SSU Water Quality

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Honors Program

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I would like to thank the Chemistry and Physics Department here at Salem State for allowing me to use their equipment and laboratories. I would like to thank the Honors Program and HPAC for approving the grant for the Okaton Fluoride-Ion Selective Electrode. I would also like to thank Dr. Christine MacTaylor who helped me with this research by lending her time, and knowledge, and by letting me in on her labs the past three semesters so I was able to get my research done.

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Abstract:

The purpose of this research was to see how the water around Salem State University's campus fared with that of national standards. Since water can contain many contaminants such as metals, pesticides, and toxins, it is important to know if standards are being upheld. The metals copper (Cu), iron (Fe), calcium (Ca), and zinc (Zn) were tested, along with the non-metal fluoride (F). The atomic absorption machine (AA) was used to find the concentration of each metal in parts per million (ppm). A new fluoride ion-selective electrode was used to determine the concentration of the fluoride in ppm in the water samples. The water tested was taken from each residence hall and campus building, and from multiple sources in each building. The main objective was to see if Salem State University's water was up to the standards.

Introduction:

Copper is a widely used metal for household pipes, and can often enter the drinking water by corrosion of the pipes. Since it is a heavy metal, it can have negative effects on a person's health if the concentration becomes too high. The maximum contaminant level goal (MCLG) for copper is set at 1.3 ppm by the EPA, as this is the level where there are no effects on one's health. If someone is exposed to levels above this for a short time, they may become nauseous or vomit. If this is occurring for a longer period of time, damage to the kidneys or liver can occur. Copper is considered to be a primary standard for water quality testing[1]. A primary standard in water is a chemical that needs to be more carefully monitored in order to protect the public since they can be the most harmful if they reach higher levels in water.

Iron is an important factor in human health and most life forms in general. It can be found in proteins and enzymes and plays a key part in cell growth. Most of the iron found in the body is located in hemoglobin and is responsible for carrying oxygen from the lungs to tissues. Dietary iron mostly comes from two sources: animal meat and plants. The compounds containing iron in these sources have different structures, with the ones from animals being more easily absorbed into the body. The average recommended daily intake for iron, based on age, gender, and other health reasons, is 7-11 mg. Iron is not easily excreted so there is a chance it can become toxic if too much is present. Tolerable Upper Intake Levels from the Institute of Medicine of the National Academy of Sciences are 40-50 mg per day. For drinking water regulations from the FDA iron falls under the category of National Secondary Drinking Water Regulations which means it may cause cosmetic or aesthetic effects on the body. The standard level is 0.3 mg/L[2].

Calcium is the most abundant mineral in the human body with the majority of it being stored in the bones and teeth. Here its function is to maintain the bone's structure and durability. Its other uses in the body include muscle function, nerve transmission, and intracellular signaling. Good sources of calcium include dairy products, kale, and broccoli. The recommended daily value of calcium depends greatly on ones age as more is needed as ones' bones brittle over time. Values range from 200 mg at birth to 1,200 mg over the age of 70. Calcium in the body is closely associated with Vitamin D which helps the mineral be absorbed into the body. This is helpful because the effectiveness of calcium absorption decreases as the amount of calcium in your body increases. Complications of excessive calcium include vascular and soft tissue calcification, constipation, and kidney stones. The Tolerable Upper Intake Levels are based on age and range from 1000 to 3000 mg per day. The standard allowed level for calcium in drink water is, along with magnesium, 20 ppm[3].

Zinc is an essential nutrient in the human body. It is important for the growth and development of bones and the metabolism. It is also an important aspect in the healing of wounds. A person can experience negative health effects if they have both too much and too little zinc in their body. If they have too little zinc, they can experience loss of appetite, a decrease in their sense of taste and smell, and they can have a weakened immune system. The EPA has established that zinc is a secondary standard in water quality, and the regulated concentration of zinc is 5ppm. A secondary standard is a standard that has guidelines that are not enforced, but can be by some states if they choose to do so, since the effects often include discoloration of skin or teeth, or the taste of the water can be off; they are not typically life-threatening. If someone is exposed to levels above this for a short term, they can experience stomach cramps, become nauseous, and vomit. If they are exposed for long term, they can develop anemia, have their good cholesterol levels decreased, and more seriously, develop nervous system disorders, and pancreas damage[4].

Fluoride has been known to aid in proper dental health. It is often added into the water source by the city or town where the water comes from for this purpose. It can also get into the water through fertilizer. In low doses, fluoride is very beneficial as it can help to reduce cavities. However, if exposed to high amounts through a lifetime the likelihood of fracturing bones, and having bone pain and tenderness increases. If children are exposed to high amounts of fluoride, the opposite dental effect can occur;

pits can develop in the enamel, and harm can come to the teeth. The EPA has established that fluoride is a secondary standard. They have set the MCLG to be 4.0 ppm, with a secondary standard to be 2.0 ppm. Drinking water has the guideline of 2.0 ppm[8].

The oldest building tested, Sullivan Building, was built in 1896 to accommodate for the growing size of Salem Normal School. Soon after, it was known as Salem Teachers' College[6]. The water collected from here was taken from a bubbler from the main floor as well as the second floor. The Mainstage Auditorium, the second oldest building tested, is a 750 seat theatre that is the main venue for the Theater Department. It is part of the Administration Building and was built in 1958[6,7]. The water sample from here was taken from a water fountain located near the bathrooms in the basement.

The Ellison Campus Center was built in 1966 with the name Student Union. It is the center of most of the activity for commuters, large group meetings, and it houses health services, along with several other student services.[5] The water sample here was taken from a bubbler on the main floor. Meier Hall, originally known as the The Arts & Sciences Building, was opened in 1966[6]. Here the water samples were taken at two places from each floor. The locations were spread out on opposite sides of the building and were chosen based on their amount of foot traffic.

Peabody and Bowditch were the first residence halls to open in 1966. They are used today to house freshman students, and can hold around 600 students between the two buildings[6]. The water collected from these buildings included the ground floor bubbler, floor three sink, and water from the top floor sink.

The O'Keefe Center was built in 1976, and is used as the sports center. It holds a pool, courts for basketball, rooms for the dance programs, and the wellness center[7]. The water sample taken from here was taken from a bubbler on the main floor of the building. In 2004, The Bertolon School of Business was built on Central Campus. It is used as a business school, as well as a building for music. It also currently holds the library[6,7]. The water sample taken from here was from bubblers on the first and second floors of this building.

Atlantic Hall was built in 2004, and is used as an upper-classmen residence hall. The building can hold around 450 students, and is set-up in an apartment style, with six residents to an apartment[7]. The water collected from Atlantic was collected from a sink from each floor. Marsh Hall was built in 2010 and is the school's newest residence hall. The building houses freshmen and consists of five floors[6]. Water samples were taken from bathroom faucets on each floor.

<u>*Experimental*</u>

The experimental procedure was as follows:

1. Collect water samples from each residence hall: Sullivan, Bowditch, Atlantic, Marsh, using sinks as the water source, except on ground floors of Sullivan and Bowditch which bubblers are the source.
2. Collect water samples from campus buildings: Sullivan Building, Mainstage Auditorium, Campus center, Meier Hall, O'Keefe, and the Bertolon building, using bubblers as the water source, and as many floors as possible.
3. Make up standards for each metal being tested. From the 1000ppm stock, make up 50mL of:
    a. Cu standards: 0.01, 0.05, 0.10, 0.50, 1.00, 5.00 ppm
    b. Ca standards: 0.10, 0.50. 1.00, 5.00, 10.00, 20.00 ppm
    c. Fe standards: 0.01, 0.05, 0.10, 0.50, 1.00, 5.00 ppm
    d. Zn standards: 0.01, 0.05, 0.10, 0.50, 1.00, 5.00 ppm
4. Run a standard through the AA machine, followed by the 30 samples, recording the concentration. Make sure to blank the AA machine about every 10 samples to ensure that drifting does not occur.
5. Repeat for each metal being tested, recording the ppm.
6. Repeat for the Fall 2012 Semester using same water samples, which contain small amounts of nitric acid to try and preserve.
7. For the Spring 2013, collect all new samples.
8. Repeat steps 1-5.
9. Set up the fluoride ion selective electrode, and connect to a pH/mV meter.

10. Set up each sample, using 5mL of each sample in vials.

11. Test each sample with the electrode, recording the mV reading.

12. Using a standard curve, change the mV reading to ppm.

Data Analysis:

Graphs of Spring 2012:

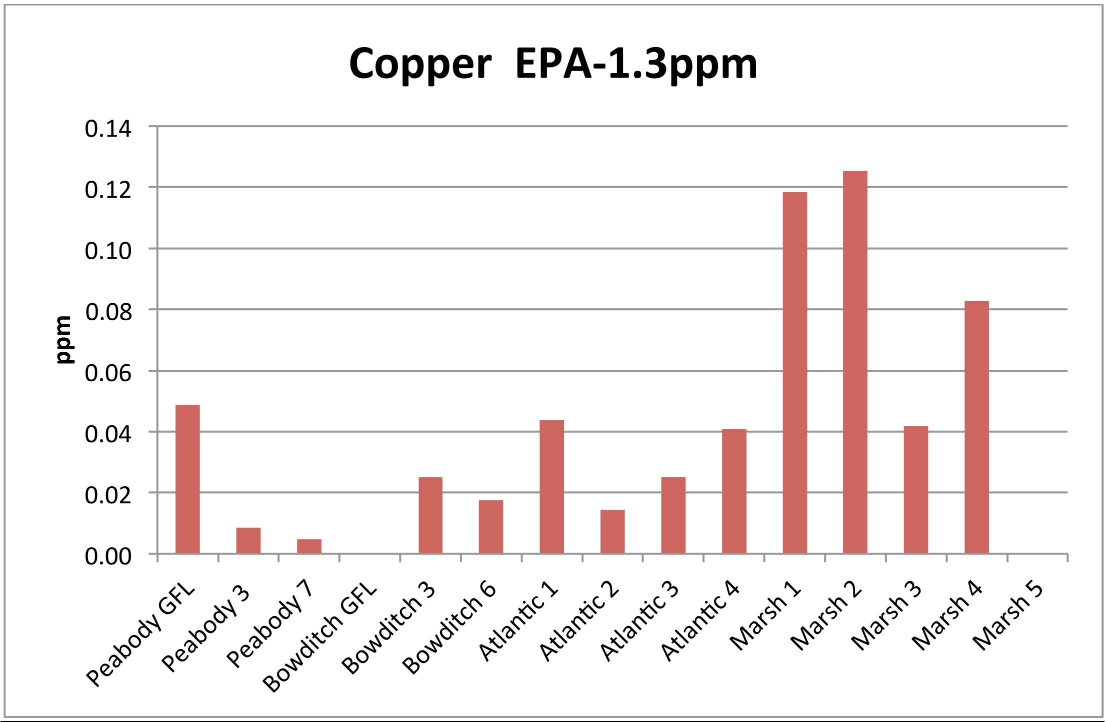

Figure 1. Copper levels residence halls Spring 2012

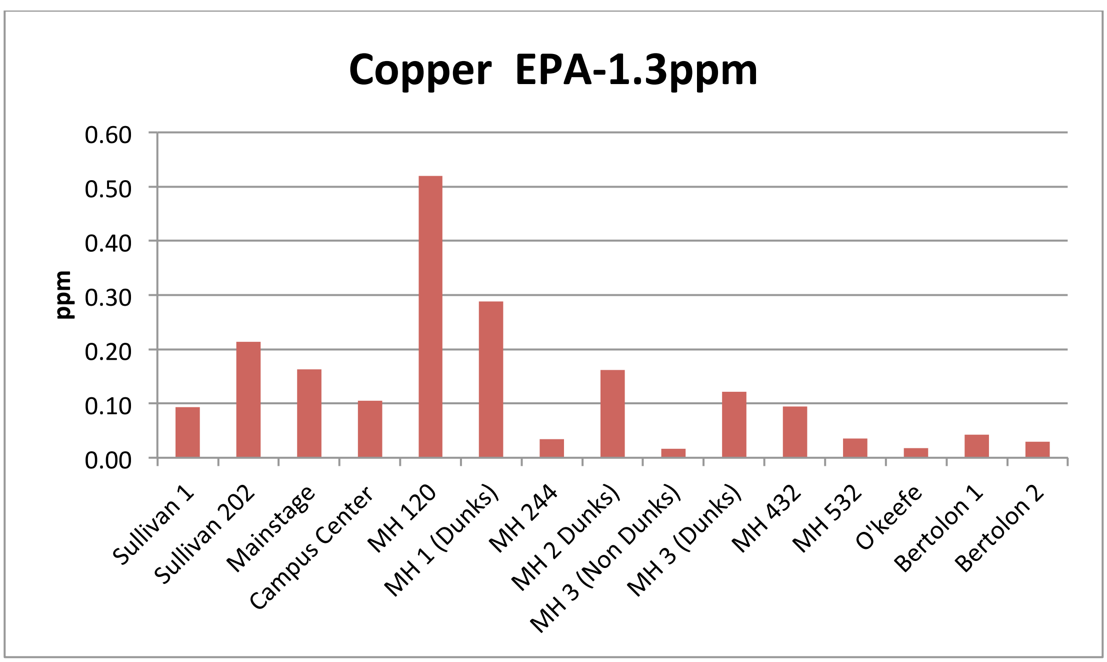

Figure 2. Copper levels academic buildings Spring 2012

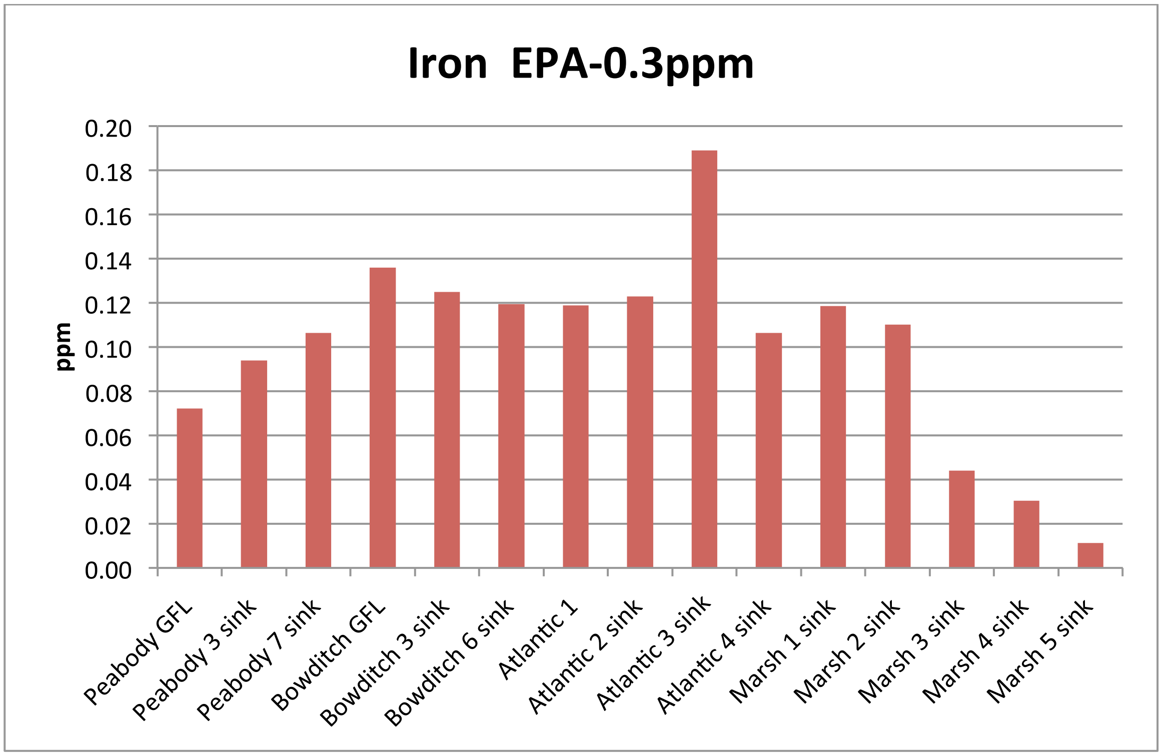

Figure 3. Iron levels residence halls Spring 2012

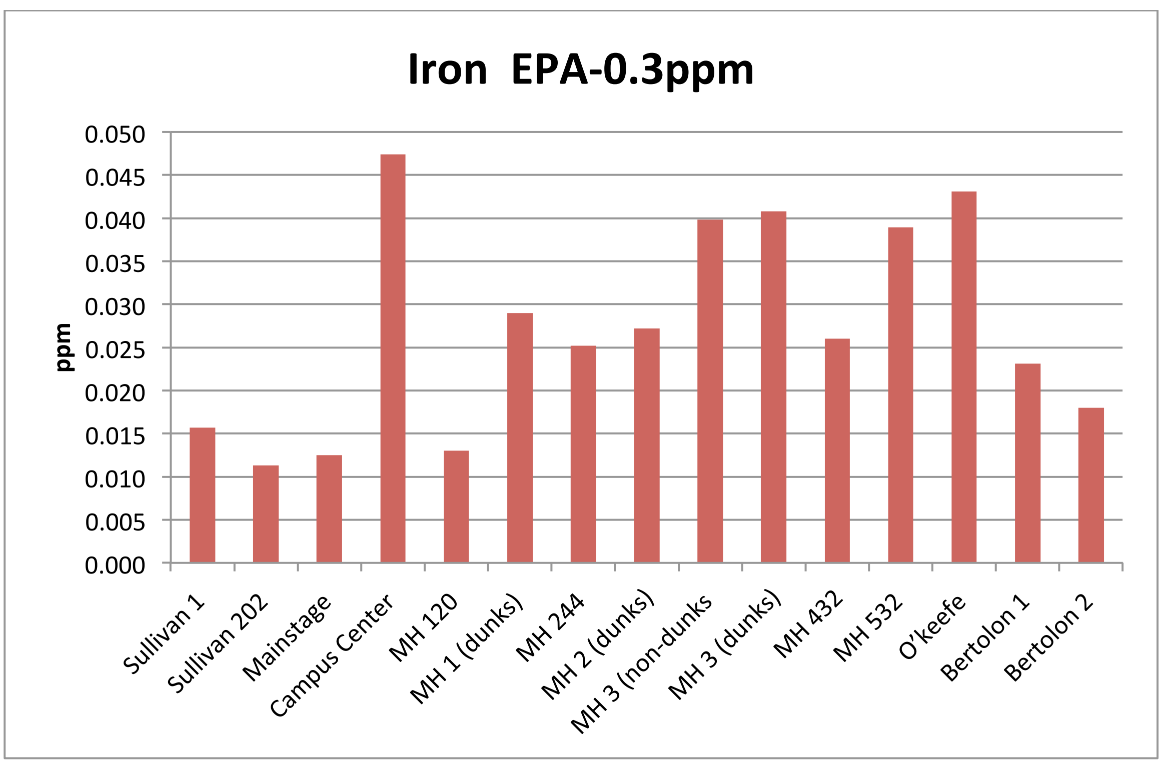

Figure 4. Iron levels academic buildings Spring 2012

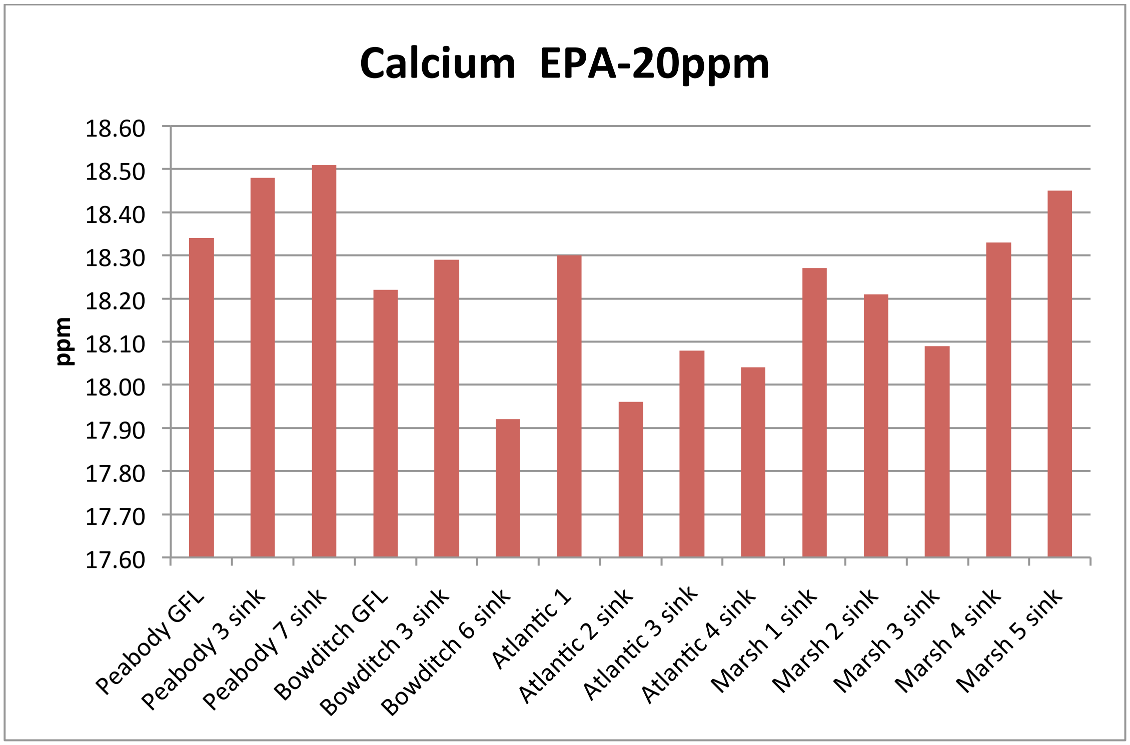

Figure 5. Calcium levels residence halls Spring 2012

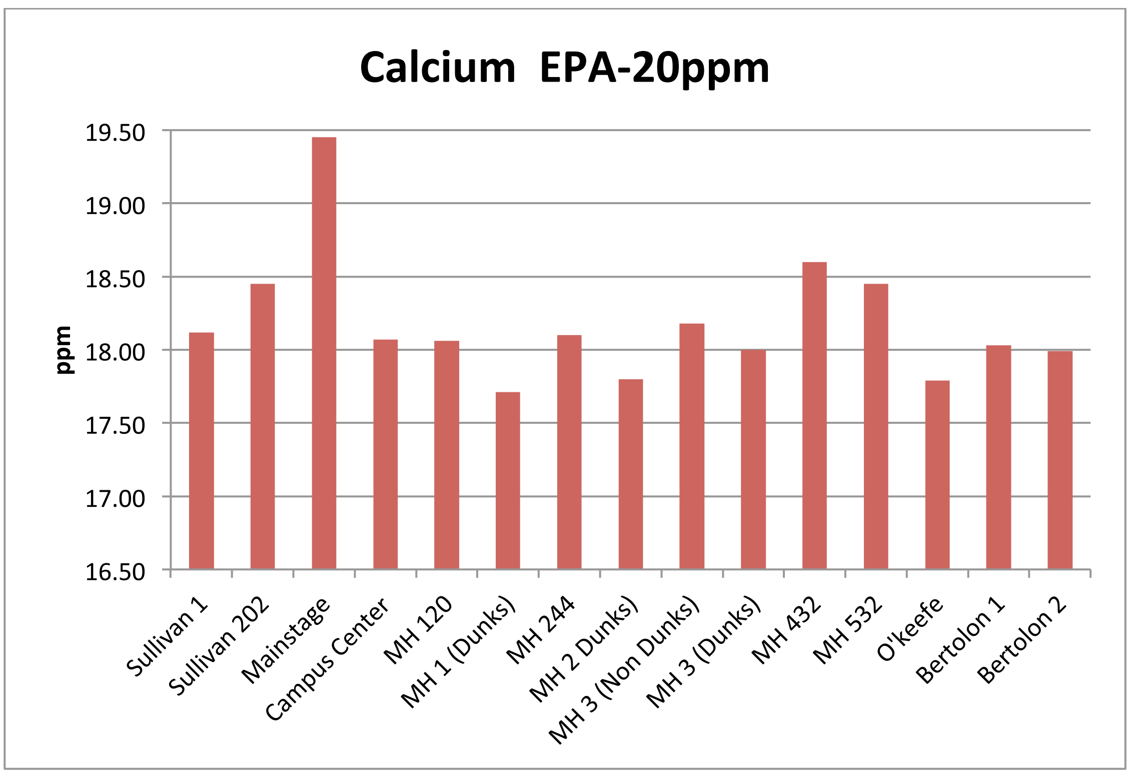

Figure 6. Calcium levels academic buildings Spring 2012

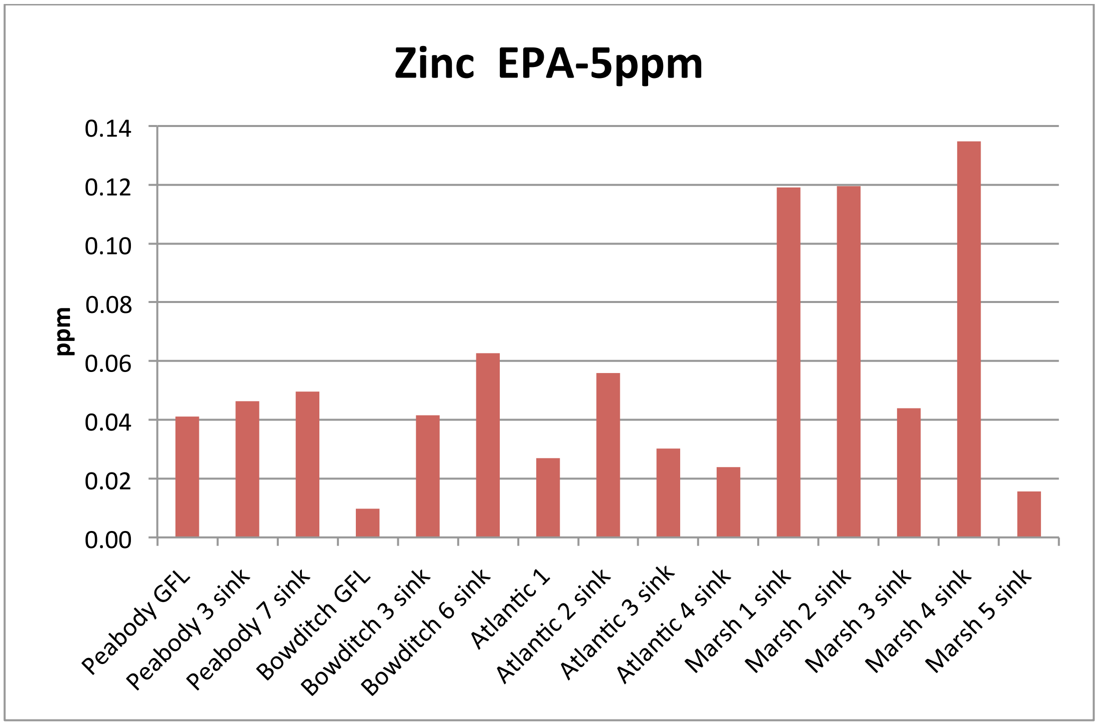

Figure 7. Zinc levels residence halls Spring 2012

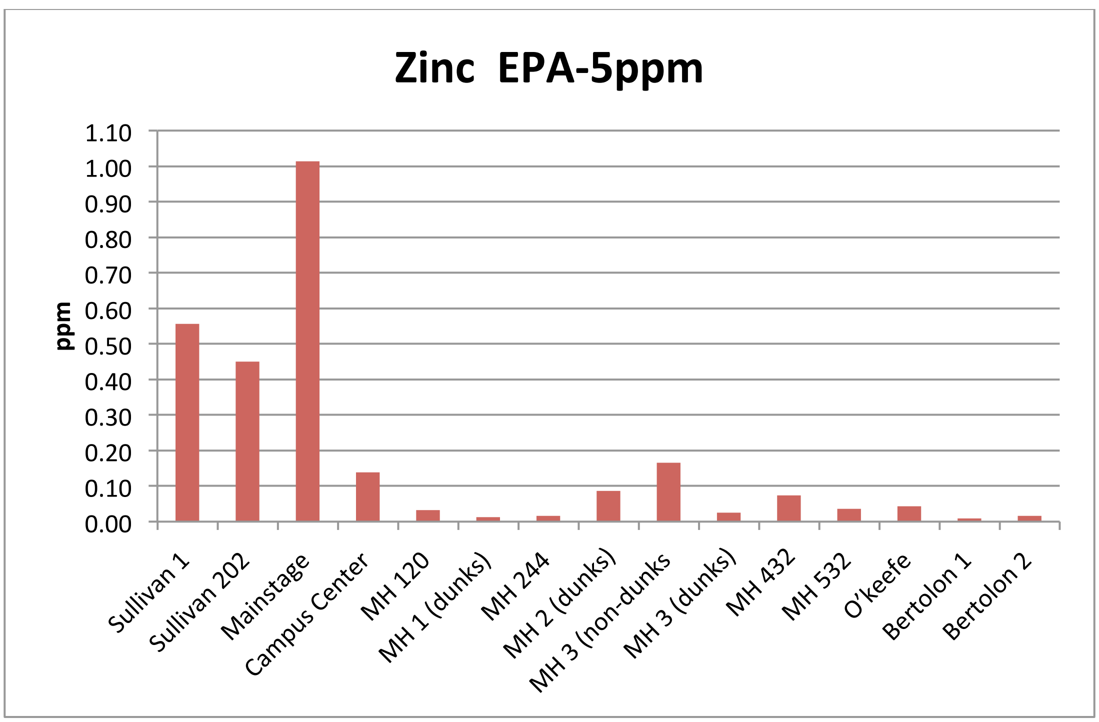

Figure 8. Zinc levels academic buildings Spring 2012

Table of Spring 2012 data

Water Sample	Copper (ppm)	Iron (ppm)	Calcium (ppm)	Zinc (ppm)
Peabody GFL	0.0487	0.0721	18.34	0.0412
Peabody 3	0.0085	0.0939	18.48	0.0463
Peabody 7	0.0048	0.1065	18.51	0.0497
Bowditch GFL	0.0000	0.1360	18.22	0.0097
Bowditch 3	0.0251	0.1248	18.29	0.0416
Bowditch 6	0.0175	0.1195	17.92	0.0627
Atlantic 1	0.0438	0.1189	18.30	0.0269
Atlantic 2	0.0144	0.1229	17.96	0.0560
Atlantic 3	0.0250	0.1890	18.08	0.0303
Atlantic 4	0.0409	0.1064	18.04	0.0240
Marsh 1	0.1184	0.1186	18.27	0.1190
Marsh 2	0.1254	0.1100	18.21	0.1195
Marsh 3	0.0419	0.0440	18.09	0.0439
Marsh 4	0.0828	0.0305	18.33	0.1347
Marsh 5	0.0000	0.0112	18.45	0.0157
Sullivan 1	0.0938	0.0157	18.12	0.5560
Sullivan 202	0.2140	0.0113	18.45	0.4507
Mainstage	0.1632	0.0125	19.45	1.0140
Campus Center	0.1050	0.0474	18.07	0.1395
MH 120	0.5202	0.0130	18.06	0.0325
MH 1 (dunks)	0.2881	0.0290	17.71	0.0130
MH 244	0.0345	0.0252	18.10	0.0155
MH 2 (dunks)	0.1614	0.0272	17.80	0.0864
MH 3 (non-dunks	0.0160	0.0398	18.18	0.1662
MH 3 (dunks)	0.1216	0.0408	18.00	0.0249
MH 432	0.0940	0.0260	18.60	0.0733
MH 532	0.0351	0.0389	18.45	0.0363
O'Keefe	0.0181	0.0431	17.79	0.0440
Bertolon 1	0.0421	0.0231	18.03	0.0099
Bertolon 2	0.0300	0.0180	17.99	0.0155

