FINDING OF NO SIGNIFICANT IMPACT: I have reviewed this environmental assessment including the explanation and resolution of any potentially significant environmental impacts. I have determined the proposed action will not have significant impacts on the human environment and that preparation of an Environmental Impact Statement (EIS) is not required.

Rational for Recommendations: The proposed action would not result in any undue or unnecessary environmental degradation. The proposed action will be in compliance with the Roswell Resource Management Plan and Record of Decision (October, 1997).

TR Kreager

T. R. Kreager
Assistant Field Office Manager - Resources

10/22/02

Date

Bureau of Land Management

Habitat Protection Zone
Environmental Assessment

EA-NM-060-00-030

Chaves County, New Mexico
October 2002

U.S. Department of the Interior
Bureau of Land Management
Roswell Field Office
Roswell, New Mexico

Introduction

Purpose and Need for the Proposed Action

In May 1997, the U.S. Fish and Wildlife Service (USFWS) provided the Bureau of Land Management (BLM) with a biological opinion on the Roswell Resource Area Draft Resource Management Plan (RMP). In the opinion of the USFWS, implementation of the Proposed RMP would jeopardize the continued existence of the federal endangered Pecos gambusia (*Gambusia pecosensis*) unless the six elements of their prescribed "reasonable and prudent alternative (RPA)" are also implemented. The record of decision to adopt the Roswell Approved RMP was signed in October 1997, incorporating the reasonable and prudent alternative into the plan.

The biological opinion for the Pecos gambusia RPA reads, in part:

> *"1. Use the best available hydrologic information to map the source and movement of water that supplies springs occupied by Pecos gambusia on the BLNWR and the Salt Creek Wilderness. Close the lands within the mapped area to oil and gas leasing unless or until BLM can demonstrate that mandatory protective measures will ensure no aquifer contamination.*
>
> *"2. For existing lease within the mapped area, apply appropriate measures taken from BLM's 'Practices for Oil and Gas Drilling and Operations in Cave and Karst Areas' and any other appropriate measures to ensure no contamination of water that supplies springs occupied by Pecos gambusia on the BLNWR and the Salt Creek Wilderness. Use monitoring procedures that will detect any surface or subsurface accidents soon enough that they can be discovered and corrected before significant harm to the aquifer occurs.*
>
> *"3. Continue the policy contained in the Interim Oil and Gas Leasing EA (BLM 1995) of selling no new oil and gas leases on lands with 100-year floodplains, unless or until BLM can demonstrate that other mandatory protective measures will provide equivalent protection.*
>
> *"4. The Roswell DRMP/EIS (BLM 1994) contains proposed surface use and occupancy requirement for oil and gas activities in floodplains. It states, 'No surface occupancy would be allowed within floodplains or within 200 meters of the outer edges of 100-year floodplains, to protect riparian areas' (Appendix 3). Change the wording of this sentence to indicate the purpose of the policy is to protect the integrity of the 100-year floodplain, not just riparian area within the floodplain."*

BLM incorporated the Pecos gambusia RPA into the 1997 RMP. Items # 3 and #4 became BLM management policy by this action. Since 1997 the source and movement of water that supplies the springs occupied by the Pecos gambusia have been mapped. (See Appendix F, Balleau Study.) The purpose of this document is to analyze the impacts of implementing the remainder

of RPA item #1 and item #2 which includes the impacts of closing lands within a designated area to oil and gas leasing, and the application of protective measures and design features to existing lease developments. The need for this environmental assessment is also evident in the presence of other special status species occupying the same springs as the Pecos gambusia. Therefore, this document will also analyze the impacts of this habitat protection as they relate to rangeland management, special status species habitat protection, minerals management, recreation management, visual resource management, and other resource concerns.

Conformance with Land Use Plans

The proposed action conforms with the Roswell Approved Resource Management Plan (RMP) and Record of Decision (BLM 1997) as required by 43 CFR 1610.5-3.

Relationships to Statutes, Regulations, or Other Plans

The proposed action and alternatives are consistent with the Federal Land Policy and Management Act of 1976 (43 CFR USC 1700 et seq.; the Clean Water Act (33 USC 1251 et seq.), as amended; and the Endangered Species Act (16 USC 1535 et seq., as amended. The leasing of oil and gas is authorized by the Mineral Leasing Act of 1920, as amended and supplemented by Acts. Leasing is consistent with the Federal Land Policy and Management Act. The proposed action and alternatives are consistent with these laws and with the regulations in 43 CFR 3100.

Proposed Action and Alternatives

Proposed Action

The proposed action is to administratively designate the BLM/Bitter Lake Habitat Protection Zone (HPZ) to contribute to the protection of groundwater resources supplying springs at the Bitter Lake National Wildlife Refuge (BLNWR), and to conduct specific management actions within the special management area in order to implement the Reasonable and Prudent Alternative for the Pecos gambusia. The Habitat Protection Zone is comprised of a subsurface area defined by the hydrologic formation of water supplying the springs within the BLNWR, and the surface subwatershed area draining toward the BLNWR. Federal lands and minerals within the Habitat Protection Zone would receive special emphasis for all BLM-authorized actions (Appendix A, Map 1). The proposed action would affect approximately 12,585 acres of federal mineral estate and approximately 9,945 acres of federal surface estate within the boundary of the Habitat Protection Zone.

Implementation elements for the Habitat Protection Zone would be:

- Identify unleased federal mineral parcels and remove from future lease sales in accordance with the 1997 RMP.
- Remove from future lease sales expiring and expired tracts of federal mineral estate.

- Apply appropriate protective measures and design features to existing oil and gas lease developments, including but not limited to, Practices for Oil and Gas Drilling and Operations in Cave and Karst Areas, when applicable (Appendix 5 Roswell RMP).

- Apply the drilling and development concepts of EA #NM-066-00-121, Shelly Federal #2 Well. (See Appendix D) These drilling and development concepts would be:

  1. Access roads would be constructed without excessive grading or blading activities and would be limited to grubbing of vegetation and leveling of the access roads for a smooth running travelway. Gravel surfacing material would be utilized instead of caliche and placed on the minimally disturbed ground surface within the proposed road route. All other existing access roads would be maintained in as good or better condition than existed at the commencement of operations.

  2. Well pads would be constructed without excessive grading or blading activities and would be limited to grubbing of vegetation and leveling of the pad. Gravel surfacing material would be utilized instead of caliche and placed on the minimally disturbed ground surface within the proposed well pad.

  3. In lieu of lined earthen reserve pits, steel tanks would be used (see Roswell RMP, Appendix 3, page AP3-5). No reserve pit, or any other pits, would be constructed for the drilling activity. Above ground steel tanks would be used for drilling muds and would be located within the perimeter of the well pad. Utilizing steel tanks during drilling operation would prevent potential contaminants from leaching into the groundwater, and to reduce disturbance of fragile soils in the area. The tailings and muds contained in the steel tanks would be disposed at an authorized disposal site.

  4. Casing is comprised of steel pipe of various diameters intended to prevent any transfer of fluids between the borehole and the surrounding formations. The casing would be set at different formations to protect the integrity of the well, and to seal off and protect the groundwater aquifers. Progressively smaller diameter casing would be used during the drilling process, the borehole below each string of casing is smaller than the borehole above. The steel pipe casing would be placed in the borehole as drilling progresses to prevent the wall of the borehole from caving in, to prevent seepage of fluids, and to provide a means of extracting gas if the well is a producer. The operator would submit a casing and cementing program as part of the application for permit to drill (APD) approval. This program would be reviewed by a BLM petroleum engineer for adequacy.

  5. A surface hole would be drilled to a depth sufficient to protect the fresh water aquifers using fresh water as the drilling fluid. Surface casing would be set at this depth and cemented in place. A volume of cement sufficient to circulate to the surface would be used. A cement slurry would be raised uniformly between the casing and the borehole. Ideally, the cement would completely and uniformly surround the casing and form a strong bond to the borehole wall while preventing the contamination of groundwater aquifers. This casing string would protect fresh water from the Quaternary Alluvium and

Artesia Group. The surface casing would be pressure-tested prior to drilling any deeper and witnessed by a BLM petroleum engineer technician.

A volume of cement would be raised uniformly up from TD of each subsequent string of casing from total depth (TD) to the surface. A BLM petroleum engineer technician would monitor the actual circulation of cement and verify that the cement job was properly done.

The drilling fluids, also referred to as mud, may be a mixture of bentonite, barite, gypsum, fresh water, sodium chloride (salt water), and chemical additives. The mixture of different additives to the drilling fluids provide viscosity and density to the mud. In addition, the additives in the mud support the borehole walls from caving in, the mud (clay) deposits a cake plaster on the wall of the borehole to prevent loss of drilling fluids to the formations (seals permeable zones), and the mud also exerts hydrostatic pressure that serves to protect against blowouts by holding back subsurface pressures. When mud is being circulated, bottomhole pressure is the hydrostatic pressure required to help move the mud up the annulus. Once the wellbore is drilled, the mud along with borehole cuttings, are circulated back to the steel tanks.

Throughout the drilling phase, a driller's log or daily tour report would be maintained and used to report to the producer's operations staff of daily progress and occurrences during each driller's tour. It would show the hourly breakdown of time spent on various operations and records drilling rate at different depths, formation types, drilling breaks, lost circulation zones, when connections are made, when bits are changed, oil and gas shows, blowout preventer equipment (BOPE) tests, casing integrity tests, and other items. This information is used to monitor the drilling phase of the well and is made available to the BLM for review.

6. If the well is determined to be non-productive, no production casing would be set and appropriate cement plugs would be placed in the well bore to plug and abandon the well. This action would be evaluated upon receipt of a Notice of Intent to Plug and Abandon. At this time borehole data would be reviewed by a BLM petroleum engineer to determine the exact setting depths of the cement plugs. If the well is successful, and production casing is set, and the well will be completed for gas production.

7. If the well is a producer, a production packer would be placed on the production tubing and set above the perforations and a pressure gauge placed at the surface to monitor the status of the production casing during the life of the well. A production packer would seal off the production casing from the producing zone. This would allow monitoring for any internal casing leaks, which would register on the pressure gauge installed at the surface.

- Apply appropriate protection measures and design features to all proposed rights-of-way actions.
- Implement monitoring programs to detect oil and gas surface and subsurface

contamination.

- Continue the livestock grazing deferment decisions for Allotment 64056 and 64057 as described in EA# NM -060-1999-089 (BLM 1999).

Alternative A - Expanded Habitat Protection Zone

Under this alternative, approximately 5,800 acres of additional federal mineral estate and approximately 4,100 acres of federal surface estate would be incorporated into the Habitat Protection Zone. This alternative would essentially include the remaining lands between the Salt Creek Wilderness and Highway 70, and lands west of, and including a portion of the Pecos River between the BLNWR Middle Tract and Highway 70 (Appendix A, Map 2). Similar management actions as found in the Proposed Action would apply to the additional lands.

Additional management opportunities would be afforded by designating the entire area between the Salt Creek Wilderness and the BLNWR as the HPZ. The expanded area would include the federally endangered Interior least tern nesting area located on public lands, a portion of the Pecos River and associated floodplain, and encompass an entire grazing allotment (64056). This alternative allows for more of a landscape level planning effort for a multitude of species and habitats. It ties in with concurrent livestock grazing Cooperative Management Plans prepared for riparian allotments along the Pecos River, and those current decisions found in the Roswell RMP such as floodplain protection.

Specific actions within the Expanded HPZ are the same as the Proposed Action.

No Action Alternative

Under this alternative, all activities authorized by BLM would be conducted in accordance with the Roswell RMP. On oil and gas leases, the operational aspects of exploration, development, and production of oil and gas, and the eventual abandonment of well and other facilities, are the same as described under the proposed action, and authorized by permit or right-of-way. These activities would be conducted according to standard conditions of approval that would mitigate impacts, and would be attached to the authorization. Standard terms and conditions of oil and gas leases, Onshore Oil and Gas Orders, regulations, and Notices to Lessees would also apply to these activities, when needed.

The Roswell RMP, however, by incorporating the biological opinion of Pecos gambusia RPA, states further implementation actions are necessary. Failure to implement the biological opinion and the RPA represents a deviation from management prescriptions delineated in the RMP. Therefore, a No Action Alternative conflicts with the management policies and intent of the Roswell RMP and will not be discussed further in this document.

<u>Affected Environment and Environmental Consequences</u>

General Setting

The primary area of interest is located approximately ten miles northeast of Roswell, NM via Highway 285 north and Highway 70 east, which bisects the area (Appendix A, Map 1). It is located on the upper terrace west of the Pecos River and generally runs northwest to southeast toward the Bitter Lake National Wildlife Refuge. A secondary and much smaller area is located on the northern boundary of the Salt Creek Wilderness Area administered by the BLNWR.

Topography

Elevation above sea level is approximately 3,700 feet in the northwest portion of the area, and drops down to approximately 3,480 feet along the Pecos River to the southeast on the BLNWR. Topography of the subwatershed is flat to gently sloping within the majority of the area. Significant topographic features include Dunahoo Hills which are notable escarpments bordering the Pecos Valley on the northeastern portion of the area, Big Lake and Shaw Lake (dry playas), Skull Lake sinkholes, and the Lost River drainage which enters the BLNWR.

Climate

The climate of the area is generally classified as semi-arid with an average growing season of 195 days (April to October). During the growing season, the daily temperatures average from 55 to 80 degrees Fahrenheit (F). There are frequent highs of 100 degrees F. or more during the summer. Minimum winter temperatures occasionally drop below 0 degrees F. The average annual temperature is 61 degrees F. High winds from the west and southwest are common from March to June.

Annual precipitation averages 8 to 12 inches a year. Wide fluctuations from year to year are common, ranging from a low of about two inches to a high of over twenty inches. Eighty percent of the annual precipitation occurs in the form of rainfall during the months of June through September. Snowfall averages less than four inches annually and may occur from November through April, and usually melts within a short time.

Critical Elements

The following elements have been evaluated and either are not present or are not affected by the proposed action or alternatives in this environmental assessment: Areas of Critical Environmental Concern (ACECs); Farm Lands (Prime or Unique); Native American Religious Concerns; Wastes, Hazardous and/or Solid; Wild and Scenic Rivers; Wilderness; Minority or Low Income Population Concerns.

Leasable Minerals Resources (Oil and Gas)

In depth information of oil and gas resources in the RFO is found in the 1994 *Roswell Resource Area Draft Resource Management Plan/Environmental Impact Statement*, the 1997 *Roswell Resource Area Proposed Resource Management Plan/Final Environmental Impact Statement*, and the 1997 *Roswell Approved Resource Management Plan and Record of Decision*.

The Proposed Action would affect approximately 12,585 acres of federal mineral estate and approximately 9,945 acres of federal surface estate within the boundary of the Habitat Protection Zone. Within the boundary of the Habitat Protection Zone are all or part of seventeen (17) current oil and gas leases. Within the Zone, nine unleased parcels totaling approximately 1,520 acres of federal mineral estate would no longer be made available for leasing for an indefinite period of time. Oil and gas exploration and development would continue on existing leases on a case-by-case basis until lease expiration or abandonment.

Development of existing leases would follow Onshore Oil and Gas Order No. 1: Operations; Practices for Oil and Gas Drilling and Operations in Cave and Karst Areas, when applicable (Appendix 5, Roswell RMP); and the concepts (see Proposed Action) of the Preferred Alternative analyzed in EA #NM-066-00-121, Shelly Federal #2 Well (Appendix D of this document). The techniques, tools and practices described in these documents are designed to ensure that no contaminants would reach the water that supplies the springs occupied by the Pecos gambusia and other special status species in the BLNWR.

Information for all affected leased and unleased oil and gas parcels within the HPZ is found in Appendix B.

Affected Environment

The leasable minerals within the area of interest are predominantly oil and gas. Within the boundaries of the Proposed Action are all or part of 17 oil and gas leases that are the location of 20 natural gas wells. There are nine unleased parcels totaling approximately 1,520 acres of federal mineral estate. The potential for further oil and gas development in order to fully develop a lease, and in accordance with well spacing requirements established by the New Mexico Oil Conservation Division (NMOCD), is projected to be approximately 66 wells.

Within the boundaries of Alternative A, are all or part of twelve (12) current oil and gas leases totaling approximately 5,464 acres of federal mineral estate that are the location of 12 natural gas wells. There are three unleased parcels totaling approximately 300 acres of federal mineral estate. The potential for further oil and gas development in order to fully develop a lease, and in accordance with well spacing requirements established by the NMOCD, is projected to be approximately 25 wells.

The legal descriptions of the public lands and federal minerals estate for the Proposed Action and Alternative A are listed in Appendix E.

Environmental Consequences

<u>Proposed Action</u>

New wells on existing leases would be required to follow appropriate stipulations and design features as set forth in Onshore Oil and Gas Order No. 1: Operations; Practices for Oil and Gas Drilling and Operations in Cave and Karst Areas, when applicable (Appendix 5, Roswell RMP);

and the concepts of the Preferred Alternative analyzed in EA #NM-066-00-121, Shelly Federal #2 Well. The impacts these stipulations and design features have been previously analyzed in these documents. These stipulations and design features would be applied to federal surface ownership and to federal mineral estate.

Proposed Action - Land Status and Approximate Acreage

Federal Surface	Private Surface (w/ Federal Minerals)	Total Federal Minerals	Total Surface Acres
9,945	2,640	12,585	12,585

Proposed Action Surface Drainage Area - Land Status and Approximate Acreage

Federal	Private	BLNWR	State	Total Acres
4,810	4,500	2,480	640	12,430

Alternative A - Land Status and Approximate Acreage of Additional Area

Federal Surface	Private Surface (w/ Federal Minerals)	Total Federal Minerals	Total Surface Acres
4,100	1,700	5,800	5,800

Alternative A

New wells on existing leases would be required to follow appropriate stipulations and design features as set forth in Onshore Oil and Gas Order No. 1: Operations; Practices for Oil and Gas Drilling and Operations in Cave and Karst Areas, when applicable (Appendix 5, Roswell RMP); and the concepts of the Preferred Alternative analyzed in EA #NM-066-00-121, Shelly Federal #2 Well. The impacts these stipulations and design features have been previously analyzed in these documents. These stipulations and design features would be applied to federal surface ownership and to federal mineral estate.

Cumulative Impacts

The Proposed Action and Alternative A differ only in the total number of acres of federally managed surface and federal mineral estate. In both situations, the ground water supplying the springs on BLNWR would be protected from possible hydrocarbon contamination by the casing and cementing programs. Further, the monitoring program would allow detection and

remediation of possible leaks.

Surface disturbance from well pads, roads and pipeline rights-of-way would continue at pace that was analyzed in the reasonable and foreseeable development found in the Draft Roswell RMP. Mitigation for these impacts are found in Appendixes 2 and 5 of the Roswell RMP, and the Preferred Alternative of EA # NM-066-00-121.

