Evapotranspiration vs. Compacted Soil: Comparative Results of a 5-Year Basin Lysimetry Study in Anchorage Alaska

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werc Water and Environmental Research Center

UAF UNIVERSITY OF ALASKA FAIRBANKS

Lysimetry Project Participants

- University Researchers…
  - Bill Schnabel (UAF)
  - Jens Munk (UAA)
  - Bill Lee (UAA and UAF)
  - Dave Barnes (UAF)
  - Tarek Abichou (Florida State University)
- Weston Solutions…
  - Skip Koch
  - Lance Larsen
  - Barbara Pape
  - Tanya Kozinski
- Air Force Personnel…
  - 673rd Civil Engineer Squadron, Asset Management Flight, Environmental Element Restoration Section (673 CES/CEANR)
  - John Mahaffey
  - Gary Fink
  - Tim Plucinski

JBER Landfill Site

(Operating Unit 1 Landfill Areas: LF05, LF07, LF07A, and LF13)

- 56-Acres of Buried MSW
- In operation between 1951-1993
- Variable Depth to Waste
- Seeking Alternatives to Prescriptive Cover
- Bird Air Strike Hazard (BASH) Compliant
- Wildlife Compensation

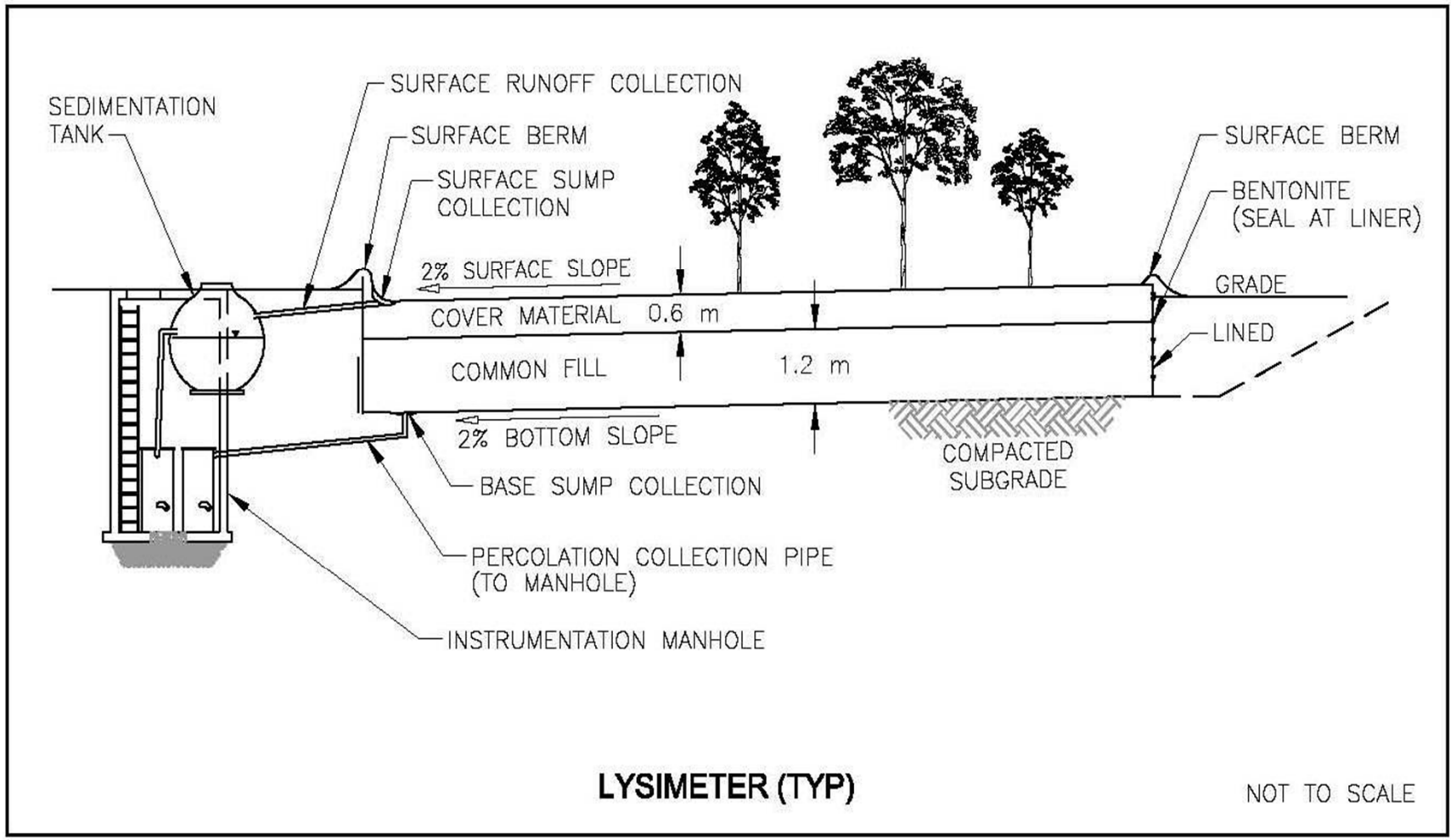
Evapotranspiration Covers

- Woody vegetation can reach and remove moisture from deep within the subsurface via transpiration
- Thick, uncompacted soil layers can store moisture for plant access

Regulatory Question

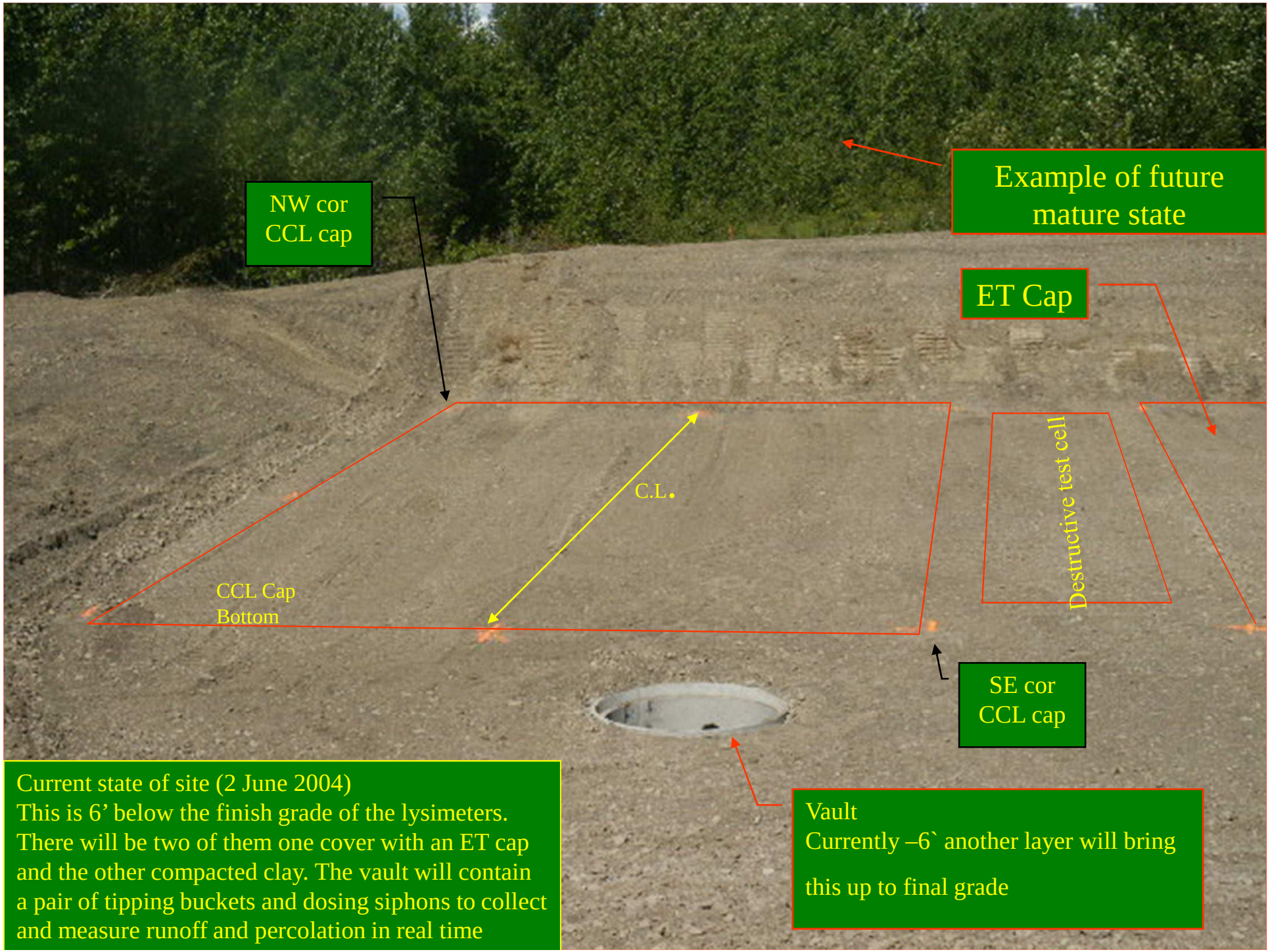
- *Will a 2 ft. layer of forest soils planted with woody vegetation reduce infiltration at least as much as would a 6 inch erosion layer underlain by an 18 inch compacted soil layer?*

