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EDP/F-01 (77)

Environmental Development Plan



Oil Shale-FY 1977

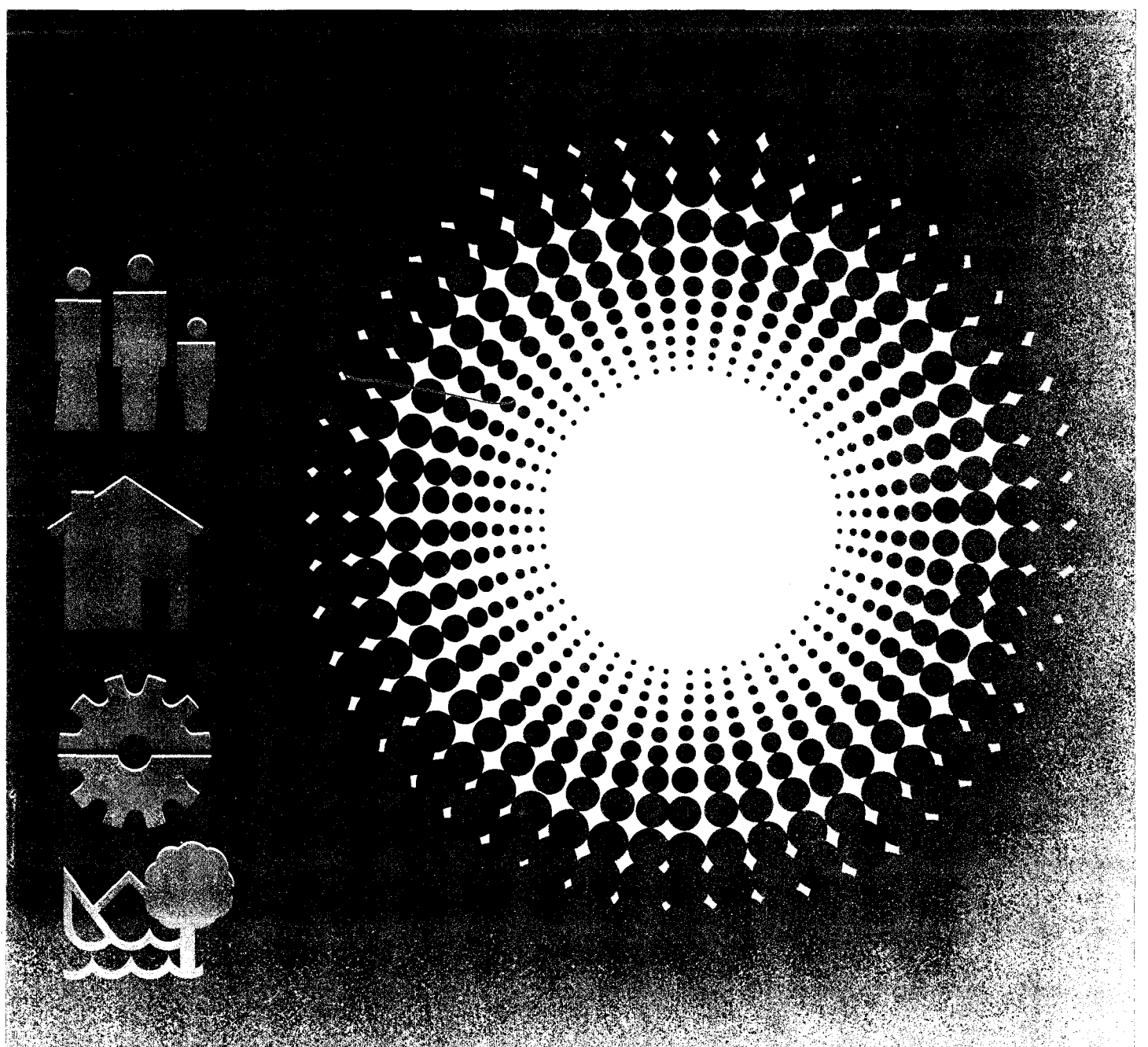
June 1977

Billy Lockridge -
233-4086

**U.S. Energy Research & Development
Administration**

Office of Assistant Administrator for
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MASTER



Environmental Development Plan (EDP)

**OIL SHALE PROGRAM
(FY 1977)**

June 1977

**U.S. Energy Research & Development
Administration**

**Office of Assistant Administrator for
Environment and Safety**

**Office of Assistant Administrator for
Fossil Energy**

OIL SHALE PROGRAM
ENVIRONMENTAL DEVELOPMENT PLAN

PREPARED BY: John D. Powderly DATE: 6/22/77
CO-CHAIRMAN, AFE

Ralph Franklin DATE: 6/22/77
CO-CHAIRMAN, AES

CONCURRENCE: Morris S. Singer DATE: 6/24/77
DIRECTOR, ESP

Wash D. Coathie
by J.W. Wallace DATE: 6/23/77
DIRECTOR, OGST

Nathaniel F. Barr DATE: 6/22/77
DIRECTOR, DTO

Ron WA Williams DATE: 7/6/77
ASSISTANT ADMINISTRATOR, APAE

Mary E. Tynan for M.C. ... DATE: 6/29/77
CONTROLLER, OC

APPROVAL: Brian ... DATE: 7/7/77
ASSISTANT ADMINISTRATOR, AFE

James L. Liverman DATE: 7/7/77
ASSISTANT ADMINISTRATOR, AES

ENVIRONMENTAL DEVELOPMENT PLAN

OIL SHALE PROGRAM

JUNE 1977

ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

Technology Program Office: Oil, Gas, and Shale Technology
Division of Fossil Energy

Technology Program: Oil Shale

Contact: Matthew Reilly, ESP
20 Massachusetts Avenue, Room 4211
(202) 376-9086

Robert M. Jameson, DTO
20 Massachusetts Avenue, Room 2512
(202) 376-9073

Jerry W. Ramsey, OGST
20 Massachusetts Avenue, Room 4121
(202) 376-4868

This Environmental Development Plan is used for planning the environmental, health, and safety research activities for the ERDA Oil Shale Program. The Plan is subject to changes and will be updated annually.

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1. INTRODUCTION

1.1 Purpose

This Oil Shale Environmental Development Plan (EDP) identifies and examines the environmental, health, safety, and socio-economic issues concerning the development of the ERDA Oil Shale Program, the requirements and actions needed to resolve these issues, and a time-phased action plan for the evaluation and mitigation of environmental impacts. This Plan has been formulated in accordance with the requirements and objectives of ERDA Immediate Action Directive (IAD) No. 0500-4 dated December 14, 1976. This EDP is the primary document to plan, budget, manage, and review the environmental activities for the ERDA Oil Shale Program. The work described herein provides for the continuous updating of criteria for judging the environmental acceptability of the ERDA Oil Shale Program.

1.2 Scope

The Plan addresses the oil shale energy system including mining, crushing and sizing, fracturing, in situ and surface retorting, product recovery and upgrading, transportation, and end use. The ERDA environmental activities and projects related to the oil shale technology development program are included in this Plan. Also included is a survey of activities of other Federal agencies which relate to oil shale environmental issues and requirements.

1.3 Perspective

This is the first ERDA Oil Shale EDP. Continuous interaction within ERDA and with other agencies will provide input for EDP updating. The Plan will be updated annually to reflect this interaction, accommodate changes, incorporate the results of assessments and associated environmental progress.

2. TECHNOLOGY DEVELOPMENT PROGRAM

2.1 Introduction

The purpose of this chapter is to summarize briefly the oil shale technology, the resource and background information, the energy system, and ERDA's Technology RD&D Program.

2.2 Resource and Background Information

Oil shale is a fine grained rock that contains varying amounts of organic material called kerogen which upon pyrolysis, or retorting, yields a synthetic oil and gas.

The major deposits in the United States exist in the Colorado-Wyoming-Utah area, known as the Green River Formation, and the Upper-Mississippi Valley-to-Michigan area, known as the Devonian and Mississippi deposits (see Figure 2-1).

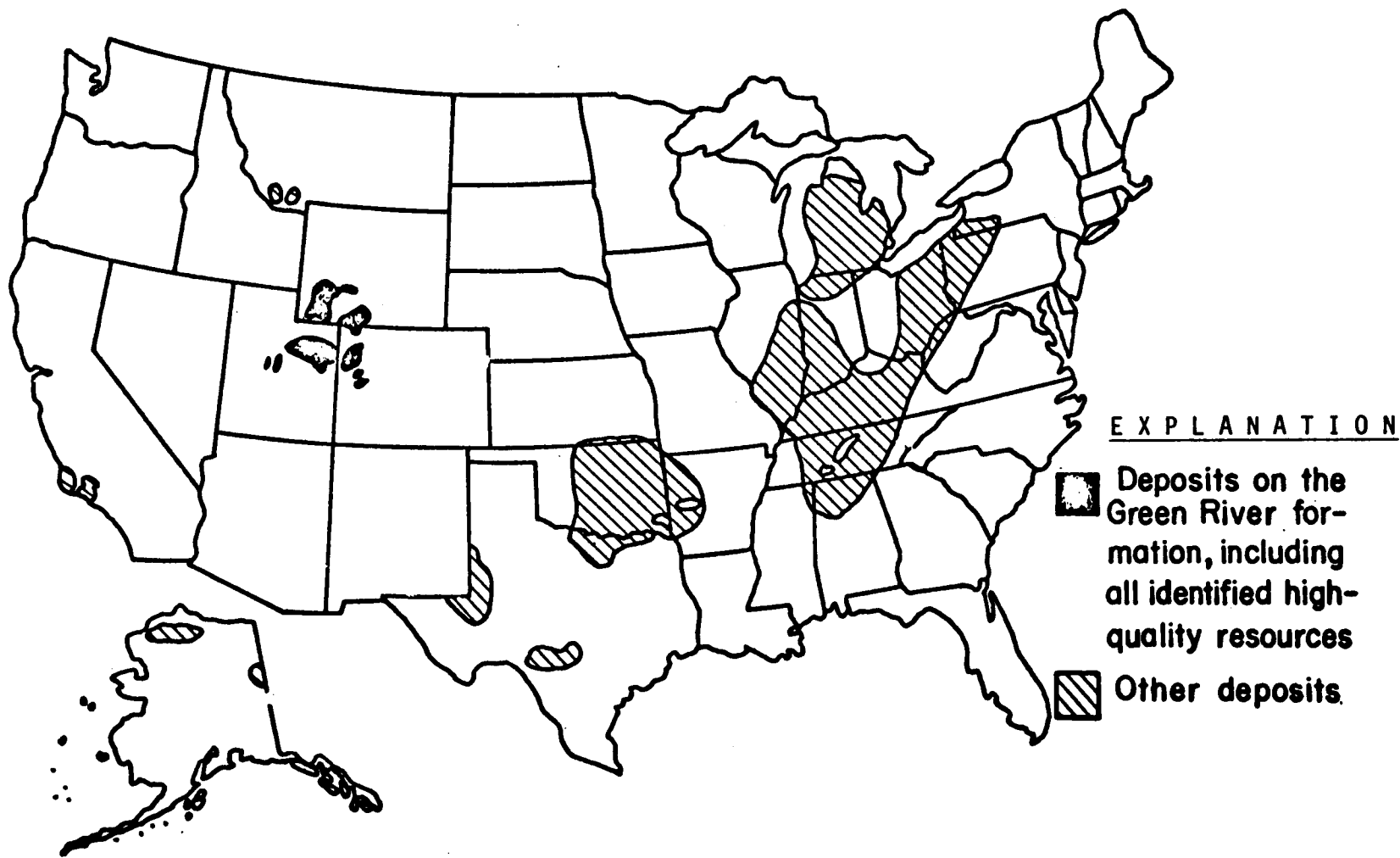
The richer shale deposits are located in the Green River Formation. Estimates of recoverable oil range from 0.6 to 1.8 trillion¹ barrels of oil. These variations are based on utilization of shale which yields from 15 to 25 gallons of oil/ton of shale. The Michigan Antrim oil shale deposits on the other hand consist of predominantly low-grade oil shale (less than 15 gal/ton), and gasification is considered to be the most applicable technology for this resource. The potential yield of the eastern deposits is equivalent to 3.4 trillion barrels of oil if the gas can be recovered.

During World War II, a high demand for liquid fuels prompted Congress to pass the Synthetic Liquid Fuels Act of April 5, 1944. After passage of this Act, the Federal Government initiated an effort to develop feasible processes for producing a synthetic oil from shale. Working under the Synthetic Liquid Fuels Act, the Bureau of Mines (BOM) began development of a gas combustion retort in 1945 at the Anvil Points Facility, a research facility on the Naval Oil Shale Reserve near Rifle, Colorado. Work was primarily laboratory oriented for the next several years. A six-company industry group leased the BOM Anvil Points Facility, modernized the retort, and conducted further experimental operations during 1964 to 1967.

¹ ERDA, Office of Fossil Energy, "Oil Shale Strategy," prepared for the Office of Management and Budget, October, 1975.

FIGURE 2-1

PRINCIPAL REPORTED OIL SHALE DEPOSITS OF THE UNITED STATES



Source: Duncan, D.C., and V.E. Swanson (1965) Organic-Rich Shale of the United States and World Land Areas, U.S. Geological Survey Circular 523. Washington: Government Printing Office.

2.3 Oil Shale Energy System

Shale oil can be produced from oil shale by three general retorting processes: surface or above ground, true in situ, and modified in situ. In each case, the oil shale must be heated (retorted) to 400°C, or higher to bring about pyrolysis of the kerogen and production of shale oil or gas. The process used to produce the synthetic fuel depends on the depth, assay, and geographic location of the shale formation or deposit, and the technological, economic, and environmental tradeoffs.

The basic oil shale energy system is depicted in Figure 2-2. The shaded blocks in the diagram show areas of technology research and development in which ERDA is involved. However, ERDA's environmental oil shale program covers the oil shale system in its entirety. Following are brief descriptions of the oil shale energy system and the ERDA technology program.

2.3.1 Surface Retorting

Surface processes require mining of oil shale. It can be mined by either underground or surface methods. The mined oil shale must be crushed and sized before retorting. Following retorting the retorted oil shale must be disposed of.

