Soil Properties for Reclaimed, Fire-disturbed and Undisturbed Forested Soils in Northern Alberta, Canada

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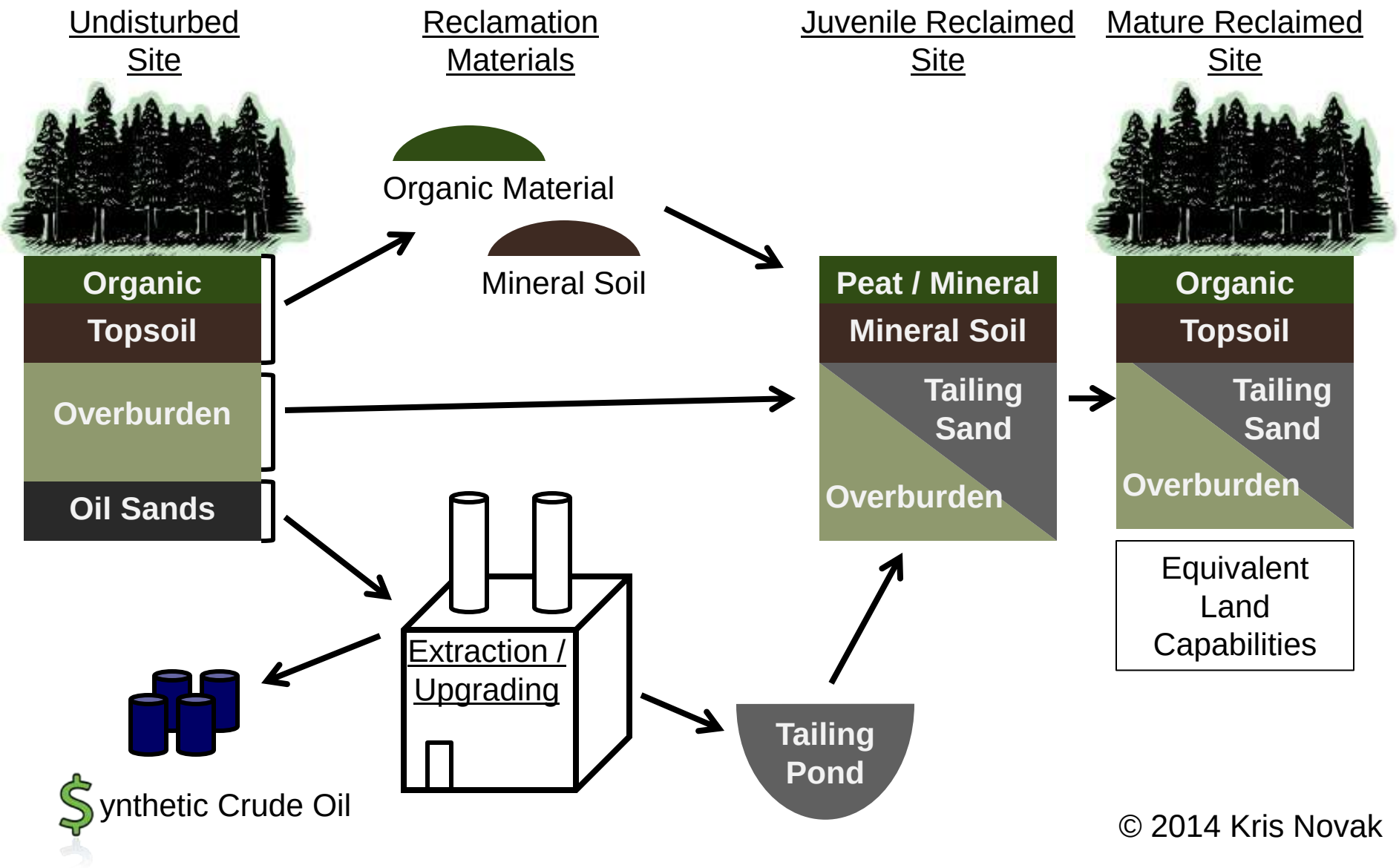
Oil Sands Reclamation



