Testimony of Kevin Frederick, Administrator
Water Quality Division
Wyoming Department of Environmental Quality

Before

U.S. Senate Committee on Environment and Public Works

Hearing to receive testimony on
"Cleaning up Our Nation's Cold War Legacy Sites"

March 29, 2017 at 10:00 AM
Room 406 Dirksen Senate Office Building

Good morning Chairman Barrasso, Ranking Member Carper, and honorable Members of the Committee. My name is Kevin Frederick. I am the Water Quality Administrator for the Wyoming Department of Environmental Quality, and I thank the Committee for inviting the State of Wyoming to share its perspective on environmental cleanup of Cold War legacy sites.

Wyoming is home to 38 formerly used defense sites. My comments today focus on those that have had the most significant environmental impact, which are the seven former Atlas Missile sites in southeast Wyoming. The Atlas Missile was the first fully operational strategic missile developed by the U.S. and was designed for deployment of nuclear warheads during the Cold War era of the late 1950's and early 60's. Missile sites were used for the housing, readiness, and potential launch of nuclear missiles. The Atlas Missile sites played a crucial role in protecting the

safety and security of the American people and ensured the military readiness of the United States armed forces. However, some of the sites have, and continue to cause serious environmental problems.

The Atlas used liquid rocket propellant for fuel and liquid oxygen as the oxidizer. Trichloroethylene, or TCE, a known carcinogen, was used to clean the rocket fuel tanks, engines, and lines to prevent accidental explosions. Spent TCE drained into a series of unlined pits and channels. The amount of TCE that may have been released ranges from hundreds to thousands of gallons at each site. It's been said that as little as one teaspoon of TCE can contaminate one million gallons of water.

Groundwater within the Ogallala aquifer underlying some missile sites has been impacted with TCE at levels far above the safe drinking water limit of 5 parts per billion. The Ogallala is one of the most important of the nation's aquifers, supplying the agricultural and drinking water needs of the bread-basket states in the Midwest. All of the missile sites are located within 75 miles of Cheyenne, the most densely populated area in the state and the home of F.E. Warren Air Force Base, one of the country's nuclear missile command and control launch centers. Residents rely heavily upon high quality groundwater, much from the Ogallala, for municipal drinking water supplies.

Wyoming's missile sites have some of the largest and deepest TCE plumes in the U.S. The largest, at Missile Site 4 eighteen miles west of Cheyenne, is roughly 12 miles long and 3 miles wide in places. At Missile Site 4, concentrations of TCE in groundwater are greater than 240,000 ppb, or 48,000 times the safe drinking water limit. Some of the City of Cheyenne's municipal drinking water supply wells, as well as two water wells owned by private landowners, have already been impacted by TCE from Atlas 4.

Plumes at three other sites are roughly 1 mile long by one-quarter to one-half mile wide, and the remaining two are a few hundred feet in length and width. All sites have TCE in groundwater ranging from hundreds to thousands of parts per billion. TCE plumes at three of the sites have migrated beneath adjacent private properties, and many of the people who live near the missile sites depend on private wells that are not equipped to remove TCE.

TCE is a dense non-aqueous phase liquid, which means that it tends to adhere to materials it comes into contact with—that is, it is sticky—and it sinks to the bottom of aquifers. Managing TCE contamination at missile sites in Wyoming is further complicated by highly variable and unpredictable geology, short fieldwork seasons, large volumes of TCE, and long time frames of more than 50 years since the releases occurred. Adding to that complexity, TCE typically cannot

be excavated and removed, and it is difficult to remediate. In short, these are not your garden variety contaminated sites.

Taken together, these factors make TCE very difficult, expensive, and time-consuming to clean up once it reaches groundwater, and costs quickly reach into the millions of dollars. Each of the seven Atlas Missile sites in Wyoming will require significant human and capital resources to complete cleanup, and each presents unique challenges and difficulties. Overall costs expended to date at the seven missile sites exceed $45,000,000, and much work remains to be done. As of 2015, the Department of Defense estimated that the cost to complete the investigation and remediation of formerly used defense sites in Wyoming at $285,134,000.

