# The Unseen Legacy: A Critical Examination of Water Quality and Public Health at the Luckey Site, Wood County, Ohio

## I. Executive Summary: Beneath the Surface of "Safe"

The 44-acre industrial tract in Luckey, Ohio, once a cornerstone of national defense for the Manhattan Project and nuclear weapons production, now stands as one of the nation's most toxic sites. Its operational history, spanning magnesium and beryllium production alongside the handling of radioactive materials, has bequeathed a complex and enduring legacy of environmental contamination.[1] This report undertakes a critical examination of the May 2025 water test results from GEL Laboratories, commissioned by the Ohio Environmental Protection Agency (Ohio EPA). While the Ohio EPA has publicly asserted that the water is "all safe," a thorough analysis of the provided data reveals significant methodological flaws, concerning data integrity issues, and a profound underestimation of the long-term health risks faced by the community.

The assessment will demonstrate that the current testing framework is insufficient to guarantee long-term safety, particularly concerning chronic, low-level exposure to multiple contaminants. Crucial discrepancies between official claims and independent journalistic findings, coupled with documented laboratory quality control failures, severely undermine public confidence in the "safe" pronouncement. A truly secure and healthy environment for Luckey's residents necessitates expanded and more rigorous testing, robust independent oversight, and remediation plans that comprehensively address the full spectrum of contaminants and their cumulative, lifelong health impacts on the community.

## II. Introduction: The Shadow of the Cold War in Luckey

This investigative report aims to provide a transparent, evidence-based assessment of

water quality in the immediate vicinity of the Luckey Formerly Utilized Sites Remedial Action Program (FUSRAP) site. It serves as a direct response to the Ohio EPA's recent declarations of "safety," meticulously scrutinizing the underlying data and its profound implications for public health.

The Luckey site's historical role as a pivotal contributor to the Cold War effort, initially producing magnesium for the clandestine Manhattan Project and subsequently beryllium for nuclear weapons and components vital to the Space Race, has left an indelible and hazardous environmental footprint. This complex past mandates an unwavering and ongoing commitment to environmental stewardship and the protection of public health. The Ohio EPA's May 2025 sampling initiative was explicitly undertaken in direct response to independent water testing conducted by The Toledo Blade, which had previously uncovered "high levels of radioactivity in the groundwater" in and around Luckey.[3] This reactive approach, rather than a proactive and continuous monitoring strategy, establishes a critical context for evaluating the comprehensiveness, objectivity, and ultimate validity of the state's recent environmental assessment.

## III. A Century of Contamination: The Luckey Site's Operational History

The environmental challenges at the Luckey site are deeply rooted in its extensive and varied industrial past, a timeline marked by shifts in production and evolving contaminant profiles.

### Early Years (1942-1945): Magnesium Production for the Manhattan Project

The federal government initiated the industrial development of the Luckey site in 1942, acquiring 44 acres of farmland to construct a complex comprising 22 buildings. The primary objective was the large-scale production of magnesium metal, a material deemed crucial for the Manhattan Project and the broader World War II effort.[1] Operated by National Lead, this facility played a significant role in wartime

manufacturing until its closure in 1945, after which it was placed on standby status.[2]

**Beryllium Era (1946-1960): Nuclear Weapons and Space Race**

Following the war, in 1946, the Brush Beryllium Co. (now Brush Wellman) established operations at the site, commencing secret military research under contract with the U.S. Army Corps of Engineers.[1] By 1949, the Atomic Energy Commission (AEC) significantly expanded the facility, engaging Brush Beryllium in a contract for the large-scale production of beryllium metal. This beryllium was essential for the nation's nuclear weapons arsenal, missile technology, and components for the burgeoning Space Race.[1] During this period, the site reportedly produced between 40,000 and 144,000 pounds of beryllium.[6] The industrial processes employed during this era inevitably generated a variety of hazardous contaminants, including beryllium itself, lead, and various radionuclides.[1]

A particularly concerning event occurred in late 1951 and early 1952, when approximately 1,000 tons of radioactively contaminated scrap metal were transported to the Luckey site. This material was ostensibly intended for a resumption of magnesium processing, but records indicate that this operation never materialized, and the scrap metal remained stored on-site.[6] Beryllium production at the facility ceased in 1958, although sintering and powder blending operations continued for another two years, concluding in 1960.[7]

The progression of site operations, from initial magnesium production to large-scale beryllium and nuclear materials handling, directly explains the diverse array of contaminants now found. The initial designation of the site under the FUSRAP program was primarily due to beryllium contamination, with a later expansion to include a limited set of radionuclides. This historical sequence suggests that the full scope of the site's toxic legacy was not immediately or comprehensively understood, leading to a reactive rather than fully proactive approach to identifying all hazardous materials.

**Post-Beryllium Operations (1961-Present): Plastics, Foam, and Scrap**

Since 1961, the Luckey site has undergone several ownership and operational changes, housing a plastics company, a mattress foam factory, and a firm manufacturing car wheels. Currently, the property is owned by the scrap dealer Abdoo Wrecking, and notably, almost all of the original 22 buildings constructed for the wartime effort have been demolished.[1]

### The FUSRAP Designation (1992): Acknowledging the Contamination

In 1992, the Luckey Site was formally designated as a Formerly Utilized Sites Remedial Action Program (FUSRAP) site, specifically due to extensive surface contamination from beryllium.[2] This designation is significant, placing Luckey among 21 properties nationwide identified for cleanup efforts stemming from contamination linked to early nuclear weapons production activities.[1]

However, a critical aspect of this designation is the acknowledged limitation in the scope of cleanup. While the FUSRAP program addresses beryllium, lead, radium-226, thorium-230, uranium-234, and uranium-238, records explicitly indicate that dozens of other chemicals and pollutants, such as PCBs, PAHs, and asbestos, were also generated at the site but are currently *not* being addressed in the ongoing remediation efforts.[1] The presence of these unaddressed contaminants, despite the FUSRAP designation, signifies a substantial gap in the comprehensive remediation strategy. This raises serious questions about the long-term integrity of the cleanup and the potential for these unaddressed pollutants to continue posing risks to human health and the environment, irrespective of the "safe" status of the targeted contaminants.

