

# Creating a Bathymetric Database & Datum Conversion



**Mitchell Brown**

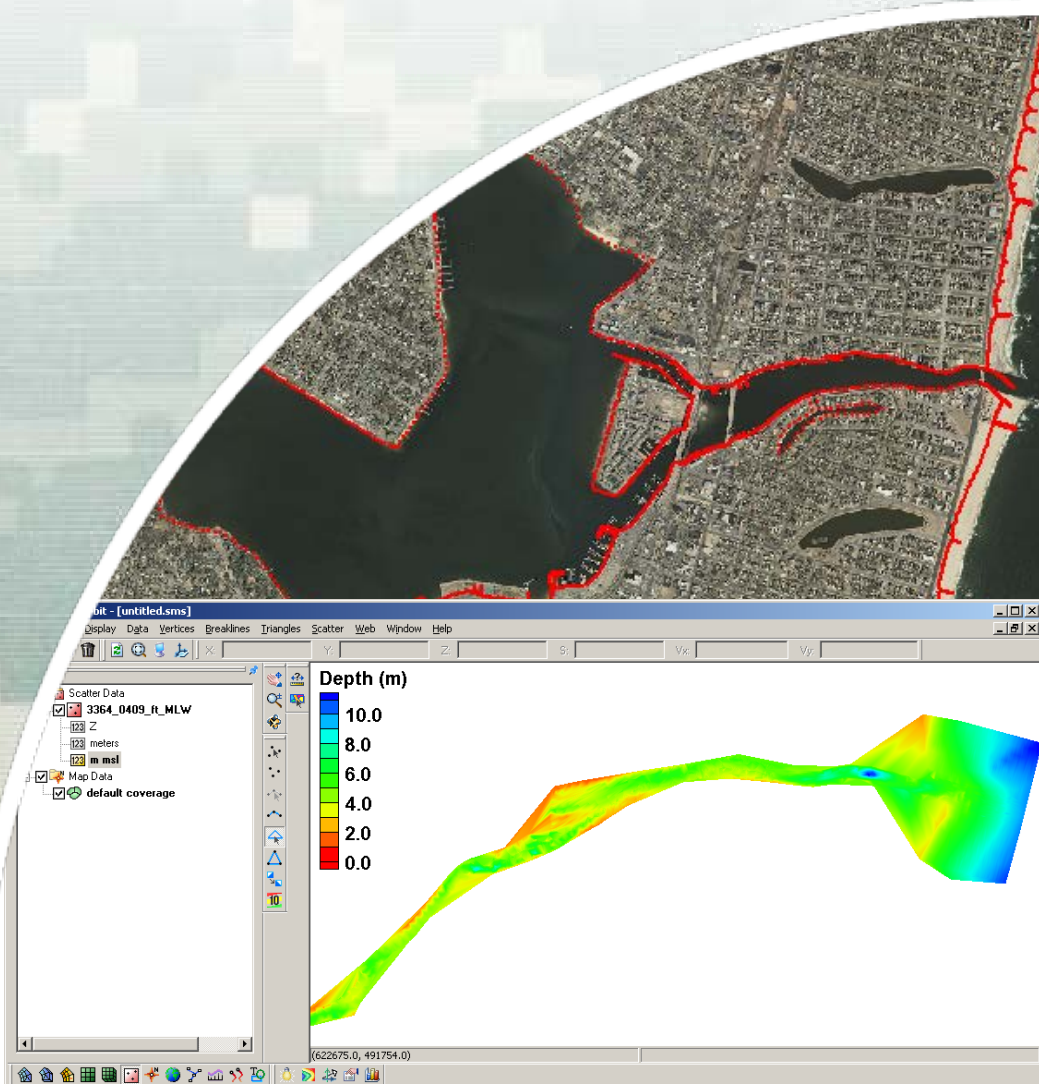
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June 11, 2012



US Army Corps of Engineers  
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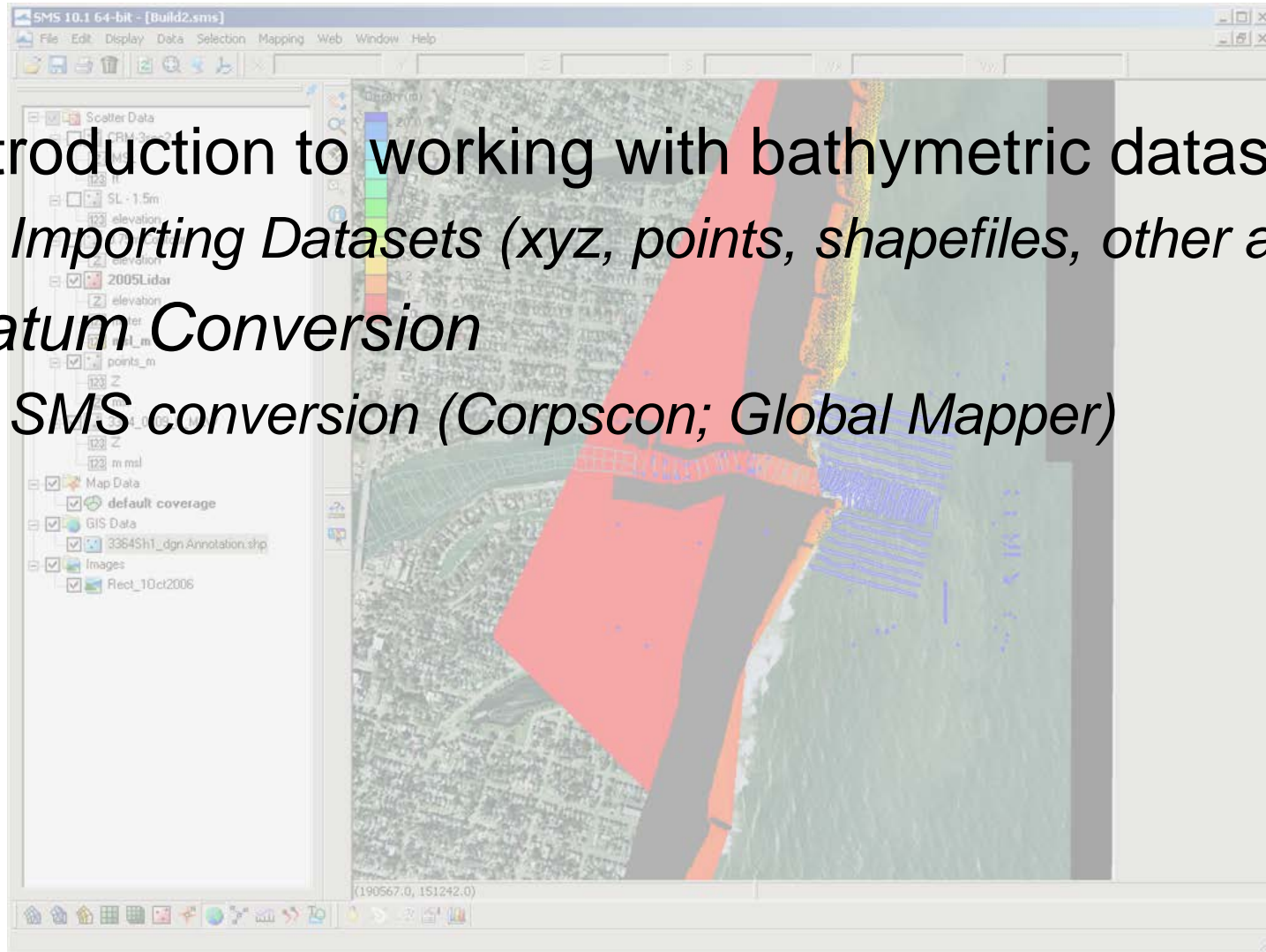




# Introduction to Bathymetric Databases in SMS



- Introduction to working with bathymetric datasets
  - ▶ *Importing Datasets (xyz, points, shapefiles, other ascii)*
- *Datum Conversion*
  - ▶ *SMS conversion (Corpscon; Global Mapper)*

