Domain 06 Aquatic Instrument System (AIS) Site Characterization Report

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See configuration management system for approval history.

Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	04/22/2014	ECO-01811	Initial release
B	02/29/2016	ECO-03610	Adding McDiffett Creek

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1 DESCRIPTION

1.1 Purpose

Information collected and described here is used to inform the site design activities for the NEON project Aquatic Instrument System (AIS). This report includes information gathered by the Aquatic (AQU)/STREON (STR) and Environmental, Health, & Safety (EHS) teams. The purpose of this report is for the science team to outline what is desired at each site within a domain in order to obtain the best scientific data possible to help answer NEON's Grand Challenge Questions; therefore, this is not a design document, but a report that is an input to the design process.

This report takes precedence over other documents and reports that may repeat the information contained herein.

The Appendices include summary tables for the convenience of the multiple audiences of this report; some of the information in the tables is repeated from the body of this report while other information is exclusive to the summary tables.

1.2 Scope

AQU site characterization information presented in this document is for the Domain 06 aquatic locations: Kings Creek (core), and McDiffett Creek. Site that have been previously characterized and are not currently considered for construction are McDowell Creek (relocatable) and Kings Creek STREON. The details for these two sites are included for historic purposes as Appendix E and F respectively. Issues and concerns for each site that need further review are also addressed in this document according to our best knowledge. Unless otherwise noted, the information contained herein takes precedence over the same information repeated elsewhere; thereby, this document contains the official change-controlled information pertinent to these sites.

Disclaimer: All latitude and longitude coordinates are subject to the variation inherent in our GPS equipment and the conditions at the site. Some of the Aquatic sites are in narrow canyons with limited satellite coverage; resulting in coordinates that are not accurate to within 50 cm.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

AD[01]	
AD[02]	
AD[03]	
AD[04]	

2.2 Reference Documents

RD[01]	NEON.NPR.000008	NEON Acronym List
RD[02]	NEON.NPR.000243	NEON Glossary of Terms
RD[03]	[Reference to photos]	
RD[04]	[Reference to map(s)]	
RD[05]	http://kpbs.konza.k-state.edu/location/urban.html	

2.3 Verb Convention

"Shall" is used whenever a specification expresses a provision that is binding. The verbs "should" and "may" express non-mandatory provisions. "Will" is used to express a declaration of purpose on the part of the design activity.

3 DOMAIN 06 AIS SITE CHARACTERIZATION REPORT

3.1 Kings Creek

Kings Creek site is a 2nd order wadeable stream that drains a mixed agricultural, pasture and tallgrass prairie-dominated watershed. The flow regime of Kings Creek is considered intermittent and flashy: discharge can be very low or entirely dry during an annual period lasting from August through February, when spring rains recharge the water table. High-intensity storms may cause flow to increase several orders of magnitude over the course of a few hours during any time of year. During base flow conditions, however, Kings Creek is shallow enough to facilitate most planned field work in the NEON aquatics program.

3.1.1 Aquatic Auxiliary and Aquatic Portal Locations for Construction

The initial estimated location for the Aquatic Auxiliary Portal is:

Figure 1 A Google-Earth-Derived Image of Aquatic Auxiliary Portal for Domain 06 Kings Creek

Table 1 Aquatic Auxiliary Portal Location

Aquatic Auxiliary Portal	Latitude	Longitude
Location	39.104140°	-96.603410°

The initial estimated location for the Aquatic Portal is:

Table 2 Aquatic Portal Location

Aquatic Portal	Latitude	Longitude
Location	39.104140°	-96.603410°

3.1.2 Sensor Locations for Construction

The GPS coordinates for S1, S2 the Met Station locations obtained by AQU, with input from EHS, are presented in Table 3 and Table 4. Many aquatic sites are in narrow canyons or covered by dense canopy, which reduces satellite availability. In these situations, AQU will provide a description of the location and an approximate GPS location (e.g. not accurate to within <1m). This description will suffice for the planning stages, but sites will likely need to be physically marked prior to construction.

Personnel access and electrical resources will most likely be on the left bank at all sensor locations. Where locations coincide with a high vertical bank, an access ladder may be required.

These coordinates are to be used for the input to the AIS design:

Table 3 Sensors 1 and 2 locations

Sensor	Latitude	Longitude
S1	39.104803°	-96.602355°
S2	39.104985°	-96.603451°

Table 4 Met sensor location

Sensor	Latitude	Longitude
Met Station	39.104895	-96.603551

The pressure transducer for determining discharge should be co-located with the S2 sensor.

Figure 2 Kmz File of Domain 06 Kings Creek Denoting Locations of S1, S2, and Met Station

Figure 3 S1 location at Domain 06 Kings Creek. Shown here is the right bank

Figure 4 Location of S1 showing both banks; photograph is oriented downstream. Note that the left bank is more gently sloping relative to the right bank.

Figure 5 Location of S2 sensor at Domain 06 Kings Creek, oriented upstream. Note that the bank where this photograph was taken is approximately 2.6 m above the stream bed.

Figure 6 Photo of Met Station Location at Domain 06 Kings Creek

Figure 7 View of ideal parking location near the Konza Prairie Biological Station greenhouses for Kings Creek. The distance between parking and stream channel is approximately 200 m.

3.1.3 Groundwater Wells

The groundwater observation wells network at the site (Figure 8, Table 5) will consist of 8 – 2" diameter wells installed using a geoprobe or powered hand auger. Topography at the site is fairly flat open agricultural land with forest canopy surrounding the stream reach. The wells will be installed in the forested area surrounding the stream. Required drilling depths will vary due to the topography of the reach with total depths between ~5-10 meters below ground surface. Access to the site will be via the existing gravel road directly to the south of the AIS reach, for wells on the south side, and via the gravel road on the north for wells on the north side. Prior to drilling, a defined access path will be established for each well.

The exact location of wells may vary during the drilling process due to the presence of obstruction, if one is encountered during the construction. This is not anticipated to occur at this site due to the nature of the soils.

AQU prefers the surface completion of the wells to include an above-grade stick-up protective cover and be minimally invasive. The State of Kansas has several requirements for construction of groundwater monitoring wells that NEON will either need to meet or apply for a waiver. Chief among the State requirements are 1) an acceptable grout to fill the annular space such as neat cement, bentonite chips, or a bentonite / cement mixture; 2) surface seal of the well requires a poured concrete or cement slab poured around a steel outer casing with a locking cap; and 3) a licensed well driller is required to be onsite.

Figure 8 Initial Groundwater Well Locations Based on EMS Kmz File at Domain 06 Kings Creek

Table 5 Groundwater Observation Well Locations

Well ID	Latitude	Longitude
D06-KING-OW-01	39.104891°	-96.602302°
D06-KING-OW-02	39.104692°	-96.602433°
D06-KING-OW-03	39.104513°	-96.602845°
D06-KING-OW-04	39.104922°	-96.602949°
D06-KING-OW-05	39.104767°	-96.602017°
D06-KING-OW-06	39.104076°	-96.602217°
D06-KING-OW-07	39.104040°	-96.602508°
D06-KING-OW-08	39.104655°	-96.602509°

3.1.4 Riparian Vegetation Cover

During 2010-2011 site visits, the following plant density and type were observed by the AQU team:
The riparian area adjacent to Kings Creek consists of gallery forest. Mature bur and chinquapin oak, walnut, elm, hackberry and hickory trees extend 5-100 m from the stream channel. Beyond the gallery forest riparian area tallgrass prairie dominates land cover. Ground cover consists of shrubs, bushes, vines and forbs that cover 70-90% of the area; however, movement through the forest is not particularly difficult. Poison ivy is present in the riparian area.

Figure 9 Typical riparian canopy vegetation at Domain 06 Kings Creek

3.1.5 Bank Morphology

The bank angle is estimated from the top of the bank, where one might stand to observe the stream, to the top of the water. The estimated angle is from the water to the bank, as illustrated in Figure 10 below.

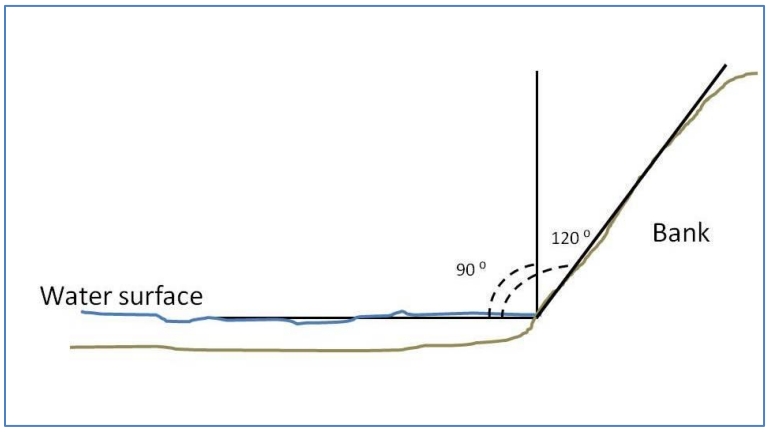

Figure 10 How Bank Angle is Measured

During 2011 site visits, AQU observed the following bank conditions at S1 and S2:

At nearly all points along the active channel, banks are typically characterized by a 1-4 m high, deeply incised clay abutment on one side and a more gradually sloping bank on the other.

Table 6 Bank conditions at Domain 06 Kings Creek

Morphology Type	S1	S2
RB* angle	90	160
LB* angle	140	90
Maximum water height	3.7	2.6
Bank full width (m)	9.3	10.7
Substrate composition	Cobble, boulder, clay and sand	Cobble, boulder, clay and sand

* RB (right bank) and LB (left bank) are determined by facing downstream.

Figure 11 Typical bank structure of Kings Creek

3.1.6 Site Photos

The following photos of are representative of the site.

