Does pavement wear generate microplastics in stormwater runoff?

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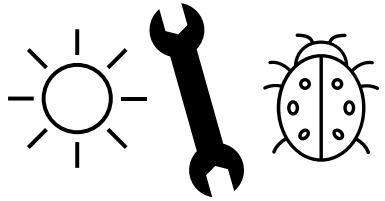
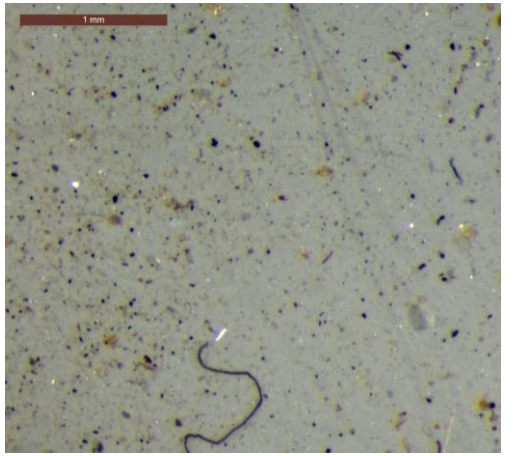
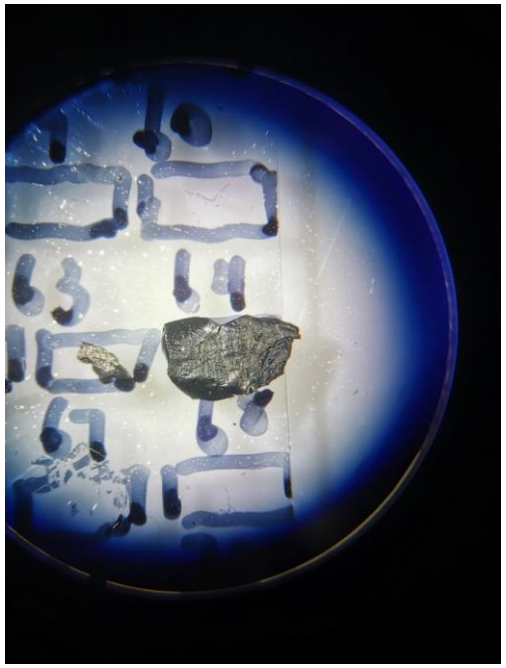
Microplastics

- 1 µm - 5 mm
- Primary studies: marine & freshwater.
- Fragmentation 
- Contaminant transport pathways vs sources
- Stormwater
  - Both pathway and diffuse source





Tire and Road Wear (TWRP)

- Largest source of microplastic pollution?[1]
  - Mechanical abrasion of tires with pavement
  - Pavement wear over time

Avg. life span[2]:

Asphalt	Concrete
15.5 yrs	27.5 yrs

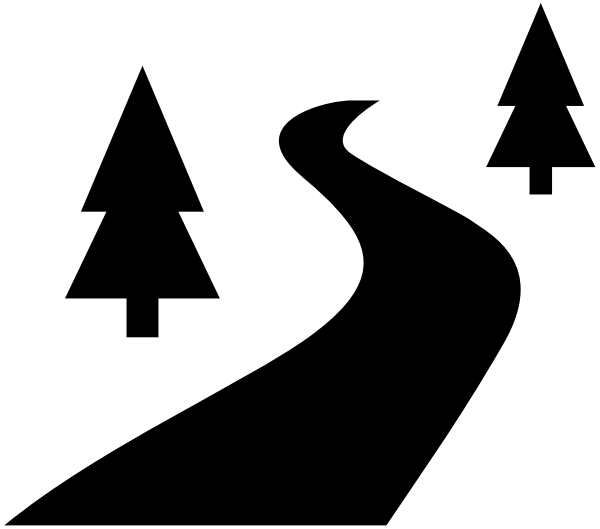
- Many tire wear studies.
- Unknown: Relative contribution of road wear?

Rødland et al. (2022). Sci. Total Envi. *824.*[1] Michigan Concrete Association. (2020).[2]

Microplastics in Pavement

- Asphalt & concrete additives since ~1930's
- Improves physical characteristics
- Common additives:
  - Elastomers and thermoplastics

