

Green Infrastructure Low Impact Development (LID)

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Overall Goal of LID

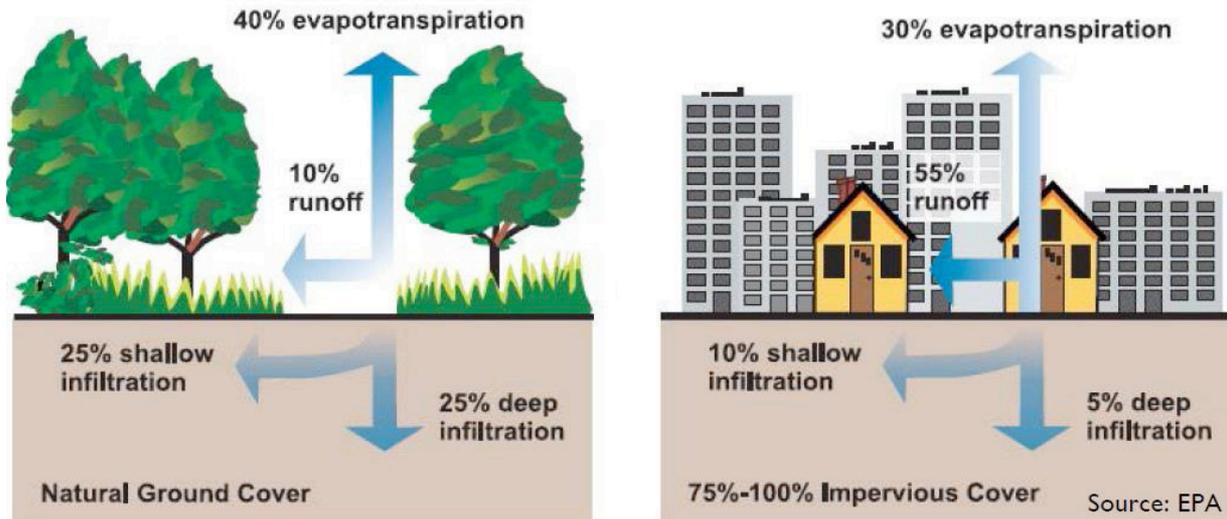
- Conserve existing natural resources (green infrastructure); develop sustainably; and restore urban environments in order to:
 - Improve water quality
 - Reduce flooding
 - Conserve and restore habitat
 - Recharge aquifers
 - Reduce heat island effect
 - Protect & promote outdoor recreation
 - Improve quality of life

Context

- Stormwater runoff from agricultural lands, roads, lawns, and other surfaces is now the most common source of water pollution in the U.S.
- Existing stormwater infrastructure is aging, expensive to maintain, and inadequate to handle heavier rainfalls our region is experiencing due to climate change.
- Traditional development methods exacerbate the problems



Development and Stormwater



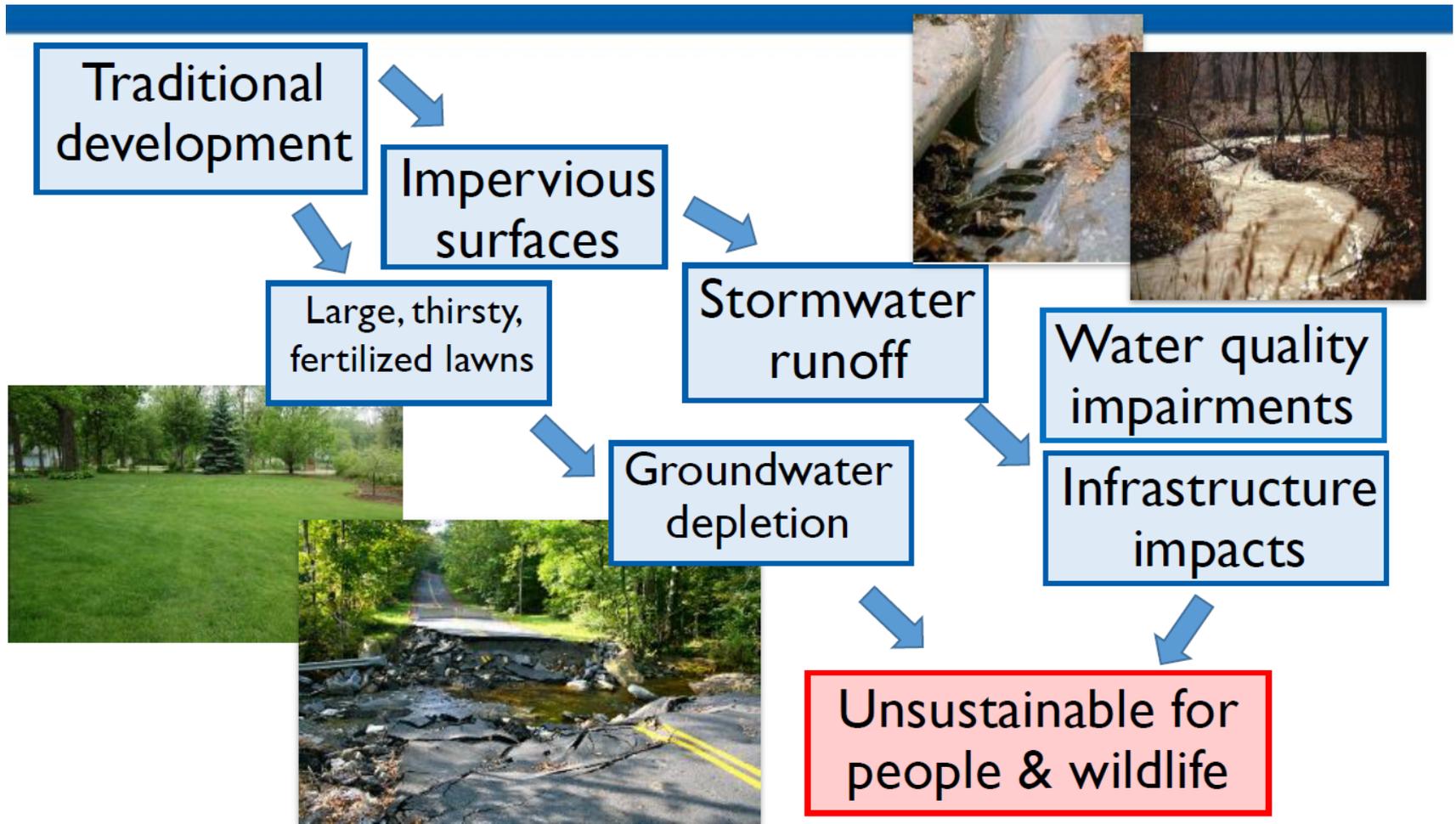
- More impervious surface leads to more runoff and less infiltration
 - These surfaces might be obvious – like buildings, roads, and parking lots – or less obvious – like grassy lawns – which result in more runoff than natural vegetation