Adjacent private and state lands would continue to undergo oil and gas lease development. A current State lease within the surface drainage area has been drilled for natural gas. It should be noted that private lands are immediately adjacent to the northwest boundary of the BLNWR Middle Tract. BLM does not have the mineral estate for these private lands.

Other Minerals Resources (Salable, Locatable and Solid Leasable)

Under the 1997 Roswell RMP the area included in the Proposed Action and Alternative A are open to leasing of solid minerals, mineral materials disposal, mining claim locations, and would remain so. Impacts of this land use decision were analyzed in the Roswell Draft RMP.

Lands and Realty

Affected Environment

A wide variety of existing rights-of-way (ROW) traverses the HPZ due to the area's proximity to Roswell including: Highway 70; Atchison Topeka and Santa Fe Railroad; Capitan, Old Clovis Highway, Bitter Lake and East Pine Lodge county roads, electrical transmission lines, gas transportation lines, buried cable, and sundry ROW for access roads and collection pipelines associated with the currently limited oil and gas lease development activities. ROW for oil and gas operations are granted under the Mineral Leasing Act and the Federal Land Policy and Management Act, and are considered surface actions.

All right-of-way actions are subject to conditions of approval designed to mitigate negative impacts. Refer to the Roswell RMP Appendix 2 for conditions of approval. A list of all known existing ROW within the areas covered by the Proposed Action and Alternative A is found in Appendix C.

Environmental Consequences

Rights-of-way would only be required where projects cross BLM-administered surface. Surface disturbance would be less over split-estate leases because this situation normally requires fewer and shorter rights-of-way across public lands. Existing developed leases generally have extensive roads, pipelines, and other infrastructure in place; fewer and shorter rights-of-way would be required. Conversely, partially developed leases on public land would require extensive ROW for access and pipeline construction.

Access, production and distribution facilities provided by rights-of-way on public lands are essential to the economics of oil and gas operations. Most oil and gas rights-of-way involve short-term use of public lands and an exception would be the major interstate product pipelines. Productivity is restored upon successful rehabilitation of disturbed areas. Reclamation may not be successful in some areas and site productivity would not be restored. Generally, soil and vegetation resources are most affected by right-of-way construction. All approved right-of-way actions are subject to standard or special conditions of approval, or both, designed to mitigate negative impacts. Refer to the Roswell RMP Appendix 2 for conditions of approval.

Rights-of-way for oil and gas operations on existing leases would continue to be approved, subject to standard or special stipulations, or both. The reasonable and foreseeable development of the existing leases in both the Proposed Action and Alternative A is estimated at being 91 wells. Therefore, probably no more than 91 ROWs would be issued for access roads and no more than that number for pipeline ROWs.

There would be no change to existing transportation.

Cumulative Impacts

The estimated annual addition of about 6 acres of rights-of-way-related disturbance is not significant, this estimate is based on two gas wells per year in the area of concern. Cumulative impacts of ROW is not significant especially in light of the large existing ROWs already in place, such as Highway 70; Atchison Topeka and Santa Fe Railroad; Capitan, Old Clovis Highway, Bitter Lake and East Pine Lodge county roads, electrical transmission lines, and gas transportation lines.

Noxious and Invasive Species

Affected Environment

There are no known populations of invasive or noxious weed species on the proposed Habitat Protection Zone. There are, however, populations of goldenrod, a species of concern. Species of concern are native plants that may be toxic to livestock and BLM's policy is to limit the spread of such species as much as possible.

Infestations of noxious weeds can have a disastrous impact on biodiversity and natural ecosystems. Noxious weeds affect native plant species by out-competing native vegetation for light, water and soil nutrients. Noxious weeds cause estimated losses to producers $2 to $3 billion annually. These losses are attributed to: (1) Decreased quality of agricultural products due to high levels of competition from noxious weeds; (2) decreased quantity of agricultural products due to noxious weed infestations; and (3) costs to control and/or prevent the noxious weeds.

Further, noxious weeds can negatively affect livestock and dairy producers by making forage either unpalatable or toxic to livestock, thus decreasing livestock productivity and potentially

increasing producers' feed costs and animal health care costs. Operators bear the increased short-term costs and consumers would bear long-term costs should the spread of noxious weeds remain uncontrolled.

Noxious weeds also affect recreational uses, and reduces realty values of both the directly influenced properties and adjacent properties.

Recent federal legislation has been enacted requiring state and county agencies to implement noxious weed control programs. Monies would be made available for these activities from the federal government, generated from the federal tax base. Therefore, all citizens and tax payers of the United States are directly affected when noxious weed control prevention is not exercised.

Environmental Consequences

The construction of an access road, pipeline and/or well pad may unintentionally contribute to the establishment and spread of noxious weeds. Noxious weed seeds could be carried onto the project areas by construction equipment, the drilling rig and transport vehicles. The main mechanism for seed dispersion on the roads and well pads is by equipment and vehicles that were previously used and or driven across or through noxious weed infested areas. The potential for the dissemination of invasive and noxious weed seeds may be elevated by the use of construction equipment typically contracted out to companies that may be from other geographic areas in the region. Washing and decontaminating the equipment prior to transporting the equipment onto the construction areas would minimize this impact.

Impacts by noxious weeds will be minimized due to requirements to eradicate the weeds upon discovery. Multiple applications may be required to effectively control the identified populations.

Cumulative Impacts

The impacts of surface disturbance by lease development have been previously analyzed in the Roswell Draft RMP. No impacts greater than those associated with the reasonable and foreseeable development are anticipated under either the Proposed Action or Alternative A. Development of existing oil and gas lease would continue, with conditions of approval regarding preventing the spread of noxious weeds. Conditions of approval regarding noxious weeds can be found in the Roswell RMP, Appendix 2.

Vegetation Resources

Affected Environment

The vegetative communities within the Proposed Action and Alternative A are identified in the Roswell Draft Resource Management Plan/Environmental Impact Statement (RMP/EIS). Appendix 11 of the Draft RMP/EIS describes the Desired Plant Community (DPC) concept and identifies the components of each community. Plant communities present are the grassland and

mixed desert shrub communities. Site-specific vegetation resources are most easily described using information from BLM-administered grazing allotment range monitoring files or recent environmental assessments for grazing authorizations. The Proposed Action and Alternative A encompass all or portions of six BLM-administered allotments. North of Highway 70 are Allotments 64053, 64054 and 64055. South of Highway 70 are Allotments 64056, 64057 and 64058. The largest allotments are 64053 and 64056. General vegetation descriptions are for these two allotments since they comprise the bulk of the proposed habitat protection zone. Refer to allotment boundary maps in Appendix A, Map 2.

Allotment Name	**Allotment Number**	**Ecological Range Sites**	**Special Features**
		Allotments North of Highway 70	
James Cliett	64053	Salt Flats SD-3 (Big Pasture) Gyp Upland SD-3 (North) Loamy SD-3 (River Pasture)	Dunahoo Hills, Skull Lake, Big Lake, Lost River
E.H.. Cattle Co.	64054	Salt Flats SD-3	Cultivated Lands
Sinkhole Flats	64055	Salt Flats SD-3	Prairie Dog Colony
		Allotments South of Highway 70	
Melena	64056		Pecos River, Interior Least Tern Habitat
Longley	64057	Loamy SD-3	Prairie Dog Colony, Significant Cave
Blackwell Estate	64058	Loamy SD-3	Playa Lake

Plant species present include alkali sacaton, gyp dropseed, tobosa, black grama, blue grama, gyp grama, gyp muhly, gyp dropseed, threeawn, tobosa, sand dropseed, fluffgrass, saltgrass, witchgrass, false holly, silver nightshade, coldenia, pickleweed, buckwheat, perennial forbs, fourwing saltbush, broom snakeweed, creosote, mesquite and javelinabush. Saltcedar are found in bands along low-lying drainages.

Environmental Consequences

Under the Proposed Action, potential impacts to vegetation resources from oil and gas lease development would be limited to the existing leases. Vegetation would be totally removed from sites during construction, such as locations for drill pads and access roads. The reasonable and foreseeable development for existing leases would total approximately 730 acres of vegetation disturbance for well pads and access/pipeline ROWs.

Once use of a site ceases or construction is complete, disturbed areas would be revegetated according to BLM reclamation standards found in the 1997 Roswell RMP, Appendix 2.

Vegetative resources would be protected on parcels removed from further lease sales.
The impacts on vegetation under the Alternative A are virtually the same as the Proposed Action as applied to the increased acreage.

Cumulative Effects

Total disturbed acreage from 32 past well development (federal minerals) is approximately 290 acres (well pad, access road, pipeline). For the Proposed Action, if all 66 wells (reasonable and foreseeable development) are developed, the surface disturbance would total 594 acres. Alternative A would add a possible 25 additional wells that would add 225 acres of surface disturbance. The surface disturbance would continue past the life of this environmental assessment as long as the wells are producing and until reclamation has occurred. About 12 percent of these wells would not be successful and would be reclaimed.

Soils Resources

Affected Environment

The soils in the area of analysis is covered by the *Soil Survey of Chaves County, New Mexico, Northern Part (USDA Soil Conservation Service, 1983)* and *Soil Survey of Chaves County, New Mexico, Southern Part (USDA Soil Conservation Service, 1980)*. Soils in the area can generally be divided into three physiographic categories: floodplains, terraces, and uplands.

Floodplain soils include the Glendale-Pecos-Vinton association (Glendale-Ustifluvents-Harkey association in the northern survey). They generally formed in alluvium and have sandy loam textures, though textures range from fine sand to silt clay. These soils are at a moderate risk of water erosion, but wind erosion can be severe, especially if ground cover is inadequate to protect the soil surface.

Terrace soils include the Holloman-Gypsum land-Reeves association (Hollomex-Reeves-Milner association in the northern survey). This area includes shallow soils over gypsum, and some deep soils in depressions and on terrace fronts. They also formed primarily in alluvium and are interspersed with gypsum outcrops. Gypsum land areas, such as Dunahoo Hills in the northern part of the area of analysis are fragile environments. They can be susceptible to erosion and are difficult to vegetate once disturbed. Most of the surface drainage area feeding Bitter Lake is within this general soil unit.

Upland soils include the Reakor-Tencee association (Reakor-Alama-Bascal association in the northern survey). Reakor, Alama, and Bascal are deep soils in depressions and on alluvial side slopes. Tencee is a shallow soil over caliche. These soils are found on the western edge of the area of analysis and include the watershed draining to Berrendo Creek.

Alama-Poquita association soils occur in the area on alluvial side slopes. The slopes are 0 to 3 percent. Permeability of the Alama soil is moderately slow. Runoff is medium and the hazard of water erosion is moderate. The hazard of the soil blowing is high. The Poquita soil permeability is moderate. Runoff is medium and the hazard of water erosion is moderate. The hazard of soil blowing is high.

Bascal-Sotim association soils occur on high terraces in the area. The slopes are 0 to 7 percent. Permeability of the Bascal soil is moderate. Runoff is medium and the hazard of water erosion is moderate. The hazard of soil blowing is high. Sotim soil permeability is moderately slow. Runoff is medium and the hazard of water erosion is moderate. The hazard of soil blowing is high.

Dona Ana sandy loam soils occur on low terraces in the area. The slopes are 0 to 1 percent. Permeability is moderate. Runoff is medium and the hazard of water erosion is moderate. The hazard of soil blowing is high.

Hollomex loam soils occur on low terraces in the area with a 0 to 1 percent slope. Permeability of the Hollomex soil is moderate. Runoff is medium and the hazard of water erosion is moderate. The hazard of soil blowing is high.

Hollomex-Reeves-Milner loam soils occur on high terraces in the area with 0 to 3 percent slopes. Permeability of the Hollomex soil is moderate. Runoff is medium and the hazard of water erosion is moderate. The hazard of soil blowing is high.

Sotim-Simona association soils occur on high terraces in the area with 0 to 5 percent slopes. Permeability of the Sotim soil is moderately slow. Runoff is medium and the hazard of water erosion is moderate. The hazard of soil blowing is high. Permeability of the Simona soil is moderately rapid. Runoff is rapid, and the hazard of water erosion is high. The hazard of soil blowing is high.

Torriorthents-Philder-Rock outcrop association occurs on elevation breaks and high terraces in the area. Slopes are 0 to 30 percent. Permeability of the Torriorthents is moderately rapid. Runoff is medium to rapid and the hazard of water erosion is high. The hazard of soil blowing is high. Permeability of the Philder soil is moderate. Runoff is rapid and the hazard of water erosion is high. The hazard of soil blowing is high.

Ustifluvents frequently flooded soils occur in the area with a slope of 0 to 2 percent. Permeability of the Ustifluvents is slow to moderate. Runoff is medium and the hazard of water erosion is moderate. The hazard of soil blowing is high.

Environmental Consequences

Implementing the Proposed Action would provide some long-term benefit to soils in the area. Removing federal parcels from consideration for future lease sales means that the parcels would

not be developed for oil and gas. Soil disturbances and losses from additional well pads, rights-of-way, access roads, mineral material pits or other types of development would not occur on parcels withdrawn from leasing. The benefits would be greatest in areas with poor site conditions (e.g., gypsiferous soils), where reestablishing ground cover after disturbance is most difficult.

Surface disturbance accelerates erosion rates beyond natural levels. Reducing vegetative cover, damaging soil structure, exposing soils to wind, and concentrating surface runoff make soils more susceptible to erosion.. Access roads and pipeline rights-of-way account for the majority of soil losses occurring as a result of oil and gas activities. Mineral pits and well pads are also susceptible. Though soil losses associated with well pads are a small fraction of the total, difficulties in revegetating abandoned pads can make them prone to long-term soil losses.

Total disturbed acreage from 32 past well development (federal minerals) is approximately 290 acres (well pad, access road, pipeline). For the Proposed Action, if all 66 wells (reasonable and foreseeable development) are developed, the surface disturbance would total 594 acres. Alternative A would add a possible 25 additional wells that would add 225 acres of surface disturbance. The surface disturbance would continue past the life of this environmental assessment as long as the wells are producing and until reclamation has occurred. About 12 percent of these wells would not be successful and would be reclaimed.

Cumulative Effects

The cumulative impacts of both the Proposed Action and Alternative A would be less than that analyzed in the reasonable and foreseeable development analyzed in the Roswell Draft RMP since parcels not leased for oil and gas development would remain unleased. Potential impacts on vegetation by development of existing leases would remain the same as that analyzed previously.

Cave and Karst Resources

Affected Environment

The habitat protection zone is within a designated area of high potential for the occurrence of caves and karst. Karst terrain may consist of numerous sinkholes, disappearing streams and underground drainage systems. In karst areas, erosional processes, which would normally act on the surface, are concentrated below ground. Although a complete inventory of significant cave and karst features has not been completed for BLM lands, significant cave and karst features are known to exist within the HPZ.

Environmental Consequences

Drilling, completion, production, and abandonment of wells on existing leases could increase negative impacts on both known and undiscovered caves. Impacts include contamination of cave ecosystems from drilling fluids, oil and gas leakage, groundwater contamination, and surface

disturbance from heavy equipment. The potential for drilling fluids, cement, hydrocarbons, and chemicals to enter cave ecosystems increases with each well drilled. Long-term impacts of leaky casings caused by corroded pipe or poor cementing could allow hydrocarbons to leak into cave systems, threatening the stability of cave ecosystems.

The long-term effects of oil and gas closure would result in the protection of cave and karst features in the area of interest. Restricting activities would mean an overall lower level of surface occupancy and use in the area. With each activity that does not occur, there is a slightly decreased risk of a contaminant release or pollution in some other form.

Cumulative Effects

The cumulative impacts of both the Proposed Action and Alternative A would be less than that analyzed in the reasonable and foreseeable development analyzed in the Roswell Draft RMP since parcels not leased for oil and gas development would remain unleased. Potential impacts on cave and karst resources by development of existing leases would be mitigated by the application of the requirements found in the RMP, Appendix 5, Practices for Oil and Gas Drilling and Operations in Cave and Karst Areas, which is standard operating procedure for permitting oil & gas wells within the area that would be the HPZ.

Affected Environment - Surface Water

The Pecos River is the primary water course in the expanded area of analysis. Major tributaries from the west include Salt Creek, which joins the river in the southeast corner of the Salt Creek Wilderness; Berrendo Creek and the Rio Hondo, which drain the southwest part of the area of analysis; and Lost River, a small but important drainage that feeds Bitter Lake on the BLNWR. There are also small closed basins in the area, including the Shaw and Big Lake drainages.

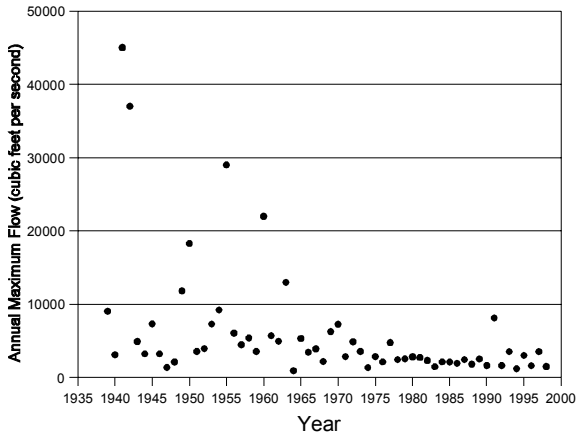


Figure 1. Annual maximum flow at USGS gauge at ACME, New Mexico (08386000) for period 1939-1988 (Ortiz et. Al. 1999). In the 25-year period 193901963, an annual maximum flow of 8,000 cfs was exceeded nine times. In the 35-year period 196401998, 8,000 cfs was exceeded only once (1991).

The flow and sediment regimes of the river have been altered dramatically since the 1930s. Santa Rosa and Sumner dams were constructed for flood control and irrigation. Flooding is now less frequent and less severe than prior to dam construction, and sediment loads have been greatly reduced (see Figure 1). As a result, the channel has become

moderately entrenched, and exhibits much less lateral migration. Flow regulation has also changed the extent, character, and condition of the riparian area on the river (Durkin et al. 1994). Sediment deposition on floodplains is important for riparian succession, and seasonal flooding is required for obligate riparian vegetation.

The hydrology and hydraulics of the river have been significantly changed by the development and management of the Bitter Lake National Wildlife Refuge. When the impoundments on the Middle Tract of the refuge were constructed, a channelized reach approximately six miles long was dug east of the natural channel, which was blocked off and abandoned. The natural channel was approximately 12 miles long, so the stream gradient effectively doubled and the sinuosity was reduced by half. The increased stream energy would naturally tend to scour the river bed, leading to entrenchment of the channel. The bed material picked up in this reach is probably deposited in the lower gradient reach south of Highway380, decreasing the channel capacity and aggravating flood hazards that are addressed by the Chaves County Flood Control Commission (U.S. Army Corps of Engineers 1999).

