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Frequently Asked Questions about Low Impact Development (LID)[1]

This frequently asked questions (FAQ) sheet is intended to provide some basic information about LID and related topics. Where appropriate, links are provided to websites to obtain additional information. If you have an LID-related question you would like answered, e-mail us via the CASQA contact link.

General Questions

Some Common LID Concerns and Misconceptions

LID Policy and Program Issues

[1] This document is a product of the California LID Portal and will be updated as more information is developed.

General Questions

1. What is “Low Impact Development (LID)?”

As our communities develop, the amount of impervious surfaces –roads, parking lots, sidewalks, and rooftops –increases, and a greater percentage of rainfall flows off the landscape as stormwater runoff, rather than seeping into the ground. Stormwater runoff picks up pollutants–including car oil, lawn fertilizers, pesticides, pet waste, and trash–and carries these pollutants to our waterways and ocean. The increased volume and velocity of runoff flowing off of impervious surfaces can also erode our creeks and rivers.

LID is gaining popularity as a better approach to stormwater management that seeks to control stormwater at the source, using small-scale integrated site design and management practices to mimic the site’s natural hydrology. LID techniques include using permeable pavements, rain gardens, rain barrels, grassy swales, soil amendments, and native plants. Reducing impervious surfaces, preserving natural vegetation and natural drainage patterns are also important LID tools. The use of LID requires a reexamination of the use and sizing of traditional urban infrastructure (e.g., streets, parking lots, detention ponds), which are often inadequate to meet natural resource protection objectives. LID techniques can help development meet stormwater management requirements, and in the broader context, support a variety of watershed and community goals by mitigating development impacts to land, water, and air.

* definition developed in collaboration by CASQA, UC Davis Extension, and the California Coastal Commission

2. How does LID differ from conventional stormwater management practices?

The main differences between LID and conventional stormwater management are:

1) By using LID, flow and volume management is more comprehensive - whereas conventional stormwater management generally addresses only peak flows and limited water quality treatment (e.g., TSS removal), LID designs are focused on managing a broad range of runoff attributes, which may include volume, rate, duration, and water quality. This comprehensive approach better addresses receiving water protection goals.

2) LID is focused on source control - conventional stormwater management uses a centralized approach where water is efficiently moved from point “A” to point “B” through a system of pipes, vaults, and ponds. LID, however, attempts to manage stormwater at the source in a manner similar to how rainwater would naturally act on the landscape. These on-site planning and design practices promote hydrologic functions similar to the natural, predevelopment hydrology.

3) LID practices are for the most part, visible, and integrated into the surrounding human landscape - LID practices such as permeable surfaces, bioretention, green roofs, and cisterns are generally visible to the casual observer. Many LID practices such as bioretention swales, rain gardens and green roofs use the biological, physical, and chemical functions of soils and vegetation to help meet stormwater objectives. In contrast, conventional stormwater practices include infrastructure, such as detention/retention ponds, pipes, and vaults.

4) LID offers additional environmental and social benefits beyond stormwater management whereas the primary benefit from conventional stormwater management is flood control and limited water quality protection.

3. What are the benefits of LID?

LID is primarily used as a stormwater management tool. The majority of LID applications are associated with new and redevelopment projects. In addition to the surface water benefits associated with LID, additional technical, economic, and social benefits can include:

- Recharge of groundwater supplies and subsurface flows;
- On-site rainwater capture and reuse (e.g., irrigation, building cooling systems, flush water) to reduce potable water demand;
- Improvement of air quality and reduction of urban heat island effects via vegetation, reduced impervious surfaces, and light colored permeable surfaces;
- Community aesthetics to improve neighborhoods by beautifying common spaces and adding aesthetic value;[2]
- Reduction of costs for municipal infrastructure needs;
- Fulfillment of state and/or federal water quality requirements;
- Economic vitality in the form of new/redevelopment, resale, etc.; and
- Leveraging of multiple municipal services, such as surface water quality, habitat protection, flood control, and climate change requirements.

[2] Summary of LID benefits from US EPA Green Infrastructure strategy document and March 5, 2007 memorandum from Ben Grumbles, Assistant Administrator for the US EPA Office of Water.

