Table 1. Supplemental model equations.

Eq. #	Variable (type)	Equation	Initial value; Units
1	PRECIPITATION (exogenous)	= GET XLS DATA ('HUC4.xlsx', 'Sheet2', 'A','B2')	cm/day
2	SNOW (exogenous)	=GET XLS DATA ('HUC4.xlsx', 'Sheet2', 'A','D2')	cm/day
3	snow to meters (auxiliary)	= Snow/ "cm/m"	m
4	"cm/m" (constant)	=0.01	cm/m
5	"snow ha-m" (auxiliary)	=SNOW*CROPLAND HECTARES	ha-m
6	CROPLAND HECTARES (exogenous)	=GET XLS DATA ('HUC4.xlsx', 'Sheet2', 'A','J2')	ha
7	cubic meters of snow (auxiliary)	= "snow ha-m"*"cubic meters per ha-m"	m^3
8	"cubic meters per ha-m" (constant)	=1000	m^3/ha-m
9	cropland snow (auxiliary)	=cubic meters of snow	m^3
10	cropland snow rate (flow)	=cropland snow	m^3
11	snowpack density (auxiliary)	=snowpack density lookup	Dmnl
12	Snowpack (stock)	=(cropland snow rate-cropland snow runoff rate)*snowpack density	0; m^3
13	cropland snow runoff rate (flow)	=(Snowpack*above 1.67 celsius)	m^3/day
14	above 1.67 celsius (auxiliary)	= IF THEN ELSE(AVERAGE TEMPERATURE> snow melting control, 1 , 0)	Dmnl
15	snow melting control (constant)	=1.67	℃
16	Surface Water (Stock)	= cropland precipitation rate+cropland snow runoff rate-cropland percolation rate- cropland surface runoff rate	0; m^3
17	cropland m of precipitation (auxiliary)	= (effective precipitation/ "cm/m")	m^3
18	"cropland ha-m" (auxiliary)	=cropland m of precipitation* CROPLAND HECTARES	ha-m
19	cubic meters of precipitation (auxiliary)	= "cropland m of precipitation"* "cubic meters per ha-m"	m^3
20	cropland precipitation (auxiliary)	=cubic meters of precipitation	m^3
21	Cropland precipitation rate (flow)	= effective precipitation	m^3
22	leaf area index lookup (auxiliary)	=cropland cover [([(0,0)-(1,0.06)],(0,0),(0.223242,0.00789474),(0.504587,0.02),(0.740061,0.0313158),(1,0.05))]	Dmnl
23	effective precipitation (auxiliary)	=IF THEN ELSE (PRECIPITATION<=0, 0 , (LAI constant 1+(LAI constant 2*(PRECIPITATION-	cm

		LAI constant 1)))-leaf area index lookup)	
24	LAI constant 1	=0.2	cm
25	LAI constant 2	=0.8	cm
26	cropland infiltration rate (flow)	= IF THEN ELSE(Surface Water>0, Surface Water* (infiltration coefficient lookup)* infiltration stop, 0)* snow melting control	m^3/day
27	infiltration coefficient lookup (auxiliary)	= cropland groundwater ratio [([(0,0)-(1,0.7)],(0,0.66),(0.100917,0.457456),(0.269113,0.279386), (0.529052,0.122807),(1,0))]	Dmnl
28	infiltration stop (auxiliary)	=IF THEN ELSE(Cropland Groundwater>= cropland groundwater capacity, 0 , 1)	Dmnl
29	cropland groundwater ratio (auxiliary)	=IF THEN ELSE(Cropland Groundwater<= cropland groundwater capacity, Cropland Groundwater/ cropland groundwater capacity	Dmnl
30	Cropland Groundwater (stock)	=cropland infiltration rate-cropland evapotranspiration	m^3
31	cropland evapotranspiration rate (flow)	= adjusted cropland evapotranspiration	m^3/day
32	adjusted cropland evapotranspiration (auxiliary)	= hydro+maxET+wilting	m^3
33	Hydro (auxillary)	=IF THEN ELSE("ground water ratio to ET, E levels"=0.19, hydroscopic ET level, 0)	m^3
34	maxET (auxiliary)	=IF THEN ELSE("ground water ratio to ET, E levels">=0.57, cropland ET, 0)	m^3
35	Wilting (auxiliary)	= IF THEN ELSE("ground water ratio to ET, E levels"=0.24, wilting ET level , 0)	m^3
36	cropland groundwater capacity (auxiliary)	(((CROPLAND HECTARES*soil depth)* "cubic meters per ha-m" (constant))*cropland fraction of soil that is water)+cubic meters of additional water capacity from organic matter	m^3
37	"ground water ratio to ET, E levels" (auxiliary)	=cropland groundwater ratio [([(0,0)-(1,1)],(0,0.19),(0.19,0.19),(0.25,0.24),(0.56,0.24), (0.57,1),(1,1))]	Dmnl
38	hydroscopic ET level (auxiliary)	= evaporation rate*((soil moisture-hydroscopic water)/ (soil water wilting point-hydroscopic water))	m^3
39	cropland ET (auxiliary)	=cropland cubic meters ET	m^3
40	wilting ET level (auxiliary)	evaporation rate +(cropland ET- evaporation rate *((soil moisture-soil water wilting point)/ (soil water below max point-soil water wilting point))	m^3
41	soil depth (constant)	=0.3	m
41	cropland fraction of soil that is water (constant)	=0.27	Dmnl
42	cubic meters of additional water	= organic matter m^3 addition*CROPLAND HECTARES	m^3

