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Lake Simcoe Region
conservation authority

A Watershed for Life

The Need for Change!
The Lake Simcoe story

Rob Baldwin, LSRCA

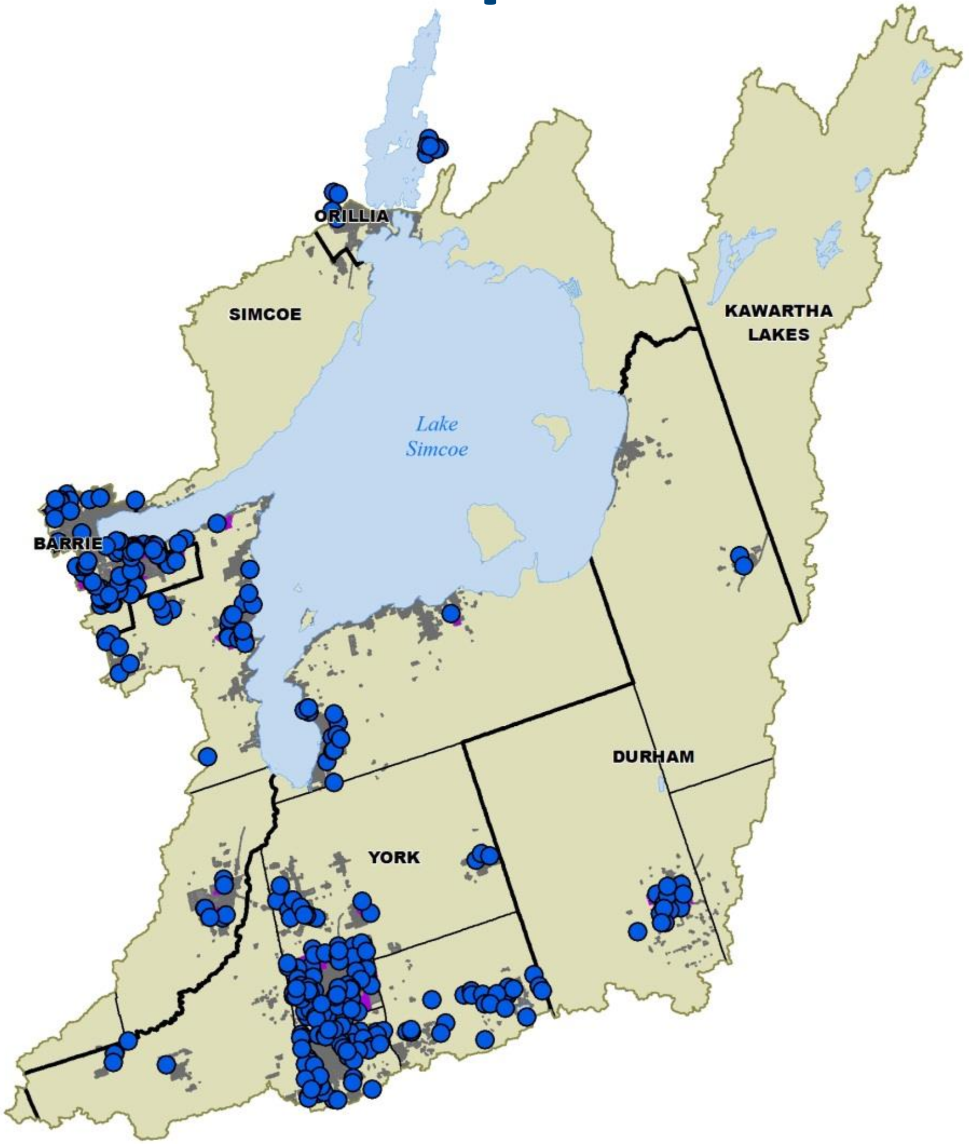
Jay Michels, EOR

2015 TRIECA Conference

March 26, 2015

Stormwater management of the past and current….?

- 277 ponds in the watershed, 135 quality and 142 quantity.
- Area treated by ponds =12,000ha
- Design criteria has the phosphorus removal of these ponds at 4.2 tonnes/year. Plus flood control.
- Are they working?



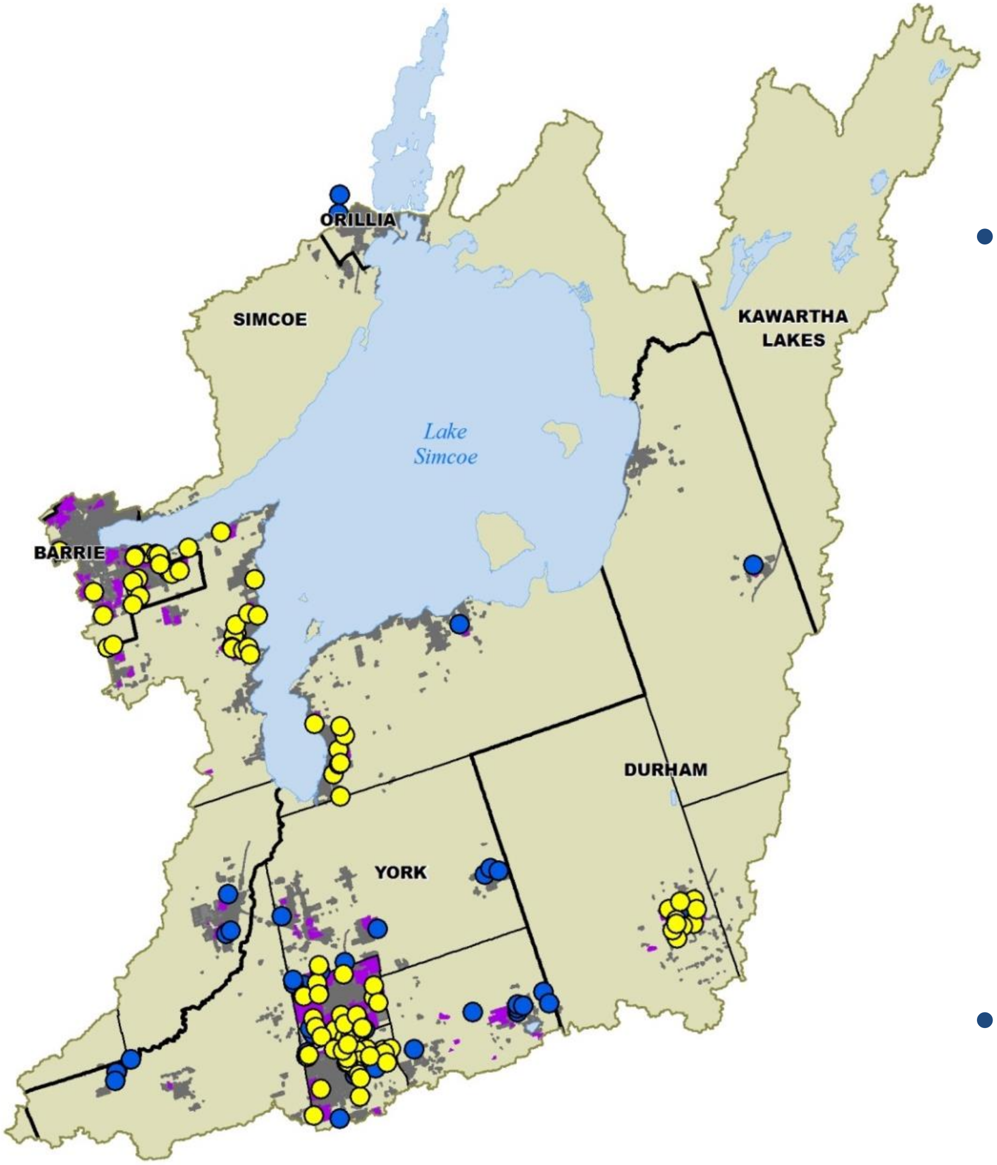
All Stormwater Ponds

Need for Change: Current SWM Practices

- Despite this the health and quality of many urban rivers and streams continues to decline.

- In 2010 a study was conducted to answer the question: Are stormwater ponds working?

Stormwater Pond Assessment



- In 2010, 98 ponds were studied to evaluate physical and chemical function
  - Pond depth
  - Physical parameters (spot and selected logging)
  - Water chemistry
  - Sediment chemistry
  - Sediment fractionation
- Average age of ponds =10, oldest =23, newest =2

Are Stormwater Ponds Working?

Maintenance

- Lack of pond maintenance decreases the available storage volume increasing the risk of flooding.

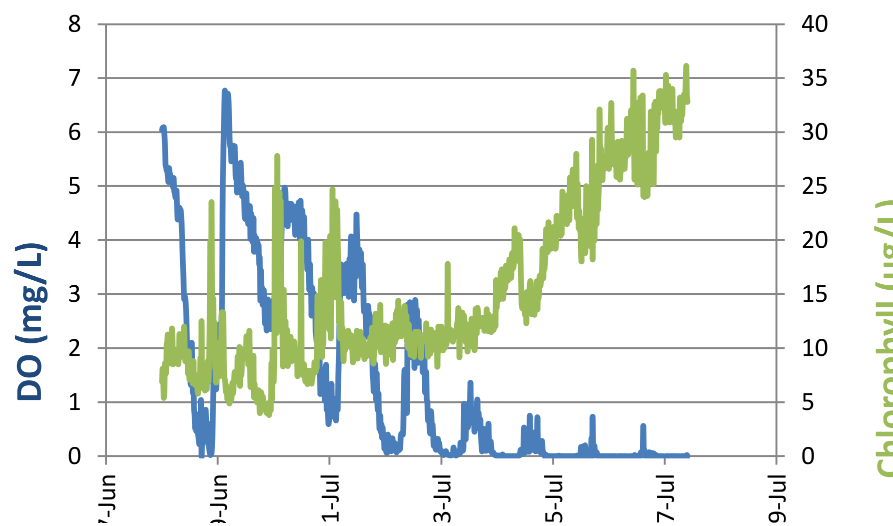
- 56 of the 98 ponds require maintenance at an estimated cost of $18.5 million.

Nutrient Attenuation

- Lack of maintenance results in 1.1 T/y loading increase, 1.5% of total annual phosphorus load,

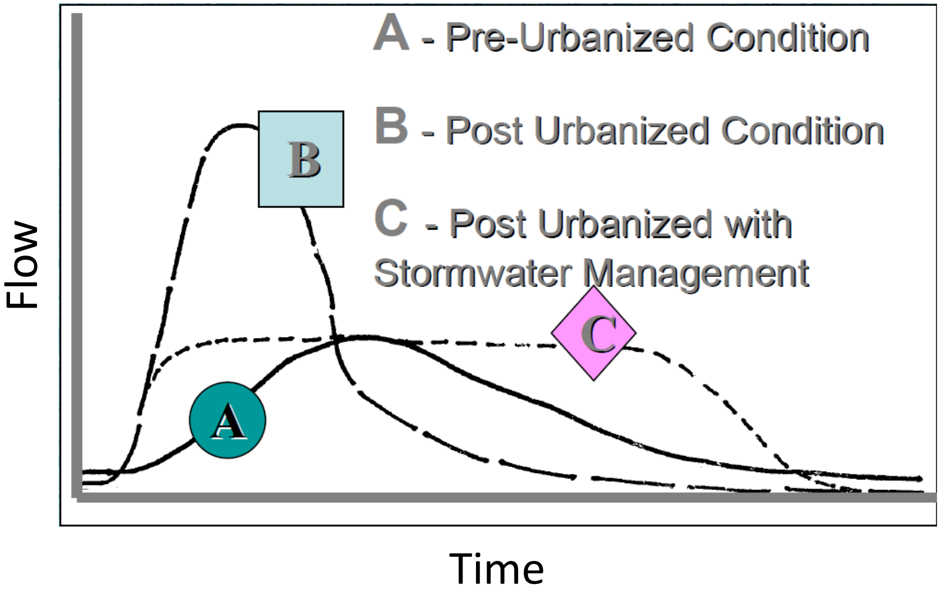
Anoxic Nutrient Release

- Under low oxygen soluble phosphorus can be released from the sediment turning stormwater ponds into nutrient sources.



