



Splash and spray assessment tool

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Background

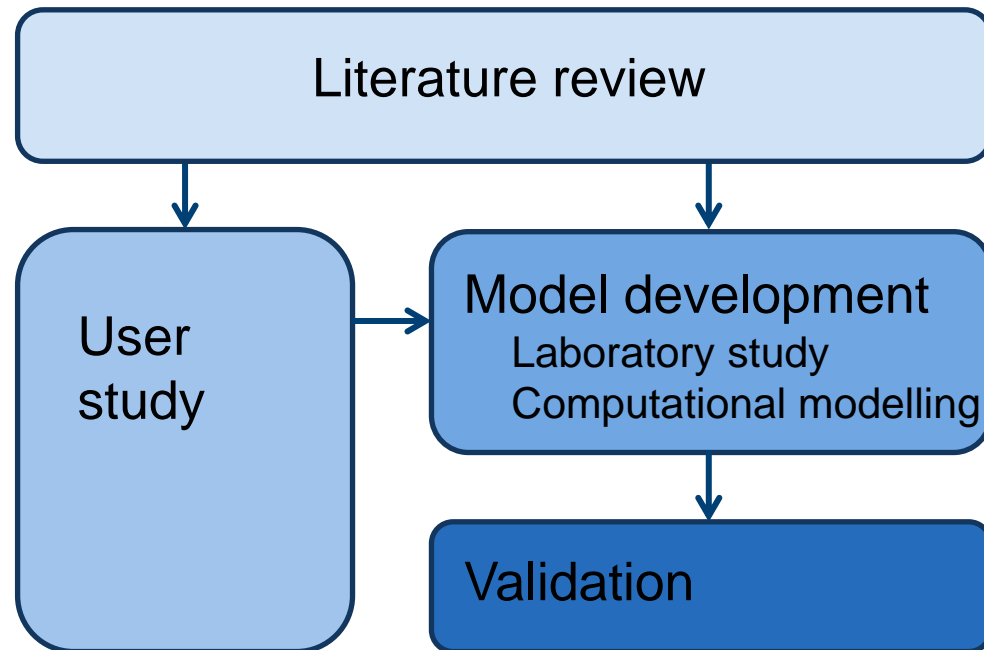
- Splash and spray contribute to a small but measureable number of accidents
- Nuisance to motorists
- Contamination and pollutants
- Road geometry and surface characteristics contribute to splash and spray
- Tool to assist design, or indicate mitigation strategies



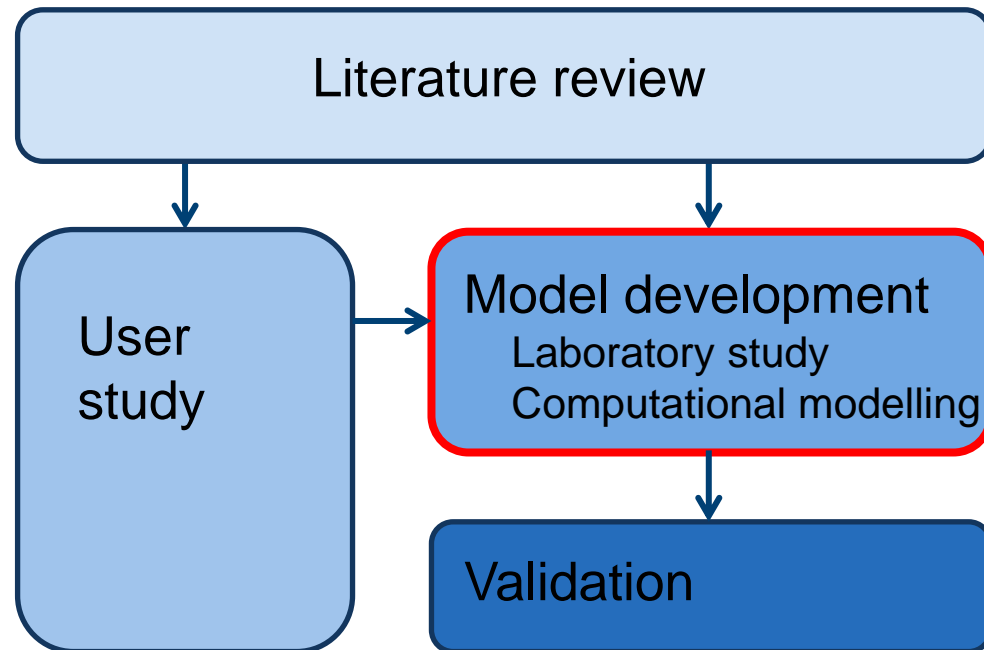
Project client and partners



Stages of development



Stages of development



Water depth model

- Literature search found a number of equations predicting water depth
- Similar general form:

$$d = k T^w L^x I^y S^z$$

Where

T = texture depth

L = drainage length

I = rainfall rate

S = slope

- Values of k, w, x, y, z to be determined through experimentation on relevant range of surfaces

