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Department of Defense Hazardous Waste Site Remediation Issues in the Republic of Korea

Edwin H. Oshiba

DEPARTMENT OF DEFENSE HAZARDOUS WASTE SITE REMEDIATION ISSUES IN THE REPUBLIC OF KOREA

THESIS

Edwin H. Oshiba, Captain

AFIT/ENV/97D-20

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT/GEE/ENV/97D-20

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ISSUES IN THE REPUBLIC OF KOREA

THESIS

Presented to the Faculty of the Graduate School of Engineering

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Engineering and Environmental Management

Edwin H. Oshiba, Captain

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William B. Nixon, Major, USAF
Committee Member

Craig M. Brandt, Ph.D.
Committee Member

Mark N. Goltz, Ph.D.
Committee Chairman

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E ala mai kakou--
Imua a loa'a ka lei o ka lanakila!

Edwin H. Oshiba

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Abstract

The purpose of this research was to provide data to DoD decision makers regarding factors influencing hazardous waste site remediation policy for South Korea. Specifically, this study addressed the following issues: (1) Current and projected international agreements and U.S. and South Korean laws and policies relevant to hazardous waste sites at U.S. installations; (2) Fundamental objectives of DoD environmental policy makers; (3) Extent of soil and ground water contamination on DoD military installations in South Korea and its effect on peacetime military operations, occupational safety and health, military readiness, and warfighting capabilities; (4) Precedents set in other foreign countries relating to hazardous waste site remediation as a method of estimating future liability; (5) Availability of resources and technical capabilities (both U.S. and South Korean) to investigate and remediate hazardous waste sites at DoD military installations in South Korea; and (6) Opportunities for cooperation between the U.S. and South Korean military with regard to hazardous waste site remediation.

A combination of literature review (academic journals, and DoD, Air Force, USFK, and South Korean directives and policy), personal interviews, and field observations were employed to obtain the necessary data using within-method and between-method triangulation methodology.

This research resulted in identification of several primary factors which have an impact on promulgation of DoD hazardous waste site remediation policy for South Korea to include: (1) Risk to human health; (2) Congressional support for remedial actions overseas; (3) Cleanup precedents set in other foreign countries; (4) Korean public's perception of

DoD with regard to environmental stewardship; (5) Korean environmental law and effectiveness of enforcement; and, (6) The effect of hazardous waste sites on wartime capabilities. Additionally, the research highlighted several shortcomings associated with the current policy that DoD policy makers should consider. More study is required to assess the influence each issue has on DoD hazardous waste site remediation policy for Korea, based on the relative values of policy makers, in order to make sound recommendations for possible policy changes.

DEPARTMENT OF DEFENSE HAZARDOUS WASTE SITE REMEDIATION ISSUES IN THE REPUBLIC OF KOREA

I. INTRODUCTION

A. Overview

As environmental issues begin to grow in importance for the citizenry of the United States' strategic allies, the Department of Defense (DoD) should consider the impact of this growth on DoD operations within those allies which host United States military forces. Failure to adequately address the environmental concerns of host countries may lead to loss of access to the land, sea and air resources vitally important for accomplishment of the DoD mission. The Republic of Korea (ROK) has been, and will remain, an important strategic ally of the United States, located in an area with high potential for future conflict due to the presence of communist North Korea and their current economic and social difficulties.

Former Air Force Chief of Staff, General Thomas D. White, in a statement he made over 30 years ago, alluded to another equally important reason for studying the impact of growing environmental awareness in foreign countries hosting DoD operations: "The mission of the Department of Defense is more than aircraft, guns, and missiles. Part of the defense job is protecting the land, waters, timber, and wildlife—priceless natural resources that make this great nation of ours worth defending" (35). Although General

White's comments focused primarily on stewardship at home, DoD has embodied this concept in its worldwide operations and applied environmental stewardship abroad. In a speech to the Third Annual Pacific Rim Environmental Conference, Ms. Sherri Wasserman Goodman, the Deputy Undersecretary of Defense for Environmental Security, emphasized the importance of environmental stewardship for DoD operations specifically in Korea: "We should realize the growing public awareness [of the environment] in Korea will influence our bilateral relationship. Maintaining access to land . . . means we will have to demonstrate integrity in our management of Korea's natural resources. They will look to us as a model" (169:7).

As articulated by Ms. Goodman, the South Koreans are rapidly changing their attitudes with regard to the value they place on environmental quality. This changing attitude can have important implications on environmental policy decisions for DoD installations and, consequently, operations in Korea. In the United States, the discovery of hazardous waste sites at DoD installations played a significant role in influencing public perceptions of DoD as a steward of public lands. In a speech to the Society of American Military Engineers, former Secretary of Defense William J. Perry spoke of efforts to combat this perception: "We take our environmental responsibility seriously. Last year, a group of six national environmental groups signed a letter which said, 'Almost unnoticed, U.S. military personnel have become major players in the battle to clean up and protect our environment' " (136:334). Secretary Perry went on to say, "DoD spends over $2 billion a year to clean up about 10,000 contaminated sites, nearly half of the overall defense environmental budget," underscoring DoD's commitment to remediation of contaminated sites. The letter from the group of six national environmental groups mentioned by Secretary Perry indicates the public's growing recognition and acceptance of DoD environmental policy. Figure 1 further illustrates the government's commitment to cleaning up the environment. It depicts the historical appropriation of funds for the Defense Environmental Restoration Program (DERP)—funds allocated specifically for clean-up of past contamination problems on DoD installations within the United States. This again accentuates the importance of remediation, and since Congress reviews and approves the DERP appropriations, it also reflects the importance the U.S. public places on correcting past environmental problems.

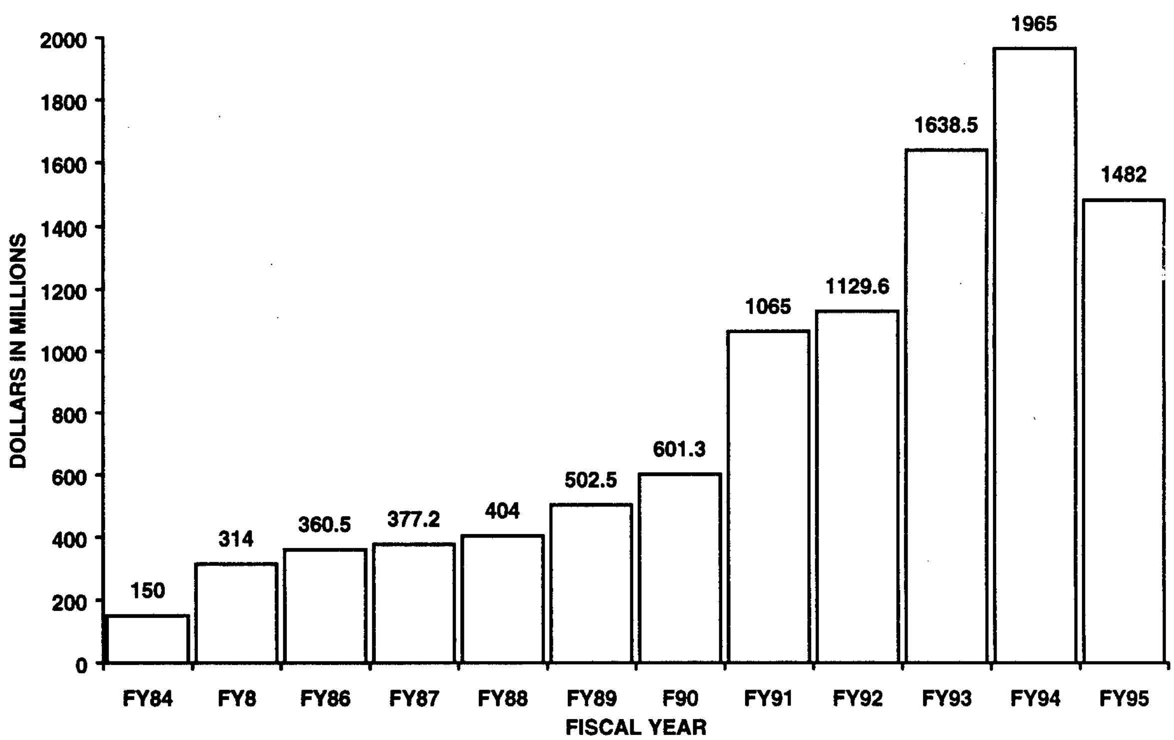

Figure 1: Historical Defense Environmental Restoration Program (DERP) Appropriations (35)

Just as Americans have judged the military's level of environmental concern by DoD's remediation actions, Korean citizens may base their perception of the United States on DoD's policy toward hazardous waste site remediation in Korea. Environmental non-governmental organizations (NGOs) in the ROK, numbering approximately 270 as of 1995, and local newspaper writers have criticized DoD installations for "casual treatment of U.S. military wastes" (14). Since these groups are restricted from entering DoD installations, activists have performed studies from beyond base boundaries, sampling storm water discharge and wastewater effluent, and measuring sound pressure levels from aviation operations (14). The NGOs publish findings from their investigations in newspapers and nation-wide environmental publications. Despite the obvious bias in their conclusions and unsubstantiated data (the articles do not mention methods of sampling and analysis), these groups are arguably successful in stirring some anti-American sentiment. DoD's policy of not releasing environmental information (including environmental standards and regulations for, and environmental assessments of units in Korea) to ROK officials only strengthens Korean perceptions of American impropriety and environmental neglect.

Hence, the goal of this research effort is to investigate DoD's hazardous waste site remediation policies in Korea and gather information relevant to effective policy formulation. While conceiving of alternative policy is not the primary focus, the study will highlight possible courses of action which may aid in averting negative repercussions on DoD operations in Korea and future economic liability due to environmental contamination. This work has important implications concerning the continued viability of DoD installations and operations in the ROK, as United States access to Korean land, sea, and airspace may depend, at least in part, upon the Korean public's perception of the U.S. as a good environmental steward.

B. Background

DoD operates and/or maintains over 100 installations throughout the Republic of Korea, totaling some 244 square kilometers with a plant replacement value of nearly $1.5 billion (see Appendix 1-1). This amounts to 0.25 percent of the total land area of South Korea, including some prime real estate in the heart of Seoul. Mountains cover approximately 70 percent of Korea's land area, however, making much of the peninsula unsuitable for agricultural, commercial, or urban development (89; 138). If this percentage is taken into consideration, DoD occupies nearly 1 percent of the total developable land area in South Korea. The magnitude of DoD's presence in Korea underscores the importance of proper environmental stewardship, especially in a country with limited land for economic growth and development.

Little, if any, research has been accomplished concerning hazardous waste site remediation at DoD installations in the ROK. Recent base closures in Europe may provide some insight into issues relevant to the legal ramifications of remediation overseas relating to base closure; however, in-depth analyses of similar actions on the Korean peninsula remain to be conducted. In fact, differences in cultural values, natural resource stores, economic base and current economic growth, environmental technologies capabilities, state of environmental policy development, state of environmental degradation, and national emphasis on environmentalism make any comparison between the European experience and Korea tenuous at best. In addition, the effects of environmental degradation on mission readiness and warfighting capability of U.S. forces in Korea are largely unknown.

Historically, DoD programs (especially overseas) focused primarily on explicitly bolstering defensive and offensive military capabilities, with little attention given to environmental issues. Air Force Instruction (AFI) 32-7006, *Environmental Program In Foreign Countries*, states the Air Force policy is to "restore sites contaminated by Air Force activities to sustain current operations and eliminate known imminent and substantial dangers to human health and safety." The AFI goes on to state, "a comprehensive DoD restoration policy does not exist" (45:2). The Office of the Secretary of Defense (OSD) issued a policy for installations or facilities identified for return to the host nation. The policy allows the use of U.S. funds only for maintenance, repair, or environmental restoration to eliminate known imminent and substantial dangers to human health and safety, "or work" required by applicable U.S. law, treaty or international agreement (39:7). AFI 32-7006 implements Air Force Policy Directive (AFPD) 32-70, *Environmental Quality,* which is based on DoD Directive 6050.16, *DoD Policy for Establishing and Implementing Environmental Standards at Overseas Installations*.

Army Regulation (AR) 200-1, *Army Environmental Program In Foreign Countries*, and Navy Instruction (OPNAVINST) 5090.1B, *Navy Environmental and Natural Resources Program Manual*, also mention similar policy objectives—comply with DoD environmental restoration policy for overseas installations, which according to AR 200-1, "states that, U.S. funds will not be spent for environmental restoration beyond the minimum necessary to sustain current operations or eliminate known, imminent and substantial dangers to human health and safety, unless required by applicable U.S. law, treaty, or international agreement." (48:14-3). In the case of each service, attention is given only to those sites which affect the current mission or installation personnel, except when legally overridden by U.S. or ROK statutory requirements.

Past presidential regimes in Korea supported this emphasis on mission with little or no regard to the environment. However, the election of President Kim Young Sam, in February 1994, provides clear evidence of a shift in the socio-political attitude in Korea; economic growth is now coupled with domestic reform (political, social, and environmental). Chapter 3, Literature Review, will provide data supporting this shift. Given the importance of South Korea to U.S. military and economic strategic interests in the region, especially in light of the current political instability in North Korea since the death of former North Korean President Kim Il-Sung, the continued minor altercations between North and South Korea (the recent discovery of a North Korean submarine infiltrating South Korea's coastline is but one example), and the potential development of a nuclear weapons capability in the North, attention should be focused on environmental issues that may hamper cooperation between the U.S. and the Republic of Korea.

C. Problem Statement

The current DoD hazardous waste site remediation policy considers cleanup action only when current operations are adversely affected, or when the site presents an imminent health hazard. Other important considerations—future access to land, sea, and air resources based on the present level and projected releases of contamination at DoD installations in the ROK, fundamental objectives of decision makers and stakeholders, both at higher headquarters and installation level within DoD and the Korean government, and the political climate and prevalent and projected environmental attitudes in Korea—were not explicit players in policy formation and eventual remediation decisions. While the cost of remediation may be hefty today, future environmental liabilities due to these considerations may exact an even greater cost tomorrow.

Existing research in hazardous waste site remediation in Korea has focused primarily on specific, non-DoD sites, primarily large industrial centers such as Chinhae Bay, Ulsan and Pusan, and Korea's urban centers. Since current DoD policy requires significant hazard levels to personnel or impact on current operations as justification for remedial action, DoD studies are limited to cursory Environmental Compliance Assessment and Management Program (ECAMP) and Environmental Compliance Assessment System (ECAS) audits, and installation-driven inspections of only the most critical environmental problems. Investigation of the underlying factors behind DoD hazardous waste site remediation policy formulation remains unstudied despite growing environmental concerns on the part of the Korean government DoD environmental leadersand despite potential remediation liability in future years.

D. Research Objective

The objective of this research is to gather data on the aforementioned considerations which influence DoD hazardous waste site remediation policy in South Korea. Specifically, information gathering efforts target:

1. Current and projected international agreements and U.S. and ROK laws and policies relevant to hazardous waste sites at U.S. installations

2. Fundamental objectives of DoD environmental policymakers

3. Extent of soil and ground water contamination on DoD military installations in Korea and its effect on U.S. peacetime military operations, occupational safety and health, military readiness, and warfighting capabilities

4. Precedents set in other foreign countries, particularly relating to hazardous waste site remediation in conjunction with base realignment and closure as a method of estimating future liability and Korean environmental regulation which may affect military operations in the ROK

5. Availability of resources and technical capabilities (both U.S. and Korean) to investigate and remediate hazardous waste sites at DoD military installations in Korea

6. Opportunities for cooperation between the U.S. and Korean military with regard to hazardous waste site remediation. In particular, this area will focus on possible environmental technology transfer between the U.S. and the ROK, perhaps furthering cooperative efforts and enhancing military and political relationships between these allies.

Literature review, field observations, and personal interviews using a scripted interview tool are employed to obtain the necessary data. Interviews encompass personnel from the Office of the Deputy Undersecretary of Defense for Environmental Security; Headquarters, United States Forces Korea (USFK); the two largest Air Force bases in Korea (Osan Air Base and Kunsan Air Base); representative Army installations in Korea (Camp Carroll, Camp Casey, and Camp Market); the Korean Ministries of the

Environment and National Defense; environmental researchers at civilian universities in Korea; and Korean environmental remediation consultants and contractors. The vast array of interviewees from diverse backgrounds and leadership positions helps shape a unique perspective into the problem of hazardous waste sites in Korea, lending insight into key factors which may ultimately affect policy recommendations. A site visit to Korea to conduct field observations allows first-hand data gathering at the operational level from both Army and Air Force organizations.

U.S. Naval operations in Korea are not explored to the same degree as Air Force and Army operations in this thesis due to the limited scope of naval presence (a single facility at Chinhae) and the nature of their mission, namely providing sealift capability for transportation of supplies and equipment to and from the Korean peninsula. The USFK environmental office agreed with this assessment; they believed investigation beyond a review of Navy environmental publications would not add unique findings to the overall research effort (89).

The inclusion of Korean environmental leader perspectives may seem inconsequential to DoD policy decisions; however, environmental policy reform by the ROK government accompanied by increasingly stringent laws and regulations in future years are definite possibilities given the current climate of change in Korea. Predicting the impact of these laws and regulations on DoD organizations, both financially and operationally, could be vitally important to continued military access to land, sea, and air resources in Korea, without which the DoD mission could not be accomplished.

Perspectives from the ROK government could provide valuable insight into DoD environmental policy formulation in Korea, ensuring adequate readiness in future years.

E. Scope and Limitations

The research is limited to hazardous waste sites and remediation of those sites; other environmental concerns, such as air and surface water pollution, and cultural and natural resource conservation, are not included. A number of alternatives for modifying the current remediation policy are presented in the conclusion. However, analysis of options, using such tools as decision analysis, multi-attribute decision analysis, and analytical hierarchy theory, will not be included. These subjects may serve as separate research topics for future study, but lie outside the scope of this research effort.

In order to gain insight into possible future environmental liability from hazardous waste sites, DoD experience with regard to base realignment and closure in foreign countries is summarized. Precedents form an important part of international environmental law. Remediation of contaminated sites in foreign nations falls within this body of law. Base realignment and closure actions in Germany and Canada could serve as excellent examples of the future consequences of poor environmental practices today. However, comparing and contrasting divergent cultures from countries as dissimilar as Korea, Germany, and Canada prove an overwhelming task in and of itself, and are foregone in this treatise. Instead, the focus will be on the precedents themselves, their effect on international environmental, and, consequently, their effect on DoD remediation policy for Korea.

Results from this study will be forwarded to the Office of the Deputy Undersecretary of Defense for Environmental Security; USFK; Headquarters U.S. Air Force; and Headquarters, Pacific Air Forces to serve as a basis for furthering policy development regarding hazardous waste site remediation in the ROK.

F. Opportunities for Technology Transfer

The need to investigate technology transfer is apparent when considering the immaturity of Korea's environmental program. While the Koreans have developed their program on a "fast track," Korea still faces substantial development in their environmental infrastructure—legislation, regulation and enforcement. Assuming environmental issues will continue to gain support in the social and political arenas, and pollution will continue to increase as the nation becomes increasingly industrialized, the need and demand for state-of-the-art pollution abatement and remediation technologies will also increase. One source for these technologies is the United States. Korea recognizes and fully supports technology transfer initiatives with the United States, evidenced by creation of the United States-Asia Environmental Partnership and negotiations with various entities within the U.S.

DoD, as an ambassador of the U.S. in Korea, has a unique opportunity to forge a lucrative partnership with the Korean government by introducing and openly discussing environmental technology transfer issues with their Korean counterparts. The partnership benefits Korea by providing environmental technologies without the lag time and expense associated with research, development and testing. A technology-sharing partnership benefits DoD by strengthening defense ties and fostering continued cooperation between the U.S. and one of her critical strategic allies in East Asia. Also, technology sharing may serve as a bargaining tool in reducing or eliminating liability associated with existing hazardous waste sites on DoD installations. Remediation costs make up a large percentage of the total costs associated with closing a base in the United States. While similar liability may not currently exist in Korea, the possibility for such liability always exists, especially considering the shortage of tillable land and the ever-increasing population and industrial burden Korea faces in the future. Elimination or reduction of DoD remediation liability in exchange for compensatory environmental technologies can be an important consideration for U.S. diplomats during future U.S./ROK Status of Forces Agreement (SOFA) or other international agreement negotiations. The possibility of such an exchange, along with its associated cost savings, merits including technology transfer opportunities in this thesis.

G. Terms Explained

A few terms used repeatedly throughout this chapter and the text are defined in Appendix 1-2. Technical definitions were primarily obtained from the United States Environmental Protection Agency (USEPA) *Information Resources Directory* (164). Military documents and personal experience serve as the basis for DoD acronyms.

II. METHODOLOGY

A. Overview

Since the scope of the thesis focuses on data gathering rather than quantitative analysis of data, qualitative research techniques were selected to analyze findings. A comprehensive literature review was combined with field observations and interviews of personnel both within the Korean and United States governments in a "triangulated" approach to determine factors which should serve as the basis for the hazardous waste site remediation policy in Korea. Development of decisions and decision-making processes from these findings were left as a future endeavor. Subsequent research may apply various decision analysis techniques, such as multi-attribute utility theory, or analytic hierarchy process (28:576-599), to the information gleaned through this effort to form revised policy. The intent was to provide a firm foundation upon which OSD, USFK, and Pacific Air Forces decision makers can define future remediation policy. Consideration of all relevant factors from stakeholder perspectives—the Korean government and DoD; base-level and headquarters personnel; and the academic and consulting communities—should allow decision makers to formulate policy capable of supporting mission objectives within budgetary and political constraints.

Interviews with selected Korean academicians at various institutions and engineers employed in environmental firms provided valuable information concerning the state-of-the-art and developing remediation technologies within Korea. This interview process, known as "elite interviewing" (101:94), greatly contributed to our comprehension of current and prospective Korean remediation capabilities. A thorough canvas and acknowledgment of these capabilities are critical, should DoD decide to emulate stateside remediation policies in Korea, since the local civilian contracted workforce would ultimately perform any remedial action necessary. While obtaining the public perspective on this issue would add additional credence to the study, it was felt that in-depth interviews with Korean government officials would suffice as a "surrogate" public.

B. Background

Answering the research question required choosing an appropriate methodology which would facilitate both identification of the major factors influencing promulgation of DoD hazardous waste site remediation policy for Korea, and validation of those factors using scientifically-acceptable theories. In general, research methodologies fell into two broad categories based on the method of data analysis, and the data themselves—quantitative methods and qualitative methods. Since the data would drive the methodology eventually chosen, an initial survey of data sources relevant to the thesis subject seemed prudent before deciding on a particular methodology to employ.

DoD regulatory documentation was the first stop in initially researching the subject of DoD remediation policy in Korea. Air Force, Army, Navy and DoD policy all espoused a general regard for human health and safety and protection of the environment "consistent with available funding" (40:2). Military regulations and instructions, however, were directive in nature, and provided little explanation and background into the basis for policy decisions. Other documents, such as assessments, studies, and journal articles, gave comprehensive detail of specific problems, but lacked substantive explanation of policy issues—they maintained a narrow focus on the remediation problem at hand, and accepted DoD remediation policy without question. In addition, the majority of those documents focused primarily on non-DoD sites, and investigated air and wastewater pollution problems as opposed to the research areas of interest—groundwater and soil contamination. However, the documents were not dismissed entirely, since they provided some insight into Korean environmental awareness as measured by the breadth and stringency of environmental laws and ROK environmental law enforcement.

The initial foray into existing literature on DoD hazardous waste site remediation issues in Korea indicated the lack of source documents, as previously surmised. This almost immediately eliminated quantitative techniques from consideration as a research methodology since robust findings would be difficult without a sufficiently large database. Gathering additional data and conducting rigorous analyses of the data to support quantitative results were possible, but deemed unlikely under the constraints of the research period.

With the unfavorable outlook associated with utilization of quantitative methods for this thesis, qualitative methods were investigated for their applicability and usefulness in fulfilling the research objectives. Historical research in the social sciences espoused qualitative methods as extremely useful in discovering basic relationships, the types of relationships which this thesis aimed to discover. Marshall identified several research categories, listed in Table 1, as good candidates for qualitative research. The applicability of her categories to this thesis seemed to strongly support use of qualitative methods over quantitative methods.

Table 1: Categories of Research Applicable to Qualitative Methods (101)

Types of Research	Describes This Thesis?
Research that cannot be accomplished experimentally for practical reasons	YES
Research that delves in depth into complexities and processes	YES
Research for which relevant variables have yet to be identified	YES
Research that seeks to explore "where" and "why" policy	YES
Research on innovative systems	YES
Research on informal and unstructured linkages and processes in organizations	YES
Research on real, as opposed to stated, organizational goals	YES

In addition to indicating the advantages of using qualitative methodologies for this study, the first look at existing remediation literature pointed out that using literature review would not suffice as a single methodology for ascertaining the basis for remediation policy in Korea. In fact, after reviewing a number of qualitative research methods, it became apparent that no single methodology would meet the needs of this study. A combination of methodologies would be required to fully understand the factors affecting remediation policy decisions for Korea. Jick called such mixed-method qualitative studies convergent methodology or "triangulation" (77:135)

C. Triangulation

A distinct tradition advocating the use of multiple research methods exists within the social science research realm and resulting literature. Various terms describe mixed-method research theory—convergent methodology, multi-method/multi-trait (101), convergent validation, or "triangulation" (126:187). The "triangulation" metaphor originates from navigation and military strategy, which utilize multiple reference points to locate an object's exact position (135:273). Given basic principles of geometry, multiple viewpoints allow for greater accuracy. Similarly, researchers may improve the accuracy of their judgments by collecting different kinds of data bearing on the same phenomenon. In social sciences, use of triangulation can be traced to Campbell and Fiske (16) who developed the idea of "multiple operationism" in 1959. They argued that more than one method should be used in the validation process to ensure variance reflected that of the trait and not of the method. Convergence or agreement between two or more methods, ". . . enhances our belief that the results are valid and not a methodological artifact" (101:268).

Denzin identified four basic types of triangulation: (1) data triangulation—the use of a variety of data sources in a study; (2) investigator triangulation—the use of several different researchers or evaluators; (3) theory triangulation—the use of multiple perspectives to interpret a single set of data; (4) methodological triangulation—the use of multiple methods to study a single problem (34:301). The logic of triangulation methodology rests on the premise that:

> no single method ever adequately solves the problem of rival causal factors. . . Because each method reveals different aspects of empirical reality, multiple methods of observations must be employed. This is termed triangulation. I now offer as a final methodological rule the principle that multiple methods should be used in every investigation. (34:28)

In short, qualitative and quantitative methods should be viewed as complementary rather than rival methods. The term "triangulation" also works metaphorically in recalling the world's strongest geometric shape—the triangle—the form used to construct geodesic domes and pyramids.

1. Between-Methods Triangulation.

Methodological, or "between (or across) methods," triangulation serves as a means of cross validation when two or more distinct methods are found to be similar and yield comparable data (34: 302). It represents the most popular use of triangulation, and involves use of multiple methods to examine the same dimension of a research problem. The methods employed here include literature review, field observations, and personal interviews. Each singular qualitative research methodology has various strengths and shortcomings; methodological methods triangulation seeks to exploit each method's strong suits while neutralizing disadvantages. More detailed explanation of each particular method is included later in this chapter.

2. Within-Methods Triangulation.

Jick and Glaser and Strauss mention a fifth type of triangulation which reflect multiple comparison groups, known as "within-method" triangulation (69:7; 77:136). This is akin to Denzin's data triangulation. For this research, the comparison groups studied using personal interviews and field observations include:

- Department of Defense
    - Top-level policy makers (DUSD(ES); DoD General Counsel; Office of the Secretary of the Air Force; and Headquarters, Air Force)
    - Mid-level policy makers (Headquarters, USFK and Eighth United States Army; 7th Air Force)
    - Installations (Air Force and Army)
- Republic of Korea

- Government policy makers (Ministry of Environment—MOE)
- Military policy makers (Ministry of National Defense—MND)
- Academicians and research scientists
- Private-industry environmental engineers

The literature review focused on similar cross-cultural groups, but in a broader sense. Source groups included:

- Department of Defense (OSD; DoD General Counsel; Air Force; Army, Navy; USFK)
- Republic of Korea (MOE; MND; ROK research institutes; academic institutes)
- ROK and U.S. academic journals

The comparisons between groups in within each research method maximize credibility of research conclusions in two fundamental ways:

a. By precisely detailing the many similarities and differences of the various comparison groups, the researcher gains a heightened awareness of the boundary conditions of the study. The boundary conditions in this case include the major players in formulating hazardous waste site remediation policy in Korea—the Deputy Undersecretary of Defense for Environmental Security, United States Forces in Korea, and the Republic of Korea. By using multiple comparison groups, much of the burden of delimiting relevant boundaries for the theory is lifted from the reader's shoulders. Any limitations or biases resulting from the research method itself become more readily visible, since a wider cross-section of the population has been surveyed than if a single group was examined. In short, replication is built into the research.

b. The researcher obtains a global answer to the research question at hand. The multiple groups studied here have contribute in some portion to the remediation policy within Korea. Information gained from only one of the groups may bias the final conclusion, and really provides a single-culture perspective to a multi-cultural problem. It would be foolish to assume U.S. environmental policy was the sole influencing factor in formulation of remediation policy in Korea. DoD installations, while "owned" by the United States, will someday return to Korean control. Also, DoD operations have a significant impact not only within the installation boundaries, but on the surrounding environment as well. Plumes of hazardous material migrating in underground aquifers may eventually cross base boundaries; soil excavated from construction sites with known or unknown concentrations of hazardous material may easily end up in Korean landfills; household hazardous wastes generated by DoD personnel are transported in Korean solid waste trucks. A multi-group investigation of this problem seems only reasonable when considering such inter-cultural, inter-governmental factors.

3. Combination of Between- and Within-Method Triangulation.

The use of information from historical literature, interviews, and field observations in this thesis effort from a number of different source groups represents employment of both methodological triangulation and data triangulation. A data triangle lies within each qualitative methodology, which taken together, form the methodology triangle. This "double triangle" (Figure 2) strengthens the overall thesis pyramid and forms a strong foundation upon which to build conclusions concerning hazardous waste site remediation policy formulation.

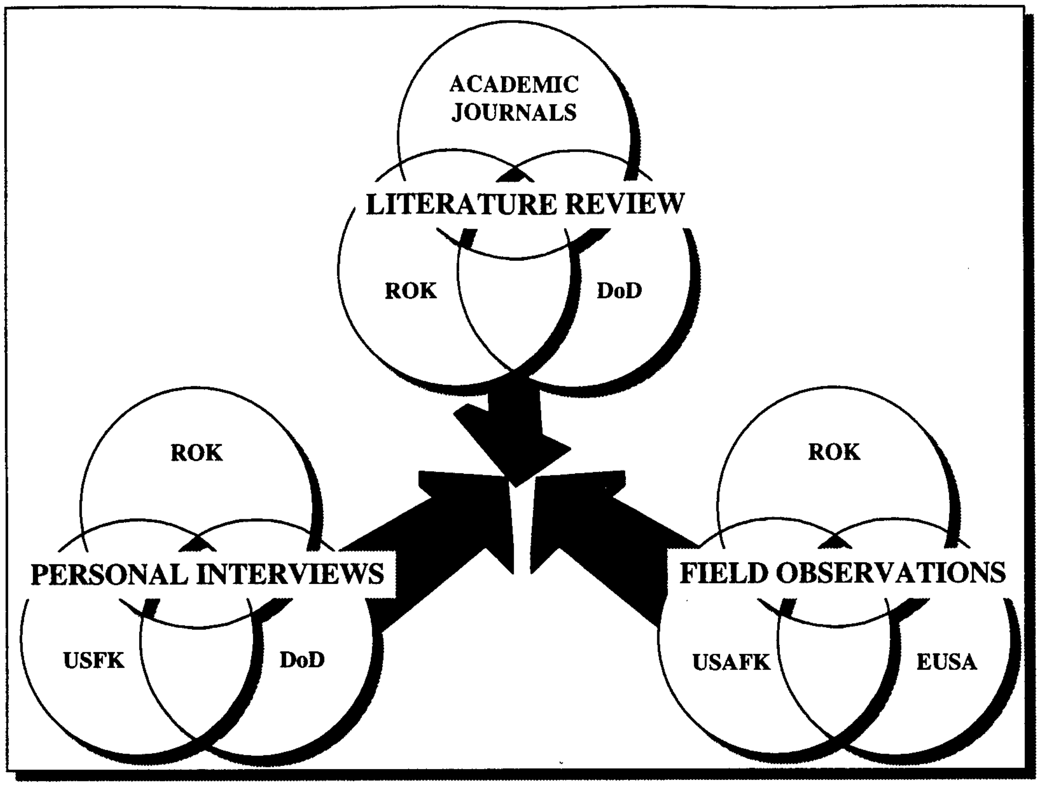

Figure 2: Between-Method and Within-Method Triangulation Methodology

D. Triangulation Methods—Literature Review

Review of relevant literature provides a base upon which to focus the study by establishing the relevant facts and theories pertinent to the thesis subject. It also helps focus the study by discovering how others have approached similar concerns. However, reviewing literature can present a predicament in qualitative inquiry by biasing the researcher's thinking and reducing openness to findings in the field. Use of data found in literature that actually may not be well-grounded in fact may also bias conclusions reached in the research effort. Alternatively, the literature review may proceed concurrently with the other methodologies, permitting verification among the processes of data collection through personal interviews and field observations (101:38-40).

A combination of these two approaches is employed here to counterbalance the advantages and disadvantages mentioned above. Literature from qualitative, social science journals and texts serves as the basis for the methodology used to attack the research questions. Information gathered from various academic journals, texts, reports, studies, environmental compliance assessments, U.S. law, international agreements, and DoD instructions and regulations set the backdrop from which to begin the investigation. From these sources come the initial and boundary conditions for the study, somewhat akin to modeling a groundwater remediation problem. Likely topics affecting future remediation policy—past and present environmental conditions on DoD installations in Korea, current DoD environmental policy and regulations, Korean environmental policy and regulations (past, present, and projected), fundamental objectives of DoD policy makers, remediation technology issues, and remediation precedents set in other foreign countries—arise from reviewing existing literature. Additional literature obtained from site visits to Korea (14-27 June 1997) and the Pentagon (5-8 August 1997) build upon the current literature database. In-depth interviews and field observations conducted during the site visits serve to crosscheck data acquired prior to and during the site visits.

While somewhat limited in availability, the existing literature base chosen for this thesis comprise the following categories:

- United States environmental law
- DoD policy and regulations (Presidential Executive Orders, DoD directives and instructions, Air Force policy directives and instructions, Army and Navy regulations)

- Korean government policy and regulations
- International agreements (Status of Forces Agreement, treaties, Memoranda of Agreement between DoD installations and local governments)
- Results of DoD-sponsored environmental studies and assessments
- Independent studies by academicians, research institutes or other interested parties
- Academic journal articles
- Texts
- Articles and documents from electronic sources (Internet)

Information from each category contributes a major portion to the research objectives and helps broaden and substantiate this study's final conclusions by presenting data from a variety of different sources and viewpoints.

E. Triangulation Methods—Field Observations

In studying environmental remediation/restoration, field observations would likely be associated with measurement-taking, data gathering, and other site characterization tasks. Important data to gather in determining whether or not a site requires remediation would fall in such categories as subsurface geology and hydrology; contaminant type(s), source(s), and amount(s); future land use; and identification of receptor groups and pathways to receptors. A few of these physical phenomena can be observed during the site visit process—fuel-stained soil, oily sheen on surface water, petroleum substance seeping from the ground, etc. These observations can serve as an aid to understanding and assessing current environmental conditions. Field observations allow the researcher to overcome some of the difficulties associated with literature review by providing a first-hand account of the system being studied. The evaluator is better able to understand the context within which the hazardous waste site remediation program operates. Understanding the program context is essential to a holistic perspective, critical in this data gathering effort. In addition, data gained from field observations may validate findings as read in literature or described by an interviewee, if indications of contamination are present at ground level. Narration and numbers found in historical data or garnered through face-to-face interviews can be verified and analyzed for bias or misinterpretation. Other strengths of field observations include:

1. The evaluator may have the opportunity to observe things those intimate with the program may overlook. Oftentimes, an outsider may bring a fresh perspective to an old or difficult-to-solve problem, such as remediation of hazardous waste sites within budgetary, regulatory, and international treaty constraints.

2. The evaluator can learn about things program participants may be unwilling to discuss in an interview. Interviewees may be unwilling to provide information on sensitive topics, or on hazardous waste sites for which a solution has not been implemented. Careful observations while touring base facilities may uncover potential remediation candidates not mentioned by interviewees or listed in the literature.

3. The evaluator gains personal knowledge and direct experience as resources to aid in understanding and interpreting the problem. Literature review may provide the relevant facts, but the "relevancy" may not become apparent without contextual application. The researcher absorbs information and forms impressions which go beyond what can be fully recorded in even the most detailed field notes (126:205).

The principal objective of this research is to understand policy and factors which influence policy rather than characterizing actual site conditions. Therefore, field observations focus not only on physical indicators of possible hazardous waste sites when conducting site visits, but also on the individuals responsible for remediation policy formulation and execution. This type of observational technique appears most often in the social science fields, where observation entails the description of events, behaviors, and artifacts in the *social setting* chosen for study (101:79). The social setting here includes not only the Korean natural environment, but the DoD environmental community at installation-level and headquarters-level (joint headquarters in Korea, Office of the Secretary of Defense, and Office of the Secretary of the Air Force).

The danger in fieldwork lies in selective observations—obtaining a "snapshot" in time of the problem at hand, or observing only those occurrences which support the hypotheses. Another potential pitfall which may occur in field observations concerns researcher bias—altering the hypotheses to fit the observations, or creating new hypotheses altogether. As early as 1965, Glaser and Strauss noted that observation is quickly accompanied by hypothesizing. When hypothesizing begins, researchers, no matter how unbiased they may feel, can no longer remain passive observers. They are "naturally drawn into actively finding data pertinent to developing and verifying [their] hypotheses" (69:6). Literature review and interviews attempt to neutralize the single-point-in-time essence of field observations as well as natural observer bias by providing historical data on the subject at hand to crosscheck findings in the field.

F. Triangulation Methods—Personal Interviews

Interviews attempt to bridge the gap between the third-person analyses associated with literature review and field observations by obtaining information which cannot be readily observed or may have been overlooked in previous studies—information stored within personnel intimate with the subject at hand. Interviewing is the oral counterpart of written surveys, both of which can be classified as survey research (33:120). Survey research methods involve obtaining information directly from the participants by posing questions orally, on paper, or in some combination. In any case, the response comes directly from the source of the data—the survey participant. The central value of the interview as a research procedure is that it allows both the interviewer and interviewee to explore the meaning of questions and answers, and obtain information not readily observed or not recorded in historical literature. In a written survey, the possibility exists for misinterpretation, leading to erroneous results. In addition, the lack of definitive historical information concerning formulation of hazardous waste site remediation policy in Korea makes creating a written survey instrument difficult at best. The aim here is to obtain a firm understanding of the factors influencing remediation policy and their importance in the decision-making scheme, not to weigh known factors and determine the best decision, or to obtain central tendencies and statistical inferences on a large population for which written survey instruments serve as the best tool for the researcher.

A number of disadvantages limit the usefulness of interviews, however. Interviewees can only report their perceptions of, and perspectives on, what has happened. Those perspectives and perceptions are subject to distortion due to personal bias, anger, anxiety, politics, and simple lack of awareness. Interview data can be greatly affected by the emotional state of the interviewee at the time the interview takes place. This emotional state can be highly influenced by the interviewer. For example, when interviewees feel sensitive about topics raised in an interview, the answers, if provided at all, are likely to be invalid. Interview data are also subject to recall error and self-serving responses (126:245).

Combining field observations and literature review with personal interviews helps to overcome many of these disadvantages, just as interviews serve as a crosscheck for field observations and literature review. Historically, field observations emerged as the dominant methodology for social and engineering research. Pioneering studies by Taylor and Gilbreth, and Mayo's classic Hawthorne studies conducted at the Hawthorne Works of the Western Electric Company, attest to the early preeminence of fieldwork (3:35). Following World War II, the balance of work shifted markedly to surveys, largely a consequence of the development of public-opinion polling in the thirties (134:1335). The debate between advocates of each research method centered around the "superiority of 'deep, rich' observational data and the virtues of 'hard, generalizable' survey data." (134:1335) Works by Seiber (134), Trow (146), and Zelditch (183) concluded that field observations and interviews used individually had serious drawbacks, and hinted at using a combination of both methods to neutralize some of the disadvantages. First and foremost, fieldwork can confirm interviewee testimony by physical observation. Obvious evidence of contamination, such as from leaking drums, stained soil, and floating petroleum products in roadside ditches, may spur additional questions and further investigation. Familiarity with the installation through site visits can also strengthen rapport and ease tensions with prospective interviewees, decreasing fear of reprisal for negative testimony and anxiety from speaking with an "unknown" researcher. Site visits also aid researchers in gaining a holistic perspective of conditions unique to a particular installation and enabling better interpretation of interview and literature results. By conducting site visits and reviewing literature prior to conducting personal interviews, these advantages are maximized.

1. Selection of Interview Guide Approach.

A number of different methods exist within the context of interviewing. The three general types are:

- Informal conversational interview
- Standardized open-ended interview
- General interview guide approach. (126:280)

The approaches differ in the extent to which interview questions are determined and standardized before the interview occurs. The informal conversational interview relies entirely on the spontaneous generation of questions during the interview—no questions are prepared beforehand. Although the most flexible of the three interview methods, this researcher eliminated the informal conversational interview approach as an option due to translation difficulties associated with interviewing Korean government officials, researchers, and the military. The standardized open-ended interview consists of a set of questions carefully worded and arranged with the intention of taking each respondent through the same sequence and asking each respondent the same questions with essentially the same words. Flexibility in probing is limited, and this type of interview is used primarily when attempting to minimize variation in the questions posed to interviewees.

While reducing the possibility of bias coming from having different interviews for different people, it limits comprehensiveness and flexibility, key components in this study given the cultural and political differences of groups involved.

The general interview guide approach involves outlining a set of issues to be explored with each respondent before interviewing begins. The issues in the outline need not be taken in any particular order and the actual wording of questions is not determined in advance. The guide simply serves as a basic checklist during the interview to ensure relevant topics are covered. The key advantages to this method of interviewing are flexibility coupled with preparation in advance of the interview. Flexibility enables the interviewer to explore more fully the opinions and behaviors of respondents; the total collection of responses should contain more and varied detail than would data from a structured interview. This is a key concern for this thesis, given the lack of historical information available. The interviewer remains free to build a conversation within a particular subject area, to word questions spontaneously, and establish a conversational style while focusing on a particular, pre-determined subject. This spontaneity increases the comprehensiveness of the data, while use of a guide makes data collection somewhat systematic for each respondent. Advance preparation in outlining issues enabled Korean translation prior to the interview, affording seamless dialogue with minimal confusion.

2. Interview Guide Questions.

In using the interview guide approach, a list of questions was assembled for each group of respondents (Appendix 2-1). The questions hit upon major topics of discussion considered important in gathering data relevant to remediation policy formulation in Korea.

Assembling the list also ensured the same basic information was obtained from each interviewee by covering similar material. The guide provided topics or subject areas within which the interviewer may explore, probe, and ask questions elucidating and illuminating the particular subject. The questions were categorized according to principal objectives set by the thesis researcher:

- Current environmental policy issues
- Projected environmental policy
- Technology and technology transfer issues
- Basic information (name, location, position within environmental policy hierarchy, educational background, etc.).

The questions were forwarded four weeks in advance of the site visits to ensure maximum preparation by each respondent and language translation for Korean interviewees. Early dispatch of the interview questions also aided in establishing a non-threatening rapport with interviewees. Previous discussions with DoD participants indicated concern due in most part to fear of reprisal for negative research outcomes, and stereotyping of the visit as an "inspection" or "assessment" of managerial performance. Forwarding questions prior to the actual site visit and interview dispelled those fears, and created an atmosphere conducive to productive information transfer between the interviewer and interviewee.

Questions were based on standard interview questions as proposed by Patton (126:290-293):

- Experience/Behavior Questions: What a person does or has done; these questions are aimed at eliciting descriptions of experiences, behaviors, actions, and activities that would have been observable had the observer been present.
- Opinion/Values Questions: What people think about the issue (hazardous waste site remediation in Korea); these questions are aimed at understanding the cognitive and interpretive processes of the respondents. Examples include:
  - "What do you believe?"
  - "What do you think about __________ ?"
  - "What would you like to see happen?"
  - "What is your opinion of __________ ?"
- Knowledge Questions: Ascertain the respondent's store of factual information. These questions assume certain things are considered known (DoD policy, USFK policy, and AF policy on hazardous waste site remediation). They attempt to discover gaps in information flow from top-level decision-makers to managers in the field.

Although there are no fixed rules in sequencing of questions in an interview, suggestions offered by Patton were followed (126:294). The interviews began with non-controversial questions (present behaviors, activities, and experiences). These asked for relatively straight-forward descriptions, requiring minimal recall and interpretation. Interviewers encouraged respondents to talk descriptively, attempting to elicit detail in their answers. Once experience/activity were described, questions soliciting interpretative, opinionated responses were asked. The literature suggested opinions/feelings were likely to be more accurate (reflective of true conditions) once respondents verbally relived the experience, grounding those feelings and opinions in relation to past or current experiences (126:294).

Background/demographic questions are usually boring—they epitomize what people do not like about interviews or surveys (126:295). In order to focus attention on remediation policy, these questions were formatted into a written document and kept until the substance of the interview was over. Respondents were allowed to complete the document at this time, ensuring the interviewees remained concerned about the important topic at hand—remediation policy—throughout the questioning.

As depicted in Appendix 2-1, identical questions were not asked of all interview participants. A concept called "elite interviewing" was employed to capitalize on the unique perspectives and expertise of each category of interviewees. An elite interview is a specialized method of interviewing that focuses on a particular type of respondent. "Elites" are considered to be the influential, prominent, and well-informed people in an organization or community. They are selected for interviews based on their expertise in areas relevant to the research. Hence, the individuals listed in Table 2 were chosen from their respective organizations as the "experts" in their particular field.

The topics/questions in Appendix 2-1 were derived prior to determining potential interviewees, to ensure adequate coverage of all areas relevant to understanding conditions influencing hazardous waste site remediation policy in Korea. Once the list of questions was reviewed and critiqued by members of the thesis committee, experts in each group—

DoD, Korean government, military, and academics—were chosen based on their knowledge base.

Table 2: List of Interviewees

Organization	Interviewees	Expertise
Government, Republic of Korea		
Korean Institute of Science and Technology	Senior Researcher	1. Korean Remediation Technology 2. Korean Government Environmental Policy
Ministry of Environment (ROK)	Minister	Korean Government Environmental Policy
Ministry of National Defense (ROK)	Director, Office of Environmental Management	Korean Military Environmental Policy
Academicians, Republic of Korea		
Hankuk University	Professor(s), Environmental Engineering	1. Korean Remediation Technology 2. Korean Government Environmental Policy
Honam University	Professor(s), Environmental Engineering	1. Korean Remediation Technology 2. Korean Government Environmental Policy
Inha University	Professor(s), Environmental Engineering	1. Korean Remediation Technology 2. Korean Government Environmental Policy
Kangwon University	Professor(s), Environmental Engineering	1. Korean Remediation Technology 2. Korean Government Environmental Policy
Korea University	Professor(s), Environmental Engineering	1. Korean Remediation Technology 2. Korean Government Environmental Policy
Kwangwoon University	Professor(s), Environmental Engineering	1. Korean Remediation Technology 2. Korean Government Environmental Policy
Seoul National University	Professor(s), Environmental Engineering	1. Korean Remediation Technology 2. Korean Government Environmental Policy
Environmental Consulting Firms, Republic of Korea		
Hanwha Energy Company	Director, Environmental Programs	Korean Remediation Technology
Department of Defense		
Deputy Undersecretary of Defense, Environmental Security (DoD)	Principal Assistant Deputy Undersecretary	DoD Environmental Policy Overseas
Deputy Undersecretary of Defense, Environmental Security (DoD)	International Affairs Staff	DoD Environmental Policy Overseas
Department of Defense General Counsel	US/ROK SOFA Matters	International Agreements

Table 2: List of Interviewees (Continued)

Organization	Interviewees	Expertise
Headquarters, United States Air Force		
Secretary of the Air Force, Environmental Safety and Occupational Health	Chief	DoD Environmental Policy Overseas
Headquarters, US Air Force	Chief, Environmental Division	Air Force Environmental Policy Overseas
Headquarters, United States Forces Korea and Eighth United States Army		
United States Forces Korea/Eighth United States Army (DoD)	Chief, Environmental Programs Office	1. DoD Environmental Policy in Korea
United States Forces Korea/Eighth United States Army (DoD)	Environmental Programs Office Staff	1. DoD Remediation Policy in Korea 2. Korean Government Environmental Policy
Headquarters, 7th Air Force		
7th Air Force	1. Civil Engineer 2. Staff Judge Advocate	1. DoD Environmental Policy in Korea 2. International Agreements
Individual DoD Installations, Republic of Korea		
8th Fighter Wing	1. Chief, Environmental Flight 2. Staff Judge Advocate 3. Bioenvironmental Engineering	1. DoD Environmental Policy in Korea 2. DoD Installation Condition 3. International Agreements 4. Local Public Perceptions
51st Fighter Wing	1. Chief, Environmental Flight 2. Staff Judge Advocate 3. Bioenvironmental Engineering	1. DoD Environmental Policy in Korea 2. DoD Installation Condition 3. International Agreements 4. Local Public Perceptions
607th Material Maintenance Squadron	Chief, Civil Engineering	DoD Installation Condition (Collocated Operating Bases)
Camp Carroll	Chief, Environmental Office, Department of Public Works	1. DoD Environmental Policy in Korea 2. DoD Installation Condition 3. Local Public Perceptions
Camp Casey	Chief, Environmental Office, Department of Public Works	1. DoD Environmental Policy in Korea 2. DoD Installation Condition 3. Local Public Perceptions
Camp Market	Chief, Defense Reutilization and Marketing Office, Environmental Programs	1. DoD Environmental Policy in Korea 2. DoD Installation Condition 3. Local Public Perceptions

Advantages to this type of interviewing process include the exceptional breadth and depth of information gained from these respondents because of their positions within their organizations. Elites can provide an overall view of their organization, and are more likely than other informants (lay citizens, other military personnel) to be familiar with the legal, medical, environmental, and financial structure of their organization. They are also able to report on their organization's policies, past histories, and future plans (101:94).

Disadvantages of working with experts center around the selection of interview questions and the researcher's role in the interview process. Elites, in general, resent restrictions placed on them by narrow, stereotypical questions. They desire more active interplay with the interviewer. In the course of an interview, considerable variation may occur in the degree of control, with the respondent occasionally assuming the questioner's role. Elites tend to respond well to inquiries related to broad areas of content and to a high proportion of intelligent, provocative, open-ended questions, allowing them the freedom to use their knowledge and imagination (101:94). The choice of an interview guide approach versus use of a scripted interview reflects these considerations, as does the depth and unrestricted nature of the interview questions.

In addition, when working with elites, great demands are placed on the ability of the interviewer, who must establish competence in the eyes of the elite by exhibiting a thorough knowledge of the topic, or have a pre-established, favorable reputation of competence in the area of study (101:94). The use of the primary thesis advisor as one of the interviewers easily met this requirement. He is a well-established and recognized expert in the field of *in-situ* bioremedation, and has military experience in the civil engineering career field as a retired lieutenant colonel in the Air Force. The author of this thesis served as the second interviewer. Timing of the interviews allowed the author to gain sufficient knowledge in hazardous waste site remediation and DoD environmental policy in the United States and Korea through a variety of graduate-level classes and extensive literature review.

G. Complexity of Triangulation

Triangulation can take on various levels of complexity, depending on the method(s) employed. "Within-method" strategy, while better than a single group-single method strategy, is on the simple end of the scale. The major limitation is the use of a single theoretical methodology, such as field observations. The "between methods" approach, designed for convergent validation, appears on the opposite end of the scale, and is currently the archetype of triangulation strategies (77:136). The decision to employ both types of triangulation in this study stems from triangulation's ability to capture a more complete, holistic, and contextual portrayal of the groups under study (77:138). The lack of research in hazardous waste site remediation in Korea makes it difficult at best to theorize the factors that may have affected formulation of the current policy, or the influential players in the decision-making process. The overarching perspective afforded by triangulation allows complete coverage of all aspects of remediation policy formulation, and may also uncover some unique variance otherwise neglected by single methods.

