ARTHUR H. HOWLAND & ASSOCIATES, P.C.

CIVIL ENGINEERS
LAND SURVEYORS
SOIL SCIENTISTS
LAND PLANNERS

January 19, 2010

Mr. Ron Cooper, Enforcement Officer
Planning and Zoning
Mallory Town Hall
9 Route 39 North
P.O. Box 39
Sherman, CT 06784

**Re: Porous Asphalt above Bedrock**
**Sherman Library Expansion**
**CT Route 37 & Saw Mill Road, Sherman, CT**

Dear Mr. Cooper,

As part of the site development plans for the Sherman Library Expansion, porous asphalt is proposed as a low impact development strategy in minimizing the amount of runoff from the driveway and parking areas of the project. To construct the proposed addition and the associated driveway and parking areas, removal of bedrock will be required. During the approval process for this project, additional attention has been paid to the construction and operation of porous asphalt in areas which are underlain by shallow bedrock. In developing the design for these areas, we have put a great deal of research into available resources on the subject from various government, university, and trade publications and presentations. Based on this research, it was found that porous asphalt can adequately provide stormwater quality and quantity management when underlain by shallow bedrock or soils that experience low infiltration rates. A summary of the research that was conducted and findings from the research can be found in the paragraphs that follow. In addition, please find details and specifications for the areas where the porous asphalt will be constructed above bedrock.

**Research from the University of New Hampshire Stormwater Center**

The porous asphalt design for the Sherman Library Expansion was shaped largely from information provided by publications and workshops that have been provided by the University of New Hampshire Stormwater Center. The University of New Hamphire Stormwater Center (UNHSC) operates and collects test data from its field site that contains numerous Stormwater "Best Management Practices" (BMP's). Once the test data is compiled, the UNHSC then compiles the information and assesses each practice's ability to provide stormwater quality and quantity management. One of the BMP's that is tested is a porous asphalt parking area that was constructed in 2004. This parking lot was constructed next to an identical size traditional impervious pavement parking area. While the traditional impervious parking lot required piping and catch basins, the porous asphalt parking area required only an underdrain system set above the subbase that would collect and pass water during an unusually large storm. Based on the comparison of the two lots and collected data, it was found that the porous

asphalt parking area performed extremely well with regard to providing sediment, total petroleum hydrocarbon, total phosphorus, and total zinc removal. A copy of the UNHSC 2007 Annual Report, which documents their findings for porous asphalt and other BMP's, has been included with this report for reference.

On a different part of campus, the University of New Hampshire also constructed a pervious concrete parking area in a location that overlays shallow bedrock. Since aquifer protection was required above the bedrock, an impermeable HDPE liner was used so no infiltration into the underlying bedrock could take place. To provide a means for overflow during unusually large storms, the pervious concrete pavement cross section was designed with a system of perforated underdrains. The design as constructed avoided the need for catch basins and pipe and provides the University of New Hampshire with a means for providing flow rate attenuation and sediment settlement without the need for land intensive surface detention systems. Evidence that the system can handle large quantities of stormwater can be found on the UNHSC website (www.unh.edu/erg/cstev/pubs_specs_info.htm) which shows a video of a truck dumping large amounts of water over a section of the subject pervious concrete. As can be seen in the video, the pervious concrete readily drains the water through the porous asphalt to the pavement subbase with no excess runoff from the edge of the parking lot. Based on research of aquifer data of the site from Connecticut Department of Environmental Protection (CTDEP) and the Housatonic Valley Council of Elected Officials (HVCEO) website, it was found that the site is outside of any established aquifer protection areas. Since the project site lies outside of any aquifer protection areas, no HDPE liner is proposed as part of the Sherman Library project in order to promote groundwater recharge. A system of underdrains is proposed as part of the porous asphalt design for Sherman Library (similar to the University of New Hampshire design) to provide a means for overflow to the drainage system during unusually large storms.

The University of New Hampshire Stormwater Center (UNHSC) provides tours of their facility where they walk visitors to each of the Best Management Practices (BMP's) that they conduct research and testing on and then give a brief discussion as to the effectiveness of each practice with regard to stormwater quantity and quality management. Following the tour, presentations regarding the performance of BMP's and the permeable pavements are provided to demonstrate the effectiveness of each measure with regard to pollutant and sediment removal. These presentations are also available online at the University of New Hampshire Stormwater Center's website (www.unh.edu/erg/cstev/). In addition to the presentations, the UNHSC also provides their UNHSC Design Specifications for Porous Asphalt Pavement & Infiltration Beds. This publication provides the background information and guidelines recommended for properly designing and specifying the various layers making up the porous asphalt cross section. A copy of this publication is provided with this letter. Lastly, the UNHSC also provides recent students' Master Theses which include in-depth research and analyses regarding various stormwater BMP's performance. Several of these theses focus exclusively on porous asphalt.

