Chesapeake Bay
Maryland Phase I WIP Strategy
Key Concepts: Septics and Stormwater
June 13th, 2011
Topics Covered

• Purpose of Reviewing Phase I WIP
• Context of our WIP Planning
• Urban Stormwater
• Septic Systems
Purposes for Reviewing Phase I WIP Strategies

- The State’s “default strategy” will use elements of the Phase I WIP Strategy, which you might also want to consider using.
- Some of the Phase I WIP Strategy elements are occurring in your jurisdiction.
- To help team members be conversant in the subject, which will improve communications during the strategy development process.
- To provide “rules of thumb” to help teams with conceptual planning of strategies.
- Provide insights about Phase II WIP and beyond.
Context of Developing WIP Strategies

• Phase II WIP is a coarse-level of planning.
  – For comparison: NPDES Stormwater permits require additional planning, which itself is fairly coarse.

• EPA promotes adaptive management; therefore, the strategies and milestones can change after the WIP is completed.

• EPA’s expectation of the Phase II WIP recognizes that we have limited time and tools.

• The following focuses on strategies for the 2017 Interim Target, but also considers Final Targets.
## Urban Stormwater

**Phase I WIP**

<table>
<thead>
<tr>
<th>Category</th>
<th>Key 2017 WIP Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-MS4</td>
<td>• Urban Nutrient Management</td>
</tr>
<tr>
<td></td>
<td>• Rural Residential Tree Planting</td>
</tr>
<tr>
<td>Phase I MS4</td>
<td>• Urban Nutrient Management</td>
</tr>
<tr>
<td></td>
<td>• 30% Impervious Retrofit</td>
</tr>
<tr>
<td>Phase II MS4</td>
<td>• Urban Nutrient Management</td>
</tr>
<tr>
<td></td>
<td>• 20% Impervious Retrofit</td>
</tr>
</tbody>
</table>

**Other Urban Practices:**
- Stream Restoration (not by name in Phase I WIP)
- Regenerative Stormwater Conveyances
- Urban Tree Canopy
Rural Residential Tree Planting

- Increase rural resident tree planting, including conversion of turf grass to tree covers. May also consider mandatory stream and waterway buffers
- 600 acres by 2017 (100 ac/yr)
- 8.6 lbs/acre/yr Reduction in Nitrogen.
- 18,000 lb Reduction by 2017
Urban Nutrient Management

- MDA regulates approximately 700 commercial lawn fertilizer applicators who manage parcels of 10 or more acres of non-agricultural land, including private lawns, golf courses, public parks, airports, athletic fields and state owned land such as restoration areas and highway right-of-ways.

- Accounting for non-compliance, an estimated 220,000 acres/year are managed.

- Annual Load Reduction (delivered)
  - 385,000 lbs/yr N
  - 59,400 lbs/yr P

- Note it is an annual practice. That is, it must be redone each year or there is no reduction.

- Although not directly comparable, new stormwater retrofits each year achieve about 16,600 lbs/yr additional nitrogen reduction, adding up over a five-year period to 249,000 lbs N. {NOTE: Not 16,600 x 5 … See Next Slide}

- UNM results in urban reductions for non-MS4 jurisdictions in Phase I WIP.
## Retrofit Cumulative Reduction Calculation

(Pounds of Nitrogen)

<table>
<thead>
<tr>
<th>Year</th>
<th>Sub-Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>16,600</td>
</tr>
<tr>
<td>Year 2</td>
<td>33,200</td>
</tr>
<tr>
<td>Year 3</td>
<td>49,800</td>
</tr>
<tr>
<td>Year 4</td>
<td>66,400</td>
</tr>
<tr>
<td>Year 5</td>
<td>83,000</td>
</tr>
<tr>
<td>5-year Cumulative Total</td>
<td>249,000</td>
</tr>
</tbody>
</table>

