LOW IMPACT DEVELOPMENT BYLAW ANALYSIS

Uxbridge, Massachusetts

CENTRAL MASSACHUSETTS
Regional Planning Commission

PREPARED BY THE CENTRAL MASSACHUSETTS
REGIONAL PLANNING COMMISSION

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Introduction

Recent scientific publications show an approximated ten percent increase in total precipitation across our region over the last 50 years. This change represents a 2.12 mm increase in precipitation per year. Under a high emission scenario, which assumes continued increased greenhouse gas emissions, annual precipitation could increase by as much as fourteen percent by the end of the century. The same models predict that precipitation during winter months could increase by as much as thirty percent, the majority of which will fall as rain rather than snow. These significant changes in precipitation across the state will have noticeable impacts on stream flows, water supply, aquifer recharge, water quality, and more. Adopting Low Impact Development (LID) best practices represents a proactive commitment to working towards preserving water quality at the local level.

The following analysis is designed to assist the Town of Uxbridge in developing options for making its local bylaws and regulations more conducive to LID strategies to manage stormwater. LID is a development style that employs nature-based solutions to manage stormwater. LID utilizes techniques that include maintaining or restoring natural landscape features and minimizing impervious surface. Implementation of LID guidelines and practices will provide Uxbridge practical approaches to curtail infrastructure development and maintenance costs; reduce flooding; recover water quality; and protect and restore natural features.

This analysis will provide a "zoning diagnostic." The diagnostic was undertaken to review Uxbridge's Zoning Bylaw and other regulations and highlight areas where they may be improved relative to LID. Many municipalities have not updated their Zoning Bylaw for many years, and as a result of outdated rules and regulations your Town may be unable to develop in way that is consistent with its vision.

The resulting diagnostic summary is comprised of a best practices guidance document, and a series of tables summarizing review of local general bylaws, Zoning Bylaws, and regulations (Appendix A and Appendix B).

The subsequent tables and associated documents will allow you to evaluate local land use regulations (including the Town Zoning Bylaws, Subdivision Rules and Regulations, and Stormwater Regulations) as they compare to established LID best management practices. Based on the findings of this analysis, the Planning Board (or other Town Officials) may seek additional funding to further refine goals and recommendations aimed at amending the Zoning Bylaw through Town Meeting or subdivision regulations through the Planning Board. This initial review positions the Town well to pursue funding for a second phase. This second phase would allow the Town to focus its efforts on creating and implementing LID best management practices into its existing bylaw.

The Commonwealth of Massachusetts's Smart Growth/Smart Energy Toolkit, Mass Audubon's LID best practice models, and other resources were used to establish three potential baseline LID implementation scenarios. These three scenarios, conventional, better, and best means of implementation, are used as a metric to characterize the level to which current land use

regulations in the Town of Uxbridge do or do not encourage LID to be implemented easily throughout the community. The color-coded tables provide a summary overview of how LID-friendly current land use regulations are, and highlights inconsistencies between different parts of the local land use rules. Results from this analysis can be found in Appendix A and B. Three columns on the left side of the tables identify conventional, better, and best management practices in encouraging LID implementation. The data in the columns on the right hand side of Appendix A and B have been extracted from Town rules and regulations following a close examination of their contents. These right-hand columns serve as a point of comparison between what is currently written in Town rules and regulations and LID best management practices.

Appendix A examines Uxbridge's Zoning Bylaw, Subdivision Rules & Regulations, and Stormwater Regulations and assesses how encouraging existing standards are toward LID implementation. Appendix B provides an evaluation of sections of the Zoning Bylaw related to Open Space Development (§ 400-28) and Conservation Design Development (§ 400-30).

Please note that not all factors (such as road width, siting of LID, limits on clearing and grading, or allowing common drives) are addressed in each of the sections considered (Zoning, Subdivision Rules and Regulations, Stormwater). Where that factor is not usually included within a regulation or bylaw, the applicable box will be greyed out. For example, setbacks and frontage requirements are addressed under zoning, but often not under other bylaws or regulations.

The analysis is broken into five goals, as defined by Mass Audubon:

Goal 1: Protect Natural Resources and Open Space

The focus of this goal is to limit clearing and grading and encourage soil management, the use of native species, and revegetation of disturbed areas.

Goal 2: Promote Efficient, Compact Development Patterns and Infill

The emphasis of this category is to make dimensional requirements such as setbacks, lot size, and frontage more flexible and to allow compact development tools such as common drives to help communities encourage efficient, compact designs, decrease impervious surfaces and increase infiltration, while still supporting new development.

Goal 3: Smart Designs that Reduce Overall Imperviousness

Goal #3 pertains to reducing impervious surface in certain site design components such as street location, road width, cul-de-sac design, curbing, roadside swales, and sidewalk design and location.

Goal 4: Adopt Green Infrastructure Stormwater Management Provisions

This goal aims to state LID as the preferred method, such as requiring roof runoff to be directed to vegetated areas, and a preference for infiltration wherever soils allow or can be amended. To meet this objective, Bylaws should specify what LID is and which best practices are preferred or required.

Goal 5: Encourage Efficient Parking

Goal #5 proposes to reduce the amount of required parking to reduce impervious surfaces and runoff.

Low Impact Development Overview

Low impact development relies on Green Infrastructure to provide alternative methods to traditional stormwater management. Green infrastructure, which includes naturally occurring and planned systems, provides a number of ecosystem services. Examples of green infrastructure might include street trees, rain gardens, and permeable pavement. Ecosystem services from green infrastructure and LID might include, but are not limited to, increased infiltration rates, faster groundwater recharge, and improved health of nearby waterways. Ecosystem services resulting from green infrastructure and low impact development are described in more detail below.

