Defining the Landscape

Chesapeake Bay Program Agricultural Workgroup’s Building a Better Bay Model Workshop
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Photos and graphics courtesy of USDA Image Gallery and CBP
Chesapeake Bay Program Modeling Tools

**Inputs**
- BMP Data
- LU Data
- Point Sources Data
- Septic Data
- U.S. Census Data
- Agricultural Census Data

**Model-Derived**
- Airshed Model
- Land Use Change Model

**Scenario Builder**

- Watershed Model
- Chesapeake Bay Model

**Meet WQS?**
- NO
- YES

**Allocation Methodology**

Reduce/Readjust Loads to Meet Standards
Scenario Builder

Livestock -> BMPs

Pasture

Crops

Manure storage practice

Fertilizer

BMPs

Image Credits
http://tennesseeextension.edu/livestock/lincoln-3-h/4H-Pages/Livestock-Skillathons-%28Beef,-Sheep-and-Swine%29.aspx
https://www.rebelwoodsranch.com
https://www.seaburst.com
http://pubs.ext.vt.edu/442/442-308/442-308.html
Scenario Builder Data Inputs and Outputs

**Parameters**
(Changeable by user)

- BMP types and efficiencies
- Land use change (BMPs, others)
- RUSLE2 Data: % Leaf area and residue cover
- Plant and Harvest dates
- Best potential yield
- Animal factors (weight, phytase feed, manure amount and composition)
- Crop application rates and timing
- Plant nutrient uptake
- Time in pasture
- Storage loss
- Volatilization
- Animal manure to crops
- N fixation
- Septic delivery factors

**Inputs**
- BMP Type and location (NEIEN/State supplied)
- Land acres
- Remote Sensing, NASS Crop land Data layer
- Crop acres
- Yield
- Animal Numbers (Ag Census or state supplied)
- Land applied biosolids
- Septic system (#s)

**Outputs**
- BMPs, # and location
- Land use
- % Bare soil, available to erode
- Nutrient uptake
- Manure and chemical fertilizer (lb/segment)
- N fixation (lb/segment)
- Septic loads
Digital Landscape

- Scenario Builder creates a “digital landscape” of land uses bases upon data from the Land Change Model and the USDA’s Census of Agriculture.
- The new “digital landscape” is an aggregated representation of the county’s land uses.
Land-River Segments

- Each county is further broken down into modeling segments that contain sets of unique sub-watershed, political and hydrogeomorphic or climatic characteristics.
- The Land Change Model provides Scenario Builder the percent of a county’s agricultural acres that exist within each LRSEG.

<table>
<thead>
<tr>
<th>Land-River Segment ID</th>
<th>Land Cover Group</th>
<th>Percent Acres in LRSEG</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>agriculture</td>
<td>1.4%</td>
</tr>
<tr>
<td>2</td>
<td>agriculture</td>
<td>0.1%</td>
</tr>
<tr>
<td>3</td>
<td>agriculture</td>
<td>0.0%</td>
</tr>
<tr>
<td>4</td>
<td>agriculture</td>
<td>3.0%</td>
</tr>
<tr>
<td>5</td>
<td>agriculture</td>
<td>0.6%</td>
</tr>
<tr>
<td>6</td>
<td>agriculture</td>
<td>0.1%</td>
</tr>
<tr>
<td>7</td>
<td>agriculture</td>
<td>0.0%</td>
</tr>
<tr>
<td>8</td>
<td>agriculture</td>
<td>25.3%</td>
</tr>
</tbody>
</table>
Census of Agriculture

• Scenario Builder uses the Census of Agriculture’s acres of crops (including fallow acres) to determine the total agricultural acres for each county.

• Total agricultural acres in each county are then placed in each LRSEG according to fractions from the Land Change Model.

