EPA Region III
Storm Water Data Subgroup

Report and Recommendations

October, 2001

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Introduction

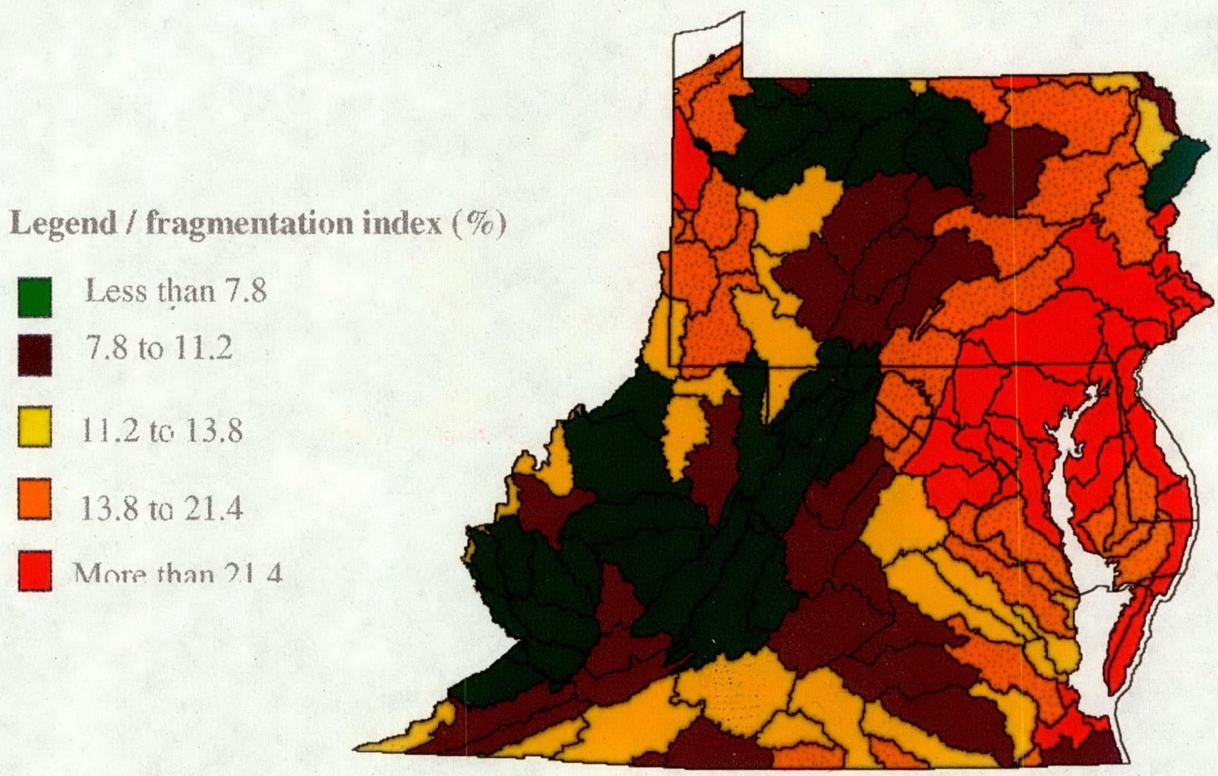
This report on storm water data presents an overview of existing EPA data and research efforts on storm water impacts. The report proceeds from a broad overview of land development spurred by population growth which creates environmental conditions that result in storm water having detrimental effects on aquatic habitat and organisms. Key findings from research studies on aquatic impacts are presented and special issues are discussed relating to stormwater sources and groundwater. Regulatory controls are connected to sources of storm water and their impacts and water quality assessment results and presented and analyzed. A framework for environmental indicator development is presented as well as a targeting strategy for focusing resources on the most critical and sensitive areas. Recommendations for specific work efforts to support the regional storm water strategy are presented.

Overview of Environmental Impacts

Ongoing development of suburban areas presents a continuing source of environmental stress primarily through loss or modification of habitat. Other development-related stresses result from storm water runoff at construction sites, stream channelization, stream flow alterations, forest fragmentation, and increases in impervious surface area.

FOREST FRAGMENTATION

Forests play an important role on landscapes both natural and developed. They benefit human uses and wildlife species, providing wood fiber, outdoor recreation, wildlife habitat and regulation of certain hydrologic processes. Forests produce tremendous amounts of energy, nutrients, and oxygen, and affect regional weather and global climates. Overall, about 70% of EPA Region III is forested and a majority of the watersheds in Region III have over 60% forest cover. Forest fragmentation is a significant environmental concern in the Region III. It refers to formerly continuous forest that has been broken up into smaller pieces. Substantial differences exist between broken-up and continous forests in their ability to support wildlife species and communities and to maintain a sustainable forest ecosystem.

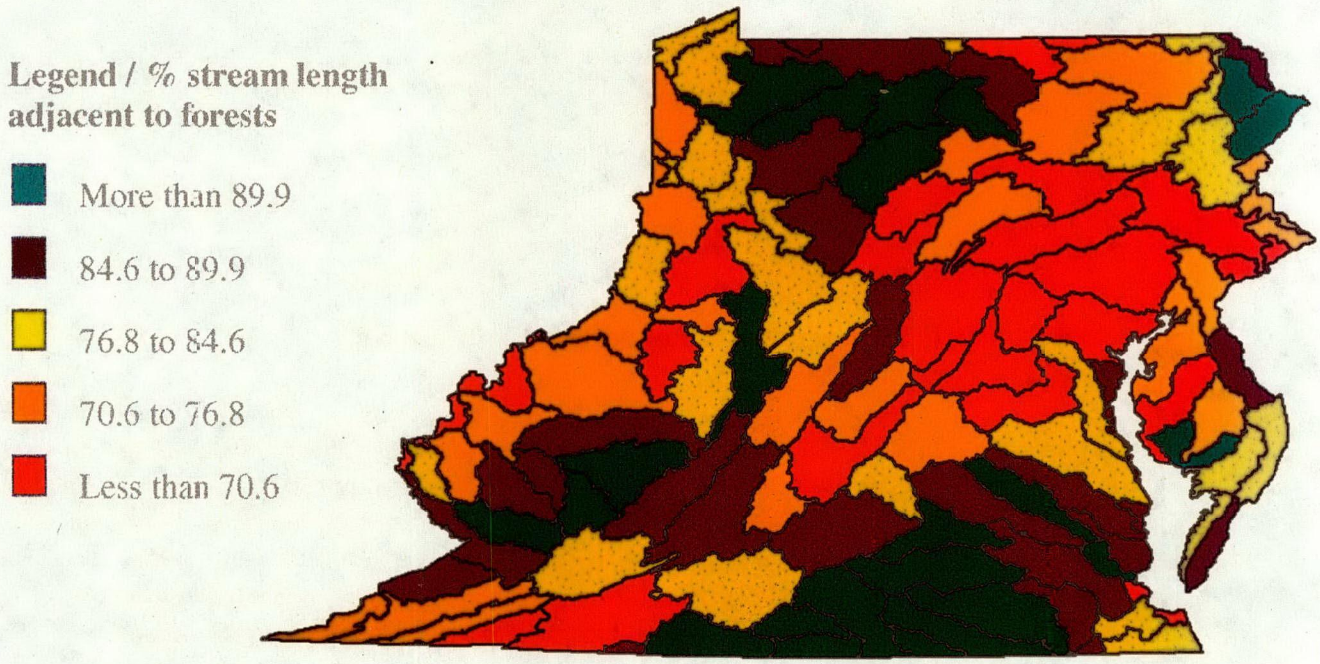


Forest fragmentation is highest in watersheds around the Chesapeake Bay area and in western Pennsylvania in the major urban centers of the region

In the eastern United States, forest loss is generally associated with conversion to agricultural and urban/suburban land uses. Increasing forest fragmentation is closely related to population change: as the population increases, the need for developed land increases resulting in more forests converted to agricultural and urban /suburban uses.

Environmental Problems associated with Forest Fragmentation
The degree of connectivity of a forest can affect the sustainability of forest species within or among watersheds. Areas with large blocks of continuous forests support a wide variety of forest species, whereas areas with small, fragmented forests support fewer interior species. Interior forest habitats are very rare and easily lost. Forest fragmentation can therefore result in the endangerment or extinction of interior species.

RIPARIAN VEGETATION
Riparian vegetation, the vegetation along the edge of a stream, influences the condition of both the stream bank and water quality. Forested riparian zones are a natural part of the healthy ecosystems. They provide an effective barrier and filter to runoff of water pollutants such as excess fertilizer, and support a variety of valuable plant and wildlife species. When forests are removed right up to the edge of a stream, the riparian zone not only loses its natural buffering capacity but also now becomes a potential source of pollution, such as solids from soil erosion, and excess fertilizer.

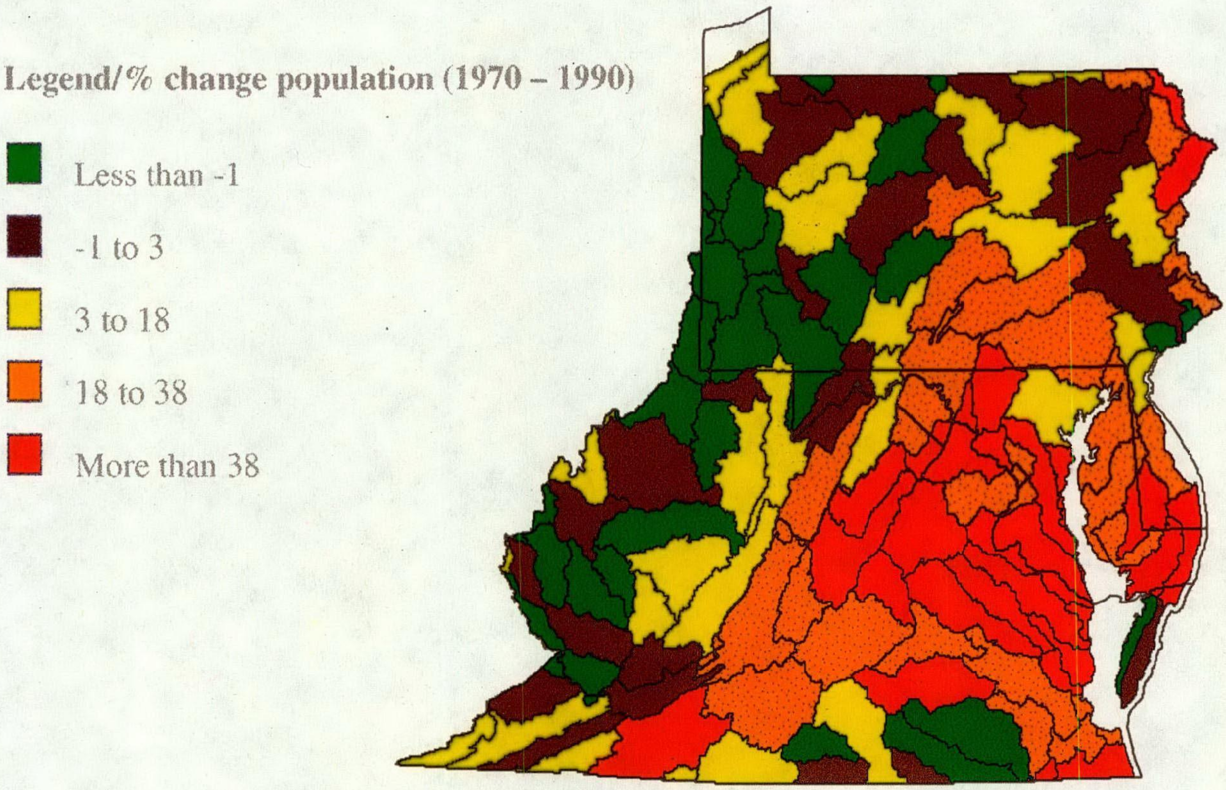


Forested riparian zones in Region III waterhseds

The Forest Health Monitoring Program (FHM), a MAIA partner, has the lead for monitoring forests in the mid-Atlantic. The Chesapeake Bay Program is actively involved in the planting of riparian forest buffers.

