# POROUS ASPHALT: DESIGN AND CONSTRUCTION

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# POROUS ASPHALT: DESIGN AND CONSTRUCTION

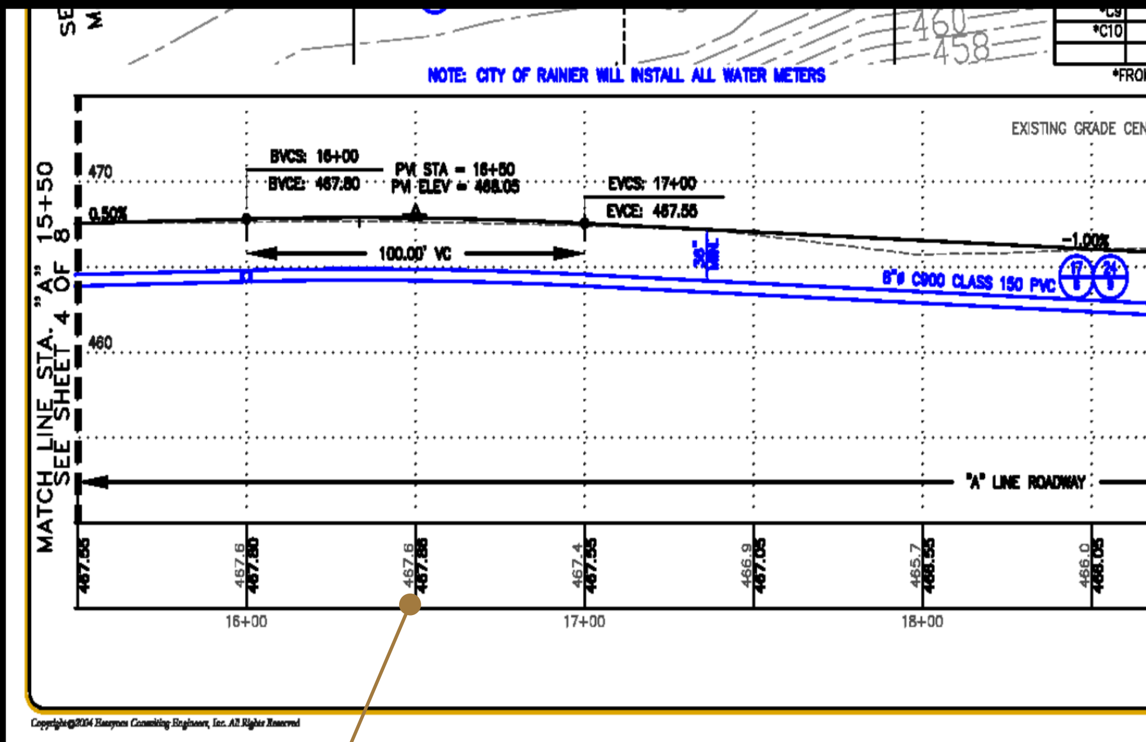
- Site Design Considerations
- Materials and Specifications
- Construction Sequencing
- Performance of Permeable Asphalt
- Emerging Green Technologies for Asphalt
- City of Puyallup Completed & Upcoming Projects
- Questions

# POROUS ASPHALT: DESIGN AND PERFORMANCE GOALS

- Properly integrated into site design
- Permeable wearing course
- Pavement Section designed for saturated subgrade
- Pavement designed to infiltrate 100% of rainfall
- Pavement depth sufficient to eliminate frost heave
- Durable wearing course
- Constructible Design (materials, sequencing)
- Prevents or accounts for surface water run-on
- Provides drainage redundancy (inlet, outlet)
- Addresses potential storm water flows in subgrade/trenches

# POROUS ASPHALT: SITE DESIGN

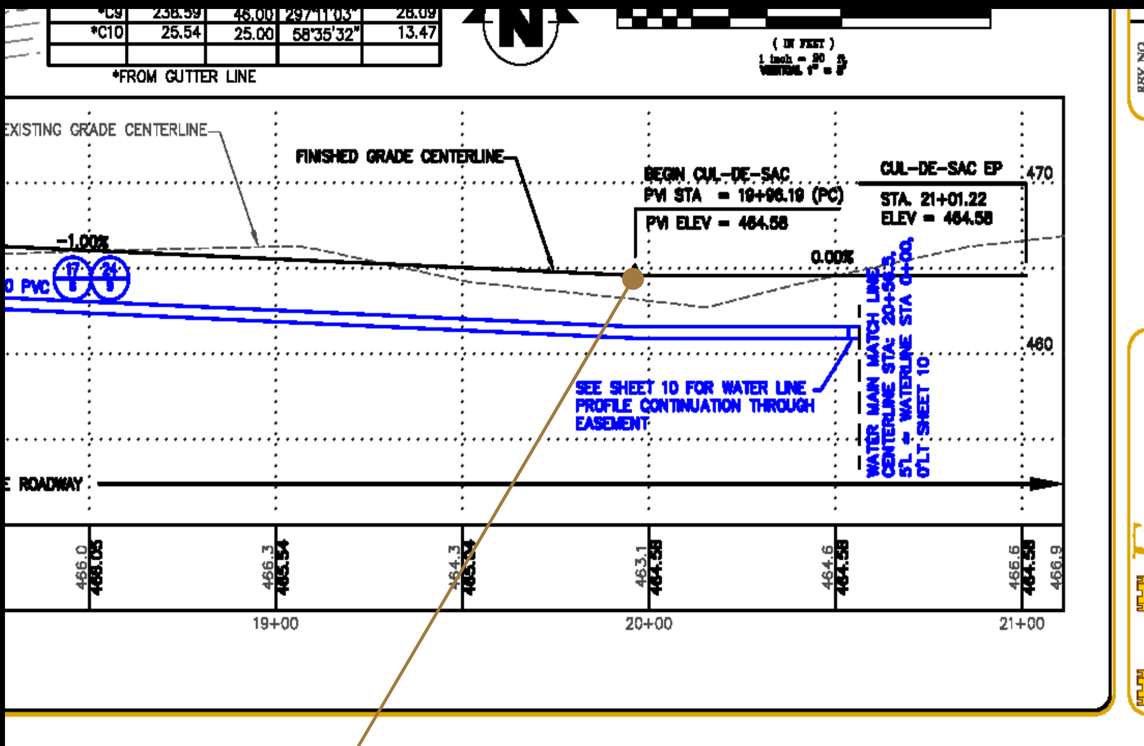
1. Minimize fill areas
2. Prevent run-on to maximum extent feasible
3. For <u>subgrade</u> slopes 2-6% address potential subsurface flows
4. Standard range for acceptable infiltration ponds not applicable, can do much less (0.1"/hour will work most times)
5. Provide redundancy for storm water.
6. Porous asphalt is a good product for local roads, parking lots and trails. It has also been used in limited freeway applications such as Arizona SR-87. This road was still in use after 20 years of service.




Finished grades slighlty above existing

# 1. MINIMIZE FILL
# 2. PREVENT RUN-ON

- To extent possible, keep roadway section in cut, but slightly above surrounding ground
- Where fill is required, use permeable materials; extended reservoir course, free draining gravel borrow, etc.




Consider Overflow Relief at Low Points

# 5. PROVIDE REDUNDANCY

- At low points on the project consider installing catch basins or other means to allow water to flow into the subgrade.
- Provide alternate ways for water to enter reservoir course (and to intercept potential run-on).
- Take advantage of porous asphalt's properties: note flat cul-de-sac in design.

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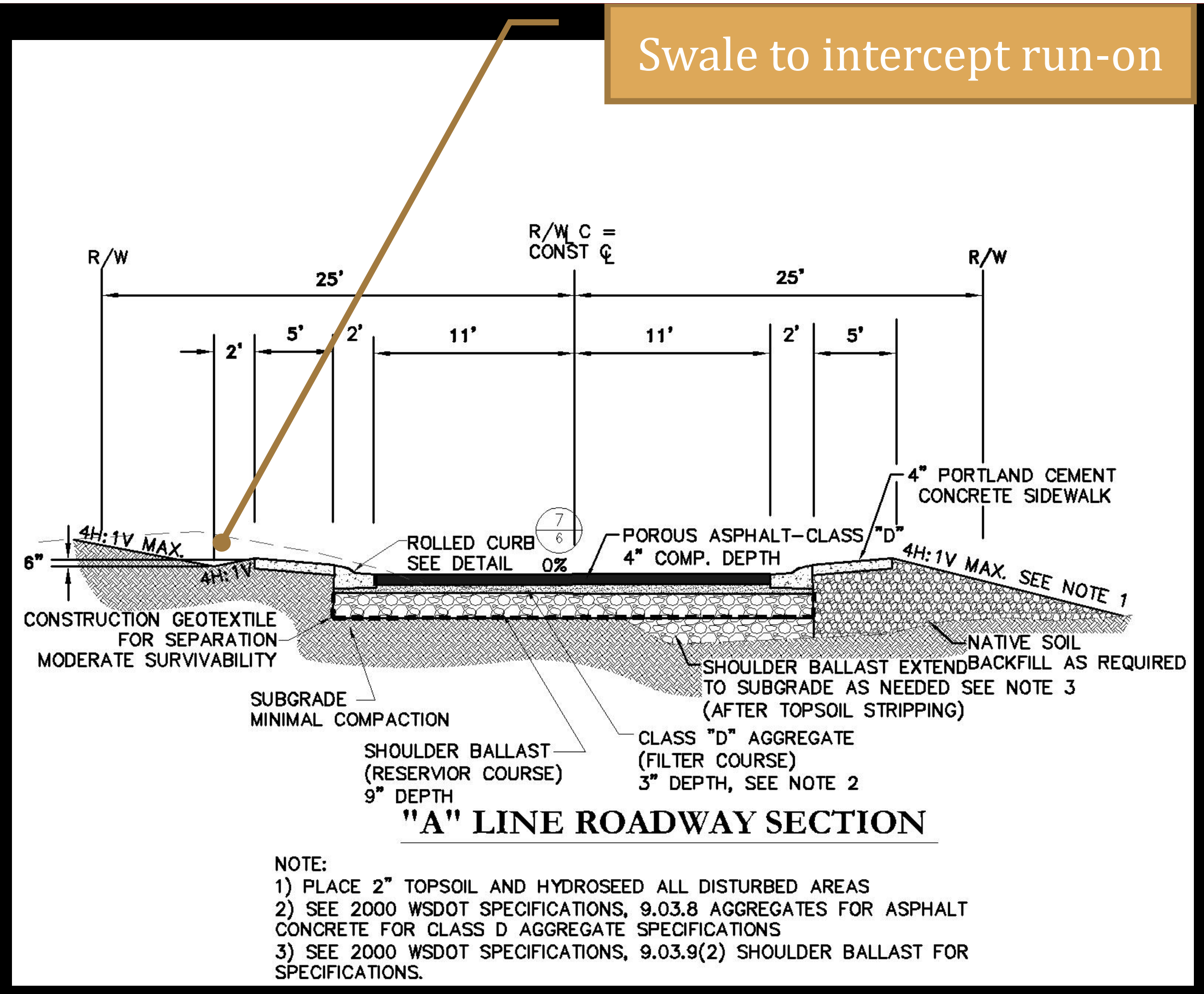



