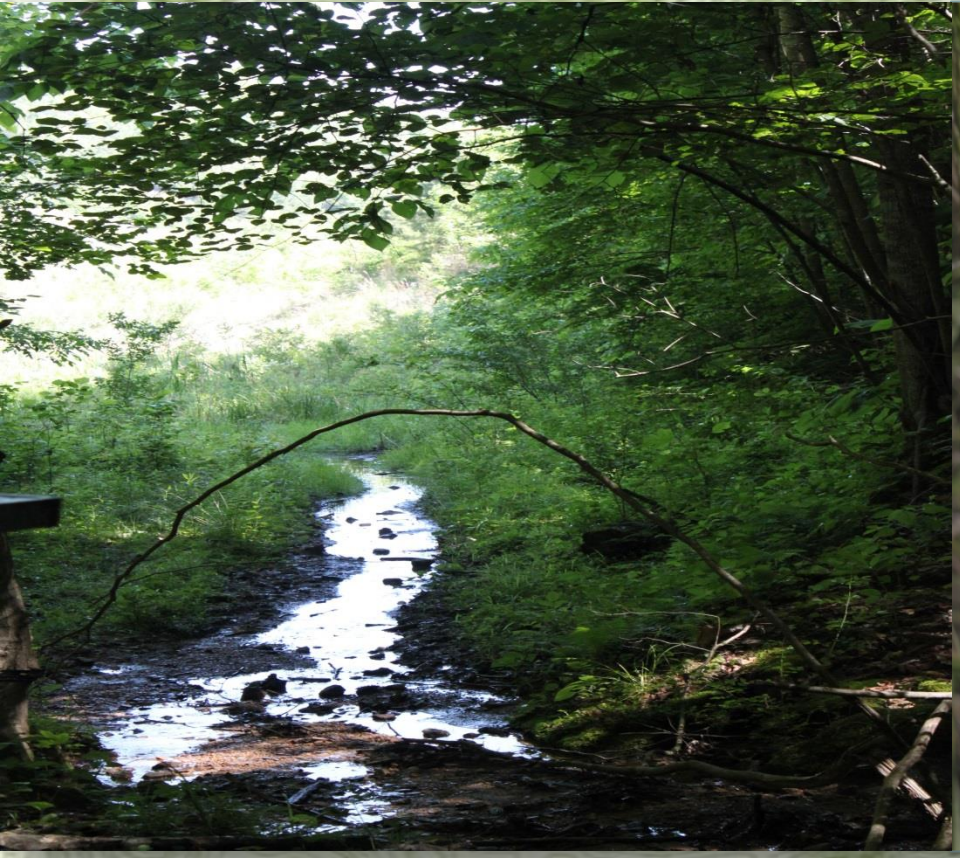


Hydrologic Assessment of a Stream Created on Mined Lands

Whitney Blackburn-Lynch, Carmen Agouridis, Travis Maupin, Chris Barton, and Richard Warner

ASMR, June 2015

Presentation Overview

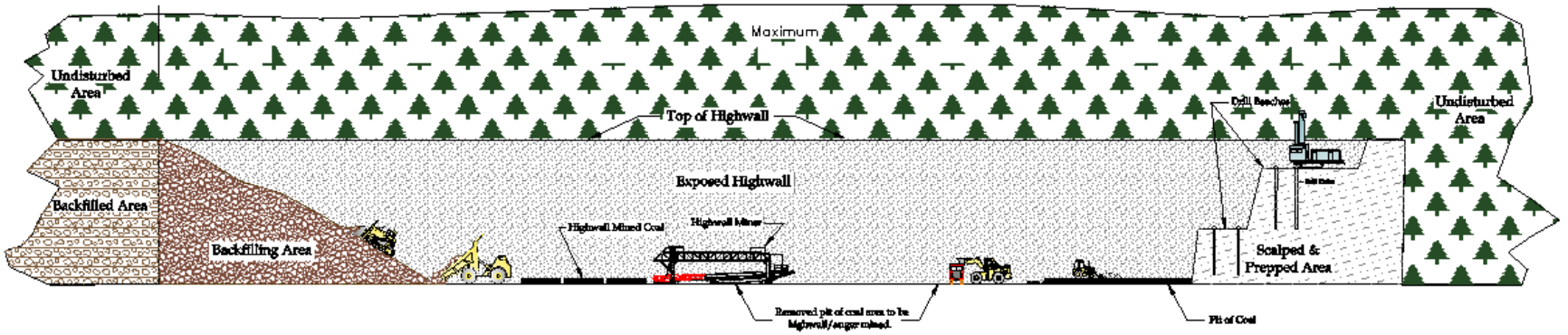
- Mining in Appalachia
- Guy Cove project
- Hydrologic data acquisition
- Hydrograph analysis
- Baseflow analysis
- Lessons learned
- Future work

MINING IN APPALACHIA

Coal Mining in Appalachia

- Approximately 29% of US coal comes from Appalachia (2013)
  - Kentucky and West Virginia account for 20%
- USEPA estimates about 3, 200 km streams buried by surface coal mining practices (2013)
- Question of how to manage large disturbances while minimizing impacts on the environment