URBAN SPRAWL

Urban Sprawl is low density, automobile dependent development outside of urban centers. It is wide-spread in the U.S. and its effects impact the quality of life in every region of America, from large cities to small towns. Urban sprawl can be measured using the U-Index (Human Use Index). The U-Index is a measure of the total watershed area that is covered by either urban or agricultural lands. Population growth is the most significant factor effecting urban sprawl in the Mid-Atlantic region: as population increases, so does the amount of land required for residential and commercial needs.



Population Change in EPA Region III (1970 – 1990)

Areas most greatly affected by Urban Sprawl

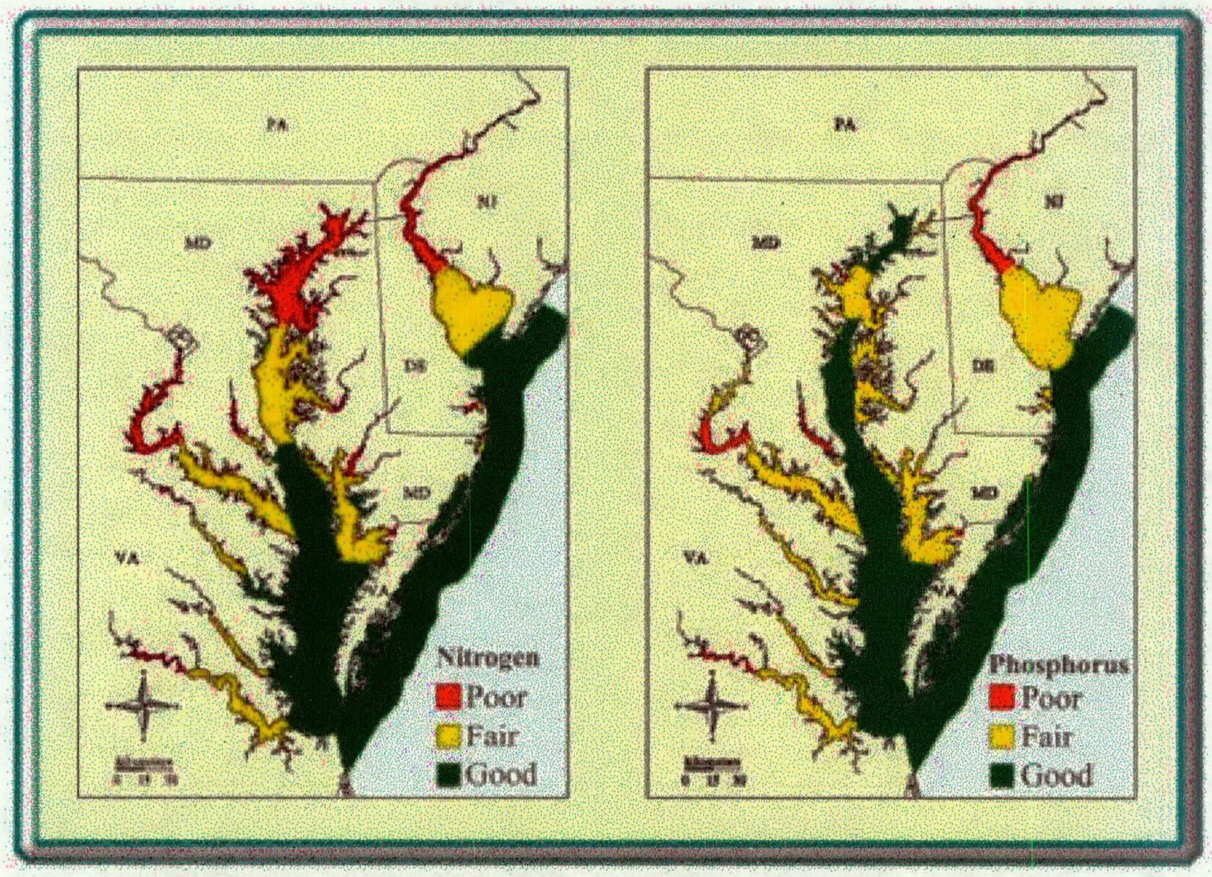
In the Chesapeake Basin alone, between the years of 1950-1980, the percent of land used for residential and commercial purposes increased nearly 180% while population increased about 50%. Based upon current trends in Maryland, in a recent six-month period, approximately 5,000 people left Baltimore City; 3,000 septic permits were issued; and nearly 10,000 acres of forests and farmlands were lost. If these trends continue, Maryland could use as much land for development in the next 25 years as it has used in the entire history of the state. Likewise, in northern Virginia, development is expanding beyond the current service areas of public water supplies provided by the Potomac River. Specifically, northern Virginia's Loudon County's population has increased by nearly 150 percent from 57,000 in 1980 to nearly 140,000 today, with the landscape changing from rural to suburban.

There are a number of environmental concerns that arise from urban sprawl. Increased human use places greater stress on the regions natural resources. Some of the resources in the region that are greatly affected by urban sprawl include freshwater streams, estuaries, forests, ground water and air.

Estuaries

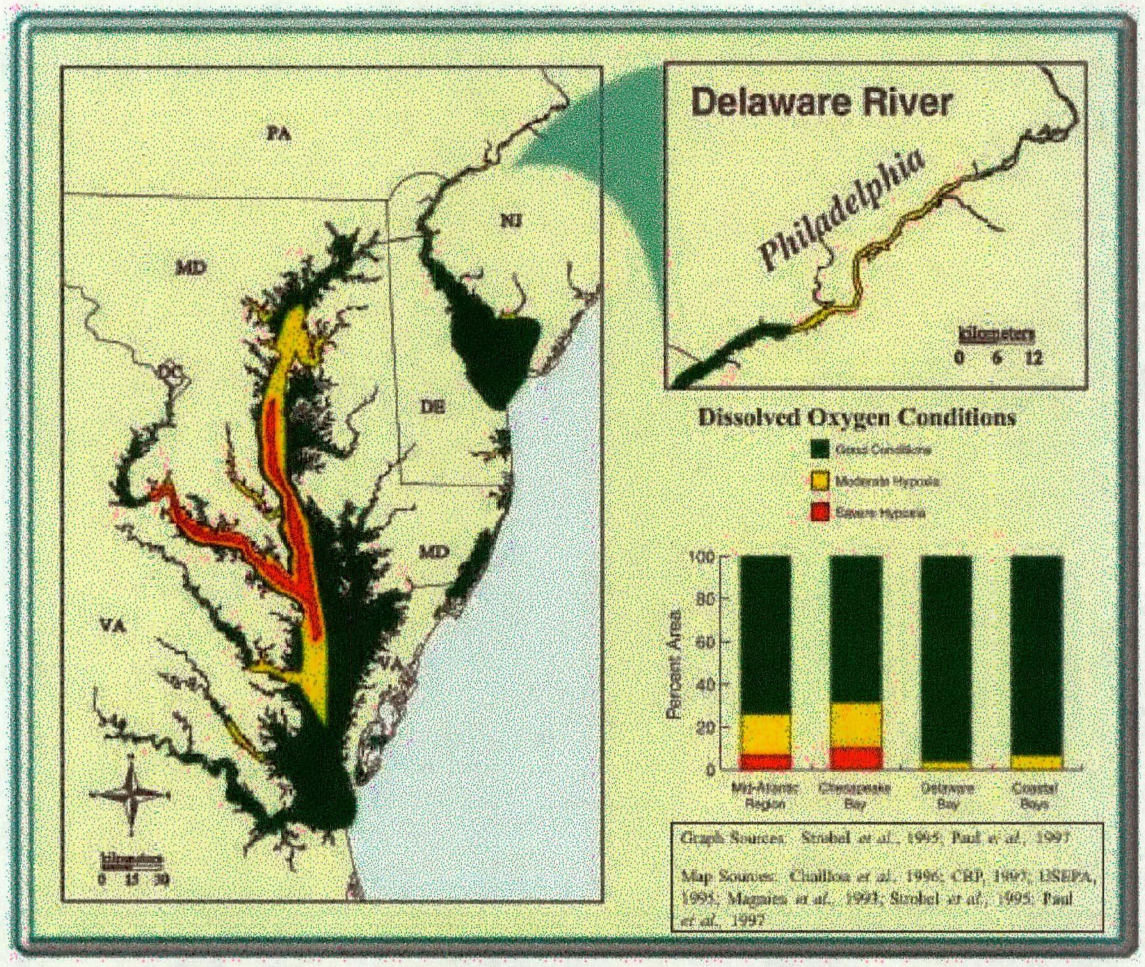
The estuaries of the mid-Atlantic region are generally adjacent to growing metropolitan areas such as Baltimore, D.C, Norfolk, and Philadelphia. These areas have a high volume of storm water runoff, which is high in pollution and effects the condition of the neighboring estuaries. The main pollutants that affect the region's estuaries are excess nutrients, which are common in storm water runoff, and contaminated sediments. These pollutants have adverse effects on various aspects of the estuarine ecosystem such as the level of dissolved oxygen, the benthic community and submerged aquatic vegetation.

The figure below shows the levels of dissolved nitrogen and phosphorous measured during the summer months in surface waters. The main source of these pollutants is excess fertilizer runoff from farms. It can be seen below that nutrient levels are higher than optimum in most rivers and upper bays.