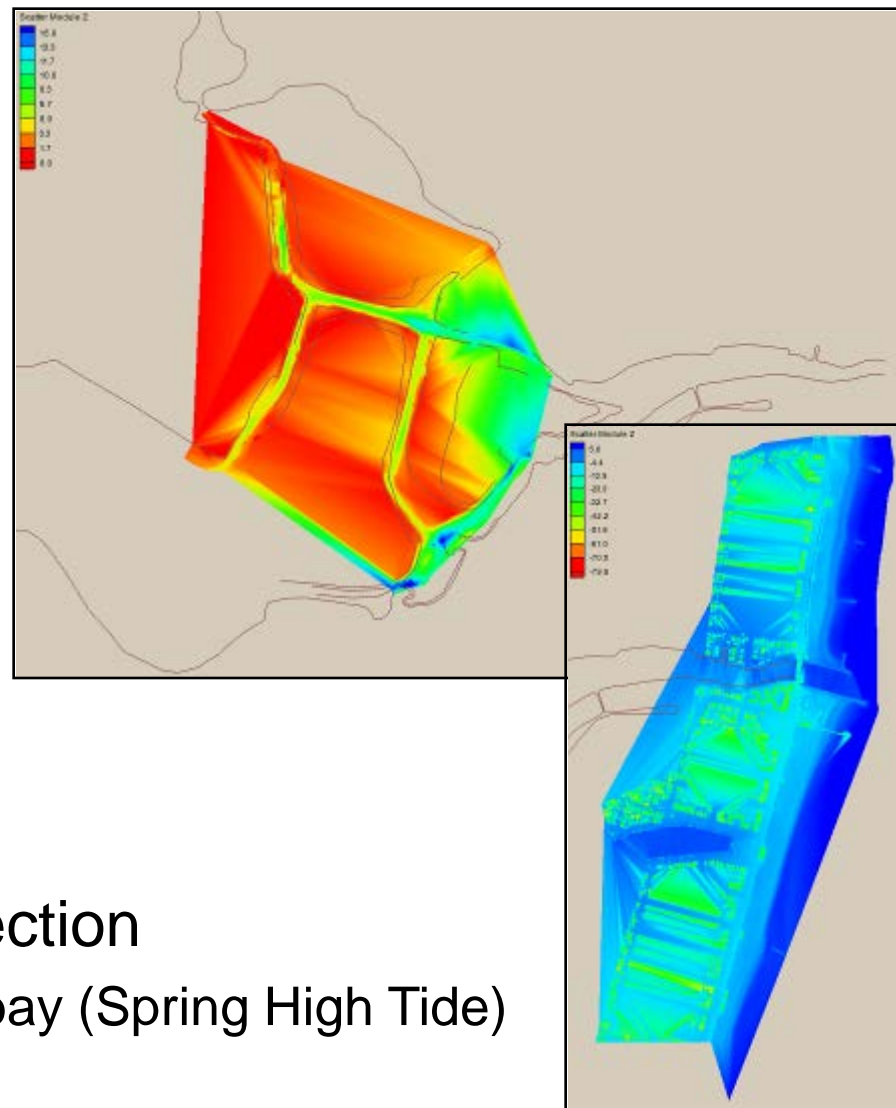




# Multiple Bathymetric Datasets

CIRP

- Limited bay bathymetry
- NOAA – Offshore datasets
- LIDAR – Shoreline and nearshore (important for structure resolution)
- Channel
  - ▶ NJ State maintains north channel and north bay channel
  - ▶ Federally maintained entrance and south channel (15 years)
- NAN-supported field data collection
  - ▶ Included bathymetry of the backbay (Spring High Tide)



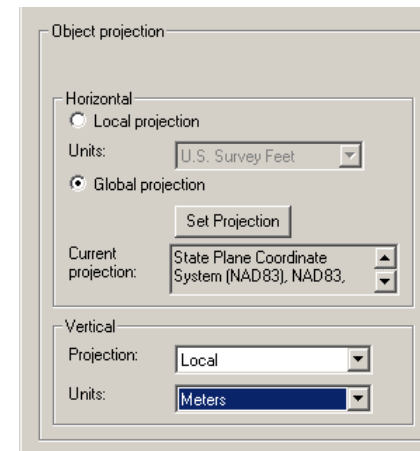
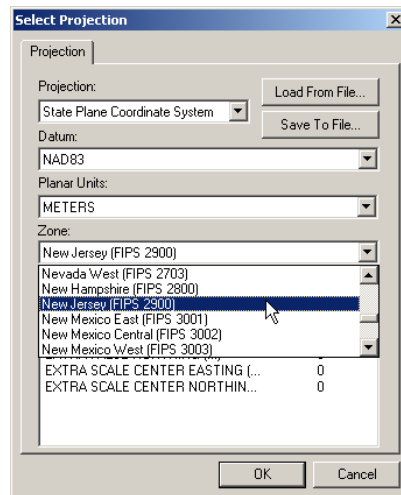
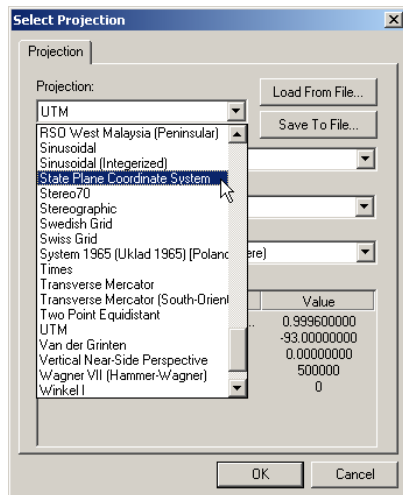


# Common Spatial Reference Datum & Vertical Datum



Horizontal Projection & Datum:  
Pick a system in metric units that is  
planar (UTM; State Plane)

Vertical Projection & Datum: Must  
be in metric as well; Datum is not  
necessary (Local)

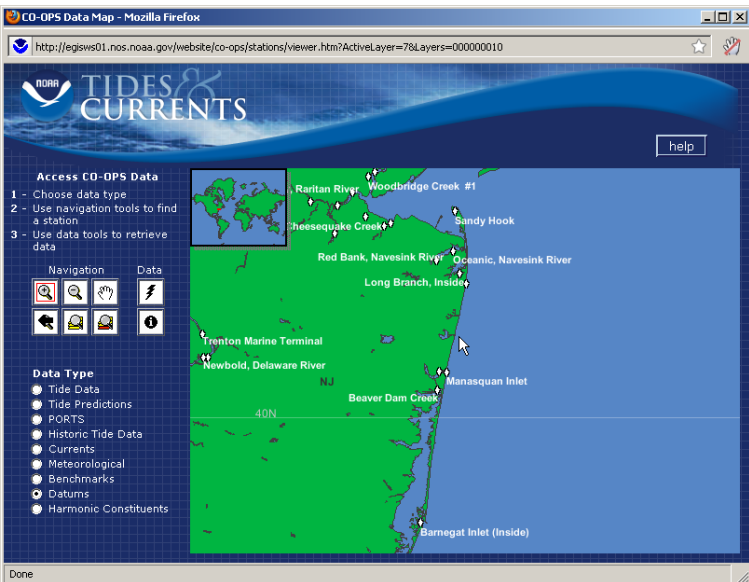


...Need to convert all bathymetric data



# Tides and Currents (NOAA)

CIRP



[http://tidesandcurrents.noaa.gov/station\\_retrieve.shtml?type=Datums](http://tidesandcurrents.noaa.gov/station_retrieve.shtml?type=Datums)

Aug 17 2011 14:07 GMT ELEVATIONS ON STATION DATUM  
National Ocean Service (NOAA)

Station: 8531991  
Name: LONG BRANCH, FISHING PIER, NJ  
Status: Accepted (Apr 17 2003)

T.M.: 75 W  
Units: Meters  
Epoch: 1983-2001  
Datum: STND

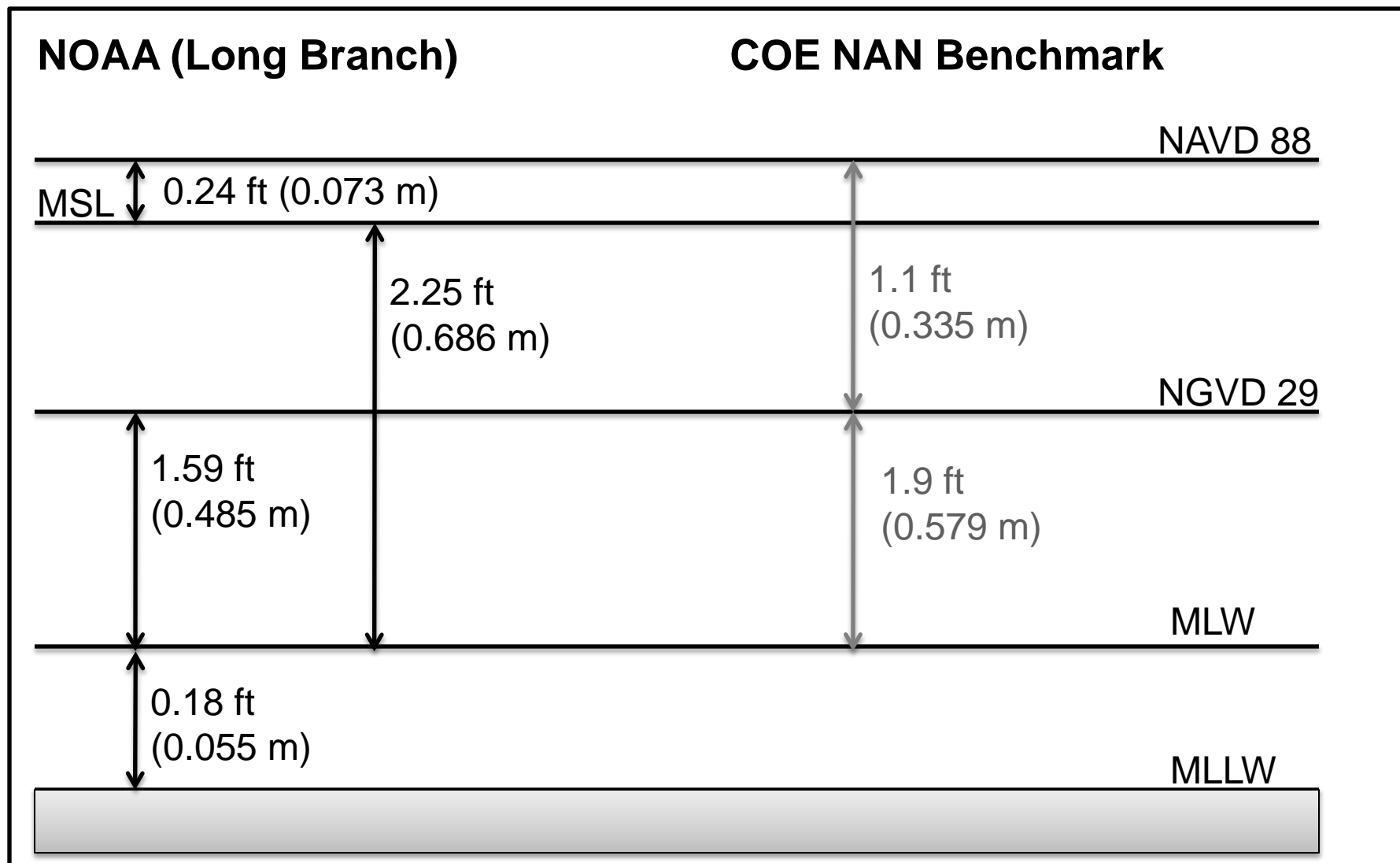
Datum	Value	Description
MHHW	7.294	Mean Higher-High Water
MHW	7.189	Mean High Water
NAVD88	6.609	North American Vertical Datum of 1988
DTL	6.542	Mean Diurnal Tide Level
MSL	6.534	Mean Sea Level
MTL	6.519	Mean Tide Level
MLW	5.848	Mean Low Water
MLLW	5.790	Mean Lower-Low Water
STND	0.000	Station Datum
GT	1.504	Great Diurnal Range
MN	1.341	Mean Range of Tide
DHQ	0.105	Mean Diurnal High Water Inequality
DLO	0.058	Mean Diurnal Low Water Inequality
HWI	12.26	Greenwich High Water Interval (in Hours)
LWI	6.04	Greenwich Low Water Interval (in Hours)

