



Mavis Consulting, Ltd Articles

Turf & Soil Specialist

January 2018

Incoming Nitrate and Phosphorus levels vs. Outgoing

Water samples were collected from incoming and outgoing surface water (creek, stream, river, drainage ditch, etc.) locations. In 2017 water samples were collected from sixteen golf courses (throughout Ohio, Indiana, Michigan, and Wisconsin) and analyzed for Nitrate Nitrogen and Dissolved Orthophosphate. In 2016 water samples were collected from sixteen golf courses (throughout Ohio, Indiana, Michigan, and Wisconsin) and analyzed for Nitrate Nitrogen and Dissolved Orthophosphate. The Phosphorus test was changed from 2015 due to most samples being below the detection limit. In 2015 water samples were collected from twenty-six golf courses (throughout Ohio, Indiana and Michigan) and analyzed for Nitrate Nitrogen and Total Phosphorus.



Purpose of Study:

To determine if there is an increase or decrease in Nitrate and Phosphorus content in the surface waters that leave golf courses.

Procedure:

Sample Collection

1. Collect water samples from surface water that enters a golf course property and where it leaves a golf course property
2. Samples are collected and then acid preservative and non-acid preservative bottles are filled and submitted to the Brookside Laboratories, Inc. for Nitrate Nitrogen (MDL = <math><0.1\text{ ppm}</math>) and Orthophosphate (MDL = 0.01 ppm) testing.
 - a. EPA method 365.2 for Orthophosphate
 - b. EPA method 353.2 for Nitrates

Results:

2017

1. There were 69 total samples collected (69 N & 69 P)
2. For NO₃ there were 3 Incoming samples BDL (Below detection level) and 4 Outgoing samples BDL
3. For Orthophosphate there were 10 Incoming samples BDL and 12 Outgoing samples BDL (Two samples were tested for Total Phosphorus and not for Orthophosphate due to test request error)

2016

1. There were 87 total samples collected (87 N & 87 P)
2. For NO₃ there were 2 Incoming samples BDL (Below detection level) and 6 Outgoing samples BDL
3. For Orthophosphate there were 12 Incoming samples BDL and 16 Outgoing samples BDL (Two samples were not tested for Orthophosphate-sample error)

2015

1. There were 154 total samples collected (84 incoming & 70 outgoing)
2. For NO₃ there were 5 Incoming samples BDL (Below detection level) and 2 Outgoing samples BDL
3. For total Phosphorus there were 12 Incoming samples not BDL and 6 Outgoing samples not BDL

