Health Consultation

TYNDALL ELEMENTARY SCHOOL
TYNDALL AIR FORCE BASE
7800 TYNDALL PARKWAY
BAY COUNTY, PANAMA CITY, FLORIDA 32404

EPA FACILITY ID: FL1570024124

COST RECOVERY NO. 40S0

JUNE 13, 2012

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared By:

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Acronyms and Abbreviations

AFB	Air Force Base
AFCEE	Air Force Center of Engineering and the Environment
ATSDR	Agency for Toxic Substances and Disease Registry
BaP	benzo(a)pyrene
BCY	bank cubic yard
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSE	Comprehensive Site Evaluation
DoD	Department of Defense
FDEP	Florida Department of Environmental Protection
MC	munitions constituents
MEC	munitions and explosives of concern
µg/dL	micrograms per deciliter
mg/kg	milligrams per kilogram (parts per million)
mg/m^3	milligrams per cubic meter
MMRP	Military Munitions Response Program
MRA	munitions response area
MRS	munitions response site
PA	Preliminary Assessment
PAH	polycyclic aromatic hydrocarbon also called polynuclear aromatic hydrocarbon
RA	removal action
SCTL	Soil Cleanup Target Level
SI	Site Inspection
SOP	standard operating procedure
SVOC	semivolatile organic compound
TAFB	Tyndall Air Force Base
TCLP	Toxicity Characteristic Leaching Procedure
TCRA	time-critical removal action
TEF	toxicity equivalency factor
TES	Tyndall Elementary School
URS	URS Group, Inc.
U.S.	United States
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
XRF	X-ray fluorescence

Summary

Introduction

This health consultation report documents the Agency for Toxic Substances and Disease Registry's (ATSDR) response to a request by U.S. Environmental Protection Agency (EPA) to assist them in addressing public health issues associated with the presence of lead shot and target debris found at Tyndall Elementary School playground.

The Air Force[1] began investigations at various munitions response areas on Tyndall Air Force Base as part of the congressionally mandated Department of Defense, Military Munitions Response Program. Their investigations included an area designated as the former Stationary Target Range. After the Comprehensive Site Evaluation Phase I of the former Stationary Target Range in 2007, discussions among Air Force personnel prompted the addition of the Tyndall Elementary School in further investigations of the site because the school grounds overlap a portion of the former range. Visual inspections of the former Stationary Target Range area identified lead shot (pellets) on both properties.

On June 2, 2009, the EPA notified ATSDR that the Air Force reported to EPA the presence of lead shot (pellets)[2] at the Tyndall Elementary School adjacent to Tyndall Air Force Base. On June 3, 2009, EPA requested assistance from ATSDR to address the public health issues of contaminants found in the Tyndall Elementary School playground area, specifically lead and polycyclic aromatic hydrocarbons (clay target pigeons) present from the past use of the grounds as a portion of a former Tyndall Air Force Base target shooting area. ATSDR and EPA visited the site and met with representatives from the Air Force and Bay County Health Department during June 16-18, 2009. On June 24, 2009, the Air Force informed elementary school parents and staff. The Air Force conducted a Time Critical Removal Action in July 2009 to remove contaminated soil from the Tyndall Elementary School playground areas.

Conclusion 1

Lead shot (pellets) and lead fragments found on the Tyndall Elementary School grounds presented an urgent public health hazard to children who may have ingested the lead shot (pellets) prior to the removal action. The Time Critical Removal Action was warranted. While most of the lead shot has been removed along with the sand and soil, lead shot and lead fragments may still remain on the school grounds near sidewalks and utility conduits. Ground

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[1] The Air Force in this report refers to Tyndall Air Force Base as well as the Air Force Center for Engineering and the Environment (AFCEE) who retained the US Army Corps of Engineers (USACE) who retained URS to prepare the Removal Action Work Plan Addendum (URS 2009a) and to perform the removal activities. A list of subcontractors appears in the Draft Final Removal Action Report January 2010.

[2] Lead shot is a term for small balls or beads of lead.

disturbing activities such as sidewalk replacement, road paving, maintenance, renovation, or construction may bring lead shot and lead fragments to the surface where children may come in contact with such items. The soil removal action by the Air Force has reduced the opportunity for current and future exposure, but site conditions will require continuous monitoring and awareness education of children, parents, and staff.

Conclusion Basis	Based on ATSDR's June 2009 site visit, lead shot was visible on the school's playground areas where children play. In 1992, as documented in TAFB newspaper, a child brought home lead shot from the playground area. Ingestion of lead shot can cause acute lead poisoning and therefore presented an urgent public health hazard. Soil removal actions have reduced that hazard.
Next Steps	ATSDR collaborated with personnel from Tyndall Air Force Base, EPA, Florida Department of Environmental Protection, and Bay County Health Department to prepare a notification letter to parents on June 24, 2009 (Appendix A). In the letter, ATSDR recommended that concerned parents have their children's blood tested for lead. Blood lead testing was offered to everyone at the school by the Tyndall Air Force Base hospital and Bay County Health Department from June 26 through September 30, 2010. The Air Force began soil removal actions at the school campus in July 2009. The Air Force is planning further investigations at the school. Removal actions taken by the Air Force in 2009 greatly reduced the potential risk to children. Land use controls are in place and Air Force personnel should conduct frequent (semi-annual) inspections of the school grounds to ensure that children cannot contact lead shot that has remained after the removal action. Additionally, public health education for school children, their parents, and school personnel should continue to help reduce the likelihood for harm.
Conclusion 2	ATSDR cannot determine the impact that lead shot in the playground has had on the Tyndall Elementary School students because of the low numbers of children tested and the delay from the time of possible exposure to the time when blood testing was conducted.
Conclusion Basis	Two of the 102 children who had blood lead testing showed blood lead levels of 6 micrograms per deciliter, higher than the national average and the 95 upper percentile which may indicate lead exposure. Limitations of the blood lead results include the following: 1) blood sampling was initiated after school

was out for the summer and the probability for exposure was lowest and 2) approximately 87% of the student population was not tested. Therefore, it is possible that some children ingested lead shot and were not tested. The half-life of lead in blood is about 28 days. Children were tested more than 28 days after exposure was prevented by instruction and the installation of orange plastic safety fencing in April 2009. Therefore, it would have been possible to only detect a high exposure level in a small percent of the children.

Next Steps Site conditions will require continuous monitoring and awareness education of children, parents, and staff.

Conclusion 3 ATSDR cannot determine the impact that the presence of polycyclic aromatic hydrocarbons (PAHs) in the playground soil has had on the health of children who used the school playgrounds because not enough information is known about the extent of PAH contamination present in the surface soils throughout the playground area at the surficial soil depths that children would routinely contact. The Air Force removed contaminated soils during the summer of 2009 as a Time Critical Removal Action.

Conclusion Basis During the Comprehensive Site Evaluation Phase II field work, screening, investigative, and confirmatory sampling events of the Time Critical Removal Action, (May-July 2009), PAH compounds were also analyzed in 324 samples. Two of the eight samples collected at surface soil depths 0 to 0.5 feet below ground surface contained total PAH benzo(a)pyrene equivalents at concentrations that exceeded the Florida Department of Environmental Protection screening value of 0.1 mg/kg total benzo(a)pyrene equivalents for residential exposures (1.96 and 18.0 mg/kg).

Approximately 318 samples were analyzed for PAHs during the Time Critical Removal Action field work at depths 1.0 to 3.0 feet below ground surface.

Next Steps The Air Force removed soil at Tyndall Elementary School playground that showed levels of PAH benzo(a)pyrene equivalents above the selected cleanup values to a maximum depth of two feet below ground surface. The Air Force has not completed the Phase II work at this time. Additional work is being planned.

Conclusion 4	Current environmental regulations, policies, standard operating procedures, and methods employed during the environmental investigations of Tyndall Elementary School have failed to address the major health concern and hazard to children – the direct ingestion of lead shot.
Conclusion Basis	The presence of lead shot in the elementary school playground presents a hazard in two distinct ways. One hazard is the direct ingestion of lead shot by a curious child who intentionally picks up the small bead (lead shot) and puts it in his or her mouth. The other is the imperceptible lead that has leached from the lead shot into the soil matrix that can stick to a child's hands and be unintentionally ingested by hand-to-mouth contact. The soil sampling protocol conducted in accordance with environmental regulations for soluble lead does not address both types of hazards presented by lead shot, and therefore, provide incomplete hazard characterization. This may have jeopardized the safety of children who used the area. Moreover, remediation decisions based solely on the results of soluble lead analysis may indicate that lead levels are too low to require clean up, leading to a mischaracterization of the site hazard and allowing lead shot to remain in the soil. This was the case following the 1992 incident of a child bringing home lead shot and the 2000 ATSDR Public Health Assessment. In previous investigations of the site, only soluble lead concentrations were analyzed and reported. The widespread presence of lead shot in the playground areas was not reported or considered to be of concern by former investigators. Laboratory analyses of soluble lead concentrations in soil were too low to warrant cleanup. Therefore, no further actions were taken until 2009.
Next Steps	As a result of our work with the EPA and Air Force at this site, ATSDR issued a letter describing this critical public health concern and suggested recommendations for addressing this issue. The letter appears in Appendix B.

Background

Site Description

Tyndall Air Force Base (TAFB) is an active United States Air Force base located in Bay County, Florida, approximately 12 miles southeast of Panama City, Florida. The base covers about 28,800 acres on a narrow 18-mile long peninsula connected to land on its southeastern boundary. TAFB is bordered by East Bay to the northeast, St. Andrews Bay to the northwest, and St. Andrews Bay and the Gulf of Mexico to the south and southeast. TAFB is connected to the Panama City area by the DuPont Bridge via Highway 98. U.S. Highway 98 bisects the base with the air field and majority of the industrial and research operations north of the highway (Figure 1). Administrative, residential, and Tyndall Elementary School are south of the highway [Booz Allen 1996].