  *Sustainability practice: Crumb rubber & syn. fibers

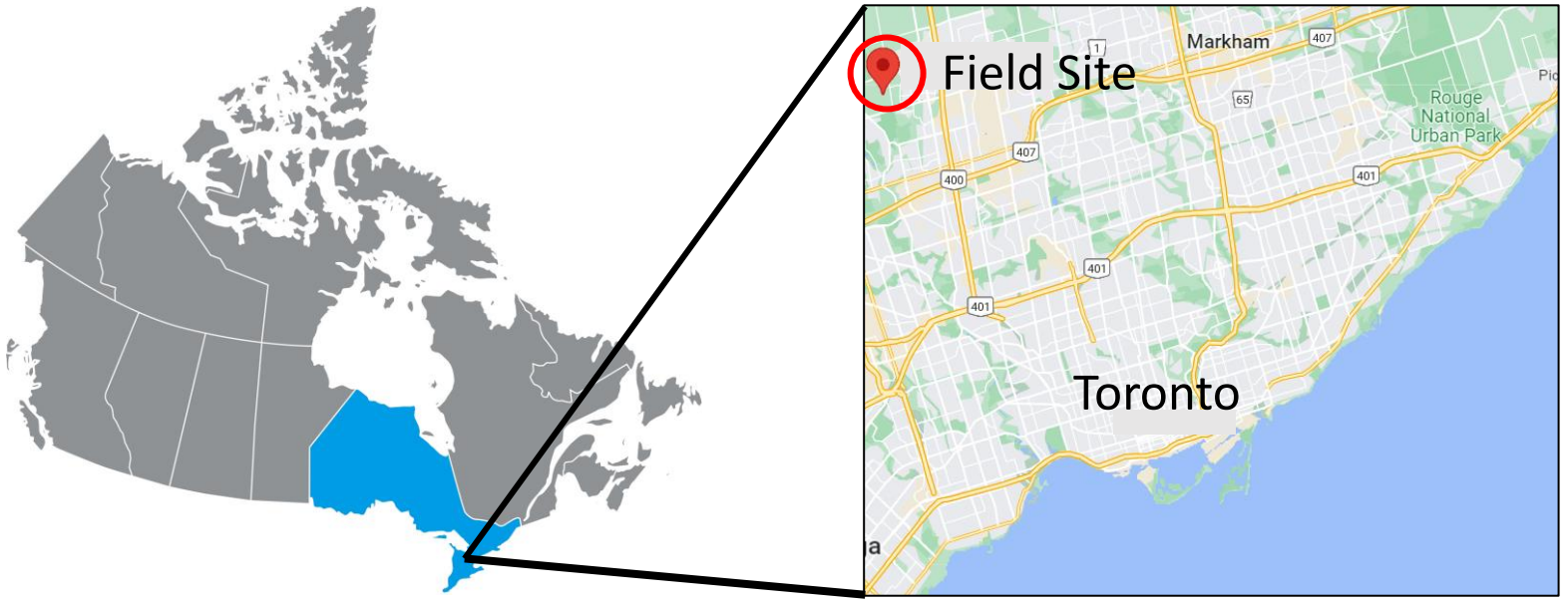


Pavement degradation research important to:

- Inform sustainability practices
- Ecotoxicology relevance
- Possible point-source

Objectives

1. Determine impacts of pavement degradation on microplastic generation in stormwater between different pavement types



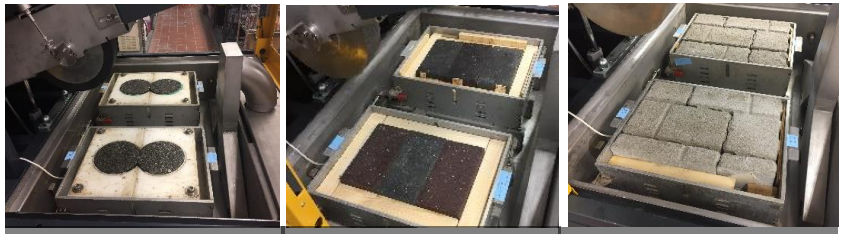
Methods: Study Site

Sample Type:

