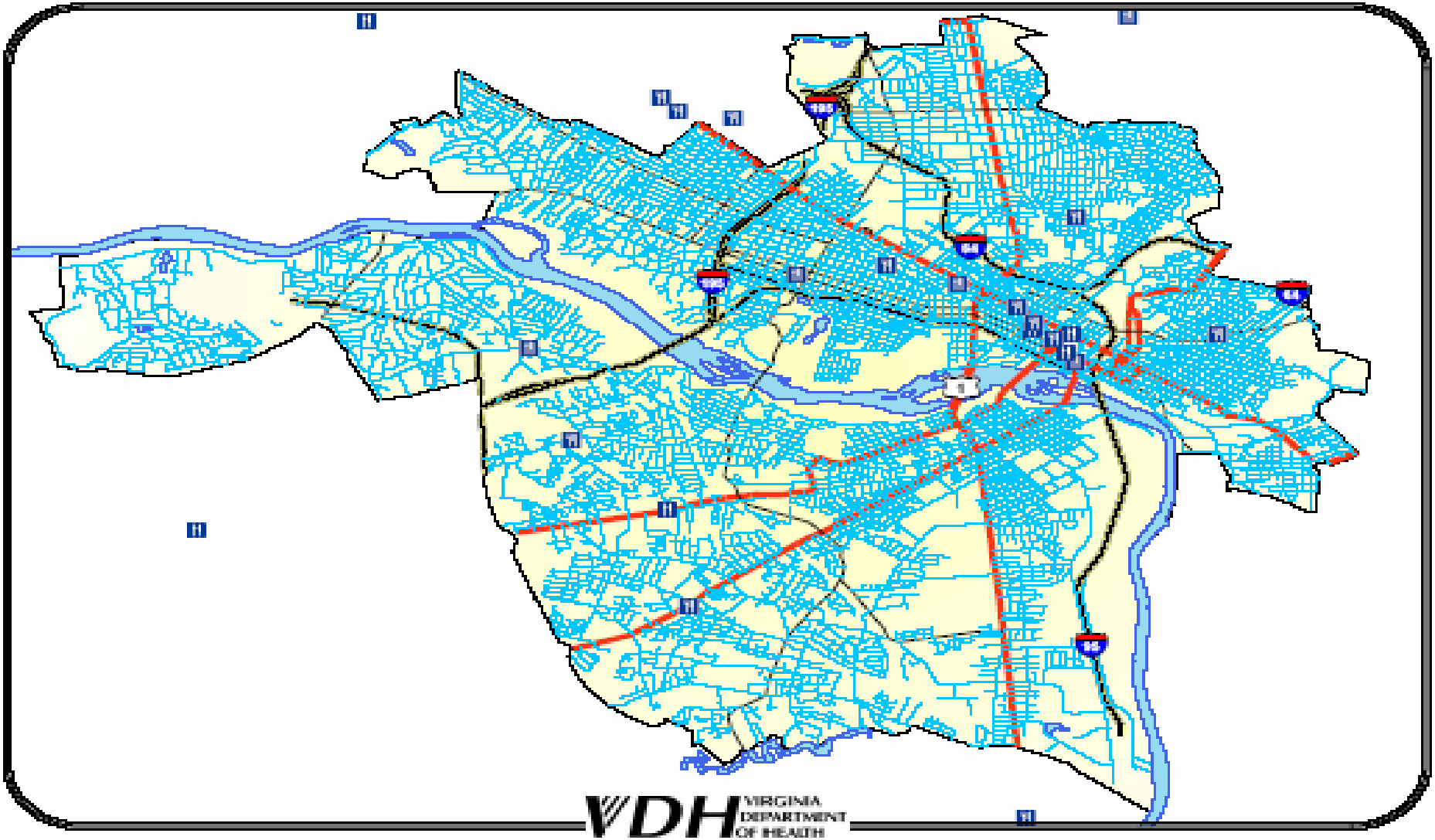
Richmond Area Delis



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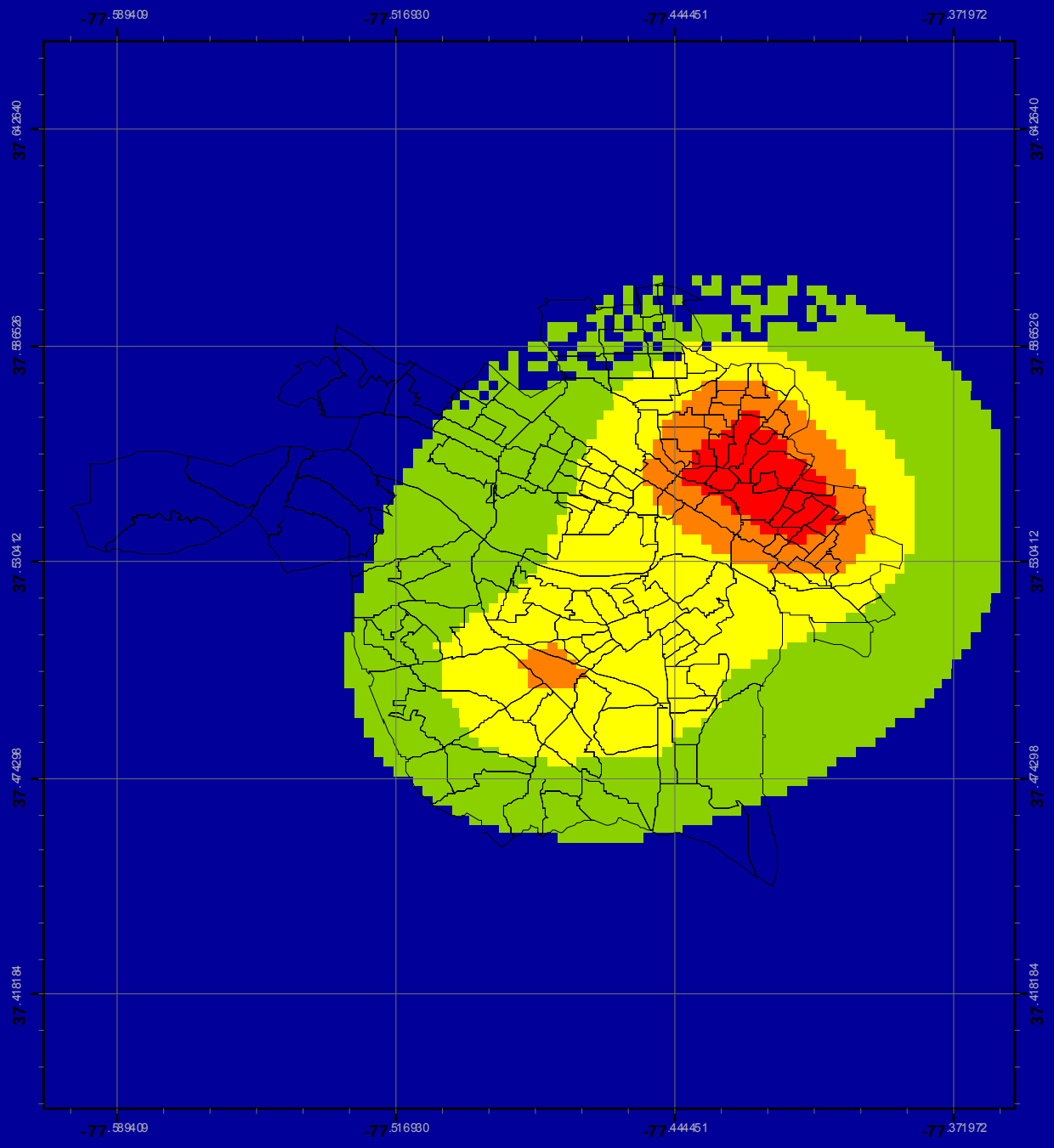

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Steps Regarding Map Release

(example: nurse requests map of locality)

- 1) Request received from Public health nurse, including outline of steps/issues involved
- 2) Identity of nurse verified
- 3) Maps produced
- 4) Applicable Health Director emailed regarding request
- 5) Maps mailed to Health Director

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Sample letter for Health Directors