Water depth - Flume experiment



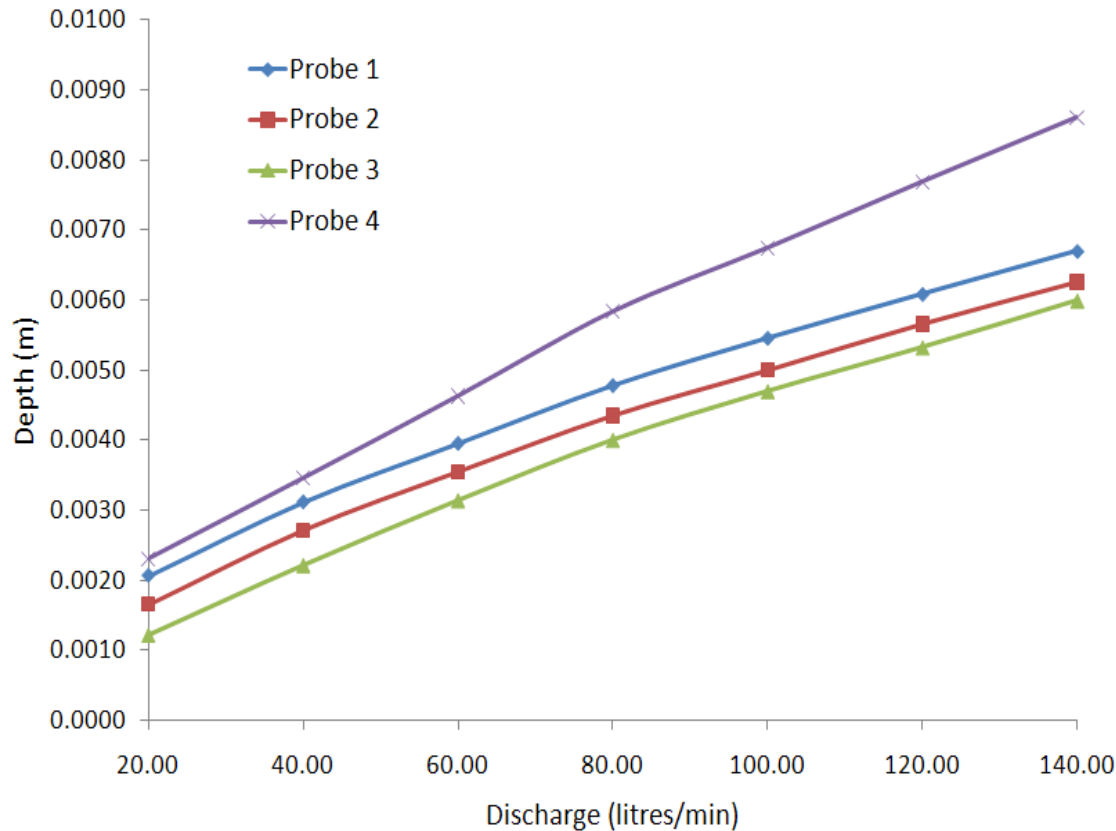
- Determine k , W , X , Y , Z by experimentation
- Slabs of various surface types
- Various 'rainfall' rates
- Various slopes

Water depth - Flume experiment



| Surface type | Texture (MPD) |
|------------------|---------------|
| SMA | 0.55 |
| Asphalt concrete | 0.63 |
| Smooth concrete | 0.21 |
| Tined concrete | 1.01 |
| OGFC | 1.64 |
| Perspex | 0.001 |

Water depth - Flume experiment

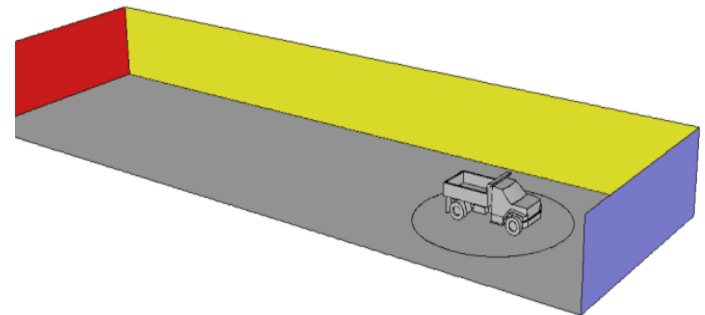
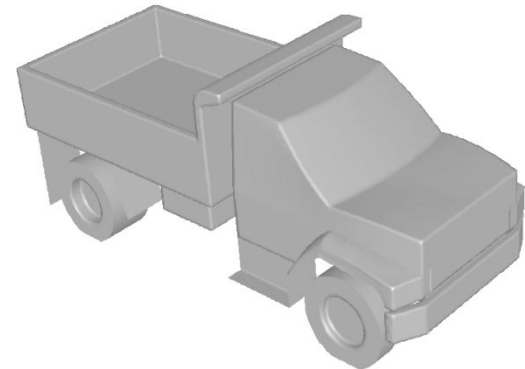


Multiple linear regression of the data

$$d = 5.9 \times 10^{-4} T^{0.087} (LI)^{0.59} S^{-0.33}$$

Splash Spray model - CFD

- CFD model consists of a dump truck and sedan car within a rectangular tube
- A turbulent air stream passes through this
- Overall velocity of the air stream chosen to represent the desired truck velocity