Development and Stormwater

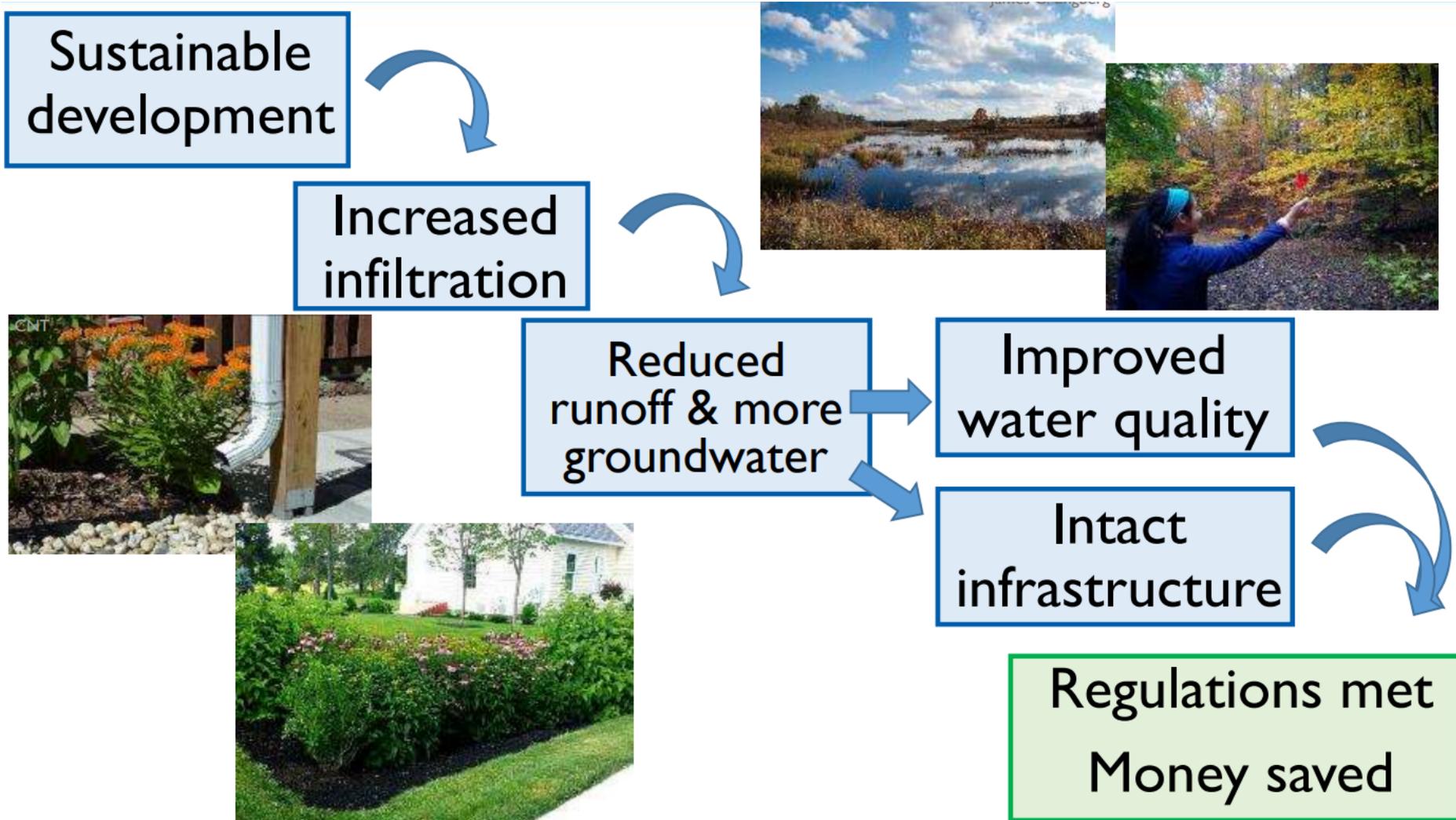
- The traditional approach to development treats stormwater as a waste product to be collected and piped to centralized detention ponds or municipal storm sewers that drain into rivers and streams, often with minimal treatment to remove pollutants, such as sediment, heavy metals, fertilizers, and oils
- Large lot subdivision development in rural areas diminishes the ability of the land to manage stormwater by clearing and carving up a development site without much regard to preserving natural vegetation



