Westmoreland Pervious Pavers
Portland, Oregon

PROJECT SUMMARY

Project Type:	Street reconstruction with pervious pavement—demonstration project
Technologies:	Pervious pavement blocks
Major Benefits:	• Pervious pavement provides more natural stormwater management than a piped system, allowing stormwater to be absorbed, filtered, and cleaned before recharging groundwater. • Stormwater infiltration into the ground reduces combined sewer overflows to the Willamette River and reduces basement flooding caused by rain storms that overload sewers. • The project will provide information about how well different pavement materials, with different section geometries, manage stormwater and hold up as a street surface.
Cost:	$412,000, with $80,000 paid by EPA grant funds
Constructed:	2004

Overview of the Stormwater System

- Deep sewer construction in deteriorated streets in the Westmoreland neighborhood made it necessary to reconstruct four blocks of street surface. Rather than repaving all four blocks with traditional materials, this presented a unique opportunity to use an alternative, pervious material for demonstration and testing purposes.

- The four blocks were repaved as follows:
  - One block (SE Knapp Street from 21st to 22nd avenues) was paved curb to curb with interlocking pervious concrete paving blocks. This block is crowned.
  - Two blocks (SE 21st from Knapp to Rex and SE Rex from 20th to 21st) were paved with pervious concrete paving blocks in the parking strips along each curb and with standard asphalt in the center strip. One block is crowned, and one is flat.
  - One block (SE 20th from Lambert to Rex) was paved curb to curb with standard asphalt.

- Stormwater from the contributing catchment area falls directly on the pavers or travels to the pavers as sheet flow or very shallow concentrated flow. Runoff infiltrates through the paver core holes and interstitial spaces, collects in the base rock beneath the pavers, and infiltrates into the soil subgrade. If runoff from large storms (greater than a 25-year event) exceeds the capacity of the paver system, it collects and flows against the street curb to the existing combined sewer inlet.

- Street trees were planted to mitigate all surface area not managed by the pervious pavers.

Figure 1: Project during construction

Figure 2: Pavers along parking strips only

Figure 3: Pavers along the full length of the street

STORMWATER CAPACITY AND SYSTEM COMPONENTS

Stormwater Management Goal

The goal was to learn how well pervious paving blocks manage stormwater and perform as a street surface and how cost effective they are. The project was designed in accordance with the City of Portland's 2002 *Stormwater Management Manual.*

System Components

Facility footprint: 28,000 square feet. (Three pervious streets: 28 feet wide by 600 feet, 200 feet, and 200 feet, respectively = 28,000 square feet.) Assumes "facility" is the entire street width curb to curb, even though two blocks use pavers only in the only parking lanes (6 to 10 feet wide per side).

Catchment area: 60,984 square feet (roofs, driveways, lawns, sidewalks, and streets). The catchment area contributing runoff to the pervious streets is assumed to extend 30 feet from each curb into the residential lots fronting the project. It includes approximately half of the impervious roof area of each home, impervious driveway and sidewalk area, and some pervious lawn and landscaped area. The contributing catchment area also includes the impervious center-strip asphalt on two of the pervious pavers blocks, which will direct flow to either or both of the paver lanes, depending on the street section.

Pervious Pavement Blocks: The pavers are 3⅛-inch-thick (8 cm) concrete interlocking blocks placed over a 3-inch-thick leveling course of fine rock (⅜-inch minus #10 crushed rock). The fine rock is also packed in between the blocks and in the drainage cores. A geotextile fabric is under the fine rock. Under the fabric is a 6-inch to 15-inch-thick course of base rock (2-inch minus #10 crushed rock) for both structure and stormwater runoff storage. A second layer of geotextile fabric lies between the subgrade and the base rock. The geotextile fabric layers reduce pollutants carried into the soil as the water infiltrates. They also prevent fine soil particles from migrating into the void space within the base rock.

The pavers in the parking lanes were installed in fields approximately 6 feet 10 inches wide on each side of the street. New asphalt was laid in the center. A 12-inch-wide concrete divider strip was placed between the pavers and the asphalt center as both a structural member and an architectural detail. It separates the two flexible surfaces, which deflect differently under loads, and provided a rigid edge to lay pavers and compact against.

Intersections were reconstructed in standard asphalt to ensure compliance with Americans with Disabilities Act (ADA) requirements. ADA specialists in the Portland Office of Transportation advised that while the paver surface is arguably compliant with ADA rules, pavers should not be placed in crosswalks. At issue are the core holes and channelized surfaces that prevent smooth rolling of small-diameter wheels. The paver runs are designed to stop short of the crosswalks.