pavement

stormwater

Pavement Degradation Testing



Asphalt cores | Rubber pavers | Concrete pavers

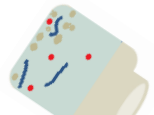
A. Particulate sample

B. POCIS (Chemical sampler)

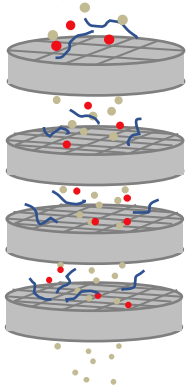
Methods: Sample Processing

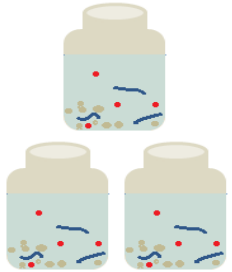
Stormwater

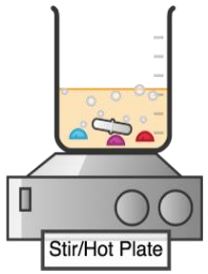
Degraded pavement particulate



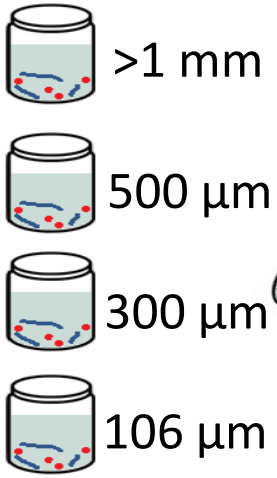
+ isopropyl alcohol

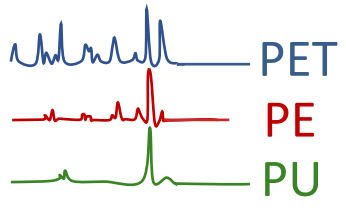


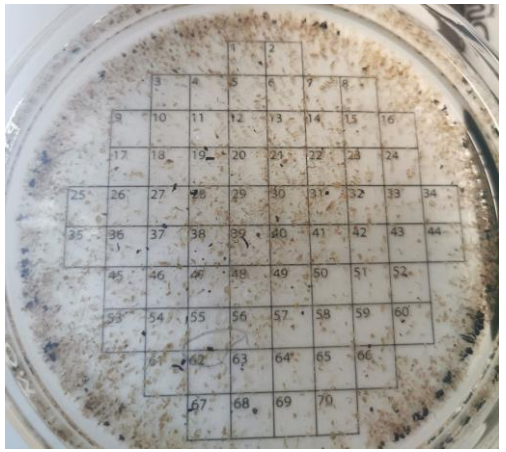




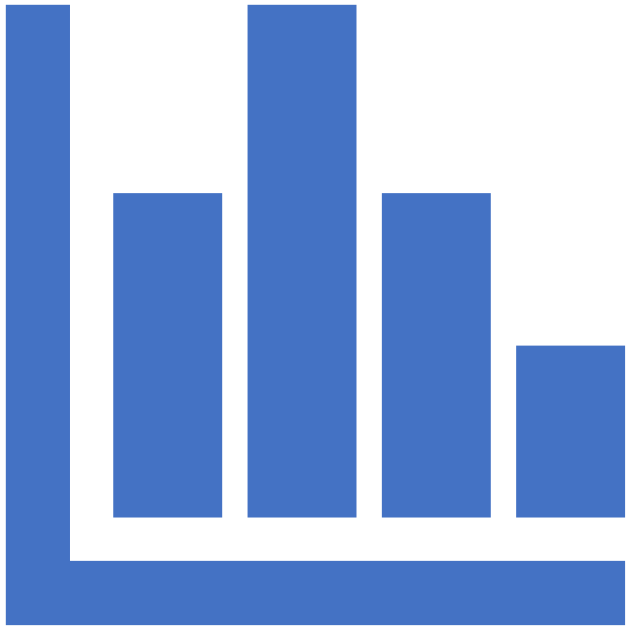
Fenton's







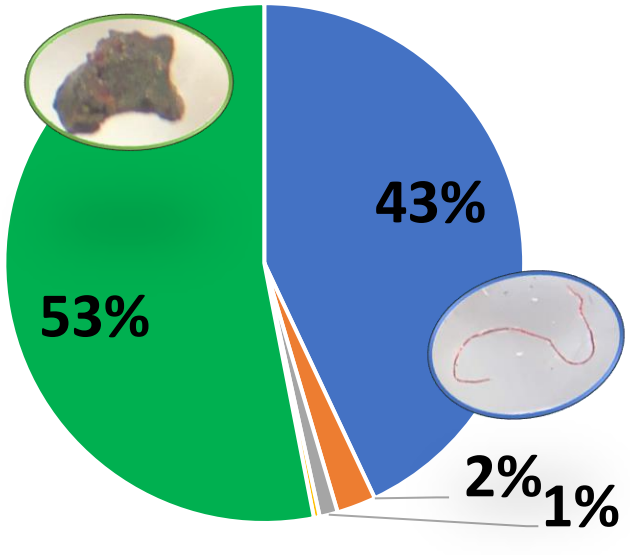
Sampling | **Sieving** | **Digestion** | **Density separation** | **Quantification** | **µFTIR**



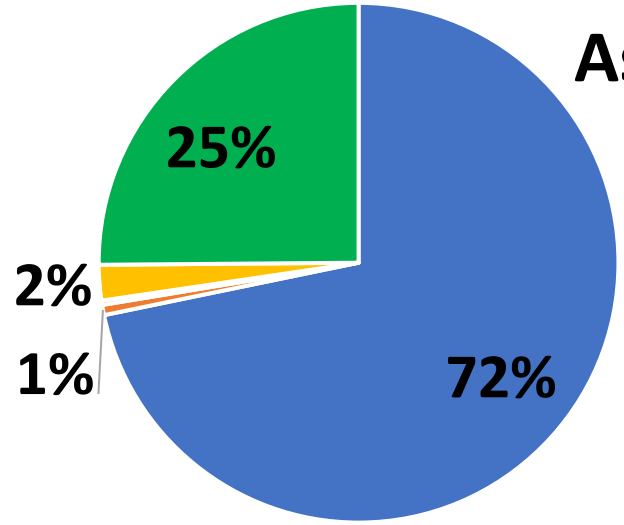
Preliminary Results
Part 1: Grab Samples

