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OAK RIDGE NATIONAL LABORATORY

MARTIN MARIETTA

Chemical Stockpile Disposal Program

Final Phase I Environmental Report

for

Tooele Army Depot Tooele, Utah

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CHEMICAL STOCKPILE DISPOSAL PROGRAM

FINAL PHASE I ENVIRONMENTAL REPORT

for

TOOELE ARMY DEPOT TOOELE, UTAH

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ABSTRACT

The Tooele Army Depot (TEAD) in Utah is one of eight continental United States Army installations where lethal unitary chemical agents and munitions are stored and where destruction of agents and munitions is proposed under the Chemical Stockpile Disposal Program (CSDP). In 1988 the U.S. Army issued a Final Programmatic Environmental Impact Statement (FPEIS) for the CSDP that identified on-site disposal of agents and munitions as the environmentally preferred alternative (i.e., the alternative with the least potential to cause significant adverse impacts). In some instances, the FPEIS included generic data and assumptions that were developed to allow a consistent comparison of potential impacts among programmatic alternatives and did not include detailed conditions at each of the eight installations. The FPEIS identified the environmentally preferred alternative using a method based on five measures of risk directed at potential human health and ecosystem or environmental effects; the adequacy of emergency response also played a key role in the method. In the Army's Record of Decision following the FPEIS, on-site disposal was selected for implementation of the program.

The purpose of this Phase I report is to examine the proposed implementation of on-site disposal at TEAD in light of more detailed and more recent data than those included in the FPEIS. The objectives of this Phase I report are to

(1) reexamine those site-specific data that were important in selecting the environmentally preferred alternative in the FPEIS (i.e., on-site disposal),
(2) make recommendations for the scope and content of the subsequent environmental impact statement to be prepared for TEAD under Phase II, and
(3) address the concern that the FPEIS was too generic to adequately determine a programmatic environmentally preferred alternative.

It was found that none of the newly collected data added any information that would have changed the FPEIS conclusion for TEAD. In addition, none of these data lend credibility to the argument that something of significance was overlooked in the FPEIS.

The recommendation of this Phase I report is to proceed with the preparation of a site-specific environmental impact statement for TEAD. The site-specific document should focus on the implementation of on-site disposal and should not consider other alternatives for disposing of the TEAD stockpile.

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ABBREVIATIONS, ACRONYMS, AND INITIALISMS

ATC	Applied Technology Council
Btu/ft^3	British thermal units per cubic foot
C	centigrade or Celcius
$CaCO_3$	calcium carbonate
CAMDS	Chemical Agent Munitions Disposal System
CFR	Code of Federal Regulations
CHB	container handling building
CML	conservative most likely
cm	centimeter
CONUS	continental United States
CO	carbon monoxide
CSDP	Chemical Stockpile Disposal Program
DOC	U.S. Department of Commerce
E	east
EA	environmental assessment
EIS	environmental impact statement
ENE	east-northeast
EOC	Emergency Operations Center
EPA	Environmental Protection Agency
EPGA	effective peak ground acceleration
ERCP	Emergency Response Concept Plan
ESE	east-southeast
F	Fahrenheit
Fig.	Figure
FPEIS	final programmatic environmental impact statement
ft	foot
FWS	U.S. Fish and Wildlife Service
g	acceleration due to gravity
GA	chemical nerve agent, also called Tabum
gal	gallon
gal/d	gallons per day
gal/min	gallons per minute
GB	chemical nerve agent, also called Sarin
H	chemical blister agent, also generally called mustard
ha	hectare
HD	chemical blister agent, also generally called mustard
HT	chemical blister agent, also generally called mustard
I	interstate
in.	inch
km	kilometer
km^2	square kilometer
L	(1) chemical blister agent, also called Lewisite (2) liter
LIC	liquid incinerator
m	meter
m/s	meters per second

m^3	cubic meter
m^3/d	cubic meters per day
MCFH	million cubic feet per hour
MDB	Munitions Demilitarization Building
mg/L	milligrams per liter
$mile^2$	square mile
MJ/m^3	megajoules per cubic meter
N	north
N/A	not applicable
NAAQS	National Ambient Air Quality Standards
NE	northeast
NEPA	National Environmental Policy Act of 1969
NNE	north-northeast
NNW	north-northwest
no.	number
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
NRC	Nuclear Regulatory Commission
NW	northwest
O_3	ozone
ORNL	Oak Ridge National Laboratory
Pb	lead
PGA	peak ground acceleration
ppm	parts per million
Pt.	Part
Pub. L.	Public Law
RCRA	Resource Conservation and Recovery Act of 1976
ROD	Record of Decision
s	second
S	south
SE	southeast
Sect.	Section
SO_2	sulfur dioxide
SR	state route
SSE	south-southeast
SSW	south-southwest
SW	southwest
TEAD	Tooele Army Depot
vs	versus
VX	chemical nerve agent
W	west
WC	worst case
WNW	west-northwest
WSW	west-southwest

FOREWORD

Under the Chemical Stockpile Disposal Program (CSDP), the U.S. Army proposes to dispose of lethal chemical agents and munitions stored at eight existing Army installations in the continental United States. In compliance with the National Environmental Policy Act (NEPA), the Army initiated a site-specific NEPA review of this proposed action at the Tooele Army Depot (TEAD), near Tooele, Utah. The environmental compliance documentation was prepared in two phases.

In Phase I, the overall CSDP decision to dispose of TEAD's stockpile by an on-site reverse-assembly and incineration process was further considered, and its validity at TEAD was reviewed with data that were newer and more detailed than those that provided the basis for the final programmatic environmental impact statement (FPEIS) (completed in January 1988) for the CSDP. A Phase I Environmental Report is prepared to present the findings of the Phase I review.

Phase II [the preparation of a site-specific environmental impact statement (EIS)] focused on the site-specific implementation (plant construction and disposal operations) of on-site disposal at TEAD. It should be emphasized that the Phase I Environmental Report was the starting point for the site-specific decision-making process, and it provided the environmental information by which the impacts of the proposed action were assessed in the site-specific EIS.

A final Phase I Environmental Report for TEAD was issued by the Army in September 1988 (*Chemical Stockpile Disposal: Final Phase I Environmental Report for Tooele Army Depot, Tooele, Utah,* Program Executive Officer–Program Manger for Chemical Demilitarization, Aberdeen Proving Ground, Md.). The report concluded that the FPEIS environmentally preferred alternative (on-site disposal), which is also the Army's preferred alternative, is indeed valid for TEAD. No new or unique site-specific information was found that would change or contradict the conclusions of the FPEIS with respect to TEAD. The report recommended that preparation of the site-specific EIS should proceed and should focus on implementation of on-site incineration and should not consider other alternatives for disposing of either the TEAD stockpile or stockpiles from other installations at TEAD.

The TEAD Phase I report was independently reviewed by Argonne National Laboratory (ANL), and the review was summarized in a report (*Chemical Stockpile Disposal Program: Review and Comment on the Phase I Environmental Report for the Tooele Army Depot, Tooele, Utah,* ANL/EES/TM-359, Argonne, Ill., November 1988). Additional recommendations for the content of the site-specific EIS were included in the ANL review. On February 8, 1989, the findings and conclusions of the TEAD Phase I report and the independent ANL review were certified to Congress by Assistant Secretary of the Army John W. Shannon. The site-specific EIS for TEAD was prepared following the Phase I certification. The Draft EIS was issued by the Army in March 1989; the Final TEAD EIS, in July 1989. The Record of Decision on this proposal was signed August 30, 1989, by the Acting Assistant Secretary of the Army (see 54 *FR* 171, 37017). Per the decision, construction of a full-scale disposal facility began at TEAD in October 1989.

This Oak Ridge National Laboratory Technical Memorandum consists of the September 1988 Final Phase I report. It was prepared to document the Phase I process for disposal of chemical agents and munitions stored at TEAD.

EXECUTIVE SUMMARY

The U.S. Department of the Army proposes under the Chemical Stockpile Disposal Program (CSDP) to destroy the nation's total stockpile of lethal unitary chemical agents (nerve and blister) and munitions. This proposed action is being carried out in response to a congressional mandate in Title 14, Pt. B, Sect. 1412 of Pub. L. 99-145, the Department of Defense Authorization Act of 1986, which directed that the destruction of the nation's stockpile of lethal unitary chemical agents/munitions be accomplished by September 30, 1994, in conjunction with the acquisition of binary chemical weapons. In March 1988, the Army presented its implementation plan (U.S. Department of the Army 1988c) to Congress and received an extension of the 1994 deadline to April 30, 1997.

The Tooele Army Depot (TEAD) is one of eight continental United States Army installations where these lethal agents/munitions are stored and where such destruction is proposed. The chemical agent inventory at TEAD consists of approximately 42%, by weight, of the total U.S. stockpile and has almost all of the munition types. None of the agents or munitions currently in storage at TEAD has been manufactured since 1968; they are in various stages of deterioration, with a few munitions already leaking. The destruction of the stockpile is necessary to eliminate the risk to the public from continued storage and to dispose of obsolete and/or leaking munitions.

The National Environmental Policy Act of 1969 (NEPA) review strategy for the CSDP has been structured to address two levels of decision making: (1) the programmatic level and (2) the site-specific level. *Programmatic-level* decision making is focused on alternate strategies—including disposal locations and technologies—for destroying the stockpile. The programmatic decisions regarding (1) on-site destruction vs off-site transport to another installation and (2) the destruction technology are national in scope and involve a number of separate, but related, issues and actions. *Site-level* decision making is focused on implementation of the programmatic strategy at a particular site and is not national in scope. Accordingly, the NEPA documentation for each level would be quite different in content and emphasis. Consistent with this NEPA strategy, the Army prepared a final programmatic environmental impact statement (FPEIS) (U.S. Department of the Army 1988a) for the CSDP.

The programmatic-level decision [*Fed. Regist.* 53 (Pt. 38), 5816-17 (1988)] to dispose of the national stockpile of chemical agents at the eight individual installations was made subsequent to the publication of the FPEIS for the CSDP. The FPEIS evaluated those issues associated with the CSDP on a national level and focused on the disposal alternatives that were identified by Congress or were suggested by public comment. Factors that were germane to decision making on the programmatic level included (1) public health and safety, (2) environmental impact, (3) emergency response, (4) security measures, (5) logistical complexity, (6) regulatory

complexity, (7) military resources, (8) program costs, and (9) public opinion. While all of these factors were considered in the Army's Record of Decision (ROD) (U.S. Department of the Army 1988b), only the first three of these are appropriate for inclusion in the NEPA review. The FPEIS addressed all three of these factors. Primarily on the basis of risk-oriented impact analyses, the FPEIS identified on-site incineration as the environmentally preferred alternative for disposal.

All of the programmatic alternatives involved the use of TEAD as a disposal site. That is, the alternatives evaluated for TEAD involved either the on-site destruction of only the TEAD stockpile or the destruction at TEAD of additional stockpiles from two or more other installations. None of the programmatic alternatives considered off-site movement of the TEAD stockpile.

Many site-specific factors were considered and taken into account in the FPEIS. However, comments received during the programmatic NEPA review indicated a perception existed that the FPEIS was flawed because it was too generic and because site-specific factors were not given adequate consideration. Because of these perceived inadequacies, a decision was made to conduct the site-specific NEPA reviews in two phases. In Phase I, the programmatic decision of on-site incineration is to be given further consideration by reviewing its validity with respect to environmental impact at each storage installation. Phase II (the preparation of either an environmental assessment or an environmental impact statement) is to address the site-specific implementation (plant construction, disposal operations, and plant decommissioning) of on-site incineration.

The objectives of this Phase I Environmental Report are threefold: (1) reexamine those site-specific data that were important in selecting the FPEIS environmentally preferred alternative (i.e., on-site incineration) for TEAD, (2) make recommendations for the scope and content of the subsequent, site-specific NEPA-compliance document for TEAD to be prepared under Phase II, and (3) address the concern that the FPEIS was too generic to adequately determine a programmatic environmentally preferred alternative. It should be noted that this Phase I Environmental Report is not intended to validate the Army's ROD for the CSDP; it can only confirm or reject the environmentally preferred alternative as identified in the FPEIS.

The framework for reexamination in this Phase I report consists of the following:

(1) New information and data are collected for TEAD and are compared with the FPEIS information used in the selection of the programmatic environmentally preferred alternative.

(2) If no differences in the data are identified, a recommendation will then be made to proceed with preparation of the site-specific environmental impact statement (EIS) for TEAD.

(3) If differences in the data are identified, but are determined to be insignificant, then a recommendation will be made to proceed with preparation of the site-specific EIS for TEAD.

(4) If significant differences in the data are identified that require further analysis in regard to the selection of the FPEIS environmentally preferred alternative for TEAD, a recommendation will then be made for reassessing FPEIS alternatives in the site-specific EIS for TEAD.

Attempts were made to collect new information and data from the following sources: site visits in April 1988; scoping meeting at TEAD on August 18, 1988; written comments on the FPEIS; cooperating agencies; and other state and local agencies. During the site-specific data collection process, no new or unique resources have been identified for the TEAD area in regard to impacts from construction, normal operations, or decommissioning. However, for impacts from accidental releases of chemical agent, several differences in data were identified, primarily as the result of including a larger geographic area in the site-specific data collection process than was done for the FPEIS.

None of the new data, either individually or collectively, add any information that would have resulted in a change in the programmatic conclusions of the FPEIS. In addition, none of these new data lend credibility to the argument that something of significance was overlooked in the FPEIS. Of all the differences identified, only the potential for increased population to affect fatality estimates can be singled out as a potentially significant difference. All other data differences have been shown to be inconsequential with respect to selecting the environmentally preferred alternative.

With regard to increases in population since the preparation of the FPEIS, revised estimates based on 1986 U.S. Bureau of the Census data, coupled with the correction of an FPEIS error in designating the coordinates of the site for the disposal facilities at TEAD, indicate that 23% more people reside in the 100-km zone around TEAD-South than were identified in the FPEIS. Recomputing the fatality estimates with this revised population gives higher fatalities than were considered in the FPEIS; however, such an increase in fatalities would apply to regional and national disposal alternatives as well as all disposal alternatives at TEAD and would not have affected the selection of on-site incineration as the environmentally preferred alternative.

This Phase I Environmental Report has determined that the FPEIS environmentally preferred alternative (on-site incineration) is indeed valid for TEAD. No new or unique site-specific information has been developed that would change or contradict the conclusions of the FPEIS.

Because of the size of the TEAD stockpile, relocation of the TEAD inventory was not considered as a viable alternative in the FPEIS. From the perspective of the affected public near TEAD, it suffices to observe that movement of agents and munitions to TEAD for destruction can only increase risk; that is, the unloading, storage, and transport of additional munitions and the processing of additional inventories at TEAD (as would be required under any FPEIS alternative except the on-site disposal alternative) would obviously subject the surrounding population to an increased potential for being impacted from an accidental release of chemical agent.

The recommendation of this Phase I report is to proceed with the preparation of a site-specific EIS for TEAD; the site-specific EIS for TEAD should concentrate on the implementation of on-site incineration and should not consider other alternatives for disposing of either the TEAD stockpile or stockpiles from other installations.

REFERENCES FOR EXECUTIVE SUMMARY

U.S. Department of the Army January 1988a. *Chemical Stockpile Disposal Program Final Programmatic Impact Statement*, Vols. 1, 2, and 3, Program Executive Officer–Program Manager for Chemical Demilitarization, Aberdeen Proving Ground, Md.

U.S. Department of the Army Feb. 23, 1988b. *Record of Decision for the Chemical Stockpile Disposal Program*, Office of the Under Secretary of the Army.

U.S. Department of the Army 1988c. *Chemical Stockpile Disposal Program Implementation Plan*, report to Congress on March 15, 1988, by Program Executive Officer–Program Manager for Chemical Demilitarization, Aberdeen Proving Ground, Md.

PREFACE

The U.S. Department of the Army proposes under the Chemical Stockpile disposal Program (CSDP) to destroy the nation's total stockpile of lethal unitary chemical agents and munitions. The unitary chemical agents to be destroyed under the CSDP include nerve agents that directly affect the nervous system and blister agents that produce blisters on exposed tissue. Unitary agents are so named because they alone can produce their desired hazardous effect on human health in their form as stored; they do not require mixing with another component to become hazardous (as is the case with binary chemical agents). These agents are stored in munitions (e.g., rockets, land mines, mortars, cartridges, and projectiles) that in addition to agents contain various explosive components (e.g., fuses, propellants, and bursters). Agents not contained in munitions are stored in bulk containers, which include bombs, spray tanks, and steel one-ton containers, none of which contains any explosives.

The proposed action is being carried out in response to a congressional mandate in Title 14, Part B, Section 1412 of Pub. L. 99-145, the Department of Defense Authorization Act of 1986, which directs that the destruction of the agents and munitions be accomplished by September 30, 1994, in conjunction with the acquisition of binary chemical weapons. in March 1988, the Army received an extension from Congress of the 1994 deadline to April 30, 1997, under Pub. L. 100-456. Under emergency conditions or if there is a significant delay in the acquisition of an adequate number of binary chemical weapons to meet the requirements of the Armed Forces, Pub. L. 99-145 allows the Secretary of Defense to defer, beyond April 30, 1997, the destruction of not more than 10% ("useful 10%") of the unitary stockpile.

Congress has directed the Army to accomplish the proposed destruction in a manner that provides: (1) maximum protection of the environment, the general public, and the personnel involved in the destruction process; (2) adequate and safe facilities designed solely for the destruction of the lethal chemical stockpile; and 93) cleanup, dismantling, and disposal of the facilities when the disposal program is complete.

The existing unitary chemical munitions are stored at eight U.S. Army installations located in the continental United States (CONUS): Aberdeen Proving Ground (APG), near Edgewood, Maryland; Anniston Army Depot (ANAD), near Anniston, Alabama; Lexington-Blue Grass Army Depot (LBAD), near Lexington, Kentucky; Newport Army Ammunition Plant, near Newport, Indiana; Pine Bluff Arsenal (PBA), near Pine Bluff, Arkansas; Pueblo Depot Activity, near Pueblo, Colorado; Tooele Army Depot (TEAD), near Tooele, Utah; and Umatilla Depot Activity (UMDA), near Hermiston, Oregon. None of the agents and munitions currently in storage has been manufactured since 1968, and although some of them are "like new," others are in various stages of deterioration, with a few items developing leaks. All items that have been verified as leaking have been either repaired and decontaminated on the spot or containerized and placed in isolated storage.

At each of the eight sites, the Army proposes to remove the agents and munitions from existing storage, transport them to a proposed on-site disposal facility, disassemble them, and incinerate the agents. No stockpiled agents or munitions are proposed to be transported to other storage installations or sites for destruction. Incineration, the selected disposal technology, has been endorsed by the National Research Council as the safest means of destroying these lethal chemical agents. For the purpose of this Phase I

report, "on-site disposal facility" refers to the incinerator and all associated structures and equipment for storing, handling, and processing the munitions and agents.

A federal program such as the CSDP requires a National Environmental Policy Act (NEPA) review to ensure that environmental factors are given adequate consideration early in the decision-making process. For the CSDP, a NEPA review strategy has been structured to address two levels of decision making: (1) the programmatic level and (2) the site level.

Implementation of this NEPA review strategy for the CSDP began in January 1986 with initiation of the programmatic Environmental Impact Statement (EIS). In January 1988, the Army issued the final programmatic EIS (FPEIS). The FPEIS discussed five alternatives: four for destroying the stockpile, and no action [required by regulations implementing NEPA (40 CFR Pt. 1500-1508)]. The five alternatives are as follows:

1. continued storage of the stocks at their present locations (the no action alternative);
2. on-site disposal of the stocks at their present storage locations;
3. relocation of the stocks to regional disposal centers at ANAD and TEAD for destruction;
4. relocation of the stocks to a national disposal center at TEAD for destruction; and
5. relocation of the inventories at some sites to alternate sites, with the remainder destroyed at their present storage locations (this alternative includes air movement of the APG and LBAD inventories to TEAD for destruction).

The FPEIS identified on-site disposal as the environmentally preferred alternative (i.e., the alternative with the least potential for significant adverse impacts). In addition, the Army's Record of Decision (ROD) for the FPEIS selected on-site disposal for implementation. The ROD stated that environmental impacts, including the hazards and risk analyses presented in the FPEIS, were a contributing but not the determining factor in the decision. Other factors considered included the feasibility and effectiveness of emergency response measures, vulnerability to terrorism and sabotage, and logistical complexity.

On-site disposal, having been selected for implementation, will require that the Army prepare eight site-specific NEPA-compliance documents for each installation to assist with the site-level decision making. The programmatic ROD stated that the site-specific NEPA documents would focus on the implementation of the programmatic decision at a given site and on specific issues and concerns related to implementation at a given site.

1. INTRODUCTION

This Phase I Environmental Report has been prepared by the U.S. Department of the Army to assist in the development of site-specific National Environmental Policy Act of 1969 (NEPA) compliance documentation for the Chemical Stockpile Disposal Program (CSDP). It is the purpose of this report to either confirm or reject the applicability of the environmentally preferred alternative as identified in the CSDP Final Programmatic Environmental Impact Statement (FPEIS) (U.S. Department of the Army 1988a) and as applied specifically to the Tooele Army Depot (TEAD), near the city of Tooele, Utah. This Phase I report is also intended to provide guidance, scoping, and input information for Phase II of this effort that will result in the preparation of an environmental impact statement for the Tooele Army Depot.

1.1 BACKGROUND

The U.S. Department of the Army proposes to destroy the nation's total stockpile of lethal unitary chemical agents and munitions. This proposed action is being carried out in response to a congressional mandate in Title 14, Pt. B, Sect. 1412 of Pub. L. 99-145, the Department of Defense Authorization Act of 1986, which directs that the destruction of the nation's stockpile of lethal unitary chemical agents/munitions be accomplished by September 30, 1994, in conjunction with the acquisition of binary chemical weapons. In March 1988, the Army presented its implementation plan (U.S. Department of the Army 1988c) to Congress and received an extension of the 1994 deadline to April 30, 1997.

The Army proposes to use a reverse assembly process followed by on-site incineration to destroy the stockpile of lethal unitary chemical agents and munitions stored at TEAD. Incineration, the selected disposal technology, has been endorsed by the National Research Council (1984) as the best and safest means of destroying these lethal chemical agents.

Approximately 42%, by weight, of the total U.S. stockpile is stored at TEAD, one of eight continental United States (CONUS) Army installations where these lethal agents/munitions are stored and where such destruction is proposed. The other Army installations include Aberdeen Proving Ground, near Edgewood, Maryland; Anniston Army Depot, near Anniston, Alabama; Lexington–Blue Grass Army Depot, near Lexington, Kentucky; Newport Army Ammunition Plant, near Newport, Indiana; Pine Bluff Arsenal, near Pine Bluff, Arkansas; Pueblo Depot Activity, near Pueblo, Colorado; and Umatilla Depot Activity, near Hermiston, Oregon. No agents or munitions from the U.S. chemical stockpile will be transported to other storage installations for destruction.

Two types of chemical agents are currently stored at TEAD: nerve agents, designated GA, GB, and VX; and blister agents, designated H, HD, HT, and L. The chemical agent inventory at TEAD consists of almost all munition types found in the U.S. stockpile. None of the agents or

munitions currently in storage at TEAD has been manufactured since 1968; they are in various stages of deterioration, with a few munitions already leaking. The destruction of the stockpile is necessary to eliminate the risk to the public from continued storage of the munitions and agents.

A federal program of this magnitude requires a NEPA review to ensure that environmental factors are given adequate consideration early in the decision-making process. For the CSDP, the NEPA review strategy has been structured to address two levels of decision making: the programmatic level and the site level. *Programmatic-level* decision making is focused on alternate strategies—including disposal locations and technologies—for destroying the stockpile. The programmatic decisions regarding (1) on-site destruction vs off-site transport to another installation and (2) the destruction technology are national in scope and involve a number of separate, but related, issues and actions. *Site-level* decision making is focused on implementation of the programmatic strategy at a particular site and is not national in scope. This two-level NEPA approach was identified and acknowledged (A. A. Hill, chairman, Council on Environmental Quality, letter to A. M. Hoeber, deputy under secretary of the Army, June 2, 1986) prior to the assessment of environmental impacts in the FPEIS. Even though the NEPA documentation for each level would be quite different in content and emphasis, many site-specific factors were considered in the FPEIS.

The programmatic decision [*Fed. Regist.* 53 (Pt. 38), 5816-17 (1988)] to dispose of the national stockpile of chemical agents at the eight individual installations was made subsequent to the publication of the FPEIS (U.S. Department of the Army 1988a). The FPEIS evaluated those issues associated with the CSDP on a national level and focused on the disposal alternatives that were identified by Congress and on others suggested by public comment.

Based primarily on risk-oriented impact analyses, the FPEIS identified on-site incineration as the environmentally preferred alternative for disposal. The impacts of three other programmatic alternatives for destruction of the stockpile were also compared:

- Rail transport of the inventories from the storage installations to a national disposal center to be established at TEAD.

- Rail transport of the inventories from the storage installations to one of two regional disposal centers to be established at Anniston Army Depot, Alabama, and at TEAD.

- Air transport of the inventories from Lexington-Blue Grass Army Depot, Kentucky, and Aberdeen Proving Ground, Maryland, to a disposal center to be established at TEAD.

However, it should be noted that all of these programmatic alternatives involve the use of TEAD as a disposal site. In other words, the alternatives evaluated for TEAD involved either the on-site destruction of only the TEAD stockpile or the destruction at TEAD of additional stockpiles from two or

more installations. None of the programmatic alternatives considered off-site movement of the TEAD stockpile.

In its implementation plan (U.S. Department of the Army 1988c), as submitted to Congress on March 15, 1988, the Army confirmed its decision to employ a reverse assembly/incineration process in the destruction of the chemical munitions/agents at each of the eight storage installations. In addition, a revised disposal schedule was proposed to incorporate lessons learned from a series of operational verification tests to be performed at chemical munition incineration facilities on Johnston Atoll in the Pacific Ocean. The revised schedule for disposal of the chemical munitions/agents at TEAD by March 1997 will provide the Army with the flexibility to use the experience gained during the operation of its demilitarization facilities on Johnston Atoll in the design and operations of the CONUS disposal facilities, including those proposed at TEAD.

On-site disposal, having been selected for implementation, will require that the Army prepare eight site-specific NEPA-compliance documents [either an environmental assessment (EA) or an environmental impact statement (EIS) for each installation]. The level of documentation will depend on the scope of issues associated with each individual installation and will be responsive to commitments made in the FPEIS regarding the site-specific documentation. These NEPA documents will be prepared to assist with the *site-level* decision making.

Comments received during the programmatic NEPA review indicated that a perception existed that the FPEIS was flawed because site-specific factors were not given adequate consideration. Another criticism was that the FPEIS was too generic and, therefore, could have overlooked a potentially significant environmental impact on the site-specific level. The Army's Record of Decision (ROD) recognized this perceived shortcoming by stating:

> *The [eight] site-specific [NEPA] reviews will focus both on the implementation of the programmatic decision and on specific issues and concerns at each site. Additional study may uncover information that would warrant the reconsideration of the programmatic decision.*

Because of the perceived inadequacies in the FPEIS, a decision was made to conduct the site-specific NEPA reviews in two phases. In Phase I, the programmatic decision of on-site incineration is to be given further consideration by reviewing its validity at each storage installation. Phase II (the preparation of either an EA or an EIS) is to address the site-specific implementation (plant construction, disposal operations, and plant decommissioning) of on-site incineration.

It should be emphasized that this Phase I Environmental Report is to be the starting point for the site-specific decision-making process, and it is to provide the environmental information by which the site-specific impacts of the proposed action are to be assessed in Phase II.

1.2 OBJECTIVES

The objectives of this Phase I Environmental Report are threefold: to reexamine those site-specific data that were important in selecting the FPEIS environmentally preferred alternative (i.e., on-site incineration) for TEAD; to make recommendations for the scope and content of the subsequent, site-specific NEPA-compliance document for TEAD to be prepared under Phase II; and to address the concern that the FPEIS was too generic (i.e., included insufficient site-specific information on the eight individual storage installations) to adequately determine a programmatic environmentally preferred alternative.

To reasonably and objectively compare the various programmatic alternatives, the FPEIS employed some generic inputs such as process and handling descriptions, on-site distances (such as storage-to-plant transport distances and distances to the nearest installation boundary), and certain meteorological data. Other inputs were more site specific as appropriate to allow a reasonable comparison of alternatives. This Phase I Environmental Report is intended to ascertain whether or not the conclusions of the FPEIS are still valid with respect to TEAD when additional, more detailed, site-specific data are taken into account. These site-specific data include (1) any new information that was not available for use in the FPEIS, (2) more-detailed information than was required for the programmatic purpose of comparing alternatives in the FPEIS, and (3) any information that was overlooked in the FPEIS.

This Phase I Environmental Report accomplishes its stated objectives by (1) incorporating applicable site-specific information for the area around TEAD, (2) supplementing the data and analyses provided in the FPEIS, and (3) using this site-specific information to assess the applicability of the programmatic environmentally preferred alternative as applied specifically to TEAD.

Section 2 of this Phase I report describes the approach taken to reassess the programmatic data for TEAD. It defines and outlines the framework under which the reexamination of FPEIS data is to be performed. The section also provides an overview of the methodology employed in the FPEIS to arrive at the selection of an environmentally preferred alternative.

Section 3 of this Phase I report presents and compares the newly collected, site-specific information and data for TEAD. The relevance of such comparisons as well as selected analyses and a determination of the significance of any differences are also provided in Sect. 3.

Section 4 contains a summary of Phase I findings, the recommendation of whether or not to proceed with the preparation of the Phase II EIS for TEAD, and recommendations about the content of the EIS document.

1.3 SCOPE

The scope of this Phase I Environmental Report is limited to reexamination of the FPEIS environmentally preferred alternative (i.e., on-site incineration) in light of detailed, site-specific data for TEAD. No other disposal alternatives (e.g., off-site transport) are to be considered. The reexamination is focused on, but is not limited to, an evaluation of those impacted environmental resources considered to be important in identifying the environmentally preferred alternative in the FPEIS.

Factors other than impacts to environmental resources that entered into the Army's ROD (e.g., vulnerability to terrorism and/or logistical complexity) are not part of this Phase I assessment. Factors that were germane to decision making on the programmatic level included (1) public health and safety, (2) environmental impacts, (3) emergency response, (4) security measures, (5) logistical complexity, (6) regulatory complexity, (7) military resources, (8) program costs, and (9) public opinion. While all of these factors were considered in the Army's ROD (U.S. Department of the Army 1988b), only the first three were addressed in the FPEIS; likewise, this Phase I report deals with only the first three factors.

This Phase I Environmental Report is not intended to validate the Army's ROD for the CSDP; it can only confirm or reject the environmentally preferred alternative (on-site incineration) as identified in the FPEIS for TEAD. It should also be noted that the FPEIS was a programmatic decision-making document and that the conclusions of the FPEIS were not binding to the preparer of the Army's ROD.

The Resource Conservation and Recovery Act of 1976 (RCRA) permit will reflect any final design changes prior to the advent of construction. Nevertheless, a plant of this complexity can expect to undergo minor configuration and process changes. These changes will go through rigorous safety reviews prior to approval and adoption.

Because of the assurance process by which changes to either the plant design or the disposal operation procedures are reviewed for their safety, a reassessment of the FPEIS risk analysis—including the reanalysis of accident event initiators, probabilities of accidents, quantities of agent released in accidents, and the mode of release—is beyond the scope of this Phase I report.

1.4 REFERENCES FOR SECTION 1

National Research Council 1984. *Disposal of Chemical Munitions and Agents,* National Academy Press, Washington, D.C.

U.S. Department of the Army 1988a. *Chemical Stockpile Disposal Program Final Programmatic Environmental Impact Statement*, Vols. 1, 2, and 3, Program Executive Officer–Program Manager for Chemical Demilitarization, Aberdeen Proving Ground, Md., January.

U.S. Department of the Army 1988b. *Record of Decision for the Chemical Stockpile Disposal Program*, Office of the Under Secretary of the Army, February 23.

U.S. Department of the Army 1988c. *Chemical Stockpile Disposal Program Implementation Plan*, report to Congress on March 15, by Program Executive Officer–Program Manager for Chemical Demilitarization, Aberdeen Proving Ground, Md.

2. APPROACH

This section defines and outlines the framework under which this Phase I Environmental Report reexamines the environmentally preferred alternative for TEAD by the use of newly collected site-specific information. The section then provides an overview of the assessment method employed in the FPEIS to arrive at the selection of the environmentally preferred alternative. This overview material is intended to assist the reader in identifying those environmental data that were explicitly linked to the selection method in the FPEIS, as well as to provide the basis for comparing site-specific data with FPEIS data in Sect. 3.

2.1 CONCEPTUAL FRAMEWORK FOR PHASE I

This Phase I Environmental Report has been prepared to ascertain whether on-site incineration is indeed the environmentally preferred alternative for TEAD by considering the newly collected site-specific data. The primary objective of this Phase I Environmental Report is to provide the technical basis for ascertaining whether the programmatic decision of on-site disposal imposes environmental impacts or health and safety risks of sufficient magnitude to warrant reconsideration of the decision for TEAD. Detailed, site-specific data will be presented and used in this report for the purposes of reexamining the FPEIS conclusions. These data will be used to ascertain whether the FPEIS conclusions were portrayed accurately and to ensure that nothing of significance was omitted. Of interest is whether or not a more site-specific or more-detailed database and further analyses will yield a significantly different conclusion than the one reached in the FPEIS. It should also be noted that the information and data collected in this Phase I effort will be used to provide a comprehensive database for preparing the site-specific EIS under Phase II.

The framework for the analysis and reexamination in this Phase I report, as illustrated in Fig. 2.1-1, consists of the following steps:

- New information and data are to be collected for TEAD and are to be compared with the FPEIS information used in the selection of the programmatic environmentally preferred alternative. This comparison is limited to only that information deemed determinant in the selection methodology of the FPEIS (see FPEIS Sect. 2.2.1.2).

- If no differences in the data are identified, a recommendation will be made to proceed with preparation of the site-specific EIS for TEAD.

