

# Short-Rotation Woody Biomass Sustainability Project: Pre- and Post-treatment Water Quality and Hydrology Data

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Version	Changes made
January 2016	Original version. Included pre-treatment water quality and hydrology data. Data accompanied Griffiths et al. 2016 JGR-Biogeosciences.
June 2017	Added post-treatment water quality data collected through October 2015 including pesticide data and water quality data from CFTs. Data accompanied Griffiths et al. 2017 Forest Ecology and Management.
January 2021	Added post-treatment water quality and hydrology data collected through the end of the project (September 2018).

## Summary:

This dataset reports the pre- and post-treatment water quality and hydrology data from a watershed-scale experiment that evaluated the effects of growing short-rotation loblolly pine for bioenergy on water quality and quantity in the southeastern U.S. (Griffiths et al. 2019). The experiment took place on the Savannah River Site, near New Ellenton, South Carolina, USA. Beginning in 2010, water quality and hydrology were measured for two years in 3 watersheds (R, B, C). At the end of February 2012, 50% of two treatment watersheds (B, C) were harvested and loblolly pine seedlings were planted and managed for bioenergy (including multiple applications of herbicides and fertilizers) (Ferreira et al. 2020). Water samples were collected from stream water (weekly), riparian groundwater (monthly), groundwater beneath the uplands (monthly), throughfall (weekly), and trenches that collected shallow subsurface flow (during storms), and these data are available for the pre- and post-treatment periods. Water samples were also collected from three concentrated flow tracks that formed in watersheds B and C in the post-treatment period. Sample collection ended on or before September 30, 2018 (throughfall sample collection ended on September 27, 2017). Water samples were analyzed for nitrate-N, ammonium-N, total dissolved N, soluble reactive phosphorus (SRP), total dissolved P, and

dissolved organic carbon (DOC) concentrations, and water temperature and specific conductivity were measured in the field. Stream water samples only were analyzed for turbidity, and total suspended solid (beginning in 2013), total nitrogen, and total phosphorus concentrations. Select samples (usually collected seasonally) were analyzed for pesticide concentrations (until May 2016). Water samples were also analyzed for stable isotopes of nitrate ( $\delta^{15}\text{N}$ ,  $\delta^{18}\text{O}$ ), and data are available for the pre-treatment period. Stream flow and trench flow were measured every 10-15 minutes, and these data are available for the pre- and post-treatment periods. Stream flow data are summarized as daily mean discharge.

#### **Associated manuscripts and reports:**

The pre-treatment data were presented in a manuscript (Griffiths et al. 2016) that utilized stable isotope of nitrate data to describe hydrological and biological drivers of watershed N cycling and sources of stream water nitrate in the 3 study watersheds.

Both the pre-treatment and post-treatment water quality data were presented in a manuscript (Griffiths et al. 2017) that examined the water quality responses to short-rotation pine production for bioenergy.

The overall findings from this project, including water quality results, are summarized in a comprehensive report (Griffiths et al. 2019).

Griffiths, N.A., C.R. Jackson, J.J. McDonnell, J. Klaus, E. Du, and M.M. Bitew. 2016. Dual nitrate isotopes clarify the role of biological processing and hydrologic flow paths on nitrogen cycling in subtropical low-gradient watersheds. *JGR-Biogeosciences* 131:422-437.

Griffiths, N.A., C.R. Jackson, M.M. Bitew, A.M. Fortner, K.L. Fouts, K. McCracken, and J.R. Phillips. 2017. Water quality effects of short-rotation pine management for bioenergy feedstocks in the southeastern United States. *Forest Ecology and Management* 400:181-198.

Griffiths, N.A., C.R. Jackson, J.I. Blake, J. Jeffers, B. Rau, G. Starr, and K. Vaché. 2019. Environmental effects of short-rotation loblolly pine production for bioenergy and evaluation of current forestry best management practices. Oak Ridge National Laboratory, ORNL/TM-2018/1055.

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#### **Dataset description:**

##### **Study site:**

This study took place in 3 watersheds in the National Environmental Research Park on the Department of Energy's Savannah River Site (SRS), near New Ellenton, South Carolina, USA. The study watersheds are located in the Upper Atlantic Coastal Plain, a region characterized by a

humid subtropical climate. Additional information on the climate, geology, and ecology of the SRS can be found in Kilgo and Blake (2005).

The three adjacent study watersheds (watershed R: 45 ha; watershed B: 169 ha; watershed C: 117 ha) are part of the larger Fourmile Branch watershed. The uplands have a flat topography (2-3% slope) and well-drained sandy soils with a loamy to clayey subsoil. Vegetation is primarily minimally managed pine in the uplands (*Pinus palustris*, *P. taiga*, and *P. elliottii*) and hardwoods in the riparian zones. Streams are characterized as blackwater (i.e., high dissolved organic matter concentrations), with intermittent flow and a sandy benthic substrate. A more detailed site description can be found in Bitew et al. (2020), Du et al. (2016), Griffiths et al. (2016, 2017, 2019), Jackson et al. (2016), and Klaus et al. (2015).

