FOR DISCUSSION PURPOSES ONLY

SURVEY OF MANAGEMENT

OF

HERBICIDE ORANGE INVENTORY

SUMMARY

CODE 943029

WASHINGTON REGIONAL OFFICE

UNITED STATES GENERAL ACCOUNTING OFFICE

803 West Broad Street, Fifth Floor

Falls Church, Virginia 22046

March 1977

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Is DLA reviewing/commenting? - separately

Is EPA reviewing?

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KEY TERMS, ABBREVIATIONS, ACRONYMS, ETC.

ACI Agent Chemical, Inc.

Adsorption - The adhesion in an extremely thin layer of molecules to the surfaces of solid bodies or liquids with which they come in contact

Agent Orange - A term used to refer to herbicide orange while used as a defoliant in Vietnam

DoD Department of Defense.

Defoliant A substance, or mixture of substances, causing the leaves or foliage to drop from a plant

Dioxin (TCDD) - 2,3,7,8-tetrachlorodibenzo-p-dioxin. A toxic impurity which is formed in the manufacture of 2,4,5-T, due to improper temperature control during manufacturing process. Dioxin in its purest form, is considered one of the most toxic substances known to man.

DLA Defense Logistics Agency (formerly Defense Supply Agency)

DPDS Defense Property Disposal Service (an organization within DLA)

EPA Environmental Protection Agency

FIFRA Federal Insecticide, Fungicide, and Rodenticide Act

GSA General Services Administration

Herbicide An agent used to destroy a plant or inhibit its growth

HO Herbicide Orange: A chemical compound procured by the Air Force for defoliation operations in Vietnam. The compound consists of approximately 50% 2,4-D and 50% 2,4,5-T.

Johnston ~~Island~~ ? Atoll - A remote ~~island~~ atoll in the Pacific Ocean, located 717 nautical miles southwest of Honolulu, Hawaii. Used by the DoD to store 1.4 million gallons of HO and other potentially dangerous materials. } ck with DNA also has other missions !!

NIOSH National Institute of Occupational Safety and Health

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Key-terms, abbreviations, acronyms, etc. (continued)

OSHA — Occupational Safety and Health Administration

Phenoxy herbicide - a group of herbicides manufactured from the same starting material, 2,4,5-T. The same starting material is used to make hexachlorophene and silvex.

ppm — parts per million (weight-to-weight) - units of measurement for traces of impurities in chemical compounds

ppt — parts per trillion (weight-to-weight)

RFQ — Request for Quotations

SCO — Sales Contracting Officer

TCDD — See Dioxin

2,4,D — 2,4,dichlorophenoxyacetic acid - a phenoxy herbicide used primarily for broadleaf weed control in corn and other grains

2,4,5-T — 2,4,5,trichlorophenoxyacetic acid - a phenoxy herbicide used primarily for brush control and more woody types of plants than 2,4-D

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SURVEY OF MANAGEMENT OF HERBICIDE ORANGE INVENTORY

SUMMARY

CHAPTER 1

INTRODUCTION

Herbicides, defined as chemical substances used to destroy or check the growth of plants, especially weeds, have been used for many years, mainly by farmers, ranchers, and others to control or inhibit the growth of weeds, woody vines, trees, and other plants on cropland, rangeland, and communication and highway rights-of-way. They were also used by the military in Vietnam to defoliate forests and jungles, thereby removing, or reducing, the natural cover used by opposing military forces to conceal their operations.

Commercial herbicides produced in the United States are marketed both domestically and overseas. In recent years, there has been increasing controversy over the use of some herbicides because it is believed their use constitutes a hazard to the environment, and more importantly, to the health of humans. The latter is the case with Herbicide Orange, which was used as a defoliant by United States military forces in the jungles of Vietnam.

In April 1970 the Department of Defense (DoD) suspended its use of Herbicide Orange leaving it with an inventory of 2.3 million gallons. Since that time, DoD has been attempting to dispose of this surplus, in compliance with Federal, state, and local laws and regulations governing the sale, transportation, storage, and disposal of hazardous materials.

OBJECTIVES OF SURVEY

Because of the long period of time which has passed since the Department of Defense suspended its use of Herbicide Orange, and because of the potential hazard it poses in its present state, we undertook this survey to assess the problems and progress in disposing of a harmful product. We wanted to

--ascertain whether the Air Force has efficiently pursued the most effective and economical means of disposal, and

--determine the costs to the Air Force and others to comply with the environmental aspects of the disposal.

SCOPE OF SURVEY

Our survey included the following steps:

--Examination of laws, regulations, and other directives relating to the disposal of hazardous materials and to environmental matters.

--Discussion with officials of the Air Force, the Defense Logistics Agency (DLA)[1/] and the Environmental Protection Agency (EPA) on the management of the Herbicide Orange Inventory and problems and progress in disposing of it.

--Examination of reports, correspondence, environmental impact statements, and other documents and records.

--Discussion with representatives of selected other Federal agencies, state government agencies, and private chemical

1/ In October 1976 the Defense Supply Agency officially became the Defense Logistics Agency (DLA).

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manufacturers concerning possible interest in acquiring the surplus herbicide. (See Appendix I for list of contacts)

--Determination of selected cost date on the management and disposition of the surplus herbicide.

The results of our survey are discussed in the chapters that follow.

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CHAPTER 2

POTENTIAL HAZARDS OF HERBICIDE ORANGE, AND INITIAL DEPARTMENT OF DEFENSE ACTIONS

In 1962, the herbicide formulation, ORANGE, was developed for military use as a defoliant in South Vietnam. This herbicide formulation consists of about 50 percent by volume of the normal butyl ester of 2,4-dichlorophenoxyacetic (2,4-D) acid, and 50 percent by volume of the normal butyl ester 2,4,5-trichlorophenoxyacetic (2,4,5-T) acid. Unfortunately, as a result of a malfunction in the production process, certain lots of the herbicide contain a contaminant 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). In experimental animals, this compound was shown to be teratogenic, that is, it caused the production of malformed fetuses and living offspring.

HERBICIDE ORANGE A POTENTIAL HUMAN HAZARD

Although South Vietnamese newspapers reported an increased occurrence of birth defects during June and July 1969, investigations by various groups did not provide a generally acceptable answer to the central question of whether 2,4,5-T as then currently produced and used constituted a risk to women of child-bearing age.

On April 15, 1970, the Secretaries of Agriculture, Health, Education and Welfare, and the Interior, jointly announced the suspension of certain uses of 2,4,5-T because of its possible effect on humans.[2/] As a result, the Department of Defense, about the same time, suspended all military use of the defoliant Herbicide Orange(HO).

[2/] This suspension action is discussed in detail in Chapter 4.

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INITIAL DEPARTMENT OF DEFENSE ACTIONS

When the stocks of HO reached Vietnam, it became the property of the South Vietnamese Government. The U.S. Department of the Air Force, acting as housekeeper for the South Vietnamese Government, maintained the inventory, issued stock to users, and kept related records. ?

From the time military use of HO was suspended until September 1971, DoD made little effort to dispose of surplus stocks, primarily because of the ongoing war effort in Vietnam. ?

In September 1971 the Secretary of Defense issued a memorandum to the Chairman, Joint Chiefs of Staff, directing him to have all stocks of HO returned to the continental United States and to have incinerated all HO which contained an unacceptable level of TCDD. (Any level of dioxin greater than the EPA established 0.1 parts per million, is considered unacceptable.)[3] awk - ? At ~~this~~ that time, there was about 1.5 million gallons of HO in Vietnam and another 860,000 gallons at the U.S. Navy Construction Battalion Center, Gulfport, Mississippi, awaiting shipment to Vietnam.

From September 1971 to April 1972, the United States negotiated with the South Vietnamese Government to regain control of all HO in Vietnam and moved it to a port area. In April 1972, the 1.5 million gallons in Vietnam was moved to Johnston ~~Island,~~ Atoll, a DoD ~~storage site~~ controlled atoll in the Pacific Ocean.

The HO is stored in 55-gallon steel drums (total drums number over 40,000) and had a September 1971 stated inventory value of $15.9 million.

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[3] See Appendix V for information on establishment of acceptable dioxin level.

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The drums at both Gulfport and Johnston ~~Island~~ Atoll are continuously being checked for leaks. When leaks are discovered, the HO is transferred from the defective drum to a good, non-leaking drum.

In September 1971 the Air Force was made responsible for disposing of the 2.3 million gallons of HO. The following table shows the funds expended by the Air Force from September 1971 through September 30, 1976.

Housekeeping, dedrumming and redrumming, and environmental monitoring:	$2,407,000
Studies (in-house and by contract) of environmental effects of HO, and preparation of environmental impact statements	1,400,000
Amendments to environmental impact statements	176,000
	$3,983,000

In addition to the Air Force, both DLA and EPA have incurred some costs relative to their involvement in the disposal of HO. We do not know the amount of such costs, since neither agency had allotted specific costs to the project.

Significant actions taken by the Air Force in carrying out its responsibilities, including the involvement of DLA and EPA are discussed below.

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ACTIONS TAKEN BY THE
DEPARTMENT OF THE AIR FORCE

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The Special Assistant for Environmental Quality, Office of the Assistant Secretary of the Air Force (Installations and Logistics) has been responsible for coordinating the Air Forces' HO disposal efforts. Other Air Force offices contributing to this effort include the Office of the Deputy Chief of Staff (Systems and Logistics), the Office of the Deputy Chief of Staff (Programs and Resources), the Office of the Deputy Chief of Staff (Plans and Operations), and the Office of the Air Force Surgeon General.

In January 1972, the Air Force filed a draft environmental impact statement with the President's Council on Environmental Quality (CEQ). This statement recommended disposing of the HO by land-based incineration. Also in January 1972 the Air Force undertook a series of studies to determine other possible disposal methods. These studies continued until April 1974 when a revised draft environmental impact statement was published. This statement recommended incineration of HO at sea because it is considered to have the least effect on the environment. Incineration on Johnston ~~Island~~ Atoll was proposed as the first alternative. Some of the other disposal methods studied were:

--Incineration in one of the 50 states

--Deep well disposal

--Burial in underground nuclear test cavities.

} suggest listing all shown in FES! particularly soil biodegradation -

The Air Force ~~issued~~ filed a Final Environmental Impact Statement ~~in~~ with the CEQ on December 6, 1974 ~~November 1974~~ which also recommended incineration of the HO at sea as the best disposal method with incineration on Johnston ~~Island~~ Atoll as

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No not directly - See our letter to EPA, 9 Mar 77.

the first alternative. Concurrently, the Air Force was investigating the possibility of reprocessing the HO and was working with EPA and DLA with a view toward selling the HO to a firm that could reprocess it to acceptable EPA registration criteria and sell it as a registered, labelled EPA product.

Need for Ocean Incineration Permit

In January 1974 EPA had declared that incineration at sea did not come under the purview of the Marine Protection, Research, and Sancturies Act of 1972, and it was therefore not necessary for the Agency to issue an "ocean dumping" permit for this purpose. In response to questions raised by the National Wildlife Federation and the Committee on Merchant Marine and Fisheries of the House of Representatives, in September 1974 EPA reversed its earlier declaration and ruled that ocean incineration did in fact come under the Act and that an ocean dumping permit would be required. Because of this, the Air Force applied to EPA on January 9, 1975 for a permit to incinerate the HO at sea ~~in January 1975~~.

Explain why → Before hearings were held on the application, the Air Force began discussing with EPA the possibility of reprocessing the HO--a concept that involves destruction or removal of TCDD only. This would turn HO into a useful product instead of destroying it. EPA agreed, and in January 1975 provided the Air Force with a list of companies they felt had the capability of removing the TCDD. Solicitation of these companies is discussed in Chapter 3.

EPA held hearings on the application in April 1975, but postponed issuing an ocean burning permit to allow the Air Force additional time to determine if the HO could be reprocessed. ↑ Why?

An EPA official said that if the Air Force is unsuccessful in reprocessing the HO, the permit hearings can be reconvened and a permit issued within three to four weeks. } The record shows this

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In December 1974 the Air Force requested permission from the Assistant Secretary of Defense (Installations and Logistics) to waive the reutilization screening for DoD-wide or inter-Governmental interest in the stocks of HO. The Assistant Secretary denied the request in February 1975, and directed that the HO be screened in an expedited fashion and then referred to the DLA for sale. The Assistant Secretary noted that the General Services Administration (GSA) had advised DoD that there were no Federal or donation requirements for the HO.

GSA had contacted several Federal agencies to find out if they were interested in using HO as early as June 1971. The Departments of Agriculture, the Interior, and Transportation, all expressed no desire to acquire HO. Based on a June 5, 1971, message from the Secretary of Defense to the Commander in Chief, Pacific Command, which stated that herbicides would not be available for redistribution, GSA took no action.

In July 1976, DLA contacted GSA to determine possible Federal agency needs for 530,000 gallons of HO with a dioxin level below the EPA established level of 0.1 parts per million. GSA contacted the Departments of Agriculture, the Interior, and Transportation and the Tennessee Valley Authority. Tennessee Valley Authority did not want the HO but expressed an interest in the 2,4-D component.

GSA has made no further attempts to find users for Herbicide Orange.

As discussed in Chapter 3 the DLA assumed responsibility for finding a source to reprocess the HO and for negotiating the sale of HO. However, the Air Force monitors the situation, and generally makes the major decisions. ?

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CHAPTER 3

DEFENSE LOGISTICS AGENCY INVOLVEMENT IN THE DISPOSAL OF HERBICIDE ORANGE

In November 1974, DLA, as the surplus property disposal agent for DoD, was assigned responsibility for disposal of Herbicide Orange via reprocessing into an EPA registrable product. The Air Force had suggested that DLA send a letter soliciting information from firms as to how they would handle the HO, then submit the responses to EPA for review and acceptance before negotiating a final contract for sale to any firm. DLA, however, preferred to have EPA provide guidelines as to what firms could or could not do with HO and then solicit bids.

DLA ISSUES REQUESTS FOR QUOTATIONS

On February 27, 1975, DLA, after consultation with EPA, mailed a Request for Quotation (RFQ) to 24 firms known to be capable of handling herbicides.[4/] The RFQ stated the herbicide would be sold subject to the following stipulations:

1. The HO must be reprocessed to meet the EPA requirements for registration of pesticides and herbicides.[5/]
2. The firm offering to purchase the herbicide must submit a detailed plan of the method of disposing of the herbicide, and explain the effects on the environment caused by the reprocessing.
3. The offeror must obtain clearance from EPA if the reprocessed product is to be used as a pesticide or herbicide.
4. The offerors must, at their own expense, process at least

4/ See Appendix II for list of 24 firms.

5/ See Appendix III for detailed discussion of requirements for registering pesticides (herbicides).

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Is EPA reviewing?

one test batch of the herbicide to prove that their method of reprocessing will work before a contract will be awarded. Tests would be conducted at a pilot plant constructed by the offeror.

Isn't there more!! Disposal of wastes. more Yes

The RFQ stated that the Government would not award a sales contract solely on the basis of the response to the RFQ, and further, that no payment would be made for any information solicited.

RESPONSES TO RFQ AND SELECTION
OF OFFEROR TO OPERATE PILOT PLANT

Three companies responded to the RFQ and appeared, with their plans for reprocessing, before an evaluation board consisting of technical advisors from EPA, the Air Force, DLA, and the Occupational Safety and Health Administration (OSHA). The three respondents were:

1. Velsicol Chemical Corporation (Chicago, Illinois)
2. Colorado International Corporation (Commerce, Oklahoma)
3. Agent Chemical, Incorporated (Houston, Texas)

The conference on reprocessing alternatives was held June 9, 10, and 11, 1975. Colorado International Corp. (CIC) and Agent Chemical, Inc. (ACI) proposed reprocessing HO through the use of the Stallings filtration process. [Not exactly true] This process was developed by a Dr. Stallings of the Fish Pesticide Research Laboratory, Fish and Wildlife Service, Department of the Interior, Columbia, Missouri. The process involves passing the HO through coconut charcoal. The dioxin in the HO is adsorbed onto the charcoal, a process which ~~is~~ was said to be irreversible in the patent application.

ACI's proposal was considered more favorable since it did suggest ? disposal of the dioxin-contaminated coconut charcoal residues by high-

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temperature incineration. CIC had not included incineration in its pilot plant design.

According to EPA, Velsicol presented the best technical method for handling the herbicide from the reprocessing and monitoring points of view. EPA's staff engineer, who evaluated the three proposals, recommended that: (1) Velsicol be allowed to proceed with a pilot plant demonstration; and (2) ACI and CIC not be allowed to proceed because both had failed to adequately address the serious problem of the ultimate disposition of large quantities of spent carbon containing the adsorbed dioxin.

Velsicol, however, was unwilling to build and operate a pilot plant at its own expense. CIC failed to accomplish certain requirements, such as acquisition of permits, licenses, and pilot plant, and failed to address the problem of destroying the dioxin. Consequently only ACI was directed to proceed with the pilot plant phase on June 19, 1975, by DLA's Sales Contracting Officer. (See Appendix IV for background on ACI's organization.)

On July 1, 1975, ACI submitted a test protocol for its pilot plant operation, and in August began construction of the pilot plant at Houston, Texas. In October, the pilot plant was moved to the Naval Construction Battalion Center, Gulfport, MS. About 2,000 square feet of ground at the Center was furnished to ACI free of charge.

On August 14, 1975, the State of Mississippi Air and Water Pollution Control Commission granted ACI a permit to construct a "Herbicide Reprocessing Pilot Plant, including herbicide handling, adsorption, incineration

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and scrubbing equipment." The permit was issued for a period of one year, subject to certain conditions, which, if violated, could result in suspension of operations.

On August 28, 1975, at the request of DLA, representatives of the Air Force, DLA, EPA, the Army Environmental Health Agency and the National Institute of Occupational Safety and Health (NIOSH) met in Washington, D.C. to review the reprocessing situation, and to determine a specific course of action on the ACI proposal. They decided they needed three documents to evaluate the ACI proposal:

1. An environmental assessment of the pilot plant process;
2. An environmental/personnel surveillance plan to be implemented during plant operation; and
3. A final report on the results of the pilot plant operation upon completion of the study.

The U.S. Air Force Environmental Health Laboratory, located at Kelly Air Force Base, Texas (EHL/K) initiated action on these documents.

On November 7, 1975, EHL/K issued an environmental assessment of DLA's action requiring ACI to demonstrate its process. The DLA Sales Contracting Officer told us this report satisfied the requirements for documents (1) and (2) above. As discussed on page 20 , ACI submitted a final report on its pilot plant operations to DLA on July 8, 1976.

ACI FAILS IN INITIAL ATTEMPTS TO INCINERATE COCONUT CHARCOAL

Because destruction of the dioxin was considered more difficult than its removal from HO, ACI first tried to incinerate non-contaminated coconut

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charcoal. During the first test, which began on November 2, 1975, the incinerator heating wire was damaged and on November 6, ACI requested permission to try a different incinerator configuration. The Air Force project officer granted an extension of six weeks for modification in the incinerator design. who was this!! Merrill.

The second pilot plant test was started on January 14, 1976. For this run, ACI had installed external heating devices in place of the internal device used previously, but retained the same system for handling liquids. This new system, however, was substandard in its construction, and the test was unsuccessful.

ACI ATTEMPTS TO REPROCESS
HERBICIDE ORANGE

After several malfunctions with the second incineration system, the Air Force, in order to expedite operations, proposed to ACI that the first reprocessing test be conducted while further changes were being made on the incinerator. Two reprocessing test runs were conducted, one on January 30, and one on February 4, 1976. In each test, samples of the HO were passed through cartridges containing the coconut charcoal.

In both tests, the dioxin content failed to drop to or below the 0.1 parts per million level ~~recommended~~ required for herbicide registration by EPA. Also, leaks developed in the cartridges during both tests. After completion of test number 2, the pilot plant contained three dioxin contaminated cartridges which, according to the terms of the pilot plant permit, could not be removed to allow for insertion of new cartridges for further tests.

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PILOT PLANT OPERATIONS STOPPED

On February 12, 1976, the pilot plant operation was stopped indefinitely, pending evaluation of the situation. The reasons for stopping operations were as follows:

1. Restrictions placed on the operations by the Mississippi State permit which stated that the "pilot plant shall be operated in a manner such that the adsorption step shall not produce more spent charcoal than may be incinerated." If ACI could not incinerate charcoal, only those cartridges housed in the pilot plant could be used--none could be stored on site.
2. ~~The Air Force believed that~~ ACI ~~did not have~~ had not demonstrated the technical competence needed to successfully incinerate the charcoal; and
3. Prior to January 1976, ACI's efforts were devoted almost exclusively to incineration of charcoal. The Air Force wanted ACI to place more emphasis on the reprocessing of HO through the charcoal.

ACI REQUEST FOR MORE TIME AND DLA'S RESPONSE

On February 13, 1976, ACI wrote the Sales Contracting Officer requesting a 45-day extension to allow for more tests. ACI believed they were near success in reaching the goals of the operation. On February 24, a follow-up report on the operation was sent to DLA which cited ACI's reasons for believing that the pilot plant could succeed if they were given more time. The report charged that many of the shortcomings during earlier tests were due to pressures exerted by the on-site personnel representing the Air Force.

DLA informed ACI by letter dated March 5, 1976, that the primary concern to the Government is the safe destruction of the dioxin after it is removed from the herbicide. DLA also informed ACI that it had not demonstrated the ability to accomplish the removal of dioxin from the herbicide to the extent required. DLA noted that ACI had not indicated what steps would be taken, during the 45-day extension, to overcome the difficulties experienced in previous pilot plant runs.

DLA informed ACI that, in order to evaluate the request for additional time, ACI must submit a detailed plan with special attention to the following points:.

1. A monitoring plan which was adequate to demonstrate both feasibility and safety of the process;
2. A definitive statement of how ACI would establish the success or failure of the pilot plant operation.

On March 16, ACI submitted its operational plan for the 45-day period. After reviewing the plan, the Air Force technical staff issued an overview report of the entire HO reprocessing concept. The staff concluded that ACI's plan as written was unacceptable at that time. The conclusion was based on the fact that the following essential information had been omitted:

--industrial hygiene practices;

--environmental protection;

--analytical capability;

--product registration;

--extrapolation of data obtained to ultimate (full-scale) reprocessing; and

--contingency plans in case of accident.

others?

DOD DECISION TO TERMINATE AGREEMENT WITH ACI

In a letter dated March 24, 1976, transmitting the report of its technical staff to DLA, the Air Force recommended to the Executive Director, Technical and Logistics Services, DLA, that ACI be advised that they had not met the requirements of the February 1975 RFQ, and that reprocessing the dioxin-contaminated HO did not appear to be a reasonable solution to the problem.

The Deputy Assistant Secretary of Defense (Supply, Maintenance, and Services) wrote the Director, DLA, on April 8, 1976, indicating that, based on a review of positions taken by the Air Force and DLA, the relationship with ACI should be terminated. Furthermore, the letter went on, DoD should move toward the option of ocean incineration of HO.

On April 9 the the DLA Sales Contracting Officer notified ACI that the firm had been allowed 10 days to show why the project should not be terminated.

On April 12 a meeting was held between representatives of the Air Force, DLA, DoD, and ACI. The Air Force Special Assistant for Environmental Quality indicated that he did not believe the project could be accomplished since there was no indication of successful incineration of the product, nor any indication that it could be handled in an

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environmentally sound manner. ACI suggested that, since its process had not been tested, there remained unresolved issues concerning recovery which did not yet place the Air Force in a position to pursue the ocean burning option.[6/]

ACI REVISES PLAN FOR
REPROCESSING HO

On April 19, ACI responded to DLA's April 9 letter, and presented a more detailed statement for utilizing the additional 45-day period. An Amended Engineering Proposal for Reprocessing Herbicide Orange was submitted on May 15, 1976. DLA considered this latest proposal an improvement over ACI's original plan because it addressed the following aspects:

--filtration objectives

--method of proof that the process actually works

--sampling techniques

--handling of cartridges ←— and disposal?

--alternative methods of disposal

-scale-up economics (pilot plant to full-scale operation).

Two key points were addressed in the amended proposal. It recommended splitting the filtration portion of the pilot plant project from the portion concerned with ultimate disposition of the spent charcoal. The pilot plant permit would be amended to allow on-site storage of spent charcoal. As alternative methods of ultimate charcoal disposal, ACI recommended (1) incineration at sea aboard the incinerator vessels VULCANUS

[6/] EPA required that all potential methods of recovering a useful product be explored before the HO is incinerated at sea.

and MATTHIAS III (ships of Dutch registry used to incinerate chemical wastes), and (2) encapsulation and permanent entombment. In addressing the second point, the adsorption issue, ACI included a letter from the Adsorption System Specialists, Calgon Corporation, which indicated that the charcoal adsorption process could be designed and operated safely.

ACI GRANTED 45-DAY EXTENSION TO CONTINUE PILOT PLANT OPERATIONS

NO!!

During the period from April 19 to May 19, 1976, the Air Force was deliberating the matter and ultimately allowed ACI a 45-day extension. The decision was based on the general consensus that HO could be reprocessed, that there was a shortage of chlorine-based chemicals and therefore there was a market for reprocessed HO.

Further, the sale of HO was seen as an opportunity to achieve some return on the taxpayers' investment, as well as avoid further maintenance costs or estimated destruction costs of over $4 million.

On May 19, the Special Assistant for Environmental Quality, Office of the Assistant Secretary of the Air Force, wrote to DLA that the Air Force felt that the Calgon test plan would provide adequate information on the ability of coconut charcoal to remove dioxin from the HO. The letter stated further that notification to ACI authorizing the 45-day extension should include the following points:

1. ACI must provide weekly reports plus a final report at the end of the 45-days with all substantiating data to prove that the process works.
2. ACI must provide data in the final report to indicate they have a satisfactory solution to the charcoal disposal problem.

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3. ACI's report must include EPA concurrence regarding the legal marketability of the reprocessed product.

4. ACI's final report must include a plan to reprocess all HO in a period not to exceed one year.

A June 4th letter from the Air Force to the Administrator, EPA, stated that ACI had been granted the 45-day extension and the spent charcoal would be encapsulated and buried in a Class I landfill. (The landfill operation would be handled, under subcontract with ACI, by the BKK Corporation of California.)

ACI'S FINAL REPORT ON RESULTS OF PILOT PLANT TESTS

ACI submitted its final report on pilot plant tests on July 8, 1976. The removal of dioxin was successfully accomplished by passing hot (212° F) HO through a column of activated coconut charcoal maintained at 212° F. ?

The report gave details of ACI's test runs during the period May 24 - July 8. Also included were:

1. Analytical data summarized from Spectronics, Inc., Dayton, Ohio, on samples processed by ACI at Gulfport, MS.

2. A copy of the contract between ACI and the BKK Corp. for entombment of charcoal residues.

3. Correspondence with Calgon Corporation through June 30, 1976.

4. A copy of the EPA (Office of Pesticide Programs) letter transferring herbicide registration labels from Colorado International to Environmental Research, Inc., a corporation set up specifically to

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facilitate the transfer of the labels. (Colorado International had the only EPA registered labels for a compound consisting of a 2,4-D/2,4,5-T mixture.) ?

A meeting was held on August 3, 1976, to review the ACI report. Representatives of the Air Force, DLA, EPA, and an Army environmental group from Aberdeen Proving Grounds, agreed that Agent Chemical had a satisfactory solution to the "wet side" (lowering the dioxin level to less than 0.1 part per million) of the problem. EPA did, however, object to the burial of contaminated coconut charcoal. They wanted ACI to incinerate it.

On September 7 a meeting was held at DLA Headquarters, Cameron Station, Virginia between representatives of DLA, DoD, and the Air Force. A DLA official noted that BKK Corp. had trouble disposing of the contaminated cannisters in California and was seeking another disposal site. It was agreed by those present that negotiations with ACI proceed, with DoD assuming responsibility for disposal of the contaminated cannisters at a later date. ? DoD would be responsible for storage and transportation, in order to obtain a fixed price contract. ?

The Administrator, EPA, wrote to the Assistant Secretary of Defense (Installations and Logistics) on September 10, 1976, with reference to the disposal of Herbicide Orange. Some of the points raised in the letter were:

1. It appeared that a successful reduction of the dioxin content in HO is feasible based on the results of the pilot plant studies.
2. The at-sea incineration of HO is no longer considered as an alternative for ultimate disposal of HO unless unanticipated problems arise.

3. It is EPA's position that the complete destruction of dioxin contaminated carbon should be achieved, if it is feasible, with present technology.

4. On-land incineration of carbon should be considered the most desirable means of disposal.

5. If land-based incineration is not feasible with present technology, a three step approach to carbon destruction would be environmentally acceptable. The three steps:

   --Continue the search for a workable method of incineration of charcoal during the wet-end of the reprocessing.

   --If a workable method is not found, place the cannisters where they may be retrieved at a later date for total destruction of dioxin.

   --Destroy the charcoal when a method is found.

EPA would have great concern as to any location for incineration. The Administrator concluded by stating that "The Air Force is to be commended for the environmentally safe actions taken thus far to remedy this complex issue."

On October 8, 1976 the Air Force ~~released~~ filed an Amendment to the Final Environmental Impact Statement which recommended reprocessing the HO via coconut charcoal adsorption of the dioxin and retrievable storage of the charcoal residues. Both EPA and the Defense Nuclear Agency responded favorably to the Amendment.

As of January 1977, the Air Force had not made a final selection of a storage site for the charcoal residues. However, based on one possible site, the first year storage costs, including site preparation and other costs, were estimated to be $345,800. (See appendix VI.)

STATUS OF CONTRACT
NEGOTIATIONS WITH ACI

Since the general acceptance of the ACI process, most Air Force and DLA efforts have been directed toward establishing a negotiating position for the Government. Several meetings have been held to establish areas of responsibility for the Air Force and DLA in implementing the proposed contractual agreement between the Government and ACI for the sale of the HO.

On October 15, 1976, DLA mailed a draft contract to ACI for comment. ACI's comments were dated October 29, which was followed by additional DLA comments on November 17. This exchange was considered to be a first round exchange of views on how to structure the contract.

The Sales Contracting Officer informed us that all activity at the pilot plant site, Gulfport, MS, will be dormant until a contract has been signed. DLA is working with the Air Force and EPA to achieve a contract acceptable to all parties. In price negotiations, the Government will attempt to get the "best price possible" for the Herbicide Orange inventory.

FOR U.S. [illegible] ONLY

CHAPTER 4

ENVIRONMENTAL ASPECTS OF CERTAIN HERBICIDE ORANGE INGREDIENTS

In April 1970, the Departments of Agriculture, Health, Education, and Welfare, and the Interior suspended the registration of liquid formulations of 2,4,5-T--one of the ingredients in Herbicide Orange--for uses around the home and on lakes, ponds, and ditch banks. In May 1970 the Department of Agriculture also canceled the registration of 2,4,5-T for uses around food crops and non-liquid formulations around the home. These restrictions on 2,4,5-T did not apply to its use on range and pasture lands, nonagriculture lands or in weed and brush control programs in communications and highway rights-of-way. Accordingly, several formulations of 2,4,5-T are still currently registered for domestic use. The suspension of 2,4,5-T was accomplished by modifying product labels to show that certain uses were no longer allowed. The restrictions on uses of 2,4,5-T were brought about primarily for two reasons:

1. A study conducted by the Bionetics Laboratories of Bethesda, Maryland, which produced evidence that 2,4,5-T caused birth deformities in laboratory mice and rats.
2. Reports from Vietnam of unusually high numbers of birth defects in areas where HO was being used.

MANUFACTURERS APPEAL SUSPENSION OF USE OF 2,4,5-T

Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), cancellations become effective 30 days after registrants receive the required notice unless, within such time, a registrant makes necessary corrections in its products, requests that the matter be referred to an advisory committee, or requests a public hearing. Registrants who contest the cancellation can lawfully continue to produce and sell their 2,4,5-T products in interstate commerce pending the outcome of the statutory proceedings. Cancellations, however, remain in effect for those products manufactured by companies that did not contest the action.

Three pesticide manufacturers (Hercules Corp., Wilmington, Delaware; Dow Chemical Company, Midland, Michigan; and Amchem Corporation, Ambler, Pennsylvania) appealed the cancellation of the Federal registration of the herbicide 2,4,5-T for certain uses in food crops, and requested that the matter be referred to an advisory committee.

The advisory committee was chosen by the Secretary of Agriculture from a list of names supplied by the National Academy of Sciences, and began meeting in February 1971. The Committees' final report dated May 1971, concluded that, as then presently produced, and as applied according to regulations in force prior to April 1970, 2,4,5-T represented no hazard to human reproduction.

The Acting Administrator of the Environmental Protection Agency in a statement published in the Federal Register of August 11, 1971, acknowledged that the advisory committee report added significantly to EPA's understanding of 2,4,5-T, but believed a hearing would be necessary to afford all registrants and the public an opportunity to present economic and other data relating to the balance the law (FIFRA) requires to be struck between benefit and risk.

It is generally agreed that the dioxin--TCDD--in 2,4,5-T is responsible for the problems associated with it. No method exists for making 2,4,5-T without also making TCDD as a by-product. The level of TCDD in the 2,4,5-T that has been produced in the last few years is below 0.1 parts per million (PPM), the level currently considered acceptable by EPA.[7/]

EPA HEARINGS ON
REGISTERED USES OF 2,4,5-T

In July 1973, EPA issued a notice of intent to hold hearings on all registered uses of 2,4,5-T. Because the effects of the dioxin residues appearing in 2,4,5-T were not known and because it was necessary to develop a method to detect TCDD in the environment (in order to determine its potential hazard), the hearings were delayed until April 1974.

EPA issued another notice of intent to hold hearings in May 1974 concerning all registered uses of herbicides derived from 2,4,5-T. Because problems arose in the efforts to develop a method to measure TCDD in the environment, the hearings scheduled for April and May were cancelled in June 1974.

At the time the hearings were canceled, EPA committed itself to continue efforts to resolve the dioxin problem. A Dioxin Planning Conference was held by EPA in Washington, D.C., during July 1974, to evaluate the current status of the various ongoing dioxin programs and to plan future objectives. Representatives from Government, industry, and academia participated in this meeting which resulted in the development of a Dioxin

7/ See Appendix V for information on establishment of acceptable dioxin level.

Implementation Plan. Because of limited resources, the initial phase of this plan is placing major emphasis on the highly known toxin TCDD. Later efforts will be directed toward other dioxins.

Recent technological advances have enabled the detection of dioxin residues in parts per trillion. EPA officials, however, still question whether dioxin residues can be accurately and consistently detected in the environment. EPA officials told us that Phase II of the dioxin study will begin soon. It will concentrate on refining the dioxin detection method, determining whether dioxin bio-accumulates in the environment, and on determining the effect level of dioxin.

EPA is concurrently conducting a review of "pure" 2,4,5-T--that is, without dioxin--to determine whether it could be causing adverse side effects. The project mandger of the 2,4,5-T review informed us that it may be impossible to determine the effects of "pure" 2,4,5-T because of the inability of manufacturers to produce 2,4,5-T without some trace of TCDD. The project manager estimates that the results of this study should be available by April 1977.

APPENDIX I

FOR [illegible]

OTHER GOVERNMENT AGENCIES AND PRIVATE FIRMS CONTACTED CONCERNING THEIR INTEREST IN ACQUIRING HERBICIDE ORANGE

Federal Government

Corps of Engineers
Department of the Interior:
  National Park Service
  Fish and Wildlife Service
Department of Agriculture:
  Agricultural Research Service
  Forest Service

State Governments

Maryland State Department of Agriculture
Virginia State Highway Department

Private Firms

Dow Chemical Company (a manufacturer of HO)
DuPont Chemical Company
Hercules, Inc. (a manufacturer of HO)
Monsanto Company (")

APPENDIX II

MAILING LIST

DLA REQUEST FOR QUOTATIONS

27 FEBRUARY 1975

1. Bartels & Shores Chemical Co.
   Kansas City, Missouri

2. Chemicaland Corporation
   80 Lister Avenue
   Newark, New Jersey 07105

3. Colorado International Corp.
   Commerce City, Colorado

4. Diamond Shamrock Chemical Co.
   Cleveland, Ohio 44115

5. Dow Chemical Company
   P.O. Box 1
   Midland, Michigan 48640

6. Gordon Chemical Corp.
   Kansas City, Kansas

7. Hercules, Inc.
   Wilmington, Delaware 19899

8. Hoffman-Taff, Inc.
   P.O. Box 1246
   SS Station
   Springfield, Missouri 65805

9. Monsanto Commercial Products Co.
   800 N. Lindbergh Blvd.
   St. Louis, Missouri 63166

10. Thompson Chemical Co.
    23529 So. Figueroa
    Wilmington, California 90744

11. Thompson-Hayward Chemical Co.
    P.O. Box 2383
    Kansas City, Kansas 66110

12. Transvaal, Inc.
    P.O. Box 69
    Jacksonville, Ark. 72076

13. Uniroyal Chemical
    Division of Uniroyal, Inc.
    Elm Street
    Naugatuck, Conn. 06770

14. Velsicol Chemical Corp.
    341 East Ohio Street
    Chicago, Illinois 60611

15. Woodbury Chemical Co.
    Denver, Colorado

16. W. B. Gary
    2604 Minosa Lane
    Hattiesburg, Miss. 39401

17. James Shiver
    REPRO Chemicals
    Washington, D. C.

18. Kenneth Lippel
    116 Beaumont Road
    Silver Spring, Md. 20904

19. Morgan Chemical, Inc.
    Hertell Military
    Industrial Park
    373 Hertell
    Buffalo, New York

20. Agent Chemical Company
    Houston, Texas

21. DuPont
    Wilmington, Delaware

APPENDIX II

MAILING LIST CONTINUED

22. Chempar Chemical
New York

23. Roussell Corporation
New York

24. TECS
Houston, Texas

APPENDIX III

REQUIREMENTS FOR REGISTRATION OF PESTICIDES

Section 3(A) of the Federal Environmental Pesticide Control Act of 1972, prohibits any person in any state from distributing, selling, offering for sale, holding for sale, shipping, delivering for shipment, or receiving and delivering, or offer to deliver to any person, any pesticide which is not registered with the Administrator of EPA. A pesticide which is not registered with the Administrator may only be transferred if:

1. The transfer is from one registered establishment to another registered establishment operated by the same producer solely for packaging at the second establishment or for use as a constituent part of another pesticide produced at the second establishment; or,
2. The transfer is pursuant to and in accordance with the requirements of an experimental use permit.

The term "pesticide" as used by EPA includes (1) any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, and (2) any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant.

In general, there are two primary requirements for registering a pesticide--safety and efficacy. The product must be proven to be safe if used according to directions and the manufacturers must show that the products can do the job for which they are intended. Specifics on the requirements for registration may be found in Section 162.8 of EPA's Registration, Reregistration, and Classification Procedures.

An EPA official stated that it takes anywhere from 10 months to 10 years to register a pesticide. The length of time involved depends on the tests performed, how well documented the application is, and whether all the necessary items have been addressed. To avoid the time involved in registering and obtaining a label for a product, there is a method available whereby a company can use the label of a similar product which is produced and registered by another company. An EPA official informed us this transfer can be made as long as the new product only has limited deviations from the registered product. The allowable amount of deviation depends on which ingredients differ, by how much, and whether the pesticide will be used on food or feed crops.

CURRENT REVIEW OF ALL PESTICIDES

The Federal Insecticide, Fungicide, and Rodenticide Act of 1972 as amended, gave EPA a period of four years in which to reregister and reclassify all pesticides registered with the Agency. The approximately 32,000 products involved in the review will be placed into one of two categories: (1) general use; (2) restricted use.

Although no decision has been made on the fate of 2,4,5-T as discussed earlier, it is currently considered to be a "suspect material" and is a candidate for adverse action.

APPENDIX IV

BACKGROUND INFORMATION OF AGENT CHEMICAL, INCORPORATED

Mail address: Box 26872, Houston, Texas 77032
Telephone No: 713-645-3322

Agent Chemical Company was formed as a partnership in 1971. Its business was, and is, retail and wholesale sales of acid, chemicals, and swimming pool chemicals. It also repackages bulk chemicals into smaller units. Sales are made to industrial and other commercial accounts.

Agent Chemical, Incorporated, a Texas corporation, was incorporated June 25, 1975, under the Texas Business Corporation Act of 1955. One of its stated purposes is "to engage in and carry on the business of reprocessing chemicals." According to the Articles of Incorporation, the number of authorized shares of stock at date of incorporation was 500,000 common stock with a stated par value of the One Dollar ($1) per share.

We were informed by a representative of the Defense Logistics Agency that Agent Chemical, Incorporated (ACI) was formed specifically to acquire, reprocess, and sell the Herbicide Orange.

The articles of incorporation list Del Hightower and Lida W. Redmond as two of the three incorporators. Mr. Hightower and Ms Redmond are also the listed partners of Agent Chemical Company.

DRAFT

Available documentation lists the officers of the Corporation, as of April 1976, as:

President: Frank H. Trifilio

Vice President: Del Hightower

Secretary-Treasurer: Lida W. Redmond

Assistant Secretary-Treasurer: A. Beryl Gainer, Ph.D.

An October 29, 1976, document shows Del Hightower as President.

We contacted ACI by telephone on December 17, 1976, and spoke with Ms. Redmond. Purpose of call was to obtain, if possible, additional information on ACI's activities with respect to Herbicide Orange. Ms. Redmond was reluctant to discuss the activities in detail "without consulting with the other officers." She did indicate, however, that ACI may have invested as much as $600,000 over a two-year period in Herbicide Orange activities. Information available indicates that ACI "buys" its expertise, so some of the $600,000 may have gone for this purpose. About $250,000 was spent on the pilot plant and equipment. Ms. Redmond stated that the officers have not, as yet, drawn any salaries.

APPENDIX V

ACCEPTABLE LEVEL OF DIOXIN AS ESTABLISHED BY EPA

EPA is still attempting to arrive at an effect level (the level at which TCDD is not harmful to the environment or humans) for TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin). Since the early 1970s, EPA has been using an informal standard of 0.1 parts per million (ppm). ? EPA has never published this level and has used it only as a working level. In our discussions with EPA officials, they offerred the following three theories on why EPA set the acceptable level of TCDD in products at 0.1 ppm:

1. In the July 28, 1971, issue of the Federal Register, EPA published a 0.1 ppm standard for the allowable level of TCDD in hexachlorophene.
2. A study performed by the Mrak Commission in 1970 concluded that HO would be safe for use if it contained less than 0.5 ppm of dioxin. At about that same time, two manufacturers of HO indicated that they had the available technology to produce HO with less than 0.1 ppm of TCDD. Apparently, EPA compromised and started using the 0.1 ppm level.
3. The advisory committee formed in 1971 to review the restrictions placed on 2,4,5-T in 1970 recommended the restrictions be removed as long as the allowable level of TCDD is set at 0.1 ppm or less.

DRAFT

APPENDIX VI

FOR [illegible]

ESTIMATED COST OF STORING DIOXIN

CONTAMINATED COCONUT CHARCOAL

I – Residue from reprocessing

1. A gallon of HO weighs 10.7 pounds.
2. 2,260,000 gallons x 10.7 = 24,182,000 pounds.
3. At the conclusion of reprocessing there will be about 48 pounds of dioxin adsorbed onto the coconut carbon. 52
4. Reprocessing the 2.3 million gallons of HO will require anywhere from 300 to 600 tons of carbon, depending on final plant design and operating conditions.

II – Storage site cost estimates (based on ~~selection of~~ a proposal/study to store at Naval Ammunitions Depot, Hawthorne, Nevada)

1st year:	Site preparation	$255,988
	Unload and stow canisters	27,827
	(Approx. 800 canisters, 10 feet long by 30 inches in diameter)	
	Surveillance and cleanup	61,944
		$345,759
2d year:	Surveillance and maintenance ($59,103) x Acceleration factor FY '78 (1.15) =	$ 67,968
3d year:	$67,968 x 1.15	78,163
4th year:	$78,163 x 1.15	89,887
5th year:	$89,887 x 1.15	103,370
Total for 5 years		$685,147

DRAFT

[illegible]

Called William [illegible] Phone [illegible]
Federal Working Group – reviews all programs of Federal Agencies – to approve the program they need to know what they are using. He will give me the contents & phone #
(Miss Debra Cartwright – clerk)

436-8677	Dept. of Agriculture (APHIS) (animal plant health)	John Kennedy	✓
436-8696 ~~436-8083~~	Veterinary Services	Dr. Williamson 436-8677 ~~Donald Miller~~	✓
447-3973	Agricultural Research Services	Kenneth Walker	✓
235-8209	Forest Services	Roger Sanquist	✓
973-4585	Atomic Energy Commission (ERDA)	Dr. Don Elle	✓
967-4335	Dept. of Commerce (overall)	Jane Lewis	✓
967-2106	Dept. of Commerce (maritime)	Frank Lescher	✓
921-2825	National Bureau of Standard	John Brewer	✓
697-1147	Air Force	Walter Barrett	✓
693-7290 -5104	Army (Forrestal Bldg	Dr. Ed Gangstad	✓
[illegible]	[illegible]	[illegible]	✓

629-5447	D. C. Government	William Childress
~~343-8377~~ 343-8484 ~~962-6177~~	G S A.	David Allingham ✓
~~A.C. 404~~ 633-3101	~~Georgia~~ HEW Disease Control	Dr. James Smith
443-3320	Food and Drug	Miss Barry ~~John [illegible]~~ ✓
443-1054	Indian Health Service	Leo Snyder ✓
496-3262	National Institute of Health	Alton Simmons ✓ consultant to W.S., Gy & NIH
574-7512	St. Elizabeths' Hospital	William Bort X
343-7305	Dept. of Interior - Indian Affairs	Art Woll ✓
343-5994	Bureau of Land Management	Robert Teegarden ✓
A.C. 206 693-0351 ext 222	Bonneville Power Admin.	Fred Gross
343-5471	Bureau of Reclamation	Lee Fraser ~~Tom Seldom~~ ✓
426-6796	National Park Service	Mr. Sherale ~~Dr. Robert Hammerschlag~~
343-2616 8032	~~Interior~~ Fish Wildlife Service	Bernard Berger ~~Don Donahue~~ ✓
[illegible]	[illegible]	[illegible]

[redacted]

755-2206	NASA	Gene Groetz ✓
—	U. S. Postal Service	Mike Parham
426-8937	Dept. of Transportation Federal Aviation Admin.	George Vian ✓
—	Federal Highway	Mr. Des Jardins
426-2301	Dept. of Transportation	Willis Mitchell ✓
426-1094	U. S. Coast Guard	Capt. Hubbs X
381-6232	Smithsonian Institute	R. S. Minnich ✓
783-9151	Dept. of State, International Boundary ~~Committee~~ Commission	Mrs. Sheehy ~~Capt. Francis Poppe~~ ✓
726-9100	U. S. Soldiers Home	Joe Barefoot ✓
A.C. 205 383-4631	Tennessee Valley Authority	Dr. William Barnes ✓
389-3857	Veterans Administration	Ralph Bartlett ✓
755-6825	HUD	Moses Bordetsky ✓

[redacted]

2-4-D

Gal.

Bureau of Standards	200 Gal
U.S. Soldiers Home	500 Gal
Tennessee Valley Authority	30,000 Gal
NASA	430 ~~Gal~~ #
Navy	16,000 ~~4,000~~ #
Interior, Bureau of land management	158,000 #
Fish, Wildlife Service	50,000 #
Dept. of agriculture (can use as much as they can get)	200,000 (amine formula) will increase to 300,000 a year for next 3 yrs.

TOTAL 2-4-D

600 lbs
1,500
90,000
430 ~~1,290~~
16,000 ~~4,000~~
158,000
50,000
300,000
~~605,390~~ lbs
616,530 lbs

[redacted]

Bureau of Standards - Brewer -
150-200 gal a yr of 2,4-D

[redacted]

Veterans Adm. – Mr. Bartlett –
Uses very little – insignificant

U.S. Soldiers Home – Barefoot
2,4-D 500 gal – a yr.

HUD – Mr. Bordetsky
no reqmt – all work contracted.

Dept. of State, International Boundary commission – Mrs. Sheehy
2,4-D used only in Maine on the Canadian border and then only a small quantity. Doesn't use 2,4,5-T. She will call me in about a month & give me a requirement when she is in contact with the team in Maine & they have ~~made~~ completed their observations.

Tennessee Valley Authority – Dr. Barnes –
They can uses as much as we can let them have, they use 30,000 gals a yr of dimethylamine salt. 2 yrs ago it cost $1.58 a gal, they paid $6.23 a gal this yr.

[redacted]

~~NASA- Gene Proctor -~~
~~will find out regmt & call me back.~~
2,4-D — 430# a yr -

Dept of Interior - Indian affairs - Art Wall
has need for 2,4-D but will call me
in the regmt - the 1st part of next week

Mr. Sherale — Natl Park Service
uses 2,4-D —
has stringent review —
Natl Capitol Parks — he recommended
I call the one who is responsible for <u>all</u>
Natl. Parks - Mr. Clyde Hurst
601-698-3288

Dept. of Transportation - Mr. Viare - FAA
Very limited amount used of both in
Alaska . no regmt.

Dept. of Transportation — Mitchell
He said most work is contracted out —
He also said Coast Guard

[redacted]

Navy - William Gebhart -

Navy treats 5,000 acres a year. ~~with~~

1,000 acres with a mixture such as orange based on the following mix; 2,4-D 2# acid equivalent per gal & 2,4,5-T 2# acid equivalent per gal. and 4,000 acres with 2,4-D. 4# is used per acre

---

Indian Health Service - Leo Snyder

Don't use any

Food & Drug - Miss Barry

Don't use any

Interior -

Bureau of Land management

Robert Teegarden - uses 2,4-D.

Does not use 2,4,5-T. (It has been banned from Interior since 1970.)

Current FY 1975 reqmt is 158,000 # of 2,4-D. It should be ~~the~~ same next yr.

National Institute of Health - Simmons

no reqmt

Fish Wildlife Service - Berger -

Use 50,000 # per yr of 2,4-D.

(16,000 acres - 3# per acre)

[redacted]

Atomic Energy Commission, Dr. Don Elle
All their work is contracted out -
the prime contractor takes care of
any herbicide reqmt or sub contracts
it out. The AEC itself does not
buy herbicides.

Dept. of Agriculture - John Kennedy
uses ~~100,000~~ 2,4-D 150,000 to 200,000 # a yr ~~for~~ (amine formula) ("Whitch Weed")
Can use as much as we can let them
have. (4 # per gal, 1 # per acre - 100,000 yr)
(attacks corn & grow plants in N & S
Carolina) Planning an eradication program
which will increase the reqmt to 300,000 # yr
for 3 yrs & then the reqmt will return to 150,000.
Does not use 2,4,5-T
Revised by Dr. Williamson.

Dept. of Commerce - Frank Leuchen -
The field offices contract it out
to state licensed applic~~ators~~ -
programs are too small to hire
their own.

Agriculture Research Services - Kenneth Walker -
Doesn't use much to speak of. Forsees
a lot of problems if DOD goes ahead with this.
His recommendation is to sell the orange as is.
It needs licensed before being moved into Commerce

[illegible] Valley Authority [illegible]

N.A.S.A. [illegible] 430 [illegible]

Navy ~~4,000~~ 16,000 #

Interior, Bureau of land management 158,000 #

Fish, Wildlife Service 50,000 #

Dept. of Agriculture 200,000 (amine formula)
(can use as much as they can get) will increase to 300,000 a year for next 3 yrs.

TOTAL 2-4-D

600 lbs
1,500
90,998
~~290~~
~~4,000~~ 16,000
158,000
50,000
300,000

~~605,390~~ lbs

616,530 lbs

[redacted]

Sprayed of Stanback — Brewer
1/21 — 200 gal ~ qt of 2,4-D

[redacted]

[illegible] Administration — Mrs. [illegible] —
very very little — insignificant

U.S. Soldiers Home — Barefoot
2,4-D 500 gal — a yr.

HUD — Mr. Bordetsky
no reqmt — all work contracted —

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They can use as much as we can let them have, they use 30,000 gals a yr of dimethylamine salt. 2 yrs ago it cost $1.58 a gal, they paid $6.23 a gal this yr.

[redacted]

NA-H- Gene [illegible] —
will find out regmt & call me back
2,4-D — 430 # a yr —

Dept of Interior - Indian affairs — Art Wall
has need for 2,4-D but will call me
in the regmt - the 1st part of next week

Mr. Sherale — Natl Park Service
uses 2,4-D —
has stringent review —
Natl Capitol Parks — he recommended
I call the one who is responsible for all
Natl. Parks - Mr. Clyde Hurst
601- 698- 3288

Dept. of Transportation - Mr. Viane - FAA
Very limited amount used of both in
Alaska : no regmt.

Dept. of Transportation - Mitchell
He said most work is contracted out -
He also said Coast Guard

Navy — William Gebhart —

Navy treats 5,000 acres a year [illegible]

4000 acres — a mixture such as orange [illegible] based on the following mix: 2,4-D 2# acid equivalent per gal & 2,4,5-T 2# acid equivalent per gal. 4# is used per acre
and 4,000 acres with 2,4-D.

Indian Health Service — Leo Snyder

Don't use any

Food & Drug — Miss Barry

Don't use any

Interior —

Bureau of Land management

Robert Teegarden — uses 2,4-D.

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National Institute of Health — Simmons

No reqmt

Fish Wildlife Service — Berger —

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(16,000 acres — 3# per acre)

Atomic Energy Commission - [illegible] Ellis -
All their work is contracted out -
the prime contractor takes care of
any herbicide reqmt or sub contracts
it out. The AEC itself does not
buy herbicides.

Dept. of Agriculture - John Kennedy
uses 2,4-D 150,000 to 200,000 (amine formula) ~~100,000~~ # a yr for ("Whitch Weed")
can use as much as we can let them
have. (4# per gal, 1# per acre - 100,000 yr)
(attacks corn & grass plants in N & S
Carolina) Planning an eradication program
which will increase the reqmt to 300,000 # yr
for 3 yrs & then the reqmt will return to 150,000.
Does not use 2,4,5-T
Revised by Dr. Williamson.

Dept. of Commerce - Frank Seuchen -
The field offices contract it out
to state licensed applicators -
programs are too small to hire
their own.

Agriculture Research Services - Kenneth Walker -
Doesn't use much to speak of. Foresee
a lot of problems if DOD goes ahead with this.
The recommendation is to sell the orange [illegible]
It needs licensed before being moved into Commerce

Summary – Herbicide Requirements

2,4-D (lb)	2,4,5-T (lb)	ORANGE (MIX) (lb)
300,000	21,000	28,000
400,000	200,000	400,000
47,000	221,000	428,000
7,500	DSSC + 2,160	
3,675	223,160	
4,750	$9 gal	
62,925	or	
605,390	$4.5/lb	
1,431,240		
11,400		
1,442,640 lb		

$ 5.37

$ 2.54/lb

Cuasory

Lone		Dioxin
2.3		
240	245T	52 T
1.10	1.1	
2.2 lbs	2.2 lbs	

Summary — Herbicide usage [illegible]

2,4-D (lbs)

300,000
400,000
47,000
7,500
3,675
4,750
62,925
605,390

1,431,240

DGSC + 11,400

1,442,640 lbs

$5-8
$2.5 - $4./lb

2,4,5-T (lbs)

21,000
200,000

221,000
DGSC + 2,160

223,160

[illegible]

$4.[illegible]/lbs

cursory

ORANGE (MIX) (lbs)

28,000
400,000

(428,000)

[illegible]

2.3
DUD [illegible]
1.1 1.1
[illegible]

[illegible]

[illegible]

EXHIBIT H

TABLE I

IDENTIFICATION DATA ON HERBICIDE-ORANGE STOCKS AT GULFPORT, MISSISSIPPI

Manufacturer	Transportation Control No. (TCN)[a]	Analysis Sequence No.	Number of TCN Drums Sampled	Total Number of Drums with Same TCN	TCDD[b] (mg/kg)
Hercules Co.	9464 8156 0001	8	3	500	<0.05
Hercules Co.	9464 8192 001	14	6	2152	n.d.[e]
Diamond Co.	FY9461 7165 0001AA	18	3	60	14.2[f]
Diamond Co.	FY9461 8156 001AA	11	3	421	8.62[g]
Thompson Hayward Co.	9463 8155 X032	1	6[c]	1546	0.32
Dow Chemical Co.	9463 8155 X052	10	12[d]	6976	0.12
Thompson Co.	9463 7184 X011	3	3	46	n.d.
Thompson Co.	9463 8155 X012	5	4[c]	808	0.17
Monsanto Co.	FY9463 7163 X0001XX	4	4[c]	563	n.d.
Monsanto Co.	FY9463 8183 X002XX	6	7[c]	2185	7.62

[a] Each separate purchase of herbicide was designated by a separate TCN.

[b] Tetrachlorodibenzo-p-dioxin content (in ppm). Results reported in this column are the average of six samples collected from six different barrels of Herbicide Orange having the same TCN. The analyses were accomplished by Dow Chemical Co. under Contract No. F41608-73-C-1629, and the results were reported previously in Dow Report No. IAS-246 dated 26 December 1972.

[c] Including two samples from the same barrel.

[d] Including two samples from each of two barrels.

[e] Not determined.

[f] Average value of five samples: 12, 17, 12, 15, 15. Other sample value was 0.07 with rechecks.

[g] Average value of four samples: 8.0, 8.1, 8.7, and 9.7. Other two samples each averaged < 0.05 with rechecks.

Agent Orange

Lynwood Gellman, DGSC, DSN 695-3518:

- Air Logistics Center in San Antonio managed Agent Orange within the AF
- Rated orders (a/k/a X-orders; exigency orders; war stoppers) were not issued. However, the companies were threatened that a rated order would be issued so they voluntarily agreed to provide whateve amounts DoD needed.
- Don Tracy, DGSC Counsel, DSN 695-4814 knows the history of AO.

Army Focal Point is U.S. Army & Joint Services Environmental Support Group at Fort Belvoir. Director is Don Hakenson, 806-7835.

Chemical & Biologic Command, Edgewood Arsenal, FOIA officer is Cheryl Fields, DSN 584-1288, Com'l 410-671-1288. Their counsel is Robert Poore. He also knows quite a bit. His number is 410-671-1288. According to Poore, the Army's New York Procurement district bought AO. They went out of business 25 years ago. Few years ago, Pentagon asked for service-wide search for all AO records. Poore participated in that search. All docs were sent to pentagon but he doesn't know where. Try calling Army public affairs. They should know.

The NARA Record Group for Army AO holdings is 472.

Talked to Don Neary, 767-1510, DLA Readiness Support. He will have someone call me. Jerry Gilbart, MMPPP, 767-1350 called. We disposed of AO but doesn't think we bought it. Once we get records from the records center, he will help me decipher them. Call him if add'l assistance is needed.

DEFENSE SUPPLY AGENCY

14 April 1976

MEMO FOR General Vaughan

ESTIMATED FEDERAL GOVERNMENT REQUIREMENTS
FOR HERBICIDE ORANGE
(GALLONS)

	2-4-D	2-4-5T	MIX
	1,442,640	223,160	428,000
DGSC -	11,400	2,160	
Forest Service	300,000	21,000	28,000
Corps of Engineers	400,000	200,000	400,000
TVA	30,000		
Dept of Interior	158,000		
Fish & Wild Life	50,000		
Agriculture	200,000		
Balance (Misc Reqmts)			

DATA REC'D - 3 SEPT 74
PROJECTED [illegible] CY 75 REQUIREMENTS

DSA FORM 104 OCT 74 REPLACES DSAH FORM 104 WHICH MAY BE USED UNTIL EXHAUSTED

PERFORMANCE IMPROVEMENT

DEPARTMENT OF THE AIR FORCE
WASHINGTON 20330

OFFICE OF THE ASSISTANT SECRETARY

2 APR 1976

MEMORANDUM FOR DEPUTY ASSISTANT SECRETARY OF DEFENSE (SUPPLY, MAINTENANCE & SERVICES)
ATTENTION: DIRECTOR FOR SUPPLY MANAGEMENT POLICY

SUBJECT: Herbicide Orange

I have reviewed the DSAH-SME letter of April 1, 1976, addressed to you, subject: Herbicide Orange. It appears that it raises certain new questions not previously raised in joint discussions on this topic and perhaps suggests that, despite the failure of Agent Chemical, Incorporated (ACI) efforts to prove reprocessing feasible, the DSA wishes to continue to pursue that avenue for disposal of this material.

First, regarding the question of continuation with ACI in the reprocessing effort, my opinion continues to be negative, as outlined in my letter of March 24, 1976, to Mr. Bruner/DSA (copy attached). Additionally, respected members of the Air Force Environmental Health Laboratory, who have worked very closely with ACI on site at Gulfport, Mississippi, feel that past performance of ACI has been such that they should not be allowed to attempt to incinerate dioxin-laden charcoal at Gulfport using their present facility and their present level of expertise.

Second, the question of a compelling reason for abandoning reprocessing and proceeding with destruction suggests to me that the situation regarding this material is not fully appreciated. After DSA canvassed the industry last year and obtained only limited response in terms of interest, it does not appear that an industrial solution is at hand. Certainly, we have not made significant progress in the past year. The degree to which reprocessing can be made to work, over what period of time and investment, and with what degree of confidence is an unknown. I would point out that the technology for reprocessing the product is but a part of the problem, since the material may not be salable due to political realities, economics, inability to obtain EPA registration and environmental problems relating to reprocessing sites. Finally, the fact that the future of 2,4,5-T contaminated by any dioxin is subject to the results of ongoing research on levels of dioxin residue in the environment adds an additional degree of uncertainty.

It is our contention that this approach has been examined and found wanting. The cost of storage continues and will increase over time. Mr. Train has indicated his concern for the manner in which the material is currently stored. The EPA and the State of Mississippi have earlier stated that they consider the material to constitute an environmental problem. I agree. If the DSA feels, however, that they wish to continue exploring the reprocessing concept, the Air Force would concur with that being done - subject to the DSA assuming full and complete responsibility for the Herbicide Orange, including storage and subsequent destruction of the material in the future.

Finally, we appreciate DSA's concern about environmental risk of continuing present storage pending destruction. We share this concern and are, again, engaged in redrumming operations. Continued drum storage, however, would appear to be in order if destruction is the approach, since the time scale would be measured in months vice years for resolution of the reprocessing option.

We appreciate the opportunity to express the Air Force's views on this subject.

Billy E. Welch

BILLY E. WELCH, Ph.D.
Special Assistant for
Environmental Quality

Attachment-

DEPARTMENT OF THE AIR FORCE
WASHINGTON 20330

OFFICE OF THE ASSISTANT SECRETARY

2 APR 1976

MEMORANDUM FOR DEPUTY ASSISTANT SECRETARY OF DEFENSE (SUPPLY, MAINTENANCE & SERVICES)
ATTENTION: DIRECTOR FOR SUPPLY MANAGEMENT POLICY

SUBJECT: Herbicide Orange

We suggest some revisions to the letter to ACI in order to highlight their failure to pursue registration and also to distinguish between the lease and the ACI offer. We feel that failure to observe this distinction has led to unwarranted conclusions concerning rights believed to be possessed by ACI. We believe the legal situation is clear: ACI held a lease on a tract of land and that lease has now expired; and ACI made an offer to purchase Herbicide Orange, which was never accepted. ACI has no further rights either to the tract of land or to be considered as a potential purchaser of the herbicide.

Additionally, we would recommend the attached communication to ACI be transmitted by telegraph to expedite this solution.

Billy E. Welch

BILLY E. WELCH, Ph.D.
Special Assistant for
Environmental Quality

Attachment-

Mr. Frank H. Trifilio
President
Agent Chemical, Inc.
6515 Eppes
P. O. Box 26872
Houston, Texas 77207

Dear Mr. Trifilio:

This is in response to your March 16, 1976, letter submitting a proposed operational plan in support of your request for a 45-day extension of time in which to prove your proposed method of detoxifying Herbicide Orange.

Technical review indicates that, as presently written, your proposal is unacceptable. Although there are several errors, we are principally concerned over your omission of essential information and failure to address entire topics central to the reprocessing effort, such as industrial hygiene, environmental protection, analytical capability, extrapolation of data obtained to ultimate reprocessing, and contingency plans in the case of accident. Additionally, 45 days appear to be an inadequate amount of time to safely conduct even the operations you have proposed. Your choice of Inconel 600 for your furnace is also a matter of concern. At the temperatures you intend to operate, we understand this material is subject to thermal fatigue. The substantial risks involved in using Inconel 600 are, therefore, obvious.

In addition to the technical problems with your proposal, you have not begun to demonstrate a feasible plan for reprocessing this material. In particular, no registration application is being pursued. The Administrator of EPA has recently informed us that processing an application for an end use label will consume two to three years. You have also provided no information on the location of the reprocessing facility, including permits for its use from the relevant state authorities. Past experience indicates that such permits are most difficult to obtain. The time period for actual disposal suggested by these factors is not acceptable.

The lease has now expired by its own terms. As you will recall, it was for six months, twice what you originally asked for. The Government has not, of course, incurred any obligation toward your company with respect to the Herbicide Orange. Your offer has not been accepted per paragraph M of the request for quotations. We feel that the Government has gone out of its way to assist you in demonstrating your plan, including leasing you a pilot plant site at no rent. Although the lease has expired, the Air Force has agreed that your property may remain on the site for a brief period of grace in order to provide you a final opportunity to provide any further information you deem pertinent to the practicality of continuing your project. You will have ten days from the date of this communication to submit such information. The Government is affording you this opportunity to ensure that your proposal receives every possible consideration. However, should you demonstrate that there is merit in further work on the site, a new lease will be required. No Government rights under the expired lease are intended to be waived by granting this period of grace.

After we have carefully reviewed any submission you choose to make, we will inform you whether you may continue with your experimental work. Because time is critical, this decision will be forthcoming as expeditiously as possible. You will not be required to remove your property from the leased premises until a decision is reached, but operations under the expired lease will not be permitted.

Sincerely,

DSAH-SME

17 November 1976

MEMORANDUM FOR RECORD

SUBJECT: HERBICIDE ORANGE

A. Telcon Major Bullock, SAFIL, 17 Nov 1976

-AF comments re Agent's ltr of 29 Oct 76 and draft contract will be furnished this week. Nothing spectacular/new. Talks mostly about ACI environmental monitoring responsibilities and the fact that AF needs to know where ACI will get the charcoal to be used and general characteristics. AF needs this data for disposal planning purposes.

-AF has decided that, for purposes of the contract, the contaminated canisters WILL BE LEFT AT THE REPROCESSING SITE. AF will accept accountability at that point and decide final or intermediate disposition later, assuming that they will not know by the time that we are in position to start negotiations with ACI. (Personal observation - AF has no need to hurry now that we have agreed to reimburse them for disposition of the canisters down-stream, per the MOA.)

-AF wants our comments on the proposed MOA of 8 Nov 76 ASAP. They have no objection to modifying it to read "reimburse" in lieu of fund, as applicable. They also agree to spelling out the fact that the two-man release applies. (An AF hat "somewhere" will get a copy of the lab report at the same time that the DSA onsite rep gets a copy, and will jointly agree that specific batches are clean enough to release to ACI for removal. AF wants our concurrence/modified MOA ASAP so that they can disseminate it to the field and identify players within the AF by name.

-NCBC and JA Commanders have expressed concern re H.O. on location. SecNav(I&L) memo to Asst Sec AF (I&L) dtd 11 Nov 76 indicates Navy license to AF for the operation expired 31 Aug 76. AF has requested a 90-day extension; however, they did not indicate when reprocessing will begin and/or end nor ultimate disposition of the reprocessed product, contaminated equipment, residual dioxin, etc. Navy plans to begin major construction of a new heavy duty equipment repair facility at NCBC, on the site where the orange is stored and the pilot plant is located, beginning 1 September 1977. They request that the contractor, the H.O. and all associated equipment be off the installation NLT 1 August 1977. The Commander JA wants to see the contractor's work schedule and plans ASAP, and wants to be brought up to speed on all other aspects.

SUBJECT: HERBICIDE ORANGE (Continued)

-SME promised to get our comments on the MOA to AF by Friday, 19 Nov 76.

B. Telcon Bob Brindle, DPDS, 17 Nov 1976

-How will the H.O. sales proceeds be distributed? 80/20 split? — ? Need to know prior to the time that dollars start coming in from the contractor. (No SPLIT – 100% DFA)

-GAO wanted to send 3 people to DPDS to take a look at the H.O. file and get copies of certain documents. Brindle offered and they agreed to the suggestion that it would be just as easy for Brindle to bring the file or specific documents required to Washington D.C. when he comes down O/A 23 November 1976.

-AFLC has requested that Brindle contact ACI to get the estimated value of the 12 contaminated canisters originally shipped to Oregon by BKK. It appears that AF plans to temporarily store them at Kelly.

-Gave Brindle the O.K. to release the proposed letter to ACI "as is." AF has not submitted their comments on previous correspondence and has no immediate reaction to the letter in question. I discussed it in general with Major Bullock by phone and sent a copy to Dr. Welch by messenger this date. It was agreed that any significant comments can be transmitted to ACI at a later date.

Paula

Paula McLain
DSAH-SME/47503

DEPARTMENT OF THE NAVY
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20350

2 FEB 1977

MEMORANDUM FOR THE DIRECTOR, DEFENSE LOGISTICS AGENCY

Subj: Disposition of Herbicide Orange located at the Naval Construction Battalion Center (CBC), Gulfport, Mississippi

There are currently 15,000 55-gallon drums of herbicide orange stored at the CBC Gulfport, Mississippi. The material is the property of the U.S. Air Force and contains a highly toxic contaminant, dioxin.

Military use of herbicide orange was banned by the Secretary of Defense in 1970, and the Air Force Logistics Command was designated the responsible agent for disposal of the material. Initially, Air Force studies involved destruction of the material. However, in recognition of its market value, it was decided to sell the material to a contractor for removal of the contaminant, and marketing in commercial channels. Accordingly, in October 1975, the Air Force, acting under license from CBC Gulfport, furnished a lease to Agent Chemical Incorporated, Houston, Texas, for construction of a pilot plant to remove the contaminant. The pilot plant was successful but resulted in production of dioxin-contaminated charcoal.

The Navy understands that the Defense Logistics Agency is now negotiating with Agent Chemical for reprocessing all herbicide orange stored at CBC Gulfport in a full scale plant to be constructed at the CBC. The early removal of the herbicide orange from the CBC is essential as the containers of this material are beginning to deteriorate after nearly 10 years of outside storage. State of Mississippi and local officials are on record in requesting the Navy to "do something" to eliminate the environmental hazards that they believe exist as a result of the material stored at CBC.

DLA now has the dominant role in the solution (i.e., marketing) to the problem. Accordingly, your assistance in expediting the reprocessing contract negotiations to an early and environmentally safe solution is solicited. The Navy will

Ann C.. rell Free

Toxic Substances Won't Just Go Away

Now that we have the technological wit to reach a distant planet, perhaps we are mature enough to face a few facts here on planet Earth. One such: millions of malformed children.

In the United States alone, 200,000 defective babies—seven per cent of all births—are born annually. Twenty per cent of their defects are from environmental influences, says the March of Dimes. Among them are some of the chemical agents being put on the market at the rate of one thousand yearly. One of the most suspect is the herbicide 2,4,5-T.

The writer is on the board of the Rachel Carson Trust for the Living Environment.

Like the Thalidomide children of the 1960s, a few are born with limbs like flippers. Others just struggle along with cleft palates, deformities of the heart, kidney or the mind.

Even with the Thalidomide tragedy and reports of birth grotesqueries in Vietnam due to Agent Orange (the same as 2,4,5-T) defoliants, we have remained rather off-hand in our approach to birth defects—particularly so, in regard to chemical mutations of parental genes or damage to the fetus in the womb.

The human mind seems to be even more repelled by the thought of teratogenic effects—birth defects—than cancer. Do we figure that, if we don't entertain thoughts about either, the malformations, the suffering the wasting will go away? That's the way it appears in regard to the long overdue passage of the Toxic Substances Control Act.

The general public seems less than insistent that it be protected, by this Act, from further disfigurements and illnesses, such as have arisen with mercury, vinyl chlorides, PCBs or from cancer triggered by environmental pollutants and chemicals. The legislation passed the Senate in March, and it will reach the House next week in a slightly different form, for the third time in five years. Most likely it will pass, but will it die again in House-Senate conference? Once it stayed in conference 18 months. In an election year, the opposing chemical companies may be even more successful in their lobbying strategy. Should it be sprung from conference, will Mr. Ford veto it?

Proposed testing procedures of both old and new chemicals is controversial, but as Environmental Protection Administrator Russell Train explains: "It's time we started putting the chemicals to the test, not the people."

Dow Chemical Company places overall industry cost of the testing at $2 billion annually. But the General Accounting Office has come up with a figure somewhere between $100 and $200 million. These costs could be small if compared with those connected with the escaping kepone or with the PCBs. Had they been tested in advance, they may never have reached the market.

Manufacturers fearing immediate wholesale banning of chemicals should consider the long and laborious testing and hearings connected with the banning of DDT, dieldrin and aldrin-endrin by EPA. These actions were made under the Toxic Substances Act's companion law: the Federal Insecticide, Fungicide and Rodenticide Act. Under it, manufacturers have been given the benefit of many doubts. Take the case of 2,4,5-T.

As "Agent Orange" it started life as a horror story and has continued as such not only with the Vietnam kids but with secret reports, backing and filling of scientists and lawsuits. But enough testing has shown that it can cause birth defects in test animals when it is combined with a substance generally known as "dioxin." Dioxin seems to inevitably develop as a contamimant in the herbicide, and it cannot yet be thoroughly screened out. It is so potent that Harvard biologist Dr. Matthew Meselson says, "If only a few parts per trillion are getting into our food supply, then 2,4,5-T should be taken off the market."

Dioxin is the same horrifying stuff causing human illnesses and animal deaths in northern Italy. People are being evacuated from their homes, bans placed on area foodstuffs and abortions sought for pregnant women. The dioxin is in trichlorophenal—used in the making of body powders and creams—that escaped during an industrial accident.

The controversial herbicide was taken off the market in 1970 for residential, general crop or over-water use and especially for any area near pregnant women. But not enough of a case was built to ban its use as a weed killer along rights of way, on range and pasture land, in rice fields or, apparently, forests.

These permissible uses have weighed heavily on the minds of many persons in EPA and in scientific and humanitarian circles. So in May 1974 EPA finally began proceedings that could result in a total ban. But it was soon determined that more sophisticated testing methods were needed. New criteria was set and the hearings closed down.

One of the new tests requires examination of the fat and livers of beef cattle that have grazed on ranges treated with 2,4,5-T.

Early results are just in. Dioxin has been found in small amounts in the fat of some of the cattle that ordinarily would be converted into steaks, roasts and hamburgers.

So what now?

EPA has several ways to go: a moratorium on all uses of 2,4,5-T pending further tests and a final decision. Or it can inform the public of the fat findings and continue with its more sophisticated studies before hearings are resumed. EPA is wrestling with the question now, but as a first step it testified a few weeks ago against the use of Agent Orange by the U.S. Forest Service in Oregon ~~in a lawsuit brought~~ by area citizens.

The tortuous road of the controversial herbicide may be only a preview of what lies ahead with the chemicals falling under the long awaited Toxic Substances Control Act. But at least with Agent Orange, knowledgeable people are working on it as they are with other chemicals in the food and drugs and pesticide area.

ATTACHMENT B

BUTYL ESTER FORMULATIONS

COMMERCIAL NAME	MANUFACTURER	2,4-D	2,4,5-T	INERTS	EPA REGISTRATION NUMBER	REMA
Butyl Brushkiller	Colorado International Corp., Commerce City, Colorado	27.5%	26.7%	45.8%	EPA #4715-181	EPA
Wood Kill	Woodbury Chemical Co. Denver, Colorado	28.7%	27.9%	43.4%	USDA #449-65	EPA
Brush Killer #23	Bartels & Shores Chemical Company Kansas City, MO	29.2%	28.4%	42.4%		EPA
Super Brush Killer	Gordon Chemical Corp. Kansas City, Kansas	27.5%	26.7%	45.8%	EPA #2217-94-AA901-473	
Brush-Rhap	Transvaal, Inc. Jacksonville, Ark.	29.0%	28.2%	42.8%	EPA #11687-11	
Line Rider 22	Diamond Shamrock	28%	27%	45%	EPA #667-95-AA	
Wood Kill	Woodbury Chemical Co. Denver, Colorado	42.67%	42.20%	15.13%	USDA #449-28	

(It is also our understanding that the Velsicol Corporation has indicated to you an interest in the reformulation possibilities.)

Judge blocks defoliation in U.P. forest

GRAND RAPIDS (AP) — The U.S. Forest Service has been banned from spraying 84 acres of the Upper Peninsula with a defoliant used in Vietnam until an environmental impact statement is approved.

The ruling by Judge Wendell Miles in U.S. District Court prohibits the forest service from spraying land in the Ottawa National Forest in Ontonagon County with "agent orange" — also known as 2,4-5T.

The forest service wanted to use helicopers to spray the pesticides in order to halt secondary shrub growth choking out a red pine plantation in which is has invested about $8,400.

But Michigan Atty. Gen. Frank Kelley opposed the spraying on grounds it might be dangerous, and Miles ruled a statement covering federal forests in 20 states is too vague and failed to consider adequately local conditions.

Use of the defoliant cannot begin until Miles approves a local impact statement, the judge said.

Kelley said that the spraying violated the 1969 National Environmental Policy Act and Federal Pesticide regulations because the government never filed a local environmental impact statement.

The government, represented by forest service officials, Secretary of Agriculture Earl Butts and the forest's superintendent said that no environmental impact statement was needed. But they argued if such a statement was necessary, they had one dealing with "use of herbicides in the Eastern Regional."

He issued a preliminary injunction banning the spraying until he approves an environmental impact statement.

House OK's b[...] lottery mon[...]

LANSING (AP) — Lottery revenues would be earmarked for education under a measure passed by the Michigan House.

The bill is designed to lend some substance to the old promises of lottery proponents. They implied at the time the games were approved by the voters in 1972 that education would be the beneficiary.

Actually, the money simply goes into the general fund, providing for education and a lot of other things, too.

So some people are still asking: "Where does the lottery money go?"

The Lottery Bureau tells people 44 per cent goes for education, 39 per cent for human

DEFENSE SUPPLY AGENCY

MEMO FOR Urbanek

Hey Joe

Wadda he say?

Wally

Air Force Lost Track of Poison From Herbicide

A highly poisonous chemical component of the U.S. Air Force's stocks of the wartime defoliant, herbicide Orange, was moved by truck to a privately owned storage location in eastern Oregon recently without the government's knowledge or permission.

An Air Force official confirmed yesterday that the service had lost trace of the whereabouts of the deadly substance, called tetradioxin, or TCDD, from Sept. 21 to early November.

"We're not satisfied, with the benefit of hindsight, that the handling of the canisters containing the dioxin was acceptable," said Maj. Charles Bullock, a special assistant for environmental quality.

Twelve steel containers with minute quantities of the substance were flown Wednesday on a C-141 from Portland Air Base to remote Johnston Island in the South Pacific.

Sen. Mark O. Hatfield (R-Ore.) had been pressing the government to remove the dioxin from Oregon since September, when he learned that his state's Department of Environmental Quality had given permission to Chem-Nuclear Systems, Inc., to store the material at a special depot at Arlington, Ore.

TCDD is a highly toxic impurity present in most of the 2.3 million gallons of the Herbicide Orange defoliant.

DSA FORM 104
OCT 74

REPLACES DSAH FORM 104 WHICH MAY BE USED UNTIL EXHAUSTED

DEFENSE SUPPLY AGENCY

MEMO FOR Urbanek

Hey Joe
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DSA FORM 104
OCT 74

REPLACES DSAH FORM 104 WHICH MAY BE USED UNTIL EXHAUSTED

MEMORANDUM FOR ASSISTANT SECRETARY OF THE AIR FORCE
(INSTALLATIONS & LOGISTICS)
DIRECTOR, DEFENSE SUPPLY AGENCY

SUBJECT: Waiver of Utilization Screening for Herbicide Orange

Reference is made to Air Force memorandum, 24 December 1974, subject as above, which recommends disposal procedurs applicable to Herbicide Orange (H. O.).

Your request for waiver of utilization screening prior to sale of the H. O. is not approved. This determination is based on the fact screening can be accomplished in an expedited manner, thereby imposing no delay on your proposed action.

Your request raises the question of whether H. O. can be sold in its present state and prior to reformulation, as that term is used by the Environmental Protection Agency in its 21 January 1975 letter to the Assistant Secretary of the Air Force (Installations and Logistics). The EPA has apparently determined, by the terms of the 21 January letter, that some or all of the H. O. cannot presently be defined as non-toxic or otherwise harmless to man and his environment. Based on this EPA position, such H. O. should be reformulated so as to meet EPA criteria prior to its sale. This requirement would not seem to preclude an approach such as a contract for reformulation coupled with or followed by a contract for sale, provided ownership and control of the H. O. were retained by the Government and no sale were consummated until the EPA approved the end product.

The Department of Defense is attempting to determine the interest of chemical manufacturers, registered pesticides manufacturers and/or reformulators in purchasing all or part of a surplus stock of herbicide commonly known as Herbicide Orange. This material consists of approximately 43% of the n-butyl ester of 2,4-D and 42% of the n-butyl ester of 2,4,5-T. The herbicide is not now registered by the Environmental Protection Agency.

This material totals about 2.3 million gallons. About 860,000 gallons are stored at Gulfport, Mississippi, and about 1,400,000 gallons on Johnston Island, some 850 miles west of Hawaii. The material at Gulfport is identifiable as to manufacturer. Some 500,000 gallons at Gulfport is thought to contain not more than 0.1 ppm tetrachloro-p-benzo-dioxin (TCDD). In the Johnston Island stocks, with blending, we project that about 40% contain 0.1 ppm or less of TCDD, and about 65% contains 0.2 ppm or less of TCDD. The overall average TCDD content of the entire lot located at Johnston Island is estimated to be about 2 ppm.

Due to the fact that this particular herbicide is not now registered, it will be necessary to obtain Environmental Protection Agency concurrence prior to offering for sale. EPA has advised that it will consider the reformulation of Herbicide Orange as a means of disposal under the Federal Insecticide, Fungicide, and Rodenticide Act if the Agency can be assured that reformulation can be conducted without hazard to man and the environment. In order to develop the necessary information which will permit this assessment, we are soliciting input from interested parties who desire to purchase and reformulate the Herbicide for the purpose of removing unacceptable dioxin (TCDD) levels.

All proposals should contain the following information:

1) name and address of the proposing company
2) location and description of reformulating facility
3) complete description of chemical process to reformulate the feedstock, and the compound(s) to be formed and the residual dioxin content
4) probable level of dioxin in reformulated product
5) dioxin residues or other residues from the reformulating process (e.g., air emissions, solid or liquid residuals), and the methods of disposal and expected environmental consequences of such disposal
6) name(s) and registration number(s) of product in which reformulated Herbicide will be used if reformulated compound is intended to be a pesticide
7) proposed quality control checks
8) the proposer must also indicate his willingness to obtain:
   a) registration or other EPA-required clearances if the product is to be used as a pesticide
   b) EPA approvals as necessary for disposal of rendered products

Those interested in reforumlating Herbicide Orange must be willing to process at least one test batch to affirm results of reformulation, and to permit and/or conduct monitoring of waste emissions to the air, water, or land as prescribed by EPA. Interested parties should also understand that the EPA will have the right to inspect the reformulating facility and reformulated product at any time.

All proposals should consider that the material will be offered FOB Gulfport, Mississippi, and Johnston Island in its present containers if found suitable for shipment or the material will be loaded in a suitable container(s) and/or conveyance(s) to be provided by the offeror.

In order for your proposal to be considered, it must be received by ______________________. Any and all proposals may be rejected.

HERBICIDE "AGENT ORANGE"

HEARING

BEFORE THE

SUBCOMMITTEE ON MEDICAL FACILITIES AND BENEFITS

OF THE

COMMITTEE ON VETERANS' AFFAIRS HOUSE OF REPRESENTATIVES

NINETY-FIFTH CONGRESS

SECOND SESSION

ON

HERBICIDE "AGENT ORANGE"

OCTOBER 11, 1978

Printed for the use of the Committee on Veterans' Affairs

Duplicate

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[From the Virginia Farm Bureau News]

HERBICIDE LIMITATIONS RELAXED

The U.S. Agriculture Department has announced a relaxation in limitations on the use of the herbicide 2,4,5-T.

Assistant Secretary M. Rupert Cutler said he will permit spraying within 200 feet of streams. The limitation had been set at a quarter mile.

The prohibition against use of the chemical within one mile of permanent dwellings will remain in effect.

Cutler also said he is reconsidering a proposal to use 2,4,5-T this year on an estimated 101 acres in the Rogue River National Forest. He rejected its use in the area August 11.

The chemical is used by farmers to control weed growth and by foresters for the elimination of unwanted hardwoods in pine forests.

Mr. SATTERFIELD. Without any further questions, and there being no other witnesses—the committee will stand adjourned.

[Whereupon, at 12:20 p.m., the subcommittee adjourned.]

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DEPARTMENT OF THE ARMY,
HEADQUARTERS, U.S. COMMANDER, BERLIN AND U.S. ARMY, BERLIN,
APO New York, October 13, 1978.

AEBA–GC–C

Hon. DAVID SATTERFIELD,
U.S. House of Representatives,
Washington, D.C.

DEAR CONGRESSMAN SATTERFIELD: I read with interest an article (Army Times, 16 October 1978) on your investigation into potential long-term health problems caused by the chemical defoliant Agent Orange. From December 1967 through December 1968 I was the Assistant Division Chemical Officer, 4th Infantry Division, and I remain attuned to comments and articles concerning defoliant use and residual effects.

As opposed to other areas in South Vietnam, the Central Highlands is predominantly a deciduous hardwood area. In that there is comparatively little herbaceous vegetation (i.e. rice crops or large grassy areas), Agent Orange was used to a far greater degree than the water soluable defoliants White or Blue.

My duties in RVN required intimate involvement with defoliation operations, conducting spray missions on a near daily basis. These missions ran the spectrum from small scale perimeter defoliation to massive operations involving the use of hundreds of barrels of Orange on a single ridge line.

One operation which I supervised in the spring of 1968 may be of particular interest because of the employment requirements of the defoliant. We had a brigade headquarters (with its associated support activities) positioned in a valley at Dak To. This complex was overlooked by a large ridge line which became known as Rocket Ridge. The NVA/VC would set up rocket and mortar positions on this commanding position so as to strike at the brigade's vital communications and helicopter assets. Their hit-and-run tactics made direct counter-engagement with them almost impossible, and the thick vegetation prevented surveillance and observation of their positions. We were directed to defoliate the ridge so as to remove vegetation and permit a clear view of their positions.

While this was effectively accomplished, to the point of eliminating the threat from Rocket Ridge, the means employed should be particularly germane to you. Using a CH–47 helicopter with a 600 gallon tank, pump, and spray bar, we flew upwards of 80 missions over the ridge.

The system required the rear deck of the helicopter to be opened, and the rotor blades caused a constant backwash of the spray into the helicopter where I and my personnel operated. Each day we would finish our duties absolutely drenched with Orange; our fatigues totally saturated and the defoliant actually dripping from our hair. To be sure, some quantities of the 100 percent strength agent were ingested by breathing and swallowing. In total, we sprayed thousands of gallons daily over a three week period.

The point is that few military personnel or Vietnamese civilians could possibly have been exposed to Orange to the degree that I and my crew were, and the operation described above is only one of many similar missions.

It is my firm conviction that Orange caused absolutely no immediate or residual effects on personnel. Although I can claim no medical expertise, I can attest to excellent health for myself as well as other soldiers with whom I've subsequently maintained contact.

While I am not a pathologist and cannot debate medical hazards except from personal observation, I have the strong opinion that ex-soldiers claiming residual health defects may indeed be looking for the easy dollar from Uncle Sam. This bandwagon effect has apparently become popular, and I seriously question both the legitimacy of the claim and their integrity.

I do not know if this information will be of value to you, but it appears that there are enough documented cases of personnel heavily and repeatedly exposed to defoliants which should bear on your examination. I would personally conclude that claims of long-term health degradation have little justification.

Sincerely,

DONALD R. TAYLOR,
Major, Chemical Corps,
Brigade Chemical Officer.

I certainly hope that is not the case. I think one thing that our hearings this morning have indicated is that there are ongoing studies and certainly it appears to me that the VA at the present time, at least, is proceeding as it should. We certainly are interested in their continuing to do so and will do everything we can to aid and assist in it. I really do not think, and I recognize what you say, that culpability is a question any longer. What we are interested in is result. If there is an adverse result, then we want to do something about it for our veterans. In that regard, I think I can speak for this committee by saying that insofar as the potential for a large volume of claims for service-connected disability, is concerned, it should no longer be a question.

If indeed there is ground for establishing service connection, and our country is responsible for it, then the volume of those claims ought not to be considered at all. I do not think anybody on this committee would disagree with that. So I think we are in complete agreement with the thrust of your statement.

I hope that these hearings have indicated at least to the other members and to you and those who have listened to us this morning that this issue is not a closed book as some have suggested. Those agencies which are involved and which have responsibility are proceeding. We hope they will continue to do so until we obtain the final answers we all seek.

Thank you very much for being here this morning. Your testimony will be very helpful to us.

I would like to say that there are a number of things we have asked to be submitted for the record and for the file of these hearings. In order to receive that information, the record will remain open for a period of 30 days and the file will remain open for a reasonable period of time in order to receive whatever additional information the witnesses here this morning can supply. Additional information will be included in the record at this point.

[Material follows:]

DEPARTMENT OF THE AIR FORCE,
HEADQUARTERS UNITED STATES AIR FORCE,
Washington, D.C., December 11, 1978.

Hon. DAVID E. SATERFIELD, III,
House of Representatives,
Washington, D.C.

DEAR MR. SATTERFIELD: Reference is made to the Congressional Testimony concerning Herbicide Orange, October 11, 1978. The following corrections should be made in the testimony as agreed to during the discussion on the floor:

Page 26, line 457, change 52 million to 44 million.
Page 42, line 735, change 52 to 44.
Page 43, line 766, change 52 to 44.

In the initial testimony submitted for the record, reference was made to 52 million pounds of Herbicide Orange procured. However, only 44 million pounds were actually disseminated. This change was made per your request to correct the testimony.

I am most appreciative of your interest in the health of our military personnel. If I can be of further assistance, please let me know.

Sincerely,

GARTH B. DETTINGER,
Maj. General, USAF, MC,
Deputy Surgeon General.

HEARINGS ON HERBICIDE "AGENT ORANGE"

WEDNESDAY, OCTOBER 11, 1978

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON MEDICAL FACILITIES AND BENEFITS,
COMMITTEE ON VETERANS' AFFAIRS,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10 a.m. in room 334, Cannon House Office Building, Hon. David E. Satterfield III (chairman of the subcommittee) presiding.

Mr. SATTERFIELD. The subcommittee will come to order.

We are meeting this morning to hear testimony from various officials of the executive branch concerning one of the herbicides used in Vietnam during the early 1960's until the early 1970's. This herbicide, commonly referred to by its code name Agent Orange, was a mixture of 2,4–D and 2,4,5–T and was the herbicide most widely used during this period of military operations. The Department of Defense had two purposes for using Agent Orange in its military operations in Vietnam. First, it was used to defoliate trees and plants for better observation of the enemy; and second, to deny the enemy food crops being grown in and adjacent to terrain under enemy control.

Agent Orange was used by spraying on a target area usually by fixed-wing aircraft or by helicopter.

About the use of Agent Orange. We meet here this morning not to question this use but, instead, because of our concern about the possible adverse health effects this herbicide may have had with respect to our Vietnam veteran population.

We are aware of the report of August 16, 1978, which was transmitted to our colleague, who unfortunately passed away yesterday, the Honorable Ralph Metcalfe of Illinois. We are aware that it identified contaminant dioxin which was found in Agent Orange. That report indicated that dioxin is highly toxic, stable, and persistent. The report also indicated that insufficient research had been conducted with regard to possible health effects it might have on those who came in contact with it.

We are aware that the General Accounting Office also report that Department of Defense officials have little information on the number of personnel exposed or the extent of exposure to this herbicide, but that it has acknowledged that aircraft crews involved in the spraying missions were the most likely to have been exposed.

I ask unanimous consent that the letter of August 16, 1978, from the General Accounting Office to the Honorable Ralph H. Metcalfe, together with its four enclosures, be admitted to the record at this point.

Without objection it is so ordered.
[The information follows:]

U.S. GENERAL ACCOUNTING OFFICE,
COMMUNITY AND ECONOMIC DEVELOPMENT DIVISION,
Washington, D.C. August 16, 1978.

B-159451

Hon. RALPH H. METCALFE,
House of Representatives.

DEAR MR. METCALFE: By letter dated April 10, 1978, you expressed concern about possible long-range adverse health effects on individuals that were exposed to the herbicide Agent Orange and requested that we examine certain aspects of the Department of Defense use of this herbicide in Vietnam and the Veterans Administration handling of disability claims submitted by herbicide-exposed Vietnam veterans. As agreed with your office of June 28, 1978, this report addresses (1) the extent of the Defense use of herbicides and othe chemicals in Vietnam, (2) the number of military and civilian personnel exposed to these chemicals, and (3) the Defense-funded studies of the health effects of these chemicals.

Our review of the Veterans Administration handling of disability claims submitted by herbicide-exposed Vietnam veterans is continuing. In addition, the Environmental Protection Agency is currently reevaluating the registered uses of chemicals 2,4,5-T, a component of Agent Orange, in this country. We plan to include these matters in a final report to you by January 1979. We expect to work closely with your staff during this period.

In summary:

Agent Orange, a 50:50 mixture of 2.4-D and 2.4.5-T, was the most widely used herbicide in Vietnam. The component 2,4,5-T contains a contaminant, TCDD (dioxin) that is highly toxic, stable, and persistent, and its use has caused great public concern.

Defense has little information available on the number or extent of personnel exposure to herbicides in Vietnam. Officials acknowledged, however. that aircraft crews involved in herbicide spraying missions were more likely to have been exposed than others; this group possibly could be traced through military records.

Defense research before herbicide use in Vietnam was primarily concerned with herbicide effectiveness rather than its health effects. Subsequent Defense ecological studies failed to demonstrate long-term health effects. In its 1974 report, however, the National Academy of Sciences concluded that further extensive studies are needed.

Defense plans to epidemiological studies related to herbicide uses in Vietnam.

These matters are discussed in greater detail in the following sections.

USE OF HERBICIDES AND OTHER CHEMICALS IN VIETNAM

Defense field tested herbicides in Vietnam in 1961 and carried out military herbicide operations from 1962 to 1971. The herbicides were used primarily for (1) defoliating trees and plants to improve observation and (2) destroying food crops of hostile forces. Four herbicides were used:

Agent Orange (a mixture of 2.4-D and 2,4.5-T):

Agent Purple (a similiar mixture of 2.4-D and 2,4,5-T that continued a different form of 2,4,5-T—it was replaced by Agent Orange in 1964);

Agent White (a mixture 2.4-D and Picloram); and

Agent Blue (cacodylic acid).

The military use of herbicides in Vietnam is detailed in enclosure I.

According to a National Academy of Sciences report. about 18.85 million gallons of herbicides were sprayed during the 1962 to 1971 period. From August 1965[1] to 1971. Defense sprayed 11.22 million gallons of Agent Orange, 5.24 million gallons of Agent White, and 1.2 million gallons of Agent Blue over about 3.6 million acres of South Vietnam. Out of this area, 66 percent was sprayed once, 22 percent was sprayed twice, 8 percent was sprayed three times, and 4

[1] About 1.27 million gallons were used before August 1965, but a breakdown of the quantities of individual types of herbicides used was not available.

The VFW strongly supports the timely study of the possible deleterious effects of dioxin upon veterans and of providing medical care and compensation for any disability resulting therefrom. We have requested our service officers stationed at VA regional offices and VA hospitals to closely monitor any case wherein dioxin toxicosis is suspected so that we may assist the Veterans' Administration, Congress, and veterans so exposed. It is our intention to identify the largest number of such cases possible, and to establish appropriate controls and followup, thereby enhancing the determination of the actual existence of any disease or disability related to or directly resulting from exposure to Agent Orange.

Mr. Chairman, we commend you and this subcommittee for recognizing the need for exploring the possible deleterious effects related to the use of Agent Orange in Vietnam upon our Vietnam veterans so exposed. We recognize a degree of apathy may be encountered within government agencies due to possible culpability or reluctance to establish etiology which could generate a large volume of claims for service-connected disability. We welcome, also, the opportunity to provide your subcommittee with any information subsequently developed as a result of the efforts of our service officers.

This concludes my testimony and I will be happy to respond to questions that you may have at this time.

Thank you.

Mr. SATTERFIELD. Thank you very much. Mr. Hammerschmidt.

Mr. HAMMERSCHMIDT. Thank you, Mr. Mayo, for your helpful statement. Have you seen any concrete evidence of apathy within Government agencies due to possible culpability which could generate a large volume of claims?

Mr. MAYO. Our service officers and our claims people have not had any cases to adjudicate in our Board of Appeals at the VA. There is nothing happening in that regard.

Mr. HAMMERSCHMIDT. Does the VFW—and I might say in your own very fine outreach program which involves many millions of veterans across the country and your concern over their medical claims—have any feel for the number of claims for Agent Orange disability might increase beyond the present level of some 300 claims?

