TECHNICAL MEMORANDUM

A Discussion of Naturally Occurring Pb-210 Levels in Soils, PRG Applicability and Clarification of USACE Activities at the Dayton, Ohio FUSRAP Sites

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Background

The primary purposes of this technical memorandum are to briefly explain that the slightly elevated concentrations of lead-210 (Pb-210) discovered by a community group and by a follow up United States Environmental Protection Agency (USEPA) investigation at the Bridgeton Municipal Athletic Complex (BMAC) are very likely the result of natural processes and do not represent residual contamination. This memorandum also serves to clarify US Army Corps of Engineers (USACE) activities at the Dayton, Ohio Formerly Utilized Sites Remedial Action Program (FUSRAP) Sites to ensure there is no misunderstanding of USACE activities at Department of Energy (DOE) referred FUSRAP Sites where Pb-210 was identified as a potential Contaminant of Concern (COC).

Explanation of Occurrences of Elevated Pb-210.

Elevated Pb-210 in soils is often encountered, due to natural processes involving radon-222 daughter washout from rain events and accumulation, and is not uncommon. Slightly elevated levels of Pb-210 are commonly found in low lying areas where rain collects and concentrates. Pb-210 levels ranging up to 20 pCi/g or even higher can be found when analyzing soil and sediment samples collected from these areas. The following quotation is taken directly from the Multi-Agency Radiation Survey and Assessment of Material and Equipment (MARSAME) manual (USEPA, 2009)

> *"Radon emissions vary significantly over time based on a wide variety of factors. For example, relatively small changes in the relative pressure between the source material and the atmosphere (indoor or outdoor) can result in large changes in radon concentrations in the air. Soil moisture content also has an effect on the radon emanation rate.*
>
> *Radon progeny tend to become fixed to solid particles in the air. These particles can become attached to surfaces as a result of electrostatic charge or gravitational settling. Air flow through ventilation ducts can produce an electrostatic charge that will attract these particles. A decrease in atmospheric pressure often precedes a rainstorm, which increases the radon emanation rate. Immediately prior to an electrical storm, an electrostatic charge can build up on equipment resulting in elevated radiation levels from radon progeny. Rainfall acts to scavenge these particles from the air, potentially*

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resulting in elevated dose rates and surface activities during and immediately following rainfall.

Pb-210 is a decay product of 222Rn and 238U. The 22-year half-life provides opportunities for buildup 210Pb and progeny in sediments and low-lying areas. As mentioned previously, rain acts to scavenge radon progeny from the air. ***Areas where rain collects and concentrates can result in elevated levels of 210Pb and progeny over time.*** *In addition, lead is easily oxidized and can become fixed to surfaces through corrosion processes. Rust or oxide films on equipment can be indicators of locations with a potential for elevated background radioactivity."*

The MARSAME document is available at the following location

http://www.epa.gov/rpdweb00/marssim/marsame.html

This radon daughter washout process is a known and established natural process. Indeed, Pb-210 accumulation and radiometric dating is an established technique used in geology to compare sedimentation rates and determine the age of deposited material. An illustration of this process is given below.

