NVLSP
NATIONAL VETERANS LEGAL SERVICES PROGRAM

Document Appendix:

NVLSP And VLSC White Paper Confirming That Veterans Who Served in Guam from 1958-1980 Were Likely Exposed to Dioxin-Containing Herbicide Agents Including Agent Orange

Part 2

February 12, 2021

Yale Law School
Veterans Legal Services Clinic

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This appendix provides a selection of sources cited in the National Veterans Legal Services Program (NVLSP) and Veterans Legal Services Clinic at Yale Law School (VLSC) white paper. Additional sources are not reproduced here due to copyright restrictions.

Part 1

Part 2

September 14, 2009

To the Veterans Administration:

For: Sgt Ralph A. Stanton
601 E Swenson
Savannah, Mo 64485

816-262-0097
rstanton@stjoelive.com

My name is Msgt LeRoy Glenn Foster, USAF, Retired. I am writing this letter to testify in support of Ralph A. Stanton's exposure to Agent Orange herbicides which I prepared, mixed and sprayed on Andersen AFB, Guam and all of the off base fuels facilities, cross country pipelines that spanned the island to the Naval Fuel Supply Depot underground storage tanks. I sprayed these herbicides in, on, and around all the places Sgt. Stanton had to work.

I prepared, mixed and sprayed these herbicides to include Agent Orange and Agent Blue herbicides which were packaged in 55 gallon drum containers identified with colored bands and 50 lb dry chemical bags with Monsanto on the bags. I was an A1C and a Sgt during the time frame of 1969 and 1970 and 1971. I worked in the 43rd Supply Squadron Fuels Division and was assigned to on and off base fuels facility operations. I used a five ton blue tractor truck and a yellow 750 gallon tank trailer which was an old MK1 oil and Adi trailer to service C124 Globemaster Aircraft which was converted into a herbicide spraying trailer.

I often would have to spray the entire pipe lines, hydrant pump stations on the flight line, the Quonset huts storing the packaged oil for the B52 bombers, the fuel valve pits, the security fences surrounding the flight line, the fuel storage facilities at Andy I, Andy II, the Liquid Oxygen bldg, the Fuel operations office, the truck refueling hardstands, the refueling fleet checkout area, all of the off base fuel storage facilities at Potts tank farm, Naval Air Station Fuel Booster pump station, Tumon Tank Farm and the entire Cross country pipeline.

I also sprayed at the Yigo and Dededo Packaged Oil warehouse Quonset hut where I operated forklifts to load and unload packaged oil for the B52 bombers jet engine oil. I would work many long hours but sprayed a lot there because of the jungle over growth . Sgt Stanton worked alongside me during the two years we were stationed there together. He often was rebuilding valves, pumps, filters etc. He also had to maintain corrosion control on those fuels systems and was always getting the wind blown spray on him. He would complain to me to keep that shit away from him as it would turn a chalky white on immediate contact.

He and I developed sterility there but never said anything to each other as we both probably thought that was much too personal to talk about. He and I have many serious diseases now and we both probably will not live much longer past 65 if we reach it. I have many friends now that have died in their forties and fifties from these herbicides.

I know that the US Air Force and the Department of Defense know the truth about these herbicides. The denial must end. I am asking our government to be honest now about these Agent Orange herbicides.

I swear to God that all of the above is true and correct.

Signed,

Msgt Leroy G Foster, USAF, Ret.
7524 E MAIN ROAD ROUTE 20
WESTFIELD, NEW YORK 14787-9663
716-232-4001
Retairforceman@aol.com

Witnessed this day of ...Sept. 15. 2009.
by.....
Notary Public...Suzanne M. Wilson
Notary Public signature.Suzanne M Wilson
Notary Public date and stamp

SUZANNE M. WILSON
Notary Public, State of New York
Qualified in Chautauqua County
Commission Expires Sept. 22, 20 11

Standard Form 600
Nov. 1952
Bureau of the Budget
Circular A-32
600-102

HEALTH RECORD — **CHRONOLOGICAL RECORD OF MEDICAL CARE**

DATE	SYMPTOMS, DIAGNOSIS, TREATMENT, TREATING ORGANIZATION (Sign each entry)
	USAF DISPENSARY (CLASS B) ANDERSEN AFB, GUAM
	USAF DISPENSARY CLASS B ANDERSEN AFB, GUAM
16OCT1968	Acne R Foster Vit A Tetracycline 250 BID RT 2 wks
	Some improvement, but still new lesion Foster RF Astringent BID Acne lotion hs RTC 2 wks to Dr. Wilson Daley
18NOV 1968	Acne R Tetracycline 250 BID Foster

SEX	RACE	GRADE, RATING, OR POSITION	ORGANIZATION UNIT	COMPONENT OR BRANCH	SERVICE, DEPT. OR AGENCY
					USAF

PATIENT'S LAST NAME—FIRST NAME—MIDDLE NAME	DATE OF BIRTH (DAY-MONTH-YEAR)	IDENTIFICATION NO.
Foster, Leroy C.		050 38 8104

SOCIAL SECURITY NUMBER _____

CHRONOLOGICAL RECORD OF MEDICAL CARE
Standard Form 600

I am adding this to show that Sgt. Foster is a "Creditable Witness". This medical record shows that Sgt. Foster was being treated for herbicide exposure while on Guam. He was never in Vietnam.

V. COMMENTS OF REPORTING OFFI[illegible] (Be factual and specific. Add any comments [illegible] increase the objectivity of the rating.)

FACTS AND SPECIFIC ACHIEVEMENTS: SSgt Foster established an effective operator maintenance program which greatly reduced system discrepancies and culminated in his section's ability to support numerous fuel handling operations. He maintained excellent rapport with CE and coordinated ground works for Tumon and Potts Tank Farm. He constantly insured that vegetation control of these two areas were continuously performed on a scheduled basis and because of his efforts, these facilities have always been excellent show-cases of the Fuels Management Branch. His excellent supervision and display of leadership resulted in the high morale and work productivity of his section. He has been very effective in accounting for over 17 million gallons of fuel, insuring that fuel is maintained at the highest quality for aircraft fueling. Right after Super Typhoon Pamela on 21 May 1976, SSgt Foster quickly reported to work and immediately made a comprehensive and complete survey of typhoon damage incurred at NAS Booster Station, the Cross-Country pipeline and the two off-base storage tank farms. He voluntarily worked 12 hours per day for over 10 days to restore off-base pumping capability and assisted at the base's mass restoration effort and clean-up program. STRENGTHS: Superior management and leadership ability, coupled with his vast technical knowledge of the bulk storage system are SSgt Foster's most valuable assets. OTHER COMMENTS: SSgt Foster fully supports the Equal Opportunity Program. I recommend him for promotion at the earliest possible time.

VI. REPORTING OFFICIAL

NAME, GRADE AND ORGANIZATION	DUTY TITLE	SIGNATURE / DATE
FRANCISCO R. SAN AGUSTIN, TSgt, FR458-66-1719, 43d Supply Squadron (SAC)	NCOIC Bulk Storage	DATE 29 June 1976

VII. INITIAL INDORSING OFFICIAL

I concur. SSgt Foster has performed outstandingly since his assignment to Andersen. He has established support with support agencies and maintains the off-base areas in an immaculate condition. He has proven himself to be an outstanding technician as well as a manager.

I am adding this performance report record to show Sgt. Foster duties and that he is a "Creditable Witness".

NAME, GRADE AND ORGANIZATION	DUTY TITLE	SIGNATURE / DATE
JAMES O. BURDETTE, SMSgt FR259-52-6292, 43d Supply Squadron (SAC)	Fuels Management Officer	DATE 30 June 1976

VIII. ADDITIONAL INDORSEMENT

I concur. I observed the efforts of SSgt Foster at least weekly. He is indeed an asset to this organization. His areas of responsibility are maintained in such a manner that promotes harmonious community relations and creates a favorable image for Andersen Air Force Base.

NAME, GRADE AND ORGANIZATION	DUTY TITLE	SIGNATURE / DATE
JACK D. WESTFALL, Colonel 235-54-0545FR, 43d Supply Squadron (SAC)	Commander	DATE 1 July 1976

IX. ADDITIONAL INDORSEMENT

NAME, GRADE AND ORGANIZATION	DUTY TITLE	SIGNATURE / DATE

* GPO : 1972 O - 470-666

Rating Decision	*Department of Veterans Affairs* *VA Regional Office*		Page 1 01/24/2011
NAME OF VETERAN Leroy G. Foster	VA FILE NUMBER 050 38 8104	SOCIAL SECURITY NR 050-38-8104	POA DISABLED AMERICAN VETERANS	COPY TO DAV

ACTIVE DUTY			
EOD	RAD	BRANCH	CHARACTER OF DISCHARGE
08/11/1967	03/25/1983	Air Force	Honorable
03/26/1983	11/30/1987	Air Force	Honorable

LEGACY CODES			
ADD'L SVC CODE	COMBAT CODE	SPECIAL PROV CDE	FUTURE EXAM DATE
	1		None

I am presenting this record to show that Sgt Foster is a "Creditable Witness". The VA has approved his agent orange exposure case for his disabilities caused by his exposure on Guam.

JURISDICTION: Reopened Claim Received 09/22/2009

ASSOCIATED CLAIM(s): 023; New/Reopen; 09/22/09
291; Specially Adapted Housing; 07/29/10
290; Automobile Allowance; 07/29/10

SUBJECT TO COMPENSATION (1. SC)

7017-7005 ARTERIOSCLEROTIC HEART DISEASE, S/P CORONARY ARTERY BYPASS, CLAIMED AS ISCHEMIC HEART DISEASE DUE TO EXPOSURE TO AGENT ORANGE
Service Connected, Peacetime, Incurred
Static Disability
100% from 08/14/1995
100% from 09/25/1995 (38 CFR 4.30)
100% from 12/01/1995
30% from 12/01/1996
100% from 09/22/2009

5242 DEGENERATIVE CHANGES OF THE LUMBAR SPINE
Service Connected, Peacetime, Incurred
Static Disability
40% from 11/05/2004

5299-5242 DEGENERATIVE DISC DISEASE AT C5-C6 AND C6-C7
Service Connected, Peacetime, Incurred
Static Disability
10% from 08/12/1992
20% from 11/25/1996
30% from 09/22/2009

7804 SCAR, CHEST AREA, CORONARY ARTERY BYPASS DONOR SITE
Service Connected, Peacetime, Incurred
10% from 09/27/1995

5215	RESIDUALS, FRACTURE RIGHT WRIST Service Connected, Vietnam Era, Incurred 0% from 12/01/1987 10% from 07/11/2001
7828-7800	RESIDUAL SCARRING FROM ACNE VULGARIS, CLAIMED AS CHLORACNE DUE TO EXPOSURE TO AGENT ORANGE Service Connected, Peacetime, Aggravated Static Disability 10% from 09/22/2009
5227	RESIDUALS, FRACTURE RIGHT RING FINGER Service Connected, Peacetime, Incurred 0% from 12/01/1987
7805	SCAR, RIGHT LEG, CORONARY ARTERY BYPASS DONOR SITE Service Connected, Peacetime, Incurred 0% from 09/27/1995

COMBINED EVALUATION FOR COMPENSATION :

0% from 12/01/1987
10% from 08/12/1992
100% from 08/14/1995
100% from 09/25/1995 (38 CFR 4.30)
100% from 09/27/1995
50% from 12/01/1996
60% from 07/11/2001
70% from 11/05/2004
100% from 09/22/2009
Individual Unemployability Granted from November 5, 2004

SPECIAL MONTHLY COMPENSATION :

S-1 Entitled to special monthly compensation under 38 U.S.C. 1114, subsection (s) and 38 CFR 3.350(i) on account of arteriosclerotic heart disease, s/p coronary artery bypass, claimed as ischemic heart disease due to exposure to Agent Orange rated 100 percent and additional service-connected disabilities of degenerative changes of the lumbar spine, degenerative disc disease at C5-C6 and C6-C7, independently ratable at 60 percent or more from 09/22/2009.

S-1 Entitled to special monthly compensation under 38 U.S.C. 1114, subsection (s) and 38 CFR 3.350(i) on account of arteriosclerotic heart disease, s/p coronary artery bypass, claimed as ischemic heart disease due to exposure to Agent Orange rated 100 percent and additional service-connected disabilities of degenerative changes of the lumbar spine, degenerative disc disease at C5-C6 and C6-C7, residual scarring from acne vulgaris, claimed as chloracne due to exposure to agent orange, residuals, fracture right wrist, scar, chest area, coronary artery bypass donor site, independently ratable at 60 percent or more from 09/22/2009.

imposed on offerors, contractors, or members of the public.

Gregory D. Showalter,

Army Federal Register Liaison Officer.

[FR Doc. 01–6056 Filed 3–9–01; 8:45 am]

BILLING CODE 3710–08–U

DEPARTMENT OF DEFENSE

Department of the Navy

Record of Decision for the Disposal and Reuse of Surplus Navy Property Identified in the Guam Land Use Plan Update (GLUP '94)

SUMMARY: The Department of the Navy (Navy), pursuant to section 102(2)(C) of the National Environmental Policy Act of 1969 (NEPA), 42 U.S.C. 4332(2)(C) (1994), and the regulations of the Council on Environmental Quality that implement NEPA procedures, 40 CFR parts 1500–1508, hereby announces its decision to dispose of surplus Navy property identified in the GLUP 94, Guam Land Use Plan Update (A Plan for Department of Defense Real Estate on Guam), dated April 1995 (GLUP '94). This surplus property is located in the United States Territory of Guam.

Navy analyzed the impacts of the disposal and reuse of GLUP '94 surplus Navy property in an Environmental Impact Statement (EIS) as required by NEPA. The EIS analyzed three reuse alternatives and identified the Reuse Plan for GLUP '94 Navy Properties, dated October 1996 (Reuse Plan), prepared by the GLUP '94 Reuse Planning Committee and the Guam Economic Development Authority (GEDA), as the GEDA Recommended Alternative. The Government of Guam is the Local Redevelopment Authority for these surplus properties, as defined in the Department of Defense Rule on Revitalizing Base Closure Communities and Community Assistance, 32 CFR § 176.20(a).

The alternative chosen will use the GLUP '94 Navy properties for parks and recreation, historic and natural resource conservation, residential, commercial, resort, industrial, and agricultural land uses, and extensive regional roadway improvements. These land uses will meet the Navy goals of achieving local economic redevelopment, creating new jobs, and providing additional housing, while limiting adverse environmental impacts and ensuring land uses that are compatible with adjacent property. Selection of the specific means to achieve the proposed redevelopment is in the hands of the acquiring entities and the local zoning authorities.

Background

In 1993, the Commander in Chief, United States Pacific Command assigned Navy to lead a review of all military land requirements on the island of Guam and develop a master plan for future DoD land use. Navy and the Department of the Air Force (Air Force) established the Guam Land Use Working Group to do a comprehensive review of military mission related land requirements on Guam.

Navy prepared and distributed a resulting master plan, known as the GLUP '94. The GLUP '94 recommended consolidation of military activities in the northern and southern parts of the island and it identified more than 8,000 acres of releasable Air Force and Navy properties.

Under the authority of the Defense Base Closure and Realignment Act of 1990, Public Law 101–510, 10 U.S.C. 2687 note (1994), the 1995 Base Realignment and Closure (BRAC) Commission recommended that Navy dispose of the property declared releasable under the GLUP '94, with appropriate restrictions. These recommendations were approved by President Clinton and accepted by the One Hundred Fourth Congress in 1995.

Description of the Property

The EIS analyzed the disposal and reuse of 2,798 acres of the 8,081 acres identified in the GLUP '94. The analysis excluded the GLUP '94 property owned by Air Force, Naval Air Station (NAS) Agana property covered under separate environmental documentation, 50 acres at Barrigada that will be transferred to the National Guard Bureau, 24 acres consisting of the Agana, Piti and Tanguisson Power Plants that Navy plans to convey by special legislation and agreement, and 23 acres at New Apra Heights which was conveyed by the Secretary of Health and Human Services to the Government of Guam for the construction of the Agat-Santa Rita Wastewater Treatment Plant. In addition to the GLUP '94 properties, the EIS analyzed the 92-acre NAS Agana Officers Housing property that was recommended for closure by the 1995 BRAC Commission.

During the Federal screening process, the National Guard Bureau requested an interagency transfer of base closure property on Guam. Navy plans to transfer about 50 acres located in Barrigada to the National Guard Bureau for use in training activities and construction of additional facilities to support the Guam Army National Guard. This property consists of about 24 acres currently leased to the Guam Army National Guard and an additional 26 acres contiguous to the 24-acre site.

The 20 GLUP '94 surplus Navy properties considered in the present NEPA study range in size from 2 acres to 698 acres and are found in the northern, Barrigada, central, and southern regions of Guam. Navy currently has no operations at any of the 20 properties slated for disposal. Combined, the 20 properties contain about 320 residential units and 17 structures that were formerly used for operations, training, printing, communications, storage, commercial, recreation, agriculture, infrastructure, and support activities. The open space and undeveloped areas contain vacant fields, closed landfills, a beach park, wetlands, ravine forests and forests with limestone soils, savanna grassland, and steeply sloped, heavily vegetated areas. There is a commercial quarry operation located on one property. There are also archaeological sites eligible for listing on the National Register of Historic Places on nine of the properties.

Navy designated, in GLUP '94, the names and location numbers for each property. The northern region contains five properties totaling 824 acres: The Federal Aviation Administration (FAA) Housing (N2) property; the Harmon Annex (N3) property; the Marine Drive Utility (N4b) property; the Tamuning Telephone Exchange (N4c) property; and the NAS Officers Housing property (a non-GLUP '94 property) located at former NAS Agana.

The Barrigada region contains four GLUP properties totaling 773 acres: The Barrigada Route 16 (N5a) property; the Barrigada Route 15 (N5b) property; the Barrigada Hawaiian Rock (N5c) property; and the Barrigada Antenna Site (N5d) property.

The central region contains five GLUP properties totaling 953 acres: The Nimitz Hill Enlisted Housing (N10a) property; Nimitz Hill Vacant Lands (N10b) property; the Sasa Valley (N12a) property; the Tenjo Vista (N12b) property; and the Polaris Point (N14) property.

The southern region contains six GLUP properties totaling 271 acres: The New Apra Heights (N15) property; the Route 2A (N16) property; the Affleje/Rizal Beach (N17) property; the Old Apra Heights (N18) property; the Navy Ordnance Annex North (West Parcel) (N19a) property; and the Navy Ordnance Annex North (East Parcel) (N19b) property.

The Environmental Analysis Process

Navy published a Notice Of Intent in the **Federal Register** on April 10, 1998, announcing that Navy would prepare an

EIS for the disposal and reuse of surplus Navy property on Guam. On May 7, 1998, Navy held a public scoping workshop at the Chamorro Village in Agana, Guam; The scoping period concluded on May 26, 1998.

Navy distributed the Draft EIS on May 14, 1999, and commenced a 45-day public review and comment period that was extended until September 15, 1999. Both oral and written comments were received. On August 26, 1999, Navy held a public hearing at the Guam Hilton hotel in Agana.

Navy's responses to the public comments concerning the Draft EIS were incorporated in the Final EIS (FEIS), which was distributed to the public on September 27, 2000, for a review period that concluded on October 23, 2000. Navy received one letter commenting on the FEIS.

Alternatives

In the FEIS, Navy analyzed the environmental impacts of three reuse alternatives. Navy also evaluated a ''No Action'' alternative that considered leaving the property in caretaker status with Navy maintaining the physical condition of the property, providing a security force, and making repairs essential to safety.

In Guam Executive Order No. 96–19, dated July 9, 1996, the Governor of Guam, Carl T.C. Gutierrez, assigned the requirement to develop and implement a reuse plan for the GLUP '94 properties to Guam Economic Development Authority (GEDA). Also in this order, the Governor created the GLUP '94 Reuse Planning Committee to assist GEDA in this task. In October 1996, the Reuse Planning Committee and GEDA prepared the Reuse Plan for GLUP '94 Navy Properties. The Reuse Plan was approved by the Guam Legislature on December 23, 1996, and signed by the Governor of Guam on January 2, 1997.

The Reuse Plan provides general land use descriptions and estimated acreage. The Reuse Plan does not quantify development densities, such as number of and sizes of buildings and structures. The Reuse Plan also does not provide details of the infrastructure and roadway improvements required to support its proposed redevelopment of the properties.

In order to analyze potential impacts on the environment, such as infrastructure, traffic, population change, and socioeconomic conditions, Navy made projections of the future development to estimate the number and size of the buildings and structures at each property that would be consistent with the Reuse Plan. Navy considered roadway expansion, easements, site constraints and used the then-applicable *I Tano-ta Land Use Plan* to estimate development densities.

The *I Tano-ta* provided a framework to manage growth and land development on Guam. The plan provided guidelines for development intensities and zoning code performance standards. The *I Tano-ta* was passed by the Guam Legislature on April 17, 1998, as Guam Public Law 24–171, and went into effect on May 1, 1999. However, the Guam Legislature repealed the law within a few days. Currently, the Governor of Guam has responsibility to act on the future of the *I Tano-ta*. GEDA has indicated that regardless of the status of the *I Tano-ta*, the proposed land uses under the Reuse Plan remain valid.

The Alternative Selected

The selected alternative, identified in the FEIS as the GEDA Recommended Alternative, proposes a mix of land uses for the 20 properties including development of parks, recreational areas, historical and natural resource conservation projects, residential, commercial, resort, industrial, and agricultural land uses, as well as extensive regional roadway improvements.

The FAA Housing (N2) property covers about 698 acres along the coast of the Philippine Sea less than one mile south of Anderson Air Force Base. There were 89 residential units on this property that provided housing for FAA and Navy personnel, and these units were demolished due to irreparable damage from Typhoon Paka in 1997. The remainder of the land contains undeveloped forests with limestone soils. The selected alternative will develop a 128-room resort hotel, a 225-acre 18-hole golf course, and 390 single-family residential units. Conservation and recreational areas will be set aside to protect the natural and cultural resources located on the cliff line.

The Harmon Annex (N3) property, covering seven acres in an undeveloped area south of the FAA Housing property, contains a two-story building (Building 50) and a storage shed. The structures are surrounded by grass fields and paved areas. The selected alternative will develop Building 50 as a community center.

The Marine Drive Utility (N4b) property, covering 25 acres north of Marine Drive (Route 1) and west of Route 3, contains Building 169, a former Stars and Stripes facility. This grassy property is divided by an electric substation and is constrained by utility easements. The selected alternative will develop 150,000 square-feet of space for commercial activities.

The two-acre Tamuning Telephone Exchange (N4c) property is found below the cliff line of Tiyan (NAS Agana) on the south side of Marine Drive. The exchange contains two buildings surrounded by paved areas. The selected alternative plans demolition of the two buildings an development of about 27,000 square feet of space of commercial activities.

The NAS Officers Housing property at Tiyan covers 92 acres on top of a steep bluff. The selected alternative plans demolition of the existing 136 residential units. This alternative will also develop the Navy Post Exchange building as a neighborhood commercial center. The Government of Guam plans to build the Laderan Tiyan Parkway along the property's perimeter, which will provide an alternate access across the Tiyan plateau for the A.B. Won Pat Guam International Airport.

The Barrigada Route 16 (N5a) property, covering 345 acres, is found about one half mile southwest of Tiyan, south of the Naval Communication Areas Master Station Western Pacific Barrigada, and east of the National Guard Armory and P.C. Lujon School. Most of the property is open area for agriculture, athletic fields, and closed landfills. The selected alternative will develop a 42-acre recreational park, a 20-acres sports complex, and 100,000 square feet of space for industrial activities and warehouses. The remainder of the property will support agriculture.

The Barrigada Route 15 (N5b) property, located east of the Barrigada Route 16 parcel and the Navy's Admiral Nimitz Golf Course, covers 358 acres. Most of the land is undeveloped except for a vacant FAA Communications Building used most recently for golf course maintenance equipment storage. This property also contains closed landfills. The selected alternative will build about 1,500 affordable single-family residential units here.

The Barrigada Hawaiian Rock (N5c) property, covering 15 acres, is found east of Route 15 and adjacent to the southeastern corner of the Barrigada Route 15 (N5b) property. Hawaiian Rock Products Corporation operates a quarry facility of 10 acres of the property. The selected alternative will allow the quarry operations to continue. This alternative will also permit development of about 3,000 square feet of space for industrial facilities and warehouses.

The Barrigada Antenna Site (N5d) parcel is found east of Route 15 and covers 55 acres that formerly supported

a Navy transmitter antenna. One building and four homes built by trespassers are located on the property's north end. The selected alternative will demolish these buildings; it will allow for construction of about 220 affordable single-family residential units and 10,000 square feet of space for commercial activities.

The Nimitz Hill Enlisted Housing (N10a) property covers 120 acres in the central region in the municipality of Asan. This property contains 78 residential units, recreational facilities, and a Quonset hut. The enlisted housing was part of the larger United States Naval Station, Nimitz Hill Annex that extended to the southeast. The Department of Defense Education Activity High School and Navy's Flag Circle housing are located to the southwest. The selected alternative will use the existing residential units for affordable and social service housing and it will allow for construction of an additional 80 single- and multi-family residential units here. This alternative will use the recreational facilities and it will preserve the property's steep slopes and dense vegetation.

The Nimitz Hill Vacant Lands (N10b) parcel covers 183 acres south of Route 6 and the Nimitz Hill Enlisted Housing (N10a) property. A Navy Public works Center sewage pumping station is located in the northern part of the property. The selected alternative will develop about 100,000 square feet of space in the northern part of the property for commercial and cultural facilities, such as hotels, shopping centers, theaters, museums and art galleries. In the southern part of the property, this alternative will build about 200 affordable residential townhouses along Mount Alutom Road. The remaining undeveloped forests will be set aside for hiking trails and conservation.

The nine-acre Sasa Valley (N12a) property, found in the central region municipality of Piti, was part of a former Navy tank farm. There are no structures on the property and it is steeply sloped and heavily vegetated. The selected alternative will allow for possible expansion of the Guam Veterans Cemetery located to the north and set aside the remainder of the property for conservation.

The Tenjo Vista (N12b) parcel, covering 559 acres, contains steeply sloped forests and wetlands. The property is located to the east of Route 1 (Marine Drive), the Polaris Point (N14) property, and both Inner and Outer Apra Harbor. There are active and inactive petroleum lines that lie beneath the property; the center of the property was a tank farm. The selected alternative will develop about 3,000 square feet of space for commercial activities along Marine Drive and it will set aside about 480 acres for conservation.

The Polaris Point (N14) property covers 82 acres and is found west of Marine Drive across from the Tenjo Vista (N12b) property. Polaris Point Access Road crosses the property from east to west and provides access to the retained Polaris Point Navy facilities. Outer Apra Harbor lies northeast of the property and Inner Apra Harbor lies southwest. There are wetlands on the northern part of the property. The southern part of the property contains one building and concrete berms remaining from the former Naval Supply Depot drum storage and waste facility. The selected alternative will develop about 50,000 square feet of space for industrial activities and warehouses and it will also preserve the wetlands.

The New Apra Heights (N15) property, covering 102 acres of undeveloped land, is found in the southern region municipality of Santa Rita. Steep slopes and swamp forest wetlands characterize the site. The selected alternative will support the development of a Government of Guam wastewater treatment plant, the widening of Routes 2A and 5, and set aside the remainder of the property for conservation.

The Route 2A (N16) property, covering 15 acres, is found in the southern region in the municipality of Sanata Rita and west of the New Apra Heights (N15) property. The property contains foundations from a demolished building. The selected alternative plans development of about 32,000 square feet of space for commercial and office uses.

The Aflleje/Rizal Beach (N17) property covers 16 acres and is found in the southern region in the municipality of Santa Rita. The property is bounded on the north by the Apra Harbor Naval Complex; on the east by Shoreline Drive (Route 2) and the Public Works Center Guam landfill; on the south by The War in the Pacific National Historical Park; and on the west by Agat Bay. The selected alternative will continue use of the property as a beach park and for conservation.

The Old Apra Heights (N18) property, a linear strip of undeveloped land located east of Cross Island Road (Route 17) in the municipality of Santa Rita, covers 13 acres. The property is traversed by access roads (driveways) that lead to private residence found further to the east. There is a Guam Power Authority electrical substation adjacent to the southern part of the property. The selected alternative will develop industrial activities on about 4.5 acres to support the Guam Power Authority's activities. This alternative will also develop 5,000 square feet of space for small neighborhood businesses on the remaining 8.5 acres.

The Navy Ordnance Annex North (west) (N19a) property covers 50 acres and it consists of undeveloped land with steep slopes and dense vegetation. It is found in the municipality of Santa Rita along Route 5 and surrounds the Tupo Reservoir. The selected alternative uses the property for parks and recreational activities.

The Navy Ordnance Annex North (east) (N19b) property, covering 52 acres, is found directly east of the Navy Ordnance Annex North (west) property on the other side of Route 5. Seventeen vacant residential units are in the southern part of the property, while the northern part of the property is undeveloped. The selected alternative will use the existing residential units and allow for development of about 11,000 square feet of space to support development of a youth camp.

Other Alternatives

Navy analyzed a second ''action'' alternative, described in the FEIS as the Lower Intensity Alternative. This alternative considers development of the GLUP '94 properties with more open space and less construction. Under this scheme, some existing facilities will be renovated rather than expanded, and fewer new buildings will be built.

In general, the Lower Intensity Alternative reduces the build-out proposed by the selected alternative by one-half. It proposes a smaller resort at the FAA Housing parcel, and would not develop a golf course. Residential development is reduced, with most of the residential units to be located in the northern and Barrigada regions. There would be less commercial development in residential neighborhoods. The Lower Intensity Alternative develops about half of the square footage proposed by the selected alternative for commercial facilities and warehouses. This alternative develops no industrial facilities at the Polaris Point (N14) property. Finally, the Guam Veterans Cemetery, the barrigada Sports Complex, and agricultural activities in Barrigada are not expanded.

Navy analyzed a third''action'' alternative, described in the FEIS as the Higher Intensity Alternative. Reuse would be similar to that proposed under the selected alternative, but with an increase in development densities approaching the maximum allowed

under Guam's then-applicable I Tano-ta land use and zoning guidelines. The Higher Intensity Alternative would allow for more new construction and development than that proposed under the selected alternative.

The Higher Intensity Alternative develops a larger resort in the northern region and it builds a 27-hole golf course at the FAA Housing (N2) property. This alternative builds a larger building at the Harmon Annex (N3) property for educational, office or community center activities. The Higher Intensity Alternative also develops larger residential subdivisions on all the properties where housing was proposed under the selected alternative. Compared to the selected alternative, the Higher Intensity Alternative would double the amount of proposed square footage of commercial and industrial facilities on several properties. This alternative also allows the Guam Power Authority to build a base load-generating power plant on the Rizal/Aflleje Beach (N17) property.

Environmental Impacts

Navy analyzed the direct, indirect, and cumulative impacts of each alternative. Effects on soils, geology, topography, hydrology, air quality, land use compatibility, noise, cultural resources, terrestrial biota and habitat, marine environment, roads and traffic, infrastructure, socioeconomic conditions, public services, and public health and safety are discussed in detail in the Environmental Impact Statement.

Significant Effects

The selected alternative will have a significant impact on land use compatibility. The proposed residential development on the Barrigada Route 15 (N5b) property is incompatible with the existing Hawaiian Rock Products Corporation quarry operations located on the Barrigada Hawaiian Rock (N5c) property. These incompatibilities could be mitigated by the use of buffers, screening, setbacks, and noise attenuation measures. This alternative would not have a significant impact on visual resources.

The selected alternative will have significant noise impacts on the new housing to be built on the NAS Officers Housing property and in the Barrigada region. The proposed residential development at the NAS Officers Housing property would be subject to vehicular noise along the proposed Laderan Tiyan Parkway. The proposed residential development in Barrigada would be subject to noise generated by the Hawaiian Rock Products Corporations' quarry operations. The impacts from noise could be mitigated by the use of buffers and noise attenuation measures.

The selected alternative could have a significant unmitigable impact on cultural resources. Pursuant to Section 106 of the National Historic Preservation Act of 1966, 16 U.S.C. 470f, (1994), and its implementing regulations, Protection of Historic Properties, 36 CFR part 800, Navy conducted a cultural resource assessment and determined that nine GLUP properties are known to contain historic sites, structures, or objects that are either listed or eligible for listing on the National Register of Historic Places. These nine properties are FAA Housing (N2), Barrigada Route 15 (N5A), Barrigada Route 16 (N5B), Nimitz Hill Enlisted Housing (N10A), Nimitz Hill Vacant Lands (N10B), Sasa Valley (N12A), Tenjo Vista (N12B), Polaris Point (N14), and Rizal/Aflleje Beach (N17).

Navy has completed consultation with the Advisory Council on Historic Preservation and the Guam Historic Preservation Officer pursuant to Section 106 and its implementing regulations. These consultations identified actions that Navy must take before it conveys GLUP '94 property and actions that the acquiring entities must take to avoid or mitigate adverse impacts on the archaeological sites that are listed or eligible for listing on the National Register. These obligations were set forth in a Programmatic Agreement, dated July 13, 2000, among Navy, the Advisory Council on Historic Preservation, and the Guam Historic Preservation Officer.

Navy will include a protective deed covenant in the conveyance documents for all historic properties. The provisions in the deed covenant will require that the acquiring entities: Obtain the express written permission of the Guam Historic Preservation Officer prior to undertaking actions that would disturb the ground of a historic site, make reasonable efforts to prevent vandalism or other disturbances, and permit the Guam Historic Preservation Officer the right to inspect the archaeological site at all reasonable times.

Under terms of the Programmatic Agreement, all projects sponsored, funded or authorized by the Government of Guam or GEDA that have the potential to affect historic properties will undergo review in accordance with Title 21 Guam Code Annotated, Chapter 76, Historical Objects and Sites (1994). As the selected alternative will develop several properties containing historic sites, the Guam Historic Preservation Officer's permission must be obtained and archaeological data recovery or other protective measures may be required.

The selected alternative will have significant impacts on traffic and circulation. By the year 2010, traffic volumes on affected roadway segments will increase from as little as one percent to as much as 40 percent on heavily affected routes. Implementation of this alternative will impact key intersections in the northern, Barrigada, and southern regions of Guam. With the exception of one northern region intersection at Routes 1 and 16, these impacts could be mitigated by the installation of traffic signals and turning lanes, realignment of intersection approaches, widening of roads, and increasing alternative transportation programs.

The selected alternative will have a significant cumulative impact on the demand for electricity. The demand for electricity by this alternative and other planned developments on Guam would require the Guam Power Authority to develop new electrical capacity earlier than previously projected. The selected alternative will upgrade or replace the electrical distribution systems at each property during redevelopment.

The selected alternative will have a significant impact on schools. This alternative's proposed residential development will substantially increase the number of students in the northern, Barrigada, and southern regions of the island. Local schools in Guam are already at capacity and in some cases the schools are over capacity. The Reuse Plan does not propose to build new schools on the GLUP properties.

The selected alternative will have significant cumulative impacts on Guam's health care, police, fire protection, and civil defense services. The new residential development in the northern and Barrigada regions proposed by the selected alternative and other planned developments on Guam will substantially increase the demand for these public services.

Less Than Significant Impacts of Disposal and Reuse

The selected alternatives will not have a significant impact on soils, geology, or topography. The Guam Environmental Protection Agency requires soil erosion control measures for new construction that will minimize soil erosion. Guam is located in a highly active seismic region. New construction activities will be required to meet current building codes governing seismic safety.

The selected alternative will not have a significant impact on storm water runoff and drainage patterns, surface and groundwater quality, or aquifer recharge potential. This alternative will alter drainage patterns and substantially increase the quantity of storm water runoff on eight properties (Harmon Annex, Marine Drive Utility, Tamuning Telephone Exchange, NAS Officer Housing, Barrigada Route 15, Antenna Site, Nimitz Hill Enlisted Housing, and Nmitz Hill Vacant Lands), with the largest increase (48 percent) at the proposed Barrigada Route 15 residential development. Runoff will be controlled by measures imposed by the Guam Environmental Protection Agency. Compliance with regulatory requirements, Best Management Practices, and spill prevention plans will minimize the potential for future groundwater contamination. The selected alternative will not have a significant impact on aquifer recharge potential.

Six GLUP '94 properties contain flood hazard zones: Tamuning Telephone Exchange, Barrigada Route 16, Tenjo Vista, Polaris Point, Route 2A, and Aflleje/Rizal Beach. Development in flood zones must comply with Guam's floodplain management regulations. Additionally, in accordance with Executive Order 11988, Floodplain Management, 3 CFR 117 (1978), Navy will place a notice in the conveyance document that describes those uses that are restricted under Federal and local floodplain regulations.

Five properties contain wetlands: Barrigada Route 16, Barrigada Route 15, Tenjo Vista, Polaris Point, and New Apra Heights. Compliance with Federal and local regulations governing development in wetlands will prevent significant impacts. Additionally, in accordance with Executive Order 11990, Protection of Wetlands, 3 CFR 121 (1978), Navy will place a notice in the conveyance document that describes those uses that are restricted under Federal and local wetland regulations.

The selected alternative will not have a significant impact on air quality. Compliance with the regulatory requirements that control emissions, such as the Clean Air Act, 42 U.S.C. 7401–7671q (1994), and Guam's Air Pollution Control Standards and Regulations, Guam Public Law 24–322 (1998), will prevent significant impacts from stationary sources. Emissions from vehicular sources are not expected to exceed Federal regulations; therefore, no significant impacts on air quality are anticipated.

The selected alternative will not have a significant impact on terrestrial biota and habitats. Navy consulted with the United States Fish and Wildlife Service under section 7 of the Endangered Species Act of 1973, 16 U.S.C. 1536 (1994). In a letter dated January 18, 2000, the Fish and Wildlife Service concurred with Navy's determination that the proposed disposal and reuse, as outlined in the Reuse plan, of the surplus Navy properties is not likely to adversely affect the following Federally-listed endangered species on Guam: the fire tree (*Serianthes nelsonii*), Mariana crow (*Corvus kubayi*), Mariana fruit bat (*Pteropus mariannus mariannus*), Mariana common moorhen (*Gallinula chloropus guami*), and the Federally-listed threatened green sea turtle (*Chelonia mydas*).

The acquiring entities will be required to prepare Environmental Protection Plans (EPPs) pursuant to the Water Pollution Control Act, Title 10, Guam Annotated Code, Part 2, Ch. 47. EPPs are management plans that identify protective measures and constraints for individual projects that must be submitted to Guam environmental Protection Agency for review and approval. The Government of Guam and the Fish and Wildlife Service executed a Memorandum of Understanding (MOU) to establish and maintain a program for the conservation of Federally listed threatened and endangered species.

The selected alternative will not have significant impact on marine resources or Federally listed threatened or endangered marine species. Navy engaged in consultation with the National Marine Fisheries Service under section 7 of the Endangered Species Act. In a letter dated December 23, 1999, the National Marine Fisheries Service concurred that the proposed disposal and reuse of the surplus Navy properties would not likely adversely affect Federally listed threatened or endangered marine species.

