

Lessons Learned from Implementing an Enterprise GIS solution for Cross-Country Pipeline Routing

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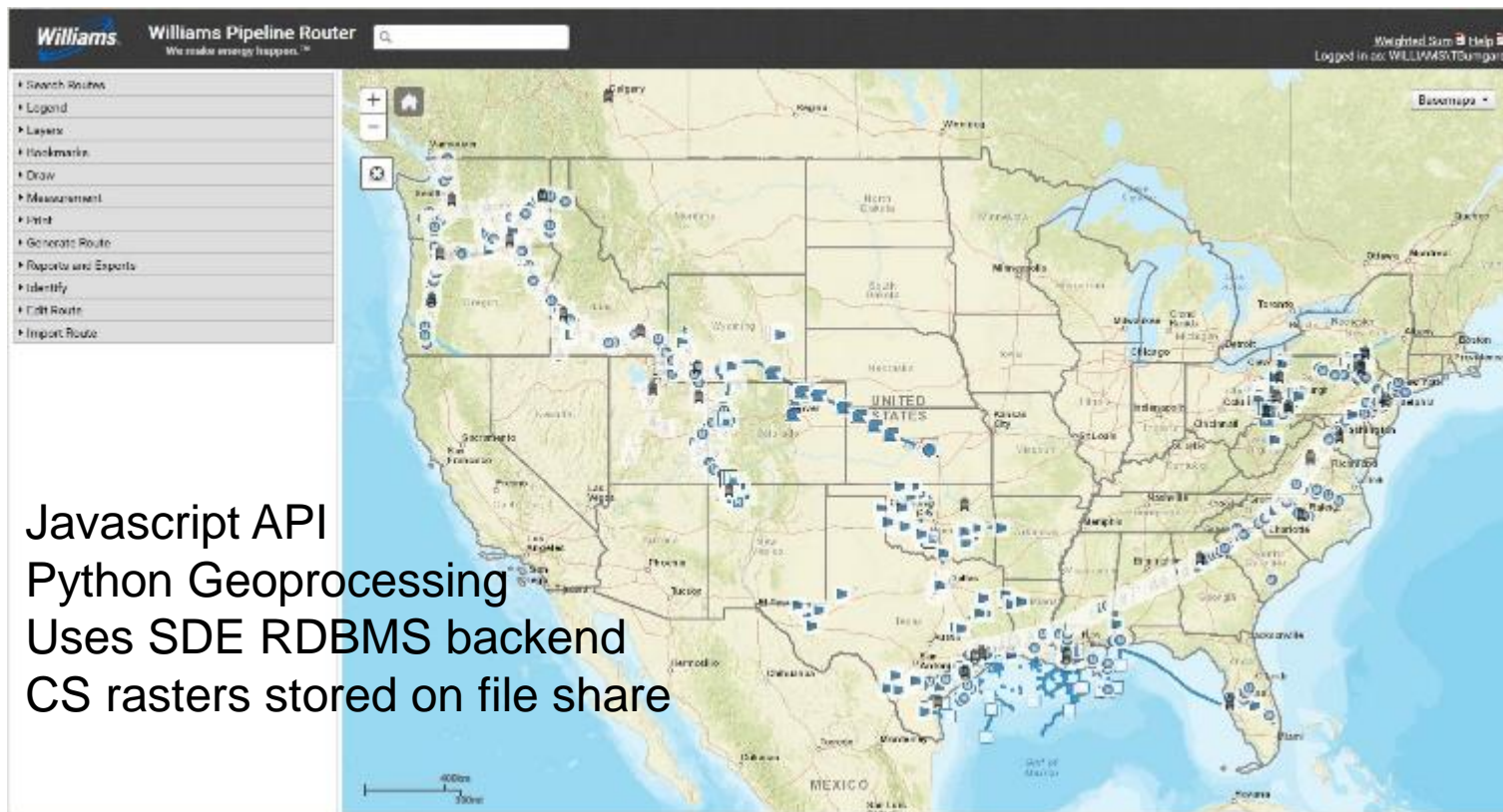
#1 IN ENERGY: U.S.

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What is Pipeline Routing at Williams?

- > GIS Web app accepting way points, input criteria and weightings that automates a least cost path or pipeline route across cost surface rasters.

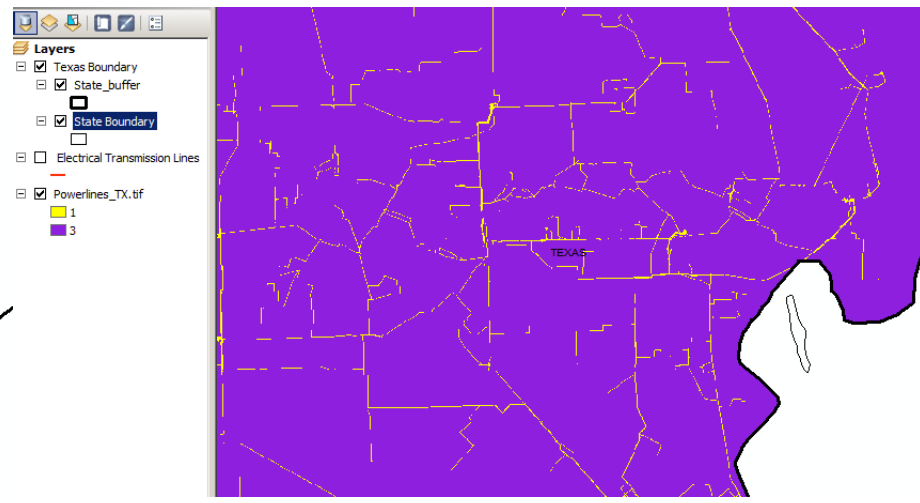
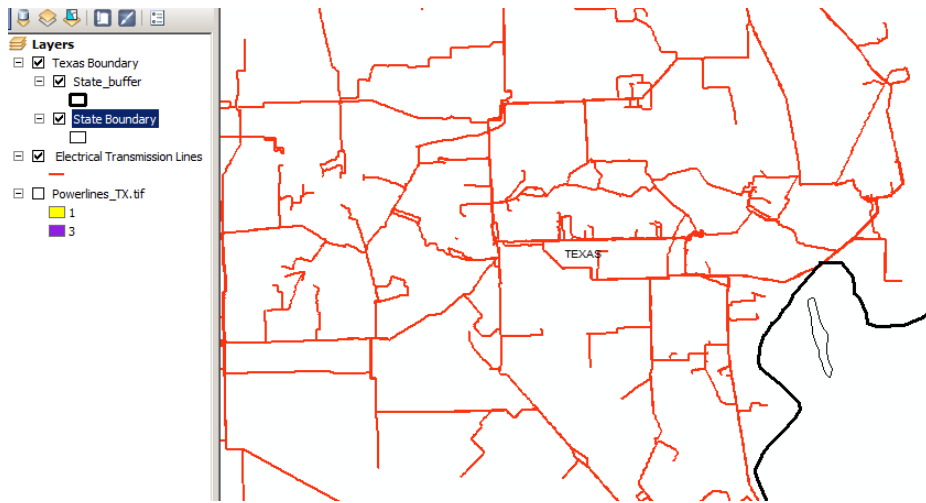