Grab Sample Morphologies

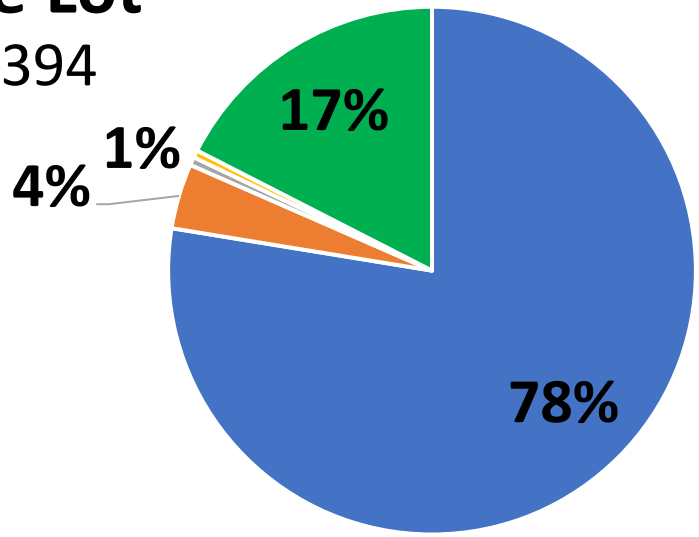
Asphalt Lot
n = 18,173

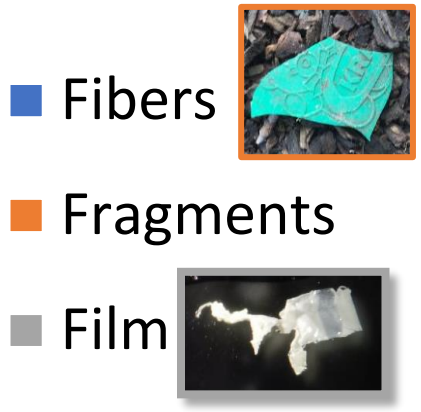


Asphalt Road
n = 5,444

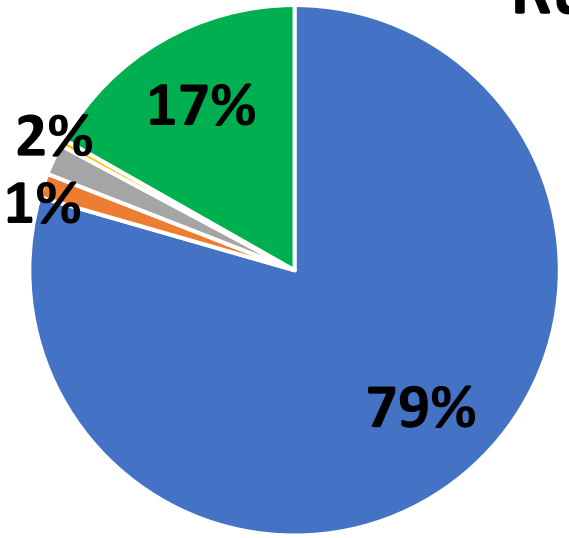


Concrete Lot
n = 6,394

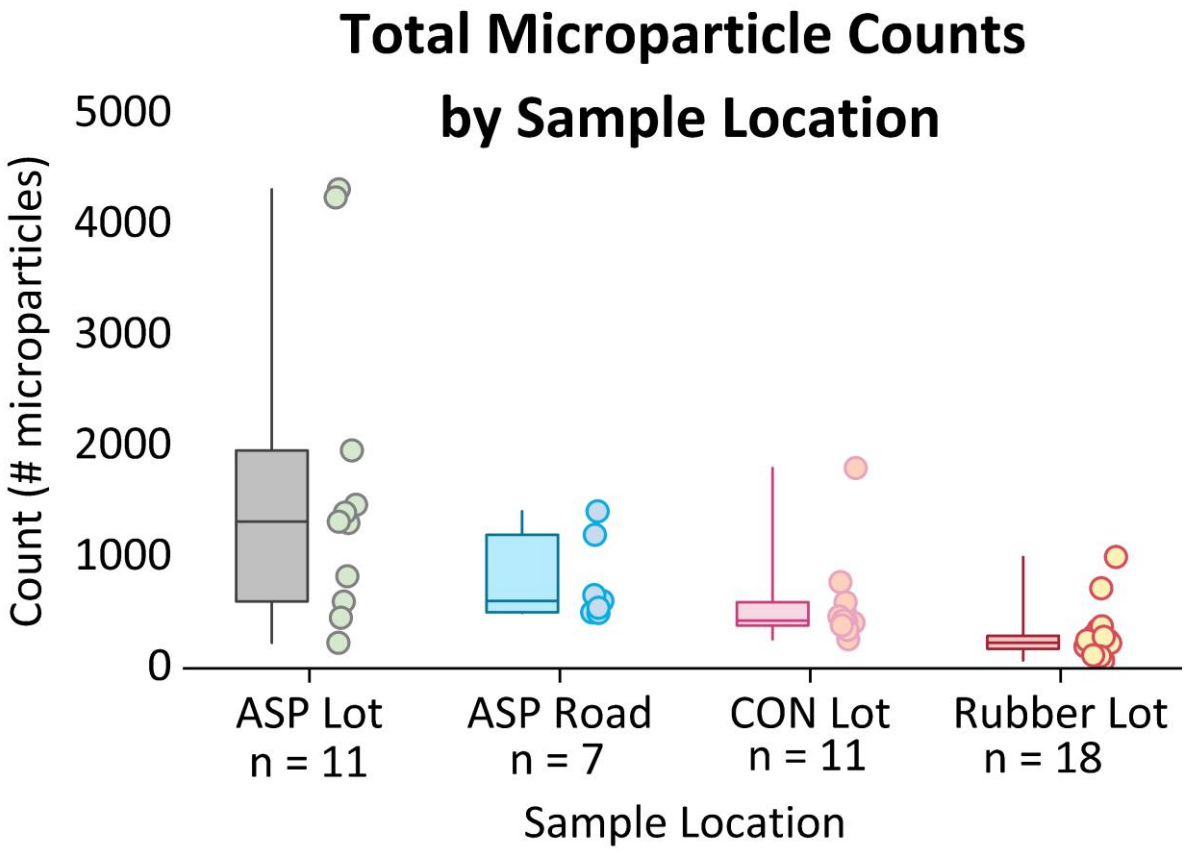


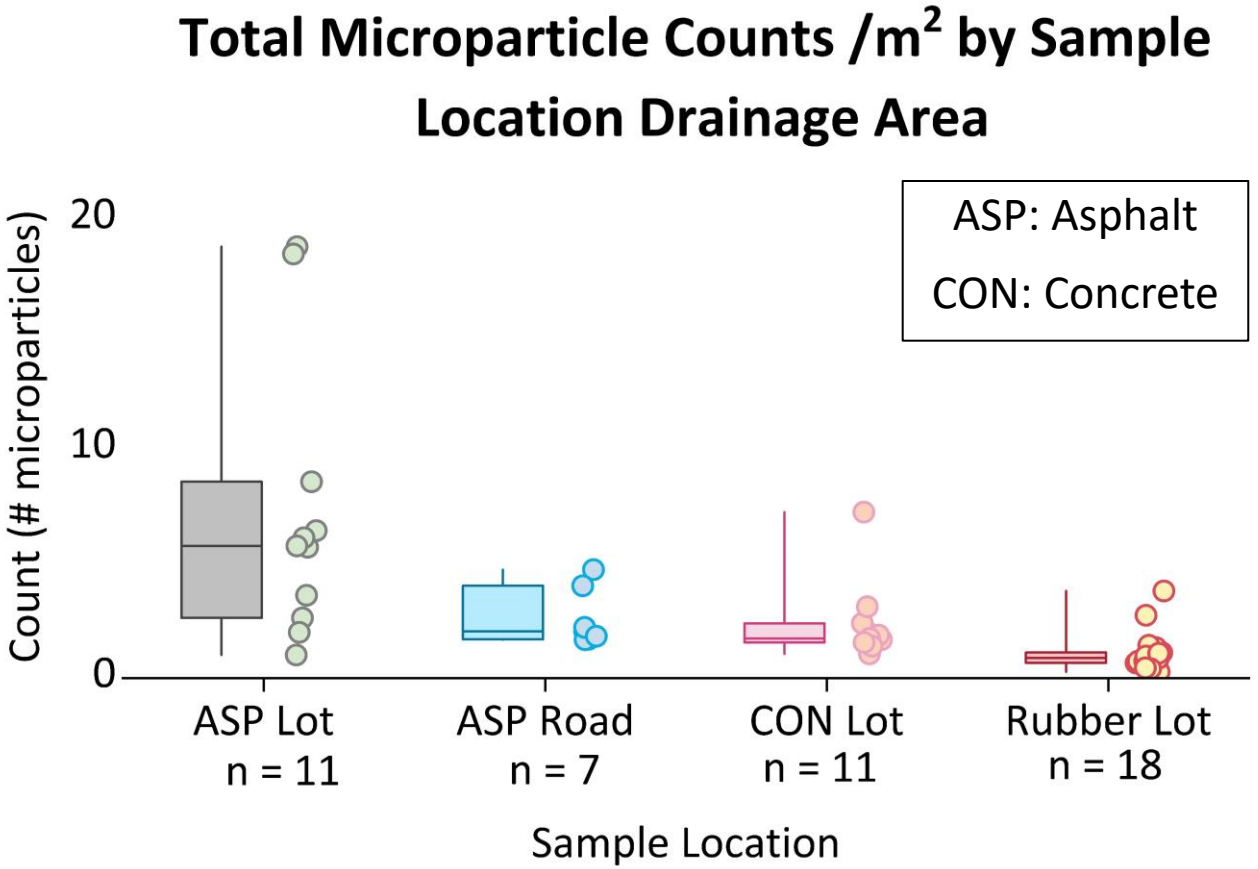


