Simulating the Impacts of Retention Basins on Erosion Potential in Urban Streams using SWAT

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City of Austin

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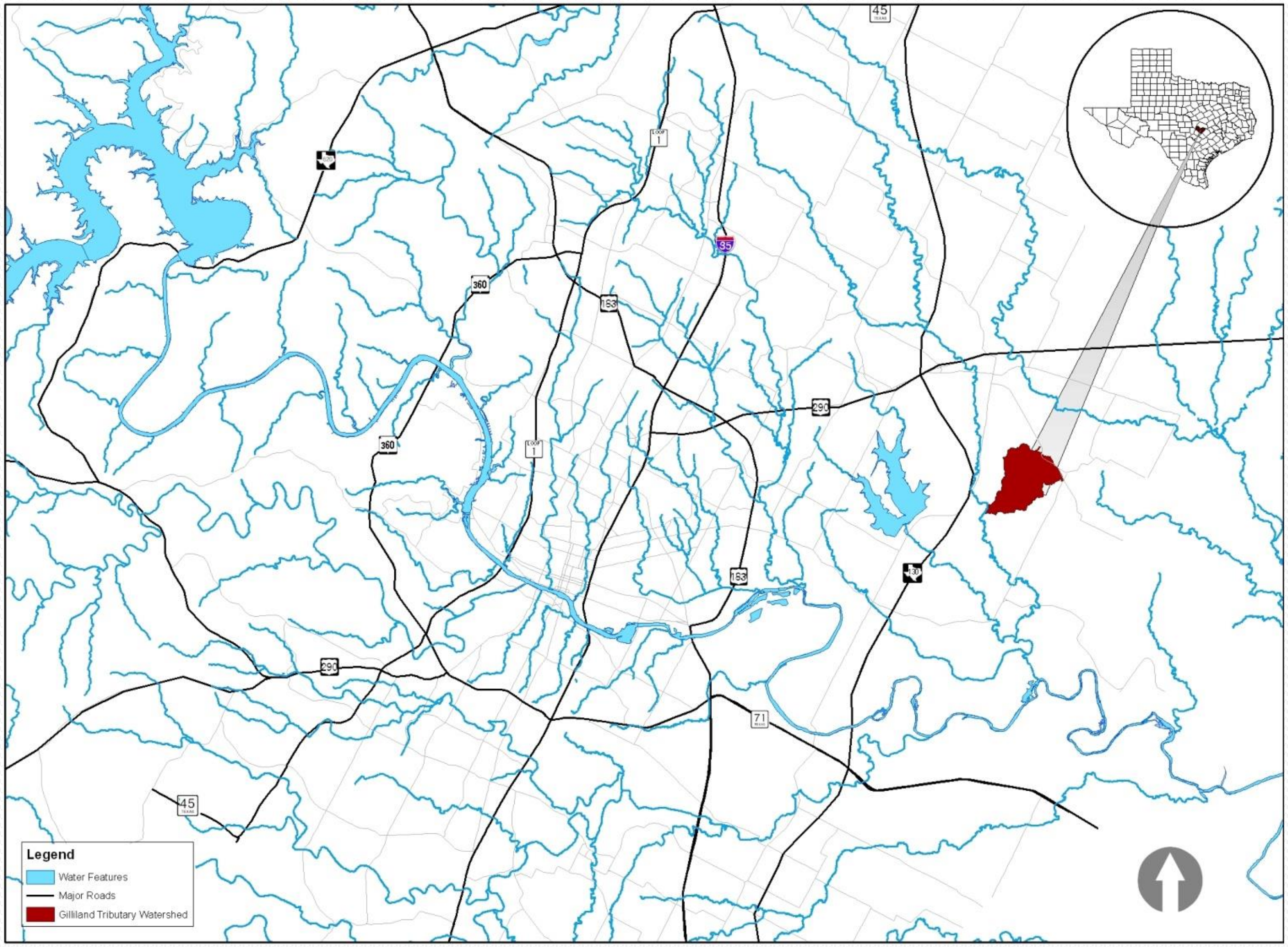
Toulouse, France
Université Paul-Sabatier

Study area



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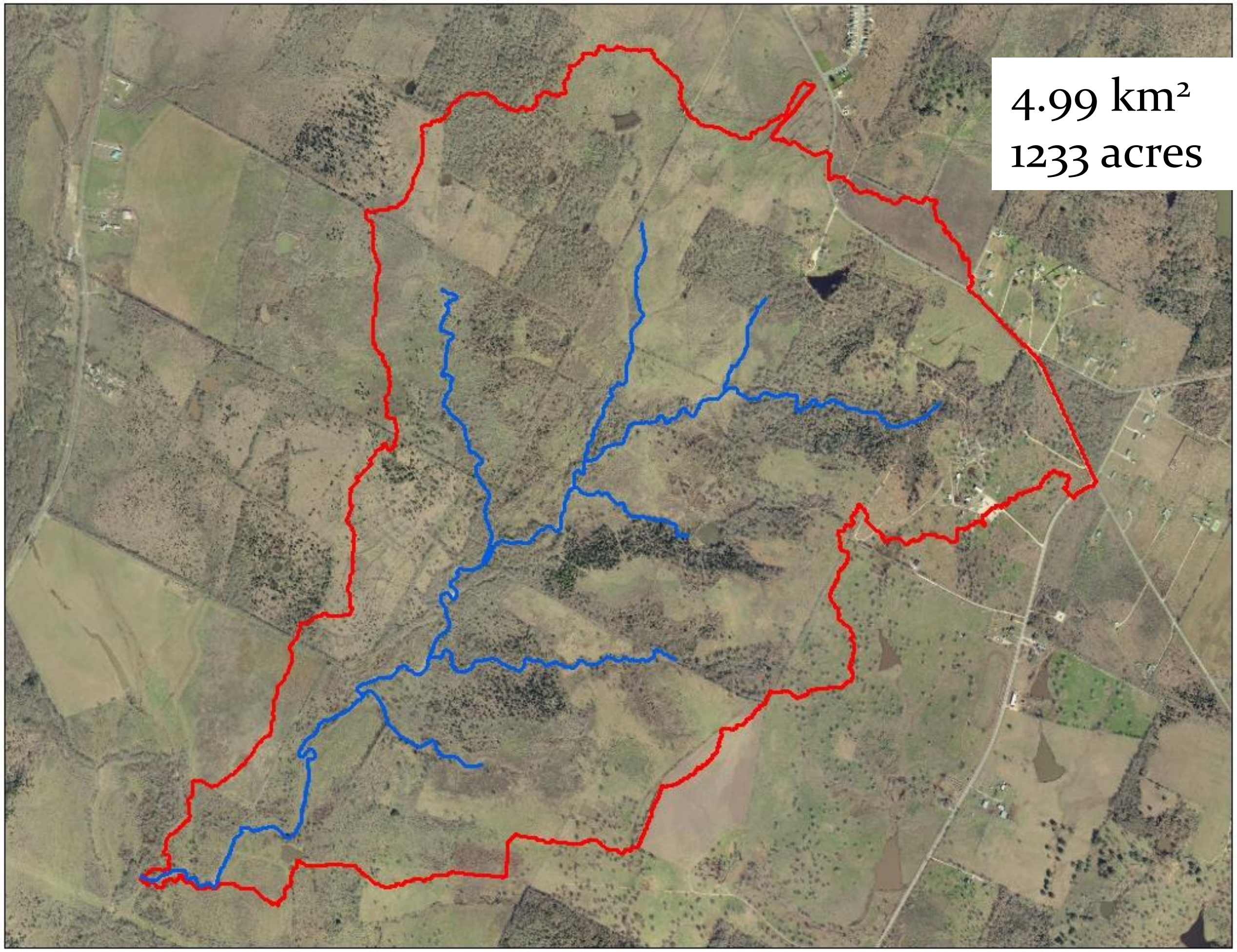
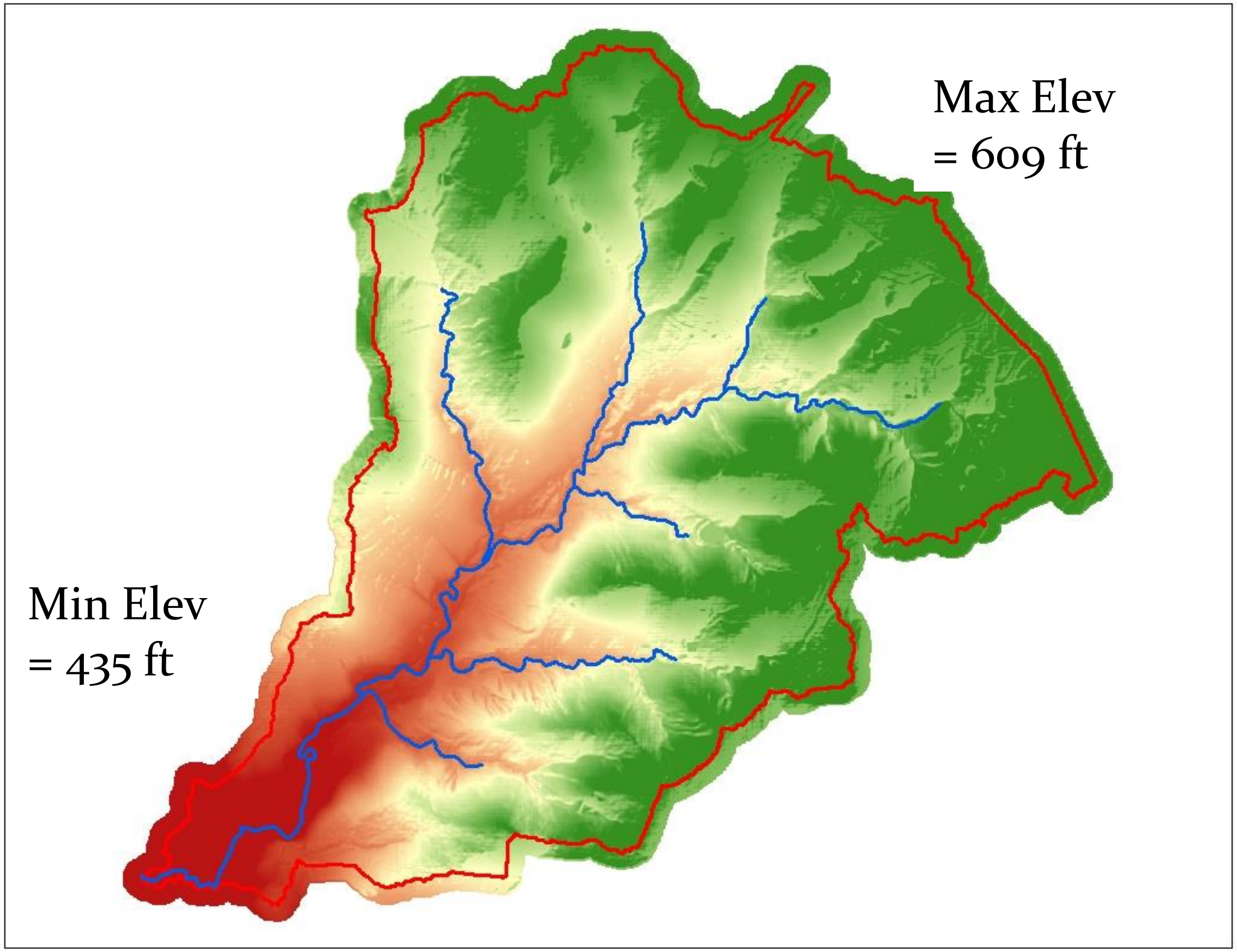
Study Watershed: Tributary to Gilleland Creek