Water quality in the river is monitored by the New Mexico Environment Department (NMED) under the direction of the New Mexico Water Quality Control Commission (WQCC). The area of analysis lies along two segments of the Pecos River as identified by the WQCC. Each river segment has specific designated uses and water quality standards, and assessments are conducted to determine whether standards are being achieved. Segment 2206 is an 89-mile reach from Salt Creek south to the Rio Peñasco. Segment 2207 is a 128-mile reach from Sumner Dam south to Salt Creek. The confluence of Salt Creek with the Pecos River is in the southeast corner of the Salt Creek Wilderness.

Under the authority of the federal Clean Water Act, the WQCC (2000a) has designated uses for streams in New Mexico. Designated uses for the two segments include irrigation, livestock watering, wildlife habitat, and secondary contact (e.g., wading). In addition, Segment 2206 has a warmwater fishery, and Segment 2207 has fish culture and a limited warmwater fishery.

The WQCC (2000a) also established water quality standards to protect the designated uses, and directs periodic water quality assessments to ensure that standards are met. According to the NMED, Segments 2206 and 2207 are currently meeting the standards for all its designated uses north of U.S. 380 (Hogge 1998; NMED 1998a; NMED 1999; WQCC 2000b).

Sinkholes and springs are also common in the area, and they continue to appear. During the winter of 1998-99 a new sinkhole formed on BLM land a few miles north of the Salt Creek Wilderness. The springs and sinkholes north of Bitter Lake on the refuge Middle Tract, and the Ink Pots, a pair of large sinkholes on the Salt Creek Wilderness provide habitat for the Pecos gambusia and other aquatic and riparian species.

The surface drainage area feeding Bitter Lake and the gambusia habitat covers approximately 12,500 acres (see Appendix A, Map 1). Three significant rights-of-way, Highway 380, the Old Clovis Highway, and the Atchison Topeka and Santa Fe Railroad, bisect the surface drainage area, effectively modifying natural surface drainage.

Environmental Consequences - Surface Water

In general, the management activities outlined in the Proposed Action and alternative would have long term benefits to surface water quality in the area of analysis. Most of the proposals could be characterized as administrative decisions that would limit the amount and severity of surface disturbing activities and occupancy of public lands. The potential for sediment loading, contaminant spills, and other hazards to water courses in the area would be reduced.
Past assessments conducted by the NMED show that surface water quality in the area has not been significantly affected by land use activities. Appropriate design features and conditions of approval would continue to be applied to future land use activities. These efforts, coupled with ongoing monitoring, would minimize the risk of future water quality impacts.

Cumulative Effects - Surface Water

The benefits for surface water quality discussed above would also constitute a cumulative benefit. Restricting land use activities would mean an overall lower level of surface occupancy and use in the area of interest. With each activity that does not occur, there is a slightly decreased risk of sediment production, contaminant releases, or pollution in some other form.

Affected Environment - Ground Water

Hydrogeology

The surface of the area consists of Quaternary - Tertiary alluvium and terrace gravel deposits. The lower or lowland area is characterized by three constructional terraces termed the Lakewood, the Orchard Park, and the Blackdom Terraces. The Lakewood terrace located adjacent to the Pecos River and is generally 10 to 25 feet above the bed of the River (Motts, Cushman, 1964). The Orchard Park terrace lies adjacent to the west side of the Lakewood terrace and for distances westward along the valleys of the major tributaries (Motts, Cushman, 1964). The Orchard Park terrace is 5 to 10 feet above the Lakewood terrace. The Blackdom terrace rises 30 to 50 feet above the Orchard Park terrace. The terraces are capped with caliche in many places. The upper or upland area consists of outcrops of the San Andres Formation. These alluvium and terrace deposits are underlain by the clastic and evaporitic facies of the Artesia Group with limestone and dolomite deposits of the San Andres Formation. Groundwater movement in the area is generally in the southeast direction. The water wells in the vicinity of the area are finished in the valley alluvium and artesian aquifers. The artesian aquifer is located in the San Andres Formation. These wells produce good to fair water. The depth to groundwater in existing water wells in the area ranges from 50 to 150 feet (New Mexico Office of the State Engineer Data, 1988).

Hydrology

The area of analysis is at the northeast limit of the Roswell ground-water basin. The Roswell

basin can be described by its three main components. First is an eastward dipping carbonate aquifer that is closely related to the San Andres limestone. It is often called the "artesian aquifer" though it is unconfined to the west. Water-producing zones near the refuge are at the upper part of the San Andres limestone and can extend into the Grayburg and Queen formations of the Artesia Group.

The Artesia Group comprises the second component of the basin, a leaky "confining bed" overlaying the carbonate aquifer. One or more water zones are present in the upper portion of the confining bed, contributing approximately ten percent of the water pumped in the Roswell basin (Welder 1983).

Finally, the confining bed is overlain by a water table aquifer of Quaternary alluvium, commonly called the "shallow aquifer." There is evidence that the unconfined shallow aquifer is not restricted to Pecos River alluvium, but actually extends downward to the Artesia Group (Kinney et al. 1968). The northern limit of the shallow aquifer falls within the area of analysis. Recharge of the Roswell ground-water basin is primarily by infiltration from precipitation, with influent from intermittent streams and subsurface underflow as secondary sources. Recharge east of the Pecos River provides flow to the river, and sustains water levels in Bottomless Lakes State Park and areas near Bitter Lake National Wildlife Refuge. The artesian aquifer receives water from the central part of the western recharge area. The shallow aquifer is replenished from the nearest part of the western recharge area (Summers 1972). The depth of the water table ranges from less than ten feet near the river in the southeast part of the area of analysis, to more than 80 feet to the west (Wilkins and Garcia 1995).

Ground water flow in much of the area of analysis converges on the Middle Tract of the refuge, which has caused concern about the risks of ground-water contamination from various sources. As a result, the U.S. Fish and Wildlife Service contracted a study of the source and movement of water supplying the refuge (Balleau Groundwater, Inc. 1999). The report provides much of the basis for delineating the HPZ in Map 1.

Environmental Consequences - Ground Water

In general, management activities would benefit ground water quality in the area of analysis. Most of the proposals could be characterized as administrative decisions that would limit the amount and severity of surface disturbing activities and occupancy of public lands. The potential for contaminant spills, and other hazards in the area would be reduced.

Cumulative Effects - Ground Water

The benefits for ground water quality discussed above would also constitute a cumulative benefit. Restricting activities would mean an overall lower level of surface occupancy and use in the area. With each activity that does not occur, there is a slightly decreased risk of a contaminant release or pollution in some other form.

FLOODPLAINS

Affected Environment

The properties of any stream or river result from the interaction of its channel geometry, streamflows, sediment load, channel materials, and valley characteristics (Rosgen 1996). The form and fluvial processes of the Pecos River have been modified by the construction of dams, which have drastically altered the streamflow and sediment regimes of the river. Flooding is less frequent and less severe than prior to dam construction, and sediment loads have been greatly reduced (see Figure 1). As a result, the channel has become moderately entrenched, and exhibits much less lateral migration than in the past. Flow regulation with the dams has also changed the extent, character, and condition of the riparian area on the river (Durkin et al. 1994). Sediment deposition on floodplains is important for riparian succession, and seasonal flooding is required for obligate riparian vegetation.

The floodplains in the area of analysis have also been altered by the construction of Bitter Lake National Wildlife Refuge as described in the Surface Water section of this document. Other developments that have affected floodplains in the area include Highway 70 and Highway 380; the Atchison, Topeka, and Santa Fe Railroad; numerous mineral material pits; natural gas wells; secondary and unsurfaced roads; and fences and other minor structures.

For administrative purposes, the 100-year floodplain provides the basis for floodplain management on public lands. They are based on Flood Insurance Rate Maps prepared by the Federal Emergency Management Agency (1983). From the north boundary of the Salt Creek Wilderness to Highway 380, the 100-year floodplain of the Pecos River covers approximately 12,200 acres, including 230 acres of state land, 1,480 acres of private land, 2,090 acres of BLM land, and 8,400 acres of refuge lands (2,260 acres and 6,140 acres on the North and Middle tracts, respectively).

There are also approximately 2,440 acres of the Salt Creek 100-year floodplain on the North Tract. The banks of the Rio Hondo, Berrendo Creek, and other small draws to the west and southwest of the Middle Tract will also be overtopped during floods with a 100-year return period. These drainages, however, are not expected to have a significant effect on the area of analysis.

Environmental Consequences

The 100-year floodplain was closed to oil and gas leasing in the Roswell Resource Management Plan (BLM 1997), therefore, neither the Proposed Action nor Alternative A would significantly affect floodplains. The reduction in the frequency and magnitude of peak flows on the river would continue to be the primary influence on floodplain function.

Cumulative Effects

Management activities would not have a significant cumulative effect on floodplain function.

Regulation of river flows would continue to be the primary influence on floodplain function. Other factors outside of BLM authority, such as the highways, railroad, and the wildlife refuge would also continue to have an effect.

Air Resources

Affected Environment

The area is in a Class II area for the Prevention of Significant Deterioration of air quality as defined by the federal Clean Air Act. Class II areas allow a moderate amount of air quality degradation. The Salt Creek Wilderness, encompassing 9,621 acres, is a mandatory Class I area near the northern portion of the habitat protection zone.

Air quality in the region is generally very good. Winds are southeasterly during the summer, becoming southwesterly in the winter and early spring. Winds average 10 mph in the fall and 16 miles per hour in the spring with peak velocities exceeding 50 miles per hour. These conditions rapidly disperse air pollutants in the region.

Though winds disperse pollutants, they also increase particulate levels when wind forces act on disturbed areas, unsurfaced roads and exposed soils. Degradation of air quality in portions of the area is also due to pollutants such as hydrocarbons and carbon monoxide from various sources including the highway traffic, the City of Roswell and local agricultural activities.

Environmental Consequences

Significant adverse impacts to air resources due to oil and gas development would not be expected and well below allowable standards in most cases. A possible exception would be high concentrations of particulate matter due to wind-blown dust for short periods. Dust from oil and gas operations could be mitigated by minimizing surface disturbances. Minimizing the size of well pads and other facilities, and designing efficient access road and pipeline networks would eliminate unnecessary surface disturbance.

Cumulative Effects

Cumulative impacts from airborne pollutants would not be expected given the wide spacing requirements of one well per 160 acres, maintenance and improvement of vegetative cover through grazing management practices and prescriptions developed for prescribed fires.

Rangeland Resources

Affected Environment

All or portions of six BLM-administered grazing allotments are located in the area of interest (See Appendix A, Map 2). Approximately 20,000 acres of rangeland overlay the habitat protection zone, of which approximately 11,200 acres are public rangelands. Two of the

allotments are under a Decision to defer livestock grazing for an indefinite period of time. These allotments are north and west of the Bitter Lake NWR and include interior least tern nesting habitat, and a significant portion of a large black-tailed prairie dog town. The following table summarizes general information for the allotments.

Allotment Number	Allotment Name	Total Acres	Federal Acres	Animal Units	Remarks
64053	James Cliett	7,347	4,535	130 Active 20 TNR	EA-NM-060-99-108
64054	E.H. Cattle Co.	698	360	18	EA-NM-060-99-019
64055	Sink Hole Flats	1,620	1,460	41	
64056	Melena	8,182	3,605	Deferred Grazing Permit	EA-NM-060-99-089
64057	Longley	1,402	1,000	Deferred Grazing Permit	EA-NM-060-99-089
64058	Blackwell Estate	760	200	4	EA-NM-060-99-101
Totals 6		20,009	11,160	213	

Environmental Consequences

The reasonable and foreseeable development of oil and gas operations has been previously analyzed in the Roswell Draft RMP. Neither the Proposed Action nor Alternative A allows development that exceeds the analysis. The impacts of continuing livestock grazing deferment on allotments 64056 and 64057 have been analyzed and described in EA #NM-060-99-089. The impacts of authorizing livestock grazing on public lands have been analyzed in the documents listed in the above table.

Cumulative Effects

Since range conditions are tied to soils, vegetation and surface disturbance, the cumulative impacts of both the Proposed Action and Alternative A are very similar to the cumulative effects on soils and vegetation. See the Cumulative Effects section for Soils and Vegetation.

Wildlife and Wildlife Habitat

Affected Environment

The area of interest provides a variety of habitat types for terrestrial and aquatic wildlife species. The diversity and abundance of wildlife species in the area are due to the presence of open water, the numerous drainages interconnecting upland habitats to the Pecos floodplain, a mixture of grassland habitat and mixed desert shrub vegetation, and riparian vegetation found within the floodplain of the river.

Common mammal species using the area include mule deer, coyote, gray fox, bobcat, striped skunk, porcupine, raccoon, badger, jackrabbit, cottontail, white-footed mouse, deer mouse, grasshopper mouse, kangaroo rat, spotted ground squirrel, and woodrat.

Allotment 64057 also supports one of the largest active black-tailed prairie dog towns in the area. The National Wildlife Federation has petitioned for emergency listing of the prairie dog as a threatened or endangered species. The petition is currently being reviewed by the USFWS to determine whether listing is warranted. A decision in the Roswell RMP (BLM 1997) states that prairie dog control will not be authorized on public lands, except in emergency situations involving public health. The prairie dog has no legal protection, and varmint hunting does occasionally occur in the area.

Numerous avian species use the Pecos River during spring and fall migration, including nongame migratory birds. The BLNWR serves as a major focal point for migratory birds (e.g., ducks, geese, cranes, waterfowl). Common bird species are mourning dove, mockingbird, white-crowned sparrow, black-throated sparrow, blue grosbeak, northern oriole, western meadowlark, Crissal thrasher, western kingbird, northern flicker, common nighthawk, loggerhead shrike, and roadrunner. Raptors include northern harrier, Swainson's hawk, American kestrel, and occasionally golden eagle and ferruginous hawk.

The Pecos River once supported a wide variety of native fish species adapted to the flow regime that existed prior to dam construction, agriculture development, and the introduction of non-native fish species. The greatest impact to fish habitat is the manipulation of water supply to meet irrigation needs. Representative Pecos River mainstem fish species include the red shiner, sand shiner, Arkansas River shiner, Pecos bluntnose shiner, plains minnow, silvery minnow, plains killifish, mosquitofish, speckled chub, river carpsucker and channel catfish.

A variety of herptiles also occur in the area. Species include the yellow mud turtle, box turtle, eastern fence lizard, side-blotched lizard, horned lizard, whiptail, hognose snake, coachwhip, gopher snake, rattlesnake, and spadefoot toad.

Special Status Species

The Pecos bluntnose shiner, Pecos gambusia, Pecos sunflower, and interior least tern are federally listed species that occur or have the potential to occur in the area of interest. Federally

proposed species include four macroinvertebrates; Pecos assiminea snail, Roswell spring snail, Koster's tryonia snail, and Noel's amphipod (freshwater shrimp). The status and presence of these species in the RFO area are discussed in the following section.

Pecos Bluntnose Shiner *(Notropis simus pecosensis)* - Federal Threatened

Historically, the Pecos bluntnose shiner inhabited the Pecos River from Santa Rosa to near Carlsbad, New Mexico. Currently, the subspecies is restricted to the river from the Fort Sumner area southward locally to the vicinity of Artesia, and seasonally in Brantley Reservoir (NMDGF 1988; USFWS 1992). Routine fish community monitoring conducted by the USFWS in the Pecos River between Sumner Dam and Brantley Reservoir show the fish remains generally abundant, especially in light of cooperative efforts between the Bureau of Reclamation and the USFWS to more closely mimic natural flows in the Pecos River.

There are two designated critical habitat areas on the Pecos River within the RFO area. The first is a 64-mile reach beginning about ten miles south of Fort Sumner, downstream to a point about twelve miles south of the DeBaca/Chaves county line. The second reach is from Highway 31 east of Hagerman, south to Highway 82 east of Artesia. Neither the Proposed Action nor Alternative A are within the designated critical habitat.

Loss or alteration of habitat (periodic dewatering), and introduction of non-native fish species of the Pecos River (Arkansas River shiner) are the key threats to the Pecos bluntnose shiner. The primary threat to the Pecos bluntnose shiner appears to be artificial manipulation of flows in the Pecos River to meet irrigation needs and subsequent drying of the river channel (NMDGF 1996). High flows in the late winter-early spring before natural spring runoff appear to displace fish into marginal downstream habitats (including Brantley Reservoir). Cessation of reservoir releases after spring runoff, before the advent of summer rains, desiccates long stretches of the Pecos River. Maintenance of water levels within the Pecos River and its tributaries is beyond the management authority of the BLM.

In addition to the manipulation of flows is the threat posed by non-native fish. The introduction and establishment of species such as the Arkansas River shiner offers direct competition with the Pecos bluntnose shiner.

Fish communities between Sumner Dam and Brantley Reservoir are monitored by the FWS in coordination with the BLM and Bureau of Reclamation. Monitoring indicates a general abundance of fish, especially in light of cooperative efforts to maintain more natural flows in the Pecos River.

Conservation Measures: No new oil and gas leases will be sold within the 100-year floodplain of the Pecos River. The following surface use and occupancy restrictions were developed to protect streams, rivers, floodplains, and springs and seeps. No surface occupancy would be allowed within floodplains or within up to 200 meters of the outer edge of 100-year floodplains. No surface occupancy would be allowed within up to 200 meters of the source of a spring or seep, or within downstream riparian areas created by flows from the source or resulting from riparian

area management. Produced water disposal pits on public lands would not be allowed on public land west of the Pecos River, within 100-year floodplains or within 200 meters of drainages or springs. OHV designations for the Pecos River floodplain include a combination of closed to OHV use and limited to designated roads/trails.

Effect Determination: May Affect, Not Likely to Adversely Affect. The effects of the proposed action and alternative have adverse aspects that are discountable or insignificant.

Pecos Gambusia *(Gambusia nobilis)* - Federal Endangered

The Pecos gambusia (*Gambusia nobilis*) was listed as endangered under the Endangered Species Conservation Act of 1969, and became an endangered species under the Endangered Species Act of 1973 when that legislation was enacted. No critical habitat has been designated. It is endemic to the Pecos River basin in southeastern New Mexico and western Texas. Natural populations within the Roswell Field Office area occur in several springs and isolated gypsum sinkholes at BLNWR. Introduced populations occur in other sinkholes at BLNWR, and at the Salt Creek Wilderness Area in Ink Pot sinkhole. In addition to the Pecos gambusia, the protection of other special status species such as the Pecos pupfish, Koster's tryonia snail, Pecos assiminea snail, Roswell springsnail, and Noel's amphipod remain a concern. Several of these species occur at the BLNWR.