### **Sampling methods:**

The pre-treatment period was designated as January 1, 2010 through February 27, 2012, and the post-treatment period was designated from February 28, 2012 to September 30, 2018. Water samples were collected from streams, riparian groundwater, groundwater beneath the uplands, interflow, concentrated flow tracks, and throughfall. The latitude and longitude of each sampling location is reported in a datafile. Samples were not collected when the sites were dry (e.g., stream water sampling stopped because of a regional drought, no samples collected from throughfall samplers when there was no or little throughfall in a given week, riparian groundwater wells did not have enough water to collect samples, etc.).

Stream water samples were collected weekly at the outlet of each watershed and at an ephemeral flowing location upstream of the outlet. Riparian groundwater samples were collected monthly from two wells that were located near the watershed outlet ('intermittent'), and two wells that were located upstream ('ephemeral'). Groundwater was sampled monthly from 19 wells that were located across the 3 watersheds and within the larger Fourmile watershed. The well names (FHR = forest hydrology research) and well depths (from surface soil to well screen) were:

- Watershed R (FHR004 [13.1 m], 005 [13.0 m], 010 [6.4 m])
- Watershed B (FHR014 [14.2 m], 014D [25.6 m], 015 [16.6 m], 015D [37.6 m])
- Watershed C (FHR001 [3.9 m], 011D [25.6 m], 012 [10.6 m], 013 [19.3 m], 013D [43.6 m], 016 [13.0 m], 016D [28.6 m])
- Fourmile watershed (FHR003 [2.7 m], 006 [10.5 m], 007 [5.4 m], 008 [6.8 m], 009 [12.4 m])

Shallow subsurface flow (i.e., interflow) was sampled from 5 trenches (1 per watershed in the established pine forest, and 1 each in watersheds B and C installed at the edge of the loblolly pine plantations and the riparian zone) that were constructed on contour within a hillslope. Multiple drains collected interflow from each trench face, and the drains emptied into v-notch weir boxes located downslope. A more detailed description of the trenches can be found in Du et al. (2016) and Jackson et al. (2016). Throughfall was collected in a funnel (200 cm<sup>2</sup>) that was connected to a 3.8 L amber polypropylene bottle. Throughfall collectors were located under the canopy (3 throughfall collectors in watershed B, 3 in watershed C, 4 in watershed R). Sampling occurred weekly (when there was sufficient volume for water chemistry analysis), and water in all throughfall collectors in a given watershed was composited before collecting a sample. Pollen

and other debris was sometimes present in the sample, resulting in high nutrient concentrations. Because the presence of debris was not always noted, all data are included in this dataset. Sampling of concentrated flow tracks (CFTs) occurred weekly until the CFT dried up.

The date and time of sample collection was recorded for all samples. Time was reported in EST; however, it is possible that EDT was recorded in error prior to October 5, 2015. In the field, water temperature and specific conductivity were measured on all samples using a hand-held temperature and conductivity probe and turbidity was measured on stream water samples using a portable turbidity meter. Beginning on April 23, 2012, specific conductivity was recorded; prior to this date, conductivity was recorded.

Water samples were brought back to the laboratory on ice, and filtered (0.7  $\mu\text{m}$ ) into clean polyethylene bottles (for nutrient and pesticide analyses) or amber glass vials (for DOC analysis). Stream water samples collected for total nitrogen, total phosphorus, and total suspended solid (TSS) analyses were not filtered. Samples for all nutrient analyses were frozen at  $-20\text{ }^{\circ}\text{C}$  until analysis, and samples for TSS, DOC, and pesticides were refrigerated at  $4\text{ }^{\circ}\text{C}$  until analysis.

#### **Stream flow and trench flow:**

Stream flow was measured every 15-minutes at a two-foot H-flume installed at the outlet of each watershed. Water level was measured using a pressure transducer and automated water sampler (ISCO 6712, Teledyne ISCO, Lincoln, NE), and stream discharge was calculated based on the known configuration of the H-flume. Data were reported as mean daily discharge (L/s).

Trench flow (i.e., interflow) was measured every 10-minutes at multiple v-notch weir boxes that collected water from the trenched hillslope. Water level in each v-notch weir box was measured using a capacitance probe (Odyssey, Dataflow System, New Zealand), and outflow from all v-notch weir boxes for a given trench was summed to give the total hillslope interflow (L/s).