Elevation Data



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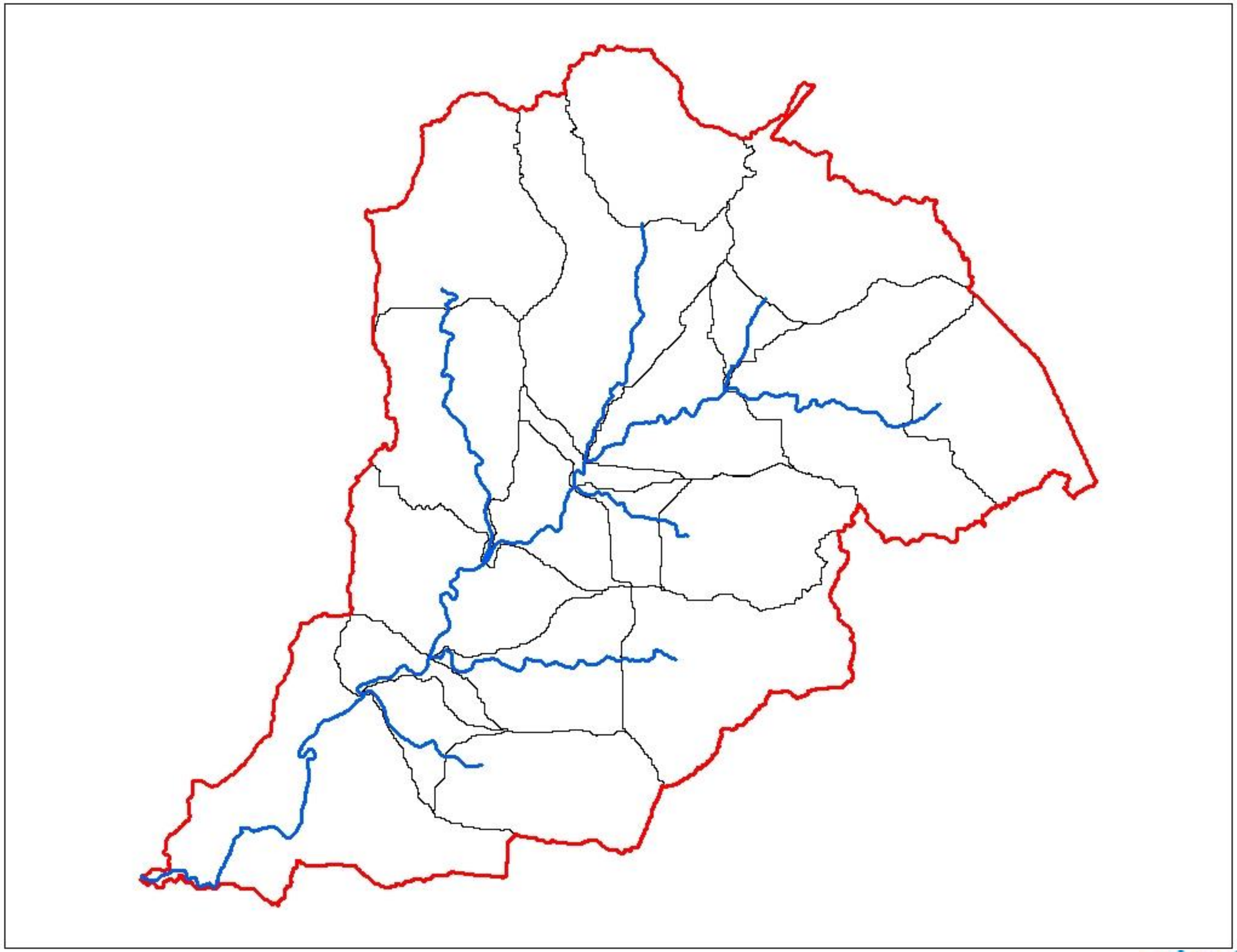
Model Sub-basins



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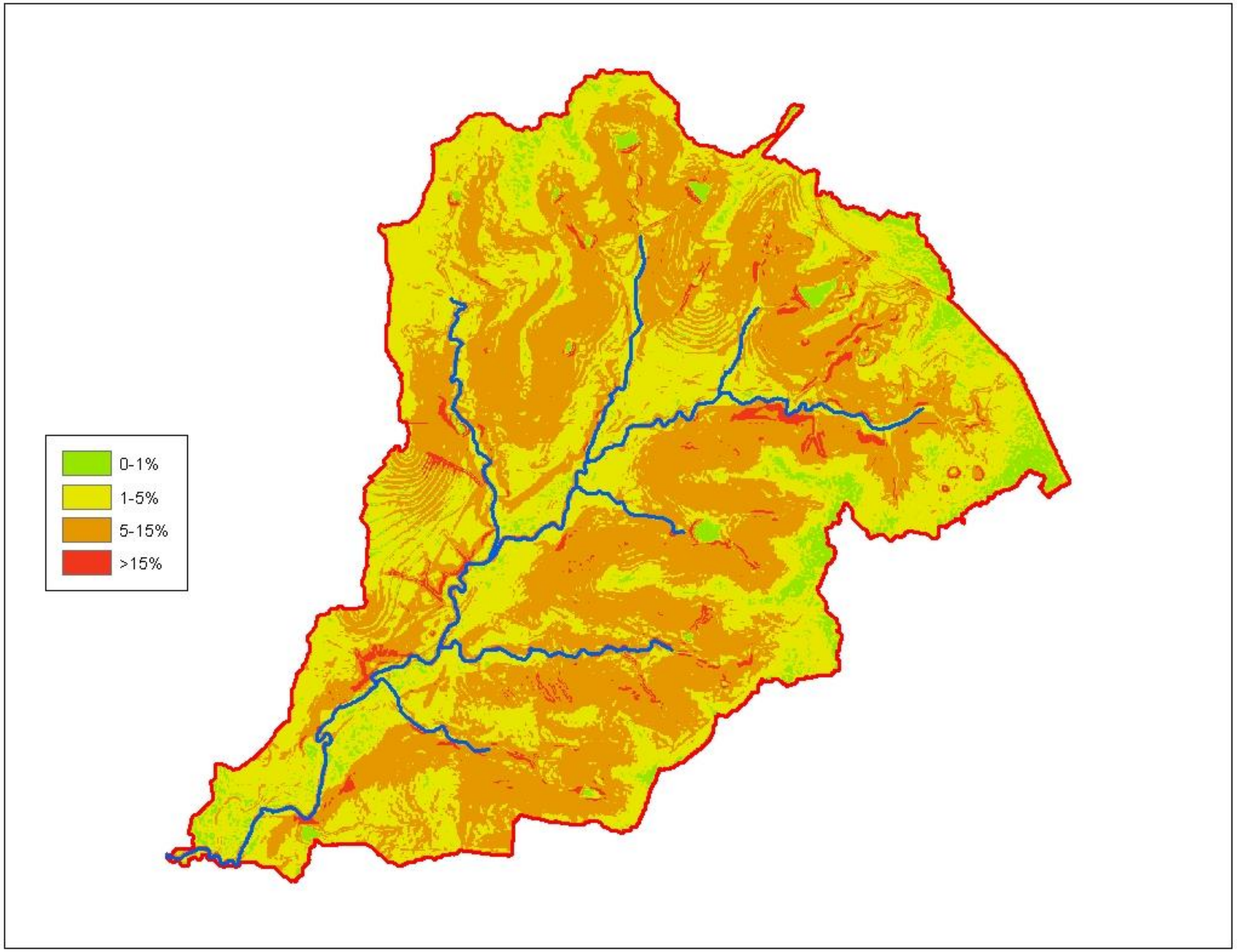
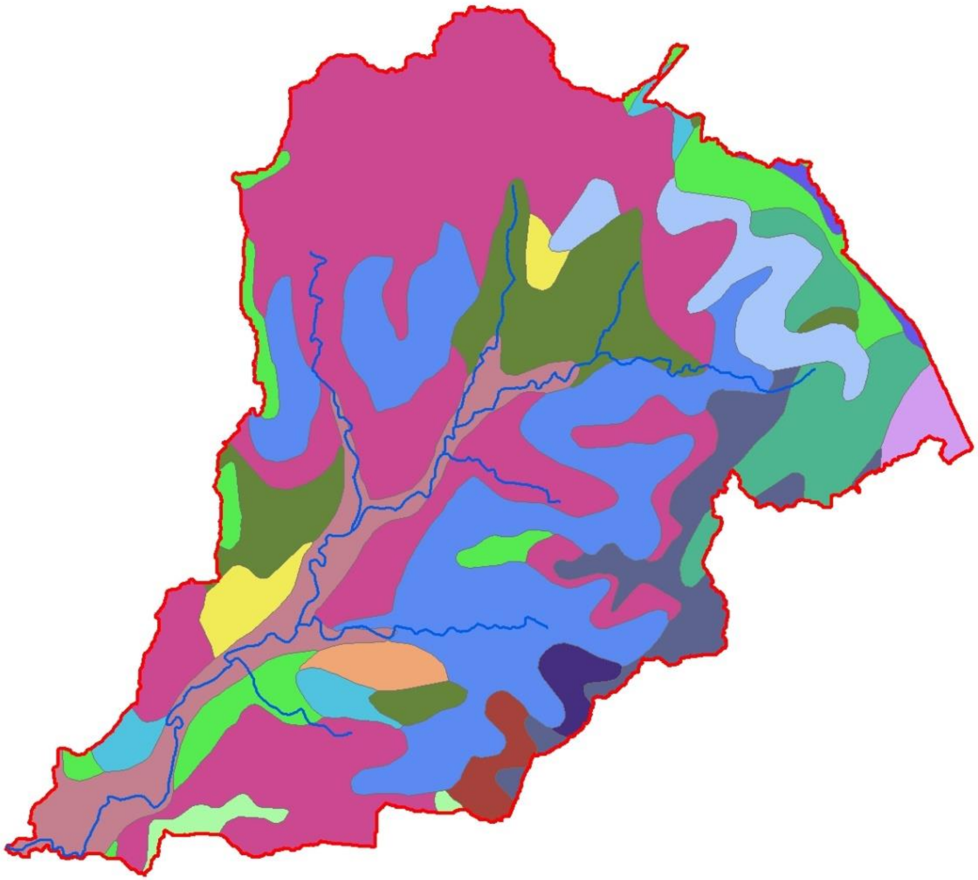
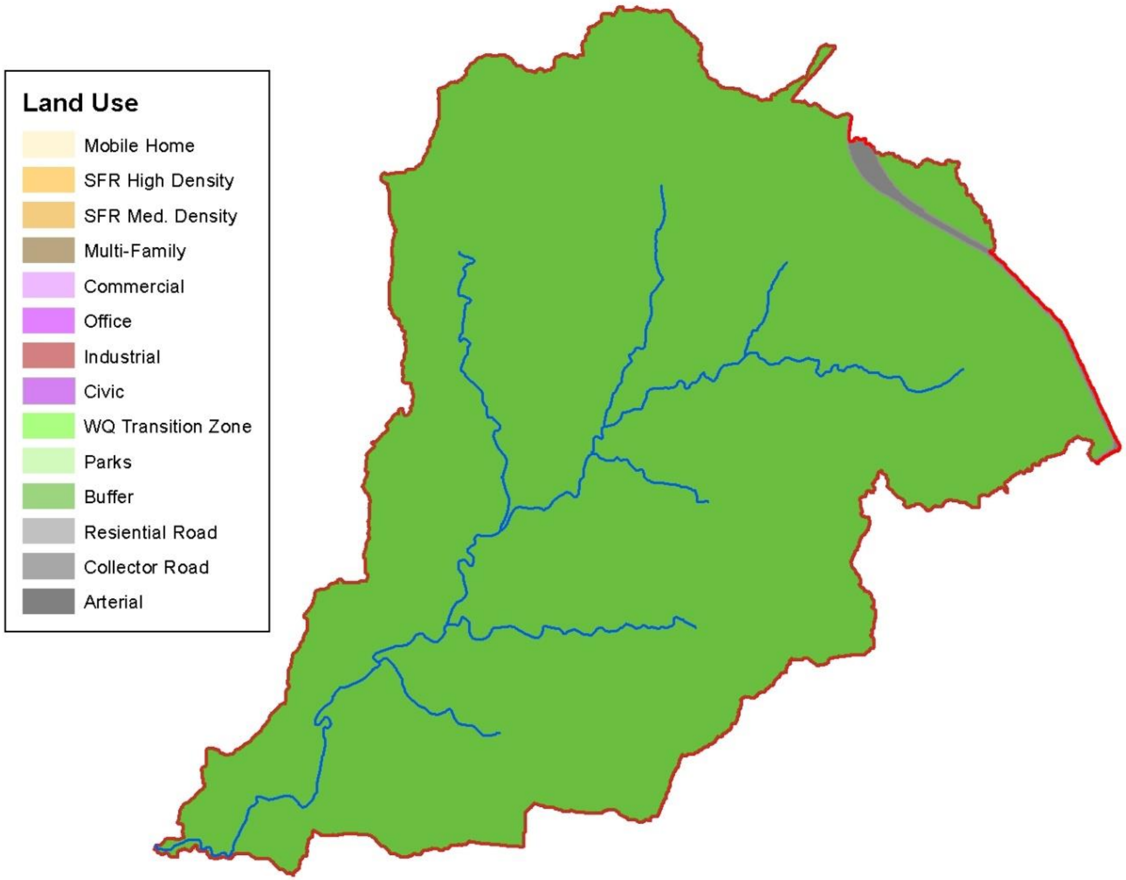
Site Slopes