H. Strengths and Weaknesses of Triangulation

Within triangulation's key assumption lies its chief strength: weaknesses in each single method are compensated by counter-balancing strengths of another. The multiple and independent measures in each leg of the triad do not share the same weaknesses or potential for bias (77:138). Although it has been observed that each method has assets and liabilities, triangulation purports to exploit assets and neutralize, rather than compound, liabilities. The three methods utilized here—literature review, field observations, and interviews—complement each other well. Triangulation attempts to compare findings both between methods and between multiple data groups as a way to validate findings. Many previous researchers have used triangulation in efforts to integrate fieldwork and survey methods. The viability and necessity of such linkages have been advocated by various social scientists (77:138; 131). All argue that qualitative methods can make important contributions to fieldwork, and vice versa, and support the use of convergent methodologies whenever possible to increase the validity of findings.

Researchers who employ a single methodology may find difficulty in defending their position should others who use a different methodology reach dissimilar results. The use of multiple methods in a single study helps to overcome such divergency by exposing the researcher to more varied findings than would be possible with a single method study. When different methods yield dissimilar results, they demand that the researcher reconcile the differences. Reconciliation is a natural part of research based on triangulation. In addition, divergence found during the course of research can lead to more universally-applicable answers. In seeking explanations for divergent results, the researcher may uncover unexpected results or unseen contextual factors—a discovery which may actually enrich the scope of findings. Hence, the process of compiling research material based on multi-methods is useful whether there is convergence or not. Where there is convergence, confidence in results grows considerably; findings seem detached from method bias or artifact. Where divergence occurs, alternative, and likely more complex, universal explanations are generated.

Weaknesses of triangulation methodology stem mainly from its qualitative nature, i.e., the lack of concrete, universally applicable rules for interpreting results. Definition of convergent results, for example, may present one such weakness. In theory, convergence, defined here as agreement between multiple findings, should seem routine. Congruence should seem self-apparent by simply comparing results of differing methods and determining concurrence. In practice, however, few guidelines exist for systematically ordering mixed data to determine agreement. For example, should all components be weighted equally (is all evidence equally useful)? If not, then what should be the basis for weighting (besides personal preference)? Given the dissimilar nature of multi-method results, determination of the level of agreement necessary to declare convergence is likely to be subjective. Fortunately, results from mixing literature review, field observations, and interviews are quite similar. All methods produce qualitative answers, which can be compared and contrasted to some degree. Use of mixed quantitative and qualitative methods, however, may not yield such easily comparable conclusions.

Other weaknesses with triangulation include:

1. Difficulty in Study Replication. Replication has been largely absent from organizational research, but is considered a necessity in scientific research. Replicating a mixed-methods study proves nearly an impossible task (77:146) Qualitative methods, in particular, are problematic to replicate.

2. Unclear or "Wrong" Research Question. Multi-methods are of no use with the "wrong" question. If the research is not clearly focused theoretically or conceptually, any methods will produce unsatisfactory results. This is true of any research effort or methodology employed (77:146). Adherence to the data gathering aspect of this thesis and disconnection with any preconceived notions as to the predominant factors surrounding

remediation policy formulation are keys to maintaining a clear conceptual focus and avoidance of this pitfall.

I. Future Remediation Policy Considerations

While the triangulation methodology serves as a determine relevant factors in formulating current remediation policy, attempting to predict future conditions (political, cultural, economic, technical, etc.) based on qualitative measures creates a unique problem. The issue centers around applying forecasting techniques, normally reserved for quantitative data, to qualitative data. Extrapolation and other mathematical methods work reasonably well for interpreting large sets of quantitative data under certain conditions—not so when dealing with descriptions of events and observations, and interpretation of legislation and policy. In fact, mathematical forecasting methods have limitations even when the data set is quantitative in nature. They apply to a finite set of data over limited spatial and temporal boundaries—boundaries set by the researcher when gathering the data. The researcher cannot assume model validity much outside the range of observations in the study sample (53:491).

Therefore, if this effort does not provide a basis for predictive methods to guide future remediation policy in Korea, then what method should be employed? Cronbach (32), one of the major figures in educational measurement and evaluation, gave considerable attention to the issue of making future predictions based on generalizations of the current situation. He concluded that social phenomena are too variable and context-bound to permit very significant empirical generalizations. Cronbach also looked at generalizations outside of educational research—generalizations in natural sciences as well as the behavioral and social sciences. His conclusion:

> "Generalizations decay. At one time a conclusion describes the existing situations well, at a later time it accounts for rather little variance, and ultimately it is valid only as history." (32:122)

Other social scientists (99; 135) have agreed with Cronbach's conclusions, that generalizations have no support in qualitative evaluations. Environmental policy, and remediation policy specifically, is largely a social as well as scientific issue. To ignore public sentiment and the political aspect of remediating hazardous waste sites would be remiss, especially considering publicly-elected officials promulgate remediation policy for the purpose of protecting the public, as well as the environment as a whole, from pollutants.

To this point, predicting future conditions upon which to base remediation policy seems a hopeless cause, at least from a theoretical viewpoint. A return to the original focus of this thesis, however, lends hope in an apparently hopeless situation. Recall that the emphasis here is on "data gathering" as opposed to "projecting." While the information gathered may not support predicting future conditions in Korea, it does underscore historical trends and emphasize prevailing environmental attitudes within the leadership (DoD and Korean Government) structure. These are important factors in shaping the policy of the future, factors which should not be ignored by current policy makers as they continually develop DoD remediation policy in Korea. The hope is to provide high quality information to top-level policy makers within DoD, USFK, and Pacific Air Forces to positively impact their ability to make decisions in the hazardous waste site remediation arena. Readers of this thesis should not view conclusions as prophecies, but as well-rounded, holistic hypotheses explaining remediation issues in Korea. It is meant to guide future policy making based on solid historical fact rather than serve as the "First Law of Remediation in Korea." Cronbach and others, while not subscribing to sweeping generalizations, support hypothesizing, with the understanding that hypotheses change over time and space (32:125). While this thesis may not stand the test of time, it provides a starting point from which continuing research and hypothesis modification can commence.

Cronbach also hints at a fallacy that may develop from attempting to apply situational data from one locale to another. Specifically, Cronbach says:

> An observer collecting data in one particular situation is in a position to appraise a practice or proposition in that setting, observing effects in context. . . As he goes from situation to situation, his first task is to describe and interpret the effect anew in each locale, perhaps taking into account factors unique to that locale or series of events. (32:125)

Hence, although DoD experienced base closures and concerns over remediation issues in other parts of the world, such as Germany and Canada, which had remedial policy implications, direct comparison to the situation in Korea is problematic. Culturally, physically, and contextually, the Korean experience is unique, and forced comparisons may lead to flawed conclusions. However, this should not serve to preclude investigating policy precedents in different situations altogether. Certain factors affecting remediation policy in Korea may not be readily apparent at first glance. These same factors may have surfaced in other areas. The decision to scrutinize remediation policy in Germany and Canada was predicated on the notion of cross-feeding and precedent-setting rather than correlation. "Lessons learned" from cleanup experiences in one part of the world should not be dismissed completely, as Chronbach's statement may lead one to believe. While direct comparison may not be possible due to the complexities inherent in differing cultures, political systems, historical development of environmental programs, country-to-country relationships, and other dissimilarities, examining DoD remediation policy in Germany and Canada may illuminate circumstances applicable to Korea. The possibility of such cases, which may have gone unnoticed without alternate country comparisons, demands at least a cursory review of remediation liabilities associated with recent base closures in Germany and Canada.

J. Conclusion

Triangulation provides the necessary theoretical foundation to support the methods employed in dredging the primary factors surrounding hazardous waste site remediation policy formulation at DoD installations in Korea. The combination of literature review, field observations and interviews from both the U.S. and Korean perspectives counteracts possible weaknesses and strengthens findings resulting from employment of each single method. The holistic approach to the question of remediation policy in Korea demands qualitative data. Social scientists have expounded this truth for years, and have since discovered the advantages of triangulation to support their findings. Best said by Weiss: "Qualitative data are apt to be superior to quantitative data in density of information, vividness, and clarity of meaning—characteristics more important in holistic work, than precision and reproducibility" (170:344-345).

Evaluation of findings from the three legs of the triangle, combined with DoD hazardous waste site remediation precedents as they apply to base closure issues elsewhere in the world, will provide a firm, all-encompassing basis for future policy formulation. Inclusion of possible technology transfer issues affecting future remediation liability at DoD installations completes this holistic view. Policy makers must proceed with caution, however, recalling that conclusions reached here remain subject to change as Korea's environmental program matures.

III. LITERATURE REVIEW

A. Overview

As mentioned in Chapter 2, review of literature on hazardous waste site remediation in Korea forms the foundation of this thesis. It supports the other two legs of the triangulation model by providing the base upon which environmental staffs at all levels formulate policy and justify required remedial action. The categories of literature relevant to this thesis are:

- United States law, and DoD, USFK, and service-specific policy and regulations;
- Korean government policy and regulations, and international agreements; and
- Studies/Assessments of DoD installations in Korea.

After reviewing and summarizing each category separately, findings will be correlated in an attempt to understand the factors affecting hazardous waste site remediation in Korea.

B. DoD, USFK, and Service-Specific Policy and Regulations

An in-depth study of DoD hazardous waste remediation issues in Korea necessarily begins with a review of the applicable regulations and policy governing DoD operations on the peninsula and the United States laws from which they originate. DoD obtains its direction from Congressional legislation and Executive Orders, which it interprets in the form of DoD directives and instructions. Directives outline broad policy, as opposed to instructions which delineate specific guidelines in particular situations. DoD agencies and the service components, in turn, translate DoD instructions and policy documents into guidance for their respective organizations. These third generation documents drive identification of contaminated sites and justify cleanup, if required, at individual installations (Figure 3).

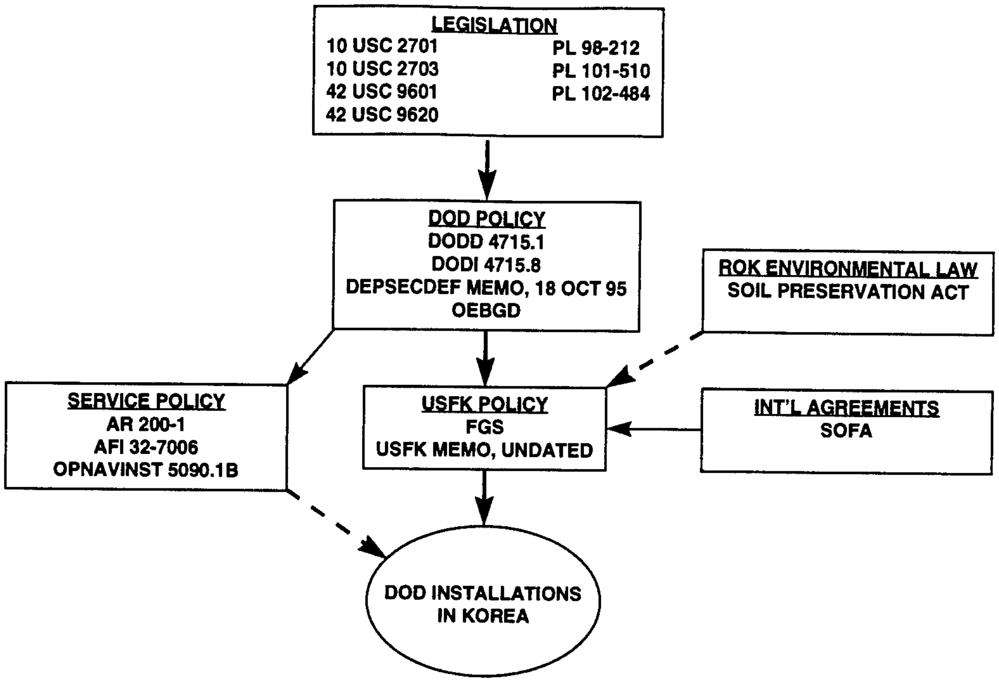

Figure 3: Schematic Diagram—Promulgation of Hazardous Waste Site Remediation Policy for Korea
(39; 40; 42; 43; 45; 48; 49; 115; 145; 154; 156; 157; 158; 159; 164; 172)

DoD Instruction (DODI) 4715.5, *Management of Environmental Compliance at Overseas Installations*, designated the CINCUSFK (Commander-In-Chief, United States Forces Korea) as DoD environmental executive agent for Korea. One of his principal responsibilities is determination of the Final Governing Standards (FGS) for Korea (41:5). Although primarily a compliance document, the FGS does contain some cleanup guidance with regard to polychlorinated biphenyl (PCB), petroleum, oil and lubricants (POL), and leaking underground storage tanks (LUSTs). More recently, DODI 4715.8, *Environmental*

Remediation for DoD Activities Overseas, levied DoD environmental executive agents with the responsibility for determining country-specific remediation policy (39:5).

Service components also promulgate cleanup policy directed specifically for their respective units in Korea. Service-specific policy should not contradict DoD or USFK policy, but focus principally on providing guidance for service-unique programs (such as the Air Force's Environmental Compliance Assessment and Management Program (ECAMP), and the Army's Environmental Compliance Assessment System (ECAS)). In instances where services share the same installation, host-tenant agreements normally specify which policies are followed. In most cases, the more stringent of comparable policies prevail, although host organizations sometimes insist that tenants follow their environmental policies since the host has overall responsibility for the installation's environmental program.

Korean environmental law also has some influence on USFK environmental policy. DODI 4715.5, the DoD Overseas Environmental Baseline Guidance Document (OEBGD), and the FGS all stipulate that the DoD environmental executive agent evaluate host nation environmental standards and "determine their applicability to DoD installations," and to "consider host nation laws together with other relevant international agreements" when developing environmental policy (41:5; 42:1-3; 165:1-3).

"Considering" host nation laws and strictly adhering to host nation laws are two very different legal concepts, however. International agreements, such as the U.S./ROK Status of Forces Agreement (SOFA), outline the binding legal agreements between two signatories and designate which country has jurisdiction in matters of criminal violation of law. Generally, SOFAs and other basing agreements do not include specific language pertaining to environmental protection or remediation, since many of these agreements were signed prior to the relatively recent environmental awareness movement. SOFA joint committees and other special negotiating bodies normally settle environmental disputes, as is the case in Korea.

We shall begin our development of DoD environmental policy in Korea with the very basis for all DoD policy—including environmental policy: United States Law. Generally, laws of the U.S. only have force within the territories of the United States, unless "language in the relevant Act gives [an] indication of a congressional purpose to extend its coverage beyond places over which the United States has sovereignty or has some measure of legislative control" (127:3). Thus, conventional, U.S.-based cleanup legislation, such as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA), have no jurisdiction in overseas locations.

At present, no U.S. legislation contains language giving an "indication of congressional purpose to extend its coverage beyond places over which the United States has sovereignty." No laws, U.S. codes, regulations, or international agreements compel DoD to remediate hazardous waste-contaminated sites in Korea. Title 10 United States Code (U.S.C.) 2701 and 2703, which set up the Defense Environmental Restoration Program (DERP) and created the Defense Environmental Restoration Account (DERA), limit DoD remedial response actions to "each facility or site owned by, leased to, or otherwise possessed by the United States and under the Jurisdiction of the Secretary [of

Defense]" (156:846; 157:1537). Although DoD maintains millions of dollars worth of real property in Korea, the U.S. does not "own" nor "lease" any of the land. DoD occupies Korean territory, but in legal terms, it does not "possess" the property because of the sovereign rights of the host nation. In addition, the SOFA states that the ROK Government "is not obliged to make any compensation to the Government of the United States for any improvements made in facilities and areas or for the buildings and structures left thereon" (43:16). By virtue of this clause in the SOFA, DoD in essence does not own any of the facilities on their installations in Korea as well. Therefore, the DERA and DERP do not apply.

Title 10 U.S.C. 2703 further emphasizes the boundaries of the DERP by requiring the Secretary of Defense to "develop a policy for determining the responsibilities of the Department of Defense with respect to cleaning up environmental contamination that may be present at military installations located outside the United States" (156:858). By requiring DoD to develop a separate cleanup policy with regard to overseas installations, Congress expressly delineated the non-applicability of the DERP to DoD's overseas installations. The Deputy Secretary of Defense (DEPSECDEF) Memo dated 18 October 1995, and DODI 4715.8 represent DoD's fulfillment of 10 U.S.C. 2703's requirement to promulgate policy on overseas cleanup. The National Defense Appropriation Act of 1984, and 42 U.S.C. 9611 and 9620 (Comprehensive Environmental Response, Compensation and Liability Act, as amended by the Superfund Amendment and Reauthorization Act of 1986), reiterate the boundaries of the DERP by specifically restricting expenditure of DERA funds and applicability of CERCLA, respectively, to restoration actions within the territories of the United States (154:9601-1; 154:9611-1; 157:1427).

Notwithstanding the absence of a legal basis for remediation overseas, DoD policy provides justification for in-theater commanders to cleanup contaminated sites at their discretion when those sites present an "imminent and substantial endangerment to human health" (more on this later). Commanders at all levels within DoD have the responsibility, in accordance with DoD Directive (DODD) 4715.1, *Environmental Security*, to "protect DoD personnel from accidental death, injury, or occupational illness by exposure to stressors beyond established limits," no matter the location (40:2). In the absence of Congressional authority, however, DoD does not have legal authority to expend funds on cleanup overseas for the sole purpose of preserving and protecting the environment of a foreign nation—an environment which the U.S. neither owns nor has jurisdiction over. Through international agreement, Korea has granted the U.S. permission to occupy Korean soil to cooperatively defend both U.S. and Korean interests against a hostile entity, but the land on which DoD activities are conducted does not belong to the U.S. Since the land does not belong to the U.S., U.S. laws do not apply (127:3).

The only piece of U.S. environmental legislation with some direct applicability overseas is the National Environmental Policy Act (NEPA). President Carter underscored this in 1979, just prior to leaving office, when he signed Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions*, which directed the consideration of environmental impacts in federal decision-making overseas. While not mandating unequivocal compliance with NEPA at overseas locations, it "further[ed] the purpose" of

NEPA by directing NEPA-like environmental impact analysis requirements for specific categories of "major federal actions...having significant effects on the environment outside the geographical borders of the United States, its territories and possessions" (17:1). However, EO 12114 is just that--an executive order. It requires DoD and other Federal agencies to *consider* NEPA at overseas locations, not comply with NEPA.

Although EO 12114 did not contain any references to cleanup actions, it did direct DoD to promulgate environmental compliance policy for its overseas installations. DODD 6050.7, *Environmental Effects Abroad of Major Department of Defense Actions*, and DODD 6050.16, *DoD Policy for Establishing and Implementing Environmental Standards At Overseas Installations*, were two results of EO 12114 (in fact, DODD 6050.16 directly references NEPA). The latter document created minimum environmental compliance standards, embodied in the OEBGD, and directed preparation of country-specific final governing standards, which incorporate host-nation laws and international agreements, for nations with significant DoD presence (36:2). In April 1996, DODI 4715.5 replaced DODD 6050.16, and clarified many of the ambiguities present in the original directive. However, it still did not address cleanup issues.

In 1990, Congress directed DoD to develop an overseas cleanup policy. At first, DoD addressed past contamination only at overseas bases slated for closure by issuing a DEPSECDEF memo in December 1993. The memo strictly prohibited the expenditure of any U.S. funds on cleanup at an overseas installation slated for closure, "beyond the minimum necessary to sustain current operations or eliminate known imminent and substantial dangers to human health and safety" (127:5). Two years later, on 18 October

1995, the DEPSECDEF signed a comprehensive, follow-up memo, addressing "remediation of environmental contamination on DoD installations or facilities overseas (including DoD activities on host nation installations or facilities) or caused by DoD operations...that occur within the territory of a nation other than the U.S." (172). Currently in draft form, DODI 4715.8 officially implements the DoD cleanup policy first introduced by the DEPSECDEF memo in October 1995.

While DoD allowed cleanup of contaminated sites presenting a "known imminent and substantial danger," it did not provide special funding for remediation of those sites. Congress conceived the DERP and DERA in Title 10, Section 2701 and 2703 of the United States Code, specifically for cleanup of sites contaminated by past DoD actions (156:845-873). Funds were appropriated for the sole purpose of remediating contaminated sites on DoD installations. However, in the National Defense Appropriations Act of 1984 and subsequent years, Congress strictly prohibited the use of DERA funds for cleanup of sites abroad. This left very few fiscal avenues to fund overseas remediation projects—even those which met the "imminent and substantial danger" provision—since most DoD accounts are tied to a narrowly defined activity (such as aircraft procurement, military construction, etc.). The two exceptions were the Operations and Maintenance (O&M) account and Environmental Compliance (EC) account. A General Accounting Office study of cleanup initiatives in DoD supported this conclusion—97 percent of the $102 million in cleanup projects executed overseas between FY93 and FY96 used O&M funds (166). While a viable source of cleanup funds, the O&M account also supports a myriad of other high priority activities on an installation (supplies, equipment, facility maintenance and repair, etc.), making the definition of "imminent and substantial endangerment" extremely important for proper justification and prioritization of remediation projects.

Recall that the responsibility for defining "imminent and substantial endangerment to human health" falls to the DoD environmental executive agent in Korea, which happens to be an Army general officer (Chief of Staff, USFK). O&M funds are generally provided to each service—a "joint" O&M account does not exist to fund environmental remediation projects in Korea. In fact, for Air Force installations, O&M funds are specifically allocated to each base. This situation presents a unique challenge to the USFK staff. They are responsible for promulgating cleanup policy which may force expenditure of millions of dollars at USFK installations; however, they control allocation of no cleanup dollars.

A review of the DoD directives, instructions, and policy memos, as well as service-specific guidance, appears in Appendix 3-1. The FGS are "the sole regulatory requirement applicable to USFK installations;" however other documents play an important role, both in shaping the FGS and fulfilling service-unique requirements (165:1-2). For example, the FGS direct USFK installations to conduct audits every year (external audits every third year, and internal audits each year between external audits) (165:1-5). The Air Force uses AFI 32-7045, *Environmental Compliance Assessment and Management Program*, to guide their internal and external audit process, and the Army relies on AR 200-1, *Environmental Protection and Enhancement*, to manage their audit process. Appendix 3-1 provides a summary of findings for each category of DoD documents reviewed.

1. DoD Directives.

DoD directives and instructions did not address remediation of contaminated sites overseas due to past DoD actions prior to the introduction of DODI 4715.8. DODD 4715.1, *Environmental Security*, alludes to remediation in paragraph D, but does not specify conditions which would trigger remedial action (40:1- 2). DODI 4715.5 specifically excludes remedial actions for past activities, and does not mention cleanup requirements for contamination resulting from current operations (41:2). DODD 4715.8 will be discussed after reviewing the DEPSECDEF memo of October 1995, which it implemented.

a. DEPSECDEF Memo, 18 Oct 95.

The DEPSECDEF memo mandates cleanup action at a contaminated site at overseas locations if one of four criteria are met: (1) the site is a "known imminent and substantial endangerment to human health and safety;" (2) the sites is necessary to "maintain operations;" (3) cleanup is required to "protect human health and safety;" or (4) if cleanup is required to meet international agreements (172). A discussion of each of the four criteria follows.

1. "Known Imminent and Substantial Endangerment." The DEPSECDEF memo provides some guidance for remedial action at overseas installations, but does not clearly specify the point when a contaminated site represents an "imminent and substantial endangerment to human health and safety." The memo also does not identify when a remedial action can be considered complete ("how clean is clean"). Paragraph 2a(2) delegates this responsibility to in-theater commanders, or installation/facility commanders, if in-theater commanders wish to further delegate their authority. The memo recognizes the

applicability of international agreements which may require remedial action for contamination below U.S. limits. In these cases, remediation may be necessary, but only after consultation with legal experts and review of diplomatic documents such as treaties and status of forces agreements. The DEPSECDEF memo fails to address how contamination will be found, since it does not require the service components to conduct baseline surveys, assessments, or characterizations to identify sites contaminated in the past.

2. "Maintain Operations." Remediation of a contaminated site to "maintain operations" may encompass a wide scope of cleanup activities. Undefined by the memo, this could be used as a basis to justify remedial action ranging from remediating a site in order to proceed with a construction project, to remediation demanded by host-nation authorities at a collocated operating base, the failure of which could impact future access to the installation or facility in contingencies (127:19).

3. "Protect Human Health and Safety." Like the preceding premises for cleanup, "protect human health and safety" is undefined and serves as a very broad justification for remedial action. One could justify remediation of almost any contamination (quantity and substance) as a protective action, especially since even very minute quantities of certain substances (chlorinated solvents, for example), may present a risk of cancer or other chronic ailment (102:202-210). By default, cleanups under this basis would be human health risk-based, given the existence of contaminant pathways to human receptors, and present and foreseeable future use of the contaminated site.

4. "International Agreements." The U.S./ROK SOFA defines the rights and responsibilities of both nations with regard to the presence of DoD personnel in Korea—

responsibilities which include adherence to ROK environmental laws. An in-depth analysis of the SOFA appears in Section B of this chapter. Generally speaking, however, SOFA provisions do not require remediation of contaminated sites, even for installations returned to the Koreans (43:15).

b. DODI 4715.8, *Environmental Remediation for Overseas Activities*.

Recently completed, DODI 4715.8 represents the first comprehensive guidance DoD has ever issued on the subject of environmental cleanup at overseas locations. It expands cleanup policy presented in the DEPSECDEF memo issued in October 1995, and attempts to clarify issues forwarded by service components.

1. The instruction expands on the DEPSECDEF memo by:

a. Requiring remedial action for past and present DoD activities resulting in contamination on DoD installations or facilities (main operating bases) and on host-nation installations or facilities representing a "known imminent and substantial endangerment to human health," as defined by the DoD environmental executive agent or in-theater component commander (39:3, 7).

b. Requiring remedial action for present DoD activities resulting in contamination beyond the boundaries of a DoD installation (39:3). It does not include contamination exclusively off-site (not emanating from an on-base source) caused by past DoD operations—an important distinction. Neglecting contamination from past operations relieves DoD from the burden of locating existing sites outside DoD installations and drastically decreases the possible number of remedial actions, especially since practices protective of the environment have drastically improved in recent years compared to the years following World War II when U.S. forces first occupied the Korean peninsula. Activities which may cause contamination off DoD or host-nation installations include training operations, exercises, and spills resulting from vehicle or heavy equipment accidents.

2. The instruction still does not define "known imminent and substantial endangerments to human health," but does specify procedures for locating "known" contaminated sites. Responsibility for defining "imminent and substantial endangerment" is delegated to in-theater component commanders in consultation with their staff medical authority and the DoD executive agent (39:12). In-theater commanders have authority to identify remediation projects through their definition of "imminent and substantial endangerment," but the DoD environmental executive agent (in this case, the Chief of Staff, USFK) "define[s], or provide[s] procedures to define, the appropriate level of remediation" and provides procedures for negotiating the scope of remedial measures with the host nation (39:5). These statements imply the involvement of three separate decision-making bodies in the cleanup process: (1) in-theater commanders decide which contaminated sites to remediate; (2) the Chief of Staff, USFK, decides when sites are sufficiently "clean" to prevent further deterioration of human health and safety; and (3) a joint ROK/US committee (such as the Environmental Subcommittee to the Joint SOFA Committee) must agree to that level of cleanup. Since each in-theater commander is given the authority and responsibility to define appropriate cleanup projects, the possibility exists for multiple definitions of "imminent and substantial endangerments" between services. DoD believes coordination

with the DoD executive agent, however, is sufficient to achieve consistency across services (92).

3. Paragraph E4c of DODI 4715.8 addresses the "how clean is clean" question by defining "clean" as the point when "the contamination no longer poses an imminent and substantial endangerment to human health, environment, and safety" (39:12). Note the inclusion of "environment" here--sites are originally identified as candidates for remedial action based on endangerment to human health and safety, but must be remediated to a point which is protective of the environment as well as of humans. The paragraph goes on to say commanders ("commanders" not defined) have the discretion to consider all remedial alternatives, from passive containment (restricting access) to permanent treatment and restoration.

4. Paragraph 2a(3) of DODI 4715.8 mandates that the Chief of Staff, United States Forces Korea, provides procedures for furnishing remedial documentation to the host government (39:5). Documentation should include the FGS, which the Korean government has yet to review. In addition, paragraph F3 requires providing information on contaminated sites, not just remedial actions, to the host nation upon request (39:14).

5. Remediation costs can be used as an offset against the residual value of DoD capital improvements (consistent with international agreements), resembling base closure procedures implemented in Germany and Canada over the past few years (39:12). By Article IV of the SOFA, however, the ROK Government does not have to compensate the U.S. for any improvements on Korean soil; residual value should not be a consideration during any future base closure negotiations (43:16).

6. The instruction allows services to collect information on hazardous waste contamination sites, and requires each service component to maintain existing information on contaminated sites until the installation is returned to the host nation and all claims are resolved (39:13-14). The distinction between "allowing" and "requiring" stems from the difference between past and present operations. The instruction "allows" active searching of sites contaminated by past DoD operations; it "requires" accurate documentation for present DoD operations resulting in a contaminated site. At minimum, the instruction suggests development of a hazardous waste site database to track releases which occur presently and in the future, and perhaps can be interpreted to permit funding of studies to locate sites contaminated in the past. The requirement to collect information also applies to contaminated sites outside DoD installations.

7. While the instruction does not specifically supersede service-specific directives, it implies they would need to be revised as necessary to conform with this instruction (92).

c. Army, Air Force, and Navy Publications.

The three service components largely follow the DEPSECDEF memo in many respects (45; 48; 49). As in the DEPSECDEF memo, service regulations do not define "imminent and substantial dangers to human health and safety," and do not include any requirements or procedures for assessing and remediating contamination from past operations. The pertinent Air Force document, AFI 32-7006, incorrectly states that the OSD policy only addresses installations slated for return to the host nation (45:2). This oversight probably occurred since the Air Force established AFI 32-7006 prior to the latest DEPSECDEF memo (October 1995). The DEPSECDEF memo written in 1993 pertained specifically to bases closing overseas. The most recent DEPSECDEF memo and yet-to-be-published DoD instruction clearly mentions DoD installations or facilities that are open and have not been designated for closure. Official release of DODI 4715.8 will certainly force wholesale revision of current service component policy due to its comprehensive changes.

d. Final Governing Standards (FGS).

Although the Final Governing Standards open with a blanket statement similar to the statement found in paragraph B1f of DODI 4715.5 (the FGS do not apply to cleanup of contamination due to past DoD operations), the FGS do provide specific direction for cleanup of POL and PCB spills and leaking underground storage tanks.

1. Clean-Up of POL and PCB spills. Paragraphs 9-3f(2), 14-3a(2), 18-3d(5), and 19-3c(3) of the FGS cover remedial actions required after a POL or PCB spill (165:9-3; 165:14-2; 165:18-5; 165:19-2). Apparently these provisions apply to spills/leaks occurring since publication of the FGS, as opposed to sites contaminated prior to promulgation of the FGS. The obligation to remediate POL and PCB spills applies regardless of whether the spill occurs on or off an installation or facility, and would, for example, include spills off an installation resulting from a fuel-truck accident or crashed aircraft. No guidance is provided for activities which may have caused contamination of soil and groundwater prior to 1995, when the first FGS were adopted, nor do they furnish limits for detection and cleanup of substances other than PCBs and POL.

2. Cleanup of Leaking Underground Storage Tanks (USTs). The FGS direct remediation of soil and groundwater contaminated by a release from a leaking UST "when there is imminent or substantial danger," and define that occasion as one which causes

"acute injury or death, rather than illness or injury typically caused by long term, chronic exposure" (165:19-2). By this definition, there is no requirement to cleanup carcinogens as well as many other hazardous materials for which long term exposures at low concentrations may cause significant human health problems. The PCB standards provided in paragraph 14-3a(2) of the FGS support USFK's definition of "imminent and substantial danger" as the limits are well above EPA's recommended levels for prevention of cancer and non-cancerous toxicity, and FDA's limit for PCBs in food sources (160).

e. USFK Remediation Policy Memo.

Attempting to clarify its position on remediation, HQ USFK drafted a memo for USFK components which awaits final coordination and approval by the Chief of Staff, USFK (145). In this memo, USFK reiterated DoD policy as presented in the October 1995 DEPSECDEF memo, and instructed their installations to conduct a preliminary assessment of sites suspected of contamination and attempt to quantify the contaminant toxicity and exposure potential upon which the decision to remediate will be based. However, USFK did not specify risk standards such as those developed by DoD *(DoD Relative Risk Primer)* and the Air Force *(Use of Risk Based Standards for Cleanup of Petroleum Contaminated Soil)*, typically used to prioritize remediation projects and assess the health risks associated with contaminated sites based on the risk of death or injury to human receptors (37; 47). Based on the new DoD instruction (DODI 4715.8), USFK must revise their policy to include such added requirements as assessing contamination off-site and properly documenting and characterizing contaminated sites.

The documents reviewed in Appendix 3-1 indicate DOD's reluctance to specify an all-encompassing remediation policy for overseas installations that is applicable in all theaters of operation. However, DOD's delegation to in-theater commanders seems reasonable since international agreements, treaties, and host-country environmental laws differ in each theater of operation. It would be difficult for staff members at the Pentagon to produce policy specific for different parts of the world and ensure currency of that policy in an ever-changing international environmental climate. Instead, DoD transferred the responsibility of maintaining compliance with host-nation environmental laws to in-theater commanders, who should have the expertise, knowledge base, and manpower to ensure they operate in accordance with their host's environmental laws and within the boundaries of diplomatic agreements. By mandating adherence with either the host-nation standards or the Overseas Environmental Baseline Guidance Document (OEBGD), whichever is more stringent, DoD has assured their operations in foreign countries conform with DoD policy to display environmental security leadership worldwide while supporting the national defense mission (40:1).

C. Korean Government Policy and Regulation

Article VII of the Status of Forces Agreement (SOFA) between the United States and Republic of Korea states:

> It is the duty of members of the United States armed forces, the civilian component, the persons who are present in the Republic of Korea pursuant to Article XV [invited contractors], and their dependents, to respect the law of the Republic of Korea and to abstain from any activity inconsistent with the spirit of this Agreement. (43:17).

When U.S. members violate ROK law, Article XXII of the SOFA explains:

> The authorities of the Republic of Korea shall have jurisdiction over the members of the United States armed forces or civilian component, and their dependents, with respect to offenses committed within the territory of the Republic of Korea and punishable by the law of the Republic of Korea. (43:33).

Although the Korean government has never exercised their criminal jurisdiction over an individual DoD member for violating Korean environmental law, these excerpts from the U.S./ROK SOFA suggest a legal basis for Korea to penalize DoD for environmental non-compliance should the ROK government decide to act. In addition to the SOFA provisions, U.S. law requires the Secretary of Defense to consider "applicable international agreements [such as Status of Forces agreements]" when developing DoD cleanup policy overseas (159:858). While "consider" does not imply strict adherence, it requires U.S. policy makers to at least review ROK environmental laws and attempt compliance within reasonable limits (usually budgetary). For these reasons, we shall review development of environmental law in Korea, evaluate current legislation, and explore the applicability of those laws to U.S. forces in Korea.

1. Development of Korean Environmental Laws.

Comprehensive environmental legislation, accompanied with requisite administrative and oversight systems to ensure compliance, did not appear in Korea until the late 1980s and early 1990s. Korea's rather late recognition of their environmental problems may seem odd when considering the advantage it should have enjoyed from observing environmental problems in the United States and its close neighbor, Japan. Japan and Korea confronted very similar conditions after World War II and the Korean War, respectively—both countries rapidly industrialized with overwhelming financial assistance and guidance from the United States in the face of near famine conditions and complete destruction of their physical infrastructure. Yet, Korea chose much the same path that Japan took, electing to ignore signs of environmental decay in favor of programs to bolster economic strength (124). Reviewing some of the key historical upheavals Korea endured since the turn of the century may help explain the environmental path they chose, and, more importantly for DoD environmental policy makers, provide insight for predicting the vector Korea will take in future years.

For thousands of years, the Korean nation endured a number of invasions by its powerful neighbors, particularly China and Manchuria. However, despite many foreign incursions during its long history, Korea maintained its political independence as a kingdom until the early 1900s, due in most part to China's role as Korea's protector (23:3). At the same time that the Chinese empire began to crumble near the end of the nineteenth century, the Meiji revolution swept over Japan, launching a new stage of economic and cultural development by importing Western technology and ideas. The resultant modernization of Japanese society—which encompassed their political, judicial, and educational systems, economy, and science and technology base—naturally tempted Japan to expand its present borders. Korea was a natural target, due to its rich mineral deposits in the north, agricultural land in the south, and geographic connection to mainland China, which contained even larger stores of natural resources (23:4).

Japan occupied Korea between 1910 and 1945, and restructured Korea's economy and society to meet the overall needs of the Japanese economy and expansionist ideals. In North Korea, the Japanese developed heavy industry, utilizing the North's mineral resources and abundant hydroelectric power. In the south, Japan exploited the area's rich agricultural land, and built textile and other manufacturing infrastructure. "Exploitation" is the correct term to describe not only what Japan did with Korean natural resources, but also to describe what Japan did to the Korean people. Japan treated Korea's citizenry as second-class compared to their own citizenry (23:4). Government officials, and plant and factory managers were all of Japanese ancestry, and although Japan instituted a modern educational system—complete with national universities to study medicine, the sciences, and engineering—everything was taught in the Japanese language and patterned after their own system (23:7).

Despite the cultural devastation, Japanese colonial rule had some positive effects on economic development in Korea. When the Japanese left at the end of World War II, they could not take the physical plant with them. They also left behind the people who helped manage those plants, and an educational system and infrastructure to continue expanding science and technology. Japan invested heavily in Korea to substantially improve infrastructure (transportation networks, communication systems, and industrial factories) and advance the state of technology, education, and agriculture (23:8; 143:7).

The Korean War, however, devastated much of the physical plant inherited from the Japanese occupation. It destroyed almost two-thirds of the nation's productive capacity—total industrial production in 1953 was estimated at a little more than one-third of the production level in 1940 (132:2). In fact, nearly ten years after the end of the Korean War, South Korea still ranked in the bottom half of the free world's economies, despite its high population density (Table 3).

In response to a host of social and economic problems in the decade following the Korean War, a coup d'etat led by General Park Chung Hee in 1961 successfully overturned the government led by Prime Minister Chang Myon. Prime Minister Chang came to power only a year earlier following a student uprising which toppled the previous government, led

Table 3: Korea in the World Economy: Rank of Selected Economic Indicators for 1962 (132:21)

Indicators	Rank in 1962
Population	23
Area	104
Population Density	7
Total GNP	34
Per Capita	56
Per Capita Export (Trade)	120
Per Capita Import (Trade)	103

NOTE: The trade and GNP rankings exclude the former Soviet Union and all of Easter Europe. Unfortunately, the source for the data only specified the total number of countries ranked (125), but did not give specific rankings of other countries for comparison.

since 1948 by Rhee Syngman (23:15; 132:3). Park found himself in the midst of a failing economy and overwhelming poverty. The GNP grew only 0.7 percent from 1954 to 1962, and the U.S. primarily funded about 70 percent of all reconstruction projects during the same period (143:9). Per capita income reached a peak of US$87 in 1962, and the average Korean life expectancy was only 54 years in 1960 (132:7). These impoverished conditions led Park to launch the first of Korea's Five-Year Economic Development Plans (143:9). During these years and the decades to follow, Korea's leaders committed the nation to rapid industrialization and modernization, using a strategy of heavy industrial development and export-led growth (59:83; 132:14, 143:41-44). By all accounts, these policies were extremely successful, as the gross national product (GNP) figures and data indicating heavy industries' share of the economy illustrate in Tables 4 and 5, respectively.

Table 4: Annual GNP Growth Rates, 1962-1991 (Percentages) (132:12)

Year	GNP	Per Capita GNP
1962-1966	7.9	5.1
1967-1971	9.6	8.7
1972-1976	9.2	7.3
1977-1981	5.8	4.2
1982-1986	9.8	8.4
1987-1991	9.9	8.9

Table 5: Structural Change In Manufacturing, Percentage Share in Manufacturing Output (132:246)

Year	Light Industry	HCI Products*
1970	70.5	29.5
1975	58.5	41.5
1980	48.4	51.6
1983	44.2	55.8
1985	43.5	56.5
1989	39.6	60.4

*HCI: Heavy and Chemical Industry (chemicals and chemical products, primary metal manufacturing, metal products, machinery, etc.)

President Park, who remained in control until his assassination in October 1979, believed economic development was the key to a stronger Korean nation—"more independent of U.S. aid and influence and as an economically stronger and independent entity" (23:19). Chun Doo Hwan and Roh Tae-Woo, both former ROK Army generals like Park, continued Park's initiatives in the years to follow, furthering economic development via government incentives to increase exports, and expand capital-intensive industries (such as machinery, electronics, transport equipment, and chemical production) (124:29).

As expected, environmental protection took a back seat during this period of unhindered industrial development. Korean leaders viewed pollution as a positive sign of growth which would either correct itself over time or be remedied by applying sound engineering practices. They considered environmental protection to be a "luxury" as opposed to the "necessities" of massive industrialization (59:16).

Despite the apathetic environmental attitude of the time, the Park Administration established Korea's first environmental law in 1961—the New Forest Law. The law set up a national reforestation program, outlining a plan to plant millions of trees in an effort to reestablish Korea's woodlands, destroyed through Japanese occupation in the early 1900s, and the Korean War in the 1950s (59:15). The first true anti-pollution legislation enacted by the ROK took the form of the Anti-Public Nuisance Control Act of 1963. The Act's central goals called for reducing and controlling pollution. However, at the time, the national priority of developing a viable and self-sufficient economy took precedence over the need to preserve and enhance Korea's environment (125:32). Consequently, the Act was largely unsuccessful since it did not include administrative functions and an enforcement mechanism for monitoring compliance and enforcing regulations. The government attempted to correct these shortcomings in 1973 when it established the Pollution Control Division within the Bureau of Sanitation, a branch of the Ministry of Health and Social Affairs (MoHSA). The division, the first environmental organization within the ROK government, oversaw public efforts to address declining air and water quality, but still had no enforcement authority. Its position within MoHSA also gave the division an overarching public health perspective, rather than an environmental point of view (59:16).

These early attempts at addressing environmental concerns, spawned in large part through exponential growth in industry and construction, had a common theme of little or no enforcement authority, which, in turn, led to lack of compliance by private industry and government. More comprehensive environmental legislation came in the late 1970s, perhaps in response to Korea's expansion into heavy industries which resulted in even more serious deterioration of the environment. Legislation included the Environmental Preservation Act, modeled after similar legislation in more developed countries, especially Japan. The Act set standards for emissions, created an emission charge system to enforce emission standards, and established monitoring programs and sanctions for violators. An amendment in 1979 created the nation's first environmental impact assessment system, although it was extremely limited in scope (the only projects required to complete an assessment were urban development projects, industrial sites, and energy projects) (26:44; 118:66). The Marine Pollution Act of 1978 was the other major environmental law passed in the 1970s, which addressed discharges to the sea (59:17).

By the late 1970s, however, industrial expansion was in full swing. The Park Administration passed the Heavy and Chemical Industry (HCI) Development Plan in 1973, favoring such industries as shipbuilding, automobiles, steel products, nonferrous metals, and petrochemicals—industries which produced copious amounts of toxic materials (143:18). Although Korea does not have a toxic release inventory (TRI) report like the U.S., a review of the U.S. TRI report for 1995 shows that the industry groups with the largest quantities of on-site releases included companies producing chemicals and allied products (highest) and the primary metals industry (second highest). The transportation equipment industry ranked the fifth highest, while fabricated metals and petroleum ranked seventh and eighth highest, respectively (163:28). Previous reports in 1988, 1993 and 1994 reveal similar trends, with the chemical-production industry and primary metals industry holding the one and two spots each of those years (163:133). Parallel industries in Korea might reasonably be assumed to have similar emission outputs. Despite this and other economic problems with investing in capital and pollution-intensive industries, Park favored the development of HCI primarily for three reasons:

1. He saw the shift in U.S. foreign policy toward Asia, as exemplified by the Nixon Doctrine and the withdrawal of U.S. troops from Korea in March of 1971, as a signal to begin formulating self-defense measures to ensure the national security of Korea. Park believed such a policy required an economy centered on defense industries, including HCI (23:437; 132:42; 143:18).

2. The administration saw Korea's current light industry-based economy as limited given several factors including:

a. The U.S. and other developed countries began restricting imports on Korea light-industry products starting in the late 1960s. Korean leaders were especially shocked when they received less than favorable treatment from the U.S. when the Korea-United States Synthetic Textile Fiber Agreement was signed in 1971.

b. The forecasted increase in light-industry exports from lesser-developed countries (such as China) would decrease Korea's advantage in the market.

c. Korea would not overcome its trade deficit and consequent foreign debt burden if it continued to rely on foreign capital goods and intermediate materials to produce light industry export products (23:438).

3. The ROK government believed Korea could undertake the task of building the necessary infrastructure due to its past successes in light-industry and by incorporating lessons-learned from developed countries (23:438-439).

While further discussion of the economic aspects pertinent to the HCI Development Plan is beyond the scope of this thesis, understanding the plan's motivators is relevant in comprehending the U.S./Korean diplomatic relationship and development of environmental policy in future years. Up to this point, the United States provided the most foreign aid of any country to Korea, including nearly $2.4 billion between 1945 and 1960 (132:256). The U.S. also operated two Air Force bases and stationed two Army divisions on the peninsula, primarily to support the ROK against North Korean invasion. The Korean population generally regarded the U.S. as a strong ally and supporter of South Korea. The withdrawal of the 7th Infantry Division—nearly one-third of all U.S. forces in Korea—in March 1971, coupled with passage of the Korea-United States Synthetic Textile Fiber Agreement, signaled a significant change in U.S./Korean foreign policy, and shocked Korean leaders and the general populace alike (23:438).

The drawdown of military forces in Korea and less-than-favorable trade agreements in 1971 awakened the ROK government to their overdependence on foreign support and subsidies both for their economic health and their national defense. President Park realized development of heavy industries provided an avenue to expand their economic industrial base as well as build vital logistical support for the military—two positive steps toward self-sufficiency. Recalling earlier discussions of Korea's history, this fervent desire for a self-sufficient nation at nearly all costs (including risk of economic failure and negative environmental impact) is quite understandable. Notwithstanding the invasions by China earlier this millennium, Korea remained an intact society for over 2,000 years prior to Japan's invasion and subsequent annexation in 1910. In fact, Korea's seclusion prior to Japanese colonization earned them the nickname of "Hermit Kingdom of the Orient" (132:1). They were, and remain to this day, a relatively homogeneous society, with a strong attachment to their heritage and pride in their culture. The Japanese takeover in 1910, followed by the devastation of World War II and the Korean War, destroyed artifacts and symbols of Korean culture. President's Park, Chun, and Rho felt restoration of South Korean pride, self-confidence, and independence should be the primary goals of the country such that all other concerns were subordinate (132:25).

By the 1980s, however, much of Korea's economic base was firmly in place, and accordingly, this same decade witnessed substantial growth in environmental legislation and major reorganization within the Korean government in an attempt to properly manage its environmental problems. This was only made possible due to the success of the HCI Development Plan, which provided leaders the "breathing room" to concentrate on items less critical to the continued independence of the South Korean nation. The Environmental Administration was created in 1980, and placed directly under the MoSHA. During the same year, Korea amended its constitution, adding a statement proclaiming that "all Korean citizens have the right to live in a healthy and clean environment" (125:32). This statement closely matches the U.S. National Environmental Policy Act, passed on 1 January 1970, which recognized that "each person should enjoy a healthful environment" (139:310). While perhaps coincidental, this recognition of environmental degradation in Korea closely followed dramatic incidents in the late 1970s in the U.S., such as the discovery of hazardous waste at Love Canal and the dioxin scare at Times Beach, Missouri (102:181). These incidents resulted from indiscriminate disposal of toxic substances by chemical companies—the same type of companies constructed in Korea as part of the HCI Development Plan a decade earlier.

Despite these attempts at curbing environmental degradation, Korea discovered a number of weaknesses in their environmental program of the 1980s. The ROK government realized that effective enforcement required decentralization of authority to the regional level. Therefore, in 1986, regional offices were established, much like the U.S. EPA's ten regional offices (124:66). However, the offices did not have the authority nor technical capability to competently assess and enforce the country's environmental laws (59:18).

The 1990s began with the creation of the Ministry of Environment (MOE), reporting directly to the ROK president, and enactment of six separate laws addressing overall environmental policy, natural resource preservation and conservation, water quality, noise and vibration control, toxic chemicals, waste management, and liability issues resulting from pollution. These laws do not confer judicial authority upon MOE, however. MOE can only monitor compliance with environmental regulations and report violations to the police for possible legal prosecution, unlike the EPA in the U.S. which can directly levy fines for non-compliance. MOE's lack of judicial powers also limits their right of access to the premises of suspected polluters, another advantage enjoyed by the U.S. EPA (124:67).

In response to growing concerns over increasing wastes from industrial and urban centers coupled with limited landfill space, the ROK government passed the Waste Management Act in 1991 to control handling, processing, and ultimate disposal of solid and some hazardous wastes, such as sludge, ash, excreta, and waste oil and acid (116). Once again, note the similarity between the Waste Management Act and the U.S. Resource Conservation and Recover Act, which established similar "cradle-to-grave" management procedures for hazardous waste (18:44).

In 1992, MOE devised its first five-year environmental master plan, much like the five-year economic development plans instituted since 1962. Remediation, however, was not one of the plan's five main goals. The plan focused on Korea's most visible problems—air pollution, surface water quality (since over 90 percent of the nation's water supply comes from surface water sources), sewage treatment, and solid waste reduction (113).

2. Current ROK Environmental Legislation.

As of 1996, the Korean government had established 24 environment-related acts (26; 111; 124; 125). These laws resemble environmental legislation in the United States, Japan, Germany and other "G-7" nations, and attempt to resolve many of the same problems encountered in these countries over the past 25 years, such as air and water pollution, soil contamination, and cultural and natural resource conservation. Appendix 3-2 contains a list of ROK environmental laws, their date of passage, and a brief summary of each law's purpose. Figures 4a and 4b compare development of major environmental laws in the United States and Korea.

The ROK government supported the explosive growth in environmental legislation with similar increases in funding. The budget for MOE in 1995 was increased to 672.9 billion won (approximately US$863 million), or 1.35 percent of the nation's total budget, compared to only 12 billion won (approximately US$15.4 million) in 1980 (113:8). This does not include funding earmarked for construction projects meant to improve overall water quality throughout the peninsula. The MOE, in concert with seven other ministries—including the Ministry of Construction and Transportation, and the Ministry of Home Affairs, prepared a Comprehensive Plan for Clean Water Supply. Engendering 11 projects and 20 implementation targets to be completed or attained by 1997, the plan calls for investment in facilities totaling 15.1 trillion won (approximately US$20.9 billion) from 1993 to 1997. The plan emphasized improvement of reservoirs at 597 locations, construction of eight multi-purpose dams and 21 large-scale water supply networks, and replacement of 20,000 kilometers of old water pipe lines (113:34). Additional expenditures include 204 billion won (US$291 million) to construct waste treatment facilities between 1995 and 2004, 83.7 billion won (US$116 million) to construct sanitary landfills in outlying regions, and 187.8 billion won (US$261 million) to construct sanitary landfills in the capital (Seoul) region alone (113:58).

