

# SURFACE RUNOFF FROM APPLICATION FIELDS AND RELATIONSHIP TO FIELD MANAGEMENT

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## Summary

1. Nutrient loss in surface runoff from Fields 1, 5a, and 12 are dominated by higher rainfall in 2015, than in other years of monitoring leading to large runoff volumes.
2. The annual loss of P and N in surface runoff from Field 1 for the five years of monitoring, averaged 0.8 and 1.8%, respectively, of that applied in slurry; for Field 12 losses were 2.2% P and 4.5% N. For Field 5a, loss of P and N was an average 6.6 and 4.4%, respectively, of that applied each year in mineral fertilizer.
3. The greater nutrient runoff from Fields 5a and 12 and proportion of that applied in slurry or mineral fertilizer was dominated by major storm events in 2015, which resulted in more than twice the volume of runoff in 2015 (5.4 and 0.9 million gallons) than the other four years combined (1.3 and 0.4 million gallons). Additionally, Fields 5a and 12 are adjacent to Big Creek, which breached its banks and flooded these fields in May and December 2015.

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## Field Site Description

Surface runoff from Fields 1, 5a, and 12 has been collected after storm rainfall-induced runoff events. The catchment area for each flume located on Fields 1, 5a, and 12 is depicted in Figures 1, 2, and 3, respectively. The catchment area is that field area which contributes runoff water to our monitoring site. Due to natural slope and elevation changes in all fields, the flumes do not collect runoff water from the entire field. The catchment areas selected for instrumentation were the largest natural drainage areas with a surface discharge off the fields. Also depicted on Figures 1, 2, and 3, are buffers imposed by the C&H ADEQ permit for ponds, school, slope, and stream, where no slurry can be applied to Fields 1, 5a, and 12, respectively. On field 12, the farm owners have implemented a 100 ft buffer along the south neighboring field.

The field area, flume catchment area, and area to which slurry can be applied to Fields 1, 5a, and 12 is given in Table 1. Annual amounts and rates of commercial fertilizer (Field 5a) and slurry from the C&H operation (Fields 1 and 12) are given in Table 2. The slurry rates are obtained from ADEQ annual management reports for the farm and commercial fertilizer application from the landowner.

## Surface Runoff of Nutrients and Sediment

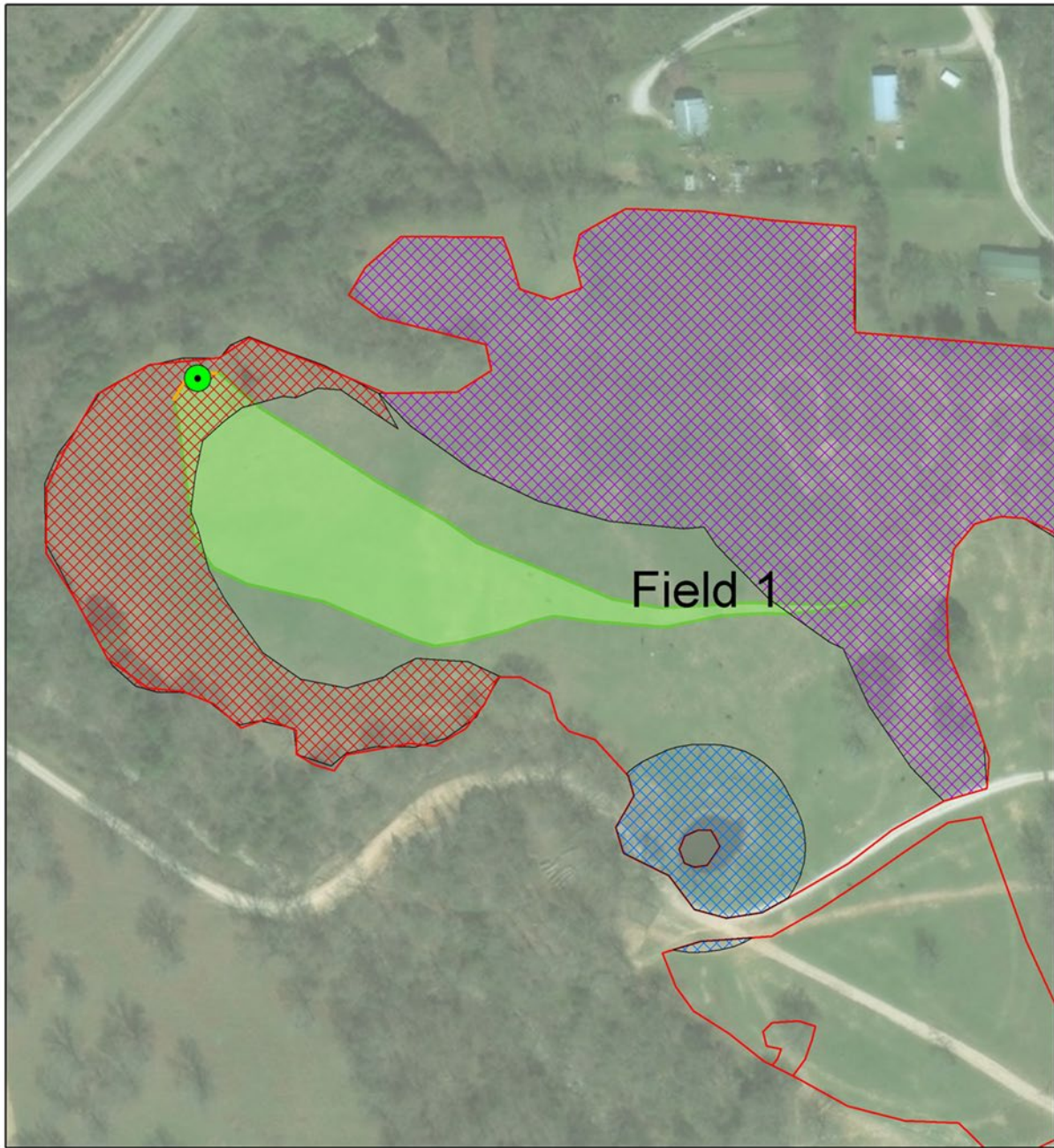
All surface runoff samples are collected by ISCO autosamplers programmed to initiate sample collection when a critical stage height is exceeded (Table 3). Pacing of sample collection is subsequently programmed to a specific volume of flow, as detailed in Table 3. This standard operating procedure for ISCO autosamplers results in the collection of one flow-weighted sample, which is subsequently analyzed. The flow-weighted event concentration of nutrients and sediment in surface runoff from each Field are detailed in Supplemental Table S1, along with runoff volume.