Concentrations of dissolved nitrogen and phosphorous in estuarine waters

The figure below shows the distribution of summertime dissolved oxygen within one meter of bottom sediments across estuarine waters. Dissolved oxygen is a major requirement for the maintenance of balanced levels of fish and other aquatic biota. Reduced levels of dissolved oxygen are a result of excess nutrients in the estuarine waters. These nutrients fuel the growth of phytoplankton, the decomposition of which consumes oxygen. It can be seen below that the Chesapeake Bay has the worst case of low dissolved oxygen levels



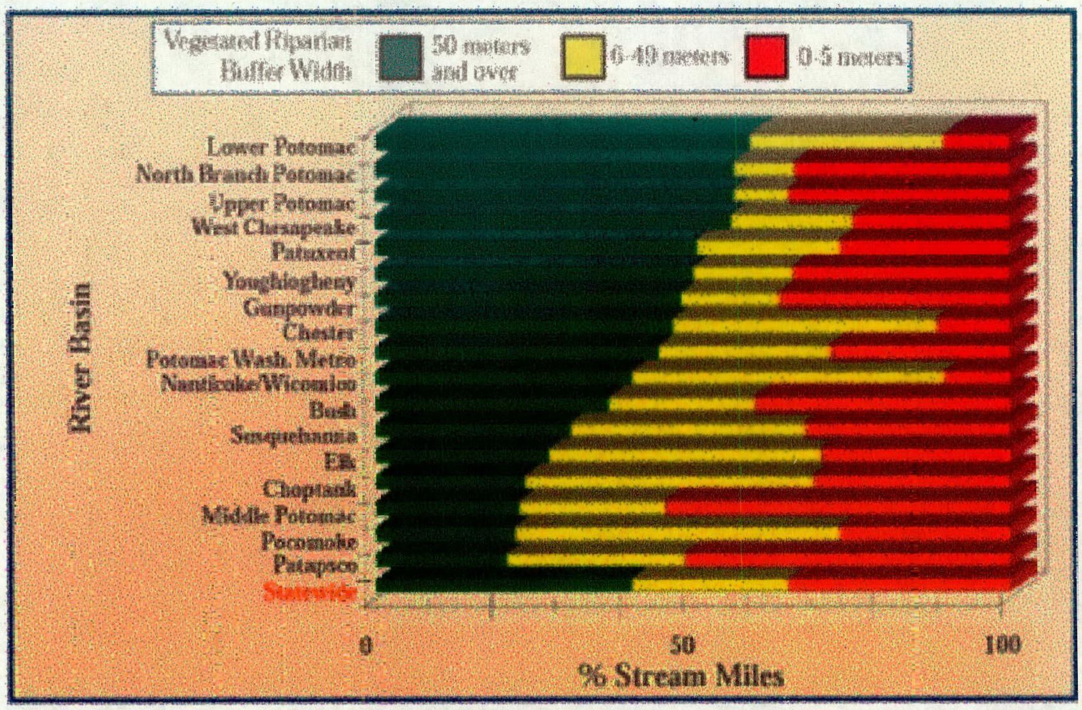
Distribution of dissolved oxygen in estuarine waters in the region

Freshwater Streams

Current patterns of suburban development have caused significant impacts to the Region's streams. If urban sprawl continues to consume forests and farmlands in the same manner as the past, the Region's streams will continue to degrade in years to come. The health of the Region's streams is largely influenced by the amount of impervious cover – asphalt, concrete and other man-made surfaces which are impermeable to rain water. Development is characterized by the conversion of land cover from pervious to impervious. In the recent EPA/Maryland streams study, when watershed imperviousness exceeds 2%, brook trout, which are pollution sensitive, are no longer found. When watershed imperviousness exceeds 15%, the index of biotic integrity, which uses fish and benthic organisms as an indicator of stream quality, is never good (i.e., fair or poor in all cases), and when imperviousness exceeds 25% only hardy reptiles and amphibians remain.

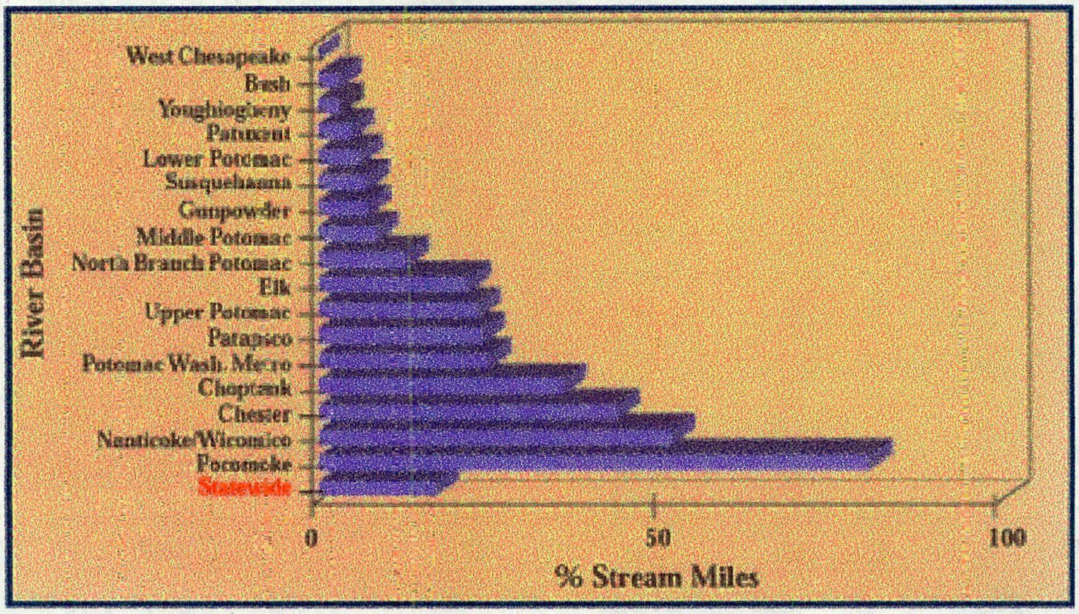
Aquatic life is strongly impacted by increases in impervious land cover

Urban sprawl also affects the physical habitat of fresh water streams in the region. In general good stream habitats have wide, naturally vegetated riparian buffers, meandering channels with stable, naturally vegetated banks, and a variety of substrates such as wood, roots and rocks. In urban areas streams are being impacted in terms of water quality, habitat, and aquatic species. The riparian zones of many of the Region's freshwater streams have been altered due to urbanization. In Maryland study, more than one-quarter (27%) of all stream miles in the state are unbuffered and 14% are buffered by vegetation other than forests such as abandoned croplands or lawns.



More than one-quarter (27%) of all stream miles in the state of Maryland are have inadequate riparian buffers.

In areas where forested lands are converted to urban land, many streams are *channelized* to drain farm fields or to allow for the rapid removal of storm water from developed land surface. In Maryland channelization causes the most severe physical habitat degradation on streams. During channelization naturally meandering streams are straightened, riparian vegetation is cut, and streamside vegetation is removed. Channelization also increases the speed at which nutrients and sediment flush from upland streams to downstream rivers and into the bays. About 17% of all stream miles in Maryland are channelized.



Channelization prevalent in heavily urbanized part of Maryland

Studies of Effects of Urbanization on Aquatic Systems

The following matrix summarizes key findings from aquatic impact studies on stream habitat and biota. The findings point to the severe impacts on aquatic species from impervious cover and are useful for indicator development.

Impact Studies of Effects of Urbanization on Aquatic systems

Watershed Indicator	Key Finding	Reference	Year	Location
Aquatic insects	Negative relationship between number of insect species and urbaniztion in 21 streams.	Banke, et al.	1981	Atlanta
Aquatic habitat	There is a decrease in the quantity of large woody debris (LWD) found in urban streams at around 10% impervious cover.	Booth, et al.	1996	Washington
Fish, habitat & channel stability	Channel stability and fish habitat quality declined rapidly after 10% impervious area.	Booth	1991	Seattle
Fish, habitat	As watershed population density increased, there was a negative impact on urban fish and habitat	Couch, et al.	1997	Atlanta
Aquatic insects and fish	A comparison of three stream types found urban streams had lowest diversity and richness	Crawford & Lenat	1989	North Carolina
Stream temperature	Stream temperature increased directly with subwatershed impervious cover.	Galli	1991	Maryland
Aquatic insects	A significant decline in various indicators of wetland aquatic macroinvertebrate community health was observed as impervious cover increased to levels of 8-9%	Hicks & Larson	1997	Connecticut
Insects, fish, habitat, water quality, riparian zone	Steepest decline of biological functioning after 6% imperviousness. There was a steady decline, with approx 50% of initial biotic integrity at 45% impervious area.	Homer, et al.	1996	Puget Sound Washington
Aquatic insects and Fish	Unable to show improvements at 8 sites downstream of BMPs as compared to reference conditions.	Jones, et al.	1996	Northern Virginia
Aquatic insects	Urban streams had sharply lower insect diversity with human population above 4/acre. (About 10%)	Jones & Clark	1987	Northern Virginia
Aquatic insects & fish	Macroinvertebrate and fish diversity decline significantly beyond 10-12% impervious area.	Klein	1979	Maryland
Aquatic insects	Drop in insect taxa from 13 to 4 noted in urban streams.	Gone and McIntosh	1986	New Jersey
Fish spawning	Resident and anadromous fish eggs & larvae declined in 16 streams with > 10% impervious area.	Limburg & Schmidt	1990	New York
Fish	Shift from less tolerant coho salmon to more tolerant cutthroat trout pop.-between 10-15% impervious area at 9 sites.	Luchetti & Fuersteburg	1993	Seattle

Watershed Indicator	Key Finding	Reference	Year	Location
Stream channel stability	Urban stream channels often enlarge their cross-sectional area by a factor of 2 to 5. Enlargement begins at relatively low levels of impervious cover.	MacRae	1996	British Columbia
Aquatic insects & stream habitat	No significant difference in biological and physical metrics for 8 BMP sites versus 31 sites without BMPs (with varying impervious area).	Maxted and Shaver	1996	Delaware
Insects, fish, habitat, water quality riparian zone	Physical and biological stream indicators declined most rapidly during the initial phase of the urbanization process as the percentage of total impervious area exceeded the 5-10% range.	May, et al.	1997	Washington
Aquatic insects and fish	There was significant decline in the diversity of aquatic insects and fish at 10% impervious cover.	MWCOG	1992	Washington
Aquatic insects	As watershed development levels increased, the macroinvertebrate community diversity decreased.	Richards, et al.	1993	Minnesota
Aquatic insects	Biotic integrity decreases with increasing urbanization in study involving 209 sites, with a sharp decline at 10%. Riparian condition helps mitigate effects.	Steedmen	1988	Ontario
Wetland plants amphibians	Mean annual water fluctuation inversely correlated to plant & amphibian density in urban wetlands. Declines noted beyond 10% impervious area.	Taylor	1993	Seattle
Wetland water quality	There is a significant increase in water level fluctuation, conductivity, fecal coliform bacteria and total phosphorus in urban wetlands as impervious cover exceeds 3.5%.	Taylor, et al.	1995	Washington
Sediment loads	About 2/3 of sediment delivered into urban streams comes from channel erosion.	Trimble	1997	California
Water quality- pollutant concentration	Annual P, N, COD, & metal loads increased in direct proportion with increasing impervious area.	US EPA	1983	National
Fish	As watershed development increased to about 10%, fish communities simplified to more habitat and trophic generalists.	Weaver	1991	Vrginia
Aquatic insects & fish	All 40 urban sites sampled had fair to very poor index of biotic integrity (IBI) scores, compared to undeveloped reference sites.	Yoder	1991	Ohio

Special Issues

Impervious Surfaces and Ground Water

Ground Water is a resource of utmost importance for support of ecosystems, stream and river systems, drinking water supplies and industrial uses. Ecologic importance of ground water includes maintaining base flow of streams, supporting biotic communities at the interface with surface water, maintaining wetlands and providing aquifer storage.

Impervious surfaces permanently block recharge to ground water through the soil and rock strata that has been covered over. Impervious surfaces create conditions which result in severe drought/flood cycles. This happens because impervious surfaces block normal recharge of ground water during rain events resulting in decreased ground water levels. Instead of recharging the water table, the rain is diverted rapidly to streams and may produce scouring of stream beds and organisms. When drought conditions exist, they are severely exascerbated by the inability of the ground water supply to maintain adequate base flow in the stream due to inadequate recharge. These conditions severely stress aquatic organisms, habitats and vegetation. Lastly, impervious surfaces change the well contribution, sometimes pulling contaminants from more distant areas. Changing of existing pathways of runoff by the use of stormwater collection systems can create or exacerbate sinkhole formation in karst/limestone geologic settings.