Figure 9. Table of values from Spring 2012

Graphs of Fall 2012 data

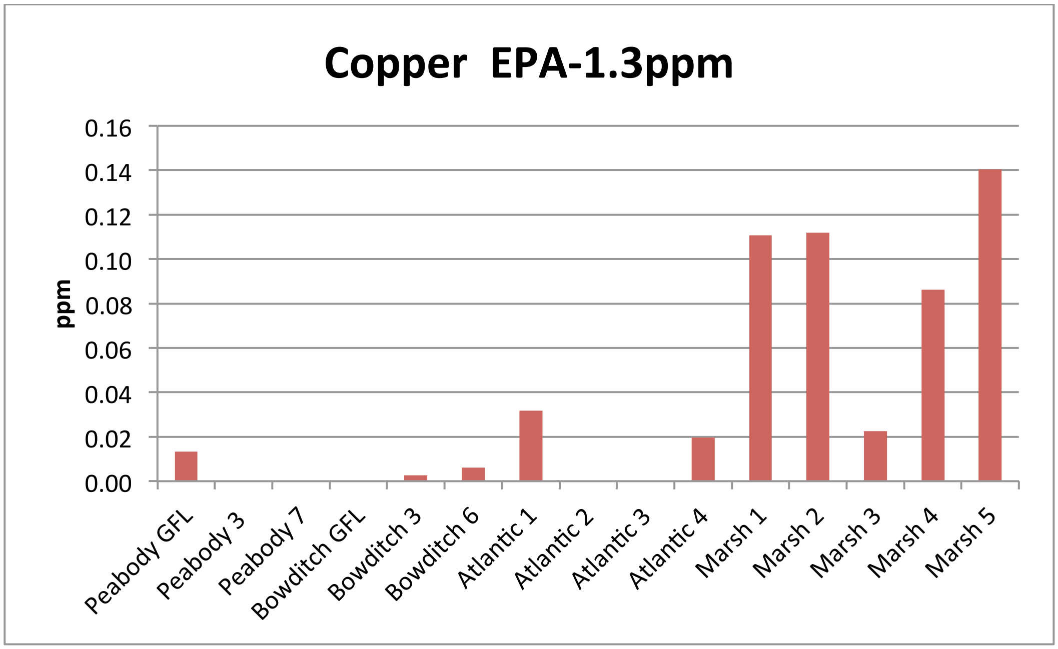

Figure 10. Copper levels residence halls Fall 2012

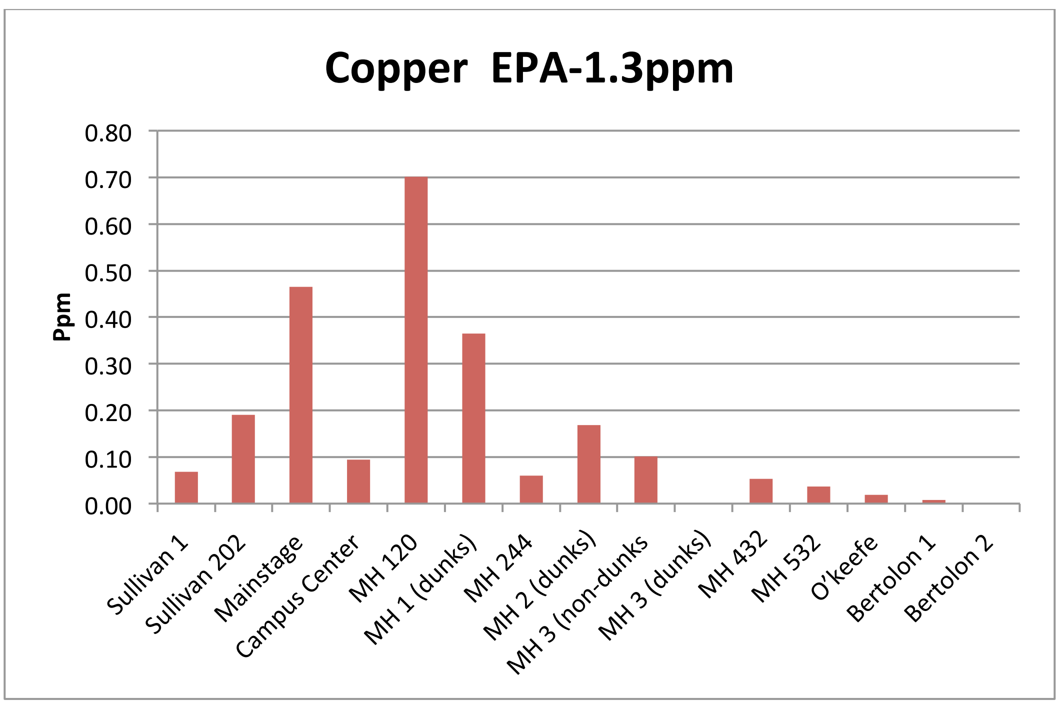

Figure 11. Copper levels academic halls Fall 2012

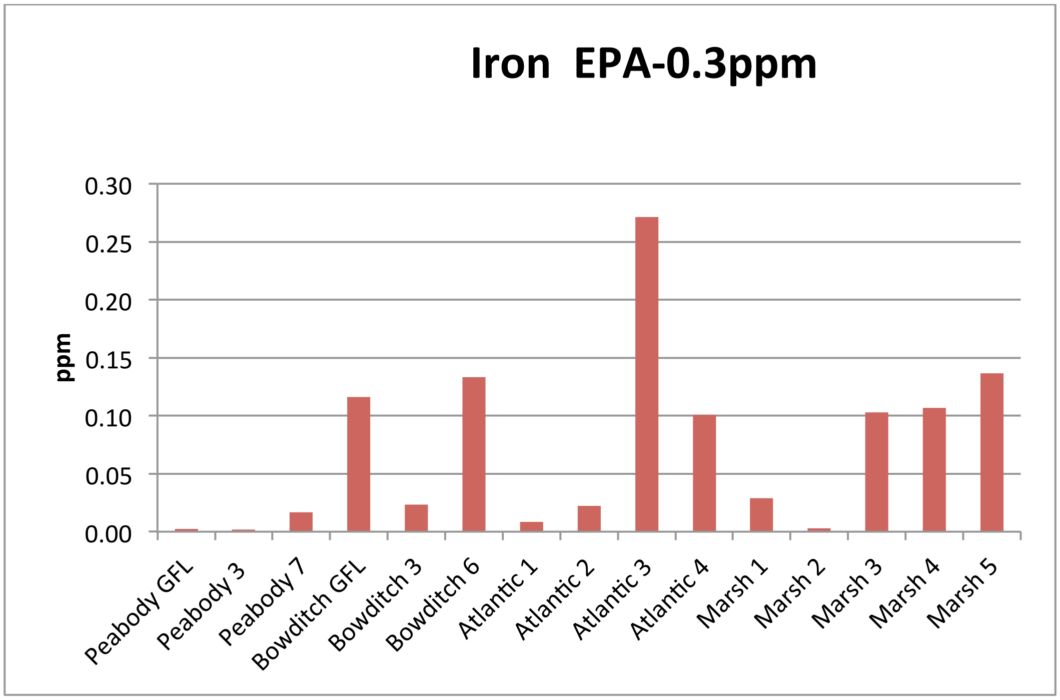

Figure 12. Iron levels residence halls Fall 2012

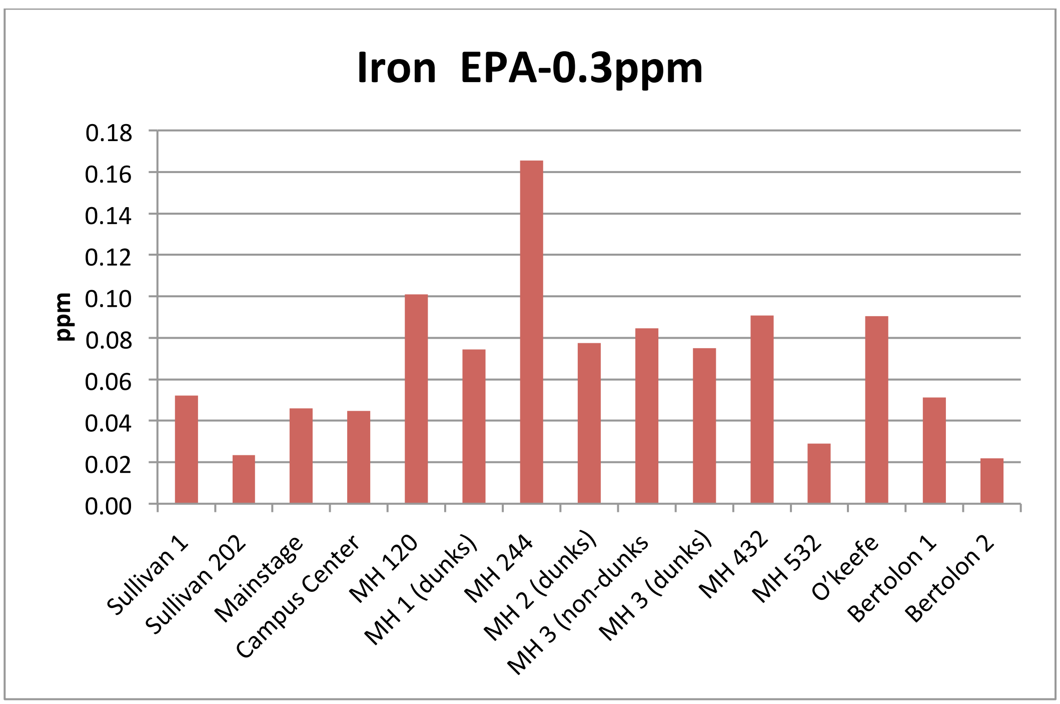

Figure 13. Iron levels academic buildings Fall 2012

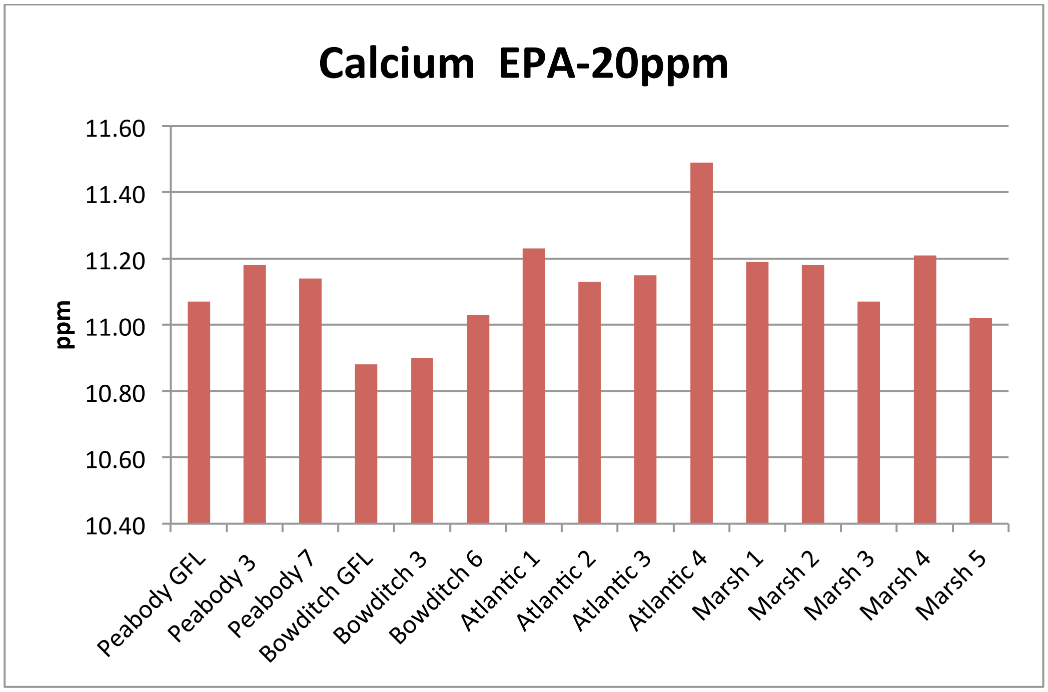

Figure 14. Calcium levels residence halls Fall 2012

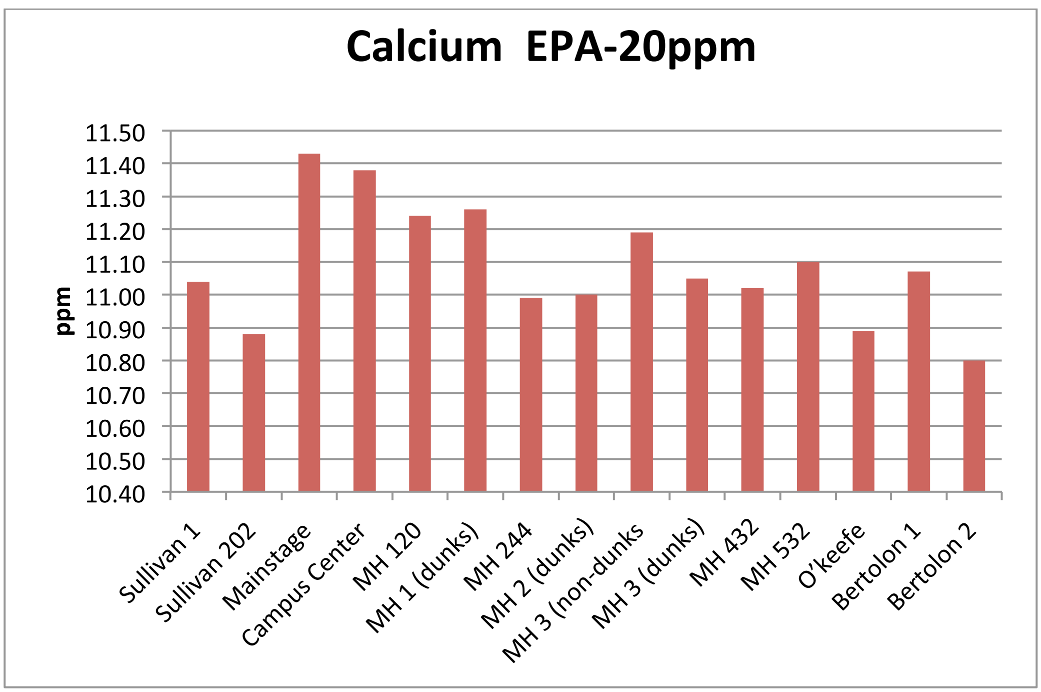

Figure 15. Calcium levels academic buildings Fall 2012

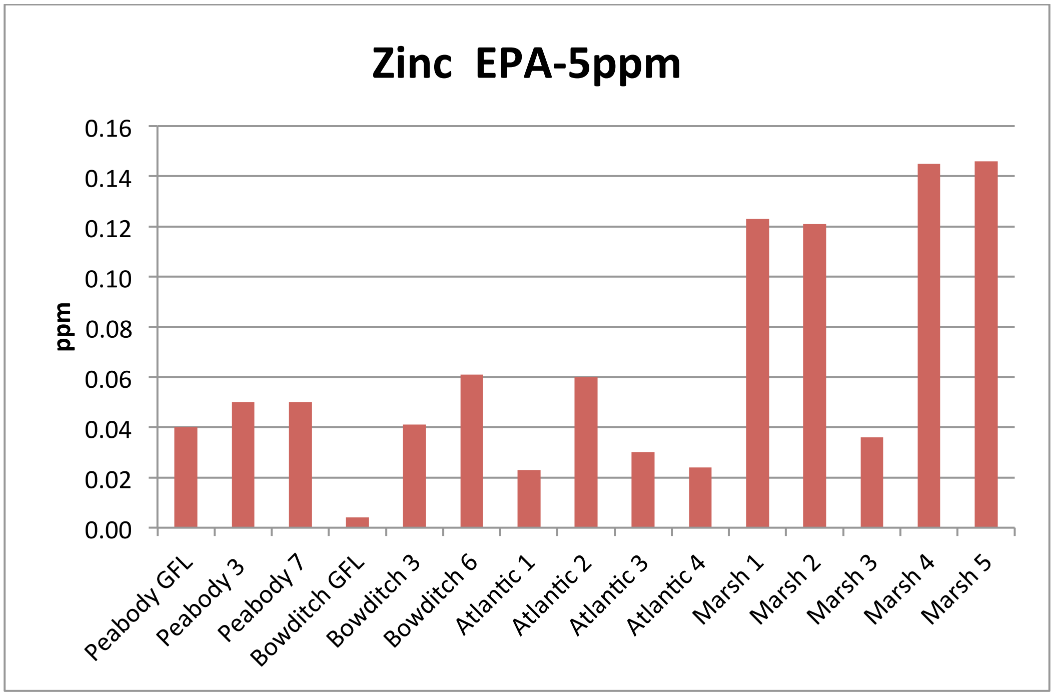

Figure 16. Zinc levels residence halls Fall 2012

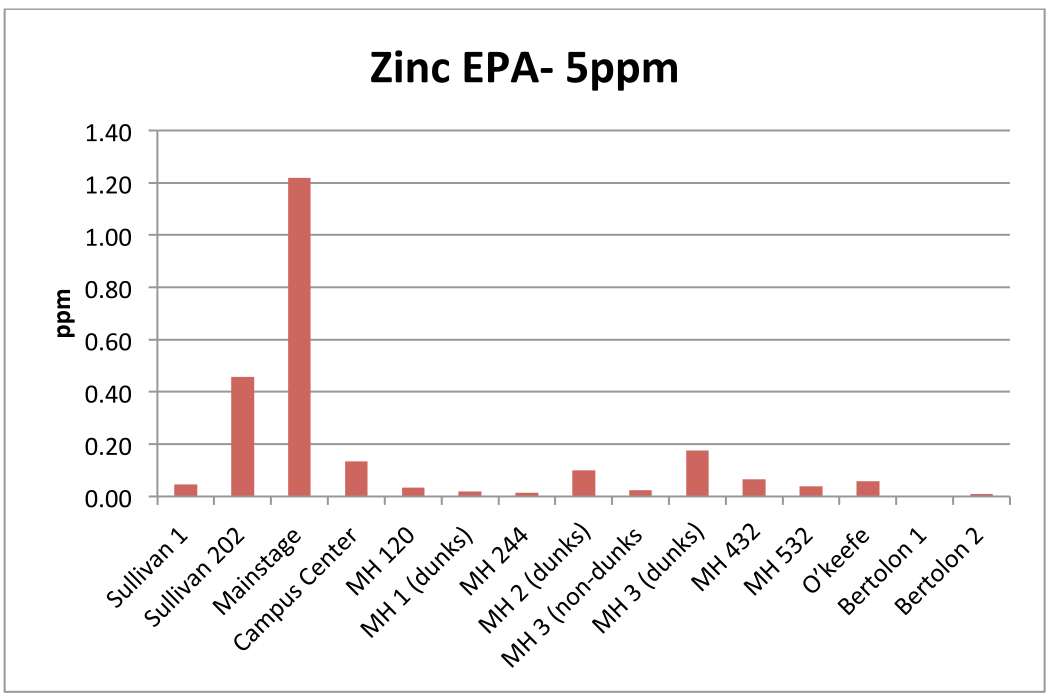

Figure 17. Zinc levels academic buildings Fall 2012

<u>Table of Fall 2012 data</u>

Water Sample	Copper (ppm)	Iron (ppm)	Calcium (ppm)	Zinc (ppm)
Peabody GFL	0.0133	0.0024	11.07	0.040
Peabody 3	0.0000	0.0016	11.18	0.050
Peabody 7	0.0000	0.0165	11.14	0.050
Bowditch GFL	0.0000	0.1163	10.88	0.004
Bowditch 3	0.0026	0.0232	10.9	0.041
Bowditch 6	0.0062	0.1334	11.03	0.061
Atlantic 1	0.0318	0.0084	11.23	0.023
Atlantic 2	0.0000	0.0223	11.13	0.060
Atlantic 3	0.0000	0.2715	11.15	0.030
Atlantic 4	0.0197	0.1008	11.49	0.024
Marsh 1	0.1106	0.0289	11.19	0.123
Marsh 2	0.1119	0.0032	11.18	0.121
Marsh 3	0.0225	0.1029	11.07	0.036
Marsh 4	0.0862	0.1067	11.21	0.145
Marsh 5	0.1404	0.1363	11.02	0.146
Sullivan 1	0.0680	0.0522	11.04	0.046
Sullivan 202	0.1903	0.0235	10.88	0.457
Mainstage	0.4645	0.046	11.43	1.218
Campus Center	0.0944	0.0448	11.38	0.135
MH 120	0.7011	0.101	11.24	0.035
MH 1 (dunks)	0.3641	0.0744	11.26	0.020
MH 244	0.0601	0.1656	10.99	0.015
MH 2 (dunks)	0.1689	0.0776	11	0.101
MH 3 (non-dunks	0.1014	0.0847	11.19	0.023
MH 3 (dunks)	0.0000	0.0751	11.05	0.177
MH 432	0.0531	0.0907	11.02	0.066
MH 532	0.0362	0.0291	11.1	0.040
O'Keefe	0.0184	0.0905	10.89	0.059
Bertolon 1	0.0075	0.0513	11.07	0.000
Bertolon 2	0.0004	0.0219	10.8	0.010

