Design and Construction of a Porous Asphalt Stormwater BMP Retrofit –

An EPA Education and Outreach Project

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EPA New England, Nov 2012

Hurd Field, Arlington, MA

What is a Porous Asphalt BMP?

A Porous Asphalt BMP is a BMP where the surface is composed of an **asphalt open-graded friction course (OGFC)** manufactured with larger-diameter aggregates to achieve an effective porosity of approximately 19% (by UNHSC Spec.).

This OGFC is underlain with a **subbase** composed of larger-diameter aggregates. The subbase provides the **structural support** for the OGFC and desired **storage capacity**. The thickness or depth of the subbase is dependent upon site constraints, the design storm size and the needed storage capacity.

Porous asphalt (**PA**) is perhaps somewhat unique in that it combines vehicular **functionality** with stormwater **treatment and control**. In addition, correctly designed and installed, PA has excellent potential for small and larger-scale urban settings due to the value of vehicular functionality and the likely high ‘transferability’ of the technology among practitioners.

Project Conception

Conceived after a Municipal Subcommittee meeting of the Mystic River Watershed Initiative. We had a candid technical discussion last fall and you were skeptical about the efficacy, longevity, and cost effectiveness of porous pavement. To address questions about the technology, EPA decided to pave a parking lot in the watershed as **an education and outreach project** funded under Section 104 of Clean Water Act, 33 U.S.C. 1254 (Research, Investigations, Training, and Information).

We believed a local site and a municipal partner within the watershed would provide the best opportunity to see the pavement on the ground and to provide peer-to-peer education on how it works.

Phase 1 – Preliminary Design and Cost Estimate

Phase 1 – Site Selection and Design

1. Work scope development (Jan-Feb 2012)
   - Normalize project scope to available funding → available unit costs
     - literature review
     - CT NEMO, UNH Stormwater Center
   - Identify:
     - unique or otherwise compounding cost factors, and
     - regulatory requirements
   - Scheduling and Project Coordination (incl., contract vehicle)

2. Site selection (Feb)
   - RFP announcement to Mystic River Watershed Assn. municipalities →
   - **6 proposals received**: Arlington, Cambridge, Everett, Malden, Medford and Winchester
   - Review of proposals; site visits to assess technical and logistical feasibility + intangibles
   - Preliminary site selection of **Hurd Field, Arlington, MA**
     - thoughtful and **detailed plan** for the site, including matching ‘grant’ funding for complementary rain garden
     - immediately adjacent to **Mill Brook**, an impaired waterway
     - Arlington: 41.38% Impervious
     - **high visability and public usage** on the site such as ball fields, a walking path, and Minuteman bike trail
     - **Technical**: available test pit data indicated strong likelihood for near 100% infiltration; not located in 100-year floodplain; small/light vehicular traffic
     - **Logistics**: very few utilities to negotiate; simple / open site plan

Site Selection – Hurd Field Parking Lot

Phase 1 – Preliminary Design and Cost Estimate [cont.]

Phase 1 – Site Selection and Design

3. Design and preliminary cost estimate (Mar-Jul)
   - Development of Memorandum of Understanding (MOU)
   - Due diligence for potential haz. waste contamination (MCP, 310 CMR 40.0001 et seq.)
   - Permitting:
     - **Federal:** CWA 402(p) and 40 CFR 122
       - ➢ New v. Increased Discharge
       - ➢ Construction General Permit (dewatering)
     - **State:** Stormwater Management Standards → incorporated into:
       - ➢ Wetlands Protection Act Regulations, 310 CMR 10.05(6)(k)
       - ➢ Water Quality Certification Regulations, 314 CMR 9.06(6)(a)
         incl. Mass Stormwater Handbook
       - ➢ MassDEP Waste and Recycling: 310 CMR 19.017 (Recycled Asphalt Product (RAP))
       - ➢ DigSafe : Massachusetts General Law, Chapter 82, Section 40, 40A et seq.

Additional work scope contingency: **Surface Infiltrometer Testing**

Phase 1 – Preliminary Design and Cost Estimate [cont.]