4. How do we know that LID is a progressive step to better protect the environment?

The foundation of LID is based on the preservation of natural watershed hydrologic functions and processes. Traditional approaches to stormwater management that focus on peak flow control and the reduction of pollutant concentrations have not adequately improved water quality, because they fail to address the changes in hydrology due to development—the critical factor contributing to impairment. LID focuses on reducing the volume of stormwater runoff, thereby reducing both the pollutant load associated with the volume and the energy from the runoff flow delivered to receiving waters. LID mimics natural watershed hydrologic conditions, increases groundwater recharge, and promotes integrated watershed management. Additionally, LID design promotes preservation of natural site features, such as stream/riparian areas, which support watershed hydrologic processes (e.g., coarse sediment delivery).

5. How does LID relate to how my municipality operates?

Currently, the primary drivers for municipalities to use LID are state and federal regulations related to stormwater management and environmental protection. However, many municipalities are recognizing the value of LID to help address other municipal needs, such as flood protection, and alleviation of storm and wastewater system capacity issues. Municipal programs that support LID include:

- Education and outreach;
- Incentive programs (e.g., reduced stormwater fees or payment for residential downspout disconnection, rebate programs for rain barrels);
- Capital projects; and
- Operations and maintenance.

Capital project efforts that promote or require LID include both public (e.g., roadways) and private (e.g., residential, commercial, industrial) projects. These LID capital projects may be part of new development, redevelopment, and/or retrofit projects.

Some Common LID Concerns and Misconceptions

6. Is LID compatible with Smart Growth and high-density urban development?

Smart growth is an urban planning and transportation concept, based on sustainability, which emphasizes concentrating growth in developed areas where infrastructure (roads, sewers, utilities) is already available to serve new development. In this way, Smart Growth uses an urban sustainability model that avoids urban sprawl. To accomplish the goal of sustainability, Smart Growth uses a suite of tools, including LID, which is compatible with environmental objectives. The lack of available open space typically associated with high-density development does not necessarily preclude the use of LID. Many LID techniques such as rainwater harvesting and evapotranspiration (green roofs) are appropriate and achievable in high-density urban environments. Large cities across the US (such as Portland, Seattle, and Chicago) have successfully demonstrated the use of these techniques, and are incorporating LID as a component to their Smart Growth and sustainable development strategies. In some cases, this involves the use of the street right-of-way to provide the majority of the stormwater mitigation for adjacent parcels or use of Alternative Compliance mechanisms (e.g., fee-in-lieu) to achieve the appropriate stormwater mitigation consistent with natural resource protection goals within the watershed.

7. Do LID practices contribute to urban sprawl?

LID is an approach that incorporates site design to mimic the natural hydrologic functions of a site. The LID approach can be adapted to many different types of land uses and specific site constraints and thus does not necessarily require additional land to implement.

8. Do LID practices create mosquito breeding habitat?

Mosquitoes require a minimum of five days and an aquatic environment to mature from egg to adult. LID structural BMPs are typically designed to drain within 72 hours and therefore do not provide an adequate breeding environment for mosquitoes. Like any infrastructure, proper maintenance is required to ensure that the system functions as designed.

9. Can emergency vehicles be accommodated with a narrow street layout?

Many urban and suburban streets are sized to meet code requirements for emergency service vehicles and provide a free flow of traffic. Many jurisdictions are finding ways to allow narrower street widths while still providing access for emergency vehicles. These solutions include vehicle pullout spaces, connected street networks, prohibiting parking near intersections, smaller block lengths, and street shoulders consisting of reinforced turf, or other pervious paving materials.[3]

10. What is "Hydromodification" and how does it relate to LID?

The term "hydromodification" originally applied to human changes to channels and shorelines, such as bank armoring, in response to the impacts of hydrologic alterations (e.g, dams). The term has evolved to include alterations of the hydrologic regime caused by land use changes from urbanization. Most analyses of efforts related to hydromodification in urbanizing watersheds have emphasized the physical changes in stream channels that have resulted from an altered flow and/or sediment regime. However, the term is being increasingly used to describe the broader hydrologic and ecological impacts associated with land use, including changes such as sediment transport and reduced infiltration due to increases in impervious surface cover. Hydromodification control, then, is the management of stormwater to reduce adverse environmental impacts due to land use changes. Pipes, detention vaults, ponds, and LID are all ways in which hydromodification control can be accomplished. However, LID is an approach where the site design techniques and BMPs result in hydrologic processes that most mimic the desired natural watershed conditions.