Chart 1. 2016 Average NO₃ and Orthophosphate results

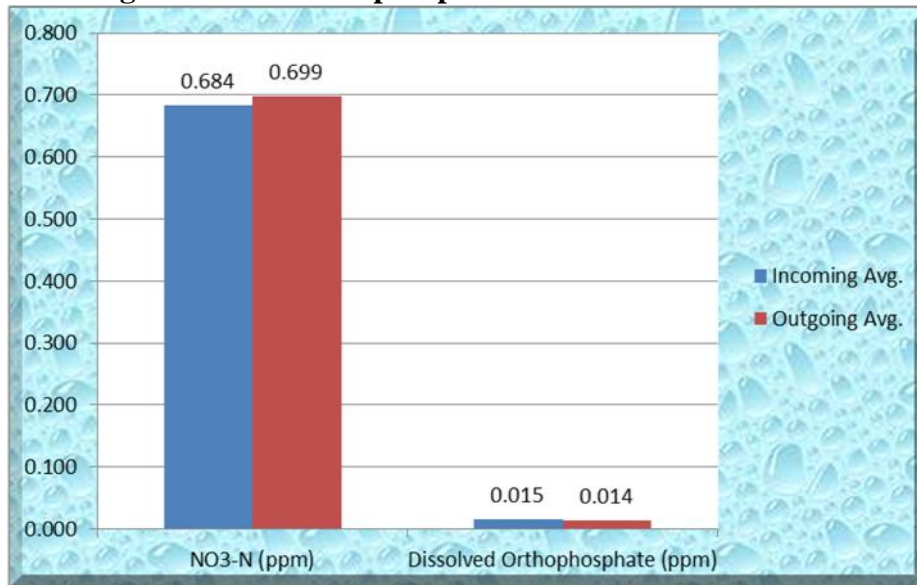


Chart 2. 2016 Average NO₃ and Orthophosphate results

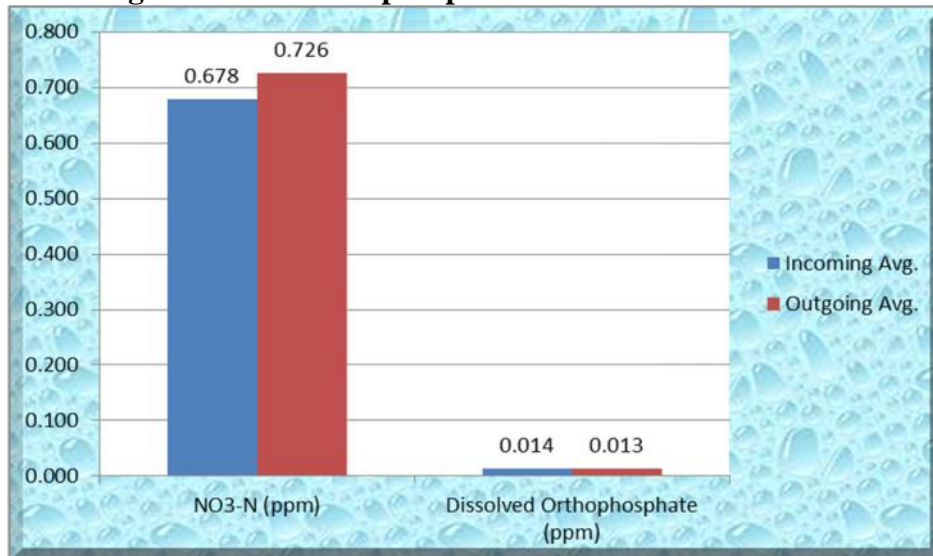
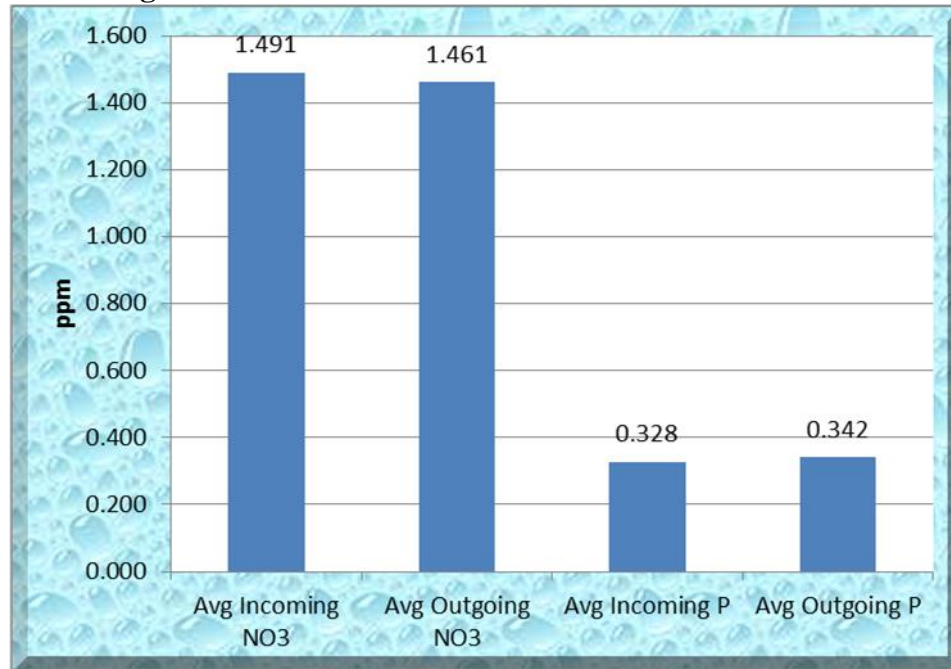


Chart 3. 2015 Average NO3 and Total P results



Discussion:

The vast majority of the samples collected contained the same or lower N and P content in the exiting water than the incoming water sample. As in 2016 the sample locations were limited to surface water sources where there is one incoming and one outgoing point. The samples have also been limited to surface water sources where there is no contribution/ drainage from sources other than the golf course (homes, roadways, industry, etc.).

Three year results indicate that there is still little to no difference in the average Nitrate and average Phosphorus (Total and Orthophosphate) content for incoming and outgoing surface water samples collected from golf courses.