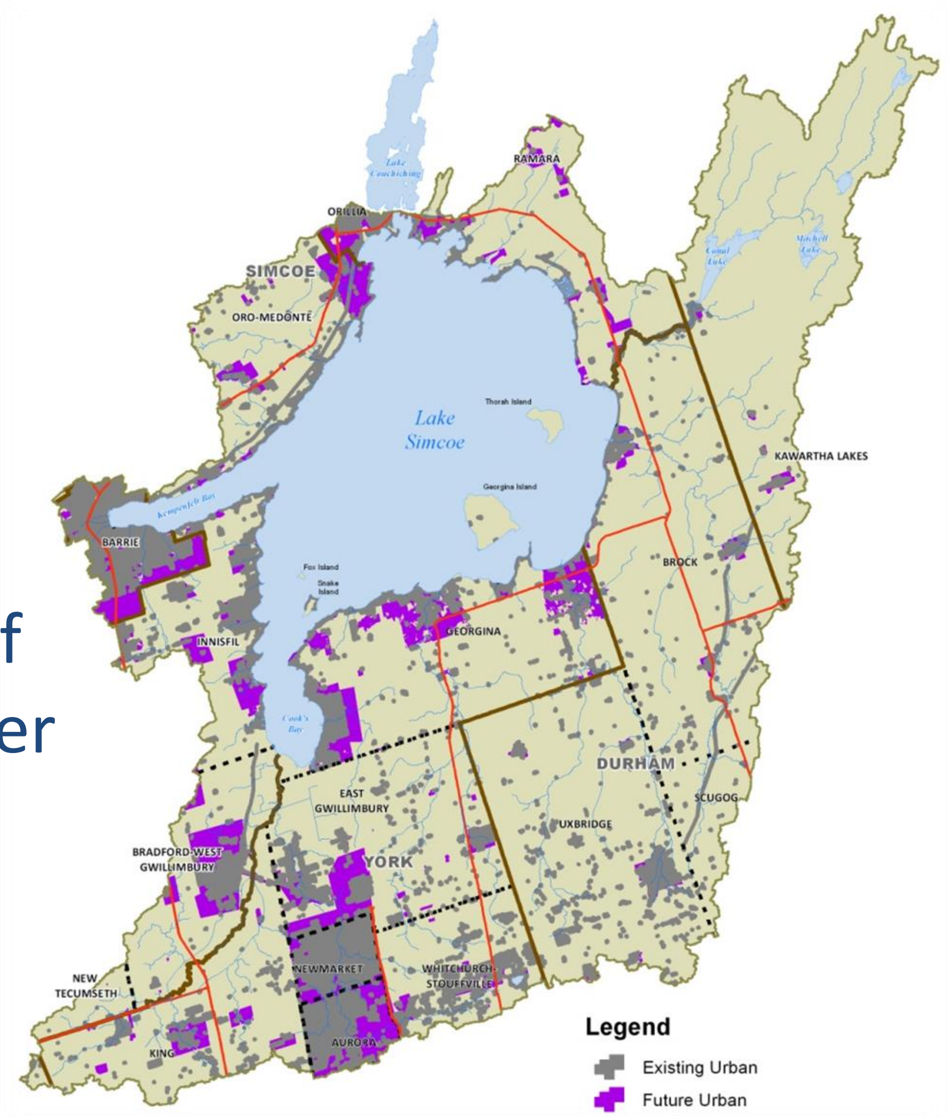
Geomorphic Impacts

- Increased runoff volume and flow duration is resulting in increased streambank erosion and sedimentation.



LID: Stormwater Management of the Future

- Existing urban area is ~23,000ha
- An additional 12,000ha of development planned over the next 20 years

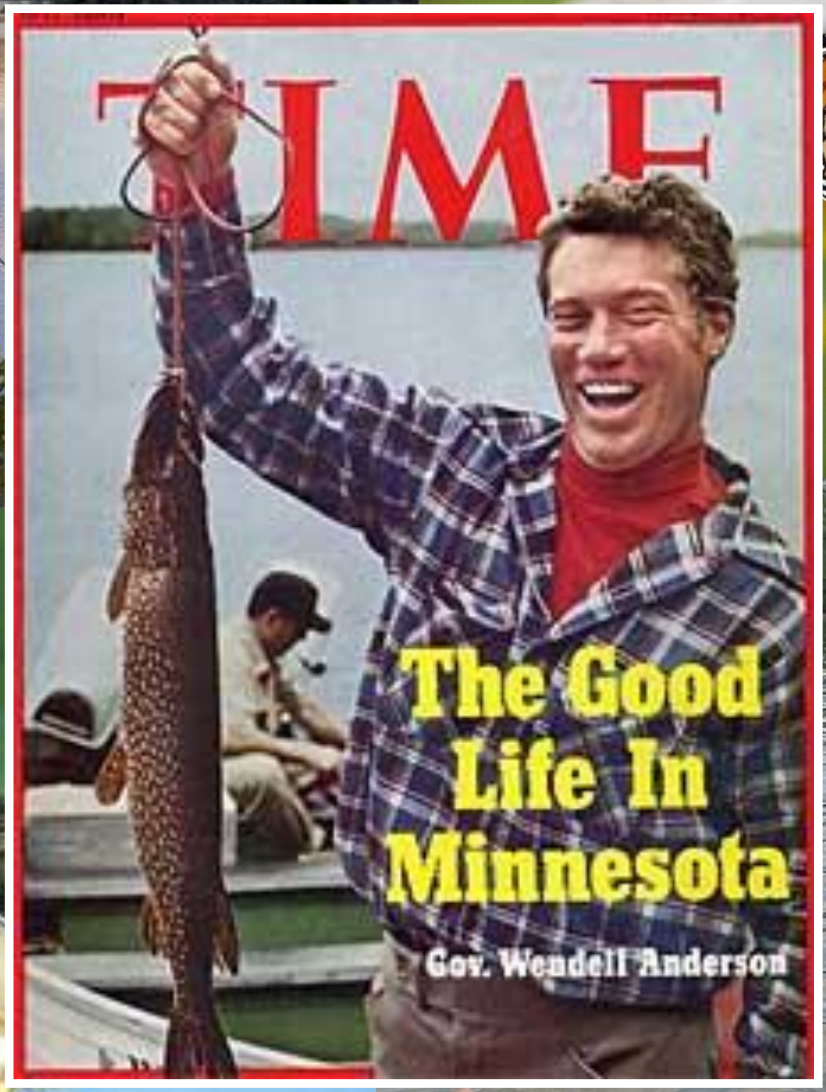


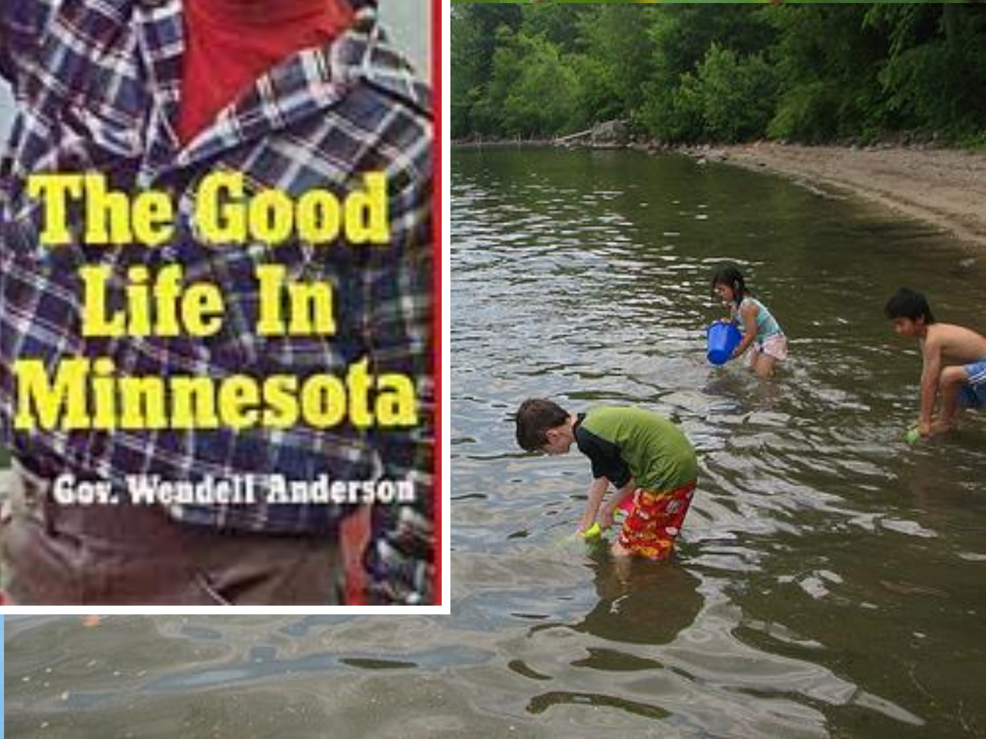
The Need for Change

- Can we achieve our water quality, quantity and aquatic targets and accommodate new urban growth?

No!!! Change is necessary….

- Low Impact Development
- More green infrastructure
- New policy, regulation and enforcement