Pilot Scale Study




CATERPILLAR


CAT
GME
GME


Example of future mature state
NW cor CCL cap
ET Cap
C.L.
Destructive test cell
CCL Cap Bottom
SE cor CCL cap
Vault
Currently –6` another layer will bring this up to final grade
Current state of site (2 June 2004)
This is 6' below the finish grade of the lysimeters. There will be two of them one cover with an ET cap and the other compacted clay. The vault will contain a pair of tipping buckets and dosing siphons to collect and measure runoff and percolation in real time

Installing the liner for the clay lysimeter

Dosing siphons


CAT
CAT


CCL
ET

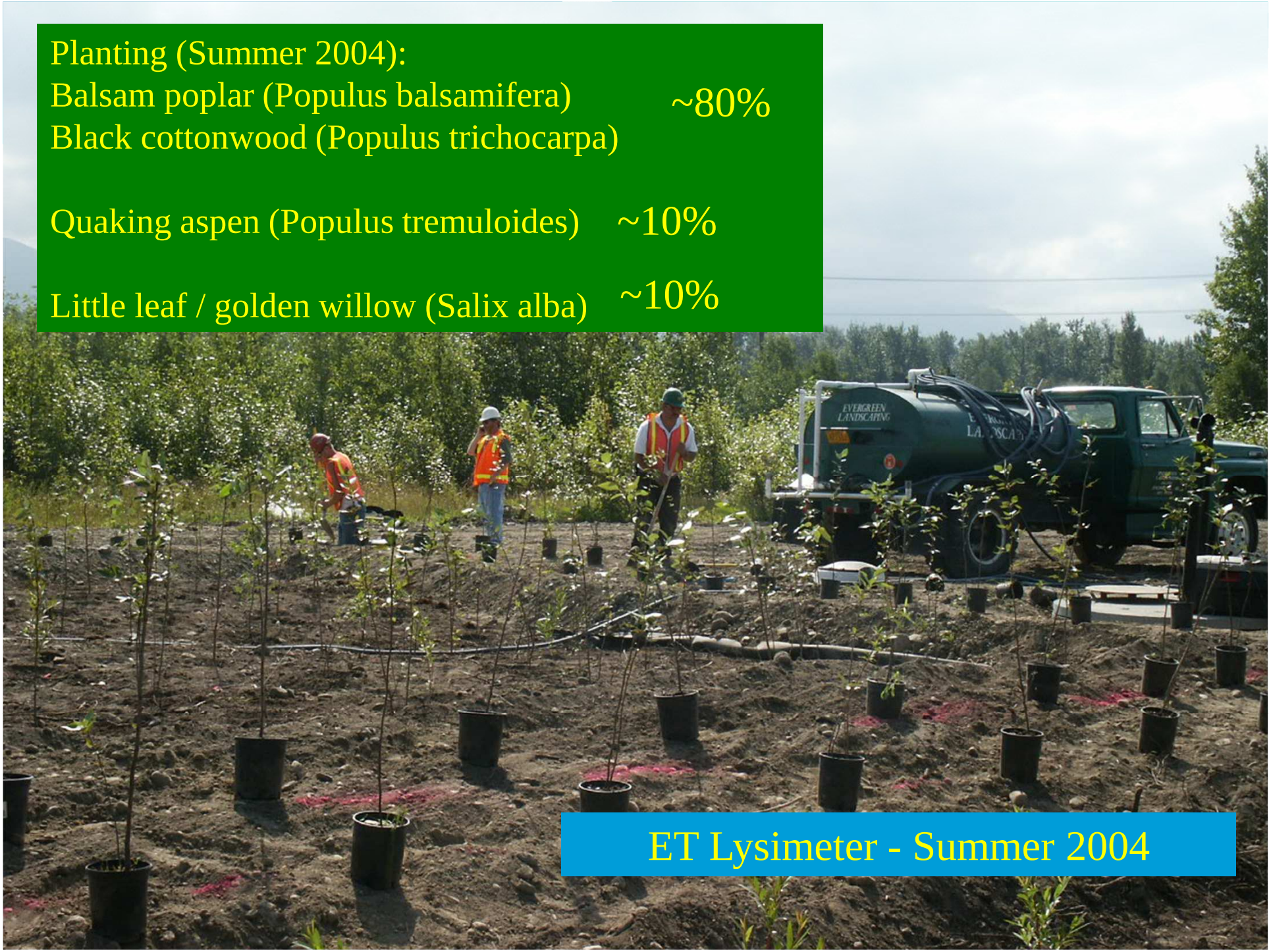
Planting (Summer 2004):

40% Beach Wild Rye
25% Wainwright Wheatgrass
20% Arctared Fescue
10% Nootka Lupine
5% Annual Rye Grass