# 2. PREVENT RUN-ON

- Swales can intercept potential run-on from higher surrounding areas.
- Note flat road section-can reduce or eliminate crown with porous pavement
- Would recommend barrier curb (no gutter) for current design
- Material specifications listed are outdated-2004 project

# POROUS ASPHALT: SITE DESIGN

3. For subgrade slopes 2-6% address potential subsurface flows
   - Construct check dams to halt flows and allow infiltration
   - Stair step excavation of subgrade (easier on parking lot projects than roads)
   - For all projects, consider placing trench dams in utility trenches to prevent undesirable piping of water off site.


# 6. POROUS ASPHALT IS A GOOD PRODUCT FOR LOCAL ROADS, PARKING LOTS AND TRAILS.

Conclusions of Final Report for SR-87 project:

- "The porous pavement test section has performed satisfactorily for five years. Although a slight decrease in the infiltration rate has occurred, both the infiltration rate and the storage capacity are above the design values."
- "Visual observation during rain storm has shown that the surface of the porous pavement section does not include sheet flow. This provides a marked difference in stripe delineation and pavement glare during night time inclement weather driving compared to conventional pavement."

# POROUS ASPHALT: SITE DESIGN

6. Porous asphalt is a good product for local roads, parking lots and trails.

- Parking lots are tough test-low speed turning motions
- Resist temptation to mix porous with impermeable pavements in same section
- Depth of section can be an issue on high volume roads-consider pervious concrete to avoid existing utilities and for life cycle cost advantages
- Good for local roads and trails

# POROUS ASPHALT MIX DESIGN

- Committee is working on a WSDOT format specification for porous asphalt (Jessica Knickerbocker, City of Tacoma lead)
- Final product is not yet ready for publication

# POROUS ASPHALT MIX DESIGN

- Asphalt materials will comply with WSDOT specifications for Class ½ HMA PG 70-22 (Polymer modified) with the following modifications:
- Asphalt cement shall be between 6.0% and 7.0% by total weight. Test for drain down and void content at 75 gyrations at 6, 6.5 and 7.0, use highest percentage that passes both tests. Use of fibers MAY allow for higher asphalt content.
- NAPA IS-115 is good starting point for aggregate specification.

| <u>Sieve</u> | <u>Percent Passing</u> |
|---|---|
| ¾” | 100 |
| ½” | 85-100 |
| 3/8” | 55-75 |
| No. 4 | 10-25 |
| No. 8 | 5-10 |
| No. 40 | |
| No. 200 | 2-4 |
| | |

# NAPA IS-155 GRADATION

- Good, general purpose aggregate specification for porous pavement
- Other aggregates can be acceptable, both larger and smaller.
- Consider requiring two face fracture requirement for better binding-offsets lack of fines.
- Some amount of fines is good for absorbing asphalt (get higher %) and thickening binder

**Contractor Aggregate Structure and Aggregate Test Data**

| Material: | 3/8"- #4 | #4 - #8 Sand | #4 - 0 | #8 - #30 Sand | | Combined Gradation | Specification |
|---|---|---|---|---|---|---|---|
| Source: | B-335 | B-335 | B-335 | B-335 | | | |
| Ratio: | 68% | 14% | 12% | 6% | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| 1/2" | 100.0 | 100.0 | 100.0 | 100.0 | | 100 | 90-100 |
| 3/8" | 99.0 | 100.0 | 100.0 | 100.0 | | 99 | 70-90 |
| U.S. No. 4 | 10.0 | 73.0 | 89.0 | 100.0 | | 34 | 20-40 |
| U.S. No. 8 | 2.0 | 6.0 | 54.0 | 75.0 | | 13 | 10-20 |
| U.S. No. 16 | 1.8 | 3.0 | 35.8 | 46.0 | | 9 | |
| U.S. No. 30 | 1.5 | 1.0 | 24.3 | 22.0 | | 5 | (No. 40: 0-8) |
| U.S. No. 50 | 1.0 | 0.6 | 17.2 | 4.0 | | 3 | |
| U.S. No. 100 | 0.9 | 0.4 | 13.5 | 1.0 | | 2 | |
| U.S. No. 200 | 0.7 | 0.2 | 10.5 | 0.5 | | 1.8 | 0-3 |

Page 1 of 2

Supplied material smaller than spec, but met voids ratio easily

# ALTERNATE GRADATION

- Good, general purpose aggregate specification for porous pavement
- Other aggregates can be acceptable, both larger and smaller.
- Consider requiring two face fracture requirement for better binding-offsets lack of fines.
- Some amount of fines is good for absorbing asphalt (get higher %) and thickening binder

Sample No. : 2

Sample of : 3/4" Clean

Sampled By : Joe Rolland

Tested By : Joe Rolland

Date of Sample : 1/19/2011

Time of Sample : 9:15 AM

Quantity Represented :

Quantity to Date :

| | |
|---|---|
| Sample wet Wt. | 1432.6 |
| Sample dry Wt. | 1418.9 |
| Moisture | 1.0% |
| Sample Washed Wt. | 1402.1 |
| % p200 Washed out | 1.2% |

Sand Equivalent Average

| Sieve Size | WT 1st Shake | WT 2nd Shake | Total Wt. Retained | Weight on Sieve | Ind % Retained | Total % Retained | Total % Passing | Specification LSL to USL |
|---|---|---|---|---|---|---|---|---|
| 3" | | | | | | | | |
| 2 1/2" | | | | | | | | |
| 2" | | | | | | | | |
| 1 3/4" | | | | | | | | |
| 1 1/2" | | | | | | | | |
| 1 1/4" | | | | | | | | |
| 1" | | | | | | | | |
| 7/8 | | | | | | | | |
| 3/4 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 100 | |
| 5/8 | 18.1 | | 18.1 | 18.1 | 1.3 | 1.3 | 99 | |
| 1/2 | 372.0 | | 372.0 | 354.0 | 24.9 | 26.2 | 74 | |
| 7/16 | | | | | | | | |
| 3/8 | 1060.0 | | 1060.0 | 688.0 | 49.5 | 74.7 | 25 | |
| 1/4 | | | | | | | | |
| #4 | 1388.1 | | 1388.1 | 328.1 | 23.1 | 97.8 | 2 | |
| #8 | | | | | | | | |
| #10 | | | | | | | | |
| #16 | | | | | | | | |
| #30 | | | | | | | | |

Nearly 50% of material between ½" and 3/8"

# GRADATION MISCUES

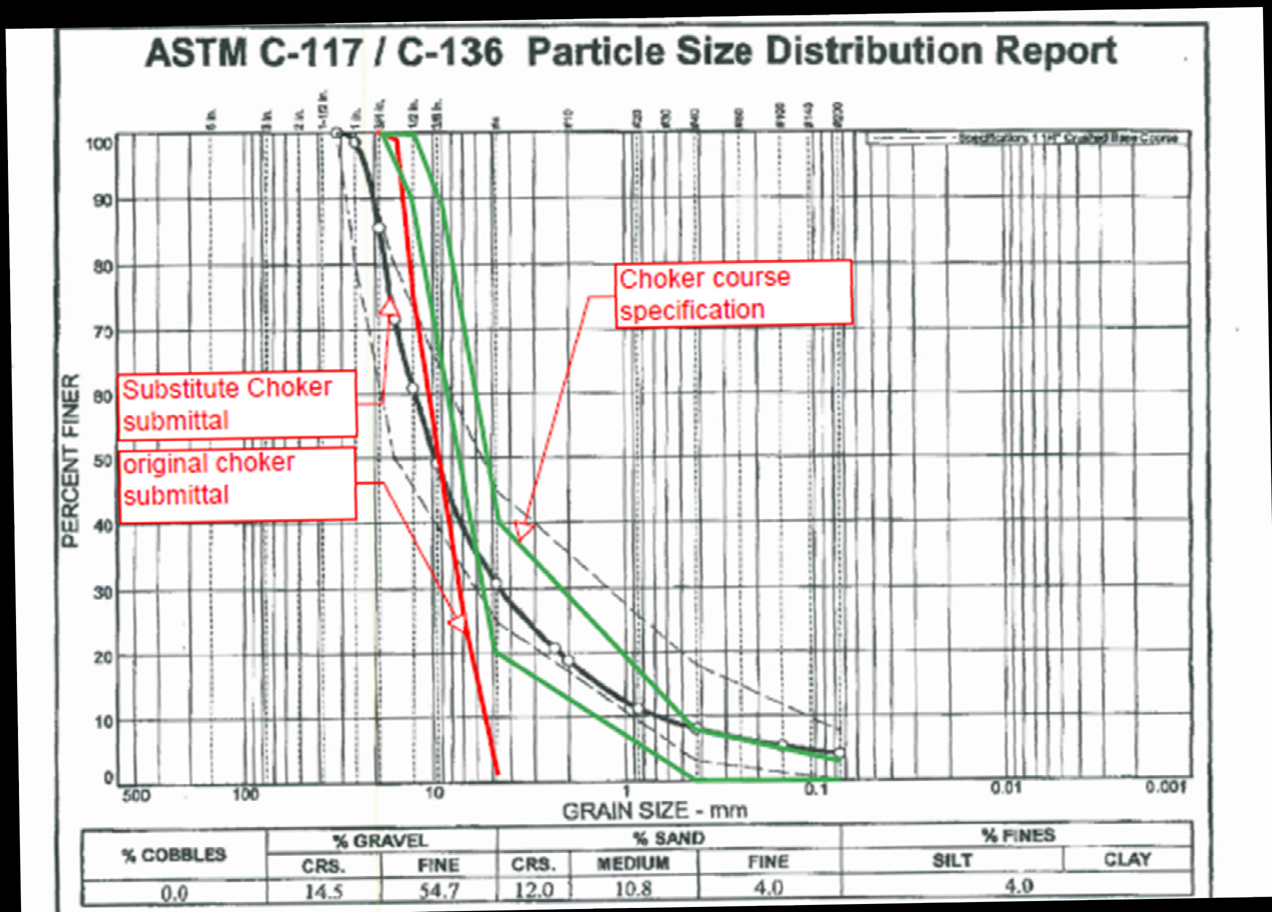
- Watch for too much aggregate of one size (poorly graded)
- Not enough fracture face
- Too little voids (too much fines)