TIME
The Good
Life In
Minnesota
Gov. Wendell Anderson

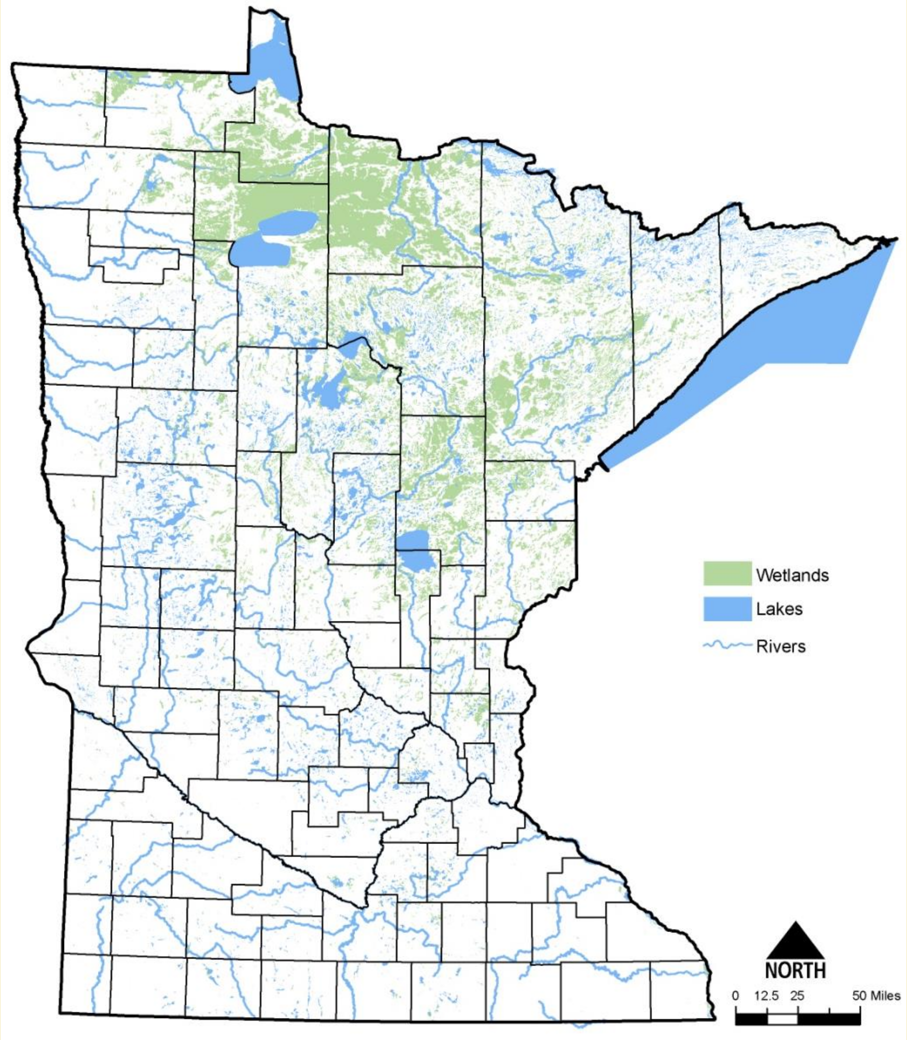


The Land of 10,000 Lakes

11,642 lakes > 10 acres

69,200 miles of rivers/ streams

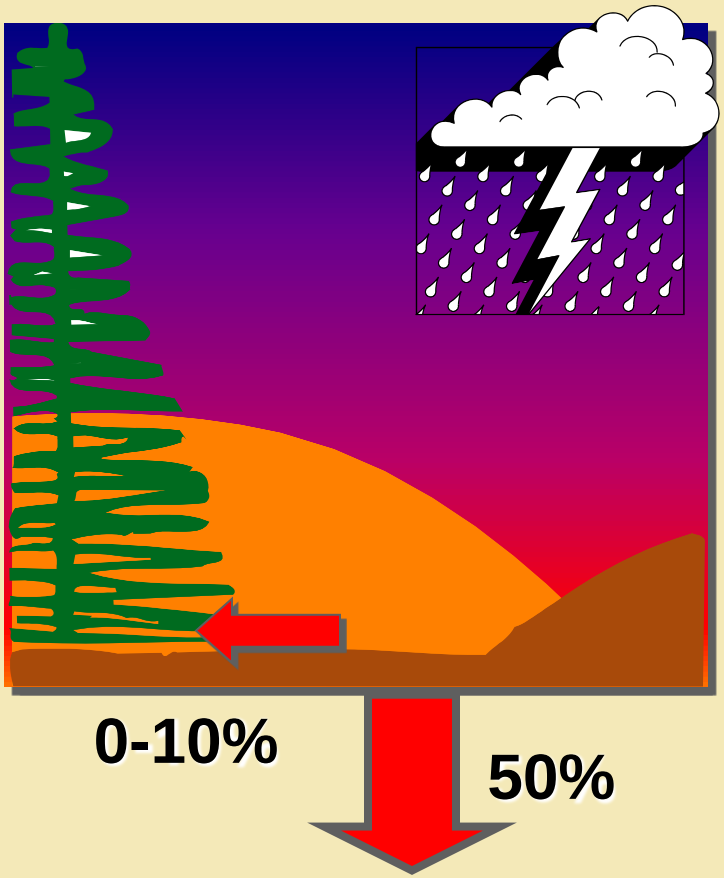
9.3 million acres of wetland

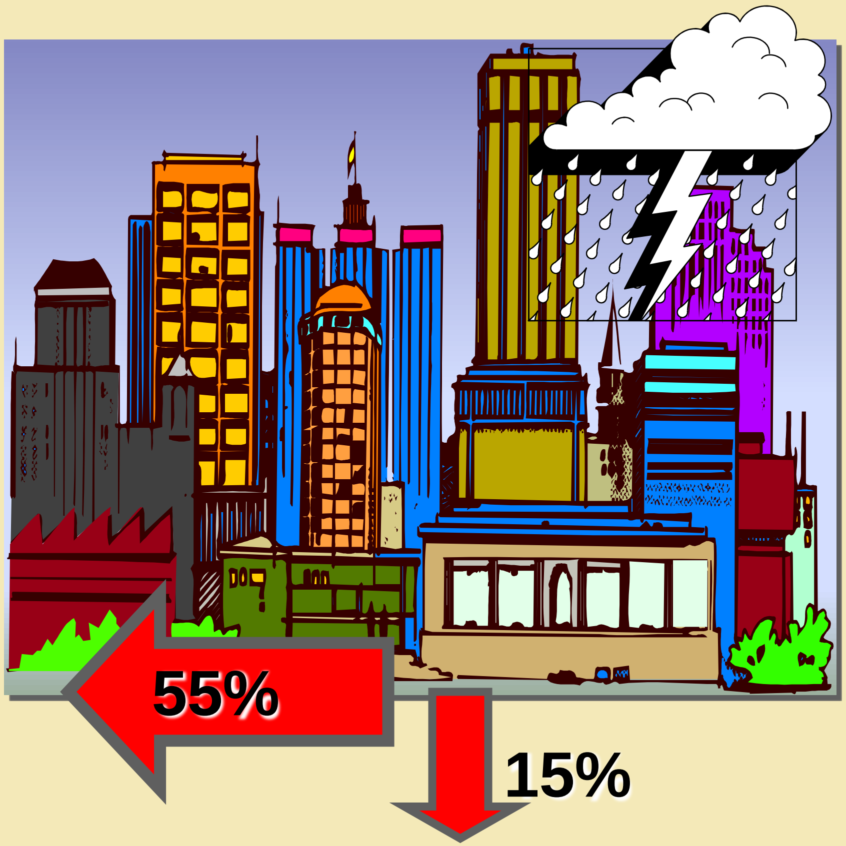


40% of all surface waters in Minnesota are found to be impaired

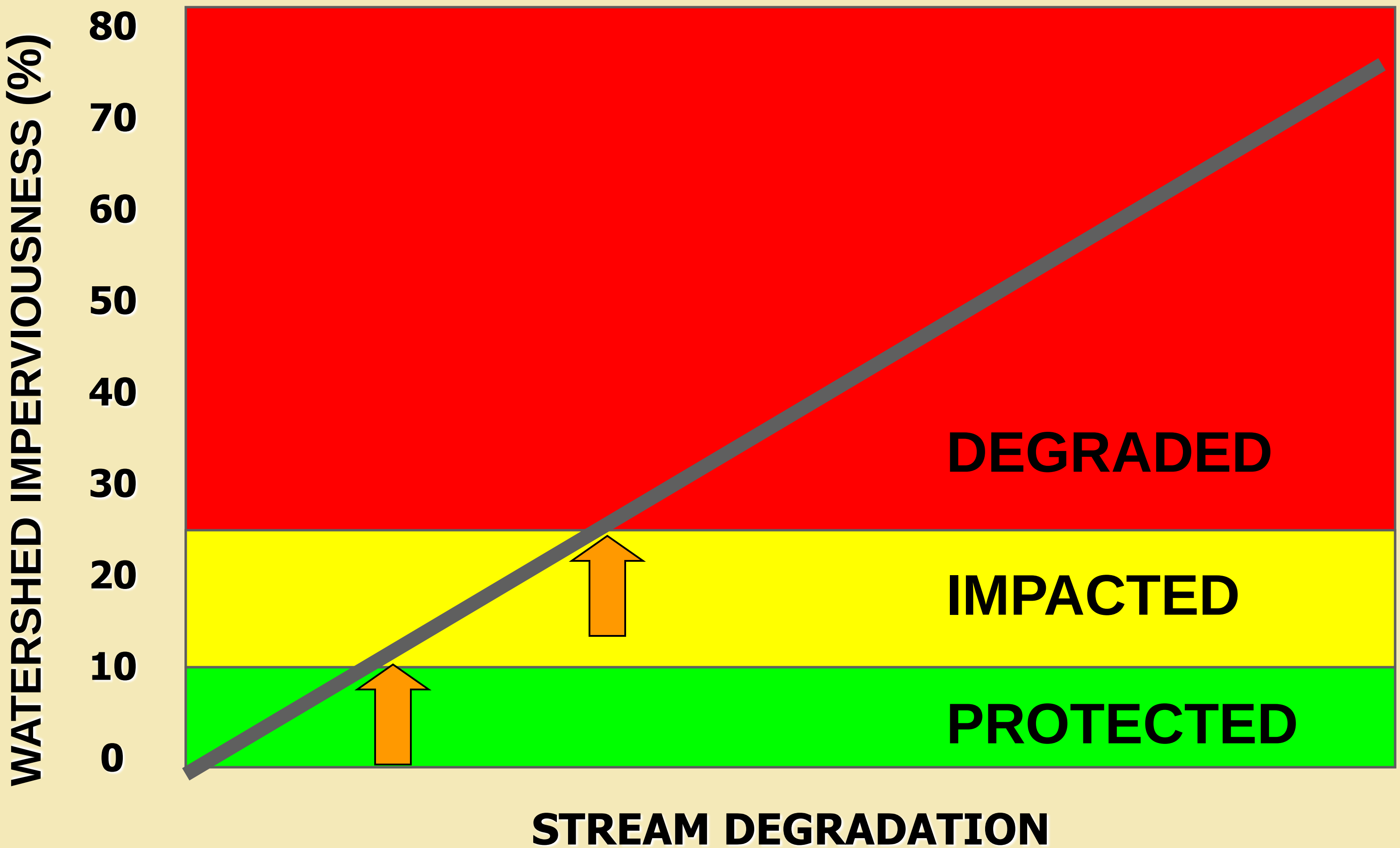
- 2008 Impaired Waters List (303d)
  - 2,575 impairments
- 2010 Impaired Waters List (303d)
  - 3,049 impairments
- 2012 Impaired Waters List (303d)
  - 3,638 impairments
- 2014 Impaired Waters List (303d)
  - 4,122 impairments

Development Impacts on the Water Cycle





Waterway Health & Imperviousness



ADAPTED FROM SCHUELER, ET. AL., 1992

Water Quantity Impacts

- Disruption of Natural Water Balance
- Increased Flood Peaks
- Increased Duration of Flows
- Streambank Erosion
- Habitat Loss
- Lower Summer Base Flows

