

# Contaminant Leaching from Recycled Asphalt Pavement

FINDINGS FROM THE LITERATURE REVIEW

JUNE 20, 2019

# Review Framework

**Objective : Summarize research on direct testing of contaminant leaching from Recycled Asphalt Pavement (RAP)**

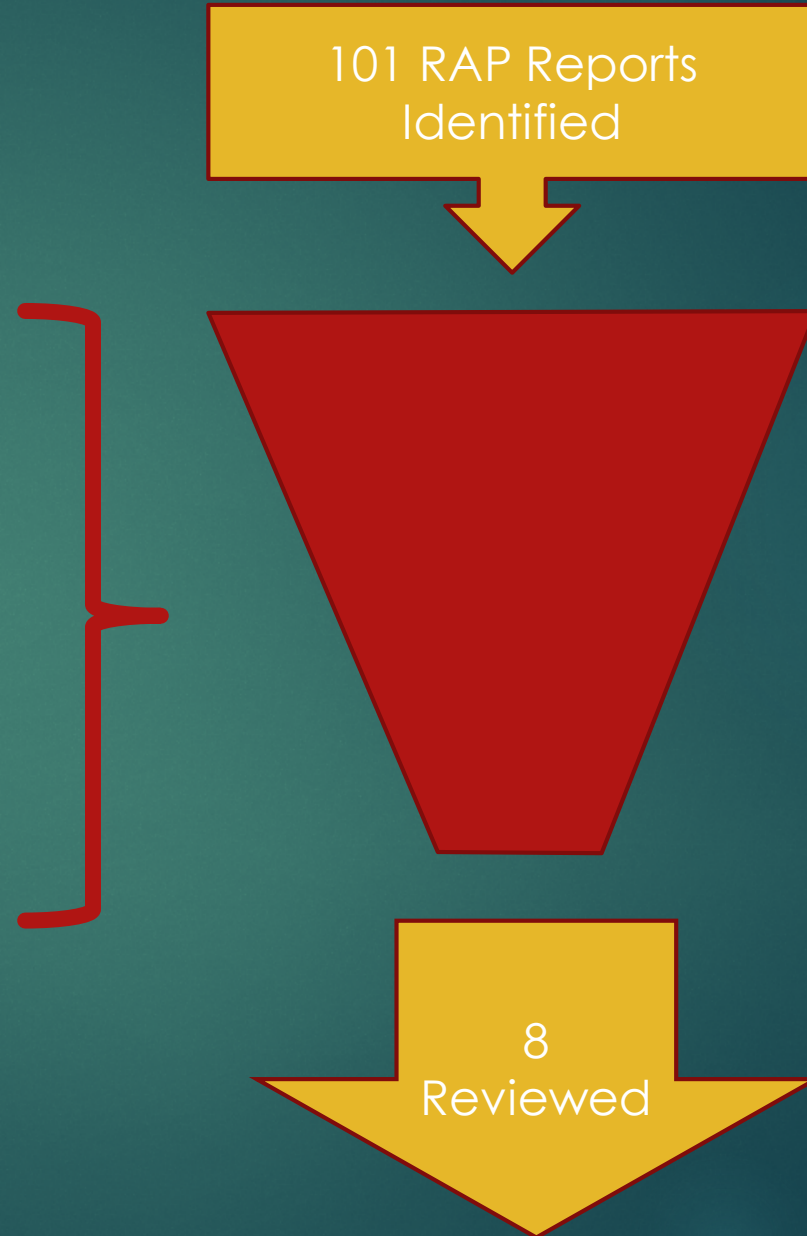
What the literature review specifically did not address:

- ▶ Did not consider source control or site BMPs
- ▶ Did not look at fate and transport
- ▶ Was not specific to Nisqually Area



# Screening Process

- Age (old studies used less rigorous laboratory techniques/equipment)
- First party/original work
- 100% RAP
- Refereed literature/scientific journal



# Report Organization

- ▶ Summary of findings from each of 8 studies
  - ▶ Described results by batch and/or column studies (or field studies in one case)
  - ▶ Studies evaluated metals, organics (PAHs) or both
  - ▶ Studies key conclusions
- ▶ Comparison of Results to Standards
  - ▶ Comparison to Washington State Groundwater standards
  - ▶ Conclusions the authors had in relation to the standards they applied
- ▶ Comparison to Conditions at Nisqually
- ▶ Summary and Conclusions



# Caveats

- ▶ Wide range of testing materials, testing protocols and study conditions
- ▶ While most of the studies were done in the U.S. some were done in Europe. European RAP represents different manufacturing processes and other differences (type of gas, vehicles, road maintenance)
- ▶ Concentrations of contaminants may not be applicable but general behavior was similar across studies