Research of one particular thesis by Joshua F. Briggs states that based on his research, the minimum recommended depth to bedrock ranges between 2' and 4'. This depth that he refers to is relative to the porous media reservoir. He states that these minimum depths are established to ensure that adequate

water quality treatment occurs in the subgrade soils. In addition, he also states that in the case where a fine grained filter course (not gravel) is used on a subbase, separation could be measured from the top of the filter bed. This provides credit for filter courses that provide water quality treatment. As can be seen on the details for the porous asphalt in areas of bedrock for the Sherman Library, an 8" filter course is being proposed 8" below the porous asphalt surface. When measured from the top of this surface, the proposed porous asphalt section for bedrock areas proposes a 37" separation to the bedrock with 24" of filter course, which is within the range specified in the Brigg's thesis. A copy of Joshua F. Briggs' thesis (Performance Assessment of Porous Asphalt for Stormwater Management can be found online on the University of New Hampshire Stormwater Center website at www.unh.edu/erg/cstev/pubs_specs_info.htm.

**Research from other sources**

Another valuable source of information regarding porous asphalt was a publication presented by the National Asphalt Pavement Association (NAPA) entitled "Design, Construction, and Maintenance Guide for Porous Asphalt Pavements. This publication states that while a number of sources state that porous asphalt should only be used on sites with gentle slopes, permeable soils (typically 0.5 in/hr), and relatively deep water table and bedrock levels, it also recognizes that Cahill Associates, who has designed numerous infiltration systems in the Mid-Atlantic states does not consider infiltration rates 0.1 and 0.5 in/hr too slow. They believe that this only means that infiltration will take place over two to three days which is ideal for water quality improvement. This publication also recommends the increase in reservoir depth and use of subsurface drains in soils with marginal permeability to provide a means of drainage during unusually large rain storms. The NAPA publication and another article entitled "Porous Asphalt: The Right Choice for Porous Pavements" by Thomas H. Cahill, P.E., Michelle Adams, P.E., and Courtney Marm is provided along with this letter.

Another source of information that proved helpful was an online presentation given to the Asphalt Pavement Association of Oregon about porous asphalt provided by David Vogt of Hooker Creek Companies, LLC (www.apao.org/documents/documents/APAOPorousAsphaltHooker.pdf). This presentation documents a site in Oregon that was developed for a Rental Store and 20,000 s.f. parking area. The project which utilized porous asphalt for stormwater management was able to be successfully developed despite the existence of shallow bedrock and concerns from the local government regarding freeze/thaw operation, heavy truck operation, and performance in areas with snow or ice buildup. This project provided an 18" filter layer above fractured bedrock or uncompacted subgrade. The porous asphalt pavement cross section provided in the presentation was constructed using 4" porous asphalt, over a 1" choker course, over a 11" coarse aggregate reservoir course. Filter fabric was installed beneath the reservoir course and above an 18" filter course place directly above fracture bedrock. In comparison with this design, the porous asphalt cross sections above bedrock for the Sherman Library provide a much more conservative design. The porous asphalt section for Sherman Library in areas of bedrock will consist of 4" porous asphalt (2-2" lifts) over a 4" choker course, over an 8" filter course, over a 3" pea stone filter blanket (instead of filter fabric), over a 10" reservoir course, over a 16" filter layer. A copy of the presentation slides which were obtained online are provided with this letter.

**Design Selection & Discussion**

Based on our research discussed in the preceding paragraphs and other sources not mentioned, we seemed to consistently find that a minimum 24" of separation should be provided between the porous media reservoir of the pavement section and bedrock. This separation is recommended to provide water quality enhancement prior to reaching the bedrock layer. As mentioned in Joshua F. Brigg's Masters Thesis, this separation can be provided from the top of a filter layer within a porous section to bedrock surface. The porous asphalt design for areas above Bedrock for the Sherman Library Addition project provides a 37" separation (with 24" of filter course) between the upper filter layer surface and the bedrock surface to provide for water quality enhancement prior to reaching the bedrock layer.

While some concern has been expressed over the ability to construct porous asphalt over bedrock or other soils with low infiltration capacity, there are several projects outlined in this letter that have successfully designed permeable pavement parking areas in areas with shallow bedrock or low infiltration soils. The porous concrete parking area at the University of New Hampshire that was constructed over bedrock and an impermeable liner demonstrates that a permeable pavement can provide peak flow rate attenuation and water quality enhancement with no infiltration capability through the use of subsurface underdrain systems. The parking area for the Hooker Creek Companies, LLC in Oregon mentioned above was able to be constructed successfully and operate as intended despite site constraints similar to those of the Sherman Library.

While the existence of bedrock does pose challenges, the proposed design can be constructed and can adequately provide stormwater management. Calculations for the porous asphalt sections in the areas of bedrock were also performed to demonstrate the adequacy of the porous asphalt section in providing adequate storage for a 100 year, 24 hour storm. It is our opinion that the porous asphalt design being submitted for the Sherman Library Addition will adequately provide stormwater quality and quantity management for any stormwater falling on the proposed porous asphalt areas of the site.

Enclosed please find the latest design details for the construction of the porous asphalt driveway and parking areas proposed as part of the Sherman Library Addition. Also, please find copies of calculations demonstrating the ability of the proposed porous asphalt section in areas of bedrock to provide adequate storage for the area draining to it. Copies of the publications and additional literature used in developing the proposed design are also included with this letter.

If you have additional questions, please do not hesitate to contact me at (860) 354-9346.

Sincerely,
**Arthur H. Howland & Associates, P.C.**