# GRADATION MISCUES

- Result of gradation miscue (poorly graded) on choker course
- Rutting, lack of interlocking

# GRADATION MISCUES

- Correction-added to existing poorly graded material correctly graded material.
- Rutting greatly reduced




# AGGREGATE SPECIFICATION- CHART

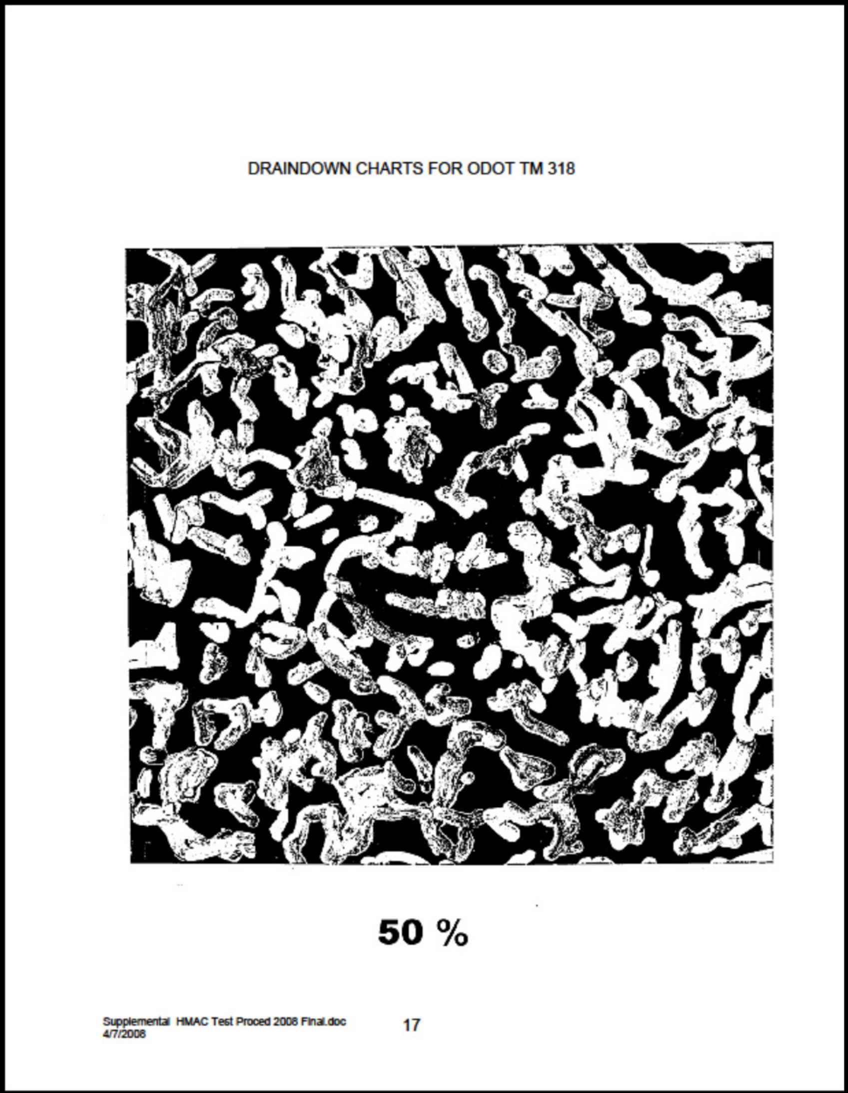
- Good way to see visually how gradation should look
- Original, poorly graded aggregate is near vertical line
- Replacement material has curve that emulates specification curve

# POROUS ASPHALT MIX DESIGN

- Air Voids 16-25% (ASTM D3203)
- Drain Down-ASTM D6390-05, 0.3% maximum @ 15° above design mix temperature
- ODOT has alternate ODOT TM 318 Drain Down Test-subjective
  - Consider adding fiber to mix design
- All requirements should be provided with mix design from supplier.

# ASTM D6390-05 DRAIN DOWN TEST

- Constituents mixed by hand per mix design
- Placed in basket with no compaction
- Cooked in oven at prescribed temperature
- Material that drops to plate weighed and compared to 0.3% standard
- Not necessarily representative of field conditions


DRAINDOWN CHARTS FOR ODOT TM 318

50 %

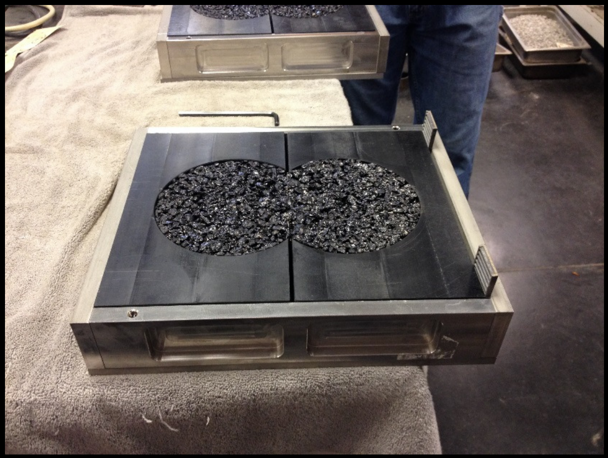
Supplemental HMAC Test Proced 2008 Final.doc 17
4/7/2008

# ODOT TM 318 DRAIN DOWN TEST

- Process similar to ASTM test- but places paper directly under sample
- Tester interprets between several example percentages of drain down pictures (see picture this page).
- Like ASTM test, not likely representative of field conditions, also subjective

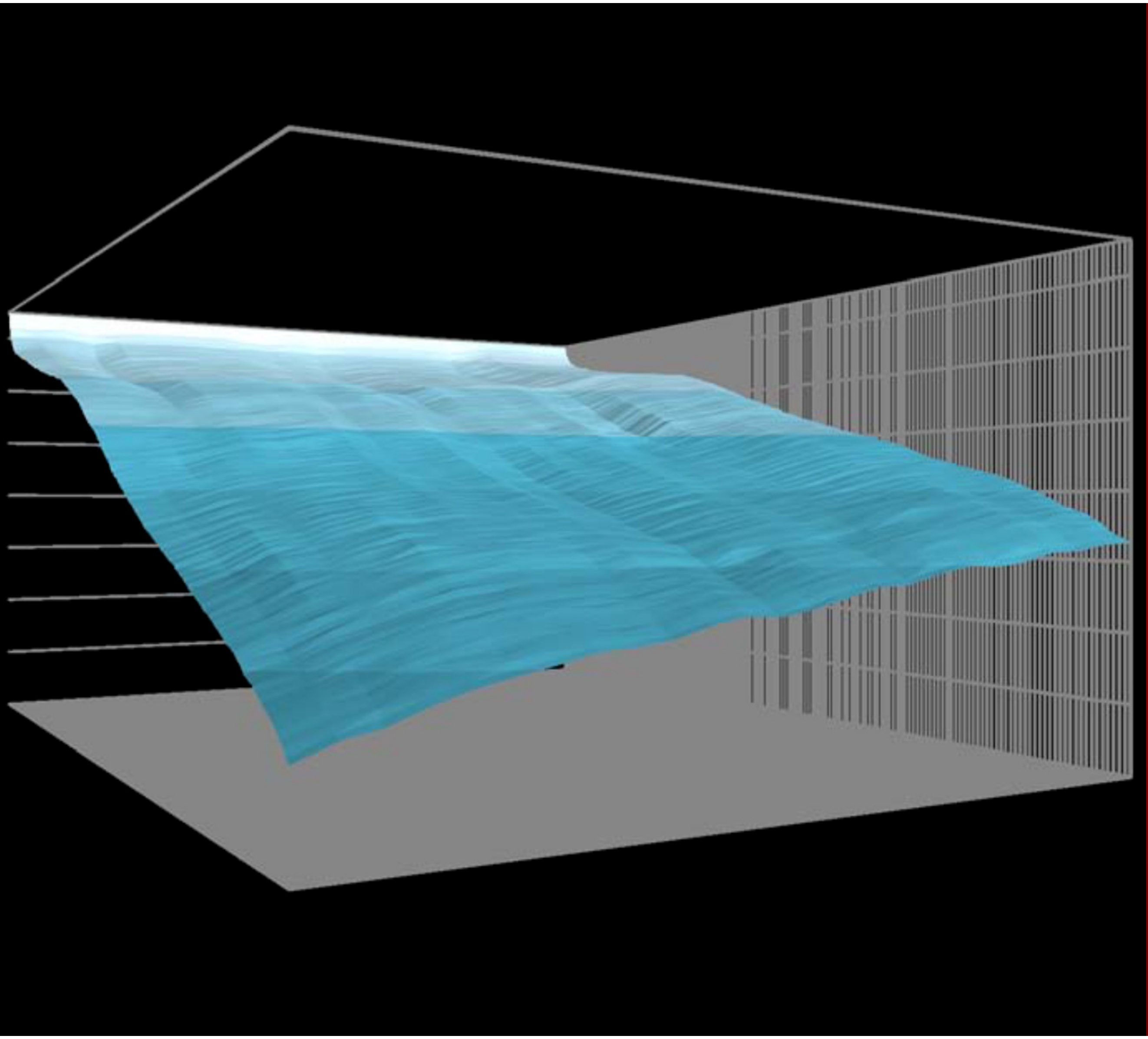
# POROUS ASPHALT MIX DESIGN

- Anti-stripping agent should be used if supplier normally uses anti-stripping in they HMA mixes.
- Should not exceed 1% by weight of aggregates
- If having difficulty meeting minimum 6% asphalt in mix design due to drain down:
  - Consider increasing fines in aggregate-but watch void ratio
  - Consider adding fiber to mix design
- Intent of minimum asphalt content, polymer modified PG 70-22 is to provide full and durable coating of aggregate.