The selected alternative will not have significant impacts on potable water, wastewater collection and treatment facilities, and the capacity for solid waste disposal. The Guam Waterworks Authority has projected that the island will have an excess capacity of 10 million gallons per day (mgd) of potable water in 2010. The projected demand for potable water under the selected alternative will be about 1.5 mgd, which is below the available excess capacity of 10 mgd.

There is adequate capacity available at the three wastewater treatment plants (the Northern District Wastewater Treatment Plant (WWTP), the Agana WWTP, and the Agat WWTP) that are planned to service the GLUP properties. The selected alternative will upgrade or replace the wastewater and treatment distribution systems at each property during redevelopment.

The selected alternative assumed that new solid waste facilities would be developed because the Ordot Landfill, which has no excess capacity, will close. The amount of solid waste generated by this alternative is projected to be less than three percent of the total municipal solid waste generated on Guam in the year 2008. Guam's Integrated Solid Waste Management Plan recommends the reuse, recovery, and recycling of solid waste to lessen the impacts on solid waste facilities.

The selected alternative will not have significant adverse socioeconomic impacts. This alternative will create over 2,000 jobs that will generate a payroll of about $32 million per year. It is expected that residents of Guam will fill the new commercial and industrial jobs.

The selected alternative will not have a significant impact on the environment as a result of the use of petroleum products or the use or generation of hazardous substances by the acquiring entity. Hazardous materials used and hazardous wastes generated by the Reuse Plan will be managed in accordance with Federal and local laws and regulations.

Implementation of the selected alternative will not have an impact on public health and safety at the GLUP '94 properties. Navy will inform future property owners about the environmental condition of the property and may, when appropriate, include restrictions, notifications, or covenants in deeds to ensure the protection of human health and the environment in light of the intended use of the property. After the property is conveyed, Navy will assist the acquiring entities in the removal and disposal of newly discovered unexploded ordnance to the extent required by then-applicable federal laws and regulations and then-applicable Navy and DoD policies, subject to Congressional authority and the availability of appropriated funds.

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, 3 CFR 859 (1995), requires that Navy determine whether any low income and minority populations will experience disproportionately high and adverse human health or environmental effects from the proposed action. Navy analyzed the impacts on low income and minority populations pursuant to Executive Order 12898. The FEIS addressed the potential human health,

socioeconomic, and environmental effects of the various proposed alternatives. Minority and low-income populations residing within the regions where the GLUP properties are located will not be disproportionately affected.

Navy also analyzed the impacts on children pursuant to Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks, 3 CFR 198 (1998). Under the selected alternative, the largest concentration of children would be present in the residential, educational, and recreational areas. The selected alternative would not pose any disproportionate environmental health or safety risks to children.

Mitigation

Implementation of Navy's decision to dispose of the surplus property does not require Navy to implement any mitigation measures. Navy will take certain actions to implement existing agreements and regulations. These actions are treated as agreements or regulatory requirements rather than mitigation.

The FEIS identified and discussed those actions that will be necessary to minimize or avoid the impacts associated with the reuse and redevelopment of the GLUP '94 Navy surplus property. The acquiring entities, under direction of Federal and local agencies with regulatory authority over protected resources, will be responsible for implementing necessary mitigation measures following disposal of the property.

Comments Received on the Final EIS

Navy received comments on the FEIS from the Earthjustice Legal Defense Fund, a private organization writing on behalf of the Center for Biological Diversity. All of the substantive comments concerned issues already discussed in the FEIS.

Regulations Governing the Disposal Decision

Since the proposed action contemplates a disposal under the Defense Base Closure and Realignment Act of 1990 (DBCRA), Public Law 101–510, 10 U.S.C. 2687 note (1994), Navy's decision was based upon the environmental analysis in the FEIS and application of the standards set forth in the DBCRA, the Federal Property Management Regulations, 41 CFR part 101–47, and the Department of Defense Rule on Revitalizing Base Closure Communities and Community Assistance, 32 CFR parts 174 and 175.

Conclusion

The Local Redevelopment Authority has determined in its Reuse Plan that the GLUP '94 surplus Navy properties should be used for various purposes including parks and recreational, historical and natural resource conservation, residential, commercial, resort, industrial, and agricultural activities. The property's location, physical characteristics, existing infrastructure, as well as current uses of adjacent property make it appropriate for the proposed uses.

Although the ''No Action'' Alternative has less potential for causing adverse environmental impacts, this alternative would not result in more efficient Navy operations or lower operational costs. Additionally, it would not foster local economic redevelopment and would not create new jobs.

The acquiring entities, under the direction of Federal and local agencies with regulatory authority over protected resources, will be responsible for adopting practicable means to avoid or minimize environmental harm that may result from implementing the Reuse Plan.

Accordingly, Navy will dispose of the GLUP '94 surplus Navy property in a manner that is consistent with the Government of Guam's Reuse Plan for the property.

Dated: March 2, 2001.

Duncan Holaday,

Deputy Assistant Secretary, (Installations and Facilities).

[FR Doc. 01–6047 Filed 3–9–01; 8:45 am]

BILLING CODE 3810–FF–M

DEPARTMENT OF ENERGY

[Docket Nos. FE C&E 01–48, C&E 01–49, C&E 01–50 and C&E 01–51, Certification Notice—197]

Office of Fossil Energy; Notice of Filings of Coal Capability of GenPower McIntosh, LLC, FPLE Rhode Island State Energy, L.P., Freestone Power Generation, L.P., and Carville Energy, LLC, Powerplant and Industrial Fuel Use Act

AGENCY: Office of Fossil Energy, DOE.

ACTION: Notice of filing.

SUMMARY: GenPower McIntosh, LLC, FPLE Rhode Island State Energy, L.P., Freestone Power Generation, L.P., and Carville Energy, LLC, submitted coal capability self-certifications pursuant to section 201 of the Powerplant and Industrial Fuel Use Act of 1978, as amended.

ADDRESSES: Copies of self-certification filings are available for public inspection, upon request, in the Office of Coal & Power Im/Ex, Fossil Energy, Room 4G–039, FE–27, Forrestal Building, 1000 Independence Avenue, SW., Washington, DC 20585.

FOR FURTHER INFORMATION CONTACT: Ellen Russell at (202) 586–9624

SUPPLEMENTARY INFORMATION: Title II of the Powerplant and Industrial Fuel Use Act of 1978 (FUA), as amended (42 U.S.C. 8301 *et seq.*), provides that no new baseload electric powerplant may be constructed or operated without the capability to use coal or another alternate fuel as a primary energy source. In order to meet the requirement of coal capability, the owner or operator of such facilities proposing to use natural gas or petroleum as its primary energy source shall certify, pursuant to FUA section 201(d), to the Secretary of Energy prior to construction, or prior to operation as a base load powerplant, that such powerplant has the capability to use coal or another alternate fuel. Such certification establishes compliance with section 201(a) as of the date filed with the Department of Energy. The Secretary is required to publish a notice in the **Federal Register** that a certification has been filed. The following owners/operators of the proposed new baseload powerplants have filed a self-certification in accordance with section 201(d).

Owner: GenPower McIntosh, LLC, (C&E 01–48).

Operator: General Electric International, Inc.

Location: Effingham County, Georgia.

Plant Configuration: Combined-cycle.

Capacity: 529 MW.

Fuel: Natural gas.

Purchasing Entities: Wholesale power market.

In-Service Date: January 2004.

Owner: Rhode Island State Energy Partners, L.P., (C&E 01–49).

Operator: FPLE Rhode Island State Energy, L.P.

Location: Johnston, Rhode Island.

Plant Configuration: Combined-cycle.

Capacity: 535 MW.

Fuel: Natural gas.

Purchasing Entities: The New England wholesale energy market..

In-Service Date: July 1, 2002.

Owner: Freestone Power Generation, L.P., (C&E 01–50).

Operator: Freestone Power Generation, L.P.

Location: Freestone County, Texas.

Plant Configuration: Combined-cycle.

Capacity: 1,050 MW.

Fuel: Natural gas.

THE UNITED STATES AIR FORCE

INSTALLATION RESTORATION PROGRAM

FINAL

SECOND
FIVE-YEAR REVIEW OF RECORD OF DECISION
FOR
MARBO ANNEX OPERABLE UNIT

ANDERSEN AIR FORCE BASE, GUAM

August 2009

THE UNITED STATES AIR FORCE INSTALLATION RESTORATION PROGRAM

FINAL

SECOND FIVE-YEAR REVIEW OF RECORD OF DECISION FOR MARBO ANNEX OPERABLE UNIT

ANDERSEN AIR FORCE BASE, GUAM

August 2009

Approved By:

MICHAEL M. MONTGOMERY Date
Assistant Director, Federal Facilities and Site Cleanup Branch
U.S. Environmental Protection Agency, Region 9

Second Five-Year Review Summary Form

SITE IDENTIFICATION

Site name *(from Waste LAN)*: MARBO Annex Operable Unit

EPA ID *(from Waste LAN)*: CERCLIS Identification No. GU6571999519

Region: Pacific Ocean	**State:** Guam	**City/County:** Yigo

SITE STATUS

NPL status: **X** Final Deleted Other (specify) _____

Remediation status (choose all that apply): Under Construction **X** Operating **X** Complete

Multiple OUs?* **X** Yes: MARBO Annex; Site-wide No	**Construction completion date**: 17 July 1998

Has site been put into reuse? Yes **X** No

REVIEW STATUS

Lead agency: EPA State Tribe **X** Other Federal Agency: United States Air Force

Author(s) name: Toraj Ghofrani, P.E. and Scott Moncrief, P.G.

Author(s) title: Environmental Engineer and Deputy Program Manager	**Author(s) affiliation:** USAF Contractor

Review period:** 02 March 2004 to 02 March 2009

Date(s) of site inspection: 09 / 09 / 2008

Type of review: Post-SARA Pre-SARA NPL-Removal only
Non-NPL Remedial Action Site **X** NPL State/Tribe-lead
Regional Discretion

Review number: 1 (first) **X** 2 (second) 3 (third) other (specify)

Triggering Action:
Actual RA Onsite Construction at OU # _____ Actual RA Start at OU # _
Construction completion Previous Five-Year Review Report
X Other (specify): USEPA concurrence with the first five-year review.

Triggering action date *(from WasteLAN)*: 06 July 2004

Due date *(five years after triggering action date)*: 06 July 2009

* ["OU" refers to operable unit.]
** [Review period should correspond to the actual start and end dates of the Five-Year Review in WasteLAN.]

Second Five-Year Review Summary Form, Continued

Site 20

Issues

- Vehicle access, pig wallows, and small trees continue to threaten the structural integrity of the *Soil Cover*. The *Soil Cover* is subject to frequent island natural disasters such as typhoons and earthquakes that can damage the structural integrity of the *Soil Cover*.

Recommendations and Follow-up Actions

- Continue O&M program, with annual inspections to check the structural integrity of the *Soil Cover*, drainage channels, and the riprap. Maintenance should occur at least semi-annually to mow and control brush and trees. Sword grass at the site should not be mowed lower than four inches above the ground, as shorter grass cover are more susceptible to erosion.

Protectiveness Statement

Based on the review of existing data and site inspections, the remedy at Site 20 is protective of human health and the environment because exposure pathways that could result in unacceptable risks are being controlled.

Sites 22, 23, 24, 37, and 38

As recommended in the first five-year review for the MARBO Annex OU, Sites 22, 23, 24, 37, and 38 were not included in the second five-year review on the basis that no new source of contamination was found during the second five-year review period.

Sites 41, 42, 43

No interim removal actions have been implemented at Sites 41, 42, or 43, and the selection of the final remedies is pending a ROD. A RI/FS was completed for these sites in 2008 and identified *Soil Removal (Unrestricted Land Use)* as the preferred remedial alternative for all three sites. It is anticipated that the *Soil Removal* alternative would provide clean closure with minimal administrative effort and no associated long-term monitoring costs.

MARBO Annex Groundwater

Issues

- LTGM data indicates TCE concentration are increasing in production well MW-1.

Recommendations and Follow-up Actions

- Continue to monitor sampling data from this well and share with Andersen AFB potable water supply facility managers.

Protectiveness Statement

The remedy for MARBO Annex groundwater is protective of human health and the environment because exposure pathways that could result in unacceptable risks are being controlled.

Other Comments

A ROD Amendment is planned to be completed for MARBO Annex groundwater by December 2009. The ROD Amendment will include a TI Waiver for the requirement of achieving MCLs in the aquifer. The amended remedy for MARBO Annex groundwater is *Long-Term Groundwater Monitoring with Contingency for Wellhead Treatment*. The ROD Amendment removes natural attenuation as a component of the remedy. The change in remedy will have no effect on the protectiveness.

EXECUTIVE SUMMARY

This is the second five-year review to evaluate if remedies that were implemented for the Record of Decision (ROD) for the Marianas Bonins Command (MARBO) Annex Operable Unit (OU) are still protective of human health and the environment. The five-year review has been completed in accordance with the United States Environmental Protection Agency (USEPA) Comprehensive Five-Year Review Guidance, June 2001, USEPA 540-R-01-007, and Office of Solid Waste and Emergency Response No. 9355.77-03B-P. To complete this second five-year review of the Final MARBO Annex OU ROD, dated July 1998, all relevant activities that have been performed and data and documents that have been generated since the implementation of remedial action have been reviewed.

The first five-year review recommended that, unless a new source of contamination was found during the second five-year review period, Sites 22, 23, 24, 37, and 38 should not be discussed in this second five-year review document. Based on a records search (Appendix A) and the site inspection in September 2008, no new source of contamination was found at Sites 22, 23, 24, 37, and 38. Accordingly, only a brief mention of these sites is included in this second five-year review of the MARBO Annex OU ROD.

Site 20 is classified as an *Operating Remedial Action* (RA), as the RA has been implemented but residual COCs have been left in place at concentrations that do not allow for unrestricted use of or unlimited access to the land. Since completion of the first five-year review, the quarterly inspection reports were the only data generated with regard to Site 20. The remedy at Site 20 is protective of human health and the environment since exposure pathways that could result in unacceptable risks are being controlled as intended by the ROD.

The land and resource use at Site 20 has not changed. With COC-impacted soil beneath the soil cover, the future land use at Site 20 remains restricted. The site and vicinity are still inactive and therefore the exposure assumptions for the human health risk assessment (HHRA) and ecological risk assessment (ERA) are still valid. No new human health or ecological exposure pathways or receptors have been identified. The toxicity data and USEPA residential Regional Screening Levels (RSLs) for Site 20 contaminants of concern remain unchanged or less stringent than the 1995 residential Preliminary Remediation Goals (PRGs) therefore rendering no changes in the 1995 HHRA results or the effectiveness of the selected remedy. Based on the site inspection, the integrity of the soil cover is still intact. However, as long as the site is accessible, the structural integrity of the soil cover may be compromised due to vehicle traffic, small trees, and pig wallows. Therefore, annual inspections and periodic maintenance of soil cover should be performed to ensure continued protection of human health or environment. Site 20 should be included in the next five-year review.

Based on human health and ecological risk assessments, MARBO Annex Groundwater is impacted by trichloroethene (TCE) and tetrachloroethene (PCE) in deep groundwater samples collected from monitoring wells IRP-29 and IRP-31 at concentrations above their respective MCLs (5 micrograms per Liter). Monitoring data indicate impacted groundwater zones exist between approximately 400 feet ground surface (bgs) to 470 feet bgs (TCE plume) and between 420 feet bgs and 490 feet bgs (PCE plume). The exact source of TCE and PCE remains unknown. The 1998

ROD selected remedial action for MARBO Annex Groundwater was *Natural Attenuation with Wellhead Treatment*, which was to eliminate the risk of direct exposure to TCE and PCE. Institutional controls (ICs) were a component of the remedy and consisted of Land Use Restrictions and Long-Term Groundwater Monitoring.

During the first five-year review, the remedy was found to be functioning as intended in the 1998 ROD and was still protective of human health and the environment. The remedy for MARBO Annex groundwater is protective of human health and the environment since exposure pathways that could result in unacceptable risks are being controlled.

During the second five-year review period, natural attenuation was determined to be ineffective in remediating the TCE and PCE in MARBO Annex Groundwater. Monitoring data suggested that neither physical (e.g., dilution) nor biological processes (e.g., reductive dehalogenation) were operating to significantly attenuate TCE or PCE in the deep part of the freshwater lens. As a result, a ROD Amendment was prepared for MARBO Annex Groundwater which included a Technical Impracticability Waiver which waives the Applicable or Relevant and Appropriate Requirement of meeting the MCL in the aquifer. The ROD Amendment is planned to be signed by December 2009. The change in remedy has no effect on the site protectiveness. MARBO Annex Groundwater should be included in the next five-year review.

Sites 41, 42, and 43 are located in the MARBO Annex; however, they are included in the Site-wide OU. The Remedial Investigation/Feasibility Study (RI/FS) document for these sites is currently under agency review. All three sites contain COCs, for which the FS indicates *Soil Removal* as the preferred remedial alternative (RA). Under this RA the COCs would be cleaned up and there would be no restrictions on future land use at any of the three sites (including residential land use). A ROD for these sites has not yet been completed. Sites 41, 42, and 43 should be included in the next five year review.

The next and third five-year review of the MARBO Annex OU ROD is due five years from the USEPA's approval of this review, and should include review of the remedies for Sites 20, 41, 42, and 43, and for MARBO Annex Groundwater. The related review period will be from 02 March 2009 to 02 March 2014.

3.0 BACKGROUND

3.1 General Background

3.1.1 Overview of the First Five-Year Review

The first five-year review of the MARBO Annex OU ROD included an evaluation of the post-ROD status of six IRP sites (Sites 20, 22, 23, 24, 37, and 38), and the groundwater beneath the MARBO Annex (Figure 1-2). The ROD review also evaluated the status of three additional IRP sites pending final remedy selection that were part of another OU but were located with in the boundaries of the MARBO Annex. The review organized the evaluated sites with respect to their media of concern, i.e. soil-related COCs and groundwater-related COCs.

3.1.1.1 Evaluated Sites Referred for No Additional Five-Year Reviews

As no new sources of contamination were identified during the document review and site inspection conducted for the first five-year review of Sites 22, 23, 24, 37, and 38, future five-year reviews were not recommended.

3.1.1.2 Evaluated Sites Subject to Additional Five-Year Reviews

Five-year reviews must be performed for Site 20 and the MARBO Annex groundwater because their selected remedies are considered *Operating RAs*, as they have been implemented but leave residual COCs in place at concentrations that do not allow for unrestricted use or unlimited access.

The selected remedy for Site 20 consisted of a *Soil Cover with Institutional Controls (ICs)*. During the first five-year review site inspection of Site 20, there were concerns regarding pig wallowing activity and small tree roots at the site that jeopardized the integrity of the *Soil Cover* in protecting the human health and the environment (EA, 2004). A regular quarterly Operations and Maintenance (O&M) program was therefore recommended to verify and maintain the integrity of the *Soil Cover* at Site 20. As part of the quarterly O&M program, "event driven" inspections were recommended to verify the integrity of the *Soil Cover* after natural disasters, such as typhoons or earthquakes. Furthermore it was recommended that signs be posted at the boundaries of the site restricting intrusive activities that would damage the *Soil Cover*, such as driving trucks, trenching, or excavating (EA, 2004). The integrity of the soil cover at Site 20 has been evaluated during the second five-year review through site inspection and the review of quarterly O&M records, and the findings are presented in this document.

The 1998 ROD selected remedy for the MARBO Annex groundwater consisted of *Natural Attenuation with Institutional Controls* to achieve the remediation goal of decreasing trichloroethene (TCE) and tetrachloroethene (PCE) concentrations in the aquifer to levels below Maximum Contaminant Level (MCL). Through physical processes of dispersion and dilution, the timeframe to achieve cleanup goals (MCLs) was estimated at 10 to 40 years, assuming a continued source of PCE and TCE did not exist (EA, 1998a). Supplemental to the natural attenuation were three ICs that included:

- **Land Use Restrictions** to monitor and restrict groundwater access in areas impacted by TCE/PCE,
- **Groundwater Monitoring** to monitor TCE/PCE and confirm the stability of TCE/PCE plumes in the MARBO Annex, and
- **Existing Wellhead Treatment** to ensure public health risk is within the acceptable range at existing USAF production wells.

During the first five-year review of the MARBO Annex OU ROD, it was determined that the overall timeframe for the groundwater remedy to effectively reduce the concentrations of the TCE/PCE to below MCLs, may take longer than 40 years (EA, 2004). At the conclusion of the first five-year review, it was recommended that if, during the second five-year review period, monitored natural attenuation (MNA) did not appear to be effectively reducing TCE and PCE concentrations in MARBO Annex Groundwater, the MARBO Annex OU ROD would be amended to either specify an active remediation method or a TI waiver to achieve the applicable or relevant and appropriate requirement (ARAR) of meeting the drinking water MCL in the aquifer (EA, 2004).

A ROD Amendment for the MARBO Annex groundwater remedy will be completed by December 2009 (EA and Metcalf & Eddy [EA/M&E], 2009a). The amended remedy is *Long-Term Groundwater Monitoring with Contingency for Wellhead Treatment*, with a TI Waiver which waives the requirement of achieving MCLs in the aquifer.

3.1.1.3 Evaluated Sites Pending Final Remedy Selection

Sites 41, 42, and 43 (formerly AOCs 54, 55, and 56, respectively) located in the MARBO Annex were designated as part of the Site-wide OU (previously referred to as the Basewide OU) and were not included in the MARBO Annex OU ROD. These sites were evaluated in the first five-year review because they are located within the MARBO Annex; however, a final remedy was not selected. A ROD is currently under development. Because a final remedy has still not been selected under the Site-wide OU, an update of the status of these sites is included in this review.

3.1.2 Environmental Setting of MARBO Annex

MARBO Annex OU is located on a broad, uplifted limestone plateau that is underlain by volcanic rocks (Figure 3-1). The limestone plateau includes numerous sinkholes and ranges in elevation from 300 to over 500 feet above mean sea level (msl). The sinkholes are very porous and provide rapid infiltration of surface water to the underlying fresh water aquifer, rendering no permanent surface water bodies at the MARBO Annex.

The surface of the limestone plateau is interrupted by two volcanic peaks, Mount Santa Rosa and Mataguac Hill, which are located northeast and north of the MARBO Annex, respectively (Figure 3-1). These low-permeability volcanic outcrops extend into the subsurface to form a lateral barrier that directs the groundwater flow towards the Tumon Bay (Figure 3-1). According to groundwater monitoring data (EA, 2008b), the groundwater at the MARBO Annex is encountered at approximately 281 to 400 feet below ground surface (bgs). Based on the 2001

Guam Water Quality Standards, the fresh or saline groundwater at the MARBO Annex is categorized as a G-1 Resource Zone for potable water (Guam EPA, 2001). Consequently, any wastewater discharges within the G-1 Resource Zone is regarded as tributary to the potential potable groundwater supply and must be free of pollutants.

Water extracted from production wells in the MARBO Annex supplies Andersen AFB. Currently, seven of the nine Andersen AFB production wells (MW-series wells) located on the MARBO Annex (Figure 1-2) are used for water production, and they can yield upwards of approximately 3.0 million gallons per day (mgd), to meet the average Base consumption of 2.0 mgd (EA, 2008c).

Although there are housing developments (Wilson Homes, Contingency Barracks, and the Andersen South Housing Area) within the MARBO Annex, they have been unoccupied since 1996 (Figure 1-2). The nearest populated areas are in the nearby villages of Dededo located approximately 50 feet west, Yigo located approximately 150 feet north, and Mangilao located approximately 25 feet east of the MARBO Annex. As of 2000, the combined population of Dededo and Yigo was approximately 62,000, which comprises approximately 40 percent of the island's population (United States Census Bureau, 2001). Dispersed, low-density populations characterize the area between these villages and the MARBO Annex.

MARBO Annex is located in the interior of Guam, away from the coastal cliff line and marine environments. Therefore, the MARBO Annex is not within the range of the critical habitats of threatened or endangered species such as the Mariana crow (*Corvus kubaryi*), the Mariana fruit bat (*Pteropus mariannus*), the Fire tree (*Serianthes nelsonii*), and the Ufa-Halomtano tree (*Heritiera longipetiolata*) (Department of Aquatic and Wildlife Resources, 1988).

3.1.3 MARBO Annex Land and Resource Use

Presently, MARBO Annex properties are inactive. According to the Andersen AFB archives, the MARBO Annex was developed for military housing, warehouses, industrial support facilities, and operational facilities. From 1944 through 1950, MARBO Annex was under the jurisdiction of the Naval Government of Guam. Following the Organic Act of 1950, the United States Government took control of the MARBO Annex and administration was transferred to the United States Navy (USN). By 1956 all operations at the MARBO Annex had ceased, except for the USN Power Plant and the water production wells. On 25 June 1958, the USAF assumed control of the MARBO Annex. Based on review of available Real Estate Property records at Andersen AFB, all temporary buildings on the MARBO Annex were removed prior to June 1960 (EA, 2004).

Subsequent to finalizing the MARBO Annex OU ROD in 1998, various land parcels have been transferred or have been proposed for transfer to other Federal or territorial agencies (EA, 1998a). Two parcels, covering 81 acres and 395 acres, respectively, have been transferred to the Government of Guam (Figure 3-2). The 81-acre parcel contains an active Guam Waterworks Authority (GWA) production well (Y-20) and included the planned construction of a high school. The 231-acre parcel contains a fire station and an active GWA production well (Y-19), and future land use plans include construction of a police station. Another 1,569-acre parcel was

offered to the United States Marines, for training facilities, however in 2003 the Marines indicated that they were no longer interested in acquiring the property. The USAF is currently considering alternate plans for future disposition of this parcel. Another 224-acre parcel is being retained by the USAF for a variety of purposes. An area near Site 20 is being retained to ensure ICs are maintained in compliance with the MARBO Annex OU ROD. Several linked areas are being retained to support the USAF groundwater production and distribution system at the MARBO Annex. Two areas (the MARBO Laundry and the Army and Air Force Exchange Service Warehouse) are being retained for USAF warehousing activities. Currently, the MARBO Annex consists of approximately 2,010 acres of land.

3.2 Background of Sites Included in this Five-Year Review

3.2.1 Background of Site 20

3.2.1.1 General Description of Site 20

Site 20 is classified as an *Operating RA*, as the RA has been implemented but residual COCs have been left in place at concentrations that do not allow for unrestricted use of or unlimited access to the land. An *Operating RA* may require management in perpetuity.

Site 20 is located in the south-central portion of the MARBO Annex (Figure 1-2). Site 20 is an abandoned quarry that was partially filled with waste and covered with soil and vegetation. The site was divided into two broad areas of concern with respect to the potential for contamination. Area A included the *Buried Waste Area* and consisted of approximately 1.84 acres of fill, averaging 10.8 feet in thickness, and a small area covered with 10 empty, deteriorated drum remnants. Area B included numerous mounds of soil, some of which were covered with construction debris, municipal trash, and metal debris (EA, 1998b).

3.2.1.2 Former, Current, and Future Land Use at Site 20

As previously discussed, Site 20 was formerly used as quarry and was subsequently an area where waste materials were disposed. Access is currently restricted and ICs have been placed on the site to restrict future use because COCs at the site pose potentially unacceptable risks to human health. There are currently no plans to modify existing land use; however, any future land use at Site 20 must include provisions for mitigating exposure of future human receptors to COCs remaining onsite.

3.2.1.3 History of Contamination at Site 20

According to the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA), Area A had surface soil contamination that required a RA. The COCs identified at Site 20 included lead, pesticides (4,4'- dichlorodiphenyldichloroethene [4,4-DDE], 4,4-dichlorodiphenyltrichloroethene [4,4-DDT], dieldrin, alpha chlordane, and gamma chlordane), and the polychlorinated biphenyl (PCB) Aroclor 1260, as shown in Table 3-1 (EA, 1997). The calculated exposure point concentrations (EPCs) that were used for the HHRA in the MARBO Annex RI/FS (ICF, 1996) are presented in Table 3-1 along with their respective

Background Threshold Value (BTV) and the 1995 residential Preliminary Remediation Goal (PRG) (USEPA, 1995):

Table 3-1. Comparison of Site 20 EPCs to 1995 Residential PRGs and BTVs used for the HHRA.

COC	EPC (mg/kg)	1995 Residential PRG (mg/kg)	BTV (mg/kg)
4,4'-DDE	6.7	1.3	NA
4,4'-DDT	6.2	1.3	NA
Dieldrin	0.12	0.028	NA
Alpha chlordane	0.44	0.34	NA
Gamma chlordane	0.38	0.34	NA
Aroclor 1260	4.4	0.066*	NA
Lead	3,604	400	166

* = PRG is based on total PCB concentration; prior to 2000 there was no PRG for Aroclor 1260.
BTV = Background Threshold Value
COC = contaminant of concern
EPC = Exposure Point Concentration
mg/kg = milligrams per kilogram
NA = not applicable; BTV is applicable only for inorganic compounds (metals).
PRG = Preliminary Remediation Goal

3.2.1.4 Initial Response at Site 20

The COCs detected in Site 20 soils were determined to be relatively stable and immobile; therefore, no immediate response was required.

3.2.1.5 Basis for Taking Action

The basis for taking action at Site 20 was excessive cancer to residential receptors (2×10^{-4}) and non-cancer (HI=4) risks associated with elevated concentrations of Aroclor 1260, pesticides, and lead in surface and subsurface soils in the *Buried Waste Area* (Figure 3-3). Though the condition of the COC-impacted soil did not require an immediate initial response, an RA was proposed for the site to protect the future human and ecological receptors.

3.2.2 Background of Site 41

3.2.2.1 General Description of Site 41

Site 41 is located adjacent to Marine Drive (Figure 1-2), covers approximately 8 acres, and is flat to gently sloping. Site 41 includes the foundations (concrete pads) of former operational support buildings such as a tool shop, a carpenter shop, a generator shop, a heavy vehicle shop, and vehicle maintenance shops. In addition, a vehicle maintenance pit associated with the former heavy vehicle shop was located at the site. Due to past operations at the former shops, potentially hazardous materials were suspected to have been discharged to the soils.

3.2.2.2 Current and Future Land Use at Site 41

Currently, the site is inactive and there are no plans to modify existing land use, however, redevelopment of this area is likely at some future date given the limited available land on Guam.

3.2.2.3 History of Contamination at Site 41

Based on the analysis of 105 surface soil samples (including 10 duplicate samples), lead was detected at concentrations ranging from 19.6 to 53,300 milligrams per kilogram (mg/kg) (EA, 2008a). At the time the HHRA was performed, 2004 USEPA Region 9 PRGs were used to conduct the risk screening; however, they have since been superseded by 2009 USEPA Regional Screening Levels (RSLs) (USEPA, 2004; USEPA, 2009). For lead, the residential and industrial RSLs are equivalent to the corresponding PRGs; 400 mg/kg and 800 mg/kg, respectively. The average concentration of lead in surface soil samples (1,257 mg/kg) exceeds both residential and industrial RSLs, as shown in Table 3-2. Therefore, lead in surface soil was identified as a COC, posing potentially unacceptable risks to future residential receptors and current industrial workers at the site.

Table 3-2. Comparison of Site 41 EPCs to Residential RSLs and BTVs.

COC	EPC (mg/kg)	2009 Residential RSL (mg/kg)	2009 Industrial RSL (mg/kg)	BTV (mg/kg)
Lead	1,257	400	800	166

BTV = Background Threshold Value
EPC = Exposure Point Concentration
mg/kg = milligrams per kilogram
RSL = Regional Screening Level

Lead was not detected in any subsurface soil samples at concentrations exceeding the residential PRG (400 mg/kg).

3.2.2.4 Initial Response at Site 41

The COC detected in Site 41 soils (lead) was determined to be relatively stable and immobile in the weathered limestone soils; therefore, no immediate response was required.

3.2.2.5 Basis for Taking Action at Site 41

The future use of Site 41 is undetermined; therefore, the site may be potentially developed for future residential or commercial use. The basis for taking action at Site 41 was related to elevated concentrations of lead in surface soil (Figure 3-4). There are no toxicity values published by USEPA to quantify cancer risks from lead using the standard HHRA methodologies; therefore, no HHRA was conducted for Site 41. The USEPA Region 9 residential PRG and RSL were based on the output of the Integrated Exposure Uptake Biokinetic (IEUBK) Lead Model for residential exposures. According to USEPA guidance, lead is assessed through the use of the blood-lead model, which uses the average concentration of lead in soil.

Though the condition of the lead-impacted soil did not require an immediate initial response, an RA has been proposed for the site to protect future human and ecological receptors.

3.2.3 Background of Site 42

3.2.3.1 General Description of Site 42

Site 42 is located approximately 900 feet south of Marine drive (Figure 1-2), covers approximately 1.5 acres, and is flat to gently sloping. Site 42 is a former gas station with two associated rusted aboveground storage tanks (ASTs). Due to past operations, discharge of fuel constituents to the soil may have occurred.

3.2.3.2 Current and Future Land Use at Site 42

Currently, the site is inactive and there are no plans to modify existing land use; however, redevelopment of this area is likely at some future date given the limited available land on Guam.

3.2.3.3 History of Contamination at Site 42

Based on the analysis of 26 surface soil samples (including two duplicate samples), lead was detected at concentrations ranging from 25.6 to 3,370 mg/kg (EA, 2008a). At the time the HHRA was performed, 2004 USEPA Region 9 PRGs were used to conduct the risk screening; however, they have since been superseded by 2009 USEPA RSLs. For lead, the residential and industrial RSLs are equivalent to the corresponding PRGs; 400 mg/kg and 800 mg/kg, respectively. The average concentration of lead in surface soil samples (485 mg/kg) exceeds the residential RSL, as shown in Table 3-3. Therefore, lead in surface soil was identified as a COC, posing potentially unacceptable risks to future residential receptors at the site.

Table 3-3. Comparison of Site 42 EPCs to Residential RSLs and BTVs.

COC	EPC (mg/kg)	2009 Residential RSL (mg/kg)	BTV (mg/kg)
Lead	485	400	166

BTV = Background Threshold Value
EPC = Exposure Point Concentration
mg/kg = milligrams per kilogram
RSL = Regional Screening Level

Lead was not detected in any of the subsurface soil samples at concentrations exceeding the residential RSL (400 mg/kg).

3.2.3.4 Initial Response at Site 42

The COC detected in Site 42 soils were determined to be relatively stable and immobile in the weathered limestone soils; therefore, no immediate response was required.

3.2.3.5 Basis for Taking Action at Site 42

The future use of Site 42 is undetermined; therefore, the site may be potentially developed for future residential or commercial use. The basis for taking action at Site 42 was related to elevated concentrations of lead in surface soil (Figure 3-5). There are no toxicity values published by USEPA to quantify cancer risks from lead using the standard HHRA methodologies. As previously discussed, lead is assessed through the use of the blood-lead model, which uses the average concentration of lead in soil compared to the results of the IEUBK Lead Model for residential exposures. Though the condition of the lead-impacted soil did not require an immediate initial response, an RA has been proposed for the site to protect future human and ecological receptors.

3.2.4 Background of Site 43

3.2.4.1 General Description of Site 43

Site 43 is located west of the former MARBO Laundry (Figure 1-2), covers approximately 35 acres, and is flat to gently sloping. Site 43 includes the foundations (concrete pads) of former operational support buildings including a welding shop, battery shop, concrete vault, machine shop, carpenter shop, motor pool garage, paint shop, warehouses, generator shed, grease stand, steam shop, supply shed, preventative maintenance shop, sign paint shop, refrigerator shop, plumbing shop, and electric shop. Due to past operations at the shops, potentially hazardous materials were suspected to have been discharged at the site.

3.2.4.2 Current and Future Land Use at Site 43

Currently, the site is inactive and there are no plans to modify existing land use; however, redevelopment of this area is likely at some future date given the limited available land on Guam.

3.2.4.3 History of Contamination at Site 43

Based on the analysis of 173 surface soil samples (including 5 duplicates) and 33 subsurface soil samples (including 4 duplicates), arsenic, cadmium, lead, Aroclor 1254, and benzo(a)pyrene, in surface soil, and arsenic and vanadium, in subsurface soil, were identified as COCs (Table 3-4) (EA, 2008a). These COCs were detected at concentrations exceeding the residential PRGs, and or BTVs, posing potentially unacceptable risks to future residential receptors and current industrial workers at the site.

At the time the HHRA was performed, 2004 USEPA Region 9 PRGs were used to conduct the risk screening; however, they have since been superseded by 2009 USEPA RSLs. The residential RSL for benzo(a)pyrene is more stringent (0.015 mg/kg) than the residential PRG, and the residential RSLs for cadmium and vanadium are less stringent (70 and 390 mg/kg, respectively) than their respective residential PRGs (Table 3-4). These changes are not significant enough to alter the conclusions of the RI/FS for Site 43, as most of these COCs are collocated with other COCs that are targeted for removal.

Table 3-4. Comparison of Site 43 EPCs to Residential PRGs, Residential RSLs, and BTVs.

COC	EPC (mg/kg)	2004 Residential PRG (mg/kg)	2009 Residential RSL (mg/kg)	BTV (mg/kg)
Surface Soil				
Arsenic	116	0.39	0.39	62
Cadmium	226	37	70	6.5
Lead	9,390	400	400	166
Aroclor 1254	31	0.22	0.22	NA
Benzo(a)pyrene	83	0.06	0.015	NA
Subsurface Soil				
Arsenic	64	0.39	0.39	62
Vanadium	225	78	390	206

BTV = Background Threshold Value
EPC = Exposure Point Concentration
mg/kg = milligrams per kilogram
NA = not applicable; BTV is applicable only for inorganic compounds (metals).
PRG = Preliminary Remediation Goal
RSL = Regional Screening Level

3.2.4.4 Initial Response at Site 43

The COCs detected in Site 43 soil samples were determined to be relatively stable and immobile in the weathered limestone soils; therefore, no immediate response was required.

3.2.4.5 Basis for Taking Action at Site 43

The future use of Site 43 is undetermined; therefore, the site may be potentially developed for future residential or commercial use. The basis for taking action at Site 43 was related to arsenic, cadmium, Aroclor 1254, and benzo(a)pyrene in surface soil, and arsenic and vanadium in subsurface soil. These COCs posed either potentially unacceptable non-cancer and/or cancer risks to current industrial workers and future residential receptors (Figures 3-6 through 3-9). Lead in surface soil also posed potentially unacceptable risks to current industrial workers and future residential receptors.

3.2.5 Background of MARBO Annex Groundwater

3.2.5.1 Description for MARBO Annex Groundwater

Since 1989, the quality of the MARBO Annex groundwater has been evaluated at least semi-annually through a network of groundwater monitoring points (EA, 2008b). The Long-Term Groundwater Monitoring (LTGM) Program for Andersen AFB was initiated in October 1995 to ensure compliance with CERCLA, RCRA, Clean Water Act, Safe Drinking Water Act, and all ARARs, with the goals of:

- establishing baseline groundwater elevation and water quality data at monitoring and production wells,
- evaluating the baseline data and identifying critical sampling locations,

- installing new monitoring wells in those critical sampling locations, and
- determining modifications to monitoring points, monitoring frequency, and analytical methods.

