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Factors Affecting Exfiltration Rate from a Subsurface Infiltration Stormwater Control Measure

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National Risk Management Research Laboratory
Water Supply and Water Resources Division
Urban Watershed Management Branch

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CSO 130

- Location: Louisville, KY
- Area:17.3 acre

14 Paver strips

4 Planters

28 Tree boxes

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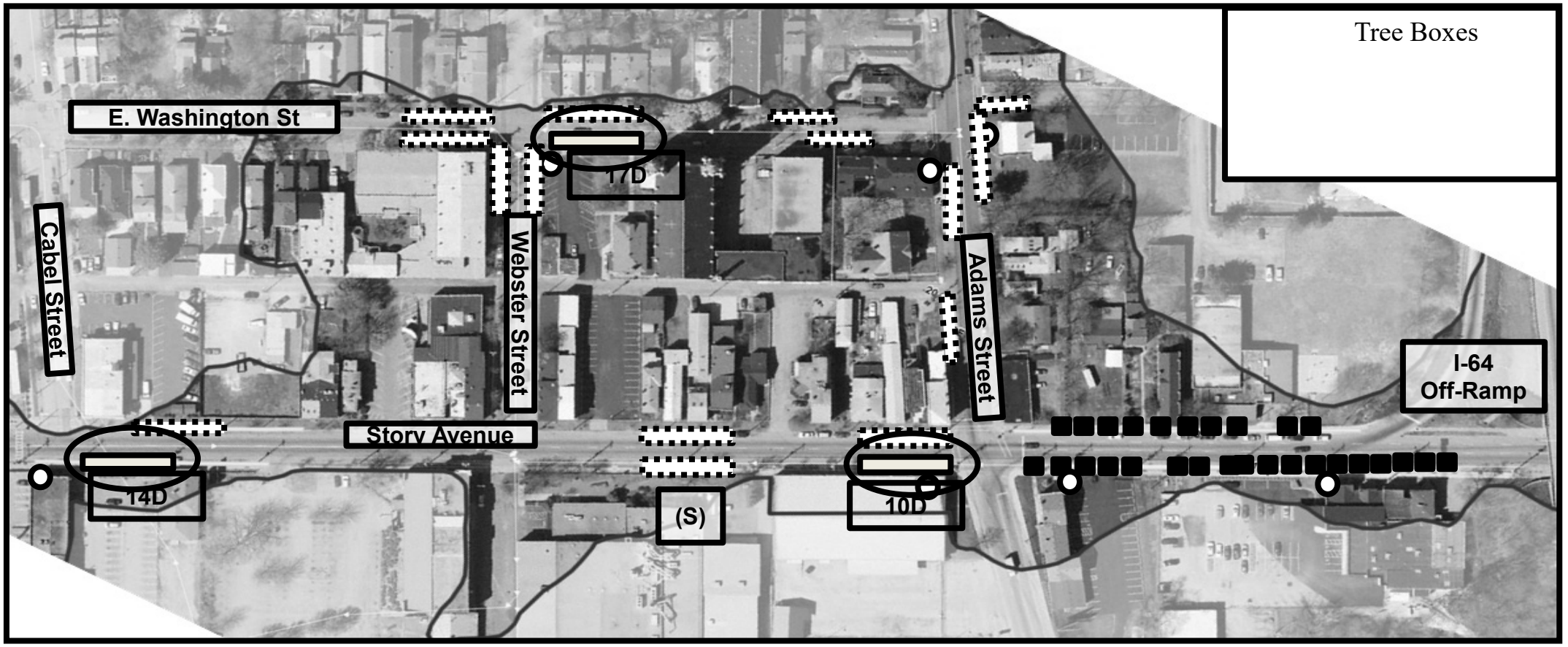
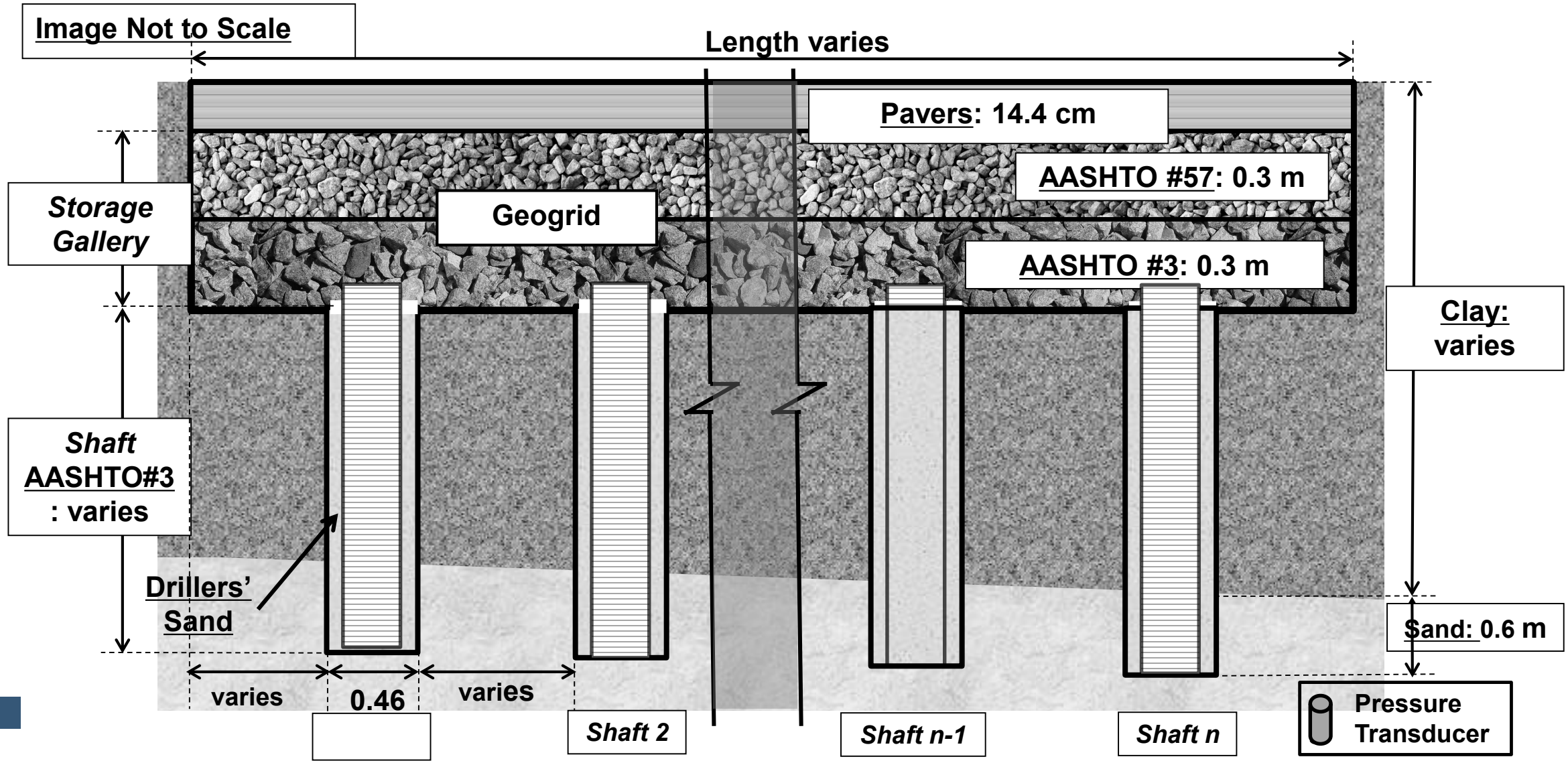
We monitored three stormwater control measures distributed throughout the basin.



