Chapter 5

Incorporating LID into the Site Design Process

This chapter provides information to assist various stakeholders, including developers and builders, on a recommended LID site design process to ensure that the proper issues and questions are addressed at the appropriate time and by the appropriate people. Following such a process prior to official submission of the preliminary site plan will result in creating a comprehensive development concept that manages stormwater and existing natural resources to the fullest extent possible and practical.

Specifically, this chapter:

- Provides an overview of the LID site design process,
- Defines this process, step by step, and
- Includes a LID site design checklist.

Using LID successfully in a site design process requires considering the LID principles from the project's inception through the final design stages. Specifically, LID development approaches and techniques need to be assimilated into the various phases of the site design process, including:

- The initial stages of site analysis to determine features to be preserved and avoided during construction,
- The program or concept development process to determine what is constructed, and how much construction the site can support, and
- The site design and revision process to address stormwater issues that remain.

This site design process is based on the following LID principles described in Chapter 2:

- Plan first,
- Prevent. Then mitigate,
- Minimize disturbance,
- Manage stormwater as a resource – not a waste,
- Mimic the natural water cycle,
- Integrate natural systems,
- Disconnect. Decentralize. Distribute,
- Maximize the multiple benefits of LID,
- Use LID everywhere, and
- Make maintenance a priority.

Kresge Foundation Headquarters in Troy
Source: Conservation Design Forum, Inc.

Overview of the LID site design process

The LID site design process builds on the traditional approach to site design. It begins with analysis of the site, and incorporates steps to involve local decision makers early in the process. The process has been consolidated into nine basic steps (Figure 5.1). Each designer may want or need to adjust the process to fit specific site circumstances.

An essential objective of the site design process – and of LID – is to minimize stormwater runoff by preventing it from occurring. This can be accomplished through the use of nonstructural BMPs in the site design (Chapter 6). Once prevention is maximized, some amount of mitigation is needed to address stormwater peak rate, volume, and water quality from increased impervious surfaces. These mitigative stormwater management objectives can be met with structural BMPs (Chapter 7).

Step 1: Property acquisition and use analysis

The initial step in the land development process is typically some sort of action on the part of a site's owner, developer, or builder, such as a purchase of title, options, site clearances, or analyses. In many cases, developers acquiring/purchasing property will undertake some level of study in order to determine the type of use (residential, commercial, industrial, etc.) that can be developed in order to determine a purchase price for the property.

Step 2: Inventory and evaluate the site

Incorporating LID into site design begins with a thorough assessment of the site and its natural systems. Site assessment includes inventorying and evaluating the various natural resource systems which may pose challenges and/or opportunities for stormwater management and site development. Natural resource systems include:

- Floodplains,
- Riparian areas,
- Wetlands,
- Natural and man-made drainage ways,
- Soils and topography,
- Geology,
- Groundwater supplies, and
- Vegetation.

Natural systems range in scale from a watershed-scale down to the site specific scale. In evaluating the natural resources of a site, it is important to consider the applicable challenges or opportunities with implementing LID techniques.

Watershed-scale evaluation

LID, as described in the Site Design Process (Figure 5.1), begins with an understanding of the site in the broader context of its watershed and relevant natural systems, based on an inventory of the natural resource system characteristics. In evaluating these characteristics for LID opportunities, the following are examples of the types of questions that should be raised:

- Does the site drain to special water bodies with special water quality needs (e.g., impaired waters, groundwater aquifer, natural river designation)?
- Does the site ultimately flow into a reservoir, groundwater aquifer, or other type of impoundment where special water quality sensitivities exist, such as use as a water supply source?
- Do other special fishery issues exist (e.g., trout stream)?
- Is the site linked to a special habitat system? (For both water quality and temperature reasons, approaches and practices that achieve a higher order of protection may become especially important.)
- Are there known downstream flooding problems, or known problems with run-on from neighboring properties?
- Is additional development anticipated for the area that could lead to further restrictions (e.g., protection of downstream land and water uses) or opportunities (e.g., partnerships in multi-site water quality or quantity controls)?