Since the LTGM Program was initiated in 1995, 26 rounds of groundwater sampling have been conducted at the MARBO Annex. Currently, 18 monitoring and three production wells are sampled as part of the LTGM Program at the MARBO OU. Nine of the monitoring wells and the three production wells are "shallow" wells that are screened across the top of the freshwater lens. Five of the monitoring wells are "deep" wells that are screened near the base of the freshwater lens. The "deep" wells are screened at depths approximately 90 to 100 feet lower than the screened intervals of the nearby "shallow" wells, to monitor water quality near the base of the freshwater lens. Two of the monitoring wells are open-boreholes that fully penetrate the freshwater lens. The two Guam Power Authority monitoring wells are fully screened across the freshwater lens. The analytical results for monitoring points in the LTGM Program are provided in Appendix B.

The northern half of Guam exhibits characteristics of a Simple Carbonate Island, a Carbonate-Cover Island, and a Composite Island according to the type of Carbonate Island Karst Model (Mylroie et al., 2001). As presented in Figure 3-1, the two volcanic peaks of Mount Santa Rosa and Mataguac Hill create a channel that directs the groundwater flow toward Tumon Bay.

Groundwater is the principal source of drinking water for Guam and is the source of freshwater for other uses. Currently, the karst limestone of the Northern Guam Lens (NGL) produces approximately 40 million gallons of freshwater per day for public use (EA, 2008c). Even though Guam receives approximately 100 inches of rainfall per year, surface water does not exist on northern Guam due to the highly permeable, eogenetic, karst limestone.

The hydrogeology model of the NGL is complex due to 400 feet of karstic geologic features with secondary dissolution channelization and water production pumping. Groundwater velocities can vary significantly and hydraulic conductivities of up to 20,000 feet per day have been observed at MARBO Annex (ICF, 1997). The vast majority of rainfall percolates through the vadose zone and creates a freshwater lens that floats atop a transition zone underlain by marine water due to density effects. The freshwater lens is approximately 100 feet thick and subject to highly conducive groundwater flow. A brackish transition zone (mixing zone) of approximately 20 feet thick exists between the freshwater lens and the underlying marine water (EA, 2008c).

The rapid infiltrating recharge to the upper portion of the freshwater lens propagates quickly (within weeks to months) to coastal discharge areas via seeps and/or large-scale dissolution features (EA, 2008c). The rapidly infiltrating recharge has created strongly oxidized groundwater conditions throughout the fresh water lens, as evidenced by shallow and deep dissolved oxygen concentrations generally ranging from 5 to 8 milligrams per Liter (mg/L) and oxidation-reduction potential ranging from 100 to 500 millivolts (EA, 2008c). The strong lateral flow component that is observed in the upper portion of the freshwater lens is not evident in the basal portion of the lens, based on contaminant trends.

Based on the extensive data-set collected over the course of the MARBO Annex LTGM Program, it is apparent that the elevation and thickness of the freshwater lens vary in response to rapid flush of short-term rainfall events, moderate-term seasonal rainfall and monsoonal wind effects on sea level, and long-term fluctuations due to El Nino/Southern Oscillation events and eustatic sea level rise. The short- and long-term rainfall events have lead to cyclic variation on the thickness of the groundwater lens, based on cyclical chloride level observations (20 and 200 mg/L) in deep groundwater monitoring wells (EA, 2008c).

3.2.5.2 Former, Current, and Future Land Use above MARBO Annex Groundwater

As previously discussed, land use at the MARBO Annex consisted of residential housing, military warehousing, and industrial support facilities. Currently, land use comprising the general area above the PCE- and TCE-impacted portion of the MARBO Annex OU groundwater aquifer is inactive. As part of the selected remedy in the MARBO Annex OU ROD, ICs restrict property deeds pertaining to the installation of water supply wells on properties affected by PCE- and TCE-impacted groundwater (Figure 3-10) (EA, 1998a). Re-development of this area is likely at some future date given the limited available land on Guam.

3.2.5.3 History of Contamination for MARBO Annex Groundwater

Based on historical groundwater monitoring results, TCE and PCE are identified as COCs in MARBO Annex groundwater. TCE has been detected in deep groundwater samples collected from GPA-1, GPA-2, and MW-2 (456, 458, and 368 feet bgs, respectively) at concentrations above the MCL of 5 micrograms per Liter (µg/L). PCE has been detected in deep groundwater samples collected from IRP-29 (475 feet bgs), at a concentration above the MCL of 5 µg/L. Both TCE and PCE have been detected in deep groundwater samples collected from IRP-31 (456 feet bgs), at concentrations above their respective MCLs of 5 µg/L (Figure 3-11). With the exception of IRP-14 (382 feet bgs), TCE and PCE have either been non-detect or detected at concentrations below the MCL in all shallow monitoring wells. For IRP-14, PCE concentrations in groundwater samples have shown a historic decrease from concentrations that were initially above the MCL of 5 µg/L to concentrations that are consistently below half the MCL. The exact source of TCE and PCE remains unknown based on the completed investigation of all potential TCE and PCE sources in MARBO Annex soil (EA, 2008a; EA, 2008c).

3.2.5.4 Initial Response for MARBO Annex Groundwater

Although the TCE and PCE plumes have been considered relatively immobile, the COCs detected in the MARBO Annex groundwater poses potential human health risks via groundwater production to the municipal water supply. The ROD for MARBO Annex OU, included long term groundwater monitoring of monitoring and production wells and wellhead treatment for three production wells in the MARBO Annex (MW-1, MW-2, and MW-3), until TCE and/or PCE concentrations were consistently below MCLs. Wellhead treatment on production well MW-2 was implemented as stated in the remedy; however, MW-2 was taken out of production in 1998 when the air stripping tower used to treat the water was fouling due to frequent carbonate build-up and the well was no longer required to meet demand. Wellhead treatment was therefore

discontinued at MW-2. Production wells MW-1 and MW-3 continue to produce potable water and have never required wellhead treatment.

3.2.5.5 Basis for Taking Action for MARBO Annex Groundwater

The basis for taking action for MARBO Annex groundwater was to protect human health, in accordance with the Remedial Action Objectives (RAOs) through implementation of ICs, against the presence of TCE and PCE in MARBO Annex groundwater at concentrations exceeding MCLs.

Agent Orange on Guam Affidavit

My name is Brian Moyer and my date of birth is March 31, 1955 and I was born in Detroit, Michigan. When I was 18 years old after graduation from high school I enlisted in the United States Marine Corps after going through Basic Training at MCRD San Diego, California and more training at infantry Training School in Camp Pendleton. It was back to MCRD San Diego to attend Sea Duty Indoctrination School were we trained on ships protocol and ships security issues with regards to nuclear weapons.

After completion of Sea Duty School I was ordered to Marine Detachment USS Proteus AS-19 which was home ported at Apra Harbor, Guam and arrived at my duty station in February 1974 and rotated back to the US mainland in February 1976. The crew from the Proteus also participated in Operation New Life and sailors and marines from the Proteus worked in the Orote Pointe refugee camp that housed thousands of Vietnamese national who fled from South Vietnam when Saigon fell to North Vietnam in April of 1975.

When we got time to get away from our duties on the Proteus we would go to various points on Guam such as Talafofo Falls, swimming at Natural Pools, snorkeling in any of the many bays around Guam. We would also go exploring in the jungle and go up to the top of Mount Lamlam. On one of our adventures of exploring we ended up at the above ground fuel lines that ran from Apra Harbor which is in the lower central, southern part of Guam all the way to Andersen AFB which is at the far north end of Guam.

Three other marines and I had to climb over the double stacked pipelines to keep going on our walk through the jungle but what I remember is that there was no thick dense vegetation growing there and I wondered how that was maintained. I found out from M/Sgt Leroy Foster in conversation approximately six months ago that he sprayed herbicides (Agent Orange) along the fuel line route for ten years on Guam.

I also was sent to Andersen AFB, Guam to attend a firefighting school in the first three months of my arrival to Guam and the Proteus were we were taught by Air Force staff how to extinguish fires with fire extinguishers all the way up to entering and fighting fires in a concrete block house that burning tires in it. The small fire were set ablaze in split 55 gallon oil drums and we put out the fires with a regular ABC rated fire extinguishers. I later found out that the fuel that was lit on fire for us to extinguish was the remnants of the fuel and Agent Orange mixture from the 750 gallon tank trailer that M/Sgt Foster used for vegetation control around Andersen AFB, Guam.

I also remember being told by one of the instructors at the Fire Fighting School that there was a "slight contamination problem with one of the wells and that if the water in the drinking fountain smelled or tasted like aviation fuel not to drink it." I was getting a drink and could taste and smell something like gasoline and spit it out and if I recall correctly the training staff had someone bring coolers of water out to the training site.

One of my other duties on the Proteus was "driver" and I was issued a military driver's license and I would end up driving up to Andersen AFB at least twice on average four times a month to pick up new personal or drop off out going personal who were returning to the mainland. I remember driving

through the main gate at Andersen AFB and looking to my left and seeing all these densely packed trees that stood about six to eight feet tall which appeared to be impenetrable.

The thing that sticks the most in my mind is that those dense growing trees were all brown in color and there were no leaves on them which didn't make sense because Guam is a tropical island approximately 400 mile north of the Equator and everything is green on Guam because of the climate and rainfall. I thought maybe the trees were intentionally burned and then Air force staff would come through with a bulldozer and plow everything away from the security fences. I found out many years later that was where M/Sgt Foster had sprayed Agent Orange type herbicides.

One other thing that I recall about going through Andersen AFB whether to go to the terminal or going to Tarague Beach is that the area that I described by the main gate fence line never "greened up" never ever did see that thick tangle of trees grow leaves on them.

Another marine named James Kuiken who resides in Vienna, Virginia and I also walked across a big field where there was hardly any grass growing to go look and climb around inside a gutted out B-52 Bomber at Andersen AFB, Guam. I found that that field had also been sprayed with herbicides by M/Sgt Foster.

At Apra Harbor I remember seeing a work party of sailors from the Proteus walking along the inner fence line and picking up trash and litter and a small trailer spray rig attached to small tractor moving along the fence line and out on the perimeter areas were the tree line started. I don't know who was driving the tractor or what was being sprayed but again years later a former crew member would state that it was Agent Orange being deployed.

I swear this affidavit is accurate and true to the best of my memory and if I am telling any lies, falsehoods or fabrications that I will be held accountable in a court of law in any jurisdiction of the United States and it Territories.

Respectfully Submitted on 24TH of January, 2017

Brian Moyer X Brian Moyer

Signed + Sworn to me this Day January 24th 2017

KAREN D. ROBINSON
Commission # FF 245627
Expires September 4, 2019
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United States Government Accountability Office

Report to Congressional Addressees

November 2018

AGENT ORANGE

Actions Needed to Improve Accuracy and Communication of Information on Testing and Storage Locations

GAO-19-24

November 2018

AGENT ORANGE

Actions Needed to Improve Accuracy and Communication of Information on Testing and Storage Locations

GAO Highlights

Highlights of GAO-19-24, a report to congressional addressees

Why GAO Did This Study

The tactical herbicide Agent Orange was first produced in 1964, and some 12 million gallons were shipped from U.S. ports to Southeast Asia from 1965 to 1970. DOD suspended its use in 1970 and incinerated remaining stockpiles at sea in 1977. Congress has expressed long-standing interest in the effects of Agent Orange exposure.

The House report accompanying a bill for the National Defense Authorization Act for Fiscal Year 2018 included a provision that GAO review the government's handling of Agent Orange on Guam. This report examines (1) information the federal government has about the procurement, distribution, use, and disposition of Agent Orange; (2) DOD and VA efforts to make information about where Agent Orange and its components were tested and stored available; and (3) challenges associated with Agent Orange testing. GAO reviewed agency policies, documents, and available archival records that GAO identified; interviewed DOD, VA, and other agency officials; and met with a non-generalizable sample of 38 veterans and a veterans service organization.

What GAO Recommends

GAO is making six recommendations, including that DOD develop a process for updating its list of Agent Orange testing and storage locations, and that DOD and VA develop a process for coordinating the communication of information on where Agent Orange was known to have been present. DOD concurred with four recommendations. VA concurred with one recommendation and non-concurred with one recommendation.

View GAO-19-24. For more information, contact Brian Lepore at (202) 512-4523 or leporeb@gao.gov

What GAO Found

Available shipment documentation indicates that nearly all of the Agent Orange procured was either used in U.S. military operations in Southeast Asia, used for testing, damaged, or destroyed. However, some records are incomplete, such as shipment documentation and logbooks that identify ports where vessels stopped on the way to Southeast Asia. GAO obtained and reviewed shipment documentation for over 12.1 million of the 13.9 million gallons of Agent Orange procured by the Department of Defense (DOD). GAO reviewed logbooks for 96 percent (152 of 158) of those shipments and identified that vessels stopped at various ports on the way to Southeast Asia, including at least one vessel carrying Agent Orange that stopped at Guam. While the logbooks GAO reviewed identify when vessels left various ports as they traveled to and from Vietnam, they do not show whether and how much cargo was loaded or unloaded at those ports.

DOD's official list of herbicide testing and storage locations outside of Vietnam that is posted on the Department of Veterans Affairs' (VA) website is inaccurate and incomplete. For example, the list lacks clarity in descriptive information and omits both testing and storage locations and additional time periods covered by testing events. Also, the list has not been updated in over a decade, though DOD and VA have obtained reports on its shortcomings since 2006. Both DOD and VA communicate with veterans in response to inquiries about Agent Orange, but some veterans GAO met with expressed confusion regarding how to obtain information on potential exposure. DOD officials acknowledged this confusion and stated that veterans are contacting multiple agencies to obtain such information. However, DOD and VA have not established a formal process for coordinating on how best to communicate information to veterans and the public regarding the presence of Agent Orange outside of Vietnam. Without a reliable list with complete and accurate information and a formal process for DOD and VA to coordinate on communicating this information, veterans and the public do not have quality information about the full extent of locations where Agent Orange was present and where exposure could potentially have occurred.

Challenges exist with testing for Agent Orange today due to degradation of the herbicide's two chemical components and a potential for sources of contamination other than the herbicide. According to scientific research, the half-life (average time for components to decrease by half of the original amount) of Agent Orange's two chemical components—n-butyl 2,4-D and n-butyl 2,4,5-T—in soil can range from several days to many months, depending on conditions. The suggested half-life of the dioxin 2,3,7,8-TCDD—a by-product of the 2,4,5-T manufacturing process—is much longer, but there are multiple sources of dioxins, including the burning of wood and waste. DOD and the U.S. and Guam Environmental Protection Agencies are testing for the acid form of the components of Agent Orange at Andersen Air Force Base on Guam. While acknowledging the low probability of conclusively identifying the components of Agent Orange on Guam, DOD has made a decision to move forward with testing to address veterans' and the public's concerns, and it expects to complete the updates for the sampling and analysis plan, field sampling, analysis, and reporting in early 2019.

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From the 1940s to the 1970s, the U.S. government developed and tested tactical herbicides in the United States and abroad. These tactical herbicides were known as "rainbow herbicides" and included Orange, Purple, Pink, Green, Blue, and White.[1] Tactical herbicides were intended for use by the U.S. military in the conflicts in Korea and Vietnam, but were not intended for use on U.S. military installations. During the mid-1960s, U.S. chemical companies manufactured and shipped large quantities of tactical herbicides to Vietnam for use by the U.S. military to eliminate enemy cover and destroy the enemy's crops. The tactical herbicide designated "Orange"—later known as Agent Orange—was first produced in 1964, and approximately 12.1 million gallons were shipped to Southeast Asia from several U.S. ports between 1965 and 1970.[2] The Department of Defense (DOD) suspended the use of Agent Orange in Vietnam in 1970 and incinerated remaining stockpiles at sea in 1977.

In 1984, the U.S. Environmental Protection Agency (U.S. EPA) determined that a form of dioxin that is a by-product of the manufacturing process of one of the two components of Agent Orange had been associated with a number of health effects, including cancer, in exposed animals and in humans, including children.[3] The Agent Orange Act of 1991, as amended, established a presumption of service connection for certain diseases manifesting in veterans by way of exposure to herbicide agents while deployed in the Republic of Vietnam at any time beginning January 9, 1962, and ending on May 7, 1975.[4] The act also required that

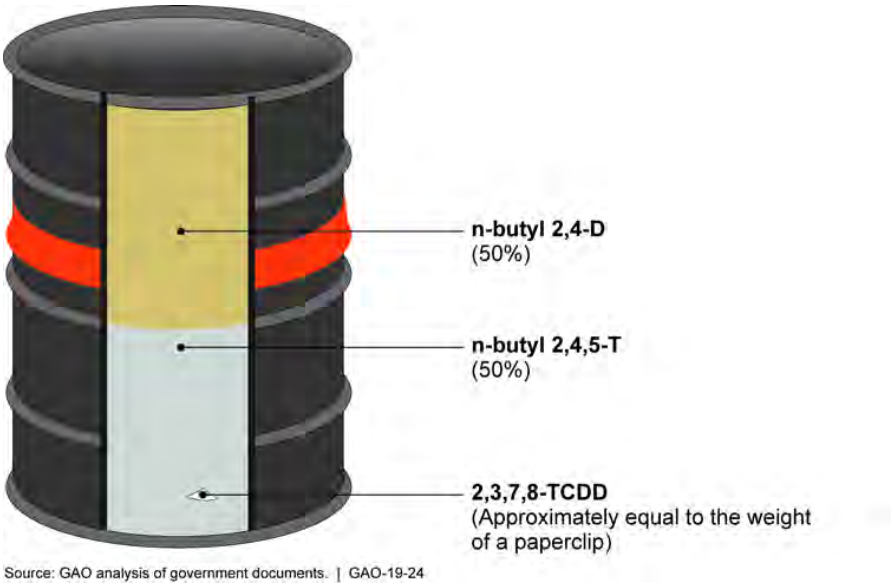
[1]Consistent with House Report 115-200 including a provision for us to conduct this review, this report focuses primarily on the tactical herbicide Agent Orange and its components. Tactical herbicides were developed specifically by DOD to be used in combat operations.

[2]In this report, we use the term "Agent Orange" following the language in our prior reports. However, DOD officials use the term "Herbicide Orange" in referring to the same agent.

[3]Environmental Protection Agency, *Health Effects Assessment for 2,3,7,8-Tetrachlorodibenzo-p-Dioxin*, EPA-540/1-86-044, September 1984. As we describe later in this report, there are many sources of dioxin contamination in addition to the dioxin that was formed as the by-product of the manufacturing process for one of the components of Agent Orange.

[4]Pub. L. No. 102-4, § 2 (1991) (codified as amended at 38 U.S.C. § 1116). Service connection is a factor the Department of Veterans Affairs considers in determining whether to grant disability compensation to a veteran.

Figure 1: Composition of Agent Orange



Source: GAO analysis of government documents. | GAO-19-24

Note: Agent Orange is composed of a mixture of 50 percent 2,4-dichlorophenoxyacetic acid (2,4-D) in its n-butyl ester form and 50 percent 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) in its n-butyl ester form, plus a contaminant, 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). This figure shows 50 percent of each chemical as if separated, but in actuality the chemicals would be mixed together and packaged in 55-gallon drums. According to archival sources, a drum of Agent Orange weighed approximately 600 pounds.

Agent Orange Origins and Life Cycle

The Crops Division of the U.S. Army Chemical Corps was established at Camp Detrick (now Fort Detrick), Maryland, in 1943 to conduct anti-crop research, development, and engineering. In 1944 the Crops Division was given the mission of developing chemical compounds to destroy or reduce the value of crops. These chemical compounds were intended to rapidly clear vegetation in military operations in order to eliminate concealed enemy positions, improve air and ground observations, and destroy or reduce the value of crops. Initial field trials at Camp Detrick were small-scale efforts involving test plots typically 6 by 18 feet in size, and the herbicides being tested were usually applied using a hand sprayer. Over the following three decades, DOD collaborated with the U.S. Department of Agriculture, universities, and private companies to conduct testing activities ranging from laboratory experiments to spray

DOD also cleaned up the Johnston Island site where Agent Orange was ultimately disposed of. Once drums of Agent Orange were stored at Johnston Island, environmental sea conditions caused them to corrode and leak. Initial cleanup activities assessed and monitored the area to track the chemical components remaining as a result of Agent Orange contamination. Site remediation and environmental monitoring continued throughout the 1970s until February 1989, when the Air Force, in accordance with the Defense Environmental Restoration Program, completed a final site cleanup at Johnston Island by destroying all remaining 2,3,7,8-TCDD-contaminated soil. Figure 4 shows drums of Agent Orange stored at Johnston Island.

Figure 4: May 1975 Photo of Drums of Agent Orange Stored on Johnston Island

Source: Alvin L. Young, *Agent Orange: A History of Its Use, Disposition, and Environmental Fate* (June 30, 2008). | GAO-19-24

Note: Many of the drums were no longer marked with an orange band around their center as a result of redrumming that took place from 1972 through mid-1977. According to archival sources, efforts were made to continue labeling new drums as "Herbicide Butyl Esters."

In addition, U.S. EPA listed on its National Priorities List two former Agent Orange manufacturing sites—the Kanawha River site in West Virginia previously owned by the Monsanto Company and a site in Newark, New Jersey, owned by the Diamond Alkali Company—due to high levels of contamination from various sources and threats to human health. In 2017, U.S. EPA entered into an agreement with the Monsanto Company on a cleanup plan to address 2,3,7,8-TCDD contamination at the Kanawha River Superfund Site in Putnam and Kanawha counties, West Virginia. The cleanup effort will focus on a 14-mile stretch within the Kanawha

previously. The 1977 figure also takes into account 14,025 gallons transferred to the Naval Construction Battalion Center Gulfport, from Eglin Air Force Base, Florida, where the Air Force had tested formulations of Agent Orange for aerial spraying. In addition, available records show that quantities of the two components of Agent Orange were stored at the former Kelly Air Force Base, Texas, until 1972 before they were transferred to the U.S. Department of Agriculture for brush control projects. These reported amounts included 106,260 gallons of n-butyl 2,4-D and 38,940 gallons of n-butyl 2,4,5-T. These records also show that 173,910 gallons of Agent Blue were stored at the installation; see figure 5.

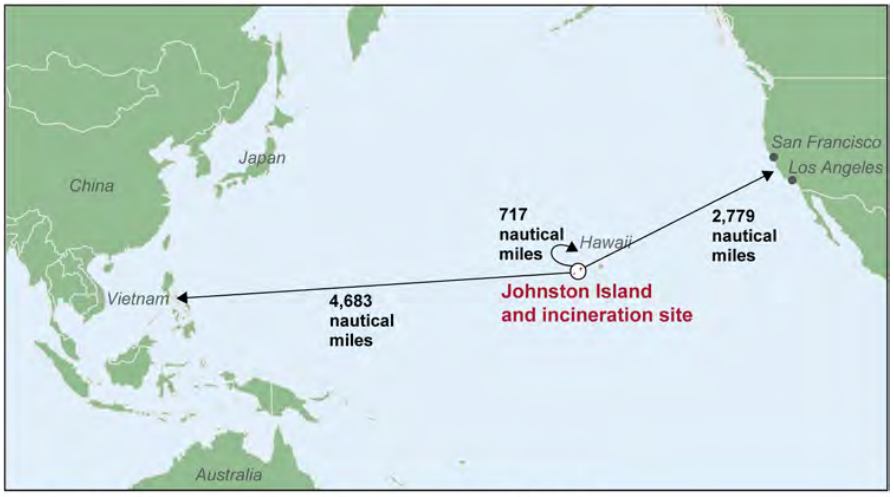
Figure 5: Photo of Drums of Agent Orange Components (n-butyl 2,4-D and n-butyl 2,4,5-T) and Agent Blue Located at San Antonio Air Materiel Area, Kelly Air Force Base, Texas

Source: National Archives and Records Administration. | GAO-19-24

Note: Photo by San Antonio Air Materiel Area, Kelly Air Force Base, Texas (October 12, 1971).

DOD chartered the incinerator ship M/T *Vulcanus* and loaded the 860,000 gallons stored at Naval Construction Battalion Center Gulfport, Mississippi, beginning in May 1977. The vessel left Gulfport, Mississippi, in June 1977, and began incinerating the Agent Orange on board in July 1977 in a research burn to test the incineration process at sea near Johnston Island. In August 1977, the M/T *Vulcanus* loaded the remaining 1.36 million gallons stored at Johnston Island and conducted two more incineration operations just southwest of Johnston Island, as shown in figure 6. By September 3, 1977, all stocks of Agent Orange had been incinerated.

Figure 6: Map of Johnston Island and M/T *Vulcanus* Burn Site



Source: GAO analysis of Department of Defense data; Map Resources (map). | GAO-19-24

Available Records Indicate That Vessels Transporting Agent Orange Stopped at Various Ports en Route to Southeast Asia, but Shipment Information Is Not Complete

Our review of documentation for the shipment of almost 12.1 million gallons of the approximately 13.9 million gallons (approximately 87 percent) of Agent Orange procured by DOD found, based on available shipment documentation, that vessels transporting Agent Orange made stops at various ports on the way to Southeast Asia. However, shipment documentation is incomplete. Manufacturers of Agent Orange blended the two components of the herbicide—the n-butyl forms of 2,4-D and 2,4,5-T—and marked 55-gallon drums for shipment to Southeast Asia. Available records indicate that manufacturers produced Agent Orange according to military specifications and marked all drums for shipment directly to the receiving U.S. military unit in Vietnam. These specifications indicated the precise herbicide formulation of Agent Orange (n-butyl esters, 50 percent 2,4-D and 50 percent 2,4,5-T) and general instructions for marking the 55-gallon drums for shipment. For example, according to a historical monograph by the San Antonio Air Materiel Area, DOD specified that each drum was to be marked with a colored band or bands around the center as well as with transportation and contract data. Figure 7 shows an example of these drum markings.

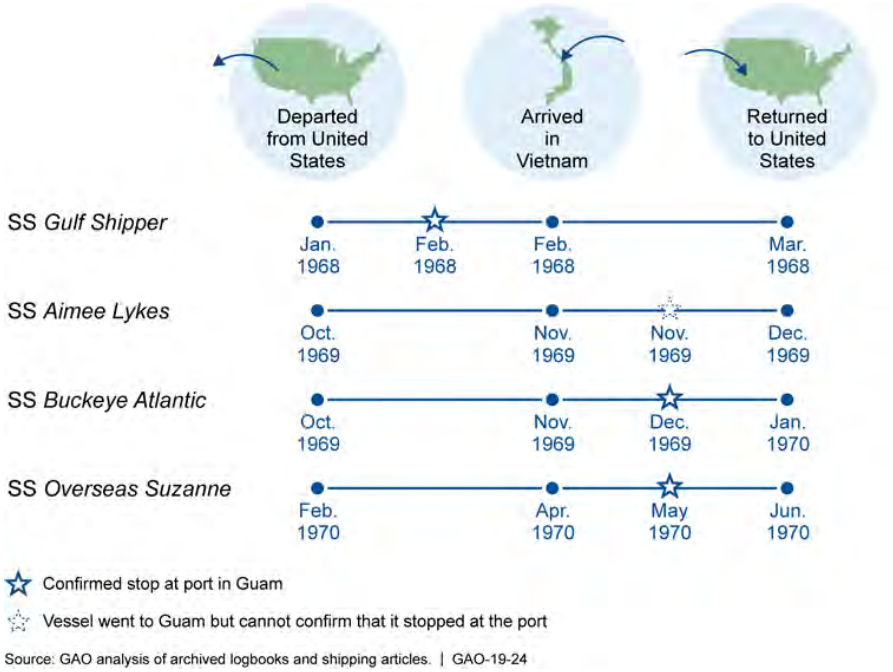
Lykes Company Ships

The Military Sea Transportation Service directly chartered merchant vessels to carry tactical herbicides during the Vietnam War. At least 28 vessels owned by the New Orleans, Louisiana-based Lykes Brothers Steamship Company transported Agent Orange between 1965 and 1970 from Gulf Coast ports to Southeast Asia. Lykes Brothers vessels were designed to handle cargo with cables that could place the cargo in a series of holds—numerous compartmented internal storage spaces. Tactical herbicides were stored vertically on pallets in these holds. The first large shipments of Agent Orange took place on the SS *Adabelle Lykes*, SS *Elizabeth Lykes*, and SS *Mayo Lykes*, traveling from the port of New Orleans, Louisiana, through the Panama Canal, and refueling in the Philippines before offloading a total of 1,782 55-gallon drums (approximately 97,000 gallons) in Saigon, Vietnam, in February and March of 1965.

Source: Photo from National Archives and Records Administration of a Lykes Line ship docked in Gulfport, Mississippi. Photo by San Antonio Air Materiel Area, Kelly Air Force Base, Texas (March 1969). | GAO-19-24

Our review of the logbooks and shipping articles for vessels carrying Agent Orange and other tactical herbicides showed that these vessels made stops at several U.S. and foreign ports, both in going to and in returning from Vietnam. For example, we identified vessels that stopped at several West Coast ports to load cargo before traveling to Vietnam, and others that made port calls to refuel in Hawaii. We also identified vessels that stopped at foreign ports such as Okinawa, Thailand, and Taiwan, as well as locations near the major U.S. Naval Supply Depots in Yokosuka, Japan, or Subic Bay, Philippines. These supply depots were major logistics hubs for U.S. military operations in East Asia, and they provided supplies to commercial ships that were chartered by DOD's Military Sea Transportation Service through contracts with shipping companies. These companies would reserve cargo space for military cargo and include Saigon, Vietnam, as a destination, but the voyages were otherwise made for normal commercial activities. From those locations, the cargo vessels traveled to one or more ports in Vietnam. However, while the logbooks we reviewed identify when vessels left the various ports as they traveled to and from Vietnam, logbooks do not provide information on whether and how much cargo was loaded and unloaded at those ports of call, nor do they indicate whether tactical herbicides were offloaded at any ports before the vessels reached Vietnam.

Figure 9: Timelines of Vessels Carrying Agent Orange That Stopped at Guam on the Way to or from Vietnam

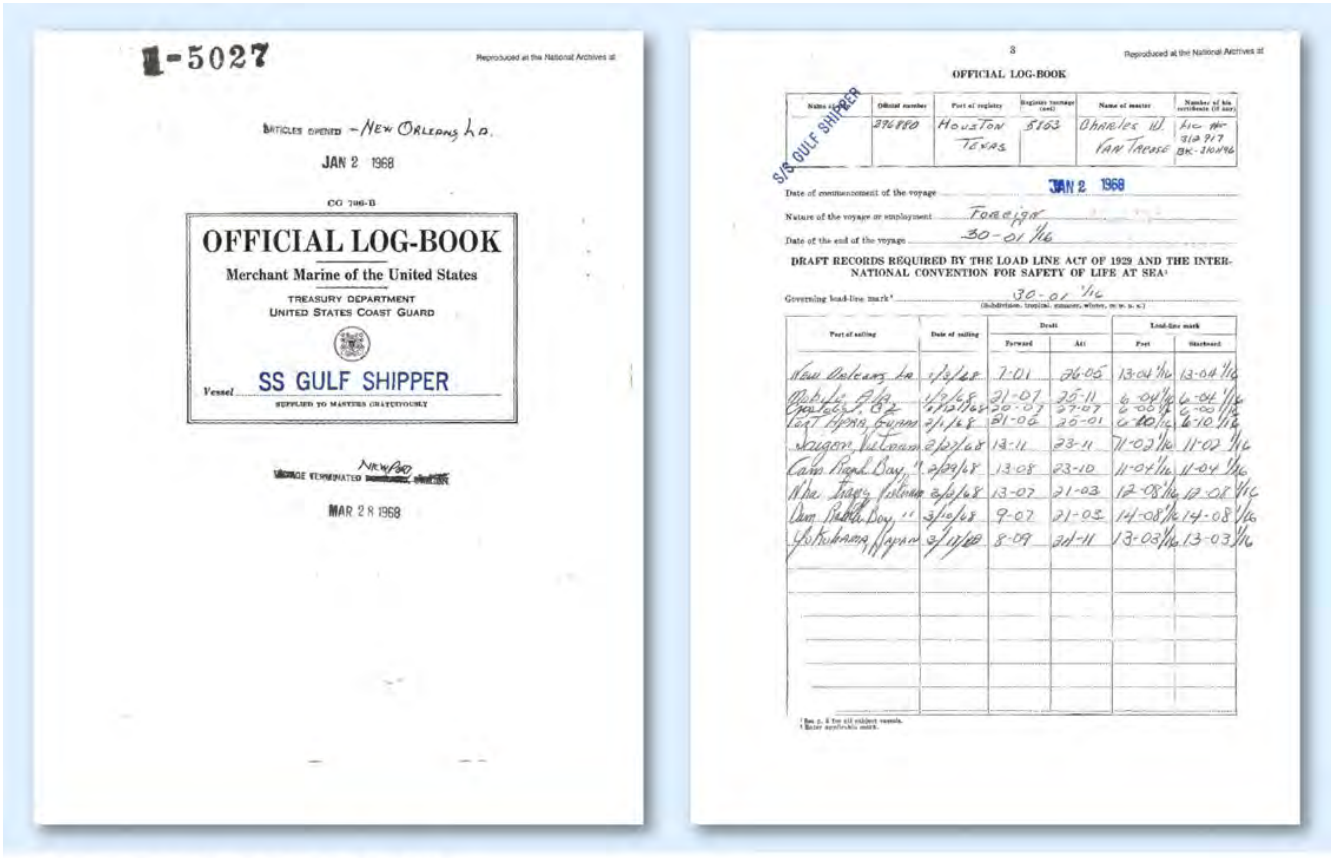


Source: GAO analysis of archived logbooks and shipping articles. | GAO-19-24

Note: While the ports of call listed in the SS *Aimee Lykes* logbook do not indicate a port of call on Guam, it does include an entry that describes pulling into Apra Harbor and offloading an injured mariner into a small motorboat so that the individual could be hospitalized on Guam. Therefore, we cannot confirm whether the vessel docked at Port Apra or stayed in the harbor.

Available shipment documentation indicates that hundreds of vessels delivered supplies to the Naval Supply Depot, including supplies bound for Andersen Air Force Base, on Guam during the Vietnam War due to both installations' strategic location in supporting the war effort. While the logbooks we were able to locate and review for vessels that transported Agent Orange to Southeast Asia between 1965 and 1970 do not show that these vessels typically stopped at Guam or the Northern Mariana Islands at any time during their voyages, we identified one ship carrying Agents Orange, Blue, and White that did stop at Guam on its way to Vietnam. Specifically, available records indicate that sometime around February 1, 1968, the SS *Gulf Shipper* stopped at Port Apra (now Apra Harbor) on Guam en route to Vietnam. Figure 10 shows a photo of the logbook from the SS *Gulf Shipper* indicating the ship's ports of call en route to Vietnam.

Figure 10: Excerpts from March 1968 SS *Gulf Shipper* Logbook



Source: National Archives and Records Administration. | GAO-19-24

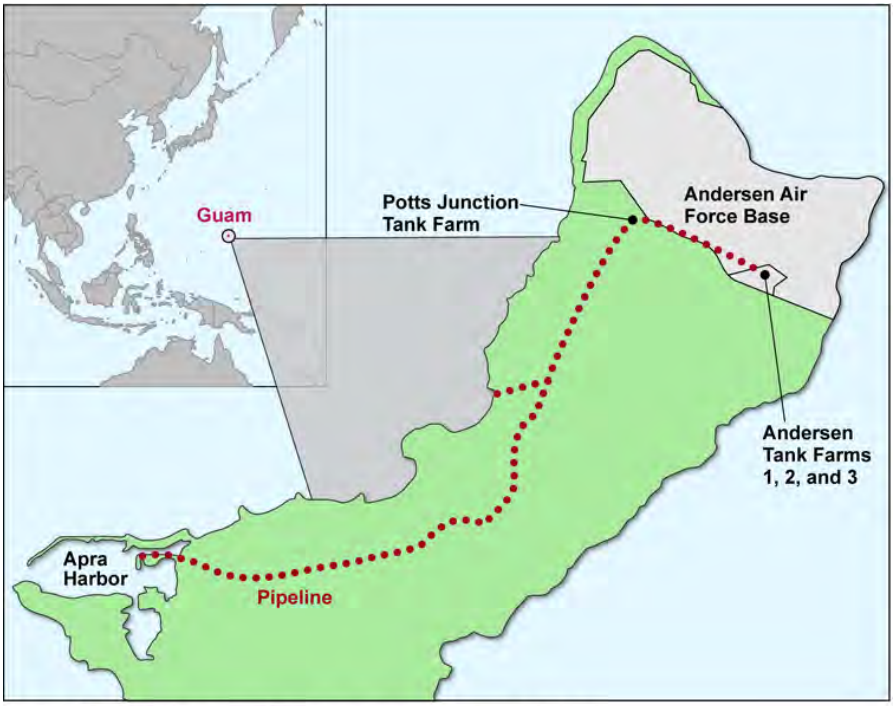
The logbooks do not provide details about whether cargo was moved on or off the vessels during these port calls, or whether tactical herbicides were offloaded at these ports before the vessels reached Vietnam. However, the SS *Gulf Shipper's* logbook indicates that the stop at Guam could have been related at least in part to the repatriation of an injured crew member to the United States, and not to matters related to the loading or unloading of cargo. Further efforts to locate information on cargo movements for the SS *Gulf Shipper*, such as customs records, manifests, or bills of lading, were unsuccessful, because those records were not routinely retained. As such, we were not able to verify why the

Vietnam after 1961. During our visit, officials at Andersen Air Force Base stated that it would have been possible to fly 55-gallon drums from Guam to supply operations in Vietnam, but that such an action would have been an inefficient method of transporting large quantities of herbicides. Agent Orange weighed approximately 600 pounds per drum, or about 11 pounds per gallon, a weight that, according to a 1966 memorandum from the Military Assistance Command, Vietnam, would have precluded large-scale transport of the herbicide by aircraft.

DOD Documents Identify the Use of Commercial but Not Tactical Herbicides on Guam

Available records show that DOD stored and used commercial herbicides on Guam, possibly including those containing n-butyl 2,4,5-T, during the 1960s and 1970s, but documents do not indicate the use of tactical herbicides on Guam. Commercial herbicides were available through the federal supply system for use on U.S. military installations worldwide. For example, the fuel supply for Andersen Air Force Base was delivered by ship to the port at Naval Base Guam and was then delivered to the Air Force base by a cross-island fuel pipeline—see figure 11. A detailed 1968 report by the Naval Supply Depot states that the Public Works Center sprayed herbicides semi-annually to control the vegetation along fuel pipelines between the depot and Andersen Air Force Base.

