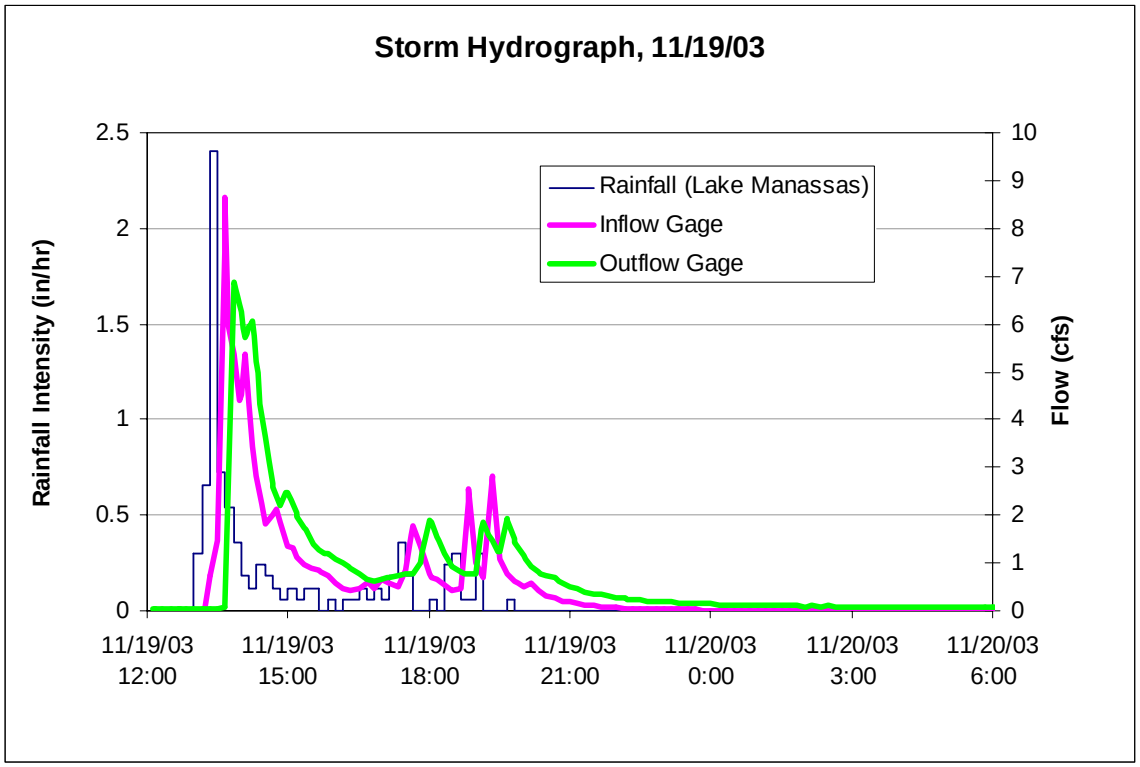
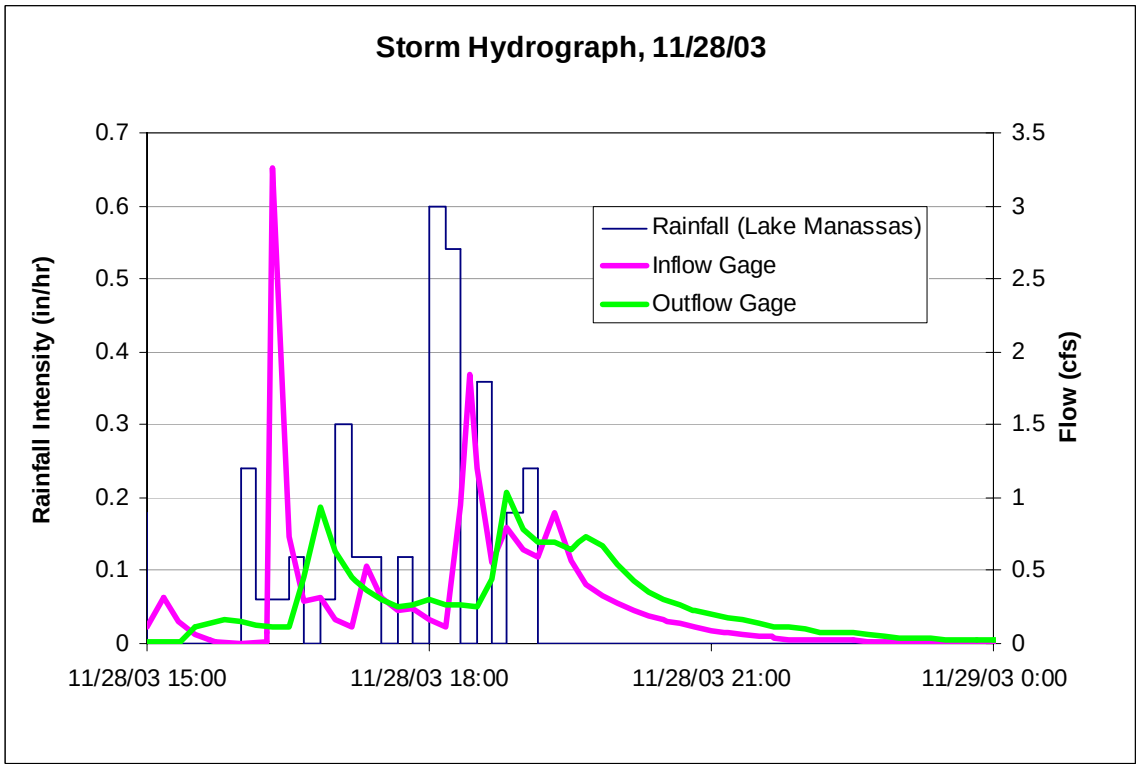
Appendix A

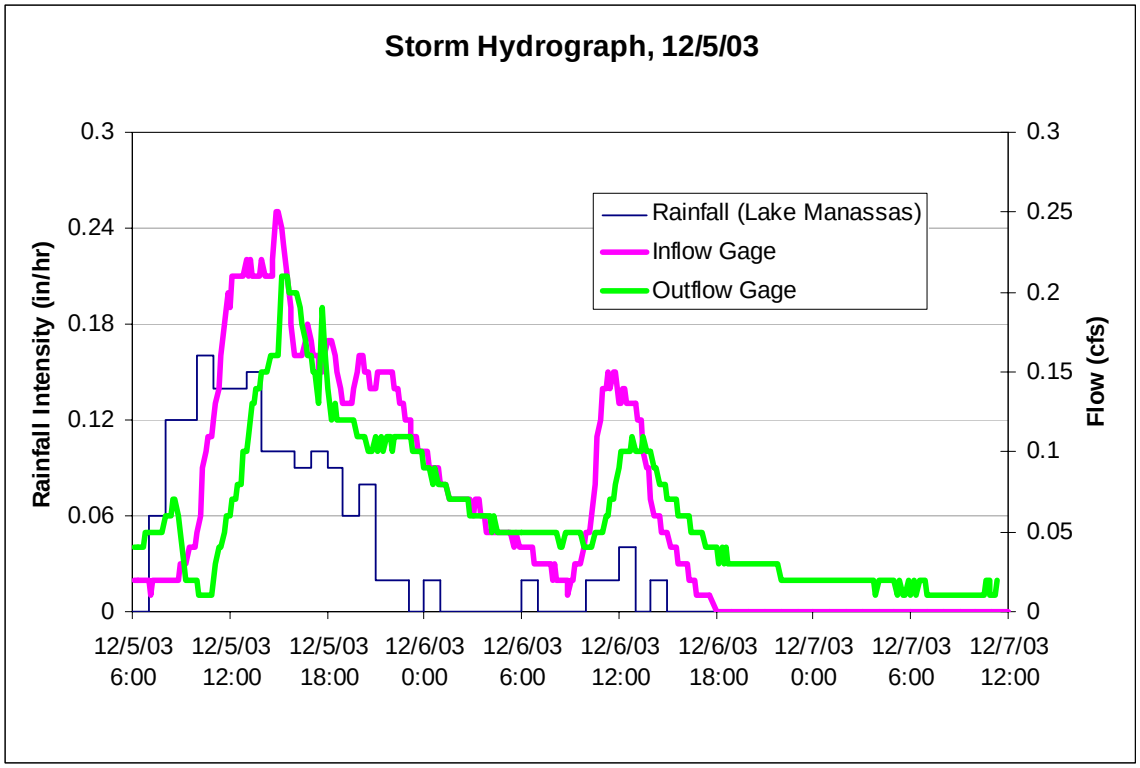
Hydrographs

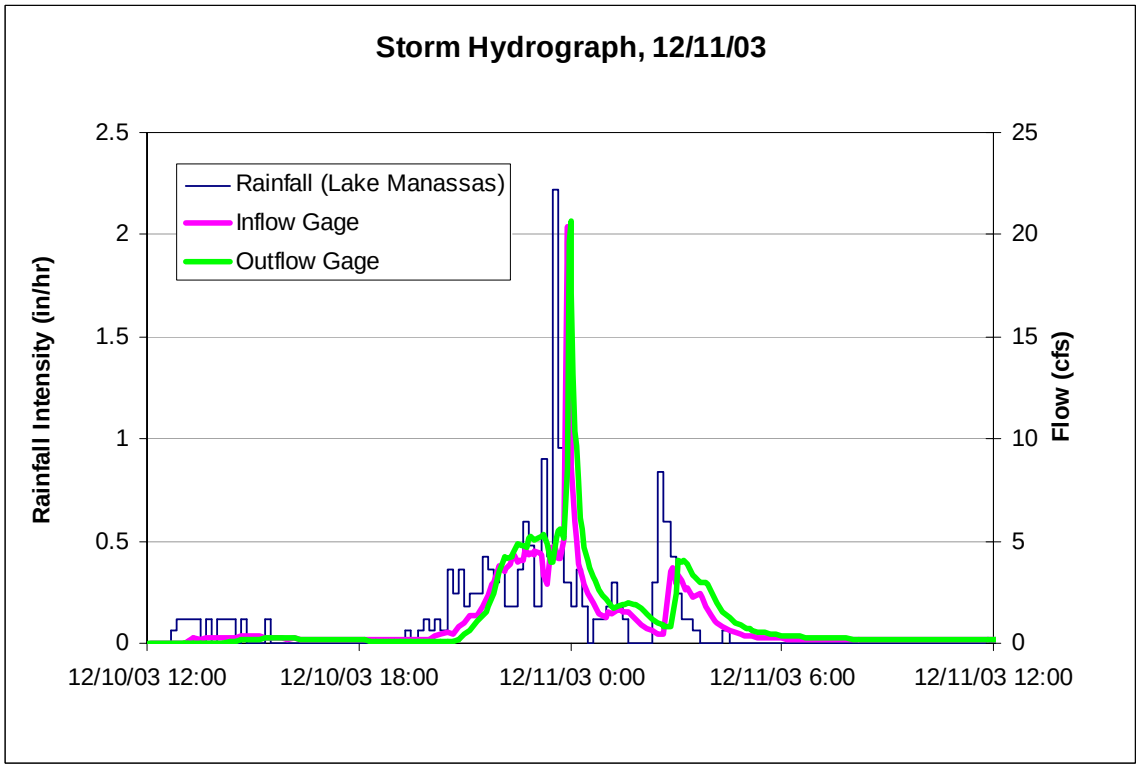
The section contains hydrographs for all of the storms that were sampled for water quality. In most cases the graphs show at least the entire time period during which samples were collected. However, occasionally the tail was removed from a graph to allow for better visualization of rest of the hydrograph. This was only done when the flows in that tail were very low and unchanging.

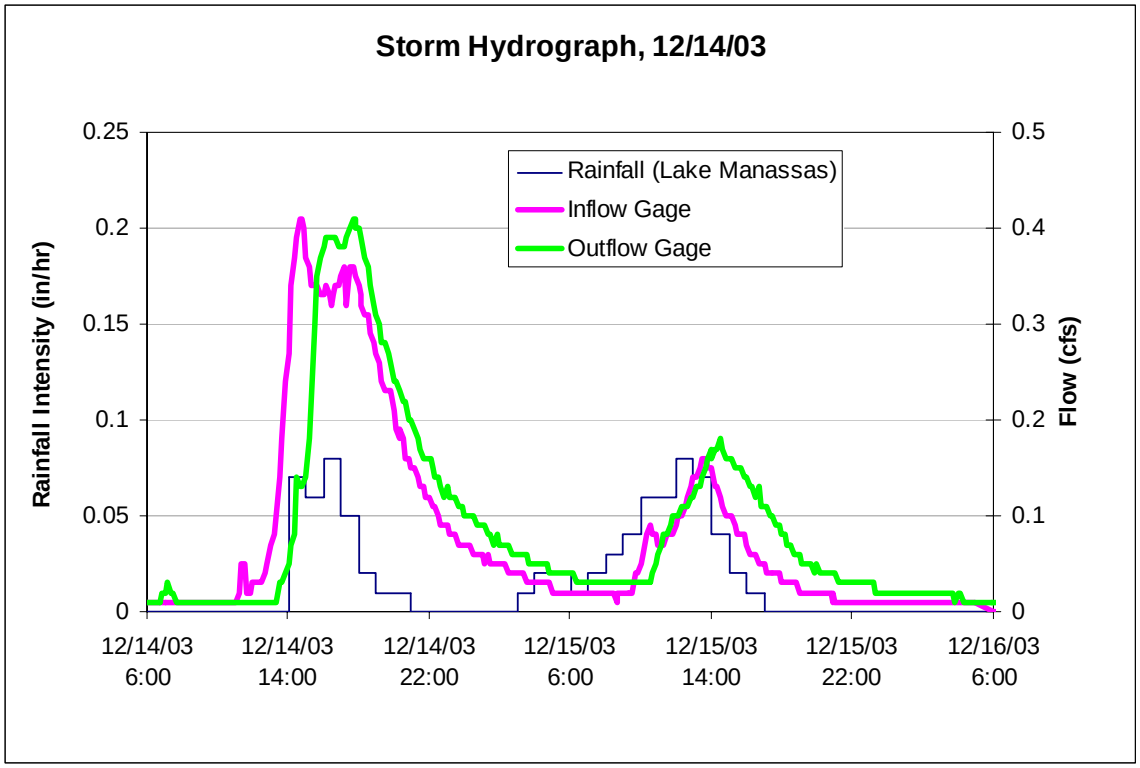
These hydrographs show the incoming flowrate, the outgoing flowrate, and the rainfall intensity from either Lake Manassas or from Kingsbrooke. The incoming flowrate shows exactly the data measured by the gage and does not account for any ungaged inflow. Even though the Lake Manassas rainfall is shown for most of these hydrographs, it often did not correspond well with the flow data. In those cases it should be understood that rainfall intensity data from the Kingsbrooke gage would have been more accurate but was not available.

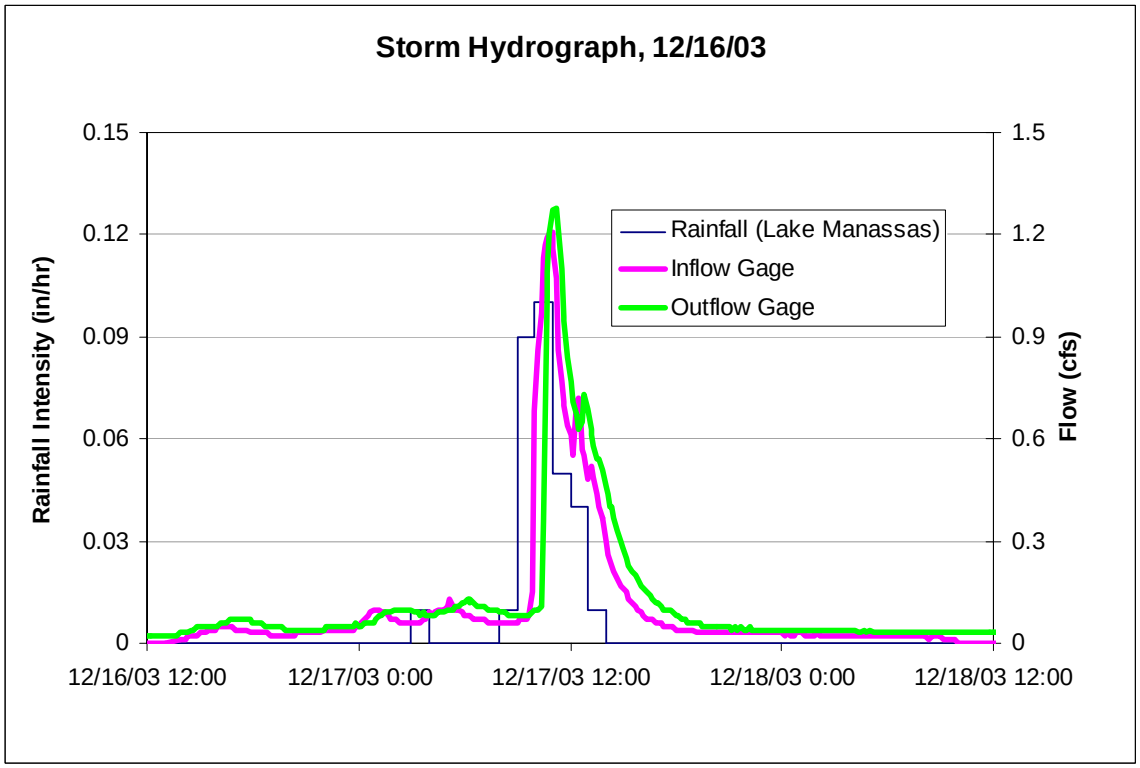

Storm Hydrograph, 11/19/03
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Lake Manassas)
Inflow Gage
Outflow Gage
2.5
2
1.5
1
0.5
0
10
9
8
7
6
5
4
3
2
1
0
11/19/03 12:00
11/19/03 15:00
11/19/03 18:00
11/19/03 21:00
11/20/03 0:00
11/20/03 3:00
11/20/03 6:00

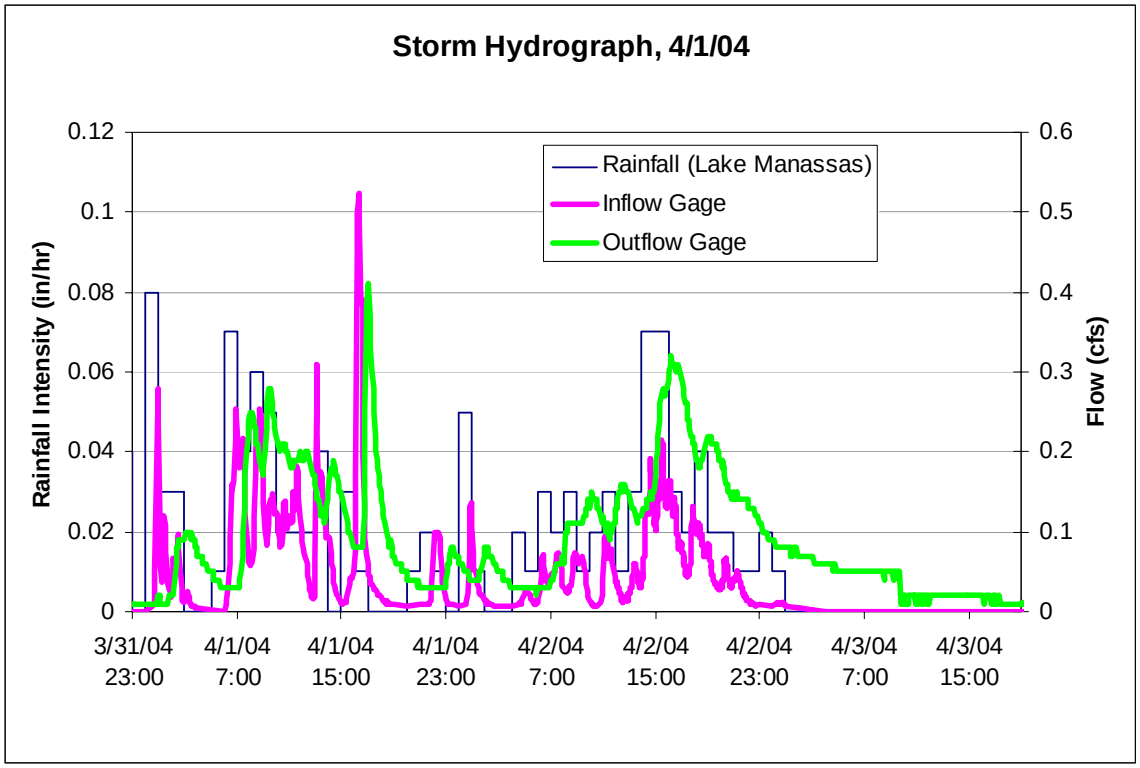

Storm Hydrograph, 11/28/03
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Lake Manassas)
Inflow Gage
Outflow Gage
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
3.5
3
2.5
2
1.5
1
0.5
0
11/28/03 15:00
11/28/03 18:00
11/28/03 21:00
11/29/03 0:00

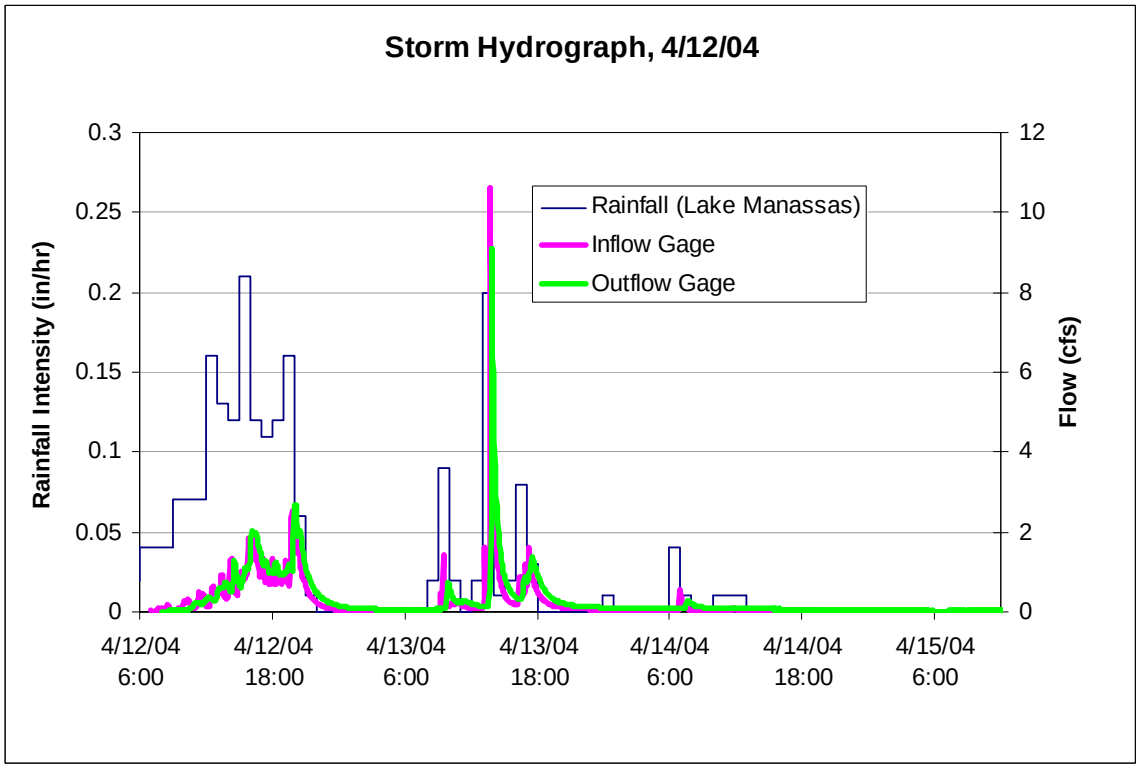

Storm Hydrograph, 12/5/03
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Lake Manassas)
Inflow Gage
Outflow Gage
0.3
0.24
0.18
0.12
0.06
0
0.25
0.2
0.15
0.1
0.05
12/5/03 6:00
12/5/03 12:00
12/5/03 18:00
12/6/03 0:00
12/6/03 6:00
12/6/03 12:00
12/6/03 18:00
12/7/03 0:00
12/7/03 6:00
12/7/03 12:00

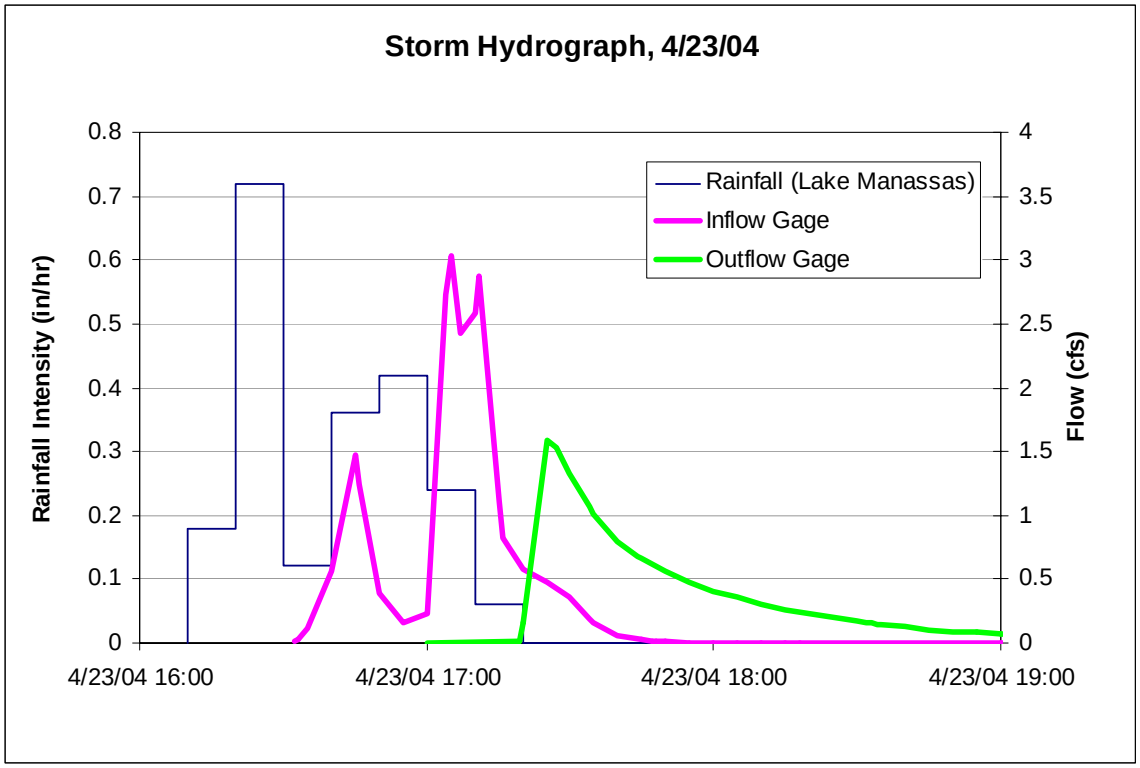

Storm Hydrograph, 12/11/03
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Lake Manassas)
Inflow Gage
Outflow Gage
2.5
2
1.5
1
0.5
0
25
20
15
10
5
12/10/03 12:00
12/10/03 18:00
12/11/03 0:00
12/11/03 6:00
12/11/03 12:00

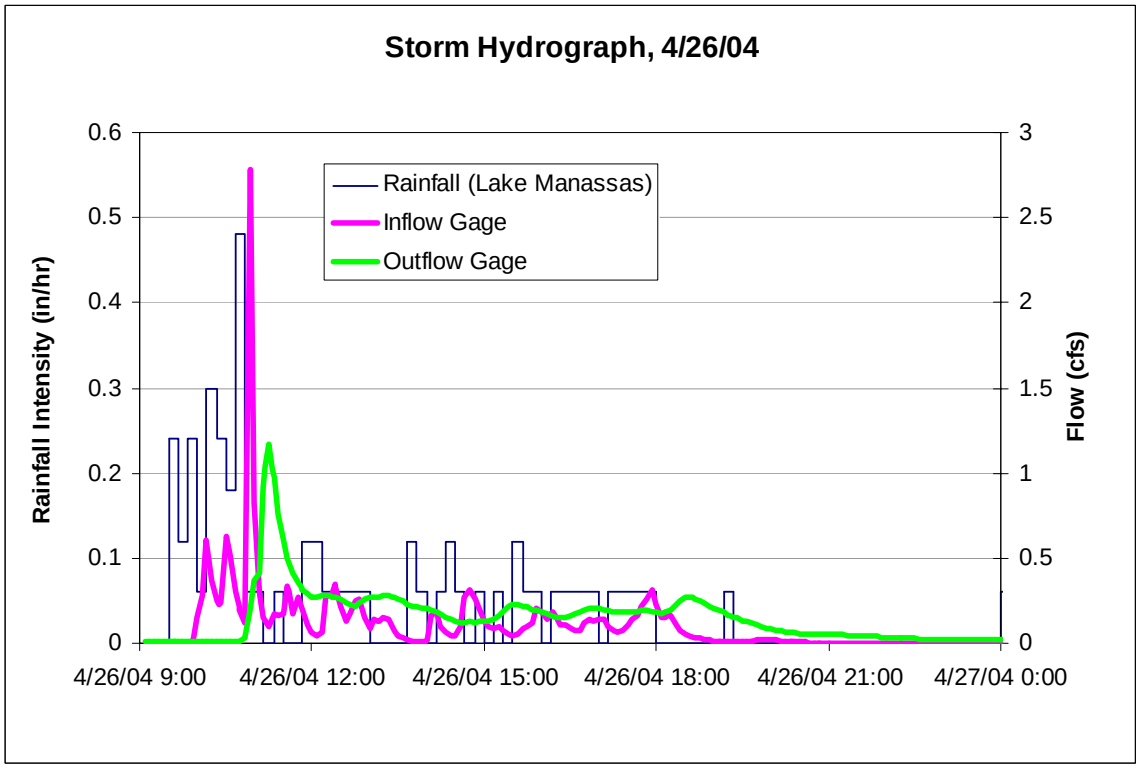

Storm Hydrograph, 12/14/03
Rainfall Intensity (in/hr)
Flow (cfs)
0.25
0.2
0.15
0.1
0.05
0
0.5
0.4
0.3
0.2
0.1
0
Rainfall (Lake Manassas)
Inflow Gage
Outflow Gage
12/14/03 6:00
12/14/03 14:00
12/14/03 22:00
12/15/03 6:00
12/15/03 14:00
12/15/03 22:00
12/16/03 6:00

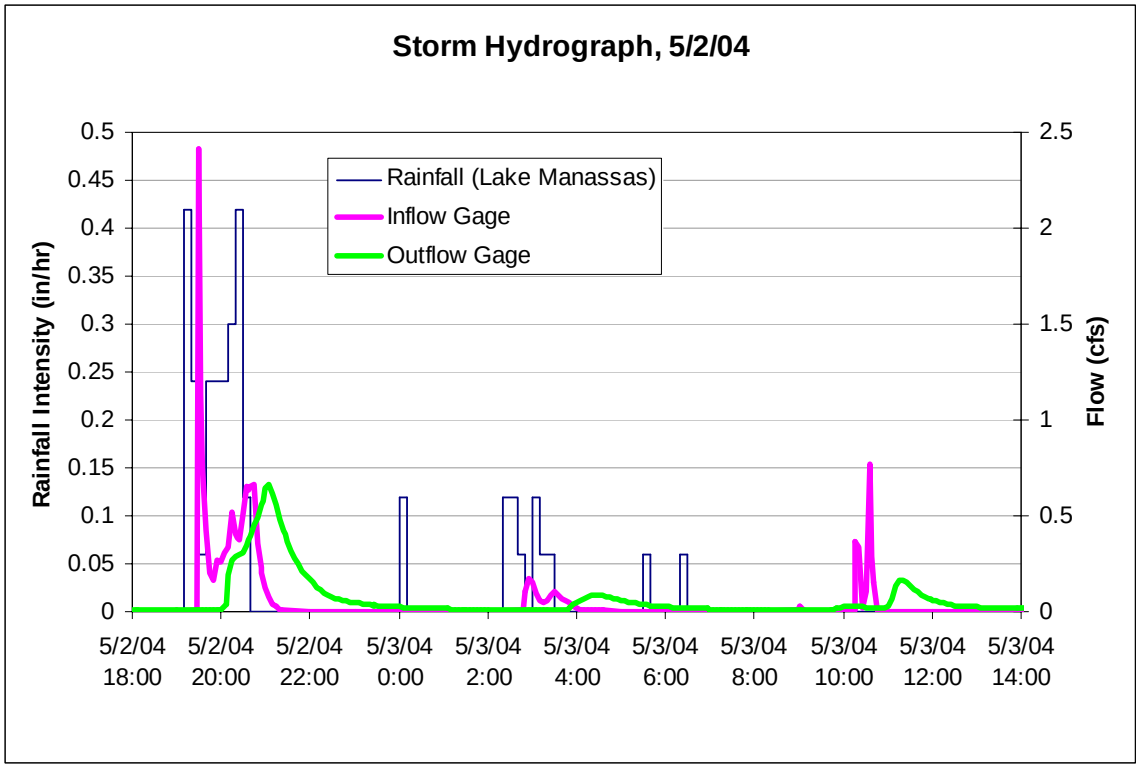

Storm Hydrograph, 12/16/03
Rainfall Intensity (in/hr)
Flow (cfs)
0.15
0.12
0.09
0.06
0.03
0
1.5
1.2
0.9
0.6
0.3
0
Rainfall (Lake Manassas)
Inflow Gage
Outflow Gage
12/16/03 12:00
12/17/03 0:00
12/17/03 12:00
12/18/03 0:00
12/18/03 12:00

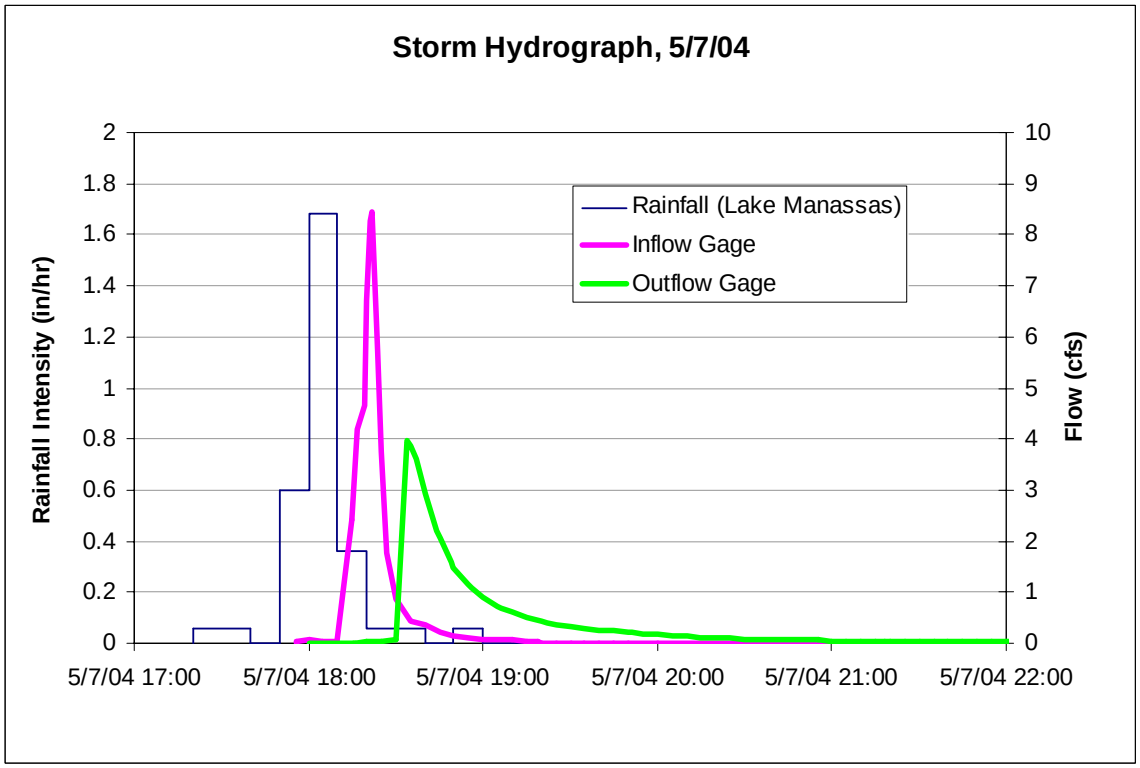

Storm Hydrograph, 4/1/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Lake Manassas)
Inflow Gage
Outflow Gage
0.12
0.1
0.08
0.06
0.04
0.02
0
0.6
0.5
0.4
0.3
0.2
0.1
0
3/31/04 23:00
4/1/04 7:00
4/1/04 15:00
4/1/04 23:00
4/2/04 7:00
4/2/04 15:00
4/2/04 23:00
4/3/04 7:00
4/3/04 15:00

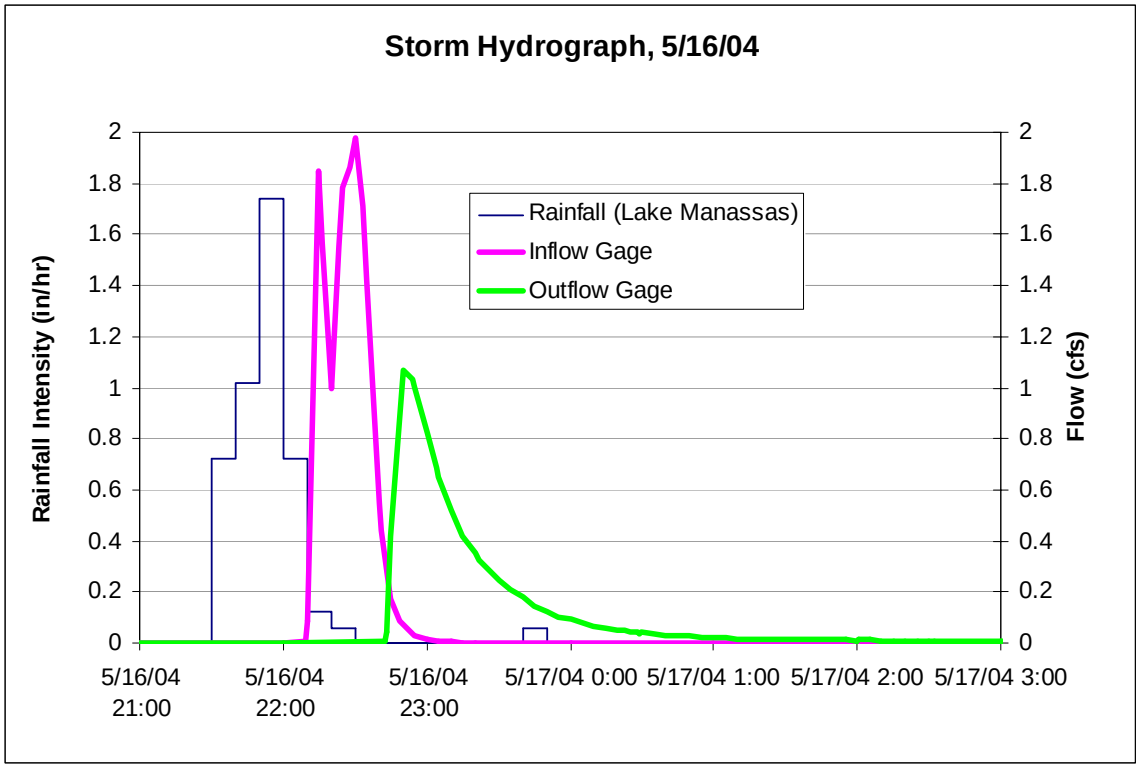

Storm Hydrograph, 4/12/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Lake Manassas)
Inflow Gage
Outflow Gage
0.3
0.25
0.2
0.15
0.1
0.05
0
12
10
8
6
4
2
0
4/12/04 6:00
4/12/04 18:00
4/13/04 6:00
4/13/04 18:00
4/14/04 6:00
4/14/04 18:00
4/15/04 6:00

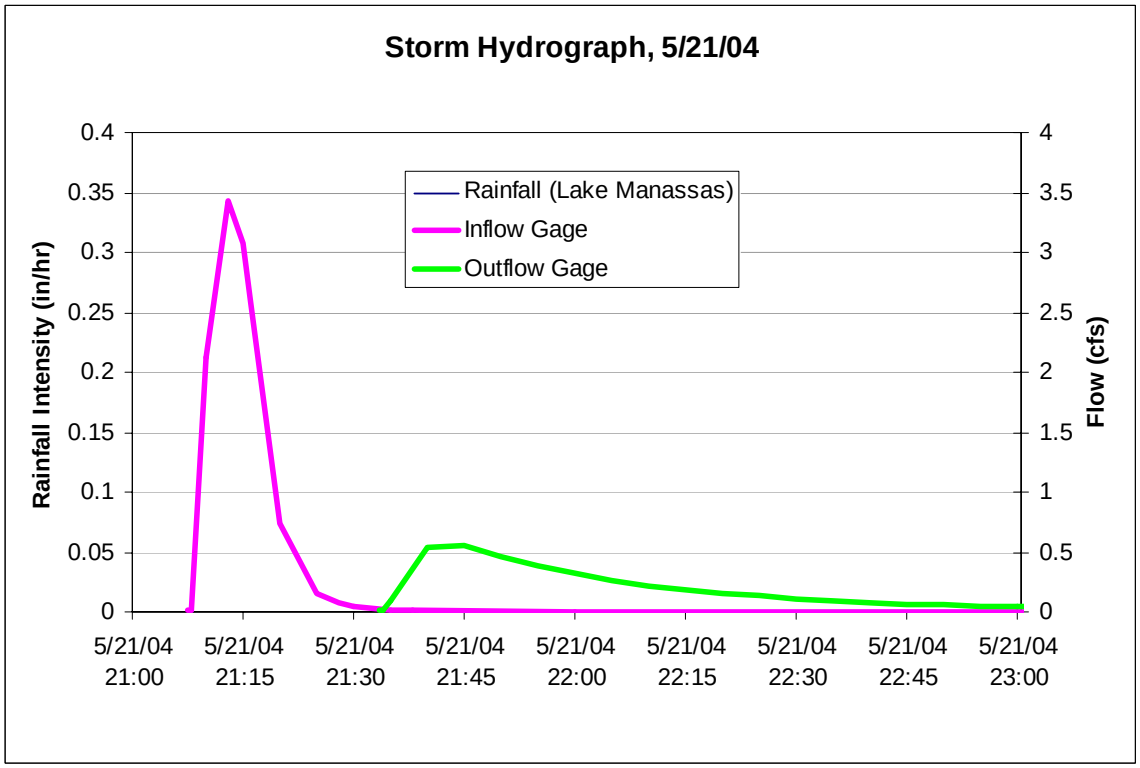

Storm Hydrograph, 4/23/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Lake Manassas)
Inflow Gage
Outflow Gage
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
0.5
1
1.5
2
2.5
3
3.5
4
4/23/04 16:00
4/23/04 17:00
4/23/04 18:00
4/23/04 19:00

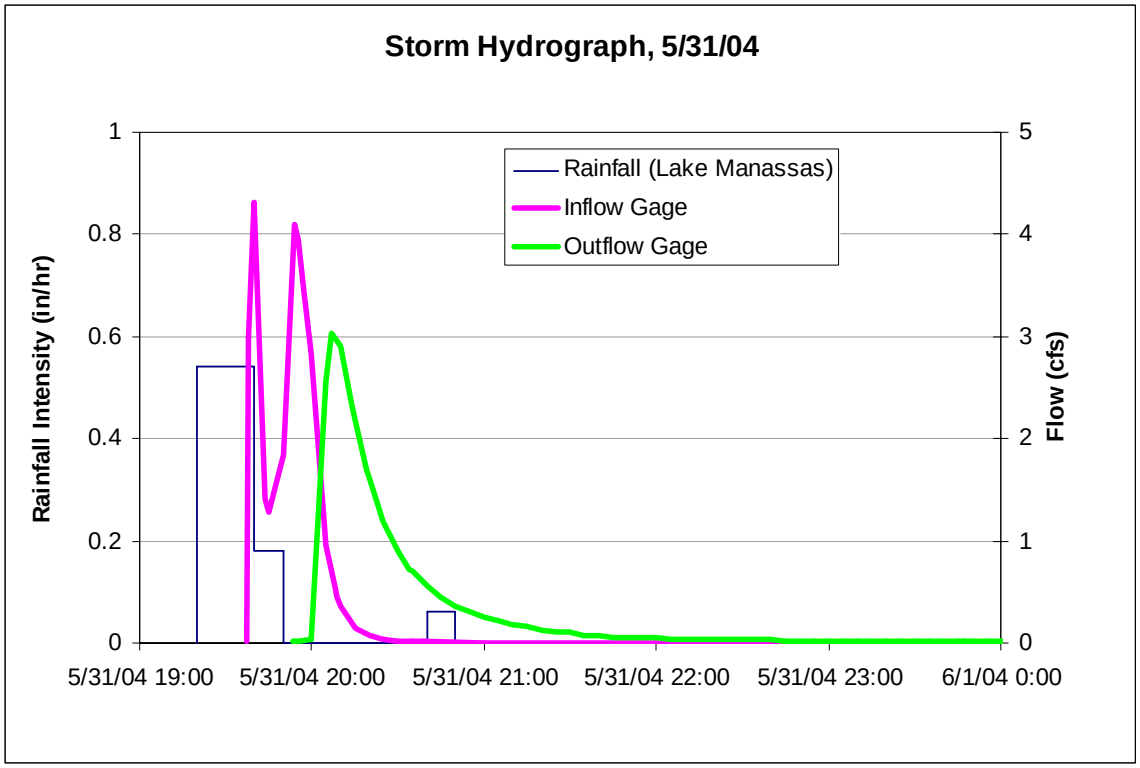

Storm Hydrograph, 4/26/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Lake Manassas)
Inflow Gage
Outflow Gage
0
0.1
0.2
0.3
0.4
0.5
0.6
0
0.5
1
1.5
2
2.5
3
4/26/04 9:00
4/26/04 12:00
4/26/04 15:00
4/26/04 18:00
4/26/04 21:00
4/27/04 0:00