Development Impacts on Water Quality

Nutrients

Pathogens

Sediment

Toxic Contaminants

Debris

Thermal Stress

Increased quantity
Decreased quality

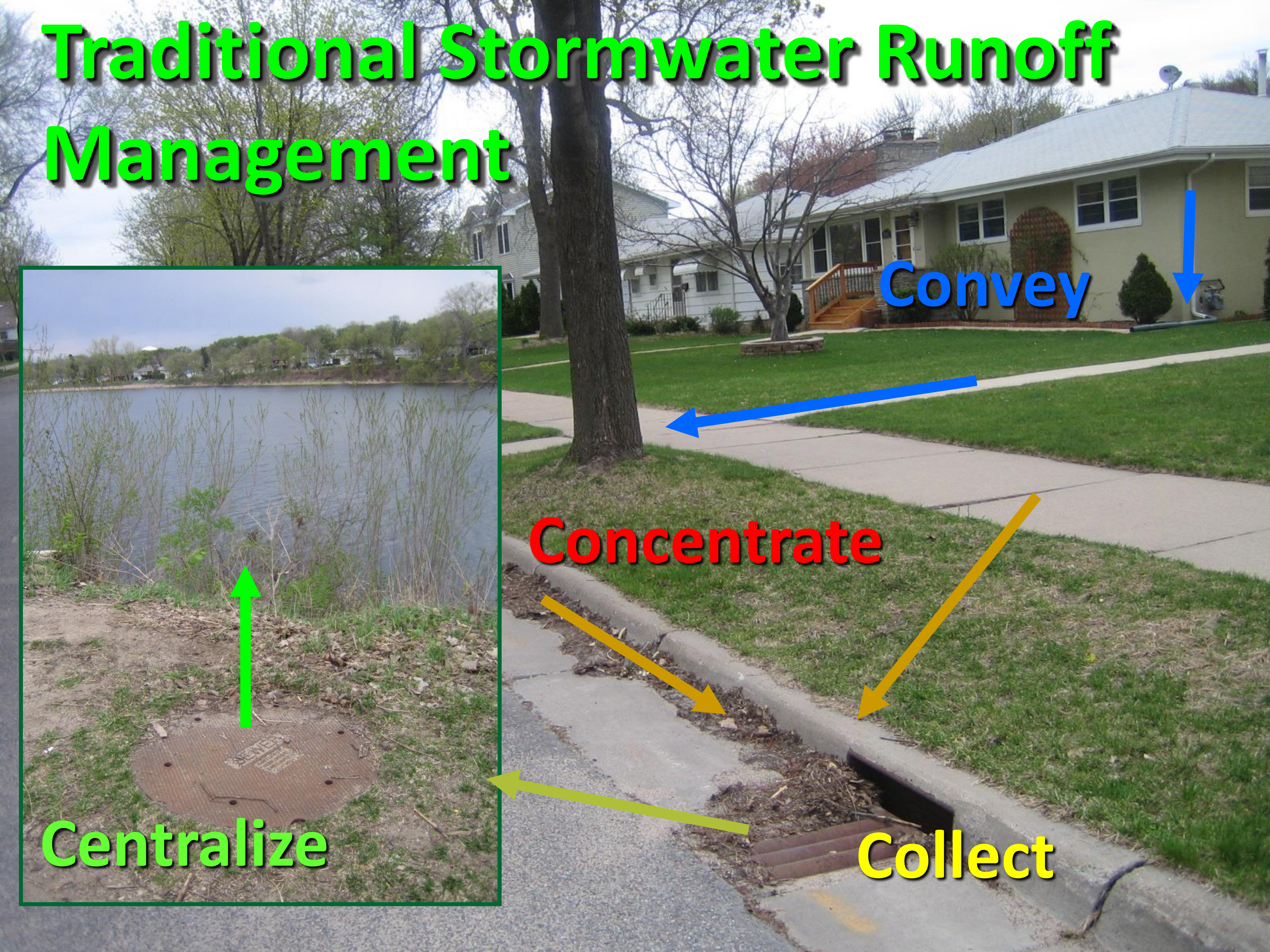
Overview of Stormwater Management

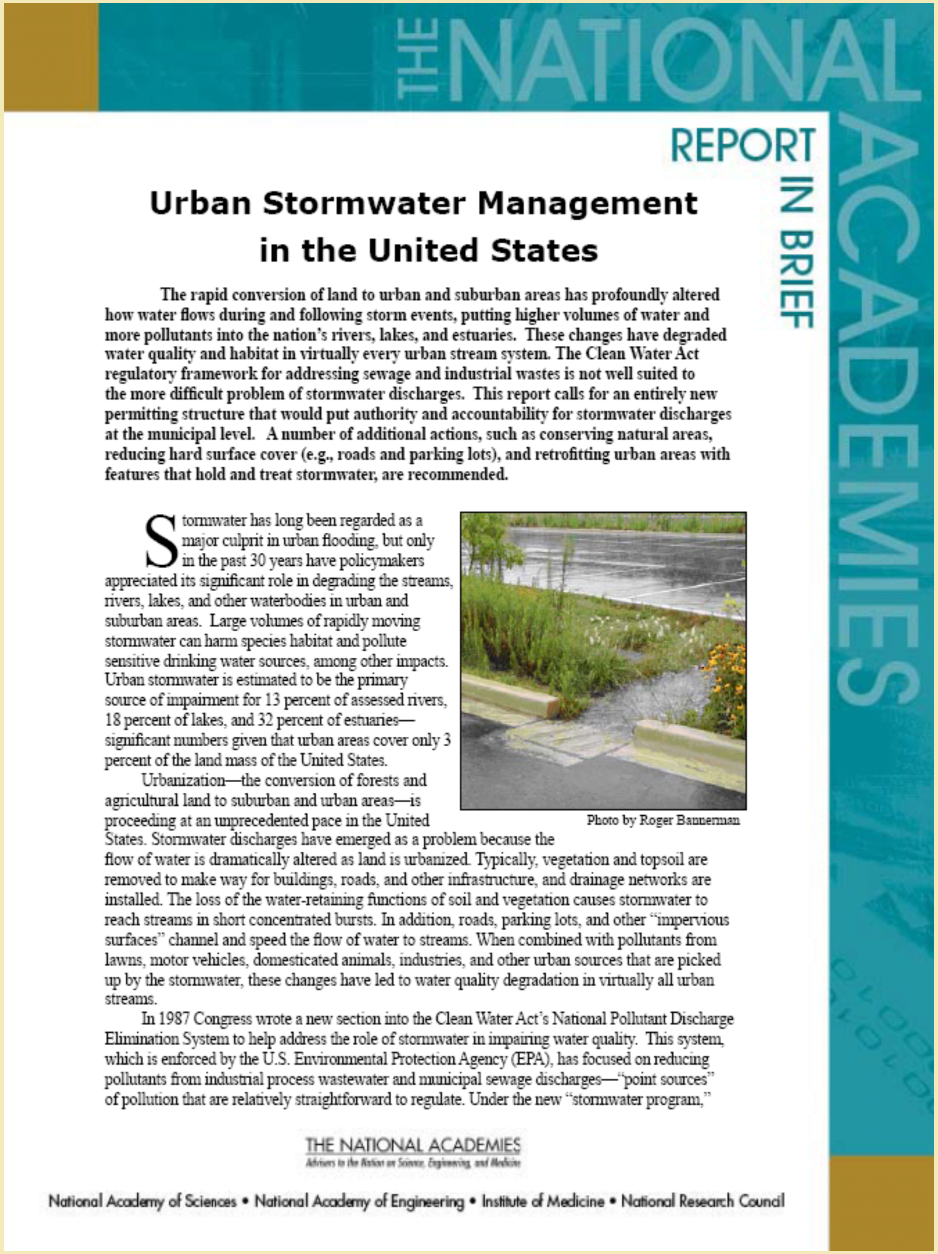
National Urban Runoff Program

1983

- Technical studies that compiled data about urban runoff
- Resulted in treatment recommendations and easy to apply standards for design and review
- Led to proliferation of ponds

Traditional Stormwater Runoff Management





THE NATIONAL ACADEMIES

REPORT IN BRIEF

Urban Stormwater Management in the United States

The rapid conversion of land to urban and suburban areas has profoundly altered how water flows during and following storm events, putting higher volumes of water and more pollutants into the nation's rivers, lakes, and estuaries. These changes have degraded water quality and habitat in virtually every urban stream system. The Clean Water Act regulatory framework for addressing sewage and industrial wastes is not well suited to the more difficult problem of stormwater discharges. This report calls for an entirely new permitting structure that would put authority and accountability for stormwater discharges at the municipal level. A number of additional actions, such as conserving natural areas, reducing hard surface cover (e.g., roads and parking lots), and retrofitting urban areas with features that hold and treat stormwater, are recommended.

Stormwater has long been regarded as a major culprit in urban flooding, but only in the past 30 years have policymakers appreciated its significant role in degrading the streams, rivers, lakes, and other waterbodies in urban and suburban areas. Large volumes of rapidly moving stormwater can harm species habitat and pollute sensitive drinking water sources, among other impacts. Urban stormwater is estimated to be the primary source of impairment for 13 percent of assessed rivers, 18 percent of lakes, and 32 percent of estuaries—significant numbers given that urban areas cover only 3 percent of the land mass of the United States.

Photo by Roger Bannerman

Urbanization—the conversion of forests and agricultural land to suburban and urban areas—is proceeding at an unprecedented pace in the United States. Stormwater discharges have emerged as a problem because the flow of water is dramatically altered as land is urbanized. Typically, vegetation and topsoil are removed to make way for buildings, roads, and other infrastructure, and drainage networks are installed. The loss of the water-retaining functions of soil and vegetation causes stormwater to reach streams in short concentrated bursts. In addition, roads, parking lots, and other "impervious surfaces" channel and speed the flow of water to streams. When combined with pollutants from lawns, motor vehicles, domesticated animals, industries, and other urban sources that are picked up by the stormwater, these changes have led to water quality degradation in virtually all urban streams.

In 1987 Congress wrote a new section into the Clean Water Act's National Pollutant Discharge Elimination System to help address the role of stormwater in impairing water quality. This system, which is enforced by the U.S. Environmental Protection Agency (EPA), has focused on reducing pollutants from industrial process wastewater and municipal sewage discharges—"point sources" of pollution that are relatively straightforward to regulate. Under the new "stormwater program,"

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"Past practices…have been ineffective at protecting water quality in receiving waters and only partially effective in meeting flood control requirements"

“Stormwater control measures that harvest, infiltrate, and evaportranspirate stormwater are critical to reducing the volume and pollutant loading of small storms”

THE NATIONAL ACADEMIES

REPORT IN BRIEF

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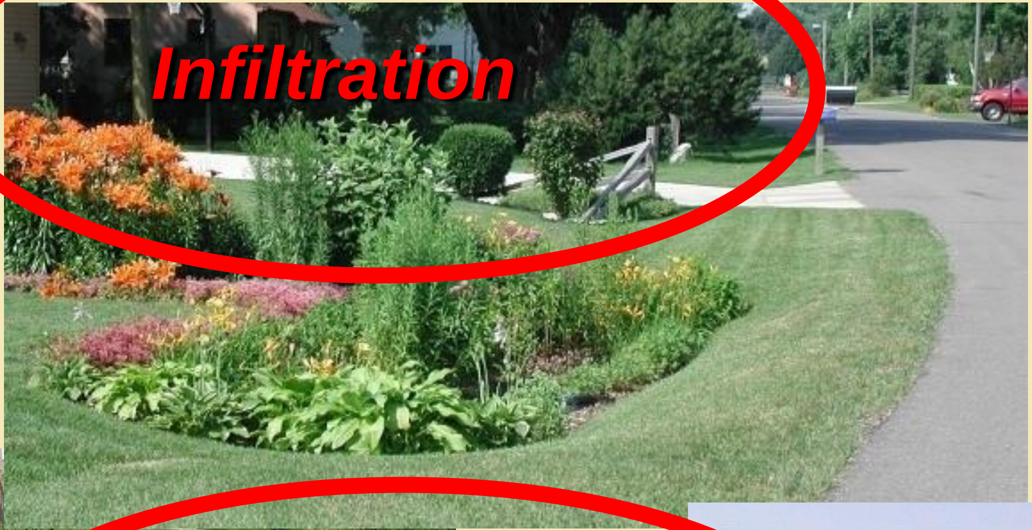
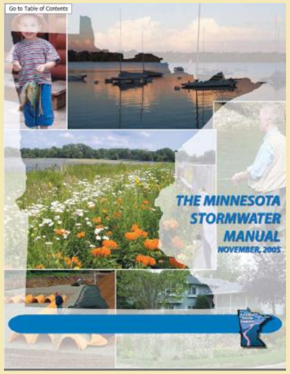
Stormwater Management



Stormwater Management Paradigm Shift

Now changing to focus on water quality, primary through small event volume control.