- **[Health District Director],**
- The Division of HIV/STD has been requested, via **[employee name that requested map(s)],** to provide geocoded STD maps of your health district for educational outreach purposes. As stated in my initial email response dated **[month/day/year**], the Division will be sending such mapping requests through the applicable District Director to ensure appropriate management of confidentiality and security issues.
- Depending on the request, maps may contain street level data of a geographic area (i.e. cities, counties, zip codes, etc.). Specific disease data plotted on a street level map presents a new and different avenue of confidentiality concern, given the close proximity of the disease to the patient's actual home address. Maps with this type of detail are virtually the same as a morbidity line list without patient names. As such, we ask that you provide appropriate guidance to the health department recipients of such maps. As a guide, the Division recommends that such maps be displayed in areas accessible only by staff whose access to such data will assist in disease prevention and control. Posting of maps in areas accessible to the public or health department offices unrelated to the project should occur only if the map contains nonspecific data, i.e. ranges of disease occurrence within defined zip codes. The Division also recommends that street level maps be destroyed and/or stored in confidential areas upon completion of associated projects.
- The requested map(s) will be addressed and mailed to you today and will arrive in a white mailing tube. The Division of HIV/STD hopes you find the map(s) to be useful and informative public health tools for targeting enhanced disease surveillance and health education/promotion activities. As always, your feedback is appreciated. Any comments or questions you have regarding the use of geographic information systems for HIV/STD data may be addressed to me at jeff.stover@vdh..virginia.gov or 804-864-7961.

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Geographic and Spatial Regression Analysis of Sexually Transmitted Diseases in Richmond, Virginia

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Background

- **Public Health**
  - **Richmond consistently ranks high for STD rates among cities (>200,000 pop)**

Chlamydia, 2001

	City	Cases	Rate*
1.	Richmond, VA	2,082	1,052.6
2.	Detroit, MI	11,552	942.0
3.	St. Louis, MO	3,195	917.6
4.	Philadelphia, PA	13,628	898.0
5.	Milwaukee, WI	8,224	874.7
6.	Baltimore, MD	5,405	830.1
7.	Newark, NJ	2,408	800.6
8.	New Orleans, LA	3,871	798.7
9.	Atlanta, GA	6,426	787.5
10.	Indianapolis, IN	6,611	768.3
:			
15.	Norfolk, VA	1,475	629.3

- Core Theory
  - STDs are geographically concentrated into core areas of transmission = CLUSTERS = GIS
- Policies and Intervention
  - Target the core