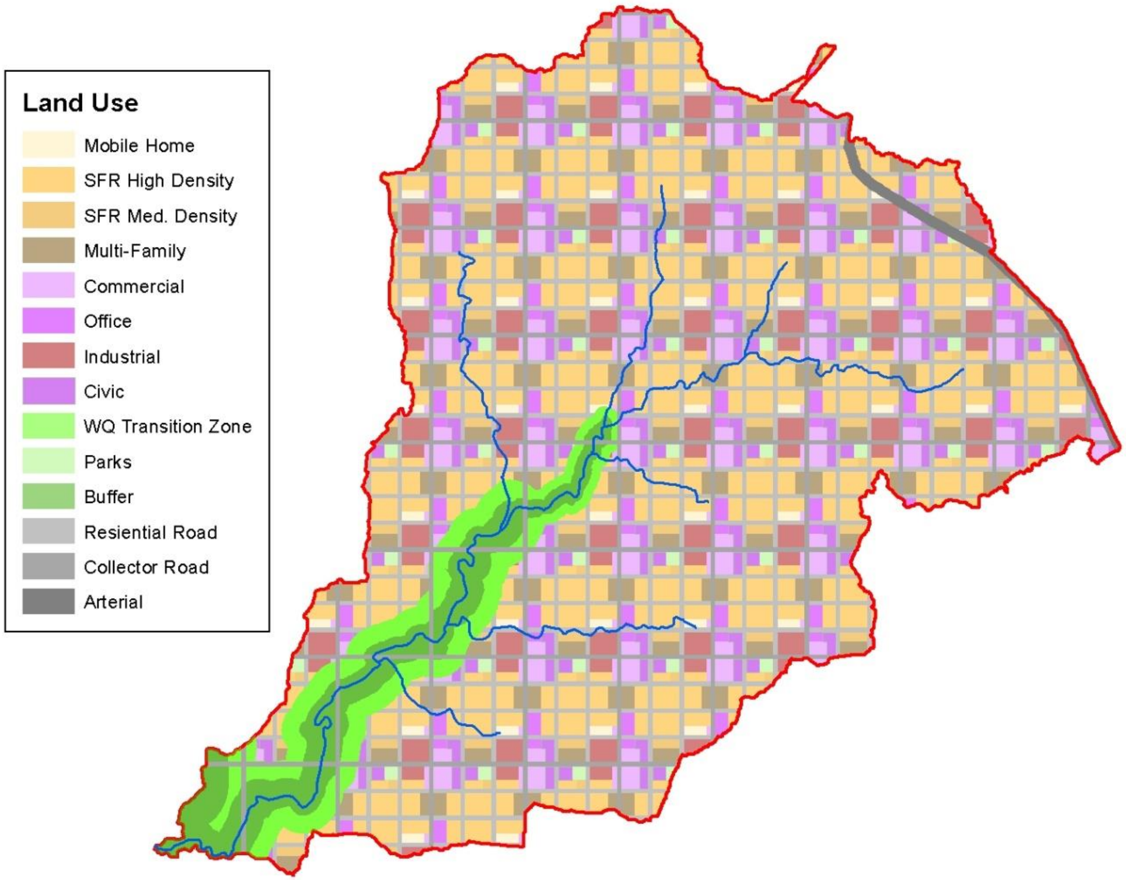
Site Soils



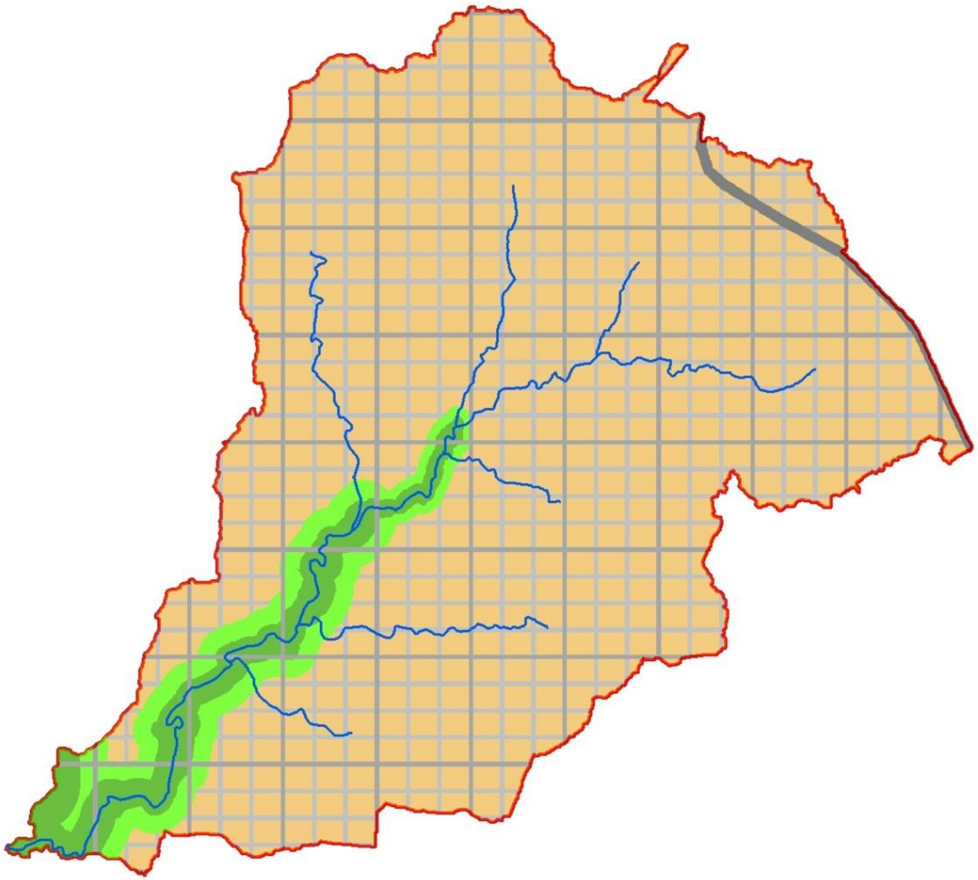
Undeveloped Land Use



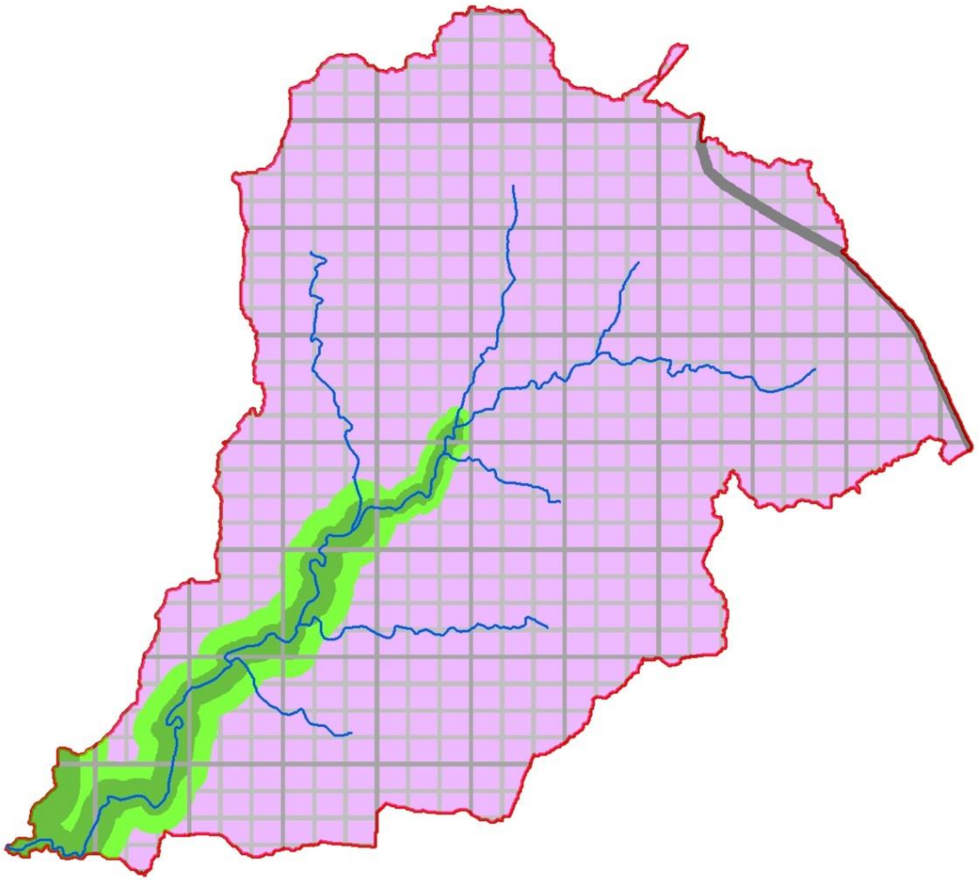
Basic Land Use – 51.2% IC



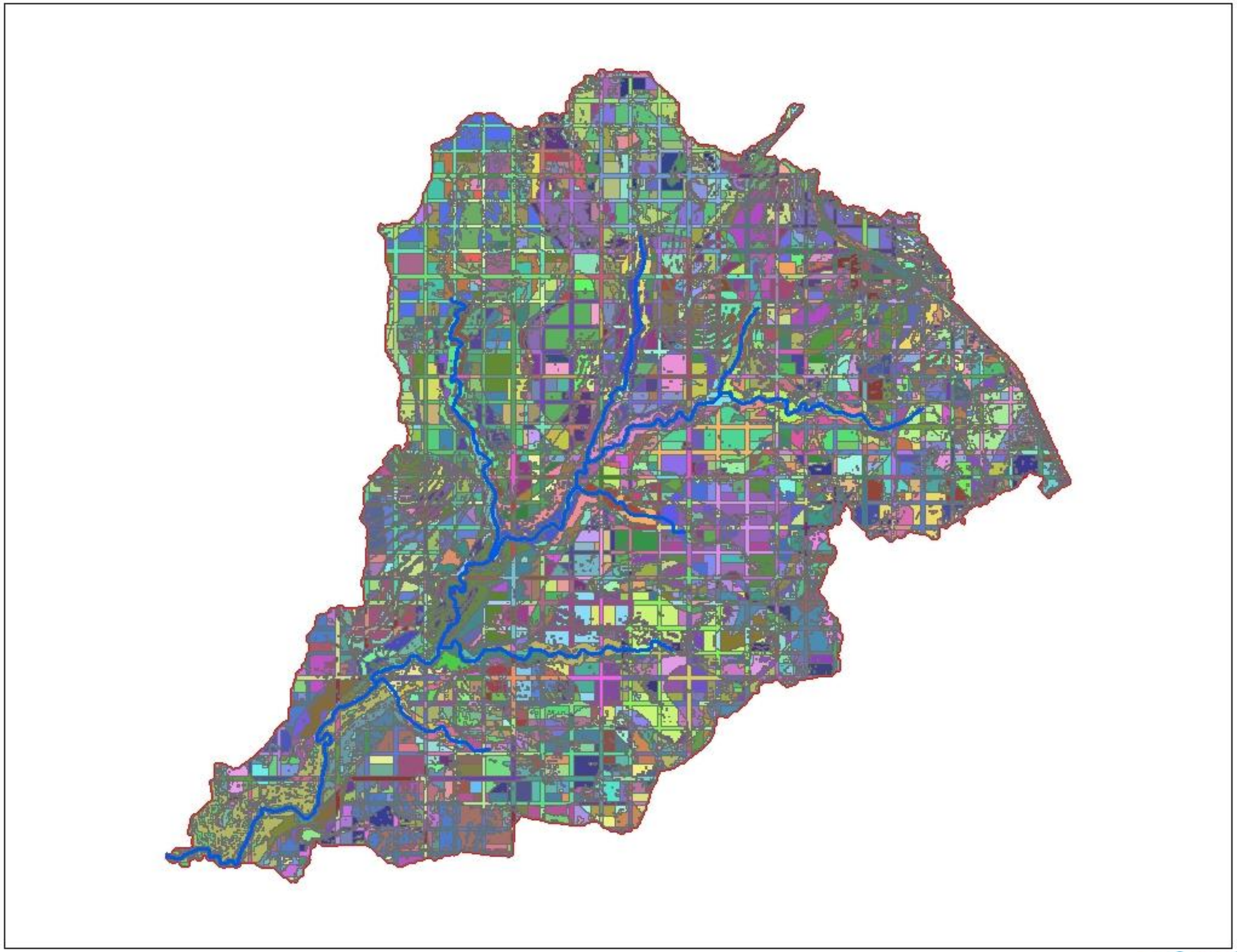
Low IC Land Use – 34.9% IC



High IC Land Use – 64.4% IC



HRU Distribution



Modeling Scenarios

- 3 impervious cover scenarios: 34.9, 51.2 and 64.4 %
- No detention
- 4 basin sizes: ½", CWO, LCRA and SOS
- 3 drawdown times: 24, 48 and 72 hours
- 4 median particle sizes: 12.5, 19, 24.5 and 38 mm
- Channel shear