Monitored strips had 5 to 10 shafts along length.



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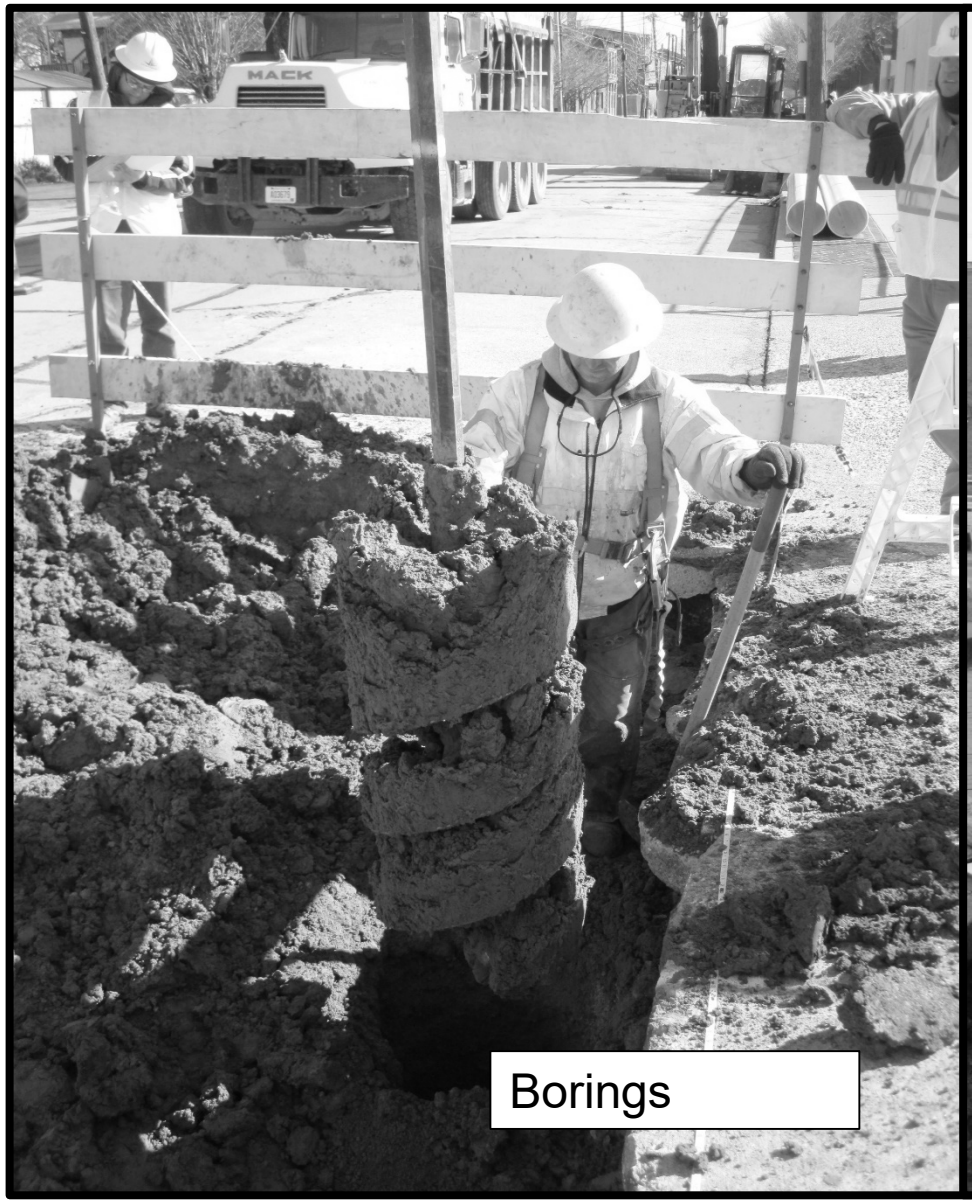
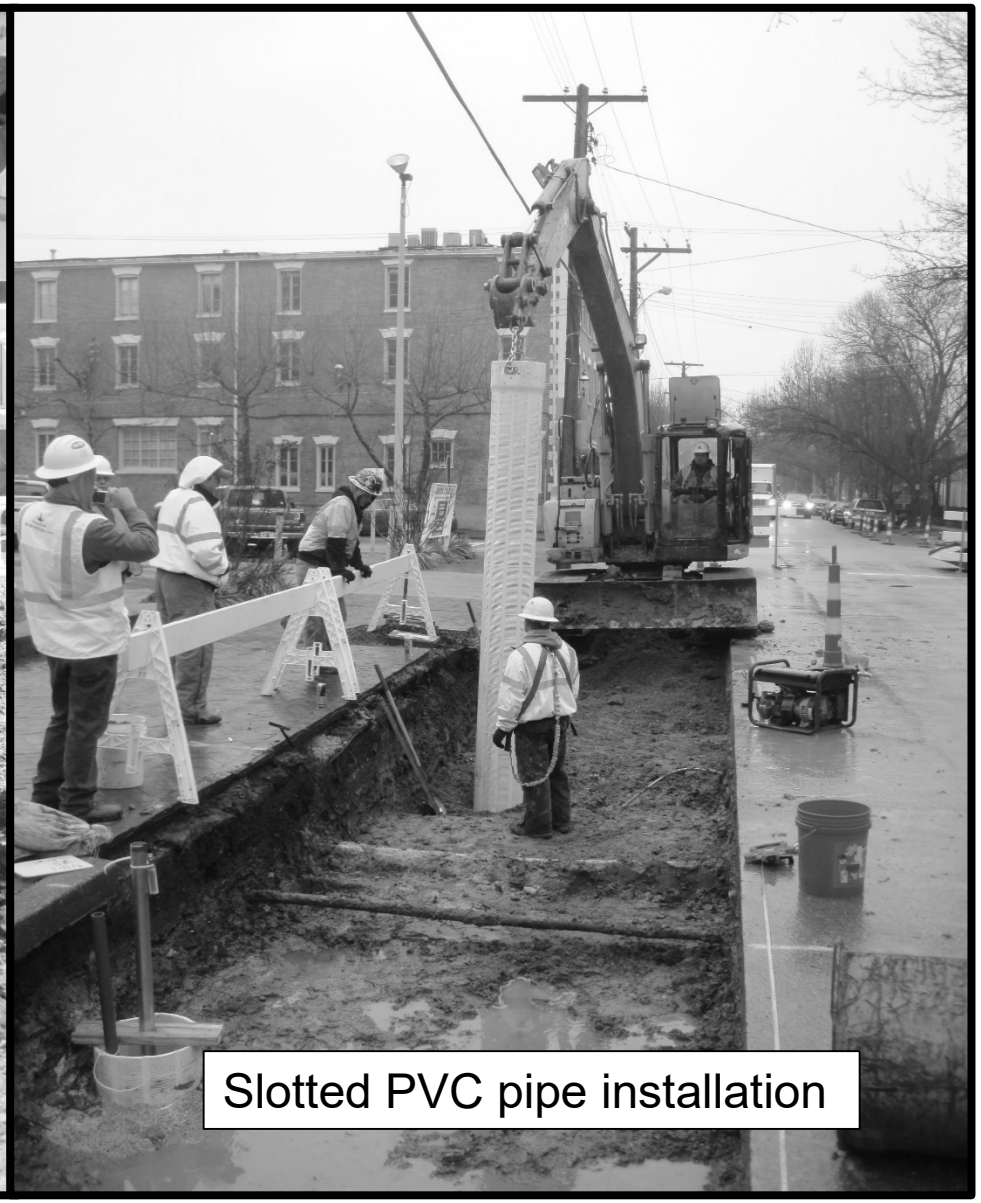