Maximum	8.269	Highest Observed Water Level
Max Date	19870102	Highest Observed Water Level Date
Max Time	09:12	Highest Observed Water Level Time
Minimum	4.389	Lowest Observed Water Level
Min Date	19780110	Lowest Observed Water Level Date
Min Time	21:00	Lowest Observed Water Level Time

Tidal Datum Analysis Period: 01/01/1979 - 12/31/1979  
01/01/1981 - 12/31/1986



# Vertical Datum Conversions







# Prep for the Coastal Modeling System



- Based off of a Cartesian grid
  - Planar coordinate system
  - Model computation is in metric and depths are positive from zero (elevations are flipped)
  - Grid is generated based off of a single bathymetry file stored in SMS scatterset file format
  - Vertical datum is not specified and is assumed local
    - The boundary condition forcing (tidal) must be in the same datum as the bathymetry
    - Typically modeling grids are brought to a mean datum such as mean sea level (msl) or mean tide level (mtl)
- → This requires that all datasets are brought in to unified projection, datum, and units
  - Shark River Inlet bathymetry will be converted to State Plane horizontal coordinates in meters with the vertical datum set to MSL in meters



# Reprojecting Coordinates and Changing Datums

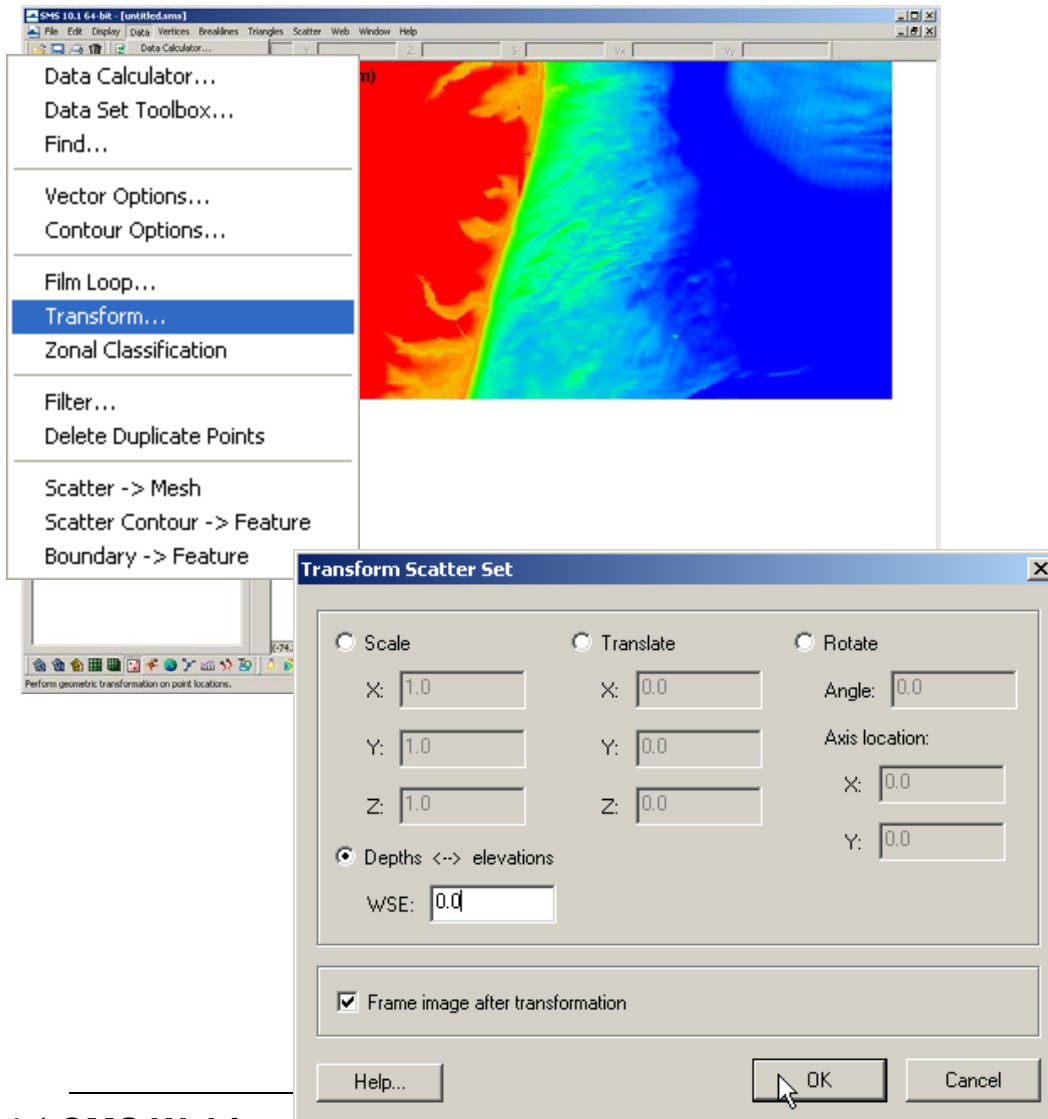


Object Projection tells SMS the present projection.  
Checking “Specify” Project Projection is used to change the projection.  
It will physically change the coordinates of everything loaded in SMS.  
The projection settings are saved in the SMS project file (\*.sms).





# Converting Elevations to Depths (CMS Requirement)



CMS uses Depths (**positive values are at the water surface and down deeper into the water column**) instead of Elevations (**positive values are at the water surface and above**)

- Data → Transform  
Can adjust scatterset data by scaling, translating (adding/subtracting), or rotating horizontal or vertical.
- Select Depths ↔ Elevations  
Flips negative elevations to positive depths. Necessary for CMS model calculation.