Figure 11: Fuel Pipeline from Naval Base Guam to Andersen Air Force Base in 1968



Source: GAO analysis of Department of Defense data; Map Resources (map). | GAO-19-24

Note: Document entitled, “Condition of Naval Supply Depot” (June 1968).

Additionally, draft environmental assessments written in 1999 and 2009 by Naval Facilities Engineering Command, Pacific, indicate that commercial herbicides containing 2,4-D were present on Guam, and that commercial herbicides containing 2,4,5-T, which included the contaminant 2,3,7,8-TCDD, had been used for weed control along power lines and substations through 1980. Further, a 1969 master storage plan for the Naval Supply Depot includes sketches of storage facilities that specify the location of weed killers. Commercial herbicides approved for DOD procurement for use on installations were issued in 55-gallon drums and 5-gallon containers during the Vietnam War era, as were a range of other products, such as fuel oil and diesel. According to DOD officials, records for such purchases were not typically retained due to short record retention policies related to such routine supply transactions.

During the course of our review, we received photographs and written statements from veterans alleging the presence of Agent Orange on Guam. However, based on our discussion sessions with veterans and civilians and our review of this documentation, we could not substantiate the presence or use of Agent Orange or other tactical herbicides on Guam. We asked veterans in our six discussion sessions about their potential for exposure to Agent Orange and where, if, and how they believe they were exposed. In their responses, some veterans in each of the six discussion sessions stated that they believe they were exposed to Agent Orange while deployed in Vietnam or other areas where a presumption of service for benefits has already been granted, while some veterans in three of the six discussion sessions stated that they believe they were exposed to Agent Orange while stationed on Guam. Specifically, some veterans in our discussion sessions described using herbicides or witnessing the spraying of herbicides at locations on Andersen Air Force Base and along the pipeline, as well as the burning of contaminated fuel as part of firefighting training on the installation. As we previously stated, according to DOD officials and archived military specifications, tactical herbicides were not authorized or available for use on lands owned by, or otherwise managed as military installations. However, commercial herbicides were widely available worldwide for use in vegetation management at military installations, to include controlling vegetation adjacent to flightlines or along perimeter fencing.

Selected Comments by Veterans at Discussion Sessions Moderated by GAO Regarding Where They Believe They Were Exposed to Agent Orange or Its Components

- I feel like I was exposed on Guam. I was [on] temporary duty there during the conflict and my duties were as a squadron controller that worked the schedules for the B-52 Bombers on Guam. I did venture into the loading area because I was with the aircrew on the Navy field at Andersen Air Force Base.
- I thought I was in contact with Agent Orange in Guam loading bombs in sites. We would move from one site to another and they would spray those areas before we got there. I never saw spraying but could smell it. One time I was near that and I broke out in boils and blisters on my face and arms.
- I was a fuel specialist [and] I witnessed spraying going on at the barracks at Marbo Annex, 2 to 3 miles off the main Air Force base. It was sprayed all around the barracks. As my job, I worked at POL [fuels]—where they stored all of the 55-gallon drums—fuels, pesticides, herbicides—in bulk storage. Those were constantly sprayed around—for maintenance and fire safety. Also, I would work on the flightline and at the pump houses—these were about 20 yards from the security fence. As I was working there, I witnessed spraying.

Source: Comments from veterans during GAO's facilitated discussions at moderated discussion sessions. | GAO-19-24.

Note: We documented, as closely as possible, the actual comments made by veterans and civilians at the six moderated discussion sessions held from December 2017 to March 2018. We did not edit their comments to further clarify the information provided. The views of these veterans are not generalizable to all veterans, but they provide illustrative examples of comments that we heard. The veterans' comments also do not necessarily reflect GAO conclusions contained in this report.

information about Agent Orange testing and storage locations is identified.

In our analysis of the DOD list, we were also unable to determine the criteria that DOD initially used to select which locations and time periods to include—particularly given that the testing varied in intensity and duration, and that the likelihood that personnel at a particular location could have been exposed to the herbicides or components was unclear. For example, some tests on the list included small laboratory experiments on a couple of plants using a very small amount of chemical agents, as in bench tests of various compounds at Forts Detrick and Ritchie, Maryland, in the 1950s, while other tests included gallons of Agent Orange or other chemical agent components that were used in field testing trials or to test aerial spraying, as in a defoliation effort in which 13 drums were sprayed by helicopter over an area covering 4 square miles. Similarly, the duration of testing events could have been over a total of 3 days, as with spray testing in Marathon, Florida, or over several months or even years, as with spray testing of several tactical herbicides at Eglin Air Force Base, Florida. Because of the variance in the size and duration of testing events; the specific areas where the testing events took place at the locations; and the number of personnel who actually came into contact with the chemical agents during the testing, the presence of a location on this list does not clearly indicate the likelihood or extent of potential exposure that individuals not involved would have had if they were simply present at the locations on the list at the times indicated.

In May 2018, during the course of our review, a DOD official noted that DOD and VA formed a joint Herbicide Orange Working Group to address the issues with the DOD list and identify criteria for including information on this list. This group held its first meeting on May 31, 2018. As of July 2018, a DOD official noted that the group was working to identify appropriate steps to take, but that it was too soon to report specific actions that were being implemented, and that no documentation on the group's efforts was available.

Without assigned responsibility for ensuring an accurate and complete list of locations where Agent Orange or its components were tested and stored; a process for updating the list as needed; and clearly defined and transparent criteria for what to include on this list, DOD will not have reasonable assurance that it has identified the most complete information possible for VA to use when informing veterans and the public of the full extent of locations where Agent Orange exposure could potentially have occurred. As a result, veterans may not have complete information about

the risk that they could have been exposed to Agent Orange during their military service, and VA may not have quality information when making important decisions on claims for veterans who may not be eligible for benefits.

DOD and VA Have Communicated with Veterans and Others about Potential Exposure to Agent Orange, but Veterans Have Expressed Confusion Regarding How to Obtain Needed Information

Both DOD and VA have communicated with veterans in response to inquiries about Agent Orange, but veterans have expressed confusion regarding how to obtain information to determine their potential exposure to Agent Orange. Further adding to this confusion are inconsistencies in the list of testing and storage locations, as discussed above. As the agency responsible for reviewing and validating veterans' disability compensation claims for possible Agent Orange exposure, VA communicates with veterans largely through the agency's website, which contains information on Agent Orange regarding related diseases, benefits, exposure locations, and resources. The VA also communicates through other means, including an annual newsletter and forums with veterans service organizations. DOD also receives inquiries from veterans about the potential that they could have been exposed to Agent Orange at DOD installations outside of Vietnam. In addition, DOD receives Freedom of Information Act inquiries and congressional requests for information on where Agent Orange was present. A DOD official stated that while they will respond to veterans' inquiries, they typically direct veterans with Agent Orange inquiries to VA.

In responding to these inquiries, both DOD and VA officials stated that they rely on the expertise of staff at the Armed Forces Pest Management Board to provide details to answer questions related to locations where exposure might have occurred. According to a DOD official, the board received 109 inquiries in 2017 alone. In addition, DOD's Joint Services Records Research Center provides information to VA regional liaisons electronically in response to their questions about where and when specific units were stationed or on temporary duty. The center extracts operational records from various record repositories and, if the information is available, corroborates the descriptions of incidents described by veterans in their claims. According to DOD officials, unless an herbicide-related incident was documented in some sort of unit record, the center would not have information on where Agent Orange was present.

Despite these various approaches for communicating information to veterans and the public, veterans we spoke with expressed confusion as to where to obtain information on their potential exposure to Agent

Orange. Specifically, we asked veterans in our six discussion sessions about what they had heard from DOD, VA, or other federal agencies about the potential that they could have been exposed to Agent Orange or its components at locations where Agent Orange was manufactured, transported, stored, used, or destroyed. Veterans in each of the six sessions stated that, generally, the federal government has not reached out to them regarding Agent Orange, but that they instead have relied on their own research to learn more about their potential for having been exposed, adding to the confusion about where to obtain information on Agent Orange exposure. Other veterans, however, stated that they have received information from VA regarding potential exposure. DOD officials acknowledged that there is confusion among veterans about a variety of issues related to their potential for exposure to Agent Orange, including where to go for information. U.S. EPA and DOD officials stated that veterans are contacting multiple agencies to get information on herbicide exposure.

Selected Comments by Veterans at Discussion Sessions Moderated by GAO Regarding What They Had Heard from the Federal Government about Negative Health Effects Associated with Exposure to Herbicides, Including Agent Orange or Its Components

- I've heard things from multiple sources—media, newspaper, television, people themselves. It has mainly been from my own research, not from a federal agency.
- Just based on the fact that I have heart disease and going through the VA process means I receive updates from VA on just about everything going on, including Agent Orange and all of the research they have done. I do know the Secretary is authorized by law from Congress late last year to add additional presumptive diseases associated with Agent Orange and how one would contract that.
- I had to do the research myself. It seems to be a secret with information coming out in spurts. When you have things happen to your body, they [the Department of Veterans Affairs] say it is not service connected. Sometimes when the government tries to explain something, they don't give the whole thing and they give it piecemeal. It does not carry any essence of importance.
- I am not hearing anything from the federal government. Most of the information I get is from a USveterans.com website and I subscribe to a daily newsletter from the Vietnam Veterans of America and the Veterans of Foreign Wars.
- There is information on the VA website about conditions attributed to Agent Orange In that context, I went to the VA website and found that there are 21 states where Agent Orange was used, including on Hawaii in Kauai. It is because of this list that I became aware that people in Hawaii may have been exposed to Agent Orange. I learned that such exposure might increase the likelihood of having diabetes or cancer. I believe the list is still on the VA website and that there is also a list of units that were possibly exposed to Agent Orange.
- I have not been contacted by any government agency with regard to Agent Orange exposure or ill health. I first heard about Agent Orange and dioxin and cancer related issues/illnesses in late 1980s or early 1990s and later on after doing own research.

Source: Comments from veterans during GAO's facilitated discussions at moderated discussion sessions. | GAO-19-24.

Working Group has the potential for being an effective forum for communicating this information; however, a DOD official noted that this is an ad hoc group, and as we discussed earlier, it has not yet determined the direction it will be taking for communicating with veterans regarding exposure to Agent Orange. By coordinating on how best to communicate this information, VA would be better positioned to provide veterans with information regarding their potential exposure to Agent Orange at locations where Agent Orange was known to have been present outside of Vietnam.

Challenges Exist with Testing for Agent Orange Today Due to Degradation and Multiple Sources of Potential Contamination

Testing to determine whether Agent Orange was present in a particular location is challenging because, for example, derivatives of Agent Orange—including the two components of Agent Orange (n-butyl 2,4-D and n-butyl 2,4,5-T) and the contaminant from the 2,4,5-T manufacturing process (2,3,7,8-TCDD)—degrade over time, and because derivatives of 2,4-D and 2,4,5-T can come from multiple sources. Regardless of these challenges, in response to a request by the Government of Guam, DOD developed a testing plan that was reviewed and accepted by U.S. EPA and Guam EPA to conduct a limited investigation into alleged Agent Orange use at three sites on Guam.

Testing for Agent Orange Presents Challenges Due to Degradation and Multiple Sources of Potential Contamination

Challenges Due to Degradation

Testing to identify locations where Agent Orange may have been present is challenging because the components of Agent Orange degrade over time. It has been nearly 50 years since Agent Orange was last transported and used in support of military operations in Vietnam. According to scientific research, it is difficult to find traces of the two components of Agent Orange—n-butyl 2,4-D and n-butyl 2,4,5-T—because, under normal environmental conditions, the n-butyl forms break

spraying…as opposed to being spilled onto the soil…would generally be expected to result in a lower soil concentration due to photolytic degradation due to sunlight. This reduces the likelihood of detecting the compound 50 years later. However, as discussed below, there are multiple sources of dioxin in Vietnam. As a result, the specific source of dioxin contamination is difficult to identify.

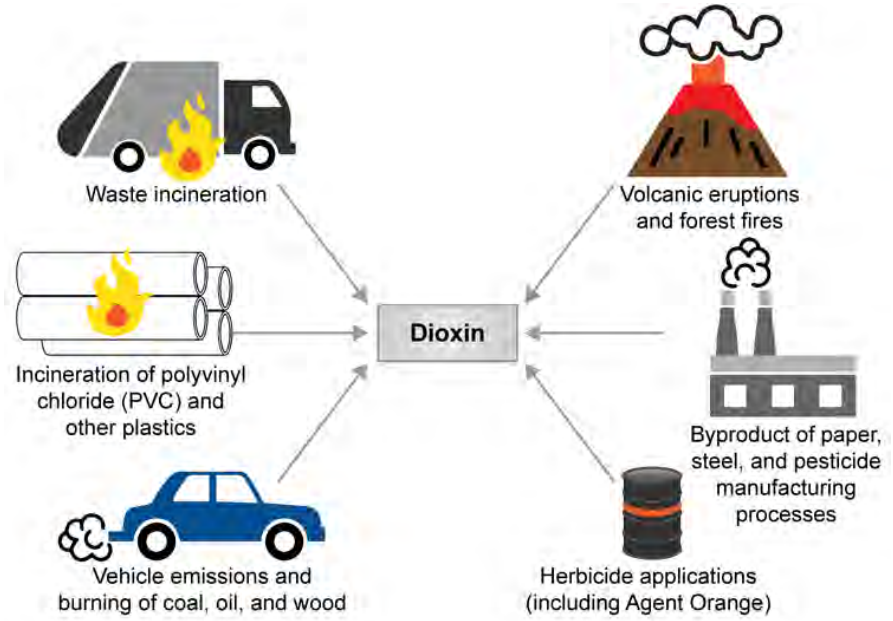
Challenges Due to Multiple Sources of Potential Contamination

Testing to identify hotspots where Agent Orange may have been present is complicated by the presence of dioxin from sources other than the herbicides as well as multiple sources of the contaminant, 2,3,7,8-TCDD. Specifically, many commercial herbicides that were available at the time of the war contained dioxin contaminants similar to 2,3,7,8-TCDD. Additionally, 2,4-D derivatives are still used in commercial herbicides today. Therefore, even if testing were to show the presence of one of the commercial herbicides, it would be difficult to make a determination whether the chemicals were present from the use of commercial herbicides or the use of tactical herbicides. Further, because 2,4-D is not a persistent chemical, the presence of 2,4-D or one of its derivatives as a component could be due to a recent use of a commercial herbicide rather than a use during the war.[1]

Moreover, multiple sources of the contaminant, 2,3,7,8-TCDD can be found in the environment today. DDE and 2,3,7,8-TCDD, dioxin, can be found in soil today, the source of the dioxin contamination is difficult to identify as coming from Agent Orange. For example, according to the World Health Organization, dioxins—including 2,3,7,8-TCDD—are primarily released by the environment with the burning of materials such as wood and waste (see figure 12).[2]

[1]World Health Organization, Dioxins and Their Effects on Human Health Fact Sheet (Updated October 2010).

Figure 12: Examples of Sources That Contribute to the Presence of Dioxins in the Environment



Source: GAO analysis of various sources. | GAO-19-24

Testing for the Components of Agent Orange on Guam Is Challenging

In 2017 the Government of Guam coordinated with DOD to test for Agent Orange and other tactical herbicides at Andersen Air Force Base due to claims from veterans that they were exposed to Agent Orange while stationed on Guam during the 1960s and 1970s. In December 2017 DOD developed a draft testing plan in collaboration with U.S. EPA and Guam EPA to test for the acid form of the components 2,4-D and 2,4,5-T at three different sites on Andersen Air Force Base. The draft testing plan did not include testing for the presence of 2,3,7,8-TCDD. According to DOD and U.S. EPA officials, they are not testing for 2,3,7,8-TCDD because the test would not be able to conclusively link any positive results to the use of tactical herbicides, given that dioxins are also produced by, among other things, burning fossil fuels. These officials noted that, over time, large quantities of fuel have been burned at Andersen Air Force Base, and they stated their belief that if 2,3,7,8-TCDD were found, the likely source would be from combustion. The areas identified for testing included the fuel pipeline, a perimeter fenceline, and an area near some fuel storage tanks. See figure 13 for a photograph of

the fenceline testing site near the fuel storage tanks on Andersen Air Force Base.

Figure 13: Fenceline Testing Site Near the Fuel Storage Tanks at Andersen Air Force Base, Guam

Source: GAO. | GAO-19-24

Based on our initial review of the draft testing plan and a review of the scientific literature, we identified and discussed with DOD and U.S. EPA officials some challenges the two agencies would face in detecting the presence of Agent Orange on Guam due to two factors: (1) the short amount of time that it takes for 2,4-D and 2,4,5-T to degrade; and (2) the inability of testing to determine whether the presence of 2,4-D and 2,4,5-T is attributable to the use of Agent Orange or to some other source.

- Degradation of 2,4-D and 2,4,5-T: DOD officials and the jointly developed draft testing plan acknowledged that the planned testing would not be able to confirm the presence of Agent Orange, given that the components degrade over time. The draft testing plan indicates that the maximum half-lives of 2,4-D and 2,4,5-T are 14 days and 24 days, respectively, in soil and groundwater. Even given the possible variation in half-lives discussed above, it is likely that no detectable concentrations remain in soil today, given that the alleged period of use on Guam was in the 1960s and 1970s.
- Inability to distinguish whether the presence of 2,4-D and 2,4,5-T is attributable to the use of Agent Orange or some other source: Even if the results were to confirm the presence of either 2,4-D or 2,4,5-T in

the proposed testing methodology, it would be difficult to determine if 2,4-D and 2,4,5-T came from Agent Orange or another source, and there were inconsistencies in the reported half-lives of the components of Agent Orange. At the same time, both DOD and U.S. EPA officials questioned the ability of any testing for 2,4-D or 2,4,5-T on Andersen Air Force Base to either confirm or deny the presence of Agent Orange on Guam. Specifically, the final testing plan states that more than 50 years have passed since the period of alleged use, and that a lack of detection provides no evidence that herbicides were not used historically. Moreover, U.S. EPA officials noted that the testing on Guam would not provide definitive proof of Agent Orange use on the island. Although DOD officials recognized these challenges and acknowledged the low probability of conclusively identifying the components of Agent Orange, they decided to move forward with testing to address veterans' and the public's concerns.

In April 2018, samples were collected from the three areas at Andersen Air Force Base, according to DOD officials. Each sample was divided following procedures outlined in the final testing plan, resulting in two identical sample sets. A sample set was sent to two independent laboratories for analysis. According to officials from DOD and U.S. EPA, test results and associated quality control reports from both laboratories agreed on the results from two of the area samples, but did not agree on the third area sample. The jointly developed decision rules for the sampling and analysis plan required the results from both laboratories to agree in order to draw a conclusion on the presence or absence of Agent Orange. As a result, according to the officials, the DOD, U.S. EPA, and Guam EPA project team agreed in July 2018 to resample the one area where the two labs reported differing results. The project team is updating the sampling and analysis plan to address the various possible reasons for the differing laboratory results in order to provide a conclusive final testing result. DOD officials told us they do not anticipate completing the updates for the sampling and analysis plan, field sampling, analysis, and reporting until early 2019. As such, we were not able to comment on the results of the final testing in this report. Moreover, DOD officials said that, provided the final resampling results are negative, DOD does not have plans to conduct additional testing, because the testing was conducted in areas alleged to be the likeliest locations for the application of Agent Orange. However, an official from U.S. EPA said that the challenges associated with testing on Guam are not insurmountable and that the agency would like to continue this investigation. Given that (1) DOD, working with U.S. EPA and Guam EPA, made a decision to test for Agent Orange and other tactical herbicides; (2) DOD, U.S. EPA, and Guam EPA

recognize the limitations associated with the testing; (3) the testing and analysis of results are still on-going; and (4) there is currently uncertainty regarding whether any additional testing will take place on Guam, we are not making any recommendations with respect to the testing plan or its execution.

Conclusions

DOD suspended the use of Agent Orange in Vietnam in 1970 and incinerated remaining stockpiles at sea in 1977, but concerns about the effects of exposure in U.S. locations have persisted. DOD developed a list that identifies locations and dates where herbicides, including Agent Orange, are thought to have been tested and stored outside of Vietnam, which VA has made publicly available on its website, but this list is neither accurate nor complete. Without assigning responsibilities for verifying the accuracy of the information included on the list; a process for ensuring that the list is updated, as new information is found; and clear and transparent criteria, indicating which locations should be included on the list, DOD and VA will not have assurance that they have the most complete information possible when informing veterans and the public of the full extent of locations where Agent Orange exposure could potentially have occurred. By relying on an inaccurate list, VA may not have quality information when making important decisions on claims for veterans who might or might not be eligible for benefits. Further, while DOD and VA both communicate with veterans in response to their Agent Orange inquiries, the two agencies do not have a formal process for coordinating on how best to communicate this information. Until DOD and VA develop a process for how best to coordinate to ensure that they are communicating information, veterans and the public may not have the information needed regarding their potential exposure to Agent Orange.

Recommendations for Executive Action

We are making six recommendations: four to the Secretary of Defense and two to the Secretary of Veterans Affairs.

The Secretary of Defense should ensure that the Under Secretary of Defense for Acquisition and Sustainment assigns responsibility for ensuring that DOD's list of locations where Agent Orange or its components were tested and stored is as complete and accurate as available records allow. (Recommendation 1)

The Secretary of Defense should ensure that the Under Secretary of Defense for Acquisition and Sustainment develops a process for updating

the revised list as new information becomes available. (Recommendation 2)

The Secretary of Defense, in collaboration with the Secretary of Veterans Affairs, should develop clear and transparent criteria for what constitutes a location that should be included on the list of testing and storage locations. (Recommendation 3)

The Secretary of Veterans Affairs, in collaboration with the Secretary of Defense, should develop clear and transparent criteria for what constitutes a location that should be included on the list of testing and storage locations. (Recommendation 4)

The Secretary of Defense, in collaboration with the Secretary of Veterans Affairs, should develop a formal process for coordinating on how best to communicate information to veterans and the public regarding where Agent Orange was known to have been present outside of Vietnam. (Recommendation 5)

The Secretary of Veterans Affairs, in collaboration with the Secretary of Defense, should develop a formal process for coordinating on how best to communicate information to veterans and the public regarding where Agent Orange was known to have been present outside of Vietnam. (Recommendation 6)

Agency Comments and Our Evaluation

We provided a draft of this report for review and comment to DOD, VA, U.S. EPA, the U.S. Department of Agriculture, and the U.S. Department of Health and Human Services. In its written comments, DOD concurred with each of our four recommendations directed to the Secretary of Defense and identified actions it plans to take to implement them. In its written comments, VA concurred with one recommendation directed to the Secretary of VA and described actions it would take to implement the recommendation. VA also non-concurred with one recommendation. In its written comments, the U.S. Department of Agriculture agreed with the report's findings related to matters under the purview of agricultural research and programs, though we did not make any recommendations to the department. Comments from DOD, VA, and the U.S. Department of Agriculture are reprinted in their entirety in appendixes V through VII. We also received technical comments from DOD, VA, U.S. EPA, and the U.S. Department of Health and Human Services, which we incorporated as appropriate.

Based on oral comments we received from DOD, we revised our recommendation regarding the development of clear and transparent criteria for what constitutes a location that should be included on the list of testing and storage locations to clarify that DOD and VA should collaborate on this effort. VA non-concurred with this recommendation, noting that DOD chairs the Herbicide Orange Working Group that will be responsible for developing the criteria (Recommendation 4). However, VA stated that as a member of the working group, it would work collaboratively with DOD as the lead. Doing so would meet the intent of our recommendation.

In its overall written comments, VA stated that it was concerned that the report conflates the terms “commercial herbicides” with “tactical herbicides,” which the department noted were distinctive from one another. While VA stated that it does not dispute that some chemicals found in the VA regulation may be included in certain commercial herbicides, VA noted that exposure to tactical herbicides intended for military operations in Vietnam is required for VA to grant disability benefits on a presumptive basis. We recognize that the presumption for service-connection applies to exposure to tactical herbicides and nothing in our report states otherwise. VA also stated in its letter that the focus on commercial herbicides is not relevant for determining the list of locations where tactical herbicides were tested or stored. We agree and as we noted in this report, the U.S. military managed tactical herbicides used during the Vietnam War era differently from commercial herbicides in the federal supply system, which were widely available worldwide for use in vegetation management at military installations. To avoid conflating tactical and commercial herbicides, the report further notes that while some of these commercial herbicides contained 2,4-D; 2,4,5-T; or both, these commercial herbicides were not in the n-butyl form used in Agent Orange. However, commercial herbicides with 2,4,5-T likely contained some level of 2,3,7,8-TCDD. Moreover, we believe it is important to reiterate that numerous commercial herbicides that were being widely used elsewhere for agriculture purposes contained the form of 2,4,5-T found in Agent Orange and thus its associated dioxin contaminant, 2,3,7,8-TCDD.

In its overall written comments, VA also recommended that GAO analyze its list to ensure that only locations where the presence of tactical herbicides has been confirmed are included on the list of locations. It is important to note that we do not maintain a list of herbicide testing and storage locations. As we noted in this report, DOD developed a list that identifies locations and dates where herbicides, including Agent Orange

List of Addressees

The Honorable Mac Thornberry
Chairman
The Honorable Adam Smith
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable Madeleine Z. Bordallo
Ranking Member
Subcommittee on Readiness
Committee on Armed Services
House of Representatives

The Honorable Tim Walz
Ranking Member
Committee on Veterans' Affairs
House of Representatives

The Honorable Gregorio Kilili Camacho Sablan
House of Representatives

Appendix I: Objectives, Scope, and Methodology

House Report 115–200 accompanying a bill for the National Defense Authorization Act for Fiscal Year 2018 included a provision that we review the government's handling of Agent Orange on Guam. In response to both this provision and a separate request letter, this report examines (1) the extent to which the federal government has information about the procurement, distribution, use, and disposition of Agent Orange or its components at locations in the United States and its territories, including Guam; (2) the extent to which the Department of Defense (DOD) and the Department of Veterans Affairs (VA) have complete and accurate information about where Agent Orange and its components were tested and stored and communicated this information to veterans and the public; and (3) challenges associated with testing for Agent Orange.

For objective one, we collected and reviewed available agency records and shipping documents on Agent Orange from the following sources:

- the U.S. National Archives and Records Administration;
- the U.S. National Agricultural Library;
- the U.S. Air Force Historical Research Agency at Maxwell Air Force Base, Alabama;
- staff historians at the Air Force Materiel Command at Wright-Patterson Air Force Base, Ohio, and Pacific Air Forces at Joint Base Pearl Harbor–Hickam, Hawaii;
- the Armed Forces Pest Management Board in Silver Spring, Maryland;
- the Defense Logistics Agency;
- the U.S. Army Corps of Engineers; and
- the Naval History and Heritage Command.

The records we researched and collected include published and unpublished materials on the procurement, shipment, and disposition of Agent Orange, including U.S. military correspondence, logistics reports, and Navy and merchant vessel logbooks. We reviewed DOD documents related to Agent Orange contracts to determine the total quantity of Agent Orange that was produced by the nine manufacturers. To show how much Agent Orange was used in Vietnam, we used estimates from the National Academy of Sciences analysis of Operation Ranch Hand data. Details about the estimated quantity of Agent Orange that was destroyed

at a location on a vessel's route, that port would not be listed in the shipping articles.

To obtain specific information about the SS *Gulf Shipper* voyage that stopped in Guam en route to Vietnam, to include documentation on its cargo and whether or not cargo was loaded or unloaded at the ports on the way to Vietnam, we contacted officials at several agencies.

- In Guam, we contacted the Customs and Quarantine Service, the University of Guam's Micronesian Research Center, and officials at Naval Base Guam for information on vessels that stopped in Guam during the Vietnam War era, and any cargo they carried.
- We also contacted archivists at the Federal Records Center in Seattle, Washington, where the SS *Gulf Shipper* logbook is archived, and the regional archives in Fort Worth, Texas, for additional information on the vessel itself and guidance on retaining and archiving cargo information. The National Archives had some information on the SS *Gulf Shipper*, such as sales documents and company correspondence records. However, the National Archives did not have records for the manifest or bills of lading, which may have documented any cargo offloaded from the ship.
- We contacted U.S. Customs and Border Protection for information on movements of vessels engaged in foreign trade in and out of ports, which is found in customs forms that are required to be archived after 30 years. We were unsuccessful in locating the customs forms for the SS *Gulf Shipper's* voyage to Vietnam through Guam; however, an official noted that although these records provide manifest numbers and ports of sailing, the manifests themselves are not archived.
- An online search on the SS *Gulf Shipper* through the U.S. Maritime Administration's website identified the transfer of vessel ownership over the years. We contacted the latest company that owned the vessel to see whether the company had retained any cargo manifests or other historical records as the ownership changed hands. However, we could not obtain this information because, according to a company official we contacted, the vessel's records, along with other historical documents, were stored in an off-site storage facility in New Jersey, and were subsequently destroyed in a fire in 1996.

We also looked at articles from Guam newspapers and news sources such as the Military Sea Transportation Service Vietnam Chronicles for any information about vessel comings and goings in Guam in early 1968 to see if they mentioned the SS *Gulf Shipper* or specific cargo being offloaded in Guam. None of these contacts or written sources provided

information specific to any cargo that was being moved through Guam, or about this particular vessel.

We also obtained original DOD reports and command histories that provided additional operational details about the procurement, distribution, use, and disposition of Agent Orange and its components. According to an Office of History, Air Force Logistics Command, monograph, the command directly responsible for managing Agent Orange was the Directorate of Aerospace Fuels at the San Antonio Air Materiel Area at the former Kelly Air Force Base, Texas, which was a sub-component of the U.S. Air Force Logistics Command during the Vietnam War. The unclassified San Antonio Air Materiel Area command histories for the years 1966 through 1973 include chapters with extensive documentation on “herbicide management.” We obtained copies of command histories from the Air Force Historical Research Agency at Maxwell Air Force Base, Alabama, and the Air Force Materiel Command at Wright-Patterson Air Force Base, Ohio.

To obtain information regarding herbicide use on Guam, we obtained command histories for Naval Base Guam and an analysis and summary of the available documentation by the historian at Andersen Air Force Base. We also spoke with Navy and Air Force officials on Hawaii and Guam to identify any relevant records pertaining to such use. In addition, we met with and obtained information from officials representing the Office of the Governor of Guam and senior members and staff from the Guam Legislature. We also met with officials representing a veterans service organization. Finally, as discussed below, we spoke directly with veterans about their recollections of herbicide use on Guam, and any documentation they might have pertaining to such use.

For objective two, we analyzed the archival search records provided by DOD to identify additional locations where Agent Orange or its components were tested and stored in the United States and its territories. We reviewed Army archives search reports of herbicide testing at Aberdeen Proving Grounds (including Edgewood Arsenal), Maryland; Dugway Proving Ground, Utah; Fort Chaffee, Arkansas; Fort Gordon, Georgia; Fort Meade, Fort Ritchie, and Fort Detrick, Maryland; and two Air Force studies related to herbicide equipment testing at Eglin Air Force Base, Florida, to determine whether there were additional sites and testing events that were not included on the DOD list found on the VA

and that we were not recording their statements. The moderator noted that we would be taking notes to make sure we accurately captured the conversations, but that we would not attribute statements directly to individuals.

For those discussion sessions held in person in Guam and Hawaii, we also administered a brief, written questionnaire about individuals' experiences during the Vietnam era (for example, duty locations, military occupation, rank), and what they had heard and experienced related to Agent Orange and other herbicides. Due to logistical obstacles, we were not able to administer the questionnaire to participants in sessions held via telephone. However, the information requested in the questionnaire was also covered in the discussion sessions themselves. Therefore, we did not analyze the information from the completed questionnaires. We also solicited from the veterans any documentation they might have that could support their allegations of the use of Agent Orange on Guam, but we did not receive documentation that corroborated the use of Agent Orange on Guam. In addition, we met with officers from the Vietnam Veterans of America to discuss how, if at all, veterans could have been exposed to Agent Orange beyond serving directly in Vietnam as part of Operation Ranch Hand, and how the organization disseminates information, especially on Agent Orange, to veterans.

For objective three, we reviewed scientific literature and agency documents regarding the degradation and sources of the components of Agent Orange and an associated dioxin contaminant, 2,3,7,8-TCDD, as well as other sources of dioxins. This review included documents from the Agency for Toxic Substances and Disease Registry and reports and protocols from U.S. EPA, the World Health Organization, the Centers for Disease Control and Prevention, and the American Industrial Hygiene Association. We also reviewed the draft and final plans for testing for the presence of the acid forms of the components of Agent Orange—2,4-D and 2,4,5-T—on Guam. We compared the information outlined in the testing plan with scientific literature on the environmental fate of the components of Agent Orange and other Agent Orange testing methodologies. We interviewed officials from DOD, U.S. EPA, and Guam EPA about the testing plan for Guam and the science surrounding Agent Orange testing. We also conducted a site visit to Naval Base Guam and Andersen Air Force Base on Guam and interviewed DOD and Government of Guam officials involved in the planning for the testing for Agent Orange on Andersen Air Force Base. We visited the three selected sites where the initial testing took place and took photographs of those sites.

We conducted this performance audit from May 2017 through November 2018, in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Comparison of the Department of Veterans Affairs (VA) List of Diseases Associated with Agent Orange against Those Identified by the National Academy of Sciences

The VA recognizes 14 presumptive diseases associated with exposure to Agent Orange or other herbicides during military service for which veterans and their survivors may be eligible to receive disability compensation benefits. The list of diseases provided by the VA has generally incorporated the findings of reviews performed by the National Academy of Sciences (the Academy). The list includes 5 diseases that have been identified as having sufficient evidence of association and 9 that have been identified as having limited or suggestive evidence of association. In the Academy's biannual reports, for a disease identified as having sufficient evidence of association, the evidence is sufficient to conclude that there is a positive association—that is, a positive association has been observed between herbicides and the outcome in studies for which chance, bias, and confounding could be ruled out with reasonable confidence. For a disease identified as having limited or suggestive evidence of association, the evidence is suggestive of an association between herbicides and the outcome but is limited, because chance, bias, and confounding could not be ruled out with confidence. Table 1 describes those 14 diseases and the extent of association identified by the Academy.

Table 1: Presumptive Diseases Associated with Exposure to Agent Orange and Certain Other Herbicides by the Department of Veterans Affairs (VA), by Level of Association

Disease	Description
Sufficient Evidence of Association	
Chronic B-cell Leukemias	A type of cancer which affects white blood cells.
Chloracne (or similar acneform disease)	A skin condition that occurs soon after exposure to chemicals and looks like common forms of acne seen in teenagers. Per VA's rating regulation, it must be at least 10 percent disabling within 1 year of exposure to an herbicide.
Hodgkin's Disease	A malignant lymphoma (cancer) characterized by progressive enlargement of the lymph nodes, liver, and spleen, and by progressive anemia.
Non-Hodgkin's Lymphoma	A group of cancers that affect the lymph glands and other lymphatic tissue.
Soft Tissue Sarcomas (other than osteosarcoma, chondrosarcoma, Kaposi's sarcoma, or mesothelioma)	A group of different types of cancers in body tissues such as muscle, fat, blood and lymph vessels, and connective tissues.
Limited or Suggestive Evidence of Association	
AL Amyloidosis	A rare disease caused when an abnormal protein, amyloid, enters tissues or organs.
Diabetes Mellitus (Type 2)	A disease characterized by high blood sugar levels resulting from the body's inability to respond properly to the hormone insulin.
Ischemic Heart Disease[a]	A disease characterized by a reduced supply of blood to the heart that leads to chest pain.
Multiple Myeloma	A cancer of plasma cells, a type of white blood cell in bone marrow.

Appendix III: Quantities of Herbicides Known to Have Been Shipped to Southeast Asia on Ships Identified as Having Stopped in Guam between February 1968 and May 1970

Based on available shipment documentation and logbooks, we identified one vessel—the SS *Gulf Shipper*—carrying Agents Orange, Blue, and White that stopped at Port Apra (now Apra Harbor) on Guam on its way to Southeast Asia. Additionally, we identified three vessels—the SS *Aimee Lykes*, the SS *Buckeye Atlantic*, and the SS *Overseas Suzanne*—that stopped in Guam on the return routes after having made various port calls in Southeast Asia.[1] For each of these voyages, we obtained shipment documentation that outlined the quantities of herbicides that records indicate had been loaded onto the vessels while at port in the United States, and to the extent available, quantities of herbicides that were discharged in Southeast Asia. We also obtained logbooks that identified the routes the vessels took from U.S. ports to Vietnam and back, and identified any port calls en route. While we are unable to confirm the reliability of the information available in shipment documentation and logbooks, details on the quantities of herbicides that were documented to have been transported on these vessels during their routes are outlined below.

SS *Gulf Shipper*: According to shipment documentation and the vessel's logbook, the SS *Gulf Shipper* left the port of Mobile, Alabama, on January 9, 1968, and stopped at Port Apra (now Apra Harbor) on Guam and offloaded a mariner for repatriation to the United States on February 2, 1968.[2] We are unable to state with certainty whether there were reasons why this vessel stopped in Guam beyond what was reported in available shipment documentation and the vessel's logbook. The logbook further indicates that the SS *Gulf Shipper* then arrived in Saigon, Vietnam, approximately February 27, 1968, with subsequent stops in Cam Rahn Bay, Vietnam, approximately February 29, 1968, and Nha Trang,

[1]Through archival research, we obtained available shipping and agency records, including U.S. military correspondence and logistics reports, and reviewed these documents to trace the federal government's procurement, distribution, use, and disposition of Agent Orange and its components. We analyzed this available documentation, referred to as shipment documentation, to prepare summary information on the quantities of Agent Orange and the vessels that carried the shipments. We used this information to obtain official Navy and merchant vessel logbooks—referred to as logbooks—to the extent they were available. While logbooks contain information such as the vessel's location, crew, and key events, they generally do not identify specific cargo that was loaded onto or offloaded from a vessel. Logbooks from the Vietnam era are generally held at National Archives and Records Administration facilities closest to the arrival ports where the voyages ended.

[2]In addition to the stop in Guam, the SS *Gulf Shipper* also stopped in Panama on the way to Vietnam.

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port of New Orleans, Louisiana, with 80,795 gallons of Agent Orange and 48,537 gallons of Agent Blue on board. Based on the available documentation, we are unable to determine the quantity of Agent Orange that was discharged in Saigon, Vietnam, or potentially any other location.