- If data differences are identified, but are determined to be insignificant by selective reanalysis, a recommendation will be

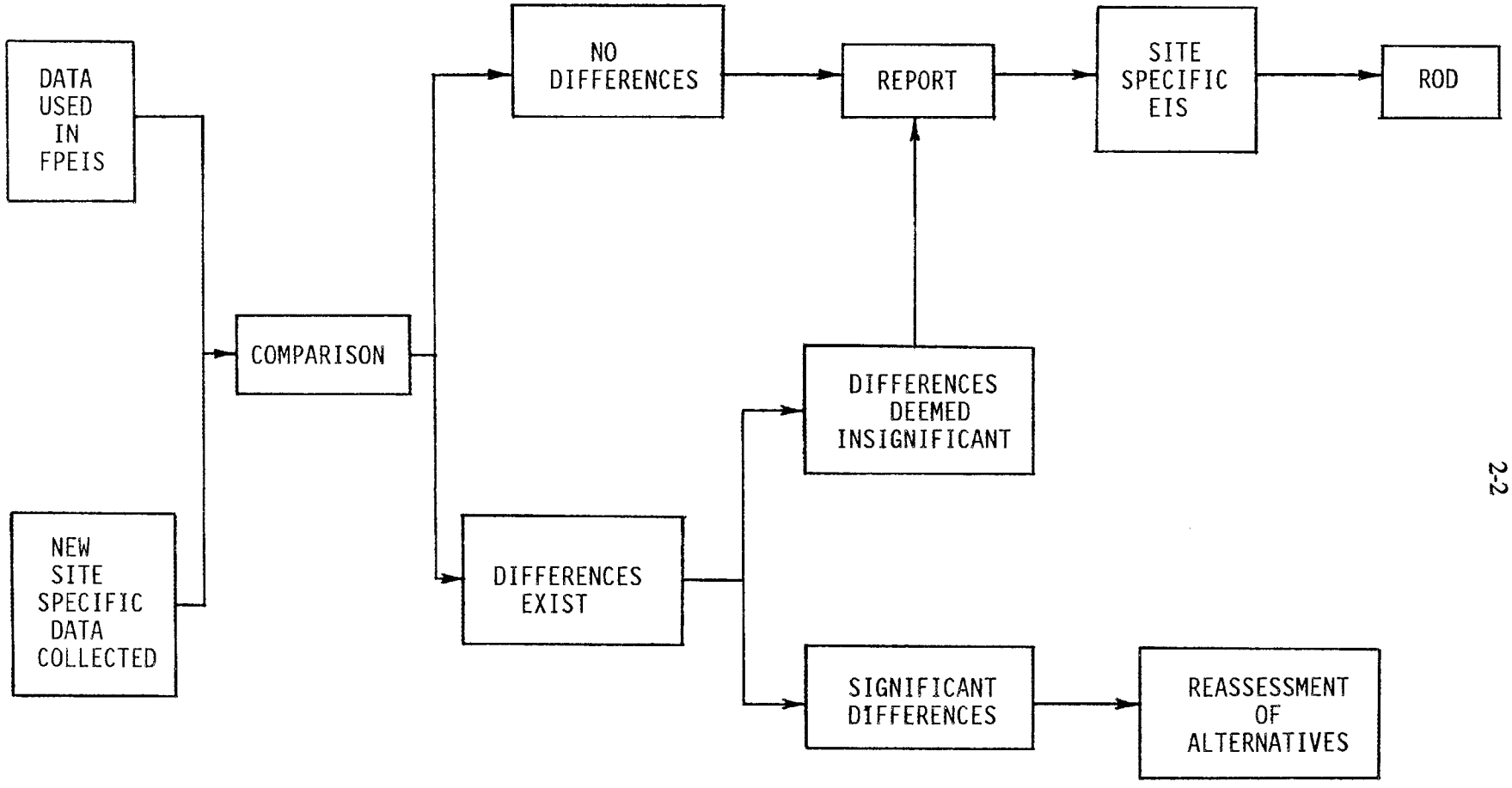

Fig. 2.1-1. Flow chart illustrating the Phase I concept. FPEIS = final programmatic environmental impact statement; EIS = environmental impact statement; ROD = Record of Decision.

made to proceed with preparation of the site-specific EIS for TEAD.

- If significant differences in the data are identified that require further analysis in regard to the selection of the FPEIS environmentally preferred alternative for TEAD, a recommendation will then be made for reassessing FPEIS alternatives in the site-specific EIS for TEAD.

2.2 DATA USED IN THE PROGRAMMATIC ASSESSMENT

The principal thrust of the FPEIS was to assess and compare the potential environmental impacts and risks associated with disposal operations that could result in events involving uncontrolled releases of chemical agents. Such abnormal events, although highly unlikely, could have environmental consequences of major proportions. The consequences could include human fatalities and chronic illnesses, loss of wildlife and/or wildlife habitat, loss of economic resources, and adverse impacts on the quality of life in the affected areas. The potential environmental impacts of other phases of the destruction program (namely, construction of disposal facilities, incident-free or normal disposal operations, and decommissioning of all disposal facilities upon completion of the program) were found to be minimal for all of the programmatic alternatives, and were not useful for distinguishing among the alternatives. Thus, abnormal disposal operations (accidents that could expose off-site populations to the agents) formed the basis for selecting the environmentally preferred alternative.

In support of the FPEIS, a comprehensive study was performed to identify the credible accidents for each programmatic disposal alternative (GA Technologies 1987a, 1987b, and 1987c). The principal areas of focus were plant operations, off-site transportation (for national, regional, and partial relocation options), on-site transportation via truck, and munitions-handling operations. Accident initiators that were considered included equipment failures, human error, and external events (seismic events, meteorites, tornadoes and high winds, lightning, and air crashes). In addition, crashes (truck, train, and airplane) and train derailment were considered as initiators for the transportation accidents. Except for the inventory differences among storage installations and certain site-specific events such as earthquakes and aircraft crashes, the accident initiators associated with plant operations are the same for all sites and all disposal alternatives.

Several thousand accidents were identified for the various disposal alternatives. These accidents were initially screened such that any accident with a probability of chemical agent release less than 1×10^{-8} (i.e., one chance in 100,000,000) was eliminated from further analysis because it was deemed not credible. Furthermore, any accidental release that posed no threat to the population beyond the installation boundary (i.e., an accident for which the downwind dispersion travels less than 500 m) was also eliminated from further analysis.

Some 3000 credible accidents survived the screening process. Each potential accident was characterized by its expected frequency, the size of the release as expressed by weight of specific chemical agent, the type of agent released, its mode of release (e.g., spill, detonation, or fire), the possible accident location, and the duration of time during which that accident could occur (i.e., the total time during which agent could be released from the onset of the disposal program until the completion of that particular activity). With the use of an atmospheric dispersion code, each accident involving agent release was characterized in terms of its plume geometry, lethal downwind distance, and extent of surface contamination. Two reasonable generic meteorological conditions were used to provide these characterizations.

To assess the potential environmental impacts and risks associated with each programmatic alternative, the accident database was combined with data on the environs of each of the eight storage installations and potential transportation corridors. The potential impact areas included human health, socioeconomics, water resources, and ecology. As such, the site-specific data for each storage installation included information on population distributions; social, economic and cultural resources; surface water and groundwater resources; ecology; land use; and emergency preparedness.

The assessment included both deterministic and probabilistic analyses of impacts. For the deterministic analysis, estimates of potential impacts to the above-noted resources were based on worst-case accident conditions. Although this analysis provided useful insight into the environmental implications of major accidents, it proved to be of limited utility for comparing programmatic alternatives. For this reason, a probabilistic risk analysis keyed to the probabilistic accident analysis and duration of the disposal program also was used. The following measures of impact formed the basis for determining the environmentally preferred alternative.

- Probability of one or more fatalities, which is the chance that there will be at least one fatality at a given site or along a transportation corridor or for the nation as a whole during implementation of a given programmatic alternative.

- Maximum number of fatalities, which is the maximum human health consequences among all credible accidents at a site or along a transportation corridor or for the nation as a whole for a given programmatic alternative.

- Expected fatalities, which is a statistical measure equal to the sum of the risk contribution of all credible accidents at a site or along a transportation corridor or for the nation as a whole for a given programmatic alternative.

- Person-years at risk, which is a statistical measure equal to the product of the number of persons near a site or along a transportation corridor at risk from that credible accident that has the greatest lethal downwind distance for a given programmatic

alternative and the length of time during which that accident could occur.

- Expected plume area, which is a statistical measure equal to the cumulative risk contribution of all potential plume areas from all credible accidental agent releases for a given programmatic alternative. This measure of risk is sensitive not only to the size of the areas potentially affected by releases but also to the probabilities of those releases. It was used as the surrogate for (or indicator of) impacts to environmental, cultural, and socioeconomic resources.

These measures were used systematically in a decision methodology developed expressly for selecting the environmentally preferred alternative.

The decision methodology consisted of three sequential tiers of examination. The first tier compared the human health impacts using the first four of the previously defined measures. If an alternative proved to be significantly worse than others on the basis of human health impacts, it was removed from further consideration. Similarly, if a single alternative was significantly superior to all others on the basis of human health impacts, it was to be selected as the environmentally preferred alternative. If more than one alternative proved to be relatively equivalent during this first tier of comparison, then these alternatives would be selected for inclusion in the next tier of comparison. Following the same procedure, the second tier used the expected plume area measure of risk to compare the potential for ecosystem and environmental impacts for only those alternatives that survived the first tier. If needed, the third tier of the selection procedure involved the comparison of alternatives that were judged to be relatively equivalent at the second tier on the basis of the feasibility and potential effectiveness for emergency planning and preparedness.

On-site disposal was found to be the environmentally preferred alternative for destruction of the CONUS stockpile based on consideration of the aforementioned programmatic decision methodology. On-site disposal was also found to be acceptable for destruction of the stockpile at TEAD. With the size of the TEAD stockpile, relocation of the TEAD inventory was not considered as a viable alternative.

In summary, site-specific data explicitly linked to (1) assessment of the potential environmental impacts and risks associated with destruction of the CONUS stockpile and (2) identification of the environmentally preferred alternative include population distributions; social, economic and cultural resources; surface water and groundwater resources; ecological resources; land use; meteorology; seismicity; aircraft activity; and emergency preparedness. Although review of the plant design and operation procedures and, in turn, the accident analysis

is beyond the scope of this study (see Sect. 1.3), seismicity, aircraft activity, and meteorology are reviewed to ascertain whether new, more-detailed site-specific information would change the accident potential or extent of agent dispersal. Emergency preparedness is not an environmental resource, but ongoing improvements that have potential for mitigating the impacts of major accidents are reviewed in this study.

2.3 DATA COLLECTION AND AGENCIES CONTACTED

This document is supported by data collected during site visits to the Tooele, Utah, area; the most recent visit occurred in April 1988. A scoping meeting was also held at the Tooele Army Depot on August 18, 1988, to solicit public input to the NEPA process and to determine the significant issues relating to the proposed action. There were no comments (written or otherwise) received at that meeting.

Written comments on the FPEIS, received since its publication, have also been reviewed. In regard to the proposed action at TEAD, only a single letter (from the Utah Bureau of Air Quality) was received; no new concerns were raised in this letter with respect to the site-specific NEPA-compliance document for TEAD.

Inputs were solicited also from the cooperating agencies, which include the U.S. Department of Health and Human Services; the Environmental Protection Agency; the Federal Emergency Management Agency; and the state of Utah Department of Health, Division of Environmental Health. The inputs from these agencies were considered in conducting this analysis.

In addition to the documents referenced throughout this report, personal contact was made with the following agencies during the collection of site-specific data.

Grantsville City Council, Grantsville, Utah (R. Castagno).

Tooele County School District, Tooele, Utah (L. LaFever).

Tooele County Sheriff's Department, Tooele, Utah (D. K. Proctor).

Tooele Police Department, Tooele, Utah (P. Mortina).

U.S. National Park Service, National Register Office, Washington, D.C. (J. Byrne).

U.S. Department of Agriculture, Soil Conservation Service, Tooele, Utah (J. Rouse).

U.S. Environmental Protection Agency, Office of Drinking Water, Washington, D.C. (R. Anzzolin).

Utah Department of Employment Security, Salt Lake City, Utah (K. Jensen).

Utah Department of Health, Division of Environmental Health, Bureau of Air Quality, Salt Lake City (L. R. Menlove and L. C. Broadhead).

Utah Division of Comprehensive Emergency Management, Salt Lake City (R. Finely).

Utah Division of Wildlife Resources, Springville, Utah (R. F. John and K. Nelson).

Utah State Data Center, Salt Lake City (S. Romer).

2.4 REFERENCES FOR SECTION 2

Applied Technology Council 1978. *Tentative Provisions for the Development of Seismic Regulations for Buildings*, National Bureau of Standards Special Publication 510, U.S. Department of Commerce.

GA Technologies 1987a. *Risk Analysis of the On-Site Disposal of Chemical Munitions*, SAPEO-CDE-IS-87010, prepared by GA Technologies, La Jolla, Calif., for Program Executive Officer–Program Manager for Chemical Demilitarization, Aberdeen Proving Ground, Md.

GA Technologies 1987b. *Risk Analysis of the Disposal of Chemical Munitions at National or Regional Sites*, SAPEO-CDE-IS-87008, prepared by GA Technologies, La Jolla, Calif., for Program Executive Officer–Program Manager for Chemical Demilitarization, Aberdeen Proving Ground, Md.

GA Technologies 1987c. *Risk Analysis of the Continued Storage of Chemical Munitions*, SAPEO-CDE-IS-87009, prepared by GA Technologies, La Jolla, Calif., for Program Executive Officer–Program Manager for Chemical Demilitarization, Aberdeen Proving Ground, Md.

MITRE Corporation 1987. *Risk Analysis Supporting the Chemical Stockpile Disposal Program*, SAPEO-CDE-IS-87014, prepared by the MITRE Corporation, McLean, Va., for Program Executive Officer–Program Manager for Chemical Demilitarization, Aberdeen Proving Ground, Md.

3. COMPARISON OF SITE-SPECIFIC AND PROGRAMMATIC DATA

This section summarizes detailed information about the environmental resources near TEAD that was collected after the FPEIS was prepared. These new data were obtained from various sources, as indicated by reference, and were supplemented by a visit to both Tooele, Utah, and the TEAD-North and -South areas by the authors in April 1988.

This section includes a resource-by-resource discussion of programmatic data and site-specific data. This section provides (1) a discussion of the use of the resource in the impact analysis; (2) a direct comparison between FPEIS data and new site-specific data, including the relevance of such a comparison; and (3) a discussion of the significance of any differences among the data. The structure of this section parallels the presentation and discussion of environmental resources in Sects. 3.1 and 3.2.7 of the FPEIS, except for the addition of subsections on land use and emergency preparedness and a subsection on the FPEIS technical database.

Only highlights concerning the newly collected data are given in this section. A more complete presentation of the detailed, site-specific information for each resource category is contained in appendices to this Phase I Environmental Report. The information in the appendices is provided to address the criticism that something of significance may have been overlooked in the preparation of the FPEIS. Because the FPEIS selection methodology for identifying the environmentally preferred alternative depended very heavily on the measures of risk described in Sect. 2.2, the emphasis of the comparisons below has been placed on population and meteorology and on the estimated number of fatalities associated with each accident category.

3.1 METEOROLOGY AND AIR QUALITY

3.1.1 Assumptions About Meteorology and the Atmospheric Dispersion of Chemical Agent in the Programmatic Document

The FPEIS identified three modes of accidental chemical agent release that could result in fatalities among the off-site population: (1) *semicontinuous release*, which involves a steady plume of vapor (e.g., during a fire or from a vent in a storage igloo) over a specified period of time (such as 60 min); (2) *instantaneous release*, which involves a single spurt of agent, such as in an explosion; and (3) *evaporative release*, which involves a spill of agent onto the ground and subsequent atmospheric dispersion of evaporated vapors. The consequences of accidental releases of chemical agent in all three modes were analyzed in the FPEIS by the use of an atmospheric dispersion model.

The human health impact at downwind locations following an accidental release of agent would depend on meteorological conditions, which dictate the amount of atmospheric dispersion. The FPEIS used the D2PC atmospheric dispersion model (Whitacre et al. 1986) to predict downwind transport of agent. In the FPEIS, results from the D2PC model were obtained for two generic meteorological conditions: *conservative most likely* and *worst case*. The conservative-most-likely scenario represents a frequently occurring meteorological condition that results in relatively large doses compared with other frequently occurring conditions. Specifically, neutral atmospheric stability (Class D) with a wind speed of 3 m/s was selected for the conservative-most-likely condition. The worst-case scenario represents a credible condition that results in near-maximum doses. Specifically, a stable atmosphere (Class E) with a wind speed of 1 m/s was chosen for the worst-case condition.

The D2PC code predicts the dosage of agent expected at locations downwind of the release point. Dosage is defined as the mathematical product of agent concentration and the duration of exposure. Within each downwind dispersion plume were three dose-response contours; the doses used in the FPEIS were chosen to be those resulting in fatality rates of 0%, 1%, and 50%. The dosage corresponding to the 0% rate (also called the *no-deaths* dose in the FPEIS) is the largest dosage that would result in no fatalities to healthy adults. Figure 3.1-1 illustrates the plume geometries and dose-response contours under the two meteorological conditions used in the FPEIS.

To simplify the analysis of the many accidents identified in the FPEIS risk analysis, the accidents were grouped into categories defined by their downwind no-deaths distances. These downwind no-deaths distance categories were used generically in the FPEIS to (1) define all accidents by category and (2) estimate fatalities by category. The distance categories used in the FPEIS are shown in Table 3.1-1. Every accidental release was assigned a distance category, and the maximum downwind boundary of that category was used to represent the entire class of similar releases. For example, an accidental release that was predicted by the D2PC code to result in a downwind no-deaths distance of 11 km was placed into the 10- to 20-km accident category, and a distance of 20 km was used to characterize that particular accident in the FPEIS. Human health impacts, as defined by potential fatalities, were based on the generic plumes described by these distance categories.

3.1.2 Comparison of Site-Specific and Programmatic Data for Meteorology and Air Quality

Since the completion of the FPEIS, additional site-specific meteorological data, including wind speed and direction, have been obtained. These data include wind measurements for a 1-year period (November 1, 1986, through October 31, 1987) from a meteorological tower near the Chemical Agent Munitions Disposal System (CAMDS) facility at TEAD-South. These data are more representative of the wind at the site of

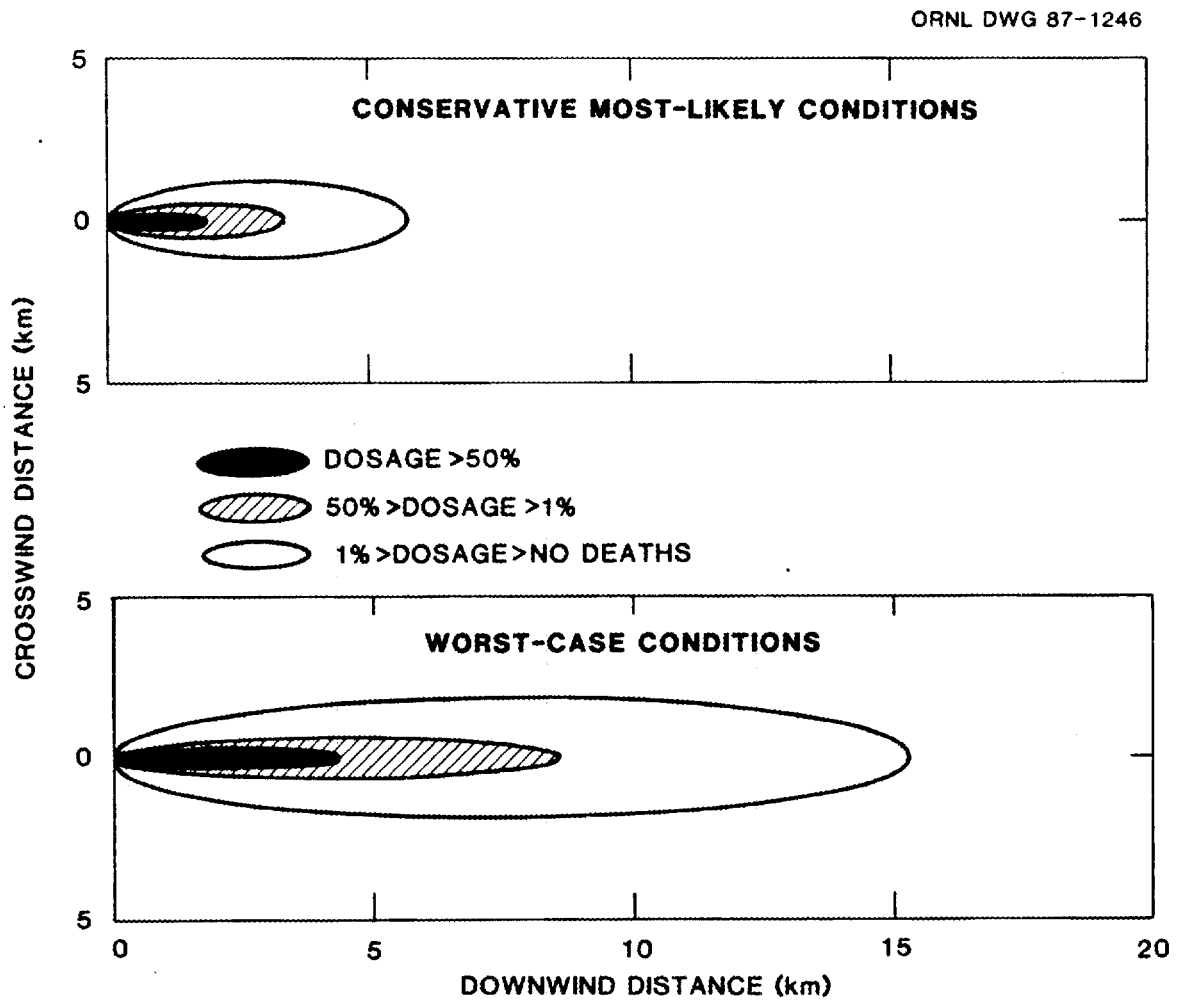

Fig. 3.1-1. A hypothetical scenario illustrating plume distances and shapes for the same accident under different meteorological conditions.

Table 3.1-1. Downwind no-deaths-distance categories used in the final programmatic environmental impact statement to characterize chemical agent releases

	Predicted accident downwind distance[a]	
Category	Greater than or equal to	but less than
1 km	500 m[b]	1 km
2 km	1 km	2
5 km	2	5
10 km	5	10
20 km	10	20
50 km	20	50
100 km	50	100

[a]Distance to the no-deaths contour as predicted from the D2PC atmospheric dispersion model.

[b]Accidents with downwind distances of fewer than 500 m will not produce plumes that travel beyond the installation boundary and, thus, were eliminated from the FPEIS risk analysis.

the proposed incineration facility than the Salt Lake City wind data that were presented in the FPEIS. Winds were measured at approximately 6 m above ground level at Salt Lake City and at 7.5 m above ground level at TEAD-South.

The wind data for the two locations can be compared most easily in the form of wind roses that summarize the wind direction and wind speed at the two locations. Figure 3.1-2 (which is a reproduction of the FPEIS Fig. 3.2.21) presents the wind rose for Salt Lake City, and Fig. 3.1-3 shows the newly available information for TEAD-South. The wind roses depict the annual joint frequency distribution of wind speed and wind direction. In these graphs, winds blowing *from* each direction are plotted as individual bars that extend from the center of the circular diagram. Wind speeds are denoted by bar widths; the frequency of wind speed within each wind direction is depicted according to the length of the bar. Note that the points on the wind roses represent the directions from which the winds come; any emissions or releases from the facility would travel downwind in the opposite direction. The frequency is given as the percentage of the total number of measurements at the location.

Examination of the wind rose for Salt Lake City (Fig. 3.1-2) reveals that the prevailing winds are from the south-southeast, with large frequencies also from the adjoining south and southeast directions. A secondary peak occurs from the north direction. These directions are aligned with the orientation of the mountain ranges on both sides of Salt Lake City. The mountains channel the flow along the axis of the valley in which Salt Lake City is situated.

The prevailing winds are from the southeast at TEAD-South (see Fig. 3.1-3), with high occurrences of wind from the adjoining south-southeast and east-southeast directions. High frequencies in these directions represent a slight shift in prevailing winds from those at Salt Lake City. Similarly, the secondary peak is also slightly shifted, occurring from the north-northwest at TEAD-South. These shifts reflect a small change in the orientation of the mountain ranges on two sides of TEAD-South, which channel the flow along the axis of Rush Valley, as compared with the mountains' orientation at Salt Lake City. In addition to wind direction, a comparison of wind speeds reveals some differences between the two locations. Very low and very high speed winds tend to occur more frequently at TEAD-South.

The site-specific wind data for TEAD-South were examined to determine the appropriateness of the conservative-most-likely and worst-case meteorological conditions (defined in Sect. 3.1.1) that were used in the FPEIS. The site-specific data indicate that neutral atmospheric stability (Class D) occurred more often (more than 35% of the time) than any of the other five stability classes; wind speeds less than 9 m/s were relatively common within this stability class. Stable atmospheric conditions (Class E) with light winds (less than 2 m/s) occurred nearly 15% of the time. These meteorological conditions are comparable to or slightly less adverse than the conservative-most-likely and worst-case conditions used in the FPEIS.

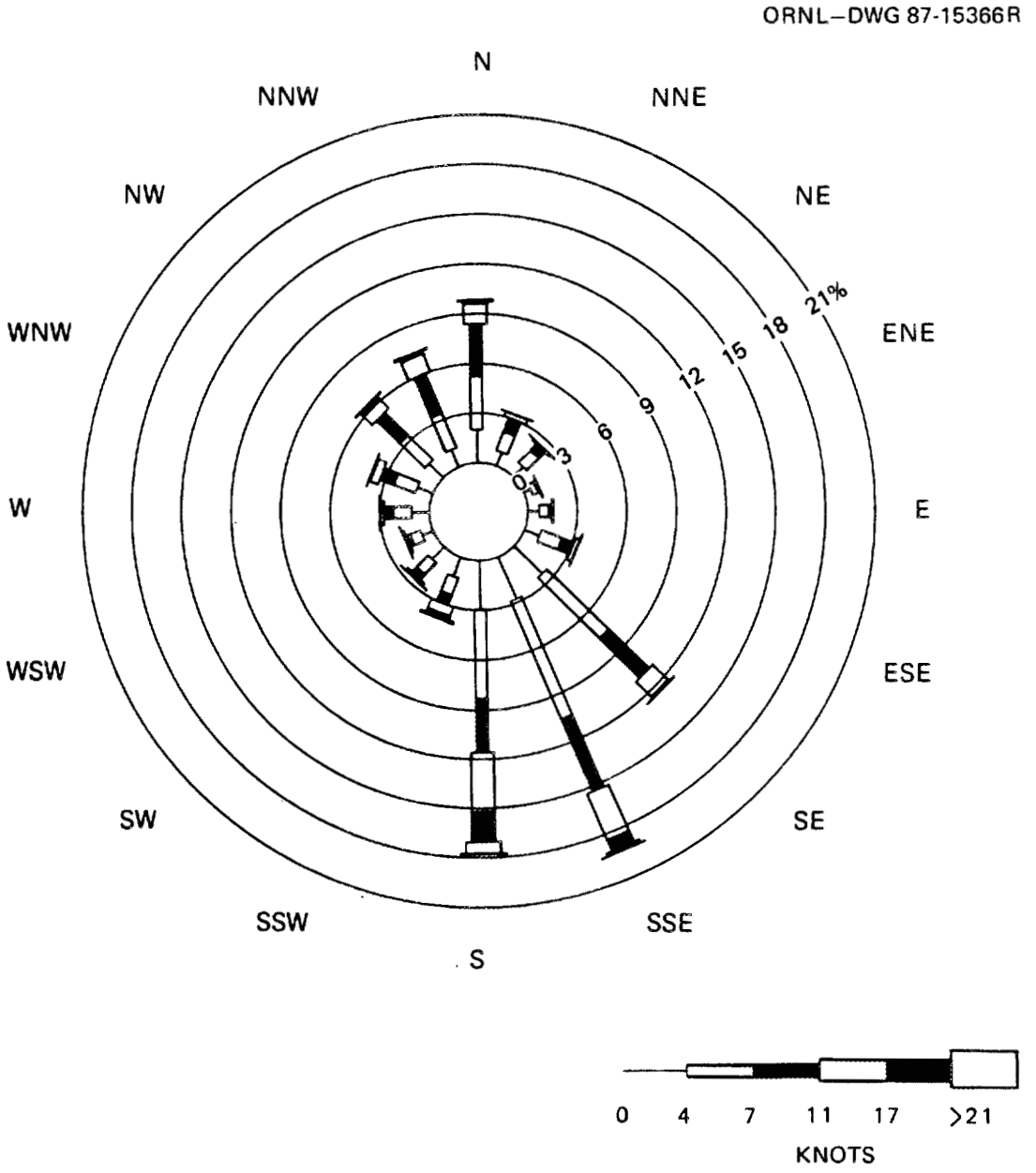

Fig. 3.1-2. Average annual wind rose, Salt Lake City, January 1, 1959, through December 31, 1964. *Source:* U.S. Department of the Army, 1986, *Notice of Intent to Construct for the Department of the Army Tooele Army Depot Chemical Stockpile Disposal System*, submitted to the Utah Department of Health, Division of Environmental Health, Bureau of Air Quality, Salt Lake City, Utah, Fig. G-1-1, Rev. 0, Program Manager for Chemical Munitions, Aberdeen Proving Ground, Md.

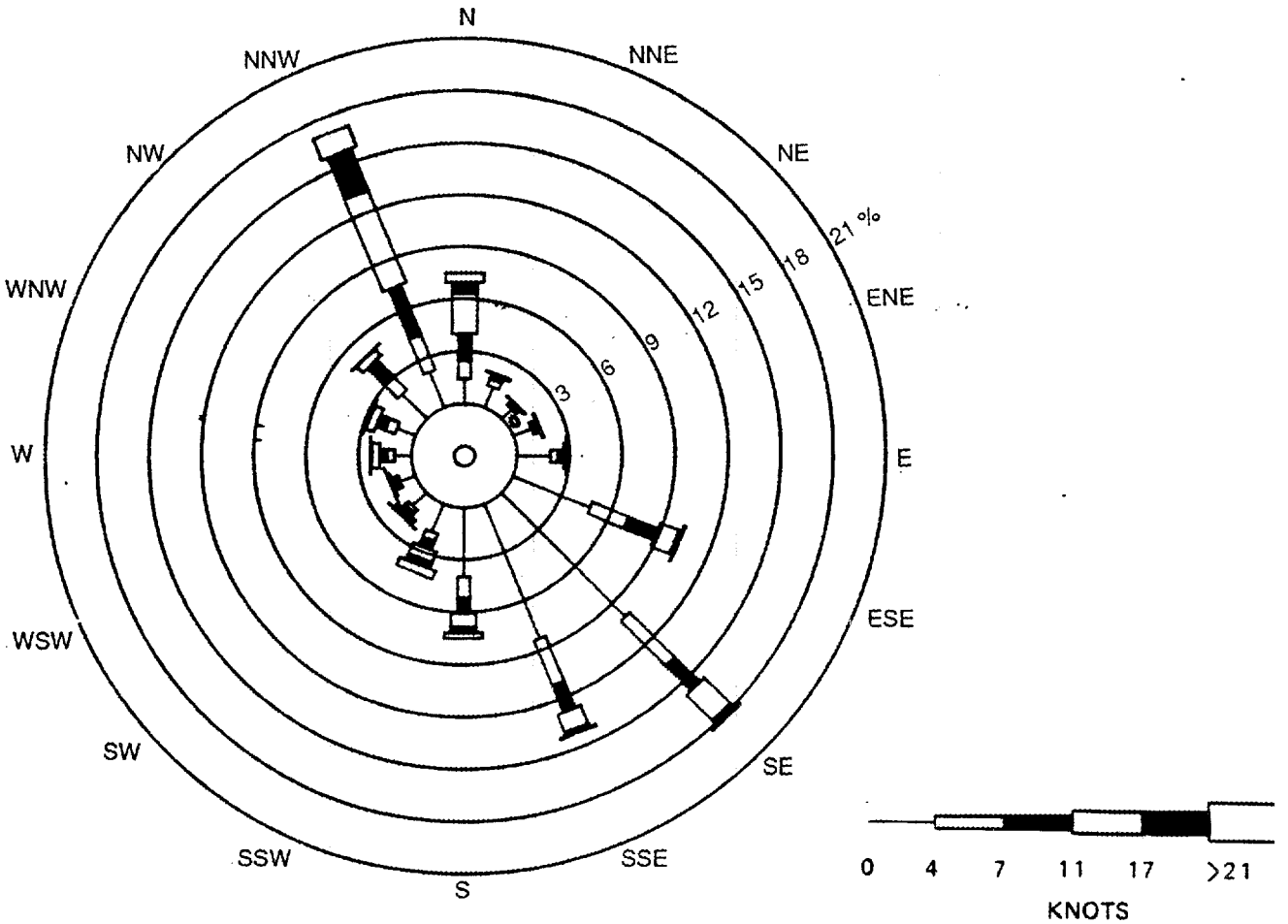

Fig. 3.1-3. Average annual wind rose, Tooele Army Depot–South, Utah, November 1, 1986, through October 31, 1987.

The FPEIS stated that all locations where the CSDP facility may be constructed at TEAD-South are designated by the Environmental Protection Agency (EPA) as attainment areas for all criteria pollutants [particulate matter, sulfur dioxide (SO_2), nitrogen oxide (NO_2), carbon monoxide (CO), ozone (O_3), and lead (Pb)]. Although this is a true statement, the FPEIS did not mention that an area that includes the extreme northeast corner of TEAD-South (and thus is not a potential site for the CSDP facility) is designated as a nonattainment area for SO_2 (L. R. Menlove, Utah Bureau of Air Quality, personal communication to R. L. Miller, Oak Ridge National Laboratory, Apr. 21, 1988).

Additional, detailed information about site-specific meteorology and air quality is presented in Appendix A.

3.1.3 Significance of Differences in Site-Specific and Programmatic Data for Meteorology and Air Quality

Site-specific data support the FPEIS assumptions about the conservative-most-likely and worst-case meteorological conditions. Both meteorological conditions as used in the FPEIS have been shown to be credible and appropriate for use in analysis of atmospheric dispersion at TEAD-South. Differences in the site-specific wind direction (as determined from the wind rose) from that in the FPEIS are insignificant.

3.2 POPULATION

3.2.1 Assumptions About Population in the Programmatic Document

In the FPEIS, the description of the distribution of population around each Army installation was taken from 1980 Bureau of the Census data. The coordinates of the census enumeration district centroids were first used to estimate the boundaries and areas of each district. Next a population density was estimated within these areas. Finally, a predefined grid of very small cells (roughly 370 X 370 m) was overlaid on the distributed population, and the number of people per cell was developed. This grid-based population was used in the estimation of fatalities from accidental releases of agent.

The FPEIS analysis of human health impacts was based on the use of the D2PC atmospheric dispersion model to define the downwind "no-deaths" distance (the distance at which fatalities would not be expected; see Sect. 3.1.1) from an accidental release of chemical agent. In computing the measures of risk (see Sect. 2.2) used in the selection of the environmentally preferred alternative, human health impacts (i.e., maximum number of fatalities) were included for each accident.

A discussion of the human health impacts (i.e., maximum number of fatalities) of the worst-case accident for each alternative was included in the FPEIS, and while the long-term health effects of exposure to sublethal

doses of chemical agents were also discussed, such effects were not a factor in the selection of the environmentally preferred alternative.

Fatality estimates were developed by overlaying the plume geometries [including the three dose-response contours (50% lethal dose, 1% lethal dose, and no deaths) as described in Sect. 3.1.1] on the population grid. First, the number of people between each dose-response contour was counted; then "fatality multipliers" were applied to the populations in each zone. Of the people inside the 50% dose-response contour, 75% were assumed to die; 25% of the people in the region between the 50% and the 1% dose-response contours were assumed to die; and 0.5% of the people in the region between the 1% dose-response and the no-deaths contours were assumed to die.

This fatality estimation process was repeated 360 times for each downwind no-deaths distance category (see Sect. 3.1.1) and for each of the two meteorological conditions. That is, each plume was rotated in increments of one compass degree around the point of release, and fatality estimates were computed for each of these increments. Among all 360 computations, the absolute largest number of fatalities was identified in the FPEIS as the "maximum number of fatalities" associated with that particular downwind no-deaths distance category. This computational technique does not take wind direction into account; instead, it is conservatively assumed that the wind has some nonzero probability of blowing in the direction that would cause the most fatalities in the event of a release.

The following assumptions and qualifications of the fatality estimation process were enumerated in the FPEIS (U.S. Department of the Army 1988, Vol. 1, Sect. 4.2.3.1).

- The assumed values of the fatality multipliers were based on linear variations of agent doses within each dose-response contour. In actuality, the doses decrease with distance from the release point at a greater than linear rate; thus, the FPEIS estimates of maximum fatalities are conservatively high.

- The D2PC atmospheric dispersion model was originally developed as a planning tool for estimating the magnitude of battlefield casualties under war-game scenarios. The model predicts dose-response contours based on the expected response of healthy adult males to battlefield agent concentrations. The variation of dose response among age classes (e.g., infants, children, and elders) was not included in the estimation of fatalities in the FPEIS. It was assumed that the dose response of healthy adult males would closely approximate the response of an average member of the general public.