Borings



Slotted PVC pipe installation

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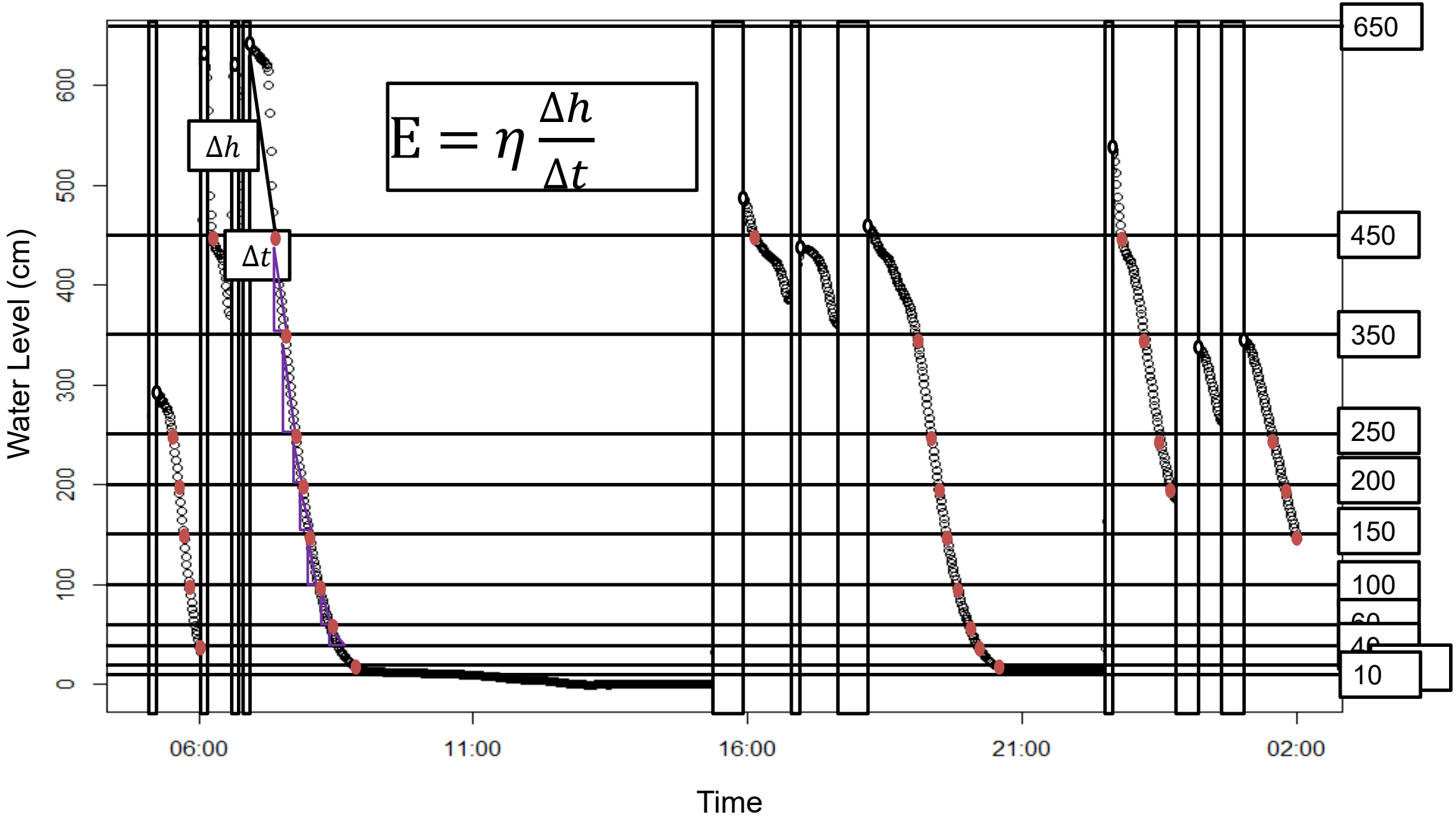
Design Characteristics of Study Strips