Computation of shear

$$\tau = \gamma_w \cdot D_H \cdot S_w$$

where,

τ = shear (Pa)

γ_w = density of water (kg/m^3)

D_H = depth of water (m)

S_w = channel slope (m/m)

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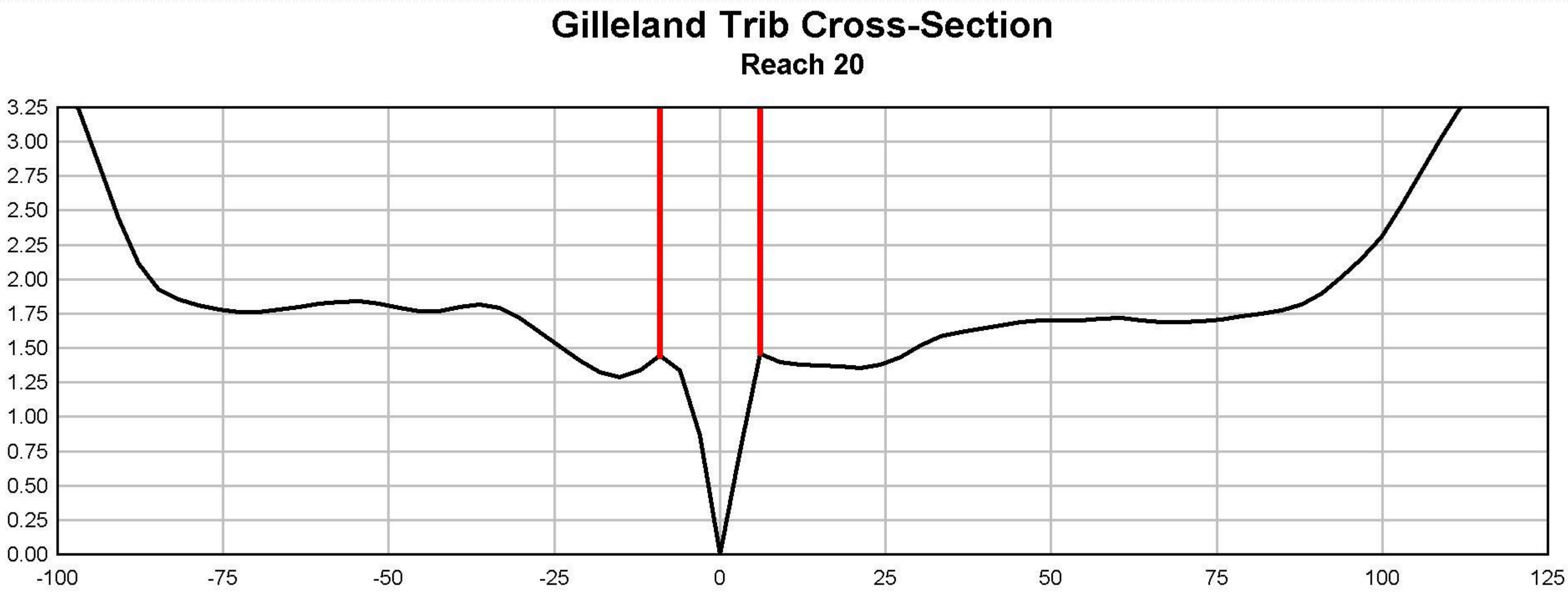

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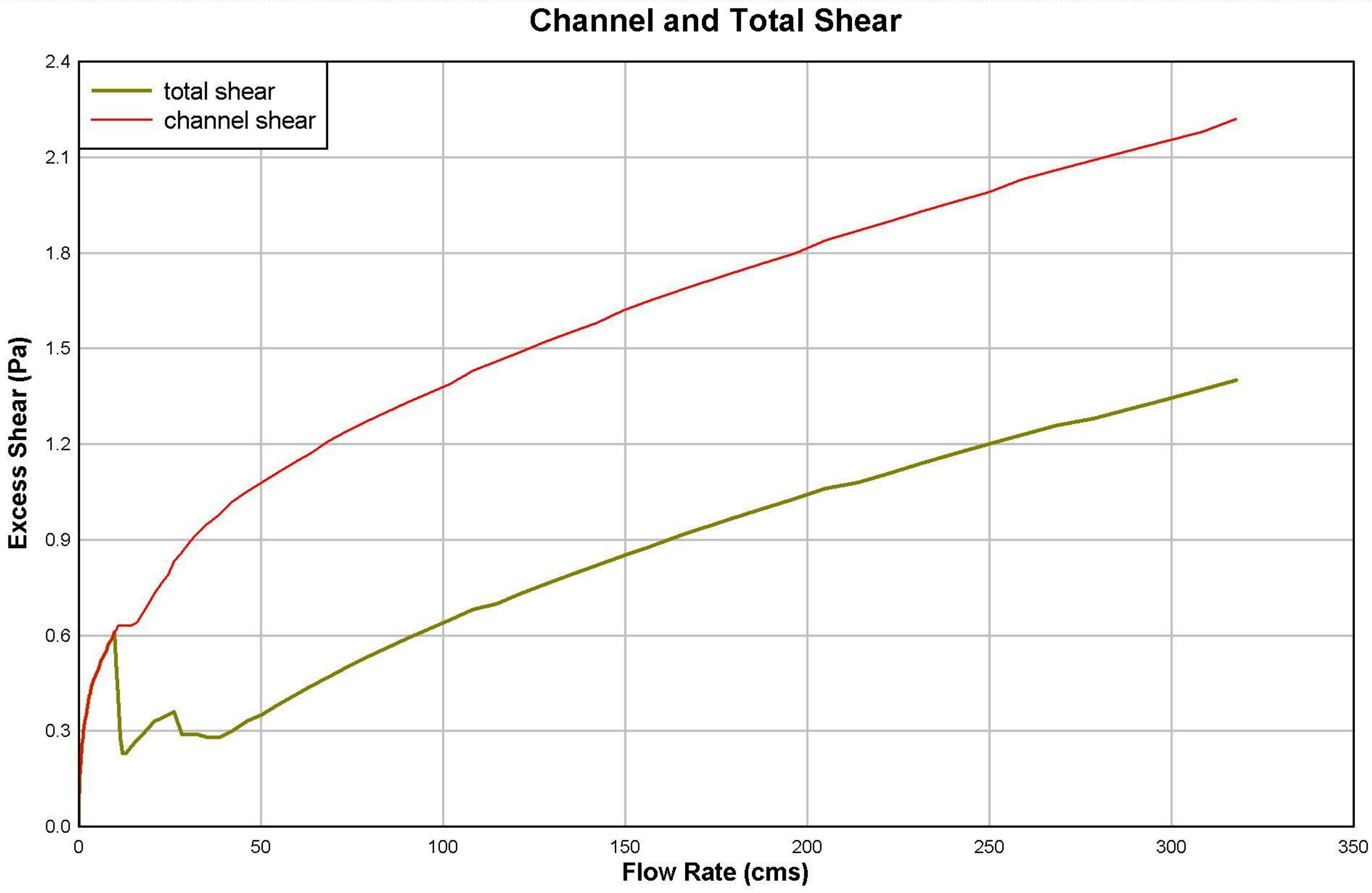

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Computation of critical shear

$$\tau_c = \Theta_c(S_g - 1) \cdot \gamma_w \cdot d_{50}$$

where,

τ_c = critical shear (Pa)

γ_w = density of water (kg/m^3)

S_g = specific gravity of soil, 2.65

d_{50} = median particle diameter (m)

θ_c = critical Shield's parameter, 0.047

ES was defined as:

$$ES = \sum(\tau - \tau_c) \text{ for all } \tau > \tau_c$$

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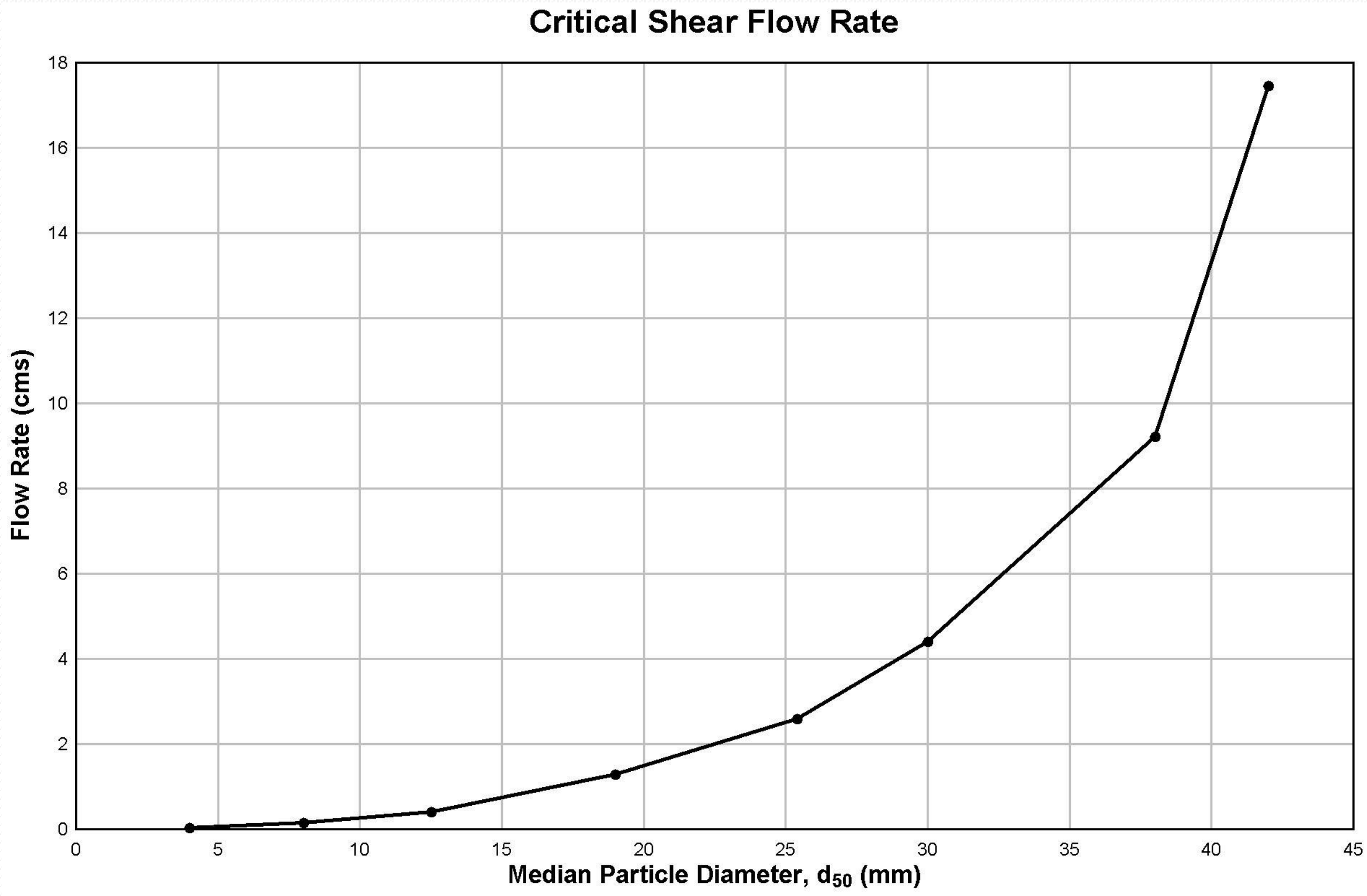