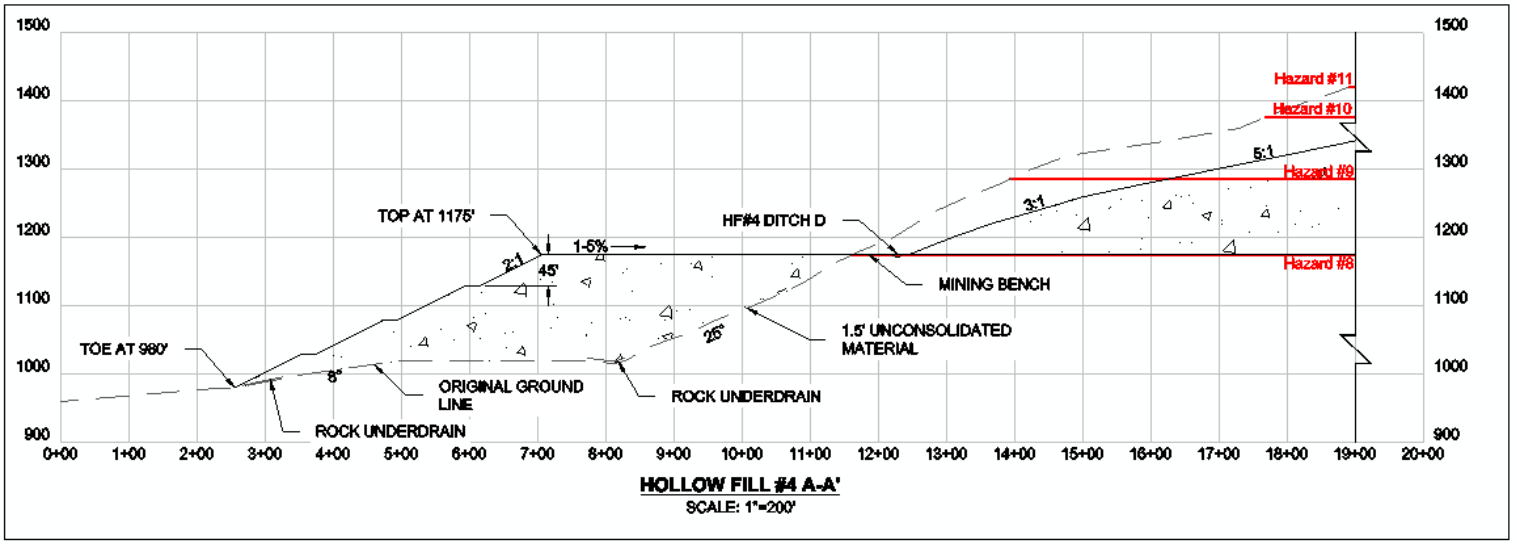
The Mine Process

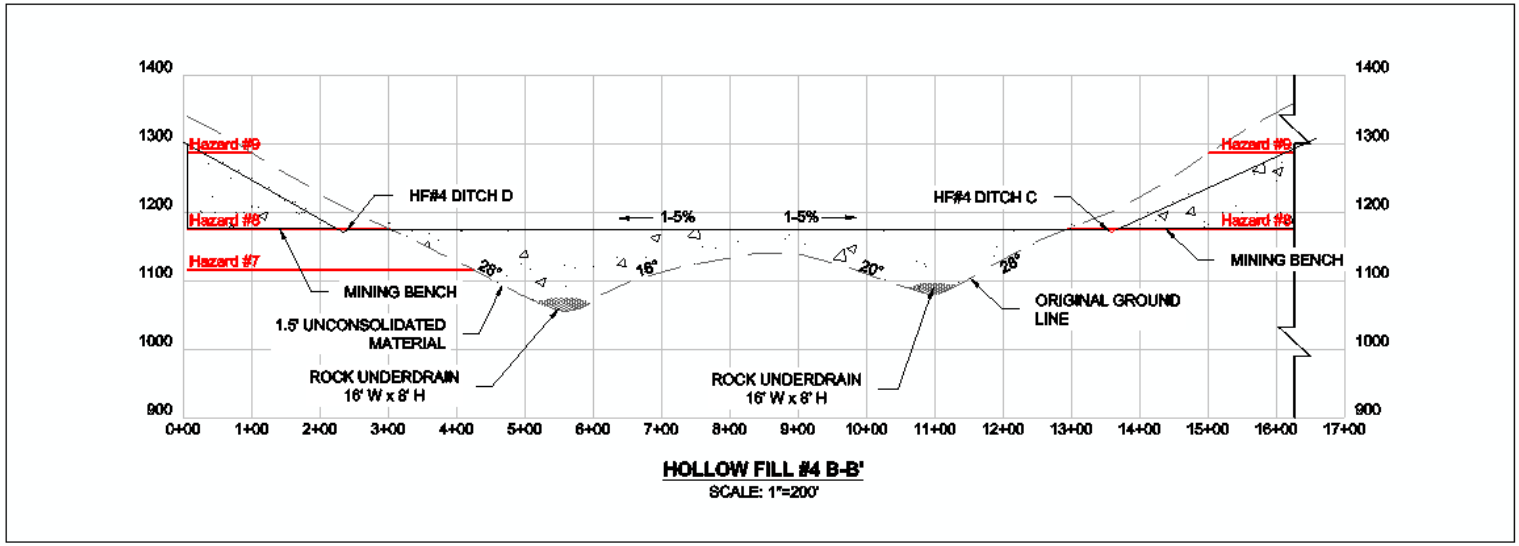


(Source: Whitney Blackburn-Lynch, Lewis Creek Permit)


Stillrock
White Branch
Oak Fork
Buck Fork

Hollowfill Design





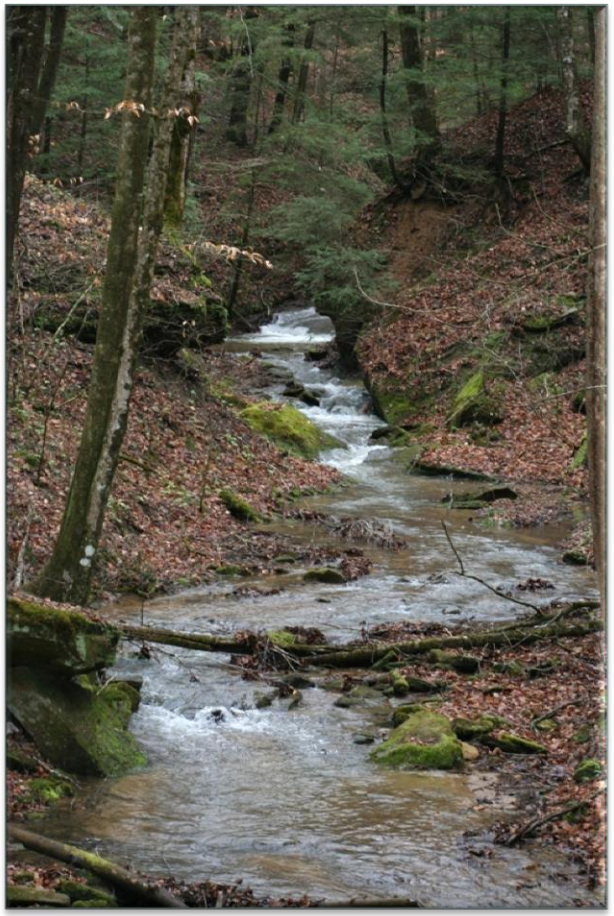
(source: Whitney Blackburn-Lynch, Rattlesnake Permit)