Impacts of Development



A New Approach



Source: MassAudubon

Introduction to Low Impact Development (LID)

- A low impact development (LID) approach:
 - works with the natural features of a site
 - reduces impervious surfaces like roads and parking lots
 - uses smaller, decentralized stormwater management techniques, keeping stormwater runoff close to where it falls and reducing the amount of pollutants it can pick up from lawns and roadways.
- Maintains rural character in less developed areas, and provides more green space in urban and suburban areas.
- Local bylaws can support, or hinder, the use of LID in development and redevelopment projects.

Terminology

Nature-Based Solutions

Nature-Based Solutions use natural systems, *mimic* natural processes, or work in tandem with traditional approaches to address natural hazards like flooding, erosion, drought, and heat islands.



Green
Infrastructure



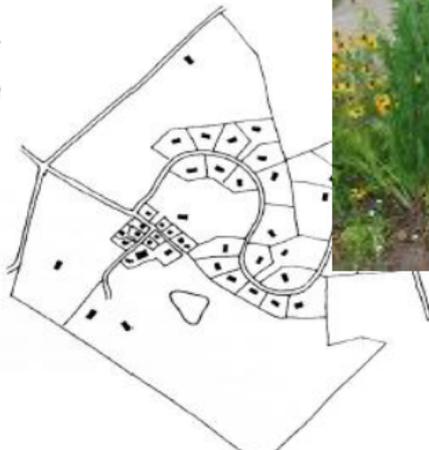
Low Impact
Development (LID)

Development Guiding Principles

1. **Conserve** the natural GI already providing free ecosystem services
2. **Integrate** LID and green infrastructure design into development
3. **Restore** urban resiliency through LID in redevelopment



Randall Arendt *Rural by Design*



Benefits of LID

Benefit	Reduces Stormwater Runoff				Increases Available Water Supply	Increases Groundwater Recharge	Reduces Salt Use	Reduces Energy Use	Improves Air Quality	Reduces Atmospheric CO ₂	Reduces Urban Heat Island	Improves Community Livability					Improves Habitat	Cultivates Public Education Opportunities
	Reduces Water Treatment Needs	Improves Water Quality	Reduces Grey Infrastructure Needs	Reduces Flooding								Improves Aesthetics	Increases Recreational Opportunity	Reduces Noise Pollution	Improves Community Cohesion	Urban Agriculture		
Practice																		
Green Roofs	●	●	●	●	○	○	○	●	●	●	●	●	◐	●	◐	◐	●	●
Tree Planting	●	●	●	●	○	◐	○	●	●	●	●	●	●	●	●	◐	●	●
Bioretention & Infiltration	●	●	●	●	◐	◐	○	○	●	●	●	●	●	◐	◐	○	●	●
Permeable Pavement	●	●	●	●	○	◐	●	◐	●	●	●	○	○	●	○	○	○	●
Water Harvesting	●	●	●	●	●	◐	○	◐	◐	◐	○	○	○	○	○	○	○	●