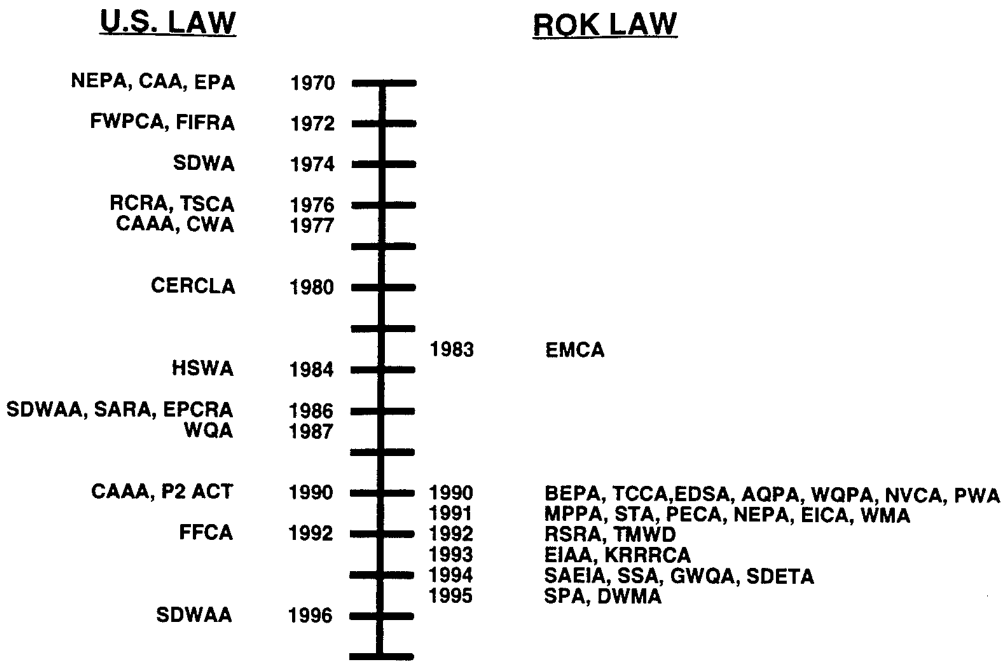

Figure 4a: Development of Major Environmental Legislation—United States Versus Korea

U.S. LAW

NEPA:	NATIONAL ENVIRONMENTAL POLICY ACT
CAA:	CLEAN AIR ACT
CAAA:	CLEAN AIR ACT AMENDMENTS
EPA:	ENVIRONMENTAL PROTECTION AGENCY
FWPCA:	FEDERAL WATER POLLUTION CONTROL ACT
FIFRA:	FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT
SDWA:	SAFE DRINKING WATER ACT
SDWAA:	SDWA AMENDMENTS
TSCA:	TOXIC SUBSTANCES CONTROL ACT
CWA:	CLEAN WATER ACT
WQA:	WATER QUALITY ACT
RCRA:	RESOURCE CONSERVATION AND RECOVERY ACT
CERCLA:	COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT
SARA:	SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT
EPCRA:	EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT
HSWA:	HAZARDOUS AND SOLID WASTE AMENDMENTS
P2 ACT:	POLLUTION PREVENTION ACT
FFCA:	FEDERAL FACILITIES COMPLIANCE ACT

ROK LAW

BEPA:	BASIC ENVIRONMENTAL POLICY ACT
EIAA:	ENVIRONMENTAL IMPACT ASSESSMENT ACT
AQPA:	AIR QUALITY PRESERVATION ACT
EMCA:	ENVIRONMENTAL MANAGEMENT CORPORATION ACT
WQPA:	WATER QUALITY PRESERVATION ACT
GWQA:	RULES AND REGS ON PRESERVATION OF GROUNDWATER QUALITY
DWMA:	DRINKING WATER MANAGEMENT ACT
STA:	ACT RELATING TO TREATMENT OF SEWAGE, NIGHT SOIL, AND LIVESTOCK WASTEWATER
SSA:	SEWER SYSTEM ACT
MPPA:	MARINE POLLUTION PREVENTION ACT
PWA:	POTABLE WATER ACT
TCCA:	TOXIC CHEMICALS CONTROL ACT
SPA:	SOIL PRESERVATION ACT
WMA:	WASTE MANAGEMENT ACT
TMWO:	ACT RELATING TO TRANSBOUNDARY MOVEMENT OF WASTES AND THEIR DISPOSAL
KRRRCA:	KOREA RESOURCES RECOVERY AND REUTILIZATION CORPORATION ACT
EICA:	ACT RELATING TO ENVIRONMENTAL IMPROVEMENT CHARGES
SAEIA:	SPECIAL ACCOUNT FOR ENVIRONMENTAL IMPROVEMENT ACT
NEPA:	NATIONAL ENVIRONMENTAL CONSERVATION ACT
EDSA:	ENVIRONMENTAL DISPUTE SETTLEMENT ACT
PECA:	ACT RELATING TO PUNISHMENT FOR ENVIRONMENTAL CRIMES
NVCA:	NOISE AND VIBRATION CONTROL ACT
SDETA:	ACT RELATING TO SUPPORT AND DEVELOPMENT OF ENVIRONMENTAL TECHNOLOGIES
RSRA:	ACT RELATING TO PROMOTION OF RESOURCES SAVING AND REUTILIZATION

Figure 4b: Explanation of Abbreviations—U.S. and Korean Environmental Law

Rather than focus on remediation of contamination from past activities, MOE decided to concentrate on preventing further environmental degradation, especially in the areas of groundwater and soil contamination. In addressing groundwater, the 1996 Report on Environmental Protection in Korea stated:

> "...once polluted, ground water is slow to recover, pointing toward the importance of taking preventive measures. The pollutants remain underground for a long time, so prevention is the only realistic choice if ground water is to remain usable." (113:40)

The same report later discussed soil contamination:

> Wastes, pesticides, and chemical fertilizer accumulate in the soil...This is an especially serious situation as once contaminated, soil cannot be restored by natural processes...Prevention measures rather than clean-up measures are therefore the most desirable means of combating this environmental problem. (113:66)

President Kim Young Sam's "Presidential Vision for Environmental Welfare" echoes the same sentiment (111). His major policy directions and target areas speak to stricter standards, construction of "basic environmental facilities" (such as sewage treatment plants and landfill sites), environmental education in grade schools and mass media, and the "greening of production and consumption," but does not mention cleanup of contaminated sites caused either by past or present activities.

It follows, therefore, that of the 24 acts listed, only one—the Soil Preservation Act of 1995, explicitly requires cleanup of contaminated sites. Prior to 1995, soil preservation came under the purview of the Water Quality Preservation Act (117). The Water Preservation Act contained three articles covering protection of soil:

- Article 45: Delegates authority to the city/provincial governor to establish water standards to protect farmland, wetlands, and forest, or "take measures to cover the soil or cutting the earth."
- Article 46:
  - Delegates authority to the city/provincial governor to restrict cultivation of agricultural and/or marine products in contaminated soil, or collect, remove, or destroy agricultural and/or marine products cultivated in a contaminated area;
  - Imposes liability on the polluter for costs incurred due to collection, removal, or destruction of agricultural and/or marine products sustained as a result of soil contamination. However, the Act does not require the polluter to remediate the contaminated area.
- Article 47:
  - Delegates authority to the Minister of Environment for promulgating contaminant standards in water, soil, or farm products, "if deemed necessary."
  - Delegates authority to the Minister of Environment to prohibit the manufacturing of agricultural chemicals deemed especially harmful to water, soil, or farm product quality.

The Water Preservation Act of 1990 did not include provisions for protecting groundwater—"water," as defined in the Act, pertains to surface water sources (rivers, lakes, streams, reservoirs, etc.). In addition, the Act did not require promulgation of national maximum contaminant levels in soil, unless necessary ("necessary" is not defined). Local governors could establish their own standards, if conditions merited more stringent measures, without consultation with MOE. Finally, the Act, while mandating restitution for damage caused to agricultural and marine crops, did not require payment for any remedial action required due to contamination of media (surface water or soil). At this point in their legislative development (1990), remediation may not have been an important consideration.

In January 1995, the ROK enacted the Soil Preservation Act in response to the growing number of soil-contaminating substances generated and used throughout the country (113:68). The Act covered four major areas:

- Extends the Soil Contamination Monitoring Network from 780 sites in 1996 to 10,000 sites by 2005. The network tests for soil acidity and heavy metals; organic chemicals are not included in the sampling scheme.
- Requires MOE concurrence when installing soil contamination prevention facilities at industrial complexes and mines. If such facilities have been installed but proper measures for soil contamination prevention are not taken due to improper design or installation, or if orders to improve or correct installed facilities are not followed, the city/provincial governor may order cessation of operations (113:68; 115).
- Promulgates "action" and "threshold" values for contamination in soil, and requires city/provincial governors to designate the area as a Soil Preservation Zone if contaminant levels exceed the action value (see Table 6). Declaration of

a Soil Preservation Zone entails implementation of steps to prevent further contamination.

- Requires the city/provincial governor to establish and implement a plan to include soil improvement projects and methods for interim land use during remediation of a Soil Preservation Zone, if the zone is to be used in the future for agricultural or industrial development. Remedial action must restore the contaminated site to levels below the threshold value.

As Table 6 illustrates, the Act specifies separate standards depending on land use. For example, if a soil preservation zone contains BTEX-contaminated soil at levels below 200 ppm, a firm may use the land for industrial purposes. Agricultural development is prohibited, unless the soil is remediated below detectable limits. The dual standard is somewhat comparable to EPA's Brownfields Initiative (162).

Table 6: Soil Preservation Act, Maximum Contaminant Levels

	Threshold Value (in ppm)		Action Value (in ppm)		US Standards
Contaminant	Agriculture	Industry	Agriculture	Industry	Soil (ppm)
Cadmium	1.5	12	4	30	1
Copper	50	200	125	500	2,800
Arsenic	6	20	15	50	5
Mercury	4	16	10	40	0.2
Lead	100	400	300	1000	5
Chromium (Cr^{6+})	4	12	10	30	5
Organophosphates	10	30	NA	NA	-
PCB	Below Detect	12	Below Detect	30	6.6
CN^-	2	120	5	300	1,300
Phenol	4	20	10	50	39,000
BTEX	Below Detect	80	Below Detect	200	See Below
Benzene	See Above	See Above	See Above	See Above	140
Toluene	See Above	See Above	See Above	See Above	1,900
Ethylbenzene	See Above	See Above	See Above	See Above	690
Xylene	See Above	See Above	See Above	See Above	990

Source: (115) for Korean standards; (37) for U.S. Standards

Table 6 also lists comparable U.S. standards for the same contaminants in soil. In some cases, ROK maximum contaminant levels are more stringent U.S. standards and levels published in the FGS (copper, chromium, cyanide, phenol, and the BTEX compounds) (165:B-1). This should signal the USFK environmental staff to consider revising the current FGS to accommodate the more restrictive ROK standards.

Another law passed in January 1995 was the Drinking Water Management Act, which provided maximum contaminant levels for drinking water obtained specifically from groundwater sources (112). Table 7 provides the maximum contaminant levels of the Act compared to similar U.S. standards for groundwater.

Table 7: Drinking Water Management Act, Maximum Contaminant Levels

	Threshold Value (in ppm)			US Standards
Contaminant	Domestic Use	Irrigation	Industry	Water (ppm)
pH	5.8-8.5	6.0-8.5	5.0-9.0	6.5-8.5
COD	6	8	10	NA
Coliform Counts	5,000 (MPN/100 mL)	NA	NA	Non-Detect
Nitrates	20	20	40	10.0
Chloride Ions	250	250	500	250
Cadmium	0.01	0.01	0.02	0.005
Arsenic	0.05	0.05	0.1	0.05
Cyanide	Non-Detect	Non-Detect	0.2	0.2
Mercury	Non-Detect	Non-Detect	Non-Detect	0.002
Organic Phosphorus	Non Detect	Non-Detect	0.2	NA
Phenol	0.005	0.005	0.01	0.001
Lead	0.1	0.1	0.2	0.05
Chromium	0.05	0.05	0.1	0.05
TCE	0.03	0.03	0.06	0.005
PCE	0.01	0.01	0.02	0.005

Source: (112) for Korean standards; (37) for U.S. Standards

3. Applicability of ROK Environmental Laws to DoD Forces in Korea.

As mentioned earlier, the SOFA contains provisions for prosecuting DoD members who violate Korean environmental law. While not as severe as U.S. environmental law, Korean environmental laws still include substantive penalties for environmental criminals. A few examples of such punishment appear in Table 8. A significant factor in Korea's inability to prosecute DoD personnel for environmental wrongdoing is the ROK government's inability to freely enter U.S. installations. Article III of the SOFA provides U.S. justification for barring free entry of Korean government officials, including MOE inspectors, onto U.S. installations on grounds of installation security (43:14-15). To date, ROK accusations of environmentally unsound practices at U.S. installations have been based solely on off-site observations made by the Ministry of Foreign Affairs, non-governmental organizations (NGOs), or reporters from the local news media (14; 122). Appendix 3-3 lists some examples of ROK allegations of U.S. environmental violations.

Table 8: Example Penal Provisions, Korean Environmental Law

Korean Environmental Law	Maximum Fine*	Maximum Imprisonment
Air Quality Preservation Act	50 Million Won ($57,340)	7 Years
Environmental Dispute Settlement Act	2 Million Won ($2,294)	1 Year
Natural Environment Preservation Act	5 Million Won ($5,734)	2 Years
Noise and Vibration Control Act	15 Million Won ($17,202)	3 Years
Act Relating to Promotion of Resources Saving and Reutilization	5 Million Won ($5,734)	1 Year
Act Relating to Treatment of Sewage, Night Soil, and Livestock Wastewater	20 Million Won ($22,936)	2 Years
Toxic Chemicals Control Act	10 Million Won ($11,468)	3 Years
Waste Management Act	30 Million Won ($34,404)	5 Years
Act Relating to Transboundary Movement of Wastes and Their Disposal	30 Million Won ($34,404)	5 Years
Water Quality Preservation Act	50 Million Won ($57,340)	7 Years
Rules and Regulations on Preservation of Groundwater Quality	5 Million Won ($5,734)	1 Year

*Conversion rate: 872 Won per U.S. $1.

NOTE: Penal provisions obtained from English translations of the respective Korean environmental laws (see bibliography).

The findings listed in Appendix 3-3, however, are not accompanied by verifiable test results, sampling and survey methodology, list of investigators and their credentials, or academically-acceptable data to support the accusations. With the exception of noise measurements, the articles did not quantify amounts of contaminants—investigators described contaminant amounts as "excessive," "exceed[ing] standard levels," and "anticipat[ory of] contamination" (14). Adequate site characterization to identify and quantify contaminants normally requires in-depth, rigorous measurements of the different media (air, water, and soil). In the U.S., environmental law and applicable regulations (Code of Federal Regulations) require strict adherence to EPA-approved guidelines for sampling and analysis before contaminant measurements are considered "acceptable" for regulatory purposes. The qualitative nature of the reports makes DoD verification of findings virtually impossible, and allows USFK to prepare rebuttals refuting claims of environmental law violation.

However, the situation may change in the near future, as MOE officials continue to pursue access to DoD installations for the purpose of conducting joint DoD/MOE environmental assessments, similar to those conducted at MND installations (58). While DoD has successfully blocked previous requests for environmental assessments by ROK officials, the matter has not been fully resolved. The SOFA Joint Committee, co-chaired by the Director General of American Affairs, Ministry of Foreign Affairs (ROK) and the Vice-Commander, USFK, directed the Environmental Subcommittee of the SOFA Joint Committee to provide a process for evaluating the "potential for environmental contamination in and around USFK installations" in September 1993 (67). The tasking stemmed from a ROK request to conduct joint environmental assessments of all USFK installations. USFK denied the request immediately on the basis that MOE was not allowed access to ROK military installations. USFK argued that if MOE could not evaluate MND bases, they should not be allowed access to DoD installations (58).

The circumstances surrounding this issue changed dramatically this past year, as MND granted full access to all of its installations in December 1996, and allowed joint MOE/MND inspections, uncovering thousands of contaminated sites. Although the Environmental Subcommittee has met just once since the 1993 tasking, meetings on the subject of joint assessments can be expected to resume in the near future in light of MND's recent change in policy with regard to installation access and joint inspections (58).

In addition, the number of criminal cases involving American military personnel for which the ROK government exercised jurisdiction has steadily increased since 1991. South Korea exercised its jurisdiction over 28.9 percent of all crimes committed by U.S. forces in Korea in 1997, indicating a gradual upward trend from 11.1 percent in 1991 and 27.6 percent in 1996. The 25 cases brought to trial thus far in 1997 represent 6.8 percent of all 366 crimes committed by U.S. forces in the country from January to September 1997, up from 3.4 percent during the same period in 1996 (149). The steady rise in cases where the ROK government has exercised jurisdiction may indicate increased willingness on the part of South Korea to hold U.S. soldiers and airmen responsible for criminal acts committed against Korean law.

MND's unprecedented openness to public scrutiny is reflected in their current "White Paper," which is available to the general public in both Korean and English languages via the Internet (118). The document summarizes Korea's national defense policy and objectives, and describes four "basic directions of national defense policy":

- Establishment of a firm defense posture (deterrent force);
- Development of internal and external military relations (key of which is the U.S.-ROK security alliance);
- Development of a future-oriented defense capability (modernize the force and work toward increased self-sufficiency); and
- Creation of a reliable armed forces image (public relations).

The fourth "basic direction" specifically mentions preservation of the environment as an important objective which MND must meet in order to fulfill Korea's overall national defense objectives (118:1-5). Specifically, MND has,

> ". . . hammered out both medium and long-range domestic defense development plans to improve management of defense resources, preserve the environment, and promote amicable relations with the civilian populace." (118:1-5)

Other comments throughout the White Paper portend developments which may impact future DoD environmental policy for Korea:

1. ROK-U.S. Security Cooperation. The White Paper refers to "certain unequal or one-sided issues" when discussing the current SOFA. Although not specifically stated, the issues include criminal jurisdiction over crimes committed by U.S. servicemen and civilian members, as well as SOFA articles and provisions related to facilities and areas (118:3-26). Interviews with MOE, the USFK environmental staff, and DoD General Counsel indicate one of the "unequal" issues concern restoration of DoD installations in Korea upon closure.

Generally, U.S. SOFAs and basing agreements with other nations contain similar language compared to the U.S./ROK SOFA concerning return of military installations to the host nation—that remedial efforts to restore land to original condition are not required (129). However, base closure actions in Germany and Canada have influenced Korea's perception of "fair" treatment. Base closures in Germany during the past decade have included an "off-set" provision whereby claims against the U.S. for environmental damage were "paid" with residual value associated with facilities and other capital improvements made on German bases. If the SOFA provisions were explicitly followed, the off-set would not have been honored by the U.S., and Germany would have been forced to pay the residual value associated with former U.S. military installations returned to the German government. The U.S./ROK SOFA differs from the U.S./German SOFA concerning off-sets in that Korea is not "obliged to make any compensation to [the U.S.] for any improvements made in facilities and areas or for the buildings and structures left thereon" (43:16). In this respect, the U.S. does not have the same "insurance policy" as it had in Germany, further complicating the restoration issue. In Canada, the deviation from SOFA provisions was more obvious. DoD agreed to pay $100 million over the next ten years for environmental damage associated with U.S. military operations at 21 Distant Early Warning Line sites, Goose Bay airfield, Haines-Fairbanks Pipeline sites, and the U.S. Naval Station, Argentia (108).

2. Defense Burdensharing. The U.S. has repeatedly asked for increased ROK defense burdensharing over the past several years, especially for facility construction. At the 1995 ROK/U.S. Security Consultative Meeting, the two countries terminated the

existing won-based cost (WBC) burdensharing agreement in favor of a new index based on the rate of domestic price increases in the ROK (Table 9).

Table 9 Defense Burdensharing, 1991-1998 (118)
unit: $ million

WBC Formula					Index Formula		
1991	1992	1993	1994	1995	1996	1997	1998
150	180	220	260	300	330	363	399

Historically, ROK burdensharing funds have been applied to the Combined Defense Improvement Program (contingency-related facility construction), logistics support (war reserve materials and depot maintenance costs), wages of Korean nationals working at U.S. bases, and military construction of support facilities, such as dormitories. The MND White Paper adds another category—projects to remediate environmental contamination (118:3-31)—which DoD opposes. DUSD-ES believes the maximum amount of burdensharing funds should go toward facility construction; environmental restoration should not "count" against the burdensharing account, especially since projects outstrip available construction funds and Article IV of the SOFA specifically relieves the U.S. of remedial responsibilities (168).

3. MND Environmental Preservation Activities. During a reorganization in 1995, MND created an environmental division within each service component, setting the wheels in motion for developing a comprehensive environmental program within the Korean military establishment. In the short two years since, MND has surveyed their installations and created a construction program to address their most severe pollution problems (see Table 10).

Table 10: MND Facilities to Prevent Environmental Contamination (118)

Facilities	Total Requirement	Constructed Before 1995 (%)	Planned in 1996	Planned in 1997 and beyond
Sewage and waste water disposal facilities	891	386 (43)	44	461
Air noise prevention facilities	12	4 (33)	1	7
City gas prevention facilities	66	49 (74)	7	10
Waste material incinerators	205	78 (38)	16	127

Further evidence of MND's commitment to protecting and preserving the environment includes:

- Development of environmental preservation and regulations and directives, and plans instituting training programs for all soldiers, airmen, and sailors.
- Development of a recycling program including use of recyclable containers in all MND dining facilities, standardization of packaging size and material to minimize waste, and operation of recycling centers.
- Identification of past waste dump sites, and investigation of soil and groundwater contamination at those sites. MND intends to "settle disputes with local inhabitants" and conduct "decontamination work" based on a prioritized medium and long-range plan.
- Comprehensive joint assessments of MND installations with MOE inspectors. These inspections, conducted between October 1995 and October 1996, measured the extent of environmental contamination at POL storage areas, ammunition dumps, airfields, waste disposal plants, and maintenance depots. A total of 53 units underwent investigations during the 12-month period (118:5-5).

Although no official documents could be obtained, MND environmental officials indicated their intent to begin remediating contaminated sites in accordance with MOE regulations within the next year (177). The previously mentioned MND White Paper confirms part of the newly developed remediation program, but lacks detail. MND accomplished their first remedial project at a previously closed logistics center in Pusan, Korea's second largest city, excavating 25 tons of oil-contaminated soil. Their environmental division chief has requested a modest remediation budget of $10 million for cleanup in 1998, and $15 million in 1999 to begin restoration of approximately 300 potential sites (177). While the funding amounts may not be significant by U.S. DoD standards, MND's intention to begin remedial action at their worst sites sets a precedent which improves the ROK government's stand in arguing for similar action by the U.S. at DoD installations in Korea.

While access and inspection of DoD installations are primary factors affecting the overall level to which the United States complies with Korean environmental law, compliance is also heavily influenced by Korean compliance with and enforcement of its own laws, especially with respect to MND. If the ROK government does not force the Korean defense establishment or civilian components to comply with Korean environmental laws, they cannot expect to exercise exclusive jurisdiction over a DoD organization or member for violating the same laws. And over the past several years, enforcement has been a major problem for the ROK government. As Table 11 indicates, although the number of environmental inspections has risen since 1988, the number of violations has not changed significantly (despite the increase in number and stringency of environmental legislation over that same time period).

Table 11: Environmental Inspection Results of Non-Governmental Organizations In Korea, 1988-1993 (59:50)

Year	1988	1989	1990	1992	1993
Inspections	56,940	65,392	108,205	121,024	130,093
Violations	8,127	11,500	16,705	11,083	12,965
% non-compliance	14.3	17.6	15.5	9.2	10

Just as startling is the low number of environmental damage compensation cases over the same time period (Table 12). Especially note the lack of civil suits. The low number of cases is commonplace for the Korean legal system where social harmony, consensus, and the authority and power of the central government are emphasized. In general, citizens are usually denied litigation as a method of settling disputes, since the litigant must prove immediate and personal damage, and epidemiological and other statistical evidence is normally disallowed by the courts. Arbitration panels are normally empowered by the ROK government to settle civil disputes, but also disallow epidemiological and statistical evidence, making it difficult for plaintiffs to win cases (59:24).

However, in many cases, parties suffering damage from environmental violations normally receive unofficial compensation from the responsible firm or individual. Receipt of unofficial compensation is reflective of a strong Confucian value system which still influences many facets of Korean daily life (59:49). The responsible firm or individual

Table 12: Environmental Pollution Damage Compensation in Korea, 1989-1993
(114:229)

Year	1989	1990	1991	1992	1993
No. of Complaints*	1,201	1,033	1,274	1,153	2,144
No. of Cases Arbitrated	19	14	22	18	48
Settlement					
Adjustment	0	0	$291,250	$150,483	$4,251,268
Civil Suit	0	0	$8,250	0	0
Agreement between Parties	$3,435,691	$4,365,879	$6,110,519	$3,384,110	$2,914,420
Total	$3,435,691	$4,365,879	$6,410,019	$3,534,593	$7,165,688

*Official complaints received by MOE through local government.

feels obligated to provide a "fair" settlement—"fair" as defined and agreed upon by all—to the injured party, which is not normally reported to the government. It is estimated that the official damage compensation figures may represent as little as one percent of the actual compensation provided to injured parties (59:49).

Nevertheless, as shown by the trends in the number of cases reported and arbitrated in Table 12, Korean citizens seem to have begun deviating from their Confucian ethic. Additionally, the compensation awarded by Korea's Central Environmental Disputes Coordination Commission, the government body with exclusive responsibility for dispute mediation in accordance with the Environmental Dispute Settlement Act, has also steadily risen since 1989.

D. Environmental Studies and Audits—A Look at Current Environmental Conditions Within Korea

Previous sections of this chapter examined the compliance issues associated with hazardous waste site remediation—compliance with U.S. environmental law, policy, and regulations; U.S./ROK international agreements; and Korean environmental law (when applicable). Tracing the origin of the overseas restoration program from U.S. environmental law has shown Congressional, Executive and DoD motivation and justification for restoration activities overseas. DODI 4715.8 embodied DoD's current policy toward the overseas cleanup program. It clearly outlined service component and USFK responsibilities in identifying possible contaminated sites, and, if necessary, adequately cleaning up those sites presenting an excessive human health risk.

Given the motivation for remedial activities in Korea, we must now determine if conditions warrant cleanup, i.e., do USFK installations contain sites which exceed maximum contaminant levels (MCLs) and present an "imminent and substantial endangerment to human health." The second requirement, imminent and substantial endangerment to human health, is especially important since only this condition triggers remedial action as specified in DODI 4715.8. Exceeding MCLs may result in cleanup action, but only if the effluent or spill represented a danger to human health or the environment. Compliance with the regulation or law which specified the MCL is a separate and distinct mater compared with remedial action. This section takes the next step in understanding the scope of the remedial problem in Korea by investigating the current "state of the environment" on the peninsula with regard to hazardous waste sites. Two categories of literature were reviewed: (1) studies and reports dealing specifically with contamination on or emanating from a DoD installation; and (2) studies and reports investigating non-DoD sites.

The first category of literature specifically assessed the scope of the contamination problem on DoD installations. A few comprehensive studies conducted by reliable sources have been accomplished to investigate sites with suspected groundwater and/or soil contamination. Compliance inspections, conducted by DoD personnel, have also been accomplished. Although these inspections primarily investigate an installation's level of compliance with DoD regulations, they sometimes identified suspected hazardous waste sites which warrant further examination.

The second category of literature attempted to evaluate Korea's present level of concern for, and action taken to abate, hazardous waste sites within the country. This level of concern was important for several reasons:

1. It served as a portent for future Korean remediation policy and legislation. If studies indicated the existence of a significant number of sites with high levels of contamination, DoD should expect the ROK government to promulgate new cleanup legislation in response to those problems, especially if such information is widely advertised to the public. A single incident in March 1991—the Doosan Electronic Company phenol spill—resulted in tumultuous changes within the ROK environmental organization. The accident, which caused temporary illness in a number of Korean citizens (but no deaths), resulted in the dismissal of the minister and vice minister of MOE within two weeks of the spill's discovery. In addition, three new environmental acts were created and three existing acts amended during the same year (97:19).

2. It may determine the level of remedial action required by DoD. With a limited defense budget and a number of competing priorities, Congressional support for cleanup of contaminated sites in foreign countries should not be expected, especially if the host country does not support remedial projects of its own (168). The ROK government stands to

strengthen their argument for DoD cleanup efforts if they aggressively support site investigation and remedial action for their contaminated sites (especially for sites on current and former Korean military installations). Consequently, Congressional and DoD support for remedial investigation and cleanup activities in Korea may increase if the ROK government aggressively pursues remediating its past environmental mistakes and applies strong pressure for reciprocal U.S. action at DoD installations with similar problems.

3. Reviewing studies conducted by non-DoD entities also helps evaluate and determine the types of remediation technology and site characterization tools currently used in Korea. As mentioned in Chapter 1, opportunities exist for cooperation between the U.S. and Korean military with regard to hazardous waste site remediation technologies, especially given the infancy of Korea's cleanup program.

4. Finally, although the vast majority of the articles do not touch upon hazardous waste site remediation at DoD installations, review of the articles may provide clues as to the direction remedial policy will take toward DoD installations in the coming years. Combined with personal interviews of Korean environmental policy makers and academicians, the articles underscore environmental issues of importance to the Korean public, which, in turn, influence environmental policy makers.

1. Non-DoD Studies.

In general, investigation of suspected hazardous waste sites on DoD installations in Korea has been almost non-existent. Similarly, studies of Korean hazardous waste sites are also quite scarce. A number of studies, conducted mainly by Korean researchers, exist for specific civilian sites, such as large industrial complexes, the most densely populated urban centers, and key economic hubs. However, these works do not center on site characterization or cleanup of contamination; rather, they concentrate on investigation of media-specific pollution problems, such as solid and hazardous waste management, air and drinking water pollution, and excessive organic and inorganic contaminants in domestic and industrial wastewater effluent (1; 5; 13; 15; 20; 22; 24; 26; 74; 75; 78; 79; 84; 85; 86; 87; 88; 93; 94; 98; 121; 182). Very few articles centered around hazardous waste site remediation; those that did investigated specific civilian industrial sites or natural resources (such as rivers or lakes) (72; 120). No documents mentioning contaminated sites at Korean military installations could be found.

A review of the journal articles referenced above, as well as a literature search using a commercially-available literature database, highlighted the predominant Korean environmental issues emphasized by researchers—water quality (coastal, surface and ground water), hazardous materials, and air pollution (see Figure 5). It should be noted that of the 130 articles reviewed, 87 percent were written by Korean academicians, and 75 percent were written in English (a larger pool of literature written by Korean researchers in the Korean language probably exists, but is not referenced in the English research databases).

In addition to the journal articles, the Korean National Institute of Environmental Research (NIER), conducted a total of 26 research projects in 1993 (more discussion on NIER follows). MOE set aside approximately 2.5 billion won (US$3.5 million) to carry out these projects. Most of the projects pursued development of technology for environmental management, pollution control, and waste treatment or obtaining baseline data on air and water pollution. Since 1990, the NIER has also stressed comprehensive environmental management in the private sector and the commercialization of anti-pollution technology among Korean firms (114:236). Summaries of the research started in 1993 are included in Appendix 3-4 (114:237-251). Also included as part of Appendix 3-4 are environmental projects accomplished by NIER under the Highly Advanced National (HAN) Projects program between 1990 and 1994. Although no cost data exists for projects prior to 1992, a total of 611 million won (approximately US$800 thousand) was allocated from public and private sources to fund research from 1992 to 1994 (114:186).

The predominant focus on air and surface water quality, and hazardous materials may be due to the visibility associated with those media. The average Korean citizen can easily observe the effects of air pollution—smog, deterioration of exterior surfaces of buildings and automobile finishes, breathing difficulties, etc. Untreated wastewater in Seoul's largest tributary, the Han River, contributes to the murky appearance and noxious smell which daily commuters notice as they travel to work. Contamination of soil and groundwater, on the other hand, is largely invisible to the public, unless such contamination results in serious health effects.

One example of a highly visible surface water spill occurred in March 1991, when the Doosan Corporation dumped 340 tons of phenol into the Nakdong River, contaminating drinking water for the city of Taegu, the third-largest city in South Korea. MOE estimated that hundreds to thousands of people became violently ill from ingesting contaminated water—not from the spill itself (which caused such a strong stench that people were reluctant to drink or use the water), but from small amounts of phenol which Doosan was

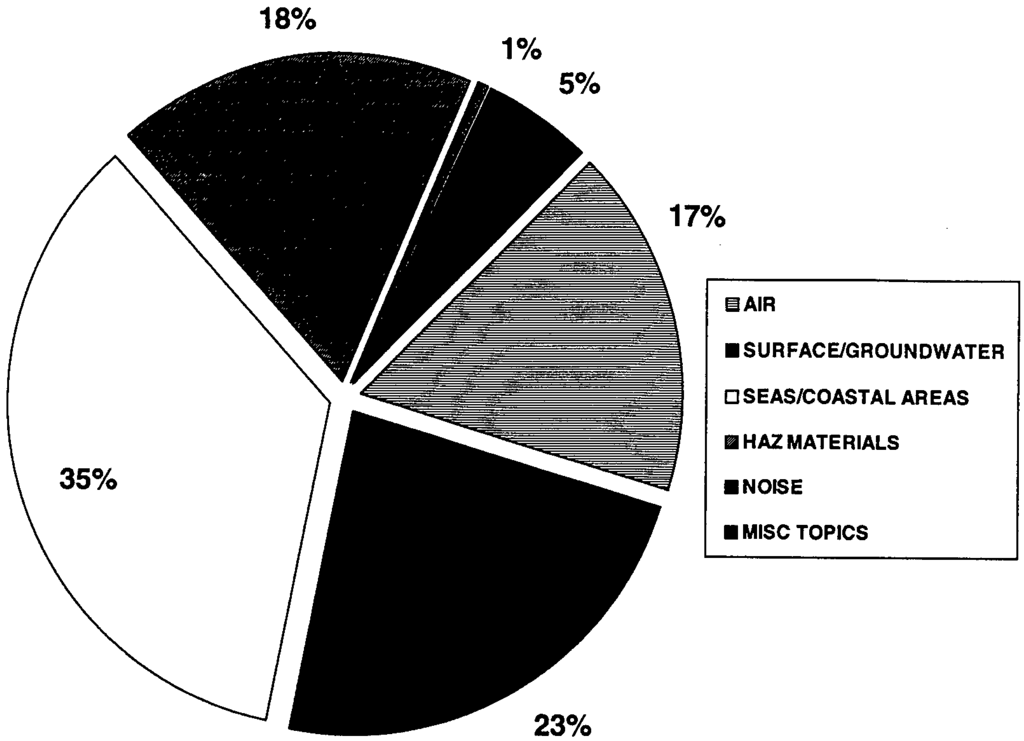

Figure 5: Distribution of Journal Article Subjects

	Article Subject						
	Air	Surface/ Groundwater	Seas/ Coastal Areas	Haz Materials	Noise	Misc Topics	Total
# Articles	22	30	45	25	1	7	130

Journal article search conducted using First Search® literature searching service using "Korea" as the search subject (no limitations placed on journal language or years of publication). Database used was the "Environmental Science and Pollution Management Database," which surveys numerous journals across multidisciplinary fields in the environmental sciences for relevant articles.

Notes:
1. Only three articles of the 30 in the "surface/ground water" category dealt with ground water contamination.
2. "Haz Materials" includes toxic materials, including heavy metals, organic solvents, and radioactive materials. Only four articles dealt specifically with risks associated with soil contamination; only two articles dealt with organic solvents (the majority of articles treated heavy metals at mines).
3. "Misc Topics" covers articles on environmental policy, and multi-subject articles.
4. "Journal articles" defined as studies/research conducted by academicians, or research scientists, published in peer-reviewed publications or as part of technical conference proceedings.

dumping into the river for days prior to the spill. After a two week suspension of operations, the ROK government allowed Doosan to reopen due to negative economic impacts associated with Doosan's closing. Thirteen days after they were allowed to resume operations, a second phenol spill occurred into the Naktong River. During the investigation, prosecutors argued that not only did Doosan illegally dump hazardous waste into the river, but they attempted to conceal the incident. In the aftermath, nine officials resigned from Doosan, including their chairman, and the Environmental Minister of South Korea, Huh Nam-Hoon, was fired. Doosan paid approximately $30 million in compensation to some 12,000 citizens, 30,000 grocery stores and the city of Taegu, which filed a suit against Doosan (55).

The outcome of the Doosan spill, however, is rare in South Korea, and can most likely be attributed to the severity of the human health effects over such a short period of time (within days of the initial spill). With the exception of the most severely contaminated sites, however, many of the negative health affects associated with hazardous waste sites occur over the long term, for which few studies have been accomplished in Korea.

Another factor contributing to the lack of research in groundwater contamination is the extensive use of surface water (lakes, streams, rivers) for potable water sources. At present, groundwater accounts for only 9 percent (2.3 billion tons) of the total water used annually (113:40). Since surface water sources provide the majority of drinking water and coastal areas supply seafood to consumers, these areas have been more intensely researched than hazardous waste sites. However, MOE predicts an increase in groundwater use in the future. This should spur the interest of academicians and government officials to begin looking at hazardous waste sites. Preliminary studies have been started to ascertain the level of pollution in aquifers and determine methods for the protection and remediation of sites which may present a risk to sources of groundwater. A survey conducted in 1993 and 1994 of 770 selected agricultural, industrial, landfill, mining, urban, and fuel oil storage areas found 99 sites (13 percent) with excessive amounts of pollutants (cadmium, NO_3-N, and trichloroethylene) (113:41).

As Figure 5 and Appendix 3-4 illustrate, very little research has been accomplished in the area of hazardous waste site remediation in Korea. The relatively small amount of literature on hazardous waste site contamination in Korea is not surprising given the relatively recent development of Korea's advanced environmental research facilities, introduction of environmental programs within their educational institutions, and the ROK government's focus on pollution prevention policies and abatement technologies versus investigation and cleanup of contaminated sites. The NIER, founded in 1978 and operated by the Ministry of Environment since 1990, is the central agency which conducts Korea's environmental research. Although it currently has a staff of about 200 professionals, NIER's facilities and equipment are inadequate and outdated, and its personnel lack sufficient training and experience (59:28). The ROK government has discussed possible upgrades to NIER's facilities, equipment, and laboratories, but funding has not been reserved for the task (59:28). MOE also established the Korean Environmental Technology Research Institute (KETRI) in 1992. KETRI, primarily a policy analysis agency, researches technology capabilities and trends and attempts to link them with national environmental policy development (59:29).

Another problem plaguing NIER which materializes when reviewing the list of research topics in Appendix 3-4 is the apparent lack of academic crossfeed and literature review which occurs at Korean research institutes. Many of the studies have been accomplished in advanced countries, such as the U.S., with similar findings (albeit in English rather than Korean). As interest in the environment grows within Korea, perhaps more "academic transfer" will occur, leading to less duplication of efforts. The establishment of the Foreign Studies Division of Hankuk University may also facilitate increased international exchange in environmental research.

Undergraduate and graduate-level study of the environment began in earnest only during the late 1980s. As such, enrollment in these fields has only recently begun to rise (see Table 13). For comparison, Stanford University's Environmental and Water Studies Program is composed of approximately 100 graduate students (141); and Cornell University's School of Civil and Environmental Engineering enrolled 91 graduate students in 1994 (30). Offerings of environmental degrees, along with student enrollment, should continue to increase in the upcoming years as NIER increases its cooperative agreements with universities and MOE strengthens environmental education in primary and secondary schools throughout the country (the ROK government has emphasized environmental education for children as young as pre-school age since 1993) (114:262-263).

Earlier in this chapter, President Kim's environmental vision was presented, and the absence of a remedial policy within that vision was contrasted to U.S. policy of cleaning up its past environmental mistakes (as evidenced by the tremendous amount of resources

Table 13: Environment-Related Enrollment (114:190)

Category	Annual No. of Graduates[1]					
	1988	1989	1990	1991	1992	1993
Undergraduate University	606	713	717	979	1,208	1,568
Graduate University	285	255	298	315	384	469

[1]Includes degrees in environmental engineering, environmental science, and other environment-related fields. Environmental science encompasses basic sciences (physics, chemistry, and biology), as well as civil engineering, chemical engineering, and machinery.

committed to the Superfund program). In addition to the reasons cited previously, the limited amount of research in environmental remediation may also be a consequence of this lack of government support for cleanup activities—lack of support in the form of strong policy and funding of site investigations, remedial action, and research and development of cleanup technology. With no apparent government and/or public pressure, the academic world does not have sufficient motivation (or funds) to undertake costly research in the field of environmental remediation when other more pressing and prevalent environmental problems exist.

Korean *chaebols*, the country's largest integrated industrial groups, have attempted to pick up some of the slack by beginning their own research on environmental remediation technologies. These groups, such as Hyundai, Daewoo, Ssangyong, Samsung, Lucky-Goldstar, and Lotte, received favorable treatment from the ROK government (such as capital, protection from labor activism, lax enforcement of environmental laws, and other concessions which aided their unimpeded growth) beginning in the late 1960s. The significance of the *chaebols'* involvement in environmental issues becomes evident when considering the tremendous influence they have on the Korean economy, and therefore everyday life, of Korean citizens. In 1994 over 70 percent of all business activity in South Korea was connected to the *chaebols*. In return, the *chaebols* provided direct financial support to the Korean political leadership (59:83).

Since the early 1990s, however, the *chaebols* have become acutely aware of the effect public perception—not just domestic perception, but global perception—has on their economic health, especially with regard to environmental issues. To be branded an uncaring corporate ecological villain is not only bad public relations, but bad business. In addition, for Korean business, trade restrictions based on environmental issues—or any considerations other than the marketplace—present an immediate and profit-threatening concern. Therefore, during the past two years, many large Korean companies (including nearly every *chaebol*) have established their own in-house capabilities to track worldwide technology and environmental trends through the creation of institutes and teams of Ph.D.-level researchers (59:142).

Nevertheless, Korean environmental firms are still just beginning to develop a cleanup capability. In reflecting upon a recent cleanup effort in Pusan, MND pointed out the limited expertise of Korean companies. MND's head of environmental programs believed a few companies are developing the necessary capabilities in remediation technology, but acknowledged they do not have capabilities similar to U.S. companies at present. To aid Korean firms in their development process, MND has established cooperative agreements with KIST to conduct bioremediation research on two of its installations. Results of such studies may not only benefit MND, but should expand the breadth of remediation technologies available to Korean environmental companies (177).

2. Environmental Compliance and Management Program (ECAMP) and Environmental Compliance Assessment System (ECAS) Reports.

With the limited number of DoD-sponsored site investigations at installations in Korea, results from Environmental Compliance and Management Program (ECAMP) assessments and Environmental Compliance Assessment System (ECAS) audits provide one of the more comprehensive looks at possible contaminated sites at Air Force and Army bases, respectively. Both "inspection" systems (ECAMP is an Air Force program; ECAS is the Army's equivalent) serve similar purposes:

- Assess the status of environmental compliance. In foreign countries, the ECAMP and ECAS processes evaluate compliance with the country-specific Final Governing Standards or Overseas Environmental Baseline Guidance Document.
- Identify and track solutions to compliance problems (44).

These audits are driven by the Korea FGS (165:1-4), which mandate internal audits (conducted using personnel from the installation) once every calendar year, and external audits (conducted by personnel from a different installation or level of command) once every three years. As their name implies, these investigations focus on compliance issues rather than site contamination issues, and the results of the investigations reflect this focus.

The assessments occasionally uncover evidence of site contamination, albeit with few details. Appendix 3-5 identifies findings from the most recent ECAMP and ECAS reports which hint at possible soil, groundwater, and/or surface water contamination (60; 61; 62; 63; 64; 65). In some cases, the findings are very explicit in concluding that the sites discovered are actually contaminated, either due to obvious physical signs (leaching of pollutants or suspected pollutants, soil discoloration, floating petroleum product, oily sheen across surface water, etc.) or testimonials from installation personnel. In other cases, findings simply state that effluent has been discharged without proper characterization, such as with overloaded or poorly designed wastewater treatment systems. In nearly all cases documented in Appendix 3-5, in-depth investigation is lacking, making risk evaluation and determination of "imminent and substantial danger to human health" difficult. A select group of sites have been characterized, and results are discussed in the next section.

3. DoD Studies.

A few DoD studies have been accomplished for sites with known contamination. These include a characterization of five sites at Kunsan Air Base (175), sampling and analysis of selected contaminated monitoring wells at Camp Carroll (153), sampling and analysis of soil at Camp Market (152), and characterization of two sites at Osan Air Base (151). However, studies of this nature are atypical, as recent remediation policy did not support intensive research efforts for other than immediate and substantial health risks.

a. Kunsan Air Base.

(1) Site Investigation.

In January 1997, Kunsan Air Base completed a study at five sites suspected of soil and groundwater contamination. A total of 57 soil samples were retrieved from 18 borings, and analyzed for polynuclear aromatic hydrocarbon (PAH) compounds and benzene, toluene, ethylbenzene, and xylene (the BTEX compounds). Table 14 lists the maximum and minimum concentration measured at each of the five sites. Aquifer testing and monitoring were also conducted to evaluate the potential migration of contaminants via the groundwater pathway using a two-dimensional groundwater transport model. Conclusions for each of the five sites were as follows:

1. Base Theater, Building 710. Relatively low concentrations of volatile organic compounds (VOCs), primarily benzene and toluene, and PAH compounds (anthracene, fluorene, and fluoranthene) were detected in soil and groundwater samples collected at this site from the four monitoring wells installed around the northern end of the facility. The elevated total BTEX and PAH concentrations were detected in soils collected from 2.5 to 4.5 foot below ground surface. Soil contaminant levels dropped to very low levels (non-detectable) at depths greater than 6 feet below ground level.

Table 14: Sampling Test Results (175:Table 4.5)

	BTEX (Soil) mg/kg		PAH (Soil) mg/kg		BTEX (Groundwater) mg/L		PAH (Groundwater) µg/L	
Facility/Area	Max	Min	Max	Min	Max	Min	Max	Min
Base Theater	251	ND	22	ND	0.01	0	0.2	0
Military Gas Station	9.2	ND	0.059	0.007	0.24	0.01	0.3	0.04
Base Transportation	0.8	ND	0.007	0.004	0.01	0.01	0.08	0.08
Command Post	4.4	ND	0.391	ND	0.33	0.01	76.3	0.03
North POL	33.3	ND	0.748	ND	6.97	0.16	137	0.08

ND: Non-detectable

Despite the absence of free-floating hydrocarbon product in any of the four monitoring wells, investigators believed some product existed beneath the foundation of the facility as evidenced by an oily sheen observed during numerous large rainfall events prior to, and once during, the study. Base engineers and investigators did not sample the sheen at any time, but the odor from the sheen indicated presence of petroleum hydrocarbon compounds.

2. North Petroleum, Oils, and Lubricants (POL) Storage Area. Elevated concentrations of VOCs (the BTEX compounds) and relatively low levels of PAHs (anthracene, benzo(k)fluoranthene, and naphthalene) were detected in soil and groundwater samples collected from five monitoring wells at North POL. Floating product (a mixture of mogas and jet fuel) was encountered in two monitoring wells located closest to the base perimeter. Numerical modeling revealed that dissolved phase contamination should migrate slowly from their place of origin to an off-base irrigation canal (which borders the North POL area and feeds large rice fields) based on hydraulic parameters measured in North POL during the field investigation.

The elevated levels of benzene and other fuel constituents measured in monitoring wells closest to the base perimeter support the numerical model, and suggest that the contamination resulted from spillage which took place from nearby tanks or from large historical spills which migrated downhill as surface runoff. The area houses numerous aboveground and underground tanks perched on the side of a hill directly up-gradient of off-base residences and rice fields. A soil gas survey conducted in 1991 at the North POL area by Far East District, Corps of Engineers, uncovered high concentrations of VOCs near an underground fuel tank (175). During the same year, base engineers documented an unquantified release of jet fuel from the top of a fuel storage tank. While these spills could be the source of the BTEX and PAH compounds found in the monitoring wells, investigators could not adequately characterize a contamination source (or sources) from the available data. Due to the uncertain location of the source(s), investigators could not conclusively determine by numerical modeling alone whether contamination is currently reaching off-base receptors (base residences and rice fields). Presence of free product in the monitoring wells closest to the base boundary, however, forced base engineers to execute a remediation project (containment trench with pump-and-treat system) to mitigate possible hazards to human health (7).

3. Command Post, Building 1305. Investigators detected relatively low concentrations of VOCs (the BTEX compounds) and PAH compounds (anthracene, benzo(k)fluoranthene, naphthalene, fluoranthene, fluorene, and chrysene) in soil and groundwater samples taken from five monitoring wells and four existing pumping wells. Prior to the site investigation, a contractor building an extension to the facility prior to the site investigation encountered free product. Soil samples collected from the site at that time indicated relatively high concentrations of total petroleum hydrocarbon (TPH)—up to 6,670 ppm. Subsequent analyses of groundwater collected from the excavation detected elevated levels of diesel range organics (13 ppm), arsenic (0.24-0.52 ppm), and lead (0.16-0.39 ppm).

The absence of elevated levels of BTEX or PAH compounds in soil samples collected from around the perimeter of the new construction area and lack of floating product in the corresponding monitoring wells suggest that the source of the contamination may lie within the confines of the foundation of the newly constructed facility addition. However, characterization of the site hydrogeology indicates moderate permeability of the shallow subsurface and relatively flat hydraulic gradients in the vicinity of the building. Both characteristics should aid in contaminant containment, eliminate pathways to human receptors, and, therefore, reduce the overall risk to human health and the environment.

4. Military Gas Station, Building 816 and Base Transportation, Building 960. Both sites contained relatively low concentrations of VOCs (the BTEX compounds) and various PAH compounds (anthracene, benzo(k)fluoranthene, and phenanthrene). Investigators found no evidence of free product at the military gas station, as previously observed by base personnel. Subsurface hydrogeology in both areas support little migration of contaminants, should they exist, due to moderate permeability of the shallow subsurface and flat hydraulic gradients (175:9-4, 9-5). As in the base command post, these hydrogeologic conditions reduce the overall risk to human health by eliminating pathways to receptors and slowing transport mechanisms.

(2) Baseline Environmental Assessment.

During the same period as the site investigations, Woodward-Clyde Federal Services conducted a preliminary environmental assessment for facilities on Kunsan Air Base. The assessment identified several areas on Kunsan that warranted further investigation, although investigators concluded that "extremely severe or large scale environmental problems" probably do not exist (175). Investigators believed the relatively low occurrence of significant environmental contamination is partially attributed to the base's comparatively short operational lifespan. Activities commonly associated with environmental contamination such as maintenance and repair did not occur on a large scale basis until the mid 1970s, when better hazardous waste and petroleum product management practices were being adopted by the U.S. military. The areas identified as having the potential to pose a human health or environmental concern follow:

1. Damaged underground storage tank (UST) at the former General Purpose vehicle maintenance facility. The UST is located on the west side of Building 810. Fuel has already been released into an adjacent concrete vault with broken cover. The fuel in the concrete vault poses an imminent release threat because heavy rainfall may displace the fuel, causing it to overflow out onto the surrounding area. The damaged tank also poses a safety and exposure hazard, especially at night when visibility is poor.

2. The petroleum, oil, and lubricant (POL) storage facilities. There have been documented and rumored large volume spill events at both the north and south POL storage yards (see previous section for detailed discussion of the north POL site). Petroleum contamination at high concentrations may pose both human health or environmental concerns.

3. The Panton Pad area. Fuel and other fluids drip or spill onto the pad, used for "hot-pit" (aircraft engines are running during the re-fueling and re-arming process) re-fueling, and discharges into an unlined drainage ditch. There is potential for human exposure as well as environmental concerns.

4. The aircraft shelters at the north and south loop and Tree areas. Historical dumping of fuels and solvents associated with aircraft maintenance activities may have occurred. There may be localized areas with high contaminant levels that may pose an environmental risk or human health concerns.

5. The area between Haje Village and the munitions storage bunkers. This area, adjacent to a small civilian village (Haje), was reportedly reclaimed from a swamp about 30 or more years ago. The exact nature of the fill is not known. Some of the material that was

used as fill may have been hazardous. The area may pose a threat as a potential source of environmental contamination if hazardous materials were used as fill.

6. The current and former dry cleaning facilities, Buildings 1360 and 508, respectively. Although Kunsan Air Base has no records of spills at either location, dry cleaning facilities have historically been associated with perchloroethylene releases. The current facility has a contained storage area for perchloroethylene, however, the storage area was constructed only about five years ago. It is possible that perchloroethylene releases may have occurred before the storage area was built, and/or at the former facility where there was no specially constructed storage area. One of the chemicals that results from the degradation of perchloroethylene in the environment is vinyl chloride, which may pose health risk concerns.

7. Jet fuel pipeline valve pit located along the road between the new General Purpose vehicle maintenance shop (Building 960) and Taxiway 06/24. The valve has had a release in the past due to seal failure. Standing water was observed nearly covering the top of the valve during this assessment, which may accelerate corrosion problems. Equipment failure may lead to the release of jet fuel into the environment.

8. Electrical transformer storage areas. There has been a documented release from polychlorinated biphenyl (PCB) contaminated electrical transformers at the scrap metal storage yard. PCB releases may have occurred at the other transformer storage locations. PCBs are suspected to pose human health risks.

9. Petroleum contaminated soil at the Co-Located Club construction site. The petroleum contaminated soil was encountered in a trench that was dug between Building

1047 and the road adjacent to the softball field. Floating product was observed on groundwater in the trench during this assessment. The petroleum impacted soil and groundwater will underlie the new Co-located Club's kitchen. Petroleum vapor and odor may permeate into the building if remediation measures are not taken.

10. Dead grass observed north of Building 2242, Phase Inspection, on the north side of the security fence. This area appears to receive precipitation runoff from the direction of Building 2242. The area may have been contaminated by runoff from the direction of Building 2242, where aircraft parts are still routinely washed on the paved areas outside the building.

b. Osan Air Base.