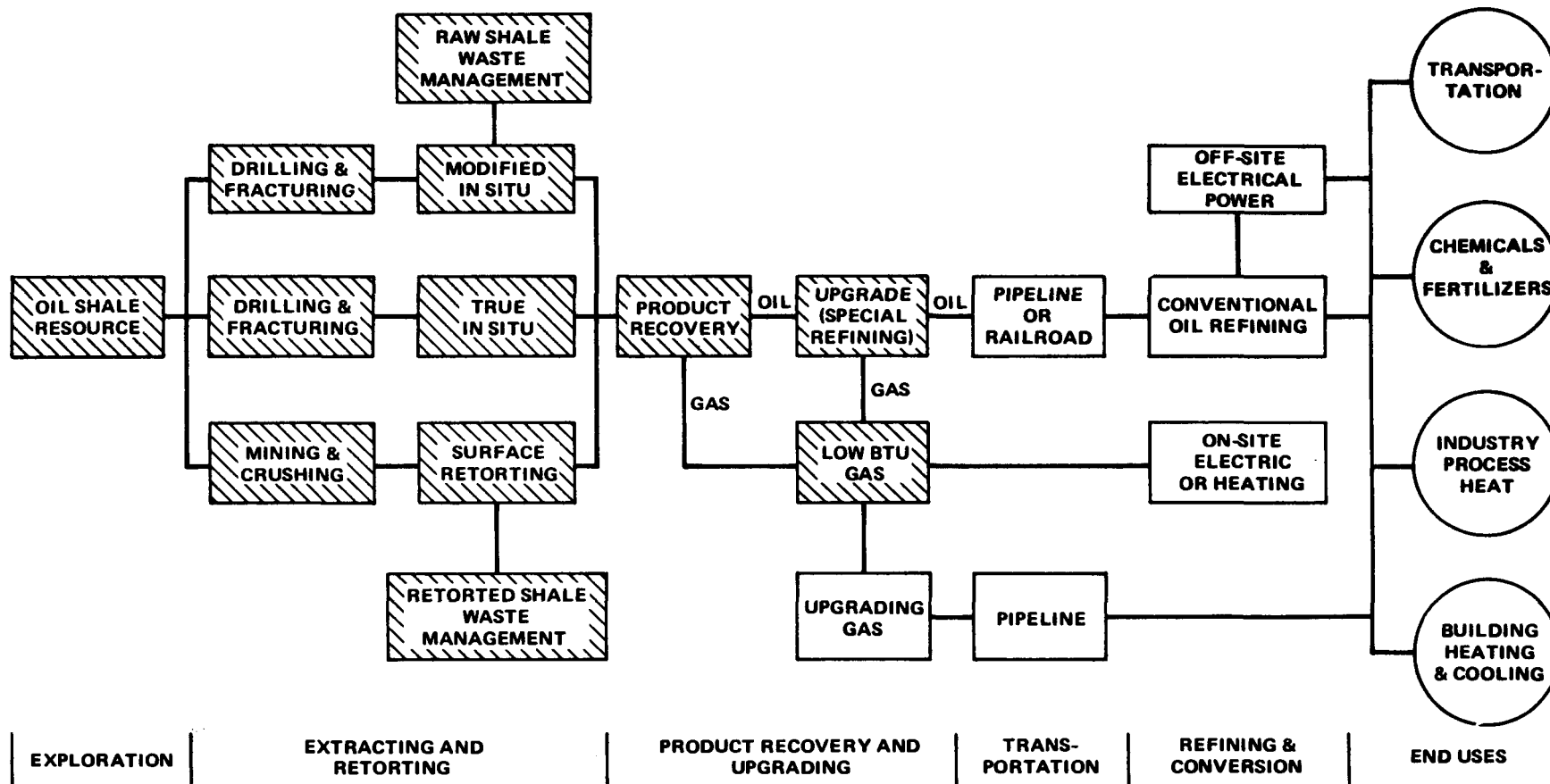
Two methods for surface retorting are of industrial interest. They are the direct- and the indirect-heated methods.

The heat required to bring about pyrolysis of the kerogen for the direct heated process is supplied by creation of a combustion zone within the retort. The combustion is sustained by gases released from the heated oil shale. In the case of indirect-heated processes, gases are circulated to an external reactor or combustion. Heat is transferred to the retort by recirculating solids or the gases through the retort and the external reactor. The products and residuals from these two methods for producing oil and gas differ somewhat in their chemical properties.

The Union Oil Company-sponsored "A" retorting process and the Bureau of Mines Gas Combustion retorting process use the direct-heated method. The Petrosix, Union "B", Superior Oil Company Multimineral Oil Shale Process and the TOSCO II company processes use the indirect-heated method. The Paraho retorting process has been demonstrated by both methods.

FIGURE 2-2 OIL SHALE ENERGY SYSTEM

5



LEGEND



2.3.2 True In Situ Retorting

True in situ processes involve underground retorting with no mining or disposal of retorted oil shale. True in situ processing of oil shale is more likely to be applied to shales of variable depths, in relatively thin beds. The oil shale formation is first fractured (using a hydraulic explosive fracturing technique) to provide the necessary surface area and permeability for combustion and thermal conduction to occur. The oil shale is then ignited via a central injection well, and combustion is sustained by pumping compressed air into the injection well. Produced gases and liquids are forced or pumped horizontally through the fracture system to production wells which surround the injection well.

2.3.3 Modified In Situ Retorting

The modified in situ process involves mining about 10 to 30 per cent of the shale to increase the void volume for in situ retorting. The remaining oil shale (directly above the mined zone) is fractured and retorted in place. Retorting in the modified in situ process can be accomplished by forcing the combustion zone to move horizontally for thin shale deposits or vertically for thick deposits. The mined shale fraction could be processed in a surface retort.

Four in situ processes are of current interest: (1) vertical modified in situ processing, (2) horizontal modified in situ processing preceded by mining to remove some of the shale, (3) horizontal modified in situ processing preceded by surface disturbance (surface uplift), and (4) modified in situ processing preceded by solution mining of soluble salts.

2.3.4 Product Recovery

The crude oil is processed to remove water and other contaminants after retorting. A recovery and separation system typically consists of a closed-cycle processing unit, such as impingement -type separators, centrifugal separators, and mechanical demisters. Absorbers and other recovery equipment commonly used in petroleum refineries can also be used. The principal functions of the system are separation and recovery of the oil or gaseous products from contaminants which include water produced in the retorting process as well as particulate material carried over from the retort.

2.3.5 Upgrading of Crude Shale Oil

Following product recovery, the crude shale oil requires further treatment to remove nitrogen containing compounds. High viscosity and pour points must also be altered in order to allow for pipeline or tanker transport. Removal of the nitrogen compounds requires special refinement. The flow characteristics may be improved by either special refinement or by the addition of pour-point depressants.

2.3.6 Low Btu Gasification

During the processing of oil shale, low Btu gas (30 to 300 Btu/ft³) is generated. Proper control of process variables during oil shale retorting allows usable gas to be produced concurrently with shale oil. The low Btu gas could be used on-site for direct heating or electrical production, or upgraded to pipeline gas for off-site use. Gas is expected to be the primary product of the eastern deposits.

2.3.7 Transportation, Conversion, and End Use

Final operations, as shown in Figure 2-2, involve transport of the upgraded crude shale oil to conventional refineries for processing and end-use application, and use of low Btu gases as described above.

2.4 Summary of ERDA's Technology Oil Shale Program

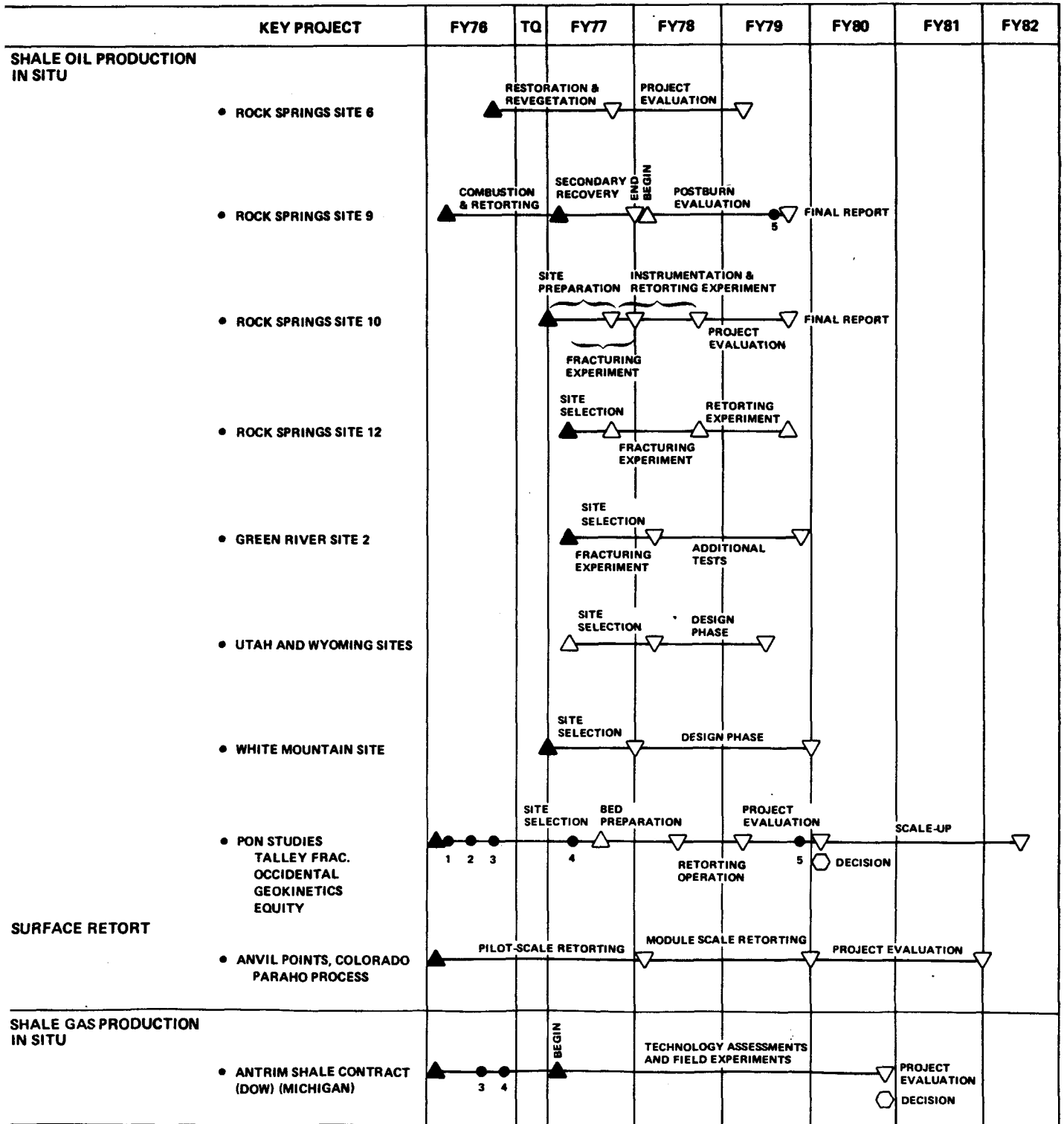
The present ERDA Program includes oil production research on true in situ methods, modified in situ methods, and advanced processing technology; gas production research targeted to both eastern and western oil shales; and supporting research for oil shale processing and control technology. This program is managed by the Division of Oil, Gas, and Shale Technology (OGST). The projects and major milestones are shown in Figure 2-3. This section presents an overview of the oil shale RD&D program as presented in the Oil Shale Program Approval Document.²

2.4.1 True In Situ

The true in situ projects include the Laramie Energy Research Center (LERC) experimental oil shale (200 foot depths) sites at Rock Springs and the pending Talley-Frac project near Rock Springs. The Talley-Frac project is a scale-up of the LERC Rock Springs experiments, and is aimed at production of 300 barrels of oil per day in the first phase, with a production goal of 5000 barrels of oil per day from a system of adjacent retorts.

² ERDA, Program Approval Document, Fiscal Year 1977, Oil Shale Program, October 4, 1976.

FIGURE 2-3 OIL SHALE TECHNOLOGY PROJECTS AND MAJOR MILESTONES



LEGEND:

▲ BEGIN MILESTONE	● 1 RELEASE RFP OR PON	● 5 PROCESS EVALUATION
▲ TASK COMPLETED	● 2 PROPOSALS RECEIVED	
▼ END MILESTONE	● 3 CONTRACTOR SELECTED	
○ DECISION	● 4 CONTRACT AWARDED	

Additional experiments will be undertaken by LERC to accelerate the study of fracturing techniques applicable to deeper oil shale deposits (400 to 1,500 feet) located in Wyoming and Utah.

2.4.2 Modified In Situ

The modified in situ projects include the pending LERC experimental site at White Mountain, the pending contracts with Occidental Petroleum, Geokinetics, Inc., and the on-going contract with the Equity Oil Co. The White Mountain experiment would be with shale beds of varying depth and thickness with some portion of the shale removed by mining prior to explosive fracturing of the bed. The Occidental project will use a modified in situ process in which retorting follows partial mining and collapse of the roof above the mined zone. The Geokinetics project will involve relatively shallow, thin shale beds, and will produce a surface disturbance (upheaval) following fracturing. The Equity project involves injection of super heated steam into thick, deep, and leached shale beds, and may include recovery of other minerals.

2.4.3 Surface Retorting

ERDA's surface retorting activity at Anvil Points consists of managing and observing the operation of the facility. The facility is currently leased by Development Engineering, Inc. (DEI). DEI is currently under contract to the Navy to produce 100,000 barrels of crude shale oil utilizing the Paraho process. ERDA monitors this R&D activity to collect data for government and industry use. The production level is about 160 barrels of oil per day.

2.4.4 Shale Gas Production

ERDA has contracted with Dow Chemical Co. to study underground gasification of Antrim oil shale (Michigan). The Dow process, developed for exploitation of the eastern shales, is proprietary. A half-ton retort at LERC is being used to study in situ burn parameters. Primary support is provided by LERC.

2.4.5 Oil Shale Technology Supporting Research

A project summary of supporting research is shown in Table 2-1. LERC, which is the primary ERDA oil shale field activity, supports research specializing in characterization of oil shale, investigation of improved techniques to produce liquid and gaseous fuels and chemical feedstocks from shale oils, and evaluation of catalysts for hydrogenation of liquid products. Additional support is provided by Los Alamos Scientific Laboratory (LASL), Sandia Laboratories (SL), and other universities. SL and LASL are investigating fracturing techniques. SL is investigating the static and dynamic properties of oil shale outside the high-shock zone and developing an overall fracturing model; LASL is investigating the interaction of oil shale with explosives in a joint rock-mechanic study with SL.

TABLE 2-1

ERDA OIL SHALE TECHNOLOGY SUPPORTING RESEARCH

SHALE OIL PRODUCTION

LERC

- Engineering and Kinetics
- Process Evaluation from Product Characteristics
- Characteristics of Oil Shale
- Anvil Points Monitoring Program
- Process Development
- Program Development
- Conversion of Shale Oil to Fuel Products
- New process Technology

SL

- Advanced Instrumentation for In Situ Processing
- In Situ Bed Preparation Study
- Diagnostics and Rock Mechanics Support
- Program Development

LASL

- Explosively Produced Fracture of Oil Shale
- Program Development

Colorado State University

- Heat Flow Mechanisms of Oil Shale

University of Wyoming

- Mechanical Properties
- Oil Shale Retort Modeling

Colorado School of Mines

- Hydro Treating
- Boundary Layer Model for Description of Retorting

LLL

- Modified In Situ Research
- Program Development

SHALE GAS PRODUCTION

University of Idaho

- Oxidation/Gasification of Carbon Residue in Retorted Shale

3. ENVIRONMENTAL, HEALTH, AND SAFETY ISSUES AND REQUIREMENTS

3.1 Introduction

Industrial developments frequently lead to environmental perturbations or impacts. The basic concern is whether those perturbations will have environmental, human health and safety, or socioeconomic consequences which are unacceptable. The purpose of this chapter is to identify the issues and requirements which, if satisfied, would resolve the environmental concerns associated with development of an oil shale industry.