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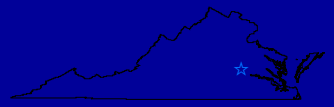
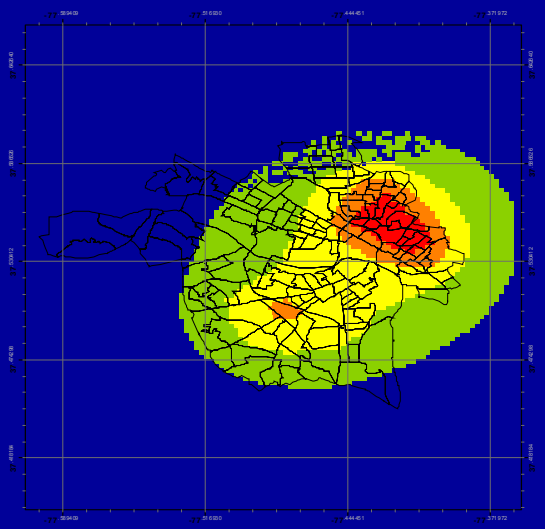
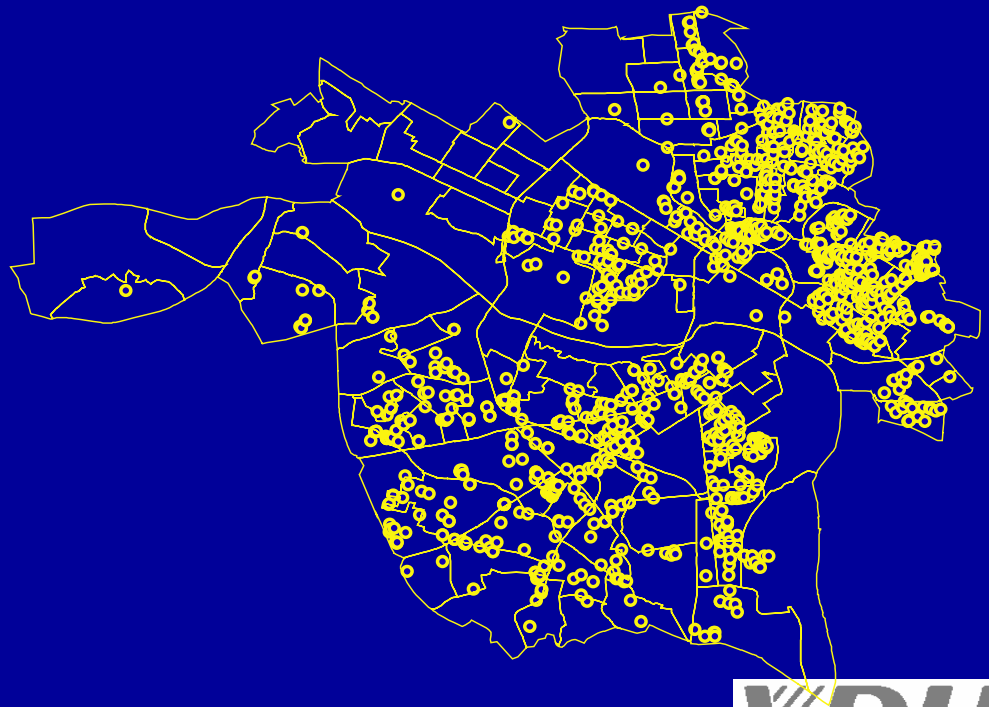
Cluster Analysis



- **Geocode STD (Gonorrhea, Chlamydia) cases in Richmond and assign to block groups**



(CrimeStat)



(GeoStan)

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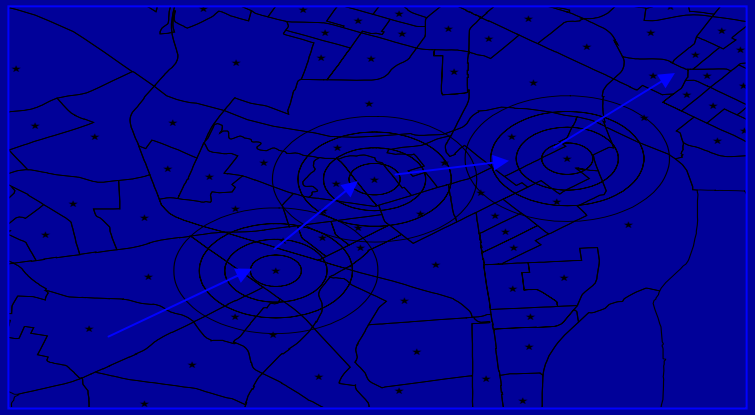
Detecting Clusters

- **Spatial Scan Statistic**

SatScan: www.satscan.org



- Aggregates blocks of high and low rates into "most likely" clusters using expected rates and Monte Carlo trials

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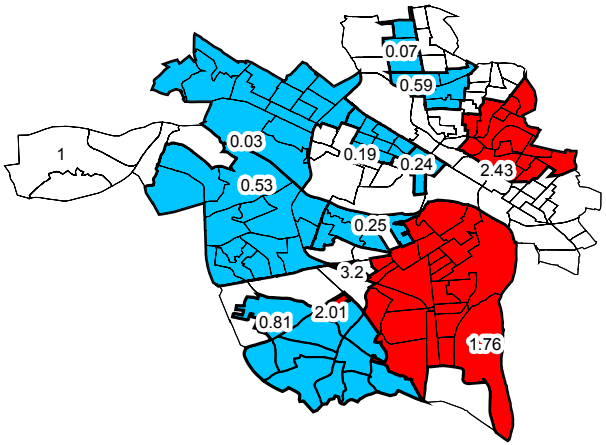
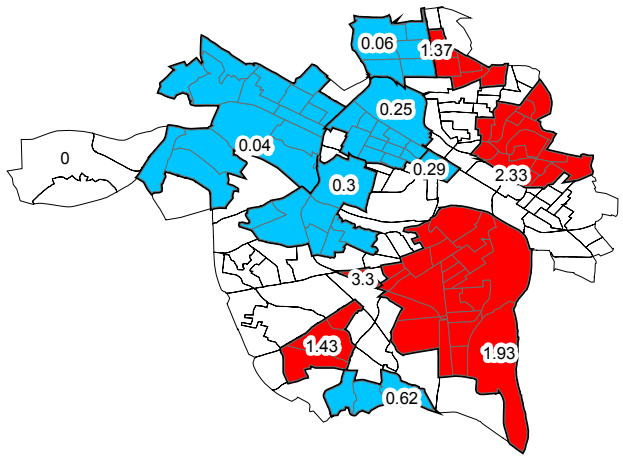
Results

