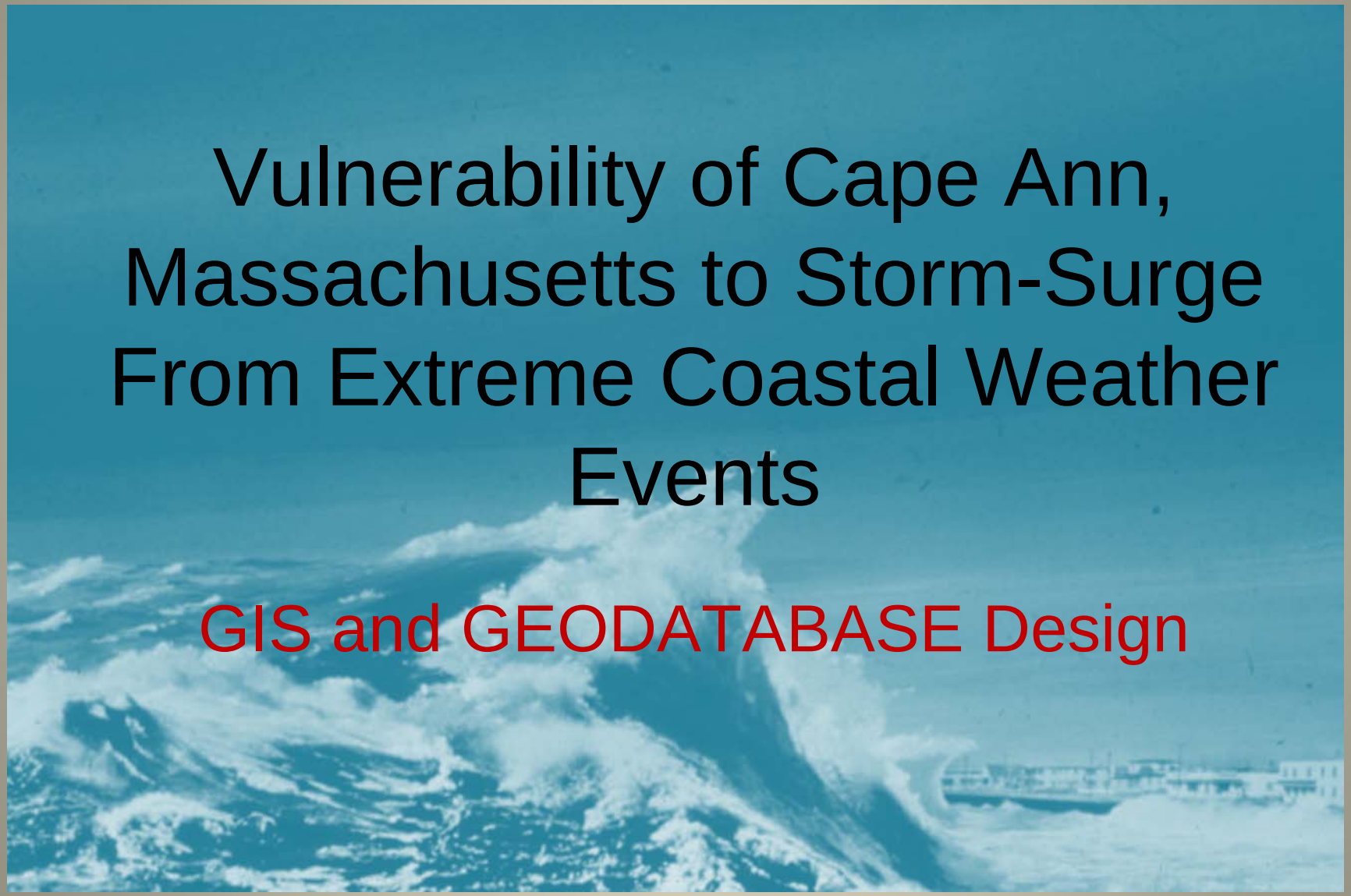


Vulnerability of Cape Ann, Massachusetts to Storm-Surge From Extreme Coastal Weather Events

GIS and GEODATABASE Design

Coastal Storm-Surge

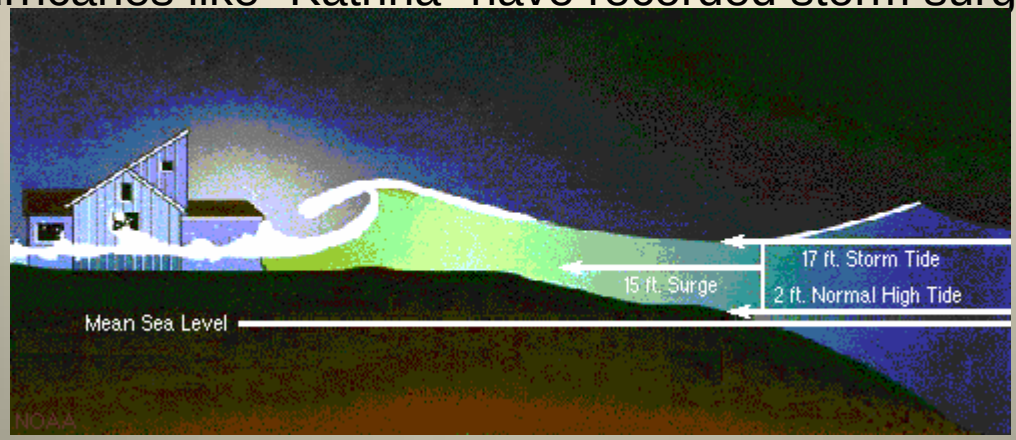
• Estimated 80 percent of U.S. population lives on or near the East/West coast.

•millions of people are at risk from disastrous weather events.

•NOAA states , “The Greatest potential for loss of life related to a hurricane is from the storm surge, which historically has claimed nine of ten victims”

•What is it Storm surge is defined as water that is pushed toward the shore by the force of the winds swirling around the storm.

•Large Hurricanes like “Katrina” have recorded storm surges close to 30 feet high



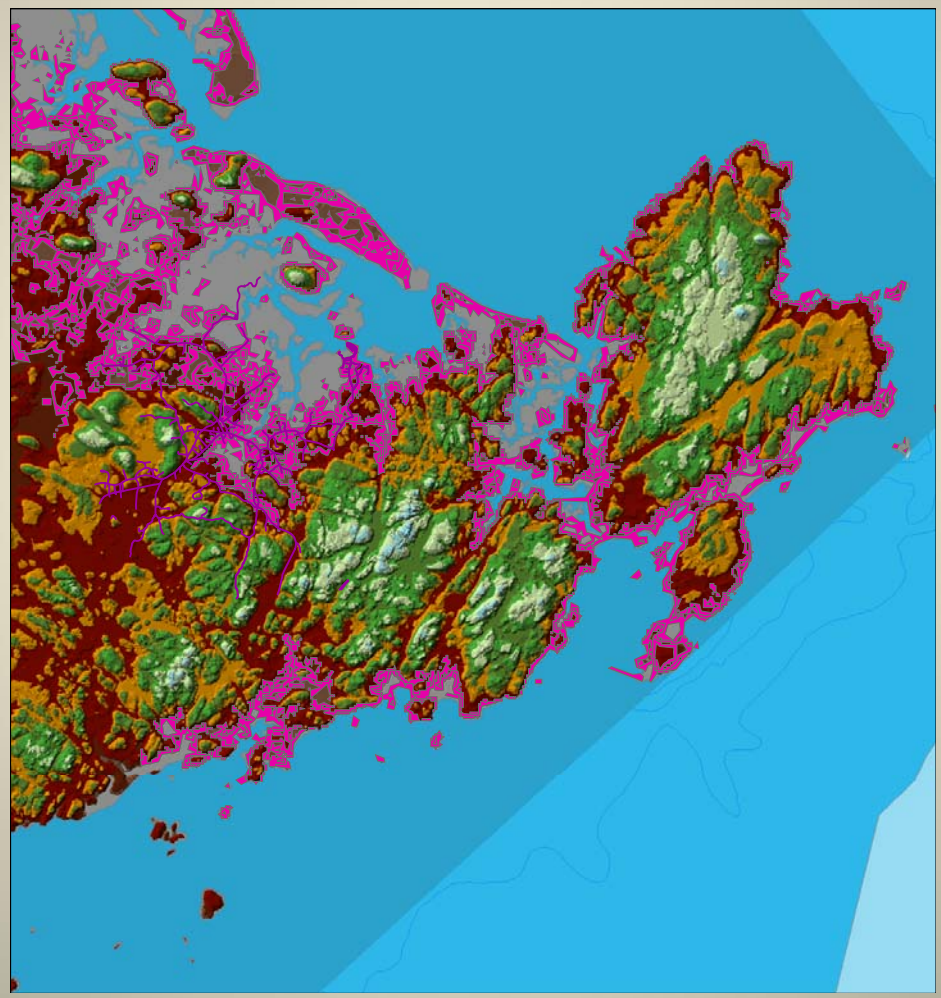
This GIS System can be used to:

1. Identify Extreme Coastal Event storm surge areas including residential, building, city infrastructure roads and bridges. Produce maps at 3 potential storm surge intervals of 10, 20 and 30 feet.

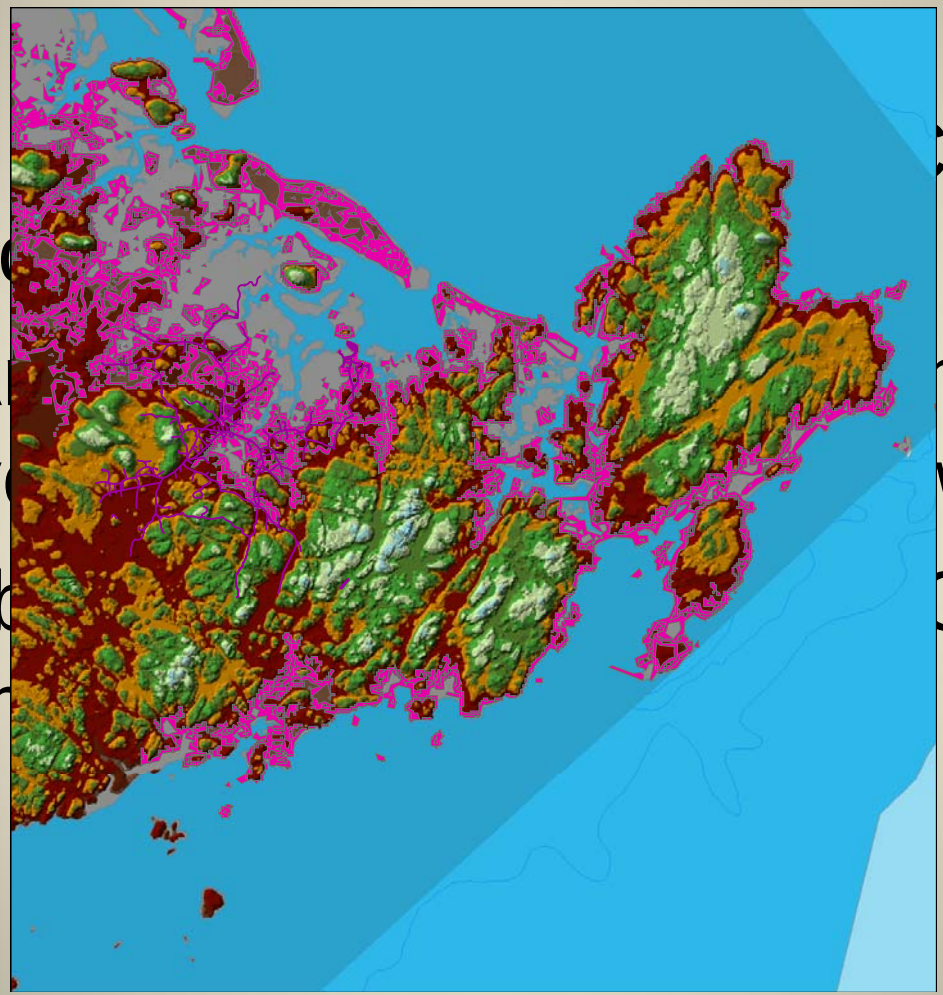
2. Identify 2 potential areas suitable for City infrastructure based on potential storm surge areas.

3. Investigate the concept of environmental inequities according to income and storm- surge locations

Cape Ann



Why Cape Ann



- For the
ape Ann
==Glou
- Cape A
ntic Ocean
from ev
vest.
- Only 2 b
Cape Ann
to the “n

Data Collection For GIS

- Both vector and raster datasets
- USGS website for National Elevation Data(NED). Replaced DEM last year.
- MassGIS website for Contours, Roads, Coastline
- projected coordinate system of NAD_1983_Stateplane_Massachusetts_Mainland_FIPS_2001

List of Data Layers included

- NED_06925434(Raster)
- Q3_floodmap (poly)
- Road layers for Cape Ann(Line)
- Coastal Zone layer(poly)
- bathometry layer for coastal elevations(line)
- Contour(line)
- TIN created from Raster
- Surge level layers created from Poly

Non Spatial Tables

- Created two non spatial tables that can be used later to geocode public building addresses.
- CityBuilding table
- EvacBuilding table

Geodatabase Setup

- 16 data layers of both vector and polygon data.
- Two Geodatabases
  - StormSurgeBaseMap.mdb
  - StormSurgeRaster.mdb