About 6,600 acres per year retrofitted.
**UNM Annual Reduction Calculation**

(Pounds of Nitrogen Delivered)

<table>
<thead>
<tr>
<th>Year</th>
<th>Sub-Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>385,000</td>
</tr>
<tr>
<td>Year 2</td>
<td>385,000</td>
</tr>
<tr>
<td>Year 3</td>
<td>385,000</td>
</tr>
<tr>
<td>Year 4</td>
<td>385,000</td>
</tr>
<tr>
<td>Year 5</td>
<td>385,000</td>
</tr>
<tr>
<td>5-year Cumulative Total</td>
<td>1,925,000</td>
</tr>
</tbody>
</table>

Note: This is also a “preventive” activity. That is, it is assumed that without this program, about 385,000 additional pounds of nitrogen would go into the Bay each year due to over fertilization of large lawns.
Phase I WIP
Stormwater Retrofit Strategies

• **Phase I MS4s:** Nutrient and Sediment reductions equivalent to stormwater treatment on 30% of the impervious surface that does not have adequate stormwater controls*. (10% from previous permit commitments plus 20% more by 2017).

• **Phase II MS4s:** Nutrient and Sediment reductions equivalent to stormwater treatment on 20% of the impervious surface that does not have adequate stormwater controls.

* Rule-of-thumb: Land developed before 1985 State stormwater law.

Note: State Highway Administration (SHA) will retrofit 20% or 30% depending on the jurisdiction.
Stormwater Retrofits
Untreated Urban Nutrient Load*

Land without stormwater controls (untreated):

- **Unit Load:**
  - Pounds/acre/Year:

- **Typical Unit Load for Untreated Urban (Nitrogen):**
  - 10 lbs/ac/yr

- **Urban Load for a particular area:**

  \[
  \text{Land Area (acres)} \times \text{Unit Load (lbs/ac/yr)} = \text{Load (lbs/yr)}
  \]

  **Example:**
  \[
  200 \text{ (acres)} \times 10 \text{ (lbs/ac/yr)} = 2,000 \text{ (lbs/yr)}
  \]

* Land developed before the 1985 State Stormwater Law usually has no stormwater controls.
Urban Load with Stormwater Retrofits

• Reduction due to Retrofit:
  \[
  \text{Unit Load (lbs/ac/yr)} \times \text{Reduction Efficiency} = \text{Reduction}
  \]
  Example: \[
  10 \text{ (lbs/ac/yr)} \times 0.25 = 2.5 \text{ (lb/ac/yr)}
  \]

• Remaining Load:
  \[
  \text{Original unit load} - \text{Reduction} = \text{Remaining Load}
  \]
  Example: \[
  10 \text{ (lbs/ac/yr)} - 2.5 \text{ (lbs/ac/yr)} = 7.5 \text{ (lbs/ac/yr)}
  \]

• Urban Load for a particular area of 200 acres:
  Multiply by the acres involved, for Example:
  REDUCTION: \[
  200 \text{ (acres)} \times 10 \text{ (lbs/ac/yr)} \times 0.25 = 500 \text{ (lbs/yr)}
  \]
  REMAINING: \[
  2,000 \text{ (lbs/yr)} - 500 \text{ (lbs/yr)} = 1,500 \text{ (lbs/yr)}
  \]
Estimated Reduction from Phase I WIP
Urban Retrofit Strategy*

Case: Small Phase 2 MS4 Municipality with total area of about 2 mi$^2$, which is equal to 1,250 acres.