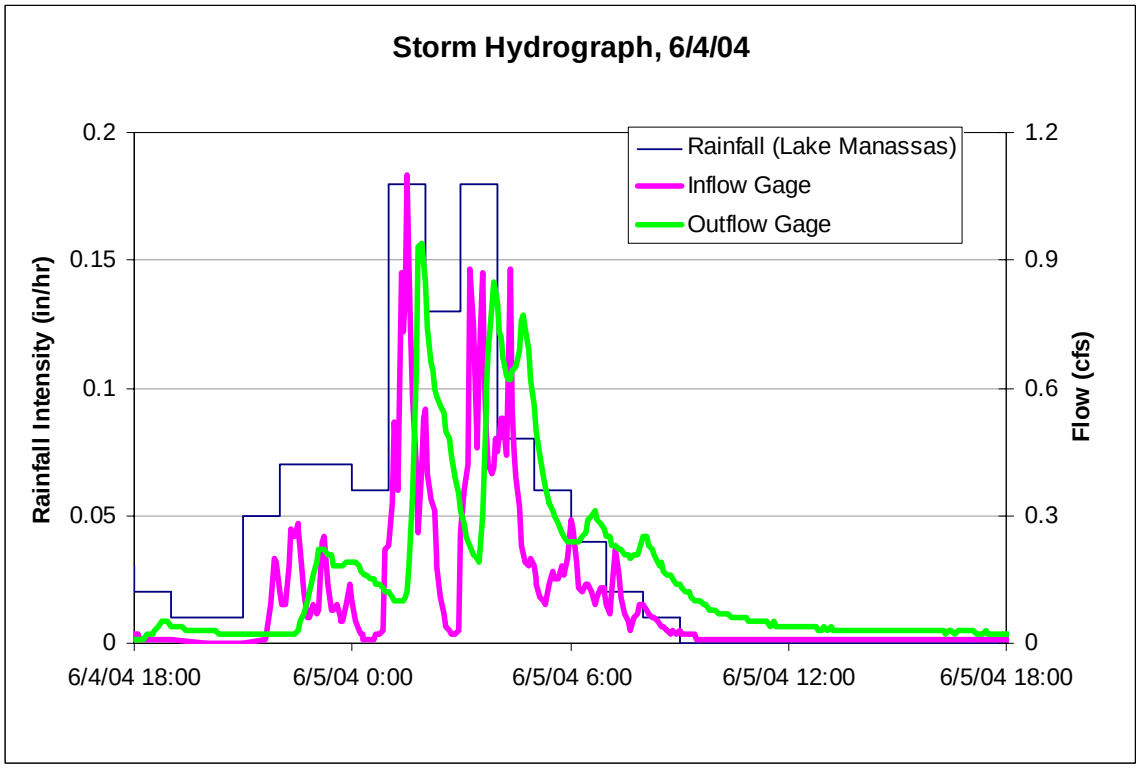

Storm Hydrograph, 5/2/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Lake Manassas)
Inflow Gage
Outflow Gage
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2.5
2
1.5
1
0.5
0
5/2/04 18:00
5/2/04 20:00
5/2/04 22:00
5/3/04 0:00
5/3/04 2:00
5/3/04 4:00
5/3/04 6:00
5/3/04 8:00
5/3/04 10:00
5/3/04 12:00
5/3/04 14:00

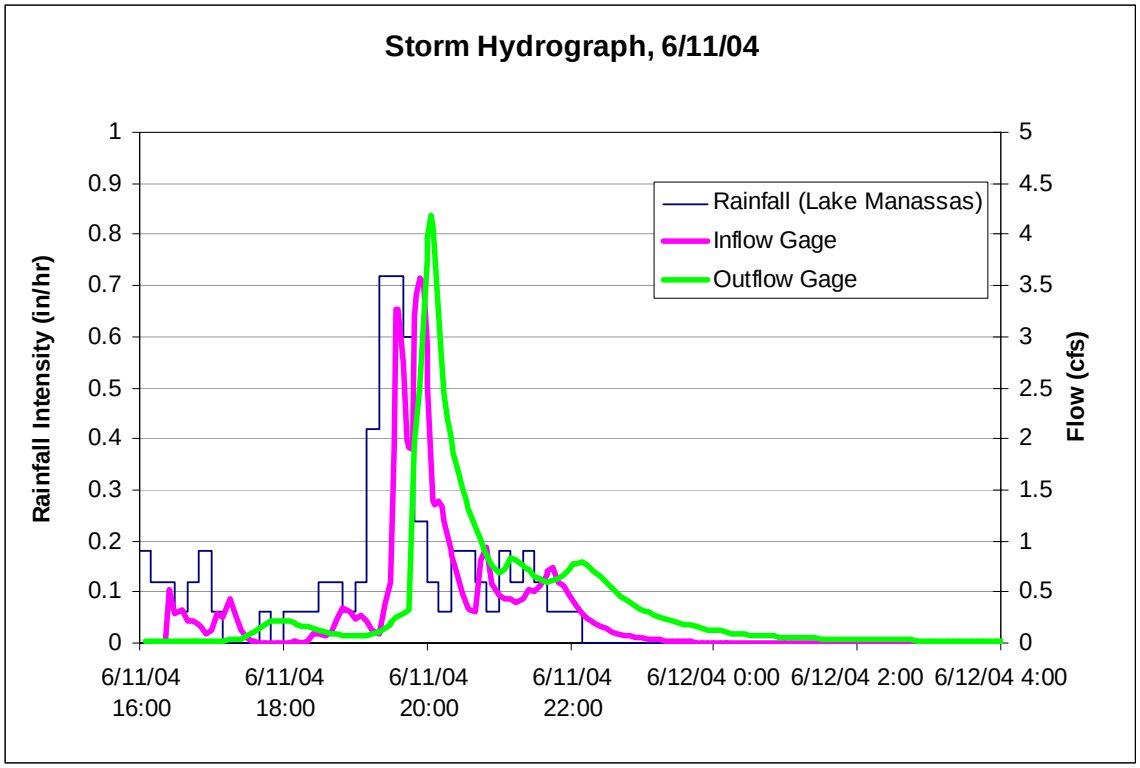

Storm Hydrograph, 5/7/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Lake Manassas)
Inflow Gage
Outflow Gage
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
10
9
8
7
6
5
4
3
2
1
0
5/7/04 17:00
5/7/04 18:00
5/7/04 19:00
5/7/04 20:00
5/7/04 21:00
5/7/04 22:00

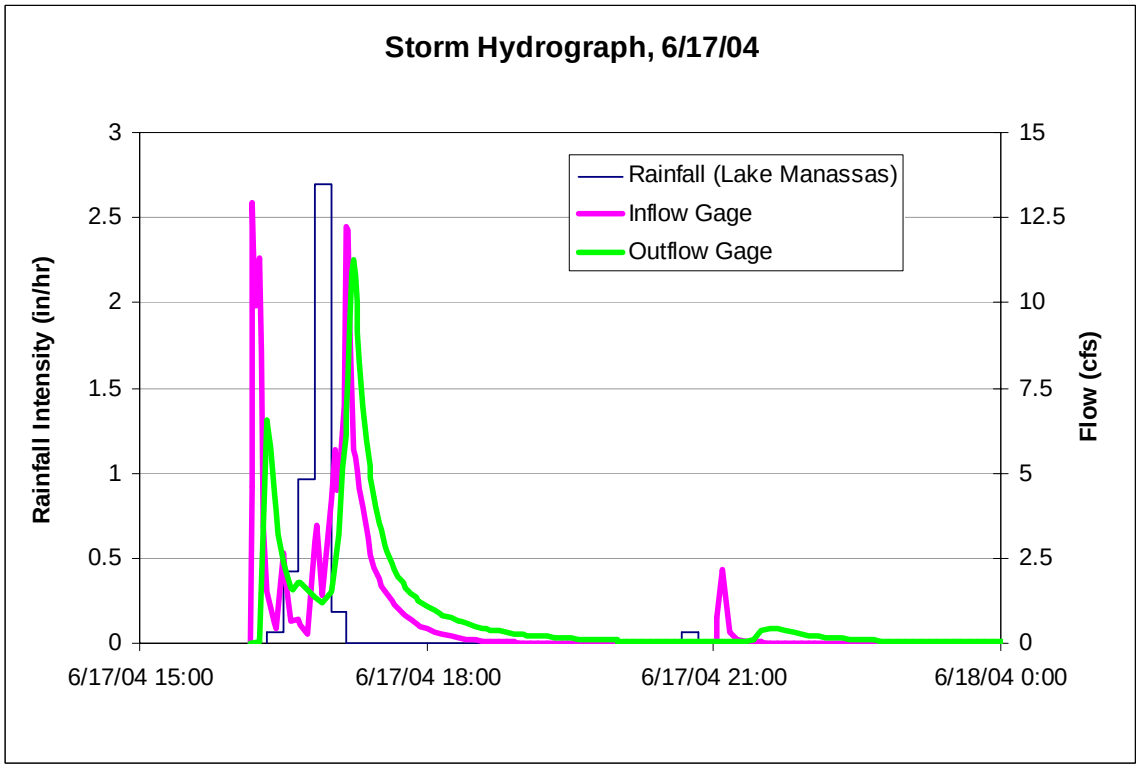

Storm Hydrograph, 5/16/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Lake Manassas)
Inflow Gage
Outflow Gage
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
5/16/04 21:00
5/16/04 22:00
5/16/04 23:00
5/17/04 0:00
5/17/04 1:00
5/17/04 2:00
5/17/04 3:00

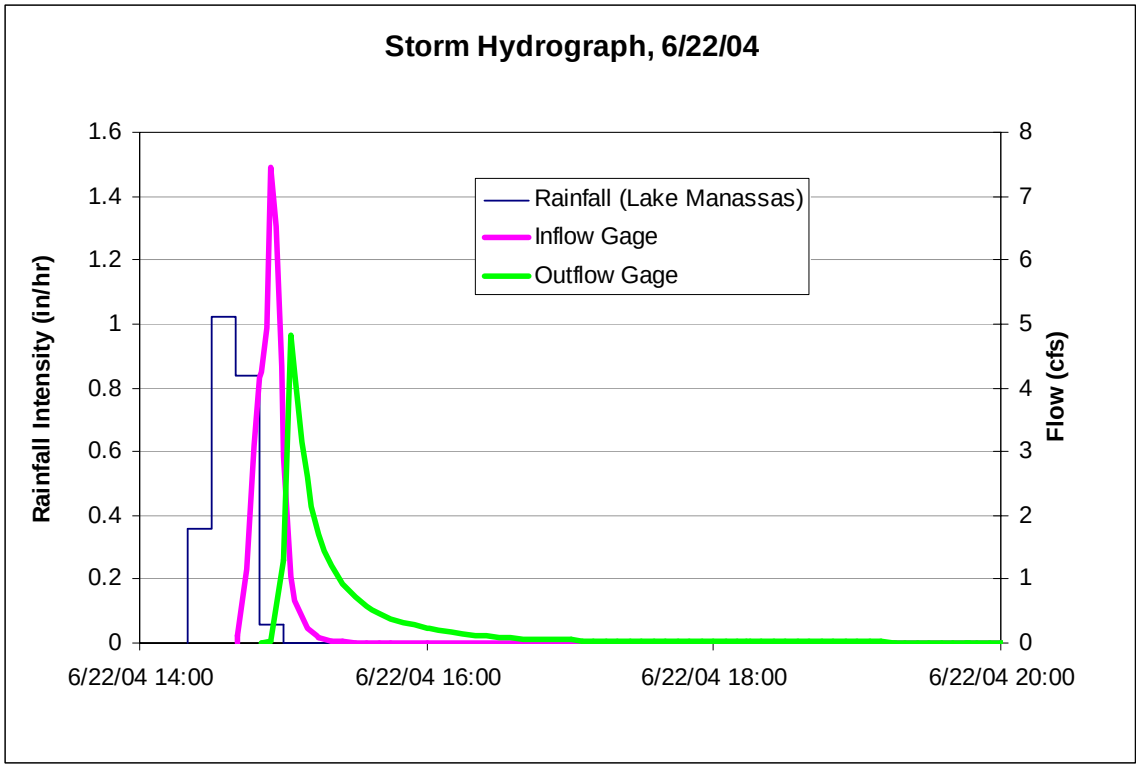

Storm Hydrograph, 5/21/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Lake Manassas)
Inflow Gage
Outflow Gage
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
4
3.5
3
2.5
2
1.5
1
0.5
0
5/21/04 21:00
5/21/04 21:15
5/21/04 21:30
5/21/04 21:45
5/21/04 22:00
5/21/04 22:15
5/21/04 22:30
5/21/04 22:45
5/21/04 23:00

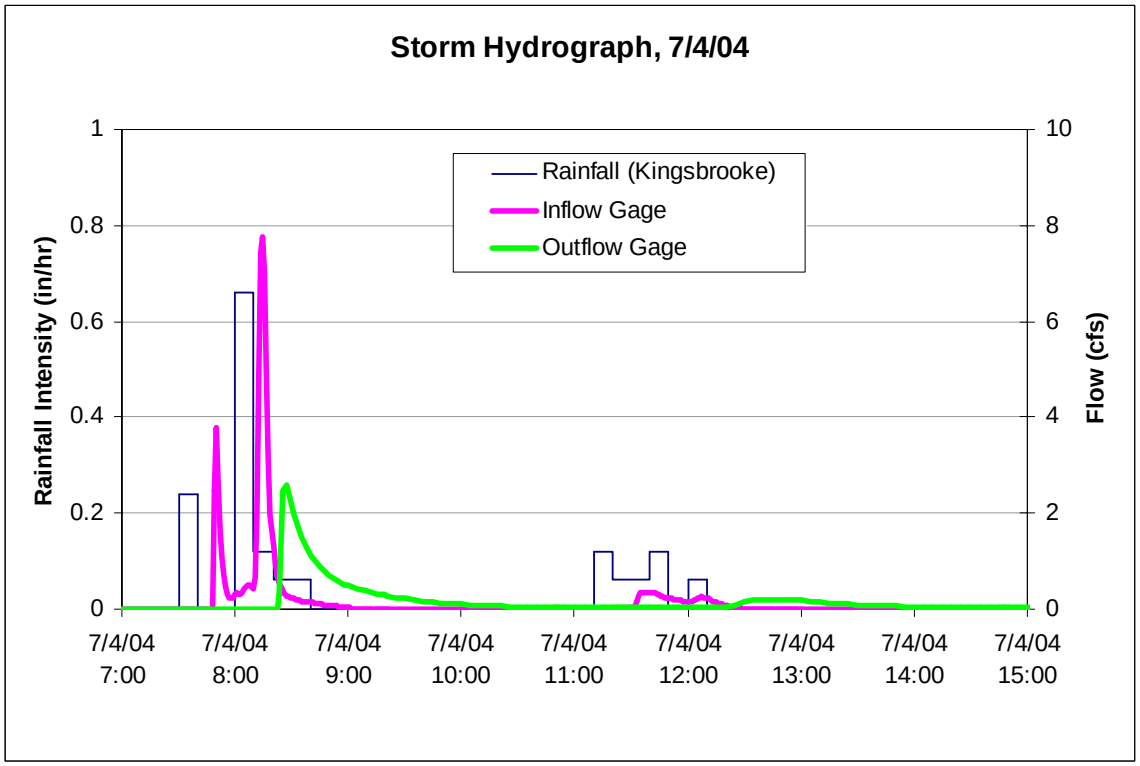

Storm Hydrograph, 5/31/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Lake Manassas)
Inflow Gage
Outflow Gage
1
0.8
0.6
0.4
0.2
0
5
4
3
2
1
0
5/31/04 19:00
5/31/04 20:00
5/31/04 21:00
5/31/04 22:00
5/31/04 23:00
6/1/04 0:00

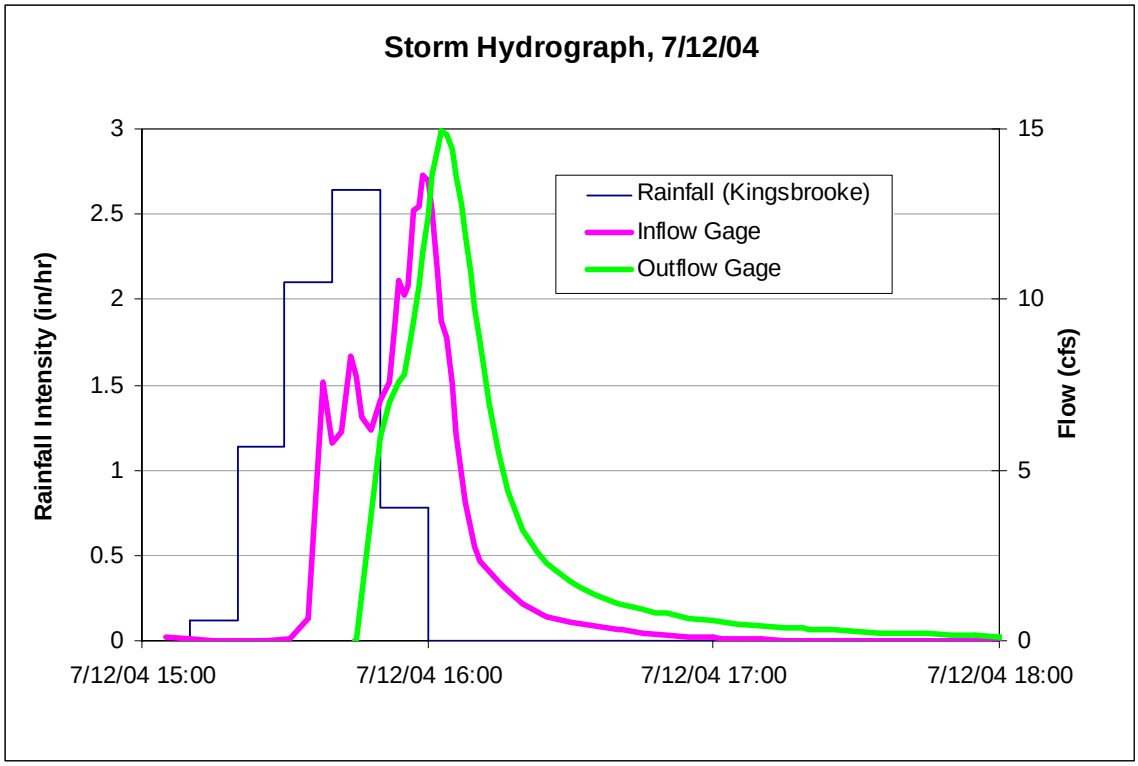

Storm Hydrograph, 6/4/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Lake Manassas)
Inflow Gage
Outflow Gage
0.2
0.15
0.1
0.05
0
1.2
0.9
0.6
0.3
0
6/4/04 18:00
6/5/04 0:00
6/5/04 6:00
6/5/04 12:00
6/5/04 18:00

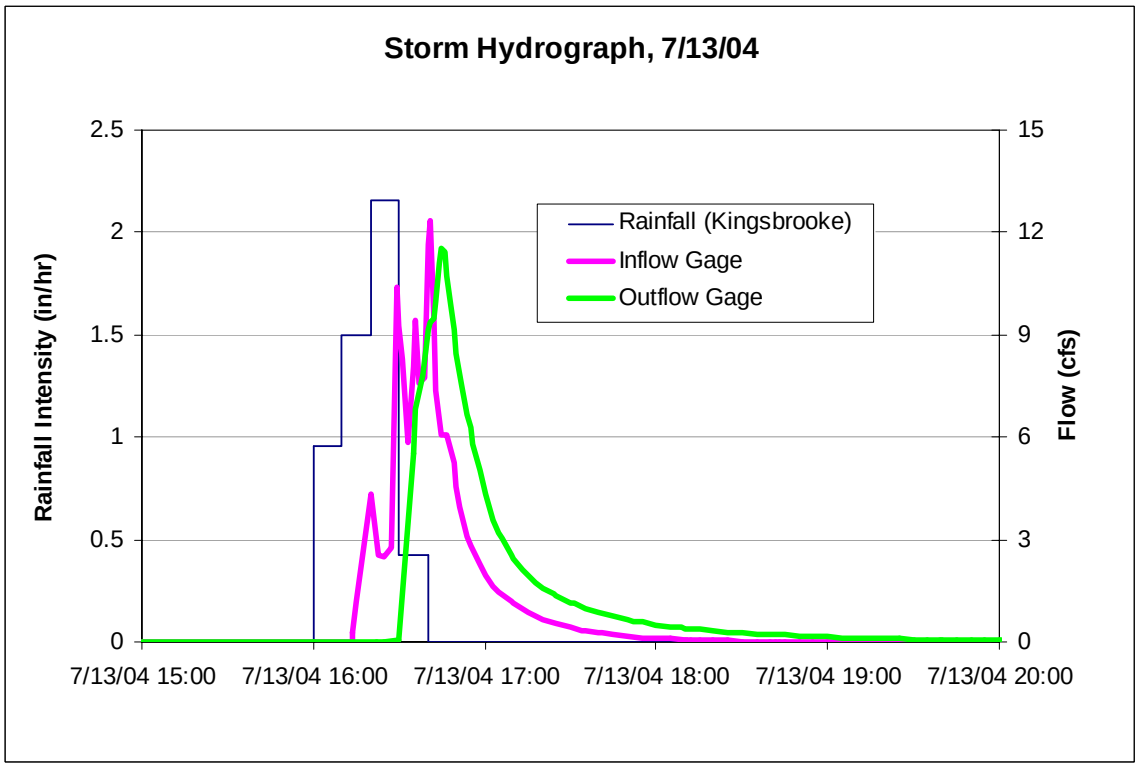

Storm Hydrograph, 6/11/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Lake Manassas)
Inflow Gage
Outflow Gage
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
6/11/04 16:00
6/11/04 18:00
6/11/04 20:00
6/11/04 22:00
6/12/04 0:00
6/12/04 2:00
6/12/04 4:00

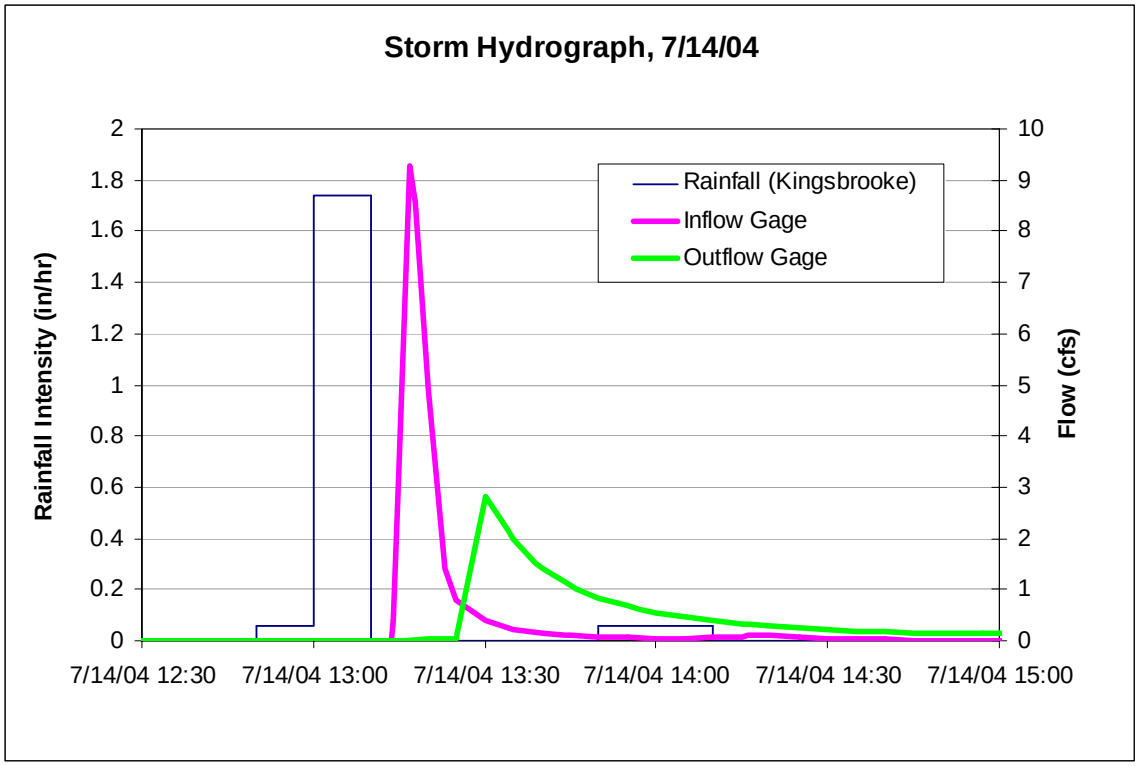

Storm Hydrograph, 6/17/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Lake Manassas)
Inflow Gage
Outflow Gage
3
2.5
2
1.5
1
0.5
0
15
12.5
10
7.5
5
2.5
0
6/17/04 15:00
6/17/04 18:00
6/17/04 21:00
6/18/04 0:00

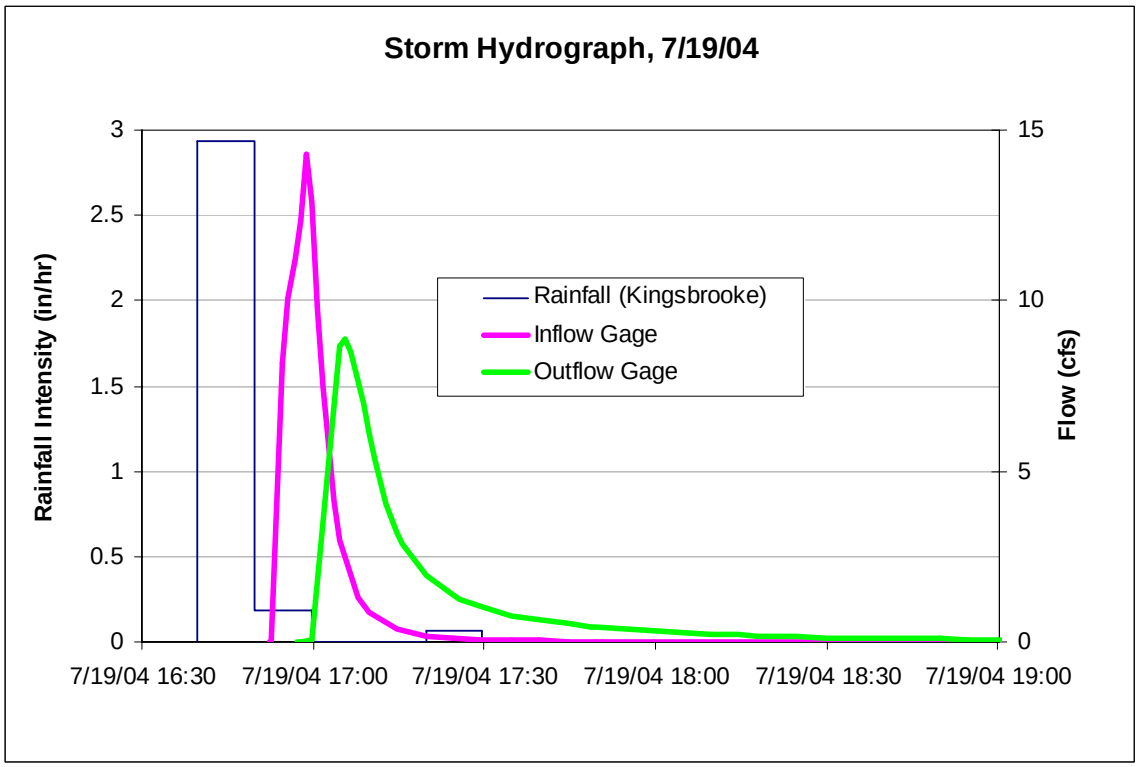

Storm Hydrograph, 6/22/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Lake Manassas)
Inflow Gage
Outflow Gage
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
8
7
6
5
4
3
2
1
0
6/22/04 14:00
6/22/04 16:00
6/22/04 18:00
6/22/04 20:00

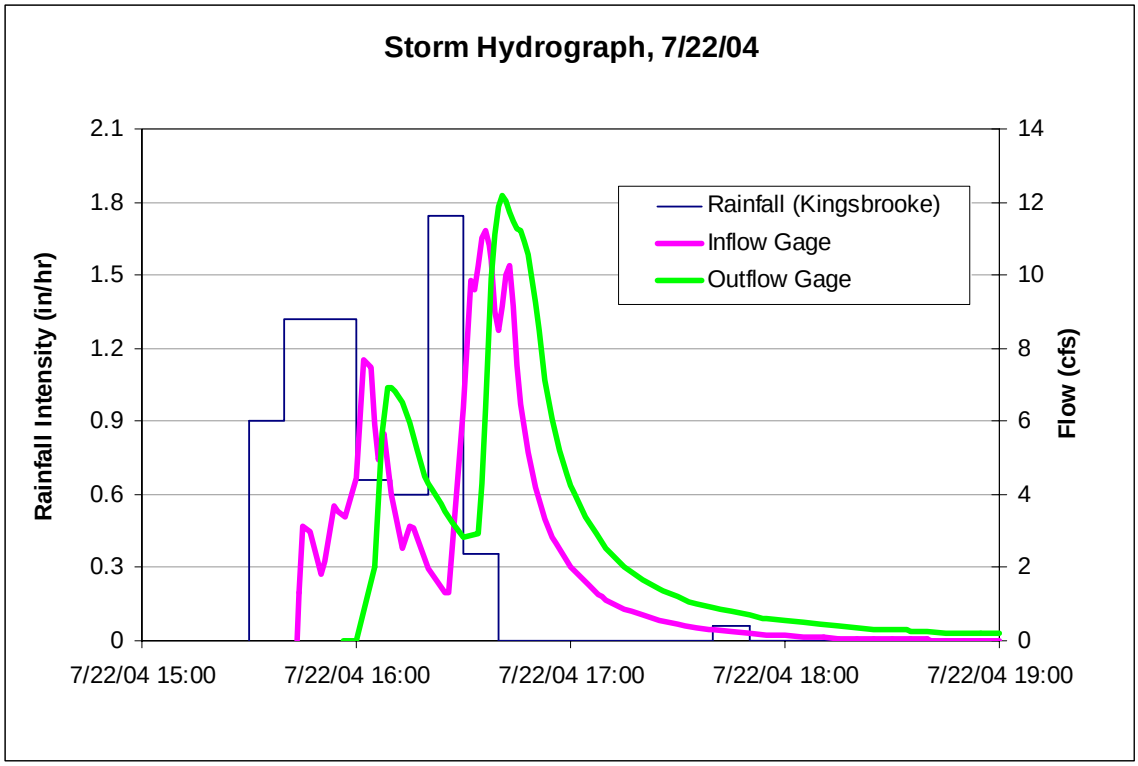

Storm Hydrograph, 7/4/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Kingsbrooke)
Inflow Gage
Outflow Gage
1
0.8
0.6
0.4
0.2
0
10
8
6
4
2
0
7/4/04 7:00
7/4/04 8:00
7/4/04 9:00
7/4/04 10:00
7/4/04 11:00
7/4/04 12:00
7/4/04 13:00
7/4/04 14:00
7/4/04 15:00

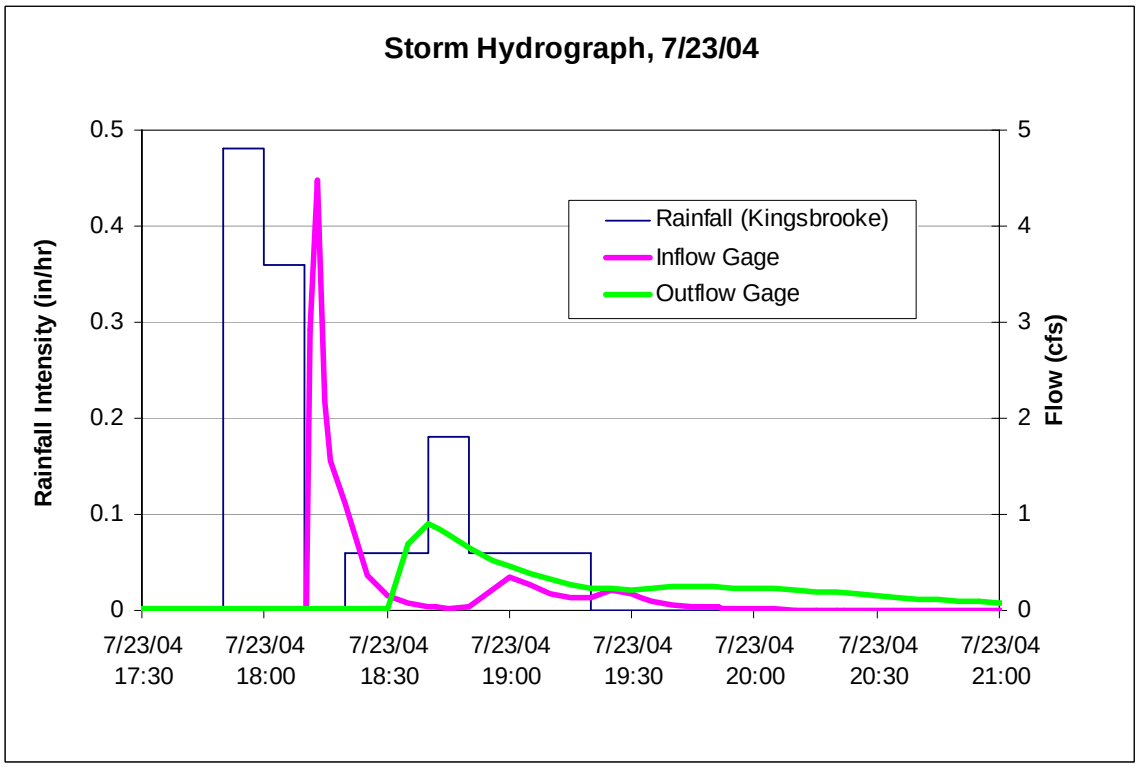

Storm Hydrograph, 7/12/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Kingsbrooke)
Inflow Gage
Outflow Gage
3
2.5
2
1.5
1
0.5
0
15
10
5
0
7/12/04 15:00
7/12/04 16:00
7/12/04 17:00
7/12/04 18:00

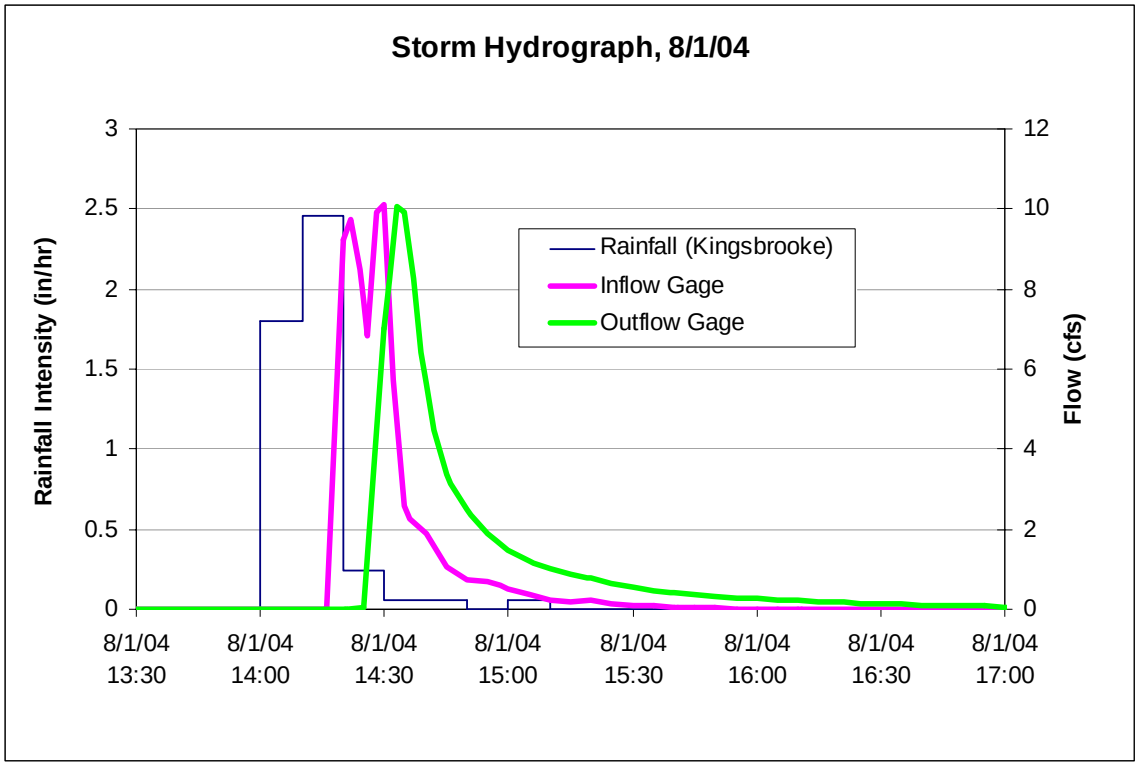

Storm Hydrograph, 7/13/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Kingsbrooke)
Inflow Gage
Outflow Gage
2.5
2
1.5
1
0.5
0
15
12
9
6
3
0
7/13/04 15:00
7/13/04 16:00
7/13/04 17:00
7/13/04 18:00
7/13/04 19:00
7/13/04 20:00

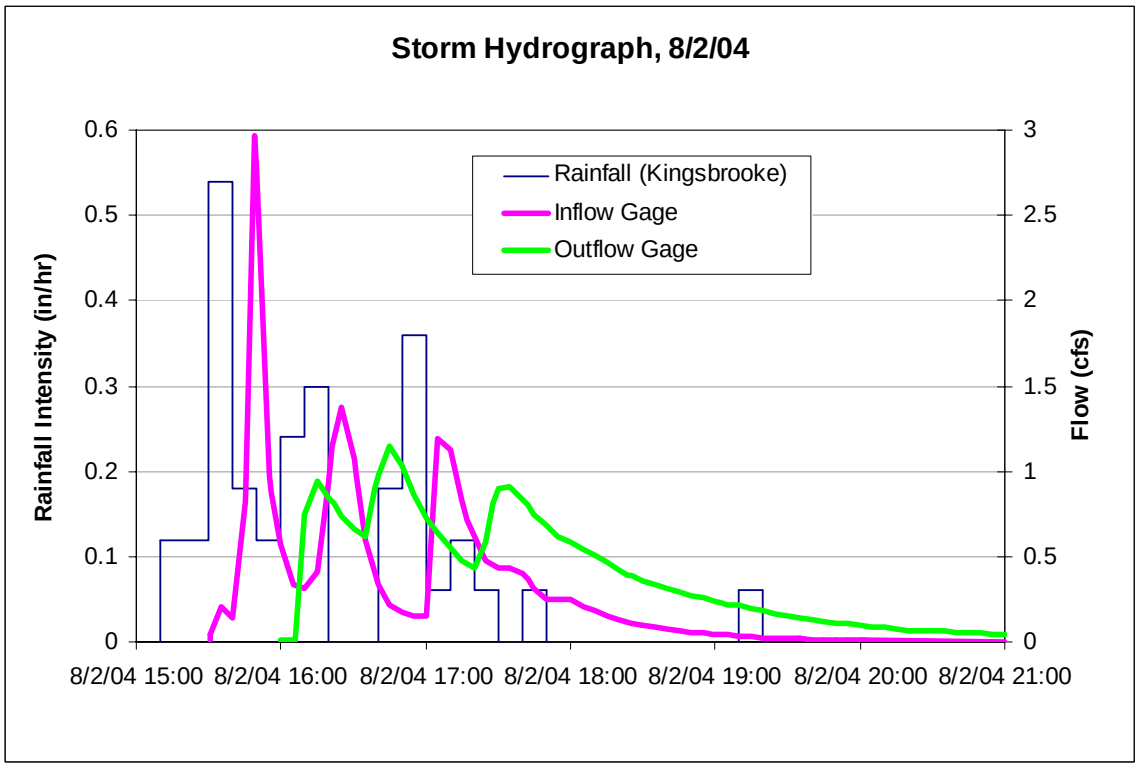

Storm Hydrograph, 7/14/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Kingsbrooke)
Inflow Gage
Outflow Gage
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
10
9
8
7
6
5
4
3
2
1
0
7/14/04 12:30
7/14/04 13:00
7/14/04 13:30
7/14/04 14:00
7/14/04 14:30
7/14/04 15:00

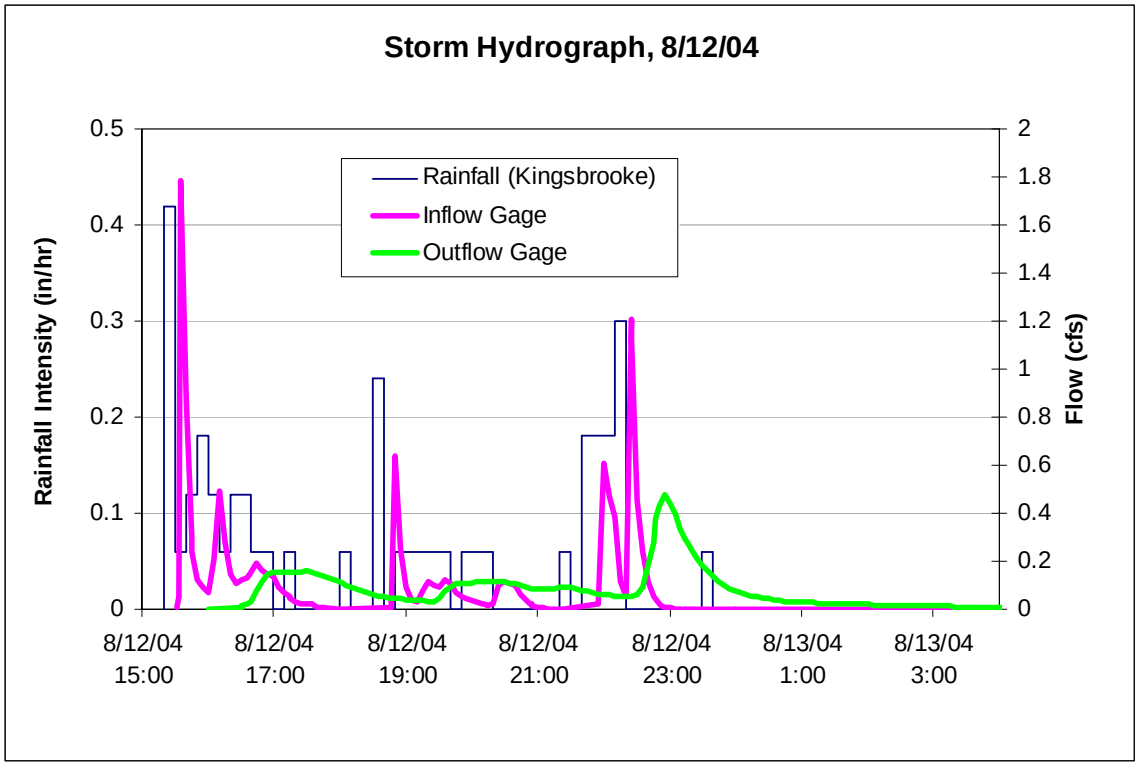

Storm Hydrograph, 7/19/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Kingsbrooke)
Inflow Gage
Outflow Gage
3
2.5
2
1.5
1
0.5
0
15
10
5
0
7/19/04 16:30
7/19/04 17:00
7/19/04 17:30
7/19/04 18:00
7/19/04 18:30
7/19/04 19:00

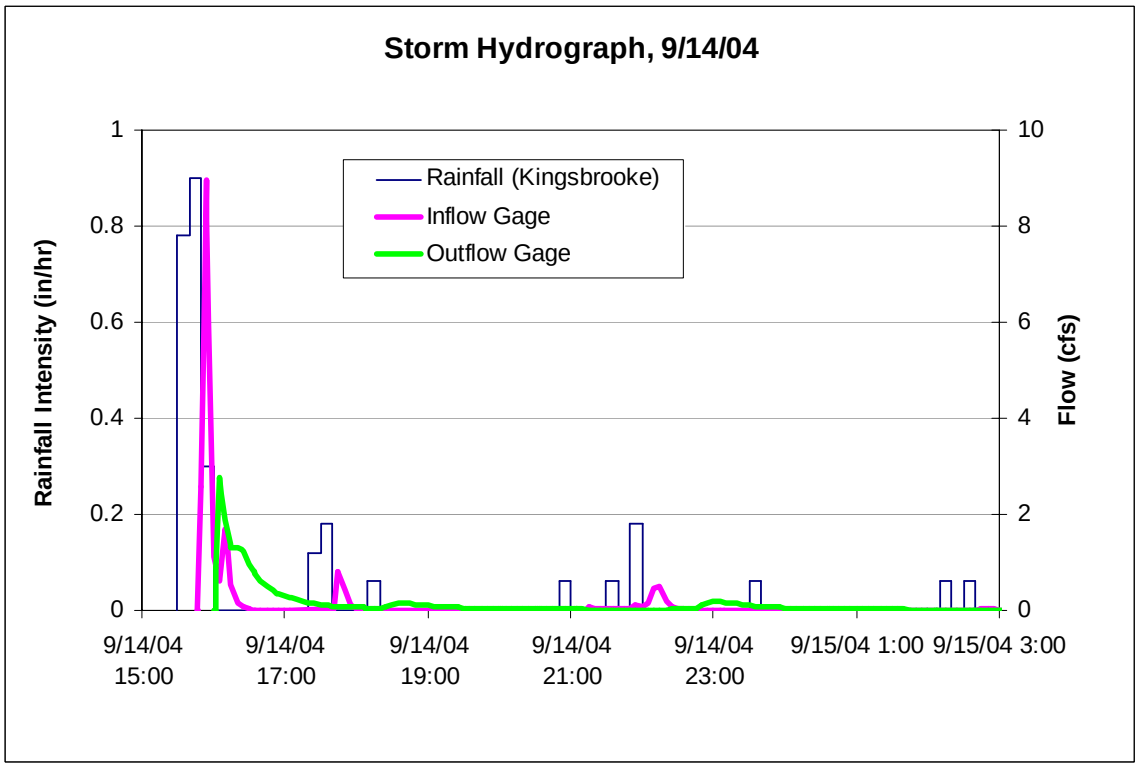

Storm Hydrograph, 7/22/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Kingsbrooke)
Inflow Gage
Outflow Gage
2.1
1.8
1.5
1.2
0.9
0.6
0.3
0
14
12
10
8
6
4
2
0
7/22/04 15:00
7/22/04 16:00
7/22/04 17:00
7/22/04 18:00
7/22/04 19:00

