4.1-a PERVIOUS PAVEMENT

Alternative Names: Permeable Pavement, Porous Concrete, Porous Pavers

BMP DESIGN APPROACH
☐ Pollutant Source Control
■ Hydrologic Source Control
☐ Stormwater Treatment
SCALE OF APPLICATION
■ All SFR and MFR < 1 acre
■ MFR 1-5 Acre and CICU < 5 acres
■ MFR and CICU > 5 acres and all WQIPs
TYPE OF APPLICATION
☐ Temporary
■ Permanent

DESCRIPTION

Pervious pavement is any system comprised of a load bearing surface that allows for movement of water through the load bearing surface into an underlying storage layer that can infiltrate or attenuate stormwater runoff. Pervious pavements are most applicable to locations with light vehicle loading. The load bearing surface can be made of porous concrete, or unit pavers or turf blocks separated by spaces and joints, through which water can drain. Pervious pavement decreases the effective impervious area of an urbanized site, thereby reducing runoff and pollutant loads leaving the site. Pervious asphalt is no longer considered a pervious pavement in the Lake Tahoe Region due to repeated failure of pilot project testing.

APPLICABILITY

- Not appropriate for soils with Ksat rates less than 1"/hr or areas with seasonally high groundwater (e.g., SEZ) where groundwater contamination and connection to surface drainage systems are concerns.
- Appropriate for locations with low traffic volumes and light vehicle loads.
- Most appropriate for areas that are relatively flat (generally less than a 5 percent slope).

- Not appropriate where sediment-laden runoff could clog the surface layer. For example, pervious pavement shall not be designed to receive runoff from roads or parking lots that are sanded, or receive runoff from erodible slopes.

Advantages

- Reduces stormwater runoff while providing a stable surface for light vehicle loads.
- Often eliminates the need for stormwater drainage systems and eliminates the need for downstream infiltration systems.
- Unobtrusive subsurface infiltration design increases aesthetic acceptability.

Disadvantages

- Requires relatively frequent maintenance.
- Applicability is limited to sites with higher soil Ksat rates, low traffic volumes, and low pollutant loads.
- May be more expensive than conventional pavement options. However, overall costs can be offset by reducing or eliminating drainage systems and downstream treatment and infiltration systems.
- Snowplow activities can damage pervious pavement dependent upon the type of equipment used and the experience of the operator.
- Does not provide pretreatment of potential pollutants.
- To date, pervious pavements have not been extensively applied or tested in the Lake Tahoe Region and construction experience is limited.

DESIGN CONSIDERATIONS

- Preferable for locations where the depth to seasonal high groundwater, bedrock, or any impermeable layer is at least 3 feet below the underlying base course.
- Provide a base course in a level layer underlying the pervious pavement. This base course shall be:
  - Washed, clean, and free of fine sediments.
  - Uniformly graded to achieve 30-40 percent void space.
  - Angular crushed rock to create an interlocking base course to improve stability and resistance to compaction or deformation.
- Where infiltration is unlikely but application is still desired, an underdrain system consisting of an impermeable membrane and perforated piping may be used to route runoff to an appropriate detention or infiltration facility.
- Pervious surfaces require redundant BMPs for infiltration. A typical method is to grade pervious surface for sheet flow into an adjacent vegetated or depressed area in case pervious material becomes clogged. To do this, gently grade pervious surface to the side (not downslope) so that excess stormwater not infiltrated will be captured on site.
- Tree canopy overhead can decrease the infiltration of pervious surfaces and increase their maintenance needs because leaves, pine needles, and other organic debris will clog pore spaces.

Consider selecting a pervious pavement from the types described below. Note that limited applications of pervious asphalt in the Lake Tahoe Region have been unsuccessful, and this type of pervious pavement is not currently recommended. When necessary, consult with a geotechnical engineer to assess the suitability of various types of pervious pavement in relation to the loads and traffic anticipated.

Porous Concrete:

- Similar in composition to a standard concrete mixture. Voids are created by eliminating finer aggregates from the concrete mix.
- Provide a minimum of 12 inches of base course below the porous concrete layer to minimize the potential for standing water to reach the porous concrete section and damage the section during freeze/thaw conditions.

Unit Pavers:

- Pre-cast units forming interlocking patterns. Discrete units (brick, stone pavers, etc.) are available in a variety of materials, colors, and shapes and are set in a pattern on the prepared base course.
- Because unit pavers are laid loose, enclose a field of pavers with a rigid frame made of concrete, metal, or plastic.
- Open-celled unit pavers are designed with precast voids. Solid unit pavers can form a permeable surface when spaced with permeable joints and set on a permeable base.