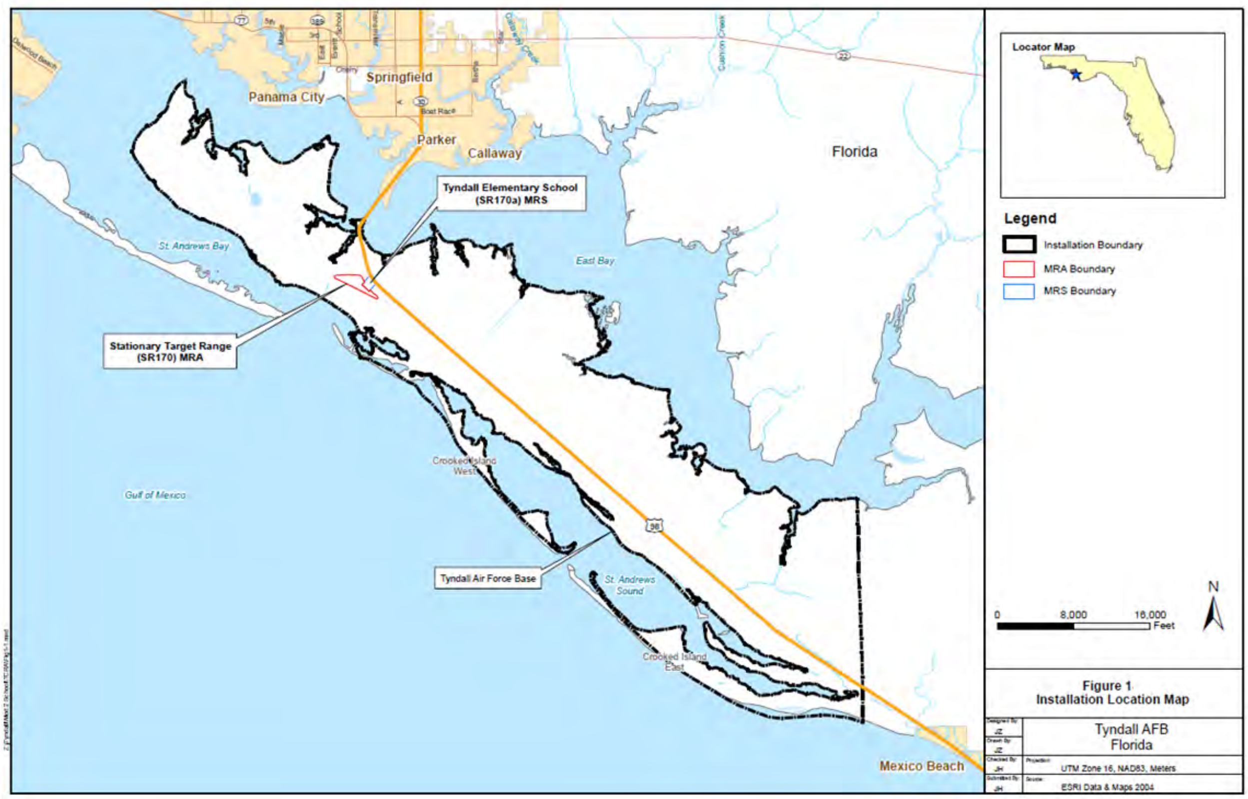

Figure 1 – Installation Location Map [URS 2010 Draft Final Removal Action Report 2010]

History and Past Use

In 1941, Tyndall Field was opened as a flexible gunnery school for the Army Air Corps. Beginning in 1946, it was an air tactical training school. Tyndall Elementary School (TES) was constructed by the Air Force in 1951, and is located off U.S. Highway 98. The school's 21 acres were once a portion of Tyndall Air Force Base that was used as a shotgun range in the 1940s to train aerial gunners during World War II (Figure 2). Gunners fired 12-gauge shot guns containing lead shot at clay targets (skeet) launched into the air from fixed towers. The targets would shatter, scattering debris and lead shot that fell to the ground [TAFB 2009; USACE 2010]. The exact area of the former target range area as well as the extent of lead shot, lead debris, and clay target contamination were not fully identified or characterized prior to the removal action. The Air Force may be planning further investigations of the former range [ATSDR 2011].

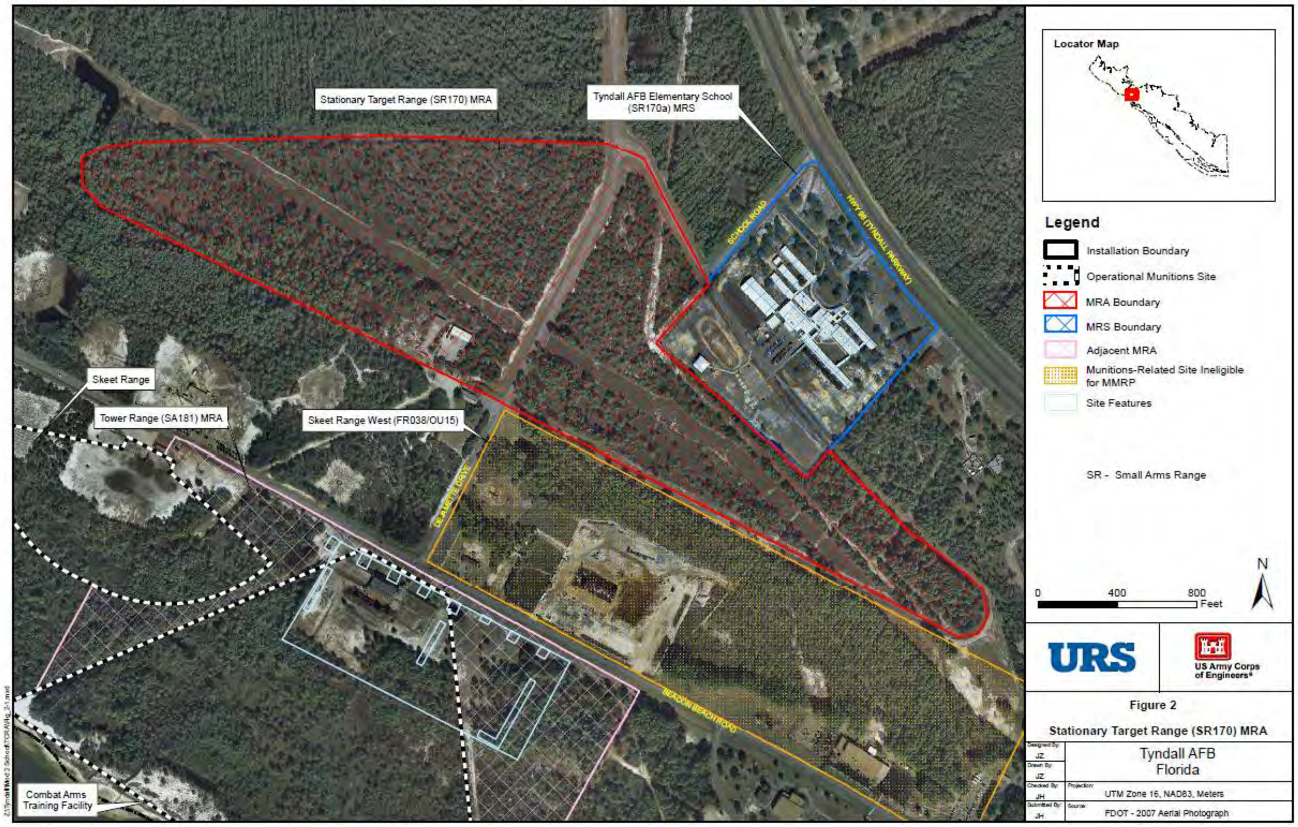

Figure 2 – Stationary Target Range overlapping Tyndall Elementary School property [URS 2010 Draft Final Removal Action Report 2010]

Tyndall Elementary School was operated by the Air Force as a school for base dependents until 1974 when the operation and maintenance of the school was transferred to the Bay County School District via a lease arrangement. Since that time, the school has been operated as a public school serving both Air Force families and the public [TAFB 2009]. Tyndall Elementary School is one of 33 schools in Bay County School District [Bay County Schools 2010]. Approximately 800 students from pre-kindergarten to fifth grade attend this school. Many of the students are military dependents who live on the base, while others live in Donaldson Point and the eastern section of the Callaway and Parker communities [Bay County Schools 2010].

The school property is fenced and a front gate leads to U.S. Highway 98. A second gate also leads to Highway 98. The playgrounds at the school extend from the front of the school to the west, south, and east of the school buildings and are within the fenced area.

Environmental Contamination

Air Force 1992 Lead Investigation

In May 1992, a student brought home lead pellets (shot) she collected while playing at recess on the Tyndall Elementary School playground. Her father notified the school, who then contacted the Air Forcing, causing them to take action [News Herald 1992]. Initially, the playground was declared off limits. However, after input from the Bay County Health Department, restrictions were expanded limiting children from playing on school property for the three weeks remaining of the school year. The Air Force conducted an investigation that included environmental sampling of soil and for lead, as well as surface radiation of the Tyndall Elementary School grounds [TAFB 1992].

ATSDR obtained the soil sampling data and the "Memo for Record" dated May 12, 1992, which described the sampling, accompanied by hand-written notes and grid drawings. The memo did not note the presence of lead shot or the extent of lead shot on the school grounds. Soil samples on the school grounds were divided into 30/200 square foot areas. Within each area, nine samples were collected to form composite samples. Specifically, 270 discrete samples were collected to form 30 composite samples. The Air Force collected a total of 34 samples from Tyndall Elementary School -- 30 within the fenced area and four outside the fence on school grounds. Additional samples were collected outside the school grounds. Samples were sent to Armstrong Laboratory for lead analysis [TAFB 1992].

Test results found lead concentrations in soil at Tyndall Elementary School ranging from 7.2 milligrams per kilogram (mg/kg) to 20,000 mg/kg. The 20,000 mg/kg sample was taken from an area beside the front gate of the school which was a grass-covered area that was not part of the playground. The second highest concentration, 340 mg/kg, was found in the southeastern corner of the school grounds on the playground [TAFB 1992]. The lead concentration in the playground ranged from 6.3 mg/kg to 340 mg/kg [ATSDR 2000]. The average concentration within the playground was 97 mg/kg. The EPA standard for lead in residential bare-soil play areas is 400 mg/kg [EPA 2001].

The Air Force also collected four air-borne lead samples in areas where children play on the school grounds. Air sample results were not reported in the memo, but two air sampling results appear as handwritten notes in the margin at 0.13 and 0.23 micrograms per cubic meter ($\mu g/m^3$) and in the base newspaper article [TAFB 1992 and Gulf Defender 1992a]. The noted health risk standard at the time was also noted as 1.5 mg/m^3. Ground level radiation measurements were also taken. Radiation levels were reported to be consistent with general background levels ("basically, less than 0.01 mR/hr"). There was no notation on the visual appearance of soil, sand, or debris or the presence of lead shot or clay target debris.