Appendix IV: The Department of Defense's (DOD) List of Testing and Storage Locations Posted on the Department of Veterans Affairs (VA) Website

Information from Department of Defense (DoD) on Herbicide Tests and Storage outside of Vietnam

Location	Dates	Agents	Project Description	DoD Involvement
Fort Chaffee, AR	5/16/1967-5/18/1967, 7/22/1967-7/23/1967, 8/23/1967 - 8/24/1967	basic, in-house, improved desiccants and Orange, Blue	During the period of 12/1966 - 10/1967, a comprehensive short-term evaluation was conducted by personnel from Fort Derrick's Plant Science Lab in coordination with contract research on formulations by chemical industry and field tests by USDA and U of HI.	Yes
Pinal Mountains near Globe, AZ	1965, 1966, 1968, and 1969	2,4-D isooctyl-ester, 2,4,5-t isooctyl-ester, silvex, propyleneglycolbutylether ester, 2,4,5-T butyl ester, 2,4,5-T 2-e-h e	In 1965, the USFS began a land improvement program in the Pinal Mountains. The program called for spraying an area of chaparral with herbicides to accomplish the objectives of multiple land use.	No
Brawley, CA	1950-51	2,4-D	The purpose was to determine means of accomplishing defoliation of tropical forest vegetation by application of a chemical agent.Here, irrigation water studies were done with the agent. H.F. Arle worked here.	Undetermined
Orlando, FL at Army Grove Air Force's Tactical Center	3/14/1944, 4/12/1944	ammonium thiocynate, zinc chloride, sodium nitrate, sodium arsenate, sodium fluoride	The purpose was to determine means of accomplishing defoliation of tropical forest vegetation by application of a chemical agent.	Yes
Marathon, FL	3/21/1944-3/23/1944	zinc chloride, ammonium sulphamate, ammonium thiocynate	The purpose was to determine means of accomplishing defoliation of tropical forest vegetation by application of a chemical agent. Spraying was done here.	Yes
Near Lake George, FL	Spring 1944	zinc chloride	The purpose was to determine means of accomplishing defoliation of tropical forest vegetation by application of a chemical agent. Spraying here.	Yes
Orlando, FL, Cocoa, FL	1944	ammonium thiocyanate and zinc chloride	Tests were conducted in 1944 by the Army in Orlando and Cocoa areas of Florida to determine the value of ammonium thiocyanate and chloride as marking and defoliation agents.. They were conducted initially at ground level and later from aircraft.	Yes

Department of Veterans Affairs 1

Information from Department of Defense (DoD) on Herbicide Tests and Storage outside of Vietnam

Bushnell Army Air Field, FL	2/1945	LN *phenoxy	Small plot experiments were commenced to test the effectiveness of LN agents. Various trials were done under contract with the USDA, aided by personnel at Camp Detrick. Here, it was aerial spray experiments on potted plants	Yes
Bushnell Army Air Field, Bushnell, FL	2/1945-4/1945	2,4-D and its ammonium salt	Trials, performed by C.W.S. personnel from Camp Detrick, MD tested the practicability of severely injuring or destroying crop plants sprayed from smoke tanks mounted on tactical aircraft.	Yes
Avon Air Force Base, FL	2/1951-4/1951	butyl 2,4 D	Trials were conducted at Avon Air Force Base, FL by Chemical Corps with personnel of the Air Force and Navy to determine the practical effectiveness of spraying pure anticrop agents from at low volume from aircraft. C-47 and Navy XBT2D-1 aircraft with various nozzles were used.	Yes
Englin Air Force Base, FL	11/1952-12/1952	2,4-D, 2,4,5-T: 143 and 974, respectively	Two trials: Chemical Corps- concerned with basic fundamental work, using 2,4-D, Air Force-concerned with evaluating prototype large capacity spray system for aircraft installation using 2,4,5-T, primarily. Used 3 atomizing nozzles: Bete Fog Nozzles, Whirljet Spray Nozzles, and Fogjet 1.5F50	Yes
Avon Park Air Force Base, FL	Spring 1954	butyl 2,4-D, butyl 2,4,5-T, Isopropyl 2,4-D	Series of tests were conducted at Avon Park AFB during the spring of 1954 to study the behavior of chemical anticrop aerial sprays when released from high-speed jet aircraft. The Navy F3D jet fighter was used with Aero 14A Airborne Spray Tanks to disperse the anticrop agents.	Yes
Jacksonville,FL	7/18/1962-7/21/1962	Purple, Fuel Oil, Mix	The HIDAL was used successfully on an H-34 helicopter to spray herbicidal materials. Therefore, it had not been calibrated previously. Spray tests were performed to do so. This was done under order by OSD/ARPA.	Yes
Eglin AFB, FL, C-52A test area	1962-70	Orange (1962-68), Purple (1962-68), White (1967-70), Blue (1968-70)	CPT John Hunter discussed vegetation changes and ecological studies of the 2 square mile test area which had been sprayed with herbicides over the period 1962-70.	Yes

Information from Department of Defense (DoD) on Herbicide Tests and Storage outside of Vietnam

Apalachicola National Forest near Sophoppy, FL	5/3/1967-5/8/1967	basic desiccants and Orange/Blue	During the period of 12/1966 - 10/1967, a comprehensive short-term evaluation was conducted by personnel from Fort Detrick's Plant Science Lab in coordination with contract research on formulations by chemical industry and field tests by USDA and U of HI	Yes
Eglin AFB, FL	6/11/1968-9/12/1968	orange, Bifluid #1, Bifluid#2, Stull Bifluid	A spread factor study was performed by the Army to correlate the spherical drop sizes of both Orange and Stull Bifluid defoliants. It involved development of new techniques to determine spread factors over an extended range of drop sizes. A spinning cup drop generator was used.	Yes
2 areas in FL, 2 areas in GA, and 1 in TN	1968	bromacil, Tandex, monuron, diuron, and fenuron	In 1968, emphasis was given to soil applied herbicides for grass control. Applications were made by a jeep-mounted sprayer on small plots or by helicopter on larger plots.	Undetermined
GA and TN	1964	diquat and Tordon 101, various	In 1964, helicopter spray tests were conducted on transmission line rights-of-way by the Georgia Power Company and Tennessee Valley Authority in collaboration with Fort Detrick to evaluate effectiveness of several commercially available herbicides.	Yes
Fort Gordon, GA	7/15/1967-7/17/1967	in-house desiccants mixtures and formulations, Orange and Blue	During the period of 12/1966 - 10/1967, a comprehensive short-term evaluation was conducted by personnel from Fort Detrick's Plant Science Lab in coordination with contract research on formulations by chemical industry and field tests by USDA and U of HI	Yes
Kauai Branch Station near Kapaa, Kawai, HI	6/1967, 10/1967, 2/1968, 12/1967	Blue,diquat,paraquat, Orange, PCP, Picloram, White, HCA, 2,4,5-T, Endothall	During the period of 12/1966 - 10/1967, a comprehensive short-term evaluation was conducted by personnel from Fort Detrick's Plant Science Lab in coordination with contract research on formulations by chemical industry and field tests by USDA and U of HI	Yes
State Forest area, 3500 ft.elevation on slope of Mauna Loa, near Hilo, HI	12/2/1966, 12/4/1966, 1/12/1967	Orange, M-3140, TORDON ester, 2,4-D ester, 2,4,5-T ester	The purpose of this project was to evaluate iso-octyl ester of picloram (TORDON) in mixtures with ORANGE, as a candidate defoliant agent, using ORANGE as standard. There were personnel from Fort Detrick there.	Undetermined

Information from Department of Defense (DoD) on Herbicide Tests and Storage outside of Vietnam

Hilo, HI	12/1966	Orange	Field tests of defoliants were designed to evaluate such variables as rates, volume of application, season, and vegetation. Data from aerial application tests at several CONUS and OCONUS locations are provided in tables. There were Fort Detrick personnel there.	Yes
Kauai,HI	1967	Orange	Field tests of defoliants were designed to evaluate such variables as rates, volume of application, season, and vegetation. Data from aerial application tests at several CONUS and OCONUS locations are provided in tables.	Yes
Vigo Plant CWS, Terre Haute, IN	5/1945-9/1945	LN (see attached) *phenoxy	Small plot experiments were commenced to test the effectiveness of LN agents. Various trials were done under contract with the USDA, aided by personnel at Camp Detrick. Here, it was aerial trials spraying field grown plants.	Yes
Jefferson Proving Grounds, Madison, IN	Summer 1945	LN *phenoxy	Small plot experiments were commenced to test the effectiveness of LN agents. Various trials were done under contract with the USDA, aided by personnel at Camp Detrick. Here, it was dropping trials.	Yes
Hays, KS, Langdon, ND	1960	stem rust of	Two studies on the stem rust of wheat were conducted during 1960 to obtain data on the establishment, development, and destructiveness of artificially induced stem rust epiphytotics.	Undetermined
Fort Knox, KY	1945	various	In 1945, a special project known as Sphinx was conducted jointly by CWS and the ARML to investigate the use of chemical agents for increasing the flammability of vegetation prior to flame attack.	Yes
Area B, Camp Detrick, MD	Spring/Summer 1953	3:1 mixture 2,4-D and 2,4,5-T	Personnel at Camp Detrick tested the feasibility of using an experimental spray tower for applying a mixture of chemical anticrop agents to broad-leaf crops.	Yes
Fort Ritchie, MD	1963	Tordon, 2,4-D, Orange, diquat, endothal, and combinations of each with Tordon	Various studies were done to explore the effectiveness of different herbicides. They were all field trials. These studies were done by personnel from the US Army Biological Laboratories.	Yes

Information from Department of Defense (DoD) on Herbicide Tests and Storage outside of Vietnam

Fort Meade, MD	1963	cacodylic acid, Dowco 173, butyediol	Various studies were done to explore the effectiveness of different herbicides. They were all field trials. These studies were done by personnel from the US Army Biological Laboratories.	Yes
Camp Detrick, MD-Fields A,B, and C	1946-1947	2,4,5-T, 2,4,5-T triethanolamine, tributylphosphate, ethyl 2,4-D, butyl 2,4,5-Ttriet 2,4-D,	The experiments were directed mainly towards the investigation of plant inhibitors applied as sprays or to the soil in the solid form to be taken up by the roots.	Yes
Camp Detrick, MD- Fields C,D, and E	1948	2,4,5-T, isopropyl phenol carbamate, LN-2426, 2,4-D	The experiments were directed mainly towards the investigation of plant inhibitors applied as sprays or to the soil in the solid form to be taken up by the roots.	Yes
Camp Detrick, MD-Fields C,D,E	1949	triethelyne. 2,4,5-T, carbamates	The experiments were directed mainly towards the investigation of plant inhibitors applied as sprays or to the soil in the solid form to be taken up by the roots. Experiments were done by Ennis, DeRose, Newman, Williamson, DeRigo, and Thomas.	Yes
Camp Detrick, MD-Fields A,B,D,E	1950	2464, butyl 2,4-D, 974, butyl 2,4,5-T, q:q 143 and 974	The experiments were directed mainly towards the investigation of plant inhibitors applied as sprays or to the soil in the solid form to be taken up by the roots. Experiments were done by Ennis, DeRose, Acker, Newman, Williamson, and Zimmerly.	Yes
Camp Detrick, MD-Field F	1950-51	2464, carbamate, butyl 2,4-D, 143 and 974 (orange?),2,4,5-T, 2,4-D, Orange	The experiments were directed mainly towards the investigation of plant inhibitors applied as sprays or to the soil in the solid form to be taken up by the roots. Experiments were done by Acker, DeRose, McLane, Newman, Williamson, Baker, Dean, Johnson, Taylor, Walker, and Zimmerly.	Yes
Fort Detrick, MD; Fort Ritchie, MD	1956-1957	various, 577 compounds	In 1956 And 1957, defoliation and desiccation were carried out at Fort Detrick and Fort Ritchie, Maryland by the Chemical Corps and Biological Warfare Research. These were bench tests.	Yes
Poole's Island, Aberdeen Proving Ground, MD	7/14/1969-	Orange, Orange plus foam, Orange plus foam Orange, Foam	During the week of 7/14/1969, personnel from Naval Applied Science Laboratory in conjunction with personnel from Limited War Laboratory conducted a defoliation test along the shoreline.	Yes

Information from Department of Defense (DoD) on Herbicide Tests and Storage outside of Vietnam

Fort Detrick, MD	8/1961-6/1963	1410 compounds	From 8/1961 to 6/1963, compounds were spray-tested in the greenhouse to evaluate them as effective defoliants, desiccants, and herbicides.	Yes
Near Wayside, Miss., Wilcox Road, Greenville, Miss.	9/19/1967	picloram, bromacil, pyriclor, and terbacil, Orange, cacodylic acid	In 1967, the Dow Chemical Company was awarded a DoD research contract. The objective was to prepare as pellets mixtures of various herbicides and to test them on varying vegetation situations for the control of a range of plant species.	Undetermined
Fulcher Ranch, Greenville, Mississippi	4/15/1968	picloram and bromicil	In 1967, the Dow Chemical Company was awarded a DoD research contract. The objective was to prepare as pellets mixtures of various herbicides and to test them on varying vegetation situations for the control of a range of plant species.	Undetermined
Gulfport, Miss.	1968-1970	Orange	While discussing the mandatory disposal of Orange, it was mentioned that 15,161 drums were being stored at Gulfport, Mississippi.	Yes
Galatin Valley near Bozeman, Montana	7/3/1953, 7/6/1953, 7/14/1953	4- fluorophenoxy-acetic acid and 2 of its esters, 3:1 butyl 2,4-D and butyl 2,4,5-T	A preliminary series of field evaluations of chemical agents for attacking wheat using a miniature spraying system mounted on light aircraft were performed by USDA.	No
Fort Drum, NY	1959	Orange	The Commanding General, 1st US Army, requested that Ft Detrick assist with defoliation efforts at Ft Drum. Thirteen drums were sprayed there on 4 square miles from a helicopter spray device.	Yes
Stone Valley Experimental Forest in Huntington County and near State College in Centre County, PA	3/1969-10/1970	bromacil, diuron, tandex, fenuron, picloram	Soil- applied herbicides were studied by the U of Pa with Ft Detrick for 18 months for their effectiveness, rapidity of action, and duration of response in native stands of central PA grasses, broadleaf weeds and woody plants. These herbicides were spread or sprayed.	Undetermined
Kingston, RI	7/26/1949, 1950-51	trieth.2,4,5-T, butyl 2,4,5-T,974	The experiments were directed mainly towards the investigation of plant inhibitors applied as sprays or to the soil in the solid form to be taken up by the roots. Experiments were carried out under supervision of T.E. Odland if RI State College. H.T. DeRigo was also there.	Yes

Information from Department of Defense (DoD) on Herbicide Tests and Storage outside of Vietnam

Beaumont, TX	6/1944	LN *phenoxy	Small plot experiments were commenced to test the effectiveness of LN agents. Various trials were done under contract with the USDA, aided by personnel at Camp Detrick. Here, they were testing on rice crops.	No
Marinette, WI, Weslaco, TX	5/1967-1/1969	arsenic compounds, Orange, cacodylic acid, sodium cacodylate	71 new arsenic compounds were tested in primary screening against 6 plant species in greenhouse tests. Then, 5 of the most active compounds were tested in field trials against Red Maple and compared to formulations of cacodylic acid and a 50:50 blend of orange and sodium cacodylate. The Ansul Co. for DoD.	Yes
Beaumont, TX	1950-51	2,4-D	The purpose was to determine means of accomplishing defoliation of tropical forest vegetation by application of a chemical agent. Here, irrigation water studies were done with the agent. Coghill, Hasse, and Yeatner worked here.	Undetermined
Granite Peak, UT	Summer 1945	LN *phenoxy	Small plot experiments were commenced to test the effectiveness of LN agents. Various trials were done under contract with the USDA, aided by personnel at Camp Detrick. Here, it was dropping trials.	Yes
Prosser,WA	1950-51	2,4-D	The purpose was to determine means of accomplishing defoliation of tropical forest vegetation by application of a chemical agent.Here, irrigation water studies were done with the agent. V.F. Burns worked here.	Undetermined
southeastern part of Kompong Cham Province and Dar and Prek Clong plantations, Cambodia	6/1969	Orange	In 6/1969, the US government received notice of charge by Cambodian government that major defoliation damage to the Cambodian rubber plantation near the RVN border had occurred as a result of US defoliation activity. This was confirmed by a team of experts.	Yes
Base Gagetown near Fredericton, New Brunswick, Canada	6/20/1967-6/24/1967	basic desiccants and Orange, Blue, various	During the period of 12/1966 - 10/1967, a comprehensive short-term evaluation was conducted by personnel from Fort Detrick's Plant Science Lab in coordination with contract research on formulations by chemical industry and field tests by USDA and U of HI	Yes

Information from Department of Defense (DoD) on Herbicide Tests and Storage outside of Vietnam

Kumbla, South India	1945-1946	LN compounds *phenoxy	The main objective of the experiments was to determine the feasibility of accomplishing severe injury or destruction of tropical food crops by the application of growth-inhibiting (LN*) compounds in static trials. Field plantings were treated with various agents at different rates in different forms.	Yes
Korea, third Brigade, 2nd Division area	7/23/1968-7/24/1968	Hyvar XWS, tandex, Urox B, Urox Oil concentrate (liquids) bromacil, tandex, Urox 22 (solids)	In 1968, chemicals were sent from the Plant Sciences Lab, Ft Detrick, MD, to the Republic of Korea for the purpose of testing their effectiveness in the control of vegetation.	Yes
Korea,2nd and 4th Brigades, 2nd Division area	8/1968	Hyvar XWS, tandex, Urox B, Urox Oil concentrate (liquids) bromacil, tandex, Urox 22 (solids)	In 1968, chemicals were sent from the Plant Sciences Lab, Ft Detrick, MD, to the Republic of Korea for the purpose of testing their effectiveness in the control of vegetation.	Yes
Korea, third Brigade, 2nd Division area	10/3/1968	Hyvar XWS, tandex, Urox B, Urox Oil concentrate (liquids) bromacil, tandex, Urox 22 (solids)	In 1968, chemicals were sent from the Plant Sciences Lab, Ft Detrick, MD, to the Republic of Korea for the purpose of testing their effectiveness in the control of vegetation.	Yes
Laos	12/1965- 1967	Orange	In December 1965, herbicide operations were begun in Laos, with sorties being flown from Tan Son Nhut and Da Nang. The purpose was the exposure of foot trails, dirt roads and other LOCs that crossed into SVN. This network leads from NVN, through the eastern panhandle, to Combodian border.	Yes
Las Marias, Puerto Rico	2/1967-12/1967	various, including Orange	During the period of 12/1966 - 10/1967, a comprehensive short-term evaluation was conducted by personnel from Fort Detrick's Plant Science Lab in coordination with contract research on formulations by chemical industry and field tests by USDA and U of HI	Yes

Information from Department of Defense (DoD) on Herbicide Tests and Storage outside of Vietnam

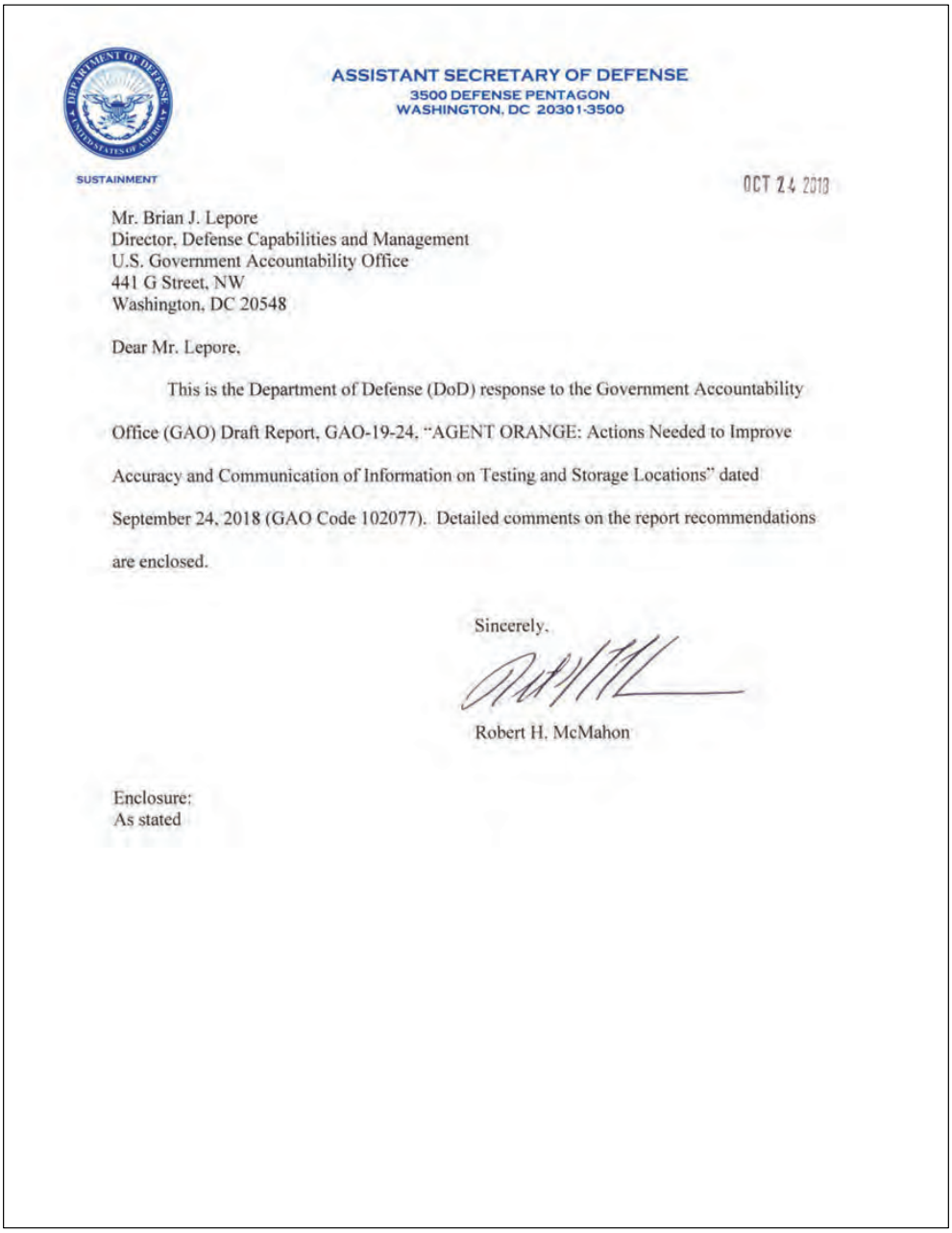
Las Mesas Cerros, Mayaguez, Puerto Rico	5/24/1968, 5/26/1968, 5/27/1968	picloram, bromacil, pyriclor	In 1967, the Dow Chemical Company was awarded a DoD research contract. The objective was to prepare as pellets mixtures of various herbicides and to test them on varying vegetation situations for the control of a range of plant species.	Undetermined
Las Mesas and La Jagua experimental areas at Mayaguez, Puerto Rico	2/1956-6/1956	2,4,5-T, 2,4-D, pentachlorophenol, ammate, weedazol, endothal Harvestaid, Butyne -1,4-diol	During February to June, 9 chemicals were evaluated in PR on 16 genera tropical woody plants. The chemicals were applied in highly concentrated solutions with a microsprayer to the leaves.	Yes
Guanica and Joyuda, Puerto Rico	6/1956-9/1956	2,4,5-T, potassium cyanate, amiendo, F-2, 6-Ca-4, Y-F Tree and Brush Kiler, ACP M-118, Shed-A-Leaf	9 chemicals were evaluated on 16 genera of tropical woody between June and September. The chemicals were sprayed to duplicate small branches, using a microsprayer.	Yes
Las Mesas and La Jagua, Mayaguez, Joyuda at Cabo Rojo, and Guanica Insular Forest at Guanica, Puerto Rico	9/1956-12/1956	6-Ca-4,Liojn Oil,2,4,5-T, B-1613, B-1638, Ammate, V-C1-186, endothal, shed-a-leaf, M-118, Y-F,esteron 2,4-D,F3,F4,F5,F6	16 compounds with defoliating properties were evaluated using 28 different tropical woody plants, each representing a separate genus. The chemicals were applied to duplicate small branches with a microsprayer and to single larger branches or whole trees with a 2-gallon knapsack sprayer.	Yes
Las Mesas and La Jagua, Mayaguez, Guanica Beach, Puerto Rico	1/1957-3/1957	V-C 3-105, V-C 1-21, V-C 1-443, F-7, TBP, Phillips 713, V-C 3-173	7 compounds were evaluated on 29 different woody plants to determine their effectiveness as defoliants, desiccants, and as killing agents. They were applied with a microsprayer to the upper leaf surfaces of duplicate small branches.	Yes
Las Mesas and La Jagua, Mayaguez, Guanica Beach, Puerto Rico	4/1957-6/1957	B-1676, B-1638, NP 1098, SD 1369, Ammate, Shed-a-leaf	7 compounds were sprayed on 25 different plants in order to evaluate their effectiveness as defoliants, desiccants, and killing agents. The compounds were applied with a microsprayer to the upper and lower leaf surfaces of duplicate small branches.	Yes
Las Mesas and La Jagua, Mayaguez, Puerto Rico	7/1957-12/1957	MgClO3, Golden Harvest Defoliant, Dow-M562, F-8, F-9, F-10, F-11, F-12	8 different spray formulations were applied to 16 different tropical trees and shrubs in order to evaluate their effectiveness as defoliants, desiccants, and killing agents.	Yes

Information from Department of Defense (DoD) on Herbicide Tests and Storage outside of Vietnam

Near Rio Grande, on the northeast coast of Puerto Rico	8/23/1967, 10/18/1967, 12/21/1967-12/26/1967	picloram, bromacil, pyriclor, and terbacil	In 1967, the Dow Chemical Company was awarded a DoD research contract. The objective was to prepare as pellets mixtures of various herbicides and to test them on varying vegetation situations for the control of a range of plant species.	Undetermined
Loquillo, Puerto Rico	4/1966, 10/1966	Orange	Field tests of defoliants were designed to evaluate such variables as rates, volume of application, season, and vegetation. Data from aerial application tests at several CONUS and OCONUS locations are provided in tables.	Yes
At Sea	Summer 1977	Orange	In 1977, the USAF incinerated 2.22 million gallons of Herbicide Orange at sea in an operation entitled PACER HO. Extensive industrial hygiene sampling efforts supporting the transfer operations at Gulfport, MS and Johnston Island indicated all exposures were inconsequential (2-3 orders of magnitude below the TLVs for 2,4-D and 2,4,5-T).	Yes, Gulfport No, JI
Thailand	1964-1965	Purple, Orange, Others	Sponsored by ARPA; ARPA Order 423, Between the mentioned dates, there was a large-scale test program to determine effectiveness of mentioned agents in defoliation of upland forest or jungle vegetation representative of SEA.	Yes
Thailand	1964-65	Orange, Blue	Field tests of defoliants were designed to evaluate such variables as rates, volume of application, season, and vegetation. Data from aerial application tests at several CONUS and OCONUS locations are provided in tables.	Yes
Replacement raining Center of the Royal Thai Army near Pranburi, Thailand	1964 and 1965	Orange, Purple	An extensive series of tests were conducted by Fort Detrick during 1964 and 1965 in collaboration with the Military Research and Development Center of Thailand. The objective was to perform onsite evaluation of phytotoxic chemicals on vegetation in SE Asia.	Yes

Source: DOD's list of testing and storage locations posted on VA's website [accessed on September 18, 2018]. | GAO-19-24.

Appendix V: Comments from the Department of Defense



ASSISTANT SECRETARY OF DEFENSE
3500 DEFENSE PENTAGON
WASHINGTON, DC 20301-3500

SUSTAINMENT

OCT 24 2018

Mr. Brian J. Lepore
Director, Defense Capabilities and Management
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Mr. Lepore,

This is the Department of Defense (DoD) response to the Government Accountability Office (GAO) Draft Report, GAO-19-24, "AGENT ORANGE: Actions Needed to Improve Accuracy and Communication of Information on Testing and Storage Locations" dated September 24, 2018 (GAO Code 102077). Detailed comments on the report recommendations are enclosed.

Sincerely,

Robert H. McMahon

Enclosure:
As stated

GAO DRAFT REPORT DATED SEPTEMBER 24, 2018
GAO-19-24 (GAO CODE 102077)

"AGENT ORANGE: ACTIONS NEEDED TO IMPROVE ACCURACY AND COMMUNICATIONS OF INFORMATION ON TESTING AND STORAGE LOCATIONS"

DEPARTMENT OF DEFENSE COMMENTS
TO THE GAO RECOMMENDATION

RECOMMENDATION 1: The GAO recommends that the Secretary of Defense should ensure that the Under Secretary of Defense for Acquisition and Sustainment assigns responsibility for ensuring that DoD's list of locations where Agent Orange or its components were tested or stored is as complete and accurate as available records allow.

DoD RESPONSE: *Concur. The Under Secretary of Defense for Acquisition and Sustainment will assign responsibility for DoD's list of locations where Herbicide Orange, or its components, were tested or stored.*

RECOMMENDATION 2: The GAO recommends that the Secretary of Defense should ensure that the Under Secretary of Defense for Acquisition and Sustainment develops a process for updating the revised list as new information becomes available.

DoD RESPONSE: *Concur. The Under Secretary of Defense for Acquisition and Sustainment will develop a process to update the DoD list based on clear and transparent criteria developed with Veterans Affairs in recommendations #3 and 4.*

RECOMMENDATION 3: The GAO recommends that the Secretary of Defense, in collaboration with the Secretary of Veterans Affairs, should ensure that the Under Secretary of Defense for Acquisition and Sustainment develop clear and transparent criteria for what constitutes a location that should be on the list of testing and storage locations.

DoD RESPONSE: *Concur. DoD will be the lead agency for searching, reviewing, and validating documentation to identify DoD locations where the development of chemicals for military use in controlling vegetation and crops in tactical situations were developed, tested, used or stored. DoD, in collaboration with the VA, will develop clear and transparent criteria for what constitutes a location for the list to be provided to the VA.*

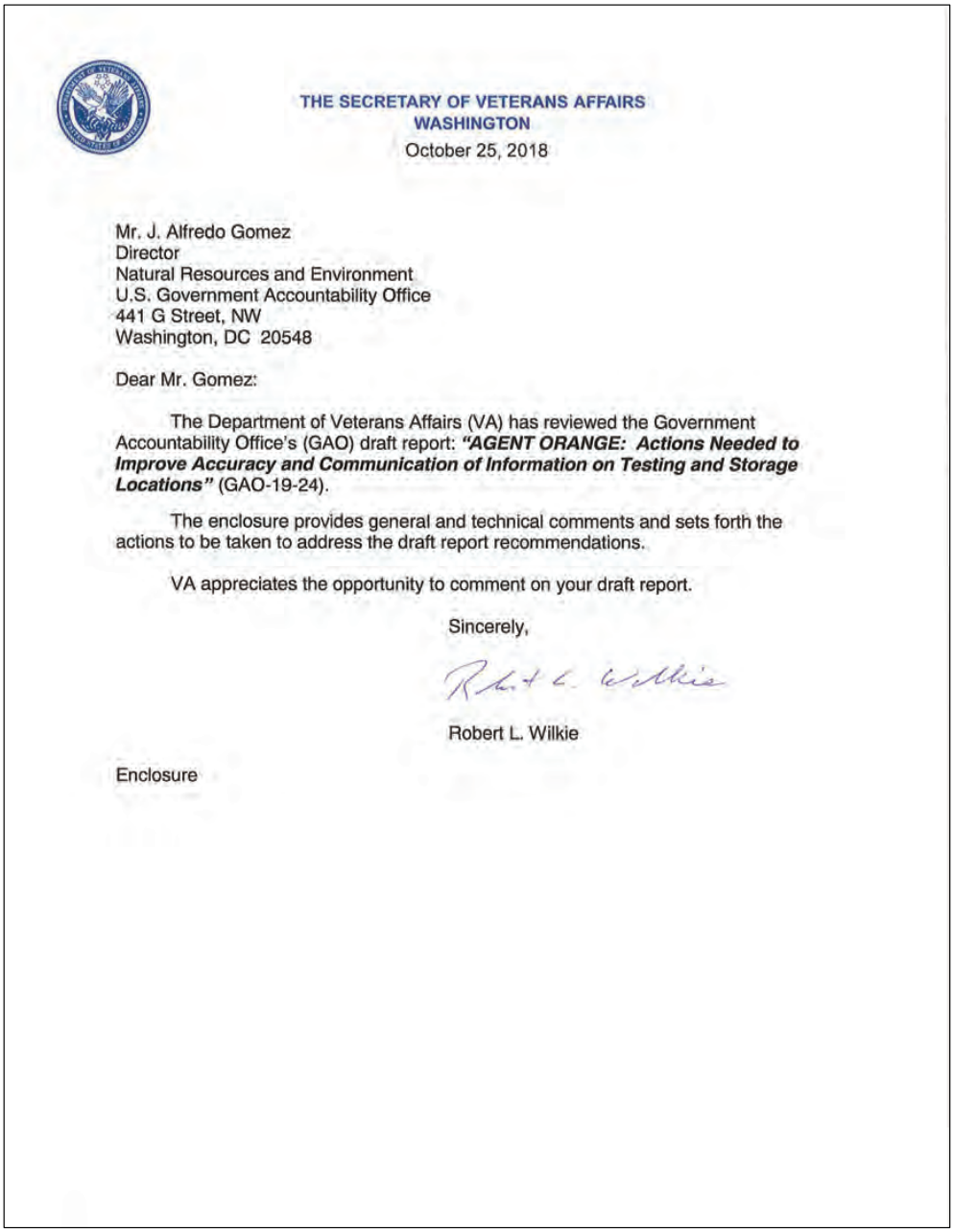
Status: DoD has engaged in thorough searches of DoD and other Federal agency records relating to Herbicide Orange and other tactical herbicides. The records discovered thus far are extensive and very useful in evaluating whether a location stored or used Herbicide Orange. DoD continues to seek and review records on these subjects as part of the process that will be developed per recommendation #2.

The DoD and VA subject matter experts (SMEs) are working collaboratively to develop clear and transparent criteria and guidance for what constitutes a location that should be on the VA list.

RECOMMENDATION 5: The GAO recommends that the Secretary of Defense, in collaboration with the Secretary of Veterans Affairs, should develop a formal process for coordinating on how best to communicate information to veterans and the public regarding where Agent Orange was known to have been present outside of Vietnam.

DoD RESPONSE: *Concur. DoD will be the lead agency for producing and updating the list. VA, however, will be the lead agency in providing information to Veterans regarding Herbicide Orange. VA will provide information and coordinate with DoD on the development of a communication plan. The DoD will develop guidance for DoD on directing inquiries regarding Herbicide Orange from Veterans or Veterans families back to the VA.*
DoD SMEs are currently serving on a DoD/VA Herbicide Orange Working Group (HOWG) that is advising the DoD/VA Deployment Health Working Group (DHWG). The HOWG has developed criteria for a location to be included on the list. The DoD has engaged in thorough searches of its and other Federal agencies' records relating to Herbicide Orange and other tactical herbicides to identify locations where Herbicide Orange and other tactical herbicides or their components were tested at, disposed of, transported through, or stored at DoD installations or DoD operational locations. DoD has continuously inter-faced closely with VA subject matter experts in this process.

Appendix VI: Comments from the Department of Veterans Affairs



THE SECRETARY OF VETERANS AFFAIRS
WASHINGTON

October 25, 2018

Mr. J. Alfredo Gomez
Director
Natural Resources and Environment
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Mr. Gomez:

The Department of Veterans Affairs (VA) has reviewed the Government Accountability Office's (GAO) draft report: ***"AGENT ORANGE: Actions Needed to Improve Accuracy and Communication of Information on Testing and Storage Locations"*** (GAO-19-24).

The enclosure provides general and technical comments and sets forth the actions to be taken to address the draft report recommendations.

VA appreciates the opportunity to comment on your draft report.

Sincerely,

Robert L. Wilkie

Enclosure

THE SECRETARY OF VETERANS AFFAIRS
WASHINGTON

October 25, 2018

Mr. Brian J. Lepore
Director
Defense Capabilities and Management
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Mr. Lepore:

The Department of Veterans Affairs (VA) has reviewed the Government Accountability Office's (GAO) draft report: ***"AGENT ORANGE: Actions Needed to Improve Accuracy and Communication of Information on Testing and Storage Locations"*** (GAO-19-24).

The enclosure provides general and technical comments and sets forth the actions to be taken to address the draft report recommendations.

VA appreciates the opportunity to comment on your draft report.

Sincerely,

Robert L. Wilkie

Robert L. Wilkie

Enclosure

Enclosure

Department of Veterans Affairs (VA) Comments to
Government Accountability Office (GAO) Draft Report
"AGENT ORANGE: Actions Needed to Improve Accuracy and Communication of Information on Testing and Storage Locations"
(GAO-19-24)

General Comments:

The Veterans Health Administration (VHA) is strongly committed to developing long-term solutions that mitigate risks to the timeliness, cost-effectiveness, quality, and safety of the Department of Veterans Affairs (VA) health care system. As such, VHA will use the findings of this report to continue to make improvements and fulfill our mission of honoring America's Veterans by providing exceptional health care that improves their health and well-being.

VA has a robust Agent Orange program centered in the Post-Deployment Health Services (PDHS) that coordinates efforts with the Veterans Benefits Administration (VBA) and will be able to respond to the recommendations of this report. Current Agent Orange efforts include the following:

1. PDHS provides oversight for an Agent Orange Registry (AOR), which currently contains more than 710,000 individuals, including more than 16,000 who were enrolled during Fiscal Year 2018. Participation in the AOR includes a comprehensive exam and history. Although the exam is not used specifically to apply for benefits, the information gained can be used as background for that process. PDHS is currently reviewing the data in the AOR to report on possible health effects associated with service during the Vietnam War in the registry participants and to generate ideas for future studies.
2. PDHS provides oversight for and management of a Web site (https://www.publichealth.va.gov/exposures/agentorange/) that covers a range of topics, such as the AOR and its eligibility, 14 conditions that have presumptive status, locations where Agent Orange was stored, used, tested, etc., (currently being revised by the Herbicide Orange Working Group), and links to VBA sites that cover eligibility for benefits and a ships list for Navy and other Veterans that provides information on specific service on ships that qualifies for Agent Orange-related service connection.
3. PDHS produces a newsletter on Agent Orange-related topics annually and sends it to the AOR population and some other Veterans and providers. The most recent newsletter is posted at: https://www.publichealth.va.gov/exposures/publications/agent-orange/agent-orange-2018/index.asp.
4. PDHS has also trained providers and other interested VA staff on Agent Orange in the last year via two webinars and a large, interactive conference in St. Louis, MO. PDHS is continually interfacing with Environmental Health Coordinators and Clinicians on topics related to possible Agent Orange exposure in Veterans.
5. PDHS has contracted with the National Academies of Science, Engineering, and Medicine to produce biennial reports on the evidence supporting associations

between exposure to tactical herbicides and a number of disease conditions. The findings of these reports are considered when making determinations on the potential addition of new conditions to the list of those presumed to be caused by exposure to Agent Orange.

6. PDHS has provided advise and materials on Agent Orange to Veterans Service Organizations and/or VA staff to use when providing educational sessions for Veterans.
7. PDHS has created a mobile application, Exposure Ed, that provides real-time information on Agent Orange and other potential exposures encountered during military service.