- Downwind no-deaths distance estimates from D2PC are accurate to within only ±50%. This limitation of the atmospheric dispersion model resulted in a systematic uncertainty that applied equally to all fatality estimates for all alternatives.

- Variations in wind direction, atmospheric stability, and terrain during a release would cause the plume to have a much more complex geometry than the simplistic ellipsoidal shape used in the FPEIS. The longer the time period over which the plume develops, the greater the likelihood that changes in the wind conditions will affect the plume geometry.

- The same variations in wind direction, atmospheric stability, and terrain make it impossible to reliably predict the shape of a very large plume contour. For this reason, fatality counts for accidents with extremely large downwind no-deaths distances were truncated at 100 km in the FPEIS.

- The census data used to develop the distribution of population around each site are representative of the place of residence; thus, these data more closely depict nighttime populations than daytime populations. Furthermore, transient populations (such as people in shopping centers or at major sporting events) and on-post employees were not included in the population data in the FPEIS.

- A distance of 500 m was used generically in the FPEIS to define the distance from the release point to the installation boundary. This distance was incorporated into the methodology of developing the population distribution from the census data, resulting in a circular exclusion zone around each site. That is, in the development of the grid-based population, the 500-m zone was assumed to be essentially equivalent to the installation boundary; the methodology of generating the grid-based population allowed all grid cells beyond this zone to be filled with a distributed population even though, in reality, no such population existed for certain cells. Likewise, other known uninhabited regions (such as lakes, forested areas, federally restricted areas, as well as the actual site boundaries) were not accounted for in the FPEIS grid-based population; all such zones were filled with population according to the method described above.

- The locations used in the FPEIS for the source of every chemical agent release were assumed to be the proposed location of the CSDP disposal facilities as estimated from a 1 : 250,000-scale map. All plumes used this release point for estimating fatalities. In the accident analyses, for which storage area accidents or on-site transportation accidents resulted in agent release, the release point may be incorrect in the FPEIS; however, the implication of this assumption would be more significant for small releases of agent than for large releases. That is, for large releases, the downwind distances predicted by the atmospheric dispersion model are significantly larger than the distance between any possible points of release at a particular site.

3.2.2 Comparison of Site-Specific and Programmatic Data for Population

The FPEIS presented residential population as of the 1980 census by radial sector and distance out to 100 km, as shown in Table 3.2-1 (a reproduction of the FPEIS Table 3.2.34). However, the coordinates used as the location of the disposal facilities in this table were incorrect. (An errata sheet for the FPEIS is in preparation.) In the FPEIS, the disposal facility location, as read from 1 : 250,000-scale maps, was incorrectly determined to be approximately 10 km south and 2.5 km west of its actual location. This incorrect location was used as the point around which population counts were developed and fatalities were estimated in the FPEIS. In this Phase I assessment, the correct location of the disposal facilities has been used to correctly portray the impacted population, as discussed below.

Because the 1980 census of population data will be nearly 10 years old by the time construction and operations of the CSDP facilities begin at TEAD-South, the latest population estimates (i.e., for 1986) have been used to adjust the 1980 census data. Unfortunately, population estimates in non-census years are limited to estimates of counties and incorporated areas. A two-step process was used in this Phase I assessment for each potentially impacted county to estimate the population change at the enumeration district level. First, the estimated population changes for incorporated areas were equally apportioned among enumeration districts comprising the named area. Second, the unaccounted-for change in county population was equally apportioned among enumeration districts comprising the non-incorporated areas.

As in the FPEIS, these population estimates were assigned to a grid (see Sect. 3.2.1). Whereas the estimates used in the FPEIS considered only population and enumeration district location in creating the grid-based population, the Phase I estimation method excludes population from areas that are clearly not residential (e.g., the Great Salt Lake; Utah Lake; Rush Valley Lake; federally restricted areas such as national forest land; and installation boundaries such as Dugway, TEAD-North, and TEAD-South). The Phase I methodology also restricts some populations to areas (e.g., the towns of Tooele, Stockton, and Faust) that clearly are inhabited but are surrounded by nonresidential areas.

The effect of using this exclusion and inclusion information is to create population distributions with larger concentrations of population than were in the FPEIS. However, these concentrated population areas are now accompanied by unpopulated areas that had small populations in the FPEIS.

The revised residential population is presented in Table 3.2-2 in the same format used in the FPEIS. The corrected location of the disposal facilities is included in this table. The effect of including the 1986 population estimates is to increase the total population within the 100-km zone by about 14%; the effect of using the correct location for the disposal facilities increases the total population almost another 10% (primarily because moving the location northward and eastward causes more of Salt Lake City to fall within the 100-km zone). The net result is

Table 3.2-1. Population distribution[a] around the Tooele Army Depot-South proposed plant site as presented in the final programmatic environmental impact statement for the Chemical Stockpile Disposal Program

	Incremental population data at specified distances[b]							
Direction	0–1	1–2	2–5	5–10	10–20	20–35	35–50	50–100
N	0	0	2	2	44	2,401	6,661	1,810
NNE	0	0	1	2	7	2,502	5,825	216,305
NE	0	0	1	2	7	179	5,410	474,531
ENE	0	0	1	2	28	278	7,777	55,626
E	0	0	2	4	37	318	484	141,120
ESE	0	0	2	7	45	270	905	17,610
SE	0	0	2	6	34	261	518	5,491
SSE	0	0	2	7	12	141	106	788
S	0	0	2	5	6	38	8	1,865
SSW	0	0	2	4	6	16	11	1,427
SW	0	0	2	6	7	22	56	55
WSW	0	0	2	6	20	102	242	229
W	0	0	2	6	27	169	290	482
WNW	0	0	2	6	36	46	18	14
NW	0	0	2	7	57	47	8	15
NNW	0	0	2	6	72	214	2,080	1,590
Total	0	0	29	78	445	7,004	30,399	918,958

[a]Note: This population is centered around the location at 40.21° north latitude and 112.38° west longitude.

[b]Distances given in kilometers.

Source: U.S. Department of Commerce, Bureau of the Census 1983. *County and City Data Book*; U.S. Government Printing Office, Washington, D.C.

Table 3.2-2. Population distribution around the Tooele Army Depot–South proposed plant site using updated population statistics[a]

	Incremental population data at specified distances[b]							
Direction	0–1	1–2	2–5	5–10	10–20	20–35	35–50	50–100
N	0	0	1	1	402	10,550	431	1,103
NNE	0	0	1	1	0	6,162	16,117	227,163
NE	0	0	0	3	49	652	94,624	529,798
ENE	0	0	0	3	3	252	28,715	31,275
E	0	0	0	8	60	675	9,192	155,090
ESE	0	0	0	5	53	316	184	43,799
SE	0	0	0	2	31	104	180	7,848
SSE	0	0	0	2	13	34	696	1,806
S	0	0	0	2	7	22	18	1,946
SSW	0	0	0	2	7	211	0	73
SW	0	0	0	2	4	6	3	0
WSW	0	0	0	2	1	902	357	493
W	0	0	0	2	1	0	0	0
WNW	0	0	0	57	251	0	1	1
NW	0	0	0	5	85	0	104	539
NNW	0	0	0	2	0	3,024	2,115	718
Total	0	0	2	99	967	22,910	152,737	1,001,652

[a]The values in this table differ from those published in the FPEIS for the following reasons. (1) The location used for the release is more precise than the one used in the FPEIS; the new location is at 40.3° north latitude and 112.35° west longitude. (2) The population used is the 1986 population as estimated by the bureau of the Census for cities and counties in Utah and as provided by the Data Resources Section of the Utah Office of Planning and Budget (the FPEIS used 1980 population counts). (3) The method used to calculate population and population density used additional information about population distribution to exclude population from some areas and restrict population to others. The population of Utah was estimated to be 14% higher in 1986 than in 1980.

[b]Distances given in kilometers.

a 23% increase (221,454 additional people) in the potentially impacted population around TEAD-South compared with that population described in the FPEIS.

The FPEIS did not consider the on-post population at any of the Army installations; however, the TEAD-South population (as many as 225 employees) for daytime, evening, and night are presented in Fig. 3.2-1. Because TEAD is the largest employer in the area (approximately 4000 employees), the distribution of daytime population is potentially augmented at the TEAD-North area by as many as 4000 people. Another on-post population exists at or around Dugway Proving Ground, southwest of TEAD-South.

Likewise, the FPEIS did not consider the daytime population around any of the Army installations. A detailed listing of place-of-work population for the area surrounding TEAD-South has been requested and should be available in September 1988. This information will be included in the NEPA analysis of Phase II (i.e., in the preparation of an EIS for TEAD-South). By merging the residential populations with the place-of-work populations, a conservative estimate of the maximum population impact (fatalities) could be obtained.

No special populations, such as those attending sporting events, have been identified for the area around TEAD-South; however, military exercises occasionally bring large numbers of troops into the region for training purposes.

Additional, detailed information about site-specific populations is included in Appendix A.

3.2.3 Significance of Differences in Site-Specific and Programmatic Data for Population

The implications of the increased population around TEAD-South can be fully explored by recomputing the fatality estimates in each accident-distance category. Overlaying the updated population of Table 3.2-2 with the same lethal plumes used in the FPEIS gives new fatality estimates for accidental releases of agent at TEAD-South. These revised fatality estimates are presented and compared with FPEIS data in Table 3.2-3.

The revised fatality estimates are larger than those in the FPEIS. As discussed above, this increase is partly due to the increase in population since the 1980 census was made and partly due to a correction of the FPEIS error in locating the disposal facilities at TEAD-South. Under the 20-km downwind-distance category, the FPEIS values have increased by almost 1 order of magnitude for the conservative-most-likely and worst-case meteorological conditions (i.e., from 4 fatalities to 38 and from 2 fatalities to 17 respectively). In addition, the worst-case accident at TEAD-South (which is assigned to the 50-km distance category as in the FPEIS) could result in 2040 fatalities, compared with the FPEIS estimate of 1100.

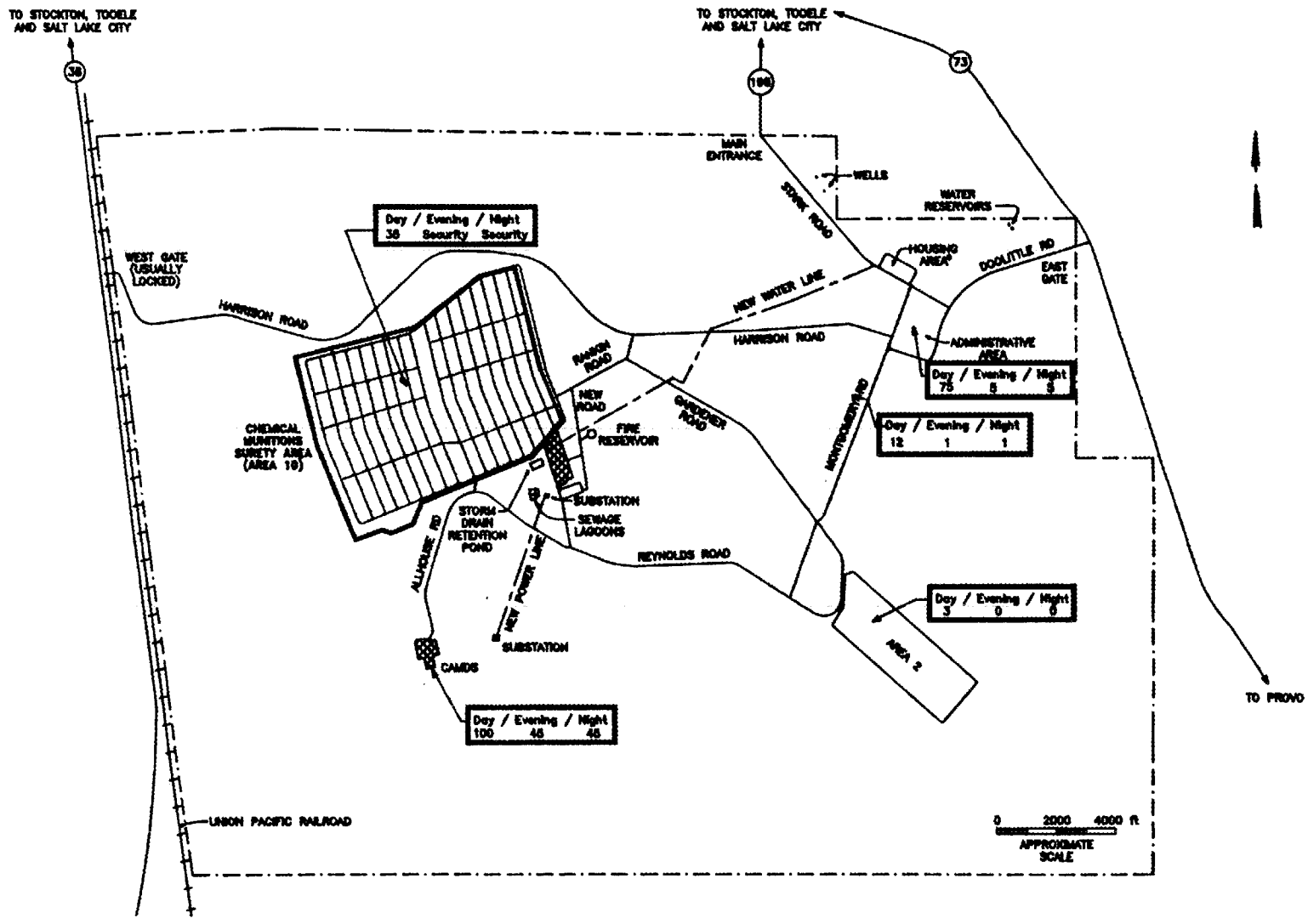

Fig. 3.2-1. On-post population at Tooele Army Depot–South by time of day. Note: Base housing is expected to be vacated by the time disposal operations begin.

Table 3.2-3. Estimated maximum fatalities by downwind distance for selected meteorological conditions at Tooele Army Depot

	FPEIS fatalities[a,b]		Phase I fatalities[a,b]	
Downwind distance (km)	Conservative-most-likely meteorological conditions[c]	Worst-case meteorological conditions[c]	Conservative-most-likely meteorological conditions[c]	Worst-case meteorological conditions[c]
1.0	0	0	0	0
2.0	0	0	0	0
5.0	0	0	0	0
10.0	1	0	1	0
20.0	4	2	38	17
50.0	NA[d]	1,100	NA[d]	2,040
100.0	NA[d]	20,000	NA[d]	30,380

[a]The number of deaths is rounded.

[b]The potential maximum fatalities equals the fatalities from a plume traveling over the greatest population density.

[c]The fatality estimates are larger for an accident in the same downwind distance category under conservative-most-likely (CML) meteorological conditions than for an accident under worst-case (WC) meteorological conditions because the CML plume is wider and hence of greater area. The accidental release of the same quantity of agent would travel farther downwind under WC conditions than under CML conditions. An accident that resulted in a certain downwind distance under CML weather would travel one or two distance categories farther under WC weather. Conversely, an accident that traveled into a certain distance category in WC weather would reach into one or two distance categories less in CML weather.

[d]NA = not applicable because the largest credible accident does not travel this distance under CML weather conditions.

While such an increase in potential fatalities is apparently significant, it should be recalled that the downwind-distance categories and fatality estimates in Table 3.2-3 were used for all accidents under all alternatives at TEAD. Any increase in potential fatalities for one alternative would also apply to all other alternatives for TEAD because the options for TEAD involved the destruction of its own inventory or additional inventories from other installations. It should also be noted that the numerical value of the maximum fatalities from the worst-case accident under on-site disposal at TEAD (2040 people as defined by the 50-km distance category) does not exceed the absolute value of the maximum fatalities (5400 people at Pine Bluff Arsenal, as given in the FPEIS) for the programmatic on-site alternative.

The inclusion of on-post populations or daytime off-post populations in the fatality-estimation process might provide supplemental information regarding an absolute upper limit for the maximum number of fatalities. However, this information would give a conservative fatality estimate in the sense that such population data would have to be merged with the census (nighttime) population database to develop estimates. Hence, the actual population would be overestimated, and larger numbers of fatalities would be estimated as a result. Such information might be useful for emergency planning efforts but could not be used to infer absolute impacts to human health.

From the perspective of the affected public near TEAD, it suffices to observe that movement of agents and munitions from other storage installations to TEAD for destruction can only increase risk; therefore, despite the fact that increased fatalities are now estimated for TEAD, on-site incineration is still the environmentally preferred alternative as compared with the other FPEIS alternatives for TEAD.

3.3 SOCIAL, ECONOMIC, AND CULTURAL RESOURCES

3.3.1 Assumptions About Social, Economic, and Cultural Resources in the Programmatic Document

Socioeconomic impacts include cultural impacts (to the historic or archaeological environment), social impacts, economic impacts, and impacts to the quality of life in the affected area. The majority of such impacts would be expected to occur in the same zone identified by the downwind no-deaths distance for human health impacts. However, the FPEIS limited the discussion of socioeconomic impacts to a radius of 10 km around each Army installation.

While the FPEIS discussed the potential impacts to socioeconomic, cultural, and historical resources and attempted to identify unique resources, impacts to socioeconomic resources were not an explicit factor in the selection of the environmentally preferred alternative. However, a surrogate measure of the environmental insult to these resources was contained in the expected-plume-area measure of risk included in the FPEIS selection methodology.

3.3.2 Comparison of Site-Specific and Programmatic Data for Social, Economic, and Cultural Resources

The social, economic, and cultural resources described in the FPEIS were limited to those counties within 10 km of the proposed CSDP facilities at TEAD-South. Supplemental information collected for this region since the preparation of the FPEIS indicates that there has been relatively little change in the data presented in the FPEIS. Additional data have also been collected for the region within 100 km of TEAD-South.

The cumulative social, economic, and cultural impacts from other projects in the TEAD area were not discussed in the FPEIS; however, in accordance with 40 CFR Pt. 1508.7, a preliminary survey of proposed activity in the region indicates the potential for cumulative impacts. The construction of the CSDP facilities at TEAD-South are expected to occur at approximately the same time as the construction of a Consolidated Maintenance Facility at TEAD-North. The combined effects on the local economy from both of these construction projects will be the additional peak monthly employment of as many as 750 construction workers. Compared with the total current labor force at TEAD, this amounts to a temporary 18.8% increase in employment. In addition, Aptus (formerly National Electric, Inc.) proposes to construct an industrial- and hazardous-waste transfer, storage, and incineration facility in Tooele County, 110 km (68 miles) west of Salt Lake City. Construction activity, involving an unknown number of construction workers, for the Aptus facility was planned to be coincident with the proposed action at TEAD-South. The construction of a cryofracture pilot plant at CAMDS could also potentially add to the temporary increase in construction workers in the TEAD area. The cumulative effect of all of this construction activity on the region would potentially be a positive influence on the economy; however, such a large influx of workers might strain other resources, such as housing, and could potentially lead to a boom-bust cycle.

Additional, detailed information about site-specific social, economic, and cultural resources is given in Appendix C.

3.3.3 Significance of Differences in Site-Specific and Programmatic Data for Social, Economic, and Cultural Resources

With the exception of a larger database that extends beyond the region of influence (a 10-km radius around TEAD-South) considered in the FPEIS, no significant differences among the FPEIS data and the site-specific data can be identified. Furthermore, it should be observed also that impacts to social, economic, and cultural resources were not explicitly included in the selection methodology for the environmentally preferred alternative in the FPEIS (recall that "expected plume area" was used as a surrogate measure). Hence, specific impacts to such resources were not a determining factor in the selection of the FPEIS environmentally preferred alternative.

3.4 SURFACE WATER AND GROUNDWATER

3.4.1 Assumptions About Surface Water and Groundwater in the Programmatic Document

Impacts to water resources were based on the use of the atmospheric dispersion model and an aquatic spill model (see U.S. Department of the Army 1988, Vol. 3, Appendix N). Contamination of surface waters near each Army installation would depend on the quantity of agent spilled or the amount of deposition following an atmospheric dispersion of chemical agent. Some additional quantity of agent deposited onto land could also be carried a short distance to surface waters during a rain that occurred before cleanup of the contaminated area. Moreover, chemical agent could reach groundwater from a spill on land by the leaching of agent deposited onto land surfaces from an airborne cloud or by recharge from contaminated surface waters.

While the FPEIS discussed the potential impacts to surface water and groundwater, no unique resources were identified. No federally designated wild or scenic rivers were identified within 100 km of any of the eight Army installations. No sole-source aquifers were identified in the FPEIS, except the 100-km zone around Aberdeen Proving Ground, Maryland. Private wells were excluded from the discussion in the FPEIS. However, impacts to water resources were not an explicit factor in the selection of the environmentally preferred alternative.

3.4.2 Comparison of Site-Specific and Programmatic Data for Surface Water and Groundwater

Several water bodies and streams near TEAD-South were named in the FPEIS; however, it was observed that no surface water leaves Rush Valley. Also, no major rivers or federally designated wild or scenic rivers are within 100 km of TEAD-South. Information on groundwater near TEAD-South in the FPEIS was brief and concentrated more on the statistics for the state of Utah than for the potentially impacted area; however, there are no sole-source aquifers (as designated by EPA) within 100 km of TEAD-South. These water resources have not changed since the preparation of the FPEIS.

Additional, detailed information about site-specific surface water and groundwater resources can be found in Appendix D.

3.4.3 Significance of Differences in Site-Specific and Programmatic Data for Surface Water and Groundwater

Supplemental information collected since the preparation of the FPEIS indicates that there has been relatively little change in the conclusions reached from the data presented in the FPEIS; no significant differences among the FPEIS data and the site-specific data can be identified. Furthermore, it should also be observed that impacts to surface water and groundwater resources were not explicitly included in the selection methodology for the environmentally preferred alternative in the FPEIS.

Hence, specific impacts to such resources were not a determining factor in the selection of the FPEIS environmentally preferred alternative.

3.5 ECOLOGICAL RESOURCES

3.5.1 Assumptions About Ecological Resources in the Programmatic Document

The term "ecological resources" in the FPEIS refers to all living organisms, except humans, that reside either on land or in water. It also includes areas (such as parklands, wilderness areas, nature conservancy areas, and wetlands) that contain important terrestrial or aquatic resources or both. Ecological resources were identified in the FPEIS for the 20-, 50-, and 100-km zones around each Army installation. The numbers of protected resources (i.e., threatened and endangered species, national parks, wilderness areas, nature conservancy areas, and wild and scenic rivers) within each zone were used in the FPEIS for comparison of impacts among alternatives because of (1) the lack of information about the density of important plant and animal species within these zones, (2) the toxicity of chemical agents to the species, and (3) uncertainties about the size of agent releases and the direction of atmospheric plumes.

Ecological impacts were based upon the plumes predicted by the atmospheric dispersion model. The zone of impact for ecological resources would extend farther than that for human health because certain species are more sensitive than humans to chemical agent exposure. For the purposes of impacts analysis, "no-effects zones" were used in the FPEIS to describe ecological impacts. These no-effects zones extended beyond the boundaries of the human no-deaths zones. The no-effects distances for agents GB and VX were based on an agent concentration of 0.000003 mg/m^3 (as set by the U.S. surgeon general for humans). This concentration results in downwind no-effects distances that are about seven times the downwind no-deaths distances. The no-effects concentrations for mustard agent are not known; hence, the no-effects distance for mustard agent was defined as equivalent to the no-deaths distance. All no-effects distances were truncated at 100 km because of the uncertainties associated with the dispersion model.

While the FPEIS discussed the impacts to ecological resources and attempted to identify unique resources, impacts to ecological resources were not an explicit factor in the selection of the environmentally preferred alternative. However, a surrogate measure of the environmental insult to these resources was contained in the expected-plume-area measure of risk included in the FPEIS selection methodology.

3.5.2 Comparison of Site-Specific and Programmatic Data for Ecological Resources

Table 3.5-1 (which is a reproduction of selected data from the FPEIS Tables 4.3.24 and 4.3.25) lists numbers of protected ecological resources within the no-deaths distance for mustard and within the no-effects distances for agents GB and VX. A number of additional protected

Table 3.5-1. Number of protected ecological resources within no-effects distances from the most serious accidents under the worst-case meteorological conditions during the on-site disposal alternative at Tooele Army Depot as presented in the final programmatic environmental impact statement

	National park units	Wilderness areas	Threatened and endangered species	Wild and scenic rivers	Nature conservancy areas	Total
Mustard agent[a,b]	1	1	1	0	0	3
Agents GB and VX[c]	1	1	5	0	1	8

[a]No-effects distances for mustard are unknown.
[b]Analysis based on accidents with no-deaths distances of 5 km for the on-site disposal alternative.
[c]Analysis based on accidents with no-deaths distances of 33 km for the on-site disposal alternative.

ecological resources, as shown in Table 3.5-2, were identified during the collection of site-specific data; detailed information about these resources is given in Table 3.5-3. Several of these resources were used to determine both the ecological resources at risk and the additional number of people using these resources that might be impacted (see Appendix A, Sect. A.5).

Because the FPEIS was a programmatic document in which millions of acres of land and water were considered, the descriptions of ecological resources were fairly general. Furthermore, it should also be observed that impacts to ecological resources were not explicitly included in the selection methodology for the environmentally preferred alternative in the FPEIS (recall that "expected plume area" was used as a surrogate measure). Hence, specific impacts to such resources were not a determining factor in the selection of the FPEIS environmentally preferred alternative.

Additional, detailed information about site-specific ecological resources is included in Appendix E.

3.5.3 Significance of Differences in Site-Specific and Programmatic Data for Ecological Resources

Site-specific data collected for TEAD-South in April 1988 indicate that, except for the numbers of resources, the description of ecological resources in Sect. 3.2.7.5 of the FPEIS is still accurate. The numbers of endangered species and parklands have not changed from the time of data collection for the FPEIS. However, there are several candidate species that may be reviewed for threatened or endangered status within the time period for preparation of the site-specific NEPA document for TEAD; such reviews may change the data in Table 3.5-1 prior to completion of the site-specific NEPA document.

3.6 SEISMICITY

3.6.1 Assumptions About Seismicity in the Programmatic Document

Applied Technology Council (ATC) (1978) data were used in the FPEIS to compare the potential for earthquake damage at each disposal site. The data were specifically used to determine the effective peak ground acceleration (EPGA) for designing earthquake-resistant, general-use facilities at TEAD-South. The design EPGA in the FPEIS was a ground motion with a 10% probability of being exceeded at least once in 50 years (475-year return period).

According to ATC, there is a 10% probability that the EPGA will exceed 0.20 g in 50 years at TEAD-South. The FPEIS also indicated that this area is in a region of active faults (suggesting that CSDP facilities could fail by surface rupture) and that lake-bed sediments near TEAD-South might be susceptible to failure by soil liquefaction or by amplification of ground motion due to soil-structure interaction. The latter phenomenon would

Table 3.5-2. Numbers of protected ecological resources that would be within no-effects distances of most-serious accidents that could occur under worst-case meteorological conditions during on-site disposal at Tooele Army Depot, as identified during the site-specific data collection process

	National park units	Wilderness areas	National forests	Threatened and endangered species	Wild and scenic rivers	Nature conservancy areas	Total
Mustard agent[a,b]	1	6	4	1	0	0	12
Agents GB and VX[c]	0	1	2	5	0	1	9

[a]No-effects distances for mustard are unknown.
[b]Analysis based on accidents with no-deaths distances of 5 km for the on-site disposal alternative.
[c]Analysis based on accidents with no-deaths distances of 33 km for the on-site disposal alternative.

Table 3.5-3. Public areas within 100 km of the Tooele Army Depot incinerator site

Area	Location: County	Location: Area[a]	Distance to site	1986 visitor days (1000s)[b]
Fishlake NF	Juab	21,389 A	85 km S	1300.4[c]
	Millard	306,324 A	85 km S	
Manti-LaSal NF	Sanpete	366,014 A	95 km SE	722.8[c]
	Utah	91,292 A	80 km SE	
Uinta NF	Juab	97,018 A	25 km S	3055.0[c]
	Sanpete	91,292 A	55 km SE	
	Wasatch	303,869 A	75 km E	
Wasatch NF	Davis	37,082 A	65 km NE	5512.6[c]
	Juab	35 A	40 km S	
	Morgan	11,757 A	80 km NE	
	Salt Lake	95,248 A	55 km NE	
	Tooele	150,183 A	15 km NW	
National wilderness areas (WA) and wilderness study areas (WSA)				
Deseret WA (in Wasatch NF)	Tooele	25,500 A	20 km WNW	NA[d]
Cedar Mountain WSA (in Wasatch NF)	Tooele	50,500 A	50 km WNW	NA[d]
North Stansbury WSA (in Wasatch NF)	Tooele	10,480 A	40 km NW	NA[d]
Mount Olympus WA (in Wasatch NF)	Salt Lake	16,450 A	60 km NE	7.6
Twin Peaks WA (in Wasatch NF)	Salt Lake	13,100 A	55 km NE	11.8
Lone Peak WA	Utah	30,088 A	50 km ENE	53.2
(in Uinta NF)		(21,166 A)	55 km ENE	
(in Wasatch NF)		(8,922 A)	65 km ENE	
Mount Timpanogos WA (in Uinta NF)	Utah	10,750 A	60 km E	47.8
Mount Nebo WA (in Uinta NF)	Juab	28,200 A	65 km SE	34.5
Rockwell WSA	Juab	9,150 A	60 km S	NA[d]
National monuments (NM), recreation areas (NRA), and wildlife refuges (NWR)				
Timpanogos Cave NM	Utah	250 A	60 km E	137.3
Little Sahara NRA	Juab	60,000 A	70 km S	278.0
Fish Springs NWR	Juab	17,992 A	90 km WSW	1.0

Table 3.5-3. (continued)

Area	Location: County	Location: Area[a]	Distance to site	1986 visitor days (1000s)[b]
Military installations				
Camp Williams State Military Reservation	Salt Lake/ Utah		25 km ENE	0.95 2.9
Dugway Proving Grounds	Tooele		30 km WSW	20.0
Hill Air Force Base	Box Elder/Tooele		90 km NW	< 0.1
Wendover Air Force Base Range	Tooele		70 km WNW	~4.0 daily
Tooele Army Depot-North	Tooele		20 km N	
State parks (SP) and recreation areas (SRA)				
Great Salt Lake SP (Antelope Island)	Davis		80 km N	Closed
Great Salt Lake SP (South Shore)	Salt Lake		50 km NNE	101.0 (1987)
Camp Floyd/Stagecoach Inn SP	Utah		25 km E	19.7
Utah Lake SP	Utah		55 km E	155.2
Wasatch Mtn. SP	Wasatch		85 km ENE	787.7
Deer Creek Lake SP	Wasatch		75 km ENE	456.6
Rockport Lake SP	Summit		95 km ENE	289.2
East Canyon SRA	Morgan		95 km NE	302.4
State waterfowl and wildlife management areas				
Ogden Bay	Weber		95 km N	2166 (1987-88)
Timpie Springs	Tooele		55 km NNW	344
Howard Slough	Davis		90 km N	911
Farmington Bay	Salt Lake		80 km NNE	375
Big Hollow	Sanpete		~100 km SE	NA[d]
Loafer Mountain	Utah		70 km SE	NA[d]
Ski areas				
Alta	Salt Lake (Wasatch NF)		70 km ENE	215.6
Brighton	Salt Lake (Wasatch NF)		75 km ENE	109.8
Deer Valley	Summit		80 km ENE	
Park City	Summit		80 km ENE	767.8 (1987-1988)
Park West	Summit		80 km ENE	
Snowbird	Salt Lake		70 km ENE	206.8
Sundance	Utah (private) (Uinta NF)		70 km ENE	NA[d]
Solitude	Salt Lake (Wasatch NF)		75 km ENE	101.0

Table 3.5-3. (continued)

Area	Location		Distance to site	1986 visitor days (1000s)[b]
	County	Area[a]		

[a]To convert acres to hectares, multiply acres by 2.471.

[b]Visitor days are defined by the National Park Service and the USDA Forest Service as 1 visitor within the area for 12 h, or 12 visitors for 1 h each, or any combination amounting to 12 h.

[c]Visitor days data listed are for entire forest, which exists in the counties listed and possibly in other counties as well.

[d]NA = not available; no records kept.

Sources: Park City Convention and Visitors Bureau, Park City, Utah, personal communication to L. W. Rickert, Oak Ridge National Laboratory, Oct. 27, 1988; U.S. Forest Service 1987, *A Summary of Recreation Use (M/RVDS) for FY 1986 by Activity*, Washington, D.C.; U.S. Forest Service 1988, *Land Areas of the National Forest System, as of September 30, 1987*, Washington, D.C.; U.S. National Park Service, Statistical Office 1988, *National Park Statistical Abstract 1987*, Denver, Colo.; Utah Department of Natural Resources, Division of Parks & Recreation 1987, *Utah State Parks & Recreation 1987 Visitation*, Salt Lake City; Camp Williams—Lt. Col. Robert Voyles, personal communication to G. Rogers, Oak Ridge National Laboratory, Nov. 14, 1988; Dugway Proving Ground—Delores Hansen, Public Affairs Office, personal communication to G. Rogers, Oak Ridge National Laboratory, Nov. 14, 1988 (1845 civilian and military work force, plus 1645 residents, as of September 1988); Hill Air Force Base—Len Barry, Public Affairs Officer, personal communication to G. Rogers, Oak Ridge National Laboratory, Nov. 14, 1988 (approximately 75% civilian, 25% military personnel); Wendover Air Force Base Range—Len Barry, Public Affairs Officer, personal communication to G. Rogers, Oak Ridge National Laboratory, Nov. 14, 1988; Fish Springs National Wildlife Reserve—Leah Layland, personal communication to L. W. Rickert, Oak Ridge National Laboratory, Oct. 25, 1988; Little Sahara NRA—Dick Traylor, BLM Recreation Information Management System, personal communication to L. W. Rickert, Oak Ridge National Laboratory, Oct. 25, 1988; State Waterfowl and Wildlife Management Areas—Joel Huener, University of Tennessee Department of Natural Resources, Division of Wildlife Resources, personal communication to L. W. Rickert, Oak Ridge National Laboratory, Oct. 27, 1988.

produce greater ground motions than those predicted by ATC. The predictions of ATC are based on the assumption that the foundation consists of rock or firm soil.

Seismic risk analysis assumed that sensitive facilities (i.e., the toxic cubicle) would be designed to withstand a maximum expected earthquake as required by Nuclear Regulatory Commission (NRC) standards.

3.6.2 Comparison of Site-Specific and Programmatic Data for Seismicity

Site-specific seismic data supplement those in the FPEIS in two important respects. First, foundation conditions (an uncertainty discussed in general terms in the FPEIS) are now known in greater detail. Second, ground motion estimates are now available for use in designing the toxic cubicle of the CSDP facilities; the cubicle is to be designed to meet NRC standards with respect to ground response during a maximum expected earthquake.

Site-specific data show that the proposed disposal facilities at TEAD-South are unlikely to be damaged by liquefaction (an acknowledged area of uncertainty as discussed in the FPEIS). The site for the proposed facilities is located about 30 m (100 ft) above the floor of Rush Valley, and the water table is correspondingly low, as indicated by several test wells. Furthermore, foundation materials are composed of cohesive clayey silts of high relative density, as determined by lithologic drill logs and standard penetrometer tests respectively. Therefore, site foundation soils under the proposed CSDP facilities at TEAD-South are not sensitive to liquefaction.

The design effective peak ground acceleration (EPGA) for the toxic cubicle was not provided in the FPEIS, but Jacobs Engineering (1988) has provided EPGAs in a recent study. Table 3.6-1 summarizes Jacobs' estimated EPGAs. Jacobs' design time history suggests using a duration of shaking of 20 s and a horizontal EPGA (84th percentile) of 1.10 g in developing corresponding design response spectra.