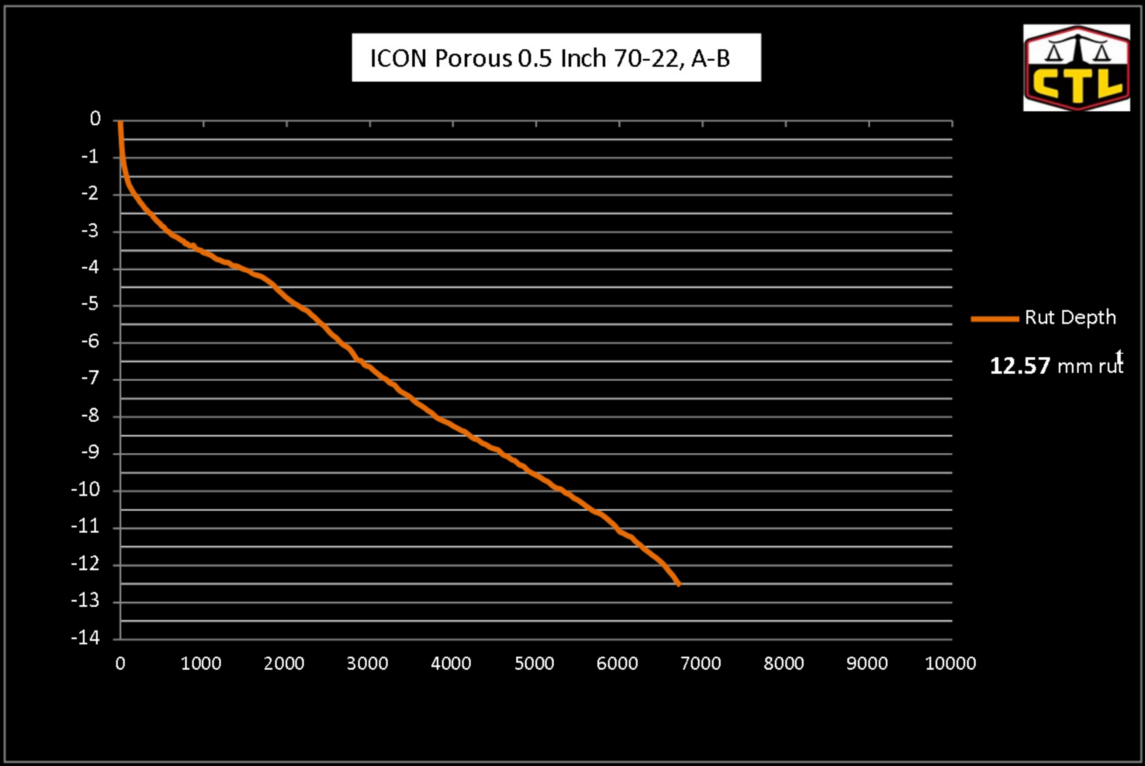
# HAMBURG ANTI-STRIPPING TEST

- Replaces previous tests used by WSDOT for HMA
- Validity on PHMA yet to be determined
- Single test run by City of Puyallup indicated failure at 6,750 passes-less than 10,000 required for HMA
- Failure did not appear to be striping but shear.



# HAMBURG ANTI-STRIPPING TEST

- 3-D profile of test area

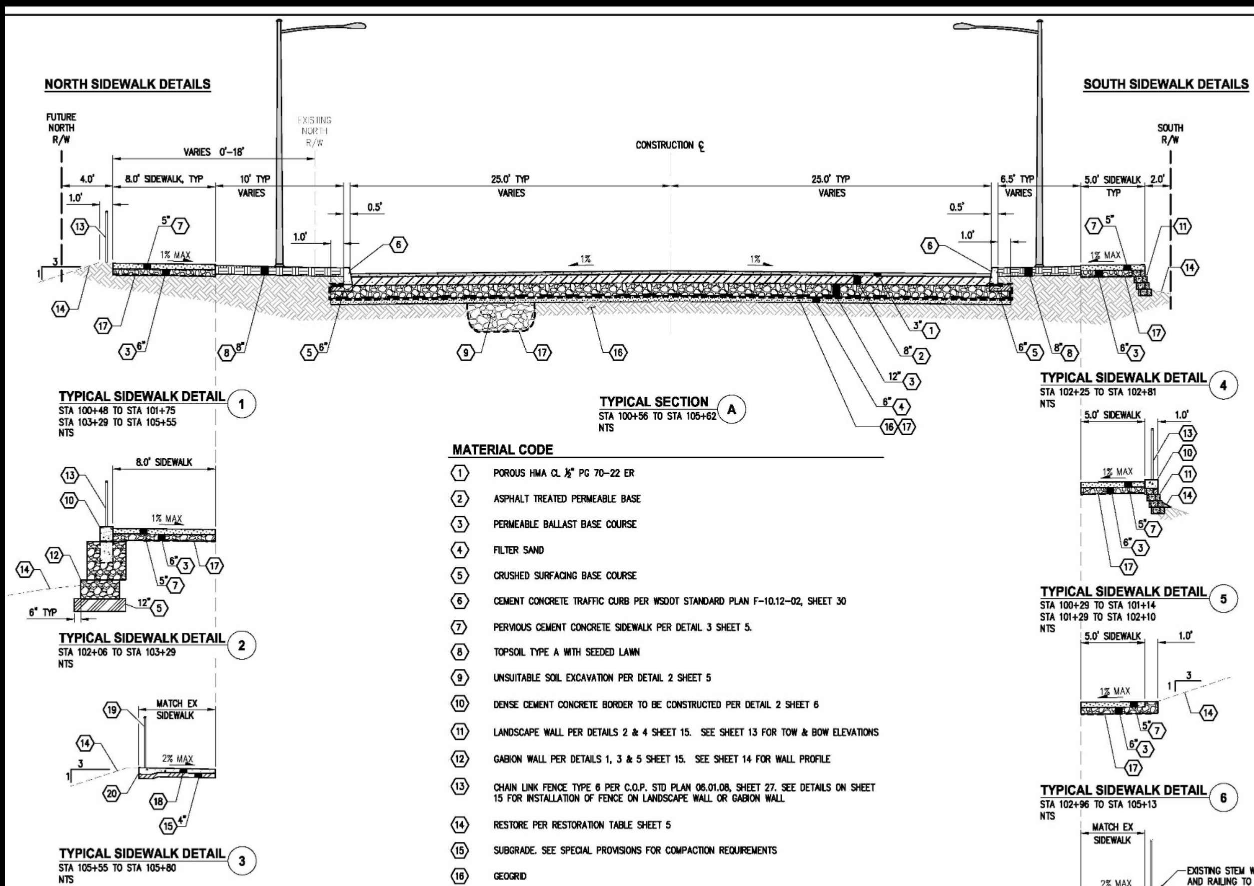



# HAMBURG ANTI-STRIPPING TEST

- Graph of rut depth vs passes
- No inflection point indicates stripping is not failure cause
- Could try to add more fines to stiffen mix, see if that performs better
- Could do more field tests with different compaction efforts, take cores, compare density, asphalt content and consistency through core.
- HMA standard varies based on asphalt grade but is generally 10,000 passes before 12.5 mm rutting

# POROUS ASPHALT SECTION DESIGN

- Starting from bottom of pavement section up:
  - Non-woven geotextile fabric
  - Non-woven geotextile fabric has been shown to provide surface for microbes which will decompose hydrocarbons
  - Not likely to clog-AOS should be similar to soils underneath, and most particles are captured in first couple of millimeters of pavement
  - Not a requirement for structural section-does not provide significant strength
  - Need structural strength or want reduced section, consider geo-grid




# GEOGRID

- Check manufacturer's recommendations for placement
- Can reduce overall section thickness
- Section shown is proposed WSU Puyallup LID Frontage Phase 1 section

**Table 3: Geotextile for separation or soil stabilization.**

| Geotextile Property | ASTM Test Method[2] | Geotextile Property Requirements[1] | | | |
|---|---|---|---|---|---|
| | | Separation | | Soil Stabilization | |
| | | Woven | Nonwoven | Woven | Nonwoven |
| AOS | D 4751 | U.S. No. 30 max. | | U.S. No. 40 max. | |
| Water Permittivity | D 4491 | 0.02 $sec^{-1}$ min. | | 0.10 $sec^{-1}$ min. | |
| Grab Tensile Strength, in machine and x-machine direction | D 4632 | 250 lb min. | 160 lb min. | 315 lb min. | 200 lb min. |
| Grab Failure Strain, in machine and x-machine direction | D 4632 | < 50% | ≥ 50% | < 50% | ≥ 50% |
| Seam Breaking Strength | D 4632[3] | 220 lb min. | 140 lb min. | 270 lb min. | 180 lb min. |
| Puncture Resistance | D 6241 | 495 lb min. | 310 lb min. | 620 lb min. | 430 lb min. |
| Tear Strength, in machine and x-machine direction | D 4533 | 80 lb min. | 50 lb min. | 112 lb min. | 79 lb min. |
| Ultraviolet (UV) Radiation Stability | D 4355 | 50% strength retained min., after 500 hours in xenon arc device | | | |