GUY COVE PROJECT

Guy Cove Project

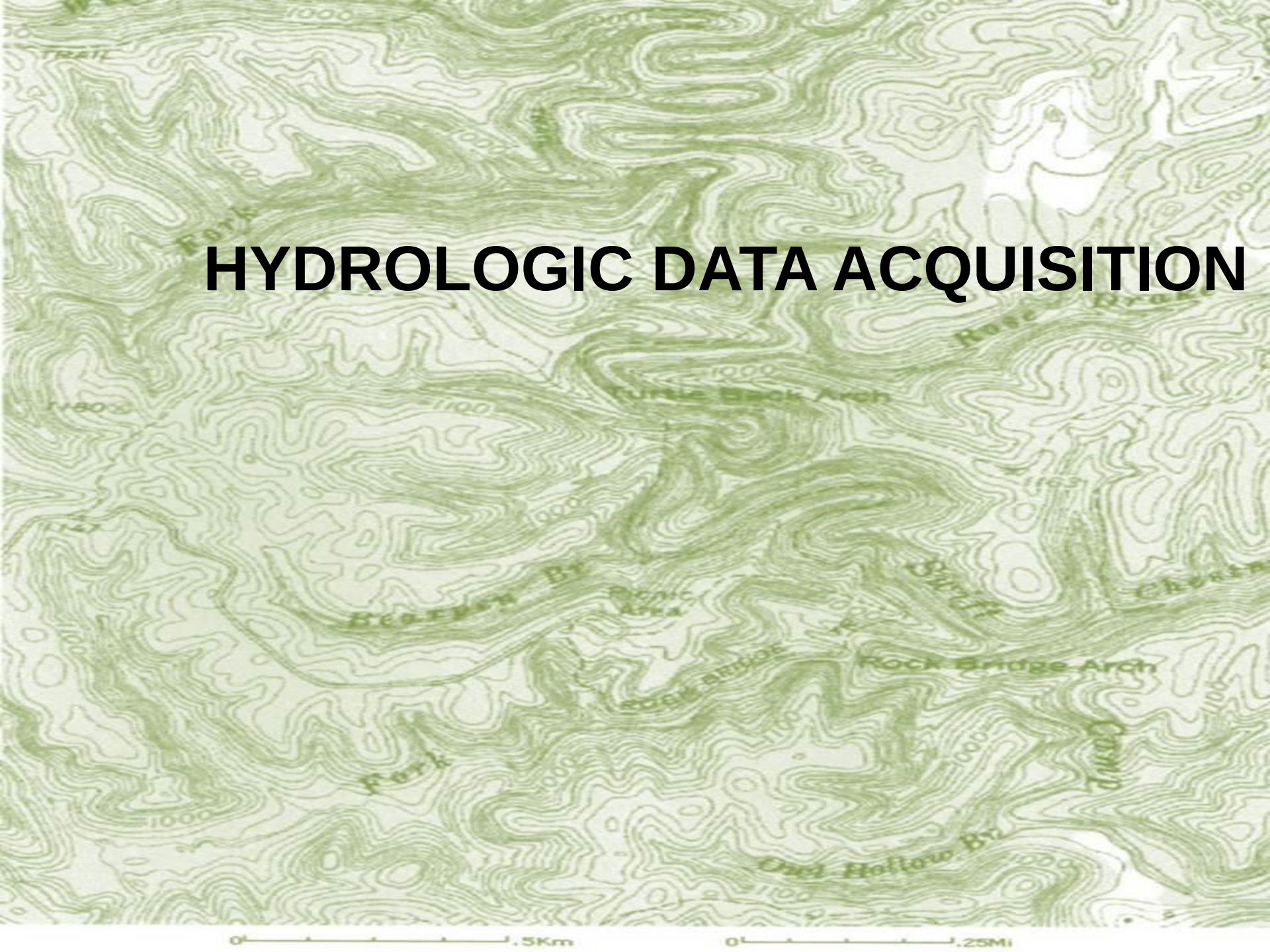
Restored Hollow Fill

(UK Laurel Fork Mine – Guy Cove)