Splash Spray model – release of water droplets

- Weir model
 - Capillary adhesion
 - Tread pickup
 - Bow wave
 - Side wave

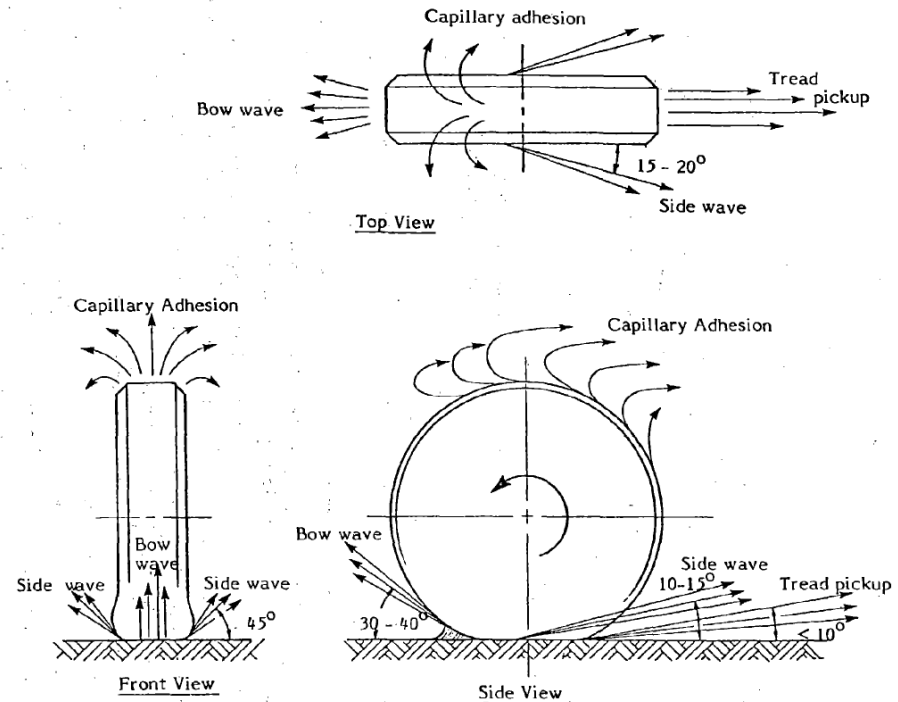
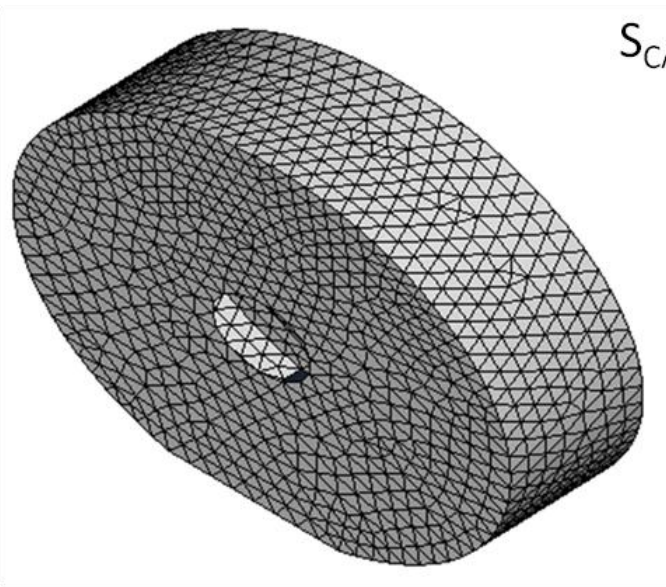


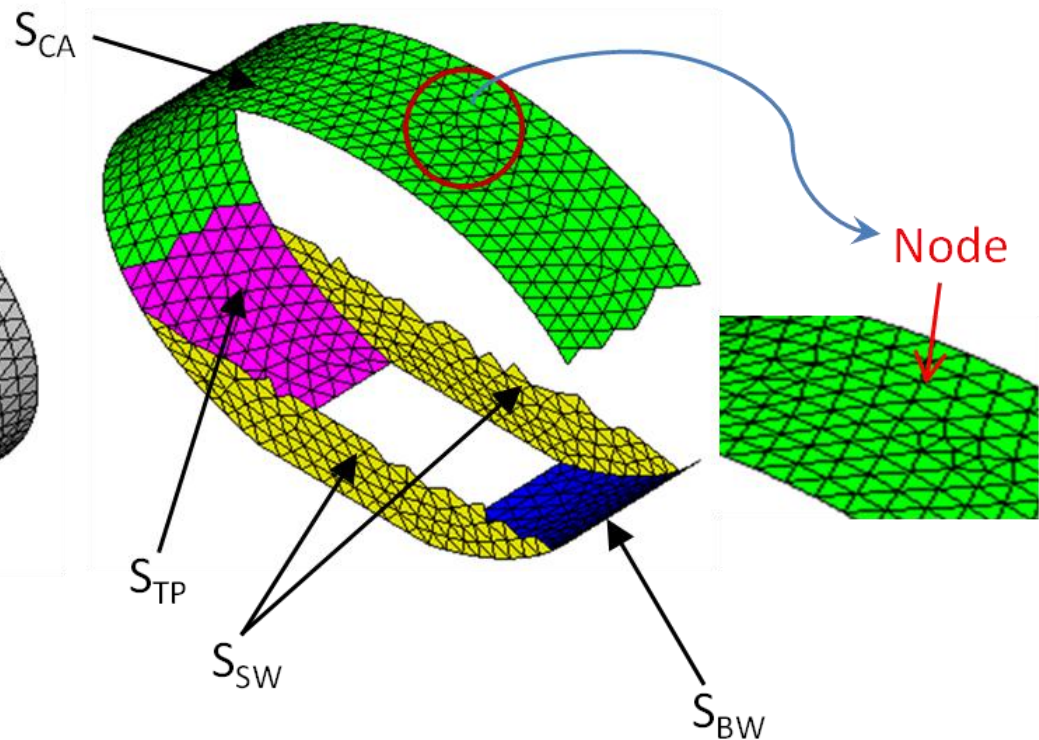
Diagram reproduced from Weir (1978)