#### **Chemical analysis:**

Nitrate concentrations were measured using the cadmium reduction method, ammonium concentrations were measured using the phenol hypochlorite method, and soluble reactive phosphorus (SRP) concentrations were measured using the molybdate-blue method (APHA 2005) on a SEAL Analytical AA3 autoanalyzer. Filtered water samples were analyzed for total dissolved nitrogen (TDN) and unfiltered samples were analyzed for total nitrogen (TN) using the combustion oxidation and chemiluminescence detection method on a Shimadzu TOC-L CSH/CSN analyzer. Filtered water samples were analyzed for total dissolved phosphorus (TDP) and unfiltered water samples were analyzed for total phosphorus (TP) using persulfate oxidation follow by the molybdate-blue method (APHA 2005) on a SEAL Analytical AA3 autoanalyzer. There were instances when a sample's TP concentrations were lower than TDP concentrations (same for TN vs TDN, TDN vs dissolved inorganic N, TDP vs SRP, etc.), possibly due to measurement and sampling uncertainty; these data were included in the dataset. All dissolved constituents (ammonium, nitrate, SRP, TDN, TDP) were analyzed on the same sample. In some instances, a sample was not analyzed for TDN as this was the last analysis conducted, and there was occasionally not enough water left for this analysis. Dissolved organic carbon (DOC) concentrations were measured using the high-temperature combustion catalytic oxidation method

on a Shimadzu TOC-L CSH/CSN analyzer. Total suspended solid (TSS) concentrations were measured using a multi-step filtration and gravimetric technique (APHA 2005). Stable isotopes of nitrate were measured using the denitrifier method with *Pseudomonas aureofaciens* bacteria (Sigman et al. 2001, Casciotti et al. 2002) at the UC Davis Stable Isotope Facility. Analysis was conducted on all water samples with a nitrate concentration >14 µg N/L. The ratios of <sup>15</sup>N/<sup>14</sup>N and <sup>18</sup>O/<sup>16</sup>O in N<sub>2</sub>O were measured on a Thermo Finnigan Gas Bench and PreCon trace gas concentration system with a ThermoScientific Delta V Plus isotope-ratio mass spectrometer. The pesticides sulfometuron methyl, imazapyr, glyphosate, and fipronil were analyzed using Ultra Performance Liquid Chromatography at the OMIC USA Inc., analytical facility. See Griffiths et al. (2016, 2017) for additional details on analytical methods.

**Data files and data dictionary:**

All data are in 11 comma separated (.csv) files. Missing numerical values (including samples that were not collected) are reported as -9999.

File 1: SRWBS\_sampling locations.csv

File 2: SRWBS\_pre- and post-treatment\_throughfall\_chem.csv

File 3: SRWBS\_pre- and post-treatment\_interflow\_chem.csv

File 4: SRWBS\_pre- and post-treatment\_groundwater\_chem.csv

File 5: SRWBS\_pre- and post-treatment\_rip\_groundwater\_chem.csv

File 6: SRWBS\_pre- and post-treatment\_stream\_chem.csv

File 7: SRWBS\_pre- and post-treatment\_pesticides.csv

File 8: SRWBS\_post-treatment\_CFT\_chem.csv

File 9: SRWBS\_pre-treatment\_nitrate\_isotopes.csv

File 10: SRWBS\_pre- and post-treatment\_stream\_flow.csv

File 11: SRWBS\_pre-treatment\_trench\_flow.csv

**File 1: SRWBS\_sampling locations.csv**

Column	Heading	Units/ Format	Description	Measurement Method
1	WATERSHED		Watershed (R, B, C, or FOURMILE).	
2	SAMPLE_TY PE		Type of water sampled (groundwater_well, interflow, riparian_groundwater_well, streamwater, throughfall_collector).	
3	SITE_ID		Primary ID for sampling location.	
4	SITE_ID_2		Secondary ID for sampling location (Well 1 or Well 2 for riparian groundwater wells)	
5	LONGITUDE	Degrees	Longitude of sampling location	
6	LATITUDE	Degrees	Latitude of sampling location	