CCL Lysimeter – Fall 2004


CCL Lysimeter - Fall 2007

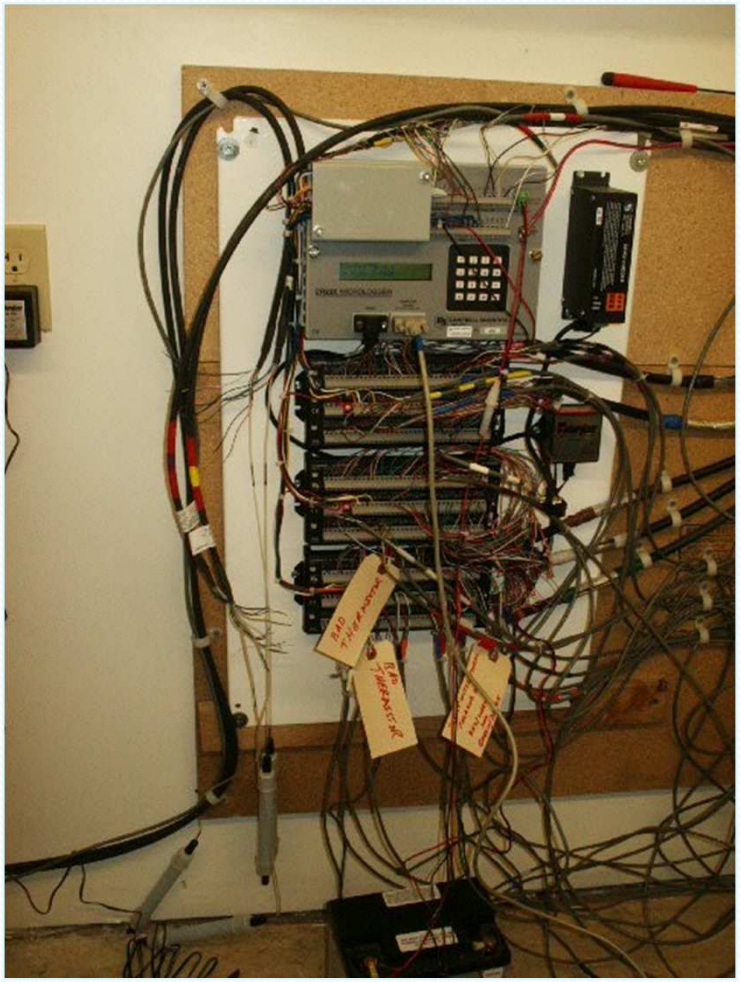
CCL Lysimeter - July 2010

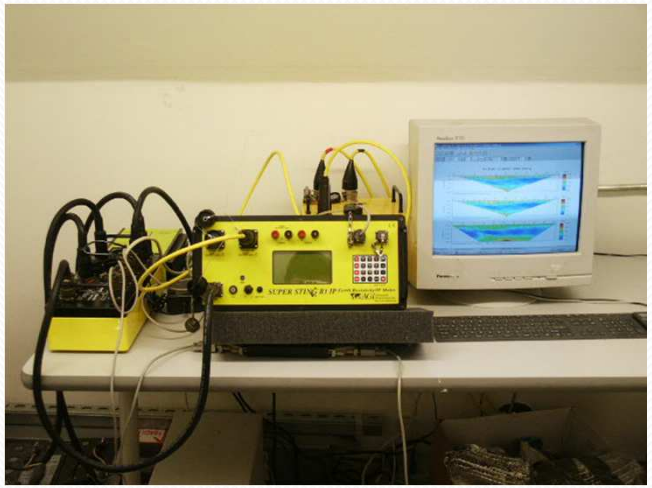

Planting (Summer 2004):
Balsam poplar (Populus balsamifera) ~80%
Black cottonwood (Populus trichocarpa)
Quaking aspen (Populus tremuloides) ~10%
Little leaf / golden willow (Salix alba) ~10%
EVERGREEN LANDSCAPING
ET Lysimeter - Summer 2004

Date	ET Cover Irrigation (mm)	CCL Cover Irrigation (mm)
7 July 2005 (ED 188)	5.0	5.0
8 July 2005 (ED 189)	17.2	17.2
11 July 2005 (ED 192)	17.2	17.2
14 July 2005 (ED 195)	7.4	7.5
17 July 2005 (ED 198)	7.8	8.1
26 July 2005 (ED 207)	6.3	6.3
Total (nearest mm)	61	61


