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Lead in Drinking Water at a South Texas University

[1]Alejandro Pena Silva, [2]Gerardo Flores, [3]Adam Flores, [4]Jongmin Kim

[1,2,4] Civil Engineering, The University of Texas Rio Grande Valley, Edinburg, Texas, USA
[3]Earth, Environmental, & Marine Sciences, University of Texas Rio Grande Valley, Edinburg, Texas, USA

Abstract: **With the Flint water crisis in Michigan, people concern more about the lead in the drinking water. Lead is a dangerous water toxin that the US Environmental Protection Agency (USEPA) sets its Maximum Contaminant Level Goal (MCLG) to be zero to prevent adverse health effects from lead poisoning. According to USEPA, buildings built before 1986 are likely to contain a lead piping system and drinking water running through those pipes may contain some level of lead. Also, worrisome level of lead was found from drinking water in public schools from US states (e.g. New York) due to the old piping system and insufficient maintenance on existing drinking water supply systems. A research team from a local Texas university measured lead in the school water fountains based on the facts that some buildings on campus are built before 1986 and year-long hot weather condition may accelerate lead leaching into the water pipelines thus resulting in higher lead level in drinking water. Test results showed that none of the water samples contained lead level greater than 15 ppb (or 15 µg/L), a Maximum Contaminant Level of lead action level in the drinking water set by USEPA. However, lead monitoring at other Texas public schools is warranted to protect Texas young citizens from lead poisoning from the drinking water.**

Keywords: **Lead in drinking water, old buildings, Texas public schools, water supply pipes.**

I. INTRODUCTION

The source of lead in drinking water is pipe lines that connect between water treatment plants and final customers. Corrosion is found to be the major cause of lead contamination in drinking water. It requires three (3) preconditions to happen, which are a) whole or parts of pipes should be made of lead, b) water should be acidic, or c) water should lack corrosion preventive chemicals such as orthophosphate hold low mineral contents. Other minor factors that can accelerate lead corrosion can be hot weather and long water storage time in the pipes. According to USEPA [3], drinking water supply in buildings built before 1986 are frequently made of lead pipes partially or in whole so that corrosion is more likely to happen in those old buildings. Continuously ingesting low-level aqueous lead is known to cause severe health problems such as reproductive problem, cardiovascular disease, high blood pressure, kidney failure, reduced growth of the fetus, seizures, and even death [3]. Even a lower lead level ingestion can be more detrimental to children causing damages to nerve system, learning disabilities, impaired hearing, malfunction in blood cells and immune system, and possible death [3]. Another group of people that is more vulnerable to lead poisoning is pregnant women since ingestion of lead may cause fetus malformation, premature birth, and even death of fetus [3]. Current regulation specifies a maximum contaminant level (MCL) of lead as 15 µg/L action level and a maximum contaminant level goal (MCLG) of lead to be 0 µg/L [3].

One tragic case that was referred in this study is the “Flint Water Crisis” [1]. In 2014, a “foul-smelling” and a color change in drinking water were reported by increasing number of residents in Flint, Michigan. It was found that the crisis was originated from severe corrosion in the water supply pipes due to change of water source from Detroit city water to Flint river along with lack of corrosion prevention (e.g. orthophosphate) and high chlorine contents in treated water. Soon the complete city declared that water was not suitable to ingest because it contained dangerous level of lead. A massive plan began to take place and it may include replacing almost every piping system affected by corrosion and it can cost millions of dollars. To prevent similar tragic incidents in the rest of the US and Texas mainly, lawmakers need to be concerned and informed about the health problems that lead in drinking water may cause and how it can be countered.

In a local Texas university, lead in water from water fountains on campus has been monitored to raise awareness and help lawmakers advance their efforts to mandate testing lead in drinking water at public schools. Lead in drinking water is an urgent issue because it can affect a whole generation of children and young adults in the long run.

