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Restoring the Chesapeake Bay with ArcGIS

Tools for Planning Stormwater Treatment

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The Chesapeake Bay

- Largest Estuary in the US

- Drains over 64,000 mi^2
    - 6 States, plus Washington, DC

- 2009 Executive Order:
    - Declared the Bay a National Treasure
    - Called for a renewed effort to restore and protect the Bay
    - Paved the way for the Chesapeake Bay TMDL

The Chesapeake Bay TMDL

Image Credit: 1

- What is a TMDL?
  - Total Maximum Daily Load
  - EPA-established "pollution diet."
  - Maximum amount of pollution a water body can receive and still remain healthy.

- The Chesapeake Bay TMDL focuses on three pollutants:
  - Nitrogen
  - Phosphorus
  - Sediment

Urban Stormwater in the Bay Watershed

- Urban stormwater pollution is a major aspect of the Chesapeake Bay TMDL.

- The Bay TMDL is affecting Municipal Separate Storm Sewer System (MS4) operators throughout the Bay Watershed.

- There are many existing tools for stormwater planning, but most are non-spatial.

- How can we use GIS to…

  - evaluate stormwater treatment options?

  - track TMDL compliance?

  - make watershed planning easier?
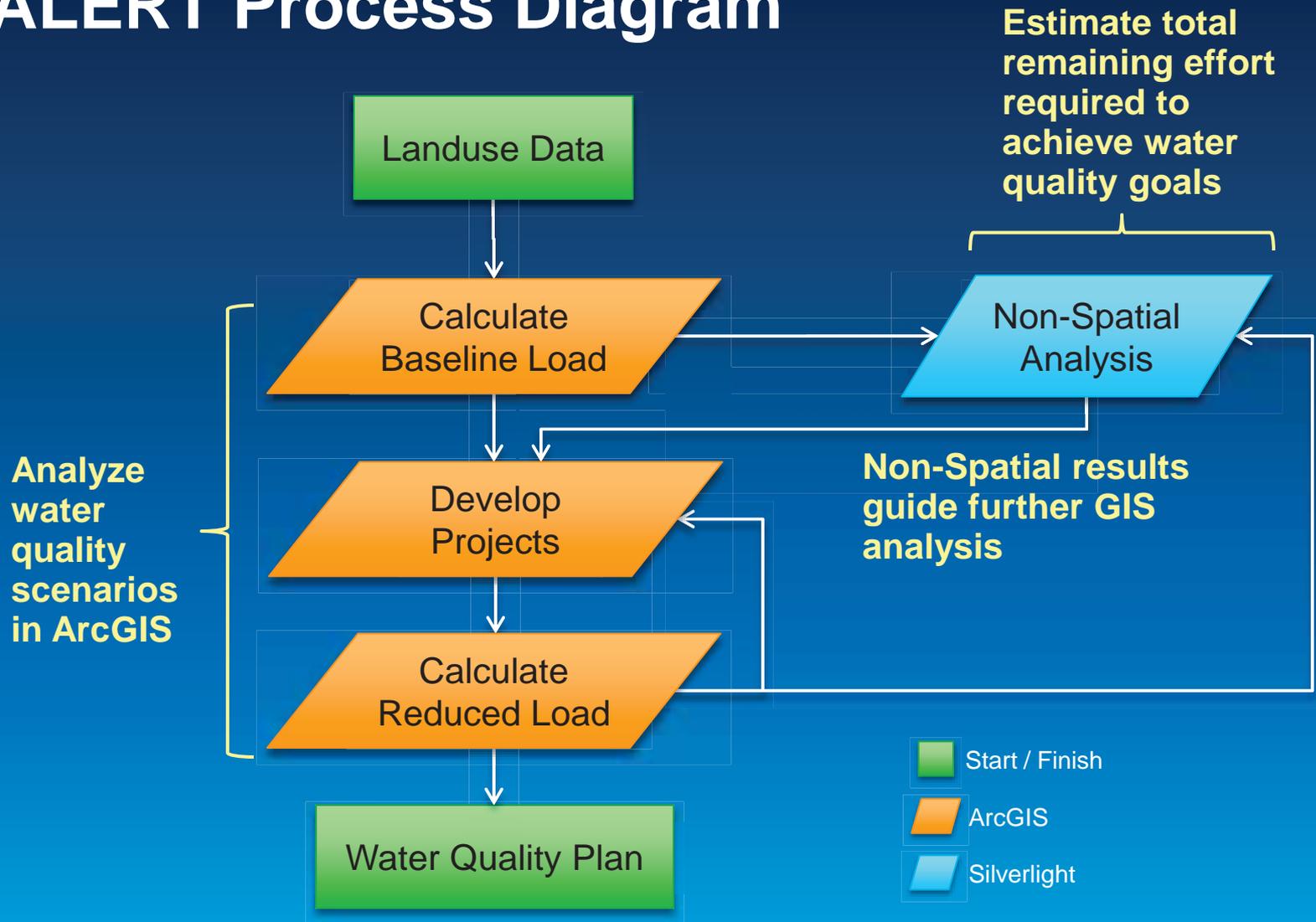

Image Credit: 2

ALERT

- AMEC developed a set of Python tools for ArcGIS, called **ALERT**

    - *AMEC Load Estimation and Reduction Tracking*

- Initially designed around Virginia's draft regulations to implement the Chesapeake Bay TMDL.