Installation of open-celled pavers that will be filled with washed gravel on the edge of a narrow roadway in Crystal Bay.

Turf Blocks:

- Open-celled units, installed similar to unit pavers, but filled with soil and planted with turf or other vegetation. In some installations, the cells are filled with crushed gravel instead of vegetation.
- Requires deep-rooted grass species or vegetation that can penetrate the reservoir base course. Frequent watering may be required for successful

vegetation establishment because the bulk of the root and soil mass are located in the top 3 to 4 inches of the turf block.

- When vegetation establishment is desired, applications are not suitable for areas providing all-day parking and heavy use areas because of insufficient sun or suppression by constant abrasion.

INSTALLATION CONSIDERATIONS

Porous Concrete:

- Any installation of porous concrete shall be overseen by an experienced professional.
- Ensure subgrade is level. Avoid exposure of subgrade to heavy construction equipment prior to the placement of the base course.
- Compact base course using a vibratory plate or other equivalent means.
- Develop a construction sequence that installs the porous concrete section after other pollutant sources have been addressed at the site to avoid clogging the porous concrete during subsequent construction activities.
- Never load materials such as soil, sand, or mulch onto pervious pavements.
- Inspect for clogging after installation and site clean-up.

Unit Pavers and Turf Blocks:

- Follow the manufacturer's specifications.
- Special subgrade preparation is required for expansive soils.

INSPECTION AND MAINTENANCE

The most crucial need is maintaining the infiltration capability of pervious pavements by not allowing the void spaces or pores to become clogged with fine sediment. Pervious pavement that accepts runoff from driveways, parking lots, or roads has a higher likelihood of clogging over time.

Inspection crews can easily identify clogged pores in pervious pavements by routinely pouring water on the pavement to verify infiltration performance. If performance is borderline, use an infiltrometer[1] to test the infiltration rate. If the infiltration rate has decreased by 20 percent or more from the benchmark rate determined at the time of installation, immediate maintenance is needed to restore the benchmark infiltration rate[2].

Vacuuming of pervious paving systems shall be a routine practice to maintain open void space. Expect more frequent maintenance cycles for areas with dense overhead tree canopy that generates substantial leaf and needle litter.

Consider taking core samples of pervious pavement after installation as a future baseline reference and for quality assurance of installation.

1 The Lake Tahoe Stormwater Community and Environmental Improvement Program. Final - September 2009, *BMP RAM Users Manual V.1, Step 4. Field Observation Protocol. Infiltrometer. pg 53-54.*
2 The Lake Tahoe Stormwater Community and Environmental Improvement Program, Final - September 2009, *BMP RAM Users Manual V.1, Step 3. Porous Pavements. Figure 9.*

EFFECTIVENESS CONSIDERATIONS

Pervious pavements can be highly effective for hydrologic source control of stormwater runoff because the BMP provides a large surface area for infiltration and the capacity of the underlying storage layer will typically exceed current design standards (e.g., 20-yr/1-hr storm). For example, the design recommendations contained herein for porous concrete call for a base course of 12 inches of uniformly graded crushed rock with an average void space of 30-40 percent. Assuming pervious pavement is designed to only infiltrate precipitation that directly falls on its surface; the design recommendations provide a storage capacity of roughly 4 inches of precipitation.

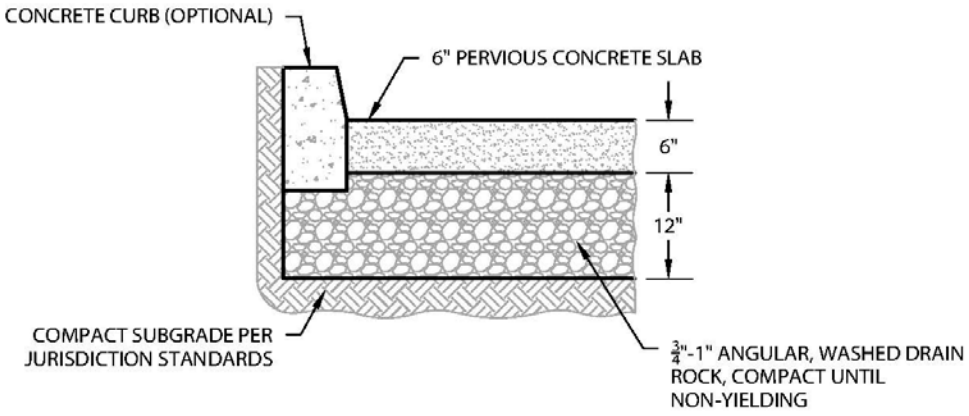
Performance of pervious pavements can markedly decline if the voids in the structural surface layer clog over time. Furthermore, standing water could damage the structural integrity of the BMP during freeze/thaw conditions. Care should be taken when designing pervious pavement to ensure that infiltrated stormwater will have low sediment loads, especially if the design routes stormwater runoff to pervious pavement for infiltration. Depending upon the design and site conditions, continued effectiveness of pervious pavement may require relatively frequent maintenance to preserve the infiltration rate of the structural surface.