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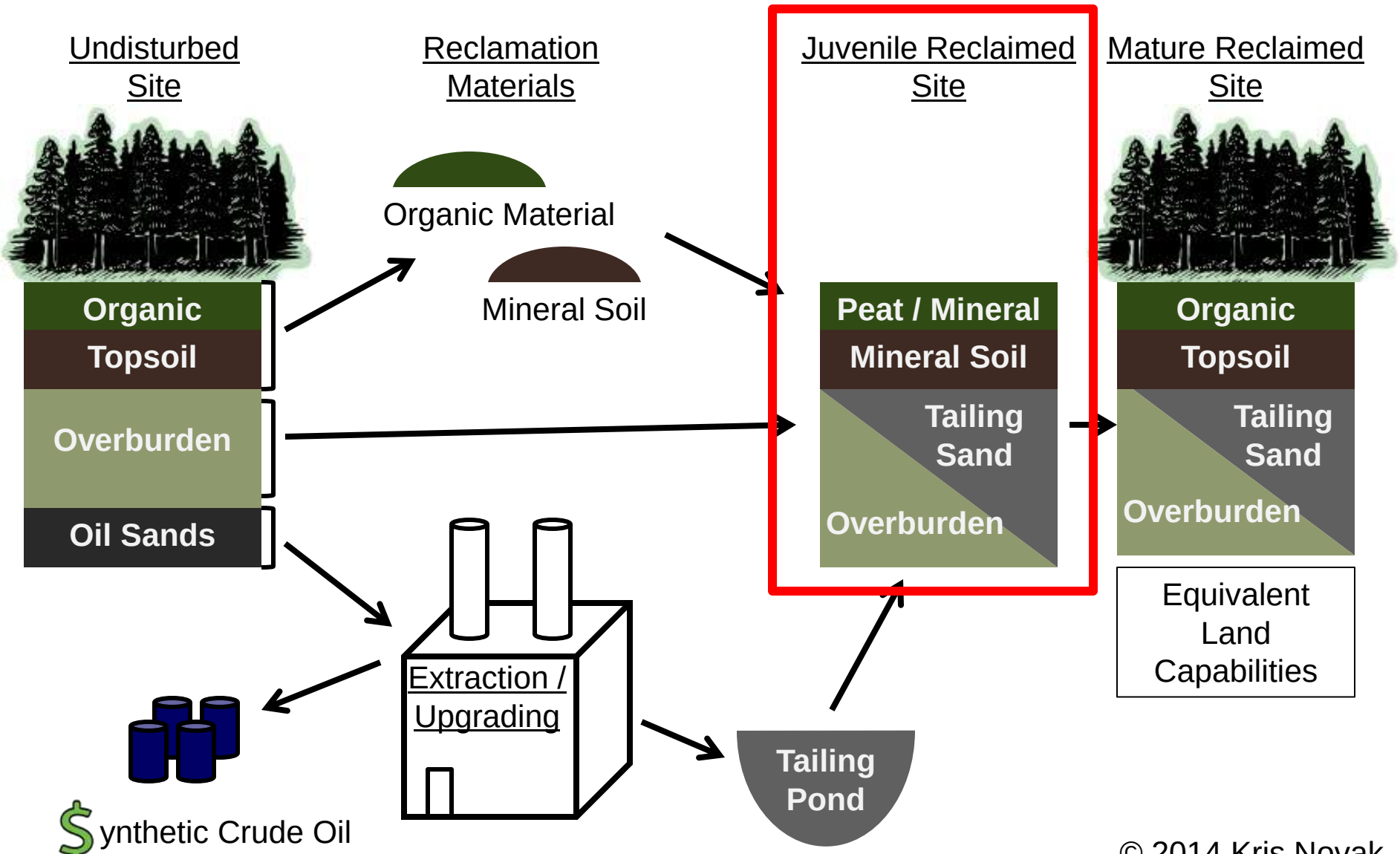