Figure 18. Table of values Fall 2012

Graphs of Spring 2013 data

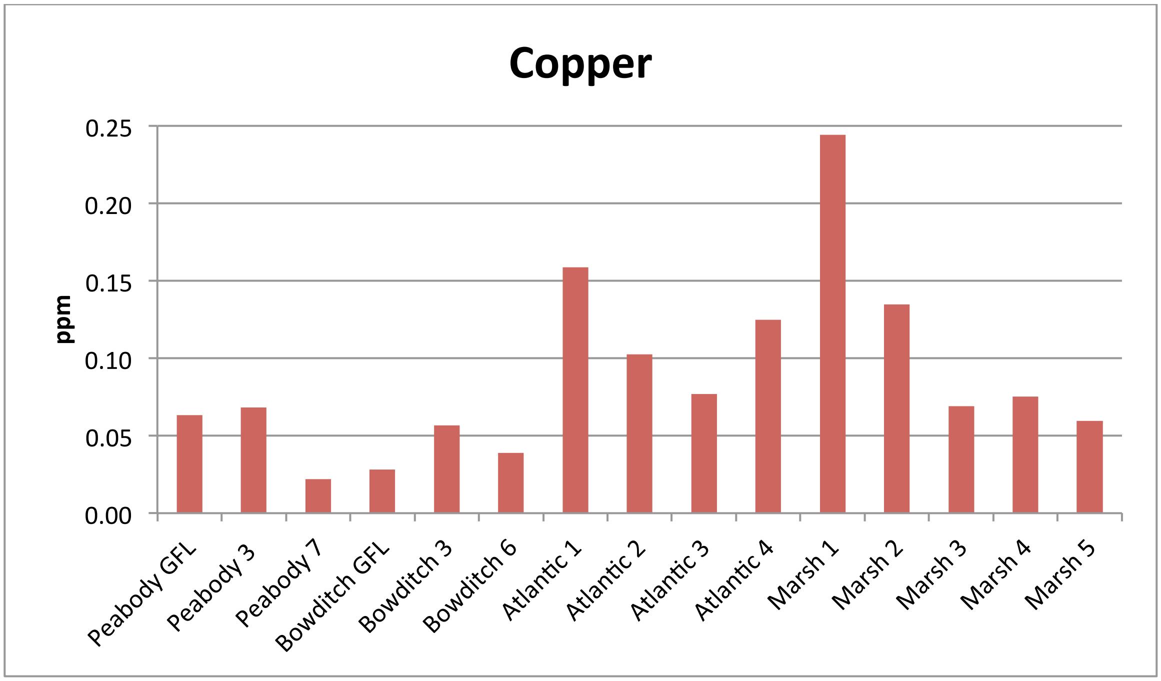

Figure 19. Copper levels residence halls Spring 2013

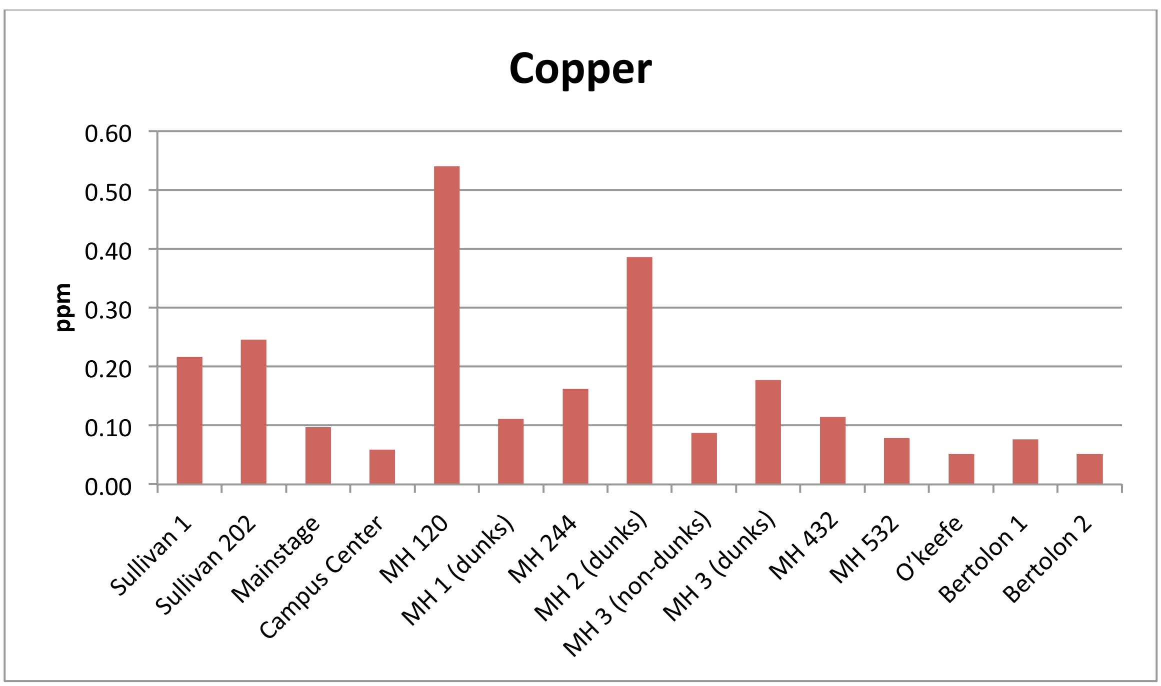

Figure 20. Copper levels academic buildings Spring 2013

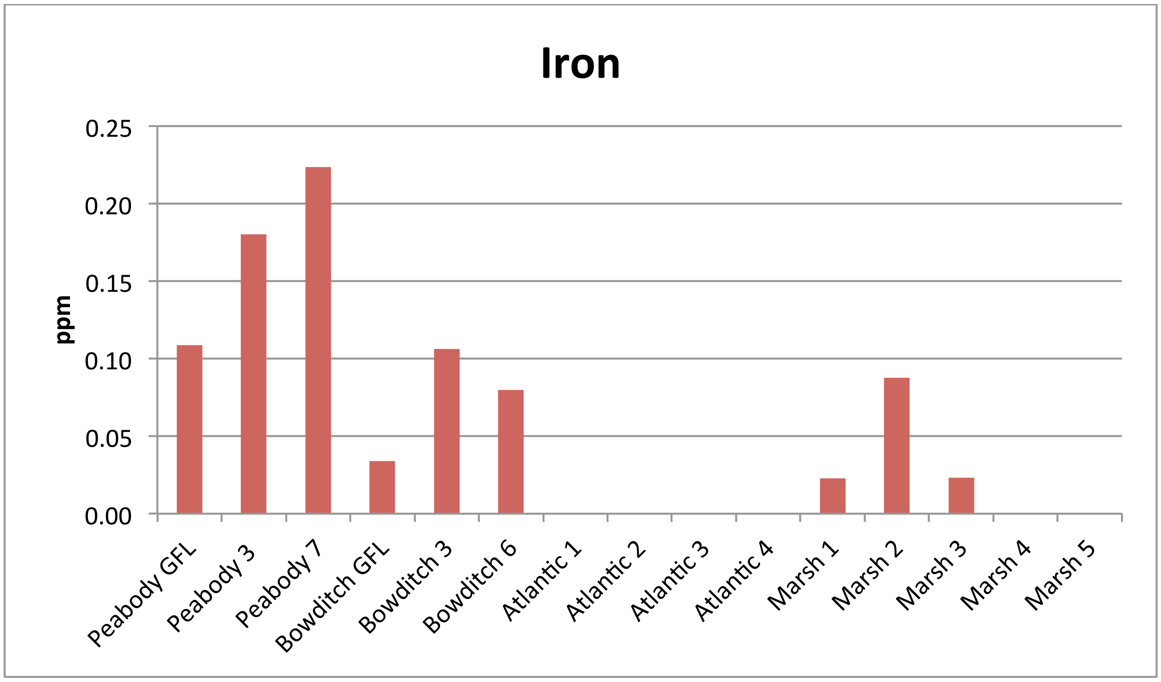

Figure 21. Iron levels residence halls Spring 2013

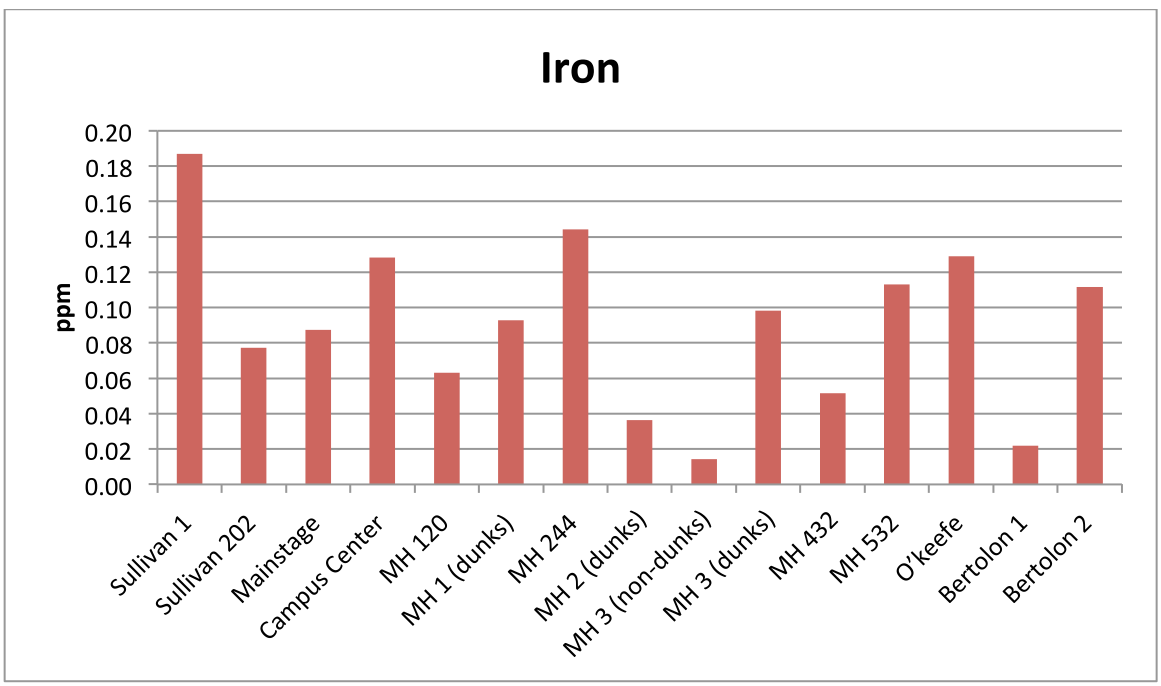

Figure 22. Iron levels academic buildings Spring 2013

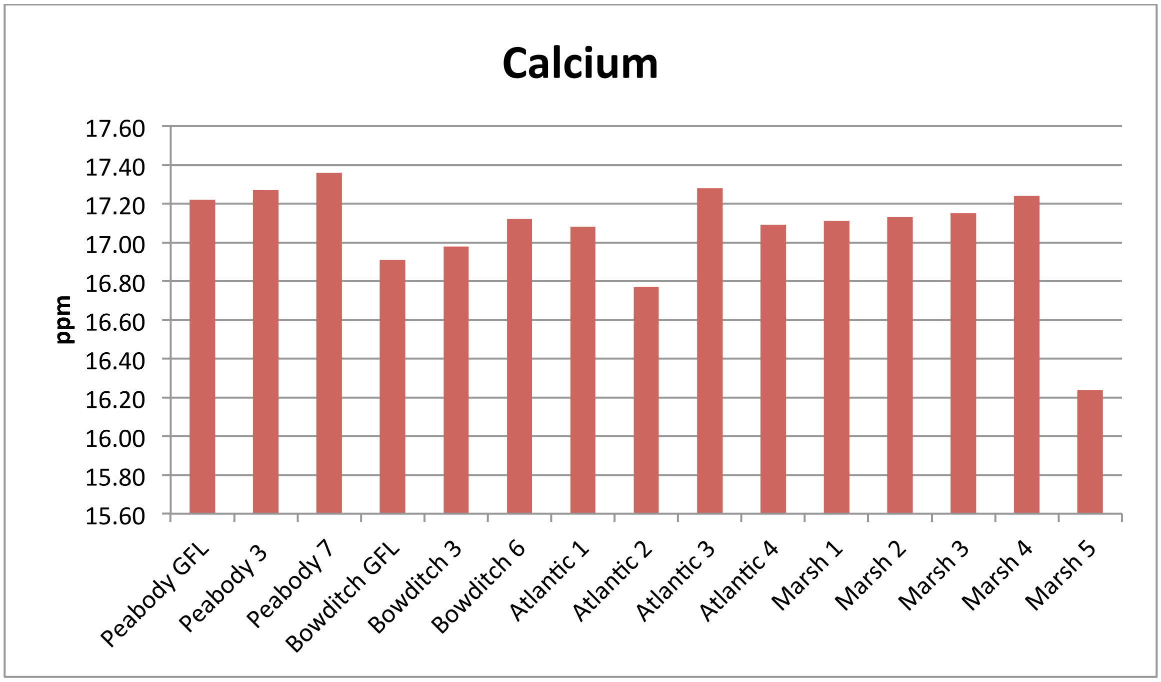

Figure 23. Calcium levels residence halls spring 2013

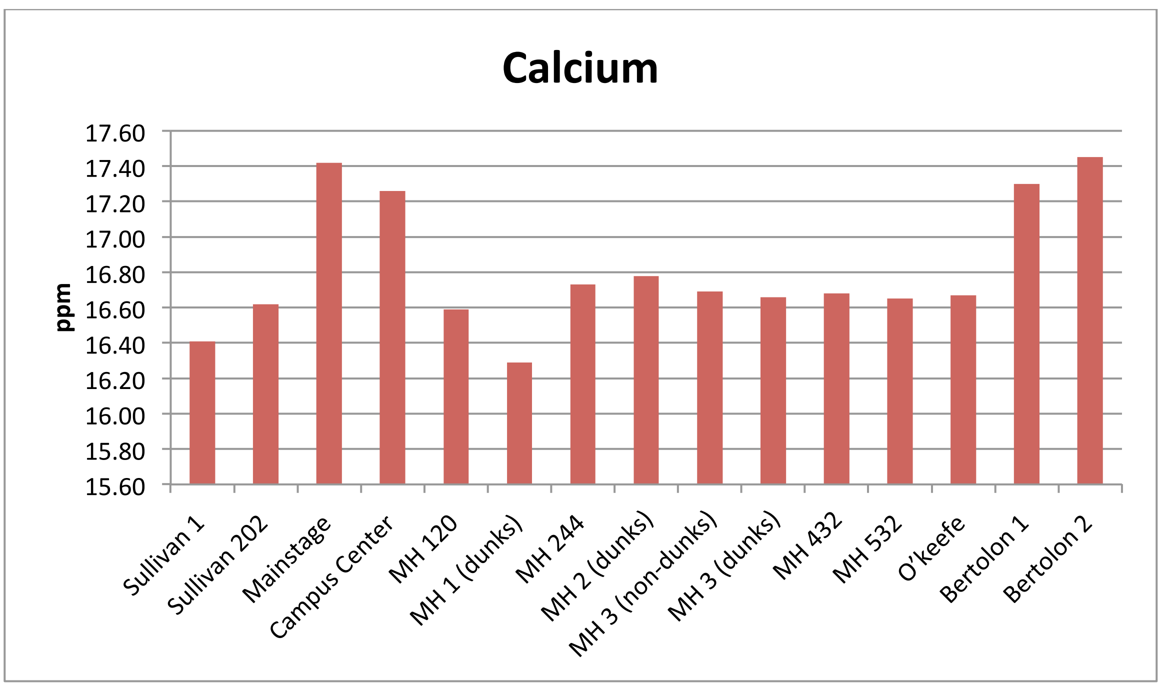

Figure 24. Calcium levels academic buildings Spring 2013

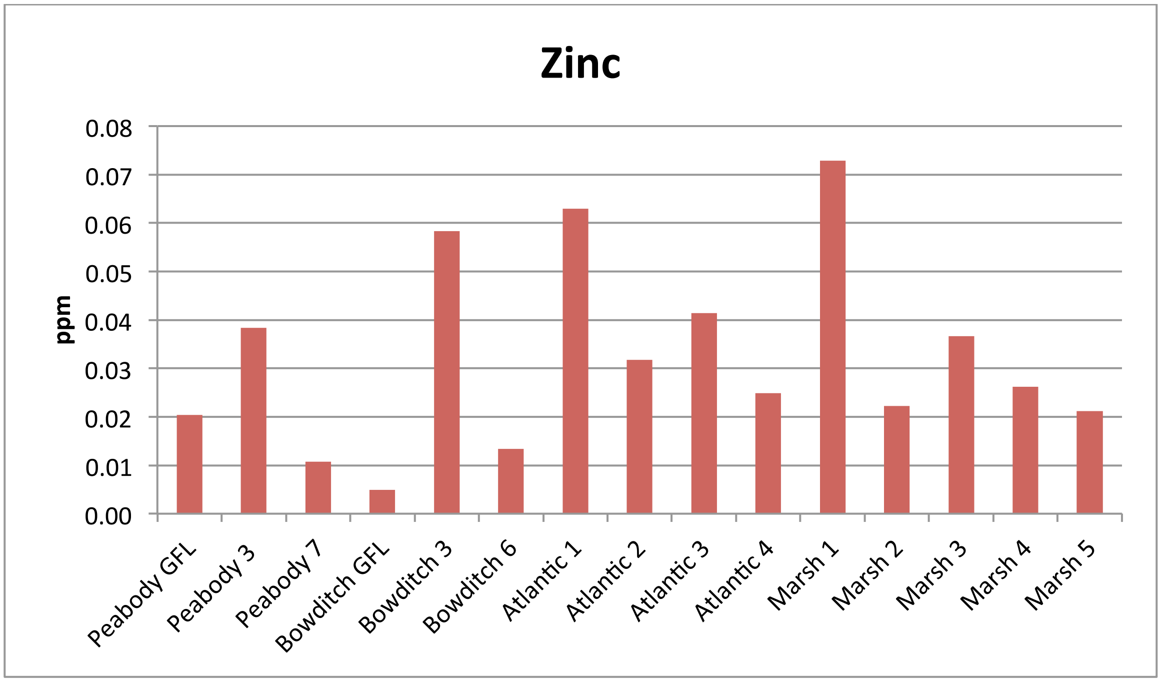

Figure 25. Zinc levels residence halls Spring 2013

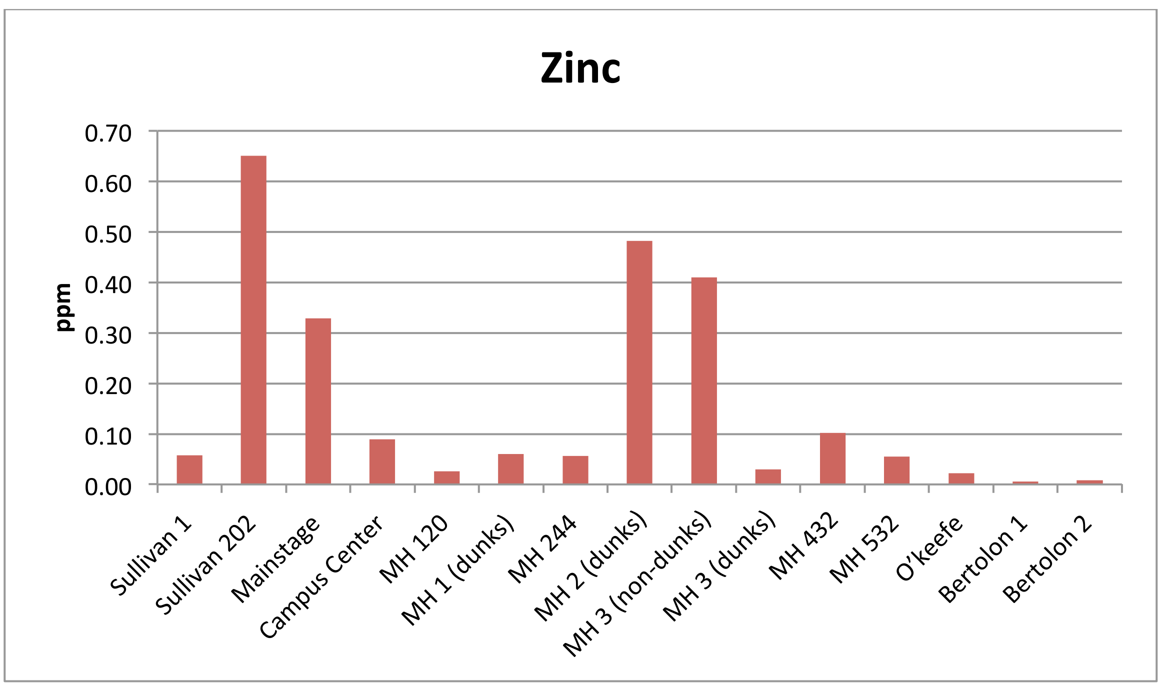

Figure 26. Zinc levels academic buildings Spring 2013

Table for Spring 2013 data

Water Sample	Copper (ppm)	Iron (ppm)	Calcium (ppm)	Zinc (ppm)
Peabody GFL	0.0632	0.1087	17.2200	0.0204
Peabody 3	0.0683	0.1803	17.2700	0.0384
Peabody 7	0.0220	0.2236	17.3600	0.0107
Bowditch GFL	0.0282	0.0341	16.9100	0.0049
Bowditch 3	0.0566	0.1062	16.9800	0.0583
Bowditch 6	0.0388	0.0796	17.1200	0.0134
Atlantic 1	0.1587	0.0000	17.0800	0.0630
Atlantic 2	0.1024	0.0000	16.7700	0.0318
Atlantic 3	0.0769	0.0000	17.2800	0.0414
Atlantic 4	0.1250	0.0000	17.0900	0.0249
Marsh 1	0.2441	0.0228	17.1100	0.0729
Marsh 2	0.1347	0.0878	17.1300	0.0222
Marsh 3	0.0690	0.0234	17.1500	0.0367
Marsh 4	0.0751	0.0000	17.2400	0.0262
Marsh 5	0.0594	0.0000	16.2400	0.0212
Sullivan 1	0.2170	0.1868	16.4100	0.0572
Sullivan 202	0.2465	0.0772	16.6200	0.6507