Low impact development outlines a formal approach for new development and redevelopment that works with the natural landscape to manage stormwater as close to its source as possible. Low impact development asks communities to rethink how they view stormwater. Rather than treat stormwater as a waste product as traditional development practices tend to, low impact development practitioners view stormwater as a resource. By combining various aspects of green infrastructure, a low impact development scenario might include: minimizing alteration of existing green infrastructure; reducing total impervious surface cover; supporting retention of naturally vegetated buffers along wetlands and waterways; and minimizing grading and alterations to natural water flow patterns. Implementing these development techniques has the potential to result in significant economic and ecological benefits. These various approaches are designed to reduce runoff and subsequent pollutant loading into nearby waterbodies.

Why Low Impact Development?

Traditional development scenarios tend to rely on converting existing green space into developable land for subdivision, connecting developed parcels via a network of impermeable roadways and parking surfaces. Between April 2005 and April 2013, roughly 38,000 acres of previously undeveloped land in Massachusetts was developed. Land conversion represents a major driver of global environmental change. Recognizing that land in Massachusetts will continue to be developed in the future, it is critical to instill methods and common practices that mitigate potential negative effects associated with development. Doing so has the potential to benefit communities locally and regionally. If implemented, the practices described here have the potential to provide ecological as well as economic benefits (please refer to Figure 1 for a summary of benefits of low impact development according to the Center for Neighborhood).

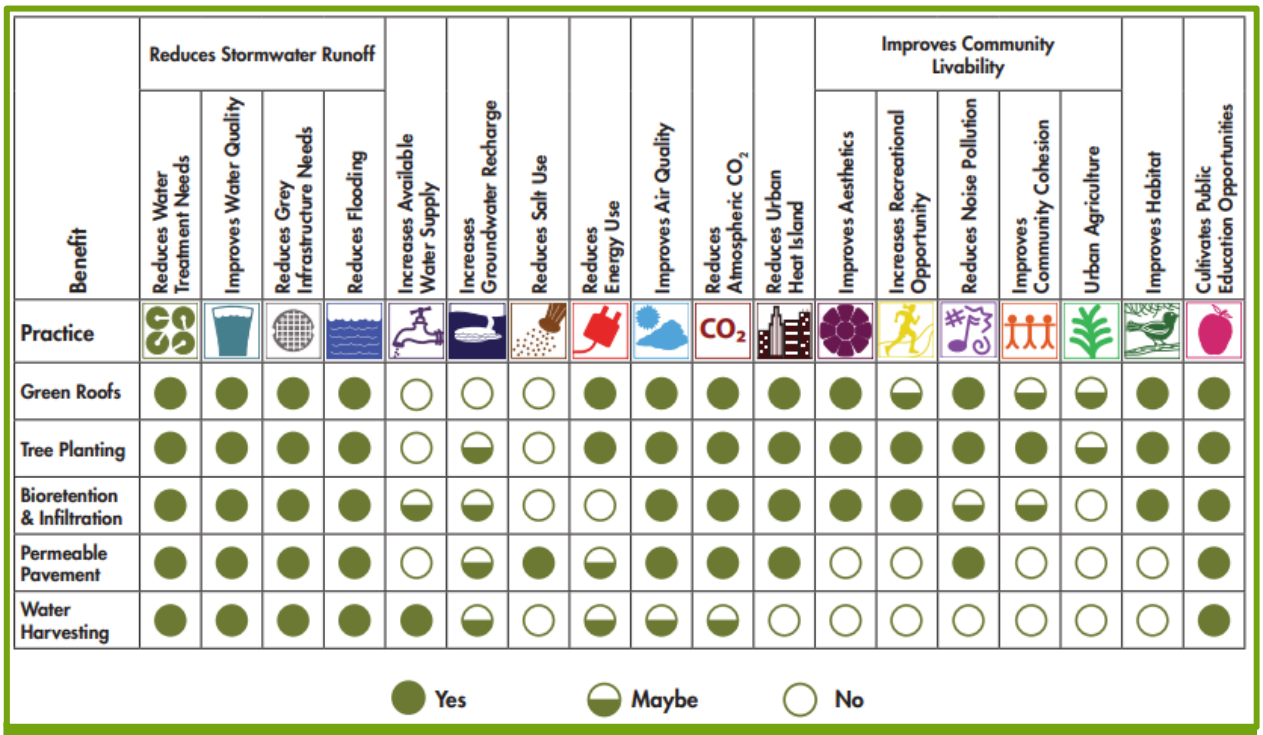

Figure 1 *Benefits of low impact development (Source: Center for Neighborhood)*

Increased impervious surface cover resulting from roadways, parking areas, rooftops, and other aspects of development can be expected to increase stormwater runoff. Without being able to be absorbed into the soil, rainfall will follow planned drainage patterns towards the nearest catch basin. As it does so, stormwater may pick up various pollutants that have collected on roadways, sidewalks, or other surfaces. These pollutants, which might include oils, debris, nutrients, chemicals, and bacteria, can have significant impacts on downstream waterways. Stormwater often tends to be warmer than nearby streams as well. Increased temperatures as well as increased volume of water can result in faster stream flow, which may lead to erosion. LID offers communities a toolkit with which they can work to decrease the problems described above. As mentioned, under an LID framework stormwater is viewed as a resource rather than a waste byproduct. Having implemented LID best practices, a community shows commitment to treating rainfall before it becomes what is traditionally considered stormwater. Low impact development attempts to manage water and associated pollutants at the source – thereby seeking to mitigate externalities development might have on rivers, streams, lakes, coastal waters, and ground water.

In a traditional development scenario, a new project might result in seventy-five to one-hundred percent impervious surface cover. Because of this high rate of impervious surface cover, approximately fifty-five percent of rainfall can be expected to runoff into conventional stormwater systems and thirty percent would be expected to escape via evapotranspiration. In the conventional development scenario, only fifteen percent of rainfall can typically be expected to be absorbed into soils via infiltration. Of that fifteen percent, approximately five

percent will be absorbed via deep infiltration. Over time impermeable surfaces will decrease infiltration and groundwater recharge, which may lead to negative impacts on surrounding watersheds and groundwater reserves. Please refer to Figure 2 for an illustrative comparison of conventional infiltration to expected LID infiltration.