Figure 12 Substrate in Domain 06 Kings Creek consists of cobble, boulder, pebbles, sand and clay. Some areas, such as the one illustrated here, are dominated by cobble

Figure 13 Example of fine substrate patch in Kings Creek. Here, bed composition is dominated by pebbles and clay

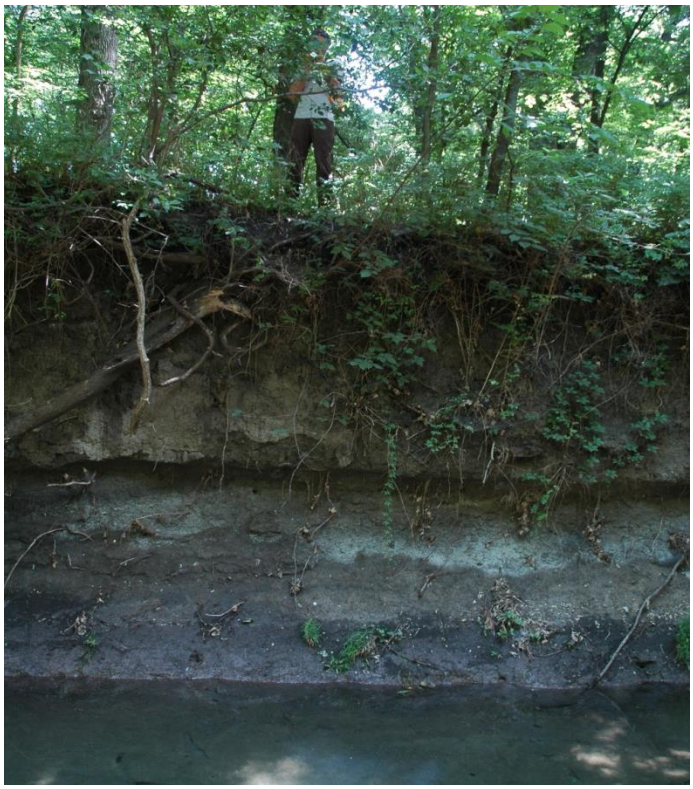

Figure 14 Example of a high, incised embankment in Kings Creek. Shown is the right bank of the S1 sensor station

Figure 15 Typical cross-section of Kings Creek. Note that one side is a high, incised clay embankment while the other bank is gently sloping

Figure 16 During base flow conditions, extensive dry sediment deposits may facilitate movement through the channel with minimal to no disturbances to riparian vegetation or the wetted stream area

Figure 17 Small tributary at the bottom of the AQU reach and upstream of the STREON reach

3.1.7 Site Access Needs

The large bank height (≥3 m in some places) represents the primary access issue at Kings Creek, though banks are not uniformly high along the entire stream. Pathways will need to be developed through the gallery forest to the sensor locations, as well as sampling locations along the sensor reach, and in some cases these will need to circumvent high banks.

3.1.7.1 Science Perspective on Access Needs (Pathways, Stairs, Etc.) to Reduce Site Erosion/Impact

Footpaths through the riparian gallery forest from the parking area or edge of field to the sensor locations will be required. The approximate location of the footpath is shown in Figure 18 (showing footpaths to both the AQU and STREON reach).

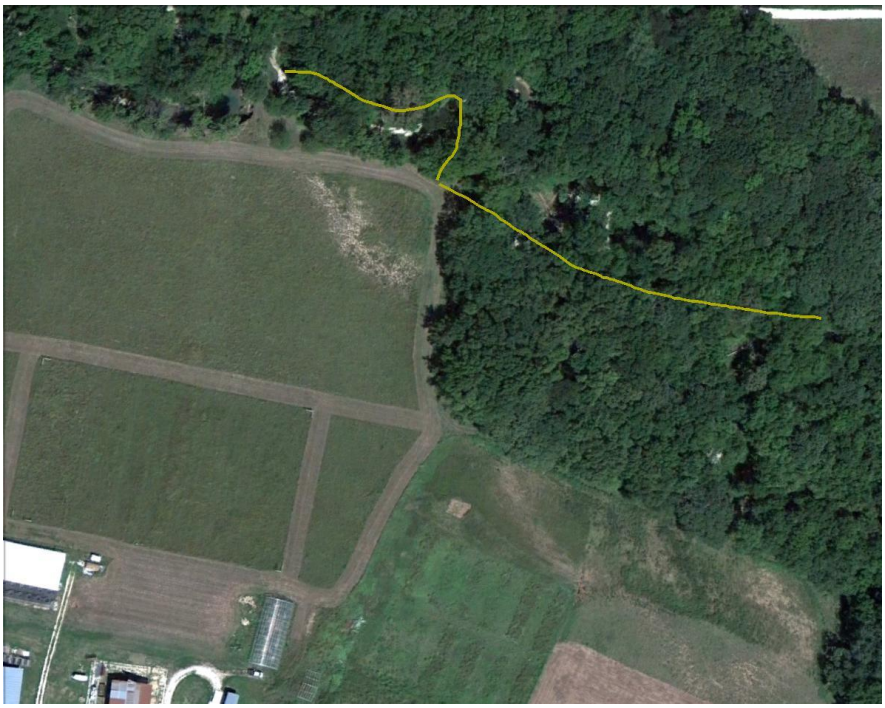

Figure 18 Approximate locations of the footpaths to be constructed to access sensors. Shown are paths to both the AQU and STREON reach sensors

3.1.8 Communications at the Site

See IT Network Docs for D06 IT information.

3.1.9 Power at the Site

The local power utility company is Bluestem Electric Coop Don Johnson 785-456-2212.

3.1.10 Site Science Construction Constraints and Limitations

Site-specific issues to consider at Domain 06 Kings Creek are:

- Extended periods (5+ months) of zero-flow will pose challenges for sensor installment and maintenance.
- Sensor installation will require consideration of episodic high flow events that will likely cause high risks of equipment damage.

Driving and access constraints for Domain 06 Kings Creek are:

- Parking is available at the greenhouse facilities of the Konza Prairie Biological Station. The distance between the parking area and NEON aquatic sites is approximately 200 m through a well-maintained field.

3.1.11 Other Issues

No other science issues are identified at this time.

3.2 McDiffett Creek

The McDiffett Creek is a 2nd order perennial stream flowing through the middle of typical Kansas crop land. The stream includes a small waterfall at the top of the reach with a large pool and several other riffle and pool segments. Thirteen species of native fish have been identified from the stream, including the endangered Topeka shiner. This background information is from The Urban's Prairie Research Area description (RD [05]). The Urban Prairie Research Area is managed by Konza Prairie Biological Station, associated with Kansas State University. The Area is a small track of land composed of native prairie, grazing, hay, and historically cultivated fields. Various crops have been rotated over the past 15 years. Cattle are also allowed to graze the area. The pasture is burned annually as condition allow. (RD [05])

Approximately 500 meters of stream are available for NEON infrastructure development. An additional 500 meters may be available downstream for NEON Aquatic Observational Sampling protocols. The 500 meter downstream reach is leased from Kansas State University.

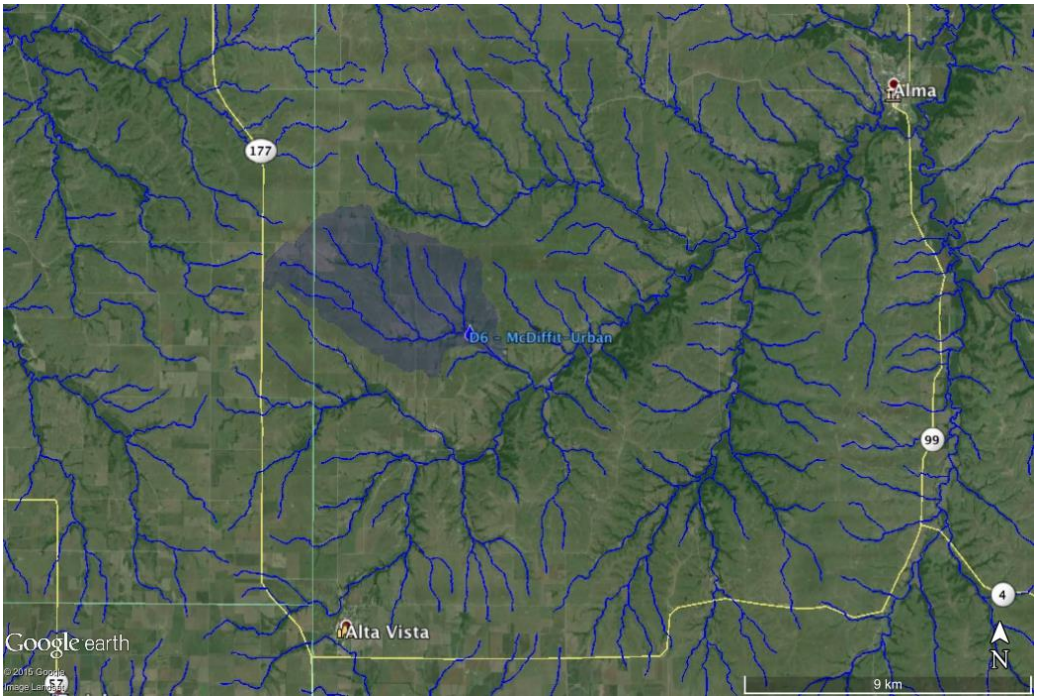

Figure 19 Map of catchment at the proposed NEON AQU site

3.2.1 Aquatic Auxiliary and Aquatic Portal Locations for Construction

The initial estimated location for the Aquatic Auxiliary Portal is shown in Figure 20 and Table 7, below.

Figure 20 A Google-Earth-Derived Image of the McDiffett Creek aquatic reach, including proposed Aquatic Portal location

This site is planned for line power. A utility power line runs parallel to the Drovers Trail Road, the gravel road shown in Figure 49.

Table 7 Aquatic Auxiliary Portal Location for McDiffett Creek

Aquatic Auxiliary Portal	**Latitude**	**Longitude**
Location	38.947463°	-96.445627°

Table 8 Aquatic Portal Location for McDiffett Creek

Aquatic Portal	**Latitude**	**Longitude**
Location	38.947463°	-96.445627°

3.2.2 Sensor Locations for Construction

The GPS coordinates for S1, S2 and the Met Station obtained by AQU, with input from EHS, are presented in Table 30. Many aquatic sites are in narrow canyons or covered by dense canopy, which reduces satellite availability. In these situations, AQU will provide a description of the location and an approximate GPS location (e.g. not accurate to within <1m). This description will suffice for the planning stages, but sites will need to be physically marked prior to construction.

