sodium mineral development

environmental assessment

draft

bureau of land management
rock springs district
rock springs, wyoming

IN REPLY REFER TO
1792(420)

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
District Office
P.O. Box 1869
Rock Springs, Wyoming 82901

August 7, 1981

Dear Reader:

The regional Sodium Mineral Development Draft Environmental Assessment that follows, analyzes the use of a resource that is of international as well as national importance. The trona deposition area within three resource areas of the Bureau's Rock Springs District is presently recognized as the world's largest commercial source of natural soda ash which is used in the production of a wide range of goods--from the glass in your car's windshield to the soap used to clean your clothes.

The Bureau of Land Management is obliged to the nation to assure that this unique resource is developed in the best interests of the public; and with such responsibility, I hope that you will review and comment on this document to assist the Bureau in making decisions for this resource's wise and timely development. Trona has been important to the economy of Sweetwater County for more than 30 years since the mineral's discovery and the subsequent construction and operation of mines and plants that have provided thousands of jobs. Nevertheless, development has also brought conflicts with other resource values and land uses as are noted in this document.

The Bureau has chosen a unique approach to the analysis of sodium mineral development in the region. A series of scenarios has been projected over the recommended land use decisions for the Kemmerer, Salt Wells, and Big Sandy planning units for the purpose of providing a framework upon which to lay the analysis. Please do not take these scenarios literally, but concentrate your attention upon how development could be influenced by the Bureau's sodium decisions and alternatives to those decisions. The scenarios do not represent BLM's projections of actual development, although companies, Federal agencies, and other sources were consulted prior to their development. Written comments on this draft EA will be accepted through September 21, 1981, by the Sodium EA Team Leader, Bureau of Land Management, Rock Springs District Office, P.O. Box 1869, Rock Springs, Wyoming 82901.

Sincerely yours,

District Manager

DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

DRAFT ENVIRONMENTAL ASSESSMENT OF SODIUM MINERAL DEVELOPMENT IN ROCK SPRINGS DISTRICT, WYOMING

WY-049-EA81-8

Located in the Counties of Sweetwater, Uinta, Lincoln, and Sublette, Wyoming

BUREAU OF LAND MANAGEMENT
ROCK SPRINGS DISTRICT OFFICE

August 1981

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PURPOSE AND NEED

The purpose of the proposed action is to provide a continuing source of soda ash from Southwest Wyoming trona (see Glossary) deposits in a timely and orderly manner that would maintain existing production, allow expansion of production to meet projected increased demands for soda ash (primary product of trona), and promote the discovery of new sodium mineral deposits (see Glossary) through prospecting. This action would also promote competition within the soda ash industry and ensure a fair market return to the public while assuring environmentally sound development.

Reasonable and technically feasible extraction operations require ownership or control of a sufficient ore reserve for economic recovery; this normally involves an area of several contiguous sections. Since Federal minerals are interspersed with private mineral ownership in a checkerboard land pattern (see Glossary) in most of the trona deposition area, issuance of Federal sodium mineral leases has been and will be a contributing factor in the recovery of both Federal and private trona deposits (pers. comm., Ned Davis 1980). The following Bureau of Land Management (BLM) actions would be needed to meet the purpose stated above: (1) competitive leasing and lease renewals; (2) issuance of prospecting permits and preference right leases; (3) review with Geological Survey of proposed mining plans; and (4) issuance of rights-of-way and temporary use permits for ancillary facilities as needed for the development of the sodium mineral source.

There is a projected need for expansion of soda ash production that would require new leases and rights-of-way. Prospecting could, if successful, lead to preference right lease applications for development. Two companies are proposing methods of solution mining to extract trona. FMC Corporation of Green River and Vulcan Materials Company (VMC) have initiated test projects to determine the economic and technical feasibility of their respective methods. FMC could require rights-of-way for further development. If Vulcan's method proves successful during the test phase, then VMC would need leases and rights-of-way to develop its proposed operation.

Currently BLM has many prospecting permit applications and competitive sodium lease applications for the Rock Springs District that will be considered following completion of this environmental assessment (EA). There are more than 40 existing leases with pending renewal reviews.

CHAPTER I

DESCRIPTION OF THE ALTERNATIVES INCLUDING THE PROPOSED ACTION

BACKGROUND

The trona deposits in Southwest Wyoming represent the largest known commercial source of natural soda ash in the world (Culbertson 1966, Innes 1980). Culbertson (1966) estimated major trona and trona/halite (see Glossary) deposits under a 1,400-square-mile area of the Green River Basin at 113 billion tons, including 67 billion tons of halite-free trona in 25 beds, each more than 3 feet thick and ranging in areal extent from 100 to 1,000 square miles. Culbertson and Burnside in a subsequent study (1979) estimated total Southwest Wyoming deposits at 134 billion tons (see Chapter III-Mineral Resources). Trona occurs in only a few places around the world and rarely in commercial quantities.

The primary products of the Wyoming trona are soda ash and sodium bicarbonate. Approximately 1.8 tons of trona are required to produce a ton of soda ash. About 55% of the soda ash production is utilized in the manufacturing of glass; 25 tons of soda ash is used for every 100 tons of glass produced (Kostick 1980). Twenty-two percent of the soda ash production is used by the chemical industry, and the remaining users include the pulp and paper, textile, cleaning, aluminum, and petroleum industries (Figure I-1). Church and Dwight's Southwest Wyoming plant uses soda ash to produce about 165,000 tons of baking soda per year, which it markets under the trade name of Arm and Hammer. It currently is the largest and most modern sodium bicarbonate facility in the world.

"Synthetic" soda ash has been made for many years by the complex Solvay process (see Glossary). The "natural" soda ash proved to be of higher purity, because it contained less sodium chloride contaminant. Also, plants producing soda ash from trona require considerably less energy, labor, and maintenance than plants using the Solvay process (Kostick 1980).

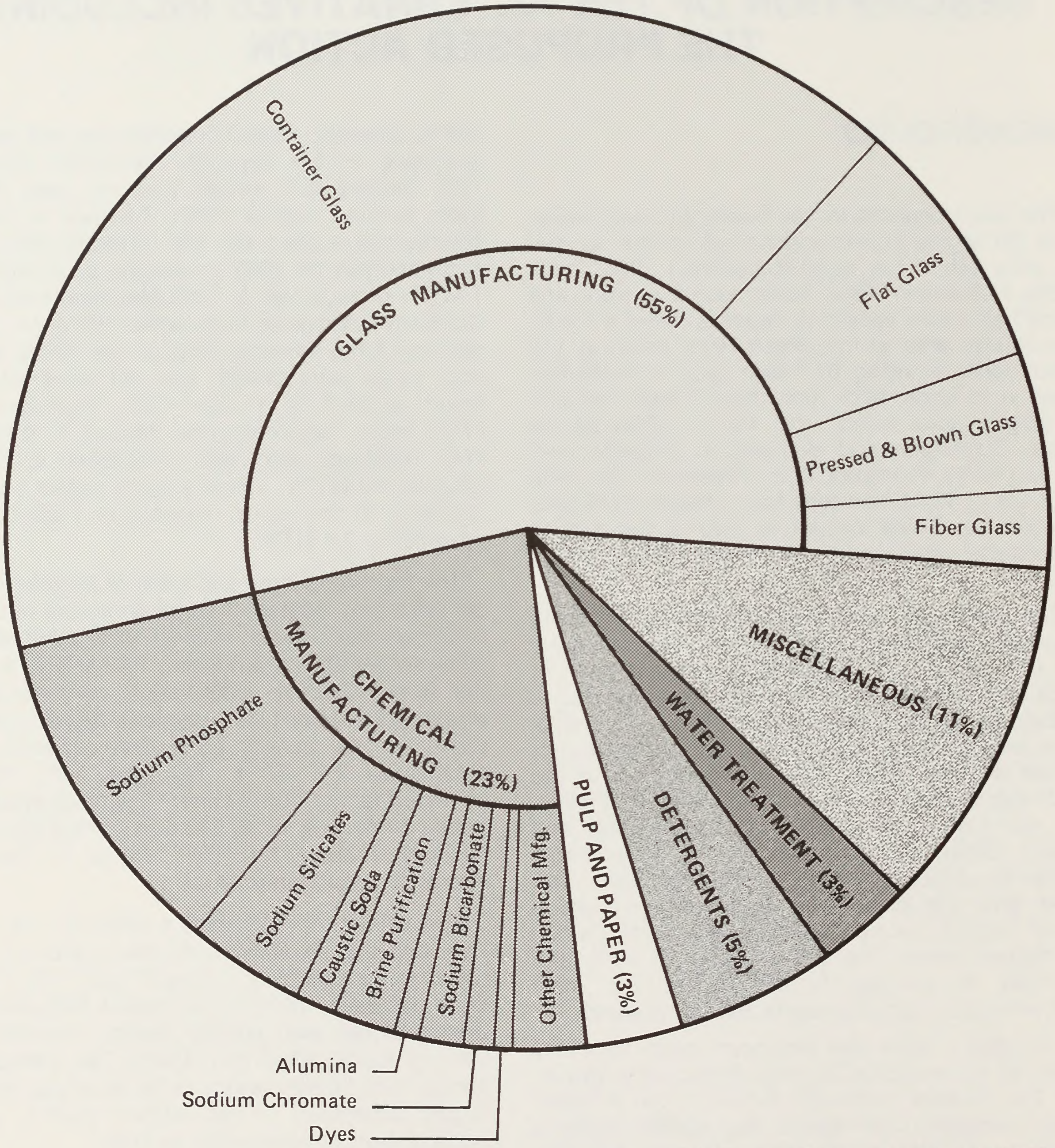
HISTORY

The four existing companies (FMC, Allied, Stauffer, and Texasgulf) are capable of producing approximately 7.82 million tons (see Glossary) of soda ash annually (Kostick 1980 and Rocket-Miner 1981); however, these companies are not currently producing at this capacity. Production levels for 1979 totalled 6.75 million tons per year (MTPY) (pers. comm., Kostick 1980). Tenneco is currently constructing a plant site and installing mine shafts in preparation for 1982 production of an additional 1 MTPY of soda ash. In 1938 Mountain Fuel Supply Company discovered trona while drilling for oil and gas near Little America. Through the 1940s, several core holes were drilled, and the trona bed was found to be 7 to 11 feet thick. Westvaco (now FMC) began developing the deposit in 1946. The FMC Westvaco plant was established in 1952 to produce 0.3 MTPY. Today it is the largest soda ash operation in the world, capable of producing approximately 2.8 MTPY.

The Big Island mine and plant of Stauffer Chemical Company, located 17 miles northwest of the city of Green River, were established in 1962 and are currently capable of producing 1.82 MTPY. In 1968, the Allied Chemical Corporation plant—located 6 miles northeast of Little America—began soda ash production; its current production capacity is approximately 2.2 MTPY. Texasgulf, Inc., the first coal-fired facility of the current Wyoming producers, began production in 1976 and its current production capacity is about 1.0 MTPY. Photo I-1 depicts a typical soda ash operation.

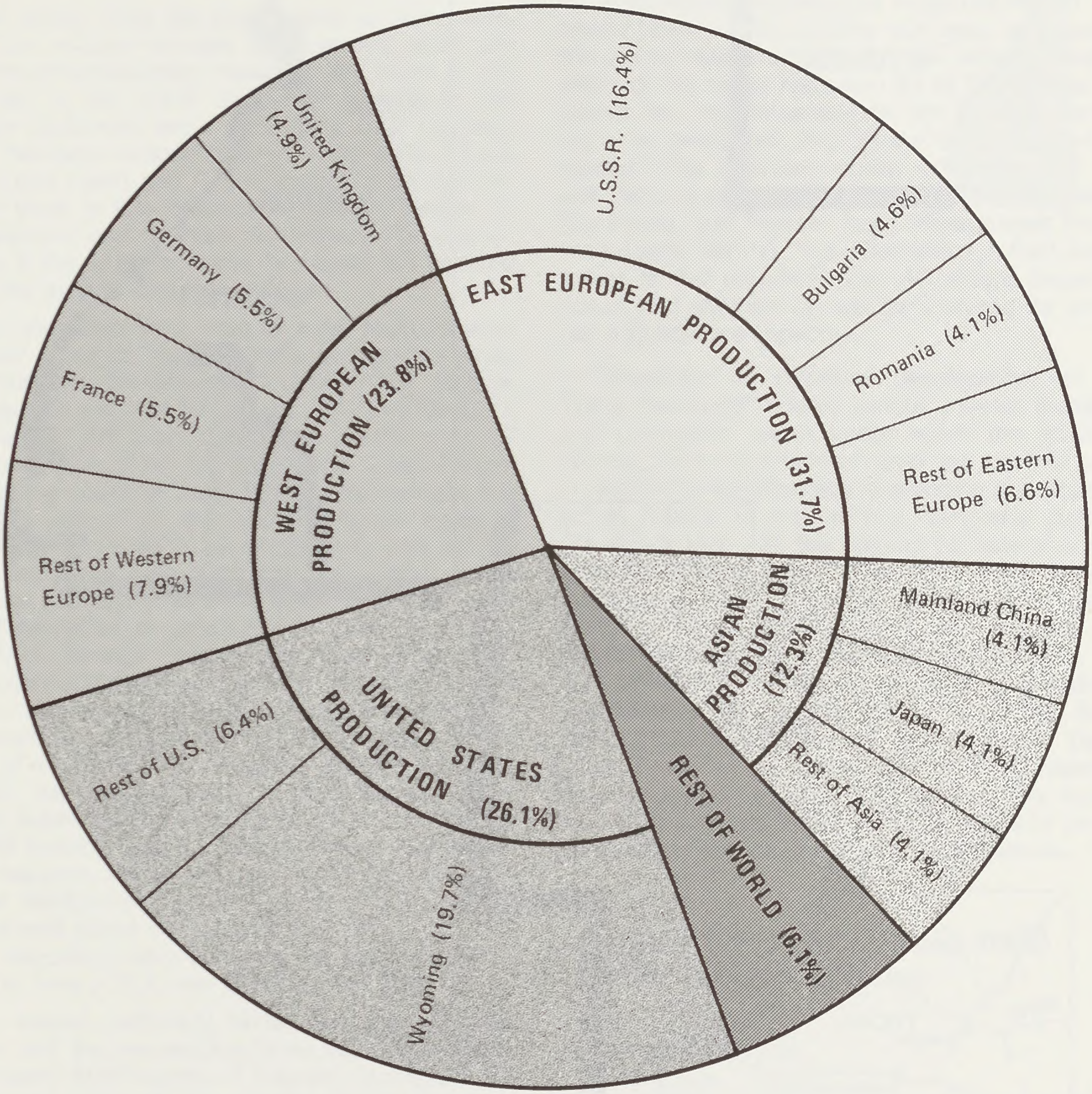
The markets for Wyoming's soda ash are extensive, and the Wyoming soda ash producers are a major world source of supply (Figure I-2). The primary domestic markets are located throughout the United States, with primary foreign markets being Latin America, Asia, and Africa. The transport of soda ash to these markets or for shipping abroad is largely dependent on the railroad system. Only a small amount is transported by truck.

Some interest has been shown in the sodium carbonate brine (black trona water; Map I-1) encountered in wells near the town of Farson. This unusual "black water" occurs in lenses or pods trapped in oil shale layers. No commercial ventures to extract soda ash from those brine deposits have yet been launched.



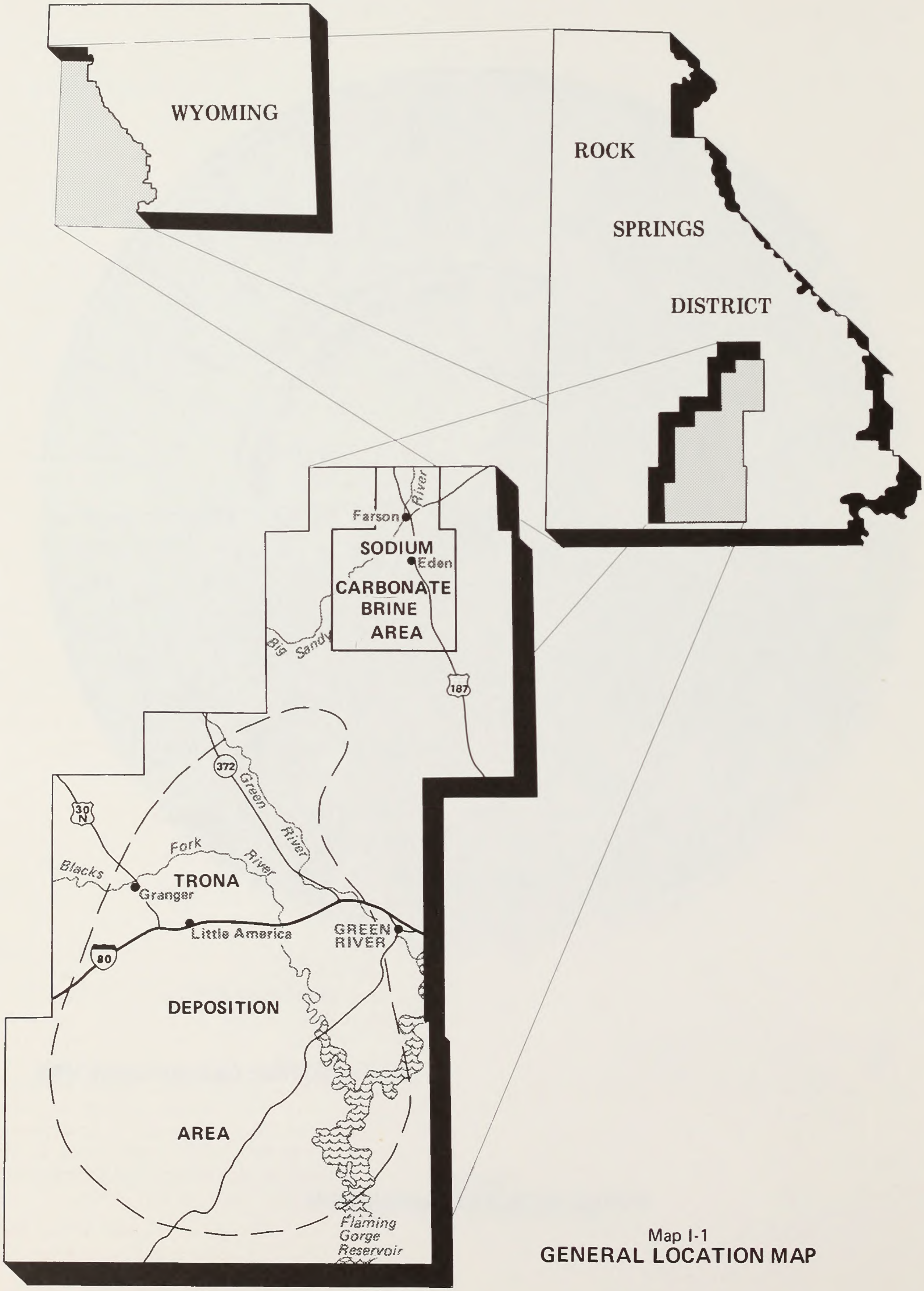
Adapted From: Kostick (1980) and Cameron Engineers (1969)

Figure I-1
END USES OF SODA ASH



Based on 1979 Plant Capacities (Kostick 1980)

Figure I-2
WORLD SODA ASH PRODUCTION



Map I-1
GENERAL LOCATION MAP

AREA OF ANALYSIS

The entire Rock Springs District is being analyzed for sodium minerals development, especially in terms of prospecting. However, the focus of this analysis is the trona deposition area and the sodium carbonate brine area (Map I-1). Development has been concentrated in these areas (Chapter II-Land Uses) and is anticipated to be concentrated there in the foreseeable future (Chapter III-Assumptions and Analysis Guidelines). For simplification in the analysis, these two areas are referred to as the sodium development area.

The trona deposition area is under approximately 914,560 acres of Federal, State, and private lands in Uinta and Sweetwater Counties. The area is bounded on the east by the city of Green River, on the west by the town of Granger, on the north by the confluence of the Big Sandy and Green Rivers, and on the south by Twin Buttes. This includes the northern portion of the Flaming Gorge National Recreation Area (NRA). Approximately 75% of the trona deposition area is checkerboard land, where alternate sections of land are public or private (Map I-2). Subsidiaries of Union Pacific Corporation and the Rock Springs Grazing Association generally own each odd-numbered section, and the Federal government manages the even-numbered sections; with scattered sections owned and managed by the State of Wyoming. The remaining 25% of the area, outside the checkerboard, is solid blocked land, mostly public lands managed by the BLM, Fish and Wildlife Service, and the Forest Service; with scattered sections owned and managed by the State or private landowners. Table I-l shows land surface and mineral status in the trona deposition area. The trona deposition area includes the Known Sodium Leasing Area (KSLA; see Glossary and Map I-1).

The sodium carbonate brine area encompasses Farson and the surrounding Eden Valley and is approximately ll4,000 acres of Federal, State, and private lands in Sweetwater County. Table I-2 shows land surface and mineral status in the sodium carbonate brine area, and Map I-2 shows the land status.

DESCRIPTION OF ALTERNATIVES AND SCENARIOS

INTRODUCTION

This section is divided into two parts: "Alternatives Including the Proposed Action" and "Scenarios of Possible Development of the Trona Resource."

"Alternatives Including the Proposed Action" is a presentation of the actions that may be taken by the public land manager for the orderly development of the trona resource. All of the actions are based on recommendations for development of trona as presented through the land use planning system. The proposed action comprises the land use recommendations identified in the Salt Wells, Big Sandy, and Pioneer Trails Management Framework Plans (MFPs). The alternatives reflect adjustments to that proposed plan. All options (proposed action and alternatives) will be analyzed for beneficial and adverse impacts.

"Scenarios of Possible Development of the Trona Resource" shows various means, locations, and production levels under which the trona resource could be developed over the next 20 years in relation to the alternatives including the proposed action. Owing to the mineral ownership patterns (Table I-1, Map I-2), the amount of Federal sodium minerals already leased, and the future development being related more to demand than Federal controls, BLM exerts only limited control over actual development in the foreseeable future. Any one of several development levels and patterns could occur during the period analyzed. Some could occur regardless of BLM actions. Trends could, however, be encouraged or discouraged by specific design of future BLM actions. The scenarios will be used as bases for the analysis of the impacts of the proposed action and alternatives.

ALTERNATIVES INCLUDING THE PROPOSED ACTION

PROPOSED ACTION

The proposed action is based upon multiple use recommendations contained in the land use plans for the Kemmerer, Big Sandy, and Salt Wells resource areas. The action contains two elements which are designed to meet the objectives of the plans in an environmentally acceptable manner. The objectives are: (a) to make sodium minerals available in an orderly and timely manner in order to meet national and export needs; (b) to promote healthy competition within the industry; and (c) to assure a fair return to the public. The specific elements of the proposed action are as follows:

1. Issue new competitive leases within the KSLA (Map I-1) in the context of the planning objectives previously mentioned.

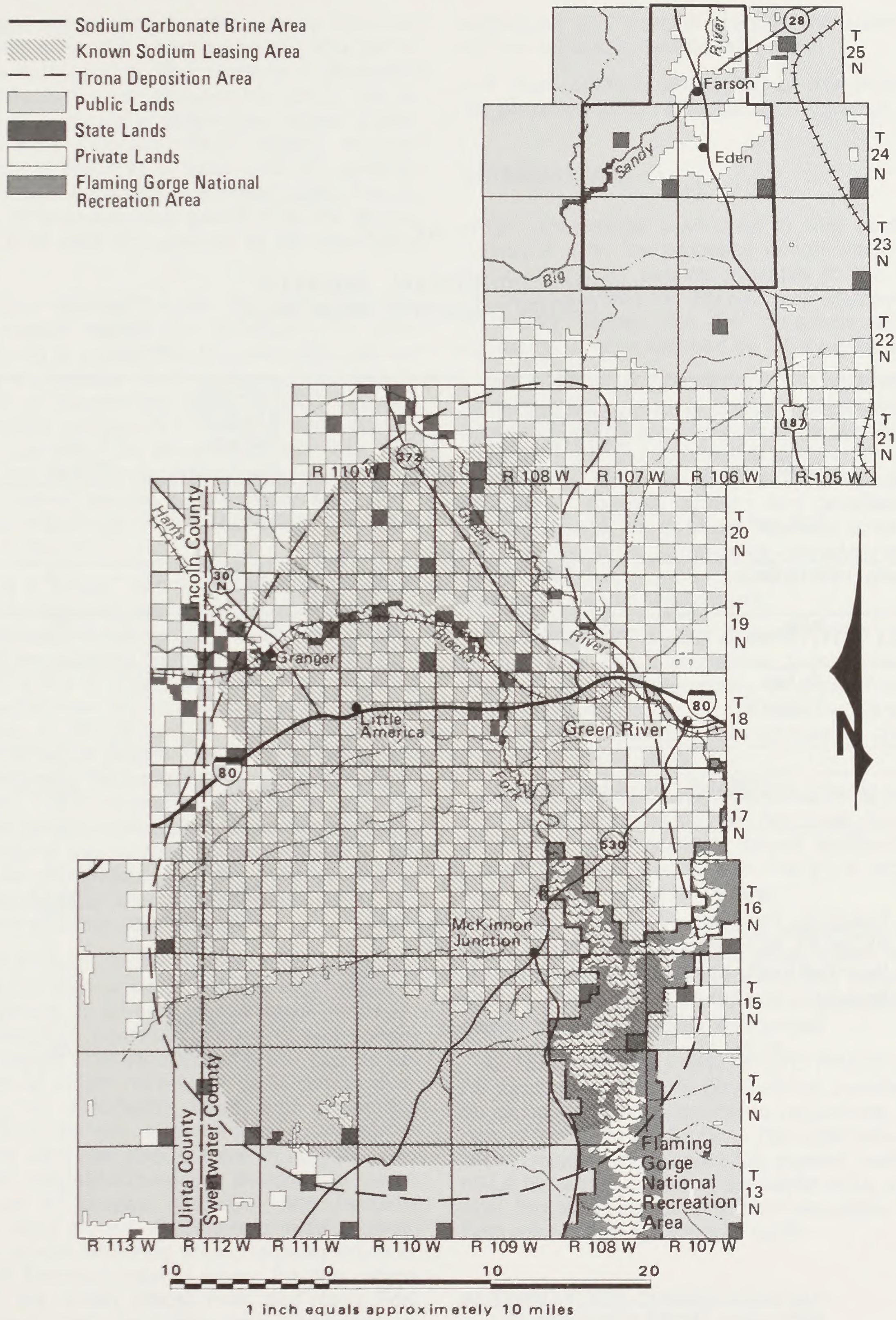
Table I-1

LAND AND MINERAL OWNERSHIP
TRONA DEPOSITION AREA

Ownership	Surface Estate in Acres	% of Total	Sodium Mineral Estate In Acres	% of Total
Private	349,560*	38.3	347,470*	38.1
State	26,020**	2.8	56,900**	6.2
BLM	488,540	53.4	510,190	55.7
Other Federal	50,440	5.5		
TOTALS	914,560	100.0	914,560	100.0

	Acres	% of Total
Federal Surface, Federal Sodium Minerals	508,100	55.5
Federal Surface, Non-Federal Mineral	30,880	3.4
Non-Federal Surface, Non-Federal Minerals	373,490	40.9
Private Surface; Oil, Gas, and Coal Reserved Federal Government	2,090	0.2
TOTALS	914,560	100.0%

*Includes 4,960 acres in the National Recreation Area
**Includes 360 acres in the National Recreation Area



Map I-2
LAND STATUS

Table I-2

LAND AND MINERAL OWNERSHIP
SODIUM CARBONATE BRINE AREA

Ownership	Surface Estate in Acres	% of Total	Sodium Mineral Estate in Acres	% of Total
Private	27,570	24	21,740	19
State	2,240	2	4,800	4
BLM	60,370	53	87,460	77
Other Federal	23,820	21		
TOTALS	114,000	100	114,000	100

	Acres	% of Total
Federal Surface, Federal Sodium Minerals	81,630	72
Federal Surface, Non-Federal Mineral	2,560	2
Non-Federal Surface, Non-Federal Minerals	23,980	21
Private Surface; Oil, Gas, and Coal Reserved Federal Government	5,830	5
TOTALS	114,000	100%

2. Issue prospecting permits outside the trona deposition area. The trona deposition area as defined in the planning documents is a geological basin (Map I-1) which includes the KSLA. The issuance of prospecting permit may initiate a preference right (noncompetitive) leasing process which could result in a lease and the development of new mine and processing plant. The issuance of a prospecting permit is at the discretion of BLM with the approval of the Geological Survey.

Leasing is contingent upon the discovery of a valuable sodium deposit (see Glossary). The Geological Survey is responsible for evaluating and determining the validity of a discovery. The recommendation on prospecting would prohibit issuance of prospecting permits in a marginal area outside the KSLA but within the trona deposition area. Prospecting and then perhaps noncompetitive leasing would be allowed outside the deposition area. Competitive leasing would be allowed within the KSLA (See No. 1 above).

There is a further recommendation in the planning system regarding issuance of prospecting permits or competitive leases in the Eden-Farson area. There are two pending preference right lease applications (PRLAs) in the area and 21 prospecting permit applications. According to the MFP recommendations if the preference right leases were issued, BLM would request that the U.S. Geological Survey designate the area as a KSLA for competitive leasing. If the preference right leases were not issued, the area would remain open for prospecting. In terms of the proposed action in this EA, this planning recommendation equates with either item 1 or 2 above since the effects are the same; i.e., leasing and possible development.

Another element of the multiple use recommendations is the application of the limited surface occupancy criteria to all new leases, lease renewals, and development proposals. These criteria consist of eight elements or stipulations which can be applied by BLM either individually or in combination, depending on opportunity, need, and desirability. These criteria do not relate directly to the objectives of the land use plan, but are, in actuality, recommended mitigation measures designed to lessen impacts on or protect resources and resource values of sage grouse strutting and nesting areas, big game crucial wintering areas, lambing areas or high value livestock grazing areas, Flaming Gorge Reservoir, the Green, Blacks Fork, and Hams Fork rivers, historic trails and sites, and wilderness inventory areas as well as to enhance public safety. Since the criteria are recommended mitigation measures, they are being included in the mitigation measures section of Chapter III-Environmental Consequences and, through analysis, the effectiveness of their application will be presented.

A more detailed description of the elements of the proposed action is included in Appendix 1.

ALTERNATIVES

The alternatives presented in this section are variations from the proposed action which involve the discretionary actions available to the Bureau; i.e., actions which the Bureau may approve, deny, or modify except for the no-action alternative whose inclusion is required by CEQ regulations.

NO-ACTION ALTERNATIVE The no-action alternative presents an array of development that could occur without the exercising of discretionary actions by BLM such as competitive leasing or allowing prospecting. These developments include the continuation of existing facilities and development of existing leases. No BLM discretionary actions such as lease renewals, issuance of necessary rights-of-way (ROW), etc., are included in this alternative. Scenarios 1 and 2 would apply.

ALTERNATIVE 1 - NO COMPETITIVE LEASING Issuance of new competitive leases would not occur. Under this alternative, all competitive lease applications would be denied and the BLM would not nominate selected tracts for leasing. Scenarios 1, 2, and 7 would apply.

ALTERNATIVE 2 - NO PROSPECTING Issuance of prospecting permits would not occur. Under this alternative, all prospecting permit applications for prospecting inside or outside the trona deposition area (Map I-1) would be denied.

No prospecting in the trona deposition area or sodium carbonate brine area would occur. Issuance of new competitive leases within the KSLA would be in the context of the planning objectives. Scenarios 1 through 6 would apply.

ALTERNATIVE 3 - UNLIMITED PROSPECTING All pending and future prospecting permits would be processed under applicable regulations, regardless of location. Particularly, this alternative would allow issuance of prospecting permits outside the KSLA but within the trona deposition area, and possibly the issuance of new noncompetitive leases. Scenarios 1 through 7 would apply.

ALTERNATIVES CONSIDERED BUT ELIMINATED FROM ANALYSIS

UNLIMITED LEASING Under this alternative, leasing would be in response to applications, all of which would be approved. The development of the trona resource in this manner would not provide for making sodium minerals available in a timely or orderly manner. By approving all lease applications and issuing leases in response to the applications, the Bureau would lose all control on where or when development of trona would occur. This is contrary to the objective outlined in the planning system.

SCENARIOS OF POSSIBLE DEVELOPMENT OF THE TRONA RESOURCES

INTRODUCTION

The following scenarios depict various ways that the trona resource may develop. These are a reflection of the proposed action and alternatives and should not be mistaken for the proposed action and alternatives. Each scenario contains a number of variables, several of which are interdependent. The following criteria concerning production levels are utilized in evaluating the scenarios:

1. Normal Expansion — This refers to the projected additions of facilities to the existing mines and/or plants (FMC, Stauffer, Allied, Texasgulf, and Tenneco) to an expanded production level of 11.4 million tons of soda ash per year. This level of expansion would be expected by the year 2000 (Scenarios 3, 4, 5, and 6).

2. Accelerated Expansion — This refers to the accelerated expansion of the existing plants and/or mines to achieve an expanded production level of 13.4 million tons of soda ash per year by the year 2000 (Scenarios 1, 2, 3, and 4).

3. Moderate Level of Production — This refers to an increase in total Wyoming soda ash production to 13.4 MTPY by the year 2000. This increased production could be accomplished with the establishment of new plants and mines to add to the expansion of the existing plants and mines (Scenarios 4, 5, and 6).

4. High Level of Production — This refers to an increase in total Wyoming soda ash production to 15.4 MTPY by the year 2000. This greatly increased production level could be achieved also with the establishment of new plants and mines to add to the increased production of existing plants and mines (Scenarios 1 and 3).

Since most of the scenarios include new plants and mines (Photos I-1 and I-2), a general description of each of these facilities follows. Rights-of-way and other use permits could be necessary for the establishment of mine and plant/mine operations. Conventional and solution mining techniques differ, but plants for both types of mines are basically similar. The area necessary for a commercial operation is dependent upon the trona reserves beneath the surface and the anticipated life of the operation. Current estimates and data indicate a range of 15 to more than 50 sections of land for operations anticipated to last 30 to 80 years.

Photo I-1 TYPICAL MINE DEVELOPMENT. One of FMC's mine entrance facilities includes a personnel change house, headframe and hoist house, ventilation and heater house, warehouse, fuel storage, and miscellaneous other structures.

TYPICAL MINE Surface facilities for conventional mine operations range from vertical shafts for personnel entry, ore hoisting (production shaft), and ventilation to a conveyor that takes the ore from the mine to the plant site. The shafts are 16 to 22 feet in diameter, and the headframe over the shaft opening depends upon the depth of the mine (usually 1,000 to 1,500 feet), the shaft's expected lifetime and use, and various surface and underground conditions. The mines are generally classified as gassy (Kostick 1980), and ventilation fans and shafts are installed to prevent the buildup of methane gas which is released during mining operations.

A hoist house is associated with the shaft and the headframe, and the mines also include underground primary crushers for the trona ore, underground storage bins, and either skip loaders or conveyor belts to carry the ore to the surface. At the surface, the trona ore is generally crushed again before it is transported by conveyor to the processing plant or a storage facility near the plant. Water runoff containment ponds would be used for ground water seepage into the mines.

Solution mining operations include a system of wells, pumps, and related facilities that inject the mining solution and recover the dissolved trona; a system of underground pipelines to carry the mining solution to the injection wells and return the trona-laden solution to the processing plant; and a mining solution preparation plant. The latter would probably be located in the vicinity of the processing plant. Twenty or more pairs of wells—each pair consisting of an injection well and a recovery well—could be operating at a given time.

The *in situ* mining process would be used for the deeper beds (about 2,000 to 2,200 feet below the surface) and theoretically would maximize recovery of the trona resource.

Rights-of-way involved with mine development could include pipelines, powerlines, access roads, buried telephone cables, as well as surface occupancy for various facilities described above.

Further information on the mines and mining operations are included in Appendices 3 and 8.

Photo I-2 TYPICAL SODA ASH PLANT. The Allied Chemical Corporation plant near Little America is indicative of the wide variety of structures and other facilities necessary for the processing, storage, and shipment of soda ash.

TYPICAL PLANT In addition to the processing plant, the plant facilities would include a steam plant, water treatment plant, trona ore (conventional mine) and coal storage buildings and/or stockpiles, cooling towers, product storage silos, and a truck and rail loadout facility for shipping the soda ash product and receiving coal (most of the plants are coal-fired). A conveyor transport system from a conventional mine or a system of pumps and pipelines from a solution mine would feed ore into the plant. As previously noted, the mining solution preparation plant would probably be located at the plant site. Other facilities at the plant sites would include a machine shop, laboratory, offices, change houses, heater house, and miscellaneous other small structures.

Other support facilities would include a water intake structure, tailings disposal ponds, sanitary sewer stabilization pond, a sanitary landfill for solid waste disposal, and topsoil and subsoil storage areas.

Rights-of-way would include a railroad spur, access roads, powerlines, buried waterlines and mining pipelines, tailings pond pipelines, buried telephone cables, and a paved surface road. Plant sites have not been located on public land.

The current production level for the existing mines and plants (not including Tenneco) is 6.8 MTPY. The current production level the plants are capable of is 7.8 MTPY.

Each scenario except for Scenario 7 contains a reference to a map (displays location of plants and anticipated production from each) and a table (displays projected production levels for timeframes of 1990 and 2000). The variables and their dimensions are as follows:

SCENARIO 1

This scenario is based on a high production level (15.4 MTPY) achieved through accelerated expansion of existing plants and mines augmented by one new mechanical mine/plant combination and one new solution mine/plant combination. No action would be required of BLM for this development to occur. The dimensions of the variables are as follows:

1. High level of production (15.4 MTPY).

2. Accelerated expansion of existing plants to processing level of 13.4 MTPY.

3. Accelerated expansion of existing mines to production level of 13.4 MTPY.

4. New plants — Two, each processing 1 MTPY (2 MTPY).

5. New mines — One conventional and 1 solution, each producing 1 MTPY (2 MTPY) to supply the two new plants.

The postulated locations of the new mines/plants are located in the KSLA in the northwest area for the conventional mine and south of Interstate 80 for the solution mine. Sufficient deposits have been leased to support this pattern of development.

See Map I-3 and Table I-3.

SCENARIO 2

This scenario involves a moderate level of production projected for the year 2000. This production level would be met by the accelerated expansion of existing plants and mines. No action would be required of BLM for this development to occur. The dimensions of the variables are as follows:

1. Moderate level of production (13.4 MTPY)

2. Accelerated expansion of existing plants to meet an accelerated processing level of 13.4 MTPY.

3. Accelerated expansion of existing mines to meet a production level of 13.4 MTPY.

4. New plants — None.

5. New mines — None.

See Map I-4 and Table I-4.

SCENARIO 3

This scenario involves a high level of production supplied by accelerated expansion of existing plant capacity, two new plants, and six new mines. New competitive leasing would be required for this development to occur. The dimensions of the variables are as follows:

1. High level of production (15.4 MTPY)

2. Accelerated expansion of existing plants to a processing level of 13.4 MTPY.

3. Normal expansion of existing mines to meet a production level of 11.4 MTPY

4. Two new plants producing 1.0 MTPY (2 MTPY).

5. Six new mines — Three conventional mines and three solution mines.

This scenario places emphasis on the development of new mines. Existing mines would be expanded to meet an 11.4 MTPY production. The remaining production (4.5 MTPY) is facilitated through development of three new conventional and three new solution mines. It is assumed that 0.5 MTPY production (soda ash equivalent) from a new conventional mine would be provided to the Bridger Power plant to scrub stack gas and for shipment to other markets as raw trona. One conventional mine would supply a new plant and the remaining conventional mine would supply material to the existing sodium bicarbonate facility.

Production from new solution mines would be used as follows: One would supply a new plant and two would supply expanded existing parent plants.

See Map I-5 and Table I-5.

SCENARIO 4

This scenario involves a moderate level of production (13.4 MTPY) projected for the year 2000. This production level would be met through accelerated expansion of existing plants, normal expansion of existing mines, and development of three new mines. New competitive lease action would be required of BLM for this development to occur. The dimensions of the variables are as follows:

1. Moderate level of production (13.4 MTPY)

2. Accelerated expansion of existing plants to a processing level of 13.4 MTPY.

3. Normal expansion of existing mines to a production level of 11.4 MTPY.

4. New plants — None.

5. New mines — Three: One conventional and two solution mines. The conventional mine would produce 0.5 MTPY. The two solution mines would produce a total of 1.5 MTPY.

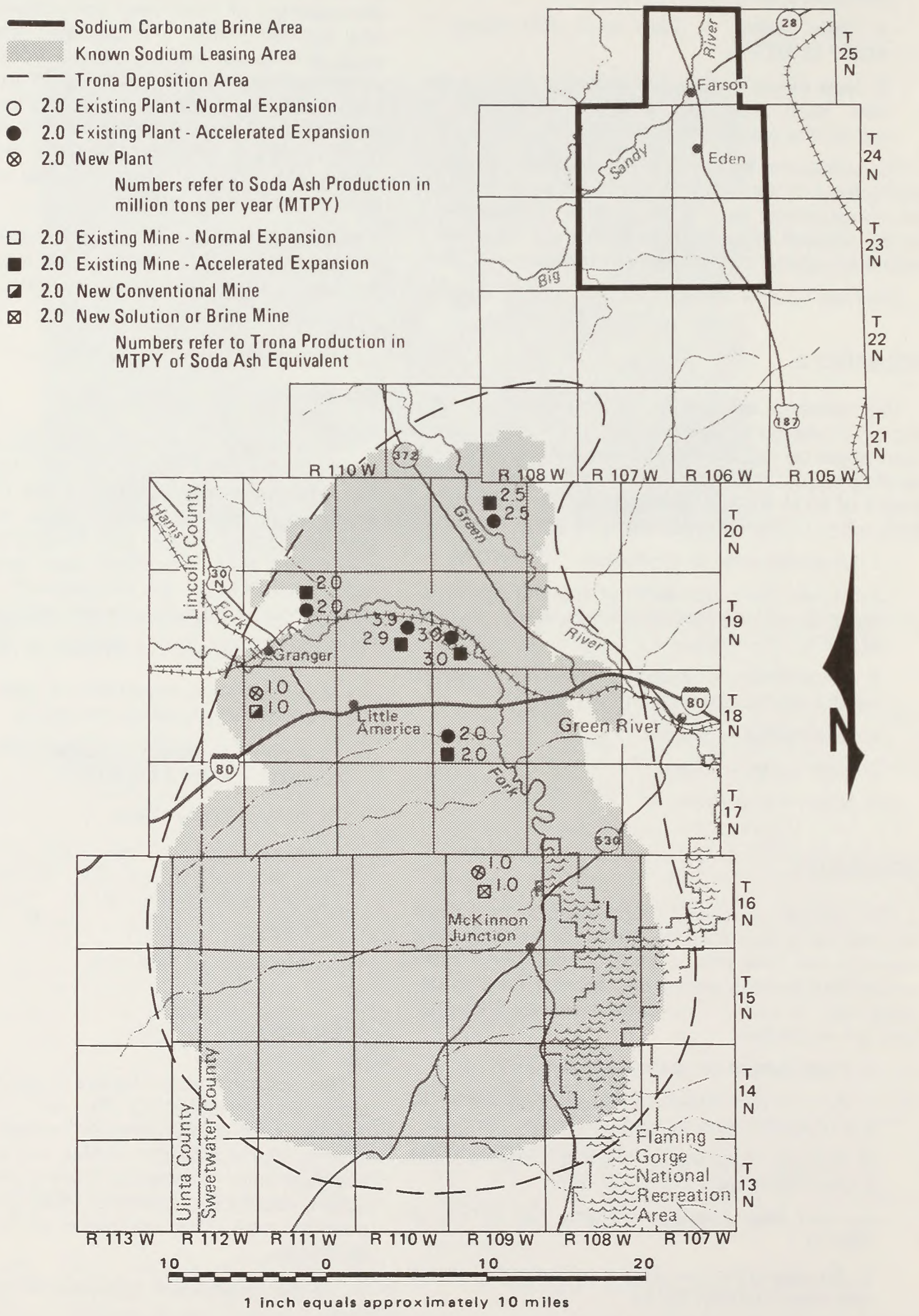
See Map I-6 and Table I-6.

SCENARIO 5

This scenario also involves a moderate level of production projected for the year 2000. This production level is met through normal expansion of existing plants and mines plus two new plant and two new mine operations. New competitive lease action would be required of BLM for this development to occur. The dimensions of the variables are as follows:

1. Moderate level of production (13.4 MTPY).

2. Normal expansion of existing plants to a processing level of 11.4 MTPY.



Map I-3
Scenario 1
LOCATIONS OF PLANTS AND MINES

Table I-3

ESTIMATED PLANT PRODUCTION IN MILLION SHORT TONS UNDER SCENARIO ONE

Plant	Existing	1990	2000
FMC	2.6	3.3	3.9
Allied Chemical-Green River	1.8	2.2	3.0
Stauffer	1.5	1.9	2.5
Texasgulf	0.9	2.0	2.0
Tenneco	--	1.0	2.0
New Plant-Solution Mining	--	--	1.0
New Plant-Conventional Mining	--	--	1.0
(Subtotals-Wyoming)	6.8	10.4	15.4
Other U.S. Production	1.8	1.5	2.3
TOTAL U.S. PRODUCTION	8.6	11.9	17.7

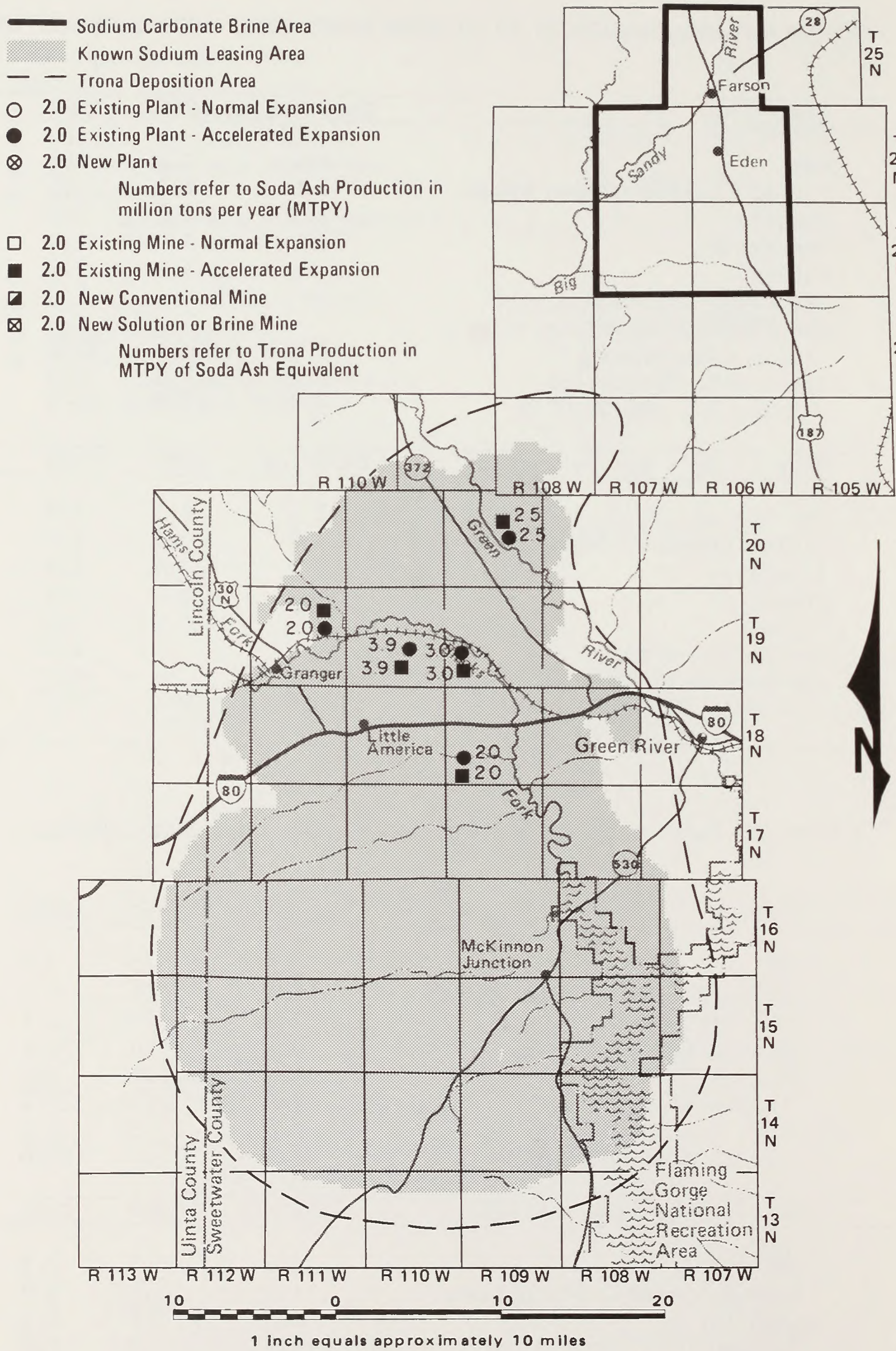
Mine in Soda Ash Equivalent	Existing	1990	2000
FMC	2.6	3.3	3.9
Allied Chemical-Green River	1.8	2.2	3.0
Stauffer	1.5	1.9	2.5
Texasgulf	0.9	2.0	2.0
Tenneco	--	1.0	2.0
New Solution Mine	--	--	1.0
New Conventional Mine	--	--	1.0
WYOMING MINE PRODUCTION	6.8	10.4	15.4

Table I-4

ESTIMATED PLANT PRODUCTION IN MILLION SHORT TONS UNDER SCENARIO TWO

Plant	Existing	1990	2000
FMC	2.6	3.0	3.9
Allied Chemical-Green River	1.8	2.2	3.0
Stauffer	1.5	1.9	2.5
Texasgulf	0.9	2.0	2.0
Tenneco	--	1.0	2.0
(Subtotal Wyoming)	6.8	10.1	13.4
Other U.S. Production	1.8	1.8	2.6
TOTAL U.S. PRODUCTION	8.6	11.9	16.0

Mine in Soda Ash Equivalent	Existing	1990	2000
FMC	2.6	3.0	3.9
Allied Chemical-Green River	1.8	2.2	3.0
Stauffer	1.5	1.9	2.5
Texasgulf	0.9	2.0	2.0
Tenneco	--	1.0	2.0
WYOMING MINE PRODUCTION	6.8	10.1	13.4



Map I-4

Scenario 2

LOCATIONS OF PLANTS AND MINES

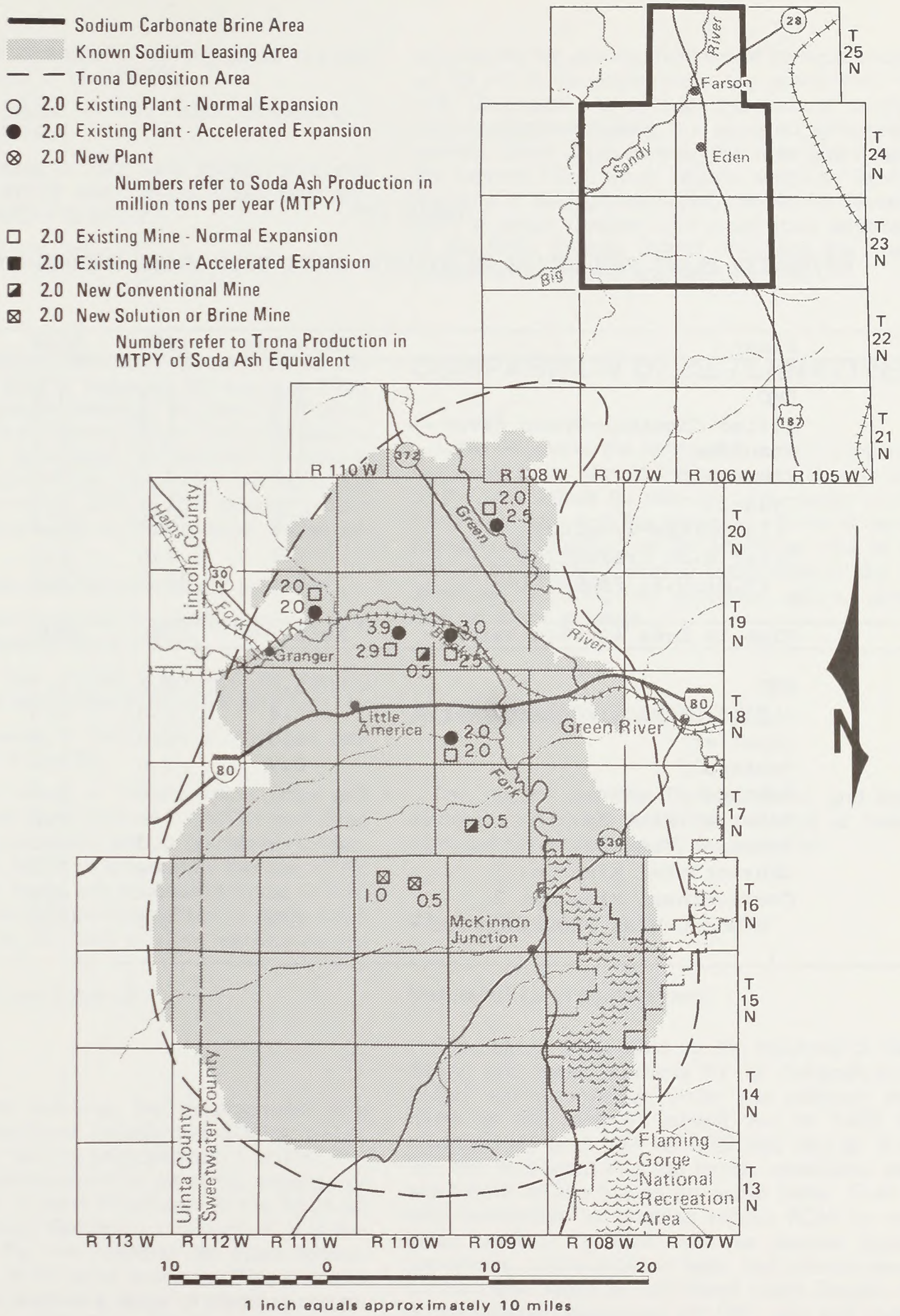
Map I-5
Scenario 3
LOCATIONS OF PLANTS AND MINES

Table I-5

ESTIMATED PLANT PRODUCTION IN MILLION SHORT TONS UNDER SCENARIO THREE

Plant	Existing	1990	2000
FMC	2.6	3.3	3.9
Allied Chemical-Green River	1.8	2.1	3.0
Stauffer	1.5	1.9	2.5
Texasgulf	0.9	2.0	2.0
Tenneco	--	1.0	2.0
New Plant-Solution Mining	--	--	1.0
New Plant-Conventional Mining	--	--	1.0
(Subtotals-Wyoming)	6.8	10.3	15.4
Other U.S. Production	1.8	1.6	2.3
TOTAL U.S. PRODUCTION	8.6	11.9	17.7

Mine in Soda Ash Equivalent	Existing	1990	2000
FMC	2.6	2.9	2.9
Allied Chemical-Green River	1.8	1.8	2.5
Stauffer	1.5	1.5	2.0
Texasgulf	0.9	2.0	2.0
Tenneco	--	1.0	2.0
Solution Mine No. 1	--	--	1.0
Solution Mine No. 2	--	0.4	1.0
Solution Mine No. 3	--	--	0.5
Conventional Mine No. 1	--	0.4	1.0
Conventional Mine No. 2	--	0.3	0.5
Conventional Mine No. 3	--	--	0.5
WYOMING MINE PRODUCTION	6.8	10.3	15.9



Map I-6
Scenario 4
LOCATIONS OF PLANTS AND MINES

Table I-6

ESTIMATED PLANT PRODUCTION IN MILLION SHORT TONS UNDER SCENARIO FOUR

Plant	Existing	1990	2000
FMC	2.6	2.9	3.9
Allied Chemical-Green River	1.8	1.8	3.0
Stauffer	1.5	2.0	2.5
Texasgulf	0.9	2.0	2.0
Tenneco	--	1.0	2.0
(Subtotals-Wyoming)	6.8	9.7	13.4
Other U.S. Production	1.8	1.8	2.6
TOTAL U.S. PRODUCTION	8.6	11.5	16.0

Mine in Soda Ash Equivalent	Existing	1990	2000
FMC	2.6	2.6	2.9
Allied Chemical-Green River	1.8	1.8	2.5
Stauffer	1.5	2.0	2.0
Texasgulf	0.9	2.0	2.0
Tenneco	--	1.0	2.0
Solution Mine No. 1	--	--	0.5
Solution Mine No. 2	--	0.3	1.0
Conventional Mine No. 1	--	--	0.5
Conventional Mine No. 2	--	--	0.5
WYOMING MINE PRODUCTION	6.8	9.7	13.9

3. Normal expansion of existing mines to a production level of 11.4 MTPY.

4. New plants — Two: each processing 1 MTPY (2 MTPY).

5. New mines — Two: One solution mine producing 1 MTPY and 1 conventional mine producing 1 MTPY (2 MTPY).

See Map I-7 and Table I-7.

SCENARIO 6

This scenario involves a moderate level of production (13.4 MTPY) projected for the year 2000. The scenario places emphasis on new mines rather than expansion of existing mines. This emphasis on new mines is predicated on success of solution mining techniques. New competitive leasing action would be required of BLM for this development to occur. The dimensions of the variables are as follows:

1. Moderate level of production (13.4 MTPY).

2. Normal expansion of existing plants to a processing level of 11.4 MTPY.

3. Less than normal expansion of existing mines to a production level of 9.8 MTPY.

4. New plants — Two: with a combined production of 2.0 MTPY.

5. Six new mines — Three solution mines with a combined production of 2.1 MTPY and three conventional mines with a combined production of 2.0 MTPY. It is assumed that 0.5 MTPY production (soda ash equivalent) would be provided to the Bridger Power Plant to scrub stack gas and for shipment to other markets as raw trona.

See Map I-8 and Table I-8.

SCENARIO 7

This scenario assumes the development of a new small mine/plant outside the existing KSLA. The production level is projected at 0.4 MTPY. This production would presumably be at the expense of the production of some mine/plant in the KSLA as presented through Scenarios 1 through 6. It is further assumed that this scenario can occur concurrently with any of the other scenarios. This scenario will be used to analyze a range of planning recommendations or alternatives affecting prospecting outside the KSLA. The operations could be at Eden-Farson or anywhere else in the district, but outside the KSLA. In the Eden-Farson area, PRLAs are under consideration and following adjudication, production could occur. Should this occur, the area affected by the development would be recommended for KSLA designation requiring action from the U.S. Geological Survey with provision to conduct new competitive leasing but issue no prospecting permits. Other areas outside this area and outside the present KSLA would require action by BLM in the form of issuing prospecting permits for development to occur. Development could occur anywhere in the Rock Springs District, including the Eden-Farson area, with the approval of a PRLA.

COMPARISON OF ALTERNATIVES

Table I-9 shows the anticipated range of impacts that could occur should the proposed action or any of the alternatives be selected. The range of impacts depends upon the projected effects of developments as depicted in the scenarios, and is intended for use as a relative comparison of the alternatives, including the proposed action, rather than an actual situation.

AUTHORIZING ACTIONS

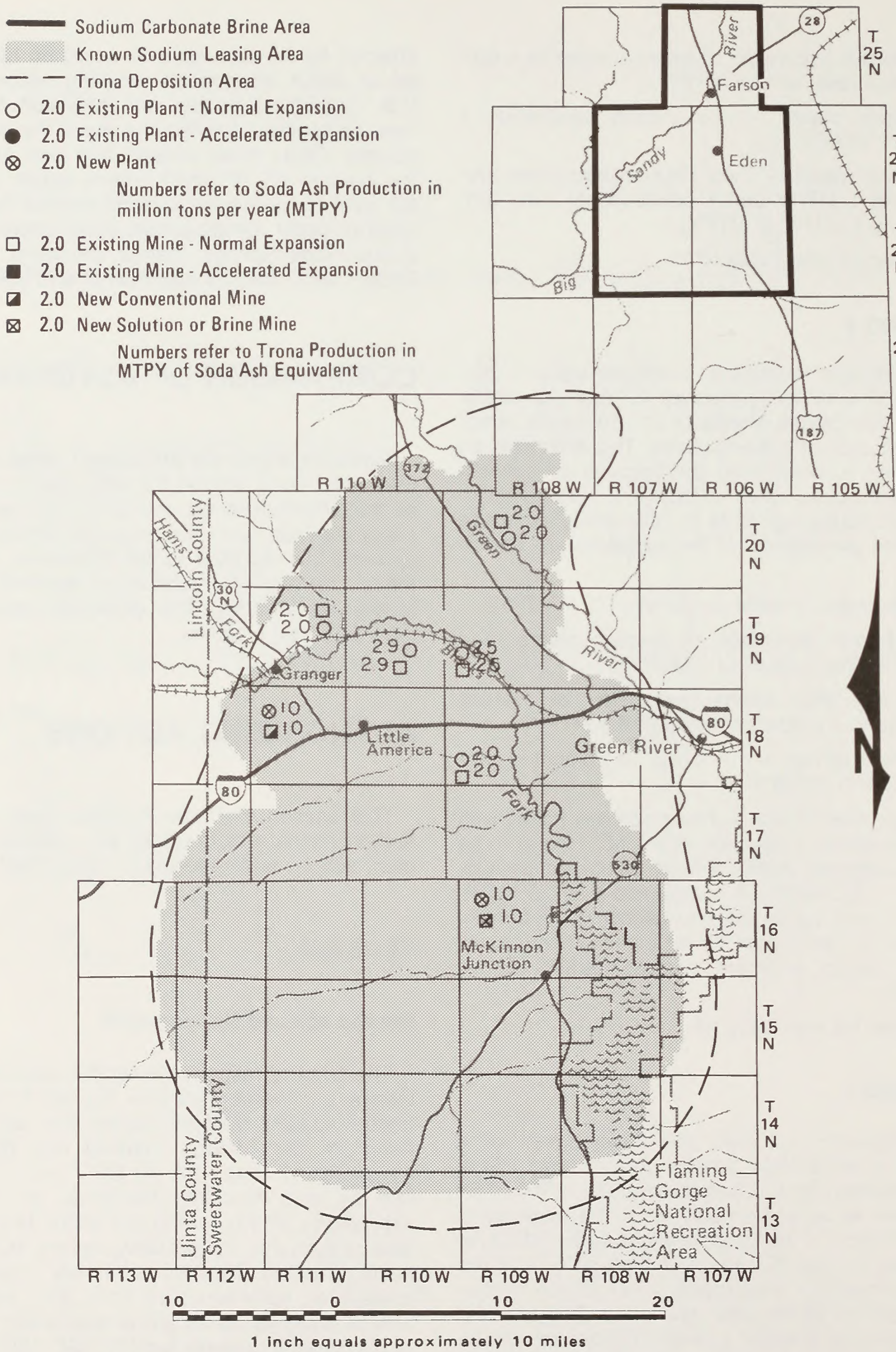
This section identifies Federal, State, and local authorizations which would be required to implement actions addressed in this document:

FEDERAL

Bureau of Land Management

The BLM is responsible for the issuance of new leases and lease renewals for all Federally-controlled sodium minerals under the authority and terms of the Mineral Leasing Act of 1920 as amended (41 Stat. 437; 30 USC Sec. 261-3). BLM has the lead input into the terms, conditions, and stipulations of the leases on public lands. BLM is also responsible for granting various ROW for off-lease ancillary facilities such as access roads, powerlines, communication lines, and railroad spurs across public lands as authorized under Section 28 of the Mineral Leasing Act (30 USC 185) and under Title V of the Federal Land Policy and Management Act (FLPMA) of October 21, 1976 (P.L. 94-579, 90 Stat. 2743 *et seq*).