Rubber Lot
n = 5,138



Grab Sample Counts

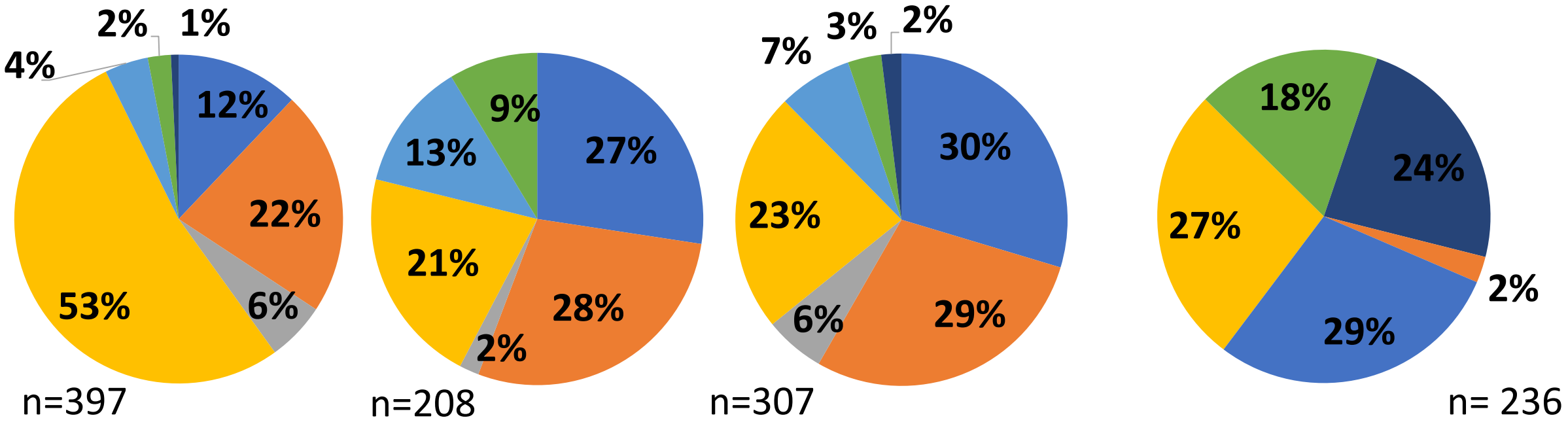




Field Blank Avg (n = 11): 14 ± 5 total microparticles

Polymer ID Results

µFTIR Analysis			Raman Analysis
Asphalt Lot	Asphalt Road	Concrete Lot	Rubber lot



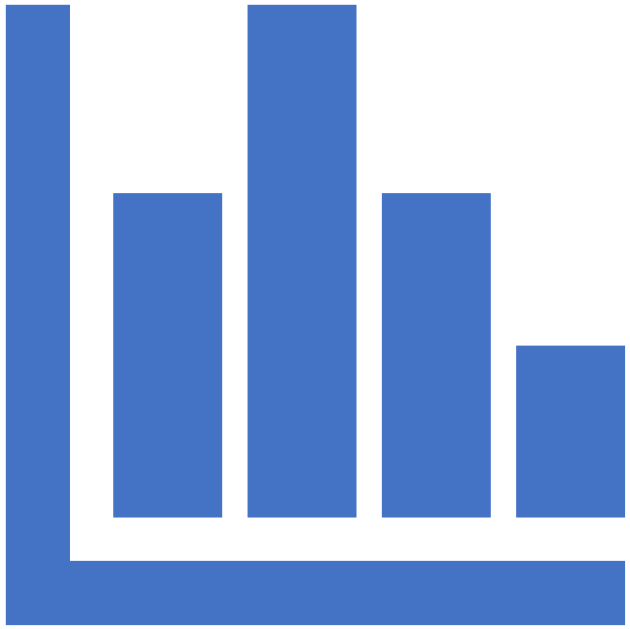