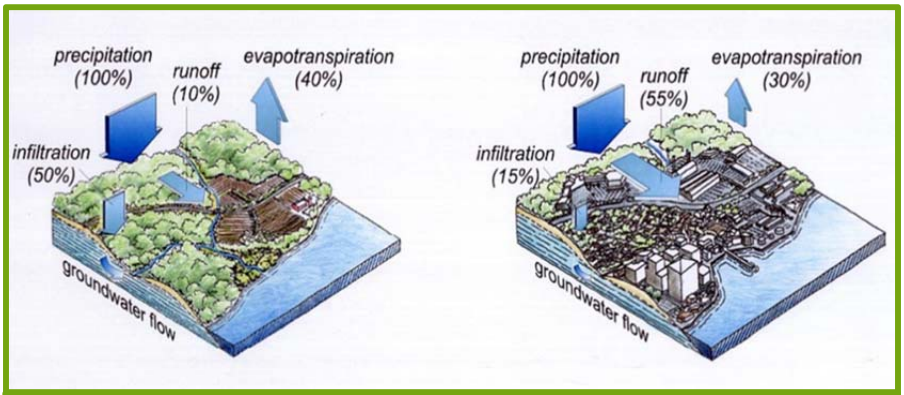

Figure 2 *Comparison of conventional (right) and LID (left) infiltration (Source: MA Smart Growth Toolkit)*

Man-made swales, vegetated areas, and other methods to capture rain water can meaningfully reduce the amount of rainfall that ends up in local sewer systems and polluting nearby bodies of water. Capturing rainfall onsite not only allows water to be filtered, but allows sufficient time for rainwater to infiltrate soils and improve groundwater recharge times. The United States Environment Protection Agency (EPA) estimates a very different scenario for developments that choose to implement LID best practices over conventional management systems. In this scenario, only ten percent of rainfall is anticipated to contribute to runoff, twenty-five percent of rainfall will be absorbed through shallow infiltration, an additional twenty-five percent can be expected to be absorbed via deep infiltration, leaving forty percent to leave via evapotranspiration.

Implementing LID

There are a number of approaches communities can take in implementing LID practices. Table 1 presents costs calculated by EPA for its New England Stormwater Management Optimization Tool. The tool, which presents capital costs for several best management practices in New England, shows cost per cubic foot. Depending on how town Zoning Bylaws and subdivision regulations are written, certain aspects listed in Table 1 may be required for any new development or redevelopment. Dimensional standards set in zoning regulations provide another method for communities to enforce LID best practices by reducing lot size, encouraging clustered development, reducing road widths, and more. In addition to the ecological benefits to water quality described above, there are a number of economic benefits that can result from LID. In a nationwide study on cost savings resulting from LID, the EPA found that total capital cost savings from LID reached as high as eighty percent in some cases. Cost savings can result from a number of practices. Adding bioswales to roadways and parking areas will reduce the total amount of pavement, curbs, and gutters that might otherwise be needed to manage stormwater. Similarly, encouraging compact residential development can reduce cost by lowering building operation costs, increasing the number of lots available for sale, and reducing site grading.

Best Management Practice	Cost ($/ft3) 2016 dollars
Bioretention	15.46
Dry Pond or detention basin	6.80
Enhanced Bioretention	15.61
Infiltration Basin	6.24
Infiltration Trench	12.49
Porous Pavement (asphalt)	5.32
Porous Pavement (concrete)	18.07
Sand Filter	17.94
Gravel Wetland System	8.78
Wet Pond wet detention basin	6.80
Subsurface Infiltration/Detention System	67.85

Table 1 Summary of costs (Source: EPA)

Installing green roofs, rain barrels (Figure 3, right), and other means to capture runoff onsite negates the need to install and manage cost intensive detention basins and pipe delivery systems. Preserving natural features to reduce stormwater runoff can result in a number of secondary benefits as well. Increasing green space can provide aesthetic values, recreational opportunities, and increased property values to communities as well. Thus, there are many well documented benefits to implementing LID best management practices.

Figure 3 *Rain Barrel*

Describing baseline metrics

The Town of Uxbridge has been evaluated based on criteria derived from established low-impact development best practices. These best practices can be broadly described in five (5) major categories. These categories include: (1) protecting natural resources and open space; (2) promoting compact development and infill development; (3) encouraging smart design to reduce impervious surface cover; (4) adopting green infrastructure stormwater management provisions; and (5) encouraging efficient parking strategies.

Natural Resources and Open Space

Figure 4 *Sample parking lot vegetation (Source: CMRPC)*

In order to determine whether or not Town requirements encourage protecting natural resources and open space, the Zoning Bylaw and Subdivision Regulations have been evaluated for reference to: managing soils for revegetation; limiting clearing and lawn size as well as retention or planting of native vegetation (please see Figure 4 for sample parking lot vegetation); and requiring native vegetation and trees. The Town's Stormwater Regulations are included in this analysis as well.

The Town currently meets several established best management practices, though generally, Town regulations tend to meet conventional best management practices. This analysis noted that current subdivision regulations and the Stormwater Management bylaw encourage preservation of existing vegetation where possible and require that disturbed portions of the site are stabilized. The Stormwater Regulations additionally stipulate that native species and habitat creating species should be used in all landscape plans to the maximum extent possible, and that invasive species shall not be planted. However, there are several areas of improvement identified.

Recommendations to improve protection of natural resources and open space

- Prohibit removal of topsoil and require rototilling following construction
- Set clear standards to minimize clearing in Zoning Bylaw
- Require high percentage (75%) of native plantings

Promoting Efficient Compact Development Patterns and Infill Development

Town Zoning Bylaws and subdivision regulations were evaluated on five main criteria to establish whether or not they meet best practices to promote compact development and infill development. As they are currently written, Town regulations tend to meet conventional best management practices. Town Zoning Bylaws require minimum lot sizes, frontage, and setbacks, do not address limiting impervious surface cover or encourage pervious paving materials. Uxbridge's Subdivision Rules & Regulations allow for common driveways for up to four (4) residential units.