Strategy: Retrofit 20% of Untreated Urban Land*

Untreated Urban Land: Land developed before 1985 (estimate)

- Step 1: Determine Area of Untreated Land, e.g., 80% developed before 1985
  - E.g., 80% of 1,250 acres is 1,000 acres

- Step 2: Determine 20% of Untreated Land:
  - E.g., 1,000 acres x 0.2 = 200 acres

- Step 3: Calculate Load Reduction (Assume 25% efficiency of BMPs for nitrogen)
  - 200 acres x 10 (lbs/ac/yr) x 0.25 = 500 lbs/yr reduced

* This is simplified example that equates total area to impervious area.
Some Stormwater BMP Efficiencies

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Nitrogen</th>
<th>Phosphorus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Extended Detention Ponds</td>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>Wet Ponds and Wetlands</td>
<td>20%</td>
<td>45%</td>
</tr>
<tr>
<td>Infiltration Practices</td>
<td>80%</td>
<td>85%</td>
</tr>
<tr>
<td>Filtering Practices</td>
<td>40%</td>
<td>60%</td>
</tr>
<tr>
<td>Vegetated Open Channels</td>
<td>45%</td>
<td>45%</td>
</tr>
</tbody>
</table>
Alternative to 25% Efficiency Estimate

Example: Weighted Average of Future BMPs:

20% Infiltration at 80% Efficiency
30% Wet Ponds at 20% Efficiency
25% Filtering Practices at 40% Efficiency
25% Vegetated Open Swales at 45% Efficiency

$0.2 \times 0.8 + 0.3 \times 0.2 + 0.25 \times 0.4 + 0.25 \times 0.45 = 0.43 \text{ (43% Efficiency)}$

Reduction Calculations:

Previous: 200 acres $\times$ 10 (lbs/ac/yr) $\times$ 0.25 = 500 lbs/yr

Alternative: 200 acres $\times$ 10 (lbs/ac/yr) $\times$ 0.43 = 860 lbs/yr
Putting it Together for a Phase I MS4 Urban Retrofit Strategy for 2017

The strategy development process can be very simple:

• **Step 0**: It is assumed you have an estimate of the Area to be treated (Range is about 3,000 – 40,000 acres).

• **Step 1**: It is assumed you know the Remaining Percentage to treat from past permit cycles:
  – E.g., 4% remaining from past 10% treatment permit requirement.

• **Step 2**: Total percentage of untreated area to be treated by 2017
  – E.g., 4% + 20% = 24%

• **Step 3**: Estimate percentage of all urban area,
  – E.g., If untreated area is 70% of total urban area, and you will be treating 24% of that, then: (Total Urban Area) x 0.7 x 0.24 = (Urban Area Treated)
  – % Total Urban Treated area is: (Urban Area Treated)/(Total Urban Area)

• **Step 4**: Estimate aggregate retrofit efficiency: e.g., 33%

• **Step 5**: Enter percentage of area treated & efficiency.
Refinement Issues to Consider:

1. Pervious vs Impervious.

2. Local Land Area Estimates vs EPA Bay Program Estimates

3. Geographic Location of Treatment:
   - Beware of varying delivery factors within your county, e.g., above/below a reservoir, between major basins.

4. More Explicit BMPs
   - Although we advocate using a simple approach for BMP analyses, some might wish to mimic more complex local plan elements in MAST.
   - Recommend: You have simplified approach as a fall-back.
Septic System Nitrogen Loads

• Basic Loading Calculation for a System:
  \[ X \text{ people/system} \times Y \text{ lbs/person/year} = \text{ lbs/system/year} \]
  - Load to the septic system drain field
  - People/system 2.6 – 3.2
  - Load/person 8.6 – 9.5

• Accounting for losses:
  \[ X \text{ people/system} \times Y \text{ lbs/person/yr} \times \text{Delivery Factor} \]
  - Deliver Factor \( \leq 1 \)
  - Load to the nearest surface water
  - Does NOT account for transport to the Bay
Septic System
Nitrogen Loads by Zone

• Three Zones for Load Estimates to Surface Waters:
  1. Critical Area: Within 1,000 ft of tidal waters
  2. Near Streams: Within 1,000 ft of a perennial stream
  3. Other Areas

• Transport of Load to Nearest Surface Waters:
  1. Critical Area: 80% reaches the water
  2. Near Streams: 50% reaches the water
  3. Other Areas: 30% reaches the nearest water