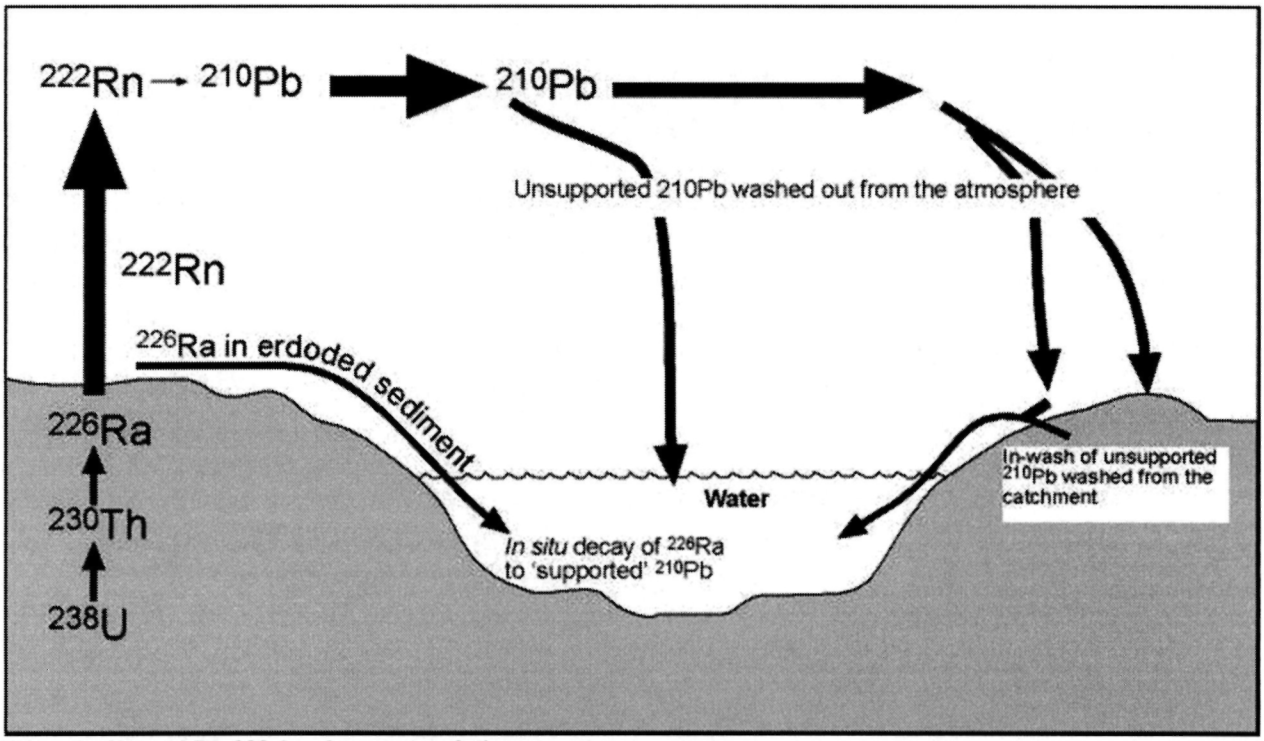

Figure 1 - Natural Rn-222 daughter accumulation

An example study of this process can be found at the following location

"Sediment accumulation and radionuclide inventories (239,240Pu, 210Pb and 234Th) in the northern Gulf of Mexico, as influenced by organic matter and macrofaunal density"

Kevin M. Yeager, Peter H. Santschia, Gilbert T. Roweb

http://www.sciencedirect.com/science/article/pii/S0304420304001240

Many more examples are available on the internet.

It may also be worth noting that analyzing Pb-210 by gamma spectroscopy can be challenging as it emits a low energy gamma ray (46.54 keV) with a low intensity (4.25%) that is somewhat difficult to reliably quantify directly. Indeed, of the twelve background reference area samples USEPA collected from Koch Park, ten of the twelve Pb-210 results were "U" flagged (i.e. were detected at levels below the instrument MDC).

USACE activities at the Dayton, Ohio FUSRAP Sites

It was recently **incorrectly** reported that USACE has previously cleaned up low levels of Pb-210 under the FUSRAP Program at the Dayton, Ohio FUSRAP Sites.

http://stlouis.cbslocal.com/2014/08/01/some-disagree-with-epas-call-that-bridgeton-athletic-complex-safe-for-use/

> *"Ed Smith, of the Missouri Coalition for the Environment, says both the citizens's and EPA's tests came back with the same levels of Lead 210, it's just the EPA doesn't think they're dangerous levels.*
>
> *"We'd like to see an interpretation – a comparative analysis to other sites with Lead 210, and what that means for human health," Smith says. "This is a high-use field."*
>
> *Smith says the EPA is ignoring what happened in Dayton, Ohio. Radioactive levels lesser than Bridgeton's* ***were removed*** *in Dayton by the Army Corps of Engineers in 2004"*

The statement above in bold is inaccurate. USACE investigated four Ohio Sites as part of the CERCLA process in 2004. The conclusion for each Ohio Site was that the site does not pose a threat to human health or the environment and (based on its support to the Nation's early atomic energy program) no further action under FUSRAP is warranted. At this time, no remediation of any kind was performed at the Dayton, Ohio FUSRAP Sites by USACE.

It is also worth noting that elevated Pb-210 levels were encountered in several Dayton, Ohio samples collected by USCAE. These samples were considered to be within normal background for the areas they were collected. The following backup information was provided by USACE:

> *"Radioactive material reported to exist in sediment in manhole 3 outside the Dayton Unit III (Bonebrake) site is not outside the range of naturally occurring background levels for Pb-210. One might also find Pb-210 in underground confined spaces, such as a manhole, that tend to concentrate naturally occurring radioactive materials from the decay of*

radon gas. Additionally, if dose to humans is considered the current Preliminary Remediation Goals (PRGs) would not apply and much higher values would replace them.

Pb-210 that was detected in sediment from manhole 3 at a concentration of 11 pCi/g is within the range of values reported for some background sediments in the state of Ohio. Ohio sediments in nature may contain Pb-210 at 5.1 to 19 pCi/g as measured in an Ohio no-till basin. At Dayton Unit III, a "relatively elevated" concentration of Pb-210 measured in sediment from manhole 3 could be attributable to the run-off and concentration of surface soil fines containing recently deposited Pb-210 fallout. Airborne Pb-210 is generated continuously by the emanation of radon from soils containing the naturally occurring uranium decay chain. The study of Ohio sediment is referenced below. The stated sediment concentration range is fairly wide and encompasses the manhole 3 concentration.