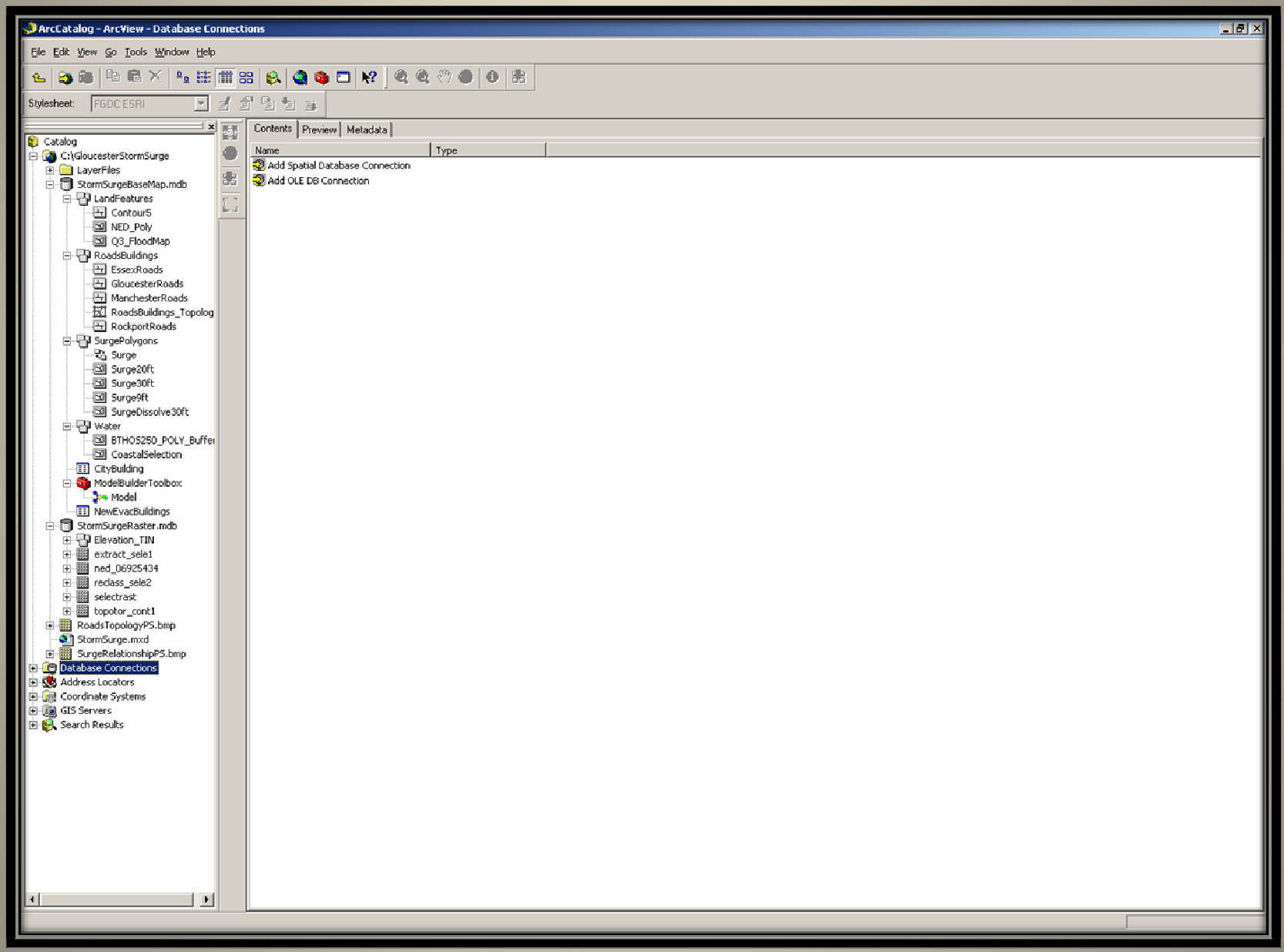
StormSurgeBaseMap.mdb

- Primary storage for feature classes, domains, and topology and relationship classes.
  - 4 Feature Sets (LandFeatures, RoadsBuildings, SurgePolygons, Water)
  - 2 non spatial tables(CityBuildings and NewEvacBuildings)
  - 1 topology with 4 rules on RoadsBuildings Feature Set
  - relationship class in the SurgePolygons Feature Set called Surge

StormSurgeRaster.mdb

- does not have any feature datasets, domains or topology rules.
- primary purpose of this database is to store the raster datasets
- Raster data to large to include in other database

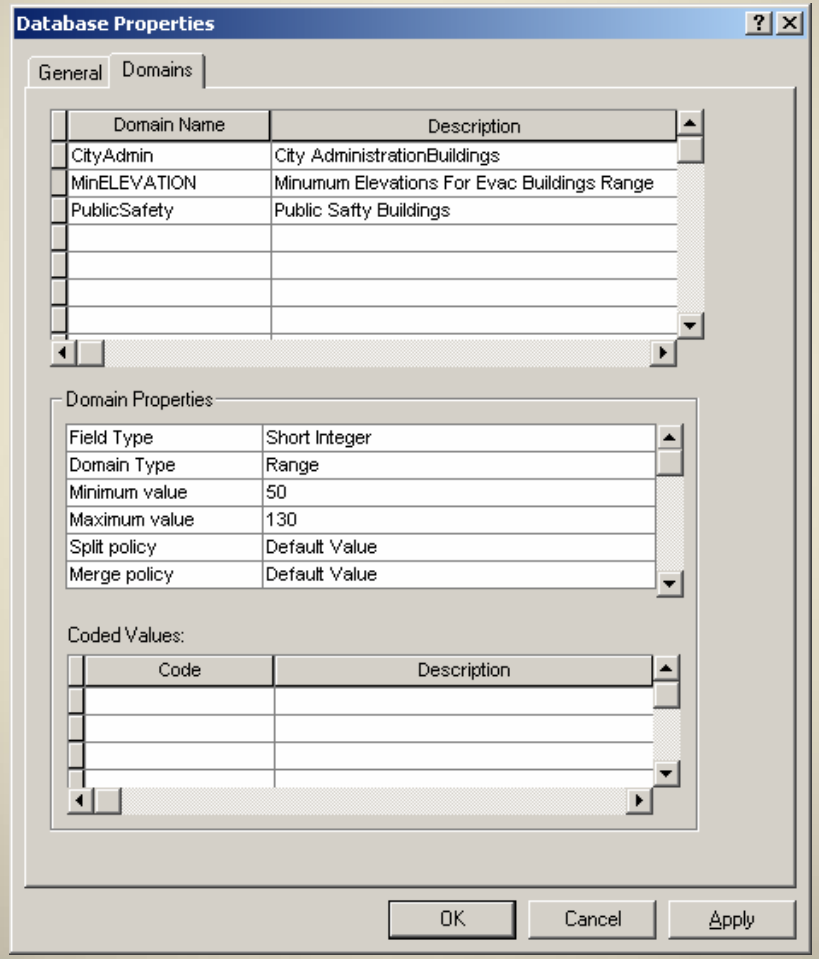
Snapshot of ArcCatalog Databases



Domains

- Coded Value Domains(2)
  - CityBuilding table was built and populated with address data of public administration buildings and contains:
  - two coded value domains.
  - These domains are used to code differentiate whether the building is a public safety building or a City Administration building. d City public safety buildings of Gloucester.
- Range Domain(1)
  - second table NewEvacBuildings , was designed to populate with possible locations of new city buildings
  - The table contains a range domain that constrains the new buildings to certain elevation levels above what is considered a high enough elevation range based on the study. At this point the range is set to elevations from 40 feet to 100ft.

