

Impacts and Identification of Tidal Intrusion Sources in Manchester-by-the-Sea's Wastewater Collection System



TATA & HOWARD

2017 NEWEA Spring Meeting

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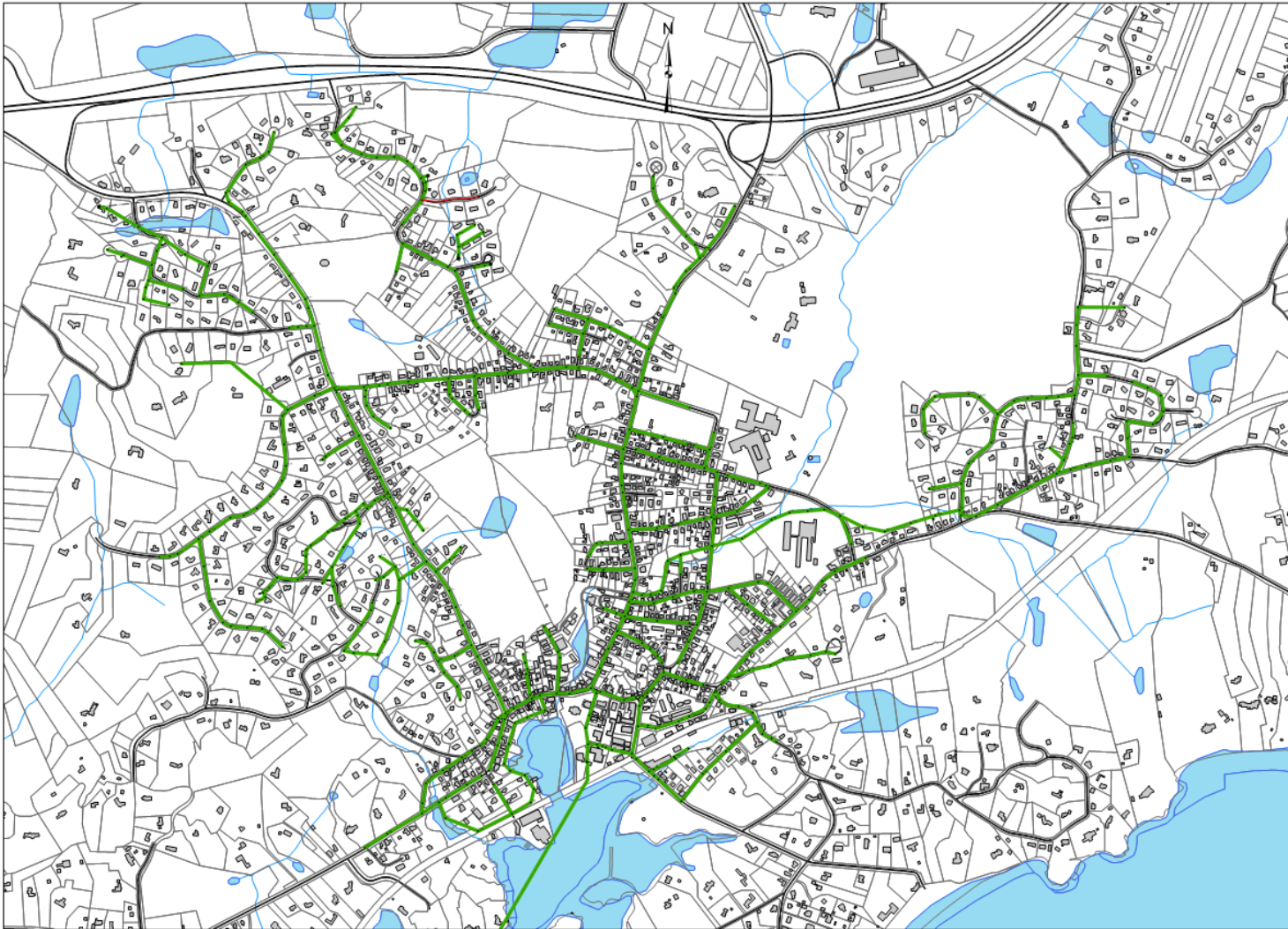
Manchester-by-the-Sea