Main plastics and suspected sources

Plastic Types: Varied by Lot

- Polyester, Rayon, Paint, …

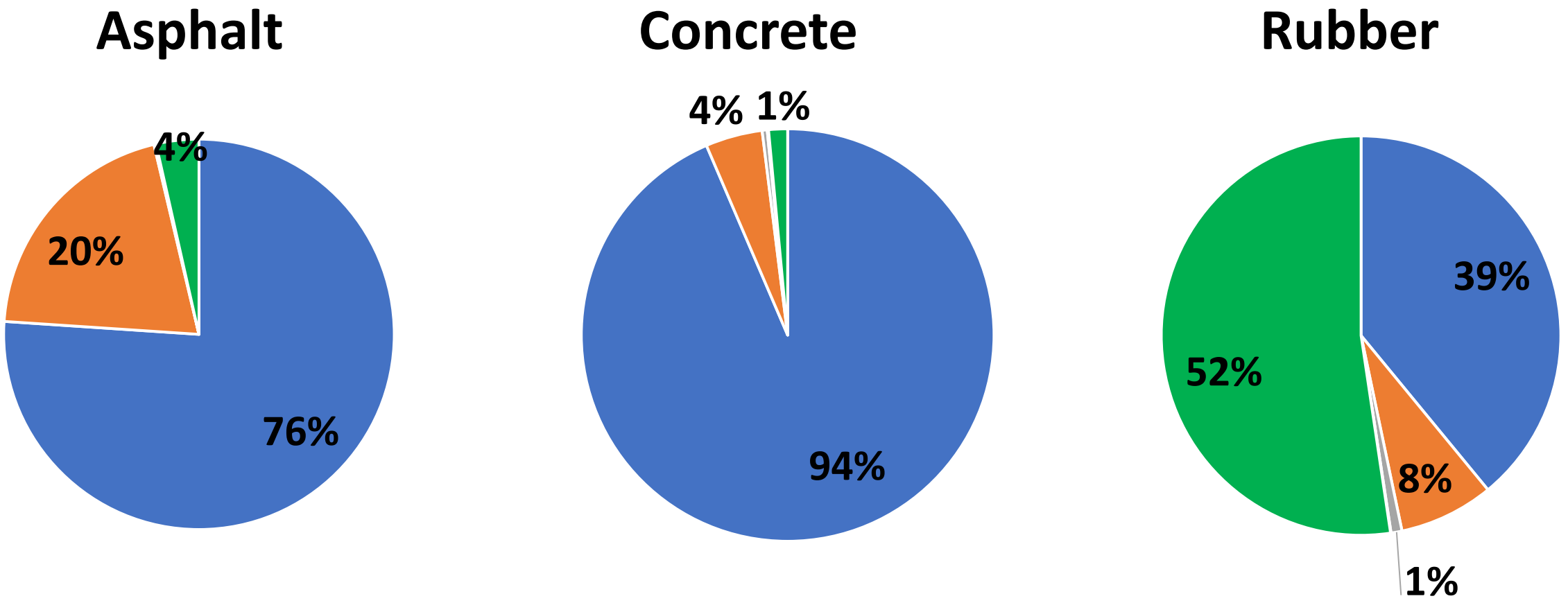
Sources?

- Abraded tire rubber
- Abraded pavement (rubber)
- Atmospheric deposition
- Plastic litter
- Synthetic textile fibers
- Paint (road markings)