(1) Site Investigation.

In July 1996, the U.S. Army Corps of Engineers (COE), Far East District (FED) conducted a site investigation near two three million gallon JP-4 tanks at Osan Air Base. Leaks in the steel piping and valve pits between Tanks 8 and 9 released JP-4 into the subsurface, in close proximity (within 2,000 feet) of several drinking wells. As part of an earlier study accomplished in August and September of 1995, FED installed soil borings, collected subsurface soil samples, constructed seven monitoring wells and collected groundwater samples, which yielded no signs of contamination (151). Since the time of the 1996 study, the base has connected to the city's commercial water system and converted their drinking water wells to contingency use only.

Results from the 1996 study provided quite different results from the 1995 investigation. FED bored seven monitoring wells using a six-inch outside diameter hollow stem auger in the vicinity of Tanks 8 and 9, and collected soil samples, soil headspace samples, and groundwater samples. Investigators also collected relevant data for characterizing the subsurface hydrogeology in the area. The Korea Institute of Science and Technology (KIST) analyzed the soil, soil headspace, and water/sediment samples using standard EPA-approved methods; Clayton Environmental Consultants in Pleasanton, California, conducted the groundwater analyses. (The Corps of Engineers later invalidated KIST as an EPA-approved laboratory due to questionable practices.) All soil, soil headspace, and water/sediment samples returned non-detectable quantities of benzene, toluene, ethylbenzene, m, p xylenes, o-xylene, diesel, and TPH gasoline; results of the groundwater samples are shown in Table 15 below:

Table 15: Groundwater Sampling Results, Osan Air Base (151)

							(μg/L)	
Contaminant	Well 1	Well 2	Well 3	Well 4	Well 5	Well 7	MCL	MDL
Benzene	32	1.4	1.1	6.6	0.5	2.4	5	0.4
Ethylbenzene	3	ND	ND	ND	ND	ND	700	0.3
Toluene	3.1	0.6	0.3	0.7	0.5	0.4	1000	0.3
o-Xylene	0.5	ND	ND	ND	ND	ND	NS	0.4
m, p Xylenes	7.5	ND	ND	ND	ND	ND	NS	0.4
TPH Gasoline	250	ND	ND	ND	ND	ND	NS	50

MCL: Maximum contaminant level (drinking water)
MDL: Method detection limit (minimum concentration above non-detect)
ND: None detected
NS: No standard
All quantities in parts per billion (μg/L)
Note: Monitoring well 6 was damaged after completion and prior to sampling; only six of the wells were sampled.

The highest levels of groundwater contamination were detected in Well 4 (between the tanks), and Well 1 (downgradient of Tank 9). Subsurface characterization indicates a five-foot clay layer underlies the site, with layers of silt and sand beneath the clay. The low permeability clay should retard groundwater flow (and, consequently, contaminant transport) in this layer. Contamination in the silty and/or sandy layers would migrate more quickly. However, since the release of JP-4 occurred several years ago, it is possible the plume of fuel has migrated beyond the limits of this investigation (151:6).

Based on the groundwater gradient in the area, the installation has no receptors (i.e., drinking water wells) downgradient. If the levels of benzene detected at Well 1 represent the highest at the site, the plume may naturally attenuate by the time it reaches the base boundary, approximately 2,000 feet away (128). However, if the majority of the plume has already moved beyond Well 1, groundwater in excess of the MCL may move (or has moved) off base.

(2) Health Risk Assessment and Remedial Alternative Review.

In June 1993, the Air Force Center for Environmental Excellence (AFCEE) conducted a site visit to prioritize known areas of contamination based on risk to human health. Investigators reviewed information from base personnel and existing data with regard to ten sites and concluded the following:

1. Building 1073, VIP Billeting, and Communications Manholes. Approximately 400 gallons of diesel fuel leaked from an underground storage tank adjacent to building 1073. Communications manholes in the area have filled with a fuel/water mixture during heavy rains, probably seeping from the subsurface soil layers since the UST has been previously removed. AFCEE investigators deemed the vapors from the fuel contamination as an imminent health risk; yet, as of December 1994, the area had not been characterized, and contaminated soil had not been removed (110).

2. Building 942, Heating Facility. Building 942 is the site of a heating oil spill, totaling approximately 800 gallons. Investigators considered the site a potential health risk from vapors and dermal contact, due to its proximity to two dormitories. Similar to Building 1073, as of December 1994, the area had not been characterized and contaminated soil had not been removed (110).

(3) AMC Ramp JP-4 Spill.

On 5 April 1986, a 40,000 barrel fuel tank exploded at the POL tank farm at Osan Air Base, releasing approximately 500,000 to 700,000 of JP-4 (6:1). The Corps of Engineers that 230,000 gallons was recovered soon after the explosion. The amount of fuel that burned, volatilized, washed into the neighboring Chinwi Chon River, or infiltrated the soil has never been estimated or documented. The Corps of Engineers conducted the first of many studies at the site in 1989. At that time they installed 98 boreholes in the POL tank farm and surrounding area, and sampled the soil vapors for POL. Conclusions of the 1989 study were:

- There was little, if any, gross contamination at the POL tank farm;
- Almost the entire surrounding area exhibited high VOC readings (6:1).

Five observations wells were installed in 1992—one of which contained 4.5 feet of free product. Later that year, a pump-and-treat system was installed; however, no records exist indicating the amount of product recovered. Subsequent studies in 1993 and 1994 recommended additional characterizations at the site followed by installation of a groundwater remediation system (6:2). To date, none of the studies performed hydraulic tests on wells with the intent of identifying groundwater hydraulic characteristics or identified the source(s) or location of the contaminant.

(4) Drinking/Wastewater Working Group.

The group, consisting of bioenvironmental engineering, judge advocate general, environmental flight, wastewater treatment section, and Collocated Operating Base (COB) maintenance flight, addresses drinking and wastewater issues on Osan Air Base and the COBs. Minutes from their quarterly meeting indicate the following problems:

1. Osan's well water contains trichloroethylene above the maximum contaminant level which current treatment cannot remove. Although an air stripping tower exists, design errors currently render the tower inoperable. If the commercial water source becomes contaminated or is interrupted for any reason, bottled water is the only option for human consumption.

2. Many of the wells on the northwest side of the base become inundated during the monsoon season (June and July). Wells are located within subterranean vaults which fill with water during flooding conditions. Although sump pumps exist within the vaults, their operational conditions are unknown and flooding is usually too great to ensure continuous operation (104).

c. Collocated Operating Bases (COBs).

(1) Drinking Water Quality.

The drinking/waste water working group established to address drinking and waste water discrepancies at Osan Air Base also investigates similar problems at the U.S. Air

Forces COBs in Korea. Minutes from their 13 December 1996, meeting revealed the following discrepancies with drinking water systems at the COBs (Table 16):

Table 16: Drinking Water Discrepancies, COBs (104; 105)

Installation	Potable?	System Type	Problems
Chongju AB	No	Well/City	Bacteriological contamination (wells)
Kimhae AB	Partial	City	ROKAF system (unknown quality)
Kwangju AB	No	Well/City/ Surface	Bacteriological contamination and disinfection problems due to joint USAF/ROK control and operation of water system (wells)
Suwon AB	Partial	Well/City	Solvent and bacteriological contamination (wells)
Taegu AB	No	Well/City	Solvent, lead contamination
Kooni Range	Yes	Well	None
Pilsung Range	Yes	Well	Bacteriological contamination and disinfection problems due to ROKAF control and operation of water system

NOTE: At those bases with partially potable systems, two separate water systems serve the installation, providing portions of the base with potable drinking water.

Of the installations listed, only two—Kooni Range and Pilsung Range—have potable drinking water systems; all installations which support contingency operations in wartime have systems which are either non-potable or partially potable. Contaminants in the drinking water at two of these installations, Suwon and Taegu Air Bases, originate from hazardous waste sites.

1. Suwon Air Base. The water system at Suwon is divided between "A side" (community area, including dormitories) and "B side" (flightline operations). Side A has four water wells, and Side B has five water wells. An additional well is scheduled for installation in Side A during the summer of 1997. The wells on Side A have exceeded the maximum drinking water standard for TCE from a suspected contaminant plume located beneath the wells (52:14-2). The local city water system now supplies all drinking water to this portion of base—a contingency water source does not exist should the local system

become inoperative or non-potable. Two of the five wells on Side B contain measurable uranium isotopes, although existing documentation does not specify the concentration of the isotopes. As of 29 November 1995, the Osan Air Base Bioenvironmental Engineering Office certified the entire Suwon Air Base drinking water system safe for human consumption (52:14-2). No other site investigations have been accomplished, nor are any planned in the near future to research and remediate the source of the TCE contamination.

2. Taegu Air Base. Seven water wells and a connection with the local city's water system provide drinking water for Taegu Air Base. Two of the seven wells are currently shut down due to jet fuel contamination (50:14-3; 100). A pump-and-treat system was installed in March 1982 to remediate the source of the contamination; however, effluent from the system, which discharged into a local stream, contained contaminants in excess of ROK and USFK limits. As a result, the Osan Air Base Bioenvironmental Engineering Office ceased remediation of the site in 1996, although the groundwater remains contaminated with high levels of petroleum hydrocarbons. Recent conversations with base personnel indicate the system was restarted on 4 August 1997, with modifications to the contaminant removal system to meet effluent limits (100). The history and analysis of groundwater contamination at Taegu Air Base is the subject of an on-going investigation conducted by Captain Ray Marsh. His research focuses on the performance of the pump-and-treat system and movement of the JP-4 jet fuel at Taegu Air Base. Results are expected in late 1997 (100).

(2) Wastewater Treatment Plant Effluent.

The drinking/waste water working group also uncovered serious discrepancies with waste water treatment at all COBs. In the minutes from their 16 December 1996 meeting, the working group reported the following results from effluent analyses (Table 17): Note that effluent at all installations were not analyzed for other contaminants, such as heavy metals, petroleum hydrocarbons, chlorinated solvents, and other analytes common to Air Force operations. A list of industrial wastewater effluent limitations is contained in the FGS, and includes a number of heavy metals, nutrients (such as nitrogen and phosphorus), and other hazardous substances (PCB, TCE, PCE, and benzene) (165:4-9). In addition, effluent monitoring is not accomplished on a regular basis, as specified in the FGS (165:4-7). Past treatment practices may have resulted in release of one or more of these pollutants in excessive amounts, especially given the age and poor performance of current treatment techniques and the problems areas noted in Table 17.

Table 17: Waste Water Effluent Discrepancies, COBs (104; 105)

Installation	Exceeds Standards?[1]	Treatment Type[2]	Problem Areas
Chongju AB	Unknown	Primary	Unknown
Kimhae AB	Yes	Primary	Mineral oil, phosphates, cyanide
Kwangju AB	Yes	Primary	COD, mineral oil, phosphates
Suwon AB	Yes	Primary	COD, mineral oil, phosphates
Taegu AB	Yes	Primary	Mineral oil, phosphates
Kooni Range	Unknown	Primary	Unknown
Pilsung Range	Unknown	Primary	Unknown

Notes:

1. Effluent at some installations not tested; hence "unknown" if effluent exceeds ROK and USFK limits.
2. Primary treatment utilizes physical processes, such as screening and sedimentation, to remove a portion of the pollutants that will settle, float, or that are too large to pass through simple screening devices. While the most visibly objectionable substances are removed, the effluent still has enough BOD to cause oxygen depletion problems and enough nutrients to accelerate eutrophication (102:241).

d. Camp Carroll (Groundwater Sampling).

Two studies, one conducted by Woodward-Clyde Consulting in November 1992, and a follow-on investigation completed by FED in August 1996, examined possible contamination in the groundwater for Camp Carroll, Waegwan, Korea. Camp Carroll serves as the Eighth U.S. Army's logistics center and depot maintenance facility for all Army vehicles and heavy equipment (including armored vehicles and tanks) in Korea. Deep well clusters on the western and central portions of Camp Carroll provide drinking water to the installation. The U.S. Army Center for Health Promotion and Preventative Medicine, Pacific in Sagami, Japan, and Armstrong Laboratory at Brooks Air Force Base, Texas, analyzed samples from various monitoring wells located around both well fields. Results yielded the following:

1. Metals: None of the samples, except for one analyzed by Sagami, exceeded the maximum contaminant levels for any metal (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver). The one sample, a blind duplicate from Monitoring Well 23, contained 0.205 ppm of lead (the MCL for lead is 0.015 ppm). Armstrong Laboratory's analysis of the sample from Well 23 showed a lead concentration less than 0.020 ppm (analytical limit) (153:2).

2. Volatile Organic Compounds (VOCs): Both laboratories found various VOCs exceeding the MCL in a number of wells, including tetrachloroethylene, 1,1-dichloroethene, and trichloroethylene (TCE) (153:2).

3. Semivolatile Organic Compounds (SVOCs): Analysis conducted by Sagami indicated several SVOCs exceeding the MCLs—di(2-ethylexyl)phthalate, heptachlor, and

lindane. The concentration of di(2-ethylexyl)phthalate exceeded the MCL in all the wells (11 of the 16 possible monitoring wells) sampled. Armstrong Laboratory did not examine samples from any of the wells for SVOCs (153:2).

4. Malathion: Armstrong Laboratory analyzed samples for malathion, and found non-detectable concentrations in all wells. This represents a change for one of the wells (SB-6) which previously contained high levels of malathion (153:2).

FED collected most samples in duplicate and sent batches to both laboratories for comparison. Each laboratory followed internal quality control and quality assurance procedures in accordance with analytical guidelines. However, both laboratories reported receiving nearly all samples at elevated temperatures (greater than 4 degrees centigrade), and some samples were analyzed past the EPA-recommended holding time (153:1).

Water samples are in a chemically dynamic state, and the moment they are removed from the sample site, chemical, biological, and/or physical processes may alter their compositions. Analyte concentrations may change significantly due to volatilization, sorption, diffusion, precipitation, hydrolysis, oxidation, and photochemical and microbiological effects (81:39). An increase in sample temperature or exceeding the maximum holding time increases the likelihood that at least a few of these processes, such as volatilization and microbiological degradation, affected the measured concentration of contaminant in the samples taken. This is especially true for VOCs and SVOCs. For both classes of contaminants, these physical and biological processes may decrease the level of analyte actually present in the aquifer. FED reached the same conclusion and consequently mentioned that "all values should be considered 'estimated'," and "may be biased low" (153:1).

The report concluded that Camp Carroll's aquifer remains contaminated with VOCs, although samples also indicated the presence of several SVOCs (153:3). Two previously uncontaminated monitoring wells near the southern perimeter of the installation now contained measurable quantities of VOCs and SVOCs (in fact, the concentration of di(2-ethylexyl)phthalate, a SVOC, exceeded the MCL at both wells), which may indicate movement of a contaminant plume from an on-base source(s) to off-base receptors. However, sufficient hydrogeologic data does not exist to conclusively prove movement of contamination off-post (153:3).

e. Camp Market (Vehicle Destruction Yard).

FED completed an investigation of Defense Reutilization and Marketing Office's (DRMO's) vehicle destruction yard on Camp Market in October 1992. Based on discoloration and strong organic odor of the soil, and interviews with DRMO employees, FED decided to analyze soil for total petroleum hydrocarbons (TPH). They also analyzed soil for heavy metals, common in used motor and lubricating oils (152). Five sites were sampled—three based on employee testimony (areas where vehicles were dismantled and fluids drained), and two to test for migration of contaminants within the vehicle storage yard and off-site.

The results of the study show significant contamination at the surface, but rapidly declining concentration with soil depth and no migration off-site. The highest concentration of TPH, 47.1 g/kg, represents a soil which is 4.7 percent oil and grease by weight, but decreased to non-detectable levels just three to four feet below ground surface at two of the four sites sampled. Concentrations for heavy metals showed similar decreases, although lead values increased with depth at two of the four sites sampled. Lead, chromium, and cadmium concentrations clearly exceed the MCL at all depths sampled (ground surface, two feet, and three to four feet); arsenic levels varied, with half of the sampled concentrations at or above the MCL at varying soil depths. FED also tested for barium, mercury and selenium; however, the report received from DRMO officials did not include test results. The report mentioned that reported contaminant concentrations "are within the boundaries of what might be found in natural soils," although no reference is provided to substantiate the claim and no background samples were taken (152).

Selected samples were also analyzed for VOCs and SVOCs (exact number of samples and contaminants tested unknown). FED reported only two positive results for methyl ethyl ketone and benzene; both concentrations were below their respective MCLs.

The soil geology was characterized as six inches of angular stone, followed by a mixture of unconsolidated silty loam and compacted clays. Although no borings were taken, investigators concluded the soil as fairly impermeable through observation of ponding immediately below the surface and much dryer soils at greater depth. In fact, the soil was so compact that FED investigators used a bucket loader to excavate soil below the top 12 inches of soil since the hand auger used to collect samples could not penetrate further (152).

The report concluded the following:

1. The site poses "little threat to human health and safety," and there is "no compelling motivation for taking any action to remediate this site" (152). However, no comprehensive risk analysis was accomplished. Pathways such as inhalation of contaminated dust particles, inhalation of gas byproducts from anaerobic degradation (which investigators mentioned as a likely process due to the presence of a "strong odor" at the site), and runoff into a nearby waterway used to irrigate rice fields in the area (possible bioaccumulation of contaminants in plants and aquatic wildlife) were not mentioned in the report, and may not have been considered by FED investigators as possible health threats. During a site visit conducted in June 1997, this researcher observed numerous apartment complexes in the area, which may not have been present during the initial site investigation in 1992, and increases the number of possible human receptors. These receptors may include the very young and aged—population groups exceptionally susceptible to health effects from minute amounts of contaminants (31:123).

2. If the site is disturbed in the future, the excavated soil must be treated as a hazardous waste due to the amount of multiple contaminants it contains (152). This should be an important consideration based on the amount of civilian urban development in the area and possibility of base closure in future years. Although the current SOFA contains provisions protecting the U.S. from remediating base closure sites to original conditions, precedents set in Europe and Canada as well as popular pressure for cleanup of military sites (as exemplified by the recent MND cleanup of a closed military logistics center in

Pusan) should force U.S. officials to at least contemplate the possibility and estimate the expense associated with disposing of the contaminated soil at this site.

3. To mitigate migration of contaminants, FED recommended *in situ* soil stabilization through cementation or tilling to promote aerobic degradation. Both represent remedial actions which FED have not accomplished as of June 1997. The site remains open to the elements, trafficked by heavy equipment, and continues to be used for storage of disassembled vehicles and tires.

IV. PERSONAL INTERVIEWS/FIELD OBSERVATIONS

A. Overview

Information presented in Chapter 3 brought to light numerous significant hazardous waste site remediation issues in Korea. Findings in the other two legs of the triangulation methodology—personal interviews and field observations, which are presented here—were either comparable with, or opposed to, results from the literature review. Similar findings from all three methodologies suggest validation; dissimilar findings require further exploration and explanation to determine the cause of divergence. As explained in Chapter 2, mixed-method methodologies, such as triangulation, strengthen the validity of findings by eliminating many of the biases and capitalize on the individual strengths inherent in a single methodology.

Utilizing the interview guide shown in Appendix 2-1, 37 individuals were interviewed, cutting across the different organizations and fields of expertise designated in Chapter 2. Appendix 4-1 provides a list of the interviewees, their position, and their affiliation. In addition, site visits were conducted at three U.S. Army installations and two U.S. Air Force installations in Korea, providing valuable "first-hand" knowledge to corroborate findings from literature and interviewee testimonials.

B. Personal Interviews

Generally, the personal interviews netted findings which validated conclusions from the literature review. However, interviewees also provided additional information found only through the interview process. Their unique insights, drawn from personal experiences and their distinct perspectives of hazardous waste site remediation policy, aided immeasurably in understanding the numerous factors which affect the overall policy formulation process. As was done in Chapter 3, interview results will be presented in each research area—DoD remediation policy, Korean government remediation policy and international agreements, and the current condition of the Korean environment and of DoD installations in Korea.

In some cases, interviewees agreed to provide information on the condition of anonymity. Where possible, however, references to interviewees are provided throughout this chapter and the thesis.

1. DoD Remediation Policy.

a. Pentagon Perspective.

Interviewees provided a variety of differing opinions and interpretations of the current DoD hazardous waste site remediation policy. Top DoD environmental officials defended the lack of specificity in the current policy on the basis of inherent differences among the numerous countries in which DoD operates. Policy makers consciously attempted to make overseas remediation policy as flexible as possible, giving installation commanders the discretion to make the "right decision" with regard to remedial action based on:

1. A reasonable belief that the contaminated site is harming human beings. DoD managers and leaders at the installation level have the obligation to provide DoD members with a healthy, safe environment in which to work and play. Any policy regarding remediation of potentially hazardous sites should be flexible enough to allow

responsible parties to take appropriate action as necessary to protect human health based on their professional judgment.

2. The state of relations with the host-nation and local community, which may vary from country to country, or even between provinces within a country. For example, America's unique relationship with Canada, as exemplified by Canada's participation in, and support for, aerospace defense over North America for over fifty years, has a bearing on the degree of restoration the U.S. may be willing to accomplish at former DoD sites in Canada in contrast to other countries, such as Korea, which have received considerable defense assistance from the U.S (168).

3. Funds availability (since funds from the local installation operations and maintenance account currently pay for overseas remediation projects).

4. Installation-specific mission priorities. (168)

In addition to these "flexible factors," interviewees introduced a number of other factors which have a bearing on promulgation of DoD overseas remediation policy in general, and on remediation policy for South Korea specifically.

1. Level of host nation environmental awareness and Congressional and DoD perception of the host-nation's responsiveness and protection of their own environment. Expenditure of U.S. funds for remediation projects in a foreign country where care of the environment ranks low among other national priorities, or enforcement of environmental laws is weak, will not receive support in Congress. Although Congressional and DoD leaders believe that Korea has a strong environmental program with regard to policy and

legislation, there is a perceived lack of effective enforcement and little cleanup activity (19; 27; 70; 168).

MND's environmental activities play a particularly influential role in DoD remediation policy for Korea since they represent DoD's counterpart in Korea (168). Until very recently, MND did not regard protection of the environment as one of their primary objectives. Environmental staffs were not established until 1995, and MND installations were regarded as "safe havens"—off-limits to all organizations outside MND, including other ROK government organizations such as MOE (177). Such policies made enforcement of environmental laws difficult on MND installations. However, recent events have demonstrated ROK resolve to strengthen enforcement of Korean environmental laws, at least with regard to MND. MND allowed joint MND/MOE environmental compliance assessments at all military installations for the first time in 1996 (58; 89; 177). Besides uncovering hundreds of contaminated sites, the assessments spurred MND to establish a modest restoration budget to fund additional site characterizations and cleanup as necessary (177). Bowing to government and public pressure, MND also funded a $3 million soil remediation project at a former MND logistics center in Pusan to comply with the 1995 Soil Preservation Act—the first such cleanup project ever undertaken by MND (58; 177). As MOE continues to improve and strengthen its enforcement mechanism, the perception of weak enforcement will likely disappear in future years.

2. Cleanup precedents set by DoD when closing overseas installations. While Pentagon and USFK respondents referred to Article IV of the SOFA as clear justification

for not remediating contaminated sites when returning DoD installations to the host nation, nearly all acknowledged that historical cleanup precedents may force future cleanup requirements in Korea regardless of SOFA provisions (56; 58; 129; 168). DoD General Counsel explained that environmental issues fall into the realm of international law, which, like the American judicial system, is derived from historical precedents. Although international law does not currently require foreign nations to cleanup contaminated sites they generated on host nation soil, the U.S. is "encouraging" such requirements by its actions. By agreeing to pay restitution for environmental damage in Canada and permitting offsets to the residual value of former DoD installations in Germany, when SOFAs for both countries clearly did not require such restoration, the U.S., in effect, is giving countries valid arguments for forcing remedial action in the future regardless of existing international agreements (129; 168).

When DoD closed a number of its installations in Germany, the U.S./German SOFA required the German government to reimburse the U.S. for the residual value of former U.S. installations ("residual value" is the monetary value of capital improvements made on a military installation, normally equal to the plant replacement value). However, due to significant hazardous waste contamination on those installations, DoD agreed to waive the residual value payments. In essence, the U.S. "paid" millions of dollars for remediation of contaminated sites when it decided to forego any reimbursement for residual value. On-going negotiations with Panama over return of DoD installations in the near future include possible payment for remediation of contaminated sites. Depending on the outcome of negotiations, Panama may serve as yet another precedent supporting hazardous waste site remediation on DoD installations in Korea (56; 129; 168).

Remediation of contaminated sites on former U.S. military installations in Canada provides another example of precedent-setting and the applicability of international law. Canada requested U.S. payment for remediation in connection with closure of 21 distant early warning (DEW) line sites, Goose Bay Airfield, Haines-Fairbanks Pipeline sites, and U.S. Naval Station, Argentia. Special negotiators for both nations established technical groups for each of the four groups of installations plus a legal team. The U.S. legal team argued that DoD had no legal obligation to pay for cleanup based on international law and existing agreements. The Canadian team, however, argued that the U.S. is responsible under international law to pay for environmental damage. Both technical teams agreed on the assessment of contamination at all installations—the sites clearly represented imminent threats to human health and safety. Negotiations concluded with the U.S. agreeing to pay $100 million over ten years for remediation of contaminated sites presenting an imminent and substantial endangerment to human health, and for sites which, if not remediated, would present an imminent and substantial endangerment in the future (108; 168).

3. Inevitability of Remedial Action. A few interviewees went as far as saying that restoration is inevitable; that as the overseas environmental program develops over time, a shift in focus will occur placing the spotlight on restoration vice compliance. With regard to the Air Force's overseas environmental program in particular, the early environmental program goals centered on compliance with the OEBGD. Now that final

governing standards, which incorporate host nation environmental laws, have been developed for most overseas locations, the focus will shift to restoration, especially in light of foreign countries' developing awareness of environmental problems. This has already occurred in Germany and in most European countries; DoD will inevitably witness the same growth in awareness in Korea.

4. Differences in status of forces, basing, and/or other international agreements between the U.S. and the host nation force generic DoD overseas remediation policy. As mentioned earlier, some interviewees justified the current policy based on country-unique conditions, such as differing basing agreements or SOFAs, which prevent specifying more detailed overseas remediation policy. In practice, however, these agreements are relatively congruent for all nations which serve as a DoD base of operations with regard to hazardous waste site remediation. Most SOFAs and basing agreements state that restoration of an installation to original conditions (condition of the land upon initial U.S. occupancy) is not required upon its return to the host nation (127; 129). DoD General Counsel, however, believed that re-negotiations of such SOFAs in the future may include remediation requirements specific to certain countries, especially those countries with advanced environmental programs (129). Therefore, the possibility of dissimilarities in SOFAs forced DoD to promulgate a flexible overseas remediation policy, capable of universal application to all DoD organizations, regardless of service and operating location (108; 129; 168).

5. Legal requirement to conduct remediation. At present, no U.S. law, code, or regulation requires remediation of hazardous waste sites at overseas installations.

Executive orders, DoD policy, and international agreements provide some legal basis for conducting remedial actions on DoD installations discretionally, based on the risk to human health during the period of U.S. occupation. However, DoD has no legal/Congressional authority to expend funds on remediation once an installation is returned to the host nation. DoD "owns" no real property in Korea—the land belongs to the ROK, and DoD is allowed to use the land within the provisions of the SOFA. Therefore, since the United States is not the sovereign state on its military installations in Korea, U.S. laws requiring remediation do not apply (27; 129; 168).

6. Funding. Besides providing their insight on various factors which influence DoD overseas remediation policy, interviewees discussed various funding issues as they relate to overseas cleanup. They did not believe the availability of funding should detract from promulgating effective overseas remediation policy—risk to human health, environmental preservation, and binding law should be the prevailing drivers in determining whether cleanup is necessary at contaminated sites. However, they did believe that a sound, accurate, justifiable, and realistic strategy is fundamental to gaining support—financial and otherwise—from Congress for the overseas restoration program. The critical nature of Congressional funding support becomes evident when considering:

a. The only funds available for remediation in Korea are compliance and operations and maintenance funds, both of which are predicted to decrease, while requirements grow in future years (70; 168). Congressional endorsement of remedial activities overseas may help reverse that trend, given their recognition of the costs involved with cleanup of contaminated sites in the United States. Even the most sound remediation program—simultaneously protective of the environment and human health—stands little chance of success without proper resources for execution (70).

b. Remediation overseas is inherently a matter of international policy, not just environmental policy, and, therefore, requires Congressional support for success (129). For example, with regard to cleanup of former DoD sites in Canada, the Senate Armed Services Committee expressed concerns about the precedent such cleanup would create, especially if U.S. legal experts believe there is no statutory obligation to remediate contaminated DoD sites in Canada. The committee stated that "*political* [italics added for emphasis] and military relations [between Canada and the United States] could be adversely affected if the [cleanup] agreement is not funded" (108). Such statements highlight the relationship between DoD remedial actions and U.S. international policy. Since Congress and the Executive Branch of the U.S. government promulgate international policy, their support is imperative to policy sympathetic of remediation overseas.

c. Shrinking federal budgets have mandated Congressional scrutiny of DoD budget requests in many areas, including environmental cleanup. With regard to the Air Force, environmental managers, at base- and Major Command-level, historically viewed the DERA budget as "an infinite source of funds, so changing priorities and poor project estimates were acceptable" (70). Congress now demands sound justifications and accurate estimates for not just remediation projects, but all Congressionally-approved programs (such as the Military Construction Program), especially when the program has exceeded the budgeted amount, the time allotted for completion, or has been as fluid as the cleanup program has been (56; 70).

Hence, while Pentagon interviewees were unanimous in their support for a remediation policy based primarily on human health and environmental preservation considerations, all conceded that adequate funding from Congress is crucial to a successful restoration program overseas.

b. Installation Perspectives.

The preceding discussion dealt primarily with comments from Pentagon officials. Their focus on broad policy understandably supports the current DoD remediation policy for overseas locations, since it would be nearly impossible to write a single policy which addresses the unique conditions for every country in which DoD operates. As would be expected, the DoD community in Korea had a markedly different view on current DoD remediation policy. They identified two major problems spawned by the current policy's purposely vague definition of "imminent and substantial endangerments."

1. Project Justification. Interviewees at installation and headquarters-level criticized the lack of clear guidance, referring specifically to the imprecise definition of "imminent and substantial endangerments to human health," as inadequate for determining which hazardous waste sites needed cleanup. DoD policy does not define a specific human health risk threshold which, if exceeded, properly justifies remedial action. DoD delegated authority for defining "imminent and substantial endangerments" to DoD executive agents for each region of the world in which DoD operates. For Korea, the Commander-In-Chief, USFK, serves as the executive agent. Installation-level

environmental personnel identified the need for such a definition in order to identify, justify, and prioritize hazardous waste site remediation projects to installation commanders and higher headquarters consistently among all services. Overseas remediation projects compete for local installation operations and maintenance funds—funds which also pay for such mission-essential items as parts for aircraft, tanks, heavy equipment and vehicles; aviation, vehicle, and ground equipment fuel; supplies; utility fees; and infrastructure maintenance and repair. Without well-grounded, uniformly-applied risk-based standards for justifying remediation projects, installation personnel felt the restoration program in Korea had little chance of success (7; 83; 147; 181).

2. Site Identification/Closure After Remedial Action. Interviewees also felt that adequate site characterizations could not be accomplished given current policy. Without a firm standard to judge which contaminated sites exceeded acceptable human health risks, investigative studies would only yield inconsistent results, since the definition of "imminent and substantial endangerments" may vary depending upon investigator and installation commander opinion. For example, installation personnel provided the following definitions of "imminent and substantial endangerments to human health" during interviews:

a. Exceeding U.S. EPA promulgated maximum contaminant limits (MCLs);

b. Exceeding MCLs published in the Korea FGS (which may vary from U.S. EPA standards due to the influence of Korean environmental law);

c. The use of a particular threshold depends upon the defense posture—contingency versus peacetime—of forces. For example, drinking water contaminated with trichloroethylene concentrations exceeding 5 ppb (U.S. EPA MCL) is not acceptable for human consumption in peacetime. However, the same drinking water would be considered potable in contingency situations. Such long-term human health risks are insufficient justification for remediation projects (9).

d. MCL thresholds are not appropriate for determining remedial action. Rather, decisions should be based solely on risk-based analysis, dependent on site-specific conditions such as categories of receptors, contaminant pathways, and future land use.

Depending on the definition for "imminent and substantial endangerments to human health," individual installations, even within the same branch of service, may conceivably follow very different courses of action for sites with identical concentrations and types of contaminants. The same confusion exists for the level of cleanup as well. DoD policy defines exit criteria ("how clean is clean") based on the "imminent and substantial endangerments"—once the endangerment has been eliminated, the site can be considered "clean." However, since the definition of "endangerment" could conceivably differ from installation to installation, between subsequent commanders on an individual installation, and based on the defense posture (peacetime versus wartime), a contaminated site may never actually be permanently cleaned up (7; 83; 147; 181).

c. USFK Perspectives.

USFK environmental officials had a slightly different outlook on DoD's current policy. As an almost exclusive policy-formulating organization, USFK's Environmental Programs Office (EPO) exercises little control over the Army's environmental budget, and has absolutely no control over Air Force and Navy budgets on the peninsula. Funds for Air Force and Navy restoration projects come directly from their respective higher headquarters, Pacific Air Forces and Pacific Fleet. The 19th Theater Army Area Command (19th TAACOM), which receives funds directly from Department of the Army, controls funds for Army restoration projects. This unique organizational structure, while effective for joint command and control during a wartime scenario, inhibits effective environmental policy formulation in peacetime, since EPO does not have the resources (funding) to support policies they formulate for the three services on the peninsula. The only resources on which EPO has some direct influence are host-nation funds—the ROK-Funded Construction Program (ROKFC) and Combined Defense Improvement Projects (CDIP). Both programs harbor tremendous resources—nearly $100 million in 1997 alone. However, they have historically been used for quality of life projects (dormitories) and contingency-related construction (mission facilities, runway upgrades or repairs, war readiness material storage, etc.), respectively. In the case of CDIP, the ROK government specifically earmarks funds for direct, war-related infrastructure which are capable of joint ROK/U.S. use, and must approve projects prior to funding and construction. USFK has complete control over ROKFC projects—from conception through approval. Interestingly, the CY97 ROKFC and CDIP submittal from EUSA contained only one environmentally-related project—upgrade of a sewage treatment plant at Camp Red Cloud—in a list consisting of 44 projects totaling nearly $277 million. In fact five dormitory projects, one dining hall project, and construction of a medical supply warehouse ranked above the upgrade (57; 89).

Additionally, a unique insight surfaced during personal interviews which affects the current direction of USFK environmental policy. There appears to be hesitation within USFK/EUSA to release information on USFK's environmental program, especially on hazardous waste sites. The hesitation stems from the fear that release of information would lead to a negative perception of DoD on the part of the MND, MOE, Korean senior leadership, and the Korean public at large. As evidence of this belief, interviewees pointed to:

- USFK's hesitation to release the Korea FGS to MOE; and
- The lack of meetings between delegates to the U.S./ROK Environmental Subcommittee in order to devise a process for evaluating the potential for environmental contamination in and around USFK installations. The Environmental Subcommittee received direction from the Joint Committee to develop such a procedure in September 1993, which would probably result in information sharing or joint inspections.

In contrast to this view, interviewees felt disclosure of the FGS and open discussions with ROK environmental officials concerning DoD hazardous waste sites in Korea would reassure MND/MOE that USFK was actively pursuing investigations and remedial efforts, not only for the protection of USFK personnel, but for the Korean populace as well. The Korean government would also discover that USFK standards for water, wastewater, air, and soil were comparable to ROK standards, and that USFK's emphasis and management of the overall environmental program—cleanup, compliance, conservation, and pollution prevention—were far ahead of similar programs within MND (58; 89).

2. <u>Korean Environmental Policy and Current Environmental Conditions</u>.

Korean interviewees contributed immensely to the thesis by candidly discussing issues relevant to Korean environmental policy. Their comments confirmed many of the findings from literature, as well as revealed some non-documented aspects of Korea's environmental program pertinent to remediation of hazardous waste sites both on and off DoD installations.

a. <u>Laws Applicable to Remediation of Hazardous Waste Sites</u>.

Interviewees cited the Soil Preservation Act (SPA) and the Groundwater Protection Act as the two pertinent regulations governing identification, and driving remediation of hazardous waste sites (4; 21; 76; 177; 178; 179). The SPA, which governs contamination in soil and sediments, served as the catalyst for most site characterizations and remediation projects conducted in Korea to date.

Despite existence of the Groundwater Protection Act, reliance on surface water sources for potable water has shifted Korea's remediation program decidedly toward soil remediation, rather than groundwater remediation, decreasing the application and influence of the Groundwater Protection Act as compared to the SPA (4; 21). The ROK government has responsibility for protection and cleanup of groundwater as a natural resource. MOE admits basic assessment is needed, but the expense of studies has severely limited the scope of existing studies. MOE concedes that groundwater use will inevitably grow due to surface water contamination and possible shortages in potable water sources in the future (21; 111).

MOE explained the "threshold" and "action" levels present in the SPA. Once contamination exceeds the threshold level, the site should be monitored for further contamination, and potential contamination sources removed. However, actual remedial efforts do not have to begin until the action level is exceeded. Remediation can still be avoided if activities on the site (such as farming or industrial production) are halted, and the site secured from entry (somewhat akin to reducing risk pathways). If the developers wish to continue use of the site, then remediation must take place, and contaminant concentration(s) must be reduced below the threshold level(s). A current topic of controversy is the existence of high background levels of SPA-listed contaminants, which complicates identification of sites contaminated from anthropogenic sources rather than natural sources, and complicates the determination of cleanup levels (21).

The SPA currently addresses contamination due to heavy metals, phenol, PCB, and BTEX compounds, but does not include standards for other common soil contaminants such as organic solvents and total petroleum hydrocarbon. MOE believes other contaminants may be included in a future amendment of the SPA, but could not verify such action would definitely take place (21).

To date, underground storage tanks (UST) at gas stations have been the focus of MOE's remedial investigations and actions (where necessary). Although the UST program is expanding into other areas, such as military installations and schools, and plans call for future expansion of assessments, other activities, including industrial operations, have not been the subject of in-depth investigation by MOE (21; 80; 137; 177). Recent studies concluded that only one to five percent of all gas stations in Korea need remediation based on the SPA's 80 mg/kg BTEX standard. MOE believes the low percentage (relative to U.S. figures) may be due to the fact that most Korean gas stations were newly constructed (21).

One project attributable to SPA regulations that gained much attention was the MND cleanup of POL and organic solvent-contaminated soil at a former logistics center in Pusan. Despite known dumping of hazardous waste on the installation for a period of 40 years, the site was sold to the city of Pusan without any remedial action. When the city began building on the site, they found the contamination. At first, MND attempted to absolve themselves from liability, resulting in negative publicity and public pressure to accomplish cleanup. Separate government and MND investigations revealed contamination in excess of SPA limits, forcing MND to remove and remediate over 25,000 tons of soil (presumably using an off-site incineration facility or other ex-situ technology) at a cost of US$3 million (177).

The above example was the first remediation project undertaken by MND, and represents the growing level of attention to hazardous waste site contamination within Korea's military. Results from the joint MND/MOE inspection conducted in 1996 include identification of approximately 300 potential remediation sites on MND's 2,000 installations. MND plans to conduct in-depth site characterizations at these sites by 2000, followed by prioritization and cleanup. In order to accomplish its aggressive investigation and cleanup schedule, MND requested US$10 million for cleanup activities in 1998, and US$15 million in 1999, the first time a clean-up budget has been requested for MND. MND's restoration program is expected to last approximately ten years, an optimistic time period given the suspected severity of contamination at MND installations (21; 177).

Two instances of environmental law violations resulting in ROK legal action surfaced during the course of interviews:

1. GTE Diesel Fuel Spill. On 24 September 1996, the Suwon City Prosecutor's Office formally indicted (criminally) a contractor of GTE for spilling diesel fuel on Osan Air Base. The Air Force Office of Special Investigations (AFOSI) initiated the investigation and submitted their report to ROK authorities. In turn, the Suwon City prosecutor, prosecuted the contractor (believed to be an Australian citizen), who was not present at the time of his trial. Upon his return to Korea, the contractor must either hire an attorney and challenge the charges at trial, pay one million won (approximately US$1,390) and plead guilty, or spend 50 days at a hard labor site. To date, the spill site has not been cleaned, and the ROK government and GTE continue to negotiate a settlement to remedy the contamination (19).

2. Daeho Diesel Fuel Spill. On 31 October 1995, Daeho Construction, a base contractor, was prosecuted for spilling diesel fuel on Osan Air Base in violation of the Basic Environmental Policy Act (see Appendix 3-2, Chapter 3). AFOSI initiated the investigation and notified the National Police Agency when the investigation was

completed. The Suwon City Prosecutor's Office fined Daeho one million won. Consequently, Daeho paid the fine and cleaned the contaminated site in accordance with the ROK Soil Preservation Act (19).

Although neither case involved American citizens, they demonstrate ROK resolve to enforce Korean environmental law against both foreigners and ROK citizens for environmental non-compliance within the confines of a USFK installation.

b. Current Environmental Conditions.

Feedback from the Korean academic community and MOE confirmed the existence of hazardous waste sites located throughout the peninsula. However, due to the limited scope of the SPA and its recent promulgation (1995), only those sites contaminated primarily with POL, heavy metals, and nitrates (from agriculture) have been discovered (21; 137; 179). In addition to gas stations and military installations previously mentioned, other sites include: (1) areas of agricultural and livestock run-off; (2) mines and petroleum refineries; (3) oil storage tanks; (4) landfills; and (5) industrial sites (137). Additional information was provided for the following categories of sites:

(1) Mines and Refineries.

Twenty-four sites with contaminants over SPA limits have been identified to date; however, this number is probably severely underestimated since relatively few site investigations have been conducted. Despite the ROK government's claims of increased emphasis on environmental protection, current mine closure procedures seem inadequate. Mining companies are responsible for remediation of any contamination at their site for three years after closure; if contamination is discovered after that time period, however, the ROK government is responsible for cleanup (137). Such policy suggests the government continues to value industrialization and economic growth over environmental protection.

(2) Oil Storage Tanks.

A 1996 survey (source of survey unknown) found 10,912 contaminated sites, of which about 100 sites, currently under further investigation, contained contaminants over the SPA standards (137). For comparison, a 1994 study on petroleum contaminated sites estimated three million USTs containing petroleum in the United States, of which as many as 500,000 may be leaking (2:1). Varying factors may account for the relatively low number sites found in Korea, including:

- Relatively recent construction of gas stations in Korea as compared to the United States (21);
- Questionable analysis techniques employed by Korean investigators (4);
- Limited scope of investigation. Korean interviewees consistently referred to surveys of gas stations only; other tanks containing petroleum products, including heating oil and jet fuel, still require investigation (21; 76; 80).

(3) Landfills.

Limited land area and rising per capita waste generation rates since 1987 have focused renewed attention on landfill management in Korea (114:100). In an attempt to control contamination from improperly designed landfills, MOE has closed over 850 landfills, and is investigating another 445 for possible closure. Despite these high numbers, it is estimated that many more landfills remain to be identified and investigated

(137). For example, MOE estimates that only two percent of the 536 "sanitary" landfills in Korea were designed to prevent leaching (113:58).

Leachate emanating from a closed landfill at a USFK installation, Camp Page in Chunchon, resulted in recent public attention and demonstrations. According to a Korean investigator, the leachate contained total petroleum hydrocarbon (TPH) concentrations in excess of 10,000 parts per million. Interestingly, USFK had not identified this site as a potential hazardous waste site in their most recent ECAS assessment (4; 64).

MOE had no data available on their overall hazardous waste site remediation program. They reported that investigation and remediation of mines are underway at about ten sites near farms and populated areas, which significantly differs from information received from a Korean researcher (21; 137). The difference may result from the qualifier ("near farms and populated areas") that MOE attached to their figure as opposed to the all-inclusive number of sites provided by the Korean researcher.

c. Future Policy Direction.

(1) SOFA Revision.

Both MOE and DoD officials foresee continued pressure by the ROK government to allow joint ROK/US environmental assessment of DoD installations and to revise the SOFA to require DoD to remediate known contaminated sites on DoD installations prior to their return to the ROK (19; 21; 58; 129; 168; 177). MOE pointed to discovery of contamination on previously returned DoD installations, MND policy of restoration prior to base closure, and the German experience with Soviet installations after reunification as factors which support their request for a SOFA revision (21). Another factor adding to the mounting pressure for SOFA revision concerns a perceived inequity between the U.S./ROK SOFA compared with SOFAs between the U.S. and other foreign nations (21; 58; 129). The inequity pertains to which country retains jurisdiction for crimes committed by U.S. servicemen, their dependents, and foreign contractors employed by USFK. Article XXII of the SOFA calls on the ROK to hand over its authority to prosecute crimes committed by Americans to USFK unless the crimes are serious in nature (43:33-34; 129). The definition of "serious" oftentimes triggers disputes between the ROK and the U.S., especially when the crime is socially sensitive (such as rape, rape/homicide, and murder) (129; 149).

SOFA renegotiations between the U.S. and the ROK have stalled over this issue. The current U.S./ROK SOFA is based on NATO SOFAs, containing the same shared jurisdiction formula. The ROK would like to see language in the SOFA pertaining to criminal jurisdiction mirror that of the U.S./Japan SOFA, which gives Japan almost exclusive jurisdiction for any crime committed by U.S. military members against Japanese nationals. U.S. negotiators oppose such a change due to:

1. Differences between the Korean and American judicial systems regarding assumed innocence and guaranteed, competent legal representation during trial and sentencing.

2. The longstanding trust developed between America and Japan regarding fair and humane treatment of accused servicemen. Although Korea contends their treatment of accused individuals mirrors that of the U.S., they have not conclusively and consistently demonstrated such action (129).

3. Japan's reasonable application of the exclusive jurisdiction clause. In the past, Japan has requested exclusive jurisdiction for only the most serious crimes committed by U.S. servicemen (murder). Korea has not demonstrated such restraint, requesting jurisdiction for a wide variety of crimes dependent on public pressure and visibility (129). USFK believes the environmental restoration issue will not be a point of negotiations until the criminal jurisdiction issue is settled (58).

With regard to the joint inspection issue, USFK believes the U.S./ROK SOFA Joint Committee is the appropriate group to negotiate/discuss the possibility of U.S./MOE environmental assessments on DoD installations (58). As mentioned in Chapter 3, the Joint Committee was charged in September 1993 with devising a process "to evaluate the potential for environmental contamination in and around USFK installations," which a joint assessment could fulfill (67). One of USFK's primary arguments against such inspection recently dissolved when MND opened their installations for joint MND/MOE assessments. Continued (and increasing) Korean public and governmental pressure may force the Joint Committee to resolve this issue in the not-so-distant future (58).

(2) Increased Emphasis On Remediation.

Both DoD and Korean interviewees foresee a shift in emphasis from compliance to remediation as Korean environmental awareness and remediation technology develops in the future. Availability of funds, however, may be a limiting factor in the amount and type of remedial projects undertaken by the ROK government and Korean companies. MOE anticipates continued government subsidy of the entire remediation program in

Korea, at least until a major incident occurs or a "Love Canal-type" discovery is made which induces overwhelming public pressure to reform current remediation policy (21).

(3) Preservation of Potable Water Sources.

In his "Presidential Vision for Environmental Welfare," ROK President Kim, Young Sam outlined major policy directions and target areas for the future (111:3). One of the major policy directions included construction of basic environmental facilities:

> Investment in water-related facilities shall be greatly increased so that any water-related problems can be firmly addressed. Basic environmental facilities, such as water supply and sewage system, sewage treatment facilities and waste landfill sites, shall also be expanded. (111:3)

This major policy direction centered squarely on the preservation of water resources through construction of related infrastructure. No other media—air or soil—was specifically targeted in any of his seven major policy directions, illustrating the emphasis the ROK government intends to place on water resources. USFK personnel echoed the same sentiment during interviews pointing especially to wastewater effluent as a specific problem for DoD installations throughout Korea (19; 27; 58; 83; 180). The quality of Osan Air Force Base's wastewater effluent, in particular, has been a "distracting issue," halting USFK/MOE discussions on general environmental issues until the perceived wastewater problem is resolved (58). Further discussion on wastewater issues follows in a subsequent section.

d. Other Issues.

(1) Advanced Environmental Education and Research.

All universities visited had a viable and growing environmental remediation program. Areas of study include:

1. Light Non-Aqueous Phase Liquid (LNAPL) and Dense Non-Aqueous Phase Liquid (DNAPL) transport (179). U.S. EPA generally considers DNAPL as an "unrecoverable contaminant," the presence of which may lead to a decision that a contaminated site is "technically impracticable" to cleanup (12:33). Research in this area seems to indicate Korean desire to further their expertise in remediation technology.

2. Aquatic ecology, surface water, and groundwater pollution (82).

3. Agricultural runoff, including leaching of pesticides into soil and groundwater (82; 137).

4. Groundwater hydrology and subsurface hydrogeology (25).

5. Landfill design (4; 137).

In addition to the research being conducted in Korean universities, MOE is conducting research on several environmental remediation technologies, including soil vapor extraction, soil washing, and bioremediation (21). MND is also delving into advanced environmental education and research. They have established cooperative agreements with universities in Korea and the United States to educate their officers in environmental engineering, and wish to establish similar ties with the Air Force Institute of Technology and the Environics Laboratory at Tyndall Air Force Base, Florida (177). KIST, on the other hand, while probably the best equipped Korean organization to conduct environmental research in the field, has met with significant difficulty in finding sites to conduct field studies. KIST researchers have experienced problems in even the most basic of tasks, such as obtaining soil samples to study the remediation of diesel fuel contamination due largely to lack of cooperation by hazardous waste site owners (178).

MND has attempted to relieve some of the pressure, and perhaps, further its own remediation technology base by allowing KIST to conduct research in bioremediation on two of its installations (177).

(2) Environmental Research and Remediation Capabilities.

Korean *chaebols*, the country's largest integrated industrial groups, have also begun research on remediation technologies. Industry giants such as Samsung and Kolon have subsidiaries which conduct research in, and market, environmental remediation technologies (133). Other companies, such as Yukong and Lucky-Goldstar, have undertaken cooperative environmental research with foreign companies (4).

A meeting with one of the *chaebols*, Hanwha Energy Corporation, validated findings from literature. Hanwha established an environmental business team in 1995 to provide comprehensive consulting and engineering design services in environmental issues. They organized the team in into several distinct groups—(1) Phase I - Environmental Site Assessment; (2) Phase II - Remedial Investigation; (3) Treatability Study; (4) Remedial Design Phase; and (5) Remedial Action Phase—similar to the U.S. CERCLA process. During their interview, Hanwha provided a summary of their environmental remediation capabilities, which include:

1. Instrumental sampling and laboratory analysis (GeoProbe™ boring; mobile analytical laboratory; soil gas analysis; subsurface image analysis; various analytical analysis for BTEX compounds, TPH, and toxic chemicals)

2. GIS modeling of hydrogeology and contaminant transport and fate

3. Application of remediation technologies such as soil vapor extraction, soil washing, and bioremediation.

Hanwha mentioned that some U.S. firms have entered the Korean environmental remediation marketplace, and collaborated with Korean firms. They reiterated that while other Korean firms specialize in certain aspects of remediation (research, remediation technologies, etc.), Hanwha is the only firm that has developed a comprehensive program capable of accomplishing site characterization, remedial design, employment of cleanup technology, and post-closure monitoring (76).

Despite these positive signs of progress in the Korean environmental remediation program, MND felt Korean companies possess only limited expertise at present. Colonel Yang, Director of MND's Office of Environmental Management, based on his experience with the MND cleanup effort at Pusan, believed a few companies are developing the necessary aptitude in remediation technology, but that they do not currently have capabilities similar to U.S. companies (177).

3. Current Environmental Conditions at DoD Installations.

a. USFK-Wide Findings.

Several recurring trends emerged during discussions with installation-level personnel which are detailed below:

1. Wastewater Treatment. Wastewater treatment is one of the most significant and visible problems at most DoD installations in Korea. In the majority of installations visited, wastewater treatment consists of primary treatment (removal of contaminants using physical mechanisms as opposed to biological and/or chemical means) only.