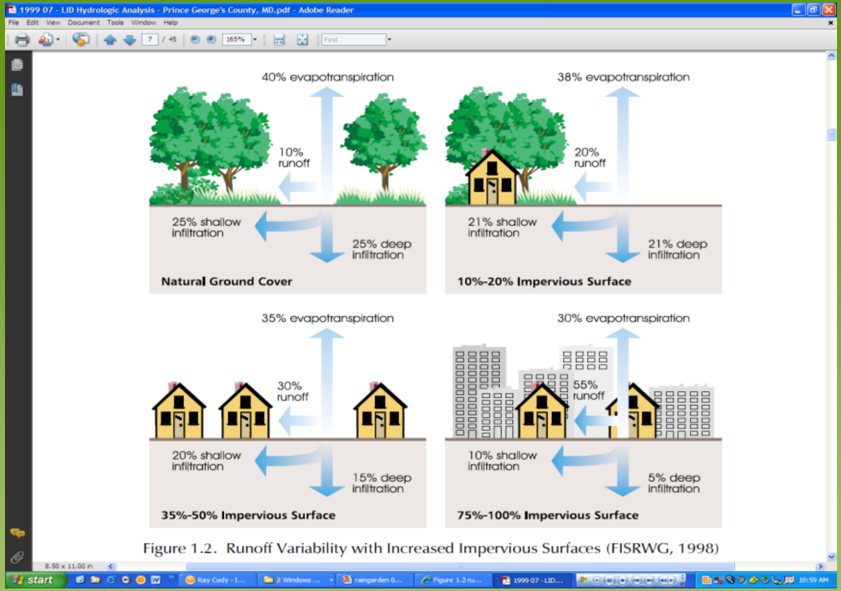
Phase 1 – Site Selection and Design

4. Anticipated Performance:

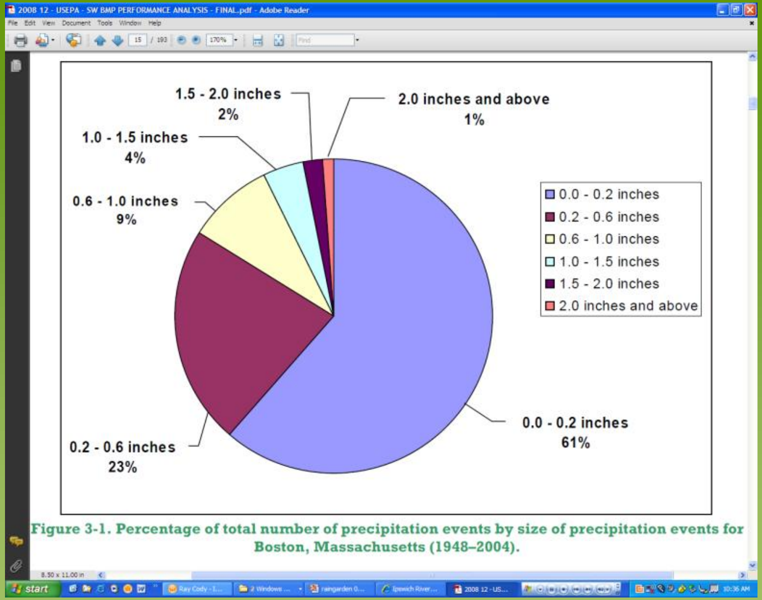
100% infiltration at minimum 1” design storm

The reality:

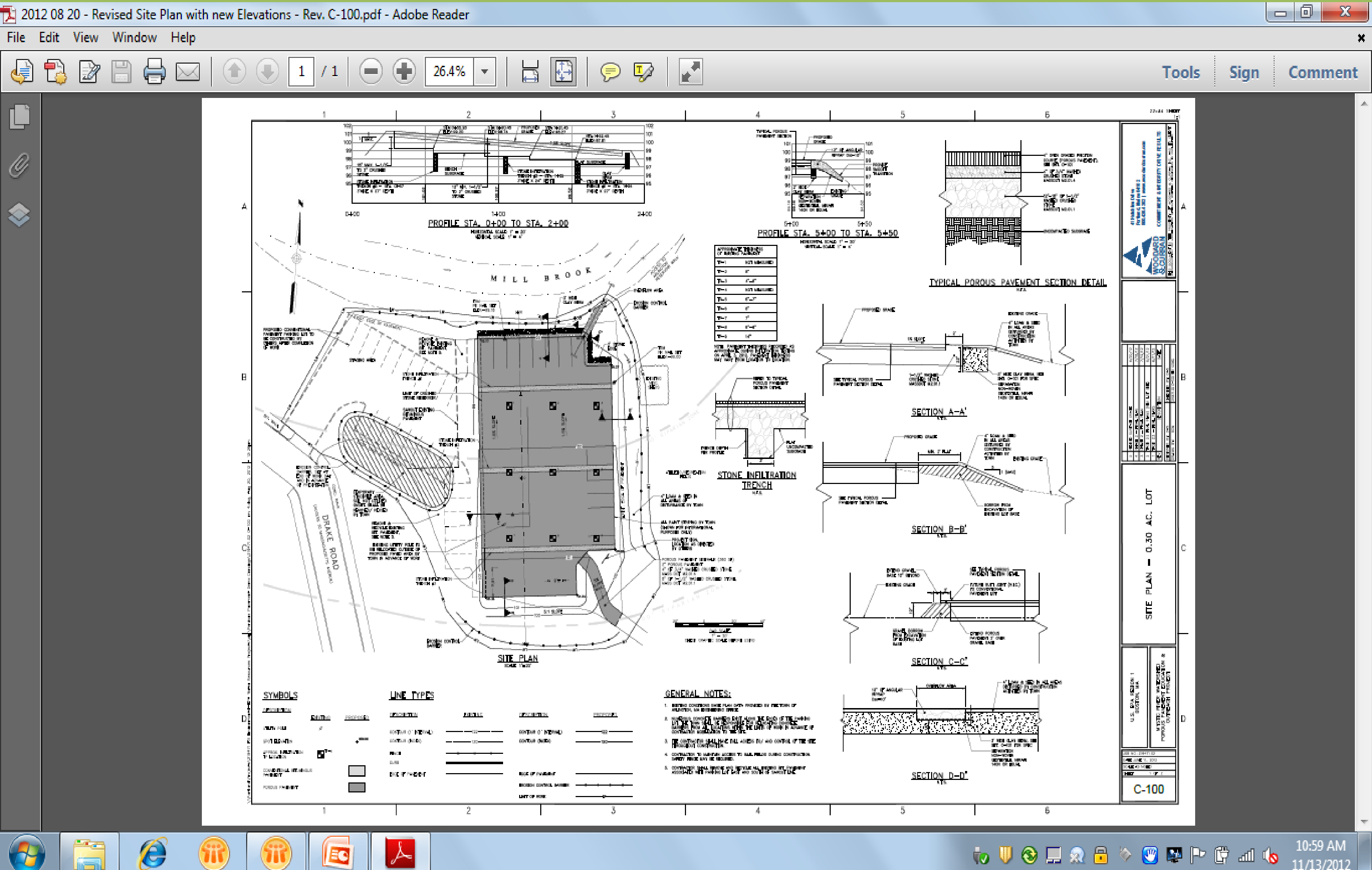
- Storage – **4.8 - 6.6 inches storage capacity**
- Infiltration – **Average: 8.25 in/hr**