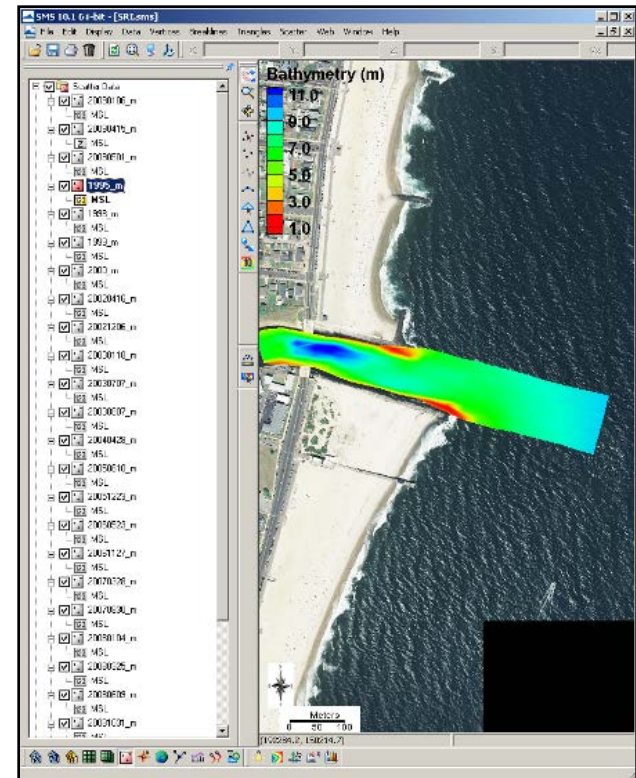


# NAN Channel Surveys



## 15 Year Record of Bathymetry

Date	Survey Type	Date	Survey Type
1-Jan-1995	Condition	28-Mar-2007	Condition
6-Jan-1998	Condition	30-Aug-2007	Before Dredge
6-May-1999	Condition	4-Jan-2008	After Dredge
11-Apr-2000	Condition	25-Mar-2008	Condition
16-Apr-2002	Condition	9-Jun-2008	After Dredge
6-Dec-2002	Before Dredge	31-Oct-2008	After Dredge
18-Jan-2003	After Dredge	8-Dec-2008	Before Dredge
7-Jul-2003	Condition	6-Jan-2009	After Dredge
7-Aug-2003	After Dredge	15-Apr-2009	Before Dredge
28-Apr-2004	Condition	1-May-2009	After Dredge
10-Jun-2005	Condition	20-Aug-2009	Before Dredge
23-Dec-2005	After Dredge	10-Dec-2009	After Dredge
23-May-2006	Condition	6-Jan-2010	After Dredge
27-Nov-2006	Condition		



Horizontal Datum:

State Plane NAD27 New Jersey 2900 (ft)

Vertical Datum:

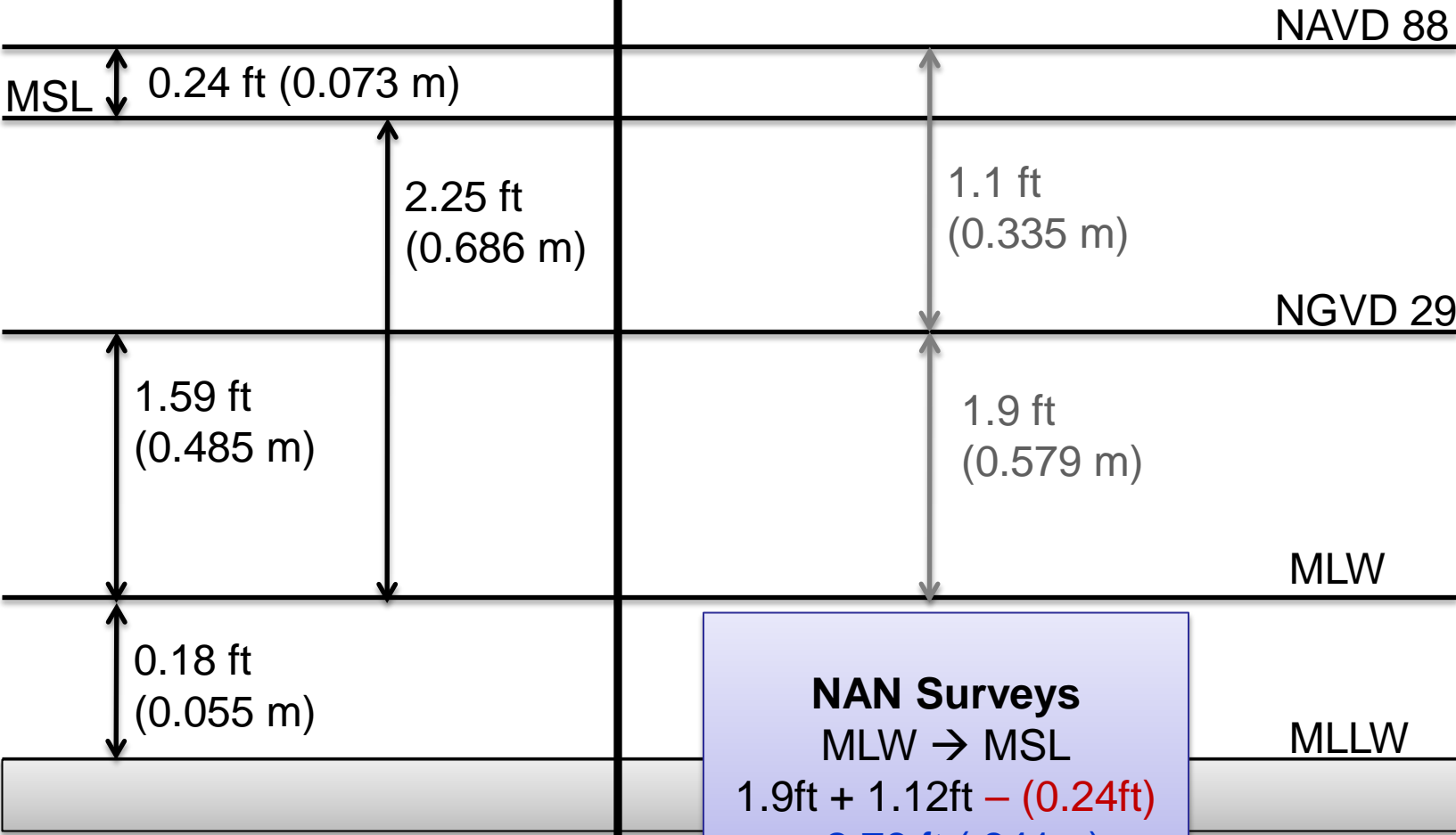
MLW (ft) – COE Datum (not local NOAA benchmark)