Drinking water protection programs, such as EPA's wellhead protection and source water assessment programs can be a tool to help manage stormwater runoff and are an obvious opportunity for program coordination

MS4s and Construction Activities

Proper management of storm water runoff requires multi-media efforts. Storm water falls on superfund sites, RCRA sites, picks up atmoshperic pollutants, may cause flooding, erosion, sedimentation, turbidity, impacts fish & wildlife habitat, impacts finfish & shellfish harvesting, boat navigation, recharges ground water tables, and recharges surface water intakes. In the MS4 Program, EPA has the ability to require implementation of low impact development (LID) plans in targeted growth areas. LIDs are especially needed in developing areas because their implementation can avoid degradation of stream quality. By using LIDs, a variety of enviornmental objectives can be achieved. The main objectives are:

Reduce Stream Velocities - overland flow will be reduced, thus reducing stream velocities and the resulting scouring during rain events.

Mitigate Flooding Damage - overland flow reductions reduce stream flow volume and potential for flooding.

Stabilize Water Column - Increased infiltration will increase base flow of receiving streams. Without proper base flow, the habitat does not provide a stabile environment for aquatic life support.

Maintain Natural Organic Matter (NOM) Levels - NOM, decreases bio-availablity of toxics and increases acidity.

Maintain Water Supply - Increased infiltration also provides for more recharge to ground water (which may be used for well supplies) and increases base flow, which provides a more stable water supply for surface water intakes (volume is more consistent and salt water intrusion is prevented).

For these reasons, the storm water managment component of the MS4 permits should contain LID requirements for targeted growth areas.

Storm Water Sources, Impacts and Applicable Regulations

The table on the next two pages provides the linkage between sources of storm water, associated pollutants, impacts to habitat and biota, and the associated regulatory programs. It details the environmental damage caused by improper storm water management.

The first column identifies the major categories of activities (alterations of the natural land surfaces) which result in damage to the aquatic environment. The second column identifies physical and/or chemical effects which result form these activities. The third column provides details of how these effects result in damage to aquatic organisms and their habitat. The last column identifies the regulatory programs which are believed to have the capacity to properly manage the respective activities to prevent environmental damage.

This table is useful for a number of purposes:

- as a baseline for review of existing impacts and applicable regulations to assess the adequacy of the regulatory authority in abating those impacts;
- as a source for developing environmental indicators that adequately link program activities with environmental outcomes;
- and as a source for developing an increased understanding of storm water impacts and emerging areas of concern, particularly natural organic matter and scouring.

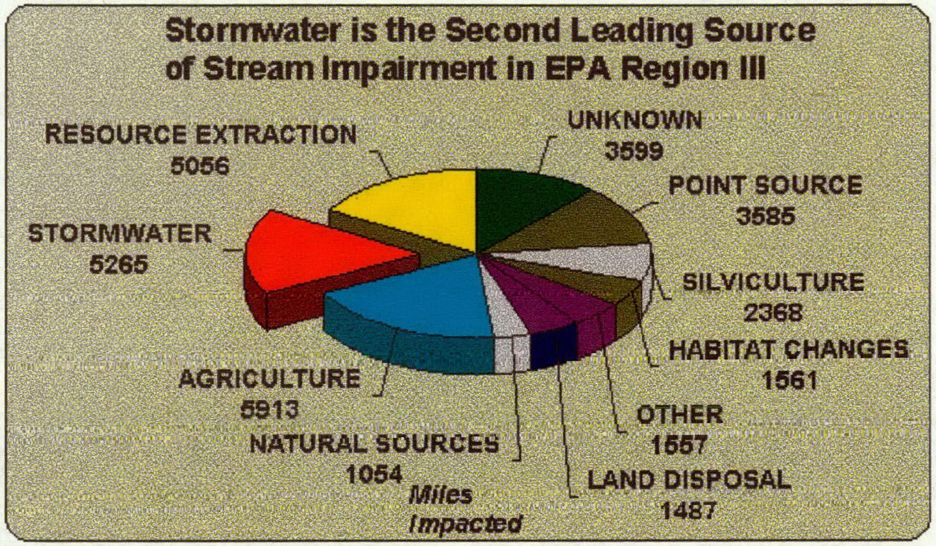
Storm Water Sources, Impacts and Applicable Regulations

Source of Impairment	Pollutants	Impacts	Regulatory Programs
Construction	**Additional Runoff** Due to Lack of Vegetation (Bio-retention Is Severely Reduced)	Increased Erosion at Construction Sites and in Receiving Water	Local E&S State Regs EPA Permit & Guidance
	TSS/TDS	Abrasiveness Damages Plants, Finfish & Other Aquatic Organisms, Etc (Food Supply for Finfish)	
		Sediments bury Plant Shoots and Fill Habitat Areas on Stream Bed	
	Turbidity	Blocks Sunlight Necessary for growth of aquatic organisms	
	Oil & Grease	Impairs habitat, aquatic life and wildlife.	
Forest Harvesting/ Farming/Spills	Same As **"Construction"**	Same As **"Construction"**	NPS TMDLs

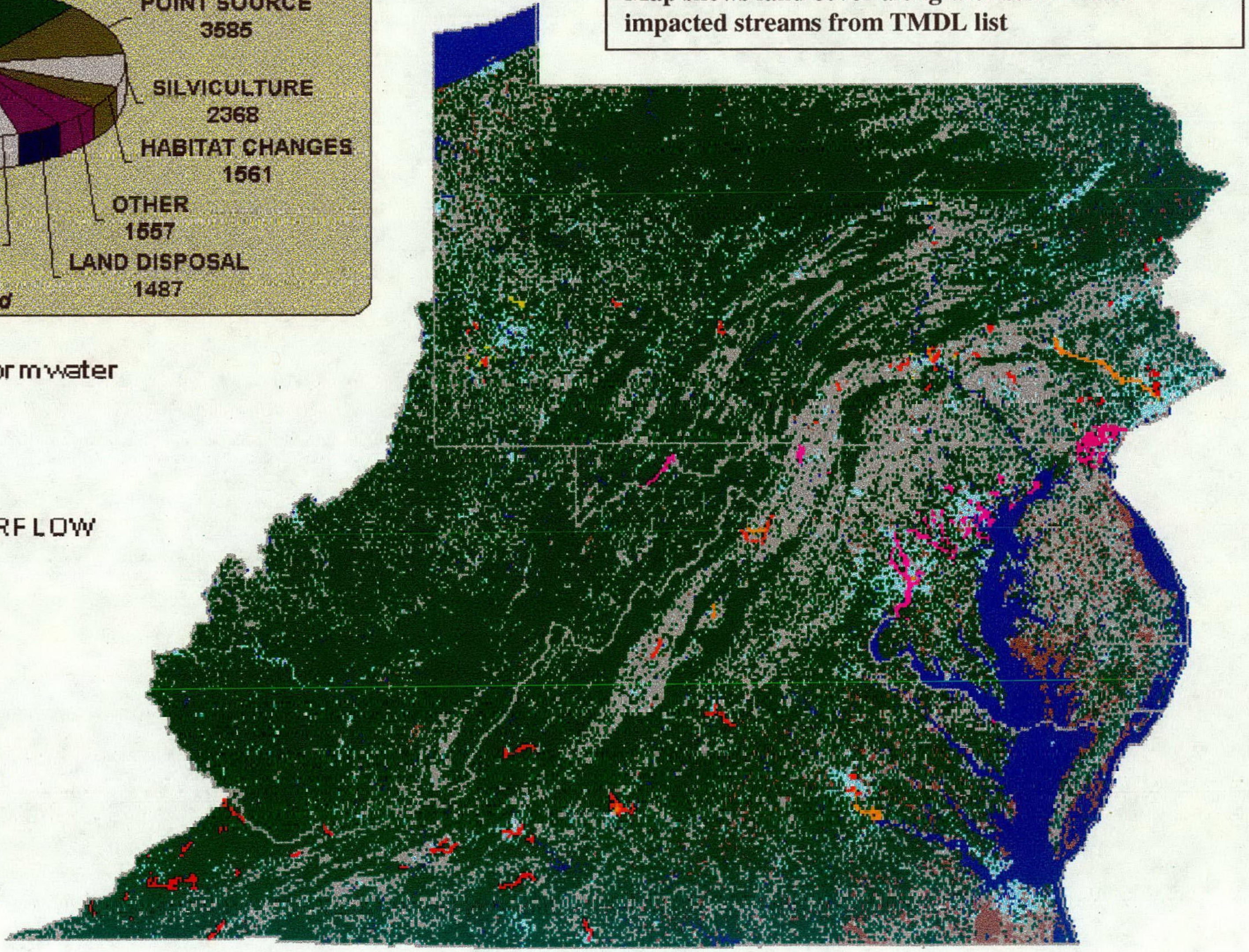
Major Sources of Impairment	Pollutants	Impacts	Regulatory Programs
Imperviousness	**Stream Velocity & Hydraulics**	Scouring	MS4 Permit NPS Grants Local Zoning Local E&S State Regs EPA Permit & Guidance TMDLs
		Erosion/damage to Physical Structure of Stream Bed and Stream Bank - Habitat Does Not Support SAVs	
		Damage to Hydrology Reduces Habitat (Reduced Base Flow) Which Creates Additional Stress on Aquatic Organisms, Reduces Population.	
	Reduction of Natural Organic Matter (NOM)	Needed for sustainability of aquatic life (NOM provides food for small aquatic organisms and reduces bioavailability of toxics in the water column & in sediment.)	
	Increases Pollutants in Runoff	Urban/Commercial/Industrial Activities & Atmospheric Deposition place pollutants on impervious surfaces which mobilize more easily than on vegetated surfaces.	
	Flooding and Recharge	When vegetation is removed and replaced with impervious surface, rainfall cannot infiltrate and recharge groundwater supplies. As the %imperviousness in a drainage area increases, the potential for flooding increases. Flooding is a threat to safety and can damage property.	