Rain events between .5 and 1.5 inches are responsible for about 75% of runoff pollutant discharge – “First Flush”

Regulations Driving More Effective Stormwater Management

National Pollutant Discharge Elimination System (NPDES)

Total Maximum Daily Loads (TMDL)

Antidegradation

NPDES MS4

MS4 Six Minimum Control Measures

1. **Public Education and Outreach**
2. **Public Participation/Involvement**
3. **Illicit Discharge Detection and Elimination**
4. **Construction Site Runoff Control**
5. **Post-Construction Runoff Control**
6. **Pollution Prevention/Good Housekeeping**

TMDL

Total
Maximum
Daily
Load

Antidegredation

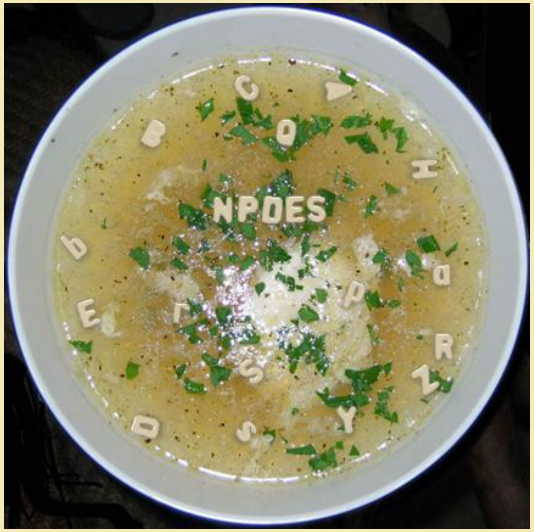
City must demonstrate what past present and future best management practices will be reasonably required to return stormwater runoff to 1988 levels.

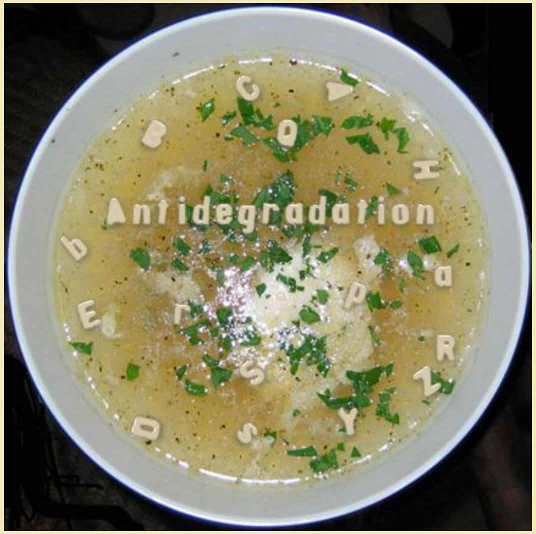
NPDES, TMDL, Antidegredation - OH MY!

What is the Pathway to Compliance?

The Challenge

We need coordination and synchronization of coverage under federal and state regulatory programs.





The Challenge

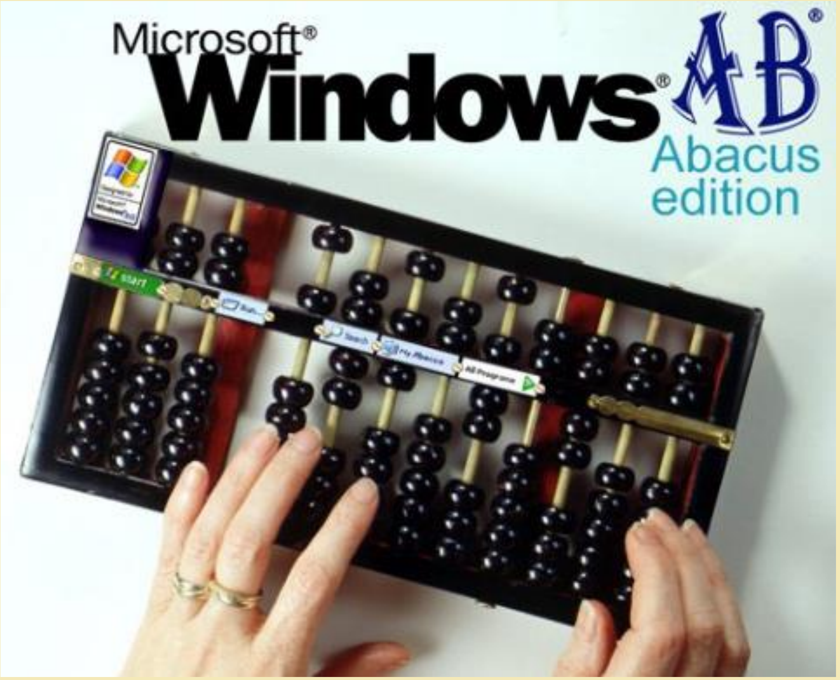
We need more flexibility in design to give credit for a wide variety of structural and non-structural BMPs.

Builders Association

The Challenge

We need our regulatory requirements and have consistent performance standards and matching calculation methods to enable practitioners and regulators to use innovative structural and non-structural BMPs in a manner similar to stormwater ponds.

Cities
Stormwater
Coalition



The Challenge

Water resources are continuing to degrade. We need a better system to protect and restore our urban and urbanizing systems.

Environmental and Natural Resource Groups

Other Considerations

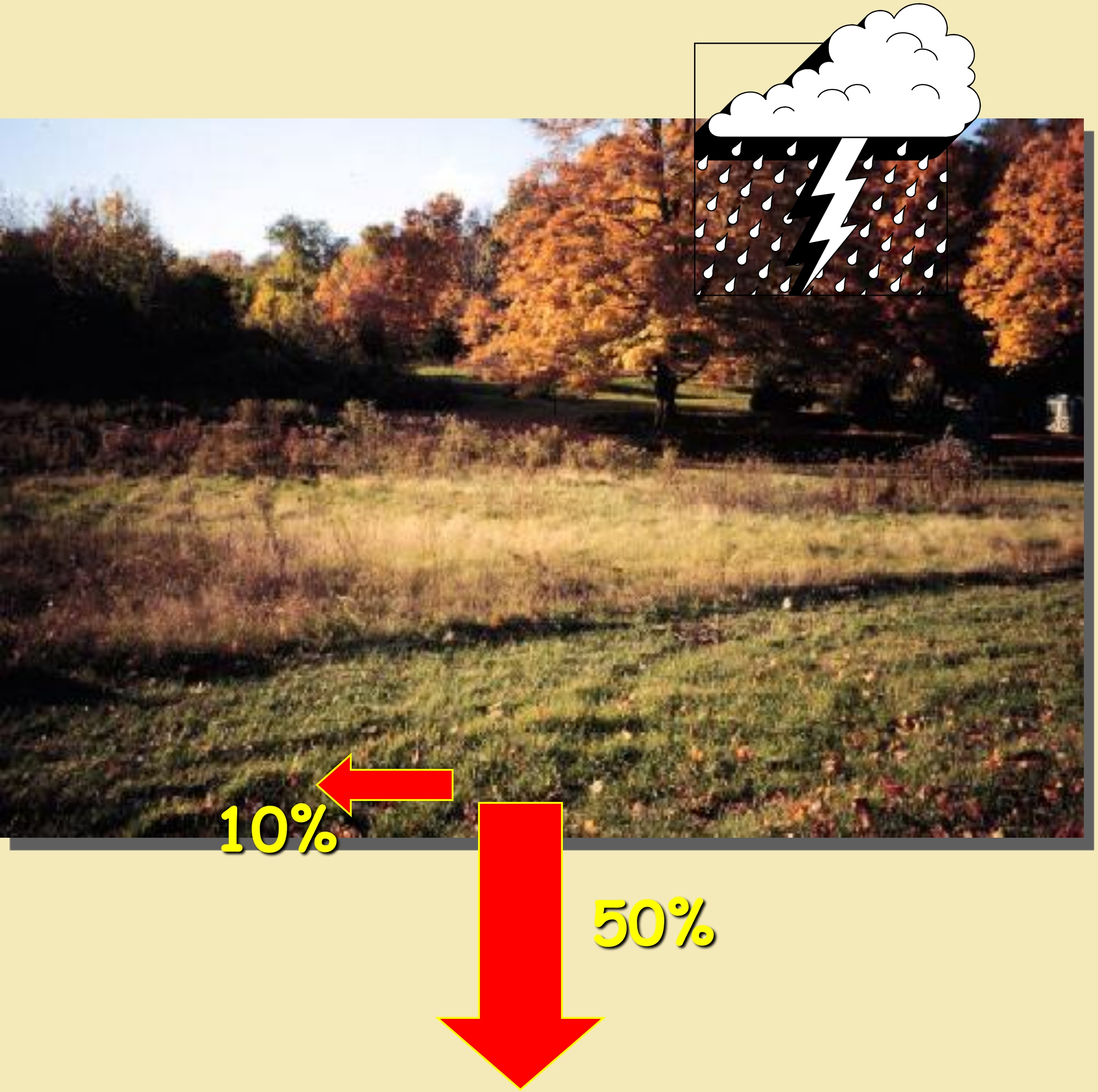
Recognize the importance of Cost-Effectiveness and long term maintenance

Public Works Association

How do you make this…

function like this?

Design Principles



Retain & Restore the Natural Landscape

Conventional

Low Impact Development (LID)

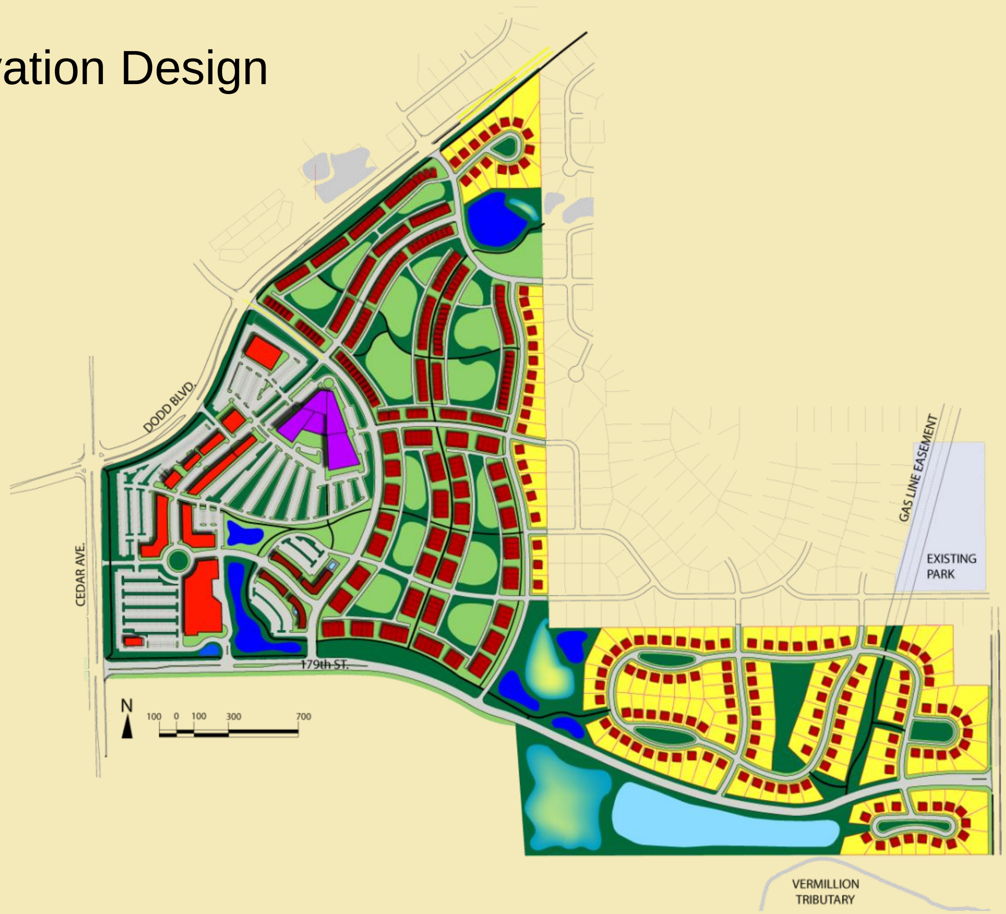
Primary Goal of LID

Design each development site to protect, or restore, the natural hydrology of the site so that the overall integrity of the watershed is protected. This is done by creating a "hydrologically" functional landscape.