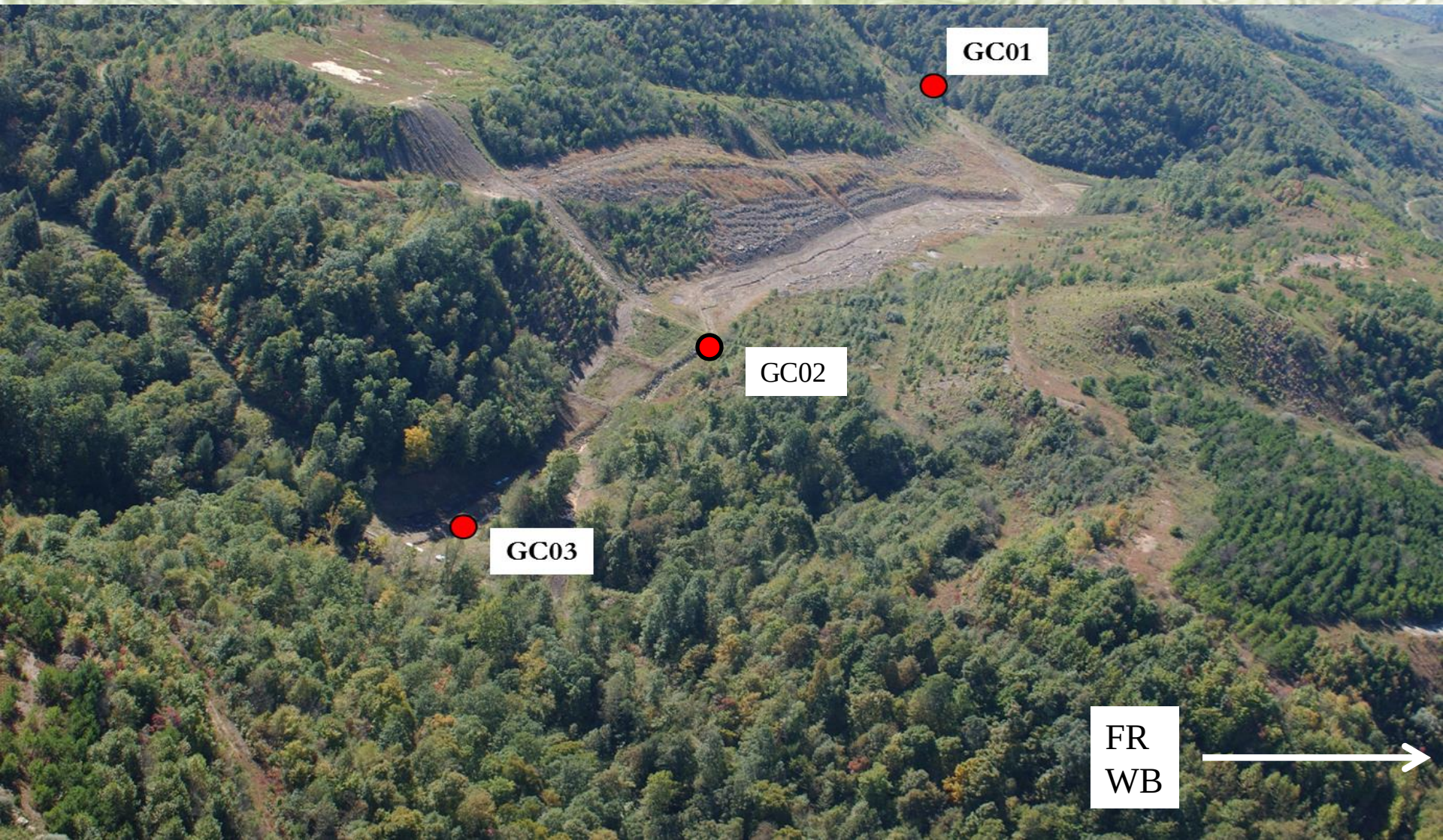


Un-mined Headwater Stream

(UK Robinson Forest)

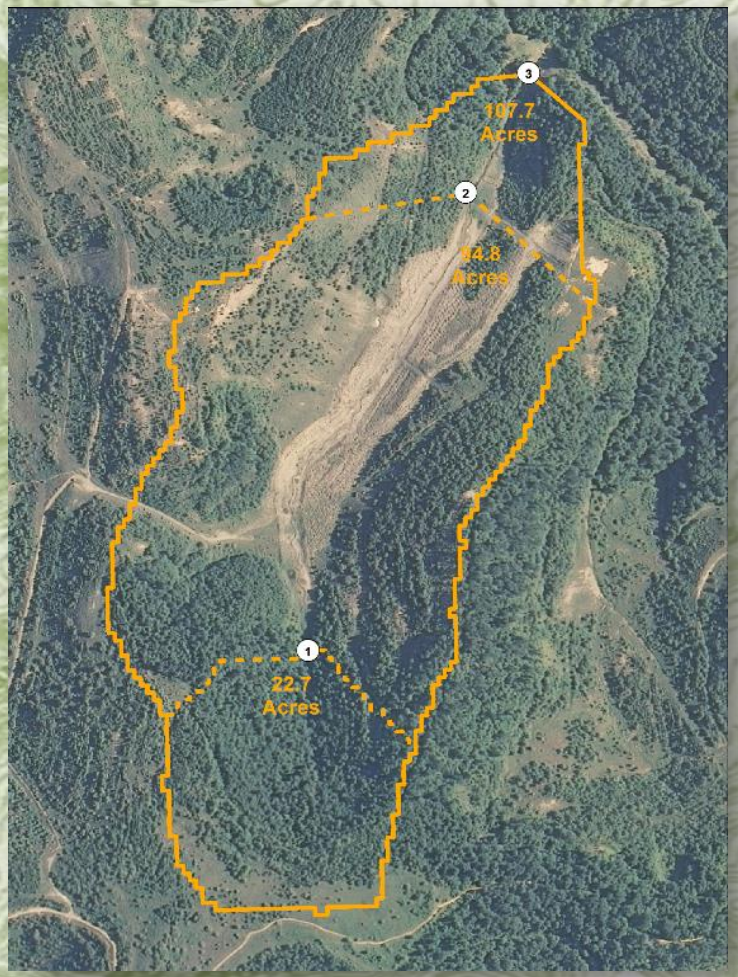

HYDROLOGIC DATA ACQUISITION
Turtle Back Arch
Rock Bridge Arch
Owl Hollow Rd
.5Km
.25Mi