# GEOTEXTILE

Reference:

Section 9-33.2(1) of WSDOT 2012 Standard Specifications

# POROUS ASPHALT SECTION DESIGN

- Reservoir Section
  - Looking for 30-40% voids-storage space for water to allow infiltration
  - Want readily available rock with few fines
  - Want rock that is angular, of varying sizes to maximize interlock-provides a stable working surface for construction

**9-03.9(2) Permeable Ballast**

Permeable ballast shall meet the requirements of Section 9-03.9(1) for ballast except for the following special requirements. The grading and quality requirements are:

| Sieve Size | Percent Passing |
|---|---|
| 2½″ | 100 |
| 2″ | 65-100 |
| ¾″ | 40-80 |
| No. 4 | 5 max. |
| No. 100 | 0-2 |
| % Fracture | 75 min. |

All percentages are by weight. The sand equivalent value and dust ratio requirements do not apply. The fracture requirement shall be at least one fractured face and will apply the combined aggregate retained on the No. 4 sieve in accordance with FOP for AASHTO TP 61

# RESERVOIR COURSE

Reference:

Section 9-03.9(2) of WSDOT 2012 Standard Specifications

- Should be clean, less than 2% passing #100 as shown is good.
- 60-100% between 2" to ¾" allows for large void space.
- 75% fracture requirement is good for interlock, but requiring 2 face fracture, if available is better.

# RESERVOIR COURSE

- Material in picture passed 75% fracture requirements, but was difficult to work with.

# ALTERNATE RESERVOIR COURSE

- Mix used by City of Puyallup is blend developed by PW Streets. Uses a standard 1-1/4” CSBC rock blended with #57 rock.
- CSBC had void content of 12.5%
- #57 rock had void content of 41.3%
- Staff mixes the rock manually at 1:1 ratio
- Used as reservoir course and for porous gravel alleys, shoulders
- Can be used as single rock under porous asphalt, no choker course required-workable surface for pavers

# CHOKER COURSE

- If using larger diameter permeable ballast for reservoir course, there is a need for another layer to provide a working surface for paving machines.
  - Use 1” to 1-1/2” layer of same aggregate as in asphalt mix design
  - Or use porous asphalt treated base
- Porous asphalt treated base can reduce overall pavement section thickness for structural design
- Can also provide a more stable surface for construction than aggregate alone.
- Standard WSDOT specification for aggregate for ATB may need to be modified to allow more permeability.

# PAVEMENT SECTION DESIGN

- Pavement section thickness needs to address:
  - Frost heave depth-lower Puget Sound basin around 1’
  - Hydrology-allow water to infiltrate before next storm
  - Structural-design flexible pavement thick enough to distribute load over assumed poor, saturated soils.
- Frost heave only concern if fine grained, poor soils=>hydrology and structural will over ride in these cases
- Hydrology and Structural generally will follow each other based on soils.

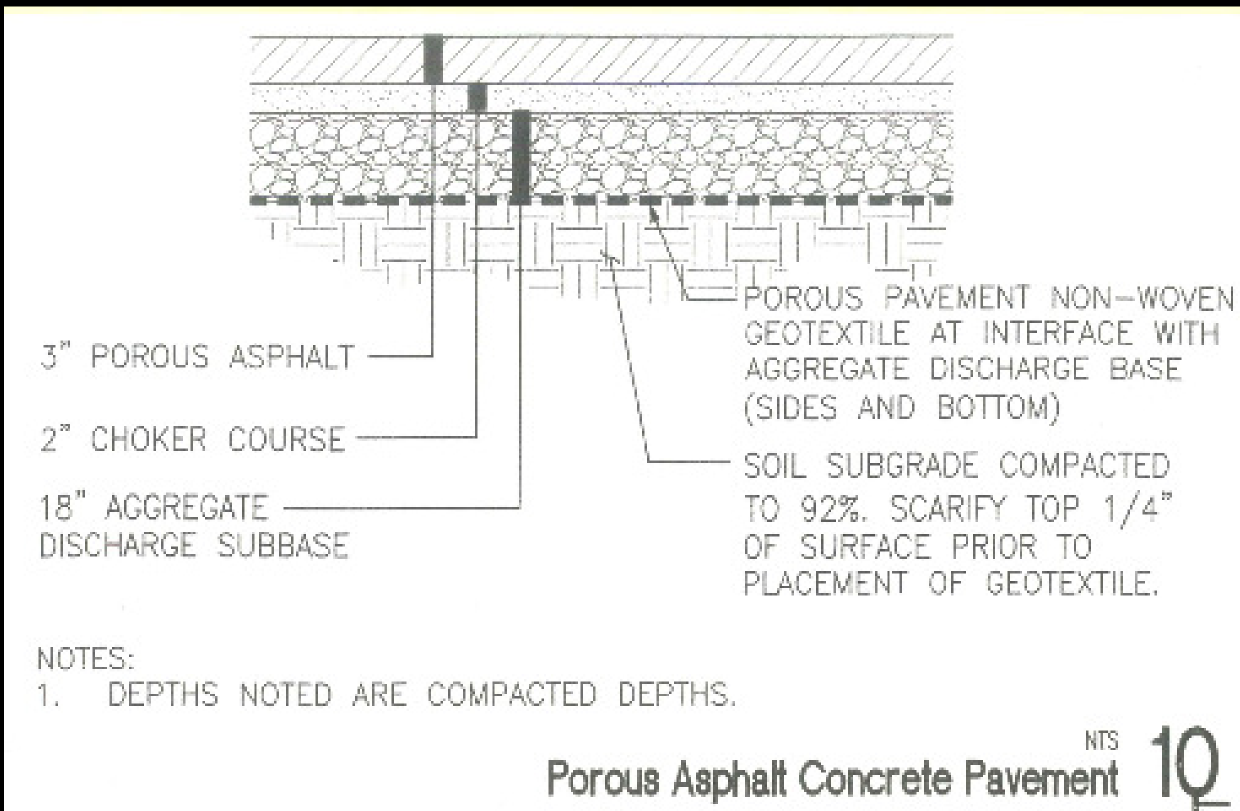
# STRUCTURAL DESIGN

**WSDOT Flexible Pavement Layer Thicknesses Design Table for New or Reconstructed Pavements - LOW ESAL LEVELS**

**(English Version)**

| Design Period ESALs | Subgrade Condition | Layer Thickness[1] (feet) | | | |
|---|---|---|---|---|---|
| | | HMA Surfaced | | BST Surfaced | |
| | | Reliability = 75% | | Reliability = 75% | |
| | | HMA Surface Course | Crushed Stone[2] | BST | Crushed Stone[2] |
| < 100,000 | Poor | 0.25 | 0.85 | 0.08 | 1.50 |
| | Average | 0.25 | 0.75 | 0.08 | 1.10 |
| | Good | 0.25 | 0.75 | 0.08 | 0.90[5] |
| 100,000 to 250,000 | Poor | 0.30 | 0.95 | 0.08 | 1.75 |
| | Average | 0.30 | 0.70 | 0.08 | 1.30 |
| | Good | 0.30 | 0.70 | 0.08 | 1.00 |
| 250,000 to 500,000 | Poor | 0.35 | 1.00 | 0.08 | 2.00 |
| | Average | 0.35 | 0.65 | 0.08 | 1.50 |
| | Good | 0.35 | 0.65 | 0.08 | 1.10 |

- WSDOT has pavement design software which can be used for this purpose (EverStress)- requires some expertise to use
- WSDOT also has design guideline tables which are functional for designing pavement thickness
- Choose the appropriate table based on traffic levels, assume poor subgrade condition for all porous pavements




# STRUCTURAL DESIGN

- Section used at the WSU LID Center
- Note, choker course was not used, aggregate for reservoir course was deemed adequate for working surface
- Would not recommend compaction of subgrade as shown here.

# CONSTRUCTION

- Sequencing Important:
  - Plan site work to keep construction traffic off subgrade
  - Example-excavate to subgrade as moving out, back fill with aggregate from opposite end
  - Once geotextile and reservoir rock is down, can compact that and allow traffic on rock.
  - For anything but asphalt treated base, will likely need rollers around to fix/compact rock as pavers are working

# CONSTRUCTION

- Watch materials and placement:
  - Look for aggregate to be porous, no sheen or sealed off areas
  - Make sure subgrade has not been compacted by construction traffic, if it has, scarify before geotextile and rock are placed.
  - Watch for asphalt in the beds of delivery trucks-indicates drain down issue
  - Make sure rollers are on the asphalt in the correct temperature range (by mix design)
  - Make sure rollers are using vibratory compaction (assuming test were passed during mix design)

Compacted subgrade

Loose, open subgrade

# CONSTRUCTION OBSERVATION KEYS

- Check that subgrade is not compacted or sealed off
- Should be loose, open graded.
- Pavement has been designed for poor subgrade, only soft, yielding subgrade should be concern.



# CONSTRUCTION SEQUENCE

- Back dump rock onto geotextile
- Spread aggregate with dozer to design depth
- Compact aggregate at full design depth.