# Conversions

**NOAA (Long Branch)**

**COE NAN Benchmark**

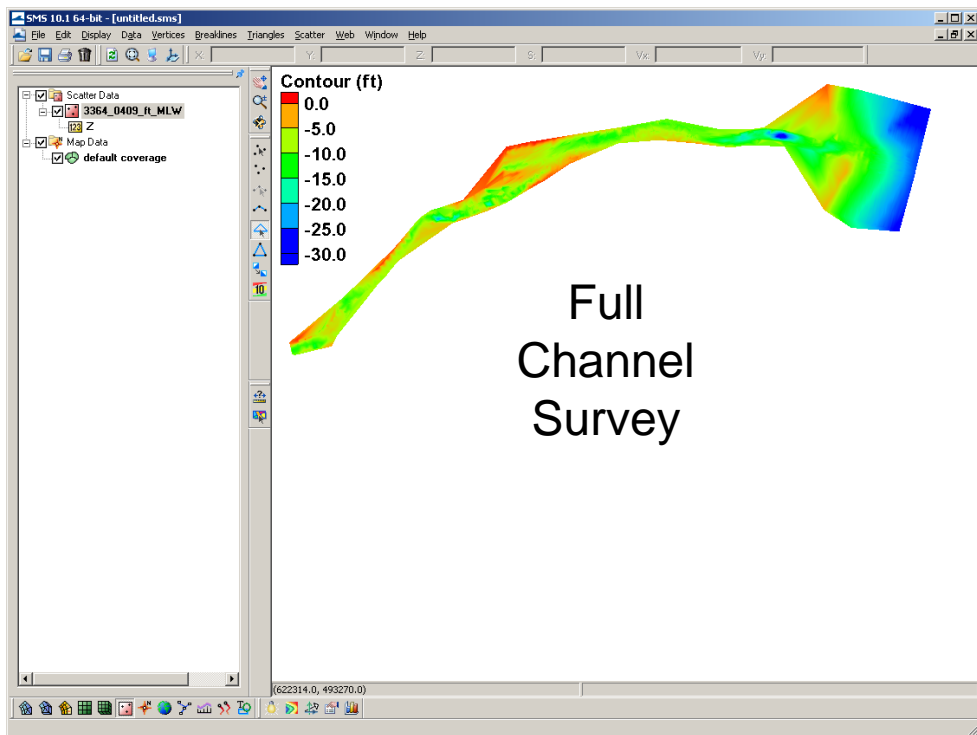


**NAN Surveys**  
MLW → MSL  
 $1.9\text{ft} + 1.12\text{ft} - (0.24\text{ft})$   
 $= 2.76\text{ ft } (.841\text{m})$



# NAN Channel Surveys Extended in to Bay

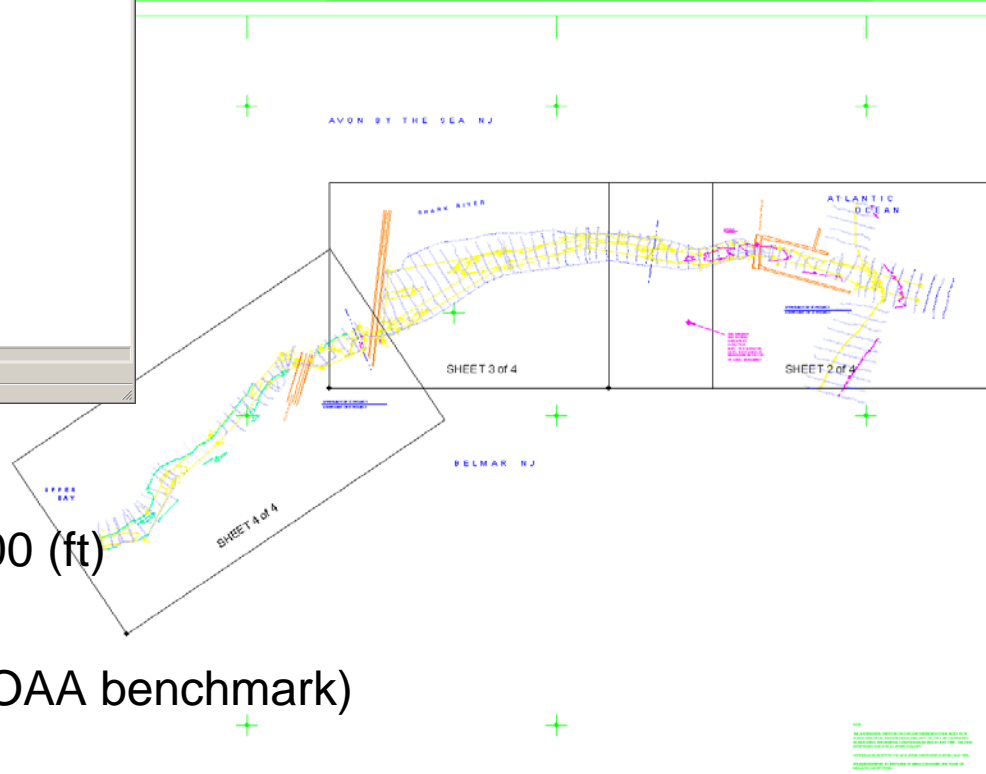
CIRP



## NAN Surveys

MLW → MSL

$$\frac{1.9\text{ft} + 1.12\text{ft} - (0.24\text{ft})}{= 2.76\text{ ft } (.841\text{m})}$$



Horizontal Datum:

State Plane NAD27 New Jersey 2900 (ft)

Vertical Datum:

MLW (ft) – COE Datum (not local NOAA benchmark)



# Dataset Calculator



The screenshot displays the 'Dataset Calculator' software interface. The main window is titled 'Dataset Calculator' and contains several panels:

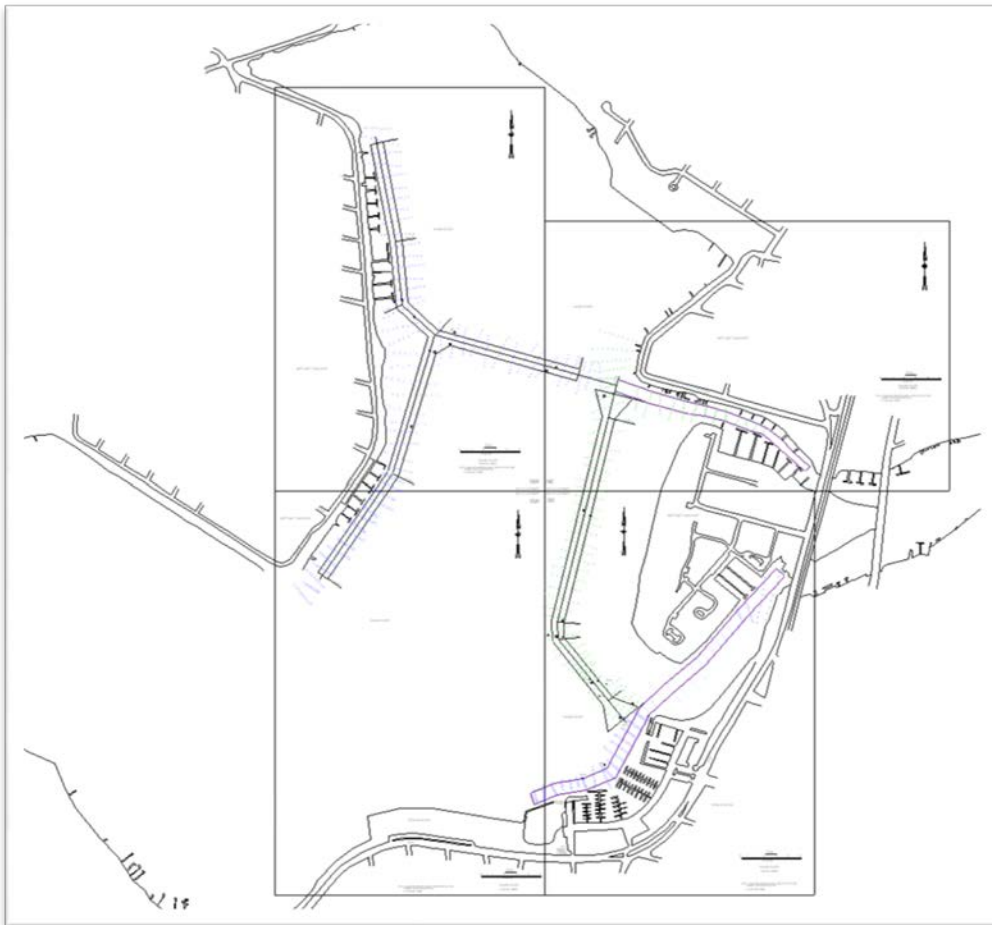
- Tools:** A list of tool categories including Math, Spatial, Temporal, Conversion, Coastal, and Modification. The 'Data Calculator' tool is highlighted.
- Data Sets:** A list of data sets, including '3364\_0409\_ft\_MLW (active)' and its components: 'a. Z', 'b. x location', 'c. y location', and 'd. meters'.
- Calculator:** A numeric keypad and a display showing the expression 'd+0.841'.
- Time Steps:** A panel showing a time range of '1, 0 00:00:00'.

The background shows a map of a coastal inlet with a color-coded elevation or depth scale ranging from 0.0 to 35.0 feet. The map is titled 'Contour (ft)' and includes a legend with values: 35.0, 29.2, 23.3, 17.5, 11.7, 5.8, and 0.0.

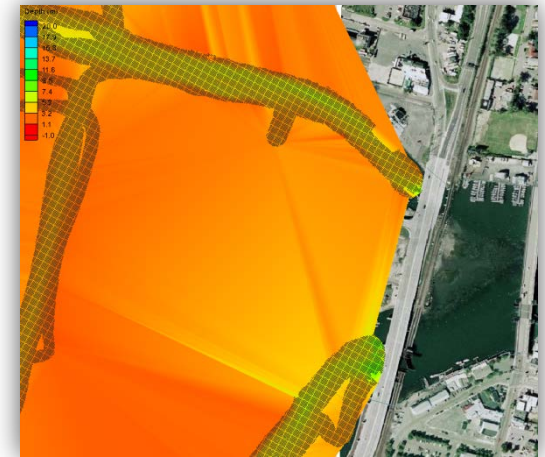


# NJ DEP Channel Surveys

CIRP



June 2009  
Survey



Provided conversion from local datum  
to NAVD88:

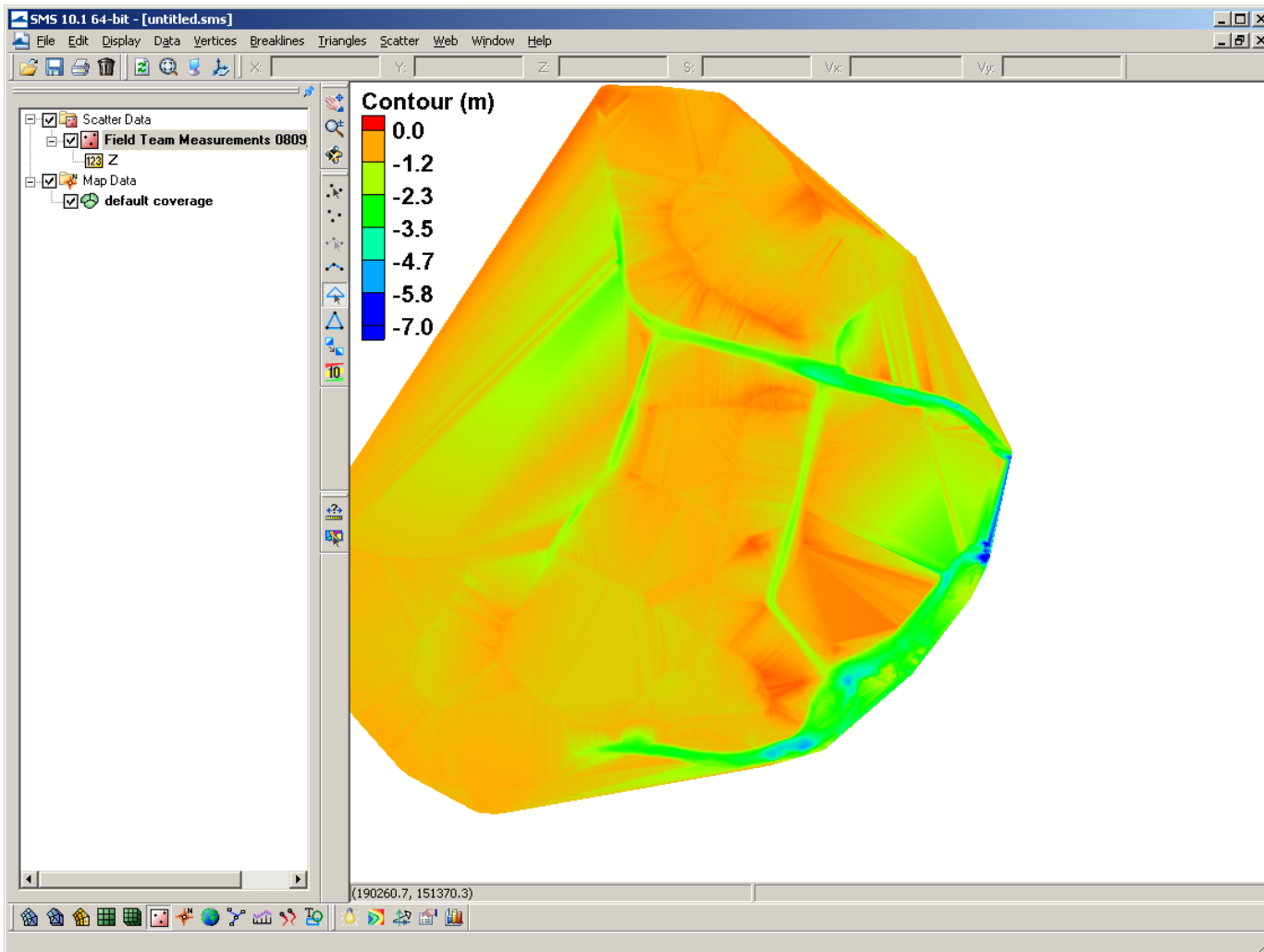
MLW → NAVD88  
+ 2.41 ft (0.735 m)