BLM must also concur with the mining and reclamation plan before approval is granted by GS.



Map I-7
Scenario 5
LOCATIONS OF PLANTS AND MINES

Table I-7

ESTIMATED PLANT PRODUCTION IN MILLION SHORT TONS UNDER SCENARIO FIVE

Plant	Existing	1990	2000
FMC	2.6	2.9	2.9
Allied Chemical-Green River	1.8	1.8	2.5
Stauffer	1.5	2.0	2.0
Texasgulf	0.9	2.0	2.0
Tenneco	--	1.0	2.0
New Plant-Solution Mining	--	--	1.0
New Plant-Conventional Mining	--	--	1.0
(Subtotals-Wyoming)	6.8	9.7	13.4
Other U.S. Production	1.8	1.8	2.6
TOTAL U.S. PRODUCTION	8.6	11.5	16.0

Mine in Soda Ash Equivalent	Existing	1990	2000
FMC	2.6	2.9	2.9
Allied Chemical-Green River	1.8	1.8	2.5
Stauffer	1.5	2.0	2.0
Texasgulf	0.9	2.0	2.0
Tenneco	--	1.0	2.0
Solution Mine No. 1	--	--	1.0
Conventional Mine No. 1	--	--	1.0
WYOMING MINE PRODUCTION	6.8	9.7	13.4

Map I-8
Scenario 6
LOCATIONS OF PLANTS AND MINES

Table I-8

ESTIMATED PLANT PRODUCTION IN MILLION SHORT TONS UNDER SCENARIO SIX

Plant	Existing	1990	2000
FMC	2.6	2.9	2.9
Allied Chemical-Green River	1.8	1.8	2.5
Stauffer	1.5	2.0	2.0
Texasgulf	0.9	2.0	2.0
Tenneco	--	1.0	2.0
New Plant-Solution Mining	--	--	1.0
New Plant-Conventional Mining	--	--	1.0
(Subtotals-Wyoming)	6.8	9.7	13.4
Other U.S. Production	1.8	1.8	2.6
TOTAL U.S. PRODUCTION	8.6	11.5	16.0

Mine in Soda Ash Equivalent	Existing	1990	2000
FMC	2.6	2.6	2.6
Allied Chemical-Green River	1.8	1.8	1.8
Stauffer	1.5	1.5	1.5
Texasgulf	0.9	2.0	2.0
Tenneco	--	1.0	2.0
Solution Mine No. 1	--	--	1.0
Solution Mine No. 2	--	0.3	0.6
Solution Mine No. 3	--	--	0.5
Conventional Mine No. 1	--	--	1.0
Conventional Mine No. 2	--	0.5	0.5
Conventional Mine No. 3	--	0.5	0.5
WYOMING MINE PRODUCTION	6.8	10.2	13.9

Table I-9

COMPARISON OF LONG-TERM IMPACTS OF ALTERNATIVES BASED ON SCENARIOS OF SODIUM MINERAL DEVELOPMENT IN THE ROCK SPRINGS DISTRICT

	Proposed Action	No-Action Alternative	Alternative 1- No Competitive Leasing	Alternative 2- No Prospecting	Alternative 3- Unlimited Prospecting
Anticipated Wyoming Soda Ash Production in Million Tons Per Year	13.4-15.4	13.4-15.4	13.4-15.4	13.4-15.4	13.4-15.4
Cumulative Use/Loss of Trona Reserves Through 2000 in Million Tons	373.53-397.9	374.23-397.18	373.53-397.9	373.53-397.9	373.53-397.9
Fossil Fuel Energy Consumption in Million BTUs Per Year	96.5-113.8	96.5-110.9	96.5-113.8	96.5-110.9	96.5-113.8
Percent of Conflict With Other Mineral Development Above Existing Situation	0-80	0-30	0-80	0-80	5-85
Disturbance of Soil/Vegetation Associations in Acres	12,200-19,000	12,200-15,200	12,200-19,000	12,200-17,400	12,250-19,070
Water Consumption in Acre-Feet Per Year	45,894-54,113	45,950-52,743	45,950-54,113	45,894-52,743	45,895-54,114
Big Game Summer Habitat Disturbed in Acres	4,100-10,900	4,100-7,100	4,100-10,900	4,100-9,300	4,150-10,970
Pronghorn Crucial Winter Habitat Disturbed in Acres	4,100-8,100	4,100-5.500	4,100-8,100	4,100-6,500	4,135-10,950
Wintering Pronghorn Displaced	64-127	64-86	64-127	64-97	64-127
Waterfowl Lost Per Year in Tailings Ponds	90-110	90-100	90-110	90-100	90-110
Wild Horses Displaced	0-51	0	0-51	0-51	0-51
Livestock AUMs Lost	273-727	273-473	273-727	273-620	273-727
Acres of Visual Resources Degraded	10,660-19,560	10,660-14,900	10,660-19,560	10,660-15,400	10,660-19,560
Total Direct Employment	5,421-6,560	5,421-6,310	5,421-6,560	5,421-6,405	5,421-6,560+
Total Indirect and Induced Employment	3,147-3,608	3,147-3,471	3,147-3,608	3,147-3,523	3,147-3,608+
Total Population Increase From 1980	4,665-8,092	4,829-7,158	4,665-8,092	4,665-7,533	4,665-8,092+
Total Personal Income in Millions of Dollars	190.11-214.83	190.11-209.68	190.11-214.83	190.11-212.84	190.11-214.83+
Total Bachelor Residences Needed	729-835	729-804	729-835	729-816	729-835+
Total Family Residences Needed	6,564-7,526	6,564-7,240	6,564-7,526	6,564-7,349	6,546-7,526
Additional School Enrollments	2,212-3,444	2,212-3,071	2,212-,3444	2,212-3,213	2,121-3,444
Severance Taxes in Millions of Dollars	16.78-19.91	16.78-19.29	16.78-19.91	16.78-19.91	16.78-19.91
Production Taxes in Millions of Dollars	21.81-25.88	21.81-25.07	21.81-25.88	21.81-25.88	21.81-25.88
Property Taxes in Million of Dollars	8.14-16.51	8.14-14.04	8.14-16.51	8.14-15.01	8.14-16.51

Source: Table III-12 of this EA.

GEOLOGICAL SURVEY (GS)

The Area Mining Supervisor of the GS must approve the mining and reclamation plan prior to commencement of mining operations by a company. The area mining supervisor must also concur with this EA. The GS is also responsible for determining the royalty requirements and terms and conditions related to mining operations.

FOREST SERVICE (FS)

The FS recommends conditions of surface use on lands under its jurisdiction, such as the Flaming Gorge NRA. The FS must concur with subsequent mining and reclamation plans for involved NRA lands before approval is granted by GS. The FS is also responsible for granting various ROW for ancillary facilities on NRA lands.

FISH AND WILDLIFE SERVICE (FWS)

The FWS has similar responsibilities for the Seedskadee Wildlife Refuge as the FS has for the NRA.

Coordination is required with the FWS in the following environmental circumstances:

1. Fish and Wildlife Coordination Act (16 U.S.C. Sec. 661 *et seq*) when an action would or could involve navigable waters and a fish and wildlife resource.

2. Bald and Golden Eagle Act of 1969 (16 U.S.C. 668-668c) when a proposed or carried out action would or could involve an eagle, its nest, and (or) its habitat.

3. Endangered Species Act (16 U.S.C. Sec. 1531) when a proposed or carried out action would or could involve an endangered/threatened species and (or) its habitat (Section 7 consultation).

BUREAU OF RECLAMATION

The Bureau of Reclamation (formerly Water and Power Resources Service) has responsibilities for its withdrawn lands (see Glossary) similar to those of the FS and FWS.

ADVISORY COUNCIL ON HISTORIC PRESERVATION

Section 106 of the National Historic Preservation Act of 1966 as amended (16 U.S.C. Sec. 470 *et seq*) requires that the President's advisory council have an opportunity to comment on any undertaking which could affect cultural resources on, or eligible for inclusion on, the National Register of Historic Places.

Executive Order 11593 requires of each Executive Branch agency, bureau, or office the protection and enhancement of the cultural environment. The Council implements these regulations through procedures outlined in 36 CFR 800, "Protection of Historic and Cultural Properties."

BLM will require compliance with the National Historic Preservation Act. Consultation will be made with the State Historic Preservation Officer as applicable.

STATE OF WYOMING

STATE LAND BOARD

The board is responsible for managing State lands for special use purposes, for leasing both the surface estate and subsurface and for land sales.

DEPARTMENT OF ENVIRONMENTAL QUALITY (DEQ)

The DEQ is responsible for the air, water, and land quality in the state. The department has four main divisions each of which is responsible for the necessary permitting and mitigation under its jurisdiction. These are:

1. Air Quality Division
2. Land Quality Division
3. Solid Waste Management Program
4. Water Quality Division

Permits issued by DEQ include mining permits, water discharge permits, and permits for solid waste disposal (National Wildlife Federation 1979, State of Wyoming 1979).

WYOMING STATE ENGINEER

The Wyoming State Engineer is responsible for the appropriation and administration of the water resources in Wyoming. Applications to appropriate water must be filed with the State Engineer prior to undertaking proposed water developments.

STATE HISTORIC PRESERVATION OFFICER (SHPO)

The SHPO is consulted to assure that an undertaking would not cause damage or change the character of a site that is of National Register quality or is a potential nominee to the Register. The SHPO will consult with the agency to either remove or mitigate any effect.

INDUSTRIAL SITING COUNCIL

The Wyoming Industrial Development Information and Siting Act of 1975 requires a siting permit for industrial development costing $50 million or more in 1975 dollars. The Wyoming Industrial Siting Council is the issuing agency. The act requires a prospective developer to furnish plans for alleviating socioeconomic impacts that would result from establishing the industry in Wyoming and to provide other information prior to State approval of construction.

COUNTY

Sweetwater and Uinta County Commissioners have jurisdiction over land use zoning for their respective counties. While county zoning may be ineffective in controlling the use of public lands, application of zoning can be within the public interest; e.g., zoning of flood plains or for open space.

PRIVATE LANDOWNERS

Consultation with private landowners would be necessary when private lands would be affected by an action. The Rock Springs Grazing Association and three subsidiaries of the Union Pacific Corporation—Rocky Mountain Energy (RME), Upland Industries Corporation, and the Uinta Development Company—control about 80-90% of the private lands in the trona deposition area. Farmers and ranchers control most of the private land in the Eden-Farson area.

CHAPTER II

AFFECTED ENVIRONMENT

CLIMATE

The area has a relatively cool and semiarid climate. Weather patterns and precipitation result from two general weather systems: Winter storms are caused by frontal systems transporting moist Pacific air; while summer precipitation is provided by a northerly flow of warm moist air from the Gulf of Mexico, and consists of scattered, high intensity thunderstorms.

The average annual precipitation across the area is approximately 7.9 inches. Severe flooding is not a major concern in the area; however, rapid runoff from heavy thunderstorm rains can cause flash flooding. When the rains coincide with the melting of the winter snowpack, the flooding can be intensified. The annual snowfall in the area is 40 inches. Appendix 4 includes data on the area's climate.

AIR MOVEMENT PATTERNS

Frequency of wind direction and speed for the sodium development area (see Glossary) can be estimated using data gathered at Fort Bridger, Wyoming. Based on five years (1950 to 1954) of hourly wind observations, the prevailing wind direction is west-southwest and occurs 25% of the time. The annual average wind speed associated with this direction is a substantial 20 miles per hour (mph). The second most prominent (by frequency of occurrence) wind direction, west, occurs 23% of the time and has an associated annual average speed exceeding 18 mph. Calm conditions (wind speed less than 2 mph) occur only 5% of the time on an annual basis (Environmental Research and Technology, Inc., 1978).

VERTICAL TEMPERATURE PROFILE

It is necessary to understand the thermal structure of the atmosphere to evaluate the impact of emissions. The stability of the atmosphere regulates its ability to disperse pollutants. Stability conditions can be generally classified into three broad categories: stable, neutral, and unstable.

Under stable atmospheric conditions, air temperature decreases with height at a rate less than the adiabatic lapse rate (see Glossary) of -5.4°F per 1,000 feet. Under certain stable conditions, the temperature will increase with height. This is referred to as an inversion condition and suggests a vertical temperature profile that is inverted or reversed from that "normally" expected. During stable atmospheric conditions, atmospheric motions are suppressed and, consequently, any pollutant emitted at the ground level tends to remain close to the ground.

During unstable conditions, the vertical temperature decreases faster than the adiabatic rate. Strong vertical motions are associated with these conditions such that pollutants emitted near ground level are rapidly dispersed upward through a large volume of air, thus minimizing the surface concentrations.

When the temperature decreases with height at approximately the adiabatic lapse rate, it is referred to as a neutral condition. The vertical dissemination of low-level emissions during neutral conditions exceeds that of a stable atmosphere but is less than during unstable conditions.

AIR QUALITY

The air quality area described is the sodium development area and the urban sites of Rock Springs and Green River. Most of the air quality monitors in the area were installed to survey urban or industrial environments, although the area is primarily rural. (See Appendix 4 for details on the monitors and the data collected.)

The sodium development area lies within the Wyoming Intrastate Air Quality Control Region (AQCR), as designated by the U.S. Environmental Protection Agency (EPA). National Ambient Air Quality Standards (NAAQS) and State of Wyoming standards for total suspended particulates (TSP), sulfur dioxide (SO_2), carbon monoxide (CO), and nitrogen oxides (NO_x) are shown in Table II-1. The Clean Air Act Amendments of 1977 charged EPA with promulgating a 3-hour (or less) primary standard for NO_x unless there is "no significant evidence" that such a standard is needed to protect public health.

Table II-1

NATIONAL AND WYOMING STATE AMBIENT AIR QUALITY STANDARDS
(Concentrations in ug/m^3 unless otherwise noted)

Pollutant	National Primary Standard1/	National Secondary Standard1/	Wyoming Standard1/
1) Total Suspended Particulates			
Annual Geometric Mean	75	60	Same as Secondary
24-Hour Maximum	260	150	Same as Secondary
2) Sulfur Dioxide			
Annual Arithmetic Mean	80	---	60
24-Hour Maximum	365	---	260
3-Hour Maximum	---	1,300	1,300
3) Carbon Monoxide			
8-Hour Maximum	10 mg/m^3	Same as Primary	Same as Primary
1-Hour Maximum	40 mg/m^3	Same as Primary	Same as Primary
4) Nitrogen Dioxide			
Annual Arithmetic Mean	100	Same as Primary	1003/
5) Photochemical Oxidants			
1-Hour Maximum	160	Same as Primary	Same as Primary
6) Hydrocarbons (Nonmethane)			
3-Hour (6 to 9 a.m.)	160	Same as Primary	Same as Primary
7) Hydrogen sulfide (H_2S)			
0.5-Hour Average	---	---	704/
0.5-Hour Average	---	---	405/

1/National standards, except those based on annual averages or annual geometric mean, are not to be exceeded more than once per year.

2/No standard.

3/Emission of nitrogen oxides from new gas-fired fuel-burning equipment shall be limited to 0.2 lb. per million Btu of heat input. This does not apply to internal combustion engines with a heat input of less than 200 million Btu per hour.

4/Standard not to be exceeded more than two times per year.

5/Standard not to be exceeded more than two times in any 5 consecutive days.

The State of Wyoming has classified (January 1972) the Wyoming Intrastate AQCR as Priority III for TSP, meaning that ambient air quality within this region was better than the state standards. The trona mining area 6 miles northwest of Green River is listed by EPA as a nonattainment area (Environmental Research and Technology, Inc., 1978).

Table II-2 lists the existing TSP and SO_2 regulations for Prevention of Significant Deterioration (PSD). These levels, designated for Class I, II, and III areas, are set to regulate incremental increases of TSP and SO_2 from new sources within Priority III regions according to the amount of energy or industrial growth desired. The allowable PSD air quality increments represent the maximum increase in pollutant concentrations allowable over and above existing baseline ambient levels. For all PSD classes, air quality deterioration would be permitted as long as neither the applicable PSD air increment nor the secondary NAAQS is exceeded. The following classes of desired growth were established by the EPA:

Class I — areas where nearly any air quality deterioration would be considered significant, thus allowing little or no energy or industrial development.

Class II — areas where deterioration that would normally accompany moderate, well-controlled growth would not be considered significant.

Class III — areas where deterioration would be permitted to allow concentrated or very large scale energy or industrial development as long as the secondary NAAQS are not exceeded.

The State of Wyoming was initially classified a Class II area with the exception of five wilderness areas and two national parks larger than 6,000 acres, which have been classified mandatory Class I. None of the present Class I areas are located in or adjacent to the sodium development area. Areas located in or adjacent to the sodium development area that could gain permanent Class I status in the near future include the Flaming Gorge National Recreation Area (NRA), managed by the Forest Service, and three Wilderness Study Areas (WSAs) managed by the Bureau of Land Management (see Chapter II-Wilderness). If these areas are recommended as Class I for air quality by the respective government agencies, the final decision would be made by the State of Wyoming.

TOTAL SUSPENDED PARTICULATES

The area experiences higher particulate levels than the surrounding areas, largely a result of trona mining operations and the commercial and industrial activities in Green River and Rock Springs (Appendix 4). Long-term trends indicate decreases in mean levels at Granger and most of the Rock Springs area (Science Applications, Inc., 1980).

The natural background concentration of suspended particulates in the area as determined by the Wyoming DEQ is 22 $\mu g/m^3$ annual geometric mean. The Wyoming Department of Environmental Quality (DEQ) has determined that nonattainment areas for suspended particulates exist around the FMC, Stauffer Chemical, and the Allied Chemical plants (Table II-3). The designation of each of the three nonattainment areas has been based on an annual concentration exceeding 60 $\mu g/m^3$. The nonattainment area around the Allied plant occupies 150 acres, while the nonattainment areas around FMC and Stauffer Chemical each encompass approximately 1,000 acres. The Wyoming DEQ has not designated any nonattainment areas based on the 24-hour particulate standard. Part D of the Clean Air Act as amended in August of 1977, requires the demonstration of attainment of air quality standards (primary and secondary) as expeditiously as practical, but in the case of the national primary standards, not later than December 31, 1982. Wyoming DEQ has developed an implementation plan for the nonattainment areas in Sweetwater County. Efforts to attain air quality standards at the three soda ash processing plants will follow the DEQ plan.

SULFUR DIOXIDE AND NITROGEN DIOXIDE

With respect to sulfur dioxide, ozone, carbon monoxide and nitrogen oxides, the State of Wyoming has been designated either as better than NAAQS or as "cannot be classified." All of Sweetwater County is a Class II area for sulfur dioxide. See Appendix 4 for details on the area.

Limited nitrogen dioxide (NO_2) data are available for the sodium development area. However, data collected near Kemmerer and the Jim Bridger Power Plant indicate no violations of the Federal NO_x annual standards.

Long-term trends indicate sulfur dioxide levels near the development area have decreased and nitrogen dioxide levels are higher (Science Applications, Inc., 1980).

Table II-2

ALLOWABLE AIR QUALITY INCREMENTS UNDER
PREVENTION OF SIGNIFICANT DETERIORATION RESTRICTIONS

EPA Pollutant Standard	Increments in Micrograms Per Cubic Meter Class I	Class II	Class III
Total Suspended Particulates (TSP)			
Annual	5	19	37
24-hour	10	37	75
Sulfur Dioxide (SO_2)			
Annual	2	20	40
24-hour	8	91	182
3-hour	25	512	700

Source: Clean Air Act Amendments (1977).

Table II-3

MEAN CONCENTRATIONS OF TOTAL SUSPENDED PARTICULATES (mg/m^3)
AT THE FOUR EXISTING PLANTS

Company	Monitor Sites	1977 Arithmetic	1977 Geometric	1976 Arithmetic	1976 Geometric	1975 Arithmetic	1975 Geometric	1974 Arithmetic	1974 Geometric
Allied Chemical	1	52	44	57	52	142	94	133	124
	2	40	35	40	37	58	49	134	-(1)-
	3	32	26	43	36	101[1]	-(1)-	57	49
	4	36	29	49	37	50	-32-	68	57
	5	38	33	41	36	-(1)-	-(1)-		-(2)-
FMC	1	31	25	33	28	33	28	43[3]/	35[3]
	2	262	229	290	250	272	232	274[3]/	206[3]
	3	156	138	172	154	159	130	160[3]/	133[3]
	4	64	51	78	62	74	56	80[3]/	59[3]
	5	37	34						
	6	28	24						
Stauffer	1	265	209	218	156				
	2	29	25	27	23				
	3	24	22	27	23				
	4	36	33						
Texasgulf	1	23	21	22	20	18	16	24	21
	2	24	21	26	21	20	18	22	20
	3	24	21	23	20	20	17	24	22
	4	23	17	25	23	23	20	29	26

Source: Wyoming Department of Environmental Quality 1979a.

1 Insufficient Data.
2 Hi-Vol Inoperative.
3 One Quarter's Data.

OTHER FORMS OF AIR POLLUTION

Other forms of air pollution within this area are dust and vehicle emission. Roads are predominantly dirt-surfaced. Throughout the summer months, dust is created from vehicle movements on existing roads. This form of pollution is localized and most dust settles within a few minutes after being disturbed. At times blowing dust will cause localized pollution. Vehicle emissions are generated by recreation, commercial, and local ranch vehicles. Oil and gas exploration in this area is increasing and may result in further development and increased vehicle emissions, altering ambient CO, NO_x, and HC levels.

A fog condition is evident near existing plants on calm, cold winter days during periods of high barometric pressure. The fog conditions extend 15 to 20 miles from the plants. Data on the incidence of heavy fog in the area is not available. Increased mining in an area increases the amount of particulate matter in the atmosphere and particles serve as nuclei for the condensation of water vapor, thus increasing the incidence of fog when the relative humidity is high (Science Applications, Inc., 1980). Higher frequencies of fog may be expected near large bodies of water such as the Green River and the Flaming Gorge and Fontenelle reservoirs (Science Applications, Inc., 1980).

TOPOGRAPHY

The sodium development area lies within the Green River Basin, one of the largest Tertiary Age topographic depressions to result from the formation of the Rocky Mountains. The Green River Basin is a structural basin that is a shallow syncline (see Glossary) underlain by the Wasatch, Green River, and Bridger formations (Bradley 1964). The basin is a little more than 100 miles long in a north-south direction and about 60 miles wide. It is bounded on the west by the linear ridges of the Overthrust Belt, to the north by the Gros Ventre and Wind River Mountains and the Sweetwater Uplift, to the east by the Rock Springs Uplift, and to the south by the Uinta Mountains. Erosion of these uplands has filled the basin with great volumes of sediments.

The basin is characteristic of high desert plateau surrounded by mountain ranges. The surface is generally flat-lying with elevations of about 6,300 feet. Several buttes which reach elevations of about 6,500 feet dot the landscape. The lowest elevation, 6,000 feet, is the shoreline of the Flaming Gorge Reservoir.

Ephemeral and intermittent streams (see Glossary) originate in the area and flow in a generally southern direction. The two major rivers of the area are the Blacks Fork and the Green. The area is characterized by a dendritic drainage pattern (see Glossary) typical of the surface erosion pattern of newly horizontal sediments.

Despite the large area of nearly level land, a considerable part of the sodium development area is characterized by badland topography. This picturesque badland terrain is typical of the Bridger Formation.

Other topographic features of the area include active sand dunes, some desert pavement (see Glossary), and playa lakes (see Glossary).

GEOLOGY AND MINERAL RESOURCES

Within and adjacent to the sodium development area, there are proven resources of oil and gas, coal, sand and gravel, trona (see Glossary), and oil shale. Low concentrations of uranium and phosphate occur in numerous thin beds of the Wilkins Peak Member (Wyoming Geological Survey 1979).

Trona and other minerals such as halite (see Glossary) are found in abundance in beds of the Wilkins Peak Member of the Eocene Green River Formation (440 to 3,500 feet below the surface). These beds of saline minerals, which occur interlayered with oil shale, marlstone, limestone, tuff, siltstone, and sandstone, were deposited during cyclical or periodic evaporation of the waters of Lake Gosiute, an enormous lake that existed in southwestern Wyoming during the Eocene Epoch some 50 million years ago.

Lake Gosiute underwent a complex and long series of size and depth fluctuations during its 4 million-year existence. In its early life, the lake was large and overflowed so continuously that it was an entirely freshwater lake. As the climate became considerably more arid, the lake shrunk to about half its former size and ceased to overflow. At times it became extremely saline, depositing extensive beds of trona, halite, and other saline minerals and resulting in the alkaline soils presently found in the area. Seasonal floods lowered salinity and brought accumulations of organic matter, resulting in marlstone and oil shale deposits. The history of this lake is well represented by a remarkable series of lacustrine, paludal, and alluvial sediments (see

Glossary) which intertongue and overlap (Bradley 1964; Bradley and Eugster 1969).

SODIUM MINERALS

More than 40 beds of trona ranging in thickness from a few inches to 40 feet are known in the Wilkins Peak Member. Twenty-five major beds more than 3 feet thick and more than 100 square miles in extent were designated by Culbertson (1966). Table II-4 shows the estimated resources of trona as identified by Burnside and Culbertson (1979). The thicker mineable beds normally contain at least 90% trona (Deardorff and Mannion 1971).

Kostick (1980) reports economic resources of 52 billion tons in the trona deposition area. Forty billion tons of trona ore are recoverable from easily-mineable beds using mining systems that leave 25% of the ore in place for roof support. That 40 billion tons of trona ore could be refined into about 23 billion tons of soda ash. The Wyoming producers mined nearly 4 million tons of trona in 1969 and more than 12 million tons in 1980 (1981 Wyoming Trona Factbook).

The trona beds located in the southern part of the area are usually mixed with halite. Halite occurs only in the lower half of the Wilkins Peak Member. Trona beds containing recognizable halite, which is generally considered to be a contaminant and presents economic difficulties in the production of soda ash, are not presently being mined. For similar reasons salt beds which are contaminated with trona are unlikely to be produced even though thick enough beds exist. Future technological advances may make this mineral mixture valuable.

The "black trona water" occurs in the Wilkins Peak Member of the Eocene Green River Formation. Numerous wells have been drilled in the Eden-Farson vicinity where this unusually black water has been encountered (Map II-1 and Table II-5). Due to the limited amount of information available, it is presumed that "the black water represents lake water trapped in sediments during the recessions of the lake (Gosiute), which affected trona deposition to the southwest" (Dana and Smith 1973).

Other minerals associated with the trona deposits (Bates 1969) that may be of commercial interest in the future are:

shortite	($Na_2CO_3{\cdot}2CaCO_3$)
northupite	($Na_2CO_3{\cdot}MgCO_3{\cdot}NaCl$)
pirssonite	($Na_2CO_3{\cdot}CaCO_3{\cdot}2H_2O$)
gaylussite	($Na_2CO_3{\cdot}CaCO_3{\cdot}5H_2O$)
bradleyite	($NaPO_4{\cdot}MgCO_3$)
common salt	($NaCl$)

COAL

There are no active coal mines located in the sodium development area and none are planned. Two important coal-bearing units are located near the sodium development area—the Rock Springs Formation east of the area and the Hams Fork Coal Region of the extreme western portion of Wyoming.

SAND AND GRAVEL

Sand and gravel has historically come from terrace deposits along the Green River. With the increase in industrial and commercial development, the demand for this sand and gravel has risen accordingly.

Sand and gravel reserves are concentrated on the terrace deposits located north of the city of Green River. As many as six separate gravel benches have been deposited by the river since Pleistocene times. The Tertiary Age Bishop Conglomerate Formation is a second source of material. There is no development at this time from the latter source.

OIL AND GAS

Exploration, development, and actual production of oil and gas occur within the sodium development area, and 95% of the Federal land in the area is encumbered by oil and gas leases. State lands are also under lease. The entire area has been identified as an economic oil and gas reserve.

There are six unitized oil and gas fields within or adjacent to the area: Butcher Knife Springs, Bruff, Church Butte, Massacre Hill, Moxa, and Whitefeather. The oil and gas occurs in much deeper formations than the trona, but its extraction could conflict with the mining of trona.

OIL SHALE

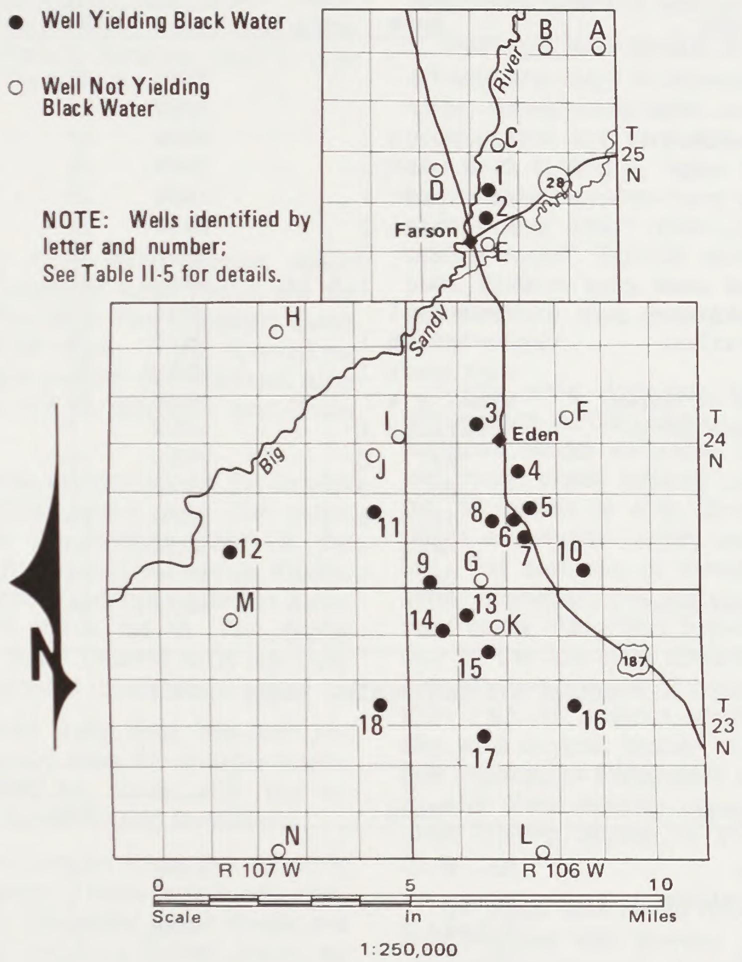
An estimated 66 billion barrels of shale oil is contained in the Wilkins Peak Member of the Green River Formation. On April 15, 1930, Executive

Table II-4

ESTIMATED IDENTIFIED RESOURCES OF TRONA AND INTERMIXED TRONA
AND HALITE BY BED IN THE GREEN RIVER BASIN, SOUTHWESTERN WYOMING

	Total Resources Trona and Mixed Trona - Halite		Trona Resources				Mixed Trona - Halite Resources			
			< 4 ft. Thick		≥ 4 ft. Thick		< 4 ft. Thick		≥ 4 ft. Thick	
Bed No.	Area in Square Miles	Million Short Tons	Area in Square Miles	Million Short Tons	Area in Square Miles	Million Short Tons	Area in Square Miles	Million Short Tons	Area in Square Miles	Million Short Tons
1	324	5.4	104	0.4	220	5.0	---	---	---	---
2	469	10.0	100	0.4	364	9.4	---	---	5	0.2
3	442	3.5	242	0.9	194	2.5	---	---	6	0.1
4	528	6.3	190	0.7	338	5.6	---	---	---	---
5	712	9.5	221	0.8	401	6.6	5	<0.1	85	2.1
6	587	6.0	219	0.8	78	0.9	---	---	290	4.3
7	617	3.6	381	1.4	221	2.1	9	<0.1	6	0.1
8	431	1.9	373	1.4	58	0.5	---	---	---	---
9	733	9.6	270	1.0	70	0.8	29	0.1	364	7.7
10	459	4.8	56	0.2	26	0.3	119	0.4	258	3.9
11	615	6.9	235	0.9	32	0.4	2	<0.1	346	5.6
12	811	10.7	201	0.7	344	4.5	---	---	266	5.5
13	370	1.8	305	1.1	65	0.7	---	---	---	---
14	774	12.0	151	0.6	372	5.4	---	---	251	6.0
15	848	11.8	232	0.9	271	3.7	2	<0.1	343	7.2
16	860	7.2	524	1.9	117	1.3	---	---	219	4.0
17	870	12.3	199	0.7	429	7.0	3	<0.1	233	4.6
18	276	1.4	104	0.4	6	0.1	117	0.4	49	0.5
19	208	1.5	118	0.4	90	1.1	---	---	---	---
20	217	1.9	103	0.4	114	1.5	---	---	---	---
21	310	1.3	290	1.1	20	0.2	---	---	---	---
22	267	1.2	234	0.9	3	0.3	---	---	---	---
23	293	1.2	268	1.0	24	0.2	---	---	---	---
24	153	1.4	92	0.3	61	1.1	---	---	---	---
25	105	1.2	50	0.2	55	1.0	---	---	---	---
	TOTALS	134.4		19.5		62.2		0.9+		51.8

Source: Burnside and Culbertson (1979).



Map II-1
BLACK WATER OCCURRENCES

Table II-5

WELLS DRILLED IN THE VICINITY OF EDEN-FARSON
CONTAINING BLACK WATER

Well	Operator	Name	Location			
				Sec.	T	R
1	Gerry Stout	No. 1	SESW	22	25N	106W
2	Sitzman	No. 1	SWNW	27	25N	106W
3	Mintech-Marathon	Van Metre 1	SESW	17	24N	106W
4	do.	C. Tomich 1	SWNW	21	24N	106W
5	do.	DeLambert 1	NWNE	28	24N	106W
6	do.	E. Tomich 2	NWSW	28	24N	106W
7	do.	do. 3	SESW	28	24N	106W
8	do.	do. 1 & 1A	NESE	29	24N	106W
9	Page T. Jenkins	Jenkins 1	SWSE	31	24N	106W
10	Mintech-Marathon	M. Tomich 1	NWSE	34	24N	106W
11	do.	Watterson 1	NENW	25	24N	107W
12	U.S. Bureau of Mines	Wyoming 4	NENW	33	24N	107W
13	Wyoming Trona Corp.	McDermott 1	SWNW	5	23N	106W
14	do.	do. 2	SESE	6	23N	106W
15	do.	do. 3	NWNE	8	23N	106W
16	do.	do. 6	SWNW	15	23N	106W
17	do.	do. 4	NENW	20	23N	106W
18	do.	do. 5	C	13	23N	107W
*	Colorado Synfuels	*	NESE	36	24N	108W

WELLS NOT CONTAINING BLACK WATER

Well	Operator	Name	Location			
				Sec.	T	R
A	Fred Meyers	No. 1	SESE	1	25N	106W
B	Mintech-Marathon	Olsen 1	SESE	2	25N	106W
C	do.	Grandy 1	SWSE	15	25N	106W
D	Vernon Mrak	No. 1	C	21	25N	106W
E	John Coppes	No. 1	NWSW	27	25N	106W
F	Mintech-Marathon	B. McMurray 1	NWNW	15	24N	106W
G	do.	No. 401-2	SWSE	32	24N	106W
H	U.S. Bureau of Mines	Wyoming 5	NESW	3	24N	107W
I	Mintech-Marathon	Bird 1	SESE	13	24N	107W
J	Charles Stout	No. 1-17	NENW	24	24N	107W
K	Mintech-Marathon	No. 401-1	NESE	5	23N	106W
L	Mt. Fuel Supply Co.	Windmill 1	SESE	33	23N	106W
M	El Paso Natural Gas Co.	Simpson Gulch 1	NESW	4	23N	107W
N	Page T. Jenkins	Pittman 1	SW	34	23N	107W

Source: Dana and Smith 1973, p. 154.

*Recent discovery; not shown on map.

Order 5327 withdrew all lands containing oil shale from disposal. The Green River Formation is found in Utah, Colorado, and Wyoming, and its oil shale contains approximately 731 billion barrels of recoverable oil.

Currently there is no oil shale mining in the sodium development area. The Energy Research and Development Administration (ERDA) is operating an *in situ* research project near Green River, but no commercial development is expected within the next 10 years. Colorado Synfuels also is conducting tests on State lands in the area.

PALEONTOLOGY

There are basically three fossil-bearing areas within the sodium development area. These are the Bridger Basin area, the Blue Rim-Lombard Butte area, and the Laney Fish Beds. These formations are found throughout the sodium development area in T. 13-21 N., R. 106-113 W. (McGrew and Bown 1976).

The Bridger Basin area encompasses the largest portion of the trona development area. The major fossil bearing zone in the Bridger Basin is the Bridger formation which contains numerous fossils. Erosion is the major factor contributing to the exposure and collection of these fossils. The highly erodible nature of the fossil bearing soils will continue to expose new potential fossiliferous sites.

The Blue Rim-Lombard Butte area has less potential for fossil discoveries than the Bridger Basin. Future discoveries could be made with the increased erosion of the fossil bearing formations.

The Laney Fish Beds contain fossil fish found in the Green River Formation. These fossils are fairly numerous and common. Generally these fossils are uncovered by quarrying and, to a limited extent, by erosion.

SOILS

The soils in the area are light colored and have poorly developed horizons (see Glossary). Soil structure is absent for the most part, except for a weak, platey crust on the surface. Generally the soils are alkaline and effervesce with acid. All the soils tend to be well drained, except for those formed in playas. Soil texture, depth, and stoniness vary with relief. Shallow, coarse-textured stony soils are common on open benches adjacent to the Green River. In many places deep, stone-free soils in association with stabilized dunes occupy partially protected, sweeping basal slopes below low ridges.

The area soils are sandy loams, silt loams, and silty clay loams weathered from very fine sandstones, silt stones, and mud stones. Considerable erosion has occurred in the past because of the sparse vegetation and wide variation in precipitation intensities over the years. Wind erosion has created small dune areas of well-sorted fine sands.

Drainages and stream bottoms have accumulated silts and clays in alternate layers of varying textures. These fluvial soils are more resistant to wind erosion, but are very susceptible to head cutting and bank cutting by water movement. Consequently, the major washes have precipitous banks several feet deep which undercut and slump during periods of runoff. Soluble salts are evident in these soils. Sodium salts have led to the destruction of soil structure, thus greatly reducing water infiltration in these soils.

Sandy soils dominate the ridge areas. These areas often contain coarse gravels from old erosion surfaces. Water infiltration is very rapid (72 inches per hour). Water holding capacity is low (3 inches per 60 inches of soil). Since precipitation is infrequent, vegetation rapidly uses what water is available. The surfaces of these soils are very friable. When disturbed, the surfaces yield to wind erosion very easily. Attraction between soil particles is low due to the low clay content (less than 15%) and the very low amount of organic matter present (less than 1%). As a direct result of this low amount of clay and organic matter, nutrient supply and storage capacity of these soils is low. Nutrient availability and water-holding capacity are, therefore, the most limiting factors in establishment of vegetal cover.

The playa lake areas have sandy clay loam surface textures with heavier textures beneath which are water saturated. The profiles have been dispersed by high accumulations of soluble salts. Saltbush and greasewood are key plant species that live on the playas.

SOIL MAPPING UNITS

General soils groups for the trona deposition area are shown on Map II-2 and in Table II-6. Legend for general soils map and table:

1. Made up of varying amounts of Millpot, Leavitt, Stunner, Brownsto, Starley, and Roxal soils. This unit is predominated by clay loams, and it has a high pH, shallow depths, and droughtiness. Slopes tend to be steep, and soil

Table II-6

GENERAL SOILS UNIT LIMITATIONS

Unit #	ERD	AWC	pH	Wind	H_2O	Slope	Perm.	Gravel	Strength
1	x	x	x			o		x	
2		x	x						x
5	x	x				x			
6	x	x							*
8	x	x	o		o	x			
12	x	x				x			
14		x		x					
17		x	x		o		o		o
27	x	x							
28		x		o					
29	x	x	x		x	x			
30	x	x	o		o	o			o
31	x	x		x	x	x	x		
32		x	x		x		x		
34		x						x	
36		x							

ERD - effecting rooting depth; critical - less than 20 inches.
AWC - average water-holding capacity; critical - less than 3 inches.
pH - relative alkalinity; critical - greater than 8.5.
Wind - rated as having "severe" potential for wind erosion.
H_2O - rated as having "severe" potential for water erosion.
Slope - critical - greater than 30%.
Permeability - critical - less than 0.06 of an inch infiltration/hour.
Gravel - potential as gravel source.
Strength - exhibits low strength when wet.

x - majority of soils in unit have critical rating.
o - less than half of soils in unit have critical rating
* - landslide potential.

Table II-7

SUMMARY OF GROUND WATER POSSIBILITIES

Hydrogeologic Unit	Formation	Thickness	Ground Water Possibilities
1	Alluvial, Gravel Glacial deposits	0-150±	Poor to Fair
2	Bridger Formation	500-1,500±	Poor
3	Laney Shale	100-1,000±	Fair
4	Wilkins Peak	0-1,400±	Poor
4	Tipton Tongue	0-400 ±	Poor to Fair
4	Wasatch	0-3,500±	Good Artesian
5	Fort Union	0-2,500±	Unknown

strength is low in a few series (see Glossary). The Starley series has potential as a gravel source.

2. Made up of varying amounts of Dines, Dines Overflow, Grieves, Ret, Kandaly, Monte, and Dinco soils. This unit is noted for its low strength. It is droughty, has a high pH, and tends to be wind erodible.

5. Made up of varying amounts of Blackhall, Blazon, Delpoint, Redcreek, Rentsac, and Redwash soils. This unit is made up of shallow, droughty soils. Slopes tend to be steep, and soils highly water erodible. A few components have low strength due to clay loam texture.

6. Made up of varying amounts of Blackhall, Blazon, Elk Mountain, McFadden, and Manburn soils. This unit is shallow to bedrock and droughty. A few soils have a clay loam texture, low strength and steep slopes. The McFadden is known for its landslide potential.

8. Made up of Thayer, Dines, Haterton, Horsely, Jansley, Huguston, and Winton soils. This unit has steep slopes, a root restrictive layer and droughtiness. A few components have high pHs and are highly water erodible.

12. Made up of varying amounts of Teemat, Teeler, Pishkun, Cheadle, and Starley. This unit is made of shallow, droughty soils that tend to have steep slopes. Some soils in this unit exhibit high pH and high potential for water erosion.

14. Made up of varying amounts of Huguston, rock, Kandaly, Teagulf, and Pepal soils. This unit is droughty and generally wind erodible.

17. Made up of varying amounts of Monte, Youjay, Westvaco, and Kandaly soils. This unit is characterized by high pHs and droughtiness. A few soils in this unit are low in strength, slowly permeable and water erodible.

27. Made up of varying amounts of Firehole, McCullen, Buckboard, rock, and Jansley soils. These soils are primarily shallow to bedrock and droughty.

28. Made up of Huguston, Teagulf, Pepal, Winton, Tasselman, Thayer, Cambarge, McCullen, and Zirkel soils. These soils are generally droughty, and a few exhibit a high potential for wind erosion.

29. Made up of Horsely, Haterton, and Monte soils. This unit is shallow to a root restrictive layer, has high pHs, is water erodible, and steep in slope.

30. Made up of varying amounts of Horsely, Huguston, Youjay, and Pepal soils. This unit is shallow to a root restrictive layer and droughty. Some soils in this unit exhibit high pHs, water erodibility, steep slopes and low strengths.

31. Made up of varying amounts of Rallod, rock, and badlands. This unit is geologically erodible and sensitive to any disturbance. Slopes are steep and the soil is shallow to bedrock. Badlands are very low in strength when wet and are very slowly permeable.

32. Made up of varying amounts of Garita, Youjay, and Westvaco. This unit is droughty and has high pHs. Some soils exhibit water erodibility and are very slowly permeable.

34. Made up of varying amounts of Gasson, rock, Pepal, Thayer, Cambarge, and Leckman. This unit is very droughty. Gasson and Cambarge are potential sources of gravel.

36. Made up of varying amounts of McCullen, Buckboard, Leckman, Terada, and Zirkel soils. This unit is droughty.

A third-order, semi-detailed soil mapping of most of the Known Sodium Leasing Area (KSLA) and soil series descriptions are available in the BLM Rock Springs District Office.

WATER RESOURCES

GROUND WATER

Ground water in the sodium development area is contained in the geologic region referred to as the Green River Basin (see Topography). Characteristics of individual water-bearing units cover a wide range in thickness, distribution, sorting, and grain size. Their water yielding, transmitting, and storing abilities similarly cover a wide range.

Recharge to ground water reservoir in the Green River Basin is mainly by seepage from runoff and streamflow. Discharge is mainly by evaporation, seepage to streams and lakes, transpiration by plants, and pumpage from wells. In general, the water table is relatively stable. Wells tapping bedrock aquifers, such as the Wasatch Formation, at locations several miles from perennial streams generally have annual water level fluctuations of less than 3 feet. Shallow wells tapping bedrock near perennial streams and wells in alluvial and terrace deposits had fluctuations of as much as 7 feet.

The movement of ground water generally follows the topography and the surface drainage pattern, although its flow may be interrupted by faulting.

Deep artesian aquifers, however, may not conform as closely to the topography and drainage patterns.

The predominant use of ground water in the area is for livestock watering. Industrial use, primarily trona processing, represents a tap of ground water sources. Also, a small number of wells and springs are for domestic use and irrigation.

Ground water in the Green River Basin can be divided into hydrogeologic units based on similar geologic and hydrologic characteristics for ease of discussion (Table II-7). They are:

1. Unconsolidated floodplain and terrace deposits of fluvial and glacial origin.

2. Conglomerates, mudstones, and sandstones of upper Tertiary age including the Bishop Conglomerate and the Bridger Formation.

3. Laney Shale Member of Green River Formation.

4. Sandstones, limestones, mudstones, and shales of middle to late Tertiary age, including the Green River and Wasatch Formations.

5. Sandstones, limestones, quartzites, shale, and mudstone, including the Fort Union Formation and some Paleocene rocks.

Generally, ground water in the Green River Basin becomes more saline (mineralized) with increased depth and with increasing distance from recharge areas. Recharge areas are places where surface water and precipitation enter an aquifer. Saline minerals are leached from rocks of the aquifer thus increasing the concentration of dissolved chemical constituents. Appendix 5 includes data on chemical constituents for the hydrogeologic units.

Total dissolved solids concentration for alluvial ground water in the area indicates the water has concentrations above the limits recommended by the Wyoming DEQ for domestic use, but within the standards for livestock and wildlife use (Table II-8).

Water yields from floodplain and terrace deposits are dependent upon the sorting of the material. Well yields range from less than 10 gallons per minute (gpm) in glacial deposits to a possible maximum of 500 gpm in clean sand and gravels.

Hydrogeologic unit 2 in the Green River Basin contains predominantly a sodium bicarbonate water type. Overall, the calcium bicarbonate water is suitable for livestock, industrial, and domestic use. The sodium bicarbonate water is suitable for livestock use in some cases. Water yields from this unit are dependent upon the continuity of fractures within formations. Yields from wells and springs tapping this unit are less than 50 gpm.

Water contained in the Laney Shale member of the Green River Formation (hydrogeologic unit 3) is composed of sodium sulfate, sodium chloride, and sodium carbonate types. Trace metal concentrations are generally low and do not exceed EPA criteria for domestic or livestock uses. Because of the high conductance values found in Laney Shale wells, this water is considered to be too saline for most uses, but may be locally acceptable for livestock use. Water yields range from 1 to 75 gpm in hydrogeologic unit 3. Local sandstone bodies found within the shale may yield up to 300 gpm.

Ground water within hydrogeologic unit 4 consists of sodium bicarbonate, sodium sulfate, and sodium chloride types. Data on trace metal concentrations are not available for this unit. However, concentrations observed in other formations are thought to be representative.

Water yields for the Green River Formation range from 1 to 170 gpm and are extremely variable. The range for water yields in the Wasatch Formation is from 1 to 700 gpm. High water yielding wells in the Wasatch are confined to the sandstone members.

Water in the Mesozoic and Paleozoic rocks (hydrogeologic unit 5) is a calcium bicarbonate type, according to records for wells in the area. Data on trace metal concentrations are not available for this unit.

SURFACE WATER

Surface water in the area is used for domestic water supplies and for irrigation and livestock watering. Trona and coal mines also use surface water in their operations. The major water source for the soda ash plants is from the Green River. Average annual flow of the Green River at Warren Bridge near Daniel, Wyoming, is 369,600 acre-feet (period of record 1930-1973).

Bureau of Reclamation estimates Wyoming's average annual allotment at 805,000 acre-feet, although the actual allotment will vary between that figure and 1,043,000 acre-feet per year based on the Upper Colorado River Compact stipulations (pers. comm., Wyoming Water Development Commission 1981). Water depletions for 1980 included 254,700 acre-feet for irrigation (including entire Lyman project and Little Snake Uses); 4,374 for municipal and domestic use; 2,200 for livestock consumption; 40,695 for electric power; 5,000 for oil and gas production; 22,452 for trona production; and 6,300 for the Seedskadee Project. Total depletions are 445,391 acre-feet per year, with a remaining allocation of 359,609 acre-feet based on Bureau of Reclamation estimates.

Table II-8

WATER QUALITY STANDARDS1/

Parameter	Public Water Supply Standards	Livestock and Wildlife Standards	Cold Water Fisheries	Comments
Suspended Sediment	2/	2/	80 mg/1	Affects water potability and physical habitat for fish.
Total Dissolved Solids	500 mg/1	3,000 mg/1	2,000 mg/1	Above 3,000 mg/1 could be injurious to stock and wildlife (EPA 1975).
Specific Conductance	2/	2/	2/	Used to predict dissolved solids and aquatic productivity.
pH	5.0 to 9.0	7.0 to 9.2	6.5 to 9.0	Indicator of hydrogen ion concentration and aquatic productivity.
Alkalinity	2/	30-130 mg/1 3/	20 mg/1 minimum	Above 170 mg/1 can cause diarrhea with stock (McKee and Wolf 1963).
Fecal Coliform 4/ Organisms	0/100 ml	2/	2/	Indicator of pathogenic bacteriological contamination.
Temperature	5/	2/	18.2° C maximum	

1/ Water quality standards recommended by the Wyoming Department of Environmental Quality.

2/ No recommended standard.

3/ Alkalinity is shown as concentration of calcium carbonate ($CaCO_3$); from National Academy of Science, 1972.

4/ Standard set for the recreation season (May 1 to September 30) is 200/100 ml for primary contact recreation (Wyoming Department of Environmental Quality 1979b).

5/ No temperature change has been identified that would adversely affect the potability of public water supplies.

The sodium development area falls within the Green River Basin and is drained by watersheds of the Blacks Fork, the Green River, the Big Sandy, and numerous ephemeral streams flowing into the Blacks Fork arm of the Flaming Gorge Reservoir. Perennial streams, which include the Hams Fork, the Blacks Fork, the Big Sandy, and the Green River, originate in mountainous areas where the greatest precipitation occurs and where ground water inflows sustain base flows. Streams originating at lower elevations are ephemeral or intermittent and flow mainly in response to direct runoff from snowmelt and rainstorms. The major part of the annual runoff occurs during spring and early summer.

Due to the predominantly arid conditions in the area, little vegetation has been established along ephemeral or intermittent streams to stabilize these drainages. Moderate to extensive sheet and gully erosion presently occurs during periods of precipitation and runoff.

The Blacks Fork watershed represents the major drainage in the sodium development area. The average daily discharge for the Blacks Fork near Little America, based on water records from 1962-1976, is 373 cubic feet per second (cfs).

The quality of surface water in the area is generally less than found in the headwater areas. With increasing watershed area, water quality deteriorates as a result of natural sources of dissolved solids, return flows from irrigation, and return sewage flows from municipalities. During periods of low flow, concentrations of dissolved solids in streams that have mean discharges of less than 100 cfs can exceed 2,000 milligrams per liter (mg/l). See Appendix 4 for a summary of the water quality at selected sites in the sodium development area.

High suspended sediment loads are associated with high water discharges as the result of spring runoff. The average unit sediment yield for the Blacks Fork watershed amounts to 1.49 tons per acre per year.

The Blacks Fork contributes about 14% of the water inflow to Flaming Gorge Reservoir and about 20% of the dissolved solids load. Other minor tributaries contribute approximately 3% of the total annual water inflow. Contributions of dissolved solids, however, are six times this amount due to extensive leaching of the soils in these areas (Madison and Waddell 1973). The contribution of sediment and dissolved solids results in a nutrient enrichment of waters in the numerous coves and two arms of the reservoir.

VEGETATION

TERRESTRIAL PLANTS

The trona deposition area has seven vegetation types: sagebrush-grass; desert shrub; saltbush; greasewood; juniper; barren; and broadleaf trees, floodplain willow and cottonwood. These vegetation types, or associations, are shown on Table II-9. The sodium carbonate brine area is basically an agricultural area (see Chapter II-Land Uses). Table II-10 shows some of the common plants in the area.

SAGEBRUSH-GRASS TYPE

The area is dominated by sagebrush-grass, which covers 694,068 acres (Table II-9), or approximately 77% of the trona deposition area. This broad association extends from the lowest point in the area (approximately 6,000 feet) to near the highest point (8,300 feet). Sagebrush may be found on many soil types, slopes, and elevations. The plant species associated with the type vary in percent composition and diversity based on soil characteristics or climatic factors of the site. Many subtypes having a similar aspect are present within this overall classification. Each of the subtypes varies between 25-70% shrubs, 30-60% grasses, and a trace to 20% forbs. This type contains areas that could be classified as grass, meadow, or perennial forb types. These are of such small acreages or indefinite boundaries that they were not broken out in this discussion or in the tables. The subtype dominated by big sagebrush covers approximately 75% of the sagebrush-grass category.

The subtype rabbitbrush (*Chrysothamnus viscidiflorus*) covers approximately 10% (73,164 acres) of the sagebrush-grass. This subtype occurs on the more sandy soils of the area.

Percent vegetal cover ranges from approximately 6% in the lower precipitation and shallow soil areas to 60% in the deep soil, higher precipitation zones. The average vegetal cover is 35%.

DESERT SHRUB TYPE

The desert shrub type covers 36,582 acres, approximately 4% of the area, and it is characterized by areas dominated by spiny hopsage (*Grayia spinosa*) and horsebrush (*Tetradymia* spp.). These shrubs become dominant in sandy, clayey, and sand dune areas. Composition in the desert shrub type is similar to the sagebrush-grass: 25-60% shrubs, 10-35% grasses, and 0-15% forbs. Cover

Table II-9

VEGETATION TYPES OF THE TRONA DEPOSITION AREA

Vegetation Type	Acres	Percent
Sagebrush-Grass	694,068	77
Greasewood	45,728	5
Saltbush	73,165	8
Juniper	18,291	2
Floodplain Cottonwood and Willow	36,590	4
Barren	9,146	<1
Desert Shrub	36,580	4
	914,560	100

Table II-10

COMMON PLANTS OF THE TRONA DEPOSITION AREA

Grasses and Grass-Like	
Wheatgrass	Squirreltail
Indian ricegrass	Inland saltgrass
Bluegrass	Bromegrass
Needlegrass	Sedge
Threesquare	Rush
Galleta	
Forbs	
Phlox	Russian thistle
Lupine	Pussytoes
Buckwheat	Beardstonque
Kochia	Goldenweed
Halogeton	Biscuitroot
Shrubs and Trees	
Sagebrush	Snowberry
Rabbitbrush	Horsebrush
Greasewood	Winterfat
Shadscale	Juniper
Nuttall's saltbush	Cottonwood
Buffaloberry	Aspen
	Willow

density ranges from 10-45%. This type is generally found in the drier basin areas within the broader sagebrush-grass association.

SALTBUSH TYPE

The saltbush vegetation type comprises 73,165 acres, or approximately 8% of the total area, and it is characteristic of the more alkaline lowlands within the area where tight, impervious soils are common. Sparse cover and considerable bare ground are generally characteristic. The dominant shrub species is Gardner's saltbush (*Atriplex nuttallii*); the dominant grasses are squirreltail, Indian ricegrass and western wheatgrass. The composition is 70-90% shrubs, 10-20% grasses, and a trace to 20% forbs. The vegetal cover averages only 13%, making areas with this vegetation type highly susceptible to erosion.

The variations of subtypes within this type are relatively minor compared to that described for the sagebrush-grass vegetation community. The species association remains fairly constant with percent composition being the primary variable. Big sagebrush, black greasewood, and rabbitbrush are the primary species which would increase in percent composition on the fringes of the saltbush type.

GREASEWOOD TYPE

This vegetation type comprises approximately 5% of the area, or 45,728 acres, and it is characteristic of alkaline soils along live and intermittent stream basins in the lower elevations of the area. The soils in these areas are generally too tight and saline to support a high density of meadow grasses. Many of the areas currently are receiving considerable amounts of water erosion. Shrubs dominate the greasewood composition, ranging from 40-70%. Grasses usually comprise 10-35%, and forb species comprise 2-30% of the vegetation. The average vegetal cover is 18%.

BARREN TYPE

Barren areas have little or no vegetation due to soil and environmental factors. Perennial and annual forbs are the main species which occur. The total area which they cover is about 1%.

JUNIPER TYPE

This association covers approximately 18,291 acres, or 2% of the area. The juniper species are found in the shallow, rocky south and east facing slopes. The juniper woodland has a variety of understory species which inhabit the deeper soil pockets. Vegetal cover ranges from 8-23% with an average of 13.5%.

FLOODPLAIN WILLOW AND COTTONWOOD TYPE

The floodplains along the Green and Henry's Fork Rivers cover approximately 4% of the area. These areas are dominated by cottonwood (*Populus angustifolia*), willow (*Salix* spp.), silver buffaloberry (*Sheperida commutata*) and numerous understory species. The composition is 10-85% trees and shrubs, 5-30% forbs, and 10-45% grasses. There are many subtypes, meadows to willow thickets, but all are characterized by many of the same species, with only the percent composition changing. This is a highly productive and heavily utilized area. The percent vegetal cover averages 85%.

POISONOUS PLANTS AND NOXIOUS WEEDS

Locoweed (*Astragalus* and *Oxytripis* spp.) is probably the most common poisonous plant in the sodium development area. Other species of poisonous plants are larkspur (*Delphinium* spp.) and death camus (*Zygadenus* spp.). It is estimated that these plants occupy minimal acres, and they are primarily found in the sagebrush-grass type. In the sodium development area as a whole, poisonous plants are a minor problem.

Noxious weeds are more of a problem because they are found in agricultural areas near the sodium development area, primarily the Bridger Valley. Herbicide spraying programs are conducted under the direction of the Wyoming Department of Agriculture. Noxious weeds found in the area are common quackgrass (*Agropyron repens*), field bindweed (*Convolvulus arvensis*), spurge (*Euphorbia* spp.), and whitetop (*Cardaria* spp.) (Booth and Wright 1959).

In addition to the above poisonous plants and noxious weeds, selenium indicator plants are found in the area. Selenium is an element that is essential to animals but can be poisonous when ingested in too high amounts (U.S. EPA 1976). Primary selenium indicator plants in the area are woody aster (*Xylorhiza glabruiscula*) and prince's plume (*Stanleya* spp). No estimate of acreages is possible.

THREATENED OR ENDANGERED PLANTS

Three species of plants found in the area are candidates for threatened status:

1. *Physaria condensata* Rollins (Tufted twinpod) has been collected since 1938 near Fort Bridger, Wyoming. It was proposed as threatened in 1975 (*Federal Register* 40:27887 July 1, 1975) and listed as a candidate species in a status of review in 1980 (*Federal Register* 45:82480 December 15, 1980). Potential habitat is considered to be southwestern Wyoming, northeastern Utah, and southeastern Idaho. Known populations are found west of the KSLA; it is unlikely it occurs within the KSLA.

2. *Stanleya pinnata* var *gibberosa* Rollins (Dissected prince's plume) was first collected in 1938 near Fort Bridger and Carter, Wyoming. Its potential habitat is considered to be limy shale slopes in southwestern Wyoming, northeastern Utah, and southeastern Idaho. It was listed as a candidate threatened species December 15, 1980 (*Federal Register* 45:82480).

3. *Astragalus proimanthus* Barneby (Precocious milkvetch). This species grows in southwestern Wyoming on shale ridges and slopes between 6,900 to 7,200 feet in elevation. Shale ridges and slopes in southwestern Wyoming, northeastern Utah, and northwestern Colorado are considered potential habitat. It was listed as a candidate species for proposal as threatened in 1980 (*Federal Register* 45:82480).

Of the above plants, only *Astragalus proimanthus* is suspected to occur within the KSLA. There are no plants in the area that have been proposed as endangered.

AQUATIC PLANTS

No specific information is presently available pertaining to aquatic plant species or their distribution within the sodium development area, although there are aquatic habitats, i.e., Henry's Fork, Green River, and associated oxbows (see Glossary). Being seasonal in nature, aquatic plants are most abundant during the summer and fall. Environmental requirements which are most important to aquatic plants are the availability of water and sunlight. Wide ranges of environmental conditions and the extremes of habitat condition which are associated with unstable aquatic environments result in a complete absence or only occasional establishment of aquatic plant communities.

TERRESTRIAL WILDLIFE

The major habitat types found in the area are saltbush-greasewood and sage brush-grasslands. These habitat types provide for a variety of wildlife species. A complete list of wildlife species known to occur in the area is available at the BLM Rock Springs District Office.

THREATENED OR ENDANGERED SPECIES

Federally-listed species which could occur in the area are the peregrine falcon, bald eagle, and the black-footed ferret. Species of high State interest include the burrowing owl.

Peregrine falcons are rare migrants in the area, but probably are not nesting residents, since no eyries have been located.

A winter concentration of bald eagles occurs in the cottonwood trees along the Green River from November through April. An aerial survey by BLM biologists on January 9, 1981, documented 9 bald eagles from I-80 to the Big Sandy confluence with the Green River, and 19 from the Big Sandy to the Fontenelle Dam.

It is generally accepted that black-footed ferrets are associated with prairie dogs. However, with little information available on black-footed ferret/prairie dog relationships and no recently reported sightings in Wyoming, sites essential for black-footed ferrets' recovery have not been identified.