Shoulder ballast-clean, fractured loose in place

# CONSTRUCTION OBSERVATION KEYS

- Note clean, interlocking look of rock


# CONSTRUCTION OBSERVATION KEYS

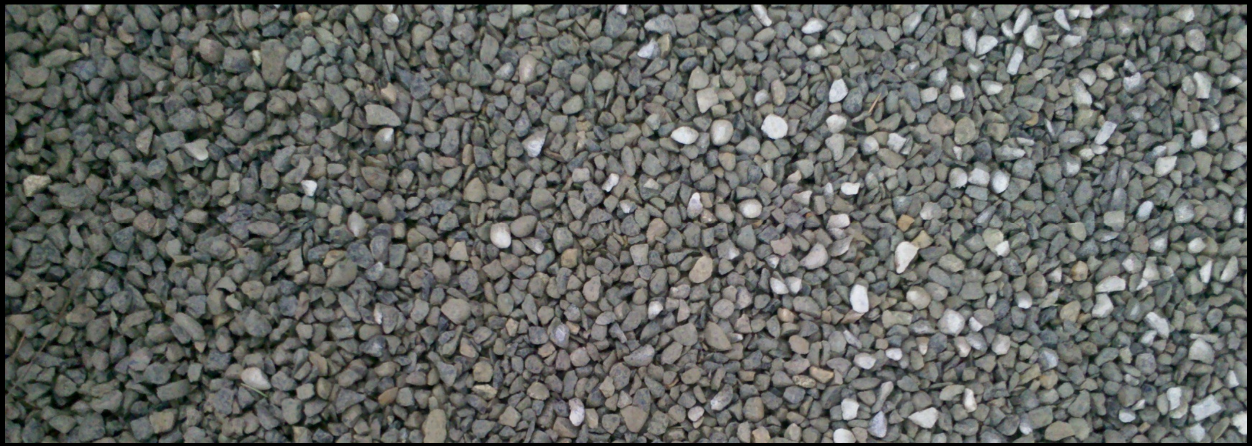
- Compare and contrast:
- Left cell is porous reservoir course rock
- Right cell is dense graded CSTC

Note sealed off appearance

Clean, free draining, interlocked

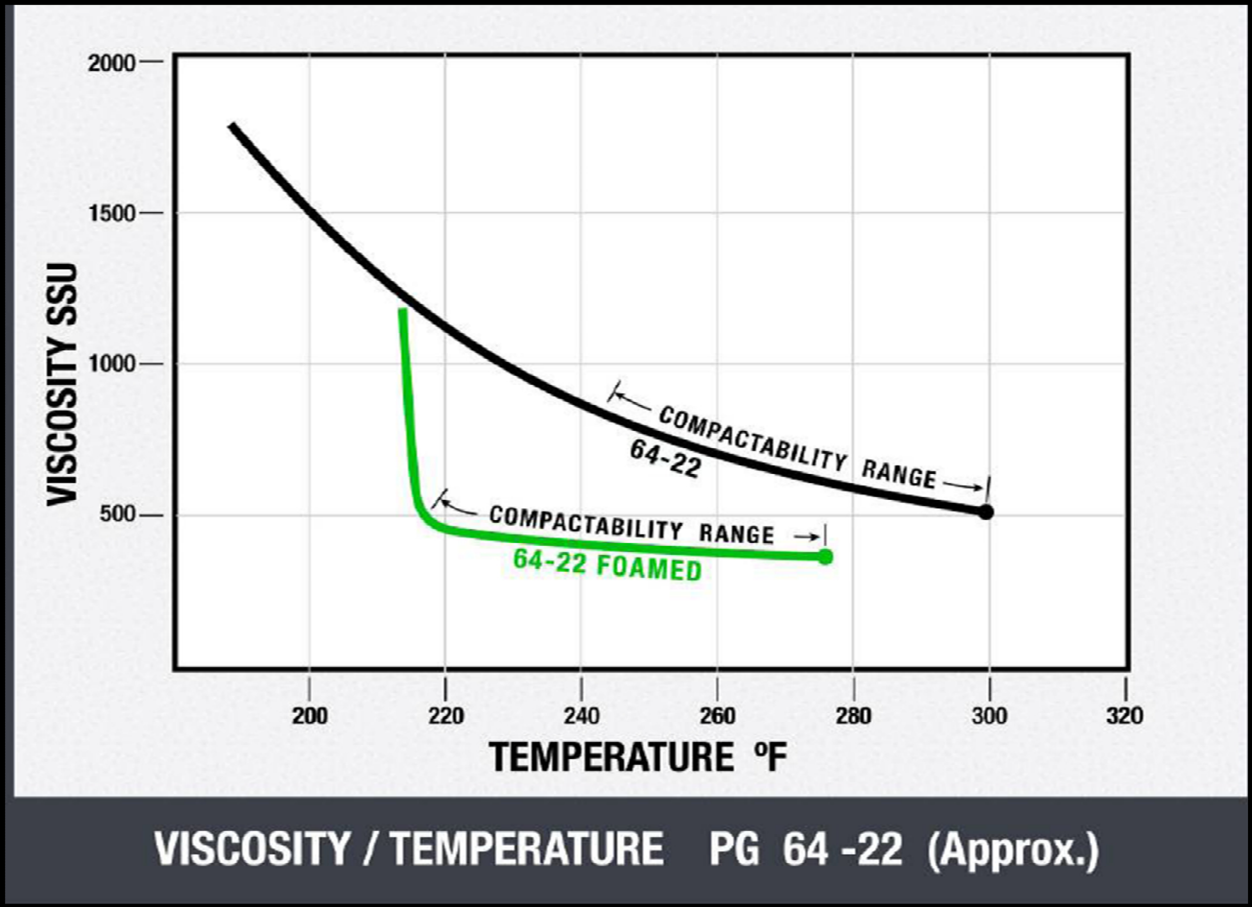
# CONSTRUCTION OBSERVATION KEYS

- Compare and contrast:
- Left  picture is standard CSBC
- Right picture is good choker course



# CONSTRUCTION OBSERVATION KEYS

- Test Time!!!
- Which of the two choker courses shown would be acceptable?
- Why is the other not acceptable?




# CONSTRUCTION OBSERVATION KEYS

- Make sure compact start within the compaction range specified by the mix design
  - Too Early (too hot)-final mat may not have desired porosity
  - Too Late (too cold) – final mat will not compact to desire density, surface may be uneven, likely candidate for raveling


# CONSTRUCTION OBSERVATION KEYS

- Porous asphalt will not look much different than dense graded HMA
- Left cell is porous
- Right cell is control dense graded HMA.
- Fun Fact: dense graded HMA was so porous, had to add dirt to it to clog it enough to provide run off.

# CONSTRUCTION

- Placement and Acceptance:
  - Test for infiltration rate using modified ASTM test
    - Initial tests should average over 200"/hour
    - Remember that 1"/hour would still be adequate
  - City of Puyallup will be testing existing densities of porous asphalt pavements to see if density range can be established for porous asphalt
  - If range can be established, will help inspectors with controlling compaction to desire range
  - Look for sealed of areas in pavement. Again, only if extensive areas closed off would remedial action be required.

# POST CONSTRUCTION


# POST CONSTRUCTION

- Consider installing signage advising unique nature of pavement
- Covenants or other instruments tied to land/title for private developments



# MAINTENANCE

- Sweep regularly with regenerative air or vacuum sweepers
  - TOP: Tymco Model 600 Regenerative Sweeper also available with Alternative Fuel option
  - Bottom: Elgin Crosswind Regenerative Sweeper also available with Alternative Fuel option

# POST CONSTRUCTION

– Other Concerns/Issues

- Protection of pavement during building construction.
- Homeowner/End User care of pavement.
- Education of maintenance personnel.
- Utility installations and road way repairs.

# POROUS ASPHALT PERFORMANCE

# MYTH BUSTERS

# Myth #1 - Porous asphalt (and other types of porous pavements) will clog over time and is not durable.

- Truth – While some caution is needed to prevent careless transport of sediments and fines on to pavements, many pavements have been operating for decades with little maintenance and others that have become clogged have been successfully rehabilitated.
- Clogging has occurred from asphalt draining down from the surface and resetting lower in the asphalt pavement. Use of polymer modified asphalt, stiffer asphalts and sometimes the use of fibers mitigates this effect.
- Initial installation of porous asphalt at Walden Pond completed in 1977 still functioning.
- Arizona SR-87 still in use after 20 years (checking if still in place)
- "Several dozen large, successful porous pavement installations, including some that are now 20 years old, have been developed by Cahill Associates of West Chester, PA, mainly in Mid-Atlantic states"
- Use of regenerative vacuums periodically can restore pavements to installation infiltration rates or higher.

## Myth #2 - Porous asphalt will rut under traffic loads.

- Truth –
- The structural strength of flexible pavements comes primarily from the supporting roadway section, not the asphalt.
- Cahill Associates experience confirms that the deeper pavement sections generally result in a more durable pavement.
- Further, A Caltrans study performed in 1989 on the structural value of open graded asphalt-treated base and open graded asphalt concrete pavement concluded that these materials would be assigned the same structural strength value as their dense graded counter parts.
- ODOT has also concluded in their design guidelines that open graded asphalt will be given the same structural value as dense graded asphalt.

## Myth #3 - Porous asphalt will lead to pollution of the ground water.

– **Truth –**

- **Intuitively, porous asphalt decreases pollution risk by keeping stormwater dispersed. Not a pollution generating surface.**
- **Several studies have looked at the water quality treatment that occurs at the geotextile soil interface and concluded that removal of most pollutants is very good.**
- **Other studies have shown that the porous pavement itself traps many of the heavy metals with fine sediments, and adsorption occurs to neutralize them. More study is needed in this area, but so far the results are positive.**

# EcoStorm Plus

- Treats Stormwater With Pervious Concrete

## Myth #4 - Porous asphalt is prohibitively expensive.

- **Truth –**
- **Porous asphalt costs about 20% more than HMA.**
- **On a 20,000 square foot parking lot, 3” porous asphalt over 2” choker course at 2010 prices would be $43,000 ($2.15/sq ft) vs. $36,000($1.85/sq ft) for 3” Class ½” HMA over 2” CSTC.**
- **The cost differential above represents about 1 ea. 2-cartridge StormFilter®**
- **There is more depth of ballast and geotextiles for porous asphalt vs. HMA.**
- **Porous asphalt may replace and eliminate catch basins, pipes, water quality treatment devices and storm ponds which may actually SAVE money.**

# City of Puyallup 8th Ave NW project information:

- Cost of top 2 layers (asphalt and binder/leveling course) = $8.98/sf (4” asphalt and 2” permeable crushed surfacing).
- Prices are based on the following:
  - Asphalt thickness: 4”
  - Asphalt/ton: $102.00/ton
  - 2” choker coarse/ton: $41.00/ton
- Overall project cost/SF: $ 23.49/sf (note this includes EVERYTHING the City installed on the project)
- Cost of project as bid: $408,561
- Final cost of project: $369,514
- SF of roadway: 15,725 SF
- Length of road: 629 LF
- Width of road: 25 LF

Breakdown of various items:

Porous asphalt: 480 tons

Pervious concrete sidewalk: 344 SY

Permeable paver sidewalk: 287 SY

Raingarden: 10,000 SF, located in 6 different cells.