Of further note, while cluster development is encouraged for specific types of development (Townhouse Development, Age Restricted Development Overlay District, and Conservation Design Development) no clear cluster development regulations for proposals that do not meet these specific requirements exist. Rather, the Zoning Bylaw states that dwellings should be constructed in "appropriate clusters in a manner which will maximize preservation of open

land and which will not detract from the ecological and visual qualities of the site or its neighborhood environment" and specifies different maximum allowable densities dependent on the type of development. Figure 5 on the following page illustrates a potential lot layout around greenspace under a cluster development model.

If written comprehensively, Town zoning regulations are able to encourage density and reduce overall impervious surface cover. The following opportunities have been identified to adjust existing language to meet additional LID best management practices.

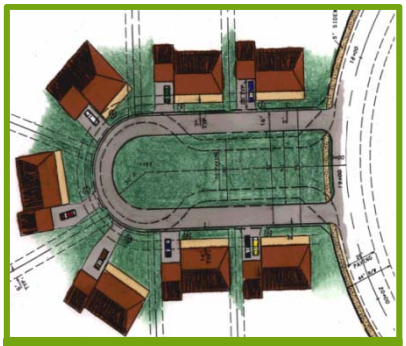

Figure 5 *Example green space and lot placement for sub-division (Source: MA Smart Growth)*

Recommendations to improve compact development patterns and infill development

- Adopt language in bylaws defining clear setback and frontage minimums with the option for no frontage minimum in select cases
- Adopt language to limit total impervious surface cover of a proposed development
- Adopt language to clearly define minimum open space requirements for cluster development option (in addition to Townhouse Development, Age Restricted Development Overlay District, and/or Conservation Design Development)
- Adopt language to clearly define housing yield calculation for cluster development
- Adopt language to eliminate minimum parcel size for cluster development
- Adopt language to clearly define a review process that takes into account conservation areas, house sites, street and trail alignment, and lot lines for cluster development
- Adopt language that clearly defines conservation priorities, requires contiguity of open space, and monitoring of open space for cluster development

Encouraging Smart Design to Reduce Impervious Surface Cover

Figure 6 *Example of wide road width (Source: MA Smart Growth)*

Figure 7 *Example of narrow road width (Source: MA Smart Growth)*

The most criteria were given to this section, which focuses on implementing smart design characteristics that will work to reduce impervious surface cover in Town. Broadly, town Zoning Bylaws and subdivision language pertaining to roadways, sidewalks, and utilities were used to establish whether or not best practices are in place to reduce impervious surface cover. Generally, the Town currently meets a number of conventional standards as defined by LID best management practices. Examples of these conventional standards include: street location, road width (refer to Figures 6 and 7 on the following page for a graphic comparison of a conventional wide road, to a best practice narrow road), and road right of way requirements

as defined by subdivision regulations. The Town's Subdivision Rules & Regulations currently allow sidewalks, curbing, and closed drainage systems requirements to be waived if the project proposes efficient, low-impact development that does not drain onto the Public Way. The Subdivision Rules & Regulations also mandate that utilities servicing any subdivision shall be located underground, positioned within the street right of way. While these regulations demonstrate LID best management practices, there are a number of items that could be addressed to better meet established best management practices.

Recommendations to encourage smart design to reduce impervious surface cover

- Adopt language to locate streets such that they minimize grading, road length, and avoid important natural features
- Adopt language clearly limiting road width and road right of way to that described in best management practices
- Adopt language clearly allowing one way loop streets and common drives (Subdivision Rules & Regulations reference common drives from more than three residences, but it is unclear when and how common driveways are permitted)
- Adopt language requiring landscaped plantings in cul de sacs and provide open drainage along curbs
- Adopt language allowing sidewalks to be sited along natural land contours and encourage permeable paving options

Adopting Green Infrastructure Stormwater Management Provisions

When first considering LID, this category is likely to be the first discussed, however as shown, there are other methods through which towns can encourage and enforce LID implementation. Many of the criteria described in this section are referenced throughout the other four categories. The criteria used to describe this category of LID best practices include: requiring that clean roof runoff is directed to landscaped areas facilitating infiltration; implementing LID as the standard stormwater management design; considering bio-retention and other LID features towards landscaping and open space requirements during site plan review procedures; allowing easy siting LID features across land uses; allowing permeable paving (Figure 8, right) for use on residential driveways, parking areas, walking/bike paths, and emergency access ways;

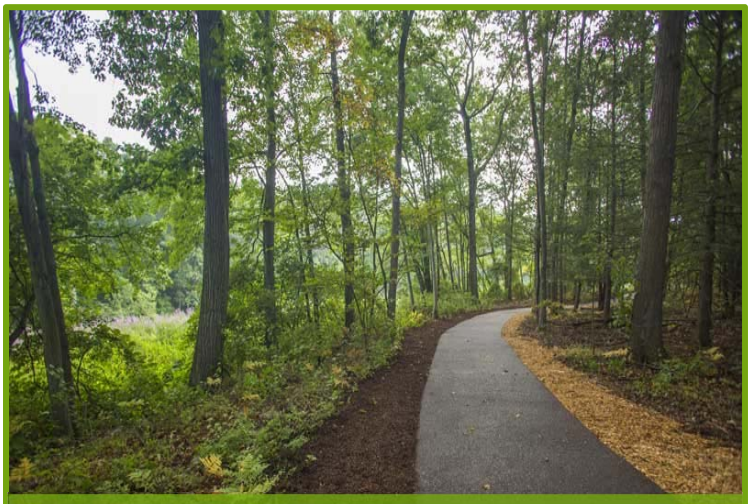

Figure 8 *Porous pavement comprised of 50 percent recycled rubber chips and 50 percent chipped granite aggregate at the Wellesley Office Park Walking Path needed to be strong enough to tolerate periodic flooding. (Source: Porous Pave)*

requiring a stormwater management plan with the preference of surficial bio-retention and swales; and enforcing an in depth construction and erosion sedimentation plan.