- Javascript API
- Python Geoprocessing
- Uses SDE RDBMS backend
- CS rasters stored on file share

What are Cost Surfaces?

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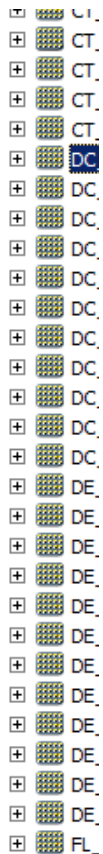
- Criteria rasters that are created from input GIS data where raster cells are given numeric values based on the input data geometry and/or attributes.
- Example below is Powerlines:
 - TX Powerlines use 20 ft. buffer
 - Assign 1 to lines with KV=> 69 and a
 - Assign 3 to other lines (and other areas in the state.)



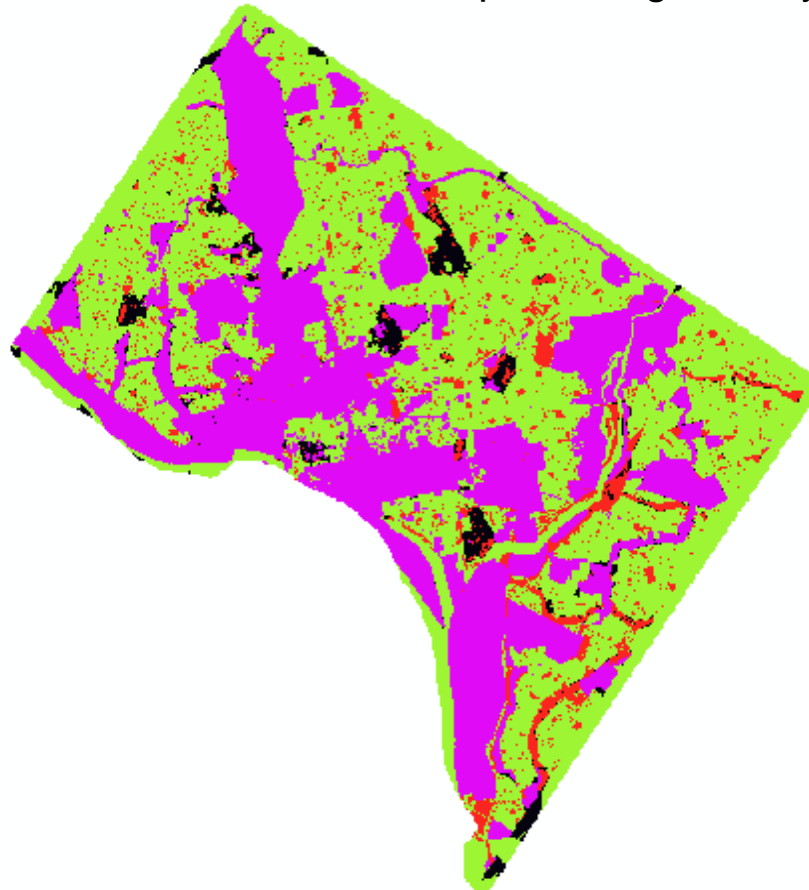
What are Cost Surfaces?

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Specifically, Criteria rasters that are created from input GIS data where raster cells are given numeric values based on the input data geometry and/or attributes.