The Pecos gambusia is a small fish 25-40 millimeters long and is endemic to the Pecos River Basin in southeastern New Mexico and western Texas. Historically, Pecos gambusia occurred as far north as the Pecos River near Fort Sumner, New Mexico, and south to Fort Stockton, Texas. However, recent records indicate that its native range is restricted to sinkholes or springs and their outflows, on the west side of the Pecos River in Chaves County, New Mexico. In spite of population declines, the species remains locally common in a few areas of suitable habitat. In New Mexico, populations are present on the BLNWR and the Salt Creek Wilderness Area (both Chaves County). These areas constitute the key habitat of the species in the RFO area. Populations of Pecos gambusia occur in several springs and isolated gypsum sinkholes at the BLNWR Middle Unit (Lake St. Francis Research Natural Area) and the Ink Spot sinkhole in the Salt Creek Wilderness. The drilling aspects of the well may have a remote potential negative affect upon groundwater aquifers supplying springs and isolated gypsum sinkholes at the refuge.

Endangerment factors include the loss or alteration of habitat (e.g., periodic dewatering) and introduction of exotic fish species (e.g., mosquitofish). Potential impacts to habitat may also occur from surface disturbing activities at sinkholes or springs and their outflows.

Located in the area of interest are other developments that pose an even greater risk for surface and subsurface contamination, such as the growing subdivision located one mile west of the BLNWR, the Atchison Topeka and Santa Fe Railroad, and Highway 70. At the present time, the BLM does not own either the surface or the mineral estate to lands located immediately adjacent to the BLNWR. These lands pose a much greater and immediate threat to the Pecos gambusia. The probability of contamination of groundwater resources supplying springs at the BLNWR from oil and gas development is very remote, but not discountable. The probability of an

accident occurring increases as the number of producing wells are developed in the area.

Conservation Measures: The following surface use and occupancy restrictions were developed in the Roswell RMP to protect streams, rivers, floodplains, and springs and seeps. No surface occupancy would be allowed within floodplains or within up to 200 meters of the outer edge of 100-year floodplains. No surface occupancy would be allowed within up to 200 meters of the source of a spring or seep, or within downstream riparian areas created by flows from the source or resulting from riparian area management. Produced water disposal pits on public lands would not be allowed on public land west of the Pecos River, within 100-year floodplains or within 200 meters of drainages or springs. OHV designations for the Pecos River floodplain include a combination of closed to OHV use and limited to designated roads/trails. Site-specific evaluations would be conducted on a case-by-case basis. Implementation elements found in this EA for all proposed wells in the Habitat Protection Zone.

Effect Determination: May Affect, Not Likely to Adversely Affect.

Interior Least Tern *(Sterna antillarum athalassos)* - Federal Endangered

The interior least tern nests on shorelines and sandbars of streams, rivers, lakes, and man-made water impoundments. There are only three known nesting habitats in the Roswell Field Office (RFO) area. The primary areas are on the alkali flats on the east side of Unit 16 and around Bitter Lake on BLNWR. A secondary area is an alkali flat due north of the refuge on public lands on Allotment 64056. The third area is located on City of Roswell property at the old desalinization plant where terns once nested on the evaporation ponds behind the plant and have since abandoned. No other nesting terns have been found to date. BLNWR is considered essential to tern breeding habitat in the state.

Sporadic observations of least terns have been recorded elsewhere in the Pecos River valley. The tern may occur on public lands in Chaves County along the river because suitable nesting habitat is found on sites that are sandy and relatively free of vegetation (i.e., alkali flats). Other potential habitat sites are saline, alkaline, or gypsiferous playas that occasionally hold water. However, ephemeral playas do not support fish, the main staple for terns.

Specific surveys for nesting least terns have been conducted in potential habitat along the Pecos River and playas by the New Mexico Natural Heritage Program under a challenge cost share agreement with the BLM. Surveys were conducted at eight designated survey sites in the RFO area during the June/July 1997 season. A flyover was noted at the Overflow Wetlands Wildlife Habitat Area, and two nesting pairs were observed on Allotment 64056 north of the BLNWR (NMNHP 1997). No other nesting terns have been found to date.

Channelization, irrigation, and the construction of reservoirs and pools have contributed to the elimination of much of the tern nesting habitat. Unpredictable flow patterns below reservoirs can pose problems for nesting terns. Increased human activity on river sandbars threaten nesting terns, including the use of recreational vehicles on previously unreachable habitat during periods of drought.

Conservation Measures: No new oil and gas leases will be sold within the 100-year floodplain of the Pecos River. Surface use and occupancy restrictions were developed in the Roswell RMP to protect streams, rivers, floodplains, and playas and alkali lakes. No surface occupancy would be allowed within floodplains or within up to 200 meters of the outer edge of 100-year floodplains. No surface occupancy would be allowed within up to 200 meters of playas and alkali lakes. OHV designations for the Pecos River floodplain include a combination of closed to OHV use and limited to designated roads/trails.

Effect Determination: May Affect, Not Likely to Adversely Affect.

Pecos (Puzzle) Sunflower (*Helianthus paradoxus)* – Federal Endangered

The Pecos sunflower is found along alkaline seeps and cienegas of semi-desert grasslands and the short-grass plains (4,000-7,500 feet elevation). Plant populations are found both in water and immediately adjacent to water sources where the water table is near the surface. The New Mexico Energy, Minerals and Natural Resources Division and BLM staff have conducted surveys along the Pecos River through riparian studies and during routine field reconnaissance. The largest and most secure population is still found on BLNWR. The only known locations on public lands are two areas are located on the east side of the Pecos River.

Key threats to the Pecos sunflower include dewatering of riparian-wetland areas where this species is found, surface disturbing activities by oil and gas, rights-of-way, and excessive livestock grazing.

The proposed action and alternative would not impede potential habitat from becoming suitable habitat, and would not impede the further development of existing riparian-wetland habitat on public lands.

Conservation Measures: No new oil and gas leases will be sold within the 100-year floodplain of the Pecos River. The following surface use and occupancy restrictions were developed in the Roswell RMP to protect streams, rivers, floodplains, and springs and seeps. No surface occupancy would be allowed within floodplains or within up to 200 meters of the outer edge of 100-year floodplains. No surface occupancy would be allowed within up to 200 meters of the source of a spring or seep, or within downstream riparian areas created by flows from the source or resulting from riparian area management. Potential habitat occur within the Overflow Wetlands WHA. These wetlands are protected from surface disturbing activities and livestock grazing has been canceled on Allotment 65041. Livestock grazing on Allotment 64056 has been indefinitely deferred through the 1999 grazing authorization process. In addition, the 1999 livestock grazing authorizations for several riparian allotments included regulatory mechanisms to further protect potential habitat for this species. Site-specific evaluations would still be conducted on a case-by-case basis for all riparian areas for occurrence or monitoring when new populations are found.

Effect Determination: May Affect, Not Likely to Adversely Affect. The effects due to the

proposed action and alternative have adverse aspects that are discountable or insignificant.

Pecos Assiminea Snail (*Assiminea pecosensis*) - Proposed Endangered with Critical Habitat
Roswell Springsnail (*Pyrgulopsis roswellensis*) - Proposed Endangered with Critical Habitat
Koster's Tryonia Snail (*Tryonia kosteri*) - Proposed Endangered with Critical Habitat
Noel's Amphipod (*Gammarus desparatus*) - Proposed Endangered with Critical Habitat

These three snails and one amphipod are found in the same locations and share the same threats and management needs. All have extremely limited distribution in the Roswell FO area. Significant populations of these species occur at sinkholes, springs and associated spring runs and wetland habitat at the Bitter Lake National Wildlife Refuge. The Roswell springsnail and Koster's tryonia (*Hydrobiid* snails) are known only from Bitter Creek, Lost River and Sago spring system at the refuge, and North Springs at the Roswell Country Club (private land, status uncertain). The Pecos assiminea (marine snail family) is known only from the refuge and Diamond Y Spring near Ft. Stockton, Texas. Noel's amphipod is known only from the refuge. If listed as endangered, BLNWR would be considered critical habitat for these species.

Potential impacts to the snails include local and regional groundwater depletion, surface and ground water contamination, oil and gas extraction activities within the supporting aquifer and watershed, and direct loss of their habitat. The use of septic tanks in the area of interest pose an increased risk of sewage contamination in local groundwater.

Located in the area of interest are other developments which pose an even greater risk for surface and subsurface contamination, such as the growing subdivision located one mile west of the BLNWR, the Atchison Topeka and Santa Fe Railroad, and Highway 70. At the present time, the BLM does not own either the surface or the mineral estate to lands located immediately adjacent to the BLNWR. These lands pose a much greater and immediate threat to the Pecos gambusia. The probability of contamination of groundwater resources supplying springs at the BLNWR from oil and gas development is very remote, but not discountable. The probability of an accident occurring increases as the number of producing wells are developed in the area.

Conservation Measures: The following surface use and occupancy restrictions were developed in the Roswell RMP to protect streams, rivers, floodplains, and springs and seeps. No surface occupancy would be allowed within floodplains or within up to 200 meters of the outer edge of 100-year floodplains. No surface occupancy would be allowed within up to 200 meters of the source of a spring or seep, or within downstream riparian areas created by flows from the source or resulting from riparian area management. Produced water disposal pits on public lands would not be allowed on public land west of the Pecos River, within 100-year floodplains or within 200 meters of drainages or springs. OHV designations for the Pecos River floodplain include a combination of closed to OHV use and limited to designated roads/trails. Implementation elements found in this EA for all proposed wells in the Habitat Protection Zone.

Effect Determination: May Affect, Not Likely to Adversely Affect.

Environmental Consequences

The HPZ would continue to be impacted by development of existing oil and oil and gas leases. The magnitude of impacts from individual wells, and associated roads and pipelines, depend on the proposed location of each development. Typically, wells are staked at locations that are geologically selected, regardless of environmental considerations. Individual gas wells usually do not result in negative impacts to wildlife or wildlife habitat due to the small area of disturbance, in contrast to field or complete lease development. Activity in developed oil and gas fields would continue to produce long-term negative impacts on wildlife populations and habitat from the operation and maintenance of producing wells, pipelines and access roads. Wildlife displacement from noise and visual intrusions would continue to occur within established fields.

Future oil and gas development would initially result in the direct loss of wildlife habitat. Oil and gas field development would have negative, long-term cumulative impacts to wildlife habitat due to the magnitude and concentration of surface disturbances, such as oil and gas pads, pipelines, access roads, power lines, and associated human activity in the area. Wildlife habitat would be afforded protection from oil and gas development on parcels removed from lease sales.

The specific actions proposed by an oil and gas lessee or operator to develop an existing lease may potentially affect special status species and their habitat. The potential for affecting special status species, particularly aquatic species, is highest within the groundwater protection zone and Pecos River. At this level of analysis, the BLM cannot accurately predict where locations for projects (e.g., wells, roads, pipelines) would occur on existing leases, or how projects would affect or not affect a listed species. Subsequent development of leases creates the potential for affecting special status species, but the magnitude of impacts would depend on the specific location of a project, mitigation developed during the permitting process, or constraints that may limit mitigation, such as lease boundaries or orthodox locations. Each proposal would be scrutinized for possible impacts to special status species. The possibility of a "may affect" or other determination exists with individual projects, which may lead to informal or formal Endangered Species Act consultation with the USFWS, if the implementation elements found in this EA for all proposed wells in the Habitat Protection Zone are not applied.

Cumulative Effects

Oil and gas field development would have negative, long-term cumulative impacts to wildlife habitat due to the magnitude and concentration of surface disturbance and associated human activity. Existing and new fields would not be fully reclaimed, and portions would remain unusable for wildlife for 20 years or more. Habitat on private and state lands is even more subject to impacts because it is not afforded the somewhat limited protection given to habitat on adjacent public lands. Thus, the public lands are even more valuable as important habitat for a variety of wildlife species and natural communities. Public lands would become more valuable for wildlife as adjacent lands may be developed without the special considerations that the BLM applies to federal actions.

Cultural Resources

Affected Environment

A record search through the RFO's archaeological files revealed a total of eight prehistoric and historic sites have been recorded in the area identified in the area of interest. One of the two historic sites is a small trash dump and the other is a 1900 - 1920's habitation site with a foundation present, two ground depressions and associated trash scatter. Five of the remaining six sites are lithic artifact scatters. One of these also has fire-cracked rock which is likely the remnants of cooking hearths. The sixth prehistoric site is a small lithic scatter with two pot shards.

The expanded area adds an additional 14 historic and prehistoric sites in the area of effect. Three historic sites are present with one being a habitation site with two dugouts, a concrete foundation and associated trash dating between 1900 and 1945. The other two historic sites are twentieth century trash dumps.

Eleven prehistoric sites have been recorded. Two of these appear to be habitation sites. One is a quarry site where stone raw materials were obtained and used. The remaining eight prehistoric sites are campsites where pottery and cooking hearths were found as well as stone artifacts.

The archaeology discovered has generally been a result of federal laws and regulations which require the proponent of a Federal undertaking to have the area of effect culturally inventoried in order to mitigate damage to significant archeological and historic sites. These identified sites are usually avoided from surface disturbing activities. Occasionally, significant sites are excavated for their data potential and construction is allowed through them. Over time, it is expected that more archaeological and historic sites will be discovered in this area.

Environmental Consequences

Surface disturbance from oil and gas development can result in negative impacts to cultural resources, although the documented damage to cultural resources from oil and gas development is small. Illegal artifact collecting is the primary cause of direct negative impacts to cultural resources. Increasing access to remote areas allows the public ready access to cultural properties in those areas.

Cumulative Effects

Cumulative impacts to cultural resources are difficult to estimate. Avoiding sites during development of all types has substantially reduced impacts to cultural resources.

Visual Resources

Affected Environment

The area of interest is a combination of Class II and Class III areas for visual resources management. The boundary of the Class II area generally lies about one mile outside the Middle Tract of BLNWR.

Changes in any of the basic landscape elements (e.g., form, line, color, texture) caused by a management activity should not be evident in a Class II area. A contrast may be seen, but should not attract attention. In a Class III area, contrasts to the basic elements caused by a management activity may be evident and begin to attract attention in the landscape. The changes, however, should remain subordinate to the existing landscape.

Environmental Consequences

Increased activity in developing oil and gas resources would change the visual character of the natural landscape. Visual impacts would result from the presence of structures and equipment, in both concentrated and dispersed settings. Scenic quality would be affected over the long term. Visual impacts would be mitigated to some extent by painting, requiring the use of low profile facilities, restricting the amount of surface disturbance, and moving facilities or sites to less visible locations. Painting all permanent surface facilities or equipment approved by the BLM would help reduce negative impacts on visual resources.

Cumulative Effects

Visual quality would be negatively affected by roads and facilities related to oil and gas activity. The landscape would lose its natural appearance and visual quality could be degraded.

Recreation Resources

Affected Environment

Recreation in the area of interest is a combination of facility-based and dispersed use. Dispersed recreational activities such as hunting, fishing, caving, sightseeing, hiking, and birdwatching. General sightseeing, wildlife viewing, and photography are nonconsumptive recreational activities that occur.

A network of roads provides access to public and private lands within the HPZ. Access to most of the private and state land is not currently controlled by fences, locked gates, or no-trespass signs. The BLM has designated off-highway vehicle use on public lands in the area as limited to existing roads and trails.

The 642-acre Dunahoo Hills Off-Highway Vehicle (OHV) area, located north of Highway 70 in Sections 13 and 18, was identified for establishment in the Roswell RMP, if demand warrants. OHV use in the area would be limited to designated roads and trails. The area is currently undeveloped as an OHV site and has existing roads and an old mineral material pit within the site.

The 80-acre Chaparral Skeet Club is located north of Highway 70 and due west of Capitan county road. It is within the boundary of the habitat protection zone. The BLM does not have any administrative authority at the skeet club but had issued a Recreation and Public Purposes Act lease to the skeet club.

The Roswell Gun Club maintains a shooting range with a safety buffer zone between Highway 70 and the Old Clovis Highway that include portions of Section 19, 24, 25, 30 and 36. The range is used by several state, federal and local government agencies, and local clubs. Facilities include buildings, large berms, parking areas, shading structures, tables, access roads and gates.

Environmental Consequences

Construction and maintenance activities related to oil and gas development could affect recreation activities. Construction of oil and gas roads and pipelines would improve access for some kinds of recreation activity. However, all recreationists would not necessarily benefit and some would cease using certain areas for recreation because of oil and gas development. Short-term losses of certain kinds of recreational opportunities and long-term loss of visual quality in areas of oil and gas development are expected under the worst case scenario.

Cumulative Effects

The cumulative effects of oil and gas development and production facilities, especially surface disturbance, such as the construction of new roads, pipelines, power lines, and well sites, would negatively impact recreation resources. Recreation opportunities would be affected by reducing the size of larger blocks of undisturbed lands. Increased traffic on roads would disturb wildlife, which would in turn reduce consumptive and non-consumptive uses of wildlife.

Socio-Economic Impacts

The effect of either the Proposed Action or Alternative, in terms of mineral leasing and development, would be a reduction in the number of leases offered for sale. Oil and gas development would be confined to existing leases. The cumulative effect of this would be negligible over the long term because of the small number of leases that would be affected within the boundaries of the Proposed Action/Alternative A, and the fact that all current leases are presently held by production. The industry may be affected because of the unavailability of new leases in the area of interest, which could affect the orderly development of an existing field or play. In turn, the manner in which existing lease wells are used to adequately drain a field could be affected.

As noted above, current leases within the HPZ are held by production. Therefore, no new wells are needed in order to hold a lease found within the area of consideration. The long-term effects of oil and gas closure on currently unleased parcels would include lost production opportunities, lost royalties and lost job opportunities, although the impacts would be minimal, given the small acreage proposed to be closed.

The unleased federal minerals amount to 12 percent (1,520 acres) of the total federal minerals (12,618 acres) under the Proposed Action within the HPZ. If Alternative A is added to the HPZ, then the unleased minerals amount to 10 percent (1,820 acres) of the total federal minerals (18,402 acres). The total acreage of the unleased parcels described here is less than three-one hundredths (0.03) of one percent of the total federal minerals (8.25 million acres) managed by the Roswell Field Office.

The primary impact to oil and gas resources would result from special stipulations and design features placed on oil and gas operations. A company would spend more on drilling, casing, cementing and development facilities in order to implement special requirements that would be attached to permits, depending on well location and depth.