Several of the items described in this section are met as a result of Town Subdivision Regulations and Stormwater Bylaw. For example, the Town's Stormwater Regulations encourage the use of non-structural LID Management practices and Better Site Design (in accordance with the Massachusetts Stormwater Handbook) to minimize reliance on structural management measures. Additionally, the Stormwater Regulations require a Construction Erosion and Sedimentation Plan which must demonstrate minimization of disturbance and protection of natural resources. However, there are additional areas that could be pursued which would further encourage groundwater recharge and reduce surface runoff.

Recommendations to encourage green infrastructure stormwater management provisions

- Adopt language to require LID in site plan review
- Adopt language to require clean rooftop runoff to be directed to onsite landscaped areas
- Adopt language that defines LID as the standard stormwater design strategy in Town Zoning Bylaws and Subdivision Rules & Regulations
- Adopt language to require bioretention and swales
- Adopt language to outline a construction erosion and sedimentation plan that exceeds NPDES requirements
- Adopt language encouraging LID to be sited along roadways and developable lots
- Adopt language to allow for permeable road paving to increase infiltration

Encouraging Efficient Parking Strategies

Figure 9 *Example of plantings in parking area (Source: CMRPC)*

Figure 10 *Example of plantings in parking area (Source: MA Smart Growth)*

Establishing clear regulations related to parking areas has the potential to have a significant impact on stormwater runoff. Three primary best practices are used to define efficient parking strategies. These best practice criteria include: clearly establishing the number of maximum parking spaces allowed; allowing shared parking to meet peak demand; and requiring landscaping within parking areas (Figures 9 and 10) to serve as LID features. The Town of Uxbridge's Zoning Bylaw gives the Planning Board the authority to reduce the amount of required parking where shared parking or other available parking is sufficient to serve the premises. This flexibility exceeds conventional provisions; nonetheless, there are select areas and language that the Town could adopt to further encourage efficient parking strategies.

Recommendations to encourage efficient parking strategies

- Adopt language establishing the maximum number of parking spaces allowed as well as minimums
- Adopt language that allows for shared parking
- Adopt language that requires landscaping as LID/bioretention within parking areas (a minimum of 10% of the interior area landscaped and a minimum of 25 square feet for island planting areas)

Creation of Site Plan Review Regulations

Finally, based on this analysis, it is recommended that the Town establish a Site Plan Review or Approval provision in the Zoning Bylaw. This action would enable the Town to transfer more "by-right" uses to Site Plan Review by the Planning Board. The benefits of implementing Site Plan Review provisions include: predictability, economic development, greater levels of review and input on project design, and the option to require minor site plan review for changes in use.

The current Uxbridge Zoning Bylaw contains a Major Nonresidential Special Permit which requires a Special Permit from the Planning Board for larger projects. The size and type of projects regulated under the Major Nonresidential Special Permit include:

- Total gross floor area of twenty thousand (20,000) square feet or;
- Fifty (50) or more required parking spaces;
- Total daily trip generation of four hundred (400) or more trips as estimated by the Institute of Traffic Engineers Trip Generation Manual, latest edition;
- Inclusion of a drive-in or drive-through facility. A drive-in or drive-through facility shall mean an establishment that by design, physical facilities, service, or by packaging procedures encourages or permits customers to receive services, obtain goods, or be entertained while remaining in their motor vehicles;
- Electrical generating facilities with a capacity of three hundred fifty (350) megawatts or less using natural gas, renewable and ultra-low sulfur fuels, wind, provided however, that the Planning Board shall not issue special permits for more than two electrical generating facilities in the Town or for a combined production capacity of more than five hundred (500) megawatts in total.

However, other projects that could have significant impacts, change the character of an area, or otherwise warrant review by the Planning Board are not currently regulated. Based on the thresholds in the Major Nonresidential Projects sections, the following are a few examples of the types of projects that could occur with no land use approval in Uxbridge:

- Single story commercial/retail or office building with a 19,000 square feet footprint
- Two story building with a 9,500 square foot footprint
- Project with 49 parking spaces or less

Generally, in other communities in Central Massachusetts these categories and sizes of projects are subject to local land use permitting. The Town of Uxbridge has an opportunity to regulate these less intensive uses by Site Plan Approval to ensure that new projects incorporate certain improvements, such as green infrastructure, but also generally landscaping, lighting, parking, vehicular entrances, pedestrian access, and building location. Unchecked, the types of development listed above can substantially alter or change the character of an area over time. Site Plan Approval maintains predictability for developers but provides the Town with consistent oversight of and input on a wide range of projects.

Site plan review establishes criteria for the layout, scale, appearance, safety, and environmental impacts of commercial, industrial, and in some cases, residential developments. It usually focuses on parking, traffic, drainage, roadway construction, signage, utilities, screening, lighting, and other aspects of a project to arrive at the best possible design for a location. In most cases, Site Plan Review must be received prior to a building permit being issued.

Cumulative list of best management practice recommendations

- Prohibit removal of topsoil and require rototilling following construction
- Set clear standards to minimize clearing in Zoning Bylaw
- Require high percentage (75%) of native plantings
- Adopt language in bylaws defining clear setback and frontage minimums with the option for no frontage minimum in select cases
- Adopt language to allow for common driveways
- Adopt language to limit total impervious surface cover of a proposed development
- Adopt language to clearly define minimum open space requirements for cluster development option
- Adopt language to clearly define housing yield calculation for cluster development (in addition to Townhouse Development, Age Restricted Development Overlay District, and/or Conservation Design Development)
- Adopt language to eliminate minimum parcel size for cluster development
- Adopt language to clearly define a review process that takes into account conservation areas, house sites, street and trail alignment, and lot lines for cluster development
- Adopt language that clearly defines conservation priorities, requires contiguity of open space, and monitoring of open space for cluster development
- Adopt language to clearly reference existing plans in cluster development
- Adopt language to locate streets such that they minimize grading, road length, and avoid important natural features