Mr. MAYO. Yes, sir, that is the thrust of what I get from our national service people. They indicated that the number of inquiries made of our service officers in this connection is increasing, and there have been a good number of them.

Mr. HAMMERSCHMIDT. Do you have any figures you could supply us for the record on that?

Mr. MAYO. Not at hand. This has just been recently undertaken.

Mr. HAMMERSCHMIDT. If you could develop those for our records, it would be helpful to us.

Mr. MAYO. Yes.

Mr. HAMMERSCHMIDT. Thank you very much, Mr. Chairman.

Mr. SATTERFIELD. I wish to thank you for appearing this morning and for your statement. I notice with interest in your statement you say:

> We recognize a degree of apathy may be encountered within Government agencies due to possible culpability or reluctance to establish etiology which could generate a large volume of claims for service-connected disability.

My name is Philip R. Mayo, and it is my privilege to serve the more than 1.85 million men and women of the Veterans of Foreign Wars of the United States as special assistant to the director, national legislative service.

Mr. Chairman, the Veterans of Foreign Wars has become increasingly aware of the disturbing allegations being made regarding health hazards experienced by Vietnam veterans as a result of their exposure to the powerful defoliant commonly known as Agent Orange. The defoliant was used in Vietnam between 1962 and 1970, when it was withdrawn from use because of its apparent dangerous effects on human and plant life, and after in excess of 100 million pounds were used to defoliate more than 5 million acres of the Vietnamese countryside.

This defoliant contained a chemical known as 2,4,5-T, which in its contaminant form, dioxin, is recognized as an extremely lethal chemical toxin. Dioxin has proved fatal to laboratory animals at extraordinarily low dosages. According to the Honorable Richard L. Ottinger, the Library of Congress has estimated that one medicine drop of dioxin can kill 1,200 people. Further, experiments performed on mammals have shown that very low levels of dioxin caused cancer, liver tumors, birth defects, nervous system disorders, liver dysfunction, genetic changes, spontaneous abortions or miscarriages, and a host of other symptoms such as nausea, dizziness, and skin disease.

According to an article inserted in the Congressional Record of May 11, 1978, by a member of this subcommittee, Hon. Don Edwards, the toxic effects of dioxin on human beings has been ascertained from studying the cases of victims of industrial accidents at production facilities, such as the accident at Sevesco, Italy, in July of 1976, wherein people were thoroughly exposed to the poison and as a result the Catholic Church permitted abortions for all pregnant women who had been exposed. Also, an article appeared in the July 10, 1978, issue of the Stars and Stripes reporting the occurrence at a Moscow Mills, Mo. horse farm, where dioxin-contaminated waste oil was utilized in a horse arena, causing the death of 67 horses.

In addition, scientists disagree with respect to safe levels of dioxin exposure, and whether dioxins enter the human food chain and are stored in the body tissues. Dr. James Allen of the University of Wisconsin determined that consumption of as low as five parts per trillion of dioxin in the diet was capable of causing an increased incidence of tumors in experimental animals. The National Academy of Sciences determined in a study conducted in 1974 that there was no conclusive evidence in existence to warrant the association between exposure to herbicides and birth defects in South Vietnam.

Notwithstanding the foregoing, the VFW has noticed during recent years that there has surfaced among veterans exposed to dioxin a number of heretofore inexplicable symptoms similar to those enumerated above. The Veterans' Administration, as a result of increasing concern exhibited over the possibility of these conditions being attributable to Agent Orange, conducted a briefing with respect to this issue on September 1, 1978, and outlined their methodology for management of such cases, as enunciated in VA Circular 10-78-219 dated September 14, 1978.

percent was sprayed four or more times. The quantities sprayed annually and application rates are summarized in enclosure II.

Agent Orange was sprayed undiluted in Vietnam at the rate of about 3 gallons (containing 12 pounds of 2,4–D and 13.8 pounds of 2,4,5–T) per acre. Civilian applications of this herbicide's components are usually diluted in oil or water. A Defense official said that the heavier application was needed to assure success of the heribicide operations.

In October 1969 Defense restricted the use of Agent Orange to areas remote from population. This action was prompted by a National Institute of Health report that 2,4,5–T could cause malformations and stillbirths in mice. Researchers later attributed similar problems to the contaminant TCDD, which is produced during the manufacture of 2,4,5–T. In April 1970 Defense suspended all use of Agent Orange in Vietnam, about the same time that the Department of Agriculture restricted the domestic use of 2,4,5–T because of its possible health hazards.

In 1971 Defense directed the Air Force to dispose of all remaining stocks of Agent Orange. These stocks contained TCDD contaminant levels ranging from less than 0.05 to 47 parts per million and averaging about 2 parts per million. Current manufacturing standards for 2,4,5–T require TCDD levels to be less than 0.1 part per million.

Defense officials said that the disposal of Agent Orange was completed in September 1977.

OTHER CHEMICALS

A Defense official said that malathion and DDT were the other principal pesticides used in Vietnam; they were used throughout the war for mosquito control. Malathion was sprayed by aircraft, and DDT was applied by back pack and paint brush. The official said that no information is readily available on the quantities used in Vietnam.

Malathion is still used domestically for insect control. However, in 1972 EPA cancelled all except public health and quarantine uses of DDT because of its persistence, biomagnification, and toxicological effects.

PERSONNEL EXPOSURE TO HERBICIDES

A Defense report shows that about 2.6 million military personnel served in South Vietnam from January 1, 1965, to March 31, 1973. Defense records indicate that the number of United States civilian personnel employed by Defense in South Vietnam ranged from 49 in March 1965 to 1,522 in September 1969—cumulative data on civilians are not readily available. Defense has little information, however, on the number of personnel exposed to herbicides in Vietnam. Defense officials stated that (1) no such personnel records were maintained, (2) it would be difficult to estimate meaningful exposure data because the potential for exposure varied widely among personnel, and (3) only a few military personnel would have been exposed directly to spraying. But some personnel could have been exposed indirectly to low levels of herbicides through ingestion of contaminated drinking water and food and by skin contact.

Defense officials acknowledged that certain groups of personnel such as the herbicide handlers and aircraft crews (particularly crewchiefs and flight engineers) involved in herbicide spraying missions were most likely to have been exposed to herbicides than others. The officials said that, if required, the identity of the aircraft crews possibly could be traced through military records. The herbicide handlers were mostly Vietnamese and it would be difficult to identify and trace them.

DEFENSE-FUNDED STUDIES OF THE HEALTH EFFECTS OF HERBICIDES

The herbicides used in Vietnam were also used in the United States when the military spraying program began. A Defense official stated that, consequently, military studies made before the program began were concerned primarily with military effectiveness rather than environmental and health effects. Defense subsequently funded several studies of the ecological effects of herbicides use; included was a study made by the National Academy of Sciences, as mandated by the Congress in Public Law 91–441 (Oct. 7, 1970), on the effects of herbicides in Vietnam.

None of the major Defense-funded studies concluded that herbicide use damaged human health; however, the National Academy of Sciences, in a

February 1974 report, expressed concern over TCDD because (1) its very high toxicity to animals, (2) its presence in Agent Orange, (3) preliminary reports of the presence of TCDD in fish in Vietnam, and (4) the lack of any data permitting assessment of TCDD effects in humans. As a result, the Academy recommended that long-term studies be made to obtain a firmer basis for assessing the potential harmful effect on man. More specifically, the National Academy of Sciences stated that:

"Further intensive studies are especially required with reference to the ecological distribution, the pharmacology mechanism of toxicity, possible mutagenicity, and carcinogenicity of TCDD and its possible teratogenicity in man."

Defense-funded studies are summarized in enclosure III; the National Academy of Sciences summary of the physical and biological characteristics of the herbicide components used in Vietnam is in enclosure IV.

Defense officials believe that no firm link has been made between long-term adverse health effects and exposure to herbicides in Vietnam. They stated that Defense (1) has no plans to conduct epidemiological studies on the possible ill health effects of herbicide use in Vietnam and (2) has not issued any instructions to its medical facilities to monitor complaints of illness possibly resulting from herbicide exposure.

As agreed during the June 28, 1978, meeting with your Office, we discussed the matters in this report with Defense officials and incorporated their comments where appropriate. As also agreed we are providing copies of this report to the House Committee on Veterans Affairs. Unless you publicly announce its contents earlier, no further distribution of this report will be made until 30 days from the date of the report.

Sincerely yours,

HENRY ESCHWEGE, *Director*.

Enclosures.

ENCLOSURE I

THE MILITARY USE OF HERBICIDES IN SOUTH VIETNAM[1]

Military herbicides operations began in South Vietnam (SVN) in early 1962 and were phased out in 1971. After a relatively slow buildup from 1962 to 1965 the operations increased rapidly to a peak in 1967; declined but only slightly, in 1968 and 1969; and dropped sharply in 1970. According to information from Defense the last herbicide spraying by fixed-wing aircraft occurred on January 7, 1971. After this, herbicide operations were limited to spraying around fire base perimeters, on enemy cache sites, and along land and water communication routes; all were carried out by helicopter or on the ground. The last helicopter spraying operation under United States control was flown on October 31, 1971.

THE HERBICIDAL AGENTS USED

The herbicidal agents used in SVN were identified by code names that referred to the color bands painted on the containers of the chemicals: Orange, White, Blue, and Purple.

Agent Orange is a 50:50 mixture of the n-butyl esters of 2,4-D ([2,4-dichlorophenoxy] acetic acid) and 2,4,5-T ([2,4,5-trichlorophenoxy]acetic acid). Each gallon of Orange contains 4 pounds of 2,4-D and 4.6 pounds of 2,4,5-T on an acid equivalent basis[2]. Agent Orange was used most extensively in Vietnam until its use was terminated on April 15, 1970, because of concerns of its possible teratogenicity and its contamination with the highly toxic TCDD.

Agent Purple is a 50:30:20 mixture of the n-butyl ester of 2,4-D, and n-butyl and isobutyl esters of 2,4,5-T. It was used only until 1964, and was then replaced by Agent Orange.

Agent White is a mixture containing 2 pounds of 2,4-D and 0.54 pounds of picloram (4-amino-3,5,6-trichloropicolinic acid) per gallon on an acid-equivalent basis. It is a formulated product containing 2,4-D and picloram as the triisopropanolamine salts, with the addition of surfactants and water.

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[1] Information excerpted from "The Effects of Herbicides in South Vietnam," National Academy of Sciences, February 1974.

[2] Acid equivalent is the weight of the acid form of the chemical. This is used because the weights of various ester or amine formulations vary. Expression in terms of acid equivalents provides a uniform basis for comparison of different formulations.

Dr. CUETO. In the report, which I highly recommend that a copy be obtained—or I can try to supply one—there is a review of the very small type of information that you are asking for.

Mr. SATTERFIELD. In what report is that?

Dr. CUETO. This is the World Health Organization, IARC monograph. IARC is the International Agency for Research on Cancer, volume 15. It reviews the herbicides.

Mr. SATTERFIELD. If you could possibly make one available, we would be happy to include it in the file on this hearing.

Dr. CUETO. I will see that you get one.

Mr. SATTERFIELD. Mr. Hammerschmidt, do you have a question?

Mr. HAMMERSCHMIDT. I have one more question. Dr. Cueto, I think you were in the audience when I asked a question of Dr. Haber on a hypothetical case. Let's say our troops were in an area where it had rainfall and runoff from a defoliated area, and as we have discovered here we really have not asked the question of the rate and concentration of the herbicide that was used over there; do you think it is possible dioxin may have been carried from a defoliated area in rainfall to a low-lying area where the troops might orally take on water, and do you think they could have gotten that in their system? I know it is a hard question to answer because it is so hypothetical, but will you respond the best you can?

Dr. CUETO. The approach to answer there would be, of course, that has been indicated before in terms of the solubility of the material. It is very insoluable in water. However, one ought to consider the mechanical transportation of material and the material being absorbed into material containing the water—pollutants and mud itself in being pushed along—so that one could get a distribution in the environment of this material.

We should note one of the first actions taken by the regulatory agency was against the use of 2,4,5-T and aquatic bodies in order to prevent the possibility of a distribution through maybe physical means, not solubility necessarily, of the materials themselves.

Mr. HAMMERSCHMIDT. Thank you, Doctor.

Mr. SATTERFIELD. Thank you very much, Dr. Cueto. We appreciate your appearing this morning. Your testimony is very helpful to us.

The next and last witness is Mr. Philip Mayo, who is Special Assistant to the National Legislative Director for Veterans of Foreign Wars.

Mr. Mayo, we welcome you. We will be very glad to receive your testimony.

STATEMENT OF MR. PHILIP MAYO, SPECIAL ASSISTANT TO NATIONAL LEGISLATIVE DIRECTOR, VETERANS OF FOREIGN WARS, ACCOMPANIED BY DONALD H. SCHWAB, NATIONAL LEGISLATIVE DIRECTOR

Mr. MAYO. This is Mr. Donald Schwab, who is the legislative director of the Veterans of Foreign Wars.

Mr. Chairman and members of the subcommittee, thank you for the privilege of appearing before this distinguished subcommittee to present the views of the Veterans of Foreign Wars of the United States with respect to Agent Orange.

Mr. SATTERFIELD. What would be the equivalent, then, of that level in a rat which would produce the same result in man? What would be the amount?

Dr. CUETO. It would be close to the 0.1 microgram per kilogram because one has to consider, as I said, surface area, but one is in the area ballpark. If it is 0.1 or maybe perhaps the material may even be considered to be 0.05 micrograms, but even at 0.05 micrograms we were finding carcinogenic effects or indications of them.

Mr. SATTERFIELD. In the animals?

Dr. CUETO. In the animals.

Mr. SATTERFIELD. Isn't it a fact that a rat is a rather low moisture content animal whereas man has a high moisture content? Does that make any difference?

Dr. CUETO. Yes. There are certain species differences and this is one of the points that I think should also be considered with TCDD, and that is that various species seem to be responding with certain end points that are characteristic for each of the species. Teratogenic effects have been found not only in one species but in three species.

Carcinogenic effect is now being found not only in one species, the rat, but also the mouse. So that one begins to see that these chemicals do affect different species. Where you have a problem is where you have only one species being affected and the others not being affected. Then you have questions as to whether the information is pertinent to humans. But in this particular case the more information that is obtained, the more indication is that it is pertinent to the various species.

Mr. SATTERFIELD. What has bothered me in connection with laboratory studies with animals as related to humans is that we really have not done very much to establish a relationship between what might happen in a human as compared to what happened in laboratory tests in animals. Is it safe, then, to say this is again an opinion that an equivalent dosage in a human would produce the same result?

Dr. CUETO. No. I think there are areas referred to as risk assessment and risk evaluation and prediction demand, and this sort of thing, that takes many factors into consideration. It is a very difficult sort of thing and one can predict anything, and no one is able to check it. Therefore, what you find in the mouse you can predict will occur in man, and it is very difficult to check those findings.

Mr. SATTERFIELD. Predictions are basically opinions, then.

Let me ask you this. In the laboratory test animals, you stated that dioxin is given orally. What would one expect in man, that he would take the same quantity all in one dose?

Dr. CUETO. One would expect perhaps dermal and inhalation routes to be more pertinent to the situation in man. Therefore, the route may have an effect, and this effect may be one of quantitative differentiation one should make. The reason I say quantitative, primarily the material evidently is absorbed through the GI tract and it is absorbed dermally and by inhalation, and the material is stored then in the animal tissues as the compound itself, so evidently it gets through by the various routes and gets to the tissues.

Mr. SATTERFIELD. The thing that bothers me is that the metabolism of a rat is quite different from that of man. Is there any evidence that dioxin metabolizes in a human or is it discharged with body waste?

Agent Blue is formulated as the sodium salt of cacodylic acid (hydroxylimethylarsine oxide). It contains a minimum of 21-percent sodium cacodylate with additional free cacodylic acid for a total dimethylarsinic acid equivalent of not less than 26 percent on a weight basis, or 3.1 pounds of cacodylic acid and about 1.7 pounds of arsenic per gallon with 5-percent surfactant and 0.51 percent antifoam agent.

All agents were for use at a rate of 3 gallons per acre (28 liters per hectare), except that in the earlier operations and on rare occasions thereafter only half of this dose was used. The herbicides were applied by fixed-wing aircraft (UC-123), helicopter (UH-1), from trucks, from river boats, and from backpacks. Aircraft were outfitted with special spraying equipment consisting essentially of a container and a spray boom with nozzles. The container of the plane spray system had a 1,000-gallon capacity and normally flew at 150 feet with a delivery speed of 130 to 140 knots. The spray-on time of 3½ to 4 minutes permitted approximately 950 gallons of herbicide to be distributed at the rate of 3 gallons per acre. The capacity of the helicopter spray system container was 200 gallons but the helicopter could carry only 100 gallons because of weight limitations. Herbicide spraying from tanker trucks used 50-gallon or 100-gallon drums. Spraying by river boats was done directly from the agents original 55-gallon drums: backpack sprayers had 3-gallon drums. The great majority of the herbicides were sprayed by plane—at least into the latter part of 1970, from which time helicopter herbicide operations increased and gradually became the only aerial means of heribcide delivery.

MILITARY CLASSIFICATION OF THE HERBICIDE OPERATIONS IN SVN

The herbicide operation objectives were (1) defoliation (the use of herbicides to cause trees and plants to lose their leaves to improve observation) and (2) crop destruction (the application of herbicides to plants to destroy their food value), directed at crops of hostile forces. Herbicides were also used, although on a much smaller scale and only by helicopter or on the surface (ground or water), for clearing vegetation around the perimeter of fire support bases and other military installations, on landing zones and enemy cache sites, and along lines of communication. Thus, there were essentially two military objectives of all herbicide operations—defoliation and crop destruction.

APPLICATION OF HERBICIDES IN THE VIETNAM WAR

[In millions of gallons]

Agent	1962 to July 1965[1]	August to December 1965	1966	1967	1968	1969	1970	1971	Total
Orange		0.37	1.64	3.17	2.22	3.25	0.57	0	11.22
White		0	.53	1.33	2.13	1.02	.22	.01	5.24
Blue		0	.02	.38	.28	.26	.18	0	1.12
Total	1.27	.37	2.19	4.88	4.63	4.53	.97	.01	18.85

[1] Detail by type of herbicide not available.

HERBICIDES USED IN SVN 1965–71

Agent and active chemical components	Military application rate (pound per acre)	Millions of gallons used, August 1965 to 1971
Orange:		
2,4-D	12.00	
2,4,5-T	13.80	11.22
White:		
2,4-D	6.00	
Picloram	1.62	5.24
Blue: Cacodylic acid	9.30	1.12
Total		17.58

Source: "The Effects of Herbicides in South Vietnam," National Academy of Sciences, February 1974.

ENCLOSURE III

SUMMARY OF DEFENSE-FUNDED STUDIES WHICH DISCUSS POSSIBLE HEALTH HAZARDS FROM MASSIVE AND REPETITIVE APPLICATIONS OF HERBICIDES

Available Defense studies of the health effects of the herbicides used in Vietnam are discussed in this enclosure. These studies were made after concern was raised about the potential ecological and environmental hazards of spraying.

ASSESSMENT OF ECOLOGICAL EFFECTS OF EXTENSIVE OR REPEATED USE OF HERBICIDES (FINAL REPORT 15 AUGUST–1 DECEMBER 1967)

The contractor, the Midwest Research Institute (Kansas City, Missouri) conducted a survey to assess the ecological consequences of the extensive and repeated use of herbicides, including herbicides in Vietnam. The scope included an examination of over 1,500 pieces of scientific literature, and interviews with over 140 experts on herbicide use and animal and plant ecology.

The contractor reported that only one generation had passed since chemical herbicides began to be widely used, and no articles or books had addressed the long-term ecological effects of herbicides on flora and fauna, rangeland, forests, other nonagricultural lands, waterways, lakes, and reservoirs. The authors hoped that their study would lead to a deeper study based on the addiitonal research that is needed.

The report concluded that the aerial spraying of herbicides in Vietnam caused little or no toxicity hazard to people or animals. The report stated:

"The possible toxic hazards involved in the aerial spraying of herbicides in Vietnam are of concern to scientists and to the public.* * * After examining the voluminous toxicity data and the actual rates at which these chemicals have been applied we can make the following observations: (1) the direct toxicity hazard to people and animals on the ground is nearly nonexistent, (2) destruction of wildlife food and wildlife habitat will probably affect wildlife survival more than any direct toxic effects of the herbicides, (3) the application of Orange or white alongside of rivers and canals or even the spraying of the water area itself at the levels used for defoliation is not likely to kill the fish in the water, (4) food produced from land treated with herbicides will not be poisonous or significantly altered in nutritional quality (we use herbicides in large amounts on cropland in this country); if residues of a more persistent herbicide such as picloram should carry over to the next growing season it would retard plant growth rather than concentrate some toxic residue in the crop, (5) toxic residues of these herbicides (Orange, White, and Blue) will not accumulate in the fish and meat animals to the point where man will be poisoned by them, and (6) the primary ecological change is the destruction of vegetation and the resulting change is the destruction of vegetation and the resulting ecological succession in the replacement of this vegetation."

CONGENITAL MALFORMATIONS, HYDATIDIFORM MOLES AND STILLBIRTHS IN THE REPUBLIC OF VIETNAM, 1960–1969

A medical team representing the U.S. Military Assistance Command, Vietnam, and the Ministry of Health, Republic of Vietnam (RVN), made a cooperative study of data on about 499,000 births from 1960 to 1969 in 22 Saigon, provincial, and district hospitals to determine whether 2,4,5-T could be shown to increase developmental abnormalities in humans.

The December 1970 report describes the incidence of recorded congenital malformations, stillbirths, and hydatidiform moles in RVN before (1960–65) and after (1966–69) larger-scale military use of herbicides. The study failed to show any influence of herbicides on birth defects.

The report noted, however, that the study had several biases because:

Nearly all the information was derived from population centers and the large hospitals.

Data was restricted almost exclusively to ethnic Vietnamese. For example, Montagnards as a rule did not enter district or province hospitals, but delivered at home.

Many records had been destroyed.

Some hospitals admitted to incomplete reporting of birth defects during the earlier part of the 1960s.

That is all I have, Mr. Chairman.

Mr. SATTERFIELD. In response to your suggestion I feel we should indeed ask these questions. We will submit them in writing to the other witnesses and accept their answers in the file.

Now I would like to ask a question or two. You said quite a bit about carcinogens. This is something we are hearing a great deal about. I hear repeated time after time the statement that carcinogens cause cancer. Is that a factual statement?

Dr. CUETO. Pardon?

Mr. SATTERFIELD. That carcinogens cause cancer.

Dr. CUETO. It is a particular type of cancer. A carcinogen is defined as a chemical that causes cancer, so the answer has to be yes.

Mr. SATTERFIELD. Is it correct to state that it causes cancer? Has a cause and effect relationship between any carcinogen and cancer been factually established?

Dr. CUETO. There is evidence to consider there is such a thing as chemical carcinogenesis.

Mr. SATTERFIELD. That evidence is epidemiological?

Dr. CUETO. That evidence is evident in humans. There are compounds that have been defined as being carcinogenic to humans. Yes, when we are dealing with humans it is epidemiological data. However, there is no doubt chemical involvement has occurred.

Mr. SATTERFIELD. That is not clinical data; it is epidemiological data?

Dr. CUETO. Epidemiological data combined with clinical data so that the findings of the cancer are identified clinically, the history is taken and then it becomes epidemiological. You have a blending of epidemiological and clinical.

Mr. SATTERFIELD. In the final analysis isn't that just an opinion?

Dr. CUETO. I assure you, sir, there is sufficient evidence that certain chemicals cause cancer.

Mr. SATTERFIELD. In connection with the Dow report, I am interested in your statement that there was evidence of increase in liver and lung cancer. How was this determined?

Dr. CUETO. This is in the experimental animals.

Mr. SATTERFIELD. That is what I understand.

Dr. CUETO. One administers material to the animal and then observes the animal for a period of time. And these studies, the Dow studies and our study, was approximately 2 years. And then tissues are examined and then one detects the presence of a tumor or lesion and then compares it with controls and analyzes the data to attempt to see if one can relate it to the chemical.

Mr. SATTERFIELD. I think you stated that the dosage of dioxin in these animals was 1 microgram per kilogram?

Dr. CUETO. Yes, one microgram—0.1 of a microgram per kilogram.

Mr. SATTERFIELD. What type of laboratory animal was involved?

Dr. CUETO. This was a rat.

Mr. SATTERFIELD. Do you relate, then, 0.1 of a microgram per kilogram in a rat as being equivalent in terms of a human?

Dr. CUETO. No, not at all. One has to involve metabolic rate, and so forth. The animal metabolizes the material much faster than man, so that one has to take into consideration certain of these factors.

One microgram per kilogram of body weight given orally once weekly for 4 weeks to mice before infection with salmonella increased mortality and decreased the time from infection to death. The point is that of a very sensitive effect, an effect which occurs at such low levels that one would not expect to see perhaps chloracne, has been detected in experimental animals.

Then finally, in the paragraph referring to the carcinogenic effects, there are four compounds that we have tested at the National Cancer Institute. One of them is the unchlorinated material, referred to as the unsubstituted dibenzodioxin, the other is a dichloro-dibenzodioxin, the other one is a hexichloro-dibenzodioxin. Then there is the TCDD tetrachlorodibenzodioxin. The unsubstituted showed no carcinogenic effects on the animals in the conditions of your study.

TCDD, the dichloro material, showed there was an indication of possibility of lung cancer developing. It was not a clear sound statistical significant finding, but there is indication of it. The TCDD and the hexichloro-dibenzodioxin in a report that is forthcoming from our group indicates that there are liver and perhaps lung carcinomas developing, adenomas.

The Dow Chemical Co. has also reported, in a meeting in New York just a month or so ago, with levels of one-tenth of 1 microgram per kilogram in a 2-year study of TCDD, it was detected that there was an increase in lung squamous cell carcinomas and in the liver, in the hepatocellular carcinomas.

It was also stated that at levels lower than these in which toxicity was only slight or not detected, that no tumors were seen, no increased tumors were seen. However, one has to realize that as one hears the dosage, one sees less of an effect or it has the possibility of seeing less of an effect, unless one increases the number of animals, so that one increases the power of the tests. So one is decreasing the power of the tests as one lowers the dose.

I believe that is all that I care to mention at this time. I certainly would be pleased to either comment or attempt to answer questions.

Mr. SATTERFIELD. Very well. Mr. Hammerschmidt.

Mr. HAMMERSCHMIDT. Thank you, Dr. Cueto. I take it from your testimony dioxin may have a strong effect as a catalyst in other diseases, that is, the presence of dioxin on a long- or short-term basis might encourage the development of many, many other diseases. Is this a correct reading?

Dr. CUETO. What I am suggesting is there is a possibility of effects at lower levels of exposure involving the immunal system and that the compound may act as an immunal suppression, so one gets into a very difficult situation of relating symptoms to the chemical while the symptoms may be related to other sources, from either bacterial infection, virus infection, and so forth.

Mr. HAMMERSCHMIDT. Would the Dow studies that came out a month or two ago that you referred to, the ones presented in New York—those were laboratory studies on animals; is that correct?

Dr. CUETO. Yes.

Mr. HAMMERSCHMIDT. I think you have given us a good suggestion on some further questions that we may want to ask previous witnesses, and I am sure the chairman will follow through on that.

THE EFFECTS OF HERBICIDES IN SOUTH VIETNAM

In response to public concern about the possible effects of herbicide use on the environment and people, the Congress directed Defense to contract with the National Academy of Sciences for a study of the ecological and physiological effects of the widespread use of herbicides in South Vietnam. (Public Law 91-441, Oct. 7, 1970.) The report was issued in February 1974.

A NAS committee spent about 1,500 man-days in South Vietnam during the course of the study. The study noted that (1) long-term field studies were virtually impossible because of the security conditions in South Vietnam and (2) safe access to large areas of the country was denied to the field teams, thereby frustrating their efforts to secure critical data.

The NAS committee could not gather any definitive indication of direct damage by herbicides to human health. The committee, however, was unable to visit the Montagnards in their own locales to verify common and consistent reports of serious illness and death, especially among children, after exposure to herbicide sprays. The committee concluded that although no independent medical studies of exposed populations were available from the time of spraying against which reports of illness and death could be confirmed or refuted, the reports on the Montagnards were so consistent that they could not be dismissed and should be followed up as promptly as possible by intensive studies which should include both medical and behavioral science approaches.

Because of (1) the very high toxicity of TCDD (dioxin) to animals, (2) the presence of this substance in Agent Orange, (3) preliminary reports of TCDD in fish in Vietnam, and (4) the lack of any data permitting assessment of TCDD effects on humans, the committee recommended long-term studies to obtain a firmer basis for assessing the potential harmful effects of TCDD on man. The committee made several other pertinent recommendations which largely depended on data to be subsequently obtained from Vietnam.

ECOLOGICAL STUDIES ON A HERBICIDE-EQUIPMENT TEST AREA (TA C-52A) EGLIN AFB RESERVATION, FLORIDA, FINAL REPORTS JANUARY 1967 TO NOVEMBER 1973

The Air Force systems Command studied the ecological consequences of repetitive applications of massive quantities of herbicides from 1962 to 1970. The Command studied approximately one square mile at the Eglin Air Force Base Reservation in Florida. During this period, 346,117, pounds of herbicides (including 160.948 pounds of 2,4,5-T) were spread on the test area because of aerial spray equipment testing programs. The January 1974 report was authored by Capt. Alvin L. Young, Ph.D; Associate Professor of Life Sciences, United States Air Force Academy.

An evaluation of the effects of the spray equipment testing program on faunal communities was conducted from May 1970 to August 1973. In a 1973 study liver and fat tissue from 70 rodents from both on and off the test area were analyzed for TCDD. The analysis indicated that TCDD or a chemically similar compound accumulated in the liver and fat of rodents collected from an area receiving massive quantities of 2,4,5-T. On the basis of pathological studies, however, there was no evidence that the herbicides produced any developmental defects or other specific lesions in the animals sampled or in progeny. Lesions were interpreted to be of naturally occurring type and were not considered related to any specific chemical toxicity.

FATE OF 2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN (TCDD) IN THE ENVIRONMENT: SUMMARY AND DECONTAMINATION RECOMMENDATIONS

The Department of Chemistry and Biological Sciences. United States Air Force Academy, initiated studies on Agent Orange and TCDD in April 1972, at the request of the Air Force Logistics Command. These studies were to (1) investigate soil incorporation/biodegradation as a disposal method for Agent Orange; (2) investigate the ecological effects associated with past uses of Agent Orange; and (3) investigate the soil persistence and food chain accumulation of TCDD. The October 1976 report was authored by Capt. A. L. Young. Ph.D; Maj. C. E. Thalken, DVM, MS; Lt. Col. E. L. Arnold, Ph.D; Capt. J. M. Cupello, Ph.D; and Maj. L. G. Cockerham, MS.

The report included data on the animal studies conducted at the Eglin Air Force Base Reservation test site (see preceding report summary p. 8). During 1973 and 1974 106 beach mice and 67 fetuses were examined. The authors reported no evidence that the herbicides produced any adverse long-term health effects in the rodents. Specifically, the authors reported that:

Histopathologic examination in 1973 and 1974 of organs from the 173 adult and fetal beach mice showed only lesions which are normally observed in microscopic surveys of large numbers of field animals.

Mature animals with liver levels of TCDD from 20 ppt [1] to 1,300 ppt had no liver lesions. This is most significant in view of the massive quantities of both 2,4,5.-T and TCDD that were applied to the test site.

There was no evidence to indicate that TCDD was mutagenic or carcinogenic in the field at the concentrations noted. None of the 34 fetuses examined from animals captured on the test grid showed teratogenic effects.

The authors concluded that these studies suggest that long-term, low-level exposure (less than 1 ppb [2] to TCDD may in fact not be teratogenic, mutagenic, or carcinogenic.

ENCLOSURE IV

CHARACTERISTICS OF HERBICIDES USED IN VIETNAM

The physical and biological characteristics of the components of the herbicides used in South Vietnam as summarized by the National Academy of Sciences in its February 1974 report, are presented below.

PICLORAM

Picloram, a component of Agent White, is a selective herbicide highly active on many broad-leaved plants. In the form used in herbicide operations in SVN it has a low volatility, making damage by vapor unlikely, but has a high solubility in water and a high stability in soil which may result in problems with herbicide movement in surface and drainage waters.

The acute oral toxicity of picloram and its salts and esters is low for mammals, and chronic toxicity is low for mammals and a variety of other animals including birds, fish, and crustaceans. No toxicity studies in man are known. No teratogenicity was found in rats at 1,000 mg/kg/day.[1]

CACODYLIC ACID

Cacodylic acid, the active component in Agent Blue, is a nonselective herbicide that kills many herbaceous plants. It is a nonvolatile, highly soluble organic arsenic compound which is broken down in soil, mostly into inorganic arsenate bound as insoluble compounds which also exist naturally in the soil.

Acute and chronic toxicity studies in a variety of animals indicate a low-to-medium toxicity rating. No teratological studies nor toxicity studies in man seem to have been reported.

2,4-D AND 2,4,5-T

2,4-D and 2,4,5-T as the butyl esters, the active constituents of Agent Orange, are moderately volatile and highly insoluble in water; the triisopropanolamine salt of 2,4-D, present in Agent white, is nonvolatile and very soluble in water. Both 2,4-D and 2,4,5-T are stable at ambient temperatures. They are not very persistent within the plant because they are bound into nontoxic complexes or degraded. A highly toxic compound, TCDD, is a contaminant of 2,4,5-T but not 2,4-D (nor picloram).

Persistence of 2,4-D and 2,4,5-T in the soil is limited, and breakdown is largely accomplished by microorganisms. Adverse effects on soil microorganisms are found at concentrations of 100 ppm or more—about four times higher than would have been caused by one Agent Orange mission in SVN.

Extensive toxicological studies have shown 2,4,5-T and 2,4-D to be moderately toxic but are still inadequate to define the pharmacology or mechanisms of pathology. In acute exposures, the LD_{50}[1] ranges from 100 (pigs) to 2,000 (chicks) mg/kg.[2] Chronic doses are better tolerated and there is little cumulative action—e.g., 100 mg/kg/day for a year caused only minor deleterious effects in cattle, sheep, and chickens. A variety of unsatisfactory observations suggest that these

[1] Parts per trillion.
[2] Parts per billion.
[1] Milligrams per kilogram of body weight per day.
[1] LO_{50}—Single lethal dose to 50 percent of test population of animals.
[2] mg/kg—milligrams per kiligram of body weight.

contaminant 2,3,7,8-tetrachlorodizenbo-p-dioxin TCDD. Mixtures of these herbicides equivalent to or approximating the composition of Agent Orange have been available commercially and used in this country as well as in other countries. The health problems in the production and use of these compounds or their mixtures has been mainly associated with 2,4,5-T and its chlorinated dioxin, TCDD.

In acute and subchronic studies in experimental animals, 2,4,5-T and its contaminant TCDD have been associated with close related fetotoxic and teratogenic effects in mice, rats and hamsters. The data suggest that quantitative levels of these compounds constituting a potential harmful exposure might be estimated if one limits the question to short-term risk. This is not the case with reference to potential long-term risk.

In chronic studies, the data suggests that 2,4,5-T is carcinogenic in mice. Other data indicates that TCDD is carcinogenic in rats, and may be a strong promoter of the carcinogenicity of other chemicals. There also is evidence indicating that other chlorinated dibenzodioxins less acutely toxic than TCDD may be carcinogenic.

It becomes apparent that evaluation and prediction of the possible latent manifestations of adverse health effects in humans exposed to low or high levels of a mixture of 2,4,4-D and 2,4,5-T containing a poorly defined spectrum and concentrations of dioxins is almost impossible. This is not to say that extensive reviews of the problems have not been published—National Academy of Science, Committee on the Adverse Effects of Herbicides in Vietnam, 1974. A recent review by the International Agency for Research on Cancer (IARC) states the following in terms of possible carcinogenic effects in humans.

> A number of cases of cancer have been reported in workers exposed to TCDD, but no adequate epidemiological studies were available. An increased proportion of liver cancers has been reported in Hanoi, after the spraying of herbicides (2,4-D and 2,4,5-T) containing TCDD in South Vietnam. The significance of these observations cannot be assessed because not enough details were reported. More details of the reported cases and more extensive observation of the exposed people are needed before an evaluation of the carcinogenicity of chlorinated dibenzodioxins to man can be made.

In the first paragraph, in referring to the presence of this mixture and its use in this country, I would like to point out that the concentrations of the Agent Orange are of such a nature that they approximate 96 percent. They are said to be a 50–50 mixture. That type of material was registered in this country, was in use in this country in 1970.

However, the material was in a concentrated form for the purpose of diluting and using it in a diluted form.

The question as to whether the material used in Vietnam was a concentrated form should be asked. Not only is it a matter of the rate of application, but the concentration of the solution itself that was used. This makes a difference.

The other point is with reference to some of the work of BAMS, who reported in 1973, stating that the most significant finding in both mice and guinea pigs treated with sublethal doses of TCDD were in the lymphoid system, resulting in suppression of cell mediated immunity; low levels of TCDD that did not produce overclinical or pathological changes still reduce those defenses.

in connection with amendments to the law, and that if it is determined that an adverse health effect exists, it would be the intention of the VA to establish some sort of an outreach effort to inform those who may have been exposed of that possibility?

Dr. HABER. Yes, sir. I would consider it our public duty and responsibiilty to do that. I would have to defer to the General Counsel with respect to what our legal authority is in such a matter.

Mr. JOHNSTON. I would think we would have sufficient legal authority to make such an outreach.

Mr. SATTERFIELD. If you found that you did not, would you come to us to request it?

Mr. JOHNSTON. Yes, sir.

Mr. SATTERFIELD. I ask that question because one of my colleagues made inquiry about the outreach program and the response from the VA indicated none was now contemplated. I assume again that this response reflects the fact that your investigation is an ongoing one and you do not feel you have evidence now to justify it.

Dr. HABER. Precisely.

Mr. SATTERFIELD. I would like to echo what other colleagues have said in extending congratulations to the VA for the effort it is making. I am pleased particularly that you are proceeding on the presumption that you do not have all the answers and that you feel it is necessary to pursue every course of action in order to ascertain whether or not exposed veterans have been adversely affected.

I congratulate you for utilizing all of the resources at hand in that quest. I feel you have made a very interesting presentation in terms of what you are doing and what you plan to do. Again, I just want to say that we on this committee join you in that effort. At any time you feel we can be helpful, we certainly want you to let us know.

Dr. HABER. Thank you very much, Mr. Chairman.

Mr. SATTERFIELD. If there are no other questions, I wish to express our appreciation to you for appearing here this morning. Your testimony will be very helpful to us.

Thank you, sir.

Our next witness is Dr. Cueto, Director of the Pesticides Program, National Cancer Institute, Department of Health, Education, and Welfare.

Dr. Cueto, we welcome you this morning. We would be very happy to receive your statement.

STATEMENT OF DR. CIPRIANO CUETO, DIRECTOR, PESTICIDES PROGRAM, NATIONAL CANCER INSTITUTE, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Dr. CUETO. Thank you, sir.

Mr. Chairman, I have a written statement which I have submitted and I would like to read that and then after that to emphasize at least three points in the statement.

Mr. SATTERFIELD. You may proceed.

Dr. CUETO. In general, extensive information exists on the acute and subchronic toxicity of the herbicides, 2,4-dichlorophenoxyacetic acid, 2,4-D, and 2,4,5-tricholorophenoxyacetic acid, 2,4,5-T, and its

findings apply also to man (if effects caused by TCDD are excluded). Acute exposures such as drenching by sprays sometimes produced vomiting, headache, reduced sensory perception, and limb paralysis. Long-term occupational exposure did not produce any consistent signs of toxicity.

2,4,5–T is moderately teratogenic in mice; cleft palates were produced in the offspring of mice treated with 300 to 100 mg/kg/day through day 6 to 15 of pregnancy or a single dose of 150–300 mg/kg on a day 12 or 13.

Kidney anomalies occurred in some strains. Less clear-cut results were obtained in the hamster and rat. No malformations were produced by similar chronic treatments in some rat strains and rabbits, sheep, and rhesus monkeys. The significance of these findings for man, if any, has not been established.

TCDD (2,3,7,8-TETRACHLORODIBENZO-PARA-DIOXIN)

TCDD, a contaminant of 2,4,5-T and thus of Agent Orange, is a very toxic material. Its teratogenicity in mice is well established, though in rhesus monkeys no teratological effects have been found. The toxicity to adults of different animal species varies within wide limits (over 1,000 times), and teratogenicity in mice also varies considerably between strains. The teratogenic dose can be lower than the embryolethal dose which, in turn, is somewhat lower than the adult toxic dose. Presence of TCDD in 2,4,5-trichlorophenol and 2,4,5-T was responsible for chloracne outbreaks and other toxic effects in workers involved in the manufacture of those products.

The presence of TCDD in 2,4,5-T has caused great public concern, and TCDD may indeed pose a great environmental hazard. It is a stable and persistent compound, but it seems to be taken up by plants to only a very limited extent and is not transported from early- to late-formed parts. This inability to transport in plants and its low solubility, relatively long persistence, and lack of vertical mobility in soils, makes TCDD more nearly resemble the chlorinated hydrocarbon insecticides in behavior than it does the more biodegradable phenoxy acid herbicides such as 2,4-D and 2,4,5-T, and even picloram. It can be concentrated by aquatic organisms in experimentally designed ecosystems, but to a lesser degree than DDT. Contamination of underground water supplies appears very unlikely.

2,4,5-T is probably the main source of TCDD in the environment. It should however, be realized that at the present level of less than 0.05 ppm TCDD in the about-5,000.000 pounds of 2,4,5-T presently manufactured annually in the United States the amount of TCDD thus produced is maximally about 4 ounces (110 grams) per year which are spread over several million acres. 2,4,5-trichlorophenol should not be entirely disregarded as another potential source of TCDD. A closely related compound hexachlorodibenzo-para-dioxin, toxic at levels about 10 to 30 times higher than TCDD, may be present in or produced from a widely used chemical—pentachlorophenol. All herbicides used in the herbicide operations in SVN are toxic to animals in varying degrees. Some have been found to kill, damage tissue, or malform embryos of exposed pregnant female animals. TCDD is highly toxic and is teratogenic at least in mice. Although all these findings cannot be extrapolated to man, the question of possible harm to human embryos is raised. Further intensive studies are especially required on the ecological distribution, the pharmacology, mechanism of toxicity, and possible mutagenicity and carcinogenicity of TCDD and its possible teratogenicity in man.

Mr. SATTERFIELD. The purpose of this hearing, as I have stated, is not to inquire into the validity of use of Agent Orange in Southeast Asia but to concentrate on whether exposure to that herbicide had any adverse effects on health. If the problem does exist with regard to certain Vietnam veterans, we want to know it, and we would like to know it at the earliest practical time. We want those veterans to know it. If, on the other hand, no problem exists, we want to know that also. We feel that we have reached the point where we need to know more and that the public needs to know more about what has been done and what is being done about this problem. This hearing is designed specifically to help us learn whether we know everything there is to know about the health effects on veterans as a result of an exposure to

Agent Orange; what questions, if any, remain unanswered; what is being done to determine the answers to such questions; and what progress is being achieved in that regard.

If additional research is necessary, we want to know that. This committee is in a position to aid and assist such inquiries, especially if action by Congress to assist research is indicated.

This morning we have witnesses from the Veterans Administration, the Department of Defense, the Department of Health, Education, and Welfare, and the Veterans of Foreign Wars. With the exception of the witness from the Veterans of Foreign Wars, each of these is represented in the membership of the Ad Hoc Committee on Herbicides which was appointed by the Chief Medical Director of the VA, in May 1978 to explore:

A. The potential adverse effects of defoliants on the health of Vietnam veterans, including the symptoms and signs associated with those effects.

B. Methods for diagnosing and treating any adverse health effects discovered.

C. Approaches through which the VA might attempt to discover the relevance of adverse effects to defoliants on its patient population.

I am sure the remarks of our witnesses will assist us in these inquiries.

At this time I recognize Hon. John Paul Hammerschmidt, the ranking minority member of the full committee and the subcommittee, for any opening remarks he wishes to make. Mr. Hammerschmidt.

Mr. HAMMERSCHMIDT. Thank you, Mr. Chairman. I would like to express my own satisfaction that we are having these hearings today. I think this places our committee in the proper role of coordinator to help agencies on the one hand and citizens' groups on the other to understand what is happening in our effort to come to grips with the possible effects of Agent Orange. I am pleased that the Department of Defense, the Veterans' Administration, and the Department of Health, Education, and Welfare will be testifying.

This should provide us with information regarding coordination within the executive branch and should also address the most important areas of concern. These areas are, in my opinion, the following:

What, indeed, is the toxic effect of this chemical?

Who and how many of our servicemen were exposed to it, and what was the level of exposure?

Finally, what efforts are being made to aid these veterans as the matter is being studied?

I am also, of course, thankful the veterans groups are to be represented as I look forward to hearing their views on what else might be done to responsibly address the need of our veterans to obtain relief in those cases where relief is warranted.

This concludes my statement, Mr. Chairman. I look forward to hearing from the witnesses.

Mr. SATTERFIELD. Thank you.

Before proceeding, I would like to make a statement. When we set these hearings we were not aware that today is a holiday for some of our colleagues, several of whom had indicated they wished to attend and to testify. In light of that fact, it is my feeling that the record

Dr. HABER. I would only suggest that we are anxious to get the truth wherever we can, Mr. Edwards. If that remains a significant possibility, I would wonder if—it would be possible for Veterans Administration to somehow run that down.

Mr. EDWARDS. Thank you.

Mr. SATTERFIELD. I might observe at this point that you are not in a position probably, to voluntarily obtain that information?

Dr. HABER. I think that is extremely accurate, Mr. Chairman.

Mr. SATTERFIELD. Mr. Hammerschmidt.

Mr. HAMMERSCHMIDT. Dr. Haber, I have one more question that is probably a highly—it is highly technical knowledge to respond to, which you have. I am not sure I am going to ask it right.

Regarding the food chain presence of dioxin, I wonder what happened when it entered water. The veterans often drank water in areas where defoliation had occurred and the water came from standing sources such as bomb craters, where rainwater had accumulated. If dioxin ran off of these areas into the craters, I wonder if it loses its toxic nature or could it have a concentrated effect in that particular situation?

Dr. HABER. To the best of my knowledge, dioxin is not soluble in water, although it is, I believe, in diesel fuel oil and alcohol solvents. It would be impossible for me to speculate on how much was dissolved in drinking water someplace. I think that is difficult to answer.

Mr. HAMMERSCHMIDT. So you are saying the possibility is there, there could be a concentrated effect?

Dr. HABER. Yes, there could be, although I think solubility in water is very minimal.

Mr. HAMMERSCHMIDT. Thank you, sir.

Mr. SATTERFIELD. I have a couple of questions.

I noticed in your report that you refer to the fact that there was no adequate laboratory in the VA, which you can identify, that might do pertinent investigative work. You identified the University of Colorado as being available for certain research. Is it your feeling that you might need additional funds by way of appropriation for that purpose? Or can this be handled within the framework of funds already available, or do you know?

Dr. HABER. Although I may be guilty of naivete, I would think this is something we could probably undertake within existing funds.

Mr. SATTERFIELD. The reason I ask the question is that if it is determined that funds are needed for this purpose, this committee would be most interested in any suggestion or report dealing with such a problem. In that case, I hope you will communicate with us.

Dr. HABER. We are mindful of the committee's interest and grateful for the suggestion. Actually, the chemical analysis requires a mass spectrography which is not usual in laboratories. We went to considerable difficulty to identify places where this test could be cranked up. Our plan is to go ahead with this research study. If we find significant differences, then we would say to veterans who are applying, "If you are willing to submit to the biopsy, we can definitely ascertain whether you have traces of carcinogenesis."

Mr. SATTERFIELD. If I interpret your message correctly, you are telling us that if it is determined down the road that there are genetic effects, you will be making recommendations to us, possibly sicians, physicists, toxicologists, chemists, a whole variety of people of all kinds of political persuasion. I think if there was ever any objective study, these two studies would seem to me to be able to meet that qualification.

Fr. CORNELL. You think therefore there might very well be the—these effects might result from the food chain of the Vietnamese people, the results of it?

Dr. HABER. I would think that is certainly a possibility that has to be considered.

Fr. CORNELL. One last question.

You mentioned in your statement on page 9 that equally large quantities of the same herbicides were used in the United States without the deluge of concerns over adverse health effects. Do you not think it is possible that the people involved might not have realized the source of problems that they subsequently had, the relationship of dioxin to their physical ailments?

Dr. HABER. Yes, sir; I do.

Fr. CORNELL. And as a consequence, also, it could be, as far as the veterans are concerned, that they did not realize this either until the news media carried the stories about it and, as a consequence of course, you had these applications for consideration?

Dr. HABER. Entirely possible.

Fr. CORNELL. Thank you, Mr. Chairman.

Mr. SATTERFIELD. Thank you. Mr. Edwards.

Mr. EDWARDS. Thank you, Mr. Chairman.

Both the Surgeon General and you, Dr. Haber, rely to a certain extent on the report and study of the National Academy of Sciences released during 1974 to the effect generally that the use of herbicides by the American Armed Forces in Vietnam, did not result in serious injury to American military there. Now, however, in your statement you do point out that there are allegations of serious health consequences as a result of the defoliation for North Vietnamese and Montagnard women and children and that their later publications appeared under authorship of North Vietnamese physicians alleging significant damage to Vietnamese who were exposed to Agent Orange.

Why would the Vietnamese be damaged while the American GI's would not be?

Dr. HABER. Well, I think—first of all, the likelihood of more intimate exposure on the part of the North Vietnamese than American troops is, I imagine, significantly greater. I think one would have to, without impugning anybody's integrity, wonder about the objectivity of North Vietnamese physicians. What I am trying to suggest is that in time of war, when there were difficulties of various sorts, that it could be construed that the Vietnamese physicians who reported such instances might have been less than completely objective. That is, I think, the only point we are trying to make.

Mr. EDWARDS. Perhaps doctors from the Veterans Administration could go over and ask them whether their reports were valid or not?

Dr. HABER. It would be extremely difficult at this time to assure the accuracy of some of those observations. Although the——

Mr. EDWARDS. But you are having such a great difficulty in finding out whether or not there was any effect, you have no diagnostic method and perhaps they have. They are not totally unskillful.

of this hearing should remain open so that these colleagues will have an opportunity to submit statements for inclusion in the record of these proceedings. Accordingly, without objection the record of these hearings will remain open for 30 days for this purpose.

Our first witness this morning is Major General Dettinger, Deputy Surgeon General of the U.S. Air Force.

General, we welcome you this morning. I understand you have several gentlemen with you.

Mr. EDWARDS. May I ask some questions?

Mr. SATTERFIELD. Yes.

Mr. EDWARDS. This is the first time I have seen all this information. I was wondering why all of the testimony was not delivered to us yesterday or the day before.

Mr. SATTERFIELD. Can the staff answer that?

For the record, in case the reporter could not hear the staff response, the statements in question were not submitted and therefore not received by the subcommittee staff until yesterday afternoon for some and this morning for others.

Mr. EDWARDS. Mr. Chairman, I think all the witnesses ought to explain why the information is so delayed. It really gets in the way of a proper hearing if we have to hear the information and read the material for the first time while the witness is testifying.

Mr. SATTERFIELD. I quite agree with the gentleman. Perhaps our witnesses, when they begin their statements, will offer an explanation. We would be happy to hear it. Meanwhile General Dettinger, I understand you have several colleagues with you. It will be helpful to the record if you will introduce them.

STATEMENT OF MAJ. GEN. GARTH DETTINGER, DEPUTY SURGEON GENERAL, U.S. AIR FORCE, ACCOMPANIED BY CAPT. AL YOUNG, FROM U.S. AIR FORCE OCCUPATIONAL AND ENVIRONMENTAL HEALTH LABORATORY, BROOKS AFB, TEX., AND TOM DASHIELL, OFFICE OF ASSISTANT SECRETARY OF DEFENSE, RESEARCH AND ENGINEERING

General DETTINGER. Mr. Chairman, I am Maj. Gen. Garth Dettinger.

I have with me on my right Dr. or Capt. Al Young who has a Ph. D. in plant physiology, who has been with the herbicide program in the Air Force for the last 10 years. I can say that he is probably one of the world's leaders in knowledge of plant herbicides.

On my left, Mr. Tom Dashiell, of the Assistant Secretary of Defense's Office for Research and Engineering who also has had years and years of experience with herbicides.

Sitting behind me is Maj. James Tremblay, who is a registered professional engineer and who is associated with the USAF Occupational and Environmental Health Laboratory.

We only heard about this late Friday evening that we were to testify. The gentlemen who are involved here with us were in San Antonio. They came up during the holiday period and prepared the statements over the weekend for this rush hearing. As a matter of fact, I asked that it be delayed just a bit so we could more carefully prepare a statement and get it to you for your deliberation.

In addition, the large tome we prepared here is just hot off the presses, and that was one of the problems. It had not yet been released at all, and it is here now for the first time—thousands and thousands of man-hours of work. With that Mr. Chairman, may I begin?

Mr. SATTERFIELD. The letter that I sent was to the Secretary of Defense. And if I understand you correctly, you are saying that you were designated to appear for him as late as last Friday?

General DETTINGER. Yes, sir.

Mr. SATTERFIELD. Do you have any additional questions, Mr. Edwards?

Mr. EDWARDS. No.

Mr. SATTERFIELD. Thank you, sir. You may proceed with your statement.

General DETTINGER. Mr. Chairman, gentlemen, it is a pleasure to be here today to talk about the toxicology, environmental fate, and human risk of Herbicide Orange and its associated dioxin.

Two phenoxy herbicides, 2,4–D and 2,4,5–T, both registered by EPA, were used to formulate Herbicide Orange. All herbicides were procured from commercial sources to a military specification. Each of these herbicides has been used extensively in agriculture since the mid-1940's.

Would you believe Mrs. Fanny Fern Davis was the first to use this on the White House lawn? It was 2, 4–D and it was widely publicized at the time; so these herbicides have been used for a long period of time.

During the 9-year period from 1961 through 1969, approximately 78 million pounds of 2, 4, 5–T were used domestically in the United States; while between 1961 and 1971, a 10-year period, approximately 52 million pounds of 2, 4, 5–T were disseminated in South Vietnam. The 2,4,5–T contained the contaminant dioxin, a highly toxic compound formed during the production processes. The amount of dioxin disseminated in the United States during the 9-year period between 1961 and 1969 was probably at least four times the amount disseminated in South Vietnam. However, the domestic and worldwide use of such herbicides has not resulted in a documented increase in illness among users or the general population. There are many anecdotal episodes but pure scientific evidence of a cause and effect relationship is not there yet.

The use of Herbicide Orange in South Vietnam was primarily for the purpose of denying the enemy the cover of dense jungle foliage. The potential for exposure of U.S. military personnel to direct spray of Herbicide Orange would have been highly unlikely. Much of the aerially applied spray was deposited on the dense canopy cover in remote areas, and I stress again, in remote areas held by the Vietcong or the North Vietnamese, not our own troops.

The amount of herbicide penetrating to the forest floor (6 percent of that applied) would have been similar to the levels normally applied to brush-infested ranch land in the United States. Entry into a treated area by military personnel in South Vietnam could then be viewed as similar to entry into defoliated brush-infested ranch land in the United States treated with 2, 4, 5–T if our troops entered there at all.

effects due to herbicides and his medical record demonstrates the presence of chloracne beginning terminus with his exposure or within a period of several weeks or a few months thereafter, we have something very solid to go on. All I am saying is that that is one definite link we feel confident about that has been established.

As Mr. Peckarsky indicated already, service connection has been granted on that basis.

Fr. CORNELL. But that is the only claim where it has been granted?

Dr. HABER. Yes. That is the only instance where we can definitely make a link. We are not saying, and I hope I am not providing the impression, that there is no chance that all these other broad effects cannot occur. All we are saying is that at this time the cumulated weight of the evidence, two massive studies, one done by the National Academy of Sciences completed in 1974, one done by the Air Force just recently completed, these two studies do not provide us with incontrovertible evidence that there is a relationship between exposure and all these alleged ill effects. The only thing we can really hang our hat on is the chloracne.

Fr. CORNELL. I gather from your testimony also that you seem to concur with the statement of genetics injury, that exposure was probably for most of the soldiers in Vietnam one-time remote exposure; is that correct?

Dr. HABER. I could not disagree with that; yes, sir.

Fr. CORNELL. And therefore, we would not have any evidence of food chain effect in our veterans as far as herbicides were concerned?

Dr. HABER. No, sir, I would not care to go that far. I think there are reports in the research literature which indicate that there may be evidence of chlorinated hydrocarbons in our food chain already in this country. One study I remember having seen at the University of Florida indicated that healthy male athletes showed evidence of chlorinated hydrocarbons in the urine, indicating some of these hydrocarbons may have already entered the food chain.

I think the point is, if we find a veteran now who has evidence of chlorinated hydrocarbon somewhere in his body, one would have to ask whether this came from just the normal food chain cycle in this country or from Vietnam.

I suppose there are quantitative differences that we could find to differentiate between those.

Fr. CORNELL. But you do think it is possible that they might have felt the food chain effect even in the service in Vietnam?

Dr. HABER. I would think that is possible, yes, sir.

Fr. CORNELL. What validity do you—if you would care to give an opinion—place on the publications that you mentioned under the authorship of North Vietnamese physicians alleging various effects, infertility, abortion, and such?

Dr. HABER. Based upon my rather detailed reading of the National Academy of Sciences report and the hurried reading which I have been able to give this new report from the Air Force which just reached us in the last 24 hours, these are both very authoritative views, in my opinion. They are the most informative and objective documents at hand. They represent thousands of man-hours of work by objective, well-qualified scientists of all kinds of persuasions, biologists, phy-

Mr. HAMMERSCHMIDT. Dr. Haber, you mention in your statement the 1949 industrial accident in West Virginia. Has any data evolved from this accident that you have in hand and, if not, when do you expect to have that data?

Dr. HABER. Yes, sir. There has been some data, but it is not as complete as we would like. What happened was, there was an industrial explosion in this town, a number of people were exposed, some 233; they all became ill. The recovery was complete in almost all cases. There seemed not to have been any definitive evidence that any of those patients, people, died of malignancy or other causes attributable presumably to the herbicide.

We are working with a number of other government agencies to get to the bottom of that. We feel that that and, as the previous witness indicated, several other accidents need to be examined in greater detail. We are working with a number of Federal agencies to try to get to the bottom of this and, if need be, we will do whatever has to be done in order to get definitive answers to those questions.

Mr. HAMMERSCHMIDT. Well, if you should come to any conclusions or tentative conclusions that you think would be appropriate and helpful to these hearings while the records are still open, I am sure that the chairman would appreciate them, should that develop.

Dr. HABER. Indeed.

Mr. HAMMERSCHMIDT. The Department of Medicine and Surgery circular provides for the quarterly reporting concerning veterans requesting assistance for herbicide-related symptoms. For whom is this report prepared?

Dr. HABER. For the Associate Deputy Chief Medical Director, but it would come to my attention. I am the responsible agent in the Department of Medicine and Surgery.

Mr. HAMMERSCHMIDT. When will the first report be prepared?

Dr. HABER. The first report is due I believe October 16. We will have some data about that.

Mr. HAMMERSCHMIDT. Will this committee be furnished a copy of those reports for our hearing record?

Dr. HABER. Yes, sir.

Mr. HAMMERSCHMIDT. Mr. Chairman, in most of those inquiries I have made on any evidence that might develop from the Veterans' Administration, I ask unanimous consent it be included in the record in the proper manner.

Mr. SATTERFIELD. Without objection it is so ordered. The file of this hearing will remain open for a reasonable period of time to receive any such reports.

Mr. HAMMERSCHMIDT. Thank you, Mr. Chairman.

Mr. SATTERFIELD. Thank you. Fr. Cornell.

Fr. CORNELL. Thank you, Mr. Chairman.

Dr. Haber, am I correct in concluding from what you said that chloracne is the only problem that you feel today might be related to exposure to the herbicides?

Dr. HABER. No. I think that goes a little bit further than I would care to go. What we are saying is that chloracne is important because it is the most unequivocal evidence of tissue damage because of exposure to the herbicides. We know when a veteran alleges long-term ill

Ground combat forces normally did not enter a previously treated area for several weeks after treatment, if at all, because defoliation did not occur until 3 or 4 weeks following treatment. Numerous environmental factors e.g., photodegradation has been shown to destroy dioxin within a matter of hours—probably within 6 hours but certainly within 24 hours, would have reduced the potential for exposure to military personnel under such circumstances.

Some U.S. personnel were exposed to the herbicides—and I refer to those actively engaged in the handling and dissemination operations. Some absorption of chemicals following direct skin contact and by inhalation of vapors and aerosols did undoubtedly occur, but percutaneous absorption would have been minimal because of the closed transfer systems employed and the use of protective equipment employed during ground loading operations. Nonetheless, occasional leaks did occur during ground handling operations and sporadic skin contact could have occurred.

In the airborne operations, occasional leakage also occurred. The potential for exposure of the vapors of 2,4–D, 2,4,5–T and dioxin in the ground loading or airborne operations would have been similar to our disposal operation of 2.2 million gallons of Herbicide Orange in the summer of 1977.

I am pleased to report that during the disposal operations, where we maintained the strictest surveillance operations, the level of 2,4–D and 2,4,5–T were at least two orders of magnitude below the accepted permissible exposure levels for these materials. No dioxin was detected during ground transfer disposal operations in any air samples collected. It is reasonable to conclude that the levels of 2,4–D, 2,4,5–T and dioxin in air during routine ground transfer and airborne operations in South Vietnam would not have been any different than the levels noted during the disposal operations in 1977.

A comprehensive occupational physical examination program was conducted as part of the disposal operation. A comparison of available preoperational and postoperational physical examinations did not reveal any acute physical effects as a result of involvement in the dedrumming and transfer activities where these 2.2 million gallons were dumped to be carted away and disposed of.

Ground combat forces and combat helicopter elements were routinely exposed to aerially applied insecticide and smoke screens immediately prior to, and during air and ground assault operations. The insecticides (primarily malathion, which is used extensively in this country and is the prime insecticide used) were for the purpose of reducing mosquito populations in an attempt to control malaria and the smoke screens were to provide camouflage. I want to stress that herbicides were not used in this fashion.

In general, if the available data on animal toxicology for 2,4–D and 2,4,5–T were classified according to the U.S. Environmental Protection Agency scheme, the relative toxicity of 2,4–D and 2,4,5–T would be classed as slightly to moderately toxic. By this same scheme dioxin would be classed as extremely toxic. Animal toxicology data indicate that no-effect dose levels for 2,4–D, 2,4,5–T and dioxin do exist in animals. It is reasonable to conclude, therefore, that there also exist threshold levels of exposure for humans below which no effects would occur. Animal experiments do confirm that there is a clear species susceptibility difference and, in fact, the experience with a number of episodes involving human exposure to dioxin suggests that man is a more resistant species to dioxin than other animals. In addition, in cases where documented exposure to dioxin has occurred—and there have been at least 28 industrial occupation exposures—the reported physical effects were, in general, transitory.

The tumorogenicity, teratogenicity, or mutagenicity of dioxin have not been substantiated in humans; however, as with many other chemical compounds routinely found in the environment today, the long-term effects of even the slightest exposure to dioxin cannot be unequivocally defined at this time.

Chloracne is a visible, diagnosable acniform condition which can occur following exposure to TCDD (dioxin). In the absence of chloracne, systemic symptoms would have been unlikely in our U.S. personnel assigned to Vietnam. It is conceivable that mild chloracne signs could have developed and gone undetected and that mild systemic conditions including the nervous system (tingling or numbness in the extremities), mild psychiatric conditions (nervousness, anxiety, depression), or other systemic involvements (such as malaise, weakness or loss of appetite) could have also gone undetected. These symptoms, however, would have cleared shortly after removal from exposure to the chemicals as has been shown to occur in industrial accidents where individuals were known to have been exposed to high levels of dioxin; thus any current symptoms claimed to exist by Vietnam veterans are almost certainly due to some etiology other than the past exposure of these individuals to Herbicide Orange in Vietnam.

I regret that we were not able to present this large tome in a more timely manner. It really only came to my attention this past Friday. This does represent a massive amount, and probably the single most comprehensive compilation of the world's literature on the toxic effects of herbicides and dioxin.

With this, Mr. Chairman, I would like to present this for your exhibit. Thank you very much. We will try to answer any questions.

Mr. SATTERFIELD. I understand you are presenting it for the record?

General DETTINGER. Yes; Mr. Chairman.

Mr. SATTERFIELD. Without objection. It will be accepted in the file of these proceedings so that it will be available for inspection and it is ordered. Would you answer the questions now of Congressman Edwards.

Mr. EDWARDS. Thank you, General, for your testimony. It is your conclusion, after your studies, that the claims made by certain persons with regard to the damage that the spraying of this herbicide in Vietnam resulted in is generally without foundation?

General DETTINGER. Yes; we feel that is so from our present evaluations of the entire world literature and evaluations of the substance over many years at our Eglin Test Range. There is no denying that the contaminant dioxin, which was unknown during the early production because simply it was not detectable at the amounts that it was contained in the 2,4,5-T, certainly is a toxic substance. However, the distribution of this was so minute generally, certainly far, far less than the industrial accidents that have occurred, such as an acci-

Mr. SATTERFIELD. Thank you for that explanation. I noted in the statement of Dr. Haber that he said no health care had been deferred or denied any veteran alleging adverse health effects as a result of exposure to herbicides. I assume by your statement that you mean if a veteran has a health defect which he can demonstrate was incurred in the service and which did not exist prior to that service, then he is being treated, that the question of what may have produced that defect insofar as his own opinion is concerned is not the point. The point is whether he has a disability, regardless of cause.

Dr. HABER. Precisely, Mr. Chairman.

Mr. SATTERFIELD. Thank you, sir. Mr. Hammerschmidt.

Mr. HAMMERSCHMIDT. Dr. Haber, I would like to congratulate the Veterans Administration for its obvious effort to be fair and thorough in this matter. In your statement, I detect no attitude of callousness nor carelessness. So I am impressed with the way you are on top of it.

I want to turn back to Mr. Peckarsky for a moment to pursue the line of questioning that Mr. Edwards and the chairman were discussing with you, just to clarify for the record and for my own mind.

I note that in the statement that one of those claims that was adjudicated was evidently for—was presumably due to herbicide, a skin condition. Yet under title 38 of the Code you say that there is no allowance for a claim alleging herbicides. That may be because it is related to genetic damage. I am not sure.

Would you clarify how that one claim was allowed, Mr. Peckarsky?

Mr. PECKARSKY. Yes, sir. What we did was told all of our field stations, the 58 field stations we have in every State of the country, to send us a copy of the rating decision, any time there was an allegation that the disability for which they were claiming compensation was or could have been the result of exposure to defoliants in Vietnam.

In attempting to compile a report for the Congress for the purposes of this hearing, we attempted to categorize the various categories of claims in relationship to whether or not there was an allegation that this particular disability was related to exposure. It really, under the law, has no foundation in title 38. The skin condition that we granted service connection for was chloracne. It is, as has been pointed out by Dr. Haber, one of those entities most often associated with exposure to defoliants and this was a rather easy case to service connect.

We have also denied service connection for skin diseases because they were either developed too late to be related in service exposure or were not the proper types of skin conditions or some other agency that could have caused them was shown in the man's history. So there is no firm yes or no conclusion that can be drawn.

Mr. HAMMERSCHMIDT. Well, should medical evidence and time develop in fact that there could be genetic or other physical damage from herbicides, then the code would need to be changed to accommodate, I am assuming.

Mr. PECKARSKY. Genetic damage, yes, sir, definitely. Currently the law only provides for payment of compensation on the basis of average impairment of earning capacity in an individual. So obviously what he passes on genetically to his progeny does not affect his earning capacity and therefore there is no current provision of law to compensate for such potentiality. Should this develop, Congress would have to give this serious consideration.

Mr. EDWARDS. Dr. Haber, I believe you just testified that there is no diagnostic test to determine the presence of dioxin in the body tissue. So how are you going to be able to tell if the 10 test cases have dioxin in the tissue?

Dr. HABER. Well, Mr. Edwards, my point is, there is no standard test at this point that would say, regardless of whether a test shows dioxin or not, that would say yes, this veteran's symptoms are due to herbicide exposure or not. What we are undertaking is a research study which would hopefully lay to rest the charge made by some that dioxin is retained in the fat tissues for long periods of time. That has not been substantiated in human subjects as far as we are aware. So this research study would determine whether or not that allegation is a real possibility.

Mr. EDWARDS. Mr. Chairman, my last question is regarding the 450 to 500 claims that have been filed with the VA claiming herbicide exposure. This is as of September 30, 1978. What has happened to those 450 to 500 cases?

Dr. HABER. With your leave, might I ask Mr. Peckarsky to respond to this question?

Mr. PECKARSKY. Mr. Edwards, of the 450 claims that have been filed, 92 of them have been adjudicated. That is, a decision has been made and a copy of that decision has been forwarded to us in Washington, as is required by our current procedures.

Those 92 claims, 8 of them have been allowed; 72 of them have been denied. That makes a total of 80 claims where we had a specific diagnosis. The other claims had no diagnosis at all and obviously no basis for the allowance of benefits because the law requires that benefits be based on disability. The other——

Mr. EDWARDS. So what are you telling us about the other 400 cases?

Mr. PECKARSKY. They are still in various stages of development trying to present the case in the most favorable light for the veteran, which is our mandate. When all of the evidence that is potential is rounded up and evaluated, they too will be rated and they will also be sent to the central office for review.

Mr. SATTERFIELD. I would like to ask a question at that point about those who have been adjudicated. Were they adjudicated on the basis of exposure to Agent Orange or were they adjudicated on the basis of service-connected disability established by some other means?

Mr. PECKARSKY. Very good question, Mr. Chairman.

There is no such provision under law for relating a claim to an incident or an alleged exposure. The law is based on disability incurred or aggravated coincident in point of time with military service, so that the etiological basis is of really no significance under the law unless it is one of the various disabilities that the law has considered chronic constitutional diseases and poses a statutory period for the granting of service connection, such as arthritis, cancer, multiple sclerosis.

There is no disability relatable to Agent Orange that the Congress has seen fit to call chronic constitutional disability. Therefore, etiology is not an important factor in our adjudications. Development of disability and the ability factually to relate it in point of time to the service are the two elements that we have to develop and that we have to dispose of.

dent in Italy where high concentrations were dumped on the people following an explosion in 1976. Those individuals received documented high levels of dioxin, yet many of the things that have been claimed—higher incidents of spontaneous abortions—have not occurred.

Higher incidences of birth defects have not occurred. Persistent symptoms have not occurred. Therefore, taking these into account, together with review of the literature, we feel clearly the risk or the possibility of individuals having sustained some adverse effects from use of Agent Orange in South Vietnam is extremely remote—extremely remote.

I cannot say that on a rare occasion in some remote location some people were not sprayed directly, but this was never the way it was done in the operational field. What many people saw were these other antipesticides and antiinsecticide operations going on, or the smoke that was often given as combat troops went into an area. But almost exclusively 94 percent of this material was sprayed in Vietnam in forested areas—only a small amount of it was sprayed on foodcrops, and again it was in the remote areas held by the enemy at that time.

Mr. EDWARDS. General, the U.S. military used this defoliant for a number of years. Why, then, was it halted in 1970 if it was so benign?

General DETTINGER. Well, I think we all know that at that time clearly there was a mounting tide of opposition to the Vietnam war. There was a great deal of public sentiment against our involvement there. This was classified by many people as another chemical warfare agent. In fact, it was used in the United States for 15 years before the Air Force used it in Vietnam, but in its connotation over there it was swept into, I clearly believe, the entire opposition that arose at that time against our involvement in South Vietnam.

I will say purely as a sop to the political side, this was one of the programs we felt should be removed to decrease the opposition to our involvement there.

Coincidentally, at that time there were reports in other areas of the world. There was an episode in Globe, Ariz., which received wide publicity in the press. There were other reports at that time which stimulated public arousal, and so at that point in time it was decided best that we remove the agent which was obviously being accused of widespread but unconfirmed, and since unconfirmed, damage to human life and to property. And as a matter of fact, the National Academy of Sciences carried out a review in 1973 and 1974, and did a thorough evaluation in Vietnam of the results of Herbicide Orange. They came to the conclusion that they could find no evidence of carcinogenesis, mutagenesis, teratogenesis, and that the results were remarkably small on the population and the environment in South Vietnam.

Mr. EDWARDS. Do we have the report of the National Academy of Sciences? Can you make that report available?

General DETTINGER. I believe we can. Yes. Mr. Dashiell has that, and we can make that available to you.

Mr. SATTERFIELD. Without objection it will be admitted in the file of this hearing.

Mr. EDWARDS. General, would you state that this is an accurate statement, that laboratory testing of dioxin on mice, rats, and monkeys has pointed out an alarming incidence of birth defects, miscarriages, cancer, and other disorders in animals exposed to dioxin?

General DETTINGER. There is no question that the dioxin in experimental animals, in concentrations which were considerably above what would normally have been used or to which our troops would have been exposed, have caused problems. There is no question dioxin is a toxic substance. However, some of those studies have been shown ultimately to have a very high level of TCDD present in the material that was used.

Some of the test animals unfortunately were in these series of mice, a series in 1968, a particular strain, that has been shown to have inherently a large birth defect incidence. In some of the Rhesus monkey studies, again, unfortunately, some of the monkeys used in that study were, if you will, leftovers from another study. Therefore, the clear cut cause and effect between dioxin and the findings in the monkeys is under some possible suspicion.

Mr. EDWARDS. My time has expired. I would like to ask you one more question, General. You point out in your statement that in the period 1961 through 1969 approximately 78 million pounds of 2,4,5-T were used domestically in the United States, and during about the same period 52 million pounds were disseminated in South Vietnam.

The area in which the material was disseminated in the United States was how much larger than the area of use in Vietnam?

General DETTINGER. I would like to defer that, please, to Captain Young.

Can you answer that specific question?

I think perhaps we ought to get that for the record.

[The information was submitted as follows:]

Approximately 14 million acres were sprayed in the United States and approximately 3 million acres in Vietnam.

Mr. EDWARDS. Would you guess 10, 20, 30 times greater in the United States?

General DETTINGER. We would rather not guess; and I cannot.

Mr. EDWARDS. It is certainly clear that it was disseminated in the great ranchlands of the West, millions and millions of acres, while it was much more concentrated in Vietnam.

General DETTINGER. Yes; there is this factor. The materials sprayed in the United States in the late 1950's and early 1960's was a variety that had a clearly higher concentration of dioxin than that Herbicide Orange used in Vietnam, so we will have to also modify the statement and say there was more dioxin also delivered, probably 4 times as much minimally in the United States in that amount than was delivered in the 52 million pounds in South Vietnam, but we must admit the area was smaller in Vietnam.

Mr. SATTERFIELD. Mr. Hammerschmidt.

Mr. HAMMERSCHMIDT. Thank you, Mr. Chairman.

General Dettinger, is there medical opinion that disagrees with your own opinion that any current symptoms claimed to exist by Vietnam veterans are almost certainly due to some etiology other than Agent Orange?

General DETTINGER. On any topic there are people who will talk on both sides, and there surely are other individuals who have been seen

Dr. HABER. The procedure to be followed has been outlined in a number of communications we have addressed to our field medical centers. The veteran coming into a VA hospital and alleging exposure will undergo a complete history and physical examination. A specific notation will be made on a 3 by 5 locater card, color-coded for the month in which the veteran appears, on which pertinent data alleging the symptoms, questioning him in detail about the time of exposure insofar as he can remember it, the occurrence of any symptoms at that time.

We have indicated to our physicians and other interested staff that the complete history must indicate any further exposure to other agents, any symptoms of the nature that we have heard so much about, the occurrence of paraseizures, numbness and tingling of the extremities, loss of sexual drive, anxiety or other more organic symptoms such as gastrointensinal discomfort, easy fatigability, any symptoms which can be referrable to any of the organ systems, unusual or protracted infections or others of that like.

Laboratory examinations are then undertaken to confirm the presence of such abnormalities and if there is any reason for it, from the standpoint of skin disease, we would undertake to do a biopsy of the tissue that appeared to be diseased. This material will then be collected and put into a master file. If tissues were taken from the veteran, these would be sent to the Armed Forces Institute of Pathology to be retained in perpetuity against the possibility that new knowledge, subsequently developed, may reveal pathology of a type as yet unknown.

In the central office we are maintaining a total registry of all Vietnam veterans who have presented themselves to the hospital for alleged defects and these will be analyzed as the reports come in.

In addition, we have a special committee set up of internists, neurologists, psychiatrists, pathologists, who will review all cases to determine whether or not there is any clue that the alleged symptoms may or may not have been due to the exposure to the herbicides. If pathology is found of any sort, whether related to this instance or not, the veteran would of course be treated, hospitalized, if he is eligible and if that should turn out to be necessary.

On his medical record, a detailed examination into the facts relating to this exposure through an overprint which we have sent out to our field hospitals is completed and this is also retained in a form which is recoverable.

We are, unfortunately, Mr. Edwards, handicapped by the fact that there is no single specific test which can be done which would verify or deny the possibility of Vietnam exposure. I have made allusion to the fact that we wish—we are now bringing forth a research protocol which will take fat samples from exposed veterans with, of course, their consent, and match this with an equal number of fat samples from veterans who could not have been exposed to dioxin in Vietnam because they were never in Vietnam. We will then determine whether indeed there is the persistence of dioxin in such tissues and whether there is a difference between veterans who have exposure and those who have not. This research study will be conducted by the Veterans' Administration.

15. Dr. Schepers mentioned the current review of cancer incidence statistics which can be derived from the VA's enormous data file which is compiled from the diagnoses reported for each hospitalized veteran (Patient Treatment File-PTF). The annual incidence of liver cancer has recently been reviewed. Records are available for the period 1963 through 1977. There is no conclusive indication that liver cancer has increased in the age categories representative of veterans who served in the Vietnam War. For veterans below the age 25 years, there have been 32 cases over the period 1967 through 1977. This represents an average of about 3.0 cases per year. However, during 1974 there were 7 cases and in 1976 5 cases occurred. In between these two years there were none. (Appendix D-1) When these cancers are averaged out over three year periods (Appendix D-2) there does appear to be a slight increase of cases between 1969 and 1974. For the age group 25 years through 34 years there were 63 cases with an average of about 5.6 per year. However, spurts of cancer increase also occurred in 1973 and 1976. These spurts yielded higher values for the final six years of this review period. There is no explanation yet for this. The records have been called for to determine whether any of these cases represented Vietnam War veterans. The tables do however show that liver cancer has all along been relatively prevalent in the older age group veterans, none of whom may be expected to include Vietnam War veterans.

16. Ms. Offutt stated that the EPA can probably assist with the identification of these individuals. She described the serious concerns of her agency with the question of pollution of the ecosystem by herbicides and pesticides. The rebuttable presumption injunction to which Dr. Kuroda had referred is an illustration of the posture the EPA may adopt on these matters. She clarified that if as a result of the evidence which may be offered during hearings concerning this rebuttable presumption, the hypotheses on which it is based are destroyed, the EPA will withdraw the presumption. Until such retraction occurs, the presumption reflects the persuasions of the EPA concerning herbicide 2,4,5-T. The EPA has a voluminous collection of literature on herbicides, and Ms. Offutt invited members of the committee to consult their library rather than attempting to start all over again.

17. The meeting was adjourned at 4 p.m. The members all expressed preference for a morning meeting. The next session of the committee will be called for September 8, 11, 22 or 25, 1978.

GERRIT W. H. SCHEPERS, M.D.,
Chairman.

Dr. HABER. Thank you.

Mr. SATTERFIELD. Please answer the questions of Mr. Edwards.

Mr. EDWARDS. Thank you, Mr. Chairman, and thank you, Dr. Haber, for your testimony.

It appears that the VA is moving ahead with plans in some depth on this subject. However, even though 7 or 8 months have passed, you have no real results to report to us as yet; is that not correct?

Dr. HABER. Yes, sir, that is substantially correct.

Mr. EDWARDS. As you pointed out on page 9, where your testimony was that approximately 18.85 million gallons of herbicide were sprayed on Vietnam while this study indicates that approximately 107 million pounds—they are gallons, it is different, I see. We will correct that appropriately.

Dr. HABER. Yes, sir.

Mr. EDWARDS. Major General Dettinger's testimony was to the effect that the GI's in Vietnam were not significantly exposed to dioxin. Do you believe that to be your testimony, too?

Dr. HABER. Yes, sir; we would agree with that. Obviously most of our information has to come from the Department of Defense on exposures but we have seen nothing to contravene what they have indicated.

Mr. EDWARDS. Dr. Haber, what procedure do you follow when a veteran walks into a VA office and says that he has Agent Orange poisoning?

on TV who have an opinion diametrically opposed to the one we hold, there is no question. I do not think as yet that the scientific validity of their statements has been proven conclusively at all. Many of the symptoms that people complain of—Vietnam veterans—are those that occur in the normal population without any exposure to chemicals whatsoever.

The alleged numbness and tingling is a very, very common symptom of hyperventilation of individuals who are under some sort of mental anxiety or strain. Depression, malaise, lethargy, clearly go along with individuals who are suffering some sort of emotional trauma in their social adaptation or their living. Impotence, loss of sexual drive is extremely common. These are very vague symptoms. There has not been one single human death reported at all from any exposure to any of these herbicides or dioxin, TCCD, not one.

Mr. HAMMERSCHMIDT. General, is it true as some suggest that one medicine drop of dioxin can kill 1,200 people? That is, I know, an interesting question. What I was wondering, how many tons of Orange go into one drop of dioxin?

General DETTINGER. I cannot give you that figure. There is no question it is extremely toxic in the micrograms. No question. But one drop, it is an amount I just cannot tell you, I am sorry, at this point.

Mr. HAMMERSCHMIDT. Do you believe there is a reluctance within the administration to establish a connection between dioxin and many problems of veterans due to the possible difficulty of processing claims?

General DETTINGER. No, I do not believe so, sir. Actually, what we have been doing is trying our darndest to first get a real handle on the world literature to find out what is scientifically reported in this area. We are giving this now to the Veterans' Administration. We have offered the service of one of our extremely competent physicians to help in their evaluation of the problem. We certainly want to get to the bottom of it, there is no question.

There is a lot of ongoing study in this area not within the Department of Defense right now, although we have collected the names of all Ranchhands—these are the people who were involved with the spraying operation—we have 499 names now we finally collected—very difficult to do this many years later. We have also contacted the president of the Ranchhands Reunion group, and we will be getting to them a questionnaire in an attempt to locate all of the people and to try to survey what happened to these people who we clearly know were involved with handling these materials. These would be the people involved. As for the people who were on the ground—it is extremely remote that any of them would have ever gotten in contact with the material.

Mr. HAMMERSCHMIDT. Have you discussed the operational handling during Vietnam with any of the 300 men who have applied to the Veterans' Administration based on Agent Orange maladies?

General DETTINGER. None of the Ranchhand group as far as we know has made application for any disability. We had one gentleman call from that group recently who said he is married and he wanted to have a child, and he wondered if there was any danger. We assured him we felt there was none. But none of these 499 that we know of today has applied for any kind of disability.

Mr. HAMMERSCHMIDT. Mr. Chairman, I just have one more statement for this witness.

General, I detect throughout your statement a rather positive attitude toward the use of these dioxins. Don't you feel that perhaps DOD should be a bit more cautious and adopt a wait-and-see attitude concerning any potential long-range disabilities?

General DETTINGER. Of course we need to look at the many industrial exposures and find out exactly what will happen in the long term. We no longer use the material. Our best evidence now indicates that we do not have a problem and that there is not a problem. We can only go on the best available scientific evidence to date.

There was recently, just this spring, an international conference held in Lyon, France, and it was suggested that several of the major accidents be carefully followed over the next several years both here in this country, in Germany, and elsewhere to determine exactly what the long-term effects were of people who were known to be exposed to specific doses of the dioxin. Where it was established clearly, we are following those. We are also continuing our own studies on the degradation of dioxin at our Eglin Test facility. We are going to cooperate fully with the VA in providing all this, and any additional information on the Ranchhand group. So we are certainly not letting this lay down at all. We recognize there may be a remote possibility for long-term effects with dioxin alone.

The 2,4-D and 2,4,5-T have been given orally as medicines, would you believe, in the years past for various kinds of conditions. So, therefore, these herbicides are certainly not in question at all.

Mr. HAMMERSCHMIDT. Sir, I thank you for your comprehensive statement and your responsive answers.

Mr. SATTERFIELD. Mr. Applegate.

Mr. APPLEGATE. Thank you, Mr. Chairman.

General, I appreciate your being here and giving us some valuable information as we deliberate.

I think that Mr. Hammerschmidt and Mr. Edwards very probably asked the questions of interest to me. I suppose as we hear some further testimony on down the line we will have some additional questions. I guess the only thing that I wanted to get verification on is that, talking about the smaller area of Vietnam compared to the large expansive areas of the United States and how much they use. You said the amount of dioxin would have been about four times the amount. Is that per unit or is that a total?

General DETTINGER. That is the total amount delivered to the continental United States, sir. The total amount delivered versus the total amount delivered to Vietnam. I think Dr. Young can come up with an answer regarding the area that was mentioned before, if we may, Mr. Chairman.

Dr. YOUNG. Sir, we are talking about in Vietnam applying some 44 million pounds of 2,4,5-T. Remember, when Vietnam was over we did return 1.3 million gallons of Herbicide Orange from Vietnam back to Johnston Island in 1972. So not all the 2,4,5-T that we procured was actually disseminated in Vietnam. Some was brought back. There was still some 800,000 gallons that was never shipped to Vietnam but also had been procured. In Vietnam we sprayed Orange on approximately 3 million acres. Granted, quite a bit of that was repetitive.

results are still unreported and thus not yet analyzed by the Institute staff. His Institute may be willing to sponsor additional needed research. However, he cannot make a firm commitment at this time since the Institute is currently undergoing reorganization so that command lines and action centers may change.

11. Col. Bayer stated, in response to various questions, that the DOD never contracted with chemical companies to have the components of Agent Orange specially made for DOD. The available production of the chemical industry in the USA (eight (8) companies) was used. Agent Orange therefore varied quantitatively by lot according to the source of manufacture. DOD has kept records of individual lot numbers so that the composition of each lot can perhaps be traced if the chemical companies kept similar records. DOD destroyed all its stock of Agent Orange during 1977 by burning it at sea in an EPA designated area. However, it should be possible to reconstitute the formulations of individual lots if the action of precise mixtures is deemed relevant to the inquiry concerning Agent Orange. To the present, nothing has been published to show that the combination of 2,4-D and 2,4,5-T in itself produces effects different from the biological action ascribable to the individual components separately.

12. Dr. Williams described steps that had been taken to ascertain availability of sources for analysis of dioxin levels in body fat. Dr. Williams noted that they have identified two individuals at academic institutions who have experience with the analysis and are willing to accept specimens from the VA. The costs per analysis are in the range of $600–$800 but are volume dependent. Both individuals need some reasonably firm estimates of likely number of specimens requiring analysis over a given time period such as one year. Dr. Williams noted that in-house experience in VA Laboratory Services with dioxin analysis does not exist. However, it could be developed if there were to develop a continued demand over years for a 100 or more analyses per year.

13. Dr. Thomasino queried the value of this proposed biopsy endeavor by the VA. His main concern is that there is no known body of knowledge linking tissue concentrations of dioxin to any specific syndrome of biological effects. He compared the work done at the Kettering Laboratory in Cincinnati on tissue lead levels versus clinical evidence of lead poisoning. He pointed out that it took many years of experimentation and clinical investigation before that threshold for toxic tissue burdens of lead could be arrived at. In the case of lead, one has a specific atomic moiety to measure. Matters are much more vague for dioxins. If dioxin is found in any of the fat samples obtained from veterans, it would be impossible to ascribe any meaning to such findings since there is no defined disease syndrome with which the dioxin tissue burden can be correlated. Likewise, if no dioxin is found in any of the specimens, it would still be impossible to say what this signifies, since the dioxin could have been in the tissues or in some other vital organ formerly, may or may not have induced biological responses, and subsequently may have leached out of the tissue. Until there are biomonitor data with which to correlate tissue dioxin levels, it may not be worth the enormous expense to start this biopsy program. Dr. Melvin concurred with this critique.

14. Dr. Hobson outlined the political overtones which have relevance to this biopsy issue. In the CBS presentation of Agent Orange, there was a scenario showing a physician extracting a fat sample from a patient and the physician stated emphatically that he could obtain confirmation of dioxin poisoning through such biopsy specimens. Veterans, and action groups speaking for the veterans are firmly convinced that the VA must test them for dioxin. A populist scientific spokesman also said in the CBS program that dioxin accumulates in fat and may later be released to re-exert toxic actions on vital organs during periods of weight loss. Many veterans therefore believe firmly that they may be walking around with such a chemical "time bomb" in their tissues. The VA essentially has no option but to check whether there is any proof that dioxin remains in fat eight years after the last exposure in Vietnam. If no dioxin is found in the men who are known to have had significant exposure to Agent Orange or who may even have had specific symptoms, this will be meaningful information. If as much dioxin is found in persons who have never been in Vietnam as in those who were decisively exposed to Agent Orange, this also would be meaningful information. If the determination for dioxin proves exceedingly difficult or erratic, as suggested by Dr. Holder, confirmation of this through the VA endeavor, would again be meaningful, since, if no reliable data can be obtained in even the best laboratory, the validity of the CBS statement can be challenged. Dr. Cueto supported this approach.

been exposure to 2,4-D and or 2,4,5-T. By contrast, Dioxin has not manifested an immediate toxic symptomatic response. It does evoke chloracne about 4 to 8 weeks later both after cutaneous and after inhalation exposure. This cutaneous reaction (chloracne) does not correlate precisely with the intensity or duration of exposure to the dioxin. Individuals who have had minimal exposure will show more exposure. Individual susceptibilty, personal hygiene and other factors may be significant determinants of health effects.

8. Dr. Kearney described the involvement of the Department of Agriculture with the same herbicides which were used in Agent Orange. Although the EPA has the principal regulatory responsibility for pesticides, USDA has some additional control over herbicides in general. Recently, the Department has had a flood of letters of inquiry, protest and complaint. Much concerns the fear of residents in forested areas of the U.S. that the use of herbicides and pesticides sprayed from low flying aircraft may exert health effects of an undesirable kind, either through direct exposure or through the herbicides entering the ecosystem. Although the present assessment of the USDA is that these fears are groundless, based on the known information concerning the biological actions of herbicides and pesticides, the Department has nevertheless created a medical team which will systematically examine persons who claim that they must have been significantly exposed to these chemicals. Dr. Sheldon Wagner, a dermatologist, is heading this investigation. Drs. Kearney and Melvin have remained in touch with the Italian and Swiss authorities who are monitoring the outcome of the Seveso industrial chemical accident in Italy. One death has been reported. This was an elderly woman who died from metastasising pancreatic cancer shortly after the incident. It is generally held that this cancer developed too soon after the chemical trauma to have been caused by chemicals released in that incident. No TCDD was found in liver or mesenteric fat samples analyzed to a tolerance of 0.25 nanograms per gram.

9. "Dr. Kuroda outlined the Rebuttable Presumption Against Registration with EPA filed against 2,4,5-T and its contaminant 2,3,7,8-tetrachlordibenzo-p-dioxin. This document was published in the Federal Register for Friday, April 21, 1978. The Agency is concerned about the carcinogenic and teratogenic effects found in laboratory animals when exposed to either 2,4,5-T or the dioxin. TCDD is a potent teratogen in almost every laboratory animal tested and 2,3,4-T containing low levels of TCDD (.05 ppm) is teratogenic in several strains of laboratory rodents. Even Down studies have determined that levels of TCDD as low as 10ng/day cause adverse reproductive effects in laboratory rats. Laboratory studies have shown statistically significant increases in the number of tumors in rats fed levels of TCDD as low as 5 ppt. One laboratory study has shown 2,4,5-T containing 0.05 ppm TCDD to be carcinogenic in mice. Although the evidence for mutagenic effects of TCDD did not meet the multi-test criteria for issuing the RPAR, the Agency is continually reviewing all new data especially and forthcoming from the Seveso incident. Dr. Kuroda raised the question of whether TCDD can cause effects, especially chronic effects, without causing chloracne in exposed individuals. Although there are animal species that do exhibit adverse effects without chloracne when administered TCDD, these species may not have sebaceous glands. Dr. Kuroda suggested that we look at individuals living around forested areas such as Oregon that may have been sprayed by 2,4,5-T for possible adverse effects. This population may exhibit some of the same effects supposedly seen by the Vietnam veterans since the type of exposure is similar, although the levels may be lower. She believed the Agency has received some data on people exposed (sprayed) to 2,4,5,-T that would be of interest and would try to make it available to the committee. She commented that the "Zero" content for dioxin in some military tests are not absolute zeros but reflect the limited analytical sensitivity of chemical tests available ten years ago. Dr. Melvin commented that there is an equal number of publications which provide evidence that TCDD is not mutagenic.

10. Dr. Cueto discussed the effects of mixtures of herbicided versus the effects of the individual ingredients. He could not recall any research which has specifically been done with the actual Agent Orange used in Vietnam. He is aware of only one paper incriminating 2,4,5-T as being capable of producing excess tumors in experimental animals. There was however no specific tumor type produced—only total tumor counts were slightly increased as compared with the natural incidence of tumors in the control animals. Until more research has been done, he believes that carcinogenicity can be neither ruled out nor accepted as a valid effect. He knows of no literature showing that 2,4-D can produce a similar effect. The NCI has sponsored several investigations of which the

Many times some areas received more than twice. Some areas as many as four times. But we are talking about 78 million pounds applied in the United States over the same time period, but applied repetitively to probably 8 to 10 million acres annually. You are talking about every 2,4,5-T was applied in forestry situations and brushland situations, on about 8 to 10 million acres, and so that 78 million was probably applied in repetitive situations during that time period.

How much actual total lands, we really would not have a figure on that. But probably no more than 4 times the amount in Vietnam at the most. Certainly not a magnitude, not 10 times greater.

Mr. APPLEGATE. Thank you.

Mr. SATTERFIELD. Mr. Cornell.

Fr. CORNELL. No questions, Mr. Chairman.

Mr. SATTERFIELD. General, I have a couple questions. I understand from your statement dioxin exists only in 2,4,5-T?

General DETTINGER. That is correct.

Mr. SATTERFIELD. Are there any ongoing studies in the Department of Defense on the question of health effects, possibly long-range health effects, of dioxin or 2,4-D or 2,4,5-T?

General DETTINGER. We have none at least in the Air Force ongoing at the present time, no, sir.

Mr. SATTERFIELD. You do not know about the rest of the defense establishment?

General DETTINGER. We know that EPA has some studies which are just starting. There is a Dr. Walter Melvin who is a professor at the Colorado State University who is going to be doing human fat and human milk levels of TCDD for the EPA which will be very important because we would like to know certainly if this material is stored in the fat, the levels of it and fate of it. We simply do not know what the fate is in the human body.

The other herbicides are excreted quickly, within 4 or 5 days, so there is no problem there. We know there is no buildup; biomagnification problem does not exist. We feel there is probably not a biomagnification problem with TCDD as occurs with some of the pesticides. Actually, again, it is rapidly photodegradated when it is on the leaves, on the material.

Mr. SATTERFIELD. Earlier you mentioned some studies in connection with the effects of dioxin on rats and mice. Who conducted those studies?

General DETTINGER. May I refer that to Dr. Young.

Captain YOUNG. Yes. The first studies were reported in the Journal of Science in 1970, the work by Courtney, et al. She reported in fact 2,4,5-T was very teratogenic, but I think the most important thing to remember is in the footnote at the end of her publication. In the postscript she indicated that, upon analysis of the 2,4,5-T it was found to contain 28 parts per million TCDD. Subsequent to that, there has been a lot of additional work done, and we find that it is very difficult to get, quote, "purified 2,4,5-T." Small amounts of TCDD in 2,4,5-T will cause teratogenicity, birth defects in laboratory animals.

Mr. SATTERFIELD. Was there any indication in the study to which you referred about what levels were involved—are you telling me 28 parts per million was the level?

Captain YOUNG. Of TCDD in the 2,4,5-T.

Mr. SATTERFIELD. Do you know what quantities of 2,4,5–T and in what period of time these were administered to the test animals?

Captain YOUNG. Sir, we have that information in the report.

Mr. SATTERFIELD. It is in the report?

Captain YOUNG. Yes, sir. We have prepared that information. We have cited some 144 toxicological papers.

Mr. SATTERFIELD. Could you tell me whether or not the study we are talking about was a single or multipoint study in terms of the test animals? In other words, were they given varying levels, one group a certain level, another group a different level, so that one could plot a curve of the results?

Captain YOUNG. Yes, sir, that has been done, yes. That particular study was a little study at that time but since in the NIH Environmental Sciences they have conducted extensive studies.

Mr. SATTERFIELD. I was intrigued by the fact that the monkey study to which reference was made was not conclusive because the monkeys were infected with other tests and therefore did not present a pure strain. In light of all that, the question I have is whether or not you feel there should be additional tests on the toxicity and the effect of this chemical in test animals?