Monitoring Locations



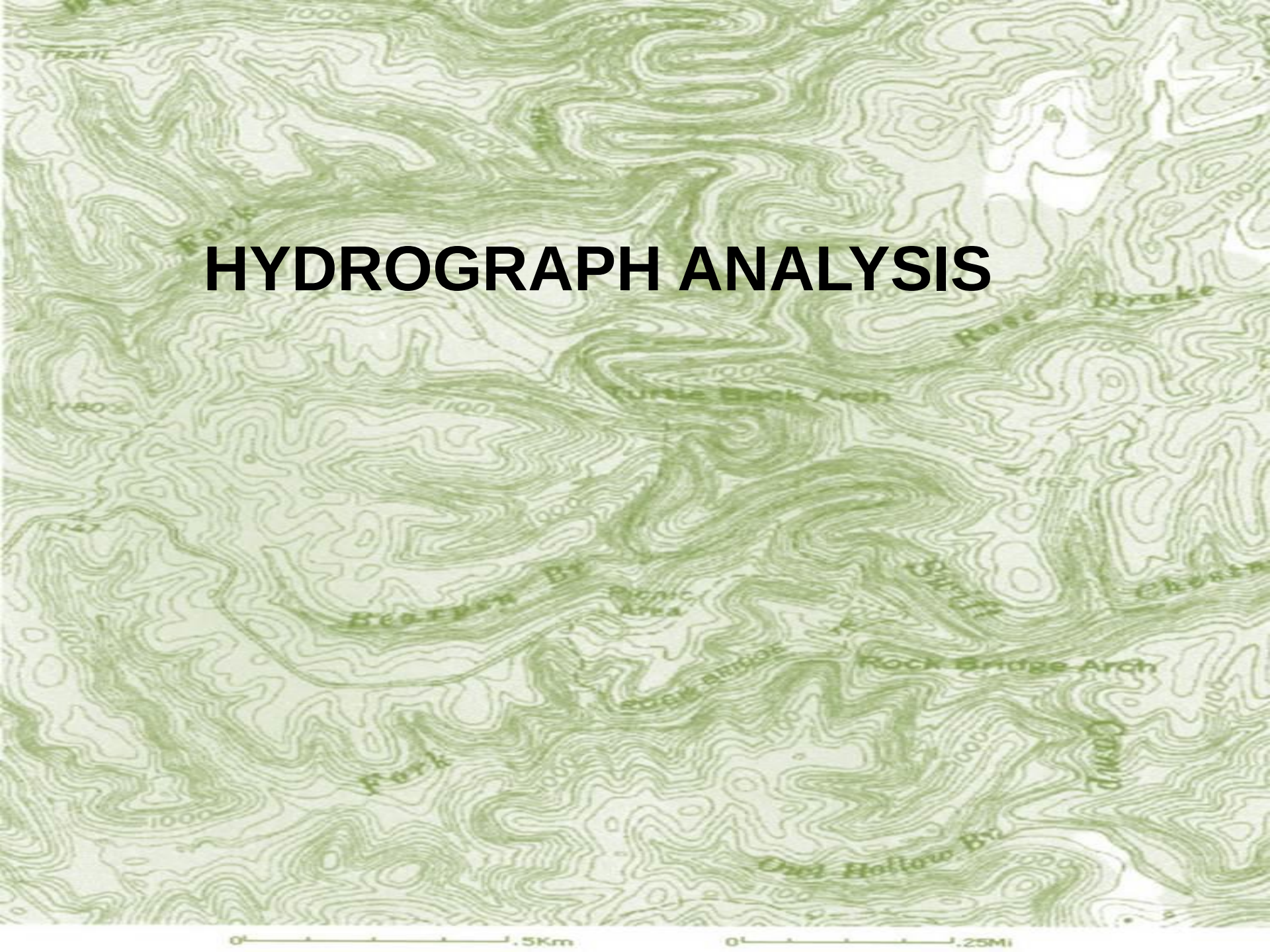
Watershed Characteristics

- GC01 (9 ha)
  - Unmined, but harvested; regenerating forest (~15 yrs)
- GC02 (38 ha)
  - FRA and stream restoration ~10%
- GC03 (44 ha)
  - Toe of valley fill
- FR (92 ha)
  - Unmined headwater stream
  - Forested
- WB (44 ha)
  - VF with no restoration/reclamation
  - Open hay pasture; regenerating forest at toe of valley fill