Nonstructural LID Tools

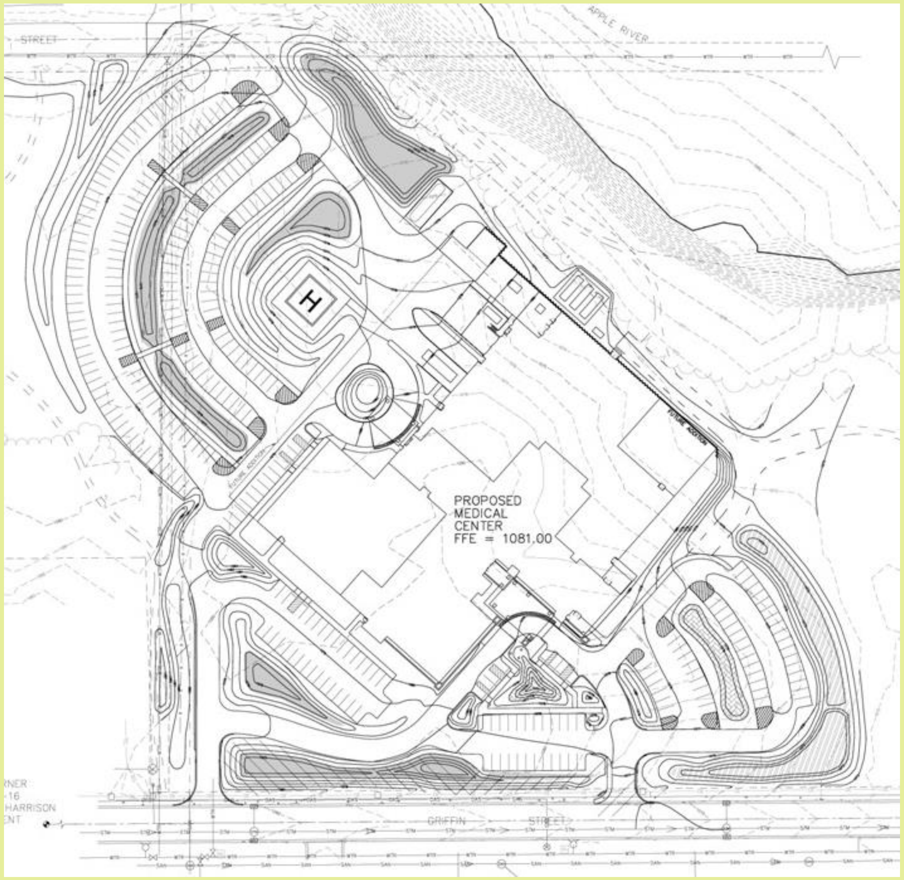
Planning/ Design

- Cluster Development, Conservation Design
- Minimize total disturbed area
- Protect natural flow pathways
- Protect riparian buffer areas
- Protect sensitive areas
- Reduce impervious areas
- Impervious disconnection



LID Structural BMPs

- Infiltration practices
  - Bioretention (rain gardens, urban forestry)
  - Infiltration trenches
  - Detention basins with infiltration design
- Vegetated swales, filter strips, biofiltration
- Vegetation: native landscaping, trees (uptake and evapo-transpiration)
- Green Roofs
- Capture / Reuse (cisterns, rain barrels, ponds)
- Permeable hard surfaces (pavers, roads, parking, driveways, sidewalks)
- Landscaping Soil Quality: protection or restoration (amendments, de-compaction)



Functional Sustainable Landscape

Minimal Impact Design Standards (MIDS)

The development of **Minimal Impact Design Standards is based on low impact development (LID) — an approach to stormwater management that mimics a site's natural hydrology as the landscape is developed.** Using the low impact development approach, stormwater is managed on site and the rate and volume of predevelopment stormwater reaching receiving waters is unchanged. The calculation of predevelopment hydrology is based on native soil and vegetation. (Minnesota Statutes, section 115.03, subdivision 5c).

Minimal Impact Design Standards (MIDS)

Minimal Impact Design Standards (MIDS) represents the next generation of stormwater management and contains three main elements that address the following challenges:

•A higher clean water **performance goal** for new development and redevelopment to provide enhanced protection for Minnesota's water resources.

•New **modeling methods and credit calculations** that will standardize the use of a range of innovative structural and nonstructural stormwater techniques.

•A **credits system and ordinance package** that will allow for increased flexibility and a streamlined approach to regulatory programs for developers and communities.

MIDS Workgroup

MIDS: Performance Goals

New development

Redevelopment

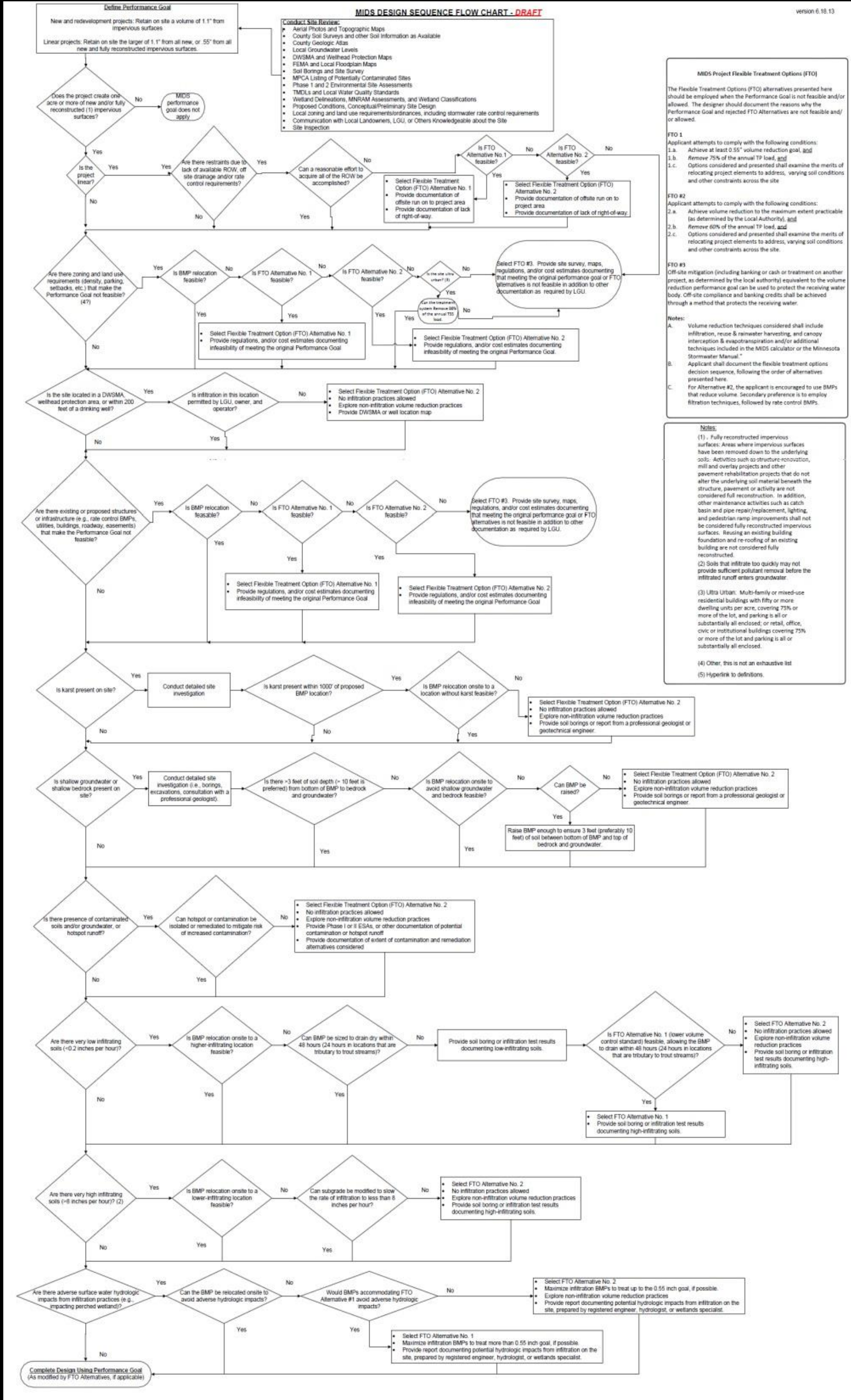
Linear Projects

Flexible Treatment options – **when a site just cannot meet the goal.**

The new, “simple” (?!) stormwater tool

The Flexible Treatment Options Decision Flow Chart

It’s just like everything else in stormwater – you can wish for “simple”, but it’s not going to work out that way



MIDS: Performance Goals

Flexible Treatment Options - Sequence & Design Guidance Flow-Chart

Site Restrictions

- Insufficient ROW
- Incompatible zoning or land use requirements
  - Ultra-urban site - >50 units/acre
- In DWSMA or wellhead protection area
- Incompatible existing or proposed structures or infrastructure
- Karst
- Shallow groundwater or bedrock
- Contaminated soils or hotspots
- Very low or high infiltrating soils
- Adverse surface water hydrologic impacts – starving a wetland

MIDS: Performance Goals

Flexible Treatment Options - Sequence & Design Guidance Flow-Chart

Option #1 = Applicant attempts to comply with the following conditions:

- **Achieve at least 0.55" volume reduction goal, <u>and</u>**
- ***Remove 75%* of the annual TP load, <u>and</u>**
- **Options considered and presented shall examine the merits of relocating project elements to address varying soil conditions and other constraints across the site**

Option #2 = Applicant attempts to comply with the following conditions:

- **Achieve volume reduction to the maximum extent practicable (as determined by the Local Authority), <u>and</u>**
- ***Remove 60%* of the annual TP load, <u>and</u>**
- **Options considered and presented shall examine the merits of relocating project elements to address varying soil conditions and other constraints across the site.**

MIDS: Performance Goals

Flexible Treatment Options - Sequence & Design Guidance Flow-Chart

Option #3 = Off-site mitigation (including banking or cash or treatment on another project, as determined by the local authority) equivalent to the volume reduction performance goal can be used to protect the receiving water body. Off-site compliance and banking credits shall be achieved through a method that protects the receiving water.