Yes



Maybe



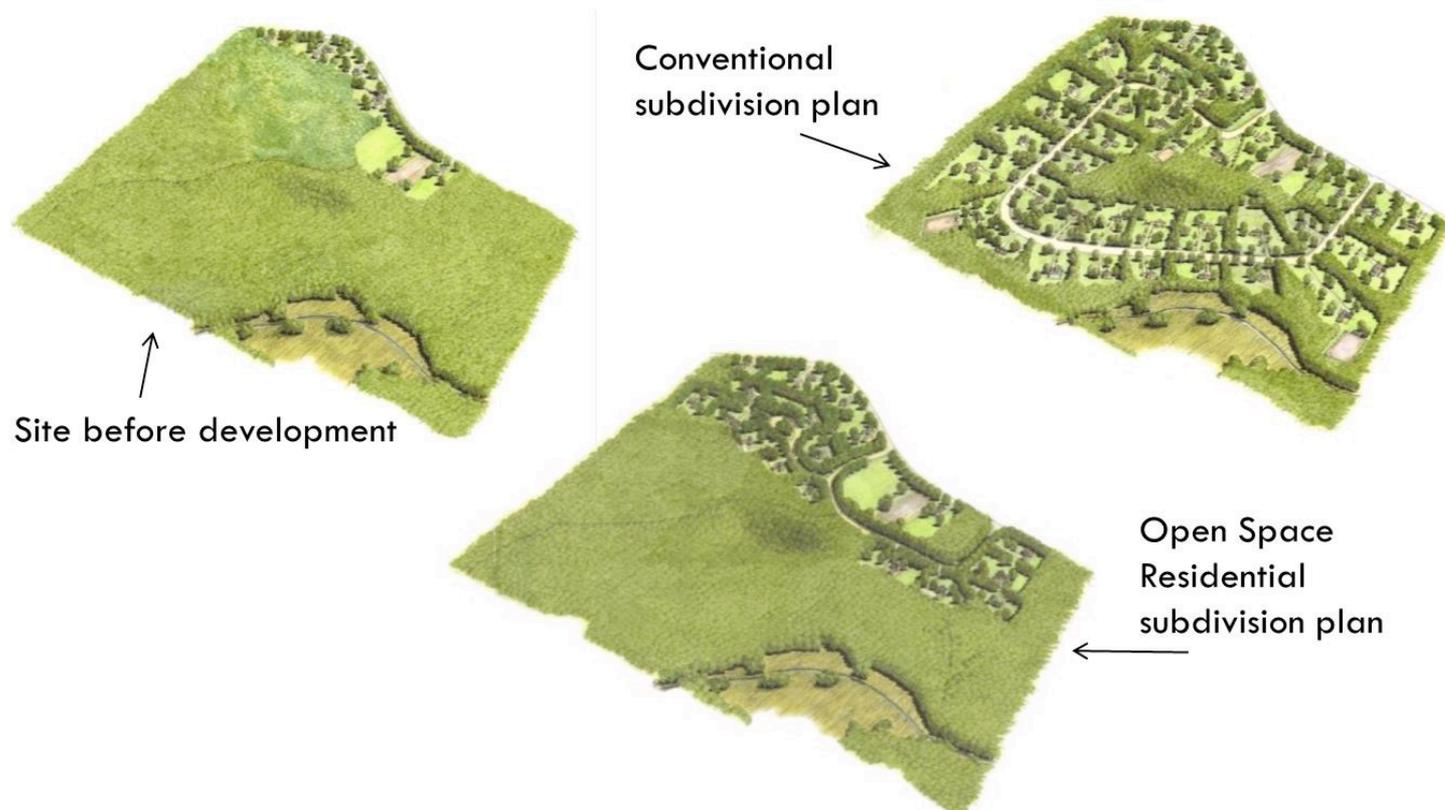
No

Source: Center for Neighborhood Technology:

https://www.cnt.org/sites/default/files/publications/CNT_Value-of-Green-Infrastructure.pdf

Open Space Residential Design

- **Benefits:**
 - Balance new development with conservation of existing GI/natural resources
 - Maintain rural character
 - Reduce grey infrastructure costs
- **Applicability:**
 - Undeveloped areas of a community zoned for residential use



MA Open Space Residential Design Best Practices Factors	Conventional	Better	Best Practice
Permit Type	Special Permit	By Right	Mandatory
Land area to which the zoning is applicable	Only a small amount of developable land	Land of particular environmental sensitivity	All developable land zoned residential
Minimum Open Space	50-65%	65-75%	> 75%
Yield Calculation	Full plan with full percolation tests	Sketch plan with selected percolation test(s)	By formula
Minimum parcel size	> 10 acres	5-10 acres	None
Review Process	No detailed analysis of site characteristics in relation to design	Cluster layout	Flexible "OSRD" 4 Step
Ownership of Open Space	Appropriate to the resources present. For example, agricultural land by the farmer, watershed land by a water dept. or district, habitat land by the conservation commission, or recreational open space by a parks and recreation commission or homeowners association.		
Dimensional Standards; area, frontage, etc.	Specified, < than for standard subdivision	Formulaic reduction with specified minimums	None set or small minimums
Quality of open space conserved: Specificity of local priorities for natural, cultural, and historic resource conservation	No indication of local conservation priorities, or language that refers only to regulated resource areas.	Lack of specificity regarding local conservation priorities; no map of priority locations	Local priorities clearly and unambiguously stated and mapped for use in site design.
Contiguity of open space; relationship to previously protected open space	No contiguity requirement	Contiguity required within subdivision	Contiguity required; adjacent land considered
Quality of open space conserved: Allowed uses of open space	Allowed use of open space not addressed	Vague language regarding use of conserved open space	Clear list of allowed uses consistent with conservation and recreation goals
Quality of open space conserved: Submission requirements - GIS maps, data, etc. to inform the review process	Vague or no language regarding submission of information on site resources and no specified process for the use of the data submitted.	General non-comprehensive data and mapping requirements; vague process for the application of the data to site design and open space conservation.	Specific plans, maps, & comprehensive data regarding natural, cultural, and historic resources required and used as the basis for open space conservation.
Relationship to Plans	Relationship to plans not discussed	Optional consideration of open space goals of OSRP, master, and/or regional policy plan	Required consideration of open space goals of OSRP, master, and/or regional policy plan
Low Impact Design	Not addressed	Encouraged	Required
Density bonus for enhanced public benefit(s)	No bonus offered	Bonus by special permit	Automatic or formulaic bonus
Review Entity	ZBA, council or selectmen as special permit authority	Planning Board	Planning Board
Flexibility re: open space protection to facilitate wastewater treatment facilities	No flexibility provided	Aggregate calculations allowed by board of health	If necessary, required open space may be reduced by < 10% to accommodate; disposal area deed restricted; aggregate calculations allowed by BoH, etc.
Monitoring of open space	No specified monitoring requirements and no requirements that would assist the party responsible for monitoring	Loose provisions to facilitate, municipal monitoring, or no specificity regarding monitoring interval	Specific provisions to aid endowed monitoring by a conservation org at 13 stated intervals