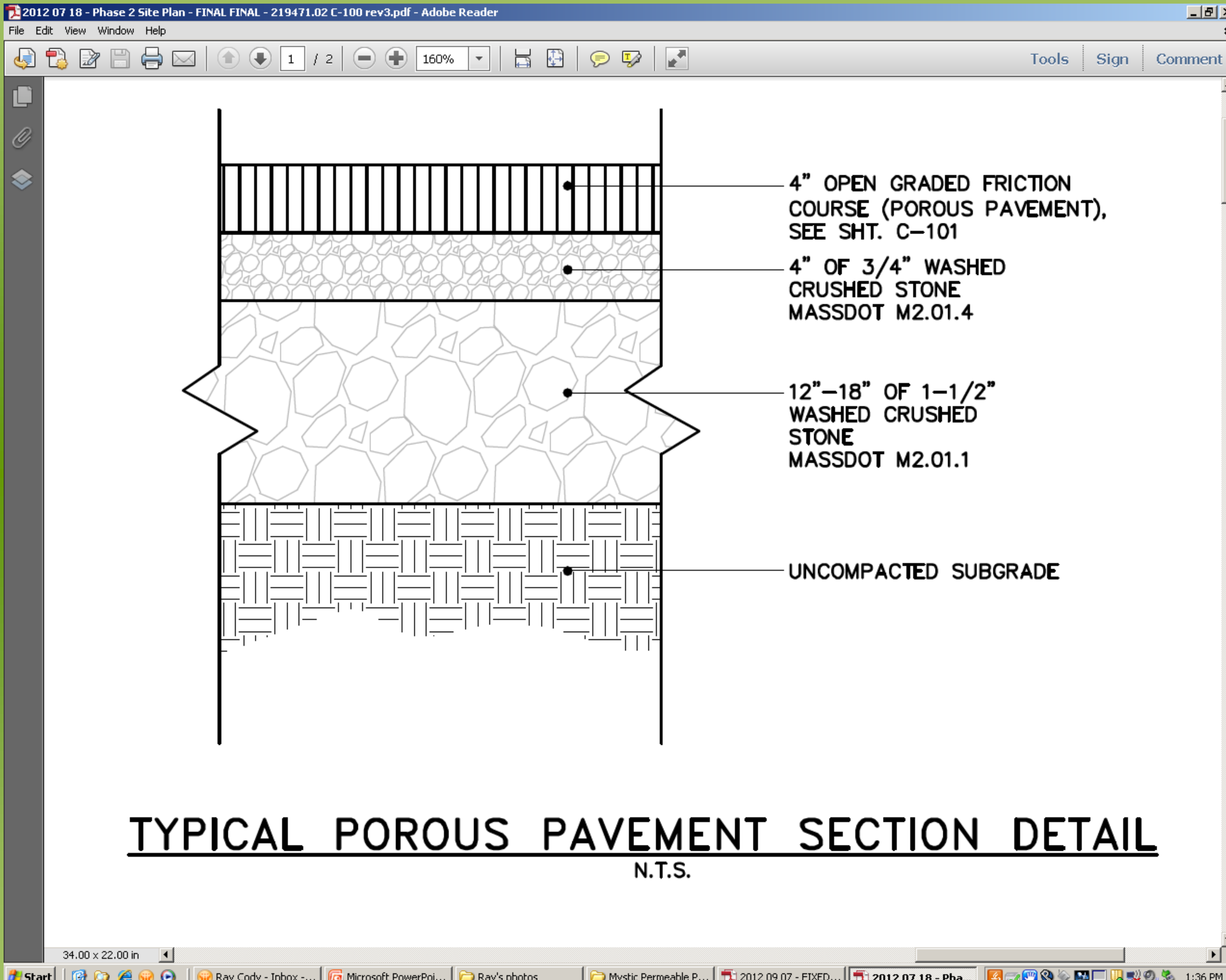
Arlington: 41.38% IC



Phase 1 – Design



Phase 1 – Design [cont.]



Phase 2 – Construction and O&M

1. **Erosion Control (Aug 8)**
   - Arlington Conservation Commission findings in **Order of Conditions**
   - **Special Condition No. 22**: “No staging or stockpiling shall take place within 100 feet of Mill Brook”.
   - Actual distance ~ 20 ft
   - Earlier communique had suggested “to the extent practicable”.
   - July 6, 2012 **clarification** Ms. Cori Beckwith, Administrator for the Arlington Conservation Commission: “[C]ondition [No. 22] is intended to discourage stockpiling in the Buffer Zone, but if it is not possible due to site constraints (explicitly described), stockpiles and staging that are properly contained by erosion/sedimentation controls may be placed nearer to the brook if Condition Number 21 above is approved by the Con Com.”
   - **Special Condition No. 21**: “Before work begins, plans for the stockpiling and staging areas and sequencing, shall be filed with the Conservation Commission for review and comment.”