**File 2: SRWBS\_pre- and post-treatment\_throughfall\_chem.csv**

Column	Heading	Units/ Format	Description	Measurement Method
1	DATE	YYYY-MM-DD	Sample collection date.	
2	TIME	HH:MM	Sample collection time (24-h clock).	
3	WATERSHED		Watershed (R, B, or C).	
4	THR1_VOL	mL	Volume of water in throughfall collector.	Water poured into a graduated cylinder and volume was measured. Volume was reported to the nearest 5 mL. Small water volumes sometimes reported as '<X value'. When the entire sampling jug was full, water volumes were reported as '> 4480'.
5	THR2_VOL	mL	Volume of water in throughfall collector.	Water poured into a graduated cylinder and volume was measured. Volume was reported to the nearest 5 mL. Small water volumes sometimes reported as '<X value'. When the entire sampling jug was full, water volumes were reported as '> 4480'.
6	THR3_VOL	mL	Volume of water in throughfall collector.	Water poured into a graduated cylinder and volume was measured. Volume was reported to the nearest 5 mL. Small water volumes sometimes reported as '<X value'. When the entire sampling jug was full, water volumes were reported as '> 4480'.
7	THR4_VOL	mL	Volume of water in throughfall collector (in R watershed only).	Water poured into a graduated cylinder and volume was measured. Volume was reported to the nearest 5 mL. Small water volumes sometimes reported as '<X value'. When the entire sampling jug was full, water volumes were reported as '> 4480'.
8	NH4_CONC	µg N/L	Ammonium-N concentration.	Ammonium-N concentrations were measured using the phenol-hypochlorite method. Detection limit (DL) is 2.0 µg N/L. Concentrations below the detection limit are reported.
9	NO3_CONC	µg N/L	Nitrate-N concentration.	Nitrate-N concentrations were measured using the cadmium reduction method. Detection limit is 2.0 µg N/L. Concentrations below the detection limit (DL) are reported.
10	TDN_CONC	µg N/L	Total dissolved N concentration.	Total dissolved N concentrations were measured using the combustion oxidation and chemiluminescence detection method.
11	SRP_CONC	µg P/L	Soluble reactive phosphorus concentration.	Soluble reactive phosphorus concentrations were measured using the molybdate-blue method. Detection limit (DL) is 2.0 µg N/L.

				Concentrations below the detection limit are reported.
12	TDP_CONC	µg P/L	Total dissolved P concentration.	Total dissolved P concentrations were measured using persulfate oxidation followed by the molybdate-blue method. Detection limit (DL) is 2.0 µg N/L. Concentrations below the detection limit are reported.
13	DOC_CONC	mg C/L	Dissolved organic carbon concentration.	Dissolved organic carbon concentrations were measured using the high-temperature combustion catalytic oxidation method.
14	SAMPLER_STATUS		DRY or WATER	DRY = assumed to be dry. When DRY, no samples were collected. WATER = water present. Most of the time, enough water was available for collection, but sometimes not enough water was available for analyses so no samples were collected.
15	SAMPLE_STATUS		ALL_SAMPLES, NO_SAMPLE, NO_NUT_SAMPLE, or NO_DOC_SAMPLE	ALL_SAMPLES = all samples collected. NO_SAMPLE = no sample collected. NO_NUT_SAMPLE = no nutrient sample collected. NO_DOC_SAMPLE = no DOC sample collected.  In some instances, a sample was collected, but not analyzed for TDN as this was the last analysis conducted, and there was occasionally not enough water left for this analysis.

**File 3: SRWBS\_pre- and post-treatment\_interflow\_chem.csv**

Column	Heading	Units/ Format	Description	Measurement Method
1	DATE	YYYY-MM-DD	Sample collection date.	
2	TIME	HH:MM	Sample collection time (24-h clock).	
3	TRENCH_ID		Watershed (R, B, or C) where the original trenches were located. "NEW_B" and "NEW_C" were trenches that were installed at the interface of the short-rotation pine plantation and the riparian zone.	
4	WATER_TEMP	°C	Water temperature of interflow measured in the field when the water sample was collected.	Hand-held temperature and conductivity probe.
5	SP_COND	µS/cm	Specific conductivity of interflow measured in the field when the water sample was collected.	Hand-held temperature and conductivity probe.
6	NH4_CONC	µg N/L	Ammonium-N concentration.	Ammonium-N concentrations were measured using the phenol-hypochlorite method. Detection limit (DL) is 2.0 µg N/L. Concentrations below the detection limit are reported.
7	NO3_CONC	µg N/L	Nitrate-N concentration.	Nitrate-N concentrations were measured using the cadmium reduction method. Detection limit is 2.0 µg N/L. Concentrations below the detection limit (DL) are reported.
8	TDN_CONC	µg N/L	Total dissolved N concentration.	Total dissolved N concentrations were measured using the combustion oxidation and chemiluminescence detection method.
9	SRP_CONC	µg P/L	Soluble reactive phosphorus concentration.	Soluble reactive phosphorus concentrations were measured using the molybdate-blue method. Detection limit (DL) is 2.0 µg N/L. Concentrations below the detection limit are reported.
10	TDP_CONC	µg P/L	Total dissolved P concentration.	Total dissolved P concentrations were measured using persulfate oxidation followed

				by the molybdate-blue method. Detection limit (DL) is 2.0 µg N/L. Concentrations below the detection limit are reported.
11	DOC_CONC	mg C/L	Dissolved organic carbon concentration.	Dissolved organic carbon concentrations were measured using the high-temperature combustion catalytic oxidation method.
12	TRENCH_ST ATUS		FLOW or NO_FLOW	FLOW = enough water was flowing out of the trench pipe(s) that water samples could be collected. NO_FLOW = no water flowing from the trench pipe(s) or a very minimal amount of water (i.e., slow drip) was flowing and thus water samples could not be collected.