# Other Benefits of Porous Asphalt Pavement

- Reduction of spray on higher speed roads. Infiltration helps recharge groundwater, helps base stream flows.
- Reduction of spray on higher speed roads.
- Reduction of hydroplaning.
- Reduction of glare.
- Less area required for stormwater control features.
- Reduced tire noise.
- May be less costly than standard road system, site dependant.
- Reduction in salt application
- Above all, pollution prevention by eliminating surface runoff.

HMA - 315° F

Aspha-Min WMA - 265° F

# Warm Mix Porous Asphalt

- Warm-mix asphalt is the generic term for a variety of technologies that allow the producers of hot-mix asphalt pavement material to lower the temperatures at which the material is mixed and placed on the road.
- Reductions of 50 to 100 degrees Fahrenheit have been documented. Such drastic reductions have the obvious benefits of cutting fuel consumption and decreasing the production of greenhouse gases.
- In addition, potential engineering benefits include better compaction on the road, the ability to haul paving mix for longer distances, the ability to pave at lower temperatures, better asphalt coverage of aggregate, and safer conditions for workers.

# CONTACT INFORMATION:

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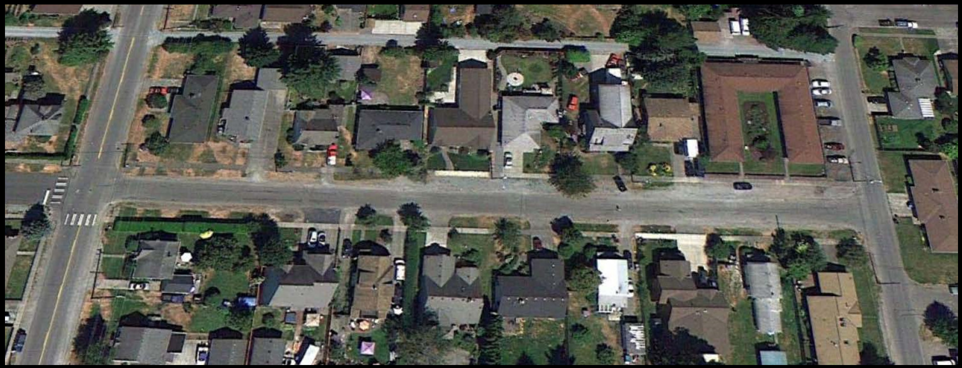
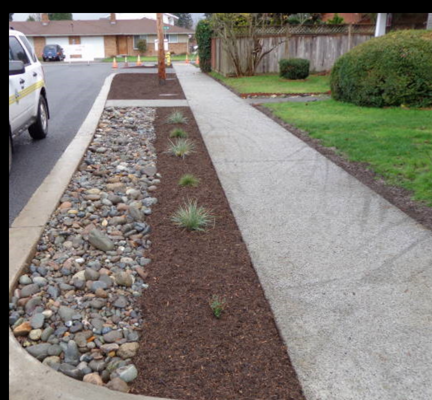
# Questions???



# CITY OF PUYALLUP PROJECTS

8th Ave NW LID Retrofit

- Converted 100% impervious=>100% Pervious
- Porous Asphalt Street
- Pervious concrete sidewalk (south side)
- Permeable Paver sidewalk (north side)
- ROW rain gardens



# CITY OF PUYALLUP PROJECTS

8th Ave NW LID Retrofit

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# CITY OF PUYALLUP PROJECTS

Wilson Loop (Porous Alley Initiative)

- Replaced HMA section with pervious asphalt section
- Street had failed, frequent complaints
- Frequent ponding on roadway
- Utilized pervious rock shoulders

# CITY OF PUYALLUP PROJECTS

6th Ave SW (Porous Alley Initiative)

- Water main replacement drove project
- Frequent street flooding events, adverse grade, no storm drainage
- Replaced HMA section with pervious asphalt section
- Utilized pervious rock shoulders


# CITY OF PUYALLUP PROJECTS

Riverwalk Trail-JEB III Link

- Porous asphalt trail
- Connects to Foothills Trail
- Allows East Pioneer Way storm flows to pass laterally

# CITY OF PUYALLUP PROJECTS

## CLARKS CREEK PARK RIPARIAN HABITAT & POROUS MAINTENANCE ROAD

# CITY OF PUYALLUP PROJECTS

Corporate Yards South Entrance

- Pervious concrete entrance, 24’ wide
- Heavy equipment access needed because of sight distance restriction on 39th Ave SE
- Utilized porous alley mix of 1-1/4” blended with #57 rock for reservoir course
- Conservative 12” thick section

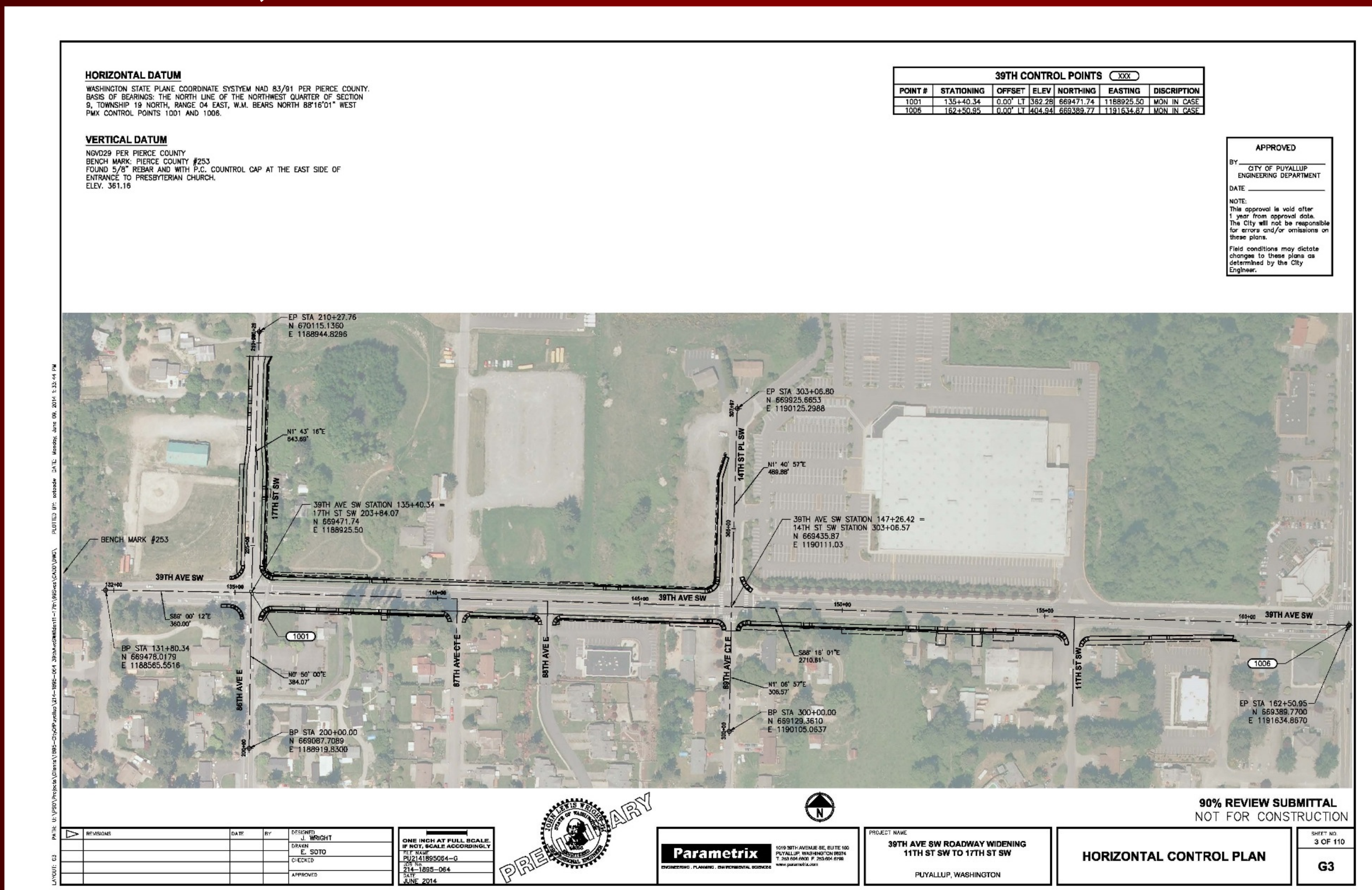
# POROUS GRAVEL ALLEYS

- Using mix of 1-1/4 and #57 rock
- Allows 2-3 years between maintenance vs. one –two times/year with dense graded
- Inexpensively addresses ponding issues