VA is concerned that the report conflates the terms "commercial herbicides" with "tactical herbicides," which are distinctive from one another. In this regard, VA is concerned that certain testing and storage locations, (e.g., Kelly Air Force Base) added to the list are based on the presence of commercial herbicides or mere components of Agent Orange or other rainbow agents.

It should be noted that exposure to tactical herbicides (those herbicides intended for military operations in Vietnam) is required for VA to grant disability benefits on a presumptive basis for Agent Orange conditions outside of Vietnam. The focus on commercial herbicides, which may include certain Agent Orange components, is not relevant for purposes of determining the list of locations where tactical herbicides were tested, stored, etc. unless such commercial agents were in fact the same form and mixture as the tactical agents used in Vietnam.

According to VA regulations, for purposes of determining diseases associated with exposure to certain herbicide agents, the term herbicide agent means a chemical in an herbicide used in support of the United States and allied military operations in the Republic of Vietnam during the period beginning on January 9, 1962, and ending on May 7, 1975, specifically: 2,4-D, 2,4,5-T, and its contaminant tetrachlorodibenzo-p-dioxin (TCDD); cacodylic acid; and picloram. See 38 Code of Federal Regulations §3.307(a)(6).

VA does not dispute that some of the above-mentioned chemicals found in the VA regulation may be included in certain commercial herbicides listed in the federal supply chain; however, of primary importance, the impetus for the creation of the list of testing and storage is to carry out the administration of providing disability benefits in accordance with the applicable Agent Orange statute and regulations. Thus, unless such commercial herbicides were in fact the same composition, forms, and mixtures as the estimated 77 million liters, or 20 million gallons, of rainbow agents (i.e., tactical herbicides) that were specifically produced for the United States and allied military

operations in Vietnam, then such discussion is misleading and not relevant for the purposes described above. See table below for estimated amounts and chemical compositions of rainbow agents used in Vietnam.

An example of this occurs in the draft report on page ten, paragraph one, where GAO mentions that some of the commercial herbicides in the federal supply system contained one or both of some form of the components of Agent Orange, including at least four that contained some form of 2,4,5-T, the component which contained the contaminant 2,3,7,8-TCDD. It should be noted, however, that such commercial forms do not, for example, equate to the mixtures of the n-butyl forms of 2,4-D (50 percent) and 2,4,5-T (50 percent), which make up herbicide orange. This is further illustrated in the last bullet on page 20, where it is noted that two components of Agent Orange were stored at the former Kelly Air Force Base.

VA recommends GAO analyze its list to ensure that only locations where the presence of tactical herbicides, as contemplated by law in 38 United States Code § 1116 and prescribed in VA regulations, has been confirmed, are included on the list of locations.

TABLE
Herbicides in Vietnam (1961 – 1971)
(National Academies of Sciences, 2014, p. 67)

Code Name	Chemical Constituents	Years Used	Veterans Agent Orange Series Estimate	Revised Estimate
Pink	60% n-butyl ester, 40% isobutyl ester of 2,4,5-T	1961, 1965	464,817 L (122,792 gal)	50,312 L sprayed; 413,852 L additional on procurement records
Green	n-butyl ester of 2,4,5-T	1961, 1965	31,071 L (8,208 gal)	31,026 L on procurement records

Purple	50% n-butyl ester of 2,4-D, 30% n-butyl ester of 2,4,5-T, 20% isobutyl ester of 2,4,5-T	1962-1965	548,883 L (145,000 gal)	1,892,733 L
Orange	50% n-butyl ester of 2,4-D, 50% n-butyl ester of 2,4,5-T	1965-1970	42,629,013 L (11,261,429 gal)	45,677,937 L (could include Agent Orange II)
Orange II	50% n-butyl ester of 2,4-D, 50% isooctyl ester of 2,4,5-T	After 1968	--	Unknown; at least 3,591,000 L shipped
White	Acid weight basis: 21.2% triisopropanolamine salts of 2,4-D, 5.7% picloram	1966-1971	19,860,108 L (5,246,502 gal	20,556,525 L
Blue Powder	Cacodylic acid (dimethylarsinic acid) sodium cacodylate	1962-1964	--	25,650 L
Blue aqueous solution	21% sodium cacodylate + cacodylic acid to yield at least 26% total acid equivalent by weight	1964-1971	4,255,952 L (1,124,307 gal)	4,715,731 L
Total, all formulations	--	--	**67,789,844 L (17,908,238 gal)**	**76,954,766 L (including procured)**

Department of Veterans Affairs (VA) Comments to
Government Accountability Office (GAO) Draft Report
"AGENT ORANGE: Actions Needed to Improve Accuracy and Communication of Information on Testing and Storage Locations"
(GAO-19-24)

Recommendation 3: The Secretary of Defense, in collaboration with the Secretary of Veterans Affairs, should develop clear and transparent criteria for what constitutes a location that should be included on the listing of testing and storage locations.

VA Comment: The Department of Defense (DoD) is the lead on this recommendation. The Department of Veterans Affairs (VA) agrees to support DoD as the lead.

Recommendation 4: The Secretary of Veterans Affairs, in collaboration with the Secretary of Defense, should develop clear and transparent criteria for what constitutes a location that should be included on the list of testing and storage locations.

VA Comment: Non-Concur. VA does not agree to take the lead on this recommendation. Rather, VA agrees to support DoD as the lead (highlighted in recommendation 3). DoD chairs the Herbicide Orange Working Group (HOWG) and has sole access to the information on storage, transport, and usage of Agent Orange.

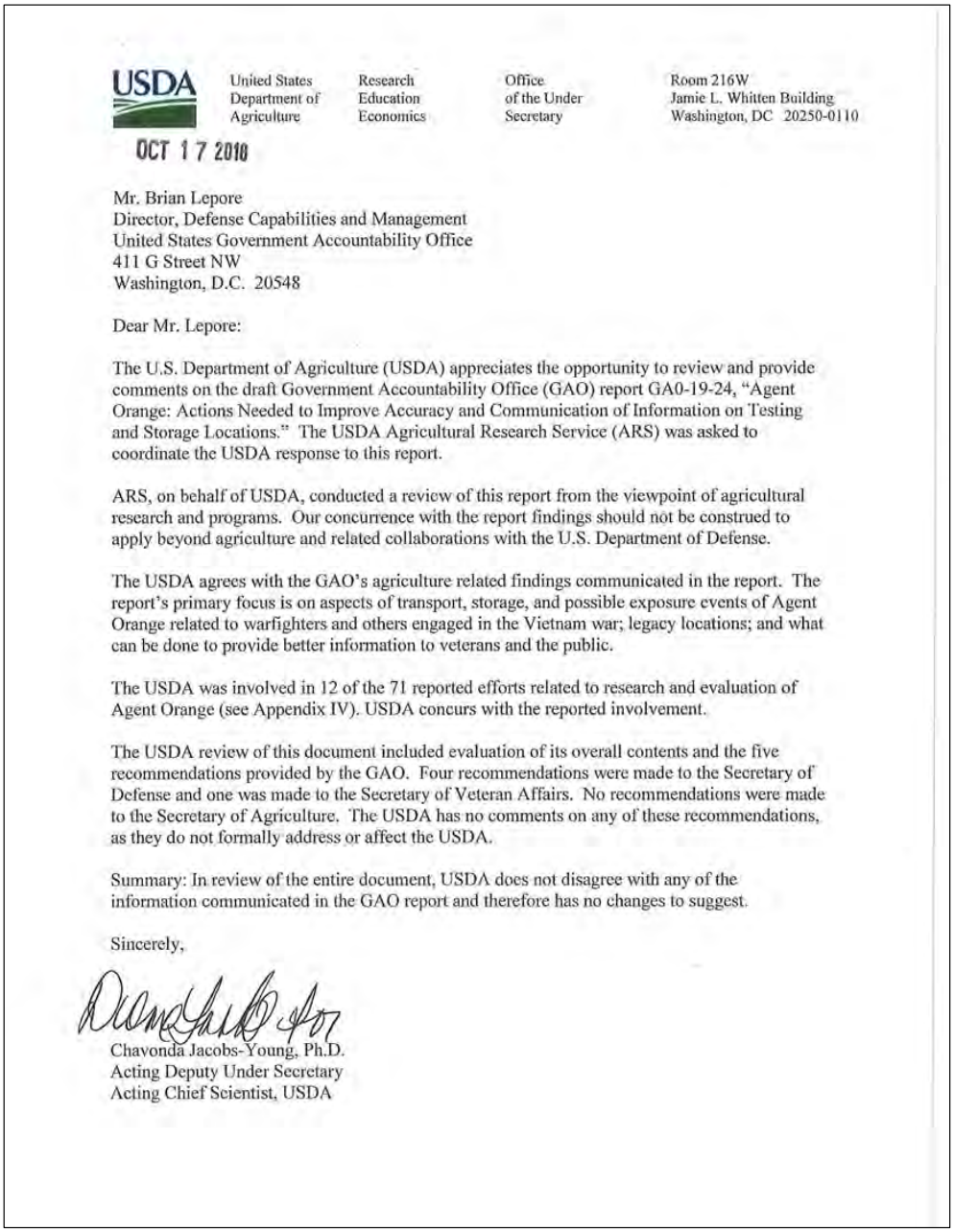
Recommendation 6: The Secretary of Veterans Affairs, in collaboration with the Secretary of Defense, should develop a formal process for coordinating on how best to communicate information to veterans and the public regarding where Agent Orange was known to have been present outside of Vietnam.

VA Comment: Concur. VA's subject matter experts (SMEs) are currently serving on a DoD/VA HOWG, which is advising the DoD/VA Deployment Health Work Group (DHWG). The HOWG developed criteria for a location to be included on the list. DoD has engaged in thorough searches of its, and other federal agencies', records to identify locations where Herbicide Orange and other tactical herbicides or their components were used or tested at, disposed of, transported through, or stored at installations or other DoD operational locations. DoD has continuously interfaced with VA SMEs during this process.

While DoD will be the lead agency to produce and update the list, VA will be the lead agency to provide information to Veterans regarding Herbicide Orange. VA will provide information and coordinate with DoD on the development of a communication plan. VA will convene a workgroup comprised of SMEs from the Veterans Health Administration and the Veterans Benefits Administration, as well as Agency communication and public affairs experts, to develop and implement the formal process to communicate where Agent Orange and other tactical herbicides were known to have been present outside of Vietnam. This effort will be closely coordinated with the designated leads at DoD tasked with updating the list. VA's workgroup tasks will also include updating VA Web

sites, producing articles for social media/newsletters, and engaging in communications with Veterans Service Organizations. The working group will brief the HOWG, and then the DHWG, on its progress, and ultimately brief appropriate senior VA leadership before the target completion date. The target completion date is August 2019.

Appendix VII: Comments from the U.S. Department of Agriculture



USDA United States Department of Agriculture | Research Education Economics | Office of the Under Secretary | Room 216W Jamie L. Whitten Building Washington, DC 20250-0110

OCT 17 2018

Mr. Brian Lepore
Director, Defense Capabilities and Management
United States Government Accountability Office
411 G Street NW
Washington, D.C. 20548

Dear Mr. Lepore:

The U.S. Department of Agriculture (USDA) appreciates the opportunity to review and provide comments on the draft Government Accountability Office (GAO) report GA0-19-24, "Agent Orange: Actions Needed to Improve Accuracy and Communication of Information on Testing and Storage Locations." The USDA Agricultural Research Service (ARS) was asked to coordinate the USDA response to this report.

ARS, on behalf of USDA, conducted a review of this report from the viewpoint of agricultural research and programs. Our concurrence with the report findings should not be construed to apply beyond agriculture and related collaborations with the U.S. Department of Defense.

The USDA agrees with the GAO's agriculture related findings communicated in the report. The report's primary focus is on aspects of transport, storage, and possible exposure events of Agent Orange related to warfighters and others engaged in the Vietnam war; legacy locations; and what can be done to provide better information to veterans and the public.

The USDA was involved in 12 of the 71 reported efforts related to research and evaluation of Agent Orange (see Appendix IV). USDA concurs with the reported involvement.

The USDA review of this document included evaluation of its overall contents and the five recommendations provided by the GAO. Four recommendations were made to the Secretary of Defense and one was made to the Secretary of Veteran Affairs. No recommendations were made to the Secretary of Agriculture. The USDA has no comments on any of these recommendations, as they do not formally address or affect the USDA.

Summary: In review of the entire document, USDA does not disagree with any of the information communicated in the GAO report and therefore has no changes to suggest.

Sincerely,

Chavonda Jacobs-Young, Ph.D.
Acting Deputy Under Secretary
Acting Chief Scientist, USDA

Appendix VIII: GAO Contacts and Staff Acknowledgments

GAO Contacts

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Staff Acknowledgments

In addition to the contacts named above, Kristy Williams and Barbara Patterson (Assistant Directors), Karyn Angulo, Emil Friberg, Ashley Grant, Karen Howard, Kelly Husted, Richard Johnson, Amie Lesser, Keegan Maguigan, Jeff Mayhew, Dennis Mayo, Parke Nicholson, Shahrzad Nikoo, Josie Ostrander, Rebecca Parkhurst, Michael Silver, Anne Stevens, Rachel Stoiko, Roger Stoltz, and Cheryl Weissman made key contributions to this report.

Related GAO Products

Agent Orange: Limited Information Is Available on the Number of Civilians Exposed in Vietnam and Their Workers' Compensation Claims. GAO-05-371. Washington, D.C.: Apr. 22, 2005.

Agent Orange: Persisting Problems with Communication of Ranch Hand Study Data and Results. GAO/T-NSIAD-00-117. Washington, D.C.: Mar. 15, 2000.

Agent Orange: Actions Needed to Improve Communications of Air Force Ranch Hand Study Data and Results. GAO/NSIAD-00-31. Washington, D.C.: Dec. 17, 1999.

Agent Orange Studies: Poor Contracting Practices at Centers for Disease Control Increased Costs. GAO/GGD-90-122BR. Washington, D.C.: Sept. 28, 1990.

Agent Orange: VA Needs To Further Improve Its Examination and Registry Program. GAO/HRD-86-7. Washington, D.C.: Jan. 14, 1986.

VA's Agent Orange Examination Program: Actions Needed To More Effectively Address Veterans' Health Concerns. GAO/HRD-83-6. Washington, D.C.: Oct. 25, 1982.

(102077)

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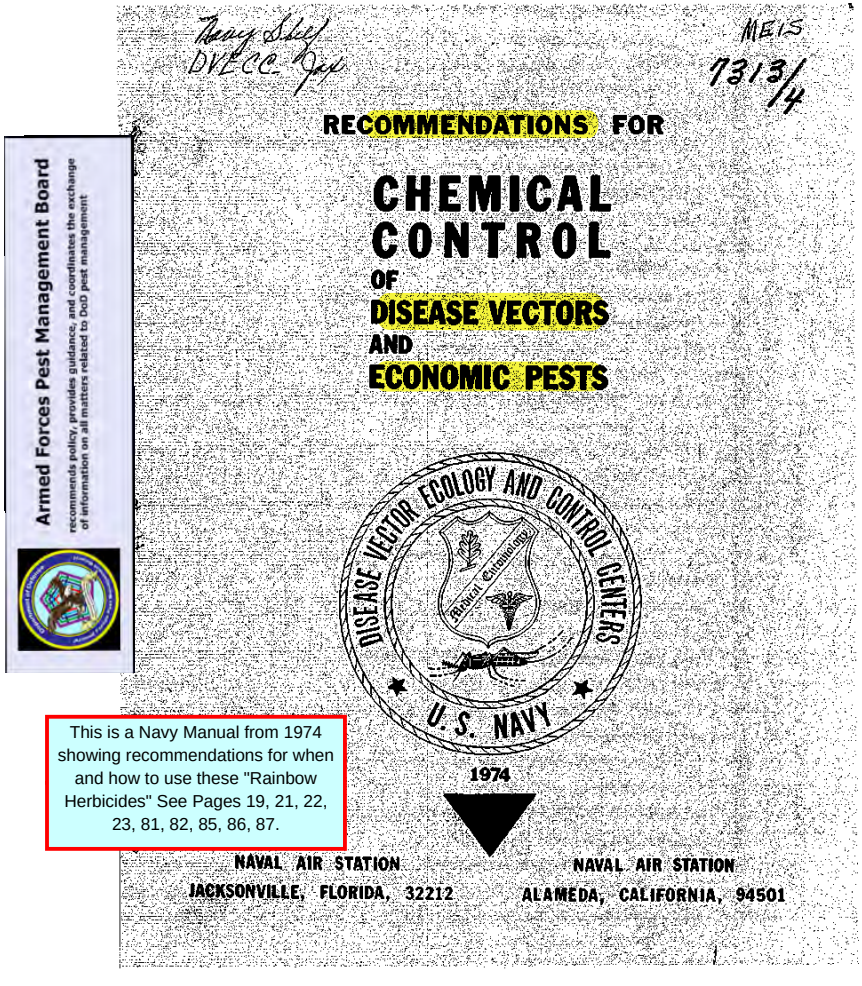

This is a Navy Manual from 1974 showing recommendations for when and how to use these "Rainbow Herbicides" See Pages 19, 21, 22, 23, 81, 82, 85, 86, 87.

Armed Forces Pest Management Board

recommends policy, provides guidance, and coordinates the exchange of information on all matters related to DoD pest management

TABLE OF CONTENTS

INTRODUCTION

Subj: Recommendations for Chemical Control of Disease Vectors and Economic Pests

1. Purpose. This publication has been prepared primarily for distribution to Armed Forces Pest Control Program personnel, military and civilian. Post engineers, public works officers and installation engineers of the respective services may also find the publication helpful. It may also be useful to individuals, householders and property owners among military personnel and their dependents.

2. Cancellation. DVECC Recommendations for Chemical Control of Disease Vectors and Economic Pests, issued 1 January 1972, is hereby cancelled and superseded.

3. Background. Since the first use of kerosene for scale insect control in 1865 and later in the century as a mosquito larvicide, numerous chemicals and other substances have been tried, some proven, but most discarded as chemical control agents. The discovery in 1939 of the insecticidal properties of DDT opened up a new and fruitful era of chemical pesticides. Since then, through synthesis, testing and laboratory and field evaluation, many new chemicals have emerged as the pesticides of today.

Some modern pesticides are more or less specific for certain animal or plant pests and have limited specialized use. Others are effective against a wide range of a certain type or group of pests. Thus, we have the insecticides, the acaricides, the rodenticides, the fungicides, the herbicides, etc. A substance found to be effective against a wide variety of insect pests may be called a broad-spectrum insecticide. An attempt has been made in this publication to give the pesticide of choice first under each pest heading and then to list one or more alternate materials. The listing of a particular pesticide as first choice is a precarious if not arbitrary business since there is no standard yardstick by which one pesticide may be compared with another for a given purpose.

The recommendation of one pesticide over another should not be taken as an endorsement of one product or material over another. Neither should it be inferred that the others are less valuable under certain conditions and locations.

4. Precautions - Reading the Label. The use of pesticides is regulated by the Environmental Protection Agency. That agency is responsible for enforcement of the Federal Pesticide Act of 1972. PESTICIDES ARE REGISTERED FOR USE AGAINST SPECIFIC PESTS AND CERTAIN TYPES OF APPLICATION. TO USE THEM OTHERWISE IS UNLAWFUL AND MAY RESULT IN RATHER SEVERE PUNISHMENT. IT IS THE RESPONSIBILITY OF THE USER TO ENSURE THAT A PESTICIDE IS USED IN STRICT COMPLIANCE WITH THE LABEL. It is also the responsibility of the user to make sure the label is current and contains the latest instructions and restrictions. Recommendations contained in this publication are intended as a guide only and must not be substituted for

HERBICIDES

FSN No.	ITEM
6840-833-1217	Amitrol, ATA*, Cytrol*, Weedazol* Must be procured from the Army. A non-selective systemic herbicide. For control of annual grasses and broadleaf weeds, perennial broadleaf weeds and grasses, cattails, poison ivy, and certain aquatic weeds in marshes and drainage ditches. 90% water soluble. $46.50/Pail (24 lbs)
6840-781-8195	Atrazine, AAtrex*, Fenamine*, Fenatrol*, Gesaprim* Primatol A* Principal use by military is as soil sterilant. 80% wettable powder. $2.20/Bag (50 lb)
6840-027-6467	Borate-Bromacil Mixture This granular mixture contains 71.2% disodium tetraborate pentahydrate, 22.8% disodium tetraborate decahydrate, 4.0% bromacil, 2.0% inert. $21.50/Bag (50 lbs)
6840-890-2146	Bromacil, Hyvar-X*, Hyvar-P*, Hyvar X-L* For general weed control in non-crop areas; particularly useful against perennial grasses. Wettable powder contains 80% bromacil. $248.00/Drum (50 lbs)
6840-926-9094	Cacodylic acid, Silvisar 510*, Phytar 560G* Difficult to procure Non-selective herbicide. The 16 gauge drum shall have a three inch wide blue band at the center line. This item is for tactical purposes only and is not for base type pest control. $271.00/Drum (55 gallons)
6840-063-3981	Copper Sulfate This water soluble crystalline herbicide contains 80.16% cupric sulfate. Used for control of algae in impoundments. $14.00/Bag (50 pounds)

This is a Synonym for Agent Blue herbicide

* Trade Name

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HERBICIDES (Continued)

FSN No.	Item
6840-577-4204	Dalapon-Na, Dowpon*, Ded-Weed*, Gramevin*, Radapon*, Unipon* Selective herbicide. Effective against quackgrass, Bermuda grass, Johnson grass and other perennial grasses as well as cattails and rushes. 85% water soluble powder. $39.00/Drum (50 lbs)
6840-681-9475	DCPA, DAC 893*, Dacthal* Selective pre-emergence herbicide controls crabgrass, witchgrass, foxtails, fall panicum and other annual grasses. Also useful against certain broadleaf weeds such as carpet weed, dodder, purslane and common chickweed. This wettable powder contains 75% active ingredient. $118.00/Box (48 lbs)
6840-905-4304	Dicamba, Banvel D*, Banex*, Mediben* Very effective on many hard to kill broadleaf species of weeds and brush which may not be controlled efficiently with 2,4-D or amitrol. Effective as soil or foliar treatment. 49% dicamba, liquid form. $29.90/Bottle (1 gallon)
6840-815-2799	Diquat, Aquacide*, Dextrone*, Reglone* Non-selective herbicide and desiccant. For aquatic weeds in still and slow flowing ponds, lakes and canals. For floating weeds. 35.3% diquat dibromide, liquid. $120.00/Drum (5 gallon)
6840-825-7790	Diuron, Karmex*, Marmer*, Di-on* Used in the military as a non-selective weed killer on sites where bare ground is desired. As a soil sterilant it is more persistent and is often recommended in light sandy soils in areas of moderate to heavy rainfall. This water dispersible powder contains 80% active ingredient. $127.00/Drum (50 lbs)

* Trade Name

HERBICIDES (Continued)

FSN No.	Item
6840-965-2071	DSMA, Ansar 184*, Ansar 8100*, Arrhenal*, DMA*, Weed-E-Rad* and others Selective post-emergence contact herbicide controls crabgrass, Johnson grass, Dallis grass, nutgrass, foxtail, watergrass, witchgrass, velvetgrass, chickweed, goosegrass, knotweed and others. Thorough coverage essential. This water soluble powder contains 63% disodium methylarsonate. $38.20/Drum (100 lbs)
6840-929-7951	Fenac, Tri-Fen*, Effective for Johnson grass seedlings, Russian thistle, morning glory, Russian knapweed, Canada thistle, perennial sow thistle and puncture vine. $228.00/Drum (30 gallons)
6840-514-0644	Monuron, Telvar* Used by the military as a soil sterilant on medium to heavy soils and under intermediate rainfall. At sterilant dosages it controls a wide range of annual and perennial plants, both grasses and broadleaf types. Water dispersible powder. $119.00/Drum (50 lbs)
6840-629-1368	Picloram, Tordon*, Borolin* Effective against a wide variety of deep rooted herbaceous weeds and woody plants. Most grasses are resistant. For noncrop use in brush control along utility rights-of-way. Since it is compatible with 2,4-D, dalapon and certain other herbicides, it is mixed occasionally with another herbicide to produce desired results. $57.00/Drum (5 gallon)
6840-926-9093	Picloram Difficult to procure. Same as preceding. The 16 gauge drum shall have a three inch wide white band at the center line. This item is for tactical purposes only and not for base type pest control operations. $390.00/Drum (55 gallon)

This is a synonym for Agent White herbicide

Rainbow Herbicide

* Trade Name

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HERBICIDES (Continued)

FSN No.	Item
6840-990-1464	Picloram Same chemical as preceding. This formulation is pelletized and contains 11.6% picloram potassium salt. $69.00/Drum (50 lbs)
6840-882-4810	Silvex Ester, 2,4,5-TP*, Garlon*, Kurosal*, Kuron* Hormone type herbicide that is absorbed by leaves and translocated. Tests have indicated that silvex is more effective than 2,4,5-T for control of certain woody plants, especially oak species. Very effective on many turf weeds such as chickweed, clover, henbit and yarrow. This emulsifiable concentrate contains 58.9% to 65.1% of any suitable low volatile ester derivative of 2-(2,4,5-trichlorophenoxy1) propionic acid (4 lb minimum acid equivalent per gallon). $38.70/Drum (5 gallons)
6840-814-7334	Simazine, Princep*, Gesatop*, Primatol* Soil sterilant. Tightly held by soil. Little lateral movement. Micro-organisms break it down in about a year. Persists longer in dry, cold or low fertility soils. Can be combined with 2,4-D, 2,4,5-T, silvex, dalapon, amitrol and others. Broadleaf plants are the most susceptible. 80% water dispersible powder. $12.10/Bag or Can (5 lbs)
6840-781-8195	Simazine Same as preceding $110.00/Drum (50 lbs)
6840-664-7060	2,4-D, Weed-B-Gone*, Weedone*, Weedar 64*, Formula 40* and others. Post emergence herbicide for broadleaf control. Sometimes for aquatic weed control. Effective against morning glory, Canada thistle, chickweed, cocklebur, golden rod, ivy, hoary cress, jimsonweed, lambsquarter, locoweed, mustards, pigweed, plaintain, Russian thistle, purslane, sagebrush, sunflower, willows and others. Avoid drift. Very susceptible desirable plants include cotton, tomatoes, grapes, fruit, trees, and ornamentals. Amine form. $14.00/Can (5 gallons)

Silvex is another rainbow herbicide

* Trade Name

HERBICIDES (Cont.)

FSN No.	
6840-825-7792	2,4-D - 2,4,5-T Mixture, Ded-Weed LV33* Restricted procurement. This solution contains 33.5% low volatile ester of 2,4-D (2.0 lb 2,4-D acid equivalent/gallon). 31.9% low volatile ester of 2,4,5-T (2.0 lb 2,4,5-T/gallon) and 34.6% inert ingredients. $297.00 Drum (55 gallons)
6840-926-9095	2,4-D - 2,4,5-T High volatile ester Difficult to procure. This solution contains 50% N-butyl 2,4-dichlorophenoxyacetate, 50% N-butyl, 2,4,5-T trichlorophenoxyacetate. The drum shall have an orange band 3 inches wide at the center line of the drum body. This item is for tactical purposes only and is not for base type pest control operations. $430.00 Drum (55 gallon)
6840-582-5440	2,4,5-T, Dacamine 4T*, Reddon*, Weedone 2,4,5-T* Selective hormone type herbicide. Effective against woody plants. Treat when plants are actively growing. Four pounds acid equivalent per gallon. $33.50/Can (5 gallons)
6840-577-4201	2,4,5-T Same as preceding. $348.00 Drum (55 gallons)

Rainbow Herbicicde

Agent Orange

Rainbow Herbicide

Rainbow Herbicide

* Trade

23

ESTIMATED RELATIVE ACUTE TOXIC HAZARDS OF PESTICIDES TO SPRAYMEN*

The estimates of hazards in this table are based primarily on the *observed acute dermal* and to a less extent oral toxicity of these compounds to experimental animals. *Where it is available, use experience has also been considered.* It should be noted that the classification into *toxicity groups is both approximate and relative.* These toxicity categories are not related to specific categories spelled out for label requirements.

Most Dangerous	*Dangerous*	*Less Dangerous*†	*Least Dangerous*
carbanolate, Temik (M)‡	aldrin (CH)	azinphosmethyl, Guthion® (OP)	Aramite® (M)
demeton, Systox® (OP)	Bidrin® (OP)	BHC (CH)	captan (M)
disulfoton, Di-Syston® (OP)	carbophenothion, Trithion® (OP)	binapacryl, Morocide® (N)	carbaryl, Sevin® (C)
mevinphos, Phosdrin® (OP)	DDVP, dichlorvos (OP)	chlordane (CH)	chlorobenzilate (CH)
parathion (OP)	dieldrin (CH)	coumaphos, Co-Ral® (OP)	2,4-D (CH)
phorate, Thimet® (OP)	dioxathion, Delnav® (OP)	diazinon (OP)	DDD, TDE (CH)
schradan, OMPA (OP)	DNOC (N)	dicapthon (OP)	DDT (CH)
tepp (OP)	DNOSBP (N)	dichloroethyl ether (M)	dicofol, Kelthane® (CH)
thionazin, Zinophos® (OP)	endrin (CH)	dimethoate, Cygon® (OP)	Dilan® (CH,N)
	EPN (OP)	endosulfan, Thiodan® (CH)	dinocap, Karathane® (N)
	ethion, Nialate® (OP)	fenthion, Baytex® (OP)	diquat (M)
	methyl parathion (OP)	heptachlor (CH)	IPC, propham (M)
	nicotine (M)	lead arsenate (M)	malathion (OP)
	pentachlorophenol (M)	lindane (CH)	maneb (M)
	phosphamidon, Dimecron® (OP)	naled, Dibrom® (OP)	methoxychlor (CH)
	sodium arsenite (M)	oxydemetonmethyl, Meta-Systox®-R (OP)	mirex (CH)
	Zectran® (C)	Ruelene® (OP)	Morestan® (M)
		SMDC, Vapam® (M)	NAA (M)
		trichlorfon, Dipterex®, Dylox® (OP)	Perthane® (CH)
		toxaphene (CH)	piperonyl butoxide (M)
		VC-13 (OP)	ronnel, Korlan® (OP)
			rotenone (M)
			simazine (M)
			2,4,5-T (CH)
			tetradifon, Tedion® (CH)
			thiram (M)
			zineb (M)
			ziram (M)

* SOURCE OF DATA: *Safety In the Use of Pesticides*, Homer R. Wolfe, William F. Durham. Proc. 2nd Eastern Wash. Fertilizer and Pesticide Conf. Pullman: Washington State University, pp. 16-21, 1956.

† The fumigant compounds acrylonitrile, D-D®, and Telone® have systemic toxicities which would indicate their placement under the "Less Dangerous" category. However, special note should be taken of the fact that the volatility of these compounds and their capacity to produce irritation of skin, eyes and other tissues indicate that appropriate caution should be exercised in their use.

‡ The chemical class to which the pesticide belongs is designated as follows: C, carbamate; CH, chlorinated hydrocarbon; M, miscellaneous; N, nitro; and OP, organic phosphorus.

WEED CONTROL RECOMMENDATIONS: THESE RECOMMENDATIONS ARE FOR GUIDELINES ONLY. USER MUST ENSURE THAT PESTICIDE IS APPLIED IN STRICT COMPLIANCE WITH THE LABEL

HERBICIDES

TYPE OF APPLICATION	PESTICIDE	TIME OF APPLICATION	ORGANISMS CONTROLLED	REMARKS
Lawns and Ornamental Turf	DSMA	Any time target weeds are growing actively and air temperature is over 70°F	dallisgrass, sandbur, bahiagrass, nutsedge, crabgrass, chickweed and wood sorrel	Do not treat new lawns until after 3 mowings. Tolerant grasses may be temporarily affected, especially in hot weather. Rain or waterings will revive them. Bent and fescue grasses are generally more sensitive, and may be temporarily discolored. Zoysia, bluegrass and bermuda are tolerant. Do NOT use on St. Augustine and centipede grasses. Spray thoroughly. Repeat as necessary at 10-14 day intervals. Keep children and pets off treated areas until material has been washed into the soil. Do NOT contaminate waters used for domestic consumption, or by animals, wildlife and aquatic life, or for irrigation purposes.
Aquatic Weeds emerged from still water such as ponds, lakes and ditches	silvex	When foliage is above water and well developed	waterlily, spatterdock, pickerelweed, alligator weed, arrowhead	Thorough coverage is essential. Special Precautions: See remarks under "Aquatic Weeds Submerged" for silvex. General Precautions: See remarks for silvex for "Brush Vines and Trees"
	diquat	When foliage is above water but before flowering	pennywort, salvinia, water hyacinth, water-lettuce, cattails, duckweed	Care should be taken to thoroughly cover all plants on water and on damp marginal areas. Reinfestation of duckweed occurs readily from untreated areas. Retreatment with diquat may be necessary to obtain season long control. See remark under "Aquatic Weeds Submerged" for diquat.

Rainbow Herbicide

WEED CONTROL RECOMMENDATIONS: THESE RECOMMENDATIONS ARE FOR GUIDELINES ONLY. USER MUST ENSURE THAT PESTICIDE IS APPLIED IN STRICT COMPLIANCE WITH THE LABEL

HERBICIDES

TYPE OF APPLICATION	PESTICIDE	TIME OF APPLICATION	ORGANISMS CONTROLLED	REMARKS
Aquatic weeds submerged in still water such as ponds, lakes and ditches	silvex	Early summer when water is above 50°F and weeds are nearing water surface	Milfoil, fanwort, bladderwort, waterweed	Uniform distribution over the water surface is necessary. Do not treat flowing water. A pond with a slight current can be treated after the water level is lowered if there will be no overflow for at least three days following treatment. Apply only in accordance with state and local laws governing chemical treatment of bodies of water for control of weeds. Special Precautions: Do not use where pond water is being used for irrigation, agricultural sprays, for domestic water supply or for livestock watering. Do not apply to water containing valuable fish unless some fish kill can be tolerated. Kill may occur in shallow coves if application is not uniform or in shallow areas not diluted by fresh water. Treatment of aquatic weeds can result in oxygen loss from decomposition of dead weeds. This loss can cause fish suffocation. Therefore, treat 1/3 to 1/2 of the water area in a single operation and wait 10 to 14 days between treatments. It is recommended that edges of pond or lake be treated first so that fish will not be trapped in shallow pockets or inlets. Apply silvex when water level is low to minimize exposure of desirable vegetation along shorelines. Do not apply algacides such as copper sulfate for 3 days before or after applying silvex since they may interfere with the action of silvex. See remarks for silvex for "Brush, Vines and Trees".

Rainbow Herbicide

WEED CONTROL RECOMMENDATIONS: THESE RECOMMENDATIONS ARE FOR GUIDELINES ONLY. USER MUST ENSURE THAT PESTICIDE IS APPLIED IN STRICT COMPLIANCE WITH THE LABEL

HERBICIDES

TYPE OF APPLICATION	PESTICIDE	TIME OF APPLICATION	ORGANISMS CONTROLLED	REMARKS
Unwanted annual and perennial broadleaved weeds and woody plants and vines on non-crop areas including industrial sites, right-of-ways of power lines, pipelines, communication lines, highways and railroads	tordon-2,4-D mixture	Any time target plants are actively growing	Perennial Broadleaved Weeds: Field bindweed, wild carrot, bouncingbet, chicory, sweet clover, wild clover, dandelion, dock, fleabane, goldenrod, horsenettle, knapweed, Russian milkweed, bur ragweed, plantain, common ragweed, sowthistle, snakeweed, spurge, Canada thistle toadflax and vetch	Do not permit these herbicides to contact susceptible crop, ornamental, vegetable, flower or other desirable plantings. Use coarse sprays under low pressure to minimize drift. Do not spray when wind velocity exceeds 5 mph. At high temperature (above 90°F), vapors from this product may injure susceptible nearby plants. Do not contaminate irrigation ditches or water used for irrigation or domestic purposes. Do not store near other pesticides. To avoid injury to desirable plants, do not handle or apply other pesticides with the same equipment used for these herbicides except as specified on the label. Rinse equipment and containers and dispose of waste by burying in non-crop lands away from water supplies. May cause skin irritation. Avoid contact with eyes, skin and clothing.

Agent White

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WEED CONTROL RECOMMENDATIONS: THESE RECOMMENDATIONS ARE FOR GUIDELINES ONLY. USER MUST ENSURE THAT PESTICIDE IS APPLIED IN STRICT COMPLIANCE WITH THE LABEL

HERBICIDES

TYPE OF APPLICATION	PESTICIDE	TIME OF APPLICATION	ORGANISMS CONTROLLED	REMARKS
Unwanted annual and perennial broadleaved weeds and woody plants and vines on non-crop areas including industrial sites, right-of-ways of power lines, pipelines, communication lines, highways and railroads	tordon-2,4-D mixture	Any time target plants are actively growing	Woody Plants: Allanthus, alder, aspen, birch, blackberry, bracken fern, buttonbush, cedar, cherry, douglas fir, elm, balsam fir, gorse, gum, hemlock, hickory, honeysuckle, kudzu, locust, maple, oak, persimmon, pine, poison oak, sassafras sourwood, spruce, sumac, tulip poplar, wild rose, willow	Do not permit these herbicides to contact susceptible crop, ornamental, vegetable, flower or other desirable plantings. Use coarse sprays under low pressure to minimize drift. Do not spray when wind velocity exceeds 5 mph. At high temperature (above 90°F), vapors from this product may injure susceptible nearby plants. Do not contaminate irrigation ditches or water used for irrigation or domestic purposes. Do not store near other pesticides. To avoid injury to desirable plants, do not handle or apply other pesticides with the same equipment used for these herbicides except as specified on the label. Rinse equipment and containers and dispose of waste by burying in non-crop lands away from water supplies. May cause skin irritation. Avoid contact with eyes, skin and clothing.

Agent White

WEED CONTROL RECOMMENDATIONS: THESE RECOMMENDATIONS ARE FOR GUIDELINES ONLY. USER MUST ENSURE THAT PESTICIDE IS APPLIED IN STRICT COMPLIANCE WITH THE LABEL

HERBICIDES

TYPE OF APPLICATION	PESTICIDE	TIME OF APPLICATION	ORGANISMS CONTROLLED	REMARKS
Brush, vines and trees in industrial sites, forests, right-of-ways of power lines, pipelines, highways, railroads, and along drainage ditch banks, fuel breaks, fence rows, golf courses, parks and achletic fields	silvex	Any time target plants are actively growing	Most unwanted woody plants such as alder, bramble, dogwood, buttonbush, maple, honeysuckle, locust, mesquite, poison ivy, persimmon, poison oak, prickly pear, cactus, sagebrush, willow, salmonberry, salt cedar, wild rose, oak, yucca, plus many species of broadleaf weeds	Do not permit these herbicides to contact susceptible crop, ornamental, vegetable, flower or other desirable plantings. Use coarse sprays under low pressure to minimize drift. Do not spray when wind velocity exceeds 5 mph. At high temperature (above 90°F), vapors from this product may injure susceptible nearby plants. Do not contaminate irrigation ditches or water used for irrigation or domestic purposes. Do not store near other pesticides. To avoid injury to desirable plants, do not handle or apply other pesticides with the same equipment used for these herbicides except as specified on the label. Rinse equipment and containers and dispose of waste by burying in non-crop lands away from water supplies. May cause skin irritation. Avoid contact with eyes, skin and clothing.
Algae in still water such as ponds, lakes and ditches	diquat	At first appearance	Algae of Spirogyra spp. and Phythophora spp.	Apply 0.5 to 1.5 ppm of water. Application methods as for submerged weeds.