**File 4: SRWBS\_pre- and post-treatment\_groundwater\_chem.csv**

Column	Heading	Units/ Format	Description	Measurement Method
1	DATE	YYYY-MM-DD	Sample collection date.	
2	TIME	HH:MM	Sample collection time (24-h clock).	
3	WATERSHED		Watershed (R, B, C, or FOURMILE).	
4	WELL_ID		Well ID (FHR001, 003, 004, 005, 006, 007, 008, 009, 010, 11D, 12, 013, 13D, 014, 14D, 015, 15D, 016, 16D).	
5	WATER_TEMP	°C	Water temperature of groundwater measured in the field when the water sample was collected.	Hand-held temperature and conductivity probe.
6	SP_COND	µS/cm	Specific conductivity of groundwater measured in the field when the water sample was collected.	Hand-held temperature and conductivity probe.
7	NH4_CONC	µg N/L	Ammonium-N concentration.	Ammonium-N concentrations were measured using the phenol-hypochlorite method. Detection limit (DL) is 2.0 µg N/L. Concentrations below the detection limit are reported.
8	NO3_CONC	µg N/L	Nitrate-N concentration.	Nitrate-N concentrations were measured using the cadmium reduction method. Detection limit is 2.0 µg N/L. Concentrations below the detection limit (DL) are reported.
9	TDN_CONC	µg N/L	Total dissolved N concentration.	Total dissolved N concentrations were measured using the combustion oxidation and chemiluminescence detection method.
10	SRP_CONC	µg P/L	Soluble reactive phosphorus concentration.	Soluble reactive phosphorus concentrations were measured using the molybdate-blue method. Detection limit (DL) is 2.0 µg N/L. Concentrations below the detection limit are reported.
11	TDP_CONC	µg P/L	Total dissolved P concentration.	Total dissolved P concentrations were measured using persulfate oxidation followed by the molybdate-blue method. Detection limit (DL) is 2.0 µg N/L. Concentrations below the detection limit are reported.
12	DOC_CONC	mg C/L	Dissolved organic carbon concentration.	Dissolved organic carbon concentrations were measured using the high-temperature combustion catalytic oxidation method.
14	SAMPLE_ST ATUS		ALL_SAMPLES, NO_SAMPLE, NO_NUT_SAMPLE, or NO_DOC_SAMPLE	ALL_SAMPLES = all samples collected. NO_SAMPLE = no sample collected. NO_NUT_SAMPLE = no nutrient sample collected. NO_DOC_SAMPLE = no DOC sample collected.



				In some instances, a sample was collected, but not analyzed for TDN as this was the last analysis conducted, and there was occasionally not enough water left for this analysis.
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**File 5: SRWBS\_pre- and post-treatment\_rip\_groundwater\_chem.csv**

Column	Heading	Units/ Format	Description	Measurement Method
1	DATE	YYYY-MM-DD	Sample collection date.	
2	TIME	HH:MM	Sample collection time (24-h clock).	
3	WATERSHED		Watershed (R, B, or C).	
4	SITE_ID		Ephemeral (E) or Intermittent (I) site.	
5	WELL_ID		Well ID (W1, W2); two wells per site per watershed.	
6	WATER_TEMP	°C	Temperature of riparian groundwater measured in the field when the water sample was collected.	Hand-held temperature and conductivity probe.
7	SP_COND	µS/cm	Specific conductivity of riparian groundwater measured in the field when the water sample was collected.	Hand-held temperature and conductivity probe.
8	NH4_CONC	µg N/L	Ammonium-N concentration.	Ammonium-N concentrations were measured using the phenol-hypochlorite method. Detection limit (DL) is 2.0 µg N/L. Concentrations below the detection limit are reported.
9	NO3_CONC	µg N/L	Nitrate-N concentration.	Nitrate-N concentrations were measured using the cadmium reduction method. Detection limit is 2.0 µg N/L. Concentrations below the detection limit (DL) are reported.
10	TDN_CONC	µg N/L	Total dissolved N concentration.	Total dissolved N concentrations were measured using the combustion oxidation and chemiluminescence detection method.
11	SRP_CONC	µg P/L	Soluble reactive phosphorus concentration.	Soluble reactive phosphorus concentrations were measured using the molybdate-blue method. Detection limit (DL) is 2.0 µg N/L. Concentrations below the detection limit are reported.
12	TDP_CONC	µg P/L	Total dissolved P concentration.	Total dissolved P concentrations were measured using persulfate oxidation followed by the molybdate-blue method. Detection limit (DL) is 2.0 µg N/L. Concentrations below the detection limit are reported.
13	DOC_CONC	mg C/L	Dissolved organic carbon concentration.	Dissolved organic carbon concentrations were measured using the high-temperature combustion catalytic oxidation method.
14	WELL_STAT US		DRY or WATER	DRY = assumed to be dry (or not enough water present for any analysis). When DRY, no samples were collected and no field measurements (temperature and specific conductivity) were taken. WATER = water samples may or may not have been collected (if not enough water for a sample, water too muddy to sample), but field measurements (temperature, specific conductivity) most often collected. Occasionally, no water quality data were collected but water was present because of equipment malfunctions.
15	SAMPLE_STAT ATUS		ALL_SAMPLES,	ALL_SAMPLES = all samples collected NO_SAMPLE = no sample collected