These coordinated are to be used for the input to the AIS design for S1, S2, and the Met station are summarized in Table 9-Table 11 and Figure 21. The staff gauge associated with the stream discharge measurement will be co-located with the S2 sensor set.

Table 9 Sensor and Discharge locations for McDiffett Creek

Sensor	Latitude	Longitude
S1	38.946750°	-96.443855°
S2	38.946622°	-96.443016°
Staff Gauge	38.946622°	-96.443016°

Table 10 Sensor Field Device Post (FDP) locations for McDiffett Creek

FDP	Latitude	Longitude
S1-FDP	38.947091°	-96.443611°
S2-FDP	38.946652°	-96.442911°

Table 11 Met station, Secondary Precipitation, NADP and locations for McDiffett Creek

Sensor	Latitude	Longitude
Met Station	38.947360°	-96.443810°
Met/Precip FDP	38.947413°	-96.443933°
Secondary Precipitation Gauge	38.947431°	-96.443849°

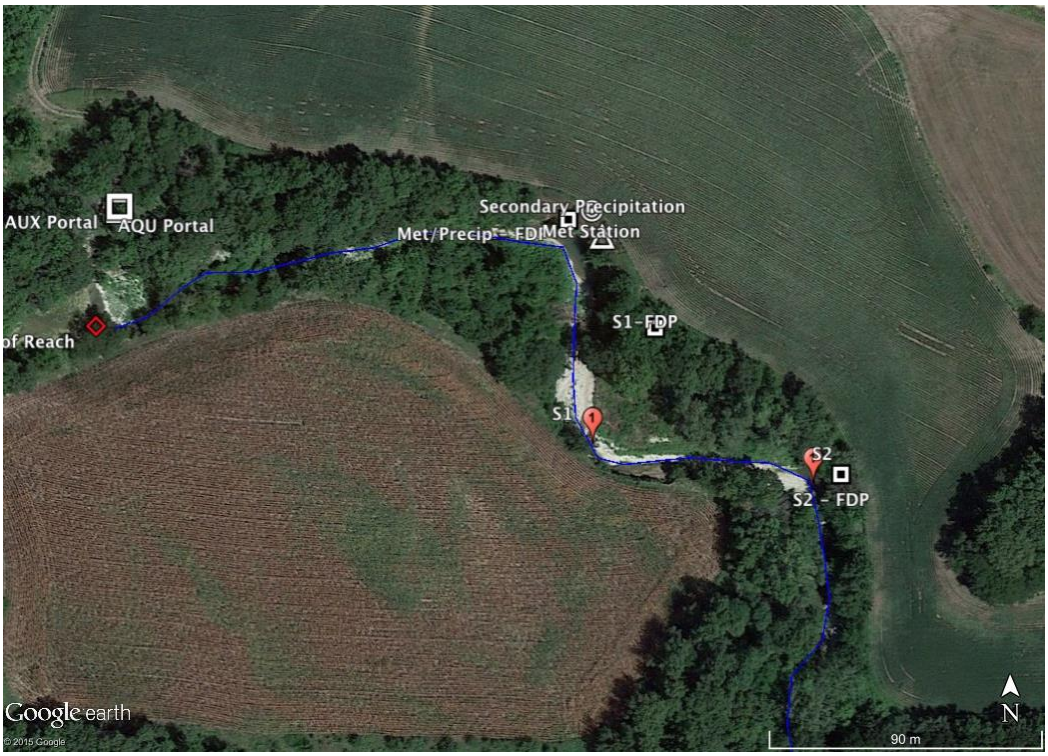

Figure 21 Map of D06 McDiffett Creek with AQU S1, S2, and micrometeorology station locations

Figure 22 S1 Location at D06 McDiffett Creek

Figure 23 S2 Location at D06 McDiffett Creek. Shown looking downstream.

3.2.3 Groundwater Wells

Groundwater well locations will be selected and finalized during a site visit by the NEON hydrologist. Shown in Figure 24 are tentative locations selected by other team members during the initial characterization visit. Once the proposed well locations are selected, Table 12 below will be populated with coordinates. At present a site visit is planned for late spring 2016 for confirmation of the wells. Installation will likely utilize either a direct-push drill rig or rotary auger, depending on the density of underbrush near the stream.

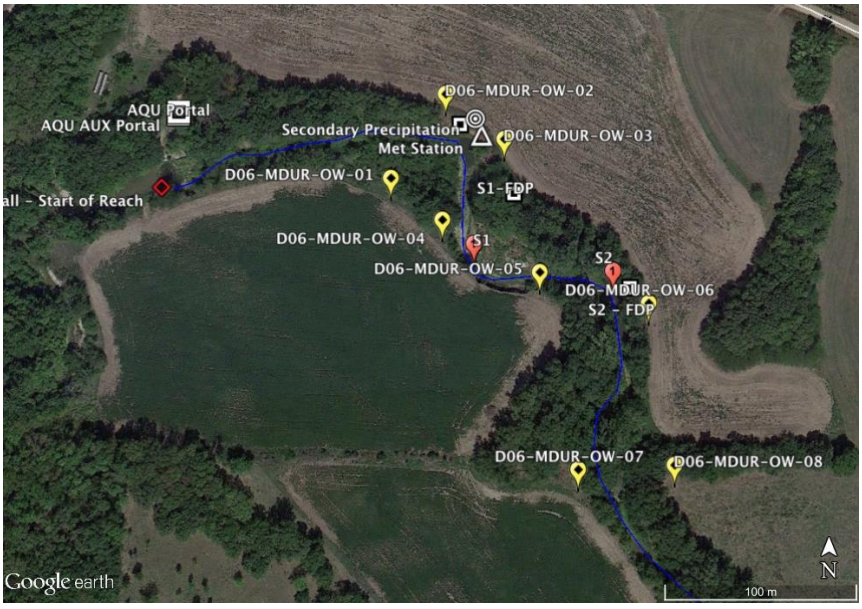

Figure 24 McDiffett-Urban Groundwater Observation Well locations

Table 12 Coordinates for Groundwater Observation Wells**

Well ID	Latitude	Longitude
D06-MCDI-OW-01		
D06-MCDI-OW-02		
D06-MCDI-OW-03		
D06-MCDI-OW-04		
D06-MCDI-OW-05		
D06-MCDI-OW-06		
D06-MCDI-OW-07		
D06-MCDI-OW-08		

** Table to be completed once the NEON Hydrologist has had a chance to visit the site, which is tentatively planned for spring 2016.

3.2.4 Riparian Vegetation Cover

During 2015 site visit, the following plant density and type were observed by the AQU team:

The riparian area adjacent to the McDiffett Creek consists of steep banks lined with a forest buffer and is located within a historically farmed field with regular crop rotation. Grasses, woody shrubs, and larger timber are present in the riparian zone. A mix of small woody species, small herbaceous, and some invasive vetch are present within the channel. Observations were made in November. Growing season updates will be more accurate.

Figure 25 Riparian vegetation, incised banks, and surrounding crop fields at D06 McDiffett Creek

3.2.5 Bank Morphology

The bank angle is estimated from the top of the bank, where one might stand to observe the stream, to the top of the water. The estimated angle is from the water to the bank, as illustrated in the Figure 26 below.

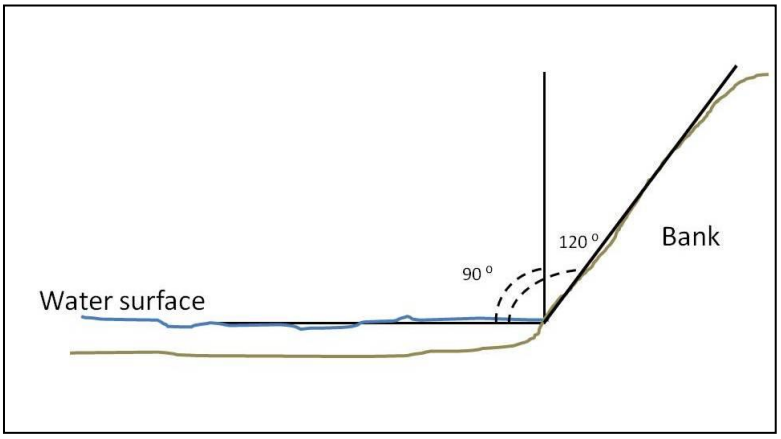

Figure 26 How Bank Angle is Measured

During 2015 site visits, AQU observed the following bank conditions at S1 and S2:

Table 13 Bank attributes of D14 Sycamore Creek at sensor locations

Morphology Type	S1	S2
RB* angle	100	100
LB* angle	100	100
Wetted depth	6.3	0.16m
Wetted width†	3.5	0.3m
Substrate composition	Gravel, silt	Gravel, silt

* RB (right bank) and LB (left bank) are determined by facing downstream.
†Note that these distances *do not* correspond to the width between incised banks- which likely represents the true bank full width. Distances between incised banks exceed 10 m in each case.
^For infrastructure purposes, the extreme water level sand anchor should be used at S1 and S2

3.2.6 Site Photos

The following photos of are representative of the site.

Figure 27 Steep incised banks will require developed access, such as stairs, to prevent erosion

Figure 28 Banks heights are in excess of 4 meters

Figure 29 Substrate is a mix of gravel, cobbles, and silt

Figure 30 Bank angles are flat and then vertical. The flat portion is around 10 meters

Figure 31 A limestone shelf waterfall feature is just above the NEON aquatic reach

3.2.7 Site Access Needs

For Operations at the site, some access improvements are required. A small vehicle access exists at the Eastern edge of the property, near the limestone shelf and shown in the foreground of Figure 31. This access may be useful for running power and for securing access to the site.

Farther downstream, the banks become tall and incised and are susceptible to erosion, primarily due to foot traffic over the life of the project. Improving access down these banks is necessary to reduce erosion and may be needed at two or more locations for creek access for AIS maintenance and AOS protocols, as shown in Figure 33. Pathways to these improved access points may also be needed, depending on permitting needs and coordination with the site hosts**. Improved access planning should include improved stairs** correctly placed along the permitted reach. The location for these stairs will be determined after the permitted reach is designated.