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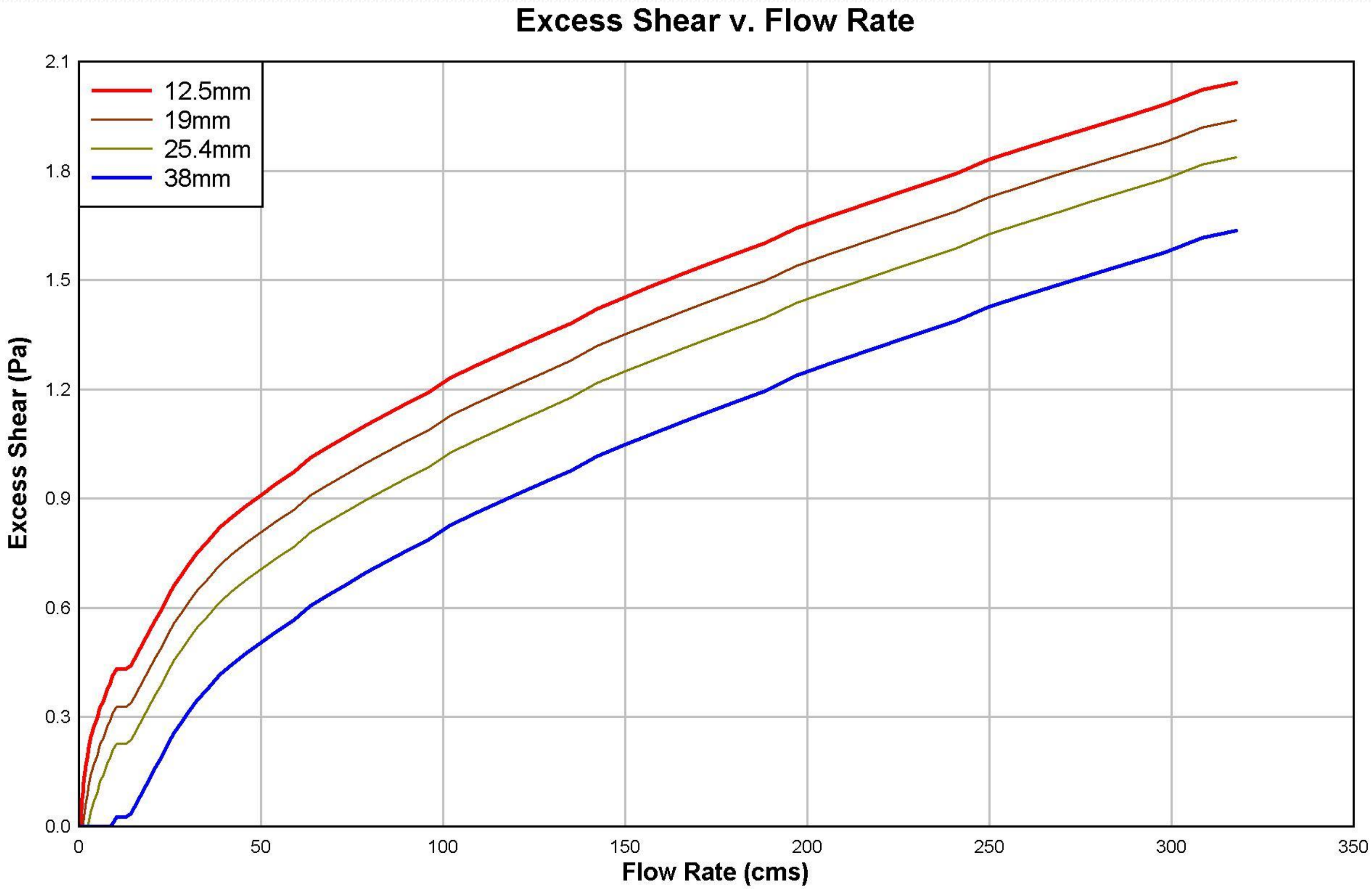
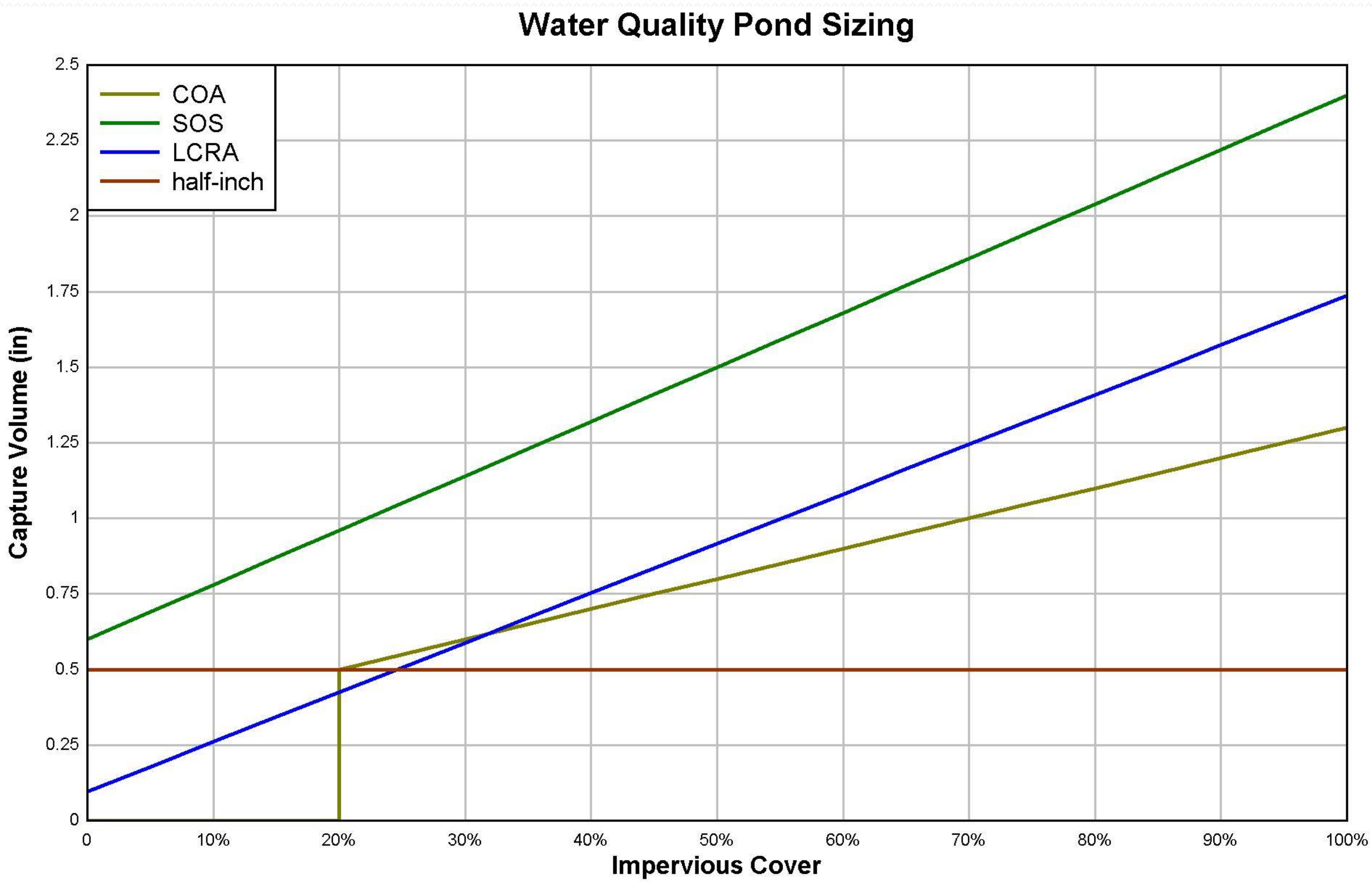

Excess Shear v. Flow Rate
Excess Shear (Pa)
Flow Rate (cms)
12.5mm
19mm
25.4mm
38mm
0.0
0.3
0.6
0.9
1.2
1.5
1.8
2.1
0
50
100
150
200
250
300
350



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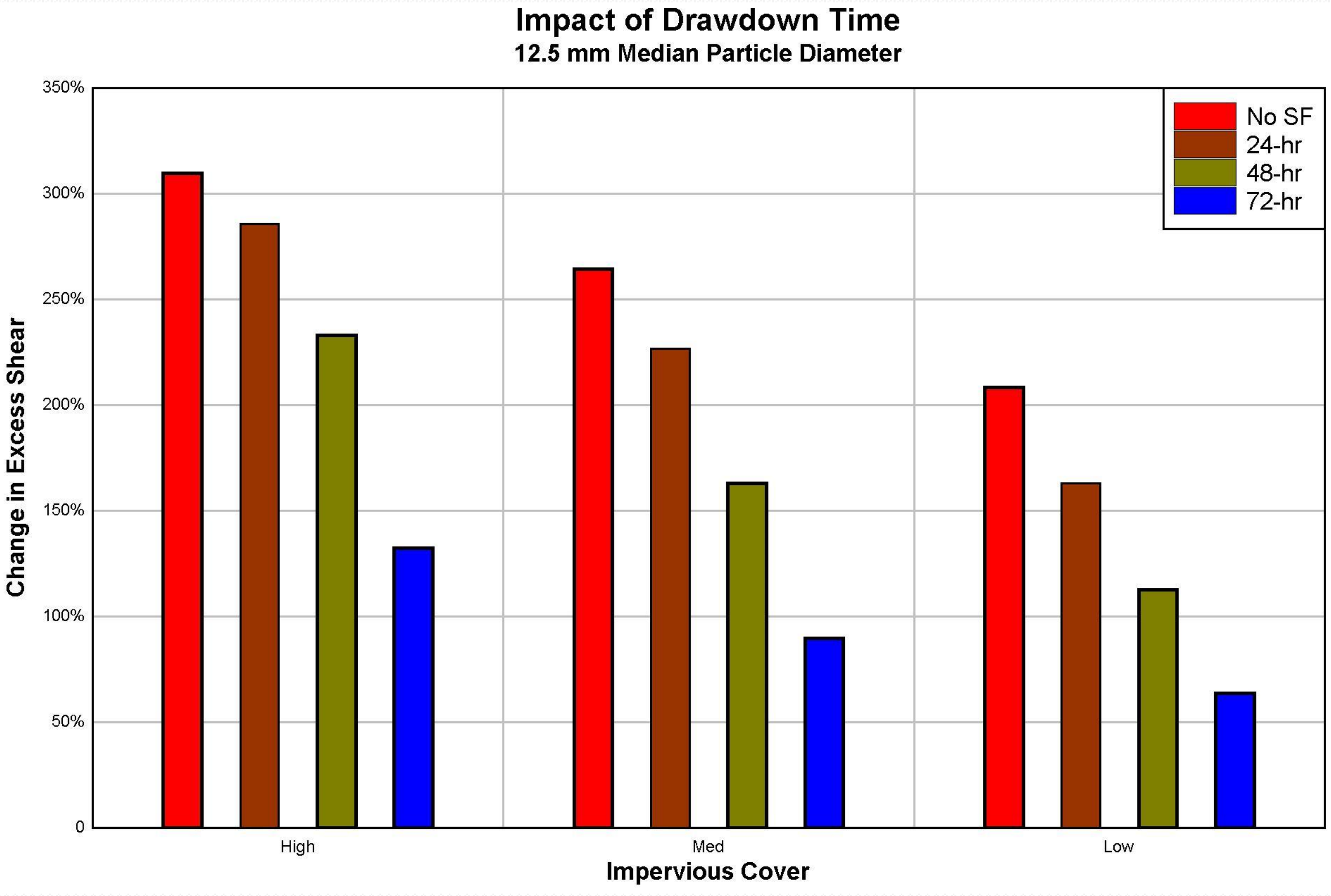