# Our Findings



# First...understanding detection limits

## Below Detection $\neq$ Zero

- ▶ Detection Limits are defined by the method
- ▶ Method Detection Limits are not always attainable
- ▶ Methods have changed radically over the past 20 years



	State Standard				
Benzo(a)pyrene	0.008	<0.010-0.020	BDL- 0.02	<0.071	<0.025-<0.025

# Batch Studies

- ▶ 7 of the 8 studies performed batch type tests
- ▶ 6 studies included analysis of metals; 4 studies included analysis of PAHs
- ▶ pH, liquids to solid ratio, elutriate, duration of testing (hours to days) were the key testing variables



Figure 11: Laboratory Setup for Batch Extraction Experiments.



# Batch Studies

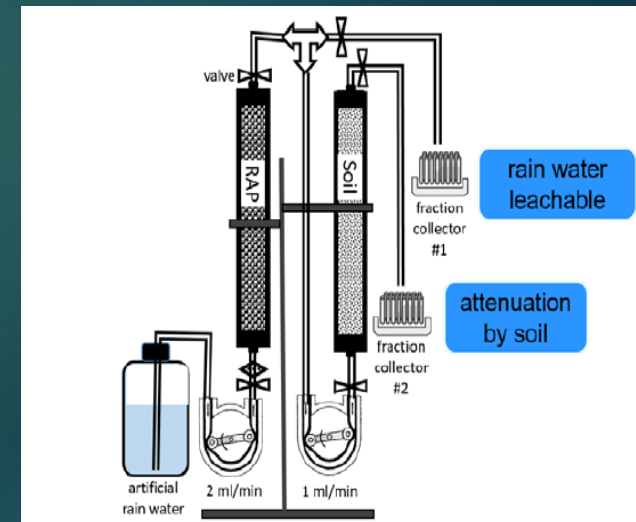
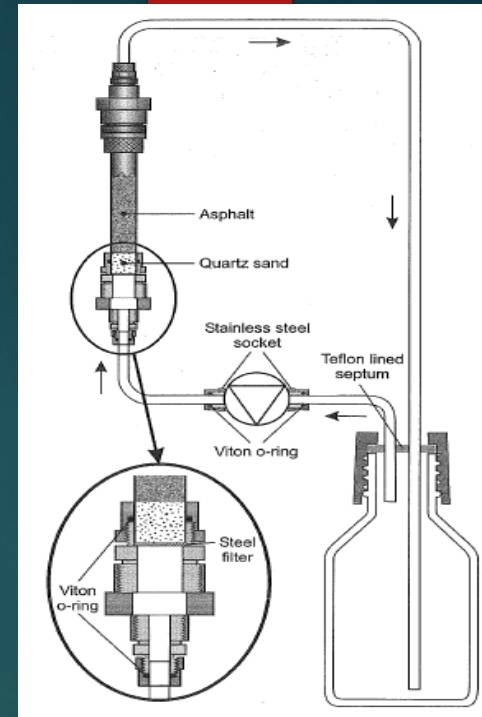
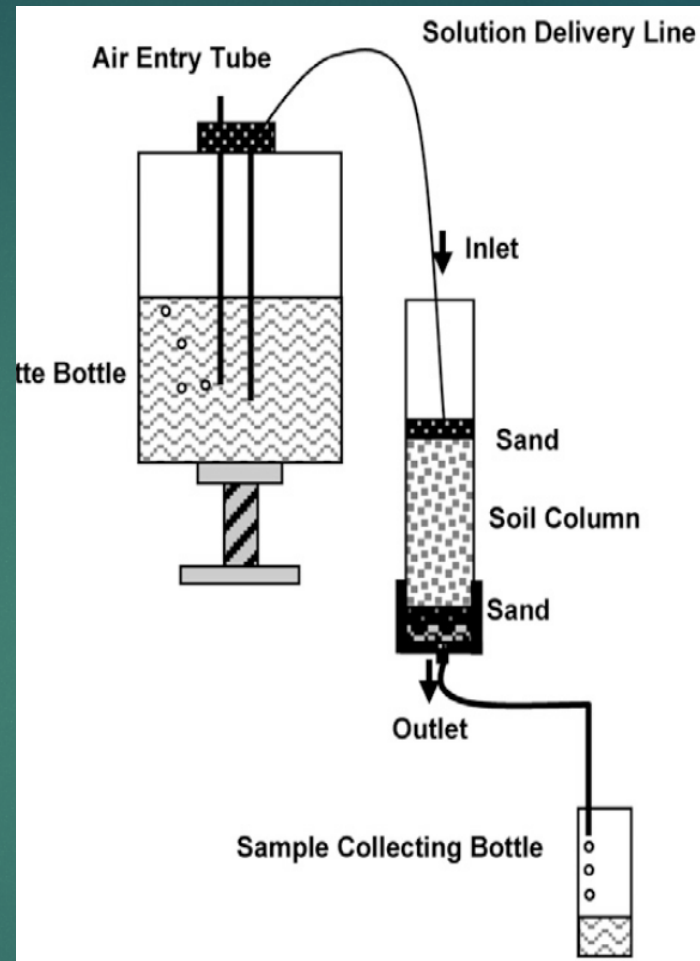
- ▶ Some metals were detected above GW standards; higher concentrations were measured at low pH
- ▶ Only 50% of the studies used appropriate Detection Limits (DLs) for PAHs
- ▶ 13 of the 16 PAHs were detected in at least one of the studies
- ▶ 5 PAHs exceeded GW standards in 50% of the studies where DLs were appropriate