Thank you to the Brookside Consultants of Ohio for helping to fund the majority of the analytical cost, Brookside Labs for their excellent analytical and customer service, and especially to all of the golf courses and their staff for allowing me to collect samples and conduct this study.

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Date Reported	Site	Sample ID	NO3-N (ppm)	Dissolved Orthophosphate (ppm)	
4/10/2017	1	A	0.94	0.01	BDL= Below Detection Level MDL NO3 = .1 MDL P = .01
4/10/2017	1	B	0.53	0.01	
8/17/2017	1	A	0.36	0.031	
8/17/2017	1	B	<.1	0.012	
3/31/2017	3	A	0.94	0.01	"A" Incoming Sample "B" Outgoing Sample
3/31/2017	3	B	0.96	0.01	
8/25/2017	3	A	1.03	0.015	
8/25/2017	3	B	1.05	0.018	
5/22/2017	4	A	5.68	0.11	
5/22/2017	4	B	5.56	0.12	
7/14/2017	4	A	3.95	0.1	
7/14/2017	4	B	4.14	0.09	
8/29/2017	4	A	<.1	0.025	
8/29/2017	4	B	<.1	0.033	
5/22/2017	5	A	4.04	0.02	
5/22/2017	5	B	4.16	0.01	
7/14/2017	5	A	0.83	0.06	
7/14/2017	5	B	0.81	0.05	
8/21/2017	5	A	0.22	0.014	
8/21/2017	5	B	0.27	<.01	
5/22/2017	6	A	<.1	<.01	
5/22/2017	6	B	0.15	<.01	
6/19/2017	7	A	0.24	0.03	
6/19/2017	7	B	0.23	0.02	
10/13/2017	7	A	0.4	0.017	
10/13/2017	7	B	0.39	0.022	
3/27/2017	8	A	2.64	<.01	
3/27/2017	8	B	3.12	<.01	
8/9/2017	8	A	2.85	<.01	
8/9/2017	8	B	2.99	<.01	
5/22/2017	9	A	0.87	0.02	
5/22/2017	9	B	0.84	0.03	
7/14/2017	9	A	2.47	0.07	
7/14/2017	9	B	2.52	0.06	
8/11/2017	9	A	<.1	0.102	
8/11/2017	9	B	<.1	0.084	
4/18/2017	10	A	6.46	0.014	
4/18/2017	10	B	6.4	0.02	
6/28/2017	10	A	1.27	0.03	
6/28/2017	10	B	1.25	0.03	
10/20/2017	10	A	0.35	0.023	
10/20/2017	10	B	0.32	0.031	
5/30/2017	11	A	1.06	<.01	
5/30/2017	11	B	1.07	<.01	
6/26/2017	11	A	1.22	0.01	
6/26/2017	11	B	1.22	0.01	
3/13/2017	12	A	0.34	<.01	
3/13/2017	12	B	0.35	<.01	
7/19/2017	12	A	0.127	0.07	*Total P
7/19/2017	12	B	0.127	0.03	*Total P
6/13/2017	14	A	0.95	0.02	
6/13/2017	14	B	0.89	0.02	
4/18/2017	17	A-1	1.9	0.017	
4/18/2017	17	B-1	1.79	<.01	
4/18/2017	17	A-2	1.09	0.012	
4/18/2017	17	B-2	1.34	0.017	
4/10/2017	22	A	0.53	0.02	
4/10/2017	22	B	0.47	0.06	
7/27/2017	22	A	0.34	<.01	
7/27/2017	22	B	0.27	<.01	
9/18/2017	22	A	0.25	<.01	
9/18/2017	22	B	0.19	<.01	
4/18/2017	26	A	0.25	<.01	
4/18/2017	26	B	0.24	<.01	
7/25/2017	26	A	0.46	<.01	
7/25/2017	26	B	0.42	<.01	
10/27/2017	26	A	0.3	<.01	
10/27/2017	26	B	0.27	<.01	
10/6/2017	28	A	0.76	0.051	
10/6/2017	28	B	<.1	0.016	