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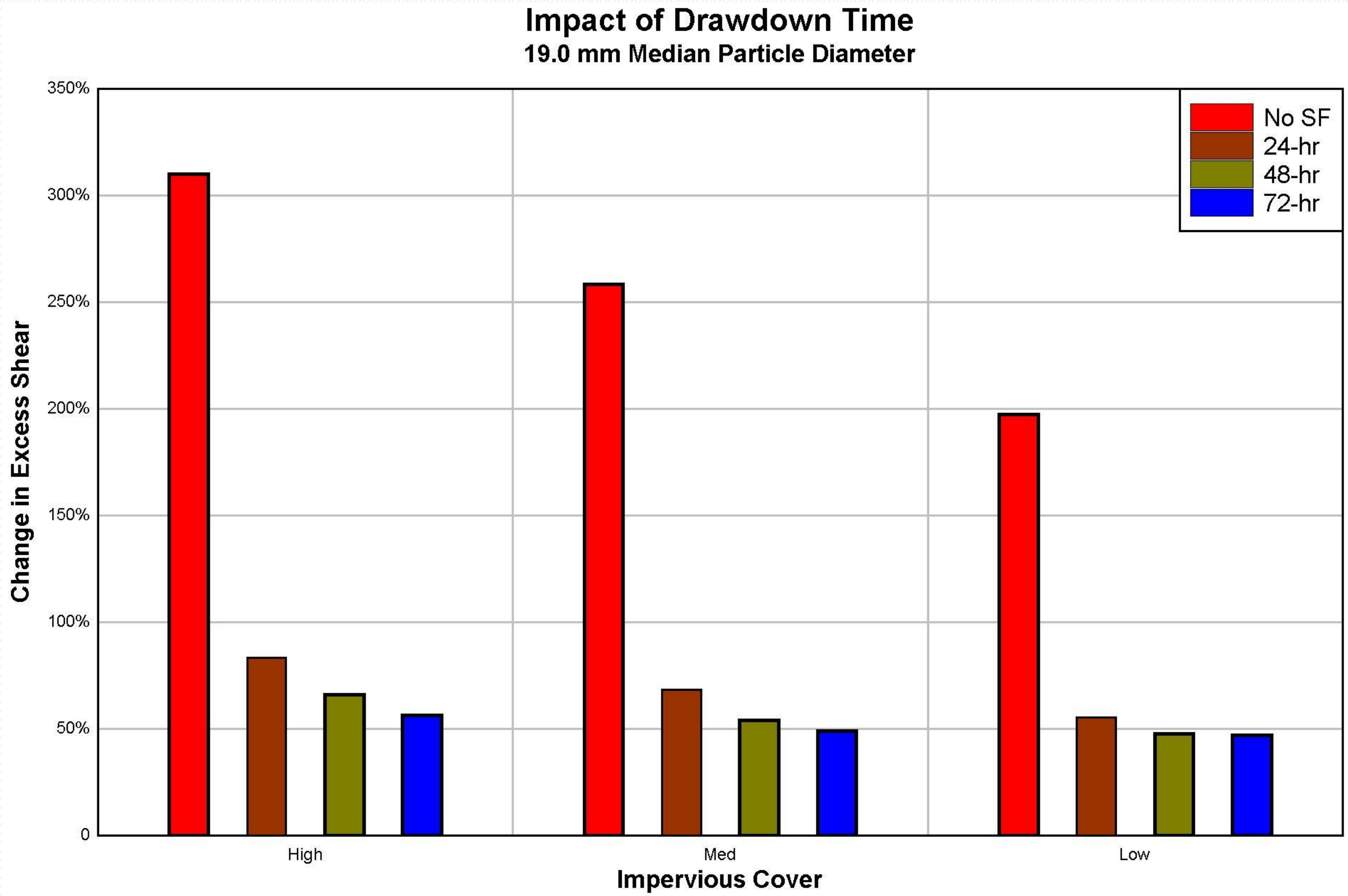
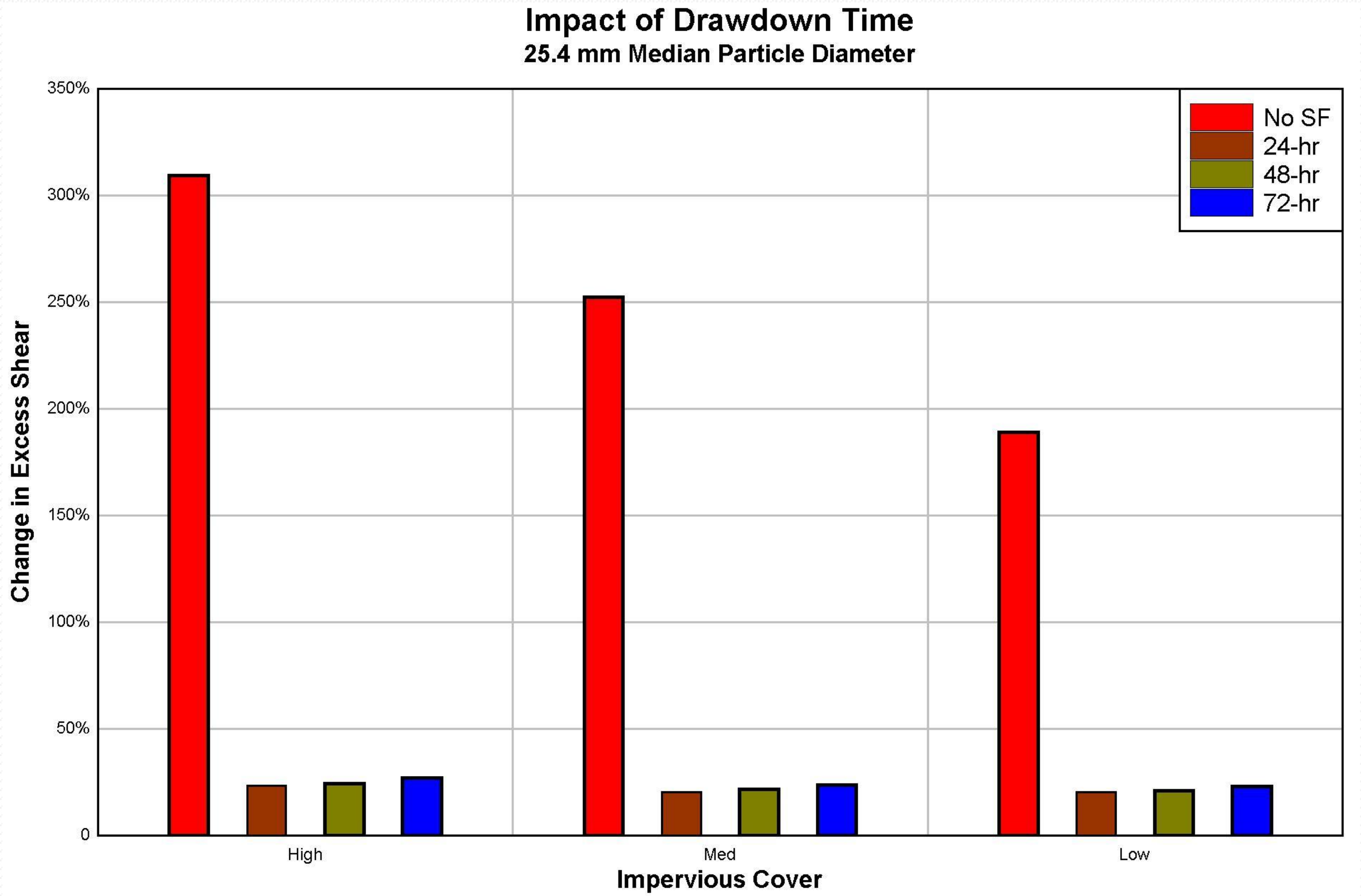

Impact of Drawdown Time
19.0 mm Median Particle Diameter
Change in Excess Shear
350%
300%
250%
200%
150%
100%
50%
0
No SF
24-hr
48-hr
72-hr
High
Med
Low
Impervious Cover



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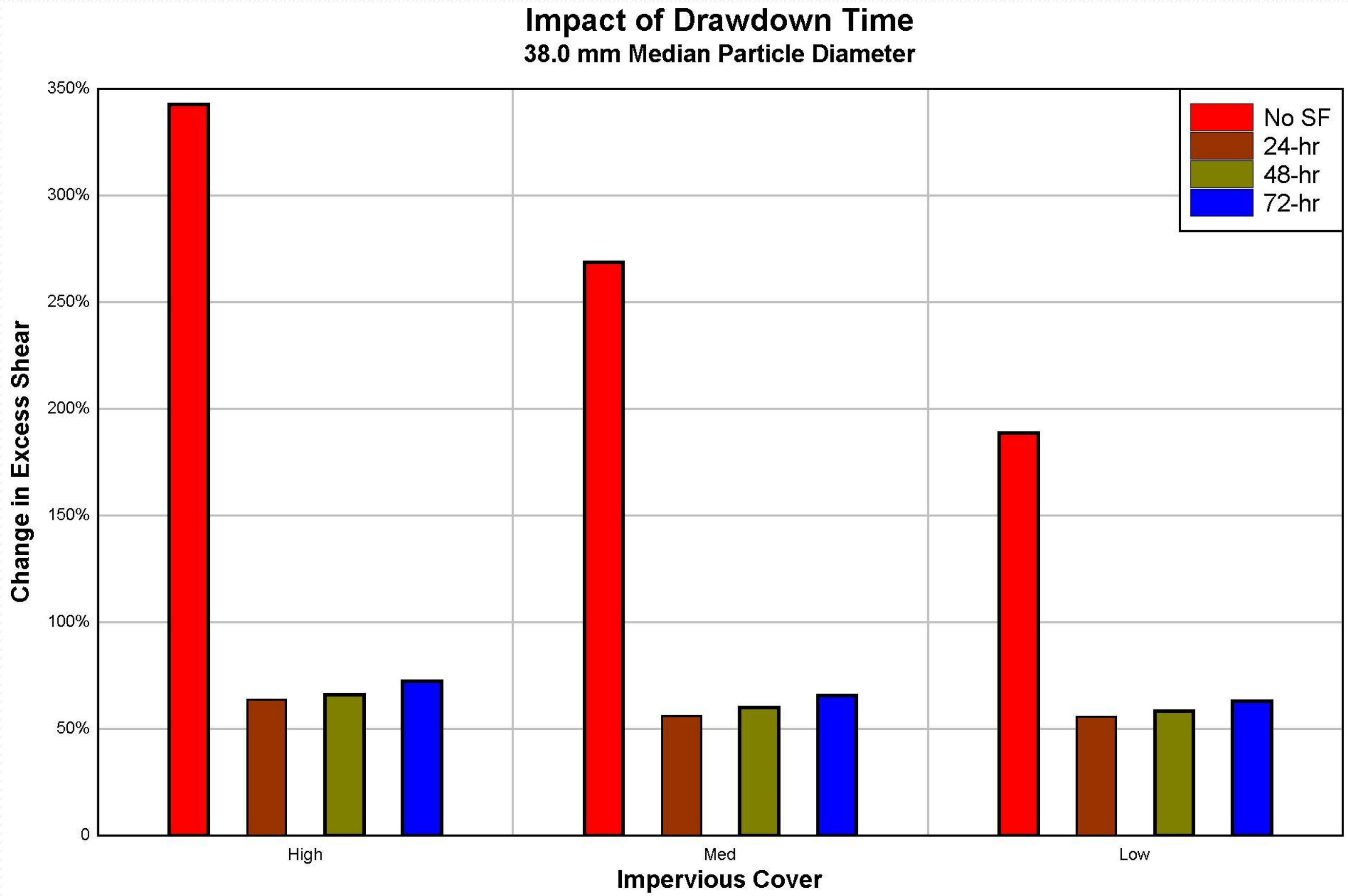
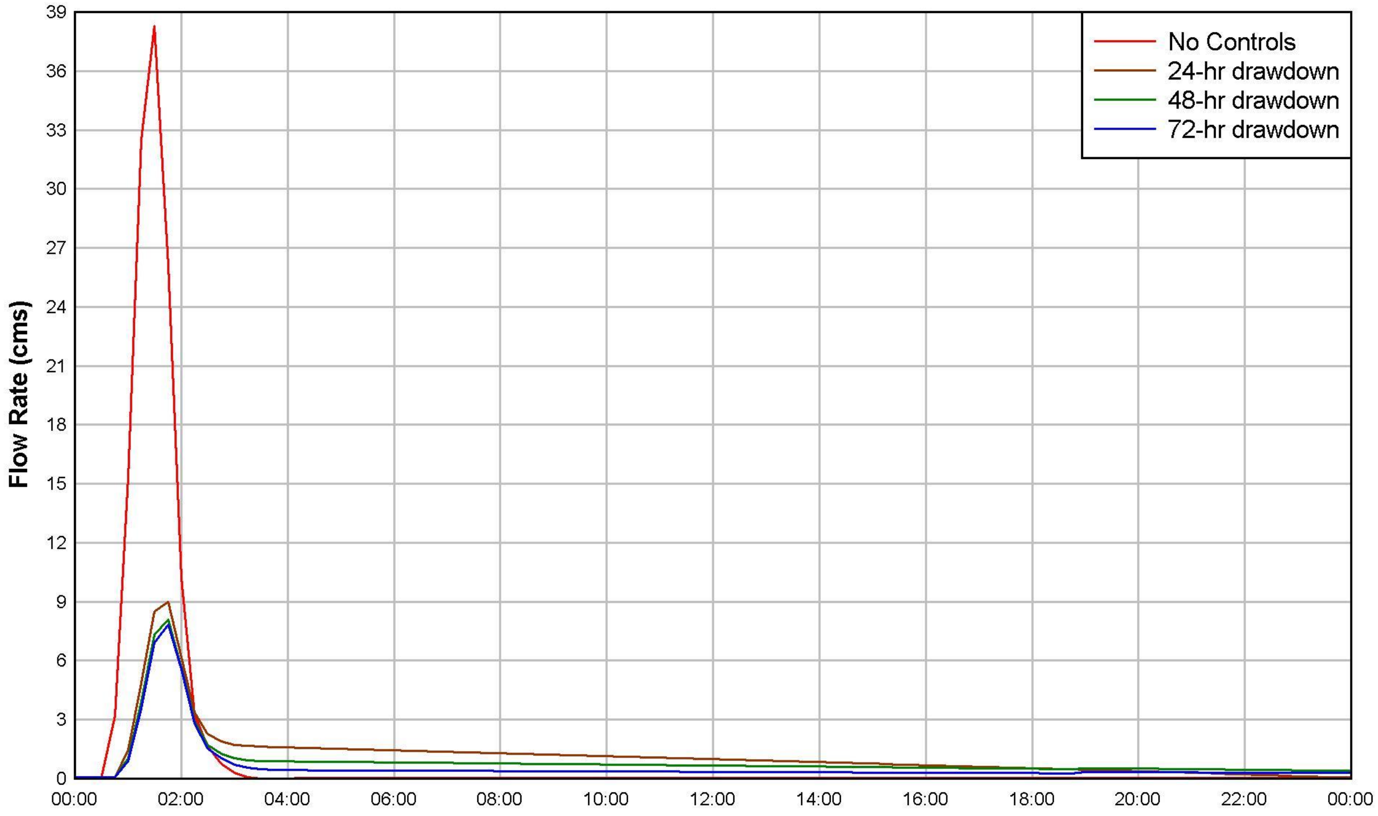
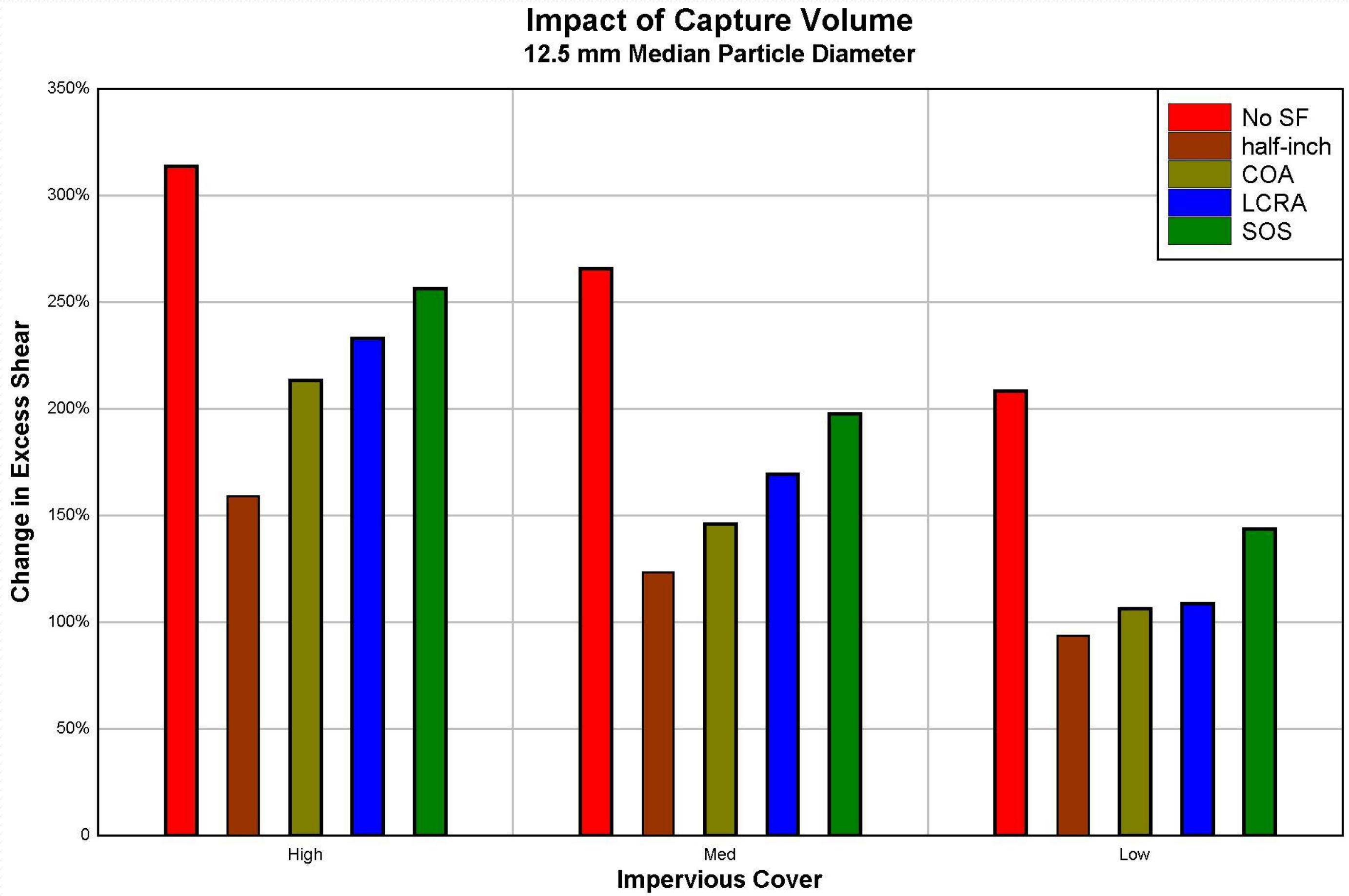