Domains Setup

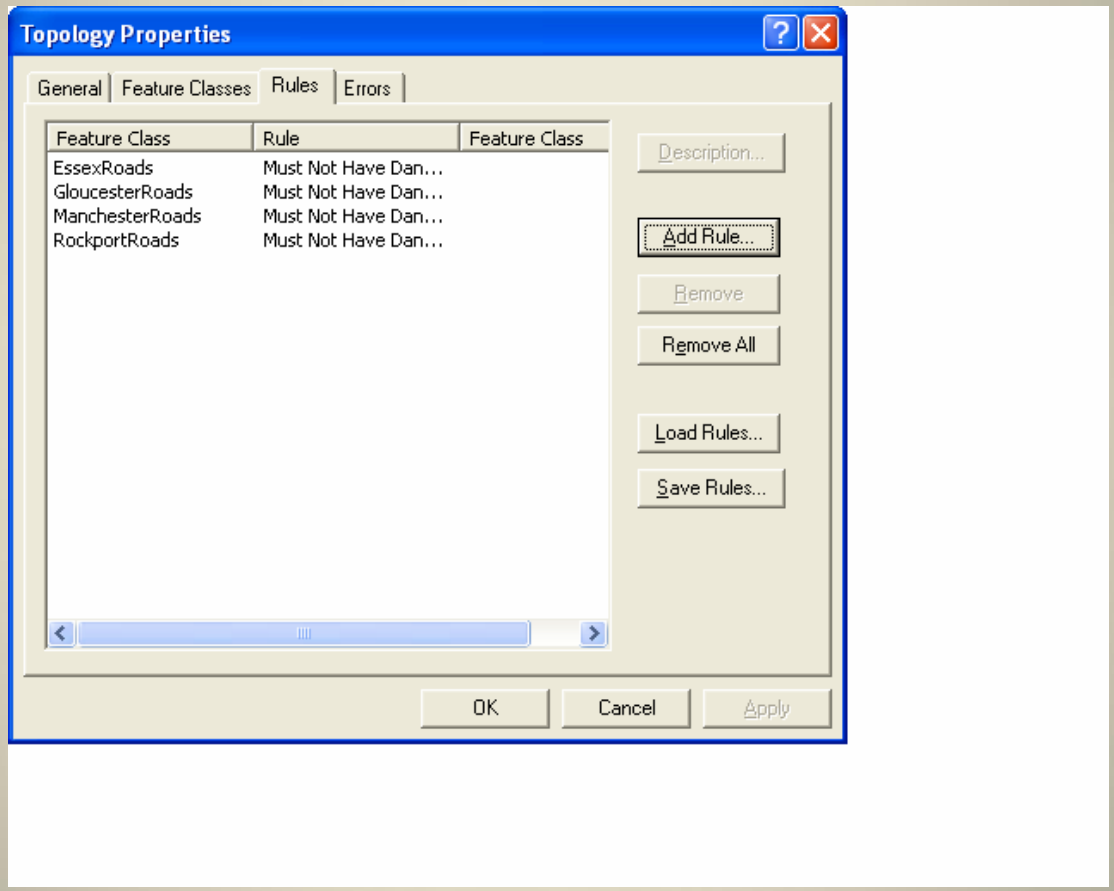


Topology

- topology in the RoadsBuildings Feature Set

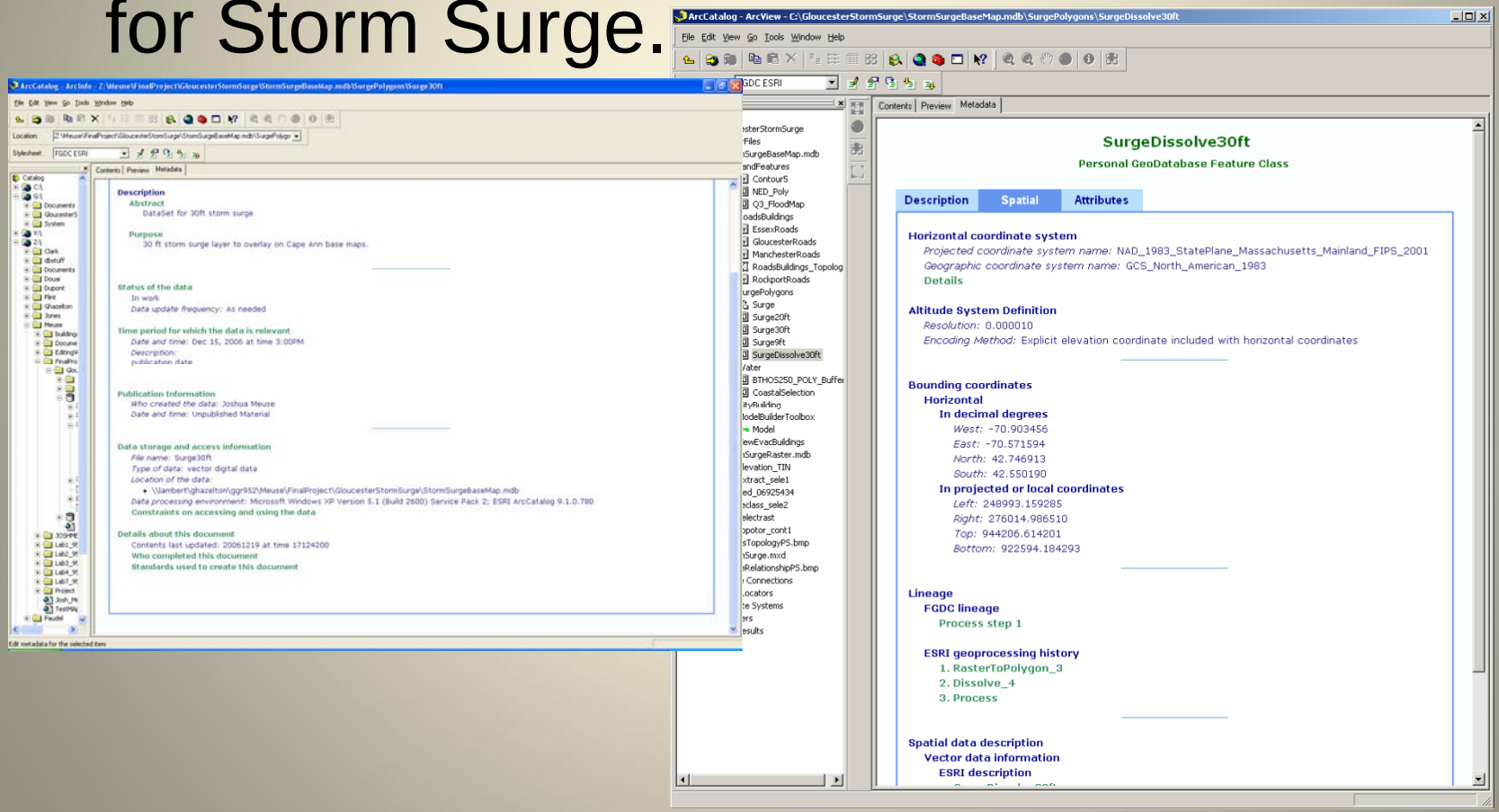
- contains four separate rules constraining the road layers
- To control accuracy of each road layer, the rule “must not have Dangles” was applied to each town road layer.

Topology


Topology Properties
General
Feature Classes
Rules
Errors
Feature Class
Rule
Feature Class
EssexRoads
Must Not Have Dan...
GloucesterRoads
Must Not Have Dan...
ManchesterRoads
Must Not Have Dan...
RockportRoads
Must Not Have Dan...
Description...
Add Rule...
Remove
Remove All
Load Rules...
Save Rules...
OK
Cancel
Apply

Layer MetaData

- Metadata included on all 3 created layers for Storm Surge.



