To Drink or Not to Drink … A study of Water Units on BNL's Site

Lauren Barriteau
Marine Environmental Science, SUNY Maritime College, Bronx, NY 10465

Russell Rohan
Environmental Science, Allegheny College, Meadville, PA 16335

Steve Coleman
Environment Safety and Health, Brookhaven National Lab, Upton, NY 11973

I. Abstract

The debate on whether or not bottled water is safer or healthier than tap water has been ongoing for many years. This debate has historically been a topic of conversation onsite at Brookhaven National Laboratory (BNL). For quite some time, the laboratory has experienced groundwater contamination on different occasions. In 1996 high concentrations of radionuclides were found in the groundwater. Though the Lab was swift in addressing the problem, the events that took place have had residual effects on the opinions employees have about the drinking water, which it sources from groundwater wells directly on the BNL site. Due to this, some of the workers on site prefer to drink from bottled water coolers. While the bottled water dispensers provide an alternative to tap water, they also have the capability to create their own set of problems. For example, bottled water dispensers may impose their own health risks and can be a large cost for the Lab. In response, the Environmental Protection Division proposed two possible solutions; either implement a cleaning service for the bottled water dispensers or integrate more bottle filling water fountain stations on site. The goal of this project was to gather data on the various water units on site including kitchen faucets, water fountains, bottled water dispensers and bottled- water storage areas, and evaluate the conditions and cleanliness of these units through the use of surveys and literature review. With this information, on locations, accessibility, and infrastructure of the various units, the hope is that management can more effectively create a policy that can regulate potable water use on site. The results of this study show that there are advantages and disadvantages to each solution. As a result of this summer, my partner and I have strengthened our communication skills, thought processing, and expanded our networks.

II. Introduction

Currently, the bottled water on the Brookhaven National Laboratory (BNL) site is in need of more effective and comprehensive regulation. To meet this need the Environmental Protection Division (EPD) proposed two viable solutions that could possibly be used to address this issue. The research question driving this project was as follows; between adding more bottle filling stations and implementing a cleaning service for the water coolers on site, what is the most beneficial solution to the current problem of bottled water dispensers that are not maintained properly? The goal of this project was to assist the Environmental Protection Division in answering this question by gathering survey data on the water units on site. The hope is that this data can aid in creating the best policy to regulate bottled water on site by providing the EPD with a better knowledge of where the different potable water units are, availability of potable water and current state of all units.

It is valuable to understand the origin of the current problem before evaluating the viability of the two possible options. Some staff on site are apprehensive about drinking the tap water. This apprehension is rooted in a number of factors based on both facts and personal bias but the most notable is the history of tap water contamination on site. The most commonly mentioned contamination is from the High Flux Beam Reactor (HFBR). The HFBR operated from 1965 to 1996, and was used for scientific research. The High Flux Beam reactor was shut down in 1996 for routine maintenance but in 1997 high levels of tritium (above state and federal drinking standards) were found in the groundwater south of the HFBR. The lab was swift in addressing the contamination but as a result the Department of Energy shut down the HFBR in November 1999 [1]. The events that took place have had residual effects on the opinions

employees have about the potable water on site. As a result some people use water coolers for drinking water. Not only are the bottles that supply the water coolers very expensive, but if the units are not properly cleaned they can pose health risks to the user. One solution could be to implement new bottle filling stations to promote the drinking of tap water. The problem with this is that not every building/current fountain unit has the ability to have a bottle filling station installed without additional infrastructure changes (i.e., plumbing, electrical, or building renovation). Another solution could be to implement a cleaning service for the water coolers. The problem with this is that it could be an unnecessary cost to the lab if there are other clean water sources available. Also, this would not be the most sustainable option from an environmental perspective.

There are a few areas to consider when evaluating the importance of this project and its impact; the health and quality of the water being used whether it is tap or bottled water, monetary impacts to the BNL, and the employee perception:

Health Impacts

There are several possible forms of contamination that can be present when using these dispensers. The **first is bacteria**. As the dispenser is used the amount of potentially contaminated air increases in the bottle and comes in direct contact with the water. Because the exterior of the bottle contacts the water inside of the dispenser there is a possibility for contaminants to be transmitted this way as well. Improper cleaning of water dispensers and the bottles used can lead to a build of heterotrophs and micro bacteria in the water[3]. **The second is chemical contamination.** Leaching of organic compounds from Polyethylene terephthalate (PET) bottles

can deposit hazardous chemicals into the water in these dispensers[4]. This leaching is promoted in many cases because bottles are stored improperly (ex. near heat or light sources).