Spatial Scan (2000)
Max. Cluster Size Set at 10% of Pop.
9,999 Replications



Spatial and Temporal Scan (2000-2002)
Max. Cluster Size Set at 10% of Pop.
Max Temp Cluster set at 1 year
9,999 Replications



Relative Risk, STD Incidence

RR=1, non-cluster

RR<1, Low Cluster

RR > 1, High Cluster

N
W E
S

0 1.5 3 6 9 12 Miles

Core Characteristics

Predictor	Clusters			Analysis of variance
	Low Cluster (RR < 1.0)	Non-clustered (RR = 1.0)	High cluster (RR > 1.0)	
Drug arrest rate	5.2	12.9	17.5	p < 0.0001
Income	27,511	18,365	11,362	p < 0.0001
African-American status	15.5	31.3	49.5	p < 0.0001
STD cases by cluster	1106	452	1243	
Study population by cluster	86435	69,983	41372	

First indication that we should consider a spatial model to characterize associations between variables

(SAS)

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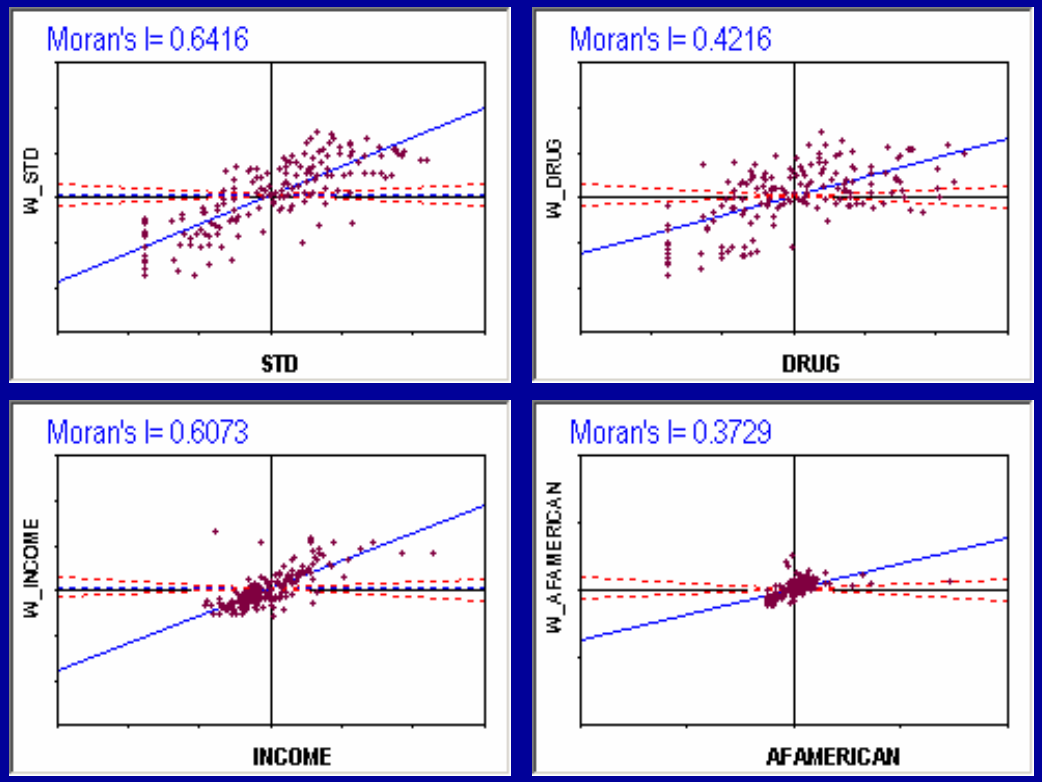
Spatial Dependence?