<table>
<thead>
<tr>
<th>State</th>
<th>County Name</th>
<th>Crop Name</th>
<th>1997</th>
<th>2002</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE</td>
<td>Kent</td>
<td>Corn for Grain Harvested Area</td>
<td>42,274</td>
<td>43,548</td>
<td>55,105</td>
</tr>
<tr>
<td>DE</td>
<td>Kent</td>
<td>Soybeans for beans Harvested Area</td>
<td>80,709</td>
<td>68,647</td>
<td>57,251</td>
</tr>
<tr>
<td>DE</td>
<td>Kent</td>
<td>Wheat for Grain Harvested Area</td>
<td>26,229</td>
<td>20,509</td>
<td>22,367</td>
</tr>
</tbody>
</table>
Watershed’s Harvested Cropland Acres Over Time

<table>
<thead>
<tr>
<th>Year</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982</td>
<td>12,000,000</td>
</tr>
<tr>
<td>1987</td>
<td>11,000,000</td>
</tr>
<tr>
<td>1992</td>
<td>10,000,000</td>
</tr>
<tr>
<td>1997</td>
<td>10,000,000</td>
</tr>
<tr>
<td>2002</td>
<td>9,000,000</td>
</tr>
<tr>
<td>2007</td>
<td>8,000,000</td>
</tr>
<tr>
<td>2012</td>
<td>7,000,000</td>
</tr>
</tbody>
</table>
Agricultural Land Uses

- Animal Feeding Operation
- Concentrated Animal Feeding Operations
- Alfalfa*
- High-Till without Manure*
- High-Till with Manure*
- Hay without Nutrients
- Hay with Nutrients*
- Low-Till with Manure*
- Pasture*
- Degraded Riparian Pasture
- Nursery

* Also has nutrient management version

- Each crop in the Census of Agriculture maps to a land use.

<table>
<thead>
<tr>
<th>Crop Name</th>
<th>Land Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa Hay Harvested Area</td>
<td>Alfalfa</td>
</tr>
<tr>
<td>Corn for Grain Harvested Area</td>
<td>High-Till with Manure</td>
</tr>
<tr>
<td>Lettuce, All Harvested Area</td>
<td>High-Till without Manure</td>
</tr>
</tbody>
</table>
Double Cropping

• In reality, many agricultural acres produce more than one crop per year.
• Acres of Total Harvested Area reported by the Census of Agriculture should include double cropped acres.
• Scenario Builder breaks crops into those which are eligible for double cropping and those which are not.
• Scenario Builder then breaks up the Total Harvested Area amongst cropped acres and double cropped acres.
• This impacts the amount of nutrients applied to the land to meet crop need of all harvested crops.
Degraded Riparian Pasture

• States defined degraded riparian pasture acreages for Tributary Strategies planning.
• Acres are removed from pasture acres.
• Direct excretion rates on degraded riparian pasture are 9 times that of regular pasture.
AFO/CAFO Land Uses

- AFO/CAFO land uses are meant to simulate production areas upon which stored manure can be lost from storage and transportation.
- Acres are not defined by number of animals. Census of Agriculture farm counts by animal type are multiplied by fractions in table to achieve animal production area acreages.

<table>
<thead>
<tr>
<th>Farm Animal Type</th>
<th>Acres per farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle and Calves</td>
<td>0.5</td>
</tr>
<tr>
<td>Total Hogs and Pigs</td>
<td>0.2</td>
</tr>
<tr>
<td>Any Poultry</td>
<td>0.25</td>
</tr>
<tr>
<td>Sheep and Lambs</td>
<td>0.1</td>
</tr>
<tr>
<td>Milk Goats</td>
<td>0.05</td>
</tr>
<tr>
<td>Angora Goats</td>
<td>0.05</td>
</tr>
</tbody>
</table>
Wooded / Other

• “Wooded and Other” land use is primarily forest, but also includes other areas not classified as agricultural or developed.

• Wooded and Other is calculated as a “left over” acreage for each segment after combining acres from the Census of Agriculture with acres from the Land Change Model.
At this point, Scenario Builder has aggregated model land uses for each LRSEG.

The next step is to apply BMPs that can impact the LRSEG’s final set of land uses, nutrient generation and application, and nutrient runoff into streams.
Land Use Loading Rates

- Loading rates from literature sources used as a starting point for each land use type. Final rates are based on regional conditions and calibration to observed flows and concentrations and estimated loads. Median edge-of-stream loading rates per acre for calibration are listed below.