Monetary impact

The other factor that brings urgency to this matter is the cost of supplying the bottle filling stations versus the cost of bottled water delivery and cooler maintenance. Data gathered on the water bottles supplied to the site in the form of cost estimates and bottle totals make it clear that constantly supplying the site with bottled water is very expensive. In certain locations the use of bottled water is necessary since tap water might not be immediately accessible in some temporary buildings or areas onsite. But in cases where clean drinking water is available through nearby fountains, the purchase of bottled water is not very sustainable.

III. Methods

This project can be looked at as two phases. One being literature review and the other being data collection. Literature review was a necessary step to gain an understanding of both the history of potable water on site at Brookhaven National Laboratory, as well as the current knowledge of both bottled and tap water. The information found on the history of BNL's potable water as well as trends in concentration of staff on site, shaped the criteria for which buildings were focused on during the data collection phase of the project. Due to the established criteria and the allotted time for the project, buildings were chosen considering the amount of foot traffic as well as those marked off as delivery points for bottled water.

Once an adequate amount of literature review was carried out data collection could be carried out. The first step in gathering the data was to contact individuals with authority over the building or the Facility Project Manager (FPM). Making contact with these individuals allowed us to get access to certain buildings with entry restrictions. On the other hand some buildings did not require any correspondence with the Facility Project Manager of the respective buildings. Before the buildings could be surveyed it was also necessary to print out the buildings key plans and the surveys we would use for the different water units. Key Plans are a small scale diagram of a building's layout that indicates the different rooms, exits and other basic infrastructure of a building. As stated before, data was collected in the form of surveys. There were four different surveys used, one for each respective water unit including water fountains, bottled water dispensers, bottled water storages and faucets. The surveys were used to analyze the cleanliness of each water unit and its design/components if applicable. The factors taken into account when evaluating the state of the units were, if there was a noticeable amount of dust/ dirt present, the color of the water, the flow rate and if there is an odor present. To evaluate the design and components of each unit the surveys looked at the model type, how many outlets were available and if there was a visible filter attached. The next step in the data collection process was to document the location of the respective units in the various buildings. This was accomplished by marking down the location of each water unit on the key plan. Each water unit was given a certain symbol to identify the type of unit on the key plan. The importance of recording the locations was to gain an understanding of the proximity of the different water units to each other. More specifically, in some cases the presence or lack thereof one unit could negate or create a need for another and sway the final decision that will be made on the site's water policy. After any data was collected it was input into a spreadsheet. This provided the ability to effectively

organize the data as well as observe any notable trends that could be useful for determining the most effective policy.