II. METHODOLOGY

Each building on the campus that was deemed highly accessed by students were prioritized. Any water fountain located on the top floor was sampled in a total of four separate bottled containers. Of those four, two were to be designated for the morning and the other two for the afternoon. Morning samples is tested to investigate if water tanks, if any, can contribute to lead leaching in drinking water. Afternoon samples represent drinking water after long running time. Within each sampling event, one water sample was collected immediately after tuning water on at the water fountain and another one was collected after running water for 30 seconds. This is considered because according to the USEPA [3], water that runs for more than 30 seconds tends to lower chances of containing lead contamination. After the collection, all samples were added three drops of 70% nitric acid to keep all metal ions in suspension. Each analysis included a blank of distilled water.

Each sample before acidification was tested for pH, alkalinity, and hardness as a baseline data using test strips (Part No. 480008 and 480005, Industrial Test Systems, Inc., Rock Hill, SC).

Aqueous lead in each sample was measured using HACH LeadTrak™ [2] low level lead testing kit (Cat No: 89231-376, Loveland, CO) (Fig. 1). It can measure up to 150 µg/L as lead in water. Acid soluble lead, as Pb^{2+}, in a water sample is first concentrated on a Fast Column Extractor. The lead is then eluted from the Extractor and determined colorimetrically with an indicator. Test results are measured at 477 nm [2]. All the equipment in direct contact with water samples was bathed in acid and rinsed with distilled water three times after the test procedure.

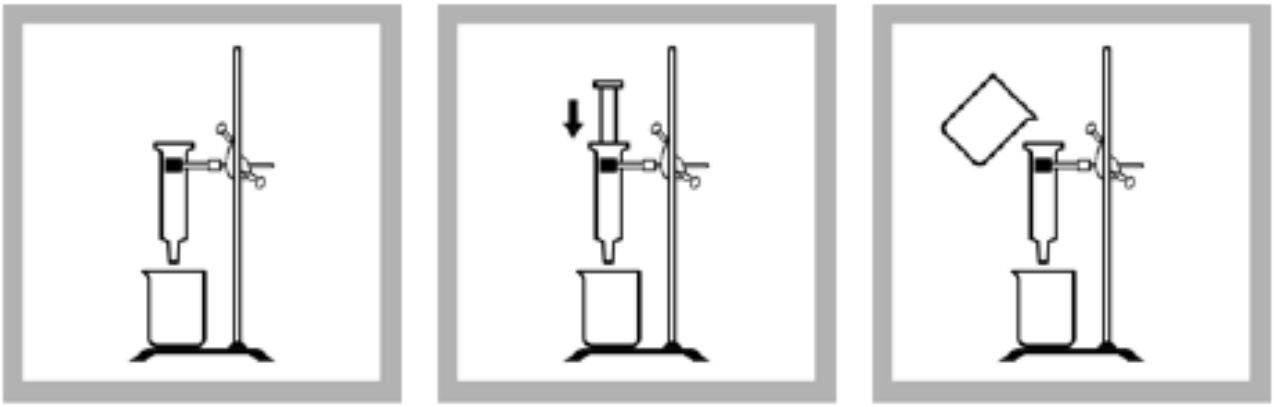


Figure 1: LeadTrak™ steps 6 through 8

III. RESULTS

Baseline data showed that drinking water from all water fountains on the campus was safe. All samples were neutral pH between 7.0 and 7.5 and had alkalinity of 120 to 180 ppm. High total hardness was measured from all samples with greater than 300 mg/l as $CaCO_3$. High total harness is widely observed in a local Texas water resource.

Aqueous lead test results from all the drinking water samples were all below 15 µg/L, an MCL for lead action level. In other words, drinking water samples from buildings built before 1986 were found to be containing aqueous lead level below USEPA's lead MCL (data not provided).

However, it was noted that lead level in the water samples from the same water fountain decreased after 30 second run (Fig. 2). Statistical analysis showed that mean aqueous lead levels in the drinking water sample after 30 second run (1.94 ± 0.60 µg/L as lead, n=16) were significantly lower than ones before the run (1.56 ± 0.80 µg/L as lead, n=16) (two sample t-test, p=0.47, α=0.05).

Also, lead contents in morning samples were significantly higher than those collected in the afternoon (Fig. 3). In accordance with two sample t-test, p value was 0.32 at α=0.05 thus the hypothesis, lead level in the water decreases after hours of water consumption, was valid.