Because lead concentrations at the playground area were below EPA standards, and air and radiation sampling results indicated no increased health risks, the Air Force concluded that no further action was needed. Children were allowed back on the playground. No documents were found that mention whether any follow-up actions were taken.

ATSDR's Involvement

In 1997, ATSDR conducted a site visit of Tyndall Air Force base to gather information needed for a public health assessment. ATSDR visited the elementary school because past exposure to lead was identified by the Air Force. During the site visit, ATSDR did not see visible signs of lead shot in the playground area and noted that sand had been deposited onto the playground, although no specifics were noted such as dates, amount, source, or confirmatory sampling. There were no notes about shot still being present.

As the lead concentrations in the playground area and related exposures were associated with lead levels below the EPA recommended soil standards for residential soil, ATSDR released the final public health assessment for TAFB in July 2000 stating that soil lead levels were too low to present a health hazard. ATSDR was not aware that lead shot remained accessible to children on the playground.

On June 3, 2009, EPA notified ATSDR that the Air Force had found lead shot at the Tyndall Elementary School. On June 5, 2009, EPA requested assistance from ATSDR to address the public health issue of contaminants found in the playground area, specifically lead and polycyclic aromatic hydrocarbons (PAHs) present from the past use of the grounds as a portion of the former target shooting area.

ATSDR and EPA visited the site and met with representatives from the Air Force and Bay County Health Department from June 16-18, 2009, and again from November 18-20, 2009. ATSDR coordinated with the Air Force, EPA, Florida Department of Environmental Protection (FDEP), and Bay County Health Department to write a notification letter to parents on June 24, 2009 (Appendix A) which recommended that concerned parents have their children's blood lead level tested.

Tyndall Air Force Base designated the investigational area as the Stationary Target Range (SR170) Munitions Response Area, which overlaps a portion of the Tyndall Elementary School campus designated as SR170a. The hazard that lead shot presents is not solely based on its chemical characteristic property to dissolve into a soil matrix, adhere to a child's hands, and be ingested or carried by rainwater into an aquifer. The hazard described in this health consultation is direct and intentional ingestion of lead shot (pellets) by a curious child. Figure 3 show the Tyndall Elementary School sign at the front of the school. Figures 4 and 5 show the playground areas in the back and sides of the school. Orange safety fencing can be seen around investigational grids.

Figure 3 TES Front Sign

Figure 4 TES playground

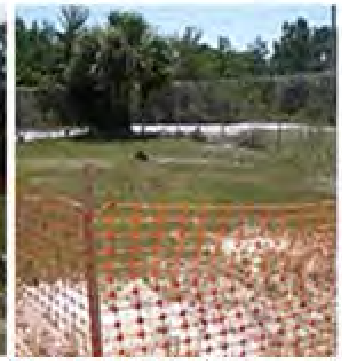

Figure 5 TES playground

Air Force 2009 Lead and PAH Investigation

As part of the congressionally mandated Department of Defense, Military Munitions Response Program[3], the Air Force began Phase I investigations at various munitions response areas on Tyndall Air Force Base. Their investigations included the former Stationary Target Range which they designated as SR170. After the CSE Phase I of the former Stationary Target Range (SR170) in 2007, discussions among Air Force personnel prompted the addition of the Tyndall Elementary School in further investigations of SR170. The Air Force designated TES as SR170a.

In May and June 2009, TAFB conducted two soil sampling events, discrete samples at 0.5, 1.0, 1.5, and 2.0 feet depth intervals below ground surface (bgs) using X-Ray Fluorescence (XRF) technology for soluble lead. Any lead shot present was removed from the samples prior to analysis, along with other large particles of rock and debris to comply with the sampling protocol.

According to the December 2008 Draft Final Workplan for Comprehensive Site Evaluation Phase II, a description of each soil sample was to be noted in a field logbook: "Document any information about the sample location that is out of the ordinary (e.g., fill, discoloration, odor, the presence of man-made items, etc.). Document the presence of any projectiles, clay target debris, or other small arms debris near the sample location. … Record the presence of these items in the field logbook and the XRF Analysis Sample Collection Field Sheet. Photograph any items that may potentially be range-related."

[3] The Military Munitions Response Program, Comprehensive Site Evaluation CSE Phase I consists of historical records review, visual surveys, and interviews, while the CSE Phase II consists of visual surveys and environmental sampling. The goal of the CSE Phases I and II are to obtain sufficient data to serve as the basis for USAF decision-making regarding further munitions response actions or investigations (USACE 2010). These are not ATSDR programs.

Sampling Results

The results of the screening analysis provided the contaminant levels that children might contact and assisted the Air Force and EPA in determining the need for removal action.

Initially TAFB collected approximately 270 discrete soil samples in and around the school yard as a part of the CSE Phase II to address the former shooting area which encompasses Tyndall Elementary School property [USACE 2010]. The soluble lead concentrations in soil ranged from non-detectable to 4,302 mg/kg. In June 2009, 130 additional soil samples were collected to further delineate the soluble lead contamination. The results ranged from non-detectable to 495 mg/kg. In addition, four soil samples were collected and analyzed for PAHs [USACE 2010].

Lead

Approximately 175 samples representing 42% of the total number of samples were collected at 0.5 feet bgs. This data represents the soil depth that children would contact. The average lead concentration at this depth was 226 mg/kg with values ranging from non-detectable to 3,602 mg/kg. The 95% upper confidence limit[4] of the average (UCL) was 1151mg/kg and the geometric mean was 77 mg/kg. Approximately 19 of the samples (10.8%) were greater than or equal ($\geq$) to 400 mg/kg.

Approximately 175 samples (42%) were collected at 1.0 ft. bgs. The average lead concentration at this depth was 168 mg/kg and values ranged from non-detectable to 4,302 mg/kg. Approximately 18 of the samples (10.2%) were $\geq$ 400 mg/kg. Approximately 44 samples were collected at 1.5 ft. bgs representing 9.5% of the total sampling. The average lead concentration at this depth was 118 mg/kg and values ranged from non-detectable to 901 mg/kg. Two of the samples or 4.7% were greater than 400 mg/kg. Six samples were collected at 2.0 ft. bgs representing 1.5% of the total sampling. The average lead concentration at this depth was 435 mg/kg and values ranged from non-detectable to 2,024 mg/kg. One sample (16%) was greater than 400 mg/kg, which skewed the data at this depth.

[4] The 95% UCL is a value that would be higher than the true average contaminant level 95% of the time. It is used as a conservative value to make sure that, even if there were limited samples, higher levels of contaminants that may be present at the site are taken into account.

Table 1 - Comprehensive Site Evaluation Phase II Sampling Summary

Depth (feet bgs)	Samples > 400 mg/kg / Samples at Depth	Average Lead Concentration (mg/kg)	Geometric Mean Lead Concentration (mg/kg)	Percent above 400 mg/kg*
0.5	19 / 175	226	77	10.8
1.0	18 / 175	168	56	10.2
1.5	2 / 44	118	51	4.6
2.0	1 / 6	435	65	16

* EPA standard for bare residential soil.

In summary, the CSE Phase II screening analysis showed the average soil lead concentration for combined depths to be approximately 180 mg/kg. About nine percent (9%) of the total soil samples collected showed lead levels above 400 mg/kg, EPA's residential soil standard for bare soil [EPA 2000]. These data indicate that there are several lead "hot spots," but the average soil lead concentration is lower than the EPA standard.

Polycyclic aromatic hydrocarbons (PAHs)

The Air Force also collected four soil samples at (0.5 feet bgs) below grade for polycyclic aromatic hydrocarbon (PAH) analysis during the screening process because PAHs are a major component of the clay targets (skeet) used at the former target range and in the wadding of shotgun shells [Jorgensen and Willem 1987; EEA 1992; EA 1995; Peddicord and LaKind 2000; EPA 2003, ITRC 2003, Yardley 2003].

The following PAH compounds were analyzed: acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene (BaP), benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorine, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene. The Air Force used the EPA recommended toxicity equivalency factor (TEF) methodology which weighs the toxicity of the less toxic compounds as fractions of the toxicity of the most toxic, benzo(a)pyrene (BaP) [EPA 1993]. The carcinogenic PAH TEFs were used to evaluate the toxicity and assess the risk as a single hazardous substance. The EPA provisional guidance uses benzo(a)pyrene as the index chemical (i.e., having a relative potency of 1.0) and includes relative potency factor values for seven carcinogenic PAHs [EPA 1993]. The TEF for each carcinogenic PAH is an estimate of the relative toxicity of a PAH compound compared to the BaP equivalent. The total adjusted values were added together. The Air Force used the FDEP cleanup standard for residential exposures of 0.10 mg/kg total BaP toxic equivalents [FDEP 2005].

Two of the four screening samples at 0.5 feet bgs analyzed for PAHs contained total BaP equivalents (1.96 and 18.0 mg/kg) at levels that exceeded the FDEP screening value of 0.1 mg/kg total BaP equivalents for residential exposures [USACE 2010; FDEP 2007]. The results of the screening analysis provided the contaminant levels in the soil at which children might contact, and assisted the Air Force and EPA in determining the need for removal action.

During the Time Critical Removal Action, confirmatory sampling was conducted to verify soil removal at levels exceeding the FDEP screening value. Four of 320 samples (1.25%) were collected from two (100 x 100 feet) grids at 0.5 feet bgs for PAH analysis. They showed total BaP equivalent levels below the FDEP screening value of 0.1 mg/kg. These samples represent the soil depths at which children would be exposed. All other confirmatory samples were collected from 1.0 foot to 3.0 feet bgs - a depth at which children would not have access. A total of 22 of 320 samples (6.9%) exceeded the total BaP equivalents FDEP screening value. Of those, 14 were at 2.5 feet bgs.

In general, there were too few PAH samples collected from the surface soil at the point of exposure throughout the playground for ATSDR to evaluate the potential for exposure to result in harmful effects.

Following the results of the CSE Phase II analysis, the Air Force subdivided Tyndall Elementary School away from the Stationary Target Range (SR170) Munitions Response Area and designated it as a Munitions Response Site in June 2009 to allow for further evaluation and for a munitions response action to be initiated.