Pervious Pavement Inspection and Maintenance Table

INSPECTION AND MAINTENANCE ACTIVITIES	SUGGESTED FREQUENCY	INSPECTION EQUIPMENT	MAINTENANCE EQUIPMENT
Inspect and treat contributing sediment sources. ▪ Stabilize contributing eroding slopes and bare soil areas to prevent sediment entry onto pavement. Most pervious pavement failures occur when substantial quantities of sediment erode onto the pavement surface, either during the construction period or over time.	Annually (May—June)		Soil Amendment Seeds/Plants Irrigation Mulch, Riprap, Coir Logs, etc.
Inspect pervious pavements for signs of reduced void space or for ponding water during spring snowmelt and major storms. It may be helpful to pour water on the pervious surface to verify infiltration performance. ▪ If ponding water is present or void spaces are clogged, cleaning of the pavement is needed. ▪ Clean pavement by removing sediment, litter, and debris from the surface and voids with a vacuum sweeper, effective at PM-10 (particulate matter ≤10 microns) removal. ▪ If vacuuming doesn't restore desired infiltration, pressure washing the surface may restore infiltration of the pervious pavement. Use less than 3000 psi of pressure and always perform first on a test section to be sure there is no structural damage to the pavement[3]. A combination of first vacuuming, followed by pressure washing may be used for extremely clogged voids[4]. ▪ If routine cleaning does not restore infiltration rates, consider pavement rehabilitation or replacement (described below).	Spring and fall and after major storm events (April—Oct)		PM-10 Street Sweeper Vacuum Pressure Washer
Measure the infiltration rate of the pervious pavement using an infiltrometer and the protocols outlined in the BMP RAM. ▪ When infiltration rates have decreased 20% over the baseline (construction) readings, or if the average infiltration rates are below 1.5"/hr, thorough cleaning of the pavement with vacuum sweeper and/or pressure washer is necessary. ▪ If infiltration rates remain below acceptable levels after thorough cleaning, rehabilitation, or replacement may be necessary. o Rehabilitate pervious pavement to restore infiltration capability by lifting surface materials (where possible) for inspection of the underlying materials to identify locations and extents of blockages and remove sediment as necessary. o Evaluate need for cleaning and replacing geotextiles and clean or replace as necessary.	Annually (May—June)	6" Infiltrometer Plumber's Putty Water Ruler Stop Watch	PM-10 Street Sweeper Vacuum Pressure Washer Tools as necessary for rehabilitation
Inspect pervious pavement surface for signs of deterioration, spalling, or structural damage by vehicles (snowplow). ▪ Repair areas as necessary. ▪ It may be necessary to replace or refill the pea gravel in a gravel filled paver block installation.	Annually in spring		Pervious Pavement Patch or New Paver Filler Material
Inspect outlets (if applicable) annually for signs of erosion, undercutting, and clogging. Make sure that any excess runoff is properly accessing the downstream treatment system and is not flowing off the property. ▪ Stabilize eroded or undercut areas. ▪ If outlet is clogged, the system likely needs rehabilitation (described above).	Annually in spring		Rock, Cobble, Riprap Tools as necessary for rehabilitation

3 Tennis, P., Leming, M. and Akers,D., Portland Cement Association, 2004, *Pervious Concrete Pavements page 21*
4 EPA, 1999, *Storm Water Technology Fact Sheet—Porous Pavement*

Pervious Concrete Figure



PERVIOUS CONCRETE
(ON A SLOPE LESS THAN 5%)

NOTES:

1. PERVIOUS CONCRETE SHALL BE INSTALLED BY A CONTRACTOR THAT HAS SUCCESSFULLY COMPLETED A NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA) PERVIOUS CONCRETE INSTALLERS' COURSE OR POSSESSES AN EQUIVALENT CERTIFICATION.