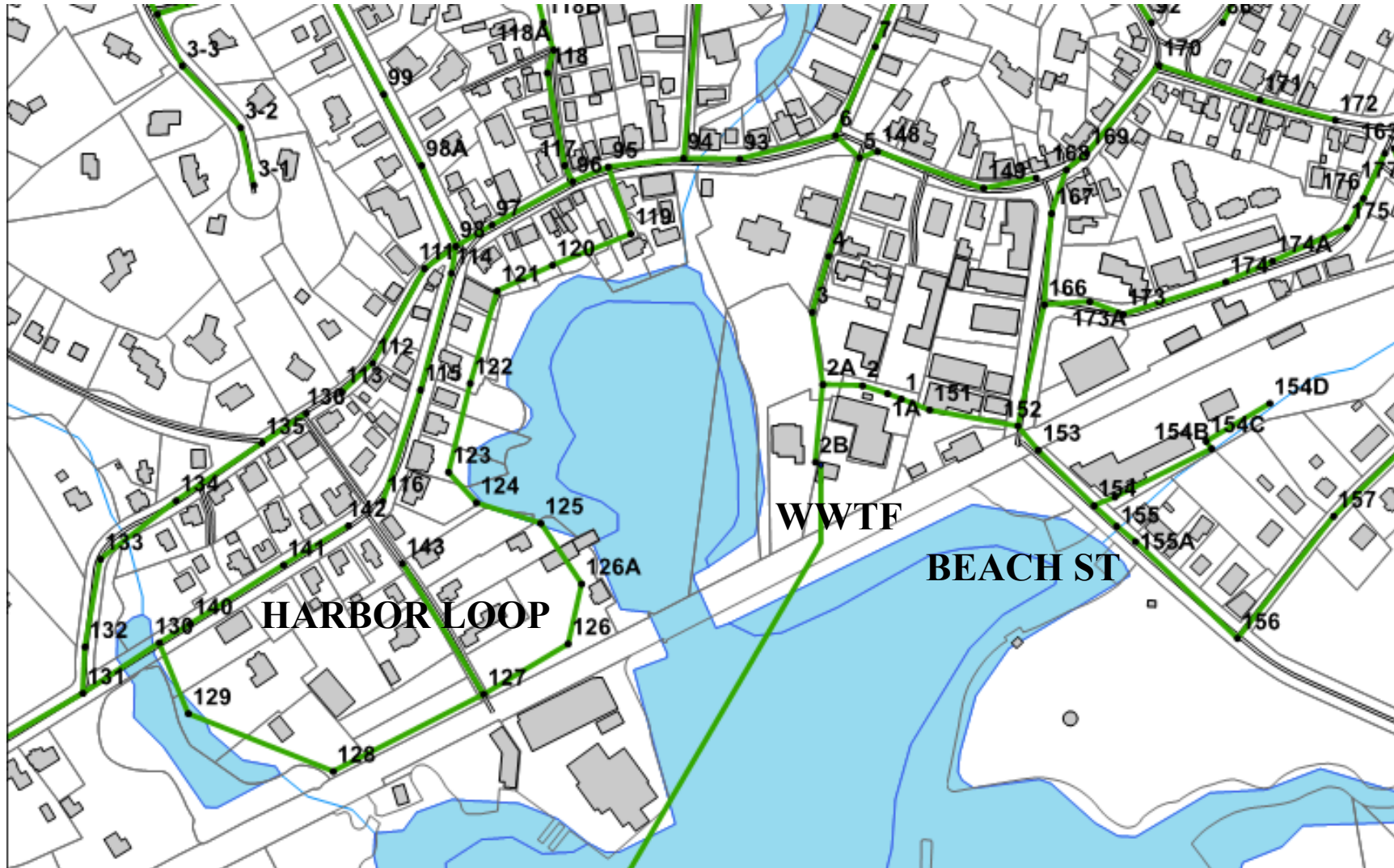
Manchester-by-the-Sea WWTF



Manchester-by-the-Sea Collection System



Shoreline Collection System



Harbor Loop



Beach Street



Background and Acknowledgements

Investigations into Tidal Intrusion Date Back to 2011

Wright-Pierce: December 2012/January 2013

- Salinity Sampling, Video inspection, depth measurements in 12 SMH

Woodard & Curran: October 2013

- Salinity Sampling in 9 SMH's

Woodard & Curran: July 2014

- Salinity Sampling in 4 SMH's

Infiltration and Inflow Investigations

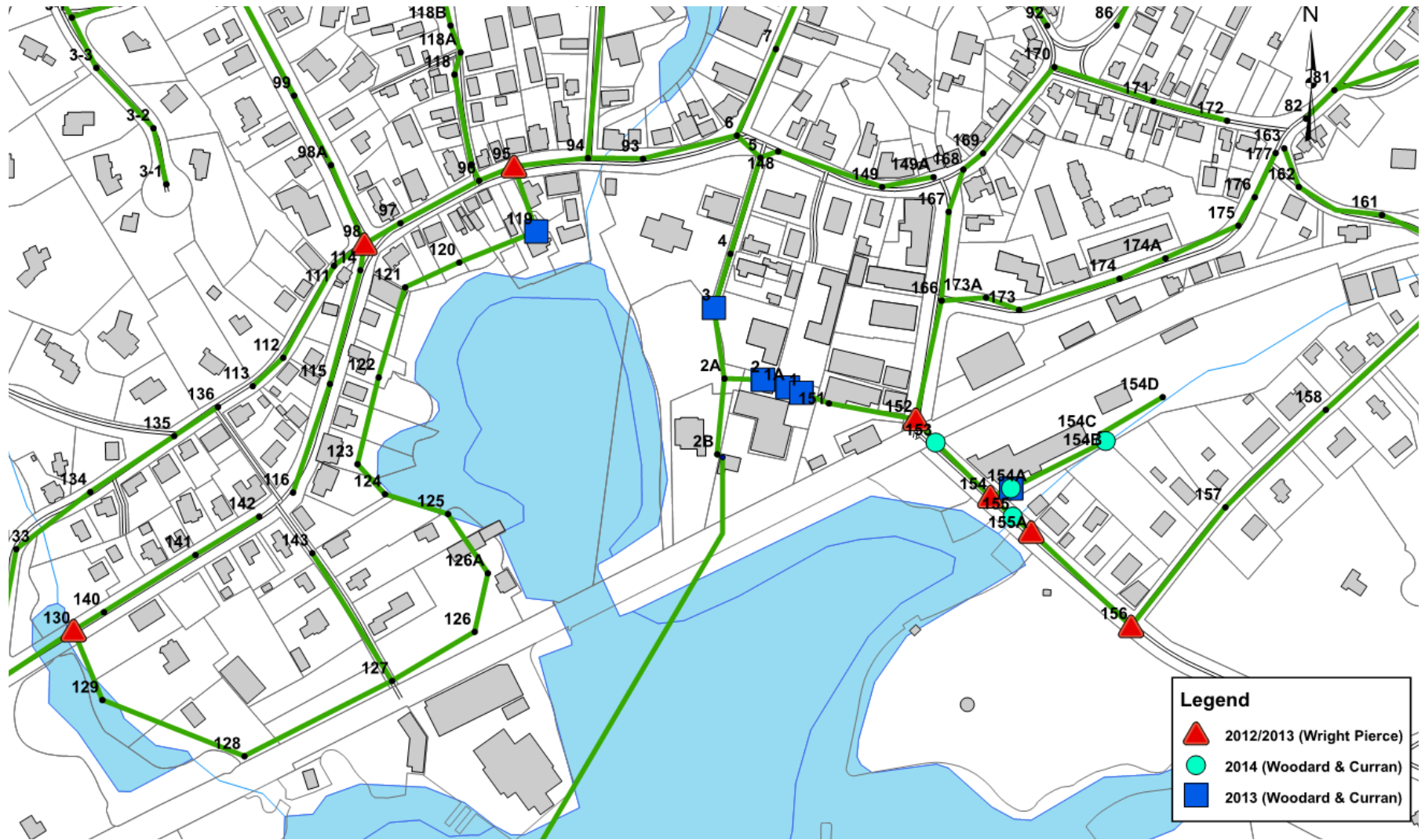
Woodard & Curran I/I Analysis Report December 2013

- Flow Metering Program
- Smoke Testing and Dyed Water Flooding

Woodard & Curran SSES Phase II Report September 2014

- Flow Isolation
- Manhole Inspection
- CCTV Inspection

2012-2104 Salinity Sampling Locations



2012-2014 Sampling Data

Salinity Testing Results 2012 - 2014				
Manhole No.	Salinity (ppt)			
	Dec 2012	Jan 2013	October 2013	July 2014
156	0.3 - 0.7			
155A	0 - 4			
155				0 - 0.3
154B				
154A			3.0 - 14	2.9 - 12.2
154	0 - 35			
153				2.8 - 6.1
152	1.6 - 30.6			
151				
2			2.4 - 7.2	
1A			3.9 - 5.7	
1			3.4 - 7.4	
130	0.3 - 2.6			
119			N/A - 4.5	
98	0.2 - 0.3			
95	0.2 - 2.8			
3			0.6 - 3.9	

BEACH STREET:

Salinity at high tide over 30 ppt in 2012.
Dropped to 12-14 ppt in later investigations.

HARBOR LOOP:

Salinity at high tide 3-4 ppt.

LEGEND	
	Beach Street Area
	Harbor Loop Area
	WWTF

Tidal Intrusion Source Identified

- Tidal source identified between SMH 154 and SMH155A January 2013.
- Service Lateral
- Estimate Flow: 29,000 gpd
- Repaired in September 2013.



Impacts of Tidal Intrusion at WWTF



Impacts of Tidal Intrusion at WWTF

- Discernable flow increases during high tide periods
- Increases in salt concentration can impact treatment performance
 - Total Organic Carbon removal
 - Oxygen Uptake Rate
- Operator routinely increases biomass in system in advance of significant tidal events.

Operations Data during Maximum High Tide

Plant MANCHESTER W WTP

Month JULY 2016

	Process Control										SEPTAGE GAL/DAY 49	SPEC. LAB.			DEPTH OF BLANKET			
	LBS. OF SOLIDS IN AERATION TANKS				LBS. OF CLARIFIER SOLIDS		TOTAL LBS.	TARGET LBS.	DIFF.	WAS (GAL)		WAS (MG/L)	WAS (LBS.)	INFL SOLIDS (LBS.)	INFL D.O.	EFF D.O.	CLARIFIER #1	CLARIFIER #2
	A1 ³⁷	A2 ³⁸	A3 ³⁹	A4 ⁴⁰	C1 ⁴¹	C2 ⁴²	43	44	45	46		47	48	50	51	52	53	54
1	3673	2440	4576	2072	1617	1359	15737	14000	1737	12000	8760	877		2.9	7.8	1.0	0.5	
2														3.5	7.7	0.5	0.5	
3														4.3	7.8	1.0	1.0	
4														4.7	7.8	1.0	0.5	
5	4341	2644	4098	2624	1207	675	15589	14000	1589				460	2.3	7.6	0.5	0.5	
6	4129	2836	3810	2714	1138	971	15598	14000	1598	8000	15240	1017	362	4.3	7.7	0.5	0.5	
7	4220	2452	4212	2460	1154	2110	16608	14000	2608					3.4	7.7	0.5	1.0	
8	3984	2832	3886	2840	1359	1025	15926	14000	1926	12000	11940	1195		3.0	7.6	0.5	1.0	
9														2.2	7.6	1.0	1.0	
10														2.2	7.8	1.0	1.0	
11	3833	2718	3544	2587	941	774	14397	14000	397	8000	17480	1166		3.0	7.8	0.5	0.5	
12	4083	2333	3810	2288	1009	2095	15618	14000	1618				387	4.1	7.7	0.5	1.0	
13	3681	2615	3544	2505	1078	1055	14478	14000	478	8000	15480	1033	385	3.8	7.7	1.0	0.5	
14	3825	2350	3666	2329	592	729	13491	14000	-509					3.6	7.7	0.5	0.5	
15	3681	2399	3362	2346	804	1184	13776	14000	-224	8000	7180	1146		3.4	7.6	0.5	0.5	
16														3.2	7.5	1.0	1.0	
17														3.1	7.5	1.0	1.0	
18	3484	2468	3317	2456	858	638	13221	13000	221	8000	19420	1296		2.6	7.5	0.5	0.5	
19	3582	2170	3666	2199	782	1025	13424	13000	424				432	1.3	7.5	0.5	1.0	
20	3263	2452	3172	2591	600	645	12723	13000	-277				357	2.2	7.6	0.5	0.5	
21	3871	2472	4227	2436	531	736	14273	13000	1273					2.4	8.2	0.5	0.5	
22	3415	2526	3400	2575	1882	751	14549	13000	1549	8000	17040	1137		2.2	8.0	1.0	0.5	
23														1.7	7.1	0.5	0.5	
24														1.0	7.4	0.5	1.0	
25	3681	2681	3833	2595	721	660	14171	14000	171	4000	21160	706		2.2	7.6	0.5	0.5	
26	4091	2509	4022	2317	1252	1988	16179	14000	2179				544	1.5	7.5	0.5	1.0	
27	3871	2366	3597	2350	1472	1738	15394	14000	1394	8000	15760	1052	502	3.9	7.7	1.0	1.0	
28	3681	2374	3787	2415	759	850	13866	14000	-134					3.9	7.6	0.5	0.5	
29	3263	2472	3423	2607	1488	1488	14741	14000	741	8000	16820	1122		4.2	7.6	1.0	1.0	
30														2.2	7.7	1.0	1.0	
31														2.9	7.5	1.0	1.0	
TOTAL																		
AVE.	3783	2505	3748	2465	1062	1125	14688	13750	938	2968	16025	379		429	2.9	7.6	0.5	0.5