- ALERT framework has since been updated and expanded to apply outside of Virginia and the Chesapeake Bay.

- Built to help communities:

    - plan stormwater projects

    - quickly evaluate different scenarios

    - estimate the cost of compliance

ALERT Process Diagram

Estimate total remaining effort required to achieve water quality goals

Landuse Data

Calculate Baseline Load

Non-Spatial Analysis

Analyze water quality scenarios in ArcGIS

Develop Projects

Non-Spatial results guide further GIS analysis

Calculate Reduced Load

Water Quality Plan

Start / Finish

ArcGIS

Silverlight

ALERT Process: Calculate Baseline Loads

Calculate Baseline Loads

Landuse Data

- Polygon layer attributed with pollutant loading and runoff information.

either
- lbs/ac/yr (Loading Rates)
- mg/L (Event Mean Concentrations)
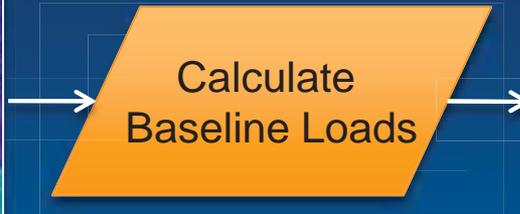
Baseline Loads

- Total annual pollutant loads (lbs/yr) are calculated.

- Simple Method calculations consider:
  - Impervious area
  - Runoff coefficients
  - Annual precipitation

ALERT Process: Develop Project Database

Project Database

- Treatment area polygons
- Pollutant removal and runoff reduction efficiencies
- Other relevant information

Water Quality Projects:

Pond Retrofit, 65 acres
Nitrogen Efficiency: 15%
Runoff Reduction: 0%
Cost: $275,000

Bioretention, 5 acres
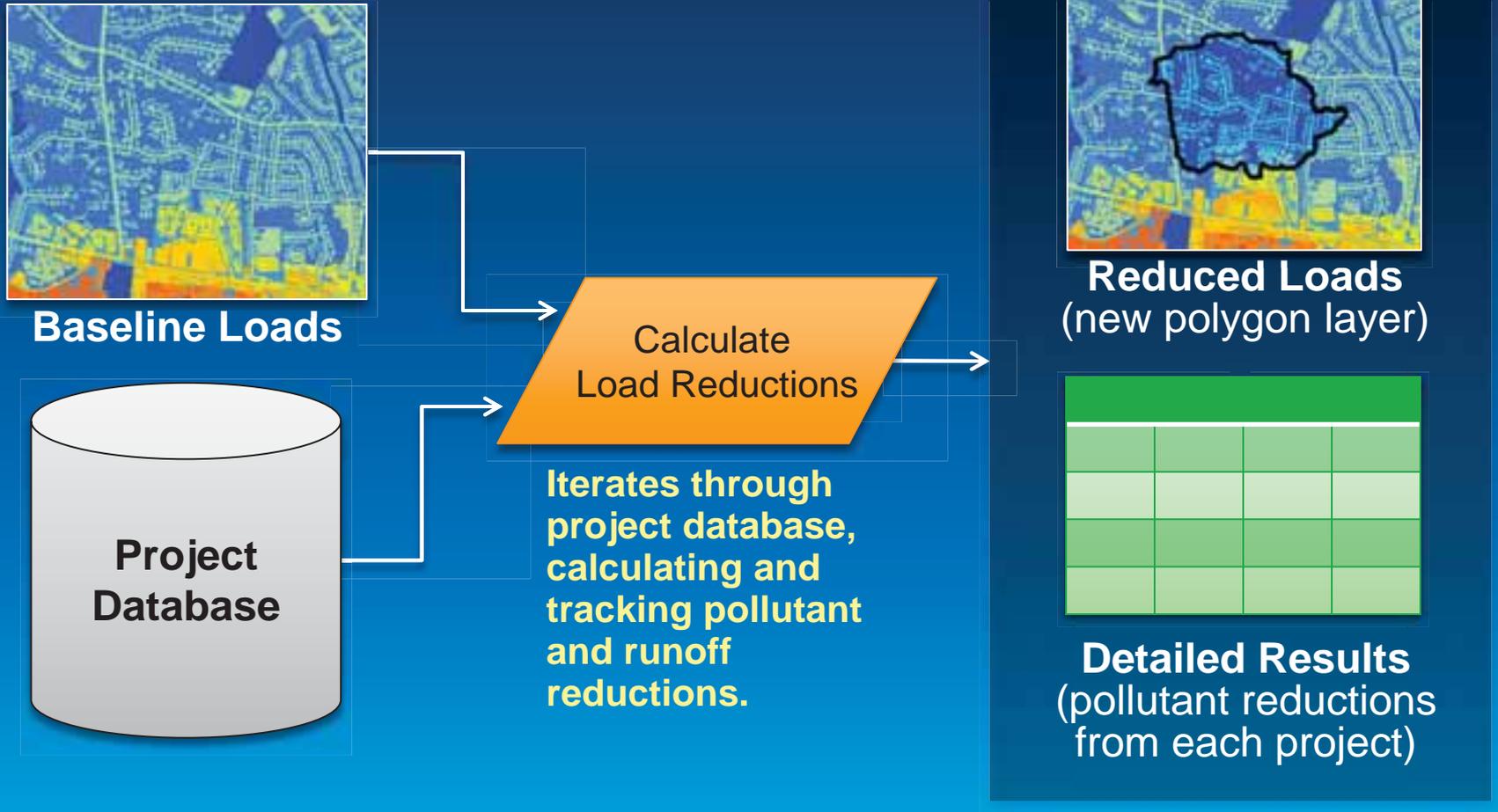Nitrogen Efficiency: 45%
Runoff Reduction: 20%
Cost: $110,000