The Department of Defense is ultimately responsible for contamination at Atlas Missile sites. As the state's lead environmental oversight agency, the Wyoming Department of Environmental Quality coordinates with the Corps of Engineers to investigate, characterize, and remediate contaminated soils and groundwater at these sites. Of the seven sites in Wyoming, two are in the remediation phase to treat contaminant plumes; one is in pilot stage remedial testing; one is in the site characterization phase; two are awaiting DoD funding for site characterization; and one, Missile Site 7, is under evaluation for closure. Cleaning up the contamination from these Cold War era sites will require ongoing

cooperation between the Army Corps of Engineers and the Wyoming Department of Environmental Quality. While at times frustrating, the Wyoming Department of Environmental Quality is fortunate to have a relatively good and constructive working relationship with the Corps of Engineers. Collaboration between our respective agencies, together with public involvement, allows cleanup of these sites in a way that works, and that is cost effective. Upfront planning and communication, including a clear understanding of the roles and responsibilities of the agencies involved, and mutual understanding of the federal and state regulations at work are essential to the success of this endeavor. Adhering to these basic tenets makes the process work best for all parties involved.

Further details on each of the Wyoming missile sites, as well as observations and recommendations that may help improve the overall cleanup process at these sites, are provided in the Appendix to my written testimony.

Mr. Chairman, Mr. Ranking Member, and Members of the Committee, I thank you for your time and remain available to answer any questions you may have.

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Appendix

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By some estimates, there are over 300,000 sites in the United States where soil or water are contaminated. The United States Environmental Protection Agency estimates that expenditures for soil and groundwater cleanup at these sites through 2033 may exceed $200,000,000,000 (not adjusted for inflation).[1] At the formerly used Atlas Missile sites in Wyoming, groundwater impacts are particularly severe and will require significant effort to investigate and remediate. As of 2015, the Department of Defense estimated that the cost to complete the investigation and remediation of formerly used defense sites (FUDS) in Wyoming through 2060 at $285,134,000.

Several factors are expected to make cleanup of FUDS in Wyoming expensive. At the seven former Atlas Missile sites, trichloroethylene (TCE) has contaminated groundwater and threatened drinking water supplies in an already arid area where water is scarce. Wyoming sites are considered complex. Attributes that add to the complexity of cleaning up the former Atlas Missile sites include extensive groundwater contamination at depth, large releases and/or source zones, multiple and/or recalcitrant contaminants, widespread contaminant distribution in the subsurface, long timeframes since releases occurred, and heterogeneous geology. Complexity is also directly tied to the contaminants present. Some of the most challenging contaminants to remediate are dense non-aqueous phase liquids like TCE. Additionally, Wyoming has some of the largest and deepest TCE plumes in the US, rivaled only by TCE-contaminated Superfund sites.

The following table presents a status update on each missile site in Wyoming, including the corrective action period funded and Wyoming Department of Environmental Quality (WDEQ) oversight costs for each of those timeframes.

[1] *Alternatives for Managing the Nation's Complex Contaminated Groundwater Sites, by Committee on Future Options for Management in the Nation's Subsurface Remediation Effort; Water Science and Technology Board; Division on Earth and Life Studies*; National Research Council (2013).

Former F.E. Warren Atlas Missile Sites 1 through 7
Corrective Action (CA) Funding

Missile Site 1

CA Period	Installation	Total Approved	Total Pending	CA Year
2010-2012	FE WARREN AFB FAC SITE 1 (B08WY0464)	$2,951.51	$0.00	2009
2012-2014	FE WARREN AFB FAC SITE 1 (B08WY0464)	$1,177.81	$0.00	2011

Missile Site 1 is located 20 miles north of Cheyenne, immediately west of Interstate 25. This site has a TCE plume that measures 5,600 feet in length and 3,500 feet in width. Groundwater is flowing east and slightly northeast. Depth to water varies but is approximately 200 feet below ground surface (BGS). This site is currently unfunded by the U.S. Army Corps of Engineers (USACE) under the Defense and State Memorandum of Agreement (DSMOA) and not under active investigation or remediation. Groundwater monitoring was last conducted at this site in 2012. USACE investigation costs to date are $386,600. WDEQ oversight funds have been $4,129.32.