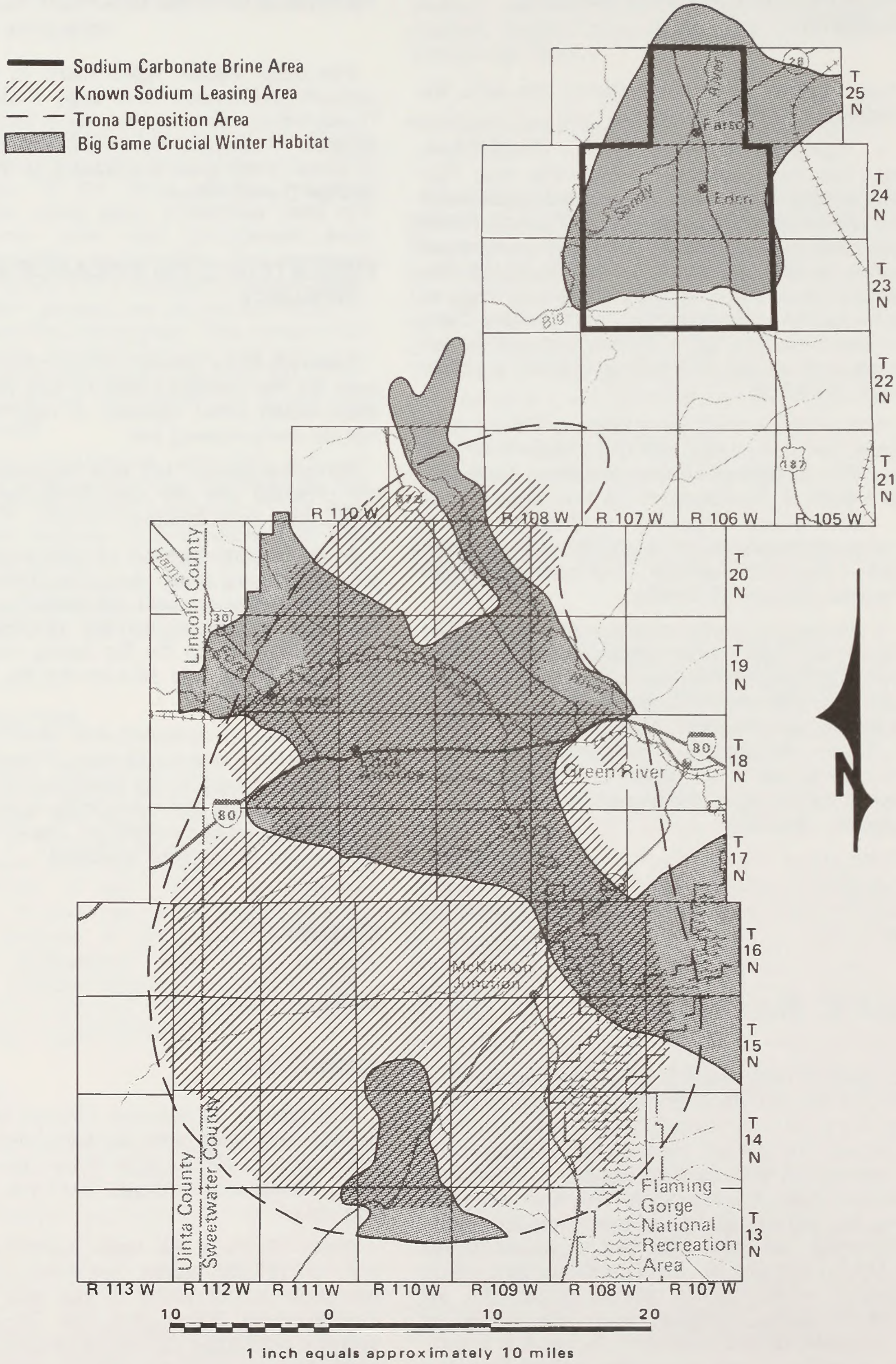
MAMMALS

GAME

PRONGHORN

This species is common throughout the sodium development area with an estimated 4,800 antelope (average density of 3 animals per square mile) using the area, including 4,300 in the trona deposition area.

About 19.5% of the trona deposition area (Map II-3), or 177,885 acres, has been designated as pronghorn crucial winter habitat (see Glossary) by the Wyoming Game and Fish Department. The average population density of pronghorn in District winter habitat is 10 animals per square mile, indicating approximately 2,750 antelope winter in the



Map II-3
CRUCIAL BIG GAME WINTER HABITAT

trona deposition area. Most of the sodium carbonate brine, an estimated 109,000 acres, is crucial winter habitat for approximately 1,700 pronghorn.

The use of the winter ranges appears to be variable, depending upon climatic conditions and the depth of accumulated snow. For example, it was found during aerial observation flights the winter of 1978-79 that pronghorns had shifted their winter use farther south to below Big Dry Creek because deep snow covered their traditional winter range. They did not return to the area until after the spring thaw.

MULE DEER

This species occurs infrequently in the majority of the area, but usually inhabits riparian areas along the Green and Blacks Fork rivers. An important mule deer winter range occurs in the southern part of the trona deposition area (Map II-3). An estimated 250 deer use the range, which covers about 4% of the area, or 36,580 acres. Winter habitat in the vicinity of the Green River, Hams Fork River, and two arms of the Flaming Gorge Reservoir totals an estimated 60,000 acres, with approximately 400 deer wintering in that area. An estimated 65,400 acres of deer winter habitat is located in the sodium carbonate brine area.

ELK

Elk are found during the winter months in the southwestern segment of the mule deer winter range. They do not use any other part of the area, although an important elk winter range occurs between the trona deposition area and the sodium carbonate brine area.

MOOSE

Moose occur infrequently in the area and can be found in the riparian zones along the Blacks Fork and Green rivers. No moose crucial winter range occurs in the area.

COTTONTAIL RABBIT

This is the primary small game species in the area. The populations are generally abundant throughout the area.

NONGAME

FURBEARERS

Those found in the area include badger, beaver, bobcat, muskrat, mink, and weasel. Species classified as predators include coyote, porcupine, raccoon, red fox, and skunk. Data concerning population are not available for these species.

RODENTS

Various rodents occur in the area and include white-tailed prairie dog, Richardson ground squirrel, Uinta ground squirrel, least chipmunk, Uinta chipmunk, Great Basin pocket mouse, deer mouse, northern grasshopper mouse, and bushytail woodrat.

BIRDS

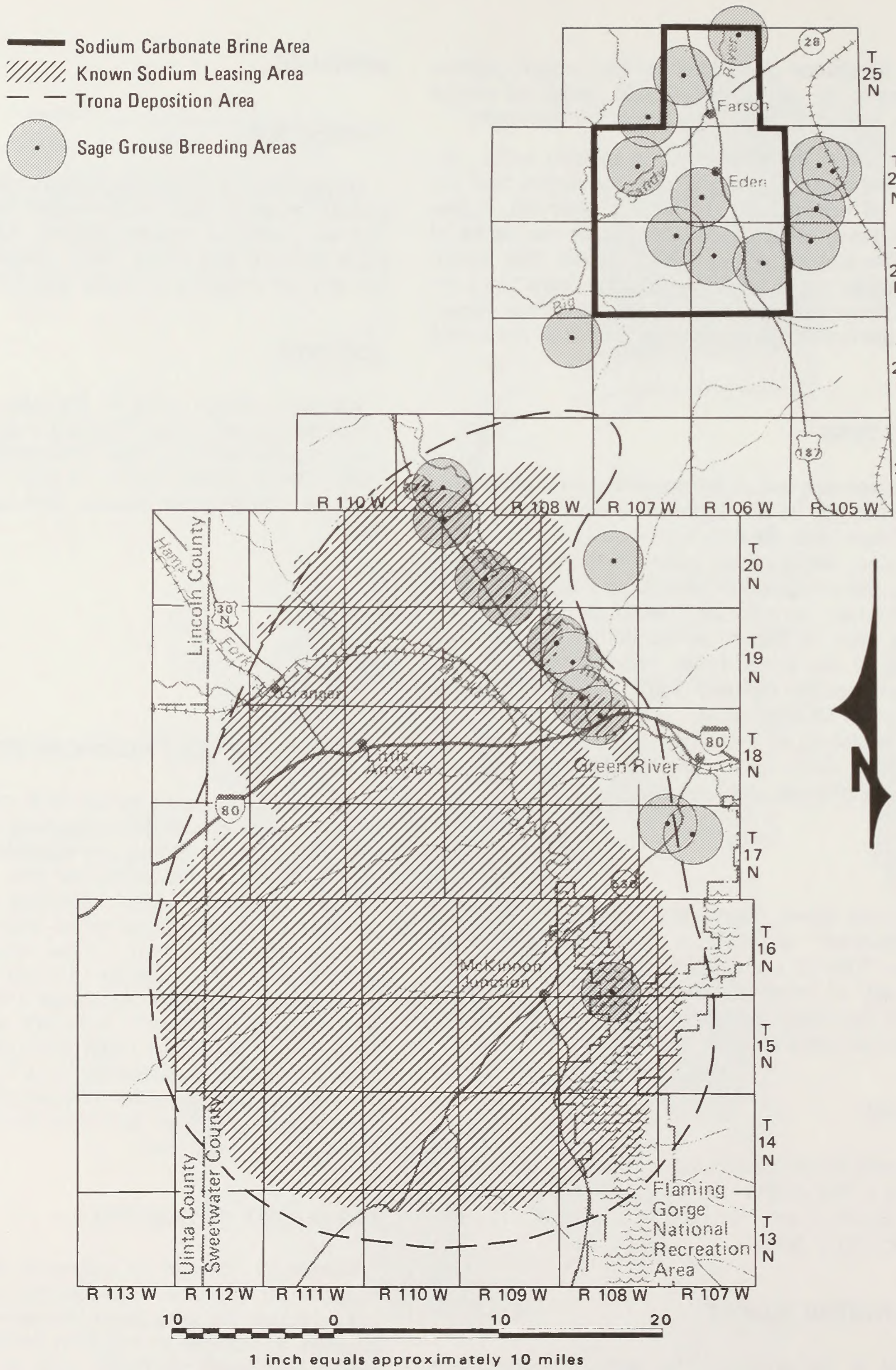
GAME

SAGE GROUSE AND MOURNING DOVE

The most important game birds present in the area are sage grouse and mourning dove. Population data for sage grouse management units in the vicinity of the area show extreme variability in annual populations. Major strutting grounds and breeding complexes occur within the sodium development area (Map II-4). These strutting grounds and breeding complexes are of major importance to the grouse's life cycle, and large areas of vegetation must be preserved. A recent conference on sage grouse established that 90% of the grouse's nesting behavior occurred within a 2-mile radius of the strutting ground. Little is known about the dove populations other than that their numbers fluctuate widely from year to year.

MIGRATORY WATERFOWL

Numerous species of migratory waterfowl (list available at the BLM Rock Springs District Office) pass through the area during the spring and fall migrations. In addition to migratory birds, several species of waterfowl commonly nest on any available water. They generally follow the major drainages such as the Green River, but will utilize any available stock reservoir, beaver pond, and stream. Seedskadee National Wildlife Refuge populations and Wyoming Game and Fish Department esti-



Map II-4
SAGE GROUSE AREAS

mates of populations in the local breeding areas are listed in Appendix 6.

NONGAME

RAPTORS

The entire area is used by raptors at some time during the year. Raptors which may be seen include goshawk, Cooper's hawk, sharp-shinned hawk, marsh hawk, rough-legged hawk, ferruginous hawk, red-tailed hawk, Swainson's hawk, bald eagle, golden eagle, osprey, prairie falcon, merlin, American kestrel, screech owl, great-horned owl, long-eared owl, short-eared owl, burrowing owl, and saw-whet owl. Raptor nesting sites must not be disturbed between March 15 and July 1. All except the rough-legged hawk nest in the area. See Appendix 6 for Seedskadee refuge populations.

SHOREBIRDS

Stock ponds, reservoirs, and rivers provide necessary feeding and nesting habitat for shorebirds. Nesting shorebirds include snowy egrets, great blue heron, black-crowned night heron, American bittern, white-faced ibis, rails, avocets, killdeer, and sandpipers. Appendix 6 lists Seedskadee populations.

SMALL BIRDS

Species of small nongame birds found during breeding bird surveys conducted in 1977 by the Wyoming Game and Fish Department include common flicker, Say's phoebe, horned lark, barn swallow, black-billed magpie, sage thrasher, mountain bluebird, vesper sparrow, sage sparrow, Brewer's sparrow, and others.

REPTILES AND AMPHIBIANS

Little information is available concerning reptiles and amphibians in the area other than the species present. Amphibians include the Utah tiger salamander, blotched tiger salamander, Great Basin spadefoot toad, chorus frog, and leopard frog. Reptiles include sagebrush lizard, northern plateau lizard, tree lizard, eastern short-horned lizard, midget faded rattlesnake, Great Basin gopher snake, wandering garter snake, and ornate box turtle (Biosystems Analysis, Inc. 1981).

AQUATIC WILDLIFE

HABITAT

The fish species commonly found within the area are noted in Table II-11. They are largely associated with the Hams Fork River, Blacks Fork River, Green River, and Flaming Gorge Reservoir. In the cold desert plains associated with the KSLA, game fish habitat becomes restricted due to water withdrawals for irrigation or industry, resulting in higher water temperatures and accelerated sedimentation. Nongame fish predominate in lowland areas due to their adaptability and wider tolerance limits for less optimum stream habitat conditions.

BLM stream inventories indicate that 63% of the stream habitat on public land in the Rock Springs District is in an apparent declining trend. Surface (soil) disturbance, low water flows, channel erosion, altered runoff patterns, and subsequent accelerated erosion and sediment loading of drainage systems are the most important factors affecting stream habitat in the KSLA. Stream habitat quality data for the area are available at the BLM Rock Springs District Office.

THREATENED, ENDANGERED, OR SENSITIVE SPECIES

As noted in Table II-11, several fish species exist within the area which, while not on the Fish and Wildlife Service Threatened and Endangered Species List, are considered to be rare or sensitive by authorities and agencies within Wyoming.

Three State-level rare or sensitive nongame fish species exist in the Green River drainage system—the roundtail chub (*Gila robusta*), flannelmouth sucker (*Catostomus latipinnis*), and bluehead sucker (*Catostomus discobolus*). While not Federally listed, they are in definite need of conservation and preservation due to their reduced distribution and range (Baxter and Simon 1970).

Recently, the bonytail chub (*Gila elegans*) has been nominated for consideration as a threatened species by the Fish and Wildlife Service. While presently thought to be extinct in Wyoming (Baxter and Simon 1970), the former range of this fish included tributaries of the Green River system. Taxonomically, this fish is closely related to the roundtail chub. Surveys recently conducted in the southern half of the KSLA have established its absence in this area (Bio/West 1981). The Colorado River squawfish (*Ptychocheilus lucius*) and humpback

Table II-11

FISH SPECIES COMMON TO THE KSLA

Game Fish	Nongame Fish
Mountain Whitefish	Common Carp
Kokanee Salmon	Utah Chub
Cutthroat Trout	Roundtail Chub (S,S,-)*
Rainbow Trout	Bonneville Redside Shiner
Brown Trout	Speckled Dace
	Fathead Minnow
	White Sucker
	Utah Sucker
	Flannelmouth Sucker (S,-,-)*
	Mountain Sucker
	Bluehead Sucker (S,R,-)*
	Mottled Sculpin

*Population status classification as noted by Baxter and Simon (1970), the Wyoming Game and Fish Department (1977), and the Bureau of Land Management.

E = Apparently Extinct
R = Rare
S = Sensitive
- = No Designation at Present

chub (*Xyrauchen texanus*), former residents of the Green River system in Wyoming, are also considered to be extinct in this State (Baxter and Simon 1970). Considerations for these fish within the Endangered Species Act will, therefore, not be necessary.

WILD HORSES

Horses from six wild horse management areas use portions of the sodium development area. At the 1981 winter count, there were 1,056 horses in these six areas. It is estimated that 184 of those wild horses use the sodium development area at any given time. The estimated population in the development area would consume at least 3,208 AUMs (animal unit months; see Glossary) of forage annually. Table II-12 shows the number of horses counted in each wild horse management area, the estimated number in the development area, and projected herd management levels.

The wild horse populations in the Rock Springs District have an average net increase of 15% per year. However, since much of the sodium development area falls into the checkerboard land pattern where BLM roundup operations are conducted, the increase would not be expected to be this high.

The sodium carbonate brine area is within one wild horse area that has been designated for special management. The White Mountain Wild Horse Management Area will be managed for 150 wild horses in the solid-block lands that include the sodium carbonate brine area and 100 wild horses in the checkerboard lands outside the brine area (Map II-5). A special turnout will be established off U.S. 187 for motorists to view the wild horses. Specific details are contained in the White Mountain Wild Horse Management Plan, available for review in the BLM Rock Springs District Office.

CULTURAL

ARCHEOLOGY

Archeological resources consist of all the prehistoric and historic physical evidence of past human activity, other than written documents, which can be used to reconstruct the lifeways and the culture of past peoples. This evidence includes sites, artifacts, floral and faunal remains, and other features, and the contexts in which they occur. Archeological surveys in the area have been scattered, and few have been conducted with the scientific design necessary to determine past settlement patterns. Most of the recent surveys have been undertaken by trona and oil companies to comply with BLM requirements and Federal laws regarding cultural resources. Appendix 7 summarizes the prehistoric chronology which is most often applied to this area. One percent of the area (13,745 acres out of a total area of 1,028,560 acres) has been surveyed. A total of 350 sites were located in these surveys for an average site density of 21.5 sites per square mile. Because these surveys were concentrated in oil and gas and trona areas, many ecological zones are poorly surveyed and the average number of sites per square mile most likely would be significantly changed with an adequate random sampling of the area. Using the biased average of 21.5 sites per square mile, a total of 34,553 sites for the sodium development area could be predicted.

Archeological inventories with a scientific research design would have to be conducted before a local model for site locations could be developed. From various studies in southwestern Wyoming, sites seem to cluster around water sources, especially springs, creeks, rivers, playas, and interdunal ponds. Campsites tend to be associated with areas of sand deposition. Various types of specialized sites such as lithic quarries and animal traps are located in areas where they are made possible by natural conditions. Site types in the area include lithic scatters, campsites, fire pits, quarries, animal kill sites, stone circles, and petroglyphs.

Presently one archeological site in the area, the Pine Springs site (Map II-6), has been nominated to the National Register of Historic Places. A Paleo-Indian occupation is evidenced at this site and throughout that portion of the sodium development area. Lifeways during this period were typified by hunting of now-extinct species of big game. Paleo-Indian sites are also known in the Eden-Farson area.

The Middle Plains Archaic and all succeeding periods are characterized by various types of hunting and gathering cultures that intensively occupied the area. A number of Middle Archaic sites are known in the area, and there is an extremely good chance that others remain to be found. However, most known sites in the area are dated Late Archaic and Late Prehistoric. A majority of newly-discovered habitation sites will probably be dated in these periods.

Table II-12

HORSE MANAGEMENT AREAS PARTIALLY IN SODIUM DEVELOPMENT AREA AND HORSE NUMBERS AT WINTER 1981 COUNT

Horse Management Area Number	Horse Management Area Name	Horse Management Area Total Count	Estimated Number of Horses in Sodium Area	Projected Herd Management Levels
1	Little Colorado	209	20	75[2/]
7	Wells	452	45	0
8	Pilot Butte	237	50[1/]	250
11	Firehole	86	10	0
18	North Granger	18	5	0
19	South Granger	54	54	0
TOTAL		1,056	184	

[1/]Portion will be in White Mountain Wild Horse Management Area (Map II-5).

[2/]Horses will not be in sodium development area.

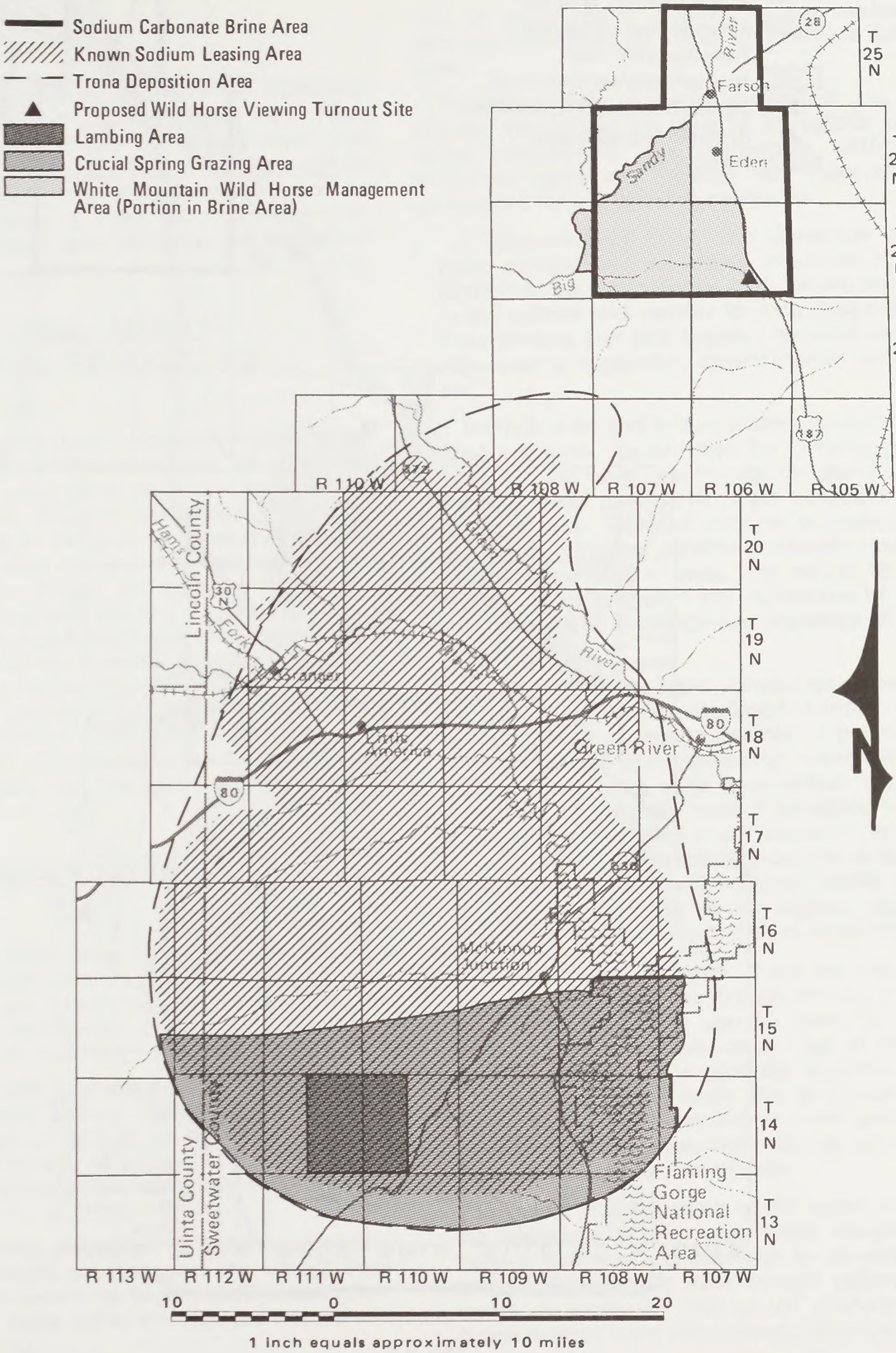
Table II-13

1979 TRAFFIC COUNTS IN TRONA DEPOSITION AREA

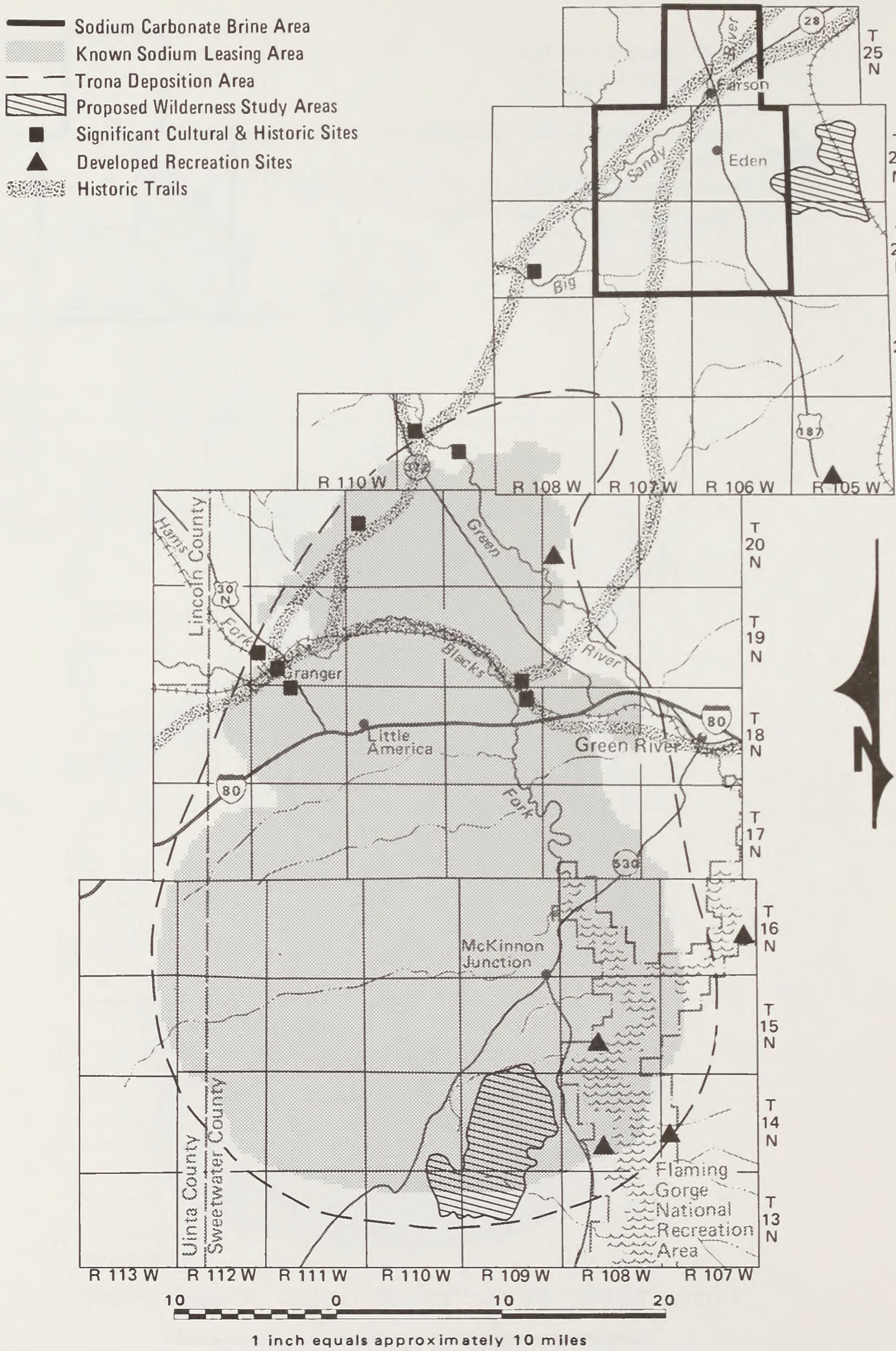
Highway	Segment	Average Daily Traffic	Expansion Factor[1/]
I-80	Junction with Wyoming 372 to West Green River Interchange	7,740	
I-80	Green River Marginal	7,300	
I-80	East Green River Interchange to West Rock Springs Interchange	11,850	1.80
WYO 530	Green River Corporate Limits to Wyoming-Utah State Line	570	2.00
WYO 372	Junction with Interstate 80 to end of FAS 1906 (17.3 miles)	730	
WYO 372	End of FAS 1906 to Fontenelle	<250	1.73
WYO 373	Junction with Interstate 80 to Wyoming-Utah State Line	280	1.60

Source: Wyoming State Highway Department (pers. comm., Garrett 1981).

[1/]Expansion factors are for 20 years. They depict the future traffic projections by the Wyoming State Highway Department, which notes that the projections are subject to change due to unforseen circumstances.



Map II-5
GRAZING MANAGEMENT IN SODIUM DEVELOPMENT AREA



Map II-6

CULTURAL, HISTORICAL, RECREATION, AND WILDERNESS VALUES IN SODIUM DEVELOPMENT AREA

HISTORICAL

Appendix 7 summarizes some of the known historic sites in the sodium development area. There are numerous historic sites in this area which were important to the peopling of the West. Although the conditions of these sites vary considerably, and the relative significance of many later sites is yet unknown, their historic importance has not diminished.

RECREATIONAL USE OF CULTURAL RESOURCES

Because of their fragile and unrenewable nature, there is almost no recreational use for cultural resources in the area; rather, they have scientific and educational use. The only recreational use for cultural resources in the area is connected with the historic trails (Map II-6) and the western migration movement. Fort Bridger, for example, is the most famous historic site in western Wyoming, and it is currently a developed state park. The various trails in the area have the potential of being monumented and having brochures developed for individuals who wish to retrace the routes of the pioneers. There are a number of potential sites dating from the settlement period which can be interpreted, such as the early ranches along the Green River.

VISUAL RESOURCES

There are three major landscape types in the sodium development area: mountainous areas, alluvial valleys, and desert plateau. Variations occur within these landscapes through vegetation patterns, soils, and minor landforms.

The mountainous areas appear as large rolling hills with deeply incised drainages. Much of this landscape type is covered by sagebrush with juniper growing primarily on slopes. Areas of mountain shrubs such as mountain mahogany occur sporadically.

Alluvial valleys generally have groves of cottonwood and thickets of willow near the water's edge and otherwise appear as large meadows and green fields. Some areas within this type are farmed and may be irrigated.

Desert plateau makes up the bulk of the area. The plateau is flat but has been highly dissected through stream action. Slopes from the plateau to creeks and streams are steep, sometimes precipitous to gently rolling. Portions of this landscape type are highlighted by buttes and badland formations.

The vulnerability of these landscapes; i.e., the amount they would be affected by various uses; varies considerably. The vulnerability within the landscape types and variants can, however, be generalized for the following categories:

1. ***Mountainous Type***: The landscape offers many opportunities for hiding structures behind landforms, but steep slopes imply severe damage to the surface and visibility for long distances on mountaintops and side slopes. The usual vegetative cover is sagebrush, desert shrubs, and juniper.

Uniform color and texture makes disruption evident but gives opportunities for blending structures into the landscape through the use of color. In some areas, juniper stands are associated with exposed rock. Selected removal of juniper and avoidance of regular patterns in development can reduce the effects of uses. The natural distribution of rock is difficult, if not impossible, to duplicate through rehabilitation and represent an aesthetic loss.

2. ***Alluvial Valley Type***: Alluvial valleys tend to be flat but broken by vegetation. Farmed areas are composed of regular patches of ground defined by fences and marked by structures, hay storage piles, and other farm-related features. These areas generally have a backdrop of hills that reduces the effect of structures in the landscape. These provide opportunities for screening. Some areas are sparsely timbered, similar to the timbered areas of the desert plateau, but with less dissection in valleys and more uniformity.

3. ***Desert Plateau Type***: There are many opportunities for hiding use through the use of landform, but some areas can be seen for many miles on side slopes and on the top of the plateau. The vegetation is generally sagebrush and desert shrubs which make this landscape type subject to disruption because of their uniformity. Opportunity does exist, however, for disguising activities through the use of color.

In juniper concentrations of the desert plateau, the landscape is even more easily disrupted by clearing activities. Opportunities for development and rehabilitation do exist through judicious removal of vegetation that would produce edge characteristics more characteristic of juniper.

Vertically oriented buttes, bluffs, and badlands in portions of the desert plateau type draw attention to themselves as features. Most disruption is competitive with the features and, without careful siting, is highly distractive. Uniformity of color and texture can assist in disguising actions, but areas with varicolored banding make this technique more difficult. Disruption of the natural structure or plain surfaces destroys the visual interest in these areas. Thus the compatibility of vertical, highly visible areas with most uses is low.

MANAGEMENT CLASSES

The three wilderness study areas and the Flaming Gorge NRA (Map A1-1) qualify as Class I Visual Resource Management (VRM). VRM Classes represent the limits of modification the area can tolerate without significant impact as determined through measurement using the BLM contrast rating system. Class I areas represent more stringent constraints to visual modification than Class II. Class II is more stringent than Class III, etc. Where modification exceeds the constraints, an interim management "Class V" is used to indicate the temporary status of the area affected and to indicate that rehabilitation of the area is needed.

The sodium development area is within the Wyoming Basin physiographic province (see Glossary). Local visual ratings in this area are typically VRM Classes III and IV, which comprise about 80% of the public lands in the area. Scenic quality—one of the three factors considered in determining VRM class—is rated B to C on an A to C scale where A represents the best scenery. The area's visual sensitivity is largely medium to low.

The Flaming Gorge NRA and the three WSAs (about 10% of the area) are classified VRM Class I. The human visual sensitivity of these areas is high, which contrasts with the much lower sensitivity of the surrounding area. The unique recreation values offered by the Flaming Gorge NRA would be sensitive to development in contiguous lands, especially along the foreground-middleground zone (see Glossary) as seen from the normal operating level of the reservoir and the Green River. That zone can be seen for a distance of 3 to 5 miles from the NRA. The Ashley National Forest's plan for the NRA identifies the need to protect these visual values through Federal cooperation on adjacent lands.

WILDERNESS

Section 603 of the Federal Land Policy and Management Act (FLPMA) requires that the public lands be inventoried for wilderness values and possible designation as wilderness. Those lands that are identified as Wilderness Study Areas (WSAs) will remain in interim management until the BLM makes recommendation for or against inclusion of these lands in the National Wilderness System and Congress responds to that recommendation.

Further information concerning the individual areas can be obtained from the BLM Rock Springs District Office.

Three WSAs within the sodium development area have been proposed for further consideration. Management Framework Plan (MFP) recommendations regarding the wilderness suitability of these areas will be available by Fiscal Year 1982.

About 1,000 acres of the 10,300-acre Buffalo Hump WSA (WY-040-306) are within the sodium carbonate brine area (Map II-6), and most of those acres are withdrawn to the Bureau of Reclamation for the Eden-Farson Irrigation Project. Wilderness values identified in the intensive wilderness inventory of this area include solitude, hiking, backpacking, camping, bird watching, wildlife photography, horseback riding, hunting, and historic and cultural values.

The Devil's Playground WSA (WY-040-401) and the Twin Buttes WSA (WY-040-402) are the southeast portion of the trona deposition area. These adjoining WSAs include 24,276 acres of highly eroded badlands that are devoid of vegetation, with 7,837-foot Black Mountain and 8,012-foot Twin Buttes being the most prominent points in the area. Wilderness values identified in the intensive wilderness inventory of these areas include naturalness, topographic diversity, hiking, camping, horseback riding, photography, sightseeing, and fossils.

RECREATION

Recreation activities in the sodium development area are primarily dispersed uses. Hunting and fishing are the most frequent uses and these activities are often combined with camping and picnicking. Access in the area is provided by gravel roads and two-track trails, so use of four-wheel drive recreation vehicles is often necessary to pursue these activities.

Currently, the dispersed recreational opportunities in the area exceed demand except in permitted hunting. Damage to the environment is considered minimal with the exception of littering and off-road vehicle (ORV) use in certain areas that have highly erodible soils.

Use during 1975 for the Flaming Gorge NRA was 705,400 visitor-days (see Glossary) with 1,572,700 recreation visits recorded. In 1970, the NRA had 532,700 visitor-days use and 1,977,400 recreation visits.

The recreation use capacity for the Flaming Gorge NRA is approximately 2.9 million visitor-days per year (U.S. Department of Agriculture 1977). Annual visitor-day use capacity in the Northern Desert Management Area, the northern portion of which is in the trona deposition area, is approximately 1.7 million. The major developed areas in the Northern Desert portion of the NRA (Map II-6) are Buckboard Crossing and Marina, on the west side of the reservoir about 4 miles south of the confluence of the Blacks Fork and the Green rivers and 20 miles south of the city of Green River on Wyoming 530; Squaw Hollow, 6 miles south of Buckboard; Firehole, on the east side of the reservoir about 25 miles southwest of Rock Springs and 30 miles south of Green River; and Upper Marsh Creek, about 20 miles south of Firehole on Wyoming 373. Use by Green River and Rock Springs residents is high, and the demand for "bedroom" camping by those travelling on I-80 is increasing (U.S. Department of Agriculture 1977). The Buckboard/Squaw Hollow area represents a major, high-density recreational development that includes boating, camping, and resort facilities.

The Forest Service's "Multiple Use Management Guide" and "Recreation Management Plan" for the Flaming Gorge NRA (documents available for review from the Supervisor's Office, Ashley National Forest, Vernal, Utah) indicate the significance of the NRA and the associated recreational and esthetic values.

Other uses of the area include the collection of rocks and minerals and other objects of interest. On Flaming Gorge Reservoir and the Green River, boating, canoeing, and floating are common uses as well as some swimming. Winter activity includes general snowplay, such as sledding. Ice fishing is popular on the west side of the reservoir, which receives moderate winter use. Firehole, in addition to Buckboard and Squaw Hollow, is a popular ice fishing area. Sightseeing for wildlife, scenery, and historical attractions is common. Wilderness experience is found in the more remote parts of the sodium development area (see Wilderness section). Opportunity also exists for hiking, backpacking, and horseback riding. Picnic areas include BLM's 14 Mile Reservoir north of Rock Springs and the FMC and Stauffer areas in the KSLA (Map II-6). Recreation values are further discussed in Appendix 7.

LIVESTOCK GRAZING

The predominant agricultural land use in the sodium development area is range livestock production. The Federal lands have been organized into grazing allotments and may have State and private lands mixed in. The livestock permittees utilize these lands in addition to base lands outside the area in their yearlong operations. Typically cattle enter the allotments in the spring, remain through the summer, and are moved to base lands for the winter. Sheep generally use the area in the winter and are moved to other areas or to the National Forest in the summer. They spend other times on the base lands in some cases. The sheep are gathered into large bands in the spring and are trailed to other grazing areas. They trail back into the area in the fall.

There are 11 grazing allotments partially or wholly in the sodium development area. These allotments are used by 60 cattle operators, 23 sheep operators, and 11 operators that run both kinds of livestock. Approximately 60,970 AUMs are available in the trona deposition area, including about 35,932 AUMs on Federal lands. The existing sodium facilities have removed an estimated 8,100 acres (540 AUMs) from production.

There is one lambing ground in the area on the Henry's Fork Allotment (see Map A1-1). About 4,000 sheep use this area in May and June. There have been cases in the past where lambing was done on Federal land in the development area, but this is not a general practice. The majority of the lambing is done on allotments or base lands adjacent to the development area.

The north end of the Henry's Fork Allotment furnishes critical spring grazing to the permittees. It is imperative to the permittees' year-round operations that their livestock come off the home lands and graze on the public lands. The checkerboard area also furnishes crucial winter range to the sheep herds. This area remains open enough in the winter that the sheep operators are able to use it in their year-round operations.

LAND USES

Land uses in the sodium development area are centered around soda ash production, oil and gas production, and agriculture. Those industries are influenced by the policies of the Federal Government and subsidiaries of the Union Pacific Railroad Company which have extensive land holdings in the area. Major transportation routes are found in the area; Table II-13 shows the importance of some of these routes.

URBAN AND SUBURBAN

The towns and communities in or adjacent to the area provide basic services to the soda ash, oil and gas, and ranching industries. The incorporated towns serve as area trading places for the surrounding industrial interests. Rock Springs is the regional trading center.

EDEN AND FARSON

Eden and Farson (1980 combined population 478, estimated by THK Associates, Inc., 1979a) are almost entirely agricultural communities providing limited services to the surrounding agricultural area and truck traffic on U.S. Highway 187 and State Highway 28. These communities are not incorporated.

ROCK SPRINGS

The city of Rock Springs (population 19,411, 1980 Census of Population and Housing) is located 14 miles east of the trona deposition area and is the major service center. It has experienced considerable growth in the past 15 years due to industrial development, including Pacific Power and Light's Jim Bridger Electrical Generating Plant, various coal mines, oil and gas exploration and development, and soda ash production.

GREEN RIVER

The city of Green River (population 12,785, 1980 Census of Population and Housing) originated with the arrival of the Union Pacific Railroad to the area. Today it serves as the Wyoming Division headquarters for that company. Green River has experienced considerable growth in the past 15 years as a result of the railroad, oil and gas, and soda ash industrial development. Being the closest major community to soda ash operations, Green River normally is most affected with the changes in that industry. This city is the county seat for Sweetwater County.

LITTLE AMERICA

Originally established as a service station/motel for traffic on old U.S. Highway 30, Little America is now a major service location for both I-80 traffic and soda ash production. The estimated 1980 permanent population of this *defacto* community is 144 (THK Associates, Inc., 1979a).

GRANGER

The community of Granger started as a group of section houses along the Union Pacific Railroad. It is greatly affected by the nearby trona mines, and especially by the Texasgulf, Inc., soda ash operation. The 1970 population was 137, and the present population is 176 (1980 Census). Much of Granger's new population has located in mobile homes. The majority of future growth is expected to take place on the east side of the Blacks Fork River.

LYMAN

The town of Lyman is predominantly a ranching community providing services to the surrounding area and to some tourist traffic off of Interstate 80. The town is bypassed by the interstate 2 1/2 miles to the north, creating some problems for the commercial enterprises situated in town. The town has received considerable pressure from industrial and construction workers, especially those in the soda ash industry. Its population increased from 425 in 1960 to 643 in 1970 and to its present population of 2,293 (1980 Census).

MOUNTAIN VIEW

Mountain View (population 629, 1980 Census), a recently incorporated community, provides services to local ranchers. The community is being subjected to a growing demand for housing from the soda ash industry and oil and gas development.

COMMERCIAL

Almost all of the commercial development in the sodium development area is located within the incorporated communities. The major exception is Little America, which has a well-established commercial development consisting of motel, restaurant, service station, and truck repair facilities.

INDUSTRIAL

There are four soda ash production facilities located within the trona deposition area: Texasgulf, FMC, Stauffer, and Allied Chemical (Map I-4). Church and Dwight operates a sodium bicarbonate plant adjacent to Allied's operation. Tenneco is constructing another soda ash production facility. Currently, these plant sites and associated facilities cover 8,100 acres.

Oil and gas development is another major industry of the area; including various producing unitized fields and major pipeline pumping stations. Mountain Fuel Supply Company operates three natural gas processing plants in the area, including two within the trona deposition area. Mountain Fuel has a 100 million cubic feet (mmcf) per day absorption processing plant and a 3 mmcf sweetening plant (see Glossary) at Church Buttes (T. 16 N., R. 113 W., Sec. 1), and it recently opened a 12.5 mmcf sweetening plant at Butcher Knife Springs. Amoco plans a sweetening plant at Moxa Arch, just outside of the trona deposition area in Lincoln County. The Trailblazer and MAPCO pipelines pass through the northern portion of the trona deposition area, and other major pipelines pass through the area.

AGRICULTURE

Land use in the sodium development area has historically been livestock grazing. Approximately 80% of the trona deposition area, or 732,000 acres, is utilized for this purpose. The BLM manages approximately 60% of this grazing acreage.

Cultivated areas are primarily located in the Eden-Farson area and along the Green and Blacks Fork rivers. Most of the hay crop produced is used for livestock. About 21,000 acres yearly are put into irrigated alfalfa hay in the Eden-Farson area.

PUBLIC PURPOSES

Approximately 140,360 acres of Federal, State, and private lands are dedicated for the Seedskadee National Wildlife Refuge and the Flaming Gorge NRA.

In 1970, the Seedskadee National Wildlife Refuge was established to provide habitat and refuge for migrating birds and waterfowl. Of the 22,112 acres of withdrawn Federal lands, 8,360 acres are within the sodium development area. The refuge is managed by the Fish and Wildlife Service.

The Flaming Gorge NRA includes lands surrounding the Flaming Gorge Reservoir on the Green and Blacks Fork rivers. The area extends from about one mile south of the city of Green River to below the Wyoming-Utah state line. Approximately 132,000 acres, or 80% of the Wyoming portion of the NRA, is within the trona deposition area. The recreation area is managed by the U.S. Forest Service.

Sweetwater County has zoned the area around the NRA as agricultural to foster maintenance of that area as open space (THK Associates 1977). The area is south of the city of Green River, bounded by State Highway 530 on the west and State Highway 373 on east, and extending to the Wyoming-Utah border.

SOCIOECONOMIC CONDITIONS

The socioeconomic environment that would be most affected by the proposal encompasses Sweetwater and Uinta counties. Prior to 1970 population in both counties was on the decline. The expansion of trona mining and soda ash production; coal and coke development; the Bridger Power Plant's construction and operation; and increased oil and gas exploration and development spurred population growth in the 1970s that reached boomtown proportions in the major cities and changed the population characteristics of the area drastically. In place of a predominantly ranching and rural-based population, the area became progressively more urban and industralized. Local governments were hard pressed to keep pace with the growth. In many cases the quality of life was reduced due to overtaxing basic facilities such as housing, health care, streets, services, sewers, etc. Communities experienced increases in crime rates, traffic congestion, accelerated retail price increases, and other adverse impacts associated with the growth. Average incomes increased, and there was an exodus of natives from lower-paying public and private sector jobs to mineral development occupations.

POPULATION

The estimated 1970 and 1980 populations of Sweetwater and Uinta counties and their major communities are shown on Table II-14. The aggregate affected population numbers approximately 54,744, with 76% of this population contained in Sweetwater County. Most of this population is the

Table II-14

1970 AND 1980 POPULATIONS FOR SWEETWATER AND UINTA COUNTIES

Area	1970 Population	1980 Population	Percentage Increase 1970-1980
Uinta County	7,100	13,021	83
Evanston	4,462	6,421	44
Lyman	643	2,284	255
Mountain View	N/A	628	-
Sweetwater County	18,391	41,723	127
Granger	137	177	29
Green River	4,196	12,807	205
Rock Springs	11,657	19,454	67
South Superior	197	586	197
Wamsutter	139	681	390

Source: 1980 Census of Population and Housing, Wyoming.

Table II-15

1977 EMPLOYMENT BY MAJOR INDUSTRIAL SECTOR FOR UINTA AND SWEETWATER COUNTIES

Industrial Sector	Uinta County	Sweetwater County
Agriculture	346	207
Mining	313	5,618
Construction	127	2,376
Manufacturing	165	335
Transportation	518	1,384
Wholesale Trade	67	514
Retail Trade	825	2,536
Finance	78	316
Service	267	1,737
Public Administration	1,302	2,242
Miscellaneous	356	908
TOTAL	4,364	18,173

Source: Wyoming Employment Report, Wyoming Department of Administration and Fiscal Control.

direct result of past energy developments and the 1970s' boom-town growth in Rock Springs, Green River, and the rural areas of Sweetwater County. Only recently has energy boom-town growth affected Evanston and Uinta County.

Growth in Sweetwater County has stabilized relative to those boom years and the only major industrial construction activity at present is the Tenneco mine and plant facility.

EMPLOYMENT AND INCOME

Employment in Sweetwater and Uinta counties by major industrial sector is shown in Table II-15. The mining industry in Sweetwater County was the largest employer with more than 30% of the annual work force of 18,173 in 1977. The mining industry employment in Sweetwater County increased 197% from 1,666 employees in 1971 to 5,618 in 1977, while total employment in Sweetwater County increased only 109%. The mining sector in Uinta County employed 7% of the total 1977 work force of 4,364.

Table II-16 shows the employee distribution in Sweetwater and Uinta counties by major soda ash producer for 1979. Approximately 84% of the total 3,739 trona mining/processing industry employees reside in Sweetwater County, with the remaining 16% living in Uinta County. The Southwestern Wyoming Industrial Association estimates 1980 trona industry employment at 4,003 (including employees of Church and Dwight Company) with approximately 79% of the total employees residing in Sweetwater County (56% in Green River and 23% in Rock Springs); 18% in the Bridger Valley of Uinta County; and the remaining 3% living in other places (Wyoming Trona Industry Facts 1980). The trona industry constitutes more than 20% of the counties' labor force and 1.6% of the State's labor force (Wyoming Trona Industry Facts 1980).

Unemployment trends for 1979 and unemployment rates from January to November 1980 are shown in Table II-17. Sweetwater County showed a stable unemployment trend in 1979, while Uinta County and Wyoming State showed a decreasing trend of 2.5% and 0.5%, respectively. Unemployment rates were higher for Sweetwater County, Uinta County, and Wyoming State in every month from January through November 1980 than for the same time periods in 1979, with the exception of Uinta County unemployment rates for September which were 0.2% lower in 1980. Workforce in migration and resident employment force have apparently met and surpassed the 1980 employment demands as reflected in the increasing unemployment rates from 1979 to 1980.

Average weekly wages rates for the third quarter 1979 and second quarter 1980 are shown in Table II-18. In both quarters the mining industry paid the highest average weekly wage rates, with second quarter 1980 weekly wages being more than $28 and $43 greater for Uinta and Sweetwater counties, respectively, than third quarter 1979 wage rates. Average weekly wage rates of $363.50 and $281.96 were reported for Sweetwater and Uinta Counties, respectively, for the second quarter 1980. Southwestern Wyoming Industrial Association estimates payrolls from 4,003 soda ash industry employees at $101,683,000 annually, exclusive of fringe benefits (Wyoming Trona Industry Facts 1980).

Total personal income and per capita personal income for residents of Sweetwater and Uinta counties from 1972 to 1978 is shown in Table II-19. Total personal income increased 240% from $98,407,000 in 1972 to $334,804,000 in Sweetwater County, while per capita personal income increased only 97%. A similar trend was shown in Uinta County with total personal income increasing 132% and per capita personal income increasing 72%. Increasing total county population can account for total personal income rising faster than per capita personal income.

Table II-20 shows labor and proprietors income by industrial sector. The mining industry in Sweetwater County received $116,604,000 in labor and proprietors income during 1977, which represents approximately 45% of the county's total. Labor and proprietors income from mining increased 583% in Sweetwater County from 1971 to 1977, while the total county's labor and proprietors income increased 346%. The mining industry in Uinta County received 13% of the county's total labor and proprietors income of $41,037,000.

HOUSING

With a vacancy ratio of 3% in Rock Springs and similar ratios in surrounding areas, there is virtually no vacancy in Sweetwater and Uinta counties. The Assistant City Planner for Rock Springs states that this 3% reflects moves and temporary vacancies (Rocket-Miner 1980b).

Single-family residences are in greatest demand, with 44.6% and 61.8% of the total residences available in Sweetwater and Uinta counties, respectively, in 1979 being single-family residences (Table II-21). The 1980 Rock Springs Community Profile compiled by the Industrial Development Division of the Wyoming Department of Economic Planning and Development (DEPAD), cites the estimated

Table II-16

EMPLOYEE DISTRIBUTION IN THE SODA ASH INDUSTRY

Company	Sweetwater County	Uinta County	Total Employees
Allied Chemical Corp.	1,040	260	1,300
FMC Corporation	1,064	286	1,350
Stauffer Chemical Company of Wyoming	582	18	600
Texasgulf	440	44	484
Tenneco	5		5
TOTAL	3,131	608	3,739

Source: Mineral Development Monitoring System, Minerals Division, DEPAD, State of Wyoming, by Stuart/Nichols Association Rev. 10/79.

Table II-17

UNEMPLOYMENT RATE 1979

County/State	Unemployment Rate													
	(Dec. 78)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Trend
Uinta	(2.8)	3.9	2.6	2.5	2.1	1.7	1.9	2.4	2.0	2.0	1.8	1.9	1.4	-2.5%
Sweetwater	(3.3)	3.2	2.6	2.3	2.9	2.5	2.9	2.8	3.1	2.7	2.7	2.9	2.8	Stable
Wyoming	(3.6)	4.0	3.3	3.0	2.8	2.2	2.5	2.4	2.4	2.3	2.2	3.0	3.4	-0.5%

Source: Job Service of Wyoming.

UNEMPLOYMENT RATE 1980

County/State	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Uinta	3.6	2.4	2.9	2.5	2.2	3.0	3.1	2.5	1.8	2.4	5.1
Sweetwater	4.0	3.7	3.4	3.4	2.8	3.9	3.3	3.4	3.0	3.5	4.6
Wyoming	4.2	4.1	3.6	3.6	3.4	3.9	3.6	3.3	3.2	3.8	4.5

Source: Civilian Labor Force and Unemployment, Job Service of Wyoming.

Table II-18

AVERAGE WEEKLY WAGE

Industry	3rd Quarter 1979 Uinta Co.	3rd Quarter 1979 Sweetwater Co.
Mining	$ 408.15	$ 441.33
Construction	442.31	417.83
Manufacturing	207.18	342.25
Transportation/Commerce/Utilities	341.88	357.98
Wholesale Trade	266.27	297.39
Retail Trade	126.83	154.57
Finance/Insurance/Real Estate	206.57	217.30
Services with Agriculture/ Forestry/Fisheries	192.19	213.69
Public Administration	228.75	220.24

Industry	2nd Quarter 1980 Uinta Co.	2nd Quarter 1980 Sweetwater Co.
Mining	$ 436.60	$ 484.92
Construction	352.93	431.85
Manufacturing	244.46	346.94
Transportation/Commerce/Utilities	346.78	390.29
Wholesale Trade	316.53	374.15
Retail Trade	142.94	159.24
Finance/Insurance/Real Estate	230.92	229.20
Services with Agriculture/ Forestry/Fisheries	247.58	293.65
Public Administration	212.06	196.49

Source: State and County Summary of Covered Employment and Total Payrolls by Industry, Employment and Security Commission of Wyoming, Research and Analysis Section.

Table II-19

TOTAL PERSONAL INCOME AND PER CAPITA PERSONAL INCOME FOR SWEETWATER AND UINTA COUNTIES

County	Income Classification	Year 1972	1973	1974	1975	1976	1977	1978
Sweetwater	Total Personal Income 1/	98,407	135,616	189,100	218,675	251,511	283,241	334,804
	Per Capita Personal Income	4,661	6,005	7,109	7,203	7,959	8,400	9,197
Uinta	Total Personal Income 1/	29,884	35,117	41,498	45,625	48,959	58,313	69,454
	Per Capita Personal Income	3,819	4,226	4,794	4,794	5,095	5,778	6,587

Source: Wyoming Income Report, Prepared by Division of Research and Statistics, Department of Administration and Fiscal Control, State of Wyoming, September 1980.

1/ Reported in thousands of dollars.

Table II-20

1977 LABOR AND PROPRIETORS INCOME
FOR SWEETWATER AND UINTA COUNTIES
IN THOUSANDS OF DOLLARS

Industrial Sector	Uinta County	Sweetwater County
Agriculture	$ 806	$ 2,105
Mining	5,411	116,604
Construction	2,064	43,312
Manufacturing	1,823	5,598
Transportation	9,088	25,392
Wholesale Trade	691	7,526
Retail Trade	5,752	20,034
Finance	807	4,066
Service	2,615	16,276
Public Administration	11,863	19,404
Miscellaneous	117	65
Total	41,037	260,382

Source: Wyoming Income Report, Wyoming Department of Administration and Fiscal Control 1979b.

Table II-21

HOUSING CHARACTERISTICS: SWEETWATER AND UINTA COUNTIES

County/ Community	Total Units	Single-Family	Multi-Family	Mobile Homes
Sweetwater County 1/	13,463	5,999	3,514	3,950
Rock Springs	7,469	3,234	2,841	1,394
Green River	3,498	2,056	557	885
Balance of County	2,496	709	116	1,671
Uinta County 2/				
Evanston	1,896	1,171	183	542 3/
Lyman	648	232	15	401
Mountain View	241	130	0	111

1/ 1979 Sweetwater County Land Use and Housing Update (Draft), THK Associates.

2/ Lincoln-Uinta Association of Governments, 1980.

3/ Includes 100 travel trailers counted as mobile homes.

cost of a new three-bedroom home (1,100 square feet) with two car garage and located in an area of comparable homes, as approximately $82,500.

A housing alternative available in Rock Springs is mobile homes (Table II-21). As the cost of new homes is prohibitive and older homes are unavailable, the new residents of the area must seek alternatives such as rental and mobile units. The cost of rental units is comparable to that of mobile homes and does not offer the satisfaction of owning one's residence nor the economic incentives associated with resale and tax advantages. Estimates in the 1980 Rock Springs Community Profile indicate the average rent for a three-bedroom home is $400 per month and for a one- to three-bedroom apartment is $350 per month.

Tables II-22 and II-23 illustrate the changes in housing type that have taken place in Sweetwater and Uinta counties in the past ten years. Mobile homes and multiple-family dwellings in Sweetwater County have increased from 8% and 20%, respectively, in 1970 to 29% and 26%, respectively in 1979. The percentage of mobile homes almost doubled in Uinta County (18.9-37.2%) between 1973 and 1979 at the expense of single-family dwellings. Condominiums and modular homes are being built as alternative housing.

HEALTH SERVICES

Health services are centered in the Sweetwater County Memorial Hospital in Rock Springs and the Memorial Hospital in Evanston. Both facilities are being fully utilized but the Evanston facility is beginning to be taxed beyond its capabilities. Both counties are short of adequate medical personnel. At present Rock Springs has 22 doctors plus 5 emergency room doctors under contract with the hospital; 11 dentists; and a 100-bed capacity hospital (1980 Rock Springs Community Profile). The area needs approximately 9 more physicians (Rocket-Miner 1980c).

Evanston has 4 physicians, 3 dentists, and the 85-bed-capacity Memorial Hospital (DEPAD, 1980 Evanston Community Profile).

SCHOOLS

Public school facilities in Uinta County are at capacity. All facilities in Uinta School District No. 1 are being operated at optimum capacity as of the spring of 1980, with the exception of the high school.

In Sweetwater County School Districts 1 and 2, facilities have accommodated the needs to date. Population growth has slowed recently, but adequately financed building programs have not been precluded. Tables II-24 and II-25 contain school capacity statistics for Sweetwater and Uinta counties.

OTHER INFRASTRUCTURE AND SERVICES

Sewer, water, utilities, and roads as well as police and fire protection, are of concern to the growing communities of this area. Perhaps the greatest lag is in sewer development. The city of Rock Springs is finally completing its sewer system addition, early in 1981, and it is operating at capacity. An EPA grant for another addition may be in doubt because of budget cuts. Lack of the addition would affect housing and mobile home park development outside the city limits. In Evanston capacities are being exceeded in the short term. In Green River environmentalists are concerned that peak flows are going directly into the Green River and destroying trout habitat.

Adequate police and fire protection now exist in Rock Springs and Green River, but it is anticipated to be lacking in the booming Evanston area. All public services in Uinta County are expected to suffer as employees are drawn toward higher paying mineral development occupations.

TAX REVENUE

The trona industry is a major source of tax revenue to Sweetwater County and Wyoming State. A mineral severance tax of 5.5% and an *ad valorem* production tax of 7.14% are levied directly on the assessed valuation of trona production. Total severance and *ad valorem* production taxes have increased 1,803% in absolute dollars from $735,596 in 1970 to nearly $14 million in 1980 (Wyoming Trona Factbook 1981). Table II-26 shows the total taxable trona production in addition to severance tax, *ad valorem* production tax, and *ad valorem* property tax revenues received from 1976 to 1980. *Ad valorem* property taxes are paid on personal property owned by the trona mining and soda ash production industries.

Additional revenues are received by the State of Wyoming from royalties paid on trona mined on State and Federal lands in Wyoming. Table II-27 shows the State and Federal royalties paid by soda ash producers in 1979 and 1980. Royalties are charged on the finished product, which is soda ash.

Table II-22

TYPE HOUSING IN SWEETWATER COUNTY

	1970[1/]		1979[2/]	
	Number	Percent	Number	Percent
Single Family	4,554	72	5,999	45
Multiple Family	1,235	20	3,514	26
Mobile Homes	526	8	3,950	29
TOTALS	6,315	100	13,463	100

1/ 1970 Census of Population and Housing.

2/ 1979 Sweetwater County Land Use and Housing Update (draft), THK Associates.

Table II-23

TYPE HOUSING IN LINCOLN-UINTA COUNTIES
1973

	Single Family		Mobile Home		Multi-Family		
	No.	%	No.	%	No.	%	Total
Evanston	1,002	77.5	160	12.4	131	10.1	1,293
Lyman	134	54.7	102	41.6	9	3.7	245
Mountain View	128	64.3	67	33.7	4	2.0	199

Sources: April 1973 housing studies by Lincoln County Planning and Zoning Commission and Uinta County Planning and Zoning Commission.

1979

	Single Family		Mobile Home		Duplex		Multi-Family		
	No.	%	No.	%	No.	%	No.	%	Total
Evanston	1,171	60.2	542[1/]	27.9	46	2.5	183	9.4	1,942
Mountain View	130	53.9	111	46.1	0	0	0	0	241
Lyman	232	35.6	401	61.7	2	0.4	15	2.3	650

Source: Data for Evanston is from the Evanston housing survey conducted by the Lincoln-Uinta Association of Governments (LUAG) during August and September 1979. For the other communities, the count was updated from building permit records (LUAG 1980).

1/ Includes 100 travel trailers in use as residences.

Table II-24

SUMMARY OF SCHOOL FACILITIES
SWEETWATER SCHOOL DISTRICT NO. 1

Location	Name	Capacity Recommended*	Capacity Maximum	1980 Enrollment
Elementary (K-6, 8)				
Rock Springs	Desert View	320	410	331
	Lincoln	320	410	314
	Lowell	135	180	156
	Overland	520	650	533
	Roosevelt	135	180	153
	Walnut	320	410	302
	Washington	310	350	375
	Yellowstone	430	550	362
		2,490	3,140	2,526
Reliance	Reliance	350	370	358
Wamsutter	Desert (K-8)	230	300	234
Superior	Superior	160	190	92
Farson-Eden	Farson-Eden	200	275	234
Secondary				
Rock Springs	East Jr. High (7-9)	800	1,100	598
	White Mt. Jr. (7-9)	800	1,000	517
	Senior High (10-12)	1,120	1,400	977
		2,720	3,500	2,092
Farson-Eden	Farson-Eden High (7-12)	100	135	71

*Recommended by School District.

As an additional service, the district shares its facilities with the community. A full-time community services director coordinates the use of school facilities, including two swimming pools, one handball court, two auditoriums, gymnasiums, and playgrounds. The facilities are open from 5:00 p.m. to midnight, and nominal fees are charged at the discretion of the district.

Source: School District No. 1.

