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

THESIS

Edwin H. Oshiba, Captain

AFIT/ENV/97D-20



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## 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

December 1997

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To my wife, In-Kyong, and son Andy—There are no words which can adequately convey my heartfelt appreciation for your endless support, understanding and patience. I have made a habit of neglecting you, placing work and career before family, time and again. And yet, you continue to stand by me through it all. Throughout the past 18 months, you have been my encouragement. I just hope there will come a time when I can do for you what you have done for me.

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

Edwin H. Oshiba

*Table of Contents*

## *List of Figures*

Page

## *List of Tables*

Page

*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.

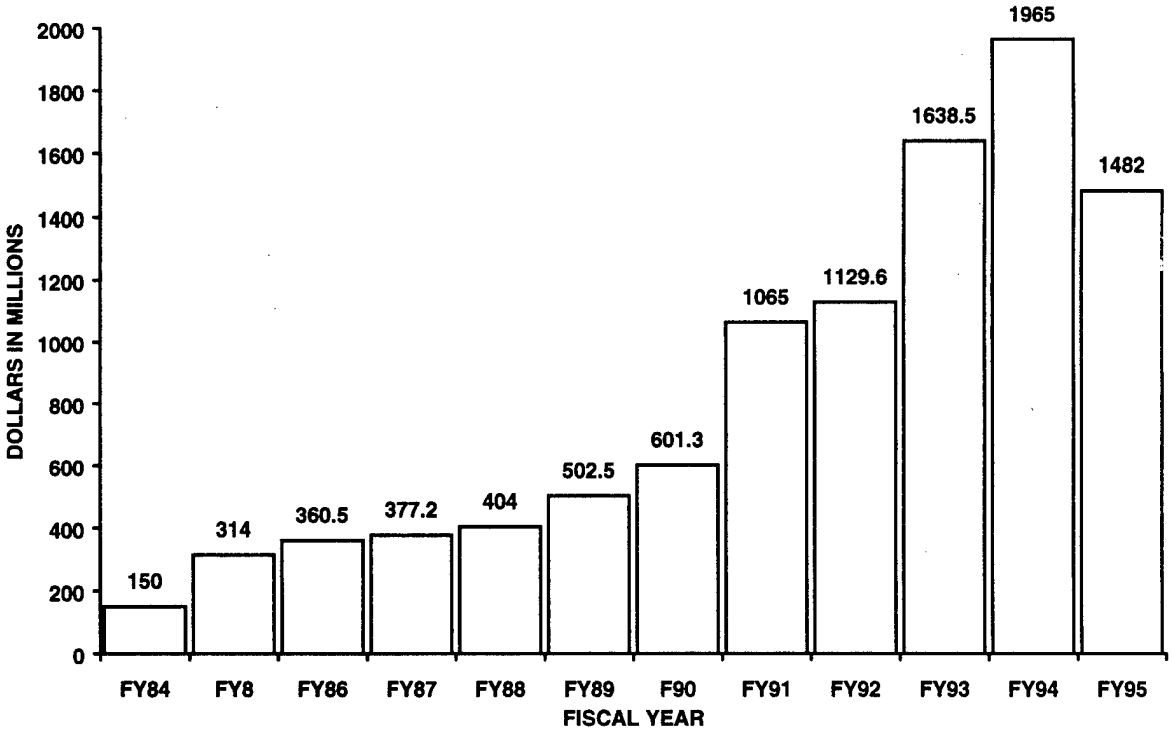


***Figure 1: Historical Defense Environmental Restoration Program (DERP) Appropriations*** (35)

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; 7$^{th}$ 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.