	capacity from organic matter (auxiliary)		
43	soil moisture (auxiliary)	=cropland groundwater ratio	Dmnl
44	hydroscopic water (constant)	0.19	Dmnl
45	soil water wilting point (constant)	= 0.24	Dmnl
46	evaporation rate (auxillary)	= (arbitrary meters of evaporation only per day* CROPLAND HECTARES)* “cubic meters per ha-m”	m^3
47	arbitrary feet of evaporation only per day(constant)	= 0.001000000032	m
48	cropland cubic meters ET (auxillary)	= "cropland ET ha-m"* “cubic meters per ha-m”	m^3
49	"cropland ET ha-m" (auxiliary)	=CROPLAND EVAPOTRANSPIRATION* CROPLAND HECTARES	ha-m
49	CROPLAND EVAPOTRANSPIRATI -ON (exogenous)	=GET XLS DATA ('HUC4.xlsx', 'Sheet2', 'A','Z2')	m
50	soil water below max point (constant)	= 0.57	Dmnl
51	organic matter m^3 addition (auxiliary)	= Cropland Organic Matter [([(0,0)-(10,20000)],(0,0),(1,2205.73),(2,4411.46),(3,6617.19),(4,8822.92),(5,11028.6),(6,13234.4),(7,15440.1))]	m^3/ ha
52	Cropland Soil Organic Matter (stock)	=humification-cultivation	3; Dmnl
53	Humification (flow)	= plant residue per hectare lookup function	Dmnl/day
54	Cultivation (flow)	=IF THEN ELSE(AVERAGE TEMPERATURE> 50, cultivation loss of organic matter rate * Cropland Soil Organic Matter, 0)	Dmnl/day
55	plant residue per hectare lookup function (auxiliary)	= plant residue [([(0,0)(70000,7)],(0,0),(10000,1),(20000,2),(30000,3),(40000,4),(50000,5),(60000,6),(70000,7))]	Dmnl
56	cultivation loss of organic matter rate (constant)	=0	Dmnl
57	plant residue (auxillary)	= ((Cropland Residue/CROPLAND HECTARES)* Cropland Residue)*microbial activity	Dmnl
58	Cropland Residue (stock)	= plant residue rate-volatilization	kg
59	volatilization (flow)	Crop Residue*typical volatilization of residue	kg/day
60	microbial activity (auxiliary)	PULSE TRAIN(microbial degradation start, microbial duration , microbial activity repeat interval, microbial activity last pulse time)	day
62	typical volatilization of residue (constant)	=0.02	Dmnl
63	plant residue rate (flow)	= Plant Biomass*litter fraction	kg/day
64	litter fraction (constant)	=0.66	Dmnl
65	Plant Biomass (stock)	= plant harvest rate- plant residue rate-harvested grain	1000;kg

66	harvested grain (constant)	=0.3	Dmnl
67	plant harvest rate (flow)	=Cropland Biomass*cropland harvest outflow	kg/day
68	cropland harvest outflow (auxillary)	= PULSE TRAIN(cropland initial pulse time outflow, cropland duration outflow , cropland repeat interval time outflow , cropland last pulse time outflow)	day
69	Cropland Biomass (stock)	= plant growth rate-plant harvest rate	kg
70	plant growth (auxiliary)	= ((plant growth*plant available water)*CROPLAND HECTARES)*cropland grown inflow	kg/ day
71	plant grown inflow (auxiliary)	=PULSE TRAIN(cropland initial pulse time inflow, cropland duration inflow , cropland repeat interval time inflow , cropland last pulse time inflow)	day
72	Growing Degree Days (stock)	GDD inflow-GDD outflow	℃
73	plant available water (auxiliary)	= soil moisture [([(0,0)(1,1)],(0,0),(0.19,0.19), (0.24,0.36),(0.57,0.75),(1,1))]	Dmnl
74	cropland surface runoff rate(flow)	= cropland runoff *cropland runoff lookup	m^3/ day
75	cropland runoff lookup (auxiliary)	=cropland groundwater ratio [([(0,0)-(1,1)],(0,0), (0.33945,0.114035), (0.59633,0.320175),(0.733945,0.491228), (0.850153,0.688596),(1,1))]	Dmnl
76	cropland runoff (auxiliary)	= IF THEN ELSE(rain and snow proxy>0, Surface Water* cropland runoff coefficient, 0)* snow melting control	m^3
77	rain and snow proxy	=cropland snow proxy+ cropland rain proxy	1
78	cropland runoff coefficient (constant)	=0.34	Dmnl
79	cropland rain proxy	=IF THEN ELSE(cropland precipitation rate>0, 1 ,0)	1
80	cropland snow proxy	=IF THEN ELSE(cropland snow runoff rate>0, 1 , 0)	1
81	Discharge (stock)	=Cropland surface runoff rate-discharge outflow	0; m^3
82	discharge outflow (flow)	= Discharge	m^3/day
83	cropland biomass per hectare (auxiliary)	=(Cropland Biomass/CROPLAND HECTARES)	kg/ha
84	cropland cover lookup (auxiliary)	=Cropland biomass per hectare [([(0,0)-(6000,1)],(0,0),(100,0.1),(200,0.2),(300,0.3), (400,0.4),(500,0.5),(600,0.6),(700,0.7),(800,0.8), (900,0.9),(1000,1),(2000,1),(3000,1),(4000,1),(5000,1), (6000,1))]	Dmdl
85	“R-FACTOR” (exogenous)	= GET XLS DATA ('HUC4.xlsx', 'Sheet2', 'A','X2')	Tons/ha
86	“K-factor” (constant)	=0.49	Tons/ha
87	“LS-factor” (constant)	=.573	Tons/ha
88	“p-factor” (constant)	=0.75	Tons/ha
89	“c-factor” (auxiliary)	= cropland cover lookup	Dmnl
90	Erosion (auxiliary)	=(“K-factor”* “R-FACTOR”)* “LS-factor” * “c-factor” * “p-factor”)	Tons/ha