3.2 Environmental Concerns

Three classes of environmental concerns related to oil shale technological development are physical disturbances, pollutant discharges, and affected resources. The major concerns for the oil shale processes are listed in Table 3-1. The upper portion of the table covers the extraction through retorting phases of the oil shale energy system (see Figure 2-2). Some of the concerns (e.g., contaminated retort water, subsidence, and fugitive emissions) are common to the three processes. Others are specific to one or two processes, e.g., the retorted shale waste piles from surface retorting, discharge of leachates directly into aquifers with the in situ processes.

3.3 Issues and Requirements

A series of environmental issues and requirements is identified which relates directly to these concerns. An overview of the environmental issues is given in Table 3-2 and the issues and requirements are summarized in Table 3-3. These issues were compiled from a variety of sources such as ERDA's Oil Shale Program Approval Documents and Balanced Program Plan (BPP), the Council on Environmental Quality (CEQ) annual reports, and public forums. The requirements provide a framework to further organize and manage the work to be done to resolve the issues. The appendix includes a correlation of ongoing federally supported projects with these requirements. Each issue is briefly discussed. Those requirements involving work specific to a process or a site are noted in Table 3-3. The other requirements are general to synthetic fuel processes.

TABLE 3-1

POTENTIAL ENVIRONMENTAL CONCERNS

PHASE	OIL SHALE PROCESSES	PHYSICAL DISTURBANCES	POLLUTANT DISCHARGES	AFFECTED RESOURCES	
				Physical Resources	Socioeconomic
Extraction through Retorting	Surface Retorting	Aquifer Local Interruption Land disconfiguration (stripmining) Roof collapse Noise (drilling, retorting) Retorted Shale Waste Piles	Runoff or leachate (metals, organics, salts) from retorted shale pile Dust from mining, crushing & grinding Fugitive emissions & off-gases from retort (venting to air) Contaminated retort water (metals, organics, salts) in settling ponds	Water for dust control, process cooling and vegetation and community use Secondary recovery of minerals	Financing Labor Force
	True In Situ	Work site disturbance Subsidence or uplift Noise (drilling, fracturing) Aquifer local interruption Heat	Leachate (metals, organics, salts) from retorted shale into aquifer Fugitive emissions and off-gases from retorting (venting to air) Contaminated retort water (metals, organics, salts) in containment ponds	Water for community use and process cooling	Community Services Housing Power
	Modified In Situ	Aquifer local interruption Subsidence or uplift Noise (drilling, fracturing) Raw shale waste piles Heat	Leachate (metals, organics, salts) from retorted shale into aquifer Runoff or leachate (mainly salts) from raw shale piles Dust from mining/fracturing Fugitive emissions & off-gases from retorting (venting) Contaminated retort water (metals, organics, salts) in settling ponds	Water for community use, processing, and vegetation of raw shale	Equipment
Upgrade through End-Use	All Processes	Land disturbances for facilities, roads/other transportation Physical plants	Evaporation & emissions of crude oil volatiles, during storage, upgrading and refining Accidental spillage	Water for upgrade/end use stages and community use	

TABLE 3-2
OVERVIEW OF OIL SHALE ENVIRONMENTAL ISSUES

<u>ISSUES</u>	<u>OBJECTIVE</u>	<u>SIGNIFICANCE</u>	<u>UNCERTAINTY</u>
A. Air Quality Impact	Determine what is released and where it goes.	All hazardous emissions require control to an acceptable level.	What is an acceptable level of unregulated emissions.
B. Water Resource	Determine water needs for an oil shale industry.	Water is a limited resource in the oil shale regions.	How much water can be allocated to the oil shale industry.
C. Health Effects	Determine oil shale pollutants to water sources. Determine the health consequences of the pollutant releases.	All hazardous effluents require control to an acceptable level. Many pollutants are known health hazards.	What is an acceptable level of water contamination. What are the health risks and probabilities of exposure.
D. Ecological Effects	Determine the ecological consequences and fate of the pollutant releases; Determine physical disturbances.	Many pollutants are ecological hazards. Large areas of land are affected.	What are the ecological impacts. What are the unavoidable disturbances and what is an acceptable level of disturbance.
E. Land Use Impact	Determine land impacts. Manage waste disposal, subsidence and landscape recovery.	Land disturbances will interfere with subsequent uses; waste piles are unattractive and sources of pollution.	Can solid wastes be permanently stabilized; can landscapes be returned to an acceptable condition.
F. Occupational Risks	Determine health and safety risks to the worker; develop procedures to protect the worker.	Many pollutants are known health hazards; there are industrial safety concerns	Worker environment is uncharacterized.
G. Transport and End Use Impacts of Shale Oil	Determine toxicity of shale oil products (volatiles, combustion products) and accidental hazards.	Commercial expansion leads to wide-use and distribution of products.	Unknown toxicity of products.
H. Social-Economic Impact	Provide for orderly development of impacted communities.	Boom-town phenomena places undue stress on surrounding towns.	How to effectively provide for timely planning and financial assistance.
I. Compliance with Regulation and Standards	Meet the legal requirements of federal, state, and local laws.	Laws have effect on designs, plans, and monitoring functions of oil shale operations.	Can the laws and regulations be met.
J. Environmental Controls	Develop and assess environmental controls for pollutants.	Pollutant releases must be controlled to acceptable levels.	Availability of controls and understanding of acceptable levels of control for unregulated pollutants.
K. Significance and Application of Results	Develop plans, evaluations, and assessments for an environmentally acceptable oil shale program.	Direction of the environmental program is essential.	Technical, environmental, financial, and institutional constraints exist for oil shale commercialization.

TABLE 3-3
 ENVIRONMENTAL, HEALTH, AND SAFETY ISSUES AND REQUIREMENTS
 OIL SHALE

Issue A

Will development of an oil shale industry result in degradation of air quality in the region?

Requirements

- A-1 Assess current information on air quality
- A-2 Develop improved procedures and systems for continuous air monitoring
- A-3 Accumulate baseline operational and post-operational air quality data around facilities and sites
- A-4 Characterize, identify, and quantify chemical constituents of the process streams
- A-5 Characterize chemical transformation of atmospheric releases
- A-6 Improve the atmospheric transport and dispersion models for steep terrain
- A-7 Develop capability for advisory response to major accidental releases

Issue B

Will development of an oil shale industry impact the limited water resources of the region?

Requirements

- B-1 Assess current information on surface and subsurface water supplies and their allocation
- B-2 Develop improved procedures for continuous monitoring of water for pollutants
- B-3 Accumulate baseline, operational, and post-operational water quality and quantity data around experimental facilities and sites
- B-4 Characterize, identify, and quantify the chemical constituents of the process stream.
- B-5 Characterize the chemical and microbiological transformations of liquid and solid wastes in soil and aquatic media.
- B-6 Model the environmental transport and fate of the solutes released to surface and subsurface waters.
- B-7 Quantify the consumptive water use by research or demonstration-sized operations, and measure the perturbation of ground water.

• Site or process specific work.

Issue C

What would be the effect on man of any deterioration of air and water quality?

Requirements

- C-1 Screen samples of emissions and effluents for biological effects.
- C-2 Conduct secondary biological screening in animals and plants.
- C-3 Conduct acute and subacute toxicity studies with biologically active components.
- C-4 Conduct inhalation, ingestion and dermal exposure studies.
- C-5 Conduct reproduction, teratogenicity and mutagenicity studies.
- C-6 Define the cellular and molecular mechanisms for biological damage and repair.
- C-7 Conduct metabolic and dose distribution studies.
- C-8 Conduct base-line characterization studies of tissues, cells, and molecules most sensitive to energy-related pollutants.
- C-9 Define the potential for carcinogenic and synergistic interaction of oil shale-related pollutants with other environmental stresses.
- C-10 Improve bioassay systems, instruments, and methods for risk assessment.
- C-11 Validate the use of cell screening systems to predict carcinogenicity and mutagenicity in man.

Issue D

What would be the effect on ecological systems of any deterioration of air and water quality?

Requirements

- D-1 Screen samples of emissions and effluents for acute toxicity to standard terrestrial and aquatic organisms.
- D-2 Determine potential for materials to accumulate in aquatic and terrestrial biota.
- D-3 Screen pre- and post-treatment effluents and fractions for acute toxicity to terrestrial and aquatic species indigenous to development sites.
- D-4 Determine the effects of sublethal exposures to representative class compounds on organismic and population characteristics.
- D-5 Determine the effects of key contaminants on functional aspects of model ecosystems.
- D-6 Evaluate changes in community structure and monitor for signs of toxicity in receiving waters associated with operating facilities.

TABLE 3-3, (continued)
 ENVIRONMENTAL, HEALTH, AND SAFETY ISSUES AND REQUIREMENTS
 OIL SHALE

Issue E

Can disturbed land be reclaimed, and can processed shale be managed in an environmentally acceptable way?

Requirements

- E-1 Provide a collection of plant materials and technologies for use in reclamation of landscapes.
- E-2 Develop techniques for re-establishment of key microbiological processes in soil.
- E-3 Determine the recovery time for reclaimed landscapes.
- E-4 Determine the extent of subsidence or uplift following in-situ extraction of oil shale and the effect on ground water movement.
- E-5 Determine the extent of surface area impacted by heat following in-situ extraction.
- E-6 Conduct monitoring of baseline, operational, and post-operational soil and plant systems.
- E-7 Estimate the hydrologic cycle for processed oil shale waste mounds.
- E-8 Define procedures for management of processed oil shale.
- E-9 Define the degree of mobilization, and fate of trace metals, and organic residuals present in processed shales.
- E-10 Evaluate the tendency for trace contaminants in stabilized shale to become biologically available, and characterize significant food chain transfers.
- E-11 Characterize chemical and microbiological transformations of organic residuals within processed shale piles or in fresh water and soil systems.

Issue F

Are the risks to the occupational work force acceptable?

Requirements

- F-1 Develop measuring and monitoring systems for work areas.
- F-2 Develop individual dose monitoring systems.
- F-3 Design and implement a program to evaluate workers in the oil shale industry.
- F-4 Evaluate physiological effects of pollutants from oil shale.
- F-5 Develop risk estimates for in-plant exposure of workers.
- F-6 Develop decontamination procedures for accidental and routine exposures of workers.
- F-7 Assess data from biological screening and toxicity studies for application to industrial hygiene.
- F-8 Conduct epidemiology studies of workers.
- F-9 Conduct site, safety, and industrial hygiene surveys and assessments

Issue G

Are there hazards associated with processing, transfer, storage, and combustion of shale oil?

Requirements

- G-1 Characterize, identify, and quantify the chemical constituents in the volatile fractions and the combustion products of shale oil.
- G-2 Evaluate the toxic properties of substances from shale oil.
- G-3 Assess the potential health and environmental hazards associated with storage and transfer of shale oil.
- G-4 Assess the need for, and if necessary, develop treatment procedures for accidental and routine exposures to shale oil products.

o Site or process specific work.

TABLE 3-3 (continued)
 ENVIRONMENTAL, HEALTH, AND SAFETY ISSUES AND REQUIREMENTS
 OIL SHALE

Issue H

Are the socioeconomic effects associated with oil shale development acceptable?

Requirements

- H-1 Assess effects of an oil shale processing facility on local planning or surrounding communities.
- H-2 Determine impact of conveying shale oil to refineries by rail, highway, pipeline, and marine transportation.
- H-3 Estimate the impact of using shale oil on present demands and future needs for oil resources.

Issue I

Are facilities in compliance with standards and regulations?

Requirements

- I-1 Prepare environmental assessments or EIS documents.
- I-2 Determine compliance with and obtain necessary air, water, and land use, including waste disposal, permits.
- I-3 Evaluate land management regulations and practices and determine effect on oil shale plants.

Issue J

Are there adequate environmental controls?

Requirements

- J-1 Assess the atmospheric emission and particle control needs
- J-2 Evaluate the effectiveness of contaminated water cleanup, management, and disposal procedures.
- J-3 Identify pollution control needs to mitigate trace material leaching from spent shale and related impacts.
- J-4 Determine end-use environmental control technology or requirements.
- J-5 Develop systems for management and control of gas, liquid, and solid wastes and pollutant discharges.

Issue K

What is the significance and what are the applications of the environmental health and safety related data:

Requirements

- K-1 Assess output from all requirements and issues to redefine priorities, sharpen the focus of the requirements, determine the relevance of ongoing research projects, recommend new courses of action and plans, and identify applications.
- K-2 Conduct integrated energy-related environmental assessments involving socioeconomic effects, bio-environmental analyses, and local and regional cost/risk/benefits studies, natural resource impacts or other energy-environmental tradeoffs and evaluations.
- K-3 Develop plans and surveys for site selections.
- K-4 Systemize oil shale data and information.

3.3.1 Impact on Air Quality

The potential sources of emissions from an oil shale processing facility include:

- Off-gas from retorting operations
- Fugitive emissions from the retort
- Stack gases from shale oil upgrading and refining operations
- Evaporation from product transportation and storage facilities
- Evaporation from retort water treatment and retention ponds
- Retorted shale dust
- Dust from shale mining, crushing, and transport
- Exhaust from mining, drilling, and surface preparation equipment, transport vehicles, and refineries, etc.

The off-gases and stack gases contain, principally, hydrogen sulfide, ammonia, particulate matter, and hydrocarbons. The other sources emit one or more of the following major pollutants: carbon monoxide (CO), hydrocarbons (HC), nitrogen dioxide (NO₂), particulate matter, photochemical oxidants, and sulfur dioxide (SO₂). In addition, there is a potential for the release of other hazardous trace materials to the atmosphere, such as polynuclear aromatic organic matter and trace metals. These trace materials have not been fully characterized. Controls are required for federal and state regulated emissions, and there is public concern over the unregulated trace materials. The unregulated materials need to be characterized and acceptable levels established to provide a basis for developing controls. Another factor which may constrain development in the Rocky Mountain region is the inadequate knowledge of the dispersion of pollutants over a complex terrain and long-range transport processes.

More accurate models of atmospheric transport and dispersion are needed since pending legislation would prevent significant deterioration of air quality in certain regions.

3.3.2 Impact on Water

Basic concerns with water include:

- Local interruption of aquifers and watersheds
- Availability of water for oil shale development
- Water consumption during mining, retorting, and vegetation of waste piles
- Pollution of surface and underground water

A geological evaluation and analysis are necessary to predict the effects that mining and retorting will have on local water.

The potential sources of water contamination are:

- Retort water
- Backflood water
- Leachate or runoff from retorted and raw shale
- Waste waters
- Conventional water contaminants, e.g., wash-down and cleanup, sanitary waste water, etc.

Retort water is generally produced with the shale oil on a 1-to-1 basis during in situ retorting. Surface retorting processes produce relatively small quantities of retort water. It is composed primarily of water formed by combustion and pyrolysis. The retort water generally contains unacceptable concentrations of dissolved solids, ammonia, hydrogen sulfide, and organic compounds.