Site design characteristics	10D	14D	17D
Drainage area (m^2)	1540	2310	3930
Impervious area (m^2)	1050	1500	2550
Impervious percentage	68%	65%	65%
Length (m)	21.3	24.4	29
# of shafts	5	7	10
Bottom infiltration area (m^2)	0.82	1.15	1.64
Permeable pavement area (m^2)	52.6	60.3	71.6
Permeable pavement area (m) : Bottom infiltration area	64.2	52.4	43.7
Drainage area : Permeable pavement area	29.3	38.3	54.9
Impervious area : Permeable pavement area	20.0	24.9	35.6
Impervious area : Bottom infiltration area	1280	1304	1555

Example shows the water level in Shaft1 in Strip 10D on April 11, 2013



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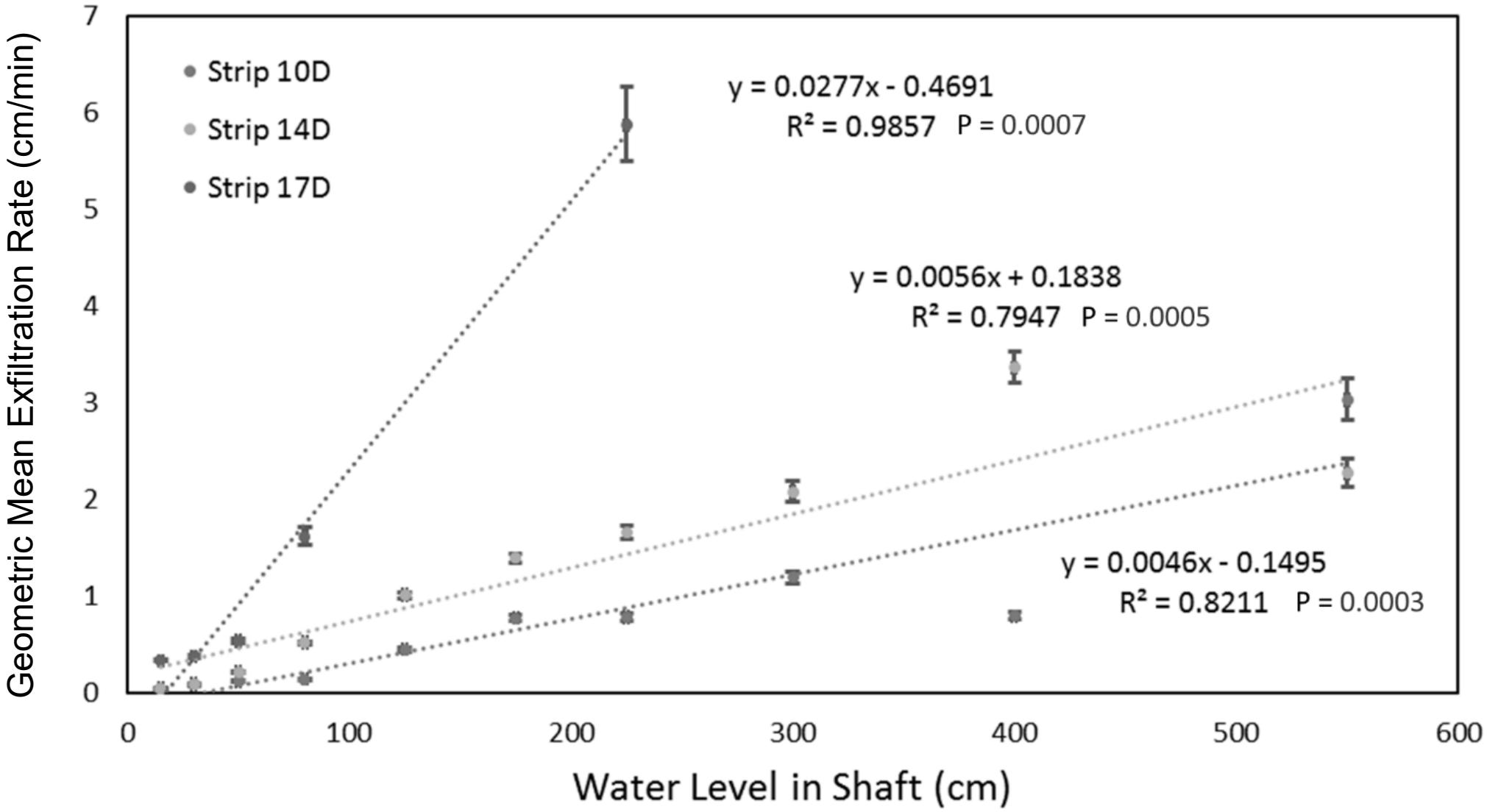
Summary statistics of exfiltration rates at variable water levels