			NO_SAMPLE, NO_NUT_SAMPLE, or NO_DOC_SAMPLE	NO_NUT_SAMPLE = no nutrient sample collected NO_DOC_SAMPLE = no DOC sample collected  In some instances, a sample was collected, but not analyzed for TDN as this was the last analysis conducted, and there was occasionally not enough water left for this analysis.
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**File 6: SRWBS\_pre- and post-treatment\_stream\_chem.csv**

Column	Heading	Units/ Format	Description	Measurement Method
1	DATE	YYYY-MM-DD	Sample collection date.	
2	TIME	HH:MM	Sample collection time (24-h clock).	
3	WATERSHED		Watershed (R, B, or C).	
4	SITE_ID		Ephemeral (E) or Intermittent (I) site.	
5	WATER_LEVEL	cm	Water level by flume at outlet of each watershed (at intermittent sites only).	Visual measurement of water level based on reading of a permanently installed staff gauge.
6	DISCHARGE	L/s	Stream discharge.	Calculated based on the H-flume equation and water depth.
7	WATER_TEMP	°C	Temperature of stream water measured in the field when the water quality sample was collected.	Hand-held temperature and conductivity probe.
8	SP_COND	µS/cm	Specific conductivity of stream water measured in the field when the water sample was collected.	Hand-held temperature and conductivity probe.
9	NH4_CONC	µg N/L	Ammonium-N concentration.	Ammonium-N concentrations were measured using the phenol-hypochlorite method. Detection limit (DL) is 2.0 µg N/L. Concentrations below the detection limit are reported.
10	NO3_CONC	µg N/L	Nitrate-N concentration.	Nitrate-N concentrations were measured using the cadmium reduction method. Detection limit is 2.0 µg N/L. Concentrations below the detection limit (DL) are reported.
11	TDN_CONC	µg N/L	Total dissolved N concentration.	Total dissolved N concentrations were measured using the combustion oxidation and chemiluminescence detection method.
12	SRP_CONC	µg P/L	Soluble reactive phosphorus concentration.	Soluble reactive phosphorus concentrations were measured using the molybdate-blue method. Detection limit (DL) is 2.0 µg N/L. Concentrations below the detection limit are reported.
13	TDP_CONC	µg P/L	Total dissolved P concentration.	Total dissolved P concentrations were measured using persulfate oxidation followed by the molybdate-blue method. Detection limit (DL) is 2.0 µg N/L. Concentrations below the detection limit are reported.
14	DOC_CONC	mg C/L	Dissolved organic carbon concentration.	Dissolved organic carbon concentrations were measured using the high-temperature combustion catalytic oxidation method.
15	TN_CONC	µg N/L	Total nitrogen concentration.	Total nitrogen-N concentrations were measured using the combustion oxidation and chemiluminescence detection method.
16	TP_CONC	µg P/L	Total phosphorus concentration.	Total phosphorus-P concentrations were measured using the persulfate digestion and molybdate-blue method. Detection limit (DL) is 2.0 µg N/L. Concentrations below the detection limit are reported.

17	TURBIDITY	NTU	Turbidity of stream water.	Measured in the field using a portable turbidity meter.
18	TSS_CONC	mg/L	Total suspended solid concentration.	Total suspended solids measured on unfiltered samples via a multi-step filtration and gravimetric technique.
19	STREAM_ST ATUS		FLOW or NO_FLOW	FLOW = water level >0 or water chemistry sample(s) were collected. NO_FLOW = no water chemistry samples were collected and water level was 0 or was not measured.

**File 7: SRWBS\_pre- and post-treatment\_pesticides.csv**

Column	Heading	Units/ Format	Description	Measurement Method
1	DATE	YYYY-MM-DD	Sample collection date.	
2	TIME	HH:MM	Sample collection time (24-h clock).	
3	WATERSHED		Watershed (R, B, C, or Fourmile).	
4	WATER_SAMP LED		Sampling location (CFT [concentrated flow track], gw [groundwater], rip_gw [riparian groundwater], stream [stream water grab sample], stream_storm [sequential sampling of stream water during a storm], interflow).	
5	SITE_ID		Site ID for CFT (CFT0, CFT3), groundwater (FHR001, 003, 004, 005, 006, 007, 008, 009, 010, 011, 11D, 012, 013, 13D, 014, 14D, 015, 15D, 016, 16D), riparian groundwater (I = intermittent, E = ephemeral), stream (I = intermittent, E = ephemeral).	
6	GLYPHOSAT E_CONC	µg/L	Glyphosate concentration.	Glyphosate concentration was measured using Ultra Performance Liquid Chromatography at the OMIC USA Inc., analytical facility. Detection limit was 2 µg/L.
7	IMAZAPYR_C ONC	µg/L	Imazapyr concentration.	Imazapyr concentration was measured using Ultra Performance Liquid Chromatography at the OMIC USA Inc., analytical facility. Detection limit was 2 µg/L.
8	SULFO_CON C	µg/L	Sulfometuron methyl concentration.	Sulfometuron methyl concentration was measured using Ultra Performance Liquid Chromatography at the OMIC USA Inc., analytical facility. Detection limit was 1 µg/L. A level of 'trace' is a qualitative result below the detection limit.
9	FIPRONIL_C ONC	µg/L	Fipronil concentration.	Fipronil concentration was measured using Ultra Performance Liquid Chromatography at the OMIC USA Inc., analytical facility. Detection limit was 1 µg/L.