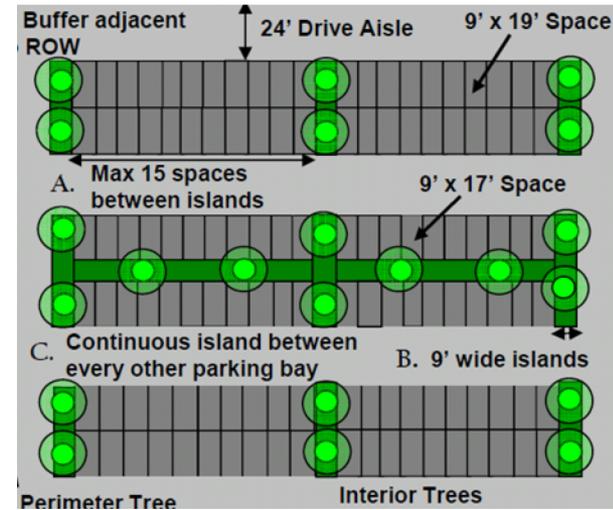
Reduce Impervious Surfaces

- **Applicability:**
 - New subdivision streets
 - Existing streets with excessive paved widths
 - New and existing parking lots
- **Benefits:**
 - Reduces stormwater runoff
 - Reduces cost of pavement and roadway maintenance
 - Increases roadway safety
 - Reduces heat island



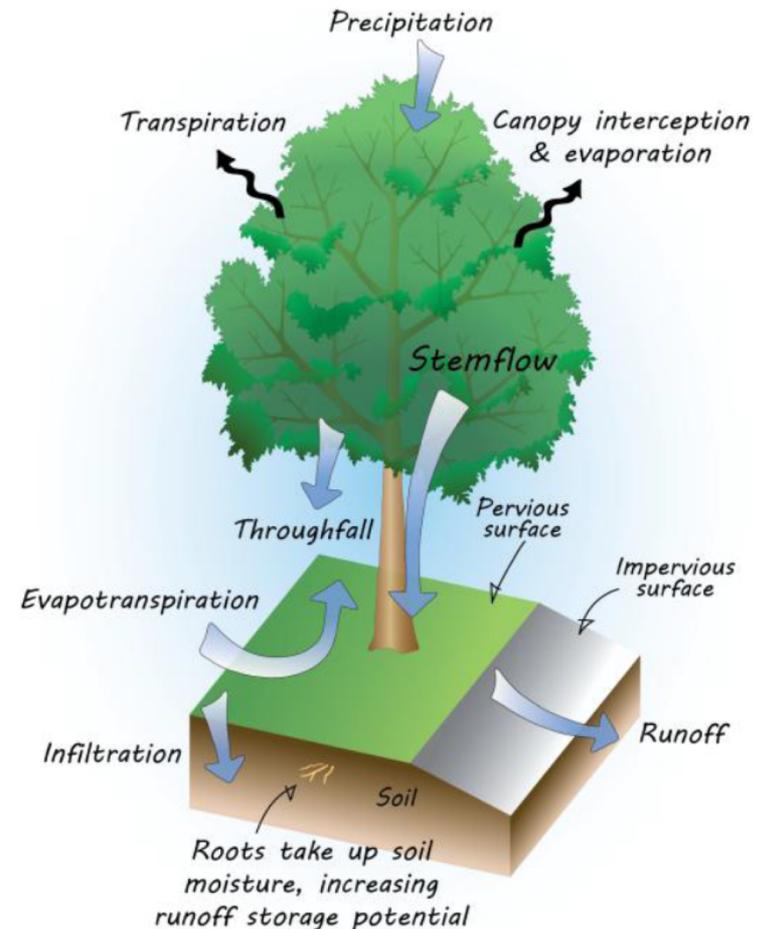
Reduce Impervious Surfaces - Parking

- Incentivize reduced parking; establish parking maximums; allow shared parking
- Encourage LID techniques in perimeter and internal landscaping
- Require large expanses of parking to be broken up with landscaped islands or medians



Street Trees

- **Applicability:** Trees can be used in many situations, including:
 - Along roads, streets, and multi-use paths
 - Surrounding parking lots and within parking lot islands or medians
 - In parks, playgrounds, and plazas
- **Benefits:**
 - Reduce stormwater runoff
 - Delay peak flows
 - Increase groundwater recharge
 - Pollutant removal
 - Reduce urban heat island effect
 - Improve livability/quality of life