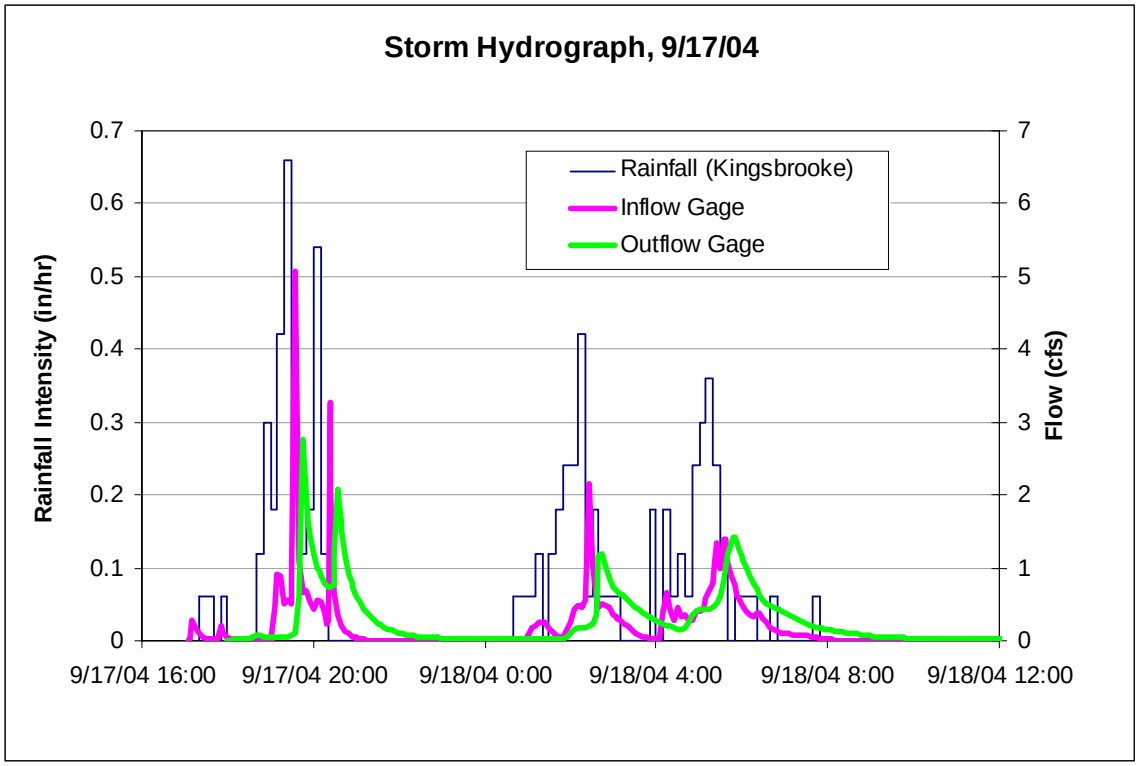

Storm Hydrograph, 7/23/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Kingsbrooke)
Inflow Gage
Outflow Gage
0.5
0.4
0.3
0.2
0.1
0
5
4
3
2
1
0
7/23/04 17:30
7/23/04 18:00
7/23/04 18:30
7/23/04 19:00
7/23/04 19:30
7/23/04 20:00
7/23/04 20:30
7/23/04 21:00

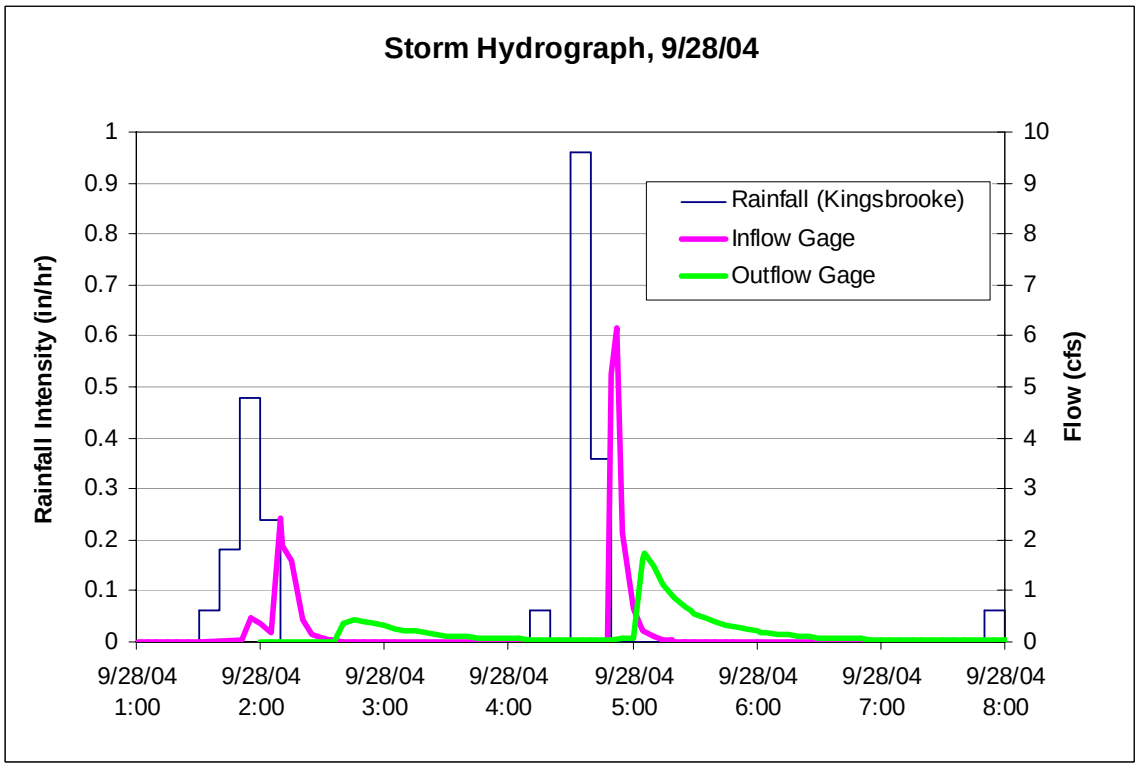

Storm Hydrograph, 8/1/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Kingsbrooke)
Inflow Gage
Outflow Gage
3
2.5
2
1.5
1
0.5
0
12
10
8
6
4
2
0
8/1/04 13:30
8/1/04 14:00
8/1/04 14:30
8/1/04 15:00
8/1/04 15:30
8/1/04 16:00
8/1/04 16:30
8/1/04 17:00

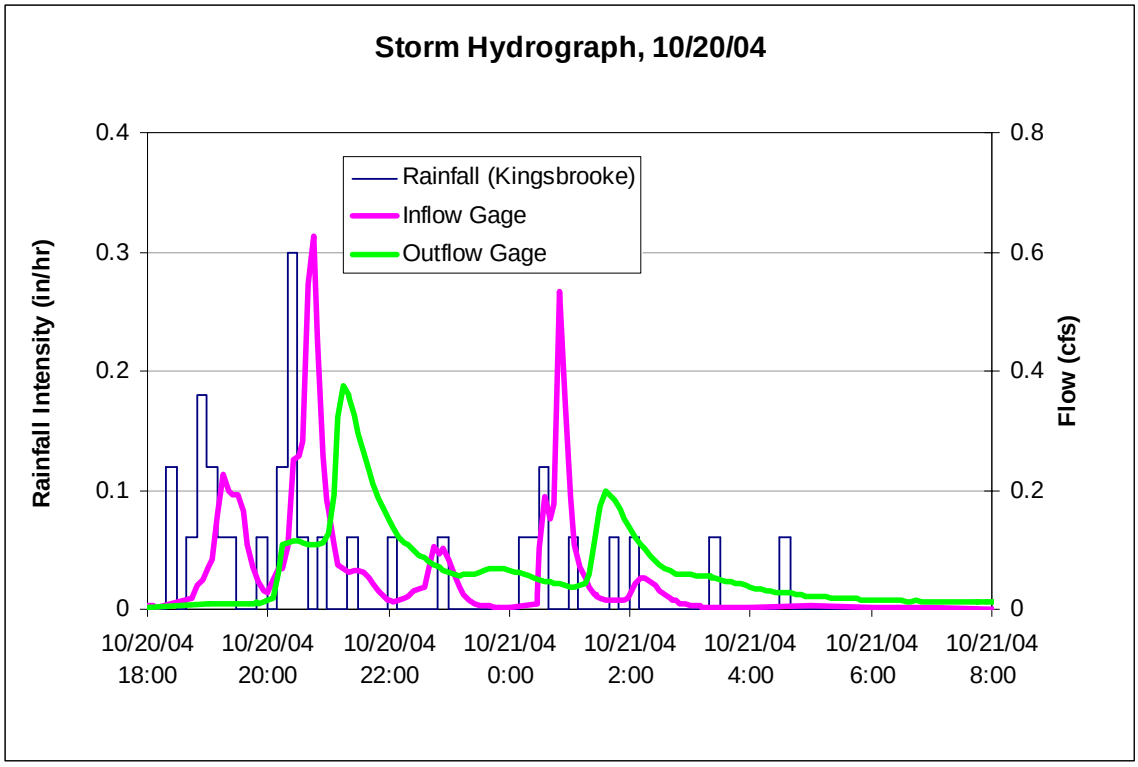

Storm Hydrograph, 8/2/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Kingsbrooke)
Inflow Gage
Outflow Gage
0.6
0.5
0.4
0.3
0.2
0.1
0
3
2.5
2
1.5
1
0.5
0
8/2/04 15:00
8/2/04 16:00
8/2/04 17:00
8/2/04 18:00
8/2/04 19:00
8/2/04 20:00
8/2/04 21:00


Storm Hydrograph, 8/12/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Kingsbrooke)
Inflow Gage
Outflow Gage
0.5
0.4
0.3
0.2
0.1
0
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
8/12/04 15:00
8/12/04 17:00
8/12/04 19:00
8/12/04 21:00
8/12/04 23:00
8/13/04 1:00
8/13/04 3:00


Storm Hydrograph, 9/14/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Kingsbrooke)
Inflow Gage
Outflow Gage
1
0.8
0.6
0.4
0.2
0
10
8
6
4
2
0
9/14/04 15:00
9/14/04 17:00
9/14/04 19:00
9/14/04 21:00
9/14/04 23:00
9/15/04 1:00
9/15/04 3:00


Storm Hydrograph, 9/17/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Kingsbrooke)
Inflow Gage
Outflow Gage
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
7
6
5
4
3
2
1
0
9/17/04 16:00
9/17/04 20:00
9/18/04 0:00
9/18/04 4:00
9/18/04 8:00
9/18/04 12:00


Storm Hydrograph, 9/28/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Kingsbrooke)
Inflow Gage
Outflow Gage
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
10
9
8
7
6
5
4
3
2
1
0
9/28/04 1:00
9/28/04 2:00
9/28/04 3:00
9/28/04 4:00
9/28/04 5:00
9/28/04 6:00
9/28/04 7:00
9/28/04 8:00


Storm Hydrograph, 10/20/04
Rainfall Intensity (in/hr)
Flow (cfs)
Rainfall (Kingsbrooke)
Inflow Gage
Outflow Gage
0.4
0.3
0.2
0.1
0
0.8
0.6
0.4
0.2
0
10/20/04 18:00
10/20/04 20:00
10/20/04 22:00
10/21/04 0:00
10/21/04 2:00
10/21/04 4:00
10/21/04 6:00
10/21/04 8:00

Appendix B

Original Chemistry Data

Summary of Column Headings

DATE: date and time of collection of grab baseflow samples and lysimeter samples
DATE1, DATE2: the starting and ending times of storm flows
SAMNO: number of samples collected and composited during the storm
FLO: average flowrate during a storm or current flowrate during a baseflow grab sample (cfs)
TOTFLO: total flow recorded during the storm period (cf)
DO: dissolved oxygen (mg/L)
FIELDPH: pH measured on site for baseflow samples
LABPH: pH measured for composite storm samples in the laboratory
TEMP: water temperature for baseflow samples
COND25: conductivity at 25 degrees Celsius (μmho/cm)
PALK: phenolphthalein alkalinity (mg/L as $CaCO_3$)
TALK: total alkalinity (mg/L as $CaCO_3$)
THARD: total hardness (mg/L as $CaCO_3$)
OP: ortho-phosphate phosphorus (mg/L as P)
TP: total phosphorus (mg/L as P)
NH3_N: ammonia nitrogen (mg/L as N)
TKN: total Kjeldahl nitrogen (mg/L as N)
OX_N: oxidized nitrogen, nitrite and nitrate (mg/L as N)
Occasionally only the concentration of total nitrogen (TN) was measured. In those cases the TN concentration is shown spanning across both the TKN and the OX_N columns because TN = TKN + OX_N.
COD: chemical oxygen demand (mg/L)
TOC: total organic carbon (mg/L as C)
TURB: turbidity (NTU)
TSS: total suspended solids (mg/L)
SCA: soluble calcium (μg/L)
EFE: extractable iron (μg/L)
SMG: soluble magnesium (μg/L)
EPB: extractable lead (μg/L)
EZN: extractable zinc (μg/L)
MISC: miscellaneous comments, usually the volume collected for a lysimeter sample

Table B. 1. Chemistry for inflow storms, I1.

DATE1	DATE2	SAMNO	FLO	TOTFLO	LABPH	COND25	THARD	OP	TP	NH3_N	TKN	OX_N	COD	TOC	TURB	TSS	SCA	SMG	EPB	EZN
11/19/03 13:13	11/20/03 0:15	17	0.900	35,800	6.6	65	19	0.16	0.67	0.21	1.28	0.50	27.9	7.9	24	20.8	5,170	<2,500	5.4	<15.0
11/28/03 16:17	11/28/03 21:08	4	0.476	8,340	7.1	175	23	0.14	0.22	0.08	1.21	0.36	34.4	11.0	27	15.0	6,370	<2,500	<3.0	21.3
12/5/03 7:44	12/6/03 16:35	12	0.104	12,340	7.2	195	25	0.07	0.12	0.12	0.63	0.41	17.6	5.1	29	14.0	7,490	<2,500	5.6	<15.0
12/10/03 13:07	12/13/03 2:10	46	0.446	98,110	7.0	115	38	0.15	0.21	0.07	0.69	0.72	17.8	5.4	32	24.8	9,160	3,570	3.8	<15.0
12/14/03 11:16	12/15/03 20:19	6	0.114	13,540	7.0	110	26	0.09	0.14	0.06	0.51	0.38	13.9	5.1	22	6.4	7,080	<2,500	<3.0	<15.0
12/16/03 13:53	12/18/03 9:46	8	0.111	17,600	6.9	100	32	0.13	0.20	0.08	0.74	0.43	22.2	5.9	37	19.2	8,510	2,560	<3.0	18.4
4/12/04 7:21	4/15/04 1:02	70	0.279	65,900	7.0	91	29	0.26	0.36	0.24	1.43	0.62	30.7	6.6	50	58	7,830	<2,500	<3.0	22.4
4/23/04 16:33	4/23/04 17:47	6	0.739	3,326	6.8	59	19		0.74		6.47		41.8	12.9		272	6,160	<2,500	4.3	96.4
4/26/04 9:54	4/26/04 19:06	11	0.181	6,008	7.2	62	12	0.05	0.12	0.26	0.84	0.34	17.5	4.0	14	26	4,330	<2,500	<3.0	<15.0
5/2/04 19:27	5/3/04 10:47	6	0.069	3,792	7.5	55	6	0.08	0.24	0.22	1.21	0.21	27.4	3.3	24	59	2,380	<2,500	4.1	27.9
5/7/04 17:56	5/7/04 19:19	7	0.936	4,719	6.2	36	11	0.08	0.30	0.53	1.87	0.38	36.7	3.5	65	135	4,240	<2,500	<3.0	46.3
5/16/04 22:10	5/17/04 2:49	5	1.165	2,810	5.7	22	5	0.06	0.14	0.33	1.14	0.25	30.9	4.7	23	48	1,990	<2,500	4.3	34.1
5/21/04 21:08	5/21/04 21:38	3	0.923	1,728	7.4	125	10	0.08	0.28	0.61	1.61	0.87	24.6		40	102	4,010	<2,500	<3.0	43.1
5/31/04 19:38	5/31/04 20:39	7	1.22	4,552	7.6	22	5	0.06	0.16	0.28	0.92	0.27	19.6	4.1	30	39	2,140	<2,500	<3.0	25.1
6/4/04 21:38	6/5/04 9:33	17	0.207	8,918	7.7	46	13	0.08	0.10	0.25	0.71	0.51	11.7	4.9	7.7	8.0	5,310	<2,500	<3.0	<15.0
6/11/04 16:21	6/11/04 23:39	21	0.468	12,380	6.9	63	10	0.10	0.16	0.14	0.69	0.39	14.5	5.4	7.9	15.2	3,870	<2,500	<3.0	<15.0
6/17/04 16:10	6/17/04 19:28	30	1.62	19,402	6.5	56	11	0.24	0.37	0.41	1.80	0.67	34.3	11.7	26	32	4,360	<2,500	<3.0	<15.0
6/22/04 14:41	6/22/04 15:14	7	1.24	4,888	6.4	28	9	0.04	0.17	0.20	1.56	0.23	19.0	5.3	15	24	3,470	<2,500	<3.0	19.7
7/12/04 15:31	7/12/04 17:02	26	3.31	18,252	7.6	33	6	0.18	0.25	0.21	0.81	0.42	15.9	5.1	8.0	20.0	2,340	<2,500	<3.0	<15.0
7/13/04 16:14	7/13/04 17:40	25	3.056	15,950	5.9	51	11	0.24	0.33	0.21	1.25	0.56	29.8	9.3	12	17.0	4,240	<2,500	<3.0	15.2
7/14/04 13:14	7/14/04 13:44	4	1.735	3,247	6.1	18	<1	0.10	0.16	0.17	0.61	0.20	10.2	3.2	9.0	17.6	<1,500	<2,500	<3.0	<15.0
7/19/04 16:53	7/19/04 17:51	9	1.945	6,862	6.1	31	<1	0.79	0.88	0.43	1.20	0.32	14.7	4.6	16	30	<1,500	<2,500	<3.0	21.8
7/22/04 15:44	7/22/04 17:08	35	4.36	22,310	6.4	51	7	0.26	0.36	0.26	1.41	0.64	29.7	10.2	12	10.8	2,790	<2,500	<3.0	<15.0
7/23/04 18:11	7/23/04 19:51	4	0.380	2,326	6.3	32	6	0.08	0.15	0.20	0.78	0.40	19.3	6.8	15	26	2,260	<2,500	<3.0	<15.0
8/1/04 14:16	8/1/04 15:40	10	2.04	10,420	6.6	50	8	0.24	0.35	0.17	1.11	0.51	21.1	6.7	9.0	19.2	1,970	<2,500	<3.0	<15.0
8/2/04 15:31	8/2/04 19:00	8	0.47	5,917	7.0	61	27	0.21	0.32	0.13	1.38	0.55	34.7	11.9	31	30	6,150	2,780	<3.0	18.8
8/12/04 15:33	8/12/04 22:51	3	0.133	3,495	6.6	41	11	0.15	0.31	0.44	1.71	0.50	32.1	9.0	36	69	4,540	<2,500	<3.0	35.0
9/14/04 15:47	9/14/04 16:33	5	1.559	4,377	6.7	94	23	0.07	0.26	0.43	1.77	0.88	28.0	4.2	60		9,410	<2,500	4.0	60.0
9/17/04 17:06	9/18/04 7:53	13	0.281	14,930	6.9	55	15	1.30	1.36	0.06	0.62	0.49	18.1	5.5	11	12.0	5,810	<2,500	<3.0	<15.0
9/28/04 1:51	9/28/04 5:18	4	0.332	4,125	5.8	23	220	0.21	0.29	0.18	1.16	0.14		3.5	280		63,300	16,200	<3.0	39.7

Table B. 2. Chemistry for outflow storms, O1.

DATE1	DATE2	SAMNO	FLO	TOTFLO	LABPH	COND25	THARD	OP	TP	NH3_N	TKN	OX_N	COD	TOC	TURB	TSS	SCA	SMG	EPB	EZN
11/19/03 12:42	11/21/03 0:07	49	0.413	52,640	6.5	65	20	0.16	0.33	0.06	1.60	0.34	27.4	9.6	27	12.9	5,100	<2,500	4.0	<15.0
11/28/03 15:21	11/29/03 0:58	4	0.265	9,180	7.6	131	24	0.11	0.17	0.05	0.92	0.21	27.8		25	10.8	6,060	<2,500	3.6	24.4
12/5/03 10:52	12/7/03 10:53	11	0.064	11,140	7.3	165	36	0.06	0.12	0.18	0.92	0.25	19.8	6.4	20	10.8	8,790	3,360	<3.0	<15.0
12/10/03 13:02	12/13/03 1:15	53	0.527	114,300	7.0	95	30	0.13	0.20	0.05	0.66	0.46	16.8	5.5	45	36	7,350	2,950	<3.0	<15.0
12/14/03 13:13	12/16/03 5:54	7	0.104	15,210	7.2	130	35	0.06	0.06	0.02	0.41	0.27	12.9	4.9	18	4.0	8,480	3,330	6.1	<15.0
12/16/03 11:21	12/18/03 20:44	10	0.106	21,890	6.9	124	45	0.09	0.13	0.03	0.55	0.33	15.9	5.9	29	8.4	10,800	4,260	3.9	<15.0
4/1/04 0:17	4/3/04 18:23	44	0.095	22,531	7.1	150	43	0.04	0.08	0.04	1.27	0.54	22.6	8.0	24	7.6	10,400	4,050	<3.0	33.4
4/12/04 8:38	4/15/04 12:30	87	0.306	83,596	7.3	108	42	0.17	0.25	0.09	0.97	0.58	24.0	7.1	32	22	10,100	3,970	<3.0	16.7
4/23/04 17:20	4/23/04 18:33	5	0.591	2,615	6.9	78	24	0.06	0.23	0.09	1.40	0.64	33.5	9.7	22	21.2	5,830	<2,500	<3.0	22.3
4/26/04 10:11	4/27/04 1:39	16	0.154	8,598	7.3	74	27	0.02	0.08	0.03	0.69	0.20	23.2	8.2	17	8.8	6,590	2,650	<3.0	18.3
5/2/04 20:06	5/3/04 13:26	6	0.072	4,502	6.9	250	9	0.05	0.11	0.04	0.68	0.14	24.6	7.8	16	8.8	3,410	<2,500	<3.0	19.3
5/7/04 18:16	5/8/04 2:02	10	0.215	6,027	6.6	54	10	0.13	0.21	0.23	1.05	0.38	20.8	5.8	22	22.4	3,960	<2,500	<3.0	19.4
5/16/04 22:43	5/17/04 0:28	4	0.326	2,075	6.7	83	13	0.16	0.26	0.17	1.33	0.34	32.1	10.3	13	24.4	5,300	<2,500	3.6	22.6
5/31/04 19:54	5/31/04 23:47	8	0.334	4,691	7.4	47	8	0.09	0.16	0.11	0.80	0.33	22.4	7.4	15	8.4	3,320	<2,500	<3.0	16.8
6/4/04 17:54	6/6/04 3:40	28	0.121	14,666	7.3	72	15	0.06	0.11	0.04	0.69	0.32	19.9	7.9	11	2.4	6,030	<2,500	<3.0	<15.0
6/11/04 16:47	6/12/04 5:54	28	0.339	16,010	6.9	81	11	0.10	0.16	0.06	0.78	0.31	19.2	7.5	16	20.0	4,360	<2,500	<3.0	<15.0
6/17/04 16:10	6/18/04 3:44	41	0.592	24,702	6.3	62	11	0.19	0.30	0.23	1.46	0.54	33.0	12.2	21	13.2	4,360	<2,500	<3.0	<15.0
6/22/04 14:51	6/22/04 19:15	9	0.330	5,246	6.8	48	9	0.21	0.33	0.10	1.14	0.36	24.4	8.2	17	20	3,610	<2,500	<3.0	<15.0
7/4/04 8:23	7/4/04 15:49	6	0.184	4,914	7.3	100	150	0.16	0.25	0.20	1.18	0.57	29.9	10.1	10	10.0	34,700	15,600	3.2	23.0
7/12/04 15:45	7/12/04 21:53	32	0.987	21,853	7.1	45	9	0.20	0.30	0.06	0.92	0.41	21.8	6.9	28	38	3,410	<2,500	<3.0	<15.0
7/13/04 16:22	7/13/04 23:40	30	0.736	19,400	6.1	59	13	0.21	0.30	0.14	1.19	0.51	30.9	10.1	27	26	5,360	<2,500	<3.0	21.2
7/14/04 13:16	7/14/04 18:35	8	0.224	4,294	7.3	62	15	0.10	0.17	0.07	0.88	0.22	25.2	10.2	13	10.8	5,840	<2,500	<3.0	<15.0
7/19/04 16:58	7/19/04 21:29	13	0.490	7,988	6.6	58	8	0.17	0.30	0.14	1.19	0.39	22.3	7.9	27	43	3,150	<2,500	<3.0	<15.0
7/23/04 18:07	7/24/04 1:56	6	0.111	3,133	6.8	91	34	0.09	0.16	0.02	0.93	0.20	35.1	12.8	11	7.2	7,870	3,420	<3.0	<15.0
8/1/04 14:21	8/1/04 19:52	13	0.62	12,270	6.7	67	8	0.25	0.39	0.09	1.18	0.51	25.0	8.1	24	28	3,090	<2,500	<3.0	20.0
8/12/04 16:31	8/13/04 3:05	4	0.092	3,514	7.3	97	36	0.17	0.26	0.04	1.09	0.27	37.4	14.2	9.0	7.2	8,380	3,720	<3.0	21.0
9/14/04 16:02	9/15/04 2:07	5	0.156	5,652	7.0	78	25	0.14	0.20	0.12	1.12	0.60	24.7	8.1	7.3		5,780	2,630	<3.0	17.9
9/17/04 18:05	9/18/04 13:32	18	0.275	19,300	7.0	52	12	0.13	0.18	0.02	0.57	0.27	20.2	7.1	8.1	4.5	4,930	<2,500	<3.0	<15.0
9/28/04 2:36	9/28/04 8:10	5	0.204	4,106	6.9	51	10	0.37	0.46	0.06	0.62	0.17	19.6	7.2	8.1		3,890	<2,500	<3.0	<15.0
10/20/04 19:48	10/21/04 8:23	4	0.071	3,219	7.0	93	35	0.29	0.29	0.26	0.82	0.28	23.4	8.3	9.3	5.0	8,040	3,680	<3.0	<15.0

Table B. 3. Chemistry for baseflows collected in the outflow gage, O2.

DATE	FLO	DO	FIELDPH	TEMP	COND25	PALK	TALK	THARD	OP	TP	NH3_N	TKN	OX_N	COD	TOC	TURB	TSS	SCA	SMG	EPB	EZN
3/1/04 9:03	0.004	11.52	7.4	2.5	704	0.0	132.9	230	<0.01	0.02	0.03	0.28	<0.01	16.8	12.6	1.7	<1.0	53,700	23,900	<3.0	27.8
3/10/04 9:35	0.007	14.20	7.6	4.4	561	0.0	112.4	200	0.01	0.02	0.01	0.31	0.01	11.7	5.1	3.4	1.6	44,600	22,400	<3.0	22.6
3/15/04 10:31	0.006	10.38	7.9	10.7	657	0.0	141.9	260	<0.01	0.02	0.01	0.35	<0.01	11.2	4.8	3.2	2.0	56,600	28,800	<3.0	16.5
3/22/04 9:08	0.031	15.92	7.6	2.8	572	0.0	130.5	225	<0.01	0.06	<0.01	0.46	<0.01	15.6	5.1	20	32	49,000	24,900	3.8	32.3
3/30/04 8:52	0.009	11.29	7.7	6.3	620	0.0	159.4	240	0.01	0.02	0.02	0.36	<0.01	10.6	4.7	4.2	3.0	52,500	26,500	<3.0	15.2
4/6/04 9:15	0.004	13.7	7.7	4.0	533	0.0	120.7	190	0.01	0.02	0.02	0.35	0.06	12.6	4.7	3.7	<1.0	42,000	20,800	<3.0	17.2
4/12/04 10:55	0.004	10.6	8.6	26.7	584	5.2	155.5	231	<0.01	0.06	<0.01	0.47	<0.01	14.8	5.6	9.5	10.8	52,700	24,200	<3.0	<15.0
4/27/04 10:40	0.011	8.70	7.6	18.9	250	0.0	84.0	94	0.02	0.07	0.02	0.91	0.02	28.9	9.7	17	5.0	22,200	9,380	<3.0	24.7
5/4/04 10:20	0.006	10.8	7.7	14.7	331	0.0	93.2	125	0.02	0.04	0.03	0.57	<0.01	15.8	6.9	6.9	3.2	26,600	13,700	<3.0	<15.0
5/11/04 13:30	0.002	6.00	8.4	29.6	503	5.3	149.2	200	0.02	0.06	0.04	0.66	<0.01	24.8	8.4	9.4	8.8	42,900	22,900	<3.0	33.1
6/3/04 8:37	0.006	6.96	7.3	20.4	435	0.0	121.9	175	0.04	0.09	0.05	0.63	0.02	18.4	8.7	6.0	4.8	37,800	20,000	<3.0	<15.0
6/8/04 8:19	0.006	8.65	7.6	20.8	459	0.0	113.8	190	0.01	0.05	0.04	0.41	<0.01	15.6	6.5	5.2	2.4	40,300	21,500	<3.0	<15.0
6/15/04 6:40	0.005							230	0.04	0.07	0.03	0.52	<0.01	17.4	8.6	4.9	4.4	43,200	20,800	<3.0	<15.0
6/22/04 6:54	0.004	6.58	7.4	20.9	486	0.0	145.4	210	0.04	0.09	0.02	0.55	<0.01	19.6	9.6	7.9	5.2	45,200	22,800	<3.0	<15.0
7/13/04 8:50	0.007	7.34	7.3	25.4	304	0.0	88.7	120	0.04	0.08	0.01	0.92	<0.01	28.9	11.3	6.8	1.6	29,000	11,500	<3.0	<15.0
7/20/04 8:30	0.007	7.07	7.1	22.7	291	0.0	85.9	110	0.03	0.09	0.04	0.92	<0.01	27.6	11.4	11	8.0	26,200	11,000	<3.0	<15.0
7/27/04 7:38	0.009	6.81	7.2	23.4	434	0.0	136.9	190	0.03	0.06	0.02	0.70	<0.01	22.8	10.2	3.7	1.6	43,700	19,900	<3.0	22.5
8/3/04 7:50	0.009	6.46	7.0	24.2	238	0.0	77.6	105	0.05	0.10	0.04	1.23	<0.01	44.4	15.3	11	4.0	24,100	10,400	<3.0	18.6
8/17/04 8:39	0.036	7.71	6.7	23.1	190	0.0	48.0	71	0.07	0.16	0.02	1.15	0.30	39.8	14.8	16	15.6	16,500	7,260	<3.0	33.1
9/8/04 8:47	0.020	9.36	6.8	22.5	253	0.0	28.6	87	0.13	0.21	0.02	1.16	0.87	34.8	11.4	13	6.0	20,100	9,050	<3.0	21.1
9/28/04 7:30	0.031	7.12	6.6	20.6	94	0.0	26.9	35	0.12	0.18	0.02	0.83	0.07	24.0	8.8	11	4.0	8,220	3,510	<3.0	15.4

Table B. 4. Chemistry for baseflows collected in the rip-rap below the outflow gage, O3.

DATE	FLO *	DO	FIELDPH	TEMP	COND25	PALK	TALK	THARD	OP	TP	NH3_N	TKN	OX_N	COD	TOC	TURB	TSS	SCA	SMG	EPB	EZN
6/22/04 7:45	0.004	5.85	6.9	19.7	474	0.0	152.2	180	0.02	0.02	0.02	0.19	1.19	6.4	3.7	3.0	<1.0	43,400	18,700	<3.0	<15.0
7/13/04 8:25	0.010	4.82	6.6	21.0	374	0.0	120.5	150	0.02	0.04	0.02	0.30	1.37	5.4	3.1	33	6.8	35,300	14,700	<3.0	<15.0
7/20/04 8:00	0.007	4.00	6.6	21.2	408	0.0	140.4	175	0.02	0.04	0.03	0.23	1.26	5.1	3.4	12	3.6	40,900	17,300	<3.0	<15.0
7/27/04 7:25	0.008	4.80	6.6	21.4	426	0.0	144.8	175	0.02	0.04	0.02	0.24	1.26	7.4	3.8	13	<1.0	41,100	17,900	<3.0	<15.0
8/3/04 7:20	0.009	3.21	6.4	21.4	316	0.0	114.2	130	0.02	0.06	0.03	0.33	1.10	8.7	4.1	45	8.8	31,100	12,500	<3.0	<15.0
8/10/04 7:05	0.000	4.38	6.5	20.7	390	0.0	148.0	160	0.02	0.04	0.01		1.42	6.4	3.3	11	1.2	37,100	16,100	<3.0	<15.0
8/17/04 7:10	0.000	4.42	6.5	20.8	436	0.0	153.9	175	0.02	0.02	0.02	0.20	1.38	8.3	3.4	4.7	2.4	42,300	16,500	<3.0	<15.0
8/24/04 7:45	0.000	4.26	6.6	21.3	496	0.0	185.5	200	0.02	0.02	<0.01	0.18	0.78	7.0	3.2	5.0	3.1	48,800	18,100	<3.0	<15.0
8/31/04 7:25	0.000	3.87	6.5	22.0	546	0.0	202.4	240	0.02	0.03	0.01	0.20	0.50	7.5	2.7	1.4	<1.0	56,700	23,100	<3.0	<15.0
9/8/04 7:55	0.001	5.01	6.5	21.6	597	0.0	213.9	260	0.02	0.03	0.02	0.25	0.49	6.9	2.8	2.0	1.2	61,600	24,900	<3.0	<15.0
9/21/04 8:00	0.000	4.50	6.8	20.0	442	0.0	148.4	170	0.01	0.02	<0.01	0.32	1.22	9.0	3.4	4.3	<1.0	41,500	16,500	<3.0	<15.0
** 9/28/04 7:00	0.049	7.83	6.9	20.6	116	0.0	35.1	47	0.13	0.19	0.04	0.75	0.15	21.5	7.7	11	4.8	11,300	46,100	<3.0	<15.0
10/5/04 10:30	0.000	4.40	6.8	19.8	402	0.0	161.2	165	0.02	0.05	0.10	0.38	1.29	9.2	3.5	3.9	<1.0	40,200	16,000	<3.0	<15.0
10/13/04 8:30	0.000	6.12	6.9	17.6	463	0.0	184.2	200	0.02	0.04	0.01	0.37	0.94	7.6	3.0	1.3	<1.0	48,500	19,500	<3.0	<15.0
10/19/04 10:10	0.000	6.87	6.9	17.5	513	0.0	182.3	210	0.02	0.03	0.04	0.28	1.08	6.8	3.1	1.4	<1.0	51,200	20,800	<3.0	<15.0
10/26/04 9:15	0.001	6.64	7.0	17.3	417	0.0	183.1	200	0.01	0.04	<0.01	0.36	1.30	5.8	2.8	1.1		48,600	19,900	<3.0	<15.0

* These were the flows at the outflow gage, not at the O3 sampling location.
** The 9/28/04 sample from O3 was removed from the analysis because it was an outlier, with very significantly higher flows and different chemistry than the other samples.

Table B. 5. Chemistry for samples from the lysimeter in the upper terrace, L1.

DATE	THARD	OP	TP	NH3_N	TKN	OX_N	COD	TOC	SCA	EFE	SMG	EPB	EZN	MISC
4/6/04 10:35	380	0.01	0.02	0.31	1.10	0.07	28.2	10.2	102,000		30,000	<3.0	<15.0	1215 mL
4/12/04 9:40	430	0.02	0.02	0.30	1.04	<0.01	23.4	2.4	115,000		35,400	<3.0	<15.0	1225 mL
4/19/04 10:55	480	<0.01	0.01		0.96	<0.01			128,000		38,100			420 mL
4/26/04 9:15	500	<0.01	0.01	0.20	1.20	<0.01	26.5	9.7	135,000		39,800	<3.0	<15.0	790 mL
5/3/04 10:00	490	<0.01	<0.01	0.19	0.97	<0.01	26.7	10.6	124,100	96.1	44,300	<3.0	<15.0	960 mL
5/10/04 11:55	480	<0.01	0.01	0.09	0.96	<0.01	32.7	11.9	122,000	113	42,600	<3.0	<15.0	575 mL
5/17/04 9:50	470	<0.01	0.01	0.10	0.87	<0.01	36.6		118,000		41,500	<3.0	<15.0	525 mL
5/24/04 10:50	470	<0.01	0.02	0.09	0.94	<0.01	35.0	13.8	117,000		42,300	<3.0	<15.0	875 mL
6/2/04 9:00	460	<0.01	0.03	0.09	1.04	<0.01	34.8		115,000		41,100	<3.0	<15.0	700 mL
6/7/04 12:30	450	<0.01	0.02	0.09	1.01	<0.01	38.4		113,000		40,700	<3.0	<15.0	650 mL
6/14/04 8:05	360	0.01	0.05	0.08	1.14	<0.01	47.3		82,100		38,400			240 mL
6/21/04 7:25	440	0.04	0.05	0.19	1.23	<0.01	47.8		113,000		37,300			450 mL
6/28/04 7:45		<0.01	0.05	0.15	1.20	<0.01								190 mL
7/6/04 8:05	440	0.01	0.05	0.23	1.21	<0.01	43.7		114,000		37,100			520 mL
7/12/04 6:40		0.02	0.04	0.14	0.86	<0.01	50.0					<3.0	<15.0	300 mL
7/19/04 7:35	440	0.02	0.06	0.21	1.14	<0.01	52.5		117,000		36,800			510 mL
7/26/04 7:20	440	0.04	0.06	0.25	1.27	<0.01	49.7		114,000		38,300			500 mL
8/2/04 7:15	450	0.04	0.06	0.21	1.37	<0.01	70.5		118,000		37,100			350 mL
8/9/04 7:30	420	0.04	0.13	0.19	1.64	<0.01	69.3		107,000		37,000			190 mL
8/16/04 7:25	380	0.02	0.03	0.20	1.37	<0.01	57.1		98,700		32,400			330 mL
8/23/04 7:35	260	0.02	0.04	0.12	1.43	<0.01			50,600		32,400			120 mL
8/30/04 7:30	260	<0.01	0.03	0.05	1.39	<0.01	55.6		48,900		34,300			240 mL
9/7/04 7:25	360	0.01	0.03	0.27	1.09	<0.01	37.5	15.4	95,400		30,400	<3.0	<15.0	1180 mL
9/13/04 7:25	310	<0.01	0.04	0.16	0.88	<0.01	38.7	15.2	78,800		27,100	<3.0	<15.0	790 mL
9/20/04 8:25		<0.01	0.02	0.13	1.12	<0.01								380 mL
9/27/04 7:45		<0.01	0.03	0.08	1.22	<0.01								140 mL
10/4/04 7:30	320		0.10		1.10		53.5		85,500		26,100			150 mL
10/12/04 7:40		0.03	0.12	0.08	0.77	0.02								120 mL
10/18/04 7:50		<0.01	0.07	0.12	0.52	<0.01								215 mL
10/25/04 7:55		<0.01	0.08	0.04	0.57	0.05	46.7							200 mL

Table B. 6. Chemistry for samples from the lysimeter in the middle terrace, L2.

DATE	THARD	OP	TP	NH3_N	TKN	OX_N	COD	TOC	SCA	EFE	SMG	EPB	EZN	MISC
4/6/04 10:25	400	<0.01	0.01	0.07		0.03			109,000		32,300			180 mL
4/12/04 9:35	390	<0.01	0.01	0.07	0.46	<0.01	5.9	9.4	103,000		31,300	<3.0	<15.0	1330 mL
4/19/04 10:45	370	<0.01	<0.01		0.14	<0.01	6.2	2.2	97,500		29,900	<3.0	<15.0	1270 mL
4/26/04 9:10	380	<0.01	<0.01	0.09	0.20	<0.01	5.2	2.4	101,000		29,900	<3.0	<15.0	1330 mL
5/3/04 9:55	380	<0.01	<0.01	0.10	0.18	<0.01	2.4	2.1	97,200	493	34,300	<3.0	<15.0	1305 mL
5/10/04 11:50	380	<0.01	0.01	0.09	0.19	<0.01	4.0	2.1	96,400	463	33,700	<3.0	<15.0	1240 mL
5/17/04 9:40	380	<0.01	<0.01	0.12	0.26	<0.01	3.4	2.3	97,000		33,200	<3.0	<15.0	1230 mL
5/24/04 10:45	390	<0.01	<0.01	0.09	0.18	<0.01	5.8	3.8	97,700		34,400	<3.0	<15.0	1130 mL
6/2/04 8:55	390	<0.01	0.01	0.11	0.12	<0.01	5.1	4.2	98,800		34,200	3.9	<15.0	1335 mL
6/7/04 12:35	390	<0.01	0.01	0.10	0.19	<0.01	5.7	3.3	99,800		34,500	<3.0	<15.0	1245 mL
6/14/04 8:10	360	<0.01	<0.01	0.09	0.12	<0.01	5.6	3.0	95,500		29,200	<3.0	<15.0	1245 mL
6/21/04 7:30	390	<0.01	<0.01	0.10	0.15	<0.01	5.1	3.9	104,000		31,500	<3.0	<15.0	1300 mL
6/28/04 7:50	400	<0.01	<0.01	0.13	0.45	<0.01	5.3	3.6	107,000		31,600	3.6	<15.0	1290 mL
7/6/04 8:10	410	<0.01	0.01	0.09	0.21	<0.01	10.3	3.4	110,000		32,200	3.1	<15.0	1310 mL
7/12/04 6:45	420	<0.01	<0.01	0.09	0.16	<0.01	6.9	4.4	113,000		33,000	<3.0	<15.0	1260 mL
7/19/04 7:40	420	<0.01	0.02	0.10	0.18	<0.01	6.1	4.1	117,000		32,300	<3.0	<15.0	1270 mL
7/26/04 7:25	430	<0.01	0.02	0.12	0.31	<0.01	8.6	3.1	115,000		34,900	<3.0	<15.0	1300 mL
8/2/04 7:20	430	<0.01	0.02	0.12		<0.01	8.2	5.1	117,000		32,700	<3.0	<15.0	1370 mL
8/9/04 7:35	400	<0.01	0.02	0.10		<0.01	9.0	3.4	107,000		32,700	<3.0	<15.0	1270 mL
8/16/04 7:30	400	<0.01	<0.01	0.10	0.38	<0.01	10.1	3.5	109,000		32,100	<3.0	<15.0	1270 mL
8/23/04 7:40	380	<0.01	<0.01	0.08	0.28	<0.01	10.3	3.2	106,000		28,800	<3.0	<15.0	1230 mL
8/30/04 7:35	400	<0.01	<0.01	0.08	0.32	<0.01	8.2	3.7	106,000		32,200	<3.0	<15.0	1250 mL
9/7/04 7:30	410	<0.01	0.01	0.07	0.27	<0.01	9.3	3.0	113,000		32,100	<3.0	<15.0	1210 mL
9/13/04 7:30	400	<0.01	0.03	0.10	0.30	<0.01	10.7	3.9	109,000		31,900	<3.0	<15.0	1250 mL
9/20/04 8:30	420	<0.01	<0.01	0.06	0.32	<0.01	9.9	3.3	115,000		32,900	<3.0	<15.0	1270 mL
9/27/04 7:50	430	<0.01	0.02	0.07	0.36	<0.01	5.7	2.7	117,000		33,500	<3.0	<15.0	1240 mL
10/4/04 7:35	430		0.06		0.28		8.5	3.3	117,000		33,500	<3.0	<15.0	1240 mL
10/12/04 7:45	420	<0.01	0.07	0.08	0.28	<0.01	7.0	3.0	116,000		33,100	4.2	<15.0	1300 mL
10/18/04 7:45	440	<0.01	0.06	0.09	0.30	<0.01	7.6	2.7	119,000		34,100	<3.0	<15.0	1250 mL
10/25/04 8:00	430	<0.01	0.06	0.06	0.26	<0.01	5.2	2.5	115,000		35,200	<3.0	<15.0	1290 mL

Table B. 7. Chemistry for samples from the lysimeter in the crushed bluestone layer of the lower terrace, L3.

DATE	THARD	OP	TP	NH3_N	TKN	OX_N	COD	TOC	SCA	SMG	EPB	EZN	MISC
8/23/04 7:50	400	<0.01	0.01	0.33	0.57	<0.01	8.2	3.3	93,900	40,700	<3.0	<15.0	1210 mL
8/30/04 7:45	420	<0.01	0.12	0.27	0.59	<0.01	6.0	3.0	95,600	43,500	<3.0	<15.0	1000 mL
9/7/04 7:40	420	<0.01	0.01	0.22	0.48	<0.01	7.6	3.0	95,600	43,300	<3.0	<15.0	800 mL
9/13/04 7:40	400	<0.01	0.04	0.20	0.45	<0.01	6.8	3.0	89,500	43,900	<3.0	<15.0	865 mL
9/20/04 8:40	420	<0.01	0.01	0.18	0.58	<0.01	6.4	2.7	98,100	43,100	<3.0	<15.0	1390 mL
9/27/04 8:00	430	<0.01	0.02	0.23	0.66	<0.01	5.8	3.1	96,300	45,400	<3.0	<15.0	1830 mL
10/4/04 7:45	430		0.10		0.43		6.8	3.0	99,700	43,400	<3.0	<15.0	1830 mL
10/12/04 7:55	430	<0.01	0.08	0.17	0.48	<0.01	6.0	3.0	100,000	43,600	3.4	<15.00	1870 mL
10/18/04 7:35	430	<0.01	0.07	0.22	0.31	<0.01	7.2	3.2	101,000	44,000	<3.0	<15.0	1785 mL
10/25/04 8:10	420	<0.01	0.06	0.16	0.28	<0.01	5.8	2.9	95,400	45,200	<3.0	<15.0	1860 mL

Table B. 8. Chemistry for samples from the lysimeter in the clay topsoil layer of the lower terrace, L3clay.

