Enhancing Stormwater Management and Biodiversity Through Nature-Based Solutions in Campus Creek Headwaters

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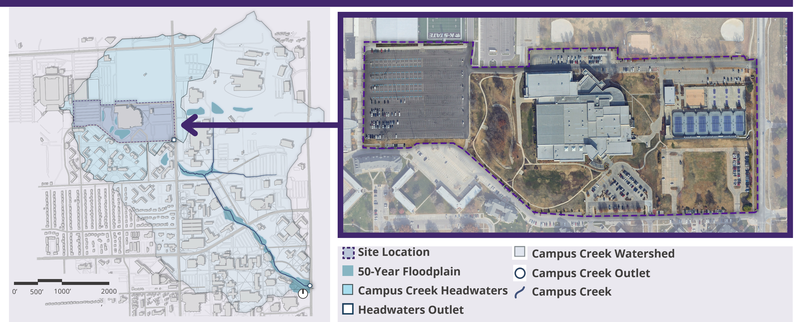
Why the Headwaters?



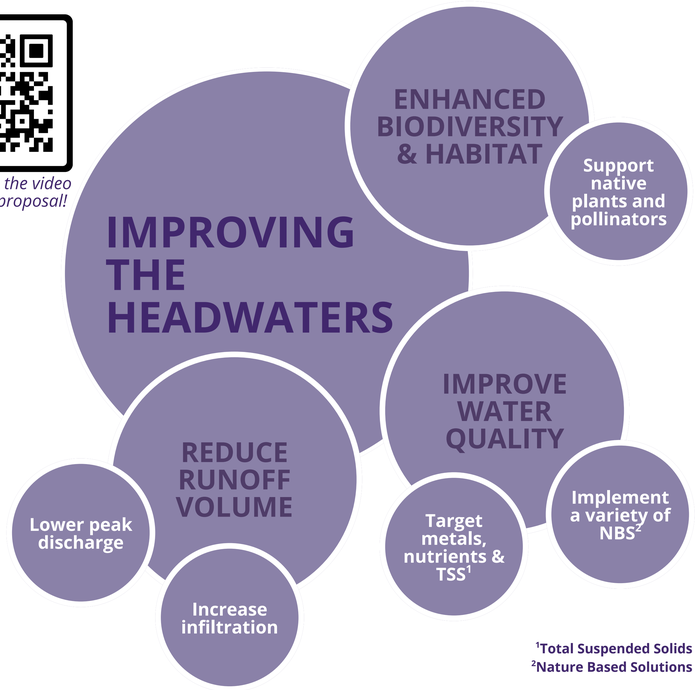
Site Location
50-Year Floodplain
Campus Creek Headwaters
Headwaters Outlet
Campus Creek Watershed
Campus Creek Outlet
Campus Creek

- **Urbanization impacts headwater streams**
  - Increases impervious surfaces
  - Leads to higher runoff volumes, peak flows, and pollutant loads
  - Degrades water quality and disrupts ecological functions
- **Role of headwater streams**
  - Trap floodwaters and reduce downstream flooding
  - Filter contaminants before they reach larger waterways
  - Support nutrient cycling and ecological health
- **Campus Creek Headwaters**
  - Makes up 28% of the entire Campus Creek watershed
  - Characterized by high impervious cover and lack of green infrastructure

Scan to see the current state of the Campus Creek headwaters, sampling locations,etc.

Design Goals

Scan to see the video of project proposal!



[1]Total Suspended Solids
[2]Nature Based Solutions

Sources

Imberger, M., Hatt, B. E., Brown, S., Burns, M. J., Burrows, R. M., & Walsh, C. J. (2023). Headwater streams in an urbanizing world.

Kansas State University EPA Campus RainWorks Team. (2025). The Wildcat Circuit [Unpublished]. Kansas State University.

United States Department of Agriculture. (1986). Urban hydrology for small watersheds (TR-55). Soil Conservation Service.

Van Seters, T, & Drake, J. (2015). Five year performance evaluation of permeable pavements. Sustainable Technologies Evaluation Program.

Xerces Society. (2025). Native Plants for Pollinators and Beneficial Insects: Southern Plains Region.

Methods

Plant Selection

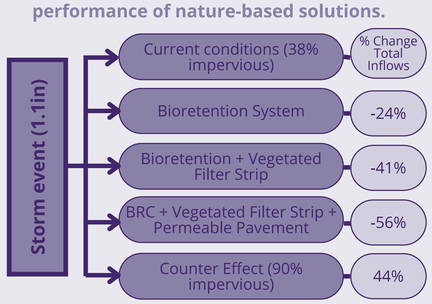
- Review of literature
- Pollinator-supporting Konza native flora

Permeable Pavement Selection

- Review of literature
- Poured pavement vs interlocking blocks
  - Compared infiltration capacity and pollution filtration
  - Compared layers, depth, and void space

EPA SWMM Modeling

- Simulates runoff, infiltration, and the performance of nature-based solutions.