**File 8: SRWBS\_post-treatment\_CFT\_chem.csv**

Column	Heading	Units/ Format	Description	Measurement Method
1	DATE	YYYY-MM-DD	Sample collection date.	
2	TIME	HH:MM	Sample collection time (24-h clock).	

3	WATERSHED		Watershed (B or C).	
4	CFT_ID		CFT ID (CFT0, CFT3, CFT4).	
5	WATER_TEMP	°C	Temperature of CFT water measured in the field when the water sample was collected.	Hand-held temperature and conductivity probe.
6	SP_COND	µS/cm	Specific conductivity of CFT water measured in the field when the water sample was collected.	Hand-held temperature and conductivity probe.
7	NH4_CONC	µg N/L	Ammonium-N concentration.	Ammonium-N concentrations were measured using the phenol-hypochlorite method. Detection limit (DL) is 2.0 µg N/L. Concentrations below the detection limit are reported.
8	NO3_CONC	µg N/L	Nitrate-N concentration.	Nitrate-N concentrations were measured using the cadmium reduction method. Detection limit is 2.0 µg N/L. Concentrations below the detection limit (DL) are reported.
9	TDN_CONC	µg N/L	Total dissolved nitrogen concentration.	Total dissolved N concentrations were measured using the combustion oxidation and chemiluminescence detection method.
10	SRP_CONC	µg P/L	Soluble reactive phosphorus concentration.	Soluble reactive phosphorus concentrations were measured using the molybdate-blue method. Detection limit (DL) is 2.0 µg N/L. Concentrations below the detection limit are reported.
11	TDP_CONC	µg P/L	Total dissolved phosphorus concentration.	Total dissolved P concentrations were measured using persulfate oxidation followed by the molybdate-blue method. Detection limit (DL) is 2.0 µg N/L. Concentrations below the detection limit are reported.
12	DOC_CONC	mg C/L	Dissolved organic carbon concentration.	Dissolved organic carbon concentrations were measured using the high-temperature combustion catalytic oxidation method.
13	CFT_STATUS		DRY or WATER	DRY = CFT was checked, but no sample was collected if the CFT was dry. WATER = water was present in the CFT and a sample was collected.

**File 9: SRWBS\_pre-treatment\_nitrate\_isotopes.csv**

Column	Heading	Units/Format	Description	Measurement Method
1	DATE	YYYY-MM-DD	Sample collection date.	
2	TIME	HH:MM	Sample collection time (24-h clock).	
3	WATERSHED		Watershed (R, B, or C).	
4	WATER_SAMPLED		Sampling location (gw [groundwater], rip_gw [riparian groundwater], stream [stream water grab sample], throughfall, interflow).	
5	SITE_ID		Site ID for groundwater (FHR001, 003, 004, 005, 006, 007, 008, 009, 010, 011, 11D, 012, 013, 13D, 014, 14D, 015, 15D, 016, 16D), riparian groundwater (I = intermittent, E = ephemeral), stream (I = intermittent, E = ephemeral).	
6	SITE_ID_2		Riparian groundwater well ID (W1, W2).	
7	D15N	‰	Stable isotope of nitrate δ <sup>15</sup> N.	Stable isotope of nitrate δ <sup>15</sup> N and δ <sup>18</sup> O were measured using the denitrifier method with <i>Pseudomonas aureofaciens</i> bacteria at the UC

				Davis Stable Isotope Facility. All samples with a nitrate concentration >14 µg N/L were analyzed for stable isotopes of nitrate.
8	D18O	‰	Stable isotope of nitrate δ <sup>18</sup> O.	Same as above.