DATE	THARD	OP	TP	NH3_N	TKN	OX_N	COD	TOC	SCA	EFE	SMG	EPB	EZN	MISC
4/6/04 10:15	290	<0.01	0.02	1.25		0.04			72,100		27,500			215 mL
4/12/04 9:30	330	0.03	0.06	2.00	3.04	0.02	41.1	24.3	59,600		43,000	<3.0	26.4	1260 mL
4/19/04 10:35	330	0.01	0.06		3.20	<0.01	38.4	21.6	61,100		42,500	<3.0	18.8	1240 mL
4/26/04 9:05	330	0.06	0.07	2.50	3.08	0.08	36.6	20.9	62,300		42,800	3.6	<15.0	1250 mL
5/3/04 9:50	390	0.06	0.09	2.73	3.41	0.08	34.8	22.9	66,000	21,000	55,400	<3.0	<15.0	1255 mL
5/10/04 11:45	390	<0.01	0.08	2.51	3.31	<0.01	35.4	24.3	66,300	23,000	53,900	<3.0	<15.0	1205 mL
5/17/04 9:35	380	0.02	0.11	2.29	3.39	<0.01	33.0	25.2	65,700		53,000	<3.0	<15.0	1225 mL
5/24/04 10:40	400	0.02	0.11	2.77	3.26	<0.01	30.9	26.5	66,300		55,800	3.8	<15.0	1125 mL
6/2/04 8:50	420	0.02	0.14	2.63	3.51	<0.01	29.1	28.1	69,400		58,900	3.2	<15.0	1300 mL
6/7/04 12:40	410	<0.01	0.10	2.54	3.36	<0.01	31.9	25.8	68,400		58,100	5.5	<15.0	1110 mL
6/14/04 8:15	410	<0.01	0.08	2.60	2.88	<0.01	31.1	26.4	68,300		57,300	6.4	<15.0	1255 mL
6/21/04 7:35	410	0.06	0.07	3.03	3.14	0.08	30.8	25.8	71,200		55,500	<3.0	<15.0	1250 mL
6/28/04 7:55	400	<0.01	0.02	2.56	3.60	<0.01	31.2	23.3	69,800		54,000	7.5	<15.0	1270 mL
7/6/04 8:15	420	<0.01	0.08	2.59	3.54	<0.01	30.3	22.2	73,200		56,400	6.7	<15.0	1290 mL
7/12/04 6:50	420	0.05	0.08	2.51	3.52	0.01	30.2	21.6	73,300		57,300	<3.0	<15.0	1260 mL
7/19/04 7:45	400	0.01	0.08	2.68	3.36	<0.01	30.0	20.9	73,500		53,300	4.8	<15.0	1260 mL
7/26/04 7:30	430	0.06	0.08	3.18	3.44	0.08	30.1	21.7	73,900		59,000	<3.0	<15.0	1230 mL
8/2/04 7:25	440	0.01	0.06	2.87	3.43	<0.01	30.7	20.5	76,200		59,500	4.0	<15.0	1250 mL
8/9/04 7:40	390	0.05	0.07	3.06	3.63	0.10	28.8	20.1	65,800		54,100	<3.0	<15.0	1270 mL
8/16/04 7:35	370	0.05		3.12	3.29	0.13	32.3	20.1	65,000		50,800	3.4	<15.0	1240 mL
8/23/04 7:45	330	0.05	0.05	2.98	4.21	0.11	32.7	20.8	63,200		43,100	<3.0	<15.0	1250 mL
8/30/04 7:40	370	0.04	0.05	3.01	3.69	0.12	31.2	19.7	66,000		48,700	<3.0	<15.0	1260 mL
9/7/04 7:35	360	0.02	0.05	3.01	3.76	<0.01	30.9	18.6	65,500		48,300	<3.0	<15.0	1100 mL
9/13/04 7:35		0.01	0.05	2.46	3.08	0.02								180 mL
9/20/04 8:35		0.02	0.05	2.25	3.16	0.02								140 mL
9/27/04 7:55		0.01	0.06	2.08	3.39	0.01								100 mL
10/4/04 7:40	400		0.12		3.64		40.7		72,000		52,400			180 mL
10/12/04 7:50		0.04	0.10	2.01	3.34	<0.01								130 mL
10/18/04 7:40		<0.01	0.07	2.15	3.01	0.04								170 mL
10/25/04 8:05		<0.01	0.08	2.31	3.26	<0.01	51.0							150 mL

Appendix C

Water Chemistry Analysis

About Appendix C:

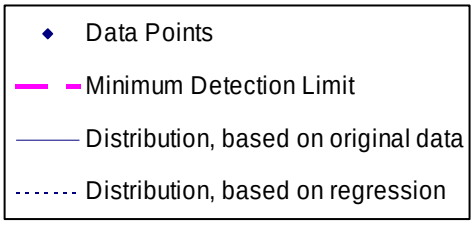
This appendix contains the following for each constituent:

- Summary Statistics: Statistics that were shown include the number of data points; how many of those data points were less than the minimum detection limit; the data points' mean, median, standard deviation, minimum, and maximum; the mean and standard deviation of the natural logarithms of the data points (only for lognormal distributions); which distribution type was chosen (normal or lognormal or uniform); the R^2 value for the linear or exponential regression on the probability plot; the median of the regression-calculated distribution (in the original units); and the mean and standard deviation for the regression-calculated distribution (in either original units or log units).
  - ***Bold, italic*** font was used as a reminder that log units are shown for the mean and standard deviations for the lognormal distributions, not the original units.
  - The abbreviation "Logn" means Lognormal.
  - "<MDL" means that the value for that statistic is less than the minimum detection limit.
  - "?" means that the statistic could not be calculated because at least one of the data values was less than the minimum detection limit.
  - [a] For the outflow baseflow samples from the riprap sampling location, one of the water samples was an outlier for almost every constituent. Its abnormality was probably related to the high flows occuring at that time (0.049 cfs, compared to the next highest flow of 0.008 cfs or the normal gaged flow of 0 cfs was normal), meaning that the flow was not just the normal slowly-seeping baseflow, but also contained some storm flow. That water sample (9/28/04) was removed from the analysis.
  - [b] The pH values were all assumed to be normally distributed.
  - [c] This distribution was assumed to be lognormal despite the fact that a linear regression would have a better R^2 value than the exponential regression did. If a linear regression / normal distribution were used in those cases, then the regression concentration at (z = -1) would negative. Using an exponential regression and lognormal distribution avoided negative data values.

- [d] When all of the data values were less than the minimum detection limit, then the distribution was assumed to be uniform between zero (0) and the detection limit (MDL).

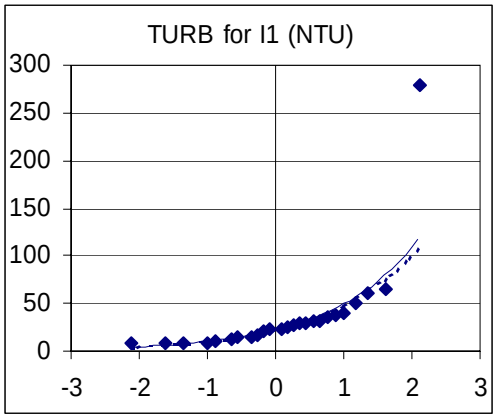
- Probability Plots: These are plots of the data point values versus their Z-scores at each sampling station, based on the equations in section 3.4.1.2. If there were at least 2 data points, then a linear regression or an exponential regression was performed and plotted; this dashed line approximates the data's normal or lognormal distribution. If all of the data was greater than the detection limit, then the distribution (solid line) could also be calculated using the original data's mean and standard deviation.

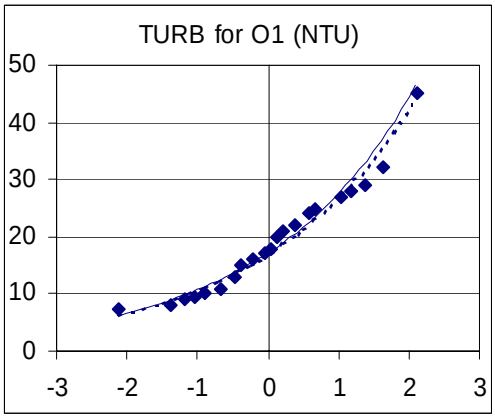
Legend for the Probability Plots:

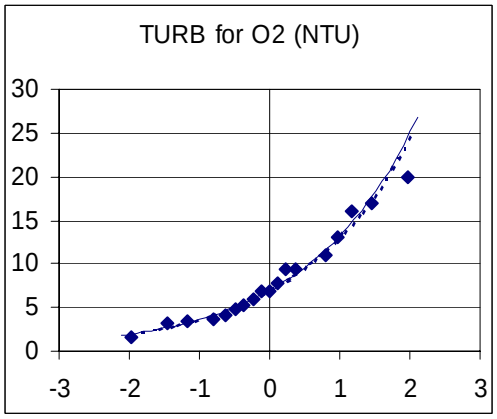


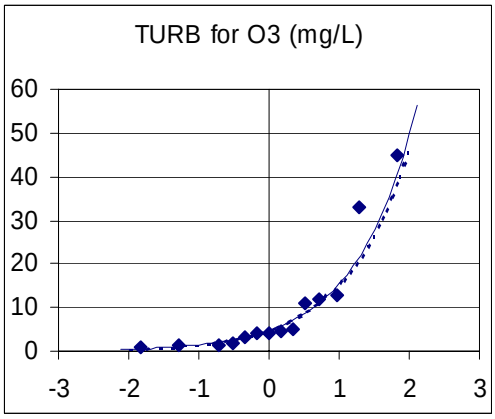
Suggested Data Distributions: To help visualize the relationships between the sampling locations, the distributions for all sampling stations were plotted on the same chart, in different colors. If a distribution could be estimated from original data, then that was used in the plot. If the only available distribution was calculated based on linear or exponential regression, then that regression was used. If all the data was less that the minimum detection limit, then a uniform distribution was plotted between zero and the detection limit. Each distribution was labed with the sample station's abbreviation (I1 for inflow, O1 for outflow storms, etc.), and a color legend was provided on each chart. The height of the probability distributions was adjusted such that the total integrated area under each curve equaled one, but the probability units themselves were not shown.

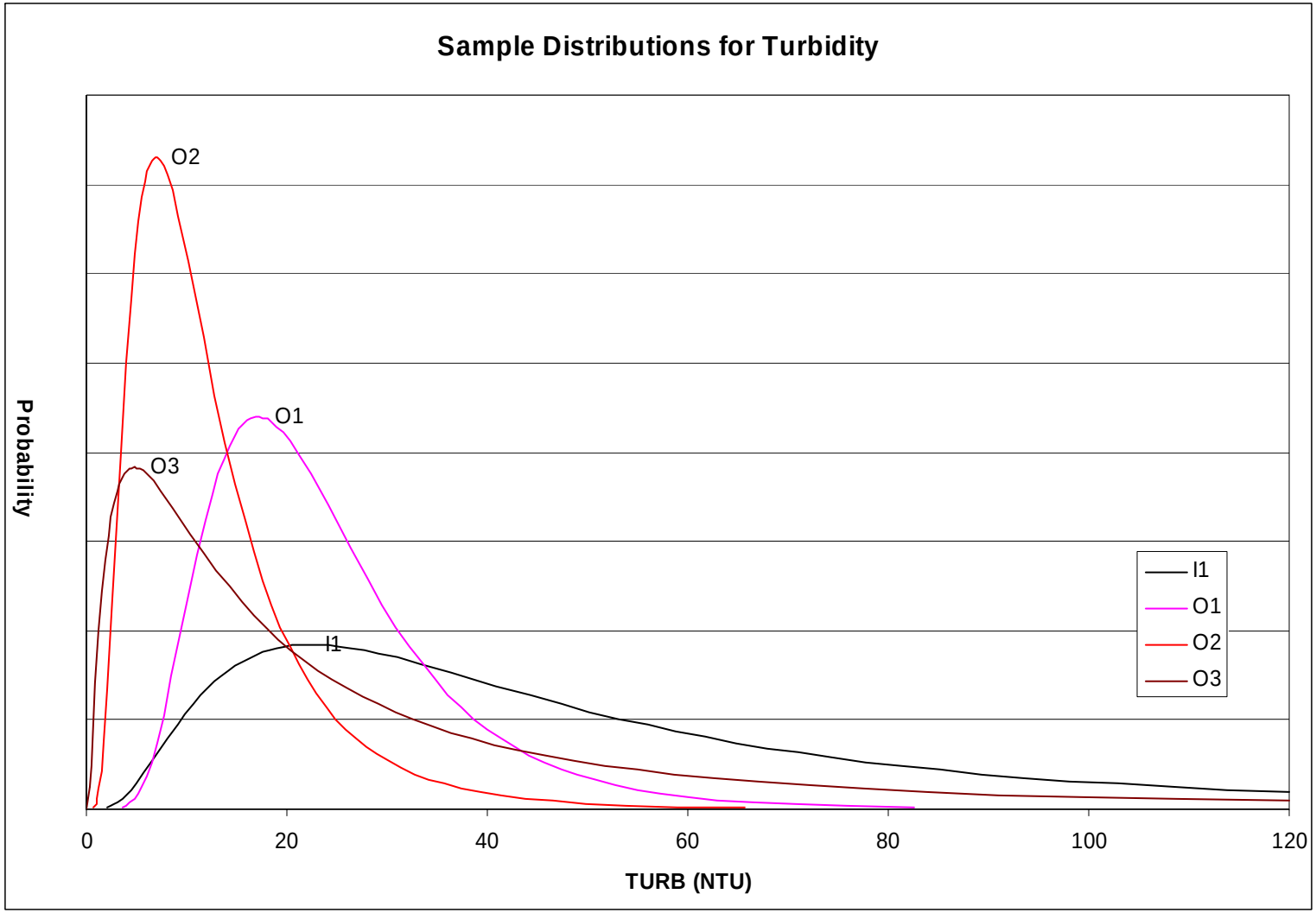
Turbidity, TURB (NTU)					
		Inflow I1	Outflow Storm O1	Upper Outflow Baseflow O2	Lower Outflow Baseflow O3 [a]
# Points …		29	30	21	15
From Data	Mean	33.538	19.06	8.3571	9.4733
	Median	24	17.5	6.9	4.3
	StDev	49.759	8.7484	5.0097	12.824
	Min	7.7	7.3	1.7	1.1
	Max	280	45	20	45
	Logn Mean	*3.1131*	*2.8431*	*1.9413*	*1.5700*
	Logn StDev	*0.7857*	*0.4743*	*0.6409*	*1.1712*
From Plots	Distribution	Lognormal	Lognormal	Lognormal	Lognormal
	R2	0.9102	0.9687	0.9781	0.9352
	Median	22.581	16.864	6.9002	4.8537
	Mean	*3.1171*	*2.8252*	*1.9316*	*1.5797*
	StDev	*0.7512*	*0.4611*	*0.6307*	*1.1341*



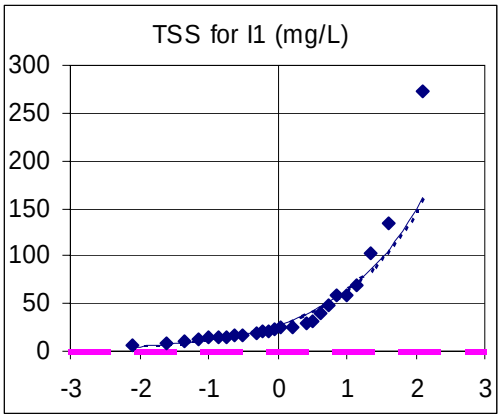


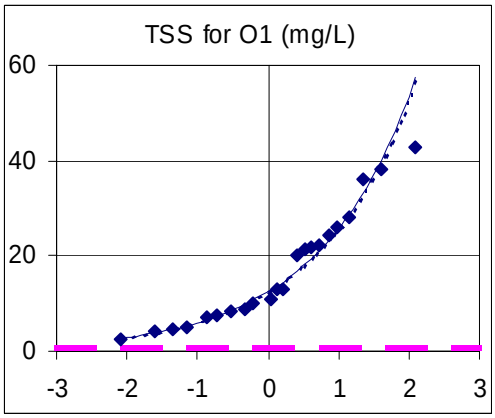


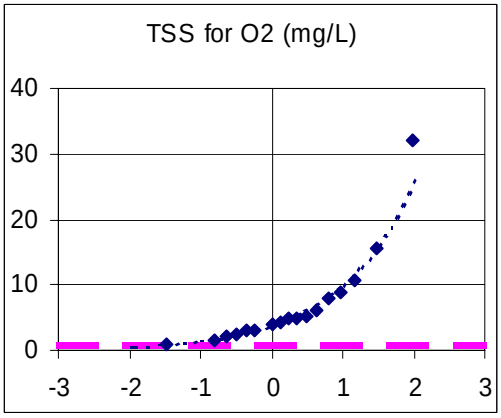


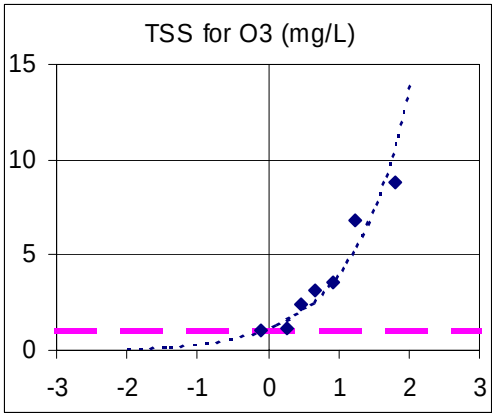

Sample Distributions for Turbidity
Probability
O2
O1
O3
I1
0
20
40
60
80
100
120
TURB (NTU)
I1
O1
O2
O3

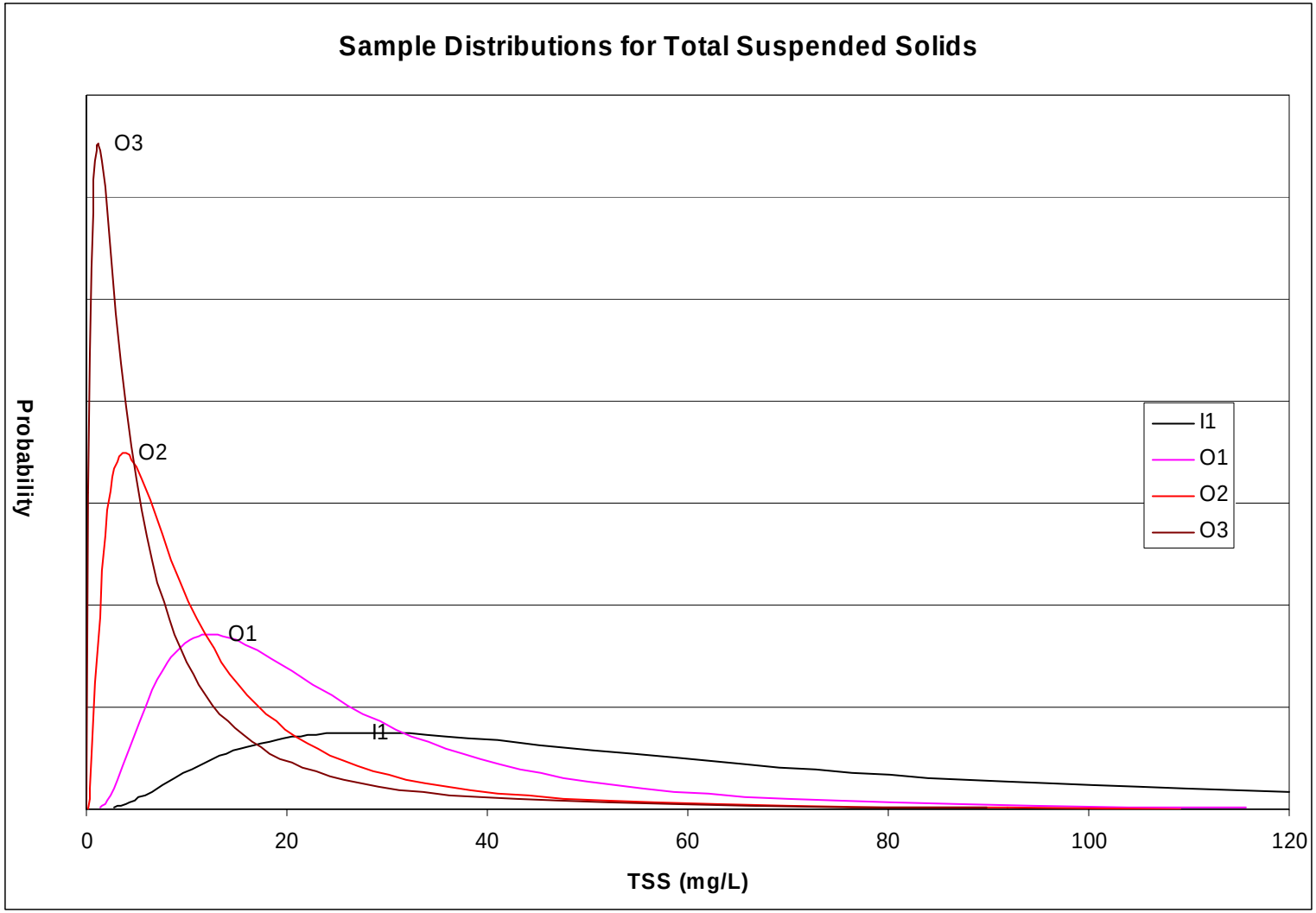
Total Suspended Solids, TSS (mg/L) minimum detection limit (MDL) = 1					
		Inflow I1	Outflow Storm O1	Upper Outflow Baseflow O2	Lower Outflow Baseflow O3 [a]
# Points (<MDL)		28	28	21 (2)	14 (7)
From Data	Mean	41.786	15.779	?	?
	Median	24.4	10.8	4	<MDL
	StDev	53.648	10.927	?	?
	Min	6.4	2.4	<MDL	<MDL
	Max	272	43	32	8.8
	Logn Mean	*3.3117*	*2.5196*	*?*	*?*
	Logn StDev	*0.8443*	*0.7287*	*?*	*?*
From Plots	Distribution	Lognormal	Lognormal	Lognormal	Logn [c]
	R2	0.9531	0.981	0.9861	0.9409
	Median	27.821	12.263	3.7673	1.1502
	Mean	*3.3258*	*2.5066*	*1.3264*	*0.1399*
	StDev	*0.8294*	*0.7273*	*0.9618*	*1.2452*





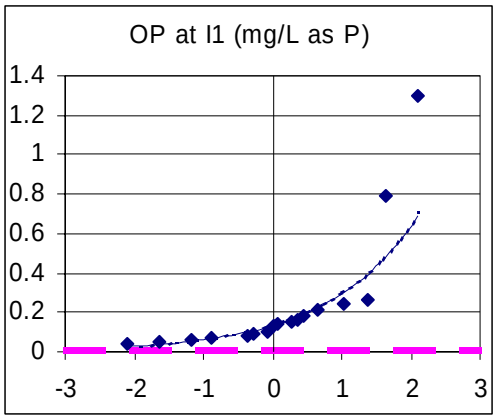


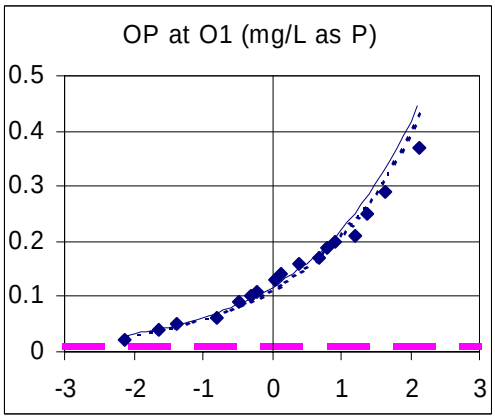


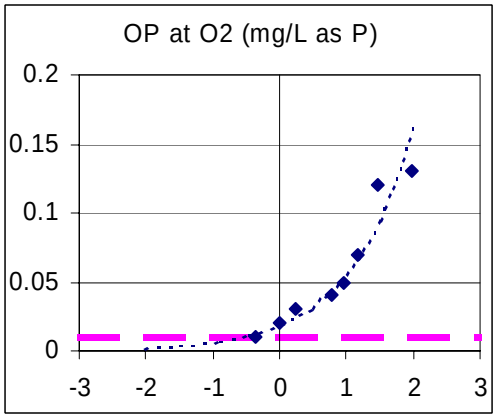

Sample Distributions for Total Suspended Solids
Probability
O3
O2
O1
I1
I1
O1
O2
O3
0
20
40
60
80
100
120
TSS (mg/L)

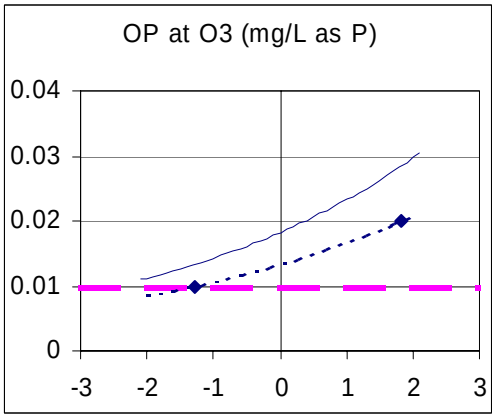
Ortho-Phosphate Phosphorus, OP (mg/L as P); MDL = 0.01									
		Inflow I1	Outflow Storm O1	Upper Outflow Baseflow O2	Lower Outflow Baseflow O3 [a]	Uppper Lysimeter L1	Middle Lysimeter L2	Lower Lysimeter L3	Lower Lysimeter in Clay L3clay
# Points (<MDL)		29	30	21 (4)	15	29 (15)	29 (29)	9 (9)	29 (8)
From Data	Mean	0.1966	0.139	?	0.0187	?	?	?	?
	Median	0.13	0.13	0.02	0.02	<MDL	<MDL	<MDL	0.02
	StDev	0.2543	0.0782	?	0.0035	?	?	?	?
	Min	0.04	0.02	<MDL	0.01	<MDL	<MDL	<MDL	<MDL
	Max	1.3	0.37	0.13	0.02	0.04	<MDL	<MDL	0.06
	Logn Mean	*-2.0076*	*-2.1442*	*?*	*-4.0044*	*?*	*?*	*?*	*?*
	Logn StDev	*0.7789*	*0.6365*	*?*	*0.2439*	*?*	*?*	*?*	*?*
From Plots	Distribution	Lognormal	Lognormal	Lognormal	Logn [c]	Logn [c]			Logn [c]
	R2	0.9026	0.9694	0.9566	1	0.7954			0.7105
	Median	0.1371	0.1108	0.0186	0.0133	0.01	Uniform[d]	Uniform[d]	0.0185
	Mean	*-1.9870*	*-2.2000*	*-3.9846*	*-4.3200*	*-4.6052*			*-3.9900*
	StDev	*0.7714*	*0.6373*	*1.0921*	*0.2225*	*0.7245*			*0.6984*

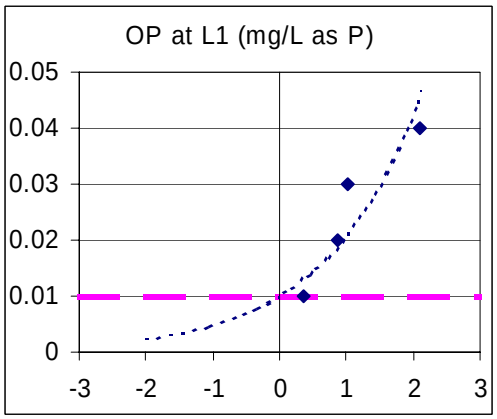
Total Phosphorus, TP (mg/L as P); MDL = 0.01									
		Inflow I1	Outflow Storm O1	Upper Outflow Baseflow O2	Lower Outflow Baseflow O3 [a]	Uppper Lysimeter L1	Middle Lysimeter L2	Lower Lysimeter L3	Lower Lysimeter in Clay L3clay
# Points (<MDL)		30	30	21	15	30 (1)	30 (13)	10	29
From Data	Mean	0.324	0.2183	0.0748	0.0347	?	?	0.052	0.0738
	Median	0.255	0.205	0.06	0.04	0.035	0.01	0.05	0.07
	StDev	0.2676	0.0968	0.0528	0.0119	?	?	0.0402	0.0270
	Min	0.1	0.06	0.02	0.02	<MDL	<MDL	0.01	0.02
	Max	1.36	0.46	0.21	0.06	0.13	0.07	0.12	0.14
	Logn Mean	*-1.3410*	*-1.6301*	*-2.8337*	*-3.4193*	*?*	*?*	*-3.3368*	
	Logn StDev	*0.6165*	*0.4978*	*0.7364*	*0.3567*	*?*	*?*	*1.0062*	
From Plots	Distribution	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Logn [c]	Normal
	R2	0.9364	0.9641	0.9209	0.9709	0.975	0.9433	0.825	0.9873
	Median	0.2604	0.1901	0.0561	0.0288	0.0291	0.0074	0.0348	0.0694
	Mean	*-1.3455*	*-1.6602*	*-2.8806*	*-3.5474*	*-3.5370*	*-4.9063*	*-3.3581*	0.0694
	StDev	*0.6217*	*0.4881*	*0.7400*	*0.4044*	*0.8237*	*1.1489*	*1.0096*	0.0306

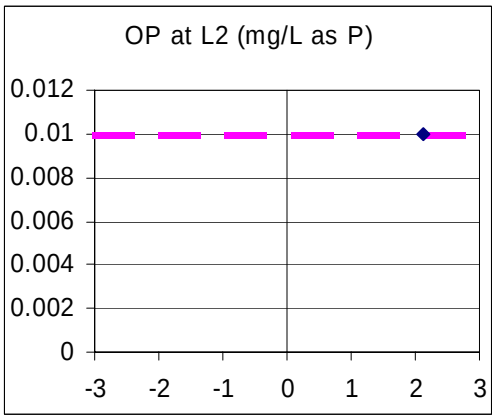

OP at I1 (mg/L as P)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-3 -2 -1 0 1 2 3

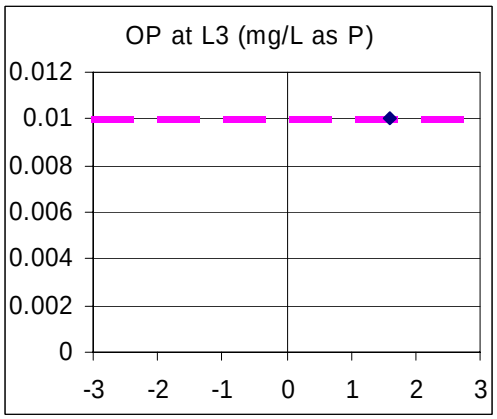

OP at O1 (mg/L as P)
0.5
0.4
0.3
0.2
0.1
0
-3 -2 -1 0 1 2 3

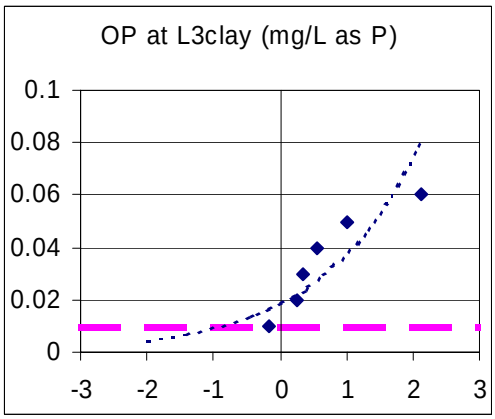

OP at O2 (mg/L as P)
0.2
0.15
0.1
0.05
0
-3 -2 -1 0 1 2 3

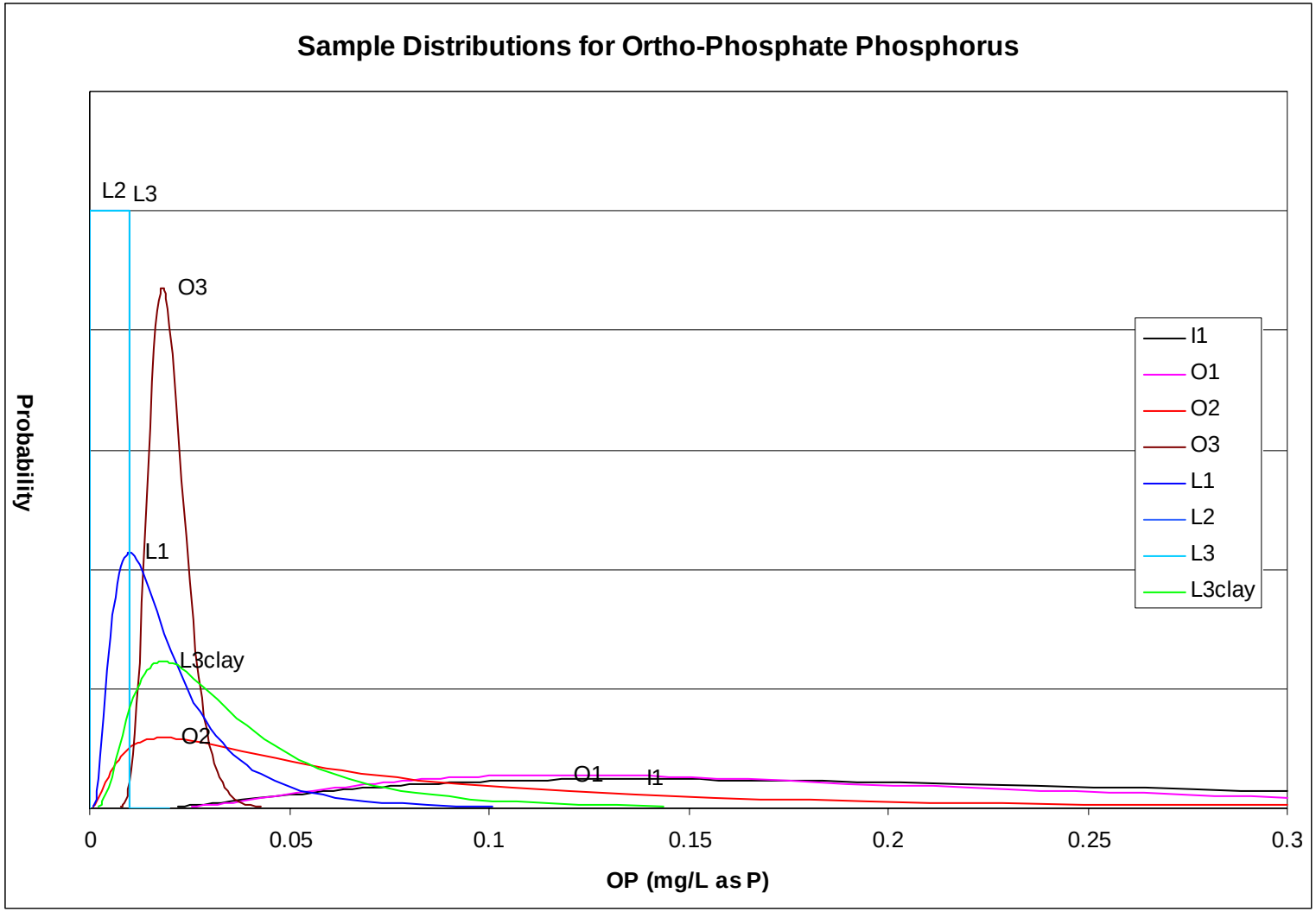

OP at O3 (mg/L as P)
0.04
0.03
0.02
0.01
0
-3 -2 -1 0 1 2 3

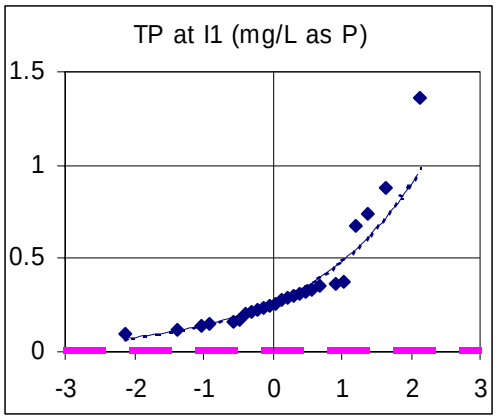

OP at L1 (mg/L as P)
0.05
0.04
0.03
0.02
0.01
0
-3 -2 -1 0 1 2 3

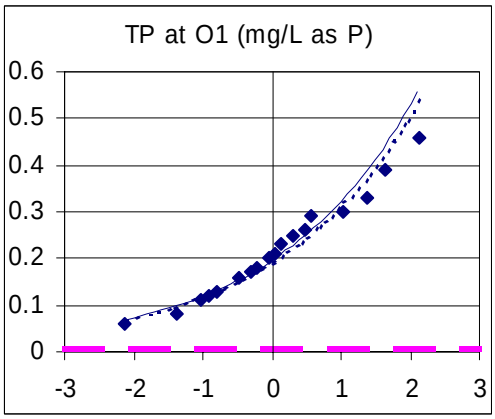

OP at L2 (mg/L as P)
0.012
0.01
0.008
0.006
0.004
0.002
0
-3 -2 -1 0 1 2 3

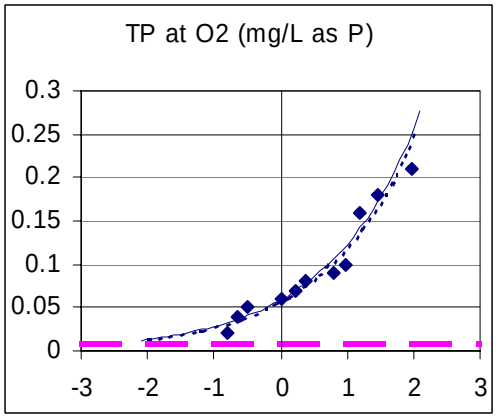

OP at L3 (mg/L as P)
0.012
0.01
0.008
0.006
0.004
0.002
0
-3 -2 -1 0 1 2 3

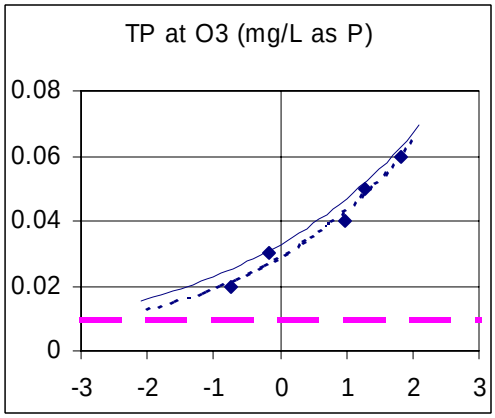

OP at L3clay (mg/L as P)
0.1
0.08
0.06
0.04
0.02
0
-3 -2 -1 0 1 2 3

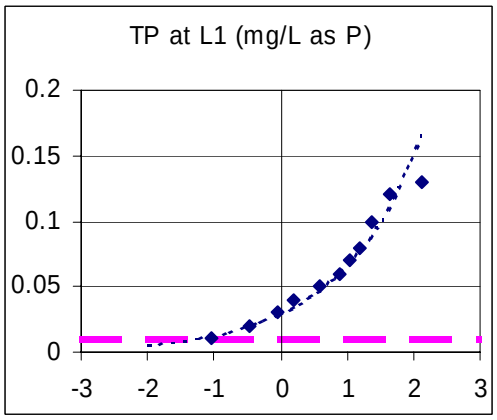

Sample Distributions for Ortho-Phosphate Phosphorus
Probability
L2
L3
O3
L1
L3clay
O2
O1
I1
I1
O1
O2
O3
L1
L2
L3
L3clay
0
0.05
0.1
0.15
0.2
0.25
0.3
OP (mg/L as P)

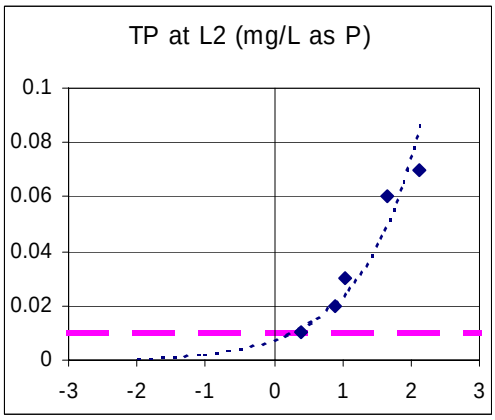

TP at I1 (mg/L as P)
1.5
1
0.5
0
-3
-2
-1
0
1
2
3

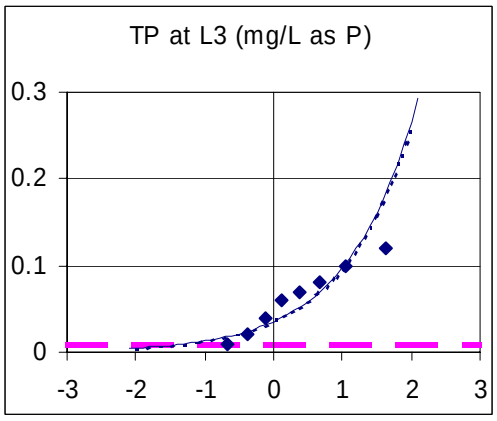

TP at O1 (mg/L as P)
0.6
0.5
0.4
0.3
0.2
0.1
0
-3
-2
-1
0
1
2
3

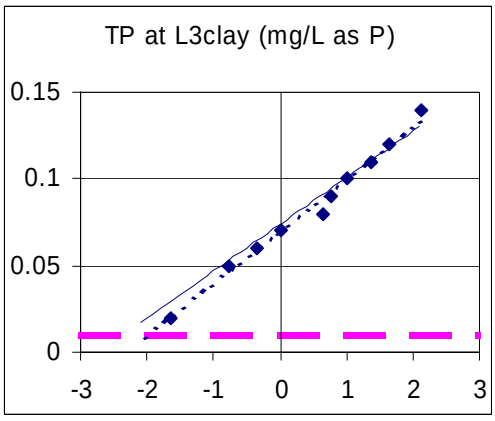

TP at O2 (mg/L as P)
0.3
0.25
0.2
0.15
0.1
0.05
0
-3
-2
-1
0
1
2
3

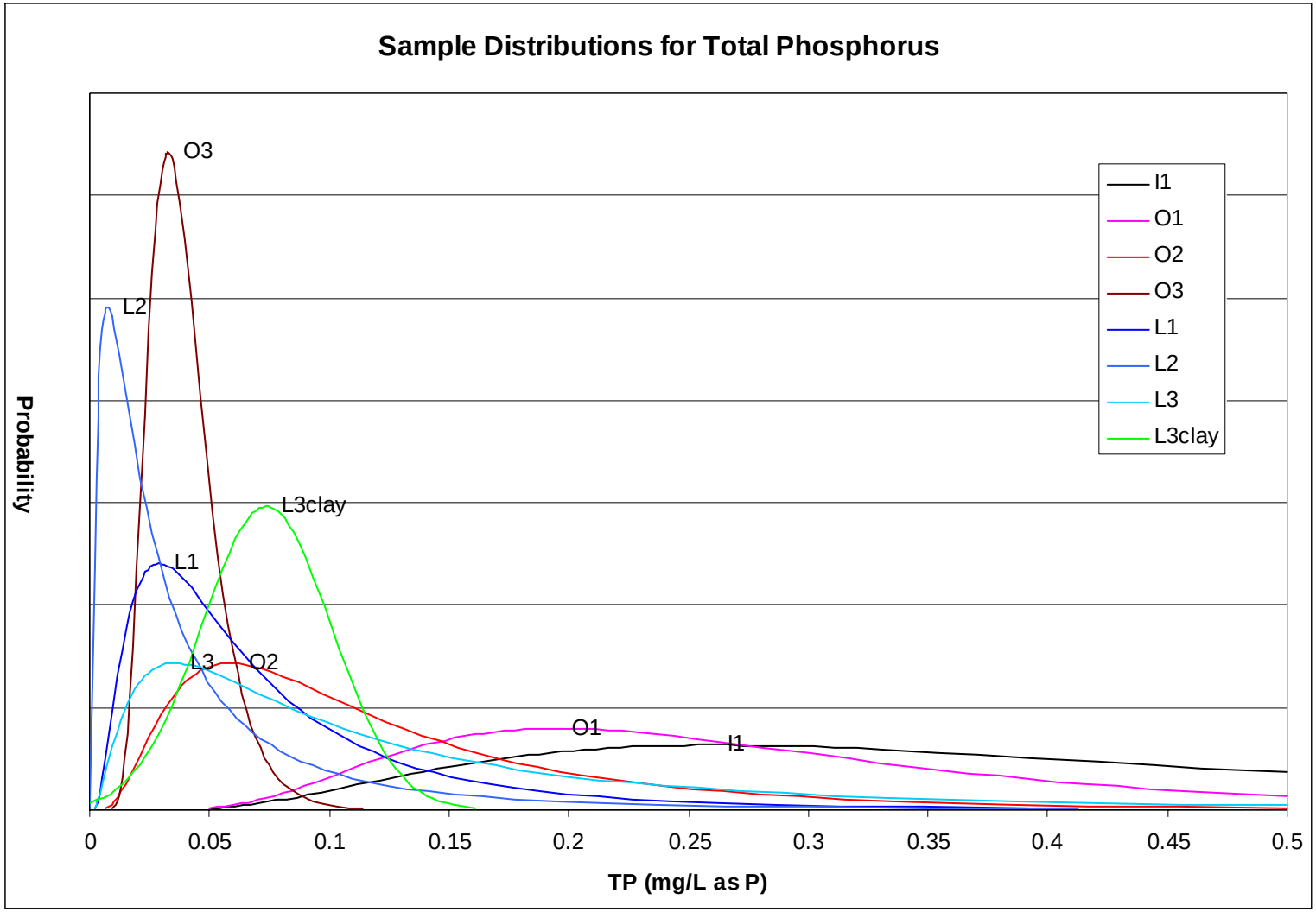

TP at O3 (mg/L as P)
0.08
0.06
0.04
0.02
0
-3
-2
-1
0
1
2
3


TP at L1 (mg/L as P)
0.2
0.15
0.1
0.05
0
-3
-2
-1
0
1
2
3


TP at L2 (mg/L as P)
0.1
0.08
0.06
0.04
0.02
0
-3
-2
-1
0
1
2
3

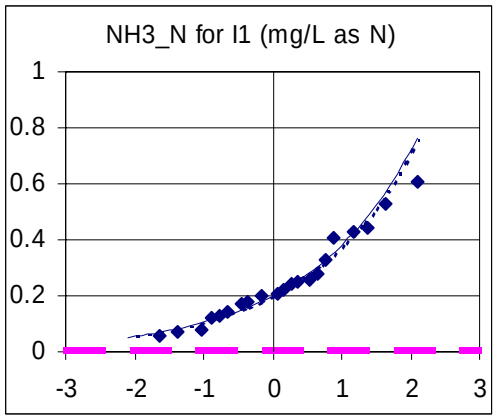

TP at L3 (mg/L as P)
0.3
0.2
0.1
0
-3
-2
-1
0
1
2
3

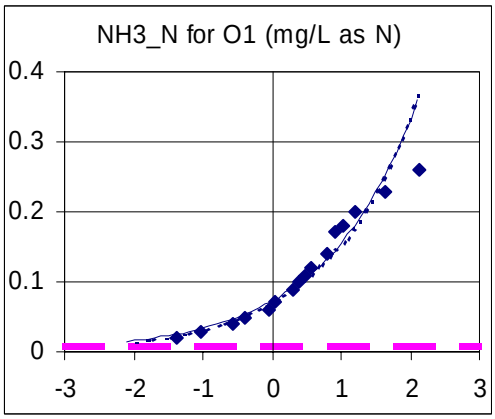

TP at L3clay (mg/L as P)
0.15
0.1
0.05
0
-3
-2
-1
0
1
2
3

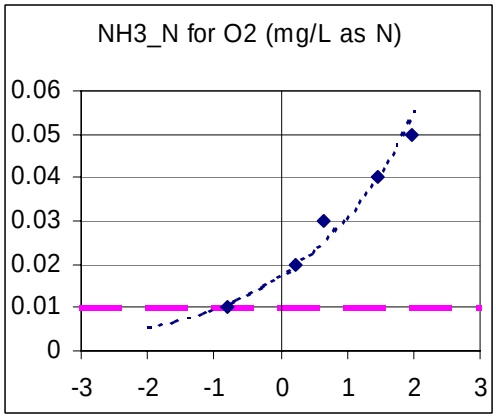

Sample Distributions for Total Phosphorus
Probability
TP (mg/L as P)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
I1
O1
O2
O3
L1
L2
L3
L3clay
O3
L2
L3clay
L1
L3
O2
O1
I1