Data Manipulation

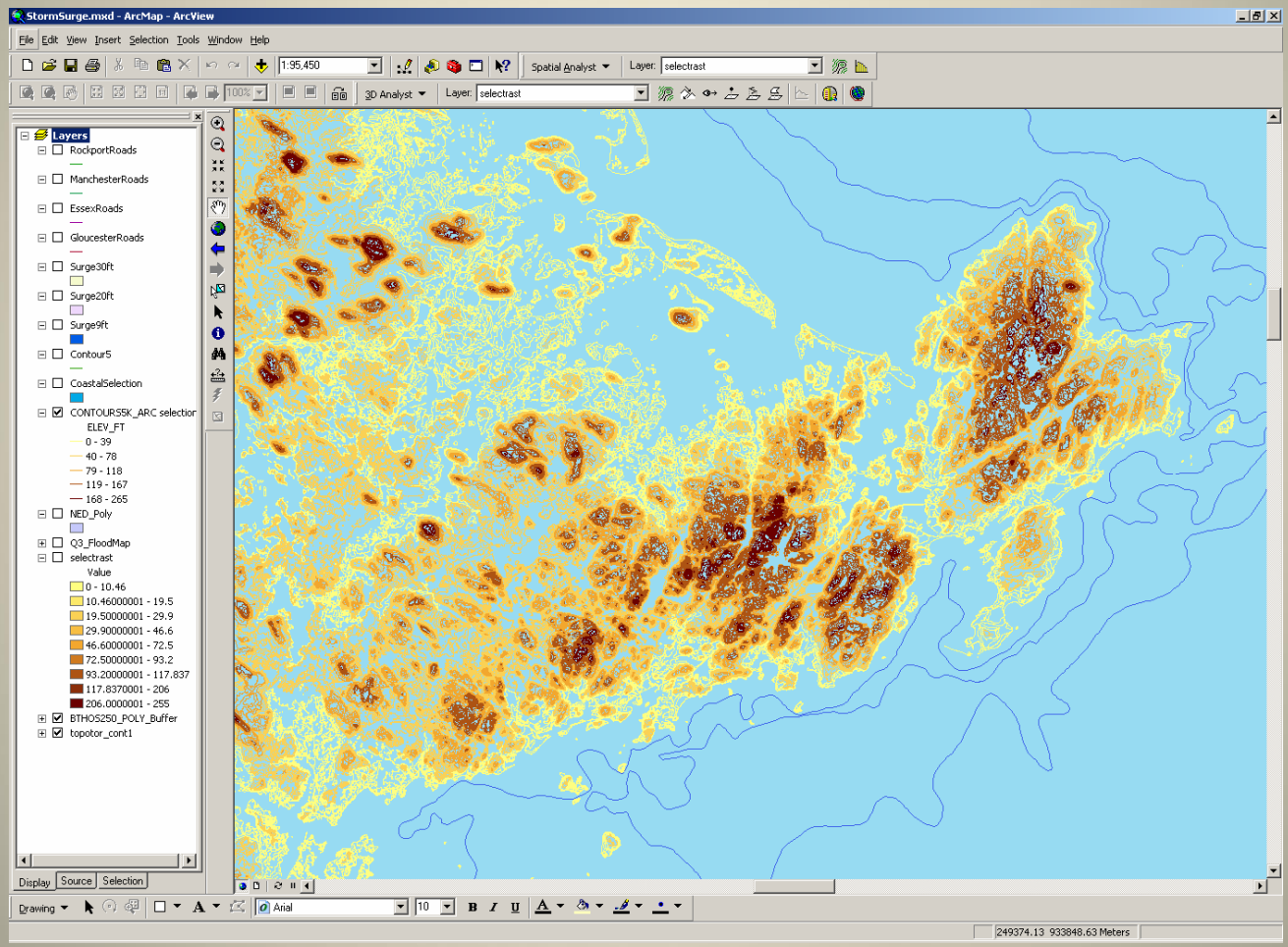
- primary need to have a polygon layer of elevations to interact with the other layers of data
  - Cannot select “areas” with line data
  - Overlays/clips select by location not as effective with line data

- first convert the vector line contour data to a raster dataset. Then raster to polygon using Spatial Analyst toolset
  - Use dissolve tool to clean up polygon layer after conversion

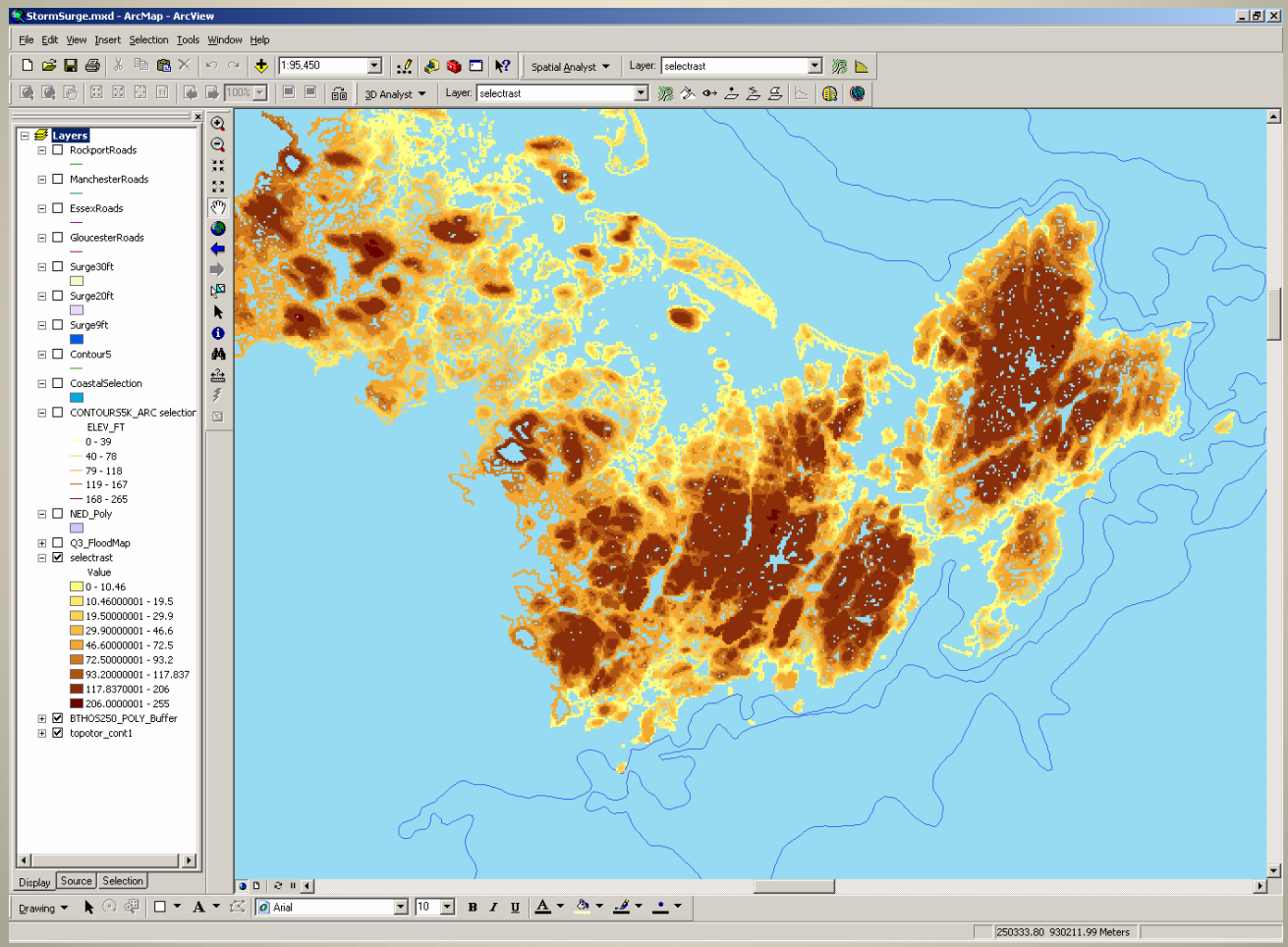
Once Solid Base layer Complete

- Create polygon Surge layers to use in geoprocessing selections, overlays etc.
- Perform Selections based on Location to Determine Roads effected by varying storm surge heights
- Perform selections based on LandUse and storm surge
- Perform Selections based on Building Addresses and storm surge