Overall Cumulative Effects

The overall cumulative effects of establishing and managing resources administered by the BLM within the boundaries of the Proposed Action by the inclusion of several thousand acres of land adjacent to the Salt Creek Wilderness and the Bitter Lake National Wildlife Refuge (Middle Tract) would be the long term protection of a large portion of the landscape along the Pecos River corridor. Both Salt Creek Wilderness and Bitter Lake NWR have management goals to protect resources albeit in two separate units. The designation of the Habitat Protection Zone would serve as a bridge between the two units, with similar goals for the preservation of significant ecosystems while retaining multiple-use objectives for public lands.

Consultation and Coordination

BLM, Roswell Field Office staff –
Rand French, wildlife biologist
Paul Happel, natural resources specialist
Michael McGee, hydrologist
Richard Hill, surface protection specialist
Irene Gonzales-Salas, realty specialist
Howard Parman, planning & environmental coordinator
Dan Baggao, wildlife biologist
Pat Flanary, archeologist
Helen Miller, range conservation specialist
Jim Schroeder, hydrologist
John Simitz, geologist
Armando Lopez, petroleum engineer

US Fish & Wildlife Service -
Bill Radke, manager, BLNWR
Dennis Coleman, biologist
Ken Butts, manager, BLNWR

US Bureau of Reclamation - Gary Dean, fishery biologist,

State of New Mexico agencies –
Seva Joseph, Environment Department, Surface Water Quality Bureau
David Probst, Department of Game and Fish, endangered species biologist

Chaves County Public Lands Advisory Committee

Southeast New Mexico Grazing Association –
Lewis Derrick

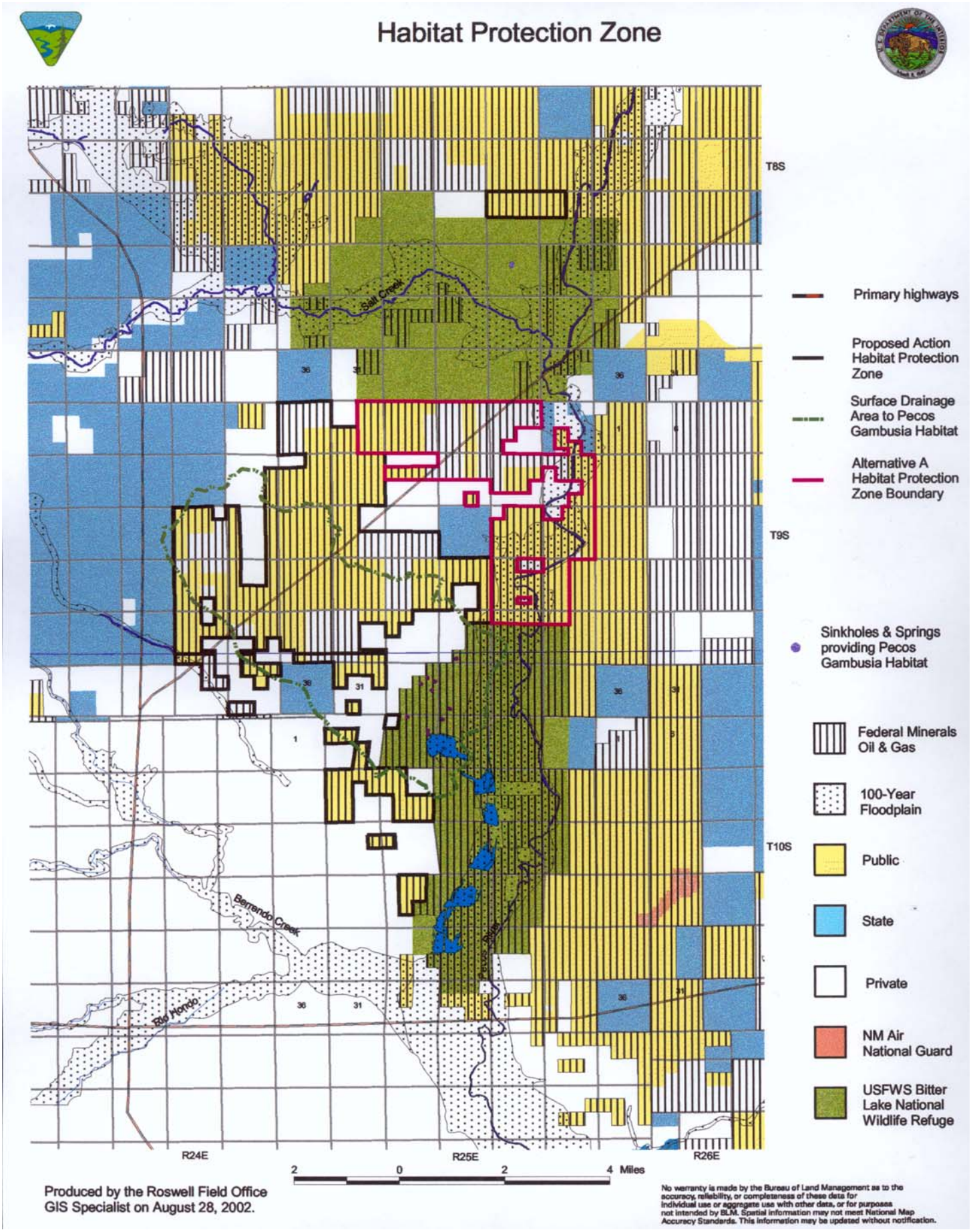
New Mexico Oil & Gas Association -
Frank Gray, Texaco
Chuck Moran, Yates Petroleum

APPENDIX A

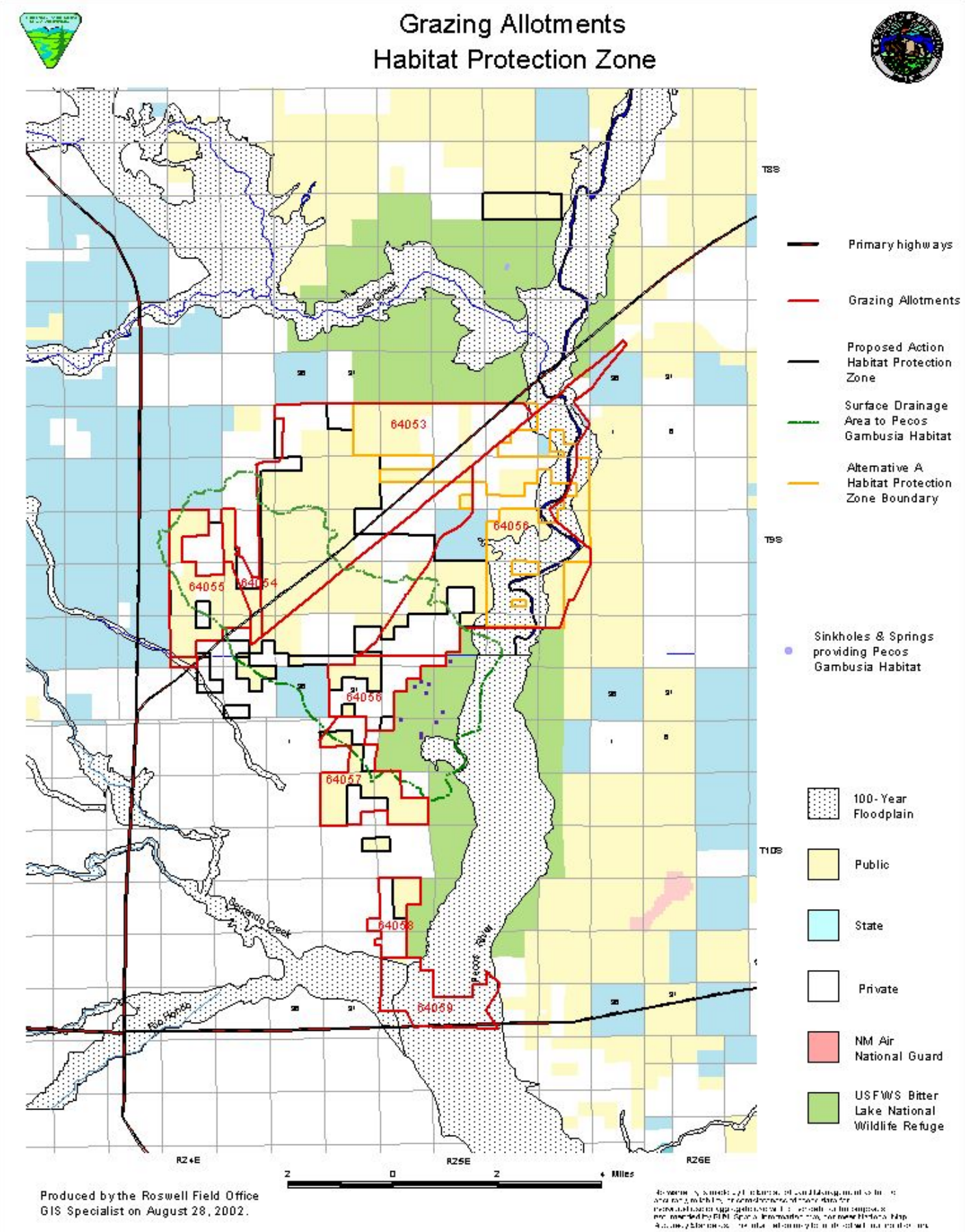
MAPS

Map 1 - Habitat Protection Zone
Map 2 - Grazing Allotments, Habitat Protection Zone

Map 1


Habitat Protection Zone
T8S
T9S
T10S
R24E
R25E
R26E
Salt Creek
Berrendo Creek
Rio Hondo
Pecos River
Primary highways
Proposed Action Habitat Protection Zone
Surface Drainage Area to Pecos Gambusia Habitat
Alternative A Habitat Protection Zone Boundary
Sinkholes & Springs providing Pecos Gambusia Habitat
Federal Minerals Oil & Gas
100-Year Floodplain
Public
State
Private
NM Air National Guard
USFWS Bitter Lake National Wildlife Refuge
2 0 2 4 Miles
Produced by the Roswell Field Office GIS Specialist on August 28, 2002.
No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data, or for purposes not intended by BLM. Spatial information may not meet National Map Accuracy Standards. This information may be updated without notification.

Map 2


Grazing Allotments
Habitat Protection Zone
T8S
T9S
T10S
64053
64056
64055
64054
64056
64057
64058
64059
Primary highways
Grazing Allotments
Proposed Action Habitat Protection Zone
Surface Drainage Area to Pecos Gambusia Habitat
Alternative A Habitat Protection Zone Boundary
Sinkholes & Springs providing Pecos Gambusia Habitat
100-Year Floodplain
Public
State
Private
NM Air National Guard
USFWS Bitter Lake National Wildlife Refuge
Berrendo Creek
Pecos River
Rio Hondo
R24E
R25E
R26E
2 0 2 4 Miles
Produced by the Roswell Field Office
GIS Specialist on August 28, 2002.

APPENDIX B

Oil and Gas Leases Within
the Habitat Protection Zone

Appendix B

½Legal Description and Status of Oil and Gas Parcels within the Habitat Protection Zone

Township 8 South, Range 25 East, NMPM (Source: BLM OG Plat)

Section 14	NM29417	NW¼	160.00
Section 15	NM27061	N½	320.00

Township 9 South, Range 24 East, NMPM (Source: BLM OG Plat 3/25/98)

Section 1	NM18602	Lots 1-4, S½N½, SW¼	482.02
	Unleased	**SE¼**	**160.00**
Section 11	NM18602	SE¼NE¼, E½SE¼	120.00
Section 12	**Unleased**	**N½NE¼**	**80.00**
	NM18602	SW¼NW¼	40.00
	Unleased	**SE¼NW¼, N½NE¼, N½, SW¼**	**200.00**
	NM33943	S½SW¼, Lots 1-4	251.04
Section 13	NM33943	All	647.05
Section 14	NM90852	NE¼NE¼	40.00
	NM33943	SE¼NE¼, E½SE¼, W½W½	280.00
Section 15	NM33943	All	640.00
Section 22	NM33943	N½N½	160.00
	Unleased	**S½N½, SW¼, E½SE¼**	**400.00**
Section 23	NM33943	W½NW¼, E½NE¼	160.00
	NM33944	S½	320.00
Section 24	NM33943	N½N½	160.00
	NM33944	S½N½, S½	480.00
Section 25	NM16071	E½, NW¼, N½SW¼, SE¼SW¼	600.00
Section 26	NM16071	E½, SE¼SW¼	360.00
	Unleased	**NW¼SE¼**	**40.00**
Section 27	NM16071	W½NE¼, SW¼NE¼	120.00
	Unleased	**W½, SW¼SE¼**	**360.00**
Section 34	NM16071	W½NE¼, SE¼NE¼	120.00
Section 35	NM16071	N½NE¼, S½SW¼	160.00
	Unleased	**NE¼NW¼**	**40.00**

Township 9 South, Range 25 East, NMPM (Source: BLM OG Plat 2/23/00)

Section 6	NM29615	SW¼	160.00
Section 7	NM29615	NE¼	160.00
	NM19829	W½, SE¼	480.00
Section 17	NM19829	S½	320.00
Section 18	NM19829	W½, SE¼	480.00
Section 19	NM19829	N½	320.00
	NM17038	SW¼	160.00
	NM18602	SE¼	160.00
Section 20	NM19829	N½NE¼, SE¼NE¼, NE¼SW¼NE¼, S½SW¼NE¼, N½NW¼SW¼NE¼, NW¼	327.00
	NM58924	S½NW¼SW¼NE¼	5.00
	NM18602	S½	320.00
Section 21	NM19829	N½	320.00
	NM17038	W½SW¼	80.00
	Unleased	**E½SE¼**	**80.00**
Section 28	NM14291	N½NE¼	80.00
Section 29	NM17038	N½NW¼	80.00
	Unleased	**SW¼NE¼**	**40.00**
Section 30	NM17038	N½NE¼, W½W½, S½SE¼	320.00
	NM18602	E½W½	160.00
Section 31	NM17038	N½N½, SW¼NW¼, SE¼SW¼, SE¼NE¼	280.00

Township 10 South, Range 25 East, NMPM (Source: BLM OG Plat 12/29/94)

Section 5	**Unleased**	**Lot 4**	**40.20**
Section 6	NM16074	Lot 5, SE¼NW¼, W½SE¼	159.30
Section 7	NM16074	N½NE¼, NE¼NW¼, Lot 1	159.61
	NM18484	Lots 2 - 4, SE¼NW¼, E½SW¼, SE¼NE¼	278.99
Section 8	NM16074	N½NW¼	80.00
	NM18819	S½NW¼, E½SW¼, W½SE¼	240.00
	NM32580	E½SE¼	80.00
Section 17	NM56222	SW¼NW¼	40.00

Section 18	NM56222	SE¼NE¼	40.00
Section 20	NM18484	W½NE¼, E½NW¼, NE¼SW¼	200.00
Section 29	NM18484	E½SW¼	80.00
Section 32	**Unleased**	**E½NW¼**	**80.00**

Total Federal Minerals	12,618.21 acres
Total Leased	11,178.01 acres
Total Unleased	1,520.20 acres

Alternative A - Additional Federal Mineral Estate Acreage

Township 9 South, Range 25 East, NMPM (Source: BLM OG Plat 2/23/00)

Section 2	NM-A 19053	SW¼SE¼, NE¼SW¼, N½SE¼SW¼	100.00
Section 3	NM35925	Lots 1 - 4, S½N½, N½SW¼, SW¼SW¼	440.40
Section 4	NM29615	Lots 1 - 4, S½N½	321.68
	NM35925	S½	320.00
Section 5	NM35925	Lots 1 - 4, S½NW¼, SW¼, NE¼	380.00
	NM29615	SW¼, W½SE¼	240.00
	NM34649	SE¼NE¼, E½SE¼	120.00
Section 6	NM29615	Lots 1 -2, S½NE¼, SE¼	320.24
Section 8	NM29615	S½NW¼	80.00
	NM34649	S½NE¼	80.00
Section 9	NM34649	NW¼	160.00
	NM35925	NE¼	160.00
	NM19175	SW¼SE¼	40.00
Section 10	NM34649	N½	320.00
	NM19175	N½SW¼, NW¼SE¼	120.00
Section 11	NM14291	E½E½, SW¼SE¼	200.00
	NM11596	N½NW¼, SE¼NW¼	120.00
Section 14	NM14291	E½E½	160.00
	NM14994	S½NW¼, N½SW¼	160.00
	NM-A 19053	NW¼SE¼, N½SW¼SE¼, S½SW¼	140.00
	Unleased	**S½SW¼SE¼**	**20.00**
Section 15	NM16073	E½NE¼, NE¼SE¼,	

		E½SW¼	200.00
	NM19175	W½NE¼, E½NW¼	160.00
	NM14291	SW¼NW¼	40.00
	NM17203	W½SW¼	80.00
	Unleased	**NW¼SE¼**	**40.00**
	NM-A 19053	S½SE¼	80.00
Section 22	**Unleased**	**SW¼NE¼, NW¼NW¼ NW¼SE¼**	**240.00**
	NM16073	W½SW¼	80.00
	NM17203	E½SW¼	80.00
	NM-A19053	SE¼NE¼, W½SE¼, S½SW/¼SE¼	140.00
Section 23	NM14120	NE¼, S½NW¼	240.00
	NM38626	SW¼	160.00
	NM-A 19053	N½NW¼	80.00
Section 26	NM14291	N½NW¼	80.00
Section 27	NM-A19053	N½NE¼	80.00
	NM14291	N½NW¼	80.00

Total Federal Minerals	5,783.76 acres
Total Leased	5,463.76 acres
Total Unleased	300.00 acres

Proposed Action - Current Oil and Gas Leases with Estimated Maximum Potential Development within the Habitat Protection Zone

Lease No.	Operator	Acres in Zone	All or Part of Lease	Status	Existing Wells / Name	Potential Maximum Development
NM-14291	Yates, et al	80.00	Part	HBP	0	1
NM-16071	Yates, et al	1,360.00	All	HBP	1 Karen Fed 1	10
NM-16074	Yates, et al	398.91	All	HBP	1 Adell UJ Fed 1	2
NM-17038	Abo Petr	920.00	All	HBP	2 Abo VT Fed 1 GP Fed Com 1-21	6
NM-18484	Abo Petr	558.99	Part	HBP	1 Unruh AFF Fed Com 1	4
NM-18602	Yates, et al	1,282.02	All	HBP	1 Marie VU Fed 1	10
NM-18819	Sharbro Oil	240.00	All	HBP	3 Mountain VR Fed 1, 2 & 3	0
NM-19829	McKay	2,235.00	All	HBP	4 McKay Harvey Fed 1, 2 , 3 & 4	9
NM-27061	Yates, et al	320.00	All	HBP	2 Crosby TV Fed 1 Crosby TV Fed 2	0
NM-29417	Stevens	160.00		HBP	1 Paul Hicks Fed 1	0
NM-29615	Yates/Texaco	317.23	Part	HBP	0	2
NM-32580	Yates (only)	80.00	All	HBP	0	0
NM-33943	Yates, et al	2,298.09	All	HBP	2 Melena Fed 1 Summers Fed Com 1	16
NM-33944	Yates, et al	800.00	All	HBP	1 Shelly Fed 1	4
NM-56222	Yates, et al	80.00	All	HBP	1 Eakin AFB Com 1 (fee)	1