Splash Spray model – release of water droplets

Front wheel

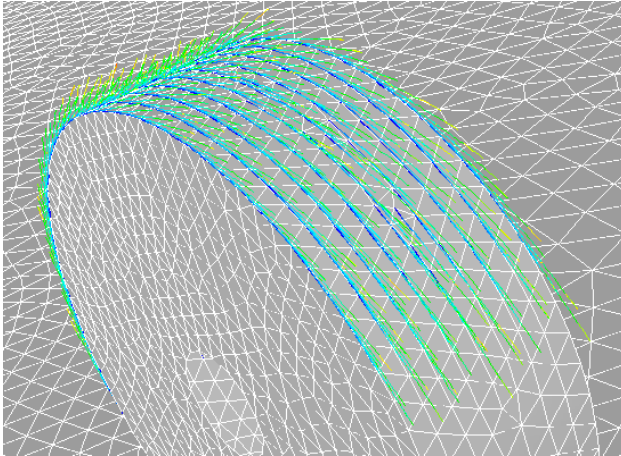


Surfaces (S) for droplets release

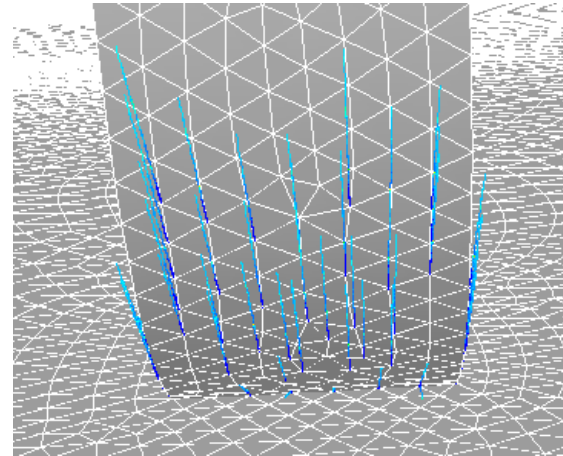


Splash Spray model – release of water droplets