The results of the CSE Phase II indicated that lead and PAH concentrations in some soil samples were above the human health screening values, and upon input from EPA and FDEP, were determined to pose an imminent and substantial threat to human health on the Tyndall Elementary School campus [USACE 2010]. For this reason, the Air Force began a Time Critical Removal Action to remove the contaminated soil above the selected cleanup levels to a maximum depth of two feet below ground surface (bgs) at Tyndall Elementary School [USACE 2010].

Air Force 2009 Soil Removal

The Air Force began removing contaminated soil at the Tyndall Elementary School in July 2009, under a Time Critical Removal Action. Field activities completed as part of the Removal Action included site preparation, waste characterization, investigative samples chemical analysis, contaminated soil excavation, dust control and monitoring, tree removal, transportation and disposal, equipment decontamination, backfill and grading, and site restoration [TAFB 2010].

Soil was removed in areas that exceed selected clean-up levels. Depending on the lead concentration, soil was excavated down to either 0.5 or 2.5 feet. There were areas where underground utilities were encountered where the excavation could not proceed down to 2.5 feet. In these areas, soil was excavated to a depth of 1.5 feet. All excavated areas were filled with clean soil cover [TAFB 2010].

Soil samples with Toxicity Characteristic Leaching Procedure (TCLP) lead test results greater than 5 milligrams per liter were treated in-situ (in place) prior to excavation and disposal [USACE 2010]. The in-situ treatment consisted of mixing the soil with a commercial calcium sulfate compound that binds the lead, making it resistant to dissolving out the soluble components (leaching). Upon receipt of confirmation sampling results below cleanup levels, excavated areas were backfilled with off-site borrow material and the site was graded, re-vegetated, and restored with playground equipment [USACE 2010]. Additionally, sand was placed around the playground equipment to meet the drop fall zone requirements (Florida Building Code, Section 423 State Requirements for Educational Facilities) [TAFB 2010]. The goal of the soil removal was to remove soil until sampling results indicated that contaminant concentrations were below their clean-up values or until a depth of two feet below ground surface was reached. Several grids exceeded their clean-up values, but because of utility lines, excavation could not reach two feet bgs. Approximately 34,900 bank cubic yards (BCY)[5] of soil were excavated. Materials obtained from off-site sources were tested for volatile organic compounds, semi-volatile organic compounds, pesticides, and metals to be used for back fill of the playground area [USACE 2010]. New playground equipment was installed.

Prior to the soil removal, Air Force divided the area into 73 grids of approximately 100 by 100 ft. Soil was screened for lead in the field using X-ray fluorescence (XRF). As the excavation of each grid proceeded, the XRF was used for in-situ screening of soil within the excavation to determine if additional soil removal was required prior to confirmation sampling. Sampling points were arranged in a square grid pattern with an approximate spacing of 50 feet between samples. The number of samples collected per grid was based on the total grid area, with generally four samples per 100-foot by 100-foot grid (or one sample per 50-foot by 50-foot sub-grid). Samples were collected at differing depths from 0.5 to 2.5 inches below surface grade. Each confirmation sample was analyzed in the field for lead using XRF and for PAHs at the off-site laboratory by Method 8270C [USACE 2010]. Ten percent of the soil samples screened by XRF were selected for confirmation laboratory analysis to determine the accuracy of the XRF screening. A small aliquot of the homogenized sample was transferred to a 4-ounce jar and sent to the laboratory for lead analysis by Method 6010B to correlate field and lab results. The correlation (r) between the XRF and laboratory analyses was 0.9748, which was within the 0.900 criteria [USACE 2010].

When XRF screening results were below the field delineation value of 300 mg/kg for lead, then a discrete confirmation soil sample was collected from the grid for lead by XRF and off-site laboratory

[5] One Bank Cubic Yard (BCY) equals 27 cubic feet (3'x3'x3') of earth in situ. When excavated and loaded loosely into a truck, the original one BCY of material expands to approximately 1.25 Cubic Yards (CY). The conversion from BCY to CY is required to estimate the correct quantity and costs of materials to be handled or transported after excavation.

analysis of PAHs. Samples for PAH analysis were sent to the laboratory only if XRF results for the confirmation soil sample were below the field delineation value for lead. If XRF results for the lead confirmation soil sample were above the field delineation value, an additional 0.5 feet of soil was removed from the grid (or approximately 50-foot by 50-foot sub-grid) and the grid (or sub-grid) was re-screened using XRF for lead as previously described. The process was then repeated [USACE 2010].

If confirmation soil sample analytical results indicated that both lead and PAHs were below their respective removal action cleanup levels, the grid was identified as passing. Passing grids were cordoned off, eliminating cross-contamination from heavy equipment and personnel until the grid could be backfilled [USACE 2010].

Exposure to Contaminants – Public Health Implications

Tyndall Elementary School Children Blood Lead Levels

On June 24, 2009, parents were advised to have their children receive complimentary blood lead test. The Air Force and the Bay County Health Department offered the testing. Parents were given a state of Florida standard Lead Poisoning Prevention questionnaire.

A total of 102 children had their blood (venous) lead tested from June 26 to September 10, 2009. That number represents only approximately 13% of the total population of children attending Tyndall Elementary School. The half-life of lead in adult human blood has been estimated to be from 28 days [Griffin et al. 1975 as cited in ATSDR 2005] to 36 days [Rabinowitz et al. 1976; Todd et al. 1996 as cited in ATSDR 2005]. This means that once in the blood stream, it takes roughly one month for blood lead levels to decrease by half the value once exposure has stopped. Children were tested more than 28 days after exposure was prevented by instruction and the installation of orange plastic safety fencing in April 2009. Therefore, it is only possible to detect a high exposure level in a small percent of the children.

Eighty-nine children, ranging in age from 3 to 13, received blood lead testing at Tyndall AFB medical center. Blood lead levels ranged from 1 to 6 µg/dL. Two children had blood lead levels at 3µg/dL. Two children had blood lead levels at 6 µg/dL indicating that the children were exposed to lead from some undetermined source. Neither child was living in a home built before 1978. Even though results of the blood lead tests performed at TAFB indicated that no child had a blood lead level at or above CDC's recommended intervention level of 10 µg/dL, ATSDR recommended that the Air Force follow-up with these families to try to identify the source of lead exposure and to reduce further exposures.

Thirteen of the 102 children, ranging in age from 6 to 11, were tested at the Bay County Health Department[6]. Blood lead levels ranged from non-detectable to 4 µg/dL. There were two children with blood lead levels at 3 and 4 µg/dL, respectively. The families of all children tested for lead received educational material about lead, lead sources, and how to reduce potential exposure to lead [BCDOH 2010].

The 2007-2008 National Health and Nutrition Examination Survey for the U.S. population reported the blood lead geometric mean of 6-11 year olds to be .988 µg/dL confidence range (.914-1.07) with the 95th percentile reported as 2.5 µg/dL confidence range (2.10-2.88) [CDC 2010]. For the Tyndall Elementary School children who were tested, the geometric mean of blood lead levels was 1.337 µg/dL confidence range (0.485-2.189) with the 95th percentile being 2 µg/dL. The age distribution did not impact blood lead results.

Tyndall AFB programmed funding for blood lead screening at Bay County Health Department through September 30, 2010. Additionally, military dependents attending Tyndall Elementary School can have blood lead screening at the base hospital indefinitely [USAF 2010].

Centers for Disease Control and Prevention - Lead Program

The Lead Contamination Control Act of 1988 authorized CDC to initiate program efforts to eliminate childhood lead poisoning in the United States. As a result of this act, the CDC Childhood Lead Poisoning Prevention Program was created, with primary responsibility to: develop programs and policies to prevent childhood lead poisoning; educate the public and health-care providers about childhood lead poisoning; provide funding to state and local health departments to determine the extent of childhood lead poisoning by screening children for elevated blood lead levels, helping to ensure that lead-poisoned infants and children receive medical and environmental follow-up, and developing neighborhood-based efforts to prevent childhood lead poisoning; and support research to determine the effectiveness of prevention efforts at federal, state, and local levels [CDC 2002].

CDC collects elevated blood lead data on children less than 6 years old from the Childhood Blood Lead Surveillance program from each state [CDC 2009]. Data from the program show that national averages of blood lead levels have been steadily decreasing over time. The national average percent of children with elevated blood lead levels (>10 µg/dL) in 2007 was 1.0% of the children tested, which is down from 7.6% in 1997 [CDC 2009]. The national average blood lead level for children 1-5 years of age was 1.9 µg/dL in 2002 [CDC 2005a].

Previously, CDC responded to the accumulated evidence of adverse effects associated with lead exposures by lowering the Blood Lead Level (BLL) of Concern, a value at which action should be

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[6] Bay County Health Department mistakenly included the results of one child not associated with TES in the TES blood testing results. That data was removed from our analysis.

taken to stop or reduce exposure to lead. It is not a toxicologic threshold for health effects. Between 1960 and 1990, the blood lead level for individual intervention in children was lowered from 60 µg/dL to 25 µg/dL. In 1991, CDC recommended lowering the level for individual intervention to 15 µg/dL and implementing community-wide primary lead poisoning prevention activities in areas where many children have BLLs >10 µg/dL. Activities, such as taking an environmental history, educating parents about lead, and conducting follow-up blood lead monitoring were suggested for children with BLLs of >10 µg/dL. The current toxicological literature and state-of-the-science assert that no blood lead threshold has been identified in children, meaning that a “safe” blood lead level has not been determined [CDC 2002].

In January 2012, the Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP) released their report, Low Level Lead Exposure Harms Children: A Renewed Call for Primary Prevention. Based on its conclusions that blood lead levels < 10 µg/dL harm children, the Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP) recommended “elimination of the use of the term 'blood lead level of concern’” and instead, the use of a reference value based on the 97.5th percentile of the NHANES-generated blood lead distribution in children age 1-5 years (currently 5 µg/dL) to identify children with elevated blood lead levels. These lower levels currently impact approximately 450,000 U.S. children. The absence of identified blood lead levels without deleterious effects underscores the critical importance of primary prevention [ACCLPP 2012].