- Adopt language clearly limiting road width and road right of way to that described in best management practices
- Adopt language clearly allowing one way loop streets and common drives (Subdivision Rules & Regulations reference common drives from more than three residences, but it is unclear when and how common driveways are permitted)
- Adopt language requiring landscaped plantings in cul de sacs and provide open drainage along curbs
- Adopt language allowing sidewalks to be sited along natural land contours and encourage permeable paving options
- Adopt language to require LID in site plan review
- Adopt language to require clean rooftop runoff to be directed to onsite landscaped areas
- Adopt language that defines LID as the standard stormwater design strategy in Town
- Adopt language to require bioretention and swales
- Adopt language to outline a construction erosion and sedimentation plan that exceeds NPDES requirements
- Adopt language encouraging LID to be sited along roadways and developable lots
- Adopt language to allow for permeable road paving to increase infiltration
- Adopt language establishing the maximum number of parking spaces allowed as well as minimums
- Adopt language that requires landscaping as LID/bioretention within parking areas (a minimum of 10% of the interior area landscaped and a minimum of 25 square feet for island planting areas)
- Adopt language that allows for shared parking
- Creation of Site Plan Review Regulations

Additional Resources

- *Freeborn, John. "Decreasing Runoff And Increasing Stormwater Infiltration."* Virginia Cooperative Extension *(2011):. Web. 20 Nov. 2017.*
- *Howard Perlman, USGS. "Impervious Surfaces and Urban Flooding: USGS Water-Science School."* Water.usgs.gov*. N. p., 2017.*
- *Lambin, E. F., and P. Meyfroidt. "Global Land Use Change, Economic Globalization, and the Looming Land Scarcity."* Proceedings of the National Academy of Sciences *108.9 (2011): 3465-3472.*
- EPA. Costs of Low Impact Development, LID Saves Money and Protects Your Community's Resources. Fact Sheet
- EPA, Reducing Stormwater Costs through Low Impact Development Strategies and Practices
- Opti-Tool: Stormwater Nutrient Management Optimization Tool
- http://www.mass.gov/envir/smart_growth_toolkit/pages/SG-slides-lid.html
- Massachusetts Climate Change Adaptation Report

APPENDIX A

LID Analysis of Uxbridge Zoning Bylaw, Subdivision Rules & Regulations, and Stormwater Regulations

Factors	Conventional	Better	Best	Community's Zoning	Community's Subdivision Rules & Regulations	Community's Stormwater/LID Bylaw/Regulations
GOAL 1: PROTECT NATURAL RESOURCES AND OPEN SPACE						
Soils managed for revegetation	Not addressed	Limitations on removal from site, and/or requirements for stabilization and revegetation	Prohibit removal of topsoil from site. Require rototilling and other prep of soils compacted during construction		Not addressed.	Site plans should ensure that existing vegetation is preserved where possible and that disturbed portions of the site are stabilized. Use of impervious surfaces for stabilization should be avoided.
Limit clearing, lawn size, require retention or planting of native vegetation/naturalized areas	Not addressed or general qualitative statement not tied to other design standards	Encourage minimization of clearing/ grubbing	Require minimization of clearing/grubbing with specific standards	Planning Board shall consider efforts to integrate the proposal into the existing landscape through vegetative buffers, plantings and the retention of open space and agricultural land.	Not addressed.	Site plans should ensure that existing vegetation is preserved where possible and that disturbed portions of the site are stabilized.
Require native vegetation and trees	Require or recommend invasives	Not addressed, or mixture of required plantings of native and nonnative	Require at least 75% native plantings	Not addressed.	Not addressed.	Native species and habitat creating species should be used in all landscape plans to the maximum extent possible. Invasive species shall not be planted.
GOAL 2: PROMOTE EFFICIENT, COMPACT DEVELOPMENT PATTERNS AND INFILL						
Lot size	Required minimum lot sizes	OSRD/NRPZ preferred. Special permit with incentives to utilize	Flexible with OSRD/NRPZ by right, preferred option	Required minimumlot sizes dependent on the use. In granting a Conservation Design Special Permit, the Planning Board may authorize the modification of lot size requirements.		
Setbacks	Required minimum front, side, and rear setbacks	Minimize, allow flexibility	Clear standards that minimize and in some instances eliminate setbacks	Required minimum front, side, and rear setbacks dependent on the district and whether use is pricipal or accessory. In granting a Conservation Design Special Permit, the Planning Board may authorize the modification of yard requirements.		
Frontage	Required minimum frontage for each lot/unit	Minimize especially on curved streets and cul-de-sacs	No minimums in some instances, tied into other standards like OSRD design and shared driveways.	Required minimum front, side, and rear setbacks dependent on the district and whether use is pricipal or accessory. In granting a Conservation Design Special Permit, the Planning Board may authorize the modification of frontage requirements.		

Factors	Conventional	Better	Best	Community's Zoning	Community's Subdivision Rules & Regulations	Community's Stormwater/LID Bylaw/Regulations
Common driveways	Often not allowed, or strict limitations	Allow for 2-3 residential units	Allow for up to 4 residential units, preferrably constructed with permeable pavers or pavement	Not addressed.	Reference to private, unnamed roads providing ingress to and egress from more than three residences. No mention of permeable paving materials.	
Limit impervious area – Rural Districts In high density areas, require post-development infiltration to = or > predevelopment	Not usually addressed in zoning and subdivision regs for rural/suburban residential?	<15%	<10%	A Conservation Design Special Permit may be issued by the Planning Board in the Agricultural zoning district, provided that each lot has a maximum coverage by buildings of 25%, and by buildings and other impervious surfaces of 40%.	Not addressed.	Not addressed.
GOAL 3: SMART DESIGNS THAT REDUCE OVERALL IMPERVIOUSNESS						
Street location	Numeric and geometric standards based primarily on vehicular travel and safety, with basic pedestrian requirements e.g. sidewalks	Flexibility in applying standards, to reduce area of impact, grading, avoid key natural features	OSRD design preferred by-right. Require locating streets to minimize grading and road length, avoid important natural features		Unless otherwise specified, roadways shall conform to the most current revisions of the Construction Standard Details, MassDOT Traffic Management Plans and Detail Drawings; the 2009 Manual on Uniform Traffic Control Devices and the Standard Municipal Traffic Code published by the MassDOT-Highway Divisionon Rules & Regulations.	
Road width	Major and minor categories, 24-30’	Wide, medium, narrow categories. 22-24’ max, plus 2’ shoulders	Wide, medium, narrow, and alley categories. 20-24’ widest for 2 travel lanes, 18-20’ low traffic residential neighborhood, plus 2’ shoulders. Allow alleys and other low traffic or secondary emergency access and all shoulders to use alternative, permeable materials.		Primary, Secondary and Cul-de-sac categories, 24-30’.	
Road ROW width	50-75’, fully cleared and graded	40-50’, some flexibility in extent of clearing	20-50’depending on road type	Setbacks for structures from private and public roads shall be a minimum of forty (40) feet.	Primary, Secondary and Cul-de-sac categories, 50-72’.	Not addressed.