TOTAL LBS
15,600-16,600

TOTAL LBS
12,700-13,800



Operations Data during Maximum High Tide

Plant MANCHESTER W WTP

Month OCTOBER 2016

	Process Control										SEPTAGE GAL/DAY 49	SPEC. LAB.			DEPTH OF BLANKET		
	LBS. OF SOLIDS IN AERATION TANKS				LBS. OF CLARIFIER SOLIDS		TOTAL LBS. 43	TARGET LBS. 44	DIFF. 45	WAS (GAL.) 46		WAS (MG/L) 47	WAS (LBS.) 48	INFL SOLIDS (LBS.) 50	INFL D.O. 51	EFF D.O. 52	CLARIFIER #1 53
	A1 ³⁷	A2 ³⁸	A3 ³⁹	A4 ⁴⁰	C1 ⁴¹	C2 ⁴²											
1													2.7	7.6	1.0	1.0	
2													3.0	7.5	1.0	1.0	
3	3468	1953	3355	1872	2019	2193	14860	14000	860	8000	14000	934	1.4	7.2	1.5	1.5	
4	3529	1982	3385	1941	1495	1746	14078	15000	-922			379	2.0	7.3	1.0	1.0	
5	3347	1921	3279	1908	607	1700	12762	15000	-2238			468	2.0	7.2	0.5	1.0	
6	3423	1880	3339	1872	2360	1336	14210	15000	-790				1.7	7.2	1.5	1.0	
7	3028	2301	3066	2395	2451	2474	15715	15000	715	4000	7780	260	1.0	7.2	1.5	1.0	
8													2.0	7.2	1.0	1.0	
9													4.6	6.8	1.0	1.0	
10													6.0	7.0	1.0	1.0	
11	3400	1970	3392	1925	2375	1465	14527	15000	-473			464	3.5	7.3	1.5	1.0	
12	3521	2129	3324	2084	1366	2140	14564	15000	-436	4000	12760	426	2.9	7.5	1.0	1.0	
13	3362	2015	3408	2002	1123	1677	13587	15000	-1413				3.0	7.1	0.5	1.0	
14	3294	2105	3248	2203	1662	1366	13878	15000	-1122				1.8	7.4	1.0	1.0	
15													3.0	7.5	0.5	1.0	
16													3.5	7.7	1.0	1.0	
17	3871	2317	3764	2305	3104	2535	17996	16000	1896	4000	18180	606	1.9	7.4	2.0	2.0	
18	3597	2297	3430	2239	2171	2300	16034	16000	34			500	2.5	7.8	1.5	1.0	
19	3901	2358	3681	2333	2618	2709	17600	16000	1600	4000	14960	499	2.5	7.7	2.0	1.5	
20	3613	2195	3514	2256	2360	1533	15471	16000	-529				3.2	7.9	1.5	1.0	
21	3453	2460	3575	2395	1488	1973	15344	16000	-658				2.2	7.9	1.0	1.0	
22													5.1	7.5	1.0	1.0	
23													5.8	7.9	1.0	1.0	
24	3962	2374	3825	2293	2269	2558	17281	16000	1281	8000	12120	809	4.1	7.7	2.0	1.5	
25	3810	2178	3977	2203	1176	2163	15507	16000	-493			462	3.6	7.8	1.0	1.0	
26	3575	2305	3643	2293	1670	2603	16089	16000	89	4000	13060	436	467	3.0	8.0	1.0	1.5
27	3810	2219	3954	2382	1518	2679	16562	16000	562				2.6	8.0	1.0	1.5	
28	3400	2129	3119	2137	3309	2922	17016	16000	1016	12000	14480	1449	4.7	8.0	2.0	1.5	
29													6.3	7.8	1.0	1.5	
30													5.4	7.6	1.0	1.0	
31	3484	2427	3339	2244	2467	2482	16443	16000	443	4000	12140	405	3.6	7.7	2.0	1.5	
TOTAL										52000		5824					
AVE.	3542	2176	3481	2164	1980	2128	15471	15500	-29	1677	13276	188	454	3.2	7.5	1.0	1.0