- Quantifies spatial dependence observed with ANOVA



(GeoDa)

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Diagnostics

Test	Model	P value
Moran's I	Error	0.0072
Lagrange Multiplier	Error	0.0165
Robust LM	Error	0.1695
Kelejian-Robinson	Error	0.0421
Lagrange Multiplier	Lag	<0.0001
Robust LM (lag)	Lag	<0.0001
Lagrange Multiplier	SARMA	<0.0001

Evaluation

(SpaceStat)

Diagnostic	OLS	Spatial LAG
R2	0.67	0.71
LIK	-624.39	-609.17
AIC	1256.79	1228.33
Breusch-Pagan	0.0007	0.1029
Jarque-Bera	0.1265	n/a
Multicollinearity	14.52	n/a
Lagrange Multiplier	n/a	0.2626

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Conclusions

- Identified core area of 15 census blocks (VDH started targeting these areas)
  - Core remained intact even after 3-fold adjustment for underreporting
- Drug arrest rate, low socioeconomic status, African-American proportion highly significant predictors of STD rate
- Revealed area of maximum return for further network analysis
- Developed methodology for enhanced surveillance

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Geographic and Spatial Regression Analysis of Sexually Transmitted Diseases in Richmond, Virginia

Chris Delcher*, Jeff Stover — Division of HIV/STD, Virginia Department of Health

Richard B. Rothenberg –** Emory School of Public Health

Abstract

The objective of this research was to examine the geographic epidemiology of sexually transmitted diseases (STD) in Richmond, Virginia and to employ an ecological regression study design to assess the correlation between STD rates and census-block-aggregated per capita income levels, drug arrest rates, and percent African-American population. The study population included pooled geocodable cases (N= 8159) of gonorrhea and chlamydia diagnosed for three years (2000-2002) in Richmond. First, a geographic analysis, using the spatial scan statistic, identified highly probable (p<.0001) clusters of high STD rates at the block group level. Second, a spatial linear regression technique was applied to the data (Y2000) after diagnostics of the ordinary least squares (OLS) model confirmed significant spatial autocorrelation. Before and after adjusting for spatial effects, high incidence rates of STDs were strongly correlated (p<0.0001) with all the independent variables tested. From a surveillance perspective, this analysis illustrates that the spatial scan statistic can be a useful tool for identifying neighborhoods of core STD transmission in an urban area.

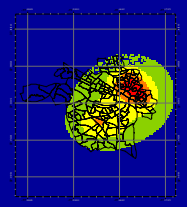


Fig. Interpolated surface from STD data points. Points not shown because of confidentiality (produced with CrimeStat).

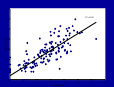


Fig. Scatterplot of incidence rates (square root transformed) of chlamydia and gonnorhea, by Richmond block group, 2000. We used an aggregate STD rate based on this finding.

Spatial Scan Method

The spatial scan statistic was used to test for the presence of clusters of STDs and to identify their approximate location. The open domain software Satscan (v.3.0.5) distributed by the National Cancer Institute was used for this purpose.

In this study, the Satscan software was applied to the 163 Richmond block groups in order to generate possible clusters of high and low STD incidence. The Monte Carlo simulation used to test significance was set at 9,999 iterations and set to generate both high and low clusters. Clusters were mapped using ArcMap 8.3 (Environmental Systems Research Institute, 2002).