11. Do LID practices that encourage infiltration cause soil and/or groundwater contamination?

Generally, LID systems do not pose a risk to groundwater contamination if properly designed. Urban stormwater has relatively low pollutant concentrations, and plants and microbes in the bioretention soil are capable of breaking down and neutralizing many pollutants when in low concentrations. If contamination is a concern at the end of an LID practice lifecycle, then the top 2-3 inches of soil, where most of the pollutants that did not break down are captured, can be removed and sent to a proper disposal facility. Additionally, pretreatment may be used to remove suspended solids and associated pollutants adsorbed to those solids.[4]

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[3] *Neighborhood Street Design Guidelines,* prepared by Neighborhood Streets Project Stakeholders. November 2000 http://www.oregon.gov/LCD/docs/publications/neighsstreet.pdf (accessed Feb 2009).

[4] *Influencing Factors and a Proposed Evaluation Methodology for Predicting Groundwater Contamination Potential from Stormwater Infiltration Activities.* Water Environment Research, Volume 79, Number 1. S. Clark., R. Pitt (2007).

12. Who will be responsible for maintaining LID practices?

LID practices that are in the public right-of-way are in most cases maintained by the municipality or public entity in which they are located. LID practices that are on private property are maintained either by the property owner or in some cases by a homeowner or commercial property association. To ensure long-term performance, it is important to define the maintenance responsibilities as part of the new or redevelopment agreement.

LID Policy and Program Issues

13. Do vegetated LID practices require irrigation? If so, is promoting such LID practices contradictory to the statewide water conservation requirement?

When using LID systems that require vegetation, such as bioretention systems, every effort should be made to utilize plants that do not require irrigation beyond the initial plant establishment period. LID project proponents should consult with a registered landscape architect familiar with the types of plants appropriate for bioretention or other LID practices. LID vegetative guidance is available through various LID resources including the CASQA website. Promoting LID practices is not contradictory to the statewide conservation requirement, as LID practices can be planted with native or drought tolerant plants compatible with the conservation requirement..

14. Does LID conflict with flood services that I provide to my customers?

LID does not conflict with flood protection efforts. The use of LID is intended to preserve and maintain the hydrologic functions of a site and therefore reduce the amount of rainfall that is converted to overland flow. The reduced volume of stormwater leaving the site should complement flood control efforts. Several municipalities are using LID practices to address nuance flooding issues that otherwise would necessitate costly investments in traditional stormwater infrastructure. The overall imperviousness of a developed site and the degree to which any implemented LID techniques reduce the peak flows from the site will influence the size and quantity of downstream flood control structures that may be required.

15. What are the benefits of training my (municipal) staff on implementation of an LID program?

The ability to communicate LID design principles and practices necessitates a basic understanding of the technical and design considerations. Several types of training are beneficial for municipal staff to improve their knowledge of LID and their ability effectively communicate LID requirements to project applicants. Technical training presenting the basics of the hydrologic impacts of development, impacts of stormwater runoff, and methods on how LID can be used as an environmental protection strategy will provide a foundation for program development. Training should be sought that includes the following LID components::

- Design, construction, operation, and maintenance concepts and procedures;
- Municipal codes, regulations, and development standards and how they impact efforts to implement LID programs;
- Institutional influences on water quality programs; and
- Stormwater financing and how it can be most efficiently structured to fund an LID program and create incentives for implementation.

16. What elements do I need to have in place for a successful municipal LID program?

LID programs are most successful when appropriate economic and regulatory policies and ordinances are in place. Development standards must be properly structured to support the implementation of LID strategies. Building and zoning codes must be made flexible enough to allow for LID practices, which are often impeded by traditional building code structures. LID can also be promoted through economic drivers, such as reduced fees based on volume captured or sufficient on-site controls to reduce the need for costly downstream management facilities. Financial and regulatory incentives have also been used successfully to encourage LID adoption. Clearly identifying municipal (environmental or sustainability) goals that include stormwater management, and developing interagency cooperation are critical to the early and continued success of LID programs. In addition, construction of LID pilot projects, monitoring of those projects, and subsequent adaptation of design considerations to conditions will improve local experience and knowledge, resulting in the construction of successful LID projects.

LID Technical Issues

17. How closely can infiltration practices be located to slopes?

In some cases, LID BMPs may be located near slopes, but care must be taken to ensure that infiltration on or near slopes does not create conditions for slope failure. A geotechnical engineer should be consulted before installing an infiltrating stormwater BMP on or near slopes.

18. Can infiltration practices be located next to buildings?

Generally, building foundations should be outside the cone of saturation from infiltration practices. Infiltration practices, such as bioretention and permeable pavement, can be adjacent to buildings and a 5-10 foot rule-of-thumb has often been utilized. Additionally, an impermeable lining can be utilized to provide protection.