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Date Reported	Site	Sample ID #2	NO3-N (ppm)	Dissolved Orthophosphate (ppm)	
10/14/2016	1	A	0.37	0.016	BDL= Below Detection Level MDL NO3 = .1 MDL P = .01
10/14/2016	1	B	0.16	BDL	
7/7/2016	1	A	0.52	0.03	
7/7/2016	1	B	BDL	0.026	
10/7/2016	3	A	1.21	0.02	"A" Incoming Sample
10/7/2016	3	B	1.2	0.022	"B" Outgoing Sample
7/12/2016	3	A	0.97	0.021	
7/12/2016	3	B	0.98	0.021	
5/6/2016	3	A	0.73	BDL	
5/6/2016	3	B	0.73	BDL	
10/21/2016	4	A	2.28	0.047	
10/21/2016	4	B	2.26	0.081	
8/3/2016	4	A	1.46	0.012	
8/3/2016	4	B	1.44	BDL	
4/6/2016	4	A	5.76	0.118	
4/6/2016	4	B	5.73	0.122	
10/21/2016	5	A	0.54	0.022	
10/21/2016	5	B	0.48	0.02	
4/20/2016	5	A	6.4	BDL	
4/20/2016	5	B	6.76	BDL	
4/25/2016	6	A	BDL	BDL	
4/25/2016	6	B	BDL	BDL	
9/15/2016	7	A	0.25	0.012	
9/15/2016	7	B	0.19	0.012	
6/21/2016	7	A	0.32	0.022	
6/21/2016	7	B	0.25	0.01	
5/11/2016	7	A	0.31	BDL	
5/11/2016	7	B	0.31	BDL	
6/27/2016	8	A	2.35	0.014	
6/27/2016	8	B	2.62	0.014	
3/31/2016	8	A	0.65	0.021	
3/31/2016	8	B	0.63	0.025	
10/21/2016	9	A	BDL	0.077	
10/21/2016	9	B	BDL	0.068	
8/3/2016	9	A	0.29	0.097	
8/3/2016	9	B	0.35	0.085	
4/6/2016	9	A	1.88	0.027	
4/6/2016	9	B	1.84	0.029	
10/21/2016	10	A	0.47	0.019	
10/21/2016	10	B	0.44	0.02	
6/14/2016	10	A	1.89	0.025	
6/14/2016	10	B	3.09	0.021	
4/18/2016	10	A	8.28	0.025	
4/18/2016	10	B	8.4	0.027	
3/18/2016	10	A	9.37		
3/18/2016	10	B	9.3		
4/26/2016	11	A	1.07	BDL	
4/26/2016	11	B	1.08	BDL	
4/27/2015	8	B	2.65	BDL	

Date Reported	Site	Sample ID #2	NO3-N (ppm)	Dissolved Orthophosphate (ppm)	
7/13/2016	12	A	0.26	0.018	BDL= Below Detection Level MDL NO3 = .1 MDL P = .01
7/13/2016	12	B	0.29	0.014	
3/24/2016	12	A	0.34	BDL	
3/24/2016	12	B	0.33	BDL	
9/1/2016	14	A	0.37	0.016	"A" Incoming Sample
9/1/2016	14	B	0.3	BDL	"B" Outgoing Sample
6/21/2016	14	A	1.49	0.029	
6/21/2016	14	B	2.85	BDL	
3/24/2016	14	A	1.08	BDL	
3/24/2016	14	B	1.12	BDL	
10/21/2016	17	A-1	0.1	0.098	
10/21/2016	17	A-2	0.15	0.065	
10/21/2016	17	B-1	0.35	0.047	
10/21/2016	17	B-2	BDL	0.09	
8/3/2016	17	A-1	0.4	0.07	
8/3/2016	17	A-2	0.27	0.045	
8/3/2016	17	B-1	0.26	0.043	
8/3/2016	17	B-2	BDL	0.04	
5/6/2016	17	A-1	1.65	0.019	
5/6/2016	17	A-2	1.12	0.01	
5/6/2016	17	B-1	1.52	0.016	
5/6/2016	17	B-2	1.23	0.012	
10/21/2016	19	A	0.49	0.038	
10/21/2016	19	B	0.29	BDL	
4/18/2016	19	A	0.99	BDL	
4/18/2016	19	B	1.01	BDL	
9/15/2016	22	A	0.28	BDL	
9/15/2016	22	B	0.25	0.013	
8/18/2016	22	A	0.34	0.013	
8/18/2016	22	B	0.37	0.012	
6/10/2016	22	A	0.26	BDL	
6/10/2016	22	B	0.15	BDL	
10/7/2016	26	A	0.51	BDL	
10/7/2016	26	B	0.51	BDL	
7/22/2016	26	A	0.33	0.014	
7/22/2016	26	B	0.29	0.015	
4/20/2016	26	A	0.2	BDL	
4/20/2016	26	B	0.18	BDL	
10/17/2016	28	A	0.32	0.023	
10/17/2016	28	B	BDL	0.051	