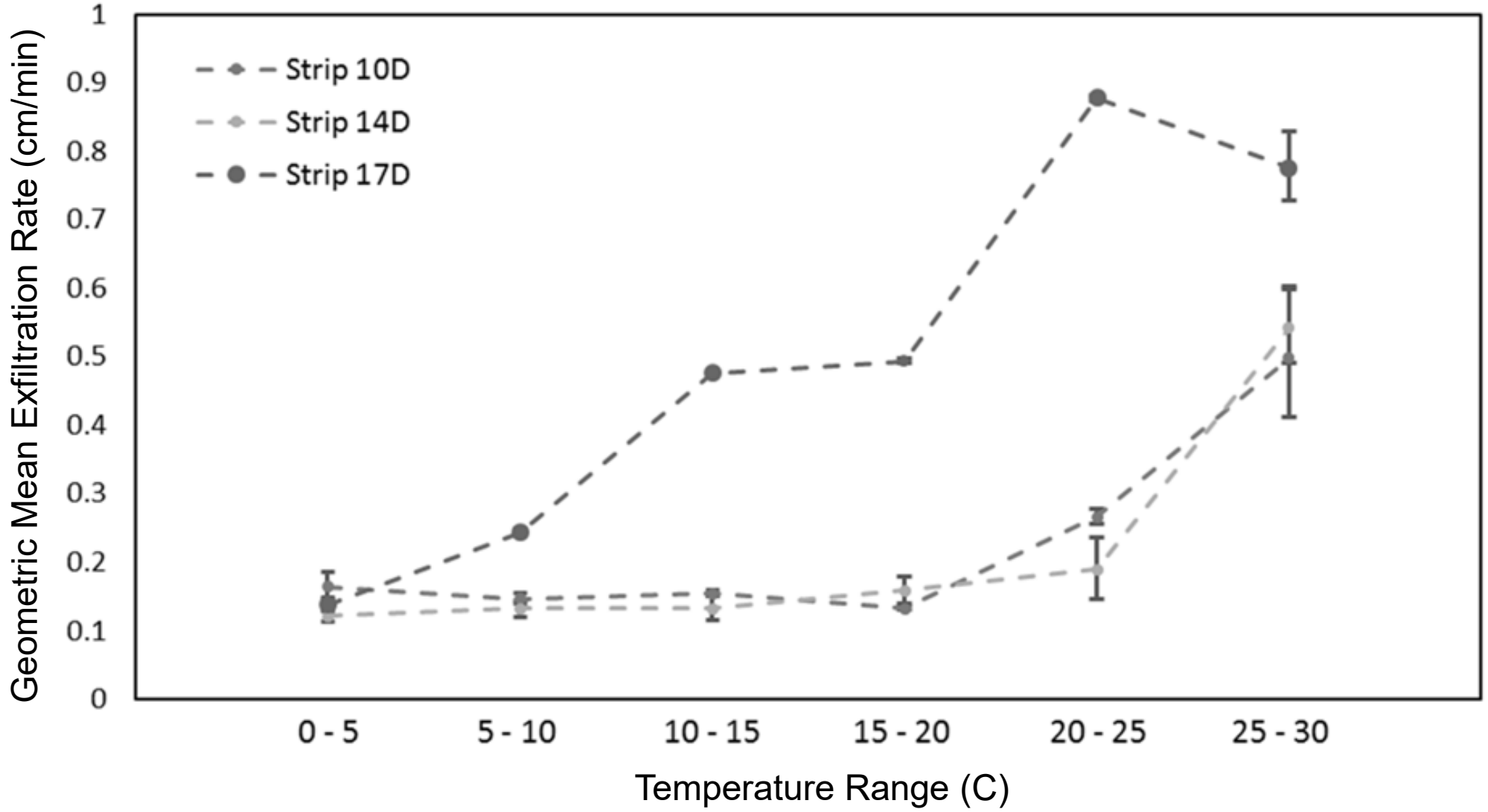
Hydraulic head (cm)	Exfiltration Rate (cm/min)								
	10D			14D			17D		
	N	Geometric mean	Median	N	Geometric mean	Median	N	Geometric mean	Median
10 - 20	3584	0.05	0.04	5793	0.05	0.04	815	0.33	0.38
20 - 40	2238	0.10	0.07	4378	0.09	0.07	838	0.38	0.40
40 – 60	1646	0.13	0.08	1837	0.22	0.25	304	0.54	0.58
60 - 100	1791	0.15	0.09	1392	0.52	0.62	151	1.62	1.76
100 - 150	980	0.45	0.48	896	1.01	1.20			
150 - 200	686	0.78	0.72	638	1.39	1.72			
200 - 250	583	0.79	0.71	453	1.66	1.95			
250 - 350	584	1.19	1.16	531	2.08	2.94	91	5.87	6.83
350 – 450	568	0.80	0.72	348	3.36	4.03			
450 – 650	257	3.03	3.86	488	2.27	3.53			

Note: N = sample size.

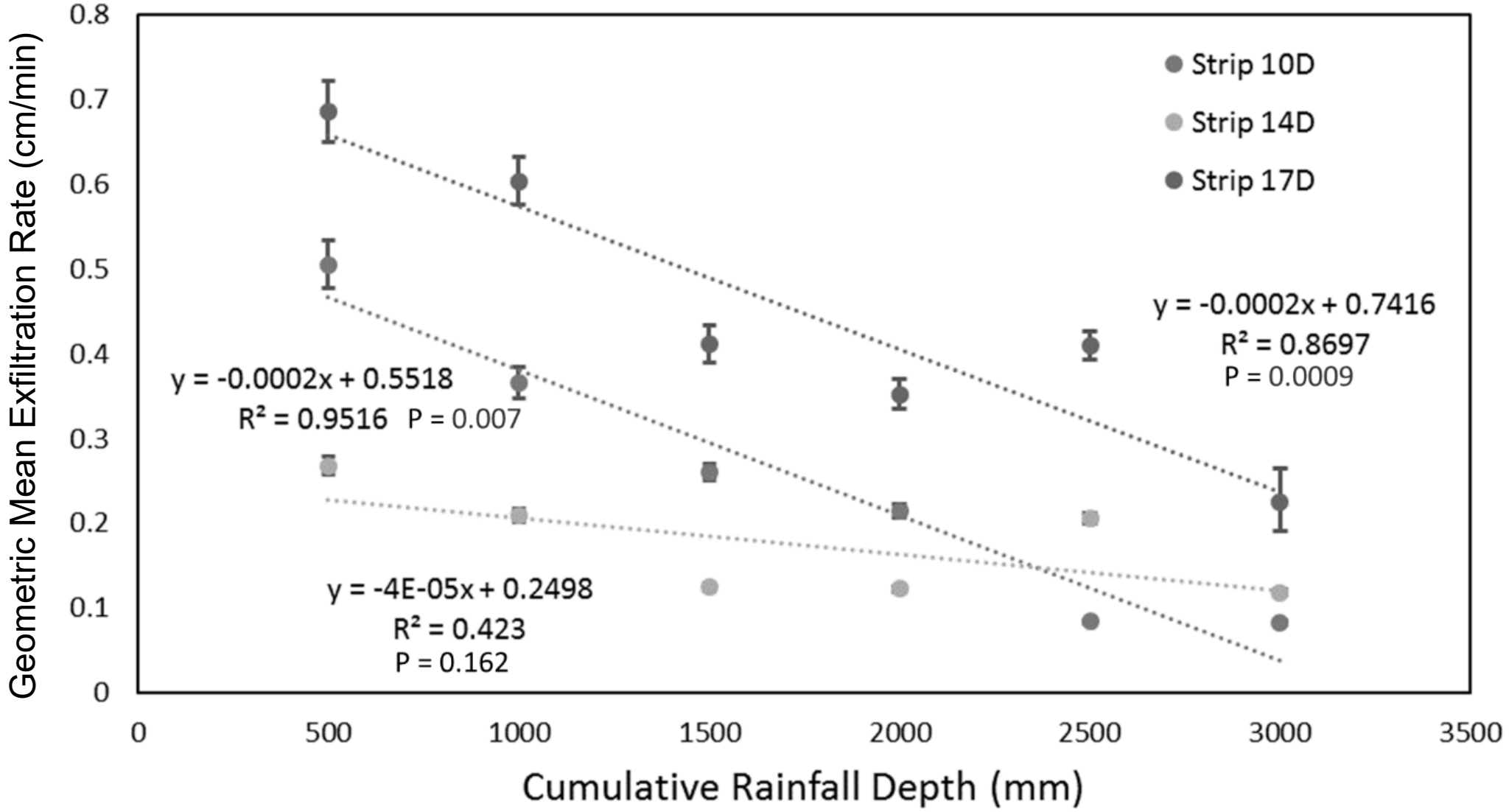
The exfiltration rate increased with water level.



