# Attachment D
# Research Proposal Template
## Roads & Highways Monitoring Committee
Subgroup of the Stormwater Working Group

**1. RESEARCH PROPOSAL TITLE**
Water quality benefits of porous asphalt on roadside shoulders and gutters

**2. RESEARCH PROBLEM DESCRIPTION**
Existing roadway sections may not have the funding or the right-of-way width available to install stormwater management facilities providing the Washington State Department of Ecology's Basic or Enhanced Treatment standard. Where soil infiltration rates are sufficient, one suggested solution is to install a porous asphalt pavement system between the lane edge and the curb (or edge of pavement where no curb exists) to presumably treat and infiltrate stormwater. Ecology currently does not approve permeable pavement systems for water quality treatment due to insufficient data. Permeable pavement is approved for flow control. Therefore, these systems may only be currently installed where stormwater flow control is needed, but treatment is not required. While research on the water quality benefits of pervious pavement has been promising, data has not been sufficient to demonstrate compliance with Ecology's minimum requirements for runoff treatment. Studies have shown that infiltration rates through porous asphalt are very high shortly after construction. However, there is a need for more research to determine long-term infiltration rates and clogging, particularly on porous asphalt shoulders.

**3. RESEARCH OBJECTIVE**
Monitor infiltration rate and total suspended solids, oils, metals, and phosphorus removal in a roadside porous asphalt gutter section at various depths below the surface. The objective is to determine if a roadside porous asphalt gutter will remove pollutants sufficiently to meet Ecology's minimum requirements for runoff treatment. A second objective will be to monitor infiltration rate and water quality performance over a number of years to determine long-term effectiveness.

While the research objective could have a national need, this proposal is specific to Washington State runoff treatment BMP criteria. A porous asphalt gutter project will be constructed in Summer 2013 by the City of Spokane Valley. An existing roadway with low volume ADT will be retrofitted to include porous asphalt gutters for flow control (runoff treatment would be beneficial but is not required per Ecology standards). Subgrade soils have a high infiltration capacity. As part of this proposal, the project proposes to set up long term monitoring for this site and follow the Ecology QAPP process for reviewing and approving porous roadside asphalt for both basic and enhanced runoff treatment.

The Spokane Valley project is applicable to low-ADT roadways (<7,500). To expand applicability of this study, roadways with moderate volume (7,500 to 30,000 ADT) and high volume (>30,000 ADT) traffic should also be monitored. This can be accomplished by re-opening old monitoring stations, such as the 1997 WSDOT study in Redmond, if available (see Section 4).

*_V__Effectiveness ____Source Identification ____Status & Trends*

**4. LITERATURE SEARCH AND RESEARCH IN PROGRESS SUMMARY**
WSDOT, 2010: "WSDOT Strategies Regarding Preservation of the State Road Network" identified possible permeable pavement applications in Washington State.

- The paper focused primarily on durability of permeable pavements and open-graded friction courses. The study suggested that these surfaces not be used for highway pavement. While research has indicated water quality benefits with pervious pavement, due to reduced durability they are not recommended for mainline highways.

Chai, L., Kayhanian, M., Givens, B., Harvey, J., and Jones, D. (2012). "Hydraulic Performance of Fully Permeable Highway Shoulder for Storm Water Runoff Management." *J. Environ. Eng.*, 138(7), 711–722

- This paper is focused on hydraulic performance of permeable shoulders, and is based in CA. The research found that the subgrade Ksat is the limiting design parameter (at least $10^{-5}$ cm/s), presumably due to the high infiltration rate of the porous asphalt and storage volume of the sub-base layer.

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Kayhanian, Masoud, 2012: "Adapting Full-Depth Permeable Pavement for Highway Shoulders and Urban Roads for Stormwater Runoff Management." Stormwater Magazine.
http://www.stormh2o.com/SW/Articles/Adapting_FullDepth_Permeable_Pavement_for_Highway_18309.aspx

- The article describes retrofitting existing roadways for full-depth permeable shoulders, and references University of CA Pavement Research Center studies. These studies have determined that the retrofit is technically feasible and is economically advantageous in urban areas when compared to conventional stormwater structure installation. However, these studies are theoretical and haven't been tested in the field yet by this group.

Matthias and Horner, WSDOT, 1997: "Effect of Road Shoulder Treatments on Highway Runoff Quality and Quantity."
http://www.wsdot.wa.gov/research/reports/fullreports/429.1.pdf

- Porous asphalt highway shoulders, gravel shoulders, and conventional asphalt shoulders were tested near Redmond, WA. The porous shoulders reduced runoff by 85% and solids and pollutants by more than 90% as compared to a conventional asphalt shoulder. After one year, the porous asphalt showed no signs of clogging and had an infiltration rate of 1750 in/hr.
- The study suggested long-term infiltration rate studies to determine the clogging rate of the porous asphalt.
- The research was done in 1997, and follow-up documents were not readily found. Additional literature search will be needed to determine if subsequent papers were published. If additional research was not performed, the proposed monitoring study would help fill this data gap.