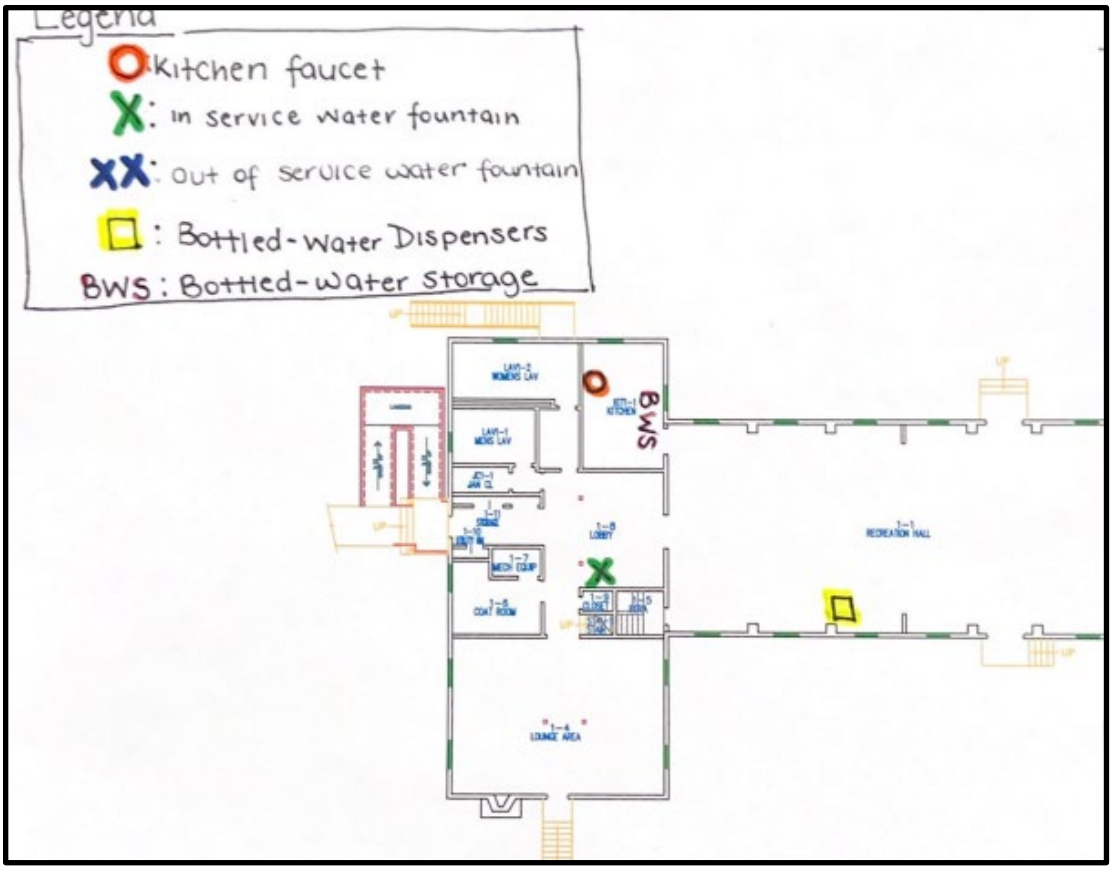

Figure 1: This is an example of one of the key plans used to map out the units within a building

IV. Results

Within the data collected from the 46 buildings on Brookhaven National Lab's site (fig.2), there were some common trends that could prove to be notable when creating the water policy. The first notable trend was in the usage of the units, specifically of bottled water dispensers and water fountains. 69% of the recorded water fountains were either not used often or not used at all compared to 4% for the recorded bottled water dispensers. This is an important finding to keep in mind seeing that the current problem onsite revolves around the uses of these

unit types. Filters are attached to some water units to remove chlorine or iron and improve taste and color. Across the 46 buildings we recorded 100 faucets. Within this sample size, 37% of the faucets had a filter helping to ensure the quality of the water. If filter cartridges are not replaced in the appropriate time frame, the filter can begin to be counter productive, building up and releasing bacteria, mold, and other contaminants. Within the 37 filters seen on the faucets, 70.3% of these filter cartridges were replaced in the year of 2022. Water fountains were the other type of water unit on BNL's site that we observed have filters attached. Throughout the 46 buildings surveyed, there were 70 water fountains in total with 37% of them having visible filters and only 10 of these filter cartridges were replaced within the past year.

If water bottle filling stations are implemented as a solution, having outlets accessible is a key component in being able to install the unit. Only 30% of the water fountains observed had outlets near or next to the unit. In turn, this would mean that a good portion of bottle filling stations would require some form of renovation to the respective buildings infrastructure to be installed.

At BNL in order for one to have a water dispenser it is supposed to be approved by EPD. An evaluation is done to make sure that the dispenser is needed in that intended area. While surveying the water dispensers throughout the buildings it was made a point to check if they were BNL approved as they would have a red tag or BNL barcode. 71 out of a total of 98 (72.4%) water dispensers observed were found to have a tag or bar code.

In ensuring the health of employees from the various water units such as faucets, fountains and water dispensers it is important that they are cleaned frequently. While surveying the water units we noticed some common trends related to the units' cleanliness such as white stains which may be due to mineral build up, rust and dust/ dirt. Of the 100 faucets observed on

site 14% showed a build up of white stains in the sink and 30% with rust build up around the drain area. The water fountains had similar trends. Only 4 water coolers had a tag that indicated the last time the dispenser was cleaned. 46 water dispensers showed buildup with dirt or dust in the drain area. When it came to bottled water storage, 31% of the bottle water storage locations were stored in direct sunlight, near a window or a heat source like a radiator. As stated earlier, improper conditions such as these can lead to a number of negative health impacts.

Outside of the data collected in buildings, data was also collected on the prices associated with each proposed solution. With regard to the "cleaning service for dispensers" option, on average Brookhaven National Laboratory purchases 121 five- gallon water bottles in one week, totaling $9,680. This adds up to about 6,292 bottles a year at a total of about $503,360. This price does not include the fee that would be required for a cleaning service as a quote is not available for this expense. As far as bottle filling stations, each new unit would cost about $1000 - $2,000. In addition, additional costs may be necessary for renovation that would be needed to install certain units such as new outlets or plumbing alterations. These additional costs would be subjective to each specific building as some are much older than others.