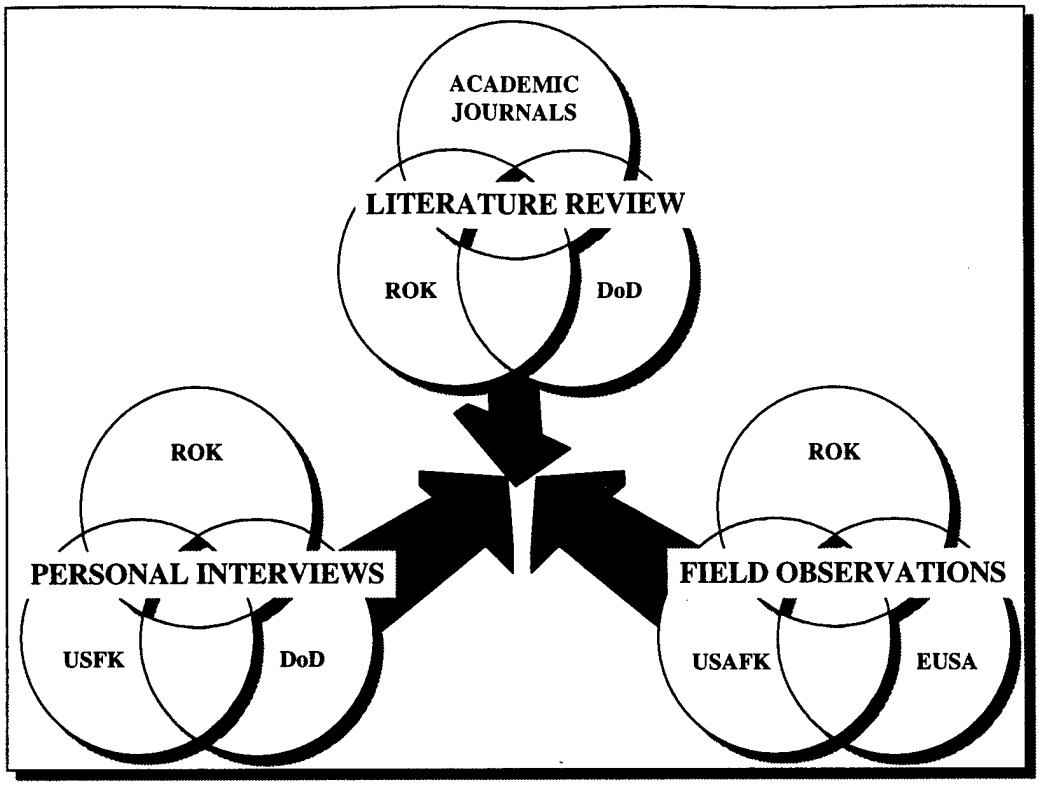


***Figure 2: Between-Method and Within-Method Triangulation Methodology***

## 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<br>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<br>2. Korean Government Environmental Policy |
| Honam University | Professor(s), Environmental Engineering | 1. Korean Remediation Technology<br>2. Korean Government Environmental Policy |
| Inha University | Professor(s), Environmental Engineering | 1. Korean Remediation Technology<br>2. Korean Government Environmental Policy |
| Kangwon University | Professor(s), Environmental Engineering | 1. Korean Remediation Technology<br>2. Korean Government Environmental Policy |
| Korea University | Professor(s), Environmental Engineering | 1. Korean Remediation Technology<br>2. Korean Government Environmental Policy |
| Kwangwoon University | Professor(s), Environmental Engineering | 1. Korean Remediation Technology<br>2. Korean Government Environmental Policy |
| Seoul National University | Professor(s), Environmental Engineering | 1. Korean Remediation Technology<br>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<br>2. Korean Government Environmental Policy |
| **Headquarters, 7th Air Force** | | |
| 7th Air Force | 1. Civil Engineer<br>2. Staff Judge Advocate | 1. DoD Environmental Policy in Korea<br>2. International Agreements |
| **Individual DoD Installations, Republic of Korea** | | |
| 8th Fighter Wing | 1. Chief, Environmental Flight<br>2. Staff Judge Advocate<br>3. Bioenvironmental Engineering | 1. DoD Environmental Policy in Korea<br>2. DoD Installation Condition<br>3. International Agreements<br>4. Local Public Perceptions |
| 51st Fighter Wing | 1. Chief, Environmental Flight<br>2. Staff Judge Advocate<br>3. Bioenvironmental Engineering | 1. DoD Environmental Policy in Korea<br>2. DoD Installation Condition<br>3. International Agreements<br>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<br>2. DoD Installation Condition<br>3. Local Public Perceptions |
| Camp Casey | Chief, Environmental Office, Department of Public Works | 1. DoD Environmental Policy in Korea<br>2. DoD Installation Condition<br>3. Local Public Perceptions |
| Camp Market | Chief, Defense Reutilization and Marketing Office, Environmental Programs | 1. DoD Environmental Policy in Korea<br>2. DoD Installation Condition<br>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).