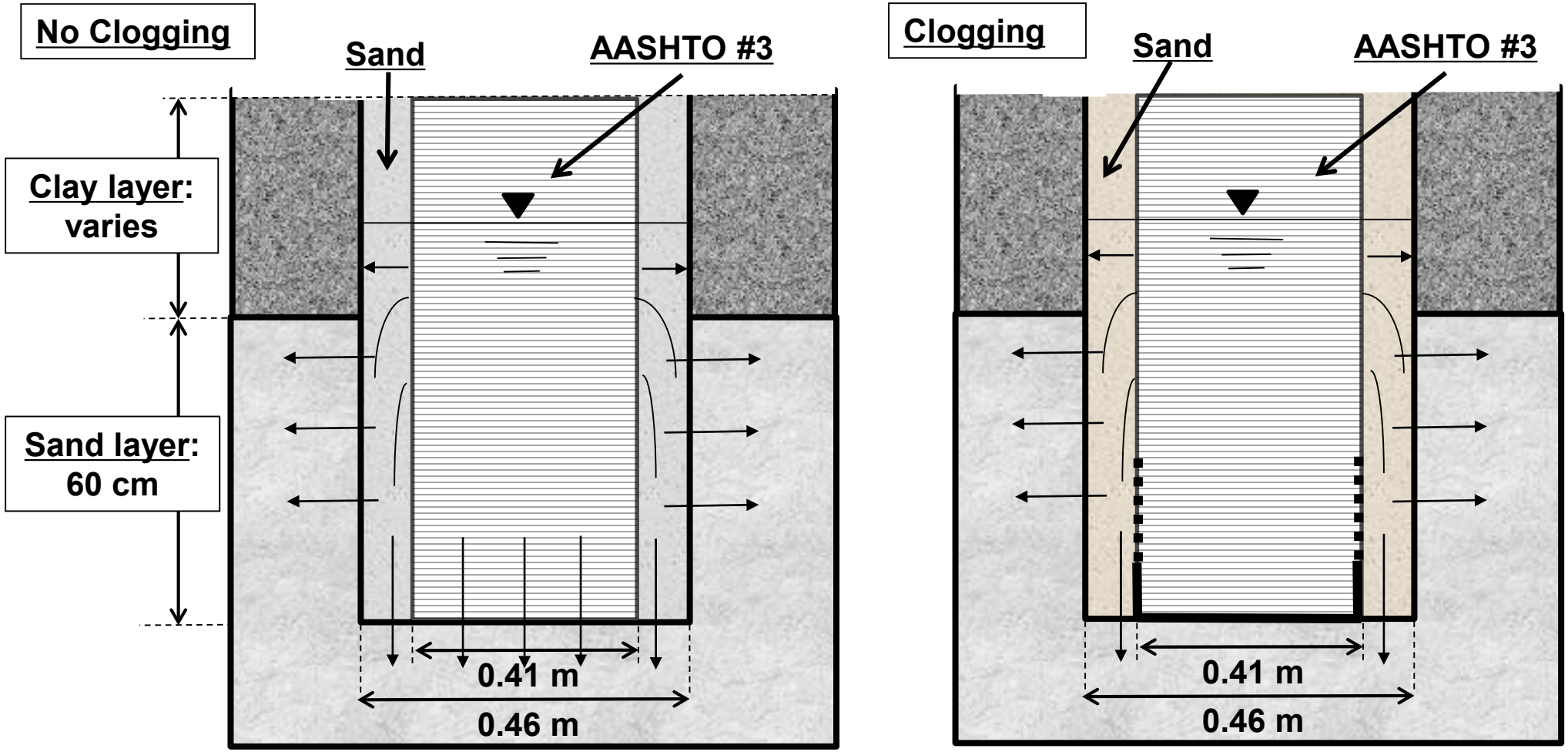
The exfiltration rate increased with water temperature.



The exfiltration rate decreased with cumulative rainfall depth.