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Median N Loading Rate</th>
<th>Median P Loading Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forests</td>
<td>3.1</td>
<td>0.13</td>
</tr>
<tr>
<td>Hay without Nutrients</td>
<td>6.2</td>
<td>0.03</td>
</tr>
<tr>
<td>Pasture</td>
<td>8.2</td>
<td>0.92</td>
</tr>
<tr>
<td>Hay with Nutrients</td>
<td>9.5</td>
<td>0.05</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>9.5</td>
<td>0.87</td>
</tr>
<tr>
<td>Low-Till with Manure</td>
<td>39.6</td>
<td>1.73</td>
</tr>
<tr>
<td>High-Till without Manure</td>
<td>40.2</td>
<td>3.08</td>
</tr>
<tr>
<td>High-Till with Manure</td>
<td>44.8</td>
<td>2.05</td>
</tr>
<tr>
<td>Degraded Riparian Pasture</td>
<td>45.9</td>
<td>10.97</td>
</tr>
<tr>
<td>Nursery</td>
<td>253.8</td>
<td>111.98</td>
</tr>
</tbody>
</table>
Conservation Tillage and Land Use

- All row crop acres are assumed to be high-till.
- Acres reported under conservation tillage convert high-till acres to low-till.
Nutrient Application Management and Land Uses

- Nutrient management acres are defined each year by states.
- Nutrient management acres result in lower crop need, and thus lower application of nutrients to meet crop need.

- Alfalfa*
- High-Till without Manure*
- High-Till with Manure*
- Hay with Nutrients*
- Low-Till with Manure*
- Pasture*

Graph showing the increase in acres implemented from 1987 to 2012 for different types of land uses across different states.
Land Conversion BMPs

- Alternative Crops
- Conservation Tillage
- Nutrient Application Management (All Forms) – *More appropriately characterized as a reduction in application for crop need.*
- Forest Buffers
- Grass Buffers
- Land Retirement
- Stream Access Control with Fencing
- Tree Planting
- Wetland Restoration

Some BMPs convert model land uses to land uses with lower nutrient export rates.

High-Till with Manure

Forest
Animal Information

- Angora Goats
- Beef
- Broilers
- Dairy
- Hogs and Pigs for Breeding
- Hogs for Slaughter
- Horses
- Layers
- Milk Goats
- Other Cattle
- Pullets
- Sheep and Lambs
- Turkeys

- Animals are spread across the landscape in a similar way as crops.
- The Census of Agriculture provides animal counts by county.
### Application of Manure and Nutrients

- Organic nutrients are generated by animals across a county.
- Organic nutrients are applied to cropland after direct excretion on pasture, storage and handling losses on animal production areas and volatilization.
- Organic nutrients are applied to fulfill crop nutrient needs.
- Excess organic nutrients are applied in a sequence across land uses.
- Remaining crop need is fulfilled with inorganic fertilizer.

<table>
<thead>
<tr>
<th>Animal Type</th>
<th>lb TN / lb of Manure</th>
<th>lb TP/lb of Manure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angora Goats</td>
<td>0.011</td>
<td>0.0027</td>
</tr>
<tr>
<td>Beef</td>
<td>0.0059</td>
<td>0.0016</td>
</tr>
<tr>
<td>Broilers</td>
<td>0.0129</td>
<td>0.0035</td>
</tr>
<tr>
<td>Dairy</td>
<td>0.0052</td>
<td>0.0011</td>
</tr>
<tr>
<td>Hogs and Pigs for Breeding</td>
<td>0.0066</td>
<td>0.0021</td>
</tr>
<tr>
<td>Hogs for Slaughter</td>
<td>0.0062</td>
<td>0.0021</td>
</tr>
<tr>
<td>Horses</td>
<td>0.0059</td>
<td>0.0014</td>
</tr>
<tr>
<td>Layers</td>
<td>0.0131</td>
<td>0.0047</td>
</tr>
<tr>
<td>Milk Goats</td>
<td>0.011</td>
<td>0.0027</td>
</tr>
<tr>
<td>Other Cattle</td>
<td>0.0037</td>
<td>0.001</td>
</tr>
<tr>
<td>Pullets</td>
<td>0.0136</td>
<td>0.0053</td>
</tr>
<tr>
<td>Sheep and Lambs</td>
<td>0.0105</td>
<td>0.0022</td>
</tr>
<tr>
<td>Turkeys</td>
<td>0.0132</td>
<td>0.0049</td>
</tr>
</tbody>
</table>
Potential Future Land Use Data

- Common Land Units from the Farm Service Agency and the Cropland Data Layer from NASS could be used to further define agricultural acres in each county.
Potential Discussion Items

• Is there sufficient data to include **soil nutrient content data** in a future version of Scenario Builder?

• Is there sufficient data or surveys available to update **conservation tillage implementation** on a more regular timescale?

• Is there sufficient data to define cropland that does **NOT receive manure**.