Impact of Drawdown Time
38.0 mm Median Particle Diameter
350%
300%
250%
200%
150%
100%
50%
0
Change in Excess Shear
No SF
24-hr
48-hr
72-hr
High
Med
Low
Impervious Cover

Effects of changing drawdown rate





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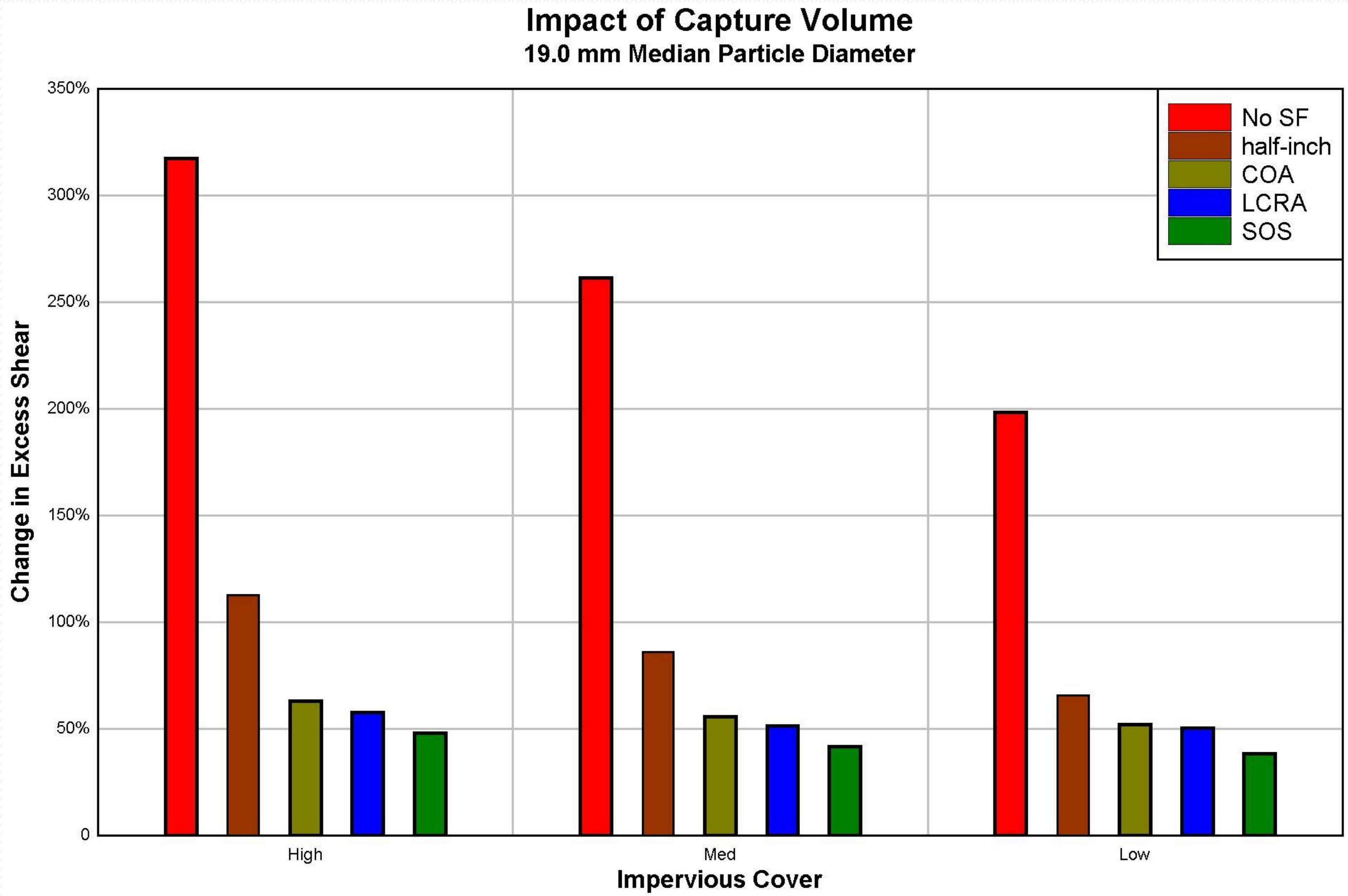
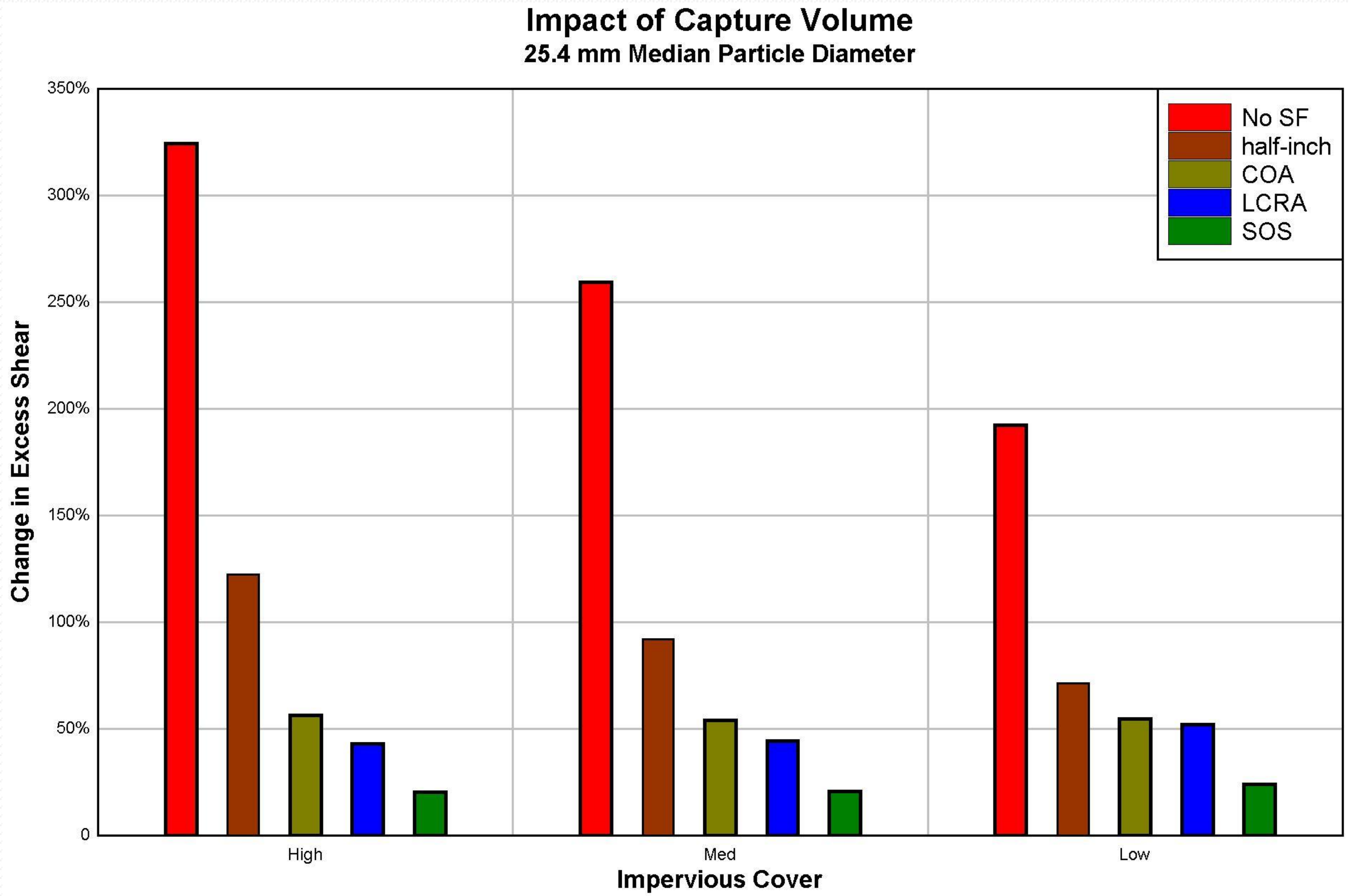