• E.g., Calculation in Critical Area:
  − 2.6 people/system x 8.6 lbs/person/yr x 0.8 = 17.9 lbs/yr

• Except for the Critical Area, these do not include transport loss to the Bay: {See Next Slide}
Septic System Nitrogen Transport Losses to Bay

- Transport Losses to Tidal Waters (Bay):
  - Critical Area: Entire 80% is delivered to the Bay
  - Near Streams: 50% reaches the stream - loss to Bay
  - Other Areas: 30% reaches the stream - loss to Bay

Within 1,000 ft of streams, 50% reaches the stream, then there is additional transport loss as the loads are delivered to the Bay.

Same Principle for “Other Areas”
Septic System Nitrogen Transport Losses to Bay

• Sample Calculations:
  – Critical Area: Entire 80% is delivered to the Bay
    \[2.6 \times 8.9 \times 0.8 \times 1 = \text{Annual Load to Bay}\]
  – Near Streams: 50% reaches the stream - loss to Bay*
    \[2.6 \times 8.9 \times 0.5 \times \text{DF}^* = \text{Annual Load to Bay}\]
  – Other Areas: 30% reaches the stream - loss to Bay*
    \[2.6 \times 8.9 \times 0.3 \times \text{DF}^* = \text{Annual Load to Bay}\]

* DF - The additional loss during transport to the Bay varies across the State. DF was about 0.75 as a statewide average in the Phase I WIP model.
### Numbers of Maryland Septic Systems in the Bay Watershed

<table>
<thead>
<tr>
<th>Zone</th>
<th>Number of Septic Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Area</td>
<td>46,255</td>
</tr>
<tr>
<td>1000 feet of Stream</td>
<td>134,807</td>
</tr>
<tr>
<td>Other</td>
<td>237,473</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>418,535</strong></td>
</tr>
</tbody>
</table>
Septic Systems Strategies Overview

• Two General Strategy Options:
  – Upgrade to Nutrient Removal Technology, also called “best available technology” (BAT)
  – Connect to Advanced Wastewater Plant

• Both Reduce the Nitrogen Load by about Half (50%)
# Septic Systems
## Phase I WIP 2017 Strategy

<table>
<thead>
<tr>
<th>Category</th>
<th>Key 2017 WIP Strategies</th>
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<tbody>
<tr>
<td>Critical Area</td>
<td>• Upgrade 33,252 systems (60%) to BAT</td>
</tr>
<tr>
<td></td>
<td>– 27,522 Septic Owners to upgrade*</td>
</tr>
<tr>
<td></td>
<td>– 5,700 New or Failing to be upgraded</td>
</tr>
<tr>
<td>Near Streams</td>
<td>• No explicit strategy</td>
</tr>
<tr>
<td>Other</td>
<td>• No explicit strategy</td>
</tr>
</tbody>
</table>

* In 2011, assess options to phase in requirement to retrofit all septic systems in the Critical Area using best available technology beginning in 2012. Assessment to include viability of tax credits, income-based criteria for grant eligibility and other means to facilitate upgrades.

**Other Septic Reductions:**
• 930 Septic Connections
Phase I WIP Short on Upgrades

• Final Allocation calls for 39% Reduction:
  – 39% reduction implies upgrading 78% of systems*

• 2017 Plan calls for upgrading about 8% of systems
  – Implies upgrading remaining 70% between 2017 and 2020

• Implications:
  – Phase II WIP needs greater pace of upgrades than 8%.
  – Phase II WIP 2017 strategy needs upgrades outside of Critical Area.
  – If only 78% systems upgrade, which ones do and which ones don’t upgrade? What are the funding implications?
  – Phase II WIP needs to commit to a process for resolving these issues.

* 50% reduction per system necessitates upgrading 2 x 39%, or 78% as a ball-park estimate
END