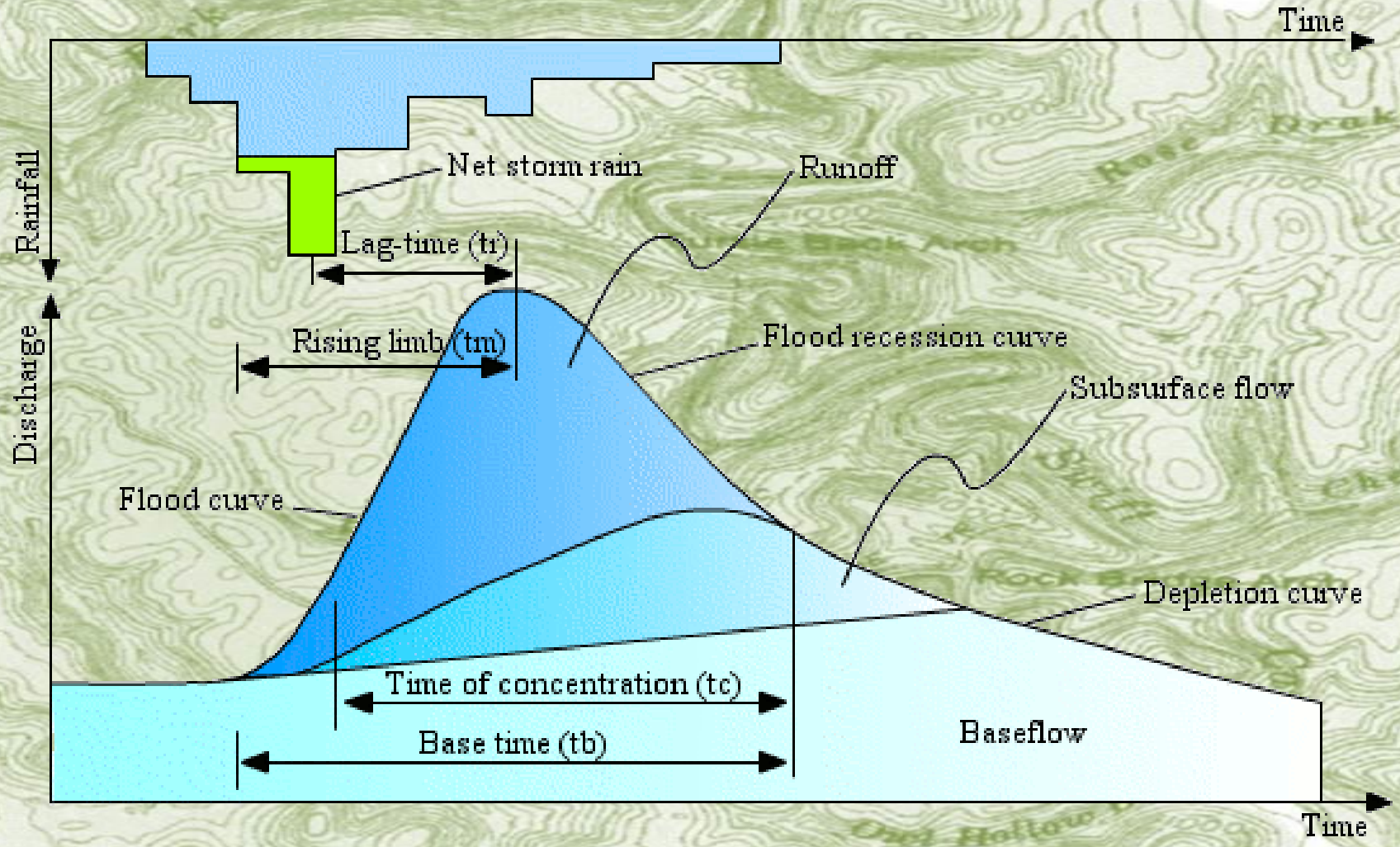


Hydrologic Data

- Rainfall
- Discharge
  - 2010 (early-March) to 2013 (mid November)
  - 10-15-minute intervals
  - No flow data Dec.-Feb. due to freezing temperatures


HYDROGRAPH ANALYSIS
Turtle Back Arch
Rock Bridge Arch
Fork
Drake
Rose
Owl Hollow Rd
.5Km
.25Mi

Storm Event Analysis



Statistical Analysis

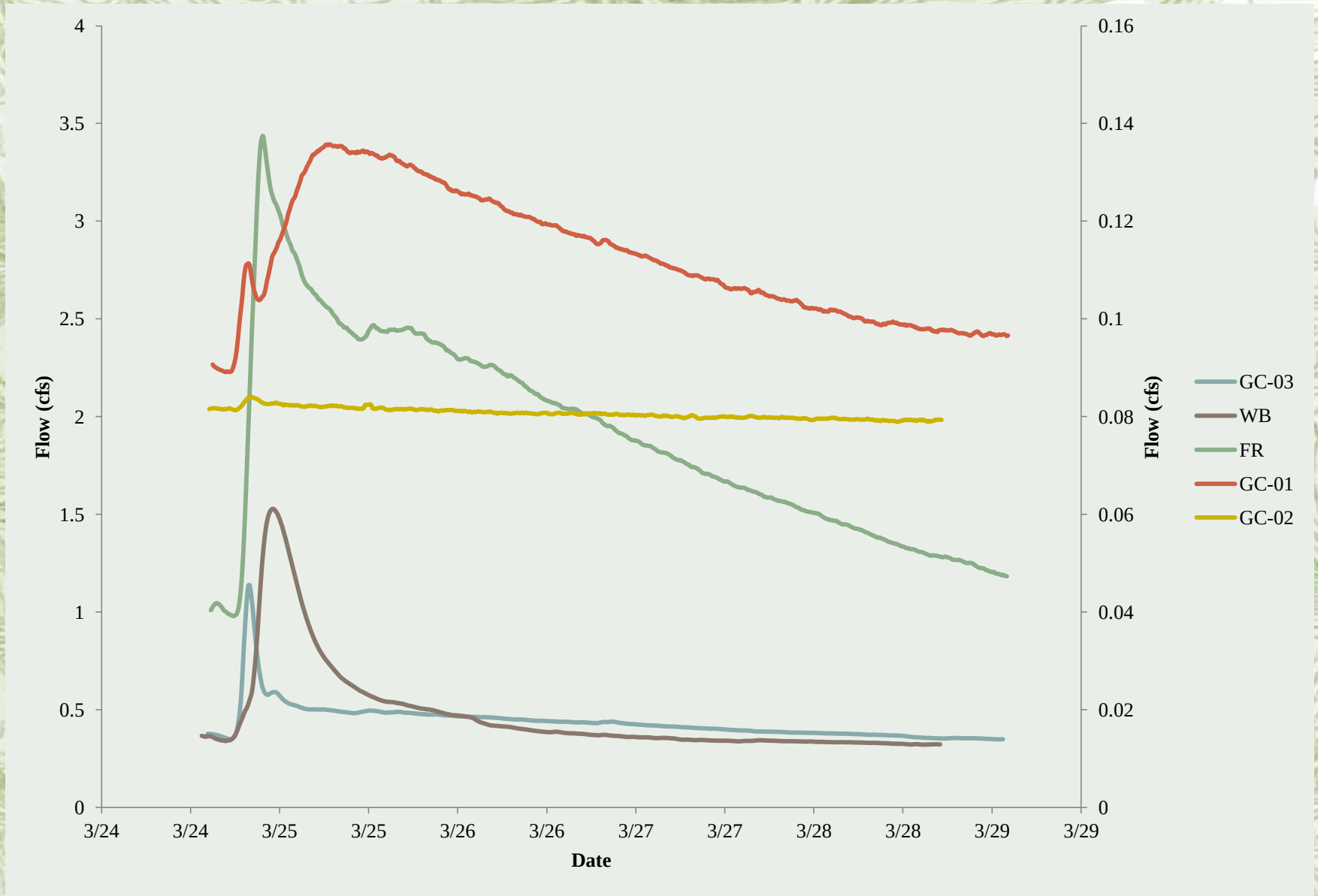
- Second-order autoregressive model (PROC AUTOREG) to account for linear connection between GC01, GC02 and GC03
- Drainage area as covariate
- Each hydrograph parameter was evaluated individually
  - H_0=No difference in hydrograph parameter between sites
- One-way ANOVA on ranks to test for differences in number of days of flow between sites

Rainfall

- 57 rainfall events for study period
- Rainfall depths
  - 129 mm below normal (2010)
  - 270 mm above normal (2011)
  - 179 mm below normal (2012)
  - 93 mm above normal (2013)