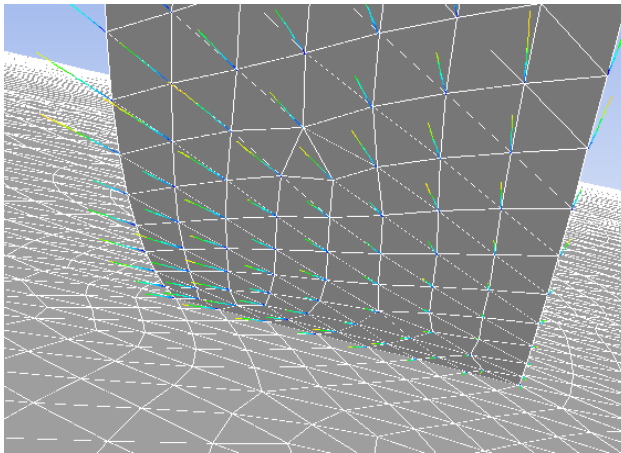
CA



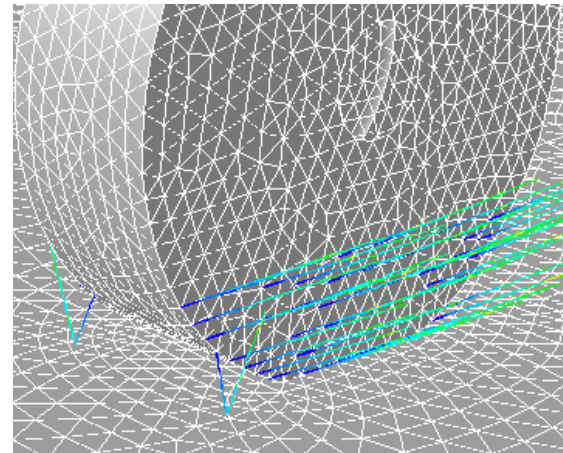
TP



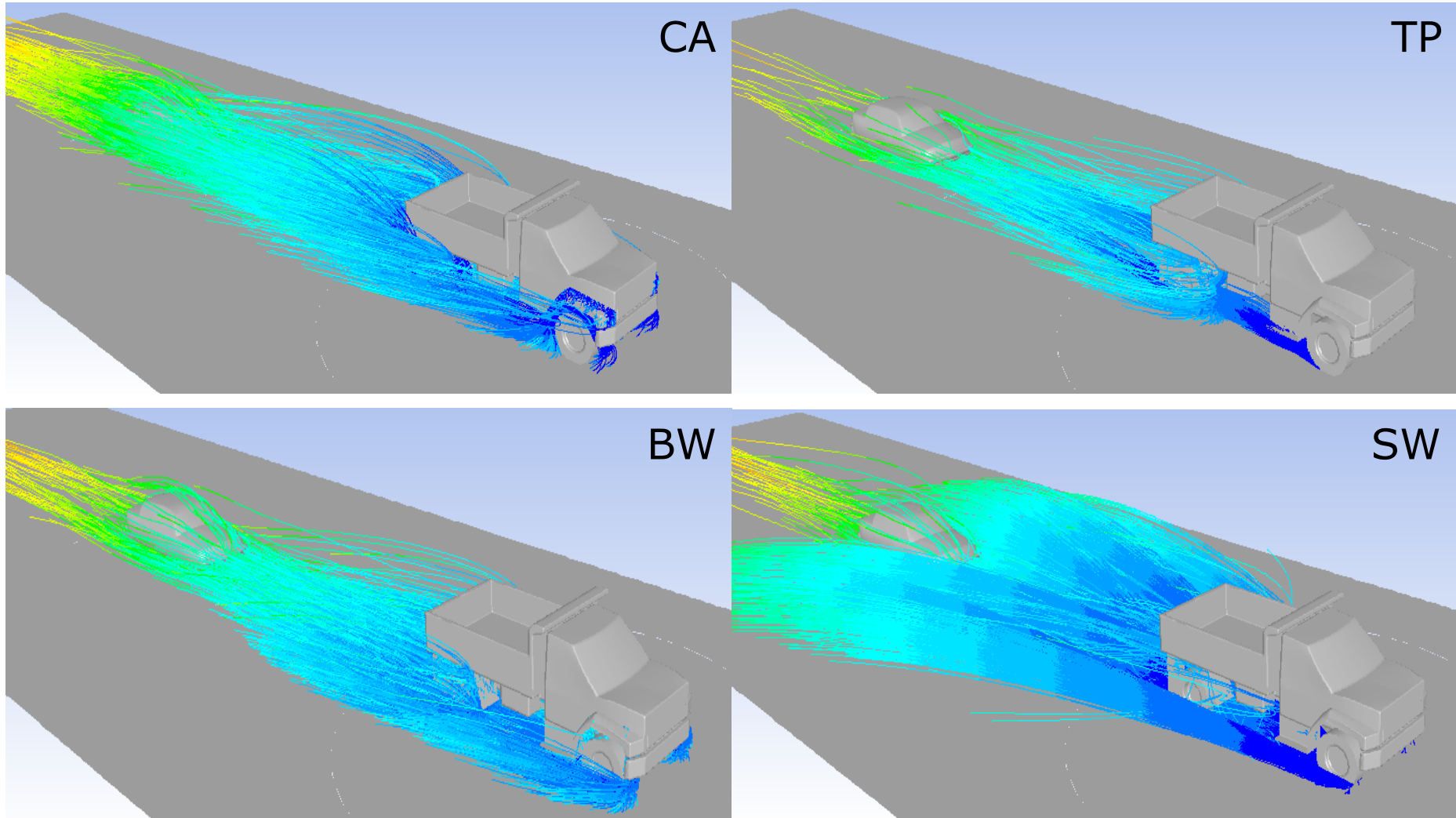
BW



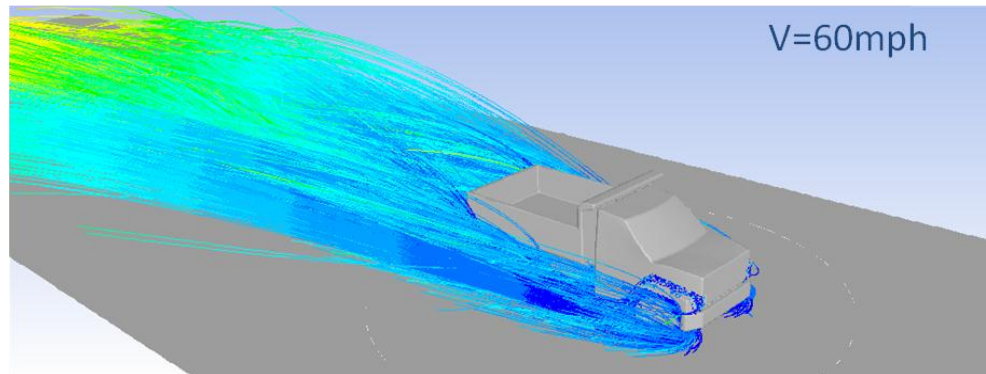
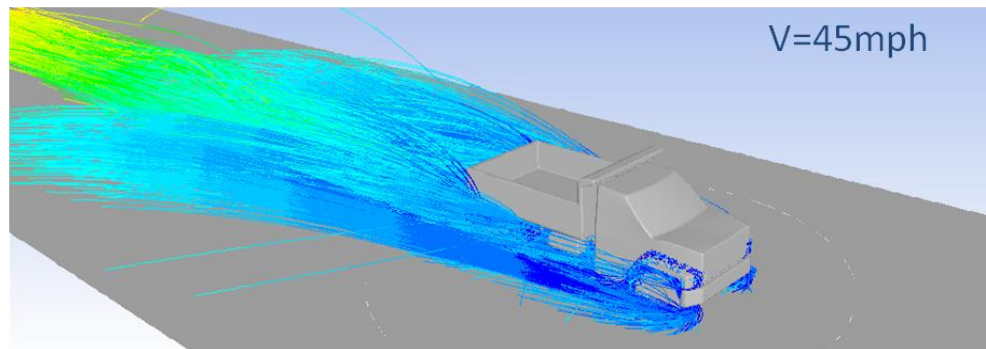
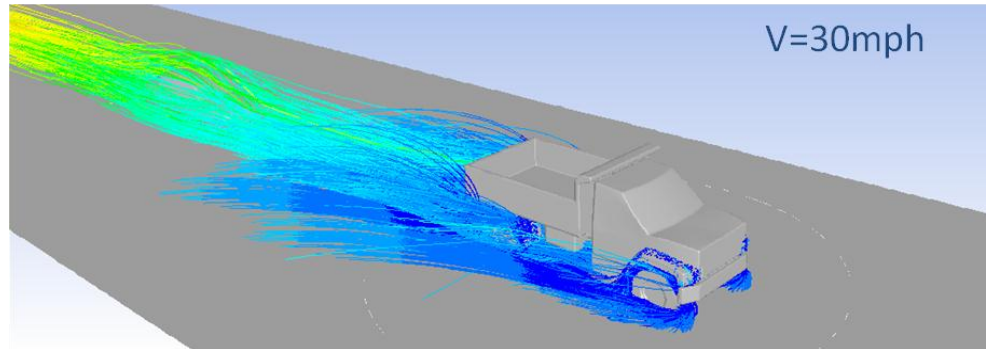
SW