Backflood water is natural groundwater that reenters an in situ retort after its development. The water becomes contaminated as it contacts the retorted oil shale and newly exposed minerals.

Leachate or runoff from processed shale disposal piles results from exposure to precipitation. Inorganic solids, hydrocarbons, and toxic trace elements may be leached from this material. This is discussed further in Section 3.3.3

Waste waters (sour) are collected from retorting and upgrading facilities, such as retort gas scrubbers, tail gas units, gas flares, and low-Btu gas treating units. Major contaminants include suspended particulates (shale fines), ammonia, hydrogen sulfide, toxic trace metals, phenols, and other organic compounds.

Storm runoff at the plant site may result in erosion and increased sediment, dissolved solids, and oily waste discharges to local surface streams.

3.3.3 Impact on Health and Safety

The concern relative to the occupational work force in an oil shale processing facility is exposure to potentially toxic materials. Trace quantities of these materials are present in oil shale, or are produced chemically during retorting and shale upgrading. These materials may be present in fugitive emissions, liquid and gas streams, waste waters, and processed shale. The health hazards associated with physical contact with the materials need to be examined according to a

systematic protocol based on realistic doses and exposures. Many of the biological assays, dose-response data, etc., used to quantify potential risks to the occupational work force will be used in evaluating risks to the general population.

Occupational safety assessments are needed. However the safety problems probably are not significantly different from those in other mining and chemical industries.

The potential for failure of waste pond integrity and accidental release of liquid products from storage and transportation facilities appear to be the major safety concerns relative to the general population and ecosystems. Appropriate safety procedures will have to be incorporated in the system design and operation.

3.3.4 Impact on Ecological Systems

Ecological systems are involved in two general ways: as a pathway for potentially hazardous substances to man and as a direct recipient of chemical and physical impacts, e.g., exposures of plants and wildlife to pollutants, and land and aquifer disruptions.

The general environmental pathways by which hazardous substances reach man are via atmospheric transport (inhalation), water transport (ingestion), and by food chain (ingestion). Direct impacts on ecosystems are generally accepted as likely to occur, although to what extent or degree is unknown. The major direct impact will be the disruption of local plant and animal communities as a result of waste disposal. Obviously vegetation will be removed or disturbed on sites where structures and roads are built.

Other effects may include the disturbances of animals by noise and high levels of human activity, and the potential loss in productivity or injury to plants and animals from chronic low-level emissions of gases such as sulfur dioxide and photochemical oxidants.

The ecological R&D program will identify any potential impacts on vegetation, animal life, and aquatic life. A major requirement is the development of baseline data that characterize the present ecological state in areas of oil shale development.

3.3.5 Impact on Land Use

The potential solid wastes from oil shale development include:

- Retorted oil shale
- Raw oil shale

- Sludges and salts from wastewater treatment facilities and retention ponds
- Drilling and mining wastes, sludges from SO₂ scrubbers, spent chemicals, etc.

Retorted shale, drilling and mining wastes, and shale fines constitute the most significant portions of the total solid wastes.

The retorted shale is the solid residue remaining after the retorting and contains varying amounts of organic and inorganic residuals depending on the retorting process. It remains underground in the in situ retorting, but it presents a major solid waste management and disposal problem for the surface retorts. It contains leachable salts as well as organic materials. The leachable salts include bicarbonates, chlorides, and sulfates of calcium, magnesium, potassium, and sodium. The proportion of the leachable salts in the retorted shale is much greater than that in the raw shale. The organic materials present in the retorted shale include substances such as amines, aromatic acids, phenols, and traces of polynuclear aromatic organic materials.

The true in situ processes require drilling of boreholes resulting in a large quantity of drill cuttings, which are discarded. Similarly, the modified in situ processes require mining of a portion of the shale deposit. Mined shale may be processed in a surface retort, or it may be discarded without further processing. Also, raw oil shale fines produced during preparation of mined shale for surface retorting may be discarded.

Special areas will be designated for the disposal of retorted shale, drilling and mining wastes, and raw shale and drill cuttings. The resulting potential loss of habitat for plant and animal communities and natural erosion of the disposal piles by wind and water can be mitigated by vegetating the disposal piles. Problems and uncertainties related to the vegetation of retorted shale include water requirements, accumulation of toxic trace elements in the vegetation, long-term stability and successional characteristics of the vegetation, and effects of microclimate on vegetation.

Components of the solid wastes can enter the environment in the form of soluble salts which can be leached or in the form of small particles which can become airborne. Other uncertainties include the stability of disposal piles, fugitive dust, and arsenic-laden catalysts.

3.3.6 Transport and End-Use Impacts of Shale Oil

The potential hazards affecting the occupational work force and general populace during processing, transport, storage, and combustion of shale oil in the upgrading through end use phases of the oil shale system are similar to those discussed under Section 3.3.3, Impact on Health and Safety. The concerns are with inhalation or dermal contact with shale oil derivatives. Derivatives involve the liquids or vapors from the crude and upgraded shale oil (see 3.3.1, air quality issue), the refined and distilled fractions of the oil, and the combustion products.

The accidental hazards such as fire explosions, accidental spills, etc., are similar to those dealt with by the existing petroleum industry.

3.3.7 Socio-Economic Impact

The western oil shale resources are located in remote, sparsely populated regions. The eastern resources cover larger areas but development would occur only in rural areas. In either case, development of oil shale resources will require establishment of new communities with their inherent problems. Smaller towns will be impacted by influx of workers, their families, and those who supply community services. This has been described as the "boom-town" phenomena.

Concerns focus on:

- Socio-economic characteristics of the region
- Social impact of construction and influx of labor force
- Provisions for social services
- Land, water use, and transportation planning
- Economic impacts associated with expansion
- Competition of existing economy with oil shale
- Definition of local, state, or federal responsibilities
- Public acceptance
- Need for planning and financial assistance to accommodate the growth

3.3.8 Compliance with Regulations and Standards

Major federal environmental, health, and safety laws applicable to oil shale include:

- National Environmental Policy Act of 1969
- Non-nuclear Energy Research and Development Act of 1974

- Clean Air Act of 1970
- Federal Water Pollution Control Act Amendment of 1972
- Occupational Safety and Health Act of 1970
- Toxic Substances Control Act of 1976
- Solid Waste Act of 1976
- Mineral Leasing Act of 1970

In addition, other federal, state, and local laws and rules must be reviewed and followed for each individual project. ERDA has established and adopted certain guidelines which relate to the implementation of the various regulations (ERDA Manual, Part 0500 series and Regulation 10 CFR 711).

Some specific concerns are:

1. There are expected occupational hazards and toxic substances associated with oil shale for which standards have not been established. ERDA will establish interim operating guidelines to protect against these hazards.
2. New Source Performance Standards have not been established for oil shale facilities.
3. Background levels of some criteria pollutants, such as ozone, particulate matter, and non-methane hydrocarbons in remote regions of Colorado and Utah already exceed the federal and state ambient air standards. It is not known if the sources are natural or man-made. This is a major potential constraint to oil shale development.

3.3.9 Environmental Controls

Environmental controls may be required for all phases of the oil shale system to comply with existing regulations and standards for air and water quality. Additional environmental control R&D will be considered for noncriteria pollutants and solid waste associated with oil shale based on results of health and ecological studies. Assessments on the adequacy of control devices and strategies will be conducted on a continuing basis.

3.3.10 Significance and Application of Results

ERDA development of environmentally acceptable oil shale processes requires plans, evaluations, and assessments. The purpose of these EDP

requirements is to prepare and document environmental plans, assessments, resolutions, and projections to supply the necessary environmental information for energy decisions and standards development. ERDA's plan needs to be coordinated with other Federal, State, and local agencies involved with the development of oil shale. This EDP is the baseline planning document to initiate this coordination of plans. Documented plans can avoid costly delays and duplication of environmental R&D.

3.3.11 Other Issues

Other issues, such as global ecological effects of increasing carbon dioxide in the atmosphere and impacts of cooling system are pertinent for all fossil fuel cycles. They are included in the detailed issues and requirements set presented in the Appendix. These issues will be discussed in future ERDA documents.

4. ENVIRONMENTAL ACTION PLAN

4.1 Introduction

The following plan is the environmental R&D program for ERDA's major oil shale field experiments. The plan is designed to resolve the environmental issues identified and discussed in Chapter 3, in a time frame consistent with the oil shale milestones. The plan consists of environmental schedules and NEPA requirements for each oil shale field project. This chapter also includes a brief description of the status of the on-going environmental activities.

4.2 Environmental Requirements Schedule

The environmental requirements schedule presented in Figure 4-1 combines the necessary environmental work with the oil shale technology milestones. Each environmental task is defined and letter coded with the environmental requirements listed in Table 3-3. Although the requirements are numbered, it does not always infer the sequence in which the work is to be performed. The requirements schedules show many environmental tasks are conducted simultaneously to coordinate the work with field operations or the work is independent.

4.2.1 True and Modified In Situ Oil Shale Processes

The Rock Springs oil shale project is the basic model for generation of environmental information for the true in situ process. The environmental schedule lays out a reasonable and practical course of environmental activities, and is considered the initial effort to provide the information necessary for continuous evaluation of the Environmental Impact Assessment or preparation of an Environmental Impact Statement. These activities will also resolve the environmental issues associated with the In Situ Oil Shale Program. The precise phasing of the environmental work is dependent on the Rock Springs site activity level (i.e., measurement of emissions must be taken during retorting and product recovery stages).

Baseline data characterization and air/water monitoring is scheduled at the other true and modified in situ sites (Figures 4-1A and 4-1B). The extent of additional environmental activities will initially be limited to characterization of process streams and preliminary biological and ecological screening, provided that the sites are developed to retorting and product recovery stages.

The four contracts selected under the Oil Shale Program Opportunity Notice (Talley-Frac, Geokinetics, Equity Oil, and Occidental) will conduct retorting and product recovery R&D operations. EDP environmental requirements schedules will be developed when the technology schedules become available.

4.2.2 Surface Retort and Gasification Oil Shale Processes

The surface retort and gasification processes produce somewhat different sets of environmental concerns. For example, the increased water content of the product from the in situ processes indicates that the chemical conversions taking place differ from the surface retorting processes, which produce very little water. Also, increased dispersions of pollutants is greater for underground gasification processes than for the oil production processes. Environmental studies similar to those performed at Rock Springs, are planned for the surface retorting process at Anvil Points and the Antrim gasification project. A better understanding of the health and environmental consequences of these two processes will result from these studies. The surface retorting and shale gasification schedules are shown in Figure 4-1C and 4-1D, respectively.

4.2.3 General Oil Shale Environmental Schedule

The general oil shale environmental requirements schedule is shown in Figure 4-2. The general environmental studies are continuations of the process specific work involving more advanced evaluations. The process specific requirements which appeared in Figure 4-1 are primarily data acquisition and preliminary screening studies under actual operating conditions. They are coordinated with the general studies which deal with common aspects of several processes and include health, ecological, control and physical/chemical process studies, as warranted according to integrated assessments. The general requirements are directed towards determination of the overall health and ecological consequences of the oil shale energy system.

4.2.4 NEPA Requirement and Schedules

The National Environmental Policy Act (NEPA) requires Federal agencies to prepare detailed Environmental Impact Statements (EIS) for major federal actions

that will significantly affect the environment. ERDA's implementing Guidelines³ provide for an environmental appraisal process which includes Environmental Impact Assessments (EIA) and EISs.

The schedules shown in Figure 4-1 list the EIAs and possible EISs needed for specific ERDA oil shale projects. Rock Springs EIAs for individual experimental sites, which are all within one contiguous area, will be integrated into one EIA. It will document all previous environmental work and project the potential impact of continuing the Rock Springs oil shale experiments. The EIAs from all the oil shale projects will be reevaluated annually to determine what changes, if any, have occurred that would alter the conclusions of the previous assessment.

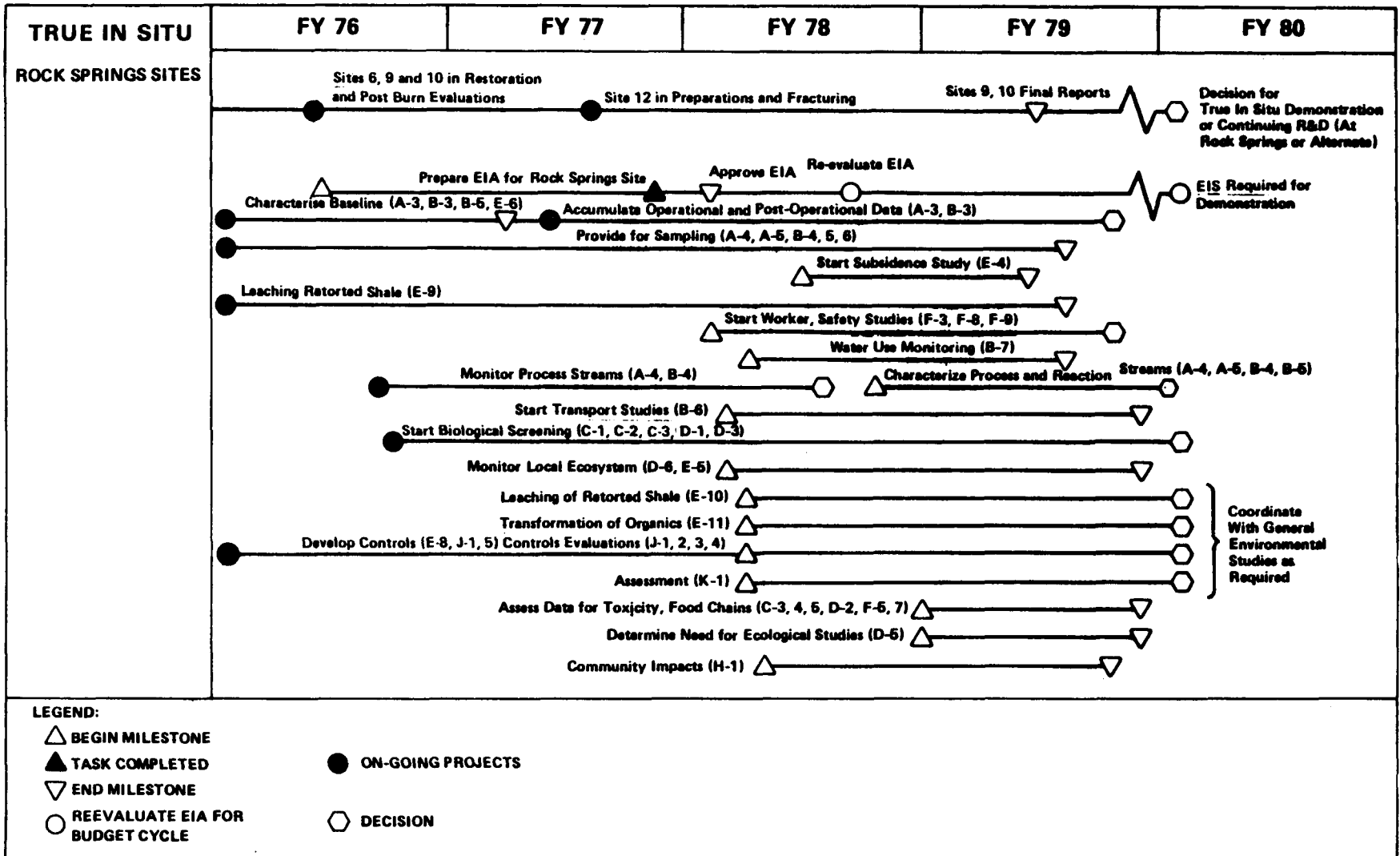
Environmental acceptability is a prerequisite to further development of oil shale technologies. Adequate discussion of environmental information, concerns, and impacts with the public avoids delay and helps to establish acceptability. The NEPA documents are the prime mechanism for public involvement. An EIS for the Prototype Oil Shale Leasing Program was completed by the Department of Interior in 1973. In view of ERDA's expanding oil shale program, a need is projected for a programmatic EIA or EIS for the Oil Shale Program. The environmental R&D defined in this EDP will provide the necessary information for any future programmatic impact evaluation.