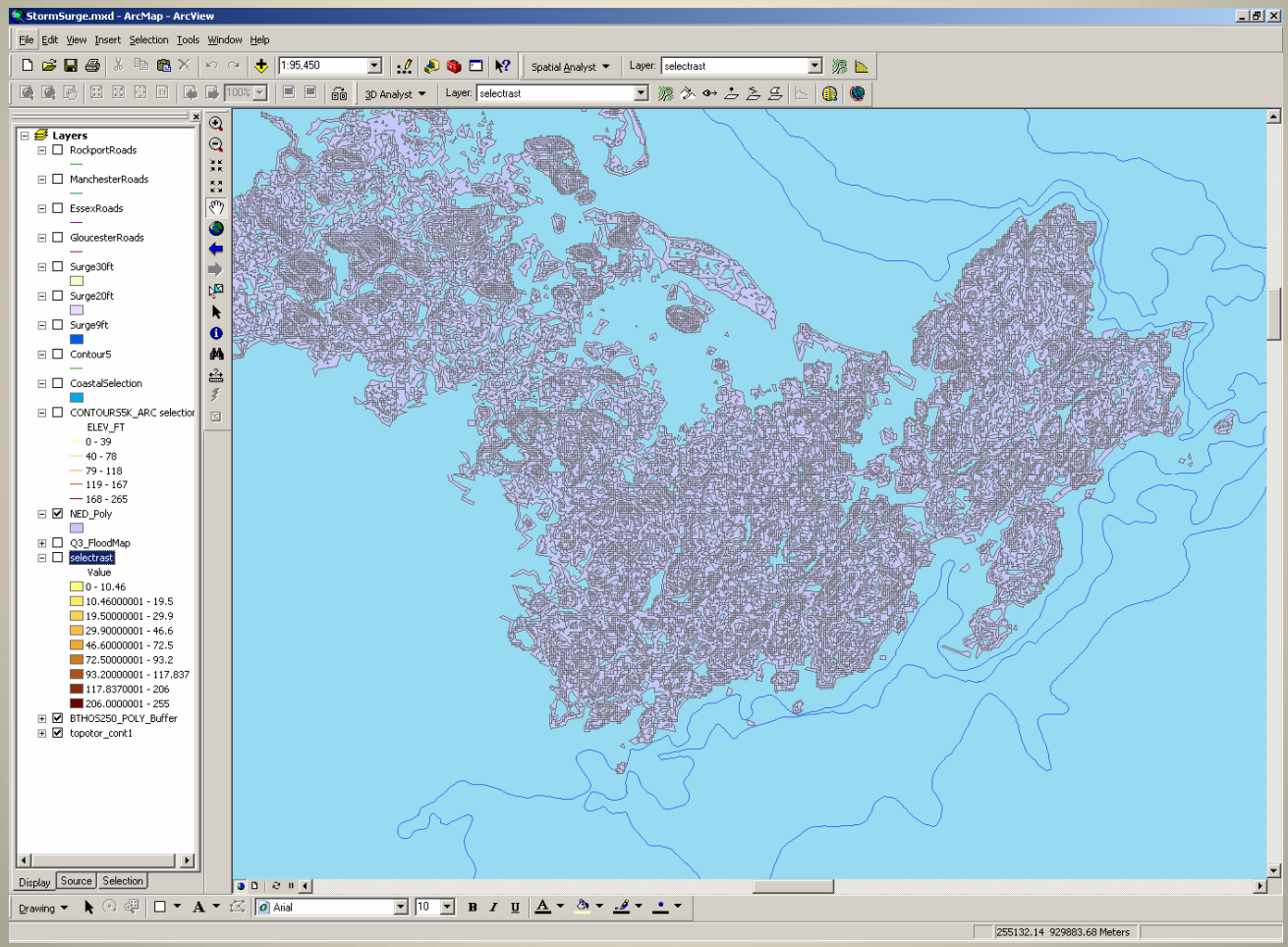
Vector Line Contour



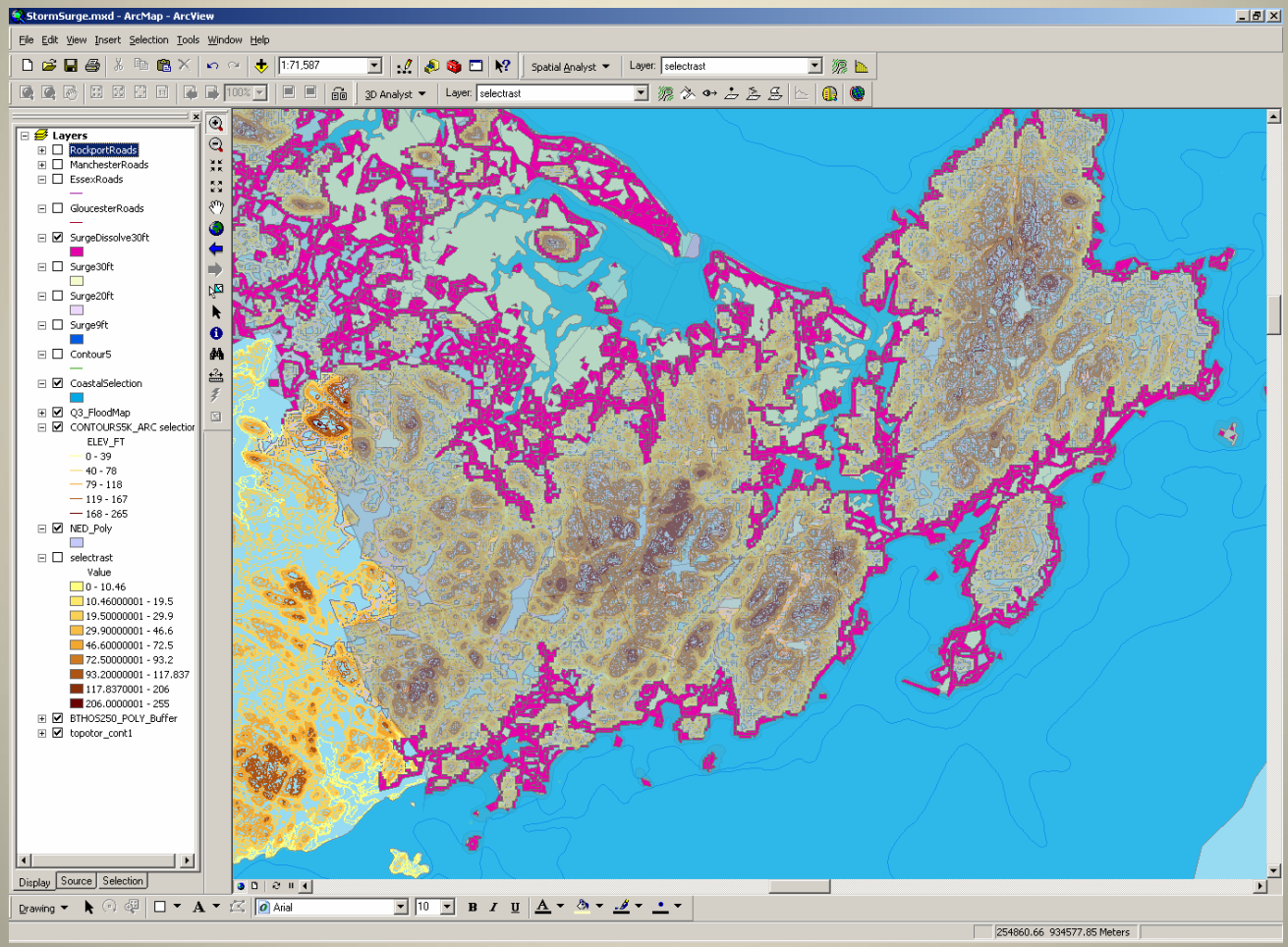
Raster Contour Created



Polygon Contour Created



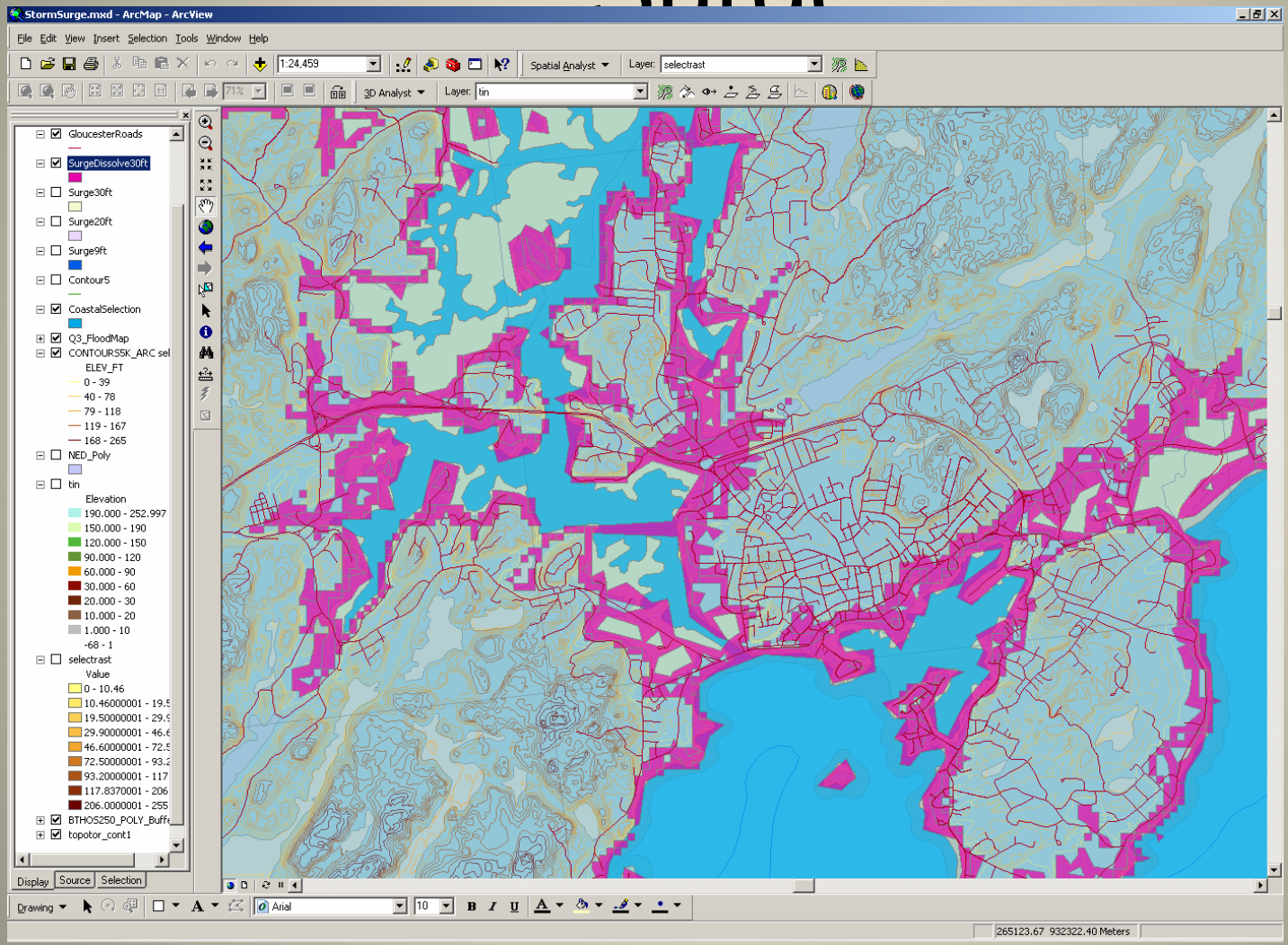
30 ft Polygon Storm-Surge



Possible Analysis with GIS

- The types of Analysis that can be performed on this GIS include:
- Identify roads affected at each storm-surge level.
- Identify public administration buildings effected by the surge
- Identify public safety buildings effected by the surge
- Identify evacuation routes off Cape Ann depending on storm-surge levels