# COMING SOON

# CITY OF PUYALLUP PROJECTS

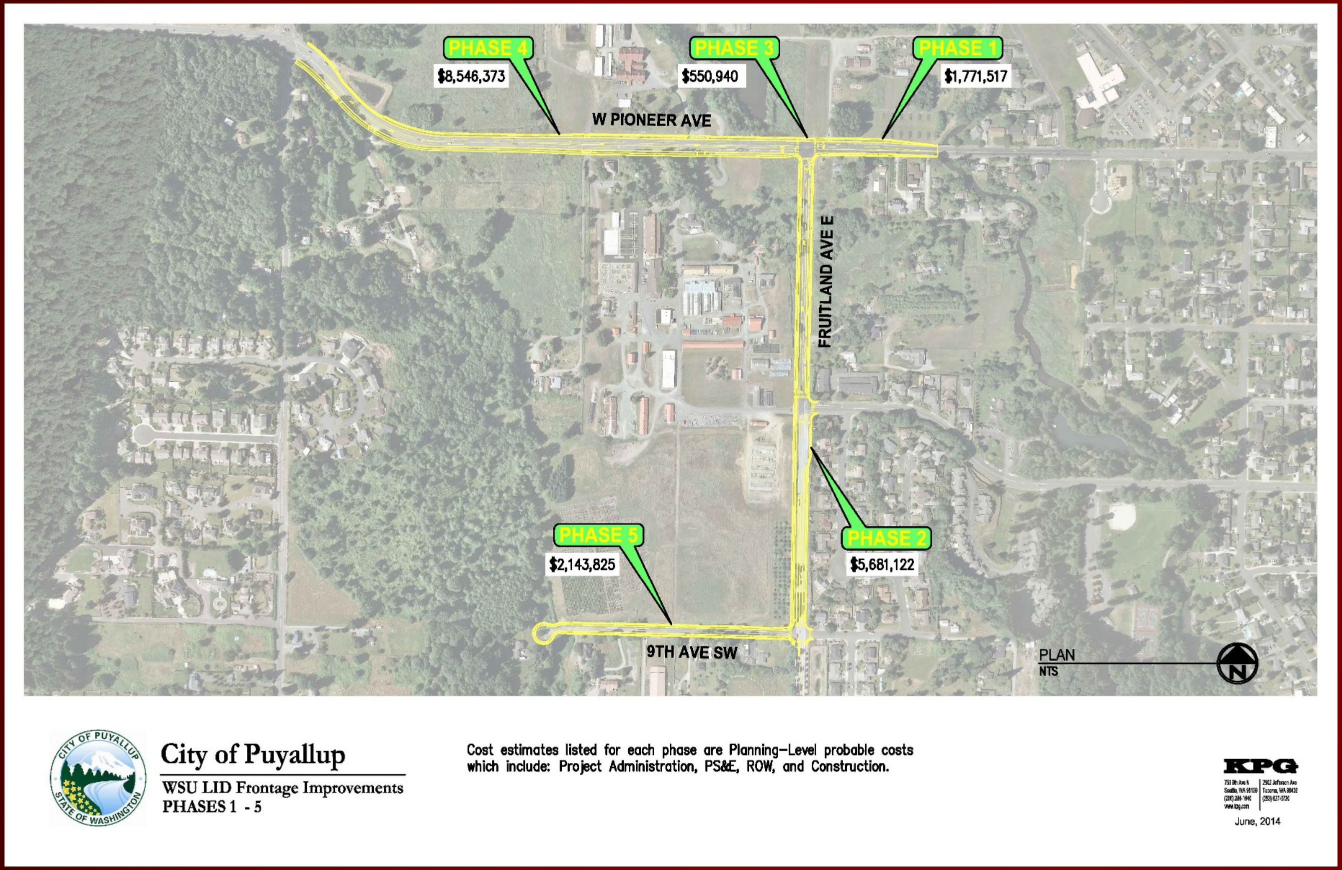
## 39$^{TH}$ AVE SW, 11$^{TH}$ ST SW TO 17$^{TH}$ ST SW




- Pervious concrete roadway & sidewalks
- Standard concrete for intersections
- Overall less cost than HMA
- Construction 2015

# CITY OF PUYALLUP PROJECTS

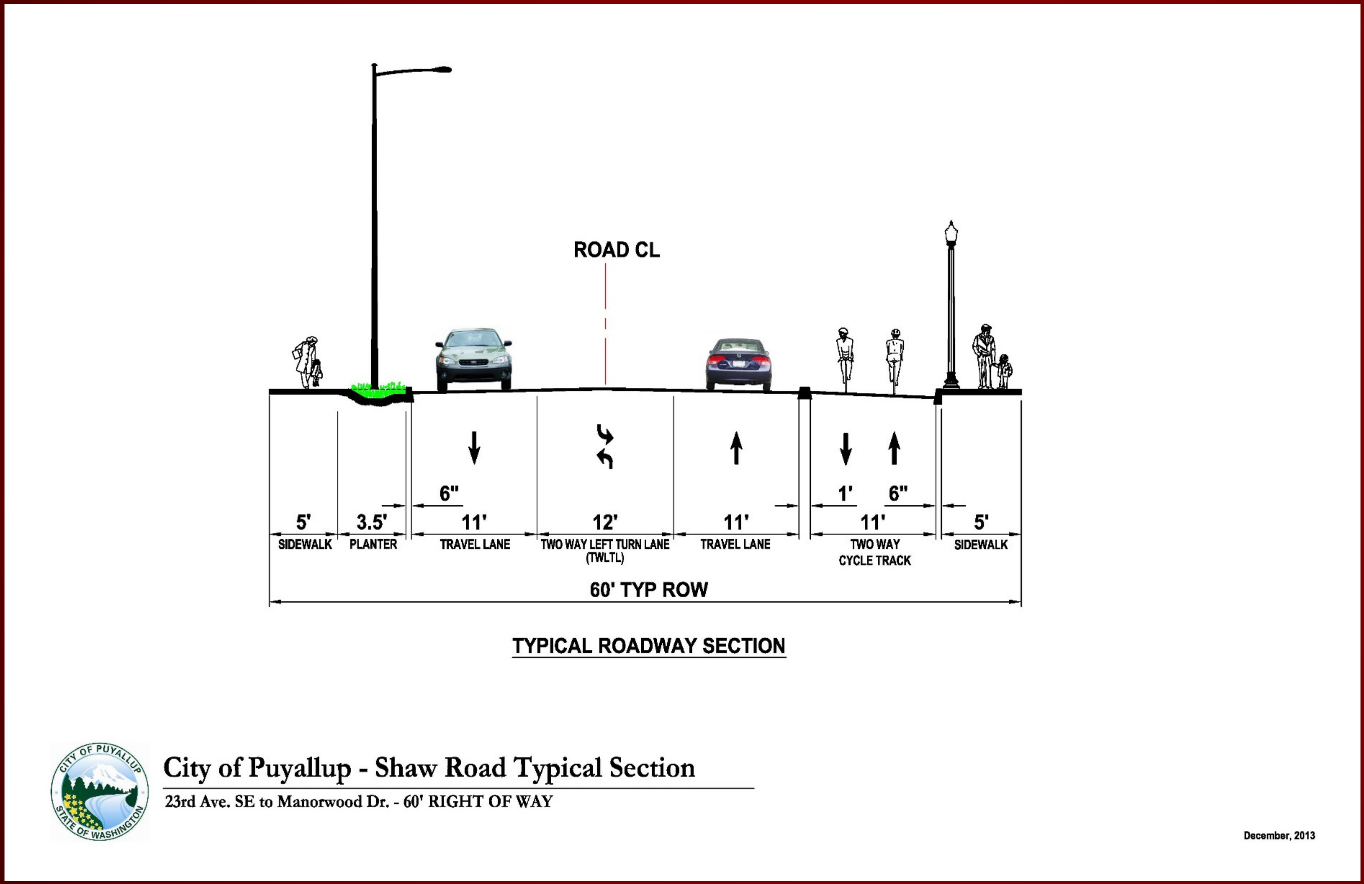
## WSU LID FRONTAGE IMPROVEMENT




- Pervious concrete and porous asphalt roadways
- Testing built into design
- Standard concrete for intersections
- Phased Construction starting 2015

# CITY OF PUYALLUP PROJECTS

## SHAW ROAD, 23RD AVE SE TO MANORWOOD DRIVE




- Pervious concrete roadways and bike track, sidewalks
- Construction projected for 2016

# TWO CONTENT LAYOUT WITH TABLE

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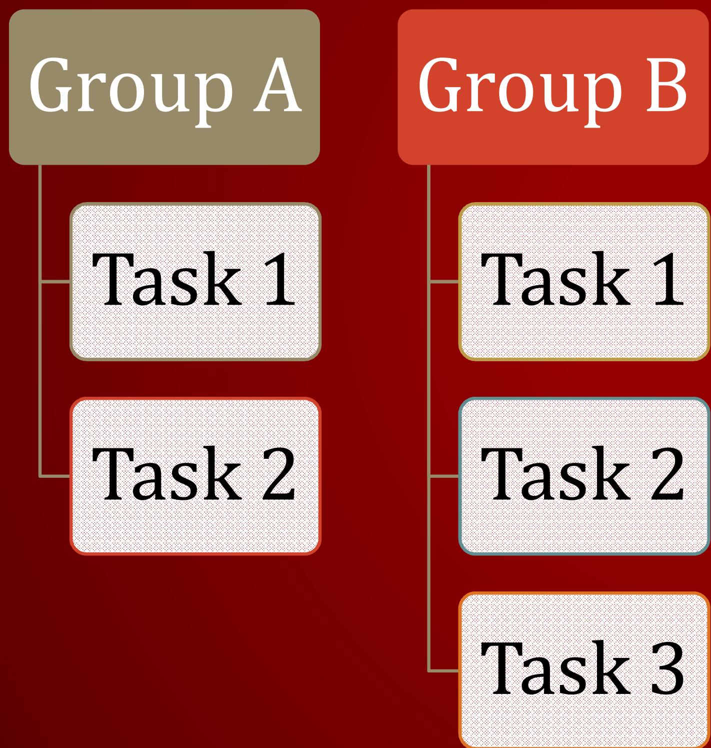
| | Group A | Group B |
|---|---|---|
| Class 1 | 82 | 95 |
| Class 2 | 76 | 88 |
| Class 3 | 84 | 90 |

# TWO CONTENT LAYOUT WITH SMARTART

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