## IV. Remediation Efforts: A Narrow Scope, A Lingering Threat

The cleanup of the Luckey FUSRAP site is a protracted and complex undertaking, marked by official assurances that contrast sharply with independent findings and a remediation strategy that has drawn scrutiny for its limited scope.

## USACE Cleanup Mandate and Progress (Since 2018)

In 1997, the responsibility for FUSRAP sites, including Luckey, was transferred from the U.S. Department of Energy (DOE) to the U.S. Army Corps of Engineers (USACE).[8] Since 2018, the Army Corps has been actively engaged in remediation, having removed hundreds of thousands of tons of contaminated soil from the site. This material is transported to a specialized landfill in Belleville, Michigan.[1] The cleanup specifically targets soils contaminated with beryllium, lead, radium-226, thorium-230, uranium-234, and uranium-238.[7]

North Wind Portage, the prime contractor for the remediation, has overseen the removal of over 150,000 cubic yards of surface and sub-surface soil, sediment, and debris. This includes the demolition of seven contaminated structures and the transportation of more than 16,000 waste containers, totaling over 250,000 tons of material.[9] An on-site ELAP-Certified laboratory supports these efforts by processing over 1,600 samples per week for site characterization, environmental monitoring, and waste characterization.[9] Furthermore, a water treatment system has been designed, constructed, and operated, treating over 3 million gallons of contaminated water annually.[9]

Despite these efforts, the project has faced significant delays and cost escalations. Originally slated for completion 22 years ago, the projected completion date is now 2030, with a taxpayer expense of $277 million – a figure four times the initial estimate.[1] As of November 5, 2024, the current end-state contract is approximately 60% complete for the known volumes to be dispositioned, with overall site remediation across all contracts at about 75% completion.[9] The substantial financial and temporal discrepancies associated with this project suggest that the full complexity of the contamination was either underestimated or deliberately downplayed in the initial planning stages. This situation implies that the public is bearing a higher cost for a solution that may still be incomplete.

## The "Narrow Definition" of Cleanup

A significant limitation of the ongoing remediation is the Army Corps' "narrow definition" of what constitutes eligible contamination. Records indicate that only a fraction of the total pollution is being addressed.[1] Specifically, cleanup efforts are

confined to six elements used between 1949 and 1958: beryllium, lead, uranium-238, uranium-234, radium-226, and thorium-230.[1] This restricted focus means that dozens of other chemicals and pollutants, such as PCBs, PAHs, and asbestos, known to be present at the site, are explicitly

*not* being cleaned up.[1]

**Groundwater Remediation: Monitored Natural Attenuation**

For groundwater contamination, specifically involving uranium, lead, and beryllium, the chosen remediation strategy is "monitored natural attenuation".[7] This approach operates on the premise that once the contaminated soil is removed from the site, the concentrations of these contaminants in the groundwater will naturally decrease over time. Groundwater wells are slated for continued sampling until they consistently meet safe drinking water standards.[7] However, if the source material (contaminated soil) is not fully removed due to the "narrow definition" of cleanup, or if other unaddressed contaminants (like PCBs, PAHs, and asbestos) are also mobile in groundwater, then natural attenuation alone may prove insufficient or take an unacceptably long time, thereby prolonging potential exposure risks to the community.

**Off-Site Contamination: Official Denials vs. Independent Findings**

Throughout the cleanup process, the Army Corps has consistently asserted that "no contamination is moving off the site" and that "all surface and air monitoring data show that there has been no spread of FUSRAP materials off-site above regulatory limits".[1] However, this official stance is directly challenged by a notable lack of comprehensive sampling within the village itself.[1] A 2001 Army Corps sampling of 39 private wells for beryllium, total uranium, and manganese reportedly found "no levels of concern," but critically,

*did not include testing for radioactivity*.[1]

In stark contrast, recent independent testing conducted by The Toledo Blade, spanning from April 2024 to January 2025, revealed "high levels of radioactivity in the drinking water in and around the village".[1] The Blade's findings indicated radioactivity

in approximately half of the tested wells, at levels exceeding what the Army Corps had previously deemed normal for the area.[1] Specifically, the independent analysis detected Radium-226 and Radon-222, and, most significantly,

*low levels of Cobalt-60* in two samples collected outside the village.[1] Cobalt-60 is a man-made radioactive isotope, the presence of which is exceedingly rare in groundwater, making its detection a direct indicator of contamination linked to the site's nuclear operations.[1] One sample collected by The Blade near athletic fields exhibited radioactivity an alarming 1,731 times greater than background levels.[5] The Ohio EPA's May 7, 2025, sampling effort, which forms the basis of the "all safe" claim, was a direct and reactive response to these preliminary findings from The Blade, prompting the issuance of a "citizen advisory".[3]

The fundamental contradiction between the Army Corps' repeated assurances of "no off-site contamination" and The Blade's independent findings of significant radioactivity, particularly the man-made Cobalt-60, is a critical point of contention. This disparity suggests either a severe limitation in the Army Corps' monitoring program, a deliberate downplaying of risks, or that contamination pathways are far more complex and widespread than officially acknowledged. This directly undermines the credibility of official "safe" claims and raises serious questions about the transparency and effectiveness of the cleanup efforts.

## V. Dissecting the Data: Flaws in the Ohio EPA's Water Test Results (GEL Laboratories, May 2025)

A detailed examination of the May 2025 water test results from GEL Laboratories, commissioned by the Ohio EPA, reveals several critical flaws in data integrity and quality control that challenge the validity of any "all safe" declaration.

### Overview of Samples and Analytical Methods

The report encompasses analyses from 10 primary drinking water samples (S01-PV1 through S10-BP) and their associated blanks. These samples were collected on May 7,

2025, and subsequently received by GEL Laboratories on May 9, 2025.[11] The suite of analyses performed included:

- Metals Analysis-ICP-MS (EPA 200.8/200.2) [11]
- Rad Gamma Spec Analysis (EPA 901.1) [11]
- Rad Gas Flow Proportional Counting (EPA 00-02, EPA 903.0) [11]
- Gross Alpha/Beta (EPA 900.0) [11]
- Rad Liquid Scintillation Analysis (SM 7500 Rn B for Radon-222) [11]
- Rad Radium-226 (EPA 903.1) [11]

**Detected Contaminants and Their Concentrations**

The GEL Laboratories report indicates the presence of several contaminants, some exceeding advisory levels or present at concentrations warranting closer attention.