DC

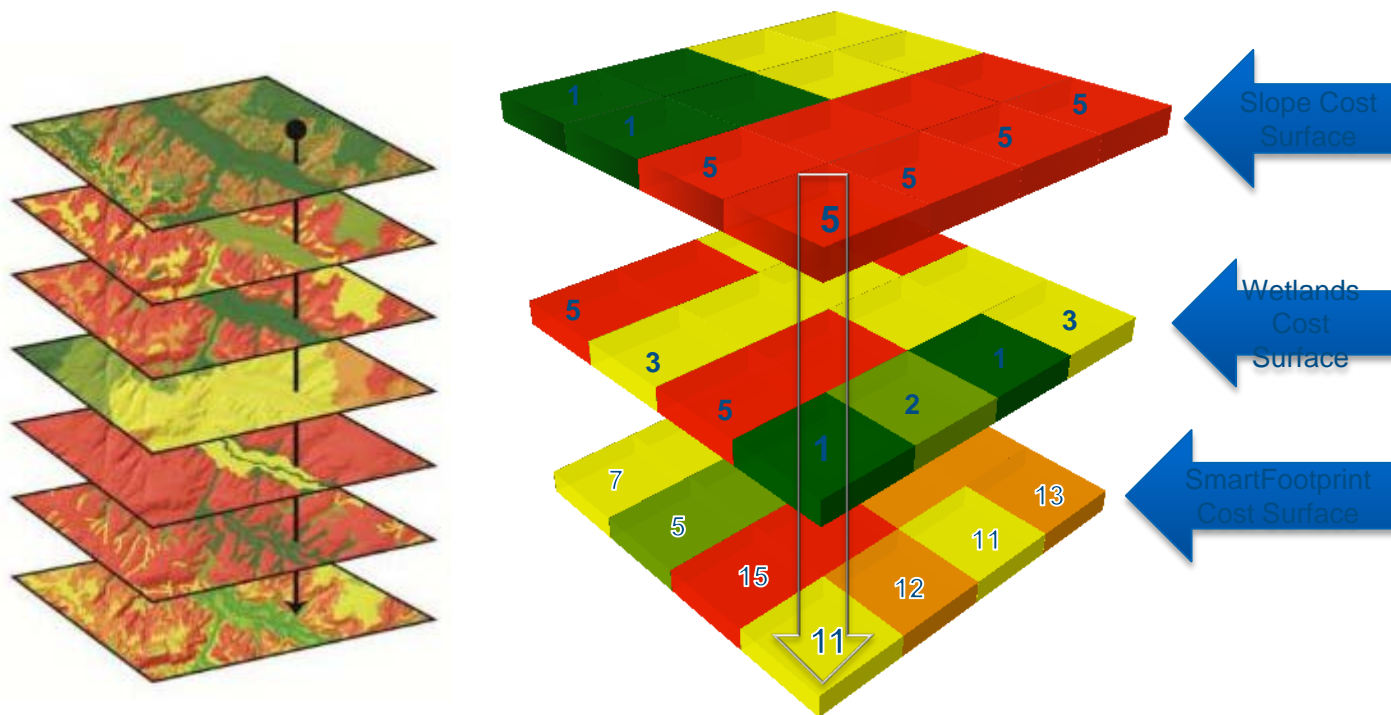


Possible Cost Surfaces Per State

DwellingDensity
 HCA
 Hydrology
 LandOwner
 Lease
 Mining
 Parcels
 Pipelines
 Powerlines
 ProposedWellProximity
 ProtectedLands
 ROW
 SideSlope
 Slope
 SurficialGeology
 Transportation
 Wetlands

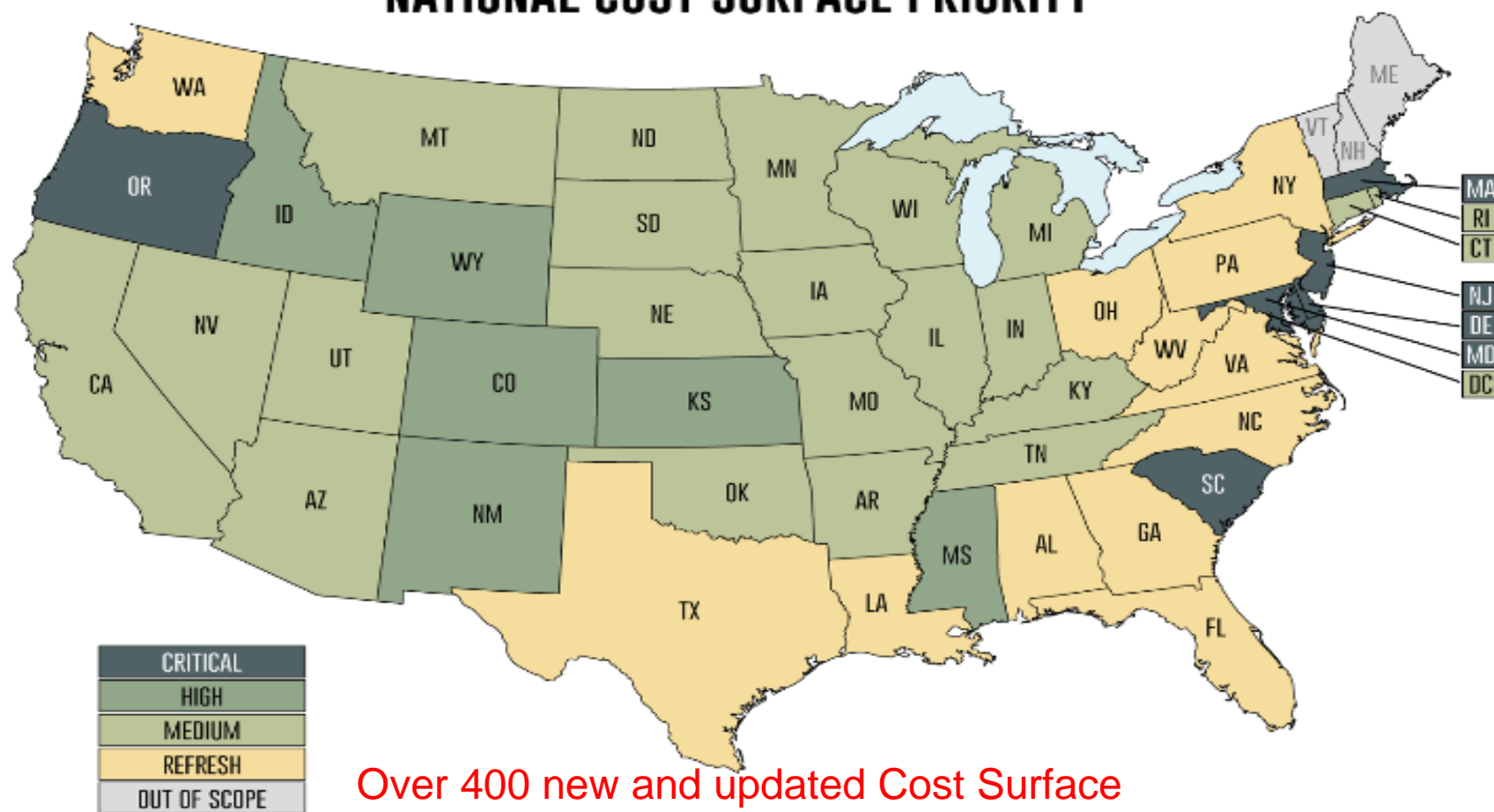
What are Cost Surfaces?

SmartFootprint Weighted Sum



Since 2015 : 45 States Completed

NATIONAL COST SURFACE PRIORITY



Over 400 new and updated Cost Surface Rasters completed by EAI and fed into Pipeline Router Application

Lessons Learned: Project Perspective

> Timeframes

- Length of project was extended couple of times
- Plan for too much time and then add 20 %
- Estimates early on based on prior experienced Williams individuals and did not include EAI involvement.

> Planning

- Plan for turnover: create Training documents and materials.
- Scope change: National rankings / scores decided on for states not in production; Models had to be customized for certain criteria to compensate.
- CS creation instructions (the matrix) need to be standardized in National, Legacy and State terms.