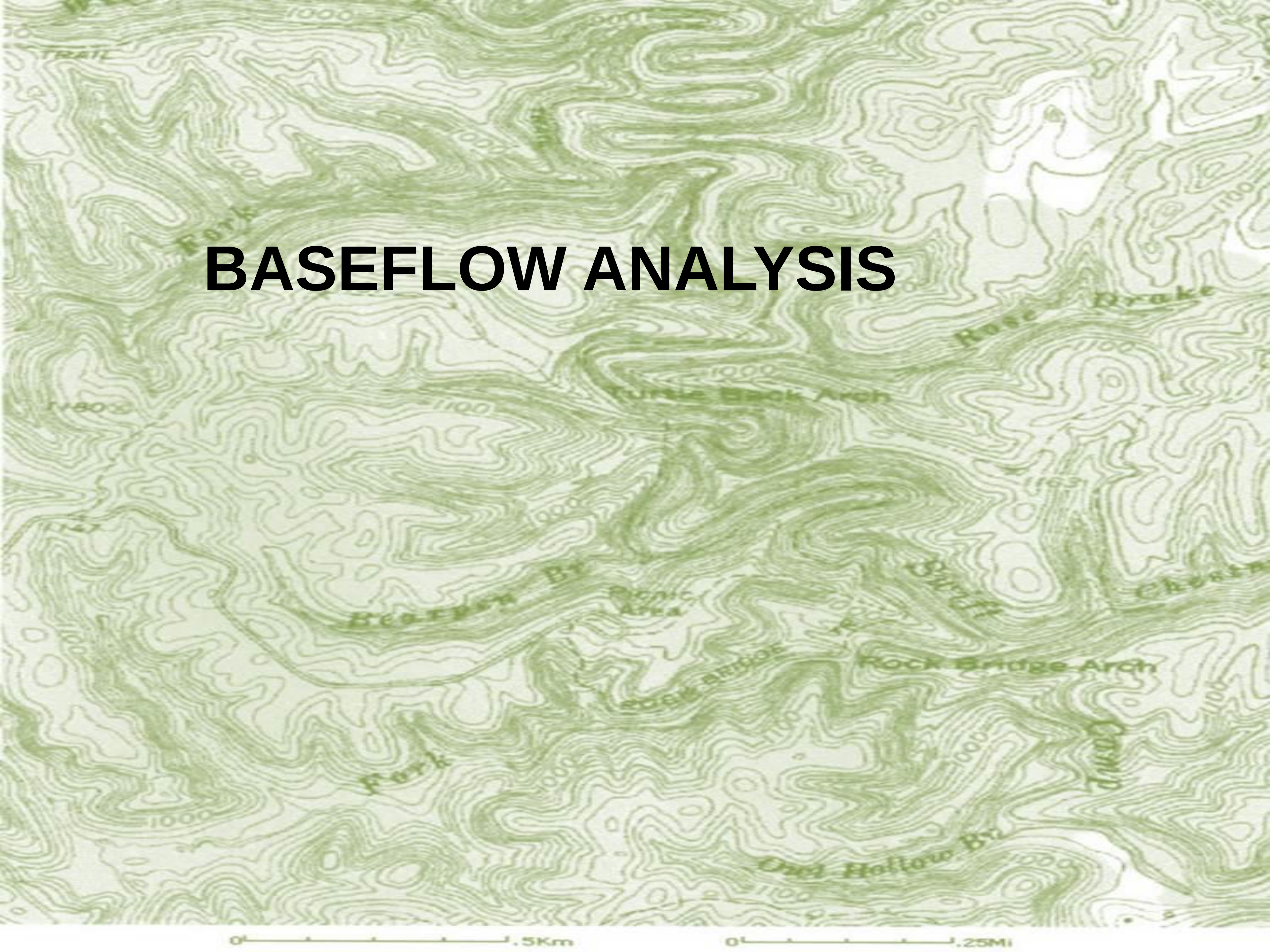
Hydrograph Parameters

Site	Response Time (hr)			Lag Time (hr)			Time to Peak (hr)			Peak Flow (cms)			Flow Duration (hr)			Total flow (m^3)			CN		
GC 01	1.369	±	1.896	15.145	±	13.445	14.204	±	13.270	0.005	±	0.004	24.788	±	21.992	147.524	±	299.822	87.770	±	10.733
GC 02	2.798	±	3.484	7.780	±	4.065	5.168	±	4.816	0.010	±	0.010	11.469	±	8.070	143.097	±	237.164	81.223	±	9.719
GC 03	1.124	±	2.502	6.680	±	7.467	6.319	±	6.503	0.057	±	0.059	12.491	±	11.378	495.476	±	621.942	91.716	±	7.101
WB	1.433	±	3.554	6.562	±	6.745	5.911	±	4.789	0.107	±	0.152	11.187	±	8.382	951.608	±	1557.037	93.349	±	9.757
FR	1.165	±	2.177	8.543	±	8.636	8.289	±	7.863	0.133	±	0.235	15.283	±	12.977	2745.228	±	5533.348	81.288	±	6.784