Water Quality Assessments:
Results and Analysis

Stormwater Runoff is a Major Source of Urban Stream Impairment in EPA Region III



Map shows land cover along with storm water-impacted streams from TMDL list

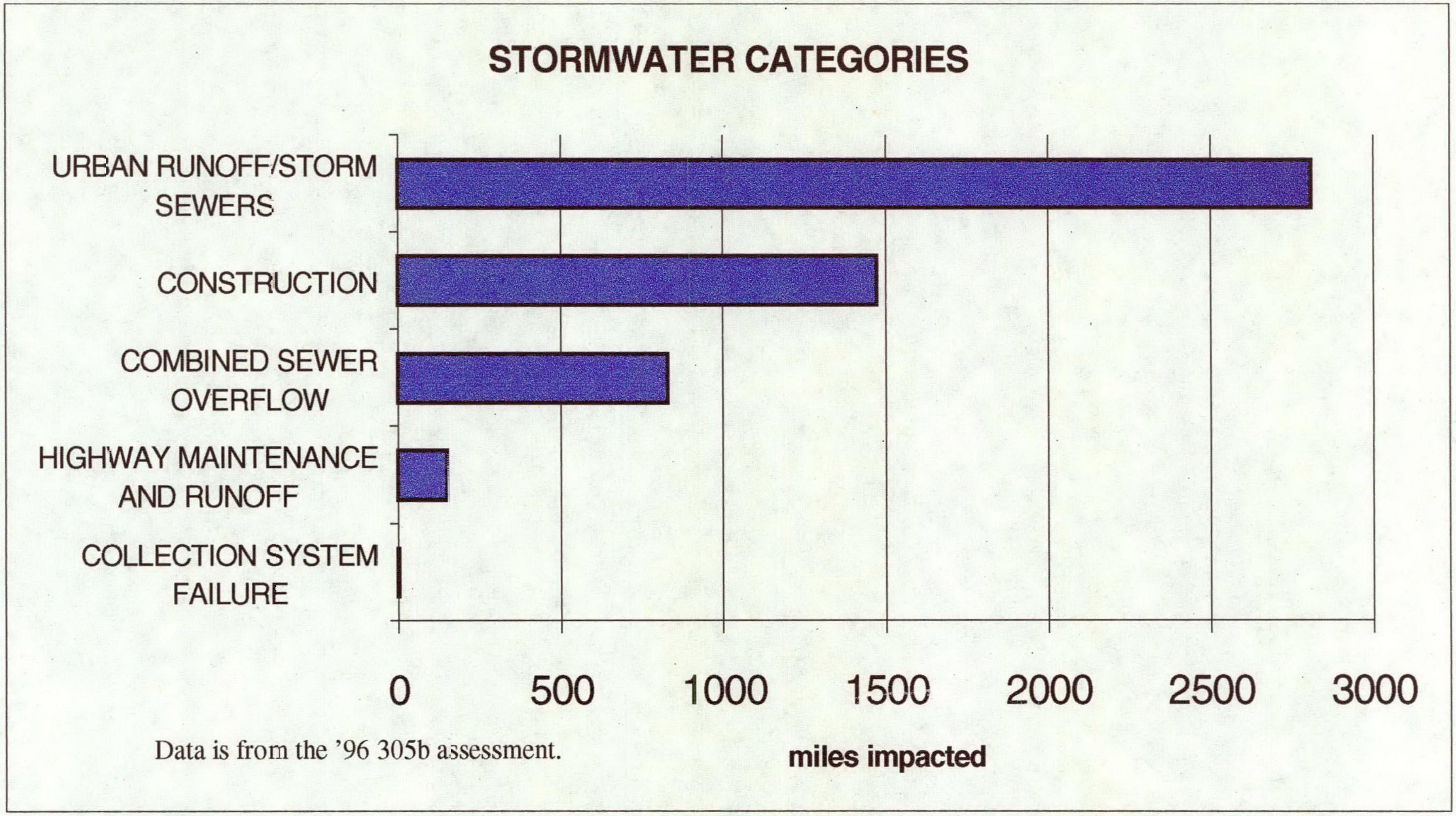


Water Quality Assessments – Storm Water

305b 1996		DC	DE	MD	PA	VA	WV
	COLLECTION SYSTEM FAILURE						2.8
	HIGHWAY MAINTENANCE AND RUNOFF	1.2					149.36
	COMBINED SEWER OVERFLOW	12.3	15.9		32.1	39.38	729.58
	CONSTRUCTION	1.3	5.1	129.2	60.9		1276.86
	URBAN RUNOFF/STORM SEWERS	36.6	147.5	372.2		887.42	1365.27
	Total	51.4	168.5	501.4	93	926.8	3523.87
305b 1998		**DC**	**DE**	**MD**	**PA**	**VA**	**WV**
	URBAN RUNOFF/STORM SEWERS	38.1	124.65		398.84	320.42	1189.73
	CONSTRUCTION	1.6	5.1		143.75		1072.83
	COMBINED SEWER OVERFLOW	12.3	7.9		17.11	32.23	514.1
	HIGHWAY MAINTENANCE AND RUNOFF						167.14
	COLLECTION SYSTEM FAILURE (SSO)			1		23.96	6.25
	Total	52	137.65	1	559.7	376.61	2950.05
305b 2000		**DC**	**DE**	**MD**	**PA**	**VA**	**WV**
	URBAN RUNOFF/STORM SEWERS	38.4	304	605	1000	719	254
	COMBINED SEWER OVERFLOW	12.3		224			
	RAW SEWAGE						297
	Total	50.7	304	829	1000	719	551
TMDL 1998		**DC**	**DE**	**MD**	**PA**	**VA**	**WV**
	URBAN RUNOFF/STORM SEWERS				457.76	535.57	
	CONSTRUCTION				142.18		
	COMBINED SEWER OVERFLOW	12.3			33.73	58.68	
	Total	12.3	0		633.67	594.25	0

*** all values are stream miles**

The chart shows typical storm water categories used in 305b assessments.



Data is from the '96 305b assessment.

Analysis of Water Quality Assessments

Based on a review of the past 6 years of state water quality assessment data, storm water runoff is the second leading source of stream impairment in EPA Region III. This refers to all storm water categories: urban runoff, storm sewers, CSOs, construction, highway runoff, and collection system failure. Storm water impacts are most prevalent in urban areas.

Over 5000 stream miles have been identified as impaired from stormwater runoff, but only about 1700 of those stream miles are on the TMDL streams list. This is because there are a number of reporting consistency issues with the assessments. Another concern that many lower order streams are not even assessed for storm water impacts. There is no consistent set of parameters which must be assessed in the 305b analysis and there is no matrix of parameters assessed/not-assessed which is available with the streams. Therefore, one cannot tell by looking at an assessment what parameters were measured and more importantly what parameters were not measured. This should be a requirement for 305b reporting.

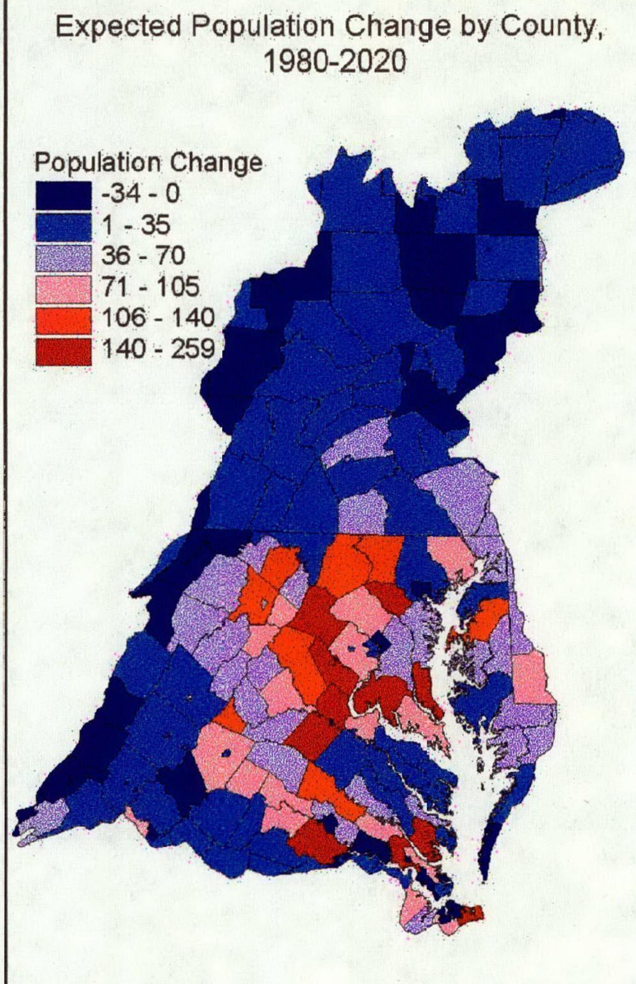
Data standards are key to evaluating water quality impairments and making comparisons and trend analyses. In the TMDL list some states use "nonpoint sources" as a source category without identifying the specific contributing nonpoint source categories. In the 305b assessments, "nonpoint sources" is not used, rather specific nonpoint sources are identified by states. This issue makes comparisons between the 305b assessment and the TMDL listings very difficult. Also, the unique stream identification system called Stream Reach Indexing is not used by states in developing water quality assessments or TMDL lists. Again this makes data analysis, especially geospatial analysis difficult when working with 305b and TMDL data together. States should report the EPA Reach File 3 identifier for all stream water quality listings. Continued focus on improving consistency in reporting standards is important for correctly assessing the problem extent and measuring progress.

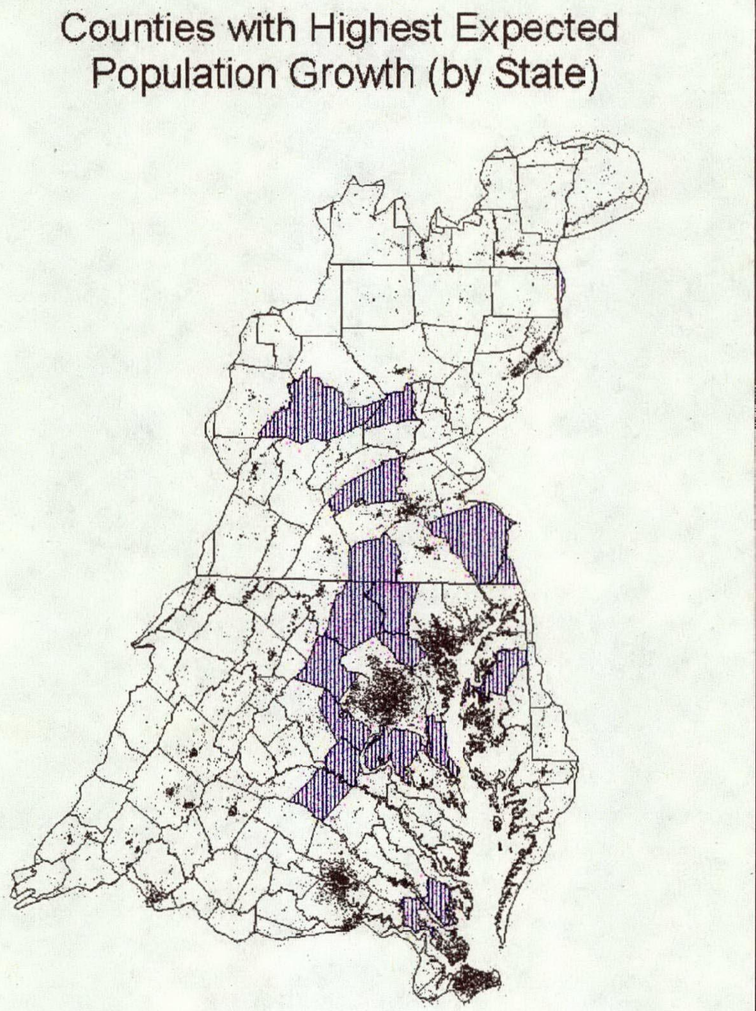
Another issue is the elecronic reporting and updating of water quality assessment data and maintenance of geospatial data layers in the spatial data library. This process needs to be streamlined and to address the issues identified above – data standards, 305b-TMDL consistency, RF3 indexing – in order to have good quality, up-to-date assessment data from which to base decisions and evaluate progress.

Chesapeake Bay Characterization

The data presented in the Chesapeake Bay characterization provides a foundation of key metrics which are necessary for modeling and predicting future growth and associated changes to land cover, impervious cover, pollutant loads and impacts to aquatic life and habitat.