Results

Spatial Scan Statistic

Fig. The movement of the scanning window. The circles are always centered at one of the block group centroids (♦) and for each centroid the radius increases continuously covering an increasing number of adjacent block groups until 10 per cent of the total population is covered. (from Ulf Hjalmars et al, 1996)

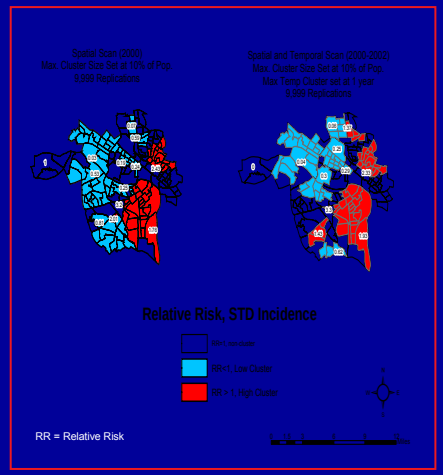


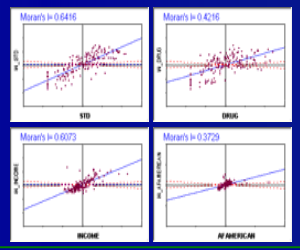
Fig. The results of the spatial scan statistic

Regression Analyses and Modeling

1. ANOVA gives first indication that independent variables are also geographically clustered.

Predictor	Clusters: Low Cluster (RR < 1.0)	Non-clustered (RR = 1.0)	High cluster (RR > 1.0)	Analysis of variance
Drug arrest rate	5.2	12.9	17.5	p < 0.0001
Income	27,511	18,365	11,362	p < 0.0001
African-American	15.5	31.3	49.5	p < 0.0001
clusters				
STD cases by cluster	1106	452	1243	
Study population by cluster	86435	69,983	41372	

2. Moran *I* statistic is one method of quantifying the extent and significance of spatial clustering. All Moran I values shown here are significant at the p=0.0001 level (produced with GeoDa)



3. Additional diagnostic test suggests that a spatial lag model would be the best fit for the data.

Test	Model	P value
Moran's I	Error	0.0072
Lagrange Multiplier	Error	0.0165
Robust LM	Error	0.1695
Kelejian-Robinson	Error	[illegible]
Lagrange Multiplier	Lag	<0.0001
Robust LM (lag)	Lag	<0.0001
Lagrange Multiplier	SARMA	[illegible]

4. Comparing the OLS model to the spatial model shows that the spatial lag model is the better fit.

Diagnostic	OLS	Spatial LAG
R2	0.67	0.71
LIK	-624.29	-609.17
AIC	1256.79	1228.33
Breusch-Pagan	0.0007	0.1029
Jarque-Bera	0.1265	nA
Multicollinearity	14.52	nA
Lagrange Multiplier	nA	0.2626

Conclusions

This analysis has empirically demonstrated substantial clustering and small-area variations in the incidence of gonorrhea and chlamydia in Richmond, Virginia in 2000. The most likely core area of fifteen census blocks, (approximately 4 square miles and 9.4 percent of the population), was identified in the northern section of the city using the spatial scan statistic. Sensitivity analysis indicated that this core remained intact through at least the end of 2002 and after adjustments were made for potential underreporting in non-core areas (see below).

After controlling for spatial dependence, variations in STD rates remained highly associated with variations in high drug arrest rates, low socioeconomic status, and higher proportion of African-American residents. In previous studies, low-income and African-American race have been geographically associated with higher STD rates. Disassortative mixing has been proposed as one reason why this community is disproportionately burdened. In Richmond, a predominantly African-American city (~60%), we expect that higher rates may be explained partially by larger pools for selection. Our results confirm that the disparity remains, at the neighborhood-level, independent of economic status.

This analysis reveals an area of maximum return for further network analysis and to begin building the type of relationships required for detailed ethnographic studies.