ET Lysimeter - Fall 2007

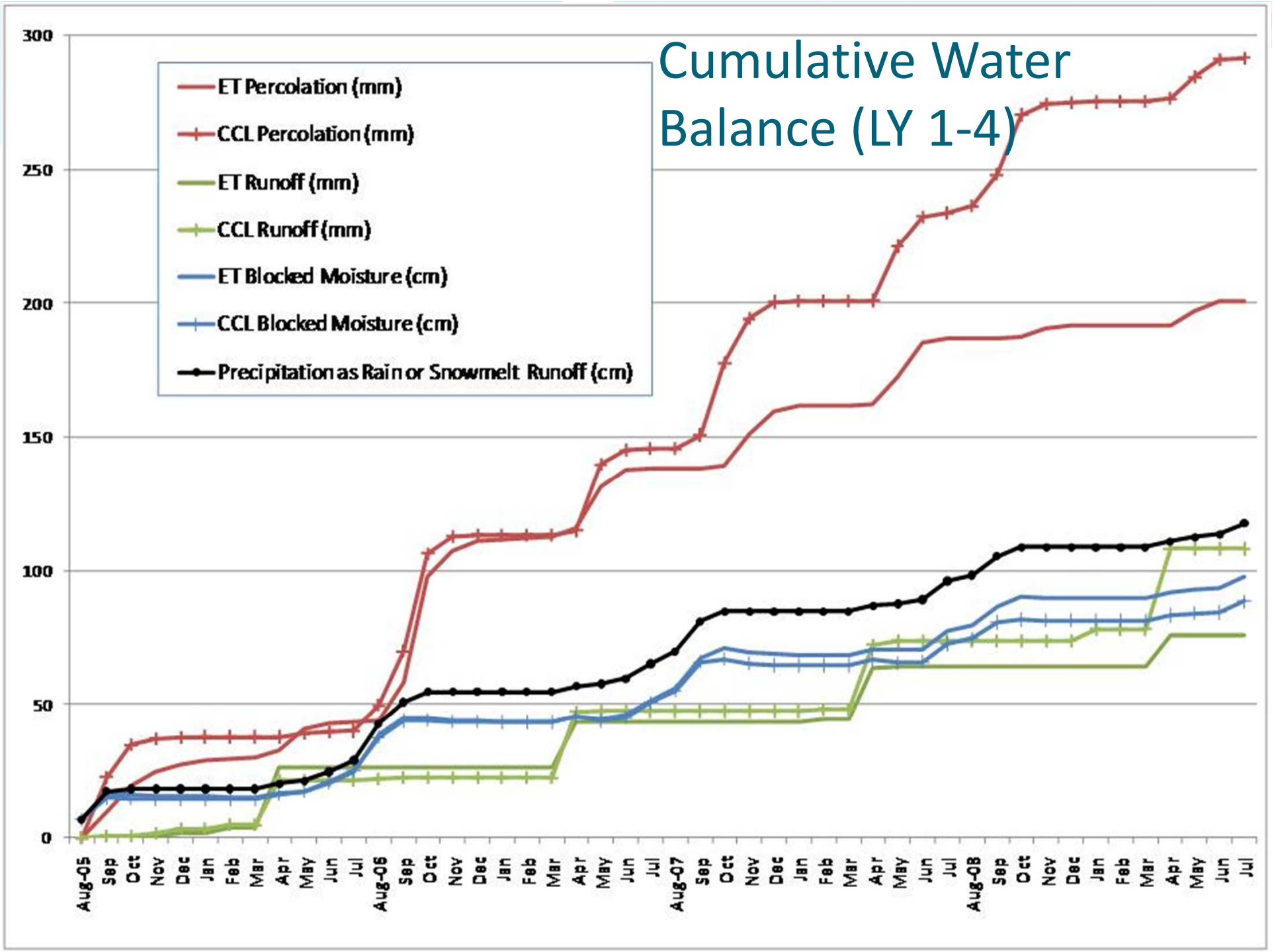

ET Lysimeter - July 2010



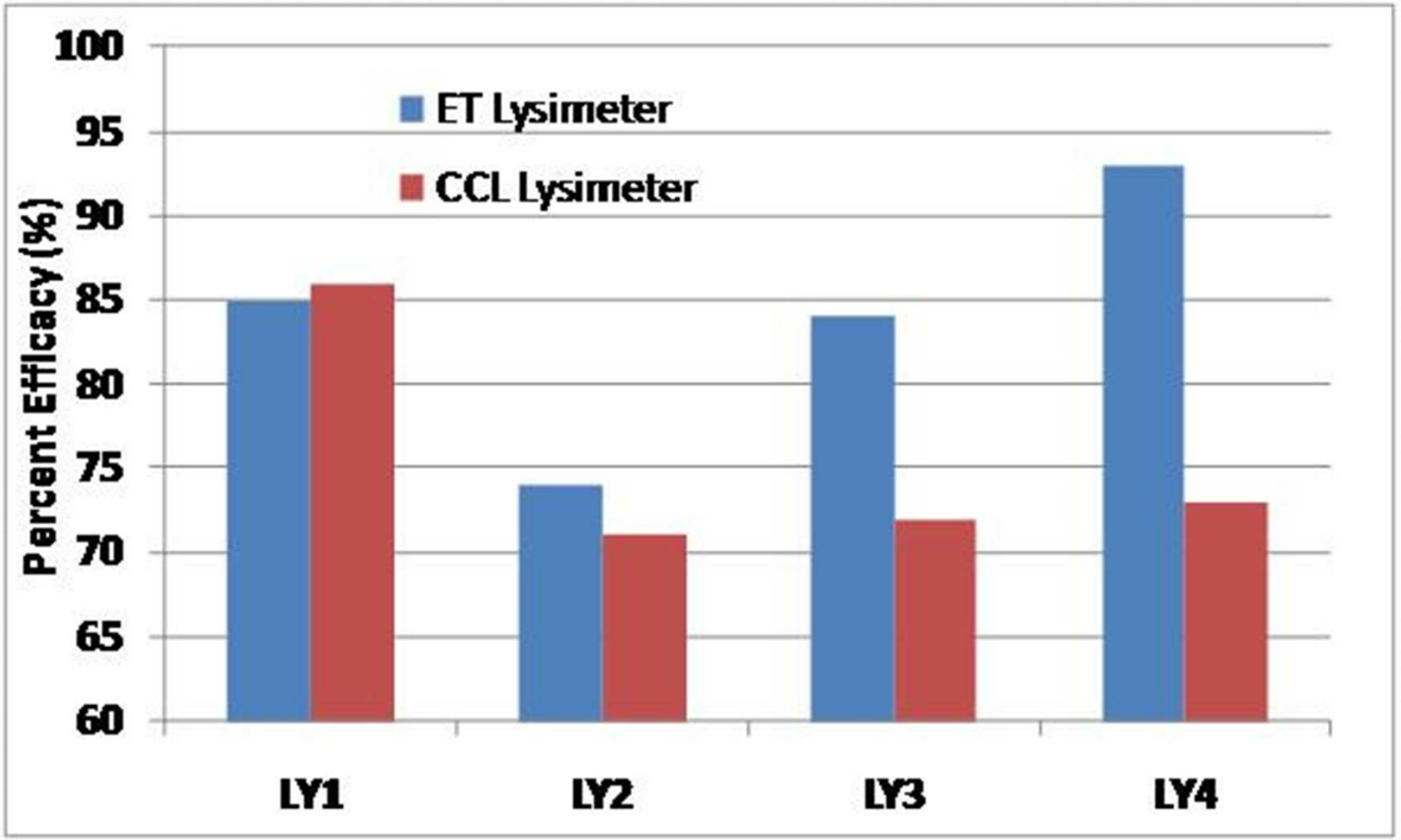


Study Results

Cumulative Water Balance (LY 1-4)



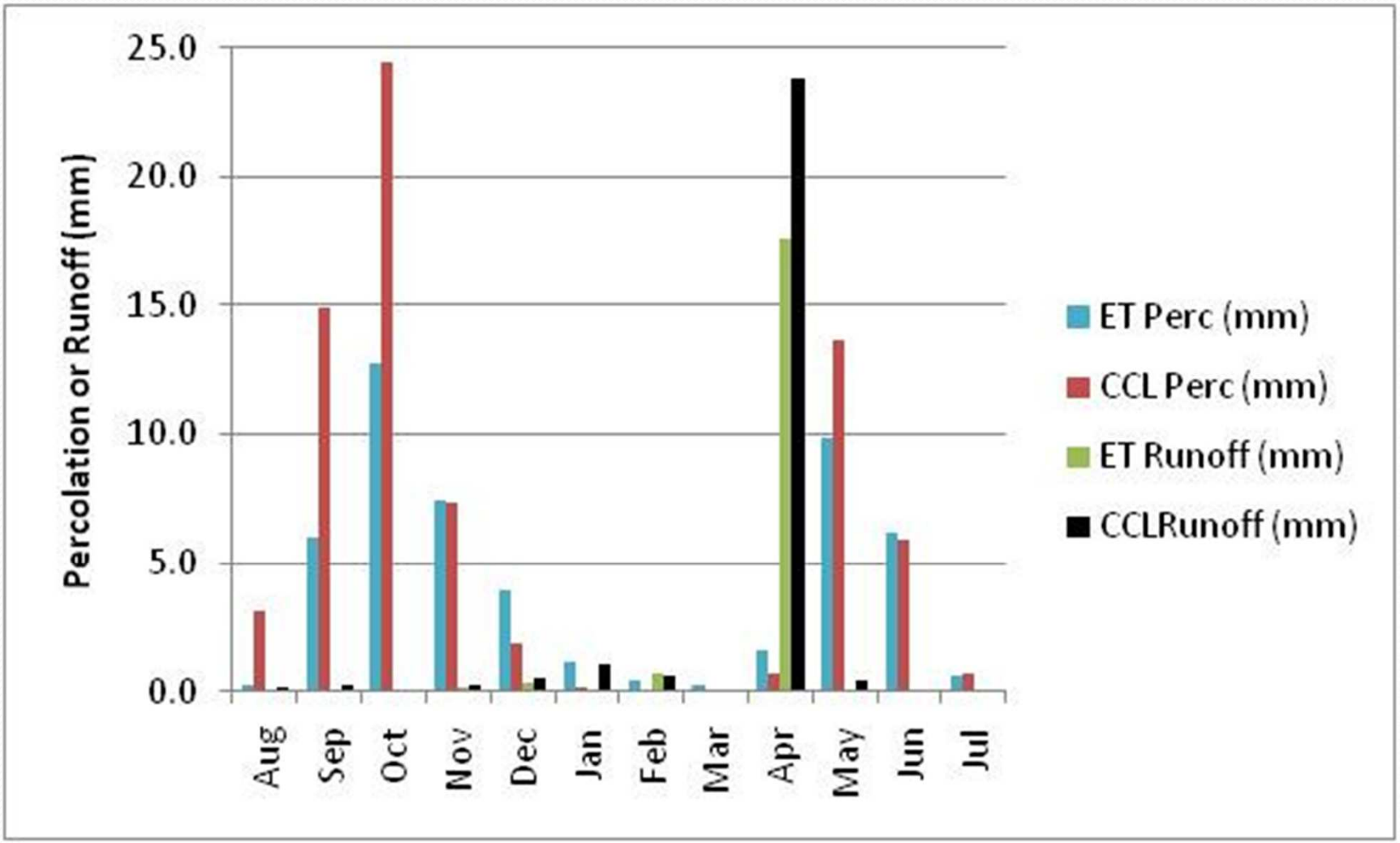
Efficacy


100
95
90
85
80
75
70
65
60
Percent Efficacy (%)
ET Lysimeter
CCL Lysimeter
LY1
LY2
LY3
LY4