Population Growth Projections

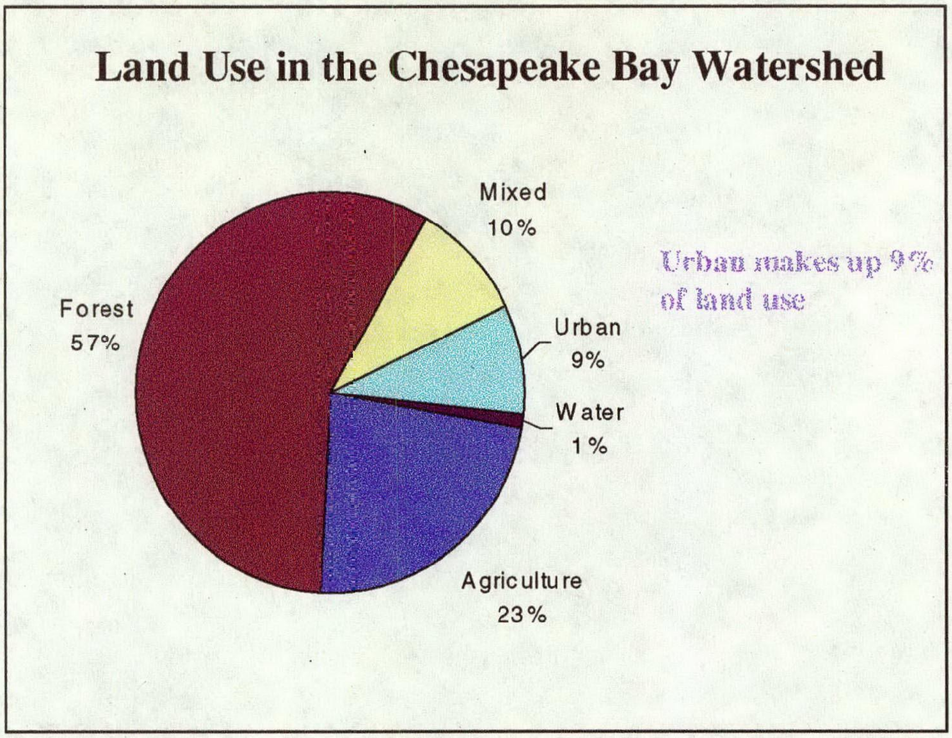




Watershed-wide, the population is projected to increase by 2.2 million people from now until 2020 (from 15.59 million to 17.76 million).

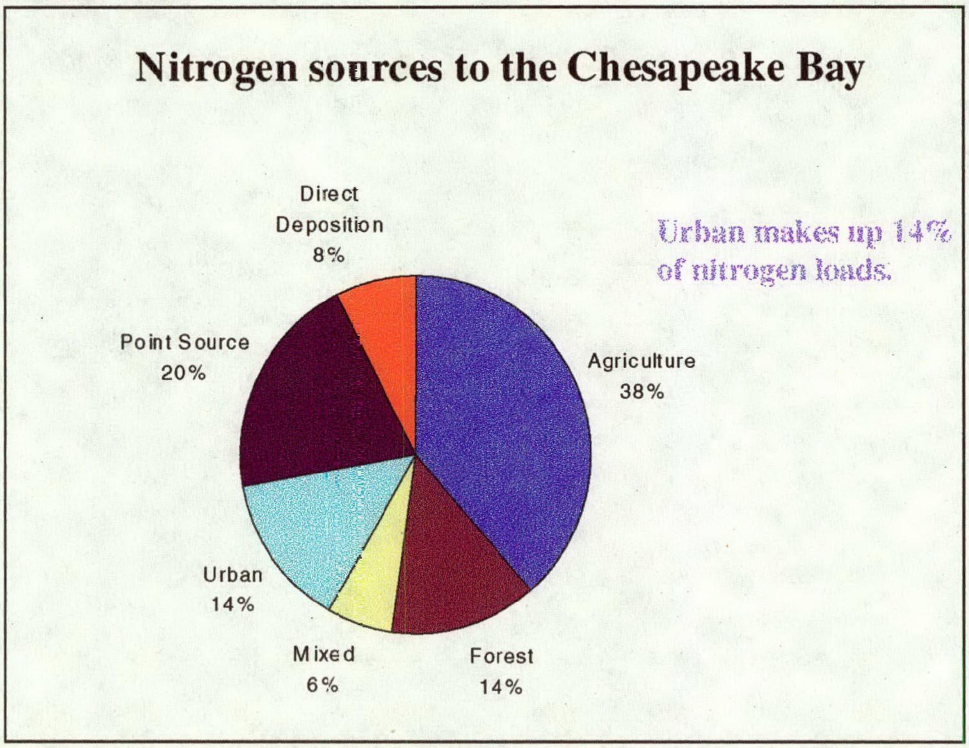
Left map: Census bureau projected population growth from 1980 to 2020, based on 1990 census data.
Right map: Indicates the counties in MD and VA that are expected to double in population by 2020; and the counties in PA that are expected to increase population by 52% by 2020.
Population is increasing throughout the watershed. With increased population comes increased impervious surfaces (roads, buildings, parking lots). Planning for and controlling additional urban stormwater runoff and pollutant loads will be very important.

Land Use

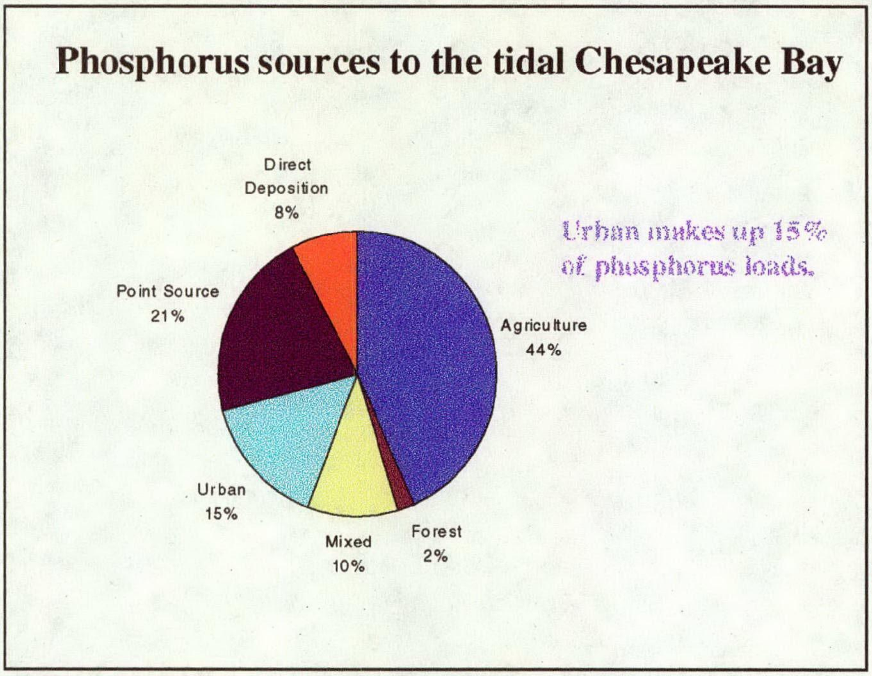


Landuse is based on 1990 EMAP data (satellite imagery) projected to 2000 using population growth and the census of agriculture.

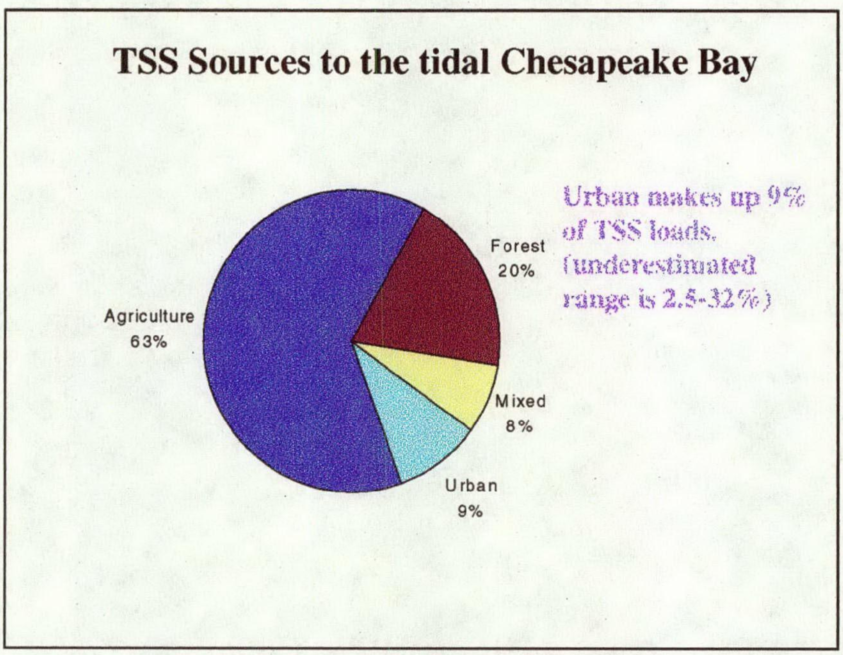
Pollutant Loads



Cities contribute to the Bay about twice the nitrogen and phosphorus load per acre as agriculture. Urban land use is responsible for 12% of total nitrogen loads to the tidal Chesapeake Bay (even though it makes up only 9% of the watershed landuse). About 90% of atmospheric contribution of nutrient loads is thought to come from anthropogenic sources such as vehicle exhaust, power plants, and ammonia from agriculture.