MLW → MSL  
+ 2.17 ft (0.661 m)

XYZ pulled out of drawing and  
changed to ascii format



# Field Data Collection – Multibeam Bay Bathymetry (August 2009)



Horizontal Datum:  
State Plane  
NAD83 New  
Jersey 2900 (m)  
Vertical Datum:  
NAVD88 (m)





# LIDAR

CIRP

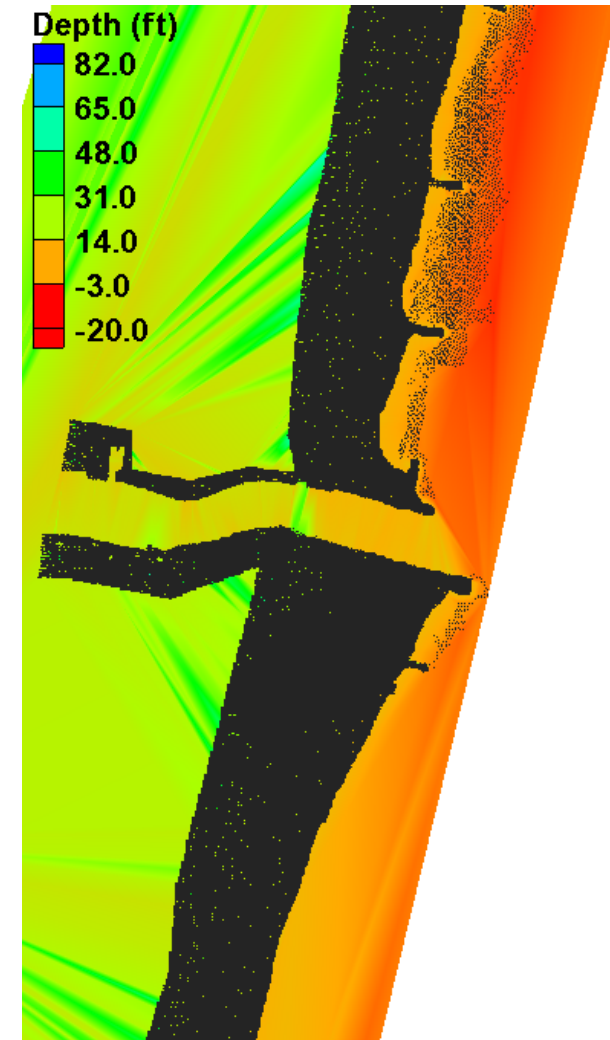
- Files are emailed in separate sections from the NOAA CSC Archive
  - Typically several to 10s of files that are 5 - 100 mb in size
- Compiling takes time
  - Points have been sampled/filtered and cropped to area of interest

Horizontal Datum:

State Plane NAD83 New Jersey 2900 (ft)

Vertical Datum:

NAVD88 (ft)





# Coastal Relief Model (DTM/DEM)

CIRP

Bathymetry & Global Relief | ngdc.noaa.gov

**NOAA NATIONAL GEOPHYSICAL DATA CENTER**  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NOAA > NESDIS > NGDC > MGGD > Marine Geology & Geophysics > Bathymetry & Relief

All MGG Coastal DEM Portal Fishing Global Lakes Multibeam NOS surveys

**Bathymetry & Global Relief**  
Scientific stewardship, products, and services for ocean depth data and derived digital elevation models

**Bathymetry (Ocean Depths)**

- Bathymetric & Fishing Maps
- Great Lakes
- IHO Data Center for Digital Bathymetry (IHO DCDB)
- International Ocean Mapping Projects
- Multibeam Data
- NOS Hydrographic Survey Data
- Satellite-derived Data
- Trackline Data

**Combined Bathymetry & Topography**

- Coastal Relief & Tsunami Inundation
- Coastlines & Coastline Extractor
- Digital Elevation Model (DEM) Discovery Portal
- Global Relief (ETOPO1, ETOPO2, ETOPO5)

**Topography (Land Elevations)**

- All Topography
- Global Land 1-km Base Elevation Project (GLOBE)
- U.S. State Images of 30-second Topographic Data
- Lidar Archive

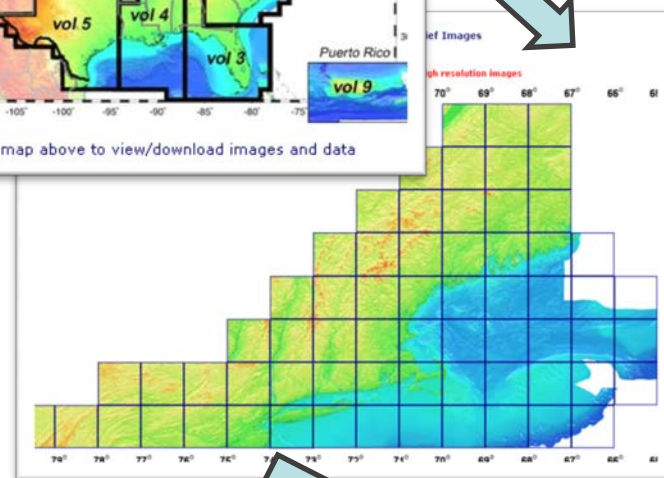
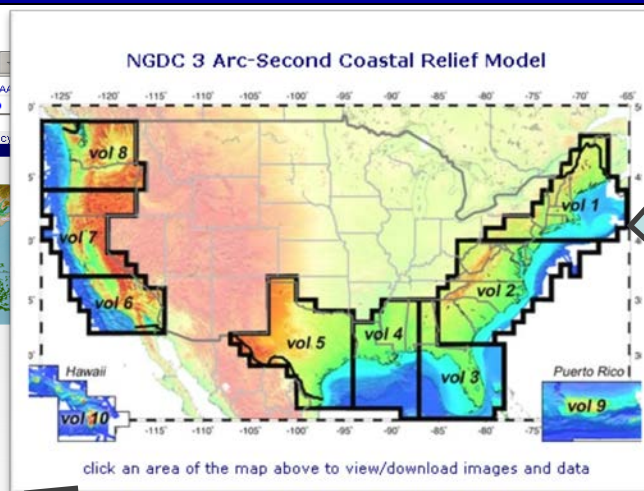
NGDC compiles, archives, and distributes bathymetric data from coastal and open ocean areas, including acting as the long-term archive for NOAA National Ocean Service (NOS) data collected in support of charting and navigation.

NGDC compiles the global **ETOPO1** 1-minute relief database, **coastal relief** models for US coastal areas, creates digital elevation models for **tsunami inundation** research, and stewards gridded topographic data from the **GLOBE** project.

NGDC participates in numerous international **ocean mapping** projects, and operates the International Hydrographic Organization (IHO) Data Center for Digital Bathymetry (**IHO DCDB**) on behalf of the member nations.

Questions: [dem.info@noaa.gov](mailto:dem.info@noaa.gov)

[NGDC Home](#) | [Contacts](#) | [Data](#) | [Disclaimers](#) | [Education](#) | [News](#) | [Privacy Policy](#) | [Site Map](#)



Generate a 3 sec  
(pt/3<sup>rd</sup> second) grid

GEODAS Grid Translator - Design-a-Grid

Windows | Macintosh | UNIX-C (Linux, BSD, etc.) | UNIX-B (Mac, etc.)