Suncor (2007)
Tailing Pond 1
Reclamation Process
SUNCOR
ENERGY


2008
First Attempt at whole
Tailings Pond Reclamation
SUNCOR
ENERGY

Pond 1 → Wapisiw Lookout 2010

Summer/Fall 2013

Soil Properties

I. Soil physical properties give insight into growth medium performance
   - Reclamation has been occurring for +30 years
   - Large inventory of soil data
   - Starting to see correlation between physical properties and ecological restoration
   - Novel sites (Suncor and CNRL)

"*Comparison would have benefitted from inclusion of natural sites that have been disturbed*"
- Rowland et al. (2008, p. 1588)

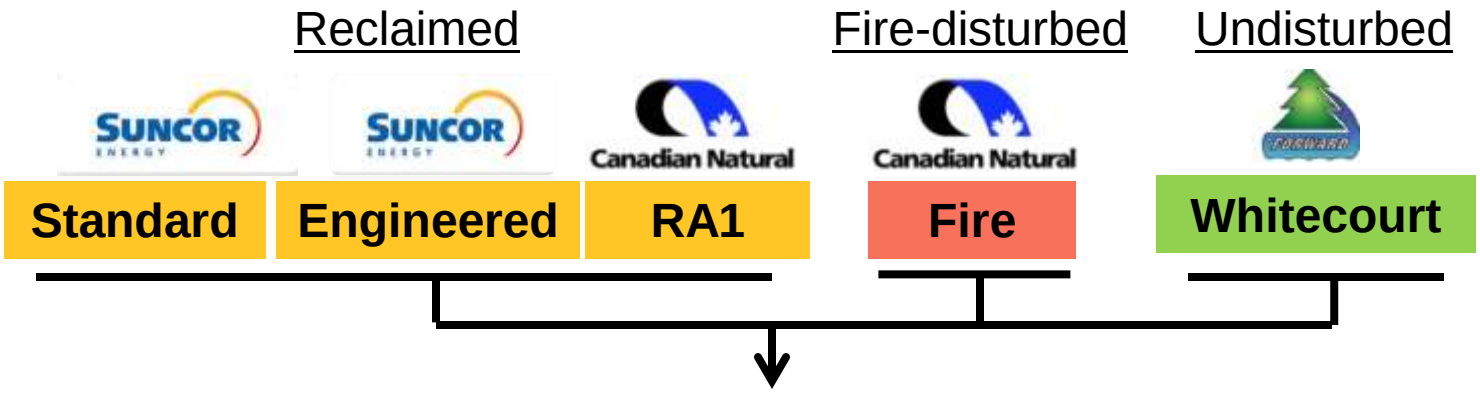
II. No comparison of human-disturbed (mining) and naturally-disturbed (fire) soils

Study Objectives

1. Compare soil properties of natural forests and juvenile soil covers.
2. Evaluate potential relationships between the physical properties of human-disturbed (reclaimed) and naturally-disturbed (fire) soils.

Study Design

Study Sites (5)



Parameters Measured

Soil Physical	Soil - Water	Soil Chemistry
• Soil Strength • Bulk Density • Texture • Pedology	• Saturated Hydraulic Conductivity (Ks) • Moisture Retention Curve (MRC)	EC, pH, NO_3, NH_4, PO_4, SO_4, Org. Carbon