Figure 11: Laboratory Setup for Batch Extraction Experiments.

# Column Studies

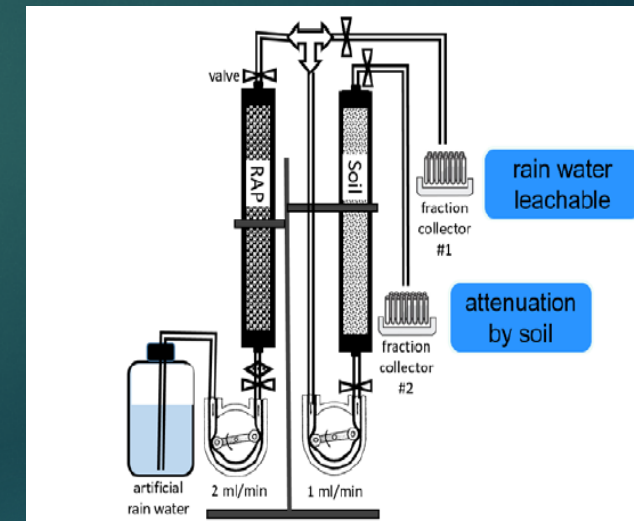
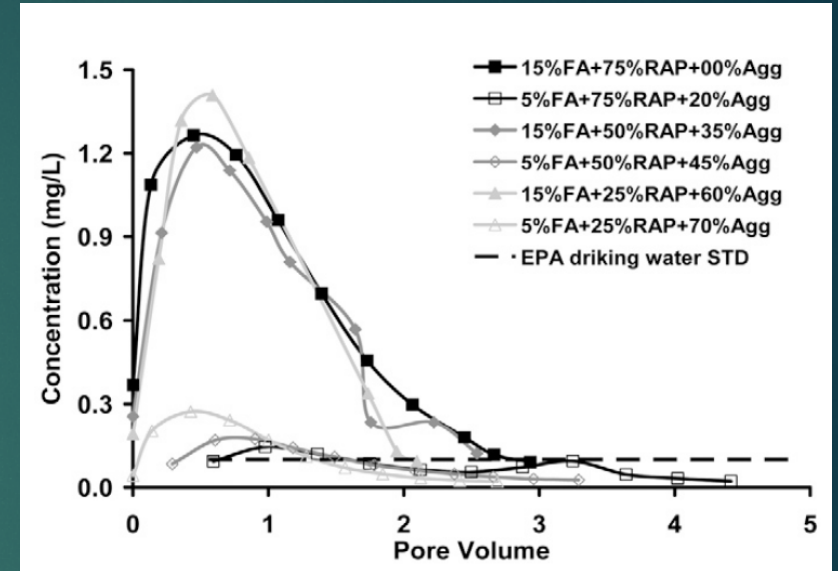
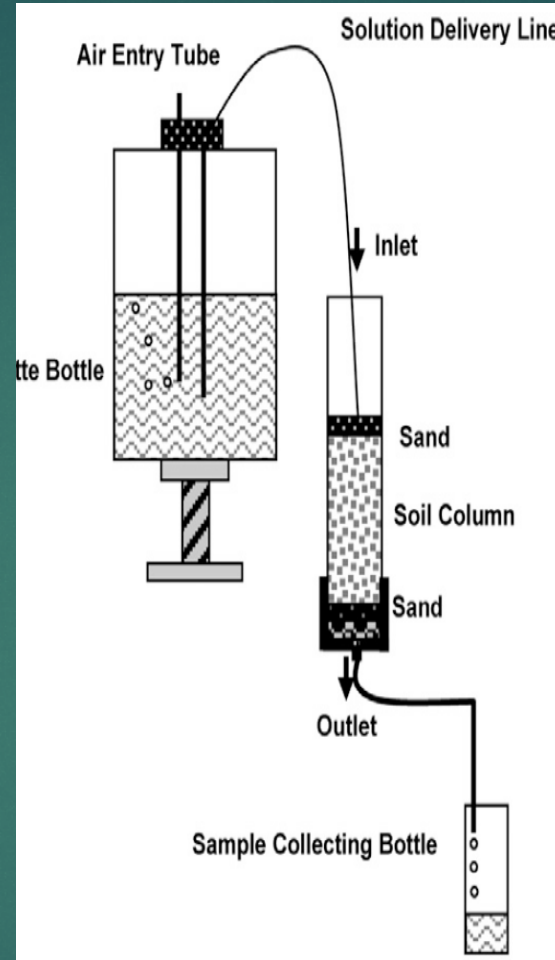
- 6 of the 8 reports included column studies
- 4 studies tested metals
- 5 studies tested PAHs
- pH, L:S, duration (weeks to months), saturation, hydraulic loading rate,