Reset | Submit | Your Grid ID: | Create a character identifier for Grid

Grid Database: | Create a character identifier for Grid

Grid Area in degrees and minutes: Upper Latitude: | Left Longitude: | Right Longitude: | Lower Latitude: |

Grid Cell Size: | Number of Latitude Cells: | Number of Longitude Cells: |

Grid Format: | Output Grid Header: |

Binary Header Format | ASCII Header | Space |

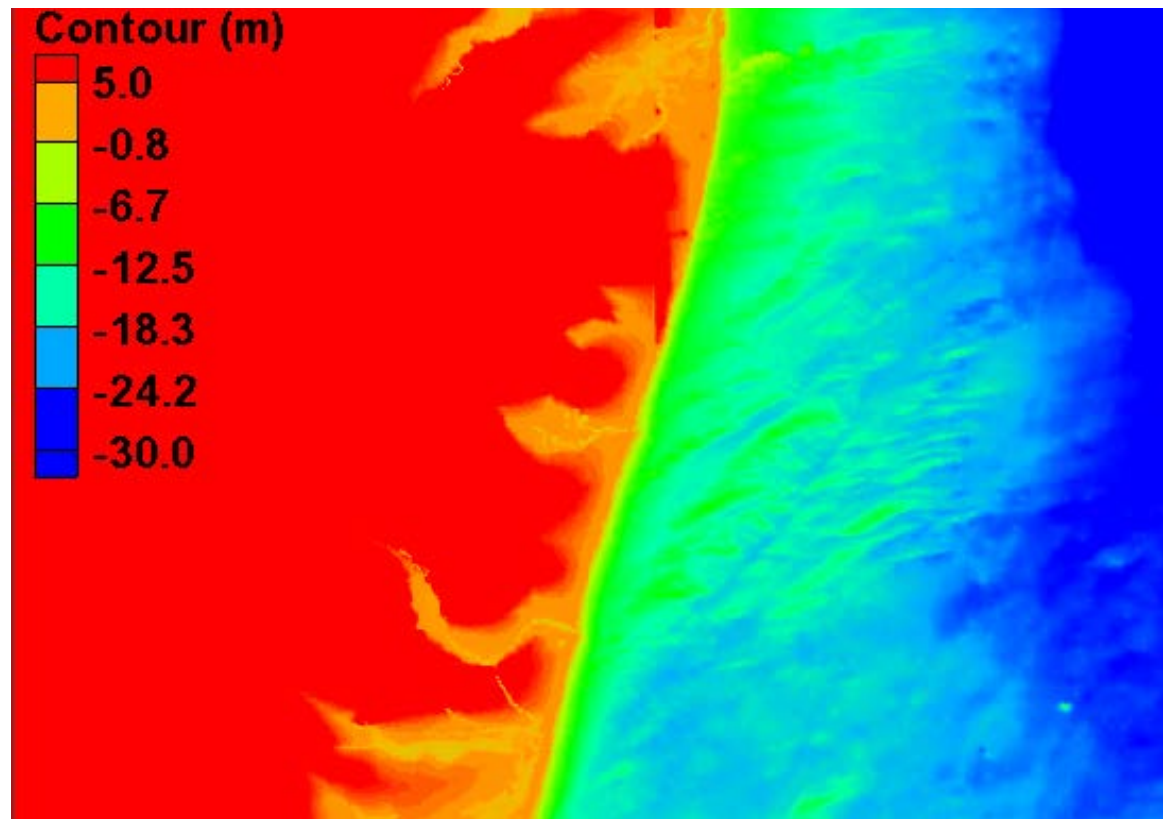
ASCII Header Format | No Header | Comma |

XYZ (lon,lat,depth) | Create Empty Grid Cells |

Balance of Image Fields



# Coastal Relief Model



Horizontal Datum:

Geographic NAD83

Vertical Datum:

MSL (m) – Not accurate for shallow bathymetry (used for offshore)





# Extra Bathymetry



- Convert shoreline shapefile in SMS

Horizontal Datum:

State Plane NAD83  
New Jersey 2900 (ft)

- Added extra bay contour (set to -0.75 m)



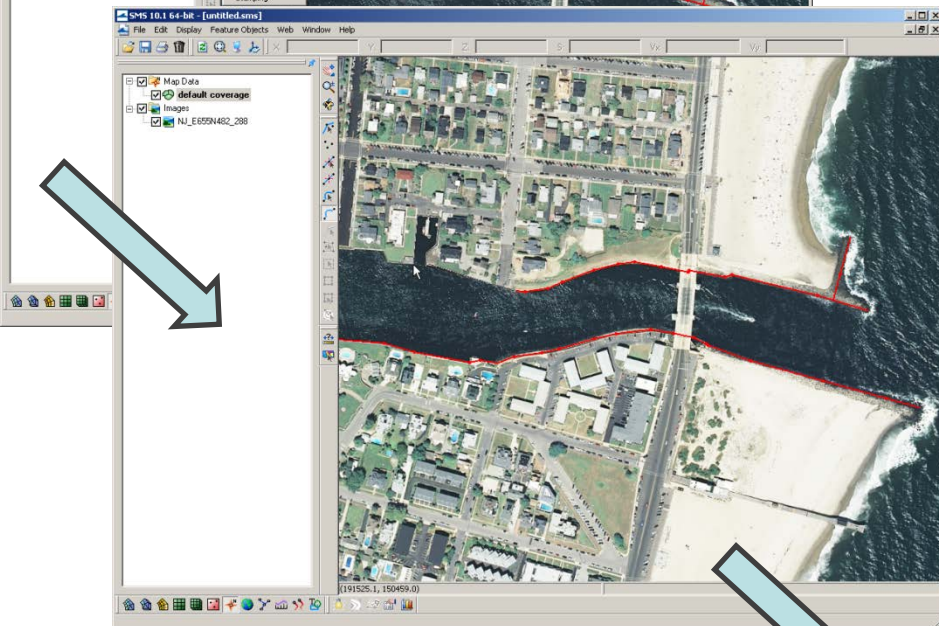


# Create a Contour Polyline in the Map Module

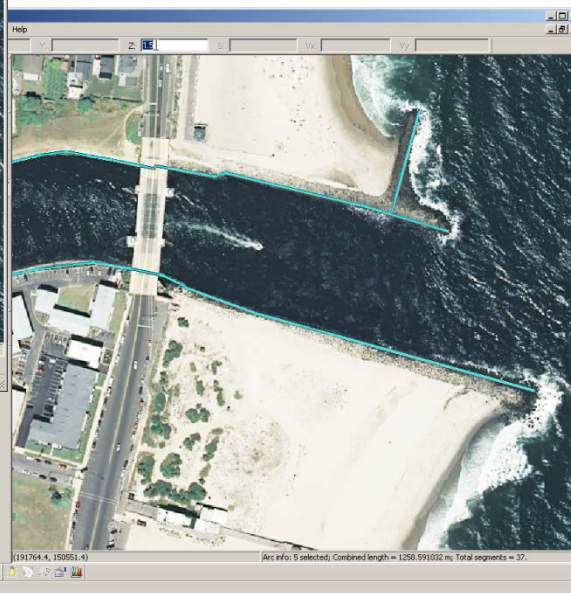
CIRP




Select Default Coverage under Map Data  
Type → Generic → Mapping/Observation/Shoals



Draw arcs (polylines) feature  
with  tool



Select arcs   
and convert the z  
elevation to the  
desired contour  
elevation