Table II-24
(continued)

SUMMARY OF SCHOOL FACILITIES
SWEETWATER COUNTY SCHOOL DISTRICT NO. 2

Location	Name	Capacity Recommended*	Capacity Maximum	1980 Enrollment
Elementary (K-6)				
Green River	Harrison	700	875	603
	Roosevelt	440	550	291
	Washington	540	675	214
	Wilson	480	600	407
	Monroe Upper Elementary (5 & 6)	540	575	548
		2,700	3,275	2,063
Granger	Granger (K-8)	100	125	55
McKinnon	McKinnon (K-8)	60	75	29
Thoman Ranch	Thoman Ranch	N/A	N/A	6
Secondary (7-12)				
Green River	Lincoln Jr. High (7 & 8)	580	725	478
	Green River High (9-12)	1,040	1,300	853
		1,620	2,025	1,331

*Recommended by the school district.

The district shares its various gymnasiums, the swimming pool, and classrooms with the community for recreation and adult education programs.

Source: School District No. 2

Table II-25

SUMMARY OF SCHOOL FACILITIES
UINTA SCHOOL DISTRICT NO. 1

Analysis of Building Capacity:	Capacity Based On Analysis of Identified Instructional Space (Regular and Special)	Capacity Based on Analysis of Total Space	Capacity Based on Stuart/Nichols Study	Maximum Capacity	Optimum Capacity	Current Enrollment 12/11/79	Current Enrollment Compared to Optimum Capacity
Evanston High School (9-12)	625	$\frac{71,270}{125}=570.16$	400	600	450	365	-85 (Under Capacity)
Evanston Middle School (6-8)	440	$\frac{46,066.5}{100}=460.67$	400	500	350	310	-40 (At Capacity)
Clark Elementary School (K-5)	500	$\frac{43,102.5}{75}=574.7$	550	600	450	520	+70 (Over Capacity)
Brown Elementary School (K-4)	90	$\frac{6,322}{75}=84.29$	100	100	75	120	+45 (Over Capacity)
East Elementary School (K-4)	90	$\frac{6,413}{75}=85.51$	100	100	75	114	+39 (Over Capacity)

Source: Wyoming Department of Education.

Note: Optimum capacity represents 80% of the highest estimated capacity for each building. The calculation of Optimum capacity also represents a consideration of classroom capacity compared to capacity based on total school space. In addition, consideration must be given to the design and utilization of space in a given facility. For example: On the basis of available space, the Evanston Middle School can accommodate 440 to 500 students if classrooms are filled to capacity, if the shop area is scheduled with the maximum number of students, if each classroom is scheduled with students each period of the school day. One hundred percent utilization of such a facility is not reasonable in terms of the educational program; therefore, the optimum capacity of this facility is rated at 350 students. More students can be accommodated by any facility if emergency measures are implemented; i.e., high pupil-teacher ratio, extended day schedule, split sessions, limited curriculum, and other possible actions which are a detriment to a quality educational program.

Table II-26

AD VALOREM PRODUCTION AND PROPERTY AND SEVERANCE TAXES
1976 to 1980[1]

Year	Trona Production[2] in Short Tons	Ad Valorem Production Tax	Severance Tax	Ad Valorem Property Tax[3]
1980	11,771,985	$7,783,519	$5,988,997	3,158,357
1979	9,974,237	5,698,082	4,388,664	3,013,966
1978	10,215,602	5,898,724	4,326,307	3,143,777
1977	8,800,607	4,239,604	3,388,234	2,736,173
1976	7,379,792	3,089,771	1,771,150	2,421,954

Source: State of Wyoming, Annual Report, Department of Revenue and Taxation, Ad Valorem Tax Division, 1980, 1979, 1978, 1977, and 1976.

1/ Includes Allied Chemical Co., FMC Corp., Stauffer Chemical Co. of Wyoming, and Texasgulf, Inc.

2/ Net taxable trona production in tons; royalties are deducted from total production.

3/ Calculated from Abstract of Assessment R11, Sweetwater County 1976 through 1980.

Table II-27

FEDERAL AND WYOMING STATE ROYALTIES COLLECTED ON SODA ASH PRODUCTION

Year	Wyoming State Royalty[1]	Federal Royalty[2]
1980	$1,554,775	N/A
1979	650,143	$8,220,446

N/A = Indicates the data is not available at this time.

1/ Source: Wyoming State Land Commission (pers. comm., Yvonne Snow); calculated on a calendar year basis.

2/ Source: United States Geological Survey (pers. comm., Arne Mattila); calculated on a calendar year basis.

In 1980 both Federal and State royalties were collected at the rate of 5%. One-half of the royalties collected by the Federal Government on trona mined on Federal lands in Wyoming are returned to the State of Wyoming.

CHAPTER III

ENVIRONMENTAL CONSEQUENCES

ASSUMPTIONS AND ANALYSIS GUIDELINES

This document is a regional analysis rather than an assessment of a site- specific action. The following assumptions and analysis guidelines have been developed to establish a base from which impacts that could be associated with the proposed action or alternatives can be analyzed. The assumptions are set forth to aid in interpreting the magnitudes of the impacts that could occur with anticipated development of the area's sodium minerals. These assumptions are based on projections of market demands for soda ash (see Appendix 8—Details of the Assumptions and Analysis Guidelines) and the anticipated interest in prospecting for sodium minerals.

INTRODUCTION TO ANALYSIS

Seven sodium mineral development scenarios will be analyzed in this chapter. These scenarios are described in Chapter I. The purpose of the scenarios is to provide a means of analysis and to discuss production possibilities. The Known Sodium Leasing Area (KSLA) could be developed and expanded in several different ways. The scenarios are a means of analyzing the different ways and means this area could develop, in relation to the proposed action and alternatives. Other potential developments within the District are considered through Scenario Seven. Each scenario will be analyzed by the elements of the existing environment (Chapter II). These include Air Quality, Topography, Geology and Mineral Resources, Soils, Water Resources, Vegetation, Terrestrial Wildlife, Aquatic Wildlife, Wild Horses, Cultural Resources, Visual Resources, Wilderness, Recreation, Livestock Grazing, Land Uses, and Socioeconomic Impacts.

Table III-1 shows the various criteria upon which the analysis is based. Basically a plant and mine site including ancillary facilities, encompasses 2,060 acres with an average of 1,200 acres taken by the tailings ponds. The plant facilities consist of the plant buildings, warehouses, storage facilities, stockpiles and change houses. A more detailed description of these facilities is included in Appendix 3. The scenarios below describe various potential developments; Appendix 8 includes detailed descriptions of the market and development conditions under each scenario. Some of the parameters projected under each of these scenarios are shown in Table III-1.

Analysis of the alternatives, including the proposed action has been made under the applicable scenarios. The short term in this analysis is 1990, or the period of time through which current BLM planning would be in effect. For the purposes of this analysis, the long term is 20 years, or the year 2000.

ASSUMPTIONS

1. Production levels and expansion levels would be as described in Chapter I.

   a. Normal expansion to 11.4 MTPY.

   b. Accelerated expansion to 13.4 MTPY.

   c. Moderate level of production to 13.4 MTPY.

   d. High level of production to 15.4 MTPY.

2. For analysis, the average acreage encompassed by tailings ponds for each plant site including existing pond is 1,200 acres.

3. It is assumed that new ancillary facilities would be necessary for all scenarios. Rights-of-way (ROW) would be issued for new facilities that traverse public lands. The average acreage disturbance figure for ancillary facilities, including existing facilities for the purpose of analysis, is 440 acres.

4. Plant and mine sites average 420 acres of disturbance each, this includes existing facilities.

5. The acreage/animal unit months (AUMs) figure utilized for analysis is 15 acres/AUM.

6. Solution mines are assumed to encompass 500 acres and 300 acres for the plant site. Ancillary facilities cover 500 acres.

7. It is assumed that sodium bicarbonate would be produced from trona from a new mine. These impacts are incorporated in the general analysis and not analyzed separately.

Table III-1

PARAMETERS OF SODA ASH
PRODUCTION BY SCENARIO

	Existing	Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5		Scenario 6		Scenario 7	
		1990	2000	1990	2000	1990	2000	1990	2000	1990	2000	1990	2000	1990	2000
U.S. Soda Ash Market in Million Short Tons															
Total Domestic Plus Exports	8.6	11.9	17.7	11.9	16.0	11.9	17.7	11.5	16.0	11.5	16.0	11.5	16.0	*	*
Wyoming Plants' Supply of Demand	6.8	10.4	15.4	10.1	13.4	10.3	15.4	9.7	13.4	9.7	13.4	9.7	13.4		
(% of U.S. Production)	(79%)	(87%)	(87%)	(85%)	(84%)	(86%)	(87%)	(84%)	(84%)	(84%)	(84%)	(84%)	(84%)	*	*
Wyoming Soda Ash Production in Million Short Tons															
Existing Plants1/	6.8	10.4	13.4	10.1	13.4	10.3	13.4	9.7	13.4	9.7	11.4	9.7	11.4	*	*
New Plants	--	--	2.0	--	--	--	2.0	--	--	--	2.0	--	2.0	--	0.43/
TOTALS	6.8	10.4	15.4	10.1	13.4	10.3	15.4	9.7	13.4	9.7	13.4	9.7	13.4	--	--
Trona Required in Million Tons	12.24	18.72	27.72	18.18	24.12	18.72	28.629/	17.66	25.029/	17.66	24.12	17.66	25.029/	--	0.72
Employment															
Permanent2/	3,835	4,910	6,310	4,910	5,721	5,045	6,405	4,910	5,680	4,910	5,730	5,045	6,100	*	1558/
Construction	1,030	630	--	375	--	785	--	420	--	400	--	550	--	*	4118/
TOTALS	4,865	5,540	6,310	5,285	5,721	5,830	6,405	5,330	5,680	5,310	5,730	5,595	6,100	--	--
Plant Sites in Acres3/															
Existing Plants	1,800	2,150	2,700	2,150	2,700	2,320	2,700	1,820	2,700	1,820	2,500	1,820	2,500	*	*
New Plants	--	--	300	--	--	--	600	--	--	--	600	--	600	*	3007/
TOTALS	1,800	2,150	3,000	2,150	2,700	2,320	3,300	1,820	2,700	1,820	3,100	1,820	3,100	--	--
Tailings Ponds in Acres3/															
Existing Plants	4,000	4,400	6,800	4,400	6,800	4,400	6,800	4,400	6,800	4,400	6,200	4,400	6,200	*	*
New Plants	--	--	1,000	--	--	--	1,300	--	--	--	1,000	--	1,300	*	5007/
TOTALS	4,000	4,400	7,800	4,400	6,800	4,400	8,100	4,400	6,800	4,400	7,200	4,400	7,500	--	--
Ancillary Facilities in Acres Disturbed3/															
Existing Plants/Mines	2,300	1,200	2,800	1,400	2,700	1,400	2,700	1,400	2,700	1,400	2,500	1,400	2,500	*	*
New Plants/Mines	--	--	1,300	--	--	--	3,300	--	2,250	--	1,300	--	3,300	*	8007/
TOTALS	2,300	1,200	4,100	1,400	2,700	1,400	6,000	1,400	4,950	1,400	3,800	1,400	5,800	--	--
Energy Consumption in Million BTUs Per Year 5/															
Existing Plants	46.8	74.9	96.5	72.7	96.5	74.1	96.5	69.8	96.5	74.9	82.1	69.8	82.1	*	*
New Plants	--	--	14.4	--	--	--	14.4	--	--	--	14.4	--	14.4	*	2.97/
TOTALS	46.8	74.9	110.9	72.7	96.5	74.1	110.9	69.8	96.5	74.9	96.5	69.8	96.5	--	--
Water Consumption in Acre-Feet Per Year6/															
Existing Plants	23,287	35,619	45,894	34,591	45,950	35,276	45,894	33,606	45,894	33,606	39,044	33,606	39,044	*	*
New Plants	--	--	6,889	--	--	--	6,889	--	--	--	6,889	--	6,889	*	1,3707/
TOTALS	23,315	35,619	52,743	34,591	45,950	35,276	52,743	33,606	45,894	33,606	45,894	33,606	45,894	--	--

1/Includes Tenneco.

2/Represents direct employment only (Table III-7).

3/Represent company figures and BLM estimates (Table III-5).

4/Rights-of-way for railroads, well, powerlines, access roads, etc.; represent company figures and BLM estimates.

5/Based on 7.2 million BTU per 1 million tons soda ash production (Kostick 1980).

6/Based on Water and Power Resources Service formula: Tons of trona X 0.62 X 1,000 gallons per ton divided by 325,850 gallons/acre-foot.

7/These figures would he in addition to each of the other scenarios; *denotes the numbers could be from any of the other scenarios.

8/Employment numbers represent peak construction and operating crews (Table III-7).

9/Includes additional 0.9 million tons of trona which would not be processed into soda ash (see Chapter 1).

8. It is assumed that a railroad spur to a solution mine/plant south of I-80, would tie into Tenneco's existing rail spur.

SCENARIO ONE

Total Southwest Wyoming soda ash production would reach 15.4 million tons per year (MTPY) by the year 2000. Accelerated expansion of existing plants and existing mines would produce 13.4 MTPY. Two new 1 MTPY plants and mines—one using solution mining and the other using conventional mining techniques—would be developed and in operation by the year 2000. BLM assumes that no Bureau action would be necessary for this scenario to occur.

SCENARIO TWO

Total Southwest Wyoming soda ash production by 2000 would be 13.4 MTPY, and it would be achieved by accelerated expansion of existing plants and mines. BLM assumes no Bureau action would be necessary under this scenario.

SCENARIO THREE

Total Southwest Wyoming soda ash production would reach 15.4 MTPY by the year 2000. Accelerated expansion of existing plants (13.4 MTPY) would be supported by normal expansion of their existing mines (11.4 MTPY soda ash equivalent of trona) and the development of two new mines (1.5 MTPY). The development of a conventional mine (0.5 MTPY) that would free current existing mine production that is being used for other purposes for soda ash. The two new plants and mines (2 MTPY total production) described in Scenario One would be developed and in operation by 2000. In addition, one other conventional mine (0.5 MTPY soda ash equivalent of trona) would be developed, but its production would not be refined to marketable soda ash. BLM assumes it would have to consider competitive leasing under this scenario.

SCENARIO FOUR

Total Southwest Wyoming production by 2000 would be 13.4 MTPY. Accelerated expansion of existing plants would be supported by normal expansion of existing mines (11.4 MTPY soda ash equivalent of trona) and two new solution mines (1.5 MTPY). A new conventional mine (0.5 MTPY) would be developed, freeing for soda ash production existing mine production that is being used for other purposes. BLM assumes competitive leasing would be considered under this scenario.

SCENARIO FIVE

Total Southwest Wyoming production would be 13.4 MTPY by 2000. Normal expansion of existing plants and mines would produce 11.4 MTPY. Two new 1 MTPY plants and mines—one using solution mining and the other employing conventional mining methods—would be developed and in operation by 2000. BLM assumes competitive leasing would be considered.

SCENARIO SIX

Total Southwest Wyoming production would be 13.4 MTPY by 2000. Normal expansion of existing plants (11.4 MTPY) would be supported by some expansion of existing mines (9.8 MTPY), two new solution mines (1.1 MTPY), and two new conventional mines (1.0 MTPY). One of the new conventional mines' production (0.5 MTPY) would not be refined to marketable soda ash. The new 1 MTPY plants and mines described under Scenario Five would be developed and in operation by 2000. BLM assumes competitive leasing would be necessary for this development to occur.

SCENARIO SEVEN

For the purposes of analysis, BLM assumes that a small plant (0.4 million tons) could be developed outside the KSLA, either as a sodium carbonate brine processing plant in the Eden-Farson area or as a plant and mine operation elsewhere in the area of analysis. Development could happen in any of the previous scenarios, and production would be at the expense of new or expanded plant/mine capacities described in the scenarios above. Under this scenario, prospecting would take place and could lead to preference right leasing and even eventually to competitive leasing.

SOLUTION MINES/PLANTS

Since solution mining techniques are experimental, an analysis of the impacts of solution mining is difficult pending further information on surface-disturbing activities and other actions associated with that kind of development. Solution mine plants would be very similar to conventional mine plants of comparable size; thus, BLM assumes that for the purposes of analysis, impacts of solution mine plants would be similar to conventional mine plants (Appendix 8).

Analysis in many instances was based on a worst-case basis to determine the fullest possible extent of an impact on any given resource or land use.

ANALYSIS OF SCENARIOS UNDER ALTERNATIVES

An analysis of the alternatives indicates that particular scenarios could not occur under certain alternatives; thus, the following scenarios are not considered under the respective alternatives: Scenarios Three, Four, Five, and Six under Alternative 1-No Competitive Leasing; and Scenario Six under Alternative 2-No Prospecting.

SUMMARY OF THE IMPACTS OF A TYPICAL MINE/PLANT SITE

The air quality surrounding and downwind from a plant site would be affected by increased emissions of total suspended particulates (TSP), sulfur dioxide (SO_2), hydrocarbons (HC), and carbon monoxide (CO). The biggest impact to air quality from a mine site and related ancillary facilities would be the increased quantities of fugitive dust.

Topography surrounding a plant site would be impacted for the most part by the construction of new facilities which requires leveling, filling, and a general change in contour. Mine sites have fewer surface facilities but still change the topography through construction of surface facilities. Additionally, mine sites are subject to subsidence.

An average plant would process roughly 1 million tons of soda ash from 1.8 million tons of trona mineral produced from a typical mine each year. This mineral is irretrievable; once removed, it would not be replaced.

Soils and vegetation would suffer through surface disturbance for both a plant and mine site. Alteration of the soils' physical and chemical character and erosion due to the loss of vegetation occurs with both plant and mine site installation. In particular, tailings ponds change the character of the soils and vegetation is unable to establish on the extremely alkaline soil. Basically 400 acres of soil and vegetation are disturbed for the average mine site and 500 acres for a plant site. This does not include 1,200 acres for tailings ponds sites which are irretrievable for production with today's technology.

The water utilized by a typical mine and a typical plant is not replaced. Waste water is generally discharged into tailings ponds. Wildlife including aquatic and threatened and endangered species can be affected by both a typical plant and a typical mine. The largest impact is through soils and vegetation losses yielding a loss of forage and wildlife habitat.

The main impact of a typical mine and a plant on wild horses would be a reduction in forage which could cause the animals to move from the affected areas. Roughly 27 AUMs are taken from production by a typical mine and 33 AUMs are removed from production by a typical plant operation excluding the tailings ponds.

Cultural values could be lost or disturbed by a mine or plant. These would have to be evaluated on a site-specific basis. Prior to the installation of either a plant or mine a cultural survey would be required of the acres involved.

A typical plant would affect the visual resources through its general presence and the emissions into the air. A mine would have a lower profile although mine facilities on the surface would be clearly visible.

A plant adjacent to a Wilderness Study Area (WSA) could affect the quality wilderness experience through a reduction in air quality and visual resources. The same may be true of a mine operation.

Recreation could be decreased by the acreages removed by the plant site or mine site (500 acres and 400 acres, respectively).

Livestock would be affected by the removal of 400 acres of forage for a mine site and 500 acres of forage for a plant site. This would result in a loss of 27 AUMs for a mine and 33 AUMs for a plant.

The establishment of a new mine or plant could conflict with other land uses such as grazing, recreation, wild horse, and wildlife use, as well as other future mineral use. Basically this would occur by the removal of the average acreage of 400 acres per mine and 500 acres for a plant, from alternate uses. A typical mine and a typical plant also generate other land uses in the form of ancillary facilities, namely rights-of-way. Pipelines, powerlines, and roads generally encompass 600 acres for a mine site and 800 acres for a plant site leading to a further disruption of soils and vegetation, loss of wildlife habitat and forage, reduction in available AUMs (40 and 53 respectively), increases in fugitive dust, and reductions in air quality.

A plant site would have greater temporary effects on the population by an increase in the work force. An increase in population yields an increase in families requiring housing, schools, and social services.

Upon completion of construction the actual work force would be reduced as fewer employees would be necessary to run the plant.

A mine project would have similar impacts but on a smaller scale since less construction and installation is necessary.

ANALYSIS OF SCENARIOS

SCENARIO ONE

AIR QUALITY

Existing pollutant concentrations of TSP, sulfur dioxide (SO_2), nitrogen dioxide (NO_2), hydrocarbons (HC), and carbon monoxide (CO) would be affected by plant development. Table III-2 gives the annual potential emissions from Tenneco's plant without any emission controls. The Clean Air Act Amendments of 1977 require all new sources with potential emissions of 250 tons or more annually to be analyzed for their impact under the Prevention of Significant Deterioration (PSD). Using this criterion and projected expansions, particulate matter, sulfur dioxide, and nitrogen oxides can be considered as significant emissions from development of sodium in the area.

Using best available control technology for emissions, the construction of two additional plants under Scenario One would result in potentially greater impacts to air quality in the southern portion of the KSLA, especially the Flaming Gorge National Recreation Area (NRA). The Tenneco plant is the most recent facility with the newest emission control equipment. Table III-3 shows the anticipated maximum increments in the ground level concentrations for significant pollutants due to the operation of the Tenneco plant. Also included in Table III-3 are the maximum anticipated concentrations within the area affected by the Tenneco plant emissions, the applicable PSD increment and the National Ambient Air Quality Standards (NAAQS). All anticipated impacts are less than the allowable PDS increments and well below the NAAQS.

Particulate levels at the three existing plants whose annual concentrations for suspended particulates exceeds 60 $\mu g/m^3$ (Chapter II) are due primarily to fugitive dust. Efforts to attain air quality standards at these plants are being made following the Wyoming Department of Environmental Quality (DEQ) nonattainment plan for Sweetwater County. From information contained in the Wyoming nonattainment plan, it appears that particulate levels would approach background levels 5 to 10 miles downwind of the individual plants (Wyoming Department of Environmental Quality 1979a).

In the event of an inversion condition, the situation would become more pronounced. However, predicted concentrations are not available.

A worst-case, 24-hour particulate concentration was modeled by Tenneco as part of its siting application. A northwest wind that would cause emissions from the existing plants to combine with the concentrations occurring in the vicinity of the Tenneco plant was considered, with the assumption of a stable atmospheric condition. The maximum concentration produced under this situation was 92 $\mu g/m^3$ including the background concentration. This level does not exceed the NAAQS of 150 $\mu g/m^3$ for a 24-hour maximum particulate concentration.

TOPOGRAPHY

Subsidence from conventional underground mining operations is expected to be minor over large areas under all scenarios. Localized subsidence of 5 to 6 feet has been measured in area mining operations, but over such large areas that they are not readily noticeable. No cracks or breaks in the ground would be created.

Untried solution mining reportedly would have less possibilities of subsidence than conventional mining due to the formation of structurally sound, domed-shaped caverns. However, tests have yet to be done. FMC, in a plan submitted to the DEQ, projects subsidence of 10 to 30 feet over a 20 to 30-year period.

The plant site grading, some access roads, and railroad spurs would modify the natural topography. Construction and the subsequent use of tailings pond areas would modify the natural topography to essentially flat areas typical of dry lake beds.

Surface-disturbing activities in badland topography would result in the destruction of unique geologic features and would accelerate erosion.

GEOLOGY AND MINERAL RESOURCES

The primary impact on the geology of the area would be the removal of the trona beds and destruction of the overlying strata by plant site construction. Due to conventional underground mining methods, only approximately 50% of the trona in a particular bed can be removed.

The 40 billion tons of trona ore in easily-mineable beds could be refined into about 23 billion tons of soda. Under Scenario One's projected production, those reserves would last approximately 860 years

Table III-2

POTENTIAL ANNUAL EMISSION RATES OF TESTED POLLUTANTS
FOR THE TENNECO PLANT

Tested Pollutant	Potential Emissions* (Tons/Year)
Particulate Matter	99,800
Sulfur Dioxide	13,754
Nitrogen Oxides	3,205
Carbon Monoxide	231
Hydrocarbons	82

Source: Tenneco 1978.

*Total emission rates without emission controls for 1 million short tons per year soda ash production.

Table III-3

MAXIMUM PREDICTED CONCENTRATIONS FROM THE TENNECO PLANT
AND APPLICABLE NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Maximum Predicted Concentration (ug/m^3)	Applicable PSD Increment (ug/m^3)	Maximum Concentration Plus Maximum Baseline Concentration (ug/m^3)	Applicable NAAQS (ug/m^3)
Particulate Matter:				
Annual Geometric Mean	4	19	26	60
24-Hour Maximum	9	37	102	150
Sulfur Dioxide:				
Annual Average	2	20	7	80
24-Hour Maximum	1	91	19	365
3-Hour Maximum	4	512	22	1,300
Nitrogen Oxides:				
Annual Average	8	Not Applicable	27	100

if the demand would stabilize after the long term. The cumulative loss/use of trona would be about 161.38 million tons in the short term and 397.18 million tons in the long term.

The conflicts between trona development and the oil and gas and oil shale industries would be 30% greater than current conflicts because of the new mine/plant operations.

Sand and gravel would be consumed for various transportation and plant facilities construction. Suitable sources would have to be located and pits developed, on both private and public land. The amount of material to be used cannot be approximated at this time.

Potential conflicts exist between trona operations and the exploration and development of other mineral resources, i.e., oil and gas, oil shale, etc. Certain activities may be incompatible with present operations, and may preclude other activities indefinitely.

Nonrenewable fossil fuels (coal, natural gas, etc.) would also be used for processing (Table III-1).

PALEONTOLOGY

Few paleontological surveys have been done in the sodium development area. The most recent survey was done in 1980 in conjunction with the MAPCO pipeline project. Several fossils were uncovered during the excavation of the pipeline trench. The possibility exists that during the construction of new plants, sinking of mine shafts, and installation of ancillary facilities, fossils would be uncovered. The number and type of fossils disturbed would be determined only as the fossils are uncovered.

SOILS

GENERAL

Main impacts on the soil are relative to surface disturbance and the resulting erosional damage. Disturbances include alteration of the soil's physical and chemical character as well as lack of surface protection due to vegetation loss. Removal of the surface soil by erosion is an irreversible resource loss. Damage to the remaining site, however, is not necessarily permanent or unreclaimable.

Site construction (including mine, mill, processing plant, tailings ponds, sewage treatment, sanitary landfills, and their associated services) is responsible for the major portion of soil damage. This can be managed for and consequently minimized.

The Wyoming DEQ (Land Guideline #3, 1976) has illustrated how soils can be rated as to their suitability for topsoil. A "good" topsoil has characteristics favorable to the establishment and growth of adapted plants.

With respect to topsoil sources necessary for rehabilitation work, the BLM manual has a table which illustrates suitability (Table III-4). If removal of soil will cause severe erosional damage and revegetation problems, the site is not considered suitable.

Sand and gravel sources are by nature serious reclamation problems. As with stockpiles, borrow areas can be developed to control the erosion problems common to cut and fill slopes.

The design and materials used for buildings, roads, and other construction purposes offers some flexibility as far as impacts imposed. Permanent foundations may not be necessary for all structures if a substantial surface can be constructed without the use of reinforcing steel and concrete. The less permanent the construction, the greater the reclamation success.

The second largest proportion of soil damage is due to access. This includes roads, railroad spurs and other ROWs, as well as prospecting and exploration activity.

Soil compaction, loss of vegetation, and visual degradation are major impacts which access produces. Though a variety of access is required, unplanned and unwarranted access promotes needless resource damage.

All landscapes, regardless of soil type, have multiple depressions of various magnitude. These depressions collect soil fines of a diverse nature. Silts, clays, and very fine sands have extremely low strengths when saturated with water. Clays actually have shear planes upon which they can slip and give away. Any pressure (vehicles, structures, equipment, etc.) on these wet soils would have the potential of causing slippage, distortion and failure to support a weight. The subsequent structural loss to the soil body would result in waterlogging, increased channel erosion, potential gullying, and decreased reclamation success.

An irreversible change in soil character would occur in the areas used for tailings ponds. Playas are frequently used for waste disposal since they are depression areas considered to be of very poor soil quality. The soils in playas contain sufficient salts to prevent most vegetative growth. However, in addition to providing wildlife and stock with an ephemeral water hole, playas serve as natural sediment basins and holding ponds for runoff.

Table III-4

SUITABILITY RATINGS FOR SOILS AS SOURCES OF TOPSOILING MATERIAL

Soil Characteristics	Degree of Soil Suitability: Good	Fair	Poor	Unsuitable[5]
pH[1]	6.0 - 8.4	5.5 - 6.0 8.4 - 8.8	5.0 - 5.5 8.8 - 9.0	Under 5.0 Over 9.0
Conductivity (Ec) mmhos/cm @ 25°	Under 4	4 - 8	8 - 16	Over 16
Saturation Percentage (SP)	25 - 80		Over 80 Under 25	
Texture class	sl, l, sil, scl	cl, sicl, sc, ls	c, sic, s	
Sodium Adsorption Ratio (SAR)	Under 6	6 - 10	10 -15	Over 15
Calcium Carbonate[2]	none - slight (0 - 15%)	moderate (15 - 30%)	high (Over 30%)	
Moist Consistence	friable	loose, firm	very firm	
Dry Consistence	loose, soft	slight hard, hard	very hard	
Selenium[3]	2 ppm or less		greater than 2 ppm	
Boron[4]	5 ppm or less		greater than 5 ppm	

1/ Saturated Soil Paste, U.S.D.A. Handbook 60, pg. 102.

2/ Effervescence with acid or $CaCO_3$ equivalent, U.S.D.A. Handbook 60, pg. 105.

3/ Hot water soluble, A.S.A. Mono #9, Part 2, pgs. 1122-23.

4/ Hot water soluble, A.S.A. Mono #9, Part 2, pgs. 1062-63.

5/ Establishment of vegetation on soils having any of these extreme conditions would be severely restricted.

Chemical analysis of playa soils shows that they have naturally higher than normal amounts of salts and heavy metals due to the concentrating character of basins (Texasgulf 1977). Lead, mercury, and zinc are concentrated in higher quantities than the "average" of many soils, while boron, selenium, and fluorine are concentrated higher than the range of many soils.

As playas are filled with industrial wastes they would no longer be available for runoff storage, sedimentation, watering animals, or as salt and heavy metal sinks.

The caustic nature of the trona production tailings would result in permanent soil modification. The concentrations of chemicals used in the mine process (i.e., cyanide) and the trona residues (i.e., fluoride) released, combined with the extreme alkalinity, would render the site incapable of growing any vegetation.

Soils subjected to accidental or operational spill would be similarly impacted.

The effects of particulates from tailings ponds and stack emissions on soils is primarily the result of vegetation loss downwind. Vegetative cover is the only protection soils have from the erosive forces of wind and water.

The concern of fluorine emissions affecting vegetation is not substantiated by soil analyses. The Colorado School of Mines Research Institute has found up to 768 parts per million (ppm) fluorine within the top six inches of an undisturbed playa soil, which which is more than double the range of many soils. An undisturbed sandy loam is found to have 544 ppm fluorine in its surface layers, which is twice the average for many soils. This is primarily due to the chemical makeup of the Bridger Formation which is the major soil source here. The Bridger and Green River Formations have andesitic tuffs (see Glossary) and fluorapatites (see Glossary) derived from the Absaroka igneous activity. The tuffs have been analyzed as having 600 ppm fluorine, while the fluorapatites are analyzed at 100-7,700 ppm fluorine (Geological Survey 1969). The naturally occurring fluorine content of the soil surface, therefore, is unusually high. The effect of fluorine compounds on vegetation downwind is not known at this time.

In considering the tailings, spills, and emissions of a trona operation, the potential for sodium increases on the soil surface could be great. When mixed with water (rain or snow) sodium acts as a dispersant to soil particles. A medium to fine textured soil, dispersed and dried, takes on massive structure. Seeds and plant roots have a difficult time trying to grow in the crusted, solid mass which results. Sheet erosion would be increased by the decreased permeability of the soil surface. When wetted, sodium-affected soils demonstrate loss of bearing capacity. They become slippery, more erodible, and less able to support a load.

As far as the effects of the *in situ* mining process on soils, all previously mentioned impacts apply. The major difference is the magnitude of the disturbances. At worst, the loss of vegetation and natural drainage would cause increased soil erosion (sedimentation, pedestalling, sheet erosion, rill, gullying, etc.), wind erosion (droughtiness, dust storms, soil loss); water logging (puddling, ponding, crusting, concentrating of salts, massive structure, etc.); and visual degradation. The area would be extremely difficult to rehabilitate; and it may never occur naturally.

SCENARIO ONE SPECIFIC IMPACTS

The severity of impacts from expansion of existing plants is a result of the type of material underlying the plant sites.

The Stauffer plant and mine is underlain by soils designated as No. 34 and No. 8 on the general soil map (Map II-2). As can be seen from the general soil map legend in Chapter II, layers of strongly alkaline soil will restrict revegetation success unless topsoil is stockpiled or brought in from a suitable source. The fine soil texture and slow permeability in this area can lead to severe water erosion hazards. In the southern part of the Stauffer site there are many gravelly and rocky areas. The potential for gravel sources here is high. The chances for reclamation success is low, due to droughty conditions.

The Allied plant site is underlain by the No. 28 soil unit. Droughtiness will again limit revegetation, as there are some gravelly soils here. There is also a high potential for wind erosion in a few of the finer textured soils here.

Texasgulf has its plant site on a No. 14 soil unit. This area has a great deal of sandy soil which has a high potential for wind erosion when the surface is stripped. Revegetation could be difficult due to the droughty conditions and "sand-blasting" effects.

Tenneco's plant and mine site is located on the general soil mapping unit No. 28. The impacts related to this site are the same as the Allied Co. plant site mentioned above.

The Granger area, which is a potential site for a new conventional type plant and mine, is underlain by soils similar to those under the Tenneco and Allied plant sites.

The McKinnon area, which is a potential site for a new solution mine and plant, has soils similar to those at the Texasgulf site.

The relationship of the various types of soil impacts is one of permanency. The impacts from ancillary facilities and ROW can be considered short term (5-10 years rehabilitation time), while impacts from tailings ponds are permanent. The long-term effects of plant and mine sites are expected to impact an area 25 to 50 years after abandonment. Acreages for these impacts are listed in Table III-5.

WATER RESOURCES

GROUND WATER

Development of the trona deposition area would likely lead to some degradation and consumption of ground water reserves primarily during prospecting, exploration drilling, mine shaft development, drilling of solution mining wells, and during mining operations.

Although ground water quality under most of the area is considered poor for most uses (Chapter II), isolated aquifers of good quality may exist in some locations. Contamination of these localized aquifers is possible via interformation mixing during drilling and mining processes. Such possibilities would increase dramatically with the advent of commercial production solution mining facilities.

The use of solution mining techniques would increase the possibility of contamination of ground water from the mining solution, the precise composition of which is unknown at this time. Contaminants from the solvent would most likely consist of sodium and other salt compounds and long-chain hydroxides.

The disposal of waste water, runoff from plant and mine facilities, and tailings via impoundment on the surface represents another potential source of ground water contamination through seepage.

Additional impacts associated with ground water other than interruption or contamination of an aquifer by mining and/or drilling would be withdrawals for plant operations and solution mining. Due to the generally poor quality of most of the ground water in the area; however it is anticipated that the primary source of withdrawal would be surface reservoirs or streams.

Little data exists for this region to adequately summarize water quality for the different aquifers; however, the Tipton Shale Member of the Green River Formation and isolated pockets of alluvium have potential for beneficial use.

Development and expansion of both convention and solution mines pose the greatest risks to aquifers above the trona beds in concern. Special care must be taken to protect these aquifers during all operations.

Extraction of soda ash from the sodium carbonate brine waters found in the Eden-Farson Valley would create additional possibilities for ground water contamination similar to those addressed above.

Accelerated expansion of existing operations in the area would increase the likelihood of contamination and/or consumption of ground water reserves. Ground water withdrawals for mine and plant operations are insignificant at this time and it is anticipated that they will remain so. The extent of possible degradation of ground water quality is dependent on specific problems and conditions present in the area of development and thus must be analyzed on a case-by-case basis.

Development of a commercially productive solution mine would greatly increase possibilities for ground water contamination due to the processes involved. Again, attempts to quantify such impacts can only be done on a case-by-case basis.

SURFACE WATER

Alterations of the natural drainages for construction of tailings and containment ponds, new plants, associated ancillary facilities, and new mines (including development of wells and appropriate injection and recovery systems necessary for solution mining) could cause significant general and local effects on the geomorphology and hydraulics of the area's stream system.

Additional blocks of land would be tied up in containment and tailings ponds as development continues. Seepage or failures of the ponds could contaminate waters in the area.

Scenario One. The accelerated expansion of existing mines and plants would result in further deterioration of surface water quality, primarily due to increases in surface disturbing activities.

The amount of waste water produced would also increase necessitating larger tailings ponds and subsequent commitments of land area.

Development of two new mine/plant operations would require additional water commitments, disturb additional acreages, and further aggravate the above situation. Consumptive use of water would increase as shown in Table III-1.

VEGETATION

There are four types of vegetational impacts which are dependent on the amount of industrial development (Table III-5). Vegetational impacts can be classified into four categories:

(a) Removal and destruction of vegetation during construction along ROW to be reseeded with native seed immediately following completion of construction will result in short-term losses to the ecosystem. Vegetative cover is usually established 5 to 10 years after seeding with a return to the present stable community over a 20 to 50-year period.

(b) Removal and destruction of vegetation due to the construction of buildings and ancillary facilities. These areas are considered long-term losses for the life of the soda ash plants. Reseeding will take place at the end of the plant's operation with a return to a stable plant community expected to take another 20 to 50 years.

(c) There is a permanent loss of vegetation in areas in which tailings ponds are constructed. At this time reclamation of tailings ponds is in the beginning experimental stages, the results of which will not be known for some time. Therefore, this vegetation cannot realistically be expected to be returned to the ecosystem, especially as it was before pond construction. This assumption is based on the fact that the tailings are an extremely concentrated caustic waste upon which no living thing can survive (pers. comm., Dorn 1980; Tenneco Permit to Mine 1978, Colorado School of Mines Research for Texasgulf Soda Ash Project 1977). At some point in the future methods of reclamation may be developed, but the vegetation communities are not expected to return to present structure.

(d) The fourth impact to vegetation is based on initial observations of deteriorating plant communities in close proximity and downwind of the processing plants (Wyoming Game and Fish Department 1973, Lundberg 1977, Barth 1980). Although little substantive work has been done, it is assumed that the deterioration seen in sagebrush communities is due to caustic fallout from particulate emissions. The current operating companies could not furnish an analysis of the particulate emissions but estimated that 85% TSP is sodium compounds ($Na_2CO_3{\cdot}NaHCO_3$, raw trona) and the other 15% is insoluble matter such as clays and other impurities (pers. comm., Rondeau 1980, Scroggins 1980, Stocker 1980, Peverly 1980). Other monitored emissions (SO_2, NO_2) are not of significant levels to affect the vegetation.

There may be a possibility that hydrofluoride, a very toxic chemical to plants, may also be involved in plant community degradation, Love (pers. comm., 1980) indicated that the underlying clay taken up with the trona contains a high level of fluorine. No specific analysis has been done for fluoride emissions; however, one company has stated that fluoride is present in the product of both the monohydrate and the sesquicarbonate soda ash process. They feel contaminants in the product are representative of the plant emissions. Because of the lack of research done on this problem, it is assumed that the sodium compounds are the causal agents involved in the deterioration of the plant communities.

Sodium is toxic to vegetation in varying degrees. Some plants, saltbush and shadscale, have evolved with a high tolerance to salts. The plants (saltbush, etc.) would be found in areas where sodium builds up in the soils, causing the more sensitive plants, sagebrush and some grasses, to die out.

Studies have also shown that as sodium builds up in soils, it reaches a maximum concentration, above which there is a deterioration of the soil structure (Goodin 1977).

Associated with the breakdown of the soil structure is reduced infiltration of water and increased erosion (Richard 1954). The reduction of available water limits plant growth and germination.

Therefore, based on a few observations the concentration of sodium compounds in the emissions (pers. comm., Peverley, Scroggins, Rondeau, Stocker 1980), and other studies on the effects of sodium (Lundberg 1977, pers. comm., Barth 1980), it can be postulated that there would be changes in the present communities. There is, also, a possible vegetation loss in areas downwind of the facilities. These effects would be particularly noticeable in the nonalkaline, sagebrush areas.

The fourth impact, plant community deterioration due to fallout, cannot be quantified at this time but would be expected to increase with expansion of existing facilities and the development of new plants and mines.

TERRESTRIAL WILDLIFE

THREATENED AND ENDANGERED SPECIES

The construction of additional soda ash production facilities is not likely to have an adverse impact on potential peregrine falcon habitat along the Green River. Disturbance of wintering bald eagles could occur if new facilities impacted the immediate vicinity of the Green River. Any disturbance of prairie dog towns, which occur sporadically throughout

Table III-5

ACRES AFFECTED BY TYPE OF DISTURBANCE/SCENARIO

	Current Disturbance	Total Disturbance Due to Existing Plant Expansion By 2000	New Disturbance Due to New Conventional Plants Plants and Mines	New Disturbance Due to Solution Plants and Mines	New Disturbance Due to Black Water Development	Total Disturbance
Scenario One						
A. Plant Sites	1,800	2,700	300	300	--	3,300
B. ROWs/Ancillary Facilities	2,300	2,800	500	800	--	4,100
C. Tailings Ponds	4,000	6,800	500	500	--	7,800
Scenario Two						
A. Plant Sites	1,800	2,700	--	--	--	2,700
B. ROWs/Ancillary Facilities	2,300	2,700	--	--	--	2,700
C. Tailings Ponds	4,000	6,800	--	--	--	6,800
Scenario Three						
A. Plant Sites	1,800	2,700	300	300	--	3,300
B. ROWs/Ancillary Facilities	2,300	2,700	1,300 1/	2,000 2/	--	6,000
C. Tailings Ponds	4,000	6,800	800 3/	500	--	8,100
Scenario Four						
A. Plant Sites	1,800	2,700	--	--	--	2,400
B. ROWs/Ancillary Facilities	2,300	2,700	250	2,000	--	4,950
C. Tailings Ponds	4,000	6,800	--	--	--	6,800
Scenario Five						
A. Plant Sites	1,800	2,500	300	300	--	3,100
B. ROWs/Ancillary Facilities	2,300	2,500	500	800	--	3,800
C. Tailings Ponds	4,000	6,200	500	500	--	7,200
Scenario Six						
A. Plant Sites	1,800	2,500	300	300	--	3,100
B. ROWs/Ancillary Facilities	2,300	2,500	1,300 1/	2,000 2/	--	5,800
C. Tailings Ponds	4,000	6,200	800	500	--	7,500
Scenario Seven						
A. Plant Sites	1,800	4/	4/	4/	300	2,100 5/
B. ROWs/Ancillary Facilities	2,300	4/	4/	4/	500	3,100 5/
C. Tailings Ponds	4,000	4/	4/	4/	500	4,500 5/

1/ Acres affected by ancillary facilities are estimated to be 400 for a mine and 500 for a mine/plant operation.

2/ Acres affected by ancillary facilities are estimated to be 600 for a mine and 800 for a mine/plant operation.

3/ Represents tailings pond disturbance for new plant only.

4/ This scenario would occur concurrently with any of the above scenarios.

5/ Total for new plant/mine and the current disturbance; add new disturbance created by any of the above scenarios for an estimate of the total impact.

the KSLA, would adversely impact potential black-footed ferret habitat.

MAMMALS

Direct impacts would be the loss of habitat including crucial wintering habitat, disruption of normal use patterns, and death or injury of individual animals due to vehicular traffic and various forms of human harassment (see Glossary). Losses of habitat due to developments under this scenario would include about 5,500 acres of pronghorn crucial winter habitat in the trona deposition area, or about 3% of antelope crucial winter habitat in that area. Forage requirements for wildlife species occurring in the area were documented in a BLM Wyoming Instruction Memorandum (WY-81-68) as follows: antelope, 74 pounds per month; deer, 103; elk, 374; and moose, 1,652. Big game summer habitat that would be lost are identified by scenario on Table III-5. Normal movement patterns would be disrupted by fencing, production plants, and tailings ponds.

Indirect impacts, especially to the crucial wintering habitat, would be changes in use patterns, possibly resulting in new demands being placed upon the crucial wintering habitat which would make it less productive during crucial periods. An estimated 86 wintering antelope would be displaced by development under this scenario. Impacts on wintering deer cannot be quantified, but less impact than that to antelope would be anticipated.

BIRDS

There would be adverse impacts resulting from the loss of habitat and the displacement or loss of individuals.

Tailings ponds pose a hazard to migrating waterfowl that use the ponds as resting areas (Table III-6). After approximately one hour in these ponds, salt crystallization render the birds incapable of flying. Death eventually results due to exposure. Anticipated increases in tailings ponds under Scenario One could result in the loss of 90 to 100 birds annually.

Beneficial impacts would result as new water sources are developed such as sewage lagoons or water wells from prospecting, exploration, etc.

Road-killed prey of various types often result in an artificial concentration of raptors along roads. Those raptors would be exposed to vehicular traffic hazards.

Disturbance of raptor nesting areas during the nesting season, especially along the Green River, could result in nest abandonment.

Powerlines would cause the death of birds by impact when, in flight, the birds hit the lines. Powerlines placed too close together would allow large birds to contact both lines simultaneously, grounding out the lines electrocuting the birds.

AQUATIC WILDLIFE

The proposed action would have limited adverse impact on the quality of habitat of aquatic wildlife under all scenarios. Habitat degradation would primarily result from water consumption and reduced stream flows during summer and fall. The primary aquatic habitat reduction anticipated would be related to reduced stream flows associated with increases of up to 130% in the amount of surface water usage and withdrawals from the Green River, as noted in Table III-1. This would result in lower base flows, on 40 miles of the Green River below Big Island, later in the season, leading to reduced instream fish cover.

Sodium related flow reductions would amount to 70-80 cubic feet per second (cfs) or about 26% of the estimated 300 cfs "survival flow" for the Green River trout fishery. These withdrawals could create significant limitations to perpetuating the rivers' trout fishery during periods of low flow especially during drought years and in the late summer or fall.

This could lead to increased eutrophication (see Glossary) of the Green River and Flaming Gorge Reservoir as well as the reduction of instream fisheries habitat quality.

The greatest impact to aquatic wildlife would result from increased industrial water demands coupled with low stream flows. Presently there are no minimum stream flow standards for the Green, Blacks Fork, or Hams Fork rivers. Without such standards as established by the State Engineer, water demands during low flow periods could result in limiting flows for the various cold water aquatic wildlife species.

The Wyoming Game and Fish Department (pers. comm., 1980) has expressed concern that post-larvae and young-of-year fish could be entrained and/or impinged on water intake structures.

Additionally, if stream flows are reduced, sedimentation of stream channels would lead to a greater production of rooted aquatic plants in mid-summer through fall. The production of increased quantities of aquatic plants and the warmer water temperatures at low flows could also lead to re-

Table III-6

SODA ASH COMPANY REHABILITATION PROGRAM MIGRATORY BIRD RECOVERIES AND LOSSES

Year	Birds Recovered	Number Mortalities
1976	175	10
1977	222	7
1978	1,142	124
1979	515	40
TOTALS	2,054	181

Source: U.S. Fish and Wildlife Service (1980). Three companies have programs.

duced oxygen levels when biological oxygen demands (BOD) increase.

Increases in sedimentation could result from various surface-disturbing activities. Increased turbidity levels would reduce penetration of light and thus reduce the production of aquatic plants which are the bases of the aquatic food chain. As a result, basic riverine productivity could be reduced between 25-75%, depending on the degree of turbidity created. Further, increased dissolved solids could result from soda ash fallout, seepage from or failure of tailings ponds, and surface runoff from plant site and transportation routes. This increase could compound the eutrophic condition developing in the rivers and reservoir surrounding the Flaming Gorge, thereby reducing the quality of aquatic habitat for game fish and recreational use of the reservoir.

WILD HORSES

Increased human activity would result in an indeterminable loss in the wild horses' range due to an area becoming unsuitable to them. This increased activity could result in an increased harassment (see Glossary) to the wild horses that could cause a decrease in population, especially if it occurred during the spring foaling season (April to June). This could happen if the wild horses were crowded into a smaller area where there was greater competition for forage, water, and space.

Wild horses seem to react to different types of human activity in various ways. In most cases they will react to short-term activity by leaving the vicinity for the duration of the activity. This displacement would become permanent if facilities for mining and treatment are developed. Currently there are 184 horses in the sodium development area. The projected future management levels for this area is approximately 53 horses. This is roughly one-third of the horses present in the area to date. Fifty-three horses would require 636 AUMs per year, roughly one-third of the number of AUMs currently needed and available to support the existing herd level of 184 horses.

Provided the management level of 53 horses is achieved, disturbance from the plants, mines, and related facilities could increase greatly, perhaps as much as three times the existing loss of 540 AUMs, before having an effect on the amount of forage needed to sustain the herd.

SCENARIO ONE

Table III-5 shows the acres disturbed by mines, plants, and related facilities for each scenario. Accordingly, the acres disturbed under the projected developments for Scenario One would not be enough to effectively impact the amount of forage (loss of 473 AUMs); therefore, the necessary number of AUMs to support the herd would not be affected. It is possible that in the areas to be developed under this scenario there are no horses; thus, there would be no direct impact on the herd.

Use of water sources for prospecting and development operations would adversely affect the wild horses if water were not available during the summer and fall. Surface disturbance would also adversely impact the wild horses due to a loss of forage.

In general prospecting is not expected to have any major adverse impacts on wild horses. However, unfenced mud pits could have an adverse impact as well as brine pits and tailings ponds for mining operations.

Benefits to wild horses through the discovery of new water sources are indeterminable as it is not known if the wild horses would use the waters.

CULTURAL

Cultural resources could be severely damaged or destroyed by a number of activities associated with the construction of the soda ash operations. The most obvious loss would be through various types of dirt work associated with mineral exploration and retrieval and with construction of new facilities and access. Improving old roads and building new roads into previously inaccessible areas would probably lead to increased vandalism of cultural resources.

On occasions, operators have uncovered previously unknown archeological and paleontological sites and reported them to authorities.

The presence of a trona processing plant would add unpleasant sights, sounds, and smells to the natural surroundings that would harm the integrity of setting, feeling, and association of sites. This would be an important consideration with resources such as historic trail routes and historic structures. It would reduce the potential of such sites for nomination to the National Register of Historic Places.

Dirt work and construction could easily cause loss of unidentified sites.

Increased human activity in those areas could result in increased ORV usage with possible destruction of archeological and historic sites.

VISUAL RESOURCES

Visual resources would be vulnerable to any sodium development, especially under those scenarios projecting new plant development. Scenarios One, Three, and Six would result in the greatest conflict and impacts, especially on the visual values of the Flaming Gorge NRA, the WSAs, and public viewing areas along existing roads.

Impacts from sodium development would occur to landform, vegetation, structural changes, and air quality. Under Scenario One, 14,900 acres of lands classified as VRM Class II and III could be downgraded to Class III and IV.

WILDERNESS

Stack emissions and dust could be transported to the three WSAs by wind currents, thereby degrading the units' air quality.

The Devils Playground-Twin Buttes WSA (WY-040-401/402; 24,276 acres) in the southeast portion of the trona deposition area would be affected under Scenarios One, Three, Five, and Six by any northerly wind. The preferred area for solution mining and subsequent soda ash plants abut these WSAs and development in that area could easily degrade the units' air quality, scenery, and other wilderness values. The Buffalo Hump WSA (WY-040-306; 10,300 acres) abuts the sodium carbonate brine area, and any development in that area could result in stack emissions and dust via prevailing westerly winds that would affect the wilderness values of the Buffalo Hump WSA and the adjacent Sand Dunes WSA (WY-040-307; 27,200 acres).

BLM interim management policy on WSAs requires protection of identified wilderness values.

RECREATION

Warder's study (1975) of the impacts associated with coal development in the region is applicable to sodium development. The major impacts on recreation from further sodium development would be decreased availability of lands for recreational purposes because of plant development and increased recreation activities as a result of increasing regional populations and associated incomes. The result of those impacts would be greater pressure on the remaining recreation resources for various activities, although new and improved access into areas would enhance the opportunities for recreational experiences in those areas. The greater the development, the greater the impact on recreation.

Noise, visual disruption, and odors associated with soda ash operations and associated ROW would reduce or eliminate the desirability of an area for recreational purposes. This could result in lowering the recreational experience especially in the Flaming Gorge NRA and along the Green River.

Occupation of certain areas (plant sites, tailings ponds, sewage treatment ponds, etc.) would make simultaneous recreational use impossible.

Increases in local population because of increases in soda ash operations would result in greater demands at recreational sites and, in many instances, would reduce the quality of the recreational experience due to the increase in demand.

This would be especially true of developed sites, although the increase in recreational use would also reduce the opportunity for solitude and thus place additional pressure on designated wilderness areas.

Plants would draw additional water from adjacent rivers, lowering stream flow and thus reducing recreational opportunities on rivers affected.

LIVESTOCK GRAZING

Adverse impacts to livestock and rangelands come about from many indirect forms. Primarily it is the disturbance to their use patterns and a loss of forage that causes the greatest impact. Use patterns are upset and forage that would be available to them is lost when water is not available, traffic or human activity increases to the extent that they are driven from an area, or surface disturbance results in a loss of topsoil among other things.

Prospecting under all scenarios is not normally expected to have a major impact on the livestock and the rangelands except as mentioned below.

In prospecting and development operations, the use of water from springs, reservoirs, and weak water wells would adversely affect livestock by reducing the availability of water during the grazing season. Surface disturbance from the construction of pipelines and ancillary facilities would adversely affect livestock and rangeland due to the fragile soils, low rainfall, and the resultant vegetation that would invade the area. Halogeton (*Halogeton glomeratus*) is the most prolific invader of disturbed sites and can be poisonous to sheep. Muenscher (1962) reports that "... 1 1/2 pounds of the green plant is sufficient to kill a sheep." Russian thistle or tumbleweed (*Salsola kali*) is another invader of disturbed areas and generally has a low forage value. These disturbances would cause a loss of topsoil from wind and water actions.

Loss of critical spring grazing areas due to development of mining operations and ancillary facilities would adversely affect the permittees' year-round livestock operations. These would also adversely impact lambing operations in the spring as well as cause a loss of winter sheep grazing areas.

Damage to fences, cattleguards, and gates could occur as a result of prospecting and development operations. Livestock losses could also result from leaving tailings ponds, mud pits, or brine pits unfenced.

Benefits to livestock and grazing operations could occur from exploration and development operations discovering and/or constructing and providing new water sources.

More land would be taken out of production for range operations. This would result in an estimated long-term loss of 1,013 AUMs under Scenario One, including the 540 AUMs removed from production by the existing operations.

LAND USES

The area's land use would be converted from agricultural to industrial in the acreages shown in Table III-1.

SOCIOECONOMIC IMPACTS

Rock Springs and Green River have already started gearing up private and public facilities to accommodate incoming residents who have found employment in mining and energy related developments. Impacts from additional soda ash development in these areas would be somewhat diluted due to the developed nature of these communities. Housing and school facilities remain as areas of major concern for Rock Springs city officials and Sweetwater County School District No. 2 in Green River (Casper Star-Tribune 1981). Many construction workers for the Tenneco Soda Ash Project already reside in the area, and peak construction workforce is expected in the summer of 1981. Population, housing, and school enrollment impacts can be expected to be distributed throughout Rock Springs, Green River, and the Bridger Valley as shown in Chapter II—soda ash industry employees residence distribution.

EMPLOYMENT, POPULATION, INCOME

Tables III-7 and III-8, respectively, show the primary and secondary employment and population resulting from construction and operational work force associated with the soda ash industry. The 1980 construction and operational work force in population is equal for Scenarios One through Six. Total direct employment would increase 30% from 4,856 in 1980 to 6,310 in Year 2000 for Scenario One. Total primary and secondary employment resulting from the soda ash industry in Year 2000 is projected at 9,781, and a population increase of 7,158 residents, or 40% from 1980, is expected. Total direct, indirect, and induced personal income of residents in the region under Scenario One is shown in Table III-9.

HOUSING, SCHOOLS, SERVICES

Table III-10 shows the housing and school enrollment requirement per scenario for soda ash industry employees. Total housing requirements to accommodate soda ash industry employees is estimated at 5,975 units in 1980. This represent 32% of the 1980 housing units available in Sweetwater County as reported by the Bureau of Census (1980 Census of Population and Housing). Total housing requirements for soda ash industry employees are expected to increase to 8,044 units, or 44% of 1980 Bureau of Census estimates for Sweetwater County by the Year 2000 for Scenario One. The additional housing units distribution would be expected throughout Rock Springs, Green River, and the Bridger Valley in similar proportions to current employee distribution of 56%, 23%, and 18%, respectively, with the remaining 3% in other places. Even with the more developed nature of Rock Springs and Green River, mobile homes could be expected to make up a significant portion of new housing requirements.

Additional school enrollments of 3,071 students, or 48% of 1980 soda ash industry-related school enrollments, could be expected from Scenario One.

School districts have requested financial assistance to cover a portion of the costs accrued from new student enrollments, as shown by the proposed Texasgulf expansion (Green River Star 1981). Additional strain would be placed on private and public services. Rock Springs has constructed a new sewage treatment facility, which is already operating at full capacity; and Green River currently needs a new sewage facility. New residents would require additional health and recreational facilities.

TAXES, PUBLIC REVENUE

Table III-11 shows the severance tax, *ad valorem* production tax, and *ad valorem* property tax that could be produced if a given scenario would develop. Severance tax and *ad valorem* production tax is expected to increase 222% from $6.0 million and $7.8 million in 1980 to $19.3 million and $25.1 million, respectively, in Year 2000 for Scenario One. Additional tax revenues would be generated from sales tax on goods and services purchased locally

Table III-7

DIRECT AND INDIRECT EMPLOYMENT IN THE SODA ASH INDUSTRY PER SCENARIO

Scenario One	Existing 1980	1985	1990	1995	2000
Direct Construction Employment1/	1,030	195	630	375	-
Indirect and Induced Employment from Construction2/	464	88	284	169	-
Direct Operational Employment3/	3,835	4,590	4,910	5,515	6,310
Indirect and Induced Employment from Operations4/	2,109	2,525	2,701	3,033	3,471
Total Direct Employment	4,865	4,785	5,540	5,890	6,310
Total Indirect and Induced Employment	2,573	2,613	2,985	3,202	3,471

Scenario Two	Existing 1980	1985	1990	1995	2000
Direct Construction Employment1/	1,030	195	375	375	-
Indirect and Induced Employment from Construction2/	464	88	169	169	-
Direct Operational Employment3/	3,835	4,590	4,910	5,315	5,721
Indirect and Induced Employment from Operations4/	2,109	2,525	2,701	2,923	3,147
Total Direct Employment	4,865	4,785	5,285	5,690	5,421
Total Indirect and Induced Employment	2,573	2,613	2,870	3,092	3,147

Scenario Three	Existing 1980	1985	1990	1995	2000
Direct Construction Employment1/	1,030	195	785	530	-
Indirect and Induced Employment from Construction2/	464	88	353	239	-
Direct Operational Employment3/	3,835	4,590	5,045	5,560	6,405
Indirect and Induced Employment from Operations4/	2,109	2,525	2,775	3,059	3,523
Total Direct Employment	4,865	4,785	5,830	6,090	6,405
Total Indirect and Induced Employment	2,573	2,613	3,128	3,298	3,523

Table III-7
(Continued)

Scenario Four

	Existing 1980	1985	1990	1995	2000
Direct Construction Employment[1/]	1,030	195	420	405	-
Indirect and Induced Employment from Construction[2/]	464	88	189	182	-
Direct Operational Employment[3/]	3,835	4,590	4,910	5,315	5,680
Indirect and Induced Employment from Operations[4/]	2,109	2,525	2,701	2,923	3,123
Total Direct Employment	4,865	4,785	5,330	5,720	5,680
Total Indirect and Induced Employment	2,573	2,613	2,890	3,105	3,123

Scenario Five

	Existing 1980	1985	1990	1995	2000
Direct Construction Employment[1/]	1,030	170	400	145	-
Indirect and Induced Employment from Construction[2/]	464	77	180	65	-
Direct Operational Employment[3/]	3,835	4,590	4,910	5,195	5,730
Indirect and Induced Employment from Operations[4/]	2,109	2,525	2,701	2,857	3,152
Total Direct Employment	4,865	4,760	5,310	5,340	5,730
Total Indirect and Induced Employment	2,573	2,602	2,881	2,922	3,152

Scenario Six

	Existing 1980	1985	1990	1995	2000
Direct Construction Employment[1/]	1,030	170	550	295	-
Indirect and Induced Employment from Construction[2/]	464	77	248	133	-
Direct Operational Employment[3/]	3,835	4,590	5,045	5,380	6,100
Indirect and Induced Employment from Operations[4/]	2,109	2,525	2,775	2,959	3,355
Total Direct Employment	4,865	4,760	5,595	5,675	6,100
Total Indirect and Induced Employment	2,573	2,602	3,023	3,092	3,355

Scenario Seven

	Year 1	Year 2	Year 3
Direct Construction Employment[1/]	138	411	-
Indirect and Induced Employment from Construction[2/]	62	185	-
Direct Operational Employment[3/]	-	-	155
Indirect and Induced Employment from Operations[4/]	-	-	85
Total Direct Employment	138	411	155
Total Indirect and Induced Employment	62	185	85

[1/]Represents peak construction employment. Plant and mine construction time and employment estimates are based on Industrial Siting Application, Tenneco Soda Ash Project 1978. Plant and mine expansion time and employment estimates are based on Texasgulf proposed expansion (pers. comm., Steve Bartenhagen) and (Green River Star 10/29/80).

[2/]Secondary employment multiplier of 0.45 provided by the BLM Input/Output Model for Sweetwater, Albany, and Carbon counties of southwestern Wyoming.

[3/]1980 operational and maintenance employment calculated at 519 employees/million tons of soda ash production per year (MTPY) from data collected from soda ash producers. Employment for new soda ash plant/mne facilities estimated at 390 employess/MTPY soda ash production, from Industrial Siting Application, Tenneco Soda Ash Project. Employment for plant/mine expansion estimated at 290 employees/MTPY soda ash production, estimated from Texasgulf expansion (Rocket-Miner 11/13/80).

[4/]Secondary employment multiplier of 0.55 provided by the BLM Input/Output Model for Sweetwater, Albany, and Carbon counties of southwestern Wyoming.