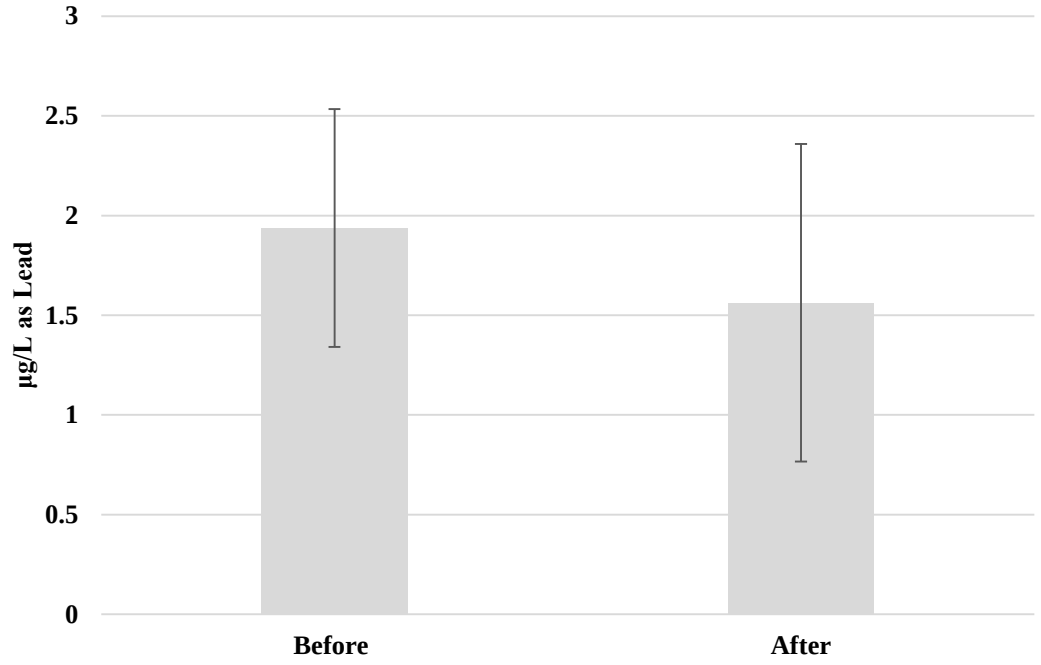


Figure 2: Comparison of lead measurements before and after 30 seconds of water running