Objectives

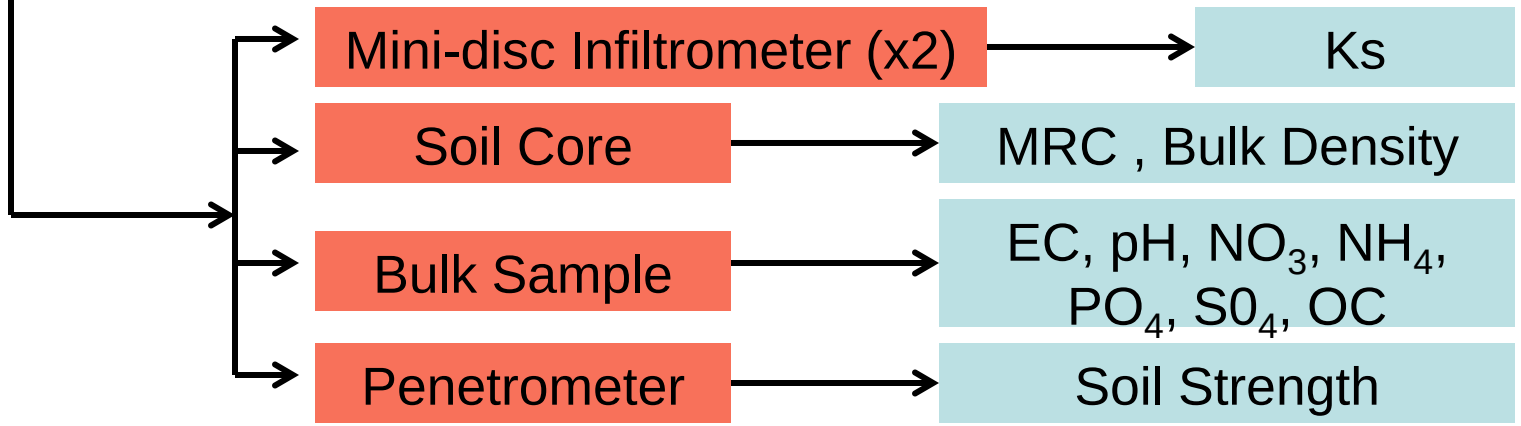
1. Reclaimed vs. undisturbed soils
2. Natural (fire) vs. unnatural (reclaimed) disturbed soils

Pit Sampling

At each site, a 10-pit sampling transect was established

At each pit, measurements from three depth:

1. **3 cm** - A Horizon or upper P:M
2. **20 cm** - B Horizon or lower P:M
3. **50 cm** - B/C Horizon or mineral



Results

Table 1 Mean extractable soil values of three reclaimed and two natural soils in the Northern Alberta oil sands regions, Canada

Class	Site	Depth (cm)	NO_3	NH_4	PO_4	pH	EC	Texture
			mg kg^{-1}				*dS m^{-1}*	
Reclaimed	Standard	3	2.2	6.2	1.9	8.0	0.8	Sandy Clay Loam
		50	1.0	4.5	1.0	8.1	0.8	Loam
	Engineered	3	3.4	5.8	1.8	7.8	0.7	Sandy Loam
		50	1.4	4.4	1.3	7.8	0.9	Sandy Clay Loam
	RA1	3	0.9	7.5	2.5	7.0	1.4	Clay Loam
		20	0.6	5.0	2.1	7.5	1.6	Clay Loam
		50	0.8	4.2	2.5	7.6	1.8	Clay
Natural	Fire	3	1.7	3.2	34.1	-	-	Sandy Loam
		20	1.7	2.9	11.4	-	-	Sandy Clay Loam
		50	1.9	2.7	5.6	-	-	Sandy Clay Loam
	Whitecourt	3	0.2	9.9	22.9	5.2	0.1	Loam
		20	0.2	3.4	5.1	5.4	0.0	Clay Loam
		50	0.2	4.8	7.0	5.5	0.0	Clay Loam