Based on flow-weighted concentration and total flow volume for each surface runoff event, the amount of nutrients and sediment based on flume catchment area are determined and presented in Table S2 in English units (i.e., lbs/acre) and in Table S3 in metric units (i.e., g/ha). There was no surface runoff measured at the flume for Field 12 in 2014 or 2018.

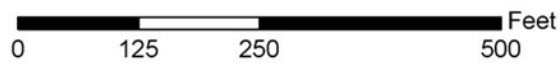
The annual flow and mean annual flow-weighted concentrations of P, N, and sediment in runoff for 2014 through 2018 are given in Table 4. The annual loss of P, N, and sediment in surface runoff from Fields 1, 5a, and 12 for 2014 through 2018 is given Table 5 in English and metric units.

Finally, the amount of P and N applied to the flume catchment area of Fields 1, 5a, and 12, loss in runoff, and percent of applied lost in runoff for 2014 through 2018 are given in Table 6. Losses are dominated by higher rainfall in 2015 than the other years of monitoring, which led to large runoff volumes (Table 6).

Mean annual nutrient loss was 0.78 lbs total P and 1.82 lbs total N/acre for BC1; 1.65 lbs total P and 2.49 lbs total N/acre for BC5a; and 1.67 lbs total P and 4.04 lbs total N/acre for BC12 (Table 7). These losses were similar to P losses reported elsewhere. For example, pastures in northwest Arkansas, also in the karst region of the Boston Mountains / Ozark Highlands, receiving poultry litter (1.5 – 2.0 tons/acre) had losses ranging from 0.94 – 1.45 lbs P/ acre (Table 7).

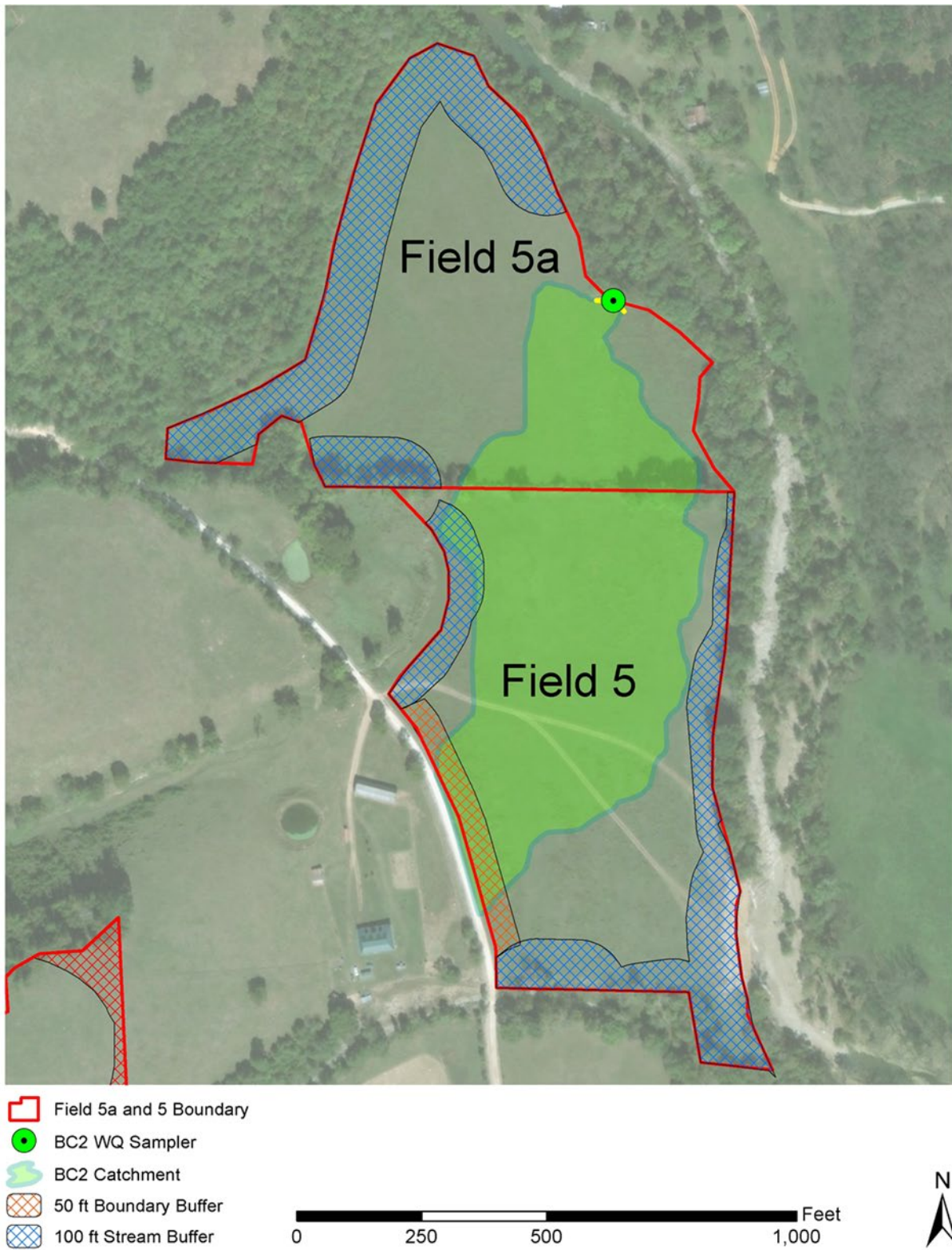


-  Field 1 Boundary
-  BC1 WQ Sampler
-  BC1 Catchment
-  100 ft Pond Buffer
-  500 ft School Buffer
-  > 15% Slope Buffer

