# North Street Reconstruction Project
# Summary of Porous Concrete Sidewalk

**Project Description**
The City of Olympia, Washington, completed a street enhancement project on North Street in 1999. The project involved rehabilitating the existing roadway pavement, stripping two new 5-foot bicycle lanes and building 1500 feet of 5.5 feet wide new sidewalk.

Because the new sidewalk area was added imperious surface the addition of the sidewalk required mitigation of the increased runoff under the rules of the city's drainage manual. To provide the required detention property would needed to be purchased for a pond. The cost estimate for the property acquisition and pond was about $110,000. As an alternative, the project team decided to install porous concrete sidewalk.

**Description of Regular Porous Concrete and Placement**
Regular porous concrete is a mixture of aggregate, cement and water, (no sand). Because aggregate contains a significant amount of voids the addition of the cement does not close off all of the voids. Up to 25% of the completed concrete can be void space, simply by random association some of these voids are flow paths through the material. Water flow rates through porous concrete material are in the order of several hundred of inches per hour.

All porous concrete mix designs are very aggregate specific. Crushed material tends to have larger void contents but were not readily available in Olympia. For the North Street Project a 3/8-inch to Number 10 washed round aggregate was used. The aggregate to water ratio (pound/pound) was 0.32. The aggregate to cement ratio in (pounds:pounds) was 4.5: 1. Polypropylene fibers, air entrainment and water reducing/retarding admixtures where used in the design mix. Final void content was around 12% and the 28-day compressive strengths are 2,400 psi. The final appearance of the porous concrete material is similar to exposed aggregate or rice crispy treats.

The final mixture is a very stiff, zero slump, concrete. The material must be raked into the forms, as it does not tend to flow well. The mixture is leveled to half an inch higher than final grades. A weighed roller is used to compress the excess material to the final grade. Expansion joints where placed every 20 feet while crack control scores where placed every 5 feet before the concrete set. The finished surface was immediately covered with plastic and left to cure for up to 7days.

**Challenges**
1) Satisfying concerns about the durability and maintenance requirements of the material. Porous concrete does require at a minimum annual sweeping and care should be taken to keep leaves and debris off of the surface. Education that detention pond maintenance was really being transformed into porous concrete surface maintenance was required. The jury on the durability of the material is still out, waiting for a few seasons to pass.

2) Determining a workable mix design. Several bench tests were required to determine the final cement, water and aggregate ratios. Local aggregate supplies materials where tested for suitability in the mix.

3) Gaining adequate experience in placing porous concrete required pouring a test panel. The city hired a contractor with porous concrete placement experience and invited all local concrete contractors to a demonstration project. The subcontractors labors who eventually placed the material was required to watch a demonstration video on placing porous concrete prior to beginning the work.

**Costs (The bottom line)**

As note previously the cost for a detention facility was estimated to be $110,000. The city of Olympia regularly pays $35 a square yard for concrete sidewalk. The 1999 construction season bids where lower than expected even for regular concrete, the average of the bids was $20 a square yard. The average bid price for the regular porous concrete was $25 a square yard. There where additional engineering costs associated with the mix design and construction inspection for the porous concrete. The increased cost of the sidewalk was about $10,000, the estimate savings by eliminating the detention facility is $100,000.

**Final Word**

Porous concrete is a new material for this area, so although it is used extensively in other parts of this country, it must demonstrate its ability to perform in this part of the county. Trial and demonstration projects are the only true way we can evaluate the benefits of this material. With an increase awareness of stormwater runoff impacts on stream water quality and fish habitat, porous concrete could be a valuable addition to the designers' toolbox to minimize the adverse impacts of development. Care should be taken in where porous concrete is used, special attention should be paid to the mix design, and experience is needed to place the material correctly. If all of these elements are considered the use of this material can significantly reduce the cost of projects while improving stormwater runoff water quality.