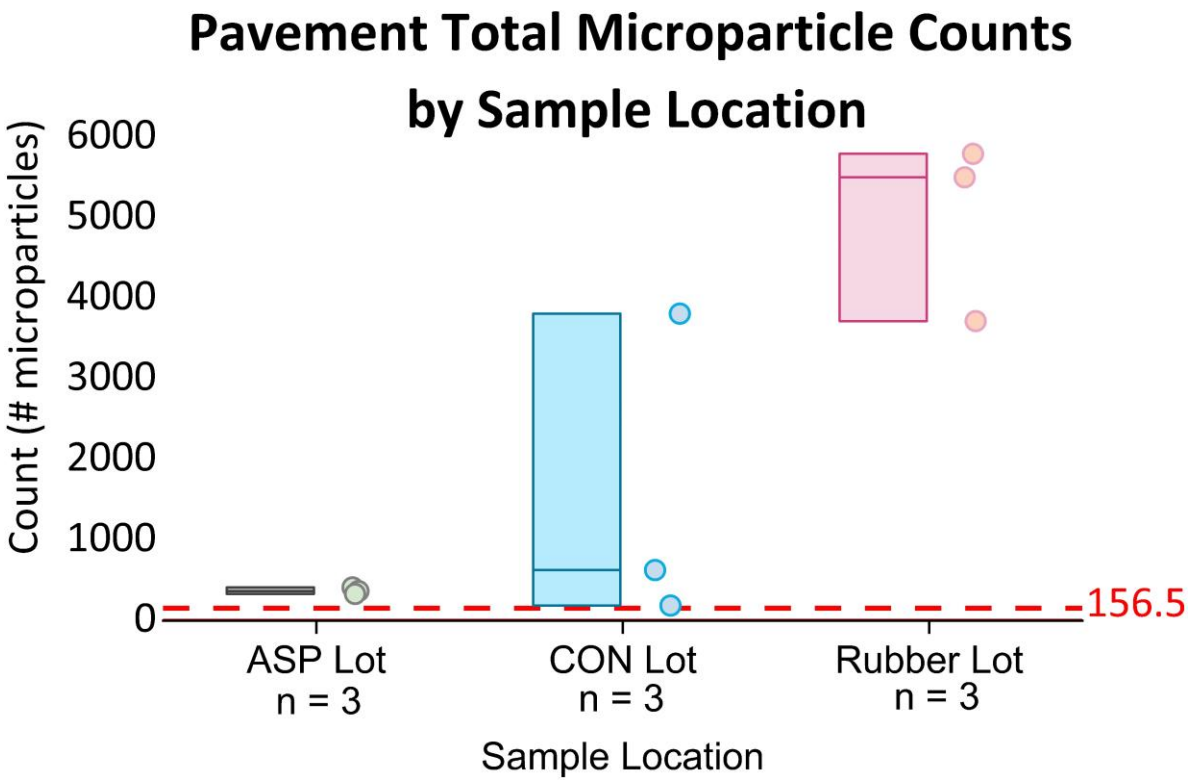


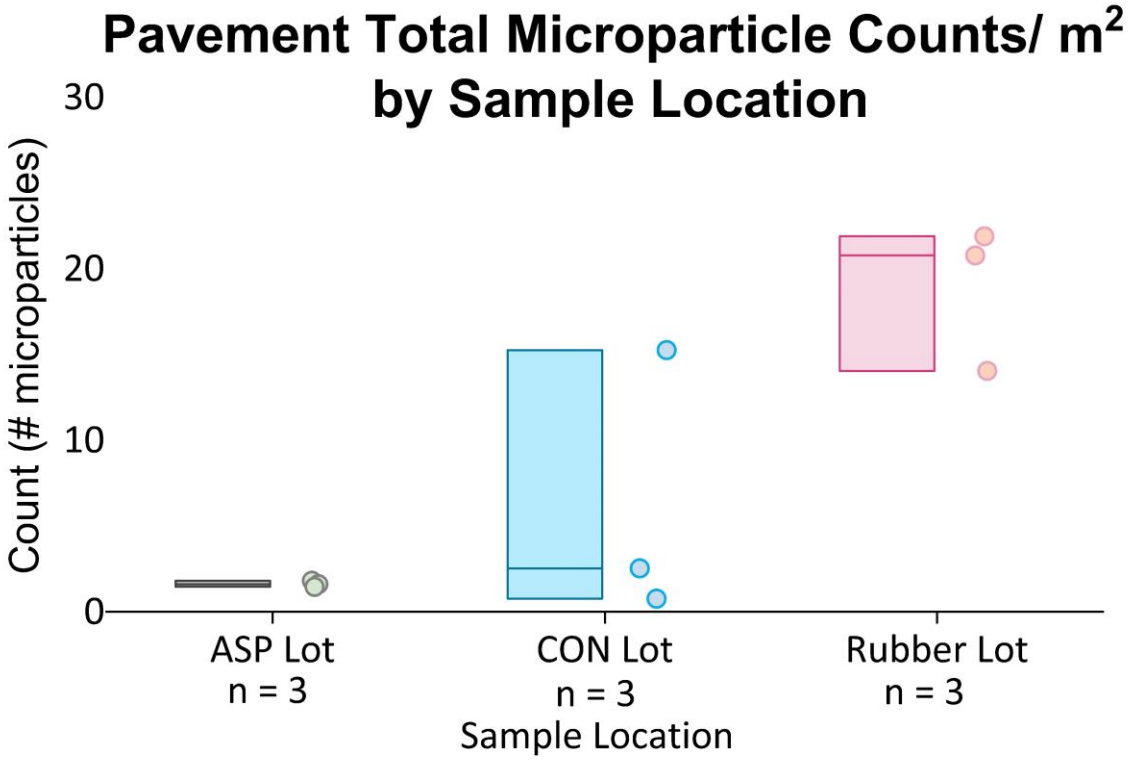
Preliminary Results Part 2: Pavement Specimens