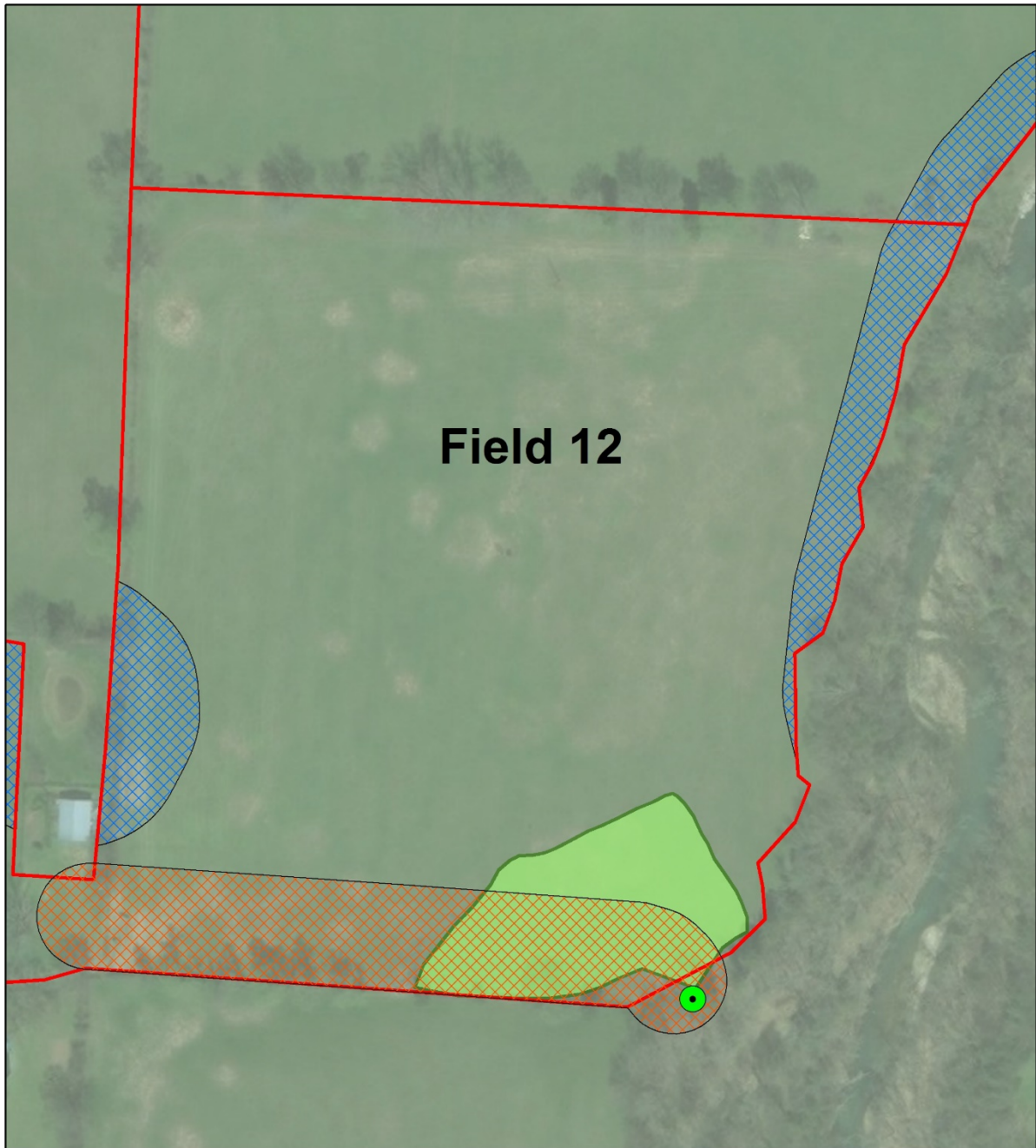







**Figure 1. Map of Field 1 showing catchment area for surface runoff flume and buffers where no slurry can be applied.**

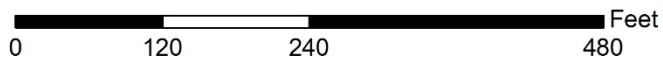




**Figure 2. Map of Field 5a showing catchment area for surface runoff flume and buffers where no slurry can be applied.**



-  Field 12 Boundary
-  BC3 WQ Sampler
-  BC3 Catchment
-  100 ft Stream Buffer
-  100 ft Property Buffer



**Figure 3. Map of Field 12 showing catchment area for surface runoff flume and buffers where no slurry can be applied.**

**Table 1. Area of Field 1, 5a, and 12 monitored for surface runoff, area of flume catchment, area of buffers where no slurry is applied, and area of flume receiving slurry.**

Site	Site ID	Field area		Flume catchment area		Buffer		Flume catchment area minus buffer		Flume catchment receiving slurry	Area of flume catchment in designated field	
		acres	hectares	acres	hectares	acres	hectares	acres	hectares	%	acres	hectares
Field 1	BC 1	15.6	6.31	1.76	0.71	0.15	0.06	1.61	0.65	91.4	1.76	0.71
Field 5a	BC 2	23.5	9.51	9.58	3.88	0.54	0.22	9.04	3.66	0 <sup>1</sup>	2.21	0.89
Field 12	BC 3	28.7	11.61	0.84	0.34	0.48	0.19	0.36	0.15	43	0.84	0.34

<sup>1</sup> Slurry has not been applied to Field 5a or the adjacent Field 5.