The ACCLPP is a federal advisory committee that provides advice and guidance to the Secretary, Department of Health and Human Services (HHS); the Assistant Secretary for Health; and the Director, Centers for Disease Control and Prevention (CDC), regarding new scientific knowledge and technological developments and their practical implications for childhood lead poisoning prevention efforts. The ACCLPP recommendations may mean changes to CDC’s current lead policy.

Changes to CDC’s policy would not have an impact for the Tyndall Elementary School lead contamination site because follow-up actions were taken with the families of the two children who had blood lead levels above 5 µg/dL, health education was provided to families, and lead contaminated soil was removed.

Florida Department of Health Childhood Lead Prevention Program

Lead Poisoning Prevention and Healthy Homes Program releases the Childhood Lead Poisoning Surveillance Report annually. According to the 2009 report, Bay County reported an increase in blood lead screening from 420 in 2005 to 1,033 in 2009 with a 1.8% new case rate (person with blood lead level > 10 µg/dL) during that same time. Bay County data of confirmed new cases compared with total Florida annual new cases show in 2005, one vs. 304; in 2006, four vs. 389; in 2007, one vs. 374; in 2008, one vs. 274; and in 2009, two vs. 190 for children ages 0 to 6 years [FDOH 2011].

Homes built prior to 1950 in Bay County ranges from 6.3-9.6% of all homes in the county; while the poverty rate for the county is 16.6-21.3%. Both housing date and poverty levels have shown the greatest impacts on blood lead levels in children.

Public Health Implications

Soluble lead in soil can be ingested directly, through hand-to-mouth contact, or it can be inhaled from soil that is kicked up in the form of dust. Evaluation of soil lead contamination at small arms ranges shows bioavailability of lead to be 100 % [Bannon 2009]. Overall, the amount of soluble lead in the TES playground area is moderate to low with only nine percent of soil samples containing lead at levels above EPA's residential soil lead standard [EPA 2001].

However, the presence of lead shot in the playground poses the greater hazard to children at TES. The weight of a single lead shot No.8 is estimated at 69 milligrams of 97% pure lead [Guruswamy 2000; Remington]. Reports of children ingesting several lead shot have shown significant increases in a child's blood lead level [Greensher 1974; Madsen 1988; McKinney 2000; Mincheff 2004]. Lead shot may be more visually appealing to young children because it resembles the kind of decorative sprinkles applied to cookies. Additionally, lead is reported to have a slightly sweet taste making it more palatable to young children [EPA 2011].

Ingested lead shot can cause severe, acute lead poisoning with a rapid elevation of blood lead levels [Greensher 1974; Gustavsson 2005; McKinney 2000; McQuirter 2003; Verbrugge 2009]. Ingested metallic lead shot is made more soluble by stomach acids, and can cause a spike in blood lead levels. In many cases, x-rays of the abdomen have shown lead shot accumulated in the appendix of these patients, and remain there for years [Cox 2005; Durlach 1986; Madsen 1988; Mincheff 2004; Verbrugge 2009]. Lead retained in the appendix provides a continuous source of lead.

Approximately 99% of the lead in blood is associated with red blood cells [DeSilva 1981; EPA, 1986; Everson and Patterson 1980, as cited in ATSDR 2010]. The half-life of lead in adult human blood has been estimated to be from about 28 days [Griffin et al. 1975 as cited in ATSDR 2005; Sayinalp 1995] to 36 days [Rabinowitz et al. 1976; Todd et al. 1996 as cited in ATSDR 2005]. This means that once in the blood stream, it takes roughly one month for blood lead levels to decrease by half the value once exposure has stopped. Even though lead decreases in the blood, lead travels to the liver and kidneys where it is absorbed by other soft tissue and slowly accumulates in the bones and teeth. The bones and teeth of adults contain more than 95% of total lead in the body. In times of stress (particularly pregnancy and lactation), the body can mobilize lead stores, thereby increasing the level of lead in the blood [ATSDR 2007a]. Since blood cells live only about 120 days, lead in blood after 120 days post exposure is the result of releases from the bone stores to the newer blood cells. The body accumulates lead over a lifetime and normally releases it very slowly. Therefore, both past and current elevated exposures to lead increase patient risks for lead effects [ATSDR 2007a].

The nervous system is the most sensitive target of lead exposure. There may be no lower threshold for some of the adverse neurological effects of lead in children. Neurological effects of lead in children have been documented at exposure levels once thought to cause no harmful effects (<10 µg/dL) [Canfield 2003; CDC 1997a]. The BLLs associated with encephalopathy in children vary from study to study, but BLLs of 70-80 µg/dL or greater appear to indicate a serious risk [ATSDR 2005]. Even without encephalopathy symptoms, these levels are associated with increased incidences of lasting neurological and behavioral damage [ATSDR 2005].

Lead has a serious impact on red blood cells and can cause anemia by inhibiting the body's ability to make hemoglobin by interfering with several enzymatic steps in the process. EPA estimated the threshold BLL for a decrease in hemoglobin to be 50 µg/dL for occupationally exposed adults and approximately 40 µg/dL for children, although other studies have indicated a lower threshold (*e.g.*, 25 µg/dL) for children [EPA 1986b as cited in ATSDR 2007b]. In cases of lead shot ingestion poisoning, children or adults may be asymptomatic (without symptoms) or present with severe cramping abdominal pain, which may be mistaken for an acute appendicitis [ATSDR 2007a].

While it appears that the children who had their blood lead tested may not have ingested lead shot from the playground, because the students were tested months after the exposures stopped, ATSDR cannot determine the impact that lead shot in the playground has had on the students. Additionally, with 87% of the student population not getting tested, it is possible that there may have been children who ingested lead shot but were not tested.

Any child having blood lead levels above the reference value of 5µg/dL, and whose exposure to lead shot is not confirmed, may have been exposed from a variety of sources not associated with Tyndall Elementary School. However, ingested lead shot found by x-ray in an affected child, may be an indication that the probable source of exposure may be from TES.

Since, at least one child brought lead shot home (1992), it is possible that others have done so. Some of these children may have younger siblings. Even though school children are being educated about the hazards now, their siblings might also be at risk of exposure. Figure 6 below is an example of how that may have occurred. Table 2 provides a time line of historical events.

In summary, ingestion of lead is dangerous and difficult to identify. Students at TES may have ingested either soluble lead or lead shot and not been identified.

Figure 6

An Exposure Scenario with Undetected Public Health Consequences

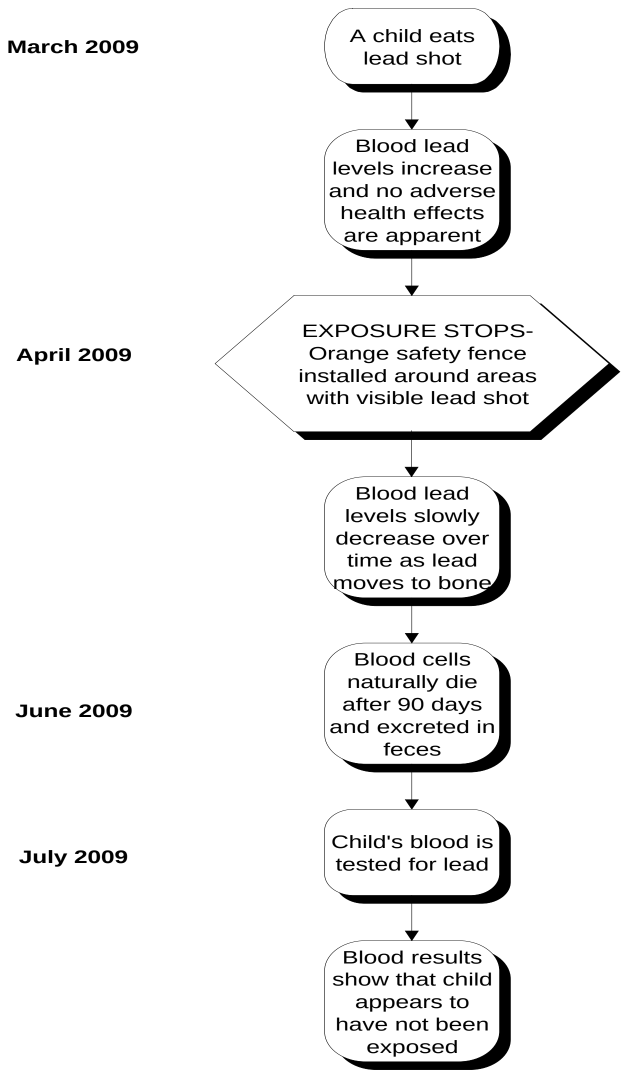


Table 2 – Historical Timeline

Date (Approximate)	Event	Results	Issue
1992	Tyndall Elementary School student brought home lead pellets (shot).	Air Force took action to investigate playground and prevented access until investigations were complete. USAF consulted with Bay County Health Department and FDEP. Lab results showed soluble lead concentrations below standards that required cleanup.	Sampling and analysis protocol excluded lead shot from the report giving misleading results of the potential hazard. Sampling results found dissolved lead in soil below 400 ppm residential standards. Therefore, no further action was taken. Lead shot remained on school grounds. No qualitative or quantitative documentation of lead was noted.
1997 – 2000	ATSDR's Public Health Assessment	ATSDR's visual inspection did not identify lead shot. ATSDR reviewed the results of the samples taken in 1992 and concurred with the Air Force and Bay County Health Department that lead in the soil at the school did not pose a public health hazard.	No identification or characterization of lead shot was made. No procedures were used to address lead shot and the acute health hazard that ingesting lead shot posed to young children.
May 2006 (URS 2007)	**CSE Phase I.** As part of the USAF Military Munitions Response Program, the Air Force investigated the historical records from on- and offsite data repositories and conducted interviews with personnel knowledgeable about munitions activities identified at Tyndall AFB.	The USAF conducted a non-intrusive visual survey of the installation to identify physical evidence to supplement the record and interview data. The USAF established boundaries of identified munitions area including the Stationary Target Range (SR 170) which overlaps a portion of Tyndall Elementary School property.	Based on the Air Force documentation, it is unclear to ATSDR if the elementary school is included in the investigations of CSE Phase I.
August 2008	**CSE Phase II.** During the August 2008 site reconnaissance, USAF personnel and contractors observed the presence of lead shot and target debris on the Stationary Target Range MRA (SR170).	The Tyndall Elementary School campus did not undergo a visual survey in 2008, but lead shot was observed near the fence that separates Tyndall Elementary School from the base. USAF revised the CSE Phase II sampling plan to include sample collection points along, but outside, the fence line on Tyndall AFB. USAF expanded investigation to include sampling within TES campus.	Air Force designated SR170a as TES for investigational purposes.