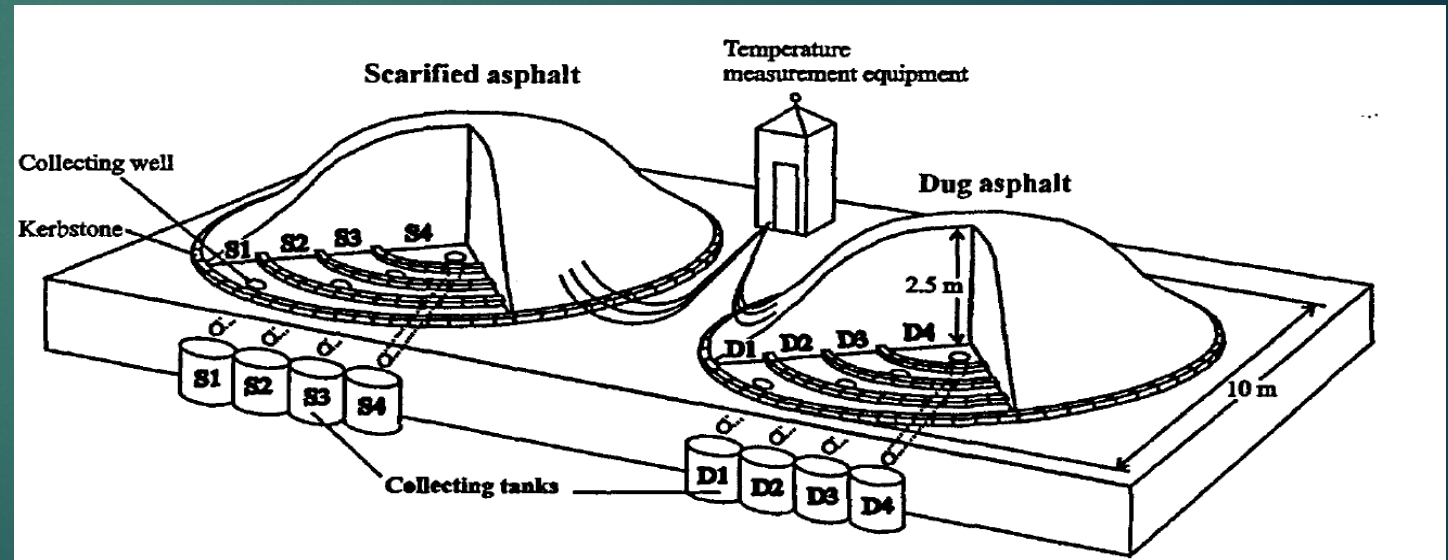
# Column Studies

- Only 4 studies tested PAHs at appropriate DLs
- All 16 PAHs exceeded the GW standard in at least one study
- 8 were above standards in at least two (50%) of the studies
- Contaminants decreased to very low or BD levels after initial flushing