Stormwater BMPs

Redevelopment, 10 acres
Nitrogen Efficiency: 50%
Runoff Reduction: 10%
Cost: Undetermined

Landuse Changes

etc…

ALERT Process: Calculate Load Reductions

Baseline Loads

Project Database

Calculate Load Reductions

Iterates through project database, calculating and tracking pollutant and runoff reductions.

Reduced Loads (new polygon layer)

Detailed Results (pollutant reductions from each project)

ALERT Process: Calculate Load Reductions

Baseline Loads

ALERT Process: Calculate Load Reductions

Treatment Area

Reduced Loads

ALERT Process: Non-Spatial Analysis

Baseline Loads

Reduced Loads

Reductions

Non-Spatial Analysis
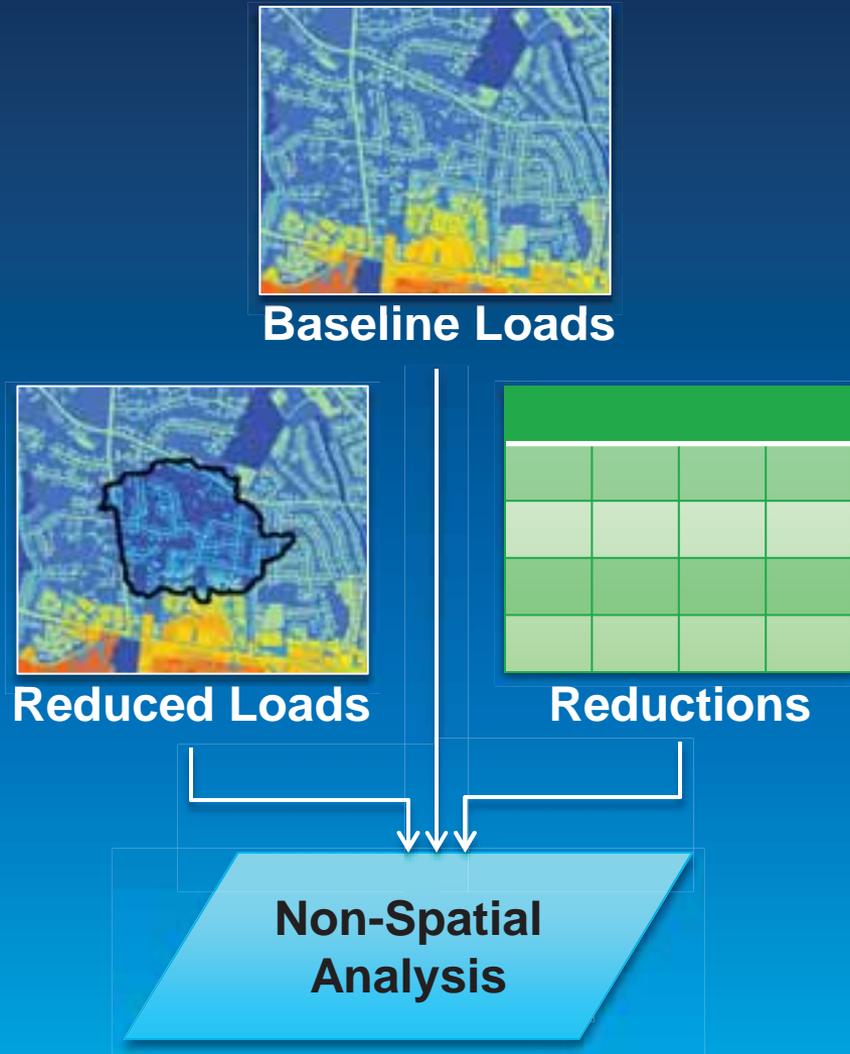
- Results from GIS analysis can feed into a non-spatial component.