Nitrogen

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Phosphorus

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pH/EC

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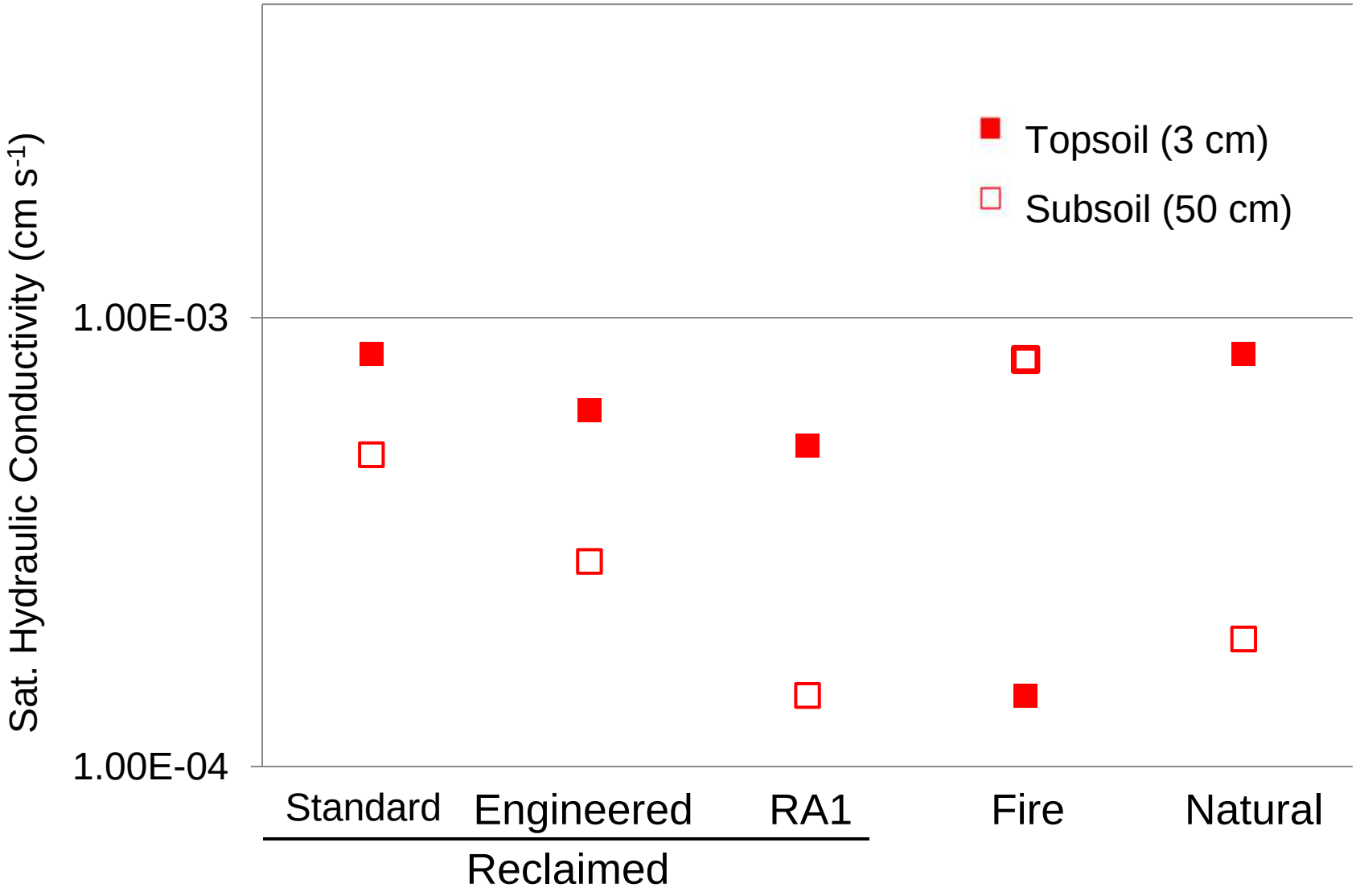
	…	…	…	…	…	…	…	…

*"On the reclamation treatments, availability of nitrate … were generally higher than in the natural forest ecotypes, while ammonium, and P… were generally lower (*Rowland et al. 2008, p. 1580)"

Saturated Hydraulic Conductivity (Ks)