# Field Study

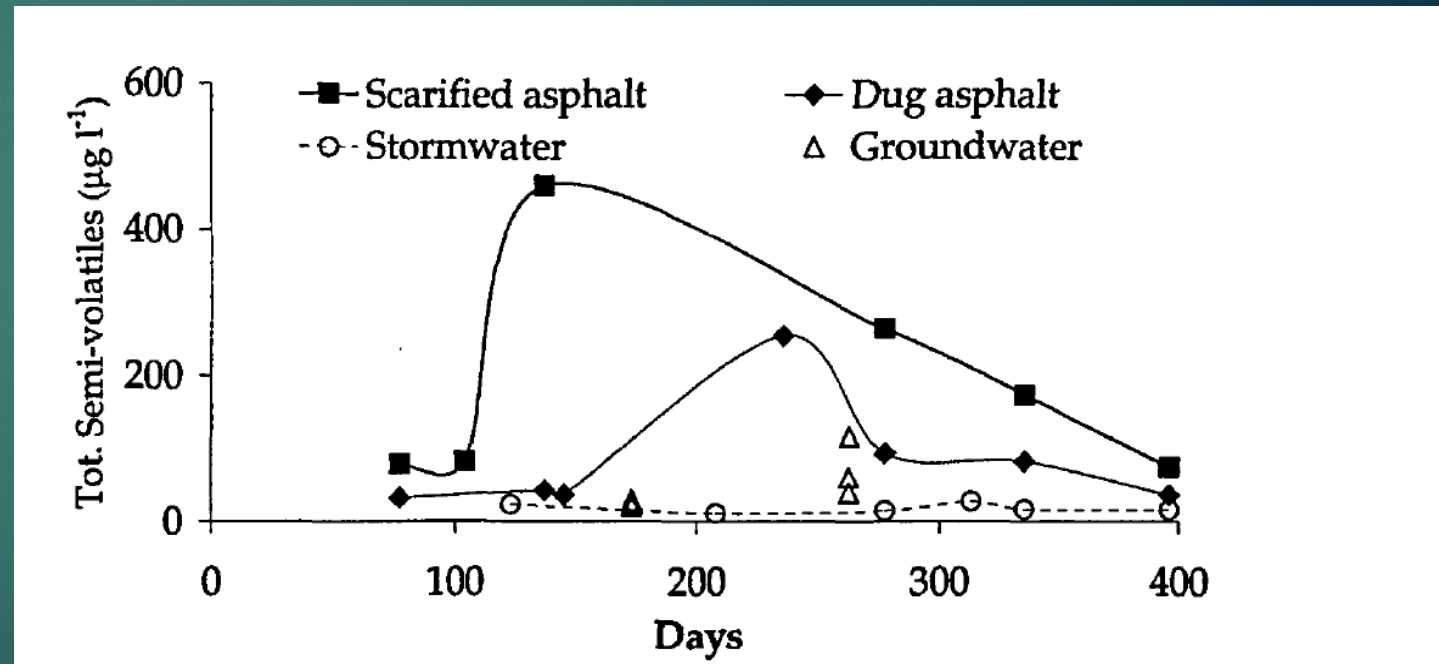
- Only one field study
- Evaluated two RAP sources (from the wear course and base course of a highway)
- Examined differences in leachate content by location in the stockpile
- Only evaluated organics
- Compared results of their column testing to stockpile testing





# Field Study

- Column studies had fewer organics and lower concentrations than stockpile leachate
- Column studies indicated much lower cumulative loading of organics (25%) than what was estimated for stockpiles
- Key conclusion:
  - Column tests may be underestimating contaminant contributions and more field studies should be done.



# Issues with the Field Study

## Concern

- ▶ This study was done in Sweden where RAP may be very different from U.S.
- ▶ Study area in southern Sweden has very low pH (4.5) rainfall and represents an aggressive leaching environment

## Response

- ▶ Concentrations of contaminants may not be representative of US RAP but the basic findings on leachate behavior likely apply
- ▶ While pH of precipitation in W. Washington is higher than in southern Sweden (5.3 vs 4.5) it is quite acidic and leaches contaminants.



# Summary

Due to many variables with testing only broad summaries can be drawn from the research

- ▶ RAP is highly variable; manufacturing process, where it came from and how long it was in use, material size, storage and weathering.
- ▶ Although metals are leached they are rarely at concentrations that exceed GW standards, it is organic compounds (e.g., PAHs) that are the bigger concern
- ▶ There were 4 PAHs consistently detected above GW standards in both batch and column studies
- ▶ Detections and exceedances of PAHs were associated with initial flushing; contaminants were often below detection after the initial flush
- ▶ A number of researchers suggested that the impact to the environment would be negligible if dilution and assimilation were considered.
- ▶ There was only one study of field conditions and it indicated that laboratory studies may not adequately account for real life conditions





Questions?



# Are the Results Overly Biased by European Studies?

Author	U.S.	Europe
Aydilek	7	
Legret		1
Metha	3	
Birgisdottir		2
Norin		2
Kang	1	
Morse	3	
Brantley	6	
<b>TOTAL RAP SAMPLES</b>	20	5
<b>TOTAL STUDIES</b>	5	3