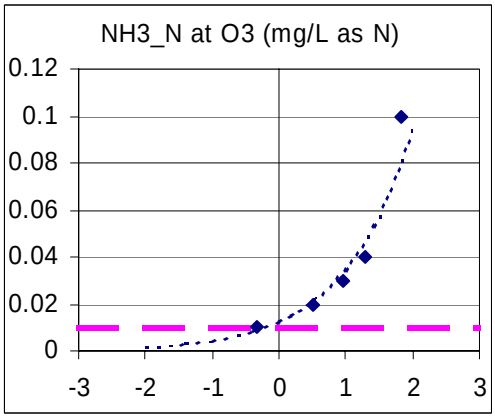
Ammonia, NH3_N (mg/L as N); MDL = 0.01									
		Inflow I1	Outflow Storm O1	Upper Outflow Baseflow O2	Lower Outflow Baseflow O3 [a]	Uppper Lysimeter L1	Middle Lysimeter L2	Lower Lysimeter L3	Lower Lysimeter in Clay L3clay
# Points (<MDL)		29	30	21 (2)	15 (3)	28	28	9	28
From Data	Mean	0.2407	0.0947	?	?	0.1557	0.0918	0.22	2.56
	Median	0.21	0.065	0.02	0.02	0.145	0.09	0.22	2.575
	StDev	0.1432	0.0694	?	?	0.0748	0.0183	0.0534	0.4270
	Min	0.06	0.02	<MDL	<MDL	0.04	0.06	0.16	1.25
	Max	0.61	0.26	0.05	0.1	0.31	0.13	0.33	3.18
	Logn Mean	*-1.6054*	*-2.6233*	*?*	*?*	*-1.9845*		*-1.5383*	
	Logn StDev	*0.6387*	*0.7608*	*?*	*?*	*0.5312*		*0.2292*	
From Plots	Distribution	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Normal	Lognormal	Normal
	R2	0.967	0.9674	0.97	0.9668	0.971	0.9893	0.9593	0.9295
	Median	0.1957	0.0688	0.0173	0.0125	0.1324	0.0885	0.2141	2.5531
	Mean	*-1.6312*	*-2.6766*	*-4.0570*	*-4.3820*	*-2.0219*	0.0885	*-1.5413*	2.5531
	StDev	*0.6367*	*0.7931*	*0.5796*	*1.0212*	*0.5300*	0.0191	*0.2271*	0.9295

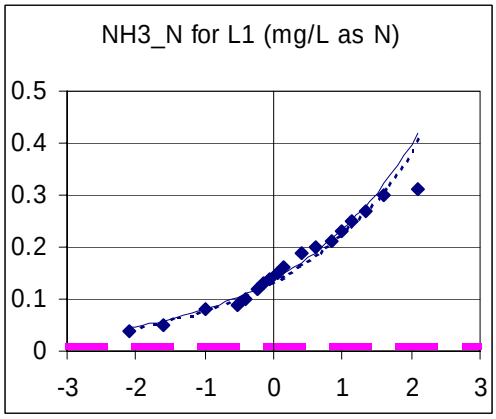
Total Kjeldahl Nitrogen, TKN (mg/L as N)									
		Inflow I1	Outflow Storm O1	Upper Outflow Baseflow O2	Lower Outflow Baseflow O3 [a]	Uppper Lysimeter L1	Middle Lysimeter L2	Lower Lysimeter L3	Lower Lysimeter in Clay L3clay
# Points …		30	30	21	13	28	25	8	27
From Data	Mean	1.304	0.967	0.6543	0.2669	1.105	0.2524	0.515	3.3715
	Median	1.18	0.925	0.57	0.25	1.11	0.26	0.525	3.36
	StDev	1.0551	0.2944	0.2976	0.0685	0.2299	0.0965	0.1086	0.2744
	Min	0.51	0.41	0.28	0.18	0.52	0.12	0.31	2.88
	Max	6.47	1.6	1.23	0.38	1.64	0.46	0.66	4.21
	Logn Mean	*0.1113*		*-0.5233*	*-1.3511*		*-1.4479*		*1.2123*
	Logn StDev	*0.5008*		*0.4590*	*0.2563*		*0.3887*		*0.0796*
From Plots	Distribution	Lognormal	Normal	Lognormal	Lognormal	Normal	Lognormal	Normal	Lognormal
	R2	0.8796	0.9871	0.9628	0.9535	0.9793	0.9737	0.9356	0.9639
	Median	1.1167	0.9672	0.5898	0.2598	1.1009	0.2312	0.5125	3.3597
	Mean	*0.1104*	0.9672	*-0.5280*	*-1.3478*	1.1009	*-1.4645*	0.5125	*1.2119*
	StDev	*0.4729*	0.2915	*0.4507*	*0.2495*	0.2273	*0.3962*	0.1078	*0.0786*

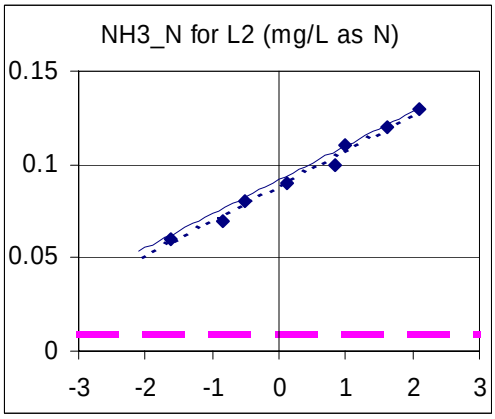

NH3_N for I1 (mg/L as N)
1
0.8
0.6
0.4
0.2
0
-3 -2 -1 0 1 2 3

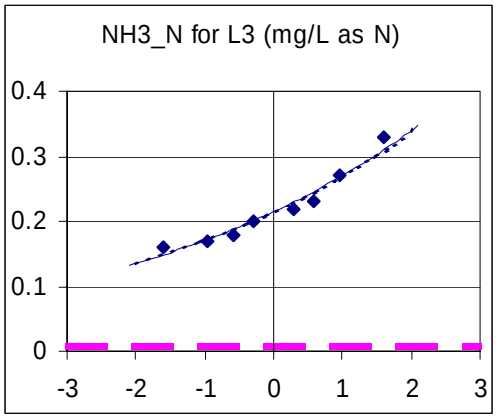

NH3_N for O1 (mg/L as N)
0.4
0.3
0.2
0.1
0
-3 -2 -1 0 1 2 3

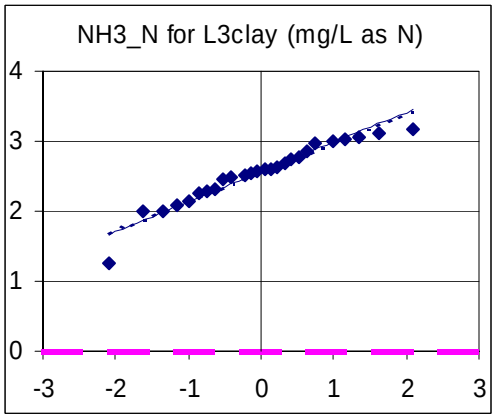

NH3_N for O2 (mg/L as N)
0.06
0.05
0.04
0.03
0.02
0.01
0
-3 -2 -1 0 1 2 3

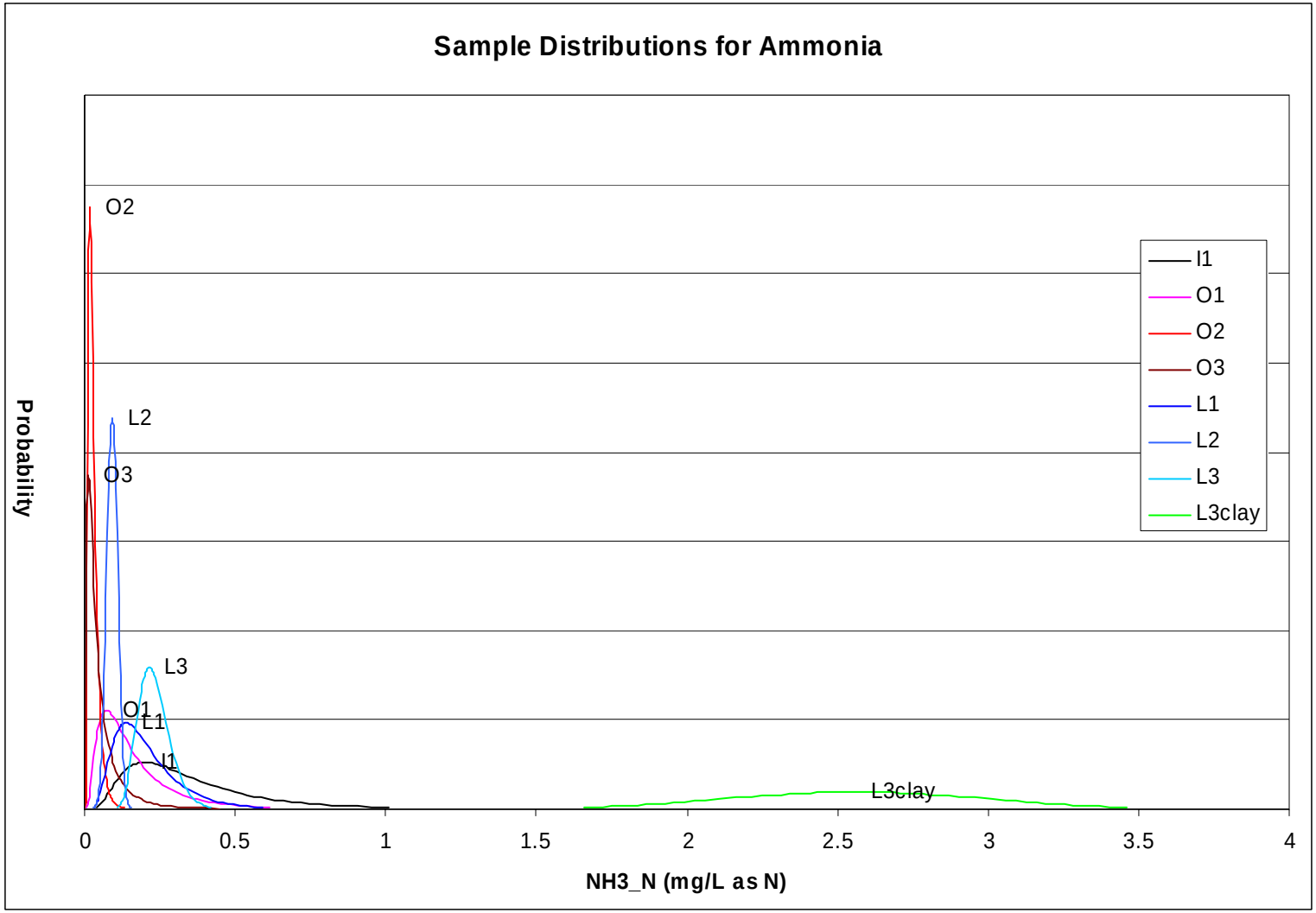

NH3_N at O3 (mg/L as N)
0.12
0.1
0.08
0.06
0.04
0.02
0
-3 -2 -1 0 1 2 3

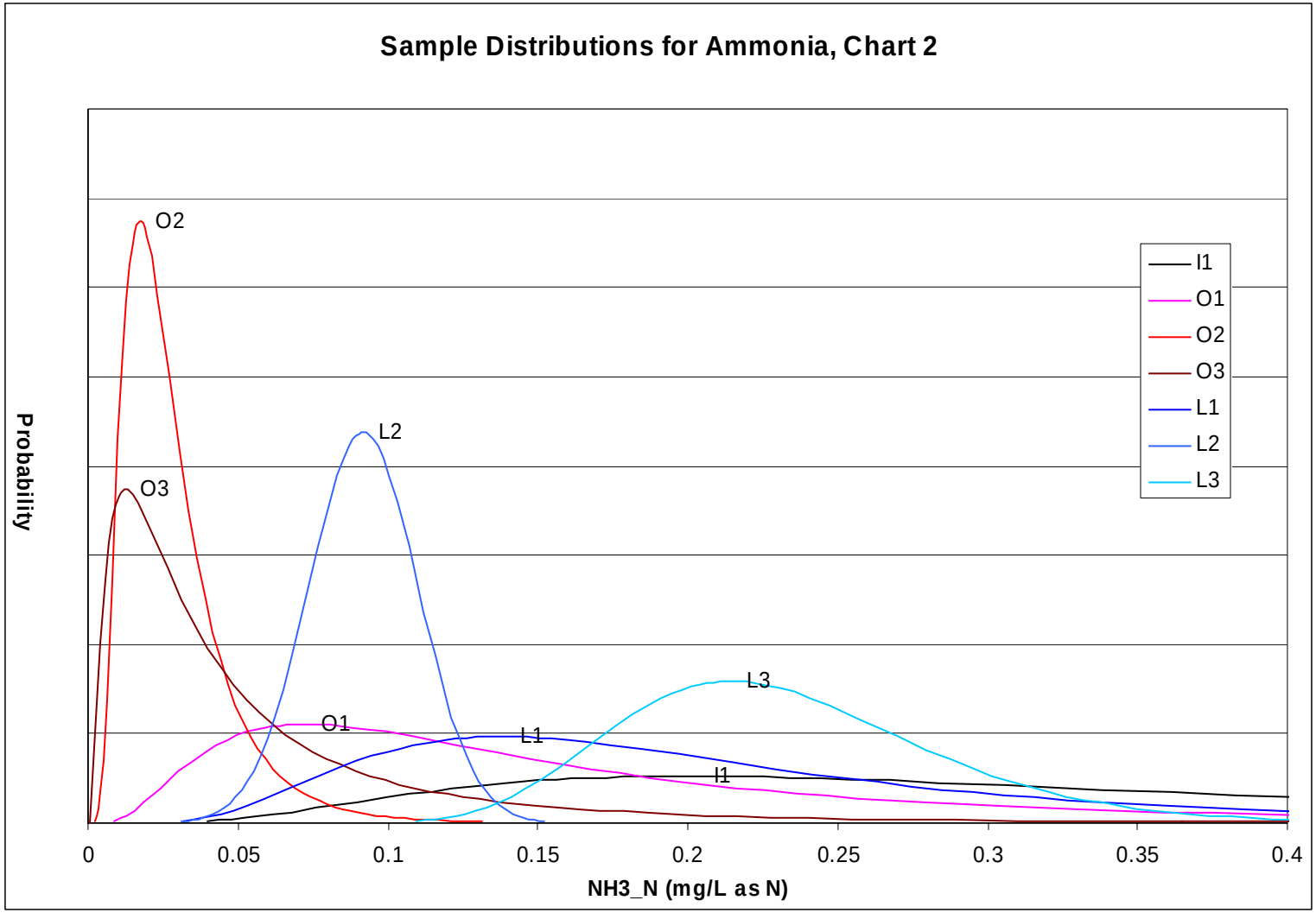

NH3_N for L1 (mg/L as N)
0.5
0.4
0.3
0.2
0.1
0
-3 -2 -1 0 1 2 3

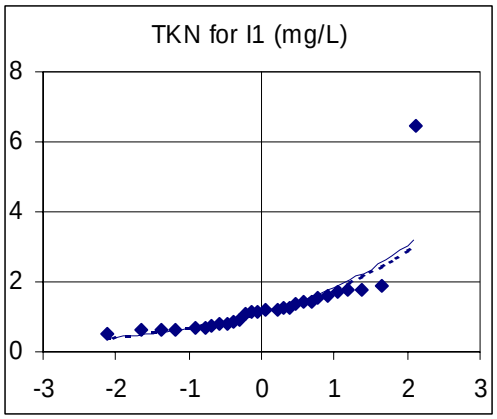

NH3_N for L2 (mg/L as N)
0.15
0.1
0.05
0
-3 -2 -1 0 1 2 3

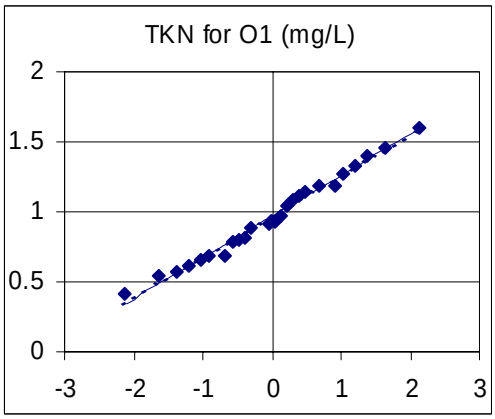

NH3_N for L3 (mg/L as N)
0.4
0.3
0.2
0.1
0
-3 -2 -1 0 1 2 3

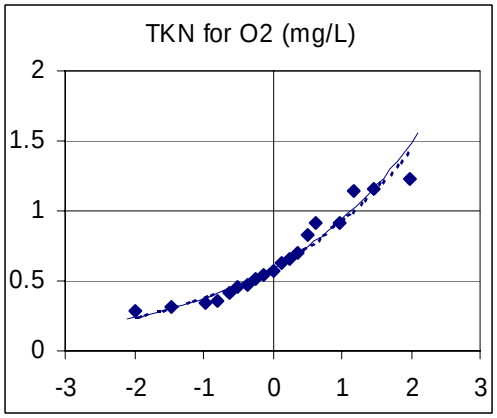

NH3_N for L3clay (mg/L as N)
4
3
2
1
0
-3 -2 -1 0 1 2 3

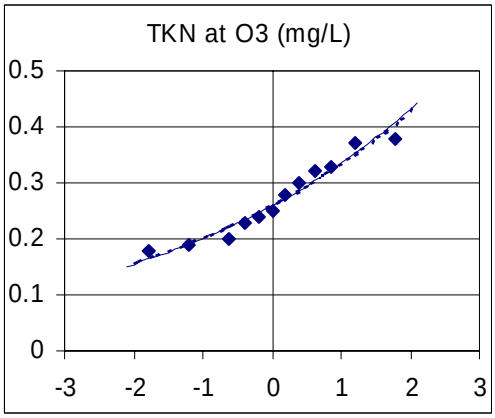

Sample Distributions for Ammonia
Probability
O2
L2
O3
L3
O1
L1
I1
L3clay
I1
O1
O2
O3
L1
L2
L3
L3clay
0
0.5
1
1.5
2
2.5
3
3.5
4
NH3_N (mg/L as N)

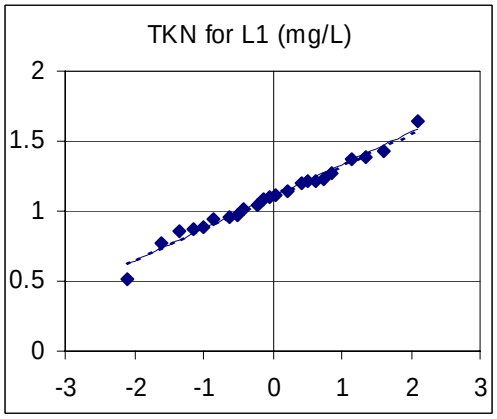

Sample Distributions for Ammonia, Chart 2
Probability
NH3_N (mg/L as N)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
O2
O3
L2
O1
L1
I1
L3
I1
O1
O2
O3
L1
L2
L3

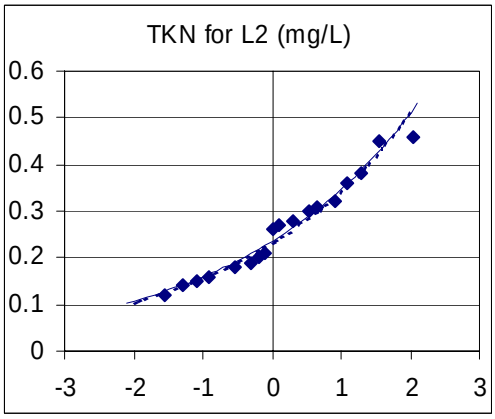

TKN for I1 (mg/L)
8
6
4
2
0
-3 -2 -1 0 1 2 3

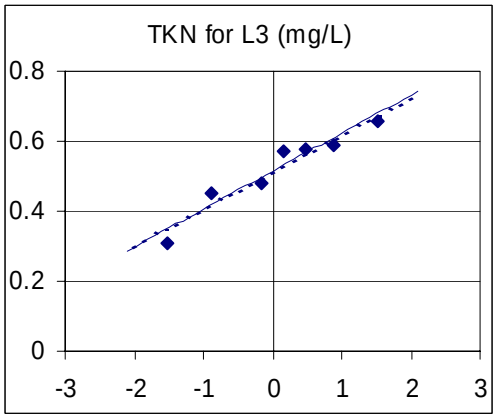

TKN for O1 (mg/L)
2
1.5
1
0.5
0
-3 -2 -1 0 1 2 3

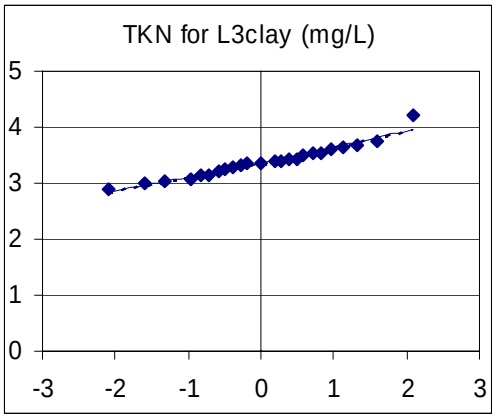

TKN for O2 (mg/L)
2
1.5
1
0.5
0
-3 -2 -1 0 1 2 3

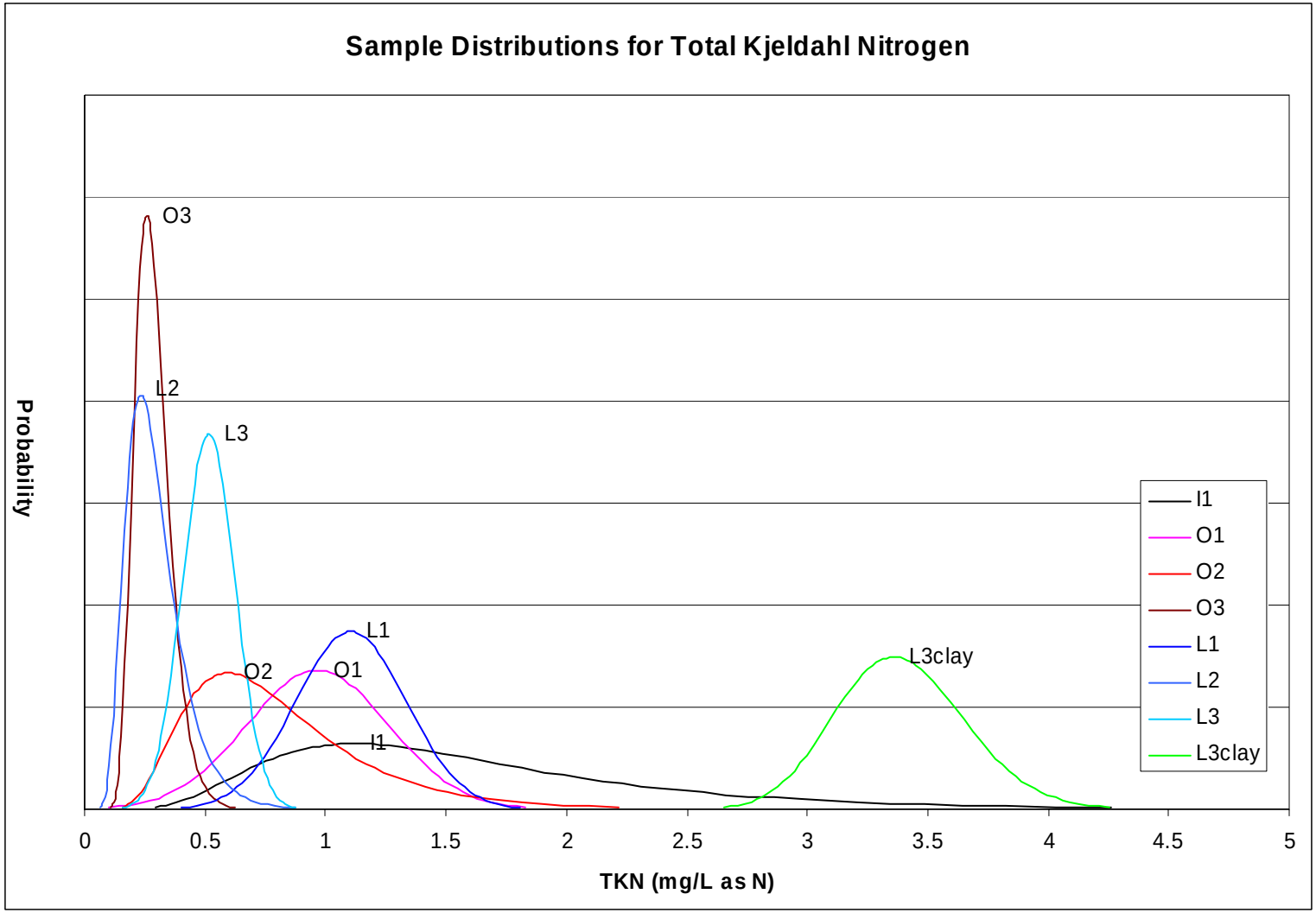

TKN at O3 (mg/L)
0.5
0.4
0.3
0.2
0.1
0
-3 -2 -1 0 1 2 3


TKN for L1 (mg/L)
2
1.5
1
0.5
0
-3 -2 -1 0 1 2 3

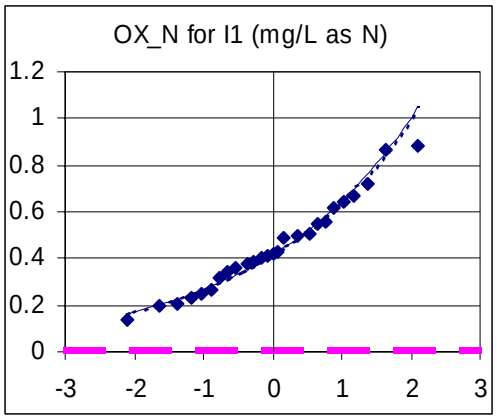

TKN for L2 (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0
-3 -2 -1 0 1 2 3

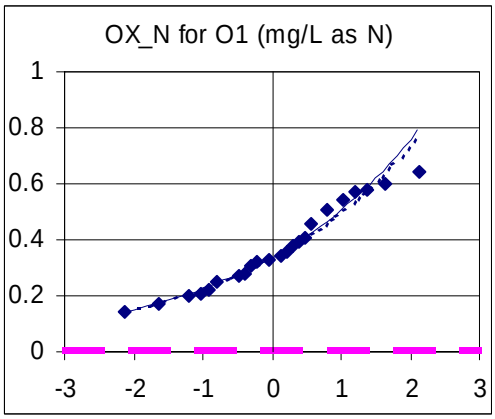

TKN for L3 (mg/L)
0.8
0.6
0.4
0.2
0
-3 -2 -1 0 1 2 3

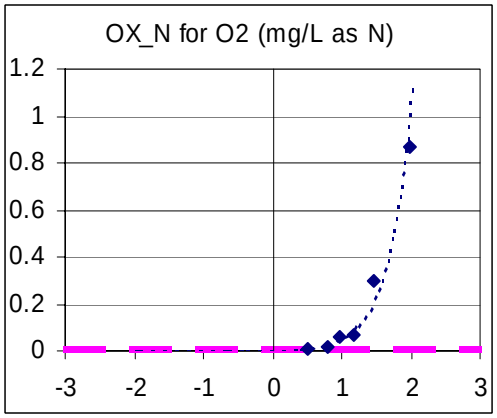

TKN for L3clay (mg/L)
5
4
3
2
1
0
-3 -2 -1 0 1 2 3

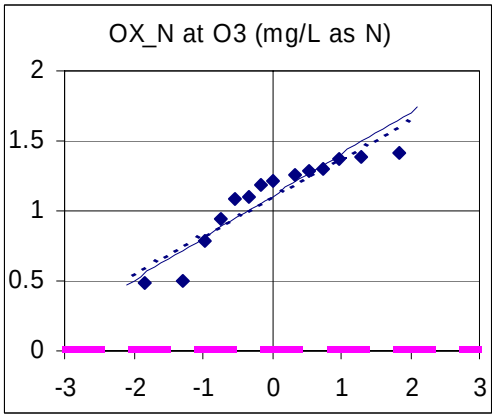

Sample Distributions for Total Kjeldahl Nitrogen
Probability
TKN (mg/L as N)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
O3
L2
L3
L1
O2
O1
I1
L3clay
I1
O1
O2
O3
L1
L2
L3
L3clay

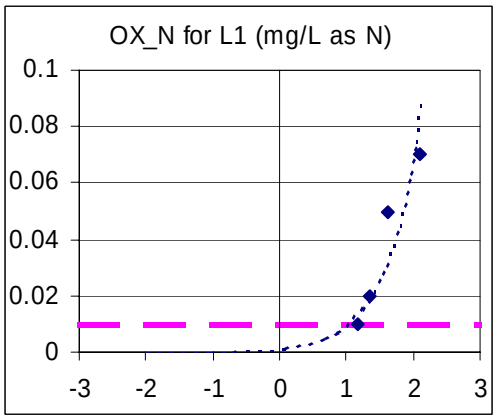
Oxidized Nitrogen, OX_N (mg/L as N); MDL = 0.01									
		Inflow I1	Outflow Storm O1	Upper Outflow Baseflow O2	Lower Outflow Baseflow O3 [a]	Uppper Lysimeter L1	Middle Lysimeter L2	Lower Lysimeter L3	Lower Lysimeter in Clay L3clay
# Points (<MDL)		29	30	21 (14)	15	29 (26)	29 (28)	9 (9)	29 (14)
From Data	Mean	0.4534	0.3647	?	1.1053	?	?	?	?
	Median	0.42	0.335	<MDL	1.22	<MDL	<MDL	<MDL	0.01
	StDev	0.1867	0.1413	?	0.3004	?	?	?	?
	Min	0.14	0.14	<MDL	0.49	<MDL	<MDL	<MDL	<MDL
	Max	0.88	0.64	0.87	1.42	0.07	0.03	<MDL	0.13
	Logn Mean	*-0.8787*	*-1.0849*	*?*		*?*	*?*	*?*	*?*
	Logn StDev	*0.4417*	*0.4047*	*?*		*?*	*?*	*?*	*?*
From Plots	Distribution	Lognormal	Lognormal	Lognormal	Normal	Logn [c]	Logn [c]		Logn [c]
	R2	0.9775	0.9781	0.974	0.8548	0.8724	1		0.8374
	Median	0.4124	0.333	0.0022	1.0976	0.0012	0.0003	Uniform[d]	0.0151
	Mean	*-0.8858*	*-1.0996*	*-6.1193*	1.0976	*-6.7254*	*-8.1117*		*-4.1931*
	StDev	*0.4388*	*0.3970*	*3.1210*	0.2774	*2.0211*	*2.2604*		*1.2789*

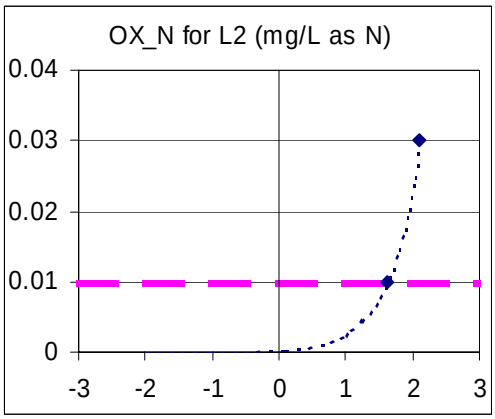

OX_N for I1 (mg/L as N)
1.2
1
0.8
0.6
0.4
0.2
0
-3 -2 -1 0 1 2 3

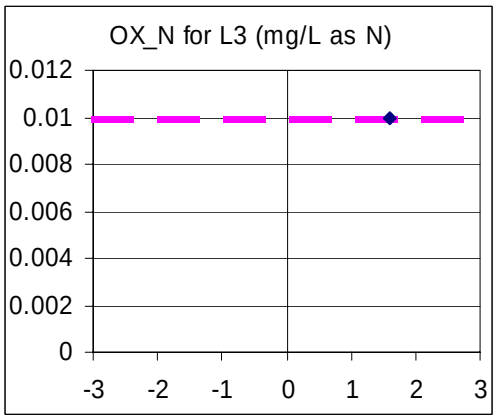

OX_N for O1 (mg/L as N)
1
0.8
0.6
0.4
0.2
0
-3 -2 -1 0 1 2 3

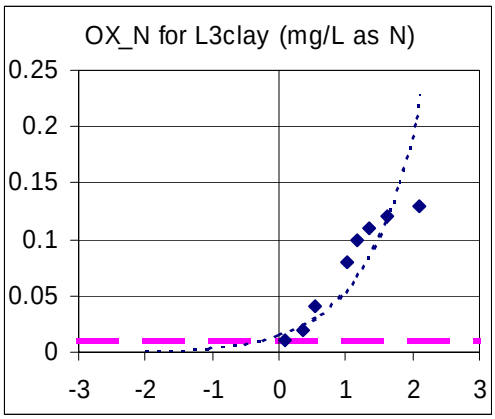

OX_N for O2 (mg/L as N)
1.2
1
0.8
0.6
0.4
0.2
0
-3 -2 -1 0 1 2 3

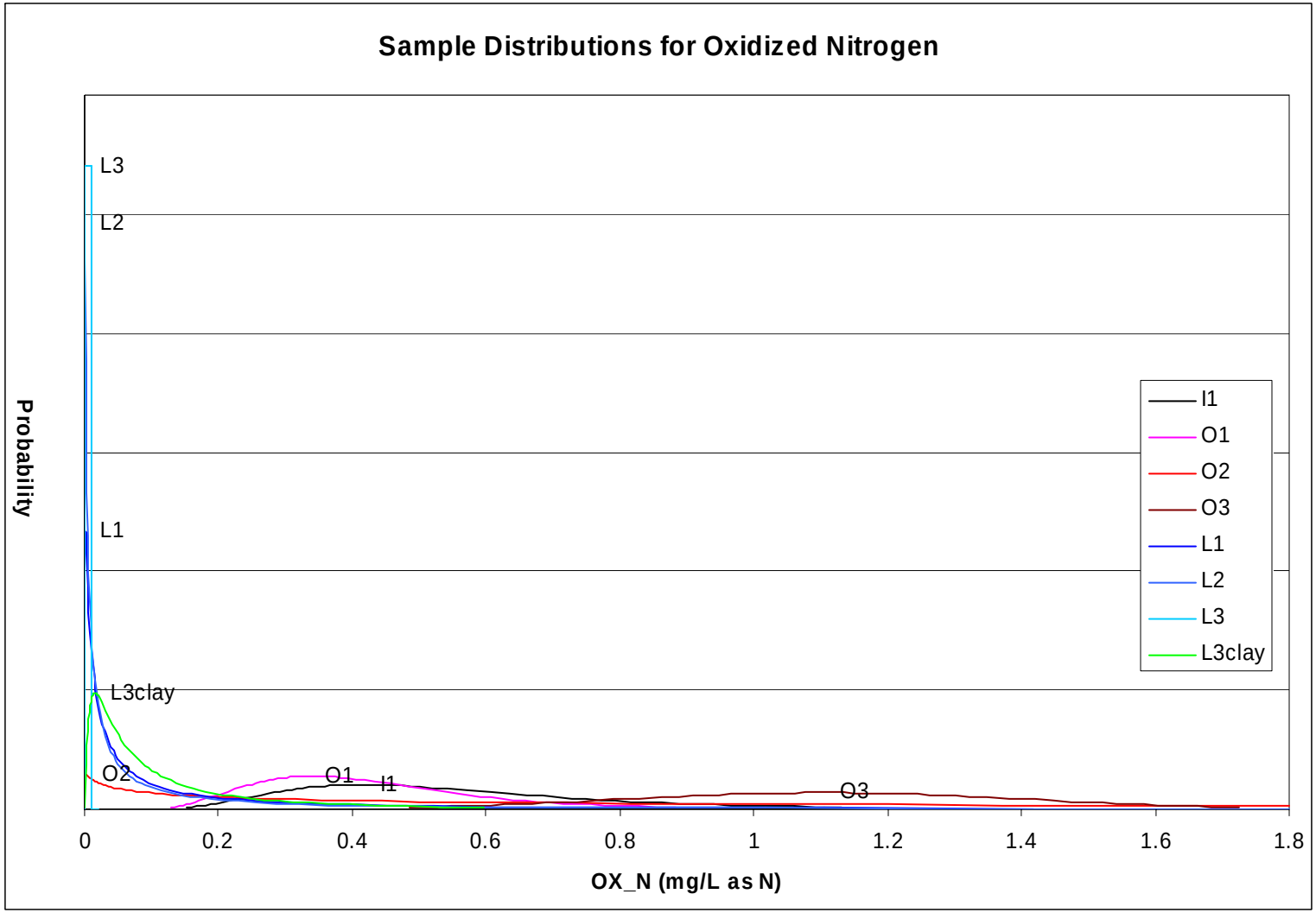

OX_N at O3 (mg/L as N)
2
1.5
1
0.5
0
-3 -2 -1 0 1 2 3

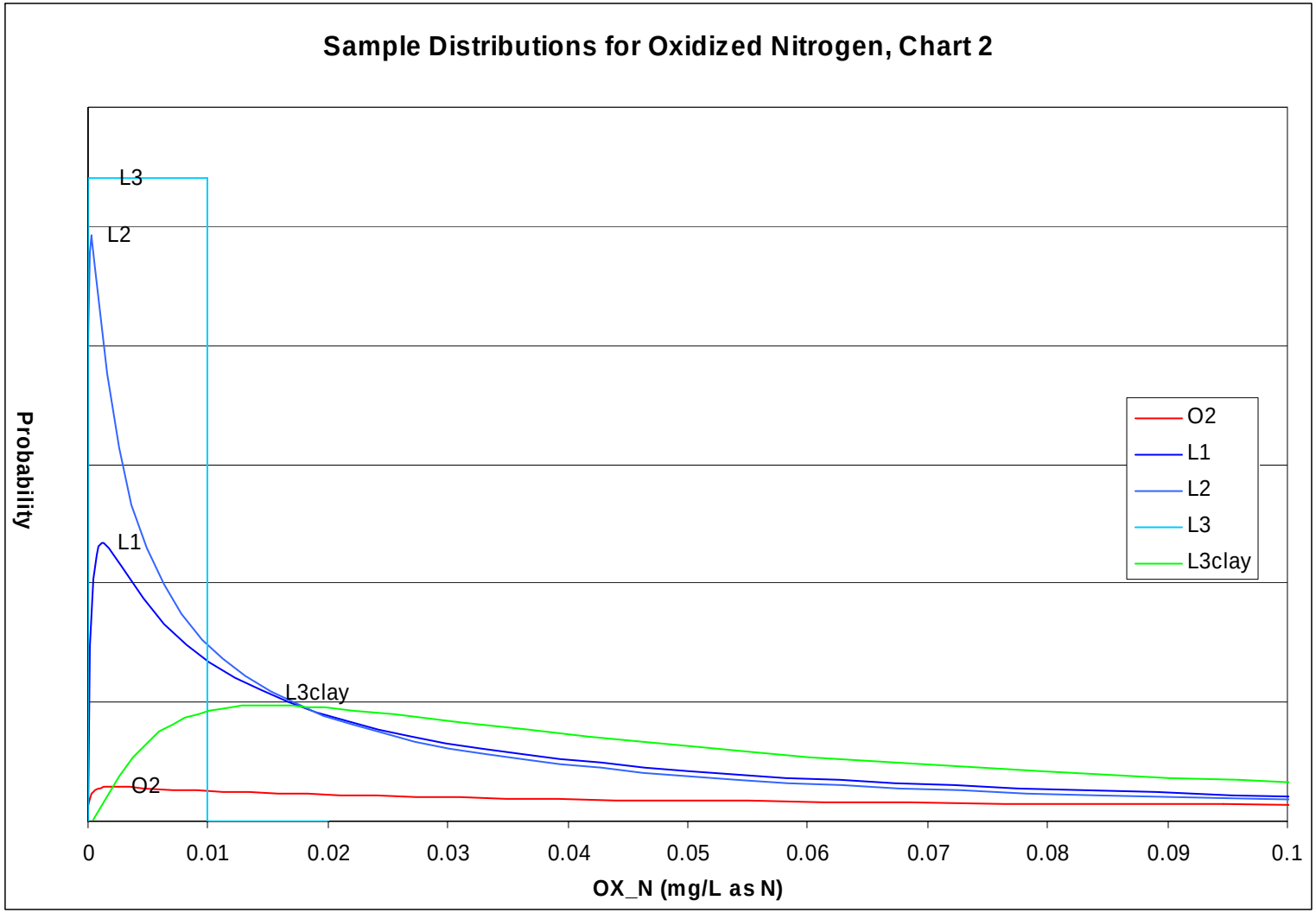

OX_N for L1 (mg/L as N)
0.1
0.08
0.06
0.04
0.02
0
-3 -2 -1 0 1 2 3


OX_N for L2 (mg/L as N)
0.04
0.03
0.02
0.01
0
-3 -2 -1 0 1 2 3

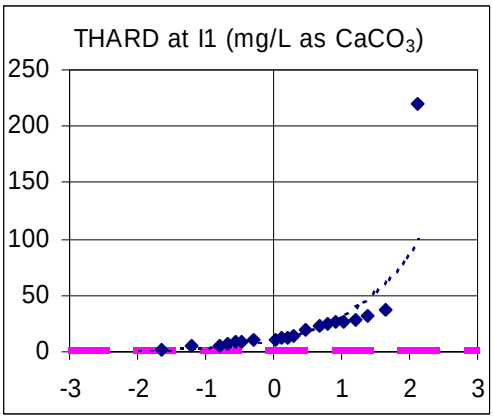

OX_N for L3 (mg/L as N)
0.012
0.01
0.008
0.006
0.004
0.002
0
-3 -2 -1 0 1 2 3

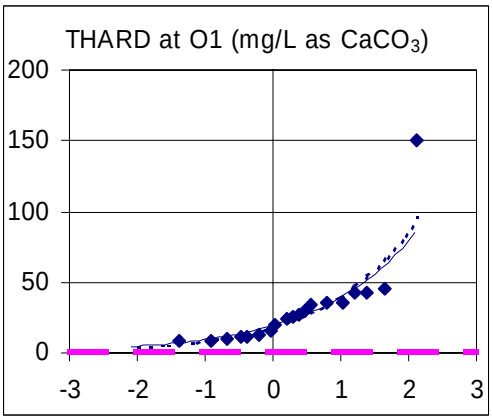

OX_N for L3clay (mg/L as N)
0.25
0.2
0.15
0.1
0.05
0
-3 -2 -1 0 1 2 3

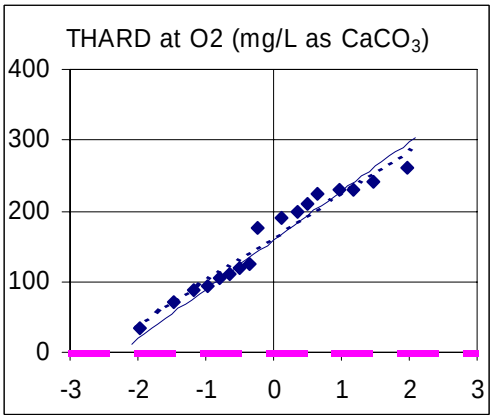

Sample Distributions for Oxidized Nitrogen
Probability
L3
L2
L1
L3clay
O2
O1
I1
O3
I1
O1
O2
L1
L2
L3
L3clay
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
OX_N (mg/L as N)

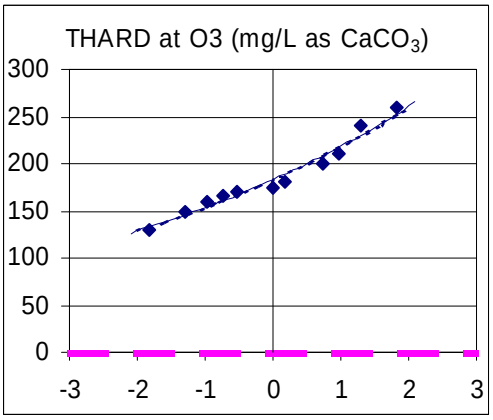

Sample Distributions for Oxidized Nitrogen, Chart 2
Probability
L3
L2
L1
L3clay
O2
O2
L1
L2
L3
L3clay
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
OX_N (mg/L as N)