Factors	Conventional	Better	Best	Community's Zoning	Community's Subdivision Rules & Regulations	Community's Stormwater/LID Bylaw/Regulations
Access Options	No common drives allowed, dead end allowed with limit on length and # of units	Allow dead end with limit on length and # of units. Allow common drives up to 2-3 units	Allow one way loop streets. Allow common drives up to 4 units, and alleys and rear-loading garages where suitable.		Reference to private, unnamed roads providing ingress to and egress from more than three residences. No mention of alleys and/or rear-loading garages.	
Dead Ends/Cul-de-sacs	120 ft or more minimum turnaround	Minimize end radii – 35 ft	Allow hammerhead turnaround		No subdivision street shall be less than two hundred fifty (250) feet in length. Private Ways can incorporate a 40 foot minimum T-shaped turnaround, in lieu of a cul-de-sac, at the Planning Board's discretion with approval from DPW and the Fire Chief.	
Cul-de-sacs	Full pavement standard	Encourage center landscaping with bioretention	Require center landscaping with bioretention		Full pavement standard.	
Curbing	Curbing required full length both sides of road	Allow curb breaks or curb flush with pavement to enable water to flow to vegetated LID features	Open drainage with roadside swales and no curbs preferred		Sidewalks, curbing, and closed drainage systems can be waived if the project proposes efficient, low-impact development that does not drain onto the Public Way.	
Roadside Swales	Allowed as an option	Preferred over closed drainage	Preferred, with criteria for proper design. Adoption of technical specifications and design templates for green infrastructure recommended		Employment of low impact development design, such as road side swales for drainage, shall be required for unimproved public and private ways.	
Utilities	Off sets required contributing to wide road ROWs	Not specified, flexible	Allow under road, sidewalks or immediately adjacent to roads to enable placement of roadside swales.		Utilities servicing any subdivision shall be located underground. All underground utilities shall be positioned within the street rights of way as Uxbridge DPW design standards may require.	
Sidewalks	Concrete or bituminous	Some flexibility in material and design	Prefer permeable pavement or permeable pavers		Curbing shall be sloped granite edging or bituminous concrete, subject to Planning Board approval, except at catch basins and intersection rounding where vertical granite curb shall be required.	

Factors	Conventional	Better	Best	Community's Zoning	Community's Subdivision Rules & Regulations	Community's Stormwater/LID Bylaw/Regulations
Sidewalk location	Required both sides of road	Allow on only 1 side of road especially in low density neighborhoods	Prefer siting with land contours and for best pedestrian utility (e.g. connect with common areas and shared open spaces) - not necessarily immediately parallel to road.		Not less than one (1) sidewalk, which is not less than five (5) feet in width, shall be constructed on one (1) side of the street.	
Sidewalk drainage	Drains to road closed drainage system	Not addressed	Disconnect drainage from road system - e.g.adjacent green strips or within vegetated areas that can absorb sheet flow		Sidewalks, curbing, and closed drainage systems can be waived if the project proposes efficient, low-impact development that does not drain onto the Public Way.	
GOAL 4: ADOPT GREEN INFRASTRUCTURE STORMWATER MANAGEMENT PROVISIONS						
Rooftop runoff	Prohibit directing clean roof runoff into closed municipal drainage systems.	Allow clean roof runoff to be directed to landscaped or naturally vegetated areas capable of absorbing without erosion, or infiltration	Require directing clean roof runoff to landscaped or naturally vegetated areas capable of absorbing, or infiltration		Sidewalks, curbing, and closed drainage systems can be waived if the project proposes efficient, low-impact development that does not drain onto the Public Way.	Not addressed.
Overall stormwater design; piping and surficial retention vs. LID	Conventional stormwater system design standards		LID design standard. Allow surficial ponding of retained runoff for up to 72 hours and credit for green roofs towards stormwater requirements		Not addressed.	The use of non-structural LID Management practices and Better Site Design are encouraged to minimize reliance on structural management measures. The design of Better Site Design and or LID Management Practices shall be in accordance with the Massachusetts Stormwater Handbook.
Site Plan Requirements	LID may not be addressed	Encourage use of LID features in site design	Count bioretention and other vegetated LID features toward site landscaping/open space requirements.			The use of non-structural LID Management practices are generally encouraged to minimize reliance on structural management measures.
Allow easy siting of LID features (bioretention, swales, etc.)	Often not addressed, may require waivers from subdivision standards	Encouraged along road ROW	Allowed on lots, common open space, or road ROW, easement recorded. For commercial development, allow an increase in floor area ratio or other developmental incentives for green roofs	Not addressed.	Developers shall employ low impact development for drainage such as roadside swales.	