NM-58924	H. Yates	5.00	All	HBP	0	0
NM-90852	Yates, et al	40.00	All	Expires 5/31/03	0	1
Total 17		11,175.24			20	66

HBP = held by production

Proposed Action - Current Gas Wells within the Habitat Protection Zone

Well Name / Lease Number	Location & Footage	Completion Date	Status	Total Depth (feet)	Producing Interval (feet)
	T. 8 S., R. 25 E.				
Paul Hicks Fed 1 NM-27061	Section 14, 1650 FNL, 1980 FWL	3/12/82	PGW	4,400	4,051-4,107
Crosby TV Fed 1 NM-29417	Section 15, 660 FNL, 660 FEL	1/24/83	PGW	4.175	3,805-4,024
Crosby TV Fed 2 NM-29417	Section 15, 1610 FNL, 1980 FWL	2000	n/a	5,308	n/a
	T. 9 S., R. 24 E.				
Summers Fed Com 1 NM-33943	Section 14, 660 FSL, 1710 FEL	10/1/84	PGW	3,900	3,374-3,378
Melena Federal 1 NM-33943	Section 15, 660 FNL, 1980 FWL	7/8/81	GSI	3,776	3,368-3,390
Shelly Federal 1 NM-33944	Section 24, 660 FSL, 990 FWL	8/17/82	PGW	3,950	3,435-3,533
Karen Federal 1 NM-16071	Section 25, 660 FNL, 990 FWL	7/9/82	PGW	4,132	3,449-3,531
	T. 9 S., R. 25 E.				
McKay Harvey Fed 1 NM19829	Section 17, 660 FSL, 660 FEL	3/21/84	PGW	5,172	3,748-3,961
McKay Harvey Fed 3 NM19829	Section 17, 660 FSL, 1980 FWL	12/13/84	PGW	4,310	3,580-3,589
McKay Harvey Fed 2 NM19829	Section 20, 710 FNL, 660 FEL	11/15/84	PGW	4,251	4,011-4,022
Marie VU Federal 1 NM-18602	Section 20, 1980 FSL, 660 FEL	7/28/83	PGW	4,300	3,724-3,892
McKay Harvey Fed 4 NM-19829	Section 21, 860 FNL, 860 FWL	11/27/84	PGW	4,309	3,892-3,909
G.P. Federal Com 1-21 NM-17038	Section 21, 1980 FSL, 660 FWL	6/1/92	PGW	4,300	3,772-3,780
Abo VT Federal 1 NM-17038	Section 30, 990 FSL, 990 FEL	12/15/82	PGW	4,325	3,637-3,650
	T. 10 S., R. 25 E.				
Adell UJ Federal Com 1 NM-16074	Section 7, 660 FNL, 660 FEL	9/9/82	PGW	4,150	3,658-3,849
Mountain VR Federal 1 NM-18819	Section 8, 660 FSL, 1650 FEL	11/29/82	PGW	4,350	3,792-3,809

Mountain VR Federal 2 NM-18819	Section 8, 1980 FNL, 1980 FWL	3/7/83	PGW	4,100	3,560-3,764
Mountain VR Federal 3 NM-18819	Section 8, 1980 FSL, 1980 FWL	4/21/83	PGW	4,150	3,758-3,774
Eakin AFB Com 1 (fee) NM-56222	Section 17, 330 FNL, 2100 FWL	4/20/93	PGW	4,200	3,796-3,792
Unruh AFF Fed Com 1 NM-18484	Section 20, 660 FNL, 1530 FEL	6/25/94	PGW	4,400	3,802-3,902

GSI = Gas well - shut in PGW = Producing gas well

Alternative A - Additional Oil and Gas Leases with Estimated Maximum Potential Development within the Habitat Protection Zone

Lease No.	Operator	Acres in Zone	All or Part of Lease	Status	Existing Wells / Name	Potential Maximum Development
NM-11596	Gothic, et al	120.00	Part	HBP	0	1
NM-14120	Gothic, et al	240.00	All	HBP	0	0
NM-14291	Yates, et al	560.00	Part	HBP	1 Lloyd Federal Com 1	3
NM-14994	Yates, et al	160.00	All	HBP	0	1
NM-16073	Yates, et al	280.00	All	HBP	1 Sarah UH Fed Com 1	1
NM-17203	Yates, et al	160.00	All	HBP	0	0
NM-19053	Sharbro Oil	620.00	All	HBP	0	6
NM-19175	Yates, et al	320.00	Part	HBP	0	2
NM-29615	Yates, et al	961.87	Part	HBP	1 Bitter Lake Fed Com 1	6
NM-34649	Gothic, et al	680.00	All	HBP	2 Monaghan Federal 1 SU Federal 1	1
NM-35925	Gothic, et al	1,201.08	All	HBP	6 Dana Federal 1, 2, 3, 4, 5 & 9	4
NM-38626	Gothic, et al	160.00	All	HBP	1 Pecos River Federal 1	0
Total 12		5,462.95			12	25

Alternative A - Current Gas Wells within the Habitat Protection Zone

Well Name / Lease Number	Location & Footage	Completion Date	Status	Total Depth (feet)	Producing Interval (feet)
	T. 9 S., R. 25 E.				
Dana Federal 1 NM-35925	Section 4, 860 FSL, 660 FEL	4/23/81	PGW	4,400	3,845-4,018
Dana Federal 2 NM-35925	Section 5, 1980 FNL, 1980 FEL	11/20/81	PGW	4,100	3,520-4,100
Dana Federal 3 NM-35925	Section 3, 1980 FNL, 1980 FEL	4/19/82	PGW	4,300	4,006-4,011
Dana Federal 4 NM-35925	Section 3, 2310 FSL, 1980 FWL	11/7/82	PGW	4,180	3,972-4,007
Dana Federal 5 NM-35925	Section 4, 660 FSL, 1980 FWL	5/13/87	PGW	4,275	3,695-4,275
Dana Federal 7	Section 9, 660 FWL, 2310 FEL	8/30/2000	P&A	4,200	4,053-4,060
Bitter Lake Fed Com 1 NM-29615	Section 5, 1980 FSL, 1980 FEL	4/12/82	PGW	4,250	3,661-3,778
SU Federal 1 NM-34649	Section 9, 1980 FNL, 860 FWL	9/27/84	PGW	4,310	4,050-4,054
Monaghan Federal 1 NM-34649	Section 10, 990 FNL, 1650 FWL	1/14/84	P&A	4,200	none
Lloyd Federal Com 1 NM-14291	Section 11, 990 FSL, 1980 FEL	10/6/82	GSI	4,396	4,133-4,153
Sarah UM Federal 1 NM-16073	Section 15, 1980' FSL, 1980' FWL	9/22/82	GSI	4,350	4,000-4,095
Pecos River Federal 1 NM-38626	Section 23. 1650' FSL, 1980' FWL	1/19/82	PGW	4,255	3,890-4,036

AAPD = Approved Application for Permit to Drill
GSI = Gas well - shut in
P&A = Plugged and abandoned
PGW = Producing gas well

APPENDIX C

Current Right-of-Way Authorizations

Current Rights-of-way Authorizations on Public Lands Within the Habitat Protection Zone

Lease Number / Width	Holder	ROW Type	Date Granted	Total Federal Miles / Acres	Active / Closed
NM52839 50'	Agave Energy	Pipeline 4"	1982	.5 / 3.0	Active
NM55724 50'	Agave Energy	Pipeline 4"	1983	.3 / 1.8	Active
NM070223 50'	Transwestern Pipeline	Pipeline 24"	1959	.71 / 4.3	Active
NMLC0065823 200'	NM State Highway Dept	Highway	1948	3.3 / 80.7	Active
NMNM055592 20'	US West Com	Telephone	1983	5.1 / 12.4	Active
NMNM0467938 50'	LEA Partners	Pipeline 4.5"	1964	.46 / 2.8	Active
NMNM058484 20'	Sanders O&G	Road	1984	.55 / 1.3	Closed
NMNM058449 30'	Central Valley Electric	Powerline 7.2 & 12.47 kV	1984	.76 / 2.8	Active
NMNM055688 33'	Yates Petroleum	Pipeline 4"	1983	5.1 / 25.5	Active
NMNM045495 50'	Transwestern Pipeline	Pipeline 6"	1981	.35 / 2.1	Closed
NMNM0070223 50'	Transwestern Pipeline	Pipeline 24"	1959	.76 / 4.6	Active
NMNM0042844 50'	TX-NM Pipeline	Pipeline 16"	1958		Active
NMNM077782 15'	US West Com	Telephone	1990	2.4 / 4.4	Active
NMNM0559928 40'	Mountain States T&T	Telephone	1964	2.4 / 11.7	Active
NMNM082218 50'	Agave Energy	Pipeline 6"	1990	1.26 / 7.6	Active
NMNM043211 50'	Transwestern Pipeline	Pipeline 4"	1981	1.2 / 7.1	Closed
NMNM044197 50'	Mesa Petroleum	Road	1981	.91 / 5.5	Closed

Lease Number / Width	Holder	ROW Type	Date Granted	Total Federal Miles / Acres	Active / Closed
NMNM055611 30'	Yates Petroleum	Road	1983	.25 / .91	Active
7/12/1900	Santa Fe Atchison Topeka RR	Railroad	1900		Active
NMNM053812 50'	Transwestern Pipeline	Pipeline 4"	1982	1.4 / 8.2	Closed
NMNM077766 60'	Southwestern Public Service	Powerline	1989	120' / .16	Active
NMNM072787 25'	Yates Petroleum	Road	1988	.53 / 1.6	Active
NMNM072824 30'	Yates Petroleum	Road	1988	.40 / 1.4	Active
NMNM053737 10'	Mountain States T&T	Cable	1982	.5 / .6	Active
NMNM040037 40' & 80'	Arends Burke Reliable Real. Tatom	Road	1980	1.0 / 7.4	Active
NMNM055599 12'	Sanders Oil	Road	1983	.25 / .36	Active
NMNM058489 80'	Southwestern Public Service	Powerline	1985	.25 / 2.4	Active

APPENDIX D

Environmental Assessment
EA #NM-066-2000-121
Shelly Federal #2

ENVIRONMENTAL ASSESSMENT
EA# NM-066-00-121

WELL NAME & NO.: Shelly Federal #2
Serial #: NM-33944

Section 23, T. 9 S., R. 24 E., NMPM
660' FSL & 1,980' FEL

Chaves County, New Mexico

OPERATOR: Yates Petroleum Corporation

ACTION: Application for Permit to Drill

SURFACE/MINERAL ESTATE: Federal Surface/Minerals

I. INTRODUCTION

A. Need for the Proposed Action:

Yates Petroleum Corporation proposes to drill and complete a **natural gas** well at the above described location. The proposed action is needed to fully develop the 800-acre mineral lease.

B. Background Information:

The proposed **Shelly Federal #2** gas well is located within the proposed BLM/Bitter Lake Habitat Protection Zone. This area is proposed for administrative designation for the protection of groundwater resources supplying springs and sinkholes at the Bitter Lake National Wildlife Refuge (BLNWR) that provide crucial year-long habitat for several threatened and endangered species. Specifically, spring and sinkhole habitats in the northern portion of the Refuge's Middle Tract.

In May 1997, the U.S. Fish and Wildlife Service (USFWS) provided the BLM with a biological opinion on the Roswell Resource Area Proposed Resource Management Plan (RMP). In the opinion of the USFWS, implementation of the Proposed RMP would jeopardize the continued existence of the federal endangered Pecos gambusia (*Gambusia pecosensis*) unless the six elements of their prescribed "reasonable and prudent alternative (RPA)" are also implemented. The record of decision to adopt the Roswell Approved RMP was signed in October 1997, incorporating the reasonable and prudent alternative into the plan.

The following elements of the Pecos gambusia RPA pertain to this environmental assessment, and reads:

"Use the best available hydrologic information to map the source and movement of water that supplies springs occupied by Pecos gambusia on the BLNWR and the Salt Creek Wilderness. Close the lands within the mapped area to oil and gas leasing unless or until BLM can demonstrate that mandatory protective measures will ensure no aquifer contamination."

"For existing leases within the mapped area, apply appropriate measures taken from BLM's "Practices for Oil and Gas Drilling and Operations in Cave and Karst Areas" and any other appropriate measures to ensure no contamination of water that supplies springs occupied by Pecos gambusia on the BLNWR and the Salt Creek Wilderness. Use monitoring procedures that will detect any surface or subsurface accidents soon enough that they can be discovered and corrected before significant harm to the aquifer occurs."

In order for the BLM to meet the reasonable and prudent alternatives, an RMP amendment is being prepared to officially designate the protection zone with protective design features that would be applied to address groundwater concerns of proposed wells that fall within the proposed area. No interim plan is being prepared since direction for the authorization of the proposed well can be found in the RMP and biological opinion.

The hydrologic mapping has been completed by Balleau Groundwater, Inc. (**Illustration #1**), and is referenced in greater detail in the environmental assessment being prepared for the proposed Habitat Protection Zone. This is the first well to be proposed in the area of interest since the development of the habitat protection zone map which is partly based on the hydrologic study by Balleau. The proposed well is located approximately three linear miles northwest of the BLNWR Middle Tract, and penetrates strata identified as a 100 to 500-year source-water area for springs and sinkholes on the Refuge (time path could differ by a factor of two due to the uncertainty of porosity values).

The proposed well is on an existing 800-acre lease which currently has one well in production, the Shelly Federal #1 (**see Exhibit A**), located in Section 24, T. 9 S., R. 24 E. (600' FSL & 990' FWL), about one-half mile to the east of the proposed well site. Current on-lease production facilities are located on the Shelly Federal #1.

C. Conformance with Land Use Plan:

The proposed action is addressed in the Roswell Resource Area Resource Management Plan/Final Environmental Impact Statement, January 1997. The proposed action is in conformance with the Roswell Approved Resource Management Plan and Record of Decision, October 1997, which supersedes all previous planning documents.

D. Relationship to Statutes, Regulations, or other Plans:

The proposed action does not conflict with any known State or local planning, ordinance or zoning.

II. Proposed Action and Alternatives

A. Proposed Action

Yates Petroleum Corporation submitted Notices of Staking on May 26, 2000, to drill the Shelly Federal #2 gas well (**see Exhibit A**). The Application for Permit to Drill (APD) was submitted on June 16, 2000. The proposed action would include access road, well pad, reserve pit construction, drilling, borehole casing and cementing, and production facility apparatus installment, described in the following:

1. The proposed access road is approximately 600 feet in length beginning from Capitan Road (mantained by Chaves County) to the proposed well pad. Of the 600 feet, about 300 feet of existing road and 300 feet of new road construction would cross public lands.

The construction of the new access road would be approximately **300** feet in length. The access road would originate from an existing two-track road that forks in a northern direction from the Capitan Road. The access road would continue from the existing two-track in an easterly direction to the southwest corner of the proposed well pad and would have a 30-foot wide maximum disturbance area with a 14-foot wide driving surface. Caliche would be used as the surfacing material.

2. The construction of the proposed well pad would be **185** feet long by **325** feet wide. Standard oilfield construction equipment consisting of track-type tractors, motor graders, dump trucks, and water trucks would be used to construct the access road and well pad. Some leveling of the well pad may be required at the proposed location.

3. The construction of the proposed earthen reserve pit would be **175** feet by **150** feet and dug **4** feet below ground level. The reserve pit would be located on the north side of the well pad. The surface pit would be plastic-lined. The pit would contain mud solids and cuttings from drilling operations, and would handle artesian water flows should they be encountered.

4. Drilling Operations:

A rotary drilling rig would be used to drill the well to a proposed total depth (TD) of **5,085** feet. The drilling of a well is of a short duration. Usually the amount of time it takes to drill or complete the well is typically two weeks but may take up to four weeks. A sequential description of the proposed drilling operation follows (Illustration #2): Casing is comprised of steel pipe of various diameters intended to prevent any transfer

of fluids between the borehole and the surrounding formations. The casing would be set at different formations to protect the integrity of the well, and to seal off and protect the groundwater aquifers. Progressively smaller diameter casing would be used during the drilling process, the borehole below each string of casing is smaller than the borehole above. The steel pipe casing would be placed in the borehole as drilling progresses to prevent the wall of the borehole from caving in, to prevent seepage of fluids, and to provide a means of extracting gas if the well is a producer. The operator has submitted a casing and cementing program as part of the APD approval. This program has been reviewed by a BLM Petroleum Engineer for adequacy or for additional, more stringent, measures that would be required on the subsurface casing and cement programs.

A 12¼-inch diameter surface hole would be drilled to a depth of 975 feet using **fresh water** as the drilling fluid. Surface casing 8⅝ inches in diameter would be set at this depth and cemented in place. A volume of cement sufficient to circulate to the surface would be used. A cement slurry would be raised uniformly between the casing and the borehole. Ideally, the cement would completely and uniformly surround the casing and form a strong bond to the borehole wall while preventing the contamination of groundwater aquifers. This casing string would protect fresh water from the Quaternary Alluvium and Artesia Group. The surface casing would be pressure-tested prior to drilling any deeper and witnessed by a BLM Petroleum Engineer Technician.

Next is the second string, a 7⅞-inch hole would be drilled from 975 feet using **brine water** as the drilling fluid to a depth of 3,370 feet. From 3,370 feet to 5,085 feet (TD), a **drilling mixture of salt gel/starch/oil/lost circulation material** would be used. The 4½-inch diameter production casing would be set at this depth and cemented in place if hydrocarbons are present. A volume of cement would be raised uniformly up from TD to approximately 2,800 feet, and from 1,260 feet up to the surface. Approximately 1,540 feet of 4½-inch diameter production casing annulus would not be cemented. A BLM Petroleum Engineer Technician would monitor the actual circulation of cement and verify that the cement job was properly done.