There are a few structures near an unused campsite near the vehicle access at the upper end of the aquatic reach. These structures, shown in Figure 32, should be removed in order to make the site less attractive to casual by passers.

Figure 32 Campsite “improvements” found near the upper end of the aquatic reach.

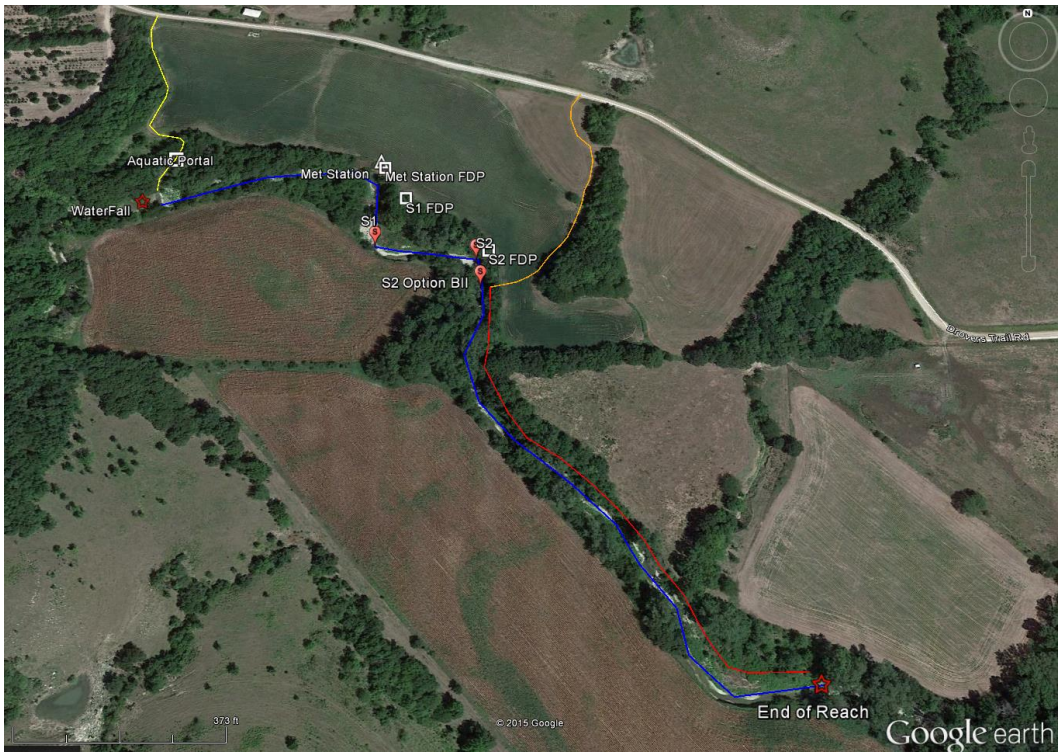

Figure 33 Access options include: a) existing vehicle access shown in yellow, b) partial vehicle access shown in orange, but would need to cut through a crop field, c) a need for stair access at a few locations along the red line for AOS protocols

3.2.8 Communications at the site

See IT Docs for D06 for IT information.

3.2.9 Power at the Site

Local line power runs along the Drovers Trail Road adjacent to the North edge of the property.

3.2.10 Site Science Construction Constraints and Limitations

Site-specific issues to consider at D06 McDiffett Creek are:

- Issues at D06 McDiffett-Urban are not expected to be significant.
- The regional management included grazing, crop rotation, and prescribed burning.
- The distance between this site and the Konza Prairie Terrestrial tower exceeds the requirements for primary precipitation.

Designs should take into account the likelihood that high stream flow may occur during semi-annual flow events.

4 APPENDIX A. FCC SUMMARY TABLES FOR AIS SITE COMPONENTS AT DOMAIN 06

4.1 Kings Creek FCC Summary Table

Site Component	Latitude	Longitude	Units
Stream, Lake, or Stream+STREON			Description
Aquatic Auxiliary Power Portal location	39.104140°	-96.603410°	Lat, Long in degrees
Aquatic Portal location			m away from bank, direction
Pathway needed? What is length?			Yes/no, description w/ length
Pathway start location	Site1-PathStartLat	Site1-PathStartLong	Lat, Long in degrees
Pathway end location	Site1-PathEndLat	Site1-PathEndLong	Lat, Long in degrees
Stairs or ladder needed?			Yes/no, description
Stairs top location	Site1-StairsTopLat	Site1-StairsTopLong	Lat, Long in degrees
Stairs length	Site2-StairsLength		Meters
Ladder top location	Site1-LadderTopLat	Site1-LadderTopLong	Lat, Long in degrees
Ladder length	Site1-LadderLength		Meters
Boardwalk needed? What is length?			Yes/no, description w/ length
Boardwalk start location	Site1-BrdwlkStartLat	Site1-BrdwlkStartLong	Lat, Long in degrees
Boardwalk end location	Site1-BrdwlkEndLat	Site1-BrdwlkEndLong	Lat, Long in degrees
Shall stairs, boardwalk be installed during construction?			Yes/no, description
Fencing needs			Description
Site management			Description
Any additional site specific information			Description

4.2 McDowell Creek FCC Summary Table

Site Component	Latitude	Longitude	Units
Stream, Lake, or Stream+STREON			Description
Aquatic Auxiliary Power Portal location	39.123891°	-96.607888°	Lat, Long in degrees
Aquatic Portal location			m away from bank, direction
Pathway needed? What is length?			Yes/no, description w/ length
Pathway start location	Site2-PathStartLat	Site2-PathStartLong	Lat, Long in degrees
Pathway end location	Site2-PathEndLat	Site2-PathEndLong	Lat, Long in degrees
Stairs or ladder needed?			Yes/no, description
Stairs top location	Site2-StairsTopLat	Site2-StairsTopLong	Lat, Long in degrees
Stairs length	Site2-StairsLength		Meters
Ladder top location	Site2-LadderTopLat	Site2-LadderTopLong	Lat, Long in degrees
Ladder length	Site2-LadderLength		Meters
Boardwalk needed? What is length?			Yes/no, description w/ length
Boardwalk start location	Site2-BrdwlkStartLat	Site2-BrdwlkStartLong	Lat, Long in degrees
Boardwalk end location	Site2-BrdwlkEndLat	Site2-BrdwlkEndLong	Lat, Long in degrees
Shall stairs, boardwalk be installed during construction?			Yes/no, description
Fencing needs			Description
Site management			Description
Any additional site specific information			Description

4.3 Kings Creek STREON FCC Summary Table

Site Component	Latitude	Longitude	Units
Stream, Lake, or Stream+STREON			Description
Aquatic Auxiliary Power Portal location	39.104140°	-96.603410°	Lat, Long in degrees
Aquatic Portal location			m away from bank, direction
Pathway needed? What is length?			Yes/no, description w/ length
Pathway start location	Site3-PathStartLat	Site3-PathStartLong	Lat, Long in degrees
Pathway end location	Site3-PathEndLat	Site3-PathEndLong	Lat, Long in degrees
Stairs or ladder needed?			Yes/no, description
Stairs top location	Site3-StairsTopLat	Site3-StairsTopLong	Lat, Long in degrees
Stairs length	Site3-StairsLength		Meters
Ladder top location	Site3-LadderTopLat	Site3-LadderTopLong	Lat, Long in degrees
Ladder length	Site3-LadderLength		Meters
Boardwalk needed? What is length?			Yes/no, description w/ length
Boardwalk start location	Site3-BrdwlkStartLat	Site3-BrdwlkStartLong	Lat, Long in degrees
Boardwalk end location	Site3-BrdwlkEndLat	Site3-BrdwlkEndLong	Lat, Long in degrees
Shall stairs, boardwalk be installed during construction?			Yes/no, description
Fencing needs			Description
Site management			Description
Any additional site specific information			Description

4.4 Kings Creek FCC Summary Table

Site Component	Latitude	Longitude	Units
Stream, Lake, or Stream+STREON			Description
Aquatic Auxiliary Power Portal location	STR-AuxLat	STR-AuxLong	Lat, Long in degrees
Aquatic Portal location			m away from bank, direction
STREON Hut location			m away from bank, direction
Pathway needed? What is length?			Yes/no, description w/ length
Pathway start location	STR-PathStartLat	STR-PathStartLong	Lat, Long in degrees
Pathway end location	STR-PathEndLat	STR-PathEndLong	Lat, Long in degrees
Stairs or ladder needed?			Yes/no, description
Stairs top location	STR-StairsTopLat	STR-StairsTopLong	Lat, Long in degrees
Stairs length	STR-StairsLength		Meters
Ladder top location	STR-LadderTopLat	STR-LadderTopLong	Lat, Long in degrees
Ladder length	STR-LadderLength		Meters
Boardwalk needed? What is length?			Yes/no, description w/ length
Boardwalk start location	STR-BrdwlkStartLat	STR-BrdwlkStartLong	Lat, Long in degrees
Boardwalk end location	STR-BrdwlkEndLat	STR-BrdwlkEndLong	Lat, Long in degrees
Shall stairs, boardwalk be installed during construction?			Yes/no, description
Fencing needs			Description
Site management			Description
Any additional site specific information			Description

5 APPENDIX B. EHS SUMMARY TABLES FOR AIS SITE COMPONENTS AT DOMAIN 06

5.1 Kings Creek EHS Summary Table

Site Component	Latitude	Longitude	Units
Sensor 1 (S1) location	39.104803°	-96.602355°	Lat, Long in degrees
Sensor 2 (S2) location	39.104985°	-96.603451°	Lat, Long in degrees
Discharge Sensor location (if needed)	Site1-DSLat	Site1-DSLong	Lat, Long in degrees
Met Station location	39.104895	-96.603551	Lat, Long in degrees
Aquatic Auxiliary Power Portal location	39.104140°	-96.603410°	Lat, Long in degrees
Aquatic Portal location	39.104140°	-96.603410°	Lat, Long in degrees