Impact of Capture Volume
19.0 mm Median Particle Diameter
350%
300%
250%
200%
150%
100%
50%
0
Change in Excess Shear
No SF
half-inch
COA
LCRA
SOS
High
Med
Low
Impervious Cover



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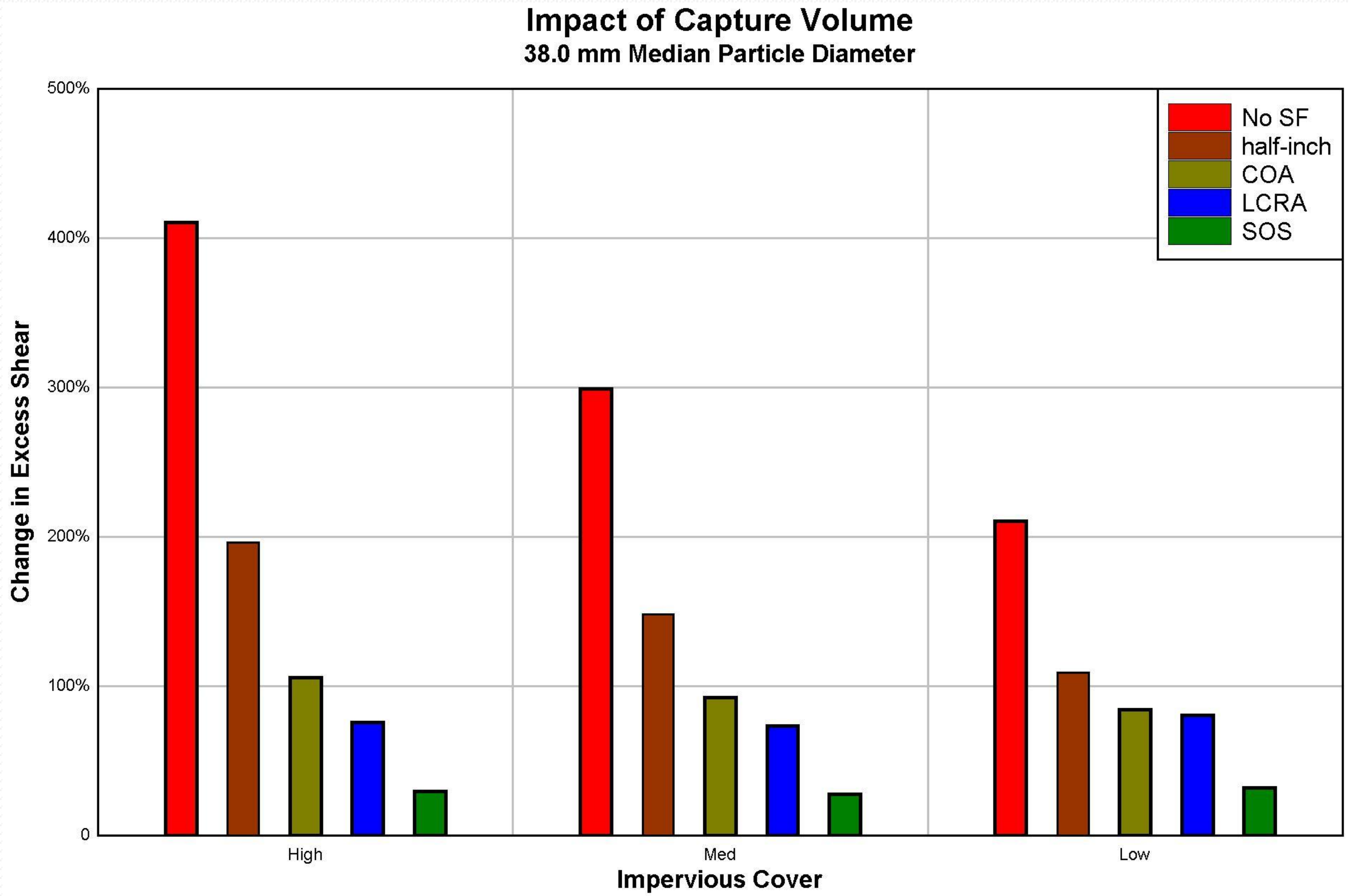
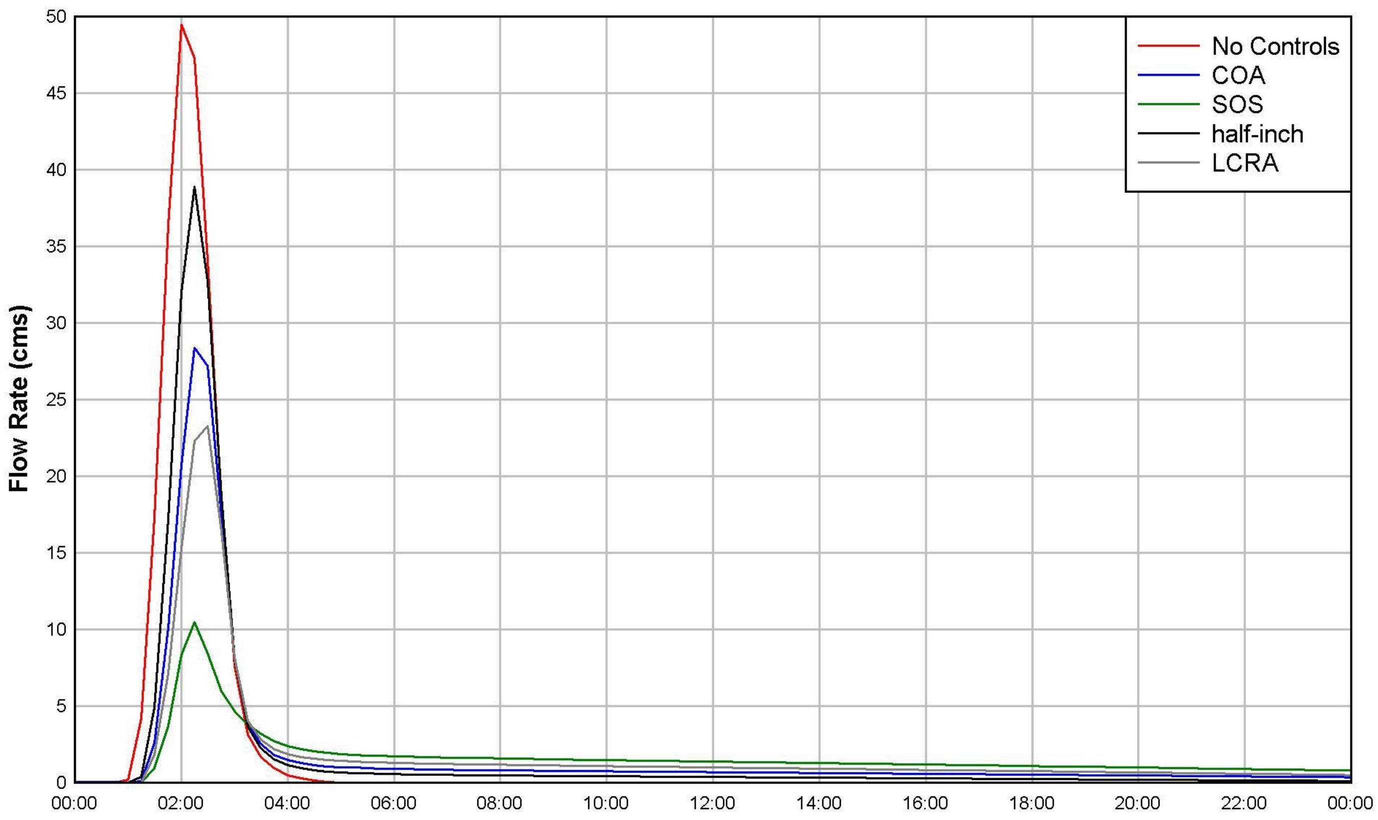

Impact of Capture Volume
38.0 mm Median Particle Diameter
Change in Excess Shear
500%
400%
300%
200%
100%
0
High
Med
Low
Impervious Cover
No SF
half-inch
COA
LCRA
SOS

Effects of changing capture volume



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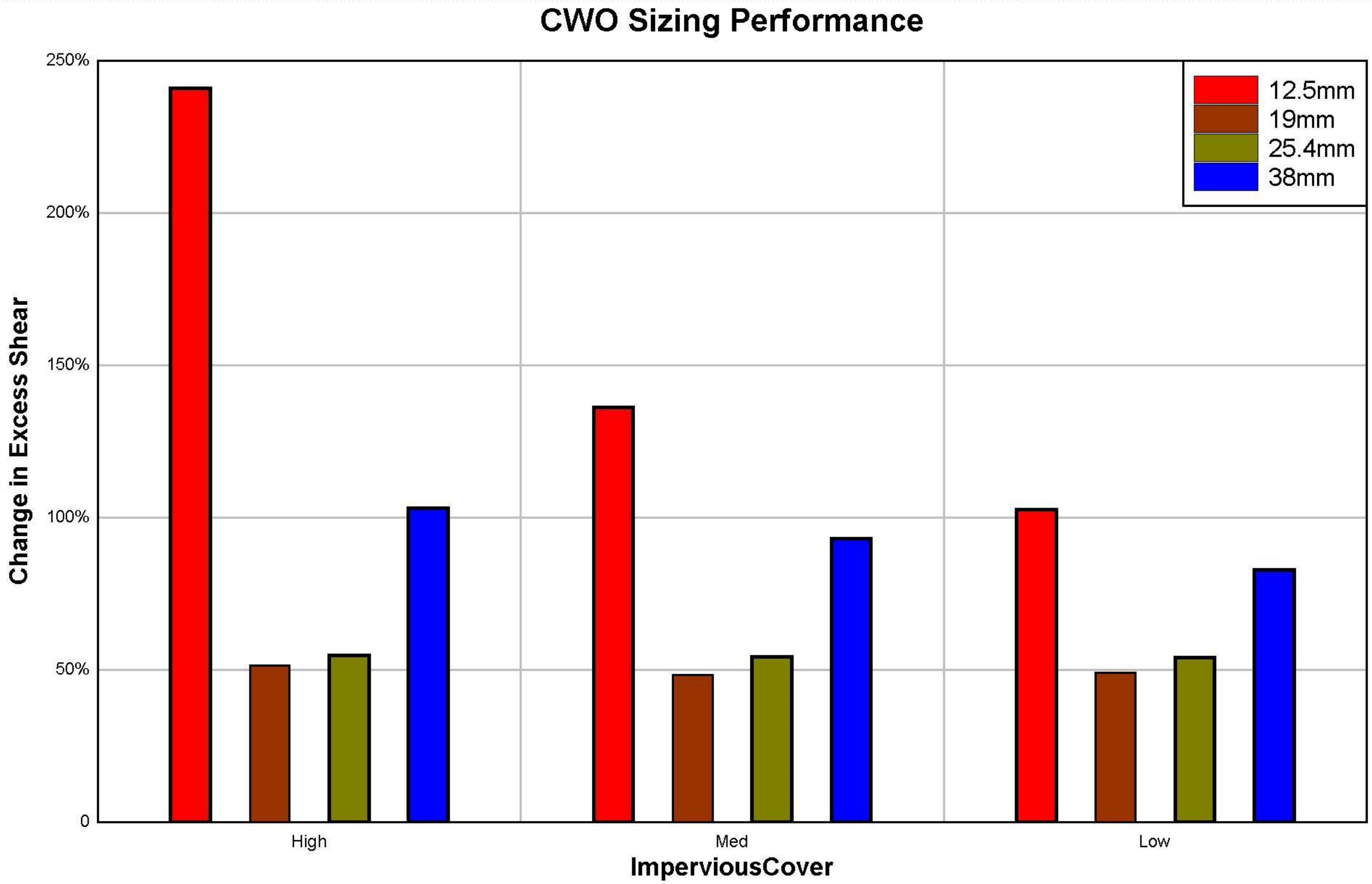
Existing sizing requirements



Conclusions

- Larger water quality capture volumes may be detrimental if the stream bed and bank has small particle diameters.
- Extending drawdown times may reduce excess shear but will result in more bypass flows.
- Optimal capture volume and drawdown rates need to be sized based on stream geomorphology when assessing erosion.
- Existing requirements are adequate for particle sizes greater that 12.5 mm.