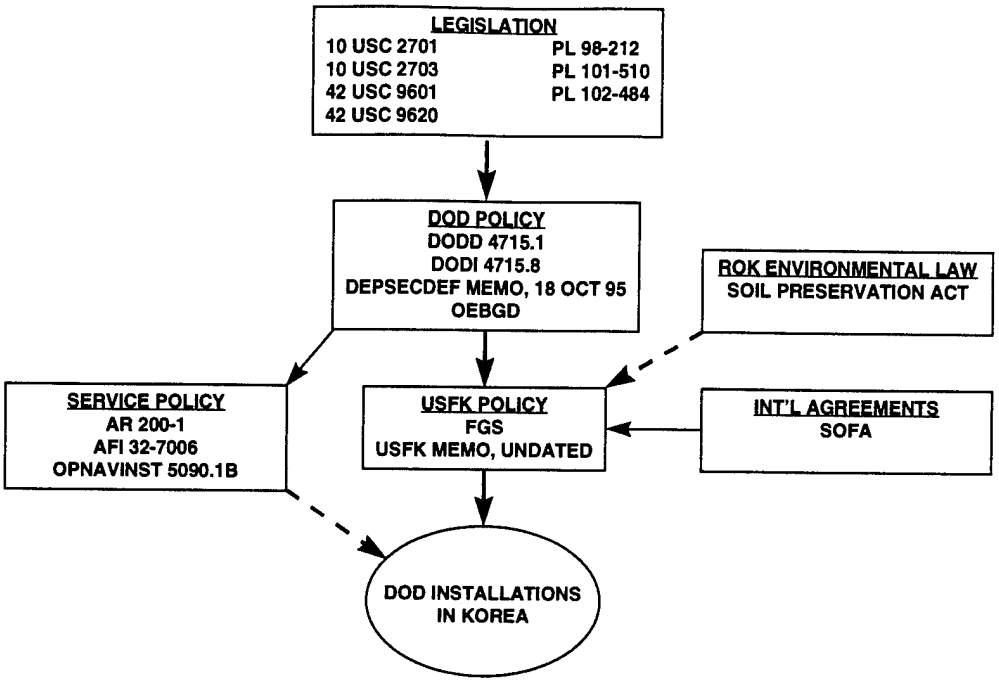


***Figure 3: Schematic Diagram—Promulgation of Hazardous Waste Site Remediation Policy for Korea***
(39; 40; 42; 43; 45; 48; 49; 115; 145; 154; 156; 157; 158; 159; 164; 172)

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).

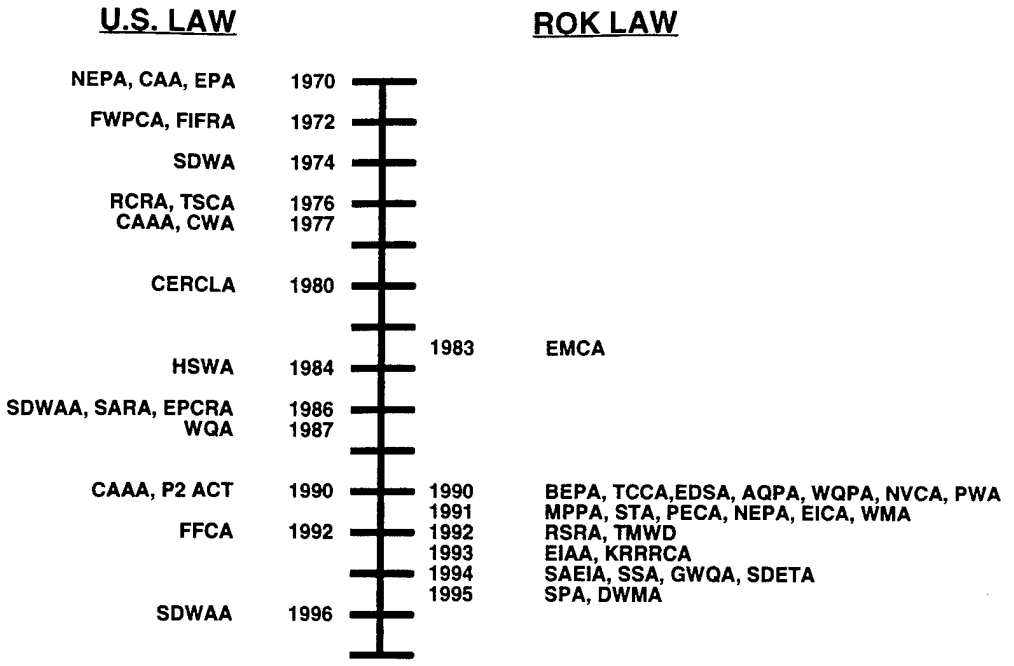


*Figure 4a: Development of Major Environmental Legislation—United States Versus Korea*