91	catchment hectares	=CROPLAND HECTARES	ha
92	catchment km^2	=catchment hectares* "ha/km^2"	km^2
93	"ha/km^2"	=0.01	ha/km^2
94	sediment delivery ratio	=SDR constant*(catchment km^2^(SDR exponent))	1
95	SDR constant	=0.42	Dmnl
96	SDR exponent	= -0.125	Dmnl
97	sediment deposition	= (total erosion*basin sediment delivery ratio)	Tons
98	total erosion	= (erosion*CROPLAND HECTARES)	Ton/catchment
99	TSS	= (sediment deposition* mg/ton)/ discharge in liters	mg/l
100	"mg/ton" (constant)	= 9.072e+008	mg/Ton
101	discharge in liters	=IF THEN ELSE(total basin liters of water>0, total basin liters of water, 1)	l
102	total basin liters of water	=basin total cubic meters of water*liters per cubic meter	l
103	liters per cubic meter (constant)	=1000	l/m^3
104	snowpack density lookup (auxiliary)	= snowpack depth[([(0,0)-(4,0.9)],(0,0),(0.3,0.05),(0.6,0.08),(0.9,0.1),(1,0.15),(2,0.17),(3,0.19),(4,0.3))]	Dmnl
105	snowpack depth (auxiliary)	=(Snowpack/cubic meters per ha-m)/CROPLAND HECTARES	m
106	basin total cubic meters of water (auxiliary)	= Discharge	m^3
107	microbial degradation start (auxiliary)	=502	day
108	microbial duration (auxiliary)	=153	day
109	microbial activity repeat interval (auxiliary)	=365	day
110	microbial activity last pulse time (auxiliary)	=24107	day
111	cropland initial pulse time outflow (auxiliary)	= 298	day
112	cropland duration outflow (auxiliary)	=189	day
113	cropland repeat interval time outflow (auxiliary)	=365	day
114	cropland last pulse time outflow (auxiliary)	=24107	day
115	cropland initial pulse time inflow (auxiliary)	=121	day
116	cropland duration inflow (auxiliary)	=177	day
117	cropland repeat interval time inflow (auxiliary)	=365	day
118	cropland last pulse time inflow (auxiliary)	=24107	day
119	GDD inflow (flow)	=growing degree units pulse events inflow	GDD/day
120	GDD outflow (flow)	=growing degree units pulse events outflow	GDD/day

121	growing degree units pulse events inflow (auxiliary)	=GROWING DEGREE UNITS*PULSE TRAIN(GDD initial pulse time inflow, GDD duration inflow ,GDD repeat interval time inflow , GDD last pulse time inflow)	GDD*day
122	growing degree units pulse events outflow (auxiliary)	=PULSE TRAIN(GDD initial pulse time outflow, GDD duration outflow ,GDD repeat interval time outflow , GDD last pulse time outflow)	GDD*day
123	GDD initial pulse time inflow	=105	day
124	GDD last pulse time inflow (auxiliary)	=24107	day
125	GDD repeat interval time inflow (auxiliary)	=365	day
126	GDD duration inflow (auxiliary)	=184	day
127	GDD initial pulse time outflow (auxiliary)	=289	day
128	GDD last pulse time outflow (auxiliary)	=24107	day
129	GDD repeat interval time outflow (auxiliary)	=365	day
130	GDD duration outflow (auxiliary)	=181	day
131	GROWING DEGREE UNITS (exogenous)	=GET XLS DATA ('HUC4.xlsx', 'Sheet2', 'A','H2')	GDD

Model equations represent one of six unique spatial layers and are subscripted to represent 53 unique water catchments, eventually representing the entire Big Sioux River water-catchment. Model research is ongoing and equations will continue to be improved and modified.