April 2009	The Air Force installed a safety fence where visible lead shot was identified on TES playground to prevent further exposure.	Exposure to lead shot on the school playground stopped.	More than 60 days later, blood lead testing begins.
May 2009	Field activities began.	Approximately 270 soil samples were collected. Soluble lead concentrations ranged from non-detectable to 4,302 mg/kg. Only nine percent of soil samples showed levels above the human health screening value (400 mg/kg). Four soil samples were analyzed for PAHs. The results indicated PAH levels in two samples above human health screening values. An additional 130 soil samples were collected to further delineate the soluble lead contamination. The results ranged from non-detectable to 495 mg/kg.	Sampling and analysis methods excluded lead shot from the investigation giving misleading results of the potential hazard. The presence of lead shot was not characterized by quantity, location, depth, or size. The CSE Phase II analysis showed the average soil lead concentration to be 180 mg/kg, much lower than the 400 mg/kg health screening value and therefore, according to CERCLA and RCRA did not require remediation. EPA RPM called the lead shot to the attention of ATSDR and the Air Force, prompting the Time Critical Removal Action.
July 2009	Time-Critical Removal Action of Soil at TES began. Soil removal, backfilling, and restoration of school grounds.	The total excavation area was divided into 73-100 feet by 100 feet grids. Roughly 34,900 bank cubic yards (BCY) (50,457 tons) of soil with lead and PAH concentrations exceeding cleanup levels were removed.	The soil, considered by EPA and FDOH to pose an imminent health hazard at TES, was excavated, treated, and disposed of in a nonhazardous waste landfill.
Late June – November 2009	Blood Lead Testing of 13% of children attending TES.	Two children were found to have blood lead levels at 6 ug/dL indicating exposure to lead. ATSDR recommended follow-up actions.	More than 60 days after exposure to lead stopped, blood lead testing began. Approximately, 87% of the TES student population was not tested. Ingesting lead shot can cause to acute lead poisoning. It is possible that some children ingested lead shot and were not tested. The half-life of lead in blood is about 28 days which made it difficult to identify the children potentially at risk for harmful health effects.

Discussion

ATSDR has two major public health concerns regarding Tyndall Elementary School property: 1) the presence of lead shot at the ground surface easily accessible to children; and 2) the sampling protocol that allowed lead shot to remain in the school's playground areas possibly impacting children for more than 60 years.

Presence of Lead Shot

The presence of lead shot at ground surfaces around the playground presented an urgent health hazard to children who used those areas. Additionally, children who took home or shared lead shots removed from the playground, with friends, may have exposed others. After the time critical soil removal action, the likelihood of children coming in contact with lead shot is drastically reduced. However, since some areas were not accessible during the removal action, lead shot may still remain beneath sidewalks, large trees, and other structures. Ground disturbing activities however, such as sidewalk replacement, road paving and maintenance, renovation, or construction may bring lead-contaminated soil, lead shot, and clay target debris to the surface where children may come in contact with such items. Therefore, institutional controls and routine visual inspections are needed to prevent children from contacting lead shot in the future.

Why was Lead Shot Allowed to Remain?

Environmental regulations set broad yet defined specific details about the results of analysis (data). However, the methods and procedures used to gather information about lead shot are not specified and rely on the stake holders to determine. Appendix C presents the current environmental regulations, policies, standard operating procedures, and methods used to gather lead data.

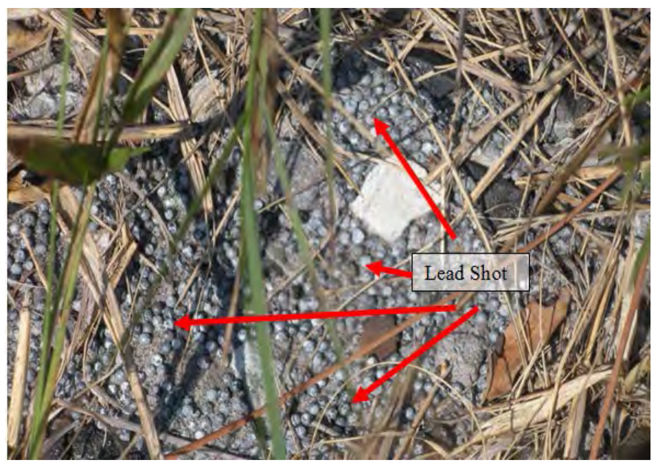
The presence of lead shot in the elementary school playground presents a hazard in two distinct ways. One hazard is the direct ingestion of lead shot by a curious child who intentionally picks up the small bead (lead shot) and puts it in his or her mouth. The other is the imperceptible lead that leached from the lead shot into the soil matrix that can stick to a child's hands and be unintentionally ingested by hand-to-mouth contact. The soil sampling protocol conducted in accordance with environmental regulations for lead does not address both types of hazards presented by lead shot; and therefore, provide incomplete hazard characterization. This may have jeopardized the safety of children who use the area.

Tyndall Elementary School Sampling and Analysis

Sampling and analysis performed at TES excluded lead shot from the investigational results. Lead shot as a contaminant was not evaluated or characterized by quantity, location, size, or depth in the Air Force documents. Figures 7 through 12 are included as a way for ATSDR to inform the reader of the quantity and size of the lead shot contamination at TES. Figures 7 through 10 show the widespread presence of lead shot available to children on the TES playground. Figure 11 – taken by EPA during our site visit – provides an indication of the size of the lead shot as compared to standard lead shot ammunition measurements shown in Figure 12.

Figure 7. Long view of part of Stationary Target Range road (aka Bambi Trail). Road transects rear play areas (on old range, at right; green polygon) from side play areas for 2nd and 3rd graders (leg of photo; magenta polygon). East gate in background. Orange plastic fencing installed in April 2009 to prevent children from accessing areas of the playground with visible lead shot and clay debris. Taken by Julie Corcoran EPA June 2009.

Figure 8. Lead shot (center of photo) on the Stationary Target Range road transectingg rear and side playgrounds at the Elementary school. Photo Taken by Julie Corcoran EPA June 2009



Figures 9 and 10. Lead shot (small round gray pellets) on school playground surface soil. Clay target debris (smooth dark black piece of debris, some pieces showing some ridging) also visible. Photos Taken by Julie Corkran EPA June 2009.

Figure 11. Lead shot taken from playground during site visit and placed on ruler for size comparison. Photos Taken by Julie Corkran EPA June 2009. Measurement of lead shot.

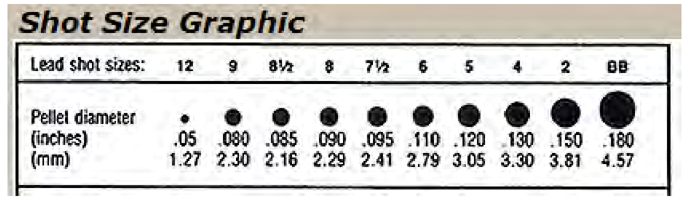


Figure 12. Shot size chart. http://shotgunworld.com.amm.html

The sampling protocol used at this site and many others sites across the country employs the technique of sieving soil samples to remove large rocks and items too large to give accurate readings in a homogenous soil sample. The sieving of soil also removes the lead shot and debris that are readily accessible and ingestible by children and which present a health hazard. The lead shot would therefore not be included in the lead extraction and leachability analysis or other tests performed by the laboratory. Analysis would only detect soluble lead. The material removed by the sieve including the hazardous lead shot is discarded and not evaluated or reported in the final sampling results. At TES, lead samples were sieved down to 0.250 mm to remove rocks and debris. The sieving process removed lead shot from any type of qualitative or quantitative analysis giving inaccurate results of the hazard potential.

Remediation decisions based solely on the results of soluble lead analysis may indicate that lead levels are too low to require cleanup. Using only soluble lead results as the remediation guide can lead to a mischaracterization of the hazard posed by the site allowing lead shot to remain in the soil. This was the case following the 1992 incident of a child bringing home lead shot. In previous investigations of the site, only soluble lead concentrations were analyzed and reported. The widespread presence of lead shot in the playground areas was not reported or considered by former investigators to be of concern. Laboratory analyses of soluble lead concentrations in soil were too low to warrant cleanup. Therefore no further actions were taken until 2009.

The 2009 CSE Phase II analysis indicated the average soil lead concentration was 180 mg/kg on the Tyndall Elementary School campus, much lower than the 400 mg/kg EPA residential lead standard. However, this time, the EPA Remedial Project Manager recognized the potential hazard of the lead shot on Tyndall Elementary School property and brought it to the attention of ATSDR. As a result, the Air Force removed contaminated soil from the school yard. The presence of elevated PAHs also supported the need for remediation. As a result of our work with the EPA and Air Force at this site, ATSDR issued a letter describing this critical public health concern and suggested recommendations for addressing this issue (Appendix B).

Other Guidelines that Include Lead Shot

Because the current EPA and AFCEE sampling methods do not specify a method to identify or quantify the acute hazards associated with direct ingestion of lead shot or metal debris, methods used at Tyndall were not representative of the site and did not address the concerns that suggested sampling was needed.

Guidelines were developed in 2003 by Interstate Technology and Regulatory Council (ITRC) for the characterization and remediation of Soils at Closed Small Arms Firing Ranges. This council, funded by the Department of Energy, Department of Defense (DoD), and EPA, and consisting of recognized technical experts from federal and state governmental agencies and industry, developed guidance and recommendations to address a number of technical issues that have presented problems in the past. For example, they recommend that a sampling method should be representative of the site and address the concerns that led to the need for sampling.

Hazards like those present at Tyndall can occur at many other locations. Therefore, ATSDR requests that the Department of Defense recognize direct ingestion of lead and other metal debris as a viable exposure pathway for children using former shooting ranges and other metal debris areas. Identification, characterization, and quantification of lead shot and metal debris needs to be included in investigations involving sampling and analysis for soluble lead. In this way, we can move closer toward the goal of protecting the health of our children.