19. Does LID work in areas with clay soils or karst geology?

When considering LID for a site, soil conditions need to be considered, including soil type, the presence of karst geology, and soil moisture content. Many design options, such as closed systems (lined practices), can be used when geology, urban or contaminated soils, or impermeable soils limit infiltration capacity. Since the goal of LID is to mimic the natural hydrologic functions of a site, the developed site only needs to mimic the same level of infiltration that would have existed in the site's natural condition. If a site has clay soils or karst geology that prevents infiltration, the developed site would only need to mimic this same level of infiltration. Where desired, soil amendments can be used to increase the infiltration capacity of a site. For sites with naturally good infiltration characteristics, maintaining infiltration rates by avoiding compaction of native soils is critical for effective LID implementation.

20. Can LID infiltrative practices be located in areas with high groundwater levels?

Some MS4 permits and BMP guidance manuals require anywhere from 3-10 feet of separation from the groundwater level for infiltration practices. This distance depends on the soil type, pollutants of concern, and groundwater use, . In some cases, however, where there may be groundwater or soil contamination, LID infiltrative practices may be restricted completely.

21. What types of plants should I use for vegetated LID practices?

The vegetative component of a bioretention system promotes infiltration, slowing of surface flow, and pollutant filtration and uptake. The types of plants used in an LID bioretention system will vary depending on climate and preference related to aesthetics and maintenance. Generally, native plant species are most appropriate for LID systems. Plants selected must be able to sustain periodic inundation of flows and require little to no irrigation. It is best to consult with local landscape professionals who understand the functional requirements when deciding which plant materials to select for these types of BMPs. Additionally, several references exist for LID vegetation selection including those provided on the CASQA LID Portal.

LID Practices

22. In general, what level of treatment do LID practices provide?

Treatment efficiencies vary by LID BMP, and they are affected by proper design, construction, and maintenance. There are various LID studies that document good removal capacities for certain types of LID BMPs (e.g. bioretention) in relation to conventional pollutants (e.g., metals, hydrocarbons, fecal coliform) ; however, less is known about newer LID BMPs (e.g., green roofs) and their treatment efficiencies for emerging pollutants of concern, such as endocrine disruptors (e.g., polychlorinated biphenyls [PCBs], Bisphenol A [BPA], and DDT). Fact sheets from the California Stormwater Quality Association (CASQA) (http://www.cabmphandbooks.com) and the US Environmental Protection Agency (EPA) (http://cfpub.epa.gov/npdes/stormwater/menuofbmps) provide some information on pollutant removals for various LID practices. Generally, practices that are located in suitable conditions and are well designed and maintained will exhibit pollutant removal for sediments, metals, and oils in the range of 70% to 95%. One of the key objectives behind using LID is to retain runoff near the source and on-site in order to prevent runoff from coming into contact with pollutants and carrying it to the receiving water body.

23. In general, what level of maintenance do LID practices need? Is it more complicated than maintaining the traditional BMPs such as detention basins?

All stormwater BMPs, including LID practices, require maintenance to function properly. Most landscaped areas have vegetated LID BMPs that require pruning, mulch/soil amendments, and, possibly mowing. LID BMPs will also require inspections to ensure they are functioning properly, which would include inspection for excessive fine sediment accumulation, adequate vegetation coverage, erosion, and adequate flow infiltration. Most permeable pavement lots will require some degree of maintenance with vacuum sweepers. There are maintenance concerns specific to each LID BMP or measure that should be considered prior to their selection. While maintaining LID BMPs requires a different skill set than maintaining traditional BMPs, it is inherently no more complicated.

24. Does a decentralized LID stormwater management system create many contaminated soil locations as opposed to a centralized system that collects pollution in one place? What do you do with the contaminated soil in vegetated LID practices, like bioretention?

One advantage of LID, which follows a decentralized approach to addressing stormwater runoff, is that it reduces the opportunities for polluted runoff to accumulate in a single spot and potentially contaminate the soil.

Additionally, urban stormwater generally has relatively low pollutant concentrations. The plants and microbes in the bioretention soil are capable of sequestering, breaking down, and neutralizing many of the pollutants when in low concentrations. If soil contamination is a concern at the end of an LID practice lifecycle, then the top 2-3 inches of soil, where most of the pollutants are captured, can easily be removed, tested, and if needed, sent to an appropriate disposal site.