TOTAL LBS
12,700-14,500

TOTAL LBS
15,400-17,800

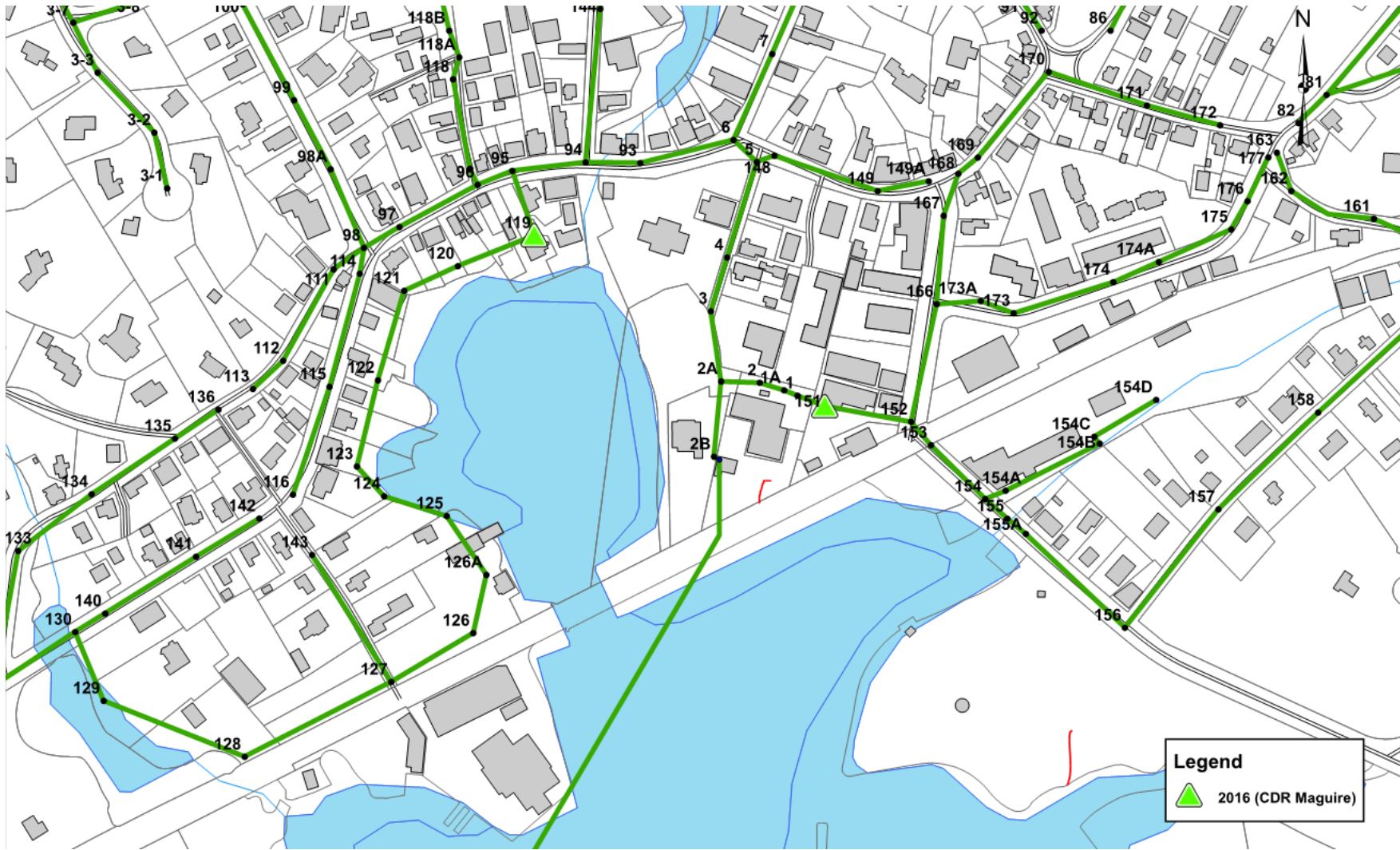


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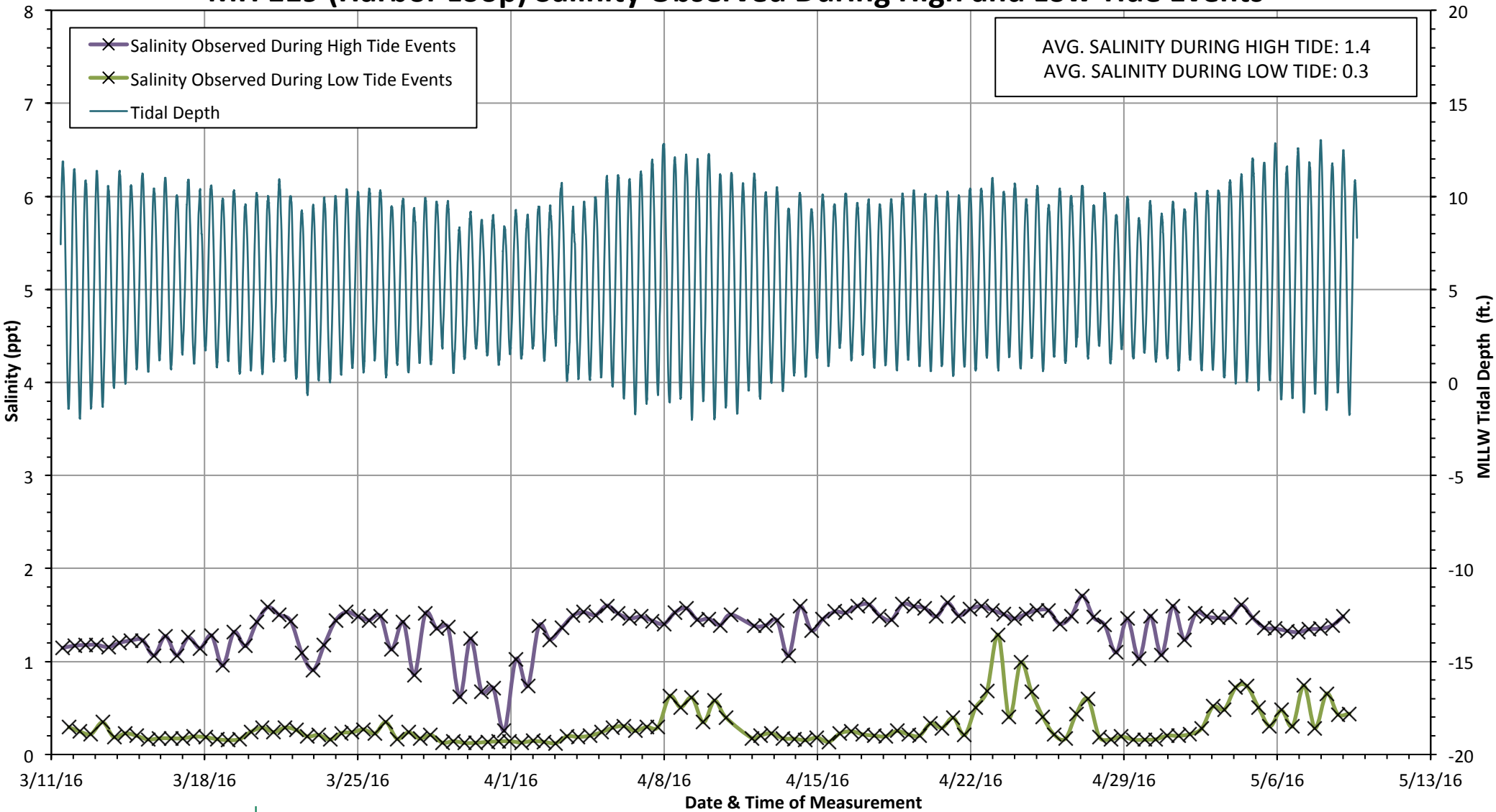
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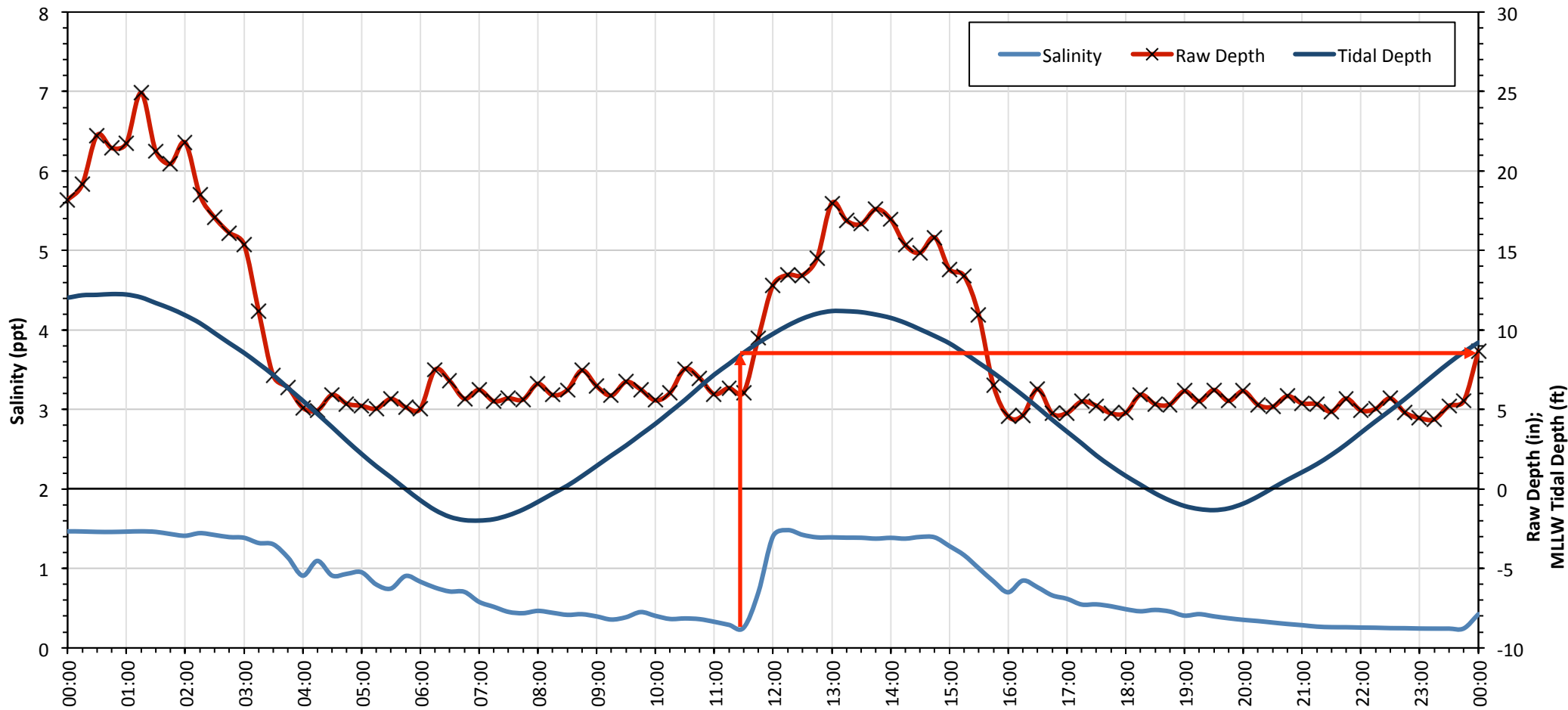
2016 Salinity Metering



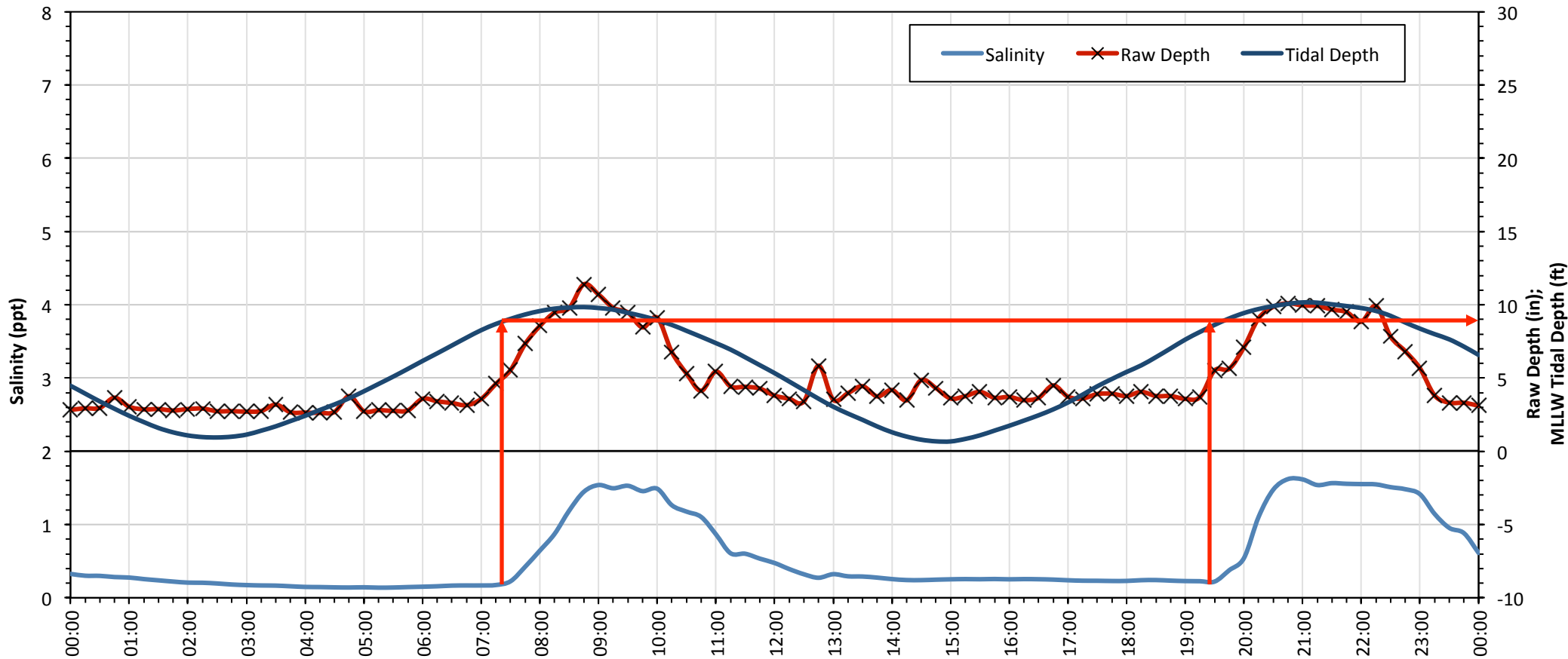
MH 119 (Harbor Loop) Salinity Observed During High and Low Tide Events