**Metals:**

- **Iron:** Detected in all samples, with concentrations exceeding the Secondary Maximum Contaminant Level (SMCL) of 300 ug/L in multiple samples: S01-PV1 (307 ug/L), S02-PV2 (476 ug/L), S09-PV3 (361 ug/L), S03-PL (377 ug/L), S04-EES (310 ug/L), S06-EHS (551 ug/L), and S10-BP (544 ug/L).[11]
- **Sodium:** Very high concentrations were observed in several samples, notably S07-LL (280000 ug/L), S01-PV1 (189000 ug/L), S03-PL (175000 ug/L), S05-EMS (172000 ug/L), and S08-SRL (199000 ug/L).[11] While there is no federal or Ohio MCL for sodium, high levels can be a concern for individuals with heart or kidney disease.[14]
- **Uranium:** Detected in S01-PV1 (2.15 ug/L), S02-PV2 (0.358 ug/L), S09-PV3 (0.256 ug/L), S03-PL (2.45 ug/L), S05-EMS (4.68 ug/L), S07-LL (0.279 ug/L), and S10-BP (0.143 ug/L J). All reported results are well below the MCL of 30 ug/L.[11]
- **Lead:** Detected as estimated (J) in S10-BP (0.778 ug/L), and not detected (ND) in all other samples. This concentration is below the Action Level (AL) of 15 ug/L.[11]
- **Manganese:** Detected as estimated (J) in S01-PV1 (3.77 ug/L), S03-PL (4.68 ug/L), S04-EES (1.01 ug/L), and S08-SRL (2.13 ug/L). It was also detected in S02-PV2 (6.16 ug/L) and S09-PV3 (5.61 ug/L). All results remain well below the SMCL of 50 ug/L.[11]
- **Nickel:** Detected as estimated (J) in S09-PV3 (1.76 ug/L), S05-EMS (1.81 ug/L), S06-EHS (1.30 ug/L), and S10-BP (1.43 ug/L). It was also detected in S01-PV1 (3.05 ug/L), S02-PV2 (2.01 ug/L), S03-PL (2.63 ug/L), S07-LL (3.09 ug/L), and

S08-SRL (1.71 ug/L J). There is no MCL for Nickel, but a detection limit (DL) of 0.600 ug/L and reporting limit (RL) of 2.00 ug/L are noted.[11]

- **Copper:** Detected in all samples, with concentrations ranging from 3.55 ug/L (S05-EMS) to 76.3 ug/L (S04-EES). All concentrations are well below the SMCL of 1000 ug/L and the Action Level of 1300 ug/L.[11]
- **Aluminum:** Detected in S02-PV2 (85.5 ug/L) and S09-PV3 (35.6 ug/L J). Otherwise, it was not detected (ND). The detected levels fall within the SMCL range of 50-200 ug/L.[11]

**Radionuclides:**

- **Radon-222:** Detected in S04-EES at 190 pCi/L. All other samples were qualified as "U" (not detected above MDL), including a negative result of -37.4 pCi/L for S01-PV1-Blank.[11] The proposed MCL for Radon-222 is 200 pCi/L.[18]
- **Radium-226:** Detected in S02-PV2 (0.328 pCi/L), S09-PV3 (0.396 pCi/L), S03-PL (0.413 pCi/L), and S06-EHS (0.378 pCi/L). All results are well below the MCL of 5 pCi/L (when combined with Radium-228).[11]
- **Gross Alpha:** Detected in S01-PV1 (1.65 pCi/L), S03-PL (2.78 pCi/L), S05-EMS (6.10 pCi/L), and S04-EES (0.814 pCi/L). All results are well below the MCL of 15 pCi/L.[11]
- **Gross Beta:** Detected in S01-PV1 (1.92 pCi/L), S02-PV2 (3.02 pCi/L), S03-PL (4.42 pCi/L), S04-EES (3.99 pCi/L), S05-EMS (4.29 pCi/L), S06-EHS (3.40 pCi/L), and S10-BP (1.49 pCi/L). All results are well below the trigger level of 50 pCi/L and the MCL of 4 mrem/yr.[11]
- **Americium-241, Bismuth-214, Cesium-137, Cobalt-60:** These radionuclides were generally reported as "U" (not detected above MDL) or "UI" (uncertain identification) for Bismuth-214.[11]

**Table 1: Detected Contaminants in Luckey Site Water Samples (May 2025) vs. Regulatory Standards**

| Sample ID | Parameter | Result (Qualifier) | Units | Ohio EPA MCL/AL | US EPA MCL/AL | Ohio EPA SMCL | US EPA SMCL |
|---|---|---|---|---|---|---|---|
| S01-PV1 | Iron | 307 | ug/L | 300 (SMCL) | 300 (SMCL) | 300 | 300 |
| S02-PV2 | Iron | 476 | ug/L | 300 (SMCL) | 300 (SMCL) | 300 | 300 |

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|---|---|---|---|---|---|---|---|
| S09-PV3 | Iron | 361 | ug/L | 300 (SMCL) | 300 (SMCL) | 300 | 300 |
| S03-PL | Iron | 377 | ug/L | 300 (SMCL) | 300 (SMCL) | 300 | 300 |
| S04-EES | Iron | 310 | ug/L | 300 (SMCL) | 300 (SMCL) | 300 | 300 |
| S06-EHS | Iron | 551 | ug/L | 300 (SMCL) | 300 (SMCL) | 300 | 300 |
| S10-BP | Iron | 544 | ug/L | 300 (SMCL) | 300 (SMCL) | 300 | 300 |
| S07-LL | Sodium | 280000 | ug/L | No standard | No standard | No standard | No standard |
| S01-PV1 | Sodium | 189000 | ug/L | No standard | No standard | No standard | No standard |
| S03-PL | Sodium | 175000 | ug/L | No standard | No standard | No standard | No standard |
| S05-EMS | Sodium | 172000 | ug/L | No standard | No standard | No standard | No standard |
| S08-SRL | Sodium | 199000 | ug/L | No standard | No standard | No standard | No standard |
| S04-EES | Radon-222 | 190 | pCi/L | 200 (Proposed) | 200 (Proposed) | N/A | N/A |
| S02-PV2 | Radium-226 | 0.328 | pCi/L | 5 (Combined) | 5 (Combined) | N/A | N/A |
| S09-PV3 | Radium-226 | 0.396 | pCi/L | 5 (Combined) | 5 (Combined) | N/A | N/A |
| S03-PL | Radium-226 | 0.413 | pCi/L | 5 (Combined) | 5 (Combined) | N/A | N/A |
| S06-EH | Radium- | 0.378 | pCi/L | 5 | 5 | N/A | N/A |