Missile Site 2

CA Period	Installation	Total Approved	Total Pending	CA Year
2010-2012	FE WARREN AFB FAC SITE 2 (B08WY0465)	$6,723.31	$0.00	2009
2012-2014	FE WARREN AFB FAC SITE 2 (B08WY0465)	$10,703.22	$0.00	2011
2014-2016	FE WARREN AFB FAC SITE 2 (B08WY0465)	$1,495.44	$0.00	2013
2016-2018	FE WARREN AFB FAC SITE 2 (B08WY0465)	$897.41	$0.00	2015

Missile Site 2 is located 16 miles northeast of Cheyenne, on the north side of State Highway 85. This site has a TCE plume that measures 4,500 feet in length and 3,000 feet in width. Concentrations range from 13 ppb to 14,000 ppb within the plume. Pilot studies are currently being conducted to determine the most appropriate way to perform in-situ bioremediation. USACE investigation costs to date are $4,102,200. WDEQ oversight between 2010 and 2016 is $18,921.97.

Missile Site 3				
CA Period	**Installation**	**Total Approved**	**Total Pending**	**CA Year**
2010-2012	FE WARREN AFB FAC SITE 3 (B08WY0466)	$17,371.78	$0.00	2009
2012-2014	FE WARREN AFB FAC SITE 3 (B08WY0466)	$17,329.94	$0.00	2011
2014-2016	FE WARREN AFB FAC SITE 3 (B08WY0466)	$53,467.57	$0.00	2013
2016-2018	FE WARREN AFB FAC SITE 3 (B08WY0466)	$3,224.78	$2,144.70	2015

Missile Site 3 is located 20 miles southeast of Cheyenne near Carpenter, WY. This site has a TCE plume that measures 6,400 feet in length and 2,400 feet in width. Concentrations range from 920 ppb to 21,000 ppb within the plume. The horizontal and vertical extent of contamination has not been defined. The vertical extent could be greater than or equal to 174 vertical feet of saturated thickness of the aquifer. The deepest well is 290 feet deep. The 2016 signed Decision Document identifies in-situ bioremediation as the groundwater remedy for the site. However, the expected timeframe to remedy complete is expected to occur in approximately 200 years. Additional work is expected to further evaluate the source zone (missile launchers) and define the leading edge of the plume. USACE investigation costs to date are $15,225,400. WDEQ oversight between 2010 and 2016 is $91,394.07.

Missile Site 4				
CA Period	**Installation**	**Total Approved**	**Total Pending**	**CA Year**
2010-2012	FE WARREN AFB FAC SITE 4 (B08WY0467)	$81,019.49	$0.00	2009
2012-2014	FE WARREN AFB FAC SITE 4 (B08WY0467)	$121,718.10	$0.00	2011
2014-2016	FE WARREN AFB FAC SITE 4 (B08WY0467)	$45,311.50	$0.00	2013
2016-2018	FE WARREN AFB FAC SITE 4 (B08WY0467)	$2,391.50	$1,220.55	2015

Missile Site 4 is located 16 miles west of Cheyenne, immediately south of Interstate 80. This site has a TCE plume that measures approximately 12 miles in length and 3 miles in width. TCE contamination in groundwater exceeds 240,000 parts per billion (ppb), well above the safe drinking water limit of 5 ppb. Atlas 4 also has the largest TCE contaminant plume (roughly 12 miles long by 3 miles wide) in Wyoming, and likely one of, if not the largest TCE plume in all of the country. The City of Cheyenne municipal water supply, as well as a two (2) private landowners' water wells, are currently or have been impacted by TCE from Atlas 4. The USACE has installed a water treatment system for the impacted municipal water wells and granulated activated carbon systems for private landowners; these systems are currently in operation and tested on an annual basis for effectiveness.