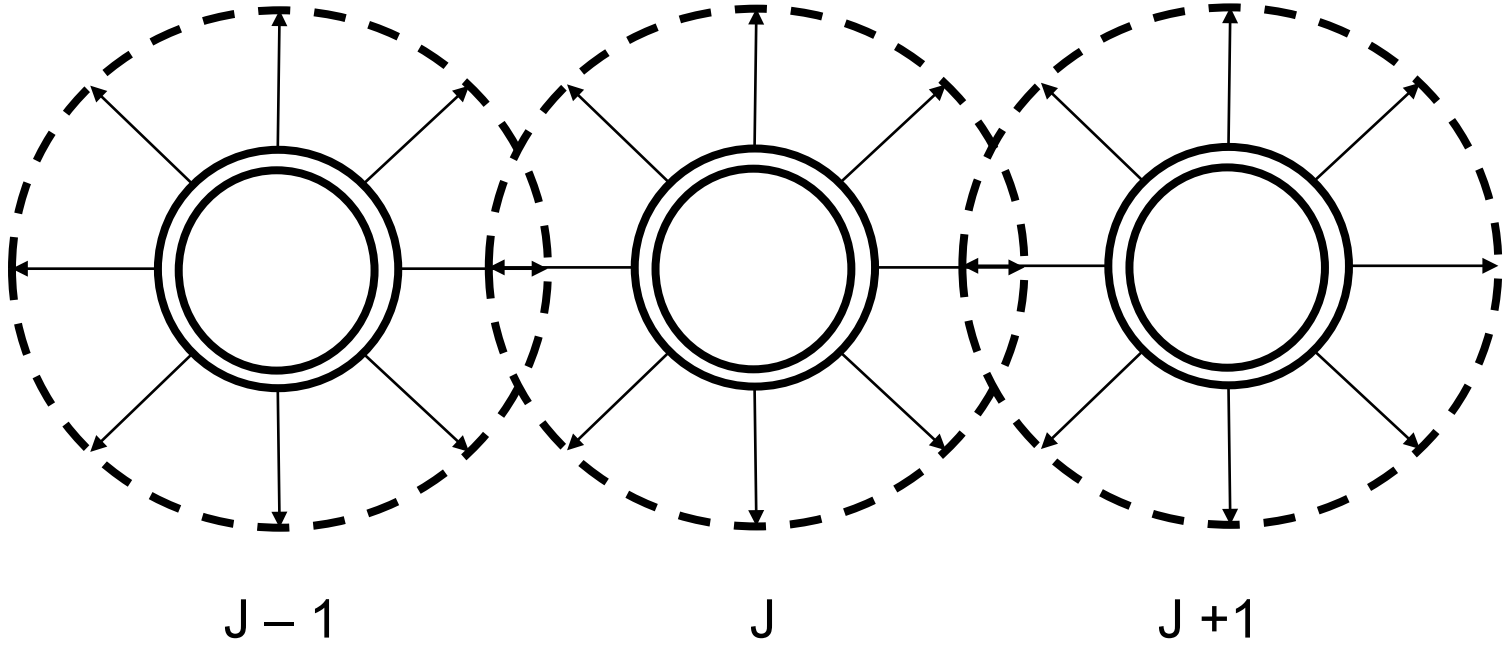


The exfiltration pathway changes as the shaft clogs.

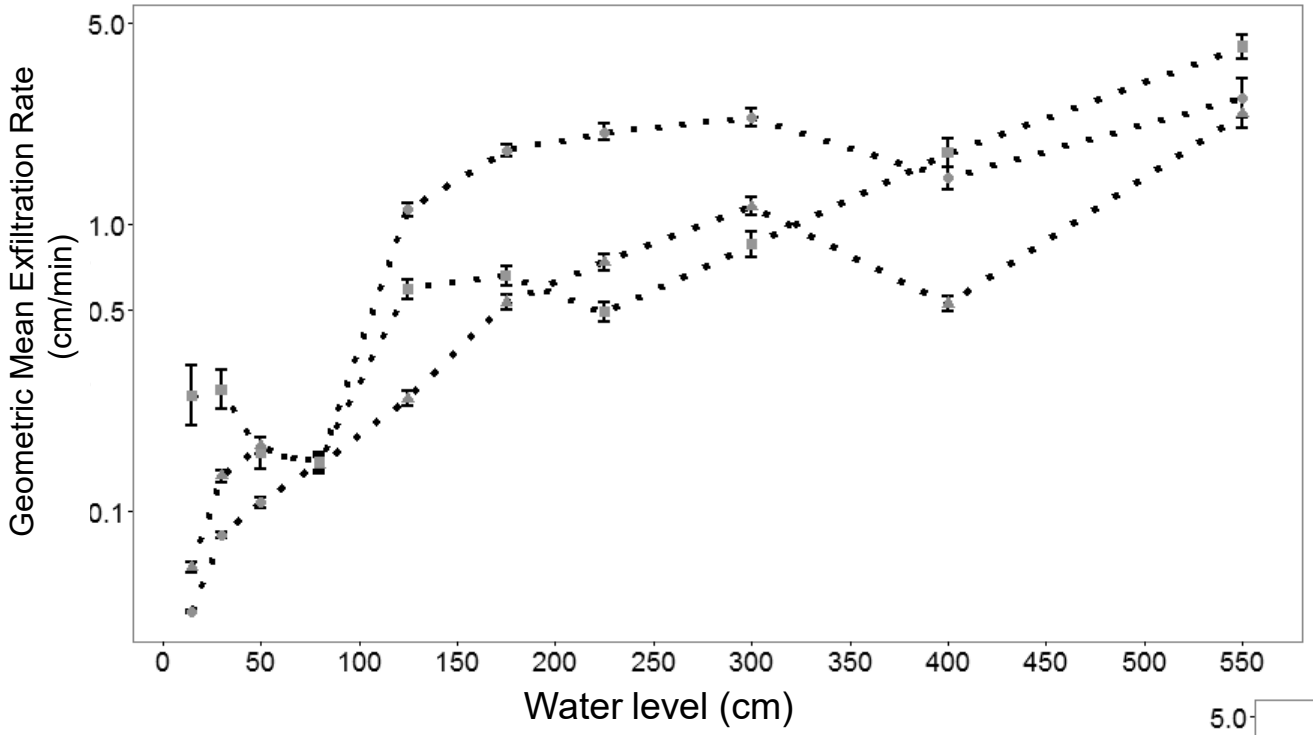


Does exfiltration from a shaft interfere with flow from adjacent shafts?

"Edge effects"