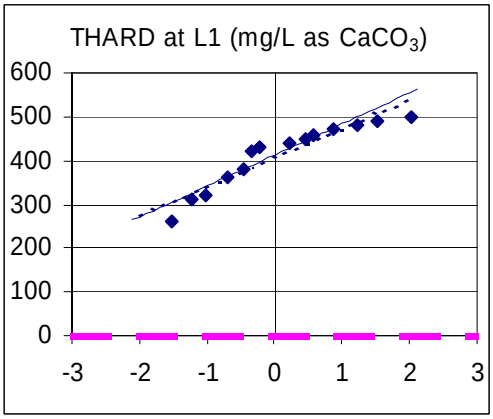
Total Hardness, THARD (mg/L as $CaCO_3$); MDL = 1									
		Inflow I1	Outflow Storm O1	Upper Outflow Baseflow O2	Lower Outflow Baseflow O3 [a]	Uppper Lysimeter L1	Middle Lysimeter L2	Lower Lysimeter L3	Lower Lysimeter in Clay L3clay
# Points (<MDL)		30 (2)	30	21	15	23	30	10	24
From Data	Mean	?	25.567	167.52	186	412.61	402.32	420	384.17
	Median	11	17.5	190	175	440	400	420	395
	StDev	?	26.484	64.992	33.552	71.045	20.969	11.547	38.325
	Min	<MDL	8	35	130	260	360	400	290
	Max	220	150	260	260	500	440	430	440
	Logn Mean	*?*	*2.9550*		*5.2111*				
	Logn StDev	*?*	*0.7114*		*0.1765*				
From Plots	Distribution	Lognormal	Lognormal	Normal	Lognormal	Normal	Normal	Normal	Normal
	R2	0.9022	0.9311	0.9513	0.969	0.8867	0.9792	0.9305	0.9348
	Median	11.268	18.166	162.63	182.96	405.64	400	413.99	379.17
	Mean	*2.4220*	*2.8996*	162.63	*5.2093*	405.64	400	413.99	379.17
	StDev	*1.0200*	*0.7758*	62.199	*0.1746*	65.887	18.737	10.958	35.989

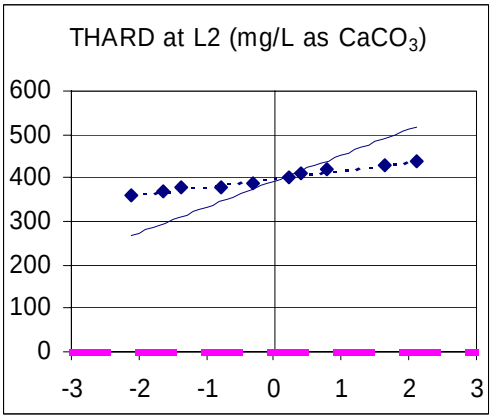

THARD at I1 (mg/L as CaCO3)
250
200
150
100
50
0
-3 -2 -1 0 1 2 3

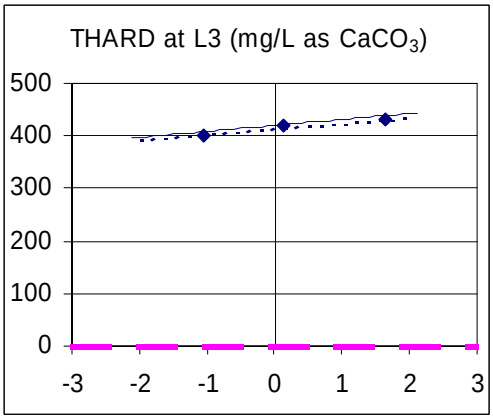

THARD at O1 (mg/L as CaCO3)
200
150
100
50
0
-3 -2 -1 0 1 2 3

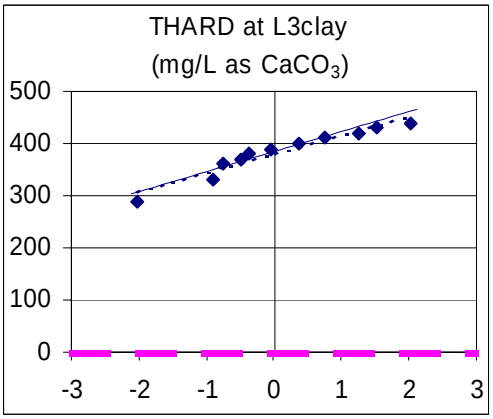

THARD at O2 (mg/L as CaCO3)
400
300
200
100
0
-3 -2 -1 0 1 2 3

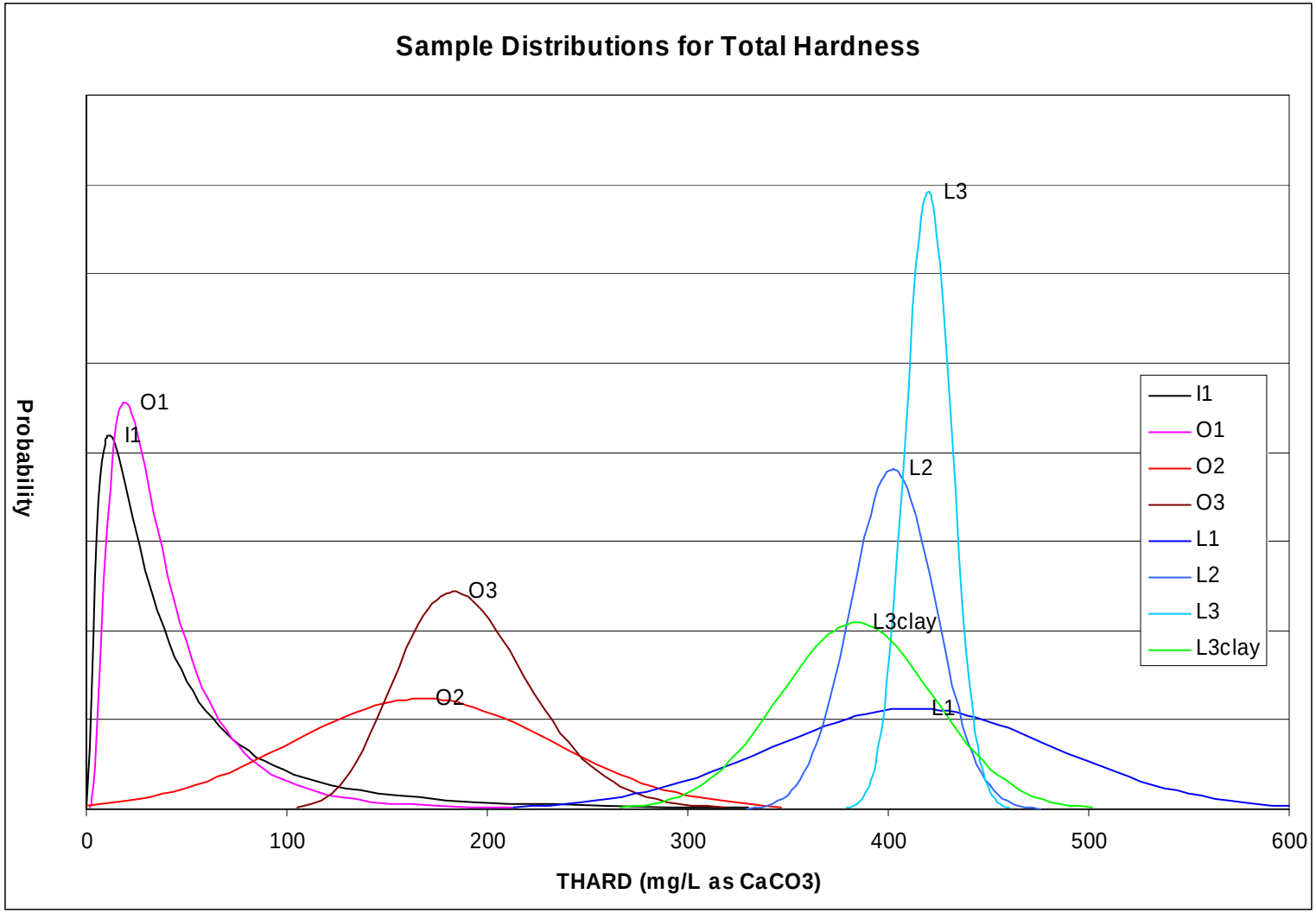

THARD at O3 (mg/L as CaCO3)
300
250
200
150
100
50
0
-3 -2 -1 0 1 2 3


THARD at L1 (mg/L as CaCO3)
600
500
400
300
200
100
0
-3 -2 -1 0 1 2 3


THARD at L2 (mg/L as CaCO3)
600
500
400
300
200
100
0
-3 -2 -1 0 1 2 3

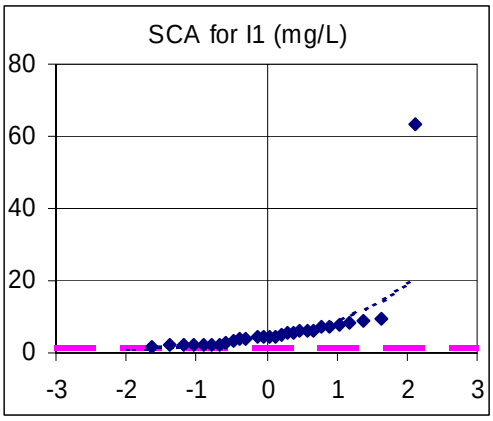

THARD at L3 (mg/L as CaCO3)
500
400
300
200
100
0
-3 -2 -1 0 1 2 3

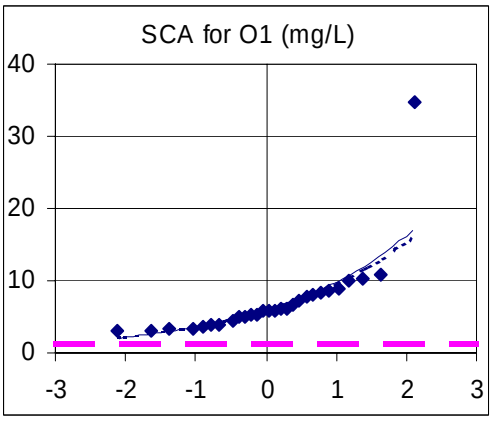

THARD at L3clay
(mg/L as CaCO3)
500
400
300
200
100
0
-3 -2 -1 0 1 2 3

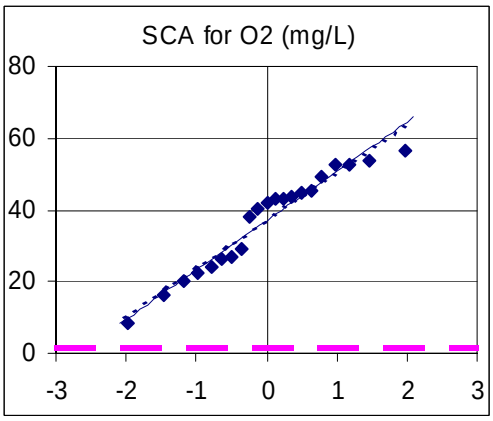

Sample Distributions for Total Hardness
Probability
THARD (mg/L as CaCO3)
0
100
200
300
400
500
600
O1
I1
O3
O2
L3
L2
L3clay
L1
I1
O1
O2
O3
L1
L2
L3
L3clay

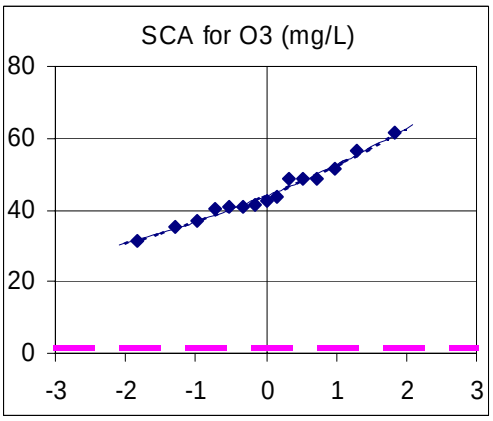
Soluble Calcium, SCA (mg/L); MDL = 1.5									
		Inflow I1	Outflow Storm O1	Upper Outflow Baseflow O2	Lower Outflow Baseflow O3 [a]	Uppper Lysimeter L1	Middle Lysimeter L2	Lower Lysimeter L3	Lower Lysimeter in Clay L3clay
# Points (<MDL)		30 (2)	30	21	15	23	30	10	24
From Data	Mean	?	6.9430	37.006	44.553	104.87	107.50	96.510	68.088
	Median	4.3450	5.8050	0.0420	42.3	114.00	108.00	95.950	67.300
	StDev	?	5.7100	13.751	8.0818	22.402	7.6611	3.3982	4.4164
	Min	<MDL	3.09	8.22	31.1	48.9	95.5	89.5	59.6
	Max	63.3	34.7	56.6	61.6	135	119	101	76.2
	Logn Mean	*?*	*1.7797*		*3.7816*				
	Logn StDev	*?*	*0.5032*		*0.1796*				
From Plots	Distribution	Lognormal	Lognormal	Normal	Lognormal	Normal	Normal	Normal	Normal
	R2	0.8762	0.8774	0.9455	0.9781	0.8722	0.9326	0.9327	0.9742
	Median	4.4201	5.9324	37.006	43.885	103.29	106.74	96.468	68.158
	Mean	*1.4862*	*1.7804*	37.006	*3.7816*	103.29	106.74	96.468	68.158
	StDev	*0.7239*	*0.4750*	13.449	*0.1791*	20.7540	6.9920	3.3361	4.3582

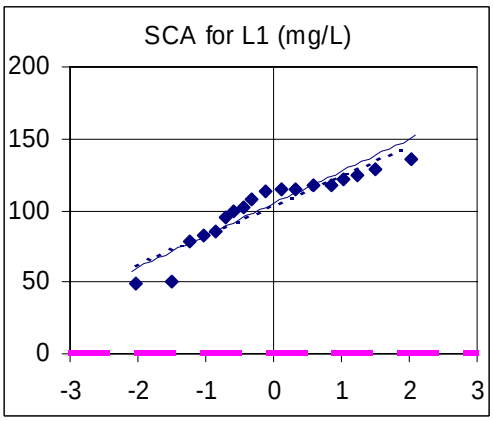
Soluble Magnesium, SMG (mg/L); MDL = 2.5									
		Inflow I1	Outflow Storm O1	Upper Outflow Baseflow O2	Lower Outflow Baseflow O3 [a]	Uppper Lysimeter L1	Middle Lysimeter L2	Lower Lysimeter L3	Lower Lysimeter in Clay L3clay
# Points (<MDL)		30 (26)	30 (18)	21	15	23	30	10	24
From Data	Mean	?	?	17.8667	18.167	36.543	32.573	43.610	51.692
	Median	<MDL	<MDL	20.800	17.9	37.100	32.700	43.550	53.950
	StDev	?	?	7.2751	3.1753	4.9226	1.6216	1.2845	7.4537
	Min	<MDL	<MDL	3.51	12.5	26.1	28.8	40.7	27.5
	Max	16.2	15.6	28.8	24.9	44.3	35.2	45.4	59.5
	Logn Mean	*?*	*?*		*2.8855*				
	Logn StDev	*?*	*?*		*0.1738*				
From Plots	Distribution	Lognormal	Lognormal	Normal	Lognormal	Normal	Normal	Normal	Normal
	R2	0.8551	0.7641	0.9455	0.9787	0.9580	0.9584	0.8576	0.8217
	Median	0.3198	1.9750	17.720	17.901	36.491	32.548	43.610	51.667
	Mean	*-1.1402*	*0.6806*	17.720	*2.8849*	36.491	32.548	43.610	51.667
	StDev	*1.7114*	*0.7125*	7.0249	*0.1737*	4.8499	1.5800	1.2031	6.7896

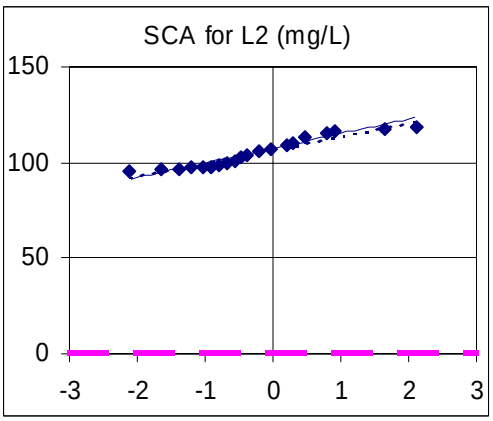

SCA for I1 (mg/L)
80
60
40
20
0
-3
-2
-1
0
1
2
3

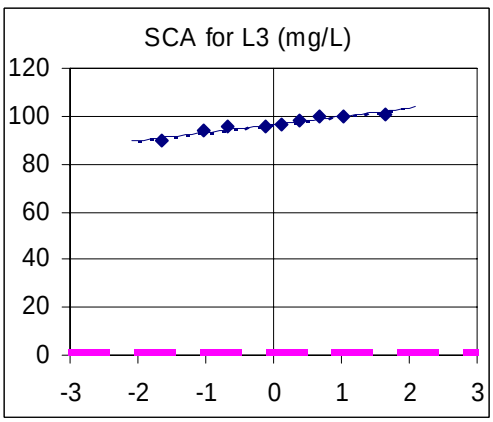

SCA for O1 (mg/L)
40
30
20
10
0
-3
-2
-1
0
1
2
3

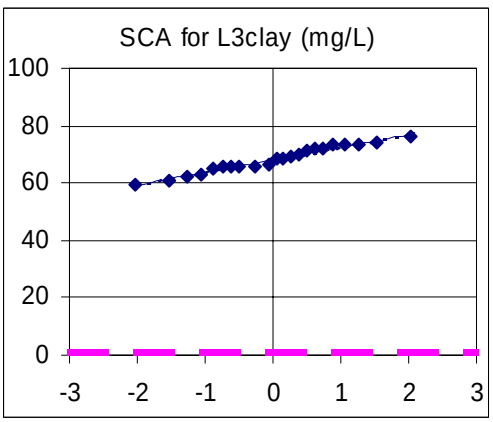

SCA for O2 (mg/L)
80
60
40
20
0
-3
-2
-1
0
1
2
3

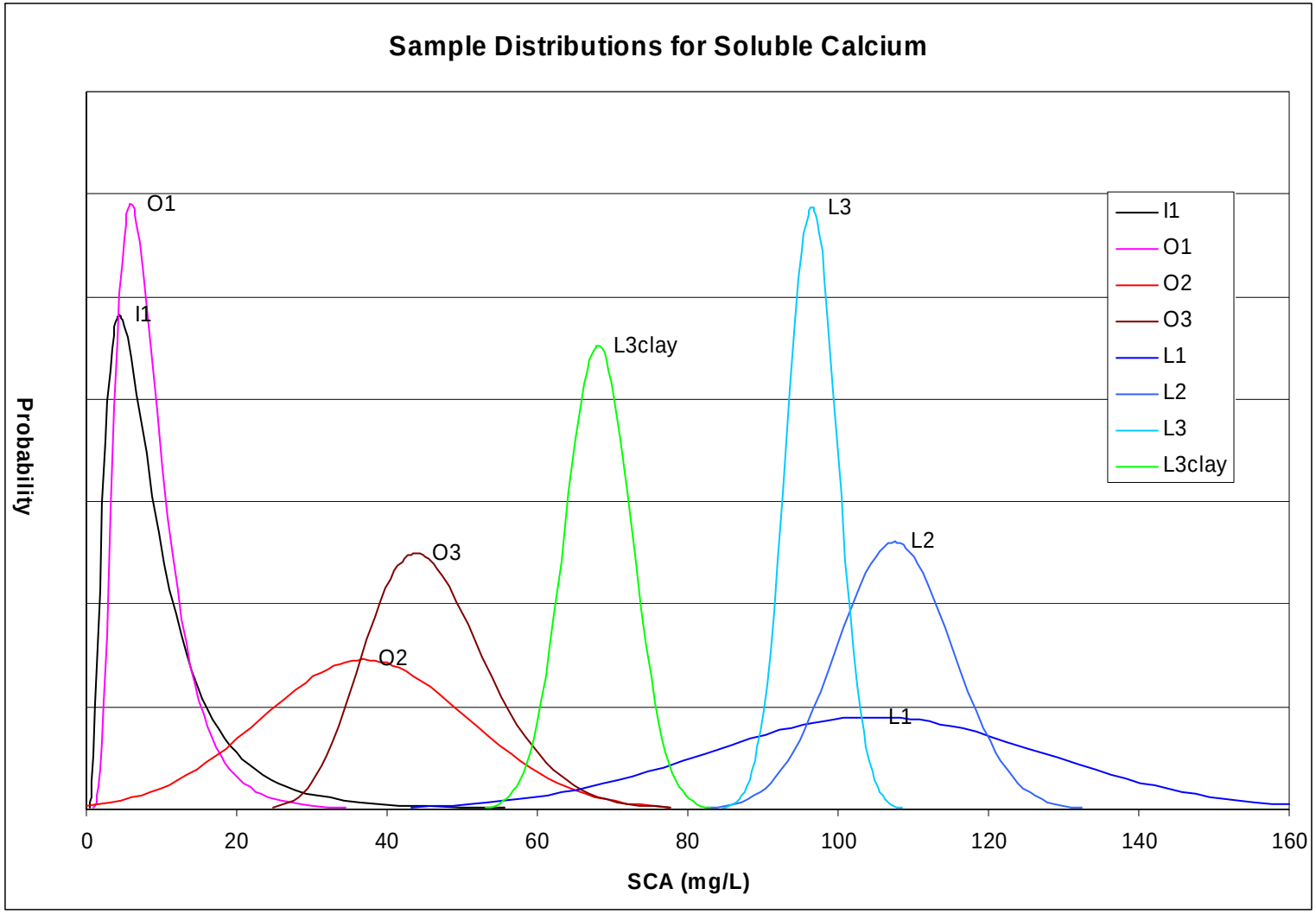

SCA for O3 (mg/L)
80
60
40
20
0
-3
-2
-1
0
1
2
3

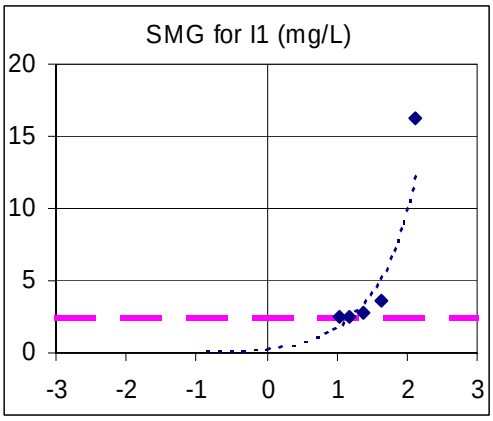

SCA for L1 (mg/L)
200
150
100
50
0
-3
-2
-1
0
1
2
3

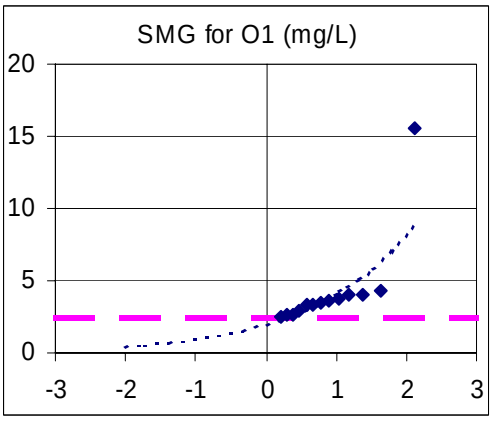

SCA for L2 (mg/L)
150
100
50
0
-3
-2
-1
0
1
2
3

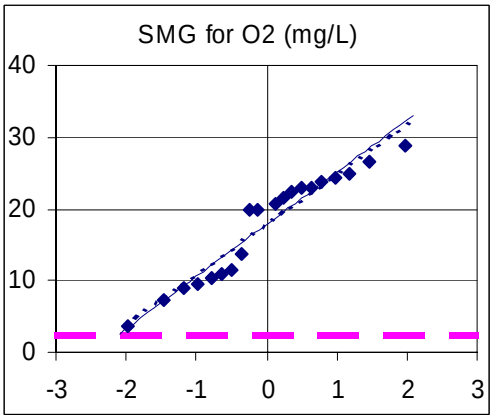

SCA for L3 (mg/L)
120
100
80
60
40
20
0
-3
-2
-1
0
1
2
3

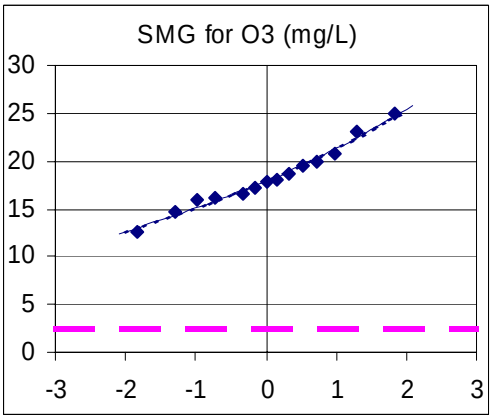

SCA for L3clay (mg/L)
100
80
60
40
20
0
-3
-2
-1
0
1
2
3

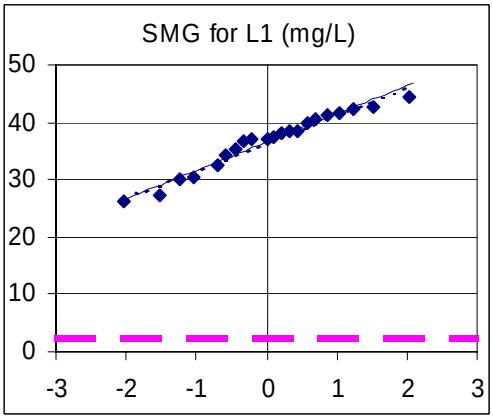

Sample Distributions for Soluble Calcium
Probability
SCA (mg/L)
0
20
40
60
80
100
120
140
160
O1
I1
L3clay
L3
O3
L2
O2
L1
I1
O1
O2
O3
L1
L2
L3
L3clay

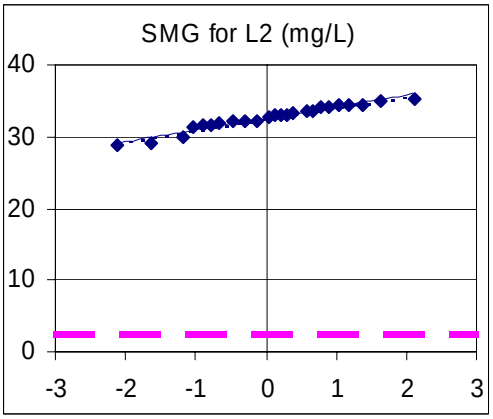

SMG for I1 (mg/L)
20
15
10
5
0
-3
-2
-1
0
1
2
3

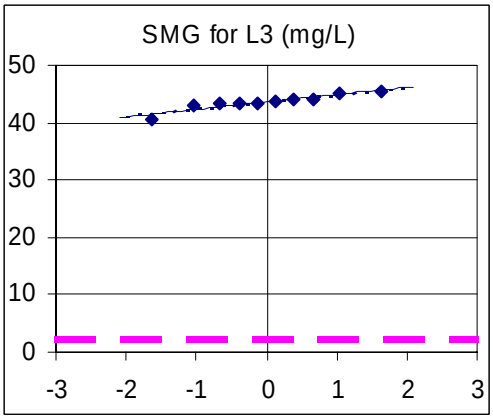

SMG for O1 (mg/L)
20
15
10
5
0
-3
-2
-1
0
1
2
3

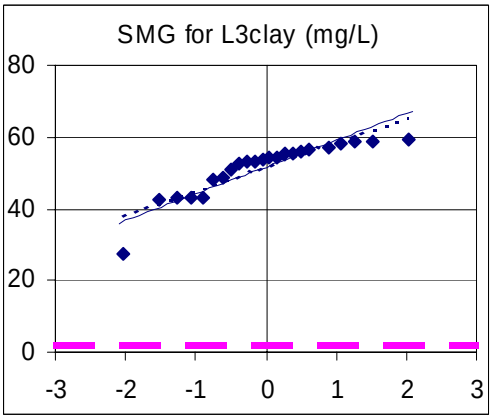

SMG for O2 (mg/L)
40
30
20
10
0
-3
-2
-1
0
1
2
3

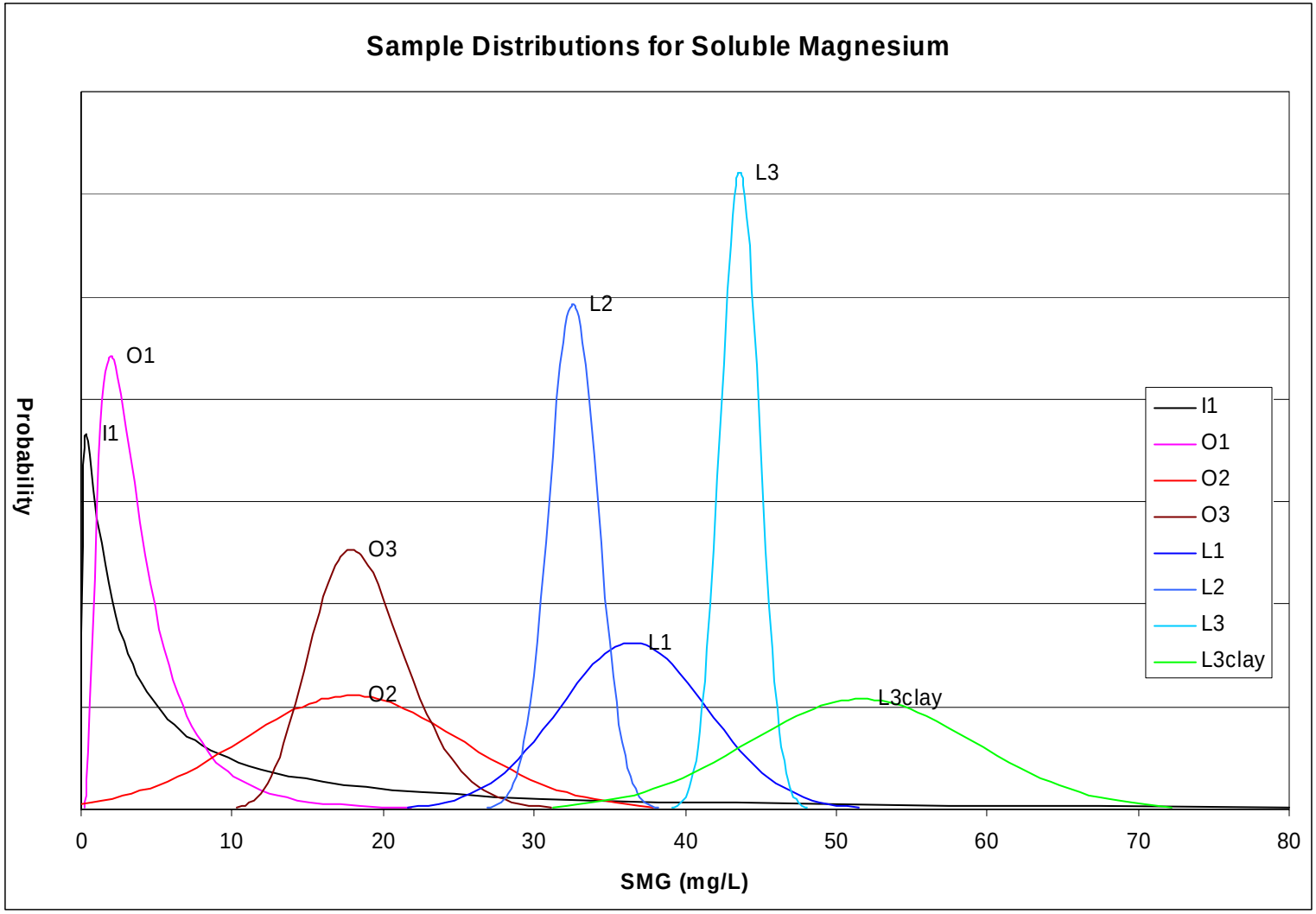

SMG for O3 (mg/L)
30
25
20
15
10
5
0
-3
-2
-1
0
1
2
3


SMG for L1 (mg/L)
50
40
30
20
10
0
-3
-2
-1
0
1
2
3


SMG for L2 (mg/L)
40
30
20
10
0
-3
-2
-1
0
1
2
3

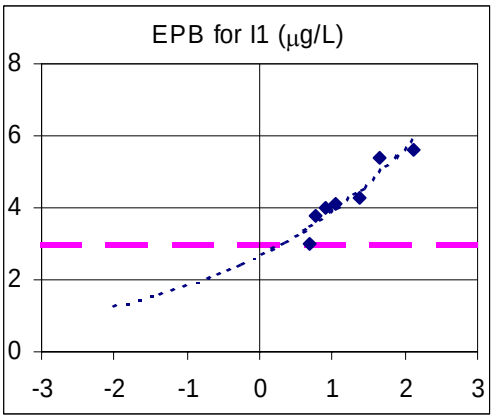

SMG for L3 (mg/L)
50
40
30
20
10
0
-3
-2
-1
0
1
2
3

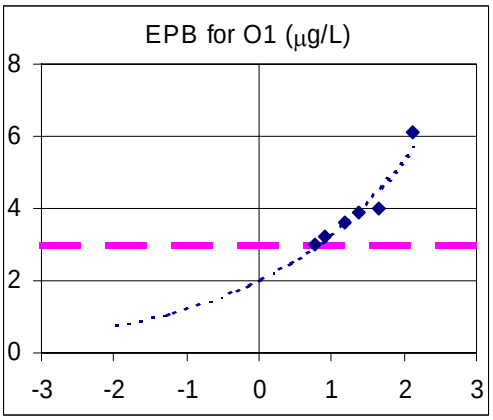

SMG for L3clay (mg/L)
80
60
40
20
0
-3
-2
-1
0
1
2
3

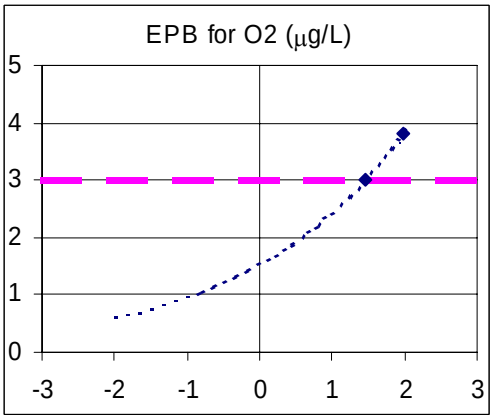

Sample Distributions for Soluble Magnesium
Probability
SMG (mg/L)
0
10
20
30
40
50
60
70
80
I1
O1
O2
O3
L1
L2
L3
L3clay

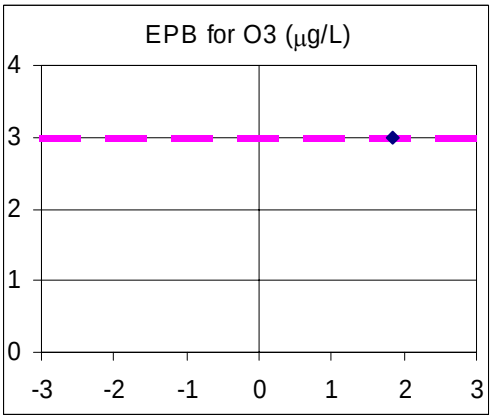
Extactable Lead, EPB (µg/L); MDL = 3									
		Inflow I1	Outflow Storm O1	Upper Outflow Baseflow O2	Lower Outflow Baseflow O3 [a]	Upper Lysimeter L1	Middle Lysimeter L2	Lower Lysimeter L3	Lower Lysimeter in Clay L3clay
# Points (<MDL)		30 (23)	30 (24)	21 (20)	15 (15)	12 (12)	29 (25)	10 (9)	22 (12)
Data	Median	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
	Min	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
	Max	5.6	6.1	3.8	<MDL	<MDL	4.2	3.4	7.5
From Plots	Distribution	Lognormal	Lognormal	Lognormal			Lognormal	Lognormal	Lognormal
	R2	0.8505	0.9386	1			0.9082	1	0.9511
	Median	2.6792	2.0061	1.5322	Uniform[d]	Uniform[d]	2.2161	2.424	2.97
	Mean	*0.9855*	*0.6962*	*0.4267*			*0.7957*	*0.8854*	*1.0886*
	StDev	*0.3742*	*0.4881*	*0.4585*			*0.3192*	*0.2057*	*0.5266*

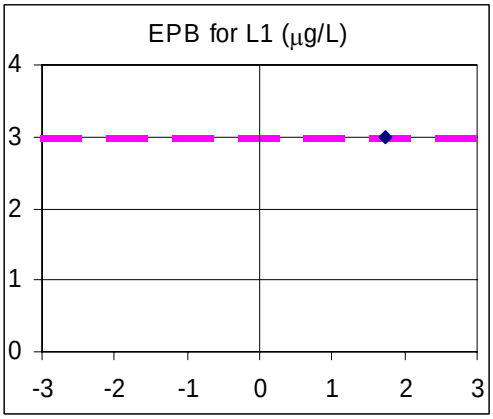
Extactable Zinc, EZN (µg/L); MDL = 15									
		Inflow I1	Outflow Storm O1	Upper Outflow Baseflow O2	Lower Outflow Baseflow O3 [a]	Uppper Lysimeter L1	Middle Lysimeter L2	Lower Lysimeter L3	Lower Lysimeter in Clay L3clay
# Points (<MDL)		30 (14)	30 (16)	21 (8)	15 (15)	12 (12)	29 (29)	10 (10)	22 (20)
Data	Median	16.8	<MDL	16.5	<MDL	<MDL	<MDL	<MDL	<MDL
	Min	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
	Max	96.4	33.4	33.1	<MDL	<MDL	<MDL	<MDL	26.4
From Plots	Distribution	Lognormal	Lognormal	Lognormal					Lognormal
	R2	0.9903	0.9456	0.9242					0.9975
	Median	16.513	15.919	17.271	Uniform[d]	Uniform[d]	Uniform[d]	Uniform[d]	6.454
	Mean	*2.8041*	*2.7675*	*2.8490*					*1.8647*
	StDev	*0.8055*	*0.3125*	*0.4104*					*0.7070*

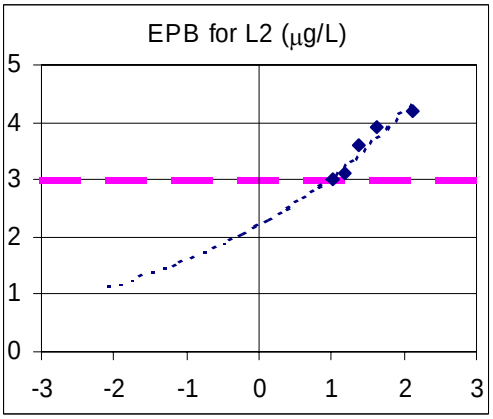

EPB for I1 (µg/L)
8
6
4
2
0
-3
-2
-1
0
1
2
3

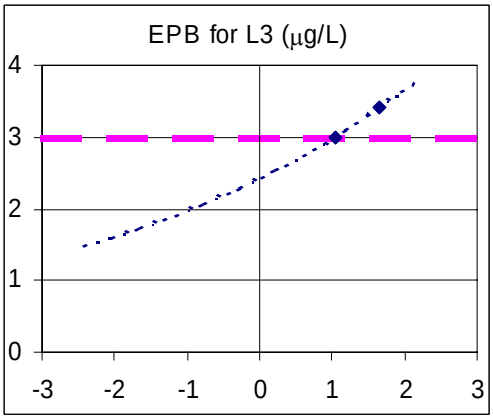

EPB for O1 (µg/L)
8
6
4
2
0
-3
-2
-1
0
1
2
3

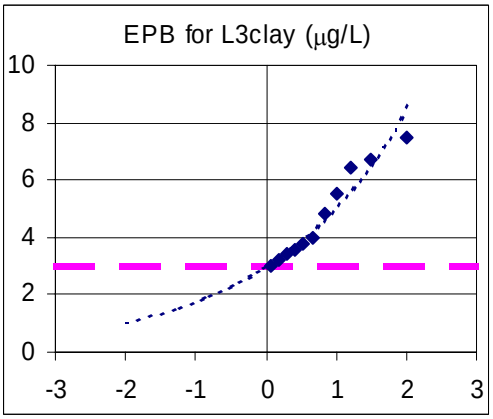

EPB for O2 (µg/L)
5
4
3
2
1
0
-3
-2
-1
0
1
2
3

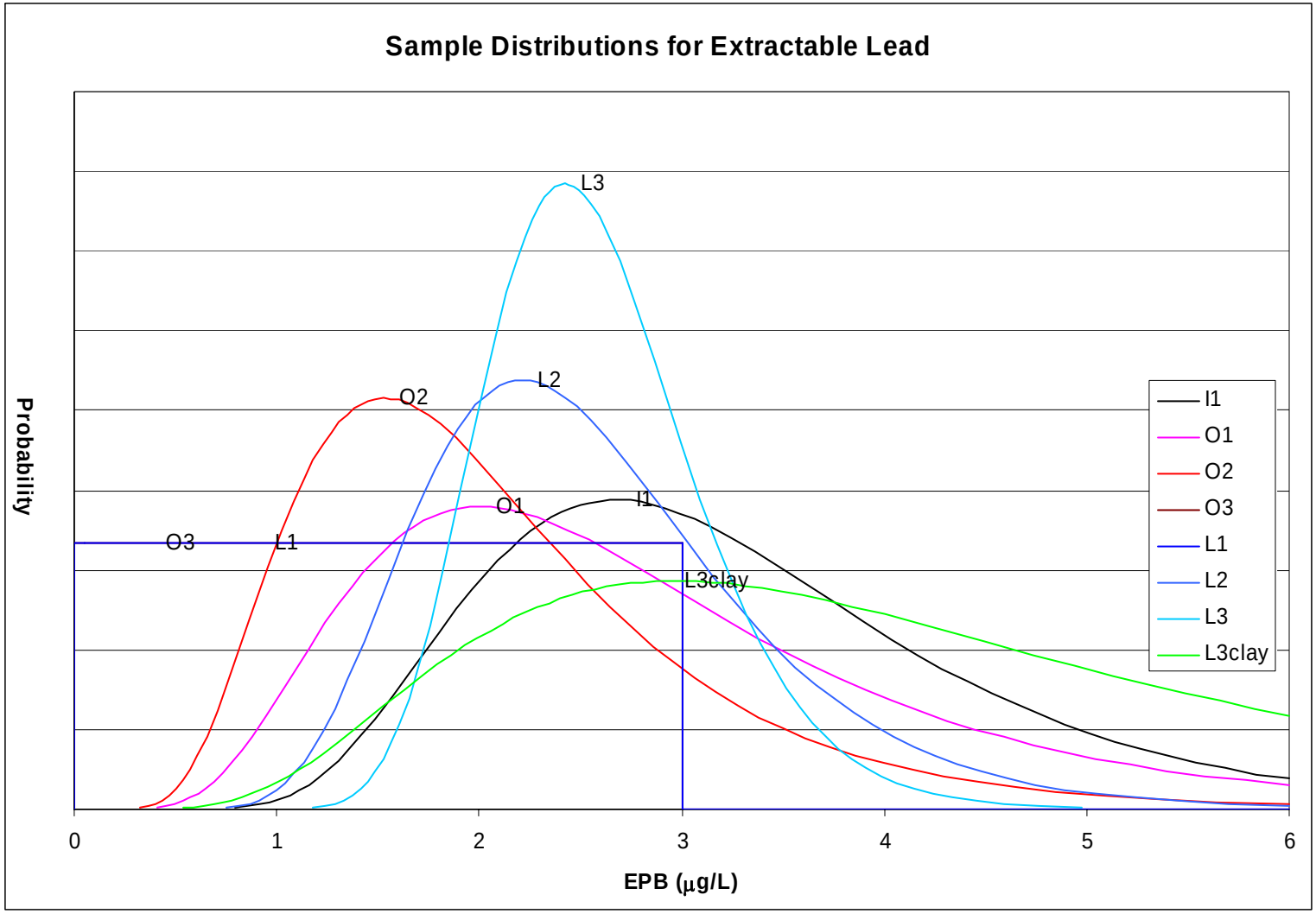

EPB for O3 (µg/L)
4
3
2
1
0
-3
-2
-1
0
1
2
3

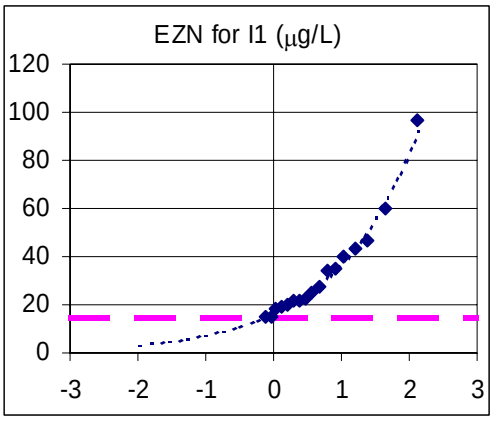

EPB for L1 (µg/L)
4
3
2
1
0
-3
-2
-1
0
1
2
3

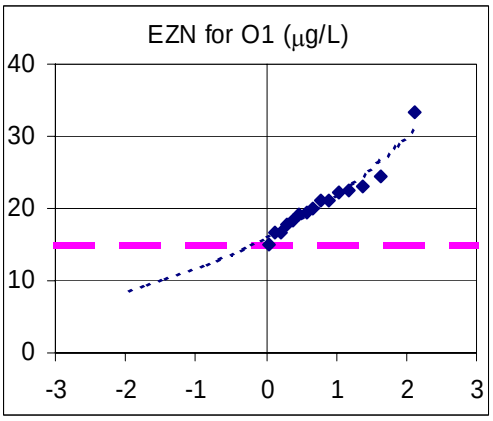

EPB for L2 (µg/L)
5
4
3
2
1
0
-3
-2
-1
0
1
2
3

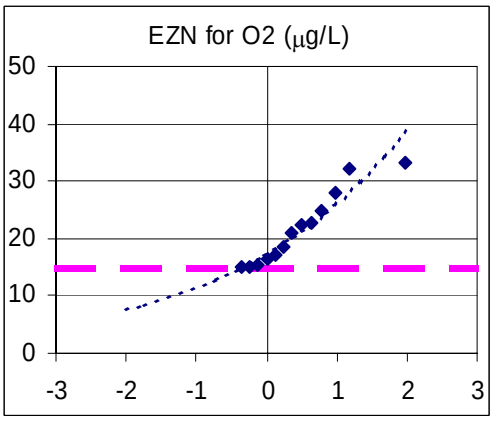

EPB for L3 (µg/L)
4
3
2
1
0
-3
-2
-1
0
1
2
3

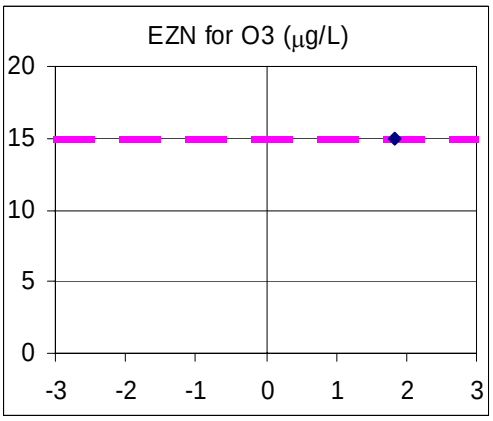

EPB for L3clay (µg/L)
10
8
6
4
2
0
-3
-2
-1
0
1
2
3

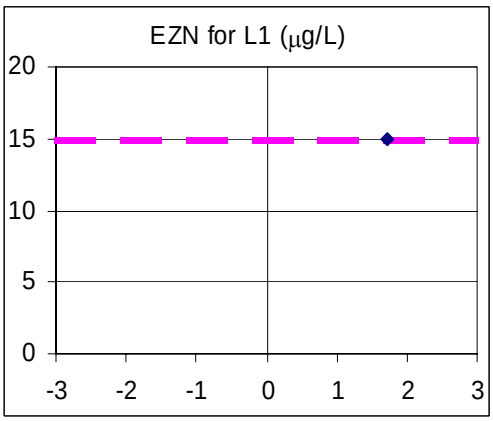

Sample Distributions for Extractable Lead
Probability
EPB (µg/L)
0
1
2
3
4
5
6
L3
L2
O2
O1
I1
O3
L1
L3clay
I1
O1
O2
O3
L1
L2
L3
L3clay