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Date Reported	Site	Sample Description #2	NO3-N (ppm)	Total P (ppm)	
11/3/2015	1	A-1	BDL	BDL	BDL= Below Detection Level MDL NO3 = <.1 MDL P = >.2
11/3/2015	1	A-2	0.12	BDL	
11/3/2015	1	B	0.11	BDL	
7/20/2015	1	A-1	0.61	BDL	"A" Incoming Sample "B" Outgoing Sample
7/20/2015	1	A-2	0.13	BDL	
7/20/2015	1	B	0.12	BDL	
3/24/2015	1	A-1	0.48	BDL	
3/24/2015	1	A-2	0.55	BDL	
3/24/2015	1	B	0.47	BDL	
11/3/2015	2	A	0.31	BDL	
11/3/2015	2	B	0.23	BDL	
3/20/2015	2	A	2.27	0.31	
3/20/2015	2	B	2.3	BDL	
10/26/2015	3	A	1.13	0.62	
10/26/2015	3	B	1.92	BDL	
9/9/2015	3	A	1.21	BDL	
9/9/2015	3	B	1.22	BDL	
5/11/2015	3	A	0.93	BDL	
5/11/2015	3	B	0.96	BDL	
7/27/2015	4	A	1.77	BDL	
7/27/2015	4	B	1.71	BDL	
4/13/2015	4	A	4.27	BDL	
4/13/2015	4	B	4.41	BDL	
10/19/2015	5	A	0.51	BDL	
10/19/2015	5	B	0.43	BDL	
7/27/2015	5	A-1	4.78	BDL	
7/27/2015	5	A-2	1.03	0.39	
7/27/2015	5	B	4.72	BDL	
4/27/2015	5	A-1	10.98	BDL	
4/27/2015	5	A-2	4.22	0.29	
4/27/2015	5	B	11.06	BDL	
4/13/2015	5	A	6.65	BDL	
4/13/2015	5	B	6.17	BDL	
10/19/2015	6	A	0.33	BDL	
10/19/2015	6	B	0.41	BDL	
8/3/2015	6	A	0.11	BDL	
8/3/2015	6	B	0.15	BDL	
5/26/2015	6	A	BDL	BDL	
5/26/2015	6	B	BDL	BDL	
10/19/2015	7	A	0.29	BDL	
10/19/2015	7	B	0.26	BDL	
8/13/2015	7	A	0.36	BDL	
8/13/2015	7	B	0.34	BDL	
4/13/2015	7	A	0.45	BDL	
4/13/2015	7	B	0.45	BDL	
7/27/2015	8	A	2.73	BDL	
7/27/2015	8	B	2.61	BDL	
4/27/2015	8	A	2.66	BDL	
4/27/2015	8	B	2.65	BDL	
10/12/2015	9	A	0.24	BDL	
10/12/2015	9	B	0.26	BDL	
7/27/2015	9	A	0.68	BDL	
7/27/2015	9	B	0.69	BDL	
4/13/2015	9	A	1.87	BDL	
4/13/2015	9	B	1.53	BDL	
10/12/2015	10	A	0.4	BDL	
10/12/2015	10	B	0.38	BDL	
7/27/2015	10	A	4.31	0.24	
7/27/2015	10	B	4.24	BDL	
4/13/2015	10	A	6.14	BDL	
4/13/2015	10	B	6.26	BDL	
10/9/2015	11	A	1.32	BDL	
10/9/2015	11	B	1.31	BDL	
7/31/2015	11	A	0.95	BDL	
7/31/2015	11	B	0.94	BDL	
3/20/2015	11	A	1.82	BDL	
3/20/2015	11	B	1.78	BDL	
10/2/2015	12	A	0.29	BDL	
10/2/2015	12	B	0.31	BDL	
7/16/2015	12	A	BDL	0.011	
7/16/2015	12	B	BDL	0.013	
3/31/2015	12	A	0.49	BDL	
3/31/2015	12	A-2	0.24	BDL	
3/31/2015	12	B	0.5	BDL	