5.2 McDowell Creek EHS Summary Table

Site Component	Latitude	Longitude	Units
Sensor 1 (S1) location	39.123663	-96.606424	Lat, Long in degrees
Sensor 2 (S2) location	Click here to enter text.	Click here to enter text.	Lat, Long in degrees
Discharge Sensor location (if needed)	39.123688	-96.606451	Lat, Long in degrees
Met Station location	39.124086	-96.606648	Lat, Long in degrees
Aquatic Auxiliary Power Portal location	39.123891°	-96.607888°	Lat, Long in degrees
Aquatic Portal location	39.123891°	-96.607888°	Lat, Long in degrees

5.3 Kings Creek STREON EHS Summary Table

Site Component	Latitude	Longitude	Units
Sensor 1 (S1) location	39.105576°	-96.603979	Lat, Long in degrees
Sensor 2 (S2) location	39.105652098	-96.604769°	Lat, Long in degrees
Discharge Sensor location (if needed)	Site3-DSLat	Site3-DSLong	Lat, Long in degrees
Met Station location	39.105209	-96.603963551	Lat, Long in degrees
Aquatic Auxiliary Power Portal location	39.104140°	-96.603410°	Lat, Long in degrees
Aquatic Portal location	39.104140°	Site3-APLong	Lat, Long in degrees

5.4 Kings Creek EHS Summary Table

Site Component	Latitude	Longitude	Units
Sensor 1 (S1) location	STR-S1Lat	STR-S1Long	Lat, Long in degrees
Sensor 2 (S2) location	STR-S2Lat	STR-S2Long	Lat, Long in degrees
Discharge Sensor location (if needed)	STR-DSLat	STR-DSLong	Lat, Long in degrees
Aquatic Auxiliary Power Portal location	STR-AuxLat	STR-AuxLong	Lat, Long in degrees
Aquatic Portal location	STR-APLat	STR-APLong	Lat, Long in degrees
STREON Hut location	STR-HutLat	STR-HutLong	Lat, Long in degrees

6 APPENDIX C. IT SUMMARY TABLES FOR AIS SITE COMPONENTS AT DOMAIN 06

6.1 Kings Creek IT Summary Table

Site Component	Latitude	Longitude	Units
REQUIRED			
Aquatic Auxiliary Power Portal location	39.104140°	-96.603410°	Lat, Long in degrees
Aquatic Portal location	39.104140°	-96.603410°	Lat, Long in degrees
DESIRED			
Cell tower visible from site			Yes/no
Cell phone signal at site			Yes/no, which carrier?
Strength of cell phone signal			Description
Facility on property			Yes/no
Internet connectivity at facility			Yes/no, description
Phone number at facility location			Area code & first 3 needed

6.2 McDowell Creek IT Summary Table

Site Component	Latitude	Longitude	Units
REQUIRED			
Aquatic Auxiliary Power Portal location	39.123891°	-96.607888°	Lat, Long in degrees
Aquatic Portal location	39.123891°	-96.607888°	Lat, Long in degrees
DESIRED			
Cell tower visible from site			Yes/no
Cell phone signal at site			Yes/no, which carrier?
Strength of cell phone signal			Description
Facility on property			Yes/no
Internet connectivity at facility			Yes/no, description
Phone number at facility location			Area code & first 3 needed

6.3 Kings Creek STREON IT Summary Table

Site Component	Latitude	Longitude	Units
REQUIRED			
Aquatic Auxiliary Power Portal location	39.104140°	-96.603410°	Lat, Long in degrees
Aquatic Portal location	39.104140°	Site3-APLong	Lat, Long in degrees
DESIRED			
Cell tower visible from site			Yes/no
Cell phone signal at site			Yes/no, which carrier?
Strength of cell phone signal			Description
Facility on property			Yes/no
Internet connectivity at facility			Yes/no, description
Phone number at facility location			Area code & first 3 needed

6.4 Kings Creek IT Summary Table

Site Component	Latitude	Longitude	Units
REQUIRED			
Aquatic Auxiliary Power Portal location	STR-AuxLat	STR-AuxLong	Lat, Long in degrees
Aquatic Portal location	STR-APLat	STR-APLong	Lat, Long in degrees
DESIRED			
Cell tower visible from site			Yes/no
Cell phone signal at site			Yes/no, which carrier?
Strength of cell phone signal			Description
Facility on property			Yes/no
Internet connectivity at facility			Yes/no, description
Phone number at facility location			Area code & first 3 needed

7 APPENDIX D. BACKGROUND DATA FOR MCDIFFETT CREEK DOMAIN 06

7.1 Historic Data

The following historic data was captured from web portals and was collected by government agencies.

7.2 Hydrology

The closest USGS gauging station is approximately 30 km downstream on Mill Creek at Paxico, KS. There is a long standing data record from this station (1954-present). The catchment size of the greater Mill Creek at Paxico is 836 km^2 (Figure 34). Given there relatively lox heterogeneity of this region it was acceptable to scale the catchments based on area. Figure 35 shows the mean monthly discharge for McDiffett Creek, which was calculated from scaling the Mill Creek record by 0.02823. The hydrograph shows a base flow condition of approximately 65 LPS. The peak flows correspond with the wetter months of late spring and early summer; with high flow conditions of approximately 5 times that of base flow.

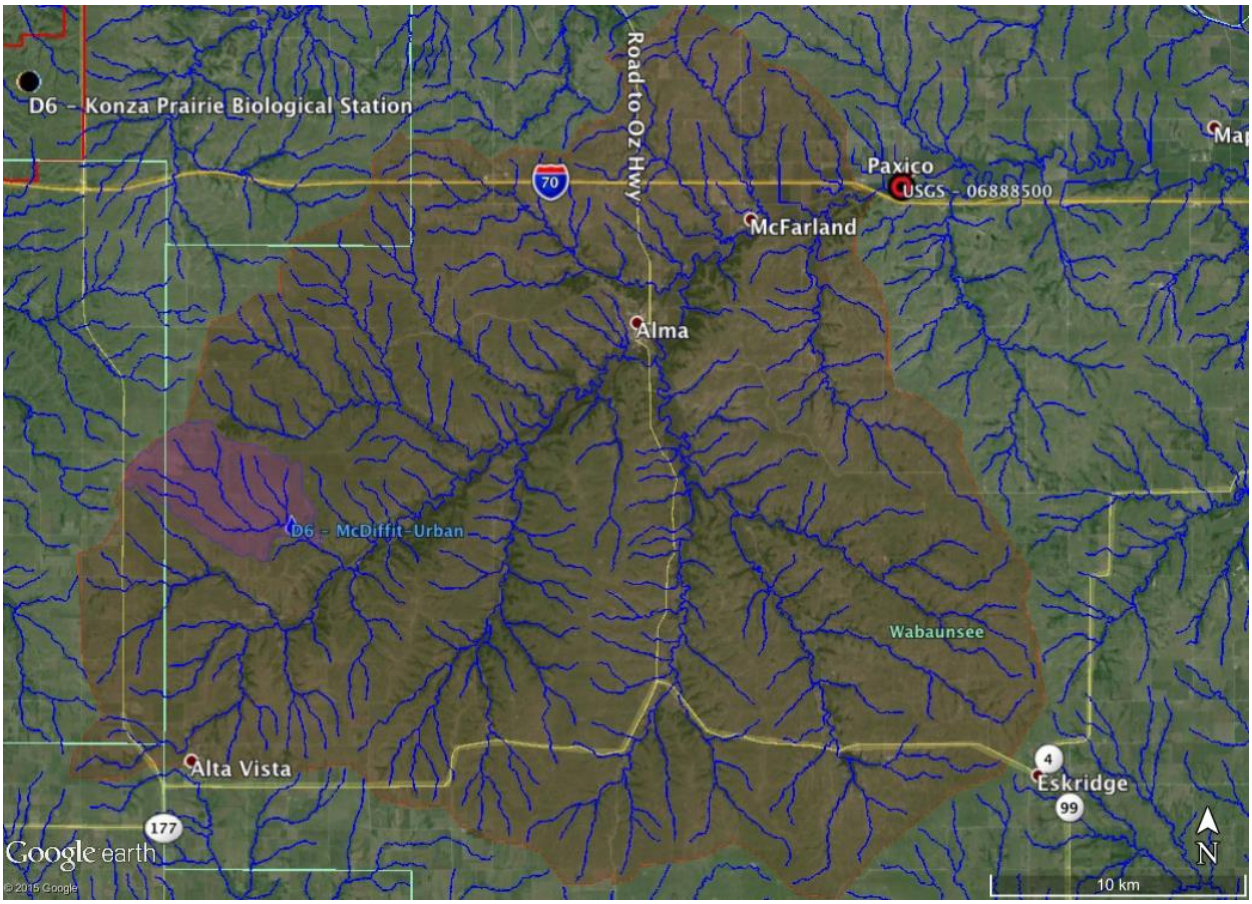

Figure 34 Map showing location of the USGS gauging station 06888500 at Paxico and the relative catchment size of Mill Creek (Orange) compared to McDiffett (Purple).