Bldg #	Facet Total	Water Fountain Total	Bottle Water Dispenser Total	Bottle Water Storage Total	Total Water Source
400	6	3	1	1	11
438	1	1	0	0	2
461	0	1	0	0	1
860	2	2	2	1	7
463	5	2	9	6	22
528	1	0	0	0	1
488	0	2	0	0	2
120	3	0	4	3	13
477	1	2	1	0	4
30	3	1	0	0	4
490	7	2	16	7	34
317	2	1	1	1	5
462	1	0	1	1	3
50	2	0	2	1	5
326	1	0	2	2	5
460	4	0	3	0	7
599	1	1	2	0	4
179	2	0	1	1	4
NSLS-II	12	9	1	1	23
735	3	4	3	2	12
830	1	0	1	1	3
817	2	0	4	2	8
555	5	8	7	6	26
510	7	5	2	1	15
815	2	4	2	1	9
515	4	4	5	4	17
480	0	3	1	1	5
535	2	2	1	1	6
422	2	1	2	2	7
423	1	0	1	1	3
734	1	4	0	0	5
725	3	0	5	4	12
478	0	0	1	1	2
479	1	0	1	0	2
801	1	0	3	2	6
703	1	3	0	0	4
901	1	2	4	3	10
902	2	0	4	4	10
452	4	1	3	2	10
494	1	0	2	1	4
493	2	0	1	2	5
Total	100	68	99	66	338

Fig.2 Screenshot taken from part of the master spreadsheet. This shows a breakdown of the sample size for each unit.

V. Discussion

As stated before, the EPD proposed two solutions to the current water issue on site, prior to this project. Either increase the quantity of bottle filling stations on site, or implement a cleaning service to properly maintain the bottled water coolers currently being used by staff. Because the main goal for the summer was to collect data, the findings of this project did not completely rule out the viability of either option. They were successful in providing a better

understanding of the status of potable water onsite as well as highlighting both the advantages and disadvantages of each possible solution. Long term, the use of bottle filling stations is more sustainable from a monetary and environmental standpoint. Though it would cost more up front to renovate fountains and necessary infrastructure, it takes far less maintenance to upkeep fountains as opposed to the bottled water coolers. On the other hand, the data as well as feedback from staff show that the preferred source of drinking water right now is the bottled water dispenser. This is an important factor to consider because it would be ineffective to renovate fountains if people would continue using bottled water coolers, especially because there were a number of coolers found that were not owned by BNL. Seeing that in many cases the use of bottled water dispensers were used because of personal preference as opposed to lack of other potable water units, it is clear that the solution to the current problem does not have just one answer. The findings from this study show that more research should be carried out to further understand the employee preference on site and not just the condition of water units. More specifically, a final decision can't be made without fully knowing what staff would want to see in the future or full costs associated with each option. That way there can be more opportunity for education on the quality of tap water on site and alleviate the current concern as well as an ability to understand which solution would be the most beneficial for all parties involved.

VI. Acknowledgements

I would like to give special thanks to my mentor Steve Coleman along with Timothy Green, Joy Haskins, Jennifer Higbie for all their guidance, insight and support throughout this internship. This project was collaborated with Russell Rohan. This project was supported in part

by the Brookhaven National Laboratory (BNL), Environmental Protection Department under the BNL Supplemental Undergraduate Research Program (SURP).

References

[1]Environmental Protection Division.*Brookhaven National Laboratory.* Brookhaven National Laboratory. The High Flux Beam Reactor (HFBR) at Brookhaven National Laboratory (BNL) is being decommissioned because the Department of Energy (DOE) decided in 1999 that it would be permanently closed. The reactor was shut down in 1997 after tritium from a leak in the spent-fuel pool was found in the groundwater.

[2]*Former Underground Storage Tanks.* (). http://www.bnl.gov/gpg/files/g-2/10_10_g-2ReportFINAL2.pdf

[3]Farhadkhani, M., Nikaeen, M., Akbari Adergani, B., Hatamzadeh, M., Nabavi, B. F., & Hassanzadeh, A. (2014). Assessment of Drinking Water Quality from Bottled Water Coolers. *Iranian Journal of Public Health, 43*(5), 674-681.

[4]Keresztes, S., Tatár, E., Mihucz, V. G., Virág, I., Majdik, C., & Záray, G. (2009). Leaching of antimony from polyethylene terephthalate (PET) bottles into mineral water. *Science of the Total Environment, 407*(16), 4731-4735. https://doi.org/10.1016/j.scitotenv.2009.04.025