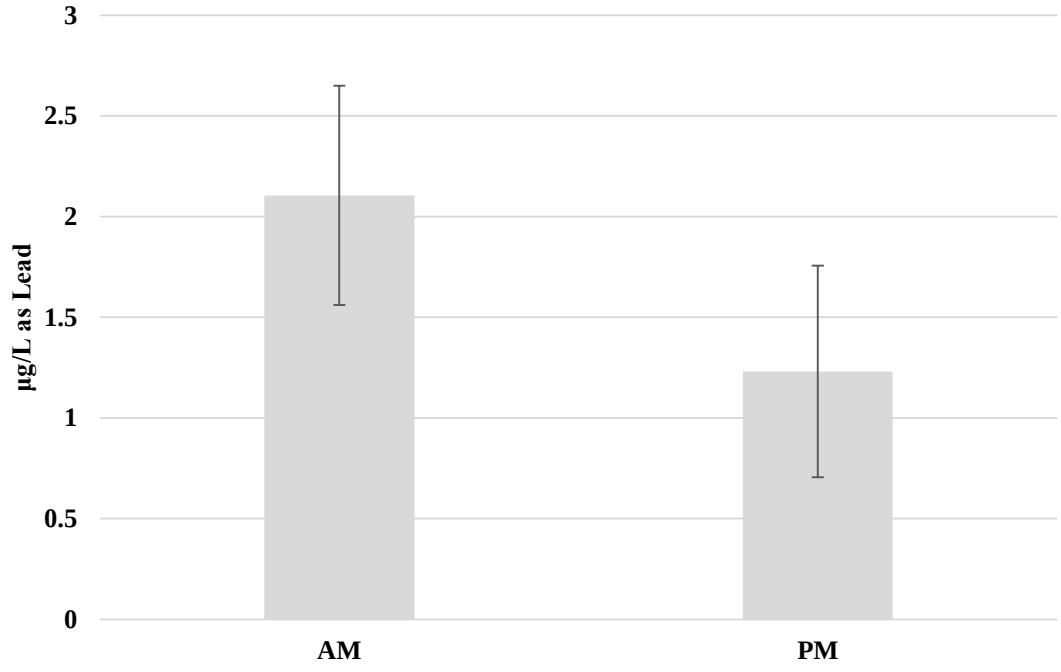
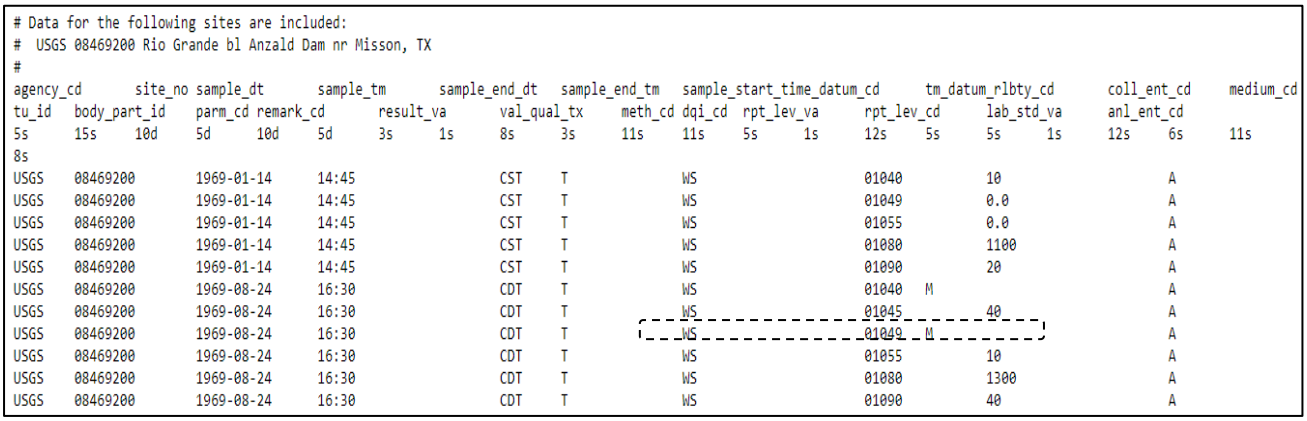


Figure 3: Comparison of lead measurements in the morning and afternoon.

IV. DISCUSSIONS

The process of the water treatment in the Southern Texas begins with the primary water supply from the Rio Grande river that runs along with the border between South Texas and Mexico. Based on historical water quality information found in the lower Rio Grande through the United States Geological Survey (USGS) database, there was a presence of lead in the river water in 1968, but it was not quantified (black dotted box in Fig.4). Within the box, "01049", "WS", and "M" mean "Lead, water, filtered, micrograms per liter", "Surface water", and "presence verified but not quantified", respectively. This implies that water resources in lower Rio Grande area may not be safe from lead contamination and local treatment plants may need to be prepared for the possible crisis associated with lead contamination in drinking water as referenced to the tragic incidents at Flint, Michigan [1].



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# Data for the following sites are included:
#  USGS 08469200 Rio Grande bl Anzald Dam nr Misson, TX
#
agency_cd       site_no sample_dt       sample_tm       sample_end_dt   sample_end_tm   sample_start_time_datum_cd      tm_datum_rlbty_cd       coll_ent_cd     medium_cd
tu_id   body_part_id    parm_cd remark_cd       result_va       val_qual_tx     meth_cd dqi_cd  rpt_lev_va      rpt_lev_cd      lab_std_va      anl_ent_cd
5s      15s     10d     5d      10d     5d      3s      1s      8s      3s      11s     11s     5s      1s      12s     5s      5s      1s      12s     6s      11s
8s
USGS    08469200        1969-01-14      14:45                   CST     T               WS                      01040           10                      A
USGS    08469200        1969-01-14      14:45                   CST     T               WS                      01049           0.0                     A
USGS    08469200        1969-01-14      14:45                   CST     T               WS                      01055           0.0                     A
USGS    08469200        1969-01-14      14:45                   CST     T               WS                      01080           1100                    A
USGS    08469200        1969-01-14      14:45                   CST     T               WS                      01090           20                      A
USGS    08469200        1969-08-24      16:30                   CDT     T               WS                      01040   M                               A
USGS    08469200        1969-08-24      16:30                   CDT     T               WS                      01045           40                      A
USGS    08469200        1969-08-24      16:30                   CDT     T               WS                      01049   M                               A
USGS    08469200        1969-08-24      16:30                   CDT     T               WS                      01055           10                      A
USGS    08469200        1969-08-24      16:30                   CDT     T               WS                      01080           1300                    A
USGS    08469200        1969-08-24      16:30                   CDT     T               WS                      01090           40                      A
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Figure 4: United States Geological Survey (USGS) lower Rio Grande river data [5]