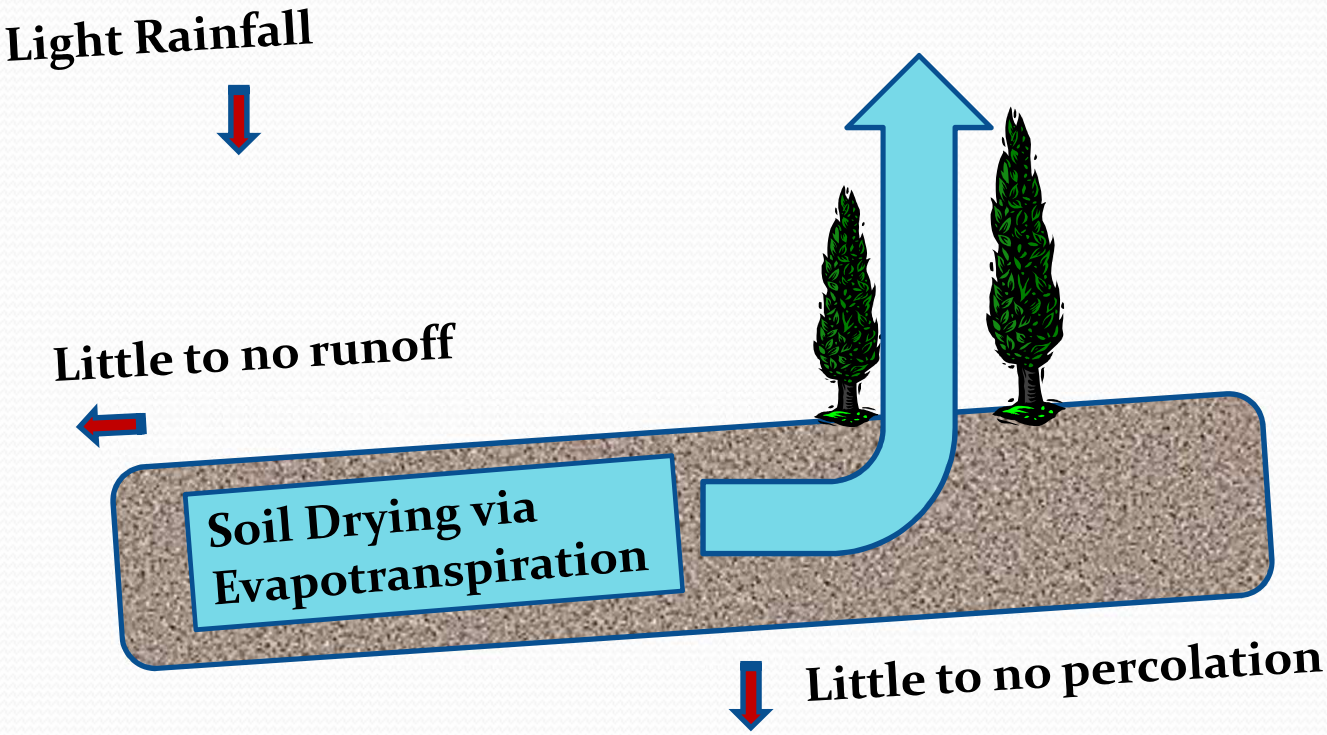
Cover Efficacy

	ET Lysimeter (LY1-LY4)				CCL Lysimeter (LY1-LY4)			
Precipitation[1] (mm)	1176				1176			
Runoff (mm)	76				108			
Percolation (mm)	201				292			
Evapotranspiration[2] (mm)	900				776			
Moisture Blocked (mm)	975				885			
% Efficacy[3]	83%				75%			
	ET Lysimeter (Yearly Totals)				CCL Lysimeter (Yearly Totals)			
	LY1	LY2	LY3	LY4	LY1	LY2	LY3	LY4
Precipitation[1] (mm)	289	362	310	215	289	362	310	215
Runoff (mm)	26	17	21	12	21	26	27	34
Percolation (mm)	43	95	49	14	40	106	88	58
Evapotranspiration[2] (mm)	220	250	241	190	228	231	195	123
Moisture Blocked (mm)	246	258	261	198	249	256	222	157
% Efficacy[3]	85%	74%	84%	93%	86%	71%	72%	73%

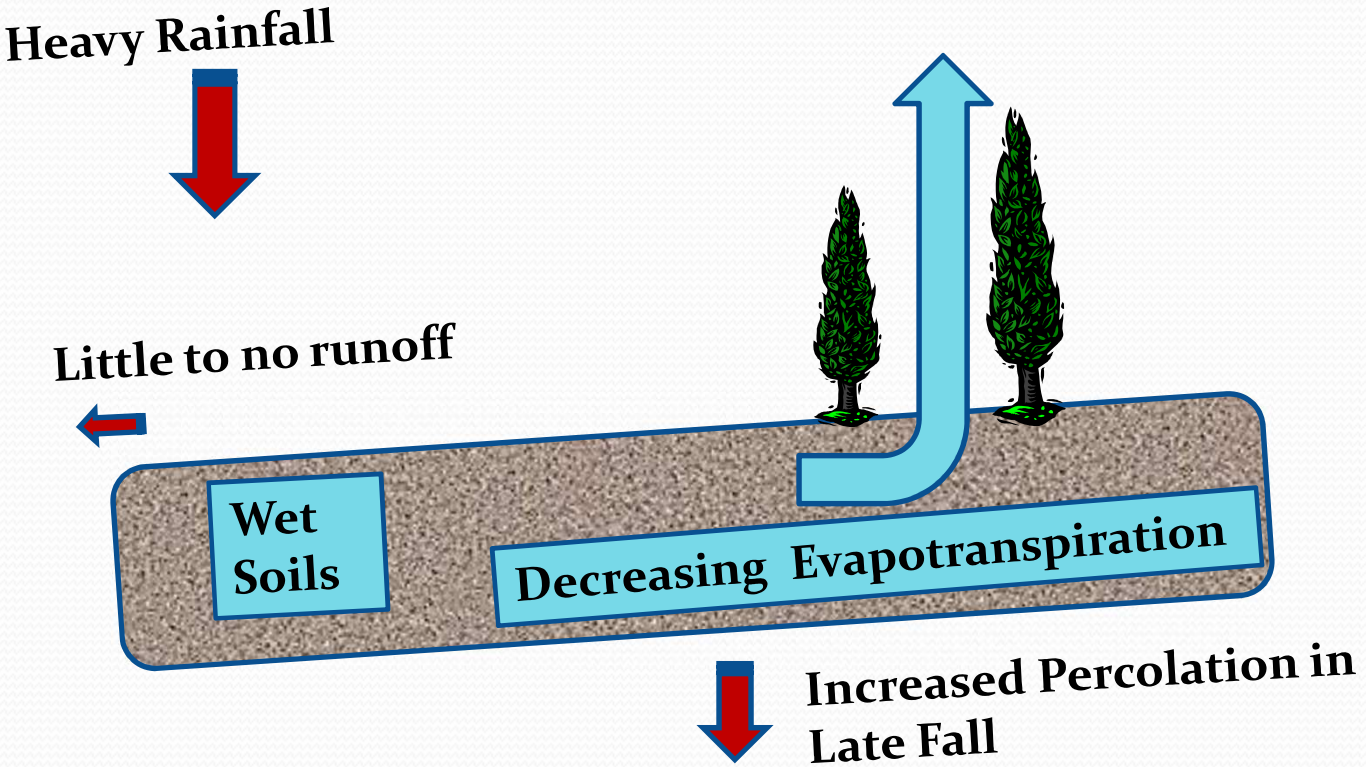
Average Monthly Perc and Runoff (LY1-LY4)