2x case increase in low rate areas 3x case increase in low rate areas

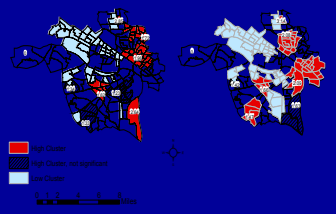


Fig. Sensitivity analysis. Spatial Scan results after a two and three-fold adjustment for underreporting

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GIS-related analys[illegible]nded [illegible] through [illegible] CDC Outcome As[illegible] grant projec[illegible]

VDH VIRGINIA DEPARTMENT OF HEALTH
Protecting You and Your Environment
http://www.vdh.state.va.us/std/

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Useful Resources

- GIS in Public Health
  - www.atsdr.cdc.gov/gis
- Public Health GIS News and Information
  - www.cdc.gov/nchs/about/otheract/gis/gis_publichealthinfo.htm
- Federal Geographic Data Committee
  - http://fgdc.er.usgs.gov
    - National Spatial Data Infrastructure
- www.mapmart.com
- http://gislounge.com/features/aa053100a.shtml
  - Geocoding 101
  - Software applications
- www.GIS.com
- www.mapinfo.com
- www.geocode.com
  - Tele Atlas

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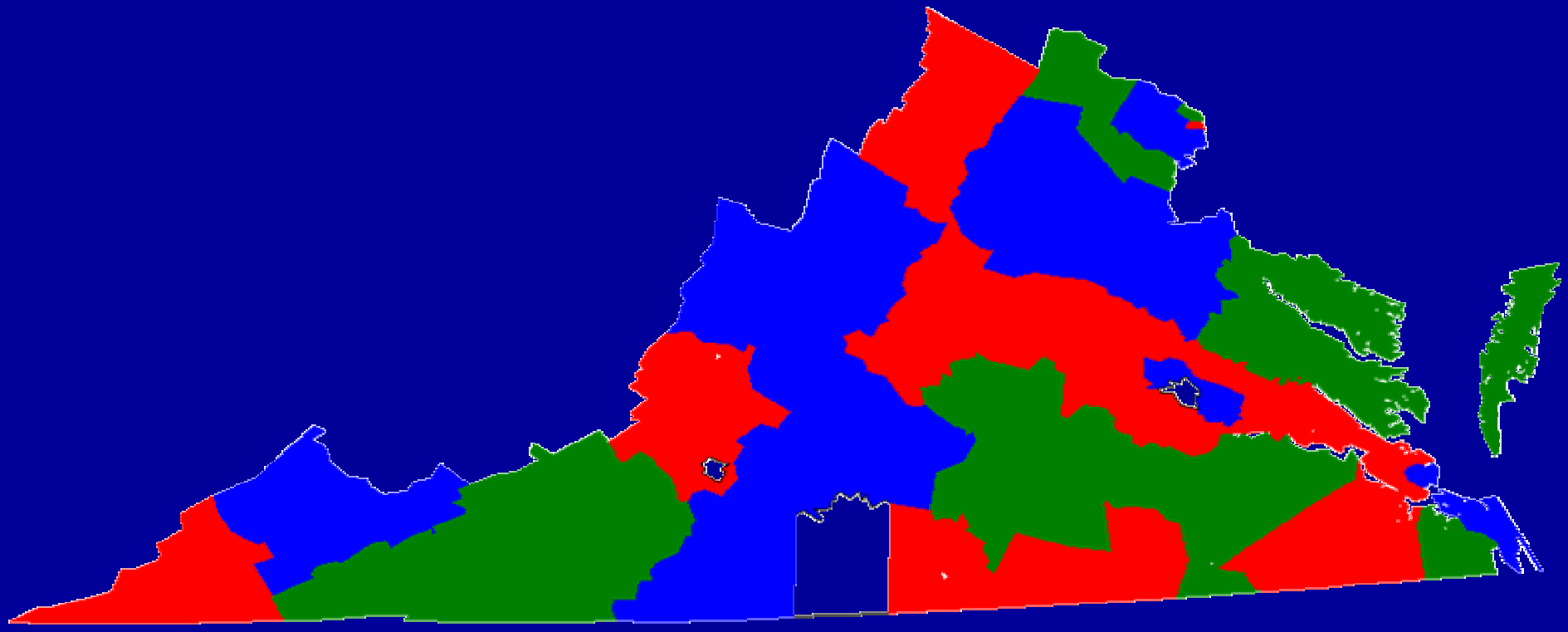
Virginia
Linking SAS & GIS



Age

486.10 - 1197.50
2865.50 - 4303.33

1242.25 - 1449.33
5103.00 - 9668.00

1509.50 - 2574.40
10350.00 - 25643.00

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