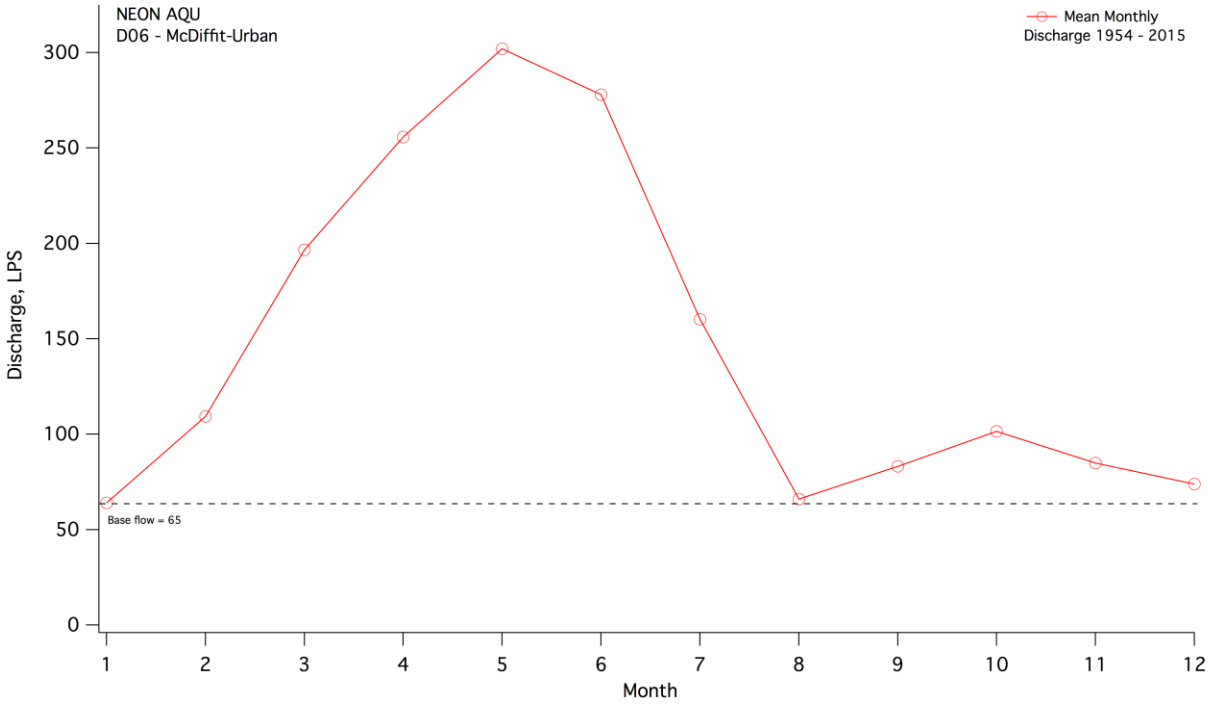

Figure 35 Estimated hydrograph of the mean monthly discharge at McDiffett Creek.

7.3 Climate and Meteorology

Meteorological records were captured from the NOAA weather station in Manhattan, KS, approximately 30km from the NEON AQU site.

The data show a mean annual precipitation of 178 cm. Figure 36 shows the accumulated monthly average from 2010-2015. The graph shows increasing precipitation through spring and early summer with a small annual pulse occurring in September.

The mean daily variability in air temperature is approximately 15°C. Over the annual cycle this region experiences summer highs around 30°C and winter lows around -10°C.

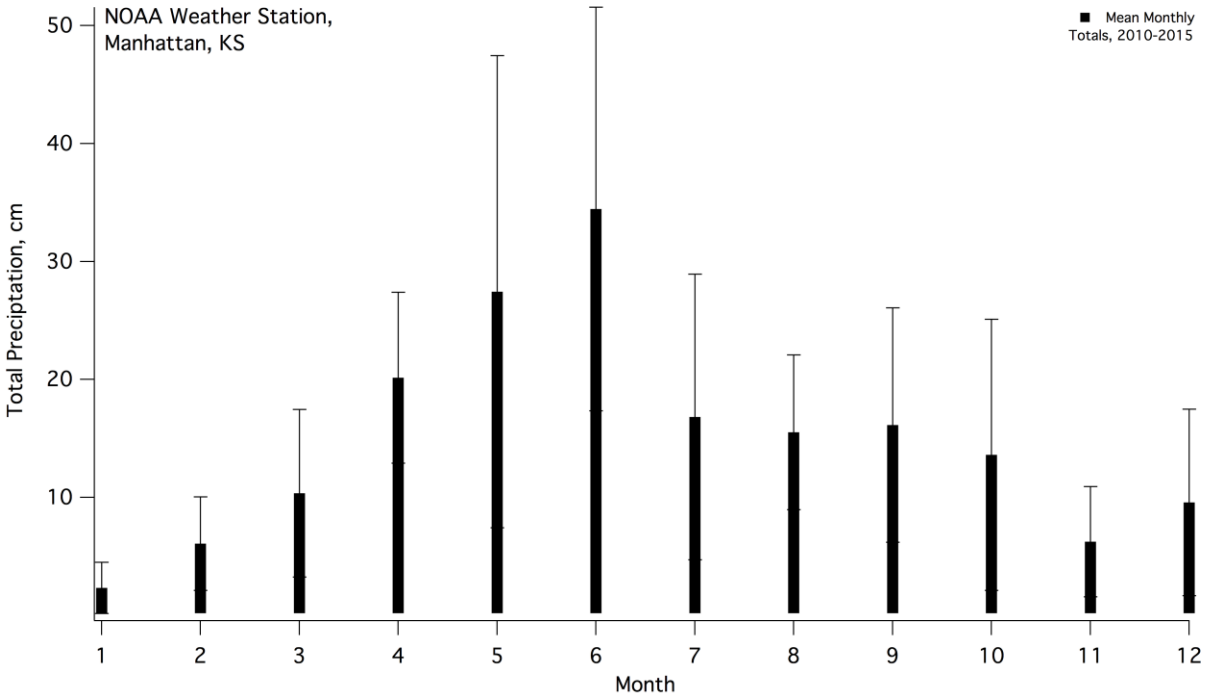

Figure 36 Mean monthly accumulated precipitation at Manhattan, KS.

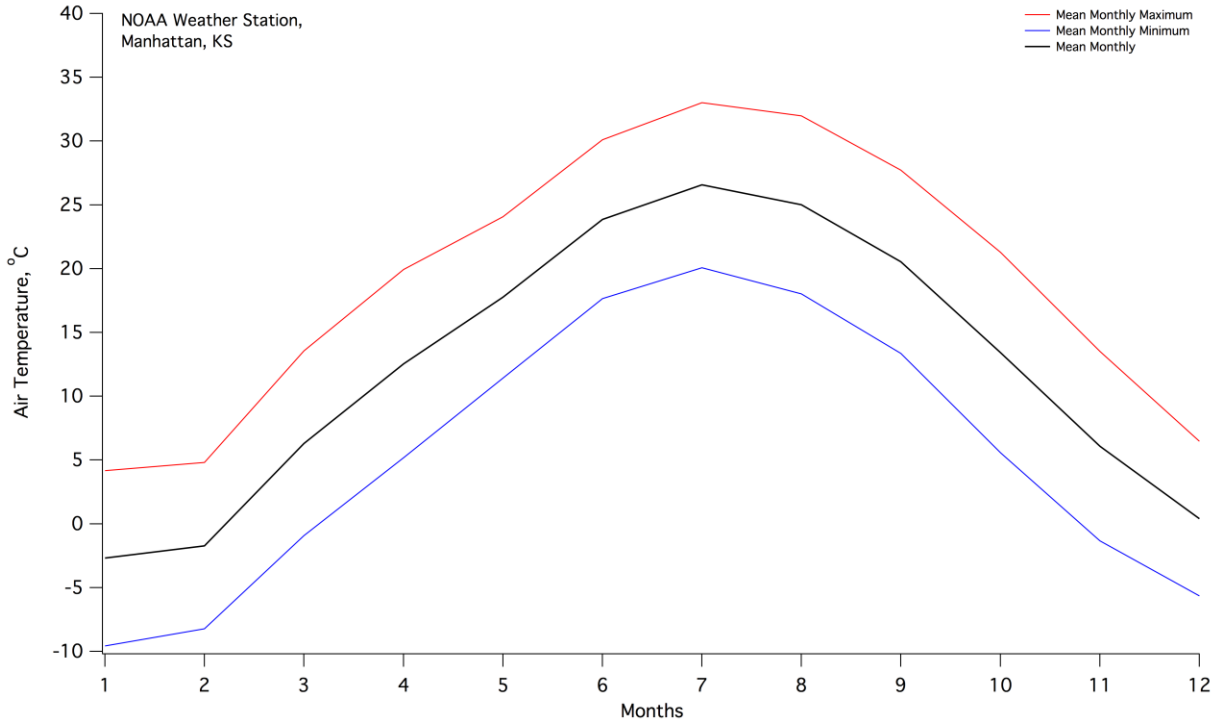

Figure 37 Mean monthly temperatures at Manhattan, KS.

8 APPENDIX E. MCDOWELL CREEK

McDowell Creek is a 4th order non-wadeable stream that drains an agricultural watershed. The flow regime of McDowell Creek is characterized by long periods of stable base flow with occasional severe high flow events during which discharge may increase by several orders of magnitude over the course of a few hours. Discharge may approach zero during the late fall of years with particularly low precipitation. Maneuverability through the channel is compromised by several factors: water clarity in McDowell Creek is very low even during base flow conditions, much of the stream consists of deep (>1 m) pools and silt dominates the channel substrate. Consequently, McDowell Creek should be considered a non-wadeable site.

8.1 Aquatic Auxiliary and Aquatic Portal Locations for Construction

The initial estimated location for the Aquatic Auxiliary Portal is:

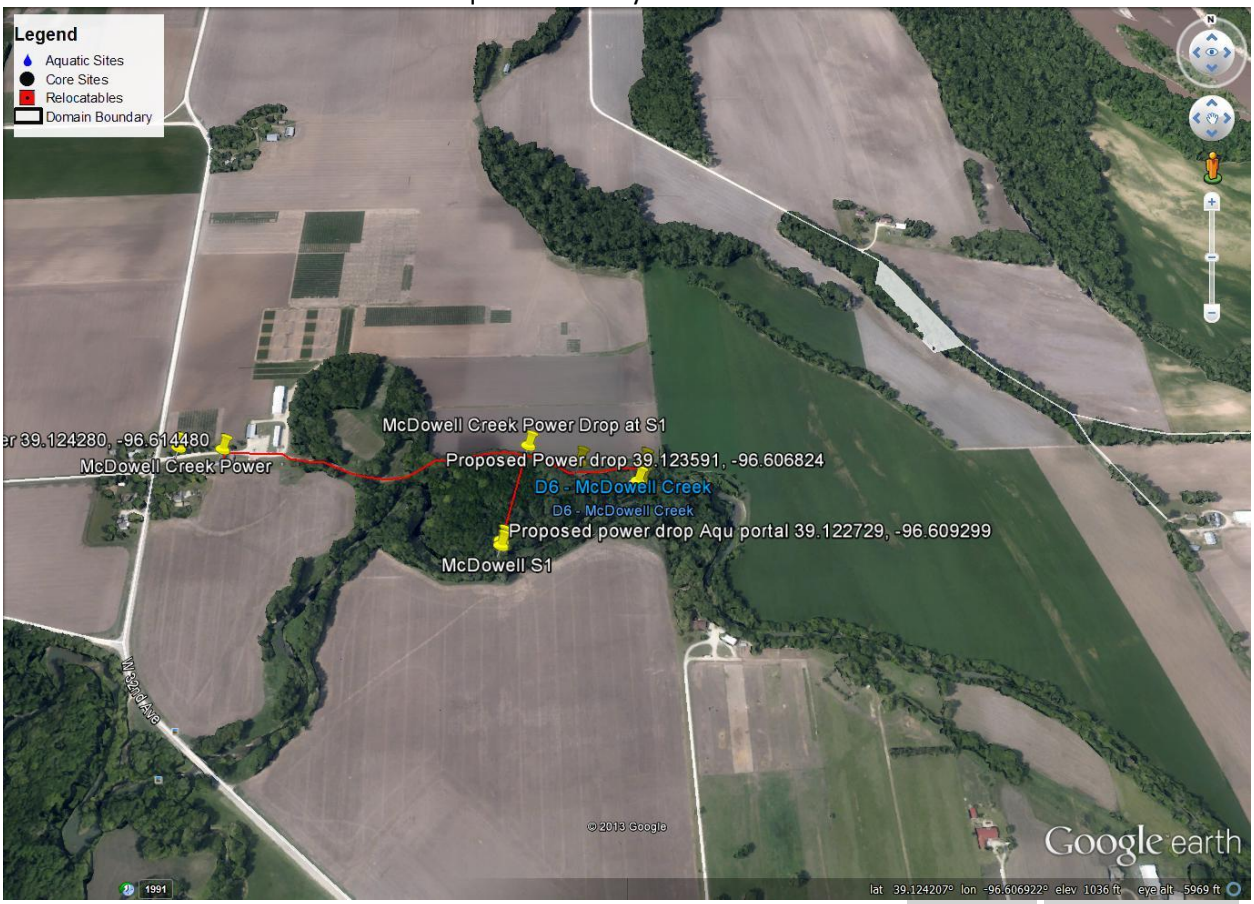

Figure 38 A Google-Earth-Derived Image of Aquatic Auxiliary Portal for Domain 06 McDowell Creek

Table 14 Aquatic Auxiliary Portal Location

Aquatic Auxiliary Portal	Latitude	Longitude
Location	39.123891°	-96.607888°

The initial estimated location for the Aquatic Portal is:

Table 15 Aquatic Portal Location

Aquatic Portal	Latitude	Longitude
Location	39.123891°	-96.607888°

8.1.1 Sensor Locations for Construction

The GPS coordinates for S1, the pressure sensor, the Met Station locations obtained by AQU, with input from EHS, are presented in Table 16 and Table 17. Many aquatic sites are in narrow canyons or covered by dense canopy, which reduces satellite availability. In these situations, AQU will provide a description of the location and an approximate GPS location (e.g. not accurate to within <1m). This description will suffice for the planning stages, but sites will likely need to be physically marked prior to construction.

These coordinates are to be used for the input to the AIS design:

Table 16 Sensors 1 location

Sensor	Latitude	Longitude
S1	39.123663	-96.606424

Table 17 Met Station & Discharge Sensor Locations

Sensor	Latitude	Longitude
Met	39.124086	-96.606648
Pressure	39.123688	-96.606451

Pressure transducers and/or velocity sensors for calculating discharge can be co-located with either sensor.

Figure 39 Kmz File of Domain 06 McDowell Creek Denoting Locations of S1, Pressure Sensor, and Met Station

Sensor locations in McDowell Creek are somewhat ambiguous, as channel habitat is homogeneous along most of the permitted reach and consists of deep pool-run sequences ideal for sensor deployment.

Access to McDowell Creek *is restricted to the left (north) bank*.

Figure 40 Location of S1 at Domain 06 McDowell Creek. Shown is the right bank; the structure of the left bank is very similar. Note the water clarity; this picture was taken during base flow conditions.

Figure 41 Location of the S1 sensor at Domain 06 McDowell Creek, facing downstream.

Figure 42 Meteorology station location at Domain 06 McDowell Creek. Station can be installed adjacent to the Kansas State University experimental plots.

Figure 43 Assessing depth can prove impossible in McDowell Creek due to poor water clarity.

8.1.2 Groundwater Wells

The groundwater observation wells network at the site (Figure 44, Table 18) will consist of 8 – 2" diameter wells installed using a geoprobe or rotary auger rig. Topography at the site is fairly flat open agricultural land with forest canopy surrounding the stream reach. The wells will be installed in the forested area surrounding the stream. Required drilling depths will vary due to the topography of the reach with total depths between ~15-20 meters below ground surface. Access to the site will be via the existing gravel road directly to the southwest of the AIS reach. Prior to drilling, a defined access path will be established for each well.

The exact location of wells may vary during the drilling process due to the presence of obstruction, if one is encountered during the construction. This is not anticipated to occur at this site due to the nature of the soils.

AQU prefers the surface completion of the wells to include an above-grade stick-up protective cover and be minimally invasive. The State of Kansas has several requirements for construction of groundwater monitoring wells that NEON will either need to meet or apply for a waiver. Chief among the State requirements are 1) an acceptable grout to fill the annular space such as neat cement, bentonite chips, or a bentonite / cement mixture; 2) surface seal of the well requires a poured concrete or cement slab poured around a steel outer casing with a locking cap; and 3) a licensed well driller is required to be onsite.

Figure 44 Initial Groundwater Well Locations Based on EMS Kmz File at Domain 06 McDowell Creek

Table 18 Groundwater Observation Well Locations

Well ID	Latitude	Longitude
D06-MCDO-OW-01	39.124070	-96.606346
D06-MCDO-OW-02	39.123837	-96.606458
D06-MCDO-OW-03	39.123959	-96.606764
D06-MCDO-OW-04	39.123689	-96.606979
D06-MCDO-OW-05	39.123825	-96.607507
D06-MCDO-OW-06	39.123446	-96.607547
D06-MCDO-OW-07	39.123732	-96.608094
D06-MCDO-OW-08	39.123294	-96.608140

8.1.3 Riparian Vegetation Cover

During 2010-2011 site visits, the following plant density and type were observed by the AQU team:
The riparian area adjacent to Kings Creek consists of gallery forest. Mature bur and chinquapin oak, walnut, elm, hackberry and hickory trees extend 100-200 m from the stream channel. Beyond the gallery forest riparian area soy and corn row crops dominate land cover. A dirt road runs between the riparian forest and crops. Ground cover consists of shrubs, bushes, vines and forbs that cover 50-70% of the area. Movement through the riparian forest can prove challenging and pathways will need to be cleared to facilitate access. Barbed wire from former pasturing operations is present. Poison ivy is present in the riparian area.

Figure 45 The riparian ground cover at Domain 06 McDowell Creek. Note the barbed wire from historic pasturing.

8.1.4 Bank Morphology

The bank angle is estimated from the top of the bank, where one might stand to observe the stream, to the top of the water. The estimated angle is from the water to the bank, as illustrated in the Figure 46 below.

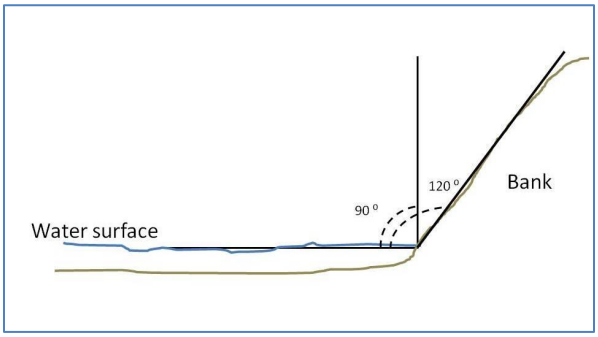

Figure 46 How Bank Angle is Measured

During 2011 site visits, AQU observed the following bank conditions at S1 and S2:
Both right and left banks in McDowell Creek consist of steeply sloping, partially vegetated, 3-8 m high clay embankments. Although isolated locations with somewhat gradual slopes allow access to the channel, permanently installed steps or ladders will be necessary to permit NEON sampling and sensor maintenance.

Table 19 Bank Conditions At Domain 06 McDowell Creek In 2011

Morphology Type	S1
RB* angle	90
LB* angle	110
Maximum water height	6m
Bank full width	18 m
Substrate composition	Silt, clay, occasional boulders

* RB (right bank) and LB (left bank) are determined by facing downstream.

Figure 47 Typical bank structure in McDowell Creek.

8.1.5 Site Photos

The following photos of are representative of the site.

Figure 48 Substrate in Domain 06 McDowell Creek consists mostly of silt, clay and sand.

Figure 49 Large snags of woody debris are present in McDowell Creek.

Figure 50 Bank height in McDowell Creek can be very high. This photograph was taken at the edge of the left bank.

Figure 51 An agricultural drainage ditch on the right bank outflows approximately midway between the S1 and S2 sensors.

Figure 52 Much of the left bank is heavily vegetated, rendering access to the channel difficult.

Figure 53 In many places, the steepness of the bank angle substantially limits access and mobility along the stream channel.

8.1.6 Site Access Needs

McDowell Creek will require:

1. Pathways constructed through the riparian forest. Movement through the riparian areas is difficult, thus pathways will prevent disturbance to vegetation and facilitate access to sensor locations.
2. Stairways or ladders from the bank to the channel. The height, extensive vegetation and clay composition characteristic of banks in McDowell Creek render access structures necessary to ensure safety.

8.1.6.1 Science Perspective on Access Needs (Pathways, Stairs, Etc.) to Reduce Site Erosion/Impact

At each sensor location and at sampling locations along the sensor reach, a set of stairs or ladder should be installed to ensure safety while accessing the channel and reducing local erosion. Additionally, footpaths through the riparian gallery forest from the parking area or edge of field to the sensor and sampling locations will be required. The approximate location of the footpath is shown in Figure 54.

Figure 54 Approximate location of required footpath for McDowell Creek.

8.1.7 Communications at the Site

See IT Network Docs for D06 IT information.

8.1.8 Power at the Site

The local power utility company is Westar Energy Marty Kinzie 785-587-2331.