Installation personnel have noticed POL products floating on effluent from wastewater treatment plants on numerous occasions, demonstrating the inadequacies of present wastewater treatment technologies. The water transporting these sometimes hazardous wastes normally flows directly into surface water sources—rivers, streams, irrigation ditches, and the Yellow Sea at Kunsan Air Base. Bioenvironmental engineering samples effluent quarterly at Air Force bases, and inconsistently at best at Army installations and collocated operating bases. Additionally, according to one bioenvironmental engineer interviewed, the scope of sample analyses do not include heavy metals which may be present from base industrial wastewater. Civil engineers reported that undersized plants at Kunsan Air Base, Osan Air Base, and Camp Casey result in untreated effluent completely bypassing the plant and/or lift stations during heavy rains.

As discussed earlier, the ROK government views adequate wastewater treatment as one of their primary environmental objectives. As a result, they have targeted DoD installations on numerous occasions for violations of the Korean Water Quality Act, which specifies standards for treatment of domestic and industrial wastewater (27; 58; 89; 180). While the Korea FGS incorporate provisions of the Water Quality Act, undersized and aged wastewater treatment systems at a number of DoD installations repeatedly exceed wastewater standards (58; 89; 180).

USFK's preferred solution to the wastewater problem is connection to regional wastewater treatment plants in the local areas. This is much cheaper than constructing and operating plants on individual installations, and results in compliance with SOFA provisions. According to the Article VI of the SOFA:

> The United States armed forces shall have the use of all utilities and services which are owned, controlled or regulated by the Government of the Republic of Korea or local administrative subdivisions thereof. The term 'utilities and services' shall include . . . sewage disposal. The use of such utilities and services . . . shall be in accordance with priorities, conditions, and rates or tariffs no less favorable than those accorded any other user. (43:17)

Although Korean sewage plants in close proximity to DoD installations have sufficient treatment capacity to effectively treat wastewater produced by DoD installations, ROK officials have insisted upon U.S. payment for construction of additional capacity at those plants and reimbursement for construction of pipelines to installation boundaries. USFK officials argue such payment is not in accordance with SOFA provisions (27; 58).

2. Soil/Water Sampling Capability. Lack of in-country soil and water sampling capability hampers installations' ability to effectively investigate suspected hazardous waste sites. All such samples must be shipped to Brooks Air Force Base, Texas, or Kadena Air Base, Japan. Consequently, sample holding times and temperatures are frequently exceeded, culminating in suspect results, especially when analyzing for VOCs and SVOCs (71; 83; 147).

3. Stormwater Ditches. Non-lined, stormwater drainage ditches ("benjo ditches") have historically been the receptors of residual hazardous waste from ineffective oil/water separators and spill events. Numerous interviewees commonly observed oil/fuel sheen on the water, and detected strong fuel odors emanating from these ditches. Water and sediment sampling have rarely occurred, if at all, in the past (8; 71; 83; 147; 171; 173).

4. Overfilling of Underground Storage Tanks. Korean contractors continually overfill underground storage tanks. Although interviewees acknowledged the potential

contamination occurring during these events, sites have never been sampled to determine the quantity of contaminants present. The "solution" to this problem has been "training" of contractors, amounting to nothing more than verbal reprimand and a reminder to be more vigilant during future operations. Apparently this solution has not worked because this researcher experienced the same events during an assignment to Kunsan Air Base in 1992, and interviewees still complained of overfill events during the site visit in June 1997 (147; 171; 173).

5. Limited Number of Site Characterizations. Installation personnel believe contaminated sites exist on their installation; however, comprehensive site assessments to determine the extent of contamination are difficult to accomplish due to funding limitations (for contractor studies) and/or manpower limitations (for in-house investigations). They have observed signs of potential contamination—oily sheens in stormwater drainage ditches, distressed vegetation, discolored soil, fuel odors emanating from manholes and excavation sites—but have not conducted in-depth investigations due to inadequate resources. In most cases, the area of suspected contamination is excavated until no physical signs of contamination is present, but further exploratory sampling is not accomplished. Projects clearly tied to mission support (maintenance and repair of mission facilities and infrastructure) or quality-of-life issues (improvement of dormitories, dining halls, recreation and fitness centers) normally secure top priority during budget discussions (58). Projects to remedy environmental compliance issues also receive attention from installation leadership since:

a. Base or higher headquarters conduct annual assessments to measure the level of compliance. These assessments (ECAS and ECAMP audits) resemble conventional inspection programs, such as operational readiness inspections and management effectiveness inspections. Since conventional inspection programs oftentimes determine the overall "grade" of operational commanders, similar emphasis is placed on compliance audits.

b. Service-specific instructions and regulations, and the FGS provides clear guidance and policy for the compliance program.

6. ROK-Funded Construction Program. In a related funding issue, DUSD(ES) believed the ROK government should pay for cleanup of contaminated sites at all ROK-funded construction projects—past, present and future. Combined Defense Improvement Program (CDIP) projects, in particular, are funded, designed and constructed by the ROK government with minimal DoD oversight. In fact, these projects—which must be specifically related to wartime operations and designed for joint ROK/U.S. use—are constructed exclusively under the supervision of MND construction inspectors. If necessary precautions were not taken to protect the environment during design or construction to prevent future contamination, it is felt that blame for the resultant contamination should lay squarely on the ROK government, and they should bear the responsibility (and cost) for cleanup. DUSD(ES) also added that the ROK government should also bear responsibility for all contamination stemming from aircraft maintenance operations which these facilities support since the original facility design should have included provisions for adequately protecting the environment (168).

7. Korea-Wide Environmental Baseline Surveys. Korea-wide environmental baseline surveys, if they exist, are not available for USFK review. Interviewees felt that numerous hazardous waste sites probably exist throughout the country as a result of poor environmental practices during the Japanese occupation and the Korean War. Some of the sites probably exist on DoD installations, or contamination from off-installation sites may have migrated onto DoD installations over the past 44 years since the end of the war. Locating and tracing sources of such contamination would be virtually impossible, especially for unrecoverable contaminants such as DNAPLs. Bases which served as operating sites for the Japanese military prior to the Korean War, such as Kunsan Air Base, may also contain residual contamination. Once again, pinpointing the source and liable party for such contamination would be extremely difficult at best (27).

8. Contamination Outside Installation Boundaries. At many DoD installations, land ceded for USFK use lies outside the physical barriers (perimeter fence line). Some training ranges, such as the MPRC in Tongduchon, do not have perimeter fencing at all, allowing free access onto property for which DoD has primary responsibility for environmental protection (181). As in the preceding finding, determination of liability for contamination on free access property would be infeasible since anyone, including Korean civilians, could presumably contaminate soil and/or groundwater without DoD knowledge (27; 83; 181).

b. Air Force-Unique Findings.

1. High Turn-Over Rate. Personnel at both Air Force bases felt strongly that the high turn-over rate of personnel was a major hindrance to effective management of the

environmental program as a whole, and the restoration problem in particular. Nearly all military personnel at Kunsan and Osan Air Bases serve a one-year tour of duty with the exception of a select handful of individuals at Osan. Interviewees complained of the "shortsightedness" associated with a one-year assignment, which inevitably leads to lowering the priority of long-term projects such as remediation of contaminated sites. According to base-level personnel, corporate knowledge is also a victim of the high turn-over rate. Information on spill sites, leaking fuel tanks, and other contaminant sources—written or otherwise—eventually becomes "lost" over the years, only to surface accidentally during construction projects or as contaminants eventually leach to the surface and enter the ground water. Inception of long-term strategic plans, such as management action plans or strategic environmental plans may solve the problem of lost corporate knowledge. The Directorate of The Civil Engineer at Headquarters PACAF recently engaged the 240th Civil Engineer Flight, Buckley Air National Guard Base, to accomplish a restoration management action plan for Osan Air Base, and Kunsan Air Base contracted with Woodward-Clyde Federal Services and AFCEE to complete a strategic environmental plan for their installation. Both documents represent an important step by decision-makers to quantify requirements and devise a long-term solution to restoration problems at the respective bases. Execution is the next step, which the high turn-over rate may hinder. At the time of the site visit in June 1997, Kunsan's environmental staff had not reviewed the first draft of the Kunsan strategic environmental plan, which was completed by AFCEE in April 1997 (7).

2. Contamination Caused By ROK Air Force/Army Units on DoD Installations. Interviewees believed poor environmental stewardship practiced by the ROK Air Force (ROKAF) and ROK Army (ROKA) tenant units on Kunsan Air Base, Osan Air Base, and the COBs may be a significant cause of hazardous waste sites at those installations. However, since the ROKAF/ROKA do not allow U.S. military personnel within their compounds, base personnel could not provide conclusive evidence of ROKAF/ROKA-created hazardous waste sites. The only indication of possible environmental mismanagement was found at Kunsan Air Base, where engineers discovered oil and grease flowing from a ROKAF dining facility into a storm water drainage ditch, and experienced several cases of illegal municipal solid waste dumping. The ROKAF unit also discharges raw domestic sewage directly into base stormwater drainage ditches, which eventually empty into the Yellow Sea. One interviewee mentioned that ROKAF/ROKA hazardous materials circumvent the base's central hazardous material distribution system. Consequently, DoD personnel are unaware of the quantities and types of hazardous materials used and disposed of by ROKAF/ROKA personnel. (7; 8; 72; 171; 173).

c. Army-Unique Findings

1. Manning. Personnel at two of the three Army installations visited complained of the minimal manning levels in the environmental staff office. Interviewees stated that the authorized manning level (one individual at Camp Carroll, and five personnel at Camp Casey) was insufficient to adequately accomplish all environmental tasks. Of the four primary areas within the environmental program (cleanup, compliance, conservation,

and pollution prevention), cleanup is the one program that does not receive equal attention since: (1) remediation of contaminated sites, other than those representing an imminent and substantial endangerment to human health, is not a requirement and, (2) cleanup must be funded from existing operations and maintenance or compliance funds, which other mission priorities normally override.

2. Project Prioritization System. The project prioritization system for Army installations does not allow direct input from installation environmental personnel. Requests for environmental project funding from all installations on the peninsula are funneled to the 19th TAACOM for review, prioritization, and funding with nothing more than the information submitted via the A-106 environmental project documentation system. 19th TAACOM periodically conducts project prioritization meetings where installation commanders may provide additional justification and data to support funding for their projects. Ultimately, however, individuals with little knowledge of installation-specific environmental conditions compare and eventually rank projects from 83 installations with varying missions (ground forces, aviation, troop support, logistics, and depot-level maintenance) without benefit of direct input from environmental experts.

d. Installation-Unique Findings

(1) Kunsan Air Base.

1. Haje Village Landfill. In the Fall of 1996, installation personnel discovered domestic waste illegally placed near the base fence line adjacent to Haje Village, a small civilian community of approximately 1,500 people. The waste, consisting of drywall, spray cans, trash, office furniture, scrap metal, and other domestic products, appeared to

be recently emplaced by the Haje Village locals. The Korea FGS specifically prohibits surface waste disposal (165:7-11). Base engineers removed seven, 10-ton truck loads of waste from the area in January 1997, destroying the "ramp" of trash which actually allowed access to the base over the existing fence line. Bi-monthly site visits since removing the trash indicate no unusual odors, stained soils, or stressed vegetation, although base personnel took no soil samples. The area surrounding the surface dump site was a former base landfill. While no records indicate that hazardous materials were disposed at the site, samples to confirm historical records were never taken. Kunsan's environmental staff also mentioned that the area serves as a "temporary" site for land farming of petroleum contaminated soil. The land farm area, however, contains no leachate collection system, or other secondary containment system. Base personnel also observed a pipe from an off-base source emptying into the base's storm water run-off in the same area. Discharge from the pipe is unknown; however, engineers believe the effluent consists of agricultural run-off fertilized with night soil (typically high nitrate concentrations) (8; 171).

2. Dumping of Construction Debris in the Yellow Sea. In December 1996, Woo Jung Construction Company, contracted by Kunsan Air Base, disposed of concrete debris from demolition of ten facilities on "South Beach" (area of coastline near the south end of the airfield). The local community publicized the incident as a violation of Korean environmental law, raising public pressure to remove the debris. According to interviewees, the demolition contractor asked and received permission from the base contracting office to dump concrete debris on South Beach. The key environmental law

in question was the Korean Waste Management Law, which requires an "approved contractor" to dispose of construction debris. Paragraph 7-3q of the FGS states:

> "No one shall dump any waste in . . . public beaches. . . harbors . . . without justifiable reasons. Other areas prohibited from open waste dumping are defined as . . . coastal areas." (165:7-3)

Engineers requested base and USFK legal officials for their opinion on the matter. Interviewees did not provide information on the final legal determination; however, as of 18 June 1997, the debris remains on South Beach (8; 171).

3. Automotive Battery "Graveyard". One of the environmental staff located what appeared to be landfilled batteries adjacent to a ROK Army gun emplacement. Although the batteries "disappeared" one day after speaking with ROKA officials, no soil sampling has been accomplished to date, despite the area's proximity to a storm water drainage ditch (which flows into the Yellow Sea) and off-base rice paddies (171).

4. Stormwater Drainage Ditches. The base bioenvironmental engineer identified storm water drainage ditches, fed by numerous non-point sources, as likely hazardous waste sites. Sludge, probably containing POL products, solvents, and/or heavy metals, have accumulated in ditches throughout base. However, no sample results exist to conclusively verify findings. The bioenvironmental engineer admitted that sampling of sediments in storm water drainage ditches, especially at areas adjacent to the base boundary, should be accomplished immediately to avoid possible violation of Korean environmental law (71).

5. Landfarm Maintenance. The base recently completed construction of a landfarm facility to remediate contaminated soils. However, the entire project, from design through construction, was not coordinated with bioenvironmental engineering. Consequently, bioenvironmental engineering did not budget funds for periodic sampling of landfarmed soil and the area surrounding the facility—requirements to ensure the landfarm operates properly and contaminants do not leach into the surrounding subsurface (71).

(2) Osan Air Base.

1. Well Sampling At Collocated Operating Bases. The bioenvironmental engineer accomplished water sampling of all groundwater wells at the COBs in early 1997; however, he said results could not be released for this thesis due to "security considerations." Nevertheless, he did confirm that sample results at Osan indicated that several contingency wells were contaminated with POL products and chlorinated solvents (9).

2. Landfarm. A landfarm facility exists at Osan for remediation of POL-contaminated soil, which may be a potential hazardous waste site. Engineers place six- to eight-inches of contaminated soil over a subsurface consisting of gravel, sand, and clay (no geomembrane or other liner system is used), provide water and surfactant, and periodically turn the soil to enhance aerobic degradation of POL products. However, bioenvironmental engineering does not sample the soil to ensure complete degradation or possible migration of contaminants below the landfarm facility. The only method of testing is a "sniff test" (9).

(3) Camp Carroll.

1. Groundwater Contamination. The installation environmental officer verified contamination of seven drinking water wells on Camp Carroll. He mentioned that aeration towers had been installed to treat the contaminated water, and an additional tower is slated for construction in the future. Despite the existence of these towers, the seven wells remain inactive pending further investigation into the source of contamination (trichloroethylene) and direction of groundwater flow. The location of several wells, near the installation boundary, has raised concern over possible contamination emanating from the installation to off-base receptors (83).

2. Logistics Center. Two sites, one contaminated with malathion, and the other with trichloroethylene and 1,1 dichloroethylene, exist within the Material Support Center compound on Camp Carroll. Both areas have been fenced and are likely candidates for remediation in the future, if funding can be secured from 19th TAACOM (83).

(4) Camp Casey.

1. Groundwater Contamination. Two of 23 groundwater wells have been abandoned due to POL contamination. The wells provide approximately 25 percent of the drinking water for Camp Casey—16 percent comes from commercial (city) sources; 59 percent originates from a surface source (creek). According to the environmental engineer interviewed, the aquifer feeding the contaminated wells has never been investigated for possible remediation (181).

2. Surface Water Contamination. The Shinchon waterway, which supplies a portion of Camp Casey's potable water supply and serves as the primary source of

drinking water for the city of Tongduchon, has been the subject of recent public scrutiny. An article appeared in the local newspaper during the site visit to Camp Casey which alleged that water downstream from Camp Casey's sewage outfall point "looked" worse than at points above the outfall. In the article, city officials urged the installation to meet Korean environmental law. However, according to Camp Casey's environmental engineer, effluent from the sewage plant (which provides secondary treatment) is well below the Korean standard of less than 60 ppm BOD_5 (5-day biodegradable oxygen demand test), and the total suspended solids limits (the Korea FGS also mandates this standard for Camp Casey) (181).

(5) Camp Market.

POL Contaminated Site and Battery "Graveyard." The head of the Defense, Reutilization and Marketing Office's (DRMO's) environmental branch at Camp Market discussed POL contamination throughout the vehicle storage and disassembly yard. He provided documentation concerning a Corps of Engineers study accomplished in 1992 (152). In accordance with conclusions of the 1992 study, he believed in-depth investigation is still required at the POL-contaminated site and has submitted a project to 19th TAACOM. The environmental branch chief also mentioned a suspected vehicle battery landfill located adjacent to the vehicle disassembly yard. During installation of communication cables, contractors uncovered a number of lead-acid batteries. In most cases, the contents of the batteries had leaked through punctured cases. The interviewee believed that the soil is probably contaminated with lead; however, further investigation has never been accomplished at this area.

C. Field Observations

1. General.

As surmised in Chapter 2 (Methodology), many of the physical characteristics associated with hazardous waste sites cannot be readily observed without meticulous sampling and analysis techniques. Researchers spent the majority of their time during site visits interviewing personnel and collecting various types of documentation including results from previous studies and site characterizations, periodic sampling results required by DoD and USFK regulations, updates to Korean environmental law and policy, Korean environmental documents unavailable in the United States, compliance assessment results (ECAS and ECAMP reports), and official DoD correspondence.

However, a few obvious characteristics of hazardous waste sites, such as distressed vegetation, distinctive odors (POL), floating petroleum products, and oil-stained soil, are observable. Inferences can also be made about possible receptors and exposure pathways for contaminants at specific sites. Researchers focused on these readily discernible facets of hazardous waste sites during site visits in Korea.

2. Observations.

Personnel from the environmental offices provided tours of known/suspected hazardous waste sites at all installations visited. Consequently, some findings from the literature review and personal interviews were validated when contamination was observed on the ground surface. Highlights of these findings follow.

1. Municipal Solid Waste Collection Points. Numerous municipal solid waste (MSW) collection points, usually consisting of a simple concrete pad surrounded on all

sides by a short (approximately three-foot-high) concrete masonry block wall, exist on all installations visited. With very few exceptions, these collection points are not covered, and those with roofs are still open on all sides (from the top of the wall to the roof structure). The floors of a few collection points were heavily stained with what appeared to be used oil.

2. Landfarm Facility at Osan. The landfarm facility at Osan Air Base is located in close proximity to the base boundary, immediately across a two-lane road, and perched on a built-up area approximately twenty feet about ground level. Adjacent to the fence line is an irrigation ditch feeding rice fields. When touring the site, base personnel pointed out cracks in the landfarm holding pit. The pit is used to temporarily store contaminated soil while the landfarm turning bed is in use. When they noticed the cracks, the environmental staff immediately stopped accepting contaminated soil, at least until the cracks are repaired. There appears to be no plan, however, to sample soil beneath the holding pit even though no one could estimate how long the cracks had existed prior to their discovery. Interviewees did not believe that the facility's distance from the perimeter fence nor elevation presented a risk to off-base receptors should the landfarm containment system fail, or should runoff from heavy rain events enter the off-base irrigation ditch.

3. Manning Levels. Environmental staff offices at Army installations appeared undermanned given their scope of responsibilities. For example, Camp Carroll, which conducts depot-level maintenance for EUSA's entire general purpose vehicle, heavy equipment, and combat vehicle fleet and houses the Army's Material Support Center (the

largest DoD logistics complex in Korea), has one person to manage the installation's environmental program, which includes hazardous waste management, compliance, pollution prevention, cultural and natural resources, and cleanup. In comparison, Kunsan Air Base, which has a comparable amount of facility square footage, has seven personnel assigned to the base environmental function. Camp Casey, with 27 percent more acreage and 10 percent more facility square footage, has only five personnel assigned. Camp Casey's environmental office is also responsible for 4 additional installations, so that the total acreage and facility square footage that Camp Casey environmental personnel are responsible for overseeing are 66 percent and 57 percent, respectively, greater than Kunsan Air Base.

4. Environmental Programs Office, Headquarters USFK/EUSA. The focus of EPO's efforts seemed firmly aimed toward Army organizations. Little or no information on Air Force and Navy environmental programs is kept by EPO—for example, EPO does not maintain ECAMP reports for any of the Air Force bases and COBs, nor do any USFK personnel participate in external ECAMP audits. They only appeared to interface with the other services in select areas:

a. The hazardous waste management program (coordinating transportation requirements and disposal quantities with DRMO, and finding solutions for unique waste problems)

b. Problems which have captured local community attention, such as the wastewater treatment problems at Osan Air Base and Camp Casey

c. Coordination of peninsula-wide policy, such as the Korea FGS and the soon-to-be-released USFK remediation policy.

V. ANALYSIS

A. Overview

Chapters 3 and 4 presented various issues influencing hazardous waste site remediation policy in Korea from three differing perspectives—top-level DoD decision-makers, the Korean community, and the installation environmental managers, gathered using three different data collection methods—literature review, personal interviews, and field observations. These findings will now be analyzed using the triangulation methodology presented in Chapter 2 to reach the primary objective of this research—namely, to further the understanding of hazardous waste site remediation issues in Korea. A summary of the findings can be found in Appendix 5-1.

B. Background

The goal of this thesis was to gather information for use by DoD policy makers when crafting hazardous waste site remediation policy for installations in Korea. As discussed in Chapter 2, triangulation was chosen as the methodological basis for uncovering issues relevant to DoD hazardous waste site remediation policy for Korea and analyzing findings from each of the single methodologies employed—literature review, personal interviews, and field observations. Employment of each research method furnished information from various organizations within the DoD and ROK, as well as from independent academic journal articles. Findings were compared in two ways:

1. Within each method, findings from the various groups were compared for qualitative convergence. For example, perceptions concerning the state of ROK environmental awareness received from DUSD(ES), USFK, MND, and MOE were

compared to determine if convergence of perceptions occurred among the various data sources.

2. Within each group, findings furnished through the different methodologies were also compared. Taking the same example in the previous paragraph, data gathered from the personal interview with MOE concerning the level of ROK environmental awareness were compared with information from ROK government publications and academic journals.

Hence, both "within-method" and "between-method" triangulation was used to cross-check findings for internal consistency and provide external validity to the findings, respectively. Figure 6 pictorially illustrates these comparisons.

However, before attempting to compare findings, a return to the thesis goal is in order. Establishing the goal rested on a key assumption—namely, that remediation policy for Korea should consider all issues—political, legal, economic, diplomatic, technological, security, and environmental/health—relevant to cleanup of hazardous waste sites on DoD installations in Korea. Chapter 1 of the thesis articulated these issues as:

1. Compliance with U.S. and ROK environmental law and international agreements between both countries. At a minimum, DoD remediation policy in Korea must comply with the rules and regulations established by Congress. Similarly, DoD organizations must operate within the confines of agreements made with the host nation. In the case of Korea, meeting the provisions of both U.S. law and applicable international agreements entail compliance with ROK environmental law to some degree.

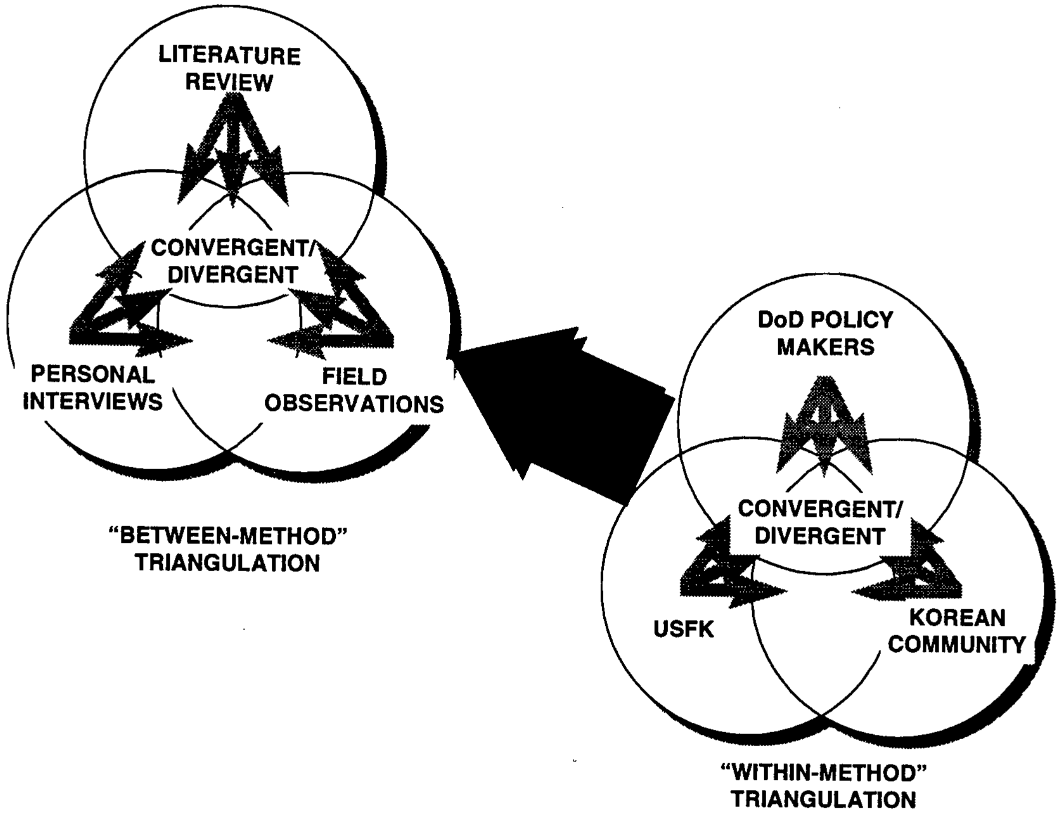

Figure 6: "Between-Method" and "Within-Method" Triangulation

In accordance with DODI 4715.5 and 4715.8, USFK is responsible for identifying applicable Korean environmental laws, determining the degree to which those laws apply, and translating requirements for all DoD organizations in Korea via the FGS.

2. Fulfillment of DoD environmental policy makers' fundamental objectives. For purposes of this study, these policy makers include the Deputy Undersecretary of Defense for Environmental Security, who provides the overarching remediation policy for all DoD activities overseas, and United States Forces Korea—the DoD environmental executive agent charged with defining remediation policy specifically for the Korean theater. After analyzing the data from personal interviews and literature, it became clear that these two

groups of policy makers had somewhat different objectives in establishing remediation policy.

3. Cleanup precedents established in other foreign countries. Clearly, DoD policy must comply with U.S. law and international agreements. Only after personal interviews were completed was the relevancy of historical precedents in other countries established.

4. Extent of soil and groundwater contamination on DoD installations in Korea, and its effect on peacetime operations and warfighting capability. The accessibility of areas critical to maintaining a mission-ready military presence in Korea, and to operating in a contingency environment depends upon the health of the environment. Depending upon the risk they present to human health, hazardous waste sites may conceivably block access to vital areas of operation, or render certain important resources (such as groundwater) unusable. In addition to the direct relationship between contaminated sites and availability of warfighting resources, indirect relationships between the extent of contamination and peacetime/wartime operations also surfaced:

a. Remediation policy determines the number of sites (by specifying the level of contaminant or human health risk to be considered "safe") and degree of remediation necessary to consider remediated sites "cleaned" (by establishing contaminant concentration-based or risk-based threshold values). This, in turn, influences the funds necessary to meet policy objectives. The funds needed to fulfill remediation policy objectives affect the ability to conduct peacetime operations, since funds for cleanup currently come from installation operations and maintenance or environmental compliance accounts. The former appropriation also pays for mission-support functions, such as maintenance and repair of infrastructure (facilities, utility systems, airfield pavements, and base pavements), utilities, supplies (including aircraft parts), and fuel. The latter appropriation is primarily used to ensure compliance with U.S. law and, in overseas locations, the country-specific FGS. While availability of funds should not inhibit a commander's ability to safeguard the health of his/her organization, the current remediation funding scheme forces commanders to compare and prioritize remediation requirements alongside mission requirements. Policy extremely protective of human health may impact mission-support functions due to finite resources and competing requirements; weak policy may not adequately protect human health and safety in peacetime and contingencies.

b. The Korean government general public clearly scrutinize DoD operations to determine their effect on the Korean environment. To date, their scrutiny has been limited to studying the possibility of contamination emanating *from* DoD installations (which has an obvious impact on the welfare of Korean citizens). However, the ROK government continues to press USFK for access onto U.S. installations in order to assess contamination *on* DoD installations, since the land area will inevitably revert to Korean use at some point in the future. Remediation policy directly affects the extent of contamination on and emanating from DoD installations in that it determines cleanup action levels and scope of DoD responsibility. In turn, the extent of contamination influences Korean perception of DoD environmental stewardship, which, in the long run, affects DoD's ability to maintain access to Korean land for its peacetime and contingency operations. Furthermore, DoD policy of prohibiting joint environmental assessments coupled with USFK policy of refusing to release the FGS and information concerning the "health" of its installations to Korean officials have aroused suspicion among the Korean populace with regard to DoD's stewardship. Such suspicion may result in mounting public pressure to evict DoD units from Korea, or, at the least, hamper U.S./ROK negotiations in other areas.

5. Extent of soil and groundwater contamination off DoD installations in Korea. Surveying the extent of soil and groundwater contamination on the peninsula, including sites on MND installation, gauges the effectiveness of ROK environmental law enforcement, and provides a sample of the remediation technology available to ROK engineering firms. Both DoD and Congressional policy makers weigh the effectiveness of Korean enforcement mechanisms when promulgating remediation policy. A prerequisite to conducting remediation activities in foreign countries is demonstrated, equivalent emphasis on environmental programs within the host-nation, and the extent of contamination on the peninsula serves as a marker of the importance the ROK government places on the environment.

6. Availability of resources and technical capabilities to investigate and remediate hazardous waste sites in Korea. Even a policy which theoretically fulfills the objectives of DoD policy makers stands little chance of being effective without sufficient resources and technical know-how for execution. This issue, partially explored above, considers the "real-world" applicability of DoD remediation policy in Korea. If the Korean engineering community cannot effectively execute remediation projects using innovative, cutting-edge technologies, DoD will be hard-pressed to fulfill remediation policy

objectives within budgetary constraints. Additionally, in assessing Korea's technical capabilities in the field of remediation technology, opportunities for cooperation between the U.S. and Korea may surface, which the U.S. should exploit to enhance military and political relationships.

While this thesis did not determine the level of influence each of the issues should exert on DoD remediation policy for Korea, or attempt to formulate the optimal policy, it did identify specific themes which policy makers should consider when trying to promulgate cleanup policy and it did establish some of the relationships between issues. Triangulation served as the basis for discovering and validating these points which surfaced when each of the three exploratory methodologies were employed.

After conducting the literature review, personal interviews, and field observations, however, it became apparent that several of the issues listed above do not lend themselves to validation using all three legs of the triangulation methodology. These include:

- U.S. and ROK environmental law, and agreements between the two;
- DoD environmental policy makers' fundamental objectives;
- Cleanup precedents; and
- Availability of resources and technical capabilities.

Field observations are not possible in each of these areas; hence validation will be based on similar findings between literature review and personal interviews only. Additionally, field observations were not accomplished at non-DoD sites due to time limitations and security considerations (for MND installations). Data gathered through literature review and interviews sufficed, however, in assessing the current level of Korean environmental law enforcement on a macro level.

Field observations were applicable only in a very gross assessment of the extent of contamination on DoD installations, and even in this category, observations were limited to contamination physically detectable at ground level. Time and resource limitations prevented actual sampling of sites, although the large pool of interviewees and available literature more than compensated for this shortcoming.

C. Degrees of Convergence

In comparing findings between the three methodologies employed, various levels of convergence appeared. These included:

1. Complete convergence—Findings were identical among the methodologies and among groups (DoD-level, installation-level, or Korean community) within a single methodology.

2. Partial convergence—Two types of partial convergence resulted:

   - Findings were similar between methodologies, but the groups surveyed within methodologies produced contradictory findings.
   - Findings were similar between groups within methodologies; however the findings between methodologies contradicted each other.

3. Divergence—Findings between methodologies and between groups within methodologies contradicted each other.

Differences either between groups or between methodologies (partially convergent or divergent findings) may appear "negative" at first. An instinctive action might be to ignore such findings since the triangulated approach could not validate them. However, recalling the discussion on strengths of the triangulation methodology in Chapter 2, divergent findings may actually strengthen the overall thesis by providing unique, insightful factors bearing upon remediation policy formulation. In practice, such divergent and partially convergent findings established a number of relationships between issues. In addition to providing a holistic picture of remedial issues in Korea, these relationships are critical to application of decision analysis methods—one of the recommended directions for future study.

D. Findings

A summary of major findings and the level of convergence which resulted from applying the triangulation methodology appears in Appendix 5-1. Detailed explanations follow below.

1. U.S. Environmental Law and DoD Remediation Policy.

1. U.S. environmental laws do not require remediation of hazardous waste sites in Korea (***Convergent Finding***). At present, no provision of U.S. environmental law specifically requires DoD to cleanup contaminated sites in Korea, or anywhere overseas, with the exception of U.S. territories abroad (154; 156; 168). Such a requirement would infringe upon the sovereign rights of the host-nation, and therefore, is not expected to change at any point in the future. However, Congressional interest in DoD remediation activities overseas continues to increase. Section 333 of Senate Bill 936, *National Defense Authorization Act for Fiscal Year 1998*, puts forth an amendment to Title 10

USC 2706 (*Environmental Restoration*), requiring a report on environmental activities of DoD overseas to include:

> A statement of the funding levels and full-time personnel required for the [DoD] to comply . . . with each requirement under a treaty, law, contract, or other agreement for environmental restoration or compliance activities.
>
> A statement of the funds to be expended by [DoD] during such fiscal year in carrying out other activities relating to the environment overseas, meetings, and studies for pilot programs and travel related to such activities. (167)

Although the proposal still requires House approval, it suggests growing Congressional interest in DoD's restoration activities overseas.

2. Acceptability/Adequateness of DoD overseas remediation policy ***(Divergent Finding)***. Results from literature and interviews verified the current policy—cleanup is justified when a contaminated site presents "imminent and substantial endangerments to human health." However, groups tended to disagree over the adequacy of the current policy.

a. DoD policy makers defended the current policy, highlighting that differing conditions between the various countries requires a flexible remediation policy. Policy makers crafted non-specific guidelines to allow in-theater commanders maximum flexibility in tailoring their restoration program to country-unique conditions, while still ensuring human health risks were abated, and provisions of international agreements were met. If commanders felt conditions warrant more specific direction, the policy delegated authority to DoD environmental executive agents (in this case, the Commander-In-Chief (CINC), USFK) to more specifically define "imminent and substantial endangerments."

b. USFK and installation personnel believe "imminent and substantial endangerment" needs further specificity. Interviewees felt the current policy allows too much latitude in interpretation between services and between installations, which may lead to dissimilar environmental conditions at DoD installations throughout Korea. The non-specificity of remediation policy also complicates the project justification process, since priorities for similar projects, even within the same service, could differ from installation to installation.

Installation-level environmental offices suggested a standardized, health risk-based procedure for quantifying the "urgency" level associated with hazardous waste sites. DoD's relative risk site evaluation framework provides such a procedure which could be applied to Korean installations. As outlined in the *DoD Relative Risk Primer*, and Figure 7, the framework evaluates the relative risk posed by a site in relation to other sites using three factors:

- The contaminant hazard factor (quantitatively measures the relative toxicity of CERCLA hazardous substances, pollutants, or contaminants);
- The migration pathway factor (qualitatively measures the likelihood of contaminant migration from the source); and
- The receptor factor (qualitatively measures the level of risk associated with the present or future human and ecological receptors of the contaminant).

The framework measures these factors in the four media most likely to result in significant exposure—groundwater, surface water, sediment, and surface soils, and combines results in a single ranking—high risk, medium risk, and low risk. Because of its broad application throughout DoD, environmental personnel should be familiar with its procedures, and with slight revision in the contaminant hazard factors to account for FGS-specific contaminants and MCLs, the DoD relative risk procedures should be readily adaptable to USFK installations. Chief among its advantages, the framework provides a common approach among DoD components for categorizing and prioritizing sites by relative risk, and does so in easily understood terms. An independent study of possible

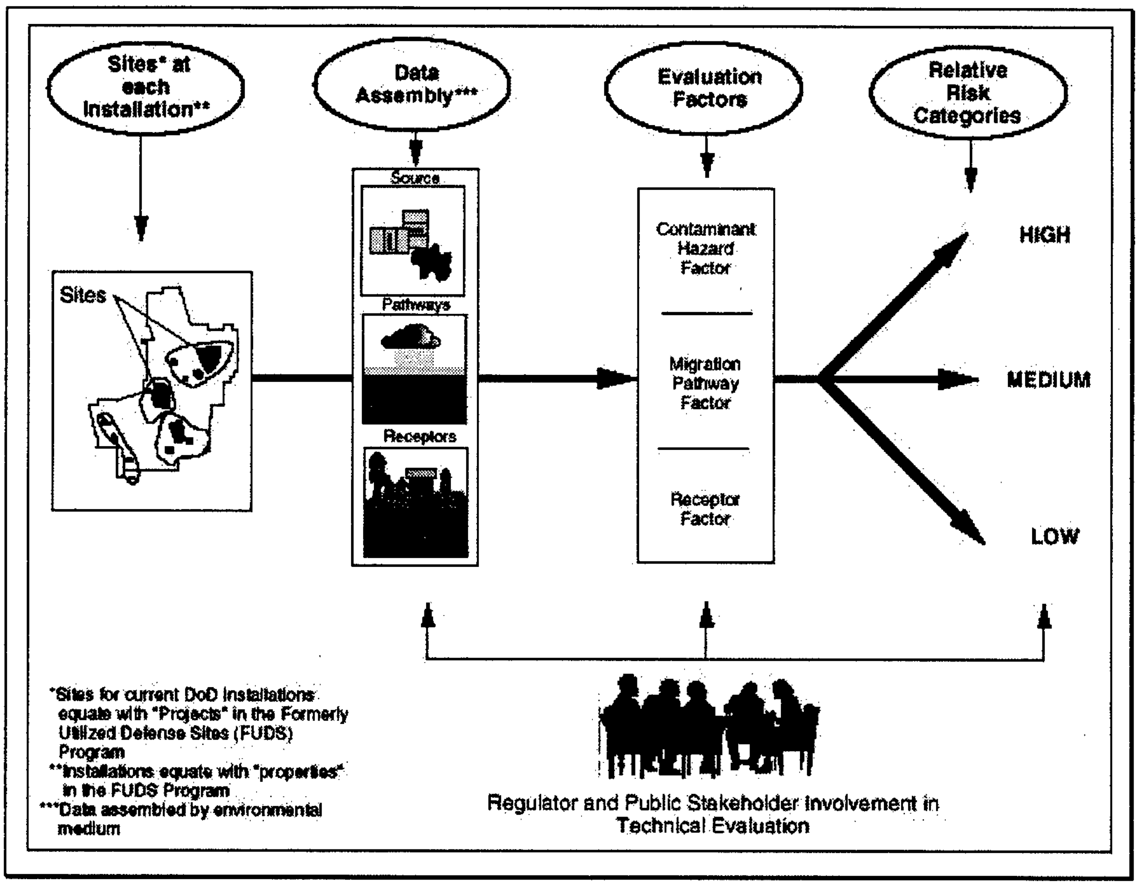

Figure 7: Relative Risk Framework (37:2)

restoration sites at Osan Air Base reached similar conclusions regarding the need for a risk-based evaluation system, and advocated use of U.S. EPA Region III's Risk-Based Concentration system (174).

c. DoD policy levies responsibility for interpreting "imminent and substantial endangerment" upon USFK; however, the organizational structure of USFK does not lend itself to adequate peacetime oversight and support of a Korea-wide restoration program. As shown in Figure 8, the Army, Air Force, and Navy components of USFK operate in separate chain-of-commands during peacetime. These separate and distinct peacetime command structures also program and allocate the funds necessary to conduct hazardous waste site assessments and execute remediation projects (as necessary). For example, Headquarters PACAF provides funds to accomplish remedial site investigations or cleanup projects at Air Force bases in Korea, either through annual O&M funds distributions to wing commanders (commanders are left to "divide the pie" as appropriate for his/her installation) or for specific projects over and above the installation's normal allotment. However, at no point in the planning, programming, budgeting and project execution process does PACAF consider the total joint environmental requirements for the peninsula. PACAF determines resource allocations strictly on Air Force mission requirements without knowledge of Army and Navy needs.

The Environmental Programs Office, a dual-hatted staff agency serving both USFK and EUSA, should have the environmental expertise coupled with cognizance of the overall joint mission in order to properly advise CINC USFK, the DoD environmental executive agent, on cleanup issues for Korea. However, EPO rarely participates in Air

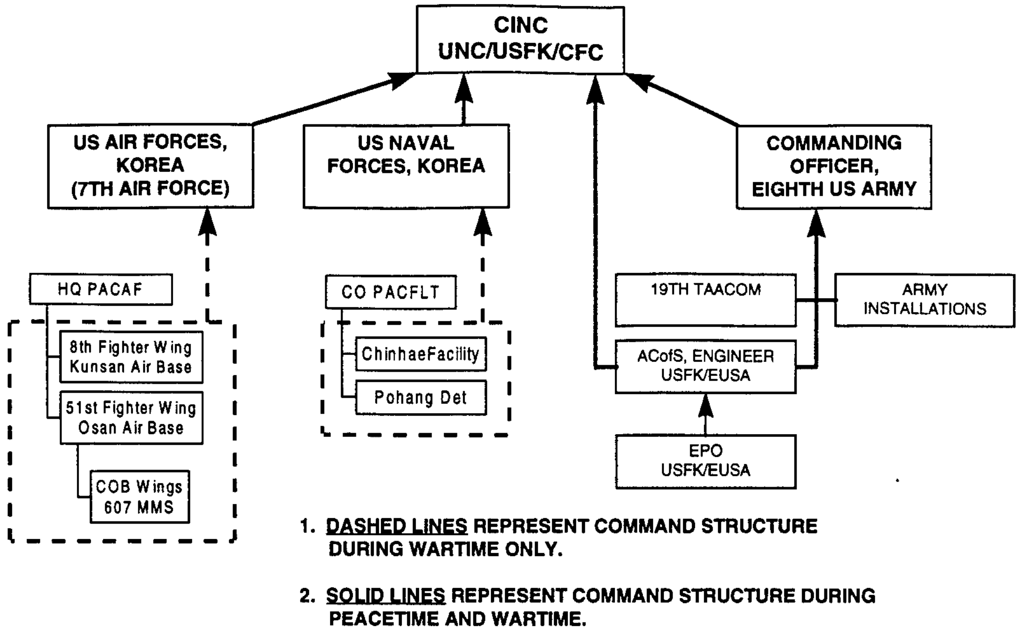

Figure 8: USFK Command Structure

Force and Navy-specific environmental matters (with the exception of coordinating with DoD installations in Korea when promulgating the Korea FGS). EPO maintains little information on either Air Force or Navy environmental programs. They maintain some information for Army installations (site investigations and ECAS reports); however, they did not have site assessments or compliance audit results for Air Force or Navy bases. In addition, EPO has very little influence over environmental funding issues even within the Army command structure, since EUSA's project prioritization and approval process is centralized at 19th TAACOM.

Much like EPO, Air Force and Navy command structures in Korea—USAFK and USNFK—also have no control over environmental funding for their respective installations in Korea. These organizations are charged with maintaining combat-capable forces to support the overall USFK-warfighting effort in Korea; yet, they have no resources for correcting environmental hazards with direct impact on contingency operations (such as contaminated groundwater wells). Both USAFK and USNFK have influence upon the host-nation funded construction programs (CDIP and ROKFC). However, as mentioned in Chapter 4, these programs have historically supported mission-related and quality of life projects

3. Cleanup precedents set in other foreign countries influence future remediation policy ***(Partially Convergent Finding)***. Although interviewees universally believed cleanup precedents have an impact on remediation policy, they expressed different opinions on the weight of the impact. In all cases, individuals believed it will be increasingly difficult to defend SOFA provisions allowing return of installations to Korea without restoration of DoD environmental contamination as the U.S. continues to agree to some sort of restitution in other countries. In Germany alone, DoD components have returned nearly 650 installations or facilities since 1990 in which residual value off-set cleanup costs. Canada serves as the latest example of paying restitution for cleanup of hazardous waste sites. Both countries have SOFAs similar to the U.S./ROK SOFA with regard to cleanup requirements.

The differences between interviewee's responses came in whether or not they believed DoD policy or SOFAs would ever be revised to include a restoration provision based on precedents. One camp believed a restoration clause would never be included given the practical realities of fiscal constraints on the availability of cleanup funds, and the fact that other SOFAs had no such provisions. They argue that precedents shall not be seen as relevant since each relationship is unique, and should be treated as such, requiring one-on-one negotiations to resolve country-specific requests for remediation. Another camp opined that the question of remediation on host-nation territory fell within the larger realm of international law, based largely on multilateral and bilateral agreements, and precedents. Although not enforced by any supernational sovereign body, countries such as the U.S. and Korea recognize international law, in practice, as binding provisions. As the U.S. continues its practice of compensating host-nations for contaminated sites caused by DoD operations regardless of any SOFA or other international agreement, the case supporting restoration in foreign countries becomes stronger—leading, perhaps, to adoption as a tenet of international law.

4. Current DoD remediation policy may allow ROK access to data on contaminated sites on DoD installations ***(Divergent Finding)***. Paragraph F3 of DODI 4715.8 allows free exchange of information on hazardous waste sites between the DoD and the Korean government, if the Korean government requests the information (39:14). One could interpret MOE's request for joint assessment of DoD installations as a request for data on contaminated sites, since the assessment's primary goal is identification of such sites. Once information is provided to MOE, the door is open to ROK claims of environmental law violations, particularly of the Soil Preservation Act. Since the U.S. must "respect the law of the Republic of Korea," and "abstain from any activity inconsistent with the spirit" of the SOFA (Article VII), it follows that DoD must at the very least consider remedial action for those sites which violate Korean environmental law. This is classified as a "divergent finding" since DODI 4715.8 was the only source of

information for the finding (USFK and installations personnel were not aware of this requirement).

On the other hand, Korean "respect" for DoD's environmental program may also result from full disclosure of environmental information. To this point, USFK has not provided Korean officials with any information regarding their environmental program in Korea—this includes DoD/USFK regulations and policy, the Korea FGS, ECAMP and ECAS reports, hazardous waste production statistics, etc. MOE's perception of the DoD environmental program in Korea has been solely based on NGO observations, innuendo, and rumors. Infrequent contact between EPO and their counterpart in MOE, evidenced by the fact that the last meeting of the Environmental Subcommittee of the SOFA Joint Committee was in September 1993 and verified by EPO (58), casts even further doubt on the effectiveness and integrity of the USFK environmental program in the minds of MOE. Allowing MOE access to USFK installations and environmental data should increase the level of "trust" between MOE and USFK, concerning USFK's stewardship of Korean land, given:

a. The equity between USFK/DoD standards and Korean environmental standards. In fact, portions of the USFK/DoD standards are generally higher than Korean standards, especially with regard to protection of groundwater resources, and handling of hazardous materials and hazardous waste.

b. The effort expended by USFK installations to comply with the FGS, and, therefore, Korean environmental law. Disclosure of annual ECAMP and ECAS findings, and the priority given to their closure by installation commanders, should demonstrate USFK resolve to adhere to ROK environmental laws.

c. General conditions on USFK installations. Although access to MND-exclusive installations was not permitted, observations of ROKAF and ROKA compounds on DoD installations indicate a level of environmental stewardship no higher than that practiced by USFK organizations. Results of joint DoD/MOE assessments should show DoD's superior care of the Korean environment when compared to MND installations (EPO and USFK interviewees generally agreed with this statement). At the least, conducting joint assessments would foster a cooperative spirit between the two organizations by demonstrating USFK's willingness to air "dirty laundry" with their host.

2. International Agreements.

1. International agreements do not require DoD activities to remediate hazardous waste sites prior to their closure and return to Korea (***Convergent Finding***). The U.S./ROK Status of Forces Agreement defines the rights and responsibilities of both nations with regard to the presence of DoD personnel in Korea. Article IV specifically addresses installations and facilities and explicitly negates any U.S. liability for restoration of contaminated sites. SOFAs with Japan, Germany, and Canada contain very similar language, relieving the U.S. of any obligation to restore facilities and areas to their previous condition.

2. International agreements will be revised in future years to require remediation of hazardous waste sites in Korea ***(Partially Convergent Finding)***. Findings in the literature and interview responses varied with regard to this issue. Some interviewees

believed such a requirement will never gain Congressional support given financial restraints, the low emphasis the ROK government currently places on remediation issues, and the precedent such a requirement would set in for DoD operations in other countries. On the other hand, other interviewees suggested restoration is inevitable—that negotiated settlements between the U.S. and Germany and Canada with regard to remediation of former DoD sites may have already set a strong precedent for future remedial action. An example from literature which may foretell of future remedial requirements in Korea is the March 1993 Supplementary Agreement with Germany. The yet-to-be-enacted agreement obligates NATO forces (including the U.S.) to "bear the costs" of assessing, evaluating and remediating environmental contamination which it caused (127:6). During interviews, Korean officials expounded their belief that the current U.S./ROK SOFA was "unfair" compared with similar agreements between the U.S. and other foreign nations, and the Supplementary Agreement with Germany just adds support to their claim.

3. <u>The SOFA may allow DoD individuals to be incriminated for violation of Korean environmental law, or held responsible for damages to third parties resulting from contamination</u> ***(Divergent Finding)***. DoD legal officials believed that DoD individuals would never be criminally prosecuted for any environmental offense committed in Korea, placing environmental issues in the realm of tort and damage law rather than criminal law. They felt the SOFA would allow the U.S. to exercise exclusive jurisdiction should the ROK government target a DoD individual for violation of Korean environmental law. However, an examination of criminal law and the SOFA seems to yield contrary findings.

a. Criminal Law. The Cornell University School of Law's Legal Information Institute defines a "crime" as:

> Any act or omission (of an act) in violation of a public law forbidding or commanding it. Most crimes (with the exception of strict-liability crimes) consist of two elements: an act, or 'actus reus' and a mental state, or 'mens rea.' Prosecutors have to prove each and every element of the crime to yield a conviction. (29)

Violation of Korean environmental law could certainly fit this definition of a "crime," under the assumption that the U.S. legal definition matches the Korean legal definition. Two examples of successfully prosecuted criminal cases against non-U.S. personnel demonstrate Korean willingness to enforce provisions of their environmental law (see Chapter 4, Section B2, *Korean Environmental Policy and Current Environmental Conditions*). In a great many cases, the U.S./ROK SOFA protects U.S. military personnel, their dependents, and contractors against prosecution under Korean laws (reference Chapter 3, Section C3, *Applicability of ROK Environmental Laws to DoD Forces in Korea*, for supporting evidence). While Korea has never exercised its jurisdiction over environmental crimes in the past, recent trends and increasing environmental awareness among the Korean populace may change this pattern.

In addition to possible Korean criminal prosecution, DoD violators of Korean environmental law could also face penalties imposed by U.S. law. Section 956 of Chapter 45 of Title 18, United States Code, states:

> Whoever, within the jurisdiction of the United States, conspires with one or more persons, regardless of where such other person or persons are located, to damage or destroy specific property situated within a foreign country and belonging to a foreign government . . . with which the United States is at peace, or any . . . airport, airfield, or . . . public structure, . . . , or cultural property so situated, shall, if any of the conspirators commits an act within the jurisdiction of the United

States to effect any object of the conspiracy, be imprisoned not more than 25 years. (155).

The preceding is an example where violators of Korean environmental law could face criminal prosecution even when the U.S. retains exclusive jurisdiction over the case. Despite the extenuating circumstances (prosecutors must show intent to damage and conspiracy to damage), the claim that U.S. military personnel in Korea "would never be criminally prosecuted for any environmental offense" may not be true. However, even if DoD legal advisors are successful in exercising exclusive jurisdiction to protect DoD members from criminal prosecution, damage claims arising from tort law may result in monetary penalties.

b. Tort Law. "Tort" denotes a common law violation for which a court provides compensation for damage—physical or psychological (144:6). Within U.S. common law, there exists a general legal duty to avoid causing harm to others, through acts of omission or commission. Carelessness in exercising this duty which results in some harm or damage to others may result in a lawsuit through which the injured can seek compensation (144:6). The U.S./ROK SOFA contains similar avenues for Korean citizens to gain restitution for damage caused by DoD members (43:38-42). Historically, Korean citizens have not filed many damage claims, which could be a matter of cultural differences as much as their ignorance of legal avenues for gaining compensation. Interestingly, according to interviewees, DoD installations have repeatedly provided payment in the past for damage allegedly caused by DoD operations rather than enter litigation with the injured party. Examples of cases include destruction of crops due to misapplication of herbicide, contamination of crops by POL emanating from on-base sources, DoD-caused contamination of local water sources, damage to facilities due to aircraft accidents, and damage to natural resources from training exercises (27). Interviewees and literature show a trend similar to criminal cases of increasing tort claims filed by Korean citizens against Korean firms during the past decade.