The drilling fluids, also referred to as mud, may be a mixture of bentonite, barite, gypsum, fresh water, sodium chloride (salt water), and chemical additives. The mixture of different additives to the drilling fluids provide viscosity and density to the mud. In addition, the additives in the mud support the borehole walls from caving in, the mud (clay) deposits a cake plaster on the wall of the borehole to prevent loss of drilling fluids to the formations (seals permeable zones), and the mud also exerts hydrostatic pressure that serves to protect against blowouts by holding back subsurface pressures. When mud is being circulated, bottomhole pressure is the hydrostatic pressure required to help move the mud up the annulus. Once the wellbore is drilled, the mud, along with borehole cuttings, are circulated back to the reserve pit. After drilling is completed, the contents of the pit would be allowed to dry, then covered by the previously excavated soil material and leveled.
Throughout the drilling phase, a driller's log or daily tour report would be maintained and used to report to the producer's operations staff of daily progress and occurrences

during each driller's tour. It would show the hourly breakdown of time spent on various operations and records drilling rate at different depths, formation types, drilling breaks, lost circulation zones, when connections are made, when bits are changed, oil and gas shows, blowout preventer equipment (BOPE) tests, casing integrity tests, and other items. This information is used to monitor the drilling phase of the well and is made available to the BLM for review.

Working pressures of the well have also been reviewed for adequate protection from downhole pressures, which includes the blowout preventer (BOP) designed to contain wellbore pressure in the event of a "kick" (high pressure surges).

If the well is determined to be non-productive, no production casing would be set and appropriate cement plugs would be placed in the well bore to plug and abandon the well. This action would be evaluated upon receipt of a Notice of Intent to Plug and Abandon. At this time borehole data would be reviewed by a BLM Petroleum Engineer to determine the exact setting depths of the cement plugs. If the well is successful, and production casing is set, and the well will be completed for gas production.

5. Sundry Notice for Lateral Gas Pipeline: If the Shelly Federal #2 becomes a producing well, Yates Petroleum Corporation would submit a Sundry Notice to notify the BLM of additional developments such as a 4-inch diameter lateral gas pipeline to tie in to a transportation line. The potential pipeline would, in all likelihood, connect the Shelly Federal #2 to an existing transportation line on the Shelly Federal #1, which is located on the same lease about 3,000 feet to the east (**See Exhibit A**). The potential lateral pipeline would be placed within a 20-foot wide working corridor. Blading and trenching would be allowed in order to bury the pipeline within the corridor. The corridor would not be authorized for use as a road, except for pipeline maintenance purposes only.

B. Alternatives:

1. BLM Preferred Alternative:

In order to meet the requirements of the biological opinion, the BLM has adopted the reasonable and prudent alternatives of the opinion (Approved Roswell Resource Management Plan, ROD-1). Selected design features found in Practices for Oil and Gas Drilling and Operations in Cave and Karst Areas would be applied (Approved Roswell Resource Management Plan, Appendix 3, AP3-1).

The access road would be constructed without excessive grading or blading activities and would be limited to grubbing of vegetation and leveling of the access road for a smooth running travelway. Gravel surfacing material would be utilized instead of caliche and placed on the minimally disturbed ground surface within the proposed road route. All other existing access roads would be maintained in as good or better condition than were existing at the commencement of operations. Surfacing material (gravel) needed for the construction of the access road and well pad could be obtained

by the operator from a federal pit in the NW¼SW¼ of Section 18 - T. 9 S., R. 25 E., Chaves County, NM..

The well pad would be constructed without excessive grading or blading activities and would be limited to grubbing of vegetation and leveling of the pad. Gravel surfacing material would be utilized instead of caliche and placed on the minimally disturbed ground surface within the proposed well pad.

The critical period for the possibility of contamination is during the drilling phase of the well. Because the well pad would be constructed within the proposed BLM/Bitter Lake Habitat Protection Zone, in lieu of lined earthen reserve pits, steel tanks would be used (see page AP3-5). No reserve pit, or any other pits, would be constructed for the drilling activity. Above-ground steel tanks would be used for drilling muds and would be located within the perimeter of the well pad. Utilizing steel tanks during drilling operation would prevent potential contaminants from leaching into the groundwater, and to reduce disturbance of fragile soils in the area. The tailings and muds contained in the steel tanks would be disposed at an authorized disposal site.

A volume of cement sufficient to circulate to the surface would be used from TD. A cement slurry would be raised uniformly between the 4½-inch casing and the 7⅞-inch borehole (most likely in stages) to the surface.

If the well is a producer, a production packer would be placed on the production tubing and set above the perforations and a pressure gauge placed at the surface to monitor the status of the 4½-inch production casing during the life of the well. A production packer would seal off the production casing from the producing zone. This would allow monitoring for any internal casing leaks which would register on the pressure gauge installed at the surface.

In addition, if the well is a producer, all production facilities would be low profile, not over 10 feet in height. The height limitation of the production facilities would reduce the visual intrusion of the facilities.

2. Relocate the Proposed Action:

No other alternative location would have significantly fewer impacts than, or have a clear advantage over, the proposed location. Therefore, the alternative of changing the location involved in this action is not analyzed further in this EA.

3. No Action:

Under this alternative the application would be rejected. None of the environmental impacts associated with the proposed action or alternate location would occur. Additionally, economic benefits of the proposed action would not be realized, and the existing environment, including the developments in place, would remain unchanged.

III. Description of the Affected Environment

A. General Setting:

The proposed access road and well pad are located on federal land about five miles northeast of Roswell, NM via Highway 70. Public lands in the general area are primarily grassland habitat and are sparsely developed with oil and gas production wells. The area is an important viewshed for the BLM as it is located in close proximity to Roswell and the BLNWR. Historical and present use of the subject lands have been limited to livestock grazing and limited energy development.

B. Rights of Record:

An inspection of the Master Title Plats and other Bureau records revealed the following title information pertaining to valid existing prior rights on the subject lands:

- Oil and gas leases **NM-33944**
- No federally administered rights-of-way will be affected in the project area.
- No mining claims are recorded within Section 23, T. 9 S., R. 24 E., NMPM

C. Affected Resources:

The following critical resources have been evaluated and are either not present or are not affected by the proposed action or the alternatives in this EA:

Areas of Critical Environmental Concern (ACEC's)
Cultural Resources (00-R-**033**-A)
Farmlands, Prime/Unique
Floodplains
Native American Religious Concerns
Wastes, Hazardous/Solid
Wetlands and Riparian Zones
Wild & Scenic Rivers
Wilderness

The impact of the proposed action and alternatives to minority or low-income populations or communities has been considered and no significant impact is anticipated.

1. Air Quality:

The area of the proposed actions is considered Class II air quality area. A Class II area allows a moderate amount of degradation of air quality. Primary sources of air pollution are wind-blown dust from disturbed or exposed soils and by exhaust emissions from motorized equipment.

2. Geology:

Permian age rocks are exposed at the surface in the area of interest. The rocks are predominately from the Artesia Group and the underlying San Andres Formation. The formations found in the Artesia Group are from oldest to youngest: Grayburg, Queen, Seven Rivers, Yates and Tansill. During the Laramide Orogeny, the entire area was tilted to the east at a two to three degree dip. During relatively recent geologic time, the Pecos River flowed several miles to the west of Roswell, and it was the dip of these beds which caused the Pecos River to migrate eastward, downcutting into the sediments to form the Pecos Valley. During this process much of the Artesia Group was removed from the Pecos Slope, a geomorphic feature which stretches from the Sacramento Escarpment to the present day location of the Pecos River. The Bitter Lake National Wildlife Refuge is located in an area where the Pecos River has cut down into sediments deposited in an arm of the extensive Permian Sea.

In the vicinity of the proposed well, Kelley=s geologic map (1971) shows the area to be covered by Quaternary deposits. To the northeast and east of the proposed location are the low-lying Dunnahoo Hills which are essentially a remnant outcrop of the Seven Rivers Formation. It isn=t until crossing to the east side of the Pecos River that a thicker section of Seven Rivers Formation, as well as the overlying Yates Formation, is encountered. Well logs in the vicinity also show only the undifferentiated Queen/Grayburg remain of the Artesia Group in the subsurface.

Subsurface Stratigraphy

Abo Formation: Mainly dark, reddish-brown mudstone and very fine to coarse grained arkosic well sorted sandstones and conglomerate (Bartsch-Winkler 1992).
Yeso Formation: Tan, red-yellow,gray., white, shale siltstone, sandstone , limestone, dolomite, gypsum, interbedded anhydrite and minor halite. Generally, more gypsum and clastic rich in the northern portion of state and more carbonate rich in the south (Bartsch-Winkler 1992).

San Andres Formation: This formation is subdivided into the three members described below.

Rio Bonito Member: Gray, brownish gray, dolomite, limestone and sandstone (Glorieta), thick bedded (Kelley 1971).

Bonney Canyon Member: Gray, light gray, local black, thin-bedded (Kelley 1971).

Fourmile Draw Member: Dolomite, gypsum, reddish mudstone, sandstone locally at top, thin bedded (Kelley 1971). Note: According to Bachman (1987) as much as 600 feet of evaporites have been dissolved in the subsurface from the top of the San Andres along the Pecos River near Roswell (Bartsch-Winkler 1992).

Grayburg Formation: Tan to brown, medium to fine grained sandstone and thin bedded mudstone with minor cherty gray dolomite (Bartch-Winkler 1992). Thirty miles north of Roswell, Grayburg and Queen Formations undifferentiated and red mudstone and muddy gypsum predominate. Bedding thickness, carbonate content and sandstone content in lower part of formation increase southward towards the Capitan Reef (Kelley1971).

Queen Formation: Thin bedded red sandstone and mudstone with dolomite and in the vicinity of Roswell gypsum and minor thin magenta and gray dolomite predominate in upper part of formation (Bartsch-Winkler 1992).

In addition, there is an absence of thick-bedded halite in the geographic area. However, the natural processes which take place at depth in the San Andres Formation may form more sinkholes in the area as denudation continues in the area over the long term.

3. Soils:

The soils are the Hollomex loam (0 to 1 percent slope) as described in the Soil Survey of Chaves County, New Mexico - Northern Part (Page 37 and Map 27). This deep, well-drained soil type is located on low terraces. It formed in calcareous, gypsiferous alluvium and residuum. Permeability is moderate, runoff is medium and the hazard of water erosion is moderate. The hazard of soil blowing is high. Loss of the surface layer results in a severe decrease in productivity. The main limitations are the shallow depth to gypsiferous material and high hazard of soil blowing. Excavation exposes material that is highly susceptible to soil blowing. Loss of the surface layer results in a severe decrease in productivity because of the shallow depth to gypsiferous material and low precipitation. Preserving as much of the existing cover during construction and promptly revegetating disturbed areas help to control water erosion and soil blowing.

4. Vegetation:

The native vegetation in the area is composed of alkali sacaton, vine-mesquite, tobosa, cactus, broom snakeweed, and annual forbs. The mean annual precipitation is11 to12 inches. There are no known populations of noxious or invasive weed species on the proposed access road and well pad. Steps would be taken to ensure noxious weeds are not introduced to the proposed site resulting from the project.

5. Water Quality - Groundwater:

The area of analysis is at the northeast limit of the Roswell ground-water basin. The

Roswell basin can be described by its three main components. The first component is an eastward dipping carbonate aquifer that is closely related to the San Andres limestone. It is often called the "artesian aquifer" though it is unconfined to the west. Water-producing zones near the Bitter Lake Refuge are at the upper part of the San Andres limestone and can extend into the Grayburg and Queen formations of the Artesia Group.

The Artesia Group comprises the second component of the basin, a leaky "confining bed" overlaying the carbonate aquifer. One or more water zones are present in the upper portion of the confining bed, contributing approximately ten percent of the water pumped in the Roswell basin (Welder 1983).

Finally, the confining bed is overlain by a water table aquifer of Quaternary alluvium, commonly called the "shallow aquifer". There is evidence that the unconfined shallow aquifer is not restricted to Pecos River alluvium, but actually extends downward to the Artesia Group (Kinney *et al.* 1968). The northern limit of the shallow aquifer falls within the area of analysis.

Recharge of the Roswell ground-water basin is primarily by infiltration from precipitation, with influent from intermittent streams and subsurface underflow as secondary sources. Recharge east of the Pecos River provides flow to the river, and sustains water levels in Bottomless Lakes State Park and areas near BLNWR. The artesian aquifer receives water from the central part of the western recharge area. The shallow aquifer is replenished from the nearest part of the western recharge area (Summers 1972). The depth of the water table ranges from less than ten feet near the river in the southeast part of the area of analysis to more than 80 feet to the west (Wilkins and Garcia 1995).

Ground water flow in much of the area of analysis converges on the Middle Tract of the refuge, which has caused concern about the risks of ground water contamination from various sources. As a result, the U.S. Fish and Wildlife Service contracted a study of the source and movement of water supplying the refuge (Balleau Groundwater, Inc. 1999). The travel time for contaminants (100 to 500- year source zone) would afford a substantial response time to mitigate potential impacts. The report provides much of the basis for delineating the area (**Illustrations #1, #3, & #4**).

There are no municipal wells, irrigation wells or domestic water wells in the area of influence between the Shelly Federal #2 and the BLNWR Middle Tract.

6. Wildlife:

Wildlife species utilizing this area for habitat include mule deer, pronghorn antelope, coyote, fox, rabbits, kangaroo rats, pocket gophers, prairie rattlesnakes, as well as a variety of songbirds, dove, quail, and raptors.
No known special status plant or animal species or critical habitat occur in the project area. The main habitat concern for this proposed project is the protection of the subsurface aquifers and groundwater supplying springs and sinkholes occupied by the Pecos gambusia on the BLNWR.

Pecos gambusia (*Gambusia pecosensis*)

The Pecos gambusia is listed as an endangered species under the Endangered Species Act of 1973. The Pecos gambusia is a small fish 25-40 millimeters long and is endemic to the Pecos River basin in the southeastern New Mexico and western Texas. Historically, Pecos gambusia occurred as far north as the Pecos River near Fort Sumner, NM, and south to Fort Stockton, TX. However, recent records indicate that its native range is restricted to sinkholes or springs and their outflows, on the west side of the Pecos River in Chaves County, NM. In spite of population declines, the species remains locally common in a few areas of suitable habitat. In NM, populations are present on the BLNWR and the Salt Creek Wilderness Area (both in Chaves County). These areas constitute the key habitat of the species in the Roswell Field Office. Populations of Pecos gambusia occur in several springs and isolated gypsum sinkholes at the BLNWR Middle Unit (Lake St. Francis Research Natural Area) and the Ink Spot sinkhole in the Salt Creek Wilderness. The drilling aspects of the well may have a remote potential negative affect upon groundwater aquifers supplying springs and isolated gypsum sinkholes at the refuge.

7. Range:

The well is located on BLM grazing Allotment 64054 operated by E.H. Cattle Company, HCR 31 Box 1318, Roswell, NM, 88201. Livestock are not actively grazing the pasture at this time. A range study site is located a few hundred yards north of the proposed well site. No range improvements are in the vicinity of the well site.

8. Visual Resource Management (VRM)/Recreation:

The proposed action is located in a designated VRM Class III area. Contrasts to the basic elements (form, line color, texture) caused by a management activity may be evident and begin to attract attention in the landscape. The changes, however, should remain subordinate in the existing landscape. Recreation in the vicinity includes seasonal hunting and sightseeing.

9. Cave/Karst:

No surface cave/karst features were observed in the immediate vicinity of the proposed action. There is the possibility of below ground level karst-type structures due to shallow occurrences of carbonates, halite and gypsum.

IV. ENVIRONMENTAL IMPACTS

Descriptions of environmental impacts for both the Proposed Action and BLM Preferred Alternative are grouped together under each resource heading for comparative purposes.

The surface disturbance involved in the construction of the access road, well pad, and reserve pit would total about **2.0** acres of federal surface, and about **1.4** acres for a potential buried pipeline.

Environmental impacts that can be anticipated include:

1. Air Quality:

Proposed Action and Preferred Alternative - Air quality would temporarily be impacted with pollution from exhaust emissions, chemical odors, and dust that would be caused by the motorized equipment used to construct the access road, well pad, reserve pit, and by the rotary drilling rig. Dust dissemination would be greatly reduced upon completion of the construction phase of the access road and well pad. Air pollution from the motorized heavy equipment would discontinue entirely upon completion of the drilling phase of the operation. Winds that frequent southeastern New Mexico generally disperse odors and emissions. The impact to air quality would become greatly reduced as the construction and drilling phases are completed.

Preferred Alternative - Surface disturbances would be kept to an absolute minimum by clearing vegetation and blading only where it is necessary to level the access road and well pad. No reserve pit excavation would occur. Blowing dust would be minimized by reducing the amount of soil disturbance during construction (and potential pipeline construction).

2. Geology:

The U.S. Fish and Wildlife Service has expressed concern over the creation of open holes by way of conduits through the borehole and associated casings and cited Martinez et al. (1988) as a case in point. The authors of the research state under the heading “Sinkholes Related to Petroleum Activity”, “The few collapse sinks related to petroleum activity involve boreholes drilled long ago, before development of proper engineering safe guards pertaining to drilling-mud design, casing placement and the use of salt tolerant cements”. In all the case studies, well were drilled 1928, and 1936 through 1938. All of the wells were underlain by 246 to 1,969 feet of salt. The type of salt found in the Permian Basin case study is halite. As there is an absence of thick-bedded halite in the geographic area of interest, the possibility for sinkhole formation due to petroleum activity is remote.

Proposed Action and Preferred Alternative - There would be no impact to the geology of the area.

3. Soils:

Proposed Action and Preferred Alternative - The construction of the access road and well pad would physically disturb about 2.0 acres of topsoil material. Where exposed, soils would be susceptible to wind blowing and water erosion. The access road may be impacted when heavy precipitation would cause water erosion damage. When water-saturated segment(s) on the access road become impassable, vehicles may still be driven over the road. Consequently, deep tire ruts would develop. Where impassable segments are created from deep rutting, unauthorized drive-arounds may occur outside the designated 14-foot wide driving surface access road. This would create additional soil impacts associated with lease development. Road construction requirements would alleviate potential impacts to the access road from water erosion damage. The impact may be fully remedied upon reclamation when the well pad and road are reseeded. The potential pipeline would disturb up to 1.4 acres of topsoil along the pipeline corridor and would mix soil horizons to a depth of 36 inches from trenching operations.

Proposed Action - Excavation of the reserve pit to a depth of 4 feet would disturb approximately 105,000 cubic feet of soil. Excavation would expose material that is highly susceptible to soil blowing. Loss of the surface layer would result in a severe decrease in productivity because of the shallow depth to gypsiferous material and low precipitation.

Preferred Alternative - The soil disturbance would be kept to an absolute minimum by clearing vegetation and blading only where it is necessary to level the access road and well pad. No reserve pit excavation would occur, and a smaller area would be required to set up steel tanks. Reducing the amount of soil disturbance during construction would minimize disturbance to the fragile soil. Surfacing the disturbed areas with gravel instead of caliche would minimize the impacts to the soil and allow the disturbed areas to revegetate. Blading would not be required for pipeline installation, this disturbance acreage could be less than 1.4 acres.