Additional, detailed information about site-specific seismicity is given in Appendix F.

3.6.3 Significance of Differences in Site-Specific and Programmatic Data for Seismicity

No significant differences in site-specific data and the data used in the FPEIS have been identified. The assumptions in the FPEIS regarding foundation conditions and ground motion have been shown to be conservative. Jacobs Engineering (1988) demonstrates that their design response spectra (developed for sites underlain by stiff soils and deep cohesionless soils) and that its matching time series are more conservative than those of either Seed and Idriss (1982) or NRC Regulatory Guide 1.60. It should be also noted that the location of the toxic cubicle at TEAD-South satisfies the RCRA seismic standards for hazardous waste disposal facilities, which

Table 3.6-1. Estimated effective peak ground accelerations (EPGAs) at Tooele Army Depot–South

EPGA (g)		Horizontal EPGA (g)	
Mean	84th percentile	Mean	84th percentile
0.71	0.96	0.81	1.10

Modified from Jacobs Engineering Group, Inc. 1988. *Draft Inc. 1988. Geological-Seismological Investigation of Earthquake Hazards for a Chemical Agent Demilitarization Facility at the Tooele Army Depot, Utah,* contractor's report to the U.S. Army Engineering Division, Huntsville, Ala.

state that the site shall be a minimum of 60 m (200 ft) from the nearest Holocene fault.

3.7 AIRCRAFT ACTIVITY

3.7.1 Assumptions About Aircraft Activity in the Programmatic Document

In the FPEIS, the external risk from aircraft crashes was based on NRC guidelines. These guidelines were used to determine whether the risk of aircraft crashes was acceptably low or whether it should be considered in the design of the disposal plant.

3.7.2 Comparison of Site-Specific and Programmatic Data for Aircraft Activity

Because TEAD-South is located in a relatively remote area, the nearby aircraft activity is correspondingly scant. As stated in the FPEIS, the nearest municipal airport is 22 km (14 miles) away, and high-altitude airways are not considered a hazard for this site. No new information has been developed to contradict these findings.

3.7.3 Significance of Differences in Site-Specific and Programmatic Data for Aircraft Activity

Consideration in the FPEIS risk analysis of air-space restriction for TEAD-South as a mitigation measure indicated that such action would have no significant impact on risk at TEAD for any alternative because of the relatively scant aircraft traffic density over TEAD (see U.S. Department of the Army 1988, Vol. 3, p. J-105). Thus, there are no significant differences between the FPEIS data and the site-specific data.

3.8 LAND USE

3.8.1 Assumptions About Land Use in the Programmatic Document

Impacts to land use near TEAD-South were not discussed in the FPEIS. While selected land-use characteristics were presented in the FPEIS under the discussion of economic resources, only fairly general land-use information was included.

3.8.2 Comparison of Site-Specific and Programmatic Data for Land Use

Supplemental information collected for the TEAD area indicates that there has been relatively little change in the generalized data presented in the FPEIS.

Additional, detailed information about site-specific land use is given in Appendix G.

3.8.3 Significance of Differences in Site-Specific and Programmatic Data for Land Use

No unique land-use resources have been identified for the region around TEAD-South. Land-use impacts were not explicitly included in the selection methodology for the environmentally preferred alternative in the FPEIS (recall that "expected plume area" was used as a surrogate measure). Hence, specific impacts to land use were not a determining factor in the selection of the FPEIS environmentally preferred alternative.

3.9 EMERGENCY RESPONSE

3.9.1 Assumptions About Emergency Response in the Programmatic Document

Emergency response capabilities at each Army installation were incorporated into the FPEIS methodology of selecting the environmentally preferred alternative. However, emergency response was considered only to the extent that implementation of enhanced emergency preparedness was acknowledged to be more feasible around each installation site than along off-site transportation corridors.

The Army is committed to enhanced emergency planning at each of the eight storage installations to reduce the impacts of all releases with potential off-site consequences and to reduce the impacts to local governments in implementing enhanced programs.

3.9.2 The Status of Emergency Response Capabilities since the Preparation of the Programmatic Document

Enhanced emergency management capabilities are necessary at TEAD regardless of the disposal alternative; however, additional measures may be necessary if other stockpiles are relocated to TEAD-South.

The Army has begun this enhancement of capabilities by requesting funds from Congress to implement the Emergency Response Concept Plan (ERCP) (Jacobs Engineering Group, Inc., and Schneider EC Planning and Management Services 1987) at all eight storage sites, including TEAD. The Army is also funding planners to work with local governments to upgrade existing plans. In addition, the Army is committed to provide technical assistance and coordinate local planning efforts. Furthermore, the Army intends to request funds to significantly improve emergency management capabilities through capital improvements in fiscal years 1989 and 1990. Combined, these enhancements are aimed at upgrading the emergency response capabilities commensurate with the ERCP.

The impacts of enhanced emergency planning on local governments include obtaining the expertise to develop a plan and incurring the costs of planning and response capabilities. The emergency planning enhancements

at TEAD will improve organizational and procedural aspects of emergency planning in the area.

Additional information about site-specific emergency response capabilities is included in Appendix C, Sect. C.1.5.

3.10 TECHNOLOGICAL INFORMATION

3.10.1 Assumptions About Technological Information in the Programmatic Document

To define all potential accidents and to describe their consequences, each of the disposal alternatives in the FPEIS required careful examination (i.e., examination of each step involved in the proposed action, as described in the FPEIS, for that alternative). Accident-event initiators that were considered included equipment failures and human error as well as external events (earthquakes, meteorites, tornadoes and high winds, lightning, and air crashes).

The approach to the analysis of accidents in the FPEIS is discussed in Sect. 2.2. Identification of the major sources of risk required that the analysis be performed on an accident-specific basis. Data presented in MITRE (1987) support analyses at that level of detail for approximately 3000 such accidents.

Event initiators for disposal plant accidents were based on the generalized FPEIS designs as well as the proposed operating procedures for disassembling the munitions, incinerating the chemical agents and explosive munition components, and decontaminating the metal munition bodies. The database for determining the probabilities of plant-related accidents, as well as the development of the event trees identifying sequences leading to a chemical agent release, were based primarily on the JACADS design.

The handling and on-site transportation of munitions/agents were also described in detail in the FPEIS. These descriptions were the basis for the analysis of handling and transport accidents. For estimating the probability of on-site transportation accidents, the FPEIS risk analysis assumed a generic transportation distance of 1.6 km (1 mile) for all eight Army installations. For determining the consequences from accidental agent release, the FPEIS assumed a generic minimum distance of 0.5 km (0.3 mile) to the installation boundary from the point of any accidental release.

3.10.2 Comparison of Site-Specific and Programmatic Technological Information

For TEAD-South, the FPEIS design described two separate facilities: a JACADS-type facility with four incinerators, and an adapted CAMDS bulk facility with one liquid incinerator (LIC) in a separate building. The current TEAD disposal plant design combines operations into a single plant [that is, one JACADS-type facility with five incinerators (including two LICs) and the associated pollution-abatement systems]. The current TEAD

design avoids the problems associated with the CAMDS add-ons such as the 100-m (330-ft) outdoor agent pipeline connecting the LIC with the CAMDS agent drain station, water table problems at CAMDS, and the transport of munitions between two high-security areas.

The actual transportation distance from an igloo to the proposed TEAD disposal plant varies from approximately 0.2 km to 2.6 km (0.1 mile to 1.6 miles). Thus, the generic on-site transportation distances incorporated into the FPEIS analysis are appropriate.

At TEAD-South, the nearest installation boundary to the proposed disposal plant location is 3 km (1.9 miles), and the storage area is a minimum of 1.5 km (0.9 mile) from the boundary. The effect of including the actual distances in the estimation of potential fatalities from accidental releases of agent has been previously discussed in Sects. 3.2.2 and 3.2.3.

3.10.3 Significance of Differences in Site-Specific and Programmatic Technological Information

Differences in plant design are due to ongoing efforts by the Army to develop a plant that can be operated safely and efficiently. Such design changes will undergo rigorous safety reviews prior to their approval and adoption into the final design. It should also be noted that all disposal alternatives at TEAD-South (including on-site disposal as well as national and regional disposal) will involve the construction of disposal facilities. Such design changes apply to all disposal alternatives at TEAD and do not provide a basis for distinguishing between alternatives or for selecting the environmentally preferred alternative at TEAD.

The generic distances (i.e., on-site transportation distances and the distance to the installation boundary) used in the FPEIS have been shown to be appropriate for TEAD-South.

3.11 REFERENCES FOR SECTION 3

Jacobs Engineering Group, Inc., and Schneider EC Planning and Management Services 1987. *Emergency Response Concept Plan for the Chemical Stockpile Disposal Program*, for Program Executive Officer–Program Manager for Chemical Officer Demilitarization, Aberdeen Proving Ground, Md.

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4. SUMMARY AND RECOMMENDATIONS

4.1 PHASE I FINDINGS

During the site-specific data collection process, no new or unique resources were identified for the TEAD area in regard to impacts from construction, normal operations, or decommissioning. However, for impacts from accidental releases of chemical agent, several differences in data were identified, primarily as the result of including a larger geographic area in the site-specific data collection process than the area used for the FPEIS.

None of the new data, either individually or collectively, add any information that would have resulted in a change in the programmatic conclusions of the FPEIS. In addition, none of these new data lend credibility to the argument that something of significance was overlooked in the FPEIS. Of all the differences identified in Sect. 3, only the potential for increased population to affect the estimates for potential fatalities can be singled out as a potentially significant difference. All other data differences, as discussed in Sect. 3, have been shown to be inconsequential with respect to selecting the environmentally preferred alternative. A summary of data differences among the new data and the FPEIS data for TEAD follows:

- *Population.* Revised population estimates based on 1986 Bureau of the Census data, coupled with the correction of an FPEIS error in locating the site for the disposal facilities at TEAD, indicate that 23% more people reside in the 100-km zone around TEAD-South than were identified in the FPEIS. Recomputing the fatality estimates with this revised population gives higher fatalities than were considered in the FPEIS; however, such an increase in fatalities would apply to regional and national disposal alternatives, as well as to all alternatives at TEAD, and would not have affected the selection of on-site incineration as the environmentally preferred alternative.

- *Meteorology and Air Quality.* Site-specific data show that the FPEIS assumptions about the conservative-most-likely and worst-case meteorological conditions are indeed reasonable for TEAD-South. No significant data differences have been identified.

- *Social, Economic, and Cultural Resources.* Additional data were collected beyond the 10-km zone used in the FPEIS; however, no unique resources or significant data differences have been identified.

- *Surface Water and Groundwater.* Little change in the FPEIS data was found. No unique resources or significant data differences have been identified.

- *Ecological Resources.* The numbers of protected ecological resources have changed since the publication of the FPEIS; however, no unique resources or significant data differences have been identified.

- *Seismicity.* FPEIS assumptions about foundation conditions and ground motion estimates have been shown to be conservative. Current design criteria for the toxic cubicle are also the same as those presented in the FPEIS. No significant data differences have been identified.

- *Aircraft Activity.* No new information has been developed to contradict the FPEIS data. There is no significant threat from accidents related to aircraft activity in the TEAD-South area.

- *Land Use.* Land use was not discussed in the FPEIS; however, no unique resources have been identified.

- *Emergency Response.* The FPEIS identified emergency response capabilities to be less than adequate at all of the eight storage installations. Activities are currently underway at TEAD to enhance these capabilities. Such an improved emergency response capability in the Tooele area strengthens the commitment by the Army to mitigate the impacts of any accidental release of chemical agent.

4.2 RECOMMENDATIONS

This Phase I Environmental Report has determined that the FPEIS environmentally preferred alternative (on-site incineration) is indeed valid for TEAD. No new or unique site-specific information has been developed that would change or contradict the conclusions of the FPEIS.

Because of the size of the TEAD stockpile, relocation of the TEAD inventory was not considered as a viable alternative in the FPEIS. From the perspective of the affected public near TEAD, it suffices to observe that movement of agents and munitions from other storage installations to TEAD for destruction can only increase risk; that is, the unloading, storage, and transport of additional munitions and the processing of additional inventories at TEAD (as would be required under any FPEIS alternative except the on-site disposal alternative) would obviously subject the surrounding population to an increased potential for being impacted from an accidental release of chemical agent.

The recommendation of this Phase I report is to proceed with the preparation of a site-specific EIS for TEAD. The site-specific EIS for TEAD should concentrate on the implementation of on-site incineration and

should not consider other alternatives for disposing of either the TEAD stockpile or stockpiles from other installations.

Items to be addressed in the site-specific EIS for TEAD include:

- Review the accident analysis database to determine whether any of the plant design changes result in larger downwind plume dispersion distances (accompanied by potential increases in fatalities) than were identified in the FPEIS.

- Include the effects of terrain in describing impacts to geographic areas outside Rush Valley.

- Include daytime population in the estimation of potential fatalities from accidental releases.

- Include sensitive populations (i.e., infants, children, and elders) in the estimation of potential fatalities from accidental releases.

Appendix A

DESCRIPTION OF SITE-SPECIFIC POPULATIONS

A.1 GENERAL POPULATION SURROUNDING TEAD-SOUTH

Table A.1-1 identifies the population distribution by distance intervals and by 22.5° radial sectors for the area within 100 km of Tooele Army Depot (TEAD), the site of the proposed incineration facilities. The population distributions were computed from the 1980 Census of Population, based on enumeration districts (U.S. Department of Commerce 1980, 1983), as updated by 1986 Bureau of the Census estimates for the cities and counties of Utah (see Table A.1-2). These data are essential to the impact analysis for an accidental agent release and for pollutants associated with normal operations. Fewer than 5 people reside within a 5-km radius of the proposed plant location at TEAD-South; approximately 100 people reside inside a 10-km radius. These residential population estimates are the best estimates of the nighttime populations in the area surrounding TEAD-South.

A.2 NEARBY COUNTIES AND COMMUNITIES

The accident analysis presented in the final programmatic environmental impact statement (FPEIS) indicates that in the very unlikely event of an accident, resources as far away as 100 km could be impacted. This area of potential impact includes parts of 12 counties—including Box Elder, Carbon, Duchesne, Jaub, Millard, Morgan, Salt Lake, Summit, Tooele, Utah, and Weber. Summary information for these counties and for the state of Utah are presented in Table A.2-1.

The communities within 50 km of the proposed location include Grantsville, Erda, Tooele, Stockton, Onaqui, St. John, Clover, Ophir, Mercur, Faust, and Vernon. Of these, only Grantsville, Tooele, and Erda are more than 30 km from the proposed plant location on TEAD-South. Table A.2-2 presents summary information for these communities. All of these communities are located in the Tooele and Rush valleys, which are geographically bounded by the Oquirrh and Stansbury mountains on the east and west, respectively; the Wasatch National Forest to the west and south; and the Great Salt Lake to the north.

A.3 SPECIAL POPULATIONS

Table A.3-1 presents concentrations of residential populations by potentially sensitive age groups—including infants to 4 years, children 5 to 14 years, and the elderly 65 or more years of age.

Table A.1-1. Population distribution around the Tooele Army Depot-South proposed plant site, based on updated population statistics[a]

	Incremental population data at specified distances[b]							
Direction	0–1	1–2	2–5	5–10	10–20	20–35	35–50	50–100
N	0	0	1	1	402	10,550	431	1,103
NNE	0	0	1	1	0	6,162	16,117	227,163
NE	0	0	0	3	49	652	94,624	529,798
ENE	0	0	0	3	3	252	28,715	31,275
E	0	0	0	8	60	675	9,192	155,090
ESE	0	0	0	5	53	316	184	43,799
SE	0	0	0	2	31	104	180	7,848
SSE	0	0	0	2	13	34	696	1,806
S	0	0	0	2	7	22	18	1,946
SSW	0	0	0	2	7	211	0	73
SW	0	0	0	2	4	6	3	0
WSW	0	0	0	2	1	902	357	493
W	0	0	0	2	1	0	0	0
WNW	0	0	0	57	251	0	1	1
NW	0	0	0	5	85	0	104	539
NNW	0	0	0	2	0	3,024	2,115	718
Total	0	0	2	99	967	22,910	152,737	1,001,652

[a]Distances given in kilometers.

[b]The values in this table differ from those published in the FPEIS for the following reasons: (1) The location used for the release is more precise than the one used in the FPEIS; the new location is at 40.3° north latitude and 112.35° west longitude. (2) The population used is the 1986 population as estimated by the Bureau of the Census for cities and counties in Utah and as provided by the Data Resources Section of the Utah Office of Planning and Budget (the FPEIS used 1980 population counts). (3) The method used to calculate population and population density used additional information about population distribution to exclude population from some areas and restrict population to others. The population of Utah was estimated to be 14% higher in 1986 than in 1980.

Table A.1-2. Updated population data for selected areas near Tooele Army Depot–South

Location	1980 population	1985 population
Tooele County	26,200	28,100
Grantsville	4,419	5,130
Ophir	40	50
Rush Valley	356	400
Stockton	437	410
Tooele (city of)	14,335	15,760
Vernon	181	200

Table A.2-1. Summary characteristics of potentially affected counties

	Population[a]		Household[b]		1986 Employment percentages[c]		
County	1980	1985 (est.)	Number	Median income	Agriculture	Manufacturing	Government
Box Elder	33,500	37,300	10,300	17,428	11.6	49.2	12.1
Carbon	22,400	23,000	7,200	20,149	16.7	3.0	23.9
Davis	146,540	180,100	47,200	20,862	27.8	8.8	30.1
Duchesne	12,700	14,300	4,400	17,345	18.5	3.8	28.1
Juab	5,550	5,800	1,800	15,095	15.2	12.2	25.9
Millard	9,050	13,600	4,200	13,004	35.2	4.5	13.6
Morgan	4,950	5,500	1,300	20,882	41.0	14.0	17.6
Salt Lake	625,000	698,000	227,400	18,418	0.2	13.8	16.6
Summit	10,400	12,200	4,100	19,577	7.5	2.6	13.6
Tooele	26,200	28,100	8,800	19,682	7.5	8.6	56.4
Utah	220,000	253,000	65,400	16,197	20.7	12.0	14.6
Wasatch	8,650	9,450	2,900	15,519	43.1	1.8	20.3
Weber	145,000	157,000	52,500	17,287	13.3	14.2	23.8
Total	1,114,750	1,666,000	390,000	17,549			
State of Utah	1,474,000		505,000	17,671	10.6	13.0	19.9

[a]Utah Office of Planning and Budget Data Resources Section 1987. "Utah Population Projections," in *Utah Data Guide* Vol. 6, No. 2, Salt Lake City.

[b]U.S. Bureau of the Census 1988. *County and City Data Book, 1988*, Files on Diskette, Washington, D.C.

[c]Calculated from Utah Department of Employment Security 1987. *Utah Annual Report 1986; Volume III*, Labor Market Information, Salt Lake City.

Table A.2-2. Summary characteristics for communities in the Tooele Valley and Rush Valley area of Tooele County

	Population					
	1970	1980	1986	Dwelling units[a]	Mean household income	Employment growth rate[b]
Grantsville	2,931	4,419	5,130	1,460	27,494	8.45
Erda						
Tooele	12,539	14,335	15,760	5,045	28,141	16.79
Stockton	469	437	410	149	28,924	35.50
Onaqui						
Rush Valley	541	356	400	132	27,295	NA
Ophir	76	42	50	23	29,213	121.27
Mercur						
Faust						
Vernon	NA	181	200	59	26,361	38.85

Sources: Master Plan Report, Tooele Army Depot, December 1986; *Installation Environmental Assessment*, June 1982; Utah Office of Planning and Budget, Data Resources Section 1987. "Utah 1986 City Population and 1985 per capita income estimates," in *Utah Data Guide*, Vol. 6, No. 4, Salt Lake City; "Wasatch Front Regional Council Surveillance of Land Use," in *Draft Socioeconomic and Land Use Background Document*, in support of the Cryofracture Chemical Demilitarization Project, Preliminary Draft Environmental Impact Statement (rev. 0), 1985.

[a]Number of residences within each community, including single-family houses, apartments, mobile homes, and dormitories, based on building permits.

[b]1987 estimated average employment growth rates for the next 15 years for municipalities in Tooele County, as developed by the Utah Department of Employment Security and cited in the *Draft Socioeconomic and Land Use Background Document*, in support of the Cryofracture Chemical Demilitarization Project, Preliminary Draft Environmental Impact Statement (rev. 0).

Table A.3-1. Sensitive population, by age distribution, around Tooele Army Depot–South

	Sensitive population (%) by age groups				
County	< 5 years	5–14 years	> 65 years	Total	Remaining population (%)
Box Elder	13.9	20.9	9.1	43.9	56.1
Carbon	12.0	18.4	9.9	40.3	59.7
Davis	13.9	21.8	4.8	40.5	59.5
Duchesne[a]	0.1	0.2	0.1	0.4	99.6
Juab[a]	0.1	0.2	0.1	0.6	99.5
Millard[a]	0.1	0.2	0.1	0.5	99.5
Morgan[a]	0.1	0.2	0.1	0.4	99.6
Salt Lake	12.1	17.9	7.7	37.7	62.3
Summit[a]	0.1	0.2	0.1	0.4	99.6
Tooele	12.5	22.0	6.6	41.1	58.9
Utah	12.6	19.5	6.6	38.7	61.3
Wasatch[a]	0.1	0.2	0.1	0.4	99.6
Weber	10.9	17.4	9.6	37.9	62.1

[a]Percentages based on 1980 Census Data, population data for 1984.

Data from: Utah University, Graduate School of Business, Bureau of Economic and Business Research January 1983. *1983 Utah Statistical Abstract*, Salt Lake City.

Sources: U.S. Bureau of the Census 1988. *County and City Data Book, 1988*, Files on Diskette, Washington, D.C.

A detailed listing of the place-of-work population for the area surrounding TEAD-South has been requested and should be available in September 1988. This information will be included in the NEPA analysis of PHASE II (i.e., in the preparation of an environmental impact statement for TEAD-South). By augmenting the residential populations with the place-of-work populations, a conservative estimate of the maximum population impact (fatalities) can be obtained.

A.4 ON-SITE POPULATION

The distribution of people during the day, evening, and nighttime hours within the TEAD-South boundaries is presented in Figure A.4-1. These data show that the largest concentrations of people on site are located in the Administration Area, approximately 4 km east of the proposed plant location; in the CAMDS area, which is approximately 2.5 km south-south-west of the proposed plant location; and in the Chemical Agent Storage Area, which is adjacent to the proposed plant location. Additional people are located in Area 2 and in the Laundry Area, approximately 4 km southeast and 3 km east of the proposed plant location respectively.

A.5 TRANSIENT POPULATIONS

As part of Tooele Army Depot's mission to support the soldier in the field, occasional military exercises are conducted near the TEAD-South area. The Rush and Skull valleys are used as assembly and maneuver areas during these exercises. Although no munitions or chemical weapons are involved in such exercises, the exercises cause a temporary population increase in the area surrounding TEAD-South. One such exercise, FIREX 88, resulted in a transient increase in the nearby population to more than half of the 1985 Tooele County population. Temporary increases in local population associated with the training and support missions of Tooele Army Depot are considered a significant part of the existing environment.

Within a 100-km radius of the proposed facilities at TEAD-South are several land areas that have periodic visitors. These include nationally operated forests, wilderness areas, monuments, recreation areas, and refuges, as well as state-operated parks, recreation areas, wildlife management areas, waterfowl management areas, and ski areas. Until 1987, the U.S. Forest Service maintained detailed records of visitor activities within the areas under its control (U.S. Forest Service 1987); the National Park Service also maintains records of use of its facilities (U.S. National Park Service 1988). Forest visitors swim, camp, hunt (large and small game and also waterfowl), picnic, and ski, so users are likely to visit a forested area at any given time of the year. Table A.5-1 was compiled by examination of Bureau of Land Management maps, wilderness area maps, and U.S. Geological Survey maps, in addition to state-produced maps of prominent recreational areas. The table identifies visited areas, their approximate distances and directions from the proposed facilities at TEAD-South and, if available, the numbers of visitor days for 1986.

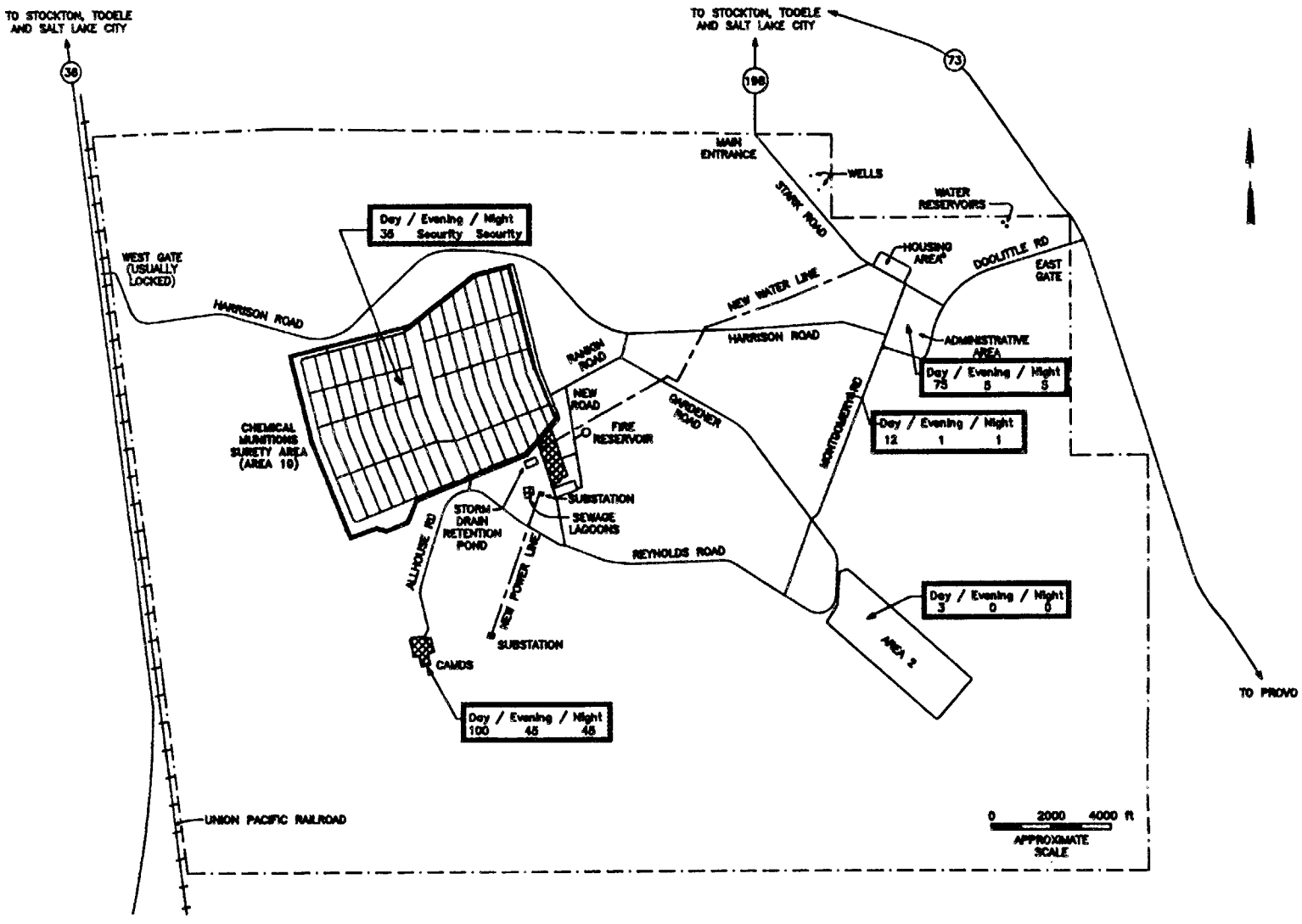

Fig. A.4-1. On-post population at Tooele Army Depot-South by time of day. Note: Base housing is expected to be vacated by the time disposal operations begin.

Table A.5-1. Visitation statistics for public areas within 100 km of Tooele Army Depot–South

Area	Location: County	Location: Area[a]	Distance to site	1986 visitor days (1000s)[b]
		National forests		
Fishlake	Juab	21,389 A	85 km S	1300.4[c]
	Millard	306,324 A	85 km S	
Manti-LeSal	Sanpete	366,014 A	95 km SE	722.8[c]
	Utah	91,292 A	80 km SE	
Uinta	Juab	97,018 A	25 km S	3055.0[c]
	Sanpete	91,292 A	55 km SE	
	Wasatch	303,869 A	75 km E	
Wasatch	Davis	37,082 A	65 km NE	5512.6[c]
	Juab	35 A	40 km S	
	Morgan	11,757 A	80 km NE	
	Salt Lake	95,248 A	55 km NE	
	Tooele	150,183 A	15 km NW	
		National wilderness areas (WA) and wilderness study areas (WSA)		
Deseret WA (in Wasatch NF)	Tooele	25,500 A	20 km WNW	NA
Cedar Mountain WSA (in Wasatch NF)	Tooele	50,500 A	50 km WNW	NA
North Stansbury WSA (in Wasatch NF)	Tooele	10,480 A	40 km NW	NA
Mount Olympus WA (in Wasatch NF)	Salt Lake	16,450 A	60 km NE	7.6
Twin Peaks WA (in Wasatch NF)	Salt Lake	13,100 A	55 km NE	11.8
Lone Peak WA	Utah	30,088 A	50 km ENE	53.2
(in Uinta NF)		(21,166 A)	55 km ENE	
(in Wasatch NF)		(8,922 A)	65 km ENE	
Mount Timpanogos WA (in Uinta NF)	Utah	10,750 A	60 km E	47.8
Mount Nebo WA (in Uinta NF)	Juab	28,200 A	65 km SE	34.5
Rockwell WSA	Juab	9,150 A	60 km S	NA

Table A.5-1. (continued)

Area	Location: County	Location: Area[a]	Distance to site	1986 visitor days (1000s)[b]
National monuments (NM), recreation areas (NRA), and wildlife refuges (NWR)				
Timpanogos Cave NM	Utah	250 A	60 km E	137.3
Little Sahara NRA	Juab	60,000 A	70 km S	NA
Fish Springs NWR	Juab		90 km WSW	NA
Military installations				
Camp Williams State Military Reservation	Salt Lake/ Utah		25 km ENE	NA
Dugway Proving Grounds	Tooele		30 km WSW	NA
Hill Air Force Base Range	Box Elder/Tooele		90 km NNW	NA
Wendover Air Force Base Range	Tooele		70 km WNW	NA
Deseret Test Center	Tooele		85 km W	NA
Tooele Army Depot-North	Tooele		20 km N	~ .004
State parks (SP) and recreation areas (SRA)				
Great Salt Lake SP (Antelope Island)	Davis		80 km N	NA
Great Salt Lake SP (South Shore)	Salt Lake		50 km NNE	NA
Camp Floyd/Stagecoach Inn SP	Utah		25 km E	NA
Utah Lake SP	Utah		55 km E	NA
Wasatch Mtn. SP	Wasatch		85 km ENE	NA
Deer Creek Lake SP	Wasatch		75 km ENE	NA
Rockport Lake SP	Summit		95 km ENE	NA
East Canyon SRA	Morgan		95 km NE	NA
State waterfowl and wildlife management areas				
Ogden Bay	Weber		95 km N	NA
Timpie Springs	Tooele		55 km NNW	NA
Howard Slough	Davis		90 km N	NA
Farmington Bay	Salt Lake		80 km NNE	NA
Big Hollow	Sanpete		~100 km SE	NA
Loafer Mountain	Utah		70 km SE	NA

Table A.5-1. (continued)

Area	Location		Distance to site	1986 visitor days (1000s)[b]
	County	Area[a]		
		Ski areas		
Alta	Salt Lake (Wasatch National Forest)		70 km ENE	215.6
Brighton	Salt Lake (Wasatch National Forest)		75 km ENE	109.8
Deer Valley	Summit		80 km ENE	NA
Park City Ski Area	Summit		80 km ENE	NA
Park West Ski Resort	Summit		80 km ENE	NA
Parley's Summit	Summit		80 km ENE	NA
Snowbird	Salt Lake		70 km ENE	206.8
Sundance	Utah (Uintah National Forest)		70 km ENE	NA
Solitude	Salt Lake (Wasatch National Forest)		75 km ENE	101.0

NA = not available.

[a]To convert acres to hectares, multiply acres by 2.471.

[b]Visitor days are defined by the National park Service and the USDA Forest Service as one visitor within the area for 12 h, or 12 visitors for 1 h each, or any combination amounting to 12 h.

[c]Visitor days data listed are for entire forest, which exists in the counties listed and possibly in other counties as well.

A.6 INDIAN ENTITIES

The Skull Valley Band of the Goshute Indians occupies the Skull Valley Indian Reservation, which is located approximately 35 km west-northwest of TEAD-South. The Stansbury Mountains lie between TEAD-South and the reservation; the mountains would act as a barrier to atmospheric dispersion of chemical agent in that direction.

REFERENCES FOR APPENDIX A

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APPENDIX B

DESCRIPTION OF SITE-SPECIFIC METEOROLOGY AND AIR QUALITY

The climate in the TEAD-South area can be characterized as continental and heavily influenced by the surrounding mountains. Temperatures vary considerably between daytime and nighttime hours and among seasons. On calm, clear nights, colder air drains from the surrounding slopes into Rush Valley, where TEAD-South is located. From November through March, minimum temperatures can drop below -17° C (0° F), and temperatures below -23° C (-10° F) are possible from December through February. Temperatures usually moderate appreciably during the daytime. Maximum temperatures are frequently above 32° C (90° F) during July and August, but temperatures greater than 37° C (100° F) are extremely rare.

The area is noted for plentiful sunshine, low relative humidity, and light precipitation. This climate is caused by the great distance of TEAD-South from major sources of moisture (the Pacific Ocean and Gulf of Mexico) and the influence of the mountains between the moisture sources and TEAD-South that condense much of the moisture out of the air into precipitation when the air is lifted over the mountains. Normal annual precipitation at TEAD-South is only about 28 cm (11 in.) and is distributed fairly evenly throughout the year. Almost all of the winter precipitation is in the form of snow, and spring and fall snowstorms are also common. Annual snowfall at TEAD-South averages about 100 cm (40 in.). The probability of a tornado's striking TEAD-South is very remote (Thom 1963).

The prevailing winds are from the southeast in the TEAD-South area, with large frequencies also from the adjoining south-southeast and east- southeast directions. A secondary peak occurs from the north-northwest direction. These directions are aligned with the orientation of the mountain ranges on either side of TEAD-South; the mountains channel the flow along the axis of Rush Valley. The average wind speed is about 3.6 m/s (8.0 mph) near the surface. The wind rose in Fig. B.1-1 depicts the annual joint frequency distribution of wind speed and wind direction at TEAD-South. In this graph, winds blowing from each direction are plotted as individual bars that extend from the center of the circular diagram. Wind speeds are denoted by bar widths; the frequency of wind speed within each wind direction is depicted according to the length of the bar. Note that the points on the wind rose represent the directions from which the winds come. (Emissions from the facility will travel downwind in the opposite direction.) The frequency is given as the percentage of the total number of measurements.