The existing water main and water services had to be replaced because the existing main was too old to bear up to construction loads once the street section was excavated. Also, existing services were above the proposed subgrade elevation.

The paver interception system is approximately 80 percent efficient, per industry design guides. This means that rainfall events within the design capacity of the infiltration system will result in some curb flow.

Street Trees: Street trees were planted to mitigate stormwater impacts from the impervious areas of the reconstructed streets that do not drain to pervious pavement surfaces, as required by the *Stormwater Management Manual.*

BUDGET

The construction cost was $412,000 for all four reconstructed blocks (including the block with standard asphalt, which cost about $45,000). This included $74,000 for water line replacement. An EPA Innovative Wet Weather Projects grant to the Bureau of Environmental Services (BES) paid for $80,000 of the project cost.

The costs for project management, contract management, design, and inspection are not included in the construction budget. These elements were tracked separately and funded by BES's Capital Improvement Program budget. They amounted to an additional $115,600, or 28 percent of the construction contract.

Cost Comparisons

The cost of the street reconstruction using pervious pavers was approximately 1.8 times the cost of standard construction. This does not include the costs of water line replacement.

Data gathered from the project indicate an estimated cost of $10.50 per square foot installed, including base rock, for the three blocks using pervious pavers. This includes the entire streets, curb to curb, including the asphalt center strips in two of the blocks.

MAINTENANCE AND MONITORING

Maintenance

The Bureau of Maintenance will vacuum sweep the pavers four to six times per year to prevent a build-up of soil and to dislodge grass and weeds that manage to germinate in the core fill material. Some initial problems occurred with maintenance, as described under "Successes and Lessons Learned," below.

Monitoring

The Bureau of Maintenance will periodically inspect the paver system and record its performance as a street surface (e.g., the occurrence of cracking or rutting), as well as the costs and challenges of maintaining the surface.

Two types of monitoring devices were installed with the paver system to collect water samples and monitor how well the pavement infiltrates water and helps improve water quality. One is a 3-inch-diameter PVC pipe subdrain that collects infiltrate and conveys it to a manhole; the sampling pipe protrudes inside the manhole within reach from the surface. The other is a 6-inch-diameter PVC standpipe that can be used for observation/measurement of the groundwater elevation and for sampling. These monitoring devices have not been successful, as discussed under "Successes and Lessons Learned," below.

PUBLIC INVOLVEMENT

Public involvement included informing and engaging residents with the project through mailings, door-to-door calls, public meetings, and local press coverage. Two open houses were conducted while construction was underway: one for the public, and one as an industry demonstration.

None of the residents fronting the pervious street projects was identified as unwilling or reluctant to have the project implemented. Some concerns were raised over issues related to the project—primarily basement flooding and weed control.

A permanent interpretive sign is planned at the project site to provide information about the sustainable stormwater management techniques used.

SUCCESSES AND LESSONS LEARNED

Pervious Pavement Performance: This is Portland's first application of pervious paving blocks on a public residential street. In 2005, the city installed pervious asphalt and pervious concrete pavement on four blocks of North Gay Avenue. The Westmoreland and North Gay projects will test how these three pervious paving materials perform on residential public streets.

Information Sources: The Portland Office of Transportation retained an interlocking paver specialist to assist with quality assurance/quality control for this project. The specialist reviewed the plans and specifications at two points in the design process and provided comments. His insight on products and installation methods added value to the project and served to confirm that more speculative aspects of the design were indeed correct.

Maintenance: Street sweeping occurred only three times during the first year. Weeds grew in the pavers, particularly in large zones in front of some driveways. This could partly be a result of residents' practices—e.g., washing cars in driveways or blowing mown grass into the street. Once weeds took hold in these areas, sweeping could no longer remove them. The Bureau of

Maintenance has now purchased a more powerful vacuum sweeper, and it is anticipated that more frequent use of this sweeper will eliminate the weed problem.

Settlement: Some localized settlement is visible in the parking lanes and is being monitored. It is probably caused by heavy loads from garbage trucks over areas that received insufficient compaction during construction. Corrective measures will involve picking up the pavers and much of the base rock, compacting the subgrade with a small plate compactor, and re-laying (and recompacting) the street materials.

Monitoring: The two monitoring devices are not working because water infiltrates into the ground so quickly that it does not appear in the stand pipes. The water drains past the perforated collection system in the subgrade that was intended to deliver a monitoring sample to the manholes. BES has not corrected these devices at this time. To do so would involve picking up the pavers, removing the rock, and laying a broad sheet of stainless steel or other inert material under the perforated pipe to trap and channel more infiltrate. The stand pipes would have to be removed and reconstructed at a deeper level.