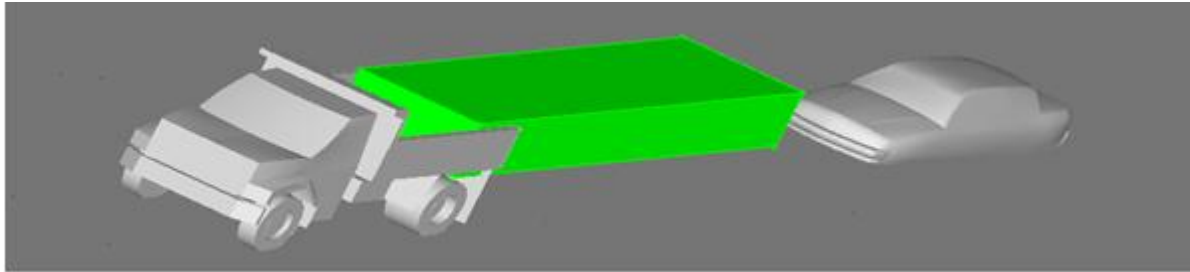
Splash Spray model – CFD for individual mechanisms



Splash Spray model – speed



Splash Spray model – characterisation



$$SD_{CA} = (-2.69 \cdot 10^{-5} \cdot V' + 2.43 \cdot 10^{-3})MR_{CA}$$

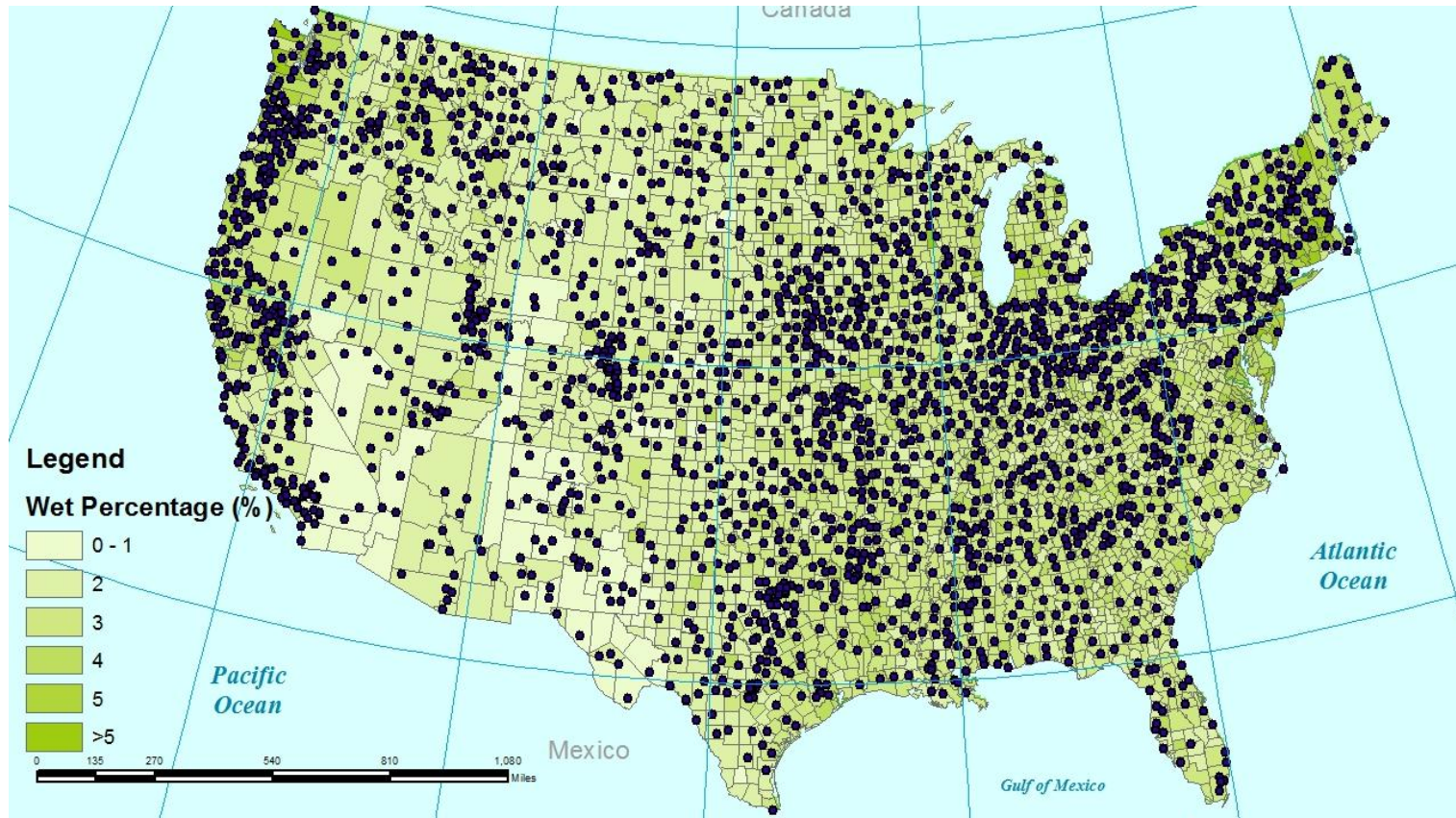
$$SD_{TP} = (1.16 \cdot 10^{-5} \cdot V' - 5.25 \cdot 10^{-5})MR_{TP}$$