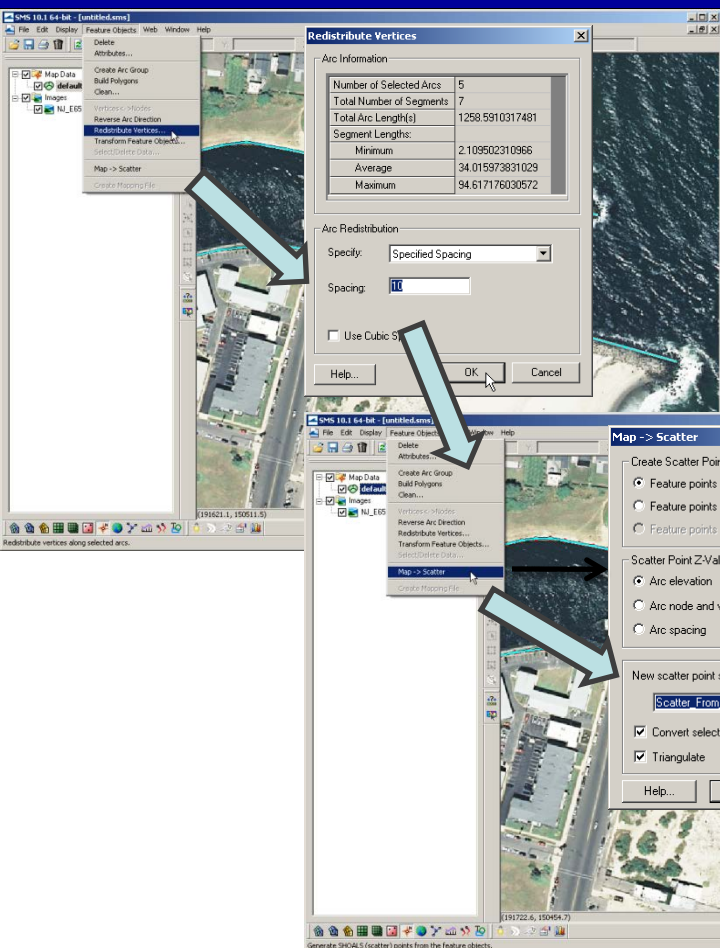




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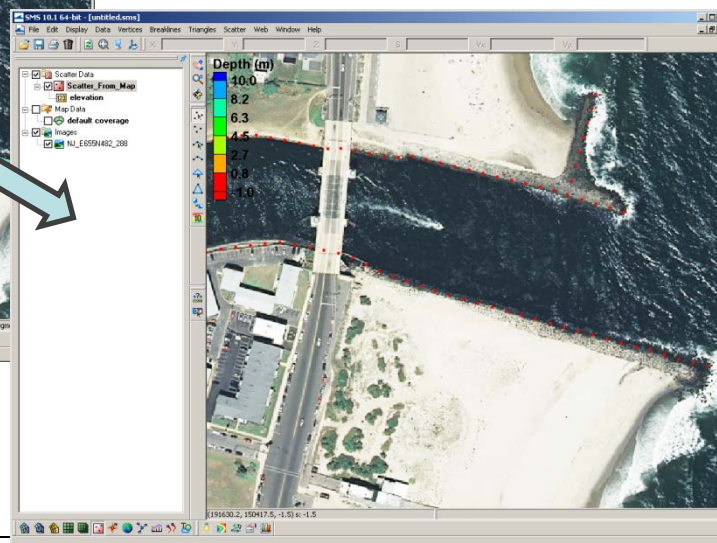
# Create Scatterset Points from Map Data

CIRP



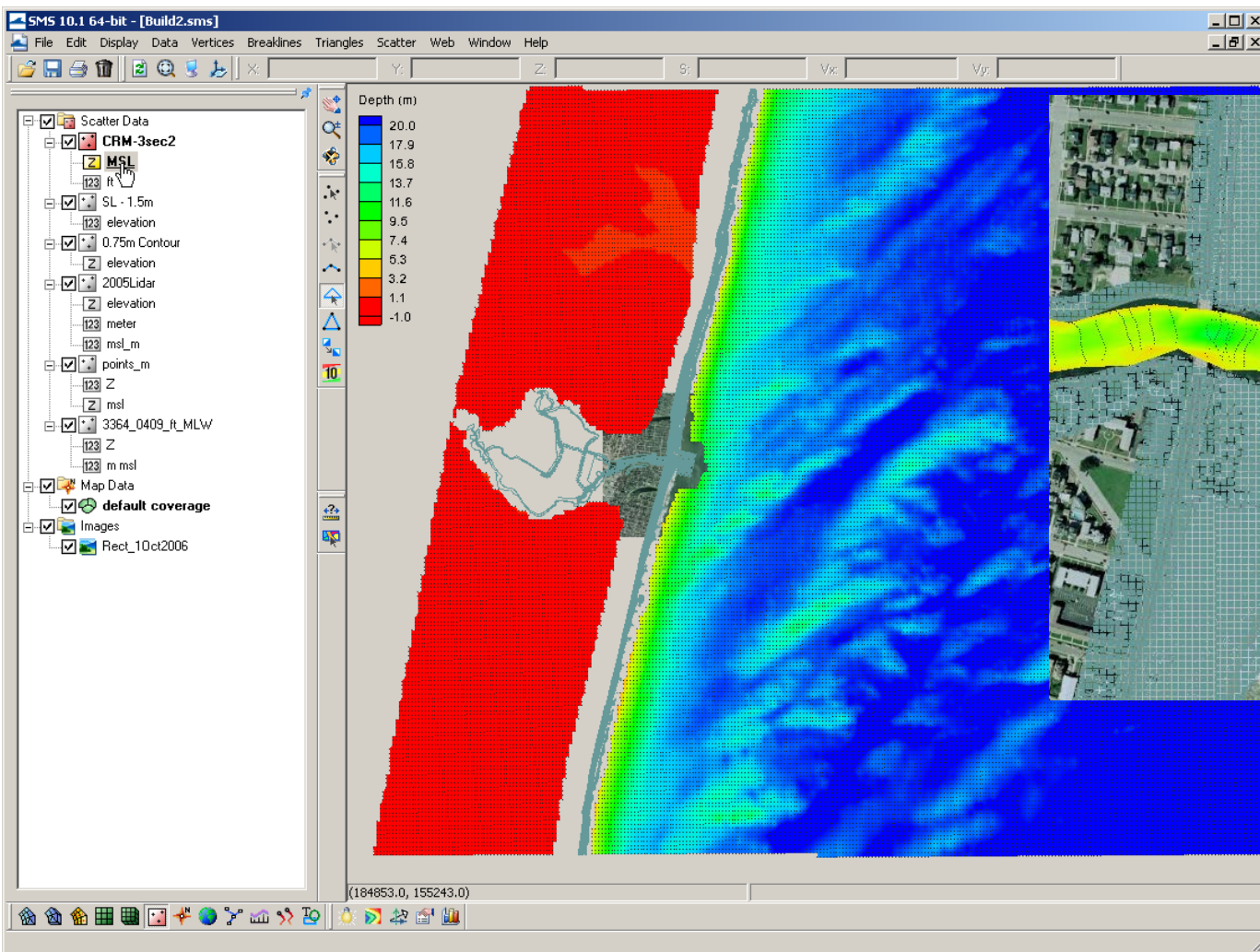
Select arcs to redistribute the spacing of vertices  
Feature Objects → Redistribute Vertices  
Specify Spacing based on horizontal coordinate system units (metric in this case)

Feature Objects → Map>Scatter  
Include Feature Pts and vertices and the Arc Elevations





# All Files Referenced to Same Horizontal and Vertical Datum



Delete unnecessary data points (check alignment and elevations in overlapping datasets)





# Merging Scattersets

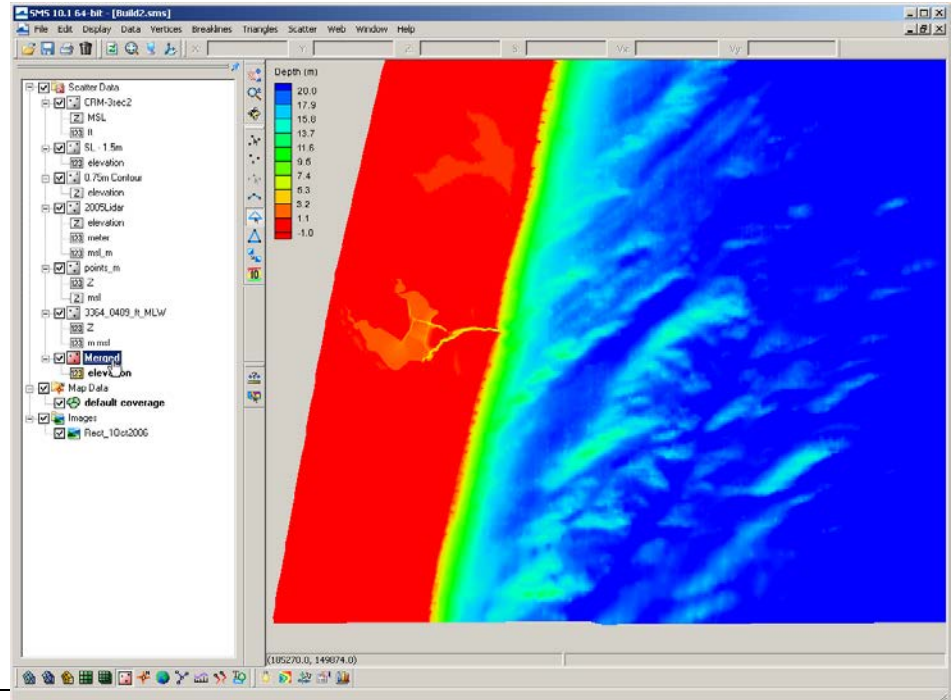
Merging all scattersets will integrate all points. Overlapping areas of scattersets should either be deleted, or use a separate method of merging (by prioritizing using triangles).

Priority	Scatterset	Merge	Dataset
1	CRM-3sec2	<input checked="" type="checkbox"/>	MSL
2	SL - 1.5m	<input checked="" type="checkbox"/>	elevation
3	0.75m Contour	<input checked="" type="checkbox"/>	elevation
4	2005Lidar	<input checked="" type="checkbox"/>	m sl_m
5	points_m	<input checked="" type="checkbox"/>	m sl
6	3364_0409_ft_MLW	<input checked="" type="checkbox"/>	m msl

Merged scatter set options:  
Name: Merged  
☐ Delete original scatter sets

Overlapping region options:  
☒ Merge all scatter points  
☐ Delete lower priority scatter points  
☒ Maintain triangulation

Select the dataset





## Questions?

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