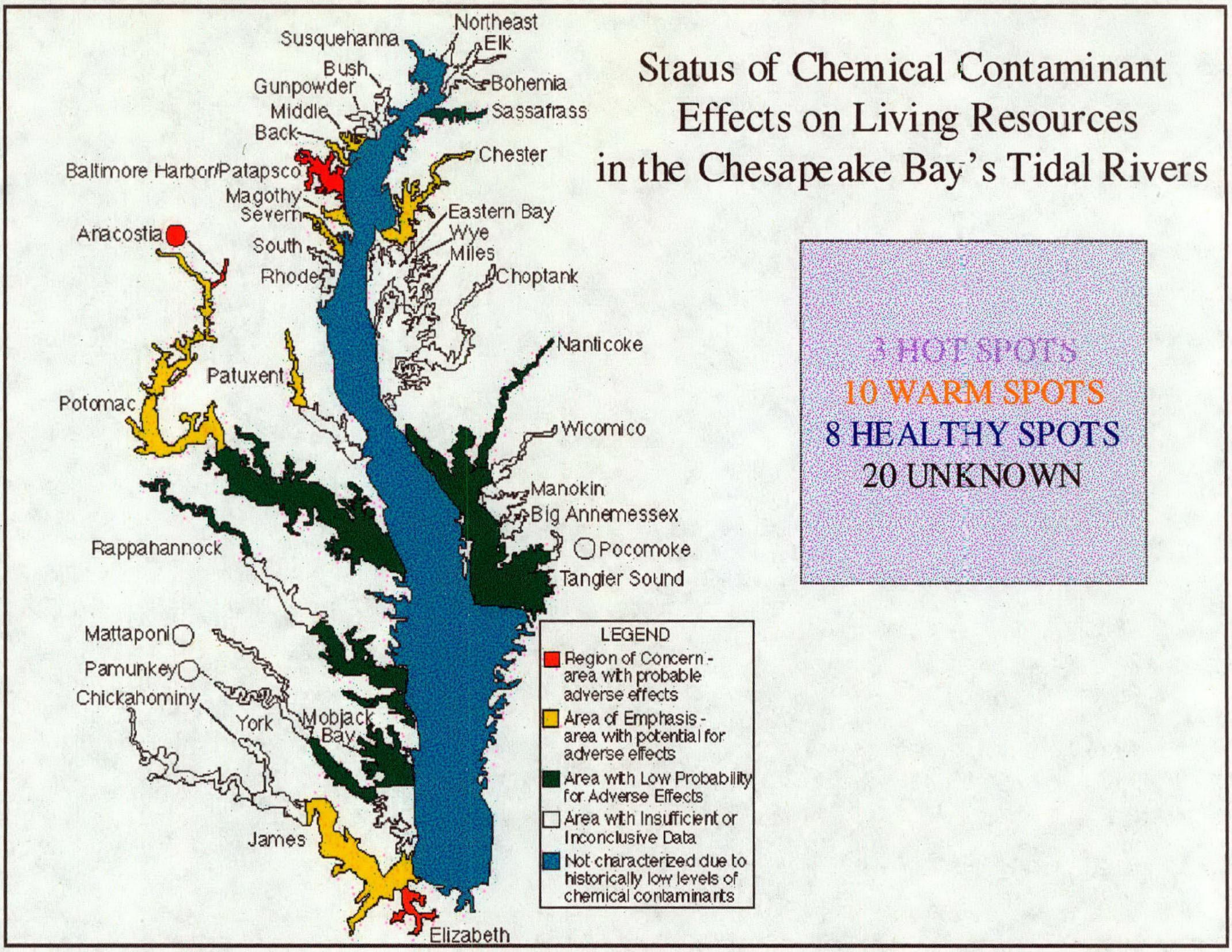


Urban land use is responsible for 21% of total phosphorus loads to the tidal Chesapeake Bay. If you look at just the nonpont sources of nitrogen, urban land use is responsible for 27% of phosphorus loads.



Urban land use is responsible for 9% of total TSS loads to the tidal Chesapeake Bay. Urban land use is responsible for 9% of TSS loads, but this estimate does not fully account for TSS resulting from stream bank erosion and scouring of streambed that may be due to increased stormwater flow resulting from urbanization. Thus a more thorough estimate of urban contribution to TSS loads is 25-32%.

Areas of Concern



This map indicates the status of chemical contaminant effects on living resources in the tidal rivers of the Chesapeake Bay.

LEGEND:

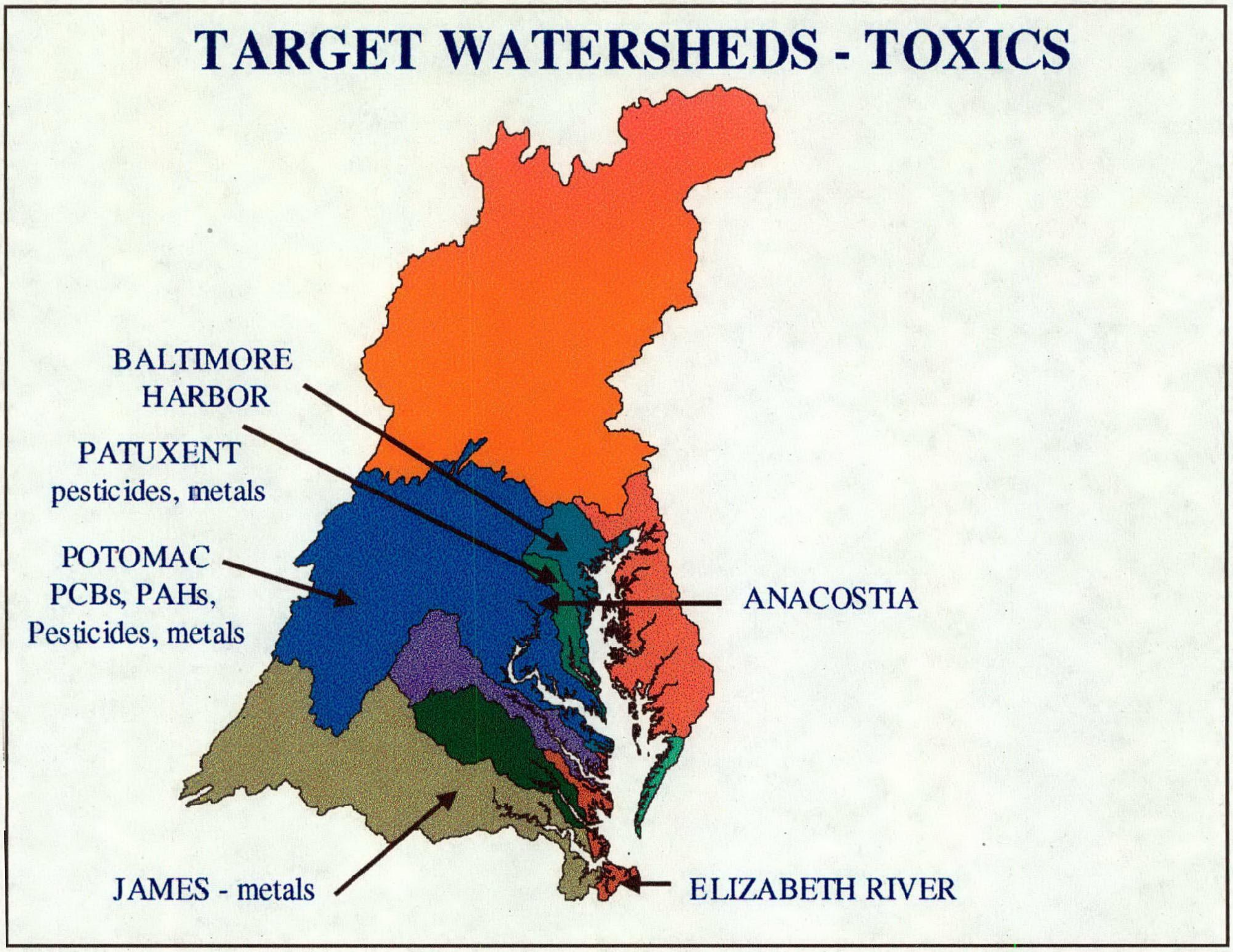
RED - Regions of Concern with known toxics problems.

YELLOW - Areas of Emphasis with the significant potential for adverse effects

GREEN - Areas with Low Probability for Adverse Effects

WHITE - Areas with Insufficient or Inconclusive Data

The CBP is currently targeting assessments in these areas to complete this characterization. The CBP has developed a list of chemicals of concern in each of the red and yellow areas.



Question: Do the chemicals of concern come from urban stormwater runoff? Or are point sources the bigger problem? Chemicals of concern can come from both point and nonpoint sources. Sometimes point sources dominant and sometimes urban stormwater runoff is the dominant source.

The target watersheds above are those watersheds that have a substantial urban stormwater contribution of chemicals of concern.

These Regions of Concern are most known for their sediments contaminated with historic/legacy chemicals that are no longer in use or have been banned, however, urban stormwater loads can be significant. The Chesapeake Executive Council committed in the Toxics 2000 Strategy to reduce the chemicals of concern in the Regions of Concern by 30% by 2010.

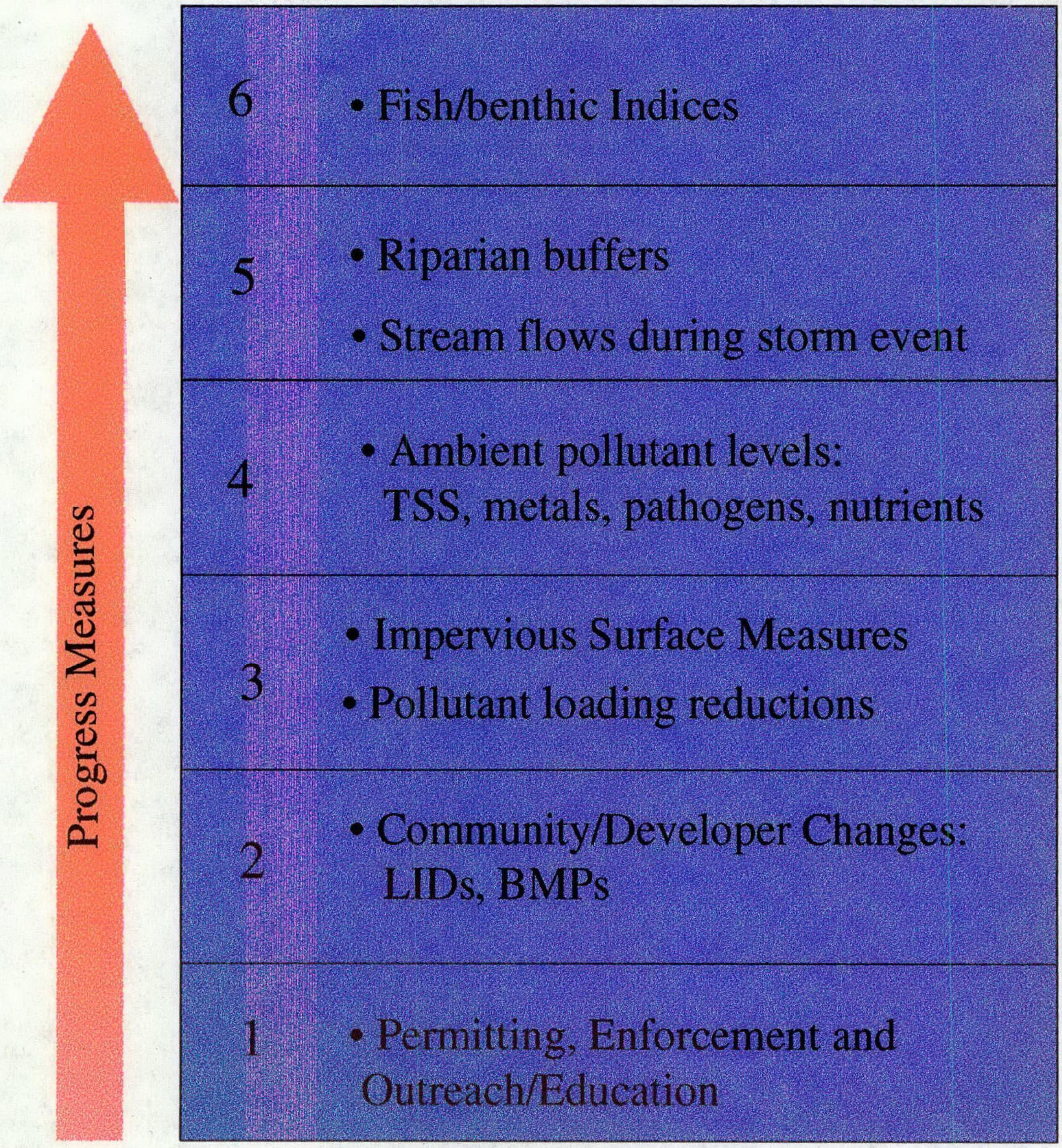
Note: Cities contribute about twice as much nitrogen and phosphorous on an acre-by-acre basis as agriculture.

Indicator Development

Environmental indicators should be developed in order to more effectively monitor administrative actions and results along a range of levels from facility actions to ambient stream measures to indices of biotic intergity. By developing such indicators, the linkages between all these varied levels of action are explicitly identified and so it becomes much easier to guage progress and effectiveness.