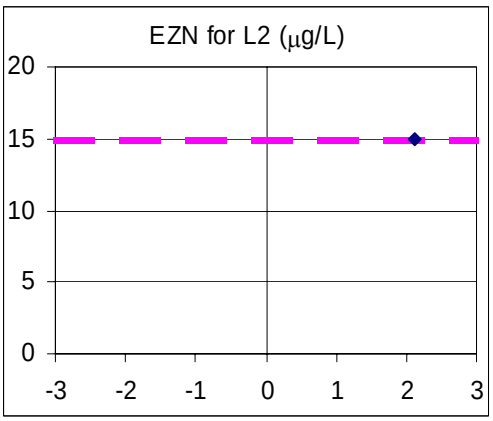

EZN for I1 (µg/L)
120
100
80
60
40
20
0
-3
-2
-1
0
1
2
3

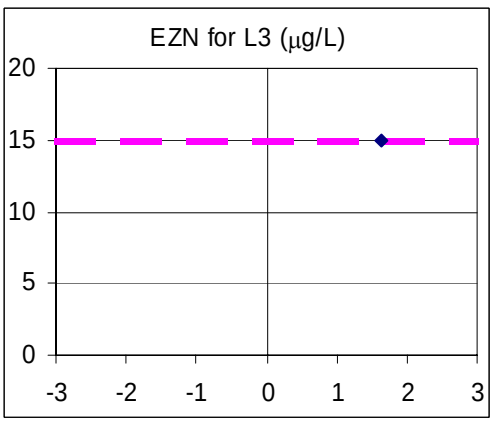

EZN for O1 (µg/L)
40
30
20
10
0
-3
-2
-1
0
1
2
3

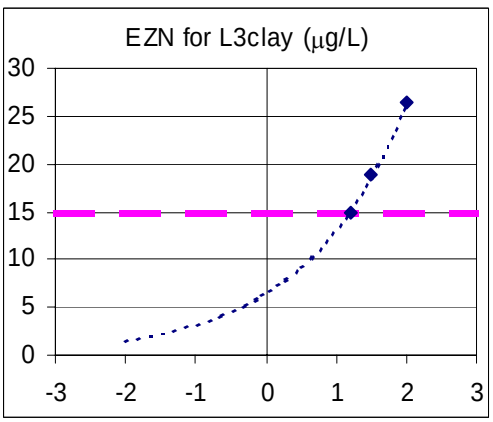

EZN for O2 (µg/L)
50
40
30
20
10
0
-3
-2
-1
0
1
2
3

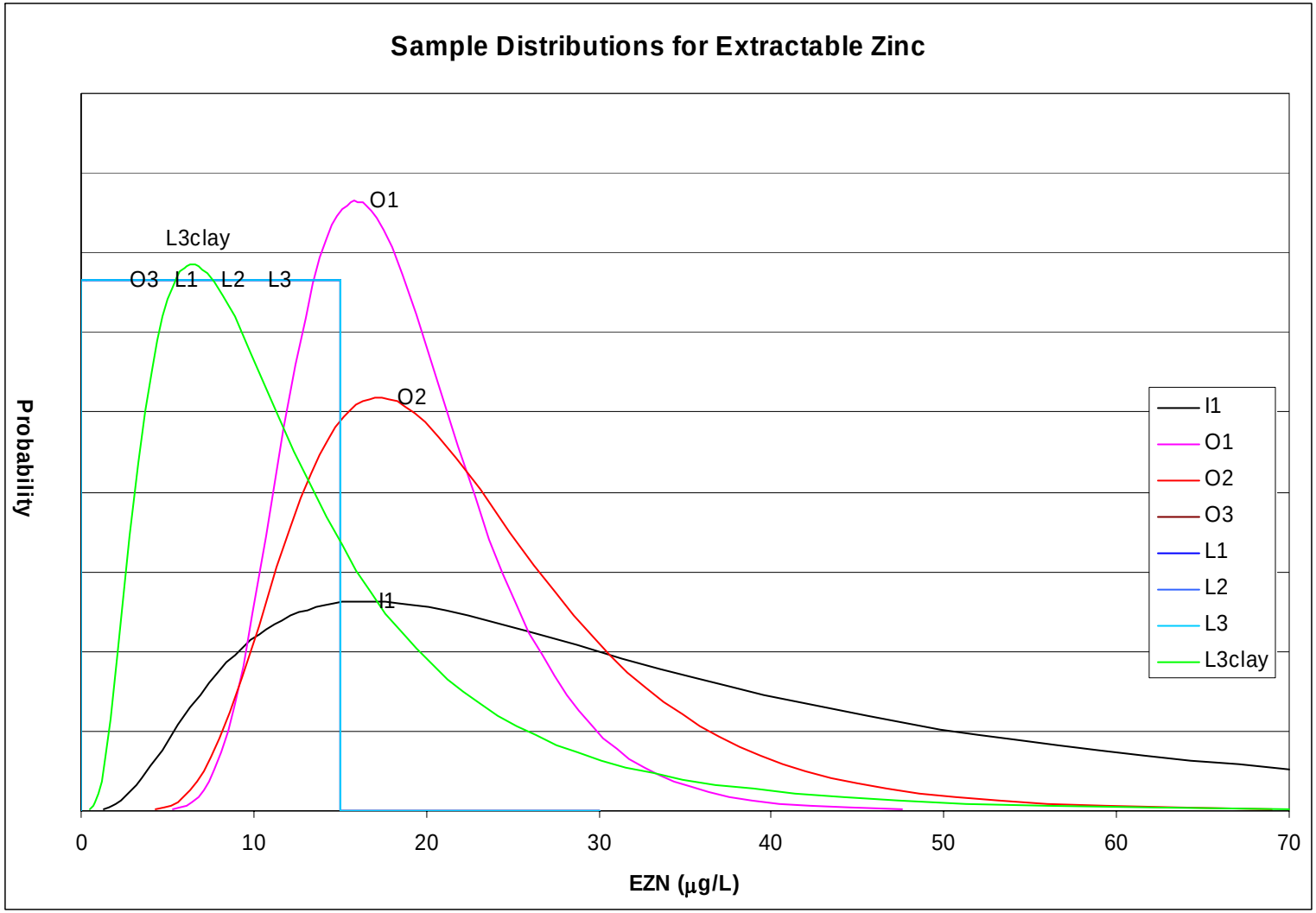

EZN for O3 (µg/L)
20
15
10
5
0
-3
-2
-1
0
1
2
3


EZN for L1 (µg/L)
20
15
10
5
0
-3
-2
-1
0
1
2
3


EZN for L2 (µg/L)
20
15
10
5
0
-3
-2
-1
0
1
2
3

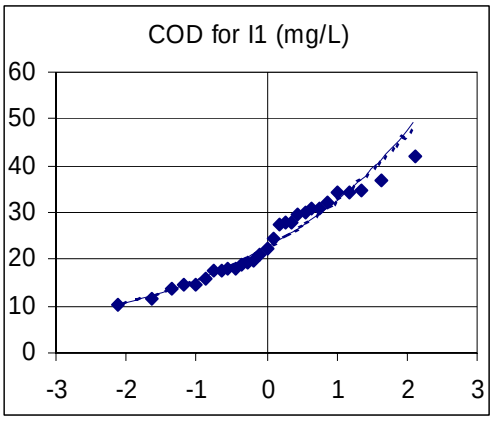

EZN for L3 (µg/L)
20
15
10
5
0
-3
-2
-1
0
1
2
3

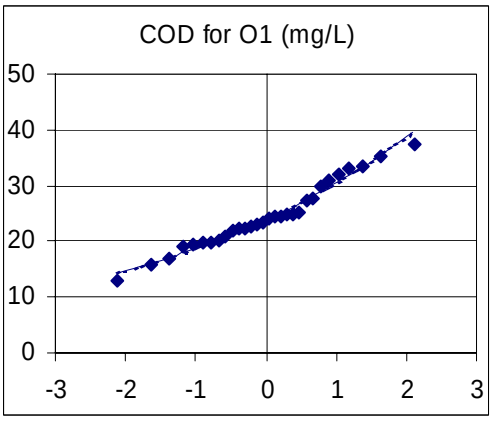

EZN for L3clay (µg/L)
30
25
20
15
10
5
0
-3
-2
-1
0
1
2
3

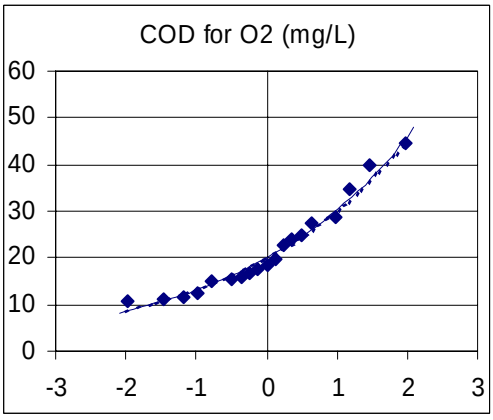

Sample Distributions for Extractable Zinc
Probability
EZN (µg/L)
0
10
20
30
40
50
60
70
O1
L3clay
O3
L1
L2
L3
O2
I1
I1
O1
O2
O3
L1
L2
L3
L3clay

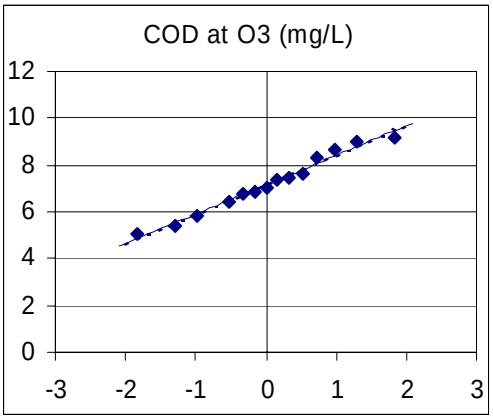
Chemical Oxygen Demand, COD (mg/L)									
		Inflow I1	Outflow Storm O1	Upper Outflow Baseflow O2	Lower Outflow Baseflow O3 [a]	Uppper Lysimeter L1	Middle Lysimeter L2	Lower Lysimeter L3	Lower Lysimeter in Clay L3clay
# Points …		29	30	21	15	23	29	10	24
From Data	Mean	24.003	24.527	21.719	7.1667	43.574	6.9414	6.66	33.467
	Median	22.2	23.7	18.4	7	43.7	6.2	6.6	31.2
	StDev	8.4407	5.8681	9.4869	1.2579	12.858	2.2352	0.8168	5.0691
	Min	10.2	12.9	10.6	5.1	23.4	2.4	5.8	28.8
	Max	41.8	37.4	44.4	9.2	70.5	10.7	8.2	51
	Logn Mean	*3.1143*	*3.1717*	*2.9939*		*2.2985*		*1.8896*	*3.5011*
	Logn StDev	*0.3718*	*0.2431*	*0.4156*		*0.6020*		*0.1196*	*0.1351*
From Plots	Distribution	Lognormal	Lognormal	Lognormal	Normal	Lognormal	Normal	Lognormal	Lognormal
	R2	0.9644	0.977	0.9713	0.9777	0.9773	0.9617	0.9806	0.8062
	Median	22.519	23.849	19.901	7.1558	41.76	6.8781	6.5229	33.273
	Mean	*3.1144*	*3.1717*	*2.9908*	7.1558	*3.7319*	6.8781	*1.8753*	*3.5047*
	StDev	*0.3667*	*0.2413*	*0.4109*	1.262	*0.2995*	2.2119	*0.1376*	*0.1209*

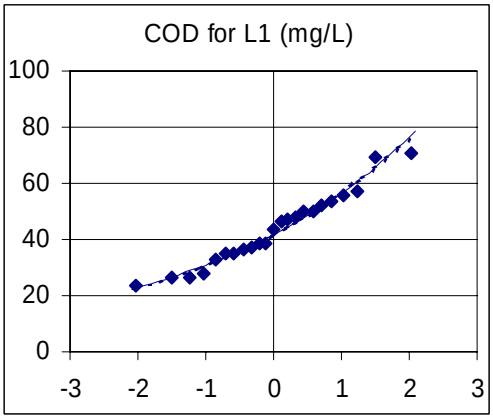
Total Organic Carbon, TOC (mg/L)									
		Inflow I1	Outflow Storm O1	Upper Outflow Baseflow O2	Lower Outflow Baseflow O3 [a]	Uppper Lysimeter L1	Middle Lysimeter L2	Lower Lysimeter L3	Lower Lysimeter in Clay L3clay
# Points …		29	29	21	15	8	29	10	22
From Data	Mean	6.4414	8.3931	8.7714	3.2867	11.15	3.4690	3.02	22.786
	Median	5.4	8	8.7	3.3	11.25	3.3	3	21.95
	StDev	2.8292	2.1633	3.2573	0.3925	4.1734	1.3515	0.1619	2.6372
	Min	3.2	4.9	4.7	2.7	2.4	2.1	2.7	18.6
	Max	12.9	14.2	15.3	4.1	15.4	9.4	3.3	28.1
	Logn Mean	*1.7786*	*2.0972*		*1.1833*		*1.1931*		*3.1199*
	Logn StDev	*0.4088*	*0.2481*		*0.1185*		*0.3029*		*0.1143*
From Plots	Distribution	Lognormal	Lognormal	Normal	Lognormal	Normal	Lognormal	Normal	Lognormal
	R2	0.948	0.9783	0.9683	0.9794	0.8644	0.8998	0.9505	0.9672
	Median	5.9511	8.1411	8.6406	3.2565	11.15	3.2512	3.0039	22.586
	Mean	*1.7836*	*2.0969*	8.6406	*1.1807*	11.15	*1.1790*	3.0039	*3.1173*
	StDev	*0.4002*	*0.2473*	3.4638	*0.1184*	3.9344	*0.3099*	0.1668	*0.1109*

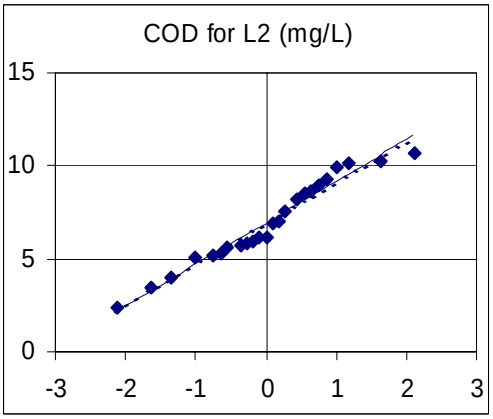

COD for I1 (mg/L)
60
50
40
30
20
10
0
-3 -2 -1 0 1 2 3

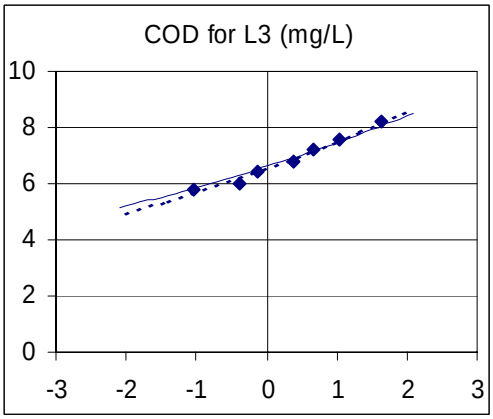

COD for O1 (mg/L)
50
40
30
20
10
0
-3 -2 -1 0 1 2 3

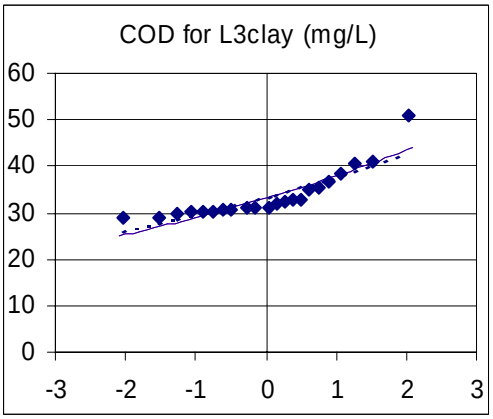

COD for O2 (mg/L)
60
50
40
30
20
10
0
-3 -2 -1 0 1 2 3

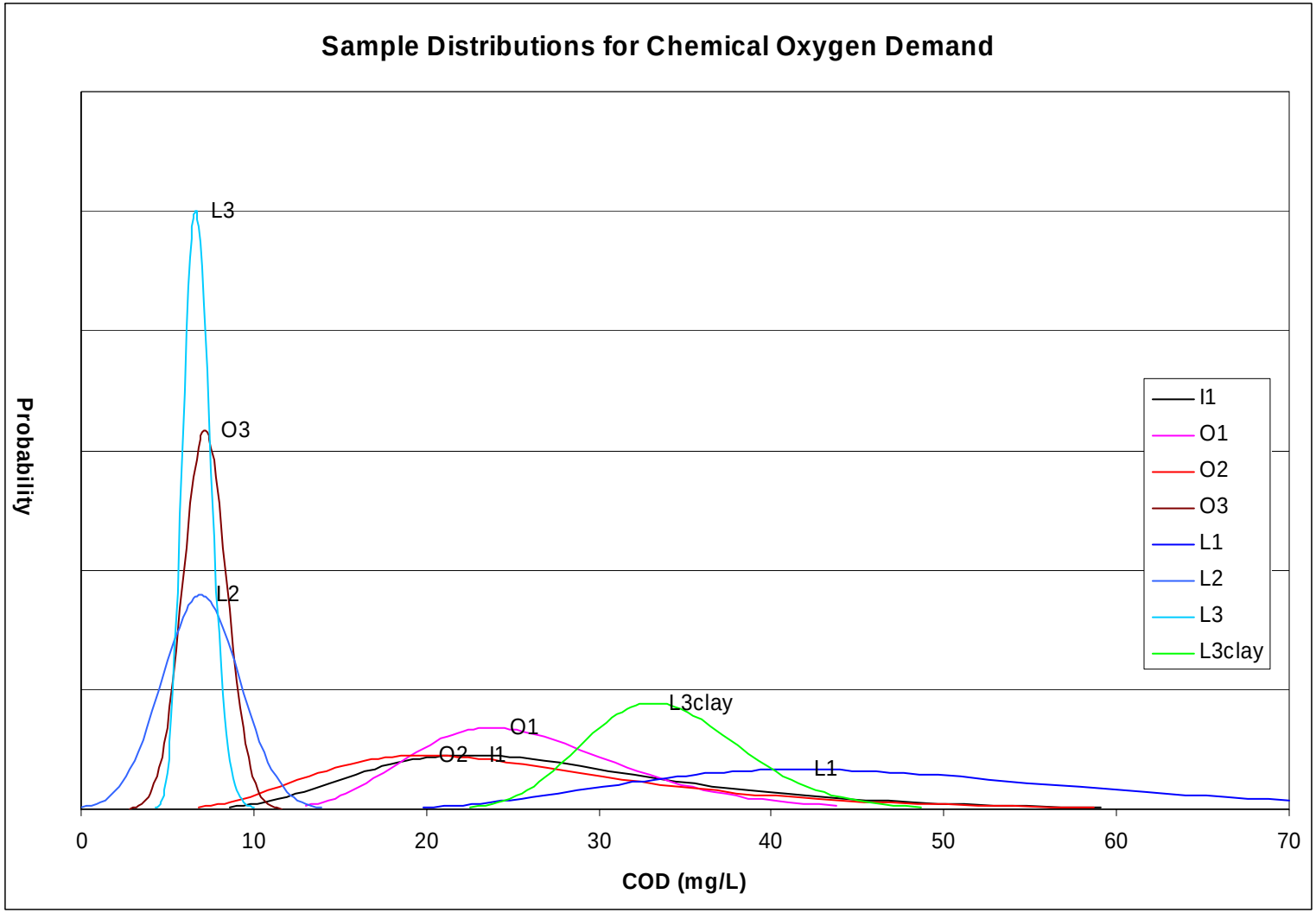

COD at O3 (mg/L)
12
10
8
6
4
2
0
-3 -2 -1 0 1 2 3

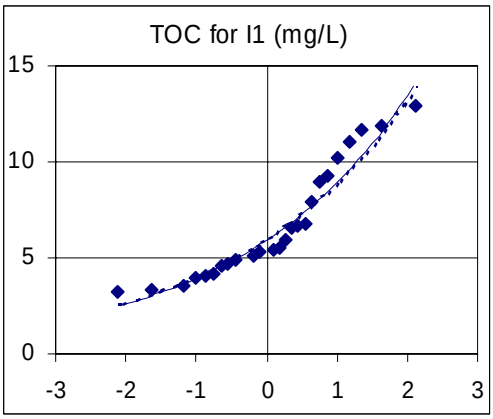

COD for L1 (mg/L)
100
80
60
40
20
0
-3 -2 -1 0 1 2 3

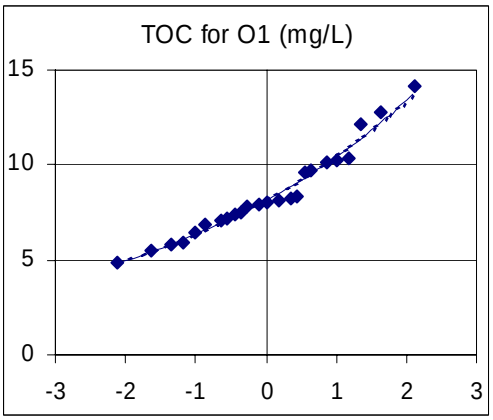

COD for L2 (mg/L)
15
10
5
0
-3 -2 -1 0 1 2 3

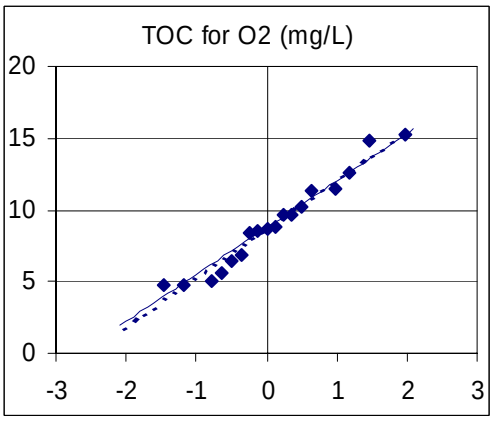

COD for L3 (mg/L)
10
8
6
4
2
0
-3 -2 -1 0 1 2 3

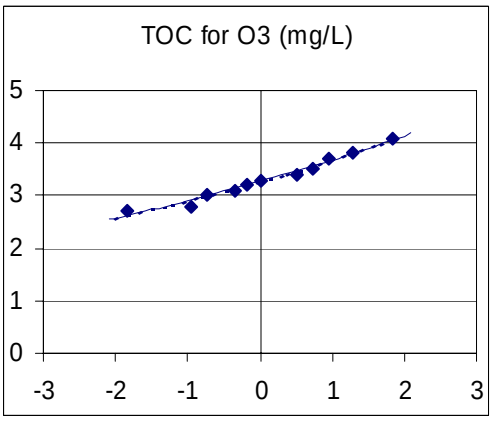

COD for L3clay (mg/L)
60
50
40
30
20
10
0
-3 -2 -1 0 1 2 3

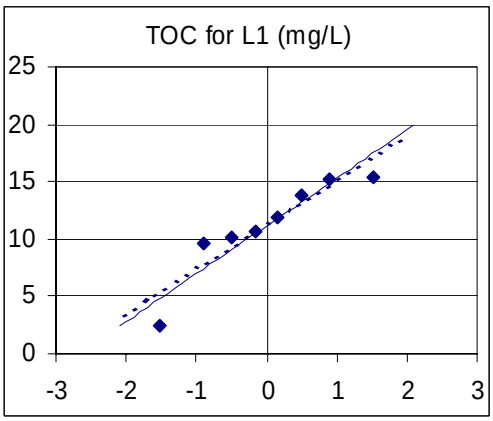

Sample Distributions for Chemical Oxygen Demand
Probability
COD (mg/L)
0
10
20
30
40
50
60
70
L3
O3
L2
L3clay
O1
O2
I1
L1
I1
O1
O2
O3
L1
L2
L3
L3clay

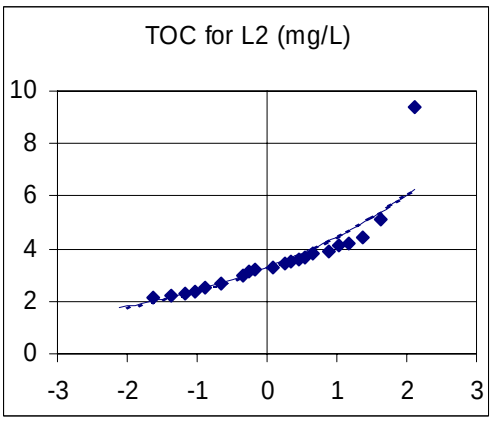

TOC for I1 (mg/L)
15
10
5
0
-3 -2 -1 0 1 2 3

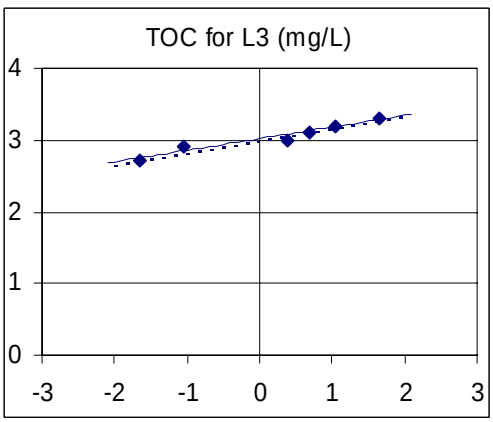

TOC for O1 (mg/L)
15
10
5
0
-3 -2 -1 0 1 2 3

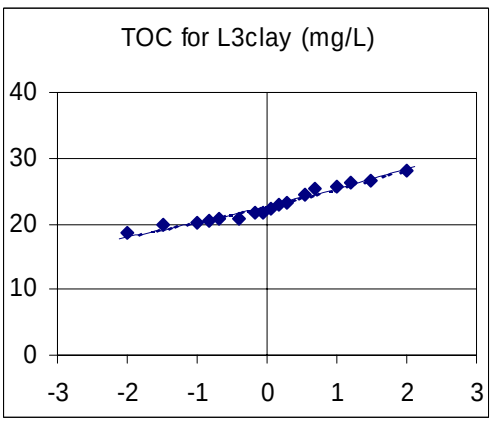

TOC for O2 (mg/L)
20
15
10
5
0
-3 -2 -1 0 1 2 3

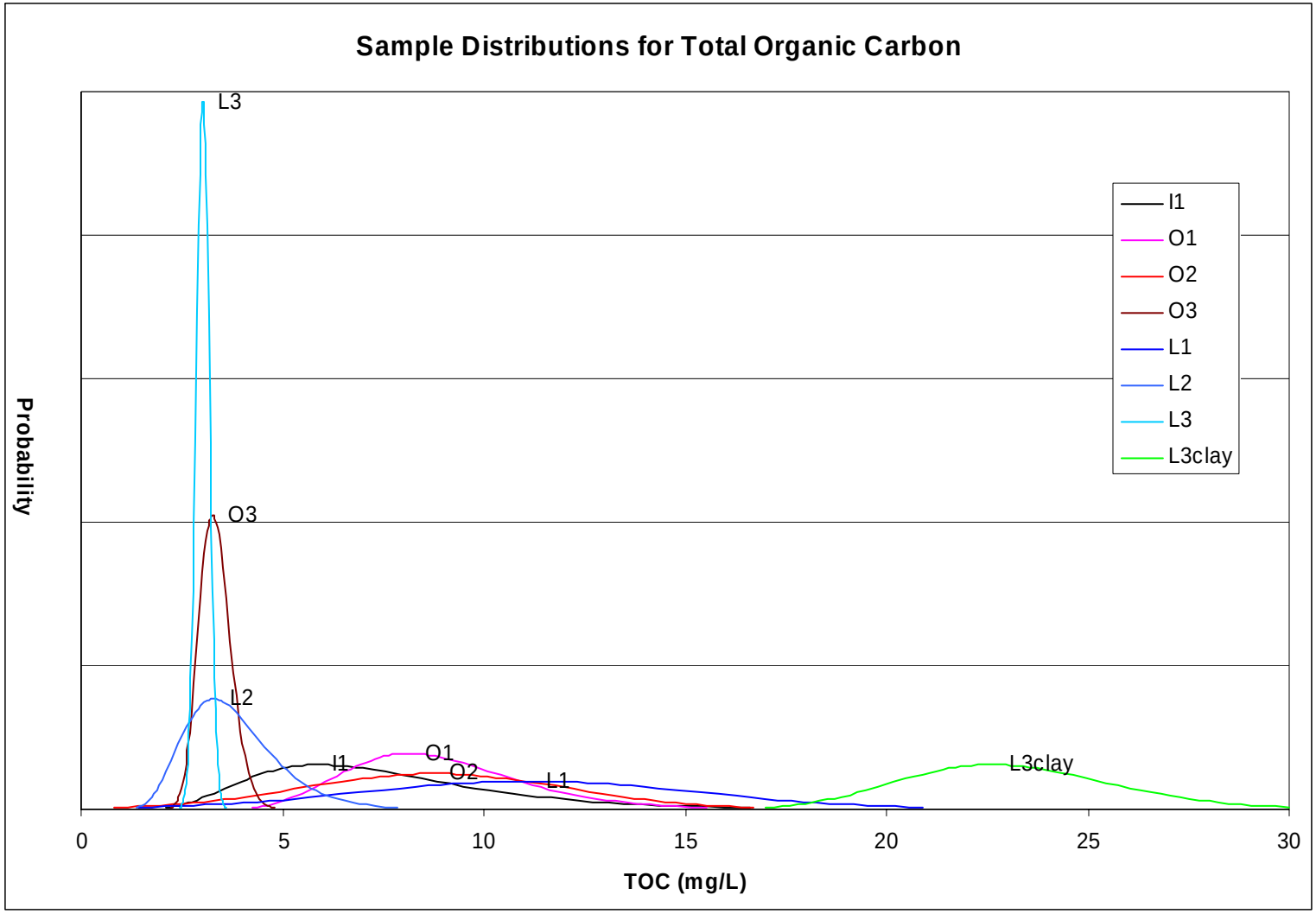

TOC for O3 (mg/L)
5
4
3
2
1
0
-3 -2 -1 0 1 2 3


TOC for L1 (mg/L)
25
20
15
10
5
0
-3 -2 -1 0 1 2 3

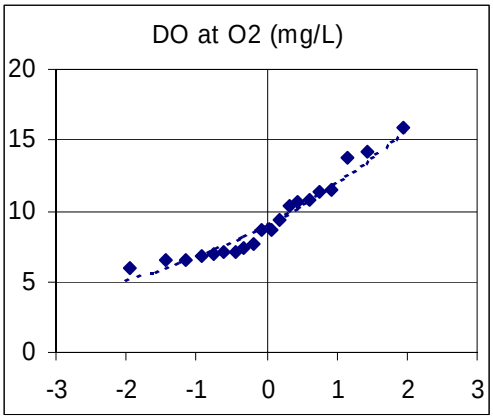

TOC for L2 (mg/L)
10
8
6
4
2
0
-3 -2 -1 0 1 2 3

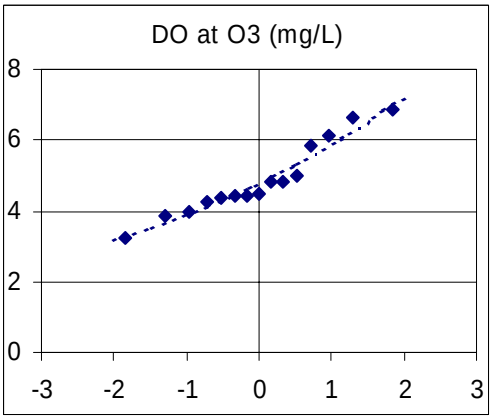

TOC for L3 (mg/L)
4
3
2
1
0
-3 -2 -1 0 1 2 3

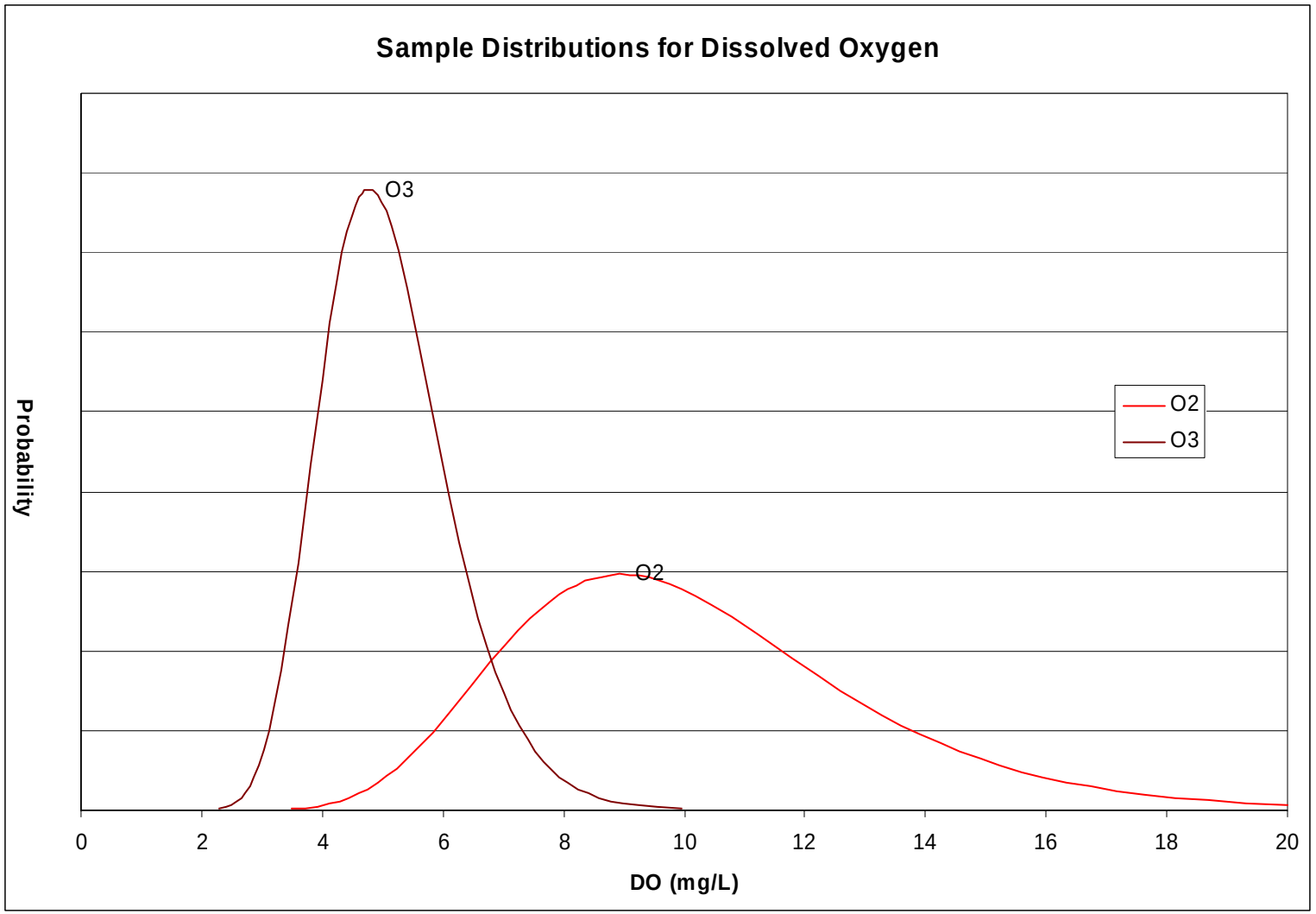

TOC for L3clay (mg/L)
40
30
20
10
0
-3 -2 -1 0 1 2 3


Sample Distributions for Total Organic Carbon
Probability
TOC (mg/L)
0
5
10
15
20
25
30
L3
O3
L2
I1
O1
O2
L1
L3clay
I1
O1
O2
O3
L1
L2
L3
L3clay

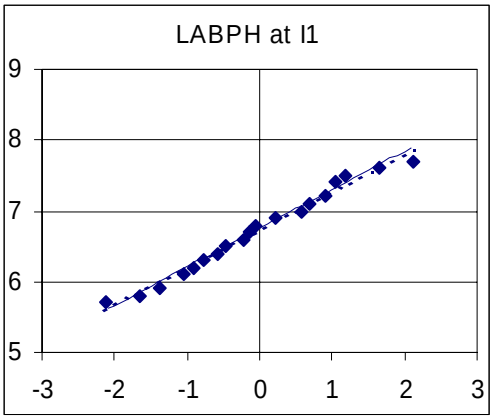
Dissolved Oxygen, DO (mg/L)			
		Upper Outflow Baseflow O2	Lower Outflow Baseflow O3 [a]
# Points …		20	15
From Data	Mean	9.3585	4.8767
	Median	8.675	4.5
	StDev	2.8657	1.0477
	Min	6	3.21
	Max	15.92	6.87
	Logn Mean	*2.1949*	*1.5637*
	Logn StDev	*0.2903*	*0.2098*
From Plots	Distribution	Lognormal	Lognormal
	R2	0.9443	0.9531
	Median	8.9793	4.7763
	Mean	*2.1949*	*1.5637*
	StDev	*0.2838*	*0.2064*

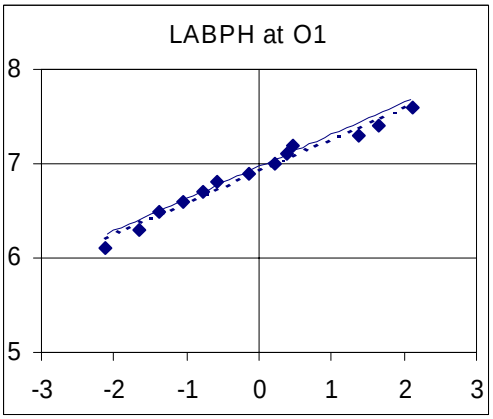


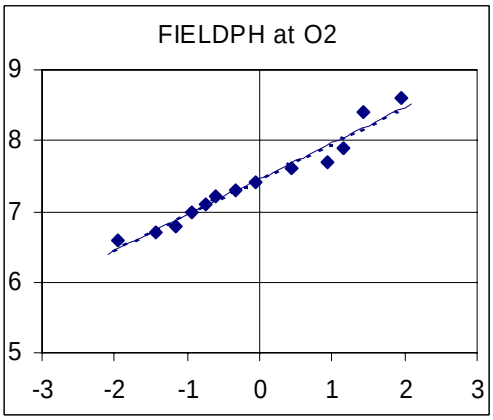


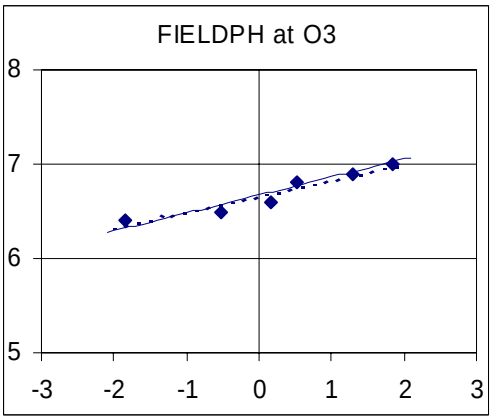

Sample Distributions for Dissolved Oxygen
Probability
O3
O2
O2
O3
0
2
4
6
8
10
12
14
16
18
20
DO (mg/L)

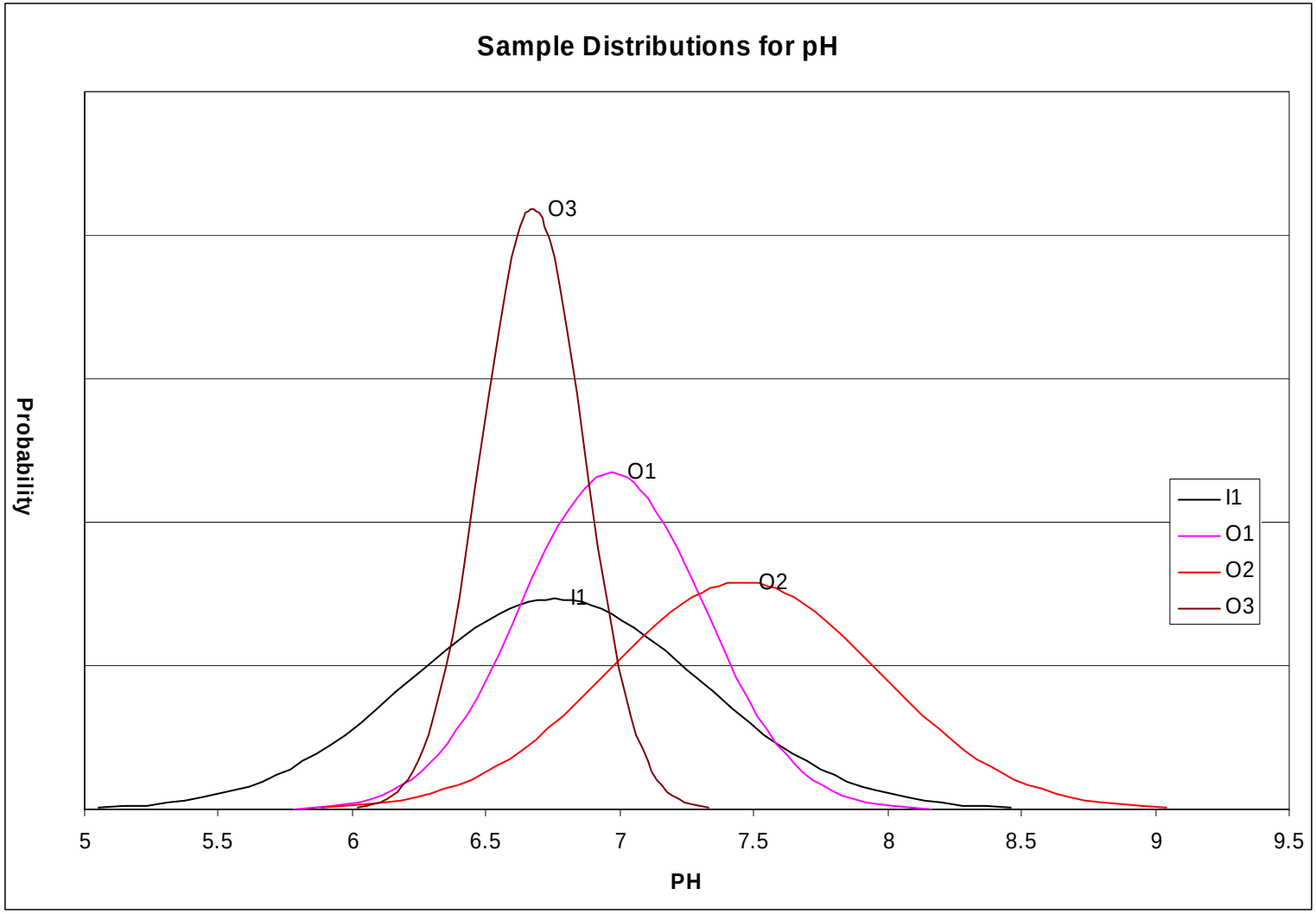
pH, LABPH or FIELDPH [b]					
		Inflow I1	Outflow Storm O1	Upper Outflow Baseflow O2	Lower Outflow Baseflow O3 [a]
# Points …		30	30	20	15
From Data	Mean	6.7567	6.97	7.46	6.6733
	Median	6.85	7	7.5	6.6
	StDev	0.5456	0.3405	0.5051	0.1907
	Min	5.7	6.1	6.6	6.4
	Max	7.7	7.6	8.6	7
From Plots	Distribution	Normal	Normal	Normal	Normal
	R2	0.9845	0.9759	0.9616	0.9312
	Median	6.7318	6.9216	7.4575	6.6579
	Mean	6.7318	6.9216	7.4575	6.6579
	StDev	0.5346	0.3328	0.5057	0.1742