$$SD_{BW} = (2.67 \cdot 10^{-5} \cdot V' - 4.71 \cdot 10^{-4})MR_{BW}$$

$$SD_{SW} = (1.65 \cdot 10^{-5} \cdot V' - 3.99 \cdot 10^{-4})MR_{SW}$$

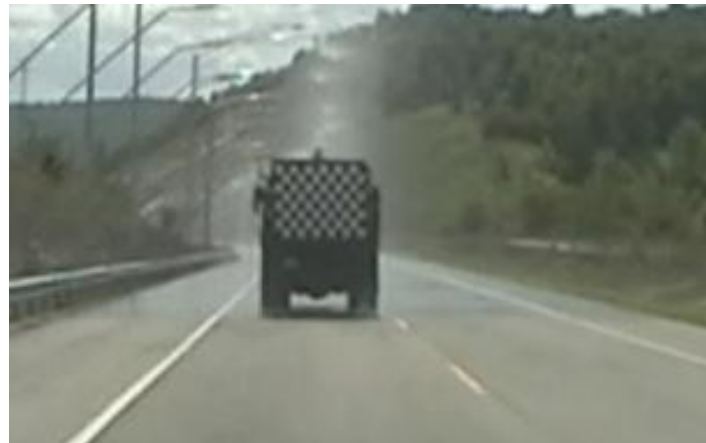
$$SD_W = SD_{CA} + SD_{TP} + SD_{BW} + SD_{SW}$$