3. ROK Environmental Law and Current Environmental Conditions.

The level of ROK environmental awareness and compliance with Korean environmental law is increasing ***(Convergent Finding)***. The data consistently highlighted the importance of two prerequisites which Korea must demonstrate before U.S. policy makers consider revising the current DoD remediation policy: (1) a strong emphasis by the Korean government in preserving the environment as exemplified by stringent environmental laws in various media (air, surface water, groundwater, soil, and sediments); and (2) a commitment by the Korean government to enforce those laws. Findings from literature review and personal interviews unanimously supported Korean progress in fulfilling the first prerequisite. The past decade witnessed explosive growth in ROK environmental legislation and funding, which U.S. policy makers generally regard as positive signs of increased Korean environmental awareness. In addition to the increase in number of laws, the stringency of those laws have also increased. In many cases, Korean environmental laws meet or exceed U.S. EPA standards. In fact, interviews with Korean researchers revealed that MOE used European standards as a baseline when promulgating the 1995 Soil Preservation Act, which specify MCLs more restrictive than U.S. MCLs in some cases (see Table 18 below).

Table 18: Comparison Between U.S. and European Soil Standards, Select Analytes (177[1])

Contaminant	U.S. RCRA Action Levels (mg/kg)	European Soil Standard Action Levels (mg/kg)
Arsenic	80	29
Cadmium	40	0.8
Chromium	400	100
4,4-DDT	2	Lowest Detectable Limit
Lead	100	85
Nickel	2,000	210
Tetrachloroethylene	10	0.01
Toluene	2,000	0.05
Trichloroethylene	60	0.001
Xylene	200,000	0.05

[1]Soil standards obtained during interview with MND.

Assessing the efficacy of Korean environmental enforcement proves more problematic. Although findings seem to indicate an improvement, U.S. interviewees still believe Korea's enforcement requires substantial improvement. Top-level DoD policy makers felt Korea must demonstrate enduring and consistent resolve in cleaning up its own environmental mistakes, especially those attributable to MND operations, before the U.S. agrees to expend increased resources to remediate contamination on DoD installations.

In past years, Korea has focused its energies in pollution prevention and conservation measures, regarding remediation of soil and groundwater as technically futile. Nevertheless, work continues in Korean universities and research centers, aimed at developing remediation technologies and a better understanding of the fate and transport of contaminants in the soil and groundwater. Korea has undertaken a few remedial projects, and aims to align more resources toward this end, especially with regard to cleaning up landfills and other contaminated sites in close proximity to urban centers, agricultural areas, and drinking water sources.

As demonstrated in Chapter 3, MND in particular has shown a strong commitment to environmental preservation and restoration in recent years. The events in Chapter 3 with regard to MND "openness" are precedent-setting changes for an organization considered "untouchable" by government and civilian entities in Korea. MND's willingness to share information and their apparent embrace of an environmental ethic, evidenced by action and words, should signal DoD, and especially USFK, to re-examine their policy with regard to environmental restoration in Korea. For many years, USFK used MND's "closed-door" policy and apparent disregard for the environment as an excuse to prohibit joint environmental assessments on DoD installations, restrict ROK access to ECAMP and ECAS reports, and deny review of the Korea FGS. U.S. policy makers felt DoD forces in Korea should not be held accountable for Korean environmental law violations if the Korean military was not leading the way (58; 89; 168). Now that MND has officially instituted an environmental program and appears to have taken steps toward compliance, the basis for much of USFK's "closed-door" remediation policy regarding the environment has disappeared.

<u>4. Current Environmental Conditions at DoD Installations in Korea</u>.

1. <u>Suspected and confirmed hazardous waste sites, contaminated primarily with petroleum, oils and lubricants (POL), organic solvents, and heavy metals, exist at numerous locations throughout the peninsula *(Convergent Finding)*</u>. Examination of available site investigations conducted by the Corps of Engineers, Far East District, Air

Force Center for Environmental Excellence (AFCEE), 240th Civil Engineer Flight, and Woodward-Clyde Federal Services at Kunsan Air Base, Osan Air Base, Taegu Air Base, Camp Carroll, and Camp Market confirmed the existence of at least eight sites requiring action to remediate significant health effects and/or prevent migration of contaminant plumes to off-base areas (110; 151; 152; 153; 174; 175; 176). These sites include:

- Kunsan Air Base: North POL Storage Area
- Osan Air Base:
  - AMC Ramp Site and POL Tank Farm Area (adjacent areas)
  - Bulk Storage Tanks 8 and 9
  - Building 942, Heating Facility
  - Building 1073, DV Quarters, and adjacent communications manholes
- Taegu Air Base: JP-4-Contaminated groundwater wells
- Camp Carroll: TCE-Contaminated groundwater wells
- Camp Market: POL-Contaminated soil (Vehicle Disassembly Area)

In addition to these sites, a number of additional areas require preliminary assessment to determine the extent of contamination, migration pathways, and possible receptors. At Osan Air Base alone, another 37 sites were identified in a recent restoration program survey (174). Review of the most recent Environmental Compliance Assessment and Management Program (ECAMP) and Environmental Compliance Assessment System (ECAS) reports, combined with personal accounts from installation personnel and field observation revealed approximately 79 additional sites at USFK installations across the peninsula with possible contamination. These include effluent from wastewater treatment plants that treat mixed influent from industrial operations and domestic sources and stormwater effluent which have never been analyzed for contaminants, leaking aboveground and underground fuel storage tanks, soil stained from POL spills, and groundwater with excessive levels of organic solvents and heavy metals (60; 61; 62; 63; 64; 65). Sites identified by the ECAMP and ECAS audits for which comprehensive investigations have not been accomplished warrant a closer look by qualified, experienced technical personnel to ensure dangerous conditions do not exist or will not exist in the future.

In all cases, including those with confirmed contamination, the scope of the problem remains unknown. Additional investigation is required to adequately characterize the site hydrogeology, locate contaminant source(s), estimate the quantity of contaminant(s), and predict the speed and direction of contaminant plume(s), and assess risk to human health. At Kunsan AB, Taegu AB, Camp Carroll, and Camp Market, several sites are located in close proximity to the installation boundary. Contaminant plumes may begin to migrate off-base if remedial projects are not undertaken soon.

At nearly every USFK installation, wastewater treatment plants are severely undersized and/or outdated. The majority of bases treat wastewater from domestic and industrial sources using septic tanks or Imhoff tanks, which only provide primary treatment. Effluent from the plants, which discharge to off-base streams, rivers, and estuaries, has rarely been analyzed for heavy metals and other potential contaminants. At stateside locations, wastewater effluent would not normally be considered a source of hazardous waste contamination. However, the poor management of industrial wastewater (often containing heavy metals and organic solvents from metal plating, painting, and other maintenance operations) and archaic treatment technology prevalent at many USFK installations make wastewater effluent a possible source of hazardous wastes in Korea.

2. Drinking water wells at several main operating bases (MOBs) and collocated operating bases are contaminated with POL and organic solvents, potentially impacting DoD and ROK military units ***(Convergent Finding)***. This finding is presented separately from the information above because it has a potential impact on warfighting capabilities of DoD and ROK military units (where ROKAF and/or ROKA units are jointly stationed). Although most of the MOBs obtain drinking water from commercial sources, drinking water wells serve as contingency sources of water should primary, civilian sources become contaminated or services interrupted. The possibility of such a scenario becomes increasingly likely in a wartime situation. Examples of groundwater contamination at the MOBs include:

a. At Osan Air Base, home of the most forward-deployed Air Force wing in the world and only 48 miles from the North Korean border, 24 wells—the majority of Osan's secondary water source—have been shut-down due to contamination from various POL products (173; 174).

b. At Camp Carroll, where depot-level maintenance is conducted on all of the Army's vehicles and heavy equipment (including armored combat vehicles) in Korea, seven of the installation's 13 groundwater wells have been shut down due to high levels of trichloroethylene. Unlike Osan, Camp Carroll's wells provide its primary water source (83; 153).

c. The four wells providing drinking water to the dormitories on Suwon Air Base are contaminated with excessive levels of trichloroethylene. The local city water system now supplies all drinking water to this portion of base—no contingency water source exists should the local system become inoperative or non-potable (52:14-2; 104; 107).

d. Seven water wells and a connection with the local city's water system provide drinking water for Taegu AB. Two of the seven wells are currently shut down due to jet fuel contamination (50:14-3). A pump-and-treat system was installed in March 1982 to remediate the source of the contamination; however, effluent from the system, which discharged into a local stream, contained contaminants in excess of ROK and USFK limits. As a result, the Osan Air Base Bioenvironmental Engineering Office ceased remediation of the site in 1996, although the groundwater remains contaminated with high levels of petroleum hydrocarbons. Recent conversations with base personnel indicate the system was restarted on 4 Aug 97, with modifications to the contaminant removal system to meet effluent limits. The history and analysis of groundwater contamination at Taegu AB is the subject of an on-going investigation focusing on the performance of the pump-and-treat system and movement of the JP-4 jet fuel at Taegu AB. Results are expected in late 1997 (100).

e. Two of 23 groundwater wells at Camp Casey, which houses the most forward-deployed division in the U.S. Army, are contaminated with POL. Although the well system supplies only 25 percent of the total potable water to the installation, the post's proximity to the North/South Korea Demilitarized Zone (less than 10 miles) and the large population it supports (more than 8,800 personnel), make Camp Casey's commercial and surface water supply a likely target during a contingency. In addition, installation environmental engineers reported that no site investigation has ever been conducted for the contaminated wells—thus, the source of contamination is unknown and the resultant plume may be migrating to other locations on post or moving off-post.

5. Opportunities for Cooperation.

Numerous opportunities for cooperation between DoD and the ROK government exist in the field of environmental remediation ***(Convergent Finding)***. Environmental training, advanced education (graduate and post-graduate studies), and technology transfer are the main areas in which significant inroads can be made to improve the overall U.S./ROK relationship (56; 168; 177). Interviews with both DoD and ROK officials indicated both organizations would lend support for such cooperative ventures; however, little progress has been made thus far (56; 168; 177). The infancy of Korea's remedial capability and MND's environmental program as a whole establish cooperative ventures as an "easy target" for success. At least one environmental firm claims to have expertise in such innovative cleanup technologies as soil washing, in-situ and ex-situ bioremediation, and soil vapor extraction (76), though typically, physical ex-situ techniques, such as dig-and-burn are used for remediation (177). Although ROK research and development funding in environmental technology has risen dramatically over the past few years (701%), it still falls short of perceived needs (114:182). Cooperative efforts between DoD and the ROK government would assist Korea in obtaining the tools necessary to meet their environmental challenges while fostering good will between both governments.

E. Generalizations

1. Suspected Hazardous Waste Sites. As chronicled earlier in this chapter, a number of confirmed and suspected hazardous waste sites exist on DoD installations throughout Korea—a finding supported by previous investigations, interviewee testimony, and independent field observations. Nineteen (95 percent) of the twenty HQ USFK and installation personnel interviewed firmly believed, based on personal observations and experiences, that hazardous waste sites existed on DoD installations in Korea. One interviewee from the legal field had no knowledge of such sites, but regarded his opinion as naive due to limited experience in the military legal profession and environmental law (three months). Each of the five installations visited displayed some visible signs of possible soil and/or groundwater contamination, ranging from the obvious (POL odors emanating from, and stains on soil, installation of pump-and-treat systems, areas secured from personnel entry due to known contamination) to the questionable (distressed vegetation, oily sheens on surface water). Each base, however, had at least one obviously contaminated site. Existing literature describing hazardous waste sites at Korean DoD installations consisted of:

- Four in-depth site investigations (involved chemical sampling);
- Four consolidated studies (review of existing data, studies, and, in one case numerous personal interviews);

- Two base support plans (Suwon AB and Taegu AB) reporting areas of known contamination; and
- Six compliance assessment reports highlighting the possibility of contaminated sites at numerous Army and Air Force locations based on field observations and limited personal interviews.

Despite the preponderance of evidence suggesting the strong possibility of contamination, all categories of literature lacked elements necessary to adequately characterize hazardous waste sites. In reviewing the existing site investigations, several shortcomings become evident:

a. Unknown quantity of contaminant in subsurface. Only one study (6) included an estimate of the quantity of contaminant(s) present in the subsurface. Without a known quantity, the plume size and extent of migration, especially with respect to vertical depth, are difficult to determine.

b. Unknown source of contaminant. A majority of the investigations (75 percent) did not pinpoint the exact location(s) of contaminant source(s). Sampling results from relatively few monitoring wells mapped areas with high concentrations of hazardous wastes. However, without known source locations, the studies could not determine future paths of migration. In a few cases, such as the contamination of the groundwater aquifer at Camp Carroll and Taegu Air Base, determination of migration paths are critical due to plume proximity to the installation boundary. In addition, elimination of the contaminant source may be the only way to cleanup the site, especially if the source continues to emanate hazardous waste after a remediation technology is employed.

c. Unknown background concentrations of contaminants. Determination of background concentrations were not accomplished in any of the literature reviewed. Knowledge of naturally-occurring contaminant concentrations is essential to differentiating between anthropocentric and intrinsic pollutants, which, in turn, influences risk assessment and cleanup levels.

d. Poorly characterized hydrogeologic conditions. With one exception (175), investigators did not perform hydraulic tests on wells with the intent of identifying hydraulic characteristics. This includes the JP-4 spill site at Osan Air Base, where an estimated 500,000 to 700,000 gallons of JP-4 was released. Since the accident occurred in 1986, no less than 4 studies have been accomplished and 98 boreholes and 16 monitoring wells installed, but no attempt to characterize the source of free product, nor the subsurface conditions, has ever been undertaken (6:2, 5). Estimation of contaminant transport (speed and direction), and infiltration rates for source definition is not possible without a thorough understanding of the subsurface hydrogeology.

e. Risk assessment not thoroughly accomplished or not accomplished at all. Given the current remediation policy, it seemed surprising that only one study (175) adequately assessed hazardous waste sites for human health risks. Common discrepancies included:

(1) Failure to address all contaminant pathways. In all but the Kunsan study (175), investigators overwhelmingly focused on the groundwater pathway, ignoring exposure to contaminated dust and volatized wastes, and uptake and bioconcentration of contaminants in flora and fauna.

(2) Failure to fully address off-base receptors with respect to future land use. Investigators probably neglected consideration of future land use since SOFA provisions do not currently require environmental remediation in conjunction with base closure. As mentioned in earlier sections, however, cleanup precedents and heightened ROK environmental awareness and compliance may lead to a natural evolution of international environmental policy and law requiring future remediation of hazardous waste sites in foreign nations.

(3) Use of MCLs in lieu of dose/response data to determine risk to human health. Only three studies made reference to published cancer risk and hazard quotient data when assessing human health risk (174; 175; 176). Other investigations relied on MCLs as the determinant of risk. (The 1993 AFCEE health risk assessment and remedial alternative review of Osan Air Base used health-based risk to determine the "potential for adverse health effect" (110). However, the report's authors did not specify the basis for their conclusions, i.e., where cancer risk factors and/or hazard quotients were derived from.)

In addition to these issues, which support the finding of inadequately scoped hazardous waste sites mentioned earlier, the absence of a standardized risk model and appropriate risk thresholds for investigators to apply when conducting site investigations seems especially troubling. The National Academy of Sciences (NAS), in a 1983 report on risk assessment in the federal government, suggested a four-step approach to risk assessment, illustrated in Figure 9 (102:192). Figure 9 includes an additional step—the

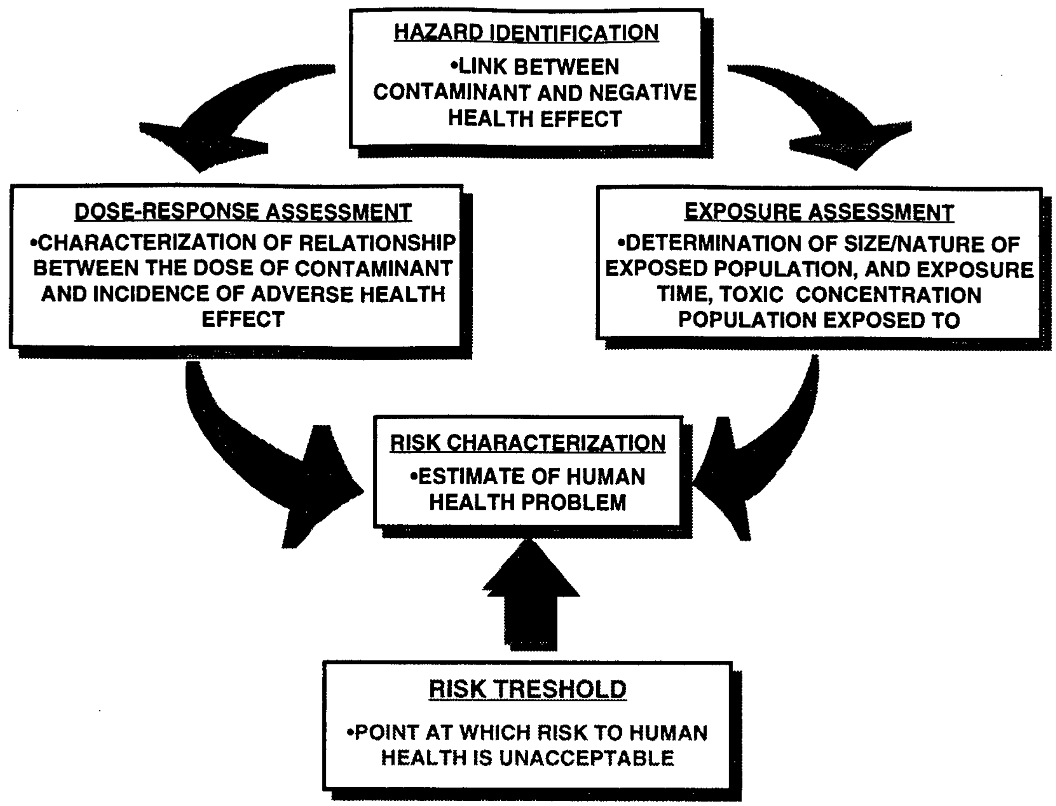

Figure 9: Four-Step, Risk Assessment Approach (102:192-193)

determination of a risk threshold influencing ultimate risk characterization. In the United States, this step is accomplished by the Record of Decision process, which incorporates the views of the local community, state environmental regulators, and installation-level senior leaders levied with site restoration responsibility. The group collectively reviews the risk assessment produced by the scientific community (installation environmental engineers), and makes a final decision regarding cleanup strategy based on political, economic, technical, and health-risk factors.

The report outlined two other recommendations pertinent to our discussion of DoD overseas remediation policy:

- a clear conceptual distinction between assessment of risks and the consideration of risk management alternatives; that is, the scientific findings and policy judgments embodied in risk assessments should be explicitly distinguished from the political, economic, and technical considerations that influence the design and choice of regulatory strategies (123:151); and

- The process followed by the government for adoption of inference guidelines should ensure that the resulting guidelines are uniform among all responsible agencies and are consistently adhered to in assessing the risks of individual hazards. (123:166)

Since the report, DoD has devised several risk-based approaches to sequence its restoration program—the Relative Risk approach being the most recent (37). The relative risk model and present DoD policy for stateside restoration fulfill both NAS recommendations by (1) devising a clear methodology for assessing risks without specifically defining a risk threshold or amount of a hazardous substance, which, if exceeded, will trigger remedial action; and (2) mandating uniform application across all services at all installations. The ROD process embodies the risk management approach to determining the ultimate remedial strategy and incorporates the "political, economic and technical" considerations mentioned in the NAS report.

Current DoD overseas and USFK remediation policy do not appear to fully comply with all NAS recommendations:

1. Although both DoD and USFK policymakers inherently recommend use of a risk-based approach by dictating "imminent and substantial endangerments to human health" as the sole criteria for justifying remediation projects, they do not specify adherence to a single risk-based approach, such as the NAS four-step process.

2. Policy does not mandate clear separation of scientific assessment and risk management considerations. Record of Decision-type proceedings are not required, and installation commanders have complete responsibility for determining a risk threshold which invokes remedial action, and relevant cleanup standards. The lack of a multi-group quorum for deciding cleanup actions acceptable to both the liable party and the local community intrinsically mixes scientific findings and policy judgments, especially since the public is not involved in the ultimate cleanup decision. While SOFA provisions and legal issues may negate any requirement to include host-nation involvement in cleanup decisions, political considerations, such as ROK environmental awareness, cleanup precedents, and the state of U.S./ROK relations, should influence remediation decisions given the possibility of future remediation liability.

3. Policy allows installation commanders the latitude to define risk thresholds and cleanup standards in accordance with local conditions. While it provides maximum flexibility for commanders, the policy also provides the opportunity for clearly divergent cleanup guidelines and standards to exist among services, and even within the same service (47; 48; 49).

The lack of clear risk-based guidance has a more significant effect than non-adherence to NAS recommendations. Without such guidance, any future attempt to conduct investigations of suspected hazardous waste sites will net the same results as it has in the past—no conclusive recommendation other than further study, or widely divergent cleanup recommendations. In recent studies, Kunsan Air Base engineers applied the State of Hawaii Department of Health's (DOH) risk-based deterministic model, while a study at Osan Air Base employed the EPA Region III Risk-Based Concentrations (174; 175). Comparisons of allowable contaminant thresholds for drinking water are shown in Table 19. Employing these thresholds can yield very different results—and, consequently, very different recommendations with regard to remedial action.

Table 19: Comparison of DOH Tier I Action Levels and EPA Region III Risk-Based Concentrations (174; 175)

	Threshold (mg/L)	
Contaminant	DOH Tier I Action Levels	EPA Region III RBC
Benzene	1.7	0.36
Toluene	2.1	750
Ethylbenzene	0.14	1,300
Xylene	10	12
Benzo(a)pyrene	0.0002	0.0092
Acenapthene	0.32	2,200
Fluoranthene	0.013	0.92
Napthalene	0.77	1,500
TPH-Gasolines	NS	Not Given

The adoption of risk-based standards to determine "imminent and substantial endangerment" also engenders controversy concerning carcinogenic versus non-carcinogenic responses to a particular toxin. The Korea FGS defines "imminent and substantial endangerments" in reference to remediation of leaking USTs as, ". . . acute injury or death, rather than illness or injury typically caused by long term, chronic exposure" (165:19-2). The key assumption for non-carcinogens is that there exists an exposure threshold—any exposure less than the threshold would be expected to show no increase in adverse effects above natural background rates (102:208). For substances that induce a carcinogenic response, an assumption is made that exposure to *any amount* of the toxin will create some likelihood of cancer (102:201). A related theory, known as the one-hit hypothesis, states that a single genotoxic (DNA-altering) event can lead to some nonzero probability of cancer; hence, the longevity of exposure does not influence illness, other than increasing the probability of getting cancer. A *single exposure* may cause cancer. By defining "imminent and substantial endangerment" as they have in the FGS, USFK has presumably chosen to ignore the effects of carcinogens and placed emphasis on non-carcinogenic effects.

2. Goal-Setting Implications.

Paragraph D2 in this chapter detailed arguments for and against non-specific DoD overseas remediation policy. Recall that DoD policymakers defended their stance for non-specific remediation objectives based on flexibility. USFK personnel criticized such policy, highlighting the excessive variance in cleanup decisions which result from the current policy. The previous section supported installation claims, using the outcome of two studies as an example of the divergent conclusions possible with adoption of two different risk-based approaches.

A review of literature from the organizational behavior field points to another, perhaps more notable effect which may arise from unclear goals. Edwin A. Locke, an organizational theorist, surmised in 1968 that specific goals result in a higher level of individual performance than do no goals or a generalized goal of "do your best" (91:824). Locke based his theory primarily on a series of well-controlled laboratory experiments with college students who performed relatively simple tasks (e.g., adding numbers) for short periods of time. A follow-up field study conducted by Gary P. Latham and Locke attempted to apply laboratory findings to the field. Logging study by Latham and Locke focused on goal-setting as method of increasing productivity within the logging industry at no cost. Managers received training and instruction to establish specific goals (number of trees felled per week) based on time-and-motion studies. Experimenters delegated authority to the managers to maximize productivity, given the basic knowledge to choose an appropriate operational goal and devise a plan to reach their goal. During the 12-week experimental period, productivity was (statistically) significantly higher in the goal-setting group compared with the control group. Moreover, absenteeism was significantly lower in the goal-setting group as well (90:40).

Some psychologists legitimately questioned whether something so deceptively simple as setting specific goals can increase the performance of employees in real organizational settings (91:825). Therefore, since 1968, numerous studies, both in the laboratory and in the field, have been conducted by various researchers to confirm Locke's original findings. Three reviews, accomplished in 1975, 1981, and 1987, attempted to survey the academic literature for evidence supporting the goal-setting theory. The first review included 27 published and unpublished reports of field research encompassing widely varying occupational groups (vending machine servicemen, keypunch specialists, skilled technicians, salespersons, telephone repairmen, truck unloaders, loggers, typists, assembly line workers, research and development managers, and surveyors. Twenty-six of the 27 reports—96 percent—supported Locke's idea of specific goal setting as a method of boosting work performance (91:830).

The second review surveyed studies accomplished between 1968 and 1980. The group of reviewers looked at not only goal specificity, but the difficulty of goals as a driver for increasing work performance. Overall, 48 studies partly or wholly supported the hypothesis that hard goals lead to better performance than medium or easy goals; 9 studies failed to support it. Fifty-one of 53 studies partially or wholly supported the view that specific hard goals lead to better performance than "do-your-best" or no goals. Combining the two sets of studies, 99 out of 110—90 percent—studies found that specific, hard goals produced better performance than medium, easy, "do-your-best, or no goals (99:131).

The final study used a meta-analytic technique to search for and compare findings of published research between 1966 and 1984. Meta-analysis refers to a statistical process enabling the reviewer to aggregate research findings across studies by using both inferential and descriptive statistics from the studies reviewed (108a:54). Besides permitting quantitative rather than qualitative gathering of results, as had been done in previous reviews, meta-analysis provides a statistical estimate for the percentage increase in productivity expected when specific hard goals are used in an organization (108a:56). Reviewers surveyed 54 studies to analyze the effect of difficult goals on performance, and 47 studies for goal specificity analysis. They concluded that goal difficulty and goal specificity/difficulty were strongly related to task performance across a wide variety of tasks and in both laboratory and field settings. The authors go on to say:

> If there is ever to be a viable candidate from the organizational sciences for elevation to the lofty status of a scientific law of nature, then the relationships between goal difficulty, specificity/difficulty, and task performance are most

> worthy of serious consideration. . . the evidence from numerous studies indicates that these variables behave lawfully. (108a:74)

For goal difficulty, meta-analysis techniques estimated the productivity increase at 11.63 percent; similarly, for goal specificity/difficulty, the increase was estimated at 8.88 percent (108a:76).

These findings certainly foretell a gloomy future for the DoD overseas restoration program given current policy objectives—remediation is justified for those sites presenting an "imminent and substantial endangerment to human health." An additional case study can be drawn from the stateside Air Force restoration program. In its early stages of development, the Air Force established vague goals and promulgated few guidelines to environmental mangers, who had free reign to develop programs based on individual assessment of site risks. The result, as stated in Chapter 4, was ineffective and inefficient management of DERA resources due to inept project estimates and extremely fluid restoration requirements at Air Force bases. The Air Force countered with adoption of the DoD relative risk assessment system, a strategic objective to cleanup those sites with the highest risk to human health, and a system for measuring accomplishment of this objective (46:3). The result of increased specificity and accountability of the Air Force restoration program has been the estimate that the entire Air Force program will be complete by 2007—not just high risk sites, but all sites (70).

If one accepts the assumption that success of the DoD restoration program in Korea ultimately depends on the performance of DoD members charged with executing the program, then this discussion on goal specificity and difficulty certainly supports a prediction of program failure, or, at the least, ineffective and inefficient execution.

3. Linkage Between Affluence and Environmental Quality/Awareness. An entire section of Chapter 3 was devoted to documenting the amazing economic growth experienced by South Korea over the past 44 years. Latter portions of Chapter 3 highlighted the growth of environmental legislation during the late 1980s/early 1990s, attempting to draw a parallel between affluence and environmental awareness. It is widely thought that poverty breeds environmental degradation; that the poorer a country is, the less resources it has to expend on "fixing" its environmental problems (148:309). As a developing country attains "developed" status, the value it places on environmental quality rises with its gross national product (GNP).

However, lack of funds do not necessarily translate to lack of interest in the environment. Many developing countries have fairly elaborate structures of rules and regulations aimed at conserving resources (148:309). Recall that Korea's first environmental law, the New Forest Law, was passed in 1961 to re-forest the peninsula—this during a time when per capita GNP was $87 and the life expectancy was about 54 years (23:15). In fact, as countries become more and more developed, certain pollution indicators actually rise, such as the per capita municipal wastes and carbon dioxide emissions (124:22; 148:311). South Korea displays many of the signs of a developed country in this regard (113:100). Their attention to the environment during their formative years and their present state of environmental legislative development attest to their continued emphasis on the environment.

In addition to attempting to demonstrate the relationship between economic growth and environmental awareness, Chapter 3 illustrated the results attainable by the

Korean government when it decides to focus its attention on a specific area. For roughly three decades, the ROK political machine had one primary goal: assure South Korea's lasting sovereignty based on a strong economic foundation. To a large extent, the ROK government has accomplished their original goal, and is now redirecting its energies in other areas, including the protection and preservation of the environment not only on a national scale, but on a global scale as well (see Appendix 5-2).

This emphasis on Korean environmental awareness and development was included because of the exceptional weight Congressional and DoD policy makers place on this issue when formulating remediation policy. If DoD policy makers and Congressional leaders doubt Korea's commitment to the environment, they only need look at their economic track record and compare it to Korea's environmental track record within the last ten years.

4. Funding *(Concurrent Finding).*

Although not an "established" influence on remediation policy, funding certainly affects USFK's ability to execute any policy promulgated by DoD. In a roundabout way, funding actually influences remediation policy for Korea, since even the most protective policy, cognizant of human health risks and damage to the environment, is not viable if it does not account for economic realities. An overly-protective policy could incur tremendous resource deficits and result in non-compliance. An under-protective policy would compromise human health. Therefore, a balance must be struck somewhere in the middle.

To this point, DoD has left the determination of where the "over/under" protective line should be drawn to USFK. USFK, in turn, has delegated that authority to the installations. And the installations, already strapped for resources and with little say in their overall budget, have nowhere to turn. This was the overwhelming response received when installation personnel were asked to characterize the remediation program at their installation.

A partial solution to the funding dilemma was offered earlier—have Korea pay for remediation of contaminated sites resulting from ROK-funded construction projects. One could certainly make a strong case for such a policy, since these projects are managed, from design to construction completion, by the MND. Contamination of soil and groundwater due exclusively to poor design (absence of pollution and/or contamination control devices such as secondary containment of underground fuel storage tanks) and/or poor construction techniques (faulty fuel pipeline welding) should not be the responsibility of USFK organizations, since USFK engineers had little say in either design or construction.

A more fundamental approach, which attacks funding at the Congressional level and is achievable within the DoD organization, will be offered in the next chapter.

F. Shortcomings In Research Techniques

Several shortcomings in each technique employed in this thesis became evident during the research. To conceal these shortcomings would only hurt the credibility of the overall study and make future research in this area all the more difficult. Hence, a short discussion of difficulties encountered follows.

1. Literature Review. A tremendous amount of information was obtained from a variety of sources—academic journal articles, site investigations/assessments, official correspondence, government white papers and studies, and legal documents, to name a few. However, the majority of information came from U.S. sources. These sources provided a detailed, in-depth picture of issues surrounding remediation policy formulation as understood by U.S. policy makers. A better understanding of the Korean environmental program would have been possible if a wider variety and larger number of Korean sources were canvassed.

The language barrier proved to be the most significant barrier in obtaining and *comprehending* Korean sources. In many cases, full-text ROK law documents, such as the Soil Preservation Act and Drinking Water Management Act, and interpretive documents were available to researchers, but printed in the Korean language (Hangul). Other documents, including the 1997-1998 MND White Paper, details of major ROK environmental laws, and commentary from MOE officials and NGOs have recently been released in Korean on the Internet, and would have added to this thesis if not for the language barrier.

Previous research looking at Korean government documents evaluating environmental conditions have shown the accuracy of the measurements reported and the methodologies on which they are based to be widely suspect (59:7, 21). While numerous Korean government documents were used in this thesis, environmental data and statistics were used exclusively for establishing trends rather than establishing fact.

2. Personal Interviews and Field Observations. While the researchers were successful in questioning the intended groups, conducting field observations, and obtaining useful information from both activities, a few problems were encountered:

a. Some of the intended interviewees were not available to participate in the interview process. These included the 7th Air Force Civil Engineer and his staff; and the Environmental Division Chief and the staff at Headquarters U.S. Air Force.

(1) 7th Air Force Civil Engineer: At the time of the site visit, the 7th Air Force Civil Engineer (7 AF/CE) and two-thirds of his staff were being replaced with newly-arrived personnel. However, in a short discussion with the incoming 7 AF/CE, he pointed out that his office did not historically concern itself with environmental issues. Policy flowed from Headquarters USFK directly to the Air Force installations in Korea with little or no direction from 7 AF/CE. As such, he and his staff could not contribute any information to the study. The 7AF/CE staff is slated to receive an additional officer, dedicated specifically to environmental issues at Air Force installations and collocated operating bases in Korea; however, the slot will not be filled until fiscal year 1998 at the earliest (130).

(2) Environmental Division, Headquarters U.S. Air Force. As was the case with the 7 AF/CE, the Environmental Division chief and the individual on the headquarters staff with responsibility for international environmental policy were not available for questioning. However, the former Environmental Division Chief served as a very capable and knowledgeable surrogate.

b. All questions devised for the Korean interviewees could not be asked, either due to time constraints or language barriers. The information gleaned, however, still proved exceptionally useful for substantiating findings from the literature review, and in manifesting "interview-unique" items not found in historical documents, nor known by their DoD counterparts.

c. The site visit at Osan Air Base was shortened during one of the two days available for interviews/field observations because of a base-wide operational exercise. Despite the unexpected event, the majority of interviews and a tour of possible hazardous waste sites, led by the Deputy Chief, Environmental Flight, were completed prior to the exercise. Staff members provided additional documentation and answers to remaining interview questions via electronic mail (e-mail) correspondence. The only negative effect felt from the exercise dealt with the inability to complete more extensive field observations at Osan Air Base.

d. Site visits to the three Army installations and two Air Force installations proved too short to accomplish substantial field observations to confirm interviewee testimony and literature findings, and to uncover findings unique to the visit itself (not duplicated with findings from interviews and literature). Although the purpose of the visit was not to conduct in-depth site characterizations such as those required in the United States for compliance with CERCLA mandates, more time at each installation could have exposed more evidence of possible contaminated sites. For example, the 240th Civil Engineer Flight, Buckley Air National Guard Base conducted an independent site visit of Osan Air Base between 31 August and 12 September 1997, for the purpose of producing an Environmental Restoration Management Action Plan. The four-person team contacted approximately 50 personnel, reviewed historical documents and conducted extensive tours of the installation during the 13-day period. Their draft report concluded that 42 possible restoration sites existed on Osan, significantly more than this thesis originally discovered prior to the Buckley site visit.

e. Field observations and interviews should have been arranged with ROK military units collocated on DoD installations and collocated operating bases. Field observations at Kunsan Air Base supported possible poor environmental management practices by the ROKAF unit stationed there, which may have already led to soil or soil/groundwater contamination on Kunsan Air Base. The difficulty of pinpointing sources of contamination once a spill has occurred, especially for DNAPLs, could lead to contentious debate between DoD and ROK officials should remediation of such sites be required in the future. Investigation of collocated operating bases COBs gains even more importance when considering that:

(1) ROK units "host" DoD functions at these locations, although certain areas and facilities are still operated and maintained by DoD. According to DODI 4715.8, DoD has responsibility to remediate contaminated sites located on "DoD facilities. . . including DoD activities on host-nation installations..." (39:3).

(2) DoD units retained responsibility for operating and maintaining facilities and areas on the COBs for many years prior to their return to the ROK. ROK units now conduct flying operations from the same locations as DoD had done in the recent past, using similar hazardous materials as DoD units employed. Determining the

source and liable party of possible contaminated sites may prove more and more difficult as the years pass.

f. Additional interviews should have been scheduled with DoD personnel at the Pentagon, such as with representatives of individual service components responsible for overseas base closure and technology transfer. Their input may have provided valuable insight.

Despite these shortcomings, information gathered from personal interviews and field observations served the purpose of validating many of the findings from literature as well as providing valuable insight into the DoD hazardous waste site remediation policy decision process, Korean environmental program, and the state-of-the-art in remediation technology available in Korea.

VI. CONCLUSIONS

This thesis effort represents the largest (and only) collection of information on hazardous waste sites on DoD installations in Korea, with particular emphasis on those factors which influence the promulgation of remediation policy. Figure 10 illustrates the major factors influencing remediation policy in Korea. Appendix 5-1 lists the major findings of the thesis.

As both Figure 10 and Appendix 5-1 depict, the primary factors affecting promulgation of effective hazardous waste site remediation policy for DoD installations in Korea are:

- Risk to human health;
- Congressional support for remedial actions overseas;
- Cleanup precedents set in other foreign countries;
- The Korean public's perception of DoD with regard to environmental stewardship;
- Korean environmental law and effectiveness of enforcement; and,
- The effect of hazardous waste sites on wartime capabilities.

This thesis does not quantify the magnitude of influence associated with each factor relative to others; it simply identifies those factors which consistently surfaced during a search of historical literature, personal interviews, and field observations of both the DoD

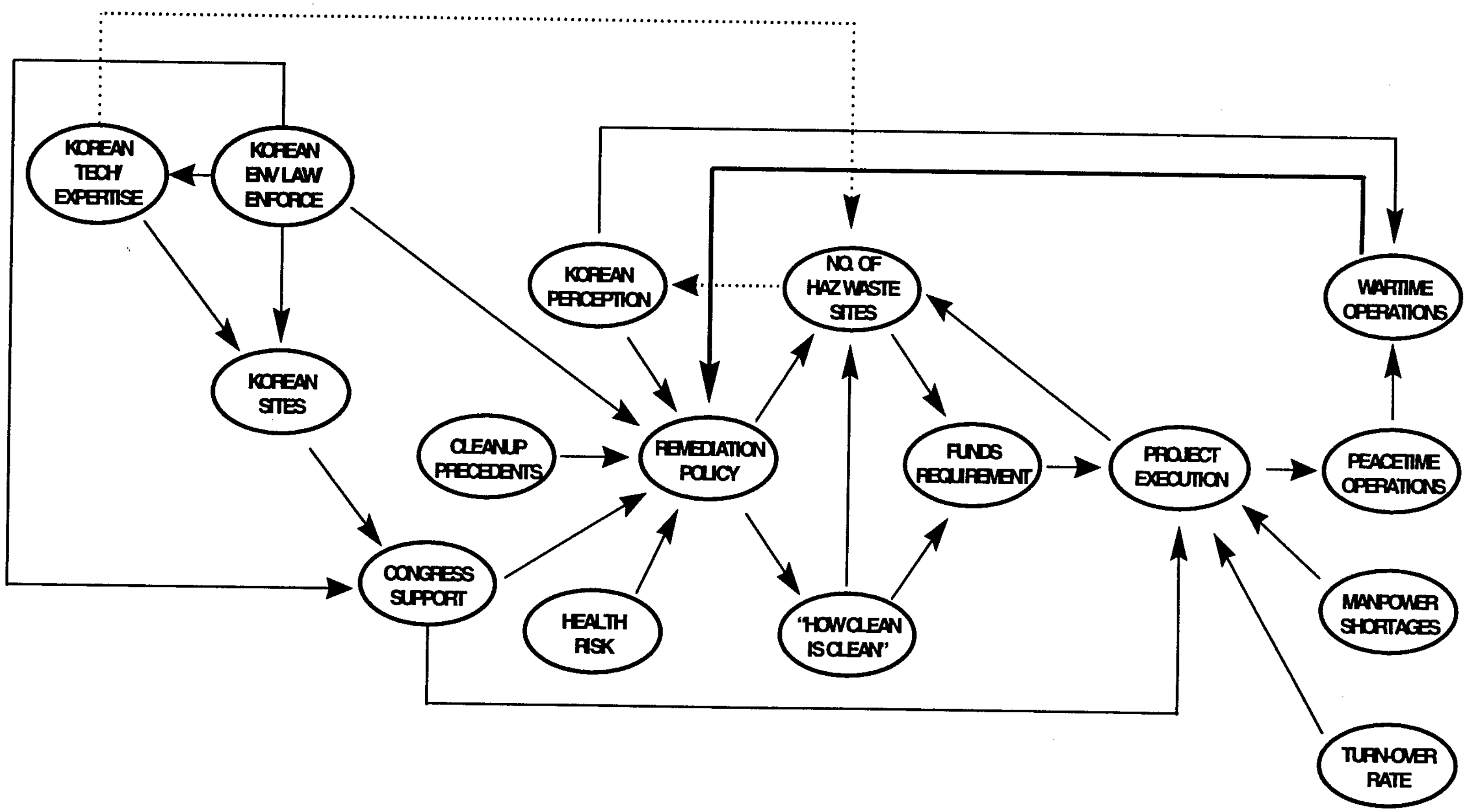

Figure 9: DoD Hazardous Waste Site Remediation Issues in Korea Relationship Diagram

(Line types added to distinguish paths of influence only; no other significance intended) and ROK communities. It is up to policy making organizations, such as DUSD(ES) and USFK, to take the information provided and apply the findings as necessary for supporting national policy objectives and mission goals.

USFK shoulders the responsibility of developing environmental governing standards based on the unique requirements of Korean environmental law balanced with mission-specific operational requirements and the OEBGD (40:3). USFK has met this requirement in nearly all aspects of environmental concern, except for providing clear guidance on remedial action of contaminated sites due to past and current DoD operations. The absence of a specific definition of "imminent and substantial endangerment" opens the door to considerable interpretation of remediation policy, which could result in wasted resources and diverse environmental conditions at installations throughout the peninsula.

Although resources for accomplishing remedial action are sourced from service-specific budgets (the Air Force funds cleanup at Air Force installations, Army funds cleanup at Army installations, etc.), misalignment of funds due to differing opinions regarding remediation among service heads may result in overall degradation of *joint* warfighting capability in Korea—a USFK responsibility. Individual services, or installation commanders for that matter, may expend funds toward cleaning up a site beyond what is truly necessary to support the mission (taking away resources from other priority projects), or allow serious degradation of the environment to a point which could affect contingency operations (i.e., groundwater well contamination at several MOBs and the COBs). The lack of personnel continuity and experience, owing to a one-year remote assignment for the majority of personnel assigned to installations in Korea, will likely continue leading to military members making important environmental decisions with little or no training or experience.

Differing budget and manpower strategies among the different services also affect the decision-making process of individual service commanders. For example, Kunsan Air Base, which supports 3 million square feet of facility space, has eight personnel assigned to their environmental staff and manages an annual budget over $3 million (FY97 figures) (7). EUSA, with a total of 82 installations spread throughout the peninsula and responsibility for supporting nearly 26 million square feet of facility space, has a combined total of 42 personnel assigned to environmental functions at the headquarters and installation-level, and manages an annual environmental budget of about $16 million (89). Per square foot, EUSA spends forty percent less in the environmental arena than one Air Force base, and averages less than one environmental person assigned per installation. Although desolate training areas and remote posts make up a large percentage of EUSA's installations, Camp Carroll, which houses EUSA's depot-level vehicle and heavy equipment maintenance activity and the Army's logistics center for the entire peninsula, has only one person assigned to environmental duties.

This review of factors affecting environmental policy in Korea highlights a possible weakness in the existing DoD remediation policy, namely the absence of a definitive, clearly-stated standard governing identification and restoration of contaminated sites. USFK has taken steps toward establishing firm guidance. However, the current guidance does not mention a critical aspect in remedial policy—determining the risk tolerance associated with a contaminated site. Without knowing the point at which the risk of either (1) acute illness or long-term disease caused by hazardous substances in the subsurface; or (2) future liability due to unsatisfactory past cleanup practices becomes unacceptable to decision-makers, installations and commanders cannot decide when to undertake remedial action, nor when to stop remedial action once begun.

Given these limitations and the possibility of significant mission degradation, more research in this area should be undertaken to clearly understand the ramifications of DoD hazardous waste site remediation policy for South Korea.

1. Optimization of Remediation Policy. This thesis put forward a number of issues affecting remediation policy for Korea; however, no "weights", or priorities were assigned. Starting with the results of this thesis, future research could estimate the relative values policy makers would assign to each factor relative to the others; apply decision analysis and optimization techniques, and compare findings with the current policy to determine how well it compares to the "optimal" policy. Political considerations, national security objectives and priorities, and budgetary constraints all play a large role in establishing international policy. Such considerations must be duly recognized and incorporated into the decision-making process prior to establishing comprehensive remediation guidance for DoD organizations operating in Korea.

2. Country Comparisons. Cleanup precedents in other foreign countries were mentioned in this research as a potential factor influencing remediation policy for Korea. A limited examination of remedial action undertaken in Germany and Canada was accomplished as part of this thesis. However, additional study could be accomplished to

increase comprehension of the legal aspects which affected cleanup liabilities in other foreign countries and determine the extent to which these aspects may affect cleanup policy for Korea.

As demonstrated in this thesis, the environmental awareness of Korea also influenced overseas remediation policy. Hence, a technique to measure the current level of awareness and forecast the rate of growth (or decline) in awareness would aid decision makers in developing effective remediation policy. An investigation of the effects of cultural, political, diplomatic, and other country-unique factors on environmental awareness in other foreign countries, such as Germany (where more empirical data presumably exists) could be accomplished. The results could then be used to develop a model for application in Korea and other countries of interest.

3. Site Characterization and Cost Model Development. Since the scope of contamination at identified hazardous waste sites is unknown, the scope and method of remedial action is unknown. What may seem like an overwhelming and expensive task at first glance may actually be trivial once sites are properly characterized. The prevalent hydrogeology may adequately contain contaminants, reducing and/or eliminating health risk pathways. Microbiological processes may allow natural attenuation to occur, destroying contaminants prior to contacting receptors on or off-base. As highlighted earlier, the lack of in-depth, scientific site assessments at DoD installations makes gauging the severity of the problem extremely difficult. Hence, baseline environmental assessments at all DoD installations should be a top priority for DoD decision-makers prior to considering any remedial action. The Air Force has begun the process by

accomplishing a restoration management action plan at Osan Air Base, followed by a similar process for Kunsan Air Base (174). The plan results from several weeks of intensive interviews, data gathering, and site investigations, and proposes a plan of attack to determine the scope of the remediation problem on the installation (174). Similar studies, at the least, should be planned for other USFK installations.

Related to site characterizations is development of a cost model to estimate cleanup costs for USFK installations based on DoD experience in the United States. The research should primarily focus on two aspects:

- Determination of the most critical hydrogeologic, contaminant, human health risk, and other variables affecting cleanup cost, limiting the number of variables to simplify the model and reduce the costs associated with site-specific data gathering. Examples of such variables include soil type, hydraulic conductivity, sorption coefficient, contaminant type, concentration, and decay rate, receptor populations, contaminant pathways, and future land use (see (73) for a comprehensive discussion of the value of geological, hydrological, and contaminant parameters necessary to characterize a site).
- Application of the model to specific DoD installations in South Korea.

Results from the model would clarify economic issues associated with remediation policy for Korea and aid DUSD(ES), USFK, and Pacific Air Force policy makers in mapping out a future requirements strategy to match cleanup policy.

4. Development of a Cleanup Requirements Strategy and Plan. As mentioned earlier, the organizational structure in Korea makes joint planning, programming, and

budgeting of restoration requirements extremely difficult. The result is "stove-piped" approaches to not only the Korean remediation program, but all overseas remediation programs. Several top-level DoD policy makers offered suggestions for solving the problem, which focused on:

- Creating a requirements strategy (determining the appropriate human and/or ecological health-based risk tolerable for contaminated sites in Korea);
- Collecting requirements (accomplish site surveys at each USFK installation);
- Populate relational database with requirements and available "solutions" (create database of project estimates);
- Apply all solutions to a decision model (prioritize requirements based on decision analysis model as mentioned previously); and,
- Publish a strategic plan, which USFK could use to advocate for resources (in reality, each service may have to advocate for their own resources if funding procedures remain unchanged)

This process for developing a sound investment strategy, which fulfills the funds requirement portion of the relationship diagram in Figure 9, depends critically upon the ability to precisely identify contaminated sites and accurately estimate remediation costs. As mentioned in Chapter 4, the DoD environmental restoration program in the United States (at least the Air Force's program) has been plagued by poor estimates and ever-changing priorities. The result has cast serious Congressional doubt on the validity of the restoration program. As stated by one top-level DoD decision maker, "the future of the entire restoration program depends on the fidelity of project estimates."

To this point, conclusions have focused on weaknesses in the DoD environmental restoration program in Korea; however, an unpredictable Korean future may also affect DoD remediation policy. Although the ROK government has shown signs of their heightened environmental awareness, continued growth in this arena is speculative at best. Korean political history has been characterized by periods of instability and centralized control. With the upcoming presidential elections in December 1997, and the specter of reunification with a poverty-stricken, economically-devastated North Korea looming in the future, sustained emphasis on environmental issues is questionable. On the other hand, remedial issues may come to the forefront should reunification occur, especially given the environmental conditions suspected in North Korea. Articles in Korean newspapers have already compared suspected environmental conditions in North Korea with the West/East German experience at the end of the Cold War. An article in the 5 May 1997 edition of the Chosun Ilbo, a daily Korean newspaper stated:

> We can learn from Germany's experience in cases where the Russian military was based on East German installations. The expenses associated with cleaning up these bases were of the highest category [expense] when compared with other unification expenses. Our government must be generous about investing funds to improve the environmental welfare of our military facilities. Also, we need to pay attention to management of environmental protection and conservation on U.S. military bases. Our government needs to work together with the U.S. . . . (66)

Regardless of the political and scientific uncertainties, proper environmental stewardship should continue to be the rule for DoD organizations in Korea. Recall the quote in Chapter 1 from Ms. Wasserman Goodman (DUSD(ES)):

> We should realize [that] the growing public awareness [of the environment] in Korea will influence our bilateral relationship. Maintaining access to land . . . means we will have to demonstrate integrity in our management of Korea's natural resources. They will look to us as a model. (169)

In particular, the issue of hazardous waste site remediation, which has played such a significant role in the American public's perception of DoD as a steward of public lands in the U.S., is likely to be viewed as important by the citizens of Korea. Therefore, in addition to the negative health effects which contaminated sites may have on personnel, DoD quiescence with regard to hazardous waste sites on DoD installations in Korea may also result in negative perceptions within the Korean populace. These negative perceptions, in turn, can easily lead to loss of access to our Korean base of operations. This is a scenario we can ill afford if we wish to continue maintaining a strong military presence in the East Asian theater, a requirement vital to fulfilling U.S. strategic security interests.

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Vita

Captain Edwin H. Oshiba was born on [redacted] in [redacted]. He graduated from Waiakea High School in 1984 and entered undergraduate studies at Santa Clara University in Santa Clara, California. He graduated with a Bachelor of Science degree in Electrical Engineering in June 1988, and received his commission on 30 June 1988, through the Air Force Reserve Officer Training Corps.

Captain Oshiba's first assignment was to the 96th Civil Engineer Squadron, Dyess AFB, Texas, as the Chief of Readiness. He also served as an Electrical Design Engineer, and deployed in support of Operation DESERT STORM as the Deputy Base Civil Engineer. Since his first assignment, Captain Oshiba has served in a variety of positions, including Chief of Contract Management and Chief of Engineering at Kunsan Air Base, South Korea, and Command Unaccompanied Housing Manager and Executive Officer to The Civil Engineer at Air Force Space Command. He received his regular commission in November 1995 and graduated from Squadron Officer School in February 1996. In May 1996, he entered the Graduate School of Engineering, Air Force Institute of Technology.

Upon graduation, Captain Oshiba will be assigned to the 1st Civil Engineer Squadron, Langley Air Force Base, Virginia.