4.3 Status of Environmental Activities

Considerable environmental oil shale R&D is currently in progress by ERDA and other Federal agencies. The Appendix includes a correlation of these ongoing federal research projects with the issues and requirements. The attachments to the Appendix list the AES sponsored projects, the AFE projects sponsored by the OGST and ESP divisions, and the projects sponsored by the other Federal agencies. The need for continuing assessment of these activities in relationship to the environmental issues and requirements presented in Chapter 3 is recognized. This assessment, which is ongoing, is evaluating the projects for scope, objectives, and results pertinent to the ERDA Oil Shale Program. Results of this evaluation will be summarized in the next annual update of this EDP.

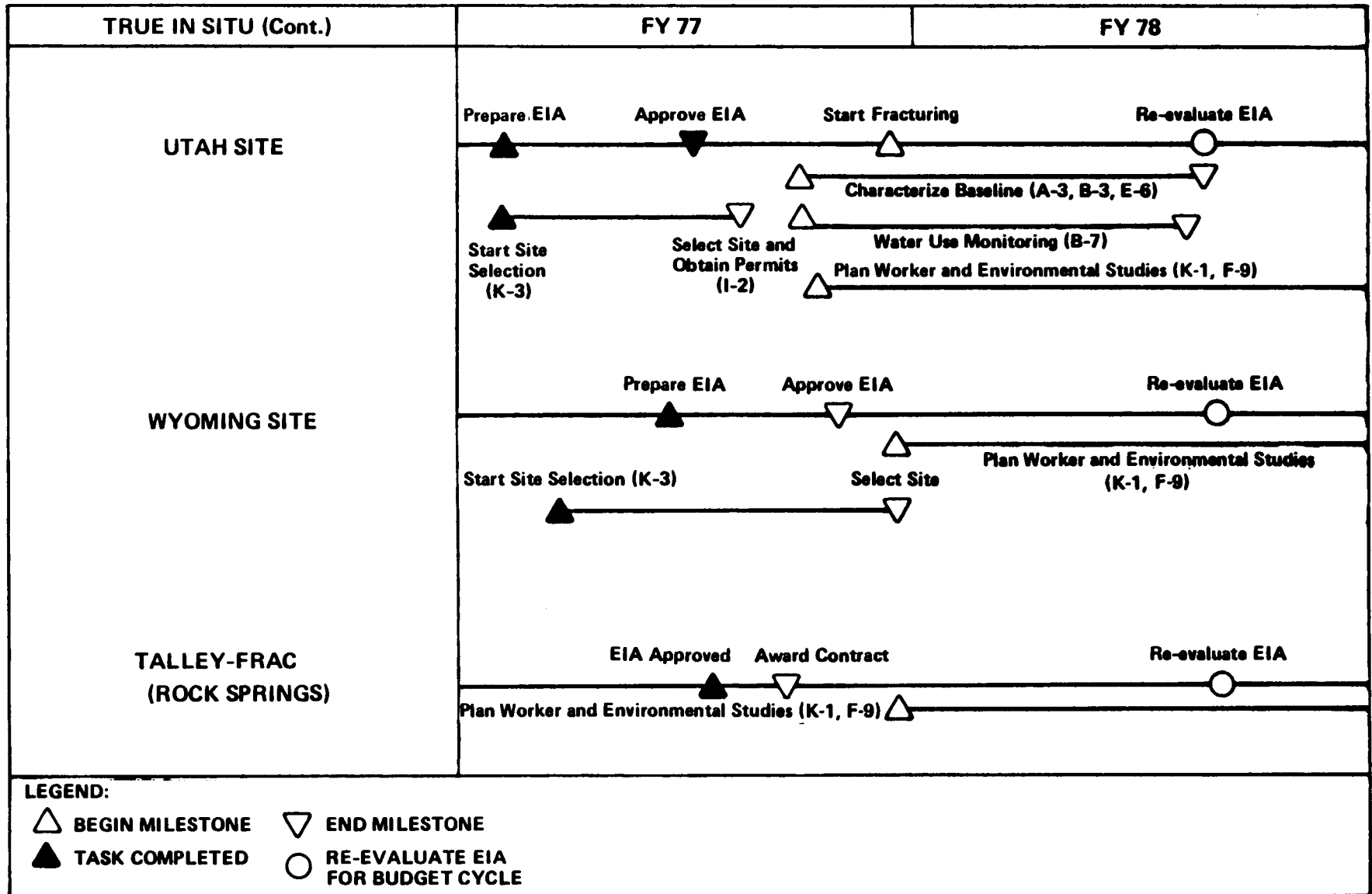
³ Code of Federal Regulations, 10 CFR 711.

FIGURE 4-1 ENVIRONMENTAL REQUIREMENTS SCHEDULE



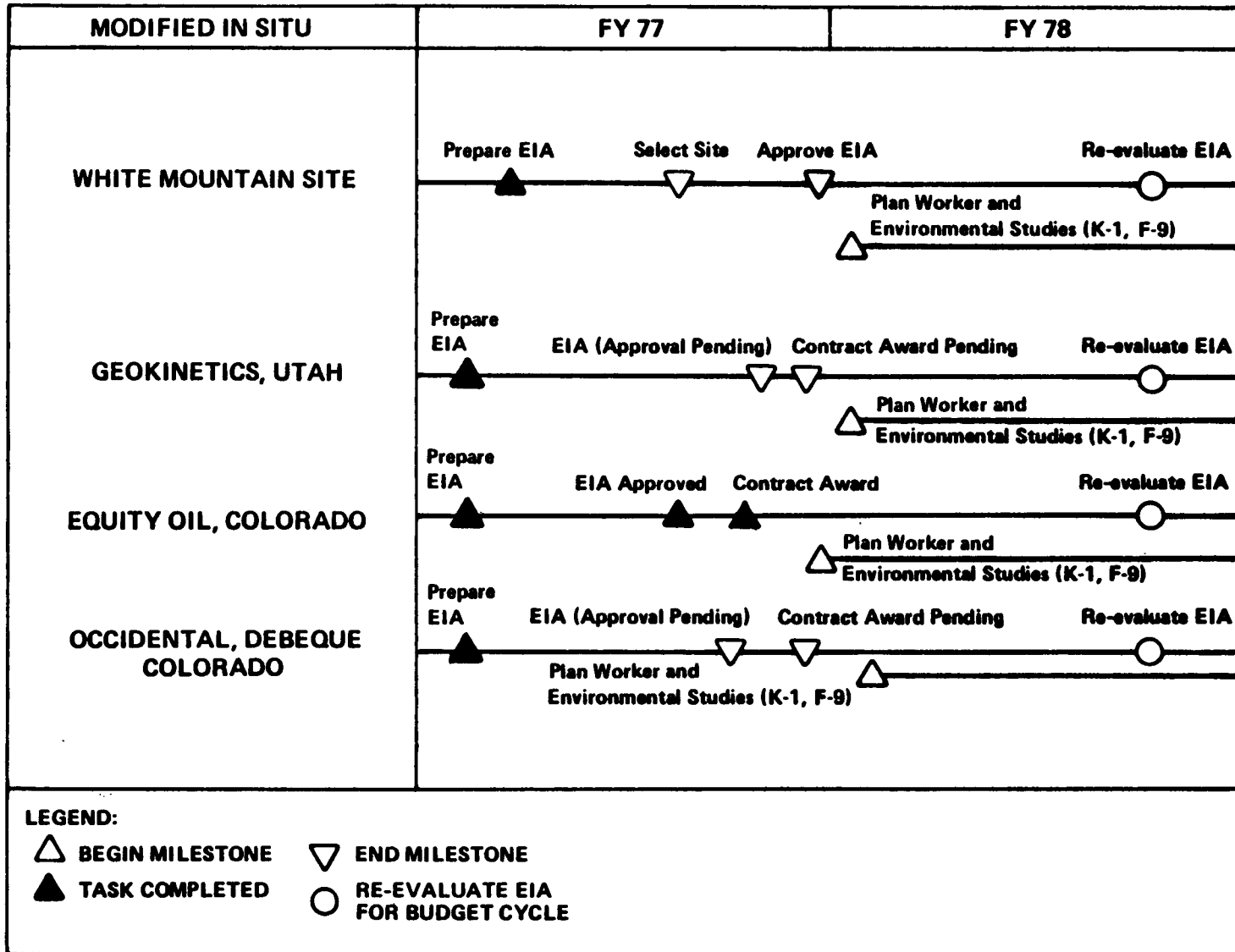
NOTE: (A-2, B-3, ETC.) A DESCRIPTION OF THESE ENVIRONMENTAL REQUIREMENTS IS FOUND IN TABLE 3-3.

FIGURE 4-1 (A) ENVIRONMENTAL REQUIREMENTS SCHEDULE



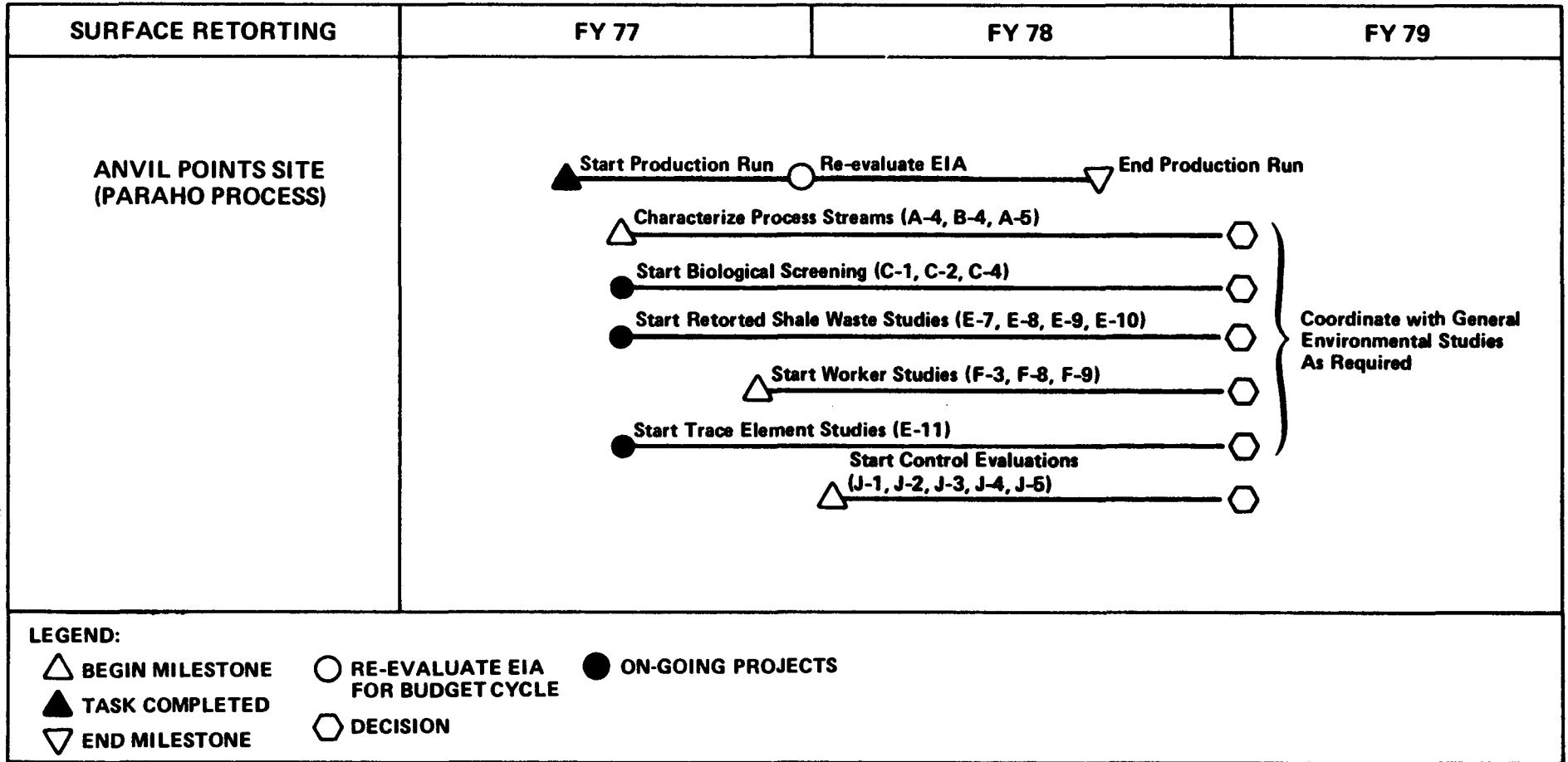
NOTE: (A-2, B-3, ETC.) A DESCRIPTION OF THESE ENVIRONMENTAL REQUIREMENTS IS FOUND IN TABLE 3-3

FIGURE 4-1(B) ENVIRONMENTAL REQUIREMENTS SCHEDULE (Continued)



NOTE: (A-2, B-3, ETC.) A DESCRIPTION OF THESE ENVIRONMENTAL REQUIREMENTS IS FOUND IN TABLE 3-3.