Relative to current PRGs, sediment activity appears to be elevated. These PRGs are derived from dose based modeling and use assumptions about human exposure pathways that are invalid for the relatively inaccessible manhole sediments. The exposure pathways for manhole sediment would be different and the source volume/geometry would be very limited for manhole sediment versus current soil/sediment assumptions. If one could actually calculate a PRG for sediment in manholes, it would likely be much higher than the current PRG to which Dayton Unit III results are being compared.

Reference:
Journal of Environmental Quality 31:54-61 (2002), 'Soil Erosion and Sediment Sources in an Ohio Watershed using Beryllium-7, Cesium-137, and Lead-210."

Site Investigation reports for each Dayton site are available at the following location

http://www.lrb.usace.army.mil/Missions/HTRW/FUSRAP/DaytonSites.aspx

The DOE LM Considered Site Database summaries of the Dayton Units 3 and 4 Sites are available at the following location

http://www.lm.doe.gov/Considered_Sites/Dayton_Project_Units_3_and_4_-_OH_07.aspx

As stated above, USACE does not believe residential PRGs are applicable to discrete locations where Pb-210 may concentrate naturally. Additional discussion of applicable PRGs and potential relative risk, including a "back-of-the-envelope" risk analysis of the drainage ditch at the BMAC using EPA's online PRG calculator tool is presented below.

Evaluation of BMAC Pb-210 Concentrations to Assess Potential Impact to Human Health Using an EPA PRG Approach

Elevated Pb-210 concentrations reported by the community group (10.89 pCi/g) and by the recent USEPA investigation (max of 9.45 pCi/g) are below USEPA's established Preliminary

Remediation Goal (PRG) of 33.5 pCi/g for Pb-210 based on a **residential occupancy** scenario at the 1E-4 upper acceptable risk level.

However, residential PRGs are derived based on the assumption of continual residential occupancy above large areas of uniformly contaminated material, to include consumption of on-site vegetation over a 30 year period. Because the drainage ditch at BMAC is not a large area used as a primary residence and no crops are being cultivated within the ditch, **it is inappropriate to directly compare residential PRGs to samples collected from this area.**

If an actual PRG were developed for Pb-210 concentrations under a recreational use scenario in and around the drainage ditch it would be higher. Indeed, simple removal of the indoor exposure and vegetation consumption pathway results in a calculated PRG of 66.2 pCi/g. This scenario envisions a person occupy the drainage ditch 7.3% of every day for 350 days a year, an accumulated time of ~613 hours each year. The most limiting pathway for Pb-210 under this modified recreational exposure scenario is the default value for soil ingestion (100 mg/day for adults, 200 mg/day for children). Scaling soil intake to an occupancy rate of 7.3% results in intake rates of 14.6 mg/day and 7.3 mg/day respectively. The calculated PRG associated with this level of daily soil intake is 887 pCi/g at an excess risk target level of 1E-4.

Based on this PRG, an approximate estimate of increased cancer risk from the drainage ditch can be calculated as follows

$$(10.89 \text{ pCi/g}) / (887 \text{ pCi/g}) * 1\text{E-}4 = 0.00000123$$

The excess risk of 1.2E-6 is a level which is well within the USEPA acceptable risk range and not requiring any remedial action or site controls. Even this nearly one-in-a-million excess cancer risk estimate is still a conservative over estimate as it envisions a child playing in a drainage ditch for roughly 90 minutes nearly every day for 30 years. This analysis also uses only default parameters used in the PRG Calculator, which are designed to be conservative.

For reference, the USEPA PRG Calculator is available online at the location below

http://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search

If someday the BMAC area was to be converted to residential use, this area would be re-graded and water drainage would be directed away. As such, though it's perhaps plausible to envision a future scenario where the area is converted to residential use, any surface soils or sediments containing Pb-210 from the drainage area would be removed as part of grading and construction activities prior to residential construction.

Conclusions

To summarize, elevated Pb-210 in excess of typical background for soil is not uncommon when sampling soils or sediments in low lying areas where rain collects and concentrates. Pb-210 present at these concentrations is a component of natural background and as such does not present a public health hazard in excess of natural background radiation. USACE has

encountered similar levels of Pb-210 at the Dayton Ohio FUSRAP sites and concluded that not only are these levels typical of natural background concentrations of PB-210 in these areas, but that the associated published USEPA PRGs that may apply to soils are not appropriate to apply to these specific locations.

In addition, USACE has not performed remedial activities to date at the Dayton, Ohio FUSRAP Sites, and no remedial activities are anticipated under FUSRAP in the future.

Any questions or requests for clarification can be addressed to the undersigned.

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