Conclusions

1. Lead shot (pellets) and lead fragments found on the Tyndall Elementary School grounds presented an urgent public health hazard to children who may have ingested the lead shot (pellets) prior to the removal action. The Time Critical Removal Action was warranted. While most of the lead shot and fragments have been removed along with sand and soil, a small amount of lead shot may still remain on the school grounds under sidewalks and near utility conduits. Remaining lead shot may be brought to the surface during ground disturbing activities such as sidewalk repairs, road paving, and maintenance, renovation, and construction such that children may come in contact with such items.

2. ATSDR cannot determine the impact that lead shot in the playground has had on the Tyndall Elementary School students because of the low numbers of children tested and the delay from the time of possible exposure to the time when blood testing was conducted

3. ATSDR cannot determine the impact that the presence of polycyclic aromatic hydrocarbons (PAHs) in the playground soil has had on the health of children who used the school playgrounds because not enough information is known about the extent of PAH contamination present in the surface soil throughout the playground area at the surficial soil depths that children would routinely contact. The Air Force removed contaminated soil during the summer of 2009 as a Time Critical Removal Action. PAHs bind tightly to soil and therefore are not likely to have remained in the surface soil where children play.

4. Soil sampling methods did not take into account the direct ingestion pathway of lead fragments (shot). Therefore, the analytical results did not sufficiently represent the nature of the hazards at former small arms ranges such as Tyndall Elementary School where the potential for direct poisoning or injury to children existed.

Recommendations

1. The Air Force should prevent (e.g., via administrative or engineering controls) children from accessing areas beyond the school fence. A buffer zone just beyond the school fence perimeter should be established and cleaned up to ensure that contamination does not directly or indirectly migrate onto the school grounds. Cleanup should begin in those areas where access cannot be controlled.
2. The Air Force should conduct semi-annual grounds inspection for lead shot, lead debris and upkeep to include adding up to 6 inches of clean sand to the high foot-traffic areas of the playground.
3. Public health education for Tyndall Elementary School children and personnel should continue to help reduce the likelihood of harm from lead exposures. Parents should be informed that children may have brought lead shot or target debris home presenting a hazard to them and their siblings.
4. The Air Force and the Bay County Health Department should offer free annual blood lead testing for children attending Tyndall Elementary School. A testing day at the school to increase the percentage of participating students to at least 25% should be considered.
5. ATSDR is requesting the Air Force become environmental public health stewards by requesting that the Department of Defense notify all services that they should take prudent action to prevent children's exposures to lead shot at all schools, day care centers, homes, or playgrounds located near former shooting ranges. The notification should also stress that current environmental procedures might not assess the risk of acute lead poisoning.
6. ATSDR recommends that all Department of Defense entities adopt the Interstate Technology and Regulatory Council (ITRC) recommendations for the characterization and remediation of Soils at Closed Small Arms Firing Ranges (2003).
7. Additionally, ATSDR recommends instituting the following procedures at former shooting ranges and other metal debris areas:
    a. Identification, characterization, and quantification of lead shot and metal debris;
    b. Semi-annual review and removal of lead shot containing soil after ground disturbing activities such as sidewalk replacement, road paving, maintenance, renovation, or construction as these activities may bring lead shot and debris to the surface where children may come in contact with them; and,
    c. Provide or post continuous education on the lead hazards present for all users.

Public Health Action Plan

1. ATSDR is proposing a three pronged approach to preventing acute poisonings associated with children swallowing lead shot or pellets at former shooting ranges: 1) Engage the Armed Services to take proactive administrative actions; 2) Engage EPA and State health departments to develop an advisory plan; 3) Seek to educate the public.

2. In all cases, ATSDR is identifying a health hazard loophole in the current practices and urges EPA to protect the public health from these hazards at firing ranges (small arms ranges). Two important areas need to be addressed: 1) changes in soil sampling methodology; and 2) land use controls.

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APPENDIX A – Notification Letter to Parents (June 24, 2009)

June 24, 2009

Dear Parents, Guardians, Students, Faculty and Staff,

The health and safety of our students, faculty and staff is a top priority for Bay District Schools and specifically for the Tyndall Elementary School.

Background — As you may know, the Tyndall Elementary School was constructed in the 1950s on a portion of Tyndall Air Force Base (AFB) that was used as a shotgun range in the 1940s to train aerial gunners during World War II. In 2000, the Center for Disease Control's Agency for Toxic Substances and Disease Registry (ATSDR) evaluated lead in soil at the school. In past years, studies have been conducted to determine if levels of lead materials present upon the school grounds presented any risk. Results of these studies have previously indicated no health hazard.

Issue — However, in May 2009, additional sampling was conducted at our school by Tyndall AFB as a result of a Department of Defense directed firing range cleanup program. These samples indicate lead and polycyclic aromatic hydrocarbons (PAHs) in several areas were above residential screening levels. PAHs are associated with the clay targets used during the training. Attached is information regarding the contaminants found at our school.

Who is affected? — In response to these new sampling results, Tyndall AFB provided notifications to the various regulatory agencies and has requested ATSDR to take another look to determine if a health hazard exists. ATSDR states that "Children and adults who play or work at various outside locations at the Tyndall Elementary School may have been exposed to lead by accidentally eating lead after getting lead containing soil on their hands and then touching their mouth or eating food with unwashed hands, intentionally eating soil containing lead, or lead pellets, or breathing lead in kicked-up dirt or soil."

What is the concern? — Although the average amount of lead and PAHs in soil at the school is not likely to be a health hazard, there are areas with higher levels. Our main concern is that children may find lead shot or remnants of skeet interesting, and may be more likely to pick up and play with the material increasing their contact and thus risk for harm.

What is being done? — As a precautionary measure, the 325th Fighter Wing commander has initiated a project to remove up to 2 feet of soil from the playground and other associated areas where levels exceed standards for residential or school land use and replace it with clean soil. This project is expected to begin in the next few weeks to ensure soil removal is completed prior to school resuming in August. Until this project begins, fencing has been erected to restrict student access to affected areas of the campus. Additionally, students present during the summer will not be using the playgrounds. We will be providing you with updated information as it becomes available.

What should I do? To address the concerns of parents, ATSDR recommends having your young child's blood lead level checked. The Bay County Health Department will be providing screening for children with no military affiliation and the Tyndall clinical laboratory will be screening military dependent children.

We have attached informational flyers to this letter that provide detailed information regarding risks associated with exposure to lead and PAHs. The flyers outline procedures for accessing medical screening and provide contact numbers for both the Bay County and Tyndall AFB public health agencies.

We are currently working with the Air Force, the United States Environmental Protection Agency (USEPA), the Florida Department of Environmental Protection (FDEP), the ATSDR, and the Bay County Health Department to ensure a safe and healthy environment is maintained for our children.

If you have any further questions or concerns, please do not hesitate to contact our public health and regulatory partners listed in Attachment 1.

Sincerely,

Libbie Pippin

LIBBIE PIPPIN
Principal, Tyndall Elementary

Darryl L. Roberson

DARRYL L. ROBERSON, Brig Gen, USAF
Commander

3 Attchs:
1. Contaminants/Contact Information
2. Lead Trifold
3. PAH Trifold

APPENDIX B – Letter to US Army Center for Health Promotion and Preventive Medicine Requesting Sampling Procedure Changes

DEPARTMENT OF HEALTH & HUMAN SERVICES Public Health Service

Agency for Toxic Substances
and Disease Registry
Atlanta GA 30333

March 9, 2011

Ms. Ronie E. Shakelford
US Army Center for Health Promotion and Preventive Medicine
ATTN: MCHB-TS-EHR (Ronie E. Shakelford)
5158 Blackhawk Road
Aberdeen Proving Ground, Maryland 21010-5403

RE: Procedures for Former Ranges that Undergo Land Use Changes

Dear Ms. Shakelford:

We are writing to request the joint services help in protecting children from acute exposure to lead and other heavy metals at former shooting ranges and other metal debris areas. While current laws provide general protection, the current sampling and reporting practices fail to provide protection from ingesting edible-size lead or metal debris. We believe the solution may be to revise the soil sampling and reporting procedures at former shooting ranges, munitions areas, and other heavy metal sites, and we seek the assistance from your military experts. We are suggesting that the joint services consider adopting the guidelines developed by the Interstate Technology and Regulatory Council[1] and procedures recommended by the Agency for Toxic Substances and Disease Registry (ATSDR) found at the conclusion of this letter.

Characterizing lead contamination at shooting ranges is required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)[2] and the Resource Conservation and Recovery Act (RCRA)[3] which both identify certain soluble lead levels as a hazardous substance. Cleanup of lead is required if lead (and other heavy metals) can be dissolved and levels migrate at potentially harmful concentrations into surface water, plants, fish, wildlife, or drinking water sources.

[1] Interstate Technology and Regulatory Council 2003 Characterization and Remediation of Soils at Closed Small Arms Firing Ranges http://metalstt.com/newsreference/ITRC_GUIDE_CLOSE_SAFR.pdf.

[2] CERCLA codified as 40 CFR Part 302, addresses lead as a hazardous substance and requires the quantity of lead to be reported to EPA's National Response Center if the amount of lead released within a 24-hour period equals or exceeds one pound of lead particles with less than or equal to a diameter of 100 micrometers (0.1 millimeters, 0.004 inches).

[3] The EPA Military Munitions Rule appears in 40 CFR Part 266 Subpart M "Military Munitions" under RCRA. Parts 260 through Part 270 specify the characteristics for identifying when military munitions become hazardous waste under RCRA Subpart C. The four characteristics are 1) ignitability, 2) corrosivity, 3) reactivity, and 4) toxicity using the Toxicity Characteristic Leaching Procedure.

Page 2 – Ms. Ronie Shakelford

At present, U.S. Environmental Protection Agency (USEPA)[4,5] and the Air Force Center for Environmental Excellence (AFCEE)[6] recommend lead sampling methods to characterize the soluble lead and the fine lead particles (< 250 µm) which they consider the primary source of lead exposure from soil.[4] These methods include removing larger lead debris (e.g., pellets, shot, and fragments) by sieving the soil before analysis. Sieving the soil would identify hazards from fine grained soil-like particles and protect the environment from metals migration, but does not address the public health concern of children *directly ingesting lead shot or metal debris*.