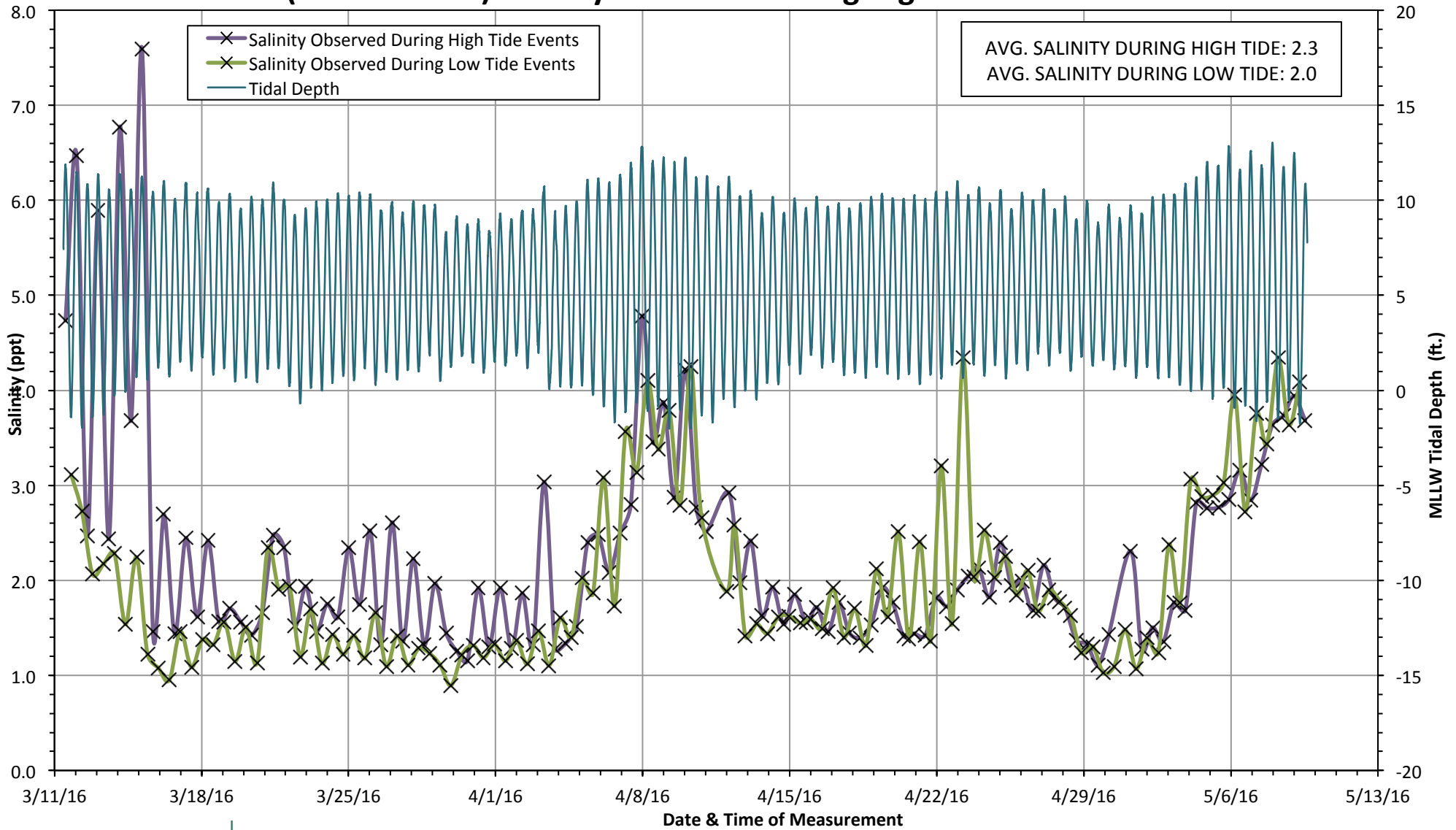
MH 119 (Harbor Loop) April 10, 2016 – Spring Tide Salinity and Depth vs Tidal Depth



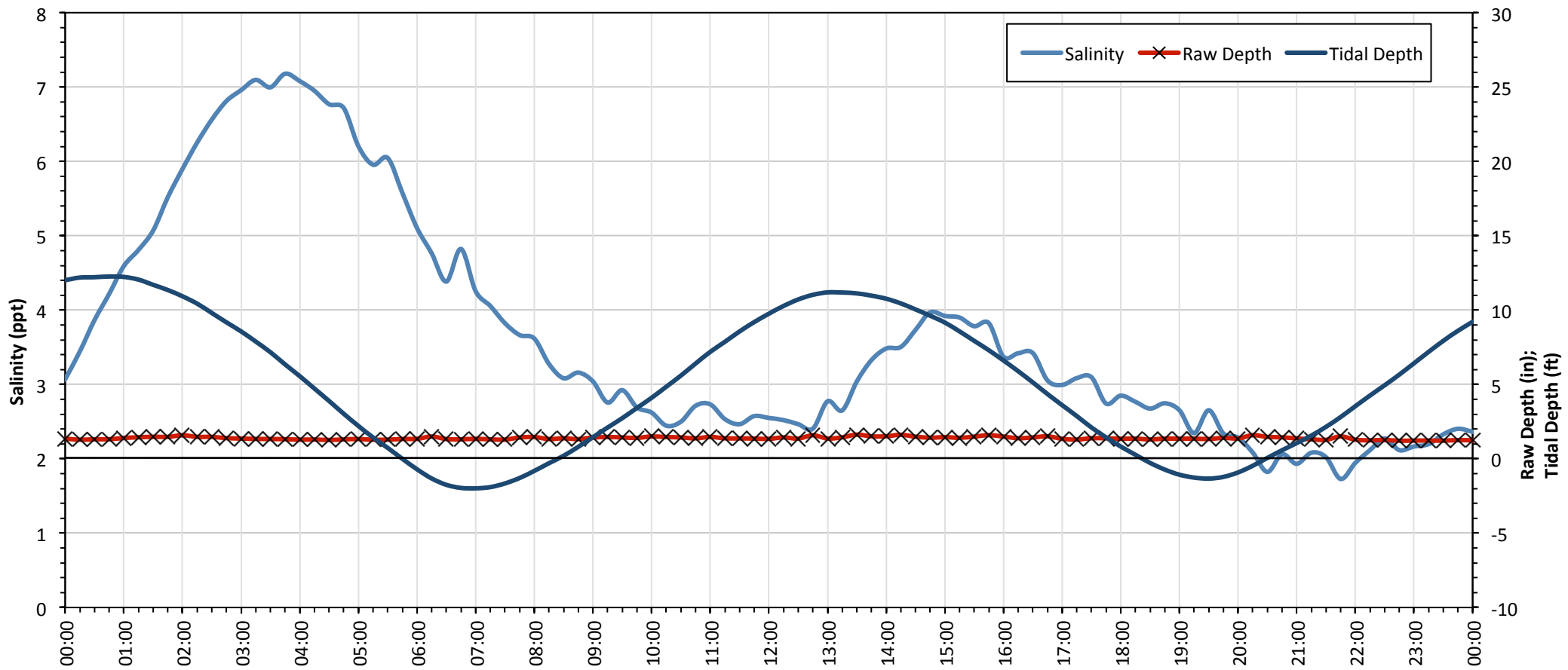
MH 119 (Harbor Loop) April 18, 2016 – Neap Tide Salinity and Depth vs Tidal Depth



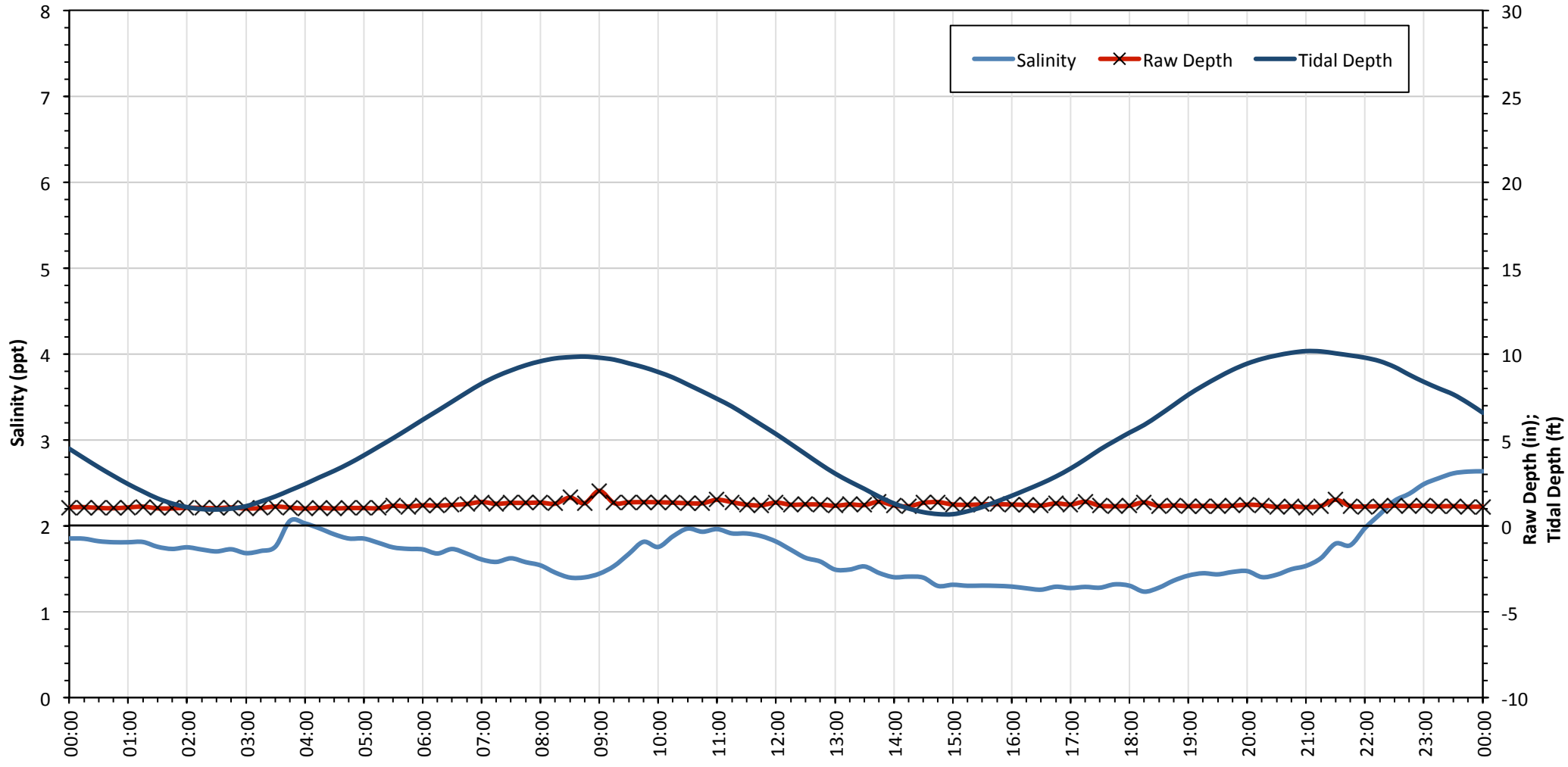
MH 151 (Beach Street) Salinity Observed During High and Low Tide Events