**Table 2. Slurry (i.e., Fields 1 and 12) and fertilizer (i.e., Fields 5a) application to the monitored fields for 2014 to 2018.**

Site	2014		2015		2016		2017		2018	
<b>Slurry applied, gals</b>										
Field 1	46,000		12,000		78,000		60,000		57,000	
Field 12	48,000		93,000		156,000		90,000		105,000	
<b>Nutrients applied in slurry, lbs/1000 gallons</b>										
	<b>P</b>	<b>N</b>	<b>P</b>	<b>N</b>	<b>P</b>	<b>N</b>	<b>P</b>	<b>N</b>	<b>P</b>	<b>N</b>
Field 1	4.8	20.1	4.8	20.1	17.5	30.3	60.3	47.2	12.4	12.2
Field 12	4.8	20.1	4.8	20.1	17.5	30.3	60.3	47.2	12.4	12.2
<b>Nutrients applied to field, lbs/acre</b>										
Field 1	14	59	4	15	88	152	232	182	45	45
Field 5a <sup>1</sup>	25	57	25	57	25	57	25	57	25	57
Field 12	8	34	16	65	95	165	189	148	45	44
<b>Nutrients applied to flume catchment, lbs</b>										
Field 1	23	95	6	25	141	244	373	292	73	72
Field 5a <sup>1</sup>	55	126	55	126	55	126	55	126	55	126
Field 12	3	13	6	25	36	63	72	56	16	16
<b>Nutrients applied to field, kg/ha</b>										
Field 1	16	66	4	17	98	170	260	203	51	50
Field 5a <sup>1</sup>	28	64	28	64	28	64	28	64	28	64



Site	2014		2015		2016		2017		2018	
Field 12	9	38	17	73	107	184	212	166	51	50
<b>Nutrients applied to flume catchment, kg</b>										
Field 1	10	43	3	11	64	111	169	133	33	33
Field 5a <sup>1</sup>	25	57	25	57	25	57	25	57	25	57
Field 12	1	6	3	11	16	28	33	26	7	7

<sup>1</sup> Nutrient applied as 19-19-19 mineral fertilizer (i.e., 19% N, 19% P<sub>2</sub>O<sub>5</sub>, and 19% K<sub>2</sub>O) in early spring at a rate of 300 lbs/acre.

**Table 3. Parameters used to enable ISCO auto-samplers at BCRET edge-of-field sites Field 1, 5a, and 12.**

Site	Identifier	ISCO enabled when stage height (inches) above	Volume pacing, 100 mL water collected per gallon of water		
			Rainfall, inches		
			<2.5	2.5 to 4	>4
Field 1	BC1	> 0.75	500	1,000	5,000
Field 5a	BC2	> 0.75	5,000	10,000	50,000
Field 12	BC3	> 0.75	500	1,000	5,000

**Table 4. Annual flow and flow-weighted concentrations of phosphorus, nitrogen, and sediment in runoff for 2014, 2015, 2016, 2017, and 2018.**

	Flow				Dissolved P	TP	Ammonia-N	Nitrate-N	Total N	Solids
	gal	L	gal/acre	L/ha	----- mg/L -----					
<b>Field 1</b>										
2014	118,481	448,451	67,319	629,696	0.407	0.630	0.243	0.247	1.644	67.238
2015	103,754	392,708	58,951	551,425	0.302	0.480	0.286	0.272	1.989	33.457
2016	3,755	14,212	2,133	19,955	0.940	1.231	0.130	0.335	2.360	59.000
2017	682,789	2,584,356	387,948	3,628,845	0.529	0.761	0.296	0.220	1.846	62.480
2018	22,165	83,895	12,594	117,801	1.197	1.404	0.383	1.392	4.023	32.175
<b>Field 5a</b>										
2014	34,350	130,015	3,587	33,548	0.613	0.779	0.170	0.023	0.683	28.933
2015	5,357,063	20,276,483	559,335	5,231,990	0.385	0.915	0.260	0.175	1.700	217.900
2016	139,663	528,625	14,582	136,402	1.134	1.405	0.980	1.598	4.010	53.200
2017	1,039,108	3,933,024	108,494	1,014,848	0.845	1.101	0.115	0.632	1.583	11.525
2018	77,413	293,008	164,961	1,543,036	1.433	1.940	0.103	0.230	2.340	89.833

	Flow				Dissolved P	TP	Ammonia-N	Nitrate-N	Total N	Solids
	gal	L	gal/acre	L/ha	----- mg/L -----					
<b>Field 12</b>										
2014	N.R. <sup>1</sup>	N.R.	N.R.	N.R.	N.R.	N.R.	N.R.	N.R.	N.R.	N.R.
2015	874,765	3,310,986	1,041,387	9,741,071	0.459	0.680	0.100	0.272	1.314	35.740
2016	2,888	10,931	3,438	32,159	0.387	0.596	0.463	0.336	2.263	346.400
2017	403,100	1,525,734	479,881	4,488,778	0.289	0.463	0.027	0.146	1.143	141.233
2018	N.R.	N.R.	N.R.	N.R.	N.R.	N.R.	N.R.	N.R.	N.R.	N.R.

<sup>1</sup> N.R. is no runoff occurred from Field 12, while the site was operational in 2014.