Permanent Address: [redacted]

SINGLE

END

APPENDIX 1-1: Inventory of U.S. Installations in Korea (89)

U.S. Army Installations				
Installation	**Major Function**	**Acres**	**Sq Km**	**Government Cost**
Camp Stanton	ADA Battalion	68	0.28	$7,838,200
Camp Gray Annex	Administrative Offices	2	0.01	$289,900
Far East District, COE	Administrative Offices	11	0.04	$2,547,700
Beason	AFKN Signal Site	4	0.02	$599,800
Brooklyn	AFKN Signal Site	34	0.14	$328,600
Charlie Block	AFKN Signal Site	7	0.03	$232,900
Dart Board	AFKN Signal Site	10	0.04	$606,100
High Point	AFKN Signal Site	11	0.04	$217,300
Morse	AFKN Signal Site	7	0.03	$408,300
Richmond	AFKN Signal Site	14	0.06	$311,600
Salem	AFKN Signal Site	11	0.04	$509,500
Tacoma	AFKN Signal Site	8	0.03	$293,800
Camp Humphreys	Airfield/Troop Support	1,249	5.05	$81,690,800
Camp Kwang Sang-Ri	Ammunition	31	0.13	$49,000
Camp Ames	Ammunition Storage	20	0.08	$976,800
Camp Essayons	Artillery Battalion	77	0.31	$14,989,200
Camp Pelham	Artillery Battalion/Brigade Company	77	0.31	$23,075,800
Camp Stanley	Artillery/Aviation Battalion	567	2.29	$56,141,400
Alamo ASA	ASA Site	8	0.03	$657,800
Kamaksan ASA	ASA Site	48	0.19	$687,000
Koryosan ASA	ASA Site	11	0.04	$419,600
Hwaaksan Evenreach	ATC Site	2	0.01	$848,200
Papyongsan	ATC Site	0	0.00	$139,600
K-16 Airfield	Aviation and Maintenance	202	0.82	$17,093,000
Camp Eagle	Aviation Battalion	77	0.31	$14,066,200
Camp LaGuardia	Aviation Battalion	34	0.14	$8,596,300
Camp Page	Aviation Battalion	471	1.91	$42,438,500
Camp Edwards	Brigade Support Area	83	0.34	$12,713,500
Command Post Tango	Command Post	241	0.98	$8,495,200
Camp Carroll	Depot	679	2.75	$65,685,000
Masan Ammo Depot	Depot	1,059	4.29	$1,215,400
Camp Red Cloud	Division HQ	207	0.84	$37,006,900
DMZ South Half	DMZ Guard Post	0	0.00	$1,459,800
Camp Castle	Engineer Battalion	51	0.21	$8,651,400
Camp Nimble	Engineer Company	14	0.06	$5,344,800
Camp Falling Water	Facility Engineer	59	0.24	$2,464,200
Camp Giant	Faciltiy Engineer	42	0.17	$5,780,900
Niblo Barracks	Family Housing	7	0.03	$1,012,400
Camp Yongin	Field Army Support	8	0.03	$2,734,500
H-220 Heliport	Heliport	52	0.21	$8,496,400
Yongsan Garrison	HQ USFK/EUSA	714	2.89	$105,044,100
Camp Greaves	Infantry Battalion	59	0.24	$15,592,000

U.S. Army Installations (Continued)				
Installation	**Major Function**	**Acres**	**Sq Km**	**Government Cost**
Camp Casey	Infantry Brigade	3,496	14.15	$125,395,300
Camp Hovey	Infantry Brigade	3,928	15.90	$50,349,900
Camp Howze	Infantry Brigade HQ	156	0.63	$25,295,300
Camp Liberty Bell	Infantry Company	17	0.07	$5,301,500
Freedom Bridge	Infantry Platoon	14	0.06	$210,200
Kimpo Mail Terminal	Mail Terminal	3	0.01	$13,000
Camp Sears	Maintenance Company	32	0.13	$5,297,500
Camp Kyle	Maintenance Company/TISA	36	0.15	$8,644,800
Chang Sang	Microwave Site	23	0.09	$661,600
Camp Jackson	NCO Academy	953	3.86	$8,119,800
Swiss-Swede	Neutral Nation	0	0.00	$1,153,200
Camp Libby	POL Terminal	1	0.00	$45,600
Kunsan POL	POL Terminal	16	0.06	$3,237,000
EUSA Retreat Center	Recreation	5	0.02	$265,300
Sungnam Golf Course	Recreation	230	0.93	$0
K-9 Airfield	RS&O Facility	5	0.02	$72,400
Camp Colbern	Signal Battalion	76	0.31	$6,109,600
Concord	Signal Site	3	0.01	$243,000
Madison	Signal Site	21	0.08	$277,700
Shinbuk Relay	Signal Site	13	0.05	$556,500
Camp Market	Storage	119	0.48	$6,280,100
Pusan Storage Facility	Storage	65	0.26	$13,457,400
Taegu Storage Facility	Storage	2	0.01	$104,000
Camp Hialeah	Support Installation	135	0.55	$20,554,900
Camp Long	Support Installation	85	0.34	$10,935,500
Camp Walker	Support Installation	192	0.78	$41,425,600
Camp Henry	TAACOM HQ	59	0.24	$21,543,800
Pier #8	Terminal	10	0.04	$1,096,200
Chejudo Training Facility	Training	48	0.19	$1,065,900
Bayonet Training Site	Training Area	1,003	4.06	$0
Bull's Eye #1	Training Area	21,177	85.70	$4,723,000
Bull's Eye #2	Training Area	1,391	5.63	$0
Gimbols	Training Area	7,486	30.30	$0
Gun Training Area	Training Area	219	0.89	$0
Mobile	Training Area	2,761	11.17	$0
Pyongtaek CPX	Training Area	90	0.36	$481,900
Watkins Range	Training Area	45	0.18	$0
Yongpyong	Training Range	3,211	12.99	$7,556,700
Camp Bonifas	UNC Security Force HQ	36	0.15	$8,933,800
Joint Security HQ	UNCMAC	0	0.00	$1,334,800
Army Subtotal:		***53,498***	***216.51***	***$938,492,200***

US Navy Installations				
Installation	**Major Function**	**Acres**	**Sq Km**	**Government Cost**
Chinhae	USN FLTACT HQ	76	0.31	$7,240,200
Pohang Depot	USMC Training Center	1	0.00	$386,850
Navy Subtotal:		***77***	***0.31***	***$7,627,050***
US Air Force Installations				
Osan Air Base	Airbase (MOB)	1,780	7.20	$252,477,784
Kunsan Air Base	Airbase (MOB)	2,549	10.32	$173,438,755
Suwon Air Base	COB	32	0.13	$16,631,078
Taegu Air Base	COB	752	3.04	$22,764,241
Kwangju Air Base	COB	316	1.28	$33,673,974
Kimhae Storage Facility	COB	86	0.35	$10,089,780
Pil-Sung Air Range	Training Area	28	0.11	$739,896
Sachon Storage Facility	Storage	3	0.01	$226,616
Kooni Air Range	Training Area	439	1.78	$437,348
Osan-Ni Ammo Storage	Ammunition Storage	604	2.44	$740,967
Chongju Air Base	COB	4	0.02	$37,489
Choejong-San	Satellite Tracking	42	0.17	$2,435,277
Wonju Air Station	Seismic Monitor	93	0.38	$1,846,845
Seoul House	Restaurant	1	0.00	$7,463
Radio Beacon Site	Signal Site	1	0.00	$0
Air Force Subtotal:		***6,730***	***27.24***	***$515,547,513***
USFK Total:		***60,305***	***244.05***	***$1,461,666,763***

Notes:

1. MOB: Main Operating Base
2. COB: Collocated Operating Base. The installation is operated and maintained by the ROK Air Force in peacetime; during contingencies, U.S. Air Force assets arrive and the installation comes under operational control of USFK. DoD supports some limited construction and maintenance and repair.

APPENDIX 1-2: Terms Explained

AF: Air Force (United States).

ARAR: Applicable or Relevant and Appropriate Requirements. 42 U.S.C § 9621(d)(2)(a) defines ARARs as:

1. Any standard, requirement, criteria, or limitation under any federal environmental law; and,
2. Any promulgated standard, requirement, criteria, or limitation under a state environmental or facility siting law that is more stringent than any federal standard. (96:238)

Aquifer: An underground geological formation, or group of formations, containing usable amounts of ground water that can supply wells and springs.

Ash: The mineral content of a product remaining after complete combustion.

Attenuation: The process by which a compound is reduced in concentration over time, through absorption, adsorption, degradation, dilution, and/or transformation.

Biological Treatment: A treatment technology using bacteria to consume organic waste.

Bioremediation: Use of living organisms to clean up oil spills or remove other pollutants from soil, water, or wastewater.

BOD_5: Five-day biochemical oxygen demand test. The BOD_5 measures the total amount of oxygen consumed by microorganisms during the first five days of biodegradation in a 300 mL bottle. The test is conducted under controlled conditions—complete darkness, stoppered bottle to keep air from replenishing dissolved oxygen removed by biodegradation, and a fixed temperature of 20 degrees Celcius (102:118).

CDIP: Combined Defense Improvements Program. A ROK burdensharing program which builds facilities which directly support the warfighting mission for USFK forces. The design and construction CDIP projects are under the complete control of MND.

Cleanup: Actions taken to deal with a release or threat of release of a hazardous substance that could affect humans and/or the environment. The term "cleanup" is sometimes used interchangeably with the terms remedial action, removal action, response action, or corrective action.

COE: Corps of Engineers. In this text, COE normally refers to the Far East District COE. They are responsible for providing technical engineering support (design, construction management, and environmental services) for DoD organizations in South Korea.

Commercial Waste: All solid waste emanating from business establishments such as stores, markets, office buildings, restaurants, shopping centers, and theaters.

Construction and Demolition Waste: Waste building materials, dredging materials, tree stumps, and rubble resulting from construction, remodeling, repair, and demolition of homes, commercial buildings and other structures and pavements. May contain lead, asbestos, or other hazardous substances.

Contaminant: Any physical, chemical, biological, or radiological substance or matter having an adverse effect on air, water, or soil.

Contamination: Introduction into water, air, and soil, of microorganisms, chemicals, toxic substances, wastes, or waste water in a concentration making the medium unfit for its next intended use. Also applies to surfaces of objects, buildings, and various household and agricultural use products.

DERP: Defense Environmental Restoration Program. The DERP, codified in 10 USC 2701 through 2708, describes the DoD restoration program, and is similar to the Superfund in that it provides funds necessary to accomplish cleanup at DoD installations in the United States and mandates use of a relative risk assessment model to prioritize and rank health risks associated with hazardous waste sites.

Disposal: Final placement or destruction of toxic, radioactive, or other wastes; suplus or banned pesticides or other chemicals; polluted soils; and drums containing hazardous material from removal actions or accidental releases. Disposal may be accomplished through use of approved secure landfills, surface impoundments, land farming, deep-well injection, ocean dumping, or incineration.

DoD: Department of Defense.

DODD: Department of Defense Directive. DoD document which provides binding policy for Defense Department organizations.

DODI: Department of Defense Instruction. DoD document which outlines guidance for Defense Department organizations. Generally, DODIs provide specific instructions which, if followed, fulfill DoD policy stated in DODDs, OSD policy memorandums, executive orders, and U.S. law.

Dump: A site used to dispose of solid waste without environmental controls.

DUSD(ES): Deputy Undersecretary of Defense for Environmental Security. The principle environmental policy-making organization within DoD.

ECAMP: Environmental Compliance and Management Program. An Air Force program to measure compliance with environmental policy and regulations, and determine the overall health of the environmental management program at a specific installation.

ECAS: Environmental Compliance Assessment System. Army equivalent of ECAMP.

EPO: USFK Environmental Programs Office.

EUSA: Eighth United States Army

FED: Far East District, Corps of Engineers. This regional office has responsibility for all Corps of Engineers endeavors in South Korea.

FGS: Final Governing Standards. A combination of host-nation environmental standards and the OEBGD applicable DoD operations in a specific foreign country. The FGS should adopt the most stringent of host-nation and OEBGD standards, considering political, economic, and technical factors.

Filling: Depositing dirt, mud, or other materials into aquatic areas to create more dry land, usually for agricultural or commercial development, often with ruinous ecological consequences. Also known as land reclamation.

Garbage: Animal and vegetable waste resulting from the handling, storage, sale, preparation, cooking, and serving of foods.

Generator: 1. A facility or mobile source emitting pollutants into the air or releasing hazardous waste into water or soil. 2. Any person, by site, whose act or process produces related medical waste or whose act first causes such waste to become subject to regulation.

Groundwater: The supply of fresh water found beneath the Earth's surface, usually in aquifers, which supply wells and springs.

Ground-Water Discharge: Ground water entering near coastal waters which has been contaminated by landfill leachate, deep well injection of hazardous wastes, septic tanks, etc.

Hazardous Waste: By-products of society that can pose a substantial or potential hazard to human health or the environment when improperly managed. Possesses at least one of four characteristics (ignitability, corrosivity, reactivity, or toxicity), or appears on special EPA lists.

Hazardous Waste Landfill: An excavated or engineered site where hazardous waste is deposited and covered.

Household Waste (Domestic Waste): Solid waste, composed of garbage and rubbish, which normally originated in a private home or apartment house. Domestic waste may contain a significant amount of toxic or hazardous waste.

Immediately Dangerous to Life and Health (IDLH): The maximum level to which a healthy individual can be exposed to a chemical for 30 minutes and escape without suffering irreversible health effects or impairing symptoms.

Incineration: A treatment technology involving destruction of waste by controlled burning at high temperatures, e.g., burning sludge to remove the water and reduce the remaining residues to a safe, nonOburnable ash that can be disposed of safely on land, in some waters, or in underground locations.

Incinerator: A furnace for burning waste under controlled conditions.

Industrial Waste: Unwanted materials from an industrial operation; may be liquid, sludge, solid, or hazardous waste.

Infectious Waste: Hazardous waste with infectious characteristics, including contaminated animal waste, human blood and blood products, isolation waste, pathological waste, and discarded sharps (needles, scalpels, or broken medical instruments).

Irreversible Effect: Effect characterized by the inability of the body to partially or fully repair injury caused by a toxic agent.

Landfills: 1. Sanitary landfills are disposal sites for non-hazardous solid wastes spread in layers, compacted to the smallest practical volume, and covered by material applied at the end of each operating day. 2. Secure chemical landfills are disposal sites for hazardous waste, selected and designed to minimize the chance of release of hazardous substances into the environment.

Leachate: Water that collects contaminants as it trickles through wastes, pesticides, or fertilizers. Leaching may occur in farming areas, feedlots, and landfills, and may result in hazardous substances entering surface water, ground water, or soil.

Leaching: The process by which soluble constituents are dissolved and filtered through the soil by a percolating fluid.

MCL: Maximum Contaminant Level

Media: Specific environments—air, water, soil.

Mitigation: Measures taken to reduce adverse impacts on the environment.

MND: Ministry of National Defense, Republic of Korea. Equivalent to U.S. DoD.

MOE: Ministry of Environment, Republic of Korea. Equivalent to U.S. EPA.

Monitoring: Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, plants, and animals.

O&M: Operations and Maintenance (funds).

OSD: Office of the Secretary of Defense.

OEBGD: Overseas Environmental Baseline Guidance Document. Promulgated by DoD, the overseas environmental standards applies to all DoD operations overseas, including those with host-nation Final Governing Standards.

PAH: Polycyclic aromatic hydrocarbon. Multi-(benzene) ring structure, many of which are either suspected or known carcinogens or mutagens. Examples include naphthalene, anthracene, and phenanthrene.

POL: Petroleum, Oils and Lubricants.

Pollutant: Generally, any substance introduced into the environment that adversely affects the usefulness of a resource.

Pollution: Generally, the presence of matter or energy whose nature, location, or quantity produces undesired environmental effects.

Release: Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment of a hazardous or toxic chemical or extremely hazardous substance.

Remediation: Cleanup or other methods used to remove or contain a toxic spill or hazardous waste.

ROK: Republic of Korea

SVOC: Semi-volatile organic compound (see VOC). SVOCs are somewhat akin to VOCs, with a lower volatility point.

SOFA: Status of Forces Agreement between the U.S. and the host-nation. The SOFA outlines the "rules of engagement" for basing U.S. forces in a foreign country, and includes such provisions as jurisdiction over crimes, condition of facilities and land prior to return to the host-nation, claims for damage to off-installation property, and use of commercially-available utility services. In most cases, "SOFA" as used in the thesis refers to the U.S./ROK SOFA.

Solid Waste: Non-liquid, non-soluble materials ranging from municipal garbage to industrial wastes containing complex and sometimes hazardous substances. Solid wastes also include sewage sludge, agricultural refuse, demolition wastes, and mining residues. Technically, solid waste also refers to liquids and gases in containers.

Toxic Substance: A chemical or mixture that may present an unreasonable risk of injury to health or the environment.

Toxic Waste: A waste that can produce injury if inhaled, swallowed, or absorbed through the skin.

Treatment: 1. Any method, technique, or process designed to remove solids and/or pollutants from solid waste, waste streams, effluents, and air emissions. 2. Methods used to change the biological character or composition of any regulated medical waste so as to substantially reduce or eliminate its potential for causing disease.

U.S. EPA: United States Environmental Protection Agency

USFK: United States Forces Korea; the joint Army, Air Force, and Navy command structure overseeing DoD combat operations in South Korea.

VOC: Volatile organic compound. A class of contaminants most commonly found in groundwater. VOCs are often used as solvents in industrial processes, and a number of them are either known or suspected carcinogens or mutagens. Because of their volatility, VOCs are normally not found in high concentrations (ppb) in surface water; however, in groundwater, their concentration can be in orders of magnitude greater (102:116)

Waste: 1. Unwanted materials left over from a manufacturing process. 2. Refuse from places of human or animal habitation.

Won: Korean measure of currency. 780 won is approximately equal to US$1.00.

APPENDIX 2-1: Interview Questions

I. BASIC INFORMATION (Interviewees)

1.	NAME:		
2.	TITLE:		
3.	ORGANIZATION:		
4.	MAILING ADDRESS:		
5.	PHONE:		
6.	FAX:		
7.	E-MAIL ADDRESS:		
8.	TIME IN CURRENT POSITION:	YRS:	MO:
9a.	EXPERIENCE IN ENVIRONMENTAL CAREER FIELD	YRS:	MO:
9b.	List past experience in environmental career field, if applicable.	(Continue on attached sheet, if appropriate)	
10.	EDUCATIONAL LEVEL (List undergraduate and graduate degrees held. Example: "BS—Civil Engineering" "MS—Eng and Envr Management" "PhD—Envr Engineering"		
11.	AREA(S) OF ENVIRONMENTAL INTEREST		

I. CURRENT ENVIRONMENTAL POLICY ISSUES:

	Question	Korean Univ	MOE	MOD	US
1.	Of the various media (air, water, soil), which presents the greatest challenge and garners the highest priority today? Why?	√	√		
2.	Of the "four pillars" of environmental management—clean-up, compliance, conservation, and pollution prevention—which pillar would you say receives the greatest emphasis from the Korean government? Why? Which would you want to emphasize?	√	√	√	√
3.	If clean-up (of which hazardous waste site remediation is a subset) is not the highest priority, where does this issue rank among national environmental problems? (Answer should include a qualitative answer rather than a number ranking).	√	√	√	√
4.	How would you characterize the "health" of the environment in Korea as related to human hazards? Describe what you mean by "health".	√	√	√	√
5.	Do you believe current levels of hazardous wastes in the environment pose a serious health hazard to the general public? "Serious" health hazard is defined as causing greater than 1 death in 1,000 individuals. a. What hazardous waste poses the greatest risk to humans? b. If a hazardous waste does not pose the greatest risk to humans, what substance does?	√	√	√	
6.	How would you characterize the level of government enforcement within the hazardous waste arena? Choose among the percentage of polluters which are not punished for unauthorized release of hazardous wastes and provide a qualitative explanation for your answer. Very High (Less Than 10%) High (Less Than 20%) Mediocre (Less Than 30%) Below Average (Less Than 40%) Poor (Less Than 50%)	√	√	√	
7.	Do you believe environmental issues currently receive the "appropriate" level of support from the Korean government? Why or why not? "Support" is defined as political attention, as measured by the time spent by legislators on investigating and developing appropriate laws and policy for environmental protection	√	√	√	
7a.	In reference to the question above, do you believe the level of funding from the Korean government is sufficient to meet current environmental needs?	√	√	√	

	Question	Korean Univ	MOE	MOD	US
7b.	In reference to the question above, do you believe the level of enforcement is sufficient to meet environmental needs?	√	√	√	
7c.	In reference to the question above, do you believe polluters are adequately punished when found guilty for environmental "crimes"?	√	√	√	
8.	How would you characterize the level of environmental awareness among the general population? (Does preservation of the environment enter into everyday decisions?)	√	√	√	
9.	How would you characterize the level of environmental awareness among the business community? (Does preservation of the environment enter into business decisions?)	√	√	√	
10.	The current Status of Forces Agreement (SOFA) between the Korean government and US states, "The Government of the United States is not obliged, when it returns facilities and areas to the Government of the Republic of Korea on the expiration of this Agreement or at an earlier date, to restore the facilities and areas to the condition in which they were at the time they became available to the United States armed forces, or to compensate the Government of the Republic of Korea in lieu of such restoration." Do you believe this is fair? If not, what recommendation(s) for change would you make?	√	√	√	√
11.	Should US installations comply with US environmental regulation and policies in Korea? Why or why not?	√	√	√	√
11a.	Should US installations comply with Korean environmental law and neglect US law, regardless of which country's regulations are more stringent? Why or why not?	√	√	√	√
11b.	Should US installations comply with US environmental law and neglect US law, regardless of which country's regulations are more stringent? Why or why not?	√	√	√	√
11c.	Should the cost of remediation be considered in the decision process? Why or why not?	√	√	√	√
11d.	Would you feel application of US environmental law to DoD installations in Korea would infringe upon the sovereignty of South Korea? In other words, would application of US environmental law on DoD installations in Korea encroach on the authority of the Republic of Korea to implement its own decision on the matter?	√	√	√	√
11e.	Should future liability be considered in the decision process (the concept of "joint and several liability")? Why or why not? This may require explanation of the US CERCLA to Korean officials.	√	√	√	√
11f.	If the US decided to implement NEPA procedures to DoD installations in Korea, how would the Korean public react to the public hearing process? Favorably? Unfavorably? Not interested?	√	√	√	

	Question	Korean Univ	MOE	MOD	US
12.	Should the US remediate hazardous waste sites on DoD installations in Korea: a. If US forces were responsible for creating the hazard? b. If the site poses a long-term hazard to humans? c. If the site poses an acute hazard to humans? d. If the site poses no known hazard to humans (short-term or long-term), but may adversely affect the ecosystem?	√	√	√	√
13.	What role does local governments play in environmental regulation and policy? Describe the environmental management organization at the local government level.	√	√	√	
14.	Describe the environmental engineering academic program at the undergraduate level. At the graduate level.	√			
15.	Is there a manifest system for tracking hazardous wastes from inception to disposal (much like the RCRA manifest system in the United States)? If not, how do regulators know how much waste is being generated, and where the waste is being ultimately disposed?	√	√		
16.	What are the hazardous wastes of greatest concern in Korea?	√	√		
17.	Landfills: a. What items are specifically banned from landfills within Korea (obtain list)? b. What percentage of those wastes are domestic wastes? c. How many landfills are currently operating within Korea? Is this sufficient to process all land-fillable wastes within the country? d. Is there a licensing process for landfills? If so, describe the process. e. Are there separate landfills specifically designated for hazardous wastes? If so, what are the specifications for construction?	√	√		

	Question	Korean Univ	MOE	MOD	US
18.	Describe US responsibilities for environmental management at COBs, munitions storage areas, bombing ranges, communication sites, command and control centers (such as CP "Tango" and CP "Oscar"). Specifically, what are our environmental responsibilities (clean-up, compliance, conservation, pollution prevention)?			√	√
19.	Explain the funding procedure for environmental projects in Korea as it applies to: a. Military installations. b. Other government entities. Specifically, at what level does authority exist for approving projects? Is funding separately appropriated for environmental projects as opposed to combined within appropriations for acquisition of aircraft, purchasing of supplies, construction of facilities, or other categories? Describe the procedure for approving environmental projects. Are there specific approval limits based on cost of the project? If so, where does the authority lie?		√	√	
20.	Are there periodic environmental assessments conducted at Korean military installations? If so, describe the process. a. How often are the assessments conducted? b. Who conducts the assessments? c. What items are assessed?		√	√	
21.	Do Korean military installations comply with Korean environmental law, or are there separate less stringent, or more stringent regulations which specifically govern them? If so, are Korean military installations specifically exempt from certain, specific laws?		√	√	
22.	Is there a publicly-released document outlining the countries top polluters (such as the US Toxic Release Inventory)? If so, are Korean military installations obligated to report their releases on this list?	√	√	√	

	Question	Korean Univ	MOE	MOD	US
23.	Is there an environment impact assessment requirement in Korea? a. If so, describe the process. b. Is the process applicable to military projects? Are there specific funding limits which trigger the requirement, or must the process be accomplished for every project?	√	√	√	
24.	Within the Ministry of Defense (or ROKA, or ROKA, or ROKN), how much priority does environmental security enjoy when compared to other traditional missions (organize, equip, train)?		√	√	
25.	Are there environmental training classes available within the military? If so, at what level (technician, first-line supervisor, installation commander, etc.)? Please provide any documentation outlining the training provided to students.		√	√	
26.	Where are analyses conducted for environmental samples taken on DoD installations? If Korean laboratories are used for analyses, what quality control/quality assurance measures are applied? Please provide copies of QA/QC documents.				√
27.	Describe the relationship between DoD environmental management organizations at the headquarters (or staff level) and installations, and the Korean government (local and national).		√		√

II. PROJECTED ENVIRONMENTAL POLICY

	Question	Korean Univ	MOE	MOD	US
1.	Of the various media (air, water, soil), which presents the greatest challenge in the future? Why?	√	√		
2.	Of the "four pillars" of environmental management—clean-up, compliance, conservation, and pollution prevention—which pillar should receive the greatest emphasis from the Korean government in the future? Why? Which would you want to emphasize	√	√	√	
3.	Do you believe environmental policy and regulations in Korea will become more stringent in the future? a. In what areas (pollution prevention, conservation, compliance, clean-up) do you expect the most changes? b. Explain the kinds of changes you expect to occur.	√	√	√	
4.	If the United States decides to withdraw its forces from the Korean peninsula, should the United States be held liable for restoration of the land to pre-occupation conditions? Why or why not?	√	√	√	√
5.	In your opinion, do you think DoD Installations in Korea will have to comply with Korean environmental law (substantively) in the future? To what extent?	√	√	√	√
6.	Do you feel extending NEPA's procedures abroad would increase the number of lawsuits using NEPA as a vehicle to litigate over foreign relations and national defense policies?				√
7.	Do you feel such litigation, as well as implementing NEPA's procedural requirements, would disrupt U.S. relations with other countries and limit the President's ability to act with the kind of flexibility and dispatch often critical in the conduct of foreign affairs?				√
8.	Do you feel the litigation might also raise difficult constitutional questions of encroachment on the powers of the President?				√
9.	Would the Ministry of Defense approve environmental remediation projects as Host-Nation funded construction projects under CDIP (Combined Defense Initiative Program) or HNFC (Host-Nation Funded Construction)?			√	
10.	Would USFK be willing to support environmental projects funded under CDIP or HNFC? If the CDIP and HNFC budgets were adjusted to account for increased environmental spending?				√
11.	Would the Ministry of Defense be willing to support a joint US/ROK program to jointly fund environmental remediation projects at DoD installations?			√	

	Question	Korean Univ	MOE	MOD	US
12.	Would USFK be willing to support a joint US/ROK program to jointly fund environmental remediation projects at DoD installations?				√
13.	Would the Ministry of Defense be willing to support a joint US/ROK environmental assessment team to assess US and ROK installations?			√	
14.	Would USFK be willing to support a joint US/ROK environmental assessment team to assess US and ROK installations?				√
15.	Would you have some potential remediation projects should policy change concerning justification for remediation projects in Korea? What are some potential projects? What would the prevalent types of remediation problems encountered (fuel spills, chlorinated solvents, etc.)				√

	Question	Korean Univ	MOE	MOD	US
1.	What are the current remediation technologies employed in Korea? Which remediation technologies are most widely employed throughout the country?	√	√		
2.	Would you feel amiable toward technology transfer between the Korean and US governments? If so, under what conditions?	√	√		
3.	Do you know of any technology transfer agreements made between the Korean government and any entity within the United States (federal, state, or local government, or private organization)? If so, please provide the details of the agreement.	√	√		
4.	What form of hazardous waste treatment is most prevalent within Korea? Do you believe this is the "correct" technology to employ? If not, what would you recommend? Why?	√	√		
5.	Are there any specific remediation technologies currently employed within the US, but not in Korea, which you are interested in obtaining?	√	√		
6.	Where are majority of remediation technologies developed (military R&D centers, government-funded laboratories, commercial centers, etc.)? a. Is there a mechanism for sharing or transferring technologies between various entities? b. Is there a "clearinghouse" for remediation technologies. If so, please describe the process/organization of the "clearinghouse".	√	√	√	
7.	Is there patent or other legal "rights of ownership" limitations to transfer of technology within Korea? To transfer of technology to other countries?	√	√		
8.	Does Korea have international agreements for technology transfer with other countries? If so, name the countries and describe the agreement.	√	√		
9.	Would technology transfer issues impinge on US patent laws?				√
10.	Would technology transfer issues or other similar US aid from military organizations in Korea impinge upon the SOFA, or other security or treaty requirements? Specifically, are there any limitations on providing documents on remediation technologies to Korea?				√

Items to Obtain:

	Item	Korean Univ	MOE	MOD	US
1.	All applicable Ministry of Defense environmental regulations and policy statements (English translation, if available).			√	√
2.	All applicable Ministry of Environment regulations and policy statements (English translation, if available).	√	√		√
3.	Organizational diagram of the Ministry of Environment.		√		
4.	Organizational diagram of the Ministry of Defense, Environmental Division (or equivalent).			√	
5.	Organizational diagram of a "typical" installation-level, chain-of-command, showing environmental management office (if organization exists). Include separate diagram for ROKA, ROKAF, and ROKN, if chain-of-command structure is significantly different.			√	
6.	Listing of currently available hazardous waste site remediation technologies.	√	√	√	
7.	Listing of restoration projects at Korean installations (project type, project cost, status of clean-up, estimated completion date).		√	√	
8.	Environmental funding levels (current and projected years) for: a. Ministry of Environment b. Ministry of Defense c. ROKAF d. ROKA e. ROKN	√	√	√	
9.	Overall funding levels (current and projected years) for: a. Republic of Korea (government-funded programs) b. Ministry of Defense c. ROKAF d. ROKA e. ROKN	√	√	√	
10.	Copies of recent environmental assessments at Korean military installations.			√	
11.	Data on hazardous waste generation at Korean military installations (historical and projected).		√	√	
12.	Copies of recent environmental assessments at DoD military installations (including COBs). a. ECAMP b. ECAS c. Other environmental assessments/studies				√
13.	Copy of the Soil Protection Act of 1995	√	√	√	
14.	Historical and most recent hazardous waste statistics including: a. Total amount of hazardous waste generated b. Total amount of hazardous waste sent to landfills c. Total amount of hazardous waste disposed (other than landfilled)	√	√		

	Item	Korean Univ	MOE	MOD	US
15.	Historical and most data on hazardous waste sites and clean-up, including: a. Total number of sites b. Cost of clean-up c. Remediation technology employed	√	√		
16.	Data on hazardous waste site remediation technologies, including: a. List of "most favorable" remediation technologies (those technologies most often employed) b. Remediation R&D budget	√	√	√	
17.	Educational data: a. Number of universities offering undergraduate programs in environmental engineering b. Number of universities offering graduate programs in environmental engineering	√			
18.	List of current/future environmental projects (current FY plus five year projections) a. FY97 Program (O&M, MILCON, Host-Nation Funded, Environmental, Medical, NAF) b. FY98—FY03 POM Submission (projects and priorities)				√
19.	Local Guidelines a. Copy of local memorandum of agreements pertaining to environmental quality.		√		√
20.	Updates to FGS and other DoD environmental policy and regulations				√
21.	Updates to Korean environmental law and policy (English translations)				√

Note: The list of questions served as a guide during the various interview process. Interviewers were cautioned to temper questions as necessary to avoid antagonizing the interviewee, based on individual personalities and situations.

APPENDIX 3-1: DoD Policy and Regulations Applicable to Overseas Remediation

Document	Title	Reference	Policy/Directive/Instruction
DODD 4715.1	Environmental Security	Para D	"It is DoD policy to display environmental security leadership within DoD activities worldwide and support the national defense mission by…Protecting, preserving, and, when required, restoring, and enhancing the quality of the environment."
DODI 4715.5	Management of Environmental Compliance at Overseas Installations	Para B1f	"Does not apply to the determination or conduct of remediation to correct environmental problems caused by the Department of Defense's past activities."
DODI 4715.8	Environmental Remediation for DoD Activities Overseas	Para B1	"This instruction applies to... b. Remediation of environmental contamination on DoD facilities or installations overseas, including DoD activities on host-nation installations or facilities. c. Remediation of environmental contamination caused by DoD operations, including training, that occur off a DoD installation or facility..."
		Para D2	"The Environmental Executive Agents...shall: a. Establish...remediation policy...the country-specific policy shall: (1) Define, or provide procedures to define, the appropriate level of remediation at contaminated sites; (2) Provide procedures for negotiating the scope of any required remedial measures with the host nation... (3) Provide procedures for furnishing documentation to the host government."
		Para D3	"The Heads of the DoD Components [SAF, SAA, SAN] shall: a. Remedy known environmental contamination... b. Resolve site-specific issues such as approving strategies for remediation and determining how best to use DoD Component resources."

Document	Title	Reference	Policy/Directive/Instruction
DODI 4715.8 (Continued)	Environmental Remediation for DoD Activities Overseas	Para E1a	"The DoD Components shall take prompt action to remedy known imminent and substantial endangerments to human health and safety due to environmental contamination that was caused by DoD operations and that is located on or is emanating from a DoD installation or facility."
		Para E3a	"The DoD Components shall take prompt action to remedy known imminent and substantial endangerments to human health and safety due to environmental contamination that was caused by current DoD operations at overseas location but that is not located on or emanating from a DoD installation or facility."
		Para E4a	"The decision as to whether a contaminated site poses an imminent and substantial endangerment shall be made by the in-theater commander of the DoD Component after consultation with the appropriate DoD medical authority and the DoD environmental Executive Agent..."
		Para E4b	"Projects...are considered completed when the contamination no longer poses an imminent and substantial endangerment to human health, environment, and safety. Commanders have the discretion to make risk-based decisions on how to carry out the remediation, raning from institutional responses, such as restricting access, to more permanent remedies."
		Para E5	"...actual or anticipated...remediation costs incurred by the host nation for DoD-caused contamination on or emanating from DoD installations or facilities or caused by current DoD operations may be considered as an offset against the residual value of DoD capital improvements."

Document	Title	Reference	Policy/Directive/Instruction
DODI 4715.8 (Continued)	Environmental Remediation for DoD Activities Overseas	Para F1	"The DoD Components may develop information, and shall maintain existing information, relating to...contamination at DoD locations until the location is returned to the host nation."
		Para F2	"Information on contamination not on a DoD installation or facility...shall be collected and maintained until issues concerning the contamination are finally resolved with the host nation."
		Para F3	"...this information shall be provided...to host-nation authorities upon request."
DoD Overseas Environmental Baseline Guidance Document	Same as Document	Para 1	"Specifically, this document does not apply to…The determination or conduct of remedial or cleanup actions to correct environmental problems caused by the Department of Defense's past activities."
		Para 19	"Spills of PCB liquids at concentrations of 50 ppm or greater will be responded to immediately upon discovery and cleaned up in accordance with the following: c. Contaminated soil located in restricted access areas will be removed until the soil tests no higher than 25 ppm PCBs and will be backfilled with clean soil containing less than 1 ppm PCBs; and d. Contaminated soil located in unrestricted access areas will be removed to a minimum depth of 10 inches or until the soil tests no higher than 10 ppm PCBs, whichever is deeper, and will be backfilled with clean soil containing less than 1 ppm PCBs."

Document	Title	Reference	Policy/Directive/Instruction
DEPSECDEF Memo, 18 Oct 95	Environmental Remediation Policy for DoD Activities Overseas	Para 2a(1)	"Service components…shall take prompt action to remediate known imminent and substantial endangerments to human health and safety due to environmental contamination caused by DoD operations."
		Para 2a(2)	"…the in-theater commander of the service component…may approve additional remediation of environmental contamination if the commander determines the additional remediation is required to maintain operations or protect human health and safety."
		Para 2a(3)	"International agreements also may require the U.S. to fund environmental remediation. Such remediation may be more extensive than that necessary to remediate known imminent and substantial endangerments to human health and safety. Before a service component…begins remediation pursuant to such an agreement it shall consult with the DoD environmental executive agent, if any, and shall obtain a legal determination that the requirement is mandatory and arises from a binding international agreement that pertains to U.S. military operating rights in the host country."
		Para 2a(3)	"International agreements also may require the U.S. to fund environmental remediation. Such remediation may be more extensive than that necessary to remediate known imminent and substantial endangerments to human health and safety. Before a service component…begins remediation pursuant to such an agreement it shall consult with the DoD environmental executive agent, if any, and shall obtain a legal determination that the requirement is mandatory and arises from a binding international agreement that pertains to U.S. military operating rights in the host country."

Document	Title	Reference	Policy/Directive/Instruction
DEPSECDEF Memo, 18 Oct 95 (Continued)	Environmental Remediation Policy for DoD Activities Overseas	Para 3	"The decision as to whether a contaminated site poses an imminent and substantial endangerment shall be made by the in-theater commander of the service component…The authority to make this decision may be delegated…to an installation or facility commander, as appropriate. Projects designed to remediate an imminent and substantial endangerment are complete when the contamination no longer poses an imminent and substantial endangerment to human health and safety."
AR 200-1	Environmental Protection and Enhancement	Para 14-6a	"Comply with comprehensive DoD environmental restoration policy, applicable DA Supplemental Policy, and Executive Agent developed country-specific cleanup policy when published."
		Para 14-6b	"…U.S. funds will not be spent for environmental restoration beyond the minimum necessary to sustain current operations or eliminate known imminent and substantial dangers to human health and safety, unless required by applicable U.S. law, treaty, or international agreement."
		Para 14-6c	"Depending on the terms of the governing international agreement, actual or anticipated environmental cleanup costs for U.S. caused environmental contamination may be included in the host nation's overall damage claim."
OPNAVINST 5090.1B	Navy Environmental and Natural Resources Program Manual	Para 18-5.19	"…International agreements, SOFA, and U.S. government policy shall be used to decide whether cleanup action should be coordinated with the EA [Executive Agent]."

Document	Title	Reference	Policy/Directive/Instruction
AFI 32-7006	Environmental Program in Foreign Countries	Para 2.2	"A comprehensive DoD restoration policy does not exist. There is an OSD policy for installations or facilities identified for return to the host nation. The policy only allows the use of U.S. funds on maintenance, repair or environmental restoration to sustain current operations or eliminate known imminent and substantial dangers to human health and safety, unless required by applicable U.S. law, treaty or international agreement. The Air Force applies this same OSD policy to all sites contaminated by Air Force operations."
USFK Cir 200-97-XX	Environmental Governing Standards (Draft)	Para 1-2	"Specifically, these Environmental Governing Standards (EGS) do not apply to...The determination or conduct of remedial or cleanup actions to correct environmental problems caused by past DoD activities."
		Para 1-6b(2)	"The sole regulatory requirement applicable to USFK installations is this USFK Circular, the EGS. Although the EGS takes into consideration...U.S. laws...ROK environmental laws and regulations...and international treaties...those underlying instruments do not set legal standard with which USFK installations must comply. The EGS does."
		Para 9-3f(2)	"Follow on steps [after a POL spill or leak] are— (a) Act to prevent migration of released POL into soils and nearby surface waters. (c) Determine soil and water cleanup action."

Document	Title	Reference	Policy/Directive/Instruction
USFK Cir 200-97-XX (Continued)	Environmental Governing Standards (Draft)	Para 14-3a(2)	"Spills of PCB liquids at concentrations of 50 ppm or greater will be responded to immediately upon discovery and cleaned up IAW the following: (c) Contaminated soil located in restricted access areas will be removed until the soil tests no higher than 25 ppm PCBs and will be backfilled with clean soil containing less than 1 ppm PCBs. (d) Contaminated soil located in unrestricted access areas will be removed to a minimum depth of 10 inches or until the soil tests no higher than 10 ppm PCBs, whichever is deeper, and will be backfilled with clean soil containing less than 1 ppm PCBs.
		Para 18-3(5)	"In the event a spill of POL or hazardous substance occurs inside a USFK installation and cannot be contained within the installation boundaries, threaten a ROK drinking water resource, or the spill occurs off-post...the unit which has caused the release will take immediate action to contain the damage and cleanup within the limits of their capabilities."
		Para 18-3(5)(f)	"Under the provisions of Article XXIII of the U.S. ROK SOFA, claims by local national individuals or organizations for damages arising from off-installation spills will be handled through the established claims procedures."
		Para 19-3c(3)	"Soil and groundwater contaminated by the release will be remediated when there is imminent or substantial danger...Imminent and substantial danger refers to acute injury or death, rather than illness or injury typically caused by long term, chronic exposure. A determination...shall be made by the Installation Commander after consultation with the USFK Surgeon and the USFK ACofS, Engineer."

Document	Title	Reference	Policy/Directive/Instruction
USFK Memo, undated (Draft)	United States Forces Korea (USFK) Environmental Remediation Policy	Para 3	"Component and subordinate activity commanders shall take prompt action to remediate known imminent and substantial endangerments to human health and safety due to environmental contamination on USFK installations or facilities."
		Para 4	"Component commanders, in consultation with the USFK Environmental Programs Office (EPO), shall determine whether contaminated sites pose either an operational risk or an imminent and substantial endangerment to human health and safety...based on site-specific information such as contaminant toxicity and exposure potential."
		Para 5	"Each installation shall establish and maintain a listing of sites where petroleum products or other hazardous substances may have been released to the environment...Each installation shall conduct a preliminary assessment of each site using existing information...Once potentially contaminated sites have been identified, each installation shall conduct a site inspection and collect sufficient data (which may include limited soil, groundwater or other environmental sampling) necessary to determine whether each site poses an imminent and substantial endangerment to human health and safety."
		Para 6	"Remediation is complete when the site no longer poses a risk to operations or an imminent and substantial endangerment to human health and safety."

Note: References to each document listed above can be found in the bibliography (original text document).

APPENDIX 3-2: Environment-Related Acts, Republic of Korea

Environmental Acts	Purpose	Date Legislated
Environmental Management Corporation Act	Establishes the Environmental Management Corporation, which manages and operates pollution control projects, such as treatment facilities, pollution abatement facilities, etc. Also provides technical assistance for design and construction.	1983, 21 May 1993, 27 Dec (Amended)
Basic Environmental Policy Act	Establishes general environmental strategy and goals, action-forcing standards, and creation of Environmental Preservation Committee, similar to the US Council on Environmental Quality. Similar to US National Environmental Policy Act. Also contains a strict, joint, and several liability clause (like CERCLA) which holds polluters liable for environmental damage.	1990, 1 Aug 1991, 31 Dec (Amended) 1993, 11 Jun (Amended) 1994, 22 Dec (Amended)
Toxic Chemicals Control Act	Assesses toxicity of chemical substances and control manufacture and distribution of toxic chemical substances. Similar to US Toxic Substances Control Act.	1990, 1 Aug 1994, 3 Aug (Amended)
Environmental Dispute Settlement Act	Provides procedures for mediation, reconciliation, and rulings for an investigation into damages and adjustment of disputes caused by environmental pollution.	1990, 1 Aug
Air Quality Control Act	Regulates emission of pollutants and odor into the air. Specifies (1) types of pollutants; (2) emission standards; (3) types of sources to be controlled; (4) methods of measuring pollution to facilitate emission control. Similar to US Clean Air Act. Regulates various sources such as industrial facilities, vehicles, households, and polluting activities; establishes non-compliance charge system.	1990, 1 Aug 1991, 31 May (Amended) 1992, 8 Dec (Amended) 1993, 11 June (Amended) 1993, 27 Dec (Amended) 1994, 5 Jan (Amended)
Water Quality Control Act	Regulates effluent into surface waters (rivers, lakes and streams). Does not apply to groundwater contamination (regulated by Basic Environmental Policy Act); does not apply to sea water (regulated by Marine Pollution Prevention Act). Specifies (1) types of pollutants; (2) emission standards; (3) types of sources to be controlled; (4) methods of measuring pollution to facilitate emission control.. Regulatory requirements and sanctions against industrial polluting sources similar to Air Quality Control Act.	1990, 1 Aug 1991, 31 May (Amended) 1992, 8 Dec (Amended) 1993, 27 Dec (Amended) 1994, 5 Jan (Amended) 1994 3 Aug (Amended)
Noise and Vibration Control Act	Prevents environmental damage and degradation to human health due to excessive noise and vibration from factories, construction sites, roads, railroads, etc.	1990, 1 Aug 1993, 27 Dec (Amended)
Environmental Dispute Settlement Act	Provides economic and efficient remedies for environmental damage; attempts to reduce financial burden of the claimant by offering voluntary arbitration. Establishes the Central Environmental Disputes Coordination Committee to arbitrate damage claims resulting from environmental pollution (note: committee made up entirely of MOE scientists—no legal representation).	1990, 1 Aug

Environmental Acts	Purpose	Date Legislated
Potable Water Act	Establishes standards for drinking water (piped water systems); requires government to fomulate plans for construction of potable water systems; establishes Safety Assessment Committee to assess safety of drinking water. Also regulates bottled water production.	1990, 3 Aug 1993, 3 Aug (Amended) 1995, 1 Jul (Amended)
Marine Pollution Prevention Act	Preserves the marine environment through regulation of hazardous substances and wastes discharged into sea from ships, marine facilities, etc. Discusses remediation of sea pollutants where contamination threatens coastal regions. Amendment required due to Korea's accession to MARPOL in 1991.	1991, 8 Mar (Wholly Amended)
Solid Waste Management Act	Specifies guidelines for proper waste treatment; regulates generation and discharge of solid wastes. Similar to US RCRA. Goal of the act is to reduce the volume of solid wastes, and treat wastes discharged to prevent human and environmental health risks. Classifies waste into two categories: (1) general wastes (non-toxic); and (2) specified wastes (hazardous). Delegates responsibility for managing general wastes to provincial governments.	1991, 8 Mar 1992, 8 Dec (Amended) 1993, 6 Mar (Amended) 1994, 5 Jan (Amended)
Act Relating to Treatment of Sewage, Night Soil, and Livestock Wastewater	Regulates treatment of sewage, night soil (human wastes), and livestock wastewater (effluent from livestock cultivation).	1991, 8 Mar 1993, 27 Dec (Amended)
Act Relating to Punishment for Environmental Crimes	Describes punitive actions taken against entities engaging in business activities causing environmental pollution which adversely affects humans.	1991, 31 May
Natural Environment Preservation Act	Preserves and protects the natural environment from artificial damage, and prevents extermination of species (biological diversity). Similar to US Endangered Species Act.	1991, 31 Dec 1994, 3 Aug (Amended)
Act Relating to Environmental Improvement Charges	Implements environmental improvement measures and secures resources for environmental investment using the "polluter-pays-principle". Revenue collected may be used for construction of environmental facilities, R&D on environmental technology, and subsidies. Charges levied on commercial/business buildings and diesel-fueled vehicles. The Special Account for the Environmental Improvement Account established in 1994 to make necessary capital available for investment in environmental improvement projects.	1991, 31 Dec 1994, 15 Jan
Act Relating to Promotion of Resources Saving and Reutilization	Promotes reduction in volume of wastes produced and discharged, and encourages energy and resource conservation through reuse and recycling schemes. Establishes a comprehensive deposit/refund system and product charge for waste management.	1992, 8 Dec

Environmental Acts	Purpose	Date Legislated
Act Relating to Transboundary Movement of Wastes and Their Disposal	Prevents environmental pollution caused by transboundary movement of wastes; control export, import, and inland transit of wastes. Passed in response to the Basel Convention relating to Control of Transboundary Movement and Disposal of Hazardous Wastes	1992, 8 Dec
Environmental Impact Assessment Act	Creates system for assessing/reviewing environmental impacts of certain projects deemed especially harmful to the environment.	1993, 11 Jun
Korea Resources Recovery and Reutilization Corporation Act	Establishes the Korea Resources Recovery and Reutilization Corporation to manage pollution prevention projects.	1993, 27 Dec
Sewer System Act	Establish standards for sewage treatment systems and requirement to formulate plans for construction of sewage treatment plants. Transferred supervision of waste-water facilities from Ministry of Construction to Ministry of Environment.	1994, 3 Aug
Rules and Regulations on Preservation of Groundwater Quality	Establishes construction standards for businesses which use more than 30 tons of groundwater per day; requires groundwater monitoring devices for underground oil or hazardous chemical storage facilities.	1994, 9 Aug
Act Relating to Support and Development of Environmental Technologies	Establishes long-term environmental technology development plan; recommends most highly effective environmental technology for use by local industry; provides technical support to small companies; legally support use of "eco-mark" labeling system.	1994, 22 Dec
Drinking Water Management Act	Establishes groundwater monitoring network; standards for different classes of groundwater based on use (domestic, irrigation/agricultural, and industrial).	1995, 1 Jan (Wholly Amended)
Soil Preservation Act	Establishes a soil contamination monitoring network (assessment), standards ("trigger value" and "action value"), regulates installation of "soil contamination prevention facilities," and soil preservation zones. Previously under Water Quality Preservation Act. Remedial action not specified, but inherent in trigger and action values. Once soil contaminated beyond action value, area must be remediated to less than trigger value before able to use that land for specific purposes (agriculture or industry).	1995, 5 Jan

Note: Acts referenced from the original legal text (listed in the bibliography) or from the following:

Ministry of Environment. Development of Korean Environmental Policy: 1996.
Ministry of Environment. Environmental Protection in Korea: 1996.
Ministry of Environment. Environmental Protection in Korea: 1994.
Lee, Shin-Bom. South Korea Environmental Report.

APPENDIX 3-3: Allegations of U.S. Violation of Korean Environmental Law

Organization	Alleged Violation
Ministry of Foreign Affairs	1. Use of Imhoff tanks (primary sewage treatment) at Camp Walker, Taegu. 2. Contamination of the Hwangguji River in Pyongtaek, near K-55 (Camp Humphreys, Pyongtaek). 3. Frequent violations of Air Quality Preservation Act due to delinquent check-ups on automobile exhaust and lack of anti-pollution devices. 4. Illegal painting of a "hill" at Kunsan AB. 5. Frequent cases of illegal burying of harmful material, such as film developing (mercury contained), solid waste construction material, and general solid waste.
Green Korea	1. Uijongbu (Camp Red Cloud): a. Water samples collected in waterways along U.S. bases exceed industrial standards. Chemical Oxygen Demand (COD) and nitrogen levels exceed standard by five times. Level of eutrophication exceeds standards by two times. Water still used for agriculture. May pollute groundwater. b. Excessive noise from helicopter operations (74.0 dB). c. Impossible to plan for greenbelt zone due to base location. d. Asbestos in abandoned buildings on Camp Indian. 2. Chunchon (Camp Page) a. Excessive noise from helicopter operations (max 89.3 dB). b. Suspected air, water, soil pollution from helicopter operations. 3. Inchon (Camp Market, AFFES depot, DECA depot) a. Illegal landfilling; suspected soil pollution. b. Excessive noise (max 68.8 dB) from factory operations. c. Surface water contamination (excessive total phosphorus, nitrogen and turbidity); heavy metals found (manganese, zinc). 4. Tongduchon (Camp Casey) a. Food wastes and edible oils dumped in waterways "through pulverizer". b. Propagation of "exotic plants," damaging to local flora. c. Surface water contamination (excessive nitrogen, COD, and turbidity). d. Suspected pollution of soil, waterways, groundwater from golf course. 5. Pyongtaek (Osan AB, Camp Humphreys) a. Excessive noise (max 112.0 dB). b. Pollution of Hangkugichun waterway (excessive COD, nitrogen, turbidity; heavy metals). Exceeds standards for industrial use; yet used for agricultural purposes. 6. Wonju (Camp Long) a. Excessive total nitrogen and turbidity in groundwater. b. Cracks in buildings and damage to crops due to "helicopter traffic." c. Exposed asbestos. d. Construction of joint ROKAF/USAF airfield destroyed a small mountain and waterways. e. "Illegal" base landfill (use for 7 years). c. Excessive noise from aircraft operations (max 107.0 dB). d. "Unfair relation" concerning use of Kunsan's runway by civilian airlines in exchange for solid waste disposal by the local government.