General DETTINGER. Certainly there should be and there are additional studies being done now. We surveyed quickly just before we came here. The Dow Chemical Corp. is doing these kinds of studies. There are numerous types of these studies ongoing. Of course, the human groups in West Virginia, that accident that occurred in 1949, the accident in 1953 are all going to be studied very carefully and so there is no question further work is coming out.

Mr. SATTERFIELD. I assume from what you have said that if any agencies of Government need the help and assistance of the DOD with regard to possible exposure in Vietnam they would receive your help?

General DETTINGER. Absolutely.

Mr. SATTERFIELD. If I am correct, studies are still ongoing and that it appears some questions which have arisen might not be completely answered. I assume your statements this morning are based upon present scientific knowledge but that the jury may still be out?

General DETTINGER. That is probably correct. However, we feel that to be honest at this point we should reassure people there is no great worry that many are putting forward, that they are in trouble now because of their involvement in South Vietnam.

Mr. SATTERFIELD. I appreciate that, but I think ongoing studies are something this committee is very much interested in. I appreciate very much your bringing this to our attention. I am sure we will follow up on it. Mr. Edwards.

Mr. EDWARDS. General, your testimony was that approximately 52 million pounds of 2,4,5-T were disseminated in South Vietnam. This report——

General DETTINGER. Sir?

Mr. EDWARDS [continuing]. On page 129 says that an estimated 107 million pounds of herbicides were aerially disseminated on 6 million acres in South Vietnam.

General DETTINGER. Yes. This was a total procurement; 52 million pounds of the Herbicide Orange were procured, not all delivered I

in mice and rats. When purified 2,4,5-T was used, the teratogenicity with regard to the kidney disappeared, which was largely due to the dioxins but remained noticeable regarding cleft palates in mice. With regard to rats, teratogenic potency declined considerably. This susceptibility of the mouse to 2,4,5-T (pure) in producing malformed offspring appears to be unique because subsequent studies in other species like the rabbit, the sheep, as well as, the rat produced little evidence of teratogenicity.

Agent Orange consists of the n-butyl esters of 2,4-D and 2,4,5-T in equal amounts and was also studied for teratogenicity in mice. It did not produce as much toxicity as its two components when tested separately although this finding is hard to interpret. It suggests that the two agents together are not showing enhanced toxicity.

The teratogenic activity of 2,4,5-T was first observed by Dr. Courtney, who obtained a sample of 2,4,5-T which was contaminated with 2,3,7,8-tetrachloro-p-dioxin. When it was pointed out that the impurity was not present in most of the samples of 2,4,5-T and was itself highly toxic, additional studies were carried out to evaluate 2,4,5-T as distinct from its impurities for teratogenicity. It turned out that the "dioxin" impurity was teratogenic and that the purified 2,4,5-T was without effect in the rat but was still producing malformations in the mouse. The dioxin, however, produced kidney anomalies in the rat and the mouse. Because of the difference in response of mice and rats to 2,4,5-T in the absence of dioxins, it is of importance to learn that in other laboratories 2,4,5-T produces no malformations in the rabbit and in sheep. In a study by Collins and Williams impure 2,4,5-T was teratogenic in the Syrian hamster which seemed to be a function of the impurity present in the sample. King, et al. confirmed that purified 2,4,5-T and 2,4-D did not produce malformations in the rat and studies in the chick embryo did not produce evidence of teratogenicity that was clear cut. The teratogenic effect of 2,4,5-T in mice when the content of the dioxin was less than 0.1 ppm was reported by Roll confirming that in the mouse indeed the pure 2,4,5-T was active. Khera and McKinley studied 2,4,5-T and 2,4-D as well as certain esters of these herbicides in rats and observed malformations at comparatively high dose levels. Similar studies on esters were also carried out by Courtney in CD-1 mice and fetotoxicity as well as teratogenicity was observed for each one of the compounds. The solvent seemed to make a contribution in altering the toxicity. Courtney also carried out several studies to determine the distribution of 2,4,5-T between the pregnant animal and its fetuses in the mouse as well as the rat to clarify the difference in toxicity.

7. Dr. Melvin said that mention frequently is made of the Globe and Missouri episodes, about which there is some doubt with respect to the role of dioxin. A much better documented event occurred at Natro, West Virginia, during 1949 in which 282 persons were grossly exposed to 2,4,5-TCP. This included factory workers and their families. Much of the material was carried home on the clothes of the workers so that their wives and children also were exposed. Most became seriously ill, with significant neurological symptoms and chloracne. There were no deaths. All recovered symptomatically except for chloracne scars. Although this group has survived for more than thirty years, epidemiological data have never been derived from their individual health experiences. Since the population of West Virginia is relatively stable, it may be possible to trace some of these individuals. They would constitute a valuable source of guidance concerning the long term or delayed effects of herbicides on human health. Dr. Melvin also described some aspects of an industrial accident in Rotterdam, Netherlands, during 1963, involving exposure of at least 10 individuals. Since the Dutch government maintains relatively good public health records it may be possible to trace the health histories of these individuals. Dr. Melvin was the Scientific Director of the USAF from 1970 through 1977 and thus is familiar with the disposal of millions of gallons of Agent Orange. About 200 AF employees were involved with the dedrumming process. Some probably made contact with the chemicals. However, there was strict, biological, medical and industrial hygienic monitoring of the operation so that contact was minimized. Agent Orange was fully studied for its chemical characteristics at this time (Appendix G). It may be worthwhile following up the health histories of these individuals.

Dr. Melvin further stated that it is his impression that the acute biological observations reported after exposure to Agent Orange (animal and human) are due to the 2,4-D and the 2,4,5-T themselves and not to the dioxin. The occurrence of symptoms shortly after exposure to Agent Orange therefore does not signify that dioxin exposure necessarily had occurred, but only that there had

3. Dr. Levinson reviewed the perspectives of the Office of the ACMD for Professional Services concerning the herbicide issue. He pointed out that the VA has traditionally managed only disease of biological origin and that it has only recently become involved with diseases of environmental etiology such as radiation effects, asbestos exposure and now herbicides. The need for education of the HCF staff is apparent. Education of patients is equally important, particularly because environmentally caused diseases are potentially preventable. There may be specific areas which will require more research, and perhaps research which the VA should sponsor or accomplish. The deliberations of the committee should address these issues.

4. Dr. Dury provided highlights of his reviews of the literature on herbicides and promised to provide a written summary. He referred to the work of Captain A. Young of the USAF who has summarized numerous publications. This report still is being evaluated by the USAF prior to its release. Dr. Dury reported that in both experiments with animals and experience with human subjects accidentally exposed to herbicides short term toxicity effects are on record. There is considerable disagreement concerning long term or delayed adverse health effects. Both the dosage and the duration of exposure influence the severity and type of health effects elicited in animal experiments. Little is known about any adjuvant or neutralizing action of mixtures of herbicides. Health effects have been recorded for animals and man with respect to symptoms, gross pathology, biochemical responses, and histological changes. The best information about human subjects derives from the DOW experiences with inadvertent exposures. Other information is suggested by the Missouri horse farm accident and the Globe Arizona event. There is evidence that dioxin at the 10 ng/kg level and 2,4,5-T at 500 ppt may induce fetotoxicity, teratogenesis and carcinogenesis in experimental rodents. There may be receptor site inhibition so that delayed indirect effects may become possible. There is no recorded evidence of this for man.

5. Dr. Holder pointed out that it is important to distinguish between the health effects of individual herbicides and their contaminants. These chemicals are not necessarily capable of the same biological action. This is especially true for the dioxins, of which there are many variants. The 2,3,7,8-tetrachlorodibenzo-para-dioxin (TCDD) appears to be the most toxic. Some of the misunderstanding about the toxicity of dioxin stems from failure to differentiate one dioxin type from another. For the Vietnam War herbicide issue, the proper dioxin (TCDD) is of relevance. It also is important to realize that not all herbicides contain dioxins and, when present, the dioxin is not always in the same amount. The 2,4,5-T supplied to the military during the Vietnam War had concentrations of TCDD varying from one part-per-million (ppm) to about 50 ppm. The phenoxy herbicide was a standard grade agricultural product. Since the war, chemical manufacturing techniques have improved so that current batches of phenoxy herbicides tend to have much less dioxin contamination. Most of Dow's experience with human subjects and much of their toxicology work on animals goes back many years. Dow has been studying these phenoxy herbicides for the past 36 years. Their main human experience involving over-exposure to TCDD leading to symptoms commenced during 1965 when about 60 employees received excessive exposure to TCDD in a trichlorophenol plant. No 2,4,5-T was involved. These 60 employees developed chloracne. Two individuals developed some depression, but all recovered. There was no lost time. It is the concensus of world experts that symptoms from TCDD toxicity does not occur in the absence of chloracne. For this reason, it seems doubtful whether Vietnam War veterans, who never developed chloracne at the time of exposure in Vietnam, did or will show signs of other disease. Little TCDD in Globe and no 2,4,5-T in Missouri or Seveso again remind that one must not group chemicals, but must relate to specific materials. In a response to a question by Dr. Queto, Dr. Holder affirmed that Dow is studying possible human reproductive effects from TCDD and has completed some karyotyping on a 2,4,5-T population.

6. Dr. Falk has had considerable experience with animal experimentation, but no direct involvement with human subjects. The chemical structure of herbicides may determine the toxicity depending, in case of the esters of 2,4,5-T, on the ease with which they can be metabolized. The position of the chlorine atoms also may alter toxicity. This applies similarly to the impurities in 2,4,5-T and its esters which have different potencies depending on whether the chlorine atoms on the dibenzo-p-dioxins are located in critical positions.

Early experiments were carried out with the acid which was contaminated with nearly 30 ppm of the tetrachlorodibenzodioxin, giving rise to teratogenicity

should say on Vietnam. Remember, we did, as has just been pointed out, recover a great deal of it back to Johnston Island and destroyed it.

Mr. Edwards. Can you correct your statement, then?

General Dettinger. It is somewhat complicated in that there are several herbicides that were used. Of course we are talking about Orange. In the early phase small amounts of Green, Pink, and Purple were used. These herbicides—again, purple was the common one being used in the United States. These had larger amounts of multidioxin, but they were used in very small quantities in South Vietnam. We were referring to the Herbicide Orange that was comparable at the time, and the major item used in South Vietnam. The 107 million pounds that you referred to here was the total amount of herbicides, and there were some arsenic herbicides used, Herbicide Blue, of which there were some 5,200 gallons of that delivered and used. That contains arsenic.

Mr. Edwards. Then perhaps it might have been clear to the committee if your statement had said while during the 10-year period approximately 107 million pounds of herbicides were aerially disseminated on 6 million acres in South Vietnam, approximately 52 million pounds of 2,4,5-T were disseminated. Would that be a correct statement? We can correct this by saying that the amount in the United States was 78 million pounds of 2,4,5-T and 44 million pounds of 2,4,5-T in South Vietnam.

Thank you.

Mr. Satterfield. Thank you.

If there are no other questions, I wish to express our appreciation for your appearance this morning. Your testimony has been very helpful to us.

General Dettinger. Thank you very much, sir.

Mr. Satterfield. Our next witness is Dr. Paul A. Haber. We welcome you this morning and understand you have certain gentlemen accompanying you. We would appreciate your identifying them for the record, please.

Then, if you would proceed with your statement, we would appreciate it.

STATEMENT OF DR. PAUL A. HABER, ASSISTANT CHIEF MEDICAL DIRECTOR FOR PROFESSIONAL SERVICES, DEPARTMENT OF MEDICINE AND SURGERY, VETERANS' ADMINISTRATION, ACCOMPANIED BY DR. W. J. JACOBY, JR., DIRECTOR, MEDICAL SERVICE DEPARTMENT OF MEDICINE AND SURGERY; DR. L. B. HOBSON, ACTING ASSISTANT CHIEF MEDICAL DIRECTOR FOR RESEARCH AND DEVELOPMENT, DEPARTMENT OF MEDICINE AND SURGERY; J. C. PECKARSKY, DIRECTOR, COMPENSATION AND PENSION SERVICES; JOHN B. DeLEO, ASSISTANT GENERAL COUNSEL; AND CHARLES M. JOHNSTON, ASSISTANT GENERAL COUNSEL

Dr. Haber. Mr. Chairman and members of the committee, in March 1978 the Veterans' Administration Department of Medicine and Surgery was informed of increasing public concern, particularly on the

42–710—79——4

part of Vietnam veterans, over the possible long-range effects of exposure of American military personnel to herbicides during the Vietnam war. Veterans' Administration central office (VACO) staff learned that a television documentary had been prepared by CBS and was due for public release. A copy of this documentary was reviewed by VACO officials.

At this time it was also learned that the Department of Veterans' Benefits Chicago office had received several claims for veterans in the area alleging adverse health effects from exposure to Agent Orange. Agent Orange, as has been testified, was one of the chemical combination types of herbicides used over several years during the Vietnam war. Its use was terminated early in 1971. All residual stock of Agent Orange was destroyed by the U.S. Air Force during 1977.

The Veterans' Administration Department of Medicine and Surgery (D.M. & S.) staff immediately took steps to inquire into this matter and to initiate the necessary actions. This has proved to be a very complex and time-consuming effort. However, I wish to emphasize as strongly as I can that no health care has been deferred or denied any veteran alleging adverse health effects as a result of exposure to herbicides in Vietnam because of this complexity and the magnitude of the task.

A vigorous effort was launched to review pertinent literature pertaining to herbicides. It was found that a large number of scientific treatises and research studies had already accumulated in the world literature since the herbicides were first brought into public use during the early 1940's. One of the most authoritative publications was the investigation and report of the National Academy of Sciences, released during 1974. This has already been brought to the committee's attention by the previous witness.

This report covered health and environmental issues devolving on the use of herbicides during the Vietnam war. The report suggested that the likelihood of long-term, serious adverse health effects among persons other than the North Vietnamese or the South Vietnamese Montagnards is highly remote. The report did refer to allegations of serious health consequences for North Vietnamese and Montagnard women and children, but there was no real possibility of verification of these claims because of the military situation at the time of the National Academy of Sciences' study.

Later publications appeared under authorship of North Vietnamese physicians alleging significant infertility, abortion, fetotoxicity, teratogenesis, and carcinogenesis among Vietnamese who had been exposed to Agent Orange, and you have heard from the previous witness about the most recent study compiled by the Air Force and just released this month.

Veterans' Administration Department of Medicine and Surgery staff immediately initiated inquiries about adverse health effects of herbicides from other Federal agencies known to have had experience with the military, agricultural, or industrial use of these chemicals. These agencies included DOD, including its constituent uniformed services, USDA, EPA, NCI, NIOSH, NIEHS, and FDA. Polarized points of view were uncovered ranging from the persuasion that Agent Orange was essentially innocuous for human beings to the conviction that

Fetotoxicity and Infertility: Membership. Persistence of dioxin in human tissues: Membership.

8. *Permissible exposure levels for human subjects:* Industrial experience—Dr. Verald Rowe. NIOSH position—Dr. Wills. Catastrophes eg Seveso—Dr. Kearney. Other current exposures—Membership.
Other current exposures—Membership.

9. *Research Needs. Policy issues. Membership.*

10. *Additional members.*

11. *Next meeting date.*

12. *Adjourn:* No later than 4 p.m.

GERRIT W.H. SCHEPERS, M.D.,
VACO Medical Service.

MINUTES OF THE AD HOC VACO ADVISORY COMMITTEE ON HERBICIDES

Meeting of July 7, 1978, 810 Vermont Ave., N.W., Washington, D.C.

1. *Attendance: Members:*

Gerrit W. H. Schepers, M.D., Sc.D., Medical Service, VACO, Chairman
Richard Levinson, M.D., Deputy ACMD for Professional Services
William J. Jacoby, Jr., M.D., Director, Medical Service VACO
John J. Castellot, M.D., Deputy Director, Medical Service, VACO
Lawrence Hobson, M.D., Ph. D, Deputy Director for Research and Development, VACO
Abraham Dury, Ph. D., Consultant to Medical Service, VACO
Philip C. Kearney, Ph. D., Office of the Secretary for U.S. Dept. of Agriculture
Donna Kuroda, Ph. D., Ecological Effects Division, Environmental Protection Agency
Carolyn Offutt, M.S., Dioxin Project Manager, Environmental Protection Agency
Hans Falk, Ph. D., Associate Director, Health Hazard Assessment, National Institute of Environmental Health Sciences
Cipriano Cueto, Ph. D., Director, Pesticides Program, National Cancer Institute
Joseph A. Thomasino, M.D., Aberdeen Proving Grounds, Major, Mc, U.S. Army
Charles Peckarsky, L.L.B., Director, Compensation and Pension Service, VACO
Majorie Williams, M.D., Director, Pathology Service, VACO
Johan Bayer, Office of Surgeon General, Colonel, MC U.S. Airforce.

Consultants:

Ben B. Holder, M.D., Medical Director, DOW Chemical Company, Midland, MI
Walter W. Melvin, M.D., Sc. D., Professor of Environmental Health Sciences, Colorado State University

Visitors:

Hank Spring, Representing Congressman S. B. McKinney
Jim Michie, Representing Senator E. Kennedy

2. Dr. Schepers introduced the members of the committee and explained the manner in which it came into being. In authorizing the committee the Chief Medical Director required it to explore the following:

(*a*) The potential adverse effects on veterans of defoliants used in Vietnam and to assess the symptoms and signs associated with those effects.

(*b*) Methods for diagnosing and treating adverse health effects of defoliants.

(*c*) Approaches through which the VA might discover the prevalence of adverse effects of defoliants used in Vietnam on its patient population. The CMD further expected the Committee to accomplish its task within one year, to prepare interim reports and a final report. Dr. Schepers outlined the manner in which VACO became involved with the herbicide problem since March 1978 and the steps which have been taken. About 500 claims have been lodged with regional offices of the Department of Veterans Benefits. An almost equal number of Vietnam Veterans have also applied for medical examinations. Since only a minority of VA health care specialists is skillful in the discipline of toxicology a brief brochure (Appendix A) was prepared and sent to all health care facilities. Interim telephonic and written orientation also was provided for these HCFs concerning administrative aspects of managing veterans who claim exposure to potentially toxic chemicals. A final version of this directive is currently being reviewed by VACO departmental chiefs. A copy will be mailed to members of the committee. The CMD also created a VACO Steering Committee to deal with inter-service issues on this problem. The steering committee submitted the questions listed in Appendix B.

6. I would like to receive periodic written reports covering the committee's progress.

JOHN D. CASE, M.D.

U.S. GOVERNMENT MEMORANDUM

To: Program Chief for cardiology and pulmonary diseases (11).
From: ACMD for professional services (11F).
Subject: Formation of an Ad Hoc Advisory Committee on Defoliants.

1. Please organize an ad hoc committee which can provide me with expert advice on the medical aspects of defoliants.
2. I would like you to serve as Chairman of the Committee.
3. The committee members may include those named on the attached list.
4. The specific areas which the committee should explore are as follows:
(a) The potential adverse effects of defoliants on the health of Vietnam Veterans, including the symptoms and signs associated with those effects.
(b) Methods for diagnosing and treating the adverse health effects of defoliants.
(c) Approaches through which the VA might attempt to discover the prevalence of the adverse effects of defoliants on its patient population.
5. In general, I would expect that the committee would complete its business in the course of one year and then disband.
6. I would like to receive quarterly committee reports covering the committee's progress.

PAUL A. L. HABER, M.D.

MAY 30, 1978.

VETERANS' ADMINISTRATION AD HOC COMMITTEE ON HEALTH RELATED EFFECTS ON HERBICIDES

AGENDA—SEPTEMBER 25, 1978

1. Roll-Call: Members, Consultants, Visitors.
2. Minutes: Review and approve after corrections. Appendices will be furnished later since they still are being Xeroxed.
3. Matters arising out of the minutes: Needed discussion. Some of the discussion can be continued at later phases of the meeting.
4. Dr. Paul Haber: Overview of VACO approach to the problem. Briefing of Vietnam War Veterans Committee Charter and status.
5. James Allen, DVM, Ph. D. University of Wisconsin, Madison, WI. Personal Research on the Toxicology of 2.4-D, 2,4.5-T and TCDD.
6. K. Dianne Courtney, Ph. D., EPA Research Triangle Park, NC. Teratogenicity Studies with Chlorodibenzo-p-dioxins.
7. V.A. Circular 10–78–219: Instructions to VA field health care facilities. Management of Individual claims concerning exposure to potentially toxic chemicals.
8. Richard Levinson, MD: Registry on herbicide cases: Status Report Inquiry by steering committee on herbicides.
9. Other matters: Open discussion.
10. Next meeting: Date. Desirable agenda items.

GERRIT W.H. SCHEPERS, M.D.
Chairman.

AGENDA—ADVISORY COMMITTEE ON HERBICIDES

Room 119, VA Central Office. July 7, 1 p.m., 810 Vermont Ave., NW., D.C.
1. *Registration of attendees:* Please provide correct names, titles, addresses.
2. *Introductions:* Dr. Gerrit Schepers, Chairman.
3. *Professional Services Overview of herbicide issue:* Dr. Richard Levinson.
4. *Review of VACO Actions with respect to Herbicides:* Dr. Schepers. et al. Brochure. Telegram and hotline. Administrative directive. Correspondence and telephonic communications.
5. *Literature review:* Dr. Dury, Membership.
6. *Methods for Diagnosing and Treating Adverse Health Effects of Herbicides:* Laboratory Tests for Dioxin: Dr. Marjorie Williams, Clinical Symptoms: Dr. Thiessen. Other: Membership.
7. *Evidence for delayed effects of herbicides, especially dioxin*—Carcinogenicity: VA PTF: Dr. Schepers. Other: Membership. Teratogenicity: Membership.

herbicides may have long-range adverse health effects for animals and man.

During the Vietnam war the defoliants were known as Agent Orange, Agent White, Agent Blue, and Agent Purple. Agent Orange was used predominantly during the latter phase of the war. These agents were mixtures of known herbicidal chemicals. Agent Orange was a mixture of 2,4-D and 2,4,5-T. A contaminant of 2,4,5-T was 2,3,7,8-tetrachlorodibenzoparadioxin, also known as TCDD or dioxin. This chemical substance is highly toxic and the effects are best known from animal experiments.

The main effects are tissue edema, liver necrosis, gastric mucosal hypertrophy, gastrointestinal erosion, thymic and lymphatic atrophy. Fetal toxicity, teratogenesis and tumor production have been reported in animals.

Human studies include industrial workers exposed to the chemicals during production, agricultural and railroad workers who utilized the herbicides, industrial accidents occurring within the United States and Europe, and Vietnamese citizens exposed to the chemicals following defoliation. The only human disorder which can be definitely linked to herbicide exposure is chloracne. The lesion may heal completely or result in scar tissue. Temporary symptoms can be produced after heavy exposure, including nausea, diarrhea, fatigue, anorexia, headaches, backaches, cutaneous sensory deficiency, impaired olfactory or gustatory sensation, tremors, and temporary focal muscle paralysis. These symptoms disappeared after a short period of time.

Many statements regarding chronic adverse effects of the herbicides in man are unsubstantiated at this time. Because of this confusing scientific evidence, D. M. & S. staff established an informal group whose purpose was to bring together pertinent known evidence concerning the health effects of herbicides and to formulate a factual base on which the VA could develop health care policies.

This group included representatives of all Federal agencies with regulatory functions and expertise concerning toxic chemicals, plus consultants from the chemical manufacturing industry and university medical centers, and has held three meetings so far. Since it has become evident that the group's deliberations may be of interest to both the Federal agencies and nongovernmental bodies, permission has been requested to reconstitute this group as a formal Federal advisory committee.

Meanwhile, it was judged important to start immediately with formulation of administrative processes to manage health care issues for individual veterans at all the VA medical centers. A brochure covering the broad issues pertaining to herbicides was developed and mailed to all medical center directors and chiefs of staff. The original copy of the brochure was prepared to March 12, 1978. It has been updated periodically as new perceptions of the problem emerged.

Next a hotline discussion with all medical center directors and chiefs of staff was held on April 7, 1978. During this conference call, detailed explanations were given concerning the main issues and guidance was provided on how to manage individual claims by veterans who express concern over possible long-term effects of exposure to the herbicides. This hotline—and I might say the hotline conference is a telephone hookup where we can speak to all VA medical centers at one time and encourage questions from them if the need arises.

This hotline conference was followed up with a telegram which provided direction to the VA medical centers' staffs on appropriate management of claims for health care.

Investigation of the problem revealed that the main scientific concern is whether a highly toxic contaminant of herbicide 2,4,5-T, namely TCDD, or dioxin, may persist in body tissues for protracted periods and thus serve as an indicator of proper exposure. Inquiry into the possibility of identifying specialized laboratory facilities within the VA or in another Federal agency which would be able to demonstrate the presence of dioxin in body tissue was made. No such laboratory could be found. To create such a facility would cost approximately $80,000 and would take about a year. A qualified Federal laboratory is located at Wright Patterson Air Force Base. Another laboratory which does reliable Government contract work at the University of Nebraska was also identified.

It was then decided to conduct a brief, controlled investigation of 20 age- and service-matched veterans, 10 being individuals who have had unquestionable exposure to Agent Orange during the Vietnam war and 20 being veterans who have not knowingly had any exposure to this agent during their military service. The objective of the study is to determine whether dioxin does indeed persist in body fat for as long as 8 to 10 years, at the level of concentration which is capable of instrumental identification with the present state of the art, roughly 1 part per trillion.

Another objective is to discover whether persons who have never been exposed to Agent Orange during the Vietnam war also carry in their body fat dioxin or other chemicals which cannot be differentiated from dioxin by currently available laboratory methods.

A third objective would be to correlate symptoms and levels of exposure with amounts of dioxin found in fat after 8 to 10 years. If dioxin is found only in the Vietnam veterans who have been exposed to Agent Orange, a biopsy approach to diagnosis may prove valuable. If dioxin is, however, found in persons never exposed to Agent Orange, or if no dioxin is found in the tissues of Vietnam war veterans who have persistent symptoms stemming from the time of their exposure to Agent Orange, the biopsy approach would obviously be of little value.

Review of literature and consultation with knowledgeable scientists have also suggested that dioxin may affect chromosomes and other body defense mechanisms—receptor sites, enzyme systems, or immunity mechanisms—so that remote adverse health consequences may be mediated even though the dioxin itself may disappear. There is considerable animal experimentation indicating that such effects can be created by dioxin-type chemical moieties.

Since the effects achieved on animals sometimes are mimicked by human ill health, VACO D.M. & S. staff have taken further steps to insure that all parameters of health management of Vietnam veterans are inquired into by the medical staff of our field medical centers. A detailed administrative document was developed, therefore, to insure proper present and future surveillance of Vietnam veterans for possible remote adverse health effects relating to toxic chemicals.

F. Duties and functions of committee

The Committee holds quarterly sessions at the Veterans Administration Central Office in accordance with an appropriate schedule of dates set at preceding meetings. A structured agenda is followed. Members are asked to prepare special presentations and gather categories of data uniquely accessible to them. All members state their views fully and explicitly and support these with documentation as needed. The views of individuals with differing opinions are recorded. Testimony is obtained from knowledgeable persons. Meetings are open to the public except when, in the discretion of the Chairman, the privacy of individuals, who may come under discussion, may be infringed. Members of the public may direct questions to the Chairman in writing and submit prepared statements for review by the Committee. At the discretion of the Chairman, such members of the public may be asked to clarify such submitted material prior to consideration by the Committee. The Committee maintains summary minutes of its findings and develops conclusions and interim reports for consideration by the staff of the Veterans Administration. The Committee maintains liaison with all other federal agencies which have knowledge of and expertise in toxicology of chemical substances which may be pertinent to the herbicide issue.

G. Estimated operating costs

The estimated annual cost for operating the Committee is $5000 and about 300 staff man-days. The Committee should have 12–15 members.

H. Number and frequency of meeting

The Committee meets quarterly for one half day per session.

I. Termination date

Unless renewed by appropriate action prior to its expiration, the Committee will expire two years from the date below.

J. Date charter was filed

AD HOC VACO ADVISORY COMMITTEE MEMBERS

Gerrit W. H. Schepers, M.D., Sc.D., Medical Service, VACO, Chairman.
Richard Levinson, M.D., Deputy ACMD for Professional Services, VACO.
William J. Jacoby, Jr., M.D., Director, Medical Service, VACO.
Lawrence Hobson, M.D., Ph.D., Deputy Director for Research and Development, VACO.
Philip C. Kearney, Ph.D., Office of the Secretary for U.S. Dept. of Agriculture.
Carolyn Offutt, M.S., Dioxin Project Manager, Environmental Protection Agency.
Donna Kuroda, Ph.D., Physical Science Administrator, Environmental Protection Agency.
Hans Falk, Ph.D., Associate Director, Health Hazard Assessment, National Institute of Environmental Health Sciences.
Cipriano Cueto, Ph.D., Director, Pesticides Program, National Cancer Institute.
J. W. Thiessen, M.D., Aberdeen Proving Grounds, Major, Mc. US Army.
Charles Peckarsky, L.L.B., Director, Compensation and Pension Service, VACO.
Paul LeGolvan, M.D., Deputy Director, Pathology Service, VACO.
Col. Sherrill Laney, Office of the Surgeon General, MC US Air Force.

To: ACMD for Professional Services.
From: Chief Medical Director (111).
Subject: Ad Hoc Advisory Committee on Defoliants.

1. Please convene a committee which can provide DM&S with expert advice on medical aspects of defoliants.

2. The committee's membership should be composed of experts from the VA, other Federal agencies and appropriate private sector institutions.

3. Dr. Gerrit Schepers may serve as Chairman of the Committee.

4. The specific areas which the committee should explore are as follows:

(*a*) The potential adverse effects of defoliants on the health of Vietnam Veterans, including the symptoms and signs associated with those effects.

(*b*) Method for diagnosing and treating the adverse health effects of defoliants.

(*c*) Approaches through which the VA might attempt to discover the prevalence of the adverse effects of defoliants on its patient population.

5. In general, I would expect that the committee would complete its business in the course of one year and then disband.

VETERANS' ADMINISTRATION, DEPARTMENT OF MEDICINE AND SURGERY,
WASHINGTON, D.C.

Subject: Special registry at the Armed Forces Institute of Pathology for pathological material from veterans with possible exposure to herbicides during the Vietnam war.

To: Directors, Medical Centers, Medical Regional Office Centers, domiciliary, outpatient clinics and regional offices with outpatient clinics.

1. Attention is directed to DM&S Circular 10-78-219, RCS 11-49 dated September 14, 1978 Possible Exposures of Veterans to Herbicides During the Vietnam War with particular reference to paragraph 7. This paragraph states that a special tissue registry will be established for central collection of surgical, cytologic and autopsy material from veterans included in this category.

2. This Circular announces the establishment of this special registry in the Environmental and Drug Induced Pathology Department at the Armed Forces Institute of Pathology (AFIP).

3. All pathological material (surgical, cytologic or other similar tissue) from veterans with possible exposure to herbicides during the Vietnam War will be examined and reported in the customary manner at each medical facility. In addition, a duplicate set of slides, blocks and representative wet tissue will be forwarded promptly to the AFIP with the case clearly marked as "Possible Exposure to Herbicides-Vietnam War." Information will also be placed on SF 515, Tissue Examination in the patient's medical record noting that pathological material has been sent to the AFIB for inclusion in the special category.

4. The material for shipment to the AFIP will be packaged in the normal manner and addressed to the Director, Armed Forces Institute of Pathology, Attention Environmental and Drug Induced Pathology Department, Washington, D.C. 20306.

5. Any questions in this connection should be directed to Dr. Paul C. LeGolvan, Deputy Director, Pathology Service (113), extension 2348.

HERBERT M. BAGANZ, M.D.,
Acting Deputy Chief Medical Director.

SEPTEMBER 29, 1978.

CHARTER OF VETERANS' ADMINISTRATION ADVISORY COMMITTEE

A. Official designation

Advisory committee on health-related effects of herbicides.

B. Objectives and scope of activity

It has recently been brought to light that enormous quantities of herbicidal chemicals were used during the Vietnam War and that there is a possibility that large numbers of Americans, many of whom now qualify as veterans, may have encountered these chemicals to an extent that long range significant health problems may have been initiated. There is considerable controversy in the published literature and it is possible that much information remains unpublished. The Veterans Administration has not previously been required to resolve toxicological issues of such a complex and highly controversial nature. The Committee will, therefore, assemble and analyze the information which the Veterans Administration needs in order to formulate appropriate medical policy and procedures in the interests of the involved veterans. The Committee will have an entirely fact-finding and advisory role and will not be required to develop policy. The Committee will adhere to all the provisions of U.S. Public Law #92-463, 5 U.S.C. App. I, Executive Order #11769 and Presidential Circular A-63, of March 27, 1974 and subsequent applicable revisions.

C. Period of time necessary to carry out the committee purpose

It is anticipated that the Committee may achieve its objectives within twelve calendar months. If an extension of time is needed, this will be properly negotiated.

D. Agency official to whom the committee reports

The Committee will report to the Chief Medical Director through the Assistant Chief Medical Director for Professional Services.

E. Agency responsibility for providing the necessary support

Veterans' Administration Department of Medicine and Surgery.

VA Department of Medicine and Surgery Circular 10-78-219, dated September 14, 1978, has been delivered to all medical centers. This circular should insure that each veteran who alleges exposure to herbicides or complains of symptoms believed to be due to exposure to herbicides will immediately receive proper administrative and health care management. These services are directed specifically to resolving the issue of whether or not verified symptoms can be professionally attributed to herbicide poisoning or attributed to some other etiologic agent or process. This will immediately provide the veteran with two benefits.

The first of these is a diagnosis and appropriate therapy.

The second benefit will be that a medical basis will have been established for the processing of a claim which any veteran may make for veterans' benefits. However, emphasis, at least from the Department of Medicine and Surgery, is on medical care. Veterans will receive appropriate treatment for whatever condition is discovered at the time they report for medical examination.

The circular also provides for quarterly reporting of statistics on the number of veterans who requested medical examination for alleged herbicide-related symptoms and the numbers professionally attributed to herbicides. These statistics will enable VA central office staff to evaluate the magnitude of the herbicide problem with more precise knowledge.

Steps are currently being taken to develop a complete central office registry for all veterans with proven exposure to herbicides during the Vietnam war. The purpose of this registry is to insure that there will be a follow-up on every case in the event that future scientific research shows that delayed adverse health effects may be a sequel to remote one-time exposure to herbicides. It is also possible that other disease entities may later be discovered to have an entiologic relationship to exposure to herbicides. The registry will take cognizance of this eventuality, including the possibility of adverse health effects on the families of Vietnam veterans.

To insure completeness of information, D.M. & S. staff have arranged with the Armed Forces Institute of Pathology to receive pathologic specimens removed at VA medical centers from Vietnam veterans with possible exposure to herbicides. Circular 10-78-234, dated September 29, 1978, was written and sent to all VA medical centers. Tissues thus referred to the AFIP will be retained perpetually to facilitate research and reinvestigation of individual cases in the light of new knowledge concerning the biological properties of herbicides.

To insure impartiality in assessing the validity of professional attributions of individual health problems to herbicide exposures, D.M. & S. has proposed the creation of an evaluation committee. Members will be derived from appropriate specialists in the various disciplines of relevance (internal medicine, neurology, psychiatry, pathology, et cetera). This committee will be activated in the near future—as a matter of a fact next week—as information will be forwarded to VACO in accordance with Circular 10-78-219.

The Veterans Administration has maintained a detailed computerized file over the past two decades on all medical diagnoses of veterans who have been admitted to bed care sections of VA medical centers. It is possible, therefore, to review retrospectively whether any particular disease has increased over the past 15 to 20 years in any age group of veterans.

Since the possibility of cancer is the most alarming prospect for any individual, VA D.M. & S. staff have commenced a review of the prevalence of cancer of the principal body organs such as liver, pancreas, lung, et cetera, in all age groups of veterans from a time preceding the use of herbicides in Vietnam through to the most recent time. If an increased incidence of cancer is discovered in any year for veterans of the age group which may be representative of the Vietnam veterans, the individual case files will be reviewed for the possibility that the veteran may have been exposed to herbicides.

The VA D.M. & S. staff have been advised, both through its review of the medical literature and through its consultations with knowledgeable resources, that the development of a rather distinctive skin eruption, chloracne, alluded to by the previous witness, occurs characteristically in persons known to have significant exposure to dioxin. This chloracne type lesion has also been evoked in experimental animals by feeding experiment involving minute quantities of dioxin. Field staff have been specially altered to the significance of this sign, so that veterans who have had chloracne will be studied very thoroughly for confirmatory evidence of exposure to herbicides.

D.M. & S. staff will also commence a review of prior diagnoses of skin diseases which have come to the attention of the VA through the mechanism of veterans' benefits adjudication. VA Department of Veterans Benefits fortunately maintains a computer file on decisions regarding skin disease rating for benefits. D.M. & S. staff will be able to identify appropriate cases by review of this file. This work has been started. It should be emphasized, however, that this approach is merely to gain access rapidly to likely cases of herbicide poisoning. It is known that exposure to dioxin does not invariably evoke chloracne, although there is a high correlation between the two.

D.M. & S. staff discovered that during 1949 an industrial accident occurred in a Monsanto Chemical Factory at Nitro, West Virginia, during which a total of 289 employees were significantly exposed to 2,4,5-TCP. Subsequent analysis of this revealed it to contain dioxin. All those exposed became ill. Families of the factory employees also were exposed and became ill, since the employees carried the chemicals home on their clothes.

The Veterans' Administration is most anxious to obtain epidemiologic data showing the outcome of this episode of exposure for individual victims, since this may be anticipated to provide elucidation of the problems of the Vietnam veterans who were exposed to herbicides. VA has identified an Institute for Environmental Health Sciences at the State University of Colorado, which is willing to undertake such an epidemiological analysis. We are also inquiring into the outcome of other industrial accidents.

It should be noted that there is a significant difference between the numbers of veterans who have reported to VA medical centers for examination and the large numbers claimed in public media to have been exposed to or to have become ill from the effects of herbicides.

During the period 1962 through 1971, approximately 18.85 million gallons of herbicides were sprayed over the combat zones of Vietnam. That figure is of course subject to change in view of the recent dis-

Circular 10-78-219
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RCS 11-49
Attachment C

Standard Form 506

CLINICAL RECORD			PHYSICAL EXAMINATION				
DATE OF EXAM.	HEIGHT	WEIGHT			TEMPERATURE	PULSE	BLOOD PRESSURE
		AVERAGE	MAXIMUM	PRESENT			

INSTRUCTIONS.—Describe (1) General Appearance and Mental Status; (2) Head and Neck (General); (3) Eyes; (4) Ears; (5) Nose; (6) Mouth; (7) Throat; (8) Teeth; (9) Chest (General); (10) Lungs; (11) Cardiovascular; (12) Abdomen; (13) Hernia; (14) Genitalia; (15) Rectum; (16) Prostate; (17) Back; (18) Extremities; (19) Neurological; (20) Skin; (21) Lymphatics.

INITIAL DATA BASE - POSSIBLE EXPOSURE TO TOXIC CHEMICALS - PART III

(Continue on reverse side)

PATIENT'S IDENTIFICATION (For typed or written entries give: Name—last, first, middle; grade; date, hospital or medical facility)	REGISTER NO.	WARD NO.

INITIAL DATA BASE -
POSSIBLE EXPOSURE TO TOXIC
CHEMICALS -
PART III

PHYSICAL EXAMINATION
Standard Form 506
General Services Administration and
Interagency Committee on Medical Records
FPMR 101-11.806-8
October 1975 506-105

Circular 10-78-219
September 14, 1978

Attachment B
(Reverse Side)

PROGRESS NOTES

DATE

INITIAL DATA BASE - POSSIBLE EXPOSURE TO TOXIC CHEMICALS - PART II

Check if following examination ordered:

C. Yes No

___ ___ Complete blood count including differential

Chest X-Ray (if no chest X-Ray within six months)

___ ___ Liver Function Profile

___ ___ Renal Function Profile

___ ___ Sperm Count

___ ___ Referral to a Dermatologist

D. Other Comments:

1. Evidence of Neoplasia: Present ___ Absent ___

Family History of:

Neoplasia Related Factors (e.g., cigarette smoking, radiation exposure, etc.)

2. Evidence of - Veteran and/or Family:

Infertility: Present ___ Absent ___

Abortions: Yes ___ No ___

Teratogenesis: Yes ___ No ___

If "yes", Describe:

3. Were veteran's spouse or children in Vietnam? Yes ___ No ___

If "yes", give details.

GPO : 1977 O-VC- 240-463(119)

STANDARD FORM 509 BACK (Rev. 11-77)

INITIAL DATA BASE - POSSIBLE EXPOSURE TO TOXIC CHEMICALS - PART II

closures by the previous witness in the Air Force. But during this time it was theoretically possible that about 4.2 million American soldiers could have made transient or significant contact with the herbicides because of this operation.

By contrast, no complaints referrable to this use of herbicides reached the VA before 1978. By close of business June 30, 1978, fewer than 300 veterans had presented themselves at VA medical centers for health problems they believed had been caused by exposure to the herbicides, although a larger number had applied for veterans' benefits.

Matters are made much more difficult by the fact that 8 years have elapsed since the use of the herbicides was terminated in Vietnam. In addition, it is known now that prior to, during, and subsequent to the Vietnam war, equally large quantities of the same herbicides have also been used in the United States of America without a great many concerns over adverse health effects. Herbicides of the 2,4,5-T type have been used by millions of Americans in agriculture, horticulture, and forestry operations. Undoubtedly millions of Americans, including Vietnam veterans, have encountered dioxin in this nonmilitary fashion.

The Environmental Protection Agency has just this year filed the first rebuttable presumption injunction against the continued use of 2,4.5-T. However, despite this injunction dioxin containing chemicals may not disappear from domestic use very soon. If later proof is produced that human health is significantly impaired by dioxin, the VA's task will be to distinguish harm which veterans may have encountered through the use of the herbicides during the war from harm which may have come to them through nonmilitary domestic exposures to chemicals. We do not anticipate that this will be easy.

From the information and data presented, it is clear what a complex and difficult task the thorough and complete investigation and evaluation of this whole herbicide problem is. We pledge, however, that the Veterans' Administration, working in close cooperation with other concerned government and private organizations, will continue to pursue it to its proper resolution.

Mr. Chairman, I am attaching for your information a copy of the rating practices and procedures to be used in handling claims for service-connected benefits arising out of alleged exposure to defoliants and statistical data on the claim for service-connection received by the Department of Veterans Benefits to date.

Mr. Chairman, that concludes my statement. Mr. Peckarsky and the other gentlemen here and I will be glad to answer any questions you and other members may have.

Mr. Satterfield. We thank you very much. Without objection, the attachment to your statement, rating practices and procedures, disability—Vietnam defoliant exposure and other information to which you refer will be admitted in the record.

[The information follows:]

Rating Practices and Procedures

DISABILITY—VIETNAM DEFOLIANT EXPOSURE

Claims contending relationship between defoliant exposure and disability.—Claims for service-connected disability benefits are being received from veterans who claim disability incurred through or aggravated by exposure to defoliants used during the Vietnam War.

Except for a skin condition known as chloracne, there are presently no firm data to incriminate the herbicides as causative agents of any other known category of disease or chronic symptom. However, a contaminant Dioxin, found in small quantities in defoliants is toxic.

No special procedures will be initiated for these claims. Instead, each case will receive a thorough development of all available evidence. This will include a request to both the veteran and the service department to furnish verification of exposure to herbicides, the extent and duration thereof and the dates on which such exposure occurred.

All other required development will be done concurrently with the request for verification of exposure to defoliants, and each case will be extended the same consideration given any other claim for service connection.

Where no disability is claimed but only exposure to herbicide is alleged, the claim will be administratively disallowed and the veteran advised that mere exposure itself is not a disease or disability. The claimant will be advised that specific disabilities must be claimed. This should be accompanied by evidence of the earliest manifestation of symptoms together with evidence of continuity.

A veteran's claim alleging herbicide related genetic damage based upon damage or defect in the veteran's child will be administratively disallowed since Title 38 U.S.C. makes no provision for such a claim.

Copies of all ratings involving defoliants will be submitted to the Compensation and Pension Service (211C3). There should be no hesitancy in submitting cases, appearing to have merit, but not meeting current criteria for service connection, to the Compensation and Pension Service (23B/211C) for advisory opinion.

Between 1 and 2 million veterans served in South Vietnam during military herbicide operations from 1962 to 1971.

There is little information on the number of personnel exposed to herbicides in Vietnam as no records were kept.

Some personnel may have been exposed indirectly to herbicides through ingestion of contaminated drinking water and food and by skin contact.

Central Office receives ratings of claims for diseases from herbicide exposure.

There have been between 450 to 500 claims filed for disease from herbicide exposure through September 30, 1978.

To date copies of 92 ratings have been received in central office in which herbicide exposure has been claimed.

These 92 ratings represent decisions of original jurisdiction prior to any appellate review.

Of the total number or ratings received 1 claim was allowed for a skin condition presumably due to herbicide.

An additional 7 claims were allowed for other reasons—6 for skin condition not related to herbicide, and 1 for malignancy also not found to be related to herbicide.

Of the remaining 84 claims disallowed 12 were claims for exposure to agent orange only without a diagnosed disease or injury.

Of the 72 denied claims with diagnosis or specific allegation some had more than one diagnosed condition falling into the following categories:

- Skin condition (acne, eczema, keloids, uriticaria, etc.)—42.
- Nervousness and fatigue (claimed)—24.
- Paralysis or numbness of extremities (alleged)—16.
- Cardiovascular and hypertension—6
- Cancers (leukemia, Lymphoma, bone, bladder, etc.)—6.
- Eent pathology—3.
- Impaired sexual activity (alleged)—2.
- Hodgkin's disease and swollen glands—2.
- Lung condition—1.
- GI condition—1.

In order to assist regional offices in the development of claims for disease due to herbicide exposure we have requested DOD to furnish us with complete maps of each herbicide mission, the dates they were carried out, the units performing the spraying missions, the unit present in the area at the time of the mission or those units entering the area after they were sprayed.

We are also developing claims for skin conditions claimed to be due to herbicides to determine in retrospect whether the skin condition claimed was actually Chloracne.

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RCS 11-49
Attachment B

MEDICAL RECORD	PROGRESS NOTES
DATE	"INITIAL DATA BASE - POSSIBLE EXPOSURE TO TOXIC CHEMICALS - PART II
	REVIEW DATA ON PART I
	A. Pertinent Medical History - include symptoms at time of exposure, or later - attributed by the veteran to exposure - (continue on another Part II if needed)
	B. Pertinent Physical Examination (PE) - (check one).
	___Physical Examination to be done (Use SF 506 or VAF 10-7978i) "Initial Data Base - Chemical Exposure, Part III "
	___Repeat Physical Examination is indicated (a prior PE has been done within six months and has been reviewed).
	___Repeat PE is not indicated (a prior PE has been done within six months and has been reviewed).
	(Continue on reverse side) (SEE OTHER SIDE)

PATIENT'S IDENTIFICATION (For typed or written entries give: Name—last, first, middle; grade; rank; rate; hospital or medical facility) | REGISTER NO. | WARD NO.

PROGRESS NOTES INITIAL DATA BASE - POSSIBLE EXPOSURE TO TOXIC CHEMICALS - PART II
STANDARD FORM 509 (Rev. 11-77)
Prescribed by GSA/ICMR,
FPMR (41 CFR) 101-11.806-8
509-110

Circular 10-78-219
September 14, 1978

Attachment A
(Reverse Side)

PROGRESS NOTES

DATE

INITIAL DATA BASE - POSSIBLE EXPOSURE TO TOXIC CHEMICALS - PART I

J. How long was veteran present at site of chemical exposure? ____

K. Was veteran issued protective gear? ____Yes ____No
If "yes" - did veteran wear this gear? ____Yes ____No
Describe gear:

L. Did veteran enter areas where chemicals previously had been sprayed or spilled - or did veteran eat from utensils or drink water contaminated by chemicals? Does veteran remember chemical names? Describe in detail.

M. What steps were taken to remove chemicals from veteran or the environment?

N. Has veteran been exposed to other potentially toxic chemicals:
(1) Prior to military service: ____Yes ____No
(2) During military service: ____Yes ____No
(3) After military service: ____Yes ____No IF "YES" DESCRIBE:

O. (1) What is veteran's military occupation code number? ____
(2) Veteran possesses a copy of DD 214, Report of Separation-Active Duty?
____Yes ____No IF "YES" ENCOURAGE VETERAN TO BRING A COPY.
(3) Veteran possesses a copy of Service health/medical record?
____Yes ____No IF "YES" ENCOURAGE VETERAN TO BRING IN A COPY.
(4) Has veteran received VA Care?
____Yes ____No IF "YES", STATE LOCATION.

GPO : 1977 O-VC 7?-??? INITIAL DATA BASE - POSSIBLE EXPOSURE TO TOXIC CHEMICALS - PART I

In those claims in which the skin disease is determined to be chloracne, and the veteran now has other chronic disease of unknown cause the claim is submitted for review by an independent medical expert to determine whether the two conditions are etiologically related.

HERBICIDAL CHEMICAL EXPOSURE CLAIMS

	Number	Percent
A. Total number of cases in study	92	100.0
Claims with diagnosis or specific allegation	80	87.0
Claims with no diagnosis	12	13.0
B. Claims with diagnosis or specific allegation	80	100.0
Allowed	[1] 1	1.3
Allowed for other reason	[2] 7	8.7
Denied	[3] 72	90.0
In summary:		
Total claims	92	100.0
Allowed	8	8.7
Denied	72	78.3
No diagnosis	12	13.0

[1] Claims for skin condition.
[2] 6 claims skin condition, 1 claim lung cancer.
[3] These 72 claims having more than 1 diagnosis or specific allegation fall into the following categories: Skin condition (acne, eczema, keloids and urticaria), 42; nervousness and fatigue (claimed), 24; paralysis or numbness and other symptoms of extremities, 16; cancers (leukemia, lymphoma, bone and bladder), 6; cardiovascular and hypertension, 6; EENT pathology, 3; impaired sexual activity (alleged), 2; Hodgkins and swollen glands, 2; lung condition, 1; GI condition, 1.

VETERANS' ADMINISTRATION, DEPARTMENT OF MEDICINE AND SURGERY WASHINGTON, D.C.

To: Directors, all VA hospitals, domiciliary and outpatient clinics.
Subject: Possible exposures of veterans to herbicides during the Vietnam War, RCS 11-49.

1. The purpose of this Circular is to proivde supplemental information to the teletype directive dated May 19, 1978, on the above subject, and instructions for documentation in the medical record. It is essential that all concerned personnel be given copies of the teletype directive and this Circular.

2. Recent publicity in the news media about illness among persons who were exposed to herbicidal agents used in Southeast Asia, may result in veterans presenting themselves at VA health care facilities for evaluation. It should be understood that there is no positive evidence for deleterious effects on the health of individuals exposed to these herbicides which is of a permanent nature. However, it is widely agreed that it is necessary to provide such individuals with meticulous medical follow-up for prolonged periods of time in order to obtain definitive answers about the health related effects of herbicides.

3. Accordingly, VA policy is to examine thoroughly all veterans who claim toxic effects from exposure to herbicides during the Vietnam War and to maintain appropriate records on them so that any late complications due to these agents can be determined and treated.

4. All Vietnam Era veterans who currently are being treated in a VAHCF, and those who apply for such care will be asked to identify their previous military occupational code number, and asked whether they were exposed to herbicidal sprays or bulk chemicals during their periods of service in Vietnam. The military occupational code number will be entered on the VA Form 10-10 (April 1978) Application for Medical Benefits, in item 13, Military Service.

5. If a veteran states that he/she was exposed to defoliant sprays or bulk chemicals, he/she will be asked the questions appearing on the initial data base, possible exposure to toxic chemicals, part I, of the regular medical history for an examination (Attachment A).

6. In eliciting the medical history and performing the physical examination (Attachments B & C), particular attention should be given to those organs which are most commonly affected by chemical intoxicants: nervous system, immune system, blood-forming system, liver, kidneys, thyroid, adrenals, gonads, skin, and lungs. Evidence concerning the following symptoms/conditions should be ascertained: an altered sex drive, sterility, frequent abortions, congenital deformities among children, repeated infections, and neoplasia. Particular attention should be directed to the detection of chloroacne, a skin condition which has been associated with acute exposure to herbicide mixtures containing the toxic chemical,

Dioxin. It is important when the first manifestation of these symptoms/conditions occurred and the details of any treatment provided.

7. Appropriate diagnostic studies should be performed and consultations obtained as indicated by the patient's symptoms and signs. Performance of nonroutine diagnostic studies such as sperm counts may be appropriate if suggested by the workup. Any surgical, cytologic or other similar tissue removed in conjunction with any diagnostic, operative or other procedure should be processed and reported in the usual manner. All slides, blocks, and tissues will be retained for inclusion in a special tissue registry, the location and operation of which will be described in a separate circular.

8. There is controversy among experts regarding to diagnostic value of measuring levels in body fat of Dioxin, a toxic contaminant of the of the herbicides utilized in Vietnam. In order to help resolve this controversy a study will be conducted, under VACO auspices, which will measure Dioxin levels in fat tissue taken from VA patients with a history of exposure to herbicides and from an unexposed control group. Until this study is completed, no VAHCF should attempt to measure tissue Dioxin levels in any of its patients without prior consent from VACO (11F).

9. Whenever a veteran seeks evaluation at a VAHCF for possible toxicity due to herbicides, the Medical Administration Service should be notified of this fact promptly. Following notification, that Service will initiate the procedures listed below:

(1) The patient data card will be used to imprint a 3 x 5 card.

(2) The 3 x 5 card will be filed alphabetically in a special file, which will be retained indefinitely.

(3) The file will be labeled "Possible Toxic Chemical Exposure File".

(4) In Item No. 17 of VAF 10–10, "Do you believe the need for care is" the following statement will be entered in the blank space: "Possible Toxic Chemical Exposure".

(5) For extra control purposes—insert at the top of VAF 10–10m, (Medical Certificate and History) the following statement: "The veteran states he/she has been exposed to chemical defoliant".

10. For all Vietnam veterans for whom these 3 x 5 cards are generated, it is essential that uniform recording of the initial data base discussed in paragraph 4 be provided. The following medical record forms will contain the data as illustrated on Attachments A, B, and C: Progress Notes (SF 509 or VAF 10–7978i) and Physical Examination (SF 506 or VAF 10–7978e). The heading, "Initial Data Base—Possible Exposure to Toxic Chemicals (Part I, II or III)" will be placed at the top and bottom (including reverse side of each form) to insure proper identification and easy retrieval. If a Vietnam veteran is currently hospitalized, the illustrated progress notes form (Parts I and II) will be completed and, in addition, the current physical examination form, already completed, will be stamped with the heading "Initial Data Base—Possible Exposure to Toxic Chemicals—Part III."

11. When the VAF 10–10 involving a potential chemical exposure and the Initial Data Base are completed and there is no indication for hospitalization or outpaient treatment, the forms will be placed in an existing or newly created veteran's Consolidated Health Record (CHR) rather than being placed in the rejected VAF 10–10 file. The placement of these forms in the CHR will insure that the record is retained for historical, clinical, statistical and research purposes.

12. A quarterly report, beginning with the quarter ending September 1978, will be submitted to reach the Associate Deputy CMD for Operations (11) by the 8th workday of the month following the close of the quarter. Negative reports are to be submitted. The report will contain the following information:

(*a*) Total number of Vietnam Era veterans claiming symptoms related to possible exposure to chemical defoliants or bulk chemicals during their tours of service in Southeast Asia.

(*b*) Of the total number of veterans alleging symptoms in subparagraph a above, the number of veterans with symptoms professionally attributed to exposure to chemical defoliants.

(*c*) Copies of Attachments A, B, and C, with copies of pertinent laboratory data and consultations, completed for each veteran included in subparagraph b will accompany the quarterly report.

Color-coded month tags should be placed on the 3 x 5 cards to provide the data required by subparagraph a. Local controls should be established to provide subparagraph b data.

13. We recommend that consideration be given to the designation of one or two clinical staff members as "environmental health physician(s)" to provide clinical management of veterans claiming exposure.

14. Questions concerning VACO's position on possible exposures to herbicides should be referred as follows: policy questions to Dr. Paul Haber (11) at extension 2213 or Dr. Richard Levinson (11F) at extension 3560, clinical questions to Dr. Gerrit Schepers (111) at extension 2550; and administrative questions to Medical Administration Service (136B) at extensions 2933 and 3468.

HERBERT M. BAGANZ, M.D.,
Acting Deputy Chief Medical Director.

SEPTEMBER 14, 1978.
Attachments.

Circular 10-78-219
September 14, 1978

RCS 11-49
Attachment A

MEDICAL RECORD — PROGRESS NOTES

DATE

INITIAL DATA BASE - POSSIBLE EXPOSURE TO TOXIC CHEMICALS - PART I

A. Date ____ Current Status of Veteran: ____ Outpatient
Inpatient

B. Branch of Service:
Military or Civilian Unit Designation:

C. How many exposures does the veteran allege?

D. What was the nature of each exposure?

E. When and where did these exposures occur? (Specify dates, military field bases, and length of exposure.)

F. Define severity of the exposure - circle or check, as appropriate.

Severe	Direct	Repeated	Prolonged
Short	Mild	Indirect	

G. At time of exposure - what was the veteran's job in service? (Field participation, rear echelon, administration, etc.)

H. How directly was the veteran brought in contact with chemicals? (Check one)

____ Veteran was member of headquarters personnel and far removed from site of chemical exposure.

____ Veteran was in field.

____ Veteran operated apparatus used for chemical spraying or handled bulk chemicals in such a manner that gross exposure was possible.

I. If, in field, was veteran undercover (building, trench, foxhole, etc.) or out in open? Was he in a vehicle at the time?

(*Continue on reverse side*) (SEE OTHER SIDE)

PATIENT'S IDENTIFICATION (*For typed or written entries give: Name—last, first, middle; grade, rank, rate, hospital or medical facility*) | REGISTER NO. | WARD NO.

PROGRESS NOTES
STANDARD FORM 509 (Rev. 11-77)
Prescribed by GSA/ICMR, FPMR (41 CFR) 101-11.806-8
509-110

INITIAL DATA BASE-POSSIBLE EXPOSURE TO TOXIC CHEMICALS - PART I

A-1

STATE DEPARTMENT OF HEALTH

PRODUCER OF WASTE (Must be filled by producer)

Name: AGent Chemical Co. (PRINT OR TYPE) CODE NO.

Pick up Address: N.C.B.C. (NUMBER) (STREET) GulfPort Miss (CITY)

Telephone Number: ( ) P.O. or Contract No.:

Order Placed By: Del Hightower Date: 7-6-76

Type of Process which Produced Wastes: Pilot Plant Test. CODE NO.
(Examples: metal plating, equipment cleaning, oil drilling, wastewater treatment, pickling bath, petroleum refining)

DESCRIPTION OF WASTE (Must be filled by producer)

Check type of wastes:

1. ☐ Acid solution
2. ☐ Alkaline solution
3. ☒ Pesticides
4. ☐ Paint sludge
5. ☐ Solvent
6. ☐ Tetraethyl lead sludge
7. ☐ Chemical toilet wastes
8. ☐ Tank bottom sediment
9. ☐ Oil
10. ☐ Drilling mud
11. ☐ Contaminated soil and sand
12. ☐ Cannery waste
13. ☐ Latex waste
14. ☐ Mud and water
15. ☐ Brine

☐ Other (Specify) CODE NO.

Components. (Examples: Hydrochloric acid, lime, caustic soda, phenolics, solvents (list), metals (list), organics (list), cyanide)

	Component	Upper	Lower	%	ppm
1					
2	Charcoal Waste. with				
3	Dioxin.				
4					
5					
6					

Hazardous Properties of Waste:
pH ___ ☐ none ☒ toxic ☐ flammable ☐ corrosive ☐ explosive

Bulk Volume: 9 Pc. Pipe ☐ gal ☐ tons ☐ barrels (42 gal.) ☐ other (SPECIFY)

Containers: 1 (NUMBER) ☐ drums ☒ cartons ☐ bags ☒ other Pipe (SPECIFY)

Physical State: ☐ solid ☐ liquid ☐ sludge ☐ other (SPECIFY)

Special Handling Instructions (if any):

The waste is described to the best of my ability and it was delivered to a licensed liquid waste hauler (if applicable).

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

[signature] SIGNATURE OF AUTHORIZED AGENT AND TITLE

HAULER OF WASTE (Must be filled by hauler)

CHANCELLOR & OGDEN, INC.
3031 East "I" Street, Wilmington, California 90744
Phone: (213) 432-8461

CODE NO.

Pick Up: 7-10-76 (DATE) Time: ___ am / pm

State Liquid Waste Hauler's Registration No. (if applicable): 9

Job No.: ___ No. of Loads or Trips: 1 Unit No. ___

Vehicle: ☐ vacuum truck ___ barrels, ☒ flatbed, ☐ other (SPECIFY)

The described waste was hauled by me to the disposal facility named below and was accepted.

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

[signature] SIGNATURE OF AUTHORIZED AGENT AND TITLE

DISPOSER OF WASTE (Must be filled by disposer)

Name (print or type): B.K.K. Co. CODE NO.

Site Address: 2210 S Azusa Ave

The hauler above delivered the described waste to this disposal facility and it was an acceptable material under the terms of RWQCB requirements, State Department of Health regulations, and local restrictions.

Quantity measured at site (if applicable): ___ State fee (if any): ___

Handling Method(s):

☐ recovery

☐ treatment (specify): ___ (EXAMPLES: INCINERATION, NEUTRALIZATION, PRECIPITATION) CODE NO.

☒ disposal (specify): ☐ pond ☐ spreading ☒ landfill ☐ injection well

☐ other (specify): CODE NO.

If waste is held for disposal elsewhere specify final location: Chem-Nuclear Systems Arlington Ore.

Disposal Date 22-9-76

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

K.O. Flaig
SIGNATURE OF AUTHORIZED AGENT AND TITLE

The site operator shall submit a legible copy of each completed Record to the State Department of Health with monthly fee reports.

FOR INFORMATION RELATED TO SPILLS OR OTHER EMERGENCIES INVOLVING HAZARDOUS WASTE OR OTHER MATERIALS CALL (800) 424-9300.

D.O.T. Proper Shipping Name: Chemicals N.O.S. Posion

PRODUCER COPY

vised December 1974

CALIFORNIA LIQUID WASTE HAULER RECORD

009-055751

STATE WATER RESOURCES CONTROL BOARD
STATE DEPARTMENT OF HEALTH

PRODUCER OF WASTE (Must be filled by producer)

Name (PRINT OR TYPE): AGent Chemical Co. — CODE NO.

Pick up Address: N.C.B.C. (NUMBER) (STREET) GulfPort Miss (CITY)

Telephone Number ( ) P.O. or Contract No.:

Order Placed By: Del Hightower Date: 7-6-76

Type of Process Which Produced Wastes: Pilot Plant Test. — CODE NO.
(Examples: metal plating, equipment cleaning, oil drilling – wastewater treatment, pickling bath, petroleum refining)

DESCRIPTION OF WASTE (Must be filled by producer)

Check type of wastes:

1. ☐ Acid solution	6. ☐ Tetraethyl lead sludge	11. ☐ Contaminated soil and sand
2. ☐ Alkaline solution	7. ☐ Chemical toilet wastes	12. ☐ Cannery waste
3. ☒ Pesticides	8. ☐ Tank bottom sediment	13. ☐ Latex waste
4. ☐ Paint sludge	9. ☐ Oil	14. ☐ Mud and water
5. ☐ Solvent	10. ☐ Drilling mud	15. ☐ Brine

☐ Other (Specify) — CODE NO.

Components:
Examples: Hydrochloric acid, lime, caustic soda, phenolics, solvents (list), metals (list), organics (list), cyanide)

	Upper	Lower	Concentration: %	ppm
1.				
2. ChARcoal Waste. with				
3. Dioxin.				
4.				
5.				
6.				

Hazardous Properties of Waste:

pH ____ ☐ none ☒ toxic ☐ flammable ☐ corrosive ☐ explosive

Bulk Volume: 9pc. Pipe ☐ gal ☐ tons ☐ barrels (42 gal.) ☐ other (SPECIFY)

Containers: 1 (NUMBER) ☐ drums ☒ cartons ☐ bags ☒ other Pipe (SPECIFY)

Physical State: ☐ solid ☐ liquid ☐ sludge ☐ other (SPECIFY)

Special Handling Instructions (if any):

The waste is described to the best of my ability and it was delivered to a licensed liquid waste hauler (if applicable)

I certify (or declare) under penalty of perjury that the foregoing is true and correct. [signature]

HAULER OF WASTE (Must be filled by hauler)

CHANCELLOR & OGDEN, INC.
3031 East "I" Street, Wilmington, California 90744
Phone: (213) 432-8461 — CODE NO.

Pick Up: 7-10-76 (DATE) Time: ____ ☐am ☐pm

State Liquid Waste Hauler's Registration No. (if applicable): 9

Job No.: ____ No. of Loads or Trips: 1 Unit No. ____

Vehicle: ☐ vacuum truck ____ barrels, ☒ flatbed, ☐ other (SPECIFY)

The described waste was hauled by me to the disposal facility named below and was accepted

I certify (or declare) under penalty of perjury that the foregoing is true and correct. [signature] SIGNATURE OF AUTHORIZED AGENT AND TITLE

DISPOSER OF WASTE (Must be filled by disposer)

Name (print or type): B.K.K. Co. — CODE NO.

Site Address: 2210 S Azusa Ave

The hauler above delivered the described waste to this disposal facility and it was an acceptable material under the terms of RWQCB requirements, State Department of Health regulations, and local restrictions

Quantity measured at site (if applicable): ____ State fee (if any): ____

Handling Method(s):

☐ recovery

☐ treatment (specify): ____ (EXAMPLES: INCINERATION, NEUTRALIZATION, PRECIPITATION) — CODE NO.

☒ disposal (specify): ☐ pond ☐ spreading ☒ landfill ☐ injection well

☐ other (specify): ____ — CODE NO.

If waste is held for disposal elsewhere specify final location: Chem-Nuclear Systems Arlington Ore.

Disposal Date: 22-9-76

I certify (or declare) under penalty of perjury that the foregoing is true and correct. K.O. Flaig — SIGNATURE OF AUTHORIZED AGENT AND TITLE

The site operator shall submit a legible copy of each completed Record to the State Department of Health with monthly fee reports.

FOR INFORMATION RELATED TO SPILLS OR OTHER EMERGENCIES INVOLVING HAZARDOUS WASTE OR OTHER MATERIALS CALL (800) 424-9300.

Chem-Nuclear ... N.O.S. Poison

DEPARTMENT OF THE NAVY
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20350

2 FEB 1977

MEMORANDUM FOR THE DIRECTOR, DEFENSE LOGISTICS AGENCY

Subj: Disposition of Herbicide Orange located at the Naval Construction Battalion Center (CBC), Gulfport, Mississippi

There are currently 15,000 55-gallon drums of herbicide orange stored at the CBC Gulfport, Mississippi. The material is the property of the U.S. Air Force and contains a highly toxic contaminant, dioxin.

Military use of herbicide orange was banned by the Secretary of Defense in 1970, and the Air Force Logistics Command was designated the responsible agent for disposal of the material. Initially, Air Force studies involved destruction of the material. However, in recognition of its market value, it was decided to sell the material to a contractor for removal of the contaminant, and marketing in commercial channels. Accordingly, in October 1975, the Air Force, acting under license from CBC Gulfport, furnished a lease to Agent Chemical Incorporated, Houston, Texas, for construction of a pilot plant to remove the contaminant. The pilot plant was successful but resulted in production of dioxin-contaminated charcoal.

The Navy understands that the Defense Logistics Agency is now negotiating with Agent Chemical for reprocessing all herbicide orange stored at CBC Gulfport in a full scale plant to be constructed at the CBC. The early removal of the herbicide orange from the CBC is essential as the containers of this material are beginning to deteriorate after nearly 10 years of outside storage. State of Mississippi and local officials are on record in requesting the Navy to "do something" to eliminate the environmental hazards that they believe exist as a result of the material stored at CBC.

DLA now has the dominant role in the solution (i.e., marketing) to the problem. Accordingly, your assistance in expediting the reprocessing contract negotiations to an early and environmentally safe solution is solicited. The Navy will appreciate being kept advised of progress toward this end and assist in any way appropriate. Mr. Carl Zillig, Manager, Shore Facilities Environmental Protection (OP-451), in the Office of the Chief of Naval Operations, telephone 697-3639, is designated the Navy focal point.

John J. Bennett
Assistant Secretary of the Navy
(Installations & Logistics)

MEMORANDUM FOR RECORD 1 October 1976

SUBJECT: Herbicide Orange (H.O.) Procurement

Following data provided by DGSC Richmond in response to our request for the procurement history on FSN 6840-00-825-7792 Herbicide Mixture low volatile esters of 2, 4-D (33.5%) and 2, 4, 5-T (31.9%) plus 34.6% inert in 55 gallon drums.

May local purchase but DGSC will buy upon receipt of a MIPR. Last procurement was made in November 1975 for Griffiss AFB, New York. Supplier - Dow Chemical. 50 drums FOB $519.35 drum, including transportation. Baird & McGuire of Holland, Massachusetts offered, 50 drums FOB $547.20 per drum.

DGSC Contacts: Mrs. Pretlow, Item Manager, DGSC-OAZ
Mr. Leonard, Asst. IM
Dr. Pat Waldrep, Chemical (DGSC-SEB)
Autovon 695-4595/3664

Paula

PAULA McLAIN
DSAH-SME

DEFENSE SUPPLY AGENCY

Inter-Office Memorandum

DATE: 14 April 1976

SUBJECT: Herbicide Orange

FROM : DSAH-G

TO : DSAH-D

1. I am not satisfied that I expressed adequately my concern at our meeting yesterday on Herbicide Orange (H.O.). Clearly the most appealing course of action at this time is for DSA to bow out. But DGSC is buying on the market what the Air Force is proposing to pay to have destroyed. The available facts do not, in my view, establish that destruction of H.O. is the only environmentally safe course of action.

2. The following summarizes the major points relating to H.O. as I see them:

A. Environmental

1. Continued storage presents a continuing though unproved environmental danger because of leakage and the risk of accident or natural disaster.

2. Detoxification involves continued storage until the process is approved and underway, plus risk of processing accidents.

3. Ocean incineration involves possibly a shorter storage time, depending on EPA clearance time, but involves risk of accident plus air and water pollution because of admitted shortcomings in "Vulcanus" process.

Conclusion. There are significant environmental risks in all available alternatives. Ocean incineration is not necessarily the safest disposition. All alternatives have not been pursued. Moreover, all alternatives require redrumming if continued storage constitutes a grave enough problem.

B. Practicability

1. Ocean incineration appears to be practicable, although environmentally questionable.

2. Detoxification:

Charcoal method has been successful on laboratory scale, not in production. More time needed.

Chemical method apparently is available through Velsicol at no cost to the Government.

Alternate methods to burning for destroying residual Dioxin have not been fully explored, e.g., encapsulation of charcoal slurry.

Conclusion. Ocean incineration appears to be the most immediately practicable course of action but only if EPA approval can be obtained within the next few months.

C. Cost

1. Ocean incineration is estimated to cost $3.5 million plus loss of value of recoverable product.

2. Recoverable value of herbicide is estimated to be between $80 - 240 million, less cost of processing and commercial profit.

3. DGSC is currently buying herbicide similar to that recovered by detoxification.

4. Termination of Agent's efforts at this time will result in a claim against the Government, possibly close to $600,000.

Conclusion. Pursuing detoxification would clearly be cost effective at this time.

3. All we can do is to make sure the decision makers have the benefit of our views. I have the impression that some Air Force people have never really honestly considered reprocessing as an acceptable alternative from the time of the Air Force study to the present.

KARL KABEISEMAN
Counsel

DEFENSE SUPPLY AGENCY

[illegible]76

MEMO FOR General Vaughan

Figures you requested re: Herbicide Orange at briefing yesterday:

(ESTIMATED $ VALUE - MILLIONS)

TECHNICAL GRADE

- ORIGINAL ACQUISITION COST TO U.S.	$10.4
- PRESENT ACQUISITION VALUE TO U.S.	$19.6
- PRESENT COST (ACID) TO COMMERCIAL PROCESSOR	$23.6
- PRESENT COST (SALT) TO COMMERCIAL PROCESSOR	$26.5

"OVER-THE-COUNTER" VALUE

- ACID (CUT 3.5 TO 1)	$82.5
- SALT (CUT 9 TO 1)	$264.5

WILLIAM R. HUGGINS
Colonel, USA
Deputy Executive Director
Technical & Logistics Services

DSA FORM 104 OCT 74 — REPLACES DSAH FORM 104 WHICH MAY BE USED UNTIL EXHAUSTED

PERFORMANCE IMPROVEMENT

6840-00-577-4194 SSC-1	$24.50 5 gal. container See attached sheet #1	2,4-D

Average Monthly Demand	95 drums
Backorders	0
Stock On Hand	405 drums
Due in - on Purchase Request (dated 7 March 1975) not on contract	404 drums

6840-00-664-7060 SSC-2	5 gal can.	2,4-D

Liquid amine salt forms which are intermediate in toxicity to plants per pound of 2,4-D acid equivalent

6849-00-577-4195 SSC-2	55 gal. drum See attached sheet #2.	2,4-D
6840-00-582-5440 SSC-1	$48.60 5 gal. can See attached sheet #3	2,4,5-T

Average Monthly Demand	18 cans
Backorders	0
Stock On Hand	228 cans

6840-00-577-4201 SSC-2	55 gal. drum See attached sheet #4	2,4,5-T

Administrative Lead Time	90 Days
Production lead time	90 Days
Procurement cycle	90 Days

ATTACHMENT B

BUTYL ESTER FORMULATIONS

COMMERCIAL NAME	MANUFACTURER	2,4-D	2,4,5-T	INERTS	EPA REGISTRATION NUMBER	REMA
Butyl Brushkiller	Colorado International Corp., Commerce City, Colorado	27.5%	26.7%	45.8%	EPA #4715-181	EPA
Wood Kill	Woodbury Chemical Co. Denver, Colorado	28.7%	27.9%	43.4%	USDA #449-65	EPA
Brush Killer #23	Bartels & Shores Chemical Company Kansas City, MO	29.2%	28.4%	42.4%		EPA
Super Brush Killer	Gordon Chemical Corp. Kansas City, Kansas	27.5%	26.7%	45.8%	EPA #2217-94-AA901-473	
Brush-Rhap	Transvaal, Inc. Jacksonville, Ark.	29.0%	28.2%	42.8%	EPA #11687-11	
Line Rider 22	Diamond Shamrock	28%	27%	45%	EPA #667-95-AA	
Wood Kill	Woodbury Chemical Co. Denver, Colorado	42.67%	42.20%	15.13%	USDA #449-28	

(It is also our understanding that the Velsicol Corporation has indicated to you an interest in the reformulation possibilities.)

MEMORANDUM FOR RECORD 7 March 1977

SUBJECT: Herbicide Orange Disposal

1. Culminating a week of discussions concerning Agent Chemical Incorporated's (ACI) attempts to reprocess Herbicide Orange (HO) to date and the Government's best interests for the future, the OSD, Air Force (AF), and DLA representees listed on Attachment 1 met in Mr. Harrell B. Altizer's Office on 4 March 1977 as a result of Dr. Billy E. Welch's 1 March 1977 memorandum, endorsed by the Acting Assistant Secretary of the Air Force (I&L) to Mr. Dale R. Babione (ASD(I&L)), Attachment 2. Dr. Welch's memorandum sums up his earlier expressed view that the totality of circumstances argue in favor of abandoning reprocessing efforts and immediately reopening AF attempts to obtain an ocean dumping permit from EPA which will allow incineration of HO at sea. Dr. Welch points chiefly to financial and technical magnitude associated with Government retention and ultimate disposal of the charcoal residual from HO reprocessing.

2. Referring to a recent OSI report on possible conflicts of interest associated with the HO reprocessing project, Mr. Bruner cited certain AF Technical statements which appeared to cast some doubt on the reliability of Wright State University's (WSU) laboratory tests for the AF during ACI's pilot plant operations. Because revalidating and reconstructing ACI's activities would be extremely difficult and time consuming, Mr. Bruner stated he had intended to endorse Dr. Welch's position and would not have recommended continuing DoD's relationship with ACI until the company failed independently to succeed in reprocessing. However, DLA discussions with AF Doctors Melvin and Taylor had substantiated that WSU's test results had been "spurious" and "inconsistent" only in the context of WSU's highly optimistic promises of technical precision in measuring TCDD. Specifically, Doctors Melvin and Taylor stated that while WSU's TCDD data and discoveries were not consistently accurate at the levels they were attempting to measure, particularly with regard to air samples from the area surrounding ACI's plant, the AF with some degree of confidence felt that WSU's results established that ACI's operation successfully reprocessed HO without significantly degrading the environment. Mr. Bruner, therefore, recommended that DoD continue with ACI until they failed in their reprocessing efforts or chose to withdraw from the project. To this end, DLA suggested a letter to ACI stating that their current operational plans were technically inadequate, listing various potential subcontractors which could help ACI in this regard and requiring ACI to submit acceptable plans and request a Mississippi State hearing on the necessary permits by early April 1977. Additionally, because of the substantially increased

MEMORANDUM FOR RECORD
SUBJECT: Herbicide Orange Disposal 7 March 1977

Government cost associated with relieving ACI of charcoal disposal, the letter would advise ACI of the lowest acceptable offer which would make the project break even and thereby protect the taxpayers. If ACI then chose to withdraw, DoD could pursue ocean incineration or any other available alternative.

3. While OSD appeared initially receptive to this recommendation, when Mr. Reynolds (AF Assistant General Counsel) stated that disposing of the charcoal residual was practically and technically impossible at this time, OSD decided that if the AF could obtain sufficient assurances from EPA that they would grant an ocean dumping permit in the immediate future DLA should terminate further efforts by ACI.

4. Subsequent to the above meeting, Mr. Altizer informed Mr. Bruner that EPA had assured the AF they they would grant an ocean dumping permit expeditiously. Mr. Altizer did not, however, specify the EPA official or the administrative level from which this assurance had come. Mr. Altizer did agree that OSD would direct both the AF to re-open their request for an ocean dumping permit and DLA to so inform ACI.

MR. RICHARD G. BRUNER
Executive Director
Technical & Logistics Services

JOSEPH W. URBANEK
Special Assistant for
Environmental Quality
Property Disposal Division

Need Procurement History — Source of Supply, Current market Value, Mr. Muller

Class 6840

(6840-00-825-7792)

Activity Codes

CE Kelly AFB

CX Defense General Supply Center, Petersburg Pike, Bellwood, Richmond, Va. 695-3374 or 3982

PA Marine Corps Supply activity. 1100 South Broad St. Phila. Pa. 445-3671 or 3672 Richard Hunter, Bill Johnson

SE Kelly AFB

SE Kelly AFB, Texas 945-7906 or 7907 F. W. Collis

SW Hill AFB, Utah 458-6660 or 6669 Melva Wilm

XG Department of Transportation, U.S. Coast Guard Supply Center Brooklyn N.Y. (31st St. & 3rd. Ave.) 938-~~[illegible]~~ 3350 X 381 382

(Blyth
1 Brig.'

Mr. Grove DNA

Mr. Futral
325-7132
Capt

Contractor help support avail on
JA including qtrs.
What are restrictions.
~~Contract~~ ~~yes~~ Our people?
Use of American Flag vessels
What transp is avail and when (Samples to Lab + return)
Food
water
elec
transportation

Contract CAS
CAS B. have written JA responsibilities

yes

MFR 9/24/76

Subj: H.O. Procurement

Following data provided by DGSC Richmond in response to your request for the procurement history on FSN 6840-00-825-7792 (Herbicide Mixture low volatile esters of 2,4-D (33.5%) and 2,4,5-T (31.9%) plus 34.6% inert.) in 55 gal drums.

May local purchase but DGSC will buy upon receipt of a MIPR. Last procurement was made in Nov. 1975 for Griffiss AFB N.Y. Supplier - Dow Chemical. 50 drums FOB $519.35 drum, including transportation. David & McGuire of Holland, Mass offered, 50 drums FOB $547.20 per drum.

DGSC Contacts: Mrs. Pretlow, Item Manager, DGSC-OA
Mr. Leonard, Asst. IM
Dr. Pat Waldrop, Chemical (DGSC-SEB)
Autovon 695-4595/3664

Paula McLain DSAH-SME

Not buying - Don't plan to buy

Mix - low volatile esters of 2-4D + 2-4-5T

33.5% 2-4D 31.9 (2,4,5-T) 55 gal drum

34.6% inert

Can Local Purchase

MIPR = DGSC buy

Nov 1975 for Griffiss AFB N.Y.

50 drums $519.35 total (per drum)

Dow Chemical FOB (incl transp)

Baird + McGuire, Holbrook Mass

$549.20 FOB

[illegible] DGSC

8.50

567-9114

Brisket

John Boyd

46394

Foreign flags over our host storage are questionable.

Futrial, DNA

Base Support Facilities

Host mgr. operated by Base Support ERDA contractor.

10-20 can be supported on a reimbursable basis

Util, water avail
distilled. If need great amounts above. Can pump salt water

Food #12.00 per day. Movie, hobby shop may be operational. 4 hole golf course.

Transp. - Micronesian Air 3 per week
MAC Contractor approx 2 times week.
Limited access island. Clearance req'd. Any items 0/14. All visitors need Foreign clearance. 3 star general would be concerned about

Field Command, Def Nuclear Agency at Hqts. Kirtland AFB

Col Schafer (Army) Dir Log

Col Sanchez Deputy

David Wilson (agreements)

Auto 8 964-7236

Contact DCAS – Need list of QA responsibilities/procurement contracts involving chemicals that could cause adverse envir impact

---

Contact Mr. Grove, DNA – 325-7132
What personnel support is available to contractor's staff, i.e. quarters, food. What industrial type, i.e. water, space (land), electricity. What restrictions?
Is commercial air transportation avail to pickup and deliver samples to CONUS? Frequency? What temporary storage space is available for contaminated charcoal canisters? Can non U.S. flag vessel embark, for example, to pick up crushed drums and/or product?

Mr. Futral, Project Manager w/advise – 9/23/7[illegible]

Contact DGSC re Procurement History
6840-00-885-7792 (Mr Putler, IM)-695-
Waldrup will advise

MEMORANDUM FOR RECORD   7 March 1977

SUBJECT: Herbicide Orange Disposal

1. Culminating a week of discussions concerning Agent Chemical Incorporated's (ACI) attempts to reprocess Herbicide Orange (HO) to date and the Government's best interests for the future, the OSD, Air Force (AF), and DLA representes listed on Attachment 1 met in Mr. Harrell B. Altizer's Office on 4 March 1977 as a result of Dr. Billy E. Welch's 1 March 1977 memorandum, endorsed by the Acting Assistant Secretary of the Air Force (I&L) to Mr. Dale R. Babione (ASD(I&L), Attachment 2. Dr. Welch's memorandum sums up his earlier expressed view that the totality of circumstances argue in favor of abandoning reprocessing efforts and immediately re-opening AF attempts to obtain an ocean dumping permit from EPA which will allow incineration of HO at sea. Dr. Welch points chiefly to financial and technical magnitude associated with Government retention and ultimate disposal of the charcoal residual from HO reprocessing.

2. Referring to a recent OSI report on possible conflicts of interest associated with the HO reprocessing project, Mr. Bruner cited certain AF Technical statements which appeared to impugn the reliability of Wright State University's (WSU) laboratory tests for the AF during ACI's pilot plant operations. Because revalidating and reconstructing ACI's activities would be extremely difficult and time consuming Mr. Bruner stated he had intended to endorse Dr. Welch's position and would not have recommended continuing DoD's relationship with ACI until the company failed independently to succeed in reprocessing. However, DLA discussions with AF Doctors Melvin and Taylor had substantiated that WSU's test results had been "spurious" and "inconsistent" only in the context of WSU's highly optimistic promises of technical precision in measuring TCDD. Specifically, while WSU's TCDD data were not consistently accurate at the levels they were attempting to measure, particularly with regard to air samples from the area surrounding ACI's plant, the AF felt confident that WSU's results validly established that ACI's operation successfully reprocessed HO without significantly degrading the environment. Mr. Bruner, therefore, recommended that DoD continue with ACI until they failed in their reprocessing efforts or chose to withdraw from the project. To this end, DLA suggested a letter to ACI stating that their current operational plans were technically inadequate, listing various potential subcontractors which could help ACI in this regard and requiring ACI to submit acceptable plans and request a Mississippi State hearing on the necessary construction permit by early April 1977. Additionally, because of the substantially increased Government cost associated with relieving ACI of charcoal disposal, the letter would advise ACI of the lowest acceptable offer which would make the project break even and thereby protect the taxpayers. If ACI then chose to withdraw, DoD could pursue ocean incineration or any other available alternative.

3. While OSD appeared initially receptive to this recommendation, when Mr. Reynolds (AF Assistant General Counsel) stated that disposing of the charcoal residual was practically and technically impossible at this time, OSD decided that if the AF could obtain sufficient assurances from EPA that they would grant an ocean dumping permit in the immediate future DLA should terminate further efforts by ACI. In making this decision, OSD was aware that the Army had already quoted the AF an estimated cost and time frame for total destruction of the charcoal, that EPA officially endorses reprocessing as a viable disposal measure, recommending only that the Government store the residual charcoal safely to allow time to develop satisfactory destruction methods, and that substantial claims from ACI to recover at least their costs to date are likely.

4. Subsequent to the above meeting, Mr. Altizer informed Mr. Bruner that EPA had assured the AF that they would grant an ocean dumping permit expeditiously. Mr. Altizer did not, however, specify the EPA official or the administrative level from which this assurance had come. Mr. Altizer did agree that OSD would direct both the AF to re-open their request for an ocean dumping permit and DLA to so inform ACI.

Attachment 1

ATTENDEES AT 4 MARCH 1977 MEETING IN OSD

Mr. Harrell B. Altizer	)	
Mr. R. F. Rozycki	)	OSD
Mr. John G. Marcus	)	
Mr. Gurden E. Drake	)	
Colonel W. W. Melvin	)	
Lt. Colonel G. D. Taylor	)	
Major Charles W. Bullock	)	AF
Mr. Grant C. Reynolds	)	
Mr. Abraham Belous	)	
Mr. Richard G. Bruner	)	
Mr. Joseph W. Urbanek	)	DLA
Mr. David P. Forbes	)	

DEPARTMENT OF THE AIR FORCE
WASHINGTON 20330

OFFICE OF THE ASSISTANT SECRETARY

21 FEB 1975

MEMORANDUM FOR THE DIRECTOR, DSA

SUBJECT: DOD Requirements for Herbicide Orange

As requested by Mr. Richard Bruner, the Air Force single manager for Herbicide Orange has contacted the Army and the Navy to ascertain that neither of those military departments has a requirement for Herbicide Orange. It is further noted that Herbicide Orange is an unregistered herbicide and its use therefore is contrary to public interests.

Accordingly, the Air Force as DOD single manager for Herbicide Orange has concluded that there is no DOD requirement for Herbicide Orange. You may therefore proceed with disposal action.

L. K. MOSEMANN II
Deputy Assistant Secretary
(Logistics)

responses and to have the Environmental Protection Agency evaluate these responses prior to that point in time when facilities for disposal by incineration at sea become available. To expedite this process requires that your office and the General Services Administration waive utilization screening. This is not an unreasonable request. Herbicide Orange is currently an unregistered product that cannot be legally used as a herbicide by anyone, in or out of the government. If the Environmental Protection Agency should register any portion of our Herbicide Orange stocks for use as a herbicide, and we do also have a request for registration pending, normal redistribution and marketing channels, including full utilization screening, would be followed for the portion that is registered. However, at best only a portion would be registered, so there will be a substantial disposal problem remaining.

Accordingly, it is requested that you authorize the Defense Supply Agency to proceed with the disposal of the Herbicide Orange as a raw chemical requiring reformulation in accordance with a process to be approved by the Environmental Protection Agency, without the necessity for DoD-wide or inter-Governmental agency screening.

I understand there may also be some question on the part of your staff concerning the application to Herbicide Orange of Title 50, USC 1512-1518, dealing with chemical warfare agents. Our legal counsel has concluded that the law does not preclude the sale of Herbicide Orange as a chemical raw material. The transportation restrictions in sections 1512-1517 apply only to lethal chemicals, which Herbicide Orange is not. The legislative history shows that "lethal" refers to chemicals killing or totally disabling on contact; e.g., various forms of poison gas. While Orange is not ingestible, it is clearly not within the lethal category. Section 1518 merely requires detoxification prior to disposal. Since Orange is not toxic, as that term is used in the Act, it may be freely disposed of. Accordingly, the Air Force General Counsel has determined that Title 50 USC 1512-1518 does not affect the proposed waiver of screening or sale for use as a chemical raw material.

Acting Assistant Secr[illegible]ry of the Air Force
(Installations [illegible] Logistics)

cc: DSAH-S

ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301

SR
INSTALLATIONS AND LOGISTICS

1975

MEMORANDUM FOR THE ASSISTANT SECRETARY OF THE AIR FORCE (I&L)

SUBJECT: Waiver of Utilization Screening for Herbicide Orange

Reference is made to your memorandum dated 24 December 1974, subject as above, which recommends disposal procedures applicable to Herbicide Orange (H.O.).

Your request for waiver of utilization screening prior to sale of the H.O. is not approved. This determination is based on the fact that screening can be accomplished in an expedited manner, thereby imposing no delay in your proposed action.

Additionally, your request raises the question of whether H.O. can be sold in its present state and prior to reformulation, as that term is used by the Environmental Protection Agency (EPA) in its 21 January 1975 letter to you. The EPA has apparently determined, by the terms of the 21 January letter, that some or all of the H.O. cannot presently be defined as non-toxic or otherwise harmless to man and his environment. Based on this EPA position, such H.O. should be reformulated [illegible] to meet EPA criteria prior to its sale. This requirement would not seem to preclude an approach such as a contract for reformulation coupled with or followed by a contract for sale, provided ownership and control of the H.O. were retained by the Government and no sale was consummated until the EPA approved the end product.

In view of the above, it is requested that the 2.3 million gallons of H.O. be screened in an expedited fashion and then referred to the Defense Supply Agency for sale. The General Services Administration has advised that there are no Federal or donation requirements for the H.O.

(Signed) Paul H. Riley
Deputy Assistant Secretary of Defense
(Supply, Maintenance & Services)

Defense Supply Agency

Encl 2

DEPARTMENT OF THE AIR FORCE
WASHINGTON 20330

OFFICE OF THE ASSISTANT SECRETARY

24 DEC 1974

MEMORANDUM FOR ASSISTANT SECRETARY OF DEFENSE (I&L)

SUBJECT: Waiver of Utilization Screening for Herbicide Orange

Herbicide Orange is a formulation of 24D and 245T containing a contaminant known as dioxin. It was used for vegetation control in Southeast Asia. Several years ago, it was determined that Herbicide Orange would no longer be employed as a herbicide by any of the Armed Forces and that existing stocks would be disposed of. Currently, the Air Force has in storage 2.3 million gallons at Gulfport, Mississippi, and Johnston Island, and we have been endeavoring to effect disposal for the total quantity. A variety of methods have been contemplated for several years pursuant to the latitude given the Secretary of the Air Force in this matter by the Secretary of Defense in a memorandum dated July 2, 1972.

We have now concluded that there are only two reasonable disposal procedures applicable to Herbicide Orange. The first of these is incineration, at sea or on Johnston Island. A final environmental impact statement covering the incineration method has recently been filed with the Council on Environmental Quality. Concurrently, and more recently, we have been in contact with several companies and the Environmental Protection Agency concerning certain chemical reprocessing steps which would reduce the dioxin to a safe level. We are now working with the Defense Supply Agency and the Environmental Protection Agency with a view toward the sale of the Herbicide Orange, not as a herbicide, but as a raw chemical which could be processed into some other end product under procedures to be approved by the Environmental Protection Agency. The basic advantage of the latter alternative is that, whereas incineration will cost the Government several million dollars, its sale as a raw chemical would at least cover our immediate past expenses and might even return to the Treasury some portion of the original acquisition cost of the material.

For disposal by sale to be an effective and timely means of disposal, it is important for the Request for Proposal to be issued by the DSA as soon as possible so as to enable us to receive

Encl 3

DEFENSE SUPPLY AGENCY
DEFENSE PROPERTY DISPOSAL SERVICE
FEDERAL CENTER
BATTLE CREEK, MICHIGAN 49016

IN REPLY REFER TO DPDS-MC

Gentlemen:

The Department of Defense is undertaking the disposal of approximately 2.3 million gallons of Herbicide Orange. The herbicide will be sold with the stipulation that it must be reprocessed to remove the tetrachloro-p-benzodioxin to the degree which will be satisfactory to the Environmental Protection Agency.

The attached Request for Quotations is being forwarded for your use if you have the capability and interest to reprocess the material for the purpose of obtaining the residue.

Any questions concerning this request for proposals should be directed to the Sales Contracting Officer, Phone Area Code 616-962-6511, extensions 6733 or 6929.

Sincerely,

for RICHARD B. URBAN
Chief, Contracting Division
Directorate of Sales

Encl

REQUEST FOR QUOTATIONS

THE GOVERNMENT MAY NOT AWARD A CONTRACT ON THE BASIS OF THIS REQUEST FOR QUOTATIONS. NO PAYMENT WILL BE MADE FOR THE INFORMATION SOLICITED.

Opening Date: 28 Mar 1975
Time: 3:00 PM EST

A. QUOTATIONS(Offers) ARE DESIRED FOR THE PURCHASE OF THE MATERIAL LISTED BELOW:

- -

LOCATION: Gulfport, Mississippi

1. Herbicide, orange, consisting of approximately 43 percent n-butyl ester of 2, 4-D and 42 percent of the n-butyl ester 2, 4, 5-T with traces of tetrachloro-p-benzodioxin (TCDD).

This herbicide is not registered with EPA.

Stored in 55 gallon drums.

860, 000 gal.

- -

LOCATION: Johnston Island

1. Herbicide, orange, consisting of approximately 43 percent n-butyl ester of 2, 4-D and 42 percent of the n-butyl ester 2, 4, 5-T with traces of tetrachloro-p-benzodioxin (TCDD).

This herbicide is not registered with EPA.

Stored in 55 gallon drums.

1, 400, 000 gal.

B. Government will load on purchasers conveyance in present containers if they are suitable for shipment or the Government will transfer the material to suitable containers and/or conveyances provided by the purchaser and load as necessary. Purchaser will be required to remove material and all containers including those containers not suitable for shipment of material. Transportation costs will be borne by the Purchaser.

INSPECTION HOURS: 0800 - 1500 DAILY
LOADING HOURS: 0800 - 1500 DAILY

C. IT HAS BEEN DETERMINED THAT THIS PROPERTY IS NO LONGER NEEDED BY THE FEDERAL GOVERNMENT.

D. THE HERBICIDE MUST BE REPROCESSED TO THE EXTENT THAT IT MEETS THE STANDARDS SET BY EPA FOR REGISTRATION OF HERBICIDES. TO AID IN THE EVALUATION OF YOUR PROPOSAL, IT IS REQUIRED THAT DETAILED ANSWERS BE FURNISHED FOR THE FOLLOWING:

E. THE PURCHASER WILL BE RESPONSIBLE FOR CLEANING OF THE DRUMS TO THE SATISFACTION OF THE ENVIRONMENTAL PROTECTION AGENCY.

F. ALL OFFERORS ARE ADVISED THAT THEY MUST COMPLY WITH ALL APPLICABLE FEDERAL, STATE AND LOCAL LAWS, ORDINANCES AND REGULATIONS WITH RESPECT TO ENVIRONMENTAL POLLUTION DURING THE PROCESSING OR USE OF THE HERBICIDE PURCHASED FROM THE DEPARTMENT OF DEFENSE.

1. What mode of shipment will be used to transport the material?

____

2. At what rate will it be removed from its present location? Submit a proposed removal schedule for each item. ____________________

____

3. Estimated time enroute from Government premises to destination?

____

4. Where will the material be processed? ____________________

____

5. At what rate will it be processed? ____________________

____

6. Where will material be stored while awaiting processing? __________

____

7. What security will be provided over the material while it is awaiting processing? ______________________________________

____

G. In addition to answering the above questions, each offeror must submit a plan together with applicable technical data, which plan must outline in detail the method which will be used to reprocess the material including the containers. If the offeror's plan or any portion thereof or supporting technical data relating thereto contain trade secrets or privileged information, such material may be so marked and if so marked, will be treated as confidential by the Government.

The plan should be arranged in the following manner:

1.) An introduction and general outline of the proposed methods of handling the material and containers, submitted on letter-size paper, double spaced, in 10 copies.

2.) Location and description of the reprocessing facility.

3.) A complete description of the chemical process to be used in reprocessing of the material, the compounds to be formed and the residual dioxin content.

4.) Probable level of dioxin in the reprocessed product.

5.) Dioxin residues or other residues from the reprocessing (e.g. air emissions, solid or liquid residuals) the method of disposal and expected environmental consequences of such disposal.

6.) Name(s) and registration number(s) of product in which reformulated Herbicide will be used if reprocessed compound is intended to be a pesticide.

7.) Documented test results, if available.

8.) Proposed quality control checks.

H. The proposer must also obtain:

1.) Registration or other EPA required clearances if the product is to be used as a pesticide or herbicide.