Table III-8

POPULATION RESULTING FROM THE SODA ASH INDUSTRY PER SCENARIO

Scenario One	Existing 1980	1985	1990	1995	2000
Population Resulting from Direct Construction Employment1/	1,906	361	1,165	694	-
Population Resulting from Indirect and Induced Construction Employment2/	719	136	438	264	-
Population Resulting from Direct Operational Employment3/	11,889	14,229	15,221	17,097	19,561
Population Resulting from Indirect and Induced Operational Employment2/	3,271	3,915	4,185	4,703	5,382
Total Direct Population	13,795	14,590	16,386	17,791	19,561
Total Indirect and Induced Population	3,990	4,051	4,623	4,967	5,382
Direct, Indirect, and Induced Population Increase from 1980	-	856	3,231	4,973	7,158

Scenario Two	Existing 1980	1985	1990	1995	2000
Population Resulting from Direct Construction Employment1/	1,906	361	694	694	-
Population Resulting from Indirect and Induced Construction Employment2/	719	136	264	264	-
Population Resulting from Direct Operational Employment3/	11,889	14,229	15,221	16,477	17,735
Population Resulting from Indirect and Induced Operational Employment2/	3,271	3,915	4,188	4,532	4,879
Total Direct Population	13,795	14,590	15,915	17,171	17,735
Total Indirect and Induced Population	3,990	4,051	4,452	4,796	5,879
Direct, Indirect, and Induced Population Increase from 1980	-	856	2,582	4,182	7,829

Scenario Three	Existing 1980	1985	1990	1995	2000
Population Resulting from Direct Construction Employment1/	1,906	361	1,452	981	-
Population Resulting from Indirect and Induced Construction Employment2/	719	136	549	372	-
Population Resulting from Direct Operational Employment3/	11,889	14,229	15,640	17,236	19,856
Population Resulting from Indirect and Induced Operational Employment2/	3,271	3,915	4,303	4,743	5,462

Table III-8
(Continued)

	Existing 1980	1985	1990	1995	2000
Total Direct Population	13,795	14,590	17,092	18,217	19,856
Total Indirect and Induced Population	3,990	4,051	4,852	5,115	5,462
Direct, Indirect, and Induced Population Increase from 1980	-	856	4,159	5,547	7,533

Scenario Four

	Existing 1980	1985	1990	1995	2000
Population Resulting from Direct Construction Employment1/	1,906	361	777	749	-
Population Resulting from Indirect and Induced Construction Employment2/	719	136	295	282	-
Population Resulting from Direct Operational Employment3/	11,889	14,229	15,221	16,477	17,608
Population Resulting from Indirect and Induced Operational Employment2/	3,271	3,915	4,188	4,532	4,842
Total Direct Population	13,795	14,590	15,998	17,226	17,608
Total Indirect and Induced Population	3,990	4,051	4,483	4,814	4,842
Direct, Indirect, and Induced Population Increase from 1980	-	856	2,696	4,255	4,665

Scenario Five

	Existing 1980	1985	1990	1995	2000
Population Resulting from Direct Construction Employment1/	1,906	315	740	268	-
Population Resulting from Indirect and Induced Construction Employment2/	719	121	279	102	-
Population Resulting from Direct Operational Employment3/	11,889	14,229	15,221	16,105	17,763
Population Resulting from Indirect and Induced Operational Employment2/	3,271	3,915	4,188	4,430	4,886
Total Direct Population	13,795	14,544	15,961	16,373	17,763
Total Indirect and Induced Population	3,990	4,036	4,467	4,532	4,886
Direct, Indirect, and Induced Population Increase from 1980	-	795	2,643	3,120	4,864

Table III-8
(Continued)

Scenario Six

	Existing 1980	1985	1990	1995	2000
Population Resulting from Direct Construction Employment[1]	1,906	315	1,018	546	-
Population Resulting from Indirect and Induced Construction Employment[2]	719	121	384	208	-
Population Resulting from Direct Operational Employment[3]	11,889	14,229	15,640	16,678	18,910
Population Resulting from Indirect and Induced Operational Employment[2]	3,271	3,915	4,303	4,588	5,202
Total Direct Population	13,795	14,544	16,658	17,224	18,910
Total Indirect and Induced Population	3,990	4,036	4,687	4,796	5,202
Direct, Indirect, and Induced Population Increase from 1980	-	795	3,560	4,235	6,327

Scenario Seven

	Year 1	Year 2	Year 3
Population Resulting from Direct Construction Employment[1]	255	760	-
Population Resulting from Indirect and Induced Construction Employment[2]	96	288	-
Population Resulting from Direct Operational Employment[3]	-	-	481
Population Resulting from Indirect and Induced Operational Employment[2]	-	-	133
Total Direct Population	255	760	481
Total Indirect and Induced Population	96	288	133
Direct, Indirect, and Induced Population Increase from Year 1	-	697	263

[1] Assuming 50% of construction employees are married, and 66% of married construction workers bring their spouses and the remaining 34% bring their spouses and 2 children (Industrial Siting Application, Tenneco Soda Ash Project). Results in 1.85:1 population to construction employee ratio.

[2] Assuming 90% of service sector employees are married, and the average family size is 3.3 (U.S. national average famly size). Only 50% of service sector employment is expected to require work force in migration (Industrial Siting Application, Tenneco Soda Ash Project).

[3] Assuming 90% of operational and maintenance employees are married, and the average family size is 3.3 (U.S. National Average Family Size). This results in a 3.07 total population per employee which is very close to the 3:1 ratio used in the Industrial Siting Application, Tenneco Soda Ash Project.

Table III-9

PERSONAL INCOME FROM THE SODA ASH INDUSTRY PER SCENARIO[1]

Scenario One

	Existing 1980	1985	1990	1995	2000
Wages from Direct Construction Employment[2]	13,883	2,628	8,491	5,054	-
Direct, Indirect, and Induced Income from Direct Construction Wages[3]	20,134	3,812	12,315	7,330	-
Wages from Direct Operational Employment[4]	96,719	115,760	123,830	139,088	159,138
Direct, Indirect, and Induced Income from Direct Operational Wages[5]	127,437	152,525	163,159	183,263	209,680
Total Personal Income	147,571	156,337	175,474	190,593	209,680

Scenario Two

	Existing 1980	1985	1990	1995	2000
Wages from Direct Construction Employment[2]	13,883	2,628	5,054	5,054	-
Direct, Indirect, and Induced Income from Direct Construction Wages[3]	20,134	3,812	7,330	7,330	-
Wages from Direct Operational Employment[4]	96,719	115,760	123,830	134,044	144,284
Direct, Indirect, and Induced Income from Direct Operational Wages[5]	127,437	152,525	163,159	176,617	190,108
Total Personal Income	147,571	156,337	170,489	183,947	190,108

Scenario Three

	Existing 1980	1985	1990	1995	2000
Wages from Direct Construction Employment[2]	13,883	2,628	10,581	7,144	-
Direct, Indirect, and Induced Income from Direct Construction Wages[3]	20,134	3,812	15,345	10,360	-
Wages from Direct Operational Employment[4]	196,719	115,760	127,235	140,223	161,534
Direct, Indirect, and Induced Income from Direct Operational Wages[5]	127,437	152,525	167,645	184,758	212,837
Total Personal Income	147,571	156,337	189,990	195,118	212,837

Table III-9
(Continued)

Scenario Four	Existing 1980	1985	1990	1995	2000
Wages from Direct Construction Employment[2/]	13,883	2,628	5,661	5,459	-
Direct, Indirect, and Induced Income from Direct Construction Wages[3/]	20,134	3,812	8,210	7,917	-
Wages from Direct Operational Employment[4/]	96,719	115,760	123,830	134,044	143,250
Direct, Indirect, and Induced Income from Direct Operational Wages[5/]	127,437	152,525	163,159	176,617	188,746
Total Personal Income	147,571	156,337	171,369	184,534	188,746

Scenario Five	Existing 1980	1985	1990	1995	2000
Wages from Direct Construction Employment[2/]	13,883	2,291	5,391	1,954	-
Direct, Indirect, and Induced Income from Direct Construction Wages[3/]	20,134	3,323	7,819	2,834	-
Wages from Direct Operational Employment[4/]	96,719	115,760	123,830	131,018	144,511
Direct, Indirect, and Induced Income from Direct Operational Wages[5/]	127,437	152,525	163,159	172,629	190,407
Total Personal Income	147,571	155,848	170,978	175,463	190,407

Scenario Six	Existing 1980	1985	1990	1995	2000
Wages from Direct Construction Employment[2/]	13,883	2,291	7,413	3,976	-
Direct, Indirect, and Induced Income from Direct Construction Wages[3/]	20,134	3,323	10,751	5,767	-
Wages from Direct Operational Employment[4/]	96,719	115,760	127,235	135,684	153,842
Direct, Indirect, and Induced Income from Direct Operational Wages[5/]	127,437	152,525	167,645	178,777	202,702
Total Personal Income	147,571	155,848	178,396	184,544	202,702

Scenario Seven	Year 1	Year 2	Year 3
Wages from Direct Construction Employment[2/]	1,860	5,540	-
Direct, Indirect, and Induced Income from Direct Construction Wages[3/]	2,698	8,034	-
Wages from Direct Operational Employment[4/]	-	-	3,909
Direct, Indirect, and Induced Income from Direct Operational Wages[5/]	-	-	5,151
Total Personal Income	2,698	8,034	5,151

[1/]Reported in $1,000.

[2/]Wages average $432 per week for construction workers in Sweetwater County during the second quarter of 1980 (Table II-34). Average work force is estimated at 60% of peak work force.

[3/]Personal income multiplier of 1.4503 for the construction sector, derived from BLM Input/Output Model for Sweetwater, Albany, and Carbon counties of southwestern Wyoming.

[4/]Wages average $485 per week for mine/plant employees in Sweetwater County during the second quarter 1980 (Table II-34).

[5/]Personal income multiplier of 1.3176 for the mining sector, derived from BLM Input/Output Model for Sweetwater, Albany, and Carbon counties of southwestern Wyoming.

Table III-10

ADDITIONAL HOUSING REQUIREMENTS AND SCHOOL ENROLLMENTS EXPECTED PER SCENARIO

	1980	1985	1990	1995	2000
Scenario One					
Bachelor Residences	852	653	848	835	804
Family Residences	5,123	5,403	6,076	6,591	7,240
School Enrollments	6,341	6,964	7,703	8,452	9,412
Scenario Two					
Bachelor Residences	852	653	758	809	729
Family Residences	5,123	5,403	5,897	6,361	6,564
School Enrollments	6,341	6,964	7,549	8,154	8,553
Scenario Three					
Bachelor Residences	852	653	919	895	816
Family Residences	5,123	5,403	6,340	6,751	7,349
School Enrollments	6,341	6,964	7,998	8,612	9,554
Scenario Four					
Bachelor Residences	852	653	774	820	724
Family Residences	5,123	5,403	5,929	6,383	6,517
School Enrollments	6,341	6,964	7,577	8,172	8,472
Scenario Five					
Bachelor Residences	852	645	767	713	730
Family Residences	5,123	5,386	5,915	6,062	6,574
School Enrollments	6,341	6,949	7,565	7,836	8,547
Scenario Six					
Bachelor Residences	852	645	837	789	777
Family Residences	5,123	5,386	6,174	6,380	6,999
School Enrollments	6,341	6,949	7,856	8,202	9,099
Scenario 7		Year 1	Year 2	Year 3	
Bachelor Residences		48	144	19	
Family Residences		96	288	177	
School Enrollments		83	247	231	

1/ Total bachelor residences calculated at 0.33 residence required per construction employee, assuming 50% of the bachelors share a residence, 0.1 residence required per service sector employee. Housing requirements based on the assumptions used in Table III-7 and III-8 (employment and population tables).

2/ Total family residences calculated at 0.5 residence required per construction employee, 0.9 residence per operational employee and 0.45 residence per service sector employee. Family housing requirements based on the assumptions used in Table III-7 and III-8 (population and employment).

3/ Additional school enrollments calculated at 0.34 pupil per construction employee, 1.17 pupils per operational employee and 0.585 pupil per service sector employee. School enrollment requirements based on the assumptions used in Table III-8 and III-7 (population and employment).

Table III-11

TAX REVENUE PER SCENARIO IN 1980 DOLLARS[1]

	1980	1985	1990	1995	2000
			Scenario One		
Severance Tax[2]					
Ad Valorem	5,989	8,834	10,890	14,741	19,286
Production Tax[2]					
Ad Valorem	7,784	11,481	14,153	19,158	25,065
Property Tax[3]	3,158	5,002	5,892	9,162	14,041
			Scenario Two		
Severance Tax[2]					
Ad Valorem	5,989	8,834	10,890	13,607	16,781
Production Tax[2]					
Ad Valorem	7,784	11,481	14,153	17,685	21,810
Property Tax[3]	3,158	5,002	5,892	7,018	8,144
			Scenario Three		
Severance Tax[2]					
Ad Valorem	5,989	8,834	11,404	15,308	19,912
Production Tax[2]					
Ad Valorem	7,784	11,481	14,821	19,895	25,879
Property Tax[3]	3,158	5,002	6,428	10,181	15,006
			Scenario Four		
Severance Tax[2]					
Ad Valorem	5,989	8,834	10,890	13,607	16,781
Production Tax[2]					
Ad Valorem	7,784	11,481	14,153	17,685	21,810
Property Tax[3]	3,158	5,002	5,892	7,554	8,465
			Scenario Five		
Severance Tax[2]					
Ad Valorem	5,989	8,834	10,479	13,381	16,781
Production Tax[2]					
Ad Valorem	7,784	11,481	13,619	17,390	21,810
Property Tax[3]	3,158	5,002	5,570	8,197	12,433

Table III-11
(Continued)

	1980	1985	1990	1995	2000
		Scenario Six			
Severance Tax2/					
Ad Valorem	5,989	8,834	10,479	13,381	17,408
Production Tax2/					
Ad Valorem	7,784	11,481	13,619	17,390	22,624
Property Tax3/	3,158	5,002	6,107	8,680	13,398
		Scenario Seven			
		Year 1	Year 2	Year 3	
Severance Tax2/					
Ad Valorem		-	-	337	
Production Tax2/					
Ad Valorem		-	-	438	
Property Tax3/		-	-	1,501	

1/Reported in $1,000.

2/Tax calculated using a constant 71.48 mill levy, 42% taxable trona production and 5.5% severance tax. Value per ton of trona is 1980 valuation of $9.25/ton with an estimated 2% annual growth rate. Conversion of 1 to 1.8 used for soda ash to trona ratio.

3/Assesed valuation of mines and plants is equal to 15% of cost (pers. comm., Mary Kourbelas). Calculated at a constant mill levy of 71.48. Mine and plant facility costs are estimated as follows:
(1) Conventional mine/plant cost $300-$400 million (BLM Sodium Workshop 2/28/80).
(2) Solution mine/plant cost $180 million 1979 basis (pers. comm., Thomas Parrot VMC).
(3) One million ton expansion in plant and mine facilities estimated at $63 mill for Texasgulf (Rocket-Miner 11/13/80).
(4) BLM estimates based on above data.
  (a) New conventional mine/plant cost $350 million.
  (b) New conventional mine cost (1 MTPY) $150 million.
  (c) Expansion of existing plant/mine (1 MTPY), $75 million.
  (d) Expansion of existing plants without mines, $50 million.
  (e) New solution plant/mine development, $200 million.
  (f) New solution mine development, $20 million.

by soda ash industry plants and soda ash industry related employees purchases in the region. The State of Wyoming can expect additional revenues from state royalties levied on trona mined on Federal lands. One-half of Federal royalties collected from trona mining on Federal lands in Wyoming is returned to Wyoming State Government. If State and Federal royalties increase directly proportional to soda ash production; revenues from State royalties would amount to $3.3 million by Year 2000 for Scenario One. Under the same assumption, Federal royalties would amount to $20.8 million by Year 2000 for Scenario One.

SCENARIO TWO

AIR QUALITY

The expansion of the five existing operations would result in impacts to air quality similar to the existing situation.

TOPOGRAPHY

The expansion of the five existing operations would result in impacts to topography similar to the existing situation.

GEOLOGY AND MINERAL RESOURCES

Cumulative trona loss/use would be 159.94 million tons in the short term and 374.23 million tons in the long term. The 40 billion tons of easily mineable trona would last for 1,100 years if the production level would level off after the year 2000.

Impacts on the oil and gas and the oil shale industries would be about the same as the current situation.

SOILS

The impacts of existing plant expansion would be the same as in Scenario One.

WATER RESOURCES

Scenario Two would have little impact on ground water resources in the area.

Normal expansion of existing operations with no new mine or plant proposals would cause some additional degradation and consumption of surface water. Impacts associated with this scenario, however, would be less significant than those associated with other scenarios. See Table III-1 for consumptive water use.

VEGETATION

Disturbance of vegetation is shown in Table III-5. Impacts similar to those in Scenario One would be expected.

TERRESTRIAL WILDLIFE

About 4,100 additional acres of crucial winter habitat in the trona deposition area, or approximately 2% of the pronghorn crucial winter habitat, would be lost, and 64 antelope would be displaced. Other direct and indirect impacts similar to those in Scenario One would occur. Anticipated increases in tailings ponds would result in the loss of 90 to 100 migrating waterfowl annually.

AQUATIC WILDLIFE

The same situation would exist under this scenario as under Scenario One, except the impacts would be 100% greater than the current situation because of the reduction in streamflow.

WILD HORSES

The impacts under this scenario would be similar to those anticipated under Scenario One.

CULTURAL

The impacts would be similar to those anticipated under Scenario One.

VISUAL RESOURCES

An estimated 10,660 acres would be impacted, reducing its VRM classification from II and III to III and IV.

RECREATION

The impacts would be similar to those anticipated under Scenario One.

LIVESTOCK GRAZING

Loss of land to existing plant expansion would result in a loss of an additional 273 AUMs (813 total) of forage for livestock. Other impacts would be similar to the current situation.

LAND USES

The area's land use would be converted from agricultural to industrial in the acreages shown in Table III-1.

SOCIOECONOMIC IMPACTS

The impacts of Scenario Two are expected to be less than Scenario One due to the lower level of soda ash production.

EMPLOYMENT, POPULATION, INCOME

The employment and population increases for Scenario Two are shown in Tables III-7 and III-8, respectively.

HOUSING, SCHOOLS, SERVICES

Impacts on housing requirements, school enrollments and private and public services would be less than Scenario One due to the lower levels of soda ash production (Table III-10).

TAXES, PUBLIC REVENUES

Severance tax, *ad valorem* production tax, and *ad valorem* property tax revenues expected for Scenario Two are shown in Table III-11. State and Federal royalties expected in the year 2000 are $2.9 million and $18 million, respectively.

SCENARIO THREE

AIR QUALITY

The expansion of the existing operations and construction of two plants, and development within the sodium carbonate brine area would increase concentrations of PSD, SO_2 and NO_2. However, with best available control technology, the concentrations would not exceed PSD increments or NAAQS levels for individual plants. The most severe impacts would occur as a result of combined effects from all the plants. In a stable atmospheric condition the combined concentrations could be expected to increase from the existing situation. The potential for exceeding the 24-hour maximum concentration for PSD, SO_2, and NO_x are not available for a worse case situation. Impacts would be similar to those under Scenario One.

TOPOGRAPHY

Impacts would be similar to those under Scenario One.

GEOLOGY AND MINERAL RESOURCES

Scenario Three would have the greatest impact on the other mineral resource developments in the sodium development area. With six new mines and two new plants, the conflict between sodium mineral development and the oil and gas, oil shale, and other mineral industries in the KSLA would be about 80% greater than the current situation.

Cumulative loss/use of the trona resource under this scenario would be 157.5 million tons in the short term and 397.9 million tons in the long term. This represents the greatest use of the scenarios analyzed in this EA, although similar to Scenario One.

SOILS

For impacts relative to expansion of existing plants, see Scenario One.

Disturbances imposed by new conventional plants and mines which could be developed in the Granger and Blacks Fork areas are discussed in Scenario One. Soils in these two areas are similar to those at the Tenneco and Allied plants.

The soils in the area that could be developed for solution mines and plants in the McKinnon area and McKinnon 'North' are similar to each other. See Scenario One for details.

The area west of McKinnon, which has potential for being developed for solution mining, has both soil units 17 and 30. Some soils in No. 17 have high alkalinity and clay content. Revegetation would be limited to certain types of plants which can withstand massive soils with high pHs. Travel off paved roads may be limited to drier seasons due to low strength when the soils are wet. This heavy type of soil is also highly erodible to water.

The other soils in Unit No. 17 are coarse and sandy. This relates to droughty revegetation conditions and a high potential for erosion by wind action.

Revegetation of Unit No. 30 west of McKinnon would be limited by a few soil types and have steep slopes which would require topographic modification. There are also a few soils in this unit which are highly water erodible and have low strength when wet.

Any development in the immediate vicinity of Little Dry Creek would result in an irrepairable loss of this drainages resource value "as is".

WATER RESOURCES

Impacts associated with this scenario would not differ greatly from those associated with Scenario One. The construction of six new mines and two new plants would require additional water supplies in excess of that required for the two new mine/plant operations proposed in Scenario One (see Table III-1). Possibilities for ground water contamination would increase due to development of the six new mines.

Surface disturbance could be significant, although little data exists at this time to adequately quantify impacts. Increases in both suspended and dissolved solids loads in surface waters would be expected as surface and hydromorphologic conditions are changed.

VEGETATION

Impacts of Scenario Three on vegetation would be similar to those outlined in the Scenario One discussion. See Table III-5 for the amount of disturbance caused by developments under this scenario.

TERRESTRIAL WILDLIFE

An estimated 9,300 acres of wildlife habitat, including 6,500 acres of antelope crucial winter habitat in the trona deposition area, would be affected by developments under this scenario. The crucial winter habitat loss represents 4% of the pronghorn crucial winter habitat in the trona deposition area, and 102 antelope would be affected.

Harassment of animals would be considerably higher under this scenario because of the six new mines.

Waterfowl losses in tailings ponds would average 90 to 100 per year.

AQUATIC WILDLIFE

The increased consumption of water resources (Table III-1) would further decrease the base flows of streams later in the season, leading to impacts as described under Scenario One.

WILD HORSES

Fifty-one horses would move out of the immediate area being developed due to the loss of 620 AUMs of forage to developments under this scenario. Other impacts would be similar to those described under Scenario One.

CULTURAL RESOURCES

The impacts would be similar to those described under Scenario One, except the additional mine developments could result in additional loss/discovery of unidentified sites.

VISUAL RESOURCES

Extensive development under this scenario would result in 15,400 acres of land now classified as VRM Class II and III being downgraded to Class III and IV. The Flaming Gorge NRA's Class B scenic quality would be reduced to Class C on 5,540 acres, with an additional 10,000 to 20,000 acres of land visually impacted by development.

WILDERNESS

Northerly winds would transport stack emissions and dust from new plants/mines into the Devil's Playground and Twin Buttes WSAs, considerably degrading the areas' air quality, scenic values, and other wilderness characteristics.

RECREATION

Impacts would be similar to those discussed under Scenario One.

LIVESTOCK GRAZING

A long-term loss of 1,160 AUMs is anticipated under this scenario. Other impacts would be similar to those discussed under Scenario One.

LAND USES

The area's land use would be converted from agricultural to industrial in the acreages shown in Table III-1.

SOCIOECONOMIC IMPACTS

Scenario Three has a slightly higher market growth rate for trona production with a soda ash equivalence of 15.9 MTPY. Therefore, impacts from Scenario Two are expected to be slightly greater than Scenario One.

EMPLOYMENT, POPULATION, INCOME

Tables III-7 and III-8, respectively, show the primary and secondary employment and population resulting from construction and operational workforce in population is equal for Scenarios One through Six. Scenario Three shows a slightly higher total direct employment and population rate than Scenario One in the Year 2000 due to the 0.9 MTPY (trona to soda ash ratio of 1.8 to 1) higher trona demand. Total direct employment would increase 32% to 6,405 for Scenario Three. Total primary and secondary employment resulting from the soda ash industry in Year 2000 is projected at 9,928 for Scenario Three, which would show the largest primary and secondary population increase of 7,533, or 42% from 17,785 residents in 1980. Total direct, indirect, and induced personal income of residents in the region is expected to increase the most under Scenario Three (Table III-9). An increase in total personal income of $14.5 million, $4.5 million, and $3.2 million would be expected for 1990, 1995, and 2000, respectively, above total personal income received in Scenario One.

HOUSING, SCHOOLS, SERVICES

Table III-10 shows the additional housing and school enrollment requirement per scenario. Scenario Three is expected to result in housing requirements of 8,165 units by Year 2000. The additional housing units distribution would be expected throughout Rock Springs, Green River, and the Bridger Valley in similar proportions to current employee distribution of 56%, 23%, and 18%, respectively, with the remaining 3% in other places (Wyoming Trona Industry Facts 1980). Even with the more developed nature of Rock Springs and Green River, mobile homes could be expected to make up a significant portion of new housing requirements. Additional school enrollments of 3,213 pupils, or 51% of 1980 soda ash industry-related school enrollments, could be expected from Scenario Three. School districts have requested financial assistance to cover a portion of the costs accrued from new student enrollments, as shown by the proposed Texasgulf expansion (Green River Star 1981).

Additional strain would be placed on private and public services. Rock Springs has constructed a new sewage treatment facility, which is already operating at full capacity. Green River currently needs a new sewage facility. New residents would require additional health and recreational facilities.

TAXES, PUBLIC REVENUE

Table III-11 shows the severance tax, *ad valorem* production tax, and *ad valorem* property tax that could be produced if a given scenario would develop. Scenario Three would be expected to produce higher tax revenues due to the additional 0.9 MTPY trona production. Severance tax and *ad valorem* production tax are expected to increase 232% to a level of $19.9 million and $25.9 million, respectively, in Year 2000 for Scenario Three. *Ad valorem* property tax revenues are expected to be $965,000 higher for Scenario Three than Scenario One in Year 2000. Additional tax revenues would be generated from sales tax on goods and services purchased locally by soda ash industry plants and soda ash industry-related employee purchases in the region.

If State and Federal royalties increase directly proportional to soda ash production, revenues from State royalties would amount to $3.4 million by Year 2000 for Scenario Three. Under the same assumption, Federal royalties would amount to $21.4 million.

SCENARIO FOUR

AIR QUALITY

The impacts would be similar to the existing situation.

TOPOGRAPHY

The impacts would be similar to those described under Scenario One.

GEOLOGY AND MINERAL RESOURCES

Sodium development conflicts with other mineral development in the area (oil and gas, oil shale, etc.) would be 30% greater than the existing situation.

Cumulative trona loss/use under Scenario Four would be 153.9 million tons in the short term and 374.5 million tons in the long term.

SOILS

Impacts of the existing plant expansion would be the same as those discussed under Scenario One. Impacts of the new plants would be the same as those discussed under Scenario Three.

WATER RESOURCES

Development of three new mines proposed in this scenario would cause further degradation of surface water quality as a result of increases in surface-disturbing activities. Additional water would be consumed as solution mines are developed and existing operations are expanded (Table III-1).

Development of three new mines in conjunction with less than normal development of existing operations would cause some impacts to ground water reserves. Impacts would be primarily from development of solution mines and would be similar to those described in Scenarios One and Three, although less significant.

VEGETATION

In addition to the losses shown in Table III-5, the discussion of impacts under Scenario One would apply.

TERRESTRIAL WILDLIFE

An estimated 4,350 acres of pronghorn crucial winter habitat in the trona deposition area would be lost in the long term, displacing 69 wintering pronghorn. Waterfowl losses in tailings ponds would average 90 birds per year.

AQUATIC WILDLIFE

The impacts would be similar to those under Scenario Two.

WILD HORSES

Thirty-five horses would migrate out of the area because of the loss of 423 AUMs due to developments under Scenario Four.

CULTURAL RESOURCES

The impacts would be similar to those discussed under Scenario One.

VISUAL RESOURCES

Developments under this scenario would result in impacts similar to those under Scenario Two, although slightly more land would be affected.

WILDERNESS

Impacts would be similar to those under Scenario Two.

RECREATION

Impacts would be similar to those discussed under Scenario One.

LIVESTOCK GRAZING

Long-term forage losses totalling 963 AUMs would be expected under this scenario. Other impacts would be similar to those discussed under Scenario One.

LAND USES

The area's land use would be converted from agricultural to industrial in the acreages shown in Table III-1.

SOCIOECONOMIC IMPACTS

See Tables III-7 through III-11 for impacts. Scenario Four would have the lowest employment and population increases of 1,545 employees and 4,665 residents by Year 2000.

SCENARIO FIVE

AIR QUALITY

The impacts would be similar to Scenario One.

TOPOGRAPHY

The impacts would be similar to Scenario One.

GEOLOGY AND MINERAL RESOURCES

There would be a 40% increase over the current conflicts between sodium development and other mineral development in the area. In the short term, 158.4 million tons of trona would be used; in the long term, 373.5 million tons would be used.

SOILS

Impacts of the existing mine expansion and the new plant developments are discussed under Scenario One.

WATER RESOURCES

Development of two new mine/plant operations and less than normal expansion of existing operations would impact ground water reserves as in Scenario Four. The new mine/plant developments would adversely impact the surface water quality and quantity as in Scenario Four. Water consumption is shown in Table III-1.

VEGETATION

In addition to the losses shown in Table III-5, the discussion of impacts under Scenario One would apply.

TERRESTRIAL WILDLIFE

The impacts would be slightly higher than those under Scenario Four.

AQUATIC WILDLIFE

The impacts would be similar to those under Scenario Two.

WILD HORSES

This scenario would not affect wild horse numbers or forage in the area.

CULTURAL RESOURCES

The impacts would be similar to those discussed under Scenario One.

VISUAL RESOURCES

Developments under this scenario would result in VRM class impacts similar to those under Scenario Four. The impact to Flaming Gorge would be similar to those under Scenario Three.

WILDERNESS

Impacts would be similar to those under Scenario Three.

RECREATION

Impacts would be similar to those discussed under Scenario One.

LIVESTOCK GRAZING

A long-term loss of 940 AUMs would be anticipated under this scenario. Other impacts would be similar to those discussed under Scenario One.

LAND USES

The area's land use would be converted from agricultural to industrial in the acreages shown in Table III-1.

SOCIOECONOMIC IMPACTS

See Tables III-7 through III-11 for impacts.

SCENARIO SIX

AIR QUALITY

The impacts would be similar to Scenario One.

TOPOGRAPHY

The impacts would be similar to Scenario One.

GEOLOGY AND MINERAL RESOURCES

There would be a 20% increase in the current conflicts between sodium development and other mineral development in the area. Cumulative loss/use of the trona resource would be 153.9 million tons in the short term and 374.3 million tons in the long term.

SOILS

The impacts relative to the existing plant expansion is discussed under Scenario One.

The impacts of new conventional-type mines and plants in the Granger areas are discussed in Scenario. One Impacts of conventional-type mines in Blacks Fork are discussed in Scenario Three.

The impacts of new solution mines in the McKinnon area are discussed in Scenario One. Impacts of new solution mines in the McKinnon "North" and McKinnon "West" are discussed in Scenario Three.

WATER RESOURCES

This scenario proposes construction of two new plants and six new mines while also allowing for some expansion of existing facilities. All surface disturbances associated with construction and operation of the new mines/plants would adversely impact water quality. As stated in Scenario Three, surface disturbances associated with solution mining (namely well drilling and construction and maintenance of necessary injection and recovery systems) may be significant. However, the information necessary to accurately predict and quantify these impacts is lacking at the present time.

The new mines as proposed in this scenario would impact ground water reserves more so than in other scenarios. The likelihood of contamination or interformation mixing of ground water is greatest during drilling and development of new mines. No attempt can be made to quantify such impacts without a detailed hydrogeologic study of the area in question and precise development proposals.

Consumption of water under this scenario is shown in Table III-1.

VEGETATION

In addition to the losses shown in Table III-5, the discussion of impacts under Scenario One would apply.

TERRESTRIAL WILDLIFE

Impacts would be slightly less than those under Scenario Three.

AQUATIC WILDLIFE

The likelihood of adverse impact on aquatic wildlife would increase under Scenario Six where the most intense development would occur. Rather than the number of plants and amount of production, the location of facilities and their sources of water are the key factors impacting aquatic wildlife.

WILD HORSES

Developments under this scenario would result in the loss of 553 AUMs of forage for wild horses. Forty-six horses could migrate out of the immediate development area because of the loss of forage.

CULTURAL RESOURCES

The impacts would be similar to those discussed under Scenario One.

VISUAL RESOURCES

Developments under this scenario would result in 14,570 acres of VRM Class II and III lands being downgraded to Class III and IV. The impact would be greater than those under Scenario Three, especially to the visual values of Flaming Gorge, and public viewing areas along existing roads.

WILDERNESS

Impacts would be greater than those under Scenario Three.

RECREATION

Impacts would be similar to those discussed under Scenario One.

LIVESTOCK GRAZING

Long-term forage losses of 1,093 AUMs would be expected. Other impacts would be similar to those discussed under Scenario One.

LAND USES

The area's land use would be converted from agricultural to industrial in the acreages shown in Table III-1.

SOCIOECONOMIC IMPACTS

Scenario Six projects soda ash production at 13.4 MTPY with an additional 0.9 MTPY demand for unprocessed trona in Year 2000.

EMPLOYMENT, POPULATION, INCOME

Scenario Six would result in long-range employment and subsequent population increases of 2,107 employees and 6,327 residents by Year 2000 (Tables III-7 and III-8). Personal income is tied directly to employment (Table III-9).

HOUSING, SCHOOLS, SERVICES

Scenario Six would have long-term requirement of an additional 1,801 housing units and space for an additional 3,071 students (Table II-10).

TAXES, PUBLIC REVENUES

Severance tax, *ad valorem* production tax and *ad valorem* property tax revenues expected from Scenario Six are shown in Table III-11. Scenario Six would result in the highest long-term severance tax and *ad valorem* production tax revenues of $17.4 and $22.6 million expected in Year 2000. *Ad valorem* property tax revenues are shown in Table III-11. State and Federal royalties expected in Year 2000 are $2.9 million and $18 million respectively for a 13.4 MTPY level of soda ash production (assuming royalties increase proportional to production). At the 13.9 MTPY production level (soda ash equivalent production) expected Scenario Six, State and Federal royalties would amount to $3 million and $18.7 million, respectively, under the same assumption.

SCENARIO SEVEN

Impacts under this scenario would be additional, for most resources, to those stated under each of the previous scenarios. In many cases, impacts cannot be fully identified because a site has not been established for the hypothetical mine/plant. Air quality would be most affected.

Since production under this scenario would be in lieu of production in the KSLA, the cumulative trona loss/use would be the same under each scenario. Additional losses of soils, vegetation, and wildlife habitat on 750 acres would be anticipated. An additional loss of 50 or more AUMs for livestock grazing would be expected, although dependent upon the plant site. The scenario probably would have no additional impact to wild horses, unless it would be near the proposed White Mountain wild horse viewing area.

WILD HORSES

Visible operating facilities in the White Mountain Wild Horse Management Areas special viewing turnout along U.S. 187 would detract from the public's enjoyment of the wild horses. (The White Mountain area is part of the Pilot Butte Management Area, Table II-26 and Map II-5). However, if these facilities were near U.S. 187, but away from the special viewing area, it is expected the impacts would be minor.

PALEONTOLOGY

In analyzing the impact on paleontology by scenario, an analysis of Scenario Seven provides the most complete analysis of all scenarios. This is because Scenario Seven includes the actions of Scenarios One through Six plus the possibility of impacts, through prospecting and Preference Right Lease Applications (PRLAs), to the area around Eden-Farson. All three of the fossil-bearing areas (Bridger Basin, Blue Rim-Lombard Butte, and Laney Fish Beds) could be affected under this scenario.

Prospecting outside the KSLA could affect the three fossil-bearing areas also since portions of these formations occur outside the KSLA. The actual action of drilling for trona samples would probably have little effect on paleontological resources. However, any blading or open pit excavation could uncover and possibly damage fossils.

VISUAL RESOURCES AND WILDERNESS

Should such a plant be located in the sodium carbonate brine area, its stack emissions and dust via westerly winds could affect the Buffalo Hump WSA (WY-040-306; 10,300 acres) which abuts the area and the adjacent Sand Dunes WSA (WY-040-307; 27,200 acres).

RECREATION AND CULTURAL RESOURCES

Additional impacts to those stated for the previous scenarios would be expected.

SOCIOECONOMIC IMPACTS

This scenario allows for development of a small 0.4 MTPY soda ash plant/mine outside the KSLA at the expense of production inside the KSLA. The impacts of this scenario could have a wide range of effects; for instance, if PRLAs are granted in the Eden-Farson area, a boom-town growth situation could be initiated. In contrast the development of a small plant/mine near Green River or Rock Springs at the expense of plant/mine development inside the KSLA would have very similar if not equal impacts.

EMPLOYMENT, POPULATION, INCOME

Tables III-7, III-8, and III-9 show the projected employment required, population expected, and personal income expected, respectively, from the development of a small (0.4 MTPY) soda ash plant/mine facility. The greatest employment, subsequent population, and income increase of 596 employees; 1,048 residents; and $8 million would be expected during the second year of construction. Employment and population from the soda ash plant/mine facility is expected to stabilize after the third year at 240 employees and 614 residents if no additional plant or mine developments are undertaken. Personal income of $5.15 million is expected in the third year, and may fluctuate with changes in wages and employment.

HOUSING, SCHOOLS, SERVICES

The projected housing requirements and school enrollments expected from the construction and operation of the proposed plant/mine facility are shown in Table III-10. Impacts on services and infrastructure would be dependent upon the area of development, and can only be evaluated when a specific area has been identified.

TAXES, PUBLIC REVENUES

Table III-11 shows the severance tax, *ad valorem* production tax, and *ad valorem* property tax revenues that are expected from the development of Scenario Seven. Soda ash production of 0.4 MTPY is expected to produce $337,000, $438,000, and $1.5 million of severance tax, *ad valorem* production tax, and *ad valorem* property tax revenues, respectively. Revenues from State and Federal royalties would be dependent upon the location of the mine facility.

SUMMARY OF IMPACTS

The impacts projected under each scenario differ for the various elements. Impacts by scenario under the proposed action and alternatives are shown in Table III-12. A comparison of scenario impacts follows:

Air quality would be most affected under Scenarios One and Three because of the accelerated expansion of existing plant facilities as well as two new plants. Increased processing from existing plants and new plants would increase emissions more than the other scenarios. Scenarios Five and Six would have the next greatest effect and Scenarios Two and Four the least effect.

Topography probably would be affected the largest extent under Scenario Three because of the amount of surface disturbance required for this scenario to develop. Scenario Two would probably have the least affect.

Geology and mineral resources would be impacted under Scenarios One and Three to a greater extent than the remaining scenarios. This is due largely to the removal of a greater amount of trona.

The greatest impact to soils would be under Scenario Three due to the large amount of surface disturbance, causing soil displacement and disruption of soil structures. Scenario Two would have the least impact due to the amount of ground disturbance.

Scenario Three would also have the greatest consumption and depletion of surface water for development followed by Scenario One. Scenarios Two and Five would utilize the least amount of water.

Vegetation would be impacted to the greatest extent under Scenario Three due to the large amount of acreage disturbed. Scenario Two would have the least impact due to the smallest number of acres disturbed.

Terrestrial wildlife would be most affected by Scenario Three due to the loss of vegetation for forage. Scenario Two, which would disturb the least amount of vegetation, would remove the least amount of habitat for wildlife.

Aquatic wildlife could also suffer its greatest impacts under Scenario Three, since this scenario requires the greatest amount of surface water. Demands on surface water could reduce the fisheries habitat.

Wild horses would be most affected and more would be displaced under Scenario Three. This is due largely to the amount of vegetation and forage disturbed under this scenario.

Cultural resources could be affected to a greater extent under Scenario Three due to the large amount of surface disturbance that could impact these resources. This being the case, Scenario Two would have the least effect.

Visual resources would be affected by Scenarios One, Three, and Six due to the plant development and effects on our quality.

Scenario Three would have the greatest effect on wilderness as far as air quality is concerned. Solution mining, presented in Scenarios One, Three, Four, Five, and Six, could encroach upon the WSA boundaries and affect the wilderness values. Any

Table III-12

ANTICIPATED LONG-TERM IMPACTS OF SCENARIOS BY ALTERNATIVE

Proposed Action*					Alternative 1 No Competitive Leasing		No-Action Alternative	
Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7[1/]	Scenarios 1, 2, and 7	Element	Scenario 1	Scenario 2
15.4	13.4	13.4	13.4	13.4- 15.4	Impacts Same as Previously Shown Under Respective Scenario	Anticipated Wyoming Soda Ash Production in Million Tons Per Year	15.4	13.4
397.9	374.33	373.53	374.33	373.5-397.9	"	Cumulative Use/Loss of Trona Reserves Through 2000 in Million Tons	397.18	374.23
110.9	96.5	96.5	96.5	99.4-113.8	"	Fossil Fuel Energy Consumption in Million BTUs Per Year[2/]	110.9	96.5
80	30	40	20	20-80	"	Percent of Conflict with Other Mineral Development Above Existing Situation	30	0
17,400	14,450	14,100	16,400	13,800-19,000	"	Disturbance of Soil/Vegetation Associations in Acres (Includes Current Loss of 8,100 Acres)	15,200	12,200
52,743	45,894	45,894	45,894	47,264-54,113	"	Water Consumption in Acre-Feet Per Year[3/]	52,743	45,950
9,300	6,350	6,000	8,300	5,700-10,900	"	Big Game Summer Habitat Disturbed in Acres	7,100	4,100
6,500	4,350	4,400	6,300	5,700- 8,100	"	Pronghorn Crucial Winter Habitat Disturbed in Acres	5,500	4,100
102	69	69	97	89-127	"	Wintering Pronghorn Displaced[4/]	86	64
90-100	90	90	90	90-110	"	Waterfowl Lost Per Year in Tailings Ponds	90-100	90-100
51	35	0	46	0-51	"	Wild Horses Displaced	0	0
620	423	400	553	380-727	"	Livestock AUMs Lost[5/]	473	273
15,400	11,310	11,920	14,570	14,820-19,560	"	Acres of VRM Classes II and III Degraded to Classes III and IV[6/]	14,900	10,660
6,405	5,680	5,730	6,100	5,576-6,560		Total Direct Employment	6,310	5,421
3,523	3,123	3,152	3,355	3,208-3,608	"	Total Indirect and Induced Employment	3,471	3,147
7,533	4,665	4,864	6,327	4,928-8,092	"	Total Population Increase From 1980	7,158	4,829

Table III-12

ANTICIPATED LONG-TERM IMPACTS OF SCENARIOS BY ALTERNATIVE

Proposed Action*					Alternative 1 No Competitive Leasing		No-Action Alternative	
Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7 1/	Scenarios 1, 2, and 7	Element	Scenario 1	Scenario 2
212.84	188.75	190.41	202.70	195.26-214.83	--	Total Personal Income in Millions of Dollars	209.68	190.11
816	724	730	777	743-835	--	Total Bachelor Residences Needed	804	729
7,349	6,517	6,574	6,999	6,741-7,526	--	Total Family Residences Needed	7,240	6,564
3,213	2,131	2,206	2,758	2,437-3,444	--	Additional School Enrollments 7/	3,071	2,212
19.91	16.78	16.78	17.41	16.78-19.91	--	Public Revenue-Severance Tax in Millions of Dollars 8/	19.29	16.78
25.88	21.81	21.81	22.62	21.81-25.88	--	Public Revenue-Production Tax in Millions of Dollars 8/	25.07	21.81
15.01	8.47	12.43	13.40	9.64-16.51	--	Public Revenue-Property Tax in Millions of Dollars 8/	14.04	8.14

*Scenarios One and Two are also included in Proposed Action.

1/ Represents range of new development under Scenario 7 with the developments uner other scenarios.

2/ Based on 7.2 million BTU per 1 million tons soda ash production (Kostick(1980)).

3/ Based on Bureau of Reclamation formula: Tons of Trona X 0.62 X 1,000 gallons per ton divided by 325,850 gallons/acre-foot.

4/ Based on District average of 3 pronghorn per square mile of crucial winter habitat.

5/ Represent losses above estimatead 540 AUMs lost to current development. Losses are based on average of 15 acres per AUM. Although greater losses could occur if prime grazing areas were disturbed.

6/ Does not include degradation of scenic quality that could occur in Flaming Gorge National Recreation Area under Scenarios Three and Five.

7/ Represent increasea over 6,341 enrolled in 1980.

8/ In 1980 tax dollars.

Table III-12
(Continued)

ANTICIPATED LONG-TERM IMPACTS OF SCENARIOS BY ALTERNATIVE

Alternative 3-Unlimited Prospecting								Alternative 2-No Prospecting
Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7[1]	Element	Scenarios 1, 2, 3, 4, 5, and 6
Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Anticipated Wyoming Soda Ash Production in Million Tons Per Year	Impacts Same As Previously Shown Under Respective Scenario
-	-	-	-	-	-	-	Cumulative Use/Loss of Trona Reserves Through 2000 in Million Tons	-
-	-	-	-	-	-	-	Fossil Fuel Energy Consumption in Million BTUs Per Year[2]	-
35	5	85	35	45	25	25-85	Percent of Conflict with Other Mineral Development Above Existing Situation	-
15,270	12,250	17,470	14,490	14,150	16,450	13,850-19,070	Disturbance of Soil/Vegetation Associations in Acres (Includes Current Loss of 8,100 Acres)	-
52,744	45,951	52,744	45,895	45,895	45,895	47,265-54,114	Water Consumption in Acre-Feet Per Year[3]	-
7,170	4,150	9,370	6,400	6,050	8,350	5,750-10,970	Big Game Summer Habitat Disturbed in Acres	-
5,550	4,135	9,350	6,385	6,035	8,335	5,735-10,950	Pronghorn Crucial Winter Habitat Disturbed in Acres	-
Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Wintering Pronghorn Displaced[4]	-
-	-	-	-	-	-	-	Waterfowl Lost Per Year in Tailings Ponds	-
-	-	-	-	-	-	-	Wild Horses Displaced	-
478	276	625	426	403	556	383-732	Livestock AUMs Lost[5]	-
Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Acres of VRM Classes II and III Degraded to Classes III and IV[6]	-

Table III-12
(Continued)

ANTICIPATED LONG-TERM IMPACTS OF SCENARIOS BY ALTERNATIVE

Alternative 3-Unlimited Prospecting								Alternative 2-No Prospecting
Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7[1/]	Element	Scenarios 1, 2, 3, 4, 5, and 6
Slightly Higher Than Previously Shown	Slightly Higher Than Previously Shown	Slightly Higher Than Previously Shown	Slightly Higher Than Previously Shown	Slightly Higher Than Previously Shown	Slightly Higher Than Previously Shown	Slightly Higher Than Previously Shown	Total Direct Employment	-
-	-	-	-	-	-	-	Total Indirect and Induced Employment	-
-	-	-	-	-	-	-	Total Population Increase From 1980	-
-	-	-	-	-	-	-	Total Personal Income in Millions of Dollars	-
-	-	-	-	-	-	-	Total Bachelor Residences Needed	-
Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Same as Previously Shown	Total Family Residences Needed	-
-	-	-	-	-	-	-	Additional School Enrollments[7/]	-
							Public Revenue-Severance Tax in Millions of Dollars[8/]	-
							Public Revenue-Production Tax in Millions of Dollars[8/]	-
							Public Revenue-Property Tax in Millions of Dollars[8/]	-

*Scenarios One and Two are also included in Proposed Action.

1/Represents range of new development under Scenario 7 with the developments uner other scenarios.

2/Based on 7.2 million BTU per 1 million tons soda ash production (Kostick (1980)).

3/Based on Bureau of Reclamation formula: Tons of Trona X 0.62 X 1,000 gallons per ton divided by 325,850 gallons/acre-foot.

4/Based on District average of 3 pronghorn per square mile of crucial winter habitat.

5/Represent losses above estimatead 540 AUMs lost to current development. Losses are based on average of 15 acres per AUM. Although greater losses could occur if prime grazing areas were disturbed.

6/Does not include degradation of scenic quality that could occur in Flaming Gorge National Recreation Area under Scenarios Three and Five.

7/Represent increases over 6,341 enrolled in 1980.

8/In 1980 tax dollars.

development in Scenario Seven could impact wilderness values if located near WSAs.

Scenario Three could have the greatest effect on recreation since under this scenario the largest amount of surface disturbance occurs. This removes the greatest amount of area that could be utilized for recreational purposes.

Livestock grazing would also be affected to the greatest extent under Scenario Three. Under this scenario, the greatest number of AUMs would be lost. Scenario Two would have the least effect.

Socioeconomic impacts would probably be greatest under Scenario Three.

MITIGATING MEASURES

The mitigating measures which follow are supplemental to the existing and proposed standard stipulations provided with and contained in prospecting permits (Form 3510-1); sodium leases (Form 3520-3); and rights-of-way (for railroads, pole powerlines and telephone lines, pipelines and buried cables, and roads and highways, under Wyoming State Office Instruction Memorandum WY-80-155 and appropriate *Code of Federal Regulations* standards). These forms are contained in Appendix 2. Additional site specific stipulations may be applied to individual permits. Also, these measures are supplemental to what is already required by various other agencies (i.e., Wyoming Department of Environmental Quality (DEQ), Environmental Protection Agency (EPA), etc.) related especially to air quality and water quality and quantity.

The purpose of this section is to develop types of mitigating measures that could be required to protect resource values and to minimize and reduce the impacts of the alternatives including the proposed action.

AIR QUALITY

1. Watering or other approved dust control methods may be required during the construction of plant sites, rights-of-way, tailings ponds, and during rehabilitation operations when dust and resulting air pollution exceeds standards set by the Wyoming DEQ.
2. All ore or product shipment should be done in covered trucks or rail cars.
3. To control blowing dust from dry portions of the tailings and containment pond areas especially during the summer months, a soil binder should be spread on the dry exposed surfaces.
4. Use of temporary or non-paved road surfaces during heavy vehicular traffic periods should be water sprayed or covered with a dust binding agent to reduce dust and reduce visual impacts.
5. Soil stockpiles from tailings ponds and plant sites with wind erodibility potential should be graded on all sides to a maximum slope of 4:l before being revegetated. These stockpiles should be seeded as soon as possible to provide soil stabilization. Other wind erosion precautions such as snow fences, mulching, mixing of topsoils, or covering stockpiles with soils of low wind erosion properties should be done where deemed necessary.
6. Stockpiles of trona and coal should be located either near natural or manmade windbreaks.
7. Permanent access roads to plant sites, mine shafts, parking lots, etc., should be paved to eliminate dust from vehicular movement.

TOPOGRAPHY

1. No road, pipeline, buried cable, or other major surface disturbing activity should be allowed on slopes greater than 20% unless the Authorized Officer (AO) makes exception.
2. All disturbed areas should be recontoured to blend with the natural topography.

GEOLOGY AND MINERAL RESOURCES

1. Existing sand and gravel pits should be utilized whenever the AO determines it feasible, before new sites are to be excavated.
2. Alternate sand and gravel sources should be identified for future use.

PALEONTOLOGY

If paleontological resources are discovered in the course of construction or excavation, the activity should cease and the BLM AO notified. The company should then provide a qualified individual approved by the BLM to collect and remove the fossils.

SOILS

1. All disturbed areas should be recontoured, topsoiled, and seeded as soon as possible after construction. (See Vegetation for seeding procedures.)
2. Upon abandonment of plant and mine sites, reclamation as listed in No. 1 above should be commenced immediately.
3. Site grading should be carried out only where absolutely required, as determined by the AO. Topsoil stockpiling should be done for all suitable soils as determined by the authorized officer.
4. No surface disturbing activities should be allowed during periods of high soil moisture content which would cause excessive rutting of existing roads and/or trails.
5. Construction of roads with frozen earth material mixed with snow and ice should not be allowed, unless permitted by the AO, because it would result in unstable roads causing movement of the roads during thaws. The resulting sediment of such movement would impact adjacent watersheds, riparian areas, and streams.
6. Loading facilities and associated transportation routes should be periodically cleaned through the use of vacuum or other forms of pickup.
7. All stockpiles (coal, soda ash, trona, etc.) should be covered or housed to prevent wind- or water-caused contamination of soils.
8. Soil characteristics should be one of the considerations for possible plant and tailings ponds locations. Trona fallout would have less impact on coarse-textured soils; however, vegetation is apt to be more severely affected by trona on coarse-textured soils.
9. All solid waste (trash and garbage) material generated during construction and operation should be collected and disposed of in an authorized sanitary landfill.
10. All embankment fill material for reservoir dams should come from within the reservoir areas and no borrow pits should be required unless special materials are called for, such as clay for filling a core trench. If a separate fill area is utilized, after the fill is removed the area should be stabilized.
11. A soil conservation plan tailored to each mine site should be developed and approved by the BLM AO prior to construction. The soil conservation plan will include:

    a. Identify on map of area

    -Surface disturbance during construction

    -Location of topsoil and amount

    -Sources and amount of fill material

    -Soil test sites for monitoring

    -Potential soil erosion areas

    b. Soil erosion control methods with potential site locations as identified on map of area

    c. Revegetation of disturbed areas

    -Methods

    -Materials

    -Time frames

    d. Soil fertility program to meet revegetation needs of disturbed areas

12. Waterbars should be installed on disturbed and rehabilitated areas to prevent erosion. General guidelines for installation of waterbreaks are: less than 2% grade, 200-foot interval; 2-4% grade, 100-foot interval; 4-5% grade, 75-foot interval; greater than 5% grade, 50-foot interval. A certain degree of latitude is allowed in the waterbreak interval spacing. Unstable soils may require a closer interval spacing, whereas the interval spacing may be greater on very stable soils or rock outcroppings. A conservative (close) interval spacing is the general recommendation. Waterbreaks are generally constructed on the contour and empty on the downhill side of the cleared area. They are to be constructed to begin in vegetation on the uphill side and feather out into vegetation on the downhill side.
13. There should be no blocking of drainages with vegetation or soil that has been removed.
14. Prior to road construction, centerline survey and construction designs, requested by the AO, should then be approved by the BLM AO.
15. Non-paved roads should meet the above criteria (No. 4 air quality, No.5, and No. 11 soils) and/or reviewal of the route would be required.
16. Pipeline trenches should be maintained in order to correct settlement and erosion. Pipeline trenches should be compacted during backfilling. All pipelines should be buried where they cross existing roads.
17. Topsoil or soil material should be stripped from permanent access roads and railroad routes, and should be distributed along the cuts and fills and backslopes and should be seeded.
18. Runoff should be diverted from exposed areas to stabilized channels.

19. Porous surfaces (gravel or crushed rock) should be considered as alternatives for asphalt, concrete, or cement in storage areas, parking areas, and seldom used roadways. The more porous the surface, the less problem there will be with runoff water disposal.

20. Soils contaminated by accidental or operational spills should be reclaimed through removal and disposal at an authorized dump site.

WATER RESOURCES

State and Federal regulations currently in existence which provide measures designed to protect water quality should be strictly adhered to in any development of the sodium mineral area.

GENERAL

1. Discharge of water on public lands would not be permitted without permits from DEQ and authorization from the U.S. Geological Survey (GS) and the BLM.

2. Use of existing roads to streams, rivers, or reservoirs would be used whenever possible to minimize disturbance, channelization of runoff and thus protecting water quality.

3. Plant site should be designed for "zero discharge concept" through the use of containment ponds.

4. Emergency containment ponds should be in place below tailings and containment ponds.

5. Water bearing formations with sufficient quality and potential for beneficial use should be protected.

6. It should be demonstrated that an area for a proposed tailings pond is or would be made impervious to seepage of tailings, containment, sewage, etc., ponds.

7. Tailings ponds should be designed to withstand two consecutive 100-year floods. This includes the use of diversion canals or ditches to intercept natural runoff and divert drainages below tailings pond area.

8. A contingency plan for tailings ponds failure should be prepared for BLM and DEQ approval.

9. During shaft sinking, any ground water encountered should be grouted off and sealed.

10. During any prospect and exploration drilling operation, BLM and GS should be notified if black water or flowing artesian wells are encountered.

11. A premining plan should be submitted to the BLM that addresses the hydraulic characteristic of aquifers that may be affected by mining, determine the quantity and quality of ground water to be dewatered at various stages of mining, evaluate impacts of the quantity and quality of adjacent water resources and water rights due to mining activities or dewatering.

12. Proper size culverts with appropriate energy dissipation devices as necessary (able to handle at least a 10-year flood event) would be installed at each drainage crossing with a watershed area greater than 10 square miles. A 10-square mile area is sufficient in size to produce a significant runoff capable of causing substantial erosion and washout of the drainage crossing if improperly designed or constructed. Designing culverts capable of handling a 10-year flood event would generally assure that the culvert installed would be capable of handling the volume of flow without being washed out. This size storm event could likely occur at least once during the life of an access road. The company would submit for BLM's approval the culvert size and dissipation device design prior to installation. The minimum size culvert installed should be 18 inches.

13. The company or its operator would indicate in their development plans locations of drainage crossings along with the type of structure (culvert, arch bridge, etc.) proposed to be approved by the BLM.

14. Temporary stream stability structures (e.g., gabions, weirs, etc.) would be required where access roads cross stream channels or parallel steep cutbanks and fill slopes for silt retention as determined on a case-by-case basis. Cribbing or retaining structures on constructed slopes in unstable soil steeper than 2 to 1 may also be required unless otherwise authorized by the BLM.

15. Any plant, mill, tailings ponds, and sewage lagoons should be at least one-half to one mile from a perennial water body.

16. It should be demonstrated that when solution mining techniques are to be used in trona development there will be no interformation mixing of water.

17. An intensive hydrogeologic study of proposed mine areas should be included in the premining plan. This study should address transmissibility, hydrologic gradient, water quality, defined limits of water yielding zone, water table, and points

of recharge and discharge (especially important in solution mining).

18. Solution mining should be shown to have no effect on alluvial (flood plain) deposits when mining close to any natural drainage—perennial, intermittent, or ephemeral.
19. Establishment of reporting procedures should be developed in the event a well net shows contamination, etc.
20. In the event ground water is contaminated, the following should be done.

    a. "Ground water sweep" — flush aquifer by injecting good water under pressure.

    b. Chemical treatments.

    c. Reverse osmosis technique.

VEGETATION

GENERAL

1. Studies should continue to monitor vegetation trends to determine the impact from trona "fallout" (see monitoring section).
2. All disturbed areas not to be utilized should be rehabilitated to the satisfaction and specifications of the AO.
3. Threatened and endangered species (T&E) clearances for all areas of surface disturbance should be necessary if determined by the AO.
4. Clearing of vegetation within pipeline, powerline, and communication line ROW would be limited to that area absolutely necessary for safe operation of equipment and to permit construction activities. This would reduce impacts to soil and vegetation. Driving over vegetation would be permitted. This measure would also reduce the size of the area requiring reclamation work following construction.
5. Construction of roads, pipelines, powerlines, and communication lines may be restricted between the general period of November 15 and March 1 as determined by the AO, depending on weather and soil moisture conditions to minimize total vegetation destruction and soil disturbance.
6. Vegetative data should be compiled prior to construction. Monitoring should be done to determine the progression (see monitoring section).
7. Tailings ponds reclamation experiments should be continued. Permanent vegetation plots need to be used to evaluate success over a number of years (see monitoring section)
8. The following seeding stipulation should be utilized. The operator is responsible for establishing an acceptable stand of vegetation. The seed mix, should be based on pure live seed.

Seed should be planted after September 1 and prior to ground frost; or seed should be planted after the frost has left and before May 15. Fall seeding is best. All seed must be drilled on the contour at a depth of 1/4 to 1/2 inch. Slopes too steep or rocky for machinery can be broadcast and the seed hand raked into the soil. When broadcasting the seed, the rate per acre should be doubled.

If operations are completed in the spring, the rehabilitated areas would be seeded with 15 lbs/acre oats and/or barley. The following fall the area would then be mowed and interseeded with the above seed mixture.

WILDLIFE

GENERAL

1. T&E clearance for the species of wildlife on public lands would be required before any surface disturbing activities.
2. All prairie dog towns that would be affected by construction activities must be surveyed for black-footed ferrets per BLM Rock Springs District Office Instruction Memorandum WY-04-80-59 dated September 19, 1980. Destruction of prairie dog towns should be avoided.
3. No construction activity should be allowed within one mile of the Green River during raptor nesting period of March 1 through June 30.
4. To offset the loss of big game crucial winter habitat that would be taken out of production for long periods, habitat improvement projects in the area would be required as specified by BLM. Types of projects that would be considered on a case-by-case basis are plowing and seeding, prescribed burning, guzzlers/water developments, etc.
5. All areas that would pose hazards to wildlife species would be fenced. Such areas include plant site, tailings, containment ponds, primary and secondary sewage lagoons, etc. Fencing standards should be approved by the BLM.
6. To diminish the possibility of migratory waterfowl use of tailings ponds, the most recognized method(s) of hazing, harassing, or distracting the birds should be employed. Records should be kept on the disposition of all wildlife involved in tailings ponds incidents.

7. Migratory birds that do use the tailings pond and are rendered flightless should be patrolled for and rehabilitated and released through the use of halfway houses.

8. No major surface-disturbing activities should take place within one-fourth mile of any established sage grouse strutting grounds (lek center). No surface disturbance within an additional 1 3/4 miles of the lek center may occur during the period of March 1 to June 15 unless authorized by the AO.

AQUATIC WILDLIFE

1. Plants should consider the utilization of surge storage ponds to reduce the water withdrawal needs during low river flows.

2. Funding support could be considered, for the Wyoming Game and Fish Department, for instream boulder placements to improve trout cover during low flow periods.

3. Considerations could be made for changing the Green River cold water trout fishery below the Big Island Bridge, to a mixed cold water/warm water fishery utilizing other fish species such as catfish or rock bass.

WILD HORSES

1. No utilization of developed wildlife and stock watering sources should be allowed without prior approval of the AO.

2. Fencing of all tailings ponds and pits should meet or exceed BLM specifications.

3. Development of visible operating facilities in the White Mountain Wild Horse Management Area (a portion of No. 8 Pilot Butte Management Area in Table II-12) should not interfere with the special viewing turnout to be established along Highway 187. Developments in this area would distract from the public view of the horses.

CULTURAL RESOURCES

1. A cultural inventory is required prior to any surface disturbance.

2. No surface disturbance would be allowed within one-fourth mile of well preserved wagon ruts.

3. Prior clearance must be given when previously identified areas are to be entered.

4. Alluvium deposit areas would be monitored by the archeologist during the actual surface disturbance if required by the AO.

5. All identified sites would maintain a one-fourth mile buffer zone unless authorization is received from the AO.

6. Crossing of historic trails would be limited to areas where trails are not well defined, as determined by the AO.

Trails should be crossed in a perpendicular fashion and no paralleling within one-fourth mile of trail would be allowed.

VISUAL RESOURCES

1. At the discretion of the AO visible structures should be painted with natural colors to blend with the landscape (pump houses on water lines, storage tanks etc.). Appropriate colors would be selected by the AO.

2. Limit surface occupancy in those areas visible within the foreground-middleground (see Glossary) from the Flaming Gorge Reservoir operating pool (6,040 feet MSL), for the purpose of protecting visual and recreation values of the NRA. This means that developments such as listed in the District Trona Analysis and Stipulations Staff Report (BLM 1980) would be excluded in this area but developments which have intrinsically little visual impact may be approved. The key principle is whether the structure or development would dominate the foreground-middleground. This is consistent with the Forest Service's "partial retention" policy for the NRA. See the Staff Report and the Limited Surface Occupancy section of Chapter IV.

3. All development (roads, drill pads, etc.) should be consistent with each area's existing visual contrast rating classification. Development which would exceed the visual contrast rating classification should be either modified or the area should be reclaimed to be consistent with the visual classification.