MIDS: Credit Calculator

Input

Project size or watershed

% Impervious surface

Soil type

Precipitation

Choice of stormwater practices

Calculate

1. Amount of stormwater volume control needed

   (cubic feet)

2. Amount of particulate (sediment) control needed

   (TSS - total suspended solids)

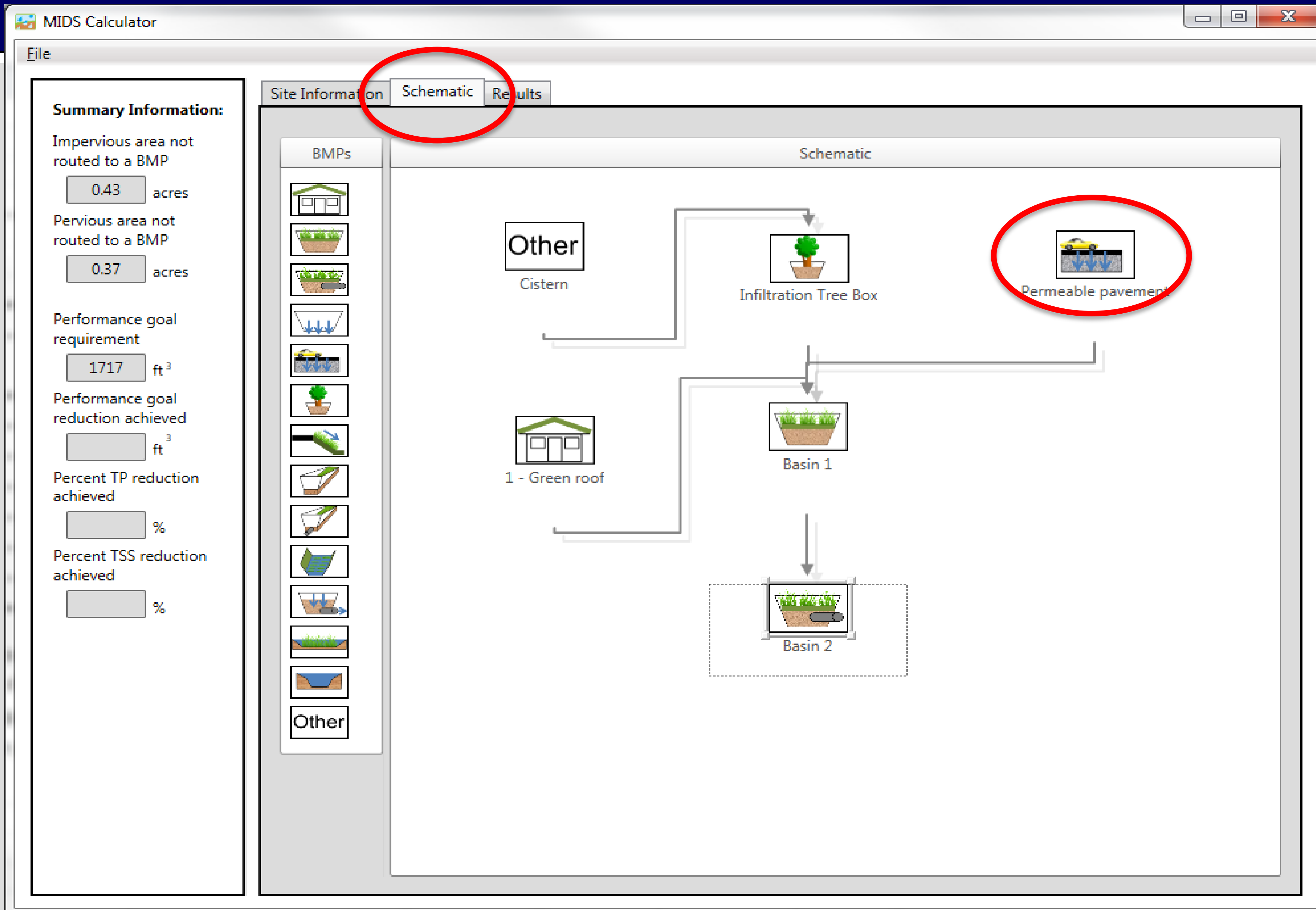
3. Amount of phosphorus control needed

   (TP - total phosphorus)

Output

1. Volume removed by practice (cubic feet)
2. Additional volume removal needed to meet requirement.
3. % Volume removed
4. Annual phosphorus load removed by BMP (lbs/yr)
5. % Annual phosphorus removed
6. Annual TSS removed (ls/yr)
7. % of Annual TSS removed

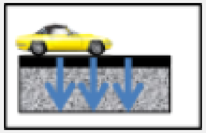
Drag and drop BMPs



Enter BMP Drainage Area Characteristics

BMP Properties

BMP Properties: 1 - Permeable pavement



Watershed | BMP Parameters | BMP Summary

BMP Name: 1 - Permeable pavement

Routing/downstream BMP

[Minnesota Stormwater Manual Wiki]

BMP Watershed Area

Land Cover	A Soils (acres)	B Soils (acres)	C Soils (acres)	D Soils (acres)	Total (acres)
Forest/Open Space - Undisturbed, protected forest/open space or reforested land					0
Managed Turf - disturbed, graded for yards or other turf to be mowed/managed		0.4			0.4

Impervious Cover (acres)	1.6
Total Area (acres)	2

OK | HELP

Permeable pavement

Minimal Impact Design Standards
for enhancing stormwater management in Minnesota

Permeable pavements allow stormwater runoff to filter through surface voids into an underlying stone reservoir for temporary storage and/or infiltration. The most commonly used permeable pavement surfaces are pervious concrete, porous asphalt, and permeable interlocking concrete pavers (PICP). Permeable pavements have been used for areas with light traffic at commercial and residential sites to replace traditional impervious surfaces in low-speed roads, alleys, parking lots, driveways, sidewalks, plazas, and patios. While permeable pavements can withstand truck loads, permeable pavement has not been proven in areas exposed to high repetitions of trucks or in high speed areas because its' structural performance and surface stability have not yet been consistently demonstrated in such applications.


An example of pervious concrete.

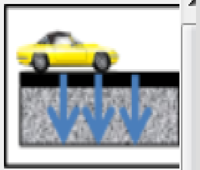
While design details vary, all permeable pavements have a similar structure, consisting of a surface pavement layer, an underlying stone aggregate reservoir layer, optional underdrains and geotextile over uncompacted soil subgrade. From a hydrologic perspective, permeable pavement is typically designed to manage rainfall landing directly on the permeable pavement surface. Permeable pavement surfaces may accept runoff contributed by adjacent impervious areas such as driving lanes or rooftops. The capacity of the underlying reservoir limits the contributing area. Runoff from adjacent vegetated areas must be stabilized and not generating sediment as its transport accelerates permeable pavement surface clogging.

Caution: Sediment control from adjacent impervious or vegetated contributing areas is required to avoid clogging of the permeable pavement surface

Enter BMP Parameters

BMP Properties

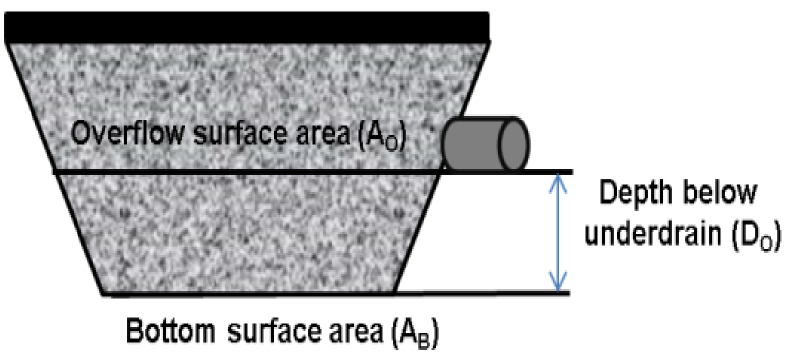
BMP Properties: Permeable Pavers



Watershed | BMP Parameters | BMP Summary

Permeable pavement

$$V = \left[\frac{A_O + A_B}{2} * D_O * n\right]$$



Required treatment volume	799	ft^3
Overflow surface area [Ao]	2100	ft^2
	0.0482	acres
Bottom surface area [Ab]	2100	ft^2
Depth below underdrain [Do]	1	ft
Media porosity [n](typical values 0.25-0.50)	0.4	ft^3 / ft^3
Will subsoil require compaction?	No	
Underlying soil - Hydrologic Soil Group	6 SM (HSG B, 0.3 in/h	
Infiltration rate of underlying soils	0.3	in/hr
User defined infiltration rate		in/hr
Required drawdown time	48	hrs
Volume reduction capacity of BMP [V]	840	ft^3
Volume of retention provided by BMP	799	ft^3

Summary of Cumulative Site Results

Site Information | Schematic | Results

Summary Information

Performance Goal Requirement

Performance goal volume retention requirement:	1557	ft3
Volume removed by BMPs:	1518	ft3
Percent volume removed	**97**	**%**

Annual Pollutant Load Reduction

Post development annual particulate P load:	0.45	lbs
Annual particulate P removed by BMPs:	0.44	lbs
Post development annual dissolved P load:	0.37	lbs
Annual dissolved P removed by BMPs:	0.36	lbs
Percent annual total phosphorus removed:	**98**	**%**
Post development annual TSS load:	148	lbs
Annual TSS removed by BMPs:	145	lbs
Percent annual TSS removed:	**98**	**%**

Summary of Cumulative Site Results

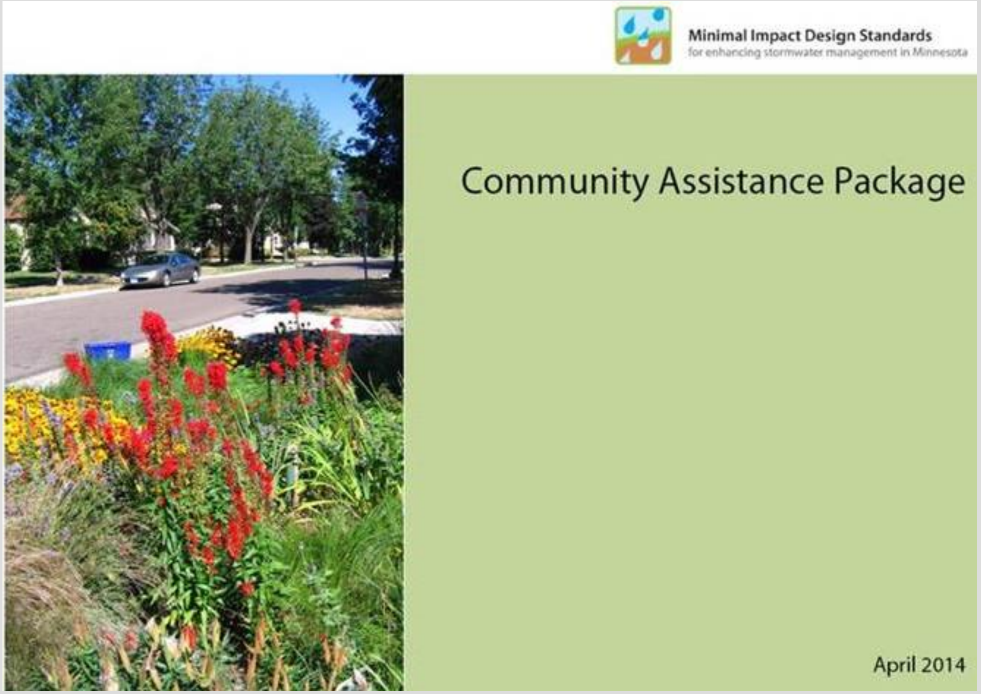
Annual Pollutant Load Reduction

Post development annual particulate P load:	0.45	lbs
Annual particulate P removed by BMPs:	0.44	lbs
Post development annual dissolved P load:	0.37	lbs
Annual dissolved P removed by BMPs:	0.36	lbs
Percent annual total phosphorus removed:	**98**	**%**
Post development annual TSS load:	148	lbs
Annual TSS removed by BMPs:	145	lbs
Percent annual TSS removed:	**98**	**%**