Lessons Learned: Project Perspective

> Logistics

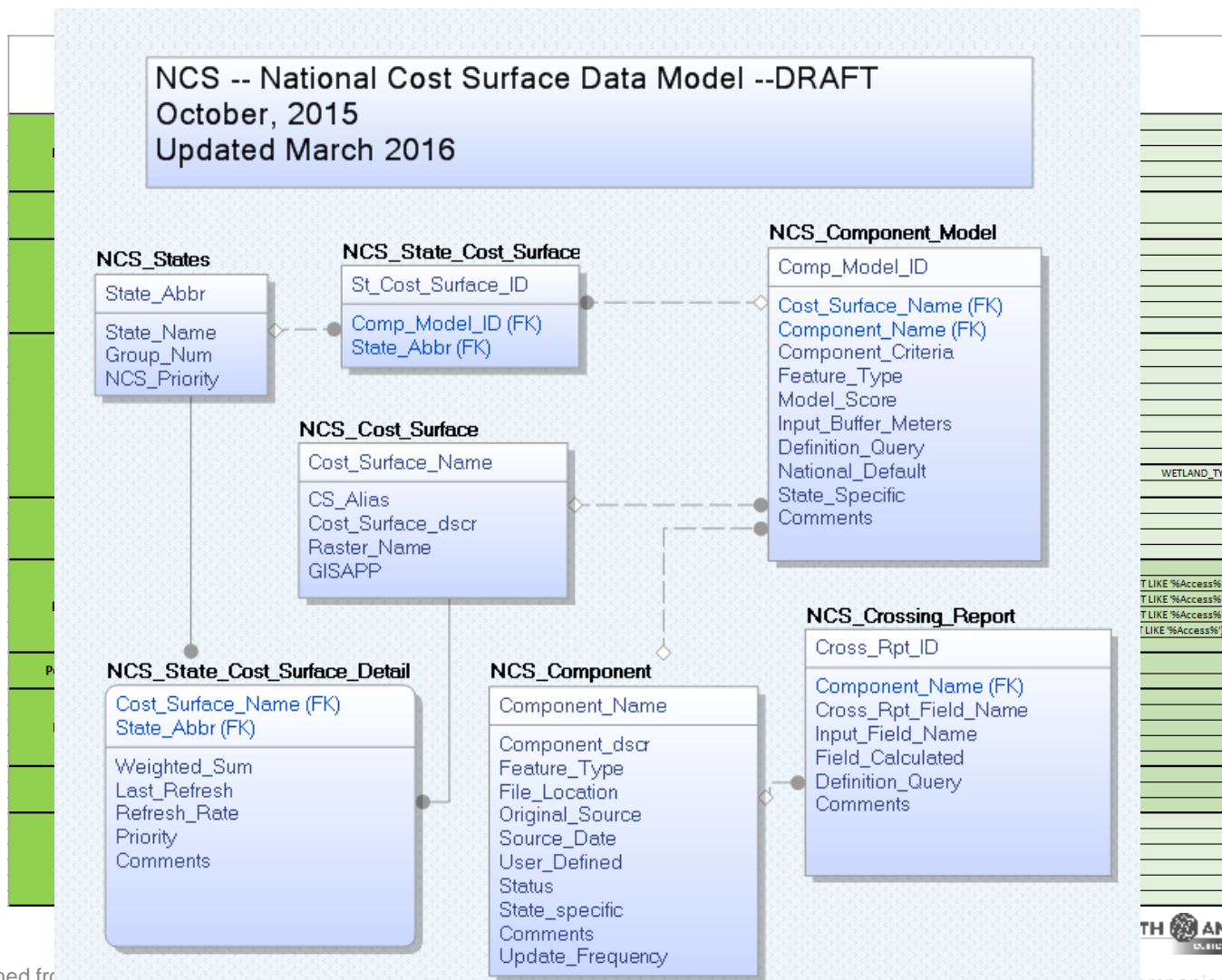
- Sharepoint external vs. Drop box
- Input data delivery to vendor; plan for it being last task so it can be most recent.
- The entire project works better with National area instead of State
- Assign team to work by criteria instead of by State.

> Resources

- Better Communication (During QC daily meet ups were ideal)
- IT GIS Data vs App team vs E&C teams
- SME knowledge transfer
- Staff in 4 different locations
- Turn over (enforced need for good documentation)

Lessons Learned: Source or Input Data

Method for storing instructions of Cost Surface creation & Entire Program Maintenance from Excel to RDBMS



Lessons Learned: Processing Discoveries

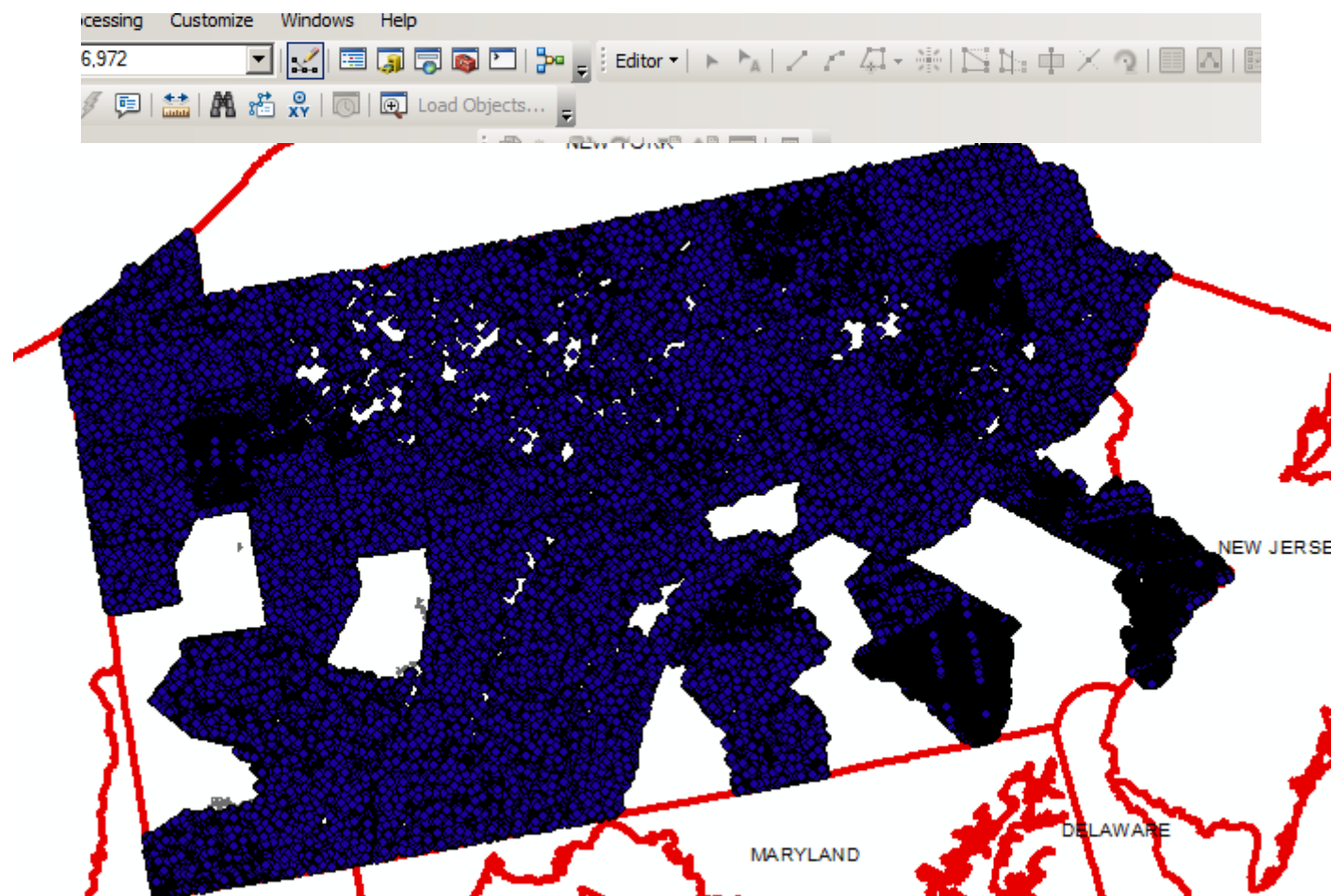
> Training/Processing:

- Using Citrix, Run/schedule processes after hours
- Multiple users, each user must have own scratch space in "environmental settings" ;
- Scratch space large chunk on the SAN.

> Pipeline Application –

- Adding 1000 ft. buffer to avoid areas of No raster cells where state boundaries meet but CS raster files do not.
- Crossing Report:
 - Clean/Repair input data to reduce topological errors
 - File in GDB vs Imported to SDE
 - Run crossings off Land Use raster more efficient than off complicated vectors from raster
 - Run parcel crossings off SDE is faster/more efficient
- Where's your Metadata? Delivery of metadata to users in application
- Exclusion Zones: Found that there are too many with some state data sources; (next slide has examples)

Lessons Learned: Exclusion Zones



Lessons Learned -- Cost Surface QA/QC

- > Standardized QC
 - Developed template

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Initials	QC Date	Time Spent	Cost Surface	Spat Ref	Cell Size are 10 Meters	Raster Format	Pixel Depth	Pixel Type	Raster Values Match Matrix	State Borders are Buffered in Raster Data	Buffers Match Matrix	Actual Data Extend to Buffered State Extent	Raster Accuracy Represents Input Data	Correct Definition Queries are applied
3	AT	4/23/2015	0.25	WY_ExclusionZones_CS	USA_Contiguous_Albers_Equal_Area_Conic	10	Tiff	8 bit	unsigned	Yes	Yes	na	Yes	Yes	Yes
4	AT	4/23/2015	0.5	WY_HCA_CS	USA_Contiguous_Albers_Equal_Area_Conic	10	Tiff	8 bit	unsigned	Yes	Yes	Yes	Yes	Yes	na
5	AT	4/23/2015	1	WY_Hydrology_CS	USA_Contiguous_Albers_Equal_Area_Conic	10	Tiff	8 bit	unsigned	Yes	Yes	Yes	Yes	Yes	Yes
6	AT	4/23/2015	0.5	WY_Mining_CS	USA_Contiguous_Albers_Equal_Area_Conic	10	Tiff	8 bit	unsigned	Yes	Yes	na	Yes	Yes	na
7	AT	4/24/2015	2	WY_ParcelCS	USA_Contiguous_Albers_Equal_Area_Conic	10	Tiff	8 bit	unsigned	Yes	Yes	na	Yes	Yes	na
8	AT	4/23/2015	1	WY_PipelineCorridors_CS	USA_Contiguous_Albers_Equal_Area_Conic	10	Tiff	8 bit	unsigned	Yes	Yes	Yes	Yes	Yes	Yes
9	AT	4/24/2015	0.5	WY_Powerlines_CS	USA_Contiguous_Albers_Equal_Area_Conic	10	Tiff	8 bit	unsigned	Yes	Yes	Yes	Yes	Yes	Yes
10	AT	4/23/2015	1	WY_ProtectedLands_CS	USA_Contiguous_Albers_Equal_Area_Conic	10	Tiff	8 bit	unsigned	Yes	Yes	Yes	Yes	Yes	Yes
11	AT	4/24/2015	1	WY_SideSlope_CS	USA_Contiguous_Albers_Equal_Area_Conic	10	Tiff	8 bit	unsigned	Yes	Yes	na	Yes	Yes	na
12	AT	4/24/2015	1	WY_Slope_CS	USA_Contiguous_Albers_Equal_Area_Conic	10	Tiff	8 bit	unsigned	Yes	Yes	na	Yes	Yes	na
13				WY_Slope_Deg	USA_Contiguous_Albers_Equal_Area_Conic	10	Tiff	32 bit	floating point	Yes	Yes				
14	AT	4/24/2015	3	WY_SurficialGeology_CS	USA_Contiguous_Albers_Equal_Area_Conic	10	Tiff	8 bit	unsigned	Yes	Yes	na	Yes	No	na
15	AT	4/24/2015	0.5	WY_Transportation_CS	USA_Contiguous_Albers_Equal_Area_Conic	10	Tiff	8 bit	unsigned	Yes	Yes		No		
16	AT	2/24/2015	1	WY_Wetlands_CS	USA_Contiguous_Albers_Equal_Area_Conic	10	Tiff	8 bit	unsigned	Yes	Yes	Yes	Yes	Yes	na

- Developed QC Instructions

over 25 pages of detailed instructions on QC of each criteria, started out with word of mouth and a few notes.