2.) EPA approvals as necessary for disposal of rendered products.

I. The offeror must substantiate all claims made for the process it proposes and demonstrate that the process can be accomplished in an environmentally acceptable manner. Each offeror also must submit documented data to substantiate that they possess the capability of processing this material as outlined in the plan.

J. Offers may be made for all or any part of this material at any location. State quantity desired.

K. This is not a formal invitation for bid but a solicitation of quotations. All offers will be reviewed by the Department of Defense and the Environmental Protection Agency to determine if any are acceptable.

L. Prior to entering into a contract, the offeror must be willing to process at least one test batch to affirm the results of the reformulation, and to permit or conduct monitoring of waste emissions to the air, water or land as prescribed by EPA. EPA shall also have the right to inspect the reformulating facility and the reformulated product at any time. The size of the test batch shall be determined by the Government. The test batch shall be processed through a pilot plant operation. Transportation of the test batch shall be the responsibility of the Government.

M. If the Government desires to accept your offer, you will be so notified and a negotiated sales contract will be tendered for your signature. A 20 percent deposit will be required when the contract is executed. Payment in full will be required before the material will be released, however, title to the material shall not be transferred to the offeror until registration of the reprocessed compound or such other approval as may be required by EPA is obtained.

____

____

____

DATE:

QUOTATION

In response to the above request, the undersigned offers to purchase the item(s) described above at the following price(s):

Item # 1

Item # 2

If more space is required, submit a separate sheet with offers. Sign all sheets.

(Name of Offeror) ____________________

(Address) ____________________ (Signature of Offeror) ____________________

(Phone) ____________________

(NOTE: Return this quotation with your proposal in a sealed envelope marked: QUOTATION - 28 Mar 1975)

Sales Contracting Officer
Defense Property Disposal Service
Room 2-4-12
50 North Washington Street
Battle Creek, Michigan 49016

ATTN: TO BE OPENED BY ADDRESSEE ONLY

- -

NOTE: These quotations will not be opened and read publicly.

17 DEC 1976

Notice of Visit from United States General Accounting Office (GAO)

DSAH-SM

DSAH-CM

1. Reference GAO Assignment Code 943029, Survey of Management of Herbicide Orange (H.O.) inventory.

2. On 10 December 1976 the following GAO Washington Regional Office representatives visited DSAH-SME:

Mr. Louis D. Hoexter
Mr. Donald R. Neff
Mr. Bernard R. Anderson

3. The purpose of the visit was to discuss the current status of the DoD effort to dispose of the 2.3 million gallon inventory for sale by reprocessing.

4. As requested by GAO, the entire official H.O. project file (which is maintained at DPDS Battle Creek) was available for review and discussion. Several documents were extracted and reproduced for GAO files.

SIGNED
[illegible]

Mrs. McLain/47503/mo/15 Dec 76

SME

SM

12/17

UNITED STATES GENERAL ACCOUNTING OFFICE
Washington Regional Office
803 W. Broad Street, Fifth Floor
Falls Church, Virginia 22046

GAO Assignment Code Number 943029

Date 10-27-76

TO:
1. Dep. Asst. Sec. Defense (Supply, Maintenance & Services)
2. Dep. Chief of Staff (Systems & Logistics)
3. Defense Supply Agency

X Major assignment

SUBJECT: **Notice of Visit (General Accounting Office)**

PURPOSE OF VISIT: Survey of Management of Herbicide Orange Inventory

APPROXIMATE DATE(S) OF VISIT: 11-03-76 through 12-31-76

LOCATION(S) TO BE VISITED	NAME(S) OF GAO EMPLOYEE(S)	DATE OF BIRTH	DATE OF CLEARANCE TOP SECRET*	DATE OF CLEARANCE SECRET**	UPDATED TOP SECRET***	AEC "Q" CLEARANCE NUMBER	AEC "Q" CLEARANCE DATE
	LITTLETON, David A.	6-04-32	10-11-60		5-01-68	WA-116375	7-31-62
	MAYER, Gloria H.	2-18-33	4-17-57		1-11-67		
	HOEXTER, Louis D.	9-14-20	5-18-56		2-01-67		
	NEFF, Donald R.	4-03-50		5-20-72			
	ANDERSON, Bernard R.	12-30-46		5-20-76			

*Based on a full field investigation conducted by Civil Service Commission under provisions of Executive Order 10450.
**NAC&I by CSC (or NAC by CSC for "Interim" clearances).
***Date TOP SECRET clearance was updated by National Agency Check conducted by CSC.

I hereby certify that the employees listed above have been granted security clearances for official purposes, for access to security information up to and including the level indicated above. This certification is not to be honored unless employees named herein present official U.S. General Accounting Office credentials.

External cc's:
- ____ Army (ATTN: R. S. Eggleston)
- ____ Navy (ATTN: NCD-3)
- X Air Force (ATTN: AFAC-G)
- X Defense Supply Agency (ATTN: DSAH-CM)
- X Deputy Comptroller for Audit Reports OASD(C) Audit

Internal GAO cc's:

Henry Connor LCD/DM

Robert J. McLaughlin
for David P. Sorando
Regional Manager

UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

LOGISTICS AND COMMUNICATIONS DIVISION

APR 1 2 1976

The Honorable
The Secretary of Defense

Attention: Assistant Secretary of Defense (Comptroller)

Dear Mr. Secretary:

The General Accounting Office is initiating a general surv[e]
the Air Force management of its stockpile of Herbicide Orange.
on this survey will be conducted under the assignment code 9905[…]

Initial work on this assignment will be performed at Headqu[…]
Department of Defense, Department of Air Force and the Defense S[…]
Agency. Subsequent survey work may be performed at the Construc[…]
Battalion Center, Gulfport, Mississippi and at Johnston Island.

If you have any questions concerning this assignment, pleas[e]
contact Mr. R. M. Gilroy, Assistant Director, LogCom, on 275-587[…]
or Mr. G. M. Bissey, Audit Manager, LogCom, on 275-6095.

Sincerely yours,

FOR Henry W. Connor
Associate Director

cc: Assistant Auditor General, USAF
Mr. Shafer (LCD)

RMG/mab

GAO ASSIGNMENT CODE 990591

UNITED STATES GENERAL ACCOUNTING OFFICE
LOGISTICS AND COMMUNICATIONS DIVISION

Apr. 21, 1976
(Date)

TO: Commander
Defense Supply Agency
Cameron Station, Alexandria, Va. 22314

[X] Major assignment
[ ] Assist to another GAO office
[ ] Field office controlled assignment

SUBJECT: NOTICE OF GENERAL ACCOUNTING OFFICE VISIT

PURPOSE OF VISIT: To examine and discuss with officials pertinent documents on Herbicide Orange

APPROXIMATE DATES OF VISIT: April 23, 1976

LOCATIONS TO BE VISITED	NAME(S) OF GAO EMPLOYEE(S)	BIRTH DATE	DATE OF TOP SECRET CLEARANCE	AEC "Q" CLEARANCE NUMBER & DATE
Hdqrs., DSA	Thomas W. Hopp	5/08/43	4/17/74 (Secret)	
	Mario Petrucelli	4/11/51	4/ 1/74 (Secret)	
	Philip A. Velte	5/29/27	(In process)	

BASIS FOR CLEARANCE: Full investigation conducted by the Civil Service Commission under provisions of E.O. 10450.

I hereby certify that the GAO employee(s) listed above have been granted security clearance for official purposes for access to security information up to and including the level indicated above. <u>This certification is not to be honored unless employee(s) named herein present official U.S. General Accounting Office credentials</u>.

Info cc:

Asst. Secy. (FM) or Comptroller:___Army,___Navy,___Air Force
Defense Agency Comptroller: x DSA,___DCA,___ __________

for James R. Murphy
Henry W. Connor
Associate Director

DEFENSE SUPPLY AGENCY

Inter-Office Memorandum

DATE: 19 OCT 1976

SUBJECT: GAO Survey, "Management of the Herbicide Orange Inventory" (Audit Code #943029)

FROM : DSAH-CM (Mr. Kaufman/47855/kk)

TO : DSAH-SM

1. Reference: DSAR 7650.2, subject: DSA Relationships with the GAO.

2. Enclosed is formal notification that GAO is initiating subject survey.

3. Pursuant to reference, this office should be advised by 25 October 1976 (by phone, 47855) of an overall point of contact within DSAH-SM for this **survey**. DSAH-CM should also be kept advised of any significant discussions or preliminary findings that may develop.

A. E. Wood, Jr.

A. E. WOOD, JR., Chief
Management Evaluation and
Information Systems Division
Office of the Comptroller

1 Encl

cc:
DSAH-OP

DSA FORM 111 NOV 72 PREVIOUS EDITIONS MAY BE USED UNTIL SUPPLY EXHAUSTED

DEFENSE SUPPLY AGENCY

9 Dec 76

MEMO FOR DICK BRUNER
DSAH-S

Attached wire service story on Herbicide Orange is forwarded for your interest and information.

Story was reproduced in Thursday, 9 Dec, early bird edition of DoD Current News clips.

Encl

CHESTER C. SPURGEON
Special Assistant for
Public Affairs

DSA FORM OCT 74 104 REPLACES DSAH FORM 104 WHICH MAY BE USED UNTIL EXHAUSTED

PERFORMANCE IMPROVEMENT

A042
R A
PM-TOXIC SKED 12-9

PORTLAND, ORE. (UPI) -- A DOZEN STAINLESS STEEL CYLINDERS OF A DEADLY CHEMICAL USED AS A DEFOLIANT IN THE VIETNAM WAR WERE FLOWN TO A PACIFIC ISLAND WEDNESDAY AFTER DISCOVERY THEY WERE STORED IN OREGON RESULTED IN A SENATORIAL PROTEST.

SEN. MARK HATFIELD, R-ORE., WHO DEMANDED REMOVAL OF THE DEFOLIANT CONTAINING THE CHEMICAL DIOXIN FROM THE STATE AND THE COUNTRY, SAID SCIENTISTS CLAIM DIOXIN "IS 100 TIMES MORE LETHAL THAN NERVE GAS."

THE SAME CHEMICAL SORCED THE ABANDONMENT OF AN ITALIAN TOWN IN JULY WHEN AN EXPLOSION RELEASED SOME OF THE SUBSTANCE INTO THE ATMOSPHERE.

THE CYLINDERS HAD BEEN STORED SINCE SEPT. 21 IN A WAREHOUSE NEAR ARLINGTON, ORE., PROTECTED ONLY BY A LOCK AND A WATCHMAN.

A SPOKESMAN FOR OREGON'S DEPARTMENT OF ENVIRONMENTAL QUALITY SAID THE STORAGE DECISION WAS MADE BY A MID-LEVEL ENGINEER WITHOUT CONSULTING HIS SUPERIORS AND WITHOUT KNOWING OF THE POLITICAL IMPLICATIONS.

IN 1970, PLANS TO STORE NERVE GAS AT THE ARMY'S UMATILLA ORDNANCE DEPOT, ALSO IN EASTERN OREGON, BROUGHT A PUBLIC OUTCRY WHICH RESULTED IN THE GAS BEING SHIPPED TO JOHNSTON ISLAND IN THE SOUTH PACIFIC. THE ISLAND IS ALSO THE DESTINATION OF THE CYLINDERS.

DIOXIN CONSTITUTES ONE PER CENT OF THE HERBICIDE KNOWN AS AGENT ORANGE, THE DEFOLIANT USED IN VIETNAM TO CLEAR JUNGLES OF VEGETATION TO FACILITATE BOMBING. AFTER THE WAR THE AIR FORCE HAD 2.3 MILLION GALLONS OF AGENT ORANGE ON HAND.

MORE THAN HALF WAS SHIPPED TO JOHNSTON ISLAND, WHERE THE DEFENSE DEPARTMENT MAINTAINS A DEPOSITORY FOR CHEMICAL WEAPONS UNDER RIGID MILITARY SECURITY.

THE AGENT ORANGE REMAINING IN THE UNITED STATES WAS CONTRACTED THIS YEAR TO AGENT CHEMICAL INC. OF HOUSTON FOR AN ATTEMPT TO REMOVE THE DIOXIN SO THE REMAINING CHEMICALS COULD BE USED AS A HERBICIDE.

UPI 12-09 04:14 AES

ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301

SR
INSTALLATIONS AND LOGISTICS

7 APR 1975

MEMORANDUM FOR The Assistant Secretary of the Air Force (I&L)

SUBJECT: Herbicide Orange

As you will recall, by memorandum dated December 24, 1974, you requested that the Defense Supply Agency (DSA) be permitted to dispose of 2.3 million gallons of Herbicide Orange by sale. Because of legal problems we were unable to respond until February 10, 1975, at which time we requested that the 2.3 million gallons of Herbicide Orange be referred to DSA for sale. Copies of both memorandums are attached for your convenience (enclosures 1 and 2).

We were aware that at the same time you were seeking our approval to sell the item, you were also considering destroying the property by burning. On January 22-23 a meeting was held at Kelly Air Force Base to discuss the disposition of the Herbicide Orange. The report of this meeting (enclosure 3) indicates that on January 9 the Air Force had submitted an application to the Environmental Protection Agency (EPA) for permission to burn the property. On February 21 the "Environmental Reporter" published a statement made by Mr. Billy E. Welch, Special Assistant for Environmental Quality, Air Force, that the advantages of incineration outweigh reformulation of the property (enclosure 4).

We have just received a copy of the EPA publication "Environmental News" dated March 24 which indicates the EPA will be conducting hearings on incineration of Herbicide Orange at the request of the Air Force (enclosure 5).

It would appear that the foregoing actions represent a position directly opposed to that expressed in your December 24, 1974 memorandum. Additionally, as you know, PBD 253 deleted funds for FY 1975 for the Air Force Herbicide Orange Demilitarization Project on the basis that the item was considered usable.

As you are aware, the Department of Defense stands to gain $3.5 million through cost avoidance plus proceeds, if we sell the Herbicide Orange rather than burn it. If there is, as now appears, a difference of opinion within the Air Force as to the preferable disposition of the

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

Herbicide Orange, it would seem prudent to keep it very low key at this time. Chemical companies planning to submit bids to DSA would undoubtedly refrain from doing so if they have reason to believe that we plan to burn the product.

It is recommended that no further action be taken at this time to initiate plans for destroying the Herbicide Orange and that all Air Force officials refrain from any further public statements about this matter until DSA has had ample time to offer the Herbicide Orange for sale and evaluate any proposals or bids received.

Enclosures (5)
As Stated

(Signed) Paul H. Riley
Deputy Assistant Secretary of Defense
(Supply, Maintenance & Services)

cc: Director, DSA

WASHINGTON 20330

OFFICE OF THE ASSISTANT SECRETARY

21 FEB 1975

MEMORANDUM FOR THE DIRECTOR, DSA

SUBJECT: DOD Requirements for Herbicide Orange

As requested by Mr. Richard Bruner, the Air Force single manager for Herbicide Orange has contacted the Army and the Navy to ascertain that neither of those military departments has a requirement for Herbicide Orange. It is further noted that Herbicide Orange is an unregistered herbicide and its use therefore is contrary to public interests.

Accordingly, the Air Force as DOD single manager for Herbicide Orange has concluded that there is no DOD requirement for Herbicide Orange. You may therefore proceed with disposal action.

L. K. MOSEMANN II
Deputy Assistant Secretary
(Logistics)

DEPARTMENT OF THE AIR FORCE
USAF ENVIRONMENTAL HEALTH LABORATORY (AFLC)
KELLY AIR FORCE BASE, TEXAS 78241

REPLY TO ATTN OF: CC

3 Oct 75

SUBJECT: EHL/K Assessment Report

TO: SEE DISTRIBUTION

1. On 12 Sep 75 the first draft report to assess the environmental impact of the Agent Chemical Inc. pilot plant for reprocessing of Orange herbicide was mailed to the organizations listed under "DISTRIBUTION." This draft report has now been revised as a result of telecon inputs from the Army Environmental Hygiene Agency (AEHA). A copy of the revised report is herein forwarded to AEHA, DSA, and Agent Chemical Inc. The report is coded R1 (Report 1, AEHA/EHL(K) Coordination Draft).

2. In view of a recent conversation between EHL(K) and Agent Chemical Inc. representatives concerning Agent's plan to patent the incineration process of their pilot plant, the above report (R1) has been slightly altered to delete certain information concerning the incineration system. This report is coded R2 (Report 2, EHL(K) Recommended Report) and is herein forwarded to the recipients of the first draft. It is felt that the alteration to restrict information on the incinerator does not detract from the assessment.

3. This Laboratory suggests that Report 2 be utilized in the preparation of the final report and that DSA contact Agent Chemical Inc. as regards the acceptability of the information presented in the report.

FOR THE COMMANDER

Carlton R Williams

CARLTON R. WILLIAMS, Lt Col, USAF, BSC
Chief, Special Projects Division

DISTRIBUTION:
AEHA/APED, Mr. Bartell
DSA/DPDS-MCC, Mr. Betts
Agent Chem Inc, Mr. F. H. Trifilio
AFLC/DS, Mr. Karl Merrill
SAF/ILE, Lt Col Mabson
AFLC/SGB, Maj Rogers
USAF/SGPA, Lt Col J. Bayer
EHL(M)
DSA/DSAH-SME

ENVIRONMENTAL REPORT OF AGENT CHEMICAL, INC.

PILOT PLANT PROPOSAL ON

REPROCESSING OF ORANGE HERBICIDE

REPORT 1, AEHA/EHL(K) COORDINATION DRAFT

(R1)

I. PROJECT DESCRIPTION

A. BACKGROUND: This document describes and assesses the environmental aspects of the operation of a proposed pilot plant designed to reprocess Orange herbicide. The USAF Environmental Health Laboratory/Kelly AFB TX (USAF EHL/K), and the U.S. Army Environmental Hygiene Agency, Edgewood MD (AEHA), and other interested organizations assisted in the preparation of this report. Orange herbicide consists of approximately equal volumes of the normal butyl esters of 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid. The physical and chemical properties of Orange herbicide are given in the Final Environmental Impact Statement titled, "Disposition of Orange Herbicide by Incineration." Orange herbicide also contains up to 30 other organic chemicals, including trace quantities (low milligram per kilogram range) of highly toxic and teratogenic 2,3,7,8-tetracholordibenzo-*p*-dioxin (TCDD), reference Aerospace Research Laboratory report titled, "Analytical Methodology for Herbicide Orange." It is the TCDD content which has been responsible for the problems associated with Orange herbicide disposal and reprocessing. "Reprocessing" is defined, in this document, as the physical/chemical reduction of TCDD to a concentration within the herbicide which renders the herbicide acceptable for registration by the Environmental Protection Agency (EPA) and thus available for subsequent marketing. A pilot reprocessing plant has been designed by Agent Chemical, Inc., Houston TX, to be constructed at the Naval Construction Battalion Center (NCBC), Gulfport MS, and it is proposed that up to 100 drums of herbicide will be reprocessed. The pilot plant will be a batch plant which will use a coconut charcoal system to remove TCDD from liquid acetone/Orange herbicide mixtures. The processed acetone and herbicide mixture will be separated by a fractionator, and the spent charcoal (TCDD contaminated) will be incinerated. The process will be completely described in Section B. The most prominent events leading to the present situation, i.e., construction of the pilot plant at NCBC by Agent Chemical, Inc. are briefly discussed below:

1) The Department of the Air Force prepared a Final Environmental Statement titled, "Disposition of Orange Herbicide by Incineration" which was filed with the Council of Environmental Quality on 6 Dec 74. The proposed action was incineration on a specially designed vessel in the open tropical sea near Johnston Island, Central Pacific Ocean. The principle alternative to the proposed action was incineration on Johnston Island.

2) On 9 Jan 75, the Air Force applied to the EPA for a "Special Permit to Incinerate Herbicide on an Incineration Vessel." On 19 Feb 75, the EPA held a public meeting in Washington, D.C. on the Air Force application for this permit. The meeting was sparsely attended and very little public concern was expressed as regards the proposed destruction action of incineration at sea. One individual, the president of a firm which produces 2,4-dichlorophenoxyacetic acid (2,4-D), spoke up for reprocessing of the herbicide. The EPA indicated that the options for use/reprocessing should be further explored prior to the destruction of Orange herbicide.

3) In response to the EPA position, the Air Force requested the Defense Supply Agency (DSA) to explore the possibility of reprocessing of Orange herbicide. On 21 Feb 75, the Defense Property Disposal Service (DSA) Federal Center, Battle Creek, MI 49016 forwarded a "Request for Quotations" to several companies for reprocessing of Orange herbicide. These quotations were to be returned for opening at 3:00 PM EST, 28 Mar 75. Agent Chemical, Inc., Houston TX was not among those forwarded a "Request for Quotations", but heard of the proposed DSA action and advised DSA prior to the deadline of their intent to submit a quotation.

4) The EPA held a public hearing on the Air Force Ocean Incineration Permit Application on 25 and 28 Apr 75 at Honolulu HI and San Francisco CA, respectively. The hearing was comprehensive in content and included a policy statement on the disposition of pesticide and herbicide waste. The summary of the EPA policy as quoted from the minutes of the hearing follows:

> "Recovery of useful value from pesticides in a disposal situation must be determined to be unfeasible before non-productive (Destructive) means can be considered. In the case of Herbicide Orange reprocessing to recover useful Herbicidal value from the 2,4-D and 2,4,5-T components with concurrent destruction of the teratogenic dioxin contaminating component appear promising. Pilot plant studies to accurately evaluate the chemical processes involved in reprocessing are required at this time. They probably can be completed in six months. EPA believes the reprocessing aspect is worthy of additional serious consideration and if feasible it may well be preferred to ultimate disposal. It might well, in light of current estimates, return 2,4-D and 2,4,5-T to commercial channels with lower dioxin content than that currently manufactured."

The hearing was not closed but was adjourned, to be reconvened upon 10 days notification from the Air Force to the EPA that a determination on the feasibility of reprocessing had been made.

5) On 9 Jun 75 at the request of DSA, representatives of Agent Chemical, Inc., the Air Force, DSA, and AEHA (consultants to DSA on environmental matters) met at Edgewood Arsenal MD to discuss the Agent Chemical, Inc. proposal. The discussion did not reveal any insurmountable technical objections to the proposal.

6) On 14 Aug 75, the State of Mississippi, Air and Water Pollution Control Commission issued a permit to "Agent Chemical, Inc., U.S. Naval Construction Battalion Center, Gulfport, Mississippi" to construct a "Herbicide Reprocessing Pilot Plant including herbicide handling, adsorption, incineration and scrubbing equipment." The permit expires on 14 Aug 1976 provided there are no violations to the 17 listed conditions including four developed specifically for this project, see Appendix A.

7) On 28 Aug 75 at the request of DSA, representatives of the Air Force, AEHA, DSA, EPA and National Institute for Occupational Safety and Health (NIOSH) met in Washington D.C. to review the reprocessing situation and to determine a specific course of action on the Agent Chemical, Inc. proposal. It was determined that three documents, listed below, were required to proceed and evaluate the Agent Chemical, Inc. proposal and the EHL(K) would initiate action on these documents:

a) An environmental assessment of the ~~pilot~~ pilot plant process.

b) An environmental/personnel surveillance plan to be implemented during plant operation.

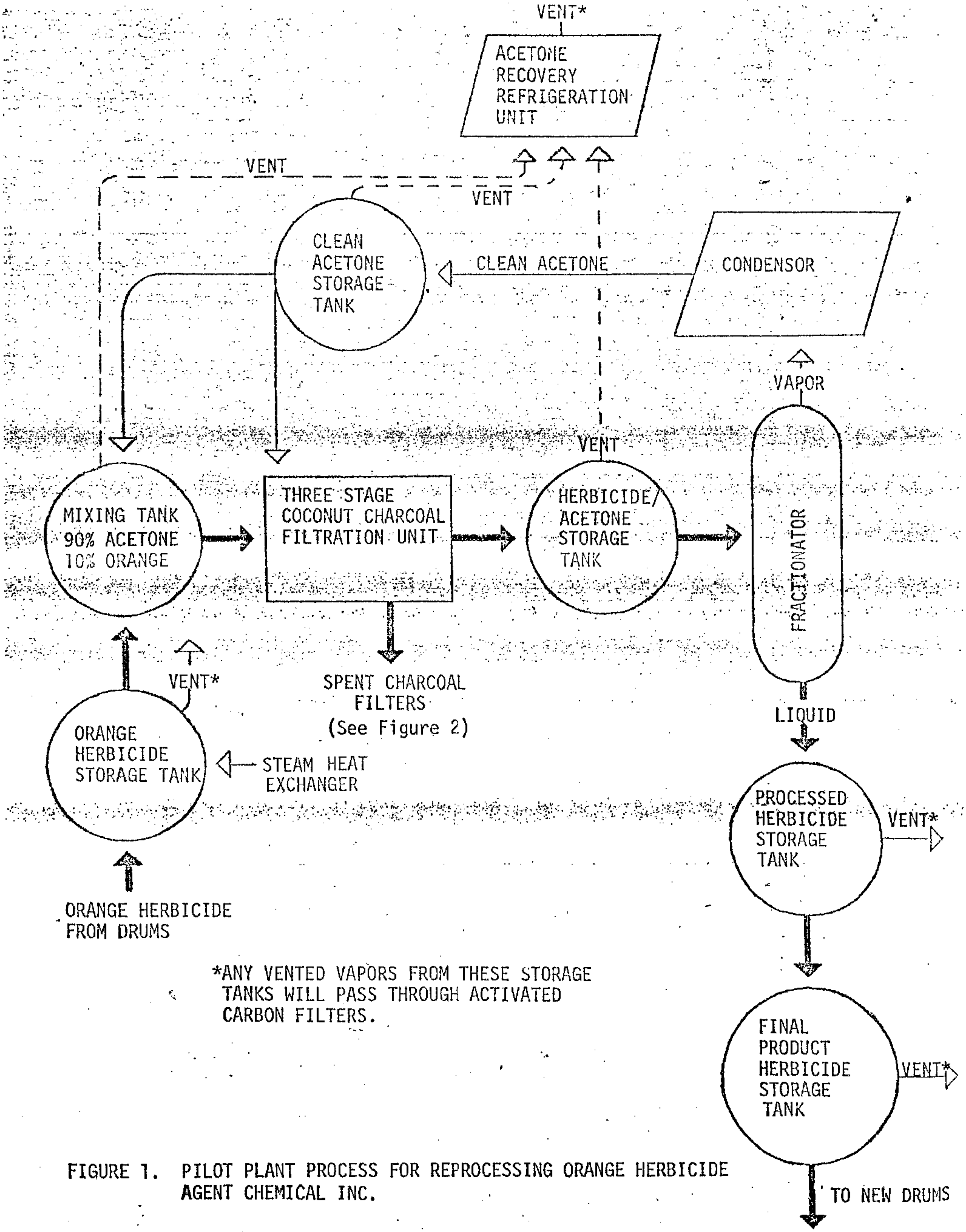
c) A final report on the results of the pilot plant operation upon completion of the study.

B. DESCRIPTION OF PROCESS

1. GENERAL INFORMATION

a. The pilot plant to be evaluated is designed specifically to demonstrate the feasibility of reprocessing Orange herbicide by adsorption of the 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) contaminant with coconut charcoal. An integral portion of this evaluation is the subsequent destruction of the TCDD which will be adsorbed on the coconut charcoal. A patent is currently being sought on the coconut charcoal process by the ~~Bureau of Sport Fisheries and Wildlife~~ United States Department of Interior (USDI), Columbia MO. Studies documented in the patent application have indicated that the process has been effective in the removal of up to 99% of the dioxin from small quantities (25 ml) of Orange herbicide. This pilot plant will investigate the feasibility of charcoal adsorption to remove dioxin from up to 100 drums (55-gallons each) of Orange herbicide. To demonstrate the capability of the plant to remove a range of TCDD concentrations, separate batches containing from 0.1 to 16 mg/kg of TCDD--with the majority in the range of 6-16 mg/kg--will be used.

b. The pilot plant process, as presented in Figure 1, will begin with the pumping of 1 to 8 drums of Orange herbicide into the Orange herbicide storage tank. (Empty drums will be recapped and placed in storage pending final disposition of the entire ~~10,000 drums~~ Orange Herbicide stock at NCBC, Gulfport MS.) Approximately 150 gallons of the Orange herbicide will then be mixed with acetone to make a 10% herbicide solution. This solution will be passed through three coconut charcoal filters (2 lbs charcoal each) in series at a rate of approximately 5 gallons per minute, the TCDD being adsorbed onto the charcoal. After passing through the charcoal, the solution will be transferred to a fractionator (distillation column) where the acetone and herbicide will be separated. The acetone will be returned for use as an Orange herbicide diluent, and the herbicide transferred to the processed herbicide storage tanks. Should unacceptable amounts of TCDD (>0.05 mg TCDD/kg for this project) be measured in the processed herbicide, it will be returned to the initial storage tank for reprocessing. Processed herbicide which meets the above specifications will be transferred to the final product herbicide storage tank. The final product will be placed in ~~clean~~ NEW drums which will be adequately labeled as described in the EHL(K) Surveillance Plan.



*ANY VENTED VAPORS FROM THESE STORAGE TANKS WILL PASS THROUGH ACTIVATED CARBON FILTERS.

FIGURE 1. PILOT PLANT PROCESS FOR REPROCESSING ORANGE HERBICIDE AGENT CHEMICAL INC.

c. A two-stage incineration system as ~~shown~~ depicted in Figure 2 is utilized to destroy the contaminated charcoal filters. The contaminated coconut charcoal in its original polypropylene cartridge (cartridge used in the liquid reprocessing system) will be placed in the first stage incinerator (maximum injection temperature to be determined by test runs of unused cartridges) and the temperature raised to 2300°F. The gases from the first stage incinerator will be exhausted to the second stage incinerator. The second stage incinerator will be maintained at 2300°F., have a stay time of approximately 9 seconds, and have excess air of >30%. These incinerator operating parameters provided extremely high efficiency (>99.9%) combustion of Orange herbicide and its contaminant TCDD during an incineration study conducted at the Marquardt Co., Van Nuys CA, see Final Environmental Statement). The incinerator stack gases will be scrubbed with a sodium hydroxide solution of pH 9 or greater to preclude the discharge of TCDD, Orange herbicide, or its constituents, pyrolyzates, HCl, and particulates. The scrubber water will then be subjected to high temperature incineration for ultimate disposal.

2. ENVIRONMENTAL CONSIDERATIONS

a. General: As described above, pilot plant operations will result in the release of materials to the environment through process vents, ~~incineration~~ SPENT CHARCOAL CARTRIDGE INCINERATION SYSTEM gases, ~~scrubber gases~~ and burial of incineration residues. The scrubber water is to be disposed via liquid incineration, therefore, no material will be discharged to ground water or surface water sources. A comprehensive Environmental Surveillance Plan has been prepared to monitor the environment in the general area of the plant and NCBC. The plan includes, but is not limited to: ambient air samples, biomonitoring of the ambient air with tomato plants, surface water samples, biomonitoring of surface water with fish, sediment samples, etc. These samples will be analyzed by EHL(K) and Wright State University. Below is a discussion of the individual point source discharges from the pilot plant which have a potential for environmental impact.

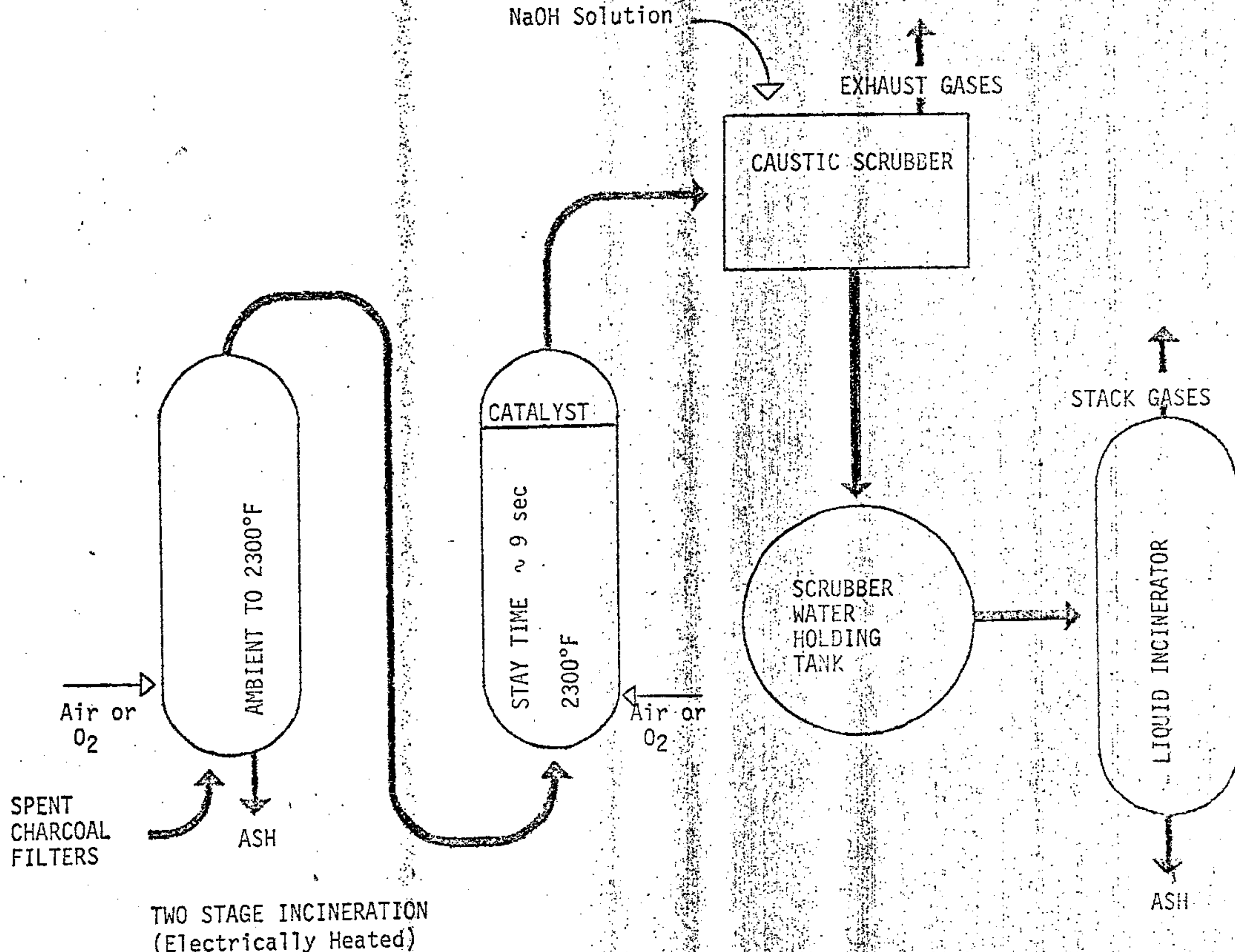


FIGURE 2. SPENT COCONUT CHARCOAL FILTER INCINERATION SYSTEM

b. Gaseous Discharges: Nine tanks/processes will emit materials either directly or indirectly into the atmosphere. The nine tanks/processes are: (1) the Orange herbicide storage tank, (2) the Orange/acetone mixing tank, (3) the herbicide/acetone storage tank, (4) the clean acetone storage tank, (5 & 6) the two processed herbicide storage tanks, (7) the final product herbicide storage tank, (8) the spent charcoal cartridge incinerator system scrubber, and (9) the scrubber water incinerator. The three tanks containing acetone will have a vapor discharge for pressure release directly to the acetone recovery refrigeration unit; this unit will be vented to the atmosphere through an activated carbon filter. The four tanks containing either Orange or processed herbicide will be vented through carbon filters to the atmosphere. The activated carbon filters are utilized to control any discharge of Orange herbicide constituents and TCDD to the atmosphere, and an attempt will be made to quantitatively monitor the efficiency of the carbon filters. The charcoal incineration process, as seen in Figure 2, includes a caustic scrubber which will remove materials such as the esters and acids of 2,4-D and 2,4,5-T, TCDD, pyrolyzates, HCl, and particulate matter from the combustion gases. The discharge from this scrubber will be continuously monitored during each incineration process, and incineration of additional cartridges will not be performed unless chemical/analytical results reveal that the operation is environmentally safe. The scrubber water will be chemically analyzed for the acids and esters of 2,4-D, 2,4,5-T and TCDD and will be utilized in bioassays for toxicity measurements. Only upon the satisfactory analysis of the scrubber water will the water be incinerated. If analyses reveal the water to be unacceptable for incineration, it will be filtered through charcoal filters until the contaminants are removed and then it will be incinerated. The exhaust gases of this incinerator will not be monitored as they would probably contain no more than water vapor and some carry over of inorganic salts.

c. Solid Wastes: Ash resulting from incineration of spent coconut charcoal filters and residue remaining after incineration of scrubber water represent the solid wastes generated by the pilot plant process. Because no contaminants such as the acids and esters of 2,4-D and 2,4,5-T or TCDD will be permitted in the scrubber water prior to incineration, the residue from the liquid incinerator should consist of inorganic salts. The ash from the charcoal incineration, and any residue resulting from the water incineration will be collected, chemically analyzed, utilized in bioassay, and drummed. With the approval of the State of Mississippi, drums of inorganic salts and ash will be buried in an acceptable landfill. If for any reason ~~an~~ approval is denied, the drums will be properly stored on NCBC.

d. Plant Failure: Any mechanical operation, such as this pilot plant, is subject to equipment failure or operator error. In this case, the equipment selected is of high caliber, and the operators are well qualified and will be on-site at all times during plant operation. The pilot plant is a low pressure or ambient pressure system throughout and will be situated on a 20 ft x 100 ft concrete slab which has a six-inch dike around the perimeter. Drains in the process area will be normally closed to contain any spilled or leaking herbicide and/or acetone. The only time drains will be opened is to allow the discharge of any accumulated rainwater. This discharge will be analyzed if practicable or contamination is suspected. Clean up of minor spills will be performed with absorbent material, and any spent absorbent material will be placed in drums and buried in a landfill approved for this purpose by the State of Mississippi. The charcoal incinerator system is designed to operate at near-atmospheric pressure; however, the possibility of high pressures in any heated vessel must be considered. Therefore, pressure gauges are installed in the incinerator and will be monitored during operation of the incinerator. Calculations using vapor release from a spent charcoal cartridge, combustion products, available oxygen, and temperature indicate that under worst case conditions the maximum possible pressure within the incinerator should be less than 200 pounds per square inch (psi). As a further precaution, a pressure sensor on the incinerator will be adjusted to terminate any heat input if the pressure rises to one half (100 psi) the maximum possible pressure. In the event of any spill or leakage at any point in the pilot plant process, plant operation will be shut down and the area cleared. Qualified personnel wearing the necessary protective equipment will assess the situation and collect appropriate samples, and all prudent action will be taken to protect personnel to minimize any adverse environmental impact.

3. PROCESS ENVIRONMENTAL QUALITY CONTROL

a. General: The pilot plant can be considered as two separate operations. First, the units (Figure 1) required to remove the TCDD from the raw herbicide; secondly, the incineration system (Figure 2) required to destroy the TCDD contained in the spent charcoal cartridges. Sampling protocols have been developed to assess quality control and environmental impact of the two operations, these protocols are discussed below.

b. Herbicide Reprocessing: Samples associated with this process will include raw Orange herbicide, filtrate from the coconut charcoal units, recycled acetone ~~to~~ FROM the clean acetone storage tank, and herbicide from the processed herbicide storage tanks. The ~~last of~~ latter of these ~~three~~ is the most critical since it must meet the EPA acceptable level for TCDD content. All raw herbicide batches and filled processed herbicide storage tanks will be sampled. The frequency of the other samples is predicated on existing research data on TCDD adsorption on coconut charcoal and the concentration of TCDD applied to the charcoal cartridge during the pilot plant study. Frequency of these samples is expected to change as experience with the system is obtained. All herbicide reprocessing samples will be analyzed for TCDD by Agent Chemical, Inc. (gas chromatograph). Selected raw Orange herbicide, processed herbicide, acetone ~~samples~~ and filtrate samples will be analyzed by Wright State University (gas chromatograph/mass spectrograph).

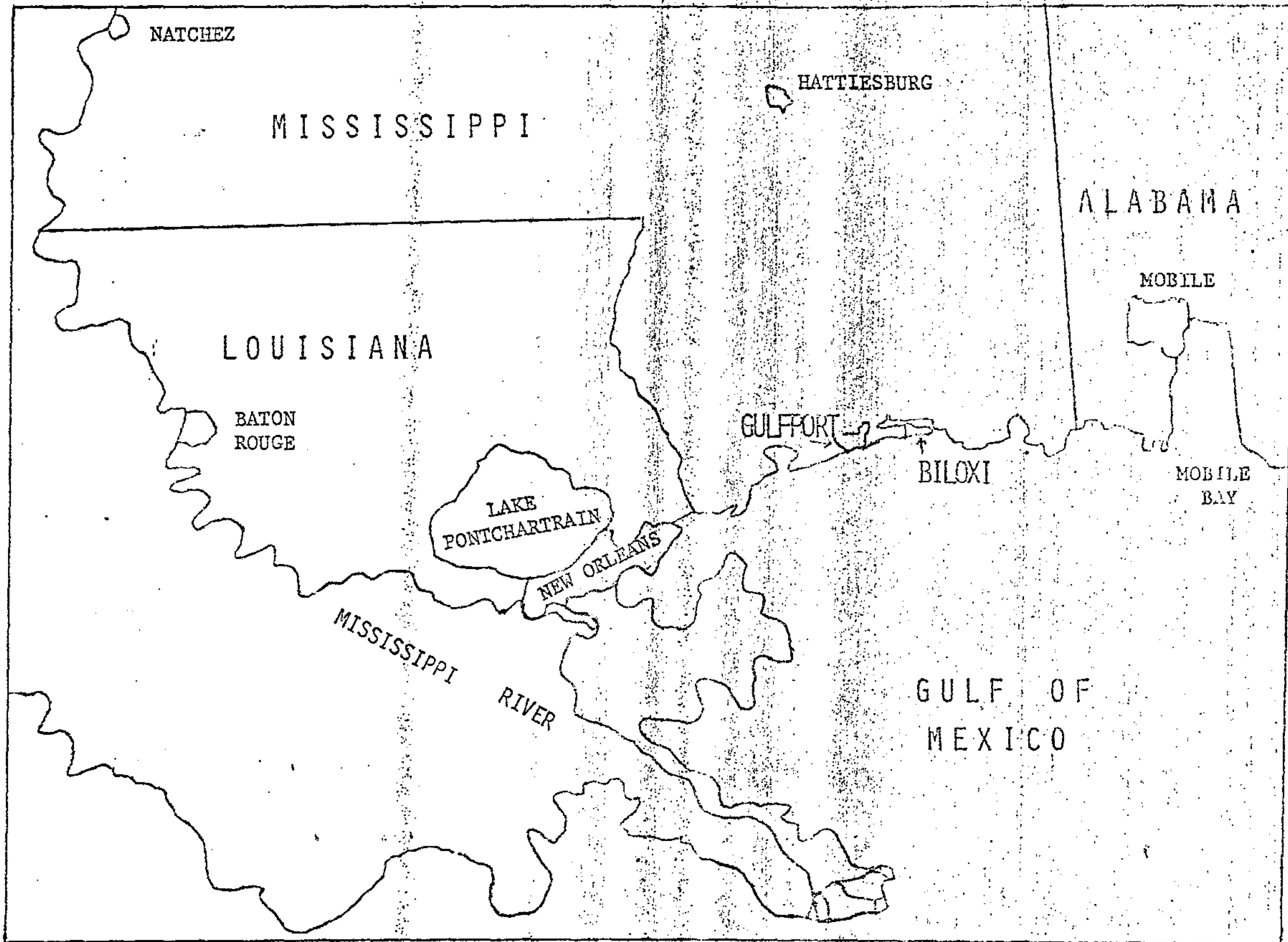


FIGURE 3. SOUTHERN GULF COAST

c. <u>Incineration Process</u>: Samples associated with this process include pre-scrubber combustion gases, post-scrubber stack gases, scrubber water, and ash from incineration. Monitoring of the pre-scrubber combustion gas utilizes a positive pressure console which houses the instruments to measure temperature, carbon monoxide, hydrocarbons and oxygen. This instrumentation (manual reading) operates continuously during the incinerator operation and these readings are utilized in assessing incinerator operation. In addition, the console includes a pH meter to monitor the scrubber water. Scrubber gas will be monitored by acceptable stack monitoring techniques utilizing benzene impingers to obtain samples for analyses of TCDD and esters and acids of 2,4-D and 2,4,5-T. Monitoring will be performed for each incinerator operation. At a minimum, scrubber water will be sampled early in the operation prior to any disposal; other scrubber samples will be collected at selected intervals throughout the operation. Samples will be utilized for static bioassays and will be analyzed for TCDD and the esters and acids of 2,4-D and 2,4,5-T. Ash samples will be removed from the incinerator and pooled according to the TCDD content of the raw Orange Herbicide ~~by ASN~~ and saved for subsequent analyses. Representative ~~Composite~~ samples of the ash ~~representing each ASN~~ will be used in static bioassays and analyzed for herbicide components and heavy metals. Agent Chemical, Inc. will perform chemical analyses on all of the above samples and will maintain logs on the readouts from the monitoring console. Wright State University will also analyze selected samples; static bioassays will be conducted by EHL(K). Process quality control is covered more extensively in the EHL(K) Surveillance Plan.

C. EXISTING SITE CHARACTERISTICS: The proposed pilot plant studies will be performed at the Naval Construction Battalion Center (NCBC), Gulfport, Mississippi. Gulfport is located on the Mississippi Gulfcoast approximately 70 miles east of New Orleans (Figure 3). The NCBC is within the city limits of Gulfport, approximately two miles north of the Gulf coast (Figure 4). The location of the pilot plant will be within the herbicide storage area of NCBC which is part of a general purpose outdoor storage area of the Center (indicated in Figure 4 and expanded view in Figure 5). The site is approximately one-quarter mile from the nearest NCBC barracks and approximately one-fifth mile from the nearest

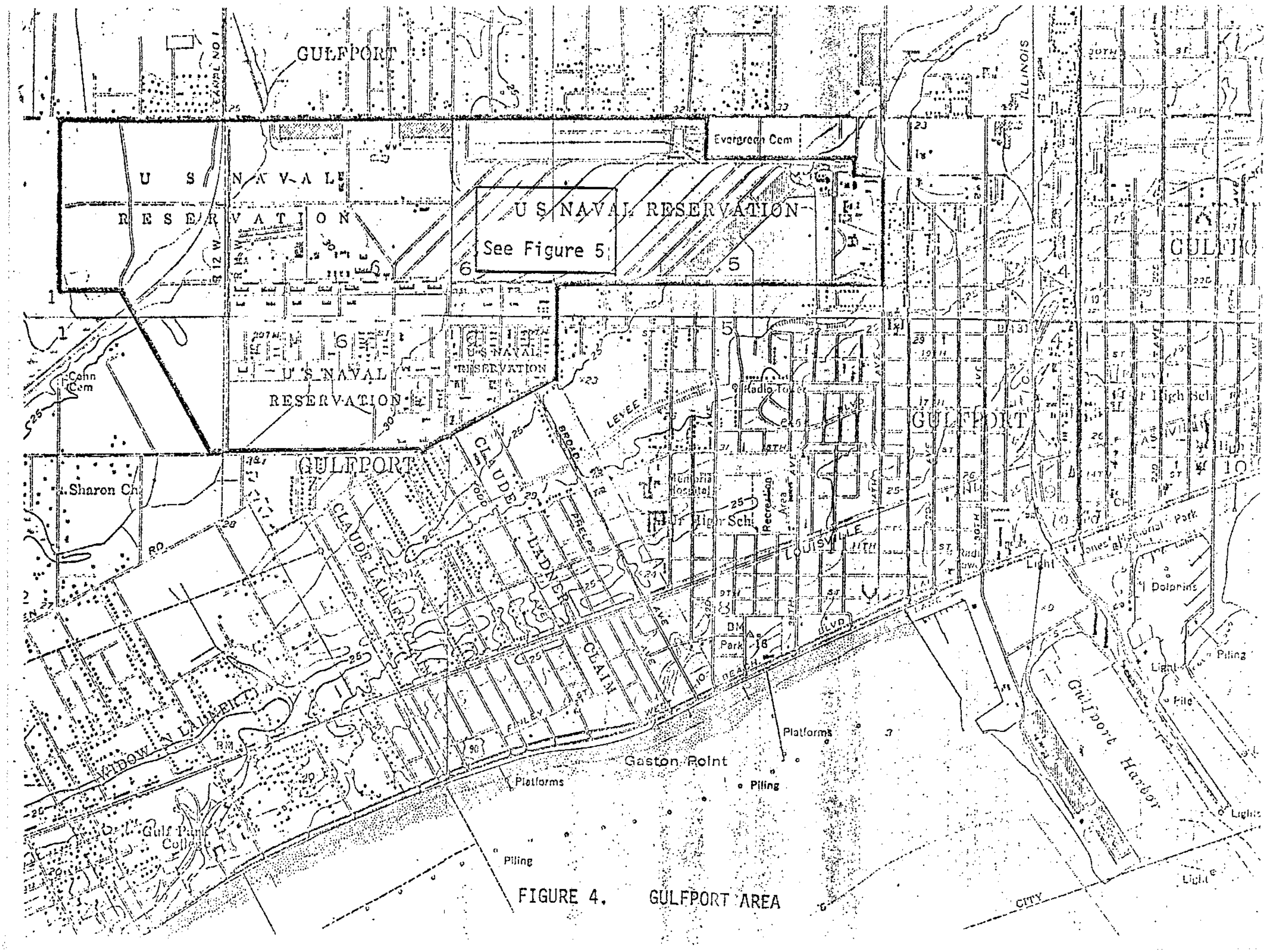


FIGURE 4. GULFPORT AREA

off-base property, a grazing pasture. The land at the site is very flat and consists mainly of cement-stablized soil with very little vegetative cover. Surface runoff is controlled by a network of three-foot deep drainage ditches which run throughout the entire outdoor storage area. Background environmental samples of air, soil and water have been taken and their analyses will be used for comparison with any samples taken during and after pilot plant studies.

II. RELATIONSHIP OF PROPOSED ACTION TO LAND USE PLANS, POLICIES, AND CONTROLS FOR THE AFFECTED AREA

The Agent Chemical, Inc. pilot plant will be on only 2,000 sq ft (20 ft x 100 ft) of land at the Naval Construction Battalion Center, Gulfport MS. The plant will be dismantled after completion of project. The location for the plant is specifically designated in the Mississippi Air and Water Pollution Control Commission Permit (Appendix A). This action does not conflict with any land use plans, policies and controls for the affected area.

III. PROBABLE IMPACT OF THE PROPOSED ACTION ON ENVIRONMENT

A. NORMAL OPERATION: No adverse environmental impact is predicted during the normal operation of the pilot plant. Bench-scale laboratory studies to date have indicated favorable results for coconut charcoal adsorption of TCDD from Orange herbicide. It is the purpose of this facility to investigate the feasibility of charcoal adsorption of TCDD and its subsequent destruction by incineration in an environmentally acceptable manner. The possible discharges from the plant include esters and acids of 2,4-D and 2,4,5-T or their pyrolyzates, TCDD, HCl, and particulates, but extensive controls have been incorporated into the project in an effort to eliminate any possible adverse effects. These controls include activated carbon filters on the vents from all acetone and herbicide storage tanks. The design parameters of the two-stage catalytic incineration system indicate that an extremely high combustion efficiency of spent

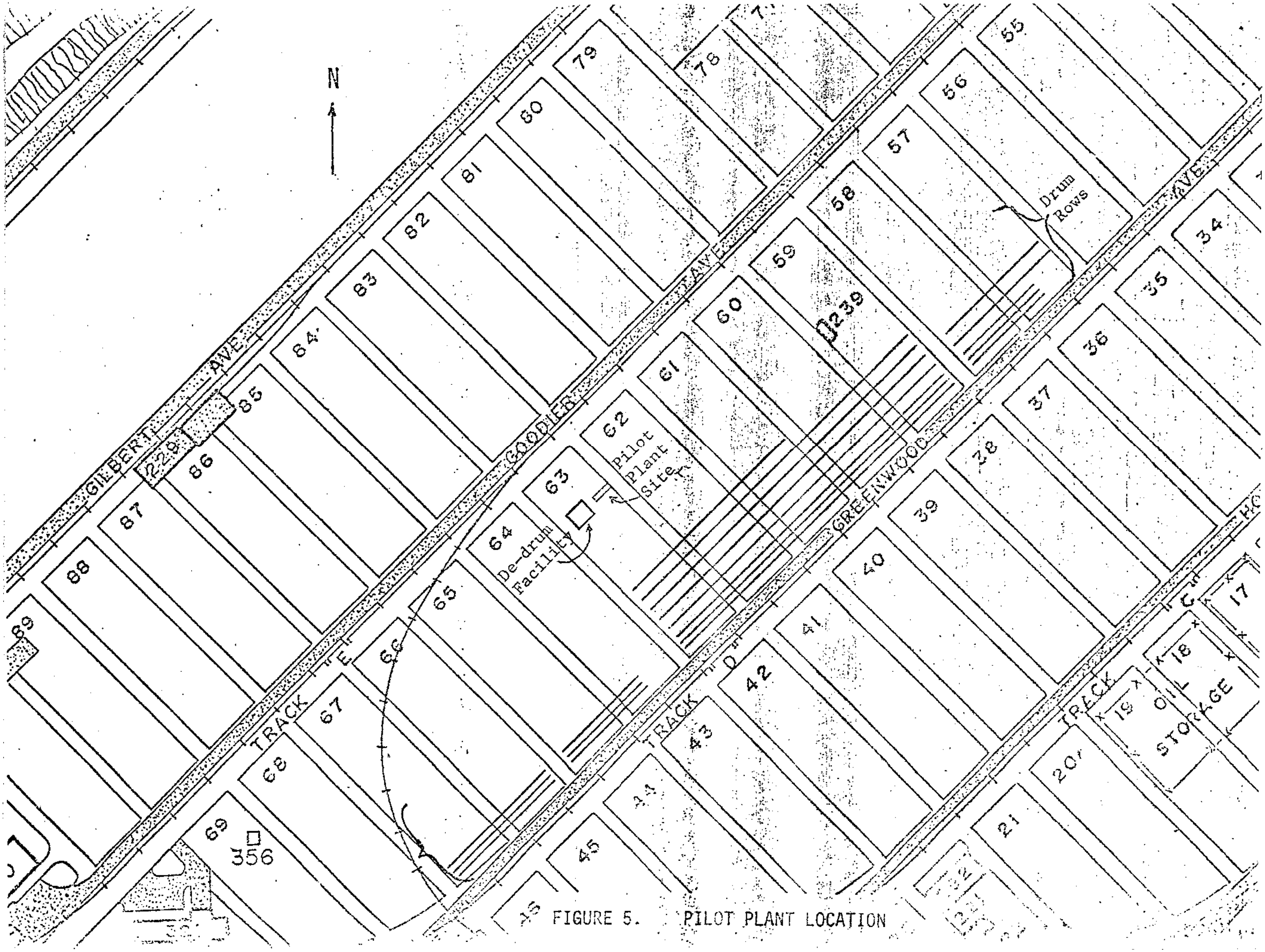


FIGURE 5. PILOT PLANT LOCATION

charcoal filters will be achieved. As an additional control, the incinerator stack gases will be passed through a caustic scrubber to prevent any discharge of possible contaminants. The gaseous discharge from the scrubber will be monitored during the operation of the incinerator. The spent scrubber water will be disposed of in a gas fired liquid incinerator. An extensive monitoring plan has been developed which gives a detailed description of the type and frequency of analyses to be performed (EHL/K Surveillance Plan). This monitoring is accomplished to detect any adverse environmental effects which may be associated with the pilot plant. Plant operation will be halted immediately should the results of the monitoring reveal adverse environmental impact. The plant will be placed in operation when steps have been taken to correct the source responsible for the environmental impact.

B. PROCESS UPSETS: Although equipment failure which could cause release of contaminants is not expected, it has been considered (Paragraph II.B.2.b.). The environmental effects of any equipment failure cannot be accurately predicted; however, should an unwanted release occur, every effort will be made to minimize the environmental implications and dispose of collected materials in an expeditious and safe manner. Additionally, the fall and winter season, the time when this plant will be operated, are periods of maximum floral and faunal dormancy. Thus, any release will have a minimum effect on indigenous plants and wildlife.

IV. ALTERNATIVES

The Agent Chemical, Inc. pilot plant discussed in this assessment represents proposed action to evaluate the alternative of reprocessing Orange herbicide. The evaluation of a pilot plant operation complies with the expressed policy of the EPA (see Paragraph I.A.b) and is in keeping with EPA policy on disposal of pesticides. In addition, the pilot plant evaluation expands on the alternatives of the Air Force Final Environmental Statement (see Paragraph I.A.1). This assessment is specific for the Agent Chemical, Inc. process, and the pilot plant demonstration is considered a requirement for compliance with EPA policy. Any other reprocessing proposals will be handled individually on an as-required basis.

V. PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED SHOULD THE PROPOSAL BE IMPLEMENTED

Under normal operating conditions, no adverse environmental effects are anticipated from this pilot facility. Extensive controls have been incorporated into the process to eliminate any harmful emissions, and every effluent from the process is being monitored for verification of this condition. Only in the event of a process upset would any adverse effect possibly occur. These process upsets and the subsequent actions to be taken are discussed in paragraph I.B.2.d.

VI. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The short-term use of the environment to complete this pilot plant study will not have a direct impact on the maintenance and enhancement of long-term productivity. Long-term productivity may actually be increased if the pilot plant is successful and the entire stock of Orange herbicide is eventually reprocessed and put to beneficial use.

VII. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES THAT WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED

The pilot plant will consume certain utilities (electricity and water) and quantities of materials such as acetone, propane, sodium hydroxide, activated carbon, etc. The plant will require resources necessary for transportation from Houston TX to NCBC, Gulfport MS. The plant will be dismantled and cleaned after the pilot project; therefore, certain resource usage will be reduced. The commitment of resources is insignificant when compared to the beneficial aspect of eventual recovery of the entire stock of Orange herbicide as usable herbicide.

VIII. CONSIDERATIONS THAT OFFSET THE ADVERSE ENVIRONMENTAL EFFECTS

The pilot plant operation is to evaluate the feasibility of reprocessing the Orange herbicide. There are no adverse environmental effects associated with the normal conduct of the project; therefore, should reprocessing prove feasible, large quantities of a valuable commodity will be recovered.

IX. DETAILS OF UNRESOLVED ISSUES

None, as stated in Paragraph I.A.4, provided that reprocessing can be accomplished satisfactorily from an environmental and public health standpoint, it (reprocessing) is preferred to destructive methods of disposal. Therefore, if the pilot plant was not allowed to operate such a situation would create an unresolved issue.

ENVIRONMENTAL REPORT OF AGENT CHEMICAL, INC.

PILOT PLANT PROPOSAL ON

REPROCESSING OF ORANGE HERBICIDE

REPORT 2, EHL(K) RECOMMENDED REPORT

(R2)

I. PROJECT DESCRIPTION

A. BACKGROUND: This document describes and assesses the environmental aspects of the operation of a proposed pilot plant designed to reprocess Orange herbicide. The USAF Environmental Health Laboratory/Kelly AFB TX (USAF EHL/K), and the U.S. Army Environmental Hygiene Agency, Edgewood MD (AEHA), and other interested organizations assisted in the preparation of this report. Orange herbicide consists of approximately equal volumes of the normal butyl esters of 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid. The physical and chemical properties of Orange herbicide are given in the Final Environmental Impact Statement titled, "Disposition of Orange Herbicide by Incineration." Orange herbicide also contains up to 30 other organic chemicals, including trace quantities (low milligram per kilogram range) of highly toxic and teratogenic 2,3,7,8-tetracholordibenzo-*p*-dioxin (TCDD), reference Aerospace Research Laboratory report titled, "Analytical Methodology for Herbicide Orange." It is the TCDD content which has been responsible for the problems associated with Orange herbicide disposal and reprocessing. "Reprocessing" is defined, in this document, as the physical/chemical reduction of TCDD to a concentration within the herbicide which renders the herbicide acceptable for registration by the Environmental Protection Agency (EPA) and thus available for subsequent marketing. A pilot reprocessing plant has been designed by Agent Chemical, Inc., Houston TX, to be constructed at the Naval Construction Battalion Center (NCBC), Gulfport MS, and it is proposed that up to 100 drums of herbicide will be reprocessed. The pilot plant will be a batch plant which will use a coconut charcoal system to remove TCDD from liquid acetone/Orange herbicide mixtures. The processed acetone and herbicide mixture will be separated by a fractionator, and the spent charcoal (TCDD contaminated) will be incinerated. The process will be completely described in Section B. The most prominent events leading to the present situation, i.e., construction of the pilot plant at NCBC by Agent Chemical, Inc. are briefly discussed below:

1) The Department of the Air Force prepared a Final Environmental Statement titled, "Disposition of Orange Herbicide by Incineration" which was filed with the Council of Environmental Quality on 6 Dec 74. The proposed action was incineration on a specially designed vessel in the open tropical sea near Johnston Island, Central Pacific Ocean. The principle alternative to the proposed action was incineration on Johnston Island.

2) On 9 Jan 75, the Air Force applied to the EPA for a "Special Permit to Incinerate Herbicide on an Incineration Vessel." On 19 Feb 75, the EPA held a public meeting in Washington, D.C. on the Air Force application for this permit. The meeting was sparsely attended and very little public concern was expressed as regards the proposed destruction action of incineration at sea. One individual, the president of a firm which produces 2,4-dichlorophenoxyacetic acid (2,4-D), spoke up for reprocessing of the herbicide. The EPA indicated that the options for use/reprocessing should be further explored prior to the destruction of Orange herbicide.

3) In response to the EPA position, the Air Force requested the Defense Supply Agency (DSA) to explore the possibility of reprocessing of Orange herbicide. On 21 Feb 75, the Defense Property Disposal Service (DSA) Federal Center, Battle Creek, MI 49016 forwarded a "Request for Quotations" to several companies for reprocessing of Orange herbicide. These quotations were to be returned for opening at 3:00 PM EST, 28 Mar 75. Agent Chemical, Inc., Houston TX was not among those forwarded a "Request for Quotations", but heard of the proposed DSA action and advised DSA prior to the deadline of their intent to submit a quotation.

4) The EPA held a public hearing on the Air Force Ocean Incineration Permit Application on 25 and 28 Apr 75 at Honolulu HI and San Francisco CA, respectively. The hearing was comprehensive in content and included a policy statement on the disposition of pesticide and herbicide waste. The summary of the EPA policy as quoted from the minutes of the hearing follows:

> "Recovery of useful value from pesticides in a disposal situation must be determined to be unfeasible before non-productive (Destructive) means can be considered. In the case of Herbicide Orange reprocessing to recover useful Herbicidal value from the 2,4-D and 2,4,5-T components with concurrent destruction of the teratogenic dioxin contaminating component appear promising. Pilot plant studies to accurately evaluate the chemical processes involved in reprocessing are required at this time. They probably can be completed in six months. EPA believes the reprocessing aspect is worthy of additional serious consideration and if feasible it may well be preferred to ultimate disposal. It might well, in light of current estimates, return 2,4-D and 2,4,5-T to commercial channels with lower dioxin content than that currently manufactured."

The hearing was not closed but was adjourned, to be reconvened upon 10 days notification from the Air Force to the EPA that a determination on the feasibility of reprocessing had been made.

5) On 9 Jun 75 at the request of DSA, representatives of Agent Chemical, Inc., the Air Force, DSA, and AEHA (consultants to DSA on environmental matters) met at Edgewood Arsenal MD to discuss the Agent Chemical, Inc. proposal. The discussion did not reveal any insurmountable technical objections to the proposal.

6) On 14 Aug 75, the State of Mississippi, Air and Water Pollution Control Commission issued a permit to "Agent Chemical, Inc., U.S. Naval Construction Battalion Center, Gulfport, Mississippi" to construct a "Herbicide Reprocessing Pilot Plant including herbicide handling, adsorption, incineration and scrubbing equipment." The permit expires on 14 Aug 1976 provided there are no violations to the 17 listed conditions including four developed specifically for this project, see Appendix A.

7) On 28 Aug 75 at the request of DSA, representatives of the Air Force, AEHA, DSA, EPA and National Institute for Occupational Safety and Health (NIOSH) met in Washington D.C., to review the reprocessing situation and to determine a specific course of action on Agent Chemical, Inc. proposal. It was determined that three documents listed below, were required to proceed and evaluate the Agent Chemical, Inc. proposal and the EHL(K) would initiate action on these documents:

a) An environmental assessment of the pilot plant process.

b) An environmental/personnel surveillance plan to be implemented during plant operation.

c) A final report on the results of the pilot plant operation upon completion of the study.

B. DESCRIPTION OF PROCESS

1. GENERAL INFORMATION

a. The pilot plant to be evaluated is designed specifically to demonstrate the feasibility of reprocessing Orange herbicide by adsorption of the 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) contaminant with coconut charcoal. An integral portion of this evaluation is the subsequent destruction of the TCDD which will be adsorbed on the coconut charcoal. A patent is currently being sought on the coconut charcoal process by the United States Department of Interior (USDI), Columbia MO. Studies documented in the patent application have indicated that the process has been effective in the removal of up to 99% of the dioxin from small quantities (25 ml) of Orange herbicide. This pilot plant will investigate the feasibility of charcoal adsorption to remove dioxin from up to 100 drums (55-gallons each) of Orange herbicide. To demonstrate the capability of the plant to remove a range of TCDD concentrations, separate batches containing from 0.1 to 16 mg/kg of TCDD--with the majority in the range of 6-16 mg/kg--will be used.

b. The pilot plant process, as presented in Figure 1, will begin with the pumping of 1 to 8 drums of Orange herbicide into the Orange herbicide storage tank. (Empty drums will be recapped and placed in storage pending final disposition of the entire Orange herbicide stock at NCBC, Gulfport MS.) Approximately 150 gallons of the Orange herbicide will then be mixed with acetone to make a 10% herbicide solution. This solution will be passed through three coconut charcoal filters (2 lbs charcoal each) in series at a rate of approximately 5 gallons per minute, the TCDD being adsorbed onto the charcoal. After passing through the charcoal, the solution will be transferred to a fractionator (distillation column) where the acetone and herbicide will be separated. The acetone will be returned for use as an Orange herbicide diluent, and the herbicide transferred to the processed herbicide storage tanks. Should unacceptable amounts of TCDD (>0.05 mg TCDD/kg for this project) be measured in the processed herbicide, it will be returned to the initial storage tank for reprocessing. Processed herbicide which meets the above specifications will be transferred to the final product herbicide storage tank. The final product will be placed in new drums which will be adequately labeled as described in the EHL(K) Surveillance Plan.

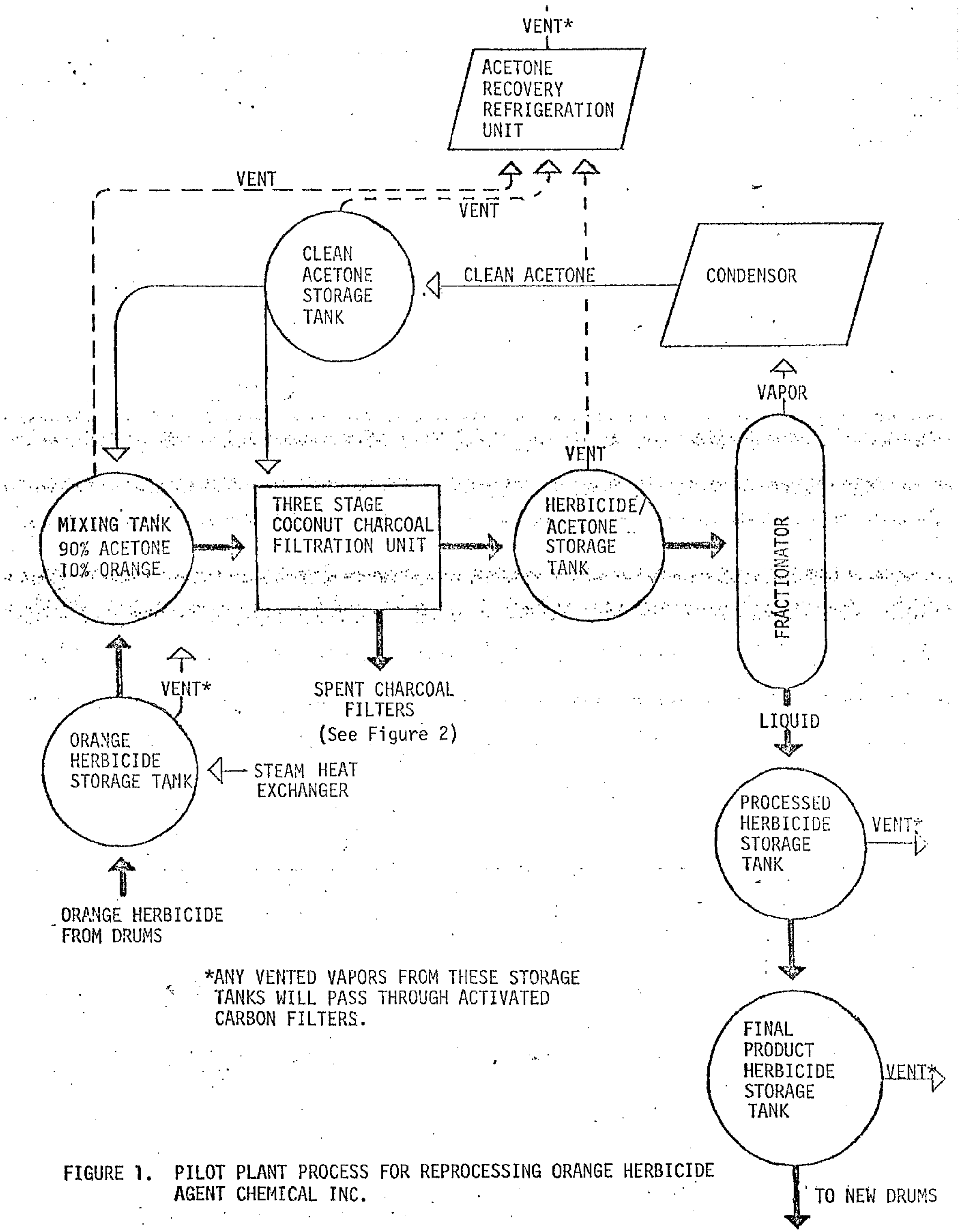


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FIGURE 1. PILOT PLANT PROCESS FOR REPROCESSING ORANGE HERBICIDE AGENT CHEMICAL INC.

c. An incineration system as depicted in Figure 2 is utilized to destroy the contaminated charcoal filters. The contaminated coconut charcoal in its original polypropylene cartridge (cartridge used in the liquid reprocessing system) will be placed into the incinerator (maximum injection temperature to be determined by test runs of unused cartridges) and subjected to a temperature of 2300°F. Based on experience gained during the test burn of Orange herbicide at the Marquardt Co., Van Nuys CA (see the Final Environmental Statement) it is anticipated that the pilot plant incinerator will provide an extremely high destruction efficiency of the charcoal, its cartridge and the adsorbed material (TCDD, 2,4-D and 2,4,5-T). The incinerator stack gases will be scrubbed with sodium hydroxide solution of pH 9 or greater to control emissions. The scrubber water will then be subjected to high temperature incineration for ultimate disposal. Residues are expected to collect in both the spent charcoal and scrubber water incinerators.

2. ENVIRONMENTAL CONSIDERATIONS

a. General: As described above, pilot plant operations will result in the release of materials to the environment through process vents, spent charcoal cartridge incineration system gases and burial of incineration residues. The scrubber water is to be disposed via liquid incineration, therefore, no material will be discharged to ground water or surface water sources. A comprehensive Environmental Surveillance Plan has been prepared to monitor the environment in the general area of the plant and NCBC. The plan includes, but is not limited to: ambient air samples, biomonitoring of the ambient air with tomato plants, surface water samples, biomonitoring of surface water with fish, sediment samples, etc. These samples will be analyzed by EHL(K) and Wright State University. Below is a discussion of the individual point source discharges from the pilot plant which have a potential for environmental impact.

b. Gaseous Discharges: Nine tanks/processes will emit materials either directly or indirectly into the atmosphere. The nine tanks/processes are: (1) the Orange herbicide storage tank, (2) the Orange/acetone mixing tank, (3) the herbicide/acetone storage tank, (4) the clean acetone storage tank, (5 & 6) the two processed herbicide storage tanks, (7) the final product herbicide storage tank, (8) the spent charcoal cartridge incinerator system scrubber, and (9) the scrubber water incinerator. The three tanks containing acetone will have a vapor discharge for pressure release directly to the acetone recovery refrigeration unit; this unit will be vented to the atmosphere through an activated carbon filter. The four tanks containing either Orange or processed herbicide will be vented through carbon filters to the atmosphere. The activated carbon filters are utilized to control any discharge of Orange herbicide constituents and TCDD to the atmosphere, and an attempt will be made to qualitatively monitor the efficiency of the carbon filters. The charcoal incineration process, as seen in Figure 2, includes a caustic scrubber which will remove materials such as the esters and acids of 2,4-D and 2,4,5-T, TCDD, pyrolyzates, HCl, and particulate matter from the combustion gases. The discharge from this scrubber will be continuously monitored during each incineration process, and incineration of additional cartridges will not be performed unless chemical/analytical results reveal that the operation is environmentally safe. The scrubber water will be chemically analyzed for the acids and esters of 2,4-D, 2,4,5-T and TCDD and will be utilized in bioassays for toxicity measurements. Only upon the satisfactory analysis of the scrubber water will the water be incinerated. If analyses reveal the water to be unacceptable for incineration, it will be filtered through charcoal filters until the contaminants are removed and then it will be incinerated. The exhaust gases of this incinerator will not be monitored as they would probably contain no more than water vapor and some carry over of inorganic salts.

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2,4-D and 2,4,5-T or TCDD will be permitted in the scrubber water prior to incineration, the residue from the liquid incinerator should consist of inorganic salts. The ash from the charcoal incineration, and any residue resulting from the water incineration will be collected, chemically analyzed, utilized in bioassay, and drummed. With the approval of the State of Mississippi, drums of inorganic salts and ash will be buried in an acceptable landfill. If for any reason approval is denied, the drums will be properly stored on NCBC.

d. Plant Failure: Any mechanical operation, such as this pilot plant, is subject to equipment failure or operator error. In this case, the equipment selected is of high caliber, and the operators are well qualified and will be on-site at all times during plant operation. The pilot plant is a low pressure or ambient pressure system throughout and will be situated on a 20 ft x 100 ft concrete slab which has a six-inch dike around the perimeter. Drains in the process area will be normally closed to contain any spilled or leaking herbicide and/or acetone. The only time drains will be opened is to allow the discharge of any accumulated rainwater. This discharge will be analyzed if practicable or contamination is suspected. Clean up of minor spills will be performed with absorbent material, and any spent absorbent material will be placed in drums and buried in a landfill approved for this purpose by the State of Mississippi. The charcoal incinerator system is designed to operate at near-atmospheric pressure; however, the possibility of high pressures in any heated vessel must be considered. Therefore, pressure gauges are installed in the incinerator and will be monitored during operation of the incinerator. Calculations using vapor release from a spent charcoal cartridge, combustion products, available oxygen, and temperature indicate that under worst case conditions the maximum possible pressure will be well within the capacity of the system. As a further precaution, a pressure sensor on the incinerator will be adjusted to terminate any heat input if the pressure rises to a preset pressure which is acceptable for safe operation of the system. In the event of any spill or leakage at any point in the pilot plant process,

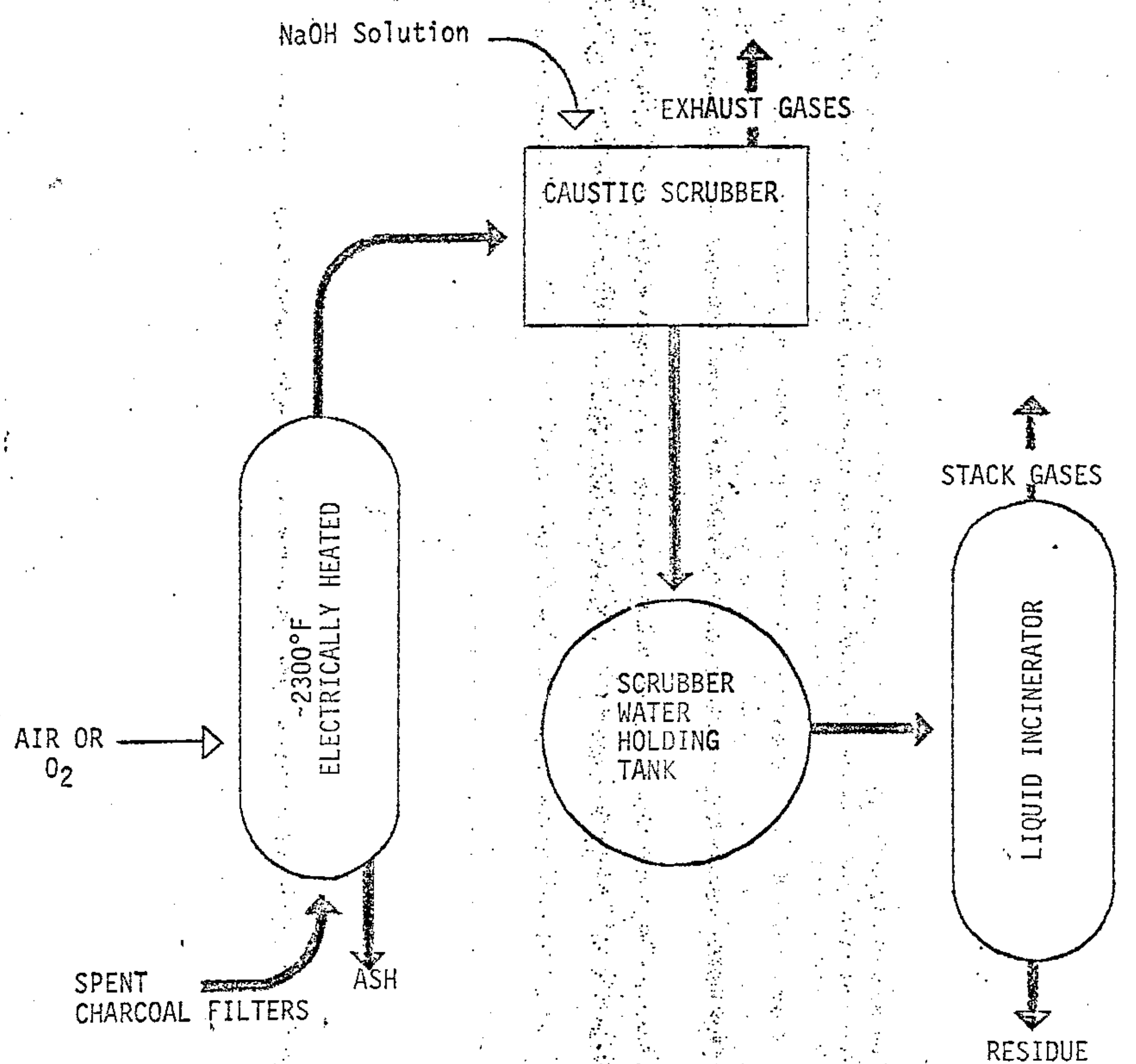

FIGURE 2. SPENT COCONUT CHARCOAL FILTER INCINERATION SYSTEM

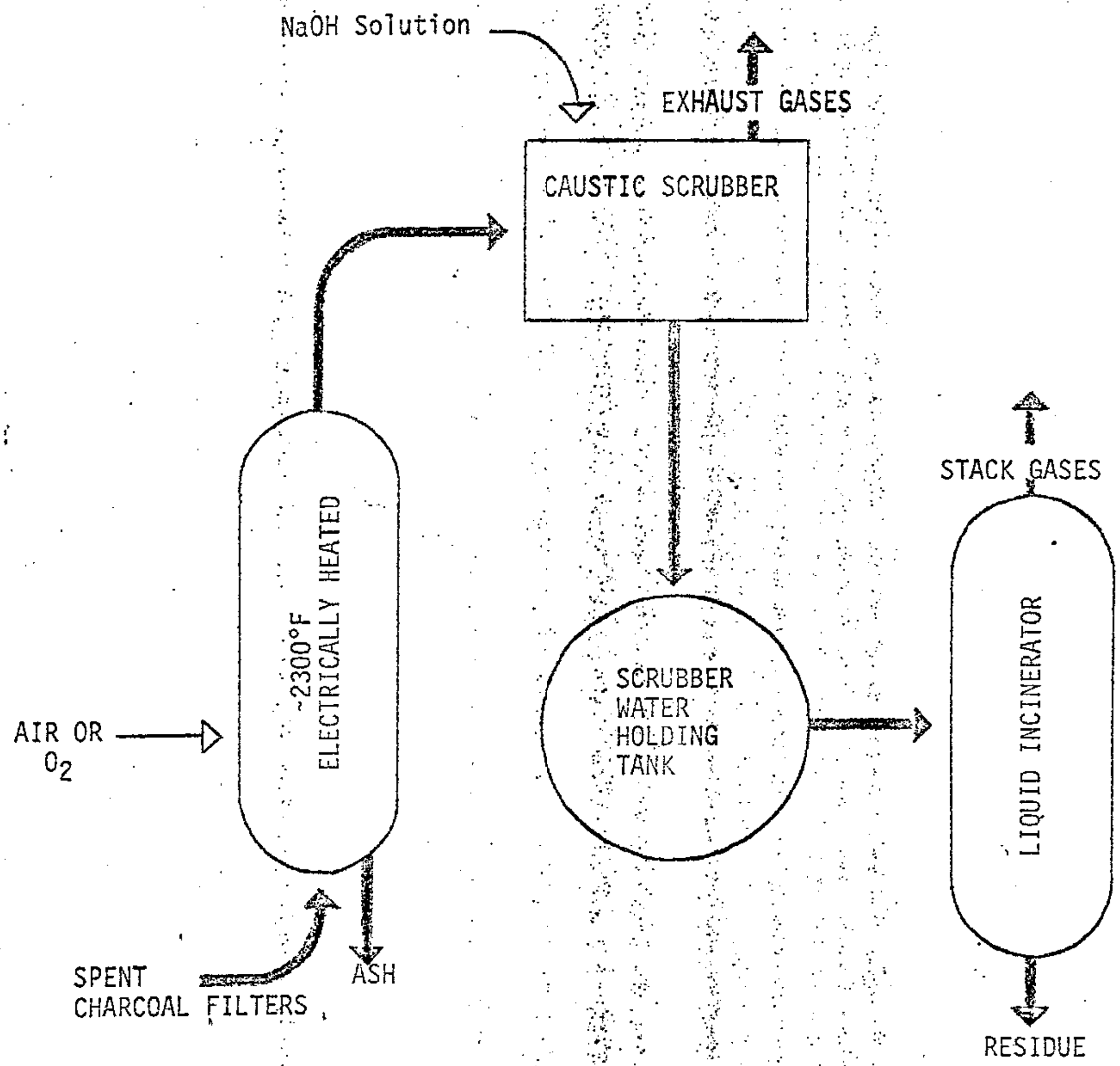

FIGURE 2. SPENT COCONUT CHARCOAL FILTER INCINERATION SYSTEM

plant operation will be shut down and the area cleared. Qualified personnel wearing the necessary protective equipment will assess the situation and collect appropriate samples, and all prudent action will be taken to protect personnel to minimize any adverse environmental impact.

3. PROCESS/ENVIRONMENTAL QUALITY CONTROL

a. General: The pilot plant can be considered as two separate operations. First, the units (Figure 1) required to remove the TCDD from the raw herbicide; secondly, the incineration system (Figure 2) required to destroy the TCDD contained in the spent charcoal cartridges. Sampling protocols have been developed to assess quality control and environmental impact of the two operations, these protocols are discussed below.

b. Herbicide Reprocessing: Samples associated with this process will include raw Orange herbicide, filtrate from the coconut charcoal units, recycled acetone from the clean acetone storage tank, and herbicide from the processed herbicide storage tanks. The latter of these is the most critical since it must meet the EPA acceptable level for TCDD content. All raw herbicide batches and filled processed herbicide storage tanks will be sampled. The frequency of the other samples is predicated on existing research data on TCDD adsorption on coconut charcoal and the concentration of TCDD applied to the charcoal cartridge during the pilot plant study. Frequency of these samples is expected to change as experience with the system is obtained. All herbicide reprocessing samples will be analyzed for TCDD by Agent Chemical, Inc. (gas chromatograph). Selected raw Orange herbicide, processed herbicide, acetone and filtrate samples will be analyzed by Wright State University (gas chromatograph/mass spectrograph).

c. Incineration Process: Samples associated with this process include pre-scrubber combustion gases, post-scrubber stack gases, scrubber water, and ash from incineration. Monitoring of the pre-scrubber combustion gas utilizes a positive pressure console which houses the instruments to measure temperature, carbon monoxide, hydrocarbons and oxygen. This instrumentation (manual reading) operates continuously during the incinerator operation, and these readings are utilized in assessing incinerator operation. In addition, the console includes a pH meter to monitor the scrubber water. Scrubber gas will be monitored by acceptable stack monitoring techniques utilizing benzene impingers to obtain samples for analyses of TCDD and esters and acids of 2,4-D and 2,4,5-T. Monitoring will be performed for each incinerator operation. At a minimum, scrubber water will be sampled early in the operation prior to any disposal; other scrubber samples will be collected at selected intervals throughout the operation. Samples will be utilized for static bioassays and will be analyzed for TCDD and the esters and acids of 2,4-D and 2,4,5-T. Ash samples will be removed from the incinerator and pooled according to the TCDD content of the raw Orange herbicide and saved for subsequent analyses. Representative samples of the ash will be used in static bioassays and analyzed for herbicide components and heavy metals. Agent Chemical, Inc. will perform chemical analyses on all of the above samples and will maintain logs on the readings from the monitoring console. Wright State University will also analyze selected samples; static bioassays will be conducted by EHL(K). Process quality control is covered more extensively in the EHL Surveillance Plan.

C. EXISTING SITE CHARACTERISTICS: The proposed pilot plant studies will be performed at the Naval Construction Battalion Center (NCBC), Gulfport, Mississippi. Gulfport is located on the Mississippi Gulfcoast approximately 70 miles east of New Orleans (Figure 3). The NCBC is within the city limits of Gulfport, approximately two miles north of the Gulf coast (Figure 4). The location of the pilot plant will be within the herbicide storage area of NCBC which is part of a general purpose outdoor storage area of the Center (indicated in Figure 4 and expanded view in Figure 5). The site is approximately one-quarter mile from the nearest NCBC barracks and approximately one-fifth mile from the nearest

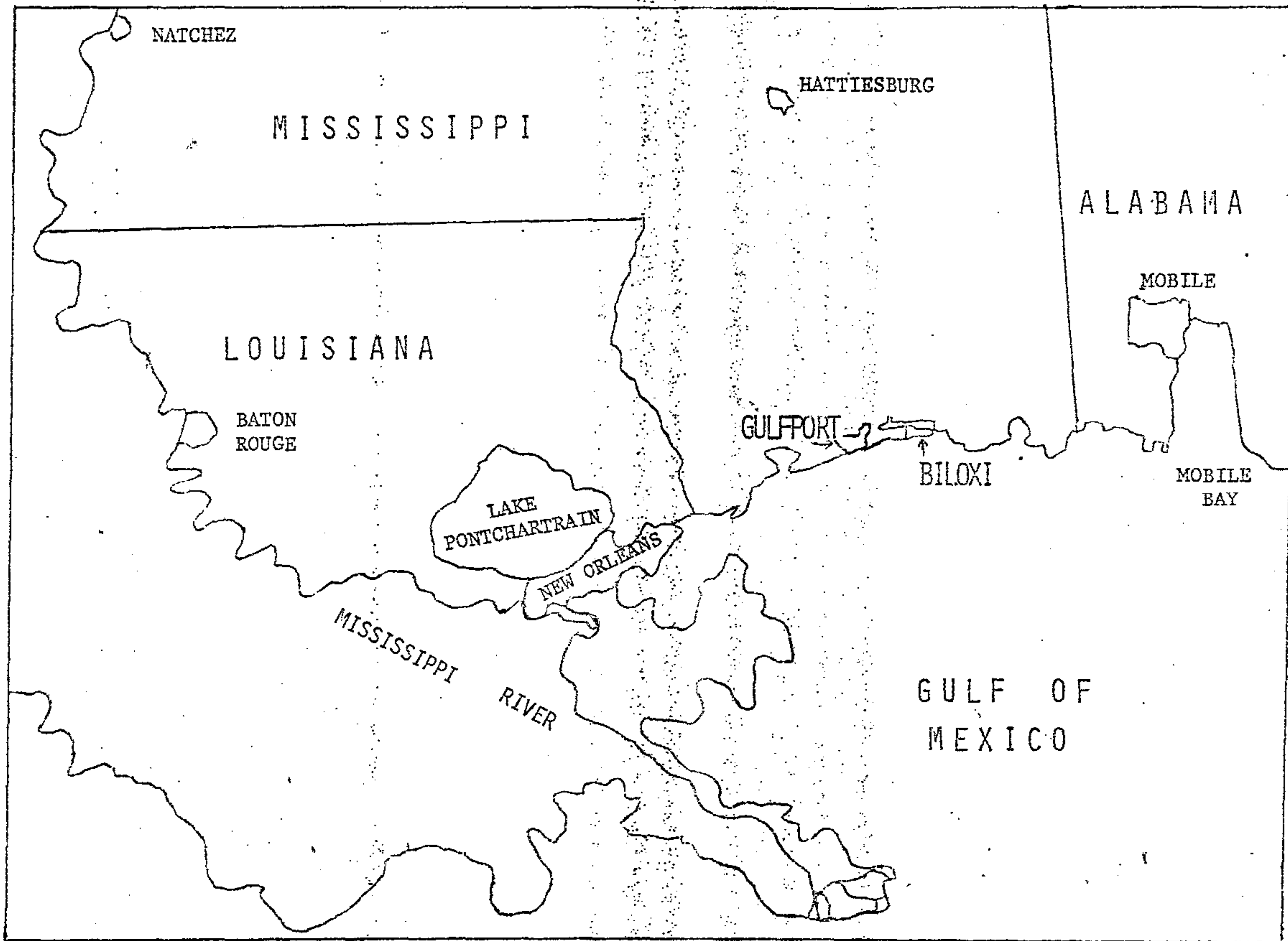

FIGURE 3. SOUTHERN GULF COAST

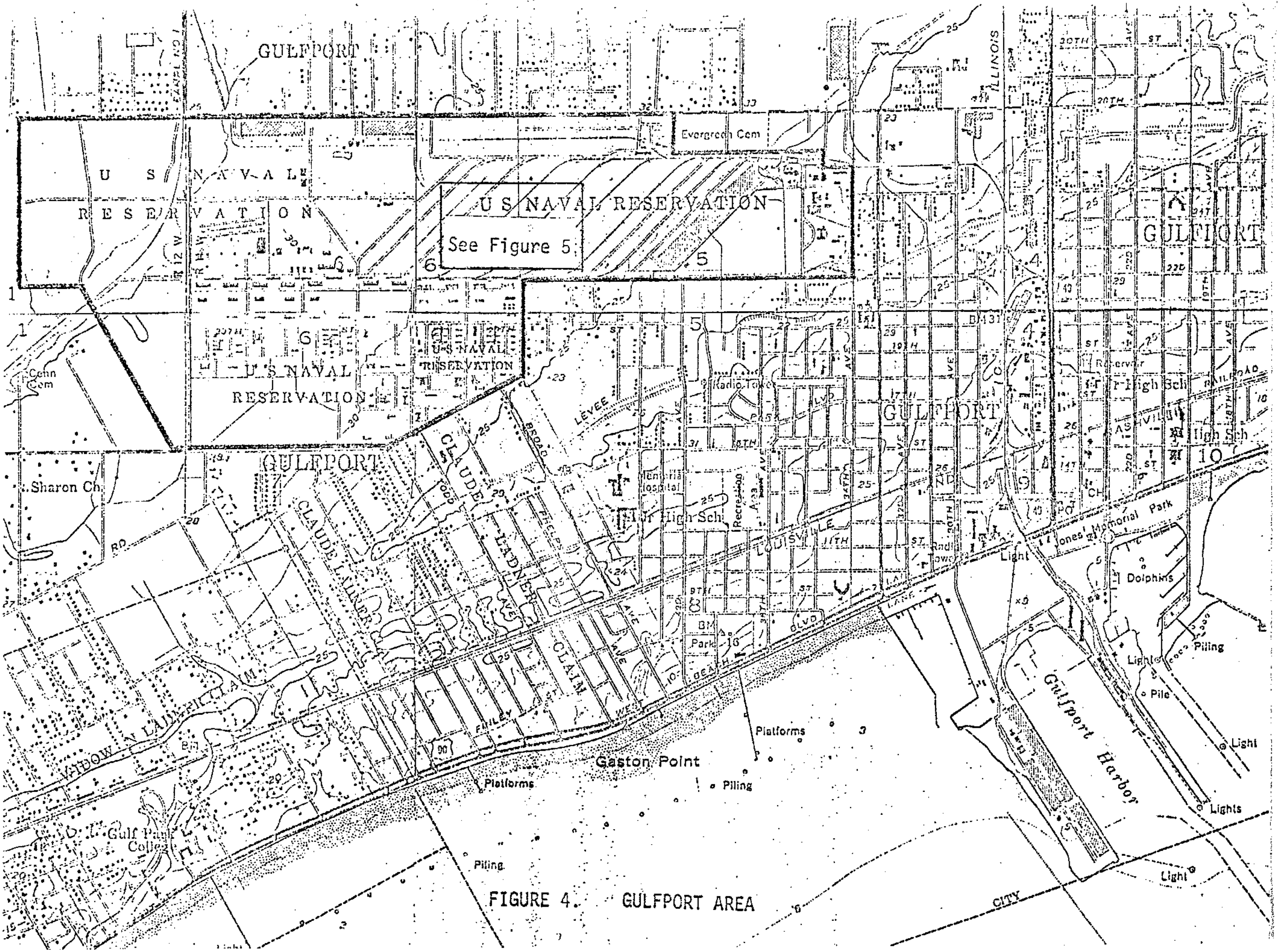

FIGURE 4. GULFPORT AREA

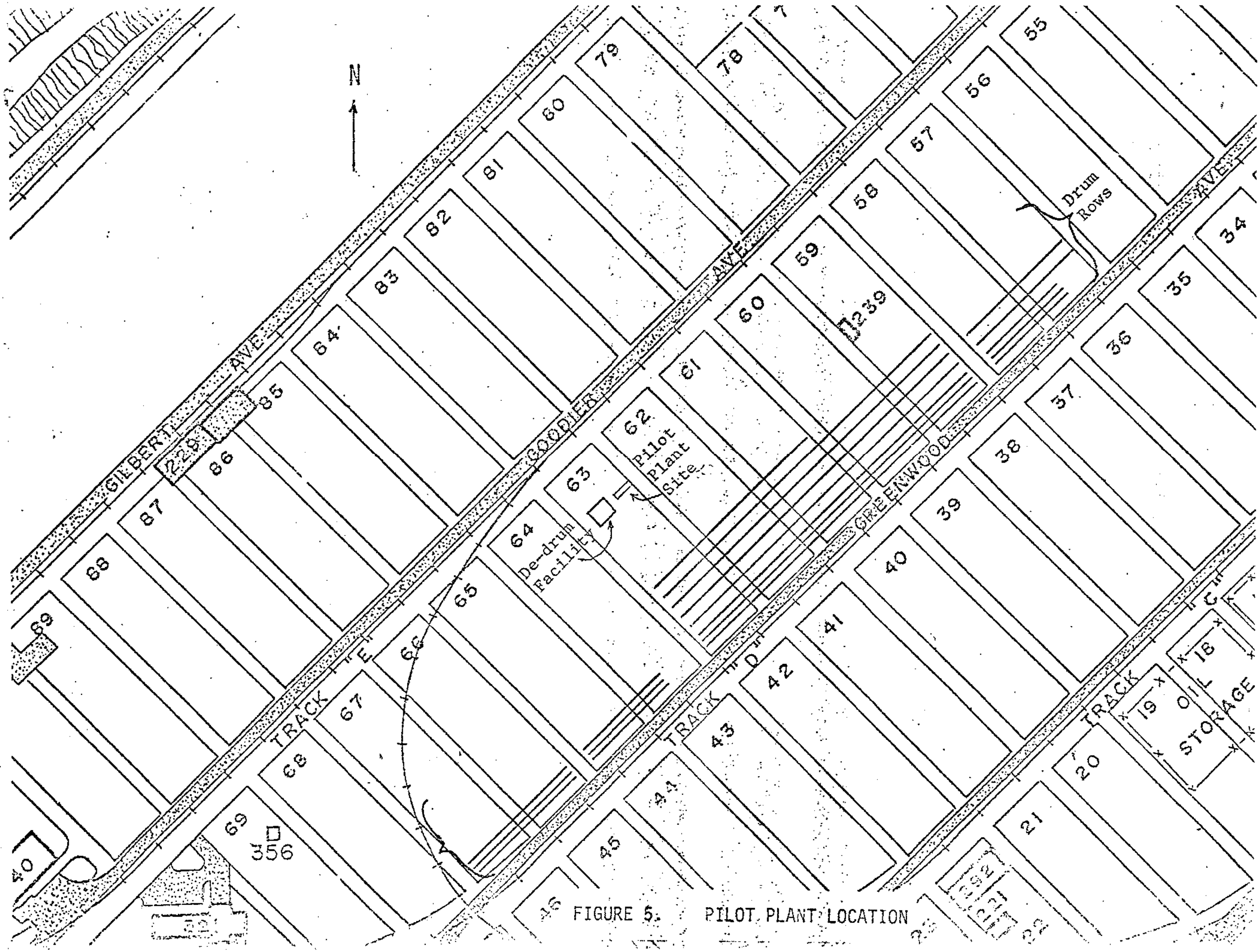

FIGURE 5. PILOT PLANT LOCATION

off-base property, a grazing pasture. The land at the site is very flat and consists mainly of cement-stablized soil with very little vegetative cover. Surface runoff is controlled by a network of three-foot deep drainage ditches which run throughout the entire outdoor storage area. Background environmental samples of air, soil, sediment and water have been taken and their analyses will be used for comparison with any samples taken during and after pilot plant studies.