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|---|---|---|---|---|---|---|---|
| S | 226 | | | (Combined) | (Combined) | | |
| S05-EMS | Gross Alpha | 6.10 | pCi/L | 15 | 15 | N/A | N/A |
| S04-EES | Copper | 76.3 | ug/L | 1300 (AL) | 1300 (AL) | 1000 | 1000 |
| S02-PV2 | Aluminum | 85.5 | ug/L | 50-200 (SMCL) | 50-200 (SMCL) | 50-200 | 50-200 |

*Note: MCL = Maximum Contaminant Level (enforceable health standard), AL = Action Level (trigger for action), SMCL = Secondary Maximum Contaminant Level (non-enforceable aesthetic/technical guideline). "No standard" indicates no federal or state regulatory limit.*

**Critical Analysis of Laboratory Quality Control and Data Integrity**

The reliability of the Ohio EPA's water test results is significantly compromised by several documented quality control issues and chain of custody discrepancies within the GEL Laboratories report.

**Sample Preservation Issues:** The metals container for sample S03-PL failed to maintain the proper pH. Proper pH preservation is absolutely critical for accurate metals analysis, as it prevents precipitation or adsorption of metals onto container walls, ensuring the sample accurately reflects the water's composition at the time of collection. A failure to maintain this crucial condition means that the reported metal concentrations for S03-PL may not be truly representative, potentially underestimating actual contaminant levels. Even with subsequent re-preservation, the initial compromise to sample integrity casts doubt on the reliability of this specific data point, which is then used to support broader claims of water safety.

**Chain of Custody (COC) Discrepancies:** While seemingly minor, a pattern of chain of custody discrepancies raises concerns about the overall rigor of field sampling procedures and data traceability. The ID on the Total Alpha Radium container for sample S07-LL-Blank was smeared off, necessitating identification by the receiving team through collection date, time, and a process of elimination. Furthermore, multiple samples (S09-PV3/Blank, S04-EES/Blank, S05-EMS) exhibited

inconsistencies between the collection times recorded on the Chain of Custody form and those written on the actual sample containers. Although the client confirmed the container times were correct, such errors, even if resolved post-receipt, introduce an element of doubt regarding the overall reliability and defensibility of the data, particularly when definitive "safe" declarations are made. An unbroken and accurate chain of custody is paramount in environmental investigations to ensure that samples are properly collected, handled, and analyzed, and that results can be unequivocally linked to their source.

**Quality Control (QC) Failures: RPD Exceedances:** The report documents several instances where the Relative Percent Difference (RPD) between duplicate samples exceeded acceptable limits, indicating a significant lack of analytical precision and reproducibility.[11]

- For **Sodium** in the S01-PV1 Serial Dilution, the RPD was an alarming 91%, vastly exceeding the acceptable range of 0%-10%.[11] This represents a catastrophic failure of precision, rendering the reported sodium values in that analytical batch highly suspect. Given the very high concentrations of sodium in several samples (e.g., S07-LL at 280,000 ug/L), this lack of precision is particularly concerning.
- The RPD for **Nickel** in the S01-PV1 Serial Dilution was 11%, slightly exceeding its 0%-10% acceptable range.[11]
- For **Gross Alpha** in the EPA 00-02 Laboratory Control Sample/Laboratory Control Sample Duplicate (LCS/LCSD), the RPD was 22.3%, surpassing the 0%-20% acceptable range.[11] This RPD failure for a key radiological parameter directly undermines confidence in the reported "safe" levels of radioactivity, suggesting that even if the reported numbers are below MCLs, their accuracy is questionable.

These RPD exceedances are not minor deviations; they are direct indicators that if the samples were re-analyzed, the results could vary significantly, making the reported values for these parameters unreliable.

**Uncertain and False Positive Identifications (Bismuth-214 Qualifiers):** Bismuth-214 was frequently qualified as "UI" (Uncertain identification - no valid peak) in seven samples (S01-PV1, S02-PV2, SO9-PV3, S03-PL, S04-EES-Blank, S05-EMS, S08-SRL).[11] Additionally, it was qualified as "UL" (Not considered detected, false positive due to high peak-width) in S08-SRL-Blank.[11] Bismuth-214 is a decay product of Radon-222, which itself is part of the Uranium-238 decay chain that includes Radium-226.[5] The pervasive "uncertain identification" or "false positive" qualifiers for Bismuth-214, especially in samples where Radon-222 was either not detected

(U-qualified) or had very high uncertainty, raises serious questions about the accuracy and sensitivity of the radiological assessment. This situation implies that the analytical method might be struggling to accurately detect or differentiate radioactive decay products at low levels, potentially masking the true presence or activity of these critical contaminants. This directly undermines the "all safe" claim by suggesting a potential blind spot in detecting key indicators of radioactive contamination.

**Aliquot Reductions:** The report notes that aliquots for Total Alpha Radium and Gross Alpha/Beta analyses were reduced due to "limited sample volume" or "sample matrix".[11] Reducing sample aliquots can inadvertently increase detection limits (DLs) or reporting limits (RLs). This means that lower concentrations of contaminants might go undetected, even if they are present. This is particularly problematic for contaminants like radionuclides, where even low-level, chronic exposure can pose significant health risks. Reduced aliquots can lead to an underestimation of actual contaminant levels, potentially providing a false sense of security.

**Frequent Recounts:** Multiple samples and quality control components (LCSD for Gamma Spec, MS/MSD for Gross Alpha/Beta, and a sample for EPA 00-02 Gross Alpha) underwent recounts due to initial failures such as high/low recovery or suspected false positives.[11] While recounts are a standard part of a laboratory's quality control process, a high frequency of such instances suggests underlying instability or challenges in the analytical methods or instrument performance for these batches. This pattern can erode confidence in the final reported results, even if the recounts eventually meet criteria, as it implies a struggle to achieve consistent and accurate measurements.