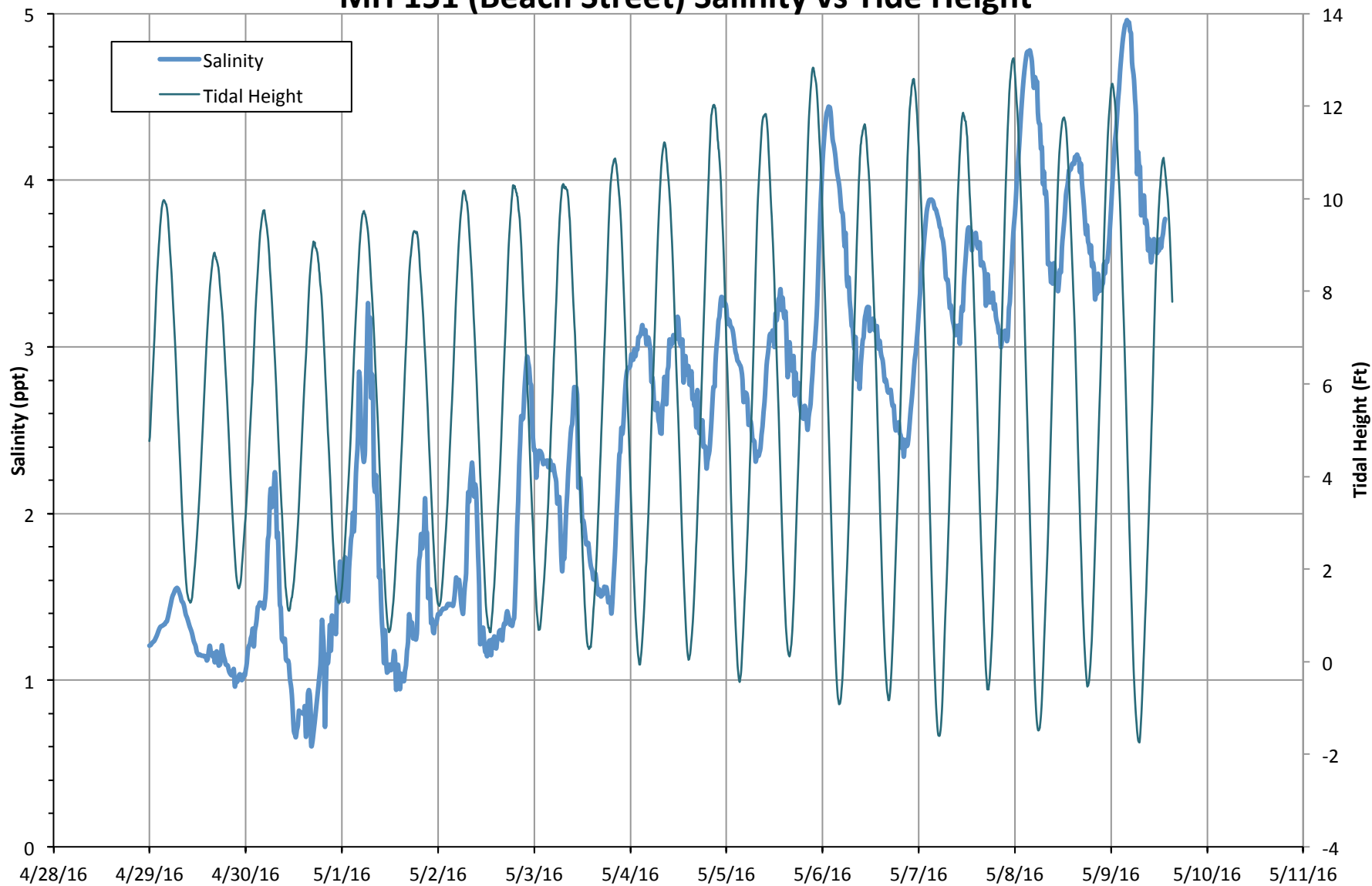
MH 151 (Beach Street) April 10, 2016 – Spring Tide Salinity and Depth vs Tidal Depth



MH 151 (Beach Street) April 18, 2016 – Neap Tide Salinity and Depth vs Tidal Depth