II. RELATIONSHIP OF PROPOSED ACTION TO LAND USE PLANS, POLICIES, AND CONTROLS FOR THE AFFECTED AREA

The Agent Chemical, Inc. pilot plant will be on only 2,000 sq ft (20 ft x 100 ft) of land at the Naval Construction Battalion Center, Gulfport MS. The plant will be dismantled after completion of project. The location for the plant is specifically designated in the Mississippi Air and Water Pollution Control Commission Permit (Appendix A). This action does not conflict with any land use plans, policies and controls for the affected area.

III. PROBABLE IMPACT OF THE PROPOSED ACTION ON ENVIRONMENT

A. NORMAL OPERATION: No adverse environmental impact is predicted during the normal operation of the pilot plant. Bench-scale laboratory studies to date have indicated favorable results for coconut charcoal adsorption of TCDD from Orange herbicide. It is the purpose of this facility to investigate the feasibility of charcoal adsorption of TCDD and its subsequent destruction by incineration in an environmentally acceptable manner. The possible discharges from the plant include esters and acids of 2,4-D and 2,4,5-T or their pyrolyzates, TCDD, HCl, and particulates, but extensive controls have been incorporated into the project in an effort to eliminate any possible adverse effects. These controls include activated carbon filters on the vents from all acetone and herbicide storage tanks. The design parameters of the incineration system indicate that an extremely high combustion efficiency of spent charcoal filters will be achieved. As an additional measure, the incinerator stack gases will be passed through a caustic scrubber to further control the discharge of possible contaminants. The gaseous discharge from the scrubber will be monitored during the operation of the incinerator. The spent scrubber water will be disposed of in a gas-fired liquid incinerator. A comprehensive surveillance plan has be developed which gives a detailed description of the type and frequency of sample collection and analyses to be performed (EHL Surveillance Plan). This monitoring is accomplished to detect any adverse environmental effects which may be associated with the pilot plant. Plant operation will be halted immediately should the results of the monitoring reveal adverse environmental impact. The plant will be placed back in operation when steps have been taken to correct the source responsible for the environmental impact.

B. PROCESS UPSETS: Although equipment failure which could cause release of contaminants is not expected, it has been considered (Paragraph I.B.2.d.). The environmental effects of any equipment failure cannot be accurately predicted; however, should an unwanted release occur, every effort will be made to minimize the environmental implications and dispose of collected materials in an expeditious and safe manner. Additionally, the plant will be operated in the fall and winter seasons which are periods of maximum floral and faunal dormancy, thus, any release of toxic materials will have a minimum effect on indigenous plants and wildlife.

IV. ALTERNATIVES

The Agent Chemical, Inc. pilot plant discussed in this assessment represents proposed action to evaluate the alternative of reprocessing Orange herbicide. The evaluation of a pilot plant operation complies with the expressed policy of the EPA (see Paragraph I.A.4) and is in keeping with EPA policy on disposal of pesticides. In addition, the pilot plant evaluation expands on the alternatives of the Air Force Final Environmental Statement (see Paragraph I.A.1). This assessment is specific for the Agent Chemical, Inc. process, and the pilot plant demonstration is considered a requirement for compliance with EPA policy. Any other reprocessing proposals will be handled individually on an as-required basis.

V. PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED SHOULD THE PROPOSAL BE IMPLEMENTED

Under normal operating conditions, no adverse environmental effects are anticipated from this pilot facility. Extensive controls have been incorporated into the process to eliminate any harmful emissions, and every effluent from the process is being monitored for verification of this condition. Only in the event of a process upset would any adverse effect possibly occur. These process upsets and the subsequent actions to be taken are discussed in paragraph I.B.2.d.

VI. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The short-term use of the environment to complete this pilot plant study will not have a direct impact on the maintenance and enhancement of long-term productivity. Long-term productivity may actually be increased if the pilot plant is successful and the entire stock of Orange herbicide is eventually reprocessed and put to beneficial use.

VII. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES THAT WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED

The pilot plant will consume certain utilities (electricity and water) and quantities of materials such as acetone, propane, sodium hydroxide, activated carbon, etc. The plant will require resources necessary for transportation from Houston TX to NCBC, Gulfport MS. The plant will be dismantled and cleaned after the pilot project; therefore, certain resource usage will be reduced. The commitment of resources is insignificant when compared to the beneficial aspect of eventual recovery of the entire stock of Orange herbicide as usable herbicide.

VIII. CONSIDERATIONS THAT OFFSET THE ADVERSE ENVIRONMENTAL EFFECTS

The pilot plant operation is to evaluate the feasibility of reprocessing the Orange herbicide. There are no adverse environmental effects associated with the normal conduct of the project; therefore, should reprocessing prove feasible, large quantities of a valuable commodity will be recovered.

IX. DETAILS OF UNRESOLVED ISSUES

None, as stated in Paragraph I.A.4, provided that reprocessing can be accomplished satisfactorily from an environmental and public health standpoint, it (reprocessing) is preferred to destructive methods of disposal. Therefore, if the pilot plant was not allowed to operate such a situation would create an unresolved issue.

DEPARTMENT OF THE AIR FORCE
WASHINGTON, D.C. 20330

OFFICE OF THE ASSISTANT SECRETARY

October 5, 1976

MEMORANDUM FOR MR. RICHARD G. BRUNER (DEFENSE SUPPLY AGENCY)

The attached Amendment to the Final Environmental Statement on the Disposition of Orange Herbicide is provided for incorporation, as appropriate, into your plans to implement the proposed action. This Amendment will be filed later this week with the Council on Environmental Quality (CEQ) after the minor corrections noted in red have been made.

As requested by the CEQ, we will wait 30 days after filing before making a final decision on the proposed action. I feel, however, that we should continue to develop contractual arrangements so a contract may be finalized quickly, if a favorable decision is reached after the wait period has elapsed.

You will note that the amended EIS does not address directly the charcoal disposal problem. In my mind, that should be the subject of a separate action.

Billy E. Welch

BILLY E. WELCH, Ph.D.
Special Assistant for
Environmental Quality

Attachment-
Amendment to
FEIS/H.O.

AMENDMENT TO THE FINAL ENVIRONMENTAL STATEMENT

"DISPOSITION OF ORANGE HERBICIDE BY INCINERATION, NOVEMBER 1974"

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EXECUTIVE SUMMARY

In April 1970, the Secretaries of Agriculture, Health, Education and Welfare, and the Interior jointly announced the suspension of certain uses of 2,4,5-T. Subsequently, the Department of Defense suspended the use of Orange herbicide, which is a herbicide that consists of approximately 50 percent 2,4,5-T and 50 percent 2,4-D. At the time of this suspension, the Air Force had an inventory of 1.4 million gallons of Orange herbicide in South Vietnam and 0.86 million gallons in Gulfport, Mississippi. In September 1971, the Department of Defense directed that the Orange herbicide be returned to the United States and that the entire 2.3 million gallons be disposed of in an environmentally safe and efficient manner. The 1.4 million gallons were moved from South Vietnam to Johnston Island for storage in April 1972. The average concentration of 2,3,7,8,-tetrachlorodibenzo-ρ-dioxin (TCDD) in the herbicide is about 2 mg/kg and total amount of TCDD in the entire Orange stock is approximately 50 pounds.

During the development of a method of disposition, from 1971 to 1974, techniques of destruction and recovery were investigated. Destructive techniques investigated included soil biodegradation, high temperature incineration, deep well injection, burial in underground nuclear test cavities, sludge burial and microbial reduction. Techniques to recover a useful product included use, return to manufacturers, fractionation and chlorinolysis.

Of these techniques, only high temperature incineration was sufficiently developed at that time to warrant further investigation. The other methods were rejected because of several considerations, including long lead-times for development with no assurance of success, the problem of disposal would be only partially solved, and the lack of industrial interest.

In December 1974, the Air Force filed a final environmental impact statement with the Council on Environmental Quality on the disposition of herbicide Orange by destruction aboard a specially designed incineration vessel in a remote area of the Pacific Ocean, west of Johnston Island.

The Environmental Protection Agency (EPA) held a public meeting in February 1975 to consider an ocean dumping permit application submitted by the Air Force in accordance with the Marine Protection, Research and Sanctuaries Act. During the conduct of this meeting, testimony was presented which indicated that techniques for chemically reprocessing the herbicide to remove unacceptable quantities of TCDD might have been developed. The EPA indicated that the option for use/reprocessing should be further explored as a means of disposition prior to destruction of the herbicide. This was felt to be completely consistent with the history of the disposal effort and with the final environmental statement in which three alternatives considered recovery of a useful herbicide. Thus, an approach which offers herbicide reclamation rather than destruction is considered appropriate, desirable and consistent with disposition efforts documented in the final environmental statement.

The interest of a number of chemical companies in reprocessing Orange herbicide was solicited in the form of a request for quotations mailed in February 1975. Since that time, a reclamation technique using coconut charcoal (activated carbon) has been developed and proven on a pilot plant scale. This technique, which removes unacceptably high concentrations of TCDD from the herbicide, will result in a product containing no more than 0.1 mg/kg TCDD. Environmental Process Research, Inc. has been issued EPA registration permits, numbers 39128-1, -2, -3 for herbicide containing 2:2, 3:3 and 4:4 pounds per gallon of 2,4-D and 2,4,5-T, respectively. The contaminated carbon cartridges and air-scrubbing carbon filters generated by this process will be placed in controlled storage until subsequent environmental analyses are completed for selecting a final disposition technique for the TCDD contaminated carbon. Destruction of the TCDD contaminated carbon is not considered at this time, to be technically, politically, and environmentally feasible.

The Marine Protection, Research and Sanctuaries Act requires that the EPA Administrator consider land-based alternatives to ocean incineration prior to issuing a permit. The granting of a permit by EPA is contingent on the demonstration by the applicant that there are no feasible alternatives to the disposal of herbicide Orange by incineration at sea. As stated above, reprocessing has been proven technically feasible and can be accomplished in an environmentally acceptable manner. The cost of several million dollars to incinerate the material will be avoided, and it is proposed to sell the herbicide to the reprocessing company. Reprocessing in lieu of destruction will recover a useful and valuable herbicide and return the material to legal and productive use with a potential net return to the U.S. Government.

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PART I. INTRODUCTION

A. THE PROBLEM AND PROPOSED ACTION: The Air Force is charged with the responsibility for the ecologically safe, efficient and, if possible, economical disposal of approximately 2.3 million gallons of Orange herbicide. The proposed action for such disposition is reclamation of the entire stock of Orange herbicide. Reclamation of the herbicide consists of reprocessing the Orange herbicide to reduce the level of TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin) contamination (via adsorption of the TCDD onto activated carbon) to an acceptable degree, thereby yielding a registrable herbicide mixture. This proposed action will generate air-scrubbing carbon filters and TCDD contaminated carbon cartridges which will be sealed and placed in monitored, recoverable storage. Subsequent environmental analyses will be conducted to determine the availability of feasible technology to dispose of the spent carbon in an environmentally safe manner. Reprocessing operations are proposed to take place on the present storage sites, the Naval Construction Battalion Center (NCBC), Gulfport MS and Johnston Island (JI), Central Pacific Ocean. This action will result in both releasing the herbicide, a valuable resource, for commercial usage and eliminating the potential environmental hazard which is inherent in the long-term storage of the herbicide.

1. DESCRIPTION OF ORANGE HERBICIDE: This herbicide consists of approximately 50% by volume of the normal butyl ester of 2,4-dichlorophenoxyacetic (2,4-D) acid and 50% by volume of the normal butyl ester of 2,4,5-trichlorophenoxyacetic (2,4,5-T) acid. A small quantity, known as Orange II, is an approximately 1:1 mixture by volume of the normal butyl ester of 2,4-D and the isooctyl ester of 2,4,5-T. Unfortunately, as a result of a malfunction in the production process, certain lots of the herbicide contain a contaminant, TCDD. In experimental animals this compound has been shown to be teratogenic, i.e., it caused malformations in fetuses including those leading to both still and live births. The military and certain other uses of 2,4,5-T ceased in 1970. For more detailed description see the Final Environmental Statement, Part II-F, pp. 31-62 (1).

2. LOCATION OF ORANGE HERBICIDE: The herbicide is stored in 55-gallon steel drums at two locations. There are approximately 860,000 gallons at NCBC, Gulfport MS and approximately 1,400,000 gallons on JI, Central Pacific Ocean.

B. HISTORICAL DOCUMENTATION OF EVENTS

1. In 1962, the herbicide formulation, Orange, was developed for military use as a defoliant. This herbicide formulation is a mixture of n-butyl esters of 2,4-D and 2,4,5-T.

2. South Vietnamese newspapers reported an increased occurrence of birth defects during June and July 1969. This action elicited far-reaching reactions from governmental agencies, segments of the scientific community, lay groups concerned with environmental problems, and from the communications media. Government-sponsored panels of experts, special commissions established by scientific organizations, hearings before subcommittees of the

U.S. Congress, and conferences attended by representatives from industry, government, and universities examined available data and heard expert opinions. These groups were not able to provide a generally acceptable answer to the central question of whether 2,4,5-T, as currently produced and used, constituted a risk for human pregnancy (2).

3. On October 29, 1969, it was announced that a series of coordinated actions was being taken by several governmental agencies to restrict the use of the herbicide 2,4,5-T. This was precipitated by release a few days earlier of the findings of a study by Bionetics Research Laboratories, Litton Industries, Inc., (3), in which it was found that mice treated during early pregnancy with large doses of 2,4,5-T gave birth to defective offspring.

4. Additional animal experiments performed early in 1970 confirmed that pregnant mice exposed to 2,4,5-T did deliver some malformed offspring. The question then was one of whether, or to what extent, such animal data could be extrapolated to man. On April 14, 1970, the Secretary of Health, Education and Welfare (HEW), advised the Secretary of Agriculture that: "In spite of these uncertainties, the Surgeon General feels that a prudent course of action must be based on the decision that exposure to this herbicide may present an imminent hazard to women of child-bearing age." Accordingly, on the following day, the Secretaries of Agriculture, HEW and Interior jointly announced the suspension of the registration of 2,4,5-T for: "I. All uses in lakes, ponds or on ditch banks. II. Liquid formulations for use around the home, recreation areas and similar sites." A notice for cancellation of registration was issued on May 1, 1970 for: "I. All granular 2,4,5-T formulations for use around the home, recreation areas and similar sites. II. All 2,4,5-T uses on crops intended for human consumption" (4, p.4).

5. All registrants of 2,4,5-T were advised of these actions. Two of the registrants, Dow Chemical Co. and Hercules Inc., exercised their right under Section 4.c. of the Federal Insecticide, Fungicide and Rodenticide Act to petition for referral of the matter to an advisory committee. The National Academy of Sciences supplied a list from which was selected a nine-member advisory committee of scientists with appropriate qualifications from universities and research institutes over the country. It was the consensus of the committee that the central issue was whether use of the herbicide does in fact constitute an imminent health hazard, especially with respect to human reproduction.

6. During the intervening months since restrictions were placed on the use of 2,4,5-T, a number of additional studies have been carried out on several animal species, and a few reports on human exposure during pregnancy have been further evaluated. Although the new data have not answered all of the questions that have been or could be raised, they undoubtedly provided a more substantial basis than previously existed for making a scientific judgment about possible effects of this herbicide on prenatal development. In undertaking such judgment, the advisory committee (4) took into account certain considerations that seemed appropriate to the issue, as follows: 1) As is frequently the case, available

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U.S. Congress, and conferences attended by representatives from industry, government, and universities examined available data and heard expert opinions. These groups were not able to provide a generally acceptable answer to the central question of whether 2,4,5-T, as currently produced and used, constituted a risk for human pregnancy (2).

3. On October 29, 1969, it was announced that a series of coordinated actions was being taken by several governmental agencies to restrict the use of the herbicide 2,4,5-T. This was precipitated by release a few days earlier of the findings of a study by Bionetics Research Laboratories, Litton Industries, Inc., (3), in which it was found that mice treated during early pregnancy with large doses of 2,4,5-T gave birth to defective offspring.

4. Additional animal experiments performed early in 1970 confirmed that pregnant mice exposed to 2,4,5-T did deliver some malformed offspring. The question then was one of whether, or to what extent, such animal data could be extrapolated to man. On April 14, 1970, the Secretary of Health, Education and Welfare (HEW), advised the Secretary of Agriculture that: "In spite of these uncertainties, the Surgeon General feels that a prudent course of action must be based on the decision that exposure to this herbicide may present an imminent hazard to women of child-bearing age." Accordingly, on the following day, the Secretaries of Agriculture, HEW and Interior jointly announced the suspension of the registration of 2,4,5-T for: "I. All uses in lakes, ponds or on ditch banks. II. Liquid formulations for use around the home, recreation areas and similar sites." A notice for cancellation of registration was issued on May 1, 1970 for: "I. All granular 2,4,5-T formulations for use around the home, recreation areas and similar sites. II. All 2,4,5-T uses on crops intended for human consumption" (4, p.4).

5. All registrants of 2,4,5-T were advised of these actions. Two of the registrants, Dow Chemical Co. and Hercules Inc., exercised their right under Section 4.c. of the Federal Insecticide, Fungicide and Rodenticide Act to petition for referral of the matter to an advisory committee. The National Academy of Sciences supplied a list from which was selected a nine-member advisory committee of scientists with appropriate qualifications from universities and research institutes over the country. It was the consensus of the committee that the central issue was whether use of the herbicide does in fact constitute an imminent health hazard, especially with respect to human reproduction.

6. During the intervening months since restrictions were placed on the use of 2,4,5-T, a number of additional studies have been carried out on several animal species, and a few reports on human exposure during pregnancy have been further evaluated. Although the new data have not answered all of the questions that have been or could be raised, they undoubtedly provided a more substantial basis than previously existed for making a scientific judgment about possible effects of this herbicide on prenatal development. In undertaking such judgment, the advisory committee (4) took into account certain considerations that seemed appropriate to the issue, as follows: 1) As is frequently the case, available

data are insufficient for a definitive statement of conditions under which a specified risk might occur, assuming that freedom from risk is ever attained; 2) Since most chemicals under suitable laboratory conditions could probably be demonstrated to have teratogenic effects, and certainly all could be shown to produce some toxic effects if dosages were high enough, it would not be reasonable to consider the demonstration of toxic effects under conditions of greatly elevated dosage to be sufficient grounds for prohibiting further use of a particular chemical; and 3) Benefits are to be expected from the continued use of 2,4,5-T. The necessity of making a value judgment of benefit versus risk, therefore, must be accepted, not only for this herbicide, but for numerous valuable drugs, some natural nutrients, and many other chemicals, some of which are known to be teratogenic in laboratory animals. The risk versus benefit judgment for a particular herbicide or drug can be evaded only if it can be shown that another compound is equally as efficient and involves less risk. This presupposes that the risk potential of a substitute herbicide is at least as well known as that of the original (in this case 2,4,5-T) - a fact that may be difficult or impossible to ascertain. The substitution of a relatively unknown pesticide for an older one with known adverse effects is not a step to be taken lightly.

7. The task of making a judgment about the central question of hazard to human pregnancy is complicated by still other considerations. Although herbicides are of economic benefit to man, their use is not without possible hazard to the environment and to other aspects of human welfare. In various connections, questions have been raised about: a) damage to nontarget plants caused by spray drift or by movement in water, b) damage to subsequently planted sensitive crops owing to herbicide persistence in the soils, and c) acute or chronic toxicity to man or other animals aside from that related to pregnancy.

8. It is scientifically impossible to prove that a chemical is without hazard. Pesticide regulations now require that new agents be tested for acute and chronic toxicity, mutagenicity and carcinogenicity. These tests may involve the use of two or more species of animals taken through several generations and the examinations of thousands of individuals. Since it is necessary to extrapolate from effects in test animals to man and since species are known to differ in sensitivity to chemicals, the permissible residue levels in food must always be manyfold below the minimal effect level for the species tested.

9. A major producer of 2,4,5-T submitted evidence that the 2,4,5-T used in the Bionetics test contained 27 ± 8 ppm of an impurity identified as TCDD. This impurity was tested and found to produce teratogenic effects in several species of animals at widely varying dose/body weight ratios and by different routes of administration (4).

10. Human exposure to an environmental chemical such as 2,4,5-T depends on: a) pattern of usage, i.e., how widely and frequently it is applied and in what amounts and b) its fate in the environment, i.e., how it accumulates and degrades in relation to its application rate. The chlorophenoxy herbicides 2,4-D and 2,4,5-T have been widely used to control broad-leaved weeds for over

Also, the majority of commercial herbicide formulations for selective control of broad leaf weeds are combinations of 2,4-D and the more costly 2,4,5-T.

20 years. Because 2,4,5-T is more expensive than 2,4-D, it has been primarily used to control woody plants and a few herbaceous species against which it is more effective than 2,4-D. ~~Also, because of the cost difference, commercial formulations containing 2,4,5-T are usually mixtures of the two herbicides~~.

11. Most of the 2,4,5-T is applied as a spray to foliage. Lesser amounts are sprayed on the trunks and branches of dormant trees, injected into the bases of trees, poured or sprayed into frills around the trunks of trees, or sprayed or painted on newly cut stumps of trees. Amino salts of 2,4,5-T dissolved in water are most often used when the herbicide is applied to foliage, and esters dissolved in oil are most often used when it is applied to bark. The spray concentrations usually vary between 0.1 and 2.5%, and the rates of application are usually between 0.5 and 8 pounds per acre, depending on the size and sensitivity of the plants being treated. Higher rates and concentrations were used in Vietnam for military purposes (5).

12. In September 1971, the Secretary of Defense directed the Joint Chiefs of Staff (JCS) to dispose of both Continental United States (CONUS) and Vietnam stocks of Orange herbicide. The Air Force was assigned this responsibility.

13. The Department of the Air Force prepared a Final Environmental Statement entitled, "Disposition of Orange Herbicide by Incineration" (1) which was filed with the Council of Environmental Quality on 6 Dec 74. The proposed action was incineration in the open tropical sea near Johnston Island, Central Pacific Ocean, on a specially designed vessel. The ~~principle~~ principal alternative to the proposed action was incineration on Johnston Island. Major technical support of incineration as a means of destruction of the herbicide and its constituents was supplied by technical reports from the Marquardt Company, Van Nuys CA (6) and A.D. Little Inc., Cambridge MA (7). The Marquardt Company report was entitled, "Report on the Destruction of 'Orange' Herbicide by Incineration" and described the activities of an actual test incineration project conducted at the Van Nuys location in November 1973. The A.D. Little report was entitled, "Review of Proposed Action to Dispose of Orange Herbicide by Incineration." The "proposed action" in the title refers to incineration at sea and the report is a scientific study of the probability of destruction of Orange herbicide from theoretical considerations.

14. On 9 January 1975, the AF applied to the EPA for a "Special Permit to Incinerate Herbicide on an Incineration Vessel." On 19 February 1975, the EPA held a public meeting in Washington DC on the AF application for this permit. The EPA indicated that the options for use/reprocessing should be further explored prior to the destruction of Orange herbicide. In response to the EPA positions, the AF requested the Defense Supply Agency (DSA) to explore the possibility of reprocessing Orange herbicide. On 27 February 1975, DSA, Federal Center, Battle Creek MI forwarded a "Request for Quotations" (RFQ) to several companies for reprocessing of Orange herbicide. These quotations were to be returned for opening at 3:00 PM EST, 28 March 1975. Agent Chemical, Inc. (ACI), Houston TX responded to the RFQ.

15. The EPA held a public hearing on the AF Ocean Incineration Permit Application on 25 and 28 April 1975 at Honolulu HI and San Francisco CA, respectively. The hearing was comprehensive in content and included a policy statement on the disposition of pesticide and herbicide waste. The summary of the EPA policy as quoted from the minutes of the hearing (8) follows:

> "Recovery of useful value from pesticides in a disposal situation must be determined to be unfeasible before non-productive (Destructive) means can be considered. In the case of Herbicide Orange reprocessing to recover useful herbicidal value from the 2,4-D and 2,4,5-T components with concurrent destruction of the teratogenic dioxin contaminating component appear promising. Pilot plant studies to accurately evaluate the chemical processes involved in reprocessing are required at this time. They probably can be completed in six months. EPA believes the reprocessing aspect is worthy of additional serious consideration and if feasible it may well be preferred to ultimate disposal. It might well, in light of current estimates, return 2,4-D and 2,4,5-T to commercial channels with lower dioxin content than that currently manufactured."

The hearing was not closed but was adjourned, to be reconvened upon ten days notification from the AF to the EPA that a determination on the feasibility of reprocessing had been made.

16. On 9 June 1975, at the request of DSA, representatives of ACI, the AF, DSA, and Army Environmental Hygiene Agency (AEHA) (consultants to DSA on environmental matters) met at Edgewood Arsenal MD to discuss the ACI proposal to reprocess the herbicide as per their response to the RFQ. The discussion did not reveal any insurmountable technical objections to the proposal.

17. On 14 August 1975, the State of Mississippi, Air and Water Pollution Control Commission issued a permit to "Agent Chemical, Inc., U.S. Naval Construction Battalion Center (NCBC), Gulfport, Mississippi" to construct a "Herbicide Reprocessing Pilot Plant including herbicide handling, adsorption, incineration and scrubbing equipment." The permit expired on 14 August 1976. In October 1975, a permit to operate for one quarter was issued by the State of Mississippi; this permit has been renewed periodically.

18. On 28 August 1975, at the request of DSA, representatives of the AF, AEHA, DSA, EPA, and National Institute of Occupational Safety and Health (NIOSH) met in Washington DC to review the reprocessing situation and to determine a specific course of action on ACI's proposal. It was determined that three documents were required to proceed and evaluate the ACI proposal and that the USAF Environmental Health Laboratory, Kelly AFB, Texas (EHL/K) would initiate action on these documents: 1) an environmental assessment of the pilot plant process, 2) an environmental/personnel surveillance plan to be implemented during plant operation, and 3) a final report on the results of the pilot

plant operation upon completion of the study. The first two of these documents (9,10) were completed with the assistance of AEHA. The final report was to be accomplished at the completion of the pilot plant study.

19. In February 1975, Stalling, et al., of the U.S. Department of Interior (USDI), filed for a patent "Method of Removing Polynuclear Aromatic Compounds by Adsorption with Coconut Charcoal." Orange herbicide had been used in the experiments to support the patent application. Subsequently, Dr. Stalling, USDI, Fish Pesticide Research Laboratory, Fish and Wildlife Service, Columbia, Missouri, entered into an interagency agreement with the AF. Under this agreement, Dr. Stalling, et al., are conducting on-going studies with Orange herbicide to determine specific loading rates, TCDD capacities of the charcoal, adsorption mechanisms, charcoal disposal options, etc. The studies have shown coconut charcoal adsorption of TCDD from Orange herbicide to be feasible on a laboratory scale. In addition these studies have provided recommended flow rates and suggestions for estimating charcoal requirements, but this information was only intended as initial parameters for a pilot plant (11,12).

20. On 7 July 1976 ACI submitted to DSA, Battle Creek MI, a report titled, "ACI Report of Pilot Plant Operation and Proposed Reprocessing of Herbicide Orange, 24 May - 8 July 1976" (13). This is the only report that has been submitted by ACI on their activities to reprocess Orange herbicide. The report is favorable toward the reprocessing option and includes sections on pilot plant design, pilot plant performance, scale-up design, and EPA registration. The ACI report discussed only the final of the three attempts to conduct a pilot plant study. The first two attempts, October 1975 and January 1976, were not carried to completion, primarily because of the reprocessor's particular incineration problems. As a result of these problems, ACI conducted a third pilot plant study which did not attempt carbon incineration but proposed disposition of the spent carbon cartridges in a Class I landfill. (At that time burial in an approved hazardous waste landfill was the only disposal method considered.) Details of pilot plant design, operation, and results are included in the ACI report.

C. USES OF PHENOXY HERBICIDES

1. REASONS FOR USE: This part remains unchanged from Final Environmental Statement, Nov 74 (1).

2. EXTENT OF USE: This part remains unchanged from Final Environmental Statement, Nov 74 (1).

3. REGISTRATION

a. The government edict on 2,4,5-T (4) suspended the registration of liquid formulations for use around the home and recreational areas, and for uses on lakes, ponds, and ditch banks. This restriction did not include its use on range and pasture lands, non-agricultural lands, or in weed and brush control programs on communications and highway rights-of-way. Several formulations of 2,4-D and 2,4,5-T are currently registered for domestic use. Existing stocks of Orange herbicide ~~is~~ are not a registered herbicide and cannot be ~~domestically~~ used or sold domestically or released for sale to ~~foreign~~ foreign countries.

b. The Orange herbicide stock to be reprocessed by the proposed action represents a resource of considerable monetary value. The registration and appropriate utilization of all or part of this resource would be a significant beneficial action. The method by which ACI intends to register reprocessed Orange herbicide is stated succinctly in the ACI Pilot Plant Report (13). A Texas corporation, Environmental Process Research Inc. (EPR), was chartered by ACI to facilitate the transfer of registration(s) from Colorado International Corp. (CIC) to EPR. EPR has received the transfer of registration(s) for three formulations of herbicide containing 2,4-D and 2,4,5-T (2:2, 3:3, and 4:4 pounds of each ester per formulation) (15). ACI states that, when the labels are printed to show the new company designation and the EPA registration number, the reprocessed herbicide would be marketable (13).

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PART II. PROJECT DESCRIPTION

A. INTRODUCTION: Since public release of the Final Environmental Statement, "Disposition of Orange Herbicide by Incineration"(1), the EPA has taken the position that reclamation, if environmentally and economically acceptable, is preferable to incineration of herbicide. The proposed action is to reprocess the herbicide via carbon filtration to reduce TCDD concentrations to acceptable levels which will provide a registrable and useable herbicide. TCDD contaminated carbon cartridges and air filters generated by the proposed action will be sealed and placed in monitored, recoverable storage until environmental analyses are completed for selecting an environmentally safe and feasible method of disposition. Extensive pilot reprocessing studies conducted by ACI and closely monitored by the Air Force have demonstrated that the reprocessing aspect of reclamation is feasible and economically practical. The handling, transportation, and disposition of cartridges containing TCDD-contaminated carbon resulting from the reprocessing operation are described in detail under Section C.

B. DESCRIPTION OF REPROCESSING OF ORANGE HERBICIDE

1. REPROCESSING SITES: Herbicide reprocessing (i.e. dedrumming, filtering, and redrumming the existing herbicide) will take place at the present storage sites, NCBC and JI. These two locations each have several attributes which make them the locations of choice for the reprocessing operation. Of paramount importance is the fact that movement of the contaminated herbicide to the processing plant will be restricted to no more than a few hundred yards. It will neither be necessary to dedrum non-shippable drums nor move the unprocessed herbicide from Federal property. Neither site will require the exercise of the right of eminent domain, result in trespass or encroachment to private citizens within the U.S. or its possessions or to any other nation's interests, or impair the economic activity of any commercial enterprise. Additionally, by using these sites the unprocessed herbicide will never be removed from the area under environmental monitoring controls outlined in Sections III.B.(3) and III.C.(3) below. Therefore, reprocessing on-site, where stored, combines maximum control of the unprocessed herbicide with minimum risk of environmental insult.

2. METHOD OF REPROCESSING

a. <u>Introduction</u>: Reprocessing of Orange herbicide has been investigated and it has been concluded that from operational, environmental and public health viewpoints, the TCDD content of the herbicide can be reduced satisfactorily to yield registrable herbicide (i.e., with 0.1 mg/kg TCDD, or less) by a physicochemical process. This process is adsorption of the TCDD on activated coconut carbon. The reprocessing is primarily concerned with the use of activated carbon cartridges, but it also includes such topics as transport of herbicide to the reprocessing plant, dedrumming, packaging (drumming) of the final product, removal of final product from the plant, disposal of the empty Orange herbicide drums, and quality control measures to be applied to plant operations with particular emphasis on the suitability of the final product. The work leading to the above satisfactory conclusion concerning reprocessing of the herbicide was conducted by ACI at NCBC, Gulfport MS (see Part I.B). ACI submitted a report (13) on 7 Jul 76 to DSA titled, "Agent Chemical, Inc. Report of Pilot Plant Operation and Proposed Reprocessing of Herbicide Orange, 24 May - 8 Jul 1976"; this report included major sections on: 1) Pilot Plant Operation, 2) Reprocessing Plant Design, 3) Registration of Product, 4) Unresolved Issues and, 5) Disposal of Spent Carbon Charcoal Columns (= cartridges). The EHL(K) monitored the pilot plant activities of ACI; analyzed the data relating to TCDD adsorption, scale-up to reprocessing size, and proposed disposition of spent cartridges and air-scrubbing filters; and has concluded that reprocessing and use represents a satisfactory means of disposition of Orange herbicide stock. The remainder of this section will be concerned with a description of the proposed means of reprocessing. The proposal is to reprocess the NCBC, Gulfport stock of herbicide at NCBC and the Johnston Island stock at Johnston Island. The "Description of Process" which follows will be concerned primarily with the NCBC stock with comments on the Johnston Island operation.

b. Description of Process

(1) General: The reprocessing plant consists of the following units: 1) raw herbicide storage tanks, 2) heating tank, 3) diesel-fired boiler to provide steam to the heating tank, 4) activated coconut charcoal cartridges, 5) product (reprocessed herbicide) tanks and 6) appropriate pumps, filters, piping, etc. The herbicide in the heating tank will be heated to about 100°C and passed through the carbon (coconut charcoal) adsorption columns from where it will be discharged through filters into the process tanks. Samples will be collected from both the storage and process tanks to determine TCDD removal efficiency and provide quality control of the final product. The adsorption cartridges will be operated in a staged (series) configuration. Pilot plant data showed clearly that the minimal amount of carbon will be required if such a configuration (series) were utilized (13). The staged series to be used is such that valves control the flow direction so that any cartridge can be made first, second, etc., in the series. Therefore, when an expended cartridge is removed from the multi-cartridge rack and replaced by a new cartridge, the valving will be readjusted so that the new cartridge will be in the end position. This method insures that low TCDD herbicide (i.e. herbicide which has already passed through carbon cartridges) is further treated by virgin carbon thus maximizing the TCDD reduction. When an exhausted cartridge is removed from the system it will be immediately sealed at both ends and readied for shipment in an environmentally safe manner for placement in the recoverable storage site.

(2) Agent Chemical, Inc. - Reprocessing: Analyses of the data from the ACI pilot plant study reveal that TCDD can be effectively and efficiently removed from Orange herbicide by adsorption on activated carbon. The test program consisted of a total of seven reprocessing runs: six single-column runs designed to obtain basic data on adsorption of TCDD, and a series run (Run 7) to demonstrate the ability of the process to produce a satisfactory product. Analyses of the data of the single-column runs resulted in the conclusion that a series system would provide satisfactory reprocessing. The validity of this conclusion is reinforced by the results of run 7 in which approximately 75 pounds of activated carbon

reduced the concentration of TCDD in approximately 200 gallons of Orange herbicide from 3.71 mg/kg to less than 0.1 mg/kg. It is noted that the adsorptive capacity of the activated carbon used in run 7 was not fully utilized. These data support ACI's proposal (13), that activated carbon adsorption presents a feasible means of reprocessing the Orange herbicide. In the large-scale reprocessing plant, ACI proposes to use storage and product tanks of about 12,000 gallon capacity. The individual cartridges will be 10 feet long, 30 inches in diameter, having a wall thickness of 3/8" and made of new steel. ACI estimates that approximately 1000 columns will be used for the entire project. The carbon weight per column is calculated to be 1,284 pounds, therefore, the carbon for the entire project (NCBC and Johnston Island) is 1,284,000 pounds or 642 tons. ACI had an agreement, described in the ACI Pilot Plant Report (13), with Calgon Corp. Calgon estimated that approximately 460 tons of carbon will be utilized for the entire project. EHL(K) data analyses indicate that between 300 and 600 tons of carbon may be required, depending upon final plant design and operating conditions. The proposed processing rate of 10,000 gallons per day will result in an on-stream reprocessing operation of about 86 days at NCBC. Factors such as de-drumming and redrumming rates may impact on the reprocessing time estimate. Corresponding time estimates for the Johnston Island operation are not available since plant design may vary from that at NCBC. However, if the design is similar, the time duration of the reprocessing operation on JI should be about 140 days.

(3) Environmental and Occupational Health Considerations: The reprocessing plants at NCBC and Johnston Island will be designed to minimize any emissions of herbicide liquid or vapor to the environment and to provide a safe working environment for the operating personnel. The NCBC plant will require special attention due to its location in a populated area and the possibility of broad-range impact on "disinterested" people or "interested" organizations. The plant at Johnston Island will receive the same attention although the personnel and environmental conditions are vastly different. Except for the dedrum procedure, the plants will be designed and operated in a similar fashion. At NCBC, it is most important that every effort be made to minimize and control vapors from the dedrumming facility. The situation is discussed in the following section. One positive factor occurring from the reprocessing option is that about 200 drums per day will require de-drumming and the drum disposal facilities have been designed and constructed for a rate of 1,000 drums per day to support the incineration option, as described in detail in the Final Environmental Statement (1). The operation of the plant involves heating of herbicide, pumping of herbicide from tanks to cartridges, etc., and removing of used cartridges and replacement with new cartridges. These operations all represent potentials for accidents which may physically injure an individual or cause liquid herbicide, herbicide vapors, or TCDD to be released to the environment. The plant engineering will be such that these potential problems will be minimal and contingency plans will be in-being to reduce the severity of any accident. All equipment which contacts the herbicide will be sized and selected so that compatible and reliable equipment is used. For example, the problems associated with the repair of an Orange-contaminated pump, the loss of processing time if a pump needs to be replaced, and the environmental impact associated with a leaking pump all dictate that only

the very best equipment be used. The cartridges, as previously mentioned, will be of new 3/8" steel to preclude rupture. The weight of the column dictates that proper equipment be utilized in removal/replacement of cartridges. The cartridges will be valved on both ends and, when a cartridge is replaced these valves will remain on the cartridge and kept closed. Another important operation with potential impact is charging the cartridge with carbon and herbicide; it is necessary that a cartridge be charged prior to being put on stream. This operation will be conducted with herbicide with a low or non-detectable concentration of TCDD, and vapors from the procedure will be filtered through carbon prior to release into the environment. The plant, from the process tanks to the filling of drums with salable product, will be designed for closed loop containment of vapors. Where vapor exhaust is required such exhaust will be through carbon filters. There will be no liquid effluent, i.e., no water or solvent is used in the reprocessing plant. The used adsorption cartridges and air-scrubbing carbon filters will be sealed and readied for placement in recoverable storage in a remote location. Storage will be in an enclosed, secured structure or chamber. Such storage would allow removal at some future date when environmental analyses are completed for selecting a feasible disposal method. Upon completion of the operation, plant facilities will be cleaned with solvent and this equipment either returned to use in the chemical production industry or disposed of in an appropriate manner.

c. Herbicide Dedrum/Transfer and Drum Disposal

(1) Introduction: Careful consideration, from an environmental and occupational health standpoint, was given to the proposed methods of transfer of herbicide from 55-gallon storage containers to the reprocessing plant and the ultimate disposal of the empty drums. The Orange herbicide is stored at both NCBC and Johnston Island in approximately 16,000 drums and 25,000 drums respectively. Dedrumming facilities have been built at both locations to permit the collection of the herbicide in a sump from which the material can be pumped to the reprocessing facility holding tanks. The empty drums will then be rinsed with diesel fuel and crushed. In addition, an estimated 7,000 drums which have previously contained herbicide are in storage at Johnston Island and will be rinsed. The 7,000 drums were identified as leakers and the herbicide was transferred to other drums. The crushed drums will be recycled as "scrap steel" to be smelted in a steel manufacturing process. Details of the above, along with the environmental considerations, are provided in the following paragraphs. The data on herbicide residuals in rinsed drums, presented below, are based on experiments with recently-drained drums.

(2) Detailed Operations

(a) Dedrumming Facility: The dedrumming facilities at NCBC and Johnston Island are of two different designs, although both accomplish the same task, of removing the herbicide from the drums. In the NCBC facility the drums will be deheaded and most of the herbicide will be pumped out of the drums to the collection sump. Then, the drums will be inverted to drain into the sump for five minutes. At the Johnston Island dedrumming facility, each drum will be tipped on its side on a sloped ramp, a hole will be punctured in the bottom and the drums allowed to drain into the collection sump. Air sampling data collected during drum draining tests at NCBC have indicated that atmospheric concentrations of Orange herbicide vapors were well below ACGIH Threshold Limit Values for 2,4-D and 2,4,5-T. Nevertheless, the NCBC dedrumming facility will be maintained at a pressure slightly less than atmospheric with all exhausted air being discharged through activated carbon to adsorb odors and minimize the chance of damage to nearby flora. No such enclosed area is provided at the Johnston Island facility due to the paucity of native flora and the adequacy and direction of the natural ventilation. Ambient air samplers will be utilized to document conditions throughout the dedrumming operations at both sites. Personnel at both sites will wear appropriate safety/protective clothing during all operations (ref III.H. below).

(b) Drum Rinse Procedures: Drum draining experiments conducted at NCBC in Sep 74 (15,16) and Apr 75 (8) have revealed that about 0.28-1.82 pounds of herbicide remains in a well-drained drum. To reduce this residue, the following rinse procedures will be performed on each drum. At NCBC, the inverted drums will be given a spray rinse with two gallons of diesel fuel and allowed to drain for an additional two minutes. At Johnston Island the drained drums will receive two separate spray rinses with one gallon of diesel fuel, each rinse being followed by a two minute drain period. The rinse operations will require about 100,000 gallons (~35,000 at NCBC) of diesel fuel. At the conclusion of the project, the diesel fuel will be recycled as a stock diluent.

(c) Ultimate Drum Disposal: The 40,500 empty drums generated by accomplishment of the dedrumming operation and the estimated 7,000 drums already empty will be crushed and disposed of by recycle as "scrap" metal for steel manufacturing. Disposal as scrap is considered more favorable from the long-term environmental standpoint than disposal of unrinsed drums in a landfill because the Orange and its components would be rapidly destroyed in the steel making process. As the scrap drum metal is reprocessed into new steel, it would be subjected to high temperatures (~2900°F) for an extended period of time (~6 hours). This exposure is much more severe than that which would be received if the non-combustible drums were subjected to incineration in a pesticide incinerator (2000°F, 2 sec) as defined by EPA in 40 CFR 165 (17). Recycle into steel not only conserves the drum metal but also raw materials used in steel making. The utilization of one ton of scrap steel in the steel making process conserves about 4 tons of iron ore, coal, and limestone. Therefore, the recycle of 47,500 fifty pound drums as scrap will conserve approximately 4,750 tons of raw material. This method of ultimate disposal will also preclude the return of any Orange herbicide drums to manufacturers, formulators, or drum reconditioners for reuse.

C. DESCRIPTION OF DISPOSITION OF TCDD-CONTAMINATED CARTRIDGES

1. GENERAL: Air-scrubbing carbon filters and TCDD-laden carbon cartridges will be generated during the proposed herbicide reprocessing. These items will be sealed and placed in monitored recoverable storage until subsequent environmental analyses are completed for selecting a feasible and environmentally acceptable disposal technique for the carbon.

2. TRANSPORTATION OF CARTRIDGES AND FILTERS: Spent cartridges will be drained of herbicide, sealed, and readied with the air filters for shipment to the storage site. Transportation of the cartridges and filters from the herbicide reprocessing sites to the storage site will be by truck, rail, or ship, as appropriate. The carrier will be required to have the proper authorization for transportation of these items as hazardous waste for the specific purpose of disposition. Such authorizations from the Interstate Commerce Commission (ICC), the Department of Transportation (DOT) and appropriate state agencies will include provisions to require the carrier to adhere to all applicable laws, regulations, and statutes. Commercial ocean vessels will be required to have current operational approval from the U.S. Coast Guard for operation from all U.S. ports and will follow all applicable maritime laws, regulations and statutes.

3. STORAGE SITE CRITERIA: There appears to be no regulatory criteria specifically governing recoverable storage of hazardous wastes. So long as such storage is designed and operated so as to prevent violation of air and water pollution regulations, the selection of the storage site, and its design and maintenance are governed solely by good judgment and a desire to protect the environment and to safeguard human health. With the above in mind, the following extremely conservative criteria will be guidelines in selecting the storage site:

a. Remote, i.e., removed from populated areas.

b. Controlled and limited access.

c. Enclosed~~, i.e.,~~ from weathering in an above ground unit ~~with concrete slab solid walls and roof or an~~ or suitable underground chamber.

d. Clearly marked in the immediate vicinity as to its use and restrictions.

e. Dedicated to the singular purpose discussed herein.

f. Designed to preclude any impact on municipal water supplies, shellfish beds, wildlife, fisheries (including spawning and breeding areas), ~~or~~ recreational areas, and prime or unique farmlands.

g. Located in an arid climate, not in a 100-year flood plain, and in an area of low seismic activity.

In addition, the site selected or the transport of the air filters and TCDD-contaminated activated carbon cartridges should not require the exercise of the right of eminent domain or result in a trespass or encroachment to private citizens within the U.S. or its possessions or to any other nation's interests. If possible, the site should be completely under the control of the Federal government to minimize local politically controversial effects on state or other government units. The site location should not result in international controversy, be in conflict with international law, or impair the economic activity of any commercial enterprise.

4. STORAGE AND STORAGE SITE MAINTENANCE: After off-loading at the storage site, the sealed metal cartridges and air filters will be treated for corrosion control either by painting techniques or encasement inside high density polyethylene cylinders of one-inch thickness and sealed at both ends. The number of structures or chambers to be used for storage is as yet unknown. Regardless of the number of cartridges, the pattern of storage will be essentially the same for all of them. The cartridges may be placed side by side in long rows. Each row may be multi-tiered; the number of tiers will be limited to insure that the pressure on the bottom tier is well below the fracture pressure of the storage structure/material. Compressible material will be used as protective spacers between adjacent cartridges. The number of rows will depend on the width of the storage area. Typically, there will be a single row against each wall with one end of each cartridge in contact with the wall. Between the wall rows there may be double rows with the inner ends separated by compressible spacers. Between a wall row and a double row and between any two double rows there will be aisles approximately 20 feet wide to facilitate movement of equipment such as a fork-lift. The storage area will be ~~enclosed~~ covered if needed to protect the cartridges from weathering. Biannual inspections will be conducted. The inspection will consist of visual observations and documentation of the condition of the cartridges and filters. If evidenced by any cartridge or filter container fracture, corrosion, or leakage, surface swipe samples and air samples will be collected for TCDD analysis.

5. CHARACTERISTICS OF HERBICIDE: This will be the same as Part II.F. (same title) as the Final Environmental Statement, Nov 74 (1).

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PART III. PROBABLE ENVIRONMENTAL IMPACT OF PROPOSED ACTION

A. SUMMARY STATEMENT OF TOTAL IMPACT: As a result of herbicide reclamation, the concentration of TCDD in the herbicide will be reduced to 0.1 mg/kg or less by carbon adsorption allowing a registrable, salable herbicide to be returned for beneficial use. The air-scrubbing carbon filters and TCDD-contaminated carbon in sealed airtight encapsulated cartridges will be placed in recoverable storage. Only minimal release of the herbicide or of any of its components to the environment is expected. Therefore, any environmental impact should be negligible.

B. AIR QUALITY

1. ENVIRONMENTAL IMPACT

a. General: During reclamation, the use of activated carbon filters on all vents, leak-free pumps and plumbing, and valved and sealed cartridges will prevent any significant escape of the herbicide or its components to the air environment.

b. Reprocessing

(1) Potentials for Impact: There are five separate processes/operations inherent to reclamation that could result in the release of material into the atmosphere: 1) dedrumming the herbicide and pumping it into plant storage tanks, 2) heating and processing of the herbicide including cartridge charging, 3) redrumming finished product, 4) removal of the contaminated carbon cartridges from the reprocessing system, transportation ~~of cartridges~~ and preparation of them for recoverable storage, and, 5) disposal of empty Orange herbicide drums and other contaminated equipment. Operations 1 and 3 involve transfer of the herbicide at or near ambient temperatures. Considering the low volatility of the herbicide in this temperature range and the maximum possible concentration of TCDD in the raw herbicide, the potential for impact is minimal. Operation 2 requires heating the herbicide to 100°C and maintaining it at this temperature during the low-pressure adsorption process. Two factors increase the impact potential during this operation. First, the volatilities of the herbicide and the TCDD are increased by heating, and second, the TCDD will be greatly concentrated by adsorption on the activated carbon. Process accidents (e.g. vessel rupture, plumbing leaks, etc.) could result in the release of significant quantities of herbicide and some TCDD to the atmosphere. Rupture anywhere other than the raw herbicide vessel would result in release of herbicide with low concentration of TCDD (0.1 mg/kg or less expected) since the bulk of the TCDD would be adsorbed on the activated carbon. Operation 4, removal, transportation, preparation for storage and storage of the contaminated cartridges and filters has minimal potential for introducing herbicide or TCDD into the air environment. The cartridges will be closed to the environment by valves before removal from the system. They will contain relatively small quantities of herbicide, but the concentration of TCDD adsorbed onto the carbon will be many times greater than that in the raw herbicide. Since the cartridges are to be constructed of 3/8" thickness, "new" steel, the chances for rupture or accidental opening of one of the cartridge valves at the reprocessing site is minimal. The possibility exists that a cartridge might

be dropped during on-loading at the reprocessing site or off-loading and placement at the storage site. Furthermore, there exists the possibility of the transport vehicle being involved in an accident. Either of these events could result in rupture of the steel cartridge. The latter event is unlikely considering the strength of the structural unit. Nevertheless, if the unlikely occurrence of a cartridge or air filter container rupturing does occur, the contaminated carbon will retain the adsorbed TCDD and a clean-up process will be accomplished readily, concurrently with the use of proper safeguards. Operation 5 involves dismantling/disposal of those parts of the dedrumming and reprocessing equipment that come into contact with TCDD-contaminated herbicide and which cannot be cleaned adequately for further use. Even this material, however, can be expected to have at most only low level contamination since it will be rinsed and/or flushed with either diesel oil, acetone, or another acceptable solvent following completion of reprocessing. Operation 5 also includes disposal of empty Orange herbicide drums. Drum disposal procedures have been developed to minimize the potential for any environmental impact as a result of drum disposal aspects. However, it is necessary to consider the following items: 1) the Orange residual remaining on the crushed drums which are put into the steel manufacturing process; 2) the Orange residual which remains on the drums while the drums are in storage and/or being transported to the steel manufacturing site; 3) the operations at Gulfport and Johnston Island to reduce the Orange residual in drained drums. It is anticipated that a crushed drum may contain an average residual of about 0.03 or 0.05 lb of herbicide at Johnston Island and Gulfport, respectively.

(2) Probable Impact: Undoubtedly, there will be small quantities of herbicide and TCDD released into the atmosphere during reprocessing (including dedrumming, processing, drum disposal, and redrumming). Studies conducted during dedrumming, drum rinsing, and pilot plant reprocessing have documented atmospheric concentrations that can be anticipated. All of these studies involved extensive sampling, highly efficient sampling trains, sensitve analytical methods, and a variety of biomonitoring systems. Analytically detected levels of 2,4-D and 2,4,5-T have, in all cases, been well below the recognized TLV's for these compounds. However, airborne levels during the final pilot plant operation apparently did result in physiological damage to native plants (thistle) and biomonitoring plants (tomato). This damage was confined to the operational location (NCBC) and was limited to a maximum distance of 1600 feet from the pilot plant. This is the only case of physiological response noted at NCBC even though periodic environmental studies have been conducted at NCBC for the past several years and all pilot plant operations have been continually monitored. However, pilot plant operations in June 1976 were the first in which heated herbicide was used. Also, it was the first time biomonitoring was conducted under ideal growing conditions. Considering that tomato plants are sensitive to Orange herbicide in the low parts per trillion range and the fact that the damaged plants recovered following shut-down of the pilot plant, the airborne levels were very low at the damage sites. Such damage during a full-scale reprocessing plant operation is not anticipated due to additional engineering constraints such as carbon-filtered vents and leak-free pumps that will be incorporated to eliminate discharge of herbicide to the ambient air. Nevertheless,

considering that desirable, herbicide sensitive vegetation is present both on NCBC and outside the facility boundary about 2400 feet from the reprocessing site, there is concern regarding airborne transportation of herbicide, and biomonitoring will be accomplished during operation of the full-scale reprocessing plant. Biomonitoring is essential in that test plants are not only sensitive to airborne herbicide levels below analytical detection limits but also because plant response to airborne herbicide is discernible in less time than is required to obtain analytical results of air samples taken at the time of exposure. If test plant damage is encountered, the reprocessing plant will be checked immediately for leaks, loose fittings, faulty vent filters, etc., and any faults will be corrected. Extensive and/or continued damage coupled with an absence of discernible faults will result in operational shut-down so that thorough inspection and repair can be accomplished. Air concentrations of TCDD that have been detected are extremely low, spurious, approach analytical detection limits, and appear to be more closely related to contamination of the storage area than to handling or processing of the herbicide. On the basis of these findings and observations, it is anticipated that there will be only minimal impact on air quality in the immediate vicinity of the reprocessing plant and no measurable impact on air quality outside of this area due to herbicide reprocessing. Storage of the air-scrubbing carbon filters and TCDD-laden carbon inside their containers should have no impact on air quality. The sealed filters and cartridges should prevent release of any TCDD to the ambient air. Disposal of drained, rinsed, crushed drums containing a film of Orange ranging between 0.02 and 0.08 lb via a steel-making furnace is not expected to result in significant impact. During the process, the Orange herbicide would be converted essentially to hydrogen chloride, carbon dioxide and water. The air pollution control equipment normally associated with steel making operations would be sufficient to minimize any environmental impact of the combustion products. The environmental impact associated with the solvent cleaning, crushing, and storage of drums at NCBC Gulfport and Johnston Island will not be significant. The solvent spray will rapidly reduce the Orange residual in the drum and the Orange removed will be contained in the solvent. The drums will be crushed after drainage of the solvent spray. The crushing of the drums will reduce the opportunity of any residual herbicide from entering the environment while the crushed drums await shipment to a steel manufacturing plant. The environmental impact associated with the storage and transport of such crushed drums is not significant. Since the herbicide is a film on the inner surface of the crushed drums, any evaporation would be retarded.

(3) Air Quality Monitoring

(a) Monitoring of air quality will utilize three approaches: 1) use of ambient air samplers placed at strategic points around the reprocessing plants and around the dock at JI during loading operations to collect samples for analyses, 2) use of biomonitoring plants (tomato) positioned at strategic points around the reprocessing plants and around the dock at JI during all loading operations, and 3) visual observations of native flora in the vicinities of the reprocessing plants.

(b) All air sampling instruments used will have a demonstrated efficiency under field conditions and utilize either benzene impingers or Chromosorb II® to collect herbicide components. Periodic samples will be collected during plant operation and analyzed for 2,4-D and 2,4,5-T. Selected samples will be analyzed for TCDD. In addition, pre- and post-operational samples will be collected and analyzed. No air sampling is scheduled relative to transportation and disposition of the carbon cartridges and air filters.

C. WATER QUALITY

1. ENVIRONMENTAL IMPACT

a. General: During reprocessing, there will be no waste streams nor release of any raw or processed herbicide to surface or ground waters. Processed herbicide will be transferred to drums and transported from NCBC by rail or truck; removal from JI of drummed or bulk processed herbicide will be by ship. Thus, potential impact on water quality at NCBC is virtually nil. On the other hand, due to the proximity of the reprocessing plant site to the lagoon and the requirement for ship-loading at JI, the potential for impact upon the island's water supply (lagoon) and upon the fringing reef is of greater concern. The fact that the reprocessing site is a concrete pad surrounded by a retention dike together with the absence of any waste stream discharge of herbicide/TCDD during reprocessing means that potential impact on the island's drinking water supply is limited to any accidental spillage while loading processed herbicide onto the ship. This possibility will be remote because stringent precautions will be taken to preclude any accidental spillage. However, it is possible to dump cargo from the cargo ship if the safety of the crew/vessel is threatened. Also the possibility of a vessel sinking while loaded with processed herbicide is of environmental as well as personnel concern. Both of these contingencies were considered early in the planning for incineration at sea (the principal alternative) and the low probability of occurrence was acceptable when compared with other positive aspects of the action. Any vessel used will have been approved by the U.S. Coast Guard for operations from U.S. ports and will follow all applicable maritime regulations. Loading and conveyance via barge or ship of toxic or ecologically harmful cargo (chlorine, petroleum, fertilizer, etc.) is a routine activity. Quantification of the impact of cargo jettison or ship sinkage is not prudent because of the many assumptions required. Such an event in the harbor at Johnston Island would present a very grave situation as regards environmental resources. At Johnston Island, the island's water supply (ocean water for distillation), portions of the fringing reef, and the biological reef communities would be adversely affected. Cargo-jettison or vessel sinkage in the open tropical ocean is not anticipated to be environmentally disastrous. Any effects would be generally localized and not persistent. The tremendous dilution afforded by the ocean, the physical chemical properties of Orange herbicide (i.e., hydrolysis to the less toxic acid, settling due to specific gravity and insolubility), biodegradation and photodecomposition of residual concentrations would all tend to reduce the hazard of a large scale release of Orange herbicide into the ocean. It is noted that the Orange herbicide stock on Johnston Island was transported there via vessel and that the Orange herbicide in Gulfport would be transported to the Central Pacific by vessel if the principal alternative were selected. Transportation of the carbon cartridges and air filters to the storage site from NCBC would be by rail and/or truck. From JI this aspect would require transport by ship from JI to the Continental U.S. and transport by rail and/or truck from port of entry to the storage site. Truck/rail transport includes virtually no likelihood of impact on water quality other than the highly improbable combination of vehicular accident resulting in cartridge rupture followed by subsequent spillage into a body of water. The ship transport aspect includes the same potential for cartridge dumping as noted above for the herbicide. However, should such an event occur in shallow water or should a cartridge be accidently dropped into the harbor at JI, the cartridge likely could be recovered intact and sent on to the storage site. Loss in deeper water would diminish recovery chances and, depending on depth and pressure, could feasibly result in cartridge rupture or decomposition, thus releasing the TCDD-laden carbon to the surrounding water. The tremendous dilution capabilities of the ocean should, however, negate serious and longlasting effects from such an occurrence.

b. Reprocessing

(1) Potential for Impact: Evaluation of the potential impact on the aquatic environment of reprocessing Orange herbicide on the present storage sites requires different criteria for each location. Differences are due to dissimilar ecology of the areas and potential for impact. The reprocessing procedure will be very similar at each location with neither waste streams nor release of raw or processed herbicide to surface or ground waters. Processed herbicide will be redrummed and transported off NCBC by either rail or truck. Removal of drummed or bulk processed herbicide from Johnston Island, however, must be by ship. A potential for impact on water quality in the lagoon and especially near the wharf does, therefore, exist due to spillage, leaks, natural catastrophe, etc. The salt water intake for desalination of the island's water supply is located near the wharf. Thus, there are both ecological and health implications to any contamination of the lagoon. Additionally, the Johnston Island area is considered a relatively unique and somewhat fragile tropical ecosystem (18, 19). For these reasons, an extensive study of the status of water quality was conducted in 1973. This study is summarized in Part III, Section C, pp. 76-91 of the Final Environmental Statement (1).

(2) Probable Impact: There are no anticipated impacts on water quality at either reprocessing location. At NCBC, the only conceivable impact on water quality would be in the event of a herbicide spill directly into the drainage ditches in the storage area during transfer of the drums from storage to the reprocessing plant. These ditches have already been diked at all road crossings surrounding the reprocessing site, and there is little possibility of direct spillage into ditches at any other point. At Johnston Island, since the reprocessing plant site is a concrete pad surrounded by a retention dike, the only potential impact on water quality is during loading of processed herbicide onto a cargo vessel. This possibility will be remote because stringent precautions will be taken to prevent any accidental spillage. Disposition and storage of carbon cartridges and filters include no anticipated impacts on water quality.

(3) Water Quality Monitoring:

(a) At NCBC, monitoring will be concentrated on the fresh water drainage ditches traversing the storage and reprocessing site. Pre-operational water samples will be taken immediately prior to initiation of reprocessing and, during the operation, water samples will be collected daily. In addition to the water samples, sediment, soil, and biological samples will be collected weekly. Samples will be analyzed for acids and esters of 2,4-D and 2,4,5-T. Selected periodic samples will also be analyzed for TCDD.

(b) At Johnston Island, monitoring will be concentrated on the lagoon and the freshwater reservoirs. Pre-operational water samples will be collected from these areas and daily samples collected during the reprocessing program. During vessel loading of reprocessed herbicide, the sampling program will be intensified. In addition to the water samples, sediment and biological samples will be collected weekly. Samples will be analyzed for acids and esters of 2,4-D and 2,4,5-T. Selected samples will periodically be identified for analyses of TCDD.

(c) No water sampling program is planned in conjunction with transportation and storage of carbon cartridges.

D. MARINE FLORA AND FAUNA OF JOHNSTON ISLAND: This part remains unchanged from Final Environmental Statement, Nov 74 (1).

E. TERRESTRIAL FLORA AND FAUNA: This part remains unchanged from Final Environmental Statement, Nov 74 (1).

F. SOIL (CORAL AND SAND): This part remains unchanged from Final Environmental Statement, Nov 74 (1).

G. THE ECOLOGICAL SIGNIFICANCE OF JOHNSTON ISLAND: AUTHORITATIVE OPINIONS: This section remains unchanged from Final Environmental Statement, Nov 74 (1).

H. HUMAN WELFARE: Reprocessing Orange herbicide at NCBC and Johnston Island will not endanger the health of any personnel. The results obtained during monitoring of the pilot reprocessing plant illustrate the very low atmospheric concentrations of 2,4-D and 2,4,5-T that can be anticipated in the vicinity of a reprocessing plant. It should be noted that all reported analytical results are well below the accepted TLV's for these compounds. For those operations posing potential exposure to high concentrations of TCDD (e.g. removal of exhausted carbon cartridges from the system), maximum practical use of personnel protection devices will be required. This will include the use of airline respirators, disposable coveralls, gloves, hats, and impervious foot gear. The safety and industrial hygiene aspects of each option have not been discussed, but any contractor working on this project will be required to concur and comply with all applicable laws, regulations, statutes, etc.

occupational health and safety

I. BENEFICIAL ASPECTS OF THE PROPOSED ACTION: The principal beneficial aspect of the proposed action is the return of nearly 2.3 million gallons of highly effective herbicide for registered use. There are other important benefits to be obtained by performing the proposed action in a timely manner. These benefits include: 1) minimizing the cost involved in the maintenance of the Orange herbicide storage areas, 2) making the land in the current storage areas available for other use, and 3) eliminating potential contamination/pollution of Johnston Island lagoon. The present storage of the Orange herbicide is in 55-gallon drums. Routine maintenance of the storage sites is accomplished to identify leaking drums, repair or redrum the leakers, and contain any spillage resulting from the leakers or the redrumming operation. This operation is expensive. The land area which comprises the storage site on Johnston Island is high value property, and its dedication for long-term storage of Orange herbicide represents a constraint on future plans and activities on the island. The normal operation of the storage site represents a low level potential for contamination of the lagoon water. However, a catastrophic event affecting the herbicide storage area could cause massive spillage and could result in pollution of the lagoon, possible contamination of the drinking water supply, and possible damage to the reef.

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PART IV. ADVERSE ENVIRONMENTAL IMPACT WHICH CANNOT BE AVOIDED:

No significant unavoidable adverse environmental effects from the reclamation of Orange herbicide are expected. A large stock of a manufactured product, which is presently unusable due to unacceptable levels of a contaminant (TCDD), is to be rendered acceptable, thus salvaging a considerable resource. This will be accomplished via adsorption of the TCDD onto activated charcoal. The contaminated charcoal will be contained in airtight metal cartridges, treated for corrosion control, and placed in recoverable storage until environmental analyses show that the TCDD-contaminated carbon can be disposed of in a feasible and environmentally safe manner. There will be no waste streams nor programmed releases of herbicide to the environment.

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PART V. ALTERNATIVES TO THE PROPOSED ACTION

A. PRINCIPAL ALTERNATIVE - INCINERATION AT SEA: The Air Force proposes reclamation of Orange herbicide by on-site reprocessing at both the Naval Construction Battalion Center (NCBC), Gulfport MS and Johnston Island. In the event that reclamation is not accepted, the Air Force will pursue the primary alternative of incineration at sea. Incineration at sea was the proposed action in the Final Environmental Statement entitled, "Disposition of Orange Herbicide by Incineration" (1). The supportive data for the incineration method of disposal remain unchanged from that presented in the Final Environmental Statement.

B. OTHER ALTERNATIVES TO THE PROPOSED ACTION: Many other possible alternatives were considered and discussed in Part V of the Final Environmental Statement (1). For convenience, the following is a listing of the various alternatives:

1. Incineration on Johnston Island
2. Conventional incineration in the CONUS
3. Use
4. Return to manufacturer
5. Deep (injection) well disposal
6. Burial in underground nuclear test cavities
7. Sludge burial
8. Microbial reduction
9. Fractionation
10. Chlorinolysis
11. Soil biodegradation
12. No disposal action

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PART VI. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY: The proposed action would have a positive effect on long-term productivity and enhancement of the environment. Several acres on NCBC and Johnston Island which are now dedicated for storage of Orange herbicide would be returned for beneficial use. The proposed reprocessing sites are to be located within the present storage areas, thus, even the local short-term use of acreage necessary for reprocessing would have a negligible negative effect on the environment.

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PART VII. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES WHICH WOULD BE INVOLVED IN THE PROPOSED ACTION IF IMPLEMENTED: This action would involve the irrevocable use of certain resources as follows:

A. The charcoal cartridges will be about 10 feet long and 30 inches in diameter. Each cartridge will be constructed of approximately 1,400 pounds of 3/8 inch thick steel. For the entire operation, a maximum of 1,000 cartridges containing 700 tons of steel will be required.

B. Each cartridge will be filled with approximately 1,280 pounds of activated coconut charcoal. Thus, the total maximum quantity of charcoal needed would be 640 tons.

C. The drum rinse operation will require two gallons of No. 2 diesel oil per drum for a total requirement of approximately 100,000 gallons.

D. A relatively small quantity (approximately 25,000 gallons) of diesel oil will be burned to generate the steam required in the operation.

E. Other materials, including corrosion control coating of the expended charcoal columns, valves, pumps, etc., will be required.

F. Storage tanks and other high-value equipment will be cleaned after completion of reprocessing and returned to beneficial use.

The total quantity of resources required for the operation is highly acceptable when compared to the eventual reclamation of nearly 2.3 million gallons of herbicide. The proposed action would not involve destruction of archaeological or historical sites or unalterable disruption in ecosystems. It would not curtail the beneficial use of the environment.

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PART VIII. CONSIDERATIONS THAT OFFSET THE ADVERSE ENVIRONMENTAL EFFECTS:

NOTE: This part was not used in the Final Environmental Statement, Nov 74 (1).

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PART IX. DETAILS OF UNRESOLVED ISSUES: The course of action for final disposition of the TCDD-contaminated carbon generated by the proposed action has not been determined at this time. Final disposition of the contaminated carbon cartridges and air-scrubbing filters is an unresolved issue for which a subsequent environmental analysis will be conducted.

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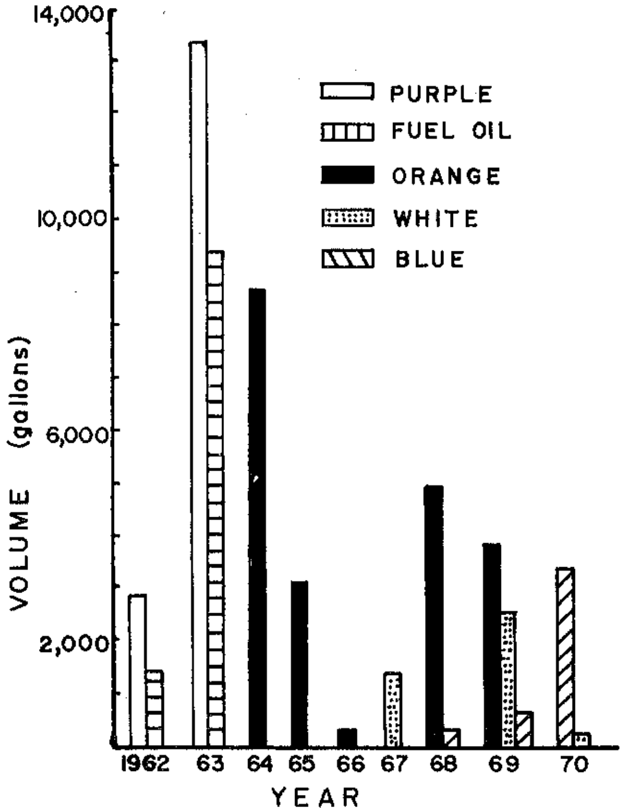


Figure I-10. Annual Dissemination of Herbicides on Eglin AFB Test Area C-52A

deposited on the test area (total of all grids) is shown in Table I-6. The approximate deposition rate of herbicides, pounds active ingredient per acre, for each grid is shown in Table I-7.

4. DESCRIPTION OF PESTICIDES

As closely as possible the equipment utilized on TA C-52A was tested under realistic yet controlled conditions. Most testing programs involving military herbicides and insecticides actually included the pesticides themselves rather than simulants. The low toxicity associated with these pesticides was the salient justification for such action.

a. Orange

Orange was a reddish-brown to tan colored liquid soluble in diesel fuel and organic solvents, but insoluble in water. One gallon of Orange contained 4.21 pounds of the active ingredient of 2,4-dichlorophenoxyacetic acid (2,4-D) and 4.41 pounds of the active ingredient of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T). Orange was formulated to contain a 50:50 mixture of the n-butyl esters of 2,4-D and 2,4,5-T. The percentages of the formulation were:

n-butyl ester of 2,4-D	49.49%
free acid of 2,4-D	0.13%
n-butyl ester of 2,4,5-T	48.75%
free acid of 2,4,5-T	1.00%
inert ingredients (e.g., butyl alcohol and ester moieties)	0.62%

Some of the physical, chemical, and toxicological properties of Orange are listed in Table I-8.

TABLE I-5. APPROXIMATE TOTAL VOLUME OF HERBICIDES, INSECTICIDES, AND/OR SIMULANTS APPLIED TO TEST AREA C-52A, EGLIN AFB RESERVATION, FLORIDA, 1962 - 1970	
CHEMICAL	GALLONS DISSEMINATED
Orange	19,807
Purple[a]	16,164
White	4,172
Blue	4,395
Stull Bifluid[b]	1,716
Fuel Oil	10,863
Orange Simulant[c]	1,460
Malathion Insecticide	215
Total	58,792

[a]Purple was a mixture of n-butyl 2,4-D (50%), n-butyl 2,4,5-T (30%), and isobutyl 2,4,5-T (20%). The isobutyl portion was included as a measure to depress the freezing point of 2,4,5-T. This mixture was eventually replaced by Orange.

[b]Stull Bifluid consisted of Orange (85%) plus a chemical additive, which when mixed in the spray system pump during agent dissemination produced a gel defoliant.

[c]Orange simulant consisted of glycerine (68%), sodium thiosulfate (16.8%), and water (15.2%).

TABLE I-6. TOTAL POUNDS OF ACTIVE INGREDIENTS OF HERBICIDES DISSEMINATED ON TEST AREA C-52A, EGLIN AFB RESERVATION, FLORIDA, JUNE 1962 - DECEMBER 1970	
HERBICIDE	POUNDS ACTIVE INGREDIENT
2,4-D	169,292
2,4,5-T	160,948
Picloram	2,253
Cacodylic Acid and Sodium Cacodylate	13,624

TABLE I-7. APPROXIMATE DEPOSITION RATE OF HERBICIDES APPLIED TO TEST AREA C-52A, EGLIN AFB RESERVATION, FLORIDA

TEST GRID[a]	GRID AREA[b], Acres	HERBICIDE (POUNDS ACTIVE INGREDIENT/ACRE)				
		2,4-D	2,4,5-T	PICLORAM	CACODYLIC ACID	ARSENIC[c]
1	92	947 (1962-1964)[d]	947 (1962-1964)	- -	- -	- -
2	92	584 (1964-1966)	584 (1964-1966)	- -	- -	- -
3	92	30 (1967)	- -	8 (1967)	11 (1968)	6
4	240	183 (1968-1969)	160 (1968-1969)	6 (1969-1970)	53 (1969-1970)	28

[a]The test grids are described in text

[b]In actuality, grids 2 and 3 fall within the confines of the 640 acre grid 4. However, the positioning of the test arrays on grid 4 has resulted in most of the herbicide being disseminated within a 240 acre area, with only slight infringement on the original sites of grids 2 and 3.

[c]Pounds per acre of arsenic as the organic pentavalent form; calculated on weight of Blue applied per acre.

[d]Years when the majority of the herbicide was applied.

TABLE I-8. PHYSICAL, CHEMICAL, AND TOXICOLOGICAL PROPERTIES OF THE THREE MAJOR HERBICIDES AND ONE MAJOR INSECTICIDE

CHEMICAL	SPECIFIC DENSITY (25C)[a]	VISCOSITY CENTIPOISE (23C)	MOLECULAR MASS	WEIGHT OF FORMULATION (lbs/gal)	WEIGHT ACTIVE INGREDIENT (lbs/gal)	SOLUBLE IN WATER	RELATIVE TOXICITY	SPECIFIC TOXICITY FOR WHITE RATS (mg/kg)
Orange	1.282	43	618	10.7	8.62	No	Low	566
White	1.120	125	1,173	9.4	2.54	Yes	Very Low	3,080
Blue	1.324	14	296	10.9	3.10	Yes	Very Low	2,600
Malathion	1.232	36	328	10.3	9.74	No	Low	1,375

[a]As determined by the Air Force Armament Laboratory

b. White

White was a dark brown, viscous liquid that was soluble in water but insoluble in organic solvents and diesel fuel. One gallon of White contained 0.54 pound of the active ingredient of 4-amino-3,5,6-trichloropicolinic acid (picloram) and 2.00 pounds of the active ingredient of 2,4-D. White was formulated to contain a 1:4 mixture of the triisopropanolamine salts of picloram and 2,4-D. The percentages of the formulation were:

triisopropanolamine salt of picloram	10.2%
triisopropanolamine salt of 2,4-D	39.6%
inert ingredient (primarily the solvent triisopropanolamine)	50.2%

Some of the physical, chemical, and toxicological properties of White are listed in Table I-8.

c. Blue

Blue was a clear yellowish-tan liquid that was soluble in water, but insoluble in organic solvents and diesel fuel. One gallon of Blue contained 3.10 pounds of the active ingredient dimethylarsinic acid (cacodylic acid). Blue was formulated to contain both cacodylic acid (as the free acid) and the sodium salt of cacodylic acid (sodium cacodylate). The percentages of the formulation were:

cacodylic acid	4.7%
sodium cacodylate	26.4%
surfactant	3.4%
sodium chloride	5.5%
water	59.5%
antifoam agent	0.5%

Some of the physical, chemical, and toxicological properties of Blue are listed in Table I-8. It should be noted that cacodylic acid and sodium cacodylate contain arsenic in the form of the pentavalent, organic arsenical. This form of arsenic is essentially nontoxic to animals as can be noted by the LD_{50} value for white rats. Of the total formulation, 15.4% is arsenic in the organic form, only trace quantities are present in the inorganic (toxic) form.

d. Malathion

Malathion insecticide (0,0-dimethyphosphorodithioate) was a clear brown to colorless liquid with a slight characteristic odor. The ultra-low-volume (ULV) formulation was very slightly soluble in water (145 ppmw). Malathion ULV had a minimum purity of 95%. One gallon of ULV malathion contained 9.74 pounds active ingredient and 0.51 pound inert ingredients. Some of the physical, chemical, and toxicological properties of malathion are listed in Table I-8.

SECTION II

BIOASSAY AND CHEMICAL RESIDUE STUDIES OF THE SOILS OF TEST AREA C-52A

From the rates that were applied during the years of testing spray equipment, it was obvious that Test Area C-52A at Eglin AFB Reservation offered a unique opportunity to study herbicidal persistence and soil leaching. Yet, the problem of how best to assess the level of residue was a difficult one. The herbicides could be chemically present but because of soil binding might not be biologically active. Moreover, as noted in Section I, many chemicals were applied to the test area, and a biological assessment might be the result of two or more chemicals interacting. Thus, both bioassay techniques and analytical analysis were employed. The results of the bioassay studies by A. L. Young and J. H. Hunter have not been published; however, the methodology developed and the results obtained have played a major role in understanding the ecological succession of the plant and animal communities on the test area. Thus, a detailed synopsis of their work is included in this report.

1. SYNOPSIS OF BIOASSAY RESEARCH, 1969 - 1970

In the late summer of 1969, six 5-foot cores were randomly collected from an area known to intersect spray flight paths used for missions involving the herbicide designated as Orange. The samples were taken to the laboratory and subsampled for bioassay and analytical results. The bioassay technique employed the use of soybean (variety Clarke 63) for detecting phenoxy-herbicide residue. The experiments were conducted under greenhouse conditions. No standard herbicide concentrations were included; instead, cores from treated areas were compared to control cores and the relative differences noted. Comparisons for each depth were made against control plants for the particular depth.

These initial bioassay studies indicated two things. First, significant concentrations of herbicides (or phytotoxic materials) were present on the test grid; and second, these herbicides were definitely leaching or penetrating into the soil (at least to a depth of 3 feet). Moreover, the bioassay analysis indicated different relative concentrations of herbicides both between cores and within a given core.

As noted earlier, the area of interest was an area greater than one square mile. Obviously, this area was too large to completely bioassay or to subject to chemical analyses. Therefore, it was decided to find the areas of greatest herbicide concentration and follow up with detailed bioassay and chemical analyses. To find these specific areas, it was necessary to design an experiment that would allow inferences about herbicidal persistence for the entire test area. Consulting statisticians assisted in designing the experiment and in analyzing the results.

In order to properly evaluate herbicidal persistence and soil leaching, a vegetation chart of the test grid was prepared on 26 March 1970. The greatest amounts of vegetation were found near the water sources of the grid. There were two areas that supported very dense vegetation. A terracing effect of diminishing amounts of vegetation away from these two areas was apparent. The effects of repeated spray could be seen along the flightpaths most frequently used in test programs. In these strips, vegetation occurred only near the water sources and even there it was scant. By considering the flightpaths, the water sources, and the terracing effects, it was possible to divide the test grid into 16 vegetation areas. These areas formed the base for the random selection of soil samples. The statistical null hypotheses that were to be investigated included the following:

1. There were no herbicide concentration differences among the soils of the various vegetative areas.

2. There were no differences in herbicide content among soil depths down to 3 feet.

3. There were no interactions between the vegetative areas and the soil depths.

In order to conduct an experiment that would provide reliable evidence with respect to these hypotheses, three random 3 foot soil cores were taken from each of the vegetative units and three from a control area, an area 0.2 mile northwest of the square mile grid. Figure II-1 shows the sites for the random sampling of these soil cores. These cores provided the replication for the experiment. Because of the time involved in taking the soil cores and the possible effects of the soil drying out if left unplanted for several days, it was necessary to apply the technique of blocking over the days of soil core removal and planting. The experiment was initiated 1 April 1970. Again the bioassay organism was soybean (five seeds per cup and one cup per 6 inch increment of soil core), and the experiment was conducted in a greenhouse.

A series of standards for herbicide Orange was included in this experiment (range of standards was 0.25 to 4.00 ppm Orange). All standards were prepared in soil taken from the top 6 inch increment of control soil. The results indicated that there were herbicidal persistence and leaching; of the 48 treatment cores collected and bioassayed, 27 cores were significantly different from control cores (95% probability level). The results indicated that soil leaching or penetration was much more prevalent along the dissemination flightpaths than in other areas of the test grid. Moreover, there were differences among the soils of the various vegetative areas within a given flightpath. Likewise, differences were found in herbicide content among the increments of many of the soil cores. This was probably due to both the elapsed time since herbicide application and to such factors as rainfall frequency and organic matter content of the soil. It is interesting to note that there were no statistical evidences of differences between wet and dry soils that received approximately the same amounts of herbicide. Efforts to quantitate the bioassay were confined to only the top 6 inch increment because of within-core variations. By considering that all phytotoxic effects were from Orange, the approximate concentration was 2.82 ppm herbicide. This was an average value for the top 6 inches of soil core for the eight cores showing greatest herbicide concentration.

In reference to the statistical null hypothesis, all three were rejected: (1) there were differences in herbicide concentration between cores; (2) there were differences in herbicide content within cores; and, (3) there were interactions between the sampling areas and the soil depths (this indicated non-uniformity in soil strata).

Sixteen of the soil cores (one from each vegetation type) were subsampled for arsenic concentration (hence, a measure of Blue). The arsenic was extracted by a cold-acid extraction technique and analyzed by atomic absorption spectrophotometry. Four of the 16 locations contained arsenic levels above 1.0 ppm in the top 6 inches of soil. A further analysis for arsenic in the soil profile indicated that arsenic readily (and almost uniformly) leached throughout the soil profile. In areas receiving repetitive applications of Blue, the top 6 inches of soil contained arsenic levels of 1.4 ppm, and the additional 6 inch increments down to 5 feet contained from 0.70 to 1.2 ppm arsenic.

From the bioassay study, it was evident that some areas of the test grid contained high levels of phytohormonal herbicide residue (i.e., residue showing plant responses similar to those caused by 2,4-D; 2,4,5-T; and picloram). Thus, 5 foot cores were collected from two areas (dry soils) exhibiting highest herbicide residue. Each core was divided into 6 inch increments, placed in amber bottles, and immediately shipped to the United States Department of Agriculture, Pesticide Degradation Laboratory, Beltsville, Maryland, for analysis of 2,3,7,8-tetrachloro-dibenzo-p-dioxin (TCDD). No TCDD was found in either soil core (the Pesticide Degradation Laboratory reported a detection limit capability of 0.0005 ppm TCDD).

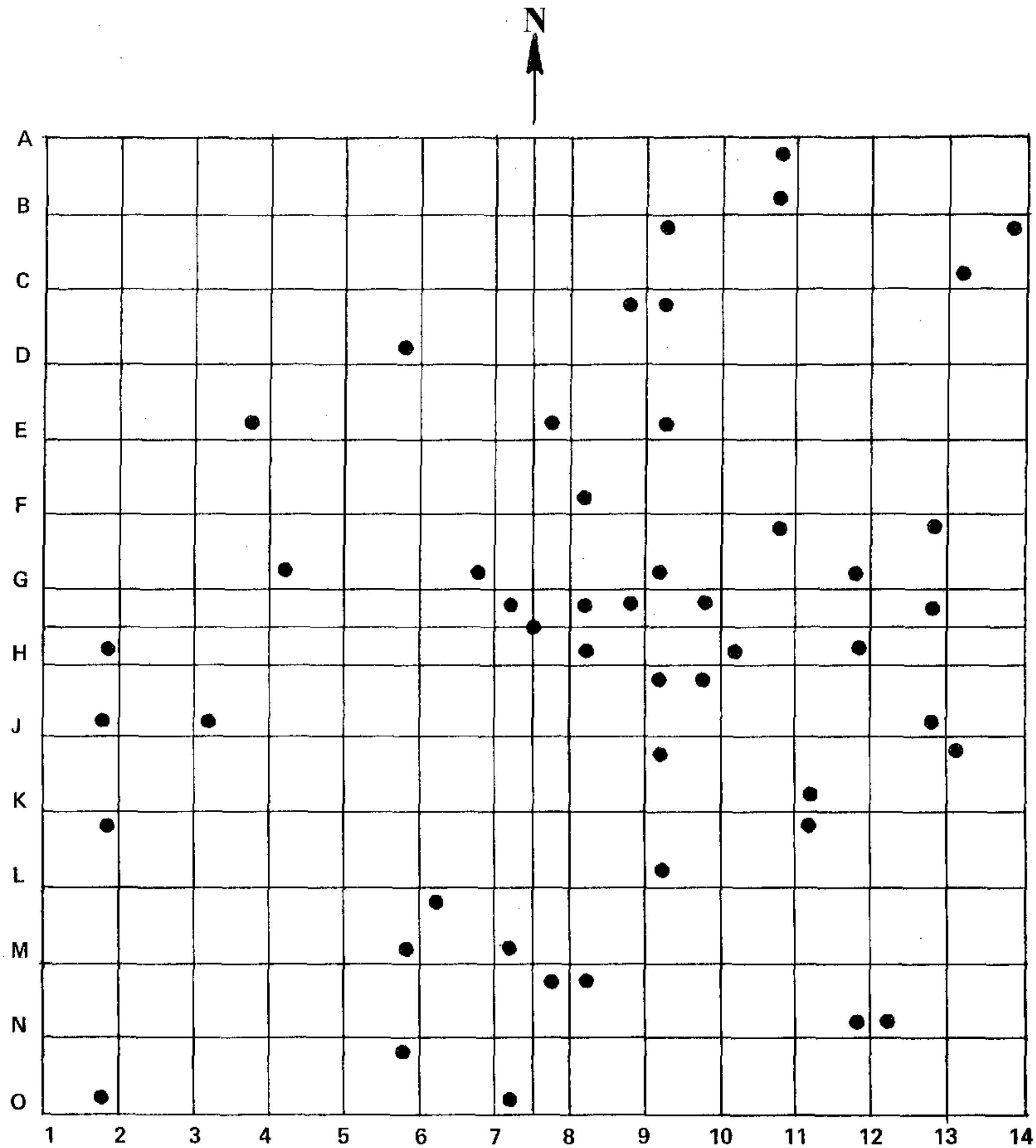


Figure II-1. Collection Sites for the Random Sampling of 3 Foot Soil Cores For Residue Analyses

2. SYNOPSIS OF BIOASSAY RESEARCH, 1970 - 1971

a. Introduction

A follow-up bioassay experiment of six of the field locations studied in the previous bioassay experiments was initiated in December 1970. Three of the samples were selected because they showed leaching to a depth of 36 inches, two because of leaching to 30 inches, and the remaining sample because of leaching to 18 inches. In addition, two samples were obtained from grid 1 (the 1962 - 1964 grid). These samples had not been previously bioassayed, but because of prior history, it was expected that data on persistence could be obtained from both a bioassay and a chemical analysis.

Since the preliminary work indicated that although equal amounts of Orange were introduced into soil cores, the varying organic composition of the soil at different depths influenced the amount of Orange available to the plants. This investigation attempted to determine if differences in amounts of herbicides and in soil composition do affect plant growth and, if so, the magnitude of this effect. This information was then used to estimate the concentration of Orange in the selected sites.

b. Method and Materials

In order to calculate the effects of herbicide concentration upon plant growth and to study the effects of soil depth on herbicide activity, a soil core was taken from a control site 0.2 mile northwest of the one square mile test area. This core was collected in 6 inch depth segments down to 3 feet. After being dried, sieved, and weighed, each depth-segment unit was divided into seven parts and treated so that soil samples from each unit contained the following concentrations of Orange: 0.028 part per million (ppm), 0.057 ppm, 0.113 ppm, 0.226 ppm, 0.454 ppm, and 0.908 ppm; one soil unit was not treated and so had 0.0 ppm concentration of Orange. These soil samples were then used as standards.

Each of these samples was thoroughly mixed and distributed among six cups. Five soybean seeds were planted in each of three of the cups and five cucumber seeds were planted in each of the remaining three cups for each concentration. All bioassays were conducted in an ISCO E-3 environmental chamber maintained at a diurnal temperature regime of 90^{o} to 70^{o}F, a diurnal humidity regime of 65% to 85%, and a 14-hour daylength. The length of the cucumber plants from the root tip to the end of the epicotyl was measured after 6 days. The soybeans were harvested 10 days after planting, and the root length of each plant was recorded.

Samples of soil were also collected from six selected sites on the test grid. These locations were coded using the coordinate of the grid marker and the direction with respect to that marker in which the cores were taken. These six locations were B-14 SW, C-9 SW, J-3 NE, M-8 SW, N-12 NW, and 0-7 NE. A composite of three soil cores, 2-1/2 feet apart, was collected from each site at a distance 50 feet from the designated grid marker and on an imaginary line perpendicular to the specified direction for sampling. These cores were collected in 6-inch segments down to 3 feet, and the soil from the corresponding depth segments for each of the three cores collected from a specified site were throughly mixed. A control soil sample was collected in a similar manner from the same location that the soil for the standards was taken. The soil from each site/depth segment unit was distributed among six cups and a bioassay was conducted in the same manner as that described above for the Orange concentration standards. Again both cucumber and soybeans were used as the test organisms.

This same procedure was used to collect and bioassay soil samples from sites 50 yards south of grid markers O-5 and O-8 which are on the southern border of the present test area (and in the old grid 1 area). Control soil was collected for this bioassay also from the same site as the other controls and the standards, and soybeans and cucumbers were used as the test organisms.

In addition, soil samples from many locations on the test grid were collected and analyzed for organic matter content. Samples were analyzed by the use of a muffle furnace (total combustion of organic matter).

c. Statistical Methods

General. Except as noted, statistical analyses were conducted to test for significant differences at the 0.95 probability level. If a significant difference was indicated at this level, further testing was conducted at the 0.99 probability level.

Wide variations occurred among the measurements of the plants within the individual cups. The seeds actually belonged to two populations: (1) those seeds that would germinate under proper conditions and (2) those seeds that would not germinate. It was impossible to determine which population an individual seed belong to in all cases, and the extreme values (zero length when a seed did not germinate) would have biased the results had the arithmetic mean been used as a representative cup value. Therefore, the median measurement of the plants within a cup was used as the cup value, and the cup became the experimental unit.

Calibration of Standards. An analysis of variance (ANOVA) technique was employed to study the effects upon the plants grown in the soils treated with the standard concentrations of the defoliant Orange. This was done to determine those concentrations which affected plant growth in a significantly different manner. Also, it was hypothesized that because of soil composition variations with depth, a different percentage of the applied defoliant would be bound to the soil or in other ways unavailable to the plants. If this were the case, different standard curves would have to be developed for each depth group.

A test for homoscedasticity indicated unacceptable differences in variances. The transformation:

$$x = \log_{10} (x' + 1)$$

Where :

x = the transformed data

x' = the original cup value

provided homogeneity of variance.

Both the concentration levels and the depth increments were arbitrarily selected and thus are parametric factors. Since each corresponding site/depth-segment was treated alike, the experiment has a cross-classified design, and the statistical model can be expressed:

$$y_{ijk} = a + c_1 + d_j + (cd)_{ij} + e_{ijk}$$

Where:

a = the overall effect

c_i = the effect of the i^{th} concentration ($i = 1,2,\ldots,m$)

d_j = the effect of the j^{th} depth-segment ($j = 1,2,\ldots,n$)

e_{ijk} = the error factor for the k^{th} replicate of the i^{th} concentration and the j^{th} depth-segment

y_{ijk} = the cup value for the k^{th} replication of the i^{th} concentration and the j^{th} depth-segment

The ANOVA technique employed was based on this model. In each instance that a significant difference was indicated between the levels of a factor or when a significant interaction was indicated, Duncan's new multiple range test was used to separate the levels into homogenous groups.

A mathematical expression of the form

$$y = a + bx$$

which approximated the relationship between the defoliant concentration and the cup value was determined for each homogenous group by the method of least squares. To find such a relationship a correlation study was undertaken which compared the standard data and square root and logarithm transformations of both the concentration and cup values. Once the proper form of the data was selected, regression analysis was used to study the mathematical expressions. This included tests of the following hypotheses:

(1) The data does not fit the curve (lack of fit test).

(2) One regression line can be used for all the depth groups.

(3) The regression coefficients for the different depth groups are equal.

(4) If all the regression coefficients are equal, the elevations (Y-intercepts) are equal.

Analysis of the Grid Samples. The concentration of Orange present in the soil from each site/depth-segment taken from the testing area was estimated by using the calibration curves developed for the standard concentrations. The bioassay of the standard Orange concentrations and the bioassay of the grid soil samples were done at different times; therefore, an adjustment of the data was necessary to eliminate the bias and confounding introduced by this procedure. Since control plants were grown with each group, the grid soil bioassay data was weighted according to the ratio of the average of the controls for the test area data to the average of the zero standard concentration data. (A paired-observations t-test of these groups indicated they were significantly different at the 0.95 probability level.)

3. RESULTS AND DISCUSSION

a. Calibration of Standard Curves

The results of the ANOVA was the same for both soybeans and cucumbers. The interaction effect between concentration and depth-segments was non-significant; therefore, this effect was pooled with the residual term. The effects of both concentration and depth were highly significant (at a probability level greater than 0.99). These ANOVA tables are presented in Table II-1 along with the means and the results of Duncan's new multiple range tests.

The multiple range tests indicated that for both soybeans and cucumbers each concentration level was significantly different from every other concentration level, and the range of the standard curve could include all the concentration levels tested, i.e., from 0.0 ppm to 0.908 ppm. The

TABLE II-1. ANALYSIS OF VARIANCE - ORANGE STANDARDS

Concentration	6	5.3013	0.8836	152.34[a]	3.0419	0.5070	144.86[a]
Depth	5	0.6875	0.1375	23.71[a]	0.7185	0.1437	41.06[a]
Conc. x Depth	30	0.1195	0.0040	- - -	0.1620	0.0054	1.93
Residual	84	0.5389	0.0064		0.2314	0.0028	
Adj Error	114	0.6584	0.0058		0.3934	0.0035	

[a]Indicates significance at the 0.99 probability level.

DUNCAN'S NEW MULTIPLE RANGE TEST

Soybean Data Results -

Conc. Mean Values:	1.06	0.97	0.92	0.80	0.73	0.59	0.43
Depth Mean Values:	0.91	0.85	0.78	0.74	0.71	0.70	

Cucumber Data Results -

Conc. Mean Values:	1.17	1.04	0.99	0.93	0.83	0.75	0.69
Depth Mean Values:	1.07	0.93	0.91	0.87	0.85	0.85	

Note: Common underscoring indicates homogenous groups at 0.95 probability level.

depth-segment groupings for soybeans were somewhat different that those for cucumbers. At the 0.95 probability level, three distinct depth groups were indicated from the cucumber data set. The groupings indicated by the soybean data set were not as clearcut, and the 18 to 24 inch depth-segment could be placed into two different groups. Since the cucumber data set indicated that this depth-segment should be placed in the last (deepest) depth group, a similar decision was made in the case of the soybean data. These depth groupings are as follows:

Group	Depth, inches Cucumber	Soybean
I	0 to 6	0 to 6
II	6 to 18	6 to 12
III	18 to 36	12 to 18
IV	- - -	18 to 36

In the correlation analysis, the necessity for transformation of both the Orange concentration values and cup values were studied. In addition to the untransformed data, square root and logarithmic transformations were included. The correlation matrices for both the soybean and the cucumber data sets are presented in Table II-2. In both cases, the best correlation (soybeans: -0.8896; cucumbers: -0.8335) was

$$\log_{10}(\text{cup value} + 1) \times \sqrt[2]{\text{concentration (ppm)}}$$

TABLE II-2. CORRELATION MATRICES			
CUP VALUES	CONCENTRATION (ppm)		
	NO TRANS	$LOG_{10}(x+y)$	SQUARE ROOT
SOYBEAN DATA			
No Trans:	-0.7423	-0.7761	-0.9353
$Log_{10}(x+y)$	-0.8405	-0.8637	-0.8896
Square Root	-0.8085	-0.8363	-0.8758
CUCUMBER DATA			
No Trans:	-0.6547	-0.6908	-0.7703
$Log_{10}(x+y)$	-0.7399	-0.7728	-0.8335
Square Root	-0.7049	-0.7385	-0.8094

The method of least squares was used to determine the best fitting linear expression of the relationship between these two transformations for each of the four depth groups identified for the soybean standards and the three depth groups identified for the cucumber standards. These preliminary mathematical equations along with the square root of the percent of deviations from the mean explained by the regression equation (correlation coefficient) are presented in Table II-3.