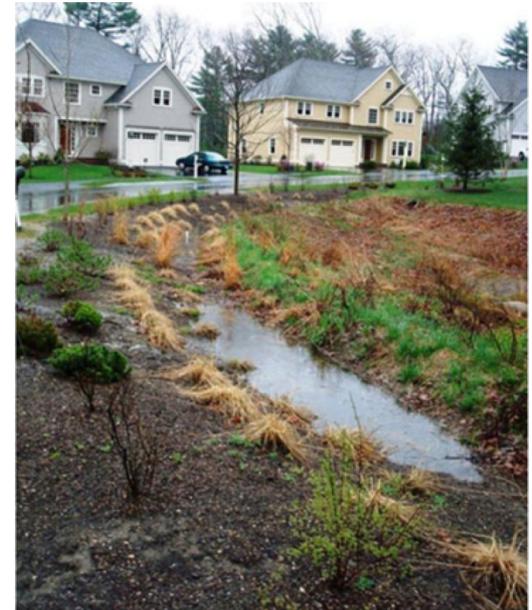
Vegetated Swales & Bioretention Areas

- **Applicability:**

- Between sidewalks and streets and in curb extensions/bump-outs
- In parking lot islands and medians
- In parks, playgrounds, and plazas
- Adjacent to buildings to treat roof runoff

- **Benefits:**

- Reduce stormwater runoff
- Increase groundwater recharge
- Pollutant removal
- Habitat and aesthetic value



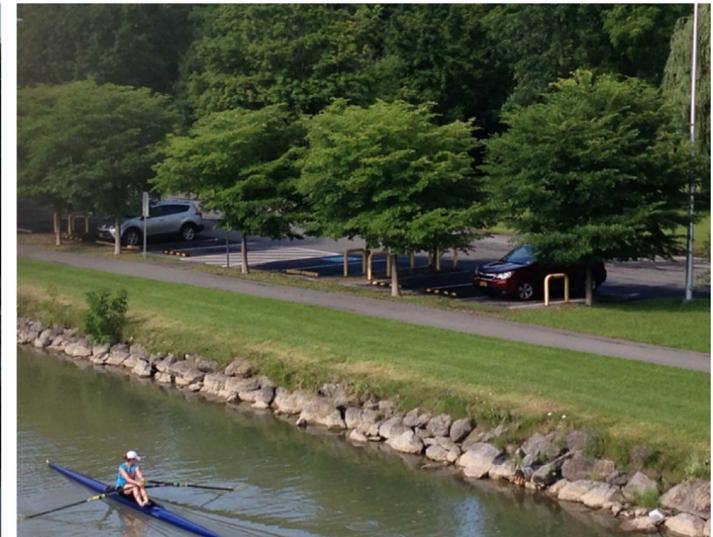
Porous Asphalt / Permeable Paving

- **Applicability:**
 - Low traffic areas including parking stalls, overflow parking areas, sidewalks, multi-use paths, plazas
 - Combine with structural soils, street trees, and reduced impervious surfaces
- **Benefits:**
 - Reduce stormwater runoff
 - Delay peak flows
 - Increase groundwater recharge
 - Reduce need for additional stormwater infrastructure
 - Does not require additional land for stormwater management
 - Reduce winter salt and sand usage due to low/no black ice



Structural Soils

- **Applicability:**
 - Urban streetscapes, parking lots, multi-use paths
 - As a “break out” zone under a sidewalk adjacent to a narrow tree belt
 - Combine with street trees and porous asphalt/permeable paving
- **Benefits:**
 - Promotes healthy urban tree growth
 - Reduces stormwater runoff
 - Recharges groundwater
 - Prevents heaving of sidewalks/pavement from tree roots



Challenges and Opportunities

- LID / GI often works with grey infrastructure (as opposed to entirely replacing it), reducing the amount of grey infrastructure needed
- Different solutions for urban vs. rural settings
- Maintenance is key – need solutions that will be maintained over time
- Integrate into private development (land use regs) and public projects (utility replacement, roadway reconstruction, complete streets, public facilities...)
- Co-benefits are many – climate resilience, water quality, public health, habitat, livability

Resources

- MassAudubon's bylaw review tool:
<https://www.massaudubon.org/our-conservation-work/advocacy/shaping-the-future-of-your-community/publications-community-resources/bylaw-review>
- Sustainable Neighborhood Road Design Guidebook:
http://www.apa-ma.org/apa-ma_documents/Publications/NRB_Guidebook_2011.pdf
- Massachusetts Stormwater Handbook:
<https://www.mass.gov/files/documents/2016/08/qi/v2c2.pdf>
- FRCOG's Green Infrastructure Guide for Public Works Projects:
<https://frcog.org/wp-content/uploads/2019/01/Green-Infrastructure-Guide-for-Public-Works-Projects-2018.pdf>

Grant Background and Main Tasks

- The high water quality of the Green River is degraded by polluted stormwater runoff from downtown Greenfield – bacteria, sediment and nutrients.
- This project is envisioned as the first of many to use innovative stormwater management structures to reduce urban stormwater runoff to the Green River, an important tributary to the Deerfield River.
- Funding for the project has come from several sources: the Town of Greenfield, MassDEP 319 grant program, Mass Environmental Trust, Greening Greenfield, and many hours of volunteer work.
- Project tasks include:
 - retrofitting a 2 acre parking lot with LID structures
 - installing LID structures along Olive Street
 - design and installation of 2 rain gardens
 - implementing a public education and outreach campaign
 - working with local officials to identify opportunities to incorporate LID into town regulations

Importance to Greenfield

Downtown area (from CSLD 2012 study):

- Stormwater is discharged directly into the Green River or one of its tributaries, potentially washing pollutants such as salt, oil, hydrocarbons and heavy metals from the road into the river.
- Impervious surfaces cover approximately 25 acres of the 29-acre downtown area. In a one-inch, one-hour storm, about 680,000 gallons of water run off the site and into the Green River.
- The urban heat island effect increases air temperatures and the temperature of stormwater runoff entering the river systems, negatively impacting fish and other wildlife.



