Summary of **Low Impact Development** (**LID)** White Paper: Stormwater Management Program Effectiveness Literature Review
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Ranked Question #6-1. Which LID measures are most effective at reducing flow from developed areas?

Summary of literature review:

All LIDs can be effective at reducing flows, it all depends on proper sizing of the facility to receive the drainage. Bioretention has the benefit of allowing local exfiltration as well as detention to reduce flows.

Summary of recommended effectiveness studies:

To better assess how well facilities are being sized for local conditions, effectiveness studies should be conducted with facilities that are sized following the WDOE stormwater manual to evaluate how well the sizing procedure achieves the desired results.

Ranked Question #6-2. Will installing porous pavement in alleys and road rights-of-way with rain gardens substantially reduce runoff?

Summary of literature review:

Bioretention in any location will reduce flows dependent on the sizing. However, focusing infiltration in alleys may place the infiltrated water near building foundations. As a practical matter, alleys may be a less desired location for substantial amounts of infiltration.

Summary of recommended effectiveness studies: None.

Ranked Question #6-3. Does amending landscapes with compost significantly reduce flows during small and medium storms?

Summary of literature review:

Compost will act as storage when placed in landscapes, but the amount of compost typically used in landscapes is small. The amount of rainfall attenuation will be small.

Summary of recommended effectiveness studies: None.

Ranked Questions #6-4 and #6-5. Is LID more effective than traditional BMPs for improving hydrology at the basin scale?, and Will a developed basin with a high density of LID measures have measurable differences in hydrology and pollutant loads compared to a similar basin with a low density of LID measures?

Summary of literature review:

Widespread use of LID within a relatively highly developed basin is expected to reduce small to medium size storm flows at the basin scale. Higher flows may still occur during large storms, so traditional BMPs may be needed in conjunction with LIDs to help detain the largest flows. Correspondingly, improvements in stream hydrology and reduction of pollutant loads can be anticipated.

Summary of recommended effectiveness studies:

Effectiveness studies of widespread basin scale use of LIDs should be conducted to reveal flow patterns to show/confirm improvements in stream hydrology and reduction in pollutant loads.

Ranked Question #6-6. How well can a calibrated and verified stormwater model (*e.g.*, SUSTAIN and EPA SWMM5) function as a replacement for a control in a paired watershed study design?

Summary of literature review:

Models can be used to help reduce field work effort, but the quality of the model depends on the quality of the data used to calibrate the model. It also depends on little change in development in the control watershed.

Summary of recommended effectiveness studies:

Effectiveness study of the quality of a model can be conducted through a rigorous evaluation of the calibration data.

Ranked Questions #7-1 and #7-2. Does the installation of bioretention, bioinfiltration, biofiltration, rain gardens, and other LID measures have a measurable effect on water quality?, and Which LID measures are most effective at improving water quality from developed areas?

Summary of literature review:

Bioretetion facilities have a beneficial effect on almost all effluent water quality parameters, especially total suspended solids. Pollutant loads are typically reduced using these LID techniques. But it is not clear if slightly elevated nutrient concentrations alone during storms that produce discharge are at levels and frequency relevant to concern in receiving waters. Green roofs appear to add nutrients and metals as a result of their rich soil and runoff contact with building materials.

Summary of recommended effectiveness studies:

Basin scale effectiveness studies of the effect of nutrient concentrations on receiving waters and local ground water can help identify whether nutrients are of significance during storms that produce flow.

Ranked Question #7-3. Can compost mixes and plant species be tailored to enhance removal of specific pollutants (*i.e.*, phosphorus, metals, bacteria)?

Summary of literature review:

A number of products have been shown to be effective as a compost amendment for reduction of nutrients. Soil mixes that carefully manage soil compost and fertilizer additions can minimize nutrient runoff. The water quality benefit of flow reduction through proper sizing will result from having fewer small storms that produce runoff from impervious areas.

Summary of recommended effectiveness studies:

Effectiveness studies of soil composition together with effectiveness of sorptive amendments will provide guidance to more standardized soil mixes for LIDs.

Ranked Questions #7-4 and #7-5. Is LID more effective than traditional BMPs for improving water quality at the basin scale?, and Will a developed basin with a high density of LID measures have measurable differences in pollutant loads compared to a similar basin with a low density of LID measures?

Summary of literature review:

These questions have not been addressed in the literature for receiving waters. But proper LID sizing and widespread use in a basin would reduce small and medium sized storm discharges of untreated stormwater. The reduced number of small, untreated stormwater runoff flows will likely reduce exposure to poor water quality while reducing loads. The higher the density of LIDs, the greater the reduction in concentrations and loads can be expected.

Summary of recommended effectiveness studies:

Effectiveness studies of the basin scale use of LIDs would not only document changes in hydrologic response in receiving waters, but also reduced exposure to pollutants.

Ranked Question #7-6. Does bioretention treat runoff sufficiently to allow for infiltration without violating groundwater quality standards?

Summary of literature review:

The literature indicates that nitrate from bioretention facilities alone may increase in concentration and infiltrate locally. Copper may also originate from materials in soil and compost.

Summary of recommended effectiveness studies: None.

Ranked Question #7-7. What type and frequency of maintenance is needed to ensure the long-term performance of bioretention facilities?

Summary of literature review:

This question was not answered directly in the literature reviewed. Apparent performance problems with LIDs were associated with specific construction or maintenance activities.

Summary of recommended effectiveness studies:

Effectiveness studies for maintenance needs are needed to evaluate owners' maintenance programs.

Ranked Question #11-1. What, if any, LID measures are feasible in areas with tight soils?

Summary of literature review:

The literature indicated bioretention and pervious pavement LIDs had greater subsurface exfiltration than expected for soils that were considered low permeability.

Summary of recommended effectiveness studies: Perform local field study of exfiltration conditions around bioretention facilities especially where low infiltration sub-grades exist.

Ranked Question #11-2. What, if any, LID measures feasible in areas with shallow groundwater?

Summary of literature review:

This question was not answered because most of the LIDs evaluated did not have groundwater near the surface. If ground water rises into LID facilities, the primary affect will be to reduce available storage designed for inflows.

Summary of recommended effectiveness studies: None.