Many local South Texas cities use either a conventional sedimentation process with rapid sand filters or a solid contact process unit that is used based on flow demand of localities before water delivery. The primary disinfectant used in the water treatment plan that is supplying drinking water to the campus in this study includes chlorine dioxide and chloramine. To our knowledge, no local water treatment plants currently operate activated carbon filter or other advanced water treatment to remove heavy metals like lead from the source water. Also, local government has not practiced public awareness regarding preventive measures to detect and stop any possible lead contamination in the drinking water. There was no lead measured from the water treated by local water treatment plants in accordance with the 2016 water quality consumer report for the local water distribution line (Table I). However, it should be noted that water lead contamination often happens via lead leaching from lead pipes, fixtures and solder around houses [3].

TABLE I: 2016 CONSUMER QUALITY REPORT FROM CITY OF EDINBURG, TEXAS [4]

Year	Contaminant	Date Samples	MCLG	Action Level (AL)	90th Percentile	# Site Over AL	Unit of Meas-ure	Violation	Source of Contaminant
2016	Copper	2016	1.3	1.3	0.1	0	ppm	N	Corrosion of household pluming system, Erosion of natural deposits; Leaching from wood preservatives.
2016	Lead	2016	0	15	2.7	**00**	**ppb**	N	Corrosion of household pluming system, Erosion of natural deposits; Leaching from wood preservatives.

Although the consumer report shows zero lead level in the plant effluent, the lead can be eroded off from the pipes that distribute the water to the community. From this assumption, lead levels in the drinking water were monitored from a local Texas university. Although the change in the lead levels wasn't significant in the samples (Fig.1.), a few samples showed drop in lead level by 1 µg/L by running water for more than 30 seconds before drinking from water fountain as directed by USEPA [3]. The similar analogy can apply to the difference between morning and afternoon samples. There was a difference observed in lead readings from the morning to those from the afternoon (Fig.2). Afternoon lead readings were lower than morning readings. The reason for this change in lead is the time that drinking water was left in the storage tank. The longer water held in a storage tank the more likely lead can dissolve into the water thus morning drinking water sample that was stored in the storage overnight can show higher lead level compared to afternoon drinking water samples. It may be advisable to educate students to drink water from water fountains on campus after running 30 seconds, especially in the morning. It should be noted that there is no safe lead level in drinking water in accordance with USEPA [3].

Overall drinking water on campus is found to be safe from the lead contamination. However, this does not necessarily mean that water distribution lines in other Texas public schools are maintained as the local university in this study has done. More monitoring and data collection should be warranted to make sure that young generations in Texas are well protected from lead poisoning while they are nurtured in the public schools. More education about preventive measures to keep drinking water safe from lead contamination is necessary for local communities as well.

V. CONCLUSION

Drinking water samples collected from water fountains in a local Texas university showed no lead contamination. All the samples contained less than 15 µg/L as lead, USEPA's MCL of lead action level [3]. Decrease in lead level was observed from drinking water samples collected after 30 second run. Running water for more than 30 seconds was recommended by USEPA as to reduce lead contamination from household water faucets [3]. It was also observed that morning water samples contained higher lead level than afternoon drinking water samples from the same water fountain on campus. Lead monitoring and testing in Texas public schools is highly recommended to prevent any possible lead poisoning at public schools. Also, more education about preventive measures to reduce possible lead levels in water is essential for localities. Daily practice to reduce possible lead in drinking water is important since there is no safe lead level in drinking water as per USEPA [3].

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