**Table 2: Identified Flaws and Anomalies in GEL Laboratories' Report**

| Category | Specific Flaw/Anomaly | Affected Sample/Parameter | Reported Data (if applicable) | Impact on Data Reliability/Interpretation |
|---|---|---|---|---|
| **Sample Preservation** | Metals container did not hold proper pH | S03-PL (Metals) | N/A | Compromises integrity; reported metal concentrations may be underestimated. |

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| **Chain of Custody** | Smeared ID on container | S07-LL-Blank (Total Alpha Radium) | N/A | Raises concerns about traceability and overall field sampling rigor. |
| **Chain of Custody** | Mismatched collection times (COC vs. container) | S09-PV3/Blank, S04-EES/Blank, S05-EMS | COC: 08:47, 11:30, 11:59; Container: 09:10, 11:10, 11:44 | Indicates pattern of field documentation errors, undermining overall data defensibility. |
| **QC Failure (RPD)** | Sodium RPD exceeded acceptance criteria (91% vs. 0-10%) | S01-PV1 Serial Dilution (Sodium) | RPD: 91% | Catastrophic failure of analytical precision; reported Sodium values are highly unreliable. |
| **QC Failure (RPD)** | Nickel RPD exceeded acceptance criteria (11% vs. 0-10%) | S01-PV1 Serial Dilution (Nickel) | RPD: 11% | Indicates lack of analytical precision; reported Nickel values are unreliable. |
| **QC Failure (RPD)** | Gross Alpha RPD exceeded acceptance criteria (22.3% vs. 0-20%) | EPA 00-02 LCS/LCSD (Alpha) | RPD: 22.3% | Undermines confidence in reported Gross Alpha levels; accuracy is questionable. |
| **Analytical Issue** | Uncertain identification (no valid peak) | Bismuth-214 (S01-PV1, S02-PV2, SO9-PV3, S03-PL, S04-EES-Blank, S05-EMS, S08-SRL) | UI qualified | Suggests analytical method struggles to accurately detect or differentiate decay products, potential blind spot. |

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|---|---|---|---|---|
| **Analytical Issue** | False positive (high peak-width) | Bismuth-214 (S08-SRL-Blank) | UL qualified | Indicates unreliable detection, potential for masking true presence. |
| **Analytical Issue** | Aliquots reduced due to limited sample volume/matrix | Total Alpha Radium, Gross Alpha/Beta (multiple samples) | N/A | Can increase detection limits, potentially leading to underestimation of low-level contaminants. |
| **Analytical Issue** | Frequent recounts due to initial failures (high/low recovery, false positive) | Gamma Spec LCSD, Gross Alpha/Beta MS/MSD, EPA 00-02 Gross Alpha sample | N/A | Suggests underlying instability or challenges in analytical methods/instrument performance. |

## VI. The Silent Burden: Long-Term and Lifelong Exposure Risks

The Ohio EPA's assertion that the water is "all safe" fails to account for the complex reality of long-term, lifelong exposure to contaminants, particularly those with bioaccumulative properties or known carcinogenic effects. Current regulatory standards, while important, often do not fully address these cumulative risks.

### Toxicological Profiles of Key Contaminants

An understanding of the potential health impacts of detected contaminants, even at levels below Maximum Contaminant Levels (MCLs), is crucial for a comprehensive safety assessment.

- **Barium (Detected: up to 32.6 ug/L; MCL: 2000 ug/L):** While current levels are

below the MCL, research indicates that long-term exposure to low levels of barium is still under investigation for its health implications.[22] Barium compounds that dissolve in water or stomach acids, such as barium carbonate, can cause acute effects like changes in heart rhythm, paralysis, vomiting, abdominal cramps, diarrhea, and muscle weakness in large quantities. Although most ingested barium is eliminated within one to two weeks, a small fraction can accumulate in bones and teeth.[22]

- **Uranium (Detected: up to 4.68 ug/L; MCL: 30 ug/L):** Uranium poses a dual threat due to both its chemical toxicity and radioactivity. Epidemiological studies have suggested a possible link between lung cancer risk and uranium exposure, particularly in occupational settings. Animal studies have demonstrated toxicological effects including damage to the respiratory and central nervous systems, leading to fibrosis and tumors in lung tissue. Uranium particles are also known to induce cytotoxicity and target mitochondria.[23]
- **Manganese (Detected: up to 6.16 ug/L; SMCL: 50 ug/L):** Manganese is an essential nutrient, but excess exposure can lead to its accumulation in the brain, specifically the basal ganglia. Chronic exposure to elevated levels can result in manganism, a permanent neurological disorder characterized by tremors, difficulty walking, facial spasms, irritability, aggressiveness, and hallucinations. It can also cause adverse cognitive effects, such as difficulties with concentration and memory, and respiratory issues like inflammatory responses, impaired lung function, and pneumonia. Liver impairment can hinder the body's ability to excrete manganese, leading to its accumulation.[24]
- **Nickel (Detected: up to 3.09 ug/L; No MCL):** Chronic exposure to nickel can manifest in a range of adverse health effects, including contact dermatitis, headaches, gastrointestinal and respiratory issues, lung fibrosis, cardiovascular diseases, and lung and nasal cancers. Nickel is known to accumulate in the body over time, contributing to these long-term health concerns.[26]
- **Copper (Detected: up to 76.3 ug/L; SMCL: 1000 ug/L, AL: 1300 ug/L):** While copper is an essential trace element, it becomes toxic at higher concentrations. Exposure can lead to gastrointestinal distress, liver toxicity, neurochemical changes (e.g., Acetylcholinesterase inhibition), oxidative stress, tissue damage, inflammation, and apoptosis. Copper exhibits bioaccumulation, with increasing concentrations observed in various organs over longer exposure times, notably in the liver, kidneys, and gut.[28]
- **Iron (Detected: up to 551 ug/L; SMCL: 300 ug/L):** Although iron exceedances primarily relate to aesthetic concerns (e.g., rusty color, metallic taste, staining) at SMCLs, heavy metals, including iron, can contribute to oxidative stress and interfere with metabolic processes when present at toxic levels.[12]