- Non-spatial ALERT tools are used to roughly estimate the remaining effort needed to meet water quality goals.

  - Project needs (acres of treatment)

  - Capital and annual maintenance costs

- Total area of required additional treatment is back-calculated based on pollutant reduction targets.
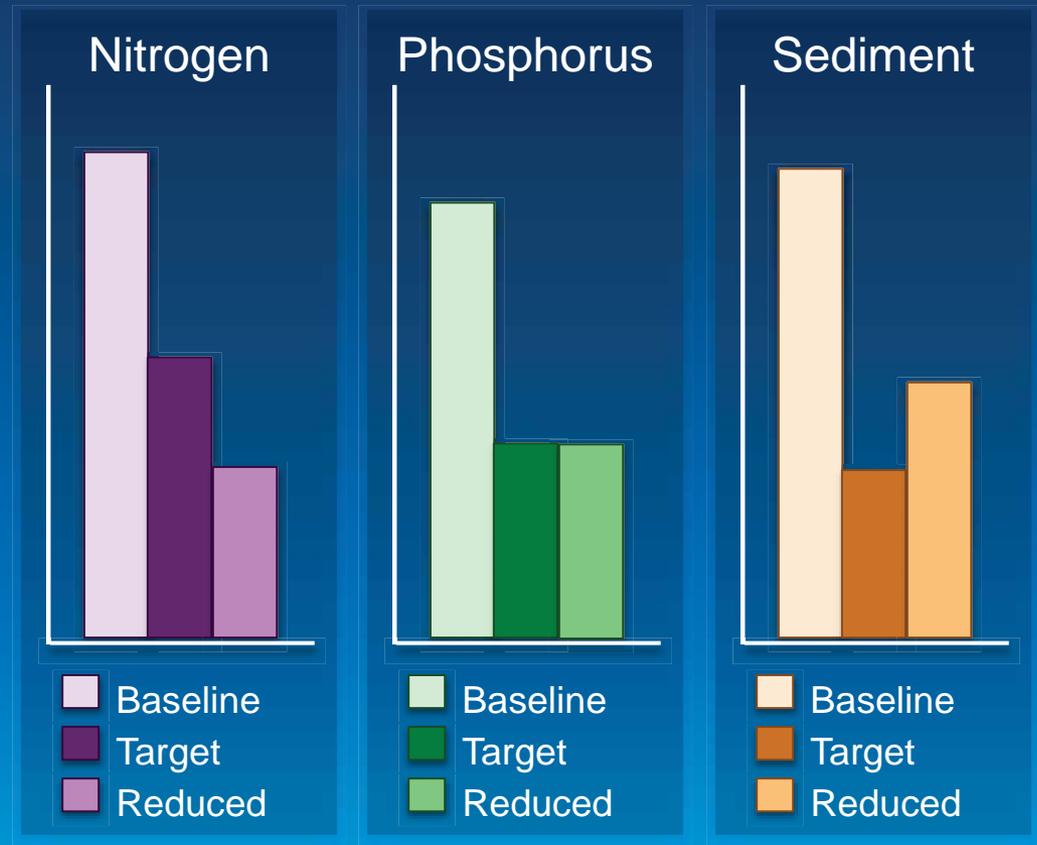
ALERT Process: Non-Spatial Analysis

1. Project Mix	% by Area
Bioretention	10%
Filtration	10%
New Ponds	30%
Pond Retrofits	50%

2. Target Pollutant	Phosphorus

3. Results	
Treatment Area	145 acres
Initial Cost	$3.5 m
Annual Maint.	$81,000

Pollutant Loads (lbs/yr)

Nitrogen — Baseline, Target, Reduced

Phosphorus — Baseline, Target, Reduced

Sediment — Baseline, Target, Reduced

Results are used to guide further GIS analysis.

More Information:

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