Exposure model – meteorological data

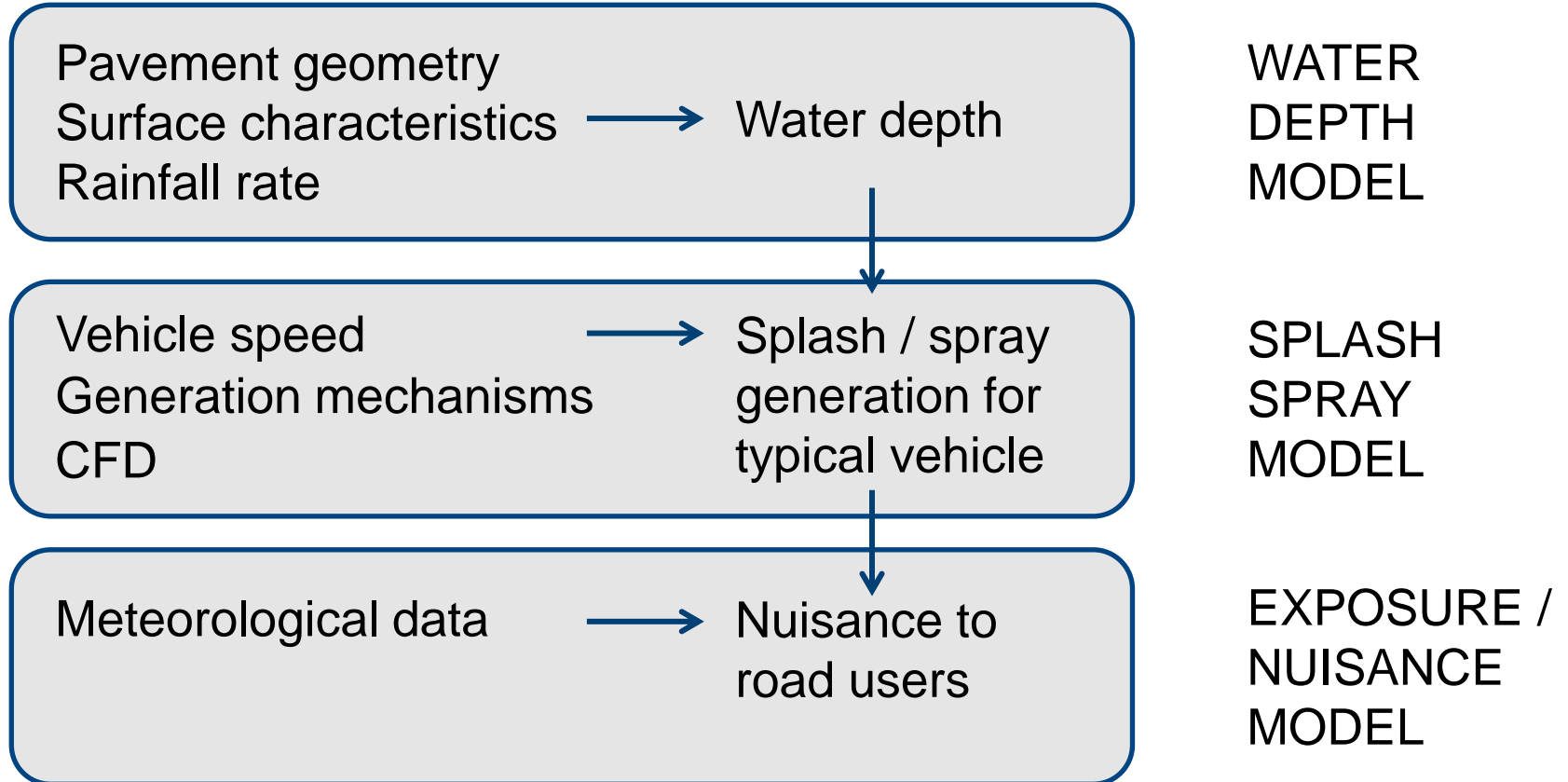


Exposure model – user nuisance

- User perception study
- Videos:
 - Passing
 - Following
 - Dump truck
 - Tractor / trailer
 - Sedan / SUV
- Occlusion factor from chequerboard

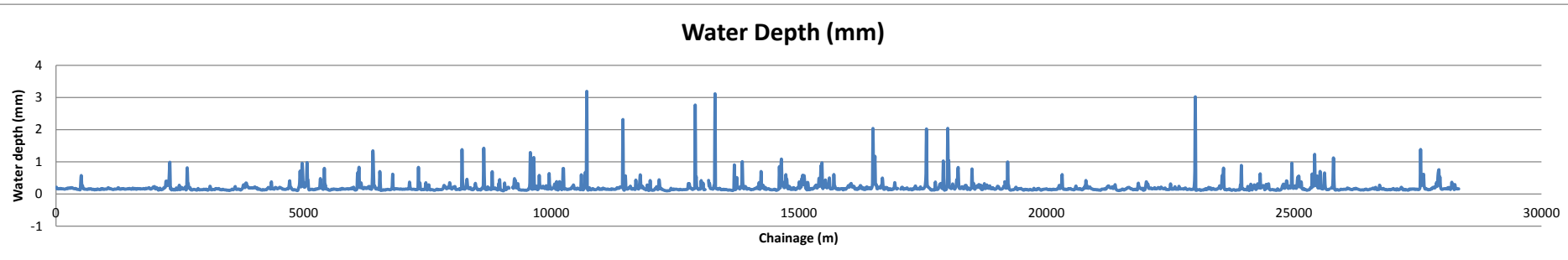


Model development - final



Model development - example

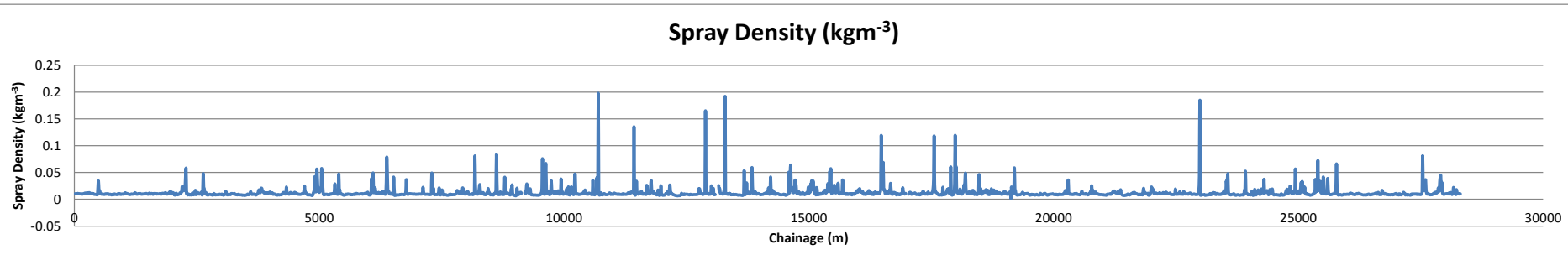
- Crossfall + Gradient + Texture + Rainfall = ...



- + CFD = ...

Model development - example

- Spray Density



- Identify 'hot spots' for mitigation measures
 - Different surfacing
 - Realignment

Thank you

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