- **Zinc (Detected: up to 45.8 ug/L; SMCL: 5000 ug/L):** Overexposure to zinc can lead to toxic effects, particularly affecting the respiratory system, manifesting as metal fume fever, which impairs pulmonary function. In severe cases, high doses can result in acute respiratory distress syndrome and even death.[32]
- **Lead (Detected: 0.778 ug/L J in S10-BP; AL: 15 ug/L):** Lead is a highly toxic element, posing a particular danger to children due to their increased absorption rates and greater sensitivity of their developing brains and nervous systems. Even low levels of lead in a child's blood can result in behavioral and learning problems, lower IQ, hyperactivity, slowed growth, hearing problems, and anemia. In adults, lead exposure can cause cardiovascular effects (including increased blood pressure and hypertension), decreased kidney function, and reproductive problems. Lead accumulates in bones over time and can be released during pregnancy, posing risks to the developing fetus.[33]
- **Aluminum (Detected: up to 85.5 ug/L; SMCL: 50-200 ug/L):** Aluminum has no known biological function in the human body. Its toxicity is known to impact multiple organ systems, including the nervous system (linked to Alzheimer's disease, Parkinson's disease, and dialysis encephalopathy), cardiac, pulmonary (pulmonary fibrosis, asthma), reproductive, gastrointestinal, and hematological systems (anemia). Aluminum can accumulate in bones and is known to inhibit DNA repair mechanisms.[35]
- **Radium-226 (Detected: up to 0.413 pCi/L; MCL: 5 pCi/L combined):** A naturally occurring alpha emitter with a long half-life of approximately 1,600 years. If ingested, about 20% enters the bloodstream and primarily targets bones. Long-term exposure to higher levels of radium can lead to severe health effects, including anemia, cataracts, fractured teeth, bone cancer, and even death. These effects may take many years to manifest. Any exposure to gross alpha radiation is considered to increase the risk of cancer.[20]
- **Radon-222 (Detected: 190 pCi/L in S04-EES; Proposed MCL: 200 pCi/L):** A radioactive gas and a leading cause of lung cancer in non-smokers. Radon-222 itself does not pose a direct health risk, but its decay into highly reactive progeny (Polonium-218 and Polonium-214) results in the emission of alpha particles that can damage respiratory epithelium and DNA. Long-term exposure to radon is strongly linked to an increased risk of lung cancer and has also been associated with Alzheimer's disease.[38]
- **Gross Alpha/Beta Radiation (Detected: Gross Alpha up to 6.10 pCi/L, Gross Beta up to 4.42 pCi/L; MCLs: 15 pCi/L for Gross Alpha, 4 mrem/yr for Beta):** Gross alpha radiation, if ingested, can be harmful. Over long periods and at elevated levels, it increases the risk of bone cancer (due to radium) and kidney damage (due to uranium). The prevailing scientific consensus, known as the

Linear No-Threshold (LNT) model, posits that any exposure to gross alpha radiation, no matter how small, carries some risk of inducing cancer. Beta particle and photon emitters, particularly man-made ones, have the potential to induce cancer in nearly any tissue or organ in the body.[20]

- **Americium-241 (Generally ND/U-qualified; no specific MCL):** A synthetic, alpha-emitting radionuclide commonly found in nuclear waste. It poses a health risk primarily when ingested or inhaled, as its alpha particles cause localized molecular damage within tissues. High doses have been linked to dermal and subdermal effects, and animal studies have shown decreased long-term survival. The presence of Americium-241, even if below detection limits, is indicative of man-made nuclear contamination.[41]
- **Bismuth-214 (UI/UL qualified; no specific MCL):** A heavy metal and a decay product of Radon-222. Studies have shown that Bismuth has a high capacity to accumulate in the tissues of aquatic species and can cause DNA damage. While it is increasingly considered a "green" alternative to lead in some industrial applications, its toxicological profile is still being studied, and the frequent "uncertain identification" or "false positive" qualifiers for Bismuth-214 in the report are concerning, as they suggest potential analytical limitations in accurately assessing its presence.[43]
- **Cesium-137 (Generally ND/U-qualified; no specific MCL):** A man-made radioactive isotope resulting from nuclear explosions or the breakdown of uranium, with a half-life of approximately 30 years. It readily dissolves in water and can travel long distances in the environment. Food and drinking water are primary sources of exposure. Cesium-137 emits both beta and gamma radiation, which can cause damage to cells and tissues throughout the body. Its presence, even if below reported detection limits, serves as a clear indicator of man-made nuclear contamination originating from the site.[45]
- **Cobalt-60 (Not detected in GEL report; independently detected by The Blade; no specific MCL):** A man-made radioactive isotope, rarely found in groundwater, with a half-life of approximately 5.27 years. Chronic exposure to cobalt can lead to multi-organ system effects, including endocrine dysfunction, cardiovascular diseases (such as cardiomyopathy), neurological damage, gastrointestinal issues, hematological disorders, and pulmonary diseases (e.g., hard metal disease).[47] The critical absence of Cobalt-60 detection in the GEL Laboratories report, despite independent findings by The Toledo Blade, represents a significant failure of the Ohio EPA's testing to capture a direct signature of man-made nuclear contamination, thereby directly undermining their credibility and the "all safe" assertion.

**Table 3: Toxicological Overview of Key Contaminants and Long-Term Health Risks**

| Contaminant | Primary Health Concerns (Long-term/Chronic Exposure) | Bioaccumulation Potential | Relevant Regulatory Standard Type |
|---|---|---|---|
| Barium | Changes in heart rhythm, paralysis, gastrointestinal distress, muscle weakness. Long-term effects under study. | Small amount in bones/teeth; generally not bioaccumulative [22] | MCL |
| Uranium | Lung cancer risk, kidney damage, respiratory/CNS damage, cytotoxicity [20] | Accumulates in kidneys, bones [23] | MCL |
| Manganese | Permanent neurological disorders (manganism), cognitive effects, respiratory issues [25] | Accumulates in brain (basal ganglia) [25] | SMCL |
| Nickel | Contact dermatitis, headaches, GI/respiratory issues, lung fibrosis, cardiovascular disease, lung/nasal cancer [26] | Accumulates in body [27] | No MCL |
| Copper | Liver toxicity, neurochemical changes, oxidative stress, tissue damage, inflammation [28] | Accumulates in liver, kidney, gut, heart, brain, muscle [28] | SMCL, AL |
| Iron | Aesthetic concerns (color, taste, | Yes, in some forms [31] | SMCL |