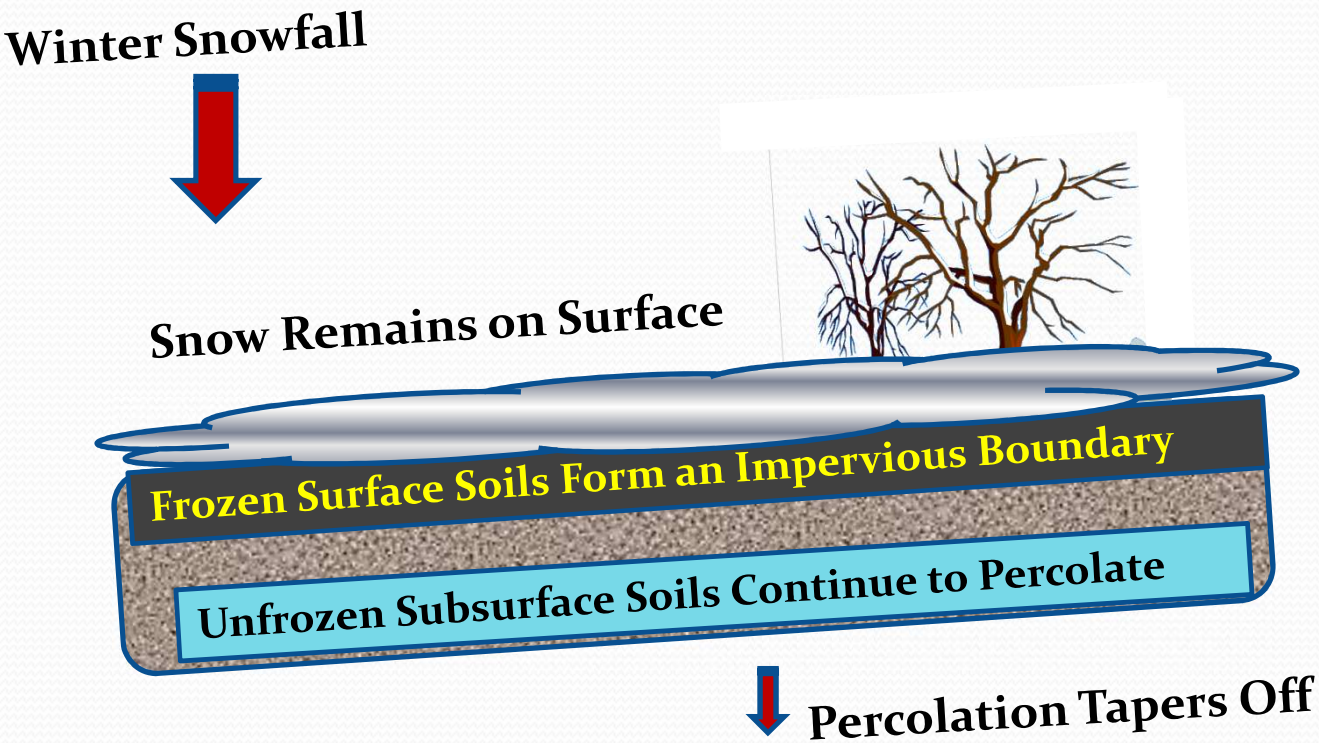
Conceptual Model - Summer



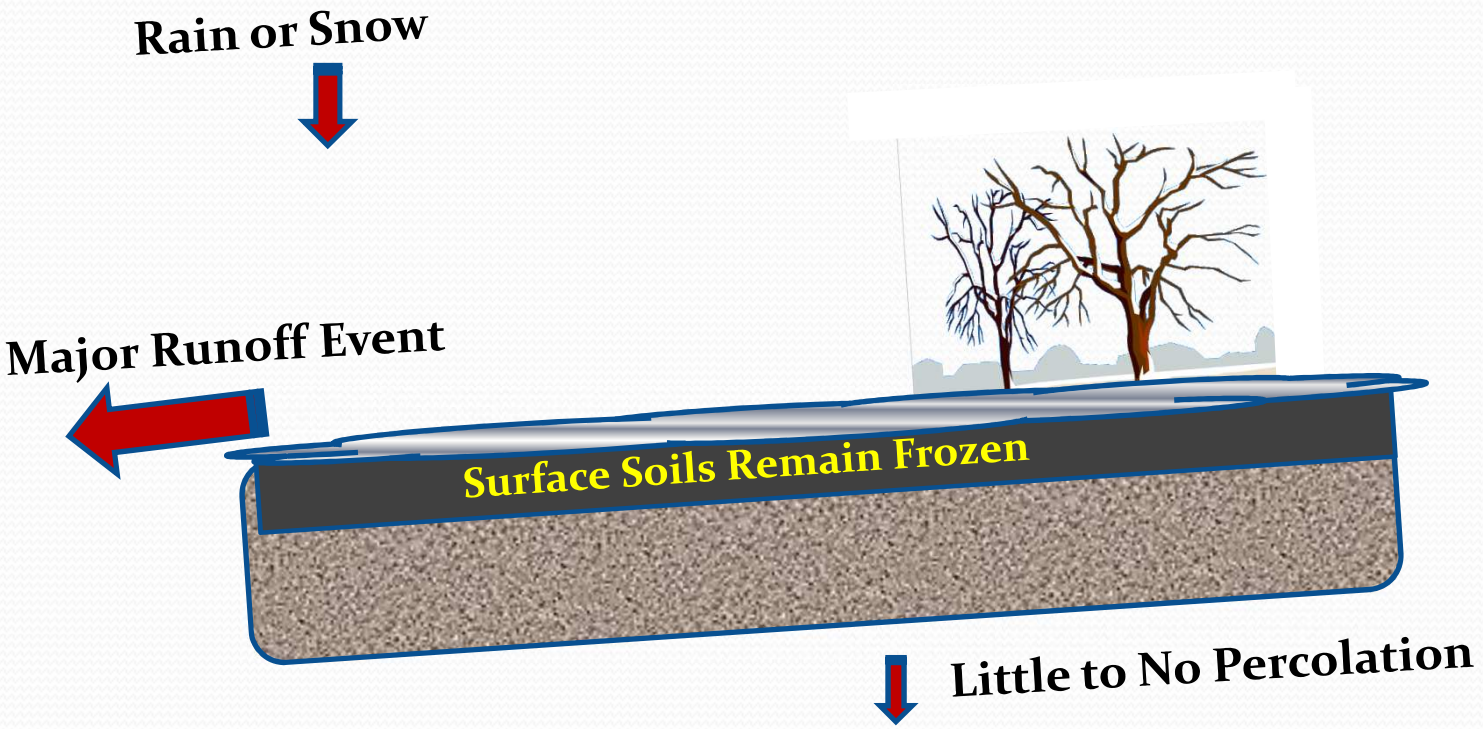
Conceptual Model – Late Fall



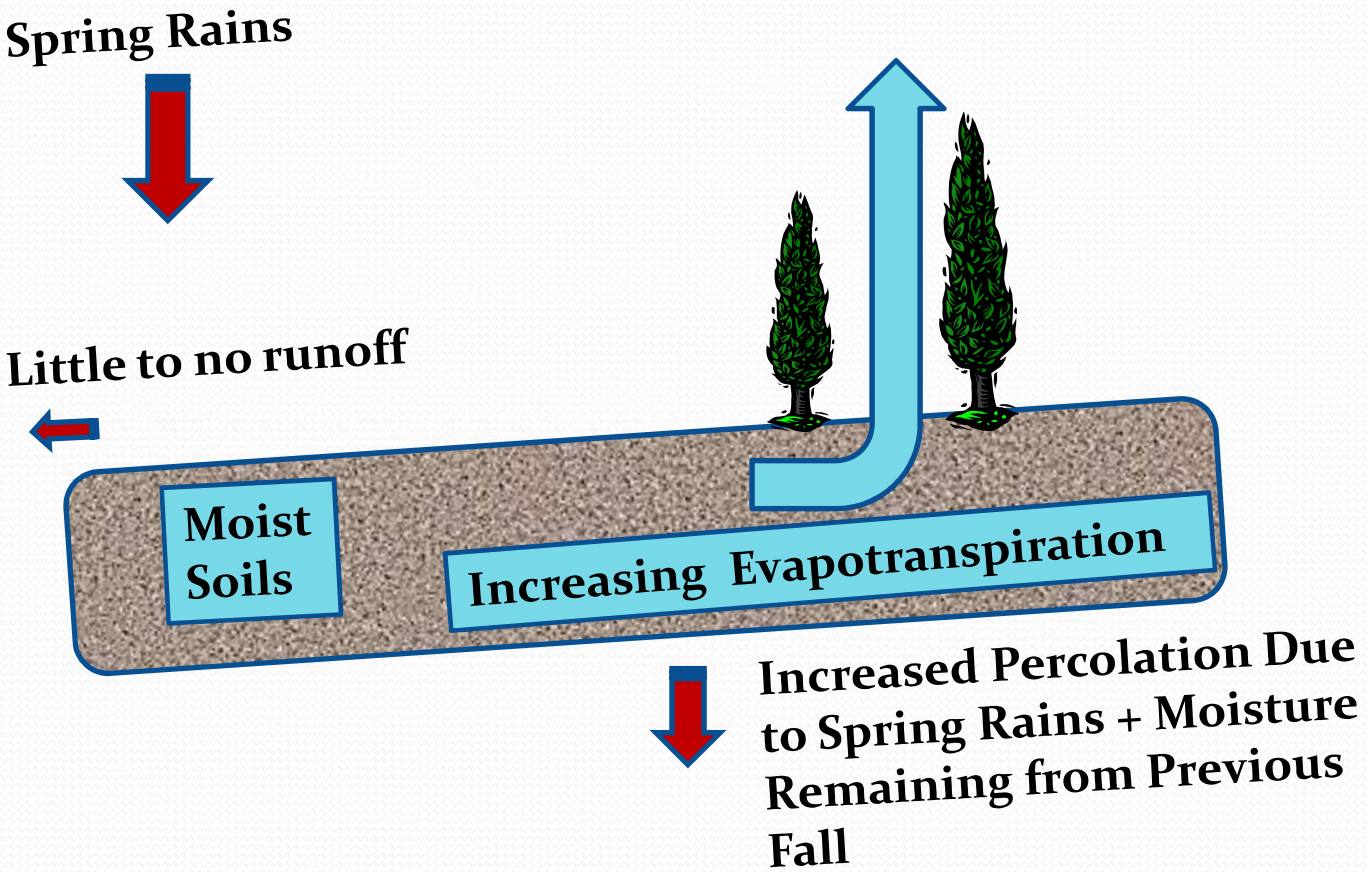
Conceptual Model – Winter



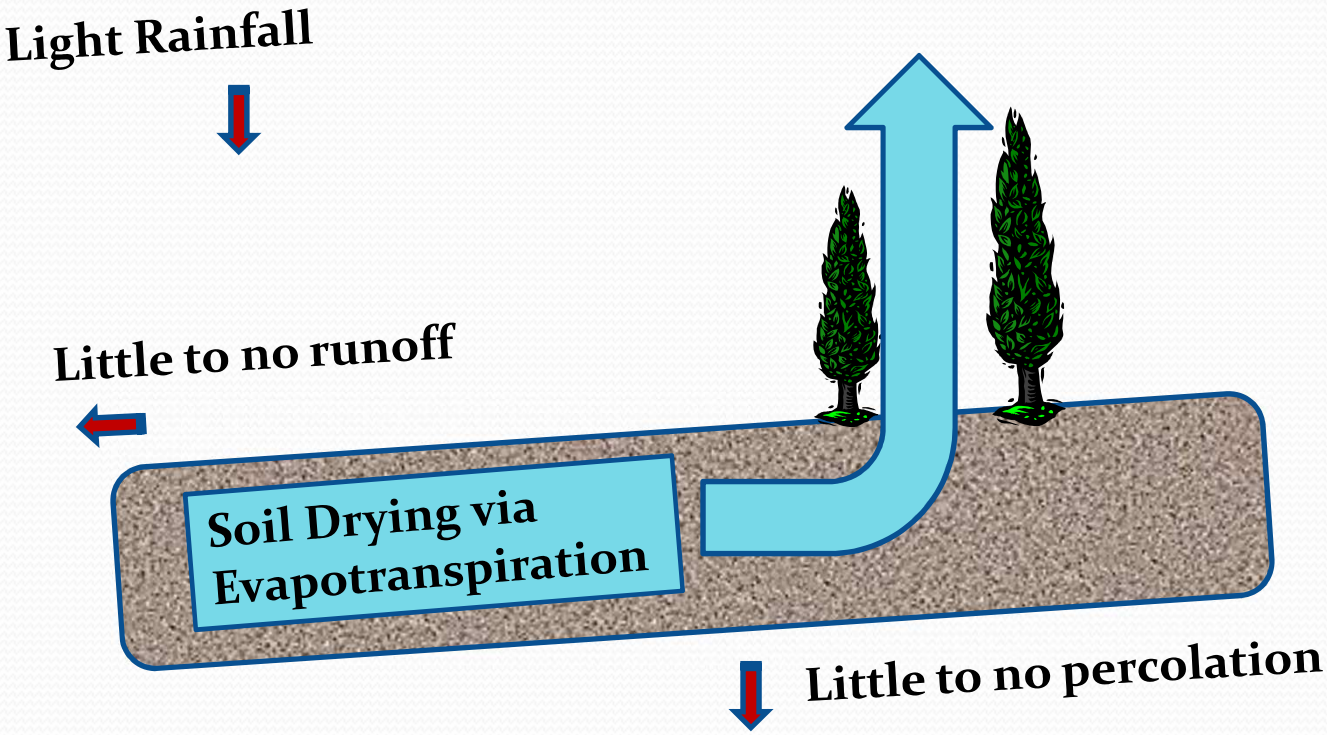
Conceptual Model – April Snowmelt



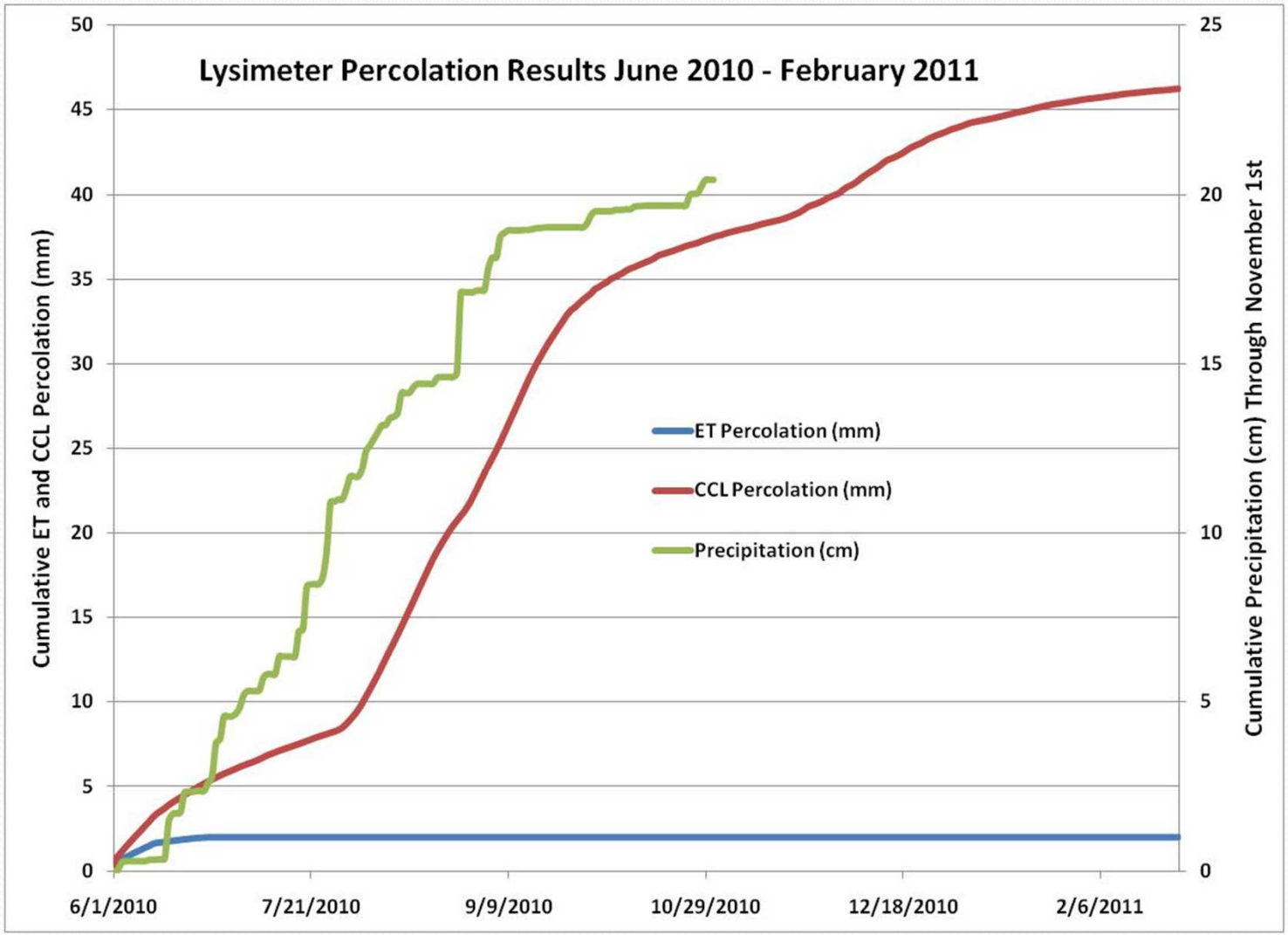
Conceptual Model – Early Spring



Conceptual Model - Summer



Latest Results



ET Percolation: 3mm

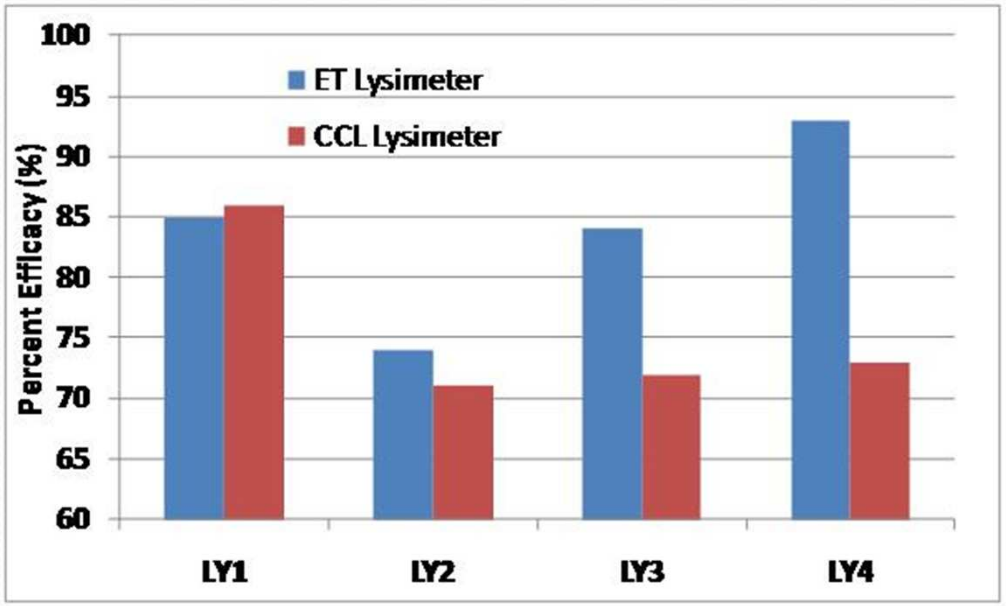
CCL Percolation: 46mm