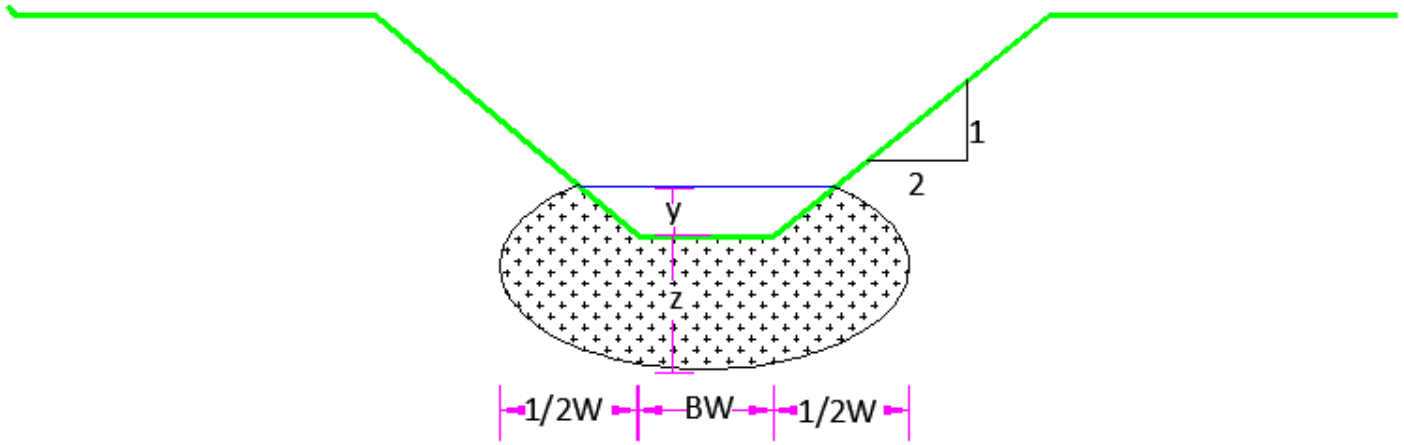
20.1 mm depth, 19.0 hr duration storm event

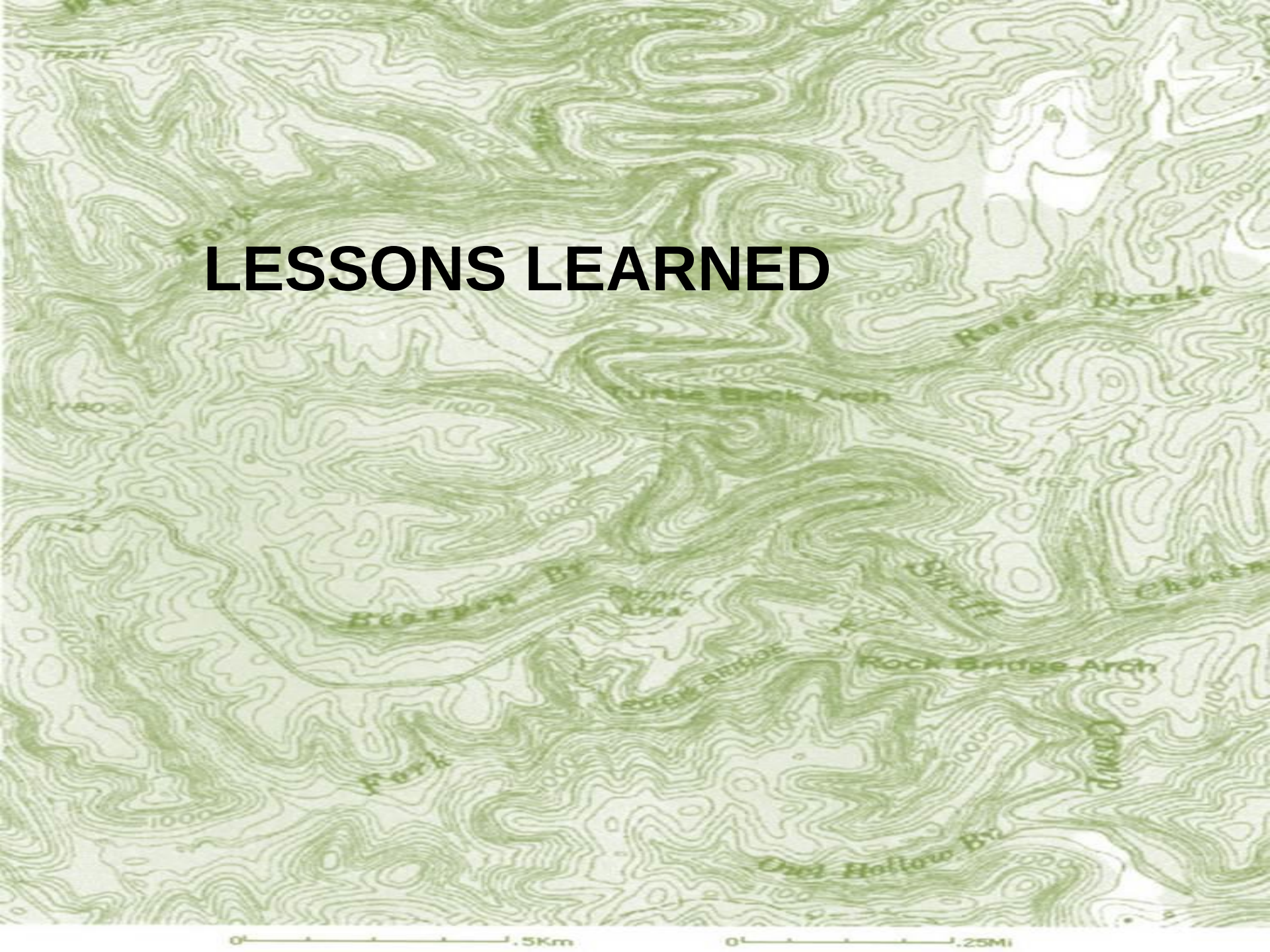
BASEFLOW ANALYSIS



No. Days of Baseflow

Parameter	Site				
	FR	GC01	GC02	GC03	WB
Days of flow	29.0	25.0	10.0	28.7	29.3


1
2
y
z
1/2W
BW
1/2W


LESSONS LEARNED
Turtle Back Arch
Rock Bridge Arch
Rock Bridge
Owl Hollow Rd
Fork
Rose
Drake
.5Km
.25Mi

Lessons Learned

- There is a disconnection between the stream and the groundwater. Flow loss is expected.
- Retrofitting an existing hollowfill has significant problems.


FUTURE WORK
Turtle Back Arch
Rock Bridge Arch
Owl Hollow Rd
.5Km
.25Mi

Future Work

- Developing systems to minimize loss and increase stream recharge.
- Evaluation of infiltration by plant uptake.
- Inclusion of design for reconstructed headwater streams in mining application, evaluation of said headwater streams.

Questions?

UK

UNIVERSITY OF KENTUCKY

College of Agriculture

College of Engineering