TABLE II-3. PRELIMINARY MATHEMATICAL RELATIONSHIPS FOR STANDARD CONCENTRATIONS			
GROUP	DEPTH, in.	REGRESSION EQUATION	CORR. COEFF.
SOYBEAN DATA			
I	0 to 6	Y = 1.15 - 0.59X	0.86
II	6 to 12	Y = 1.11 - 0.64X	0.86
III	12 to 18	Y = 1.06 - 0.69X	0.98
IV	18 to 36	Y = 1.01 - 0.72X	0.98
CUCUMBER DATA			
I	0 to 6	Y = 1.27 - 0.49X	0.86
II	6 to 18	Y = 1.13 - 0.52X	0.87
III	18 to 36	Y = 1.06 - 0.50X	0.92

Where:

$Y = \log_{10}(\text{cup value} + 1)$

$X = \sqrt[2]{\text{concentration}}$

F-tests were employed to further analyze these results as follows:

Hypothesis Tested	F-Value Soy Bean Data	F-Value Cucumber Data
(1) The data does not fit the curve:		
Depth Group I	[a]55.49	[a]58.14
Depth Group II	[a]53.92	[a]271.84
Depth Group III	[a]420.24	[a]320.00
Depth Group IV	[a]1,184.46	- -
(2) One regression equation can represent all depth groups	[a]11.26	[a]14.00
(3) All the regression coefficients are equal	0.98	0.04
(4) The elevations are equal	[a]28.39	[a]36.82

[a]Indicates significant at the 0.99 probability level; hypothesis rejected.

Except for the hypothesis that all the regression coefficients are equal (which was not rejected), these hypotheses were rejected at the 0.99 probability level for both the soybean and cucumber data sets. Thus within each data set, the slope of the regression equations for the different depth groups is equal. However, rejection of the last hypothesis indicates that the intercept for each depth group is different. A common regression coefficient was computed for each data set, and the final equations are as follows: (These equations are plotted in Figures II-2 and II-3).

Depth Group	Regression Equation for Root Lengths: Soybeans	Cucumbers
I	$Y = 1.18467 - 0.68076 \cdot X$	$Y = 1.27936 - 0.50374 \cdot X$
II	$Y = 1.12705 - 0.68076 \cdot X$	$Y = 1.12775 - 0.50374 \cdot X$
III	$Y = 1.05610 - 0.68076 \cdot X$	$Y = 1.06402 - 0.50374 \cdot X$
IV	$Y = 0.99721 - 0.68076 \cdot X$	- -

Where:

$$Y = \log_{10}(\text{cup value} + 1)$$

$$X = \sqrt[2]{\text{concentration (ppm)}}$$

and $$0.0 \leq X \leq \sqrt[2]{0.908}$$

b. Analysis of Grid Samples

Using the relationships expressed in the previous paragraph, estimates were made of the concentration of herbicide Orange in the soil samples taken from the defoliant testing area. These estimates along with the limits of the 95% confidence intervals are presented in Table II-4. Analysis for organic matter content are presented in Table II-5. A comparison of organic matter content within selected cases is presented in Table II-6.

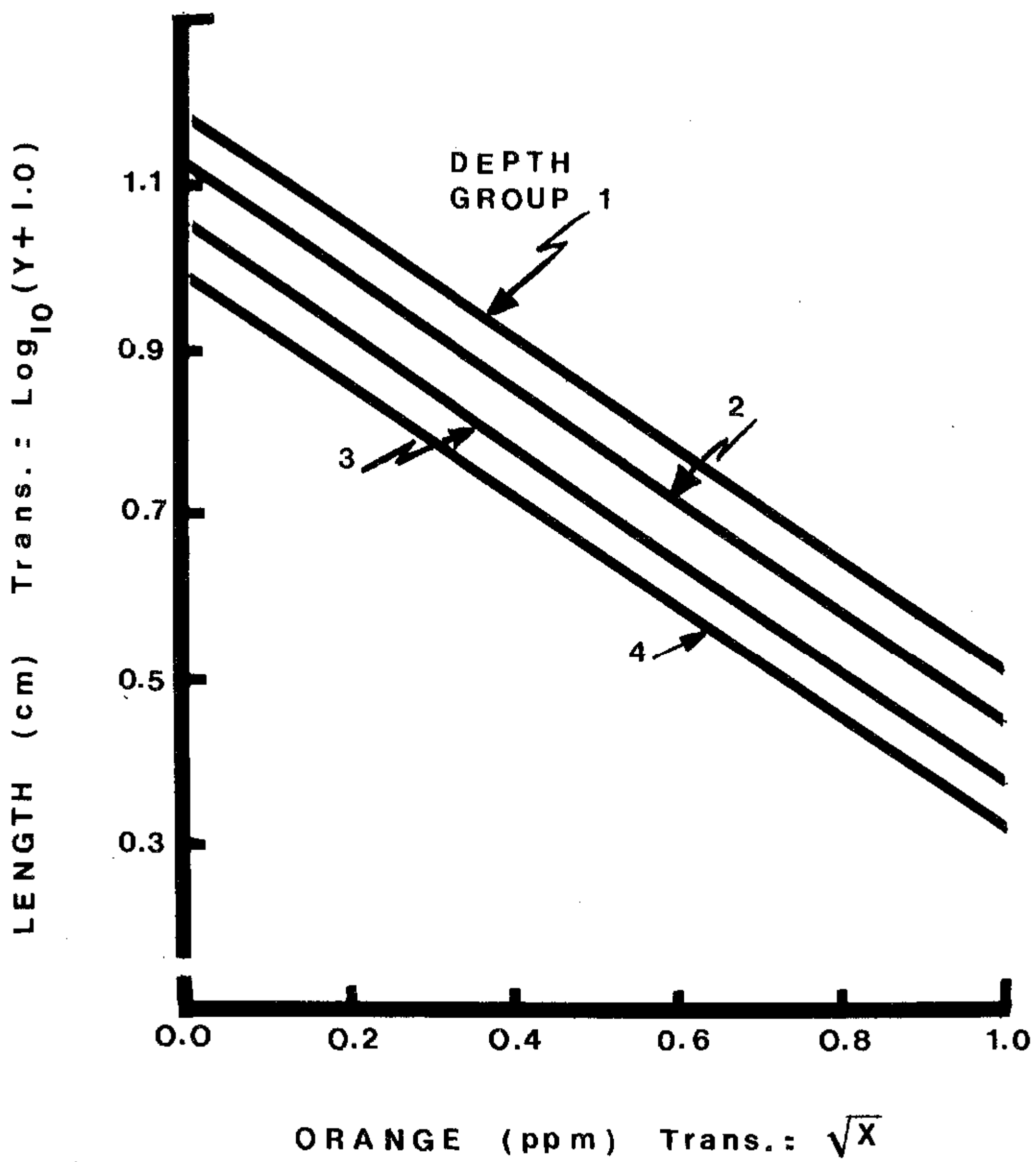


Figure II-2. Concentration Calibration Curves for Soybean Bioassay [see text for description of depth groups]

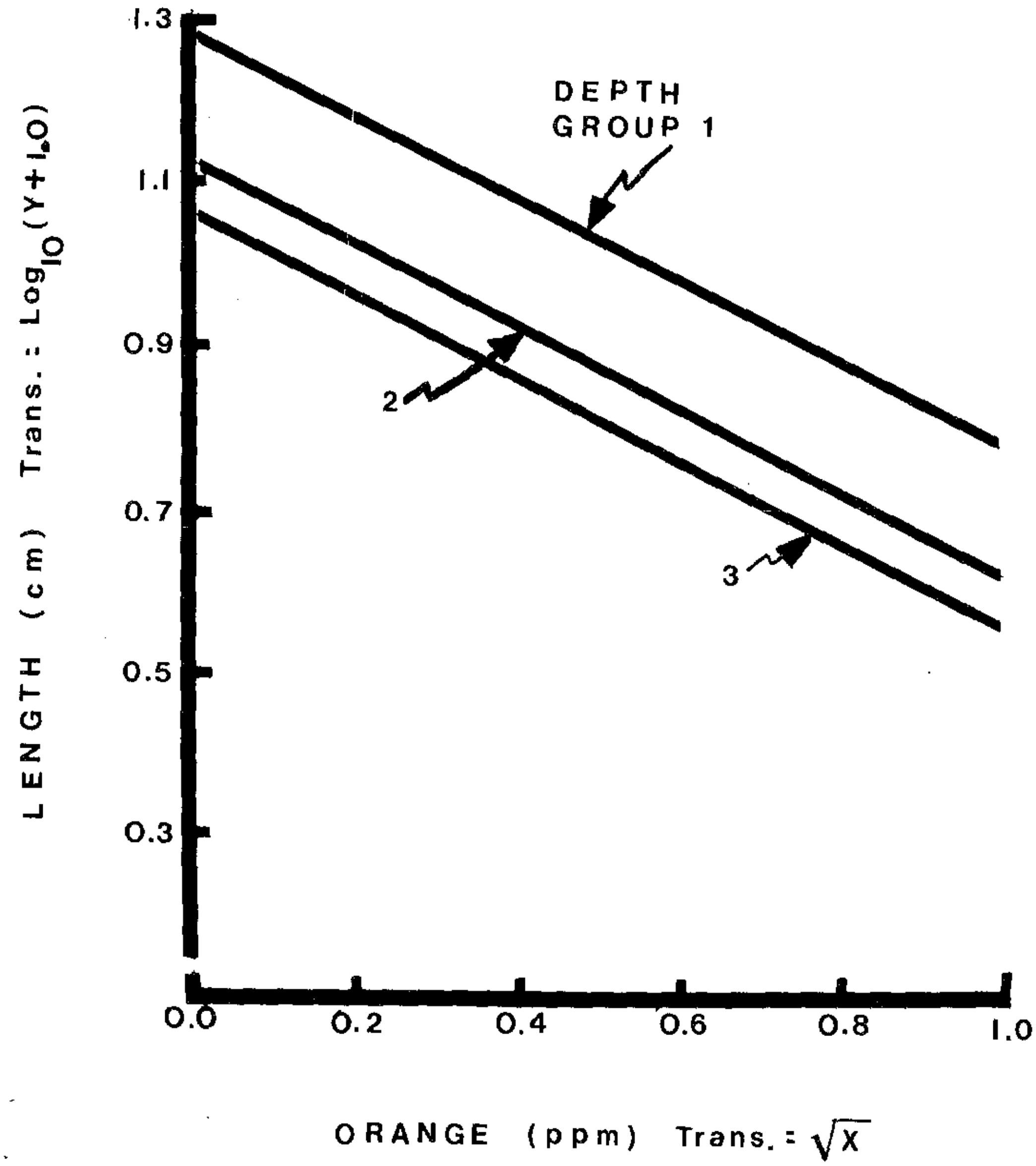


Figure II-3. Concentration Calibration Curves for Cucumber Bioassay [see text for description of depth groups]

TABLE II-4. CONCENTRATION ESTIMATES OF ORANGE AND 95% CONFIDENCE INTERVAL LIMITS VIA BIOASSAY ANALYSES

Site	Depth Segment	Soybean Data			Cucumber Data		
		Lower Limit	Concentration Estimate (ppm)	Upper Limit	Lower Limit	Concentration Estimate (ppm)	Upper Limit
B-14	1	0.0000	.0113	.1638	0.0000	.0032	.1526
B-14	2	0.0000	.0730	.3413	0.0000	0.0000	.0358
B-14	3	0.0000	.0138	.0593	0.0000	0.0000	.0363
B-14	4	.0003	.0130	.0450	0.0000	0.0000	.0344
B-14	5	.0012	.0175	.0528	0.0000	0.0000	.0341
B-14	6	.0148	.0475	.0987	0.0000	.0000	.0341
C-9	1	.0693	.3034	.7030	.0087	.1652	.5183
C-9	2	.0535	.2975	.7389	0.0000	.0161	.0932
C-9	3	.0765	.1579	.2684	0.0000	.0079	.0723
C-9	4	.0344	.0791	.1420	0.0000	0.0000	.0333
C-9	5	.0344	.0791	.1420	0.0000	0.0000	.0326
C-9	6	.0293	.0712	.1315	0.0000	.0003	.0389
J-3	1	.0814	.3297	.7447	.0136	.1851	.5532
J-3	2	.0214	.2094	.5912	0.0000	.0050	.0632
J-3	3	.0263	.0805	.1645	0.0000	.0025	.0540
J-3	4	.0057	.0297	.0725	0.0000	0.0000	.0391
J-3	5	0.0000	.0017	.0196	0.0000	0.0000	.0387
J-3	6	0.0000	0.0000	.0105	0.0000	0.0000	.0393
M-8	1	.0814	.3297	.7447	.0017	.1260	.4473
M-8	2	.0222	.2120	.5957	0.0000	.0032	.0567
M-8	3	.0700	.1485	.2562	0.0000	..0098	.0778
M-8	4	.0367	.0824	.1464	0.0000	0.0000	.0331

TABLE II-4. CONCLUDED

Site	Depth Segment	Soybean Data Lower Limit	Soybean Data Concentration Estimate (ppm)	Soybean Data Upper Limit	Cucumber Data Lower Limit	Cucumber Data Concentration Estimate (ppm)	Cucumber Data Upper Limit
M- 8	5	.0477	.0985	.1675	0.0000	0.0000	.0343
M- 8	6	.0426	.0911	.1578	0.0000	0.0000	.0330
N-12	1	.0814	.3297	.7447	.0005	.1136	.4243
N-12	2	.0183	.1993	.5738	0.0000	.0044	.0613
N-12	3	.0567	.1289	.2304	0.0000	.0039	.0594
N-12	4	.0691	.1282	.2054	0.0000	.0005	.0406
N-12	5	.0985	.1672	.2540	0.0000	0.0000	.0339
N-12	6	.0593	.1147	.1883	0.0000	0.0000	.0326
0- 7	1	.0169	.1718	.4885	0033	.1377	.4689
0- 7	2	.0183	.1993	.5738	0.0000	.0111	.0812
0- 7	3	.0441	.1097	.2046	0.0000	.0262	.1151
0- 7	4	.0344	.0791	.1420	0.0000	.0022	.0507
0- 7	5	.0247	.0640	.1217	0.0000	.0007	.0423
0- 7	6	.0293	.0712	.1315	0.0000	0.0000	.0326
0- 5	1	0.0000	.0321	.2225	.0184	.2020	.5826
0- 5	2	0.0000	.0196	.2142	0.0000	.0209	.1040
0- 5	3	0.0000	.0010	.0259	.0025	.0508	.1605
0- 5	4	0.0000	.0018	.0202	0.0000	.0026	.0526
0- 5	5	0.0000	0.0000	.0102	0.0000	.0116	.0806
0- 5	6	0.0000	.0012	.0180	0.0000	.0252	.1110
0- 8	1	0.0000	.0249	.2040	0.0000	.0047	.1611
0- 8	2	0.0000	.0029	.1489	0.0000	0.0000	.0385
0- 8	3	0.0000	0.0000	.0178	0.0000	0.0000	.0347
0- 8	4	0.0000	0.0000	.0103	0.0000	0.0000	.0369
0- 8	5	0.0000	0.0000	.0103	0.0000	0.0000	.0370
0- 8	6	0.0000	.0007	.0160	0.0000	0.0000	.9354

TABLE II-5. PERCENT ORGANIC MATTER OF SOIL FROM TEST AREA C-52A
[Samples Collected between December 1970 and June 1971]

SAMPLE	DEPTH, Inches	ORGANIC MATTER' %
A-11	0-6	0.68[b]
B-8	0-6	1.05[a]
B-14	0-6	1.13[a]
C-11	0-6	0.55[a]
D-7	0-6	0.87[a]
E-3	0-6	0.73[b]
E-6	0-6	0.37[b]
F-12	0-6	1.31[a]
J-1	0-6	0.85[a]
L-10	0-6	0.68[b]
N-5	0-6	0.76[a]
N-8	0-6	0.41[b]
N-12	0-6	0.72[a]
O-2	0-6	0.45[b]
CONTROL (0.2 mile NW of grid)	0-6	1.25[b] 1.99
C-9	0-6	0.96
C-9	6-12	0.71
C-9	12-18	0.72
C-9	18-24	0.67
C-9	24-30	0.87
C-9	30-36	0.41
G-11	0-6	1.65[b] 1.99
G-11	6-12	1.04
G-11	12-18	1.61
G-11	18-24	1.49
G-11	24-30	1.06
O-7	0-6	0.57
O-7	6-12	0.52
O-7	12-18	0.56
O-7	18-24	0.62
O-7	24-30	0.54
O-7	30-36	0.59
CONTROL (0.2 mile NW of grid)	0-6	2.03[a]
	6-12	1.35[a]
	12-18	0.86[a]
	18-24	0.73[a]
	24-30	0.83[a]
	30-36	0.71[a]

[a]Average of three replicates.

[b]Determined by the Wakley-Black wet digestion method; all others analyzed by weight loss after 30 minute heating in tared crucible.

[c]Samples designated by the closest permanent sampler station. Samples taken 50 feet from sampler.

TABLE II-6. PERCENT ORGANIC MATTER WITHIN TREATMENT AND CONTROL CORES TAKEN FROM TEST AREA C-52A				
DEPTH, inches	CONTROL	ORGANIC MATTER, %		
		C-9	G-11	0-7
0 to 6	2.03	0.96	1.99	0.57
6 to 12	1.35	0.71	1.04	0.52
12 to 18	0.86	0.72	1.61	0.56
18 to 24	0.73	0.67	1.49	0.62
24 to 30	0.83	0.87	1.06	0.54
30 to 36	0.71	0.41	0.96	0.59

4. CONCLUSIONS

The varying effects of different concentrations of herbicide Orange and the changes in soil composition associated with different depths are clearly indicated by the ANOVA and multiple range tests on the bioassay of the standard concentrations. Thus, it should be expected that the same concentration of Orange in different types of soils will be reflected by different plant growth patterns.

An obvious disparity exists between the soybean data and cucumber data estimates of Orange concentration at various test area sites. Confounding occurred because parts of this experiment were conducted at different times without statistical balancing. The attempt to adjust for those differences by weighting the data to reflect the differences in the control plants was not successful. Evidently the differences in the environments could not be explained by such a simple adjustment.

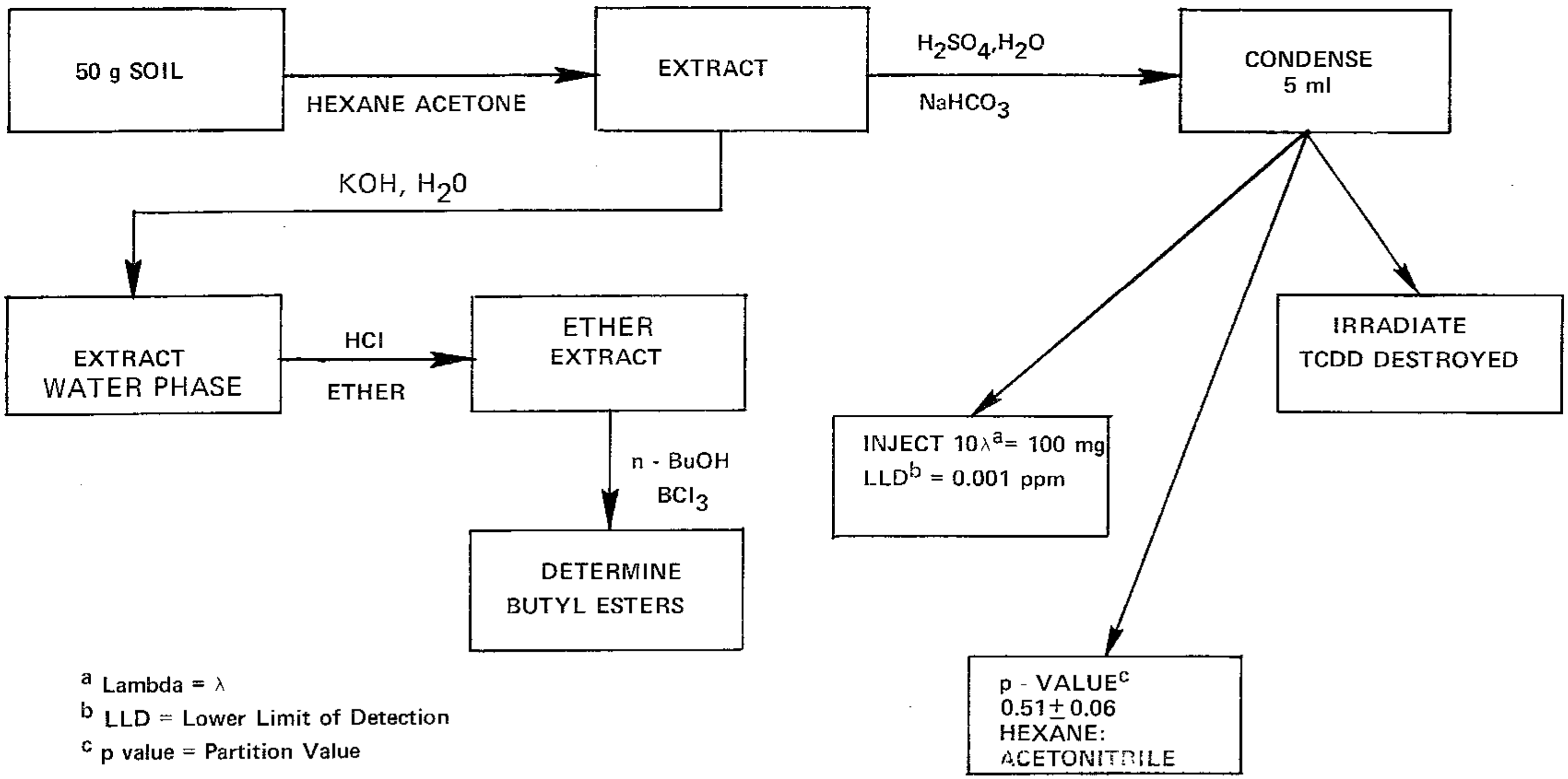
5. CHEMICAL ANALYSES OF SOIL CORES

As a result of the bioassay analyses previously discussed, those soil samples collected in November 1969 and in April and December 1970, which caused the greatest growth inhibition, were analyzed chemically for 2,4-D; 2,4,5-T; picloram; arsenic; and the contaminant TCDD.

a. Methods and Materials

A 25 to 50 gram soil sample was weighed, acidified, and extracted with 1:1 hexane: acetone (see Figure II-4). The hexane:acetone was made basic and the aqueous phase saved for extraction by ether after acidification, butylation via boron trichloride, and the subsequent determination of 2,4-D and 2,4,5-T. The hexane phase was gently shaken repeatedly with sulfuric acid until the sulfuric acid was clear. The hexane phase was then condensed and the extract representing 50 - 100 mg of soil was injected on a 5% OV-225 gas chromatographic (GC) column. The GC was equipped with a Ni^{63} electron capture detector. If a peak was found within $\pm 10\%$ of the retention time of TCDD, the sample was irradiated with ultraviolet light for 16 hours. Column chromatography was also employed.

A gas chromatograph trace of the TCDD samples is shown in Figure II-5. This figure shows an unaltered and a spiked soil sample before and after ultraviolet light treatment for three different soil samples. In no case was any TCDD detected. Notice also that the added TCDD was completely destroyed by UV irradiation.



a Lambda = λ

b LLD = Lower Limit of Detection

c p value = Partition Value

Figure II-4. Analysis Flow Chart for the Extraction of 2,4-D; 2,4,5-T; and TCDD from Lakeland Sand

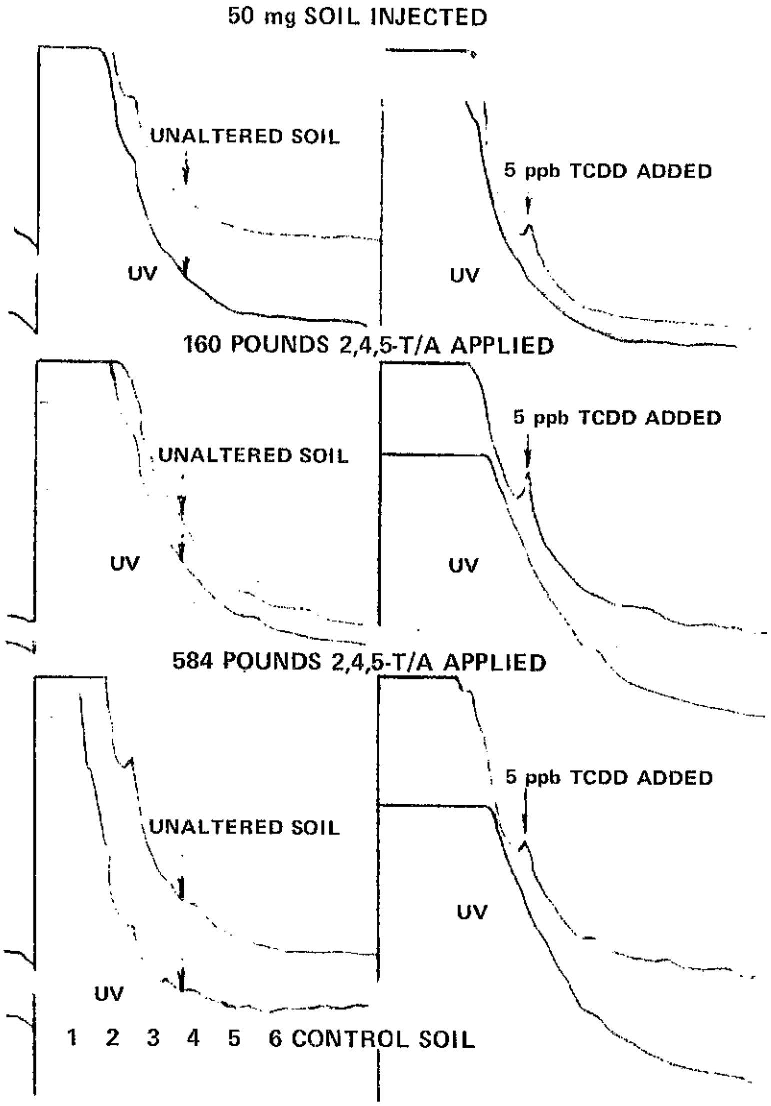


Figure II-5. Gas Chromatograph Traces of TCDD Samples. (The Traces Represent 50 mg of Extracted Soils from Grids 2 and 4. See Table I-7)

The soils were analyzed for arsenic using 6 mls of 1:1 $H_2SO_4/HC1O_4$ per 10 g, followed by reductive distillation and development of a molybdenum blue color. Nine soil cores (to the 36-inch depth) were analyzed for picloram by Dow Chemical U.S.A. The minimum detection limit for picloram was 5 ppb.

Additional soil samples were collected in June and October 1973 from near sampler sites C-9, F-6, and 0-7 and from the center of Grid 1 located approximately 1000 feet south of sampler station 0-7 (see Figure I-5). These soil samples were analyzed for TCDD by the Interpretive Analytical Services, Dow Chemical, U.S.A., Midland, Michigan. The method of analysis reported by the Interpretive Analytical Services is as follows:

> 10 gms of soil were extracted with 1:1 acetone-hexane, and the hexane recovered from the extract by the addition of water. (J. Assoc. Offic. Anal. Chemists 56, 728 (1973). (Initially, the soil extracts were subjected to separation procedures involving only silica gel column chromatography, but too many interferences were found for best sensitivity. Hence, all samples were treated by a modification of the techniques developed by Baughman and Meselson, "An Analytical Method for Detecting Dioxin", National Institute of Environmental Health Sciences Conference on Dibenzo-dioxins and Dibenzo furans, Research Triangle Park, NC, April 1973, published in Evnironmental Health Perspectives, No. 5, August 1973). The modified procedure is as follows:
>
> Hexane extracts from above washed with successive 10 ml portions of concentrated H_2SO_4 until H_2SO_4 is colorless (4 - 5 washings).
>
> Hexane evaporated to 0.5 ml, and passed through a silica gel column. Dioxins eluted from the column and 1:5 benzene-hexane. Eluate evaporated to a small volume, and taken up in 0.5 ml hexane. (This step is in addition to the Baughman-Meselson procedure, and was found necessary to achieve best sensitivity.)
>
> Hexane solution from above placed on an Al_2O_3 column. PCB's eluted with 1:4 $CC1_4$-hexane. Dioxin eluted with 1:4 CH_2C1_2-hexane. Eluate evaporated to small volume and injected directly into an LKB-9000 gas chromatography-mass spectrometer combination.
>
> Column Conditions: 6 ft x 1/8 inch stainless steel packed with 3% OV-3 on 80/100 mesh Gaschrom. Z, isothermal at 230°C. Retention time ~ 6.5 min.
>
> Detector: mass spectrometer set to monitor m/e = 320 and 322 simultaneously.

b. Results and Discussions

Table II-7 shows the results of all analyses for soils collected during the period 1969 through 1971. Notice the persistence of 2,4-D and 2,4,5-T in soil core J-3NE from April to December 1970. However, it should be emphasized that if no herbicide degradation had occurred, a concentration of approximately 80 ppm 2,4,5-T might be expected within the top 6 inches (see Table II-7, assuming the weight of a one acre 6-inch increment weighs 2 million pounds). Notice that cores M-8SW, N-12SW, and 0-5S show leaching of 2,4-D, and 2,4,5-T. This particular region of the grid received 1,168 pounds per acre of Orange from 1964 to 1966. Moreover, O-5S may have received heavy concentrations of herbicides when Grid 1 was in use (1962 to 1964). Table II-8 compares chemical and bioassay data for the same core (M-8S), collected in December 1970 and subsampled for analyses. These data suggest that chemical analysis for 2.4-D and 2,4,5-T alone may not account for all the biologically active phytotoxic components (e.g., degradation products and/or fuel oil residue). Note that the trend is reasonably similar between methods of analysis.

No TCDD residues were found by the Pesticide Degradation Laboratory in any of the soil samples at a minimum detection limit of less than 1 ppb. Recent analyses of drums of Orange in storage suggest that the average concentration of TCDD in Orange may be 2 ppm[2]. If it is assumed that all the 2,4,5-T sprayed on TA C-52A was contaminated with 2 ppm TCDD, then approximately 0.5 pound of TCDD was disseminated in this test area. However, the analyses of TCDD in the part per trillion (ppt) range would be required for detection of potential residue. The results of soil samples collected in June and October 1973 and analyzed by Interpretive Analytical Services, in the parts per trillion range, did in fact indicate the presence of TCDD or a TCDD-like chemical compound. These data are shown in Table II-10. The greatest concentration of TCDD was found in the soil core from the center of Grid 1. This grid received on the average 947 pounds 2,4,5-T per acre in the period 1962-1964. The levels detected in the 6 to 12 and 12 to 18 inch depths were probably due to contamination at the time of sample collection. These data suggest that TCDD or a TCDD-like compound may persist for an extended period of time. Moreover, it would appear that the Orange (Purple) disseminated on this test grid was significantly contaminated with this compound.

Significant levels of picloram were found in November 1969 near Sampler K-9. Notice that at this date the residue was confined to the top 12 inches. However, by May 1970 picloram may have moved to the lower increments within the soil profile.

Table II-7 also shows the levels of arsenic found in selected soil cores. From the data in this table, it is evident that there is no appreciable build-up of arsenic in the soil. Perhaps this is due to leaching or possibly to the reduction and volatilization of dimethylarsine from the cacodylic acid. These observations are further verified by data on arsenic levels from sites J-3NE, C-9SW, K-9N, and 0-8S collected and analyzed in June 1973. Table II-9 compares the arsenic levels from these sites collected in 1970 and again in 1973.

c. Conclusions

Small amounts (in parts per billion) of 2,4-D, 2,4,5-T, and picloram were found persisting on the test area in June 1971. The last application of Orange was December 1969, while the last application of White was May 1970. The last application of Blue was in September 1970; nevertheless, no significant build-up of arsenic has been noted. However, leaching of the arsenical from the soils may have occurred. Significant TCDD residue (or a TCDD-like compound) has been detected in the parts per trillion range from Grid 1.

---

[2]Personal communication with Dr. Walter Melvin, February 1973, Air Force Environmental Health Laboratory, Kelly AFB, Texas.

TABLE II-7. RESULTS OF CHEMICAL ANALYSES FOR PICLORAM; 2,4-D; 2,4,5-T; 2,3,7,8-TCDD; AND ARSENIC IN SOIL SAMPLES FROM EGLIN AFB RESERVATION TEST AREA C-52A

SOIL SAMPLE[a]	DEPTH[b]	PICLORAM[c], ppb	2,4-D, ppb	2,4,5-T, ppb	TCDD[d], ppb	ARSENIC[d], ppm
NOVEMBER 1969						
K-9N	1[e]	34, 21	1.2	2.8	<1.0	2.24
	2	21, 11	7.0	2.0	<1.0	0.86
	3	<10, 6	0.1	0.8	<1.0	0.90
	4	<10, 5	0.1	0.6	<1.0	0.52
	5	<10, <5	0.1	0.9	<1.0	0.62
	6	<10, < 5	0.1	0.3	<1.0	0.54
6 APRIL 1970						
J-3NE	1	ND	1.7	1.2	<1.0	0.55
	2	ND	1.7	1.0	<1.0	0.34
	3	ND	0.1	1.0	<1.0	0.41
	4	ND	0.1	1.0	<1.0	0.41
	5	ND	ND	ND	< 1.0	ND
	6	ND	0.1	0.7	<1.0	0.52
10 DECEMBER 1970						
J3NE	1	<10	<0.1	2.4	< 0.1	4.70
	2	<10	<0.1	1.8	< 0.1	1.30
	3	<10	<0.1	1.1	< 0.2	0.90
	4	<10	<0.1	0.7	< 0.2	0.55
	5	<10	<0.1	1.0	< 0.2	1.13
	6	<10	<0.1	0.3	< 0.2	0.90
6 APRIL 1970						
J-9SE	1	ND	1.6	5.9	<1.0	3.21
	2	ND	1.1	0.1	<1.0	0.48
	3	ND	0.1	0.7	<1.0	0.20
	4	ND	0.1	0.4	<1.0	0.27
	5	ND	0.1	0.3	<1.0	0.27
	6	ND	0.1	0.4	<1.0	0.20

TABLE II-7. CONTINUED						
SOIL SAMPLE[a]	DEPTH[b]	PICLORAM[c], ppb	2,4-D, ppb	2,4,5-T, ppb	TCDD[d], ppb	ARSENIC[d], ppm
10 DECEMBER 1970						
B-14SW	1	<10	< 0.1	0.6	< 0.1	0.55
	2	<10	2.4	0.4	< 0.1	0.55
	3	<10	0.6	0.4	< 0.1	0.55
	4	<10	< 0.1	0.2	< 0.2	0.58
	5	<10	< 0.1	< 0.1	< 0.3	0.41
	6	<10	< 0.1	< 0.1	< 0.1	0.48
10 DECEMBER 1970						
C-9SW	1	<10	< 0.1	1.8	< 0.4	1.64
	2	<10	< 0.1	1.2	< 0.3	0.88
	3	<10	< 0.1	0.3	< 0.2	0.48
	4	<10	< 0.1	0.3	< 0.1	0.48
	5	<10	< 0.1	<0.1	< 0.2	0.55
	6	<10	< 0.1	0.4	< 0.4	0.52
10 DECEMBER 1970						
M-8SW	1	<10	5.6	7.0	<0.2	0.90
	2	<10	5.8	1.4	<0.2	0.48
	3	<10	7.6	2.8	<0.2	0.34
	4	<10	15.0	5.6	<0.1	0.41
	5	<10	5.0	2.8	<0.5	0.34
	6	<10	13.2	6.8	<0.2	0.55
10 DECEMBER 1970						
N-12SW	1	<10	7.6	2.2	<0.2	1.86
	2	<10	10.0	1.0	<0.2	1.05
	3	<10	11.8	1.2	<0.2	0.76
	4	<10	4.8	1.4	<0.3	0.69
	5	<10	6.0	2.6	<0.2	0.69
	6	<10	7.0	3.0	<0.2	0.76
10 DECEMBER 1970						
O-5S	1	ND	0.8	1.2	<0.1	0.90
	2	ND	0.6	0.6	<0.1	0.80
	3	ND	0.6	1.2	<0.2	0.76
	4	ND	0.6	0.6	<0.2	0.41
	5	ND	<0.1	8.4	<0.7	0.69
	6	ND	0.6	1.4	<0.1	0.55

TABLE II-7. CONTINUED

SOIL SAMPLE[a]	DEPTH[b]	PICLORAM[c], ppb	2,4-D, ppb	2,4,5-T, ppb	TCDD[d], ppb	ARSENIC[d], ppm
10 DECEMBER 1970						
0-7NE	1	<10	ND	6.6	< 0.2	1.52
	2	<10	2.8	0.2	< 0.3	0.76
	3	<10	3.6	0.4	< 0.2	0.76
	4	<10	0.8	2.6	< 0.2	0.62
	5	<10	5.6	2.6	< 0.2	0.62
	6	<10	1.2	0.2	< 0.6	0.62
10 DECEMBER 1970						
0-8S	1	ND	<0.1	1.2	< 0.1	2.70
	2	ND	<0.1	2.6	< 0.1	0.58
	3	ND	<0.1	0.8	< 0.1	0.62
	4	ND	<0.1	0.6	< 0.1	0.20
	5	ND	<0.1	1.2	< 0.1	0.41
	6	ND	<0.1	0.6	< 0.2	0.07
13 MAY 1970						
K-9N	1[e]	ND	0.1	8.7	<1.0	3.94
	1	ND	0.1	3.2	<1.0	4.25
	2	17, 7	ND	ND	ND	ND
	3	<10, 5	ND	ND	ND	ND
	4	11, <5	0.1	0.1	<1.0	0.41
	4	ND	0.1	ND	<1.0	0.41
	5	<10,<5	ND	ND	ND	ND
	6	10, 5	0.1	0.9	1.0	0.41
	6	ND	0.1	1.0	1.0	0.48
13 MAY 1971						
G-9N	2	92, 160	ND	ND	ND	ND
10 DECEMBER 1970						
CONTROL	1	<10	< 0.1	<0.1	< 0.2	0.55
or 8 APRIL 1971[f]						
	2	<10	< 0.1	< 0.1	< 0.3	0.41
	3	<10	< 0.1	< 0.1	< 0.2	0.55
	4	<10	< 0.1	< 0.1	< 0.4	0.24
	5	<10	< 0.1	< 0.1	< 0.4	0.41
	6	<10	< 0.1	< 0.1	< 0.5	0.48

TABLE II-7. CONCLUDED

[a]Samples designated by the nearest permanent air sampler station on the one square mile test grid. All samples were taken 50 feet from a certain air sampler, except control site was 0.4 mile from the one square mile grid.

[b]Samples taken with a core borer in 6 inch increments. Depth 1 = 0 to 6 inches; 2 = 6 to 12 inches; 3 = 12 to 18 inches; 4 = 18 to 24 inches; 5 = 24 to 30 inches and 6 = 30 to 36 inches. Each increment was uniformily mixed prior to sampling for chemical analysis.

[c]Picloram analysis was performed by International Research and Development Corporation and/or The Dow Chemical Company; Dow Chemical Method ACR 69.10, modified.

[d]Analysis performed by E. A. Woolson, Pesticide Degradation Laboratory, United States Department of Agriculture, Beltsville, Maryland.

[e]Two samples from same depth were taken 10 feet apart.

[f]Control soil for picloram analysis taken 8 April 1971, and other analyses performed after 10 December 1970 sampling.

TABLE II-8. A COMPARISON OF CHEMICAL AND BIOASSAY DATA FOR SOIL CORE M-8[a] COLLECTED DECEMBER 1970

DEPTH, Inches	CHEMICAL ANALYSIS, ppb[b]	BIOASSAY ANALYSIS[c]	
		LOWER LIMIT, ppb	UPPER LIMIT, ppb
0-6	12.6	80	745
6-12	7.2	22	596
12-18	10.4	70	256
18-24	20.6	37	146
24-30	7.8	48	168
30-36	20.0	43	158

[a]Sample collected 50 feet southwest of air sampler station M-8.

[b]Total concentration of 2,4-D and 2,4,5-T.

[c]Data from soybean bioassay (see Table II-4)

TABLE II-9. A COMPARISON OF ARSENIC LEVELS IN SOIL CORES COLLECTED IN 1970 AND 1973 FROM TA C-52A[a]

DEPTH, Inches	LOCATION[b]							
	J-3NE		C-9SW		K-9N		O-8S	
	1970	1973	1970	1973	1970	1973	1970	1973
0-6	4.70	0.85	1.64	1.68	3.94	0.62	2.70	1.46
6-12	1.30	0.47	0.88	0.56	4.25	0.54	0.58	0.42
12-18	0.90	0.59	0.48	0.60	[c]ND	0.41	0.62	0.45

[a]Analysis performed by E. A. Woolson, Pesticide Degradation Laboratory, United States Department of Agriculture, Beltsville, Maryland.

[b]Samples collected 50 feet in the designated direction (e.g., NE) from the permanent air sampler station.

[c]ND = not determined.

TABLE II-10. LEVELS (PARTS PER TRILLION) OF 2,3,7,8 TETRACHLORODIBENZO-p-DIOXIN (TCDD) IN SOIL FROM TA C-52A COLLECTED IN JUNE OR OCTOBER 1973[a]

DEPTH, Inches	LOCATION				
	C-9	F-7	O-7	GRID 1	CONTROL
0-6	<10[b]	11	30	710	<20[c]
6-12	ND	ND	<10	140	<10
12-18	ND	ND	<10	72	<10
18-24	ND	ND	<10	<10	<10
24-30	ND	ND	<10	<10	<10
30-36	ND	ND	<10	<10	<10

[a]Method described in text.
[b]Lower limit of detection in parts per trillion TCDD.
[c]Probable interference from excessive organic matter.

SECTION III

STUDIES OF THE VEGETATION OF TEST AREA C-52A

The first studies of Test Area C-52A were those concerned with vegetation. Testing of aerial spray equipment began in June 1962, and following heavy applications of materials in 1963 and 1964, vegetation surrounding the test site showed changes suggestive of herbicidal damage. In the fall of 1966, concern about the extent of this damage led to the establishment of a contract with the University of Florida, Gainesville, Florida. The purpose of the contract was to conduct a taxonomic study that would quantitatively measure changes in density of vascular plants in the area adjacent to the test grid (References III-1, III-2, and III-3).

Observations of tree growth rings in those reports prompted studies (Reference III-4) concerned with assessment of spray drift upon the forest trees adjacent to the test area. A third study (Reference III-5) was concerned with the histological examination of a plant species growing in the flight lines on the test grid. Synopses of Reference III-1 to III-5 are included in this section. The last report, and the one most concerned with the current research effort (Reference III-6), will be summarized and referred to in this report within the section on current studies.

References:
III-1. Ward, D. B.: Ecological Records on Eglin AFB Reservation - - the First Year. AFATL-TR-67-157, Air Force Armament Laboratory, Eglin Air Force Base, Florida, 1967. Unclassified.
III-2. Ward, D. B.: Ecological Records on Eglin AFB Reservation - - the Second Year. AFATL-TR-68-147, Air Force Armament Laboratory, Eglin Air Force Base, Florida, 1968. Unclassified.
III-3. Ward, D. B.: Ecological Records on Eglin AFB Reservation - - Conclusions. AFATL-TR-70-55, Air Force Armament Laboratory, Eglin Air Force Base, Florida, 1970. Unclassified.
III-4. Hunter, H. H. and B. M. Agerton: Annual Diameter Growth of Conifers Adjacent to Eglin Reservation Test Area C-52A as Related to the Testing of Defoliant Spray Equipment. AFATL-TR-71-52, Air Force Armament Laboratory, Eglin Air Force Base, Florida, 1971. Unclassified.
III-5. Sturrock, T. T. and A. L. Young: A Histological Study of Yucca filamentosa L. from Test Area C-52A, Eglin Reservation, Florida. AFATL-TR-70-125, Air Force Armament Laboratory, Eglin Air Force Base, Florida. 1970. Unclassified.
III-6. Hunter, J. H. and A. L. Young: Vegetative Succession Studies on a Defoliant-Equipment Test Area, Eglin AFB Reservation, Florida. AFATL-TR-72-31, Air Force Armament Laboratory, Eglin Air Force Base, Florida. 1970. Unclassified.

1. SYNOPSIS OF TAXONOMIC STUDIES, 1966 - 1969

a. General Observations

In the fall of 1966, turkey oak, Quercus laevis, adjacent to the test clearing was severely affected, apparently by herbicide driftage; and the large proportion of the trees of this species gave the entire forest an abnormal aspect. Upper branches of all trees had apparently been completely defoliated, and many or even most of the twigs were killed. On the lower trunks a proliferation of small branchlets had appeared; in all cases, these branchlets began growing in the spring of 1965, as determined by the number of bud scale scars present.

Blue-jack oak, Quercus incana, and sand live oak, Quercus germinata, were also heavily damaged near the test clearing but appeared undamaged as little as 1.1 miles from the clearing in an area where turkey oak still exhibited signs of damage.

Longleaf pine, Pinus palustris, and sand pine, Pinus clausa, adjacent to the test clearing appeared unaffected. Needle length and internode length were normal, as compared with similar plants away from the test area.

A sampling was made of the growth rates of four tree species as indicated by width of annual growth rings. Blue-jack oak, turkey oak, and long-leaf pine produced growth rings that appeared to vary independently of spray applications to the adjacent TA C-52A. Sand pine seemingly showed a positive correlation with a marked increase in growth in the years immediately after the 1963 - 1964 period of heavy spray application.

Extensive observation of the vegetation in all directions from TA C-52A indicated a rapid disappearance of damage attributable to spray driftage. The maximum distance that damage was definitely detected was 5 miles, seen on trees at the upper end of Range 52, north of the test area.

Observations made later in this project failed to disclose damage at any distance from the test area that was not attributable to the 1963 - 1964 period of activity. Following a testing period in 1969, particular attention was given to the oaks, pines, and herbaceous plants in various directions from TA C-52A. A few sand pines along the south edge of the test area had visible abnormalities in their early spring growth, but this had largely disappeared by early August. Other vegetation appeared normal, suggesting that herbicide driftage, if any, from the 1969 series of tests was significantly less than in earlier years.

b. Quantitative Sampling

In the fall of 1966, a program was devised to permit the quantitative measurement of changes in density of stand of vascular plants in the area adjacent to TA C-52A. Since changes in the herbaceous plants might be more subtle and more difficult to detect than those in the larger woody plants, an experimental design was developed that would disclose differences of slight magnitude but of statistical significance.

Five stations were selected in apparently homogeneous woodland east of the test area, and at each station four parallel transects of 50 meters were laid out at right angles to an imaginary radius from the center of TA C-52A. The first of these sets of transects was immediately adjacent to the test clearing, and the fifth was at a distance of 2.0 miles. All plants intercepted by the transects were counted and listed. The resulting data were interpreted by a conventional analysis of variance and F-test.

The 2157 plants of 54 species intercepted by the 1000 meters of transect were found (with a few exceptions) not to differ significantly in their frequency with distance from the test area. This was taken to mean that the supposedly higher spray driftage near the test area had not had a significant effect on the viability of individuals of most species.

A few species were found to differ significantly with distance from the test area. Eleven species fluctuated significantly in number of individuals at varying distances from the test area, but upon examination, these differences were found to result from natural heterogeneities in the supposedly homogeneous woodland. They could not be attributed to spray effects.

Three species were found to be absent near the test area and to increase significantly away from this area. These species were the small, upright legume, Tephrosia mohrii, the persimmon, Diospyros virginiana, and the weeping haw, Crataegus lacrimata. Again, since the legume is a perennial with a deeply buried rootstock and the other two are trees which would have left evidence in the form of dead trunks, it is probable that these species were not exterminated by spray driftage near the test area, but rather reflect an original and natural heterogeneity in their distribution.

Only in the case of four species was there clear evidence of influence by proximity to the test area. The number of individuals of four herbs - Hypericum gentianoides, Solidago odora, Warea sessilifolia, and Rhynchosia cytisoides - decreased significantly away from TA C-52A. More meaningfully, the number of individuals of these species increased significantly adjacent to the test site. These four species are noted for their ability to rapidly colonize cleared land. The observed variation in number of individuals is best explained by these species utilizing the opening in the canopy resulting from the spray-induced loss of foliage by the oaks.

By early August 1969 the oaks in the area of the five transect stations again had normal foliage. At that date, it was not possible to find individuals of the Hypericum, the Warea, or the Rhynchosia, and the Solidago was very reduced in number. The presumption is that the spray-induced damage of 1963 - 1964 to the forest surrounding the test site had largely disappeared and that by 1969 the vegetation of the area was again essentially normal.

2. SYNOPSIS OF GROWTH OF SAND PINE, 1969 - 1970

a. General Comments

One of the observations noted in Reference III-1 was that the growth of sand pine, Pinus clausa, was seemingly related (positive correlation) to the periods of heaviest testing of spray equipment. This observation prompted an investigation, conducted between March 1969 and June 1970, into the growth of tree rings.

The species of trees selected for sampling were sand pine, longleaf pine, P. palustris, and turkey oak, Quercus laevis. A total of 18 sand pines were cut along with two longleaf pines and two turkey oaks. Sand pines were cut at ground level, and all others were cut 2 to 3 feet above ground level. A cross section was cut from the end of each trunk and was sanded so that the annual growth rings could be measured - to the nearest 0.1 mm.

An examination of the relative amount of annual herbicide delivery on TA C-52A revealed that the greatest amount of defoliant drift probably occurred in the following increasing order of years: 1967, 1966, 1962, 1965, 1969, 1968, 1964, and 1963. This order is based primarily on the amount, type, and formulation of materials sprayed per year. The amount of drift and defoliant damage that occurred would also have depended upon climatic and flight conditions. For example, probably very little drift damage occurred in 1967 because relatively little testing was done and all testing occurred during winter months (the time of a reduced level of plant growth). Likewise, damage would have been expected in 1964, not only because of the many Orange missions, but also because all testing occurred from May through July and some of the missions were flown at altitudes greater than the usual 150 to 200 feet.

b. Results

An initial examination of the annual diameter growth data indicated that possibly the growth of some trees was directly or indirectly stimulated by spray drift from defoliant testing. However, an analysis of the data did not substantiate this hypothesis. Growth obtained by trees during individual years of testing was often no greater than growth obtained in some previous year before defoliant spraying started. When the total annual diameter growth for individual pines during years of defoliant testing was compared with the same number of years before testing, no significant differences were apparent. Five of nine treatment trees (those close to TA C-52A) and three of six control trees made less total growth during the years of testing. For longleaf pine, one sample showed a decrease and the other an increase between 1962 and 1968.

Several of the pines located close to TA C-52A made less annual growth in 1963 - 1964 (period of expected greatest damage) when compared to the annual diameter growth of other years of defoliant testing. However, the reduced amount of growth did not seem to be related to defoliant spraying because three control trees also grew less in 1963 than any other year between 1962 and 1969. In addition, the amount of diameter growth in 1963 for trees close to TA C-52A was often no less than the diameter growth for some year previous to defoliant testing.

Difficulties were encountered in measuring annual diameter growth in turkey oak. The older increments could be easily differentiated, but the last three to five increments were not discernable. Gross observations of the diameter growth of the turkey oak sampled close to TA C-52A indicated the tree had grown less during the years of defoliant testing. As discussed in Reference III-3, the annual diameter growth of two turkey oaks that had grown within a few hundred yards of TA C-52A was measured, but without a clear indication that annual diameter growth was inhibited by defoliant testing. The greatest amount of tree defoliation around TA C-52A had been noticed on turkey oak, and a reduction in annual diameter growth was expected to be most evident in individuals of this species. However, the small amount of sampling showed no indication of a general reduction of annual diameter growth during the years of testing.

An attempt was made to relate annual diameter growth to rainfall and temperature. An analysis of average, maximum, and minimum monthly temperatures recorded since 1949 at Niceville, Florida, revealed a high degree of uniformity for the same months from year to year. Rainfall for each month, however, varied greatly over the years; and many attempts were made to discover what combinations of monthly rainfall data correlated with annual growth. While the combination of April and May rainfalls yielded the highest correlation of any two other months, only one sample showed a significant probability (95 percent confidence level) of this rainfall being related to annual diameter growth. Therefore, the rainfall data available could not be used to explain the annual growth patterns of the trees observed.

3. SYNOPSIS OF HISTOLOGICAL STUDY OF YUCCA, 1970

a. General Comments

The military herbicides Orange (2,4-D and 2,4,5-T) and White (2,4-D and picloram) function as growth regulators in their herbicidal behavior. A study was undertaken to determine whether structural (histological) changes were evident in a plant species (Yucca filamentosa) found in a high herbicide residue area of TA C-52A.

Observations have confirmed that the largest bulk of the various chemicals used in the testing of aerial defoliation spray equipment was released and fell within the instrumented test area (TA C-52A). As a result of these repetitive applications, many plant species (i.e., the dicotyledonous plants) were selectively eliminated. The vast majority of the remaining plant life was monocotyledonous with the only distinct plant association being broomsedge (Andropogon virginicus), switchgrass (Panicum virgatum), and yucca (Yucca filamentosa). Field observations indicated that yucca was the most persistent species occuring in the flight-line areas of the test grid. Observations on gross morphology indicated no differences between plants occurring on and off the test grid; however, crownal areas (the plant part at the soil surface) appeared to be different.

Specimens of yucca were selected from areas of high herbicide residue and from an area sufficiently distant from the treated area to preclude contact with the herbicides and/or herbicide residues. Tissue samples obtained from the crown area of these plants were prepared for microscopic observation.

b. Results

Both cross and radial sections of treated and control plants were examined. The control plants were used to establish the normal development of this species. Yucca is different from most monocotyledonous plants in that it has some secondary growth and develops a periderm-like structure. In addition, repeated divisions of parenchyma cells and the suberization of their products produces tangential bands of cork progressing inward and including some of the fibrovascular bundles which have an uncharacteristic forked habit of growth. All of these structures were quite evident in both the control and the treated samples.

Based on these studies, there is no apparent difference in the formation of structures in Yucca filamentosa specimens obtained from an area subjected to repetitive applications of military herbicides and specimens from an area not receiving the herbicides. Both samples followed the normal structure for this species, as described in the scientific literature.

While these observations were conducted on a very small sample of the plants which did persist in the heavily treated area, no evidence of malformations was found. A larger sample and many more observations of different tissues of the plants might detect abnormalities in this species under these conditions, and it is also possible that a larger sample of untreated plants would similarly produce individuals with malformations - - such anomalous structures are often found in many species of plants grown under different environmental conditions.

4. CURRENT VEGETATIVE SUCCESSION STUDIES

a. Introduction

The first complete survey of the vegetation existing on the herbicide test grids was initiated in 1971 (Reference III-6). The 1971 survey established a base line from which future observations or surveys could proceed to determine the rate and type (plant species involved) of plant succession on the test grids.

The June 1973 studies of vegetation are a continuation of the 1971 survey and provide precise data and photographs to illustrate changes that have occurred during a 2-year period.

b. Materials and Methods

In May 1971, the one square mile grid (Figure I-4) was divided into 169 sections (each 400 by 400 feet). The percentage plant cover in each 160,000 ft^2 section was visually estimated, and a vegetative coverage map resulted. In June 1973, the same technique was used to construct another vegetative coverage map. Coverage was ranged into five classes as follows: Class O = 0 to 5% cover, Class I = 5 to 20% cover, Class II = 20 to 40% cover, Class III = 40 to 60% cover, Class IV = 60 to 80% cover, and Class V = 80 to 100% cover.

In June 1971, three 400 by 400 foot sections from each coverage class were randomly selected for a detailed collection of dicotyledonous (broadleaf) plant species. A diagonal transect starting 20 feet within the northwest corner of each section was walked to the southeastern boundary. Plants were collected along the transect, and the results were tabulated for the number of dicotyledonous plants occurring in each section. A control area 0.2 mile northwest of the one square mile grid and an area in the center of the plot formerly occupied by Grid 1 were also surveyed. In June 1973, each of these areas was again surveyed by the same method. A square-foot analysis was performed on (1) 15 additional 400 by 400 feet sections, (2) the control area used in 1971, (3) a new control area west of the one square mile grid, and (4) a 160,000 ft^2 section in the center of area occupied by Grid 1. The additional 15 sections were randomly selected, and within each section, nine areas, each measuring one square foot, were analyzed (Figure III-1). The square foot sampling sites were selected by dividing the 400 by 400 foot sections into three strips, each 133 feet wide. A line was drawn in center of each strip and three one-square-foot areas were selected by generating d_1, d_2, and d_3 as distances to be walked. The distances were generated by a random number generator which included constraints that assured one sampling area from each one-third of the transverse with the sampling area being random within the one-third area. After each distance was walked-off, the metal square-foot measuring device was placed, and the percent coverage for each plant species was visually estimated.

d. Results and Discussion

The 1971 and 1973 vegetative coverage maps are shown in Figures III-2 and III-3, respectively. Table III-1 shows the percent coverage that each vegetative class occupied in June 1971 and in June 1973.

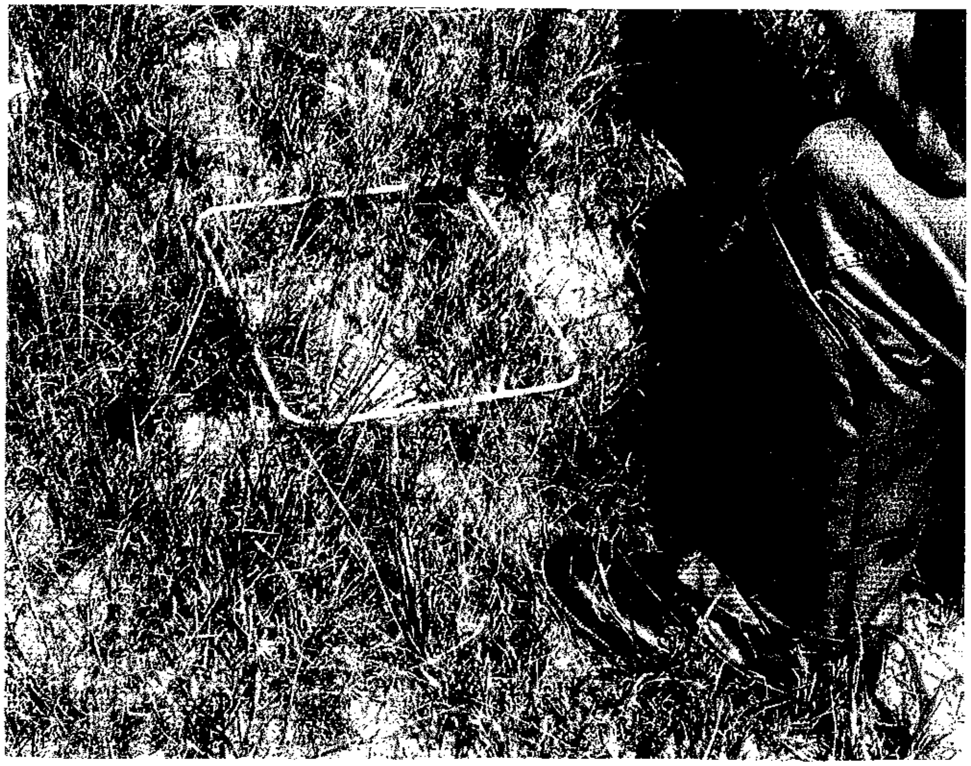


Figure III-1. Square-Foot Measuring Device in Use During Vegetation Survey - June 1973

TABLE III-1. PERCENT OF VEGETATIVE COVER OCCUPIED BY VEGETATIVE CLASS FOR THE 1 SQUARE MILE GRID

VEGETATIVE CLASS	JUNE 1971	JUNE 1973
0 (0 to 5%)	4%	0%
I (5 to 20%)	14%	4%
II (20 to 40%)	29%	12%
III (40 to 60%)	25%	18%
IV (60 to 80%)	21%	42%
V (80 to 100%)	4%	23%

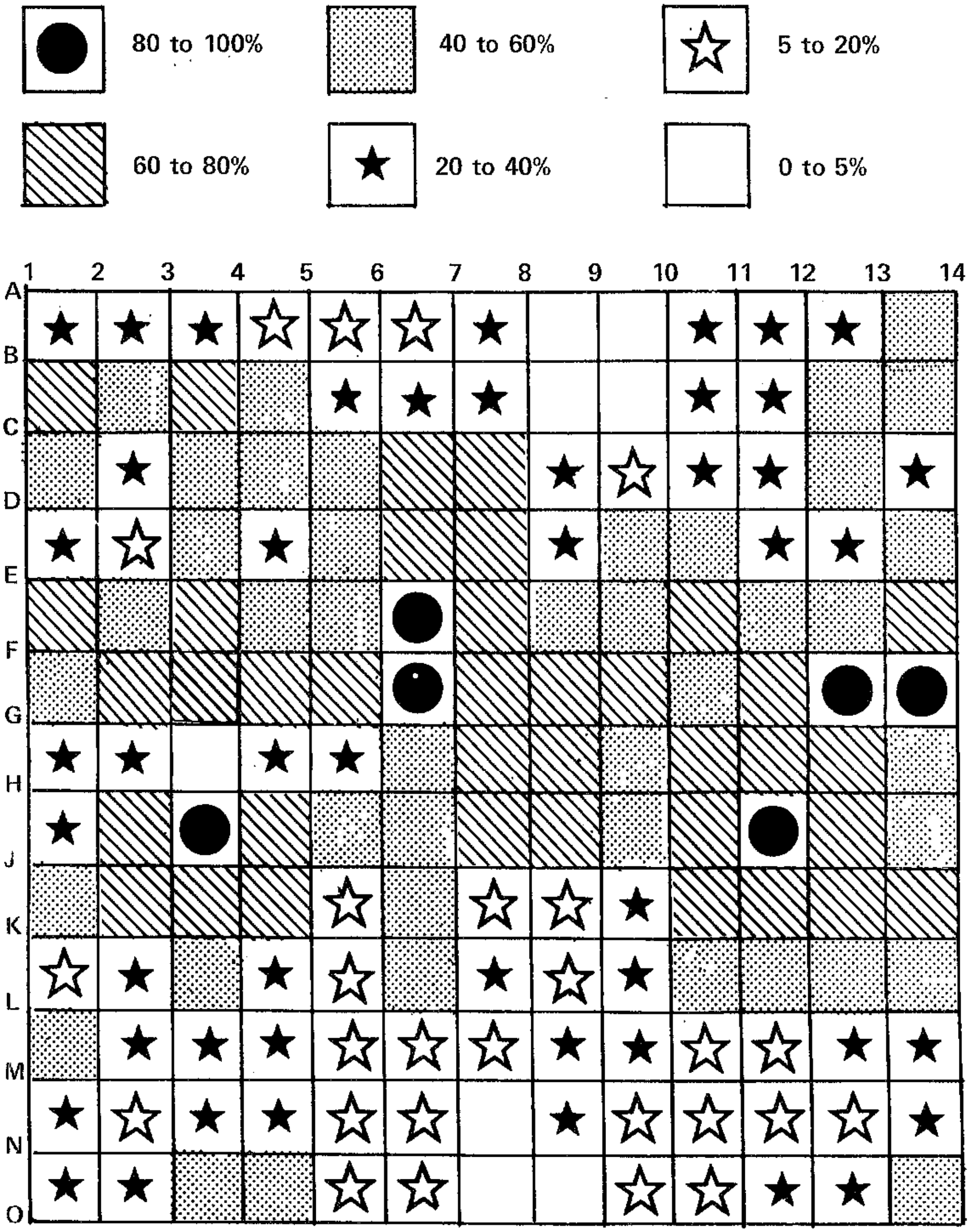


Figure III-2. Vegetative Coverage of the One Square Mile Grid on Test Area C-52A, May 1971

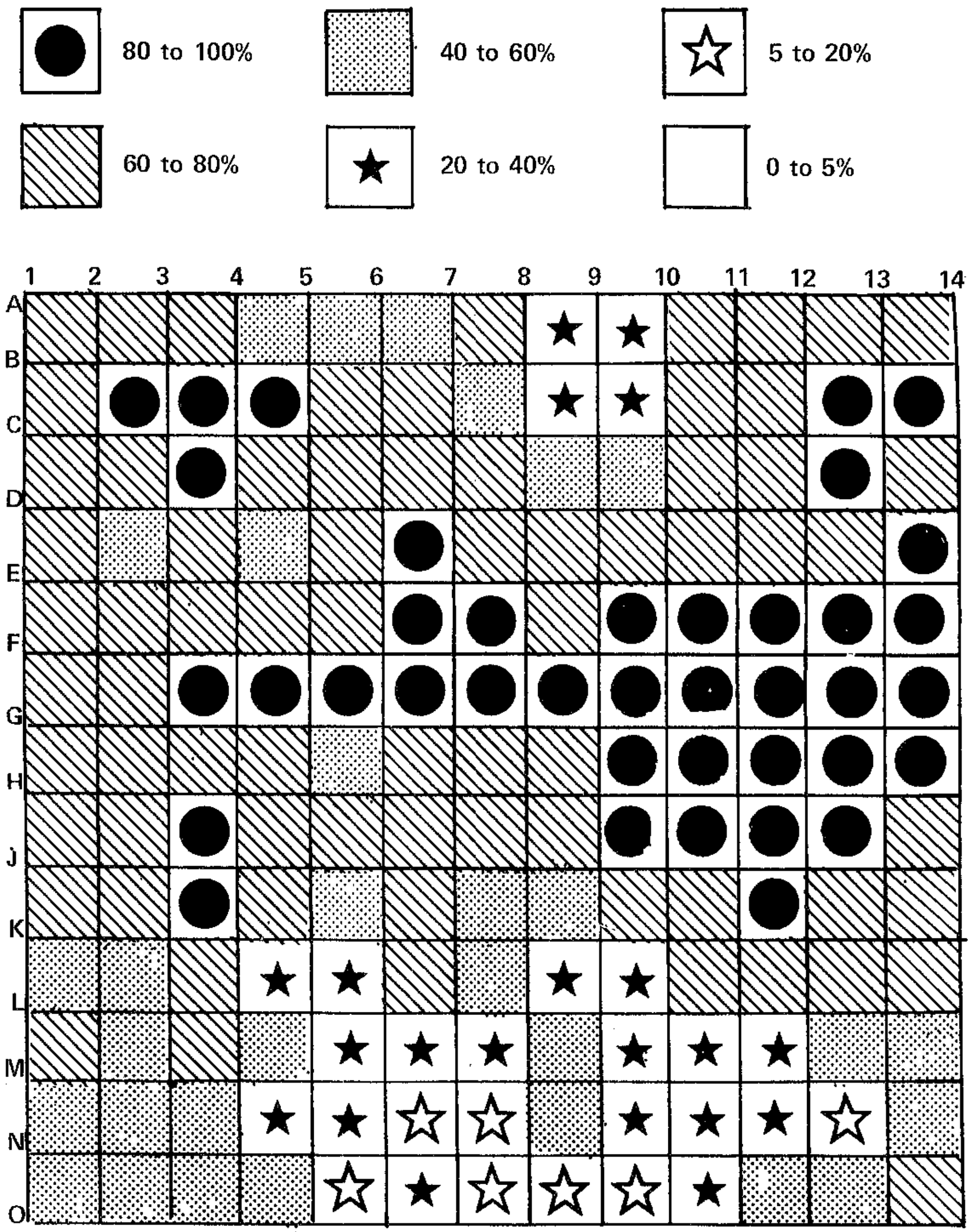


Figure III-3. Vegetative Coverage of the One Square Mile Grid on Test Area C-52A, June 1973

After a 2 year period, no vegetative class O areas were judged to remain on the one square mile grid. All class O areas had developed into class I or II areas. The greatest change in number of individual areas occurred from class II to IV (14% of total) and class III to IV (17% of total). For those areas with less cover than class V, 19 class IV areas, two class III areas, four class II areas and four class I areas did not change in percent cover during the 2 year interval.

Examples of vegetative cover changes are illustrated in Figures III-4 to III-13 by comparing the 1971 and 1973 photographs of identical areas. All of these photographs represent changes from one coverage class to another, except for area N-5 (Figures III-6 and III-7). Although an increase in vegetative coverage can be seen for N-5, this increase was not enough to place the area in Class II. Figure III-14 and Figure III-15 illustrate an increase in number of shrubs for a Class IV area.

In 1971, data on number of dicotyledonous or broadleaf species were assembled, and the same 400 by 400 feet areas were again surveyed in 1973. Table III-2 shows the increase in numbers of broadleaf plants after 2 years. The numbers of broadleaf plants are still significantly increasing in all areas, including Control Area 1. As is expected, the greatest percent change occurs in those areas with the smallest amount of vegetation because these areas have open sections where seeds can germinate free of competition from other plant species. However, these areas are relatively dry, windblown sites, and vegetative succession will continue to be relatively slow as compared to areas on the grid that have more poorly drained soils, and therefore, more available soil moisture. An indication of relative rate of succession for different areas of the one square mile grid is illustrated by observing the speed with which class O, I, II, and III areas change to other classes. For example, all 1971 class O areas on the northern section of the grid are now in class II, but 1971 class O areas in the southern portion of the grid only changed to class I in the 2 year interval.

From June to September 1971, 74 dicotyledonous species were collected on the one square mile grid, and 33 additional species were found during the June 1973 survey. Table III-3 contains a complete list of all species that have been found on the grid. The relative frequency of occurrance of all new species collected in 1973 was rare or infrequent except for Euphorbia maculata and Polygonella gracillis. Plants that were found in Control Area 2 but not found on the grid were rosinweed (Silphium ovatifolium), hairy bedstraw (Galium pilosum), sun flower (Helianthus sp.), and flax (Linum floridanum).

Because the square-foot analysis technique is a more accurate method of determining vegetative cover, the results of the two methods are compared in Table III-4. This shows that visual estimations of 400 by 400 foot areas were 8% to 30% higher than the more accurate square-foot technique. However, class rankings for the two methods are the same except for areas found to have 40% to 60% vegetative cover by the square-foot analysis. The most significant comparison of the two methods is that which shows Control Site 2 and Grid 1 area to be in class III instead of class IV.

As a result of the square-foot analysis, the most important plants on the grid in terms of coverage are the grasses, switchgrass (Panicum virgatum)(Figure III-16), and, woolly panicum (P. lanuginosum) (Figure III-17). These two grasses were found to comprise from 44% to 64% of the existing coverage for all vegetative classes. The most important dicotyledonous plants are rough buttonweed (Diodia teres) (Figure III-18), poverty weed (Hypericum gentianoides) (Figure III-19), and common polypremum (Polypremum procumbens). These three dicots occupy from 3% to 17% of the existing cover in all classes on the grid.

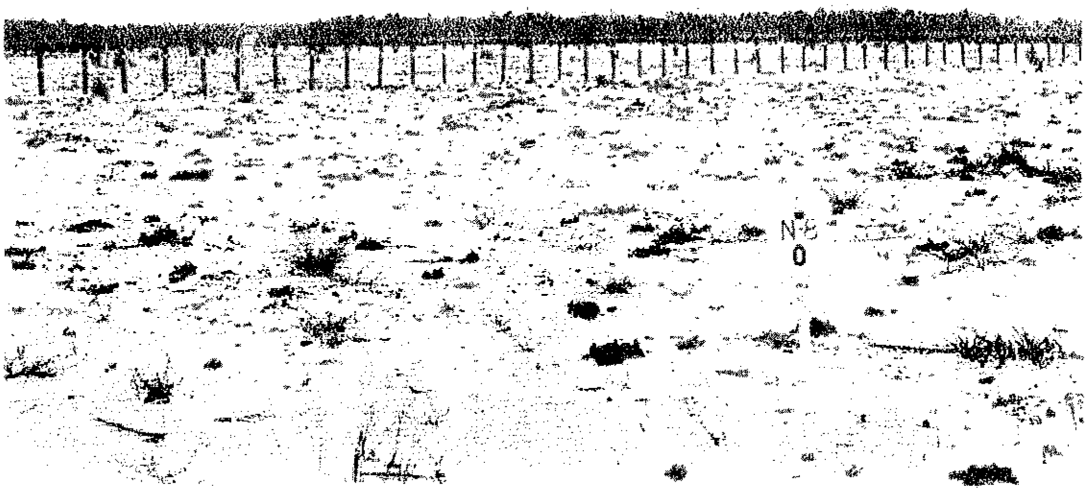


Figure III-4. Area N-8, June 1971, Looking SE from Sampler N-8

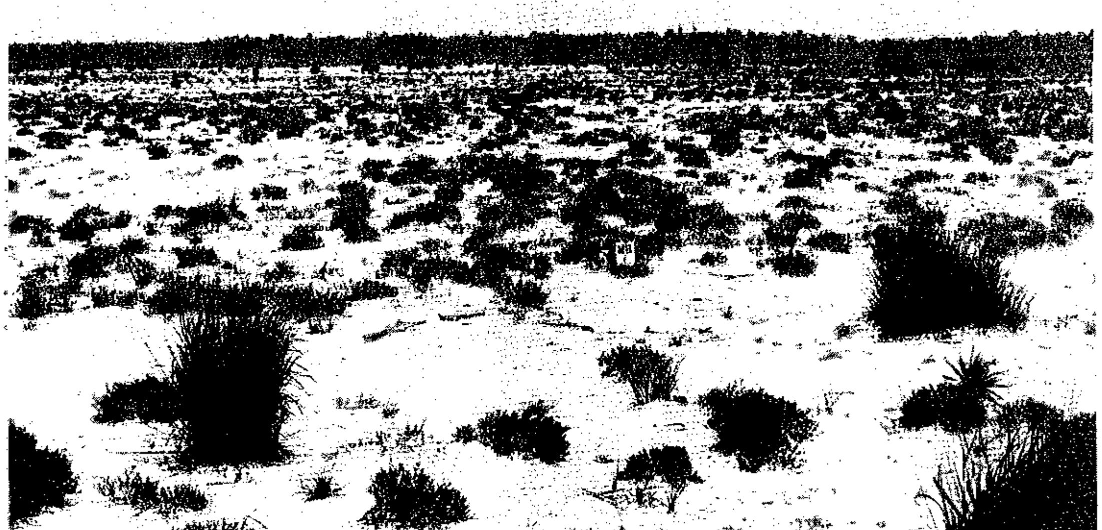


Figure III-5. Area N-8, June 1973, Same View as Figure III-4 After 2 Years

Figure III-6. Area N-5, June 1971, Looking SE from Sampler N-5

Figure III-7. Area N-5, June 1973, Same View as Figure III-6 After 2 Years

Figure III-8. Area L-10, June 1971, Looking SE from Sampler L-10

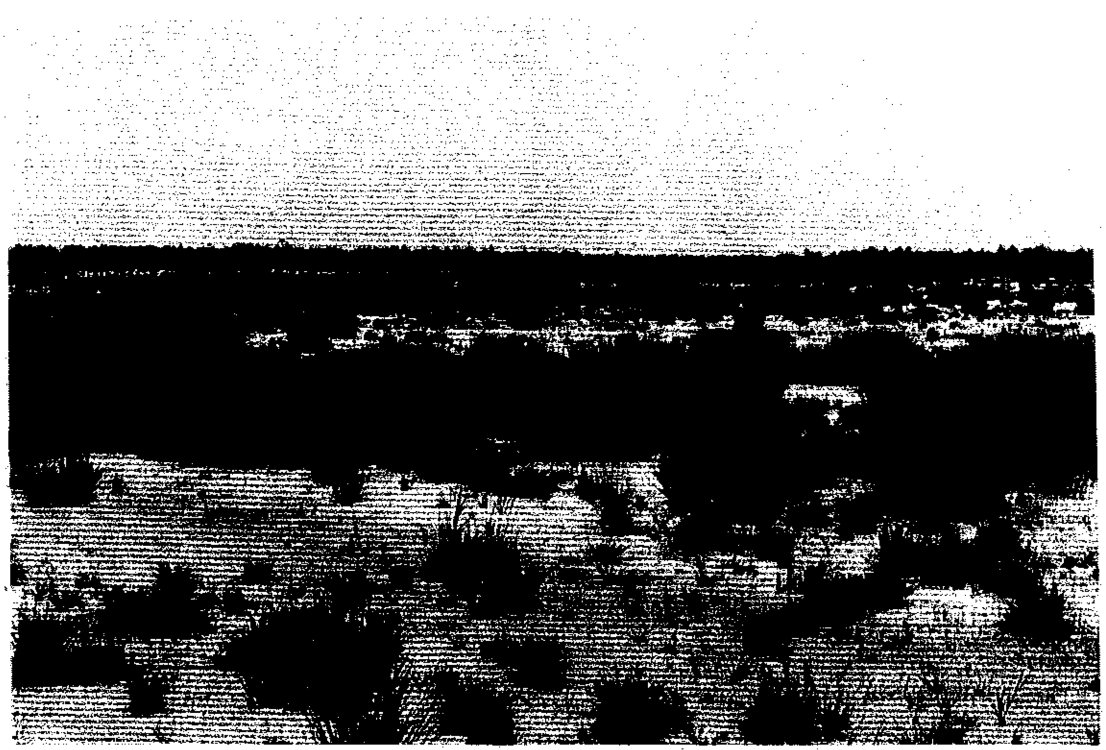


Figure III-9. Area L-10, June 1973, Same View as III-8 After 2 Years

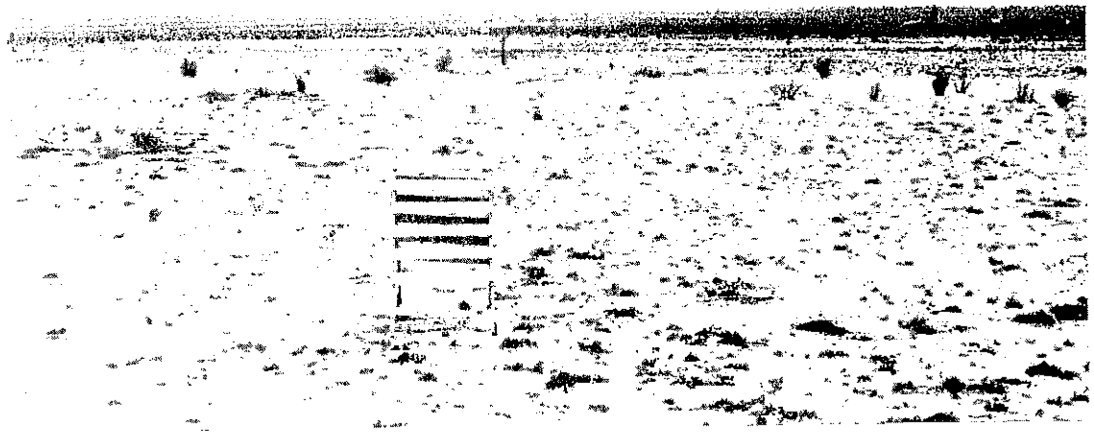


Figure III-10. September 1971 View of North-South Flightpath on One Square Mile Grid from Sampler A-9

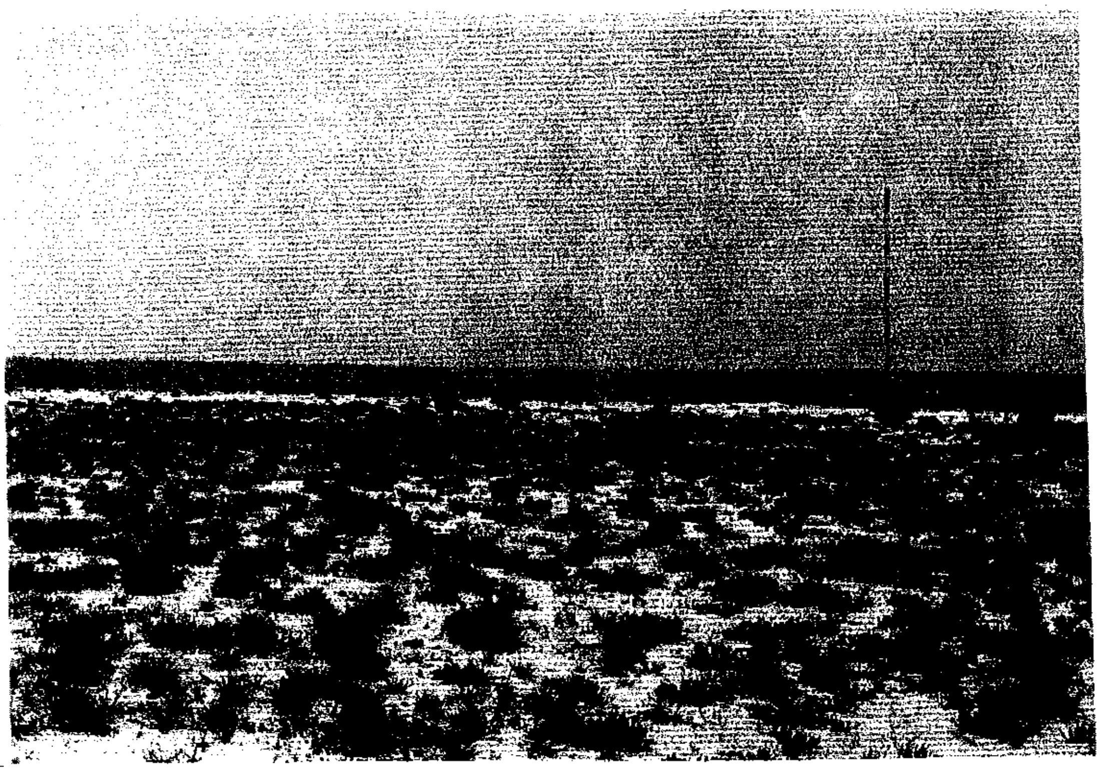


Figure III-11. June 1973 View from Same Position as Figure III-10 After 2 Years

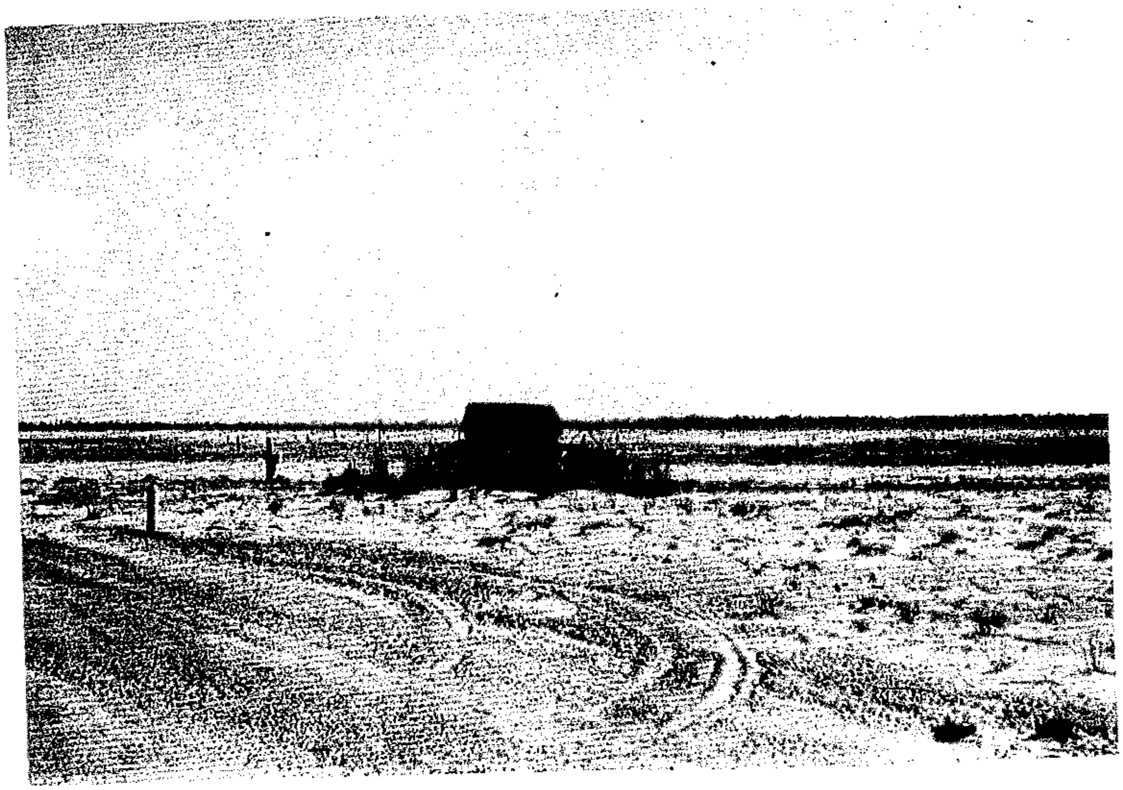


Figure III-12. April 1969 Looking South Near Sampler G-5

Figure III-13. July 1973, Same View as Figure III-12 After 4 Years

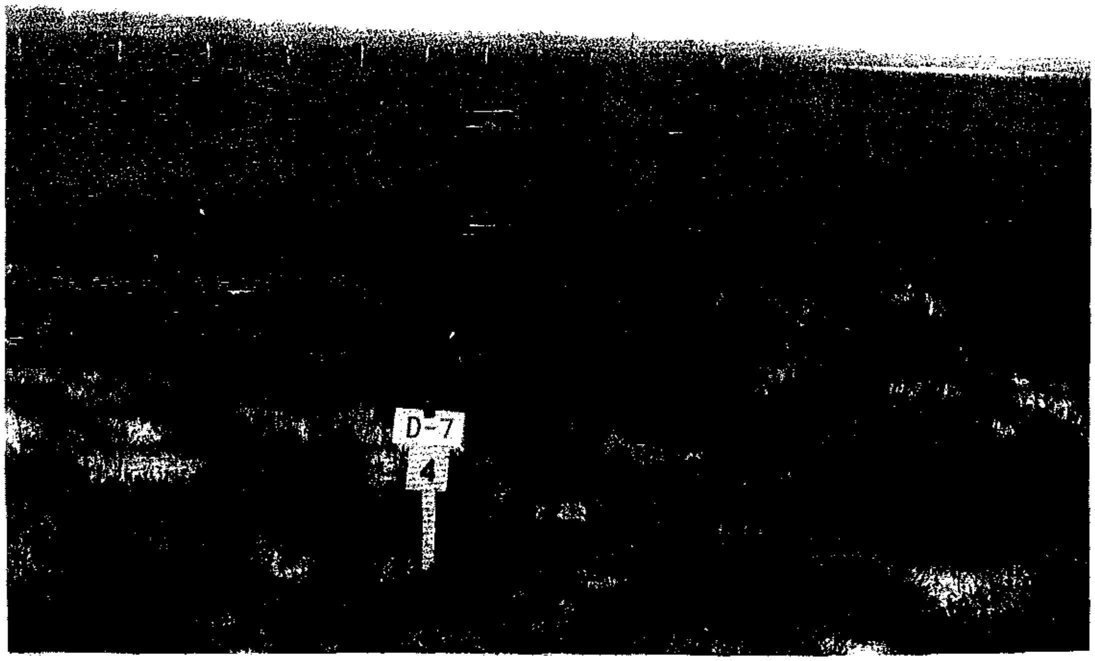


Figure III-14. Area D-7, June 1971, Looking SE From Sampler D-7

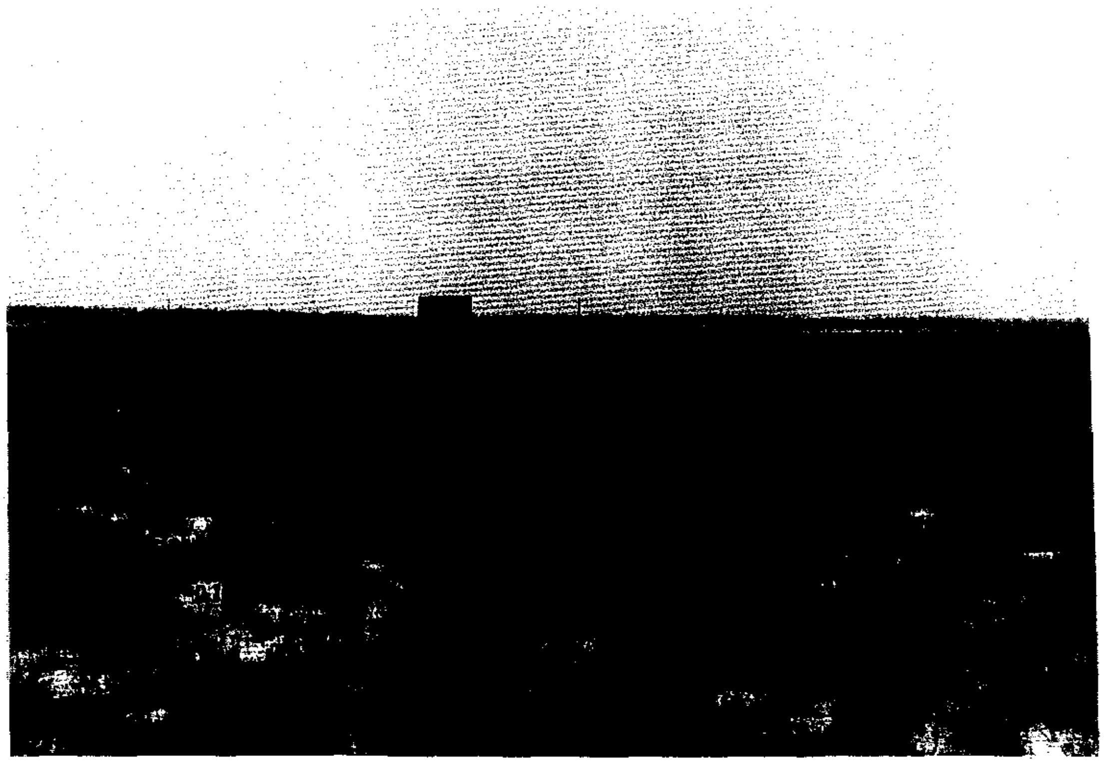


Figure III-15. Area D-7, July 1973, Same View as Figure III-14 After 2 Years (Notice increase in number of shrubs after 2 years)

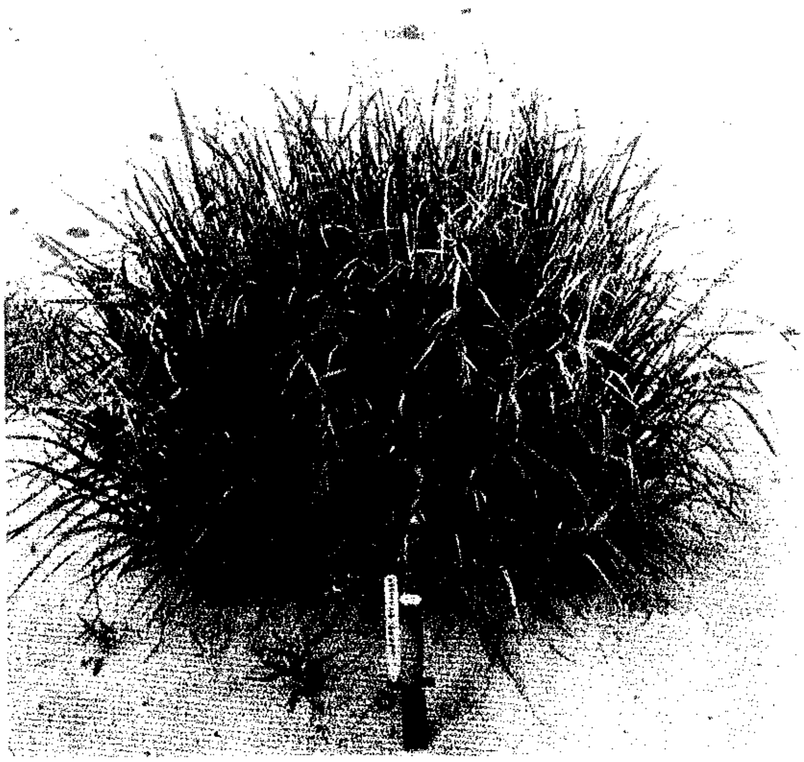


Figure III-16. Switchgrass (Panicum virgatum)

Figure III-17. Woolly panicum (Panicum lanuginosum)

Figure III-18. Poorjoe or Rough Buttonweed (Diodia teres)

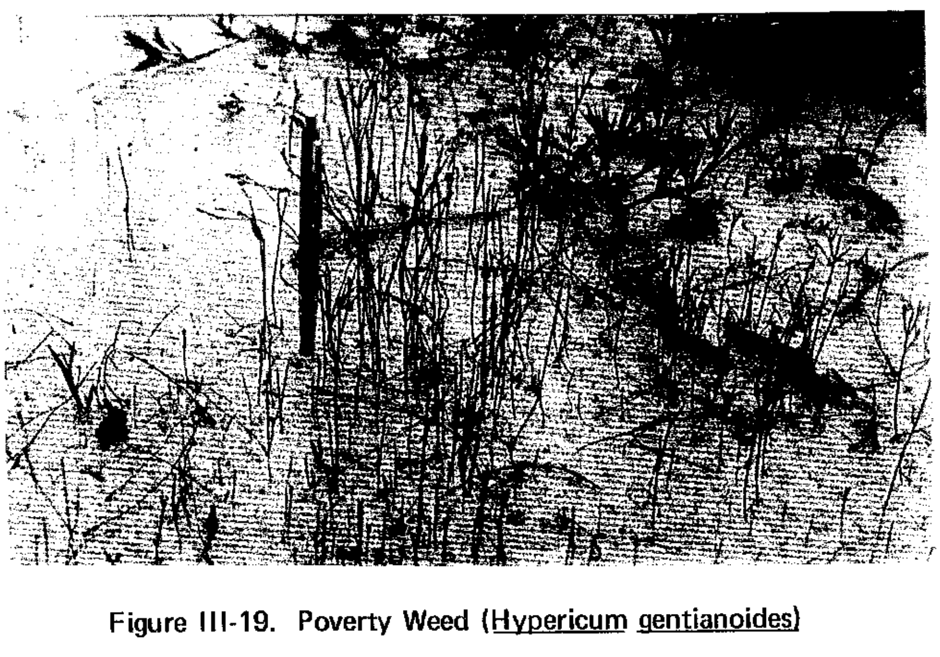


Figure III-19. Poverty Weed (Hypericum gentianoides)

TABLE III-2. VEGETATIVE COVER CHANGES AND DICOTYLEDONOUS PLANT SPECIES CHANGES BETWEEN JUNE 1971 AND JUNE 1973

400 BY 400 FT AREAS SURVEYED	CLASS RANKING		NUMBER OF DICOTYLEDONS COLLECTED		PERCENT INCREASE 1971 TO 1973
	1971	1973	1971	1973	
B-8, M-7, N-8	O	I, II	[a]5	[a]10	100
L-10, N-5, M-2	I	I,II,III	[a]6	[a]13	116
D-12, A-11, C-11	II	IV	[a]13	[a]23	76
D-9, K-13, J-1	III	IV	[a]17	[a]27	59
D-7, C-6, E-3	IV	V	[a]19	[a]37	94
E-6, F-12, H-11	V	V	[a]24	[a]37	54
Grid I Area	IV	IV	17	27	59
Control Area 1	V	V	28	39	39
Control Area 2	ND	IV	ND	44	ND

[a]Average of the three 400 by 400 ft areas

TABLE III-3. SPECIES OF DICOTYLEDONOUS SHRUBS AND HERBS COLLECTED ON TA C-52A ONE SQUARE MILE GRID IN SUMMER 1971 AND 1973

SPECIES	COMMON NAME	VEGETATIVE CLASS AND FREQUENCY OF OCCURENCE
SHRUBS		
*Baptisia ellipitica	wild indigo	V; rare
*Baptisia hirsuta	wild indigo	V; rare
Callicarpa americana	American beautyberry	IV; rare
Diospyros virginiana	common persimmon	IV; infrequent
Ilex glabra	gallberry	V; infrequent
Ilex opaca	American holly	IV; infrequent
Lespedeza sp.		III; rare
Pinus clausa	sand pine	IV; rare
Pinus palustris	longleaf pine	IV; rare
Quercus laevis	turkey oak	III, IV, V; frequent
Quercus sp.		V; infrequent
Quercus sp.		IV; infrequent
Quercus sp.		III, IV; infrequent
Quercus sp.		IV, V; infrequent
HERBS		
Acanthospermum australe	paraquay bur	III; frequent
Achillea millefolium	common yarrow	III; infrequent
Agaloma discoidalis		II, III; frequent
*Agalinis divaricata	foxclove	IV, V; infrequent
Ambrosia artemisiifolia	common ragweed	II, III, V; frequent
*Arenaria caroliniana	Carolina sandwort	II, IV, V; rare
Asclepia humistrata	common milkweed	IV; rare
*Asclepias tuberosa	butterfly weed	IV; rare
*Asyrum hypericoides	St Andrews cross	IV; rare
*Baccharis halimifolia	groundsel baccharis	
*Balduina angustifolia		IV, V; rare
Bigelowis nudata		V; infrequent
Cassia fasciculata	partridgepea senna	0,I,II,III; frequent
Centella asiatica		V; rare
*Chenopodium sp.	goosefoot	V; rare
Chrysobalanus oblongifolius	gopher apple	III, V; frequent
*Chrysoma pauciflosculosa		V; rare
*Chrysopsis aspera	golden-aster	
Chrysopsis graminifolia	grassleaf golden-aster	II; infrequent
Chrysopsis mixta	golden-aster	II; infrequent
*Clitoria fragrans	pigeonwings	V; rare
Cnidoscolus stimulosus	risky treadsoftly	III, IV; infrequent
Crotalaria maritima	rattlebox	III, IV, V; infrequent
Crotalaria sagittalis	arrow crotalaria	V; rare

*Collected only in June 1973

TABLE III-3. CONTINUED

SPECIES	COMMON NAME	VEGETATIVE CLASS AND FREQUENCY OF OCCURENCE
HERBS Continued		
*Croton argyranthemus		V; rare
Croton glandulosus	tropic croton	III; rare
*Cuphea sp.	cuphea	IV; rare
Diodia teres	rough buttonweed	all classes; common
Erechtites hieracifolia	fireweed	V; infrequent
*Erigeron annuus	annual fleabane	IV,V; frequent
Eriogonum tomentosum	wild buckwheat	II,IV; infrequent
Eupatorium capilifolium	dogfennel	II,III,IV; frequent
*Euphorbia maculata	spotted spurge	I,II,IV,V; frequent
Euphorbia supina Raf.	prostrate spurge	I; infrequent
Froelichia floridana	Florida snakecotton	I; infrequent
Galactia microphylla	milkpea	II,III; infrequent
Gnaphalium falcatum	cudweed	IV; infrequent
Gnaphalium obtusifolium	fragrant cudweed	IV,V; frequent
Gnaphalium purpurem	purple cudweed	III,IV; infrequent
Hedyotis procumbens		V; rare
Hedyotis uniflora		V; rare
*Heterotheca subaxillaris	camphor telegraph plant	IV; rare
Hypericum gentianoides	poverty weed	II,III,IV; frequent
*Hypericum myrtifolium	St Johns-wort	V; infrequent
*Kalmia harsuta	sandhill kalmia	V; rare
*Kragia virginica		IV; rare
Lechea patula	pinweed	III,IV; frequent
*Lechea villosa	hairy pinweed	IV; rare
*Liatris secunda	pinkscale gayfeather	V; infrequent
*Liatris gracilis	slender gayfeather	V; infrequent
Lithospermum caroliniense	Carolina gromwell	I,III; infrequent
Lobelia brevifolia	lobelia	V; frequent
Lugwigia virgata	false loosestrife	V; rare
Lupinus diffusus		0,I,III; infrequent
Lupinus nuttallii	sandhills lupine	I; rare
Mollugo verticillata	carpetweed	I; rare
Oxalis stricta	yellow woodsorrel	III; rare
Paronychia patula	nailwort	I,II,III; frequent
Petalostemon caroliniense	prarie-clover	I; infrequent
Phlox floridana	Florida phlox	II; infrequent
*Physalis heterophylla	clammy groundcherry	V; rare
Pluchea rosea		V; rare
Polygala nana	bachelor button	IV,V; infrequent
Polygala polygama	bitter polygala	II,III,IV,V; frequent
Polygala sp.	polygala	III; infrequent
*Polygonella gracilis	jointweed	I,II,IV; frequent

*Collected only in June 1973

TABLE III-3. CONCLUDED

SPECIES	COMMON NAME	VEGETATIVE CLASS AND FREQUENCY OF OCCURENCE
HERBS Concluded		
Polypremum procumbens	common polypremum	IV; infrequent
*Pterocaulon undalatum		V; rare
Rhexia alifanus	meadowbeauty	IV; frequent
*Rhexia lutea	yellow meadowbeauty	V; frequent
*Rhexia mariana	Maryland meadowbeauty	V; rare
*Rhexia salicifolius		V; rare
*Rhexia virginiana	common meadowbeauty	V; rare
Rhynchosia galactioides	pinebarrenpea	I,II,IV; frequent
Rhynchosia reniformis	dollarleaf rhynchosia	V; rare
Rubus sp.	blackberry	III; infrequent
*Rudbechia hirta	blackeyed coneflower	IV,V; rare
Rumex acetosella	red sorrel	II,III,IV; frequent
*Sabatia angularis	rosegentian	V; rare
Schrankia microphylla	littleleaf sensitive brier	IV,V; infrequent
*Smilax sp.	greenbrier	II,IV,V; frequent
Sophronanthe hispida		IV,V; frequent
Stylisma villosa		0,I; rare
Stylosanthes biflora	twin pencilflower	III; rare
Tephrosia sp.		III; rare
Tithymalus spaerospermus	common euphorbia	all classes; common
Tragia linearifolia	noseburn	IV; rare
Tragia smallii	noseburn	V; rare
*Tragia sp.	noseburn	V; rare
*Verbena carnea	verbena	V; rare
Vernonia angustifolia	ironweed	IV; infrequent
Wahlenbergia merginata	rockbell	III,IV; infrequent
Warea sessilifolia		III,IV; infrequent

*Collected only in June 1973

TABLE III-4. DATA COMPARISON OF PERCENT VEGETATIVE COVER BY VISUAL OBSERVATION OF OVERALL PLOT VERSUS THE SQUARE-FOOT TRANSECT METHOD, 1973 DATA

VEGETATIVE CLASS/SITE	VEGETATIVE CLASS CRITERIA	VISUAL ESTIMATE[a]	SQUARE-FOOT TRANSECT[b]
Class I	5 to 20%	19	11
Class II	20 to 40%	29	19
Class III	40 to 60%	60	41
Class IV	60 to 80%	76	67
Class V	80 to 100%	89	80
Control Site 2[c]		75	45
Grid 1[d]		75	47

[a]Average of 12 estimates

[b]Average of 27 transects

[c]Located 0.1 mile west of Sampler E-1

[d]Center section of Grid 1 located 1000 feet south of Sampler 0-7

e. Conclusions

A comparison of vegetative coverage and occurrence of plant species on the one square mile grid between June 1971 and June 1973 has shown that areas with 0 to 60% vegetative cover in 1971 have a coverage of 15% to 85% in 1973. Those areas having 0 to 5% coverage in 1971 (areas adjacent to or under flightpaths used during herbicide equipment testing) now have 15% to 54% coverage. The rate of change in the coverage seems to depend on soil type, soil moisture, and wind; there is no evidence to indicate that existing vegetative coverage is in any way related to herbicide residue in the soil. Dicotyledonous or broadleaf plants that are normally susceptible to damage from herbicide residues presently occur throughout the entire one square mile grid.