Vertical and horizontal depths are under investigation, but TCE is believed to have migrated down to the White River Formation, which is a tight claystone with lenticular arkosic conglomerate. USACE Investigation costs to date are $8,067,400. The City of Cheyenne municipal water supply treatment system for the TCE impacts cost $4.56 million with an annual operation and maintenance cost of $205,000. WDEQ oversight between 2010 and 2016 is $248,049.09.

Missile Site 5

CA Period	Installation	Total Approved	Total Pending	CA Year
2010-2012	FE WAR AFB AF FAC SITE 5 (B08WY0468)	$3,332.97	$0.00	2009
2012-2014	FE WAR AFB AF FAC SITE 5 (B08WY0468)	$4,319.40	$0.00	2011
2014-2016	FE WAR AFB AF FAC SITE 5 (B08WY0468)	$5,619.41	$0.00	2013
2016-2018	FE WAR AFB AF FAC SITE 5 (B08WY0468)	$751.23	$244.45	2015

Missile Site 5 is located east of the town of Chugwater, approximately 45 miles North of Cheyenne. This site has a TCE plume that measures 1,000 feet wide by 3,600 feet in length. The highest TCE concentration detected at this site is 370 ppb. Groundwater flow is northeast. The depth to water ranges from 93 to 130 feet BGS. The greatest depth at which TCE was detected above the MCL was at 138 feet BGS. However, because the adjacent deep well was 240 feet total depth, TCE could be above cleanup levels at greater depth. The separation between the 138 foot deep well and the 240 foot deep well is 102 feet. In-situ bioremediation is identified in the Decision Document as the remedy. Injection wells were constructed and bioremediation substrate injected in 2016. Effectiveness is still being evaluated. USACE investigation costs to date are $10,410,100. WDEQ oversight between 2010 and 2016 is $13,271.78.

Missile Site 6

CA Period	Installation	Total Approved	Total Pending	CA Year
2010-2012	FE WAR AFB AF FAC S-6 (B08WY0656)	$976.61	$0.00	2009
2012-2014	FE WAR AFB AF FAC S-6 (B08WY0656)	$1,014.55	$0.00	2011
2014-2016	FE WAR AFB AF FAC S-6 (B08WY0656)	$1,239.50	$0.00	2013

Missile Site 6 is located northeast of Cheyenne near Meriden, WY and west of State Highway 85. This site has a TCE plume that measures 500 feet by 800 feet. The maximum concentration of TCE in groundwater detected at the site to date is 101 ppb. PBC's have also been detected up to 1000 ug/kg in soils. Groundwater flow is east-southeast. The depth to water is approximately 100 feet. The greatest depth at which TCE was detected was 124 feet BGS. Additional monitoring well installation and groundwater field sampling was conducted in May 2015. DSMoA funding was not included in the original 2016-2018 Cooperative Plan. However, an addendum is under negotiation to include this site. USACE investigation costs to date are $1,228,400. WDEQ oversight between 2010 and 2016 is $3,230.66.

Missile Site 7				
CA Period	**Installation**	**Total Approved**	**Total Pending**	**CA Year**
2010-2012	FE WARREN AFB FAC SITE 7 (B08WY0657)	$1,104.98	$0.00	2009
2012-2014	FE WARREN AFB FAC SITE 7 (B08WY0657)	$1,831.64	$0.00	2011
2014-2016	FE WARREN AFB FAC SITE 7 (B08WY0657)	$1,837.74	$0.00	2013

Missile Site 7 is located in Pine Bluffs, close to and north of Interstate 80. Groundwater flows generally southeast and the depth to water varies but is generally 80 feet below ground surface. TCE has been detected at a maximum concentration of 134 ppb. At its maximum extent the TCE apparently extended horizontally less than or equal to 150 feet by 300 feet. The fracture flow in the area makes a determination of the horizontal extent of contamination somewhat ambiguous. The USACE has proposed No Further Action for Atlas 7, however, the WDEQ has not concurred and believes further investigation is necessary in order to support that determination. USACE investigation costs to date are $504,600. WDEQ oversight between 2010 and 2016 is $4,774.36.