Barrett, Journal Of Irrigation And Drainage Engineering, 2008, Effect of a Permeable Friction Course on Highway Runoff.

- This study provided a direct comparison of runoff over 32 months from both conventional asphalt pavement and permeable friction course (PFC) from the same research site.
- The study findings showed concentrations of TSS, total metals, and phosphorus were significantly lower from PFC than conventional asphalt pavement.
- Future research recommendations included; the need for a long-term monitoring program to document any changes in water quality performance, evaluate different maintenance strategies, and life cycle cost.

Berbee, Rijs, Brouwer, and van Velzen. "Characterization and Treatment of Runoff from Highways in the Netherlands Paved with Impervious and Pervious Asphalt". Water Environment Research, 1999, Volume 71, Number 2, pages 183-190.

- This study was conducted in the Netherlands to assess the quality and quantity of runoff from impervious and pervious asphalt.
- Results showed runoff from well maintained porous asphalt contains relatively low concentrations of heavy metals, mineral oils, polynuclear aromatic hydrocarbons, and suspended solids.
- The study concluded unused sections of highways, particularly shoulders are more sensitive to clogging. While high speed traffic causes turbulence that keeps the permeable pavement voids in the travel lanes open, supporting pollutant transport through the pavement structure, pollutants tend to move toward and settle in the less used shoulder portion of the pavement. The study recommended an aggressive maintenance program using both pressure washing and vacuuming equipment to sustain both drainage and water quality benefits.

Washington Stormwater Center Permeable Pavement Study (in progress).
http://www.wastormwatercenter.org/permeable-pavement-research-facility

- A parking lot at the WSU Puyallup campus was replaced with test sections of both porous asphalt and permeable concrete, located both in the travel lanes and parking stalls. The infiltration rate of the subgrade is low (0.003 in/hr). The test sections will also vary in level of maintenance to determine its impact to clogging and water quality through the permeable pavements.
- Subgrade infiltration rates at the Puyallup study area are very low while they are very high at the Spokane Valley study area. However, runoff treatment data through the porous asphalt section will be applicable to the proposed Spokane Valley study.

**5. Geographic Scope and Urgency of Research**

*How broadly will the results of this research apply?*

*_____Nationally ____Pacific Northwest _√__WA Only ____Eastern WA ____Western WA ____Puget Sound Basin*

*How quickly will you need the results of this research?*

*____ASAP ____Within 6 months _√__Within 1 year ____Within 2 years _√__Within 5 years ____Ongoing*

**6. Conceptual Research Approach**

Roadside porous asphalt projects will be constructed in Summer 2013 at various locations in the City of Spokane Valley. Monitoring stations will need to be purchased and installed to collect samples. Water quality samples will be collected at various depths below the permeable asphalt surface and subsurface. The goal of the initial research will be to attain samples from six to ten storm events over the course of one year. The 2014 water year is a suggested sample time frame, from October 1, 2013 to September 30, 2014. Control samples will be collected from runoff from the project site before it is allowed to pass through the permeable asphalt. Samples will be analyzed for typical stormwater pollutants, such as phosphorus, metals, fecal Coliform, BOD, total suspended solids, and total petroleum hydrocarbons.

Infiltration rates through the porous asphalt should be monitored for at least five years to determine initial clogging rates. At the end of the five year cycle, water quality monitoring should be performed again to determine if treatment capacity degrades over time.

If the test section near Redmond, WA is still in place (Matthias, 1997), infiltration rate and water quality monitoring at that location would be highly useful information for long-term effectiveness of porous asphalt shoulders.

**7. ESTIMATED COST AND TIMING** (Optional)

Roadside porous asphalt project construction will commence in Summer 2013 and will be funded by the City of Spokane Valley. Monitoring stations will need to be purchased and installed at additional cost. The best timing for monitoring station installation is during construction of the porous/permeable gutter. Obtaining samples will require additional funding for staff sampling time, asphalt infiltration rate testing, sample analysis, data analysis, and reporting. In the Spokane area, the summer and early fall months are generally dry. Stormwater sampling opportunities may begin in the second half of September to October. This proposal suggests one year of initial sampling. Infiltration rates are proposed to be sampled for five years with another water quality monitoring round at the end of the 5 year cycle.

Funding for monitoring at other locations, such as the Redmond test section, will also be required.

**8. CONTACT INFORMATION**

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