Rainbow Herbicide

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March 30, 2020

Mr. Harry Allen
Federal On-Scene Coordinator
U. S. Environmental Protection Agency
Region 9, Emergency Response Section
2445 North Palm Drive, Signal Hill, CA 90755

Subject: Guam Chlorinated Herbicides Investigation –October 2019 Data Results
Task Order Number: 68HE0919F0113
Document Control Number: 0035-08-AAJD

Dear Mr. Allen:

Under the Task Order (TO) No. 68HE0919F0113, the United States (U.S.) Environmental Protection Agency (EPA) Region 9 Federal On-Scene Coordinator (FOSC), Harry Allen, tasked the Weston Solutions, Inc. (WESTON®) Superfund Technical Assessment and Response Team (START), at the request of the Government of Guam, to support a continuing investigation of residual legacy chlorinated herbicides on Guam in October, 2019 (**Figure 1**).

This sampling event is a continuation of earlier investigations conducted in April 2018 and November 2018. This investigation is being conducted based on reports of chlorinated herbicide use by veterans who were stationed in Guam at the request of the Government of Guam. To date, locations within Andersen Air Force Base (AAFB) and locations along a pipeline located off base have been tested for certain herbicides (Weston, 2019). An off-base sampling event for residual herbicides was conducted by the EPA and START in November 2018. During that sampling event, trace concentrations of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) and 2-(2,4,5-trichlorophenoxy) propionic acid (2,4,5-TP, also known by the common name "silvex" or "fenoprop") were detected in samples collected from locations along a pipeline reportedly involved in chlorinated herbicide spraying (Weston, 2019). Previous sampling locations from the April 2018, November 2018 and October 2019 sampling events are depicted in **Figure 2**.

Chlorinated herbicides were reportedly applied during the 1960s and 1970s. A Navy field manual reported 2,4,5-T was an approved herbicide for use on Guam (Navy, 1958). It is anticipated that any herbicide residuals may have undergone degradation since the time they were used. Limitations in resolution for the previously utilized EPA Method 8151A may have restricted the ability to detect the contaminants of concern at the lower concentrations necessary to quantitatively assess long-term risks. Therefore, a modified analytical method with increased resolution, EPA Method 8321A, was utilized to detect herbicides at lower concentrations than was possible with EPA Method 8151A. In addition, EPA requested dioxin/furan analysis of soil samples to provide supporting evidence of legacy chlorinated herbicide use. For the October 2019 sampling event, in conjunction with analyzing soil samples for legacy chlorinated herbicides, dioxin/furan analysis was performed using EPA Method 8290. The method includes 17 dioxin and furan congeners,

some of which were known manufacturing byproducts of the production of chlorinated herbicide components (EPA, 2006).

This letter report presents a summary of START mobilization activities and analytical results from soil samples collected during the October 2019 sampling event. **Attachment A** provides a list of citations for this document, **Attachment B** provides a photographic log of Site conditions and Site activities, **Attachment C** provides the figures for this letter report, and **Attachment D** contains the soil sampling analytical results, toxic equivalency quotient (TEQ) calculations using the Kaplan-Meier (K-M) method, and data validation reports.

Mobilization Activities

Sampling took place over two days, October 2, 2019 and October 4, 2019. The sample locations were determined based on locations provided by a veteran who reported knowledge of herbicide spraying events (**Figure 1**). For each sample, START used dedicated sampling equipment to collect 5-point composite surface (0 to 0.25 feet below ground surface) soil samples from areas where the veteran indicated herbicide spraying may have occurred. A total of ten 5-point composite surface soil samples (including two duplicate soil samples) were collected from areas along different sections of the pipeline. Samples were collected at valves and other common access points along the pipeline where spraying of chlorinated herbicides reportedly took place. Sample aliquots were collected using dedicated disposable scoops and homogenized in a disposable aluminum pan prior to being placed in a clear 8-ounce soil jar. Soil samples were placed on ice and chilled to 4 degrees Celsius prior to being shipped to a TestAmerica laboratory in Denver, Colorado for analysis. All ten soil samples were analyzed for chlorinated herbicides by EPA Method 8321A and for dioxins and furans by EPA Method 8290. A photographic log of Site conditions and Site activities is provided in **Attachment B-Photographic Log.**

Sampling Results

No detections were observed for chlorinated herbicides using EPA Method 8321A during the October 2019 sampling event (**Table 1**). One or more individual dioxin and furan congeners were detected in all 10 composite samples, including the two duplicate samples using EPA Method 8290 (**Table 2**). All sample results are compared to EPA Regional Screening Levels (RSLs) for residential soil (EPA, 2019a) and to Tropical Pacific Environmental Screening Levels (TPESL) for unrestricted land use in shallow soil where groundwater is not a concern or potential drinking water source (TPESL, 2017).[1]

For the dioxin and furan congeners, the total dioxin TEQ concentration for each sample was calculated using the K-M mean estimation technique following the EPA Advanced K-M TEQ Calculator version 9.1 (TEQ Calculator [EPA, 2014]) for comparison to the 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) RSL. These data are presented in **Attachment D - Sampling Results**. In order to calculate a TEQ, a toxic equivalent factor (TEF) is assigned to each member of the dioxin and dioxin-like compounds category. The TEF is the ratio of the toxicity of one of the compounds in this category to the toxicity of the two most toxic

[1] Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater Screening Levels, Tropical Pacific Edition (TPESL, 2017), is prepared by Hawaii Department of Health, Hazard Evaluation and Emergency Response for use in tropical areas outside of Hawaii, including Guam and the Commonwealth of the Mariana Islands.

compounds in the category, which are each assigned a TEF of 1 (i.e., 2,3,7,8-TCDD and 1,2,3,7,8-pentachlorodibenzo-p-dioxin). TEFs have been established through international agreements and currently range from 1 to 0.0001 (Van den Berg and others, 2006; EPA, 2016). A TEQ is calculated by multiplying the actual grams weight of each dioxin and dioxin-like compound by its corresponding TEF (e.g., 10 grams times 0.1 TEF = 1 gram TEQ) and then summing the results. The number that results from this calculation is referred to as grams TEQ.

Calculations of sums or totals for multi-constituent chemicals such as total dioxin TEQs have typically involved simple substitution of zero, one half the detection limit (DL), or the DL for left-centered (non-detect) congeners. Because this practice introduces bias to estimates used in statistical calculations, many sources now strongly caution against the use of arbitrary surrogate values for non-detects for data with three or more non-detect, qualified and/or rejected congeners (TEQ Calculator [EPA, 2014]). Helsel (2009) describes an approach for calculating totals using the K-M approach which uses a nonparametric maximum likelihood estimator in calculations of the intermediate mean and total TEQ on influential congeners (high toxicity, TEQ factors close to 1 [Van den Berg and others, 2006], high concentrations) (TEQ Calculator [EPA, 2014]). The EPA has been utilizing the K-M method for the treatment of non-detect dioxin congeners since 2009 (EPA, 2009a, 2009b) and developed the TEQ calculator macro in 2014 to estimate TEQ using the K-M Method. Further details regarding the use of the K-M estimator for deriving TEQ estimations are presented in the K-M discussion of the EPA Advanced K-M TEQ Calculator (TEQ Calculator [EPA, 2014]). K-M data output for this site, including the K-M TEQ calculations, using the EPA Advanced K-M TEQ calculator is provided in **Attachment D-Sampling Results.**

The total dioxin TEQ concentrations exceeded the EPA RSLs for 2,3,7,8-TCDD of 4.8 picograms per gram (pg/g), but did not exceed the TPESL (EPA, 2019a; TPESL, 2017) in 8 of 10 composite soil samples, including both duplicate samples (G-01-01-D and G-04-02-D). TEQ values exceeding the EPA RSL value ranged from 5.1 pg/g (G-03-01) to 13 pg/g (G-04-01), with the highest TEQ value at the Tiyan Junction location. The individual dioxin congener 1,2,3,4,6,7,8-heptachlorodibenzodioxin (1,2,3,4,6,7,8-HpCDD) exceeded its EPA RSL value of 480 pg/g in one sample (G-04-01). Figures depicting Site sampling locations and EPA RSL exceedances are presented in **Attachment C-Figures 3 through 6**.

Discussion

The chlorinated herbicide 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) itself is not considered carcinogenic, but 2,4,5-T was known to have varying levels of contamination with the known carcinogen, 2,3,7,8-TCDD, from the manufacturing process. Contamination with 2,3,7,8-TCDD led to the discontinuation of use of 2,4,5-T and similar chlorinated herbicides in 1985 (CDC, 2016). In previous research, TCDD was found in pre-1970 samples of 2,4,5-trichlorophenol, the manufacturing precursor of 2,4,5-T. In addition to TCDD, other polychlorinated dibenzo-*p*-dioxins (PCDDs), including 2,7-dichloro-dibenzo-*p*-dioxin and 1,3,6,8-tetrachloro-dibenzo-*p*-dioxin, were measured in the same pre-1970 samples (Cochrane and others, 1982). Additionally, herbicide formulas often included simultaneous use of chemicals including 2,4-dichlorophenoxyacetic acid (2,4-D), kerosene, and diesel (EPA, 2019b). The purity of these additive substances is unknown due to lack of data. A summary of literary citations for this document is provided in **Attachment A-Citations**.

As described above, 8 of 10 samples had total dioxin TEQ results that exceeded the RSL and 8 of 10 had detections of the 2,3,7,8-TCDD congener. All samples, including the two samples with the total dioxin TEQ below the EPA RSL value, had high levels of octachlorodibenzodioxin (OCDD) and 1,2,3,4,6,7,8-HpCDD. Without a sample of the alleged herbicides used during the reported spraying event at the Site, a site-specific dioxin congener fingerprint comparison cannot be completed. For this discussion, data collected at this Site were compared with documented dioxin congener fingerprints from peer-reviewed publications with similar contaminants of concern. Ubiquitous combustion process sources such as wood fires and vehicle exhaust are common sources of 1,2,3,4,6,7,8-HpCDD and OCDD in the environment (Quadrini and others, 2015). Also, OCDD may originate from weathering of pentachlorophenol (EPA, 2006; Quadrini and others, 2015; Towey and others, 2010). These congeners may consequently dominate regional PCDD and polychlorinated dibenzofurans (PCDF) fingerprints (Quadrini and others, 2015).

Tiyan Junction was the location where trace concentrations of 2,4,5-T and 2,4,5-TP were detected during the 2018 sampling event by EPA and START (Weston, 2019). The highest total dioxin TEQ concentration (13 pg/g in sample G-04-02) was measured at this location during this sampling event (Figure 6). Total dioxin TEQ concentrations ranged from 6.3 pg/g (sample G-04-02) to 13 pg/g (sample G-04-01), which was 1.4 times higher than any other TEQ result recorded during this sampling event and 2.7 times higher than the EPA RSL of 4.8 pg/g for 2,3,7,8-TCDD. At the Tiyan Junction location (samples G-04-01, G-04-02 and G-04-02-D [duplicate sample]), all samples contained elevated levels of 1,2,3,4,6,7,8-HpCDD, OCDD, 1,2,3,4,7,8,9-heptachlorodibenzofuran (1,2,3,4,7,8,9-HpCDF) and octachlorodibenzofuran (OCDF) in relation to other congeners. Samples that contained elevated levels of 1,2,3,4,7,8,9-HpCDF and OCDF tended to have higher TEQ concentrations.

Following a similar methodology to that presented in Quadrini and others (2015) and Cleverly and others (1997), the individual congener data were plotted by sample (**Figure 7**) and the total dioxin/total furan data for each sample were plotted using mean and standard deviation to measure central tendency (**Figure 8**). Quadrini and others (2015) showed that OCDD and 1,2,3,4,6,7,8-HpCDD likely originated from non-herbicide sources (e.g., fuel combustion) and so were excluded from the data presented in **Figure 7**. Additionally, the exclusion of data for OCDD and 1,2,3,4,6,7,8-HpCDD allowed for better resolution of the congener distribution in **Figure 7**. The individual congener distribution for samples (**Figure 7**) and the central tendency for total dioxins/total furans (**Figure 8**) collected during the 2019 sampling event show high OCDF and 1,2,3,4,7,8,9-HpCDF levels, similar to herbicide fingerprints presented in literature by Cleverly (Cleverly and others, 1997). Although there is no conclusive samples from the spraying event and a complete dioxin congener fingerprint comparison cannot be completed, the congener patterns in some soil samples are consistent with residual chlorinated herbicides. **Figure 7** in **Appendix D presents** the congener distribution, excluding OCDD and 1,2,3,4,6,7,8-HpCDD as previously discussed, for all sample locations during the 2019 sampling event. **Figure 8** in **Appendix D** presents the data for total dioxins/total furans with the central tendency of sample data presented for each congener.

Summary

In the October 2019 sampling investigation, samples collected at the Tiyan Junction location contained total TEQ concentrations ranging from 6.3 to 13 pg/g (G-04-01), which was 1.4 times higher than any other TEQ result recorded during this sampling event. Total TCDD in this location ranged from 1.1 to 1.4 pg/g. In addition, the Andersen fence line location (GS-3) contained Total TCDD at concentrations ranging from 2 to 2.1 pg/g with TEQs of 5.1 and 6.0 pg/g. Although no detections of trace chlorinated herbicides were observed during the 2019 sampling event, trace concentrations of 2,4,5-T and 2,4,5-TP were detected at the Tiyan Junction location sampling site during the 2018 sampling event and have been detected on Andersen at other locations (Weston, 2019).

As previously discussed, OCDD and 1,2,3,4,6,7,8-HpCDD concentrations may be attributed to other sources. Whereas the congener 1,2,3,4,6,7,8-HpCDD is not associated with chlorinated herbicides, higher OCDD concentrations could be a marker indicating that TCDD was initially higher but has degraded. 2,3,7,8-TCDD concentrations are anticipated in soils where residual 2,4,5-T is detected.

Taking into consideration the length of time since the reported use of chlorinated herbicides on Guam and their subsequent weathering, TCDD and/or other congeners have undergone environmental degradation. Concentrations may have originally been higher because the relative degradation rates vary depending on the congener and environmental conditions (EPA, 1989). Migration of dioxin congeners within the soil profile is possible over time (Fan and others, 2006; Banout and others, 2014).

It is probable that TCDD dioxin congener concentrations detected in soils are associated with chlorinated herbicides. Records of chlorinated herbicide use by the military on Guam (Navy, 1958) and veteran affidavits documenting the use of 2,4,5-T and 2,4,5-TP along with data collected from previous soil sampling events suggest the presence and use of chlorinated herbicides was likely. Finally, the herbicides in question were known to contain TCDD.

To clarify any remaining uncertainty about herbicide types, amounts and locations sprayed, continued investigation of suspect areas is recommended. Additional sampling at depths up to 12 inches is suggested to account for possible degradation and migration of residual herbicides and dioxin congeners. Similarities and differences between sample location characteristics (environmental conditions, vegetation cover, historical land use, previous excavations, use of imported fill, etc.) and the congener profiles should be further investigated as possible markers to aid in identifying historical herbicide use.

Respectfully,

WESTON SOLUTIONS, Inc.

Amanda Wagner
START Project Scientist

0 Miles 4

PREPARED BY:
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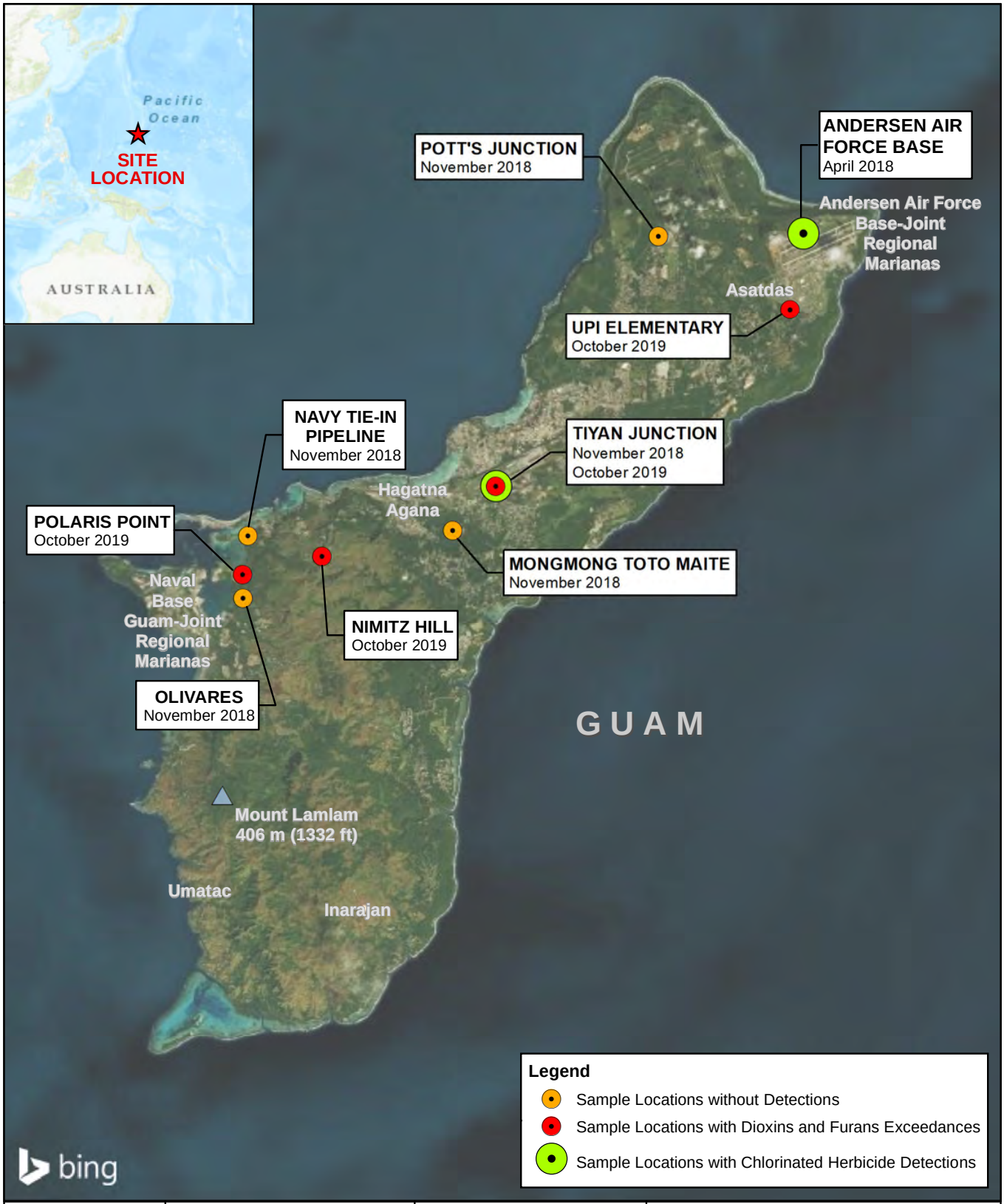
PREPARED FOR:
EPA Region 9
Pacific
Southwest

FIGURE 1
SITE LOCATION
Guam Chlorinated Herbicides
Site Investigation
Guam

Contract: 68HE0919D0002; **TO:** 68HE0919F0113

Document Control Number: 0035-08-AAJD



0 Miles 4

PREPARED BY:
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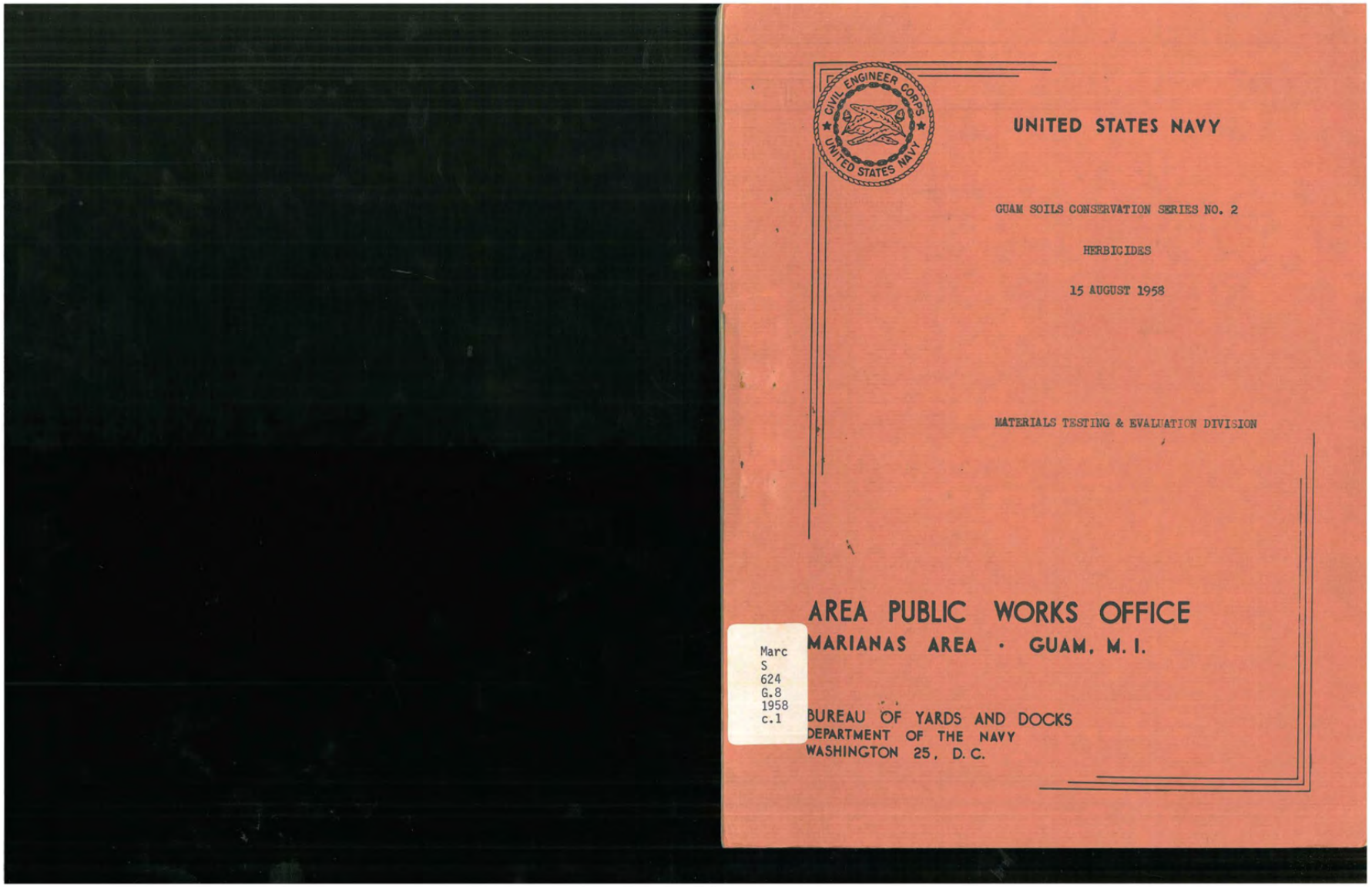
PREPARED FOR:
EPA Region 9
Pacific
Southwest

FIGURE 2
HISTORIAL SAMPLE RESULTS
Guam Chlorinated Herbicides
Site Investigation
Guam

Contract: 68HE0919D0002; **TO:** 68HE0919F0113 **Document Control Number:** 0035-08-AAJD



HERBICIDES --- CHEMICALS FOR CONTROL OF VEGETATION ON GUAM

by Paul B. Souder

A plant species which is desirable under one set of circumstances may become highly undesirable under slightly different conditions. In the wrong area all types of vegetation from trees to microscopic plants may be weeds, vegetation that needs control.

A survey of installations on Guam indicates that the types of areas involved in the undesirable vegetation problem fall into three fundamental categories:

(1) Control of weeds and brush on unimproved grounds - elimination of tangantangan and brush along road and utility line right of ways;

(2) Control of weeds in turf grasses - burr grass, sensitive plant and wild daisy removal in lawn areas; and

(3) Control of weeds and brush on semi-improved grounds - antenae fields, airfields, igloos, storage areas, etc.

The control of weeds and brush on unimproved grounds is limited to work necessary to prevent a return of undesirable trees and brush to open areas. This control can be accomplished by mowing or spraying once or twice a year.

Highway weed control emphasizes the diversity of this problem. Weeds along road shoulders threaten to break up the pavement surface and interfere with drainage. They may make the surface slippery. It takes a good deal of manpower to trim weeds and grass around guardrails, culverts, signs and signals, bridge approaches, and traffic islands. In such locations, vegetation may be a safety hazard and an eyesore and may shorten the life of pavement, curbing and wood or metal fixtures. In dry months, vegetation along the road may be the tinder that spreads fire from a carelessly discarded cigarette or match. Furthermore, weeds and grass may catch windblown rubbish, keeping the roadside cluttered.

Another weed problem is frequently found along drainage ditches, where vegetation clogs the ditch, interfering with

the flow of water. Since the ditch bottom cannot usually be mowed, digging and scraping is the only alternative. But this also is a costly hand operation. Worse than that, shoveling and scraping soon cuts away enough elevation to change the flow of water. Here, of course, we are making a distinction between rank weed growth, which is an obstruction in the ditch, and a good sod bottom where each blade of grass acts as a little check dam to prevent erosion and silt deposits.

In the control of weeds in turf grasses (on lawns, parks and other improved areas) much of the necessary weed control can be achieved by well regulated programs for fertilizing, mowing, watering, and control of insects and diseases. Inadequacies in any of these may cause a weakening of the turf grasses, with subsequent weed invasion.

The control of weeds on semi-improved grounds, can usually be accomplished by mechanical mowing, which should prevent invasion of an area by trees and brush, and which should protect grass from excessive shading, which may kill it. Turf here is used for soil stabilization where a trim appearance is not so essential.

Economically the problem of weed and brush control along right of ways (highway, powerlines, and drainage ditches) in open storage and fuel storage areas and weed control in ornamental turf (home lawns, golf courses, institutional grounds, communication areas and airfields) throughout military reservations, has consumed enormous amounts of time, labor, and public funds.

The control of weeds is therefore a serious matter to nearly everyone, since their effects are felt directly or indirectly. There are several methods of weed control which parallel the general methods of insect and disease control. Mechanical methods, such as cultivation, mowing, hand pulling, flooding, smothering by nonliving materials, pasturing, and turning have all been used in the past. Biological methods are frequently used, especially employment of competitive and smother crops to suppress weed species. Insects have been highly useful in the control of cacti.

Chemical methods of weed control have been used for many years. Alone or in combination with other methods, they are extremely efficient. Chemicals used to destroy plant life are called herbicides, and they are usually classified into two broad groups. Nonselective herbicides are chemicals which destroy plant life in general without regard to species.

Selective herbicides are selective in their action, as the name implies, and may be used to control specific undesirable plants without serious damage to desirable species growing in the same area.

The problem of destroying all plant growth on a given area is relatively simple. There are a number of efficient non-selective herbicides from which to choose. On the other hand, the selective destruction of one plant species without harming other species growing contiguously is considerably more difficult. The killing of burr grass in a lawn without damage to the remainder of the grass is an example of this type of problem. Both the burr grass and desirable grass plants have many characteristics in common. It is only by utilizing some characteristic which they do not share that it is possible to effect selective killing. Such characteristics may involve the size of leaf, type of leaf surface, susceptibility to specific chemicals, or other physical or physiological property. By the careful regulation of the concentration of chemicals, it is often possible to turn a non-selective herbicide into one which is selective, since the lethal doses for different plants vary considerably. The choice of the proper chemical for a particular weed-killing problem may thus be simple or complex, depending upon guides one may have to follow, few of which exist on Guam.

Whether it is desired to eradicate scrub growth along roadways, remove brush from utility and pipeline right of ways, and remove woody growth from cleared land, many factors must be considered.

Some methods use chemicals more effectively than others, requiring a minimum of application. Some methods are easier and cheaper to perform from the standpoint of labor needed. Different species show variations in ability to withstand treatment by different methods. The choice of application method may depend upon the size of the weed trees, number of stems or amount of brush, quantity and size of desirable trees, availability of suitable labor and equipment, and finally - the end result desired.

Economics in a direct fashion holds the key to rapidly expanding interest in herbicides. As "hoe labor" becomes less available and more expensive, selective herbicides acceptance and demand mount among users throughout the world.

The selectivity in selective herbicides may mean many levels of weed killing activity. In some cases overuse of

a selective herbicide will kill all vegetation, while in others general contact killers carefully used will have a selective action. Selectivity of application will often substitute for or supplement chemical activity of herbicides. For example, oil directed at the base of ornamental shrubs will control small weeds, but if oil hits the leaf of the shrub, then it too is killed.

Preemergence herbicides sprayed after planting will stop weed seeds, normally lodged close to the soil surface, from germinating and will do so without harming crop seeds planted 1½ to 2 inches deep. Solubility of the herbicide will influence activity, also; the less soluble chemicals remain near the soil surface and control shallow germinating weed seeds but do not reach deep plant seeds or root crops.

If a plant crop possesses a very different structure and growth habit from those of weed plants present, control of the weeds in the crop's presence may take advantage of some or all of these differences. Some herbicidal formulations that will wet or stick only to weeds and not to crops have been used extensively. Cereals have corrugated waxy leaf surfaces which are narrow and generally almost vertical, making retention of a herbicide difficult. The smooth, broad, nearly horizontal leaves of many weeds, on the other hand, permit easier coverage by and retention of herbicides and eventual killing of the weed plant.

The exposed growing points of broad-leafed plants allow easy contact by herbicides during any stage of life, as contrasted with the protected growing points of narrow-leafed plants. Cereals, for example, have their growing points located in the plant crown which remains in a protected position below the soil surface. Other plants have a dormant period during which herbicides have little effect. During this dormancy, applications of herbicides to control annual week plants may be made without crop damage.

The selective herbicides used in largest quantity take advantage of differences in plants tolerance to toxic chemicals. Those chemicals which can produce many physiological responses in plants - hence their general name of "growth regulators" - are receiving most research now. These plant harmone chemicals have definite limitations and will cause serious damage to desirable plants if improperly used. Environmental conditions often cause selective herbicides to perform inconsistently, giving rise to charges that they are unreliable. Some (2,4-D for example) have highly volatile forms which may drift to fields

adjacent to sprayed fields and cause crop damage.

Another method for obtaining selectivity of herbicides has been recognized. It utilizes the ability of certain plant enzymes to control chemical reactions which convert inactive compounds to ones that will produce growth responses in plants. The process, beta-oxidation, can be shown to break down certain compounds within the tissues of one plant species and not in another. 4-chloro, 2,4-dichloro-, 2 methyl-4-chloro-, 3,4-dichloro-, and 2,4-5 trichloro- derivatives of gamma-phenoxy-butyric acid have been tested. These compounds are related to the derivatives of gamma-phenoxyacetic acid - MCPA and 2,4-D. Susceptible plants possess enzymes which convert butyrics to acetics, killing the host plant. Certain of these butyrics are acceptable weed killers for weed control with such crops as clover. If MCPA or 2,4-D is used for weed control here, serious damage results.

Evidence indicates that soil microorganisms degrade the butyric acid derivatives to acetic acid derivatives, if washed off plants by rain or if applied to soil. Damage to crop plants may then result through absorption through the roots.

Butyric derivatives should be more effective because they will translocate more readily (being non-toxic at first) and accumulate in greater amounts in plant tissues before conversion to acetics. Some plant pathologists point out that 2,4-D kills too quickly in perennials, interfering with translocations, and permitting regrowth.

The use of proper chemicals by qualified personnel has resulted in a substantial improvement in weed control, especially where all vegetation is considered undesirable for fire hazard reduction purposes. Where mechanical (or hand) weeding and chemical methods have been compared, chemical control usually has given better results with much less average cost per unit of area treated. Although it may seem expensive to go over the ground once with the proper chemicals, the long-term cost, as reported, has been much less than that of mechanical or manual clearance because the chemicals used killed not only top growth but also most roots. When roots were killed the time between treatments was greatly extended and follow-up retreatments with selected soil-sterilant chemicals usually cost much less than the original application.

In using herbicides certain rules are in order:

(1) Read the directions: Each manufacturer sells a different mixture, so naturally the correct way to apply the product varies. Most weed killers for lawns contain 2,4-D, mercury, or potassium cyanate. Each must be used in a specific way. For tangantangan there are AMS, Brush Killers, and certain oils. Each requires different procedures.

(2) Use the right amount: The chemicals are so potent that a very small amount is enough. Apply enough to kill the weeds, but not enough to injure the lawn grass. So measure accurately! Too little of the chemical--weeds stay healthy; too much poison--grass also killed. Follow the directions and you will get perfect control. The old adage, "If a little is good, more is better", definitely does not apply when using weed killers.

(3) Wait until weeds are growing actively: 2,4-D must be absorbed by the leaves and this happens readily only when the weed is growing. Wait for warm, sunny weather, but do not apply when drought has checked plant growth. If your lawn is starved, the weeds will be growing so slowly they won't absorb much poison.

(4) Choose a calm day: Wind is dangerous because the drift of fine dust or spray can travel to nearby flowers (even for a mile or more sometimes) and kill or injure every plant it touches. Most brands are perfectly safe to use except on breezy days. A few brands of 2,4-D are especially volatile, so are never safe immediately next to flower beds. (Read the directions.)

(5) Clean the sprayer: Any overlooked residue of 2,4-D will make any later use of the sprayer lethal to your garden flowers and vegetables. Either scrub the sprayer thoroughly after each use for weed killers, or better still, reserve a special sprayer just for weed killers. A kerosene rinse, followed by three changes of water, is the minimum to do a safe cleaning job. Don't forget to run these through the hose and nozzle, too. Also avoid contaminating garden supplies, such as plant food and insect killers.

(6) Be patient: Most of the chemical weed killers don't have a single lethal punch that brings sudden death. Rather, the weeds decline slowly. Except for a progressive curling of the leaves, you can't see that anything is happening until one day, several weeks later, you realize the weeds have vanished!

(7) Don't mow for five days: You want the roots killed, too, not just the leaves - so allow time for the chemicals to move down the leaves. Mowing after dry powders are applied is especially bad because the fanning of the blades blows the chemical off the weeds.

(8) Follow approved schedule of treatments: These chemicals are not one-shot treatments. Timing of follow-up is important - too close may kill lawn grass, too far apart lets weeds flourish. Usually three treatments are needed (see the brand directions).

Chemical herbicides have been applied to weeds, trees, or brush in just about every imaginable way - to the foliage, to the bark, on wounds, on stumps, in notches, in frills, in slits, or on soil. Any method will work as long as it introduces enough toxic material into conducting tissues of the plant.

For application on foliage, the proper season or stage of growth for spraying woody plants is very important. Soil moisture must be adequate for appreciable shoot or root growth if good kills are to be obtained. Since soil moisture conditions are not entirely predictable, a considerable amount of personal judgment must be involved. Such factors as rainfall, slope, soil depth, abundance of vegetation on the site, root-shoot ratio (old plants versus sprouts following cutting), root distribution, and soil fertility all influence the availability of water within a plant. With ground equipment spray applications may be (1) made broadcast, by employing a boom for completely spraying the entire area uniformly, or (2) made to individual plants or areas, making sure complete coverage is accomplished.

Dormant sprays are usually used only on deciduous woody plants, completely covering stems by a power sprayer and a mixture of oil as the diluent. This method can be used in dense brush where other sensitive plants exist.

With basal sprays, chemicals are used in concentrated form on the lower parts of the stems of woody plants. Best results are obtained on soils that are neither excessively wet or dry. Cover all sides of the stems near the ground line, using a solid-cone spray, and apply enough to have runoff at the base into the soil. Apply 2 to 3 fluid ounces of spray mixture for each inch of stem diameter. Stems larger than two inches in diameter should be frilled or cut into near the base and the spray mixture applied liberally to the cuts.

Cut surface treatment is used for elimination of trees.

Stump treatment utilizes the same basal spray solution, applying it to the top of stumps as well as to all sides to the ground line, with runoff into the soil. The cut surface or painting and daubing method may be also used for stump treatment.

Soil applications may be applied by sprayer or in dry form. Chemical herbicides may be extended with water, oils, wetting agents, and emulsifiers. Water is generally the primary diluent for foliage sprays. Oils may be used alone or in emulsion in the spray mixture. Diesel oil and kerosene are most common. For basal sprays oil is used alone as carrier of 2,4-D and 2,4,5-T esters. For foliage sprays it is commonly added in small amounts to increase penetration of leaves, bud scales, and bark.

Too much oil on leaves (more than 1 percent or more than 1 gallon per acre) appears to increase the amount of burn and to hinder the movement of the chemical. Where very few photosynthetically active leaves are present, the use of straight oil is good practice. Results are inferior, however, to those obtained with proper application of foliage sprays when the plants are quite active photosynthetically. Where oils are added to ester formulations, it is important to mix the oil with the ester before adding water.

Wetting agents and emulsifiers may be added to increase the effectiveness of the sprays. In general ester formulations have adequate emulsifier in them. However, if a poor emulsion is obtained, add 4 ounces of emulsifier or household detergent per gallon of commercial ester formulation. Aqueous solutions of AMS require these additives for best results. The best type of emulsifier to be added can not be clearly defined (non-ionic type is suggested) except that it should result in proper emulsification of the materials and that it should be relatively non-toxic to leaves at the concentrations used.

Herbicides may be classified according to the method of application as follows:

Soil Application

Non-selective--kills all types of plant growth.
Temporary effect.
Extended effect--few weeks to several years.

Selective--injurious to some plants or types of plants and non-injurious or slightly injurious to others. Is a matter of relative degree of injury. Value lies in being injurious to undesirable plants (weeds) and non-injurious to crop plants. Selective action may be due to tolerance on the part of the crop plant, to placement of herbicide in soil, or combination of both. Soil treatments of the selective type are usually in the nature of pre-emergence application, that is, applied after the crop is planted but before it emerges. However, the application may be made before planting (pre-planting) or after emergence (post-emergence), frequently by directed spray.

Foliage Application

Non-Selective
Contact--kills tissue actually contacted.
Translocated--applied to foliage is translocated to other portions of the plant where tissue is injured or killed. Action is usually slower than direct contact, desirable to permit absorption and translocation by the leaves and stems down into the roots.