4. Developments should be designed to meet VRM Class standards. Selected removal of juniper and other timber types and avoidance of regular patterns in development should be utilized to reduce the visual impact.

WILDERNESS

1. Interim management guidelines should be followed.

No lease issuance or other actions that would impair wilderness values would be allowed in WSAs pending congressional action on wilderness suitability recommendations or a change in the BLM Interim Wilderness Management Policy.

RECREATION RESOURCES

1. Improved access for the development of additional areas that could be used for recreational purposes would be necessary.
2. Loss of rock hounding areas, due to building and construction should be minimized.

LIVESTOCK

1. No utilization of developed stock watering sources should be allowed without prior approval of AO.
2. To minimize disruption of lambing operations, no new disturbing activities would be permitted in identified lambing areas from May 1 to June 10.
3. Fencing of all tailings ponds should meet or exceed BLM specifications.

LAND USES

Ancillary facilities such as roads, powerlines, and pipelines should follow existing corridors of disturbance.

MONITORING

Because the impacts of soda ash fallout are unknown, mitigation cannot be proposed at this time. A monitoring program should be established to gather the information needed to assess the impacts and determine the necessary, if any, mitigation.

The monitoring system should be designed and implemented by an interdisciplinary staff including, but not limited to, a botanist, soil scientist, and hydrologist. This type of staff would be necessary since such a monitoring system would include gathering data on water quality, air quality, soils, and vegetation.

The basic requirements of the study would be as follows:

a. Data collection each year for 15-20 years.

b. Permanent vegetation transects should be established 20-30 miles around the plant sites and particularly downwind from the plants. Control sites would be located upwind. Each plot would be monitored annually for species diversity, production, and cover. Soil tests would also be conducted.

c. Particulate samplers should be placed at various distances downwind of the plants to provide supplemental information to that supplied by the companies. Sampling for fluorides should be included.

d. Runoff installations should be constructed and monitored in an area downwind 5-10 miles to support watershed, soils, and vegetation studies.

e. A selective number of drainages in the trona region should be monitored to determine if any significant change in local water quality is taking place.

f. Companies should conduct a complete TSP analysis at least four times a year.

g. Streams directly downwind of the plants should be sampled at least four times a year.

h. In solution mining areas, a three-dimensional monitoring well net down gradient from the mine area should be established. Wells should monitor above and below the mine zone and cross the hydrologic gradient laterally. This system should be determined from the hydrogeologic study.

i. Soil tests such as those listed below, for trona fallout accumulation should be conducted on a 360° survey around each of the plants on a semiannual basis. All soil test results should be furnished to the AO. Tests should be run at 1/4, 1/2, 1 and 1-1/2 mile intervals.

1. Saturated paste pH.
2. Electrical conductivity.
3. 1:5 pH
4. Soluble cations (Ca, Mg, Na, K).
5. Soluble anions (Cl, HCO_3, CO_3).
6. Sulfate.
7. Cation Exchange Capacity (C.E.C.).
8. Extractable cations (Ca, Mg, Na, K).

9. Nitrogen.

10. Organic carbon-organic matter.

11. Calcium carbonate equivalent.

12. Gypsum.

13. Available phosphorus

14. Mechanical analysis.

15. Bulk density.

16. 1/3 atmosphere moisture content.

j. Companies should continue to experiment with the reclamation of the tailings ponds in order to find a way to restore these areas to productive portions of the ecosystem.

k. An acceptable method of monitoring seepage of tailings ponds for both ground and surface water would be required. Test wells would be an acceptable method. Information would be sent to the BLM District Office quarterly.

l. Identification of inversions or stable atmospheric conditions within the sodium development area should be made and recorded.

UNAVOIDABLE ADVERSE IMPACTS

Due to the amount and nature of disturbance caused by the plant sites, tailings ponds, and ancillary facilities (Table III-1 and Appendix 8), there would be some unavoidable adverse impacts.

AIR QUALITY

The various soda ash plants would emit various pollutants. The amount and specific types of pollutants would be monitored by the State of Wyoming DEQ. The plants would have to meet DEQ air quality standards.

TOPOGRAPHY

With the leveling of areas for the plant sites, roads, railroads, and tailings ponds, the topography would change somewhat. Up to 2,000 acres could be leveled for a soda ash plant and related facilities. Subsidence of an estimated 10-30 feet could also occur from solution mining.

GEOLOGY AND MINERAL RESOURCES

The trona mineral is a nonreplenishable resource and could not be replaced once extracted. Sand and gravel for roads and railroads once utilized would not be replaced.

There is the possibility of destruction of paleontological values from the construction of plant sites and ancillary facilities. These impacts would be considered on a case-by-case basis.

SOILS

An unknown amount of soil erosion and loss in addition to current natural erosion losses, would occur through disturbance. Accelerated erosion would occur with the denuding of soil for construction purposes. An average of 2,000 acres of soils would be disrupted for the construction of a soda ash plant and related facilities. The 1,200 acres utilized by the tailings ponds would suffer a permanent loss of soil associations.

WATER RESOURCES

There would be a loss of water from the Green River due to extended usage by the mines and plants. This could affect aquatic wildlife. With the removal of vegetation and soils by the plants and ancillary facilities, runoff could be increased.

VEGETATION

Approximately 2,000 acres of vegetation would be impacted for each plant/mine operation. Although some of this acreage is only impacted for a short term (10 years), there would be a loss of 134 AUMs for livestock and wildlife. Unless new methods of restoration are developed for tailings ponds 80 AUMs will be lost permanently. These figures can be multiplied by the number of operations in the KSLA for an overall view of the impact of trona mining to the vegetation.

WILDLIFE

Even with limited surface occupancy, under all alternatives and all scenarios, wildlife habitat would be lost via surface disturbance and loss of vegetation. Vegetation rehabilitation may help, but indications from Wyoming Game and Fish are that native species are slow to invade rehabilitated areas and habitat may not be recoverable.

Minor losses would occur along access/transportation corridors. These losses would continue for the operational life of the production facilities.

Waterfowl landing on the tailings ponds would continue to suffer fatalities. There has been no permanent answer developed for this problem, though existing industries are rehabilitating many waterfowl landing on the ponds during the dangerous seasons (fall, winter).

WILD HORSES

A loss of habitat could affect wild horses in the vicinity of the plants. The competition between wild horses, livestock, and wildlife would increase with a decrease in forage. Harassment could increase with the increased developments. There would be no direct loss to horses from new disturbance. Rather the horses would move to a different area.

CULTURAL RESOURCES

The possibility of destruction of cultural sites from plant site and ancillary facility construction exists.

VISUAL RESOURCES

The construction of plant sites would result in visual intrusions to the surrounding areas. Emissions from the plants would be visible for many miles. Roads and railroads would be highly visible, especially to traffic along Interstate 80.

WILDERNESS VALUES

Emissions from the plants could mar the skies above the Sand Dunes and Buffalo Hump WSAs. Leasing or development within the Devils Playground-Twin Buttes WSAs would mar the wilderness characteristics. Development adjacent to the wilderness boundaries could affect the naturalness and solitude of the areas.

RECREATION USES

Recreation uses for hunters and fishermen would be diminished with a reduction in wildlife. Plants could destroy areas utilized by rockhounds.

LIVESTOCK GRAZING

Roughly 134 AUMs per plant site would be lost during the first 10 years of the plant sites. Upon restoration, roughly 80 AUMs would be irretrievable due to the inability to restore tailings ponds. Harassment of livestock could increase.

SOCIOECONOMIC IMPACTS

Those impacts associated with growth that cannot be accommodated by local governments would be unavoidable: increased traffic, increased costs, and housing shortage.

SHORT-TERM USES VERSUS LONG-TERM PRODUCTIVITY

Under the alternatives and scenarios, short-term and long-term losses of natural resources would occur, with the extraction of the trona mineral.

In the short term there would be:

1. A reduction in air quality due to increased emissions from the processing plants.
2. Disturbance of roughly 2,000 acres per plant site and the loss of 106 AUMs.
3. The use of up to 52,743 acre-feet of water per year.
4. A decline in fisheries habitat and water quality due to increased water usage and sedimentation.
5. The potential disturbance of cultural resources.
6. A lowering of the quality of the outdoor recreation experience due to increased population, surface disturbance and visual intrusions.
7. Constraint of other mineral uses such as oil and gas and coal development.
8. Loss of waterfowl and wildlife in the tailings ponds.

In the long term there would be:

1. A reduction in air quality due to increased and cumulative emissions.

2. Disturbance of roughly 2,000 acres and 134 AUMs per plant site.

3. The use of up to 52,743 acre-feet of water per year.

4. A decline in fisheries due to increased water usage and increased sedimentation.

5. The inability to put the tailings ponds back into production amounts to approximately 80 AUMs lost per plant site.

6. The lowering of the quality of outdoor recreation due to increased population and industrial development.

7. Constraint of the development of other minerals such as coal, oil, and gas.

8. Loss of waterfowl and wildlife in the tailings ponds.

9. A fairly stable economic base with job security and tax income to the county due to the longevity of the industry.

10. Increase in transportation systems, railroads and highways in support of the mineral development.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Roughly 25.92 million tons of trona per year by the year 2000 would be extracted. This would result in 13.4-15.4 million tons of soda ash processed over the same period of time.

Material utilized in construction of the plant and transportation facilities may not be retrievable. Increased water utilization from the Green River would occur. An estimated 52,743 acre-feet of water per year would be utilized. This would be irretrievable for future use.

Soil associations would be lost for approximately 2,000 acres for each plant site. This amounts to roughly 134 AUMs lost for each site; the capacity to produce 80 of these AUMs would be irretrievably lost.

Construction of plant sites, railroads, and related facilities would alter the topography. Railroad grades and road beds which require cuts and fills would not be restorable to the original level of topography. However vegetation restoration is feasible.

Waterfowl would be lost in the tailings ponds at a rate of roughly 90-100 birds per year.

Companies may wish to purchase their plant sites because of long-term plant life. Reclamation would likely be the same because of State laws. However, the processing of ROWs would be reduced. The time involved in the process and filing fees and designs would not be a factor.

CHAPTER IV

CONSULTATION AND COORDINATION

TEAM ORGANIZATION

This environmental assessment (EA) was written by a four-person core team with assistance from an interdisciplinary team. The core team was primarily responsible for preparing this document with technical guidance and input from the special assistance team. Table IV-1 lists the preparers of this EA.

COORDINATION IN PREPARATION OF THE PROPOSED ACTION

A sodium workshop was held February 28, 1980, in the Rock Springs District Office. The workshop was attended by representatives of the local trona industry, Rocky Mountain Energy Company, and Geological Survey. The input obtained during this meeting was used to formulate the Management Framework Plan recommendations (MFP-2). The proposed action addressed in this EA was taken directly from the MFP documents.

The MFP-2 recommendations for sodium were among those presented by BLM during a public meeting on December 12, 1980, at Western Wyoming College in Rock Springs. Comments received at the meeting and subsequent comment period are being considered in the formulation of the MFP-3 land use decisions for sodium mineral development. The MFP recommendations also were discussed on January 8, 1981, by the BLM Rock Springs District Advisory Council during its meeting in the Mountain Fuel Building, Rock Springs. Those decisions are to be made following the 30-day comment period on this document.

PUBLIC CONSULTATION AND COORDINATION

During preparation of the Draft EA the following agencies were consulted: Bureau of Mines, Geological Survey, Forest Service, Fish and Wildlife Service, Wyoming Department of Administration and Fiscal Control, Wyoming Department of Economic Planning and Development (DEPAD), Wyoming Department of Environmental Quality, Wyoming Department of Revenue and Taxation, Wyoming Game and Fish Department, Wyoming State Highway Department, Wyoming State Mine Inspector, Sweetwater County Planning Office, the Lincoln-Uinta Association of Governments, and the Southwestern Wyoming Industrial Association.

Dennis Kostick, physical scientist for the Bureau of Mines' Washington, D.C., has met with BLM representatives several times over the past two years to discuss sodium production and necessary BLM actions to ensure continued soda ash production.

The Geological Survey District Mining Supervisor's Office, Rock Springs, Wyoming, was consulted regarding the Known Sodium Leasing Area (KSLA) boundaries and prospecting in the sodium development area. The original KSLA boundaries were amended to be more workable, logical, and less specific. Geological Survey in Laramie, Wyoming, was consulted regarding particulate emission analysis.

Personnel from the Ashley National Forest, Intermountain Regional Office, and the Zone Geologist met with BLM on October 7, 1980, in BLM's Rock Springs District Office. Their concerns regarding possible impacts to the Flaming Gorge National Recreation Area were discussed.

The Fish and Wildlife Service was contacted to obtain information regarding waterfowl losses due to tailings ponds, waterfowl populations, and possible impacts to the Seedskadee National Wildlife Refuge.

The Wyoming Department of Environmental Quality was contacted regarding possible impacts on air and water quality, DEPAD, the State Department of Administration, and the Ad Valorem Tax Division of the State Department of Revenue and Taxation provided socioeconomic data.

A meeting was held with Wyoming Game and Fish Department's representatives in September 1980 at BLM's Rock Springs District Office. The purpose of the meeting was to identify the Wyoming Game and Fish Department's concerns with sodium mineral development and to identify population numbers of affected wildlife, particularly waterfowl. BLM also discussed waterfowl populations with the Department's waterfowl biologist, Leonard Serdiux of Lander.

Table IV-1

LIST OF PREPARERS

Name	EA Assignment	Position/Expertise	Education	Experience
Renee Dana[1]	Team Leader	District Environmental Coordinator	B.S. Range Management, University of Wyoming	7 years - BLM
Matthew R. Brennan[1]	Team Leader	Formerly District Mineral Projects Team Leader/Environmental Specialist	B.S. Forestry, Utah State University	5 years - BLM 2 years - BIA
Ronald C. Herdt	Co-Team Leader	District Technical Writer-Editor	B.A. Secondary Education, University of Northern Colorado	4 years - BLM 6 years - Universtiy of Colorado
Anita M. Todd	Core Team	Word Processing Lead	1 year College of Southern Idaho	3 years - BLM
Donald L. Dutcher	Core Team	District Planning Coordinator	B.A. Liberal Arts, Whitman College, and M.A. Public Administration, University of Oklahoma	2 years - BLM 8 years - HUD
Vernon C. Hoffman[2]	Wyoming State Office EA Coordinator	Formerly Environmental Coordinator, State Office Division of Planning and Environmental Coordination, Wyoming State Office	B.S. General Agriculture, Kansas State University, B.S. Forest Management, Colorado State University	4 years - BLM 16 years - U.S. Forest Service 7 years - various Federal agencies
Andrew Tarshis	Wyoming State Office Technical Coordinator	Geologist, State Office Division of Resources		
Ann B. Aldrich	Special Assistance Team	District Botanist	B.S. Botany, University of Michigan	2 years - BLM
Bruce W. Baker	Special Assistance Team	District Wildlife Management Biologist	B.A. Biology, California State University of Northridge, M.S. Wildlife Management, Humboldt State University, and PhD. Wildlife Ecology, Texas A&M	2 years - BLM
Charles R. Crockett	Special Assistance Team	District Range Specialist	B.S. Agriculture, University of Arizona	12 years - BLM
Dean A. Decker	Special Assistance Team	District Archeologist	B.A. and M.A. Anthropology, University of California at Los Angeles	1 1/2 years - BLM 1 1/2 years - BIA
Linda S. Deuell	Special Assistance Team	District Writer/Editor		5 years - BLM
Jon M. Dolak	Special Assistance Team	Area Coordination-Salt Wells Realty Specialist	B.S. Forestry and Range Management, Colorado State University	12 years - BLM
Sally Haverly	Special Assistance Team	Area Coordination-Big Sandy Realty Specialist		4 1/2 years - BLM 23 1/2 years - Area Force
Renee LaViolette	Special Assistance Team	District Soil Scientist	B.S. Soil Scientist, University of Wisconsin	2 years - BLM
Gary McNaughton	Special Assistance Team	Area Coordination - Geology	B.S. Geology, Denison University	3 years - BLM 1 year - USGS
Bruce H. Smith	Special Assistance Team	District Fisheries Biologist	B.S. Fish and Wildlife Management, University of Wyoming	7 years - BLM
Jeff Villnow	Special Assistance Team	District Hydrologist	B.S. Watershed Science, Colorado State University	1 1/2 years - BLM
John S. Young	Special Assistance Team	Regional Economist	B.S. Animal Science, and M.S. Agricultural Systems, Colorado University	8 months - BLM 1 1/2 years - CSU

[1] Mrs. Dana replaced Mr. Brennan as Team Leader when he moved to private industry in March 1981.

[2] Mr. Hoffman retired from BLM in April 1981.

BLM requested and received socioeconomic input from various city, county, and State officials and used this information for the socioeconomic sections of this EA. Southwestern Wyoming Industrial Association and various soda ash company representatives also provided data.

PUBLIC PARTICIPATION

On August 26, 1980, a news release was sent to all local and regional media representatives informing the public of the sodium EA development and requesting their input. A second news release was sent in April 1981, also requesting public input.

A letter was sent on August 29, 1980, to approximately 500 individuals thought to have an interest in the area; i.e., environmental groups, government agencies (local, State, and Federal), public land users, private landowners, and others. Their comments and input were requested. BLM received about 50 replies to this letter requesting copies of the draft EA. Some providing comments, mostly concerns about the impacts of sodium development on wildlife and air quality.

In addition, the Bureau has received comments on the MFP recommendations from Dick Randall of the Defenders of Wildlife, the Wyoming Game and Fish Department, and Thomas Woodward, a Casper geologist with interests in sodium development.

REVIEW OF THE DRAFT

If major revisions are not required, this document could form Volume 1 of the final environmental assessment; thus, persons receiving the draft EA are encouraged to keep this document.

Draft EAs have been mailed to those responding to the letter and/or news release, as well as those listed as having authorizing actions in Chapter I. These include the following:

Federal Agencies

Geological Survey

Fish and Wildlife Service

Bureau of Reclamation

Advisory Council on Historic Preservation

Bureau of Mines

State Agencies

Governor's Office

Planning Coordinator's Office - State Clearing House (Distributes to State Agencies); also, by request to:

- Department of Environmental Quality
- Department of Environmental Quality (Air Quality Division)
- Wyoming Game and Fish Department
- Department of Education
- Wyoming State Forestry Division

State Representatives Ann Strand and James Roth

Local Government

Sweetwater County Association of Governments

Lincoln-Uinta Association of Governments

Lincoln County Commissioners

Mayor Keith West, City of Rock Springs

Rock Springs City Planner

Mayor R. W. Waggener, City of Green River

Educational Organizations

University of Wyoming Institute for Policy Research

Western Wyoming Community College

Other Organizations

Wyoming Wildlife Federations

Defenders of Wildlife

Rock Springs Gem and Mineral Club

Castle Rock Gem and Mineral Club

National Wildlife Federation

Sierra Club-Northern Great Plains Region

National Resources Defense Council, Inc.

Private Interests

ENVIROS, Inc.

Church and Dwight Company, Inc.

Rocky Mountain Energy

Tenneco Oil Company

Texasgulf, Inc.

Mountain Fuel Supply Company

Union Pacific Railroad

Stauffer Chemical Company

FMC Corporation

Rock Springs Grazing Association

Upland Industries Corporation

Uinta Development Company

A. Thomas Graham, Jr.

Thomas Woodward

Vulcan Materials Corporation

A limited number of draft EAs are available upon request from the Rock Springs District Office, the Kemmerer Resource Area Office, and the Wyoming State Office of the BLM.

Copies of the draft were also made available for public review at public libraries in Cheyenne, Evanston, Green River, Kemmerer, Rock Springs, and Superior, Wyoming.

APPENDIX 1

DETAILED DESCRIPTION OF PROPOSED ACTION ELEMENTS

PROSPECTING PERMITS AND PREFERENCE RIGHT LEASES

The Secretary of the Interior is authorized to issue prospecting permits for sodium minerals as described in 43 CFR 3510. Prospecting permits are issued for two-year periods during which the permittee has the sole right to seek sodium mineral deposits and to determine their workability and commercial value. No extension of the sodium prospecting term will be allowed (43 CFR 3511.1-1).

A preference right lease will be issued when a permittee shows within the prospecting permit term that the sodium mineral deposit discovery is valuable (see Glossary) and that the land in which it is found is chiefly valuable for development of the discovered deposit. Leases are issued for indeterminate periods, subject to readjustment and renewal after the first 20 years. Terms and conditions, such as those on mining methods, waste, period of development, and minimum production, may be incorporated into each lease.

Prospecting for trona deposits usually consists of core drilling to determine the number and thickness of trona beds in a given area. Prospecting for sodium carbonate brine would probably be accomplished through conventional water well drilling methods. Samples of the brine water would then be analyzed to determine the quality and quantity of the brine and to establish the boundaries of the reservoir. For a detailed description of anticipated prospecting methods and proposed prospecting conditions see Appendix 2.

Eight pending prospecting permit applications (Table A1-1) would be rejected because they are wholly or partially within the KSLA and/or the trona deposition area. Eight pending prospecting permit applications (Table A1-2) would be rejected because they are within the sodium carbonate brine area.

One pending prospecting permit application (Chevron's) which is outside the trona deposition area would be considered for issuance. That application by Chevron is for approximately 1,920 acres located in Sections 24, 26, and 34, T. 18 N., R. 120 W.

The KSLA contains known trona deposits sufficient to provide soda ash at current production rates for the next 3,000 years. The area surrounding the KSLA can be expected to contain economically marginal trona deposits. The noncompetitive leasing process required outside the KSLA (43 CFR 3520) does not provide a fair return to the public and generally is not appropriate for areas on the fringe of well-known and more-than-adequate reserves.

Two preference right lease applications (PRLAs) in the sodium carbonate brine area are pending final adjudication (Table A1-3). If the leases are not issued because valuable deposits have not been discovered, then the area would be reopened for prospecting to encourage those with new methods and technology to search for valuable deposits. Two other PRLAs are pending final adjudication (Table A1-3).

COMPETITIVE LEASING AND LEASE RENEWALS

The BLM leases sodium under a competitive bonus-bidding system for those areas within the KSLA. Leases are issued subject to renewal at the end of the first 20-year period with exclusive right to renew for successive 10-year periods. New and renewed leases would be subject to lease stipulations (Appendix 3), those mitigating measures developed in Chapter III which would be approved in the decision document, and the limited surface occupancy criteria. There are 42 Federal sodium leases within the trona deposition area. Tables A1-4 and A1-5 list the current sodium leases and their expiration dates, and Table A1-6 lists the pending lease applications.

LIMITED SURFACE OCCUPANCY

The limited surface occupancy criteria were developed to identify those areas (approximately 25% of the trona deposition area, or 228,640 acres) where surface occupancy should be limited to minimize the potential of significant impact to major re-

Table A1-1

PENDING PROSPECTING PERMIT APPLICATIONS IN TRONA DEPOSITION AREA

Applicant	Prospecting Permit No.	Legal Description	Acres	Entirely Within KSLA
Joann Yates	W-19980	Secs. 20, 29, 30, & 32, T. 15 N., R. 111 W.	2,551.88	Yes
Martin Yates III & S.P. Yates	W-19981	Sec. 19, T. 15 N., R. 111 W. Secs. 22, 23, & 24, T. 15 N., R. 112 W.	2,551	Yes
Martin Yates III & S.P. Yates	W-19982	Secs. 21, 25, 26, & 27, T. 15 N., R. 112 W.	2,560	Yes
Thomas C. Woodward	W-41146	Lots 5, 6, 7, 8, S1/2 Sec. 4, & W1/2NE1/4, E1/2NW1/4, W1/2W1/2, NE1/4SW1/4 Sec. 10, T. 20 N., R. 108 W. Lots 5, 6, 7, 8, E1/2W1/2, W1/2SE1/4, SE1/4SE1/4 Sec. 30. T. 21 N., R. 107 W. S1/2S1/2 Sec. 14, SW1/4SE1/4, NW1/4, S1/2 Sec. 24, & Sec. 26, T. 21 N., R. 108 W.	2,475.32	No
Thomas C. Woodward	W-45027	Sec. 22, E1/2 Sec. 28, & Sec. 34, T. 20 N., R. 108 W.	1,600	No
Thomas C. Woodward	W-41147	Lots 6, 7, 8, SW1/4NE1/4, SE1/4NW1/4, NE1/4SW1/4, NW1/4SE1/4, & S1/2SE1/4 Sec. 4, S1/2 Sec. 8, &	2,248.09	No
		Lots 2, 3, 4, & 5 Sec. 10, T. 19 N., R. 108 W.		No
		Sec. 20,		No
		W1/2W1/2 Sec. 28, & Sec. 32,		No
		T. 20 N., R. 108 W.		No
Stauffer Chemical	W-59477	Sec. 18, T. 21 N., R. 108 W. Sec. 14, & Sec. 24, T. 21 N., R. 109 W.	1,893.44	No
Stauffer Chemical	W-59525	NE1/4, S1/2, Sec. 22, & Sec. 26, T. 21 N., R. 109 W.	1,120.00	No Yes

Table A1-2

PENDING PROSPECTING PERMIT APPLICATIONS IN SODIUM CARBONATE BRINE AREA

Applicant	Prospecting Permit No.	Legal Description	Acres	Entirely Within Area
Mintech Corporation	W-52441	NE1/4, S1/2NW1/4, S1/2 Sec. 13 SE1/4 Sec. 14, SE1/4 Sec. 22, Sec. 23, Sec. 24, NW1/4, W1/2SW1/4 Sec. 25, & SE1/4, Sec. 26, T. 24 N., R. 106 W.	2,560	Yes
Mintech Corporation	W-52440	W1/2, NE1/4, Sec. 26 E1/2NW1/4, SW1/4NW1/4, SW1/4, E1/2 Sec. 27, S1/2SE1/4 Sec. 28, W1/2, NE1/4 Sec. 33, N1/2, E1/2SW1/4, SW1/4SW1/4, SE1/4 Sec. 34, & N1/2 Sec. 35, T. 24 N., R. 106 W.	2,560	Yes
John N. Tippit	W-35485	Secs. 2, 3, 10, & 11, T. 23 N., R. 107 W.	2,565.48	Yes
John N. Tippit	W-35484	Secs. 4, 5, 8, & 9, T. 23 N., R. 107 W.	2,571.84	Yes
Oluf N. Nielson	W-35487	Secs. 27, 28, 34, & 35, T. 24 N., R. 107 W.	2,560	Yes
Oluf N. Nielson	W-35486	N1/2, N1/2S1/2, SW1/4SW1/4, SE1/4SW/4 Sec. 26,	2,120	Yes

Table A1-2
(continued)

Applicant	Prospecting Permit No.	Legal Description	Acres	Entirely Within Area
		NW1/4NE1/4, SE1/4NE1/4, W1/2, W1/2SE1/4 Sec. 29, NW1/4NE1/4, SE1/4NE1/4, NW1/4, S1/2S1/2, NE1/4SE1/4 Sec. 32, & Sec. 33, T. 24 N., R. 107 W.		
W. L. Wheatley	W-32603	Sec. 14, E1/2 Sec. 15, E1/2 Sec.21, Sec. 22, E1/2 Sec. 28, & E1/2 Sec. 33 T. 23 N., R. 106 W.	2,560	Yes
Tom Wheatley, Jr.	W-32059	Lots 3, 4, 5, 6, 7, SE1/4NW1/4, SW1/4E1/2 Sec. 6, Lots, 1, 2, 3, 4, E1/2W1/2 Sec. 7, Sec. 11 Lots 1, 2, 3, 4, E1/2W1/2 Sec. 18, Lots 1, 2, 3, 4, E1/2W1/2 Sec. 19, Lots 1, 2, 3, E1/2 NW1/4, NE1/4SW1/4 Sec. 30, & Lots 1, 2, 3, 4, E1/2 W1/2 Sec. 31, T. 23 N., R. 106 W.	2,406.02	Yes
Phillip E. Johnson	W-71568	Secs. 8, 9, W1/2 15, 17 E1/2 18 T. 23 N., R. 108 W.		Yes
Grace Sulenta	W-71777	Secs. S1/2S1/2 19; 20, 21, 22, 29 T. 28 N., R. 107 W.	2,400	Yes
John Sulenta	W-71778	Secs. 15, 17, 18 N1/2, N1/2S1/2 Sec. 19 T. 28 N., R. 107 W.	2,400	Yes
Phillip E. Johnson	W-71567	Lots 1, 2, 3, 4, NE1/4SW1/4, S1/2SW1/4, SE1/4 Sec. 1 Lots 1, 2, 3, 4, S1/2N1/2, S1/2 Sec. 3 Sec. 10 W1/2NE1/4,NW1/4 Sec. 11 T. 23 N., R. 108 W.		Yes

Table A1-2
(continued)

Applicant	Prospecting Permit No.	Legal Description	Acres	Entirely Within Area
Bradford Wells	W-71569	Secs. S1/2 11, 12, 13, 14 E1/2 15 T. 23 N., R. 108 W.		Yes
Bradford Wells	W-71570	Secs. 6, 7, 17, 18 T. 23 N., R. 107 W.	2,560	Yes
Michael Spence	W-71571	Secs. 14, 15; N1/2, NW1/4SW1/4, E1/2SW1/4, SE1/4 Sec. 21; 22; NW1/4NW1/4 Sec. 23 T. 24 N., R. 107 W.	2,560	Yes
Michael Spence	W-71572	Secs. 17, 18, 19, 20 T. 24 N., R. 107 W.	2,560	Yes
James Mosley	W-71573	Sec. 30 N1/2, N1/2SW1/4, SW1/4SW1/4, S1/2SE1/4 Sec. 31 T. 24 N., R. 107 W. Secs. S1/2SE1/4, NE1/4SE1/4 Sec. 13, Sec. 24, 25 T. 24 N., R. 108 W.	2,560	Yes
James Mosely	W-71574	Secs. 26, 27, 34, 35 T. 24 N., R. 108 W.	2,560	Yes
Gerald Stout	W-71770	Secs. 4, 5, 6, 7, 8, 12 T. 28 N., R. 107 W.	2,400	Yes

Table A1-3

PREFERENCE RIGHT LEASE APPLICATIONS REJECTED AND APPEALED AWAITING DECISION

Applicant	Prospecting Permit No.	Legal Description	Acres	Dated Filed
Marine Minerals Corporation	W-25391	W1/2 Sec. 17, E1/2 Sec. 18, E1/2 Sec. 19, W1/2 Sec. 20, W1/2 Sec. 29, E1/2 Sec. 30, E1/2 Sec. 31, W1/2 Sec. 32 T. 23 N., R. 106 W.	2,560	8-7-70 Appeal Filed 8-7-75
Marine Minerals Corporation	W-25392	W1/2 Sec. 5, E1/2 Sec. 6, E1/2 Sec. 7 W1/2 Sec. 8 T. 23 N., R. 106 W. S1/2SW1/4 Sec. 29, Lot 4, SE1/4SW1/4 Sec. 30, Sec. 31, W1/2 Sec. 32 T. 24 N., R. 106 W.	2,538	8-7-70 Appeal Filed 8-7-75
John S. Wold Eugene V. Simons	W-9026	Lots 1, 2, N1/2NE1/4, Secs. 12 & 14, NW1/4, W1/2SW1/4 Sec. 22, Sec. 24 T. 15 N., R. 108 W.	2,189.88	10-3-67 Appeal Filed 8-6-79
John S. Wold Eugene V. Simons	W-9027	Sec. 6 T. 15 N., R. 107 W. Sec. 30 T. 16 N., R. 107 W. Secs. 2 & 10 T. 15 N., R. 108 W.	2,516.41	10-3-67 Appeal Filed 8-6-79

Table A1-4

PRODUCING SODIUM LEASES

BLM Lease No.	Name of Lessee	Legal Description	Acres	Expiration Date
E-022955	Allied Chemical Co.	Secs. 6, 8, 18 T. 18 N., R. 109 W.	1,939.51	10-31-87
W-095425	Allied Chemical Co.	Secs. 4, 10, 26, E1/2 T. 18 N., R. 109 W. Sec. 32 T. 19 N., R. 109 W.	2,245.77	1-31-80
W-044875	FMC Corp.	Secs. 2, 4, 6, & 8 T. 18 N., R. 110 W.	2,572.44	10-31-87
W-0111730	Stauffer Chemical Co.	Secs. 12, NW1/4 & SE1/4, E1/2NE1/4, W1/2, S1/2SE1/4 22, 24, & 26 T. 20 N., R. 109 W. Sec. 18 T. 20 N., R. 108 W.	2,497.46	10-31-81
W-0111731	Stauffer Chemical Co.	Secs. 28 & 32 T. 21 N., R. 108 W. Secs 10 & 14 T. 20 N., R. 109 W.	2,560	9-31-81
W-0256443	Texasgulf, Inc.	Sec. 26 T. 20 N., R. 111 W. Secs. 2, 10, & 14 T. 19 N., R. 111 W.	2,547.03	7-31-83
W-0153933	Tenneco	Sec. 26, T. 18 N., R. 110 W.	640	9-30-82
W-095423	Tenneco	Sec. 34, T. 18 N., R. 110 W.	640	1-31-81
W-0324547	Tenneco	Sec. 30, T. 18 N., R. 109 W.	649.92	7-31-86
0-25383A	Tenneco	Sec. 36, T. 18 N., R. 110 W. (Federal Surface State Minerals)	640	4-15-79
E-021612	FMC Corporation	Secs. 22, 26, 24, 28 T. 19 N., R. 110 W.	2,560	
W-053867	FMC Corporation	Secs. 20, 30, 32, 34 T. 19 N., R. 110 W.	2,556.32	

Table A1-5

NONPRODUCING SODIUM LEASES

Applicant	Lease No.	Legal Description	Approximate Acres In Lease	Expiration Date
Stauffer Chemical Company	W-079420	Secs. 8, E1/2, E1/2W1/2 18, 20 SW1/4 22, & 28, T. 20 N., R. 109 W.	2,560	10-31-81
FMC Corporation	W-0323406	N1/2 Sec. 18, T. 19 N., R. 110 W.	317.36	11-30-87
FMC Corporation	W-044874	Secs. 10, 12, 14, & 22, T. 18 N., R. 110 W.	2,560	1-31-77
FMC Corporation	W-0317634	Sec. 24, T. 18 N., R. 110 W.	640	5-31-86
Tenneco Oil Co.	W-081607	Sec. 20, 28, 32 T. 18 N., R. 110 W. Sec. 4 T. 17 N., R. 110 W.	2,565.85	4-15-79
Allied Chemical Company	W-095424	Sec. 30, T. 19 N., R. 109 W.	645.60	1-30-80
Allied Chemical Company	E-022957	Sec. 12, E1/2 14, W1/2 22, & all, 24 T. 18 N., R. 109 W.	1,920	10-31-77
Allied Chemical Company	E-25387	Sec. 36, T. 18 N., R. 109 W. (Federal Surface State Minerals)	640	4-15-79
Allied Chemical Company	W-15764	Sec. 8, lot 1, N1/2 NE1/4, NE1/4NW1/4, Sec. 18, & Sec. 22, T. 19 N., R. 109 W.	1,411.87	1-31-80
Allied Chemical Company	W-0313060	Secs. 2, 4, 10, & 14, T. 19 N., R. 109 W.	2,561	8-31-85
Texasgulf	W-0313077	Sec. 34, T. 20 N., R. 111 W.	661.30	2-28-84
Texasgulf	W-0313075	Secs. 14, 22, & 24, T. 20 N., R. 111 W.	1,921.65	12-31-81

Table A1-5
(continued)

Applicant	Lease No.	Legal Description	Approximate Acres In Lease	Expiration Date
Texasgulf	W-0313076	Sec. 12, T. 20 N., R. 111 W.	641.43	2-28-84
Texasgulf	W-0252727	Secs. 30, & 32, T. 20 N., R. 110 W. Sec. 6, T. 19 N., R. 110 W. Sec. 12, T. 19 N., R. 111 W.	2,523.5	7-31-83
Texasgulf	W-0252726	Secs. 28, & 34, T. 20 N., R. 110 W. Secs. 4, & 8, T. 19 N., R. 110 W.	2,563.67	7-31-84
Olin Corporation	W-0225918	Secs. 22, & 26, T. 16 N., R. 110 W.	1,280	10-31-81
Church & Dwight Corporation	W-0225919	Sec. 10, T. 17 N., R. 109 W.	640	10-31-81
Olin Corporation	W-0225916	Sec. 4, T. 16 N., R. 109 W. Sec. 34, T. 17 N., R. 109 W.	1,280	10-31-81
Olin Corporation	0-69724	W1/2W1/2 Sec. 36, T. 17 N., R. 109 W. (Federal Surface State Minerals)	160	11-15-79
Olin Corporation	W-0225917	W1/2 Sec. 2, & W1/2 Sec. 14, T. 16 N., R. 109 W.	591.34	10-31-81
Olin Corporation	W-081577	Secs. 8, 10, 20, & 22, T. 16 N., R. 109 W.	2,560	10-31-81
Olin Corporation	W-081578	Secs. 12, 14, 24, T. 16 N., R. 110 W. Sec. 18, T. 16 N., R. 109 W.	2,532.16	10-31-81
Olin Corporation	W-19724	W1/2W1/2 Sec. 36, T. 17 N., R. 109 W.	160	11-15-79
Reynolds	W-0220479	Sec. 8, 18, 20, & 22, T. 20 N., R. 110 W.	2,533.60	11-31-82
John S. Wold & Eugene B. Simons	W-63588	Sec. 4, T. 16 N., R. 108 W. Sec. 26, T. 17 N., R. 108 W.	1,176.96	
Church & Dwight Company	W-73121	Sec. 8 & 18 T. 17 N., R. 109 W.	1,282.93	
Allied Chemical Corporation	E-022957	NE1/4 Sec. 2, W1/2, W1/2E1/2, Lots 1, 2, 3, 4, Sec. 12, E1/2 Sec. 14, W1/2 Sec. 22 Lots 1, 2, 3, 4, 5, 6, 7, 8, SW1/4, W1/2NE1/4, W1/2SE1/4 Sec. 24 T. 18 N., R. 109 W.	1,918.73	

Table A1-5
(continued)

Applicant	Lease No.	Legal Description	Approximate Acres In Lease	Expiration Date
Philadelphia Quartz Corporation	W-057154	Sec. 2, T. 18 N., R. 111 W. S1/2 Sec. 26, & Sec. 34, T. 19 N., R. 111 W.	1,602.16	4-30-78
Philadelphia Quartz Corporation	W-064005	E1/2 Sec. 4, & 10, T. 18 N., R. 111 W.	960	6-30-78
Philadelphia Quartz Corporation	W-064006	Sec. 12, 14, & 24, T. 18 N., R. 111 W. Sec. 18, T. 18 N., R. 110 W.	2,554.50	6-30-78
PQ Corporation	W-081608	Sec. 6, T. 17 N., R. 110 W. Sec. 30, T. 18 N., R. 110 W. Secs. 22 & 26, T. 18 N., R. 111 W.	2,556.11	4-15-79
Diamond Shamrock	W-0309132	Sec. 22 & 24, T. 17 N., R. 108 W.	1,280	9-29-86
FMC Corporation	W-053868	Sec. 2 & 12 N1/2, N1/2S1/2 Sec. 10 T. 19 N., R. 110 W. Sec. 6 T. 19 N., R. 109 W.	2,416.96	
R. C. Strum	W-086530	Sec. 30 T. 17 N., R. 109 W.	641.07	10-31-81
K. E. Grierson	W-079653	Sec. 26 & 34, T. 17 N., R. 110 W. Sec. 2 & 4, T. 16 N., R. 110 W.	2,412.08	10-31-81
K. E. Grierson	W-079652	Sec. 32, T. 17 N., R. 109 W. Sec. 6, T. 16 N., R. 109 W.	1,172.10	10-31-81
C. G. Skruggs	W-081579	Sec. 8 & 10, T. 16 N., R. 110 W.	1,280	10-31-81
Diamond Shamrock	W-081576	E1/2 Sec. 2, 12, E1/2 14, & 24, T. 16 N., R. 109 W.	1,869.80	10-31-81

Table A1-6

PENDING SODIUM LEASE APPLICATIONS

Name of Applicant	Lease #	Legal Description	Acres	Date Filed
Stauffer Chemical	W-59890	Sec. 2, T. 20 N., R. 109 W.	316.90	7-05-77
Stauffer Chemical	W-59526	Sec. 30, T. 21 N., R. 108 W.	638.44	5-31-77
Pacific Power & Light	W-56813	Sec. 30, 32, & 34, T. 20 N., R. 109 W.	1,950.55	9-15-76
Pacific Power & Light	W-55684	Sec. 24 & 26, T. 20 N., R. 110 W.	1,280	6-07-76
Pacific Power & Light	W-55683	Sec 28 & N1/2, W1/2SW1/4, SE1/4SW1/4SE1/4, Sec. 34, T. 17 N., R. 108 W.	1,240	6-07-76
Church & Dwight Co.	W-67826	Lot 4, S1/2NW1/4, SW1/4, S1/2SE1/4 Sec. 2, 4, 14, & 22, T. 17 N., R. 109 W.	3,840	4-05-79
Church & Dwight Co.	W-68614	Sec. 26 & 28 T. 17 N., R. 109 W.		7-02-79
Amax Exploration, Inc.	W-71345	Lots 5, 6, 7, 8, S1/2N1/2, S1/2 Sec. 4 Lots 8, 9, 10, 11, 12, 13, 14, S1/2NE1/4, SE1/4NW1/4, E1/2SW1/4 Sec. 6 Sec. 8 T. 15 N., R. 109 W. Secs. 26 & 28 Lots 5, 6, 7, 8, E1/2, E1/2W1/2 Sec. 30 Secs. 32 & 34 T. 16 N., R. 109 W.	5,072.67	6-06-80
Vulcan Materials Co.	W-74418	Secs. 2 & 12 T. 15 N., R. 110 W. Secs. 28 & 34 T. 16 N., R. 110 W.	2,560	2-23-81

Table A1-6
(continued)

Name of Applicant	Lease #	Legal Description	Acres	Date Filed
AMAX Exploration Inc.	W-71820	Lots 5, 6, 7, 8, S1/2N1/2, S1/2 Sec. 4 Lots 8, 9, 10, 11, 12, 13, 14, S1/2NE1/4 Sec. 6 SE1/4NW1/4, E1/2SW1/4, SE1/4 Sec. 8 T. 15 N., R. 109 W. Secs. 26 & 28 Lots 5, 6, 7, 8, E1/2, E1/2W1/2 Sec. 30 Secs. 32 & 34 T. 16 N., R. 109 W.		7-31-80
Tenneco Oil Co.	W-73292	Secs. 20, 28, 34 T. 18 N., R. 109 W.		12-8-80
Tenneco Oil Co.	W-73293	Sec. 6 T. 17 N., R. 109 W. Secs 2, 10, & 12 T. 17 N., R. 110 W.		12-8-80
Tenneco Oil Co.	W-73295	Sec. 32 T. 18 N., R. 109 W.		12-8-80
Vulcan Materials Co.	W-74421	Secs. 26, 28, 30, & 32 T. 16 N., R. 109 W.	2,560	2-23-81
Vulcan Materials Co.	W-74420	Sec. 30 T. 17 N., R. 108 W. Secs. 22, 24, & 26 T. 17 N., R. 109 W.	2,560	2-23-81
Vulcan Materials Co.	W-74419	Secs. 4, 6, & 8 T. 15 N., R. 109 W. Sec. 34 T. 16 N., R. 109 W.		

source values (Map A1-1). The surface occupancy areas are those areas where development is encouraged and could occur without significantly impacting resource values. These areas include: (1) the four existing plants—FMC, Allied, Stauffer, and Texasgulf; (2) the Tenneco facility currently under construction; (3) an area around each existing facility and the Tenneco facility where future potential expansion is likely to occur; and (4) other desired occupancy areas shown on Map A1-1.

The limited surface occupancy criteria would be made provisions of the lease or lease renewal. The criteria would be applied at the discretion of the BLM Authorized Officer (AO) in considering site-specific proposals for the development of a particular lease. This would enable the AO to consider cost/benefit analyses and other siting constraints or opportunities that may exist in the lease area.

The boundaries of the individual criteria areas used to identify the limited surface occupancy areas of Map A1-1 are depicted on a detailed map available for review at the BLM Rock Springs District Office. The major private landowners—Rocky Mountain Energy Company (RME), Upland Industries Corporation, Uinta Development Company, and the Rock Springs Grazing Association—have generally concurred with these criteria. Authorizing development on private or State land would be at the discretion of each of the above private landowners as well as the State of Wyoming.

The limited surface occupancy criteria protect those areas where surface occupancy could conflict with other resource values. In cases where structures and developments are limited but not excluded, the limitations may affect the size, height, coloring, specific site location, season of use, and other aspects of surface occupancy to assure compatibility with other resource values. Structures such as hoist houses, processing plants, steam plants, ore and coal stockpiles, loadout, storage tanks, office/storage buildings, tailings, containment areas, etc., usually would not meet the criteria. Resource values to be protected include sage grouse habitat; historic trails and sites; water quality, visual, and recreation resources associated with the Flaming Gorge Reservoir and the Blacks Fork, Green, and Hams Fork rivers; wilderness values; vegetation; big game crucial wintering areas; high-value livestock range; and public safety.

The limited surface occupancy criteria are:

1. Limited surface occupancy within one-fourth mile of any identified sage grouse strutting grounds (lek; see Glossary), and no disturbance within an additional one-fourth mile of the lek center should occur from March 1 to May 15 unless authorized by the AO.

2. Limited surface occupancy within one-fourth mile of either side of various historic trails and sites.

3. Limited surface occupancy within one-half mile of either side of the Flaming Gorge Reservoir and the Green, Blacks Fork, and Hams Fork rivers.

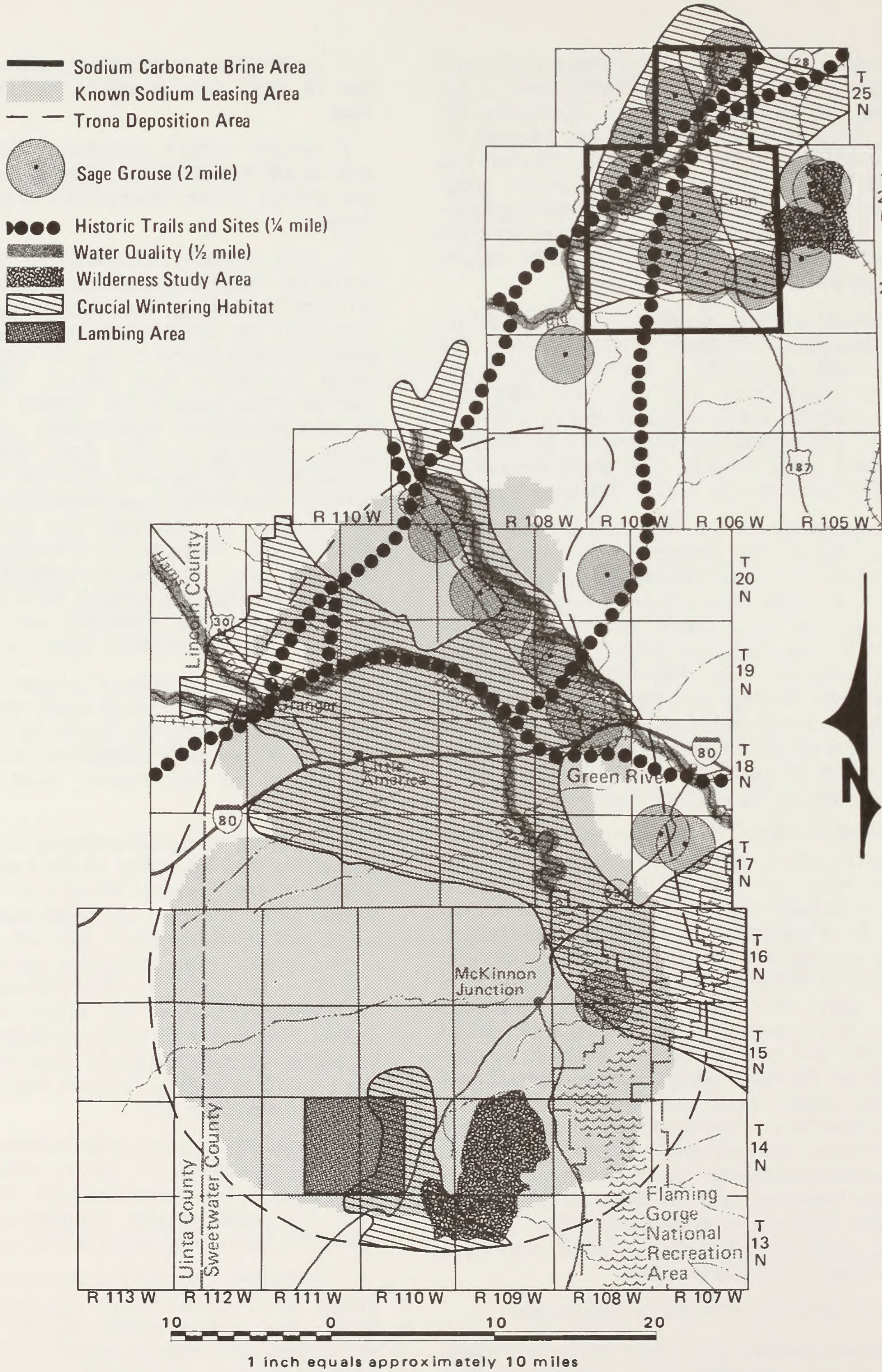
4. Limit surface occupancy in those areas within the foreground-middleground (see Glossary) from the Flaming Gorge operating pool (6,040 feet MSL) for the purpose of protecting visual and recreation values of the Flaming Gorge National Recreation Area (NRA). Developments such as those listed in the "District Trona Analysis and Stipulations Staff Report", available for public review at the BLM Rock Springs District Office, would be excluded from that area. Developments that would have intrinsically little visual impact could be approved. The key principle is whether the structure or development would dominate the foreground-middleground. See Chapter III-Mitigation, Limited Surface Occupancy. This would be consistent with the Forest Service's "partial retention" policy for the NRA.

5. No surface occupancy or other surface disturbing activities that would impair Wilderness Inventory Areas' suitability. (Refer to *Interim Management Policy and Guidelines*, issued by the Department of the Interior, BLM, December 1979.)

6. In big game crucial wintering areas, surface occupancy may be limited by the location and/or season of use. In cases where loss of big game crucial winter habitat is proposed because of developments such as roads, railroads, powerlines, communication lines, ventilation shafts, mine entrances, and ponds; the BLM AO would require improvement projects that would offset habitat losses. The type of projects would be considered on a case-by-case basis and could include seeding, prescribed burning, guzzlers and water developments, plantings, etc.

7. Surface occupancy may be limited by location and/or season of use in certain lambing areas and/or high-value livestock grazing areas. The AO would require improvement projects where the loss of rangeland is proposed.

8. Surface occupancy may be limited where activities could cause heavy fog conditions that could pose public safety hazards. The BLM would allow new mine development and allow expansion of plants on Federal land within surface occupancy areas. The operation of existing mines, milling and refining methods, surface structures, waste disposal, and abandonment/reclamation are described in Appendix 3.



Map AI-1
LIMITED SURFACE OCCUPANCY CRITERIA
(for those criteria which can be mapped)

9. Surface occupancy by visible operating facilities in the White Mountain Wild Horse Management Area should not interfere with the special viewing turnout to be established along Highway 187. Developments in this area would distract from the public view of the horses.

Form 3520–3
(September 1977)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

SODIUM LEASE

Serial Number

This lease, entered into on , by the United States of America, the lessor, through the Bureau of Land Management, and

, the lessee, pursuant and subject to the terms and provisions of the act of February 25, 1920 (41 Stat. 437), as amended, hereinafter referred to as the act, and to all reasonable regulations of the Secretary of the Interior now or hereafter in force when not inconsistent with any express and specific provisions herein, which are made a part hereof.

WITNESSETH:

Sec. 1. *Rights of lessee.* The lessor, in consideration of the rents and royalties to be paid and the conditions to be observed as hereinafter set forth, does hereby grant and lease to the lessee the exclusive right and privilege to mine and dispose of all the sodium compounds and related products, hereinafter referred to as the leased deposits, in, upon, or under the following-described tracts of land, situated in the State of

containing acres, more or less, together with the right to construct all such works, buildings, plants, structures, and appliances as may be necessary and convenient for the mining and preparation of the leased deposits for market; the housing and welfare of employees, and subject to the conditions herein provided, to use so much of the surface as may reasonably be required in the exercise of the rights and privileges herein granted for a period of 20 years, with preferential right in the lessee to renew the same for successive periods of 10 years under such reasonable terms and conditions as may be prescribed by the Secretary of the Interior, unless otherwise provided by law at the expiration of any period.

Sec. 2. In consideration of the foregoing the lessee hereby agrees:

(a) Bond. To maintain the bond furnished upon the issuance of this lease, which bond is conditioned upon compliance with all of the provisions of the lease, and to increase the amount of or furnish such other bond as may be required.

(b) Royalty. To pay the lessor a royalty of percent of the quantity or gross value of the output of the leased deposits at the point of shipment to market, during the first 20 years succeeding the execution of this lease. Royalties shall be payable monthly in cash or delivered in kind at the option of the lessor. It is expressly understood that the Secretary of the Interior may establish reasonable minimum values for the purpose of computing royalty on any of the leased deposits, due consideration being given to the highest price paid for a part or a majority of the production of like quality products from the same general area, the price received by the lessee, posted prices, and other relevant matters.

When paid in value such royalty on production shall be due and payable monthly on the last day of the calendar month following the calendar month in which produced.

When royalty is to be taken in kind the lessee will be notified prior to March 1 that delivery of royalty products will be required beginning June 1 of that year for a stated period not exceeding 12 months. When paid in kind royalty products shall be delivered in merchantable condition at the point of shipment without cost to the lessor, unless otherwise agreed to by the parties hereto, at such time and in such storage compartments provided by the lessee as may reasonably be required by the lessor, *provided* that the lessee shall not be required to hold the royalty products in storage for more than 60 days beyond the end of the month in which produced, and, *provided further*, that the lessee shall in no manner be responsibile or held liable for the loss or destruction of the royalty product in storage from causes over which the lessee has no control.

(c) Rental. To pay the lessor, annually, in advance, for each acre or part thereof covered by this lease, beginning with the date hereof, the following rentals: 25 cents per acre or fraction thereof for the first calendar year; 50 cents per acre for the second, third, fourth, and fifth calendar years, respectively; and $1 per acre for the sixth and each succeeding calendar year during the continuance of the lease, such rental for any year to be credited against the first royalties as they accrue under the lease during the year for which the rental was paid.

(d) Minimum production. Beginning the sixth full calendar year of the lease, except when operations are interrupted by strikes, the elements or casualties not attributable to the lessee, or unless on application and showing made, operations shall be suspended when market conditions are such that the lessee cannot operate except at a loss, or suspended for the other reasons specified in sec. 39 of the act, to mine each year the leased deposits from any of the lands covered by this lease to a royalty value of $1 per acre or fraction thereof, or in lieu of any mining to pay minimum royalty of $1 an acre or fraction thereof.

(e) Payments. To make rental payments to the manager of the proper BLM office, except that when this lease becomes productive the rentals and royalties shall be paid to the appropriate regional mining supervisor of the United States Geological Survey, with whom all reports concerning operations under the lease shall be filed. All remittances to the manager shall be made payable to the Bureau of Land Management, those to the Geological Survey shall be made payable to the United States Geological Survey.

(f) Plats, reports, maps. At such times and in such form as the lessor may prescribe, to furnish a plat showing development work and improvements on the leased lands and a report with respect to stockholders, investment, depreciation, and costs. To furnish in such form as the lessor may prescribe, within 30 days from the expiration of each quarter a report covering such quarter, certified by the superintendent of the mine, or by such other agent having personal knowledge of the facts as may be designated by the lessee for such purpose, showing the amount of leased deposits mined during the quarter, the character and quality thereof, amount of its products and byproducts disposed of and price received therefor, and amount in storage or held for sale. To keep and prepare maps of the leased lands in accordance with the regulations in 30 CFR 231.

(g) Weights. To determine accurately the weight or quantity and quality of all leased deposits mined, and to enter accurately the weight or quantity and quality thereof in due form in books to be kept and preserved by the lessee for such purposes.

(h) Inspection. To permit at all reasonable times (1) inspection by any duly authorized officer of the Department of the leased premises and all surface and underground improvements, works, machinery, equipment, and all books and records pertaining to operations and surveys or investigations under this lease; and (2) the lessor to make copies of and extracts from any or all books and records pertaining to operations under this lease, if desired.

(i) Assignment. To file for approval in the proper BLM office within 90 days from the date of execution, any assignment or transfer made of this lease, whether by direct assignment, operating agreement, working or royalty interest, or otherwise. Such instrument will take effect the first day of the month following approval by the Bureau of Land Management, or if the assignee requests, the first day of the month of approval. The showing required to be made with an assignment or transfer is set forth in the appropriate regulations.

(j) Equal Opportunity clause. To comply with the following:

(1) The lessee will not discriminate against any employee or applicant for employment because of race, color, religion, sex or national origin. The lessee will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex or national origin. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The lessee agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the contracting officer setting forth the provisions of the Equal Opportunity clause.

(2) The lessee will, in all solicitations or advertisements for employees placed by or on behalf of the lessee, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex or national origin.

(3) The lessee will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency contracting officer, advising the labor union or workers' representative of the lessee's commitments under this Equal Opportunity clause, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The lessee will comply with all provisions of Executive Order No. 11246 of September 24, 1965, as amended, and of the rules, regulations, and relevant orders of the Secretary of Labor.

(5) The lessee will furnish all information and reports required by Executive Order No. 11246 of September 24, 1965, as amended, and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of the lessee's noncompliance with the Equal Opportunity clause of this contract or with any of the said rules, regulations, or orders, this contract may be cancelled, terminated or suspended in whole or in part and the lessee may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order No. 11246 of September 24, 1965, as amended, and such other sanctions may be imposed and remedies invoked as provided in Executive Order No. 11246 of September 24, 1965, as amended, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

(7) The lessee will include the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order No. 11246 of September 24, 1965, as amended, so that such provisions will be binding upon each subcontractor or vendor. The lessee will take such action with respect to any subcontract or purchase order as the contracting agency may direct as a means of enforcing such provisions including sanctions for noncompliance: *Provided, however,* That in the event the lessee becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the contracting agency, the lessee may request the United States to

enter into such litigation to protect the interests of the United States.

(k) Lands disposed of with leased deposits reserved to the United States. If the lands embraced herein have been or shall hereafter be disposed of under laws reserving to the United States the leased deposits therein, to comply with all conditions as are or may hereafter be provided by the laws and regulations reserving such deposits.

(l) Operations, wages, freedom of purchase. To comoly with the operating regulations (30 CFR 231) to exercise reasonable diligence, skill, and care in the operation of the property, and to carry on all operations in accordance with approved methods and practices as provided in the operating regulations, having due regard for the prevention of injury to life, health, or property, and of waste or damage to any water or mineral deposits; to pay all wages due miners and employees both above and below ground, at least twice each month in lawful money of the United States; to accord all miners and employees complete freedom of purchase; to restrict the workday to not exceeding 8 hours in any one day for underground workers, except in cases of emergency; to employ no boy under the age of 16 and no girl or woman, without regard to age, in any mine below the surface, unless the laws of the State otherwise provide, in which case the State laws control.

(m) Taxes. To pay when due all taxes lawfully assessed and levied under the laws of the State or the United States upon improvements, output of mines, or other rights, property, or assets of the lessee.

(n) Overriding royalties. Not to create, by assignment or otherwise, an overriding royalty in excess of 1 percent of the gross value of the output at the point of shipment to market unless the owner of that interest files his agreement in writing that such interest is subject to reduction or suspension to a total of not less than 1 percent of such gross value, whenever, in the interest of conservation, it appears necessary to do so in order to (1) prevent premature abandonment or (2) make possible the economic mining of marginal or low-grade deposits on the leased lands or any part thereof.

(o) Delivery of premises in case of forfeiture. In case of forfeiture of this lease to deliver up to the lessor in good order and condition the land leased, including all buildings and underground timbering, and such other supports and structures as are necessary for the preservation of the mine or deposits.

(p) Extraction by solution. Where the minerals are taken from the earth in solution, with the express consent of the lessor which must be first had and obtained, such extraction shall not be within 500 feet of the boundary line of leased lands without the permission of or unless directed by the lessor.

Sec. 3. The lessor expressly reserves:

(a) Rights reserved. The right to permit for joint or several use such easements or rights-of-way, including easements in tunnels, upon, through, or in the land leased, occupied, or used as may be necessary or appropriate to the working of the same or other lands containing the deposits described in the act, and the treatment and shipment of the products thereof by or under authority of the Government, its lessees or permittees, and for other public purposes.

(b) Disposition of surface. The right to lease, sell, or otherwise dispose of the surface of the leased lands under existing law or laws hereafter enacted, insofar as said surface is not necessary for the use of the lessee in the extraction and removal of the leased deposits therein, or to dispose of any resource in such lands which will not unreasonably interfere with operations under this lease.

(c) Monopoly and fair prices. Full power and authority to promulgate and enforce all orders and regulations issued under the provisions of sec. 30 of the act, as amended, necessary to insure the sale of the production of the leased lands to the United States and to the oublic at reasonable prices, to prevent monopoly, and to safeguard the public welfare.

(d) Renewal terms. The right reasonably to fix royalties payable hereunder and other terms and conditions at the end of 20 years from the date hereof and thereafter at the end of each succeeding 10-year period during the continuance of this lease unless otherwise provided by law at the time of the expiration of any such period. Unless the lessee files objections to the proposed terms or a relinquishment of the lease within 30 days after receipt of the notice of proposed terms for a 10-year period, he will be deemed to have agreed to such terms and to the renewal of the lease.

(e) Waiver of conditions. The right to waive any breach of the conditions contained herein, except the breach of such conditions as are required by the act, as amended, but any such waiver shall extend only to the particular breach so waived and shall not limit the rights of the lessor with respect to any future breach; nor shall the waiver of a particular cause of forfeiture prevent cancellation of this lease for any other cause, or for the same cause occurring at another time.

Sec. 4. *Relinquishment of lease.* Upon a satisfactory showing that the public interest will not be impaired, the lessee may surrender the entire lease or any legal subdivision thereof. A relinquishment must be filed, in *duplicate*, in the proper BLM office. Upon its acceptance it shall be effective as of the date it is filed, subject to the continued obligation of the lessee and his surety to make payment of all accrued rentals and royalties, and to provide for the preservation of any mines or productive works or permanent improvements on the leased lands in accordance with the regulations and terms of the lease.