Mainstage	0.0977	0.0873	17.4200	0.3293
Campus Center	0.0588	0.1282	17.2600	0.0887
MH 120	0.5398	0.0632	16.5900	0.0261
MH 1 (dunks)	0.1116	0.0927	16.2900	0.0599
MH 244	0.1619	0.1444	16.7300	0.0562
MH 2 (dunks)	0.3864	0.0365	16.7800	0.4819
MH 3 (non-dunks)	0.0871	0.0142	16.6900	0.4096
MH 3 (dunks)	0.1777	0.0983	16.6600	0.0293
MH 432	0.1144	0.0516	16.6800	0.1014
MH 532	0.0788	0.1130	16.6500	0.0548
O’Keefe	0.0520	0.1291	16.6700	0.0226
Bertolon 1	0.0768	0.0219	17.3000	0.0063
Bertolon 2	0.0517	0.1116	17.4500	0.0078

Figure 27. Table of levels Spring 2013

<u>Graphs for Fluoride Electrode Data Spring 2013:</u>

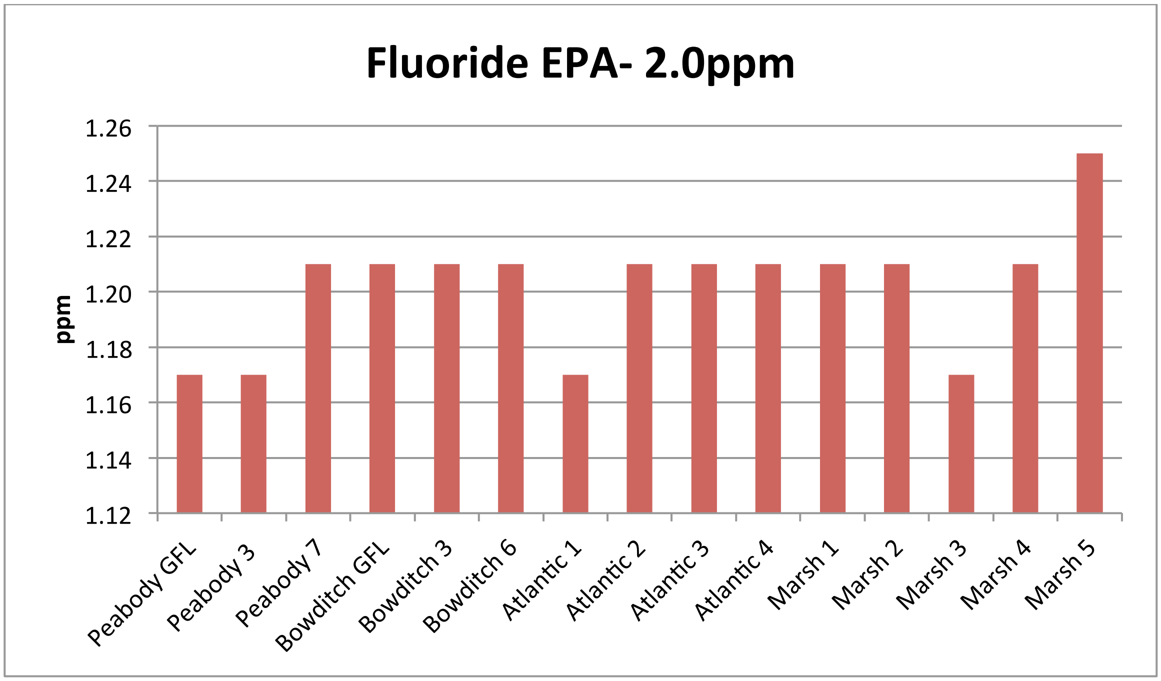

Figure 28. Fluoride levels residence halls Spring 2013

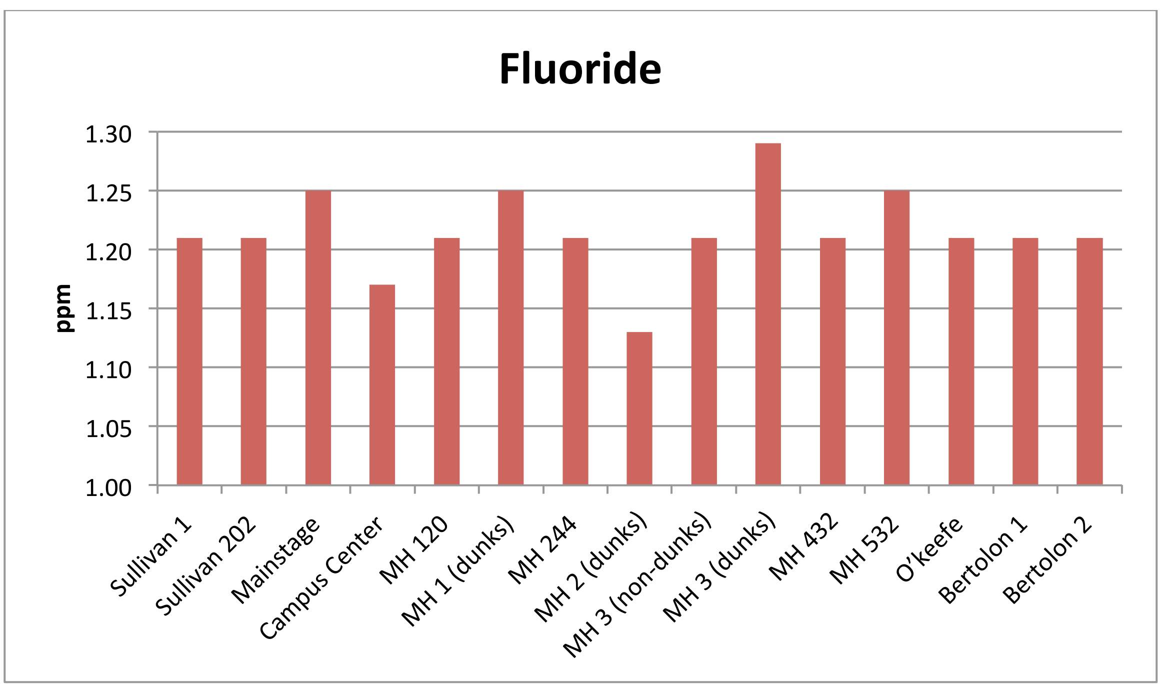

Figure 29. Fluoride levels academic buildings Spring 2013

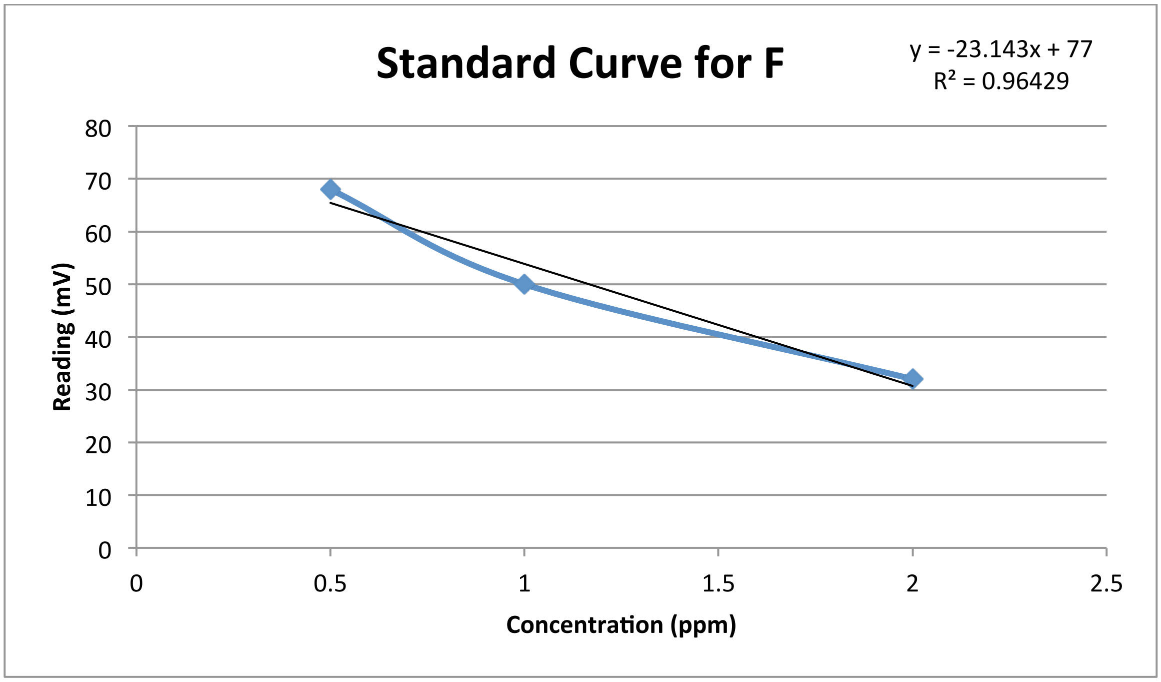

Figure 30. Standard curve for fluoride electrode

Table for Fluoride selective electrode

Water Sample	Fluoride mV	Fluoride (ppm)
Peabody GFL	50.00	1.17
Peabody 3	50.00	1.17
Peabody 7	49.00	1.21
Bowditch GFL	49.00	1.21
Bowditch 3	49.00	1.21
Bowditch 6	49.00	1.21
Atlantic 1	50.00	1.17
Atlantic 2	49.00	1.21
Atlantic 3	49.00	1.21
Atlantic 4	49.00	1.21
Marsh 1	49.00	1.21
Marsh 2	49.00	1.21
Marsh 3	50.00	1.17
Marsh 4	49.00	1.21
Marsh 5	48.00	1.25
Sullivan 1	49.00	1.21
Sullivan 202	49.00	1.21
Mainstage	48.00	1.25
Campus Center	50.00	1.17
MH 120	49.00	1.21
MH 1 (dunks)	48.00	1.25
MH 244	49.00	1.21
MH 2 (dunks)	51.00	1.13
MH 3 (non-dunks)	49.00	1.21
MH 3 (dunks)	47.00	1.29
MH 432	49.00	1.21
MH 532	48.00	1.25
O'Keefe	49.00	1.21
Bertolon 1	49.00	1.21
Bertolon 2	49.00	1.21