**File 10: SRWBS\_pre- and post-treatment\_stream\_flow.csv**

Column	Heading	Units/ Format	Description	Measurement Method
1	DATE	YYYY-MM-DD	Measurement date.	
2	B_DISCHARGE	L/s	Mean daily discharge measured at the outlet of the B watershed.	Stream flow was measured every 15-minutes at a two-foot H-flume installed at the outlet of each watershed. Water level was measured using a pressure transducers and automated water sampler (ISCO 6712, Teledyne ISCO, Lincoln, NE), and stream discharge was calculated based on the known configuration of the H-flume.
3	C_DISCHARGE	L/s	Mean daily discharge measured at the outlet of the C watershed.	Stream flow was measured every 15-minutes at a two-foot H-flume installed at the outlet of each watershed. Water level was measured using a pressure transducers and automated water sampler (ISCO 6712, Teledyne ISCO, Lincoln, NE), and stream discharge was calculated based on the known configuration of the H-flume.
4	R_DISCHARGE	L/s	Mean daily discharge measured at the outlet of the R watershed.	Stream flow was measured every 15-minutes at a two-foot H-flume installed at the outlet of each watershed. Water level was measured using a pressure transducers and automated water sampler (ISCO 6712, Teledyne ISCO, Lincoln, NE), and stream discharge was calculated based on the known configuration of the H-flume.

**File 11: SRWBS\_pre-treatment\_trench\_flow.csv**

Column	Heading	Units/ Format	Description	Measurement Method
1	DATE	YYYY-MM-DD	Measurement date.	
2	TIME	HH:MM	Measurement time (24-h clock).	
3	WATERSHED		Watershed (R or C).	
4	DISCHARGE	L/s	Interflow measured every 10-minutes.	Trench flow (i.e., interflow) was measured every 10-minutes at multiple v-notch weir boxes that collected water from the trenched hillslope. Water level in each v-notch weir box was measured using a capacitance probe (Odyssey, Dataflow System, New Zealand), and outflow from all v-notch weir boxes for a given trench was summed.

**References:**

- APHA. 2005. Standard methods for the examination of water and wastewater, 21st edition, American Public Health Association, Washington DC, USA.
- Bitew, M.M., C.R. Jackson, D.C. Goodrich, S.E. Younger, N.A. Griffiths, K.B. Vaché, and B. Rau. 2020. Dynamic domain kinematic modelling for predicting interflow over leaky impeding layers. *Hydrological Processes* 34:2895-2910.

- Casciotti, K.L., D.M. Sigman, M. Galanter Hastings, J.K. Böhlke, and A. Hilkert. 2002. Measurement of the oxygen isotopic composition of nitrate in seawater and freshwater using the denitrifier method. *Analytical Chemistry* 74:4905-4912.
- Du, E., C.R. Jackson, J. Klaus, J.J. McDonnell, N.A. Griffiths, M.F. Williamson, J.L. Greco, and M. Bitew. 2016. Interflow dynamics on a low relief forested hillslope: lots of fill, little spill. *Journal of Hydrology* 534:648-658.
- Ferreira, G.W.D., B.M. Rau, and D.P. Aubrey. 2020. Herbicide, fertilization, and planting density effects on intensively managed loblolly pine early stand development. *Forest Ecology and Management* 472:118206.
- Griffiths, N.A., C.R. Jackson, J.J. McDonnell, J. Klaus, E. Du, and M.M. Bitew. 2016. Dual nitrate isotopes clarify the role of biological processing and hydrologic flowpaths on nitrogen cycling in subtropical low-gradient watersheds. *JGR-Biogeosciences* 131:422-437.
- Griffiths, N.A., C.R. Jackson, M.M. Bitew, A.M. Fortner, K.L. Fouts, K. McCracken, and J.R. Phillips. 2017. Water quality effects of short-rotation pine management for bioenergy feedstocks in the southeastern United States. *Forest Ecology and Management* 400:181-198.
- Griffiths, N.A., C.R. Jackson, J.I. Blake, J. Jeffers, B. Rau, G. Starr, and K. Vaché. 2019. Environmental effects of short-rotation loblolly pine production for bioenergy and evaluation of current forestry best management practices. Oak Ridge National Laboratory, ORNL/TM-2018/1055.
- Jackson, C.R., E. Du., J. Klaus, N.A. Griffiths, M. Bitew, and J.J. McDonnell. 2016. Interactions among hydraulic conductivity distributions, subsurface topography, and transport thresholds revealed by a multitracer hillslope irrigation experiment. *Water Resources Research* 52:6186-6206.
- Kilgo, J.C., and J.I. Blake. 2005. *Ecology and Management of a Forested Landscape: Fifty Years on the Savannah River Site*, Island Press, Washington DC, USA.
- Klaus, J., J.J. McDonnell, C.R. Jackson, E. Du, and N.A. Griffiths. 2015. Where does streamwater come from in low-relief forested watersheds? A dual-isotope approach, *Hydrology and Earth System Sciences* 19:125-135.
- Sigman, D.M., K.L. Casciotti, M. Andreani, C. Barford, M. Galanter, and J.K. Böhlke. 2001. A bacterial method for the nitrogen isotopic analysis of nitrate in seawater and freshwater, *Analytical Chemistry* 73:4145-4153.