**Table 5. Annual loss of phosphorus and nitrogen in surface runoff from Fields 1, 5a, and 12 for 2014, 2015, 2016, 2017, and 2018.**

Date	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Solids
----- lbs/ac -----						
<b>Field 1</b>						
2014	0.30	0.43	0.07	0.11	0.72	41
2015	0.15	0.22	0.08	0.09	0.64	16
2016	0.02	0.02	0.00	0.01	0.04	1
2017	2.27	3.07	1.49	1.28	7.25	181
2018	0.13	0.15	0.03	0.18	0.44	2
<b>Mean annual</b>	<b>0.57</b>	<b>0.78</b>	<b>0.33</b>	<b>0.33</b>	<b>1.82</b>	<b>48</b>
<b>Field 5a</b>						
2014	0.02	0.02	0.00	0.00	0.02	1
2015	1.16	4.46	1.20	0.60	6.97	1,476
2016	0.14	0.16	0.03	0.04	0.20	3
2017	0.75	0.99	0.11	0.70	1.51	10
2018	1.78	2.63	0.18	0.33	3.76	134
<b>Mean annual</b>	<b>0.77</b>	<b>1.65</b>	<b>0.31</b>	<b>0.33</b>	<b>2.49</b>	<b>325</b>
<b>Field 12</b>						
2014	N.R. <sup>1</sup>	N.R.	N.R.	N.R.	N.R.	N.R.
2015	1.79	3.28	0.79	1.23	7.40	321
2016	0.01	0.02	0.03	0.02	0.12	16
2017	1.07	1.72	0.11	0.62	4.60	453
2018	N.R.	N.R.	N.R.	N.R.	N.R.	N.R.
<b>Mean annual</b>	<b>0.96</b>	<b>1.67</b>	<b>0.31</b>	<b>0.62</b>	<b>4.04</b>	<b>263</b>
----- g/ha -----						



Date	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Solids
<b>Field 1</b>						
2014	342.1	486.6	82.8	127.6	813.0	45,620
2015	171.4	246.5	92.0	104.3	719.4	17,712
2016	18.8	24.6	2.6	6.7	47.1	1,177
2017	2,546.4	3,441.5	1,676.5	1,431.2	8,132.1	203,052
2018	148.1	170.2	36.6	197.6	496.9	2,751.1
<b>Mean annual</b>	<b>645</b>	<b>874</b>	<b>378</b>	<b>373</b>	<b>2,042</b>	<b>54,062</b>
<b>Field 5a</b>						
2014	19.5	25.3	5.5	0.8	22.3	1,254
2015	1,297.7	5,000.6	1,346.0	675.4	7,819.0	1,655,477
2016	157.4	184.4	37.0	41.6	228.5	3,623
2017	836.8	1,106.4	122.2	788.2	1,697.8	11,700
2018	1,991.0	2,948.7	202.0	372.4	4,221.5	150,783
<b>Mean annual</b>	<b>860</b>	<b>1,853</b>	<b>343</b>	<b>376</b>	<b>2,798</b>	<b>364,567</b>
<b>Field 12</b>						
2014	N.R.	N.R.	N.R.	N.R.	N.R.	N.R.
2015	2,010.8	3,680.0	887.1	1,374.4	8,296.2	359,901
2016	13.1	17.3	33.0	24.0	129.8	18,215
2017	1,194.9	1,928.8	126.4	694.9	5,158.1	508,434
2018	N.R.	N.R.	N.R.	N.R.	N.R.	N.R.
<b>Mean annual</b>	<b>1,073</b>	<b>1,875</b>	<b>349</b>	<b>698</b>	<b>4,528</b>	<b>295,517</b>

<sup>2</sup> N.R. is no runoff occurred from Field 12, while the site was operational in 2014.

**Table 6. Amount of phosphorus and nitrogen applied to the flume catchment area of Fields 1, 5a, and 12, loss in runoff, and percent of applied lost in runoff for 2014, 2015, 2016, 2017, and 2018.**

Date	Rain	Phosphorus			Nitrogen		
		Applied	Loss in runoff	Percent applied lost in runoff	Applied	Loss in runoff	Percent applied lost in runoff
	inches	lbs		%	lbs		%
<b>Field 1</b>							
2014	43.39	23	0.76	3.3	95	1.28	1.3
2015	61.42	6	0.39	6.5	25	1.13	4.5
2016	41.27	141	0.04	0.0	244	0.07	0.0
2017	47.04	373	5.40	1.4	292	12.76	4.4
2018	53.84	73	0.27	0.4	72	0.78	1.1
<b>Field 5a</b>							
2014	43.39	55	0.22	0.4	126	0.19	0.2
2015	61.42	55	42.70	77.6	126	66.77	53.0
2016	41.27	55	1.57	2.9	126	1.95	1.5
2017	47.044	55	9.45	17.2	126	14.50	11.5
2018	53.84	55	25.18	45.8	126	36.05	28.6
<b>Field 12</b>							
2014	43.39	N.R. <sup>1</sup>	N.R.	N.R.	N.R.	N.R.	N.R.
2015	61.42	6	2.76	46.0	25	6.21	24.8
2016	41.27	36	0.01	0.0	63	0.10	0.2
2017	47.04	72	1.44	2.0	56	3.86	6.9

<sup>3</sup> N.R. is no runoff occurred from Field 12, while the site was operational in 2014.