The general air quality of the TEAD-South area is characterized by comparing the ambient air with the National Ambient Air Quality Standards (NAAQS) [Pub. L. 95-95 (1977)] and the corresponding Utah standards, which are identical to the NAAQS. For each criteria pollutant (particulate

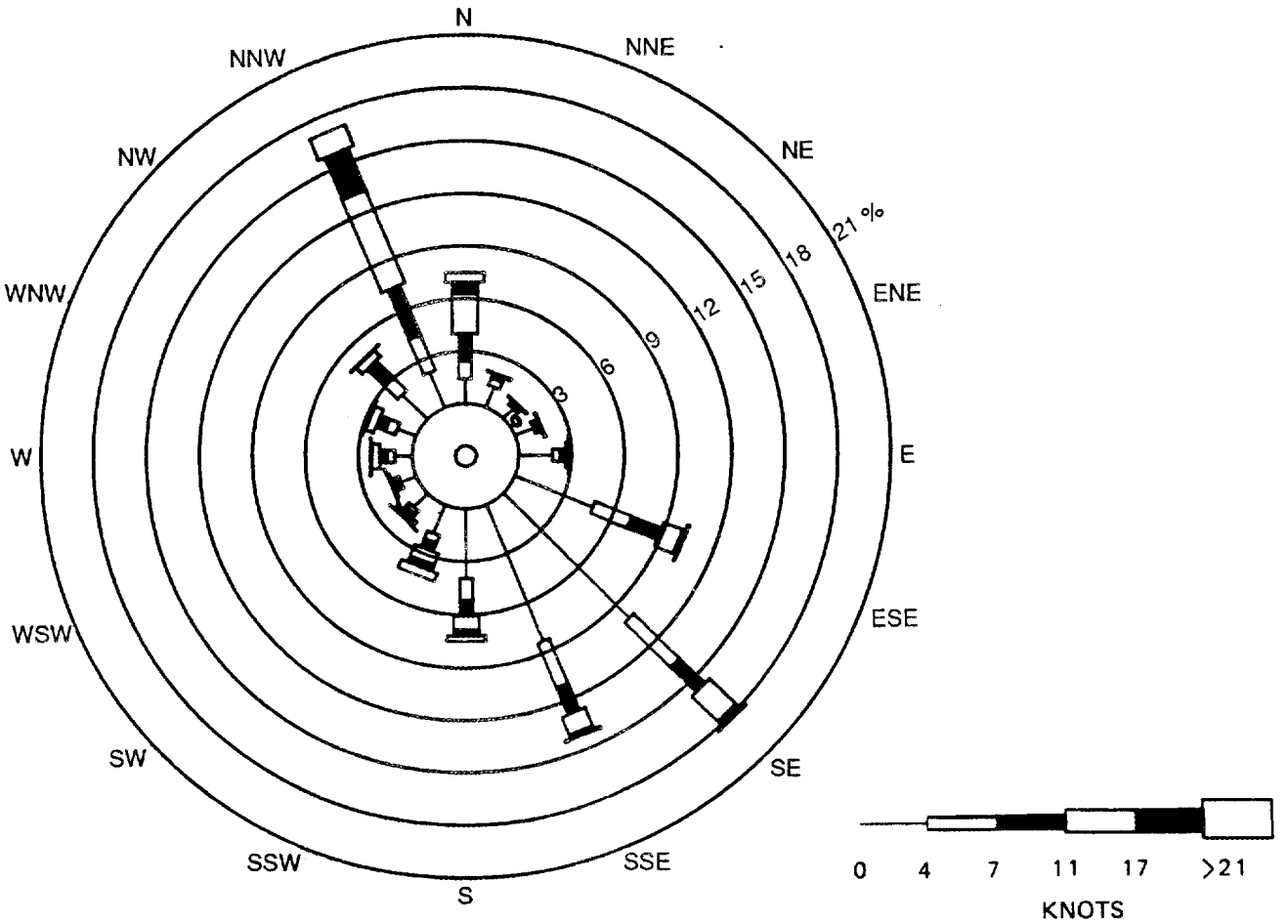

Fig. B.1-1. Average annual wind rose, Tooele Army Depot–South, Utah, November 1, 1986, through October 31, 1987.

matter, SO_2, NO_x, CO, ozone, and lead), an area is designated as an attainment area if ambient concentrations do not exceed the NAAQS. All locations where CSDP facilities may be constructed at TEAD-South are designated as attainment areas for all criteria pollutants (L. R. Menlove, Utah Bureau of Air Quality, personal communication to Robert L. Miller, Oak Ridge National Laboratory, Oak Ridge, Tenn., Apr. 21, 1988). Although an area that includes the extreme northeast corner of TEAD-South is designated as a non-attainment area for SO_2, TEAD-South is more than 40 km (25 miles) from the nearest major SO_2 sources, which are located to the north along the Great Salt Lake shore. In addition, no violations of SO_2 standards have occurred at any monitoring stations in Utah during the most recent two years of data (1985 and 1986). Monitoring of SO_2, NO_x, ozone, and particulate matter at four TEAD-South stations has confirmed that the ambient air quality is within NAAQS standards. Table B.1-1 summarizes the annual arithmetic mean concentration for the four criteria pollutants. Note that measurements of particulate matter were collected only for 1978.

Table B.1-1. Tooele Army Depot–South monitoring results annual mean (ppm)

Year	Ozone (O_3)	Sulfur dioxide (SO_2)	Nitrogen dioxide (NO_2)
1975	0.0330	NA	NA
1976	0.0283	NA	NA
1978[a]	0.0242	0.005	0.0009
1979	0.0380	0.005[b]	0.0009[b]
1980	0.0384	0.005	0.0009
1982	0.0271	0.005	0.0009
1983	0.0363[b]	0.005	0.0009
1984	NA	0.005	0.0009
1985	NA	0.005[b]	0.0008[b]

[a]The geometric mean of particulate matter concentrations for 1978 is 22.9 $\mu g/m^3$.

[b]Fewer than twelve months of data.

REFERENCE FOR APPENDIX B

Thom, H. C. S. 1963. "Tornado Probabilities," *Monthly Weather Review* **91** (10–12) 730–736.

APPENDIX C

DESCRIPTION OF SITE-SPECIFIC SOCIAL, ECONOMIC, AND CULTURAL RESOURCES

C.1 PUBLIC SERVICES/INFRASTRUCTURE

C.1.1 Police Departments

The Tooele County sheriff's department has 27 members and 15 patrol cars (D. K. Proctor, Tooele County Sheriff's Department, personal communication to S. Olive, Oak Ridge National Laboratory, Oak Ridge, Tenn., Sept. 14, 1987). The 1984 sheriff's department budget was $638,149 (Tooele County 1986). The Sheriff is on duty 5 d/week from 9:00 a.m. to 5:00 p.m. Jailers and dispatchers are on duty 24 h/d, 7 d/week.

The police department in the city of Tooele has 17 members. (P. Mortina, Tooele Police Department, personal communication to S. Olive, Oak Ridge National Laboratory, Oak Ridge, Tenn., Oct. 1, 1987). The 1986 budget for the city police department was $808,399 (City of Tooele Corporation 1985).

The city of Grantsville has four full-time members, four reserves, and four cars in its police department. In 1986, it budgeted $197,900 for the police department (City of Grantsville 1986).

C.1.2 Fire Departments

The city of Tooele has 50 members and 7 pieces of equipment in its fire department. In 1986, the department was budgeted $109,399 (City of Tooele Corporation 1985).

Fire protection in Tooele County is provided by 6 volunteer units; about 50 members belong to the Tooele County volunteer fire department. Equipment includes one truck, four pumpers, and two brush- and grass-fire trucks. The sheriff of Tooele County directs the fire department. Tooele County appropriated $134,557 for fire protection in 1984 (Utah Foundation 1984).

Grantsville has 36 volunteer members in its fire department. Equipment includes two pumper trucks, one tanker, and one brush-fire truck.

C.1.3 Schools

There are no known schools within 10 km of TEAD-South (U.S. Department of the Army 1988). However, a complete listing of schools in Tooele County is given in Table C.1-1.

Table C.1-1. Schools in Tooele County

City	Elementary			Middle and Jr/Sr high		
	Number	Students	Staff	Number	Students	Staff
Vernon	1	34	2	*d*	*d*	*d*
Tooele[a,b]	5	2652	114	42	2117	100
Grantsville	1	639	26	*d*	872	43
Ibapah	1	17	1	1	*d*	*d*
Dugway	1	253	12	1	190	13
Wendover[b]	*c*	*c*	*c*		245	16

[a]Special school in Tooele for disabled children, servicing approximately 28 students.
[b]Includes Stansbury Park Elementary.
[c]Attend elementary school in Nevada.
[d]No schools of this type in this area.
Source: Louise LaFever, Pupil Account Specialist, Tooele County School District, Tooele County, Utah, personal communication to G. O. Rogers, Oak Ridge National Laboratory, Oak Ridge, Tenn., Sept. 1, 1988.

C.1.4 Hospitals

Sixteen hospitals lie within 100 km of the proposed incinerator location at TEAD-South (see Table C.1-2). Seven of these hospitals are in Salt Lake City. These seven hospitals account for more than 62% of the hospital beds within the 100-km zone around the TEAD-South area (American Hospital Association 1986).

C.1.5 Emergency Preparedness

In 1984, Tooele County budgeted $1200 for the county's civil defense office (City of Tooele Corporation 1985). The Sheriff's office is the designated Emergency Operations Center (EOC) for the area; the alternate EOC is in the basement of the civil defense office.

In 1985, Tooele County updated its Disaster Response Plan. This plan outlines duties and responsibilities for county officials for a wide range of possible disasters. In addition, the cities of Tooele and Grantsville have developed their own plans, which are coordinated with the county plan (R. Finely, Utah Division of Comprehensive Emergency Management, Salt Lake City, and R. Castagno, Grantsville City Councilman, Grantsville, Utah, personal communication to G. Thomas, Oak Ridge National Laboratory, Oak Ridge, Tenn., Feb. 14, 1985, and Mar. 1, 1985, respectively).

Tooele County currently has limited disaster experience. Local emergency management officials responded to a major dynamite explosion that occurred 32 km (20 miles) south of the City of Tooele and to a series of floods and mudslides that occurred in the spring of 1983 and 1984. At the time of these events, there were no plans to facilitate or guide emergency response. Tooele County does have an occasional disaster exercise with the Tooele Army Depot; the most recent exercise took place in the fall of 1984. County activities centered around communication and coordination duties. The Army directs each such exercise as well as the main aspects of emergency response.

C.1.6 Transportation

In 1984, $886,972 was appropriated for roads in Tooele County (Utah Foundation 1984). In 1984, Tooele County had a total of 1016 traffic accidents. The city of Tooele had 446 of these accidents. About 70 accidents occurred in Grantsville, and Wendover had 17 accidents. Table C.1-3 lists the capacity and volume-to-capacity ratio of key highways in the TEAD area.

The maximum commuting distance for TEAD workers is 145 km (90 miles). About 62% of those commuting to TEAD live in Tooele County; about 26% reside in Salt Lake City; about 7% live in Utah County; 1% commute from Davis County; and the remainder commute from Cache, Box Elder, Wasatch, and Rich counties.

Table C.1-2. Hospitals in Tooele County

Name	Location	County	Number of beds	Average occupancy	Distance (in km)/ direction
American Fork	American Fork	Utah	72	63.9	48 ENE[a]
Brigham City Community	Brigham City	Box Elder	50	38	135 NNE[b]
Delta Community Medical Center	Delta	Millard	20	40.7	105 SSW[c]
Fillmore Community Medical Center	Fillmore	Millard	20	61.9	150 S[d]
Cottonwood Hospital Medical Center	Murray	Salt Lake	243	54.7	58 NE[e]
Central Valley Medical Center	Nephi	Jaub	31	19.4	80 SSE[f]
McKay-Dee Hospital Center	Ogden	Weber	380	62.1	108 NNE
St. Benedict's Hospital	Ogden	Weber	170	58.2	108 NNE
Mountain View Hospital	Payson	Utah	118	58.4	60 ESE[g]
Castleview Hospital	Price	Carbon	88	66.2	150 ESE
Utah State Hospital[h]	Provo	Utah	318	93.1	60 E[i]
Utah Valley Regional Medical Center	Provo	Utah	336	69.3	60 E
Duchesne County Hospital	Roosevelt	Duchesne	32	NA[j]	200 E
Holy Cross Hospital	Salt Lake City	Salt Lake	293	66.9	65 NNE
Latter Day Saints Hospital	Salt Lake City	Salt Lake	468	69.7	65 NNE
Primary Children's Medical Center	Salt Lake City	Salt Lake	173	83.2	65 NNE
Shriners' Hospital for Crippled Children	Salt Lake City	Salt Lake	45	53.3	65 NNE
St. Mark's Hospital	Salt Lake City	Salt Lake	306	63.7	65 NNE
Univ. of Utah Health Sciences	Salt Lake City	Salt Lake	370	71.1	65 NNE
Veterans Administration Medical Center	Salt Lake City	Salt Lake	392	66.7	65 NNE
Alta View Hospital	Sandy	Salt Lake	50	64	50 NE
Tooele Valley Hospital	Tooele	Tooele	33	33.3	27 N[k]
Bear River Valley Hospital	Tremonton	Box Elder	20	30	160 N
Pioneer Valley Hospital	West Valley City	Salt Lake	139	46.8	65 NNE

[a]East-northeast.
[b]North-northeast.
[c]South-southwest.
[d]South.
[e]Northeast.
[f]South-southeast.
[g]East-southeast.
[h]State psychiatric hospital
[i]East.
[j]Not available.
[k]North.

Table C.1-3. Capacity and volume-to-capacity ratios for major highways in the Tooele area

Location	Capacity (vehicles/h)	Volume-to-capacity ratio
Interstate 80		
Wendover to Timpie interchange	3200[a]	0.07[a]
Timpie interchange to Tooele interchange	3200[a]	0.10[a]
Tooele interchange to SR-201	3200[a]	0.23[a]
State Route 36		
Tooele/Juab County line to Tooele		
In Tooele city	1229[b]	0.24[b]
Tooele to SR-138	1078[a]	0.99[a]
SR-138 to I-80	1843[b]	0.31[b]
	1900[b]	0.58[b]
State Route 138		
I-80 to Grantsville		
In Grantsville city	1748[b]	0.03[b]
Grantsville to SR-36	1380[a]	0.12[a]
	1748[b]	0.15[b]
State Route 112		
SR-138 to Tooele		
In Tooele city	1429[b]	0.14[b]
	1150[a]	0.28[a]
State Route 73		
Tooele/Utah County line to SR-36		
	1179[b]	0.05[b]
State Route 199		
SR-36 to Dugway		
	211[b]	0.40[b]

[a]Directional (i.e., either eastbound/westbound or northbound/southbound).
[b]Total for both directions.

C.1.7 Waste Management

The city of Tooele has one sewer treatment plant, located in the northeast section of the city. The capacity is 7570 m^3/d (2,000,000 gal/d); the existing daily treatment is approximately 3785 m^3/d (1,000,000 gal/d).

C.1.8 Water Supplies

Four major springs are used as water sources in Tooele Valley. These include Mills Pond, Dunnes Pond, Fishing Creek, and Sixmile Creek.

The water supply for the city of Tooele consists of two canyons and six subsurface wells. Water storage consists of four storage tanks, which have a combined capacity of 26,500 m^3 (7,000,000 gal). The average water requirement for a dwelling unit within Tooele is 1850 m^3 (1.5 acre-ft) annually. Outside the incorporated areas of the valley, the water requirement per dwelling unit is 2715 m^3 (2.2 acre-ft) annually.

C.1.9 Utilities

Mountain Fuel Supply is the area's vendor of natural gas. The Tooele County system is supplied with natural gas, with a heating value ranging from 32.4 to 35.4 MJ/m^3 (870 to 950 BTU/ft^3). Mountain Fuel Supply has a total capacity for the Tooele County system of 15,910 m^3/s [2022 million cubic feet per hour (MCFH)], with a current peak firm demand of 4080 m^3/s (519 MCFH) and a current interruptible demand of 8090 m^3/s (1028 MCFH). No expansion of the Tooele County facilities is currently planned. About 58%, or 9300 m^3/s (1182 MCFH), of the maximum capacity for the Tooele County system is allocated for industrial use.

C.2 ECONOMIC RESOURCES

The economic region that is likely to be influenced by the proposed action may be described in terms of similar economic activity by the Tooele Army Depot. Nearly all the employees at TEAD reside in the Wasatch Front counties—including Tooele, Salt Lake, Utah, Weber, and Davis counties. Table C.2-1 summarizes TEAD employment in these counties. Nearly 90% of the people employed at TEAD reside in either Tooele or Salt Lake counties, and more than 97% reside in the three-county area of Tooele, Salt Lake, and Utah counties.

C.2.1 Employment

Most workers in the predominantly rural Tooele County are employed by the federal government, in the mineral industries, or are self-employed in agriculture. Other non-agricultural occupations of Tooele County residents include mining, construction, manufacturing, transportation, communications, public utilities,

Table C.2-1. Summary of Tooele Army Depot employment impact on Wasatch Front counties and the state of Utah

County	Percent of TEAD employees residing within county 1987[a]	County's total employment 1987[a]	Percent of county's overall non-agricultural employment 1983	1984	1985
Tooele	64.9	9,993	42.6	39.7	39.0
Salt Lake	24.2	333,049	NA[c]	NA	NA
Utah	8.3	74,478	NA	NA	NA
Weber	2.6	60,310	NA	NA	NA
Davis	(*b*)	52,187	NA	NA	NA
Total of all Wasatch Front counties	99.7	530,017	1.0	0.9	0.9
Total for state of Utah	100.0	640,308	0.7	0.6	0.6

[a]Utah Labor Market, May 1988, Utah Department of Employment Statistics in June 1988.
[b]Davis County data included under Weber County.
[c]NA means not applicable because TEAD is located entirely in Tooele County.
Source: Fjeldsted, B., and Crispen, J. August 1986. *Tooele Army Depot: Impact on the State of Utah,* Univ. of Utah, Bureau of Economic and Business Research.

retail/trade, finance, insurance, and real estate. Table C.2-2 summarizes the non-agricultural employment by industrial sector for 1986.

Non-agricultural sectors of the local economy, particularly in trade and manufacturing, are characterized by concentrations of skilled craft, office, and clerical workers. Retail trades encompass a total of 109 establishments, with 14 food stores, 32 eating/drinking establishments, and 16 other retail stores. Industries other than mining, construction, and manufacturing gained steadily from 1980 to 1986 (Tooele County Industrial Development Corporation 1987).

Employment in the mining industry has declined more than 18% since 1980; employment in construction and manufacturing also have declined. Although agricultural employment was approximately 12% in 1986, overall non-agricultural employment decreased 4.7% from 1983 to 1984 and 3.2% from 1984 to 1985 (U.S. Department of the Interior 1988). Construction, mining, and government provide temporary employment, which constitutes a major influence on the local labor market. In the northern part of the county, near Grantsville, cattle production and other agricultural jobs provide self-employment for many and second-job opportunities for others.

In 1985 and 1986 Tooele County experienced net emigration. Both the mineral industry located near the Great Salt Lake and the potash industry in western Tooele County experienced cutbacks associated with the flooding of the lake in 1983 and 1984. Meanwhile, employment in the federal military installations has fluctuated in recent years because of changes in national-defense budgeting priorities.

C.2.2 Housing

Residential construction in Tooele County has been declining in recent years, with a drop of 5.1% (Utah Construction Report 1986 as cited in U.S. Army Corps of Engineers 1986). About two thirds of the nearly 9000 housing units in Tooele county are owner occupied. According to the Wasatch Front Council of Governments (as cited in U.S. Army Corps of Engineers 1986), the vacancy rates in Tooele County are estimated at 1.4% for the owner-occupied units and 2.9% for rental units (U.S. Army Corps of Engineers 1986). In the City of Tooele, the vacancy rates are lower (0.55%) for owner-occupied units and higher (3.87%) for rented units (Tooele City Community Development and Furthering Fair Housing, Tooele City Planning Department 1985, as cited in U.S. Army Corps of Engineers 1986).

These vacancy rates are considered low in comparison to U.S. Department of Housing and Urban Development recommendations. A 1% to 5% vacancy rate for owner-occupied units and 4% to 6% vacancy rate for rented units is believed to maintain a suitable choice for homeowners and renters respectively.

Many military and civilian employees at TEAD commute approximately 60 km (35 miles) from Salt Lake City, where housing is more plentiful. Mobile-home communities also have provided housing for the temporary employees in Tooele County. For example, construction workers brought in to raise roads

Table C.2-2. Nonagricultural employment, by industry sector and major work site district, for Tooele County, 1985[a] and 1986[b]

Work site districts	Total		Mining		Construction		Manufacturing		Transportation, communication, public utilities		Trade		Finance, insurance, real estate		Service		Government	
	1985	1986	1985	1986	1985	1986	1985	1986	1985	1986	1985	1986	1985	1986	1985	1986	1985	1986
Tooele county	10,468	10,424	322	258	323	265	1,173	977	219	168	1,203	1,232	157	166	849	1,011	6,222	6,347
Tooele	6,914	7,082	79	203	113	103	99	114	167	126	779	787	123	132	435	567	5,119	5,050
Grantsville	563	577	(c)	(c)	113	67	(c)	194	(c)	(c)	144	153	(c)	(c)	16	16	55	123
Wendover	263	273	(c)	(c)	(c)	(c)	(c)	(c)	(c)	12	89	86	(c)	(c)	25	30	63	67
Remainder of Tooele County	2,728	2,492	243	55	97	95	1,074	669	52	30	191	206	34	34	363	387	985	1,107

[a]Utah Department of Employment Security, Labor Market Information Services, Preliminary Data, August 1986.
[b]Utah Department of Employment Security, Labor Market Information Services, August 1987.
[c]Included in totals, but not shown to avoid disclosure of individual firms (data are not disclosed if fewer than three individual firms exist in the industry).

and railways above the flooding level of Great Salt Lake were housed in trailer parks near Grantsville. Non-residential and new apartment construction is expected to decline because of tax reform and the fact that too much multifamily housing was constructed recently in the Wasatch Front area (Wasatch Front Council of Governments, as cited in U.S. Army Corps of Engineers 1986).

C.3 ARCHAEOLOGICAL/HISTORICAL RESOURCES

The histories of Tooele and Rush valleys are similar; both have supported four separate native American cultures: the Early Desert Archaics, the Late Desert Archaics, The Freemonts, and the Numic-Speaking culture. Some 11,000 years ago, the Early Desert Archaic culture inhabited the area. This culture was followed by the Late Desert Archaic culture, beginning about 3600 B.C. and ending around 600 B.C., which moved upland when the marshy areas around Lake Bonneville dried up as the lake receded. The Late Desert Archaic culture is characterized by similar stone tools and artifacts as the Early Desert Archaics.

From an archaeological perspective, the Freemont culture, originating around 700 A.D. and ending around 1400 A.D., was the most important in the area. The Freemonts were horticultural and augmented their diet by hunting. Hunting and recreational sites associated with the Freemonts are located in the Sandy Hills area, and some artifacts, such as pottery, bows, and arrows, have been found there (U.S. Department of the Army 1982).

A community of more than 100 pit dwelling along the banks of South Willow Creek are associated with the Freemonts. These dwellings are located on land controlled by TEAD-North, within the perimeter fence or on land adjacent thereto. The pit dwellings located outside the perimeter fence have experienced severe damage from previous archaeological excavations and vandalism. Because the eight Freemont pit dwellings on TEAD-North exhibit the only known intact evidence of permanent structures of the Freemont culture, they are among the most important archaeological resources in Utah. In addition, a petroglyph site containing a large flat rock carved on by both the Late Desert Archaics and the Freemonts is located within the perimeter fence at TEAD-North. These resources are protected by federal law under the Federal Antiquities Act of 1906, which prohibits the removal of native American artifacts from their *in situ* locations on federal lands without permission from the Department of the Interior.

The Numic-Speaking culture was the last native Amercian culture to inhabit the area. The Goshute, Paiute, and Shoshone were the major native American tribes in Tooele County when the Mormon pioneers first settled the area in the mid-1800s. The Numic-Speaking culture appeared about 100 to 200 years prior to the disappearance of the Freemonts. Being a more nomadic and hunting-based culture than the Freemonts, the Numic-Speaking culture adapted to the increased aridity of the area and still live on and near the Goshute and Skull Valley reservations.

The Rush and Tooele valleys were settled by ranchers and farmers in the late 1840s and early 1850s. The Donner-Reed party were the first white settlers to cross the Tooele area by wagon. The delays associated with encountering problems on the mud flats between Cedar and Pilot mountains were a major contributor to their celebrated disaster in the Fall of 1846 in the Sierra Nevada Mountains.

In 1848, a small log house was erected in a town called Willow Creek (later, Grantsville). In 1849, settlers occupied what is now called Adobe Rock, and the mouth of Settlement Canyon, near what is now the city of Tooele, where they were employed by Ezra Benson to build a saw mill. In 1850, a number of recent immigrants settled in the valley, mostly herding cattle and sheep or farming. The county of Tooele was established in 1850; the city of Tooele became the permanent County Seat in 1867 when the Court House was built.

The Tooele and Rush valleys continued to be used for grazing, which became a major industry in the area when the first railroad entered the valley. The railroad entered the valley in 1869 and remains an important area resource today. The valley was heavily used for grazing in the late 1800s and early 1900s. Dust-blown areas encompassed only 320 acres in December of 1929, when the first dust storms were encountered, but had increased to nearly 31 square miles, or 10,520 acres, by April 1935. The worst dust storm occurred on December 27, 1934, lasting for several days and causing almost unbearable living conditions and hazardous travel on area highways. Even though the Grantsville Soil Conservation District was established on May 3, 1938, delays in the initial construction of the Tooele Army Depot in June 1942 were attributed to shifting soils and blowing sands. By 1947, soil conservation districts had been organized in Tooele County. Farming has been important in the valley, but the dust-bowl effects of overgrazing and the agricultural depressions of the 1890s and 1930s diminished the role of agriculture in the valley.

The Goshute Indians reportedly used campfire smelters to make bullets from gold and silver from ore mined in the Oquirrh Mountains. Mining has been an important industry in Tooele County since 1859 and has continued to play an important economic and environmental role ever since. Millions of dollars worth of precious metals were mined in mining bonanzas at Ophir, Mercur Barren, and Gold Hill. Mining has produced more income than any other resource in the area. Resources mined in Tooele County include gold, silver, lead, and zinc from the Oquirrh Mountains; lime and calcite from the Stansbury Mountains; argonite from the Cedar mountains; and salt and potassium from the salt desert and mud flats between Burmester and Lakepoint.

Recent searches of the *National Register of Historical Places* indicate that 525 sites are located in the 12-county region; 16 of these are located in Tooele County. For the on-site disposal alternative at TEAD, the worst-case accident (as identified in the FPEIS) would be categorized by a downwind no-deaths distance of 50 km. There are 48 such sites within a 50-km radius around TEAD-South, and 13 sites are within 35 km

(see Table C.3-1). Some of these sites are discussed below (U.S. Army Corps of Engineers 1986).

- The E. T. Benson Mill is located on State Highway 138 near Mill Junction. It was built by Phineas R. Wright for E. T. Benson and John Rowberry in 1850 and uses water from area springs for power generation.

- The Bonneville Salt Flats Race Track is located 3 miles east of Wendover and has been used since 1925 for speed racing.

- Danger Cave is located a mile east of Wendover on U.S. Highway 40. This archaeological excavation provides a clear picture of the life of the hunting and gathering people who lived in the desert environment of the Great Basin from 9000 BC to 20 AD. The deep stratified deposits provide one of the more notable cross sections of long-term human development west of the Continental Divide.

- The David E. Davis House is located near Clover, off State Highway 199, and was constructed from 1883 to 1885. Built of soft-fired brick manufactured on the site, it is a two-story central passage design and is one of the earliest brick houses in the Clover area. Davis was a polygamist who had the large residence built to accommodate his three wives and their families. [This house was declared eligible for listing in the National Register in 1984 but was not listed as of May 9, 1988 (J. Byrne, National Register, personal communication to G. O. Rogers, Oak Ridge National Laboratory, Oak Ridge, Tenn., June 13, 1988). However, it is listed in U.S. Army Corps of Engineers (1986), where it is declared as being "listed on the National Register."]

- The Ground to Air Pilotless Aircraft Launch Site and Blockhouse is situated in the Knolls vicinity and is significant as the original launch site for the United States Air Force's first supersonic guided missile, which was named the Ground to Air Pilotless Aircraft. Thirty-eight test vehicles were launched from the site between June 13, 1946, and July 1, 1947.

- The Grantsville First Ward Meeting House is located in the town of Grantsville at 297 Clark Street and is locally significant as one of the early Mormon meeting houses that is still standing.

- The Iosepa Settlement Cemetery is located 15 miles south of U.S. 80 on a paved country road in Skull Valley. The cemetery is a reminder of a unique phase of Utah history. Polynesian Mormons settled in Skull Valley in 1889 to work the land and stock of the Iosepa Agriculture and Stock Company, which was owned by the Mormons. The Polynesian culture flourished until 1917, when most of the surviving inhabitants returned to the islands.

Table C.3-1. National Register listings for the region around Tooele Army Depot-South as of June 13, 1988

Site name, city, county	Approximate distance (km) from proposed facility
Jordan High School, Sandy, Salt Lake	50
Lincoln Highway Bridge, Dugway Proving Ground, Tooele	50
Diamond Cemetery, Mammoth, Juab	50
Empress Theatre, Magna, Salt Lake	50
Charles T. H. Goode House, American Fork, Utah	50
Jordan School District Administration Building, Sandy, Salt Lake	50
Salt Lake County Library, Midvale, Salt Lake	50
Showers Mine and Headframe, Mammoth, Juab	50
Lauritz Smith House, Draper, Salt Lake	49
Magna Community Baptist Church, Magna, Salt Lake	49
Warren B. Smith House, American Fork, Utah	49
Gardner Mill, West Jordan, Salt Lake	49
Old Goshen Site, Goshen, Utah	48
Draper Park School, Draper, Salt Lake	48
South Iron Blossom Headframe, Mammoth, Juab	48
J. R. Allen House, Draper, Salt Lake	47
American Fork Presbyterian Church, American Fork, Utah	47
Sunbeam Mine, Mammoth, Juab	47
Silver City Cemetery, Mammoth, Juab	47
Union Pacific Railroad Depot, Mammoth, Juab	47
Eagle and Blue Bell Mine, Eureka, Juab	47
Tintic Smelter Site, Eureka, Juab	46
Mammoth Historic District, Mammoth, Juab	45
Garside-McMullin House, South Jordan, Salt Lake	45
Beck No. 2 Mine, Eureka, Utah	45
Dividend Miner's Dry, Eureka, Utah	45
Centennial-Eureka Mine, Eureka, Juab	44
Big Hill Shaft Headframe, Eureka, Utah	44
Thomas R. Cutler Mansion, Lehi, Utah	44
Grand Central Mine, Mammoth, Juab	44
Thomas Austin House, Lehi, Utah	44
Yankee Headframe, Eureka, Utah	44

Table C.3-1. (continued)

Site name, city, county	Approximate distance (km) from proposed facility
Knightsville School Foundation, Eureka, Juab	44
Harry B. Merrihew Drugstore, Lehi, Utah	43
Fitch Cemetery, Eureka, Juab	43
Water Lily Shaft, Eureka, Utah	43
Lehi City Hall, Lehi, Utah	43
Charcoal Kilns, Eureka, Utah	43
George Henry Dansie Farmstead, Riverton, Salt Lake	42
Iosepa Settlement Cemetery, Iosepa, Tooele	42
Eureka City Cemetery, Eureka, Juab	42
Lime Kilns, Eureka, Utah	42
Knight Grain Elevator, Eureka, Juab	41
Eureka Historic District, Eureka, Juab	41
Camp Williams Hostess House/Officers' Club, Camp W. G. Williams, Utah	39
Benson Mill, Mills Junction, Tooele	39
Utah Copper Company Mine Superintendent's House, Copperton, Salt Lake	36
Copperton Historic District, Copperton, Salt Lake	36
Grantsville First Ward Meetinghouse, Grantsville, Tooele	35
John T. Rich House, Grantsville, Tooele	35
Bingham Canyon Open Pit Copper Mine, Salt Lake City, Salt Lake	27
Tooele County Courthouse and City Hall, Tooele, Tooele	26
Tooele Valley Railroad Complex, Tooele, Tooele	26
Tooele Carnegie Library, Tooele, Tooele	26
John C. Sharp House, Vernon, Tooele	24
Stagecoach Inn, Fairfield, Utah	22
Fairfield District School, Fairfield, Utah	22
Camp Floyd Site, Fairfield, Utah	21
Stockton Jail, Stockton, Tooele	17
Soldier Creek Kilns, Stockton, Tooele	14
Ophir Town Hall, Ophir, Tooele	11

Source: J. Byrne, National Register, personal communication to G. O. Rogers, Oak Ridge National Laboratory, Oak Ridge, Tenn., June 13, 1988.

- The Lincoln Highway Bridge is within the Dugway Proving Grounds boundary. It is the last vestige of the Lincoln Memorial Highway, the first coast-to-coast road in the United States. It was constructed in 1919 by the Goodyear Tire and Rubber Company.

- The Ophir Town Hall is situated at 43 Main Street in Ophir. This frame structure with a bell tower was built in 1870 and is a rare example of Ophir's civic buildings during the boom days of the late 1870s.

- The John T. Rich House is located at 275 West Clark Street in Grantsville. Built by a livestock owner as his residence in 1880, it is the only Italianate box model that was constructed with adobe.

- The John C. Sharp House was completed in 1888 in Vernon and is both historically and architecturally significant. Historically, its importance stems from its owner, John C. Sharp, who was the Bishop of the Vernon Ward of the Mormon Church for 25 years. The Sharp house is architecturally significant as one of the few examples in Utah of the Italianate box with a side passage plan.

- The Soldier Creek Kilns in Stockton are remnants of four charcoal kilns and one lime kiln that are significant because of their economic importance to Utah's mining industry. Colonel Patrick Connor's troops started the charcoal industry in Utah in 1870.

- The Stockton Jail site is located in the northwestern part of Stockton at the base of Tabernacle Hill. The jail was built in 1902 and is the best-preserved public building dating from the early years of the community.

- The Tooele County Library was built in 1911 at 47 East Vine Street in Tooele. This library was one of 23 Carnegie libraries built in Utah by the millionaire/philanthropist Andrew Carnegie, who granted $5000 for its construction. It continues to serve as the community's library.

- The Tooele County Courthouse is located at 71 East Vine Street in Tooele. The courthouse was built in 1867 and is one of the few remaining century-old civic buildings in the state. Its original use was for civic functions; however, the building was also used for entertainment events until 1941. Now owned by the city of Tooele, it is leased to the Daughters of Utah Pioneers, who maintain it as a relic hall.

- The Tooele Valley Railroad Complex was built in 1909 on 35 North Broadway in Tooele and served as a connection between the International Smelting and Refining Plant and the Union Pacific Railroads. The railroad transformed Tooele from an agricultural community to an industrial-based community. When the smelter was shut down in 1972, the rail lines were no longer needed.

- Wendover Air Force Base is located a little more than half a mile south of Wendover. The installation played a significant role in ushering in the atomic age because the installation was used as a training area for the 509th Group. The Commander of the 509th Group, Colonel Paul W. Tibbets, piloted the plane, "Enola Gay," which dropped the atomic bomb on Hiroshima.

In addition, recent searches conducted by the Utah State Historical Preservation Office indicate that there are 43 potentially historic sites in Tooele County, including old trails, cemeteries, Pony Express stations, mills, and ghost towns. Sites located on Tooele Army Depot installations are listed below.

- In the north area, a rock measuring 4 ft high and 5 ft in diameter and covered with petroglyphs was found in a deteriorated state. Although no action has yet been taken to protect the rock, it has been nominated for inclusion in the National Register of Historic Places.

- There are eight Freemont pit dwellings in the north area near the firing range just off the perimeter road. The sites are an important archeological resource in Utah because they are the only known intact evidence of permanent structures of the Freemont culture.

- Indian artifacts recently discovered by the Stearns-Roger research team near the western boundary of the north area are additional traces of prehistoric habitation. The extension and importance of this site have yet to be determined.