Sec. 5. *Protection of the surface, natural resources, and improvements.* The lessee agrees to take such reasonable steps as may be needed to prevent operations, including operation of operating plants on the leased premises, from unnecessarily: (1) causing or contributing to soil erosion or damaging any forage and timber growth on the leased lands or on Federal or non-Federal lands in the vicinity; (2) polluting air and water; (3) damaging crops, including forage, timber, or improvements of a surface owner; (4) damaging improvements whether owned by the United States or by its permittees or lessees; or (5) destroying, damaging, or removing fossils, historic or prehistoric ruins, or artifacts; and upon any partial or total relinquishment or the cancellation or expiration of this lease, or at any other time prior thereto when required and to the extent deemed necessary by the lessor to fill any sump holes, ditches, and other excavations, remove or cover all debris, and, so far as reasonably possible, restore the surface of the leased land and access roads to its former condition, including the removal of structures as and if required. The lessor may prescribe the steps to be taken and restoration to be made with respect to the leased lands and improvements thereon, whether or not owned by the United States.

Sec. 6. *Removal of equipment, etc., on termination of lease.* Upon termination of this lease, by surrender or forfeiture, the lessee shall have the privilege at any time within a period of 90 days thereafter of removing from the premises all machinery, equipment, tools, and materials, other than underground timbering placed in or on the leased lands, by the lessee, which are not necessary for the preservation of the mine. Any materials, tools, appliances, machinery, structures, and equipment, subject to removal as above provided, which are allowed to remain on the leased lands shall become the property of the lessor on expiration of the 90-day period or such extension thereof as may be granted because of adverse climatic conditions but the lessee shall remove any or all of such property when so directed by the lessor.

Sec. 7. *Proceedings in case of default.* If the lessee shall not comply with any of the provisions of the act or the regulations thereunder or make default in the performance or observance of any of the provisions of this lease and such default shall continue for a period of 30 days after service of written notice thereof by the lessor, the lessor may institute appropriate proceedings in a court of competent jurisdiction for the forfeiture and cancellation of this lease as provided in sec. 31 of the Mineral Leasing Act. If the lessee fails to take prompt and necessary steps to prevent loss or damage to the mine, property, or premises, or danger to the employees, the lessor may enter on the premises and take such measures as may be deemed necessary to prevent such loss or damage or to correct the dangerous or unsafe condition of the mine, or works thereof, which shall be at the expense of the lessee. However, the lessee shall not be held responsible for delays or casualties occasioned by causes beyond the lessee's control.

Sec. 8. *Heirs and successors in interest.* Each obligation hereunder shall extend to and be binding upon, and every benefit hereof shall inure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

Sec. 9. *Unlawful interest.* No Member of, or Delegate to, Congress, or Resident Commissioner, after his election or appointment, or either before or after he has qualified and during his continuance in office, and no officer, agent, or employee of the Department of the Interior, except as provided in 43 CFR 7.4(a)(1), shall be admitted to any share or part in this lease or derive any benefit that may arise therefrom; and the provisions of section 3741 of the Revised Statutes of the United States (41 U.S.C. sec. 22), as amended, and sections 431, 432, and 433, Title 18 U.S.C., relating to contracts, enter into and form a part of this lease so far as the same may be applicable.

THE UNITED STATES OF AMERICA

By ______________________________
(Authorized Officer)

(Seal)

____
(Title)

WITNESSES TO SIGNATURE OF LESSEE(S)

____
(Date)

______________________________ ______________________________
(Signature of Lessee)

______________________________ ______________________________
(Signature of Lessee)

______________________________ ______________________________
(Signature of Lessee)

If this lease is executed by a corporation, it must bear the corporate seal

GPO 842-443

Form 3510–1
(September 1977)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FORM APPROVED
OMB NO. 42–R1477

PROSPECTING APPLICATION AND PERMIT
(Other Than Coal)

1. What mineral are you applying for?

2. Give legal description of land requested		3. Legal description of land included in permit *APPLICANT DOES NOT FILL IN THIS SPACE*	
Total acres	Rental submitted $	Total acres	Rental retained $

4. Are the lands administered by a government agency? ☐ Yes ☐ No *(If "yes," give name of agency)*

5. Are you the sole party in interest? ☐ Yes ☐ No *(See Specific Instruction No. 5)*

6a. Are you a citizen of the United States? ☐ Yes ☐ No

b. Are you 21 years of age or over? ☐ Yes ☐ No

7a. Is application made for a corporation or other legal entity? ☐ Yes ☐ No *(See Specific Instructions No. 7a and 7b)*

b. Has a statement of qualification been filed? ☐ Yes ☐ No *(If "yes," give file number)*

8. Have you enclosed a filing fee of $10? ☐ Yes

9. Have you enclosed the first year's advance rental computed at the rate of 25¢ per acre? ☐ Yes *(See Specific Instruction No. 9)*

I CERTIFY That my interests, direct or indirect, in leases, permits, and applications therefor, do not exceed the maximum permitted by law or regulation; and that the statements made herein are true, complete, and correct to the best of my knowledge and belief and are made in good faith.

(Signature of Applicant) (Signature of Applicant)

(Date) (Attorney-in-fact)

Title 18 U.S.C. Section 1001, makes it a crime for any person knowingly and willfully to make to any department or agency of the United States any false, fictitious or fraudulent statements or representations as to any matter within its jurisdiction.

DO NOT WRITE BELOW THIS LINE

PROSPECTING PERMIT

A permit for the lands in Item 3, above, is hereby issued under the ☐ Mineral Leasing Act, 30 U.S.C. 181 *et seq.* ☐ Acquired Lands Leasing Act, 30 U.S.C. 351 *et seq.* ☐ 43 CFR 3511 *et seq.* and is subject to all regulations now or hereafter in force when not inconsistent with any express and specific provisions herein, and to the terms and conditions set forth on the reverse side hereof.

This permit, to the extent applicable, is subject to standard or special stipulations. Stipulations, if any, are attached.

THE UNITED STATES OF AMERICA

Effective date of permit ____________

This permit is issued for a period of 2 years

By ____________
(Signing Officer)

(Title)

NOTICE

The Privacy Act of 1974 and the regulation in 43 CFR 2.48(d) provide that you be furnished the following information in connection with information required by this application.

AUTHORITY: 30 U.S.C. 181 et. seq., 351 et. seq.; 43 CFR 3511

PRINCIPAL PURPOSE – The information is to be used to process your application for prospecting permit.

ROUTINE USES:

(1) The adjudication of the applicant's rights to the land or resources.

(2) Documentation for public information in support of notations made on land status records for the management, disposal, and use of public lands and resources.

(3) Transfer to appropriate Federal agencies when concurrence is required prior to granting a right in public lands or resources.

(4) (5) Information from the record and/or the record will be transferred to appropriate Federal, State, local or foreign agencies, when relevant to civil, criminal or regulatory investigations or prosecutions.

EFFECT OF NOT PROVIDING INFORMATION – Filing of this application and disclosure of the information is voluntary. If the information is not provided the application may be rejected.

GENERAL INSTRUCTIONS

1. *Number of copies.* Five copies of the application, typewritten or printed plainly and signed in ink, *must* be filed in the proper BLM office for the State in which the lands are located; except acquired and solid *(hard-rock)* minerals seven copies of the application *must* be filed. Applications for lands in the following States which have no proper BLM office should be filed in the office indicated:

North Dakota, South Dakota
State Office, BLM, Billings, Montana 59107

Kansas, Nebraska
State Office, BLM, Cheyenne, Wyoming 82001

Oklahoma
State Office, BLM, Santa Fe, New Mexico 87501

Eastern States
Eastern States Office, BLM,
7981 Eastern Avenue
Silver Spring, Maryland 20910

2. If additional space is needed in furnishing any of the required information, it should be prepared on additional sheets, initialed, and attached to your application.

SPECIFIC INSTRUCTIONS

Item 1 – Specify mineral applied for. A coal prospecting permit applicant *must* furnish a showing as to the need for additional coal production which cannot otherwise be reasonably met. If such a showing of need cannot be made, a statement of the reasons a permit is desired *must* be furnished. The required showing should be attached to the application. A prospecting permit may *not* issue for oil or gas.

Item 2 – Land description: A complete and accurate description of the lands for which the permit is desired. If the lands have been surveyed under the public land rectangular system, each application must describe the lands by legal subdivision, section, township, and range. When protracted surveys have been approved and the effective date thereof published in the Federal Register, all applications to lease lands shown on such protracted surveys, filed on or after such effective date, must describe the lands only according to the section, township, and range shown on the approved protracted surveys. If the lands have neither been surveyed on the ground nor shown on the records as protracted surveys, each application must describe the lands by metes and bounds, giving courses and distances between the successive angle points on the boundary of the tract, in cardinal directions *except* where the boundaries of the lands are in irregular form, and connected by courses and distances to an official corner of the public land surveys. In Alaska, the description of unsurveyed lands *must* be connected by courses and distances to either an official corner of the public land surveys or to a triangulation station established by any agency of the United States (such as the United States Geological Survey, the Coast and Geodetic Survey, or the International Boundary Commission), if the record position thereof is available to the general public. The applicant *must* include an accurate map or plat of the lands prepared from reliable map source, unless the lands are surveyed under the public land system of surveys.

Total area of land requested should be shown, in acres, in the space provided at the bottom of Item 2. That area, except where the rule of approximation applies, *must not exceed* the maximum permitted by law or regulation. All of the land, applied for, *must be within a 6-mile square or an area of 6 survey sections in length or width.* In instances where the United States does not own a 100-percent interest in the mineral deposits in any particular tract, the offeror should indicate the percentage of Government ownership.

Item 3 – Party in interest: Applicant must indicate whether or not he is the sole party in interest. If not, the applicant must submit, at the time the offer is filed, a signed statement setting forth the names of the other interested parties. All interested parties must furnish evidence of their qualifications to hold an interest in this permit, if issued.

Item 7a – Application by Corporation or other entity: If the applicant is a corporation, it must submit a statement containing the following information: (1) the State in which it is incorporated, (2) that it is authorized to hold mineral leases, (3) that the officer executing this application is authorized to act on behalf of corporation in such matters; and, (4) the percentage of voting stock and all stock owned by aliens or for those having addresses outside the United States. If 10 percent or more of the stock of any class is owned or controlled by, or on behalf of, any one stockholder, a separate showing of his citizenship and holdings must be furnished.

Item 7b – If the applicant is an unincorporated association (including a partnership), the offer *must* be accompanied by a certified copy of the articles of association together with the same showing as to citizenship and holdings of its members as are required of an individual. If information as to qualifications has been filed previously, reference to that serial number may be made.

Item 8 – Filing fee: A filing fee of $10 *must* accompany an application. *Filing fees are not returnable.*

Item 9 – Advance rental: An advance rental, at the rate of 25 cents per acre, or fraction thereof, but not less than $20, *must be submitted with this application.*

Sec. 1. *Prospecting.* Permittee shall diligently prospect the lands by core drilling or other acceptable methods. Permittee shall notify the regional mining supervisor of the Geological Survey of the region in which the permit lands are situated of his plans for prospecting prior to commencement of prospect work.

Sec. 2. *Operating regulations.* (a) Permittee shall comply with all regulations of the Secretary of the Interior, and, as to the lands described herein under his jurisdiction, to the regulations and orders of the Secretary of Agriculture.

(b) Permittee shall comply with the provisions of the operating regulations of the Geological Survey (30 CFR Parts 211 and 231) and all orders issued pursuant thereto. Copies of the operating regulations may be obtained from the regional mining supervisor.

(c) Permittee shall not prospect lands under administrative jurisdiction of the Forest Service without prior notice to and consent of that Service to a plan for prospecting.

(d) Permittee shall allow inspection of the premises and operations by duly authorized representatives of the Departments of the Interior, Agriculture, or other agency administering the lands and shall provide for the free ingress or egress of Government officers and for users of the lands under authority of the United States.

Sec. 3. *Multiple use.* (a) Valid existing rights acquired prior hereto on the lands described herein will not be adversely affected hereby.

(b) The granting of this permit will not preclude the issuance of other permits, leases, or other development of the same lands.

(c) The permitted lands shall be subject, at all times, to any other lawful uses by the United States, its lessees, permittees, licensees, and assigns, but such use shall not materially interfere with the permittee's operations hereunder.

(d) The Government reserves the right to sell or otherwise dispose of the surface of the permitted lands under existing law or laws hereafter enacted, insofar as such disposal will not materially interfere with the rights of the permittee.

(e) The permittee shall afford all facilities for inspection of the prospecting work on behalf of the Secretary of the Interior or head of agency administering the lands and to make a report, on demand of all matters pertaining to the character, progress, and results of such work.

(f) The permittee shall observe such conditions as to the use and occupancy of the surface of the lands as provided by law, in case any of said lands shall have been or may be entered or patented with a reservation of mineral deposits to the United States.

Sec. 4. *Removal of deposits.* Permittee shall remove from the lands only such deposits as may be necessary to experimental work or to establish the existence of valuable deposits within the permit area and shall keep a record of all mineral mined.

Sec. 5. *Rental.* Permittee must pay an annual rental of 25 cents per acre, or fraction thereof, *but not less than $20 per year.* The annual rental payment shall be made *on or before* the anniversary date of the permit.

Sec. 6. *Extension of permit.* (a) This permit may be subject to extension under applicable regulation upon approval of the authorized officer of the Bureau of Land Management and upon the showing of entitlement thereto.

(b) Application for extension of this permit, where authorized by law or regulation, must be filed, in *duplicate*, in the proper land office within the period beginning 90 days prior to the date of expiration of this permit. Unless such an application is filed within the time specified, this permit will expire without notice to the permittee.

Sec. 7. *Reward for discovery.* Permittee may apply for a preference-right lease if he shall have discovered valuable deposits of minerals covered by this permit within the permit area and within the period of this permit as issued. The showing required to be made in the preference-right lease application is set forth in the appropriate regulation. In addition, the applicant for a sodium preference-right lease must show that the lands applied for are chiefly valuable for chlorides, sulphates, carbonates, borates, silicates, or nitrates of sodium contained therein. Also, see appropriate regulation for limitation on acreage holdings.

Sec. 8. *Equal opportunity clause.* This permit is subject to the provisions of Executive Order No. 11246 of Sept. 24, 1965, as amended, which sets forth the nondiscrimination clauses. A copy of this order may be obtained from the signing officer.

Sec. 9. *Assignments.* All assignments or transfers of this permit or of any interest therein, whether by direct assignment, operating agreement, sublease, working interest, royalty interest, or otherwise, must be filed with the Bureau of Land Management for approval in accordance with the provisions of the appropriate regulation and will take effect as of the first day of the month following approval thereof, or, if transferee so requests, as of the first day of the month during which such approval is given.

Sec. 10. *Relinquishment of permit.* Permittee may relinquish this permit, in whole or part, by filing in the proper land office a written relinquishment, in *triplicate*, which shall be effective as of the date it is filed, subject to the continued obligation of permittee and his surety to make payment of all accured rentals and royalties; and, to provide for the preservation of any mines or productive works, or permanent improvements on the permit land as required by the applicable regulations and terms of this permit.

Sec. 11. *Termination or cancellation.* (a) This permit shall terminate automatically upon failure of the permittee to pay the rental *on or before* the anniversary date thereof, except that if the time for payment falls upon any day in which the appropriate land office to receive payment is not open, payment received on the next official working day shall be deemed to be timely.

(b) This permit may be cancelled in accordance with the regulations upon failure by permittee to exercise due diligence in the prosecution of the prospecting work or for violation of any terms and conditions hereof, or any of the pertinent regulations.

Sec. 12. *Protection of surface, natural resources, and improvements.* The permittee agrees to take such reasonable steps as may be needed to prevent operations on the permitted lands from unnecessarily: (1) causing or contributing to soil erosion or damaging crops, including forage, and timber growth thereon or on Federal or non-Federal lands in the vicinity; (2) polluting air and water; (3) damaging improvements owned by the United States or other parties; or (4) destroying, damaging or removing fossils, historic or prehistoric ruins, or artifacts; and upon any partial or total relinquishment or the cancellation or expiration of this permit, or at any other time prior thereto when required and to the extent deemed necessary by the lessor to fill any pits, ditches and other excavations, remove or cover all debris, and so far as reasonably possible, restore the surface of the permitted land and access roads to their former condition, including the removal of structures as and if required. The lessor may prescribe the steps to be taken and restoration to be made with respect to the permitted lands and improvements thereon whether or not owned by the United States.

Sec. 13. *Antiquities and objects of historic value.* When American antiquities or other objects of historic or scientific interest including but not limited to historic or prehistoric ruins, fossils or artifacts are discovered in the performances of this permit, the item(s) or condition(s) will be left intact and immediately brought to the attention of the contracting officer or his authorized representative.

Sec. 14. *Sodium deposits in oil shale areas.* If this application is for sodium minerals in the oil shale area described in P.L.O. 4522, September 24, 1968, a prospecting permit will be issued only in those areas where it is believed likely that, if sodium deposits are found, they will occur in discrete beds where development of the sodium deposits would not adversely affect the oil shale values of the lands. Any sodium prospecting permits or preference-right leases that may issue on these oil shale lands will be restricted to those beds valuable for sodium which the Secretary of the Interior or his delegate determines to be workable without removal of significant amounts of organic matter and without significant damage to oil shale beds.

Sec. 15. *Unlawful interest.* No Member of, or Delegate to, Congress, or Resident Commissioner, after his election or appointment, or either before or after he has qualified and during his continuance in office, and no officer, agent, or employee of the Department of the Interior, except as provided in 43 CFR 7.4(a)(1), shall be admitted to any share or part in this permit or derive any benefit that may rise therefrom, and the provisions of section 3741 of the Revised Statutes of the United States, as amended (41 U.S.C. sec. 22), and sections 431, 432, and 433, Title 18 U.S.C., relating to contracts, enter into and form a part of this permit so far as the same may be applicable.

Sec. 16. *Stipulations*

GPO 842-448

APPENDIX 2

ANTICIPATED PROSPECTING METHODS AND PROPOSED STIPULATIONS

Exploration drilling is the first step in establishing a new mine. It determines the presence or absence of trona and gives a preliminary idea of the grade and quantity of the deposit. To a lesser extent, exploration drilling indirectly tests stratigraphy, structure, wall rock alteration, and ore guides and controls. Prospecting does not require any permanent surface structures.

Two methods of drilling are most commonly used in mineral exploration in the Green River Basin: diamond and rotary. The choice depends upon the type of sample required and location of the drill site. In easily traversed terrain, truck-mounted rotary rigs are used where vertical holes several thousand feet deep are planned. Various modifications of the rotary drill provide a flexible variety of bit types and sizes capable of drilling many different types of rock. Several rotary rigs can be converted quickly to core drilling.

Trona exploration usually consists of use of a rotary drill down to the vicinity of the trona beds, at which point a core barrel and diamond bit is added to the end of the drill string and drilling continued. This procedure allows low cost drilling of the initial hole and core collection from the zones of interest. The diamond drill remains the single most versatile apparatus. Diamond drill machines usually are equipped to set and remove casing, pump the various drill muds, and cement when adverse conditions are encountered. In diamond drilling, water is the drilling medium most commonly used, a core sample is cut by the diamond bit, which is received in a barrel behind the bit. In deep holes, wire-line apparatus is used to remove and replace the core barrel inside drill rods without taking the tool from the hole. Diamond core drilling is relatively slow and costly—progress of 40 feet per 8-hour shift is considered good and generally costs in excess of $10 per foot. Chief advantages of the diamond drill are mobility and flexibility.

Rotary drills are faster and cheaper than diamond drills and are simpler to operate. In drilling most sedimentary formations, rate of progress is good and advances in excess of several hundred feet per shift often are obtained. Under good drilling conditions, flushing with air, rock chips from 1/4 to 3/8 inch commonly are obtained from the 4 1/4 inch bit, and many geologic and mineralogic features of interest can be readily identified. Major relationships such as fracturing, bedding, etc., are not preserved in the sample. Drill cuttings can be collected and are often split at the drill site for assay testing. Samples are sacked and transported to the exploration office for sample handling and logging. The principal disadvantages of rotary drilling are that most equipment can drill vertical holes only, it is difficult to set casing, and the individual sample chips are considered too small to provide needed information in some kinds of exploration drilling.

Cuttings from drilling operations are the most significant waste associated with prospecting. They are disposed of by either spreading over the surface, returned into the hole, or hauled offsite.

Proposed prospecting permit conditions are listed below:

1. The permittee would avoid any operation when the ground is muddy and/or wet. The AO could prohibit exploration, drilling, or other activities during wet or heavy snow periods.

2. Whenever possible, a portable mud pit would be used when drilling with fluids.

3. No blading or other dirt work would be allowed without written permission from the AO.

4. There would be no burying of garbage and/or trash. All trash and garbage would be hauled to an approved disposal site.

5. Access across public lands to the permit area would require authorization through the issuance of a Temporary Use Permit (TUP).

6. Any vegetation removed during blading or construction would be spread back over the disturbed area after seeding as cover for the seeded area.

7. At least 6 inches of topsoil or soil material would be stockpiled to be spread back over disturbed areas after completion of operations, unless otherwise specified by the AO.

8. Prior approval from the AO would be needed for the use of water from developed stockwater sources.

9. All prospecting activities, including but not limited to, drilling operations, water hauling, various vehicular traffic, etc.; would be restrict-

ed to the permitted area and/or the area authorized in the TUP.

10. All areas disturbed would be rehabilitated to the satisfaction of the AO.

11. Before any surface disturbing activity, a cultural resource inventory would be conducted pursuant to Executive Order 11593 and BLM Instruction Memorandum WY-80-523 at the company's expense to identify all cultural resources present within each proposed permit area.

12. If National Register quality sites are found during the cultural resource inventory, Section 106 compliance procedures would be conducted and appropriate mitigation would be applied. Salvaging or testing of non-National Register sites would be conducted pending the approval of the BLM AO.

13. Drill Hole Plugging Standards: All drill holes would be plugged in accordance with the State of Wyoming Land Quality Rules and Regulations, in particular W.S. 35-11-404.

14. No activity would take place in big game crucial wintering habitat between November 15 and March 15 without prior approval of the AO.

15. In order to protect sage grouse strutting and nesting habitat, prospecting would not be allowed between March 1 and June 15 within 1 3/4 miles of any sage grouse strutting ground (lek center).

16. No surface-disturbing activities would be allowed in identified lambing areas between May 1 and June 10 unless authorized by the AO.

17. During any drilling operation, the BLM hydrologist would be notified if black water or flowing artesian wells were encountered.

18. No surface disturbance would be allowed within one-quarter mile of any well preserved ruts of the various historic trails.

19. Prospecting occurring within any wilderness or wilderness inventory unit must comply with all laws, regulations, and the interim wilderness management policy applicable to the protection of the wilderness characteristics of the area.

20. All drainages would be kept open to allow free water movement.

21. After operations are completed, any new roads or pads constructed would be rehabilitated. All berms and borrow ditches would be smoothed to conform to the surrounding terrain.

22. All existing roads that are to be used would be graded only to prevent rutting and to fill in ruts. No other additional blading or widening of existing access roads would be allowed without permission from the AO.

23. Road drainage crossings would be designed so they would not cause siltation or accumulation of debris in the drainage crossing, nor would the drainages be blocked by the road bed. Whenever possible, streambank crossings on major drainages should be constructed with the bank feathered back at a 45° horizontal angle or less to avoid siltation.

24. No activity would take place within one mile of the Green River during the raptor nesting period of March 1 to June 30 unless allowed by the AO.

APPENDIX 3

MINING DESCRIPTION

All Wyoming trona is mined underground using modified and considerably beefed-up coal mining machinery to handle the harder, heavier, and more abrasive trona ore. Both room-and-pillar and longwall methods of mining are used. The mines are classified as gassy, and they must be well ventilated to prevent a buildup of methane gas which is associated with the oil shale layers intermingled with the trona beds. Stauffer currently is mining trona at 790 and 830 feet below the surface, while Allied and FMC are operating at about 1,500 feet and Texasgulf is mining at 1,370- and 1,420-foot depths (Kostick 1980).

All trona mines in the Green River Basin are shaft mines (Figure A3-1); the trona beds are reached by a vertical opening from the surface. Vertical shafts are used to bring trona out of the mine. Ground support (headframe) over the opening is dependent on various factors, including the length or depth of the opening, its intended lifetime and use, water and climatic conditions, and the nature of the strata exposed. The shafts are generally lined with concrete.

At least two and usually three shafts are needed for personnel entry, ore hoisting (production shaft), and ventilation. The shafts are about 16-22 feet in diameter and extend down 1,000 to 1,500 feet, depending on the depth of the ore beds. From 16,000 to 21,000 cubic yards of rock are removed during construction of each shaft and this material is generally used in the development of the plant site. Allied currently is constructing a ventilation shaft 2 miles south of its mine. The 17-foot-wide, 1,650-foot-deep shaft will require 1,800 cubic yards of concrete for the 9-inch-thick walls. The shaft will improve ventilation throughout the mine, and it will be completed and a ventilation fan installed by October 1981.

In addition to shaft sinking, ore bins are excavated and other support facilities, such as headframe, hoists, underground transformer stations, underground primary crusher, permanent main line conveyor belt, and ventilation fans are constructed. Ventilation fans remove dust and gases from the mining operation and provide fresh air to the area being mined.

MINING SYSTEMS

Underground mining systems which can be used in modern trona mines are generally classified according to the equipment used, such as conventional, continuous, longwall, or shortwall. All of these systems are adapted from coal mining, since trona is only slightly harder than coal and is found in beds like coal. Conventional, continuous, and longwall methods are currently being used for trona mining in this area.

CONVENTIONAL

This system is presently being used by Stauffer Chemical Company. In conventional mining systems, the trona is extracted in a sequence of operations. The trona face is undercut, center cut, or top cut, with a cutting machine (which resembles a large chain saw on wheels). The block or blocks of trona outlines are then drilled, using mobile powered drills, hand-held electric, or hydraulic drills. The holes are then charged with explosives and the trona is dislodged. The broken trona is gathered by a loading machine and then transported to the surface by either a shuttle car, or conveyor belt. Roof support (wooden timbers, steel crossbars and posts, or most commonly, roof bolts) is usually installed by machine. Ventilation is extended to the trona face and now the trona face is ready for the next cycle.

LONGWALL

This system is presently being used by Allied Chemical Company, and FMC plans to use the system. In the longwall mining system, large blocks of trona are completely extracted in a single, continuous operation (Figure A3-2). Hydraulic yielding jacks or self-advancing jack units (chock) support the roof at the immediate face as the trona is removed. As the face advances, the strata are allowed to cave behind the support units. The broken mineral is removed by the plowing action of the machine onto a chain-type conveyor.

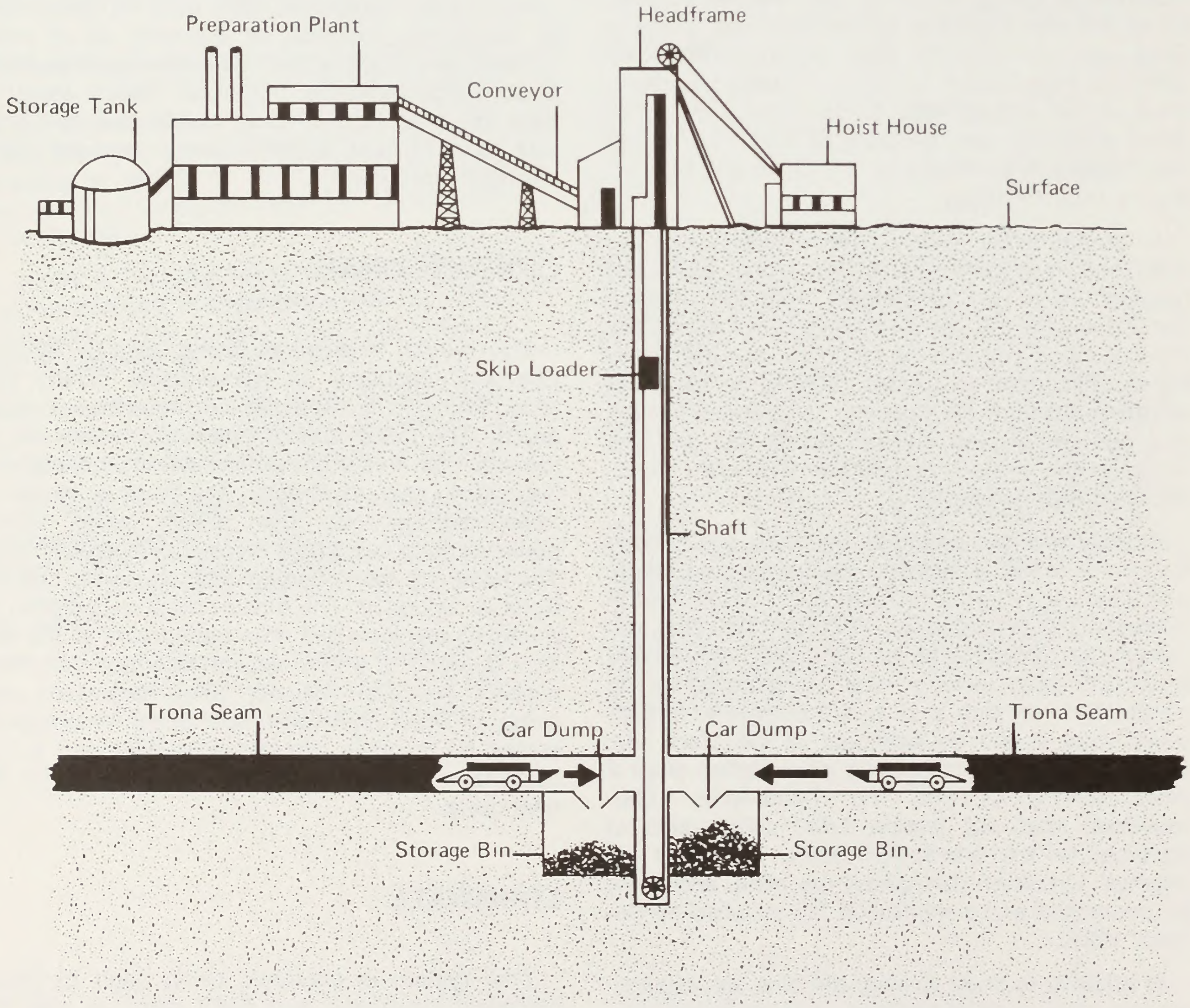


Figure A3-1

SHAFT MINE

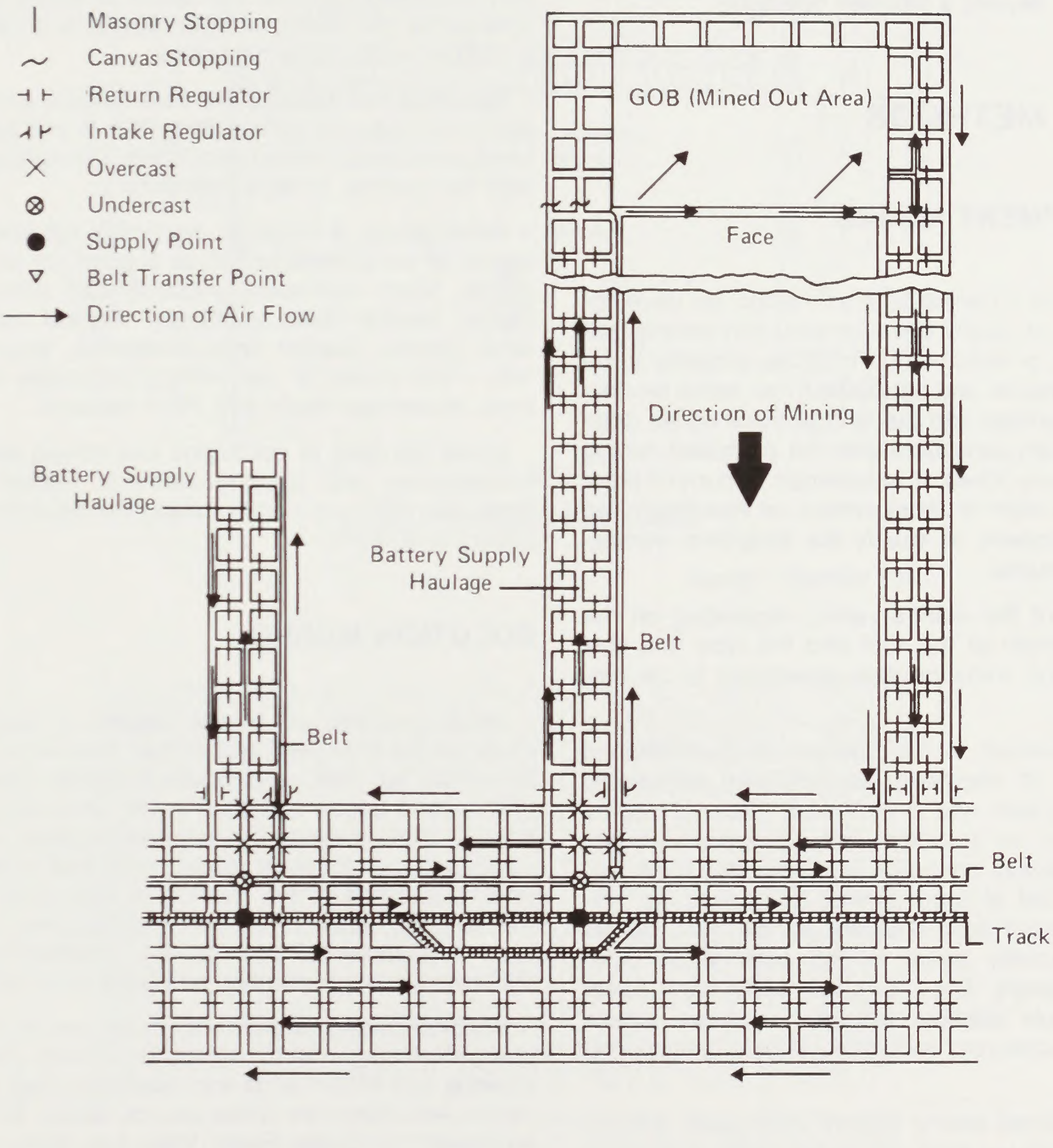


Figure A3-2

PLAN FOR LONGWALL DEVELOPMENT
(Entries Driven by Continuous Miners)

Source: Schroder 1973

Longwall mining machines fall into two general categories, plows (planers) or shearers (shearer-loaders). The plow is the simpler of the two machines, composed of a blade-like arrangement fitted with fixed bits or a saw-toothed edge that is pulled along the mining face by a heavy chain, powered and controlled from one end of the face. The plow normally cuts 3 to 6 inches of mineral from the face on each pass, and most plows are made to cut while traveling in either direction. Figure A3-3 depicts a longwall operation.

MINING METHODS

DEVELOPMENT MINING

Development mining is also known as development work, or simply development, first mining, advance work, or solid work. The trona property to be worked is divided and subdivided into areas by driving sets of entries into the field of trona on an engineered pattern consistent with the proposed mining system (Figure A3-4). It is common in current practice to drive eight or more entries (or headings) into the mine property to satisfy the long-term ventilation requirements.

The size of the entries varies, depending on the relative strength of the roof and the type and size of mining and transportation equipment to be employed.

If the selected mining system is conventional, continuous, or shortwall, development commonly follows a "room and pillar" plan. Sets of rooms (usually 4, 5, or 6 rooms, with appropriate crosscuts) are usually driven at 90° from the room entries. Each set of room entries or "panel," is normally separated from adjacent panels by a barrier of trona (usually equal to the pillar width used within the panel). The pillars left within each panel are of a size suitable for later recovery unless mining or economic conditions dictate only partial recovery.

If the selected mining system is longwall, parallel panels are driven from the dross entry, separated by a wide barrier of solid trona. At a predetermined distance (in the U.S. this has been from 1,500 to 7,500 feet), the panels are cross-connected to outline the longwall face. Longwall mining faces in the U.S. range in length from about 300 to 650 feet (see Figures A3-2 and A3-3).

RETREAT MINING

When a given area, or perhaps the entire trona property, has been developed, second mining or retreat mining is begun. The emphasis in present mining practice is definitely on retreat mining where full recovery is practiced. Roof support costs are generally lower on retreat, and production rates are consistently higher. As in development mining, it is very important from the standpoint of safety and efficiency for the mining of pillar blocks to be done in a planned and orderly sequence.

Complete extraction is the ideal choice, but there are circumstances under which this is not possible because of cost, mining conditions, the right to subside the surface, or legal restraints.

Even where a mine is practicing full recovery, blocks of trona must be left as support for streams, ponds, lakes, reservoirs, unusually bad roof areas, locally severe dips, ventilation control between large panels, bleeder entry protection, boundaries with other mines or ownerships, nearness to outcrop, oil and gas wells, and other reasons.

Under the best of conditions and mining practice, full recovery with pillaring methods seldom averages over 85%. In partial mining the equivalent recovery is 40-60%.

SOLUTION MINING

Solution mining will be the subject of increasing study as the shallower and thicker deposits of trona are mined out. FMC and Vulcan Materials Company (VMC) have begun test sites in the trona deposition area. The trona would be dissolved in place leaving cavities in an otherwise undisturbed host rock. The relative success of the method is dependent upon the ease of solution; ground stability; and, in the case of multiple-well penetrations, establishing flow channels between injection and production wells.

Solution mining methods for trona are in the experimental stage. VMC, which tentatively plans to develop a 1 MTPY soda ash operation, has established field tests on State leases about 20 miles southwest of Green River. VMC has three plants that solution mine salt. FMC's solution mining project is located 15 miles south of the current plant, and it involves injecting solvent into the trona 2,100 feet below the surface, forcing the solution through the bed and out an exit line to the processing plant. Three pipelines will connect the plant with the test project that FMC hopes will yield 1 MTPY of soda ash by the mid-1980s.

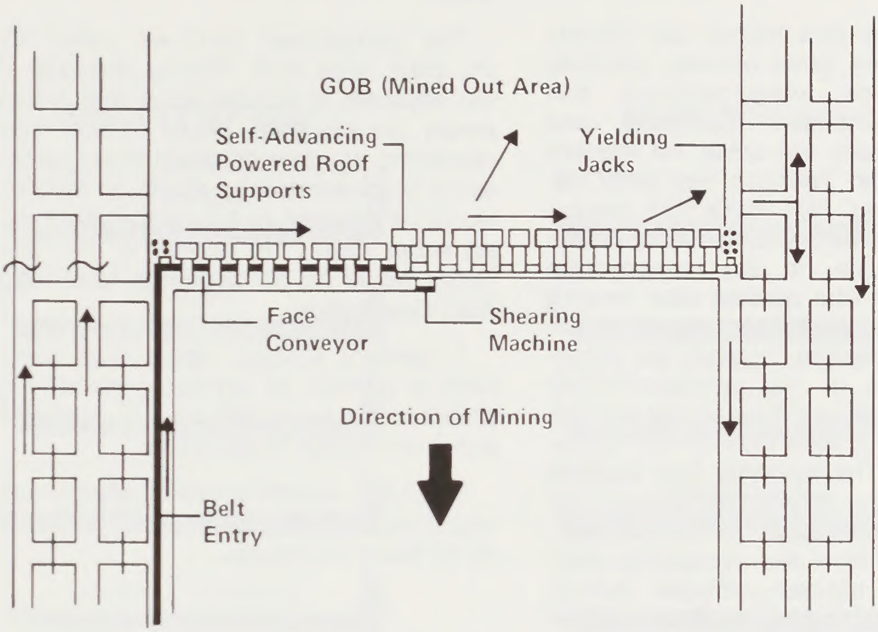
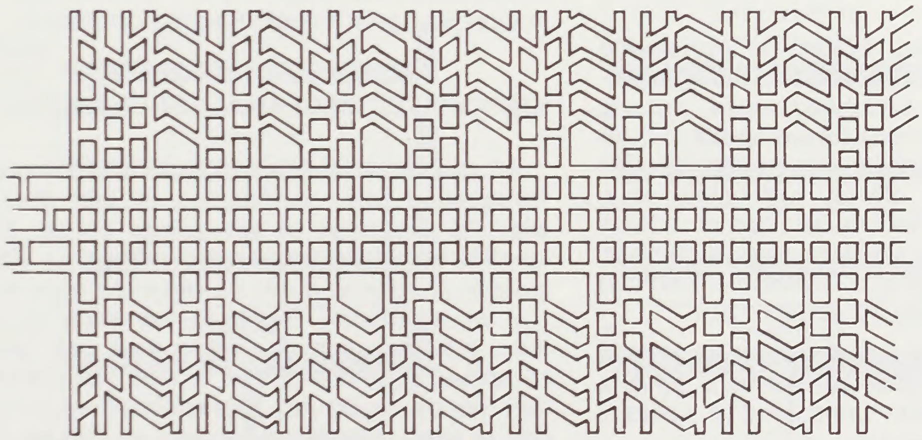


Figure A3-3

PLAN OF LONGWALL FACE

Source: Schroder 1973



Development mining is one plan of mining where the surface must be supported. Usually the rooms are driven in sets on one side of the panel as the entries are driven, then the room sets are mined in sequence on the other side in retreat.

Figure A3-4

DEVELOPMENT MINING PLAN

Source: Schroder 1973

ANTICIPATED MILLING AND REFINING METHODS

It is expected that any new milling and refinery plants built would use the same process methods currently being employed, sesquicarbonate and monohydrate. Allied Chemical Company and Stauffer Chemical Company are using the modern monohydrate process and Tenneco has been designed to use this method. FMC uses both sesquicarbonate and monohydrate processes, and Texasgulf uses sesquicarbonate. In the monohydrate process, crude soda ash (the product after heating the mined ore) is the material dissolved; and then sodium carbonate monohydrate crystals are recovered from the solution. In the sesquicarbonate process, the crushed trona ore is dissolved and the sodium carbonate monohydrate crystals are recovered from the solution. The following flow diagram (Figure A3-5) illustrates the differences between the two processes involved in soda ash production. The potential emissions from the processing plant are particulates, sulfur dioxide, nitrogen oxides, carbon monoxide, and hydrocarbons. Those pollutants usually exceed the emission rate by greater than 250 tons per year.

SURFACE STRUCTURES AND FACILITIES

Surface facilities would include a processing plant, steam plant (usually coal-fired), water treatment plant, hoist house, mine headframes, ore and coal storage buildings, cooling towers, product storage silos, load out stations, conveyor transfer system, change houses, offices, warehouse area, machinery repair shop, laboratory, heater house, and other miscellaneous small structures. Surface facilities (excluding tailings and containment ponds) usually cover approximately 70 acres of land.

Other support facilities would include a tailings disposal pond, a water runoff containment pond, a sanitary sewer stabilization pond, and a sanitary landfill for solid waste disposal.

WASTE DISPOSAL

A tailings pond covering about 200 acres of surface area is needed to support the operation of a one MTPY soda ash plant. Approximately 420 gpm of slurry and liquids would be pumped into the pond, which is the method used by all present operations. No other legal or economically feasible method of disposal is known. These ponds are self-contained with all water being eliminated by evaporation.

The containment pond will collect the runoff in the plant area from sloping drainage ditches that run adjacent to access ways and around the temporary ore stockpile. Liquid effluent from the mine, consisting of water obtained when permeable sandstone is penetrated by shafts or mining operations, would be pumped to the containment pond. Collected water would be reused in the process plant. There would be no discharge from the pond other than evaporation.

A sanitary sewage stabilization pond would be used to contain all sewage generated by plant operations. There would be no discharge from this pond, other than evaporation.

A sanitary landfill covering approximately 2 acres would be needed to dispose of solid waste generated by plant operations.

RECLAMATION

Detailed site-specific reclamation plans have been developed and are updated concurrently with the five-year mining plans for the existing soda ash operations. Any proposed operations would have to submit and obtain approval for a site-specific reclamation plan prior to commencing operation.

ANTICIPATED RECLAMATION METHODS

All surface area disturbed will be contoured and revegetated upon termination of that area's use with the exception of the tailings ponds. Sanitary landfills would be reclaimed as they are filled. All surface structures would be removed upon termination of operations. Rights-of-way such as powerlines, pipelines, communication lines, etc., would be reclaimed upon completion of their installation. Tailings ponds would not be reclaimed upon completion of plant operations because at present it is believed to be infeasible due to the lack of technological procedures. Should feasible means to reclaim these ponds become available, they would be incorporated into the applicable mining/reclamation plan. Tenneco will be looking at the possibility of disposing of tailings underground. Tailings would be pumped into mined-out areas in stages and the test monitored for distribution, control, ground support, leakage and other parameters. Such tests could not begin until a suitable area has been mined out.

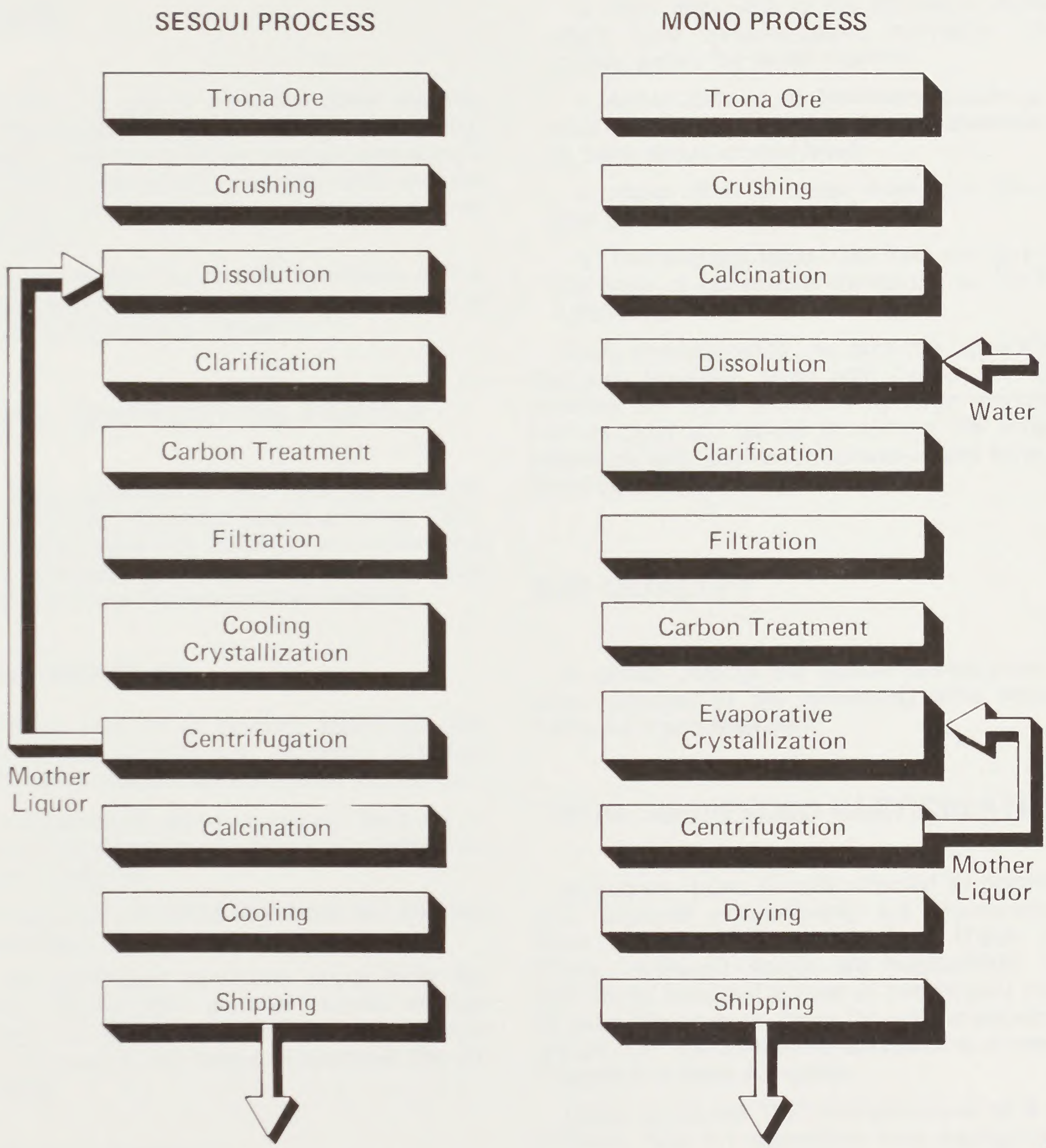


Figure A3-5

COMPARISON OF SESQUICARBONATE AND MONOHYDRATE ROUTES FOR PRODUCTION OF SODA ASH FROM TRONA ORE

Source: FMC, Green River, Wyoming

APPENDIX 4

CLIMATIC CONDITIONS AND AIR QUALITY

CLIMATE

Tables A4-1, 2, and 3 show the mean monthly temperature extremes; mean monthly and annual precipitation; and the average monthly and annual snow depths, respectively, reported from stations located in or near the sodium development area (see Glossary).

Further information on climatic conditions in the Rock Springs District are available for review in the BLM Rock Springs District Office.

VERTICAL TEMPERATURE PROFILE

From data gathered by the National Weather Service at Lander, Wyoming; Grand Junction, Colorado; and Salt Lake City, Utah; it is inferred that vertical temperature profiles in the sodium development area have the following characteristics:

MORNING SOUNDINGS

1. About 85% of all morning soundings—observation time at 5:00 a.m. Mountain Standard Time (MST)—indicate surface-based inversions.

2. Two-thirds of these inversions have an increase of temperature with height of greater than 6°F per 1,000 feet.

3. About 50% of these inversions are 800 feet or more deep.

4. Surface-based inversions occur most frequently during the summer (June through August), but the deepest inversions are most likely to occur in the winter (December through February).

AFTERNOON SOUNDINGS

1. Less than 10% of the afternoon soundings—observation time 5:00 p.m. MST—have surface-based inversions.

2. More than 75% of the surface-based inversions that do occur are more than 3,000 feet deep but have an increase of temperature with height of less than 6°F per 1,000 feet.

3. More than 50% of the afternoon soundings which have surfaced-based inversions are recorded during the winter months.

4. About 25% of all afternoon soundings indicate upper-level inversions (i.e., an inversion with its base above ground level).

5. About 80% of these inversions are more than 80 feet thick.

6. The average lapse rate from the ground to the base of upper-level inversions is -5.4°F per 1,000 feet.

These characteristics are generally applicable to the area. However, since both Lander and Grand Junction are more sheltered by large topographic barriers than are typical throughout the area, the frequency and depths of surface-based inversions could be overestimated.

AIR QUALITY

Air quality data for the sodium development area were gathered at the monitoring sites shown in Table A4-4 and Map A4-1.

TOTAL SUSPENDED PARTICULATES

Monitored values directly affected by commercial and industrial environments are represented by Sites A-6 and A-8 through A-12 (Table A4-5). These measured values are substantially higher than those recorded at rural or background industrial sites. Portions of these 24-hour maximum and annual TSP concentrations approach or exceed the Federal and State standards.

Using monitored TSP concentrations as a prime criterion, Site A-7 represents rural background for the area, since this site is apparently unaffected by local industrial operations. Comparable levels are also observed at Site A-16. The maximum 24-hour concentrations recorded in 1975 at these locations ranged from 53 to 63 micrograms per cubic meter ($\mu g/m^3$), less than half of the Federal secondary and State standard of 150 $\mu g/m^3$. The annual concentrations at both sites are 16 $\mu g/m^3$, approximately one-quarter of Federal 60 $\mu g/m^3$ guideline.

Table A4-1

MEAN MONTHLY TEMPERATURES AND TEMPERATURE EXTREMES IN DEGREES FAHRENHEIT FOR STATIONS IN OR NEAR THE SODIUM DEVELOPMENT AREA

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	Temperature Extremes	
														Max.	Min.
Church Buttes	20	23	29	38	50	59	67	65	55	45	31	22	42	96	-33
Evanston	19	21	27	38	47	55	62	61	52	42	30	21	40	99	-38
Farson	9	14	24	39	49	57	64	61	53	41	25	15	38	94	-46
Kemmerer	17	20	26	38	48	55	63	61	52	42	28	20	39	98	-33
Green River	19	24	33	44	53	62	69	68	58	46	32	23	44	--	--

Source: Environmental Research and Technology, Inc., 1977.

Table A4-2

MEAN PRECIPITATION IN INCHES AT STATIONS IN THE SODIUM DEVELOPMENT AREA

Station	Elevation (Feet)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Farson	6,591	0.41	0.46	0.45	0.69	0.96	0.85	0.64	0.61	0.67	0.69	0.36	0.32	7.11
Green River	6,089	0.49	0.52	0.67	0.99	1.20	0.92	0.57	0.84	0.65	0.98	0.50	0.38	8.71

Source: Environmental Research and Technology, Inc., 1977.

Note: All stations represent at least 30 years of data.

Table A4-3

TOTAL SNOWFALL IN INCHES AT STATIONS IN THE SODIUM DEVELOPMENT AREA

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Farson	5.5	5.7	6.3	5.3	1.8	0.2	T	0	0.1	2.8	5.2	4.4	37.3
Green River	6.2	7.3	7.5	7.3	2.2	0.2	0	0	0.1	3.7	4.1	5.0	43.6

Source: Environmental Research and Technology, Inc., 1977.

T=Trace

Table A4-4

AIR QUALITY MONITORS

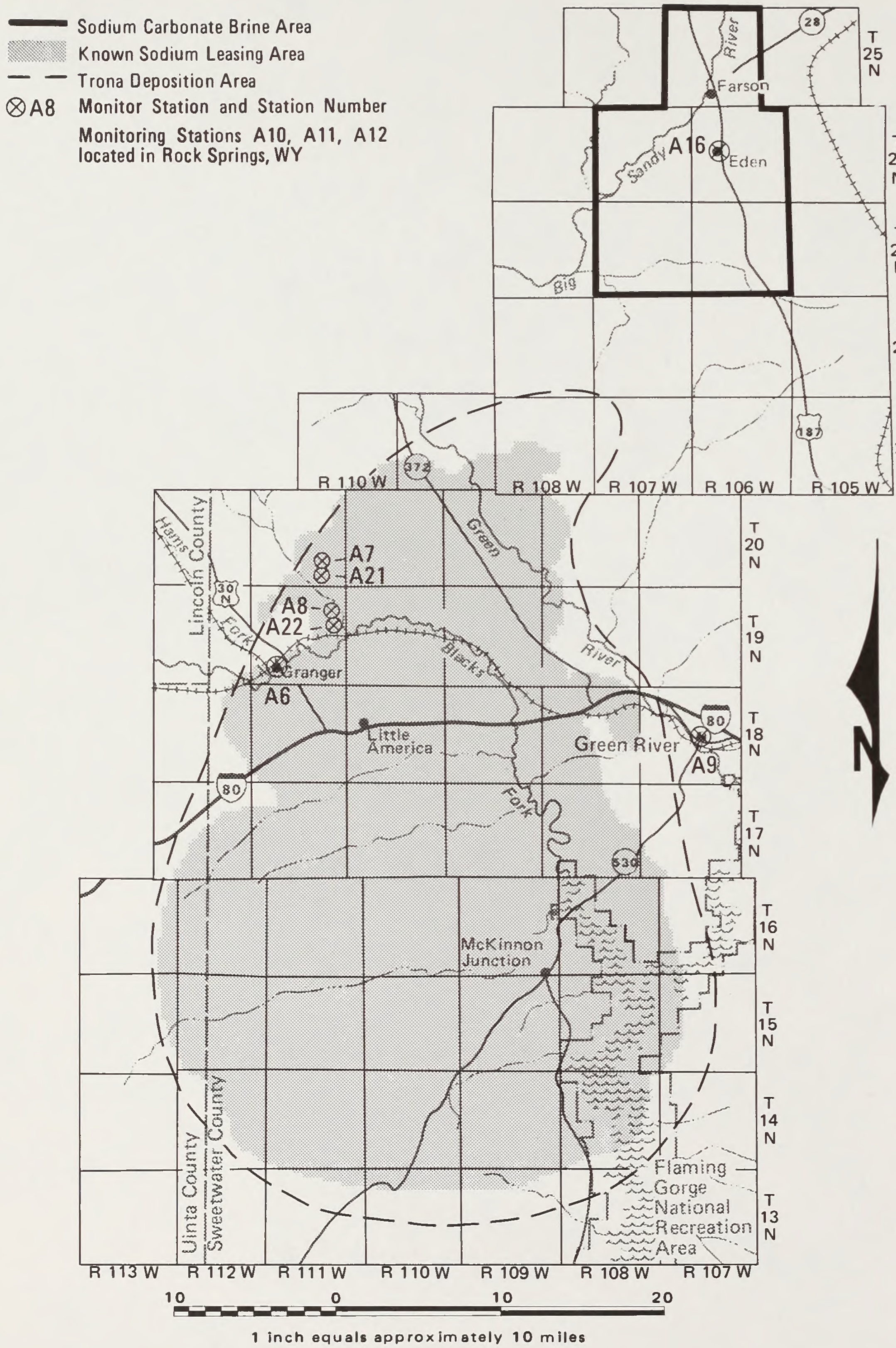
Site Code	Monitor	Location	Monitoring Purpose/ Environment	Private or State Operation	Pollutants Monitored at Site
A-6	Don Lindsley 1/	Granger	Background/Residential	State	TSP
A-7	Texasgulf No. 1	Little America	Background/Industrial	Private	TSP
A-8	FMC--Site A	Little America	Background/Industrial	Private	TSP
A-9 2/	Larry Clause 1/	Green River	Background/Residential	State	TSP
A-10	John Logan 1/	Rock Springs	Background/Residential	State	TSP
A-11	Lyman Fearn 1/	Rock Springs	Impact/Center City	State	TSP, SO_2
A-12	Robert Alder 1/	Rock Springs	Background/Residential	State	TSP
A-16	Sellers 1/	Eden	Background/Rural	State	TSP
A-22 3/	Texasgulf--Site 4	Little America	Background/Industrial	Private	SO_2

Source: ERT 1978 a.

1/ Private residences.

2/ Monitor A-9 was moved slightly south in 1976.

3/ Monitors established in 1976.



Map A4-1

AIR MONITORING STATIONS

Table A4-5

TOTAL SUSPENDED PARTICULATE CONCENTRATIONS (mg/m^3)
AT MONITOR SITES IN THE SODIUM DEVELOPMENT AREA

Site Code	Sampling Year	Number of Observations 1/	Maximum 24-Hour Concentration	2nd Highest 24-Hour Concentration	Number of Violations of the Federal 24-Hour Standards		Annual Geometric Mean 2/
					Primary	Secondary	
A-6	1973	46	114	109	0	0	43
	1974	53	209	195	0	2	54
	1975	57	93	87	0	0	27
	1976	57	150	101	0	0	39
	1977	56	102	90	0	0	32
	1978	55	121	104	0	0	29
A-7	1974	49	59	43	0	0	21
	1975	60	53	45	0	0	16
	1976	59	57	53	0	0	19
A-8	1974	34	126	91	0	0	35
	1975	92	143	99	0	0	28
	1976	37	73	70	0	0	27
	1977						
	1978						
A-9	1975	49	119	115	0	0	46[2]
	1976	58	84	80	0	0	37[2]
	1977	43	100	91	0	0	38
A-10	1975	59	131	111	0	0	40
	1976	58	259	218	0	2	58
	1977	61	127	112	0	0	46
	1978 Discont. 9/78	42	151	115	0	0	52

Table A4-5
(continued)

TOTAL SUSPENDED PARTICULATE CONCENTRATIONS (mg/m^3)
AT MONITOR SITES IN THE SODIUM DEVELOPMENT AREA

Site Code	Sampling Year	Number of Observations1/	Maximum 24-Hour Concentration	2nd Highest 24-Hour Concentration	Number of Violations of the Federal 24-Hour Standards		Annual Geometric Mean2/
					Primary	Secondary	
A-11	1972	45	271	240	0	1	119
	1973	50	321	277	3	20	118
	1974	52	347	308	7	18	115
	1975	57	231	207	0	11	90
	1976	58	248	218	0	9	100
	1977	44	220	177	0		81
	1978	61	360	254			113
A-12	1975	46	283	155	0	1	44
	1976	54	145	145	0	0	38
	1977	55	260	225			48
	1978	60	338	198			45
A-16	1975	28	63	39	0	0	16
	1976	52	94	50	0	0	19
	1977	56	45	35			15
	1978	30	39	33			15

Source: ERT 1978.

1/Samples were obtained approximately every 6 days.

2/Average of quarterly geometric means.

SULFUR DIOXIDE AND NITROGEN DIOXIDE

Data collected at A-22 should represent the general sulfur dioxide background levels of this industrial area and not depict plant emissions (Table A4-6). Only nine observations were made at this station in 1976, giving insufficient data from which to draw conclusions. However, primary data from A-22 suggests that SO_2 levels in the area should be safely below short-term standards with peak values at or below the resolution of the instrument. The maximum 24-hour SO_2 concentration recorded at A-21 in 1976 is 99 $\mu g/m^3$, 38% of the 260 $\mu g/m^3$ state standard. Data collected at A-11 in the city of Rock Springs represent urban background levels.

Table A4-6

CONCENTRATIONS OF SULFUR DIOXIDE IN MICROGRAMS
PER CUBIC METER AT MONITORS IN THE SODIUM DEVELOPMENT AREA

Site	Sampling Year	Number Observations 24-Hour	Maximum Concentration 24-Hour	2nd Highest Concentration 24-Hour	No. Violations of the Federal Standard 24-Hour	Arithmetic Mean
A-11[1]	1972	29	20	20	0	4
	1973	42	12	8	0	3
	1974	46	10	5	0	1
	1975	59	10	10	0	2
	1976	36	9	8	0	1
A-22	1976	9	2	3	0	NA

Source: ERT 1978.

1/ SO_2 gas bubbler providing 24-hour average alone.

NA = Not Available

APPENDIX 5

WATER QUALITY

Table A5-1 shows the water composition for selected wells in the hydrogeologic units. Conductance (values) data for hydrogeologic unit 1 indicate the existence of highly saline water locally.

Hydrogeologic unit 2 in the Green River Basin contains predominantly a sodium bicarbonate water type. Conductance values for this water are generally low, but some wells and springs may exceed 2,000 micromhos. The high conductance values are associated with water of high sodium content. Trace metal analyses of wells in hydrogeologic unit 2 reveal high barium concentrations (Table A5-2). However, these concentrations are below EPA criteria.

Water in hydrogeologic unit 3 has an extremely high dissolved solids concentration, as evidenced by the conductance values (Table A5-1). Conductance values for ground water in hydrogeologic unit 4 range from 500 to more than 11,000 micromhos, with an average value of approximately 3,000 michromhos. Conductance values for hydrogeologic unit 5 are very low, generally less than 1,000 micromhos.

Table A5-3 is a summary of the water quality at selected sites in the area.

The average annual yields for each of the major chemcial constituents, total dissolved solids, and suspended sediment are presented in Table A5-4. These values were computed from data for the Blacks Fork near Little America obtained during the years 1964 through 1976.