- Identify Areas of Residential and commercial zoning effected by storm-surge
- Overlay storm-surge with FEMA Flood Maps to verify accuracy
- Identify Safety areas for future public building development outside of storm-surge zones
- Investigate the concept of environmental inequity from a coastal weather event on Cape Ann by using Census income data maps with storm-surge layers.

DownTown Gloucester Post Surge



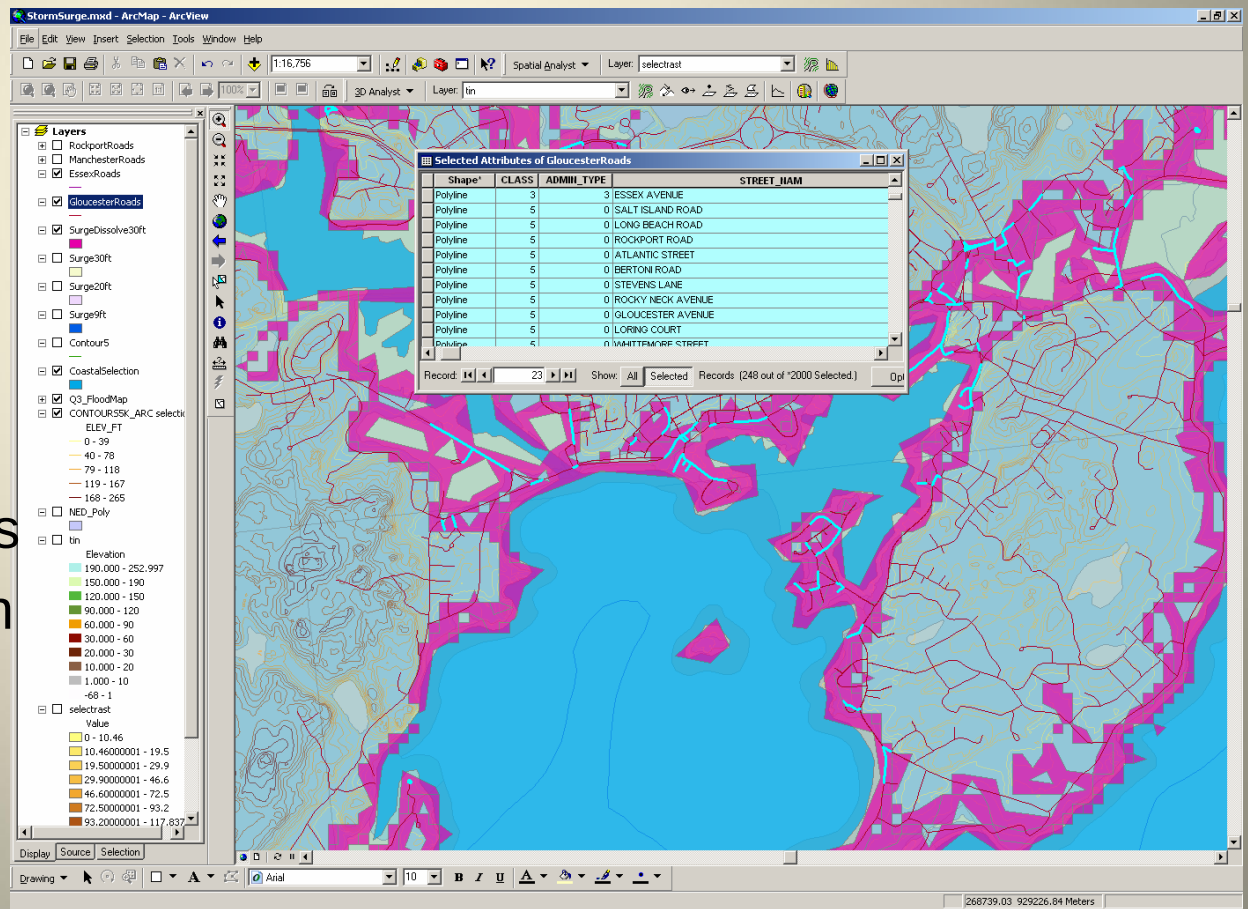
Identify Roads effected

- Perform selections based on location between roads layer and storm-surge layers.