Regulatory Question/Answer

- *Will a 2 ft. layer of forest soils planted with woody vegetation reduce infiltration at least as much as would a 6 inch erosion layer underlain by an 18 inch compacted soil layer?*
- *Answer: Yes*

Study Conclusions

- The ET Cover Design is Superior to the Prescribed CCL Design wrt Reduction of Infiltration Under Anchorage Weather Conditions
- Side Note: ET Field Scale Cover is More Compliant wrt BASH Considerations, and Saved Millions in Soil Hauling Expenses



Study Conclusions

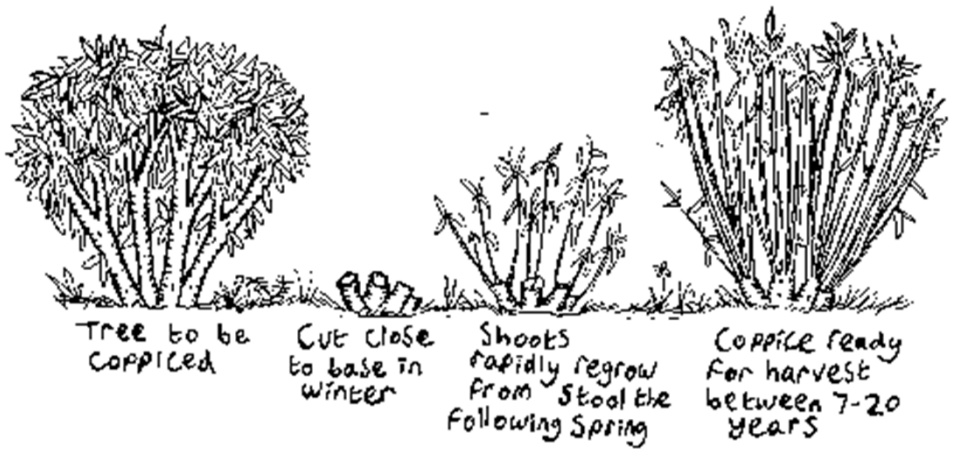
- Similar designs could find wide use in Alaska for solid waste, contaminated sites, or other applications.

Future Work

- Air Force Office of Scientific Research

- December 2010 – December 2012

- *"Using Modeling to Assess CO2 Sequestration, Engineering, Environmental, and Economic Issues Related to a Coal-to-Liquids Plant in Interior Alaska"*




March 2011

What Happens Next???

Questions?

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