Phase 2 – Erosion Control

2012 06 - Con Comm - Order of Conditions.pdf - Adobe Reader

File Edit View Window Help

1 / 15 130% Tools Sign Comment

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands
WPA Form 5 – Order of Conditions
Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

Provided by MassDEP:
91-241
MassDEP File #

eDEP Transaction #
Arlington
City/Town

A. General Information

Please note: this form has been modified with added space to accommodate the Registry of Deeds Requirements

1. From: Arlington
Conservation Commission

2. This issuance is for (check one): a. ☒ Order of Conditions b. ☐ Amended Order of Conditions

3. To: Applicant:

Wayne
a. First Name

Chouinard
b. Last Name

Engineering Division, T. of Arlingt
c. Organization

Important: When filling out forms

2012 06 - Con Comm - Order of Conditions.pdf - Adobe Reader

File Edit View Window Help

13 / 15 130% Tools Sign Comment

Bylaw ("Bylaw") that:

1. The following Resource Areas under the Act and Bylaw are present at the site: Riverfront Area and Buffer Zone. The project area is a deteriorating paved parking lot.
2. The stormwater design (porous pavement and raingarden) will decrease the runoff from the site.

<u>Additional Special and/or Bylaw Conditions</u>

20. Before work begins, erosion and sediment controls (strawbale and/or siltfence) shall be installed at the limits of the work area in such a manner as to protect the adjacent wetlands and drainage inlets.

21. Before work begins, plans for the stockpiling and staging areas and sequencing, shall be filed with the Conservation Commission for review and comment.

22. No staging or stockpiling shall take place within 100 feet of Mill Brook.

23. Prior to starting work, the applicant shall submit the names and 24 hour (emergency) phone numbers of project managers or other persons responsible for site work or mitigation.

Start 1:24 PM

Phase 2 – Erosion Control

12” Compost –filled Burlap Sock

Unknown Unknown

Phase 2 – Construction [cont.]

2. "Cut & Haul" of weathered asphalt (Aug 9-16)

- Fixed price estimate: 300 yd3
- In some places, old pavement 14" thick; average = 8-10" thick
- ~ 18 yd3 / truck
- remove and haul **300+ yd3** of weathered asphalt

Recall: BMP retrofits in urban settings may be complicated by some or all of the following factors, among others:

- **need to remove and dispose/ recycle existing pavement ("Cut & Haul");**
- need to characterize urban soils for presence of contamination;
- potential need for dewatering and/or sediment control (permitting);
- potential need for wetlands controls and permitting;
- potential need for sub-drainage network

EPA Contractors: *

- FBE Environmental, Portland, ME (Forrest Bell)
- Woodard & Curran, Portland, ME (Dave Senus, Zach Henderson, Steve Granese)
- TroCon Corporation, Woburn, MA (Paul, Chuck and Mark Troisi)

* not an endorsement.

Phase 2 – Cut & Haul

Phase 2 – Construction [cont.]

3. Excavation and Stockpiling (Aug 17-24)

- Fixed price estimate: 300 yd3
- Survey elevations and bench steps
- **Design modification:** 3 infiltration interceptor trenches
- **Unknown unknowns:**
  - boulders;
  - elevation re-design → schedule readjustment

Elevations and Benching

Challenging native soil composition containing cobbles, stones, boulders

Phase 2 – Construction [cont.]

One of many boulders

Cutting Infiltration Trenches

Phase 2 – Construction [cont.]

4. Base Aggregate (Aug 27-31)

- 650 yd3 of 1.5 - 2” crushed stone (AASHTO 3) (washed)
- 170 yd3 of ¾” crushed stone (AASHTO 57) (washed)

Note on **crushed** and **washed**

1.5 – 2” Crushed Stone

Backfilling Infiltration Trenches

Phase 2 – Construction [cont.]

1.5 – 2” Crushed Stone

¾” Crushed Stone Management and Placement

Phase 2 – Construction [cont.]

Grading Stone to Benchmarks

¾" Crushed Stone Grading

Phase 2 – Construction [cont.]

5. Open-graded Friction Course (OGFC) Production (Sept 8)

- P.K. Keating Batch Plant, Dracut, MA *

Batch Plant (Truck Queue)

Control Room

* not an endorsement

Phase 2 – Construction [cont.]