| | | | |
|---|---|---|---|
| | staining); can contribute to oxidative stress at toxic levels [12] | | |
| Zinc | Respiratory impairment (metal fume fever), severe respiratory distress, death at high doses [32] | Yes, in some forms [32] | SMCL |
| Lead | Behavior/learning problems, lower IQ, hyperactivity, slowed growth, anemia (children); hypertension, kidney/reproductive issues (adults) [33] | Accumulates in bones [33] | AL |
| Aluminum | Nervous system damage (Alzheimer's, Parkinson's), pulmonary fibrosis, anemia, bone damage [35] | Accumulates in bones, brain, kidneys, liver [35] | SMCL |
| Radium-226 | Anemia, cataracts, fractured teeth, bone cancer, death [37] | Accumulates in bones [37] | MCL |
| Radon-222 | Leading cause of lung cancer in non-smokers; linked to Alzheimer's disease [38] | No (gas, but progeny are solid) [38] | Proposed MCL |
| Gross Alpha | Increased cancer risk (bone, kidney) [20] | Yes (from constituent radionuclides) [20] | MCL |
| Gross Beta | Increased cancer risk in various tissues/organs [39] | Yes (from constituent radionuclides) [40] | MCL |

| | | | |
|---|---|---|---|
| Americium-241 | Localized molecular damage, dermal effects, decreased survival [42] | Yes (internalized) [42] | No MCL |
| Bismuth-214 | DNA damage in aquatic species; toxicity under study [43] | High capacity to accumulate in tissues [43] | No MCL |
| Cesium-137 | Cellular/tissue damage from radiation exposure [46] | Yes (distributed throughout body) [46] | No MCL |
| Cobalt-60 | Multi-organ effects: endocrine, cardiovascular, neurological, pulmonary [47] | Yes (internalized) [47] | No MCL |

**Bioaccumulation and Biomagnification: The Cumulative Threat**

Many of the detected contaminants at the Luckey site, including Lead, Radium, Uranium, Nickel, Copper, Manganese, and Aluminum, are heavy metals or radionuclides known for their persistence, bioaccumulative properties, and toxicity (PBTs).[20] Bioaccumulation is a process where a toxic substance is absorbed by an organism at a rate faster than it can be eliminated, leading to increasing concentrations within the organism over its lifespan.[50] This phenomenon is particularly concerning for PBTs due to their resistance to degradation by biological processes. Furthermore, biomagnification describes the process by which these accumulated toxins increase in concentration at successively higher trophic levels within a food chain. This poses progressively greater risks to organisms higher up the food chain, including humans, who may consume contaminated lower-trophic organisms.[50]

Specific examples from the Luckey site contaminants illustrate this concern: Lead accumulates significantly in bones [33]; Radium also preferentially accumulates in bones [37]; Manganese accumulates in the brain, particularly the basal ganglia [25]; Copper accumulates in various organs including the liver, kidneys, and gut [28]; and Aluminum can accumulate in bones, the brain, kidneys, and liver.[35] The long-term presence of

these substances in the body, even at low levels, can lead to chronic health issues that may not manifest for years.

**The Fallacy of "All Safe": Why Current Standards Fall Short**

The Ohio EPA's declaration of "all safe" is based on a limited interpretation of safety that does not fully encompass the complexities of environmental contamination and human health.

- **Limited Scope of MCLs/SMCLs:** Maximum Contaminant Levels (MCLs) are established to protect against known health risks, but often focus on acute effects or higher exposure levels. Secondary MCLs (SMCLs), such as those for Iron and Aluminum, are non-enforceable guidelines primarily concerned with aesthetic qualities (taste, odor, color) or technical issues (corrosion), rather than direct health impacts.[12] Therefore, meeting MCLs does not equate to pristine water quality, especially when SMCLs are exceeded. The frequent exceedances of SMCLs for Iron and the very high levels of Sodium, which has no MCL but is a health concern for some individuals, indicate that even if primary health standards are met, the water quality is far from ideal. Relying solely on MCL compliance to declare water "all safe" ignores these pervasive aesthetic and nuisance contaminants, which can affect usability and point to broader geochemical impacts from the site.
- **The Linear No-Threshold (LNT) Model for Radionuclides:** For ionizing radiation, including from radionuclides like Gross Alpha, Radium, and Radon, the prevailing scientific consensus is the Linear No-Threshold (LNT) model. This model posits that *any* exposure to ionizing radiation, no matter how small, carries some risk of inducing cancer, implying that there is no truly "safe" threshold for carcinogens.[18] Therefore, simply being below an MCL for a radionuclide does not eliminate risk; it only quantifies an acceptable level of risk.
- **Cumulative and Synergistic Effects:** Current drinking water standards typically address contaminants individually. However, real-world exposure involves a complex mixture of chemicals and radionuclides. The combined (cumulative) or interacting (synergistic) effects of these multiple contaminants may be far greater than the sum of their individual risks, a factor not accounted for in current single-contaminant standards.[39]
- **Chemical vs. Radiologic Toxicity:** Many radionuclides, such as Uranium, possess both radiologic toxicity (from their decay) and chemical toxicity (as

heavy metals). The chemical toxicity, which can affect vital organs like the kidneys, may not be fully characterized or accounted for within existing radiological standards.[23]

- **Lifelong Exposure vs. Short-Term Compliance:** Meeting a one-time or infrequent sampling standard does not guarantee safety over a lifetime of exposure, especially for contaminants that bioaccumulate or have long half-lives. The human body's limited capacity to excrete certain heavy metals and radionuclides means they can remain in tissues for years, causing continuous internal exposure and long-term health consequences that are not captured by periodic spot checks.[22]
- **Unaddressed Contaminants:** The Ohio EPA's testing scope does not include all contaminants known to be present at the Luckey site, specifically PCBs, PAHs, and asbestos.[1] This omission renders any "all safe" declaration fundamentally incomplete and misleading.

The most glaring contradiction in the Ohio EPA's "all safe" claim is its failure to detect Cobalt-60 in the GEL Laboratories report, despite independent journalistic investigations by The Toledo Blade explicitly identifying this man-made radioactive isotope in the groundwater around Luckey.[1] The presence of Cobalt-60 is a direct signature of man-made nuclear contamination. The absence of this critical finding in the official report represents a significant gap in the assessment of radiological contamination, directly undermining the credibility of the "all safe" assertion.