Under the Defense State Memorandum of Agreement, WDEQ receives funding bi-annually to conduct state regulatory oversight activities at various federal facilities. WDEQ oversight includes review of corrective action investigation work plans, remedy evaluations, and monitoring results. WDEQ's oversight funding for the six-year period between 2010 and 2016 was $766,241.93. The majority of oversight activities during this timeframe focused on Missile Sites 3 and 4, where groundwater contamination presents the most serious and immediate threats. WDEQ has received funding from the FUDS Installation Restoration Program as follows:

CA Period	**Component Approved Amount**	**Obligated Amount**	**Total Spent**	**Total Spent on Missile Sites**
2010-2012	$302,007.00	$125,396.00	$125.396.00	$113,480.65
2012-2014	$179,100.00	$171,494.63	$171,494.63	$155,157.66
2014-2016	$208,622.00	$117,755.25	$117,755.25*	$108,971.16
2016-2018	$163,132.00	$80,000.00	$15,430.87	$7,264.92

**Staff retirement and hiring resulted in less staff to work on projects under the federal program.*

According to the most recent annual report to Congress, the United States Department of Defense has almost 26,000 active sites under its Installation Restoration Program where soil and groundwater remediation is either planned or underway. Of these, approximately 13,000 sites are the responsibility of the Army. The estimated cost to complete cleanup at all Department of Defense sites is approximately $12.8 billion.[2] (Note that these estimates do not include sites containing unexploded ordnance.).

We offer the following observations and recommendations in hopes of improving the overall success and efficient cleanup of these formerly used defense sites not only within Wyoming, but within other states as well:

[2] *Defense Environmental Programs Annual Report to Congress - Fiscal Year 2015.*

Cooperation between state and federal agencies plays a very important part in determining how quickly and effectively sites are remediated. Strong and ongoing collaboration, as well as early incorporation of state requirements and expectations significantly helps to minimize delays in implementing successful remedies. WDEQ has found that effective components of any missile site cleanup strategy emphasize real results for the money spent, incorporate state requirements early on, adequately fund state involvement, clearly define federal and state roles in the cleanup, and include opportunities for public involvement.

Consistent application of both state and federal regulations and guidance regarding investigation and cleanup is highly important.

Adequate funding can significantly improve the remediation process in terms of both time and overall project cost. Lack of federal funding may lead to technically inadequate and incomplete site characterizations; source areas may not be adequately investigated and defined, and ineffective, costly remedies may be determined from incomplete information. For example, in 2016 an investigation of the Burn Pits at Missile Site 4 identified significant groundwater contamination in this area. Limited investigations at this site had been ongoing for the previous 10 years. With adequate funding and complete investigation, the source of TCE contamination in groundwater beneath Missile Site 4 would likely have been discovered much earlier, and plans and funding for remediation implemented much sooner than is now the case.

States play an important role in the process. State agencies are often the lead regulatory agency, often have a great deal of institutional knowledge and familiarity with the sites, and understand state requirements that apply to the cleanup process. Their knowledge and experience are valuable assets in determining investigation and remediation approaches that can save both time and money and lead to successful cleanups.

State and federal agencies should collaborate closely in the development and awarding of Performance-based Contracts (PBCs) for investigation and remediation work. The Association of State and Territorial Solid Waste Management Officials (ASTSWMO), of which WDEQ is a member, has recently published a Position Paper (attached) on performance-based contracting at federal facilities. The paper identifies challenges States continue to face regarding the use of PBCs, and highlights areas still needing attention. It also provides recommendations, including a checklist to assist all parties involved in the development and implementation of PBCs in order to improve the process at federal facility cleanups.

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