**Table 7. Loss of P and N in runoff from fields in northwest AR and eastern OK and losses from Big Creek Fields BC1, BC5a, and BC12.**

Site	Site years	Management	P applied	P runoff	% applied in runoff	N applied	N runoff	% applied in runoff	Reference
			lbs/ac/yr			lbs/ac/yr			
BC1	5	Grazed pasture with swine slurry	94	0.78	0.8	100	1.82	1.8	BCRET
BC5a	5	Fertilizer grazed and hayed pasture	25	1.65	6.6	57	2.49	4.4	BCRET
BC12	5	Grazed and hayed pasture with swine slurry	75	1.67	2.2	90	4.04	4.5	BCRET
Dumas, AR	15	Cotton – corn rotation	24	1.06	3.1	91	3.75	2.8	Daniels et al., 2019
El Reno, OK	32	Native grass	0	0.87	--	0	0.10	--	Sharpley and Smith, 1994
	29	Wheat	12	1.46	12.2	63	8.22	13.1	
Washington Co., AR	4	Grazed pasture with poultry litter	60	0.94	1.6	120	0.31	0.3	Bolster et al., 2019
	4	Grazed pasture with poultry litter	80	1.45	1.8	160	0.66	0.4	
	4	Hayed pasture with poultry litter	60	1.37	2.3	120	1.26	1.1	
	7	Hayed pasture	0	0.06	--	0	0.29	--	
Woodward, OK	14	Native grass	0	0.02	--	0	0.18	--	Sharpley and Smith, 1994
	8	Native grass	23	0.30	1.3	90	1.47	1.6	
	8	Wheat	23	1.71	7.4	92	6.47	7.0	

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## Supplemental Tables and Figures

**Table S 1. Flow and flow-weighted concentration of phosphorus and nitrogen in each runoff event for Fields 1, 5a, and 12 in 2014, 2015, 2016, 2017, and 2018.**

Date	Flow gal	Flow L	Flow gal/acre	Flow L/ha	Dissolved P	Total P	Ammonia- N	Nitrate- N	Total N	Solids
					----- mg/L -----					
<b>Field 1</b>										
4/4/2014	20,795	78,709	11,815	110,520	0.181	0.638	0.250	0.106	2.080	207.0
5/9/2014	15,956	60,393	9,066	84,802	0.079	0.312	0.170	0.209	1.630	125.9
5/13/2014	15,420	58,365	8,761	81,953	0.190	0.366	0.100	0.126	1.330	42.1
5/28/2014	17,600	66,616	10,000	93,539	0.235	0.310	0.000	0.000	0.000	56.1
6/24/2014	1,440	5,450	818	7,653	0.228	0.498	0.180	0.114	2.390	23.2
6/27/2014	41,380	156,623	23,511	219,924	1.166	1.374	0.100	0.333	1.180	12.3
7/25/2014	4,920	18,622	2,795	26,149	0.648	0.794	0.160	0.388	1.650	5.6
10/14/2014	970	3,671	551	5,155	0.529	0.746	0.980	0.698	2.890	65.7
3/25/2015	4,642	17,570	2,638	24,671	0.143	0.346	0.410	0.216	2.680	65.5
5/8/2015	12,510	47,350	7,108	66,487	0.525	0.714	0.160	0.475	2.190	16.9
5/11/2015	53,439	202,265	30,363	284,013	0.251	0.386	0.090	0.055	0.860	44.4

Date	Flow	Flow	Flow	Flow	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Solids
	gal	L	gal/acre	L/ha	----- mg/L -----					
5/18/2015	960	3,634	545	5,102	0.208	0.512	0.540	0.410	3.590	53.7
5/26/2015	6,010	22,748	3,415	31,942	0.245	0.432	0.200	0.174	1.660	37.8
6/29/2015	6,133	23,214	3,485	32,596	0.354	0.524	0.370	0.226	1.640	11.0
7/7/2015	20,060	75,927	11,398	106,614	0.387	0.444	0.230	0.345	1.300	4.9
10/13/2016	3,755	14,212	2,133	19,955	0.940	1.231	0.130	0.335	2.360	59.0
3/27/2017	19,430	73,543	11,040	103,265	0.420	0.670	0.430	0.090	1.870	124.4
4/24/2017	21,120	79,939	12,000	112,247	0.395	0.592	0.130	0.143	1.500	43.1
4/27/2017	33,110	125,321	18,813	175,971	0.550	0.784	0.080	0.107	1.320	52.2
5/1/2017	49,820	188,569	28,307	264,780	0.534	0.760	0.330	0.321	2.200	36.7
6/6/2017	559,309	2,116,985	317,789	2,972,581	0.747	0.998	0.510	0.438	2.340	56.0
5/3/2018	8,412	31,839	4,780	44,708	0.273	0.467	0.060	0.037	1.750	27.500
8/30/2018	3,030	11,469	1,722	16,104	1.617	1.875	0.690	1.869	5.510	49.600

Date	Flow	Flow	Flow	Flow	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Solids
	gal	L	gal/acre	L/ha	----- mg/L -----					
10/11/2018	10,570	40,007	6,006	56,177	1.941	2.103	0.400	2.492	5.830	12.300
11/1/2018	153	579	87	813	0.955	1.171	0.380	0.719	3.000	39.300
<b>Field 5a</b>										
6/27/2014	20,630	78,085	2,154	20,148	0.506	0.656	0.060	0.000	0.530	39.7
7/25/2014	2,000	7,570	209	1,953	0.625	0.754	0.090	0.000	0.610	9.0
10/13/2014	11,720	44,360	1,224	11,446	0.707	0.926	0.360	0.068	0.910	38.1
3/26/2015	42,743	161,782	4,463	41,745	0.813	1.330	0.390	0.225	2.590	72.3
5/11/2015	5,158,670 <sup>1</sup>	19,525,566	538,621	5,038,229	0.248	0.968	0.260	0.127	1.500	320.1
7/7/2015	155,650	589,135	16,252	152,016	0.094	0.448	0.130	0.172	1.010	261.3
3/31/2016	139,510	528,045	14,566	136,253	1.154	1.352	0.270	0.302	1.670	26.5
5/10/2016	153	580	16	150	1.114	1.458	1.690	2.894	6.350	79.9
4/24/2017	46,638	176,525	4,870	45,549	0.961	1.212	0.120	0.321	1.530	11.7