Watershed and Land Use

- Watershed delineation
  - ESRI ArcGIS Pro
  - Digital elevation models
- Curve Number Method
  - Direct runoff estimation from rainfall events by relating:
    - land use
    - soil type
    - antecedent moisture conditions
- Data sources and geoprocessing tools:
  - Site specific land use classification
  - Web Soil Survey

Field Work

Before storm

Physical Parameters		
17.5	Temperature (°C)	11.0
731.6	mmHg	735.8
910.0	SPC	206.8
8.3	NTU	92.8
530.0	TDS (mg/L)	139.0
Chemical Parameters		
73.2	DO (%)	93.9
0.5	Total N (ppm)	1.0
0.1	Total P (ppm)	0.2
Biological Indicators		
0.07	PC RFU	0.08
0.04	PC (µg/L)	-0.03
1.65	Chl RFU	1.47
Metal Concentrations		
0.01	Zn (ppm)	0.02
0.02	Fe (ppm)	0.07
0.00	Cu (ppm)	0.02

After storm

Results and Impact

73% reduction in total outflow volume through the stormwater outlet

22% of stormwater runoff within watershed can be stored during a 2-year, 60-min storm

64k ft² of natural bioretention added

11k ft² of pollinator habitat added

98k ft² of permeable pavement added

1.4M gal of storage volume added

PP Basic Pavement Design

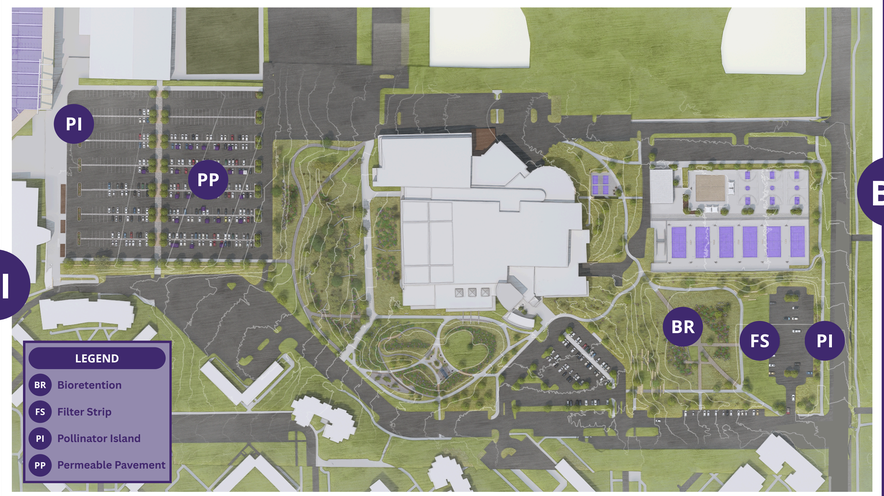
- Pervious concrete has higher infiltration rates and less clogging than interlocking blocks
- Effective at removing nutrients and metals
- High initial costs can be offset by environmental benefits

PI

Name	[1]Photo	May	Jun	Jul	Aug	Sep	Oct
Upright Prairie Cone Flower Ratibida columnifera							
Tube Beardtongue Penstemon tubiflorus							
Golden Alexanders Zizia aurea							
Missouri Evening Primrose Oenothera macrocarpa							
White Prairie Clover Dalea candida							
Butterfly Milkweed Asclepias turberosa							
Mint-leaf Bee-balm Monarda fistulosa							
Woolly Verbena Verbena stricta							
Plains Sunflower Helianthus petiolaris							
Tall Thistle Cirsium altissmum							
Partridge Pea Chamaecrista fasciculata							
Compass Plant Silphium laciantum							
Ironweed Veronia baldwinii							
Indiangrass Sorghastrum nutans							
Little Bluestem Schizachyrium scoparium							
Blue Sage Salvia azurea							
Aromatic Aster Symphyotrichum oblongifolium							

[1]Reprinted from: https://www.prairiemoon.com/

Proposed Site Design



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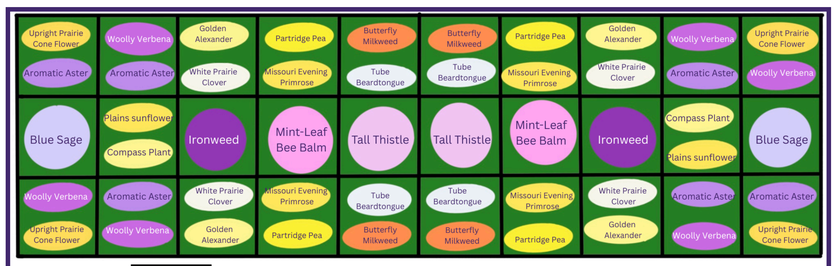

1 square meter

Indiangrass and Little Bluestem

Curve Number Analysis

Current LULC	Buildings	Courts	Open Space	Roads	Sidewalks	Turf
% Cover	9%	1%	54%	28%	6%	1%
CN	98	98	77	98	98	85
Composite CN						87

BR

WQV STORM, 1.1 in		CURRENT	BRC	BRC + VFS	BRC + VFS + PERM. PAVEMENT	COUNTER EFFECT
2-N-12	MAX TOTAL INFLOW (CFS)	3.72	2.96	3.06	2.22	4.98
	TOTAL INFLOW VOLUME (10^6 G)	0.0993	0.0759	0.0587	0.0438	0.143
2-N-14	MAX TOTAL INFLOW (CFS)	21.1	12.12	12.16	11.2	22.45
	TOTAL INFLOW VOLUME (10^6 G)	0.903	0.274	0.26	0.248	0.947
% DIFFERENCE FROM CURRENT						
2-N-12	MAX TOTAL INFLOW (CFS)	0%	-20%	-18%	* -40%	** 34%
	TOTAL INFLOW VOLUME (10^6 G)	0%	-24%	-41%	-56%	44%
2-N-14	MAX TOTAL INFLOW (CFS)	0%	-43%	-42%	-47%	6%
	TOTAL INFLOW VOLUME (10^6 G)	0%	-70%	-71%	-73%	5%

The *combination of BMPs shows the greatest reduction in peak flows and volumes, while the **counter effect shows significant increase.