*Polluted stormwater runoff
on Bank Row*



Importance to Greenfield

Outside of downtown new development can result in:

- Loss of natural resources and habitat
- Loss of groundwater recharge
- Increased flooding and erosion
- Runoff from lawns and roads can contain fertilizers, herbicides, pesticides, and other pollutants
- Large lawn areas require excessive water use



Summary of Greenfield Plans for LID Elements

- Revise zoning to encourage greater infill and use of existing buildings and lots in developed areas of town; preserve farmland and forests in less developed parts of town.
- Increase tree cover to reduce the urban heat island effect and to improve the pedestrian and bicycling environment in town.
- Reduce impervious surfaces through redesign of existing parking and streetscapes and revising parking requirements and road design standards for municipal and private development/redevelopment.
- Incorporate green infrastructure into municipal and private redevelopment/ development projects and road and parking lot projects to improve water quality and resilience to climate change.
- Encourage rain gardens and reduction of impervious surfaces on private property.

Documents reviewed:

Greenfield Regulatory Assessment for Healthy Community Design (2015)

Sustainable Greenfield Master Plan (2014)

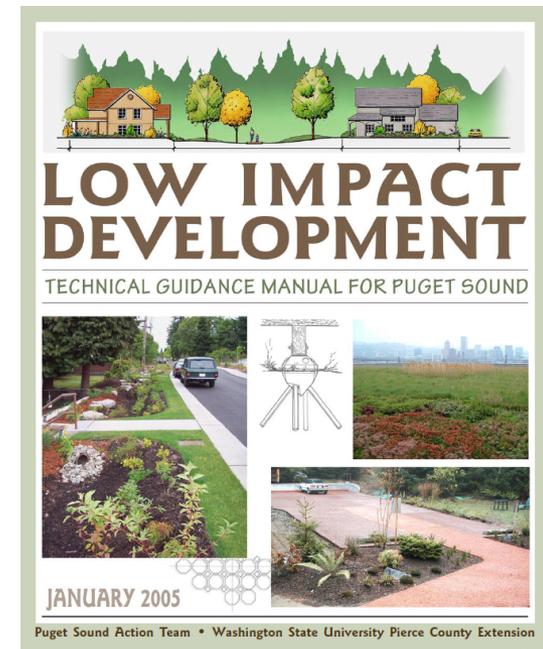
Town of Greenfield Baseline Tree Inventory (2014)

Streetscape Enhancement and Ecological Parking Lot Design (2012)

Greenfield Open Space and Recreation Plan (2012)

Options for Incorporating LID into Development/Redevelopment Projects

- Integrate into Subdivision Regulations and Zoning Ordinance
- Integrate into Stormwater Ordinance
- Develop a guidance manual for private and Town projects, reference in Stormwater Ordinance and land use regulations



Regulations Reviewed

- Chapter 880 Subdivision of Land
- Chapter 200 Zoning Ordinance
- Chapter 695 Stormwater System
- Chapter 195 Wetlands Protection

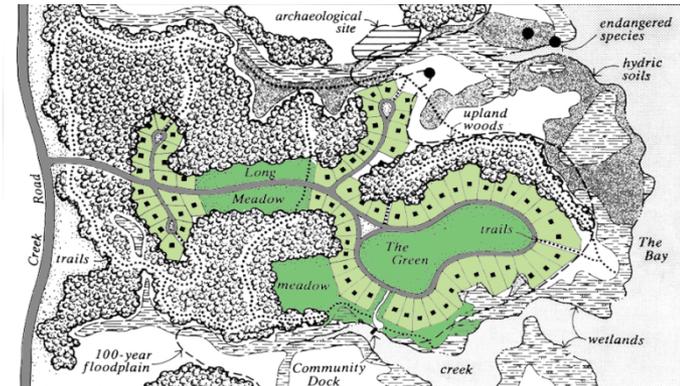
Chapter 880 Subdivision of Land

- Addresses road design, utilities, stormwater drainage, and other features of a new development when land is being divided into two or more parcels.
- Determines what the public realm will look like – “Subdivision regulations tell a story...about what a substantial part of your town is going to look like someday.”
- Adopted by the Planning Board



Preliminary Subdivision Recommendations

- Add references to Chapter 195 Wetlands Protection of the Greenfield Code
- Add an alternative plan review for preliminary plans that do not show an open space/cluster design in the Rural or Suburban Residential Districts (see Zoning recommendations also)
- Include LID definition and/or section, and reference LID throughout when mentioning drainage/stormwater
- Consider applying the Environmental Assessment to any developments over 10 units (currently only applies to developments over 10 units within 1,000 ft. of a perennial river or stream)