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9/29/2015	13	A	0.57	BDL	BDL= Below Detection Level MDL NO3 = <.1 MDL P = >.2
9/29/2015	13	A	0.26	BDL	
9/29/2015	13	A	0.45	BDL	
9/29/2015	13	B	0.46	BDL	"A" Incoming Sample "B" Outgoing Sample
7/20/2015	13	A	0.94	BDL	
7/20/2015	13	A	0.24	BDL	
7/20/2015	13	A	3.94	0.22	
7/20/2015	13	A	0.81	0.24	
7/20/2015	13	B	3.89	0.26	
4/21/2015	13	A	2.69	BDL	
4/21/2015	13	A	1.39	BDL	
4/21/2015	13	A	0.41	BDL	
4/21/2015	13	A	0.82	BDL	
4/21/2015	13	B	2.39	BDL	
9/21/2015	14	A	0.78	BDL	
9/21/2015	14	B	1.66	BDL	
7/20/2015	14	A	0.59	BDL	
7/20/2015	14	B	0.33	BDL	
4/27/2015	14	A	0.64	BDL	
4/27/2015	14	B	0.66	BDL	
9/9/2015	15	A-1	0.24	BDL	
9/9/2015	15	A-2	3.11	BDL	
9/9/2015	15	B-1	0.27	BDL	
9/9/2015	15	B-2	2.1	BDL	
4/21/2015	15	A-1	0.31	BDL	
4/21/2015	15	A-2	3.43	BDL	
4/21/2015	15	B-1	0.5	BDL	
4/21/2015	15	B-2	1.14	BDL	
8/24/2015	16	A-1	1.02	BDL	
8/24/2015	16	A-2	0.53	BDL	
8/24/2015	16	B-1	0.79	BDL	
8/24/2015	16	B-2	0.25	BDL	
5/18/2015	16	A-1	0.37	BDL	
5/18/2015	16	A-2	0.1	0.42	
5/18/2015	16	B-1	0.62	BDL	
5/18/2015	16	B-2	0.1	0.29	
7/27/2015	17	A-1	1.13	BDL	
7/27/2015	17	A-2	1.13	BDL	
7/27/2015	17	B-1	1.11	BDL	
7/27/2015	17	B-2	1.11	BDL	
4/13/2015	17	A-1	1.14	BDL	
4/13/2015	17	A-2	0.95	BDL	
4/13/2015	17	B-1	1.11	BDL	
4/13/2015	17	B-2	0.96	BDL	
7/27/2015	18	A	6.67	BDL	
7/27/2015	18	B	6.59	BDL	
4/13/2015	18	A	5.1	BDL	
4/13/2015	18	B	4.96	BDL	
7/27/2015	19	A	1.22	BDL	
7/27/2015	19	B	0.8	BDL	
4/13/2015	19	A	0.69	BDL	
4/13/2015	19	B	0.65	BDL	
7/27/2015	20	A	0.29	BDL	
7/27/2015	20	B	0.39	BDL	
6/1/2015	20	A	0.28	BDL	
6/1/2015	20	B	0.49	BDL	
5/18/2015	21	A	0.94	BDL	
5/18/2015	21	B	0.93	BDL	
8/21/2015	22	A	0.23	BDL	
8/21/2015	22	B	0.2	BDL	
5/4/2015	22	A	0.34	BDL	
5/4/2015	22	B	0.31	BDL	
5/4/2015	23	A	0.36	BDL	
5/4/2015	23	B-1	0.21	BDL	
5/4/2015	23	B-2	0.14	BDL	
7/14/2015	24	A-1	BDL	BDL	
7/14/2015	24	A-2	BDL	0.48	
7/14/2015	24	B-1	0.2	0.24	
7/14/2015	24	B-2	0.16	0.43	
4/13/2015	24	A-1	1.24	0.42	
4/13/2015	24	A-2	0.17	BDL	
4/13/2015	24	B-1	0.21	0.82	
4/13/2015	24	B-2	0.27	BDL	
10/9/2015	26	A	0.42	BDL	
10/9/2015	26	B	0.43	BDL	
4/27/2015	26	A	0.28	BDL	
4/27/2015	26	B	0.27	BDL	
4/21/2015	27	A	1.84	0.3	
4/21/2015	27	A	2.09	BDL	
4/21/2015	27	B	1.82	BDL	