Figure 31. Table of fluoride levels Spring 2013

Comparisons:

All three semesters:

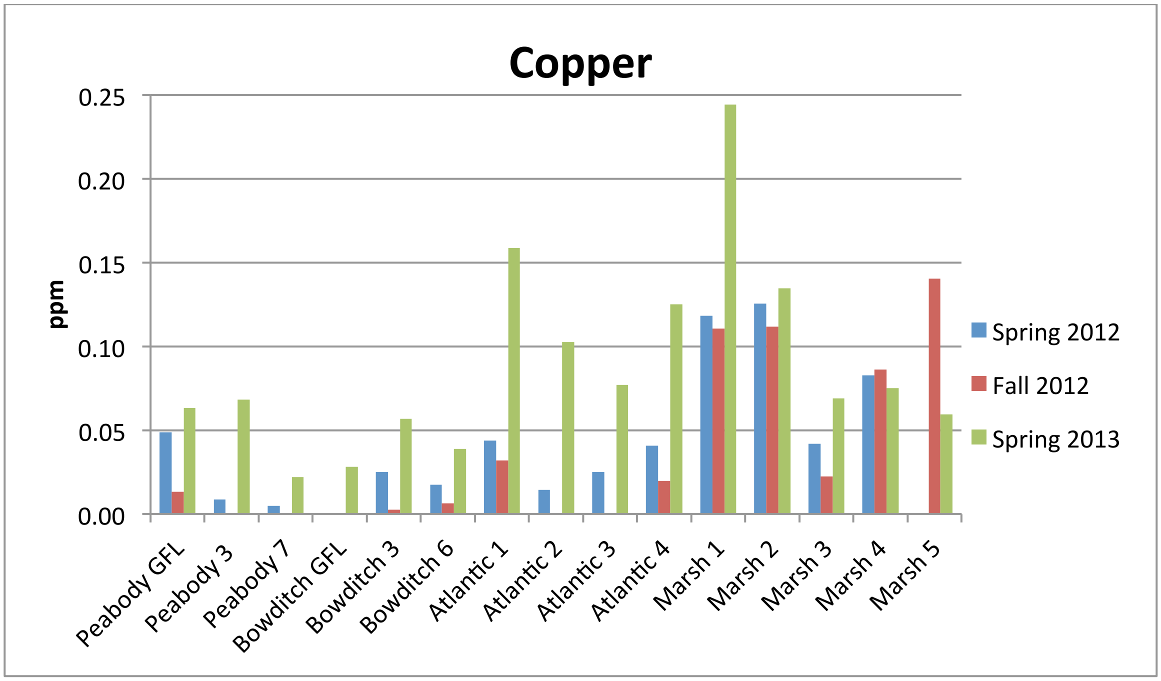

Figure 32. Copper levels residence halls all three semesters

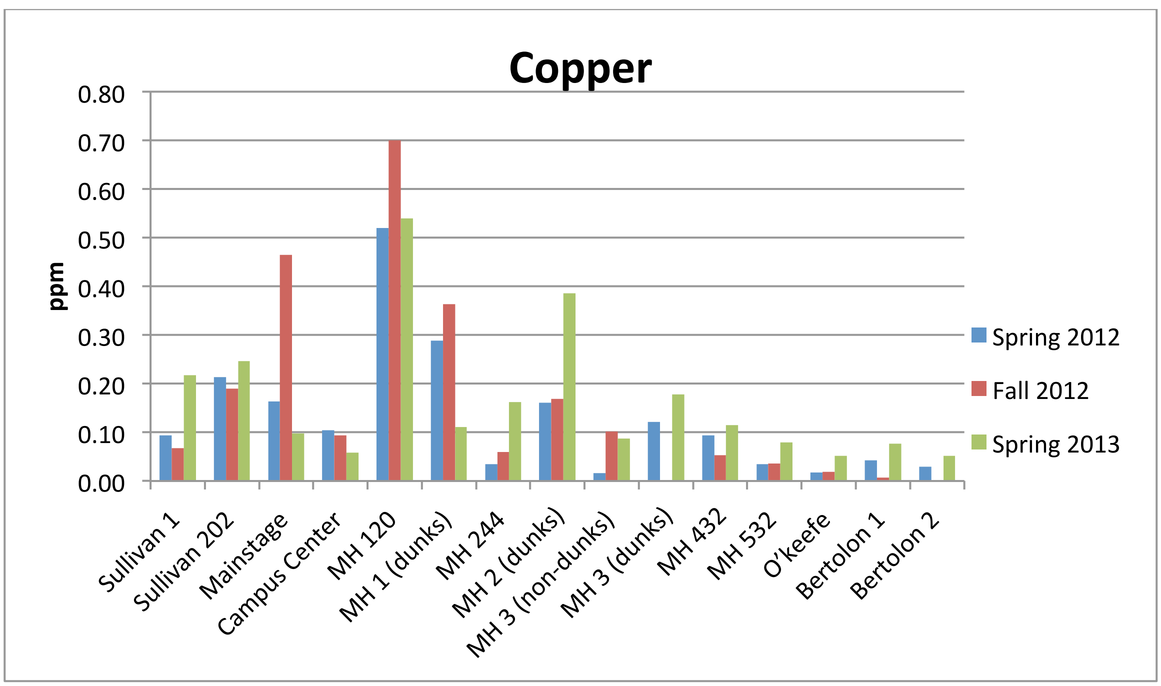

Figure 33. Copper levels academic buildings all three semesters

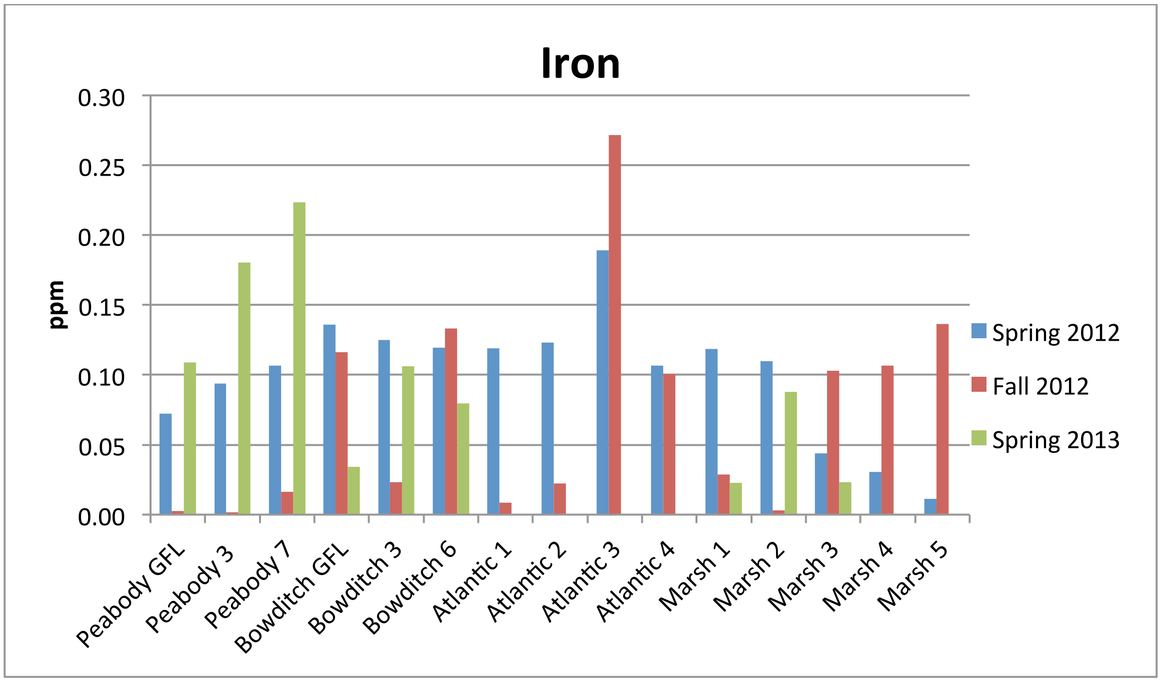

Figure 34. Iron levels residence halls all three semesters

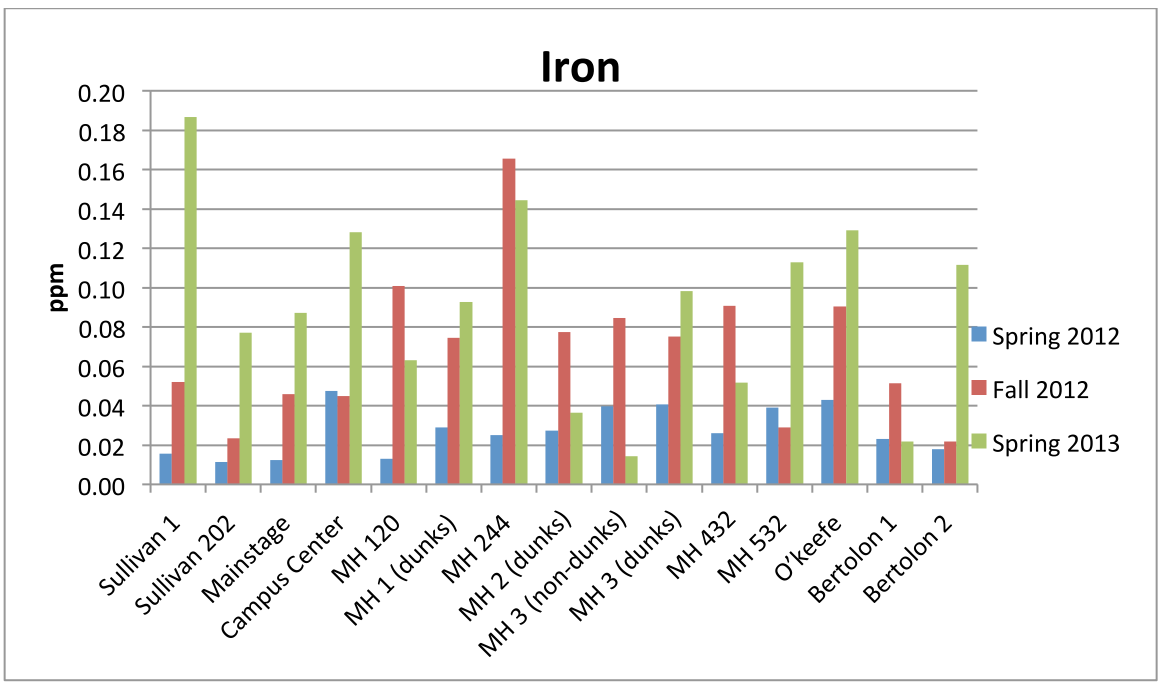

Figure 35. Iron levels academic buildings all three semesters

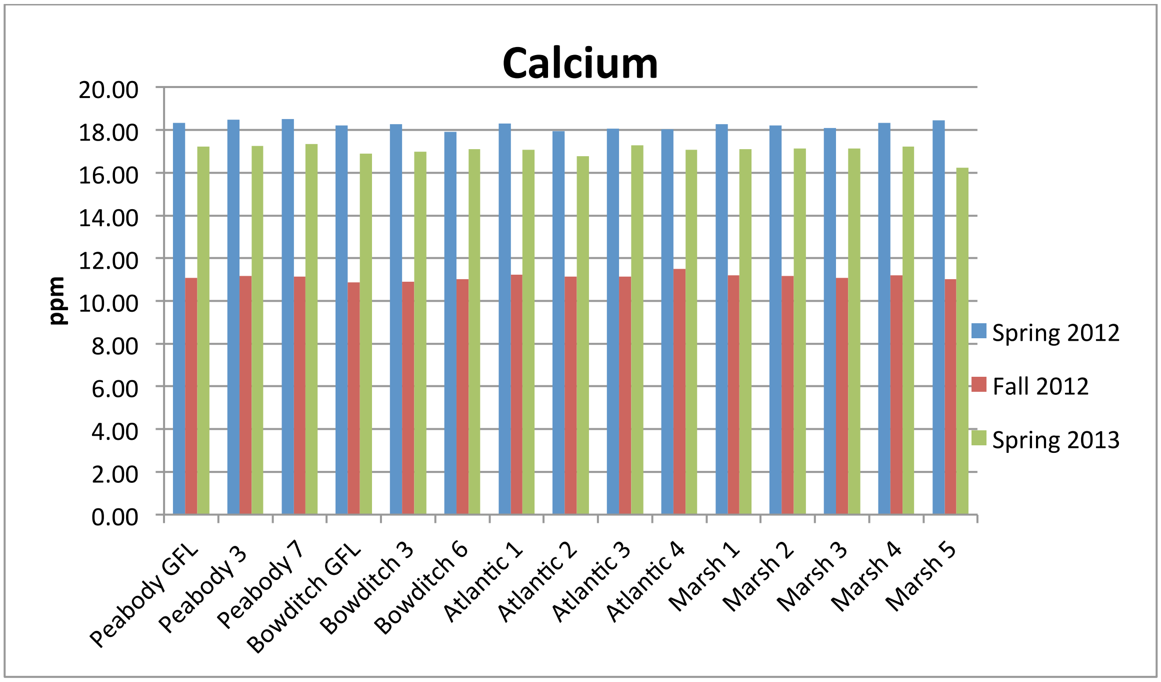

Figure 36. Calcium levels residence halls all three semesters

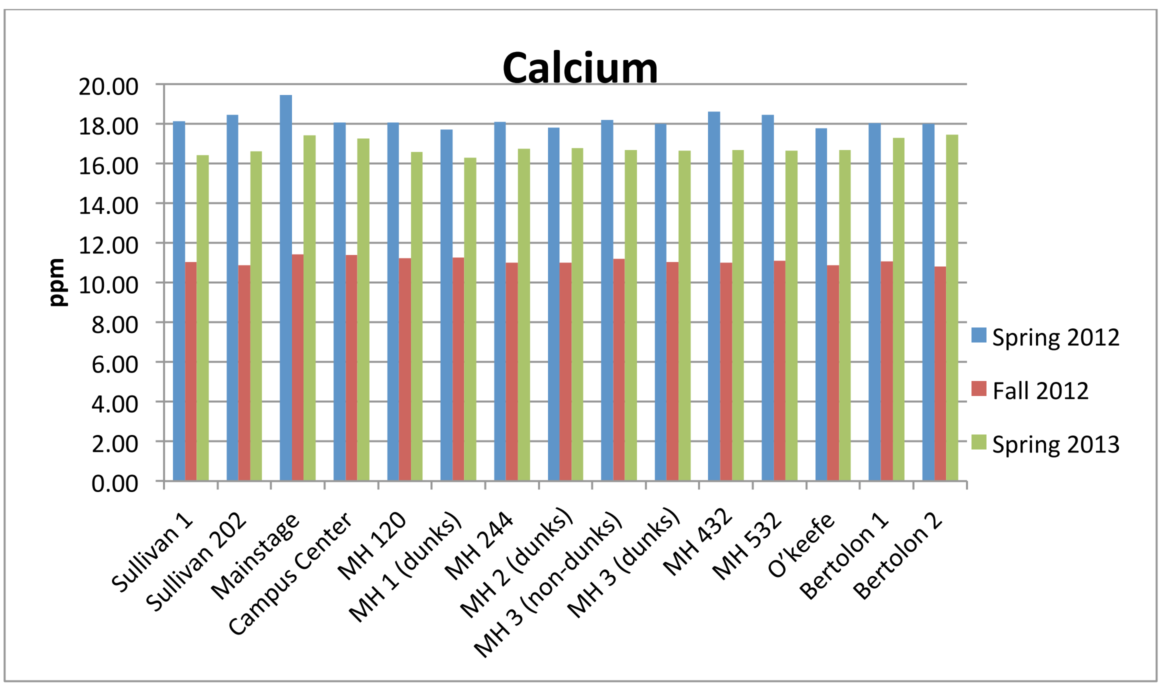

Figure 37. Calcium levels academic buildings all three semesters

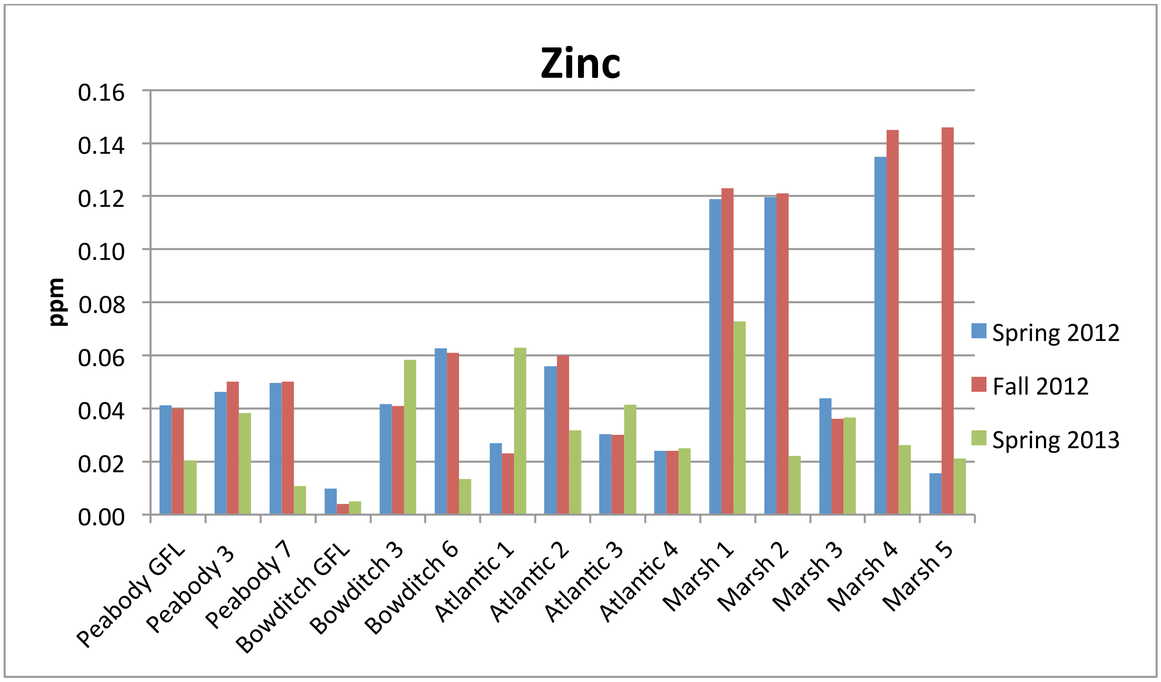

Figure 38. Zinc levels residence halls all three semesters

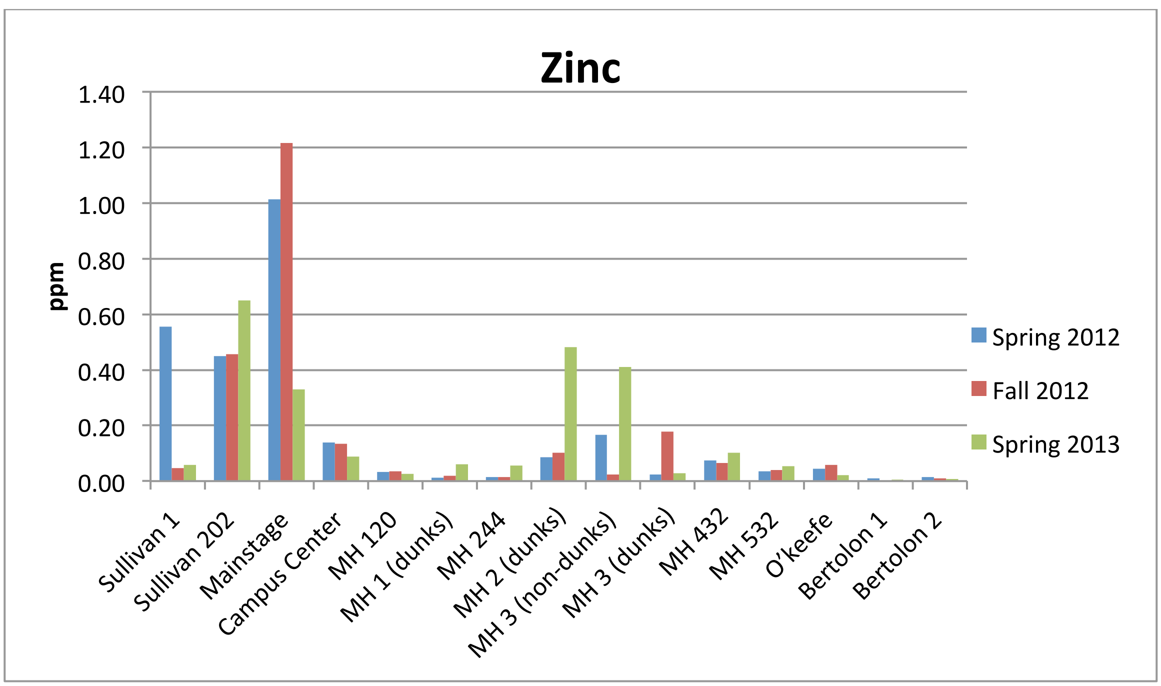

Figure 39. Zinc levels academic buildings all three semesters

Spring 2012 & Spring 2013 comparisons:

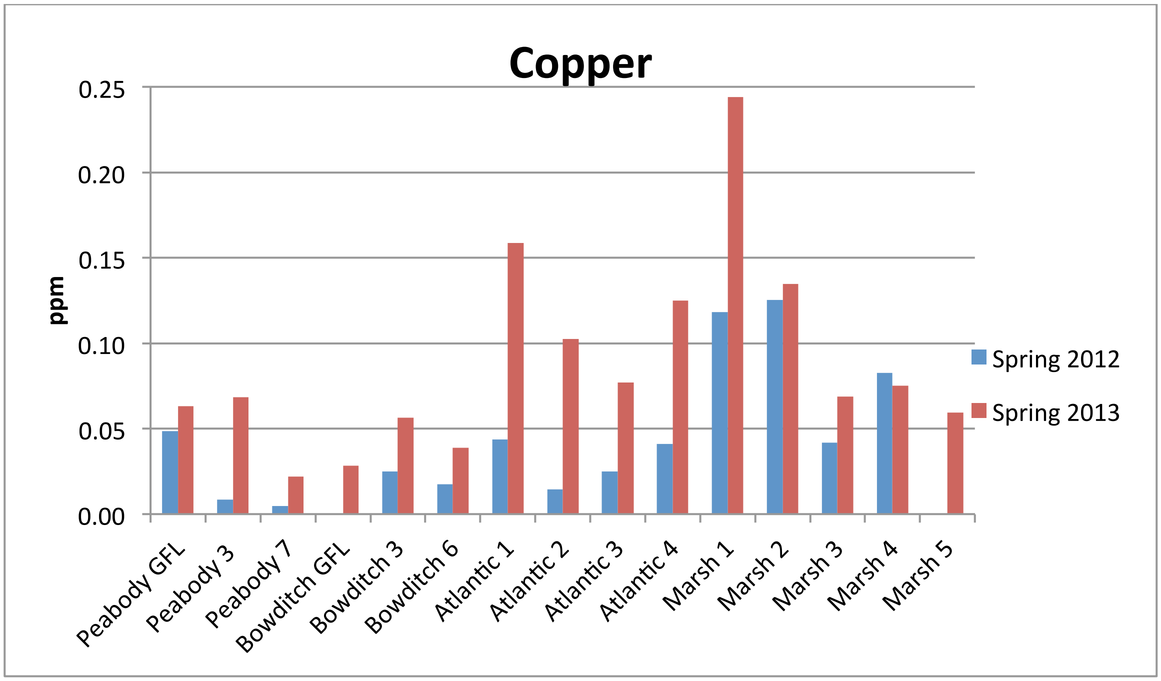

Figure 40. Copper levels residence halls comparing Spring 2012 & Spring 2013

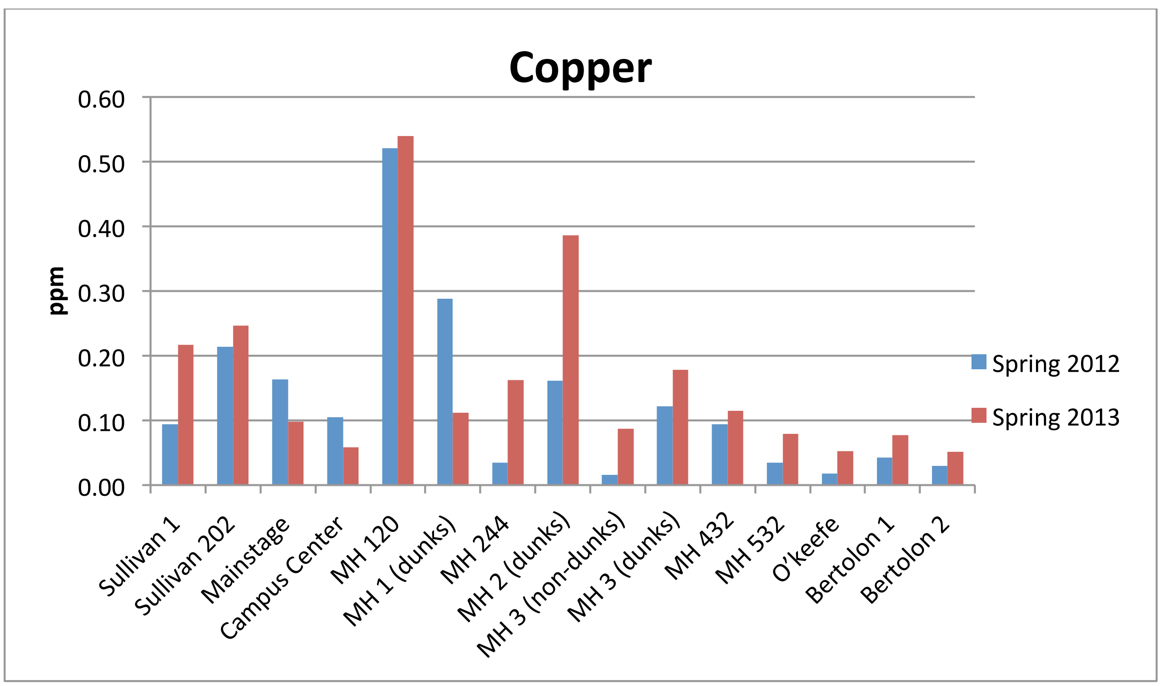

Figure 41. Copper levels academic buildings comparing Spring 2012 & Spring 2013

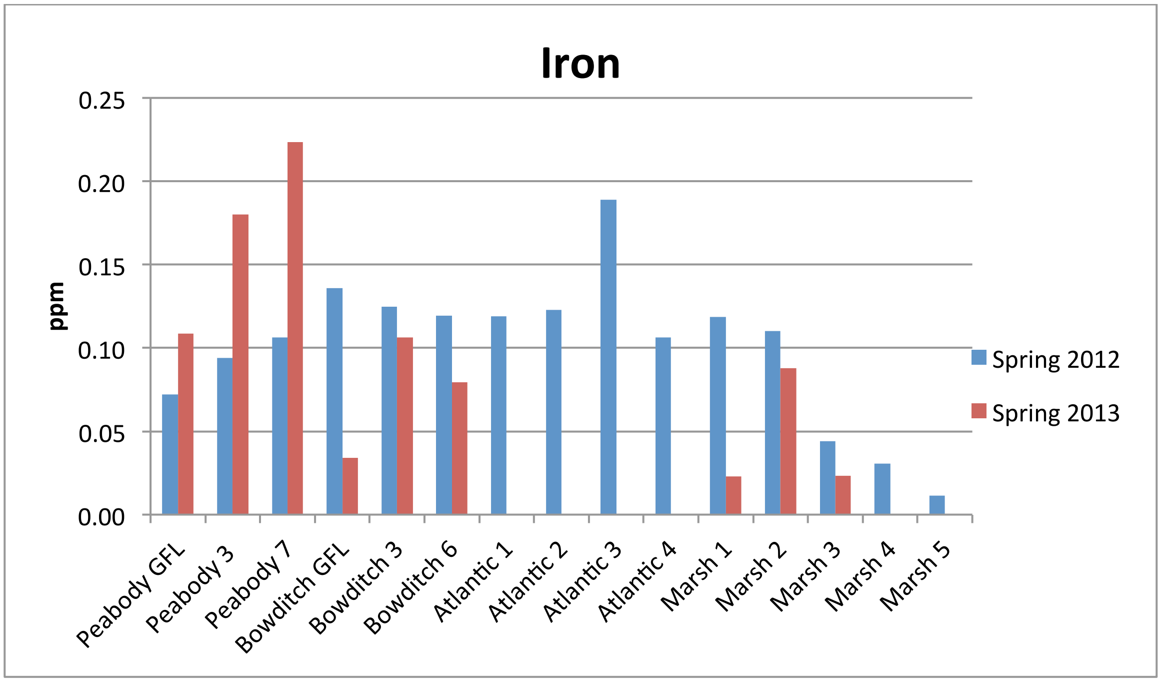

Figure 42. Iron levels residence halls comparing Spring 2012 & Spring 2013

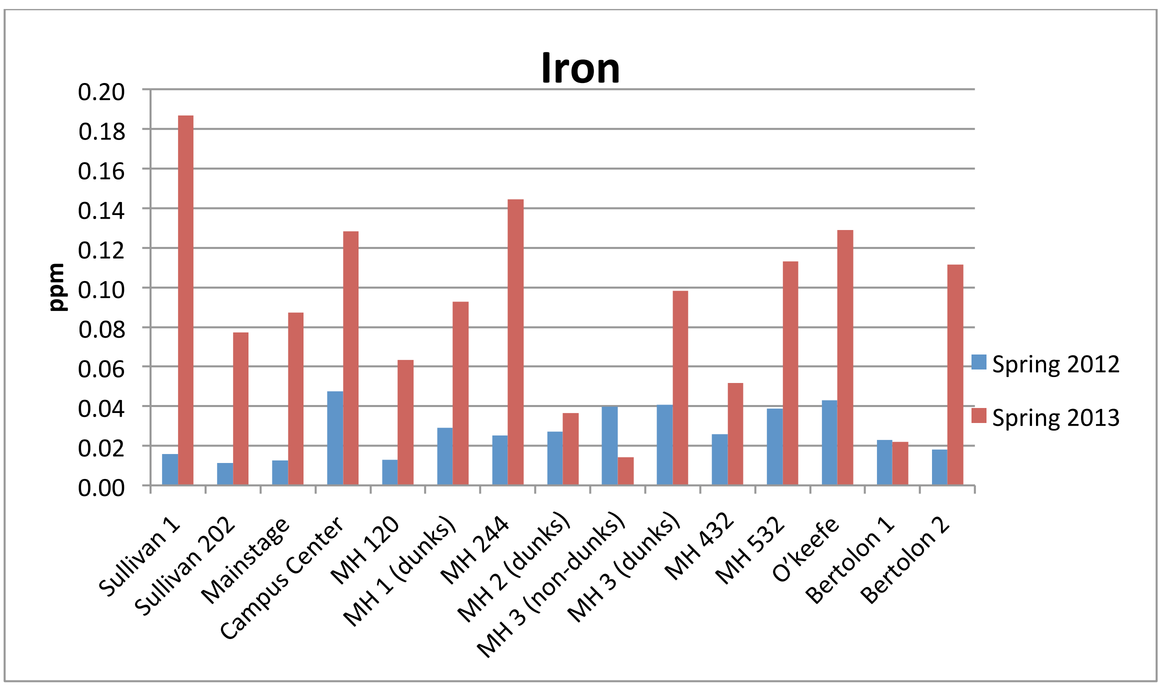

Figure 43. Iron levels academic buildings comparing Spring 2012 & Spring 2013

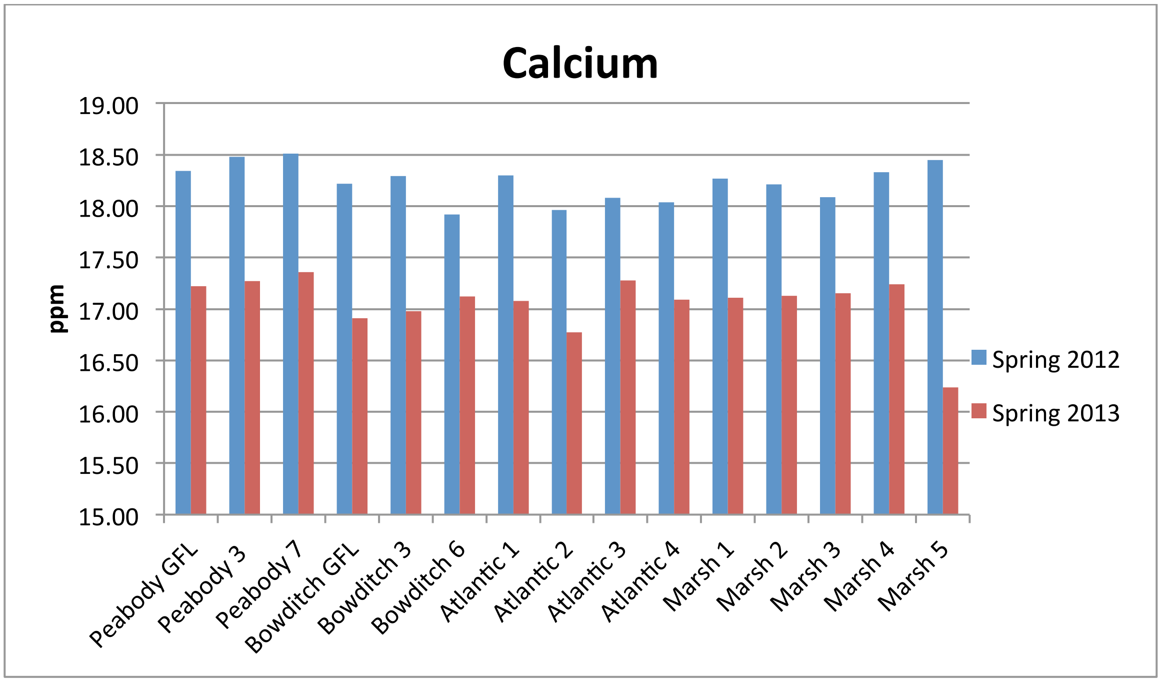

Figure 44. Calcium levels residence halls comparing Spring 2012 & Spring 2013

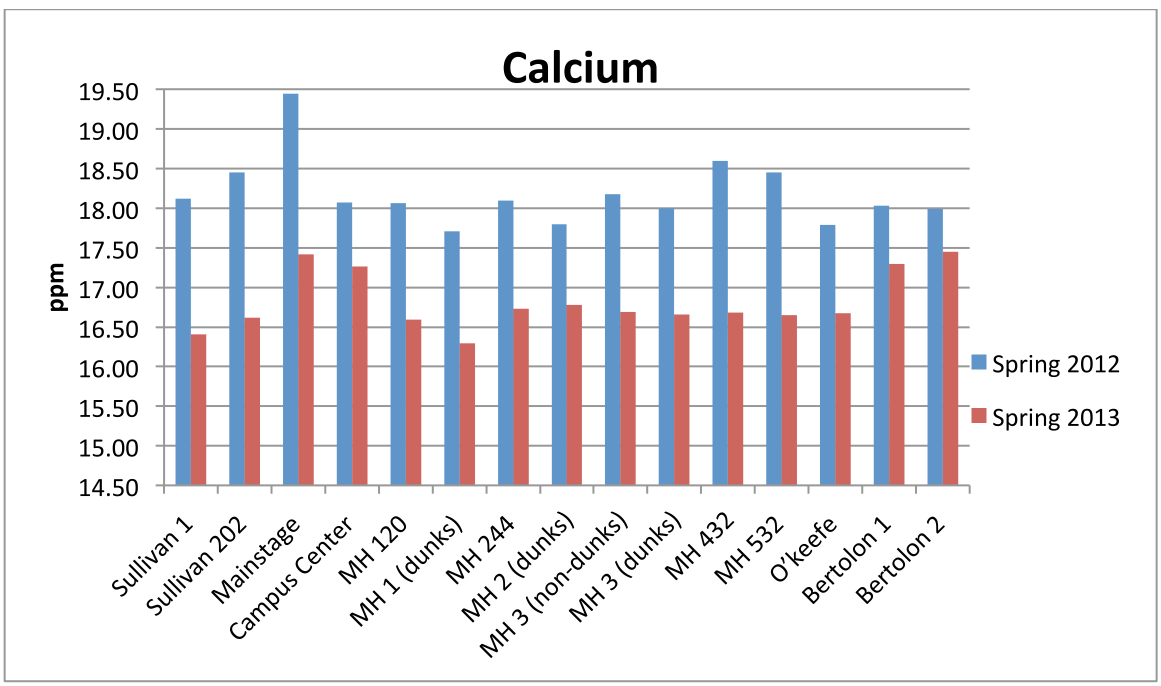

Figure 45. Calcium levels academic halls comparing Spring 2012 & Spring 2013

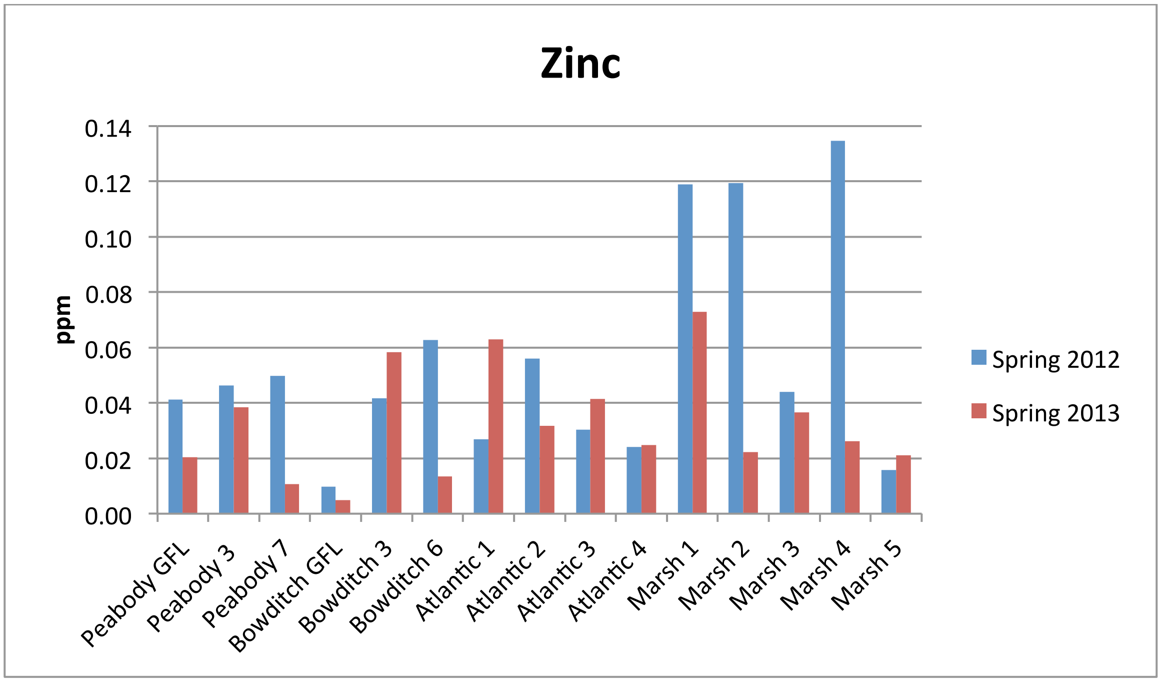

Figure 46. Zinc levels residence halls comparing Spring 2012 & Spring 2013

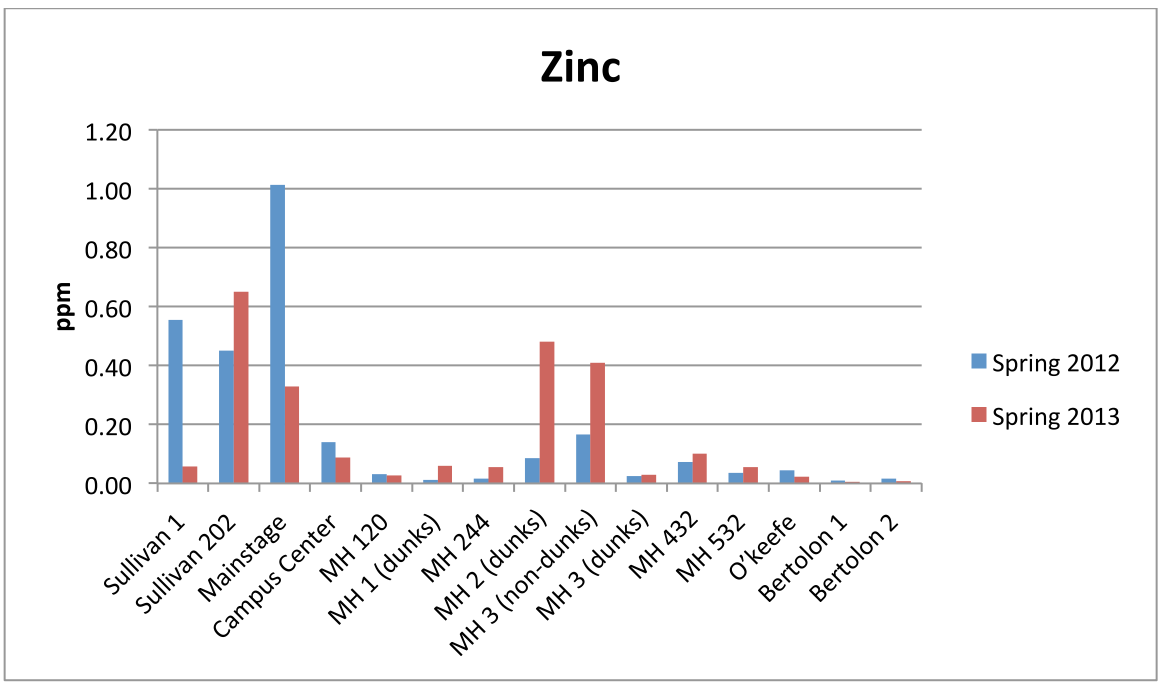

Figure 47. Zinc levels academic halls comparing Spring 2012 & Spring 2013

Discussion and Conclusion:

The water samples collected were all from buildings around campus. They were collected in plastic and glass bottles from the lab stockroom to reduce any contamination. The focus was to get water from sources most utilized for drinking. In the residence halls, the main source from which the water came was the sinks. The exceptions to that would be in Peabody and Bowditch on the ground floor lounge where bubblers were used as the source. In the buildings around campus, bubblers were the main source from which the water was obtained. Once all of the samples were collected, metal standards were made in order to calibrate the AA machine. Each standard was run, followed by the 30 water samples. From the Spring 2012 to the Fall 2013 semester, the same water samples were used. In the Spring 2013 semester, new water was collected from around campus. A new fluoride ion-selective electrode was used on all of the samples for the fluoride testing.

The main observations that were seen from Spring 2012 was that in Peabody residence hall, the iron concentration increased as the floor increased, but in Bowditch it decreased as the floor increased. Copper was observed in Peabody Hall to decrease as the floor increased, but there wasn't any notable trend connected to the floor levels with the other halls. The first floor of Meier Hall had the highest amounts of copper of all the academic buildings, and these amounts decreased as the floors increased in Meier. It was also seen in Peabody that the concentration of zinc increased with the floor, as well as in Bowditch. Calcium was seen to increase in Peabody with the floors, but no other trend was observed in the other residence halls. Sullivan Building also showed this trend from the first to second floor, but all of the academic buildings were relatively similar in calcium levels. In both Peabody and Bowditch Hall, zinc increased with the floor. Neither Atlantic nor Marsh showed a trend regarding the floor from which the water came from.

The age of the building did not have a significant effect on the water quality. The one thing that was found was that the newer resident hall, Marsh Hall, had higher amounts of copper and zinc than the rest of the residence halls. Sullivan and Mainstage had much higher levels of zinc than the rest of the academic buildings, and are the two oldest buildings on campus. Mainstage Auditorium had the highest calcium and zinc levels, and is one of the oldest buildings on campus. All of these tests and samples were run a second time to compare results.

When the water was tested one semester later, the results varied. All of the water was stored in a refrigerator over the summer with several drops of nitric acid in them in hopes of preserving them. The results however, suggest that this was not the case. Some of the levels were higher, but the majority of the levels on most of the metals tested were lower than when previously tested. The overall conclusion is that the metals didn't uphold in the water for that long period of time.

To better observe the levels of the metals in the water, new samples were collected from the same places but a year later. Observations that came out of the Spring 2013 data were that copper was seen in higher amounts in the Atlantic Hall. There is no concrete trend in the academic buildings with the copper levels. Iron was seen to increase as the floors increased in Peabody Hall, Atlantic showed no iron, and only three floors of Marsh had iron in the water. Sullivan building's first floor had the highest amount of iron amongst the academic buildings, but the second floor had a much lower level.