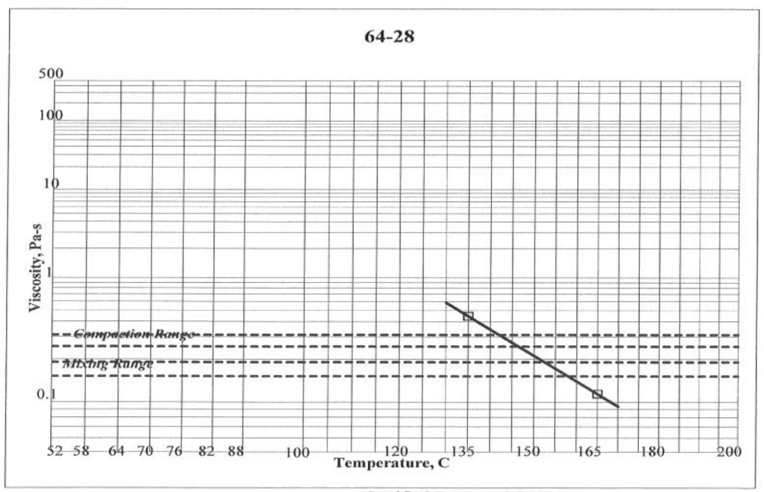
Pike Industries Inc
Central Laboratory
Belmont, NH

Pike Industries, Inc. Date: 8/28/2012
Avery Lane. Terminal, Newington, NH Tank 5

Binder:	**64-28**	Lot No.:	**64-28/12/14**
Temp (C)	Viscosity (cp)	Mixing Temperature Range, C	152 - 158
135	**445**	Compaction Temperature Range, C	142 - 146
165	**113**		

Specific Gravity @ 60 F (15.6 C) @ 77 F (25 C)

DSR (Do not enter if using two RV measurements)
Temperature, C
G*/sin d (kPa)



Certified By: Peter Moore

Polymer Binder Specs

QA/QC –

- **viscosity v. temp** – narrow range (30°C) b/t mix and compaction
- **“draindown”** – adverse condition due to poor mix where binder ‘drains’ and ‘puddles’ at base of OGFC creating impervious layer (not good)
- **compaction**

Project line item for
3rd party QA/QC, lab testing

Phase 2 – Construction [cont.]

Polyester Fibers (large diameter)

Rub-R-Road R-504 Latex Compound

Phase 2 – Construction [cont.]

6. Multiple Lift OGFC Installation (Sept 8)

- P.J. Albert, Fitchburg, MA *
- Prior experience with OGFC Installation

End of 1st Lift; OGFC sticking to drums (little soap and water spray fixes problem)

Begin 2nd Lift

* - not an endorsement

Phase 2 – Construction [cont.]

2nd Lift

2nd Lift [cont.]

Phase 2 – Construction [cont.]

Finish Compaction / Rolling

Phase 2 – Construction [cont.]

Photo taken during rainstorm showing comparative performance of traditional pavement (left) and porous pavement (right)

Phase 2 – O&M

O&M:

- **Mass SW Standard #7**: Redevelopment Project → Requirement: Long-term O&M Plan

- General Requirements and Principles:
  - Regenerative Air or Vacuum-assisted Dry Sweeper only (**Do <u>not</u> use broom sweeper**)
  - Sweep Freq.:
    - UNHSC: 2-4x per year
    - MassDEP: 12x per year
    - **Project: 4x per year recommended.** Minimum: late fall, and spring (after winter and/or pollen drop)
  - Light to medium vehicular traffic only; design to control traffic flow
  - Winter Maintenance:
    - **No sanding**
    - Chloride de-icer → ~25% of typ. application loading due to no re-freezing

Sweeping Contractor: *

Millenium
393 Mystic Avenue
Medford, MA
781/395-1200
http://powersweeping.com/index.html