ATSDR brings this potential public health problem to your attention because of a recent experience at Tyndall Air Force Base (TAFB), an active United States Air Force Base in Bay County, Florida. Tyndall Elementary School's 21-acre property was built in 1951 on a portion of TAFB property used in the 1940s as a shotgun range to train aerial gunners during World War II. Approximately 800 students from pre-kindergarten to fifth grade attend this school.

Soil sampling at the school followed the USEPA and AFCEE recommendations and detected lead levels below environmental cleanup standards. However, there was a larger threat to children at this site; lead debris (i.e., pellets, shot, and fragments) remained that could be eaten by children at school or be brought home and eaten by younger siblings. Because lead debris was left unaddressed by those sampling methods, lead shot and metal debris were found by the children. We believe this lead health threat would have been mitigated had the sampling guidance or the sampling recommendations specifically included the identification and reporting of larger, non-particulate lead material.

Lead shot ingested by a child can cause severe, acute lead poisoning. Numerous case studies have found lead shot in the stomach of people because of ingestion.[7,8,9] In such cases, x-rays of the abdomen have shown lead shot tends to accumulate in the appendix of these patients. Ingested metallic lead shot is made more soluble by stomach acids and can cause a spike in blood lead levels. One study found a level of 79 µg/dL (micrograms per deciliter) within hours following ingestion.[10] Such a spike of blood lead represents acute lead poisoning leading to the onset of unstoppable seizures, coma, cardio-respiratory arrest (heart and lung failure), and death.

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[4] EPA Technical Review Workgroup for Lead Recommendations for Sampling and Analysis of Soil at Lead Sites. April 2000. http://www.epa.gov/superfund/lead/products/sssiev.pdf

[5] EPA TRW Recommendations for Performing Human Health Risk Analysis on Small Arms Shooting Ranges 2003. http://www.epa.gov/superfund/lead/products/firing.pdf

[6] AFCEE, Technical Protocol for Determining the Remedial Requirements for Soils at Small-Arms Firing Ranges 2000. http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA418946&Location=U2&doc=GetTRDoc.pdf

[7] Greensher et al 1974. Lead Poisoning from Ingesting Lead Shot http://pediatrics.aappublications.org/cgi/reprint/54/5/641

[8] Gustavsson et al 2005. Intoxication from an Accidentally Ingested Lead Shot Retained in the Gastrointestinal Tract http://ehp03.niehs.nih.gov/article/info%3Adoi%2F10.1289%2Fehp.7594

[9] Verbrugge et al 2009. Human Exposure to Lead from Ammunition in the Circumpolar North http://www.peregrinefund.org/lead_conference/PDF/0110%20Verbrugge.pdf

[10] McKinney, PE (2000) Acute Elevation of Blood Lead Levels Within Hours of Ingestion of Large Quantities of Lead Shot. Clinical Toxicology, 38(4), 435-440.

Page 3 – Ms. Ronie Shakelford

Even at levels less than 79 µg/dL, there could be permanent damage to the brain, nerves and muscles, kidneys, and severe gastrointestinal problems. Furthermore, many lead poisonings might go undiagnosed. Acute effects from mild poisoning might go away and mild permanent damage might be misdiagnosed because the half-life of lead in blood is relatively short after an acute exposure. In cases of lead shot ingestion poisoning, children or adults may be asymptomatic or present with severe cramping abdominal pain which may be mistaken for severe abdominal pain or appendicitis.[11]

The current USEPA and AFCEE sampling methods do not specify a method to identify or quantify the acute hazards associated with direct ingestion of lead shot or metal debris. In fact the AFCEE guide advises sieving the soil material to remove "larger metal/target fragments that generally do not pose a risk via the incidental ingestion exposure route". Soil sieving is recommended through selectively smaller screens down to 250 µm (0.250 millimeter) (US Standard Number 60 sieve) which represents the particle size that adheres to children's hands.[4] This removes the larger lead debris because lead shot used for trap and skeet (Shot Number 7 to 9) ranges from 2.39 millimeters to 2.01 millimeters which is approximately ten times larger than the sieve. Therefore, lead debris removed by sieving would not be included in the lead extraction and leachability analysis. The only time the analysis of coarse material is recommended is for instances when *"degradation of the coarser materials into finer particles"* is possible.[4] Consequently, sieving is the primary method used for soil lead sample preparation before analysis. As a result, lead debris is excluded by sieving out, and areas with lots of lead debris might not qualify for cleanup, as was the case at Tyndall Elementary School.

The current USEPA and AFCEE sampling methods on the presence of lead shot or metal debris leave ATSDR with inadequate information to make health determinations to protect children from acute lead and other heavy metal poisoning. To protect against the effects of lead on children, we suggest that the joint services review and consider adopting the guidelines developed by Interstate Technology and Regulatory Council (ITRC) for the characterization and remediation of Soils at Closed Small Arms Firing Ranges 2003. This council, funded by the Department of Energy, Department of Defense (DoD), and USEPA, and consisting of recognized technical experts from federal and state governmental agencies and industry, developed guidance and recommendations to address a number of technical issues that have presented problems in the past. Generally, they recommend that a sampling method should be representative of the site and address the concerns that led to the need for sampling. ATSDR requests that DoD recognize direct ingestion of lead and other metal debris as a viable exposure pathway for children using former shooting ranges and other metal debris areas.

In addition to adopting the ITRC guidance, we recommend instituting the following procedures at former shooting ranges and other metal debris areas:

- Identification, characterization, and quantification of lead shot and metal debris;

[11] ATSDR 2010. Case Studies in Environmental Medicine Lead Toxicity http://www.atsdr.cdc.gov/csem/lead/docs/lead.pdf

Page 4 – Ms. Ronie Shakelford

- Prohibit reuse of those areas as schools and playgrounds;
- Frequent inspection and cleanup of those areas reused as parks and other recreational areas. Including:
  - Removal of the soils and shot when lead shot is found;
  - Evaluation of metal debris migration;
  - Annual review and removal of lead shot containing soil after ground disturbing activities such as sidewalk replacement, road paving, maintenance, renovation or construction as these activities may bring lead shot and debris to the surface where children may come in contact with them; and,
- Provide or post continuous education on the lead hazards present for all users.

We recognize that adopting the ITRC guidance and additional procedures is not just needed for the military – as there are many former privately owned shooting ranges throughout the United States; however, we bring this to your attention first. We appreciate the military's experience with munitions and guidance development and are keenly interested in your thoughts on moving forward with this recommendation. Should you have any questions or need additional information, please contact Mr. Gregory Zarus, Team Lead, Site and Radiological Assessment Branch, at (770) 488-0778 or email at GZarus@cdc.gov.

Sincerely,

William Cibulas

William Cibulas Jr., Ph.D.
CAPT, U.S. Public Health Service
Director
Division of Health Assessment and Consultation

cc:
Mike White

APPENDIX C – Environmental Regulations, Policies, Standard Operating Procedures and Methods

Environmental Regulations and Policies

Current environmental regulations and policies focus on lead shot that oxidizes when exposed to air and dissolves when exposed to acidic water or soil. Lead shot, lead particles, and dissolved lead can be moved by storm water runoff to nearby streams and rivers contaminating surface water, plants, fish, and wildlife. Dissolved lead can migrate through soils to groundwater contaminating aquifers and drinking water sources. While all of the above issues are valid public health concerns, they do not address the major public health concern of children, especially those at Tyndall Elementary School playground who may **directly ingest lead shot.**

Environmental laws such as EPA's Military Munitions Rule, RCRA, and CERCLA address these environmental issues as well as lead particulates (usually from active ranges) that become airborne from wind, foot traffic, soil disturbing activities, or target maintenance activities. The EPA Military Munitions Rule appears in 40 CFR Part 266 Subpart M "Military Munitions" under RCRA. Parts 260 through Part 270 specifies the characteristics for identifying when military munitions become hazardous waste. The four characteristics are 1) ignitability, 2) corrosivity, 3) reactivity, and 4) toxicity using the Toxicity Characteristic Leaching Procedure. If a total lead analysis indicates a level equal to or greater than 100 mg/kg, a Toxicity Characteristic Leaching Procedure (TCLP) must be performed. If the TCLP level exceeds 5 mg/L, the soil must be managed as a hazardous waste [CFR 2009]

CERCLA codified as 40 CFR Part 302, addresses lead as a hazardous substance and requires the quantity of lead to be reported to EPA's National Response Center if the amount of lead released within a 24-hour period equals or exceeds one pound of lead particles with less than or equal to a diameter of 100 micrometers (0.1 millimeters, 0.004 inches). Lead shot used for trap and skeet (Number 7 to 9) range from 2.39 millimeter, 0.094 inches to 2.01 millimeters, 0.079 inches [Shotgun World 2010]. Under CERCLA, even if the quantity of lead is not considered to be reportable, soil and groundwater containing lead can be investigated [AFCEE 2006].

Environmental regulations set broad yet defined specific details about the results of analysis (data). However, the methods and procedures used to gather information about lead shot are not specified and rely on the stake holders to determine.

Standard Operating Procedures and Methods

Environmental investigations use standard operating procedures (SOPs) for soil sampling which are not specified in the regulations such as CERCLA or RCRA. Soil sampling SOPs are applicable to the collection of representative soil samples, but can vary from site to site and contractor to contractor. Analysis of soil may determine whether concentrations of specific contaminants exceed established threshold action levels, or if the concentrations present a risk to public health, welfare, or the environment, but the sampling methods are usually established by the site team.

Additionally, while there are clean-up standards at the state and federal level, there is variability in the method used to determine the contaminant concentration of soil at sites. There are no requirements that stipulate a soil sample must be a composite sample or discrete sample or whether to use the maximum detected value or the average. EPA has provided many guidance documents that describe soil sampling protocol and provide suggestions. Because a person moves randomly across a contaminated area over time, to determine the amount of contamination a person would contact, exposure is thought to be best determined by averaging the sampling results of contaminant concentrations from the contaminated area [EPA 1992].

Recently EPA has drafted a white paper proposing guidance for sampling munitions sites and suggests that pulverization by grinding provides improved results especially for energetic material concerns [EPA 2010]. The method calls for grinding all material captured in sampling. "The issue of whether grinding is needed for metals appears to be complex and may be tied to the intensity of training activities, i.e. the number of rounds fired. Research into this topic is ongoing and includes the degree of grinding necessary, comparison of different grinders, and grinding cross-contamination issues." [EPA 2010].