Selective
Contact
Translocated

The action of herbicides on Guam vegetation will be reviewed, proceeding from simple inorganic compounds through complex organics.

1. Halides, Inorganic

a. Sodium chloride, NaCl, non-selective. Oldest of soil sterilants. Frequently used on paths, driveways, and on areas where it is desired to eliminate all types of vegetation. Salt kills plant tissue by plasmolysis, so fairly large quantities required to produce desired effect. Is freely soluble in water and readily leached from soil, with resultant transient herbicidal effect. 0.5% solution plus 0.25% wetting agent (Tide) showed no herbicidal effect on Guam lawns except to cause red coloration of plants treated. Potassium chloride showed no herbicidal effect in a 0.5% solution with 0.25% wetting agent.

b. Sodium fluoride, NaF, killed 95% of grass population in 1% solution with .5% wetting agent (Tide) when applied to Guam turf. Killed 60% of grass population in .5% solution with 0.25% wetting agent. No selectivity exhibited.

c. Sodium bromide, NaBr, had no herbicidal effect on grass population in 0.5% solution with 0.25% wetting agent (Tide) when applied to Guam turf. Potassium showed no herbicidal effect at the same concentration with wetting agent.

d. Sodium iodide, NaI, killed 50% of grass population after 30 days in 0.5% solution with 0.25% wetting agent (Tide) when applied to Guam turf, as did Potassium Iodide at the same concentration. No selectivity exhibited.

2. Sulfates, Inorganic

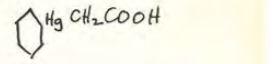
a. Ferrous sulfate (iron sulfate, iron vitriol, copperas), $FeSO_4.7H_2O$, selective herbicide against broad leaf weeds, less toxic to grasses and cereals. Apply five pounds per 1000 square feet, dissolved in water. Against lawn weeds apply dry with ammonium sulfate. Action slow, concentrations required high, more expensive and less effective than 2,4-D and arsenicals. It leaves a rusty residue on foliage and other objects, staining clothing, shoes, walks, ornamental monuments, etc.

3. Heavy metal compounds

a. Cupric nitrate, $Cu(NO_3)_2.3H_2O$, selective herbicide against weeds in lawns in 2% solution. May be applied dry. Kills by direct protoplasmic action like salts or other heavy metals.

b. Cupric sulfate, $CuSO_4$; Cupric chloride, $CuCl_2$; and Cupric acetate, $Cu(C_2H_3O_2)_2.H_2O$, resemble cupric nitrate in action, but have been used less frequently as herbicides. A 2% solution of $CuSO_4$ killed 60% of turf vegetation after 30 days, on Guam. No selectivity exhibited.

c. PMA. PMAC, PMAS, Phenyl mercuric acetate, $C_6H_5HgOCOCH_3$, selective herbicide against broad leaf grasses. To control seedling plants and dormant seed, apply 1 lb/300 sq. ft., at one week intervals, making three applications. Do not water or mow lawn for two days after treatment. Soil should be moist, grass dry, and not less than two inches tall at time of treatment.



To control mature plants, apply at rate of 2 lb/300 sq. ft. On Guam when applied once only at rate of 1 lb/300 sq. ft. (100 gms per 25 sq. ft.) very little herbicidal activity shows on vegetation and no selectivity. Is more expensive than Potassium cyanate, which gives quick control of average infestation. PMA is less likely to cause tip burning of desirable turf material, but does poison animals. "TAT-C-LECT", "SELTOX", "PARATURF" are proprietary forms in liquid form, "SCUTL" is dry form. "Ortho Crab Grass Killer", of California Spray Chemical Corp., is $.37 per pound (dry form); "Ortho Liquid Crab Grass Killer & Turf Fungicide" is $1.95 per pint (liquid). Tag Fungicide. Phix is 22% soluble PMA manufactured by Chemley Products Co., at cost of $4.40 per pound, used as a fungicide for apple scab control.

d. Mercuric acetate, $Hg(C_2H_3O_2)_2$, on Guam when applied dry (500 gms per 25 sq. ft.) ha. little herbicidal effect, though swollen finger grass was killed after 30 days.

4. Chlorates

a. Sodium chlorate, $NaClO_3$, 115% water soluble, is a white crystalline salt which, applied dry, sterilizes the soil and, in water solution, can be used either as a general or selective contact herbicide, according to strength, which can vary from one to ten percent. It is normally used non-selectively, either as a general weed-killer or, on agricultural land, a few weeks before planting. Apply 15 lbs/1000 sq. ft., in dry form. In solution, is effective as a contact spray with same translocation. It is not as effective as sodium arsenate for land clearance. It is corrosive to metals. Chlorates are powerful oxidizing agents, and when mixed with organic matter, the combination becomes spontaneously combustible. Wooden structures, weedy

(d) Polybor chlorate, 73% disodium octaborate ($Na_2B_8O_{13}.4H_2O$), 25% sodium chlorate. Spray at rate of 10 lbs per 1000 sq. ft. against annual weeds, 20 lbs per 1000 sq. ft. agains perrenial weeds, or 30 lbs dry per 1000 sq. f for soil sterilization. No fire hazard. Mfd PacBorax. Cost $0.09 per pound.

(e) Polybor-chlorate 88. Similar to polybor chlorate, somewhat less potent with 36% equivalent and 22% sodium chlorate. Little justification for manufacture in view of similarity to polybor chlorate.

(f) Chlorax, 52% sodium pentaborate tetrahydrate and 42% sodium chlorate. The 36% B_2O_3 equiv alent and 42% sodium chlorate should provide a somewhat more toxic soil sterilent than polyborchlorate and somewhat less should be required to produce similar results because of higher chlorate content. The comparative value from an economic standpoint will depen upon the cost per pound of each. Less sol- uble than polyborchlorate.

(g) Chlorax "40", 58% sodium metaborate ($Na_2B_2O_4$ and 40% sodium chlorate.

(3) CBMM, chlorate - borate - monuron mixtures.

(4) CBFM, chlorate - borate - fenuron mixtures.

(5) CBDM, chlorate - borate - diuron mixtures.

b. Magnesium chlorate, $Mg(ClO_3)_2.6H_2O$. Presents less fire hazard than sodium chlorate, and hygroscopicity keeps it in effective state. Defoliant. Corrosive to metals. 50% water soluble.

(1) E-Z-Off, 18.15% Magnesium chlorate. Mfd Gen Ch
(2) Magron, 40% Magnesium chlorate. Mfd Dow Chem
(3) M C Defoliant, 58% magnesium chlorate. Mgd Niag
(4) Ortho M C, 58% magnesium chlorate. Mfd Calspray
(5) De-Fol-Ate, 58% magnesium chlorate. Mfd Pennsal

c. Ammonium chlorate, NH_4ClO_3; Barium chlorate $Ba(ClO_3)_2$; Calcium chlorate $Ca(ClO_3)_2$; and Potassium chlorate $KClO_3$; and Zinc chlorate $Zn(ClO_3)_2$, are not as satisfac- tory as the sodium chlorate as herbicides.

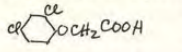
Boron compounds, non-selective soil sterilants, non poisonous.

a. Borascu, regular (Borax), (sodium tetraborate deca- hydrate), $Na_2B_4O_7.10H_2O$. An impure form of borax containing the equivalent of 34% B_2O_3 (boron oxide). Low solubility (about 0.1 pound per gallon water). It is applied dry at about five times the rate of sodium chlorate or 120 lbs per 1000 sq. ft. Rate will vary with the purpose and type of soil. No fire hazard, and because of insolubility remains in soil for a long time. Not too effective on most deep-rooted perennials be- cause it tends to stay in upper layer of soil. Desira- ble for control of weeds around inflammable structures such as wooden buildings, lumber yards, stockyards, oil tank farms, munition dumps, etc., where surface sterilization against shallow rooted weeds and grasses is desired. Cheap per pound but, at present prices, cost per acre is higher than sodium chlorate because of quantity required.

b. Borascu, concentrated, (sodium tetraborate). Similar to regular borascu but, with water removed, containing 61.5% B_2O_3 equivalent. Otherwise acts the same. Costs somewhat more per pound but may be cheaper to use be- cause only about half as much required. Saves material- ly on freight and labor involved in application.

c. BDM, Borate, 2,4-D mixtures.

(1) Borax DB spray powder, complex of sodium borate ($NaBO_2$) containing 59.5% boron trioxide and 7% 2,4-D acid equivalents (dichlorophenoxyacetic) acid,



Nonselective soil sterilent, solu- ble in water up to 2 pounds per gallon. Apply 6 pounds per square rod for deep-rooted perennials. The presence of the borate retards the breaking down of the 2,4-D, increasing its effectiveness.

(2) Borax DB granular, $Na_2B_4O_7.10H_2O$ (40.9% boron tri- oxide and 7% 2,4-D acid equivalents). Recommend the same as for the spray powder, except apply in dry form.

c. Ethylene dibromide, $C_2H_4Br_2$, 1, 2-dibromonethane, EDB, a temporary non-selective herbicide and soil sterilent. Controls nematodes and other soil organisms. Use 9 gallons per acre. Costly. Mfd. Dow (Dowfune W-85, 83% by weight).

d. Tetrachloroethane, $C_2H_4Cl_4$, 1, 1, 2, 2-tetrachloroethane, a temporary non-selective herbicide and soil sterilent. Controls nematodes and other soil organisms. Costly.

e. "D-D" mixture, a combination of Dichloropropane, $ClCH_2$-CH_2CH_2Cl, and Dichloropropene, $ClCH{=}CHCH_2Cl$, a temporary soil sterilent and herbicide, non-selective. Controls nematodes and other soil organisms. Costly.

f. Chlorobromopropene, CBP, $CH_2{=}CHCHClBr$, water emulsions at high rates produce almost weed-seed-free seed beds. Residual effects very short.

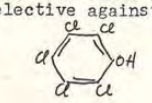
g. Monochloracetic acid, $ClCH_2COOH$, a selective herbicide and defolient. On Guam, 60% turf vegetation killed by 0.4% solution after 30 days. Non-selective, Nut grass unaffected.

h. TCA, trichloroacetic acid, CCl_3COOH, 90% sodium ammonium calcium salts used which are water soluble and soluble in most organic solvents. Corrosive on metals. Most effective on grasses and is selective as a pre-emergence treatment for annual grasses, though not so effective as DCU. In the two to three leaf stage, grasses can be controlled with 10 to 20 lbs per acre, and even lower rates may be effective for pre-emergence application. For post-emergence application, grasses and perennials require 80 to 150 lbs per acre, and a second application for complete destruction. Is most effective when applied to light, moist soil. Light rains following application are beneficial, whereas heavy rains are likely to cause dilution and leaching, reducing killing action. 30 to 100 lbs per acre is insufficient to kill nut grass. 5 to 7 lbs per acre will control weeds in legumes (7 lbs per acre is injurious to legumes). Better effects can be produced by using smaller quantities of TCA, if it is mixed with 2,4-D, CADE, MCPA, or sodium chlorate. TCA is superior herbicide compared to salts. Mfd Dow, Hooker, Monsanto, Standard Agricultural Chemicals (Santox Sodium TCA), American Chemical Paint Co (ACP Grass Killer). Cost $.37 per pound.

i. DCB, Ortho dichlorobenzene.

j. TCB, Trichlorobenzene. 2, 3, 6-trichloro benzoic acid is effective against bindweed and deep-rooted perennial weeds. Mfd Heyden Newport

k. PCP, Pentachlorophenol, Penta, is a non-selective, non-translocated, contact herbicide. The water soluble sodium salt, 85% NaPCP, is selective against broad leaf weeds and grasses. Selective action is function of ability to wet and penetrate leaf surfaces. On Guam dry pentachlorophenol has little herbicidal value at 2% concentration. As a residual herbicide, persistence in the soil enables it to destroy germinating seeds in upper layers, depending upon amount of dosage and environmental conditions. PCP would appear to decompose more rapidly in soils with a high humus content than in soils poor in organic matter. The microbiological optimum of soil conditions would seem to correspond to the lowest point of the herbicide's effectiveness.

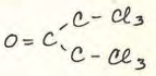


The Sodium Salt (Santobrite), however, is an excellent sterilent, applied dry, in 1% concentration, after 30 days. CADE is a chemically activated Diesel emulsion, incorporating Diesel oil and sodium pentachlorophenate, used as a contact herbicide. ARCADE has an aromatic oil substituted for the Diesel oil. A herbicide mixture containing 8 lbs NaPCP, 2 lbs acid equivalent butyl ester of 2,4-D, 2 pints Diesel oil, in 140 gallons water, applied 30 gallons per acre, gives good brush control. A pre-emergence spray of 25 lbs per acre NaPCP is required for elimination of weeds in legumes. Such a concentration is lethal to Cyperaceae, Amaranthus, Crolataria, Inomea, Euphorbia hirta, Desmodium triflorum, Euphorbia prostata, and Lantana camara.

6 CA-4 is a contact herbicide containing PCP and an aromatic distillate. CADE when mixed with TCA is more effective than either alone. Mfd Dow (Dowicide G, 85% NaPCP); Monsanto (Santophen 20 and Santobrite, NaPCP). Cost 40% $.29 per pound.

octachloradicyclopentadienedihydride or octachloro-4, 7-methanotetrahydroindane. Selectively controls crab grass in lawns. Acts on germinating seeds. 1.4 pints of 8 lbs per gallon chlordane plus 1.4 pints light petroleum in 5 gallons of water with emulsifier applied to 1000 sq. ft. as pre-emergence treatment in spring, kills seedlings if not over 1 inch high. Mfd Velsicol Corp. Cost $.73 per pound.

w. HCA, Hexachloracetane. Eradicates Johnson, Bermuda, and other weed grasses in a single application. Available as HCA concentrate, for dilution with oil; and a finished spray containing 20% HCA in an aromatic weed oil. Mfd Allied Chem & Dye, New York.

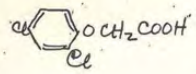


x. Dichlone, 2, 3-dichloro-4-naphthoquinone Algaecide. Use 1 oz. per 13 gallons water. Mfd Naugatuck Chem (Phygon XL). Cost $1.85 per pound.

y. 1,1' ethylene-2, 2'-dipyridylium dibromide. Non-selective herbicide, selective in cereals. Entry and translocation occur through leaves within 5 minutes of application. Root uptake takes place only with plants grown in culture solutions, because compound is strongly absorbed by soil. Mfd Imp. Chem. Ind. (G. Brit.)

10. Aryloxy compounds.

a. 2,4-D, 2,4-dichlorophenoxyacetic acid. A selective, translocated herbicide for weed control in turf. Bermuda grass, centipede grass, zoysia grass, and St. Augustine grass are very tolerant to 2,4-D. Has high toxicity against most broad leaf plants. Is non-toxic to monocotyledenous plants (grasses and cereals).



In selective spraying, susceptible perennials require a higher dosage of 2,4-D than susceptible broad leaf annuals. Apply spray when weeds are in a young, succulent, rapidly growing condition.

(1) Ester formulations are most efficient phytotoxically, most effective for translocation and assimilation in plant. Insoluble in water but used as emulsion. Low volatile ether esters (esters of butoxy ethanol, propylene glycol butyl ether and other long chain substituted alcohols, i.e., butoxyethoxy propyl ester and isooctyl ester) are more effective than lower molecular weight, methyl, ethyl, isopropyl, butyl esters. The tetrahydrofurfuryl ester as a selective weed killer in turf on Guam shows herbicidal promise at a concentration of 30 ml. per 1000 sq. ft. Morning glory vines, sensitive plant, some broad leaf grasses killed, bermuda grass and desmodium not affected at that concentration. 100 ml. per 1000 sq. ft. kills bermuda grass and desmodium. Mfd by Dow (Esteron Ten-Ten, Propylene glycol butyl ester, acid equiv 4 lbs per gal), at $4.70 per gallon. California Spray Chemical (Esteri-cide D-4, Low Volatile Weed Killer, Tetrahydrofurfuryl ester, acid equiv 4 lbs per gal), Improved Weed-B-Gon, at $1.98 per quart. American Chemical Paint Co. (Weedone LV4, Butoxyethanol ester, acid equiv 4 lbs per gal), Swift (Gold Bear Brand 44, isopropyl ester, acid equiv 3.34 lb per gal), American Chemical Paint Co. (Weedone Concentrate 48, ethyl ester, acid equiv 3 lbs per gal), (Weedone Aero-Concentrate 96, ethyl ester, acid equiv 6 lbs per gal), and (Weedone, 5%, 10%, 15%, ethyl esters).

(2) Amine formulations are used for control of weeds in turf. In mixed legume-grass lawns or pastures use 1 pint in sufficient water to give good coverage. In all grass pastures or lawns use 2 to 3 pints per acre. Do not apply to newly seeded areas until a good stand has been obtained and has reached the 3 to 4 leaf stage. Over 1 pint per acre on legume turf is fatal. For general weed control, use 2 to 4 quarts in 100 gallons water. Spray all foliage thoroughly. Repeat application as new growth appears. Use when weeds are actively growing. Their most effective use on woody plants is with addition of 0.5 to 1.0% non-toxic, light, emulsifiable spray oil in the 2,4-D water mixture. Amine formulations are generally most

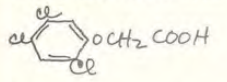
satisfactory when plants are growing rapidly and soil moisture is high. Under these conditions give superior results. Are water soluble and have low volatility. Salts ionize readily in aqueous solution and when sprayed on plant surface, stay there. Are most effective of 2, 4-D formulations for killing trees by cut-surface method. On Guam, the dimethylamine salt as a killer of tangantangan is effective at a concentration of 200 ml. per 1000 sq. ft. Mfd by Diamond Blackleaf Co. (2,4-D amine weed killer, dimethylamine salt, acid equiv 4 lbs per gal), Dow (2-4 Dow Weed Killer, Formula 40, alkanolamine salt, acid equiv 4 lbs per gal) at $3.24 per gallon. American Chemical Paint Co. (Weedar 64, alkanolamine salt, acid equiv 4 lbs per gal), and Swift (Gold Bear Brand 40 Amine Weed Control, isopropyl and diisopropanol amine salt, acid equiv 4 lbs per gal).

(3) Acid formulations emulsifiable in water are available. Where drift and volatility are hazards they may be best choice. Metalic or inorganic salts ionize readily in aqueous solutions, are less volatile and less phy totoxic.

(4) Formulations of 2,4-D and 2,4,5-T mixed are called "Brush Killers". 2,4-D is much cheaper than 2,4,5-T. The later is particularly useful for increased penetration when oil is used in the spray mixture. The mixture generally consists of 3/4 lb of the chemical plus 1/3 teaspoonful of emulsifier per gallon water. Thorough coverage is essential. Retreatment is usually necessary. A mixture containing 100 ml. each of the tetrahydrofurfuryl esters of 2,4-D and 2,4, 5-T was an effective tangantangan killer on Guam, per 1000 sq. ft., although coconut palms and lemonchina were unaffected. The addition of TCA is said to increase herbicide effectiveness. Mfd Swift (Gold Bear Brand Woody Plant Control, butoxyethoxy propanol ester of 2,4-D and 2,4,5-T, acid equiv 1-1/3 lb per gal 2,4-D and 2/3 lb per gal 2,4,5-T); Swift (Gold Bear Brand 2-2 Brush Kill, butoxyethoxy propanol ester of 2,4-D and 2,4,5-T); American Chemical Paint Co. (Weedone

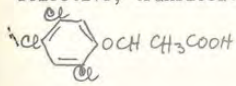
Brush Killer 32); American Chemical Paint Co. (Weedone Improved, butoxyethanol ester of 2,4-D and 2,4,5-T); and Dow (Esteron Brush Killer) at $6.81 per gallon; also Ortho Brush Killer at $2.20 per quart.

b. 2,4,5-T, 2,4,5-trichlorophenoxy acetic acid. A selective brush killer. Ester formulations are most effective for translocation and assimilation. Insoluble in water, soluble in oil, used as an emulsion. Low volatile, high molecular weight esters most toxic.



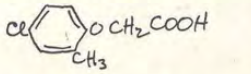
Amine salts are less herbicidal, are soluble in water, and are more difficult to manufacture. Sodium salts are least effective herbicidally, and are water soluble. The tetrafurfuryl ester is an effective tangantangan killer at 150 ml per 1000 sq. ft. Mfd. California Spray Chemical (estericide T 5, Low Volatile Brush Killer, tetrafurfuryl ester of 2,4, 5-T, acid equiv 4 lbs per gal); Swift (Gold Bear Brand 55 Brush Kill, butoxyethoxy propanol ester of 2, 4, 5-T, acid equiv 4 bls per gal); American Chemical Paint Co. (Weedone 2,4,5-T, butoxyethanol ester of 2,4,5-T); and Dow (Esteron 245) at $9.18 per gallon.

c. Silvex, 2-(2,4,5-trichlorophenoxy) propionic acid. A selective, translocated herbicide for brush control. Low volatile ether esters, then amines, as with 2,4-D, are most effective herbicides. Several formulations such as amine salt, butyl ester, propylene glycol butyl ether ester, isooctyl ester (Propon 4). Primarily for brush control, may be effective against herbaceous weeds. Has longer residual effect in soil than 2,4-D. Is more effective against clovers, other legumes and chickweed than 2,4-D. Spray woody growth up to 6 to 8 feet tall after foliage is fully developed, using a spray containing 3 to 4 quarts of Silvex per 100 gals of water. Spray should drench all plant parts including leaves and stems. Avoid drift because of danger to other plants. For knapsack application of Silvex mix 1/2 cup full in 3 gallons water. Wet all foliage thoroughly. Do not apply to stoloniferous grasses in

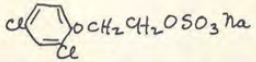


established turf such as Bermuda, Zoysia and St. Augustine. Because of greater residual effect of this compound in the soil, it may inhibit root formation from the stolons of the creeping types of grasses over a longer period than 2,4-D. For broad leaf grasses and legumes use at rate of 1½ quarts in 25 to 40 gallons of water per acre. Mfd Dow (Kuron, 2-(2,4,5-trichlorophenoxy) propionic acid, Propylene glycol (C_3H_6O to $C_9H_{18}O_3$) Butyl Ether esters, 64.5%).

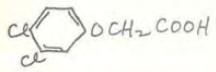
d. MCPA, MCP, 2 methyl-4 chlorophenoxyacetic acid. A selective, translocated herbicide for weed control. Herbicidal properties resemble 2,4-D although there are some specific varietal susceptibilities. Derivatives resemble corresponding compounds 2,4-D herbicidally, etc. Free acid insoluble in water, sodium and amine salts are soluble in water. Esters are oil soluble. MCP controls weeds in cereal crops such as oats, underseeded with legumes. Less injurious to clover and alfalfa in these underseedings than 2,4-D. Hurts ornamental bulbs in pre-emergence application as amine salt. Mfg Monsanto, American Chemical Paint Co. (Weedar MCP).



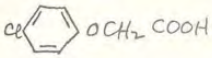
e. Sesone, SES, Sodium 2-(2,4-dichlorophenoxy) ethyl sulfate. Pre-emergence treatment for small seeded weeds, both broad-leaved and grasses. Injurious to many crops. Apply every 3 to 4 weeks for crabgrass control in turf. It can be used without danger for cultivated plants known to be extremely susceptible to 2,4-D. Non-phytotoxic to plants, but toxic to germinating seedlings. Not active when sprayed, but converted to weed killer by soil microorganisms. Thus is effective only at subsurface levels in cultivated soils. Controls approximately 50% of grasses, 10% of weeds as a pre-emergence spray. As post-emergence spray on bulbs, 4 lbs per acre results in no damage. Water soluble. Apply 2 to 4 lbs per 40 gal water per acre. Mfd Carbide and Carbon Chemicals (Sesone, Crag #1), cost $4.50 per pound.



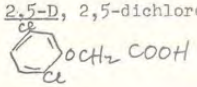
f. 3,4-DA, 3,4-dichlorophenoxyacetic acid. Selective, translocated herbicide, selectively effective against various weeds.



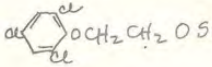
g. 4-CPA, 4-chlorophenoxyacetic acid. Selective translocated herbicide. Growth regulator.



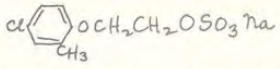
h. 2,5-D, 2,5-dichlorophenoxyacetic acid.



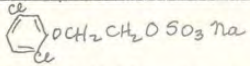
i. 2,4,5-TES, 2,4,5-trichlorophenoxyethyl sulfate. Pre-emergence herbicide. Will control most annual broadleaf and grass weeds by killing seeds as they sprout. It will not control perennial weeds or established annual weeds. Apply 2 to 4 lbs per acre, using water as solvent. Mfd by Carbide and Carbon Chemicals (Natrin).



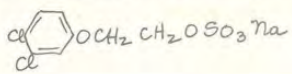
j. MCPES, 2 methyl 4 chlorophenoxy ethyl sulfate.



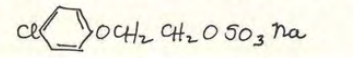
k. Sodium 2,5-dichlorophenoxy ethyl sulfate.



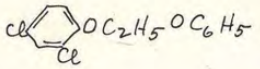
l. Sodium 3,4-dichlorophenoxy ethyl sulfate.



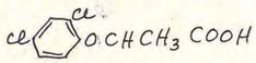
m. Parasin, sodium chlorophenoxy ethyl sulfate.



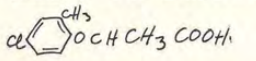
n. 2,4-DEB. Sesin, 2,4-dichlorophenoxy ethyl benzoate. Microfine wettable powder, for control of germinating seedlings of small seeded grass and broad-leafed weeds, shows promise in controlling crabgrass in turf.



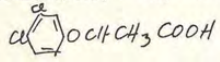
o. 2-(2,4-DP), 2-(2,4-dichlorophenoxy) propionic acid. For brush control. Mfd Carbide and Carbon Chemicals (2-(2,4-DP), butoxyethanol ester of)



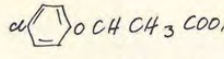
p. 2-MCPP, 2-(2-methyl-4-chlorophenoxy) propionic acid.



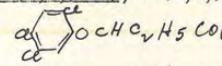
q. 2-(3,4-DP), 2-(3,4-dichlorophenoxy) proprionic acid.



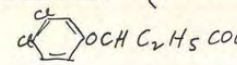
r. 2-(4-CPP), 2-(4-cholophenoxy) proprionic acid.



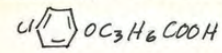
s. 4-(2,4,5-TB), 4-(2,4,5-trichlorophenoxy) butyric acid.



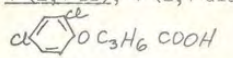
t. 4-(3,4-DB), 4-(3,4-dichlorophenoxy) butyric acid.



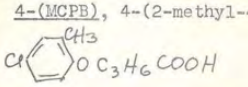
u. 4-(4-CPB), 4-(4-chlorophenoxy) butyric acid.



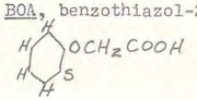
v. 4-(2,4-DB), 4-(2,4-dichlorophenoxy) butyric acid. For selective control of broad-leaf weeds. Mfd American Chemical Paint Co., Carbide and Carbon Chemicals.



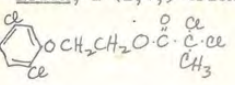
w. 4-(MCPB), 4-(2-methyl-4-chlorophenoxy) butyric acid. For selective control of weeds in legumes. Mfd. American Chemical Paint Company.



x. BOA, benzothiazol-2-oxyacetic acid.

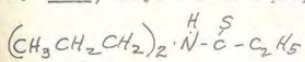


y. Erbon, 2-(2,4,5-trichlorophenoxy) ethyl-2, 2-dichloro-propionate. Erbon is a non-selective herbicide for controlling both grasses and broadleaf weeds. It acts by both root and leaf absorption, and has a high degree of persistence in the soil. Effective in controlling Bermuda grass and pig weed. Nut grass and milkweed are not affected. Erbon forms an emulsion with water, and can be applied with fuel oil or diesel oil rather than water. Use 3 to 4 quarts of Erbon per thousand square feet, or 30 to 40 gallons per acre. Thoroughly cover all vegetation and exposed soil. Avoid drift into adjacent vegetation. Mfd by Dow (Baron).



11. Carbamates

a. EPTC, Ethyl-N-N-di-n-propyl thiocarbamate. Pre-emergence herbicide for grass and broadleaf weeds. Weed control due to downward movement in soil, effective any



pineapple, sugar cane, or established perennial weeds.

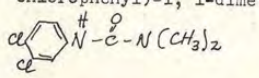
Where plants are resistant, spot treat with one pound monuron per five gallons of water, soaking the ground thoroughly. For suppression use foliar sprayings of weed oil. Resistant plants are tangan-tangan, nut grass (Cyperus rotundus), morning glory (Ipomoea congesta), bermuda grass (Cynodon dactylon), and coconut palm.

Monuron provides better immediate results after application under low rainfall conditions, costs less, is more toxic to trees, and is less resistant to leaching than diuron.

Mfd Dupont (Karmex W, Telvar W) and Pechiney - Progil (C.80). Cost Telvar W (200-950 lbs) $3.00 per lb (Tropical Garden Farms, Guam).

Used successfully on Naval Air Station, Agana, perimeter fence (20 lbs per acre in 400 gallon sprayer) internal security fence Andersen Air Force Base, and perimeter fence Naval Hospital, Guam. Is excellent grass killer, poor brush and tangan-tangan killer.

b. Diuron, DMU, DCMU, Karmex DW, Telvar DW, 3-(3,4-dichlorophenyl)-1, 1-dimethyl urea. Non-selective weed and brush killer, for most annual and perennial weeds on non-crop land such as utility, highway, pipeline rights of way, petroleum tank farms, lumber yards, storage areas, drainage ditches, etc. Use diuron in situations where more than ten inches of rain has followed treatment before the dry season, rather than monuron. Diuron is unsatisfactory under low rainfall conditions, is less toxic to trees, and is more resistant to leaching than monuron. Bermuda grass is quite resistant to diuron. Apply 30 to 40 lbs per acre for initial spray, 10 to 15 lbs per acre for follow-up. Diuron reacts very much like monuron only where more moist conditions pervail. Diuron is approximately 1/6 as soluble in water as monuron, (40 ppm). The addition of additives can improve both control and cost. For control of broad leaf weeds,



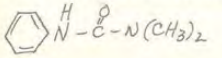
add 4 quarts of either 2,4-D amine or a mixture of 2,4-D and 2,4,5-T amine to the diuron spray, using lesser rates of the diuron. Follow up spot spraying of broad leaved weeds with hormone weed killers alone is usually advisable. Where 2,4-D ester or other oil formulation are used diuron, add 1/2 lb of calcium caseinate conditioner to each 100 gallons of spray.

Use of diuron plus aromatic weed oil (100 to 150 gal per acre without water dilution) is indicated where spraying must continue through rain and wherever quick top kill is important. In this combination spray add 1/2 lb of calcium caseinate conditioner to each 100 gallons of spray.

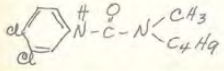
Where addition of 2,4-D or 2,4,5-T to diuron creates a spray drift hazard, add 200 lbs sodium chlorate-sodium bonate to 300 lbs diuron in lieu of 2,4-D or 2,4,5-T, or Ammate X at 3/4 lb per gallon of water or weed oil.

Mfd Dupont (Telvar DW Karmex DW 80% wettable powder), (Telvar DL Karmex DL 28% liquid suspension), cost Telvar DW (200-950 lbs) $3.70 per lb(Tropical Gardens Farm, Guam).

c. Fenuron, PDU, PMU, Karmex FW, 3-(phenyl)-1, 1-dimethyl urea. Soil sterilant and herbicide for brush control, deep rooted perennials in crop land. Application of 60 lbs per acre kills bermuda grass. Is more soluble in water (2900 ppm) than monuron, quicker acting and less permanent. Mfd Dupont (Kermex FW 80% wettable powder).

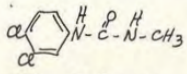


d. Neburon, 1-n-Butyl-3-(3,4-Dichlorophenyl)-1 methyl urea. Pre or post-emergence herbicide effective against crabgrass in turf. Useful where monuron or diuron can not be applied, because of a reduced tendency to leach downward in soil and a more limited foliage effect. Apply four pounds active ingredient per acre for control. Practically insoluble in water (4.8 ppm), sparingly soluble in

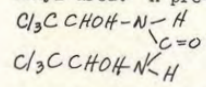


common hydrocarbon solvents. Water should be applied to soil after application of neburon. Mfd Dupont (Crabgrass and Chickweed preventer 18.5% wettable powder).

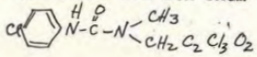
e. DPMU, Karmex M-1-W, 1-(3,4-dichlorophenyl)-3-methyl urea. Herbicide not as effective as monuron, diuron, or fenuron. Mfd Dupont (Karmex M-1-W).



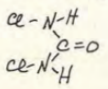
f. DCU, dichloral urea, 1,3-bis(2,2,2-trichloro-1-hydroxy ethyl urea. A pre-emergence herbicide, toxic to germinating grass seed. Has longer residual effect than IPC or TCA, effecting control as long as three months. May be applied as pre-emergence spray or disked into soil at rate of 14.6 lbs of active ingredient per acre. Mfd Carbide and Carbon Chemicals (Crag DCU 73 W is 73% wettable powder. Cost $0.90 lb.



g. UROX, 3(p-chlorophenyl)-1, 1-dimethyl urea trichloroacetate. Mfd Gen Chem (22% wettable powder) Urox weed killer. For control annuel and perennial grasses and broad leaf weeds in non-crop areas.



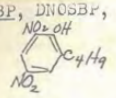
h. EH2, pre-emergence treatment for small seeded grasses in crops. Disked into soil shows promise of preplant grass weed control. Mfd Carbide and Carbon Chemicals (Crag herbicide no. 2)



13. Dinitros

Used for contact application. Action rapid and results evident after only a very short time. When applied in economical doses, they are only effective on weeds at the three- or four-leaf stage. If treated later, plant development is temporarily arrested, but is later resumed. Have a fairly high toxicity which increases with temperature, requiring care when handling such products.

a. DNBP, DNOSBP, 4,6-dinitro-O-Sec-butyl phenol. Should not be used at temperatures above 85°F or during periods of high humidity or when plant growth is wet. Limited value for weed control in turf. Less selective than arsenicals and 2,4-D, and does not control as many kinds of turf weeds.



(1) Ammonium salt. Contains 1 lb DNBP per gallon. Water soluble, selective post-emergence herbicide for broad leaf weeds and grasses in legume crops. Apply 1 gal Am DNBP per 100 gal water per acre. "Sinox W" of Standard Agricultural Chemicals is 13% Am DNBP. Cost $2.72 per gallon. "Dow Selective" is 13% Am DNBP at $2.72 per gallon.

(2) Amine salt. Contains 3 lbs DNBP per gallon. Water soluble, pre-emergence herbicide with legumes, bulb and tuber crops. In post-emergence treatment acts like Am DNBP, but cheaper. Apply 1 gal DNBP per 80 gal water per acre. "Dow Pre-merge" is 53% alkanolamine salt of ethanol and isopropyl DNBP at $4.72 per gallon. "Sinox PE" of Standard Agricultural Chemicals is 57% triethanolamine and isopropanolamine salt of DNBP. Cost $5.10 per gallon. "Elgetol-318" of Standard Agricultural Chemicals is the 36% Triethanolamine Salt of DNBP, used as a dormant insecticide and fungicide.

(3) The parent phenol, DNOSBP is dissolved in an aromatic hydrocarbon solvent with an emulsifier, so that Commercial formulation can be extended with oil, water, or an oil-water combination. Formulations contain 5 to 5.87 pounds of DNBP per gallon, and are used as general contact weed killers along ditch banks, as pre-harvest drying agents for legumes and grasses. Apply 1 quart per 6 gal kerosene and water to make 50 gal spray per acre. "Sinox General" of Standard Agricultural Chemicals is a 50% butylphenol, 10% amyl phenol mixture. "Dow General" is a 55% DNBP at $9.18 per gallon. "United General Weed Killer" of United-Heckathorn is a 55% DNBP.

b. DNC, DNOC, 4,6-dinitro-O-cresol. Acts against broad

Apply at rate of 4 lbs per acre. Mfd Naugatuck, costs $3.25 per lb.

(4) Alanap-3, a water soluble liquid containing 22% by weight N-1 naphthyl phthalamic acid as sodium salt. New 9.1 lbs per gallon; each gallon containing 2 lbs active alanap. Is selective herbicide for pre-emergence and post emergence weed control. Costs $4.75 per gallon. Mfd Naugatuck.

r. Hydrin, mixture of aromatic hydrocarbons with boiling range of 260° to 340°C, specific gravity of 1.006 to 24°C. Contact spray of 5 to 7 gal in 75 gal water per acre for smaller weeds, 15 to 20 gal in 100 gal for larger weeds. Directed contact spray in certain crops, 5 to 15 gal in 75 gallons water. Pre-emergence applications in certain large seeded crops at 15 to 20 gallons per acre without water.

s. Petroleum oils, the toxicity of oils appears to depend upon the presence of unsaturated hydrocarbons, the heavy aromatics being most effective as general weed killers. They are characteristically slow in their action and, therefore, termed "chronic" weed killers. In the case of oils of low toxicity, the toxicity may be increased by "fortifying" with phenolic compounds such as the dinitros or pentachlorophenol. Agronyl R, containing 40-50% aromatics (boiling range 450°-700°F) is a non-selective contact herbicide. Annual weeds and grasses killed, perennials retarded. Several applications necessary to kill the latter. Apply by spray at rate of 60 to 80 gal per acre at delivery rate 1.5 gal per minute at 50 lbs per square inch pressure. Agronyl A, lower in aromatics, is less effective than Agronyl R. Agronyl A can be fortified with 30 pounds of pentachlorophenol per 75 gallons of Agronyl A per acre for more effective use. Mobilsols 544B and 544C are effective herbicides but much more expensive than Agronyl R. The lighter oil fractions in boiling range of 150°C to 275°C are used to control broad-leaved weeds. Stove oil and trade-name napthas, ordinarily used as paint thinners and for dry cleaning, Kerosene and light fuel oils are not effective herbicides.

The warm and humid conditions which prevail in tropical

Guam encourage luxuriant growth of weeds and brush. Many herbicides at concentrations used in the temperate zone with good results are not applicable in the tropics because of continuous rapid growth, leaching of herbicides from soil, more rapid breakdown of herbicides as result of higher temperatures and greater microbiological action. Factors which determine choice of herbicide include cost, effectiveness, selectivity, and ease of mixing and spraying. Data on herbicide activity on Guam is limited to the summary herein. It would appear that Chloro IPC, Monuron, and Na PCP have potential as turf killers, mixtures of 2,4-D, 2,4,5-T, TCA, NaPCP and diesel oil, ammonium sulfamate and amino triozole as brush killers; and MCP Amine, Sodium Arsenite, and 2,4-D as selective weed killers in turf.