Figure 5.1
LID Site Design Process

Step 1
Property acquisition and use analysis

Step 2
Inventory and evaluate the site

Step 3
Integrate municipal, county, state, and federal requirements

Step 4
Develop initial concept design using nonstructural BMPs

Step 5
Organize pre-submission meeting and site visit with local decision makers

Step 6
Incorporate revisions to development concept

Step 7
Apply structural BMP selection process

Step 8
Apply the LID calculation methodology

Step 9
Develop the preliminary site plan

Site specific scale evaluation

Site specific factors are critical in this part of the process as they influence comprehensive stormwater management throughout the development project. A list of site specific factors to evaluate are provided on the site Design Process Checklist at the end of this chapter. Example evaluation questions include:

- What are the important hydrological functions of the site, including both surface and groundwater movement?
- What important natural resources exist on site (high quality wetlands, woodlands, special habitat, etc.)?
- What are the existing soil types? Are there opportunities for infiltration?
- What is the depth to the water table?
- What is the depth to bedrock?
- How does size and shape of the site affect stormwater management?
- Are there areas where development should generally be avoided? (Determine where buildings, roads, and other disturbance should be avoided, in terms of avoiding existing natural resource systems and rights of way).
- Are there areas where LID infiltration practices should be avoided because of historical land uses and contamination?

Western Michigan University Business, Technology and Research Park

Source: Fishbeck, Thompson, Carr & Huber, Inc.

Step 3: Integrate municipal, county, state, and federal requirements

Municipal requirements will vary from one governmental entity to another. However, the land development process in Michigan is mostly regulated and managed on the local level, with the community master plan, zoning ordinance, and subdivision/land development ordinance being essential. In addition, county, state, and federal regulations need to be considered (e.g., county stormwater standards, state and federal wetland law, threatened and endangered species). Since regulations are also continuously updated, it is important for clear, updated communication between all stakeholders involved in the development process.

City of Wixom Habitat Park

Source: Hubbell, Roth & Clark, Inc.

Step 4: Develop initial concept design using nonstructural BMPs

Information gathered in the first three steps should be used in developing the initial concept design. This step should include the use of nonstructural BMPs such as woodland and wetland protection, clustering, minimizing impervious surfaces, or other techniques described in Chapter 6.

It may be beneficial on some sites to work through preliminary calculations (Chapter 9) to ensure stormwater goals are being met.

Step 5: Organize pre-submission meeting and site visit with local decision makers

Many municipalities strongly recommend and even require a pre-meeting with the developer to effectively communicate each entity's perceptions of the project early on, and potentially discern how each other's needs

can be incorporated into the development concept. Many municipalities in Michigan and other states are also incorporating site visits into the pre-submission meeting to minimize or prevent future problems with the development.

Step 6: Incorporate revisions to development concept

The designer should integrate the information collected from the previous steps and revise the initial development concept, if appropriate.

Step 7: Apply structural BMP selection process

Determining the blend of structural BMPs that best achieve a specific site's stormwater needs is the next step in the site design process. Structural BMPs which can be used to achieve the recommended site design criteria for LID are detailed in Chapter 7. Not all structural BMPs are appropriate for every development at every site. The introduction to Chapter 7 details a selection process for determining the appropriate BMPs.

Towar Rain Garden Drains
Source: Fitzgerald Henne and Associates, Inc.

The calculations done in step 8 may be needed to make decisions on the structural BMPs that can be used at a site. Therefore, it may be necessary to combine steps 7 and 8 to complete the selection of BMPs.

Step 8: Apply the LID calculation methodology

A calculation methodology is presented in Chapter 9 of this LID manual. It allows for the integration of both nonstructural and structural BMPs. The calculation methodology is based on the recommended design criteria for total stormwater volume control, peak rate control, and water quality control that are central to LID performance.