Preliminary Subdivision Recommendations - Streets

- Focus on reducing impervious surfaces – narrower paved widths, smaller cul-de-sacs, more design flexibility to minimize cut and fill
- Additional benefits - slower vehicle design speeds, safer pedestrian environment
- Encourage LID features in cul-de-sac islands
- Where curbs are required, allow perforated or invisible curbs to allow runoff to enter roadside swales, bioretention, or other stormwater management features



Preliminary Subdivision Recommendations – Trees, Grass Plot and Sidewalks

- Require grass plot between sidewalk and road (minimum 6 feet)
- Allow sidewalks to meander to protect natural features; allow a multi-use path in lieu of one sidewalk either in ROW or in separate easement
- Encourage LID techniques within grass plots
- Require street trees on both sides of subdivision streets, planted in the grass plot or within 5 ft. of the ROW
- Retained trees can count toward tree requirement
- Remove restriction on trees planted in the grass plot
- Add size and planting requirements for trees; require diversity of species; must survive one year after planting before release of performance guarantee



Greenfield Subdivision Examples



Chapter 200 Zoning

- Zoning determines the uses, dimensions and sometimes design within different areas (districts) of town
- Amendments require a two-thirds vote of Town Council
- Purpose of zoning includes but is not limited to:
 - To facilitate the adequate provision of transportation, water, water supply, drainage, sewerage, schools, parks, open space and other public requirements;
 - To conserve the value of land and buildings, including the conservation of natural resources and the prevention of blight and pollution of the environment;
 - To encourage the most appropriate use of land throughout the city or town, including consideration of the recommendations of the master plan

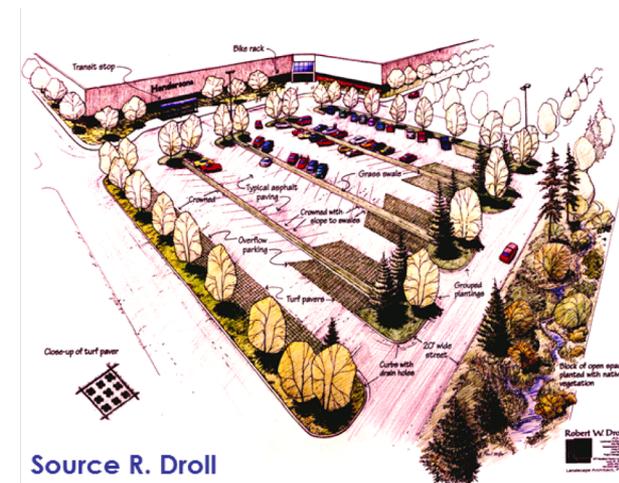
Preliminary Zoning Recommendations – Open Space/Cluster Developments

- Remove prohibition of OS/CD in the Water Supply Protection District
- Remove requirement that applicants show the potential for groundwater pollution is no greater than would be expected for a conventional development
- Revise OS/CD or adopt Natural Resource Protection Zoning as only by-right development option in the Rural Residential and Suburban Residential districts – require higher % of conserved open space; utilize conservation analysis process; deviations would require a Special Permit



Preliminary Zoning Recommendations - Parking

- PVPC parking recommendations: incentivize reduced parking; fee-in-lieu parking program; establish parking maximums in downtown; etc.
- Allow permeable paving for parking stalls and overflow parking areas (currently allow grass for overflow)
- Encourage LID techniques in perimeter and internal landscaping
- Require more shade trees (every 30 ft. instead of 40 ft. in buffer areas) and a higher percent of internal landscaping
- Require large expanses of parking to be broken up with landscaped islands or medians
- Require an Operations & Maintenance Plan for stormwater management features



Preliminary Zoning Recommendations – Driveways and Entrances, Site Plan Review

- Reduce minimum widths of driveways
- Allow the use of pervious material for residential driveways – porous pavers, paving stones, pervious asphalt, etc. – and the use of a “two-track” design
- Include LID in Approval Guidelines of Site Plan Review



Greenfield Zoning and Parking Examples



Chapter 695 Stormwater System

§695-2. Purpose.

The purpose of the City's stormwater regulations is to ensure high water quality standards and address any potential water quantity problems associated with development and to:

- Preserve hydrologic conditions that closely resemble pre-development conditions.
- Prevent flooding by managing the peak discharge and volume of runoff.
- Reduce the amount of suspended solids and other pollutants in order to maintain water quality.

Chapter 695 Stormwater System

- Applies to subdivisions and anyone needing a connection permit:
- No unauthorized person shall uncover; make any connections with, or open into; use, alter, disturb; introduce a new discharge or increase the volume currently discharged to any public way, stormwater sewer, or appurtenance thereof, without first obtaining a written stormwater connection permit from the DPW.

Preliminary Stormwater System Recommendations

- Clarify applicability; establish thresholds for projects not connecting to the existing stormwater system
- Add definitions for LID and Environmentally Sensitive Site Design
- Refer to the Local Wetlands Ordinance in addition to the WPA
- Require projects to comply with the most recent standards of the MA Stormwater Management Handbook
- Add LID as a Design Criteria