- > Knowledge exchange on how EAI and Williams would QC needed

Lessons Learned -- Cost Surface QA/QC

> Criteria Issues

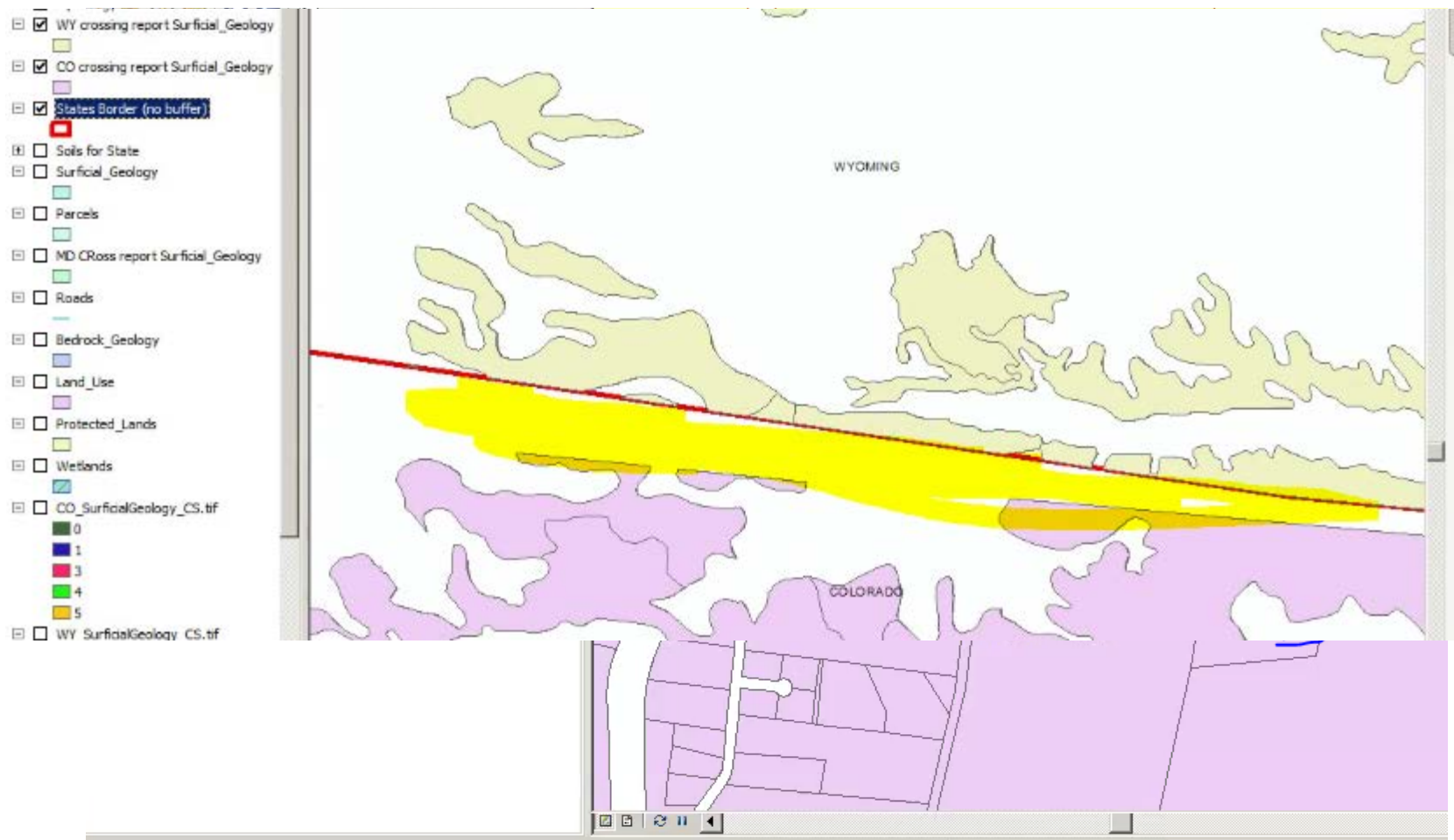
- Parcels input vectors delivered at start of project vs. “live” SDE vectors from our 3rd party.
- Slope Degree were not originally in scope; QC method had to be created