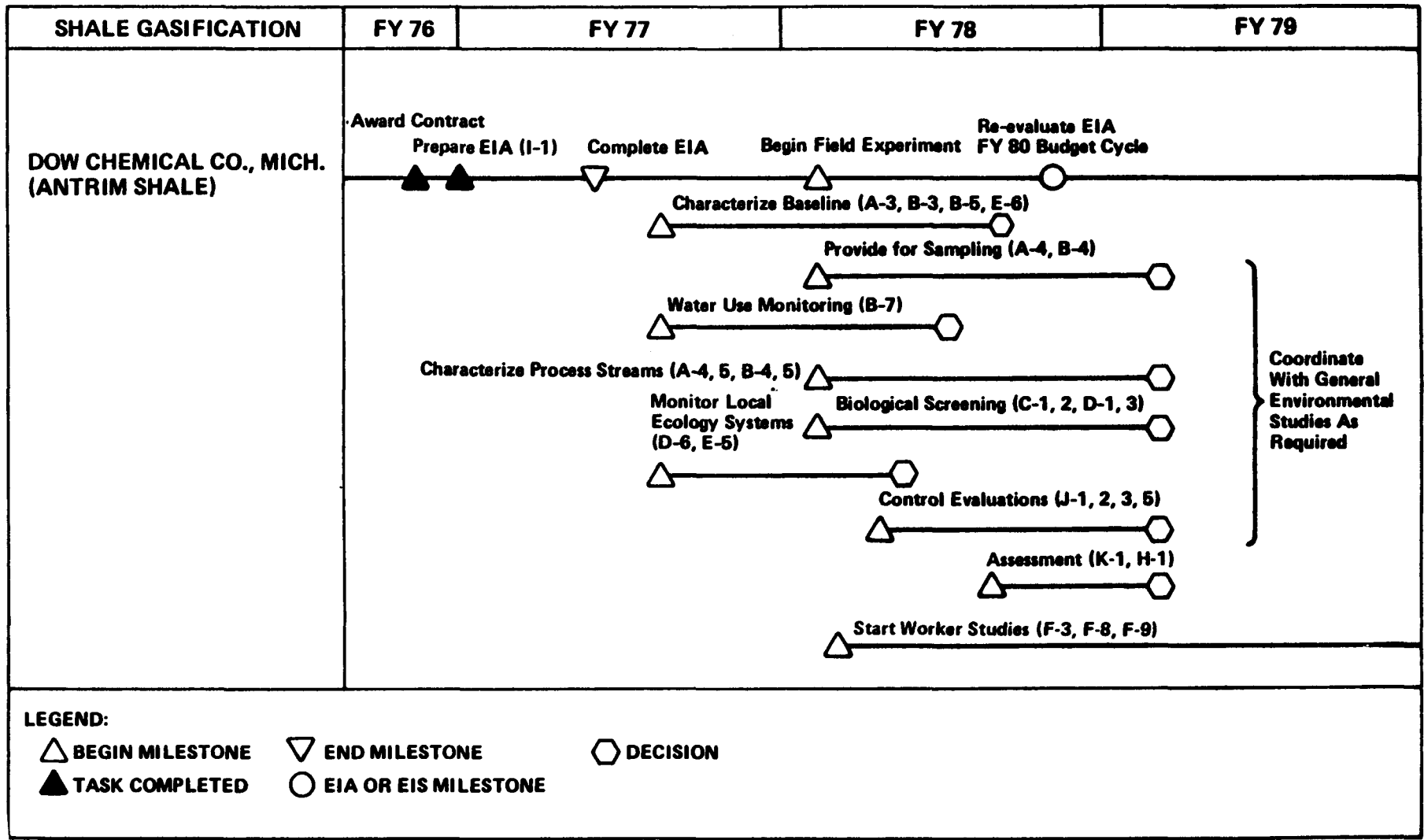
FIGURE 4-1(C) ENVIRONMENTAL REQUIREMENTS SCHEDULE (Continued)



31

NOTE: (A-2, B-3, ETC.) A DESCRIPTION OF THESE ENVIRONMENTAL REQUIREMENTS IS FOUND IN TABLE 3-3

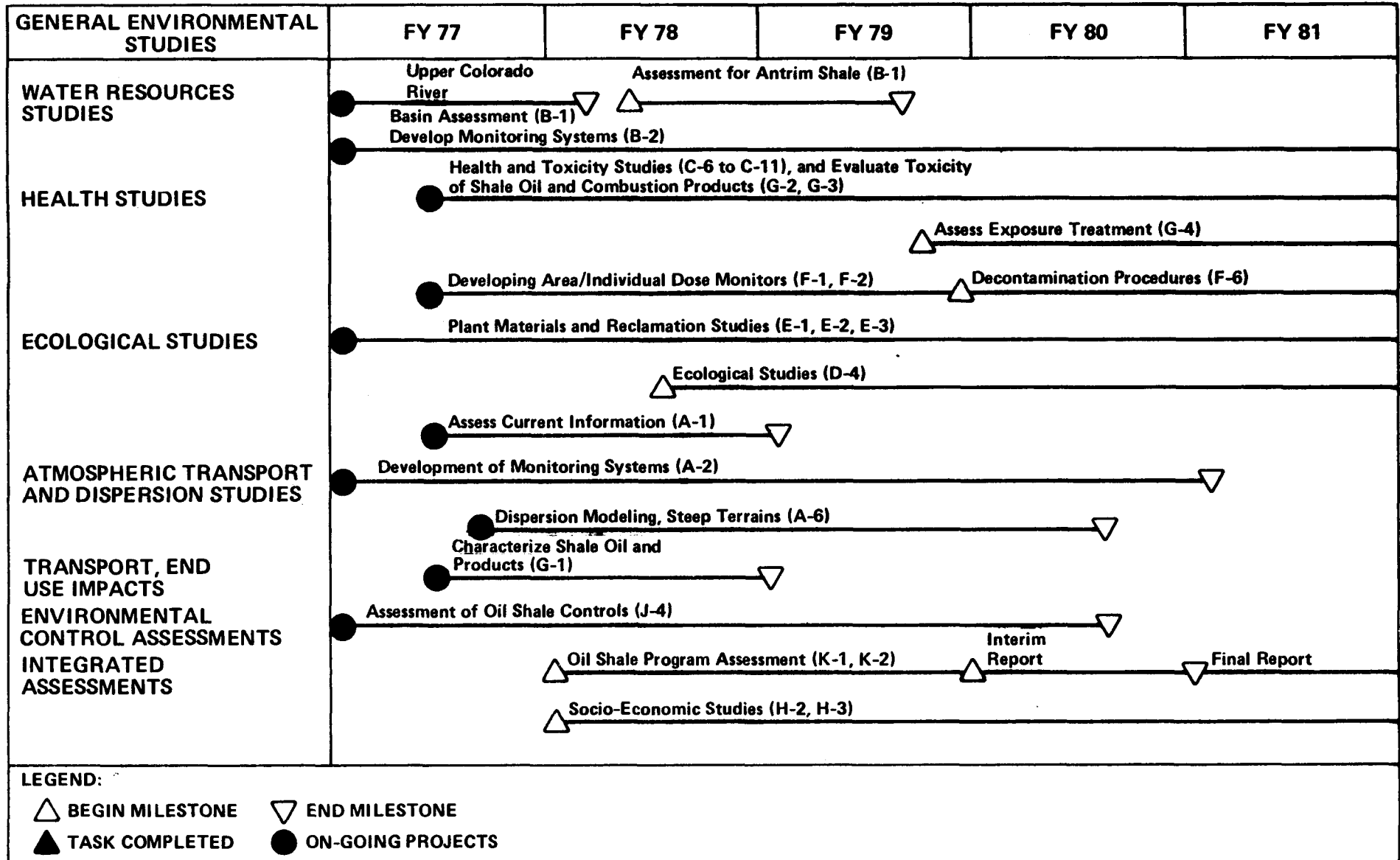
FIGURE 4-1(D) ENVIRONMENTAL REQUIREMENTS SCHEDULE (Continued)



32

NOTE: (A-2, B-3, ETC.) A DESCRIPTION OF THESE ENVIRONMENTAL REQUIREMENTS IS FOUND IN TABLE 3-3

FIGURE 4-2 OIL SHALE ENVIRONMENTAL REQUIREMENTS SCHEDULE



LEGEND:

- ▲ BEGIN MILESTONE
- ▼ END MILESTONE
- ▲ TASK COMPLETED
- ON-GOING PROJECTS

NOTE: (A-2, B-3, ETC.) A DESCRIPTION OF THESE ENVIRONMENTAL REQUIREMENTS IS FOUND IN TABLE 3-3.

5. MANAGEMENT STRATEGY

5.1 Management of EDP

This EDP requires joint resolution of issues, coordination of plans, and interaction in order to be successfully implemented. The major ERDA participants are the AES and AFE. AES and AFE management teams will be established to implement and manage the projects associated with this plan. The teams will consist of representatives from the appropriate divisions. There are four program divisions within AES: Biomedical and Environmental Research; Environmental Control Technology; Operational and Environmental Safety; and Technology Overview. These four divisions are engaged in environment, health, and safety research, assessments, and other related activities. There are three groups within AFE that are directly involved with this EDP. Management for the technology projects, and for some specific environmental support research is provided by the Division of Oil, Gas, and Shale Technology (OGST). The Division of Environmental and Socioeconomic Programs provides environmental guidance to OGST within AFE. LERC provides field technical direction and field project coordination for the major oil shale projects.

5.2 Strategy

An Environmental Overview Committee (EOC) will be established to advise the AES and AFE management on matters that relate to implementation of the plan, adequacy of the research, and associated progress. The Committee will consist of members from three ERDA divisions: Division of Technology Overview, Division of Environmental and Socioeconomic Programs, and Division of Oil, Gas and Shale Technology or their designated representatives. This Committee will be chaired by the Technology Overview representative in compliance with ERDA IAD No. 0500-4 (Requirement for an Environmental Development Plan). Other ERDA representatives such as those listed below will be called upon to contribute to the EOC as necessary:

<u>AFE</u>		<u>AES</u>
o FEPA		o BER
o MER		o ECT
o LERC		o OES
o ERDA Labs		o EOEP
		o EOIN
		o ERDA Labs

In addition, advice from other agencies will be needed to coordinate research and to assist in the orderly transfer of information. These agencies include but are not limited to: EPA, DOA, DOI, OSHA, NCI, and NIEHS.

The EOC has seven major functions:

- (1) to recommend environmental RD&D, assessments, and preparation of NEPA documents with appropriate resource requirements and priorities;
- (2) to see that the above activities are addressed in the appropriate planning, budgeting, and approval cycles;
- (3) to review environmental reports, assessments, EIAs and EISs and recommend actions as required;
- (4) to devise a strategy leading to the development of environmental performance criteria for the oil shale technology, considering both economic and technical feasibility;
- (5) to assist in using results in order to achieve technological success and environmental acceptability;
- (6) to coordinate the implementation of this EDP and to prepare the annual update; and
- (7) to make the scientific community and general public aware of this EDP through workshops, briefings, to incorporate their suggestions and to provide guidance to ERDA Laboratories and contractors.

This EDP will be phased into the oil shale program during FY 78. The issues and requirements in the EDP are currently being used for planning purposes within AES and AFE. However, it is expected that a complete budget cycle will be required to achieve full implementation of the Plan. The EOC will conduct quarterly coordination meetings to examine environmental progress, exchange information, and to conduct business to ensure that EOC functions are carried out.

5.3 Priorities

The oil shale environmental requirements have been assigned priorities and are listed in the Appendix. Criteria for the priority ranking (1, 2, and 3) were based on: (1) number of people at risk, (2) severity of the environmental impact, (3) when the information is needed, and (4) how long it takes to accumulate the information. Assessment studies during FY 1978 will improve the bases for priority assignments and will reflect research contributions from other agencies to make the scientific community and general public aware of this EDP through workshops and briefings, to incorporate their suggestions, and to provide guidance for ERDA Laboratories and contractors.

APPENDIX

OIL SHALE ENVIRONMENTAL, HEALTH, AND SAFETY ISSUES/REQUIREMENTS/PROJECTS CORRELATION

Environment, Health, & Safety ISSUES	REQUIREMENTS	Priority	Environment, Health & Safety Projects		
			AES (RPIS NO.) ⁴	AFE	OTHER AGENCIES (FY 76 Federal Inventory No.) ⁵
A. Will development of an oil shale industry result in degradation of air quality in the region?	A-1 Assess current information on air quality	1			
	A-2 Develop improved procedures and systems for continuous air monitoring	1	See Attachment 1 (11 Projects)		
	A-3 Accumulate baseline operational and post-operational air quality data around facilities and sites	1		ERDA/AFE, Environmental Aspects of In Situ Oil Shale Processing	DOI, Prototype Oil Shale Leasing Program
	A-4 Characterize, identify, and quantify chemical constituents of the process streams	1	See Attachment 1 (2 Projects)	ERDA/AFE, Environmental Research for the Anvil Points Oil Shale Research Project ERDA/AFE, Characterization of Contaminants in Oil Shale Residuals and the Potential for their Management to Meet Environmental Quality Standards	USGS, Energy Supporting Research, Hydrochemistry and Organics (054037) NIEHS, Aqueous Solution Studies of Arsenates and Vanadates (033056)
	A-5 Characterize chemical transformation of atmospheric releases	2	See Attachment 1 (1 Project)		See Attachment 3 (3 Projects)
	A-6 Improve the atmospheric transport and dispersion models for steep terrain	1	See Attachment 1 (3 Projects)	ERDA/AFE, Environmental Aspects of In-Situ Oil Shale Processing	EPA, Sulfur Budget in Large Plumes (070053)
	A-7 Develop capability for advisory response to major accidental releases	2			

⁴ Research Projects Information System

⁵ ERDA 77-50, Inventory of Federal Energy-Related Environment and Safety Research for FY 1976

APPENDIX (CONT.)

OIL SHALE ENVIRONMENTAL, HEALTH, AND SAFETY ISSUES/REQUIREMENTS/PROJECTS CORRELATION

Environment, Health, & Safety ISSUES	REQUIREMENTS	Priority	Environment, Health & Safety Projects		
			AES (RPIS NO.)	AFE	OTHER AGENCIES (FY 76 Federal Inventory No.)
B. Will development of an oil shale industry impact the limited water resources of the region?	B-1 Assess current information on surface and subsurface water supplies and their allocation	1	WRC Project		See Attachment 3 (12 Projects)
	B-2 Develop improved procedures for continuous monitoring of water for pollutants	1			See Attachment 3 (4 Projects)
	B-3 Accumulate baseline, operational, and post-operational water quality and quantity data around experimental facilities	1			See Attachment 3 (2 Projects)
	B-4 Characterize, identify, and quantify the chemical constituents of the process stream	1	See Attachment 1 (3 Projects)	ERDA/AFE, Environmental Research for the Anvil Points Oil Shale Research Project ERDA/AFE, Characterization of Contaminants in Oil Shale Residuals and the Potential for their Management to Meet Environmental Quality Standards	See Attachment 3 (7 Projects)
	B-5 Characterize the chemical and microbiological transformations of liquid and solid wastes in soil and aquatic media	2	See Attachment 1 (2 Projects)	ERDA/AFE, Environmental Aspects of In-Situ Oil Shale Processing ERDA/AFE, Mineralogical and Geochemical Study of the Colorado Oil Shales	NIEHS, Aqueous Solution Studies of Arsenates and Vanadates (033056)
	B-6 Model the environmental transport and fate of the solutes released to surface and subsurface waters	2	See Attachment 1 (2 Projects)	LERC, Laboratory Determination of Leaching Rates from Oil Shale Retorted Under Simulated In-Situ Retorting Conditions (093051) - ERDA/AFE, Environmental Aspects of In Situ Oil Shale Processing ERDA/AFE, Water Conservation with In Situ Oil Shale Development	USBM/SMRC, Water Management in Oil Shale Mining
	B-7 Quantify the consumptive water use by research or demonstration-sized operations, and measure the perturbation of ground water	2			

APPENDIX (CONT.)