25. What type of permeable pavement should I use (pervious concrete, porous asphalt, or permeable pavers)?

All of the permeable pavement types will have the same underlying structure: a crushed rock or aggregate base, which provides support to the pavement, and a storage area for stormwater. The surface treatment provides a smooth, stable and drivable or walkable surface that allows rainfall and run-on to flow through to the aggregate base. Each permeable surface type has pros and cons with regard to the cost of installation, expertise required for installation, aesthetics, durability, and maintenance. Underlying soil conditions and groundwater table elevations also need to be considered when using permeable pavements.

26. Where can permeable pavement be used?

Permeable pavement can be used for all applications except for hotspot locations and roads with high traffic and heavy trucks. Some common permeable pavement applications include:

- Low traffic residential roads, applied from curb-to-curb or in parking lanes only;
- Parking lots, applied to the full surface, in parking spaces only, or in travel lanes only; and
- Sidewalks and other pedestrian use areas.

27. Do permeable pavements clog easily?

Permeable pavements typically have high infiltration rates. Research has found that there is an early drop in infiltration capacity after the first several years following installation . Even after these declines, permeable pavement often has infiltration rates exceeding high intensity rainfall events. However, permeable pavements can clog if subject to excessive loadings of sediment or hydrocarbons. To prevent clogging or to restore the infiltration capacity of permeable pavement, consider the following maintenance and installation practices:

- Vacuum sweeping the surface (high pressure water is not recommended, as it will force particles deeper);
- Replacing permeable media between pavers; and/or
- Drilling small holes (1/2 inch) in the areas of ponding to assist in drainage.

Additionally, care should be taken in the site design phase to consider whether the site will be subject to high or on-going sediment importation (e.g., rural areas with heavy trucks traffic). In some cases, sediment traps can be designed to address this issue. However, some sites may not be conducive to the use of permeable pavements.

LID and Related Definitions

LID Best Management Practices – A practice or combination of practices that are the most effective and practicable (technical, economic, environmental) means of controlling stormwater runoff at levels compatible with environmental quality goals.

Bioretention – The method of keeping stormwater on-site using vegetated depressions engineered to collect, store, treat, and infiltrate runoff.

Detention – The process of detaining or holding stormwater runoff and slowly discharging it from the site to reduce peak flows and downstream flooding. Underground vaults and constructed ponds are the most common types of detention facilities.

Evapotranspiration – The process of water evaporation from soil and plants into the atmosphere.

Hydromodification – The process by which changes in land cover alters a site's runoff and transport characteristics.

Impervious Area – A hard surface area that prevents or retards the entry of water into the soil, thus causing water to run off the surface in greater quantities and at an increased rate of flow. These surfaces include conventional rooftops and paved areas. Many landscaped areas, road shoulders, etc. become impervious to varying degrees due to soil compaction.

Effective Impervious Area (EIA) – All of the impervious surfaces that directly contribute to site runoff. Impervious surfaces can be removed from the EIA by directing runoff to areas with infiltration soils, converting paved surfaces to permeable pavement, or converting a rooftop to a green roof.

Green Infrastructure – "Green Infrastructure" is a relatively new and flexible term, and its use depends on the context. However, for the purposes of EPA's efforts to implement the Green Infrastructure Statement of Intent, the term generally refers to systems and practices that use or mimic natural processes to infiltrate, evapotranspirate, or reuse stormwater or runoff on the site where it is generated. Green infrastructure can be used at a wide range of landscape scales in place of, or in addition to, more traditional stormwater control elements to support the principles of LID. To learn more about how EPA is promoting green infrastructure to manage wet weather impacts in urban areas, see EPA's Green Infrastructure Page (http://www.epa.gov/owow/nps/lid) and 2008 Action Strategy for green infrastructure.

Permeable Area – Areas of uncompacted soil or other material that allow water to pass through it and infiltrate into the soil.

Rainwater Harvesting – A stormwater and water conservation practice where runoff (primarily roof runoff) is captured for landscaping irrigation or indoor non-potable uses, like flushing toilets or cleaning. Rainwater harvesting systems ranges from the small scale, such as an outdoor rain barrel for a single family home, to a tank and treatment system for an office building.

Retention – The process of holding or retaining runoff close to the source for infiltration, evapotranspiration, or reuse.

Smart Growth – An urban planning strategy that focuses development in areas where existing infrastructure is available and opportunities for infill development and conservation of natural resources are maximized. Smart Growth is intended to reduce the impacts of urban sprawl.