- Completely within

- Intersect

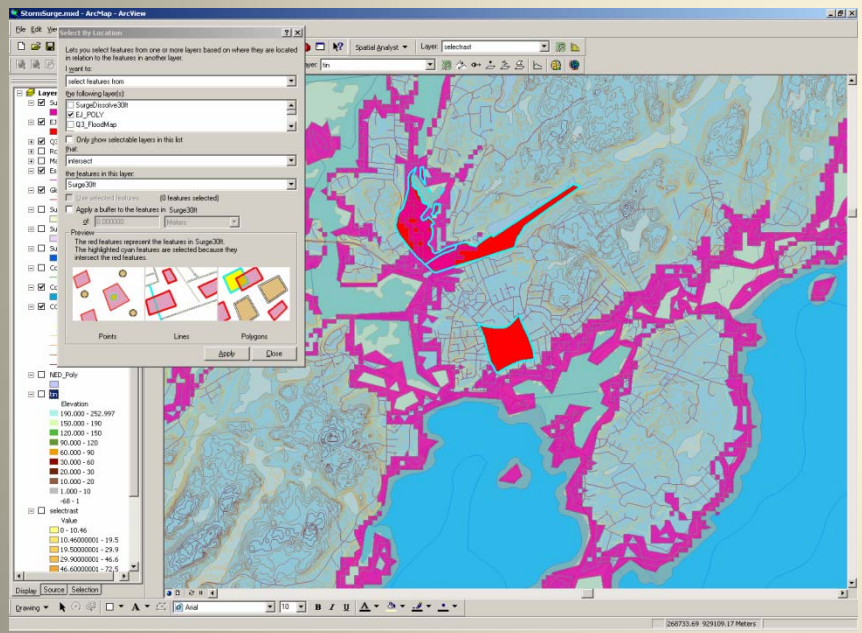
248 Gloucester roads
Are completely within
30ft surge



Environmental Justice/Equity From Coastal Event on Cape Ann

- Used **Environmental Justice Populations** poly layer from MA GIS, to find area's meeting the following criteria On Cape Ann.
  - Minority >=25%
  - -Income less than 30,515 per household
  - -Linguistic isolation
    - 1 are effected by 9ft surge, both affected by 30ft surge

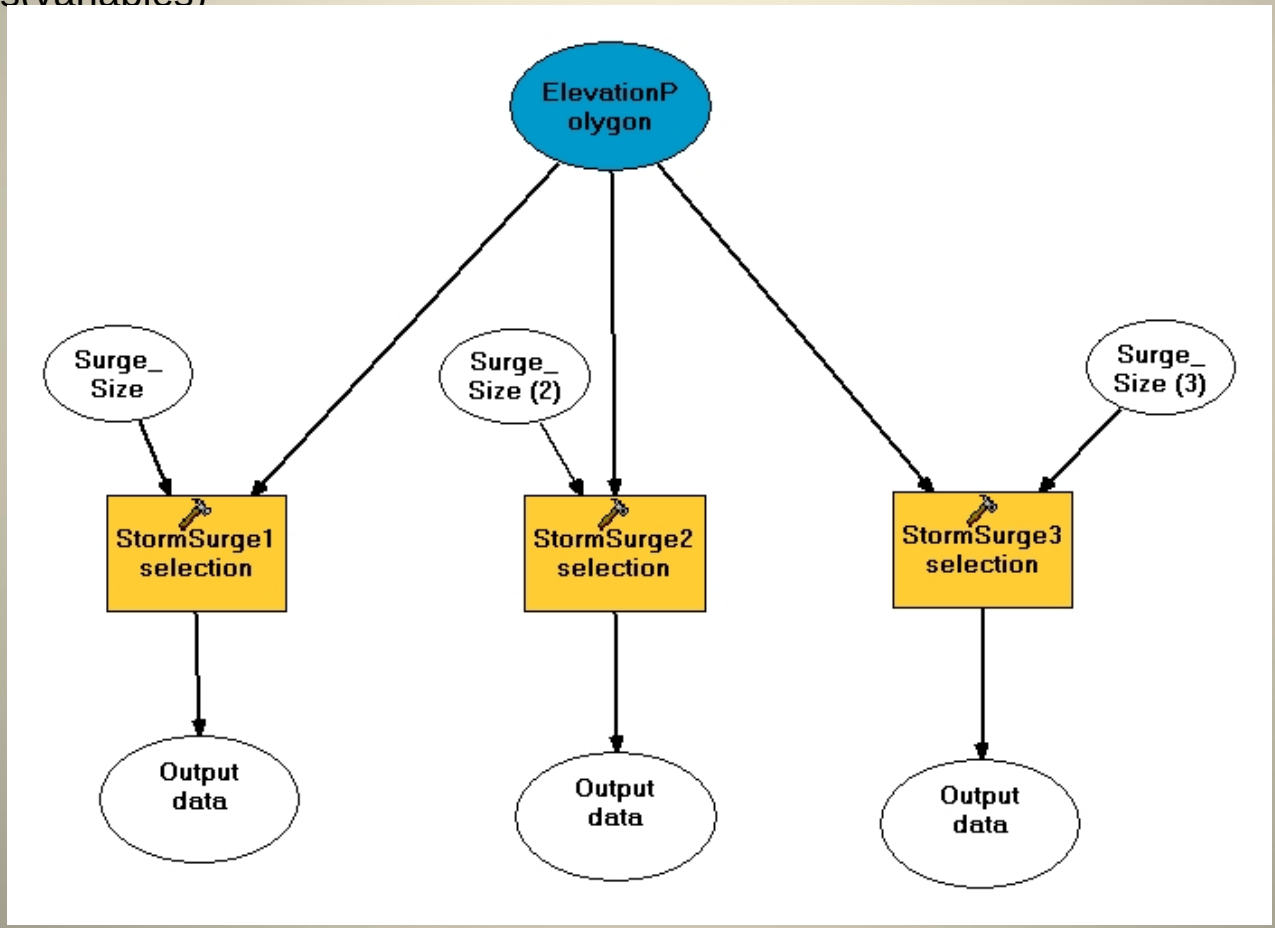
Environmental Justice Surge



- Area Effected
- 736,614 square meters
- Out of a total storm surge covering 52,551,936
- About 1.4% of total surge

Model Builder

- Created a reusable model to Select polygon areas based on different storm surge heights(variables)



Conclusion

- The key to developing this GIS was the use of geodatabases to effectively organize the data. And the use of the powerful conversion tools to convert between vector and raster data formats

- Project included
  - 2 Geodatabases
  - 4 Feature Sets
  - 16 spatial feature classes
  - 2 coded value domains
  - 1 range domain
  - 1 topology on the RoadsBuildings feature set
  - Metadata for 3 layers(created)
  - Raster dataset
  - A Model Builder Model for Surge Selection

ESRI ArcObjects And WebServices

- Wanted to make Storm surge data avaiable online.
- Use of ArcObjects to wrap my layers for creating a map viewer
- Built a prototype(in progress)

Web Services

```
<html>
<head>
   title>ArcWeb Explorer - using a custom Map Image Data Sources</title>
                <script type="text/javascript" src="http://www.arcwebservices.com/awx/awxapi-no-prototype-1.0.js"></script>
   <script type="text/javascript">

      //loads the ArcWeb Explorer SWF map
      function onBodyLoad()
      {

         AWUtils.insertMap("myMap", "948bcf0f264076d49f335f5f2d59066e",{glt:"mapImageGroupLayer", ds:"jmeuse:Surge30"});

      function onCreationComplete()
      {
         // creating an instance of AWMap
         var myExplorer = new AWMap("myMap");

         //setting the center and scale of the map
         var myLatLon = new AWLatLon(42.620000, -70.68);
         myExplorer.centerAndScale(myLatLon, 100000);
      }
   </script>
</head>
<body onLoad="onBodyLoad()">
<center>
   <!-- controls where the map will be loaded -->
   <div id="myMap" style="width:800px; height:600px;">You need at least <a href="http://www.adobe.com/shockwave/download/alternates/">Flash 8</a> to view this page.</div>
</center>
</body>
</html>
```