| U.S. LAW | | ROK LAW | |
|---|---|---|---|
| NEPA: | NATIONAL ENVIRONMENTAL POLICY ACT | BEPA: | BASIC ENVIRONMENTAL POLICY ACT |
| CAA: | CLEAN AIR ACT | EIAA: | ENVIRONMENTAL IMPACT ASSESSMENT ACT |
| CAAA: | CLEAN AIR ACT AMENDMENTS | AQPA: | AIR QUALITY PRESERVATION ACT |
| EPA: | ENVIRONMENTAL PROTECTION AGENCY | EMCA: | ENVIRONMENTAL MANAGEMENT CORPORATION ACT |
| FWPCA: | FEDERAL WATER POLLUTION CONTROL ACT | WQPA: | WATER QUALITY PRESERVATION ACT |
| FIFRA: | FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT | GWQA: | RULES AND REGS ON PRESERVATION OF GROUNDWATER QUALITY |
| SDWA: | SAFE DRINKING WATER ACT | DWMA: | DRINKING WATER MANAGEMENT ACT |
| SDWAA: | SDWA AMENDMENTS | STA: | ACT RELATING TO TREATMENT OF SEWAGE, NIGHT SOIL, AND LIVESTOCK WASTEWATER |
| TSCA: | TOXIC SUBSTANCES CONTROL ACT | SSA: | SEWER SYSTEM ACT |
| CWA: | CLEAN WATER ACT | MPPA: | MARINE POLLUTION PREVENTION ACT |
| WQA: | WATER QUALITY ACT | PWA: | POTABLE WATER ACT |
| RCRA: | RESOURCE CONSERVATION AND RECOVERY ACT | TCCA: | TOXIC CHEMICALS CONTROL ACT |
| CERCLA: | COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT | SPA: | SOIL PRESERVATION ACT |
| SARA: | SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT | WMA: | WASTE MANAGEMENT ACT |
| EPCRA: | EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT | TMWO: | ACT RELATING TO TRANSBOUNDARY MOVEMENT OF WASTES AND THEIR DISPOSAL |
| HSWA: | HAZARDOUS AND SOLID WASTE AMENDMENTS | KRRRCA: | KOREA RESOURCES RECOVERY AND REUTILIZATION CORPORATION ACT |
| P2 ACT: | POLLUTION PREVENTION ACT | EICA: | ACT RELATING TO ENVIRONMENTAL IMPROVEMENT CHARGES |
| FFCA: | FEDERAL FACILITIES COMPLIANCE ACT | 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***

| Contaminant | Threshold Value (in ppm) | | Action Value (in ppm) | | US Standards |
|---|---|---|---|---|---|
| | 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***

| Contaminant | Threshold Value (in ppm) | | | US Standards |
|---|---|---|---|---|
| | 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

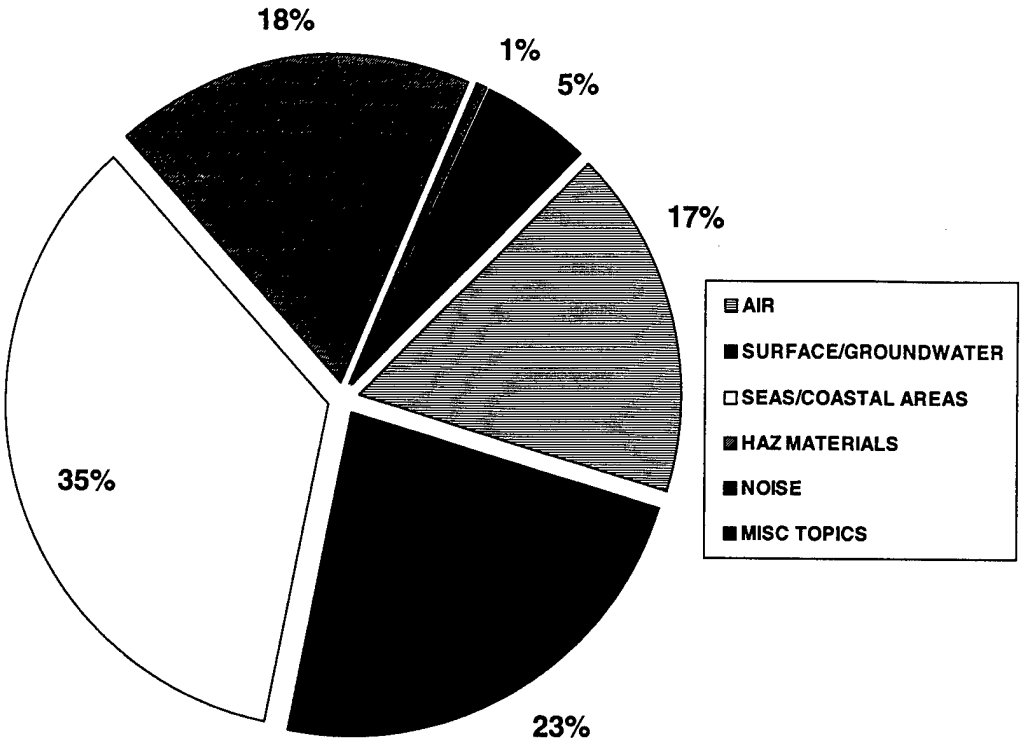


*Figure 5: Distribution of Journal Article Subjects*

| | 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. Korean Environmental Policy and Current Environmental Conditions.

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. Laws Applicable to Remediation of Hazardous Waste Sites.

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).