Date	Flow	Flow	Flow	Flow	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Solids
	gal	L	gal/acre	L/ha	----- mg/L -----					
4/27/2017	251,410	951,587	26,250	245,540	0.686	0.846	0.070	0.063	0.860	11.3
5/1/2017	381,570	1,444,242	39,840	372,661	0.734	0.916	0.220	0.281	1.560	13.1
6/6/2017	359,490	1,360,670	37,535	351,097	1.000	1.430	0.050	1.861	2.380	10.0
2/21/2018	52,210	197,615	5,450	1,031,161	1.496	2.078	0.140	0.307	2.990	66.900
2/26/2018	22,598	197,615	110,238	457,726	0.735	1.495	0.120	0.087	2.280	175.500
3/29/2018	2,605	85,533	48,934	54,149	2.067	2.247	0.050	0.296	1.750	27.100
<b>Field 12</b>										
5/8/2015	13,630	51,590	16,226	151,779	0.675	0.956	0.140	0.303	1.820	57.0
5/11/2015	853,555	3,230,706	1,016,137	9,504,884	0.194	0.364	0.090	0.135	0.830	36.7
6/1/2015	110	416	131	1,225	0.235	0.482	0.120	0.210	1.110	33.2
6/29/2015	470	1,779	560	5,234	0.396	0.687	0.020	0.143	1.230	22.8
7/6/15	7,000	26,495	8,333	77,950	0.796	0.910	0.130	0.567	1.580	29.0
3/10/2016	2,496	9,445	2,971	27,789	0.411	0.522	1.170	0.852	4.490	621.5



Date	Flow	Flow	Flow	Flow	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Solids
	gal	L	gal/acre	L/ha	----- mg/L -----					
5/2/2016	209	791	249	2,327	0.381	0.600	0.100	0.093	1.268	321.0
5/10/2016	183	694	218	2,042	0.370	0.666	0.120	0.062	1.030	96.7
4/27/2017	73,890	279,674	87,964	822,813	0.326	0.544	0.020	0.105	0.710	102.3
5/1/2017	226,240	856,318	269,333	2,519,328	0.224	0.374	0.030	0.166	1.060	40.6
6/6/2017	102,970	389,741	122,583	1,146,637	0.316	0.470	0.030	0.166	1.660	280.8

<sup>1</sup> Flow measurement by the flume on Field 5a was affected by Big Creek breaching its banks during the 5-11-2015 rainfall – runoff event.

**Table S 2. Loss of phosphorus and nitrogen in each runoff event as pounds per acre for Fields 1, 5a, and 12 in 2014, 2015, 2016, 2017, and 2018.**

Date	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Solids
	----- lbs/ac -----					
<b>Field 1</b>						
4/4/2014	0.018	0.063	0.025	0.010	0.205	20.393
5/9/2014	0.006	0.024	0.013	0.016	0.123	9.517
5/13/2014	0.014	0.027	0.007	0.009	0.097	3.075
5/28/2014	0.020	0.026	0.000	0.000	0.000	4.678
6/24/2014	0.002	0.003	0.001	0.001	0.016	0.158
6/27/2014	0.229	0.269	0.020	0.065	0.231	2.411
7/25/2014	0.015	0.019	0.004	0.009	0.038	0.131
10/14/2014	0.002	0.003	0.005	0.003	0.013	0.302
3/25/2015	0.003	0.008	0.009	0.005	0.059	1.440
5/8/2015	0.031	0.042	0.009	0.028	0.130	1.002
5/11/2015	0.064	0.098	0.023	0.014	0.218	11.240
5/18/2015	0.001	0.002	0.002	0.002	0.016	0.244
5/26/2015	0.007	0.012	0.006	0.005	0.047	1.076
6/29/2015	0.010	0.015	0.011	0.007	0.048	0.320
7/7/2015	0.037	0.042	0.022	0.033	0.124	0.466
10/13/2016	0.017	0.022	0.002	0.006	0.042	1.049

Date	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Solids
	----- lbs/ac -----					
3/27/2017	0.039	0.062	0.040	0.008	0.172	11.451
4/24/2017	0.040	0.059	0.013	0.014	0.150	4.312
4/27/2017	0.086	0.123	0.013	0.017	0.207	8.188
5/1/2017	0.126	0.179	0.078	0.076	0.519	8.662
6/6/2017	1.979	2.644	1.351	1.161	6.200	148.383
5/3/2018	0.011	0.019	0.002	0.001	0.070	1.096
8/30/2018	0.023	0.027	0.010	0.027	0.079	0.712
10/11/2018	0.097	0.105	0.020	0.147	0.292	0.616
11/1/2018	0.001	0.001	0.000	0.001	0.002	0.028
<b>Field 5a</b>						
6/27/2014	0.009	0.012	0.001	0.000	0.010	0.713
7/25/2014	0.001	0.001	0.000	0.000	0.001	0.016
10/13/2014	0.007	0.009	0.004	0.001	0.009	0.389
3/26/2015	0.030	0.049	0.015	0.008	0.096	2.690
5/11/2015	1.114	4.347	1.168	0.570	6.736	1437.560
7/7/2015	0.013	0.061	0.018	0.023	0.137	35.407
3/31/2016	0.140	0.164	0.033	0.037	0.203	3.219
5/10/2016	0.000	0.000	0.000	0.000	0.001	0.011
4/24/2017	0.039	0.049	0.005	0.013	0.062	0.475