- The TOD Park Housing area was used to help alleviate the housing shortage caused by the influx of workers into the newly created Tooele Ordnance Depot and Deseret Chemical Depot in 1942. Located in the southeast corner of the north area, the park included 1020 family housing units and was one of the larger cities in the area. The units were demolished between 1958 and 1963 when it was determined that the maintenance costs were prohibitively high and policy changes were made on maintaining civilian housing on federally owned land.

- A small cemetery dating to a pre-installation period is located in the north central section of the TEAD-South area approximately 1.5 miles from the proposed plant location. A visit to the area in April 1988 found several marked gravesites, interspersed with what appeared to be unmarked gravesites. The most recent date of death on a marked grave site is June 1, 1912.

REFERENCES FOR APPENDIX C

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APPENDIX D

DESCRIPTION OF SITE-SPECIFIC SURFACE WATER AND GROUNDWATER RESOURCES

D.1 SURFACE WATER

Eight perennial streams flow into Rush Valley from the surrounding mountains (see Fig. D.1-1); however, no surface water leaves the valley (Hood, Price, and Waddell 1969). These streams include Clover Creek, which forms in Johnson Pass between the southern Stansbury and northern Onaqui mountains; Soldier and Ophir creeks, the headwaters of which form in the Oquirrh Mountains; and Vernon, Bennion, Dutch, Harker, and Oak Brush creeks, which emanate from the Sheeprock Mountains.

Flow in these streams is variable throughout the year, attaining a maximum during the spring snowmelt and after summer thunderstorms. During the remainder of the year, a relatively low flow occurs that is sustained by groundwater discharge from springs, seeps, and mines at the higher elevations. This flow infiltrates alluvial fans at creek canyon mouths and recharges the groundwater (see Sect. D.2.2). The flow from Ophir, Bennion, and Oak Brush creeks, which is supplemented by discharge received from mines, is substantial enough to cross the alluvial fans and reach farmlands in Rush Valley.

Many additional ephemeral streams flow into these perennial creeks or Rush Valley subsequent to the spring snow melt or following major precipitation events. A small amount of streamflow reaches the valley floor, which drains to the playas in the east-central part of Rush Valley; to Rush Lake at the base of South Mountain; to Faust Creek, an ephemeral stream traversing the valley floor in the south-to-north direction; and to several small ponds in the wetlands east of Clover.

Bodies of water in Rush Valley include Rush Lake, near Stockton; Faust Creek Reservoir; Vernon Creek Reservoir; and the shallow ponds east of Clover, which persist only during prolonged periods of increased precipitation. No major rivers flow within a 100-km (62-mile) radius of the proposed incineration facility, although this area includes portions of the Great Salt and Utah lakes (U.S. Water Resources Council 1977). No surface waters are used as public water supplies in the immediate vicinity of the proposed site (U.S. Environmental Protection Agency 1981, 1982).

Surface water is used primarily for agricultural purposes in Rush Valley. Two reservoirs are located at the mouth of Ophir Canyon, near the Bates Ranch, just above the northeastern corner of the site boundary. One of these reservoirs is situated in a natural topographic depression such that it is maintained by surface runoff, while the second has recently been constructed and is being filled, presumably with surface water diverted from Ophir Creek by a recently installed transmission pipeline.

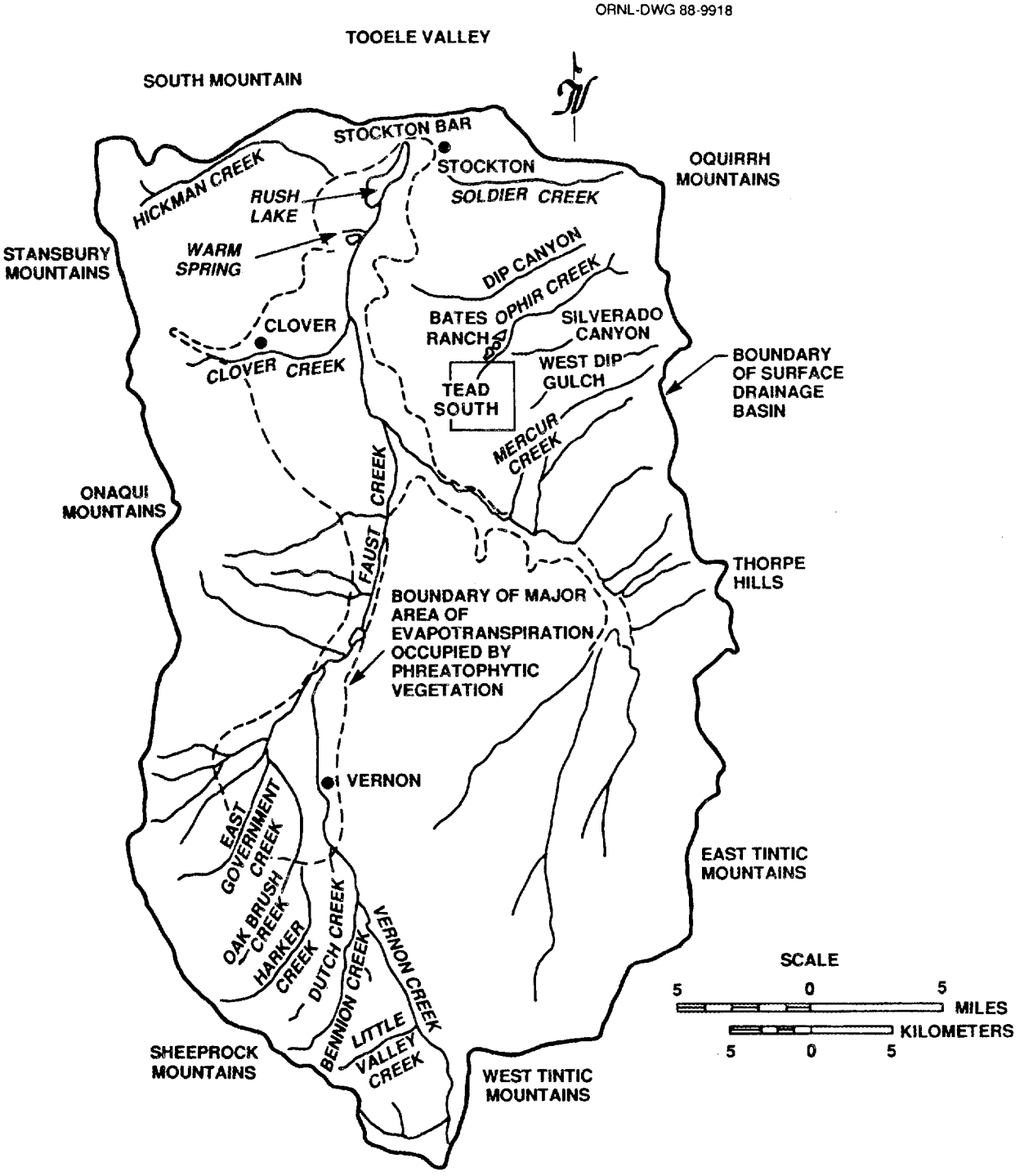

Fig. D.1-1. Major surface water discharge channels in Rush Valley. *Source:* Hood, J. W., Price, D., and Waddell, K. M. 1969. *Hydrologic Reconnaissance of Rush Valley, Tooele County, Utah,* Tech. Publication 23, Utah Department of Natural Resources, Division of Water Rights, Salt Lake City.

Water quality measurements obtained from several surface streams entering Rush Valley have been reported by Hood, Price, and Waddell (1969). Water is generally of excellent quality and suitable for human consumption. Surface water from these streams is slightly alkaline, being of the calcium bicarbonate type having a total dissolved solids ranging from 200 to 300 mg/L and classified as very hard because its hardness as $CaCO_3$ exceeds 150 mg/L (Freeze and Cherry 1979).

The lower reaches of Ophir Creek, a perennial stream, enter the TEAD-South area near its northeastern boundary. This stream is diverted along the northern side of a berm belonging to the Union Pacific railroad spur that traverses the site in a east-west direction, past the chemical weapons storage area, and discharges at the northwest to an area occupied by phreatophytic vegetation. Only a minimal flow reaches the site, except during the spring snow melt or following major precipitation events, because the flow enters the alluvial-fan aquifer (see Sect. D.2.2). West Dip Gulch, Silverado Canyon, and Mercur Creek, three ephemeral streams that have a domain of influence that includes the TEAD-South area, usually have no flow except during the spring snow melt or following summer thunderstorms.

A small dam and inlet control structure have recently been installed near the top of Ophir Canyon that will divert the flow from Ophir Creek, via a transmission pipeline, into a 62,000-m^3 (50–acre-ft) irrigation reservoir currently under construction on the northeastern corner of the TEAD-South area (Forsgren-Perkins Engineering 1988). The water rights to 60% of the total flow from Ophir Creek have been assigned to the TEAD site, and the remaining flow has been allocated to a private party. This water will be used to irrigate approximately 105 ha (260 acres) of crops grown on the northeastern part of the TEAD-South area.

Recent field measurements performed on Ophir Creek between February 1986 and May 1987 have indicated a winter (December to March) flow ranging from 4900 to 7360 m^3/d (900 to 1350 gal/min), whereas the flow exhibited between April and September generally exceeds 12,200 m^3/d (2240 gal/min) (Forsgren-Perkins Engineering 1988). According to these measurements, a minimum flow of approximately 5450 m^3/d (1000 gal/min) can be maintained indefinitely by Ophir Creek. The 60% allocation of flow from Ophir Creek is not required to meet the total water demand, including increased consumption at the site, fire protection, and the proposed incinerator facilities. Rather, the 60% allocation from Ophir Creek is being secured so that it will be available for future use, if required, at TEAD-South.

Occasional flooding from Ophir and Mercur creeks, as well as West Dip Gulch and Silverado Canyon, occurs on the northeast portions of the TEAD site during periods of intense rainfall or rapid snow melt (U.S. Department of the Army 1982). These flood waters usually spread out over large uninhabited areas, carving gullies and depositing boulders, rocks, and debris. There is no record of excessive mud slides or avalanches associated with these flooding events proceeding from the Oquirrh mountains. The southwestern portion of the TEAD-South area also has been flooded in the past by extensive storm waters moving northward across Rush

Valley. There is no record of any significant inundation of the TEAD-South area that has caused flooding of the chemical weapons storage area or that would affect the incineration facility.

Storm-water runoff from the TEAD site generally flows southwest. A large, naturally formed, northeast-to-southwest trending gully separates the chemical weapons storage area from the incineration facility. Uncontrolled runoff from the existing chemical weapons storage area and from the proposed incineration facility would follow this pathway, during both normal and accident conditions, and would drain off site to the area west of TEAD-South. Within the incineration facility, runoff from controlled areas of possible contamination would be directed to a storage lagoon.

There are two existing on-site water storage tanks, which have a combined capacity of 3800 m^3 (1,000,000 gal). Both tanks are cracked, having a combined leakage rate between 220 and 321 m^3/d (60,000 and 85,000 gal/d) (Forsgren-Perkins Engineering 1988). A 1700 m^3 (450,000 gal) fire protection water storage tank would be constructed to protect the incineration facility. The expected quantity of waste water discharged from the incineration facility is 114 m^3/d (30,100 gal/d), consisting entirely of effluent from bathroom, shower, and laundry facilities as well as laboratory cleaning and monitoring devices. No process water or hazardous material of any type would be discharged into this system. Sanitary waste would be treated and used as process water. Liquid wastes from the incineration process would be concentrated in an evaporator, and the remaining salts would then be precipitated in a dryer. The resulting solids would be packaged and stored on site prior to transportation to a regulated, off-site disposal facility. There are no liquid effluents from the plant.

D.2 GROUNDWATER

The EPA has determined that certain areas have a groundwater aquifer that is the sole or principal source of drinking water for the area. If these sources were contaminated, significant hazards to public health would be created. The counties in the continental United States containing federally designated sole-source aquifers or associated recharge or stream flow source zones can be identified from information in the EPA determinations published in the *Federal Register*. *Federal Register* citations for these determinations were obtained from the EPA (R. Anzzolin, U.S. Environmental Protection Agency, Office of Drinking Water, Washington, D.C., personal communication to J. E. Breck, Oak Ridge National Laboratory, Oak Ridge, Tenn., Apr. 8, 1986). There are no sole-source aquifers within 100 km of TEAD-South.

D.2.1 Geology

The TEAD-South area is located in the northwestern quadrant of Utah near the eastern edge of the Basin and Range physiographic province, just west of the Wasatch Mountain Range that forms the eastern edge of the province (see Fig. D.2-1) (Slemmons 1967; Everitt and Kaliser 1980). The

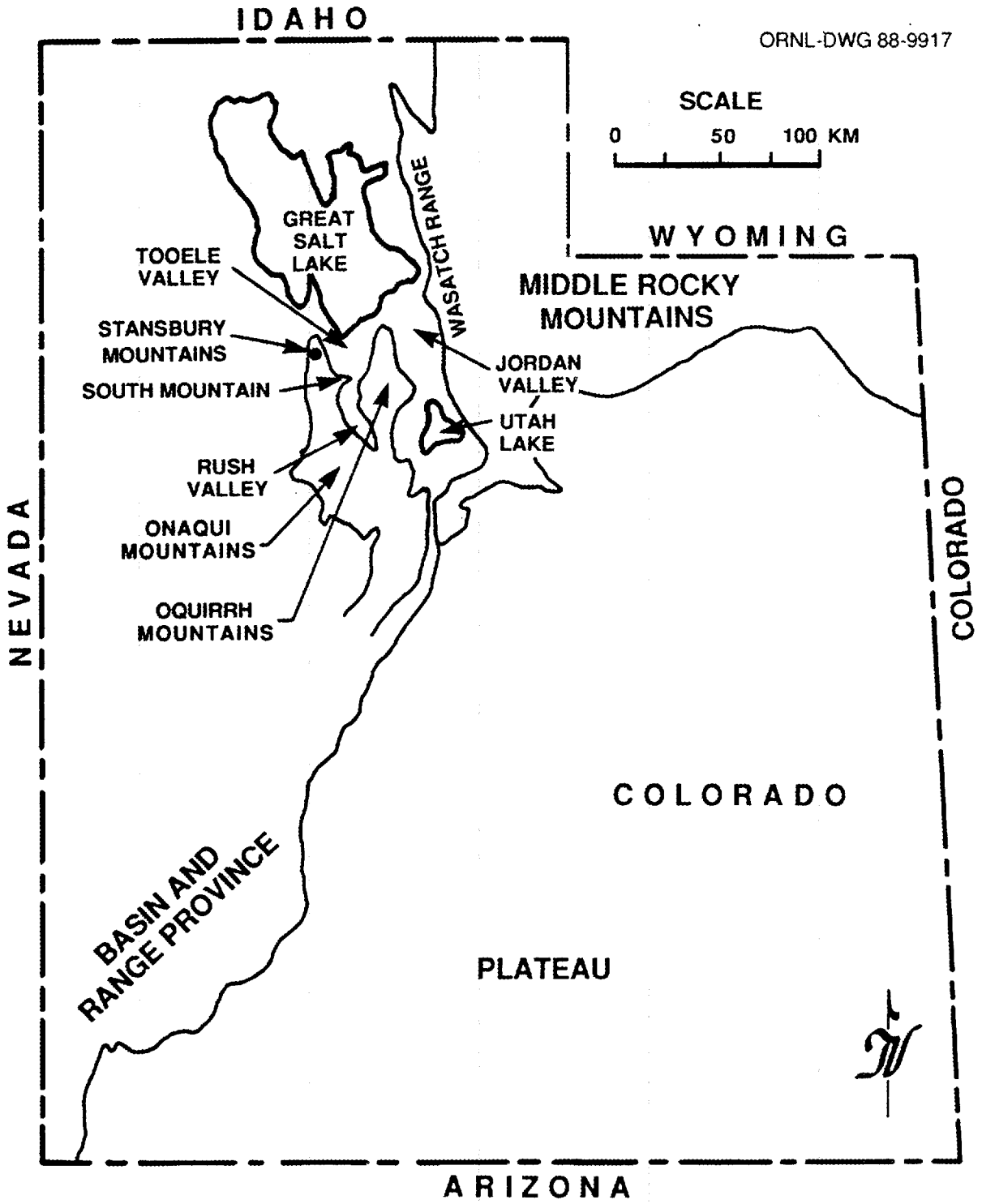

Fig. D.2-1. Tooele and Rush valleys, Utah. *Source:* Adapted from L. J. Turk, *Hydrogeology of the Bonneville Salt Flats, Utah,* Water Resources Bul. 19, Utah Geological and Mineral Survey, Division of the Utah Department of Natural Resources, Salt Lake City, 1973.

region is characterized by a series of nearly parallel, north-to-south trending mountain ranges (horsts) separated by desert basins (grabens). Rush Valley, where TEAD-South is located, lies between the Oquirrh Mountains on the east and the Stansbury and Onaqui mountains on the west. The floor of southernmost Rush Valley slopes gently toward Tooele Valley to the north, which then drains into Great Salt Lake. The two valleys are separated by South Mountain and Stockton Bar, a steep-sided, flat-topped gravel bar deposited by Lake Bonneville (ancestral Great Salt Lake) during the Pleistocene Epoch and that now serves as a surface water drainage divide between Tooele and Rush valleys. Rush Lake, near Stockton, is situated in a topographical depression at the southern base of South Mountain.

The surficial geology of Rush Valley is depicted in Fig. D.2-2, while an inferred stratigraphic cross section is shown in Fig. D.2-3. This cross section is typical of the stratigraphy exhibited in the western Great Salt Lake Desert region where topographically low desert valleys are bounded by high-rising mountain ranges. This alternating sequence of mountains and basins, which overlies Tertiary volcanic or pre-Tertiary rocks, was formed by intense block faulting, which began in the Miocene Epoch and continues to the present in some areas (Lines 1979). Subsequent stream channel erosion filled the basins with detrital deposits taken from Paleozoic sedimentary rocks comprising the adjacent mountains. Pediments created along the flanks of the mountains were covered with alluvial fans, which sorted the detrital deposits, causing the basins to be filled with conglomerate (basin fill). Later, during the Pleistocene Epoch, when Lake Bonneville inundated the region (Flint 1957), a layer of fine-grained lacustrine sediments known as playa was deposited on top of the conglomerate. The presence of Lake Bonneville also caused the conglomerate to become semi-consolidated. Since then, stream channel erosion has continued, causing additional alluvium and conglomerate to be deposited at some locations overlying the lacustrine sediments. The TEAD-South area is located near the base of the Oquirrh Mountains, where the land surface consists of relatively porous colluvial and alluvial deposits containing sand and gravel with some conglomerate and clay. Near the southwestern corner of the TEAD-South area, these surficial deposits grade into the playa or lakebed sediments, which consist mostly of poorly drained clay.

D.2.2 Groundwater Regime

Groundwater occurs in three distinct aquifers in Rush Valley (see Fig. D.2-3). The most extensive aquifer is the basin-fill aquifer. Overlying, relatively impermeable, clay-sized lacustrine sediments confine this aquifer and restrict hydraulic communication between it and the playa surfaces. The sand and gravel of the alluvial fans along the flanks of the mountains compose the second, alluvial-fan aquifer. The highest quality groundwater obtainable in Rush Valley is contained in this aquifer. In the upper reaches above the valley floor, this aquifer is unconfined; at the valley wall, the alluvial fans are interbedded with fine-grained lacustine deposits beneath the playas that act as confining beds. Hydraulic connection occurs between these two aquifers where the sand and gravels deposits grade into the conglomerates. A third, unconfined, shallow-brine aquifer resides just below the valley surface in the

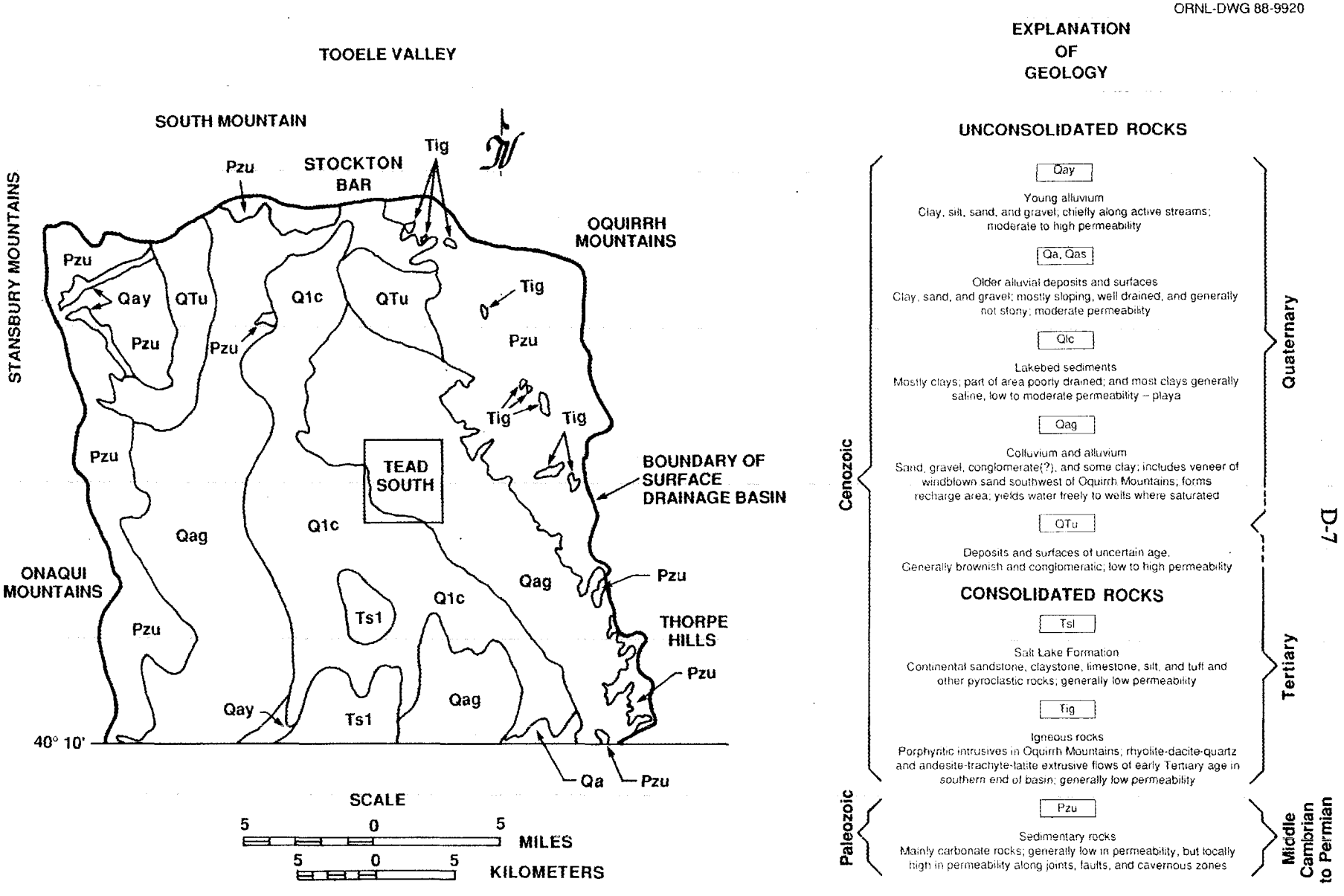

Fig. D.2-2. Surficial geology in northern Rush Valley. *Source:* J. W. Hood, D. Price, and K. M. Waddell, *Hydrologic Reconnaissance of Rush Valley, Tooele County, Utah,* Tech. Publication 23, Utah Department of Natural Resources, Division of Water Rights, Salt Lake City, 1969.

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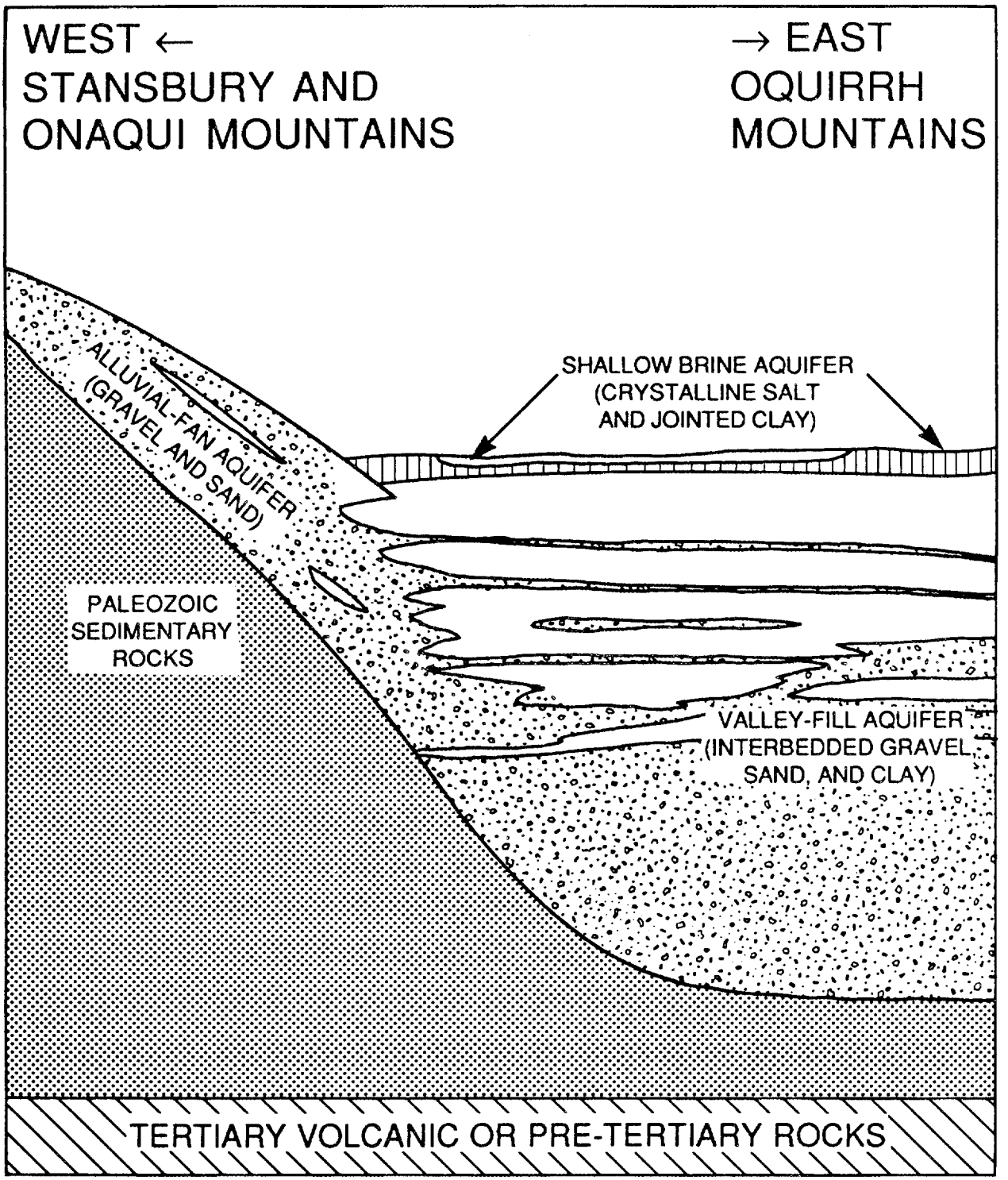

Fig. D.2-3. Inferred hydrostratigraphic cross section through Rush Valley. *Source:* Adapted from Stephens, J. C. 1974. *Hydrologic Reconnaissance of the Northern Great Salt Lake Desert* and *Summary Hydrologic Reconnaissance of Northwestern Utah*, Tech. Publication 42, Utah Department of Natural Resources, Division of Water Rights, Salt Lake City.

near-surface carbonate muds and the crystalline halite and gypsum deposits on the playa surface. This shallow-brine aquifer is hydraulically connected to the alluvial-fan aquifer where the sand and gravel deposits are interbedded with the near-surface carbonate muds.

Piezometric surface contours are shown in Fig. D.2-4 for the basin-fill and alluvial-fan aquifers. The upper hundred meters (few hundred ft) of basin fill consist of relatively impermeable, clay-sized, Lake Bonneville, lacustrine sediments—that are not part of the aquifer—that overlie as much as 915 m (3000 ft) of conglomerate (Everitt and Kaliser 1980). Near the flanks of the mountains, the conglomerate thins to a thickness of approximately 305 m (1000 ft). The piezometric surface of this artesian aquifer is located between 15 and 30 m (50 and 100 ft) below the land surface.

A southwest-to-northeast trending groundwater divide, which passes through the TEAD-South area, separates the flow of groundwater in Rush Valley into two distinct regions. North of the divide, groundwater flows toward the center of Rush Valley and then northward, where it contributes to either the base flow entering Rush Lake or the subsurface flow recharging the Tooele Valley aquifer system. South of the divide, the groundwater flows clockwise around Vernon and then eastward toward the Thorpe Hills. Liquid discharges entering the groundwater beneath the TEAD-South area can flow either toward South Mountain or the Thorpe Hills, depending on which side of the divide they enter the aquifer. The basin-fill aquifer is not recharged directly by precipitation, but by subsurface inflow from adjacent alluvial fans and underlying Tertiary or Paleozoic rocks.

Near the valley walls, flowing artesian conditions may occur in the alluvial-fan aquifer. Properly installed wells can yield as much as 5450 m^3/d (1000 gal/min) (Eakin, Price, and Harrill 1976). In this locale, the thickness of sand and gravel and the number and thicknesses of interbedded lacustrine deposits vary greatly over short distances, such that this water-bearing formation responds as a leaky aquifer. Long duration pumping induces significant groundwater contributions from these confining beds and induces a corresponding reduction in the piezometric surface elevation (to artesian conditions). In those areas where groundwater has not been pumped from wells, the quantity of groundwater moving through the alluvial-fan aquifer may exceed the transmissive capacity of lacustrine confining beds such that discharge occurs either to the shallow-brine aquifer or to surface seeps or springs located along the base of the alluvial fan. Recharge to the alluvial-fan aquifer occurs mainly from infiltration of precipitation and melted snow as well as from some subsurface inflow from consolidated rocks in the adjacent mountains.

Carbonate muds extend to considerable depths beneath the playas. The upper 4.6 to 7.6 m (15 to 25 ft) of this stratum, where there is a zone of relatively high permeability caused by a network of vertical joints in the underlying lacustrine clays, functions as the unconfined, shallow-brine aquifer (Stephens 1974; Lines 1979). The flow of groundwater in this aquifer generally parallels the surface topography, discharging

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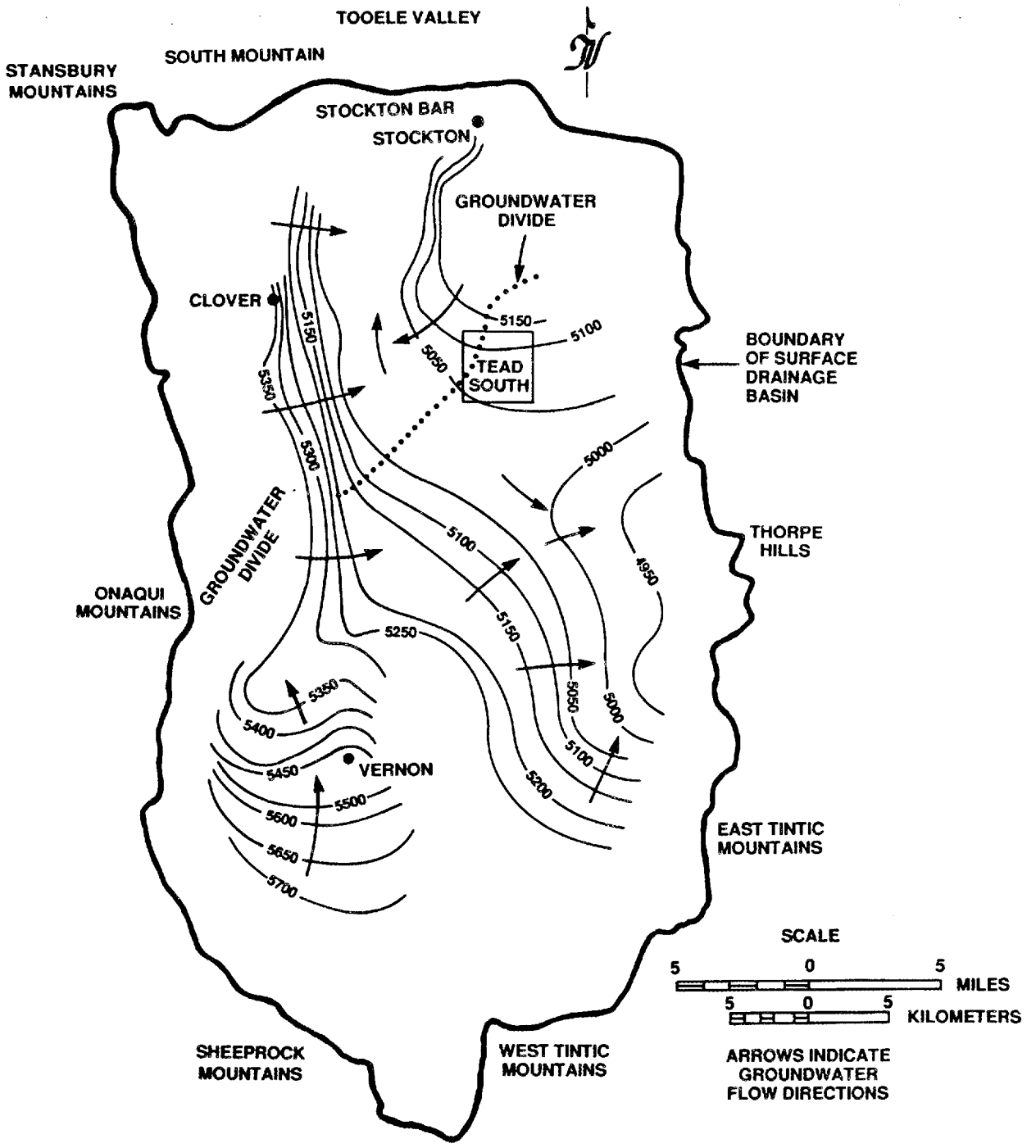

Fig. D.2-4. **Water table map in Rush Valley for the alluvial-fan and basin-fill aquifiers.** Water level contour elevations are expressed in feet above mean sea level. *Source:* J. W. Hood, D. Price, and K. M. Waddell, 1969. *Hydrologic Reconnaissance of Rush Valley, Tooele County, Utah,* Tech. Publication 23, Utah Department of Natural Resources, Division of Water Rights, Salt Lake City.

downgrade either into Rush Lake at the base of South Mountain or recharging the aquifer system in Tooele Valley to some minimal extent. The shallow-brine aquifer is recharged mainly by incident precipitation, although stream flows reaching the valley floor, excess irrigation water, discharges from mines and tunnels, and subsurface flow from nearby consolidated rocks also contribute to it (Razem and Steiger 1981).

Groundwater levels have exhibited a generally rising trend since 1982 (Wilberg et al. 1987). This has occurred because the annual precipitation in 1986 exceeded the average annual precipitation for the period of record from 1936 to 1986 by 20.6 cm (8.10 in.). This is the fifth consecutive year that annual precipitation has exceeded the long-term average by more than 10 cm (4 in.). This increased precipitation also has caused Rush Lake to grow in size and a pond to form west of the incineration facility (R. F. John, Utah Division of Wildlife Resources, Springville, Utah, personal communication to J. E. Breck, Oak Ridge National Laboratory, Oak Ridge, Tenn., May 30, 1985). These wetlands are shown in Fig. D.1-1 as the area of evapotranspiration occupied by phreatophytic vegetation.