Step 9: Develop the preliminary site plan

Once steps 1-8 of the site design process are implemented, the preliminary site plan is complete and ready to submit to the local unit of government. The result is a communicative process between developer and community to create a comprehensive development concept that manages stormwater and existing natural resources to the furthest extent possible and practical.

Reinforcing the site design process: A site design checklist for LID

The site design process for LID is structured to facilitate and guide an assessment of a site's natural features together with stormwater management needs. The LID Site Design Process Checklist will help implement the site design process. It provides guidance to the land development applicant, property owner, or builder/developer in terms of the analytical process which needs to be performed as the development proceeds. The outcome is the formulation of a LID concept for the site.

Local communities may also benefit by using this checklist for considering possible impacts to natural resources in the community and local watersheds.

Step 1: Property acquisition and use analysis

Step 2: Site inventory and evaluation

Watershed factors inventory

- ❑ Major/minor watershed location?
- ❑ State stream use/standards designation/ classification?
  - ❑ Special high quality designations? (e.g., natural rivers, cold water fishery)
  - ❑ Rare or endangered species or communities present?
  - ❑ Are there required standards?
- ❑ Any 303d/impaired stream listing classifications?
- ❑ Any existing or planned Total Maximum Daily Loads (TMDLs) for the waterbody?
- ❑ Aquatic biota, other sampling/monitoring?
- ❑ Do other special fishery issues exist?
- ❑ Is the site linked to a special habitat system?
- ❑ Are there known downstream flooding problems?
- ❑ Are there known problems with run-on from neighboring properties?
- ❑ Is additional development anticipated for the area that could lead to further restrictions? (e.g., protection of downstream land and water uses)
- ❑ Is additional development anticipated for the area that could lead to further opportunities (e.g., partnerships in multi-site or regional water quality or quantity controls)?

Site factors inventory

- ❑ Important natural site features have been inventoried and mapped?
  - ❑ Wetlands?
  - ❑ Floodplains?
  - ❑ Wellhead protection areas?
  - ❑ High quality woodlands, other woodlands, and vegetation?
  - ❑ Riparian buffers?
  - ❑ Naturally vegetated swales/drainageways?
  - ❑ Steep slopes or unique topographic features?
  - ❑ Special geologic conditions (limestone?)?
  - ❑ Historical values, certified or non-certified?
  - ❑ Known/potential archaeological values?
  - ❑ Existing hydrology (drainage swales, intermittent, perennial)?
  - ❑ Existing topography, contours?
  - ❑ Soils, their hydrologic soil groups?
  - ❑ Seasonal high water table? Depth to bedrock?
  - ❑ Special geological issues (e.g., karst)
  - ❑ Aesthetics/viewsheds?
  - ❑ Existing land cover/uses?
  - ❑ Existing impervious areas, if any?
  - ❑ Existing pervious maintained areas, if any?
  - ❑ Existing contaminants from past uses, if any?
  - ❑ Existing public sewer and water, if any?
  - ❑ Existing storm drainage system(s), if any?
  - ❑ Existing wastewater system(s), if any?
  - ❑ How does size and shape of the site affect stormwater management?
  - ❑ Are there areas where development should generally be avoided?

Step 3: Integrate municipal, county, state, and federal requirements

Master plan

- ❑ Is development concept consistent with the master plan?
  - ❑ Consistent with goals/policies of the plan?
  - ❑ Preservation of natural resources consistent with priority areas/maps?