SECTION IV

STUDIES OF THE ANIMALS OF TEST AREA C-52A

In May 1970, a survey was initiated to determine the animal species composition of the spray-equipment testing grid on TA C-52A and within the adjacent 11 square mile area. The purpose of this survey was to determine the extent of faunal ecological alteration that occurred in the test area due to repetitive applications of military herbicides.

It was expected that application of military herbicides would temporarily alter the faunal ecology of an area, primarily due to the changes in the vegetation. It had been postulated that the animals living in a sprayed area would either be killed outright by herbicides or would receive doses via water or food that would affect their reproductive processes. Laboratory studies dealing with the teratogenic and embryotoxic effects of TCDD, a contaminant found in 2,4,5-T, have been reported (Reference IV-1). It had also been suggested that animals would totally avoid a sprayed area either due to the lack of food, the offensive appearance or taste of the vegetation, or odors produced by the herbicides or their degradation products.

The objectives of this animal survey were to determine species variation, distribution patterns, migration, and relative population sizes as found on the test grid or immediately adjacent to it. Methods of study included early morning, midday, and night field trips for identification and collection of mammals, birds, reptiles, and amphibians. Many species collected were brought into the laboratory where they were photographed and either preserved or mounted, and these now serve as a reference collection to facilitate identification for subsequent studies.

The results of the 1970 animal survey were reported in Reference IV-2. A synopsis of the 1972 report and comments concerning its correlation to the 1973 studies are included in this report.

1. SYNOPSIS OF QUALITATIVE ANIMAL SURVEYS, 1970 - 1973

A total of 18 mammal species were observed off the test grid with 12 of these species also being found on the grid. All of the animals sighted on the grid used the area for foraging or as a source of drinking water except the beach mouse and the hispid cotton rat, which were using the area as their habitat. The hispid cotton rat was first seen on the grid during the 1973 study. Table IV-1 lists the mammals observed both on and off the grid. The most important economic population in the area was the deer herd. Night field trips yielded average counts of from 24 to 36 deer on the grid and within the immediate area. Close inspection of aquatic areas on the grid during early morning field trips revealed extensive activity the previous nights. In addition to the deer herd a sizable herd of feral hogs earlier crossed with Russian Boars, also inhabited the area. The hogs frequented the marshy areas, drinking and rooting for food.

During the spring of 1970, a red fox was frequently observed close to the grid and its den was found approximately 100 yards from the edge of the grid. Five kits were found in the den and based upon gross observations, they appeared healthy and normal.

The most common rodents found off the grid in 1970 along the streams that drain the area were the cotton mouse and the hispid cotton rat. In the fields surrounding the grid, the eastern

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References:

IV-1. Report of the Advisory Committee on 2,4,5-T to the Administrator of the Environmental Protection Agency, 7 May 1971

IV-2. Pate, B. D., R. C. Voigt, P. J. Lehn, and J. H. Hunter: Animal Survey Studies of Test Area C-52A, Eglin AFB Reservation, Florida. AFATL-TR-72-72, Air Force Armament Laboratory, Eglin AFB, Florida, April 1972. Unclassified.

TABLE IV-1. MAMMALS FOUND ON THE 1 SQUARE MILE GRID AND WITHIN THE ADJACENT 11 SQUARE MILE AREA

SPECIES	COMMON NAME	AREA WHERE OBSERVED	
		ON GRID	OFF GRID
Canis familiaris	wild dog	[a] +	+
Dasypus novemcinctus	armadillo	+	+
Didelphis marsupialis	opossum	+	+
Geomys pinetis	southeastern pocket gopher	—	+
Lynx rufus	bobcat	+	+
Mephitis mephitis	striped skunk	+	+
Odocoileus virginianus	whitetail deer	[b,c] +	[b,c] +
Oryzomys paulustris	rice rat	—	+
Peromyscus gossypinus	cotton mouse	—	[c] +
Peromyscus polionotus	beach mouse	[b,c] +	+
Reithrodontomys humulis	eastern harvest mouse	+	[c] +
Procyon lotor	racoon	+	+
Sciurus carolinensis	eastern gray squirrel	—	+
Sciurus niger	eastern fox squirrel	—	+
Sigmodon hispidus	hispid cotton rat	[a] +	[b,c] +
Sus scrofa	wild pig	+	+
Sylvilagus floridanus	eastern cottontail rabbit	+	+
Vulpes fulva	red fox	—	+

[a]Species found on or off grid for first time, 1973 data

[b]Dominant species; sighted during 80% of the field trips, 1973 data

[c]Dominant species; sighted during 80% of the field trips, 1970 data

harvest mouse was common. Eight pairs of the eastern harvest mouse were taken into the laboratory and allowed to breed. Six of the eight pairs had litters totalling 24 offspring which were normal in size and free from any apparent birth defects.

During the 1973 study, only two cotton mice and two eastern harvest mice were found. The cotton mice were caught near a stream draining the grid, and the eastern harvest mice were captured on the grid. There were eight beach mice captured off the grid in areas along streams and in open fields.

The most common rodent species on the grid was the beach mouse. Trapping studies during the summer of 1970 showed that this species was widely distributed throughout the grid, except in areas with less than 5% vegetative cover. In the 1973 study, the beach mouse was found predominantly in the areas of 5% to 60% vegetative cover.

At least 25 species of birds were observed in the area immediately adjacent to the grid or feeding within its boundaries. Many more species than those listed in Table IV-2 are found in the more densely forested areas near the outer limits of the 2 mile radius.

In 1970, seven species of water birds and waders were sighted repeatedly in the aquatic areas on or off the grid. The most common birds on the grid were the meadow lark and the mourning dove. It seems significant that all birds sighted, with the single exception of a grasshopper sparrow (caught in a live animal trap) were medium to large species.

In 1973, the first sightings of red-wing blackbirds and little blue heron occurred on the grid. In 1970, the meadow lark was the predominant species of bird found, while in 1973, frequent and repeated sightings of night hawks, bobwhite quail, Mississippi kites, mourning doves and meadow larks were reported.

Eighteen species of reptiles were collected or observed, with 10 species recorded on the grid and 12 species from the surrounding area (Table IV-3). Differences in faunal species composition on and off the grid due to vegetation differences can best be illustrated with the reptiles. Those species that are adaptable and occupy a variety of niches were found both on and off the grid in large numbers. The dominant species on the grid was the six-lined racerunner, and it was also one of the dominant species in the wooded area surrounding the grid. Those species whose habitat is characterized by definite vegetative type cannot adapt to the open habitat of the grid. The green anole and southern fence lizard are two of these. There are also species which occur in the forest areas but are more plentiful in the open areas, such as the eastern coachwhip. In 1973, the first softshelled turtle was seen on the grid.

Twelve species of amphibians were collected (Table IV-4). The amphibian population on the grid centered mainly around the aquatic areas with the exception of the two toad species, which were also found in the dry areas. There were breeding populations throughout most of the year in the aquatic areas on the grid: the southern cricket frog, the southern toad, the oak toad, the barking tree frog, the southern leopard frog, and the squirrel tree frog. The slimy salamander is one of the dominant species in the surrounding forest but does not occur on the grid, presumably because of its need for sufficient moist ground cover. The squirrel tree frog and the hog-nosed waterdog were first reported on the grid in the 1973 study.

2. CURRENT STUDIES ON ANIMALS

In the 1970 animal survey, 73 species of vertebrates were observed on and off the test grid. The most frequently observed species on the grid was the beach mouse Peromyscus polionotus

TABLE IV-2. BIRDS FOUND ON THE 1 SQUARE MILE GRID AND WITHIN THE ADJACENT 11 SQUARE MILE GRID

SPECIES	COMMON NAME	AREA WHERE OBSERVED	
		ON GRID	OFF GRID
Accipiter striatus velox	sharp-shinned hawk	+	+
Agelaius phoeniceus	red-wing blackbird	[a]+	+
Ammodramus savannarum	grasshopper sparrow	+	+
Bubulcis ibis	cattle egret	+	+
Botaurus lentiginosus	American bittern	+	+
Buteo jamaicensis	red-tailed hawk	—	+
Buteo liniatus	red-shouldered hawk	—	+
Butorides virescens virescens	eastern green heron	+	—
Caprimulgus vociferus	eastern whippoorwill	—	+
Casmerodius acbus egretta	American egret	+	+
Cathartes aura	turkey vulture	+	+
Chordeiles minor	night hawk	[b]+	[b]+
Colinus virginianus	bobwhite quail	[b]+	[b]+
Coragyps atratus	black vulture	+	+
Corvus brachyrhynchos	American crow	+	+
Florida caerulea	little blue heron	[a]+	+
Elanoides forficatus forficatus	swallowtail kite	+	+
Falco sparverius	sparrow hawk	—	+
Ictinia misisippiensis	Mississippi kite	[b]+	+
Sturnella magna	meadow lark	[b,c]+	[b]+
Turdus migratorius	robin	+	+
Zenaidura macroura	mourning dove	[b]+	[b]+
Unidentified Duck		+	+
Unidentified Goose		+	+
Unidentified Grebe		+	+

[a]Species found on grid for the first time, 1973 data

[b]Dominant species; sighted during 80% of the field trips, 1973 data

[c]Dominant species; sighted during 80% of the field trips, 1970 data

TABLE IV-3. REPTILES FOUND ON THE 1 SQUARE MILE GRID AND WITHIN THE ADJACENT 11 SQUARE MILE AREA

SPECIES	COMMON NAME	AREA WHERE OBSERVED	
		ON GRID	OFF GRID
Agkistrodon piscivorus	eastern cottonmouth	+	+
Alligator mississippiensis	American alligator	[a]+	+
Anolis carolinensis carolinensis	green anole	–	+
Cnemidophorus sexlineatus	six-lined racerunner	[b,c]+	[b,c]+
Coluber constrictor priapus	southern black racer	+	+
Crotalus adamanteus	eastern diamondback rattlesnake	+	–
Elphae guttata guttata	corn snake	–	+
Ferox sp.	soft-shelled turtle	[a]+	–
Heterodon platyrhinos	eastern hognose	+	–
Lampropeltis doliata doliata	scarlet kingsnake	+	–
Lygosoma laterale	ground skink	–	+
Masticophis flagellum flagellum	eastern coachwhip	+	+
Natrix sipedon pictiventris	Florida water snake	–	+
Pituophis melanoleucus mugitus	Florida pine snake	+	–
Pseudemys scripta scripta	yellow-bellied turtle	+	–
Sceloporus undulatus undulatus	southern fence lizard	–	+
Sistrurus miliarius barbouri	dusky pigmy rattlesnake	–	+
Sternotherus minor minor	loggerhead musk turtle	–	+

[a]Species found on grid for the first time, 1973 data

[b]Dominant species; sighted during 80% of the field trips, 1970 data

[c]Dominant species; sighted during 80% of the field trips, 1973 data

TABLE IV-4. AMPHIBIANS FOUND ON THE 1 SQUARE MILE GRID AND WITHIN THE ADJACENT 11 SQUARE MILE AREA

SPECIES	COMMON NAME	AREA WHERE OBSERVED	
		ON GRID	OFF GRID
Acris sryllus gryllus	southern cricket frog	b+	b+
Bufo quercicus	oak toad	b+	–
Bufo terrestris	southern toad	b+	b+
Eurycea bislineata cirrigera	southern two-lined salamander	–	+
Gastrophryne carolinensis	eastern narrow-mouthed toad	–	+
Hermidactylium sccutatum	four-toed salamander	–	+
Hyla gratiosa	barking tree frog	b+	+
Hyla squirella	squirrel tree frog	a,b+	–
Necturus beyeri	hog-nosed waterdog	a+	–
Plethodon glutinosus glutinosus	slimy salamander	–	+
Rana clamitans clamitans	bronze frog	–	+
Rana pipiens/ sphenocephala	southern leopard frog	b+	b+

[a]Species found on grid for first time, 1973 data
[b]A breeding population

and the six-lined racerunner Cnemidophorus sexlineatus. These two species were suggested as candidates for future studies of population distribution. During the months of February, March, and May 1971 a trapping study was performed on the test area for three, 4-day periods in each month (Reference IV-3). A total of 38 beach mice were captured during the three trapping periods. Thirty beach mice were captured during the February-March periods, and of these, six from the test grid and three from a control area were examined for gross deformaties. Sections of liver, kidney, and gonads were free of abnormalities, and no cleft palates were observed.

The primary purpose of the present study was two fold. First (Test Program I), animals were to be obtained for examination of gross and microscopic lesions, since it has been reported (Reference IV-1) that TCDD produces teratogenic and embryotoxic effects under certain experimental conditions. Second (Test Program II), the trapping survey discussed in the previous paragraph was to be expanded in an attempt to correlate habitat preference for the most prevalent mammal observed on the grid in order to determine if the population distribution is related to vegetative cover.

3. MATERIALS AND METHODS

Traps used for this study were Havahart traps (Havahart Traps, Department 1, P.O. Box 551, Ossining, N.Y. 10562) numbers 0 and 1 for small mammals. Traps were baited with peanut butter and oatmeal.

In June 1973, Test Program I was initiated by placement of traps on the square mile grid in two patterns. At first, one trap was placed in every other plot (400 by 400 foot areas) in every other row. For example, Row A had one trap each in plots 1, 3, 5, 7, 9, 11, and 13. Row C had one trap each in plots 2, 4, 6, 8, 10, and 12. Four to eight traps were placed in these areas. A total of 90 traps were emplaced. Traps were checked daily and the trapping duration was one week. A second portion of Test Program I utilized four sampling plots with distinct physical characteristics and involved the placement within each plot of 25 traps in five rows of five traps each, 20 paces apart, in each plot. Historically, these areas were exposed to low or high concentrations of herbicide[3]. Traps were checked daily, and the trapping was carried out for 7 days. In October 1973, a third portion of Test Program I was conducted on Grid 1 exclusively (Figure I-5). Grid 1 was divided into equal quadrants North-South and East-West, and was numbered upper left (Area 1), lower left (Area 2), lower right (Area 3), and upper right (Area 4). Twenty-five traps were placed in each area in two rows of 10 traps per row and one row of five traps with 15 paces between traps. The rows were located at 250, 500, and 750 feet from the center of the grid on the ordinate. Traps were checked daily for 7 days.

Mice, rats, and reptiles were taken to the laboratory for gross examination and prepared for histologic examination. The majority of the animals were alive on arrival but some had succumbed to the intense heat and confinement in the trap.

Live animals were subjected to a euthanasic procedure using ether. All animals were photographed, weighed, measured, and examined for developmental defects such as cleft palate, cleft lip, polydactyly, and micro-ophthalmia. All internal organs were examined for gross lesions, and individual organ weights were recorded. Representative sections of each tissue were placed in

[3]Personal communication with Donald King, Department of Zoology, University of Minnesota, Minneapolis, Minnesota.

neutral 10% buffered formalin and processed for microscopic study by the Veterinary Pathology, Washington, D.C. 20305. All remaining control and grid rat liver tissue and mouse fat and liver tissues were collected, placed in clean glass jars, frozen, and sent to the Interpretive Analytical Services Laboratory, Dow Chemical U.S.A., for TCDD analysis. The method of analysis was as described in Section II with the following exceptions: Ten grams of tissue were added to 10 ml ethanol and 20 ml 40% aqueous KOH and refluxed 2 hours. The resulting mixture was extracted with four 10 ml portions of hexane. The hexane extracts were combined, subjected to H_2SO_4 extraction and the same subsequent steps as in analysis of the soil samples.

Recovery studies using blank fish, beef liver, and soil averaged 70+% at the 10 to 25 part per trillion level.

In Test Program II, eight mouse traps were placed by computer randomization in areas which were classified according to vegetative coverage. Five vegetative areas were classified as follows: 5% to 20% coverage; 20% to 40% coverage; 40% to 60% coverage; 60% to 80% coverage; 80% to 100% coverage (see Section III, Figure III-3). Three of the 400 by 400 foot plots for each of Classes 1 to 5 were chosen at random. Eight pairs of coordinates were generated using the library random number generator for the Wang 720C programmable calculator. Each trap was placed in accordance with these coordinates. A total of 120 traps were utilized. Animals thus trapped were ear tagged with size 1, sequentially numbered, fingerling tags (National Band and Tag Company, Newport, Kentucky, 41071) and species, sex, and trap location was recorded. They were examined for external abnormalities and released. Traps were checked daily during the 8 days this study was conducted, and records were kept of original capture and the recapture of individual animals.

4. RESULTS AND DISCUSSION

During Test Program I, several different species of animals were caught, both on and off the test grid (Table IV-5). The sex distribution of the trapped animals was 23 male and 14 female beach mice, eight male and eight female cotton rats, two female eastern harvest mice, one male and one female cotton mice, ten male and seven female six-lined racerunners, one male eastern cotton mouth, and one male toad.

TABLE IV-5. TOTAL NUMBER AND LOCATION OF ANIMALS COLLECTED DURING 1973 TEST PROGRAM I

CLASS	COMMON NAME	OFF GRID	ON GRID
Mammalia			
	beach mouse	8	42
	cotton rat	10	6
	eastern harvest mouse	0	2
	cotton mouse	2	0
Reptilia			
	six-lined racerunners	4	13
	eastern cottonmouth	1	0
Amphibia			
	toad	1	0

The age of the rodents was determined by histological examination of the gonads based on the presence or absence of sperm or ova (gametes) in the gonads. Animals with gonads showing gametogenesis were classified as adults and those with gonads showing no gametogenesis were classified as immature. The age of the animals varied, but adults predominated in the sample, 55 adults, 33 immature. Nine pregnant mice and five pregnant rats were found in the adult female animals. The stage of gestation varied considerably from early pregnancy to near term. Fifty-four embryos and fetuses were examined grossly and microscopically. No developmental defects or other lesions were seen.

Gross necropsy lesions were relatively infrequent in the test population and consisted primarily of lung congestion in those animals that died prior to being brought to the laboratory. No developmental defects were seen in any of the adult animals.

Histologically, the tissues of 13 of the 26 control animals and 40 of the 63 animals from the test grid were considered normal. Microscopic lesions were noted in some animals from both groups. For the most part, these were minor changes of a type that would be expected in any animal population. One of the most common findings was parasites. A total of 11 controls and 9 grid animals were affected with one or more classes of parasites. These are summarized in Table IV-6.

Parasites may be observed in any species, and those in this population were for the most part incidental findings that were apparently not harmful to the animal. There were exceptions however. Protozoan organisms had produced focal myositis in one rat and were also responsible for hypertrophy of the bile duct epithelium in a six-lined racerunner.

Moderate to severe pulmonary congestion and edema were seen in several rats and mice. All of these animals were found dead in the traps before reaching the laboratory, and the lung lesions were probably the result of heat stroke. The remainder of the lesions in both groups consisted principally of inflammatory cell infiltrates of various organs and tissues. They were usually mild in extent, and although the etiology was not readily apparent, the cause was not interpreted as toxic.

It was highly improbable that any of the mice trapped during this study were alive during the final phase of herbicide dissemination (September 1970), although the life span of the beach mouse has been reported to be 5 years in captivity (Reference IV-3). A portion of the grid population was certainly made up of offspring of these animals present in 1970. Emigration from, or immigration to, the test grid could occur, especially on the fringe areas, since it has been reported that the area traveled by an individual beach mouse during its daily activities may extend to 5 acres (Reference IV-4).

An analysis of the ratios of organ weight to body weight, and organ weight to body length for mice captured off the grid versus mice captured on the grid was conducted within the severe constraints of limited data (June 1973 data). Female mice were not considered due to the fact all

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References:
IV-3. Benton, A.H. and W. E. Werner, Jr. Field Biology and Ecology. McGraw Hill, New York, 1966.
IV-4. Andrewartha, H.G. Introduction to the Study of Animal Populations. University of Chicago Press, 1961.

control females were pregnant and showed large individual body weight and organ weight variations. Only two of 11 female mice from the grid were pregnant. There were five control males (three mature and two immature) and 18 males (ten mature and eight immature) captured on the grid. Complete organ data were available only for 13 of the 18 grid males (nine mature and 4 immature).

It is recognized that the mature and immature mice will likely show different characteristics; however, combination of these two groups was necessary to produce any reasonable sample size. The t test for unpaired samples was used on 16 different factors (Table IV-7). These factors are as designated below:

FACTOR		DESCRIPTION
A	=	Total organ weight/body length
B	=	Total organ weight/body length
C	=	Sum of lung, heart, kidney, and brain/body weight
D	=	Sum of lung, heart, kidney, and brain/body weight
E	=	Lung weight/body weight
F	=	Heart weight/body weight
G	=	Spleen weight/body weight
H	=	Liver weight/body weight
I	=	Kidney weight/body weight
J	=	Brain weight/body weight
K	=	Lung weight/body length
L	=	Heart weight/body length
M	=	Spleen weight/body length
N	=	Liver weight/body length
O	=	Kidney weight/body length
P	=	Brain weight/body length

Formula for the procedure used:

$$"t" = \frac{\left| \frac{\Sigma X_2}{N_2} - \frac{\Sigma X_1}{N_1} \right|}{\sqrt{\dfrac{\left[\Sigma X_1^2 - \dfrac{(\Sigma X_1)^2}{N_1} + \Sigma X_2^2 - \dfrac{(\Sigma X_2)^2}{N_2} \right]}{N_1 + N_2 - 2} \left[\dfrac{N_1 + N_2}{N_1 N_2} \right]}}$$

Where

$N_1 + N_2 \neq 2$

TABLE IV-6. PARASITES FOUND IN RODENTS COLLECTED FROM CONTROL AND TEST AREA SITES, JUNE 1973

LOCATION	NUMBER OF ANIMALS EXAMINED	NUMBER OF ANIMALS EFFECTED	PARASITES		
			NEMATODES	CESTODES	PROTOZOANS
Control	20	11	9	1	5
Test Area[a]	50	9	4	0	7

[a]Animals trapped on Grids 2, 3, and 4

TABLE IV-7. SUMMARY OF RESULTS OF ORGAN WEIGHT TO BODY WEIGHT, AND ORGAN WEIGHT TO BODY LENGTH FOR MICE OFF THE GRID VERSUS MICE ON THE GRID (H ≡ On-Grid and Off-Grid Samples are from the Same Population)

$\nu = 16$

FACTOR	t	P (exceeding t, Given H)
A	0.1863	0.43
B	0.8859	0.19
C	0.9750	0.17
D	0.1025	0.45
E	1.6618	[a]0.06 [b](0.05)
F	0.2750	0.38
G	1.1025	0.14
H	0.7077	0.25
I	2.2228	[a]0.02 [b](0.10)
J	0.2363	0.41
K	0.6500	0.27
L	0.5659	0.29
M	0.4979	0.32
N	1.0214	0.16
O	1.1034	0.14
P	1.1647	0.13

[a]Significant at $p \leq 0.05$

[b]Value when control animal with lung and kidney lesions is removed from sample

When the ratios of average body weight to average organ weight of various visceral organs were compared between the male mice captured on the grid and the male mice captured off the grid it was found that on the average, the control animals had lung and kidney weights that varied significantly at the 95% confidence level. The lung variation just being significant. When this information was compared to the pathological work-up, it was found that one male control animal had multifocal subacute pneumonitis and multifocal subacute nephritis. When this animal was removed from the sample, the ratio of kidney weight/body weight between the control and grid animals no longer varied significantly. The lung weight/body weight variation became slightly more significant. It is felt this variance is due to the difference in ratio of mature to immature animals between the two groups, i.e., controls 3:2 compared to 9:4 for the grid animals.

The analyses for TCDD from rodents collected in June and October 1973 are shown in Table IV-8. An initial interpretation would be that TCDD does in fact accumulate in liver and fat of tissue from rodents living on the test grid. Data from soil analysis (Table II-10, Section II) confirm the presence of TCDD in soils of the test area. Discrepancy of levels of TCDD between soils and tissues suggest the potential for bio-magnification of this compound. These data do not correlate with previously published research (Reference IV-5). Such levels encountered in the animals reported herein would be suspect of teratogenic or pathologic abnormalities. Such abnormalities, however, were not encountered in this study. It would appear that analytically, via mass spectrometry, the chemical detected is of a very similar nature to TCDD, but biologically does not behave in the manner characterized for TCDD (Reference IV-5).

TABLE IV-8. CONCENTRATION (PARTS PER TRILLION) OF 2,3,7,8-TETRACHLORO-DIBENZO-p-DIOXIN (TCDD) IN LIVER AND FAT SAMPLES FROM RODENTS COLLECTED FROM CONTROL AND TEST SITES ON TA C-52A, JUNE OR OCTOBER 1973[a]

RODENT	TISSUES	CONTROL	LOCATION	
			GRIDS 2, 3, 4	GRID 1
Rats	Liver, Fat[b]	< 20	210	No Sample[c]
Mice	Liver, Fat[b]	< 20	300	540[d]

[a]Analysis for TCDD was performed by the Interpretive Analytical Services, Dow Chemical U.S.A., Midland, Michigan
[b]Tissues represent a composite from all animals collected at the respective location
[c]Rats do not frequent dry areas.
[d]Sample collected in October 1973.

Reference:
IV-5. Conference on Dibenzodioxins and Dibenzofurans, Environmental Health Perspectives, Experimental Issue Number Five, September 1973, National Institute of Environmental Health Science, Research Triangle Park, North Carolina.

The beach mouse was reported in Reference IV-2 as the most common rodent species on the grid in 1970. Observations in the field indicate that the beach mouse remains the most common rodent on the grid.

The 1970 study (Reference IV-2) also indicated that the beach mouse was widely distributed throughout the grid except in areas of less than 5% cover. In an attempt to correlate distribution of the beach mouse with vegetative cover, a second test program (Test Program II) was initiated with a total of 83 animals being trapped during an 8 day period, 28 June to 3 July 1973. The majority of animals (63) were found in areas with 5% to 60% vegetative cover; within this range, the greatest number of animals trapped (28) was from an area with 40% to 60% cover (Figure IV-1). A similar habitat preference has been observed along the beaches of the Gulf Coast (Reference IV-5). In this study, it appears that the beach mouse utilizes the seeds of switchgrass, (Panicim virgatum) and woolly panicum (Panicum lanuginosum) for a food source, and these are two of the most dominant plants on the grid (see photographs in Section III). Seed husks of these plants have been observed in areas of mouse activity. It is possible that another prominant plant, broomsedge bluestem (Andropogon virginicus), also provides food for the beach mouse.

In an attempt to compare the trapping data from 1971 with those data obtained in the 1973 study and, hence, to determine whether an increase in the population of beach mice has occurred, the following assumptions were made:

a. It was assumed that the traps, the bait, and the methods employed for setting and placing the traps were equally as effective and similar in the 1971 and 1973 studies.

b. It was assumed that the density of trap placement was equally as effective and similar in the 1971 and 1973 studies.

c. It was assumed that traps should be no further apart that approximately 1-1/2 times the mean random travel distance of the animal being trapped. For beach mice, this distance is approximately 300 feet (Reference IV-5).

d. On the other extreme, it was assumed that the traps should not be so dense as to impede animal movement nor disrupt animal habits.

All trapping experiments involved in this study were conducted within these extremes.

In order to produce an estimate of the population density of the beach mouse in the herbicide treated area, it was necessary to determine what portion of that area was effectively surveyed. It was also necessary to normalize the areas sampled for comparison based on the mean random travel of the beach mouse from the 1973 recapture data. A tabulation was made of the distances between the trap where initial capture occurred and the trap location of the recapture farthest from the initial capture point. These distances represent the distances that the mice from the sample were known to have traveled and were assumed to be random samples from the population of habitat radii. The longest radius observed was 3,200 feet, the next longest was 285 feet, and the shortest was 45 feet. The 3,200-foot distance was disregarded as a freak occurence because such a number appeared only once out of a sample

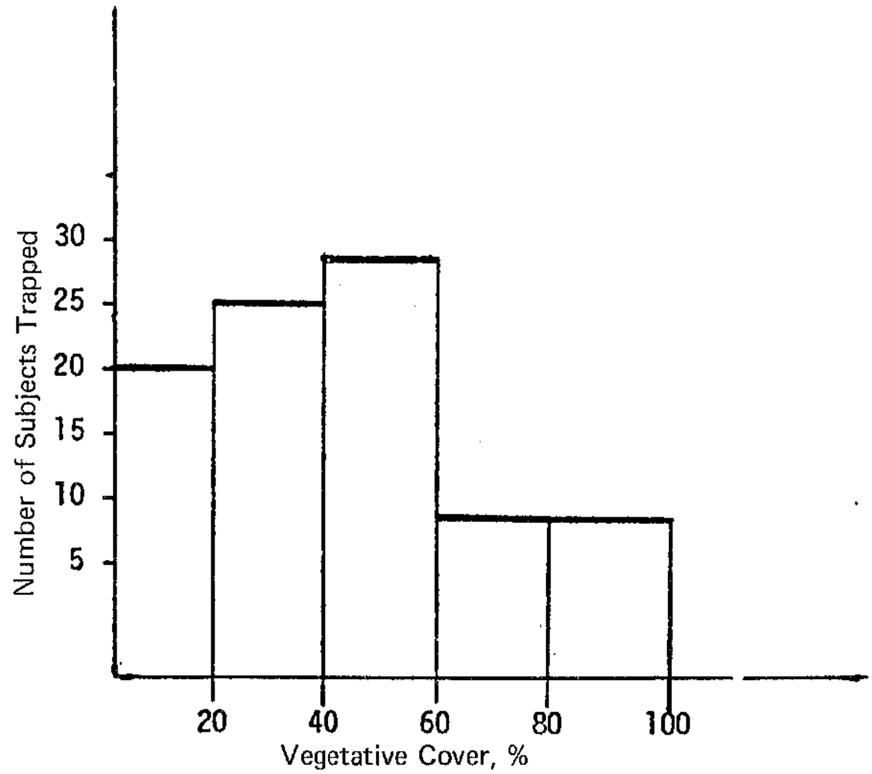

Figure IV-1. Relationship of Animals Trapped to Vegetative Cover

of 18 and it is more than 11 times as large as the next largest distance which is, itself, only 6.3 times as large as the smallest distance observed. The mean distance, 194 feet, of the remaining 17 distances was used as the average habitat radius. Circles with 194-foot radii were drawn using the traps of 12 randomly selected 400 by 400 foot plots as centers. The envelope area around the traps was estimated using a triangle, rectangle, or circle according to the fit which, by inspection, appeared to be the best. The average of the 12 areas measured was 8.3 acres with a standard deviation of 1.69, a maximum of 10.45, and a minimum of 5.17. The estimate, 8.3 acres, was used as the effective survey area for each group of eight traps.

a. Variation of the Lincoln Index

The Lincoln Index may be stated mathematically as:

$$P_1 = \frac{N_1(N_2 - R)}{R} + N_1$$

Where

P_1 = first population estimate

N_1 = pre-census sample

N_2 = total census sample

R = number of recaptures

Using the catch of 26 June and considering only the tagged animals, $N_1 = 13$. Using the catch of 27 June, $N_2 = 18$ and $R = 1$. According to this information, the first estimate is $P_1 = 222$. Enough uncertainty is introduced, however, such as how a dead animal should be counted in the pre-census sample, that an alternative method of estimation was desirable. The following equation was used to calculate the second estimate of the population.

$$P_2 = \frac{\sum_{i=1}^{8} \frac{N1_i (N2_{i+1} - R_{i+1}) + N1i}{R_i + 1}}{i_{max} - 1}$$

Where

N_1i = the catch from the ith day

$N_2 + 1$ = the catch from the (i + 1)th day

$R_i + 1$ = the recaptures from the (i + 1)th day which were captured on the (ith)day also

The values for $R_i + 1$ were corrected for the influence of mice no. 18, recaptured six times; no. 27. recaptured four times; no. 28, recaptured four times; no. 41, recaptured four times; no. 45 recaptured three times; and no. 50, recaptured three times. These mice were considered to be trap addicts. From the data available, $P_2 = 152$.

A third method was used for calculating P_3 in which the first catch was considered to be the pre-census and the second catch the census. A computer program to simulate the trapping of mice was developed with inputs of average sample size, Sa, and true population size, Pt. Twenty-five runs were made at specific values of Sa and Pt, and the estimated population was calculated with the Lincoln Index and averaged over the 25 trials. The average recapture number, Ra was also calculated. Pt was changed until $\overline{Ra}$ was equal to the observed recapture rate and $\overline{Sa}$ was equal to the observed sample size. $\overline{Pt}$ at these values is considered to be the best estimate of the population, i.e., $\overline{Pt}$ is the number most likely to produce the results which were observed in the real case. P_3 by this method was 191. This is not grossly different from the 222 and 152 estimated from P_1 and P_2. The average of P_1, P_2, and P_3 is probably the best overall estimate of the population. This average is approximately 189 total population - approximately 1.64 mice per acre.

5. CONCLUSIONS

Based on the pathologic findings of the Test Program I study, it was concluded that there was no evidence that the herbicide contaminant in question (TCDD) had produced any developmental defects or other specific lesions in the animals sampled or in the progeny of those that were pregnant. The lesions found were interpreted to be of a naturally occurring type and were not considered related to any specific chemical toxicity. The organ to body weight and organ to body length comparisons for the grid versus the control animals did not vary significantly when age and pathological lesions were considered. Chemical analysis of composite rodent liver and fat tissue indicated that there was an accumulation of TCDD-like chemical in tissue. If these data are valid (an assumption that may be challenged), what is the source of the TCDD? Seeds of switchgrass (Panicum virgatum) were found in abundance in the stomachs of beach mice. Samples of such seed collected from the test area were analyzed for TCDD. Results indicated no residue of TCDD at a minimum detection limit of less than 10 parts per trillion.

Based on information provided by the Test Program II study, it was concluded that the beach mouse forms a natural, integral part of the ecosystem of the Lakeland Sand Complex utilizing the dominant plants on the grid for food. The beach mouse continues to inhabit areas of 5% to 60% cover, with a preference for areas of 40% to 60% vegetative cover. This is indeed similar to the habitat preference of the beach mouse in other locations.

The statistical evidence derived from the Test Program II study shows that the 1.64 beach mice per acre population (based on the Lincoln Index for 1973) is slightly higher than the 0.8 and 1.4 mice per acre found on Santa Rosa Island (Reference IV-6). It was also concluded that the population of beach mice was higher in 1973 than in 1971 in the area of the test grid. Even though the first trial of the 1971 data reflected a higher count of mice per acre trapped, the low capture count on the second trial in 1971 indicates a lower actual population based on the Lincoln Index assumptions than the 1973 data. The apparent increase in beach mouse population on the grid in 1973 over 1971 was probably due to the natural recovery phenomenon of a previously disturbed area. Some areas of the test grid have already exceeded the preferred percentage of vegetative coverage of the beach mouse habitat, and other areas are either ideal or fast developing into an ideal habitat. If the test grid remains undisturbed and continues toward the climax species, a decline in the number of beach mice will probably occur simply due to his habitat preference.

Reference:
IV-6. Blair, W. F., Population Structure, Social Behavior, and Environmental Relations in Natural Populations of the Beach Mouse (Peromyscus polionotus leucephalus). Contribution from the Laboratory of Vertebrate Biological, University of Michigan, Number 48:1-47, June 1951.

SECTION V

INSECT DENSITY AND DIVERSITY STUDIES ON TEST AREA C-52A

During 1970 and 1971, an initial survey of the arthropod populations of Test Area C-52A, Eglin Air Force Base, Florida, was accomplished, and the results were published in Reference V-1.

1. SYNOPSIS OF PREVIOUS RESEARCH, MAY - JUNE 1971 (Reference V-1)

A sweep net survey of the insects on a 1 mile linear transect of Test Area C-52A resulted in the collection of more than 1,800 specimens belonging to 74 insect families and two non-insect arthropod orders. Eighteen of the taxa collected accounted for 97 percent of the collection, and of these, six taxa accounted for 72 percent of the collection: order Araneida (spiders), insect families Cicadellidae (leafhoppers), Elateridae (click beetles), Asilidae (robber flies), Hygaeidae (lygaeid plant bugs), and Pentatomidae (stink bugs). Spiders and robber flies are carnivores, stink bugs are carnivores or herbivores, and the other families are herbivores.

As plants were eliminated by the herbicides, those insects which fed specifically upon those plants disappeared; however, no direct effects of residue on the insects were observed.

The objective of the present study was to duplicate the techniques of the 1971 study as closely as possible in order to evaluate populations along the same grid line 2 years later. Qualitative and quantitative comparisons were drawn to indicate the changes in variety and number of arthropods (especially insects) that had become established on the grid since the aerial dispersal tests were terminated in 1970.

2. MATERIALS AND METHODS

The techniques used in the study discussed in this report were the same as those outlined in Reference V-1 except as discussed in the following paragraphs.

Time and manpower limitations precluded general, non-systematic sampling of the grid, therefore the bulk of this comparative study was based on sweep net surveys along sampler row 8 of the test area. This allowed a quantitative comparison of results while non-systematic net sampling of grid areas did not lend itself to such analysis. A total of five paired sweep net surveys were performed on the mornings of June 14, 16, and 18; these dates being approximately 2 years and 2 weeks after the study discussed in Reference V-1. A given "paired sweep" (200 sweeps made by 2 individuals using 15-inch diameter nets) was taken across the grid and then back to the starting point. The simultaneous sweeps were 20 feet apart. At the end of each 400 foot transect, rather than using killing jars, the net contents were emptied into a paper bag into which a vial of ethyl acetate had been placed. These bags were then tightly folded and placed in a large sack that was carried out to the same taxonomic level as in the 1971 study. Exceptions to this classification scheme included the listing of Acalypterate muscoid flies as a group and the listing of certain

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Reference:

V-1. Valder, S. M.: Insect Density and Diversity Studies on Test Area C-52A, Eglin AFB Reservation Florida. AFATL-TN-72-4, Air Force Armament Laboratory, Eglin AFB, Florida. January 1972. Unclassified.

undetermined insects only to order. Table V-1 represents a full listing of the arthropods found in the sweep net survey. The undetermined insects (112 specimens) for the most part were either immatures or only partial specimens. The identifications were based on information in Reference V-2.

Finally, due to time limitations, only one full set of sweep net survey samples had been identified at the time of this report. Therefore, while the 1971 report discussed the results of five 2-mile sweeps of sampler row 8 (essentially 10 replicates), the present study considers data only from one 2-mile sweep of the same sampler row (essentially two replicates of each 400 foot transect of the row). Representative specimens of the identified samples are in the reference collection of the Biological Studies Branch, USAF Environmental Health Laboratory, Kelly AFB, Texas.

3. RESULTS AND DISCUSSION

Those taxa or arthropods that were collected in numbers exceeding one percent of the total number of specimens collected are listed in Table V-2. This table was formatted for comparison with Table V-3 (from Reference V-1). (The various taxa are treated as families for simplicity.) Such a comparison indicated that even though the 1973 data are based on only one sweep of the grid, the total number of identified arthropods equaled 1,614 as compared to a total of 1,803 specimens from five sweeps in 1971. These data would then indicate that if the one 1973 sweep were representative of all five sweeps taken during this second study, the total number of insects caught would likely be greater than four times the number taken during the 1971 study. Further analysis of the data indicates that the 1973 survey found great numbers of very small insects as compared to the 1971 study. The majority of the Chrysomelid beetles were very small insects, and the Ocalyptrate muscoids, Psocoptera, Thysamoptera, Sminthuridae, Ocarine, and Chalcidoidea also fall into this small to minute category. Table V-1 represents a listing of all arthropods collected during the 1973 survey, and is compared to Table V-4 (from Reference V-1). Reference V-1, however, lists not only those arthropods collected in 1971, but also those groups only observed in 1970 and 1971. Therefore, the tables are not fully comparable either in taxa listed or in the number of specimens reported. Comparison of this second set of tables again shows a relatively large number of small insects found in the 1973 study. This discrepancy may simply represent a difference in sampling/separation techniques or it may indicate an influx of populations of these smaller arthropods as the vegetation and other environmental characteristics of the transects have developed since the spray program was terminated.

Figures V-1 and V-2 represent arthropod/vegetation comparisons on Test Area C-52A for both the 1971 and 1973 surveys. There exists a similarly vegetative distribution, and a slightly greater plant coverage is indicated in 1973. The extreme differences in the numbers of arthropods found on the transects during the 1971 study are shown as being reduced in 1973, and further replication as well as time would likely reduce these differences more. Comparisons of the arthropod populations have to take into consideration the fact that Figure V-1 is based on the total observed and collected specimens from Table V-4, while Figure V-2 is derived from only the identified specimens of a single sweep of the 1973 study. Therefore, although the graphs representing the number of arthropod "families" in both figures are relatively similar, and there is a tendency toward reduction of extreme differences in the 1973 transect data, further discussion and comparison might be spurious. Similar comments pertain to comparisons of the arthropod diversity graphs, even though basic

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Reference:

V-2. Pate, B. D., P. J. Lehn, R. C. Voigt, and J. H. Hunter: Animal Survey Studies on Test Area C-52A, Eglin AFB Reservation, Florida. AFATL-TR-72-72, Air Force Armament Laboratory, Eglin AFB, Florida. April 1972. Unclassified.

TABLE V-1. ANTHROPODS COLLECTED ON TEST AREA C-52A, EGLIN AFB RESERVATION, FLORIDA, JUNE 1973

TAXON	COMMON NAME	TOTAL SPECIMENS	NUMBER OF SPECIMENS COLLECTED ON TRANSECT												
			AB	BC	CD	DE	EF	FG	GH	HJ	JK	KL	LM	MN	NO
CLASS: ARACHNIDA															
ORDER: Araneida (Spiders)		144	4	9	9	16	18	36	18	7	6	6	8	4	3
ORDER: Acarine (Mites)		46			2	2	3	27	7			2	3		
CLASS: INSECTA															
ORDER: Coleoptera (Beetles) 275 Specimens collected															
Anthicidae	Antlike Flower Beetles	3						1	1		1				
Carabidae	Ground Beetles	1								1					
Chrysomelidae	Leaf Beetles	219	1	1	84	35	5	69	18			2	1		2
Cicindellidae	Tiger Beetles	7		2	1	1				1		1	1		
Coccinellidae	Lady Beetles	1											1		
Curculionidae	Snout Beetles	5		1			1		2				1		
Elateridae	Click Beetles	12		1	1	1		2		1	1	2	1	1	1
Meloidae	Blister Beetles	1							1						
Mycetaeidae	Mycetaeid Fungus Beetles	1							1						
Phalacridae	Shining Flower Beetles	12			11	1									
Tenebrionidae	Darkling Beetles	7	2	2			1	1							1
	Undetermined larvae and adults	6						2	3			1			
ORDER: Collembola (Springtails) 53 Specimens collected															
Sminthuridae		53			7	3	7	14	12	9		1			

TABLE V-1. ARTHROPODS COLLECTED ON TEST AREA C-52A, EGLIN AFB RESERVATION, FLORIDA, JUNE 1973 (Continued)

TAXON	COMMON NAME	TOTAL SPECIMENS	NUMBER OF SPECIMENS COLLECTED ON TRANSECT												
			AB	BC	CD	DE	EF	FG	GH	HJ	JK	KL	LM	MN	NO
ORDER: Diptera (Flies) 165 Specimens collected															
Acalyptrate	Muscoids	86	9	2	2	6	6	21	14	7	7	1	8	3	
Asilidae	Robber Flies	3									3				
Bombiliidae	Bee Flies	1							1						
Cecidomyiidae	Gall Midges	3			1	1							1		
Ceratopogonidae	Biting Midges	1					1								
Chironomidae	Midges	14			2	1	5	5	1						
Culicidae	Mosquitoes	2						1	1						
Muscidae	Muscid Flies	2						1	1						
Pipunculidae	Bigheaded Flies	3						1	1				1		
Sarcophagidae	Flesh Flies	4	1		2	1									
Syrphidae	Flower Flies	2			1				1						
Tachinidae	Tachina Flies	10		2	4	1	1		1			1			
Tipulidae	Crane Flies	1						1							
	Undetermined Adults	33		1	2	2	4	4	6	2	2	4	4	2	
ORDER: Ephemeroptera (Mayflies) 1 Specimen Collected															
Epnemeridae	Burrowing Mayflies	1				1									
ORDER: Hemiptera (True Bugs) 183 Specimens collected															
Corimelaenidae	Corimelaenid Bugs	6						1	5						
Corizidae	Grass Bugs	3	1	1			1								

TABLE V-1. ARTHROPODS COLLECTED ON TEST AREA C-52A, EGLIN AFB RESERVATION, FLORIDA, JUNE 1973 (Continued)

TAXON	COMMON NAME	TOTAL SPECIMENS	NUMBER OF SPECIMENS COLLECTED ON TRANSECT												
			AB	BC	CD	DE	EF	FG	GH	HJ	JK	KL	LM	MN	NO
ORDER: Hemiptera (True Bugs) Continued															
Lygaeidae	Lygaeid Bugs	6			1			4					1		
Miridae	Plant Bugs	33			2	1	1	13	5	3				6	2
Nabidae	Damsel Bugs	33	2	7		3		3	1	2	5	1	7	2	
Neididae	Neidid Bugs	1		1											
Pentatomidae	Stink Bugs	1				1									
Reduviidae	Assassom Bugs	19			3	1		4	3	1	1	2	3	1	
Scutelleridae	Scutellerid Bugs	13	2	2	1		6			1			1		
	Undetermined Nymphs	68	2	10	3	3	1	10	2	4	12	6	11	1	3
ORDER: Homoptera (True Bugs) 454 Specimens collected															
Aleyrodidae	Whiteflies	1							1						
Aphidae	Plantlice	5				1		3				1			
Cercopidae	Spittlebugs	43	1		3	25	1		4		1	4	3		1
Cicadellidae	Leafhoppers	400	21	27	81	41	32	28	27	36	28	31	22	8	18
Coccoidea	Scale Insects	1							1						
Fulgoridae	Fulgorid Planthoppers	3			2					1					
Membracidae	Treehoppers	1			1										

TABLE V-1. ARTHROPODS COLLECTED ON TEST AREA C-52A, EGLIN AFB RESERVATION, FLORIDA, JUNE 1973 (Continued)

TAXON	COMMON NAME	TOTAL SPECIMENS	NUMBER OF SPECIMENS COLLECTED ON TRANSECT												
			AB	BC	CD	DE	EF	FG	GH	HJ	JK	KL	LM	MN	NO
ORDER: Hymenoptera (Bees, Wasps, Ants) 167 Specimens collected															
Andrenidae	Mining Bees	2			1				1						
Bethylidae	Bethylids	2					1		1						
Braconidae	Braconid Wasps	2			1				1						
Chalcidoidea	Chalcids	40	2	3	7	3	3	9	6	3	1	2	1		
Cynipoidea	Gall Wasps	1					1								
Dryinidae	Dryinids	1					1								
Formicidae	Ants	99	3	4	2	4	10	28	8	10	9	4	15	2	
Halictidae	Sweat Bees	9				1		4	2	1			1		
Ichneumonidae	Ichneumon Wasps	1	1												
Mutillidae	Velvet Ants	3				1							1		1
Pompilidae	Spider Wasps	2		1								1			
	Undetermined Adults	5						2	1		1			1	
ORDER: Lepidoptera (Butterflies and Moths) 13 Specimens collected															
Microlepidoptera	Several Families	12	1				1	4	2		1	1	2		
Noctuidae	Owl Moths	1								1					
ORDER: Neuroptera (Nerve Winged Insects) 1 Specimen collected															
Myrmeleonidae	Antlions	1											1		

TABLE V-1. ARTHROPODS COLLECTED ON TEST AREA C-52A, EGLIN AFB RESERVATION, FLORIDA, JUNE 1973 (Concluded															
TAXON	COMMON NAME	TOTAL SPECIMENS	NUMBER OF SPECIMENS COLLECTED ON TRANSECT												
			AB	BC	CD	DE	EF	FG	GH	HJ	JK	KL	LM	MN	NO
ORDER: Odonata (Dragonflies and Damselflies) 12 Specimens collected															
Coenagrionidae	Damselflies	12				2	3	7							
ORDER: Psocoptera (Psocids) 66 Specimens collected															
	Family not determined	66		2	7	5	1	13	3	1	10	15	6	3	
ORDER: Orthoptera (Grasshoppers and Crickets) 92 Specimens collected															
Acrididae	Grasshoppers	36			6	7	3	11	3	3		1	2		
Gryllidae	Crickets	34	2	1	2	3	7	1	7	5	2	1	2	1	
Mantidae	Mantids	14	1		2			6	1	3	1				
Phasmidae	Walkingsticks	1	1												
Tettigoniidae	Katykids	7			1				1				5		
ORDER: Thysanoptera (Thrips) 54 Specimens collected															
	Family not determined	54		1	9	6	2	19	9	1		1	4		2
	TOTAL ARTHROPODS	1726	57	81	253	190	128	357	184	104	92	92	118	37	33
	TOTAL IDENTIFIED ARTHROPODS	1614	55	70	248	185	123	339	172	98	77	81	103	33	30

TABLE V-2. TAXA COLLECTED IN NUMBERS EXCEEDING ONE PERCENT OF THE TOTAL SPECIMENS COLLECTED[a], JUNE 1973

FAMILY	COMMON NAME	NUMBER COLLECTED	PERCENT OF TOTAL	CUMULATIVE PERCENT OF TOTAL[c]
Cicadellidae	Leafhoppers	400	24.8	24.8
Chrysomelidae	Leaf Beetles	219	13.6	38.4
Araneida	Spiders	144	8.9	47.3
Formicidae	Ants	99	6.1	53.4
Acalyptrate Muscoid	Flies	86	5.3	58.7
Psocoptera	Psocids	66	4.1	62.8
Thysanoptera	Thrips	54	3.3	69.4
Sminthuraidae	Springtails	53	3.3	72.3
Acarina	Mites	46	2.9	72.3
Cercopidae	Spittlebugs	43	2.7	75.0
Chalcidoidea	Chalcid Wasps	40	2.5	77.5
Acrididae	Grasshoppers	36	2.2	79.7
Gryllidae	Crickets	34	2.1	81.8
Miridae	Plant Bugs	33	2.0	83.8
Nabidae	Damsel Bugs	33	2.0	85.8
Reduviidae	Assassin Bugs	19	1.2	87.0

[a]Total equals 1,614 identified specimens: 1 percent of the total equals 16 specimens

[b]As discussed in the text, several of the taxa represent ordinal or super family levels of classification rather than family.

[c]Cumulated percent of total is derived by the progressive summation of the figures in the percent of total column.

TABLE V-3. TAXA COLLECTED IN NUMBERS EXCEEDING ONE PERCENT OF THE TOTAL SPECIMENS COLLECTED[a], JUNE 1971

FAMILY-COMMON NAME	PERCENT OF TOTAL	CUMULATIVE PERCENT OF TOTAL[b]
Cicadellidae - leafhoppers	31.7	31.7
Araneida - spiders (order)	18.6	50.3
Lygaeidae - lygaeid bugs	7.7	58.0
Elateridae - click beetles	4.7	62.7
Pentatomidae - stink bugs	4.5	67.2
Asilidae - robber flies	4.2	71.4
Nabidae - damsel bugs	3.9	75.3
Acrididae - grasshoppers	3.2	78.5
Reduviidae - assassin bugs	2.7	81.2
Sphecidae - sand wasps	2.6	83.8
Tenebrionidae - darkling beetles	2.4	86.2
Chrysomelidae - leaf beetles	2.2	88.4
Scutelleridae - scutellerid bugs	2.1	90.5
Coenagrionidae - dragonflies	1.4	91.9
Halictidae - sweat bees	1.4	93.3
Mydaidae - mydas flies	1.3	94.6
Tettigoniidae - katydids	1.3	95.9
Mycetophilidae - mycetophilid flies	1.0	96.9

[a]Total equals 1803 specimens: 1 percent of the total equals 18 specimens

[b]Cumulated percent of total is derived by the progressive summation of the figures in the percent of total column

TABLE V-4. INSECTS AND ARACHNIDS COLLECTED OR OBSERVED ON TEST AREA C-52A, EGLIN AFB RESERVATION, FLORIDA, JUNE 1971

ARACHNIDS ORDER	COMMON NAME	TOTAL SPECIMENS	NUMBER OF SPECIMENS COLLECTED ON TRANSECT												
			AB	BC	CD	DE	EF	FG	GH	HJ	JK	KL	LM	MN	NO
Araneida	Spiders	355	4	3	25	8	30	188	26	28	7	4	8	2	2
Phalagida	Harvestmen	1													

FAMILY	COMMON NAME	TOTAL SPECIMENS	NUMBER OF SPECIMENS COLLECTED ON TRANSECT												
			AB	BC	CD	DE	EF	FG	GH	HJ	JK	KL	LM	MN	NO
ORDER: COLEOPTERA (BEETLES) 206 Specimens Collected															
Anthicidae	Antlike Flower Beetles	1											1		
Bruchidae	Seed Beetles	1					1								
Buprestidae[a]	Metallic Wood Borers														
Carabidae	Ground Beetles	4						2	1	1					
Cerambycidae	Long Horned Beetles	1			1										
Chrysomelidae	Leaf Beetles	43	4	4	1	1	6	5	6	4	2	4	2	4	
Cicindellidae	Tiger Beetles	2				1		1							
Coccinellidae	Lady Beetles	8			1		1		4		2				
Curculionidae	Snout Beetles	10						10							
Dytiscidae[b]	Predacious Diving Beetles														
Elateridae	Click Beetles	84	12	10	15	5	13	10	2	5	1	1		7	3
Gyrinidae[a]	Whirligig Beetles														
Meloidae	Blister Beetles	3							2	1					
Mordellidae	Tumbling Flower Beetles	6						2	4						
Passalidae[b]	Passalid Beetles														

[a]Sighted but not collected in 1971

[b]Sighted or collected in 1970

TABLE V-4. CONTINUED

FAMILY	COMMON NAME	TOTAL SPECIMENS	NUMBER OF SPECIMENS COLLECTED ON TRANSECT												
			AB	BC	CD	DE	EF	FG	GH	HJ	JK	KL	LM	MN	NO
ORDER: COLEOPTERA (Continued)															
Scarabaeidae	Scarab Beetles	2		1					1						
Staphylinidae	Rove Beetles	1										1			
Tenebrionidae	Darkling Beetles	43	2	2	10		2	3	3	4		1	7	3	6
ORDER: DERMAPTERA (EARWIGS) 1 Specimen Collected															
Forficulidae	Forficulid Earwigs	1													
ORDER: DIPTERA (FLIES) 211 Specimens Collected															
Anthomyiidae	Anthomyiidid Flies	14						9	1	2	1	1			
Asilidae	Robber Flies	76	1	4	4	8	11	10	14	7		3	9	3	2
Bibionidae	March Flies	4						4							
Bombiliidae[a,b]	Bee Flies														
Calliphoridae	Blow Flies	2						2							
Chironomidae	Midges	8					4		4						
Chloropidae[b]	Chloropid Flies														
Culicidae[a,b]	Mosquitoes														
Dolichopodidae	Long-Footed Flies	3						2	1						
Drosophilidae	Vinegar Flies	16	1		2	2		2	1				6	1	1
Mycetophilidae	Fungus Gnats	18						16	2						
Mycaidae	Mydas Flies	23	1	4	3	1	3	2		1	1	4	2	1	
Muscidae	Muscid Flies	17		1			2	9	3				1		1
Pipunculidae	Bigheaded Flies	3					1		2						

TABLE V-4. CONTINUED

FAMILY	COMMON NAME	TOTAL SPECIMENS	NUMBER OF SPECIMENS COLLECTED ON TRANSECT												
			AB	BC	CD	DE	EF	FG	GH	HJ	JK	KL	LM	MN	NO
ORDER: DIPTERA (FLIES) (Continued)															
Sepsidae	Sepsid Flies	11						3	7	1					
Syrphidae	Flower Flies	9						9							
Tabanidae	Horse Flies, Deer Flies	1							1						
Tachinidae	Tachina Flies	1							1						
Tipulidae	Crane Flies	1				1									
Tripetidae	Trypetid Flies	4						3	1						
ORDER: HEMIPTERA (TRUE BUGS) 390 Specimens Collected															
Belastomatidae[b]	Giant Water Bugs														
Coreidae	Coreid Bugs	3			2										
Corimelaenidae	Corimelaenid Bugs	5			5										
Cydnidae	Cydnid Bugs	2							1	1					
Gerridae[a]	Water Striders														
Lygaeidae	Lygaeid Bugs	138		4	38	10	19	40	6	19	1		5	1	2
Miridae	Plant Bugs	2	1							1					
Nabidae	Damsel Bugs	71	2	7	8	15	3	5	9	14	2	2	4		
Neididae	Neidid Bugs	1		1											
Nepidae[b]	Water Scorpions														
Notonectidae[b]	Backswimmers														
Pentatomidae	Stink Bugs	82	2	7	22	13	7	5	4	18			4		
Reduviidae	Assassin Bugs	49	1	1	11		14		6	6	1	1	7	1	
Scutelleridae	Scutellerid Bugs	37		2	3	1	12	1	13	2			2		

TABLE V-4. CONTINUED

FAMILY	COMMON NAME	TOTAL SPECIMENS	NUMBER OF SPECIMENS COLLECTED ON TRANSECT												
			AB	BC	CD	DE	EF	FG	GH	HJ	JK	KL	LM	MN	NO
ORDER: HOMOPTERA (TRUE BUGS) 360 Specimens Collected															
Aphidae	Plantlice	4				1		1		1	1				
Cercopidae	Spittlebugs	9			1	2	1	1	1	3					
Cicadellidae	Leafhoppers	343	10	30	46	54	41	80	21	29	10	10	10	2	2
Coccidae[a,b]	Scale Insects														
Fulgoridae	Fulgorid Planthoppers	1							1						
Membracidae	Treehoppers	3						2	1						
ORDER: HYMENOPTERA (BEES, WASPS, ANTS) 125 Specimens Collected															
Apidae	Apid Bees	1								1					
Bombidae[b]	Bumble Bees														
Braconidae	Braconid Wasps	11		1	1	1	2	1	3	2					
Chalcididae	Chalcids	2						1	1						
Chrysididae	Cuckoo Wasps	1						1							
Cynipidae	Gall Wasps	2								2					
Formicidae	Ants	12			1	2		6	2			1			
Halictidae	Sweat Bees	25	3	1	2	1		12	5	1					
Ichneumonidae	Ichneumon Wasps	3								1				2	
Megachilidae	Leafcutting Bees	2	1					1							
Mutillidae	Velvet Ants	4		3										1	
Pamphiliidae	Webspinning Sawflies	5	1		1									1	2
Pompilidae	Spider Wasps	6						1		1		1		2	1

TABLE V-4. CONTINUED

FAMILY	COMMON NAME	TOTAL SPECIMENS	NUMBER OF SPECIMENS COLLECTED ON TRANSECT												
			AB	BC	CD	DE	EF	FG	GH	HJ	JK	KL	LM	MN	NO
ORDER: HYMENOPTERA (BEES, WASPS, ANTS) (Continued)															
Scoliidae	Scoliid Wasps	1						1							
Sphecidae	Sand Wasps	46	2	2		1	2	4	6	2		1		6	20
Tiphiidae	Tiphiid Wasps	4						4							
Xylocopidae[a]	Carpenter Bees														
ORDER: ISOPTERA (TERMITES) Observed Only															
Rhinotermitidae[b]	Subterranean Termites														
ORDER: LEPIDOPTERA (BUTTERFLIES AND MOTHS) 38 Specimens Collected															
Danaidae[b]	Milkweed Butterflies														
Geometridae[a,b]	Geometrid Moths														
Lycaenidae[a,b]	Blues and Coppers														
Hesperiidae[a,b]	Skippers														
Microlepidoptera[c]	Several Families	23				5	3								
Noctuidae	Owl Moths	1											1		
Nymphalidae[a,b]	Brushfooted Butterflies														
Papilionidae[a,b]	Swallowtail Butterflies														
Pieridae[a,b]	Sulfurs														
Psychidae[b]	Bagworm Moths														
Pyralidae	Pyralid Moths	14						3	1	2	1				

[c]Several families in this group, but identified no further

TABLE V-4. CONCLUDED

FAMILY	COMMON NAME	TOTAL SPECIMENS	NUMBER OF SPECIMENS COLLECTED ON TRANSECT												
			AB	BC	CD	DE	EF	FG	GH	HJ	JK	KL	LM	MN	NO
ORDER: NEUROPTERA (NERVE WINGED INSECTS) 9 Specimens Collected															
Chrysopidae[a]	Green Lacewings														
Hemerobaeidae	Brown Lacewings	1					1								
Myrmeleonidae	Antlions	8		1								1	5		1
ORDER: ODONATA (DRAGONFLIES AND DAMSELFLIES) 40 Specimens Collected															
Aeshnidae[b]	Dragonflies														
Coenagrionidae	Damselflies	25					2	21	1		1				
Corduliidae[b]	Dragonflies														
Lestidae[b]	Damselflies														
Libellulidae	Dragonflies	15					1	14							
ORDER: ORTHOPTERA (GRASSHOPPERS AND CRICKETS) 74 Specimens Collected															
Acrididae	Grasshoppers	58	1	6	6	6	8	16	7	4	1	1		1	1
Gryllidae	Crickets	3			1				1	1					
Gryllotalpidae[a,b]	Mole Crickets														
Mantidae	Mantids	4				1	3								
Tettigoniidae	Katykids	23	1		6	4	2	4	5	1					
Trydactylidae	Pygmy Mole Crickets	7						7							
ORDER: TRICHOPTERA (CADDISFLIES) Observed Only															
Family not determined															

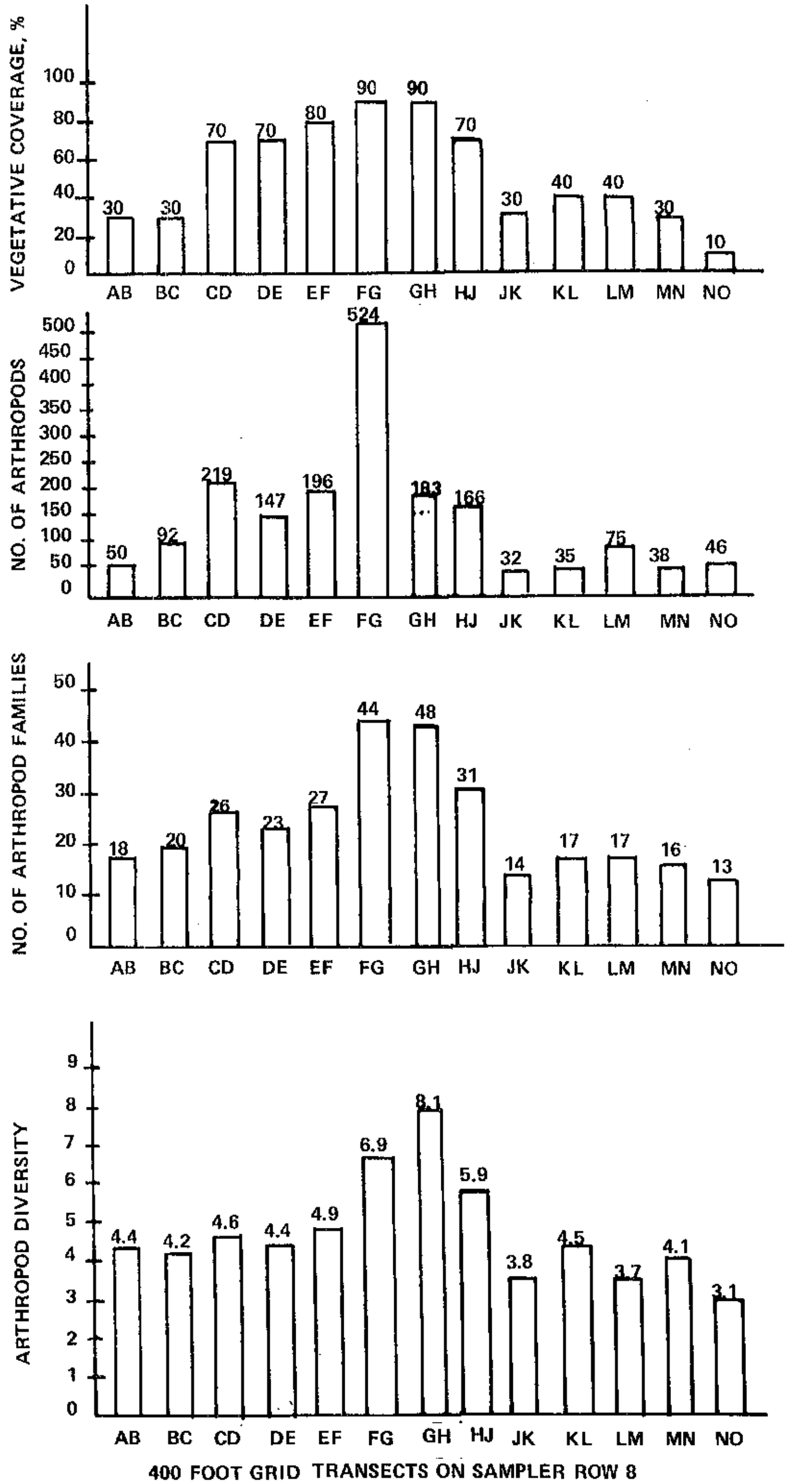

Figure V-1. Arthropod/Vegetation Comparisons on TA C-52A, 1971 Study

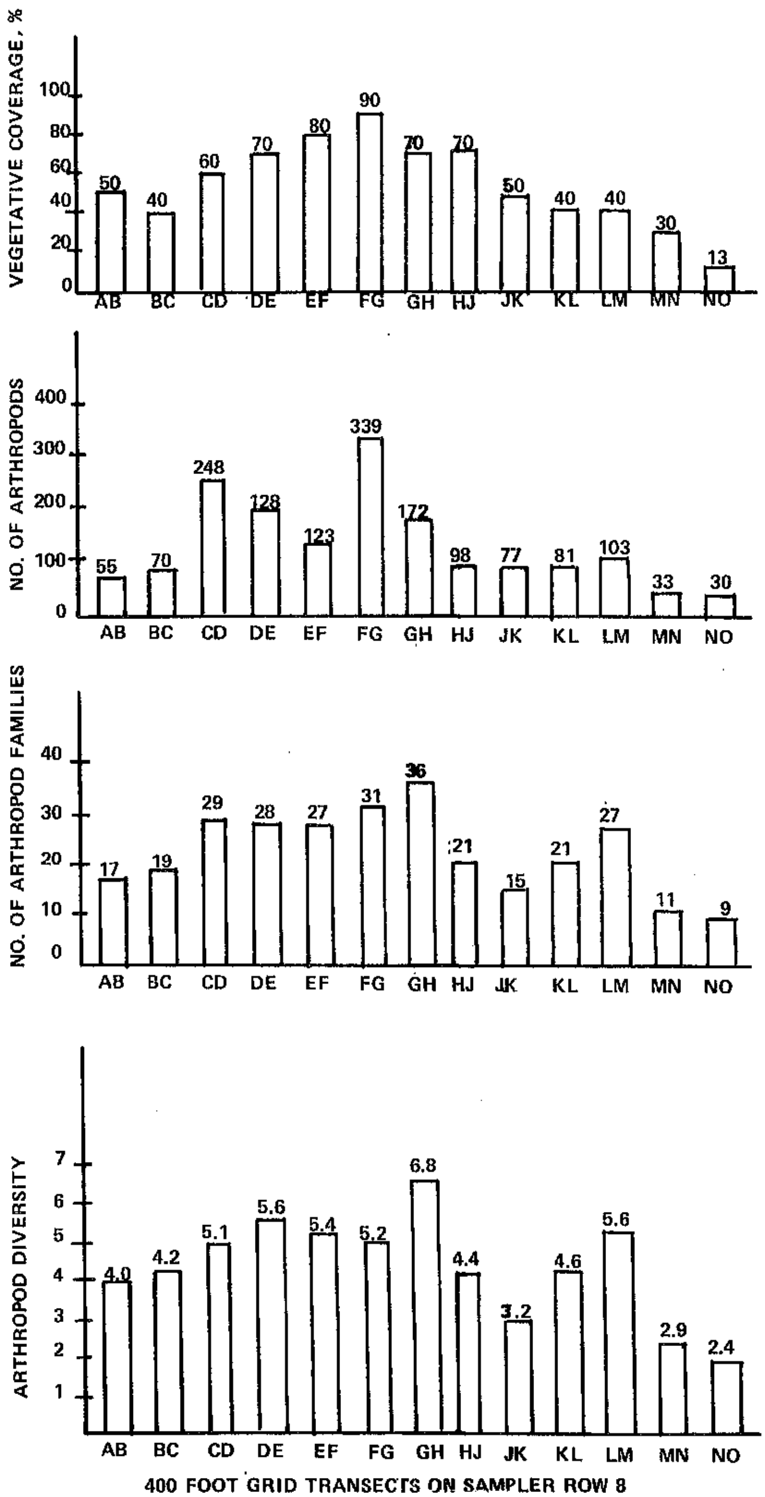

Figure V-2. Arthropod/Vegetation Comparisons on TA C-52A, 1973 Study similarities exist. The diversity index used was that of Margalef:

$$d = \frac{S - 1}{\ln N}$$

Where

d = diversity
S = number of Taxa
N = number of specimens
ln = natural log

This formula has been used in previous diversity studies on Test Area C-52A (References V-3 and V-4), and it is used elsewhere in the present report. The greatest diversity of Arthropods as indicated by this formula was in transect GH in both surveys, even though the adjacent transect FG showed equal or greater amounts of vegetation (due to the presence of standing water in this area). The greater diversity in GH is due to a large number of taxa relative to the total number of Arthropods present. This large number of different organisms is likely due to the existence of a wider variety of available niches in transect GH, which includes influences of the adjacent aquatic area, dry sandy areas, and areas more disturbed by man. (The central sampling tower of the test area is located in this transect.)

Other factors would be of interest in comparisons of the 1971 and 1973 data, such as the relationship of Arthropod population biomass to vegetative cover. While this biomass-vegetation comparison would ideally show a close correlation, two factors make it impractical. First, the influence of randomly caught large insects (especially the grasshoppers) on biomass data would be quite confounding until a great deal of replication had produced a representative sampling of these animals. Second, the 1971 insect survey considered factors other than biomass, so there is no direct basis for comparisons. Many of the other topics that were discussed in the 1971 study hold equally true at this time. Experimental biases of the sweep net technique factors affecting plant distribution, and plant-insect relationships are discussed in Reference V-1.

4. SUMMARY AND CONCLUSIONS

A sweep net survey of the Arthropods of Test Area C-52A on the Eglin AFB Reservation resulted in the collection of over 1,700 specimens belonging to 66 insect families and Arachnid orders. These totals represent only one of five paired sweeps taken over a one-mile section of the test grid. A similar study performed in 1971 produced 1,803 specimens and 74 families from five paired sweeps of the same area using the same basic sampling techniques. A much greater number of small to minute insects were taken in the 1973 survey. Vegetative coverage of the test area had increased since 1971. The two studies showed similarities in distribution pattern of vegetative Arthropod numbers, number of Arthropod varieties, and Arthropod diversity. Generally, the present study showed a reduction of the extremes found in the above parameters in the 1971 study. This result is expected to continue as the test area stabilizes and develops further plant cover, thus allowing a succession of animal populations to invade the recovering habitat.

References:

V-3. Boror, D. J. and D. M. DeLong: An Introduction to the Study of Insects. New York, Rinehart. 1952.

V-4. Lehn, P. J., A. L. Young, N. A. Hamme, and B. C. Wolverton: Studies to Determine the Presence of Artificially Induced Arsenic Levels in Three Freshwater Streams and its Effects of Fish Species Diversity. AFATL-TR-70-81, Air Force Armament Laboratory, Eglin AFB, Florida. August 1970. Unclassified.

SECTION VI

AQUATIC STUDIES OF TEST AREA C-52A

One of the major parameters involved in the process of herbicide movement and/or persistence in soils is the adsorptive capacity of the soil. The adsorptive capacity, or the cation exchange capacity (i.e., the ability of a cation to be displaced or exchanged from the soil by another cation), is closely associated with the inorganic colloids (e.g., clay particles) and organic colloids (e.g., organic matter) of the soil. A soil with a large cation exchange capacity could bind within its colloidal system a large concentration of herbicide. Soils with a low cation exchange capacity do not retain cationic herbicides (e.g., cacodylic acid or sodium cacodylate), and thus, soil leaching of these herbicides would be expected. From June 1969 to October 1970, 4,395 gallons of military herbicide Blue were disseminated on TA C-52A (Table I-7). Approximately 13,624 pounds of cacodylic acid and sodium cacodylate were sprayed onto an area of less than one square mile. The soil of the test area has a low cation exchange capacity of approximately 0.8 mg exchangeable cation per 100 g of soil (Table I-4), while the annual precipitation of the area is high (Table I-1). Data from the analyses of soil cores for arsenic (Table II-9) confirm the movement and/or disappearance of arsenic from the test grid. Moreover, Table II-7 suggests that picloram, a component of the herbicide White, has moved within the soil profile and is apparently rather residual in nature.

Test Area C-52A is drained by five streams: Mullet, Trout, Basin, Grassy, and Rucker Creeks (Figure VI-1). The combined annual flow from these streams exceeds 24 billion gallons of water. However, only Mullet, Trout, and Basic Creeks are closely associated with the test grid. The mean daily flow rate for these three streams is shown in Table VI-1. As previously noted, studies on the movement of arsenicals and picloram indicated the possibility of herbicides contaminating the three freshwater stream communities draining the test grid. Since arsenical residues may concentrate in the tissue of fish, and particularly in the tissue of oysters, studies were conducted in 1969 and 1970 to determine (1) whether arsenic residues were entering the streams from the test grid and (2), if so, whether these residues were having adverse effects on the fish populations in the streams or were accumulating in oysters found at the mouth of streams adjoining Choctawhatcheee Bay. Synopses of these studies (Reference VI-1) are included in this report.

1. SYNOPSIS OF PREVIOUS RESEARCH, 1969

a. Fish Study

To assess the effects of possible arsenic residues, a diversity index study of the fish populations of Mullet, Trout, and Basin Creeks was initiated 3 months prior to the aerial spraying of Blue and continued for approximately 4 months after spraying.

Of the three streams under investigation, Trout Creek seemed the most likely to receive herbicide residues from the grid area. The headwaters of the stream are at the bottom of steep-

Reference:

VI-1. Lehn, P. Jeffery, A. L. Young, N. A. Hamme, and B. C. Wolverton: Studies to Determine the Presence of Artifically Induced Arsenic Levels in Three Freshwater Streams and its Effects on Fish Species Diversity. AFATL-TR-70-81, Air Force Armament Laboratory, Eglin Air Force Base, Florida, 1970. Unclassified.

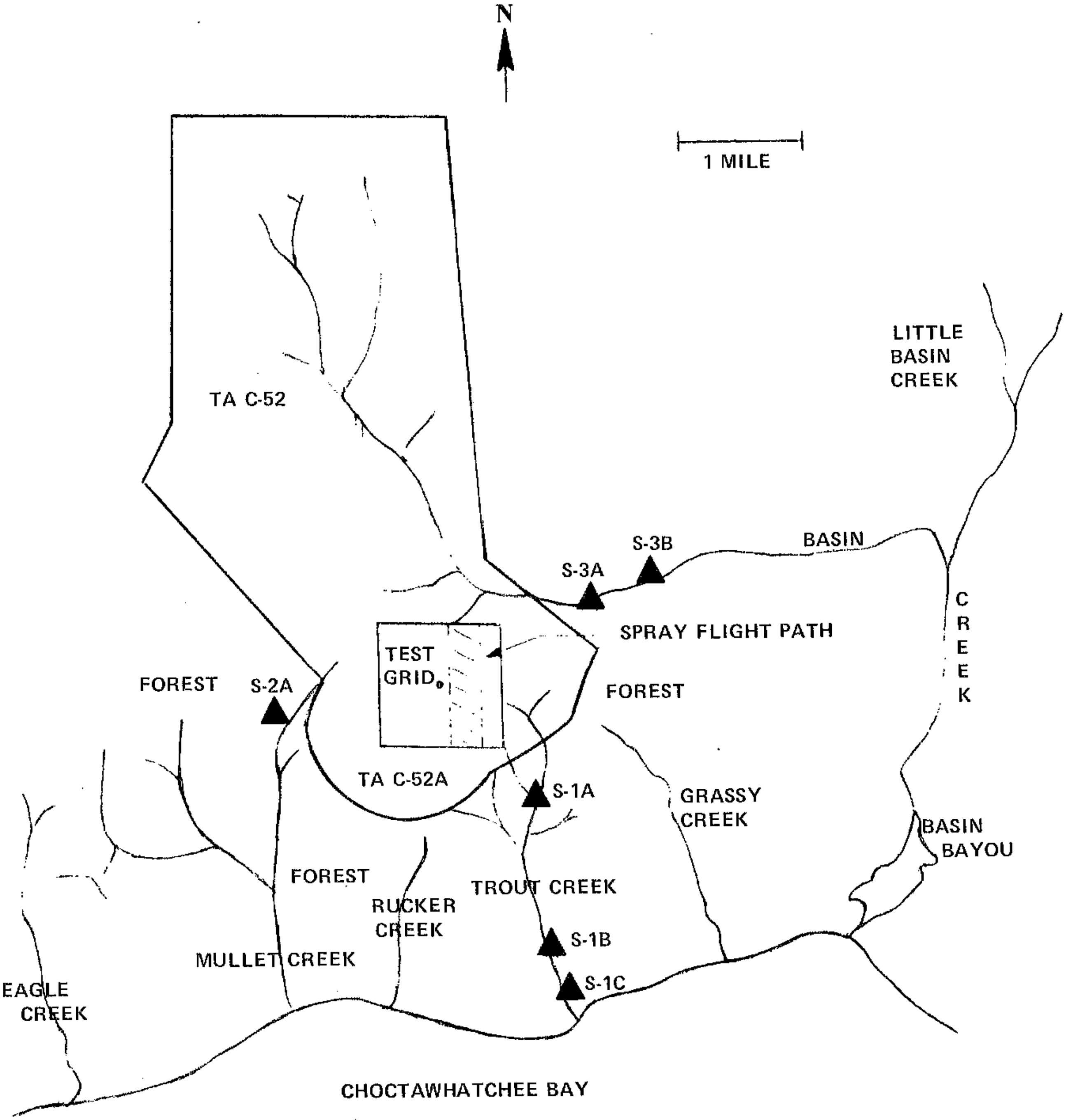

Figure VI-1. Map of Test Area Showing Streams in Relation to Test Grid and Location of Sampling Stations Used in Arsenic Monitoring Study

TABLE VI-1. CHARACTERISTICS OF SAMPLING SITES ON STREAMS DRAINING TEST AREA C-52A						
NAME	Temperature, Range, °C	Mean pH	Width, Feet	Depth, Feet	Bottom Material	Mean Flow Rate, gal/day
Basin Creek	16-23.5	5.8	to 12	to 4	Sand	39,073,000
Mullet Creek	14-23.0	6.0	to 10	to 2	Sand	3,648,000
Trout Creek	13-23.5	6.1	to 15	to 2	Sand	5,870,000
Little Basin Creek[a] (Control Stream)	15-22.5	6.0	to 8	to 3.5	Sand	3,450,000

[a]Does NOT drain TA C-52A

sided bayheads adjacent to the edge of the grid and directly in line with the lower extremities of the repeatedly used spray flightpath (Figure VI-1). From its headwaters, the stream flows approximately 2 miles directly south into Choctawhatchee Bay. As the stream nears the bay, it deepens to several feet and has a heavy deposit of leaves and other organic matter on the bottom.

Mullet Creek has portions of its headwaters originating in steep-sided bayheads within 0.5 mile of the west boundary of the spray grid and flows south for approximately 2.5 miles into Choctawhatchee Bay, deepening near its mouth with a heavy deposit of leaves and other organic matter on the bottom (Figure VI-1).

The headwaters of Basin Creek originate several miles to the north of the spray grid. The stream flows southeast within 0.25 mile of the northeast corner of the grid and joins with a small tributary originating at the north margin of the grid, continues east for approximately 3.5 miles, and turns south for 2.25 miles emptying into Basin Bayou and Choctawhatchee Bay (Figure VI-1).

Six sampling stations were established on the three streams: One on Mullet Creek, two on Basin Creek, and three on Trout Creek (Figure VI-1). The selection of sampling station locations was determined mainly by their accessibility, variation of habitat within the station, and apparent fish populations. Because of the number of stations and time involved, they were not all sampled on the same day.

On each sampling date, observations were made in an effort to detect any gross changes in the population levels of the following selected benthic organisms: crayfish (Orconectes sp.), dragonfly naiad (Gomphus sp.), freshwater snail (Neritian sp.), and an unidentified immature freshwater clam. Observations were also made to detect any morphological effects that may have occurred to eelgrass (Vallisneria americana), the only species of vascular aquatic plant common to all stations.

Fish were collected with a variety of seines ranging in length from 4 to 15 feet and in mesh size from 1/8 to 1/4 inch. All represented habitats within each station were sampled randomly, and the time of day that the samples were taken was also varied. For the first several weeks of the survey, the fish were returned to the stream after the total catch was made and counted; however, for the remainder, and majority, of the survey, the fish were preserved in 10% formalin and counted in the laboratory. In conjunction with the stream sampling, two ponds on the test grid were sampled using dip nets.

b. Residue Sampling

Samples were routinely collected at 11 stations on the streams and in Choctawhatchee Bay after each rainfall following herbicide missions, or, if no missions had been flown, samples were collected monthly. Water from these streams was sent to the Regional Environmental Health Laboratory, Kelly AFB, Texas, where it was analyzed for arsenic. Detritus (bottom) samples were taken monthly with an Eckman dredge at three randomly selected water sampling locations. After appropriate pretreatment, these were assayed in the same manner as the water samples.

In addition to water and detritus sampling, oysters were used to monitor changes in arsenic level. Because these mollusks are filter feeders, the arsenic content of their bodies was correlated with that of their environment.

Oyster racks were established in Choctawhatchee Bay at the mouths of Basin, Trout, Grassy, Mullet, and Rucker Creeks. A control rack was also located in the bay at the mouth of Eagle Creek, which does not drain the grid area (Figure VI-1). Each rack contained approximately 2,000 oysters in the 1 to 3 inch diameter range, and these were sampled periodically. The small size of the oysters was intended to discourage removal from the racks. Samples obtained from the racks were frozen and taken to the laboratory for analysis. There the sample was acidified, hydrolyzed, and neutralized before undergoing standard atomic absorption analysis for arsenic (Reference VI-2).

Water samples were collected for picloram analysis from a small bayhead of Basin Creek just north of sampler station A-11. The bulk of herbicide White was disseminated on Grid 3, with the remainder being sprayed on Grid 4 (see Section I, Figure I-5 and Table I-7). Thus, most of picloram was probably concentrated around the northern portion of the one square mile area. Other water samples for picloram analysis were collected in the bayhead of Long Creek, which is located approximately 3 miles northwest of the one square mile grid and which has a water source not associated with TA C-52A.

c. Results

Twenty-one species of fishes were collected, with three species occurring within the boundaries of the one square mile grid and 20 species from the surrounding streams (Table VI-2). Habitat and spatial isolation seemed to be the major limiting factors on the grid.

Reference:
VI-2. Hamme, N. A., A. L. Young, J. H. Hunter: A Rapid Analysis of Soil and Water by Atomic Absorption. AFATL-TR-70-106, Air Force Armament Laboratory, Eglin Air Force Base, Florida, 1970. Unclassified.

TABLE IV-2. FISH SPECIES FOUND IN PONDS AND DRAINAGE AREAS OF THE ONE SQUARE MILE GRID AND IN BASIN, MULLET, AND TROUT CREEKS

SPECIES AND COMMON NAME	AREAS WHERE COLLECTED	
	ON GRID	OFF GRID
1. *Ambloplites rupestris* - southern rock bass	-	+B
2. *Anguilla rostrata* - American eel	-	+BT
3. *Aphredoderus sayanus* - pirate perch	-	+BT
4. *Elassoma okefenokee* - Okefenokee pigmy sunfish	-	+T
5. *Erimyzon sucetta* - lake chubsucker	+*	-
6. *Esox americanus* - red-fin pickerel	-	+B
7. *Esox niger* - chain pickerel	-	+B
8. *Etheostoma edwini* - brown darter	-	+BT*
9. *Fundulus notti* - starhead topminnow	-	+T
10. *Gambusia affinis* - mosquito fish	-	+BMT*
11. *Ichthyomyzon gagei* - southern brook lamprey	-	+BM
12. *Ictalurus natalis* - yellow bullhead	+	-
13. *Lepomis punctatus* - spotted sunfish	+	+BMT
14. *Micropterus punctulatus* - spotted bass	-	+T
15. *Minytrema melanops* - spotted sucker	-	+B
16. *Notropis hypselopterus* - sailfin shiner	-	+BMT*
17. *Notropis texanus* - weed shiner	-	+B
18. *Noturus funebris* - black madtom	-	+T
19. *Noturus gyrinus* - tadpole madtom	-	+T
20. *Noturus leptacanthus* - speckled madtom	-	+BMT*
21. *Percina nigrofasciata* - blackbanded darter	-	+BMT*

*Denoted large population in area.
B = found in Basin Creek
M = found in Mullet Creek
T = found in Trout Creek

The lake chubsucker was abundant in one of the ponds on the grid but was not found in the three streams within a 2 mile radius of the center of the grid, however, the species occurs several miles downstream in more sluggish waters. The employment of a diversity index (i.e., a statistical comparison of the fish populations before and after the spray missions, representing a time period of 8 months) showed a population change in one fish species at one of the six stations studied. This change, however, was probably due to an unidentified variable (e.g., variation in collecting techniques) rather than to arsenic residue. The arsenic analyses for 588 water samples and 68 silt samples were negligible (less than 1 ppm and not significantly different from control streams). A comparison of arsenic contents of 73 oyster samples taken from sampling stations established in Choctawhatchee Bay showed no significant differences from control samples taken elsewhere in the bay at the 95% probability level (1.32 ppm arsenic versus 1.45 ppm).

The results of water samples collected from Basin, Trout, and Long Creeks, and analyzed for picloram content are shown in Table VI-3. Picloram residues were still being detected in the small bayhead north of sampler station A-11 as late as December 1971. The last mission with herbicide White was in May 1970.

TABLE IV-3. RESULTS OF CHEMICAL ANALYSIS OF WATER SAMPLES FOR PICLORAM, 1971 DATA

SAMPLE LOCATION	DATE COLLECTED	PICLORAM[a], ppb
Basin Creek, North of Sampler Station A-11 in NE Corner of one square mile grid	11 Jun 1971	11
Trout Creek, South of Sampler Station 0-11 in SE Corner of one square mile grid	11 Jun 1971	2.4
Basin Creek, same as June 1971 location	3 Dec 1971	11, 9.4
Trout Creek, same as June 1971 location	3 Dec 1971	1.4
Control; Long Creek, approximately 3 miles from one square mile grid	11 Jun 1971	< 0.1

[a]Analysis performed by the Dow Chemical Company; Method ACR 68-14

2. CURRENT STUDIES OF AQUATIC ORGANISMS

The objectives of the current studies were (1) to reaccomplish the 1969 - 1970 aquatic studies and to compare population and diversity data, (2) to accomplish an in-depth survey of the aquatic organisms in the test grid ponds, and (3) to obtain samples of aquatic vertebrates from streams and grid ponds for arsenic and TCDD residue analyses.

a. Methods and Materials

Sampling of the ponds on TA C-52A was accomplished using dip nets and, where aquatic vegetation permitted, a 4 by 15 foot seine and a variable mess gill net. Sampling of the ponds was performed twice with identical collection methods employed both times. Tadpoles (Rana pipens subsp. sphenocephala Hyla gratiosa) and lake chubsuckers (Erimyzon sucetta) were frozen for arsenic and TCDD residue analyses. Those aquatic organisms caught only for species diversity and relative quantity were preserved in 10% formalin. Tadpoles were also collected at a control pond (north of TA C-52A) and were frozen for TCDD residue analysis.

Sampling of the streams draining TA C-52A (Mullet, Trout, and Basin Creeks) and the control stream (little Basin Creek) was accomplished also using the 4 by 15 foot seine. Approximately 100 yards of each stream was worked for 2 hours. The identical sampling technique was employed, and each stream was sampled three times. (This technique was that described in Reference VI-1). Species collected only for diversity and relative quantity were preserved in 10% formalin. Crayfish (Ordonectes sp.), speckled madtoms (Noturus leptacanthus), brown and blackbanded darters (Etheostoma edwini) and (Percina nigrofasciata) and any larger fish, e.g., redfin pickerel (Esox americanus) and spotted sunfish (Lepomis punctatus), were frozen for subsequent analysis of TCDD and arsenic residue. The selection for residue analyses of the crayfish and smaller fish species was based on the fact that they are bottom feeders or primary/secondary consumers and thus likely to ingest organic matter containing TCDD and arsenic. The larger fish were selected for residue analysis because they had been in the stream for a longer time and were predators, filling niches at the top of the aquatic food web - hence, a greater likelihood of residue accumulation taking place if bio-magnification was occurring. In addition to these species, oysters were collected for arsenic analysis from the mouth of Mullet and Trout Creeks where they drain into Choctawhatchee Bay. The samples collected for TCDD analysis were sent to the Interpretive Analytical Services Laboratory, Dow Chemical U.S.A., while the samples collected for arsenic analysis were sent to the Pesticide Degradation Laboratory, United States Department of Agriculture. The analysis of arsenic was by atomic absorption of arsine generated with N_2BH_4.

All of the streams that were sampled for fish were also sampled for aquatic invertebrates. Benthic samples were taken near the stream margins and in mid-stream at each station using a modified Surber Sampler with number 15 mesh. The margins were covered with a thin layer of organic debris and entangled with the root systems of neighboring plants, while the center of the stream bed was composed almost entirely of sand. The sampler was sunk about 6 inches into the stream bottom with the net on the downstream portion; then, the sand and debris enclosed by the sampler were placed in the net - going down about 6 inches into the stream bottom. The netting was taken to a deep spot on the stream and washed so that sand and debris would pass out through the netting. The remaining contents in the mesh were transferred into an enamel pan. The debris was examined, and all invertebrate organisms were removed and placed in plastic bottles containing water from the stream. The bottles were labled and taken to the laboratory. There, the organisms were placed in boiling water for 5 minutes, transferred to containers with 70% ethanol solution, classified, and counted.

Ten-foot strip samples of the aquatic areas of the grid were taken by using an insect net to make a 10 foot linear scoop along the bottom of the pond. The debris collected was then sorted for invertebrate organisms. Figure IV-2 shows the location of the major bodies of water at the time of survey, June 1973. It should be noted that the first 6 months of 1973 were abnormally high in rainfall, and thus, the 1973 survey showed more water on the grid than observed in 1969 to 1971. The three aquatic invertebrate samples were taken from the ponds located near sampler stations F-7, F-13, and G-13.

Biological specimens were forwarded to Dow Chemical U.S.A., Midland, Michigan for determination of TCDD levels. Analysis was accomplished using a modification of the technique of Baughman and Meselson (Reference VI-3).

b. Results and Discussion

Table VI-4 compares those fish species caught in the streams (draining TA C-52A) in 1969 (Reference VI-1) and those caught in 1973. The methods of collection and the sampling stations were the same for both studies.

In order to compare the fish populations caught in 1969 with those caught in 1973, three assumptions were made:

(1) That fish caught per sampling is proportional to the total fish population at that site, so long as the methods employed are sufficiently similar.

(2) That the sampling methods remained sufficiently similar to justify assumption one during all seining operations both in 1969 and 1973.

(3) That the frequency distribution of fish caught per sampling is approximately normal.

The data for fish populations per sampling for 1969 and 1973 can be shown as:

Sampling Period	Number of Observations	Mean Number of Fish Per Sampling	Standard Deviation
Before Spraying Blue (Mar 1969)	36	84	29.6
After Spraying Blue (Oct 1969)	16	84	49.2
1973 Sampling	13	141	60.2

As can be seen from these data, the fish caught per sampling before and immediately after the dissemination of Blue in 1969 remained constant. Moreover, a significant increase in fish caught per sampling occured in 1973 as compared to 1969. If the control stations (Little Basin and Fox Creeks) are compared for population changes during this time period, the following data are obtained.