Date	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Solids
	----- lbs/ac -----					
4/27/2017	0.150	0.185	0.015	0.014	0.188	2.473
5/1/2017	0.244	0.304	0.073	0.093	0.518	4.352
6/6/2017	0.313	0.448	0.016	0.582	0.745	3.130
2/21/2018	1.375	1.910	0.129	0.282	2.748	61.491
2/26/2018	0.300	0.610	0.049	0.035	0.930	71.605
3/29/2018	0.100	0.108	0.002	0.014	0.084	1.308
<b>Field 12</b>						
5/8/2015	0.091	0.129	0.019	0.041	0.246	7.712
5/11/2015	1.644	3.084	0.763	1.144	7.032	310.939
6/1/2015	0.000	0.001	0.000	0.000	0.001	0.036
6/29/2015	0.002	0.003	0.000	0.001	0.006	0.106
7/6/15	0.055	0.063	0.009	0.039	0.110	2.015
3/10/2016	0.010	0.013	0.029	0.021	0.111	15.395
5/2/2016	0.001	0.001	0.000	0.000	0.003	0.666
5/10/2016	0.001	0.001	0.000	0.000	0.002	0.176
4/27/2017	0.239	0.399	0.015	0.077	0.521	75.031
5/1/2017	0.503	0.840	0.067	0.373	2.380	91.174
6/6/2017	0.323	0.480	0.031	0.170	1.697	287.002



**Table S 3. Loss of phosphorus and nitrogen in each runoff event as grams per hectare for Fields 1, 5a, and 12 in 2014, 2015, 2016, 2017, and 2018.**

Date	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Solids
	----- g/ha -----					
<b>Field 1</b>						
4/4/2014	20.0	70.5	27.6	11.7	229.9	22,877.6
5/9/2014	6.7	26.5	14.4	17.7	138.2	10,676.6
5/13/2014	15.6	30.0	8.2	10.3	109.0	3,450.2
5/28/2014	22.0	29.0	0.0	0.0	0.0	5,247.6
6/24/2014	1.7	3.8	1.4	0.9	18.3	177.6
6/27/2014	256.4	302.2	22.0	73.2	259.5	2,705.1
7/25/2014	16.9	20.8	4.2	10.1	43.1	146.4
10/14/2014	2.7	3.8	5.1	3.6	14.9	338.7
3/25/2015	3.5	8.5	10.1	5.3	66.1	1,616.0
5/8/2015	34.9	47.5	10.6	31.6	145.6	1,123.6
5/11/2015	71.3	109.6	25.6	15.6	244.3	12,610.2
5/18/2015	1.1	2.6	2.8	2.1	18.3	274.0
5/26/2015	7.8	13.8	6.4	5.6	53.0	1,207.4
6/29/2015	11.5	17.1	12.1	7.4	53.5	358.6
7/7/2015	41.3	47.3	24.5	36.8	138.6	522.4
10/13/2016	18.8	24.6	2.6	6.7	47.1	1,177.4

Date	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Solids
	----- g/ha -----					
3/27/2017	43.4	69.2	44.4	9.3	193.1	12,846.2
4/24/2017	44.3	66.5	14.6	16.1	168.4	4,837.9
4/27/2017	96.8	138.0	14.1	18.8	232.3	9,185.7
5/1/2017	141.4	201.2	87.4	85.0	582.5	9,717.4
6/6/2017	2,220.5	2,966.6	1,516.0	1,302.0	6,955.8	166,464.5
5/3/2018	12.2	20.9	2.7	1.7	78.2	1,229.5
8/30/2018	26.0	30.2	11.1	30.1	88.7	798.7
10/11/2018	109.0	118.1	22.5	165.3	327.5	691.0
11/1/2018	0.8	1.0	0.3	0.6	2.4	32.0
<b>Field 5a</b>						
6/27/2014	10.2	13.2	1.2	0.0	10.7	799.9
7/25/2014	1.2	1.5	0.2	0.0	1.2	17.6
10/13/2014	8.1	10.6	4.1	0.8	10.4	436.1
3/26/2015	33.9	55.5	16.3	9.4	108.1	3,018.2
5/11/2015	1,249.5	4,877.0	1,309.9	639.9	7,557.3	1,612,737.1
7/7/2015	14.3	68.1	19.8	26.1	153.5	39,721.8
3/31/2016	157.2	184.2	36.8	41.1	227.5	3,610.7
5/10/2016	0.2	0.2	0.3	0.4	1.0	12.0

Date	Dissolved P	Total P	Ammonia-N	Nitrate-N	Total N	Solids
	----- g/ha -----					
4/24/2017	43.8	55.2	5.5	14.6	69.7	532.9
4/27/2017	168.4	207.7	17.2	15.5	211.2	2,774.6
5/1/2017	273.5	341.4	82.0	104.7	581.4	4,881.9
6/6/2017	351.1	502.1	17.6	653.4	835.6	3,511.0
2/21/2018	1,542.6	2,142.8	144.4	316.6	3,083.2	68,984.7
2/26/2018	336.4	684.3	54.9	39.8	1,043.6	80,330.9
3/29/2018	111.9	121.7	2.7	16.0	94.8	1,467.4
<b>Field 12</b>						
5/8/2015	102.5	145.1	21.2	46.0	276.2	8,651.4
5/11/2015	1,843.9	3,459.8	855.4	1,283.2	7,889.1	348,829.2
6/1/2015	0.3	0.6	0.1	0.3	1.4	40.7
6/29/2015	2.1	3.6	0.1	0.7	6.4	119.3
7/6/15	62.0	70.9	10.1	44.2	123.2	2,260.5
3/10/2016	11.4	14.5	32.5	23.7	124.8	17,270.9
5/2/2016	0.9	1.4	0.2	0.2	3.0	747.1
5/10/2016	0.8	1.4	0.2	0.1	2.1	197.5
4/27/2017	268.2	447.6	16.5	86.4	584.2	84,173.7
5/1/2017	564.3	942.2	75.6	418.2	2,670.5	102,284.7
6/6/2017	362.3	538.9	34.4	190.3	1,903.4	321,975.7