Pavement Specimen Morphologies



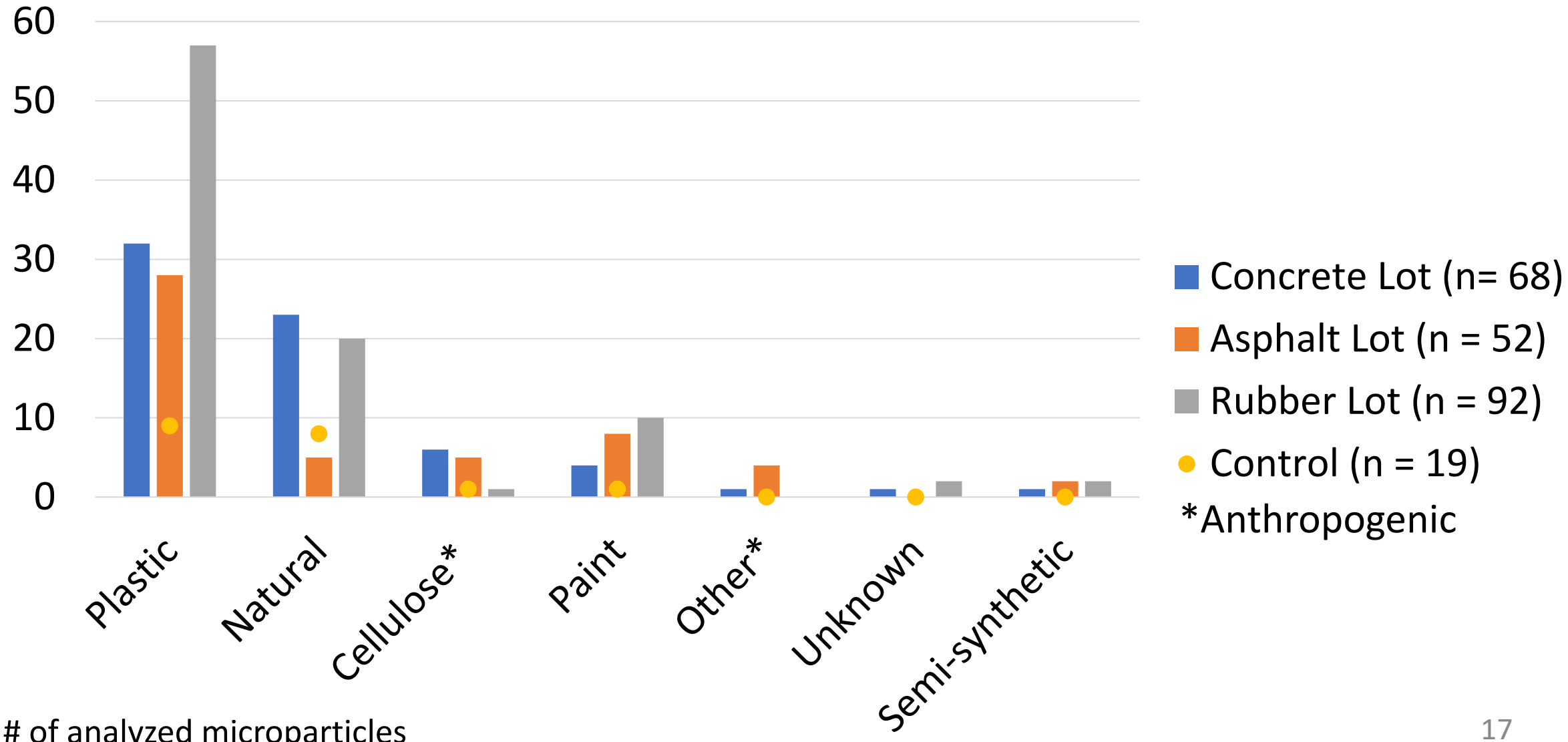
Pavement Microparticle Counts





ASP: Asphalt, CON: Concrete

Pavement Polymer ID Results



n: # of analyzed microparticles

Implications

- Road wear is a source of microplastics separate from tire wear
- Microparticle concentration highly related to traffic/pedestrians
- Abrasion may vary with pavement type and lot vs road
- Sampling method matters
  - Autosamplers vs grab sampling – different morphologies & counts
- Source control needed for road wear & tire wear particles
  - E.g. Bioretention
  - Many solutions needed!

Future Work

Chemical analysis

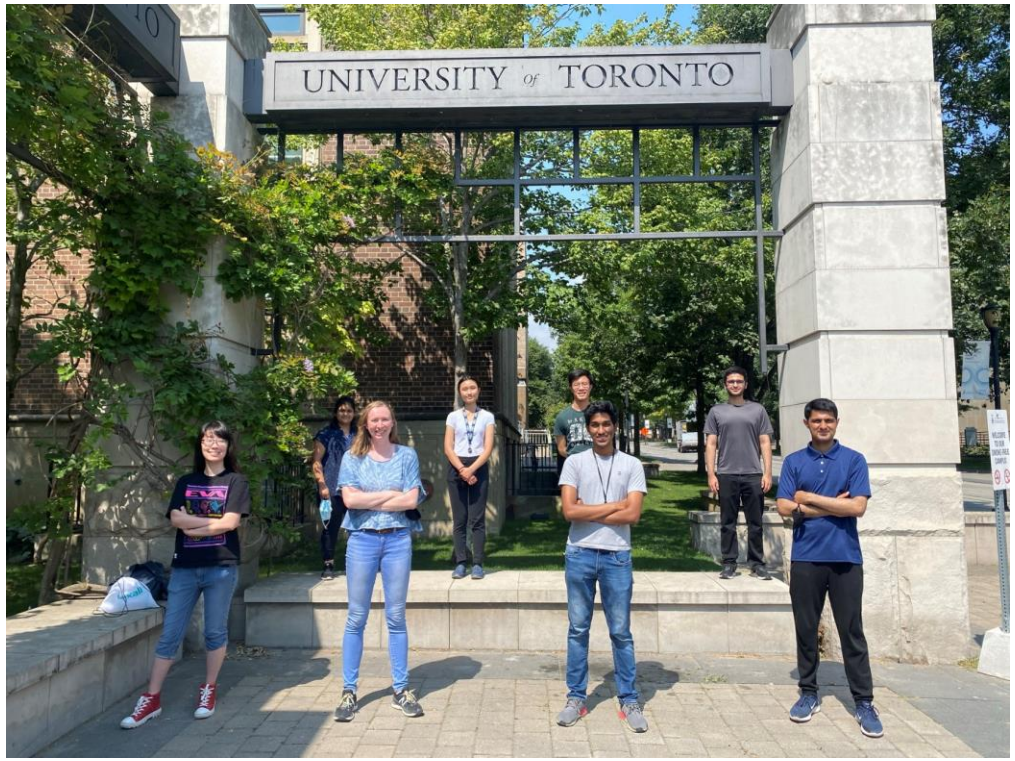
- Chemicals associated with tire & road wear

Rubber analysis

- Spectroscopy method limitations

Thank you!

Summer 2022:
Back row: William Wen & Michael Chan, Front row: Savannah Bryne, Christina Pizzonia & Shuyao Tan



Summer 2021:
Back row: Shamsunnahar Suchana, Cassidy Tan Yao Sheng Chai, Harsh Ganatra. Front row: Shuyao Tan, Ravindu Samarasekera & Naman Mamtani,