8.1.9 Site Science Construction Constraints and Limitations

Site-specific issues to consider at Domain 06 McDowell Creek are:

- High flow events- rapidly increasing discharge and associated debris flows during storms will pose damage risks to installed sensors and equipment.
- Low flow periods- flow may periodically cease, especially during late autumn. Such periods will pose challenges for sensor installment and maintenance.
- Fouling- high nutrient concentrations and turbid water could severely compromise sensor and equipment performance.
- Turbidity- poor water clarity will pose difficulties for certain procedures, such as fish sampling.

Driving and access constraints for Domain 06 McDowell Creek are:

- Parking is available at the Kansas State University experimental farm facility. The walking distance between the parking area and sampling reaches is approximately 350 meters.
- Movement through or along the channel on foot will prove difficult or impossible due to deep pools, extensive riparian vegetation, fine-grained sediment composition, and poor water clarity.

8.1.10 Other Issues

No other science issues are identified at this time.

9 APPENDIX F. Kings Creek STREON

Kings Creek STREON site is a 2nd order wadeable stream that drains a mixed agricultural, pasture and tallgrass prairie-dominated watershed. The flow regime of Kings Creek is considered intermittent and flashy: discharge can be very low or entirely dry during an annual period lasting from August through February, when spring rains recharge the water table. High-intensity storms may cause flow to increase several orders of magnitude over the course of a few hours during any time of year. During base flow conditions, however, Kings Creek is shallow enough to facilitate most planned field work in the NEON aquatics program.

9.1 Aquatic Auxiliary and Aquatic Portal Locations for Construction

The initial estimated location for the Aquatic Auxiliary Portal is:

Figure 55 A Google-Earth-Derived Image of Aquatic Auxiliary Portal for Domain 06 Kings Creek STREON

Table 20 Aquatic Auxiliary Portal Location for Kings Creek (STREON)

Aquatic Auxiliary Portal	Latitude	Longitude
Location	39.104140°	-96.603410°

The initial estimated location for the Aquatic Portal is:

Table 21 Aquatic Portal Location for Kings Creek (STREON)

Aquatic Portal	Latitude	Longitude
Location	39.104140°	Site3-APLong

9.2 Sensor Locations for Construction

The GPS coordinates for STR S1, STR 2, the Nutrient Addition Station and the Met Station locations obtained by AQU, with input from EHS, are presented in Table 22 and Table 23. Many aquatic sites are in narrow canyons or covered by dense canopy, which reduces satellite availability. In these situations, AQU will provide a description of the location and an approximate GPS location (e.g. not accurate to within <1m). This description will suffice for the planning stages, but sites will likely need to be physically marked prior to construction.

These coordinates are to be used for the input to the AIS design:

Table 22 Sensors 1 and 2 locations

Sensor	Latitude	Longitude
STR S1	39.105576°	-96.603979
STR S2	39.105652098	-96.604769°

Pressure transducers and/or additional gear deployed to calculate discharge should be co-located with the S1 sensor. **The STREON nutrient addition system at Kings Creek will only require one station,** as the sensor reach is less than 200 m. Consequently, the single nutrient addition station may be co-located with the STR S1 sensor set. The micrometeorology station shall be the same as the AQU reach:

Table 23 Met sensor location

Sensor	Latitude	Longitude
Met Station	39.105209	-96.603963551
STREON nutrient addition station	Co-located with STR S1 sensors infrastructure.	

Figure 56 Kmz File of Domain 06 Kings Creek STREON Denoting Locations of STR S1, S2, and Met Station

The STREON S1 location is in a typical cross-section of Kings Creek: both banks are about 2 meters high with one steep-angled and one gradually rising bank. A large oak tree at the location appears to be stable but may collapse into the channel in the future if local erosion persists.

Figure 57 STR S1 location at Domain 06 Kings Creek STREON (STREON).

At the STR S2 location, the left bank is substantially higher than the other (5.8 versus 2.0 m) and consists of unstable sediment. Because technicians will be approaching the stream from the left bank, this sensor location will require a stream-crossing and pathway through the gallery forest on the right bank.

Figure 58 STR S2 location at Domain 06 Kings Creek STREON (STREON). Taken from the perspective of the left bank, which is approximately 6 m above the channel bottom.

Figure 59 Met station location at Domain 06 Kings Creek STREON (STREON). This is the same location as the AQU reach

9.3 Groundwater Wells

Groundwater well info is contained in Section 3.1.3.

9.4 Riparian Vegetation Cover

During 2010-2011 site visits, the following plant density and type were observed by the AQU team:

The riparian area adjacent to Kings Creek consists of gallery forest. Mature bur and chinquapin oak, walnut, elm, hackberry and hickory trees extend 5-100 m from the stream channel. Beyond the gallery forest riparian area tallgrass prairie dominates land cover. Ground cover consists of shrubs, bushes, vines and forbs that cover 70-90% of the area; however, movement through the forest is not particularly difficult. Poison ivy is present in the riparian area.

Figure 60 Typical riparian canopy vegetation at Domain 06 Kings Creek STREON (STREON).

9.5 Bank Morphology

The bank angle is estimated from the top of the bank, where one might stand to observe the stream, to the top of the water. The estimated angle is from the water to the bank, as illustrated in the Figure 61 below.

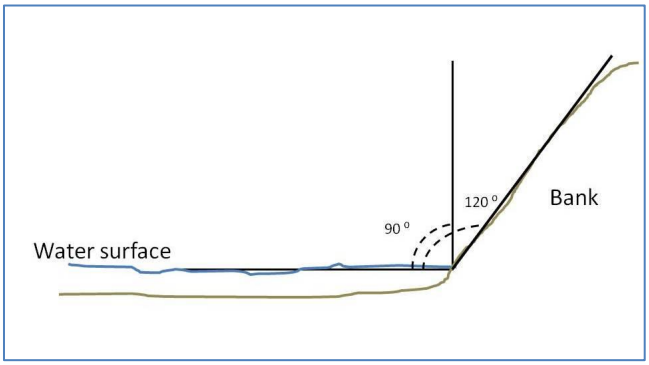

Figure 61 How Bank Angle is Measured

During 2011 site visits, AQU observed the following bank conditions at STR S1 and STR S2:

At nearly all points along the active channel, banks are typically characterized by a 1-4 m high, deeply incised clay abutment on one side and a more gradually sloping bank on the other.

Table 24 Bank Conditions At Domain 06 Kings Creek STREON In 2011

Morphology Type	S1	S2
RB* angle	90	150
LB* angle	145	90
Maximum water height	2.3 m	5.8 m
Bank full width	7.8 m	11.3 m
Substrate composition	Sand, clay, cobble	Sand, clay, cobble

* RB (right bank) and LB (left bank) are determined by facing downstream.

9.6 Site Photos

The following photos of are representative of the site.

Figure 62 Substrate in the STREON reach resembles that of the AQU reach: clay, sand, gravel and some cobble.

Figure 63 Although the tall banks may render sensor installation challenging, the riparian vegetation is reduced at some points. Shown in the upper right corner of this photograph is the left bank of the S1 STREON sensor.

Figure 64 During certain seasons, dried portions of the channel could facilitate low-impact access to sensors and sampling locations.

Figure 65 The field providing easy access to the AQU reach is also adjacent to the STREON reach.

Figure 66 Many of the tall banks at Kings Creek are composed of unstable sand and clay.

Figure 67 Immediately below the STREON reach is a large pool that will likely limit sampling below the sensors.

9.7 Site Access Needs

The large bank height (≥3 m in some places) represents the primary access issue at Kings Creek, though both banks are not uniformly high along the entire stream. Pathways will need to be developed through the gallery forest to the sensor locations, as well as sampling locations within the sensor reach, and in some cases these will need to circumvent high banks.

9.7.1 Science Perspective on Access Needs (Pathways, Stairs, Etc.) to Reduce Site Erosion/Impact

Footpaths through the riparian gallery forest from the parking area or edge of field to the sensor and sampling locations will be required. The approximate location of the footpath is shown in Figure 68 (showing footpaths to both the AQU and STREON reach).

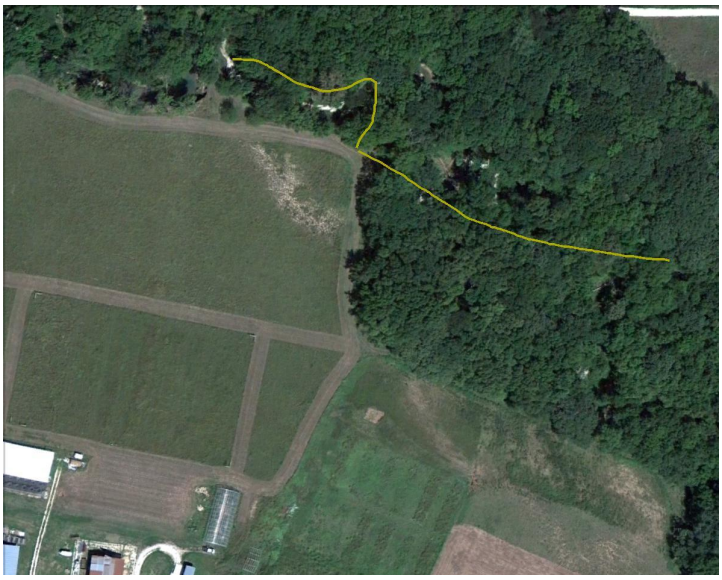

Figure 68 Approximate location of the footpaths to be constructed to access sensors. Shown are paths to both the AQU and STREON reach sensors.

9.8 Communications at the Site

See IT Network Docs for D06 IT information.

9.9 Power at the Site

The local power utility company is Bluestem Electric Coop Don Johnson 785-456-2212.

9.10 Site Science Construction Constraints and Limitations

Site-specific issues to consider at Domain 06 Kings Creek are:

- Extended periods (5+ months) of zero-flow will pose challenges for sensor installment and maintenance.
- Sensor installation will require consideration of episodic high flow events that will likely cause high risks of equipment damage.

Driving and access constraints for Domain 06 Kings Creek are:

- Parking is available at the greenhouse facilities of the Konza Prairie Biological Station. The distance between the parking area and NEON aquatic sites is approximately 200 m through a well-maintained field

9.11 Other Issues

No other science issues are identified at this time.