In Peabody, Bowditch, and Marsh, calcium increased with the floors with the exception of the fifth floor of Marsh dropping by about one ppm. Four academic buildings tested for higher calcium levels than the other academic buildings: Mainstage, Campus Center, and Bertolon. Two of these, Mainstage and the campus center are fairly old buildings and Bertolon is the newest academic building, but because it was a renovation of the Sylvania plant, there is a high possibility that some of the original plumbing is still in use. The Bertolon building is not the best building to look at when comparing age of building for this reason. Zinc showed no real trend in the academic buildings, but in the residence halls, the first floors of Atlantic and Marsh were both much higher than their upper floors and the third floors of Peabody and Bowditch were the highest of the floors tested.

All of the fluoride levels were in the same range, only varying from 1.13 to 1.29ppm, with the majority of them having a fluoride level of 1.21ppm. A few observations in the residence halls were that the lower two floors tested of Peabody were just slightly lower than floor seven. The first floor of Atlantic was the lowest, with the remaining floors all being the same at 1.21ppm. The first two floors of Marsh Hall registered 1.21 ppm, the third floor dropped to 1.17 ppm, and then increased each floor to 1.25 ppm on floor five. The academic building did not show any notable trends.

Although there are comparisons of all three semesters, the main focus is the comparison between the Spring 2012 and the Spring 2013 data. Both of these sets of data were formed with new water samples, which would lead one to the conclusion that they are the most reliable out of the three. Some of the observations that were seen were that in the resident halls, most of the copper levels were higher in the Spring 2013 data than in 2012. Some halls didn't have any copper detected in 2012, but in 2013 it was. The concentrations from 2013 were significantly higher than in 2012 in the residence halls. In the academic buildings, the same trend of 2013 being higher can be seen. However, when comparing 2012 with 2013 the values are much closer than observed from the residence halls.

When looking at the data composed from the iron testing, all but Peabody showed higher levels in 2012. There was iron detected in Atlantic hall in 2012, but not in 2013 in any of the floors. There were large differences between the years. Each floor tested from Peabody showed a higher reading between 0.05 and 0.10 ppm from the previous year. Unlike the residence halls, the academic buildings showed that the water collected and tested in 2013 produced much higher levels of iron than those from 2012.

Calcium's trend between the years is easy to see. In both the residence halls and the academic buildings calcium was higher in 2012. It was higher anywhere between one and two ppm. There isn't as clearly a trend with zinc. For the most part, the residence halls had higher levels in 2012, with marsh having a large gap between the years. The academic buildings showed that on the overall, 2013 showed higher levels, but for the most part they were pretty close. The exceptions to that main observation is that Meier hall floors two and three were much higher than the previous year, and Sullivan Building first floor, and Mainstage showed much higher levels in 2012 than 2013.

From the multiple tests that were done on the water samples taken from both the residence halls and the academic buildings, it can be concluded that all of the water is safe to drink. The EPA has regulations on each metal and the non-metal that was tested. The maximum allowable levels determined by the EPA are: Cu 1.3ppm, Fe 0.3ppm, Ca 20ppm, Zn 5ppm, and F 2.0ppm. Lead was also tested, but each value was negative, showing that there was no lead able to be detected. Based on the results, all of the water collected showed levels lower than regulations, thus they are safe to drink.

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