OIL SHALE ENVIRONMENTAL, HEALTH, AND SAFETY ISSUES/REQUIREMENTS/PROJECTS CORRELATION

Environment, Health, & Safety ISSUES	REQUIREMENTS	Priority	Environment, Health & Safety Projects		
			AES (RPIS NO.)	AFE	OTHER AGENCIES (FY 76 Federal Inventory No.)
C. What would be the effect on man of any deterioration of air and water quality?	C-1 Screen samples of emissions and effluents for biological effects	1	See Attachment (1 Project)		USGS, Energy Supporting Research, Hydrochemistry and Organics (054037)
	C-2 Conduct secondary biological screening in animals and plants	1	See Attachment (1 Project)		
	C-3 Conduct acute and subacute toxicity studies with biologically active components	1	See Attachment 1 (2 Projects)	ERDA/AFE, Characterization of Contaminants in Oil Shale Residuals and the Potential for their Management to Meet Environmental Quality Standards	EPA, Toxic Effects on the Aquatic Biota from Coal and Oil Shale Development (070003) NIEHS, Arsenic Toxicity, A Potential Environmental Hazard (033108)
	C-4 Conduct inhalation, ingestion and dermal exposure studies	1	Inhalation Toxicity Shale Dust (2525)		
	C-5 Conduct reproduction, teratogenicity and mutagenicity studies	2	See Attachment 1 (1 Project)		
	C-6 Define the cellular and molecular mechanisms for biological damage and repair	2	See Attachment 1 (2 Projects)		
	C-7 Conduct metabolic and dose distribution studies	2	Analysis for Genetic Differences (182)		

APPENDIX (CONT.)

OIL SHALE ENVIRONMENTAL, HEALTH, AND SAFETY ISSUES/REQUIREMENTS/PROJECTS CORRELATION

Environment, Health, & Safety ISSUES	REQUIREMENTS	Priority	Environment, Health & Safety Projects		
			AES (RPIS NO.)	AFE	OTHER AGENCIES (FY 76 Federal Inventory No.)
C. What would be the effect on man of any deterioration of air and water quality? (cont'd)	C-8 Conduct base-line characterization studies of tissues, cells, and molecules most sensitive to energy-related pollutants	2			
	C-9 Define the potential for carcinogenic and synergistic interaction of oil shale-related pollutants with other environmental stresses	3			FEA, Characterization of Contaminants in Oil Shale Residuals and the Potential for their Management to Meet Environmental Quality Standards (100121)
	C-10 Improve bioassay systems, instruments, and methods for risk assessment	1	See Attachment 1 (9 Projects)		
	C-11 Validate the use of cell screening systems to predict carcinogenicity and mutagenicity in man	2			
D. What would be the effect on ecological systems of any deterioration of air and water quality?	D-1 Screen samples of emissions and effluents for acute toxicity to standard terrestrial and aquatic organisms	1			
	D-2 Determine potential for materials to accumulate in aquatic and terrestrial biota	1		ERDA/AFE, Environmental Aspects of In Situ Oil Shale Processing	
	D-3 Screen pre- and post-treatment effluents and fractions for acute toxicity to terrestrial and aquatic species indigenous to development sites	1	See Attachment (1 Project)		
	D-4 Determine the effects of sublethal exposures to representative class compounds on organismic and population characteristics	2			
	D-5 Determine the effects of key contaminants on functional aspects of model ecosystems	3			
	D-6 Evaluate changes in community structure and monitor for signs of toxicity in receiving waters associated with operating facilities	1			

APPENDIX (CONT.)

OIL SHALE ENVIRONMENTAL, HEALTH, AND SAFETY ISSUES/REQUIREMENTS/PROJECTS CORRELATION

Environment, Health, & Safety ISSUES	REQUIREMENTS	Priority	Environment, Health & Safety Projects		
			AES (RPIS NO.)	AFE	OTHER AGENCIES (FY 76 Federal Inventory No.)
E. Can disturbed land be reclaimed and can processed shale be managed in an environmentally acceptable way?	E-1 Provide a collection of plant materials and technologies for use in reclamation of landscapes	1	See Attachment 1 (2 Projects)		DOA, Plant Materials Studies to Improve Technologies of Surface Mined Land Reclamation (000007)
	E-2 Develop techniques for re-establishment of key microbiological processes in soil	2	See Attachment 1 (3 Projects)		DOA, Plant Materials Studies to Improve Technologies of Surface Mined Land Reclamation (000007)
	E-3 Determine the recovery time for reclaimed landscapes	1	See Attachment 1 (2 Projects)	ERDA/AFE, Environmental Aspects of In Situ Oil Shale Processing	See Attachment 3 (4 Projects)
	E-4 Determine the extent of subsidence or uplift following in-situ extraction of oil shale and the effect on ground water movement	2		ERDA/AFE, Environmental Aspects of In Situ Oil Shale Processing	
	E-5 Determine the extent of surface area impacted by heat following in-situ extraction	3		ERDA/AFE, Environmental Aspects of In Situ Oil Shale Processing	
	E-6 Conduct monitoring of baseline, operational, and post-operational soil and plant systems	2	See Attachment 1 (3 Projects)	ERDA/AFE, Environmental Aspects of In Situ Oil Shale Processing	See Attachment 3 (6 Projects)
	E-7 Estimate the hydrologic cycle for processed oil shale waste mounds	1	Development of a chemical reaction, stability, and transport model of oil shale wastes in oil (#111)		EPA, Vegetative Stabilization of Spent Oil Shales (070112) EPA, Vegetative Stabilization of Paraho Spent Oil Shale (070113)
	E-8 Define procedures for management of oil shale wastes	1	See Attachment 1 (2 Projects)	ERDA/AFE, Characterization of Contaminants in Oil Shale Residuals and the Potential for their Management to Meet Environmental Quality Standards	See Attachment 3 (10 Projects)
	E-9 Define the degree of mobilization, and fate of trace metals, and organic residuals present in processed shales	2	See Attachment 1 (3 Projects)	ERDA/AFE, Leaching Rates of Spent Oil Shale	See Attachment 3 (6 Projects)
	E-10 Evaluate the tendency for trace contaminants in stabilized shale to become biologically available, and characterize significant food chain transfers	2	See Attachment 1 (2 Projects)	ERDA/AFE, Characterization of Contaminants in Oil Shale Residuals and the Potential for their Management to Meet Environmental Quality Standards ERDA/AFE, Role of Spent Shale in Oil Shale Processing and the Management of Environmental Residuals	FEA, Characterization of Contaminants in Oil Shale Residuals and the Potential for their Management to Meet Environmental Quality Standards (100021)
	E-11 Characterize chemical and microbiological transformations of organic residuals within processed shale piles or in fresh water and soil systems	3	See Attachment 1 (2 Projects)		

APPENDIX (CONT.)

OIL SHALE ENVIRONMENTAL, HEALTH, AND SAFETY ISSUES/REQUIREMENTS/PROJECTS CORRELATION

Environment, Health, & Safety ISSUES	REQUIREMENTS	Priority	Environment, Health & Safety Projects		
			AES (RPIS NO.)	AFE	OTHER AGENCIES (FY 76 Federal Inventory No.)
F. Are the risks to the occupational work force acceptable?	F-1 Develop measuring and monitoring systems for work areas	1	See Attachment 1 (7 Projects)		USPHS, Mortality and Morbidity Among Oil Shale Workers (032015)
	F-2 Develop individual dose monitoring systems	1	See Attachment 1 (2 Projects)		
	F-3 Design and implement a program to evaluate workers in the oil shale industry	1			
	F-4 Evaluate physiological effects of pollutants from oil shale	1			
	F-5 Develop risk estimates for in-plant exposure of workers	1	NIOSH Cooperative Studies (7281)		
	F-6 Develop decontamination procedures and protective devices for accidental and routine exposures of workers	1			
	F-7 Assess data from biological screening and toxicity studies for application to industrial hygiene	1			
	F-8 Conduct epidemiology studies of workers	1			
	F-9 Conduct site, safety, and industrial hygiene surveys and assessments	1			

APPENDIX (CONT.)

OIL SHALE ENVIRONMENTAL, HEALTH, AND SAFETY ISSUES/REQUIREMENTS/PROJECTS CORRELATION

Environment, Health, & Safety ISSUES	REQUIREMENTS	Priority	Environment, Health & Safety Projects		
			AES (RPIS NO.)	APE	OTHER AGENCIES (FY 76 Federal Inventory No.)
G. Are there hazards associated with processing, transfer, storage, and combustion of shale oil?	G-1 Characterize, identify, and quantify the chemical constituents in the volatile fractions and the combustion products of shale oil	2			
	G-2 Evaluate the toxic properties of substances from shale oil	2			
	G-3 Assess the potential health and environmental hazards associated with storage and transfer of shale oil	2			
	G-4 Assess the need for, and if necessary, develop treatment procedures for accidental and routine exposures to shale oil products	2			
H. Are the socioeconomic effects associated with oil shale development acceptable?	H-1 Assess effects of an oil shale processing facility on local planning or surrounding communities	1			See Attachment 3 (3 Projects)
	H-2 Determine impact of conveying shale oil to refineries on rail, highway, pipeline, and marine transportation	3			
	H-3 Estimate the impact of using shale oil on present demands and future needs for oil resources	2			
I. Are facilities in compliance with standards and regulations?	I-1 Prepare environmental assessments or EIS documents	1		ERDA/APE Environmental Impact Assessment Efforts	See Attachment 3 (4 Projects)
	I-2 Determine compliance with and obtain necessary air, water, and land use, including waste disposal, permits	1		ERDA/APE/LERC EIA support research	See Attachment 3 (2 Projects)
	I-3 Evaluate land management regulations and practices and determine effect on oil shale plants	2			See Attachment 3 (2 Projects)

OIL SHALE ENVIRONMENTAL, HEALTH, AND SAFETY ISSUES/REQUIREMENTS/PROJECTS CORRELATION

Environment, Health, & Safety ISSUES	REQUIREMENTS	Priority	Environment, Health & Safety Projects		
			AES (RPIS NO.)	AFE	OTHER AGENCIES (FY 76 Federal Inventory No.)
J. Are there adequate environmental controls?	J-1 Assess the atmospheric emission and particle control needs	1		ERDA/AFE, Removal of Ammonia and Alkalinity from Oil Shale Retort Oil Water	
	J-2 Evaluate the effectiveness of contaminated water cleanup, management and disposal procedures	1	Analysis, Screening Shale Oil Development(800061)		
	J-3 Identify pollution control needs to mitigate trace material leaching from spent shale and related impacts	1			
	J-4 Determine end-use environmental control technology or requirements	1	Analysis, Screening Shale Oil Development(800061)		See Attachment 3 (6 Projects)
	J-5 Develop systems for management and control of gas, liquid, and solid wastes and pollutant discharges	1		See Attachment 2 (3 Projects)	See Attachment 3 (3 Projects)
K. What is the significance and what are the applications of the environmental health and safety related data?	K-1 Assess output from all requirements and issues to redefine priorities, sharpen the focus of the requirements, determine the relevance of ongoing research projects, recommend new courses of action and plans, and identify applications	1		See Attachment 2 (4 Projects)	See Attachment 3 (5 Projects)
	K-2 Conduct integrated energy-related environmental assessments involving socioeconomic effects, bio-environmental analyses, and local and regional cost/risk/benefits studies, natural resource impacts or other energy-environmental tradeoffs and evaluations	2		ERDA/AFE, Water Conservation with In-Situ Oil Shale Development (093033)	
	K-3 Develop plans and surveys for site selections	1			
	K-4 Systematize oil shale data and information	1			

APPENDIX (CONT.)

OIL SHALE ENVIRONMENTAL, HEALTH, AND SAFETY ISSUES/REQUIREMENTS/PROJECTS CORRELATION

Environment, Health, & Safety ISSUES	REQUIREMENTS	Priority	Environment, Health & Safety Projects		
			AES (RPIS NO.)	AFE	OTHER AGENCIES (FY 76 Federal Inventory No.)
L. Will adverse ecological and climatological effects result from increases in the atmospheric concentrations of CO ₂ ?	L-1 Quantify the relative contribution of fossil fuel combustion to the global CO ₂ budget	1			
	L-2 Development of atmospheric models to assess effects	3	See Attachment 1 (2 Projects)		
	L-3 Development of models of CO ₂ cycling	3			
	L-4 Development of models to relate atmospheric concentrations of CO ₂ to changes in primary productivity	3	See Attachment 1 (1 Project)		
	L-5 Perform observations and experiments to validate models	3	See Attachment 1 (1 Project)		
	L-6 Development of international energy strategy for the combustion of fossil fuel resources	3			
	L-7 Define socioeconomic impacts which result from global CO ₂ effects	3			
M. Are the aquatic ecosystem disturbances associated with cooling systems for electrical power generation acceptable or as low as practicable?	M-1 Develop validated models of the impact of larval mortality on representative species	3	See Attachment 1 (1 Project)		
	M-2 Determine the types, amounts and effects of organic compounds formed from use of chlorine in cooling systems	3	See Attachment 1 (3 Projects)		
	M-3 Evaluate the potential of ozonation as an alternate to chlorination	3	See Attachment 1 (1 Project)		
	M-4 Develop alternate intake structure design features to reduce or eliminate fish mortalities	3	See Attachment 1 (1 Project)		