* - not an endorsement

Project Unit Cost Analysis

Project Unit Costs					
	acre			0.3	
	ft2			13,068	
	Construction		$	8.51	$/ft2
	Ancillary		$	0.96	
	Admin, Construction Mngt, O&M		$	3.34	
	TOTAL PHASE 2: Construction , Ancillary and Admin/Mngt & O&M		$	12.81	
	TOTAL PHASES 1 and 2		$	15.23	
Comparable Unit Costs					
Project Name	**Location**				
Bayside Trail Pervious Concrete	Portland, ME		$	11.83	$/ft2
University of Southern Maine - Pervious Asphal	Portland, ME		$	9.7	
Avesta Housing Pervious Concrete	Portland, ME		$	10.67	
Freeport Community Center - Pervious Asphalt	Freeport, ME		$	13	
Maine Mall Road - Pervious Asphalt	South Portland, ME		$	8.5	
Iuniversity of New Hampshire - Porous Asphalt	Durham, NH		$	8	
Greenland Meadows	Greenland, NH		$	14	
		Min		8	
		Max		14	
		Avg		10.8	
		Median		10.7	

Explanation of Project Unit Costs

Higher-end Unit Costs b/c:

- **Design Premium**
  - OGFC mix and anecdotal performance heresay
  - Need to ‘Get it Right’
- **Fixed price** contract vehicle
- **Scale** (demonstration v. larger-scale new / re-development)
- **UNHSC polymer-spec** asphalt mix and **full-scale QA/QC**
- 3rd Party QA/QC
- **Retrofit** (cut and haul; negotiate utilities)

Counterbalancing Project Offsets:

- **100% Infiltration** → No need for:
  - subdrainage network and
  - tie-in to MS4 and/or new outfall and stream bank stabilization
- **Cost sharing** with Municipality:
  - Utility relocation
  - Grading, loaming, seeding (aesthetics)
  - Pavement striping / hatching
- **Simple Retrofit** (e.g., uncomplicated site plan / existing utility grid)

NOTE: No need to consider comparative infrastructure offsets in this case

Conclusions

- Practitioners (e.g., muni's) should be able to **implement more cost-effectively** assuming capacity for in-house design and construct (EPA premium to guarantee design / performance)

- **Key elements:**
  - Proper **site selection** (e.g., soil permeability, avoid 100 yr floodplains)
  - **OGFC mix** and temperature (e.g., polymer mix; avoid "draindown")
  - **OGFC installation** (multiple "lifts", temperature)

- Cost analysis should consider comparative **infrastructure offsets**

- Technology needs **practitioner understanding / acceptance** (e.g., asphalt mix composition = outreach) → technology would benefit by more widespread / routine application

- Excellent potential for use in urban environments, but **potential barriers** include:
  - Cost
  - Potential complexity
  - Pre-design - good understanding of soil mechanics / engineering (if incorrectly situated, performance and reputation suffer)
  - Long-term performance and O&M

Selected References

- UNH Stormwater Center, UNHSC Design Specifications for Porous Asphalt Pavement and Infiltration Beds (Rev. October 2009) **http://www.unh.edu/unhsc/sites/unh.edu.unhsc/files/pubs_specs_info/unhsc_pa_spec_10_09.pdf**

- UConn Center for Land Use Education and Research (CLEAR), Permeable Pavements for Stormwater Control, webinar (Sept 2011) **http://clear.uconn.edu/webinars/permeable_pavement_webinar.pdf**

- Stormwater, Porous Asphalt Pavement With Recharge Beds: 20 Years and Still Working (April 2003) **http://www.stormh2o.com/SW/Articles/Porous_Asphalt_Pavement_With_Recharge_Beds_20_Year_228.aspx**

- National Asphalt Pavement Association (NAPA), Porous Asphalt Pavements for Stormwater Management, Design Construction and Maintenance Guide, Information Series 131, **http://store.asphaltpavement.org/index.php?productID=179**

- MassDEP:
  - Regulations and Standards: Water Quality - 310 CMR 9.06(6)(a) and Wetlands Protection Act, 310 CMR **10.05(6)(k) http://www.mass.gov/dep/water/laws/regulati.htm#wqual**
  - Policies and Guidance: MA Stormwater Handbook, Vol. 1 and 2 **http://www.mass.gov/dep/water/laws/policies.htm#storm**