Control Stations	1969 Means Per Sampling	1973 Means Per Sampling
Little Basin Creek	81	94
Fox Creek	83	84

Reference:

VI-3. Report Number IAS-405, Dow Chemical U.S.A., Midland, Michigan

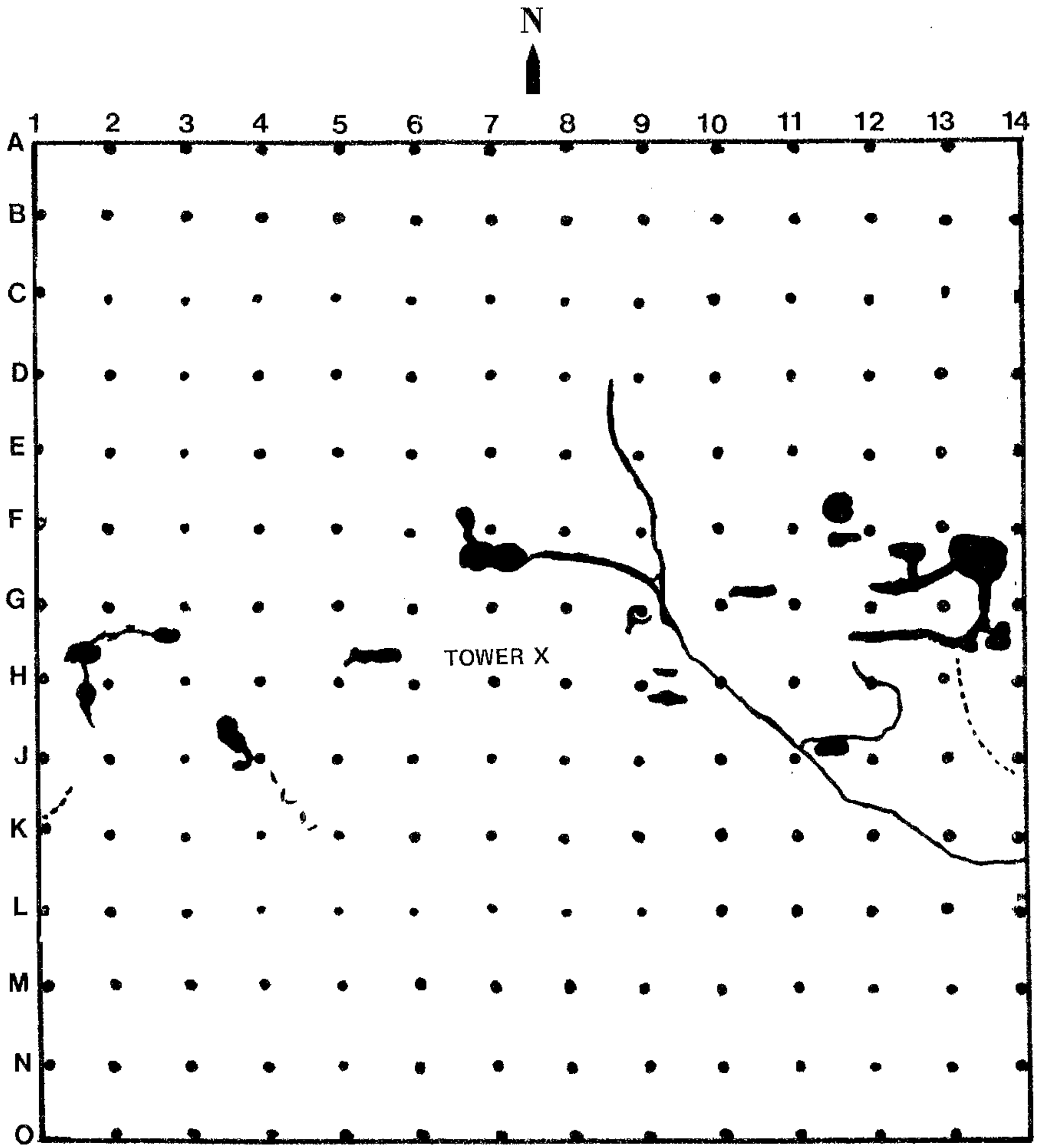

Figure VI-2. Location of Water and Major Drainage Ditches on the One Square Mile Grid of TA C-52A, 1973 Data

TABLE VI-4. FISH SPECIES COLLECTED IN 1969 AND 1973 FROM THREE STREAMS DRAINING TA C-52A AND A CONTROL STREAM

SPECIES	COMMON NAME	TROUT CREEK 1969	TROUT CREEK 1973	MULLET CREEK 1969	MULLET CREEK 1973	BASIN CREEK 1969	BASIN CREEK 1973	LITTLE BASIN[a] 1969	LITTLE BASIN[a] 1973
Notropis hypselopterus	sailfin shiner	+[b]	+	+	+	+	+	+	+
Gambusia affinis	mosquito fish	+	+	+	+	+	+	+	+
Percina nigrofasciata	blackbanded darter	+	+	+	+	+	+	+	+
Etheostoma edwini	brown darter	+	+	+	+	+	+	+	+
Lepomis punctatus	spotted sunfish	+	+	+	+	+	+	+	+
Noturus leptacanthus	speckled madtom	+	+	+	+	+	+	+	+
Ichthyomyzon gagei	southern brook lamprey	–[c]	+	+	+	+	+	+	+
Notropis texanus	weed shiner	–	–	–	–	+	+	–	–
Esox niger	chain pickerel	–	–	–	–	+	–	–	–
Aphredoderus sayanus	pirate perch	+	+	+	+	+	+	+	+
Esox americanus	redfin pickerel	–	+	–	–	+	–	+	+
Anguilla rostrata	American eel	+	–	–	–	+	–	+	+
Minytrema melanops	spotted sucker	–	–	–	–	+	+	+	–

[a] Control Stream
[b] Species Present (+)
[c] Species Absent (–)

TABLE VI-4. CONCLUDED									
SPECIES	COMMON NAME	TROUT CREEK		MULLET CREEK		BASIN CREEK		LITTLE BASIN[a]	
		1969	1973	1969	1973	1969	1973	1969	1973
Ambloplites rupestris	southern rock bass	–	+	–	–	–	–	–	–
Mugil cephalus	common mullet	–	–	–	+	–	–	–	–
Ictalurus natalis	yellow bullhead	–	+	–	–	–	–	–	–
Micropterus punctulatus	spotted bass	+	–	–	–	–	–	+	+

[a]Control Stream

There is no significant change in the fish populations at the control sites. There are insufficient data on other variables (e.g., nutrient fluctuations), on other environmental factors, or on food chain growth data to warrant pinpointing the direct cause of the fish population increase other than that it appears to be associated with the general recovery phenomenon of vegetation, animal, and insect populations as noted in other sections of this report.

The species diversity was determined by the same method employed in the 1969 study (Reference VI-1). The mean diversity for 1969 (before and after the spraying of Blue) and 1973 for the control sites are:

Control Sites	Number of Samplings	Mean Diversity	Standard Deviation	Variance
Before Blue, 1969	36	0.9779	0.3049	0.0930
After Blue, 1969	16	1.3286	0.4903	0.2404
1973 Sampling	13	1.5934	0.1952	0.0381

The 1973 sample size of 13 may be too different from that of 1969 to compare diversity indices. The dependence of the diversity index (d) on the number of samples taken (N) may exist in such a way as to bias d when large or small values of N are used. If the diversity index is plotted as a function of N (using actual data) then the difference in d values before and after spraying Blue (and hence, the 1973 data) is too greatly dependent on N to use without either correcting for the sample size difference or re-sampling (thus using nearly the same sample sizes) A correction technique was employed. A description of this method is included and is in fact an analysis of the diversity of species using Monte Carlo normalized diversity indices.

> In attempting to make comparisons between d values it appeared desirable to factor out the influences of N by making all N's the same. A small simulation was undertaken in which the observed frequency of species was assumed to be the expected value. A sample size of 80 was chosen as the common sample size because it is near the mean of the actual sample taken. Then, using the observed distribution to establish the probability of the occurrence of each species, 80 "fish" were drawn from the population. This closely simulated the process in which fish are captured until exactly 80 were caught in each sample and then the specimens classified and the data tabulated. One source of error for the simulation is the fact that the number of species, S, cannot exceed the S value for the observed case; i.e., if a species did not appear in the original sample, then the probability of its appearance in the "redrawn" sample is zero. This error, however, should be insignificant in cases where the original sample size was 30 or larger.
>
> In a further effort to make comparisons of diversity more meaningful, the expected values of sample size, N_e, and expected number of species, S_e, were calculated assuming that the variety of fish life had not decreased; i.e., the d value now is no worse than the d value for the time period before the herbicide was applied. A comparison of N_e and S_e were made with the respective observed values N_o and S_o.

The equations used are:

$$N_e = e^{\frac{S_o - 1}{d}}$$

and

$$S_e = d \log_e (N + 1)$$

The d values were calculated for the redrawn samples. The only tendency, if any, was for the diversity index to increase after spraying. Linear correlation coefficients between d and average sample size compared to distances of the sampling stations from the center of the spray area were very small and insignificant. The S_e and N_e values for 1969 both before and after spraying were compared to those for 1973 using the two control sites to establish the expected diversity index. In both cases S_o was 10 to 20 percent higher than S_e, and N_e was grossly larger than N_o. These observations both tend to imply that the collecting sites considered to be within the spray zone are richer in fish life than the control sites outside the spray zone.

By using the correction technique on the mean diversity for the control sites only, a chronologically higher diversity in fish is evidenced from before spraying Blue in 1969, through the after spray period, to the 1973 sampling.

Control Sites	Before Blue 1969 Diversity	After Blue 1969 Diversity	1973 Diversity
Little Basin	1.324	1.806	1.770
Fox Creek	1.138	1.212	1.580

This same trend was noted for the streams draining the test area. However since the control sites are assumed to be either too far away from the grid area to be affected by the herbicides or are experiencing the recovery phenomenon noted for TA C-52A, no significant changes are evident in the diversity of fish life from 1969 to 1973.

In order to compare the species proportions for the 1969 data to the 1973 data, the following assumptions were made:

(1) That the average of the percentages of a given species found in the sample is a reasonable estimate of the actual percentage of that species in the fish population in the stream.

(2) That the percentages of rare species found in the samples are not valid for comparisons because sample sizes are not large enough for a sufficiently high confidence in the percentages.

Using these assumptions, only the two most common species were compared from the 1969 and 1973 data for significant changes. The rare species, therefore, were treated as part of the general diversity analysis.

Table VI-5 compares the 1973 mean percentages for the sailfin shiner (Notropis hypselopterus) and the mosquito fish (Gambusia affinis) to the 1969 data of before and after spraying of Blue and the combined mean for 1969. The significance of the differences was tested using the t test. The sailfin shiner had a significant decrease in its proportion of the fish population in 1973 as compared to the before spray (March 1969) fish populations, but the difference was not significant when 1973 data were compared to after spray data (October 1969). For the overall comparison, however, of 1973 data to 1969 data (combined) no significant difference existed. If data for the sailfin shiner are compared only for the control sites a significant decrease occurs in the percent of the population between the March 1969 data and the 1973 data. However, such a significant decrease does not occur when 1973 data is compared to October 1969 data.

Control Station	March 1969 Means	1973 Means	October 1969 Means
Little Basin	0.869	0.623	0.788
Fox Creek	0.928	0.714	0.758

As a result of these data, it is apparent that some factor (unrelated to the herbicide or recovery phenomenon) was at work between the spring of 1969 and the fall of 1969. As a result, it is more prudent to assume no significant proportional changes existed between spring 1969 and 1973 for the most abundant species.

The three aquatic areas on the grid were observed to be areas of 80% to 100% vegetative cover with the vegetation chiefly composed of grassy plants. The pond at station F-7 is located on Rutledge Sand, and the ponds at F-12 and G-13 have Chipley Sand underlying them. The F-7 pond had a pH reading of 5.51 and was heavily congested with algae and aquatic grasses. The two other ponds had a pH reading of 6.39 and were much less overgrown with aquatic grasses and algae. Both of the ponds were known to be intermittent; partially drying up once in the last 5 years. An alligator was sighted in F-7 pond and two 6-inch lake chubsuckers (Erimyzon sucetta) were taken from it. In the east grid ponds (F-12 and G-13), sightings were made of turtles, but no fish were taken from these ponds. The results of bottom sampling these ponds for specimens of invertebrate are shown in Table VI-6. The dominant order is Odonata. Without exception, the members of this order are predacious; therefore, their supply in these ponds must be relatively extensive.

The Serber sampling of the streams is shown in Table VI-7. Fox Creek yielded very few aquatic organisms, either invertebrate or vertebrate. The yields of invertebrates were so few, in fact, that Fox Creek was considered too different from Basin, Trout, or Mullet Creeks to effectively serve as a control stream. Perhaps the low yield in organisms in Fox Creek is related to its depth (mean depth of 18 inches with pools reaching to five feet) and/or swiftness. The majority of the organisms found in the other three streams were caddis fly larvae and snails. The caddis fly larvae are omnivores, while the snails are herbivores. Presumably, there is an extensive food web associated with these invertebrates that was not sampled by the Serber sampler.

TABLE VI-5. POPULATION CHANGES IN THE TWO MOST COMMON FISH SPECIES (ALL SITES ARE GROUPED TOGETHER) 1969 AND 1973 DATA

SPECIES	DATE	NUMBER OF OBSERVATIONS	MEAN	STANDARD DEVIATION	PROBABILITY OF CHOOSING SAMPLES WITH MEANS HAVING THIS OR GREATER DIFFERENCE
Notropis hypselopterus					
	Mar 1969	8	0.79	0.117	0.01[a]
	Oct 1969	8	0.58	0.172	0.94
	Combined 1969	16	0.69	0.179	0.91
	Jun 1973	5	0.51	0.161	- -
Gambusia affinis					
	Mar 1969	8	0.102	0.101	0.92
	Oct 1969	8	0.188	0.132	0.99
	Combined 1969	16	0.145	0.122	0.96
	Jun 1973	5	0.182	0.194	- -

[a]95% level of significance

TABLE VI-6. NUMBER OF AQUATIC INVERTEBRATE SPECIMENS COLLECTED FROM BOTTOM SAMPLING THREE PONDS ON TEST AREA C-52A[a]

ORDER	COMMON NAME	LOCATION OF PONDS[b] F-7	F-13	G-13
Coleoptera	scavenger beetle	0	1	0
Hemiptera	backswimmers	3	10	6
	giant water bugs	0	1	0
Odonata	dragonflies/	10	8	1
	damsel flies	2	17	9
Trichoptera	caddis flies	1	0	0
	Total Specimens	16	37	16

[a]Each sample represents three collections with a 1-square foot Serber Sampler

[b]Ponds designated by the closest permanent sampler station

TABLE VI-7. NUMBER OF AQUATIC INVERTEBRATE SPECIMENS COLLECTED FROM BOTTOM SAMPLING THE STREAMS DRAINING TEST AREA C-52A[a]

ORDER	COMMON NAME	CREEK			
		MULLET	TROUT	BASIN	FOX[b]
Annelida	aquatic earthworms	10	11	10	1
Coleoptera	beetles	5	19	8	1
Decopoda	crayfish	1	1	0	0
Gastropoda	snails	48	96	15	0
Odonata	dragonflies	0	0	2	2
Plecypoda	freshwater clams	0	0	9	0
Trichoptera	caddis flies	51	75	158	49
	Total Specimens	115	202	202	53

[a]Ten-foot strip sample from bottom of pond using a 15-inch insect net
[b]Control station

The results of residue analysis for arsenic in aquatic organisms are shown in Table VI-8. The level of arsenic in the oysters was considerably lower than those values reported for oysters in 1970 - 1971 (average of 0.28 ppm arsenic versus 1.32 ppm, respectively). The lower levels of arsenic in 1973 may be due to the employment of different analytical procedures or to the increased stream flow noted this year, and hence, to a greater purging of the arsenic by the large volumes of freshwater entering Choctawhatchee Bay. No control tadpoles were analyzed for arsenic content, but presumably the level of arsenic was probably higher than it would be in control samples. This would be evident from data of the arsenic levels in 1973 grid soils as shown in Table II-7 (Section II).

The results of residue analysis of aquatic organisms for TCDD are shown in Table VI-9. The analysis were performed by the Interpretive Analytical Services, Dow Chemical U.S.A., Midland, Michigan. The duplicate samples were analyzed independently by high resolution mass spectrometry (see Section II for methods and materials). Duplicate samples of all biological specimens were also submitted to the Pesticide Degradation Laboratory, Agricultural Environmental Quality Institute, Beltsville, Maryland, for an independent check on results. However, none of the methods employed by the Degradation Laboratory could lower the limit of detection below 0.1 - 0.2 ppb TCDD.

3. CONCLUSIONS

From examining the data, certain observations support the idea that a recovery phenomenon is occurring in the streams draining TA C-52A. These observations are difficult to document because of insufficient data. For example, in 1969 the southern brook lamprey (Ichthyomyzon gagei) was never collected in Trout Creek, yet in 1973 it was taken in relatively large numbers. It now appears that the lamprey is breeding in Trout Bayhead south of sampler station 0-11. Moreover, all of the specimens of lamprey collected this year in Trout Creek are immature

TABLE VI-8. CONCENTRATION OF ARSENIC IN BIOLOGICAL SPECIMENS COLLECTED ON OR ADJACENT TO TA C-52A

BIOLOGICAL SPECIMEN[a] (Common Name)	LOCATION COLLECTED (June 1973)	CONCENTRATION OF ARSENIC (μg As/gram Fresh Tissue)
Oyster	Mouth of Trout Creek	0.44
Oyster	Mouth of Mullet Creek	0.12
Blue Crab	Mouth of Trout Creek	0.32
Blue Crab	Mouth of Mullet Creek	0.32
Crayfish	Little Basin Creek[b]	0.29
Crayfish	Trout Creek	0.30
Black-banded Darters	Little Basin Creek[b]	0.75
Black-banded Darters	Trout Creek	0.15[c]
Speckled Madtom	Little Basin Creek[b]	0.30
Speckled Madtom	Trout Creek	0.38
Redfin Pickerel	Trout Creek	0.23
Tadpoles	Grid Pond (F-7)	1.47

[a]Samples for analysis were either aliquots of homogenates or the entire homogenate depending on sample size.

[b]Control Samples

[c]Part of the tissue was lost in digestion of sample.

TABLE VI-9. CONCENTRATION OF 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN (TCDD) IN BIOLOGICAL SPECIMENS COLLECTED ON OR ADJACENT TO TEST AREA C-52A

BIOLOGICAL SPECIMEN[a] (Common Name)	LOCATION COLLECTED	CONCENTRATION OF TCDD (parts per trillion)
Cub Sucker	Mouth of Trout Creek	< 10
Crayfish	Trout Creek	< 10
Crayfish	Control	< 10
Oyster	Mouth of Trout Creek	< 10
Rock Bass	Trout Creek	< 10
Spotted Sunfish	Trout Creek	< 10
Spotted Sunfish	Control[b]	< 10
Tadpole	Grid Pond (F-7)	< 10
Tadpole	Control	< 10

[a]All samples were run in duplicate and analyzed independently by high resolution mass spectrometry.

[b]Control locations are noted in text.

indicating that the population was recently established (within the past two years). However, statistical comparisons of 1969 and 1973 data confirm a chronologically higher diversity in fish populations for even the control streams. Thus, the presence of the lamprey may or may not reflect a change in the habitat due to recovery from herbicide exposure.

The data on picloram in waters draining from the test grid would support the need for production studies of these streams. However, a review of toxicological data for picloram (Reference VI-4) suggests that concentrations of 1000 ppb do not seem to effect aquatic organisms. Moreover, the lack of baseline data and adequate control streams would probably make such studies futile or of doubtful value.

It is apparent from the results of samples analyzed for TCDD that representative organisms living in streams draining Test Area C-52A or in the ponds on the test area were free from TCDD contamination at a lower detection limit of less than 10 ppt. These data are not unexpected knowing the low solubility of TCDD in water and its apparent lack of movement in the soil profile (Reference IV-1).

Reference:
VI-4. Pimentel, David: Ecological Effects of Pesticides on Non-Target Species. Executive Office of the President, Office of Science and Technology, June 1971.

SECTION VII

STUDIES ON THE MICROFLORA OF TEST AREA C-52A

The soil persistence of herbicides is influenced by many environmental and biological factors. Perhaps one of the most important of these is that of the presence or absence of microorganisms. In an area such as Test Area C-52A, Eglin AFB Reservation, where the soils were subjected to repetitive applications of four different herbicides (2,4-D, 2,4,5-T picloram, and cacodylic acid) over a period of 8 years (1962 - 1970), the organisms had to either adapt to the presence of the chemicals or be adversely affected (i.e., reduction in population). For this reason, studies were initiated to examine population levels of various microflora found occurring on the one square mile grid. The initial studies[4,5] were conducted from 1967 to 1969. These studies provided data on the soil algal populations and are included as a synopsis in this report. In June 1970, a survey was conducted[6] of the soil bacterial, fungal, and Actinomycete populations found at specific sites on the grid and in control areas. The data from this study (identified in this report as the 1970 study) have been the basis for comparisons in the current study. In addition, the current studies also include a preliminary examination of aquatic algae found in the ponds in the center of the one square mile grid.

1. SYNOPSIS OF PREVIOUS RESEARCH, 1967 - 1970

In 1967, three areas were soil sampled for algal flora. Area I was Grid 1 located immediately south of the present one square mile grid. This area received a total accumulative concentration of 1,894 pounds of 2,4-D and 2,4,5-T from June 1962 through July 1964. Area II was Grid 2 located in the southwest portion of the present grid. This area received a total accumulative concentration of 1168 pounds of 2,4-D and 2,4,5-T from May 1964 through September 1966. Area III was a control area and was located 3 miles northwest of the present grid. (See Figure I-5).

Samples were taken from two levels in the soil. The first level included the surface litter and the first centimeter of soil. The second level samples included an amalgam of the soil between one and 15 cm. Two methods of culture were used. In the first, sterile filter paper was placed in sterile Petri dishes, after which approximately 10 gm of the sample soil were added. The cultures were moistened with sterile Bristol's solution and placed under fluorescent lights with an intensity of 300 ft-candles. The second method of culture preparation was identical to the first, except an additional piece of sterile filter paper was placed directly on the soil and moistened with the nutrient solution.

The number of algae was found to be low but no significant differences could be noted between the sprayed area and plots that had not received herbicides or only minimal amounts due to drift (Table VII-1). Only green and bluegreen algae were considered for identification. A total of 38 organisms were identified (Table VII-2). At least one species of Chlamydomonas, Chlorococcum, Chlorella, Micrococcus, Nostoc, Oscillatoria and Schizothrix was in every sample. In the majority of cases, Chlorococcum, Nostoc, and Schizothrix were represented by two or more species. Most of the other algae were located sporadically through the sampling period, and few were not universally distributed in all samples. A species of Sponiococcum was the only alga found repeatedly in a single location. The most frequently located alga was Schizothrix calcicola.

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[4] Arvik, J. H.: Soil Algae of the Eglin AFB Defoliant Test Range and the Response of Selected Species to Military Herbicides. Air Force Armament Laboratory Unpublished Data. 1969. Unclassified.

[5] Arvik, J. H. and J. H. Hunter. Soil Algae of a Herbicide Test Area, Eglin AFB, Florida, and the Response of Selected Species to Military Herbicides. Air Force Armament Laboratory Unpublished data. 1971. Unclassified.

[6] Hunter, J. H. Soil Microorganism Study of TA-C52A, Eglin AFB, Florida. Air Force Armament Laboratory Unpublished Survey. 1970. Unclassified.

TABLE VII-1. NUMBER OF SOIL ALGAE FOR GRAM OF SOIL FROM GRIDS I AND II, TEST AREA C-52A, AND THE CONTROL AREA, 1967 DATA

SAMPLING AREA	SOIL pH	SURFACE (0 - 1 cm)	CORE (1 - 15 cm)
Grid I (Area I)	5.4	2,360[a]	820[a]
Grid II (Area II)	5.2	2,243	567
Control	5.3	2,468	570

[a]Data are averages of three samples and three replications taken 30 days apart from September 1967 through November 1967.

TABLE VII-2. SOIL ALGAE FOUND ON OR NEAR TEST AREA C-52A, EGLIN AFB RESERVATION

CHLOROPHYTA

- Characium ambiguum Herm
- Characium sp.
- Chlamydomonas pyrenoidosa Deason and Bold
- Chlamydomonas typica Deason and Bold
- Chlorella vulgaris Beyer
- Chlorella sp.
- Chlorococcum ellipsoideum Deason and Bold
- Chlorococcum diplobionticum Hern
- Closteridium sp.
- Cylindrocystic brebissonii Meneg.
- Euglena sp.
- Homidium subtillissimum Mattox and Bold
- Hormidium flaccidum Mattox and Bold
- Protococcus viridis C. A. Agardh.
- Spongiococcus bacillaris Naeg.
- Ulothrix tenerrima Kuetz.
- Zygogonium ericetorum Kuetz.

CYANOPHYTA

- Anacystis marina Drouet and Daily
- Arthrospira brevis (Kuetz.) Drouet
- Calothrix parictina (Naeg.) Thuret.
- Coccochloris aeruginesa Drouet and Daily
- Coccochloris peniocystis Drouet and Daily
- Fischerella ambigua (Naeg.) Gom.
- Micrccoleum lyngbyaceus (Kuetz.) Crouan
- Microcoleus vaginatus (Vauch.) Gom.
- Nodularia sp.
- Nostoc commune Vauch
- Nostoc ellipsosporum (Desmaz.) Raben.
- Nostoc muscorum Ag.
- Oscillatoria lutea Ag.
- Oscillatoria submembranaceae Ard. and Straff
- Porphyrosiphon Natarisii (Menegh.) Gom.
- Rivularia sp.
- Schizothrix arenaria (Berk.) Gom.
- Schizothrix calcicola (Ag.) Gom.
- Schizothrix friezii (Ag.) Gom.

TABLE VII-3. Concluded.

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Two recent studies, however, have indicated that the 2,4-D/2,4,5-T herbicide combination has a short term effect on levels of soil microorganisms, especially bacteria (Table VII-3, items 1 and 10). Analyses of desert soil to which herbicide had been applied three months earlier have revealed that bacteria levels are still considerably reduced from levels in control soil samples. Fungal levels were also affected but not to the same degree as the bacteria.

4. MATERIALS AND METHOD

Samples were taken from the C-52A Test Grid on 13 June 1973. Eight sampling sites were selected to correspond with those sampled in the 1970 study. Three samples were taken from each of the eight 400 by 400 foot grid areas according to the pattern in Figure VII-1. Samples were taken from depths of 0 to 6 inches and from 6 to 12 inches at each site. Four control samples were taken from the same depths in an area 1/4 mile distant from the C-52A site, but similar to it in soil and vegetative cover. The control area was upwind from prevailing wind patterns, upstream from natural test grid water drainage, and never subjected to concentrated herbicide application.

In selecting areas for sampling within the 400 by 400 foot grid squares, an attempt was made to sample sites with varying vegetative cover. A system was devised to approximate cover which employed a rank ordering of the sites from 0 to 5; 0 indicated a 0 to 5% vegetative cover, 1 a vegetative cover of 5 to 20%, 2 a cover of 20 to 40%, 3 a cover of 40 to 60%, 4 a cover of 60 to 80%, and 5 a cover of 80 - 100%.

In obtaining the samples, a shovel was used to bare a slightly more than one foot deep vertical cross section of soil. The side of the cross section was marked at the 6 and 12 inch points. Soil was skimmed from the side of the hole, first from the 0 to 6 inch depth, then from the 6 to 12 inch depth. Samples were placed in plastic bags and labelled. The soil was kept at $4^{o}C$ for no more than 2 days before plating on media for microorganism analysis.

Three media were used to enumerate microorganisms. Potato dextrose agar medium plus Tergitol NPX (100 ppm) and chlorotetracycline (40 ppm) was used for maximum development of soil fungi. Nutrient agar plus 150 ppm Actidione was used for development of bacteria. Sodium caseinate medium (DIFCO Actinomycete Isolation Agar) plus 50 ppm Actidione was used for determination of Actinomycetes.

Thirty grams of each sample to be analyzed were blended with 300 ml of sterile distilled water for one minute. Dilution series were made using subsequent sterile distilled water blanks to achieve dilutions of 10^{-3}, 10^{-4}, and 10^{-5}. Dilutions were dispensed in three media in sterile petri plates with three replicates per dilution for each sample. All plated samples were incubated at $25^{o}C$.

Potato dextrose agar plates were examined for fungi after 3 days. Nutrient agar plates were examined for bacteria after 4 days, and the sodium caseinate agar plates were examined for Actinomycetes after 6 days. Counts were made from each plate and predominant organisms were isolated in pure culture for subsequent identification.

In addition to enumeration of microorganisms, 10 samples (0 to 6 inch depth) were analyzed for water content. Samples were selected on the basis of Hunter's previous estimations of relatively high or relatively low water content of a given area of the C-52A Grid and on the basis of relative vegetative cover (0 to 5). Samples tested were as follows: (1) five from relatively high moisture areas, (2) two from areas with a vegetative cover of 1, (3) one from an area with a vegetative cover of 3, (4) two from areas with a vegetative cover of 5, (5) five samples from relatively low moisture areas, (6) three from areas with zero vegetative cover, and (7) two from areas with a vegetative cover of 1.

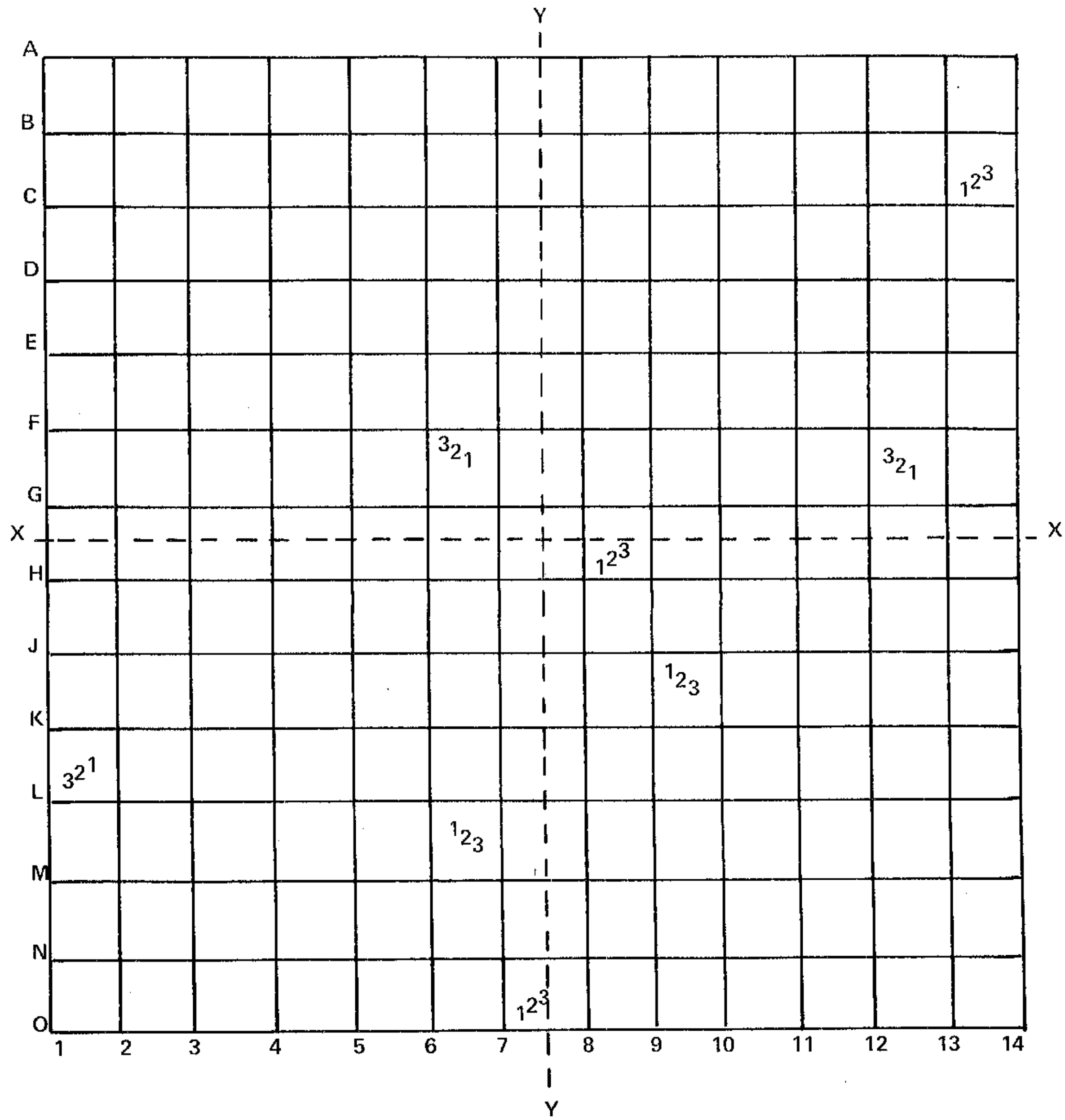

Figure VII-1. Schematic of the Test Area C-52A Grid Showing Soil Sampling Pattern (also see Figure I-5)

TABLE VII-4. AVERAGE NUMBER OF ORGANISMS PER GRAM OF SOIL FOR EACH GRID LOCATION SAMPLED (0 - 6 INCHES DEPTH) 1973

GRID LOCATION	ACTINOMYCETES	BACTERIA	FUNGI
C-13	394,000	870,000	58,750
G-13	366,670	722,500	30,000
G-7	255,000	630,000	24,375
H-8	290,000	980,000	60,000
J-9	360,000	575,000	39,909
K-2	285,000	428,000	55,000
L-6	353,330	ND	20,710
0-7	363,000	468,000	32,166

TABLE VII-5. AVERAGE NUMBER OF ORGANISMS PER GRAM OF SOIL FOR EACH GRID LOCATION SAMPLED (0 - 6 INCHES DEPTH), 1970

GRID LOCATION	ACTINOMYCETES	BACTERIA	FUNGI
C-13	440,000	ND	23,400
G-13	612,000	ND	78,750
G-7	460,000	173,000	74,500
H-8	536,000	224,000	27,500
J-9	21,465	ND	17,968
K-2	54,333	29,000	11,366
L-6	276,000	ND	10,315
0-7	NOT SAMPLED IN 1970		

5. RESULTS AND DISCUSSION

The average number of organisms per gram of soil are shown in Tables VII-4 and VII-5. Table VII-4 indicates the average number of bacteria, fungi, and Actinomycetes for each grid location sampled. Table VII-6 indicates the average number of organisms per gram of soil in terms of relative vegetative cover. Table VII-5 is a summary of the data from the 1970 study arranged for comparison with Table VII-4. Table VII-7 is a summary of the data from the 1970 study arranged for comparison with Table VII-6. Tables VII-8 and VII-9 show water content and percent organic matter, respectively, for each of the samples analyzed.

There were no large differences in the numbers of Actinomycetes, bacteria, or fungi between the sampling sites on the grid for the 0 to 6 inch depth. Comparing these data with the 1970 population levels shows an increase in the average number of Actinomycetes in the J-9 and K-2 locations and an overall increase in the number of bacteria in all sampling areas. In the K-2 area, particularly, the number of bacteria per gram of soil shows an order of magnitude increase over the 1970 level. This increase might be partially explained by the marked increase in overall vegetative cover around J-9 and K-2 since 1970.

Differences in microorganism levels in 1970 correlated to an extent with vegetative cover, the lower populations existing where cover was minimal (see Table VII-7). The 1973 data (Table VII-6) shows a significant increase in microorganisms in poorly covered areas. The 1973 data indicates no strong correlation between vegetative cover and microorganism populations. Control areas had population levels similar to those found for the grid.

Predominant bacteria isolated from the test grid were Bacillus sp. and Pseudomonas sp.. Predominant fungi were Penicillium spp., Aspergillus spp., and Fusarium spp.. In addition, Nigrospora sp., Helminthosporium sp., Pullularia sp., and Curvularia sp. were recovered. The predominant Actinomycetes were Streptomyces sp. and Nocardia sp.

Although number of organisms from the 6 to 12 inch depth were not tabulated for this report, the numbers of fungi were approximately 40 to 50% reduced from the corresponding 0 to 6 inch depth averages. The average numbers of Actinomycetes and bacteria were about the same as those from the corresponding 0 to 6 inch depth.

Water content varied very little in the 10 samples tested; the range being 0.35% to 1.22%. The average for all samples was 0.54%. There was no correlation between microorganism population levels and the slight differences in water content.

Organic matter variation was also minimal[7]. Percent organic matter variations did not correlate with differences in microorganism populations.

6. CURRENT STUDIES ON SURVEY OF AQUATIC ALGAE

The role of phytoplankton in the productivity of both soil and aquatic ecosystems is well documented. Algae have been identified (Reference VII-1) as being important in the initial

[7] This confirms data from personal communication between A. L. Young with the Department of Life and Behavioral Sciences, United States Air Force Academy, Colorado, 1973.

Reference:

VII-1. Shields, L. M., and L. W. Burrell, 1964. Algae in Relation to Soil Fertility, Bot. Rev. 30:90-128.

TABLE VII-8. WATER CONTENT OF TEN C-52A SOIL SAMPLES (0 TO 6 INCH DEPTH)			
SAMPLE	VEGETATIVE COVER	GRID LOCATION	PERCENT WATER
1	5	G-13	1.22
2	1	C-13	0.45
3	5	C-13	0.63
4	3	G-13	0.52
5	1	C-13	0.48
6	0	K-2	0.35
7	0	L-6	0.40
8	1	J-9	0.44
9	0	0-7	0.41
10	1	J-9	0.47

TABLE VII-9. ORGANIC MATTER OF SIX C-52A SOIL SAMPLES (0 TO 6 INCH DEPTH)			
SAMPLE	VEGETATIVE COVER	GRID LOCATION	PERCENT ORGANIC MATTER
1	0	K-2	0.75
2	0	J-9	0.81
3	1	J-9	1.19
4	4	G-13	[a]2.58
5	5	C-13	[a]4.29
6	3	G-13	1.88

[a]Samples taken from directly beneath a clump of panicum grass and contained root material.

TABLE VII-6. AVERAGE NUMBER OF ORGANISMS PER GRAM OF SOIL (0 - 6 INCH DEPTH), VEGETATIVE COVER, 1973			
VEGETATIVE COVER	ACTINOMYCETES	BACTERIA	FUNGI
5	310,000	1,015,000	50,000
4	300,000	1,070,000	110,000
3	1,860,000	722,500	30,000
2	283,330	890,000	32,166
1	357,000	416,000	30,800
0	326,360	529,000	25,800
CONTROL 5	235,000	ND	48,370
CONTROL 4	370,000	810,000	55,000
CONTROL 3	303,000	740,000	51,000

TABLE VII-7. AVERAGE NUMBER OF ORGANISMS PER GRAM OF SOIL (0 - 6 INCH DEPTH), VEGETATIVE COVER, 1973			
VEGETATIVE COVER	ACTINOMYCETES	BACTERIA	FUNGI
5	460,000	173,000	74,500
5	612,000	ND	78,750
3	536,000	224,000	27,500
2	440,000	ND	23,400
1	54,333	29,000	11,366
0	21,465	ND	17,968
0	276,000	ND	10,315

ecological succession of barren areas. Other investigations (Reference VII-2) have indicated the effects pesticides have on algae (Reference VII-3).

Grab samples were obtained from the pond located near the one square mile grid. Two types of samples were collected: Sample One was a collection of the suspended and precipitated algal material in the pond and Sample Two was a collection of the dense algal mat which occurred just beneath the surface of the water. The one liter samples were returned to the laboratory for algal genera identification.

Seven genera of algae were identified from the samples collected (Table VII-9). All genera were present in both samples: Sample Two being predominantly Zygnema and Sample One being predominantly Zygnema and Triploceras. The seven genera represent two divisions, Chlorophyta, the green algae, and Chrysophyta, the yellow-green or yellow-brown algae.

Data collected during the course of this study included some physical data: Of interest specifically with respect to the aquatic algae is the pH which was found to be 5.51, or slightly acid. Genera represented in the samples collected are those expected to be found under conditions of this type[8].

The previous study, conducted from September to November 1967 was more extensive than the current study and encompassed the periodicity of algal species with time. In the previous study, genera representative of two divisions were found. Representative of Chlorophyta (green algae) and Cyanophyta (blue-green algae) were identified. The present study, based on a single collection time, would be expected to identify less diversity of orders and families. No genera were found to be common to the two studies. The previous study, however, addressed only Chlorophyta (green) and Cyanophyta algae (blue-green). These data do not however necessarily indicate changes in algal populations as the previous study dealt exclusively with soil populations.

7. CONCLUSIONS

In tests performed 3 years after the last application of 2,4-D/2,4,5-T herbicide, the Test Area C-52A grid, Eglin AFB Reservation, exhibits a population level of soil microorganisms identical to that in an adjacent control area of similar soil and vegetative characteristics not exposed to massive quantities of herbicide. There are increases in Actinomycete and bacteria populations in some test site areas over levels recorded in 1970. This is possibly due to a general increase in vegetative cover for those sampling sites and for the entire test grid. No significant permanent effects could be attributed to the presence of herbicides.

Data on aquatic algae populations from ponds previously exposed to repetitive applications of herbicides indicate that the genera present are those expected in warm, acid (pH 5.5), seepage, or standing waters.

---

[8]Personal Communication with R. Lynn, Utah State University, Department of Botany, Logan, Utah, 1973.

References:
VII-2. Schluter, M. 1966. Investigations of the Algacidal Characteristics of Fungicides and Herbicides. Int. Rev. Gestamten Hydrobiol. 51:521-541.
VII-3. Wolf, F. T. 1962. Growth Inhibition of Chlorella Induced by 3-amino, 1,2,4, Triazole, and its Reversal by Purines. Nature, 193:901-902.

TABLE VII-10. AQUATIC ALGAE* FROM PONDS OF TEST AREA C-52A

DIVISION	CLASS	ORDER	FAMILY	GENERA
Chlorophyta	Chlorophyceae	Zygnematales	Desmidiaceae	Closterium Cosmarium Triploceras
Chlorophyta	Chlorophyceae	Zygnematales	Zygnemataceae	Zygnema
Chlorophyta	Chlorophyceae	Tetrasporales	Palmellaceae	Asterococcus
Chrysophyta	Bacillariophycaeae	Pennales Suborder: Fragilarineae	Fragilariaceae	Asterionella
Chrysophyta	Bacillariophyceae	Naviculineae	Naviculaceae	Navicula

*Smith, G. M. 1950. The Fresh-Water Algae of the United States. McGraw-Hill. 2nd. Ed. 709 pp.

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TECHNICAL REPORT AFATL-TR-74-12

ECOLOGICAL STUDIES ON A HERBICIDE-EQUIPMENT TEST AREA (TA C-52A) EGLIN AFB RESERVATION, FLORIDA

JANUARY 1974

FINAL REPORT: January 1967 to November 1973

Approved for public release; distribution unlimited.

ENVIRONICS AND FLAME MUNITIONS BRANCH
FLAME, INCENDIARY AND EXPLOSIVES DIVISION
AIR FORCE ARMAMENT LABORATORY
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EGLIN AIR FORCE BASE, FLORIDA

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Amphibians
Animal Survey Studies
Bioassay
Blue
Defoliant Testing
Birds
2,4-Dichlorophenoxyacetic Acid
Dimethylarsinic Acid

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report attempts to answer the major questions concerned with the ecological consequences of applying massive quantities of herbicides (346,117 pounds), via repetitive applications, over a period of eight years, 1962 - 1970, to an area of approximately one square mile. Moreover, the report documents the persistence, degradation, and/or disappearance of the herbicides from the Test Area's soils and drainage waters and their subsequent effects (direct or indirect) upon the vegetative, faunal, and microbial communities. The active ingredients of the four military herbicides (Orange, Purple, White, and Blue) sprayed on Test Area C-52A were 2,4-dichlorophenoxyacetic acid (2,4-D),
(continued)

Item 19. Continued
Ecological Investigations
Fish
Herbicide
Herbicide Equipment Test Grid
Histology
Mammals
Microbial Survey
Military Defoliation Program
Necropsy
Orange
Purple
Reptiles
TCDD
Teratogenic
Test Area C-52A, Eglin AFB Reservation
2,3,7,8-Tetrachlorodibenzo-p-dioxin
2,4,5-Trichlorophenoxyaetic Acid
Vegetative Coverage Survey
White

Item 20. 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), 4-amino-3,5,6-trichloropicolinic acid (picloram), and dimethylarsinic acid (cacodylic acid). It is probable that the 2,4,5-T herbicide contained the highly teratogenic (fetus deformina) contaminant 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD). Significant herbicide residues were found in 1969. However, analysis of soil cores in 1971 indicated residues of 2,4-D, 2,4,5-T, picloram, and arsenic to be in the parts per billion range; no TCDD was found at this detection limit. Soil samples collected in June and October 1973 showed TCDD (or a TCDD-like chemical) levels ranging from less than 10 parts per trillion (ppt) to 710 ppt. Direct effects of the herbicides on the vegetative community were temporary. With the disappearance of residue, vegetative succession was initiated. By 1973, the majority of the test area could not be distinguished from control sites. Analysis of sample animal populations indicated that no histological or gross abnormalities were present in adults or their progeny.

PREFACE

The Air Force project directly related to the information in this report is Air Force Systems Command Project 5154-02, Ecological Survey of Test Area C-52A, Eglin AFB Reservation, Florida. This report documents five years of ecological investigations performed between 1967 and 1973.

The assistance provided during portions of this report by the Air Force Environmental Health Laboratory, Booz-Allen Applied Research, Dow Chemical U.S.A., United States Air Force Academy, United States Department of Agriculture, University of Alabama, University of Florida, and Vitro Services is gratefully acknowledged.

Information on the test grid monitoring system and types and amounts of defoliants disseminated on Test Area C-52A from July 1962 to April 1969 was obtained from Armament Development and Test Center working papers, "Defoliant History of Test Area C-52A", by Helen Biever. After April 1969, this same information was obtained from Vitro Services, Vitro Corporation of America. Information on soils of Test Area C-52A was obtained from a July 1969 soil survey of Eglin AFB Reservation prepared by the Soil Conservation Service of the United States Department of Agriculture.

This technical report has been reviewed and is approved.

F. Ramon Bonnano

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SUMMARY

In support of programs testing aerial dissemination systems, a one square mile test grid on Test Area (TA) C-52A, Eglin AFB Reservation, Florida, received massive quantities of military herbicides. The purpose of these test programs was to evaluate the capabilities of the equipment systems, not the biological effectiveness of the various herbicides. Hence, it was only after repetitive applications that test personnel began to express concern over the potential ecological and environmental hazards that might be associated with continuance of the test program. This concern led to the establishment of a research program in the fall of 1967 to measure the ecological effects produced by the various herbicides on the plant and animal communities of TA C-52A. This report documents 6 years of research (1967 - 1973) on TA C-52A and the immediately adjacent streams and forested areas.

This report attempts to answer the major questions concerned with the ecological consequences of applying massive quantities of herbicides (346,117 pounds), via repetitive applications, over a period of 8 years (1962 - 1970) to an area of approximately one square mile. Moreover, the report documents the persistence, degradation, and/or disappearance of the herbicides from the soils and drainage waters of TA C-52A, and the subsequent effects (direct or indirect) of the herbicides upon the vegetative, faunal, and microbial communities.

The active ingredients of the four military herbicides (Orange, Purple, White, and Blue) sprayed on TA C-52A were 2,4-dichlorophenoyxacetic acid (2,4-D), 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), 4-amino-3,5,6-trichloropicolinic acid (picloram), and dimethylarsinic acid (cacodylic acid). It is probable that the 2,4,5-T herbicide contained the highly teratogenic (fetus deforming) contaminant 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). From 1962 to 1964, 92 acres of the test grid received 1,894 pounds 2,4-D, 2,4,5-T per acre while, in 1964 to 1966, another 92 acres received 1,168 pounds per acre. From 1966 to 1970, a third distinct area of over 240 acres received 343 pounds per acre of 2,4-D and 2,4,5-T, and 6 pounds per acre of picloram; and from 1969 to 1970, this same area received 53 pounds per acre of cacodylic acid (28 pounds per acre of arsenic as the organic pentavalent form; calculated on weight of Blue applied per acre).

From the rates of herbicides that were applied during the years of testing spray equipment, it was obvious that TA C-52A offered a unique opportunity to study herbicidal persistence and soil leaching. Yet the problem of how best to assess the level of herbicide residue was a difficult one. The herbicides could be chemically present but because of soil binding might not be biologically active. Thus, both bioassay techniques and analytical analyses were employed. The first major bioassay experiment was conducted in April 1970. By considering the flightpaths, the water sources, and the terracing effects, it was possible to divide the one square mile test grid into 16 vegetation areas. These areas formed the basis for the random selection of 48 soil cores taken from the surface to a depth of 3 feet. Soybean bioassays indicated that 27 of the 48 cores were significantly different from control cores (95% probability level). The results indicated that soil leaching or penetration was much more prevalent along the dissemination flightpaths than in other areas of the test grid. Efforts to quantitate (chemically) the bioassay were confined to only the top 6 inch increment because of within-core variations. By considering that all phytotoxic effects resulted from 2,4-D and 2,4,5-T, the average value for the top 6 inches of the eight cores showing greatest herbicide concentration was 2.82 ppm (parts per million) herbicide. Chemical analyses of soil cores collected from the eight sites showing greatest phytotoxic concentrations were performed in December

1970. Results indicated that the maximum concentration of either 2,4-D or 2,4,5-T was 8.7 ppb (parts per billion). A 1970 analysis of soil cores from areas receiving the greatest quantities of Blue indicated maximum arsenic levels of 4.70, 1.30, and 0.90 ppm, respectively, for the first three 6 inch increments of the soil profile. These same increments were again collected and analyzed in 1973, and the levels of arsenic were 0.85, 0.47, and 0.59 ppm for the three consecutive 6 inch increments. Leaching of the arsenical from the soils may have occurred. In November 1969, picloram analysis of soil cores from areas receiving greatest quantities of White indicated maximum levels of 2.8 ppm picloram present in the 6 to 12 inch increment. An analysis of the same sites in 1971 indicated the picloram had leached further into the soil profile but concentrations were significantly less (ppb). The analyses of soil cores in 1971 showed no residue of TCDD at a minimum detection limit of less than 1 ppb, even in soils previously treated with 947 pounds 2,4,5-T per acre. However, data from soil analysis (via mass spectrometry) of four total samples collected in June and October 1973 indicated TCDD levels of $<$ 10, 11, 30, and 710 parts per trillion (ppt), respectively. These levels were found in the top 6 inches of soil core. The greatest concentration (710 ppt) was found as a sample form the area that received 947 pounds 2,4,5-T in the 1962 - 1964 test period.

A comparison of vegetative coverage and occurrence of plant species on the one square mile grid between June 1971 and June 1973 showed that areas with 0 to 60% vegetative cover in 1971 had a coverage of 15% to 85% in June 1973. Those areas having 0 to 5% coverage in 1971 (areas adjacent to or under flightpaths used during herbicide equipment testing) had 15% to 54% coverage. The rate of coverage seemed to be dependent upon soil type, soil moisture, and wind. There was no evidence to indicate that the existing vegetative coverage was directly related to herbicide residue in the soil: some dicotyledonous or broadleaf plants that are normally susceptible to damage from herbicide residues occurred throughout the entire one square mile grid except in a few irregularly spaced barren areas. The square-foot transect method of determining vegetative cover indicated that the most dominant plants on the test area are the grasses - switchgrass (Panicum virgatum), woolly panicum (Panicum lanuginosum), and the broadleaf plants - rough buttonweed (Diodia teres), poverty weed (Hypericum gentianoides), and common polypremum (Polypremum procumbens). In 1971, 74 dicotyledonous species were collected on the one square mile grid; in 1973, 107 dicotyledonous species were collected. All of the plant species collected were pressed, mounted, and placed in the Eglin AFB Herbarium.

An evaluation of the effects of the spray equipment testing program on faunal communities was conducted from May 1970 to August 1973. The extent of any faunal ecological alteration was measured by assessing data on species variation, distribution patterns, habitat preference (and its relationships to vegetative coverage), and the occurrence and incidence of developmental defects as well as gross and histologic lesions in postmortem pathological examinations.

A total of 73 species of vertebrate animals (mammals, birds, reptiles, and amphibians) were observed on TA C-52A and in the surrounding area. Of these 73 species, 22 were observed only off the grid, 11 were observed only on the grid, and 40 were observed to be common to both areas. During the early studies, no attempts were made to quantitate animal populations in the areas surrounding the grid; however, in 1970 preliminary population studies by trap-retrap methods were performed on beach mouse (Peromyscus polionotus) populations for a 60 day period to confirm the hypothesis that it was the most prevalent species on the grid. The hypothesis was supported by the capture of 36 beach mice from widely distributed areas on the grid, except in areas with less than 5% vegetation. Eight pairs of eastern harvest mice were taken to the laboratory and allowed to breed. Six of the eight pairs had litters totaling 24 mice. These progeny were free from any gross external birth defects. During February - May 1971, population densities of the beach mouse were studied at eight different locations on the grid and in two different areas off the grid which served as controls. Populations were estimated on the basis of the trap-retrap data. There was no difference in mouse population densities in herbicide treated and untreated control areas affording comparable habitats. All indications were that any population differences in other animal species between the test area and the surrounding area were due to differences caused by the elimination of certain plants, and therefore, certain ecological niches, rather than being due to any direct toxic effect of the herbicides on the animal populations present on TA C-52A.

During the last day of the 1971 study, 9 mice were captured and taken to the laboratory for postmortem pathological examination. There were no instances of cleft palate or other deformities. Histologically, liver, kidney, and gonadal tissues from these animals appeared normal. In the 1973 study, several different species of animals were caught, both on and off the test grid. These included beach mice (Peromyscus polionotus), cotton mice (Peromyscus gossypinus), eastern harvest mice (Reithrodontomys humulis), hispid cotton rats (Signodon hispidus), six-lined racerunners (Cnemidophorus sexlineatus), a toad (Bufo americanus), and a cottonmouth water moccasin (Ankistrodon piscivorus). A total of 89 animals were submitted to the Armed Forces Institute of Pathology, Washington, D. C., for complete pathological examination including gross and microscopic studies. Liver and fat tissue from 70 rodents were forwarded to the Interpretive Analytical Services, Dow Chemical, U.S.A., for TCDD analyses. The sex distribution of the trapped animals was relatively equal. The ages of the animals varied, but adults predominated in the sample. No gross or histological developmental defects were seen in any of the animals. Several of the rats and mice from both groups were pregnant at the time of autopsy. The stage of gestation varied from early pregnancy to near term. The embryos and fetuses were examined grossly and microscopically, and no developmental defects or other lesions were observed. Gross necropsy lesions were relatively infrequent and consisted primarily of lung congestion in those animals that had died from heat exhaustion prior to being brought to the laboratory. The organ weights did not vary significantly between the test and control animals when an animal with lungs and kidneys showing inflammatory pathological lesions was removed from the sample. Histologically, the tissues of 13 of the 26 control animals and 40 of the 63 animals from the test grid were considered normal. Microscopic lesions were noted in some animals from both groups. For the most part, these were minor changes of a type one expects to find in any animal population. One of the most common findings was parasites. A total of 11 controls and nine grid animals were affected with one or more classes of parasites. Parasites may be observed in any wild species, and those in this population were for the most part incidental findings that were apparently not harmful to the animal. There were exceptions however; protozoan organisms had produced focal myositis in one rat and were also responsible for hypertrophy of the bile duct epithelium in a six-lined racerunner.

Moderate to severe pulmonary congestion and edema was seen in several rats and mice. All of these animals were found dead in the traps before reaching the laboratory, and the lung lesions were probably the result of heat exhaustion. The remainder of the lesions in both groups consisted principally of inflammatory cell infiltrates of various organs and tissues. These lesions were usually mild in extent and although the etiology was not readily apparent, the cause was not interpreted as toxic. The analysis of TCDD from the rodents collected in June and October 1973 indicated that TCDD or a chemically similar compound accumulated in the liver and fat of rodents collected from an area receiving massive quantities of 2,4,5-T. However, based on the pathological studies, there was no evidence that the herbicides produced any developmental defects or other specific lesions in the animals sampled or in the progeny of those that were pregnant. The lesions found were interpreted to be of a naturally occurring type and were not considered related to any specific chemical toxicity.

In 1970, beach mice were not found on the more barren sections of the grid (0 to 5% vegetative cover). However, some areas of the grid had a population density that exceeded that of the species most preferred habitat as reported in the literature. In 1973, in an attempt to correlate distribution of the beach mouse with vegetative cover (i.e., habitat preference) a trapping-retrapping program of 8 days duration was conducted. The majority of animals (63) were found in areas with 5% to 60% vegetative cover: Within this range, the greatest number of animals trapped (28) was from an area with 40% to 60% cover. A similar habitat preference has been observed along the beaches of the Gulf Coast. In this study, it appeared that the beach mouse used the seeds of switchgrass (Panicum virgatum) and woolly panicum (Panicum lanuginosum) as a food source.

Trapping data from 1971 and from 1973 were compared to determine whether an increase in the population of beach mice had occurred. The statistical evidence derived from that study showed that the 1.64 beach mice per acre population (based on the Lincoln Index for 1973) was slightly higher than the 0.8 and 1.4 mice per acre reported for a similar habitat. The population of beach mice was also higher in 1973 than in 1971 in the area of the test grid. The apparent increase in beach mouse population on the grid for 1973 over 1971 was probably due to the natural recovery phenomenon of a previously disturbed area (i.e., ecological succession). Some areas of the test grid have currently exceeded the preferred percentage of vegetative coverage of the beach mouse habitat, and other areas were either ideal or fast developing into an ideal habitat. If the test grid remains undisturbed and continues toward the climax species, a reduction in the number of beach mice will probably occur simply due to the decline of preferred habitat.

A 1973 sweep net survey of the Arthropods of TA C-52A resulted in the collection of over 1,700 specimens belonging to 66 insect families and Arachnid orders. These totals represented only one of five paired sweeps taken over a one mile section of the test grid. A similar study performed in 1971 produced 1,803 specimens and 74 families from five paired sweeps of the same area using the same basic sampling techniques. A much greater number of small to minute insects were taken in the 1973 survey. Vegetative coverage of the test area had increased since 1971. The two studies showed similarities in pattern of distribution of arthropods in relation to the vegetation, number of arthropod species, and arthropod diversity. Generally, the 1973 study showed a reduction of the extremes found in these parameters during the 1971 study. This trend was expected to continue as the test area stabilizes and develops further plant cover, thus allowing a succession of insect populations to invade the recovering habitat.

Two classes of aquatic areas are associated with TA C-52A; ponds actually on the one square mile area and streams which drain the area. Most of the ponds are primarily of the wet weather type, drying up once in the last 5 years; however, one of the ponds is spring fed. Three major streams and two minor streams drain the test area. The combined annual flow of the five streams exceeds 24 billion gallons of water. Seventeen species of fishes have been collected from the major streams and three species from the spring fed pond on the grid. Statistical comparisons of 1969 and 1973 data of fish populations in the three major streams confirm a chronologically higher diversity in fish populations. However, the two control streams confirm a similar trend in diversity. Nevertheless, from examining all of the aquatic data, certain observations support the idea that a recovery phenomenon is occurring in the streams draining TA C-52A. These observations are difficult to document because of insufficient data. For example, in 1969 the southern brook lamprey (Ichthyomyzon gagei) was never collected in one of the streams immediately adjacent to the area of the grid receiving the heaviest applications of herbicides; however, in 1973 this lamprey was taken in relatively large numbers. These observations may or may not reflect a change in habitat due to recovery from herbicide exposure. Residue analyses (1969 to 1971) of 558 water samples, 68 silt samples, and 73 oyster samples from aquatic communities associated with drainage of water from TA C-52A showed negligible arsenic levels. A maximum concentration of 11 ppb picloram was detected in one of the streams in June 1971, but this level had dropped to less than 1 ppb when sampled in December 1971. TCDD analysis of biological organisms from streams draining TA C-52A or in the ponds on the test area were free from contamination at a detection limit of less than 10 parts per trillion.

In analyses performed 3 years after the last application of 2,4-D and 2,4,5-T herbicides, the test grid exhibited population levels of soil microorganisms identical to those in adjacent control areas of similar soil and vegetative characteristics not exposed to herbicides. There were increases in Actinomycete and bacterial populations in some test site areas over levels recorded in 1970. This was possibly due to a general increase in vegetative cover for those sampling sites and for the entire test grid. No significant permanent effects could be attributed to exposure to herbicides.

Data on aquatic alga populations from ponds on the one square mile grid (previously exposed to repetitive applications of herbicides) indicated that the genera present were those expected in warm, acid (pH 5.5), seepage, or standing waters.

SECTION I

INTRODUCTION

The Eglin AFB Reservation has served various military uses, one of them having been the development and testing of aerial spray equipment (e.g., herbicide spray equipment). It was necessary for this equipment to be tested under controlled conditions that were as near to being realistic as possible. For this purpose a testing installation was established in 1962 on the Eglin Reservation with the place of direct aerial application restricted to an area approximately one mile square within Test Area C-52A (TA C-52A) in the southeastern part of the reservation.

In support of programs testing aerial dissemination systems, TA C-52A received massive quantities of military herbicides. The purpose of these test programs was to evaluate the capabilities of the equipment systems, not the biological effectiveness of the various herbicides. After repetitive applications, personnel involved with the test program expressed concern about potential ecological and environmental hazards that might be associated with continuance of these test programs. This concern led to the establishment of an "Environmental Pollution Control and Monitoring System Task Team". One of the purposes of this report is to document the efforts of this task team and other personnel who were assigned to or were associated with the Air Force Armament Laboratory and the Armament Development and Test Center. Their efforts should serve as an indication of the interest and concern on the part of the Air Force for pollution abatement as an integral part of weapon systems development. In view of the controversy associated with the use of herbicides, TA C-52A offers a unique opportunity for evaluating the ecological effects of repetitive applications of herbicides. Data obtained during the past six years of research, plus the current research effort, may be of significance in dictating future programs involving herbicides in military programs, civic action applications, and the public acceptance of herbicides for continued use in weed and brush control programs.

1. DESCRIPTION OF GEOGRAPHICAL AND ENVIRONMENTAL FACTORS

a. General Area

The Eglin AFB Reservation is located in Northwest Florida where it occupies a portion of Santa Rosa Island, Okaloosa Island, the southeastern part of Santa Rosa County, the southern half of Okaloosa County, and the southwestern quarter of Walton County. It covers an area of approximately 750 square miles. To the south the Reservation is adjacent to Choctawhatchee Bay and the Gulf of Mexico, while to the north and east it is bordered roughly by the Yellow River and Alaqua Creek.

The Reservation lies on generally level or gently rolling terrain, all under 300 feet elevation and sloping to sea level on the west and south. It is drained by small tributaries of the Yellow River and Alaqua Creek and by smaller streams that flow directly into Pensacola Bay and Choctawhatchee Bay. The valleys of these streams often are steep sided and terminate abruptly. The soil of most of the Reservation consists of somewhat excessively drained, deep, acid sands of the Lakeland series. In the stream bottoms, and particularly along the Yellow River, the soils are much more heavily organic.

b. Test Area C-52A

Test Area C-52A is located in the southeastern part of the Eglin Reservation. It covers an area of approximately three square miles (Figure I-1) and is a grassy plain surrounded by a forest stand that is dominated by longleaf pine (*Pinus palustris*), sand pine (*Pinus clausa*), and

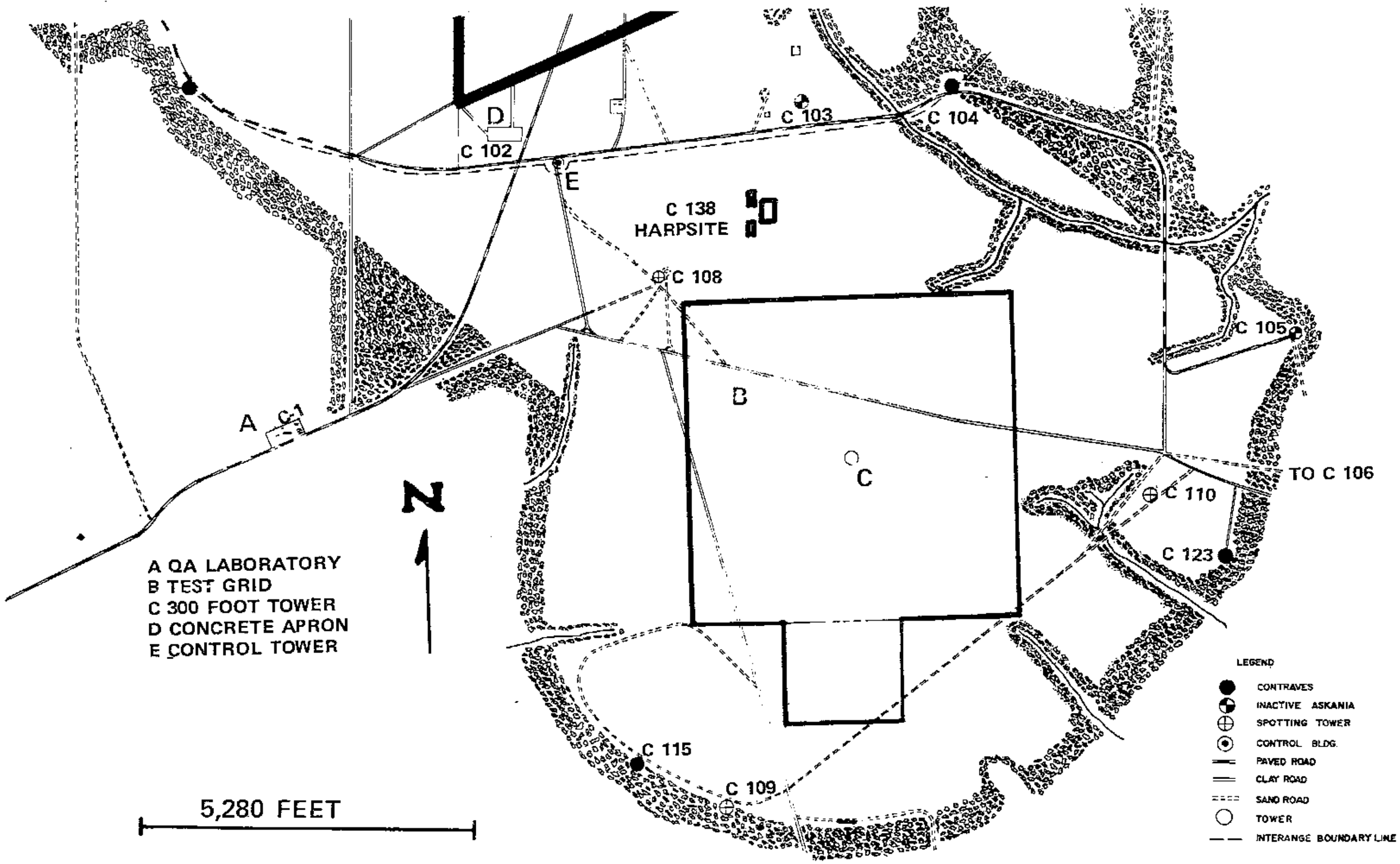


Figure I-1. Map of Test Area C-52A, Eglin AFB Reservation, Florida turkey oak (Quercus laevis). The actual area for test operations which occupies an area of two square miles, is a cleared area occupied mainly by broomsedge (Andropogon virginicus), switchgrass (Panicum virgatum), and low growing grasses and herbs. Much of the center of the range was established prior to 1960, but the open range as it presently exists was developed in 1961 and 1962.Figures I-2(a)and I-3 are aerial photographs of the one square mile test grid and the immediate adjacent area as it appeared on 16 March 1971 and 14 June 1973, respectively. The test grid is approximately 93 feet above sea level with a water table of six to ten feet. The major portion of this test area is drained by five small creeks whose flow rates are influenced by a 60.4-inch average annual rainfall (Table I-1). The average temperature for the area is 64.9^{o}F (Table I-2). The average maximum and minimum temperatures (^{o}F) by month for the test area are shown in Table I-3. For the most part, the soil of the test grid is a fine white sand on the surface changing to yellow beneath. The profile composition for a typical 3-foot soil core is shown in Table I-4. The soils of the range are predominantly well drained. acid sands of the Lakeland Association with 0 to 5% slope. Figure I-2(b) shows the location of the Lakeland, Chipley, and Rutledge sand series of the Lakeland Association as found on the one square mile grid. The Lakeland sand that covers most of the grid area forms excessively drained thick deposits that extend to a depth of about seven feet. This sand is characteristically very dry, even with 60 inches of annual rainfall. The Chipley sand is moderately well drained, and the water table in this soil may rise to within 20 to 40 inches of the surface for three months during the year. The Rutledge sand is poorly drained, strongly acid (pH 4.5 to 5.0) soil. The water table in this sand is within ten inches of the surface for several months during the year.

2. DESCRIPTION OF THE TEST FACILITY

a. Description

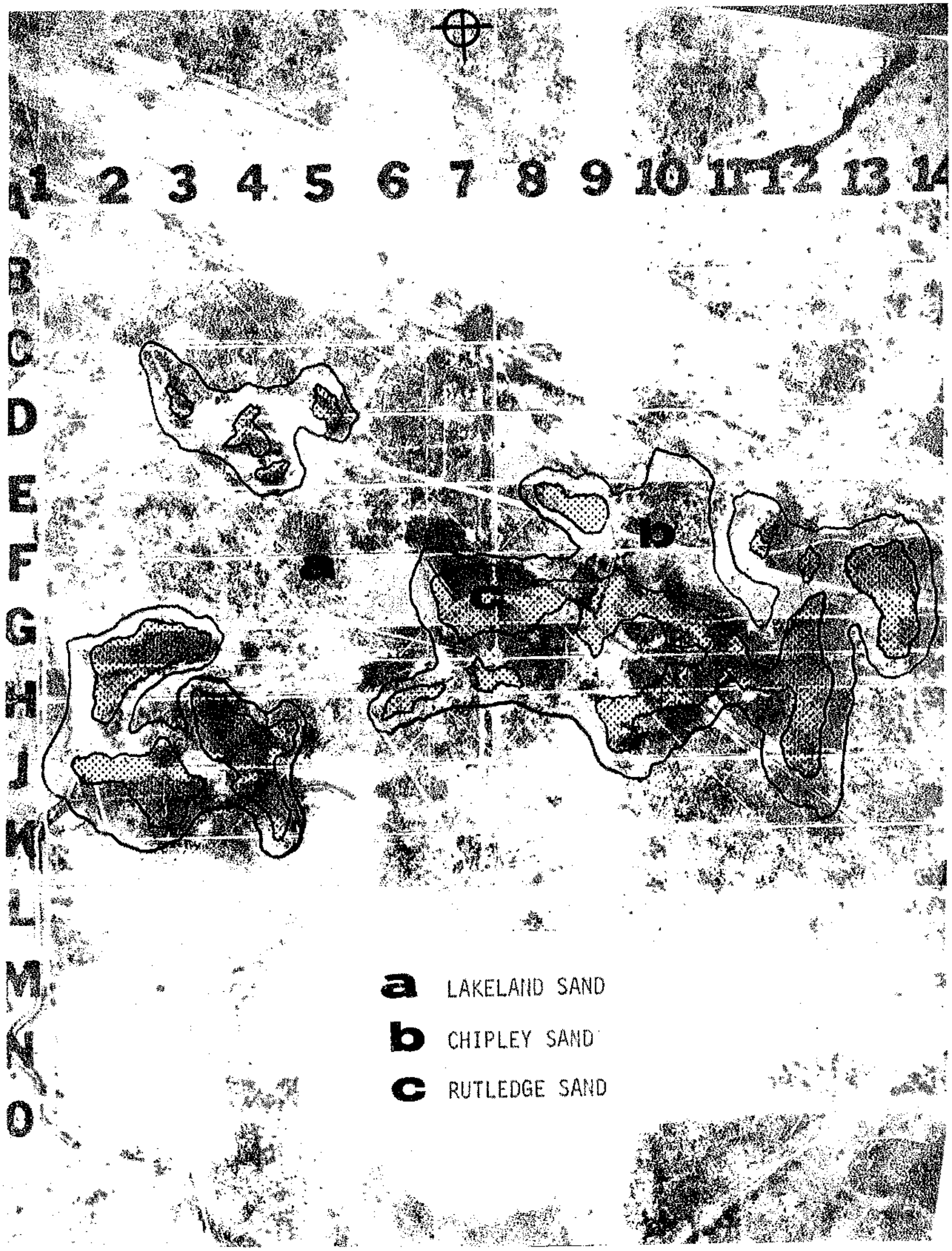
Test Area C-52A, the southern most portion of the TA C-52 range complex, is a 3 square mile cleared area on which a one square mile micrometerological and aerosol/particulate sampling grid was located (Figure I-1). Test Site C-1, on the western edge of TA C-52A, was the control center for operation of the sampling instrumentation, grid support and test data assessment. Test Site C-102 at TA C-52 Central, provided cinetheodolite time-space-position support and fixed and mobile communications for TA C-52A mission aircraft control. This test area was closed January 1971.

b. Capabilities and Uses

Test Area C-52A was used for assessing the dissemination and deposition characteristics of aerially delivered liquid and particulate materials from spray tanks and other systems of a similar nature. Micrometeorological conditions existing below 300 feet over the test area were continuously described by the Automatic Meteorological Data Acquisition and Processing System (AMDAPS) which included wind, temperature, and dew point sensors on a 300-foot tower at grid center and wind sensors on 12-foot masts located at each of the four corners of the one square mile grid. A complex of defoliant grids, intersecting near the central AMDAPS tower and oriented to eight major compass headings, provided 16 discrete sampling grids which could be selected for the most advantageous wind conditions prior to and during mission time. These grids employed glass plates and Kromekote cards for physical collection of test materials in droplet form. Each of the 250 permanent sampling stations of the TA C-52A basic grid array employed a wide variety of sampling devices including the above but were also equipped with individual commercial power and sequencing control lines for remote operation of automatic vacuum type samples which collected small particle and aerosol test materials. These sampling stations were arranged on 400-foot centers to form the one square mile grid (see sampling station array in Figure I-4). Remotely controlled, battery operated, portable samplers were also available to gather data in special purpose grid configurations anywhere in a 10 square mile area.

(a) Photograph of the One Square Mile Grid Taken at 5,000 Feet Above Ground Level on 16 March 1971

Figure I-2. Test Area C-52A



(b) Soil Types of the One Square Mile Grid on Test Area C-52A

Figure I-2. Concluded

Figure I-3. Photograph of the One Square Mile Grid Taken at 4,300 Feet Above Ground Level on 14 June 1973

TABLE I-1. ANNUAL TOTAL PRECIPITATION FOR EGLIN AFB AND NICEVILLE, FLORIDA, FROM 1964 TO 1969

YEAR	PRECIPITATION, Inches	
	EGLIN AFB	NICEVILLE
1964	68.10	72.68
1965	61.85	65.29
1966	51.10	66.95
1967	62.76	73.05
1968	31.68	42.33
1969	60.01	68.96
Average[a]	55.92	64.88

[a]Average of the two locations is 60.40 inches

TABLE I-2. AVERAGE MONTHLY TEMPERATURES (°F) FOR FOUR YEARS AT NICEVILLE, FLORIDA

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1966	45.4	50.1	56.1	65.3	73.8	76.1	81.7	79.3	77.1	67.7	56.6	49.6
1967	49.4	48.9	60.8	70.6	72.2	79.2	78.7	72.4	63.5	55.2	56.8	65.4
1968	48.7	45.9	54.5	67.9	72.3	79.9	79.2	81.5	75.5	66.6	55.0	49.3
1969	49.8	52.0	52.1	66.9	73.2	80.5	81.2	78.1	75.2	69.6	54.5	49.2
Average[a]	48.3	49.2	55.9	67.7	72.9	78.9	80.2	78.3	72.8	64.8	55.7	53.4

[a]Average temperature for 4 years is 64.9°F

TABLE I-3. AVERAGE MAXIMUM AND MINIMUM TEMPERATURES (°F) BY MONTH FOR FOUR YEARS (1966 - 1969) TAKEN FROM THE SIX FOOT LEVEL AT THE CENTER TOWER OF TEST AREA C-52A, EGLIN AFB, FLORIDA

MONTH[a]	TEMPERATURE, °F	
	MINIMUM	MAXIMUM
January	40.05	58.86
February	40.55	60.69
March	48.15	68.32
April	59.96	81.52
May	62.67	82.15
June	68.38	86.04
July	68.82	87.48
August	71.04	87.71
September	66.90	84.06
October	54.24	77.41
November	46.09	68.03
December	42.08	61.67

[a]Average temperature for 4 years is 65.54°F

TABLE I-4. SOIL PROFILE (6-INCH INCREMENTS) FOR TEST AREA C-52A, EGLIN AFB RESERVATION, FLORIDA[a]

DEPTH, Inches	SAND, %	SILT, %	CLAY, %	O.M., %[b]	C.E.C.[c]
1 - 6	91.6	4.0	4.4	0.46	1.19
6 - 12	90.1	4.3	5.6	0.20	0.81
12 - 18	92.1	4.3	3.6	0.20	0.73
18 - 24	92.9	3.5	3.6	0.00	0.69
24 - 30	93.1	2.8	4.1	0.07	0.69
30 - 36	92.8	3.6	3.6	0.07	0.69

[a]As determined by the Soils Department, University of Florida, Gainesville, Florida. Soil sample taken within 50 feet of K-9 permanent sampling station.

[b]Percent organic matter.

[c]C.E.C. (cation exchange capacity) is the ability of a cation to be displaced or exchanged from the soil by another cation. The cation exchange capacity of a typical greenhouse potting soil is 11.43. A soil with a cation exchange capacity of 1 can "bind" or "fix" 10 ppm of a given cation(s).

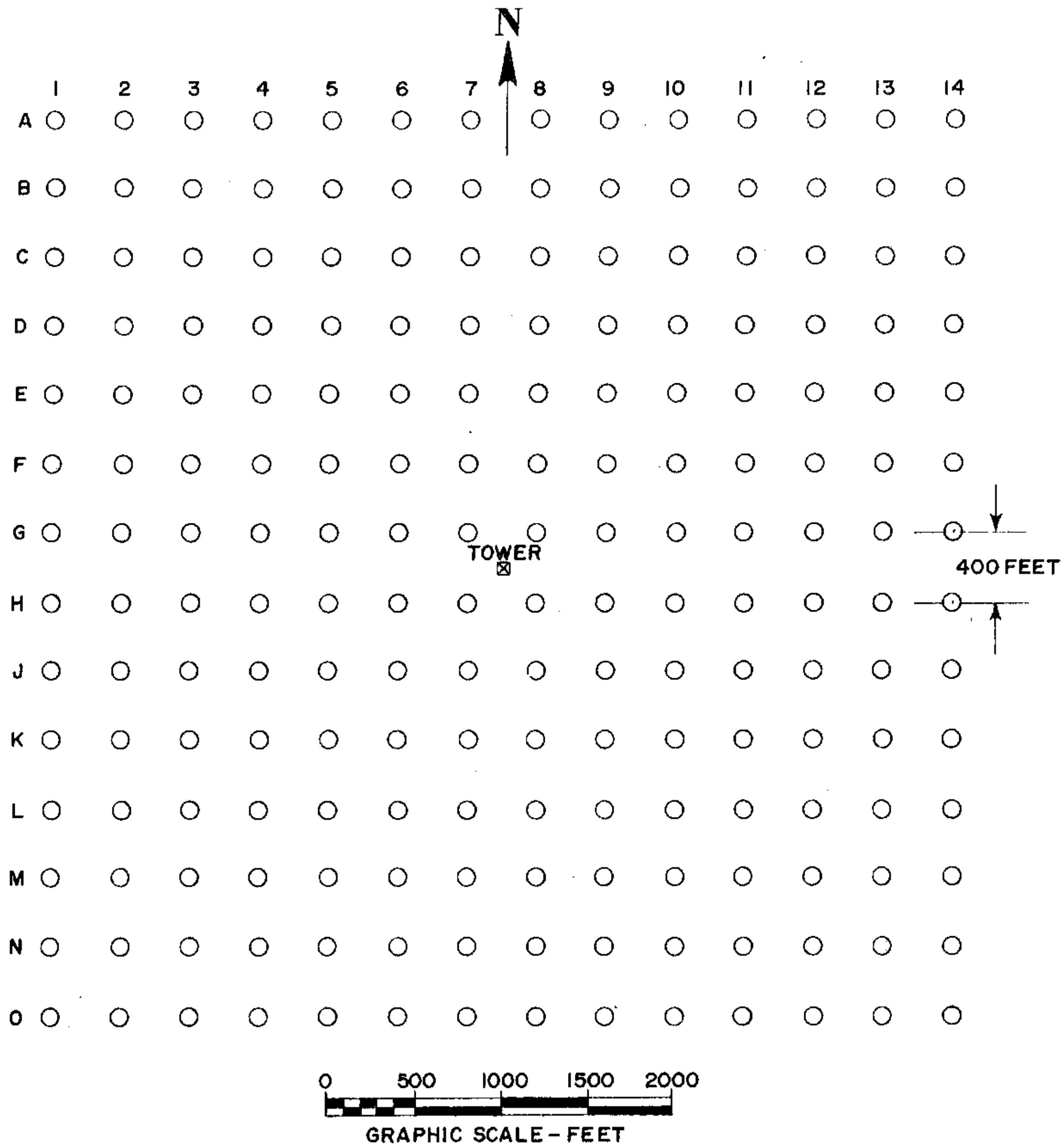


Figure I-4. Location of the Permanent Sampling Stations on the One Square Mile Grid

Fixed and portable illuminated flight line markers were available for missions during hours of darkness. A Quantitative Assessment Laboratory facility, collocated with the Test Site C-1 control center, received the collected samples and performed appropriate chemical analysis or biological assays providing data for assessment of test item performance. Micrometeorological data from TA C-52A was both recorded at the AMDAPS master station located at Test Site C-1 and transmitted to the main base Staff Meteorologist Control Center, Eglin AFB, via teletype on a 24-hour basis.

3. DESCRIPTIONS OF SAMPLING GRIDS AND HERBICIDE DEPOSITION

Descriptions of the sampling grids located on TA C-52A and individual mission data including herbicide and total gallons sprayed have been compiled by Biever[1].

a. Grid Descriptions

Figure I-5 shows the location of the various herbicide grids that were located on TA C-52A. The original sampling grid (Grid 1) for spray equipment testing became operational in June 1962. It consisted of four intersecting straight lines in a circular pattern, each line being at a 45^{o} angle from those adjacent to it. This grid was discontinued after two years. It was located immediately south of the one square mile grid.

The second sampling grid (Grid 2) consisted of three parallel lines intersected at right angles by another set of three parallel lines. These lines were 800 feet apart, thus forming four equal quadrants. The southwest corner of this grid corresponded to the southwest corner of the one square mile grid. The parallel line grid was operational during the period May 1964 to November 1965.

The third sampling grid (Grid 3) consisted of three concentric circles, with respective diameters of 1200 , 1600, and 2000 feet. This grid was located in the northeast quadrant of the one square mile grid. The concentric circles grid was operational between October 1967 and April 1968; however, difficulty in interpreting data from this sampling array caused use of this grid to be discontinued.

The fourth sampling grid (Grid 4) is a one square mile grid, the center of which was marked by a 300-foot tower. This was the last testing grid used on TA C-52A and its inwind and crosswind sampling arrays extended into Grid 2 and Grid 3. Figures I-6, I-7, I-8, and I-9 show various views of Grid 4 at the time the grid was under construction.

The two inwind and four crosswind sampling arrays of Grid 4 became operational in May 1968. Each inwind array consisted of three parallel rows spaced 400 feet apart, with 297 sampling stations per row. The aircraft flight path crossed the midpoints of the sampling lines. The crosswind sampling arrays consisted of three parallel rows 400 feet apart, with 253 sampling stations per row.

b. Deposition Rate

The total amounts of chemicals (including herbicides, insecticides, oils, and simulants) applied to TA C-52A are shown in Table I-5. All of these materials were disseminated during the period from June 1962 to December 1970 (Figure I-10). The total pounds of actual herbicides

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[1]Defoliant History of Test Area C-52A, Working Papers, Vitro Corporation of America and Armament Development and Test Center, Eglin AFB, Florida, December 1969.

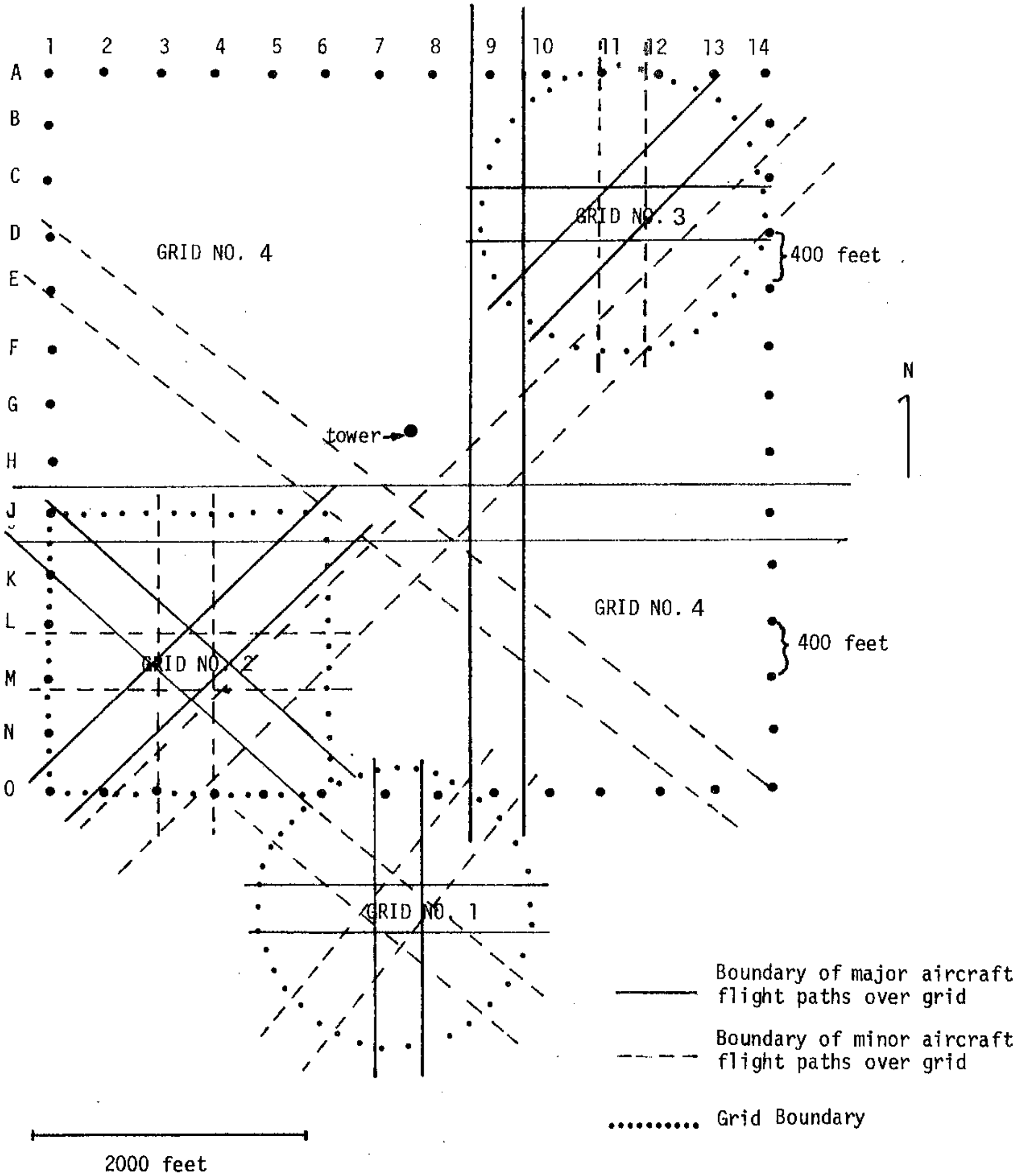

Figure I-5. Location of Test Grids and Major Flight Paths Used during Dissemination of Herbicides Over Test Area C-52A

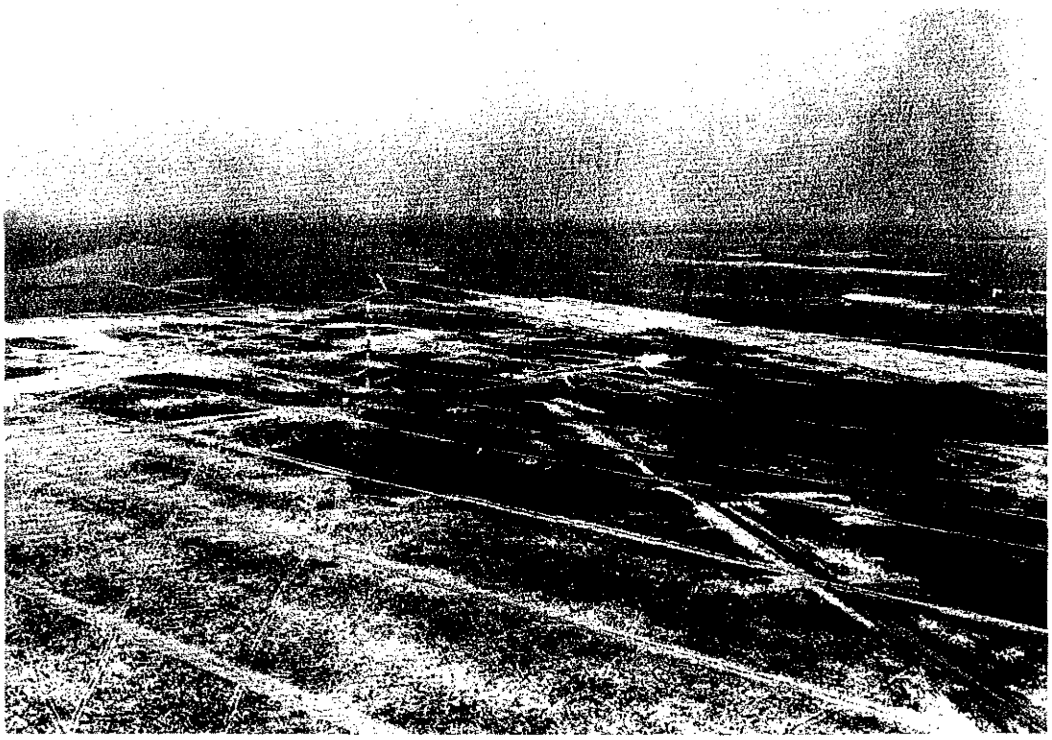

Figure I-6. A View of Grid Number 4 Looking from the Southeast to the Northwest, 1964

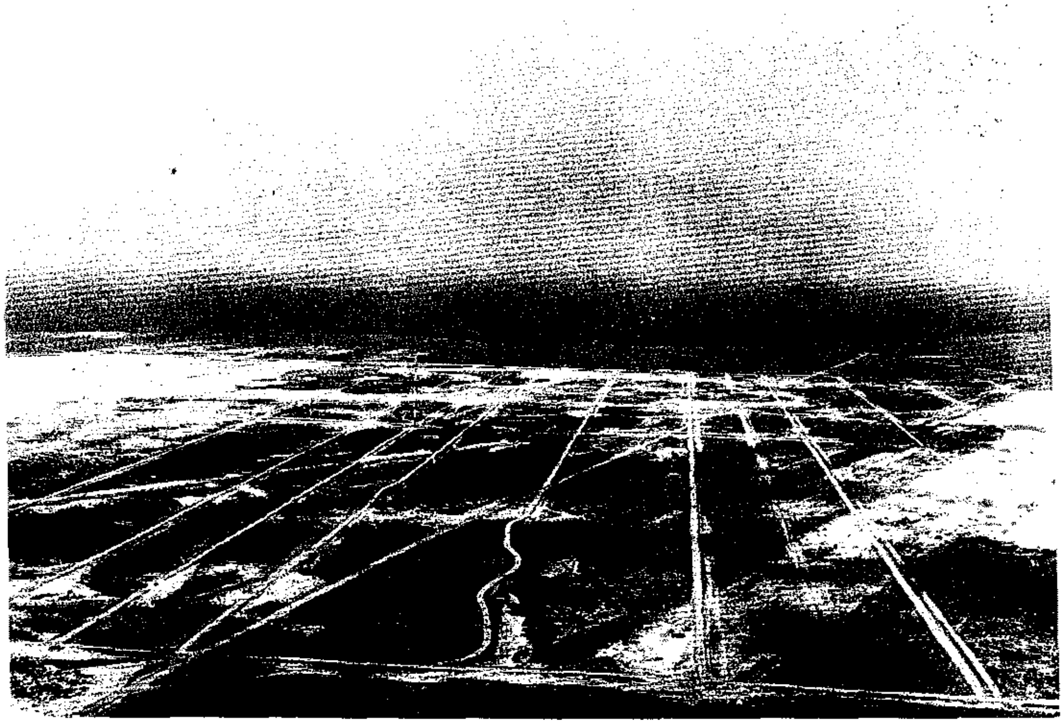

Figure I-7. A View of Grid Number 4 Looking from East to West, 1964

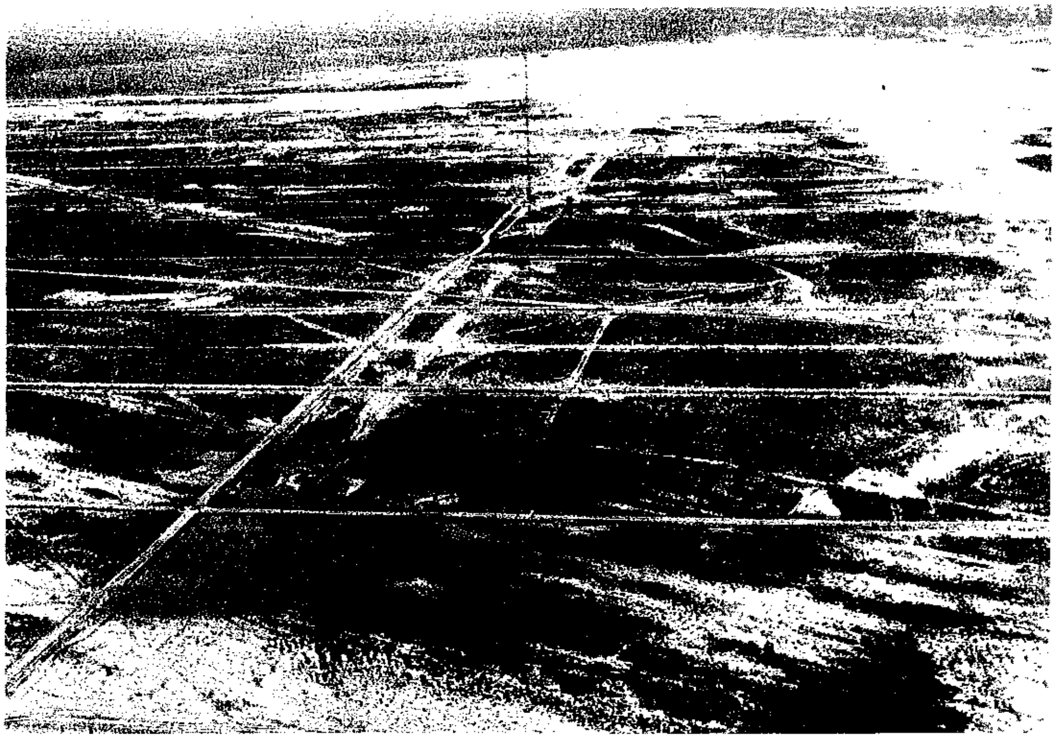

Figure I-8. A View of Grid Number 4 Looking from North to South, 1964

Figure I-9. A View of the Western Portion of Grid Number 4 Looking from the Southeast to the Northwest, 1964

TABLE II-4

TCDD ANALYSES OF MAJOR MANUFACTURER STOCKS - GULFPORT

Number of Drums	Number of Gallons	Kg Orange	Mg/Kg Conc. of TCDD	Mg of TCDD	Cumulative Total Mg of TCDD
2,652	145,860	709,500.1	<0.05	35,475.0	35,475
6,981	383,955 (529 815)	1,867,654.7 (2577154)	0.12	224,118.6	259,593.6
934	51,370	249,876.7 (2,827,030)	0.17	42,479.0	302,072.6
1,560	85,800	417,353.0	0.32	133,556.9	435.625.5
2,185	120,175	584,561.7	7.62	4,454,360.2	4,889,985.7
984	54,120	263,253.4	8.62	2,269,244.3	7,159,230.0
30	1,650	8,026.0	13.3	106,745.8	7,265,975.8
15,326	842,930.0*	4,100,225.7			7,265,975.8

* Represents 98% of the 860,000 gallons of total Gulfport Stock.

145,860 × .05 = 729300

383,955 × .12

51,370 × .17

145,860 + 383,955 + 51,370 = 581,185

2,827,030 ÷ 302,072 = 0.09