Table A5-1

CHEMICAL DEPOSITION OF GROUND WATER IN THE GREEN RIVER STRUCTURAL BASIN

Location	Hydro-geologic Unit	Calcium mg/l	Magnesium mg/l	Sodium mg/l	Potassium mg/l	Flouride mg/l	Bicarbonate mg/l	Carbonate mg/l	Sulfate mg/l	Chloride mg/l	Conductivity micromhos	pH	Total Dissolved Solids mg/l
20 N., 109 W.	3	0	4.6	23,000	37.0	110.0	8,590	24,000	59.0	2,300	50,700	10.0	53,700
18 N., 107 W.	1	180.0	120.0	--	--	0.1	552	--	1,400.0	75	3,150	7.5	2,480
18 N., 110 W.	4	3.2	2.9	--	--	8.1	944	45	1.6	1,700	6,480	8.6	3,770
18 N., 110 W.	4	4.5	0.5	1,500	5.6	8.4	1,050	--	1.3	1,700	6,540	8,2	3,780
17 N., 113 W.	1	310.0	110.0	--	--	0.4	332	--	180.0	270	4,020	7.4	3,210
17 N., 111 W.	2	8.5	0.4	300	0.6	2.2	380	--	250.0	60	1,200	8.2	819
16 N., 111 W.	2	8.0	0.9	170	1.2	1.8	310	1	92.0	23	745	8.4	463
16 N., 107 W.	1	1.6	0.1	448	1.6	2.4	841	67	80.0	45	1,710	8.8	1,070
18 N., 110 W.	3	--	1.6	10,000	21.0	18.0	4,050	4,910	2,000.0	6,400	33,800	9.8	25,800
23 N., 107 W.	3	--	1.8	2,969	6.6	--	729	3,400	189.0	113	10,196	--	6,964
23 N., 197 W.	4	1.0	0.2	420	1.2	9.3	481	175	190.0	33	2,100	9.6	1,080
23 N., 107 W.	3	160.0	200.0	1,100	3.1	1.8	466	--	2,900.0	67	8,500	7.6	4,680
24 N., 106 W.	4	1.3	0.3	230	0.6	6.1	319	36	160.0	20	23	--	622
24 N., 106 W.	3	2.0	0.4	300	0.9	5.2	369	101	160.0	13	1,650	9.7	755

mg/l=milligrams per liter.

Table A5-2

TRACE METAL ANALYSES FOR HYDROGEOLOGIC UNIT 2

Location	Arsenic mg/l	Barium mg/l	Cadmium mg/l	Chromium mg/l	Copper mg/l	Lead mg/l	Mercury mg/l	Zinc mg/l
T. 17 N., R. 111 W.	17	400	--	2	1	--	--	20

mg/l = micrograms per liter.

Table A5-3

WATER QUALITY IN SODIUM DEVELOPMENT AREA

Location/Date	Discharge cfs	Conductivity Micromohos	pH	Ca mg/1	Mg mg/1	Na mg/1	K mg/1	BiCarb mg/1	Carb mg/1	Sulfate mg/1	Chloride mg/1	Fluoride mg/1	TDS mg/1	Suspended Sediment mg/1
Green River near Green River 2-77	600	800	8.3	78	32	82	2.1	214	0	300	7.9	0.3	619	49
Green River near Green River 8-77	311	980	8.2	68	33	100	2.4	190	0	320	16	0.3	638	29
Big Sandy near Farson 11-76	29	2,400	8.3	180	63	270	3.0	240	0	1,000	38	0.7	1,690	62
Blacks Fork near Little America 10-76	25	2,800	--	190	88	310	5.1	195	--	1,200	93	0.7	1,990	4
Blacks Fork near Little America 5-77	121	1,700	--	79	35	110	6.3	230	--	290	64	0.4	706	364
Blacks Fork at bridge near Green River 10-77	--	--	--	120	50	320	5.0	150	0	880	120	0.6	1,580	--
Blacks Fork near Lyman 10-77	--	--	--	53	22	370	4.3	250	0	440	240	0.7	1,260	--
Blacks Fork at Mans Fork near Granger 10-77	--	2,900	--	230	100	360	6.2	170	1	1,400	100	0.9	2,290	--
Blacks Fork near Westvaco 10-77	--	--	--	240	97	390	6.0	160	1	1,500	110	0.9	2,430	--
Blacks Fork near Chicken Draw 10-77	--	--	--	190	82	420	5.9	170	3	1,300	130	0.7	2,220	--

Table A5-4

YIELDS OF MAJOR CHEMICAL CONSTITUENTS FROM THE BLACKS FORK RIVER NEAR LITTLE AMERICA, WYOMING

Constituent	Yield-Tons/Year
Bicarbonate	95,578
Carbonate	1,212
Calcium	32,129
Magnesium	14,834
Sodium	67,048
Potassium	1,505
Chloride	22,508
Sulfate	162,993
Total Dissolved Solids	234,699
Suspended Sediment	2,954,478

APPENDIX 6

WILDLIFE POPULATIONS

Tables A6-1, 2, and 3 show populations in the Seedskadee National Wildlife Refuge. The refuge is still in the developmental stages and the Fish and Wildlife Service feels there is a need for a buffer area around the refuge to avoid adverse effects from soda ash production (pers. comm., Fish and Wildlife Service 1980).

Table A6-4 shows Wyoming Game and Fish Department estimates of duck populations in the local breeding areas. Game and Fish Department aerial counts from 1976 to 1980 indicate average annual Canada geese populations of 39 pairs and 16 individuals along the Green River from Fontenelle Dam to Flaming Gorge and of 25 pairs and 4 individuals along the Blacks Fork River from Granger to Flaming Gorge (pers. comm., Serdiux 1980).

Table A6-1

WATERFOWL - PEAK POPULATIONS

Species	Oct - Dec	Jan - Mar	Apr - Jun	Jul - Sep
Whistling Swan	10	0	0	0
Snow Geese	200	0	0	0
White-fronted Geese	640	0	0	0
Canada Geese	120	190	110	45
Common Merganser	130	224	140	45
Mallard	500	390	180	337
Gadwall	350	25	103	140
American Widgeon	70	20	70	10
Green-winged Teal	200	400	300	800
Blue-Winged Teal	200	15	120	191
Northern Shoveller	50	0	45	60
Pintail	400	175	145	95
Redhead	80	15	120	45
Canvasback	40	0	0	0
Lesser Scaup	90	5	30	10
Ring-necked Duck	30	10	20	5
Common Goldeneye	250	520	32	3
Red Breasted Merganser	0	5	0	18
Barrows Goldeneye	20	100	16	0
Bufflehead	45	25	20	0
American Coot	100	0	75	180
Ruddy Duck	60	0	25	10
TOTAL WATERFOWL (by quarter)	3,585	2,119	1,551	1,994

Source: Seedskadee National Wildlife Refuge Output Reports, 1979, 1980.

Table A6-2

PEAK POPULATIONS OF SHOREBIRDS, MARSH, AND WATERBIRDS

Species	Oct - Dec	Jan - Mar	Apr - Jun	Jul - Sep
Herring Gull	10	8	5	
California Gull	10	0	0	15
Ring-billed Gull	50	25	52	20
Franklin's Gull	30	0	35	30
Black Tern	10	0	10	7
Wilson's Phalorope	100	0	275	150
American Avocet	10	0	10	12
Common Snipe	40	45	40	30
Long-billed Dowitcher	40	0	20	30
Lesser Yellowlegs	5	0	30	25
Willet	12	0	30	34
Spotted Sandpiper	30	0	500	400
Killdeer	100	200	450	350
Blacknecked Stilt	5	0	7	10
Forsters Tern	0	0	6	5
Marbled Godwit	0	0	40	0
Greater Yellowlegs	0	0	15	10
Long-billed Curlew	0	0	8	0
Mountain Plover	0	0	2	0
Solitary Sandpiper	0	0	0	4
Western Sandpiper	0	0	0	14
Pied-billed Grebe	26	0	20	15
Western Grebe	15	0	20	20
Horned Grebe	12	5	0	0
Common Loon	26	0	6	0
Great Blue Heron	17	15	97	60
Greater Sandhill Crane	45	5	65	10
Eared Grebe	50	0	25	25
Sora Rail	0	0	10	10
Black-crowned Night Heron	0	0	25	10
Double-crested Cormorant	0	0	5	1
White Pelican	0	0	57	0
Snowy Egret	0	0	15	10
White-faced Ibis	0	0	25	9
American Bittern	0	0	4	10
Green Heron	0	0	4	2

Source: Seedskadee National Wildlife Refuge Output Reports, 1979, 1980.

*Peak populations compiled by quarters.

Table A6-3

RAPTORS - PEAK POPULATIONS

Species	Oct - Dec	Jan - Mar	Apr - Jun	Jul - Sep
Marsh Hawk	15	33	50	15
Goshawk	10	5	3	10
Red-tailed Hawk	10	17	25	18
Swainson's Hawk	10	0	13	7
Rough-legged Hawk	50	35	12	4
American Kestrel	15	0	40	30
Barn Owl	5	2	4	5
Long-eared Owl	5	2	3	10
Screech Owl	10	8	6	0
Great Horned Owl	25	28	40	30
Golden Eagle	23	19	15	12
Bald Eagle*	31	29	2	0
Peregrine Falcon**	10	0	1	2
Prairie Falcon*	10	14	11	15
Prairie Merlin*	5	4	6	4
Osprey*	3	0	1	1
Ferruginous Hawk	5	2	4	4
Short-eared Owl	0	2	0	0
Cooper's Hawk	0	2	2	0

Source: Seedskadee National Wildlife Refuge Output Reports, 1979, 1980.

*Threatened Species - Status Undetermined
**Threatened Species - Endangered
***Threatened Species - Peripheral

Table A6-4

AVERAGE DUCK POPULATIONS IN SWEETWATER COUNTY BREEDING GROUNDS
(Eight-Year Average for 1972-1979)

Big Island Survey Area (58 Square Miles)

Species	Pairs[1/]	Grouped Ducks[1/]	Total[2/]
Mallard	71	4	146
Merganser	22	13	57
Teal	12	11	35
Gadwall	11	6	28
Coot	7	20	34
Pintail	7	-	14
Shoveller	5	-	10
American Widgeon	2	-	4
Goldeneye	1	-	2
Redhead	1	-	2
Lesser Scaup	Trace[3/]	-	Trace
Bufflehead	Trace	-	Trace
Ruddy	Trace	-	Trace
Unknown Ducks	4	55	63
TOTALS	143	109	395

Farson Survey Area (11 Square Miles)

Species	Pairs[1/]	Grouped Ducks[1/]	Total[2/]
Mallard	30	4	64
Teal	12	4	52
Pintail	8	-	16
Gadwall	5	-	10
Shoveller	3	2	8
American Widgeon	3	-	6
Merganser	3	-	6
Coot	2	2	6
Lesser Scaup	2	-	4
Bufflehead	Trace	-	Trace
Redhead	Trace	-	Trace
Unknown Ducks	3	22	28
TOTALS	71	34	176

Source: Leonard Serdiux, Wyoming Game and Fish Department, Lander (pers. comm., 1980), and Sandy Grazing ES (BLM 1978).

[1/]Data not corrected for aerial visibility bias. Data collected at peak of breeding period, or about mid-May. Serdiux (pers. comm., 1980) indicates actual numbers could be 50% greater.

[2/]The total number of ducks, determined by multiplying pairs by two and adding the grouped duck category.

[3/]Duck numbers over eight-year period too sparse to register as pair, although species could be present any given year.

APPENDIX 7

CULTURAL AND RECREATION VALUES

The cultural chronology that applies to the area is shown in Table A7-1. Historic sites in the area are listed in Table A7-2.

RECREATION VALUES

Each recreation activity has a relationship to the land, and each is related to a set of expectations for a certain experience. The presence or absence of the qualities that make up those experiences and the presence or absence of those characteristics of the land that are necessary for the activity to take place, determine the opportunity for an enjoyable experience for any activity and the geographic distribution of any activity.

Each activity is subject to the influences that affected particular qualities of the environment, and activities vary in sensitivity to the presence or absence of qualities in any given area based upon the expectations of the participants. For example, a hiking or backpacking participant has more need for a natural condition than the average camper would to fulfill his/her expectations. Distracting, unnatural conditions mean more to him than to the average camper.

Three factors have been used to differentiate significant qualities of the landscape that represent expectations: esthetic factors, natural qualities, and solitude/privacy. These factors are perceptions by various user groups presumed by the analyst.

Esthetic factors are those directly perceived through the senses, sight, smell, and hearing that are not related to impressions or association with uses *per se*. These qualities are not necessarily natural or not natural and may also represent a lack of unpleasant sensation.

Natural qualities represent desirable conditions of land untouched by man as perceived by various users. The perception of natural quality is perceived differently by various user groups; for instance, a park-like setting may appear natural to a sightseer but not to a backpacker.

Solitude/privacy is (1) the lack of distraction by outside influences that do not play a part in the experience itself and (2) the absence of other people. Noise, for instance, may be at a level that doesn't interfere with conversation but may represent an irritant to such user groups as hikers, whereas snowmobiles make a considerable amount of noise in themselves, yet this does not detract from the experience of the snowmobiler. Different people have different expectations.

Judgments based on these factors have been related to the various recreation activities in a general way on Table A7-3. These factors have been considered individually for each recreation activity.

Table A7-1

CULTURAL CHRONOLOGY OF THE SODIUM DEVELOPMENT AREA

Period/Subphase	Date	Projectile Point Style or Cultural Group	Characteristics (Sites)
Historic	300 B.P. - Present	Shoshonean Cheyenne Gros Ventre Commanche Flathead Crow Arapahoe European (White)	Hunting and gathering, some buffalo and antelope hunting by communal drives, mostly marginal subsistence
Late Prehistoric	1,700 B.P. - 300 B.P.	Shoshonean Intermountain	Marginal subsistence, hunting and gathering, pottery in some sites (Eden-Farson) (Wardell)
Late Plains Archaic	3,000 B.P. - 1,700 B.P.	Avonlea Besant	Hunting and gathering (Pine Springs) (Meadow Draw)
Middle Plains Archaic	4,500 B.P. - 3,000 B.P.	Scoggin Duncan Hanna McKean	Hunting and gathering (Pine Springs)
Altithermal	7,500 B.P. - 5,000 B.P.	McKean (?)	Generally a more arid period with marginal occupations suspected in higher areas
		EARLY PREHISTORIC PERIOD	
Plano	10,000 B.P. - 7,500 B.P.	Lusk Fredrick Cody Alberta Hell Gap Agate Basin Midland	Hunting extinct fauna (*Bison antiquus*), bison traps and some communal hunting suspected, collecting flora probable (Eden Site)
Folsom	11,000 B.P. - 10,500 B.P.	Folsom	Hunting extinct fauna (*Bison antiquus*), bison traps and some communal hunting suspected, collecting flora probable
Llano	11,500 B.P. - 11,000 B.P.	Clovis	Hunting extinct fauna, mammoth traps and communal procedures suspected, collecting flora probable

Note: After Frison (1978).

B.P. = Before Present

Table A7-2

HISTORIC SITES IN THE SODIUM DEVELOPMENT AREA

	Site	County	Type	Condition
Period I--Fur Trade and Exploration (1812-1841)				
Known or Potential Sites	Bridger/Fraeb Post	Sweetwater	Locale/ building(?)	Post gone
Period II--Acquistion, Emigration, Transportation, Communication, and Early Military History (1842-1869)				
National Register Sites	Granger Stage Station	Sweetwater	Building	To be restored
Wyoming Historic Inventory (Eligible for Nomination)	Lone Tree Stage Station	Sweetwater	Building	Deteriorated
	Oregon Trail	Sweetwater	Trail	Variable
	Overland Trail	Sweetwater	Trail	Variable
	Church Buttes Pony Express Station	Uinta	Structure	Deteriorated
	Oregon Trail	Sweetwater	Trail	Variable
	Overland Trail	Sweetwater	Trail	Variable
	Cherokee Trail	Sweetwater	Trail	Variable
Period III--Settlement and Development Period (1869-1925)	Martins PE Station	Sweetwater	Structure	Unknown
Wyoming Historic Inventory (Eligible for Nomination)	Bryan Townsite	Sweetwater	Structure	Deteriorated
Known and Potential Sites	Horseshoe Bend of Green River	Sweetwater	Old ranch	Unknown
	Hawley Ranch	Sweetwater	Structure	Unknown
	Green River Mercantile	Sweetwater	Building	--

Table A7-3

RECREATION SENSITIVITY

	Esthetic Factors			Natural Qualities			Solitude/Privacy		
	High	Moderate	Low	High	Moderate	Low	High	Moderate	Low
Recreation Vehicles						X		X	
Hunting-Big Game		X			X			X	
Hunting-Waterfowl		X			X				X
Hunting-Other			X			X		X	
Fishing	X				X			X	
Camping	X					X		X	
Picnic	X				X			X	
Hiking/Backpacking	X			X			X		
Rock Climbing		X		X				X	
Horseback Riding		X			X			X	
Rock Collecting		X			X			X	
Other Collecting		X			X			X	
Boating-Power		X		X					X
Boating-Sail	X			X				X	
Boating-Canoe	X			X			X		
Boating-Floating	X			X				X	
Swimming		X			X			X	
Snowmobile			X		X			X	
Skiing-Downhill			X			X			X
Skiing-Cross Country		X			X		X		
Snowplay		X				X			X
Wilderness	X			X			X		

APPENDIX 8

DETAILS OF THE ASSUMPTIONS AND ANALYSIS GUIDELINES

U.S. MARKET/DEMAND PROJECTIONS

The Bureau of Land Management has utilized the works of two authorities—Dennis S. Kostick, physical scientist for the Bureau of Mines' nonmetallic section in Washington, D.C., and George Innes, vice president of C. H. Kline and Company, Inc., Fairfield, New Jersey—in determining the possibilities that could exist for future sodium mineral development in Southwest Wyoming. The range of possibilities are endless considering the extent and value of the known trona deposits; nevertheless BLM has developed seven scenarios which could be within the realm of possibility. The scenarios facilitate the analysis of the impacts of the alternatives including the proposed action.

Obviously, production depends upon market conditions (not lease holdings), and it is equally certain that the quality and quantity of Southwest Wyoming trona makes its soda ash a desirable and very marketable product. Market and production projections have been made for each scenario, each based on a potential increase in demand. Domestic demand patterns are listed in Table A8-1, and Table A8-2 shows supply and demand relationships.

In the U.S. there are three sources of soda ash: (1) synthetic soda ash produced by Allied Chemical Corporation in Syracuse, New York, utilizing the Solvay Process (see Glossary); (2) natural soda ash produced by evaporation of brine by Kerr-McGee Chemical Corporation, Searles Lake, California,; and (3) natural soda ash produced from trona processed by four existing companies located between Green River and Little America, Wyoming (Kostick 1980). Because of environmental problems in using the Solvay process, rising maintenance on aging plants, and increased costs in other areas unique to synthetic production facilities, the natural soda ash producers could claim in the entire domestic market in the near future. In 1966 ten synthetic plants in America accounted for about 75% of the total U.S. domestic production. With the closing of the BASF Wyandotte synthetic plant in Michigan at the end of 1978, there was only one synthetic producer in America.

The four Wyoming producers in 1979 had approximately 76% of the U.S. soda ash production capacity (Table A8-3) and approximately 79% of the total U.S. soda ash production (pers. comm., Kostick 1980), compared to 50% in 1974, 22% in 1967, and 0.42% in 1950—the first year of operations in Wyoming. The increasing role that Wyoming plants have played in U.S. production has been due in part to substantial increases in their production and in part to the closing of synthetic soda ash plants. The potential closing of the remaining synthetic soda ash plant (Allied at Syracuse, N.Y.) for economic and environmental reasons would result in an estimated 900,000 short tons per year of production loss that could be met by increased production in Southwest Wyoming. Although Innes (1980) projects that plant will remain open through the long term.

The Solvay process produces a lower quality soda ash than is produced from natural sources and with a very undesirable byproduct: Calcium chloride. Plants in Europe (many of them owned by the Solvay company) dump this byproduct into streams, significantly contributing to water pollution. Environmental pressures are already being applied to both Western and Eastern European producers to stop polluting Europe's rivers (Innes 1980). The European plants are, in some cases, as old as the process itself, thus raising costs of maintenance and other associated costs. Simultaneously, there are economic pressures from the various nations involved to maintain the synthetic plants as major employers of their citizens.

Table A8-4 shows U.S. exports of soda ash for the last seven years. Despite a European tariff of 10.4% and transportation costs, the U.S. is now able to sell soda ash to European markets at less than it can be produced synthetically in Europe. Eventually demand for the U.S. product could be appreciably affected through the Western European market (Innes 1980); for example, recent developments in the United Kingdom (Watson 1981) could open the British market to U.S. producers.

Though possibilities for market expansion may exist, soda ash producers in other parts of the world may help supply these needs. For perspective, the estimated 1979 world consumption of soda ash by region is shown in Table A8-5; production, Table A8-6 and Figure I-2; and soda ash's uses, Figure I-1.

Table A8-1

DOMESTIC SODA ASH DEMAND PATTERNS FOR 1974-79
IN THOUSAND SHORT TONS

US Demand Pattern	1974	1975	1976	1977	1978	1979P
Glass Production	3,590	3,390	3,590	3,980	4,170	3,995
Chemical	1,890	1,630	1,660	1,670	1,720	1,686
Pulp and Paper	270	240	260	260	260	252
Water Treatment	220	200	220	220	220	213
Detergents, Cleaners	330	330	340	340	350	360
Miscellaneous	750	795	797	813	824	798
TOTALS	7,050	6,585	6,867	7,283	7,544	7,304

Source: Kostick, (1980).

P = Preliminary

Table A8-2

SODA ASH SUPPLY AND DEMAND
RELATIONSHIPS IN MILLIONS OF SHORT TONS

Year	Total U.S. Supply	Domestic Demand	U.S. Marketable Exports	U.S. Production	U.S. Imports 1/
1974	7.65	7.05	0.56	7.57	0.32
1975	7.17	6.59	0.53	7.13	0.02
1976	7.61	6.87	0.65	7.56	---
1977	8.14	7.28	0.76	8.04	0.01
1978	8.40	7.54	0.78	8.29	0.08
1979	8.37	7.30	1.00	8.25	0.40

Source: Kostick (1980); does not include industry stocks.

1/ U.S. imports primarily due to stock transfer from Allied's plant in Canada to U.S. plant.

Table A8-3

U.S. SODA ASH PRODUCTION CAPACITY
FOR 1979 IN MILLIONS OF SHORT TONS

Company	Capacity	% Total
FMC Corporation, Green River, Wyoming	2.50	26
Allied Chemical, Green River, Wyoming	2.20	23
Stauffer Chemical, Green River, Wyoming	1.52	16
Texasgulf, Inc., Granger, Wyoming	1.00	11
(Subtotal, Southwest Wyoming)	(7.22)	(76)
Kerr-McGee Chemical Corporation, Argus, California	1.45	15
Allied Chemical, Syracuse, New York	0.90	9
	9.57	100

Source: Kostick (1980).

Note: Actual production figures are confidential, so only capacity is shown. Total American production may be estimated by adding domestic consumption (Table A8-5) to exports (Table A8-4).

Table A8-4

U.S. EXPORTS OF SODA ASH
FOR 1974-80 IN MILLIONS OF SHORT TONS

Country or Region	1974	1975	1976	1977	1978	1979[b]	1980[b]
Latin America	.260	.293	.187	.351	.318	N/A	N/A
Canada	.188	.131	.187	.192	.196	N/A	N/A
Japan	.052	.057	.078	.080	.048	N/A	N/A
South Africa	.002	.029	.073	.073	.086	N/A	N/A
West Europe	.008	.003	a/	a/	.027	N/A	N/A
Other	.065	.025	.132	.078	.118	N/A	N/A
Total	.575	.538	.657	.774	.793	.997	1.094

Source: U.S. Bureau of the Census Report No. EM546 metric tons converted to short tons.

[a]Less than 1,000 short tons.

[b]Only total imports available at this time.

Table A8-5

ESTIMATED 1979 WORLD CONSUMPTION
OF SODA ASH BY REGION IN MILLIONS OF SHORT TONS

Region	Millions of Short Tons	Percent
Eastern Europe	10.08	31
United States	7.84	24
Western Europe	7.28	23
Asia/Africa/Oceania	3.36	10
Other North America	2.24	7
South America	1.68	5
Total	32.48	100

Source: U.S. Bureau of the Census (1979); metric tons converted to short tons.

Table A8-6
ESTIMATED 1979 WORLD PRODUCTION CAPACITY
OF SODA ASH BY REGION IN MILLIONS OF SHORT TONS

Region	Millions of Short Tons	Percent
Eastern Europe	11.6	31.7
United States	9.6	26.1
Western Europe	8.7	23.8
Asia/Africa/Oceania	5.0	13.7
Other North America	1.0	2.8
South America	0.7	1.9
Total	36.6	100.0

Source: Kostick (1980).

The domestic market is expected to increase at 1.8% per year, based on Kostick's figures (1980). Kostick (pers. comm., 1980) indicates the recent increases in the cost of U.S. soda ash could be a limiting factor in development of the European market. However, he also feels that developments in solution mining could keep the cost of soda ash at that price for many years in the future. Innes (1980) reports an 8.4% increase in U.S. sales to international markets, although his projections for U.S. sales are much higher.

Two existing plants expanded their production capacities in 1980. FMC recently announced an incremental increase in its production (Rocket-Miner 1981) to a total capacity of 2.8 million tons of soda ash per year (MTPY). Stauffer, with a 300,000-ton increase (Rocket-Miner 1980d) late in 1980, now has a capacity of 1.82 MTPY. Tenneco is expected to begin with a production capacity of 1 MTPY in 1982. Texasgulf plans to double its capacity to 2 MTPY by 1987 (Rocket-Miner 1980e). Kostick (1980) projects a 1 MTPY increase in FMC production by the mid-late 1980s as a result of its solution mining tests. BLM has taken these projections into consideration in developing accelerated and normal expansions of existing plants.

SCENARIO ONE

The market outlook under this scenario would be a 1.8% per year increase in the domestic market (Kostick 1980) and a projected 10% per year increase in the international markets (Table A8-7). The assumption is made that the Western European soda ash demands from U.S. producers would increase at a moderate rate, although still modest in comparison to Innes' predictions.

Kostick (pers. comm., 1980) feels Kerr-McGee production could be limited by environmental constraints in the short term. Thus, Southwest Wyoming could conceivably capture about 88% of the U.S. market, or 10.4 MTPY in 1990 and 15.4 MTPY in 2000. Kerr-McGee production would increase substantially after 1990 with the resolution of environmental constraints. Market conditions would be such that existing Wyoming plants could reach accelerated expansion and two new 1 MTPY plants could develop to compete for the additional Southwest Wyoming portion of the projected U.S. markets for the year 2000 (15.4 MTPY).

If accelerated expansion of existing plants and mine operations occurs during the short term, the new plants would not be started until favorable market conditions developed in the long term. No Federal leasing action necessary since adequate sources are available (Chapter II-Geology and Mineral Resources). BLM assumes that solution mining, although still in the experimental stage, will prove economically and technically feasible.

SCENARIO TWO

The international market would develop at a moderate rate (Table A8-8). The market outlook would be such that existing plants would capture 88% of the short term market by accelerated development of existing mines. However, accelerated production in the long term would level off to 85% of the projected market, when Kerr-McGee would be producing more soda ash. Since existing leases are involved in mine production for this scenario, no new Federal leasing would be anticipated.

SCENARIO THREE

The market outlook under this scenario would be the same as for Scenario One (Table A8-7), but existing Southwest Wyoming plants would capture only 85% of the market during the short term. Accelerated expansion of existing plants would be slower in the short term until new mines could be developed to complement normal expansion of existing mines. Accelerated expansion of the existing plants and the development of two new mine-plant operations as described in Scenario One would enable Southwest Wyoming to capture 88% of the market in the long term.

Federal leasing could be required for the new mines to be developed in the southern half of the checkerboard area, as well as for the conventional mine which would produce raw trona for use other than as marketable soda ash. The assumption is made that 0.5 MTPY of trona (soda ash equivalent) would be used for cleaning flue gasses and for markets needing raw trona.

SCENARIO FOUR

The market outlook under this scenario would be (Table A8-8). Since accelerated expansion of existing plants would be supported by normal expansion of existing mines and development of two new solution mines and a conventional mine, Southwest Wyoming production is expected to develop slowly

Table A8-7

MARKET OUTLOOK UNDER SCENARIOS 1 AND 3

	U.S. Market in Million Short Tons Domestic[1]	International[2]	Total
1979	7.72	0.88	8.60
1985	8.59	1.56	10.15
1990	9.39	2.51	11.90
2000	11.23	6.51	17.74

[1] Based on projections by Kostick (1980); domestic market would continue to increase at 1.8% per year.

[2] BLM assumption for analysis purposes, with modest foreign market increases at the rate of 10% per year.

Table A8-8

MARKET OUTLOOK UNDER SCENARIOS 2, 4, 5, AND 6

	U.S. Market in Million Short Tons Domestic[1]	International[2]	Total
1979	7.72	0.88	8.60
1985	8.59	1.43	10.02
1990	9.39	2.14	11.53
2000	11.23	4.79	16.02

[1] Based on projections by Kostick (1980); domestic market increases at the rate of approximately 1.8% per year.

[2] Based on projections by Innes (1980); foreign market continues to increase at 8.4% per year.

until after 1990. Additional Federal leasing would be needed, at least for the new mines.

SCENARIO FIVE

The market outlook is the same as for Scenario Four (Table A8-8), but Southwest Wyoming production would be achieved with normal expansion of existing plants and development of two new plants and two new mines. Some additional Federal leasing could be needed to support the new solution mining operation.

SCENARIO SIX

The market outlook in Table A8-8 applies for Scenario Six; however, mine development would be extensive and would require additional Federal leasing. Mine production actually would exceed plant production by 0.5 MTPY (soda ash equivalent) because trona production of one of the new conventional mines would not be converted to marketable soda ash. The assumption is made that such production would be used for flue scrubbing and other markets.

SCENARIO SEVEN

Another 0.4 MTPY plant could be a possibility if valuable deposits were found outside the KSLA. The sodium carbonate brine area is most probable. Production from any such plant would replace production from plants and mines described in the previous scenarios.

A brine processing plant could be in operation by 1985, located on about 300 acres of public land in the southern portion of the sodium carbonate brine area. It would include a coal-fired brine processing plant and a 250-acre-foot storage reservoir, with a system of wells, well site pumps and pipeline connections similar to an oil field. Plant production would include about 390,000 tons of soda ash and 7,000 tons of sodium bicarbonate per year. Associated rights-of-way (ROW) would include 3 miles of 80- to 100-foot-wide ROW for a 24-foot-wide, paved surface road with shoulders and drainages; 3 miles of ROW for a buried telephone cable that would parallel the access road; 14 miles of 50-foot-wide ROW for 6-inch well pipelines; 14 miles of 23-foot-wide ROW for access roads to the wells; and 3 miles of 25-foot-wide ROW for a 34.5-kilovolt (Kv), single-pole powerline. Ancillary facilities would disturb 800 acres, and 500 acres would eventually be needed for tailings or wastewater ponds.

Development of a plant based on conventional or solution mining would follow the operations described below. However, the manpower, water, and coal needs would be proportionally less than for a 1 MTPY operation. ROW needs would be dependent upon the location of the plant and mine in relationship to existing water and power sources and transportation routes, but it is assumed that the plant site would be 300 acres with 800 acres of ancillary facilities and 500 acres of tailings ponds.

TYPICAL MINE/PLANT DEVELOPMENT

SOLUTION MINING

The preferred area for solution mine development would be in the southcentral portion of the trona deposition area (pers. comm., Vulcan Materials Company 1981). This area offers the deep, thick beds that would be economical for solution mining. Although solution mining techniques are experimental, and the crucial question of how much trona can be recovered in solution is yet to be answered, BLM assumes that mining techniques will be successful and that commercial developments will be established within 10 years. Kostick (1980) predicts a commercial development by 1987.

PLANT

The predicted solution mining plant would be in the southern portion of the checkerboard lands and within the KSLA. The Area occupied by plant facilities would be about 300 acres, including storage, loadout facilities, and various structures in addition to the processing plant (see Chapter I). Tailings ponds would initially cover 500 acres. The plant would employ about 200 workers. Mine/plant operations would annually use an estimated 2,050 acre-feet of water for production, and 325,000 tons of coal would be needed in producing 1 million tons of soda ash per year. Associated ROW would include an estimated 15 miles of 50-foot-wide ROW for a 14-inch buried waterline; 10 miles of 80- to 100-foot-wide ROW for a 24-foot-wide, paved surface road with shoulders and drainages; 10 miles of 100-foot-wide ROW for a standard gauge railroad spur; 2 miles of 25-foot-wide ROW for a 34.5-Kv, single-pole powerline; 3.5 miles of 80-foot-wide ROW of a 230-Kv, double-pole powerline; and 10 miles of ROW for a buried telephone cable that would parallel the access road. A 3-acre pumping facility would be constructed at the Green River, which would be the source of water for plant operations.

MINE

Buried pipelines between the mining area and the plant it serves would require a ROW approximately 50 feet wide to accommodate the mining solution injection line and the dissolved trona recovery line. The length would be dependent upon the distance from the plant, which could range from about 1-15 miles. A mining solution preparation plant would be part of the plant facilities for a plant/mine operation, but it is assumed that a preparation facility would be adjacent to the plant it would feed. Wells would disturb about one acre per pair, plus feeder and recovery lines. Access roads, powerlines, waterlines, and communication lines could require additional ROW across public lands in the widths described above. ROW lengths of the separate mine operations would vary.

CONVENTIONAL MINING

PLANT

The hypothetical plant would process approximately 1.8 million tons of trona, mined by current conventional methods (Appendix 3). Construction of the mine and plant would require 1,030 workers during peak construction and 31 months from start to finish. Mining would involve trona beds between 1,500 and 1,700 feet below the surface. Mining operations would require 160 permanent workers, while 230 would be employed for plant operations.

The plant site would cover approximately 300 acres and the initial tailings ponds would cover approximately 260 acres; however, 800 acres of tailings ponds would be needed within 5 years. Associated ROW would include an estimated 11 miles of 80- to 100-foot-wide ROW for a 24-foot-wide paved surface road with shoulders and drainages; 3 miles of 25-foot-wide for a 34.5-Kv, single-pole powerline; 5 miles of 80-foot-wide ROW for a 230-Kv, double-pole powerline; 10.5 miles of 100-foot-wide ROW for a standard gauge railroad spur; 16.5 miles of 50-foot-wide ROW for a 14-inch buried waterline; and 11 miles of ROW for a buried telephone cable that would parallel the access road. The source of water for plant operations would be the Green River, where a pump station would be constructed.

The plant would require 2,350 acre-feet per year and 325,000 tons of coal per year. The discharge into the tailings ponds would total 762 acre-feet per year, and an estimated 400 gallons per minute of water vapor would be emitted from the cooling towers. Annual air pollution emissions from the plant would total 367 tons of sulfur dioxide (SO_2); 3,205 tons of nitrogen oxides (NO); 231 tons of carbon monoxide and carbon dioxide (CO_x); and 82 tons of hydrocarbons (HC).

MINE

Transportation of trona ore from the mine to the plant it would serve requires close consideration. Conveyor systems are practical for a plant/mine operation, but a mine separate and some distance (12-15 miles) from the plant it feeds may have to transport by truck or some other means. While such an impact has not been analyzed in this EA, a truck transportation system could impact to a much greater extent wildlife habitat and other resources than a pipeline system. The possibility of dissolving the trona and transporting it by pipeline could be an alternative.

GLOSSARY

References consulted in the preparation of the definitions include Bureau of Land Management Manuals and publications; *Dictionary of Geological Terms* (America Geological Institute 1976); *Resource Conservation Glossary* (Soil Conservation Society of America 1976); *Common Environmental Terms* (Environmental Protection Agency 1973); and several professional publications on sodium.

ACRE-FOOT. A unit of measurement equal to the quantity of water required to cover 1 acre to the depth of 1 foot; a volume equal to 43,560 cubic feet.

ADIABATIC LAPSE RATE. The rate at which the temperature of an ascending or descending air mass is changed by the process of expansion or compression; generally about 1.6°F. per 300 feet.

ALLUVIAL SEDIMENT. Clay, sand, gravel, silt, or other rock or mineral materials that have been transported and deposited by flowing water.

ANCILLARY FACILITIES. Structures outside the actual plant which are necessary to support the major functions of the processing plant; e.g., well gathering lines, powerlines, pipelines, etc.

ANIMAL UNIT MONTH (AUM). The forage required to support one cow and calf for one month (1,800 pounds on a 50 percent utilization basis); an AUM also is considered the forage required to suppport one horse, five sheep, five deer, one elk, one moose, or about 15 pronghorn.

CALCINED. Heated to a high temperature, but below the melting or fusing point to cause loss of moisture and volatile matter, reduction, or oxidation.

CHECKERBOARD LAND PATTERN. Alternating sections of Federal lands with sections owned by private landowners or the State for 20 miles on either side of the Union Pacific railroad in southwestern Wyoming. This pattern appears as a checkerboard on maps using different colors for different land status.

CRUCIAL HABITAT. A portion of the habitat of a wildlife species that, if destroyed or adversely modified, could result in the population being listed as threatened or endangered pursuant to Section 4 of the Endangered Species Act, or in some category implying endangerment by a state agency or legislature. Examples of crucial habitat include nesting areas, broodrearing areas, winter ranges, migration routes, etc.

DENDRITIC DRAINAGE PATTERN. A drainage system which, when viewed from a distance, resembles the branching of a tree.

DESERT PAVEMENT. A crust of pebbles or larger stones that accumulate when water or wind action removes the finer dust and sand; the pebble material forms a mosiac-patterned surface that protects the finer material beneath the surface from erosion. Also formed by upward movement of gravel or coarser materials from underlying sediments.

EPHEMERAL STREAMS. Streams that flow only briefly during and after rainfall in the immediate area.

EUTROPHICATION. The normally slow process by which a lake evolves into a bog or marsh, then into a terrestrial area. During this process, the lake becomes so rich in dissolved nutrients, such as nitrogen and phosphorus compounds, that algae and other microscopic plant life overpopulate the lake, "choking" it, and causing it to dry up.

FOREGROUND-MIDDLEGROUND. The area visible from a travel route, use area, or other observer position to a distance of 3 to 5 miles. The outer boundary of this zone is defined as the point where the texture and form of individual plants are no longer apparent in the landscape, and vegetation appears only in patterns or outline.

HALITE. The natural solid form of salt (NaCl). It is colorless to white when pure, and it comprises 95-99% of rock salt.

HI-VOL. A hi-volume sampler, which is a device used in the measurement and analysis of suspended particulate pollution.

HORIZON. A layer of soil or soil material approximately parallel to the land surface and differing from adjacent, genetically related layers in physical, chemical, and biological properties or characteristics such as color, structure, texture, kinds and numbers of organisms present, the degree of acidity or alkalinity, etc.

INTERMITTENT STREAMS. Streams that flow only when they receive ground-water discharge or long, continual runoff from melting snow or other surface and shallow subsurface sources.

LACUSTRINE SEDIMENT. Material deposited in the bottom of lakes and later exposed either by a lowering of the water level or by an elevation of the land.

LEK. The site of sage grouse courtship.

LIMITED SURFACE OCCUPANCY. Areas where plant site development and structures could not occur or would be limited to prevent or reduce conflicts with other resources. Developments with limited impacts, such as roads, railroads, powerlines, pipelines, communication lines, ponds, and low-visibility structures may, in most cases, meet limited surface occupancy criteria.

MONOHYDRATE PROCESS. A method used to produce dense soda ash from trona. The trona ore is calcined into soda ash, then dissolved. The soda ash solution is passed through classifiers and filters to remove all insoluble matter, then concentrated by evaporators. The soda ash precipitates as sodium carbonate monohydrate ($NaCO_3 \cdot H_2O$) crystals, and then separated from the remaining solution by centrifugation. Water is removed from the crystals by a second calcination.

NONATTAINMENT AREA. An area which is shown by monitored data, or by calculations using air quality modeling, to exceed any National Ambient Air Quality Standard for any air pollutant.

OXBOWS. A crescent-shaped lake formed by a bend in a river (meander loop) that has become separated from the mainstream by a change in the course of the river.

PALUDAL SEDIMENTS. Material that was deposited in the bottom of a swamp or marsh.

PHYSIOGRAPHIC PROVINCE. An extensive area of the landscape, normally encompassing many hundreds of square miles, that portrays similar qualities of soil, rock, slope, and vegetation of the same geomorphic origin.

PLAYA. A usually dry and nearly level lake plain that occupies the lowest parts of closed depressions, such as those occurring on intermontane basin floors.

RIPARIAN. Situated on or pertaining to the bank of a river, stream, or other body of water. Normally used in referring to the plants of all types that grow rooted in the water table or in streams, ponds, springs, etc.

SESQUICARBONATE PROCESS. A method used to produce light or intermediate density soda ash. The trona ore is dissolved in the natural state, and insoluble impurities are removed by clarification and filtration before pure sodium sesquicarbonate is crystallized. The crystals are converted to soda ash by calcination.

SHALLOW SYNCLINE. A fold in sedimentary rock strata in which the opposing ends of the beds dip downward and toward the fold's acial plane.

SODIUM DEVELOPMENT AREA. That portion of the Rock Springs District where development of sodium minerals is most likely to occur; i.e., the trona deposition area and the sodium carbonate brine area.

SODIUM MINERALS. Naturally occurring organic substances which provide sodium hemical compounds such as sodium carbonate, sodium bicarbonate, and sodium sulfate. The three commonly recognized sodium minerals are trona, mirabilite, and thenardite (Bates 1969). This EA primarily deals with trona, the major natural source for soda ash; the other minerals are sources for sodium sulfate.

SOIL ERODIBILITY. The relative ease with which one soil erodes under specified conditions as compared with other soils under the same conditions.

SOIL GROUPS. A mapping unit in which two or more defined taxonomic units occurring together in a characteristic pattern are combined because the scale of the map or the purpose for which it is being made does not require delineation of the individual soils. Also known as SOIL ASSOCIATIONS.

SOIL SERIES. The basic unit of soil classification in which the soils are essentially alike in all but one of the major profile characteristics.

SOLVAY PROCESS. A process for making synthetic soda ash from common salt (NaCl). Purified brine is saturated with ammonia gas, then carbon dioxide gas is passed through the solution to form a sodium bicarbonate precipitate. The precipitate is calcined into soda ash. Named after Ernest Solvay, a Belgian chemical engineer who developed the process more than 100 years ago.

SURFACE OCCUPANCY. Refers to plant site development and structures including, but not limited to, the processing plant, steam plant, ore and coal stockpiles, loadout stations, storage tanks, office and storage buildings, tailings ponds, containment ponds, etc. It does not refer to facilities such as access roads, railroads, powerlines, pipelines, communication lines and sites, mine shaft entrance facilities, ventilation shafts, hoist houses, sewage ponds, sanitary landfills, etc.

SWEETENING PLANT. A nautral gas process plant that removes hydrogen sulfide from "sour gas", thus converting it to "sweet gas".

TONS. Short ton as used in this document is equal to 2,000 pounds. A long ton is 2,240 pounds and a metric ton is 1,000 kilograms, or 2,204.6 pounds.

TRONA. A naturally occurring sodium sesquicarbonate ($Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$) that was formed in ancient saline lakes. It is generally honey or light brown in color, depending upon the impurities present in the mineral.

VEGETATION TYPE. A term used to differentiate the plant communities in an area; the type generally refers to and is named after the plant species or various combinations of species that dominate or appear to dominate a particular site.

VISITOR-DAY. A day in which the visitor-hours contained therein have been spent by a person in any activity except those which are part of or incidental to the pursuit of a gainful occupation. Twelve visitor-hours aggregated by one or more persons constitute a visitor-day.

VISUAL RESOURCE MANAGEMENT CLASSES. The degree of visual change that is acceptable within the characteristic landscape which is based upon the physical and sociological characteristics of a given homogeneous area. Class I provides primarily for natural ecological changes; any contrast created within the characteristic landscape must not attract attention. Class II provides for management activity, but changes in any of the basic elements (form, line, color, and texture) should not create contrasts that attract attention. Class III indicates contrasts to the basic elements caused by management activity may be evident and begin to attract attention in the characteristic landscape, although such changes should remain subordinateto the existing landscape. Class IV contrasts attract attention and may be a dominant feature in the landscape in terms of scale, although the change should repeat the basic elements inherent in the characteristic landscape. Class V applies to areas that have been disturbed to the point where the contrast is inharmonious with the characteristic landscape, and rehabilitation is necessary to bring the area back into character with the surrounding landscape.

LITERATURE CITED

Bates, Robert L. 1969. Geology of the industrial rocks and minerals. New York: Dover Publications, Inc.

Baxter, George T. and James R. Simon 1970. Wyoming fishes. Bull. No. 4. Cheyenne: Wyoming Game and Fish Department.

Beetle, A. A. 1960. A study of sagebrush. Bull. No. 368. Laramie: University of Wyoming Agricultural Experiment Station.

Bernhardt, Arthur D. 1980. Building tomorrow: the mobile manufactured housing industry. MIT Press.

Bio/West, Inc. 1981. Fisheries distribution and species composition inventory, Rock Springs District Salt Wells Resource Area, Wyoming. For Bureau of Land Management, Rock Springs, Wyoming.

Biosystems Analysis, Inc. 1981. Wildlife inventory of the Salt Wells and Pilot Butte planning units. For Bureau of Land Management, Rock Springs. Wyoming.

Booth, W. E. and J. C. Wright 1959. Flora of Montana. Parts I and II; with certain alterations and additions by W. E. Booth 1962, 1966. Bozeman: Montana State University Department of Botany and Microbiology.

Bradley, W. H. 1964. Geology of Green River formation and associated Eocene rocks in southwestern Wyoming and adjacent parts of Colorado and Utah. U.S. Geological Survey Prof. Paper 496-A. Washington: Department of the Interior.

Bradley, W. H. and H. P. Eugster 1969. Geochemistry and paleolimnology of the trona deposits and associate authigenic minerals in the Green River formation of Wyoming. U.S. Geological Survey Prof. Paper 496-B. Washington: Department of the Interior.

Clark, T. W. 1978. Current status of the black-footed ferret in Wyoming. J. Wildlife Manage. 42(1): 128-134.

Colorado School of Mines Research Institute 1977. Supplementary information on the mining plan for the Texasgulf, Inc., soda ash project. Vols. I and II. Golden, Colorado.

Culbertson, W. C. 1966. Trona in the Wilkins Peak member of the Green River formation, southwest Wyoming. U.S. Geological Survey Prof. Paper 550-B. Washington: Department of the Interior.

Culbertson, W. C., and M. J. Burnside 1979. Trona deposits in the Green River basin, Sweetwater, Uinta, and Lincoln counties, Wyoming. Open-File Report 79-737. U.S. Geological Survey.

Dana, George F., and John Ward Smith 1973. Black trona water, Green River basin. In Wyoming Geological Association Guidebook, 25th Field Conference. Casper: Wyoming Geological Association.

Deardorff, Don L., and L. E. Mannion 1971. Wyoming trona deposits. In Contributions to Geology, pp. 25-38. Laramie: University of Wyoming.

Employment Security Commission of Wyoming, Research and Analysis Section 1979. State and county summary of covered employment and total payrolls by industry. Cheyenne, Wyoming.

_____. 1980. State and county summary of covered employment and total payrolls by industry. Cheyenne, Wyoming.

Environmental Research and Technology, Inc. 1977. Final reports for the Sweetwater/Kemmerer (southwestern) study area. Fort Collins, Colorado.

_____. 1978. Regional technical report for southwestern coal development environmental statement--climate and air quality sections. Fort Collins.

Frison, George C. 1978. Prehistoric hunters of the high plains. New York: Academic Press.

Goodin, J. R. 1977. Rangeland plant physiology: salinity effects on range plants. Lubbock: Texas Tech University.

Innes, George 1980. The world market for natural soda ash. For presentation at the annual meeting of the AIME, 24-28 February 1980, Las Vegas, Nevada. Littleton, Colorado: Society for Mining Engineers.

Job Service of Wyoming 1979. Civilian labor force and unemployment. Cheyenne.

_____. 1980. Civilian labor force and unemployment. Cheyenne.

Kostick, Dennis S. 1979. Soda ash (sodium carbonate), sodium sulfate, and sodium. In Mineral Commodity Profiles. Washington: Bureau of Mines, Department of the Interior.

_____. 1980. Soda ash, sodium bicarbonate, and sodium sulfate. In Mineral Facts and Problems, Bureau of Mines Bull. No. 671. Washington: Department of the Interior.

Lincoln-Uinta Association of Governments 1980a. Lincoln-Uinta housing element. Kemmerer, Wyoming.

_____. 1980b. Population projections for Lincoln and Uinta counties. Report No. 73. Kemmerer, Wyoming.

Lundberg, Calvin E., and Morton May 1977. Effects of trona fallout on the renewable resources of southwestern Wyoming. Laramie: University of Wyoming Department of Range Management.

Lundberg, Calvin E. 1977. The local composition and distribution of vegetation in the soda ash producing area of Sweetwa-er Co., Wyoming. M.S. thesis. Laramie: University of Wyoming Department of Range Management.

Madison, R. J., and K. M. Waddell 1973. Chemical quality analysis of surface water in the Flaming Gorge reservoir area, Wyoming and Utah. U.S. Geological Survey Water-Supply Paper 2009-C. Washington: Department of the Interior.

McGrew, Paul O., and Thomas M. Bown 1976. Fossil vertebrate faunas and important paleontological sites: Green Mountain, Ferris-Seven Lakes, and Sandy EIS areas, and Sweetwater County, Wyoming. Prepared for Bureau of Land Management under Contract YA-512-CT6-192. Laramie: University of Wyoming.

McKee, J. E., and S. W. Wolf 1963. Water quality criteria. 2nd ed. Publication No. 3A. Resources Agency of California, State Water Quality Control Board.

Muenscher, W. C. 1962. Poisonous plants of the United States. rev. ed. New York: The MacMillan Company.

National Academy of Sciences 1972. Water quality criteria. A report of the Committee on Water Quality, Environmental Studies Board, National Academy of Engineering, for Environmental Protection Agency. Washington.

National Wildlife Federation 1979. Conservation directory. 24th ed. Washington.

Richard, L. A. (ed.) 1954. Diagnosis and improvement of saline and alkali soils. Ag Handbook 60. Washington: U.S. Department of Agriculture.

Rocket-Miner 1980 Annual progress edition. March 29, 1980, issue. Rock Springs, Wyoming: Rock Springs Newspapers, Inc.

_____. 1981. Annual progress edition. March 28, 1981, issue. Rock Springs, Wyoming: Rock Springs Newspapers, Inc.

Science Applications, Inc. 1980. Baseline climate and air quality for BLM lands in Wyoming (2 vols.) LaJolla California.

Southwestern Wyoming Industrial Association 1980. Wyoming trona industry facts. Rock Springs.

_____. 1981. Wyoming trona fact book. Rock Springs.

Star 1980. Texasgulf applies for expansion permits. October 29, 1980, issue. Green River, Wyoming.

_____. 1981. City agrees with Texasgulf plan as schools list their proposals. March 4, 1981, issue. Green River, Wyoming.

Star-Tribune 1981. Two-part series by Paul Krza: Texasgulf expansion causes concern and Siting council to look at impact housing problem. January 18 and 19, 1981, issues. Casper, Wyoming.

State of Wyoming 1981. 1981 Wyoming official directory and 1980 election returns. Cheyenne: Secretary of State.

THK Associates, Inc. 1976. Unpublished report for Sweetwater County Planning and Zoning Commission, including population estimates.

_____. 1977. Final land use plan for Sweetwater County, Wyoming. Prepared for the Sweetwater County Planning and Zoning Commission.

_____. 1979a. Population projections 1979-1990 Sweetwater County, Wyoming.

_____. 1979b. Sweetwater County land use and housing update (draft). Prepared for the Sweetwater County Association of Governments.

Tenneco Oil Company 1978. Industrial siting application for the Tenneco soda ash project, Sweetwater County, Wyoming. Houston, Texas.

Texasgulf, Inc. 1977. Mining plan for the Texasgulf, Inc., soda ash project, Granger, Wyoming.

U.S. Bureau of the Census 1970. Census of housing and population, Wyoming.

_____. 1980. Census of population and housing, Wyoming.

U.S. Department of Agriculture, Ashley National Forest 1977. Flaming Gorge National Recreation Area final environmental statement and management plan. Washington.

Warder, Donald S. 1975. A study of recreation use on Bureau of Land Management lands in southwestern and southcentral Wyoming coal regions--southwestern report. Laramie: University of Wyoming.

Watson, Ian 1981. US soda ash Green River's solution--Europe's problem? In Industrial Minerals, March issue.

Wyoming Department of Administration and Fiscal Control, Division of Research and Statistics 1979a. Wyoming employment report. Cheyenne.

_____. 1979b. Wyoming income report. Cheyenne.

_____. 1980. Wyoming income report. Cheyenne.

Wyoming Department of Economic Planning and Development, Minerals Division 1979. Mineral development monitoring system (rev. ed.) Cheyenne.

_____. 1980. Wyoming mineral yearbook. Cheyenne.

Wyoming Department of Economic Planning and Development, Industrial Development Division 1980a. Evanston community profile. Cheyenne.

_____. 1980b. Rock Springs community profile. Cheyenne.

Wyoming Department of Education, Administrative Services Division 1980. Evaluation report on Uinta County School District No. 1 (interim). Cheyenne.

Wyoming Department of Environmental Quality 1979a. Wyoming 1979 implementation plan for Sweetwater County nonattainment areas. Cheyenne.

_____. 1979b. Water quality rules and regulations. In Quality Standards for Wyoming Surface Water. Cheyenne.

Wyoming Game and Fish Department 1977. Current status and inventory of wildlife in Wyoming. Cheyenne.

Wyoming Geological Survey 1979. Wyoming mines and minerals (map). Laramie.

Wyoming Industrial Siting Administration 1981. Staff review of the permit application for the Texasgulf, Inc., soda ash expansion project, Granger Wyoming. Cheyenne.

PERSONAL COMMUNICATIONS

Barth, Richard. Consultant for Texasgulf, Inc., vegetation monitoring, Colorado School of Mines Research Institute, Golden Colorado. Telephone conversation September 20, 1980, with BLM Rock Springs District Botanist concerning the Texasgulf vegetation studies.

Davidson, Donna. Executive Director, Lincoln-Uinta Association of Governments. Kemmerer, Wyoming. LUAG Board Meeting attended by BLM Rock Springs District Planning Coordinator, June 1980.

Davis, Ned. Manager, trona and other minerals, Rocky Mountain Energy Company, Denver, Colorado. Meeting March 12, 1980, in BLM Rock Springs District Office with BLM District personnel.

Dorn, Robert. Plant Ecologist, Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne. Telephone conversation September 15, 1980, with BLM Rock Springs District Botanist concerning the effects of the sodium industry on vegetation and revegetation possibilities.

Garrett, G. Spencer. Wyoming Highway Department Transportation Planning Engineer, Cheyenne. Letter March 5, 1981, to BLM Rock Springs District Manager concerning traffic counts for the Green River area.

Love, Dave. U.S. Geological Survey Geologist, Laramie. Conversation September 15, 1980, with BLM Rock Springs District Botanist concerning the effects of trona plant emissions, particularly fluorine, on the environment.

Kostick, Dennis S. Physical Scientist, U.S. Bureau of Mines Nonmetallic Section, Washington, D.C. Telephone conversation November 3, 1980, with Co-Team Leader concerning soda ash production and market trends. Conversation March 18, 1981, with Co-Team Leader and BLM Rock Springs Regional Economist concerning soda ash production and market trends.

Peverley, Dee. Environmental Coordinator for FMC Corporation, Green River, Wyoming. Conversation with BLM Rock Springs District Botanist concerning total suspended particulate analysis.

Rondeau, J. C. For Stauffer Chemical Company, Green River, Wyoming. Conversation October 9, 1980, with BLM Rock Springs District Botanist concerning total suspended particulate analysis.

Scroggins, James. Environmental Coordinator, Texasgulf, Inc., Granger, Wyoming. Telephone conversation October 7, 1980, with BLM Rock Springs District Botanist concerning total suspended particulate analysis.

Stocker, Bill. Environmental Coordinator, Allied Chemical Company, Green River, Wyoming. Conversation October 9, 1980, with BLM Rock Springs District Botanist concerning total suspended particulate emissions.

U.S. Fish and Wildlife Service. Letter from Joe B. Rodriguez, Seedskadee National Wildlife Refuge Manager, October 29, 1980, to Team Leader concerning refuge bid populations, waterfolw losses in tailings ponds, and other potential impacts of sodium development.

Wyoming Game and Fish Department. Meeting of Green River division representatives September 25, 1980, in BLM Rock Springs District Office with BLM personnel to discuss wildlife concerns in sodium development area.

Wyoming Water Development Commission. Letter from David Zelenka, P.E., May 13, 1981, to BLM Rock Springs District Hydrologist concerning Green River Basin, Wyoming, water depletions.

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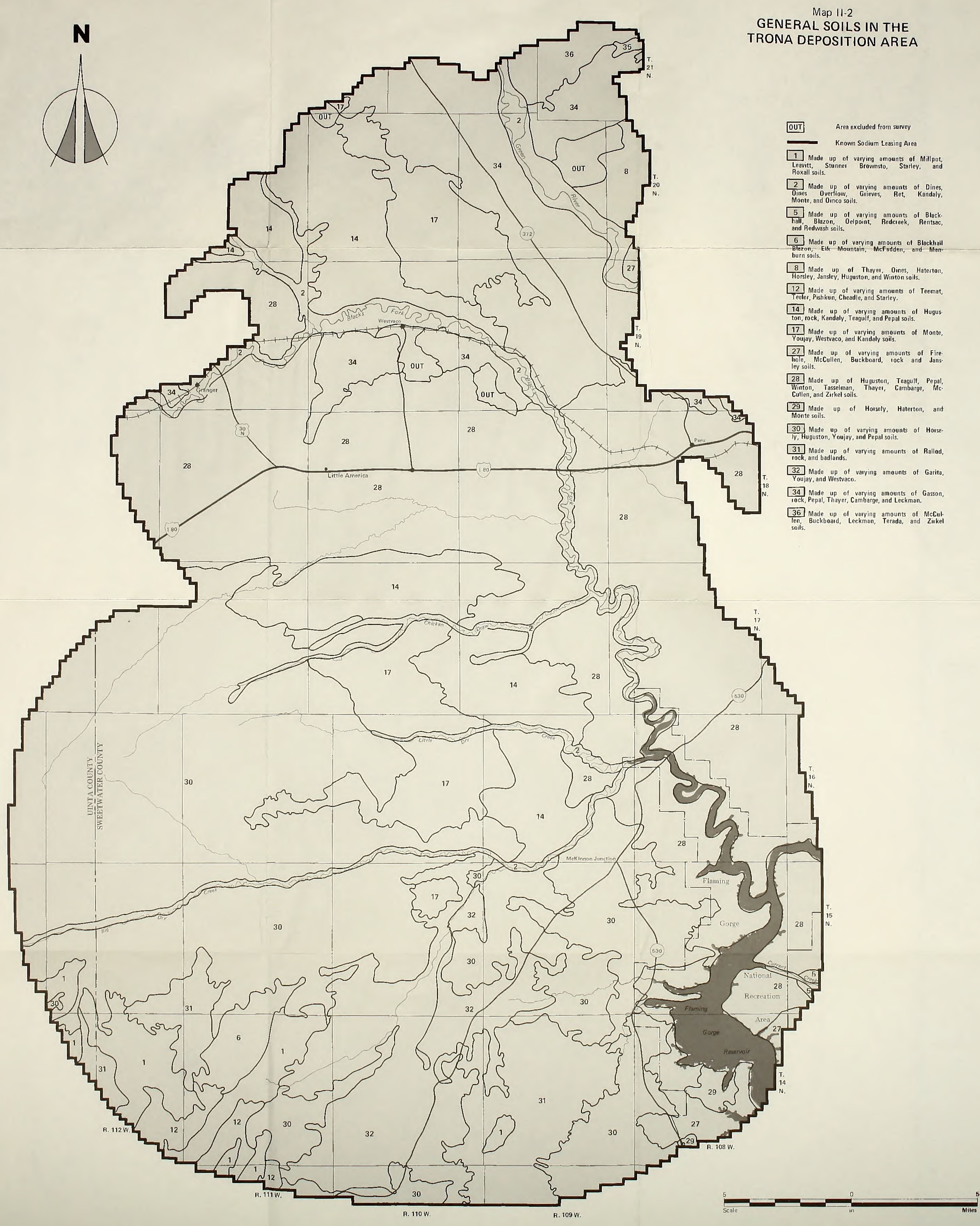
Map II-2
GENERAL SOILS IN THE TRONA DEPOSITION AREA
N
OUT Area excluded from survey
Known Sodium Leasing Area
1 Made up of varying amounts of Millpot, Leavitt, Stunner Brownsto, Starley, and Roxall soils.
2 Made up of varying amounts of Dines, Dines Overflow, Grieves, Ret, Kandaly, Monte, and Dinco soils.
5 Made up of varying amounts of Blackhall, Blazon, Delpoint, Redcreek, Rentsac, and Redwash soils.
6 Made up of varying amounts of Blackhall Blazon, Elk Mountain, McFadden, and Manburn soils.
8 Made up of Thayer, Dines, Haterton, Horsley, Jansley, Huguston, and Winton soils.
12 Made up of varying amounts of Teemat, Teeler, Pishkun, Cheadle, and Starley.
14 Made up of varying amounts of Huguston, rock, Kandaly, Teagulf, and Pepal soils.
17 Made up of varying amounts of Monte, Youjay, Westvaco, and Kandaly soils.
27 Made up of varying amounts of Firehole, McCullen, Buckboard, rock and Jansley soils.
28 Made up of Huguston, Teagulf, Pepal, Winton, Tasselman, Thayer, Cambarge, McCullen, and Zirkel soils.
29 Made up of Horsely, Haterton, and Monte soils.
30 Made up of varying amounts of Horsely, Huguston, Youjay, and Pepal soils.
31 Made up of varying amounts of Rallod, rock, and badlands.
32 Made up of varying amounts of Garita, Youjay, and Westvaco.
34 Made up of varying amounts of Gasson, rock, Pepal, Thayer, Cambarge, and Leckman.
36 Made up of varying amounts of McCullen, Buckboard, Leckman, Terada, and Zirkel soils.
T. 21 N.
T. 20 N.
T. 19 N.
T. 18 N.
T. 17 N.
T. 16 N.
T. 15 N.
T. 14 N.
R. 112 W.
R. 111 W.
R. 110 W.
R. 109 W.
R. 108 W.
Green River
Blacks Fork
Westvaco
Granger
Little America
Peru
Chicken Draw
Little Dry Creek
Big Dry Creek
McKinnon Junction
Flaming Gorge National Recreation Area
Flaming Gorge Reservoir
Currant Creek
UINTA COUNTY
SWEETWATER COUNTY
Scale in Miles
5 0 5