D.2.3 Groundwater Quality

Groundwater quality in Rush Valley ranges from fresh to briny (see Table D.2-1). In the shallow-brine aquifer beneath the playas, groundwater of the sodium chloride type contains 150,000 mg/L or more of total dissolved solids. In the central regions of the valley, most groundwater in the basin-fill aquifer has a total dissolved solids content ranging from 500 to 1000 mg/L, although values between 1000 and 3000 mg/L have been observed at several isolated locations where the basin-fill aquifer grades into the alluvial-fan and shallow-brine aquifers (Hood, Price, and Waddell 1969). This groundwater, also of the sodium chloride type, generally is suitable for consumption by livestock, but would not be recommended for irrigation of crops when the total dissolved solids content exceeds 700 mg/L (U.S. Environmental Protection Agency 1973).

The concentration of total dissolved solids decreases in the basin-fill aquifer in the direction of the valley walls. Drinking water, of the calcium magnesium bicarbonate type having total dissolved solids concentrations less than 500 mg/L, resides in the alluvial-fan aquifers. This change in groundwater type occurs because the aquifer is recharged from the upland mountainous regions whose sediments consist mainly of limestone, dolomite, and shale. In areas where prolonged pumping of the alluvial-fan aquifer has occurred, or where surface water recharge is minimal, a mixed calcium magnesium bicarbonate, sodium chloride type groundwater may be present because groundwater from the basin-fill or shallow-brine aquifers has been induced to enter the alluvial-fan aquifer. Some groundwater having high sulfate concentrations has been observed in areas where uncontrolled effluents from mines or tunnels recharge any of the three aquifer regimes. Groundwater in Rush Valley is classified as very hard (Freeze and Cherry 1979).

Table D.2-1. Water quality classification scheme according to concentration of total dissolved solids

Concentration of total dissolved solids (mg/L)	Classification
Fewer than 1,000	Fresh
1,000 to 3,000	Slightly saline
3,000 to 10,000	Moderately saline
10,000 to 35,000	Very saline
More than 35,000	Briny

Source: J. D. Hem, *Study and Interpretation of the Chemical Characteristics of Natural Water,* U.S. Geological Survey Water Supply Paper 1473, 2d ed., U.S. Government Printing Office, Washington, D.C., 1970.

D.2.4 Groundwater Use

Recharge to Rush Valley is provided almost entirely by rainfall and snowmelt from the surrounding mountains, whereas groundwater is discharged by wells, evapotranspiration, and subsurface outflow. The total quantity of groundwater flowing through the aquifer system has been estimated to be between 115,000 and 124,300 m^3/d (34,000 and 36,800 acre-ft/year) (see Table D.2-2) (Hood, Price, and Waddell 1969). Only a small fraction of the groundwater pumped from wells is used for domestic purposes; most of it supplies agricultural needs. Evapotranspiration by phreatophytic vegetation accounts for approximately 70% of the total groundwater discharge from Rush Valley. The subsurface discharge quoted in Table D.2-2 flows eastward toward the south end of the Oquirrh Mountains just below the Thorpe Hills (see Fig. D.2-4). A hydraulic gradient into these consolidated rocks has been verified in this vicinity. A subsurface discharge also may occur toward the north beneath Stockton Bar into Tooele Valley. Its magnitude, which has not been estimated or measured, is believed to be small but significant. Gates (1965) points out that there is a 91.5 m (300 ft) difference in water table elevations across Stockton Bar between Rush and Tooele valleys. Until more data are available that establish the hydraulic conductivity of the geologic deposits beneath Stockton Bar, the possibility of an underflow from Rush Valley into Tooele Valley cannot be discounted.

Some evaporation of groundwater also takes place from small agricultural holding ponds constructed in Rush Valley. Typically, these ponds intercept surface flows that reach the valley floor as well as discharges from springs and seeps. During periods of drought, when surface flows are minimal or nonexistent, groundwater is pumped to maintain these ponds. While most surface-water supplies in Rush Valley have been utilized, significant groundwater reserves still exist in the alluvial fans. Development of these supplies must be carried out such that excessive water table declines do not induce lower-quality groundwater from the basin-fill and shallow-brine aquifers to degrade them.

Total projected culinary water demand at TEAD is 2,335 m^3/d (616,400 gal/d), which includes the site proper, fire protection, and the incinerator facility (Forsgren-Perkins Engineering 1988). Water will be supplied by groundwater pumped from the alluvial-fan aquifer. The diversion of 60% of the available flow from Ophir Creek via a transmission pipeline is also possible, but not required, to sustain the culinary water demands of the TEAD-South area (see Sect. D.1). Three on-site wells provide potable groundwater. Wells No. 1 and No. 2, which are still in operation, were drilled in 1942 at the northeast corner of the site, with capacities of 2044 m^3/d (375 gal/min) and 1783 m^3/d (327 gal/min) respectively. Well No. 3, installed in 1972 near the incinerator site, provided groundwater to an elevated tank in this vicinity. It was abandoned because suspended silt rendered its groundwater impotable. The capacities of Wells No. 1 and 2 are being increased to 3816 m^3/d (700 gal/min) each. Pump controls will not allow both pumps to operate simultaneously. Pump testing performed at these wells indicates that drawdown in the alluvial-fan aquifer will not be excessive until a single well yield of 5180 m^3/d

Table D.2-2. Hydrologic budget for Rush Valley

Component	Flow rate [m^3/d (acre-ft/year)]
Discharge	
Evapotranspiration	91,200 (27,000)
Subsurface outflow	16,900 (5,000)
Wells[a,b]	16,200 (4,800)
Total discharge	
	124,300 (36,800)
Total recharge	
	115,000 (34,000)

[a]These data are for the year 1966. Only 440 m^3/d (130 acre-ft/year) of the total groundwater supplied by wells was used by approximately 750 people for drinking water.

[b]Irrigation of crops accounts for 15,900 m^3/d (4,700 acre-ft/year) of this total, whereas only 34 m^3/d (10 acre-ft/year) is consumed by livestock.

Source: J. W. Hood, D. Price, and K. M. Waddell, 1969. *Hydrologic Reconnaissance of Rush Valley, Tooele County, Utah,* Technical Publication 23, Utah Department of Natural Resources, Division of Water Rights, Salt Lake City.

(950 gal/min) is sustained (Forsgren-Perkins Engineering 1988). The hydrologic budget in Table D.2-2 does not account for the increased water consumption at TEAD-South or for the increased groundwater that will be supplied by Wells No. 1 or No. 2.

D.2.5 Groundwater Contamination

Several preexisting waste pit burial grounds are located south of the chemical weapons storage area and proposed incineration facility. These pits, some of which were constructed in the 1940s, are simple excavations having no floor or sidewall liners. They contain miscellaneous conventional and chemical munitions as well as various ordnance disposal items. A diesel fuel spill of unknown quantity also occurred in this area. Monitoring wells exist around a portion of the landfill periphery, and elevated levels of arsenic have been observed. It is unknown whether arsenic leached from the pit contents or if it was originally present in the geologic strata. Characterization of the waste has not been performed because of the danger associated with drilling into buried munitions.

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APPENDIX E

DESCRIPTION OF SITE-SPECIFIC ECOLOGICAL RESOURCES

In this appendix, the term *ecological resources* refers to all living organisms, except humans, and their terrestrial or aquatic habitats. Those areas that contain important terrestrial or aquatic resources—such as parklands, wilderness areas, Nature Conservancy areas, and wetlands—are of particular concern. Terrestrial and aquatic species protected by the Endangered Species Act are identified in this appendix for the 20-, 50-, and 100-km zones around TEAD-South. Although the human aspects of land use are addressed in greater detail in Appendix G, those aspects related to ecological resources are addressed here.

The maximum no-effects radius (i.e., 100 km), which was considered for ecological resources, includes nine counties or parts of counties in Utah. Summarized ecological resources of special concern for this 100-km zone are found in Table E.0-1. Specific information for TEAD-South can be found in U.S. Army reports for the installation (U.S. Department of the Army 1977, 1982).

E.1 TERRESTRIAL RESOURCES

The proposed site for the incineration facilities at TEAD-South lies adjacent to existing buildings and chemical storage igloos and has no significant ecological resources. The vegetation on the site is a grassland consisting of a mixture of grasses, shadscale, and sagebrush. No woods, wetlands, seeps, or unique habitat types are present.

Wildlife on the proposed site consists primarily of upland small birds and mammals (e.g., western meadowlark, desert cottontail, and deer mouse). The site is not particularly important to game animals or raptors and receives only occasional foraging use by mule deer and various raptors such as red-tailed hawks and great horned owls. Although raptor nests are located at various places on TEAD-South, traditional nesting sites or currently active nests are not present on or near the site.

In the region surrounding TEAD-South, five vegetation zones, including ten sub-types, have been identified (U.S. Department of the Interior 1983). The greasewood type occurs at low elevations [1300 to 1370 m (4300 to 4500 ft)] along the fringes of playas. Associated plant species include bud sagebrush, shadscale, saltgrass, halogeton, gray molly, Russian thistle, and alkali sacaton. The most common vegetation type in Rush Valley is the Northern Desert Scrub (U.S. Department of the Army 1977), which occurs between 1370 and 1520 m (4500 and 5000 ft). Shadscale is the dominant species in this type, and is associated with Nuttall's saltbush, little rabbitbrush, Mormon tea, winterfat, Indian ricegrass, squirreltail,

Table E.0-1. Summarized county-level data for the 100-km zone around Tooele Army Depot–South

Resource type	Name	Area (hectares)	County
National parks	Timpanogos Cave National Monument	101	Utah
Wilderness areas	Deseret	6,300	Tooele
	Mt. Olympus	4,050	Salt Lake
	Twin Peaks	32,370	Salt Lake
	Mt. Nebo	69,680	Juab
	Mt. Timpanogos	25,560	Utah
	Lone Peak	74,350	Utah
Nature conservancy areas	Layton Marsh	480	Davis
Wild and scenic rivers	None	NA[a]	NA[a]
Endangered species	Lahontan cutthroat trout		
	June sucker		
	Clay phacelia		
	Bald eagle		
	Peregrine falcon		

[a]NA = not available.

cheatgrass, spineless horsebrush, and halogeton (U.S. Department of the Interior 1983). Shadscale reaches its highest density on lower alluvial slopes (U.S. Department of the Army 1977).

The Great Basin Sagebrush vegetation type is common at yet higher elevations [1520 to 1830 m (5000 to 6000 ft)]. Dominant sage species include big sagebrush and black sagebrush, and subdominants include big rabbitbrush, little rabbitbrush, bitterbrush, bluebunch wheatgrass, and other grasses (50 CFR Pts. 17.11, 17.12; U.S. Department of the Interior 1983). The Utah juniper woodland type is common between 1830 and 2290 m (6000 and 7500 ft) on the lower foothills and mountains surrounding Rush Valley (U.S. Department of the Army 1977; 50 CFR Pts. 17.11, 17.12; U.S. Department of the Interior 1983). Utah juniper is commonly associated with serviceberry, bitterbrush, cliffrose, sagebrush species, and bluebunch wheatgrass.

Pinyon pine occurs with Utah juniper on the south end of the Oquirrh and Sheeprock Mountains and in the Tintic Mountains. The Conifer-Aspen type occurs on north-facing slopes of mountain tops at 2290 m (7500 ft) and higher (50 CFR Pts. 17.11, 17.12; U.S. Fish and Wildlife Service 1987; U.S. Department of the Interior 1983). Tree species include aspen, douglas fir, Englemann spruce, and other fir species. Associated species include columbine, larkspur, geranium, and grasses. Other less common vegetation associations found in the Rush Valley and 50-km zone include mountain shrub, perennial grass, annuals, and riparian vegetation at some springs and at Rush Lake (U.S. Fish and Wildlife Service 1987; 50 CFR Pts. 17.11, 17.12; U.S. Department of the Interior 1983).

Wildlife occurring in the Shambip River Basin, which comprises the eastern quarter of Tooele County surrounding TEAD-South (Fig. E.1-1), includes 8 amphibian species, 19 reptile species, 64 mammal species, and 235 bird species (from the list of vertebrate species in U.S. Department of Agriculture 1986). Roughly 180 bird species may breed in the region (Cook 1969). Others are present only during spring and fall migration or during winter.

The wildlife of the Shambip River Basin was the subject of a recent report by a workgroup composed of individuals from several state and federal agencies (U.S. Department of Agriculture 1986). The fauna of the Basin is here assumed to be representative of the region of possible influence for the proposed project. Therefore, the fauna outside this region will not be described except as necessary for threatened and endangered species.

Several small and big game species occur in the region—the most abundant and widespread being cottontail rabbits (desert cottontail and Nuttall's or mountain cottontail) and mule deer (Table E.1-1). Elk, black bear, and blue grouse are more restricted to mountainous areas, whereas ring-necked pheasants, sage grouse, Hungarian partridge, and waterfowl occur primarily in the valleys. A few antelope are present south of TEAD-South, and stocking has been proposed to increase the population. Reintroductions of elk and bighorn sheep to the Stansbury Mountains have also been proposed (U.S. Department of Agriculture 1986).

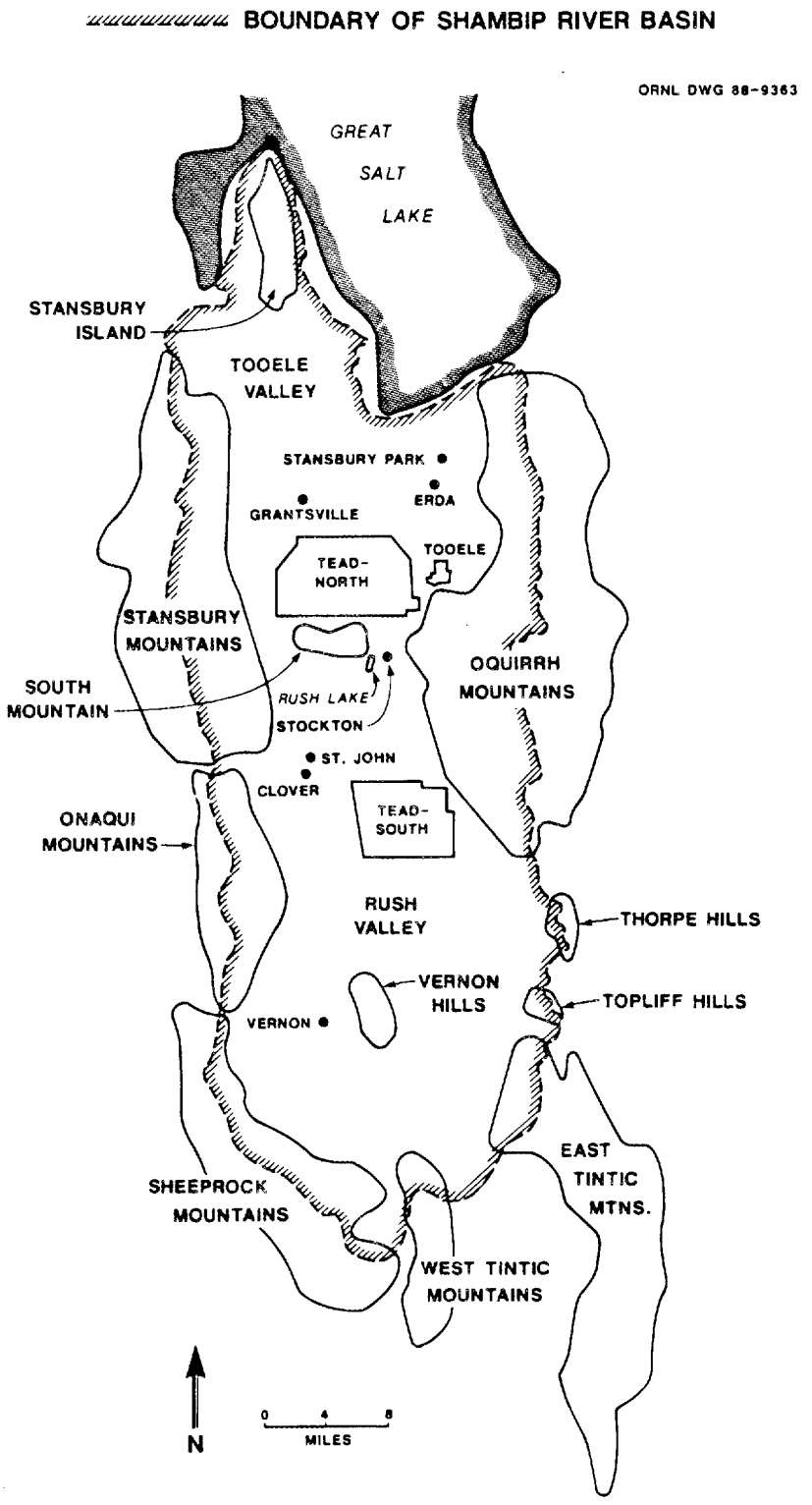

Fig. E.1-1. The Shambip River Basin.

Table E.1-1. Game and furbearer species, extents of their ranges, and their important habitats in the Shambip River Basin[a]

Species	Percent of basin occupied	Habitats
Mule deer	98	Primarily mountains and foothills
Wapiti (elk)	17	Oquirrh Mountains and foothills; proposed reintroduction to Stansbury Mountains
Bighorn sheep	0	Proposed transplant to Stansbury Mountains, including 5% of the Basin's acreage
Antelope	(*b*)	Proposed stocking in southern half of Basin, in 20% of the Basin's acreage
Desert cottontail and Nuttall's cottontail	87	Mountains and valleys
Muskrat	3[c]	Wetlands south of Great Salt Lake, Rush Lake
Mink	3[c]	Wetlands south of Great Salt Lake, Rush Lake
Cougar	(*b*)	Mountains and foothills
Black bear	(*b*)	Stansbury Mountains
Ring-necked pheasant	20	Central Basin, mostly in northern part
Chukar	28	Mountains and foothills
Sage grouse	32	Sagebrush habitat in western half of Basin south of Grantsville
Hungarian partridge	0.3	Cropland near Grantsville
Blue grouse	10	Mountains
Waterfowl	0.1	Rush Lake; wetlands south of Great Salt Lake

[a]The total area of the Basin is 311,250 ha (769,112 acres).
[b]No data available.
[c]Minimum habitat area. Stream habitat areas not included.

Approximately 20 species of raptors feed and nest throughout the Shambip River Basin. These include the golden eagle, red-tailed hawk, sparrow hawk, great-horned owl, short-eared owl, and others. Three other raptor species occur only as winter residents in the Basin (U.S. Department of the Interior 1983). Rush Valley is one of the most heavily used raptor wintering grounds in the lower 48 states (K. Nelson and R.F. John, Utah Division of Wildlife Resources, personal communications to V.R. Tolbert, Oak Ridge National Laboratory, Oak Ridge, Tenn., May 29, 1985). Also, many species of waterfowl, shorebirds, and wading birds are abundant on ponds, lakes, and reservoirs during spring and fall migration, and some of these species nest in the Basin. Furbearers include kit fox, coyote, bobcat, mink, and muskrat (U.S. Department of Agriculture 1986).

E.2 AQUATIC RESOURCES

Although the 100-km (60-mile) zone around the TEAD-South area includes Utah Lake and most of the Great Salt Lake, most of the surface water bodies in the immediate area of TEAD are ephemeral for at least part of their length (see Appendix D). The ephemeral nature of these water bodies limits the potential for aquatic habitats and for stable aquatic communities.

No perennial streams or water bodies occur within the TEAD-South boundaries (U.S. Department of the Army 1977). Most streams in the vicinity of the site are ephemeral, collecting runoff from adjacent mountains during downpours or snow melt and disappearing on the valley floor. In Fig. E.2-1, the intermittent streams in Rush Valley are indicated by dashed lines. The presence of aquatic resources in these streams depends on the amount of rainfall and the duration of water in these streams. Overall, the aquatic biota would be restricted to those invertebrate species with short life cycles or resistant life stages that could withstand dry conditions or to those species that could survive in isolated pools or impoundments on the streams.

Perennial surface waters in Rush Valley are discussed in Appendix D and are shown in Fig. E.2-1. Managed fisheries within the 50-km zone occur within Vernon Reservoir on Vernon Creek; Settlement Canyon Reservoir; Vernon, Ophir, North Willow, South Willow, and Clover creeks; and Kanaka, Horseshoe, and Clear lakes (see Fig. E.2-1). Fish species found in these water bodies include German brown, brook, cutthroat, and rainbow trout.

Rush Lake, which is the largest water body near the TEAD-South site, supports a variety of fish species. Fathead minnows and carp were the primary inhabitants of the lake prior to 1984 (U.S. Fish and Wildlife Service 1984). At that time, a bluegill and largemouth bass stocking program was undertaken. The lake currently supports a bluegill, largemouth bass, perch, and Utah chub fishery (K. Nelson and R. F. John, Utah Division of Wildlife, personal communication to V. R. Tolbert, Oak Ridge National Laboratory, Oak Ridge, Tenn., May 29, 1985).

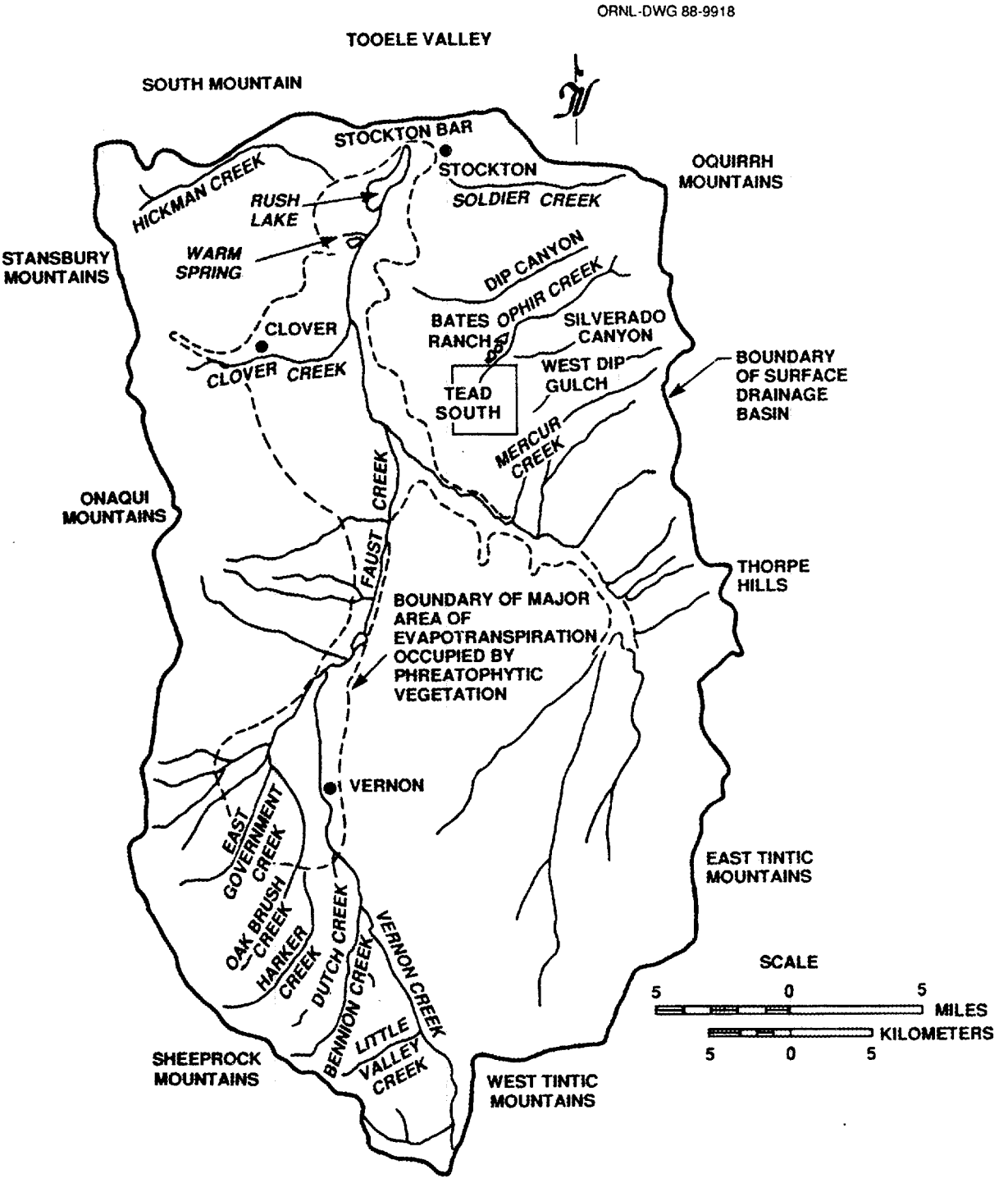

Fig. E.2-1. Major surface water discharge channels in Rush Valley. *Source:* Hood, J. W., Price, D., and Waddell, K. M. 1969. *Hydrologic Reconnaissance of Rush Valley, Tooele County, Utah,* Tech. Publication 23, Utah Department of Natural Resources, Division of Water Rights, Salt Lake City.

The aquatic life in the Great Salt Lake includes several species of algae, fungi, bacteria, protozoa, and three invertebrate species—two species of brine flies and one of brine shrimp (Felix and Rushforth 1980). Under normal conditions, no fish species inhabit the Great Salt Lake, although freshwater species inhabit the inflow area of major streams and waterfowl impoundments. Carp have recently expanded their range into the lake as salinity levels have decreased with increased precipitation (U.S. Department of the Interior 1985). The water level is currently high because of the heavier than normal precipitation that has occurred since 1982 (Perry and Perry 1985).

Utah Lake is the state's largest natural freshwater body, with a surface area of 390 km^2 (150 mi^2) (Perry and Perry 1985). It drains into the Great Salt Lake via the Jordon River. The fish community of Utah Lake includes white bass; walleye; channel catfish; black bullheads; spottail suckers; rainbow and brown trout (occasionally); redside, golden, and spottail shiners; black crappie; and green sunfish (K. Nelson and R. F. John, Utah Division of Wildlife, personal communication to V. R. Tolbert, Oak Ridge National Laboratory, Oak Ridge, Tenn., May 29, 1985, and to R. L. Kroodsma, Oak Ridge National Laboratory, Oak Ridge, Tenn., Apr. 20, 1988).

E.3 WETLANDS

The Great Salt Lake and surrounding freshwater wetlands (including freshwater impoundments for waterfowl) are important stopover areas for resting and feeding by migratory birds and for waterfowl reproduction. These wetlands provide nesting areas for thousands of waterfowl from both the Pacific and Central flyways (Montgomery 1984). Nongame, water-associated bird species also heavily use these wetlands (Perry and Perry 1985).

The area and depth of Rush Lake vary from more than 13 km^2 (5 mi^2) and up to 4.5 m (15 ft), respectively, during periods of high precipitation (U.S. Fish and Wildlife Service 1984) to the semblance of a mud puddle of several hundred acres (K. Nelson and R. F. John, Utah Division of Wildlife, personal communication to V. R. Tolbert, Oak Ridge National Laboratory, Oak Ridge, Tennessee, May 29, 1985), although some open water usually remains (U.S. Fish and Wildlife Service 1984). Rush Lake remains marshy even during dry periods, because water generally lies within 3 m (10 ft) of the surface. Recently, Rush Lake has been at a higher than normal water level as the result of higher than normal levels of precipitation that have occurred since 1982 (U.S. Fish and Wildlife Service 1984).

Plant species that can be found along the edges of Rush Lake are typical of those listed in Table E.3-1. During periods of low water levels, emergent vegetation (including sedge, rush, and saltgrass) may be common. Aquatic plants (including pondweed, chara, duckweed, *Polygonum*, *Elodea*, and *Rannunculus*) become predominant during high water levels. Common wetland species that may occur within the impact area are listed in Table E.3-1.

Table E.3-1. Wetland vegetation in the 100-km zone around Tooele Army Depot–South

Name	Name
alkali bluegrass	willow
alkali cordgrass	cottonwood
sedge	cheatgrass
rush	big sage brush
saltgrass	Russian thistle
tufted hairgrass	sand dropseed pickleweed
iodine bush	fowl mannagrass
aster Tolmie owlclover	pondweed
greasewood	chara
picklewood	duckweed
annual forbs	knotweed
watercress	*Elodea*
marsh marigold	*Rannunculus*
Russian olive	*Polygonum*

Undependable water supplies, along with the limited quantity and diversity of food sources and escape cover limits the benefit of Rush Lake, Clover Reservoir, and other water bodies to waterfowl and shorebirds. Nonetheless, Rush Lake (historically) and Clover Reservoir (since 1982) provide some suitable habitat for waterfowl nesting and are utilized for resting and feeding during spring and fall migrations (U.S. Department of the Interior 1983; U.S. Fish and Wildlife Service 1984).

Wetlands on the TEAD-South area are restricted to the northeast corner of the installation and are associated with the drainage area of Ophir Creek, which crosses the installation boundary. There are no wetlands associated with the proposed construction site for the Chemical Stockpile Disposal Facility.

E.4 THREATENED AND ENDANGERED SPECIES

No plant species listed, or proposed to be listed, by the U.S. Fish and Wildlife Service as threatened or endangered is known to occur on TEAD-South. The endangered clay phacelia (*Phacelia argillacea*) occurs within 100 km of TEAD-South, and *Astragalus lentiginosis* var. *pohlii*, which is a candidate to be reviewed for threatened or endangered status, occurs in Rush Valley and possibly other areas within 100 km of TEAD-South. Two other candidate species that may occur in the area are *Eriogonum nummulare* and *Centaurium namophilum* (U.S. Department of the Interior 1983).

Two FWS-listed threatened or endangered animal species, the bald eagle and peregrine falcon, occur within 50 km of the site. Bald eagles winter in the area from late October through March, with peak numbers in January and early February (U.S. Department of the Interior 1983). The number of eagles using the area fluctuates with the abundance of rabbits (K. Nelson and R. F. John, Utah Division of Wildlife Resources, personal communications to V. R. Tolbert, Oak Ridge National Laboratory, Oak Ridge, Tenn., May 29, 1985). Known critical roost areas are in the Oquirrh, Tintic, Sheeprock, and Stansbury mountain ranges as well as in certain areas in Cedar, South Skull, and Rush valleys. Peregrine falcons historically have nested in the mountains near TEAD-South and occasionally are sighted. The Utah Department of Natural Resources is preparing reintroduction plans for the peregrine. Potentially suitable habitats for peregrine falcon nest sites include high cliffs near riparian habitats with abundant prey species (U.S. Department of the Interior 1983). No potential nest sites are located on TEAD-South.

Five bird species that are candidates for federal listing as threatened or endangered occur in the Great Salt Lake area. These include the ferruginous hawk, Swainson's hawk, long-billed curlew, mountain plover, and western snowy plover (U.S. Department of the Interior 1983).

The federally listed aquatic endangered species that occur in the 100-km zone surrounding the site are the Lahontan cutthroat trout and the June sucker, which occur in Utah Lake. There are no federally listed aquatic species that occur within the 50- or 20-km zones around the TEAD-South area.

REFERENCES FOR APPENDIX E

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APPENDIX F

DESCRIPTION OF SITE-SPECIFIC SEISMICITY

F.1 REGIONAL SEISMICITY

A map of historically and instrumentally recorded earthquakes of magnitude 4 or greater within 320 km (200 mi) of TEAD-South is presented in Fig. F.1-1. This map shows that TEAD-South is located near the western edge of a zone of rather intense seismicity along the north-south trending Wasatch Mountains. This zone of intense seismicity correlates well with segmented Quaternary faults centered along the Wasatch Fault zone and bounded on the west by the Oquirrh Mountains Fault zone (Fig. F.1-2). Late Pleistocene surface ruptures have been identified in both fault zones and numerous Holocene ruptures have been recognized in the Wasatch Fault Zone between Provo and Ogden, Utah (Youngs et al. 1987). As described by 10 CFR Pt. 100, both fault zones are considered to be capable of producing major earthquakes in the future.

Youngs et al. (1987) used fault segment lengths and slip rate estimates to determine maximum expected magnitudes and recurrence intervals for earthquakes in the Wasatch Fault zone. Recurrence intervals for earthquake magnitudes greater than 7 range from 1350 to 2550 years for each of 6 fault segments from Ogden to Nephi (an average of 1900 years for each segment). The recurrence interval for major earthquakes throughout the Wasatch Fault zone is 330 ± 90 years. The Wasatch Fault zone is 50 km east of the chemical storage area at its closest approach. According to Youngs et al. (1987), the maximum expected magnitude along this fault zone is 7.5.

The recurrence interval for major earthquakes in the Oquirrh Mountains Fault Zone is less known. Youngs et al. (1987) estimate the recurrence interval for major earthquakes (magnitudes greater than 7) throughout the entire zone at 2200 ± 800 years. One of five discontinuous segments (the Oquirrh Marginal Fault) of this fault zone is 6.7 km east of the chemical storage area at its closest approach. Assuming the recurrence intervals of earthquakes in each segment are about equal, a magnitude 7 earthquake would be expected to recur about once every 11,000 ± 4,000 years along the Oquirrh Marginal Fault. The maximum expected magnitude along any one segment of the Oquirrh Mountains Fault zone is estimated by Youngs et al. (1987) to be between 7.0 and 7.25.

Figure F.1-3 (modified after Youngs et al. 1987) illustrates mean annual frequencies for various peak ground accelerations at Tooele, Utah, from all earthquake source zones. Relative contributions from the Wasatch Fault zone, the Oquirrh Mountains Fault zone, the West Valley Fault, and background seismicity are shown for comparison. Close examination of this figure reveals that earthquakes from the distant Wasatch Fault zone

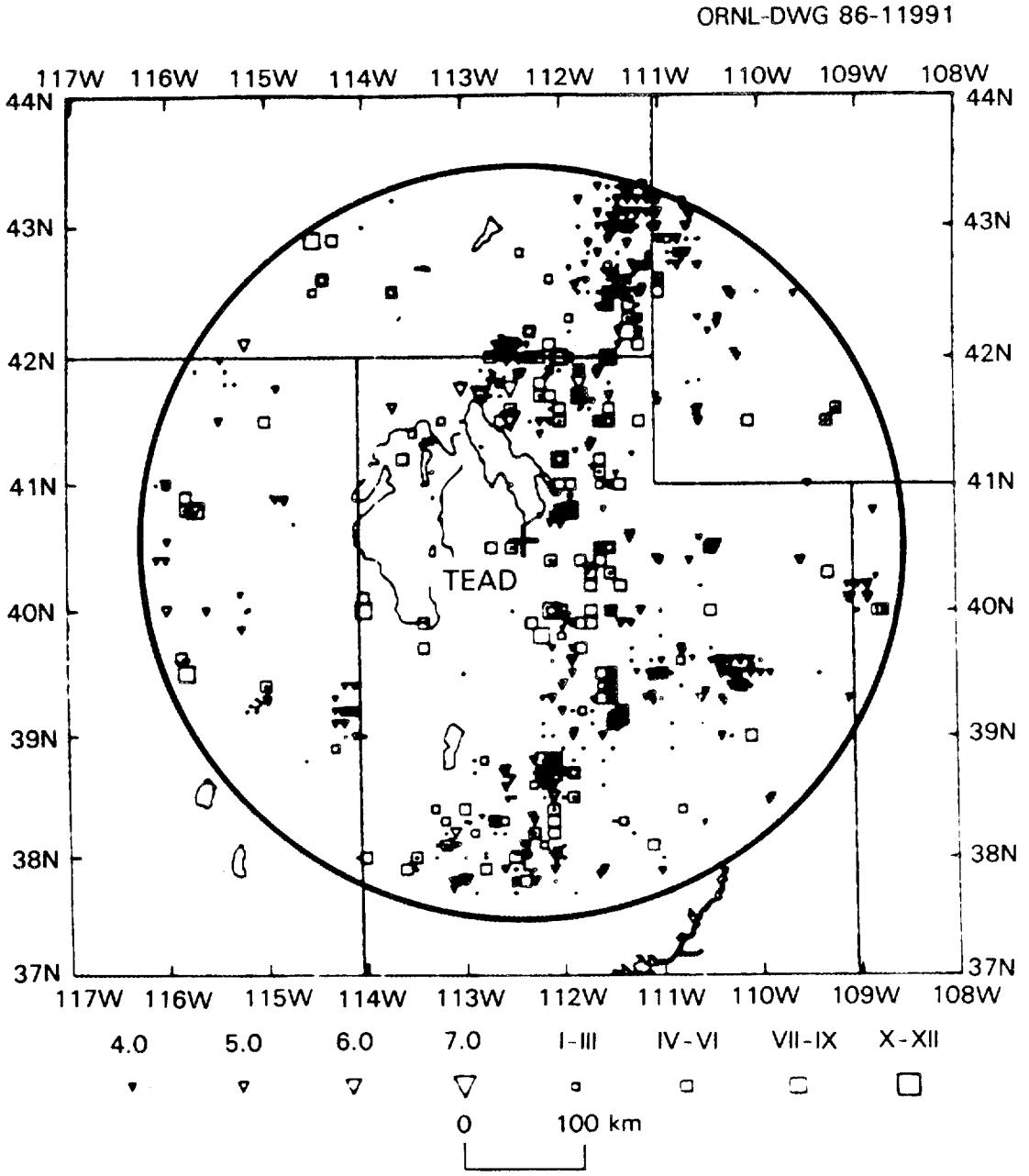

Fig. F.1-1. Historically and instrumentally recorded earthquakes of magnitudes equal to or greater than 4 within 320 km of Tooele Army Depot.