Furthermore, the consistent "U" (not detected) or "UI" (uncertain identification) qualifiers for several radionuclides (Americium-241, Bismuth-214, Cesium-137, Cobalt-60) in the GEL report, coupled with high uncertainties for Radon-222, suggests analytical limitations that may mask the true extent of radiological contamination. This is particularly problematic given the site's documented history of nuclear material handling and independent findings of radioactivity. The pattern of non-detects or uncertain identifications, when viewed against the site's context, implies a potential underreporting of radiological presence.

The fact that the Ohio EPA's testing was explicitly *prompted* by independent journalistic investigation, rather than being a proactive, routine measure for a known FUSRAP site, implies a reactive rather than preventative approach to public health protection. This raises serious questions about the adequacy of ongoing regulatory oversight and whether the community's health is prioritized proactively or only in response to external pressure.

## VII. Recommendations: A Path Towards True Safety and Transparency

To genuinely ensure the safety and well-being of the Luckey community, a fundamental shift from reactive, narrowly defined assessments to a comprehensive, transparent, and proactive approach is imperative.

### Comprehensive and Continuous Monitoring

- **Expanded Parameters:** Testing parameters must be broadened to include all known site contaminants, specifically PCBs, PAHs, and asbestos, which are currently acknowledged as present but unaddressed in cleanup efforts.[1] A complete picture of contamination requires analyzing the full spectrum of hazardous substances.
- **Increased Frequency and Locations:** Sampling frequency and the number of monitoring locations, particularly for private wells in and around Luckey, must be significantly increased. This will provide a more robust, statistically representative, and temporally relevant dataset, moving beyond sporadic snapshots.
- **Lower Detection Limits:** Analytical methods employed should consistently utilize the lowest achievable detection limits for all contaminants, especially radionuclides. This is crucial to ensure that low-level contamination, which can still pose long-term health risks, is not overlooked or merely qualified as "uncertain."

### Independent Oversight

- **Establishment of Independent Body:** An independent scientific body or a qualified third-party auditor should be established to oversee all sampling, analytical processes, and data interpretation related to the Luckey site. This measure is essential to enhance transparency and rebuild public trust, particularly given the historical contradictions between official pronouncements

and independent findings.
- **Thorough Investigation of QC Failures:** All documented quality control failures, such as RPD exceedances and uncertain identifications, must be thoroughly investigated, resolved, and their implications for data reliability clearly communicated to the public. Corrective actions should be implemented and verified.

**Health Risk Assessment**

- **Long-Term, Cumulative Assessment:** A thorough, long-term health risk assessment must be conducted that explicitly accounts for chronic, low-level, and cumulative exposures to all identified contaminants, including those with bioaccumulative or carcinogenic properties. This assessment must move beyond single-contaminant evaluations to consider the complex, synergistic effects of multiple contaminants present in the environment.
- **Vulnerable Populations:** The assessment should explicitly consider heightened risks for vulnerable populations, including children, pregnant women, and individuals with pre-existing health conditions, who may be more susceptible to adverse effects from even low-level exposures.

**Public Health Advisories**

- **Clear and Transparent Communication:** The Ohio EPA and other involved agencies must issue clear, transparent, and regularly updated public health advisories based on a precautionary principle. These advisories should openly acknowledge uncertainties, potential long-term risks, and the limitations of current standards, rather than issuing blanket "all safe" declarations.
- **Specific Guidance:** Provide specific, actionable guidance to residents on potential health concerns related to detected contaminants, even if their levels are below MCLs, especially for the aforementioned vulnerable populations.

**Re-evaluation of Remediation Plans**

- **Broadened Cleanup Scope:** The scope of cleanup must be broadened to address all identified contaminants, not just the narrowly defined six elements. This explicitly includes PCBs, PAHs, and asbestos, which pose ongoing environmental and health risks.
- **Assessment of Natural Attenuation:** The effectiveness of "monitored natural attenuation" for groundwater remediation should be rigorously re-evaluated. This re-evaluation must consider the potential for incomplete source removal and the persistence and mobility of certain contaminants. If natural attenuation is deemed insufficient for timely and complete cleanup, more active and aggressive remediation strategies should be explored and implemented.

**Community Engagement**

- **Proactive Communication:** Agencies must foster genuine, transparent, and proactive communication and involvement with the Luckey community. This includes providing easily understandable data, explaining technical complexities in plain language, and establishing clear, accessible channels for residents to voice concerns and receive timely, accurate information.
- **Informed Decision-Making:** Community input should be actively sought and integrated into decision-making processes regarding ongoing monitoring, remediation strategies, and public health protective measures.

## VIII. Conclusion: A Call for Accountability and Protection

The evidence meticulously presented in this report unequivocally demonstrates that the Ohio EPA's declaration of "all safe" regarding Luckey's water quality is a dangerous oversimplification that lacks robust scientific backing. Methodological flaws in the analytical process, significant quality control failures within the laboratory data, and a fundamentally narrow scope of analysis collectively undermine the reliability of the provided results. Crucially, the absence of Cobalt-60 detection in the official report, despite its independent identification by journalistic investigations, represents a critical and alarming gap in the assessment of man-made radiological

contamination, directly challenging the completeness of the environmental picture.

The long and complex industrial history of the Luckey site, coupled with the known toxicological profiles of both detected and unaddressed contaminants, mandates a far higher standard of care than currently observed. The inherent risks associated with long-term, low-level, and cumulative exposure to bioaccumulative and carcinogenic substances cannot be dismissed by merely meeting minimum regulatory thresholds designed for different exposure scenarios. The prevailing scientific understanding, particularly the Linear No-Threshold model for radionuclides, underscores that any exposure to such agents carries some degree of risk.

True safety for the residents of Luckey demands more than reactive statements or incomplete data; it requires proactive, comprehensive, and transparent action. Federal and state agencies must be held accountable for implementing a complete and effective cleanup that genuinely protects human health and the environment from the enduring and complex legacy of the Cold War. The community of Luckey deserves nothing less than a full commitment to genuine safety and environmental justice.

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