ATTACHMENT 1 TO APPENDIX

ERDA AES ENVIRONMENTAL PROJECTS SUPPORTING OIL SHALE TECHNOLOGY

REQUIREMENT	RPIS CONTROL NO.	TITLE
C-5, C-6, C-7	182	ANALYSIS FOR GENETIC DIFFERENCES
M-2	679	BIOCIDES
C-10, A-2	712	FINE PARTICLE STUDIES RELATED TO HEALTH
C-10, A-2	733	AEROSOL TECHNOLOGY
C-10, A-2	736	EVALUATION STUDIES OF INSTRUMENT
M-4	863	MECHANICAL IMPACTS OF ENTRAINMENT AND IMPINGEMENT
A-6	948	TERRAIN INFLUENCE ON LOW LEVEL METEOROLOGICAL TRANSPORT
B-5, B-6, E-2, E-3, E-6		
E-8, E-9, E-10, E-11	1124	ENVIRONMENTAL EFFECTS OF OIL SHALE DEVELOPMENT
A-2, C-10, F-1	1307	DEVELOP PHYSICAL METHODS TRACE CONTAMINANTS
F-1, C-10, A-2	1308	PHYSICAL METHODS OF ANALYSIS
F-1, C-10	1334	ENVIRONMENTAL POLLUTION ANALYSIS - INSTRUMENTS AND METHODS DEVELOPMENT
F-1, F-2, C-10, A-2	1598	SURVEY OF ENVIRONMENT INSTRUMENTS
A-2, C-10	1607	MULTIDETECTOR SPECTROGRAPHIC SYSTEMS
F-1, A-2	1617	TRACE ANALYSIS BY LASER TECHNIQUES
M-2	1688	NATIONAL CHLORINATION SYMPOSIUM
C-10, F-1, F-2	1707	DOSIMETRY FOR NEW ENERGY SYSTEM POLLUTANTS
C-3	1993	DELAYED EFFECTS OF INHALED OIL SHALE AND SPENT SHALE PARTICLES IN EXPERIMENTAL ANIMALS
C-1	1994	EVALUATION OF MUTAGENICITY AND CARCINOGENICITY FOR COMPOUNDS DERIVED FROM OIL SHALE PROCESSES
A-4, B-4	2126	CHARACTERIZATION OF EFFLUENTS FROM OIL SHALE RETORTING
E-2	2199	LAND RECLAMATION PROGRAM
A-4, B-4	2278	PREPARATION AND DOCUMENTATION OF OIL SHALE
A-2	2481	EVALUATION AND DEVELOPMENT OF SAMPLING SYSTEMS
C-4	2525	INHALATION TOXIC SHALE DUST
A-2, F-1	4057	DEVELOPMENT OF GENERATION AND SIZING INSTRUMENT OF FINE PARTICULATES AND AEROSOLS FOR CHARACTERIZING INHALATION HAZARD
C-3	4062	DETERMINE THE PROCESSES BY WHICH LABORATORY MAMMALS RECOVER FROM DAMAGE BY EXPOSURE TO POLLUTANTS ASSOCIATED WITH THE COAL GASIFICATION AND SHALE DISTILLATION
C-2, C-6	4066	EFFECTS OF HAZARDOUS AGENTS ASSOCIATED WITH COAL AND OIL SHALE TECHNOLOGIES ON INFORMATIONAL AND REGULATORY MACROMOLECULES OF MAMMALIAN CELLS
B-5, B-6, E-7, E-11	4111	DEVELOPMENT OF A CHEMICAL REACTION, STABILITY & TRANSPORT MODEL OF OIL SHALE PROCESS WASTES IN SOIL
L-2	6443	GLOBAL TRANSPORT PROCESSES & INTERACTIONS WITH TRACE CONSTITUENTS
A-6	6811	EFFECTS OF MOUNTAIN-VALLEY TERRAINS OF DISPERSION OF POLLUTANTS
M-1, M-2	6848	COMBINED TOXICITY EFFECTS OF CHLORINE, AMMONIA & TEMPERATURE ON MARINE PLANKTON
E-1	7003	SURVEY OF THE VIABILITY OF INDIGENOUS GRASSES, FORBS & SCRUBS: TECHNIQUES OF INITIAL ACQUISITION & TREATMENT FOR PROPAGATION IN PREPARATION FOR FUTURE LAND RECLAMATION IN THE FORT UNION BASIN
E-6, E-9, E-10	7098	TRACE ELEMENTS IN OIL SHALE
E-1, E-2, E-3, E-6		
E-8, E-9	7100	REHABILITATION POTENTIAL & PRACTICES OF COLORADO OIL SHALE LANDS
A-6	7199	ATMOSPHERIC ASPECTS OF OIL SHALE DEVELOPMENT
L-4, L-5	7210	GLOBAL EFFECTS STUDIES
L-2	7236	CO ₂ AND GLOBAL EFFECTS STUDIES
A-5	7249	GAS PARTICLE CONVERSION STUDIES
A-2, B-4	7254	STANDARD RESEARCH MATERIALS
F-5	7281	NIOSH COOPERATIVE STUDIES
M-3	7296	OZONATION IN POWER PLANT COOLING SYSTEMS
A-2	600001	AERIAL MEASURING SYSTEM (AMS)
F-1	600015	AIR SAMPLING PROGRAM
D-3, J-2	800061	ANALYSIS, SCREENING, & EVALUATION OF ECT FOR WASTEWATER GENERATED IN SHALE OIL DEVELOPMENT

ATTACHMENT 2 TO APPENDIX

ERDA AFE ENVIRONMENTAL PROJECTS SUPPORTING OIL SHALE TECHNOLOGY

<u>REQUIREMENT</u>	<u>FEDERAL INVENTORY NO.*</u>	<u>TITLE</u>
J-5		ERDA/AFE, REMOVAL OF AMMONIA AND ALKALINITY FROM OIL SHALE RETORT OIL WATER
E-9		ERDA/AFE, LEACHING RATES OF SPENT OIL SHALE
B-5, A-3, B-3, E-6, E-9		ERDA/AFE, ENVIRONMENTAL ASPECTS OF <u>IN SITU</u> OIL SHALE PROCESSING
J-5		ERDA/AFE, DEGRADATION OF THE ORGANIC COMPONENTS IN OIL SHALE RETORT WATER
A-4, B-4, J-1		ERDA/AFE, ENVIRONMENTAL RESEARCH FOR THE ANVIL POINTS OIL SHALE RESEARCH PROJECT
B-4, C-3, E-8, E-9		ERDA/AFE, CHARACTERIZATION OF CONTAMINANTS IN OIL SHALE RESIDUALS AND THE POTENTIAL FOR THEIR MANAGEMENT TO MEET ENVIRONMENTAL QUALITY STANDARDS
B-7, K-2		ERDA/AFE, WATER CONSERVATION WITH <u>IN SITU</u> OIL SHALE DEVELOPMENT
B-6, E-9, J-3		ERDA/AFE, ROLE OF SPENT SHALE IN OIL SHALE PROCESSING AND THE MANAGEMENT OF ENVIRONMENTAL RESIDUALS
B-5		ERDA/AFE, MINERALOGICAL AND GEOCHEMICAL STUDY OF THE COLORADO OIL SHALES
I-1, I-2		EIA DEVELOPMENT AND EIA UPDATE SUPPORT ACTIVITIES FOR THE FOLLOWING RESEARCH SITES: ROCK SPRINGS, UTAH, WYOMING, TALLEY-FRAC, WHITE MOUNTAIN, GEOKINETICS, EQUITY OIL, OCCIDENTAL, AND ANVIL POINTS. (INCLUDES LERC SUPPORT RESEARCH IN CHEMICAL CHARACTERIZATION, FIELD MONITORING RESEARCH, COMPLIANCE RESEARCH, ECOLOGICAL SYSTEMS RESEARCH, EFFECTS OF EFFLUENTS ON AQUATIC SYSTEMS, AND WATER RESOURCE EVALUATIONS)

* NOT ON INVENTORY

ATTACHMENT 3 TO APPENDIX A

OTHER FEDERAL AGENCIES ENVIRONMENTAL PROJECTS SUPPORTING OIL SHALE TECHNOLOGY

REQUIREMENT	FEDERAL INVENTORY NO.	AGENCY/TITLE
A-4, A-5, B-5 C-3	033056 033108	NIEHS, ACQUEOUS SOLUTION STUDIES OF ARSENATES AND VANADATES NIEHS, ARSINE TOXICITY, A POTENTIAL ENVIRONMENTAL HAZARD
A-4, B-4, C-1 E-8, J-3, J-5 I-2 B-1, B-4 B-1, B-4 B-3 B-2	054012 054015 054017 054027 054028 054032 054034	USGS, MINED AREA RECLAMATION AND RELATED COMMUNITIES USGS, ENERGY LANDS PROGRAM USGS, NATIONAL ENVIRONMENTAL OVERVIEW PROGRAM USGS, OIL SHALE HYDROLOGY, UTAH USGS, OIL SHALE HYDROLOGY, PICEANCE CREEK, COLORADO USGS, COAL AND OIL SHALE HYDROLOGY OF WY. WATER RESOURCES OF THE GREEN, POWDER, AND HANNA RIVER BASINS USGS, YAMPA RIVER BASIN ASSESSMENT, AN EVALUATION OF ENERGY DEVELOPMENT ALTERNATIVE FACTORS ON THE ENVIRONMENT
B-1, B-4 I-1 A-4, B-4, C-1 B-2 B-1 B-1, B-2, B-4	054035 054036 054037 054038 054043 054045	USGS, HYDROLOGY OF THE PARACHUTE ROAN CREEK BASIN USGS, STUDIES OF INTERRELATIONSHIPS AMONG WATER USE, ENERGY USE, AND ENVIRONMENTAL IMPACTS USGS, ENERGY SUPPORTING RESEARCH, HYDROCHEMISTRY AND ORGANICS USGS, ENERGY SUPPORTING RESEARCH, INSTRUMENTATION DEVELOPMENT USGS, DEFINITION OF POTENTIOMETRIC SURFACE OF SHALLOW ACQUIFERS IN PICEANCE CREEK IMPACTED BY OIL SHALE USGS, WATER QUALITY AND GEOCHEMISTRY OF SHALLOW ACQUIFERS OF PICEANCE CREEK, COLORADO
H-1, I-1 E-6 C-3 E-3, E-8, E-9 E-3, E-7, E-8, E-9 B-1 B-4 A-5	000004 070001 070003 070112 070113 070028 070034 070048	EPA, INTEGRATED ASSESSMENT: SOCIAL AND ECONOMIC CONSEQUENCES OF COAL AND OIL SHALE DEVELOPMENT EPA, WESTERN ENERGY RELATED OVERHEAD MONITORING EPA, TOXIC EFFECTS ON THE AQUATIC BIOTA FROM COAL AND OIL SHALE DEVELOPMENT EPA, VEGETATIVE STABILIZATION OF SPENT OIL SHALES EPA, VEGETATIVE STABILIZATION OF PARAHQ SPENT OIL SHALE EPA, GROUND WATER RESEARCH MONITORING OF ENERGY RELATED DEVELOPMENT (UINTA) EPA, IDENTIFICATION OF POLUTANTS FROM ENERGY RELATED WASTES AND EFFLUENTS EPA, SMOG CHAMBER STUDIES OF ATMOSPHERIC CHEMISTRY OF ORGANIC AND NITROGEN-CONTAINING EMISSIONS FROM EMERGING ENERGY TECHNOLOGIES
A-5, A-6 I-1 B-1, B-2, B-3	070053 070071 070130	EPA, SULFUR BUDGET IN LARGE PLUMES EPA, A TECHNOLOGY ASSESSMENT OF WESTERN ENERGY RESOURCE DEVELOPMENT EPA, WATER QUALITY HYDROLOGY AFFECTED BY OIL SHALE DEVELOPMENT (ASSESSMENT OF H ₂ O QUALITY HYDROLOGY) (UPPER BASIN)
I-3, J-5 H-1, J-5 J-1, J-6 J-6 J-6 J-6 I-1, J-4, J-5 J-6	070131 070144 070147 070193 070251 070191 120001	EPA, ENVIRONMENTAL IMPACT OF OIL SHALE DEVELOPMENT EPA, TECHNOLOGY FOR FOSSIL AND WASTE FUELS PROGRAM SUPPORT ON FOSSIL FUEL PROCESSING AND SYNTHETIC FUELS EPA, NEW CONCEPT FOR FINE PARTICLE CONTROL AT HIGH TEMPERATURE AND PRESSURE EPA, CATALYTIC DESULFURIZATION AND DENITROGENATION EPA, PILOT SCALE EVALUATION OF ADVANCED COMBUSTION CONTROL EPA, ENVIRONMENTAL ASSESSMENT/SYSTEMS ANALYSIS UTILIZING RESIDUAL OIL EPA, WESTERN ENERGY RELATED OVERHEAD MONITORING
B-4, C-9, E-9, E-10	100121	FEA, CHARACTERIZATION OF CONTAMINANTS IN OIL SHALE RESIDUALS AND THE POTENTIAL FOR THEIR MANAGEMENT TO MEET THEIR ENVIRONMENTAL QUALITY STANDARDS

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ATTACHMENT 3 TO APPENDIX (CONT.)

OTHER FEDERAL AGENCIES ENVIRONMENTAL PROJECTS SUPPORTING OIL SHALE TECHNOLOGY

<u>REQUIREMENT</u>	<u>FEDERAL INVENTORY NO.</u>	<u>AGENCY/TITLE</u>
E-3 E-8	000001 000005	DOA, REVEGETATION AND RECLAMATION OF LAND AREAS DISTURBED BY MINING DOA(FS), EFFECTS OF MINING AND RELATED ACTIVITIES ON THE FOREST AND RANGE ENVIRONMENT AND USERS AND ASSOCIATED COMMUNITIES
E-8, J-6	000006	DOA(FS), EPA (PASS THRU), TECHNOLOGIES FOR CONTROLLING EFFECT OF MINING ON THE FOREST AND RANGE ENVIRONMENT AND ON USERS AND RELATED COMMUNITIES
E-1, E-2, E-3 H-1	000007 000009	DOA, PLANT MATERIALS STUDIES TO IMPROVE TECHNOLOGIES OF SURFACE MINED LAND RECLAMATION DOA, SOCIOECONOMIC ANALYSIS OF COAL AND OIL SHALE DEVELOPMENT IN RURAL AREAS
F-4	032015	USPHS, MORTALITY AND MORBIDITY AMONG OIL SHALE WORKERS
J-5	*	BOM, TECHNICAL ASSISTANCE, OIL SHALE, ADVANCED OIL SHALE MINING TECHNOLOGY AND OIL SHALE EXTRACTION AND WASTE
E-6, E-9, J-4	*	BOM, SHALE WASTE DISPOSAL
J-4, E-8	*	BOM, UNDERGROUND DISPOSAL OF SPENT SHALE FROM THE PARAHO RETORTING PROCESS
B-7, B-1, J-4	*	BOM, WATER MANAGEMENT IN OIL SHALE MINING
J-4	*	BOM, SEEPAGE THROUGH PARTIALLY SATURATED SHALE WASTES
J-4	*	BOM, MATERIAL TESTING AND ANALYTICAL MODELING OIL SHALE WASTE DISPOSAL

A-13

* NOT ON INVENTORY

ABBREVIATIONS

AES	Assistant Administrator for Environment and Safety
AFE	Assistant Administrator for Fossil Energy
APAE	Assistant Administrator for Planning, Analysis, and Evaluation
BER	Biomedical and Environmental Research Division
BOM	Bureau of Mines
BPP	Balanced Program Plan
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
DEI	Development Engineering, Inc.
DOA	Department of Agriculture
DOI	Department of Interior
DTO	Division of Technology Overview
ECT	Environmental Control Technology Division
EDP	Environmental Development Plan
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
ENEPA	Office of NEPA Coordination
EOC	Environmental Overview Committee
EOEP	Office of Environmental Policy Analysis
EOIN	Office of Environmental Information Systems
EOPC	Office of Program Coordination
EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration
ESP	Environmental and Socioeconomic Programs Division
FEA	Federal Energy Agency
FEPA	Fossil Energy Program Planning and Analysis
FY	fiscal year
IAD	Immediate Action Directive
<u>in situ</u>	in its original position or in place
kerogen	organic material in which shale oil is extracted
LASL	Los Alamos Scientific Laboratory, New Mexico
LERC	Laramie Energy Research Center, Wyoming
LLL	Lawrence Livermore Laboratory, California
MER	Materials and Exploratory Research Division
NCI	National Cancer Institute
NEPA	National Environmental Policy Act (1969)
NIEHS	National Institute of Environmental Health Science
OC	Office of the Controller
OES	Operational and Environmental Safety Division
OGST	Oil, Gas, and Shale Technology Division
OSHA	Occupational Safety and Health Administration
PAD	Program Approval Document
PON	Program Opportunity Notice
RD&D	Research, Development, and Demonstration
retort	distill or decompose by heat
RPIS	Research Project Information System
SL	Sandia Laboratories, New Mexico
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
USPHS	U.S. Public Health Service