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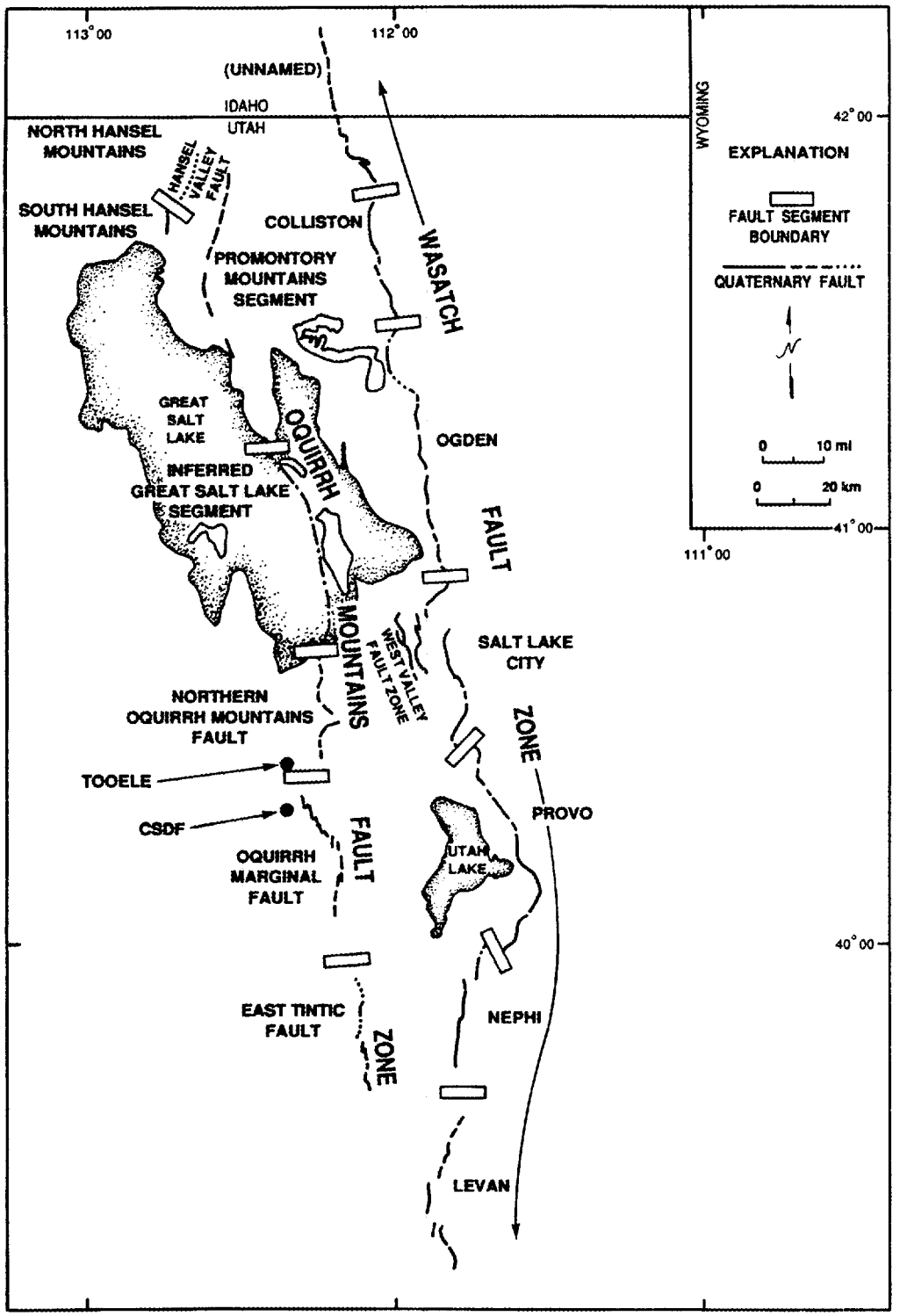

Fig. F.1-2. Quaternary and Holocene faults along the Wasatch Urban Corridor.

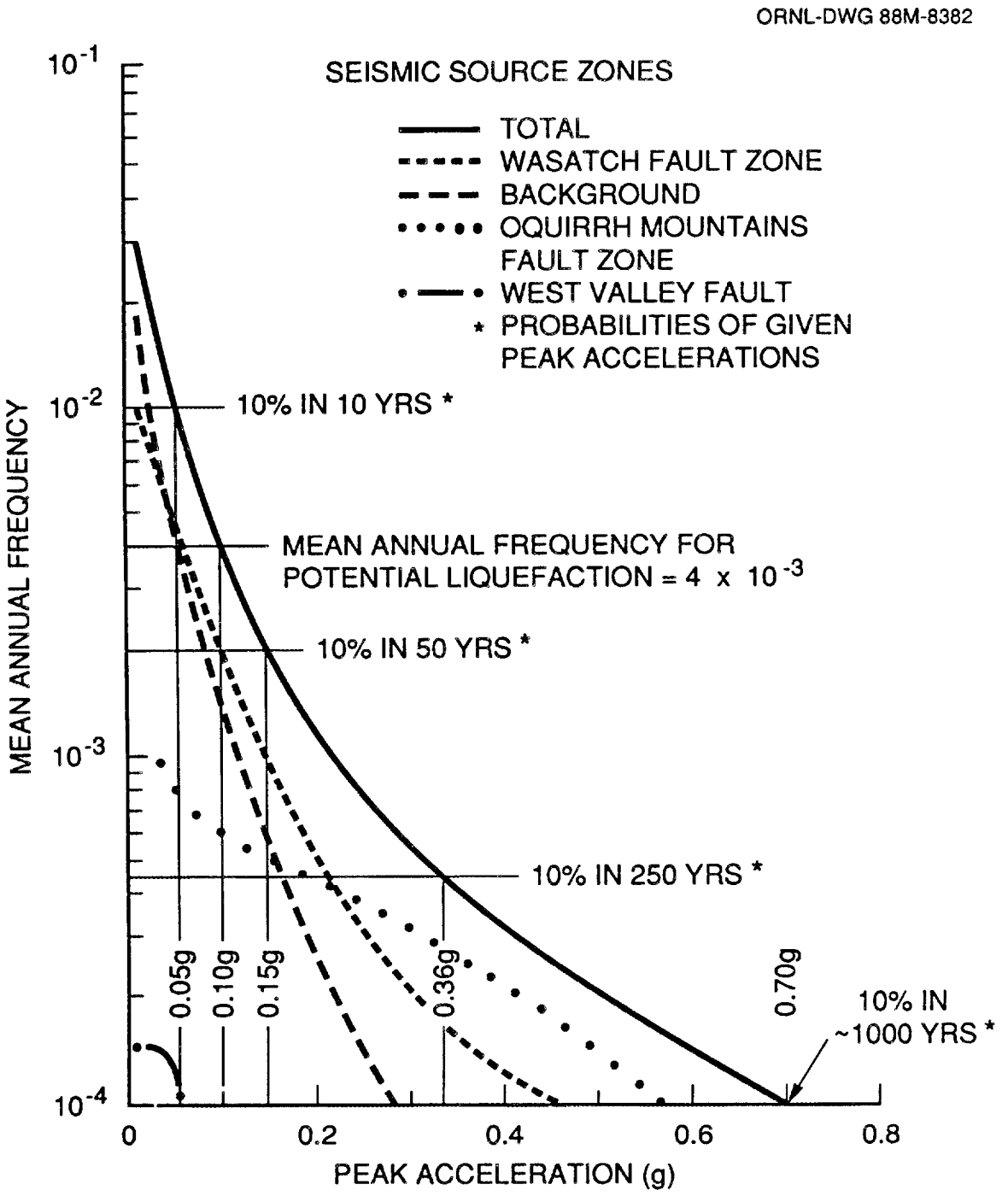

Fig. F.1-3. Mean annual frequency as a function of peak ground acceleration for various fault zones in the Wasatch Urban Corridor.

contribute the most frequent low amplitude (0 to 0.2 g) peak ground accelerations at Tooele, but earthquakes from the nearby Oquirrh Mountains Fault zone contribute the most frequent high amplitudes (greater than 0.2 g).

F.2 DETERMINISTIC ANALYSIS

In deterministic risk analysis, the objective is to predict the maximum expected ground motions at a site from maximum expected magnitudes of earthquakes and the proximity of capable faults. The maximum expected magnitude is determined from the length of surface rupture and average offset height created along the fault by a given earthquake. Predicted peak ground accelerations and durations of shaking at the site are based on appropriate magnitude-distance-attenuation relationships.

Various regulatory agencies define potentially active faults differently. According to Nuclear Regulatory Commission (NRC) standards, a fault is capable of producing significant earthquakes in the future if the ground surface has been ruptured at least once within the past 35,000 years or rupture has occurred repeatedly within the past 500,000 years (10 CFR Pt. 100). According to EPA's RCRA standards governing hazardous waste disposal sites, only Holocene (younger than 10,000 years old) faults are considered to be active (40 CFR Pt. 270.14).

Earthquakes along less prominent Late Quaternary faults in Tooele and Rush valleys (like those of the Oquirrh Mountains Fault zone) are potential sources of significant ground motion at TEAD. Jacobs Engineering (1988) extensively analyzed these faults for their earthquake potential. Figure F.2-1 shows the locations of all known potentially active faults in the vicinity of Tooele and Rush valleys, and Table F.2-1 lists seismic source parameters for these faults. Scarp heights and single event offsets range from 1 m to 25 m and 0.5 m to 4 m respectively. Many of these faults exhibit Holocene and Post-Bonneville surface ruptures, suggesting that major earthquakes have occurred on them in the last 10,000 and 15,000 years respectively. As defined by 10 CFR Pt. 100, these faults are capable of producing major earthquakes in the future.

The seismic source parameters in Table F.2-1 are used to determine mean peak ground accelerations and durations of shaking in Table F.2-2. Earthquakes along the Mid-Valley Horst and the Mercur Fault produce the highest predicted peak ground accelerations at the site. Potentially damaging earthquakes along the North Oquirrh Fault produce the longest predicted duration of shaking at the site. Although a maximum expected earthquake along the Wasatch Fault zone produces the longest duration of shaking at the site, its predicted peak ground acceleration is below the threshold of major damage (less than 0.20 g). The largest mean peak ground acceleration (0.71 g) and the longest one standard deviation above the mean duration of shaking (20 sec) are input parameters for determining the design seismic response spectra at the storage site. A conversion factor of 1.14 is used to convert the peak ground acceleration to the horizontal component of the ground acceleration (0.81 g).

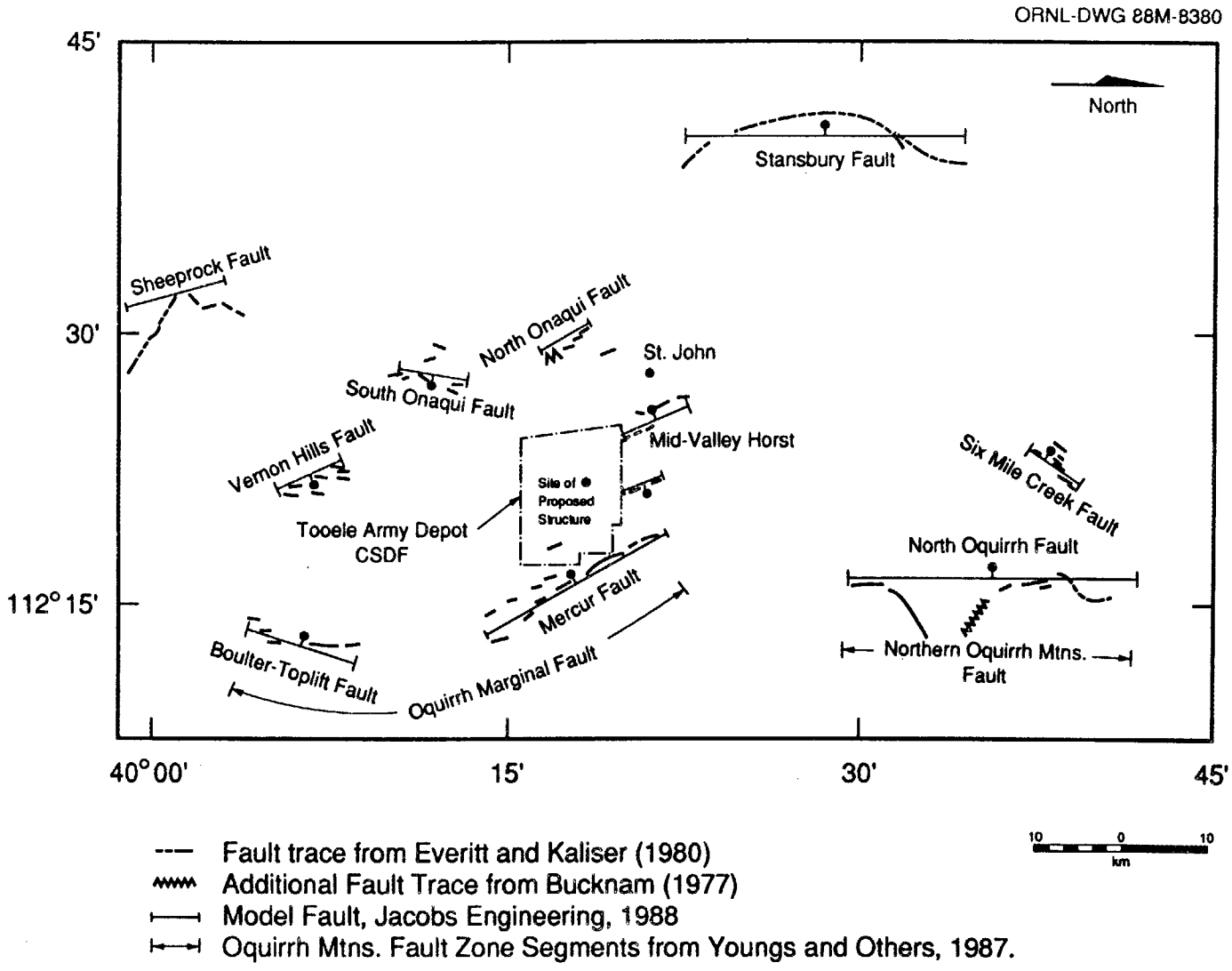

Fig. F.2-1. Potentially active faults within 30 km of the proposed facilities at Tooele Army Depot–South.

Table F.2-1. Seismic source parameters for Quaternary faults in Tooele and Rush valleys, Utah

Fault source	Age	Surface rupture length	Minimum distance from site (km)	Maximum exposure magnitude
N. Oquirrh[a]	Holocene	22.5	22.7	7.0
Six Mile Creek	Holocene	4.9	35.0	6.5
Stansbury[a]	Holocene[b]	22.3	26.4	7.1
South Mountain	Pleistocene[b]	3.1	18.9	6.4
Mid-Valley Horst:				
west side	Post-Bonneville	5.6	4.6	6.5
east side	Post-Bonneville	3.0	3.1	6.4
Mercur[a]	Post-Bonneville	15.8	6.7	6.9
North Onaqui	Pleistocene[b]	4.1	10.9	6.5
South Onaqui	Pleistocene	5.5	12.8	6.5
Boulter/Topliff	Post-Bonneville	9.1	22.8	6.7
Vernon Hills	Pleistocene[b]	5.1	19.5	6.5
Sheeprock	Holocene[b]	10.2	33.0	6.8
Wasatch/Salt Lake City seg.	Holocene	44.0	48.0	7.4

[a]Single event offsets are 2.0 m to 4.1 m, 2.4 m to 3.9 m, and 0.9 m to 1.9 m for the North Oquirrh, Stansbury, and Mercur faults respectively. Other single event offsets are presumably smaller in proportion to scarp heights and fault lengths.

[b]Precise age is uncertain.

Source: Jacobs Engineering Group, Inc. 1988. *Draft Geological-Seismological Investigation of Earthquake Hazards for a Chemical Agent Demilitarization Facility at the Tooele Army Depot, Utah,* contractor's report to the U.S. Army Engineering Division, Huntsville, Ala.

Table F.2-2. Peak ground motions at the storage site from maximum expected earthquakes in Tooele and Rush valleys

Fault source	Peak ground acceleration (g)[a]		Duration of shaking (in seconds)[b]	
	Median	84th percentile	Median (M)	M + one std[c]
North Oquirrh	0.20	0.27	13	20
Six Mile Creek	0.10	0.13	12	17
Stansbury	0.19	0.25	16	22
South Mountain	0.17	0.23	7	11
Mid-Valley Horst:				
west side	0.59	0.79	< 5	< 8
east side	0.71	0.96	< 5	< 8
Mercur	0.67	0.90	< 9	<12
North Onaqui	0.31	0.41	5	8
South Onaqui	0.26	0.36	5	8
Boulter-Topliff	0.17	0.23	11	16
Vernon Hills	0.18	0.24	8	12
Sheeprock	0.12	0.17	13	22
Wasatch/Salt Lake City segment	0.17	0.23	40	55

[a]Jacobs Engineering 1988 (based on data provided by Campbell 1987). *Draft Geological-Seismological Investigation of Earthquake Hazards for a Chemical Agent Demilitarization Facility at the Tooele Army Depot, Utah,* contractor's report to the U.S. Army Engineering Division, Huntsville, Ala.

[b]Based on data provided by Krinitzsky, E. L., Chang, F. K., and Nuttli, O.W. 1987. "Parameters for Specifying Magnitude-Related Earthquake Ground Motions," pp. 24, 26 in Miscellaneous Paper S-73-1, U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Miss.

[c]std = standard deviation.

F.3 PROBABILISTIC RISK ANALYSIS

The above analysis provides design criteria for the Safe Shutdown Earthquake (10 CFR Pt. 100). Such analyses say nothing about the probability of occurrence of such an event. Recurrence intervals for various maximum expected earthquakes vary by more than an order of magnitude, suggesting that some are more expected than others. Current NRC policy is based on deterministic risk analysis. This policy is now under review, and it is conceivable that probabilistic design criteria will be developed in the future. At present, no such guidelines are available for use in operating facilities where the consequences of failure may be catastrophic.

Standard building codes generally follow probabilistic guidelines of the Applied Technology Council (ATC) (1978). The ATC recommends that structures be designed to withstand peak ground accelerations having a 10% probability of being exceeded at least once in 50 years. However, these guidelines are not considered sufficiently conservative where there is potential for catastrophic loss of life.

Table F.3-1 summarizes annual and design life (5 years) probabilities of exceedance of given peak ground accelerations at TEAD from all earthquake source areas (based on data provided by Youngs et al. 1987). Peak ground accelerations with 10% probabilities of exceedance in 10, 50, and 250 years are listed for comparison.

Also shown in the footnotes to Table F.3-1 are peak ground accelerations from earthquakes of maximum expected magnitude on the Mercur Fault (discussed in Jacobs Engineering 1988) and the Oquirrh Marginal Fault (discussed in Youngs et al. 1987). Probabilities of exceedance of the latter accelerations are based on estimated recurrence intervals of magnitude-7-or-greater earthquakes along these faults. Jacobs Engineering divides the Oquirrh Marginal Fault discussed by Youngs into two segments, the Mercur and the Boulter-Topliff Faults (7 and 23 km east and south of the proposed incinerator site respectively). The results of Youngs et al. are slightly more conservative because the Oquirrh Marginal and Mercur faults are 50 and 16 km long, respectively, and their corresponding estimated maximum expected magnitudes are 7.0 to 7.25 and 6.9 respectively.

F.4 POTENTIAL FOR LIQUEFACTION AND RESONANCE

The potential for liquefaction at the location of the proposed toxic cubical is slight. According to the Electric Power Research Institute (1975), the highest liquefaction potential exists where shallow foundation materials are saturated, uniformly graded, cohesionless and fine grained sands at low relative density. According to open-file data provided by the U.S. Army Corp of Engineers (1988), the water table in the vicinity of the proposed toxic cubical is deep. Furthermore, strata beneath the site are predominantly cohesive claystones and siltstones of high relative density.

Table F.3-1. Probabilistic estimates for various peak accelerations at Tooele Army Depot

Mean peak acceleration (g)	Probabilities of exceedance in a given time frame (years): Annual	Plant life, 5 years	Plant life, 10 years	Plant life, 50 years	Plant life, 250 years	Return period[a] (years)
0.05	0.0105	0.0525	0.1			95
0.15[b]	0.0021	0.0105		0.1		475[b]
0.36	0.00042	0.0021			0.1	2,373
0.70	0.00010	0.0005			0.02	10,000
						Recurrence interval (years)
0.71	0.00006	0.00029			0.01	17,400[c]
0.67	0.00006	0.00029			0.01	17,400[d]
0.75	0.00009	0.00045			0.02	11,000[e]

[a]From all sources of seismic activity (based on data provided by Youngs, R. R., et al. 1987. "Probabilistic Analysis of Earthquake Ground Shaking Hazard Along the Wasatch Front, Utah," in *Assessment of Regional Earthquake Hazards and Risk Along the Wasatch Front, Utah,* U.S. Geological Survey Open-File Report 87-585, Reston, Va.).

[b]Applied Technology Council guidelines (Applied Technology Council 1978. *Tentative Provisions for the Development of Seismic Regulations for Buildings,* National Bureau of Standards Special Publication 510, U.S. Department of Commerce, Washington, D.C.).

[c]Maximum expected magnitude = 6.4 on the east side of the Mid-Valley Horst (from Jacobs Engineering Group, Inc. 1988. *Draft Geological-Seismological Investigation of Earthquake Hazards for a Chemical Agent Demilitarization Facility at the Tooele Army Depot, Utah,* contractor's report to the U.S. Army Engineering Division, Huntsville, Ala.).

[d]Maximum expected magnitude = 6.9 on the Mercur Fault (from Jacobs Engineering Group, Inc. 1988. *Draft Geological-Seismological Investigation of Earthquake Hazards for a Chemical Agent Demilitarization Facility at the Tooele Army Depot, Utah,* contractor's report to the U.S. Army Engineering Division, Huntsville, Ala.).

[e]Maximum expected magnitude = 7.25 on the Oquirrh Marginal Fault (from Youngs, R. R., et al. 1987. "Probabilistic Analysis of Earthquake Ground Shaking Hazard Along the Wasatch Front, Utah," in *Assessment of Regional Earthquake Hazards and Risk Along the Wasatch Front, Utah*, U.S. Geological Survey Open-File Report 87-585, Reston, Va.).

F.5 POTENTIAL FOR SURFACE RUPTURE

The potential for surface rupture by an earthquake during plant operations at TEAD is extremely low. Earthstore (1987), CH2M-Hill (1986), and the U.S. Army Corps of Engineers (1987) have collectively excavated more than 1 km of trenches to locate and characterize faults at the proposed site. These investigations led to the discovery of a number of Late Tertiary to Pleistocene age faults (Fig. F.5-1). According to Earthstore (1987), there are no on-site Holocene faults, based on the following observations.

- No Holocene soils were displaced by faults in any of the trenches.
- A continuous ancient soil horizon (underlying Lake Bonneville sediments where both are present and believed to be older than 125,000 years) is also unfaulted in all of the trenches.
- Examination of aerial photographs failed to reveal any Holocene scarps on site.
- Evidence of Holocene displacement on the Mid-Valley Horst dies out toward the south. The lack of displacement in the ancient soil horizon suggests a recurrence interval of at least 125,000 years (0.00001 annual frequency of occurrence) for surface rupture.

The lack of Holocene faults on site suggests that the proposed project satisfies EPA's RCRA standards (40 CFR Pt. 270.14) with respect to seismic risk. However, many of the faults identified in the above investigations have not been age dated with sufficient precision to rule out the possibility of recurring surface ruptures within the past 500,000 years.

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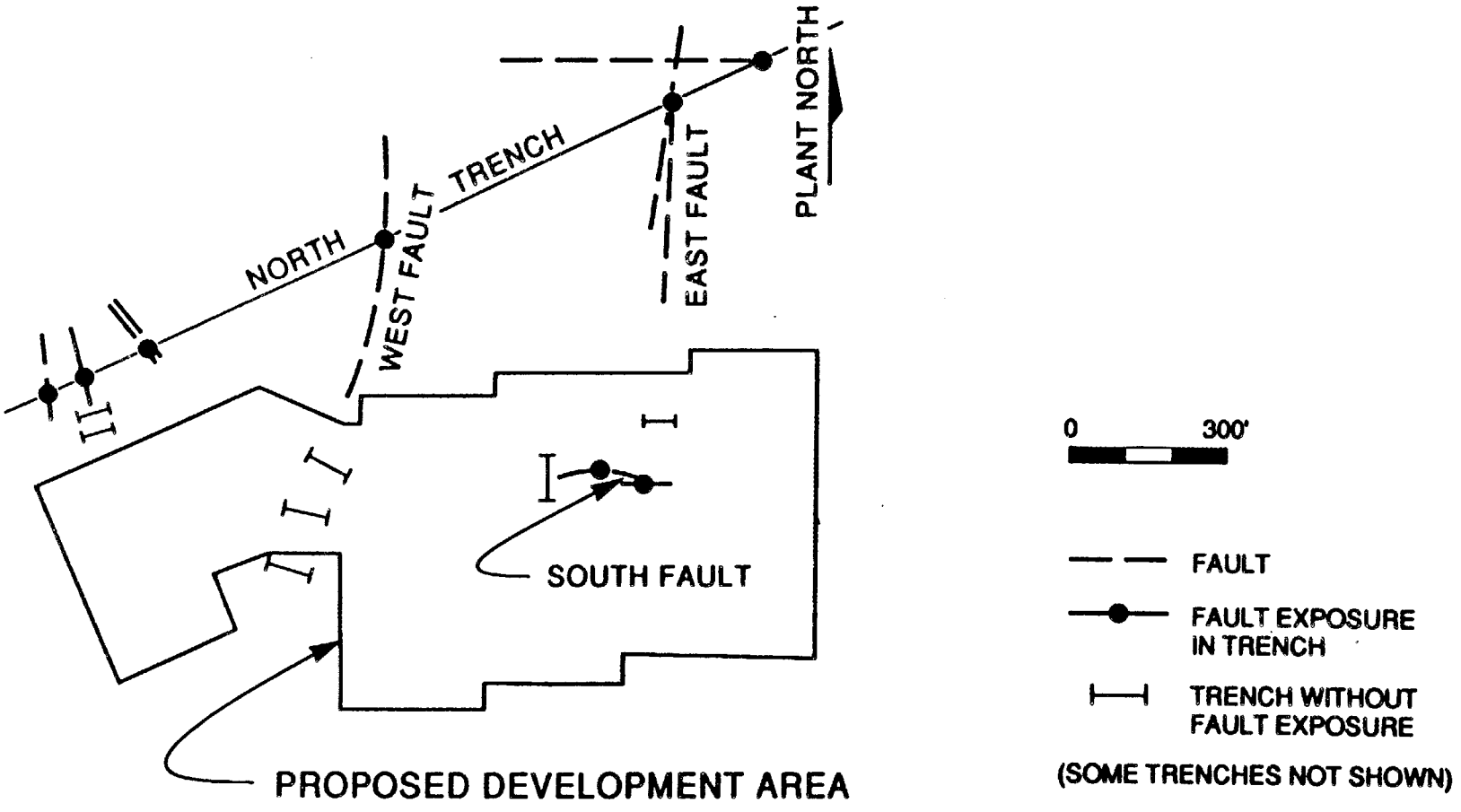

Fig. F.5-1. Potentially active faults on site and in the chemical storage area at Tooele Army Depot–South.

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APPENDIX G

DESCRIPTION OF SITE-SPECIFIC LAND USE

Outside of TEAD property, lands of the Shambip River Basin (as shown in Fig. G.1-1) are almost entirely open and undeveloped, with only about 0.5% of the Basin acreage in the communities of Tooele and Grantsville. Most of the Basin is used for grazing, and only a small fraction is in cropland. The total area occupied by all of Tooele County's croplands [8,980 ha (22,200 acres) (see Table G.1-1)] is equivalent to only 2.9% of the Shambip River Basin's 311,250 ha (769,100 acres).

The major crops of Tooele County are listed in Table G.1-1 and include wheat, barley, and alfalfa hay (Utah Department of Agriculture and U.S. Department of Agriculture 1987). Compared with Rush Valley, in which the proposed project is located (see Fig. G.1-1), the Tooele Valley supports most of the Shambip River Basin's croplands. Some wheat and barley fields in the vicinity of streams and water storage reservoirs are irrigated and provide significantly greater yields than dryland farms.

Beef cattle are the predominant livestock in the area, followed by sheep (see Table G.1-2). Grazing is the principal land use on most private property and state and federal lands found primarily in the southern half of the Basin. The Shambip River Basin provides excellent winter range for cattle.

The extensive public lands in the Basin provide ample opportunities for recreation. Hunting, hiking, and wildlife observation are popular activities.

The economic resources associated with land use are described in Appendix C.

REFERENCE FOR APPENDIX G

Utah Department of Agriculture and U.S. Department of Agriculture 1987. *Utah Agricultural Statistics*, Salt Lake City.

Table G.1-1. Statistics for 1986 croplands in Tooele County

Crop	Acres[a]	Percent of basin[b]	Yield per acre[c]
Wheat, irrigated	1,600	0.2	74 bushels
Wheat, not irrigated	2,100	0.3	31 bushels
Winter wheat[d]	3,200	0.4	47 bushels
Spring wheat[d]	500	< 0.1	62 bushels
Barley, irrigated	2,100	0.3	85 bushels
Barley, not irrigated	400	< 0.1	23 bushels
Corn	< 500	< 0.1	No data
Oats	< 500	< 0.1	No data
Alfalfa hay	12,500	1.6	3.6 tons
Other hay	2,500	0.3	2.0 tons
Total cropland	22,200	2.9	

Source: Utah Department of Agriculture and U.S. Department of Agriculture 1987. *Utah Agricultural Statistics,* Salt Lake City.

[a]Acres planted, except acres harvested for hay (one acre = 0.405 hectare).

[b]The percent of the Shambip River Basin was calculated assuming that all Tooele County cropland was contained entirely within the Basin's 311,250 ha (769,112 acres).

[c]Not all acres planted were actually harvested (one bushel = 0.035 m^3; 1 ton = 907 kg).

[d]Included in figures for wheat irrigated and not irrigated.

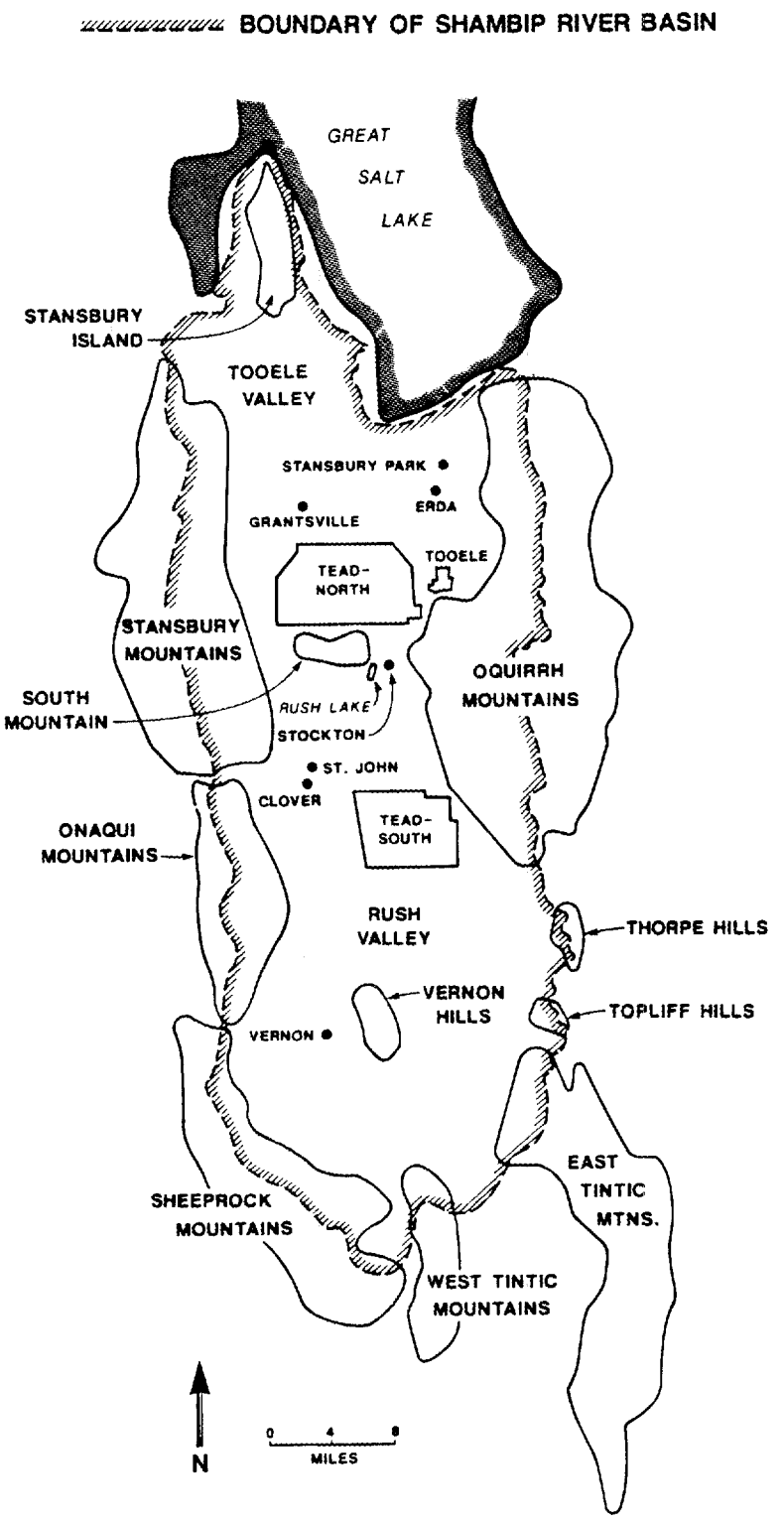

Fig. G.1-1. The Shambip River Basin.

Table G.1-2. Numbers of cattle and lambs in Tooele County, 1987

Livestock	Quantity
All cattle	22,000
Milk cows	< 500
Beef cows	14,900
Stock sheep and lambs	8,500

Source: Utah Department of Agriculture and U.S. Department of Agriculture 1987. *Utah Agricultural Statistics,* Salt Lake City.

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