> Border Issues

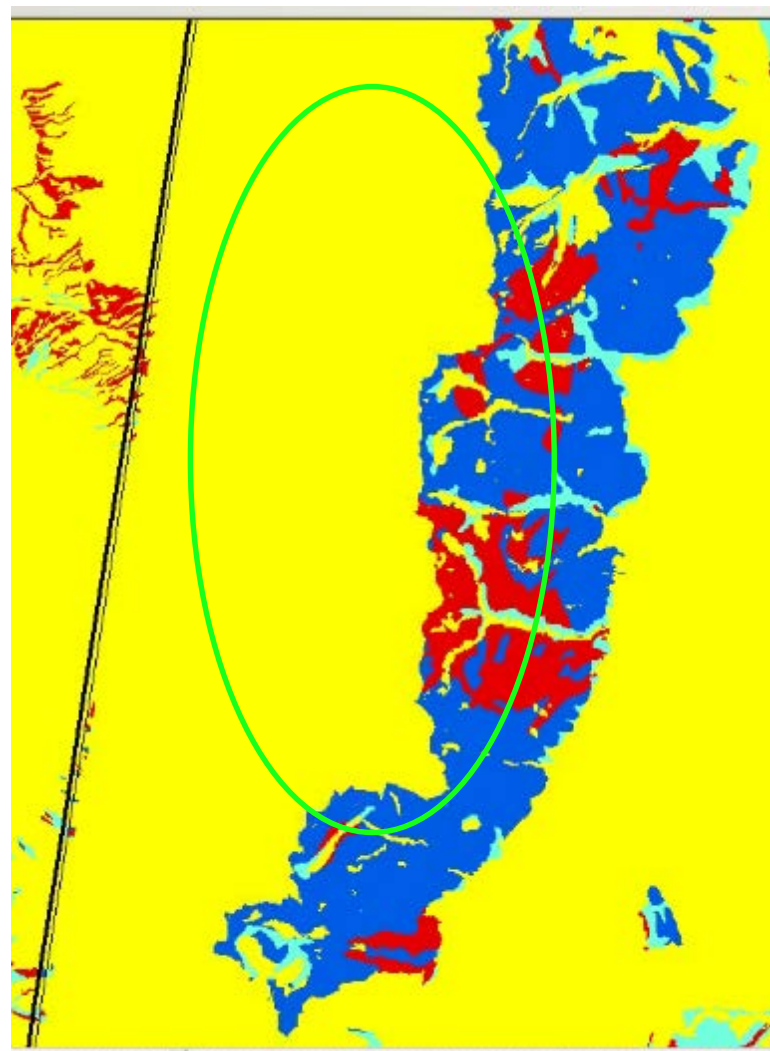
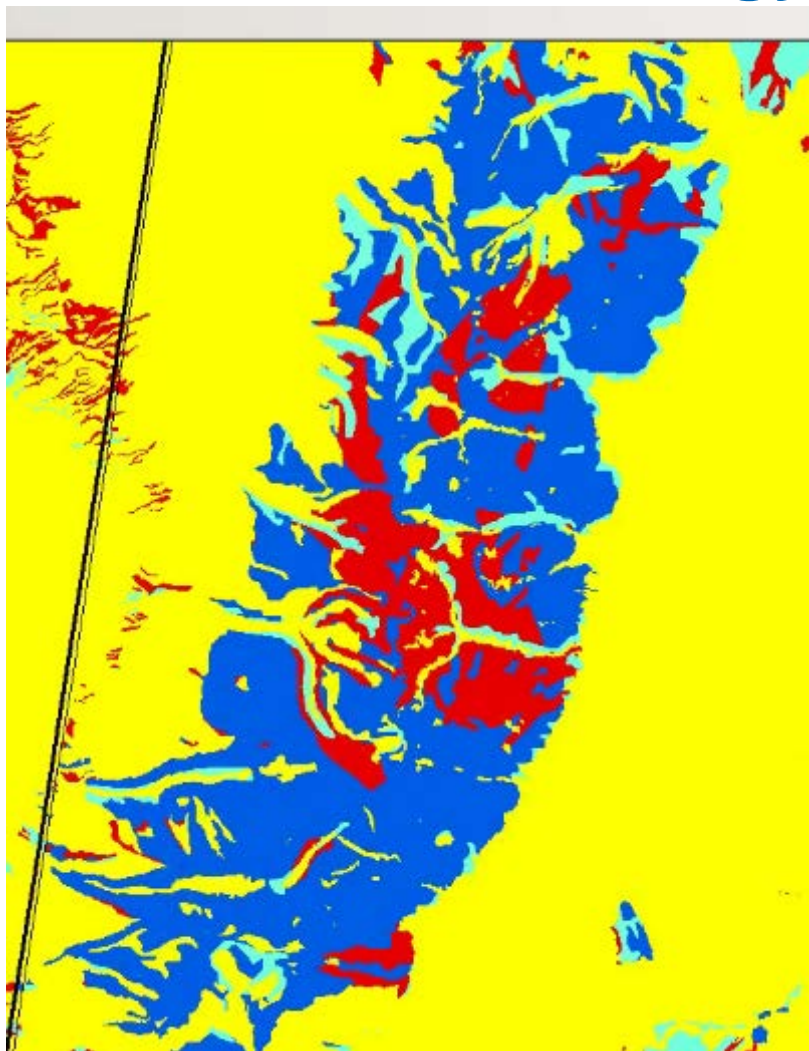
- Adding a 1000 ft. buffer was done for routing application to avoid “no data” gaps at state boundary lines.
- Surficial Geology – USGS saves their survey data with the State name, but those surveys can and usually do cross state borders, so you can have ID survey in WY for example. (Tools processed on state surveys and by state)
- Parcels – state parcel data is not coincident with ESRI provided state lines that we used.
- No Changing Buffer after processing started. Process they uses rasterizes the original buffer and everything is based of these state rasters.

Lessons Learned -- Cost Surface QA/QC

> Examples of Errors found



QC of Surficial Geology – SSURGO Soils issue



Idaho and Wyoming Border:

Williams Return on Investment

- > Per E&C staff, a 500 miles pipeline route Transco was doing took 3-4 months in man time;
- > Pipeline Router with Cost Surfaces took 18 hours on high end pc;
- > We estimate that we can now do an 100 mile route in about 20 minutes.
- > Longer the route, the more time it will save;

What's Next?

> Refresh Schedule:

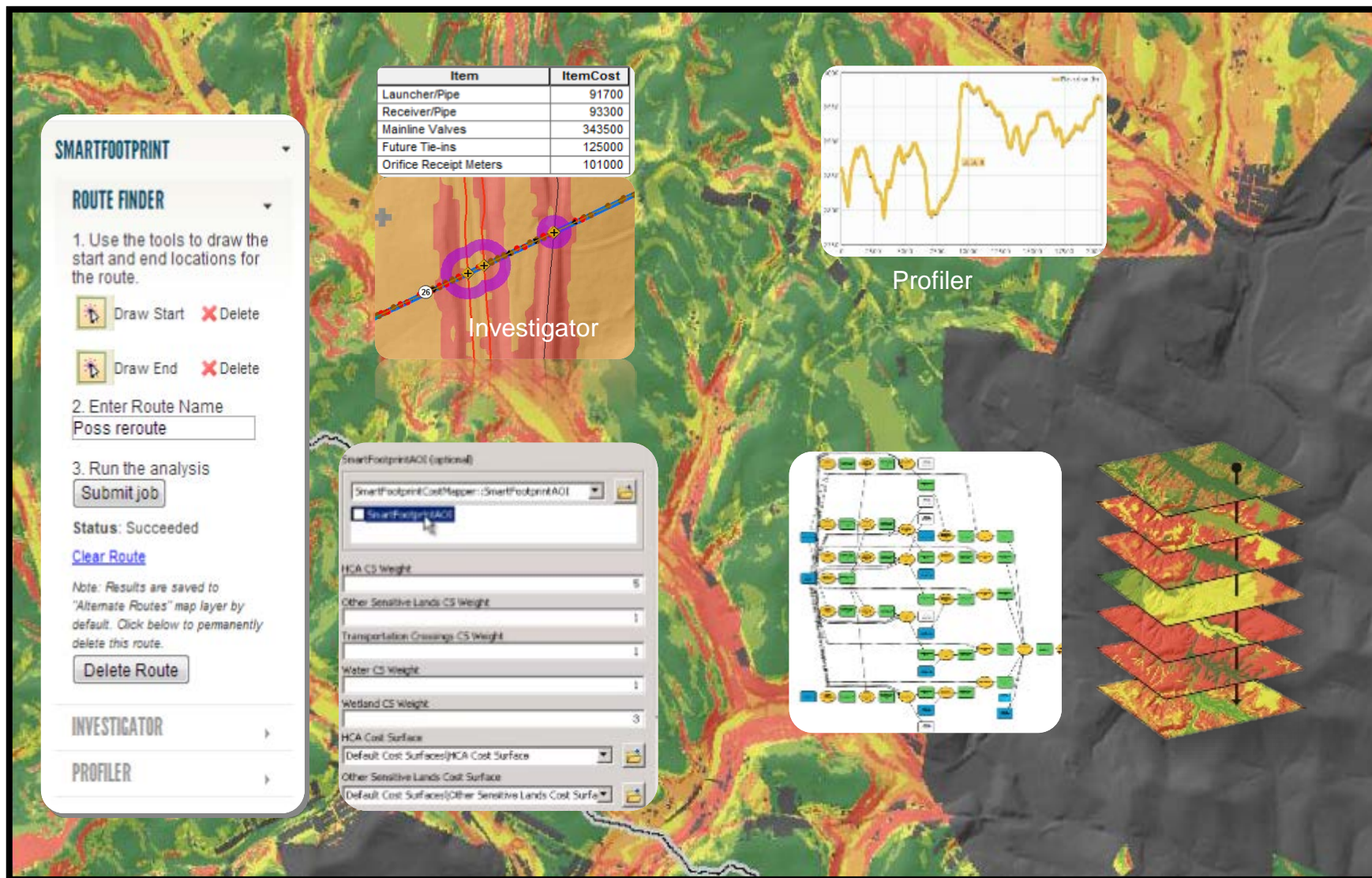
- Define Time frame for update of cost surfaces based on business and construction priority and data input refresh availability.
- Assigning staff to criteria and state priorities.