BMP Summary

BMP Name	BMP Volume Capacity (ft3)	Performance Goal Volume Reduction (ft3)	Annual Particulate P Reduction (lbs)	Annual Dissolved P Reduction (lbs)	Annual TSS Reduction (lbs)
1 - Bioretention basin (w/o underdrain)	1741	120	0.09	0.07	28
Permeable Pavers	840	799	0.2	0.15	65
Stormwater Tree Grove	281	280	0.09	0.08	31
Cistern	500	319	0.06	0.06	21
Total	3362	1518	0.44	0.36	145

MIDS: Community Assistance Package



- Background on MIDS
- How to use the package
- Long form stormwater and erosion control ordinance
- Short form stormwater and erosion control ordinance
- Illicit discharge ordinance
- Subdivision ordinance
- Conservation subdivision ordinance
- Shoreland standards (forthcoming)
- Development checklist
- Planning process checklist
- Sample adoption resolution for ordinance changes

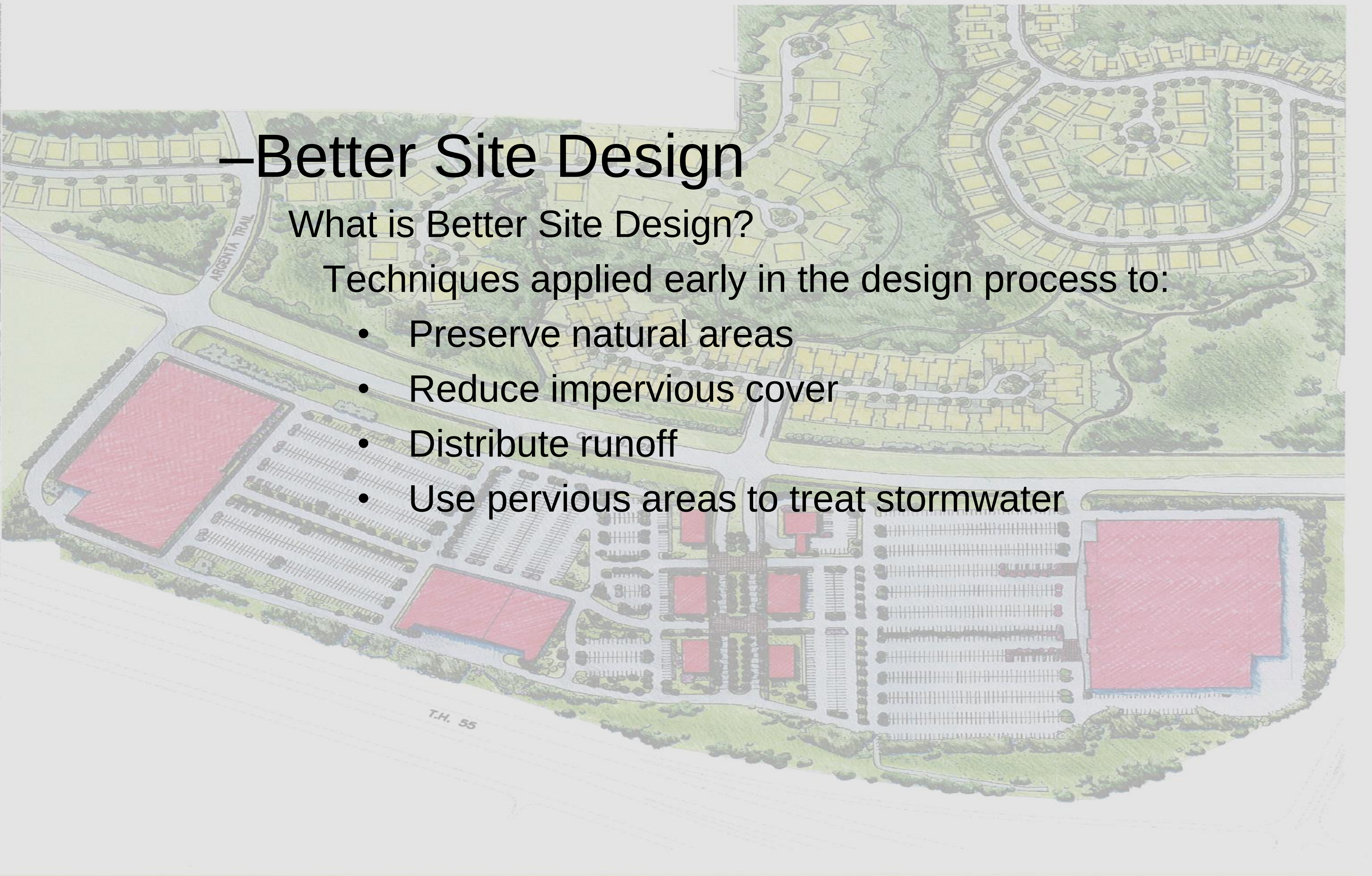
MIDS: Stormwater & Erosion Ordinance

–Better Site Design

What is Better Site Design?

Techniques applied early in the design process to:

- Preserve natural areas
- Reduce impervious cover
- Distribute runoff
- Use pervious areas to treat stormwater



MIDS: Stormwater & Erosion Ordinance

Site Design & Credit Calculator

i. Better Site Design

Open space protection and restoration

a) conservation of existing natural areas (upland and wetland)

b) reforestation

c) re-establishment of prairies

d) restoration of wetlands

e) establishment or protection of stream, shoreline and wetland buffers

f) re-establishment of native vegetation into the landscape

MIDS: Stormwater & Erosion Ordinance

Site Design & Credit Calculator

i. Better Site Design

Reduction of impervious cover

a) reduce new impervious through redevelopment of existing sites and use of existing roadways, trails etc.

b) minimize street width, parking space size, driveway length, sidewalk width

c) reduce impervious surface footprint (e.g. two story buildings, parking ramp)

MIDS: Stormwater & Erosion Ordinance

Site Design & Credit Calculator

i. Better Site Design

Distribution and minimization of runoff

a) utilize vegetated areas for stormwater treatment (e.g. parking lot islands, vegetated areas along property boundaries, front and rear yards, building landscaping)

b) direct impervious surface runoff to vegetated areas or to designed treatment areas (roofs, parking, driveways drain to pervious areas, not directly to stormsewer or other conveyances)

c) encourage infiltration and soil storage of runoff through grass channels, soil compost amendment, vegetated swales, raingardens, etc.

d) plant vegetation that does not require irrigation beyond natural rainfall and runoff from the site

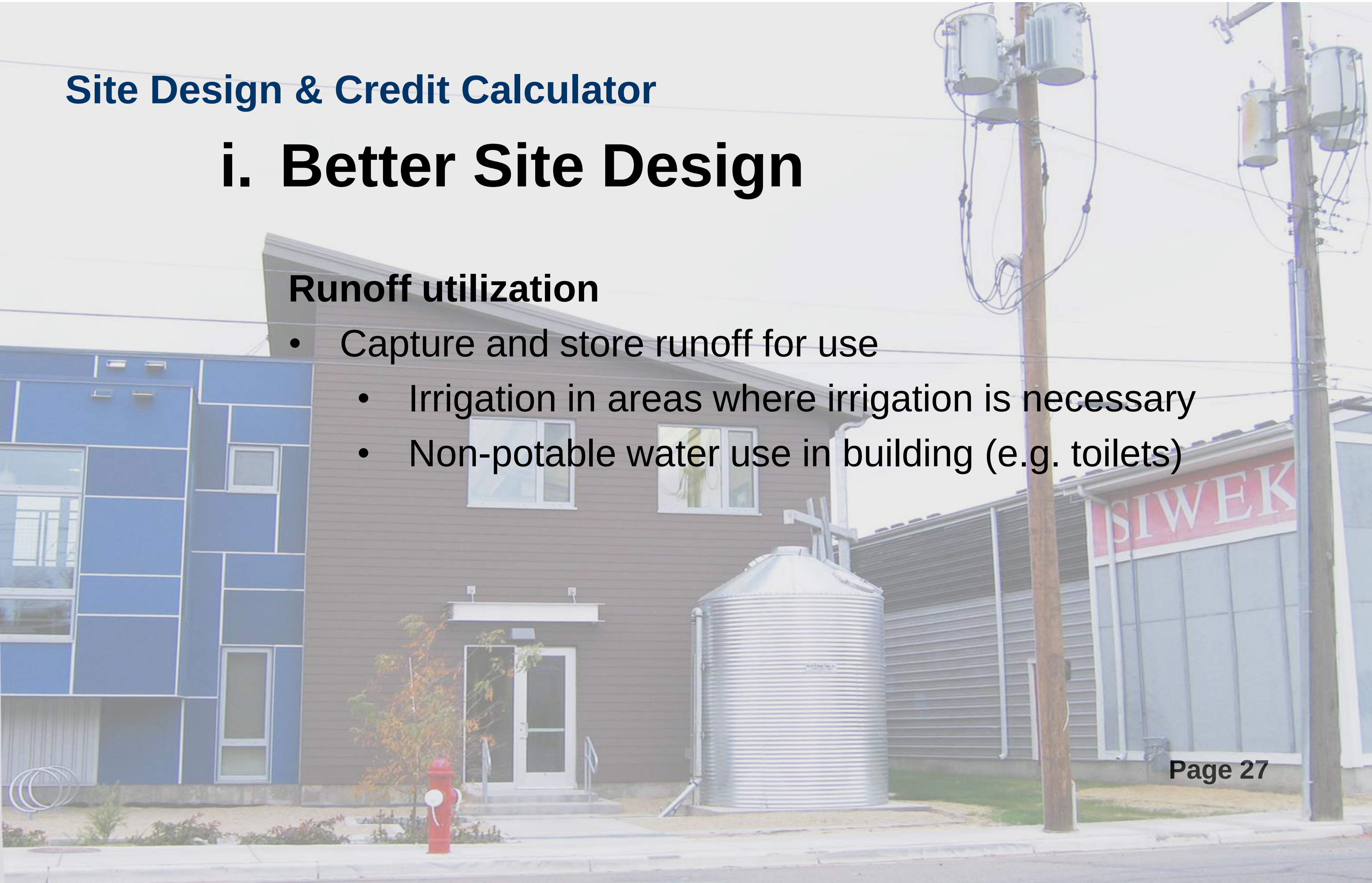
MIDS: Stormwater & Erosion Ordinance

Site Design & Credit Calculator

i. Better Site Design

Runoff utilization

- Capture and store runoff for use
  - Irrigation in areas where irrigation is necessary
  - Non-potable water use in building (e.g. toilets)



Functional Sustainable Landscape