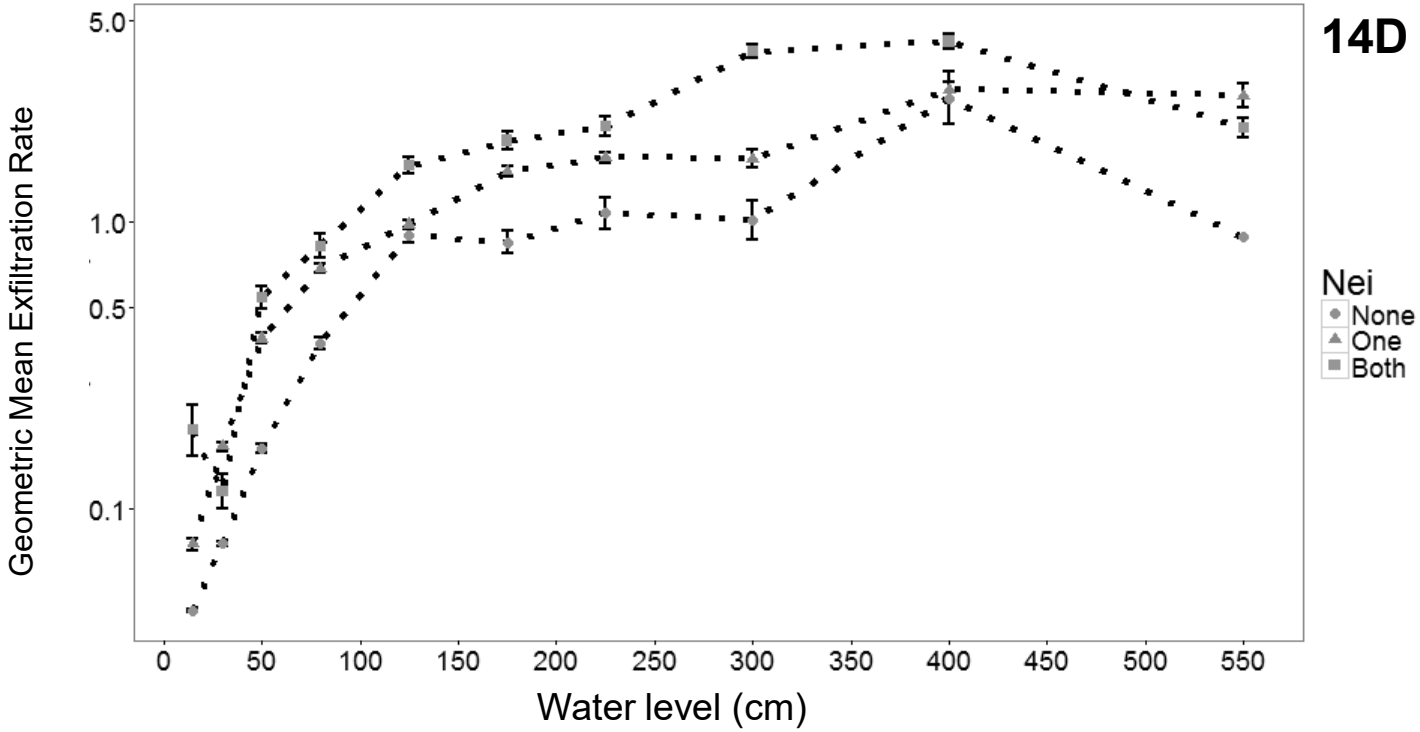
- 1) "**None**": $h_{j-1} < h_{cr}$ and $h_{j+1} < h_{cr}$;
- 2) "**One**": ($h_{j-1} > h_{cr}$ and $h_{j+1} < h_{cr}$) or ($h_{j-1} > h_{cr}$ and $h_{j+1} < h_{cr}$);
- 3) "**Both**": $h_{j-1} > h_{cr}$ and $h_{j+1} > h_{cr}$.



10D

The expected edge effect was noted for strip 10D when the water level was larger than 100 cm.

Edge effect was not observed in strip 14D.



14D

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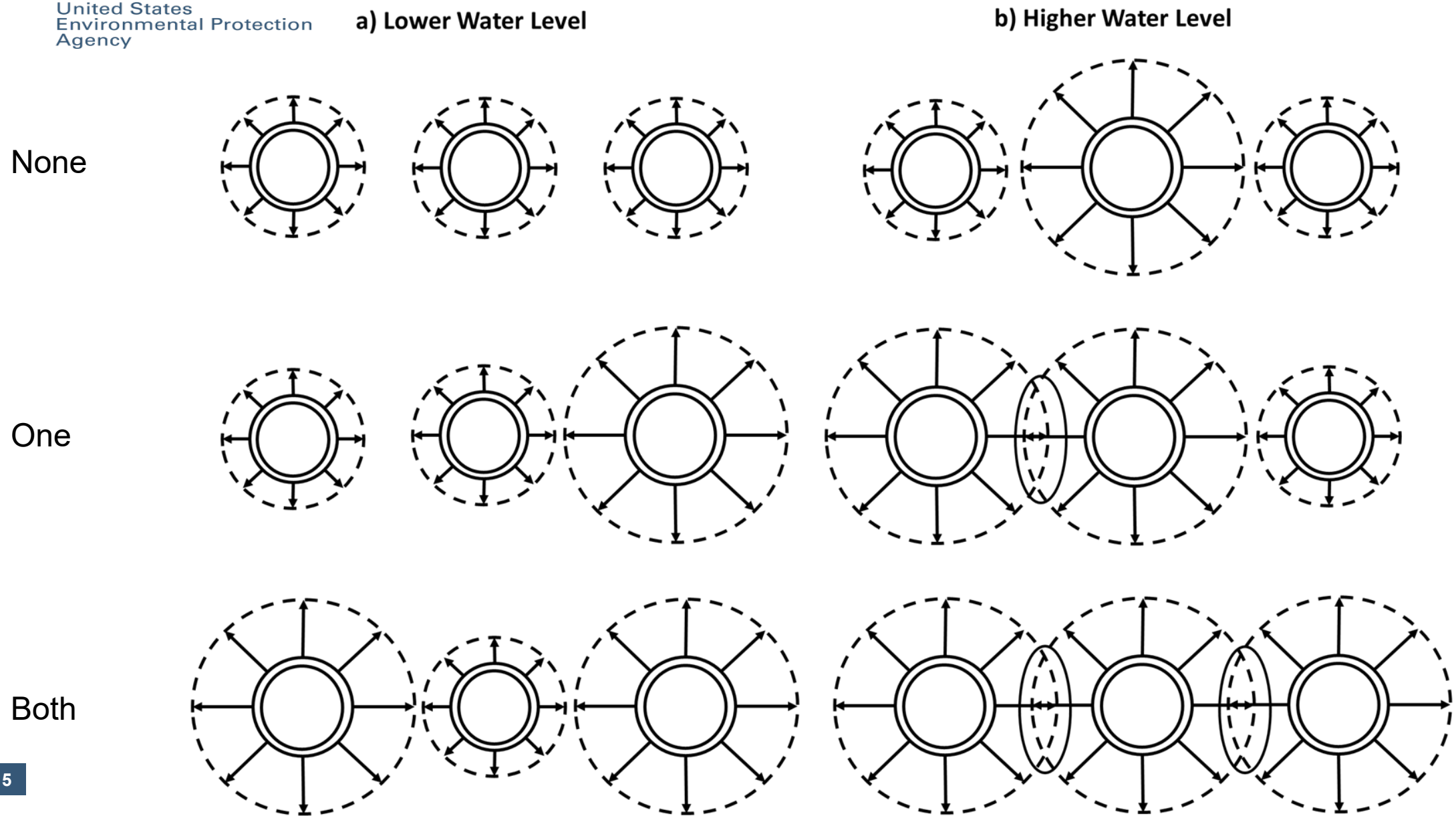

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Conclusions

- The exfiltration rates generally increased with water level and temperature, but decreased with cumulative rainfall depth (as time progressed).

- The bottom clogging process can be divided into two stages: 1) quick clogging stage; 2) slow clogging stage.

- “Edge effect” was only found in strip 10D.

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Questions?
Thank you!

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