The following chart shows a basic indicator framework for the storm water issue. Much of the research discussed earlier in the report shows a number of sensitive measures, such as percent impervious area, which have strong linkages to high level ecological health outcomes. This research provides a rich resource for developing a suite of indicators with which we can sensitively guage real environmental progress through a number of levels. Having strong linkages between intermediate environmental measures and high level health outcomes will enable the identification of significant progress at a much earlier time frame than would be possible if only the end result were measured.

Storm Water Hierarchy of Indicators



Targeting Areas for Enforcement and Outreach

Targeting increases the effectiveness of our activities by focusing limited resources on those areas which will benefit most or have the greatest result for our expenditures. There are a number of approaches to targeting. One particulalry useful approach is the use of severity criteria/indicators. Severity criteria/indicators are known quantifiable factors which can be linked to a geographic location, such as sensitive populations or endangered species habitats. There are many geospatial data layers associated with the storm water issue such as MS4 locations, impaired streams, and sensitive habitat areas. A preliminary list of relevant data layers is shown below along with maps of MS4 locations for Phase I and Phase II. The first step in the targeting strategy is then to develop the spatial analysis of these criteria and find the areas where there is the greatest concentration of severity indicators.

Severity Criteria/Indicators

Impervious surface cover

MAIA indicators - such as forest fragmentation

Storm water impaired streams

Exceptional value waters

Population growth areas/sprawl areas

Drinking water intakes

MS4 areas

Superfund sites

RCRA sites

AFOs

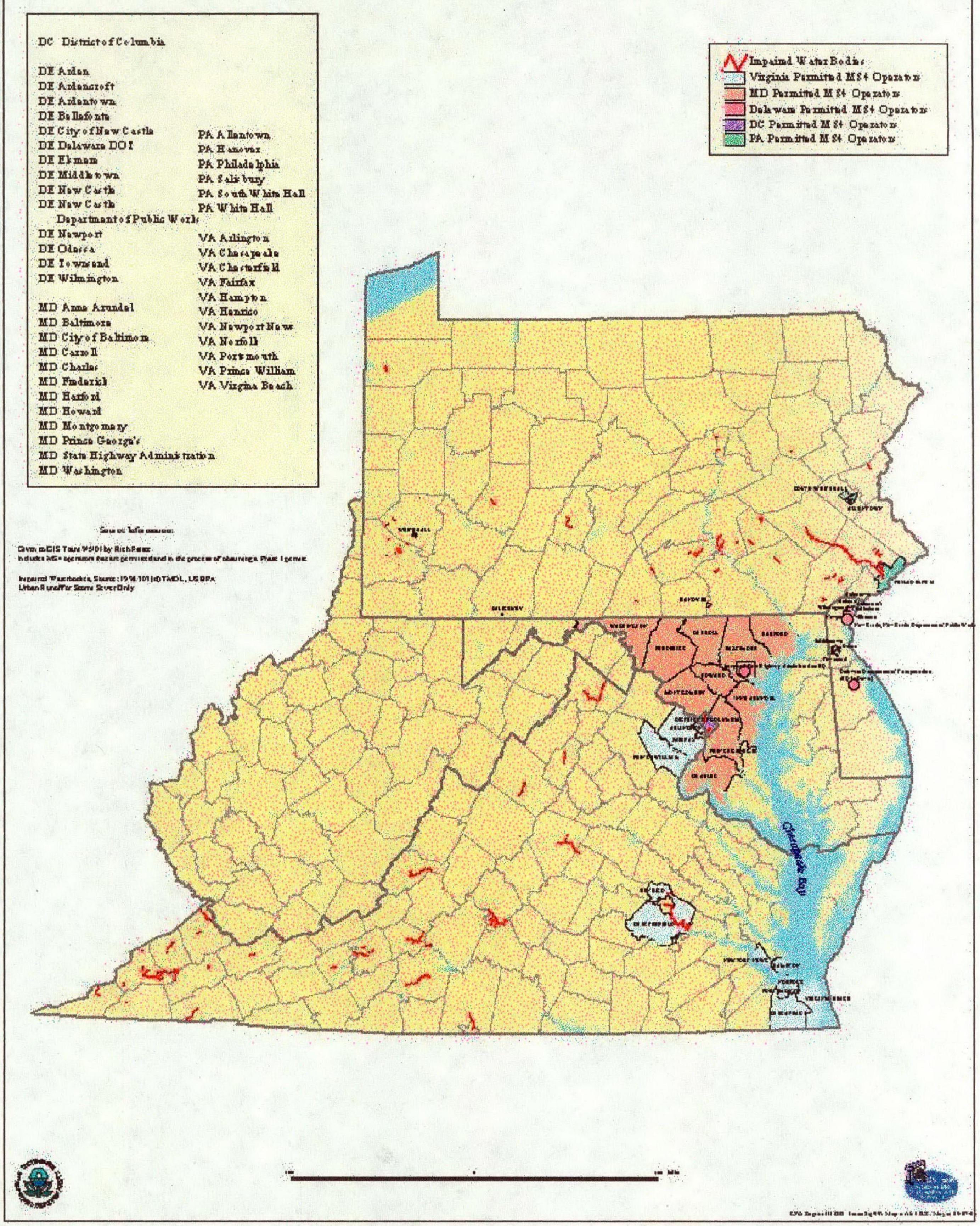
Mines

Junk yards

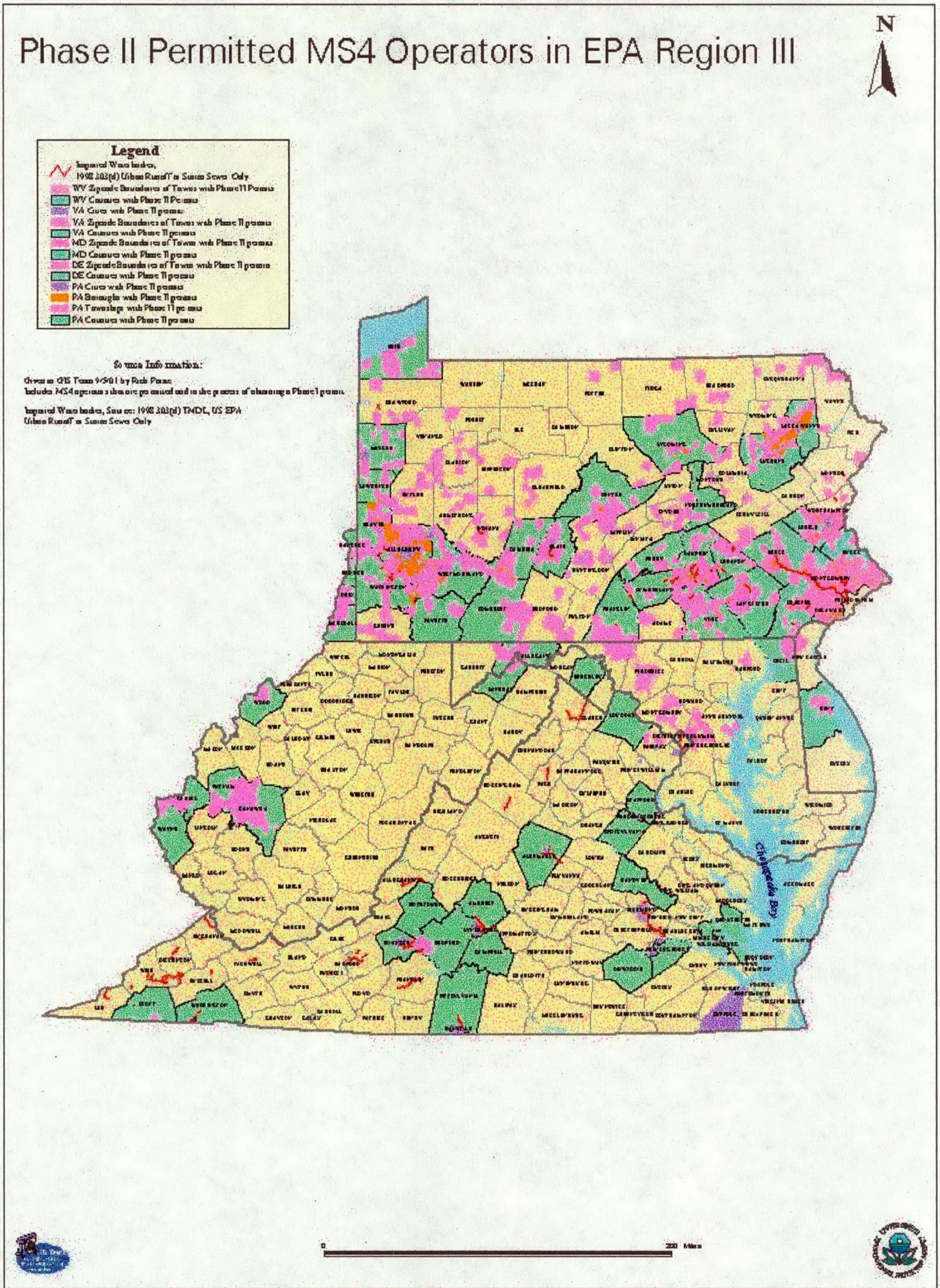
Shellfish beds

Spawning areas

Phase I Permitted MS4 Operators in EPA Region III



Phase II Permitted MS4 Operators in EPA Region III



Conclusion and Recommendations

This report has outlined the numerous environmental issues and concerns related to storm water and the sources of storm water including the drivers of population growth and development. Key findings from studies revealing the widespread environmental effects of storm water on habitat and organisms have been presented. The extent of streams identified as impaired in the Region has also been described.

The overall conclusion is that storm water is part of a pervasive and environmentally harmful pattern of development which involves the construction of large areas impenetrable by rainfall: impervious areas. Impervious cover has numerous harmful effects on such diverse conditions as stream flow, aquatic organisms (from insects to finfish), ground water recharge, erosion, and stream scouring. Sensitive organisms in particular are particularly sensitive to impervious cover and are no longer present after such cover reaches even a low percentage of the upstream watershed.

The following are the specific recommendations with suggested leads. All of the recommendations have short-term and long-term components.

Make state 305(b) and 303(d) reports/lists consistent Region-wide and more comprehensive:

* Develop data standards for reporting.
* Develop a consistent data flow process for updating the regional databases and GIS coverages.
* Develop a standard assessment matrix of monitored parameters which will be used in each stream assessment.

SUGGESTED LEAD: WPD with ESD, GIS Team and OED

Use innovative impervious surface models as well as MAIA landscape indicators to predict the most sensitive areas which have the greatest potential for degradation from storm water runoff over the next 5 years. Use modeling to identify steps to prevent degradation.
SUGGESTED LEAD: WPD, CBPO, OED and GIS Team

Identify the most sensitive/valuable areas that are presently degraded and would benefit the most by improving the management of storm water runoff. Identify steps to mitigate degradation.
SUGGESTED LEAD: WPD, CBPO, GIS Team and OED

Develop environmental indicators to sensitively measure storm water impacts and progress from abatement efforts.
SUGGESTED LEAD: OED, CBPO, WPD, with GIS Team Support

Provide comments on the SW general permit for construction activities which require permittees to address known concerns about the creation of impervious surface areas, to use LID strategies and to use newer BMP control strategies.
SUGGESTED LEAD: WPD

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