Regulations (e.g., ordinances, engineering standards)

- ❑ Consistent with local existing regulations?
  - ❑ Wetland regulations?
  - ❑ Tree/woodlands ordinance?
  - ❑ Riparian buffer ordinance?
  - ❑ Open space requirements?
  - ❑ Clustering and/or PUD options?
  - ❑ Overlay districts?
  - ❑ Wellhead protection?
  - ❑ Floodplain ordinances?
  - ❑ Are LID solutions required?
    - ❑ or incentivized?
    - ❑ or enabled?
    - ❑ or prohibited?
- ❑ Reduced building setbacks allowed?
- ❑ Curbs required?
- ❑ Swales allowed?
- ❑ Street width, parking requirements, other impervious requirements?
- ❑ Grading requirements?
- ❑ Landscaping that allows native vegetation?
- ❑ Stormwater requirements?
  - ❑ Peak rate?
  - ❑ Total runoff volume?
  - ❑ Water quality provisions?
  - ❑ Maintenance requirements?
- ❑ Consistent with county/state road requirements?
- ❑ Consistent with local stormwater regulations?
- ❑ Consistent with erosion and sedimentation requirements?
- ❑ Contaminated sites have followed state "due care" requirements for soil and groundwater?
- ❑ Consistent with state and federal wetland and/or inland lakes and streams regulations?
- ❑ Consistent with state threatened and endangered species regulations?
- ❑ Meets state floodplain requirements?

Step 4: Develop initial concept design using nonstructural BMPs

Lot configuration and clustering?

- ❑ Reduced individual lot size?
- ❑ Concentrated/clustered uses and lots?
- ❑ Lots/development configured to avoid critical natural areas?
- ❑ Lots/development configured to take advantage of effective mitigative stormwater practices?
- ❑ Lots/development configured to fit natural topography?
- ❑ Connect open space/sensitive areas with larger community greenways plan?

Minimum disturbance?

- ❑ Define disturbance zones (excavation/grading) for site?
  - ❑ Protect maximum total site area from development disturbance?
  - ❑ Barriers/flagging proposed to protect designated non-disturbance areas?
  - ❑ Disturbance setbacks defined from BMP areas, vegetated areas, tree drip lines, etc.?
- ❑ Site disturbance (excavation/grading) minimized for each lot?
- ❑ Considered mitigative practices for minimal disturbance areas (e.g., Soil Restoration)
- ❑ Considered re-forestation and re-vegetation opportunities?

Impervious coverage reduced?

- ❑ Reduced road width?

- ❑ Cul-de-sacs and turnarounds at reduced width?
- ❑ Reduced driveway lengths and widths?
- ❑ Reduced parking ratios?
- ❑ Reduced parking sizes?
- ❑ Shared parking potential reviewed?
- ❑ Utilized porous surfaces for applicable features?

Stormwater disconnected from impervious area?

- ❑ Disconnected stormwater flows from roof leaders?
- ❑ Disconnected drives/walkways/small impervious areas to natural areas?
- ❑ Used rain barrels and/or cisterns for lot irrigation?

Step 5: Pre-submission meeting and site visit with local decision makers

Step 6: Revisions to development concept

Step 7: Apply structural BMP selection process

- ❑ Meets runoff quantity?
- ❑ Quality needs?
- ❑ Manage close to source with collection/ conveyance minimized?
- ❑ Consistent with site factors (e.g., soils, slope, available space, amount of sensitive areas, pollutant removal needs, location of historical pollutants)?
- ❑ Minimize footprint and integrate into already-disturbed areas/other building program components (e.g., recharge beneath parking areas, vegetated roofs)?
- ❑ Estimate costs for both construction and maintenance?
- ❑ Consider other benefits?
  - ❑ Aesthetic?
  - ❑ Habitat?
  - ❑ Recreational?
  - ❑ Educational benefits?
- ❑ Select based on maintenance needs that fit owner/users?
- ❑ Develop long-term maintenance plan?

Step 8: LID calculation methodology

Achieved additional comprehensive stormwater management objectives?

- ❑ Minimize the pre- to post-development increase for curve numbers?
- ❑ Maximize presettlement time of concentration?
- ❑ Assume “conservative” presettlement conditions?
- ❑ Respect natural sub-areas in the design and engineering calculations?

Iterative process occurring throughout low impact site plan development and low impact stormwater management plan development?

- ❑ Soil Cover Complex Method (TR-55) is industry standard for calculations.

Step 9: Develop the preliminary site plan