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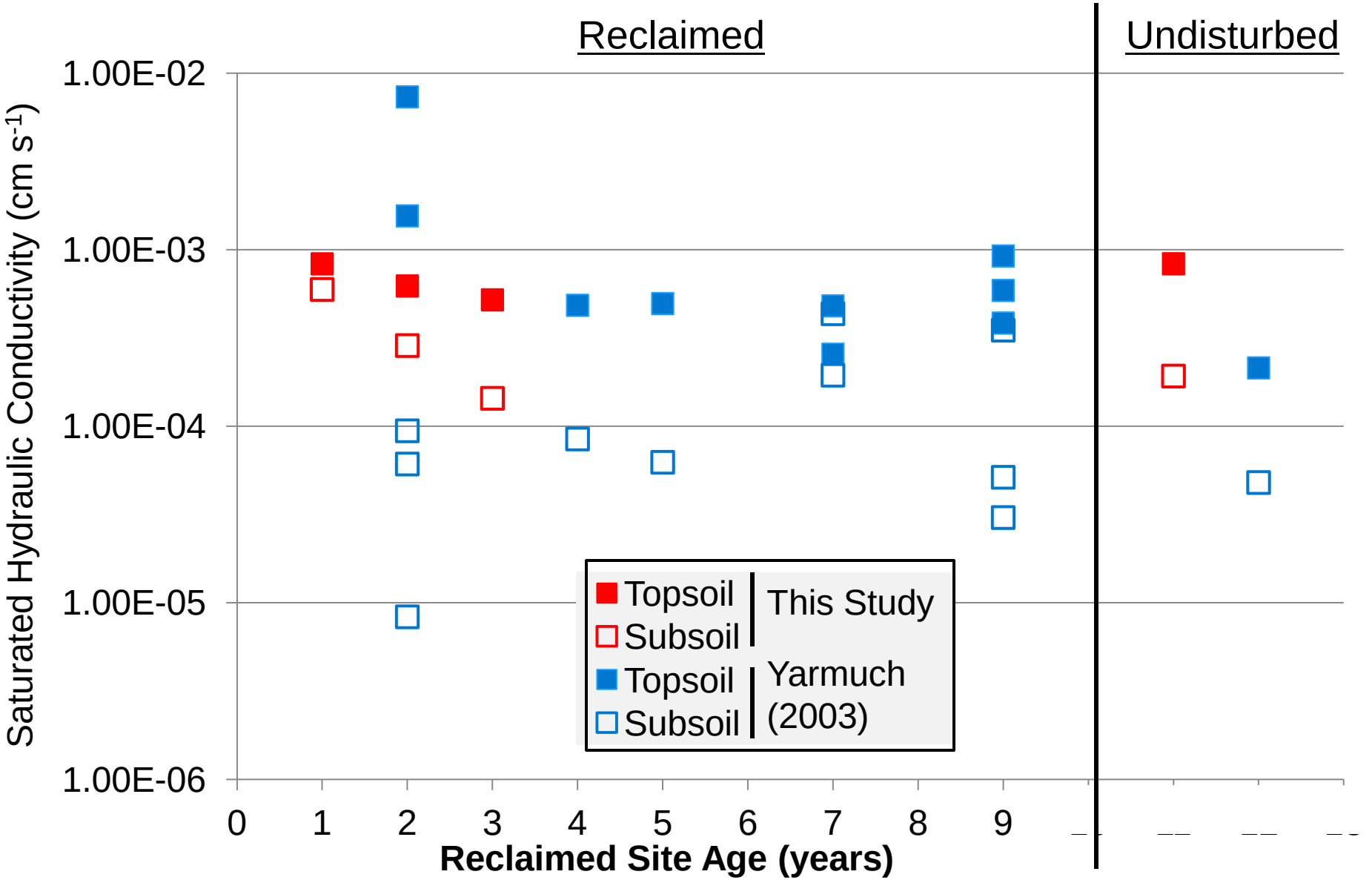

Take Home Message

Reclaimed vs. Undisturbed

- Some soil chemistry differences – N forms, **P levels**, pH
- Ks displays similar values and trends
- Consistent with literature

Reclaimed-disturbed vs. Fire-disturbed

- Nitrate (fertilized reclaimed and fire-disturbed)
- Limited similarities with other soil properties
- More work isolating the fire-effect

Future Work

- Collect the remaining data (MRC, BD, SO_4, Organic Carbon)
- FORWARD III is developing hydrological models to predict water movement and storage on reclaimed sites – the soil physical properties collected from this study will be used as model inputs for each treatment.

Acknowledgements

- Supervisor – Dr. Ken Van Rees
- Committee – Dr. Bing Si, Dr. Gordon Putz, Dr. Jim Germida
- Field Crew – Brittany Letts, Haylee Smysniuk
- FORWARD III – Brian Brassard, Paul Dinsmore, Virginia Antoniak
- UofS Peeps – Doug Jackson, Bing's lab crew, everybody else!

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Images

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Questions?