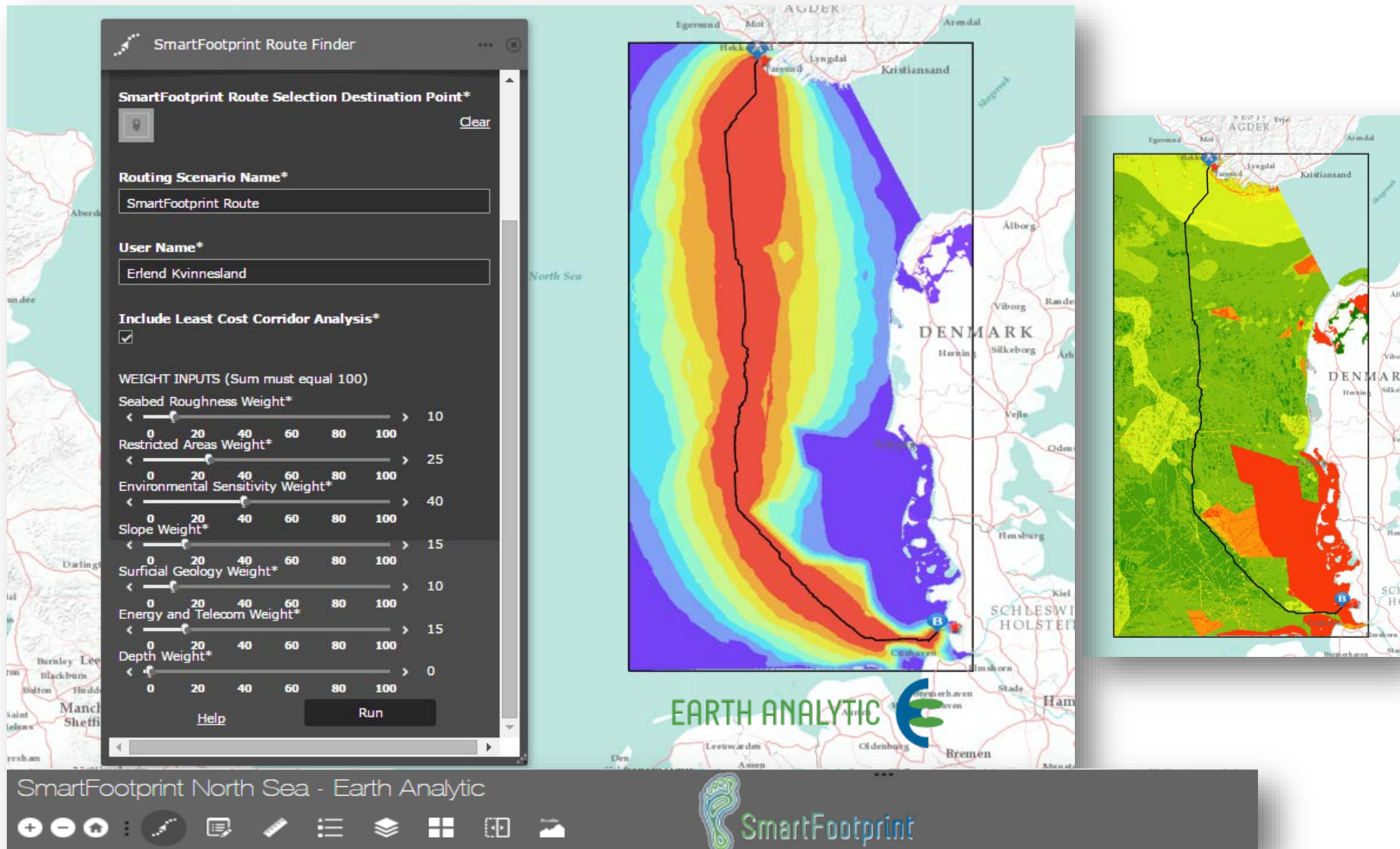
Criteria	Next Scheduled
Pipelines	7/1/2016 (include 3rd party)
Powerlines	6/9/2016
Parcels	7/1/2016
Wetlands	6/15/2016
Wetlands	6/15/2016
Protected Lands	11/13/2016
Hydrology	10/14/2016
Surficial Geology	8/16/2016
ROW	7/1/2016

Monthly
Quarterly
Annual
Every Other Year
TBD

> Future of Pipeline Routing:

- Still useful in priority states defined by E&C for ties into current assets;
- No route planning in non-operating states that we know of, but we are prepared for positive turn around in market.





Questions?