Factors	Conventional	Better	Best	Community's Zoning	Community's Subdivision Rules & Regulations	Community's Stormwater/LID Bylaw/Regulations
Permeable paving	Often not addressed, may require waivers from subdivision standards	Allowed on private residential lots for parking, patios, etc.	Allowed for residential drives, parking stalls, spillover parking spaces, emergency access ways (with proper engineering support for emergency vehicles) Two track design allowed for driveways and secondary emergency access ways (where required).		Not addressed.	Not addressed.
Stormwater management O&M plan	Typically only addressed if municipality has a stormwater or LID bylaw, or for areas subject to wetlands permitting	Required	Required, surficial bioretention and swales preferred. Closed/ underground systems requiring specialized inspection and clean out discouraged.		Not addressed.	Required.
Construction Erosion and Sedimentation Plan required	Basic general requirements	Required, contents specified	Goes beyond minimum NPDES requirements, requires minimization of site disturbance		An Erosion & Sedimentation Control Plan consistent with MA-DEP's Erosion & Sedimentation Control Guidelines for Urban and Suburban Areas of March 1997, with a 2003 reprint, shall be submitted with all applications for a Definitive Plan.	Required. Sediment and Erosion Control Plans must minimize the amount of disturbed area and protect natural resources.
GOAL 5: ENCOURAGE EFFICIENT PARKING						
Parking	Specific minimums set based on projected maximum use times	Encourage minimum # needed to serve routine use (e.g. 2/residential unit with any additional/visitors parking behind in driveway or on street.	Establish Maximum Parking spaces allowed. Do not require more than 2/residence. Allow tenants separate, optional lease agreements for parking.	Specific minimums set based on use times.		
Commercial Parking	Specific minimums set based on projected maximum use times adding all on-site uses together.	Some flexibility to reduce minimums based on street or other available nearby parking or transit.	Allowed shared parking for uses with different peak demand times. Provide model agreements/deed restrictions. Reduce parking requirements near transit. Limit parking stall size (9ftx18ft max), with up to 30% smaller for compact cars	Specific minimums based on gross floor area. The Planning Board may reduce the amount of required parking where shared parking or other available parking is sufficient to serve the premises.		

Factors	Conventional	Better	Best	Community's Zoning	Community's Subdivision Rules & Regulations	Community's Stormwater/LID Bylaw/Regulations
LID in Parking Areas	Often not addressed, may require waivers e.g. for planting islands to drain down rather than built up surrounded by curbs	Allow LID/bioretention within parking areas.	Require landscaping within parking areas, as LID/bioretention, at a minimum of 10% of the interior area landscaped and a minimum of 25 square feet for island planting areas.		Not addressed.	Not addressed.

APPENDIX B

LID Analysis of Uxbridge Open Space Development and Conservation Design Development Regulations

MA Open Space Residential Design Best Practices Factors	Conventional	Better	Best Practice	Community's OSRD
Permit Type	Special Permit	By Right	Mandatory	Nothing shall exempt a proposed Open Space Development from compliance with the Subdivision Rules and Regulations nor shall it affect the right of the Board of Health, Planning Board and/or the DPW to approve or disapprove with or without conditions, a subdivision plan. The Planning Board is the issuing authority for Open Space Development. Conservation Design Development is permitted by Special Permit.
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	Any tract of land to be developed with residential buildings comprising 2 to 4 dwelling units per building and having an exterior entrance serving no more than 2 dwelling units.
Minimum Open Space	50-65%	65-75%	≥ 75%	A minimum 40% of the total tract size shall be set aside, not built upon or paved, but shall be landscaped and/or left in its natural state and shall be considered open space.
Yield Calculation	Full plan with full percolation tests	Sketch plan with selected percolation test(s)	By formula	Applicants for a Conservation Design Development shall file a development plan that includes the results of deep soil test pits and percolation tests at intervals in no case fewer than 10 % of the proposed lots in the conservation design development.
Minimum parcel size	≥ 10 acres	5-10 acres	None	The minimum tract size is ten acres (OSD) and 30,000 square feet (CDD).
Review Process	No detailed analysis of site characteristics in relation to design	Cluster layout	Flexible "OSRD" 4 Step	A CDD is defined as a detached single-family residential development in which the lots are clustered with each group separated by permanently protected open space.
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.			For CDD, the required open space shall, be conveyed to: a. the Town of Uxbridge or its Conservation Commission; b. a conservation nonprofit organization; or c. a corporation or trust owned jointly or in common by the owners of lots within the CDD.
Dimensional Standards; area, frontage, etc.	Specified, < than for standard subdivision	Formulaic reduction with specified minimums	None set or small minimums	A minimum distance of 60' shall be maintained between structures. Setbacks from private and public roads are minimum 40'.
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.	No indication of local conservation priorities.
Contiguity of open space; relationship to previously protected open space	No contiguity requirement	Contiguity required within subdivision	Contiguity required; adjacent land considered	For CDD, a minimum of 50% of the Development Site shall be preserved as permanent open space and at least 40% of said parcel shall be contiguous open space, excluding required yards.

MA Open Space Residential Design Best Practices Factors	Conventional	Better	Best Practice	Community's OSRD
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	The required open space shall be used for conservation, agriculture, horticulture, forestry, historic preservation and education, outdoor education, recreation and park purposes, or for a combination of such purposes, as determined by the Planning Board, and shall be provided with suitable access for such purposes.
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.	No language regarding submission of information on site resources and no specified process for the use of the data submitted.
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	Relationship to plans not discussed
Low Impact Design	Not addressed	Encouraged	Required	Not addressed.
Density bonus for enhanced public benefit(s)	No bonus offered	Bonus by special permit	Automatic or formulaic bonus	The Planning Board may permit up to a 10% increase in density of a CDD if the applicant makes a dedication of land for a public purpose or proposes an access easement to open space. In addition, for land Development Sites in income producing agricultural use at the time of the filing of the Application, and where a significant portion of the Open Space land in the development is proposed to remain in agricultural use, the Planning Board may permit up to a 20% increase in density.
Review Entity	ZBA, council or selectmen as special permit authority	Planning Board	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.	Not addressed.
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 stated intervals	No specified monitoring requirements.