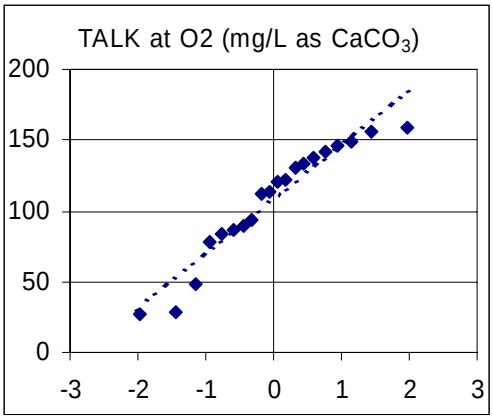


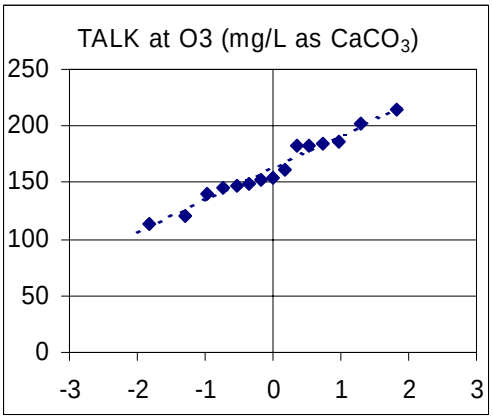


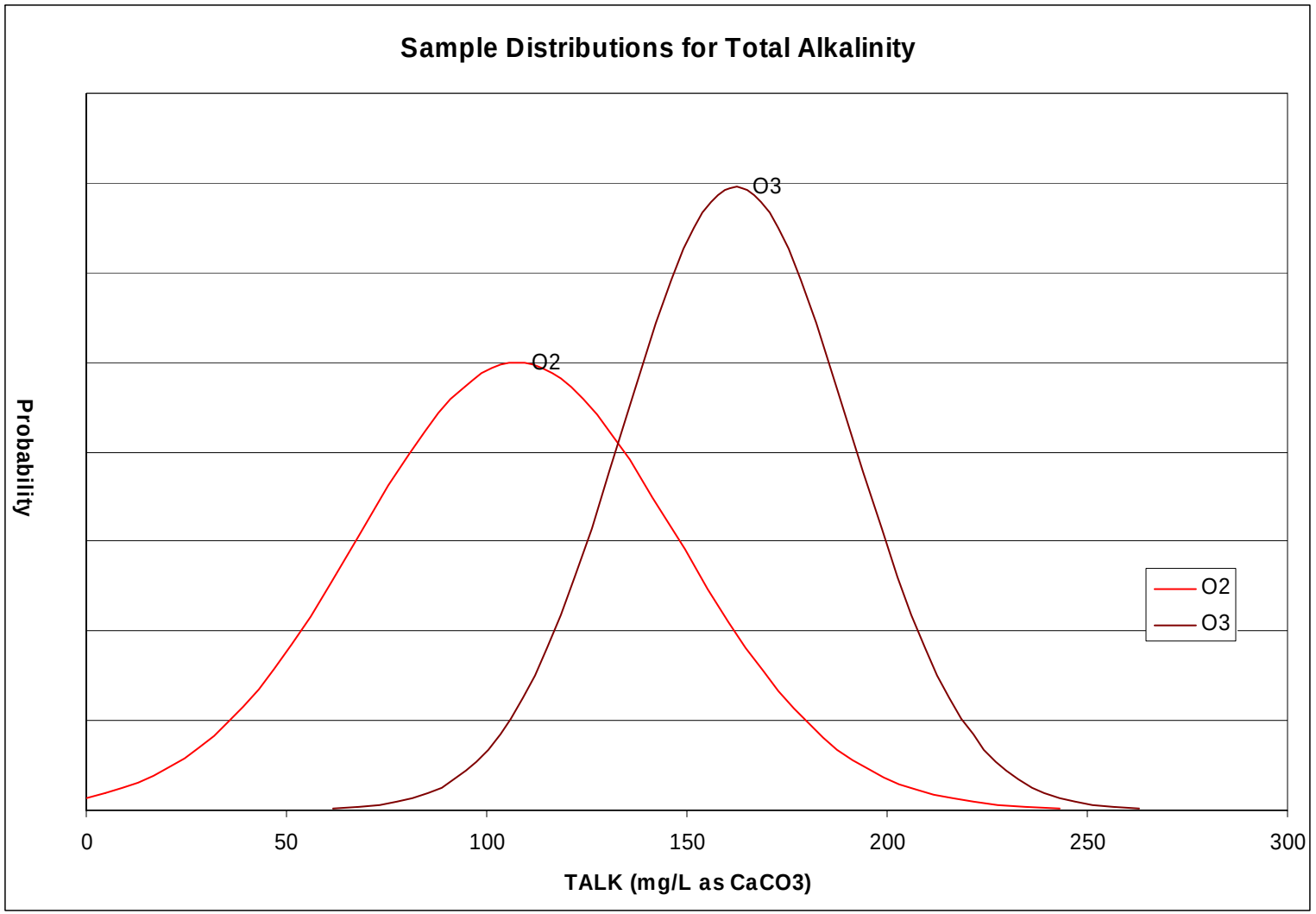



Sample Distributions for pH
Probability
O3
O1
O2
I1
I1
O1
O2
O3
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
PH

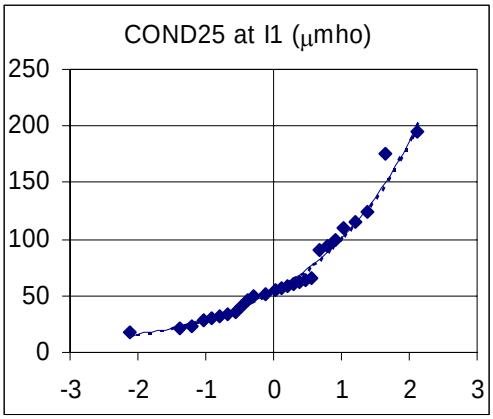
Total Alkalinity, TALK (mg/L as $CaCO_3$)			
		Upper Outflow Baseflow O2	Lower Outflow Baseflow O3 [a]
# Points …		20	15
From Data	Mean	107.67	162.3333
	Median	117.25	153.9
	StDev	40.113	28.7094
	Min	26.9	114.2
	Max	159.4	213.9
From Plots	Distribution	Normal	Normal
	R2	0.93	0.9642
	Median	107.67	162.33
	Mean	107.67	162.33
	StDev	38.919	28.414

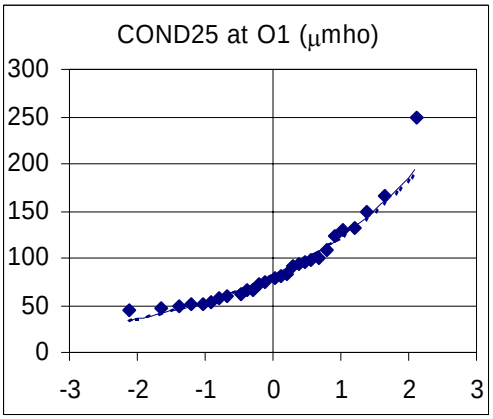


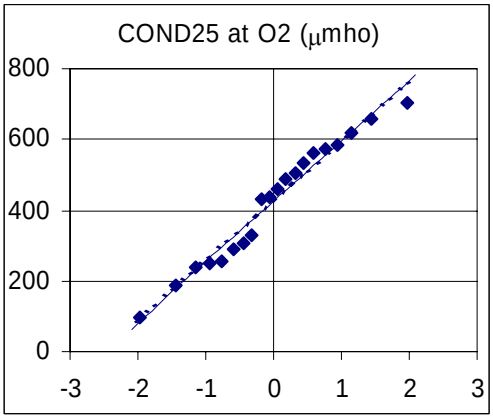


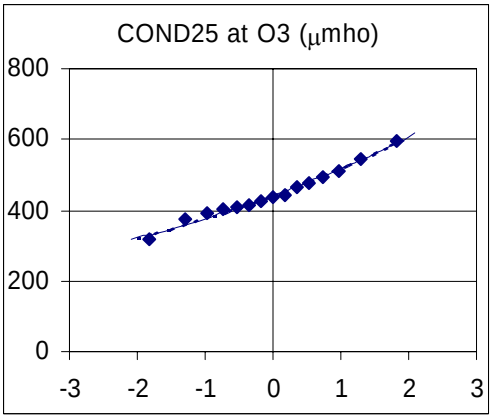

Sample Distributions for Total Alkalinity
Probability
O3
O2
O2
O3
0
50
100
150
200
250
300
TALK (mg/L as CaCO3)

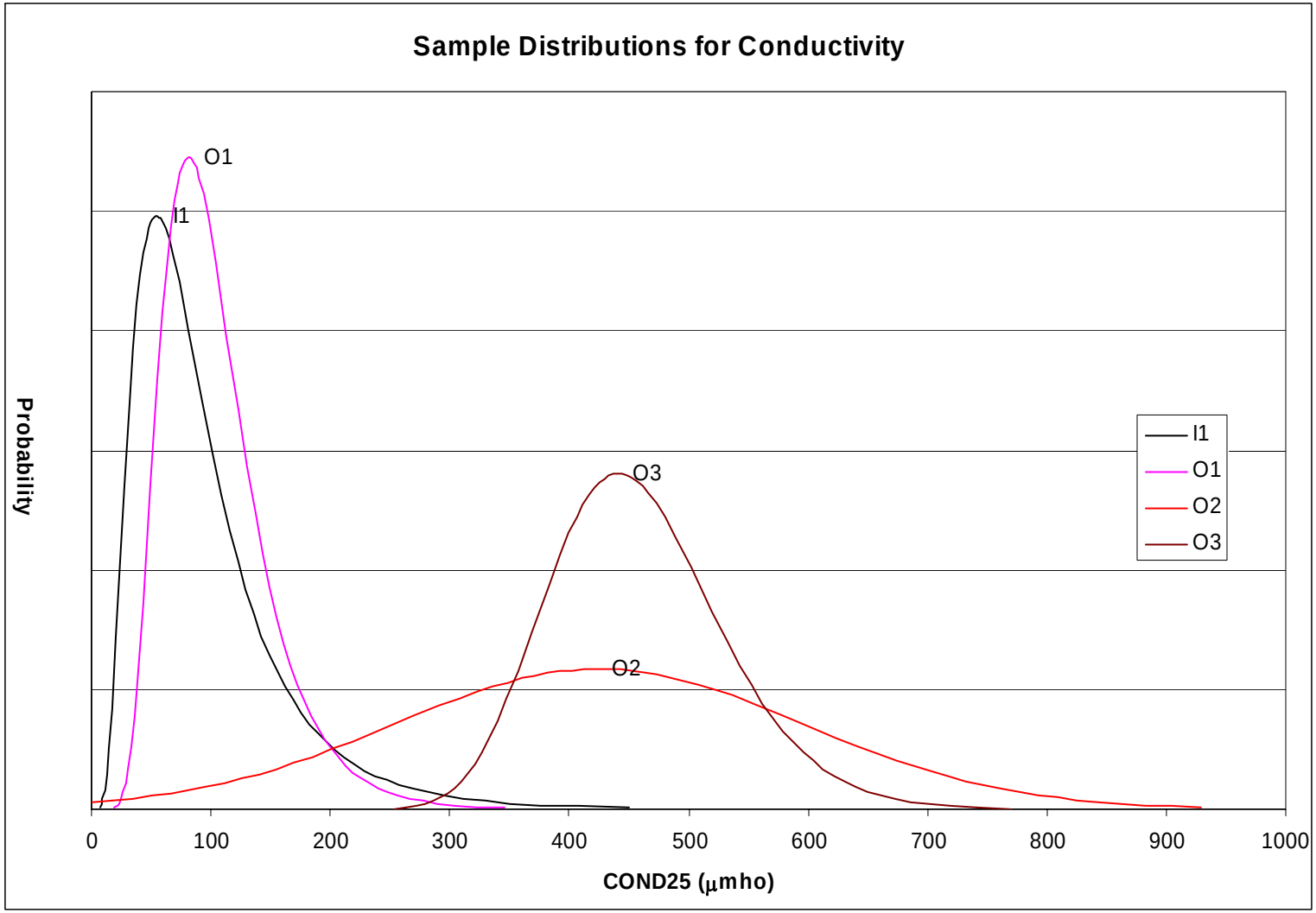
Conductivity at 25°C, COND25 (μmho)					
		Inflow I1	Outflow Storm O1	Upper Outflow Baseflow O2	Lower Outflow Baseflow O3 [a]
# Points …		30	30	20	15
From Data	Mean	65.5	89	424.95	446.6667
	Median	55	78	447	436
	StDev	43.514	43.685	171.57	71.1203
	Min	18	45	94	316
	Max	195	250	704	597
	Logn Mean	*3.9961*	*4.3980*		*6.0900*
	Logn StDev	*0.6146*	*0.4138*		*0.1590*
From Plots	Distribution	Lognormal	Lognormal	Normal	Lognormal
	R2	0.9794	0.9565	0.9704	0.9832
	Median	53.952	81.469	424.95	441.44
	Mean	*3.9881*	*4.4002*	424.95	*6.0900*
	StDev	*0.6183*	*0.4056*	107.04	*0.1589*










Sample Distributions for Conductivity
Probability
O1
I1
O3
O2
I1
O1
O2
O3
0
100
200
300
400
500
600
700
800
900
1000
COND25 (µmho)

Appendix D

Sensitivity Analysis

Average Concentrations and Confidence Limits

The table that covers the next 4 pages summarizes the concentrations used for the unsampled storms and baseflows during the sensitivity analysis. The distribution type, lognormal mean, lognormal or normal standard deviation (stdev) and number of datapoints come from Appendix B. $\hat{\mu}$ was calculated using equation 3.7. The upper and lower 80% and 40% confidence limits listed below come from a computer program by Lyon and Land (http://conflimit.nci.nih.gov) and represent the confidence limits about $\hat{\mu}$. The confidence limits about the flow-weighted or simple average concentration (μ without a hat) are listed at the end for each chemical as "10% cumulative probability", etc., as calculated using equation 3.12.

Consider an example… The lower (2-tail) 40% confidence limit of the flow-weighted average ortho-phosphate phosphorus concentration for the O2 baseflow was 0.029, meaning that the probability of the actual flow-weighted average concentration being less than 0.029 is about 30%. This value was calculated with equation 3.9…

$$LCL_{0.4} = \hat{LCL}_{0.4} * \frac{\mu}{\hat{\mu}} = 0.028 * \frac{0.0338}{0.034} \qquad (3.9)$$

$$LCL_{0.4} = 0.029$$

During the sensitivity analysis, the five or 10 concentrations listed at the bottom of each chemical were assumed to have the same probability of occurring, i.e. the "10% cumulative probability" value was allowed to represent all the concentrations that had a cumulative probability of between 0 and 20%, or the lower fifth of the possible concentrations, and so on for the 30%, 50%, 70%, and 90% cumulative probability concentrations. Each of those five (or ten) concentrations was used to in turn to calculate the pollutant loads.

The flow-weighted averages and simple arithmetic averages shown in this table are based on substituting 0.5*MDL for any sample concentrations that were less than the minimum detection limit (MDL). During the sensitivity analysis, as the substitution value for the <MDL concentrations (parameter *D*) was varied, the average pollutant concentrations varied, and so the 10% - 90% cumulative probability concentrations varied. Values shown in ***green, bold, italics*** come from the probability plots instead of from the original data.

		OP	TP	NH3_N	TKN	OX_N	COD	TOC	TSS	SCA	SMG	EPB	EZN
Inflow Storms	flow-weighted average	0.220	0.342	0.185	1.097	0.551	23.53	6.626	30.69	6,737	2,787	3.393	18.37
	distribution	LN	LN	LN	LN	LN	LN	LN	LN	LN	LN	LN	LN
	lognormal mean	-2.0076	-1.3410	-1.6054	0.1113	-0.8787	3.1143	1.7786	3.3117	***8.394***	***5.768***	***0.9855***	***2.8041***
	lognormal stdev	0.7789	0.6165	0.6387	0.5008	0.4417	0.3718	0.4088	0.8443	***0.724***	***1.711***	***0.3742***	***0.8055***
	count datapoints	29	30	29	30	29	29	29	28	30	30	30	30
	$\hat{\mu}$ for lognormal distribution	0.182	0.316	0.246	1.267	0.458	24.13	6.438	39.18	5,744	1,383	2.874	22.84
	lower 90% confidence limit	0.140	0.260	0.200	1.083	0.398	21.47	5.659	29.33	4,544	681	2.560	17.53
	lower 70% confidence limit	0.153	0.278	0.215	1.145	0.418	22.39	5.926	32.36	4,926	856	2.668	19.19
	lower 50% confidence limit	0.162	0.290	0.225	1.184	0.431	22.96	6.092	34.39	5,176	994	2.735	20.29
	lower 30% confidence limit	0.169	0.300	0.233	1.216	0.442	23.43	6.229	36.17	5,391	1,128	2.790	21.25
	lower 10% confidence limit	0.177	0.310	0.241	1.247	0.452	23.86	6.357	37.91	5,598	1,274	2.842	22.18
	upper 10% confidence limit	0.184	0.320	0.249	1.278	0.461	24.30	6.485	39.73	5,813	1,444	2.893	23.15
	upper 30% confidence limit	0.193	0.330	0.258	1.312	0.472	24.76	6.624	41.80	6,051	1,657	2.948	24.24
	upper 50% confidence limit	0.203	0.343	0.268	1.352	0.485	25.31	6.786	44.35	6,341	1,955	3.012	25.57
	upper 70% confidence limit	0.218	0.361	0.283	1.405	0.502	26.03	7.003	48.01	6,745	2,453	3.098	27.46
	upper 90% confidence limit	0.248	0.396	0.313	1.508	0.534	27.39	7.411	55.71	7,561	3,823	3.256	31.36
	5% cumulative probability	0.170	0.281	0.150	0.938	0.479	20.93	5.824	22.97	5,330	1,372	3.023	14.10
	15% cumulative probability	0.185	0.301	0.162	0.992	0.503	21.83	6.099	25.35	5,777	1,725	3.151	15.43
	25% cumulative probability	0.196	0.313	0.169	1.025	0.518	22.39	6.269	26.94	6,071	2,002	3.230	16.32
	35% cumulative probability	0.205	0.324	0.175	1.053	0.531	22.84	6.411	28.33	6,323	2,274	3.295	17.09
	45% cumulative probability	0.214	0.335	0.181	1.080	0.543	23.27	6.542	29.69	6,566	2,568	3.356	17.84
	55% cumulative probability	0.223	0.345	0.187	1.107	0.555	23.69	6.675	31.12	6,817	2,910	3.416	18.62
	65% cumulative probability	0.233	0.357	0.194	1.136	0.568	24.15	6.817	32.74	7,097	3,340	3.482	19.49
	75% cumulative probability	0.245	0.371	0.202	1.170	0.583	24.68	6.984	34.74	7,436	3,940	3.557	20.57
	85% cumulative probability	0.263	0.390	0.213	1.217	0.603	25.38	7.207	37.60	7,910	4,943	3.658	22.09
	95% cumulative probability	0.299	0.427	0.235	1.306	0.642	26.70	7.627	43.64	8,868	7,705	3.845	25.22

		OP	TP	NH3_N	TKN	OX_N	COD	TOC	TSS	SCA	SMG	EPB	EZN
Outflow Storms	flow-weighted average	0.140	0.222	0.078	0.949	0.424	22.44	7.531	20.63	7,160	3,102	3.120	16.44
	distribution	LN	LN	LN	Normal	LN	LN	LN	LN	LN	LN	LN	LN
	normal stdev				0.2944								
	lognormal mean	-2.1442	-1.6301	-2.6233		-1.0849	3.1717	2.0972	2.5196	8.687	***7.588***	***0.6962***	***2.7675***
	lognormal stdev	0.6365	0.4978	0.7608		0.4047	0.2431	0.2481	0.7287	0.503	***0.713***	***0.4881***	***0.3125***
	count datapoints	30	30	30	30	30	30	29	28	30	30	30	30
	$\hat{\mu}$ for lognormal distribution	0.143	0.222	0.097		0.367	24.56	8.398	16.20	6,728	2,546	2.260	16.72
	lower 90% confidence limit	0.117	0.190	0.076		0.324	22.80	7.771	12.69	5,748	2,022	1.940	15.18
	lower 70% confidence limit	0.126	0.201	0.082		0.338	23.43	7.994	13.80	6,076	2,189	2.048	15.72
	lower 50% confidence limit	0.131	0.207	0.087		0.348	23.81	8.129	14.53	6,284	2,298	2.115	16.05
	lower 30% confidence limit	0.136	0.213	0.091		0.355	24.12	8.239	15.16	6,457	2,392	2.172	16.32
	lower 10% confidence limit	0.140	0.218	0.094		0.362	24.42	8.35	15.77	6,621	2,482	2.225	16.59
	upper 10% confidence limit	0.145	0.224	0.098		0.369	24.71	8.448	16.40	6,786	2,576	2.279	16.84
	upper 30% confidence limit	0.150	0.230	0.102		0.377	24.98	8.545	17.10	6,966	2,679	2.337	17.08
	upper 50% confidence limit	0.156	0.236	0.108		0.386	25.32	8.666	17.96	7,179	2,805	2.406	17.38
	upper 70% confidence limit	0.165	0.246	0.115		0.398	25.76	8.824	19.17	7,466	2,980	2.499	17.78
	upper 90% confidence limit	0.181	0.264	0.130		0.420	26.57	9.113	21.63	8,018	3,332	2.677	18.52
	5% cumulative probability	0.114	0.190	0.061	0.858	0.374	20.83	6.969	16.16	6,117	2,464	2.679	14.94
	15% cumulative probability	0.123	0.201	0.066	0.893	0.391	21.40	7.169	17.58	6,467	2,667	2.828	15.46
	25% cumulative probability	0.128	0.208	0.070	0.913	0.402	21.75	7.290	18.51	6,687	2,800	2.921	15.79
	35% cumulative probability	0.133	0.213	0.073	0.929	0.411	22.03	7.389	19.31	6,872	2,915	2.999	16.05
	45% cumulative probability	0.137	0.219	0.076	0.943	0.419	22.32	7.487	20.08	7,046	3,024	3.073	16.32
	55% cumulative probability	0.141	0.224	0.079	0.956	0.427	22.57	7.576	20.88	7,222	3,138	3.147	16.57
	65% cumulative probability	0.146	0.230	0.082	0.970	0.436	22.82	7.663	21.78	7,414	3,264	3.227	16.80
	75% cumulative probability	0.152	0.237	0.087	0.986	0.446	23.13	7.772	22.87	7,640	3,417	3.322	17.10
	85% cumulative probability	0.160	0.246	0.093	1.006	0.460	23.54	7.914	24.41	7,946	3,630	3.451	17.49
	95% cumulative probability	0.177	0.264	0.105	1.041	0.486	24.28	8.172	27.54	8,533	4,060	3.696	18.22

		OP	TP	NH3_N	TKN	OX_N	COD	TOC	TSS	SCA	SMG	EPB	EZN
Outflow Baseflow	average	0.0338	0.0748	0.0238	0.6543	0.0676	21.7190	8.7714	5.9524	42,553	17,867	1.6095	17.1476
	distribution	LN	LN	LN	LN	LN	LN	Normal	LN	Normal	Normal	LN	LN
	normal stdev							3.2573		13,751	7,275		
	lognormal mean	***-3.9846***	-2.8337	***-4.0570***	-0.5233	***-6.1193***	2.9939		***1.3264***			***0.4267***	***2.8490***
	lognormal stdev	***1.0921***	0.7364	***0.5796***	0.4590	***3.1210***	0.4156		***0.9618***			***0.4585***	***0.4104***
	count datapoints	21	21	21	21	21	21	21	21	21	21	21	21
	lower 80% confidence limit	0.023	0.061	0.017	0.575	0.048	19.27		4.38			1.487	16.66
	lower 40% confidence limit	0.028	0.070	0.019	0.621	0.122	20.64		5.18			1.604	17.83
	$\hat{\mu}$ for lognormal distribution	0.034	0.077	0.020	0.658	0.287	21.77		5.98			1.702	18.79
	upper 40% confidence limit	0.039	0.084	0.022	0.694	0.738	22.83		6.79			1.794	19.69
	upper 80% confidence limit	0.053	0.100	0.025	0.761	4.726	24.77		8.66			1.966	21.34
	10% cumulative probability	0.023	0.060	0.020	0.571	0.011	19.23	7.829	4.35	38,576	15,763	1.406	15.20
	30% cumulative probability	0.029	0.067	0.022	0.617	0.029	20.60	8.393	5.15	40,954	17,021	1.517	16.28
	50% cumulative probability	0.034	0.075	0.024	0.654	0.068	21.72	8.771	5.95	42,553	17,867	1.610	17.15
	70% cumulative probability	0.039	0.082	0.025	0.690	0.174	22.78	8.393	6.76	40,954	17,021	1.697	17.97
	90% cumulative probability	0.053	0.097	0.029	0.756	1.114	24.71	9.713	8.61	46,530	19,971	1.859	19.48
Lysimeter 1	average	0.0140	0.0432	0.1557	1.1050	0.0093	43.5739	9.7667		104,874	36,543	1.5000	7.5000
	distribution	LN	LN	LN	Normal	LN	LN	Normal		Normal	Normal	Uniform	Uniform
	normal stdev				0.2299			4.1734		22,402	4,923		
	lognormal mean	***-4.6052***	***-3.5370***	-1.9845		***-6.7254***	3.7319						
	lognormal stdev	***0.7245***	***0.8237***	0.5312		***2.0211***	0.3014						
	count datapoints	29	30	28	28	29	23	8		23	23	12	12
	lower 80% confidence limit	0.011	0.033	0.138		0.004	40.21						
	lower 40% confidence limit	0.012	0.037	0.149		0.007	42.18						
	$\hat{\mu}$ for lognormal distribution	0.013	0.041	0.158		0.009	43.70						
	upper 40% confidence limit	0.014	0.045	0.167		0.013	45.16						
	upper 80% confidence limit	0.016	0.052	0.183		0.025	47.65						
	10% cumulative probability	0.012	0.035	0.136	1.048	0.004	40.09	7.679		98,702	35,187	0.300	1.50
	30% cumulative probability	0.013	0.039	0.147	1.082	0.007	42.05	8.956		102,388	35,997	0.900	4.50
	50% cumulative probability	0.014	0.043	0.156	1.105	0.009	43.57	9.767		104,874	36,543	1.500	7.50
	70% cumulative probability	0.015	0.047	0.164	1.082	0.013	45.03	8.956		102,388	35,997	2.100	10.50
	90% cumulative probability	0.017	0.055	0.180	1.162	0.026	47.51	11.854		111,046	37,900	2.700	13.50

		OP	TP	NH3_N	TKN	OX_N	COD	TOC	TSS	SCA	SMG	EPB	EZN
Lysimeter 2	average	0.0050	0.0172	0.0918	0.2524	0.0059	6.9414	3.6706		107,497	32,573	1.8034	7.5000
	distribution	Uniform	LN	Normal	LN	LN	Normal	LN		Normal	Normal	LN	Uniform
	normal stdev			0.0183			2.2352			7,661	1,622		
	lognormal mean		***-4.9063***		-1.4479	***-8.1117***		1.1931				***0.7957***	
	lognormal stdev		***1.1489***		0.3887	***2.2604***		0.3029				***0.3192***	
	count datapoints	29	30	28	25	29	29	29		30	30	29	29
	lower 80% confidence limit		0.010		0.229	0.002		3.205				2.156	
	lower 40% confidence limit		0.012		0.242	0.003		3.345				2.255	
	$\hat{\mu}$ for lognormal distribution		0.014		0.254	0.004		3.452				2.332	
	upper 40% confidence limit		0.016		0.264	0.006		3.555				2.405	
	upper 80% confidence limit		0.021		0.283	0.013		3.728				2.529	
	10% cumulative probability	0.001	0.012	0.087	0.228	0.002	6.40	3.408		105,662	32,185	1.667	1.50
	30% cumulative probability	0.003	0.015	0.090	0.241	0.004	6.72	3.557		106,755	32,416	1.744	4.50
	50% cumulative probability	0.005	0.017	0.092	0.252	0.006	6.94	3.671		107,497	32,573	1.803	7.50
	70% cumulative probability	0.007	0.020	0.090	0.263	0.009	6.72	3.780		106,755	32,416	1.860	10.50
	90% cumulative probability	0.009	0.025	0.096	0.281	0.020	7.49	3.964		109,331	32,962	1.956	13.50
Lysimeter 3	average	0.0050	0.0520	0.2200	0.5150	0.0050	6.6600	3.0200		96,510	43,610	1.6900	7.5000
	distribution	Uniform	LN	LN	Normal	Uniform	LN	Normal		Normal	Normal	LN	Uniform
	normal stdev				0.1086			0.1619		3,398	1,284		
	lognormal mean		-3.3368	-1.5383			1.8896					***0.8854***	
	lognormal stdev		1.0062	0.2292			0.1196					***0.2057***	
	count datapoints	9	10	9	8	9	10	10		10	10	10	10
	lower 80% confidence limit		0.036	0.198			6.33					2.265	
	lower 40% confidence limit		0.047	0.211			6.52					2.386	
	$\hat{\mu}$ for lognormal distribution		0.059	0.220			6.66					2.476	
	upper 40% confidence limit		0.072	0.230			6.80					2.562	
	upper 80% confidence limit		0.112	0.246			7.03					2.717	
	10% cumulative probability	0.001	0.032	0.198	0.461	0.001	6.32	2.949		95,024	43,048	1.546	1.50
	30% cumulative probability	0.003	0.041	0.210	0.494	0.003	6.52	2.992		95,926	43,389	1.628	4.50
	50% cumulative probability	0.005	0.052	0.220	0.515	0.005	6.66	3.020		96,510	43,610	1.690	7.50
	70% cumulative probability	0.007	0.063	0.229	0.536	0.007	6.80	2.992		95,926	43,389	1.749	10.50
	90% cumulative probability	0.009	0.098	0.246	0.569	0.009	7.02	3.091		97,996	44,172	1.855	13.50

Appendix E

Evapotranspiration

The Food and Agriculture Organization of the United Nations in 1998 published a set of guidelines for computing crop water requirements (FAO-56), summarized below. In that paper Richard Allen and his associates recommended using the Penman-Monteith equation to calculate the reference crop evapotranspiration, then multiplying this by a crop coefficient to predict the evapotranspiration from the crop (or in this case bioretention area) of interest. A model for a bioretention area must use fairly short time steps to be able to accommodate the modeling of short, intense storms, so equations in this section will be stated to allow for hourly or shorter calculation time steps.

E.1 Reference Crop Evapotranspiration

The reference crop evapotranspiration is based on site longitude and local weather conditions:

$$ET_0 = \frac{0.408\Delta\left(R_n - G\right) + \gamma \dfrac{900dt}{T+273} u_2\left(e_s - e_a\right)}{\Delta + \gamma\left(1 + 0.34u_2\right)} \qquad \text{(E. 1)}$$

where…

dt = length of time step (fraction of a day)
γ = psychometric constant = $0.665*10^{-3} * P$, where P is atmostpheric pressure (kPa)
T = mean air temperature for that time step (°C),
and other factors are as detailed below…

Atmospheric pressure, P, and air temperature, T, were recorded at the Occoquan Watershed Monitoring Laboratory (OWML) in Manassas every 10 minutes.

The **slope of the saturation vapor pressure curve**, Δ, is found by

$$\Delta = \frac{\partial e_s}{\partial T} = \frac{4098\left[0.618\exp\left(\dfrac{17.27T}{T+273.3}\right)\right]}{\left(T+273.3\right)^2} \qquad \text{(E. 2)}$$

Net radiation (R_n) at the earth's surface is a combination of the net short wave radiation ($(1-\alpha)*R_s$) and the net long wave radiation (R_b). Short wave radiation can be calculated from the extraterrestrial radiation (R_a) and the measured cloudiness, while longwave radiation is more closely related to temperature.

$$R_n = (1-\alpha)\,R_s - R_b \qquad \text{(E. 3)}$$

where α = albedo. A typical value for α is 0.23.

The **extraterrestrial radiation (R_a)** is…

$$R_a = \frac{12(60)}{\pi} G_{sc} d_r \{\cos(\phi)\cos(\delta)[\sin(\omega_2) - \sin(\omega_1)] - (\omega_2 - \omega_1)\sin(\phi)\sin(\delta)\} \quad \text{(E. 4)}$$

where…

G_{sc} = solar constant = 0.08202 MJ m^{-2} min^{-1}
d_r = relative distance of the earth from the sun = 1 + 0.0033 cos(2π ∗ *J* / 365)
J = Julian day (Jan 1 = 1, Jan 2 = 2, … Feb 1 = 32, …)
ϕ = station latitude = 0.676466 radians (38.7586° North)
δ = declination (radians) = 0.4093 sin[2π (284+*J*) / 365]
$\omega_1 = \omega - \pi \Delta t$, $\omega_2 = \omega + \pi \Delta t$, restricted to daylight hours as discussed below
ω = solar time angle at the midpoint of the time period = (h + E – 12)*π / 12
h = time in hours at the midpoint of the time period
E = seasonal correction for solar time (hours) = 0.1645 sin(2b) – 0.1255 cos(b) – 0.025 sin(b)
b = 2 π (*J* – 81) / 365

ω_1 and ω_2 should be limited to within daylight hours using the following…

ω_{sunset} = solar angle at sunset = arccos [-tan(ϕ)tan(δ)]
$\omega_{sunrise}$ = solar angle at sunrise = $-\omega_{sunset}$.
If $\omega_1 > \omega_{sunset}$ then $\omega_1 = \omega_{sunset}$, else if $\omega_1 < \omega_{sunrise}$ then $\omega_1 = \omega_{sunrise}$. Otherwise keep ω_1 the same.
If $\omega_2 > \omega_{sunset}$ then $\omega_2 = \omega_{sunset}$, else if $\omega_2 < \omega_{sunrise}$ then $\omega_2 = \omega_{sunrise}$. Otherwise keep ω_2 the same.
So, during nighttime either $\omega_1 = \omega_2 = \omega_{sunset}$ or $\omega_1 = \omega_2 = \omega_{sunrise,}$ and the radiation (R_a) = 0.

Short wave radiation (R_s) may be expressed as a function of the extraterrestrial radiation and the ratio of actual to possible sunshine, n/N. The n/N ratio was calculated based on daily cloud cover information from Dulles Airport and the information shown in Table A.1 below.

$$R_s = \left(0.25 + 0.5\frac{n}{N}\right) \cdot R_a \quad \text{(E. 5)}$$

Table E. 1. Relationship of n/N to Cloudiness (Doorenbos, FAO-24, 1977).

Cloudiness (tenths)	0	1	2	3	4	5	6	7	8	9	10
n/N ratio	0.95	0.85	0.80	0.75	0.65	0.55	0.50	0.40	0.30	0.15	0

Long wave radiation is more closely tied to the air temperature than to the extraterrestrial radiation, though it still has some relationship to cloudiness.

$$R_b = \left(0.9\frac{n}{N} + 0.1\right) \cdot \left[0.34 - 0.139\sqrt{e_d}\right] \cdot \sigma \cdot (T + 273)^4 \quad \text{(E. 6)}$$

where… e_d = saturation vapor pressure (kPa) at the mean dew point temperature for that time step.

σ = (4.90*10^{-9} MJ m^{-2} d^{-1} K^{-4}) (Δt days)

Soil heat flux, G, may be calculated as…

$G = 0.1\ R_n$ during the daytime, or

$G = 0.5\ R_n$ during the nighttime

Wind speed measurements for these evapotranspiration calculations must be transferred from their measurement elevation (elevation *z* and windspeed u_z) to 2m elevation (windspeed u_2) using the following equation. Windspeed was measured at OWML every 10 minutes.

$$u_2 = u_z \frac{4.87}{\ln(67.8z - 5.42)} \quad \text{(E. 7)}$$

Vapor pressure deficit is ($e_s - e_a$), where e_s is the saturated vapor pressure at the current air temperature and e_a is the actual vapor pressure. The saturated vapor pressure may be calculated from the air temperature by

$$e_s(kPa) = 3.38639 \cdot \left\{ (0.00738T + 0.8072)^8 - 0.000019|1.8T + 48| + 0.001316 \right\} \quad \text{(E. 8)}$$

$$e_a = e_s \frac{RH}{100}$$, where *RH* (relative humidity) is between 0 and 100%. (E. 9)

E.2 Crop Coefficients

The final evapotranspiration for the crop or bioretention area (ET_c) is calculated using the FAO-56 procedure for finding a Dual Crop Coefficient…

$$ET_c = (K_s K_{cb} + K_e) \cdot ET_0 \quad \text{(E. 10)}$$

K_{cb} is the basal crop coefficient. K_s is an adjustment on K_{cb} to account for water limiting conditions. Together, $K_s K_{cb}$ accounts for the transpiration part of evapotranspiration. K_e is the soil evaporation coefficient, and accounts for the evaporation directly from the soil or from any ponded water, i.e.

Transpiration = $K_s\ K_{cb}\ ET_0$ and *Evaporation* = $K_e\ ET_0$

Basal Crop Coefficient, K_{cb}

K_{cb} was calculated by on linear interpolation between $K_{cb\ ini}$, $K_{cb\ mid}$, and $K_{cb\ end}$ based on the date. During the "initial" growth period from 3/17/04 to 3/27/04, $K_{cb\ ini}$ was applied. During the "crop development" period from 3/27/04 to 4/16/04, K_{cb} increased steadily from $K_{cb\ ini}$ to $K_{cb\ mid}$. Then $K_{cb\ mid}$ held steady during the "mid-season" time periods from 4/16/04 to 10/31/04 and from 11/10/03 to 11/17/03. For the crop used at Kingsbrooke, cool season turf grass, there was no "late season" time period because $K_{cb\ end}$ was the same as $K_{cb\ mid}$. Outside of the growing seasons, the value for K_{cb} was maintained at zero; those dates were between 11/17/03 to 3/17/04.

Values for $K_{cb,ini}$, $K_{cb,mid}$, and $K_{cb,end}$ are tabulated for various crops under standard climate conditions where wind speed = 2m/s and relative humidity = 45%. For Kingsbrooke, the "crop" was assumed to be cool season turf grass, with $K_{cb,ini}$ of 0.85, $K_{cb,mid}$=0.9, and $K_{cb,end}$=0.9. The values for $K_{cb,mid}$ and $K_{cb,end}$ (but not $K_{cb,ini}$) had to be adjusted for nonstandard climate conditions using the following.

$$K_{cb} = K_{cb(Tab)} + [0.04(u_2 - 2) - 0.004(RH_{min} - 45)] \cdot \left(\frac{h}{3}\right)^{0.3} \quad \text{(E. 11)}$$

where… u_2 = average wind speed (m/s) for mid-season and late season.
u_2 was measured as 2.04 m/s in 2003 and 1.95 m/s in 2004.

RH_{min} = average value for the minimum daily relative humidity (%) for mid- and late seasons.
RH_{min} was measured at 58% for both 2003 and 2004.

h = average plant height, assumed to be 0.52 m based on estimated tree cover.

The assumption that cool season turf grass could be used as the "crop" for modeling the Kingsbrooke evapotranspiration was based on the observation that grass was the main vegetation present at the site. However, the presence of some small trees and several bushes gives some uncertainty to this assumption. If the crop had instead been considered to be an apple orchard instead of just turf grass, then $K_{cb\ mid}$ would be as high as 1.15. This would be an increase of 28%. Another uncertainty factor comes from the fact that the site is depressed below the surrounding terrain and therefore is shielded somewhat from strong winds. A reduced wind velocity at the site would reduce the evapotranspiration rate. Because of the combination of these two uncertainties, the overall evapotranspiration volume was allowed to vary by ±25%.

Water Stress Coefficient, K_s

When the soil water content is low, plants transpire less. This effect is incorporated into an evapotranspiration model as a factor on the basal crop coefficient, so that *Transpiration* = $K_s\, K_{cb}\, ET_0$. At Kingsbrooke, K_s was assumed to equal 1, meaning that there was no water stress on the plants. This assumption may be justified by noting that

(1) As a stormwater collection facility, this bioretention area a much greater volume of surface watering than would a typical farmer's field.

(2) Clayey soils, such as the topsoil at Kingsbrooke, are known to be more moisture retentive than sandy soils and take more time to dry out.

(3) The lysimeters were able to collect samples throughout the study period. If there was enough water to be drawn in by these lysimeters, then the plants should have been able to draw it up as well.

Soil Evaporation Coefficient, K_e

K_e is calculated from the following formula.

$$K_e = \min\left(\left\{K_r\left(K_{c\max} - K_{cb}\right)\right\},\ or\ \left\{f_{ew} K_{c\max}\right\}\right) \qquad \text{(E. 12)}$$

where K_r is a dimensionless coefficient dependent on the water content near the soil surface, $K_{c\,max}$ and K_{cb} are the maximum and the basal crop coefficients, calculated previously, and f_{ew} is the fraction of the soil that is both exposed and wetted.

$\boldsymbol{K_{c\,max}}$ is the upper limit on ($K_{cb} + K_e$), which is set as …

$$K_{c\max} = \max\left(\begin{Bmatrix} 1.2 + \left[0.04\left(u_2 - 2\right) - 0.004\left(RH_{\min} - 45\right)\right]\cdot\left(\dfrac{h}{3}\right)^{0.3} \end{Bmatrix}, \\ or \qquad \left\{K_{cb} + 0.05\right\}\right) \qquad \text{(E. 13)}$$

K_{cmax} was calculated as 1.17 for both 2003 and 2004.

$\boldsymbol{f_{ew}}$ When modeling a bioretention area, all the exposed soil is likely to have been wetted, so

$f_{ew} = f_e$ = fraction of soil exposed = $1 - f_c$, where

f_c = effective fraction of soil surface covered by vegetation= $\left(\dfrac{K_{cb} - K_{c\min}}{K_{c\max} - K_{c\min}}\right)^{(1+0.5h)}$ (E. 14)

where $K_{c\,min}$ is the minimum K_c for dry bare soil, set to 0.15

f_c was calculated as 0.68, so f_{ew} was 0.32.

$\boldsymbol{K_r}$ is a coefficient that limits evaporation from the soil surface layer. The value of K_r at any given time depends on the depth of water that has evaporated so far, D_e, and its relationship to the readily evaporable and total evaporable water depths. While $D_e<REW$, then $K_r = 1$, and if $D_e=TEW$, then $K_r=0$. K_r varies linearly between *REW* and *TEW*…

$$K_r = \min\left[\max\left(0, \frac{TEW - D_{e,i-1}}{TEW - REW}\right), 1\right] \quad \text{(E. 15)}$$

where *TEW* = total evaporable water;
ranges from 8-12mm for silty clay, set at 10mm for Kingsbrooke.

REW = readily evaporable water;
ranges from 22-28mm for silty clay, set at 25mm.

$D_{e,i\text{-}1}$ is the cumulative depth of evaporation from the soil surface since the last soaking. While water is ponded at the surface, $D_{e,i\text{-}1}$ equals zero and K_r becomes 1.

Appendix F

Guide to Abbreviations

A - one of the hydrology parameters varied during the sensitivity analysis; the gaged:ungaged drainage area ratio

ac - acres

B - one of the hydrology parameters varied during the sensitivity analysis; the day of the month on which to begin groundwater averaging calculations, i.e. the groundwater flowrates may have been averaged between the 1st of March and the 1st of April (B=1) or between the 3rd of March and the 3rd of April (B=3), etc.

C - one of the chemistry parameters varied during the sensitivity analysis; indicates which concentration value was used for non-sampled storms or non-sampled baseflows. Values for C are in percentages indicating the cumulative percent on the distribution of probable values for the average concentration. The actual concentration that was substituted is based on a confidence interval using that cumulative percentage and the equations in sections 3.4.2 and 3.4.3.

cf - cubic feet

cfs - cubic feet per second

COD - chemical oxygen demand

D - one of the chemistry parameters varied during the sensitivity analysis; varies between 0 and 1 and indicates which concentration to substitute for datapoints that were censored for being less than the minimum detection limit (MDL). When D=0 then a concentration of 0 is used for those datapoints, and when D=0.5 then the a concentration of 0.5*MDL is used, etc.

DO - dissolved oxygen

E - one of the hydrology parameters varied during the sensitivity analysis; refers to a multiplier on the reference evapotranspiration volume to account for uncertainties in the crop coefficient (see Appendix E for more evapotranspiration calculations)

EFE - extractable iron

EPB - extractable lead

EZN - extractable zinc

F - one of the hydrology parameters varied during the sensitivity analysis; refers to a multiplier on the rainfall depths measured at Lake Manassas to account for the fact that the Lake Manassas rainfall frequently differed significantly from the Kingsbrooke rainfall depths.

FLO - flowrate in cubic feet per second

I1 - concentration of samples taken from the inflow gage,
or loads for inflow storms (both gaged and ungaged),
or water volume for the overland inflow storms.

Gin - groundwater inflow

Gout - groundwater outflow

L1 - lysimeter placed in the crushed bluestone layer of the upper terrace

L2 - lysimeter placed in the crushed bluestone layer of the middle terrace

L3 - lysimeter placed in the crushed bluestone layer of the lower terrace

L3clay - lysimeter placed in the silt clay topsoil of the lower terrace

MDL - minimum detection limit. Concentrations below this value could not be measured accurately.

NH3_N - ammonia

O1 - related to outflow storms. Composite samples were taken automatically at the outflow gage.

O2 - related to outflow baseflow at the outflow gage; samples were taken weekly.

O3 - related to outflow baseflow samples taken from the rip-rap below the outflow gage.

OP - ortho-phosphate phosphorus

Org_N - organic nitrogen

OWML - Occoquan Watershed Monitoring Laboratory, located in Manassas, Virginia

OX_N - oxidized nitrogen

SCA - soluble calcium

SMG - soluble magnesium

TKN - total Kjeldahl nitrogen

TN - total nitrogen

TOC - total organic carbon

TOTFLO - cumulative flow volume during a storm in cubic feet

TP - total phosphorus

TSS - total suspended solids

TURB - turbidity

THARD - total hardness

Vita

Suzanne Angelo graduated from Poquoson High School in 1998, after which she moved to Blacksburg, Virginia to study at Virginia Tech. In 2003 she graduated summa cum laude with a B.S. in Civil Engineering with an environmental option and a minor in Spanish. She has worked as an intern with GKY & Associates in Springfield, Virginia before returning to Virginia Tech to study for a Master's degree. Currently she resides in Chantilly, Virginia, with her husband Vince and daughter Elizabeth.