MH 151 (Beach Street) Salinity vs Tide Height

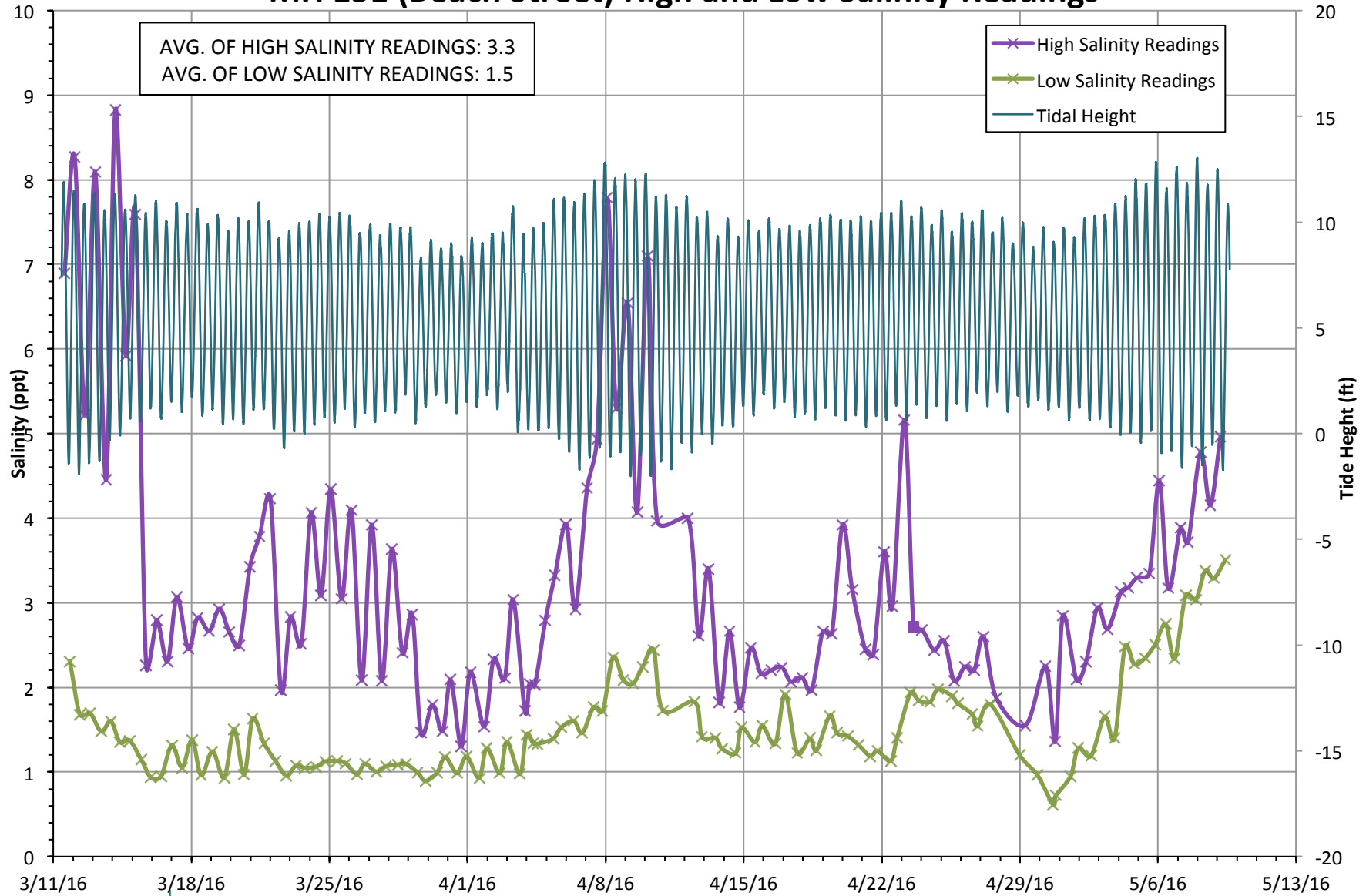


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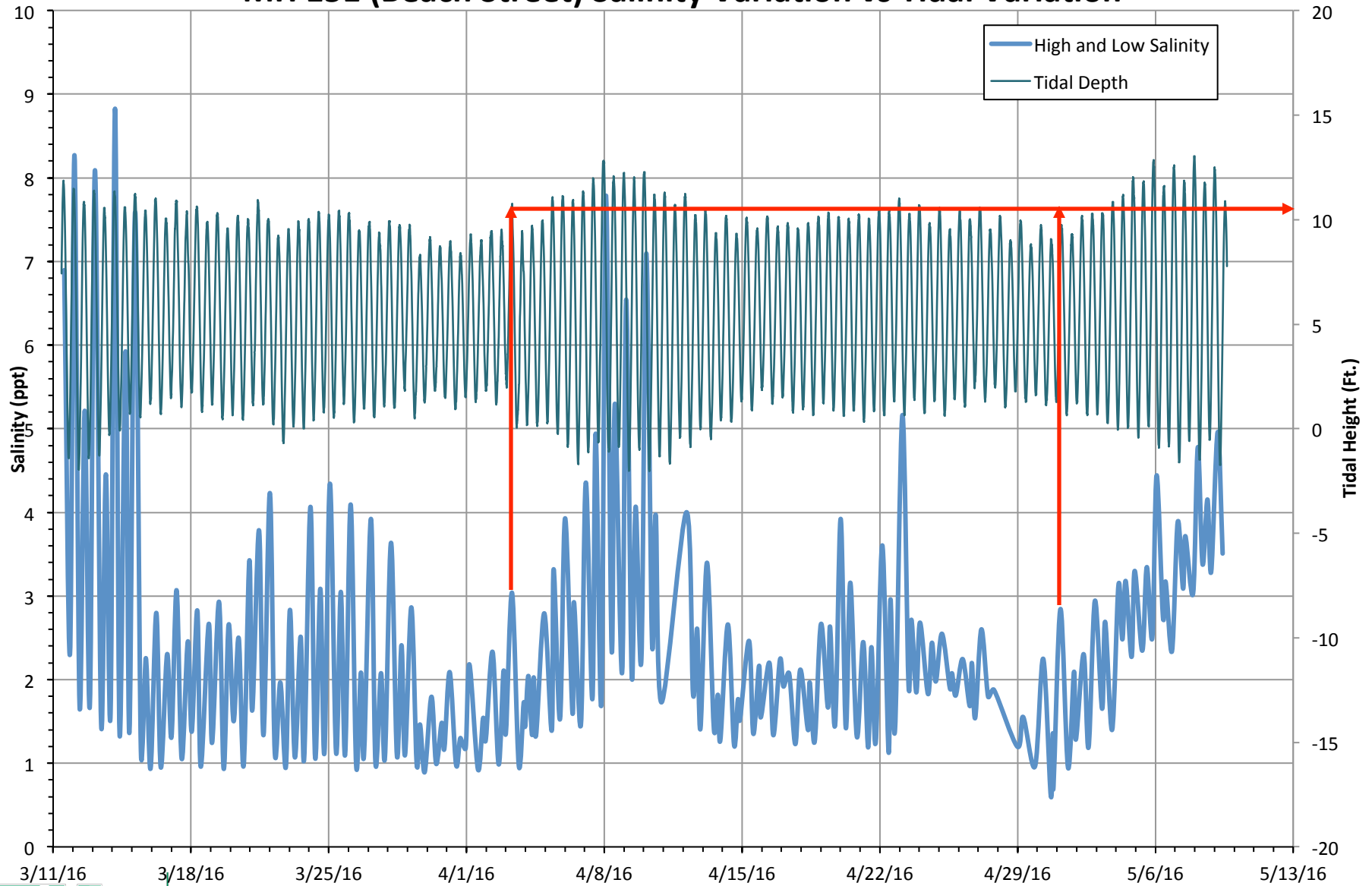
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MH 151 (Beach Street) High and Low Salinity Readings



MH 151 (Beach Street) Salinity Variation vs Tidal Variation



Conclusions of 2016 Salinity Metering

- Harbor Loop
 - Salinity and Depth increase as tidal height increases
 - Impact seen at approximately 8.5 ft tidal height
- Beach Street
 - Only Salinity increases as tidal height increases
 - Salinity increase generally lags tidal height increase
 - Impact greater when tidal height reaches approximately 10 ft
- Salinity increase from Beach Street source(s) are more significant than Harbor Loop source(s)

Beach Street Investigations

- 2016 I/I Investigations Report
 - 18,000 ft CCTV
 - 375+ Manhole inspections
- Beach Street Investigations
 - Beach Street and Tappan Street TV – Salinity