Organization	Alleged Violation
Green Korea (Continued)	7. Kunsan Air Base a. Pollution of adjacent waterways and wetland (Saemankeum). b. Illegal dumping of scrap metals and heavy metals in Korean mountains and rivers. 8. Taegu (Camp Walker, Camp Henry, Camp Carroll, K-2 Air Base) a. Excessive noise from helicopter operations (max 96.0 dB). b. Suspected water pollution (strong odors, high acidity). c. Excessive noise from aircraft operations (max 118.3 dB). 9. Pohang (POL Storage) Suspected POL pipeline oil leaks, resulting in polluted farm land which fueled a forest fire.
Honam Ilbo Daily Newspaper	Dumping of 10,000 tons of construction debris at the south end of Kunsan Air Base (beach).

APPENDIX 3-4: Research Topics Studied by the ROK National Institute of Environmental Research in 1993

	Topic
Completed in 1993	1. Classification of Environmental Information Objective: Illustrate how to establish and use environmental information systems (GIS).
	2. Classifying Pollutant Emitting Firms Objective: Determine the actual volume of emissions discharged by each firm; formulate new method of classification.
	3. Survey and Assessment of Damage Caused by Air Pollution and Acid Rain Objective: Examine and determine the impact of air pollution and acid rain on forests, soil, and buildings.
	4. Air Pollution in Urban Areas and a Photochemical Reaction Model Objective: Analyze photochemical reactions in the air in major cities; develop a model of movement and generation of secondary pollutants.
	5. Measures for Accommodating the UN Framework Convention on Climate Change Objective: Review and analyze the contents of the Convention, specifically on regulating carbon dioxide emissions.
	6. Improving the Sound Quality of Automobile Horns Objective: Study people's reactions to different types of automobile horns "to make driving safer."
	7. Performance Evaluation of Exhaust Gas Control Equipment Objective: Evaluate the effectiveness of emission control equipment and additives, quality of fuels and lubricants, and level of automobile maintenance on automobile exhaust gas emissions.
	8. Inspection of Pollutant Discharge from Astigmatic Pollution Sources Objective: Determine the impact of non-point pollution sources, means of inspection, and characteristics of effluent.
	9. Measures to Prevent Hazardous Liquid Substances from Leaking into the Sea Objective: Determine measures for the establishment and operation of storage facilities on land and effective prevention of leakage of hazardous liquids in ports.
	10. Technology to Reclaim Solid Wastes in Urban Areas and Stabilize Landfills Objective: Determine status of reclaimed land management and leachate disposal from landfills.
	11. Optimum Management of Land Reclaimed with Solid Industrial Wastes Objective: Study the types of hazardous substances emanating from land reclaimed with solid industrial wastes, and determine methods of reducing leachate of hazardous substances.
	12. Potential Environmental Damage Caused by Chemicals Objective: Study assessment systems for toxic chemicals (foreign and domestic) to establish an environmental risk assessment system designed to prevent danger to human health and damage to the environment.
	13. Search for Residual Chemicals and Development of Methods for Their Control Objective: Establish standard methods of collecting, pre-treating, analyzing, and managing air, water, and waste samples of chlorinated hydrocarbons.

	Topic
Underway Since 1994	1. Technology Development to Forecast Chronic Respiratory Diseases Caused by Air Pollution Objective: Comparative study of large cities and industrial areas (Seoul, Pusan, Ulsan) and a less polluted area in Chongju to establish the relationship between air pollution and chronic respiratory diseases.
	2. Development of Purifying Organisms for Environmental Improvement Objective: Identify which trees and other flora best reduce air pollution.
	3. Research for the Establishment of Air Pollutant Emissions Standards Objective: Study emissions of dust, sulfurous acid gas, and nitrogen oxide-emitting facilities, and review regulations for dust-generating facilities in "advanced countries" to determine a new volume-based air pollution regulation system.
	4. Study on Noise Control Measures at Plants Objective: Develop technology for abatement and control of noise in urban areas.
	5. Study on the Development of Wastewater Treatment Technology Objective: Develop anaerobic, non-oxide, and aerobic treatment technology for wastewater treatment. Evaluate the efficiency of various existing pollution treatment methods through experimentation.
	6. Study of Wastewater Treatment Technology Objective: Study prototype wastewater treatment technologies in small-scale housing complexes to determine treatment and cost effectiveness.
	7. Development of the River Environment Management System Objective: Assess various related factors for successful development of a river environmental management system aimed at reversing the deteriorating quality of water in rivers throughout Korea.
	8. Development of Biological Treatment Technology for Foul Odors from Sewage Treatment Plants Objective: Self-explanatory.
	9. Study on the Development of Hazardous Waste Management Technology Objective: Review of all known hazardous wastes and the existing classification system. Evaluate means of reducing volumes of hazardous wastes.
	10. Study on Methods of Soil Purification Objective: Use of trees and plants to remediate soil contaminated with heavy metals (phytoremediation).
	11. Study on the Prevention of Eutrophication Objective: Research various chemical treatment technologies to curb multiplication of algae in eutrophic lakes and marshes.
	12. Development of Technology to Reduce Pollution Levels in Inland Hatcheries Objective: Characterize and control effluent from in-land fish hatcheries.
	13. Study of Water Treatment Technology Through the Food Chain Objective: Study of biological treatment techniques (plankton-eating silver salmon) to remediate polluted lakes and marshes.

HAN (Highly Advanced National) Projects	
Time Period	Topic
1990-1992	1. Development of Technology for Controlling Propagation of Algae in Lakes and Marshes Outcome: Unknown, but studied use of water hyacinth and other remedial technologies for removing algae-enhancing nutrients. 2. Development of Equipment for Filtering Particles from Diesel Fuel Outcome: Successfully installed and tested prototype equipment on buses and automobiles.
1991-1993	1. Development of Technology to Assess Impacts on Ecosystems Outcome: Basic data on the impact of development on ecosystems. 2. Development of Technology for Treatment and Recycling of Organic Sludges with Microorganisms in Soil Outcome: (1) Organic sludge could not be treated through vermistabilization without pre-treatment. (2) Developed and commercialized technologies for use of night soil as fertilizer and deodorizing agent.
1992	1. Characteristics of CO_2 Emissions from Major Sources Outcome: Completed characterization of CO_2 sources and volume of emissions. 2. Basic Technology for Monitoring Greenhouse Gases Outcome: Completed survey on development and commercialization of high temperature filtering materials.
1992-1993	Development of Treatment Technology for Dyes and Other Not-Easily Decomposable Wastes Outcome: A new process was developed using anaerobic microorganisms to decompose various coloring compounds and coloring agents.
1992-1994	1. Study to Develop Environmental Risk Assessment System Outcome: (1) Database on environmental pollutants and toxic chemicals created. (2) Selected chemicals for priority management and further study based on toxicity and risk. 2. Development of Pollution and Acid Rain Resistant Species and Bio-Indicator Based Selection of Species Outcome: (1) Concentration of organic substances, total nitrogen, phosphorus, aluminum, and total sulfur higher in industrial complexes and closed-down mines than in unpolluted areas. (2) Concentration of heavy metals higher in unpolluted areas than in industrial complexes and closed-down mines. (3) Sixteen species of pollution-resistant plants and three species of sensitive plants selected as pollution indicators 3. Study on Establishment of a Marine Pollution Monitoring Network and the Change in the Pollution Situation Outcome: Gathered data on standard measurement and analysis techniques; justified expansion of marine pollution monitoring network.

HAN (Highly Advanced National) Projects (Continued)	
Time Period	Topic
1992-1994	4. Development of Stack-Gas Desulfurizing Equipment (Dry Process) for Industrial Facilities Outcome: Gathered data on performance and cost effectiveness of various desulfurizing technologies, including semi-dary and foam-spraying equipment. 5. System of Selecting Alternative Methods for Water Quality Control Outcome: Develop system for selecting alternative pollution treatment methods in small- and medium-sized cities taking into account water quality, pollution sources, and cost.
Unknown	Development of CNG-Mixed Fuel System Outcome: Successful testing and fielding of a prototype engine capable of running on CNG-mixed fuel.

APPENDIX 3-5: Environmental Compliance and Management Program (ECAMP) and Environmental Compliance Assessment System (ECAS) Inspection Results Related to Hazardous Waste Site Remediation

Location	Finding Title	Details
Osan Air Base - November 1996		
821	Lube Oil/Haz Material or Waste Stored Improperly	Two, 55-gal drums containing lube oil stored on ground, unsheltered and leaking.
1214	Inadequate Secondary Containment for Hazardous Waste	Soil saturated with engine oil and antifreeze (possible). Carryover from 1995 assessment.
511	Inadequate Secondary Containment for Hazardous Waste	Accumulation point for batteries; one battery had hole and leaking onto ground.
1712	Improper Wastewater Sludge Disposal	Sludge from wastewater treatment plant disposed by a solid waste contractor although analysis of sludge indicates waste exceeds RCRA threshold for barium, chromium, lead, and mercury. Carryover from 1995 assessment.
878	Leaking Aboveground Storage Tank (AST)	Fuel oil tank leaking (containment dike contained approximately one foot of storm water with thick layer of fuel oil).
1712	WWTP effluent exceeds standards	Provides primary treatment only; disinfection not accomplished. Oil and grease limits exceeded. No monitoring for BOD. Carryover from 1995 assessment.
Chongju Air Base - June 1996		
3001	Discharge of POL to Adjacent Creek	Overloaded wash rack oil/water separator (OWS) drains directly into creek. Oil stains on the soil at the discharge location.
3001	Lack of Domestic Wastewater Characterization	Domestic wastewater discharges to a septic tank followed by a stream. Discharge never tested by bioenvironmental engineering (BEE).
3001	Lack of Industrial Wastewater Characterization	Transportation vehicle wash rack effluent discharges from OWS into stream. Discharge never tested to determine compliance with effluent limits.
Kimhae Air Base - June 1996		
1006	Improper Disposal of Medical Waste	The medical waste incinerator is used to dispose of expired pharmaceuticals and dead animals. The ash, collected and disposed as solid waste, has never been characterized.
1006	Improper Disposal of Hazardous Waste	Spent fluids from x-ray film development process discharged directly into a drain.
2001	Discharge of POL to Adjacent Waterway	An overloaded OWS drains directly into an adjacent waterway. The vehicle maintenance yard also drains to the waterway.

Location	Finding Title	Details
	Kimhae Air Base - June 1996 (Continued)	
2001	Landfill Operations Must Meet Specific Requirements	The write-up states: "The installation commander shall ensure contractors meet specific landfill standards." It is unknown whether the landfill is sited on-base and owned/operated by DoD personnel, or off-base and owned/operated by civilian personnel.
2014	Domestic Wastewater Effluent	Wastewater effluent not tested to ensure quality limitations not exceeded.
1012	Sludge Disposal	Sludge from the contingency hospital's lift station not disposed of as either solid or hazardous waste. Unknown whether the sludge is disposed on or off-site.
1006	Total Trihalomethane Sampling	Total trihalomethane exceeded the standard and notification not provided to the unit to undertake remedial corrective measures. Two tests conducted in CY95 indicated total trihalomethane exceeded the 100 mg/L MCL. Water supplied from the Pusan municipal water system; three ponds serve as emergency back-up (no wells). Contingency Support Plan (Jan 96) for Kimhae AB, pg 14-1, rates the base water supply/emergency water supply as "poor", which may signify development of groundwater wells to augment present surface water back-up system.
	Kooni Range - June 1996	
22	No OWS at Wash rack	A wash rack next to vehicle maintenance has no OWS and drains directly to a storm water ditch.
22	Vehicle Maintenance Pit Drains to Storm Water	A vehicle maintenance pit in the CE yard drains directly into a storm water ditch.
1	Landfill Operations Must Meet Specific Requirements	The write-up states: "The installation commander shall ensure contractors meet specific landfill standards." It is unknown whether the landfill is sited on-base and owned/operated by DoD personnel, or off-base and owned/operated by civilian personnel.
NA	Improper Disposal of Lighting Ballasts	Basewide finding. Ballast units removed from fluorescent lighting fixtures discarded to trash with no attempt to identify if they contain PCBs.
NA	Improper Disposal of Possible Asbestos Containing Material (ACM)	Basewide finding. Possible ACM removed during facility maintenance discarded as general refuse.
9	Domestic Wastewater Effluent Limitations	The three domestic waste holding tanks overflowed into area ditches which flow into rice fields; no testing accomplished to determine compliance.

Kwangju Air Base - June 1996

Location	Finding Title	Details
2123	Improper Disposal of Fluorescent Bulbs	Waste fluorescent bulbs disposed as solid waste. Generally, fluorescent bulbs are high in mercury and other hazardous constituents and should be disposed as a hazardous waste unless testing/analysis indicates otherwise.
2278	Installation Lacks Waste Analysis Plan	Basewide finding. No waste analysis plan for periodic testing of all waste streams from all generators.
2151	Improper Disposal of Hazardous Waste	8th Fighter Wing maintenance personnel rinsed synthetic oil cans by filling each container with water and draining it into an OWS, which discharges into an open ditch.
535	OWS	Existing OWS too small for waste flowing through, allowing oil to pass through and discharge to the storm drain.
5356	Building Floor Drain Discharge	Floor drains were discharging oils and solvents directly into open ditches.
535	OWS Waste Characterization	A waste stream characterization had not been accomplished for each OWS. All OWS discharged to open ditches.
5356	Maintaining OWS	Frequent use of a small OWS resulted in generating waste that because of the small quantity, host nation contractors refused to remove. The volume of waste oils exceeded the capacity of the separator which overflowed into an open ditch.
215	Leaking Underground Storage Tanks (USTs) Not Removed From Service	Two USTs (215 and 123) that failed tightness testing in Sep 95 have not been emptied and removed from service.
1204	No Monthly Inventory of USTs Basewide	Monthly inventory of USTs not being conducted per requirements. No system in pace to track individual tank inventories and detect leaks between annual tightness testing.
1204	Some USTs Not Tightness Tested Annually	Eight USTs were not tightness tested during the latest annual testing in Sep 95.
535	Discharge of POL to Adjacent Ditches/Streams	All OWSs drained to adjacent ditches/streams. Oil stains present on the soil at the effluent pipe and on standing water nearby.
NA	Landfill Operations Must Meet Specific Requirements	The write-up states: "The installation commander shall ensure contractors meet specific landfill standards." It is unknown whether the landfill is sited on-base and owned/operated by DoD personnel, or off-base and owned/operated by civilian personnel.
2155	Improper Disposal of Lighting Ballasts	Ballast units removed from fluorescent lighting fixtures discarded to trash with no attempt to identify if they contain PCBs.

Location	Finding Title	Details
Kwangju Air Base - June 1996 (Continued)		
NA	Improper Disposal of Possible ACM	Basewide finding. Possible ACM removed during facility maintenance discarded as general refuse.
310	Discharge Characterization	Wastewater discharge characterization from the Imhoff tank not accomplished monthly to determine compliance with ROK standards.
310	Industrial Wastewater Characterization	Effluent from the base wastewater treatment facility not tested quarterly for constituents listed in Table 4-5 of FGS.
310	Sludge Disposal	Sludge from the Imhoff tank had not been characterized to determine an appropriate disposal method. Unknown whether the sludge is disposed on or off-site.
Pilsung Range - June 1996		
59	No OWS for Wash rack	A wash rack and vehicle maintenance building floor drain have no OWS to intercept POL before discharging directly into a nearby river.
NA	Landfill Operations Must Meet Specific Requirements	The write-up states: "The installation commander shall ensure contractors meet specific landfill standards." It is unknown whether the landfill is sited on-base and owned/operated by DoD personnel, or off-base and owned/operated by civilian personnel.
10	Improper Disposal of Lighting Ballasts	Ballast units removed from fluorescent lighting fixtures discarded to trash with no attempt to identify if they contain PCBs.
NA	Improper Disposal of Possible ACM	Basewide finding. Possible ACM removed during facility maintenance discarded as general refuse.
NA	Domestic Wastewater Discharge	Basewide finding. The six septic tank effluents discharging into a local stream not characterized.
NA	Industrial Wastewater Discharge	Basewide finding. Vehicle wash rack drains directly into a local stream without separation of oil/fuels.
Suwon Air Base - June 1996		
2214	Failure to Take USTs Out of Service	Five USTs that failed the annual tightness test (date of last tightness test not provided) have not been taken out of service.
2214	No Monthly Inventory of USTs Basewide	Monthly inventory of USTs not being conducted per requirements. No system in pace to track individual tank inventories and detect leaks between annual tightness testing.
2348	Lack of Wash rack and OWS	The Army Motor Pool washes vehicles with no wash rack or OWS.

Suwon Air Base - June 1996 (Continued)		
Location	Finding Title	Details
2218	Inadequately Designed OWSs	Several OWSs have been constructed to not only receive facility oily water, but also yard storm water which overload the system and cause oil to be discharged. Facilities at 2208 and 2506 have sinkholes that allow the waste stream to discharge directly into the ground before entering the OWS.
NA	Landfill Operations Must Meet Specific Requirements	The write-up states: "The installation commander shall ensure contractors meet specific landfill standards." It is unknown whether the landfill is sited on-base and owned/operated by DoD personnel, or off-base and owned/operated by civilian personnel.
NA	Improper Disposal of Lighting Ballasts	Basewide finding. Ballast units removed from fluorescent lighting fixtures discarded to trash with no attempt to identify if they contain PCBs.
NA	Improper Disposal of Possible ACM	Basewide finding. Possible ACM removed during facility maintenance discarded as general refuse.
NA	Wastewater Monitoring	Basewide finding. Discharge inappropriately sampled (grab versus composite) to determine compliance with standards.
2103	Domestic Wastewater Monitoring	Discharges from wastewater treatment systems at buildings 2103 and 2541 no analyzed for all required constituent/parameters.
2541	Oil Discharges to Treatment Plant	Oil was discharging to Area B wastewater treatment facility, flowing through the Imhoff tank and discharging to a stream.
2541	Sludge Disposal	Accumulated sludge in Area A and B (buildings 2103 and 2541) Imhoff tanks not analyzed and disposed in the past two years.
Taegu Air Base - June 1996		
3571	No Monthly Inventory of USTs Basewide	Monthly inventory of USTs not being conducted per requirements. No system in pace to track individual tank inventories and detect leaks between annual tightness testing.
6220	Suspected Leaking UST Not Removed From Service	A concrete UST at the bulk fuel storage pump house holding JP-4 is suspected of leaking. The ROKAF uses the tank to empty railcar drip pans until JP-4 is pumped back into the system.
3571	Failure to Take USTs Out of Service	Six USTs that failed the annual tightness test (date of last tightness test not provided) have not been taken out of service.

Taegu Air Base - June 1996 (Continued)		
Location	Finding Title	Details
5012	JP-4 Discharged to Ditch	The JP-4 recovery system (skim off product, then pump and treat) is not effective. Treatment is a large OWS whose flow is too high to allow the JP-4 to float to the top of the water. The small of JP-4 can easily be detected at the discharge point. There is no evidence that the discharge has ever been analyzed. The system has been operating since 1972 (?).
109	Oil Discharges to Imhoff Tank	POL spills have occurred into the Imhoff tank causing a biological process failure and oil discharge to surface waters.
3571	No Containment of Wash Racks and Fuel Transfer Area	There is a high potential for POL to enter the waters of the ROK from the lack of OWSs at wash racks throughout the base and a lack of secondary containment at fuel transfer areas at the gas station, truck fill stands, and railcar off-loading areas.
NA	Landfill Operations Must Meet Specific Requirements	The write-up states: "The installation commander shall ensure contractors meet specific landfill standards." It is unknown whether the landfill is sited on-base and owned/operated by DoD personnel, or off-base and owned/operated by civilian personnel.
3605	Improper Disposal of Lighting Ballasts	Ballast units removed from fluorescent lighting fixtures discarded to trash with no attempt to identify if they contain PCBs.
NA	Improper Disposal of Possible ACM	Basewide finding. Possible ACM removed during facility maintenance discarded as general refuse.
NA	Septic Tank Wastewater Discharge	Basewide finding. Domestic waste discharged to the surface waters from 14 septic tanks not tested to ensure compliance with effluent standards.
NA	OWS Discharges	Basewide finding. Oily water was discharged to the ground or surface waters at various facilities. Water not characterized.
109	Domestic Wastewater Sludge	Sludge from the drying bed not characterized to determine appropriate disposal procedures.

Kunsan Air Base -		
Location	Finding Title	Details
1050	Leaking AST	No further information exists for these findings at Kunsan Air Base.
818	POL Release	
705	UST Overfill Spills	
2852	Fuel Tank Overfilled	
1060	Tank Leak/Open Dike Drain	
2855	Fuel Tank Overfilled	
828	Possible Underground Pipe Leak	
396	Raw Sewage Discharge	
399	Overloaded Wastewater Treatment System	The existing sewage treatment facilities provide only primary treatment. The six Imhoff settling tanks are operating well above their design capabilities, resulting in effluent discharges which constantly exceed EPA standards and do not comply with Korean environmental laws
Area 1-West (Various)[1] - March 1996		
NA	No Internal Assessments Performed	Area 1 West installations have not performed internal environmental compliance assessments since 1993.
NA	Domestic Wastewater Discharge	The septic tanks at Camp Sears, Shinbuk Relay and Yawolsan discharge directly into the environment. The effluent has never been characterized nor is there any monitoring presently conducted. None of the septic tanks have leach fields.
H-220 Heliport	Contaminated Soil	Soil contaminated by heating oil from the repair of a broken underground supply line from an AST near Bldg T 2673 has not been removed. The area of contamination is estimated at approximately 2.5 m at base, 2 m in height, and of undetermined depth.
NA	UST Overfill	USTs throughout Area I West lack containment provisions for spillage of fuel during filling. Fuel stained soil was noted at USTs throughout Area I West.

[1] Includes camps in the Uijongbu and Tongduchon Enclaves: Camp Falling Water, Camp Red Cloud, Camp Essayons, Camp Sears, Camp Kyle, Camp LaGuardia, Camp Jackson, Camp Stanley, Camp Kwangsa-ri, Camp Casey, MPRC and All Training Ranges, Camp Mobile, H-220, Camp Hovey, Yawolsan, Shinbuk Relay Station, Kamaksan, Camp Castle, Camp Nimble

Area 1-West (Various) - March 1996 (Continued)		
Location	Finding Title	Details
Shinbuk Relay	Leaking ASTs	Two heating fuel oil supply line valves from three ASTs located above the Shinbuk Relay facility bunker are leaking fuel. The area of contaminated soil runs a distance of approximately four feet from the valves toward the edge of the top of the bunker. The ASTs are temporary replacements for a leaking UST located in the body of the bunker that has been taken out of service. The ECAS report does not mention if the area around the leaking UST had been previously characterized or contaminated soil removed. However, personnel noted fuel leaking from fractures in the concrete face of the bunker running into the stormwater drainage culvert.
Shinbuk Relay	Leaking Secondary Containment Around AST	The secondary containment to the fuel oil AST located behind the dining facility lacks a stormwater drain valve. Fuel oil leaking from the AST plumbing has discharged from the containment onto the ground on a downhill slope for a distance of approximately ten feet.
Camp Stanley - March 1996		
NA	Wastewater Discharge	The wastewater treatment plant fails to meet the effluent standards for 5-day BOD. The monthly 5-day BOD average for Jan and Feb 96 was 39 mg/L; the effluent standard is 30 mg/L. The 5-day BOD standards were also exceeded during the last quarter of 1995. There is a high amount of grease in the influent causing the plant to "under-perform."
Camp Essayons - March 1996		
NA	Wastewater Discharge	The wastewater treatment plant fails to meet the effluent standards for 5-day BOD (annual average 5-day BOD for 1995 was 68 mg/L; the effluent standard is 60 mg/L).
Camp Castle - March 1996		
NA	Wastewater Discharge	The wastewater treatment plant fails to meet the effluent standards for 5-day BOD. The monthly 5-day BOD average for 1995 was 71 mg/L; the effluent standard is 60 mg/L. Failure is due mainly to lack of OWSs.

Camp Casey- March 1996		
Location	Finding Title	Details
Railhead	Contaminated Soil	The crushed rock area between and around the rails at the Camp Castle Railhead, along the edge of the railhead where fuel is transferred from tank cars to storage tanks, and where couplings are kept, is stained with POL from past spills and leaks.
NA	Wastewater Discharge	The wastewater treatment plan is about 30 percent hydraulically overloaded. The plant meets effluent standards, but, occasionally, during heavy inflow, untreated influent is bypassed through the lift stations to a nearby creek.
NA	Improper Disposal of Suspected Hazardous Waste	The 702 MSB battery shop neutralizes battery acid and discharges it to the sanitary sewer without characterizing it for hazardous characteristics (heavy metals).
4th CHEM	Contaminated Soil	The soil area between the 4th CHEM's western perimeter fence and the stormwater draining culvert leading to Camp Casey's fresh water supply, and the stone wall embankment are stained with POL products that have leaked from drums stored outside the 4th CHEM's containment area.
1/72 AR BN	Contaminated Soil	A member of the 1/72 AR BN was observed draining a 5 gallon can of oil into a trash container in the northeast corner of the motor pool. Inspection of the trash container revealed POL residues indicating draining of POL containers into the trash is not an uncommon practice in this motor pool. On the concrete paving near this trash accumulation point was a previous used POL release that covered approximately 3 m^2. Older POL release stains in this area extend along the sandbags at the edge of the pavement for a distance of approximately 10 m. The write-up did not specify site characterization or cleanup as a corrective action.
Camp Red Cloud- March 1996		
TMP	Improper Disposal of Suspected Hazardous Waste	The TMP neutralizes battery acid and discharges it to the sanitary sewer without characterizing it for hazardous characteristics (heavy metals).
Camp Kyle- March 1996		
3120	Contaminated Soil	Soil contaminated by fuel oil has not been removed. The fuel oil came from the installation of a temporary AST.

Western Corridor and Camp Page (Various)[2] - February 1997

Location	Finding Title	Details
NA	Western Corridor Water Supplies Exceeded Lead/Copper Action Levels in 1995 and 1996	Installations exceeding lead/copper action levels include: Camps Howze, Garry Owens/Giant, Bonifas/Liberty Bell, Stanton, Greaves, Edwards, Swiss/Swede, Warrior Base, and Bulls Eye.
NA	Abandoned Water Supply Wells in the Western Corridor Are Not Properly Sealed	Abandoned wells, if not properly sealed, may provide a pathway for contaminants to enter the groundwater aquifer. The ECAS report did not specify how long the wells were open before discovery.
NA	No Internal Assessments Performed	Western Corridor installations and Camp Page have not performed internal environmental compliance assessments since 1993.
NA	No Site Investigations	Western Corridor installations and Camp Page have not been screened for possible contamination from past use of fuel and hazardous substances. Camps Page and Edwards have been conducting bulk fuel operations for as long as the camps' existence. Both camps operate railheads that receive fuel by rail with associated pump stations and UST/AST. In addition, Camps Edwards and Howze show elevated levels of TCE in the groundwater.
NA	Camps Howze and Edward Water Supplies Exceeded TCE MCL in 1996	Despite the high TCE levels, suggested corrective action for the ECAS finding only recommended alternative water supplies (an aeration tower for Camp Howze is in the final design stage, with construction completion estimated for Dec 97). No remedial action or site investigation was suggested.
NA	Effluent from Camps Swiss/Swede, Bulls Eye, and Ouellette Discharges into Fields/Streams	The ECAS report does not specify how long this conditions has existed (presumably, for the life of the installations which date back to the Korean War).
NA	Western Corridor Wastewater Plants Occasionally By-Pass Untreated Sewage	During the rainy season, wastewater plants become overloaded and untreated sewage is bypassed to keep plants operational. Many sewer systems manholes are below the flood level and many sewer pipes are broken or cracked.
NA	UST Overfill	UST heating oil fill points throughout Western Corridor installations were stained with POL from filling operations. The ECAS report did not specify site investigations as one of the suggested corrective actions.

[2] Includes Camp Edwards, Bull's Eye #1, Bull's Eye #2, Camp Howze, Camp Pelham, Camp Giant, Camp Bonifas, Camp Stanton, Camp Greaves, Charlie Block, Freedom Bridge, Liberty Bell, Papyongsan ATC, DMZ South Half, Joint Security Area MAC HQ, and Swiss/Swede CP MAC HQ

Location	Finding Title	Details
Warrior Base - February 1997		
Location	Finding Title	Details
NA	Warrior Base Wastewater Treatment System Unsatisfactory	Warrior Base currently maintains six septic tanks for wastewater treatment. The septic tank leaching wells are clogged and the effluent from the septic tanks is piped to a drainage ditch. This effluent does not meet the FGS criteria. Although a new wastewater treatment system is currently under construction, no site investigation for past contamination was suggested in the ECAS report.
Camp Giant - February 1997		
T-36	Bldg T-36 Not Connected to the Sewer System	The facility contains a shower facility, wash basin, and urinal, and is currently draining to a storm drain. The ECAS report does not describe the facility's current or past use, which may have produced hazardous waste.
Camp Edwards - February 1997		
Location	Finding Title	Details
Health/ Dental Clinic	X-Ray Silver Recovery Unit Effluent Not Monitored	The recovery unit consists of a plastic pail with a filter to absorb silver. No laboratory analysis of the effluent is conducted prior to release to the sewer system. Current detection technique consists of using a detection paper with insufficient sensitivity (detects g/L rather than mg/L).
Camp Stanton - February 1997		
Wash Rack	Raised Donut of Soil Located Next to Eastern-Most Wash Rack Heavily Stained With Waste POL	The donut's interior diameter was approximately 1.5 meters and its height approximately 20 centimeters. The interior of the structure had a native soil floor and was black from used POL. The donut structure appeared to have been a dumping site for POL removed from the accumulation chamber of the adjacent wash rack or used POL.
Runway	Contaminated Soil	The crushed rock parking area for helicopter fueling is stained with POL. An area approximately 6 square meters is stained with fuel from accumulation of fuel releases.
T-26	Contaminated Soil	The fill pipe plumbing to the heating oil UST behind Bldg T-26 is leaking heating oil onto the soil and into a storm water drainage ditch. The ECAS report did not specify site investigation as one of the suggested corrective actions.

Camp Garry Owens - February 1997		
Location	Finding Title	Details
Motor Pool	Fuel Dispensing Nozzle Leaking Fuel Onto Ground (4-7th CAV C Troop Motor Pool)	The fuel leaking from the nozzle stained an area approximately 6 square meters. If fuel is released at this location such that it saturates the soil and begins to flow, it will flow unhindered until it reaches neighboring rice fields. No site investigation has been accomplished to characterize the area for past spills.
Motor Pool	A Tanker of JP-8 Parked in the Motor Pool Was Leaking Fuel Onto the Ground	The tanker was parked on native soil approximately three meters from the compound's perimeter fence. There is no containment provisions along the compound's fence, which is anchored directly over an adjoining stream.
Camp Greaves - February 1997		
NA	Fuel Pod 711 in the 7th KSC CO Compound	The fuel pod is located in a dug out area directly over a storm water run-off ditch, and contained significant POL stains on the ground under the plumbing of the tank. The ECAS report did not specify site investigation as part of the discrepancy's corrective action.
Wash Rack	Two Raised Donut Structures Stained With Used POL	The donut structures were approximately 1.5 meters in diameter and 20 centimeters high. It appeared the donuts had been used to receive residues from cleaning of the wash rack OWS.
20th Support Group Installations[3] - September 1996		
NA	No Internal Assessments Performed	The 20th Support Group installations (Taegu, Waegwan, and Pusan areas) have not performed internal environmental compliance assessments in the years between the external ECAS evaluations (since 1993)
NA	No Site Investigations	All installations within 20th Support Group (SG) with the exception of Camp Carroll have not been screened for past use of hazardous substances. As found through the Environmental Baseline Study conducted at Camp Carroll and contaminated groundwater sources with volatile organic compounds (VOCs) at Camps Carroll and Hialeah, potential contamination exists at all 20th SG installations and real properties with past storage or use of hazardous substances.

[3] Includes Camp Carroll, Camp Henry, Camp Walker, Dart Board, Salem, Taegu Storage Area, Kunsan POL Terminal, Brooklyn, Chang San, Camp Hialeah, K-9 Airfield, Pier #8, Pusan Storage Facility, Masan Ammo Depot, and Chejudo Training Center

20th Support Group Installations[3] - September 1996 (Continued)		
Location	Finding Title	Details
NA	Abandoned Wells Not Sealed	Available information indicates that existing water wells at Camps Walker, George, and Carroll were neither constructed nor installed in accordance with United States Standards (e.g. capping and sealing). One abandoned well at Camp George, and two abandoned wells at Camp Carroll were not sealed in accordance with the United States standards. During this assessment FED crew was at Camp Walker to seals its five abandoned wells. Protection of the ground water aquifer is critical to maintaining the ground water quality. An abandoned well's casing can corrode over time. An opening in a corroded casing can provide a pathway for pollutants to enter the ground water.
George, Walker	Contaminated Soil	Camp George uses a rotating biological contactor (RBC) for DODD schools, and Camp Walker uses Imhoff tanks for wastewater treatment. The effluent from these plants goes to city sewers as per agreement with the city of Taegu. The effluent quality is not monitored. The scum collected from the manual cleaning of the Imhoff tanks has not been picked up by a disposal contractor in several months. Currently, there are six, 55-gal drums full of scum at the Imhoff tank site, and one, 55-gal drum full of oil that had entered the Imhoff tank due to an accidental spill. The oil drum was overfilled and some oil has spilled to the surrounding ground.
Pusan Area	Stormwater Discharge Not Monitored	Stormwater discharge is not surveyed or analyzed at the Pusan area installations.
Chejudo Training Center - September 1996		
NA	Domestic Wastewater	Installation's domestic wastewater is treated by septic tanks. The effluent, which has never been monitored or characterized, discharges directly over a farmers field.
Motor Pool	Petroleum Film In Storm Water Culvert	A 4 mm thick, 30cm wide, 6 meter long petroleum film was observed atop water collected in the storm water runoff culvert on the west side of the Chejudo Recreation Center motor pool. The water and POL had accumulated because the exit point of the culvert had been blocked by the local farmer. The motor pool has not been in use since the facility was converted to a recreational facility. The POL may be residual from a UST leak that occurred prior to the conversion of the facility. That leak was reported in the 1993 ECAS.

Chejudo Training Center - September 1996 (Contined)		
Location	Finding Title	Details
NA	Contaminated Soil	There was no secondary containment for the fuel tank for the Chejudo Recreation Center potable water auxiliary water pump at the potable water source. Fuel that has leaked from the tank's drain line had stained an area approximately one meter by three quarters of a meter about the tank.
Auto Hobby Shop	Contaminated Soil	Adjacent to the Auto Hobby Shop, an unattended 55 gallon drum of used oil had been left in the weather with an open bung. Rain water accumulated atop the drum and flowed through the open bung displacing used oil. An area approximately 1 meter by 1.5 meters to the side of the drum is contaminated with released used oil.

APPENDIX 4-1: List of Persons Interviewed

Government, Republic of Korea			
Date	Organization	Person(s) Contacted	Position
12 Jun 97	Ministry of National Defense (ROK)	Col Yang, Im-Suk	Director, Office of Environmental Management
13 Jun 97	Korea Institute of Science and Technology	Dr. Yeom, Ick Tae	Senior Researcher
25 Jun 97	Ministry of Environment (ROK)	Mr. Cho, Hyun Goo	Acting Director, Soil Conservation Division
Academicians, Republic of Korea			
10 Jun 97	Hankuk University	Dr. Kang, Guyoung	Professor
17 Jun 97	Honam University	Mr. Song, Chang-Soo	Professor
17 Jun 97	Inha University	Dr. Bae, Jae-Cho	Professor
12 Jun 97	Kangwon National University	Dr. Kim, Bomchul	Director, Environmental Research Institute
23 Jun 97	Korea University	Dr. Lee, In-Mo	Professor
24 Jun 97	Kwangwoon University	Dr. Choi, Sangil	Professor
9 Jun 97	Seoul National University	Dr. Yi, Jongheop	Professor
Environmental Consulting Firms, Republic of Korea			
16 Jun 97	Hanwha Energy Corporation	Dr. Hwang, Jong-Sic	Team Manager, Environmental Business Team
Department of Defense			
7 Aug 97	Deputy Undersecretary of Defense for Environmental Security (DUSD(ES))	Mr. Gary Vest Mr. Mike McNerney	Principal Assistant Staff
7 Aug 97	Department of Defense, General Counsel	CMDR Mike Ritter	US/ROK SOFA Legal Advisor

Headquarters, United States Air Force			
Date	Organization	Person(s) Contacted	Position
5 Aug 97	Secretary of The Air Force (SAF/MIQ)	Col Richard Drawbaugh	Chief, Environmental Safety and Occupational Health
6 Aug 97	Headquarters, Air Force (AF/ILEO)	Col Thomas Griffith	Chief, Operations Division (Former Environmental Division Chief)
Headquarters, 7th Air Force			
23 Jun 97	7th Air Force	Lt Col Mike Royko Lt Col P. Christopher Clark	The Civil Engineer Deputy Staff Judge Advocate
Headquarters, United States Forces Korea			
16, 26 Jun 97	Environmental Programs Office	Mr. Ernest P. Eddy Mr. Mark Y. Kwon Mr. Yi, Sang-Hun Mr. James L. Duff	Chief Environmental Engineer Environmental Engineer Environmental Protection Specialist
Individual DoD Installations, Republic of Korea			
16-18 Jun 97 Kunsan Air Base	8th Civil Engineer Squadron, Environmental Flight	Capt Richard Baringer Capt Theodore Baudendistel Capt Charles Wendt	Flight Chief Chief, Compliance Chief, Pollution Prevention
	8th Medical Group	Capt Keith Groth	Bioenvironmental Engineer
	8th Fighter Wing	Capt Rogers	Environmental Law
20-23 Jun 97 Osan Air Base	51st Civil Engineer Squadron, Environmental Flight	Mr. Nicholas Linden Capt Raymond Tsui Capt Thomas Kwiat Capt Pete Domahowski	Flight Chief Deputy Chief Deputy Chief Chief, Hazardous Waste

Individual DoD Installations, Republic of Korea (Continued)

Date	Organization	Person(s) Contacted	Position
20-23 Jun 97 Osan Air Base (Continued)	51st Aerospace Medical Group	Lt Col (s) Roger E. Bousam SSgt Michael Middeleton	Bioenvironmental Engineer Bioenvironmental Engineering Technician
	51st Fighter Wing	Capt Lori Chang	Assistant Staff Judge Advocate
	607th Material Maintenance Squadron	1Lt Shannon McGlynn	Chief, Civil Engineer Flight
19 Jun 97 Camp Carroll	Environmental Office, Department of Public Works	Mr. Kim, Chom-Tong	Chief
24 Jun 97 Camp Casey	Environmental Office, Department of Public Works	Mr. Yi, Tu-Ha	Chief
25 Jun 97 Camp Market	Defense Reutilization and Marketing Office	Mr. William Donnelly	Chief, Environmental Programs

APPENDIX 5-1 - Summary of Significant Findings

	U.S Law and DoD Policy Governing Overseas Remediation	
	Significant Findings	Degree of Convergence
1.	U.S. environmental laws do not require remediation of hazardous waste sites in Korea • Confirmed by literature and personal interviews • Not likely to change, but Congressional interest in overseas restoration program increasing	**Convergent**

2.	Acceptability/Adequateness of DoD overseas remediation policy
	• DoD policy makers believe policy adequate/acceptable
	• Installations believe policy too "vague"
	• Issues:
	  • Differing definition of "imminent and substantial endangerments to human health"
	  • Vague definition complicates project justification, prioritization
	  • Poor organizational structure for managing restoration program
	  • Recommended solution: Health risk-based standard
		Divergent

3.	Cleanup precedents set in other foreign countries influence future remediation policy • Differing opinions on amount of effect • No change to policy versus eventual change due to international law considerations	**Partial**

4.	Current DoD remediation policy may allow ROK access to data on contaminated sites on DoD installations
	• DODI 4715.8, Paragraph F3 (only source of finding; not validated by other methodologies)
	• Differing opinions on effect
	  • Negative: Increase public pressure
	  • Positive: Openness may foster goodwill, cooperative spirit between U.S. and ROK
		Divergent

	International Agreements	
1.	International agreements do not require DoD activities to remediate hazardous waste sites prior to their closure and return to Korea • Confirmed by literature review and personal interviews • Explicitly stated in Article IV, U.S./ROK SOFA	**Convergent**
2.	International agreements will be revised in future years to require remediation of hazardous waste sites in Korea • Differing opinions on possibility of revision • March 1993 Supplementary Agreement with Germany • ROK Officials: Current U.S./ROK SOFA "unfair"	**Partial**

	Significant Findings	Degree of Convergence
	International Agreements (Continued)	
3.	The SOFA may allow DoD individuals to be incriminated for violation of Korean environmental law, or held responsible for damages to third parties resulting from contamination • Divergent between literature and personal interviews • DoD Legal Officials: Never • Literature: Possible given: • Increase in Korean requests for exclusive jurisdiction • Title 18 USC Chapter 45, Section 956 • Tort law and Aricle XXIII	**Divergent**
	ROK Environmental Law and Current Environmental Conditions	
1.	The level of ROK environmental awareness and compliance with Korean environmental law is increasing • Confirmed by literature review and personal interviews • MND environmental program is notable indicator of positive change	**Convergent**
	Current Environmental Conditions (DoD)	
1.	Suspected and confirmed hazardous waste sites, contaminated primarily with petroleum, oils and lubricants (POL), organic solvents, and heavy metals, exist at numerous locations throughout the peninsula • Confirmed by literature review, personal interviews, and field observations • Primarily POL, organic solvents, heavy metals • Eight confirmed sites • 37 additional sites at Osan Air Base (Possible) • 79 additional sites Korea-wide (Possible)	**Convergent**
2.	Drinking water wells at several main operating bases (MOBs) and collocated operating bases are contaminated with POL and organic solvents • Confirmed by literature review, personal interviews, and field observations • Osan Air Base: 24 wells • Camp Carroll: 7 of 13 wells • Suwon Air Base: 4 wells • Taegu Air Base: 2 of 7 wells • Camp Casey: 2 of 23 wells	**Convergent**

Opportunities for Cooperation		
	Significant Findings	Degree of Convergence

1.	Numerous opportunities for cooperation between DoD and the ROK government exist in the field of environmental remediation
	• Confirmed by literature review and personal interviews
	• Includes the following relating to remediation:
	  • Training materials
	  • Advanced education (graduate and post-graduate studies)
	  • Technology transfer
	• "Easy target" for success; supported by DoD and ROK
		Convergent

	Other	

1.	Funding Problems
	• Confirmed by literature review and personal interviews
	• Does not directly influence remediation policy, but influences execution
	  • Insufficient resources → poor execution
	  • Solutions:
	    • ROK pays for remediation at ROKFC project sites
	    • Develop sound strategic funding strategy
		Convergent

APPENDIX 5-2: Treaties To Which The Republic of Korea Is a Signatory

Title	Effective Date	U.S. Signatory?
Amendments to the Annexes to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter	Unknown	**YES**
Protocol relating to modification of the International Convention for the Conservation of Atlantic Tunas	Unknown	**YES**
Protocol relating to the International Convention for the Safety of Live (SOLAS PROT 1988)	Unknown	**YES**
Agreement establishing the Fund for the Development of the Indigenous Peoples of Latin America and the Caribbean	Unknown	**NO**
Protocol to amend Paragraph 2 of Article X of the International Convention for the Conservation of Atlantic Tunas	Unknown	**YES**
Constitution of the World Health Organization	17 Aug 49	**YES**
Constitution of the Food and Agriculture Organization of the United Nations	25 Nov 49	**YES**
Agreement for the Establishment of the Asia Pacific Fishery Commission	19 Jan 50	**YES**
Constitution of the United Nations Educational, Scientific and Cultural Organization	14 Jun 50	**YES**
Convention on International Civil Aviation Annex 16 Aircraft Noise	11 Dec 52	**YES**
International Agreement for the Creation of an International Office for dealing with Contagious Diseases of Animals at Paris	21 Nov 53	**YES**
International Plant Protection Convention	8 Dec 53	**YES**
Agreement of the International Bank for Reconstruction and Development	26 Aug 55	**YES**
Agreement of the International Monetary Fund	26 Aug 55	**YES**
Convention of the World Meteorological Organization	16 Mar 56	**YES**
Agreement concerning the organization of a Joint Institute for Nuclear Research	26 Mar 56	**NO**
Statute of the International Atomic Energy Agency	8 Aug 57	**YES**
Articles of Agreement of the International Development Association	18 May 61	**YES**
Convention on the International Maritime Organization	10 Apr 62	**YES**
Convention on the Liability of Operators of Nuclear Ships	25 May 62	**NO**
Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and under Water	24 Jul 64	**YES**
International Convention for the Safety of Life at Sea	26 May 65	**YES**
Agreement establishing the Asian Development Bank	22 Aug 66	**YES**
General Agreement on Tariffs and Trade	14 Apr 67	**YES**
Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies	13 Oct 67	**YES**

Title	Effective Date	U.S. Signatory?
Statutes of the International Centre for the Study of the Preservation and Restoration of Cultural Property	22 Jul 68	**YES**
Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects launched into Outer Space	4 Apr 69	**YES**
International Convention relating to Intervention on the High Seas in Cases of Oil Pollution Casualties	29 Nov 69	**YES**
International Convention for the Conservation of Atlantic Tunas	28 Aug 70	**YES**
Convention on Road Traffic	14 Jun 71	**YES**
Convention placing the International Poplar Commission within the Framework of the Food and Agriculture Organization of the United Nations	16 Jan 73	**YES**
Convention on the Recognition and Enforcement of Foreign Arbitral Awards	9 May 73	**YES**
Treaty on the Non Proliferation of Nuclear Weapons	23 Apr 75	**YES**
Convention on the International Regulations for Preventing Collisions at Sea	29 Jul 77	**YES**
International Convention for the Prevention of Pollution of the Sea by Oil,1954, as amended in 1962 and 1969	31 Oct 78	**YES**
International Convention for the Regulation of Whaling	28 Dec 78	**YES**
International Convention on Civil Liability for Oil Pollution Damage	18 Mar 79	**YES**
International Convention for Safe Container (CSS)	18 Dec 79	**YES**
Convention on International Liability for Damage caused by Space Objects	14 Jan 80	**YES**
Vienna Convention on the Law of Treaties	27 Jan 80	**YES**
International Convention for the Safety of Life at Sea (SOLAS)	31 Mar 81	**YES**
Convention on Registration of Objects Launched into Outer Space	14 Oct 81	**YES**
Amendment of the Plant Protection Agreement for the Asia and Pacific Region	19 Oct 81	**NO**
Plant Protection Agreement for the Asia and Pacific Region	4 Nov 81	**NO**
Protocol Additional to the Geneva Conventions of 12 August 1949 and relating to the Protection of Victims of International Armed Conflicts (Protocol I)	15 Jul 82	**YES**
Protocol Additional to the Geneva Conventions relating to the Protection of Victims of Non International Armed Conflicts (Protocol II)	15 Jul 82	**YES**
Protocol relating to the International Convention for the Safety of Life at Sea (SOLAS Prot.)	2 Mar 83	**YES**
International Convention for the Prevention of Pollution from Ships as Modified by the Protocol of 1978	23 Oct 84	**YES**
Convention on the Conservation of Antarctic Marine Living Resources	28 Apr 85	**YES**
Constitution of the United Nations Industrial Development Organization	21 Jun 85	**YES**
International Tropical Timber Agreement	25 Jun 85	**YES**
International Convention on Standards of Training, Certification and Watchkeeping for Seafarers	4 Jul 85	**YES**

Title	Effective Date	U.S. Signatory?
The Antarctic Treaty	28 Nov 86	**YES**
Convention on the Prohibition of Military or any other Hostile Use of Environmental Modification Techniques	2 Dec 86	**YES**
Convention on the Physical Protection of Nuclear Material	8 Feb 87	**YES**
Treaty on the Prohibition of the Emplacement of Nuclear Weapons and other Weapons of Mass Destruction on the Sea Bed and the Ocean Floor and in the Subsoil thereof	25 Jun 87	**YES**
Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction	25 Jun 87	**YES**
Convention on the Law of Treaties between States and International Organizations or between International Organizations	29 Jun 87	**YES**
Protocol to the International Convention for the Regulation of Whaling	29 Dec 87	**YES**
Convention on the Regulation of Antarctic Mineral Resource Activities	25 Nov 88	**YES**
Convention concerning the Protection of the World Cultural and Natural Heritage	14 Dec 88	**YES**
Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare	4 Jan 89	**YES**
Convention on Early Notification of a Nuclear Accident	9 Jul 90	**YES**
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	9 Jul 90	**YES**
International Convenant on Economic, Social and Cultural Rights	10 Jul 90	**YES**
International Covenant on Civil and Political Rights	10 Aug 90	**YES**
Agreement establishing the European Bank for reconstruction and development	14 Jan 91	**NO**
International Plant Protection Convention (Revised Text)	4 Apr 91	**YES**
Charter of the United Nations	17 Sep 91	**YES**
Convention for the Protection of the Ozone Layer	27 May 92	**YES**
Protocol on Substances that deplete the Ozone Layer	27 May 92	**YES**
Protocol to the Antarctic Treaty on Environmental Protection	2 Jul 92	**YES**
Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and their Destruction	14 Jan 93	**YES**
International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage	8 Mar 93	**YES**
Protocol to the International Convention on Civil Liability for Oil Pollution Damage	8 Mar 93	**NO**
Amendment to the Montreal Protocol on Substances that deplete the Ozone Layer	10 Mar 93	**YES**
Convention on International Trade in Endangered Species of Wild Fauna and Flora	7 Oct 93	**YES**

Title	Effective Date	U.S. Signatory?
Amendment to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (art XI)	7 Oct 93	**YES**
Convention on Future Multilateral Cooperation in the Northwest Atlantic Fisheries (NAFO)	21 Dec 93	**YES**
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter	20 Jan 94	**YES**
Amendments to Annexes to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter concerning Incineration at Sea	20 Jan 94	**YES**
Framework Convention on Climate Change	21 Mar 94	**YES**
Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal	29 May 94	**YES**
Convention on Nuclear Safety	20 Sep 94	**YES**
Convention on Biological Diversity	1 Jan 95	**YES**
Amendment to the Montreal Protocol on Substances that deplete the Ozone Layer	2 Mar 95	**YES**
Convention establishing a marine scientific organization for the North Pacific Region (PICES)	1 Aug 95	**YES**
Agreement for the Establishment of the Indian Ocean Tuna Commission	27 Mar 96	**NO**
United Nations Convention on the Law of the Sea	27 Apr 96	**NO**
Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982	28 Jul 96	**YES**
International Convention to combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa	26 Dec 96	**YES**
International Tropical Timber Agreement	1 Sep 97	**YES**

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EDWIN H. OSHIBA, Capt, USAF

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Air Force Institute of Technology (AFIT)
2950 P. Street
Wright Patterson AFB, OH 45433-7765

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9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Institute for National Security Studies (INSS)
2354 Fairchild Drive, Suite 4D33
USAF Academy, CO 80840-6258

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13. ABSTRACT *(Maximum 200 words)*
The purpose of this research was to provide information to DoD decision makers regarding factors influencing hazardous waste site remediation policy for South Korea. This study addressed: International agreements and U.S. and South Korean laws and policies relevant to hazardous waste sites; objectives of DoD environmental policy makers; extent and effects of soil and groundwater contamination; cleanup precedents set in other foreign countries; availability of resources and technical capabilities to investigate and remediate hazardous waste sites in South Korea; and opportunities for cooperation between the U.S. and South Korean military with regard to hazardous waste site remediation. Data were collected and compared using triangulation methodology. This research resulted in identification of multiple factors which have an impact on promulgation of DoD hazardous waste site remediation policy for South Korea to include: (1) human health risk; (2) Congressional support for remedial actions overseas; (3) cleanup precedents set in other foreign countries; (4) Korean and U.S. perceptions; (5) Korean environmental law; and, (6) impact of contaminated sites on wartime capabilities. More study is required to assess the influence each issue has on DoD hazardous waste site remediation policy for Korea based on the values of policy makers.

14. SUBJECT TERMS
Republic of Korea, South Korea,South Korean environment, hazardous waste site remediation, overseas cleanup policy, environmental law

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