Beach Street CCTV Investigation Results



Beach Street Location Plan



Beach Street Repair March 2017

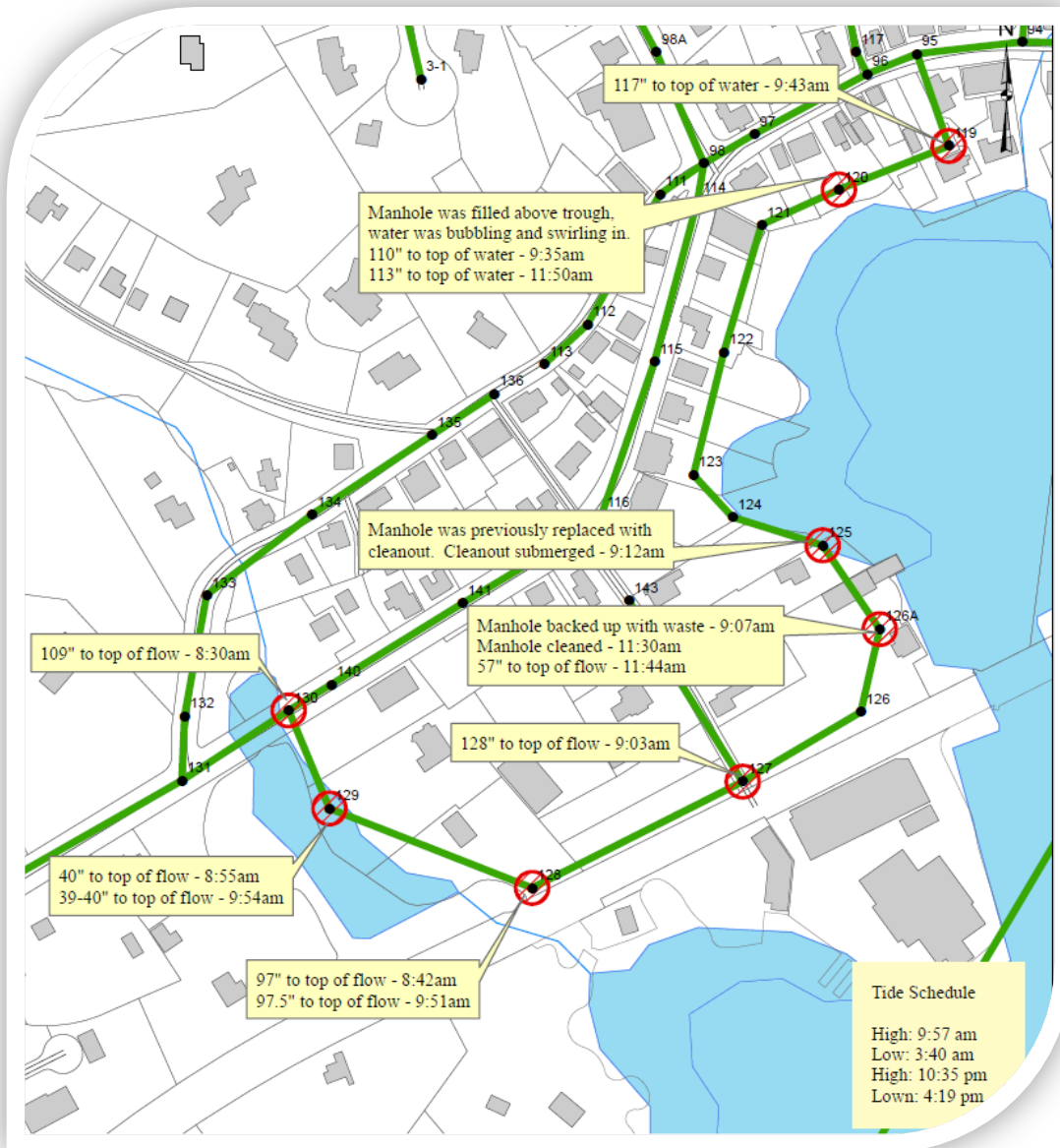


- Emergency Contract
- DI section with Himax couplings



Harbor Loop Investigations

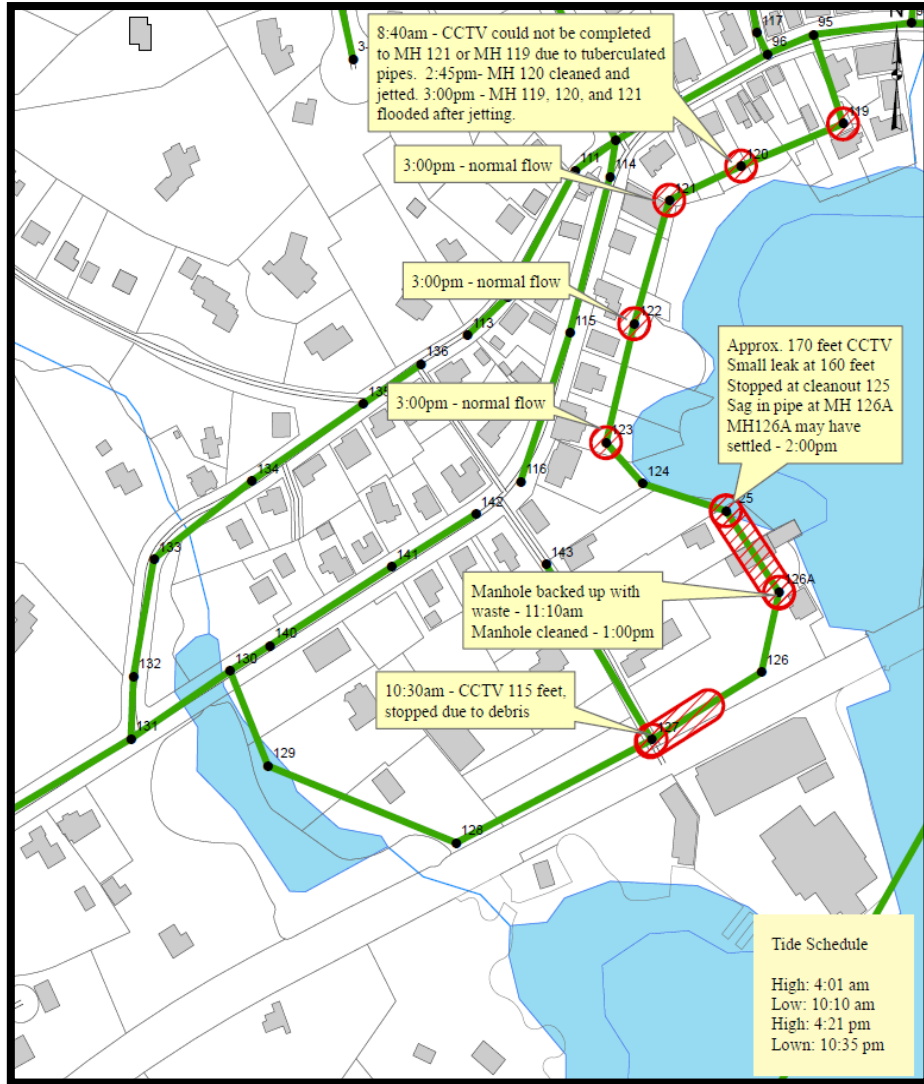
- December 2016 Harbor Loop Investigations
 - Visual MH Inspections
- January 2017 Harbor Loop Investigations
 - CCTV
 - Visual MH Inspections



December 2016 Harbor Loop

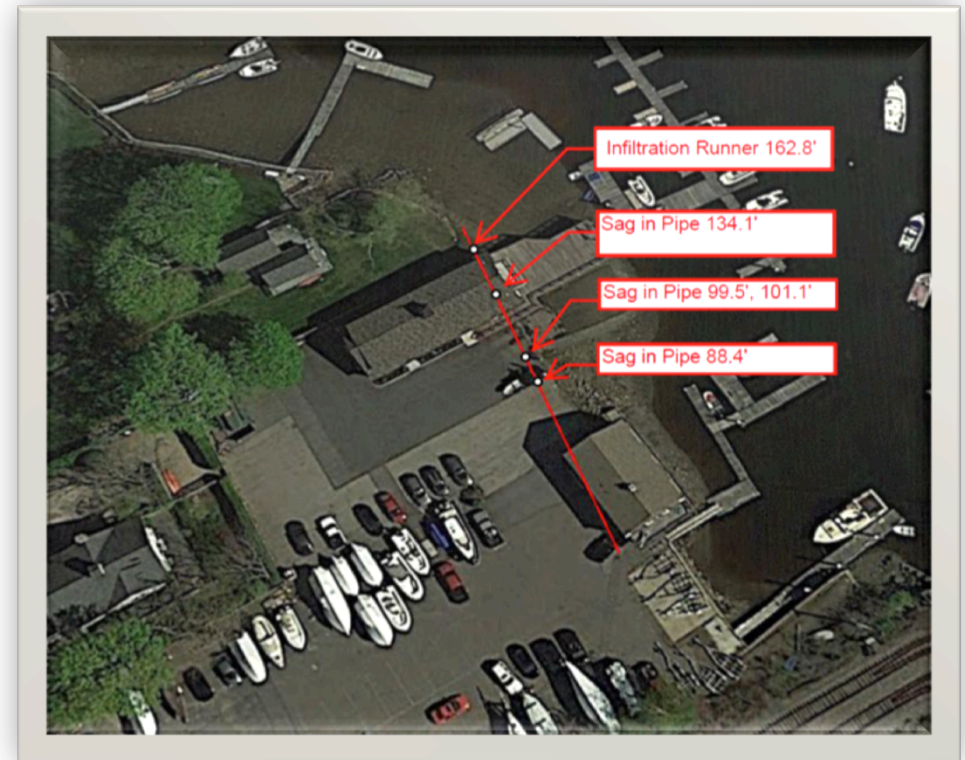
Visual and depth measurements taken before, during, after high tide.

- Results
 - Depth of flow observed to increase during high tide MH's 119-120
 - No significant change in depth of flow upstream of MH 125.
- Recommended CCTV – Low Tide

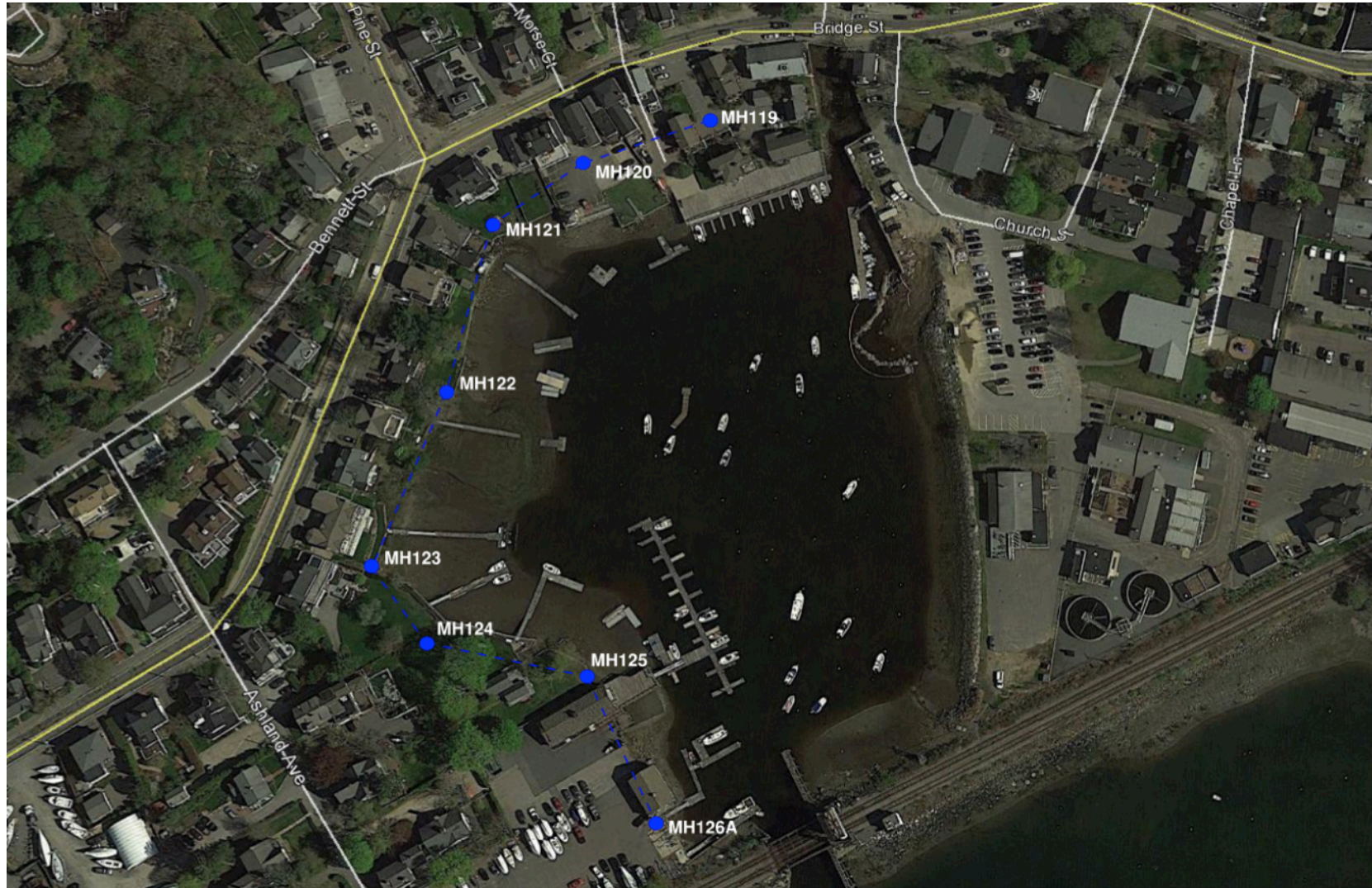


2017 CCTV Harbor Loop Inspection (January)

- Performed around low tide
- Obstacles
 - location
 - high level of corrosion and build-up
- CCTV and heavy clean planned - 2017 Sewer Rehab Contract



Harbor Loop Approximate MH Locations



Looking Forward

- Salinity Meter Installation – Beach Street
- Cleaning and CCTV Harbor Loop – 2017 Sewer Rehab Contract
 - Shoreline reconnaissance – low tide
 - Possible Smoke Testing
 - Last performed October 2013



May 30, 2017

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Questions?