4. Vegetation:

Proposed Action and Preferred Alternative - Construction activities for the access road and well pad would impact about 2.0 acres of native vegetation at the site. Vegetation that would be removed would be alkali sacaton grass that dominates the site, scattered cacti and snakeweed, phacelia and buckwheat. If drilled as a dry hole and plugged, reclamation of the site would immediately follow with vegetation re-establishing within three to five years, depending on precipitation and surfacing material. If it is a producing well, reclamation would not commence until the well is a depleted producer and plugged and abandoned. Native vegetation would encroach on the site over time with only high traffic areas remaining unvegetated.

The construction of an access road and/or well pad may unintentionally contribute to the establishment and spread of noxious weeds. The noxious weed seeds could be

carried onto the project areas by construction equipment, the drilling rig and transport vehicles. The main mechanism for seed dispersion on roads and well pads is by vehicles and equipment previously used and/or driven through noxious weed-infested areas. Washing and decontaminating the equipment prior to entering federal lands would minimize this potential impact.

Proposed Action - All plant material within the dimensions of the pad and reserve pit would be removed. Excavation of the reserve pit to a depth of 4 feet would expose less fertile soils that would not allow for re-vegetation. The potential pipeline construction would disturb up to 1.4 acres of vegetation along the pipeline corridor from trenching operations.

Preferred Alternative - The construction of the access road and well pad would require minimal grubbing of vegetation and leveling of the ground prior to the progressive surfacing of the access road and well pad with gravel material. Light removal of vegetation where needed, reduced pad size, the use of steel pits versus an in-ground reserve pit, and the use of gravel as a surfacing material would reduce impacts to vegetation. Vegetation recovery on the site would depend on the life of the well. Vegetation impacts would be short-term with the site re-vegetating in a few years since a gravel surfacing material would be used instead of caliche. Because blading would not be required for pipeline installation, this disturbance acreage could be less than 1.4 acres.

5. Water Quality - Ground Water:

Proposed Action and Preferred Alternative - The casing and cementing procedures used in drilling a gas well are designed so that drilling fluids (mud) are contained within the casing/cemented borehole and are not allowed to discharge into underground aquifers. When completed, two strings of casing and two cement sheaths would be in place from the Glorieta formation (1,260') to the surface.

The impact from drilling fluid contamination is minimal since downhole pressures would prevent drilling fluids from entering the underground aquifers. The impacts to the aquifers would be minimized by the proper cementing of casing in the borehole from the Glorieta to the surface. Once the well is completed, the casing and cement would provide adequate protection to groundwater resources by sealing off aquifers, and preventing seepage from the borehole into the underground aquifers.

If the well is a producer, produced fluids (e.g.: saltwater, oil, and/or condensate) could cause permanent damage to soils and vegetation off the well pad in the event of a breech, overflow, or spill from storage tanks associated with production facilities on the well pad.

There would be no impact to municipal wells, irrigation wells or domestic water wells between the Shelly Federal #2 and the BLNWR Middle Tract as none are located in the area of influence.

Proposed Action - There is a remote possibility that accidental drilling fluid contamination of soils and groundwater (seepage) could occur during the drilling phase. Nine millimeter thick plastic sheets would be used to line the reserve pit . There is the possibility of tears in the plastic that would allow seepage to occur. After drilling operations, all drilling material would be left on-site within the reserve pit and buried. There is the long term potential for groundwater contamination from water infiltration at the reserve pit location, especially if the liner is damaged during drilling, backfill, or other future construction activities over the location.

There exists the potential for casing failure over the life of the well due to corrosion. Specifically, from 2,800 feet to the cemented Glorieta formation at about 1,260 feet, a distance of about 1,580 feet. Cement would not be raised uniformly in the annulus of the wellbore and casing (open casing) in this section. The lack of cement in this portion does not adequately provide for the long term integrity of the well bore and casing.

Preferred Alternative -

There is a remote possibility that accidental drilling fluid contamination could occur during the drilling phase. If this happens, the effects would be very minimal because steel tanks would be used to contain drilling fluids and protect soils and groundwater from mud contamination and seepage. There is the potential for drilling fluids, cuttings, and returns to exceed the capacity of the steel tanks, in which case, contamination could still occur to soils and groundwater.

The borehole casing and cementing program would protect the sub-surface aquifers from the possibility of cross-contamination between aquifers and would enhance long term well casing integrity, since the entire 4½-inch casing would be cemented from TD to the surface. Monitoring the well for casing integrity with the use of a gage installed at the surface would alert the operator and BLM of potential leaks that may impact groundwater sources.

6. Wildlife:

Proposed Action and Preferred Alternative - Some small wildlife species may be killed and their dens or nests destroyed during construction and operation of the well. The construction of the access road and well pad would cause some fragmentation of wildlife habitat. The facilities themselves may also be used by wildlife for shelter and nesting. Upon abandonment of the well, the area would be put back to grass lands and as close to the original topography as possible. The proper reclamation of the disturbed areas would eventually lessen the impacts to wildlife habitat. The proper restoration of the lands would bring about the return of the displaced wildlife species.

Pecos gambusia

Loss or alteration of habitat (periodic dewatering), and introduction of exotic fish species (mosquitofish) are the key threats to the Pecos gambusia. Potential impacts to habitat may occur from surface disturbing activities at sinkholes or springs and their outflows. There are no sinkholes or springs in the vicinity of the proposed well. Impacts to groundwater resources have been addressed under Ground Water Quality.

The probability of contamination of groundwater resources supplying springs at the BLNWR from the proposed gas well is very remote, but not discountable. The probability of an accident occurring increases as the number of producing wells are developed in the area. The proposed well is located north of Highway 70 about three miles northwest of the Refuge.

Located between the proposed well and the Refuge are other developments which pose an even greater risk for surface and subsurface contamination, such as the growing subdivision located one mile west of the BLNWR, the Atchison Topeka and Santa Fe Railroad, and Highway 70. At the present time, the BLM does not own either the surface or the mineral estate to lands located immediately adjacent to the BLNWR. These lands pose a much greater and immediate threat to the Pecos gambusia than the proposed gas well. Weighing the possibility of groundwater contamination from the proposed well and the potential for contamination from other sources (septic tanks, highway spills, railroad spills) further reduces the magnitude of potential contamination from the proposed well.

Based on these analyses and the design features proposed under the BLM Preferred Alternative, the effects determination for the federal endangered Pecos gambusia at the BLNWR from the development of a gas well is **May Affect, Not Likely to Adversely Affect**.

7. Range:

Proposed Action and Preferred Alternative - There could be some minor disruption of livestock grazing operations in the vicinity of the well pad location during the construction and drilling phase of the well. No impacts to the range study site or range improvements would occur.

8. Visual Resource Management/Recreation:

Proposed Action and Preferred Alternative - The construction of the access road and well pad would modify the existing visual features of the landscape. The use of low-profile tanks and painting structures with an approved color would reduce the visual impact of the production facilities. Until reclamation of the access road and well pad are accomplished, oil and gas operations development may dominate the view of the landscape. There would be no impact to recreation uses in the area.

9. Cave/Karst:

Proposed Action and Preferred Alternative - There would be no impact to known cave entrances, or karst features within the project area.

B. Alternatives:

1. Relocation Alternative:

The alternative of changing the location involved in this action was not analyzed further because no other alternative location would have significantly fewer impacts than, or have a clear advantage over, the proposed location.

2. No Action Alternative

The "No Action" alternative would constitute denial of the application. This alternative would result in none of the identified environmental impacts. There would, however, be an adverse economic impact to the applicant through the denial of the lessee's right to develop the mineral reserves or through increased costs of accessing those mineral reserves through other means. There have been no significant or unmitigatable impacts identified as a result of this analysis which would warrant selection of the no action alternative.

C. Mitigation Measures:

In the unlikely event of a casing failure, one of the following actions would be pursued:

- Perforate the 4-1/2-inch casing, squeeze cement to repair the damage, and return the well to a producing status.
- Insert a string of casing (or liner) inside the 4-1/2-inch casing, cement the annular space to the surface, and return the well to a producing status.
- Plug and abandon the wellbore, rehabilitate the road and well pad.

The Roswell Field Office's Well Drilling Requirements (Exhibit B), Conditions of Approval (Exhibit C), Permanent Resource Road Requirements (Exhibit D), and the special requirements derived from this EA, would be applied to this proposed action to minimize the surface disturbance and conserve the surrounding landscape. The protective measures described for the borehole casing and cementing process are requirements in the drilling phase that would sustain the integrity of the well and would also be sufficient for the protection of aquifers. The risk of ground water contamination, though not great, is further reduced by implementing the proposed protective measures. The BLM would monitor surface activity to detect any surface accidents soon enough that they can be discovered and corrected before significant harm to the underground aquifer can occur. The gauge placed at the surface would allow monitoring of pressures within the production casing that may indicate problems with the casing.

D. Cumulative Impacts:

In the foreseeable future, lease holders could develop more wells that could accumulate to a substantial reduction of habitat. Well development mitigation measures would greatly reduce, but may not completely eliminate accidental spills or casing failures that could contaminate the aquifers. While it is unlikely that there will be significant cumulative effects from this individual action, continued oil and gas development, and other surface-disturbing activities in this area may potentially have cumulative impacts on vegetation, soil, water, and wildlife. In the foreseeable future, the cumulative impacts from oil and gas activities would be reduced as the wells play out and the lands are reclaimed.

V. Consultation and Coordination

An onsite inspection was conducted on the access road and well pad on June 14, 2000. In attendance were Cy Cowan, Regulatory Agent for Yates Petroleum Corporation, Richard Hill, Environmental Protection Specialist, and Dan Baggao, Lead Wildlife Management Biologist, BLM.

Coordination and consultation has occurred specifically with the U.S. Fish and Wildlife Services at a December 5, 2000 meeting and field trip hosted by the Roswell Field Office concerning the proposed well site.

An onsite inspection was conducted on August 8, 2001 with Carrie Hernandez, U.S. Fish and Wildlife Service, Ecological Services Field Office, and Dan Baggao, BLM. A field reconnaissance of the Habitat Protection Zone area was also conducted during that visit.

The issues and mitigation measures concerning the groundwater and Pecos gambusia habitat at the Refuge were discussed during the meetings and are reflected in the Drilling Requirements (casing and cement program) for this well. The comments and suggestions expressed during the onsite consultation and letters have been incorporated into this EA.

Reviewed by: _____

Irene Gonzales-Salas, Realty Specialist **Date**

FINDING OF NO SIGNIFICANT IMPACT
AND DECISION RECORD

EA-NM-066-00-121

FINDING OF NO SIGNIFICANT IMPACT: Based on the analysis of potential environmental impacts contained in the attached environmental assessment, I have determined that impacts resulting from the proposed actions are not expected to be significant and an environmental impact statement is not required.

DECISION: It is my decision to authorize the Application For Permit To Drill Or Deepen (APD), for the **Shelly Federal #2** gas well, submitted by **Yates Petroleum Corporation**. The provisions for the approval of the APD will include the attachment of the Roswell Field Office requirements as defined in the following exhibits; **Exhibit A** - Location Map, **Exhibit B** - Well Drilling Requirements, **Exhibit C** - Conditions of Approval, **Exhibit D** - Permanent Resource Road Requirements, and special mitigating measures developed in the environmental assessment.

In the event the well proves to be a dry hole, or when the well is abandoned, I recommend that reclamation requirements be attached to the well abandonment, including additional requirements imperative for the complete reclamation of the disturbed areas. These actions are subject to 43 CFR 3160 regulations for Onshore Oil and Gas operations on federal lease NM-33944.

Authority for these actions is the Mineral Leasing Act of February 25, 1920, as amended.

These actions will affect public lands described as:

New Mexico Principal Meridian

Section 23; SW¼SE¼, Township 9 South, Range 24 East
660' FSL & 1980' FEL

RATIONALE FOR DECISION: The proposed actions would not result in any undue or unnecessary environmental degradation. Portions of the subject lands and adjacent lands have been used for similar purposes and all present and potential uses and users have been considered.

COMPLIANCE AND MONITORING: The construction phase of the proposed actions and subsequent operational phases will be monitored as per regulations.

Larry D. Bray, Assistant Field Manager **Date**
Lands and Minerals

EXHIBIT B

WELL DRILLING REQUIREMENTS

OPERATOR'S NAME: **Yates Petroleum Corporation** LEASE NO.: **NM-33944**
WELL NAME & NO: **Shelly Federal #2**
QUARTER/QUARTER & FOOTAGE: **SW¼SE¼ and 660' FSL & 1980' FEL**
LOCATION: **Section 23, T. 9 S., R. 24 E., NMPM**
COUNTY: **Chaves County, New Mexico**

I. GENERAL PROVISIONS:

A. The operator has the right of administrative review of these requirements pursuant to 43 CFR 3165.1(a).

B. The **operator** shall hereafter be identified as the **holder** in these requirements. The Authorized Officer is the person who approves the Well Drilling Requirements.

II. WELL PAD CONSTRUCTION REQUIREMENTS:

A. The BLM shall administer compliance and monitor construction of the access road and well pad. Notify **Richard G. Hill** at least **3** working days (72 hours) prior to commencing construction of the access road and/or well pad. Roswell Field Office number **(505) 627-0247**.

B. Prior to commencing construction of the access road, well pad, or other associated developments, the holder shall provide the dirt contractor with **a copy of the approved APD signature page, a copy of the location map (EXHIBIT A), a copy of pages 1 & 2 from the Well Drilling Requirements (EXHIBIT B), and a copy of the Permanent Resource Road Requirements (EXHIBIT D).**

C. The construction of the well pad shall be kept to minimum when grading or blading except where topography irregularities necessitates ground leveling. The well pad shall be leveled to the extent possible with minimal surface disturbance and grubbing of the vegetation shall be kept to a minimum. Surfacing of the well pad shall be done with gravel material only. In order to minimize the visual resources of the area, the holder shall not have any intrusive earthen mounds above ground level on the well pad. Upon reclamation of the well pad, the holder shall comply with the Well Drilling Requirements - VI. Seeding Requirements, mandated for the well pad. (see EXHIBIT B).

D. **Reserve Pit Requirements: NO RESERVE PITS**

1. **The holder shall use steel tanks for drilling the well in lieu of reserve pits.** Steel tanks will help prevent the possibility of the drilling fluid leaching into the underground aquifers and reduce soil disturbance.

2. The steel tanks shall be constructed so as not to leak, break, or allow discharge of drilling muds. Under no circumstances will the steel tank be opened and allowed to drain drilling muds on the ground.

3. The steel tanks shall be equipped to deter entry by birds, bats, other wildlife.

4. Drilling muds shall be properly transported and disposed at an authorized disposal site.

E. **Federal Mineral Materials Pit Requirements:**

1. Gravel from new or existing pits on Federal mineral estate shall not be taken without prior approval from the authorized officer. Contact **Jerry Dutchover** at **(505) 627 - 0236.**

2. Payment for any Federal mineral materials that will be used to surface the access road and the well pad is required prior to removal of the mineral materials.

F. **Well Pad Surfacing Requirement:**

1. The well pad shall be surfaced with **6** inches of compacted gravel. The well pad shall be surfaced prior to drilling operations (see EXHIBIT D - Permanent Resource Road Requirements, 4. Surfacing).

G. **Cave Requirements:**

1. If, during any construction activities any sinkholes or cave openings are discovered, all construction activities shall immediately cease. Contact **Larry Bray** at **(505) 627-0250**.

2. The BLM Authorized Officer will, within 24 hours of notification, conduct an on-the-ground field inspection for karst. At the field inspection the authorized field inspector will authorize or suggest mitigating measures to lessen the damage to the karst environment. A verbal order to proceed or stop the operation will be issued at that time.

III. DRILLING OPERATION REQUIREMENTS:

A. **General Requirements:**

The Bureau of Land Management (BLM) is to be notified at the Roswell Field Office, 2909 West Second Street, Roswell, New Mexico, (505) 627-0272 for wells in Chaves and Roosevelt Counties in sufficient time for a representative to witness:

1. Spudding 2. Cementing casing: **8⅝** inch and **4½** inch 3. BOP and casing integrity tests

4. Unless the production casing has been run and cemented, or the well has been properly plugged, the drilling rig shall not be removed from over the hole without prior approval.

5. Submit a Sundry Notice (Form 3160-5, one original and five copies) for each casing string, describing the casing and cementing operations. Include pertinent information such as; spud date, hole size, casing (size, weight, grade and thread type), cement (type, quantity and top), water zones and problems or hazards encountered. The Sundry shall be submitted within 15 days of completion of each casing string. The reports may be combined into the same Sundry if they fall within the same 15-day time frame.

6. The API Number, as assigned to the well by NMOCD, shall be included on the subsequent report following the setting of the first casing string.

B. **CASING:**

1. The **8⅝** inch surface casing shall be set at **975 feet and cement circulated to the surface**. If cement does not circulate to the surface, the appropriate BLM office shall be notified and a temperature survey or cement bond log shall be run to verify the top of the cement. Remedial cementing shall be completed prior to drilling out that string.

2. The minimum required fill of cement behind the **4½** inch production casing **shall be sufficient to circulate to the surface**.

C. **PRESSURE CONTROL:**

1. All BOP systems and related equipment shall comply with well control requirements as described in Onshore Oil and Gas Order No. 2. The BOP and related equipment shall be installed and operational before drilling below the **8⅝** inch casing shoe and shall be tested as described in Onshore Order No. 2. Any equipment failing to test satisfactorily shall be repaired or replaced.

- Testing fluid must be water or an appropriate clear liquid suitable for sub-freezing temperatures. Use of drilling mud for testing is not permitted since it can mask small leaks.
- Testing must be done in a safe workman-like manner. Hard line connections shall be required.
- The requested variance to test the BOPE to the reduced pressure of 500 psi using the rig mud pumps is approved.

2. Minimum working pressure of the blowout preventer and related equipment (BOPE) shall be **2000** psi.

3. The appropriate BLM office shall be notified in sufficient time for a representative to witness the tests.

D. **MONITORING:**

In order to provide a means of monitoring the integrity of the 4½-inch casing during production operations, a production packer shall be required to be set above the perforations and a pressure gauge placed at the surface.

IV. DOWN HOLE ABANDONMENT REQUIREMENTS:

A. If the well is a dry hole and will be plugged, approval of the proposed plugging program may be orally obtained from the BLM. However, oral approval must be confirmed in writing by immediately filing a Sundry Notice And Report On Wells (Form 3l60-5), Notice of Intention to Abandon, and submitting an original and five (5) copies to the Roswell Field Office. The report should show the total depth reached, the reason for plugging, and the proposed intervals, by depths, where plugs are to be placed, type of plug, type of plugging mud, etc.

2. If the well is not drilled, please notify the BLM so that an official release can be approved.

V. SURFACE RECLAMATION/RESTORATION REQUIREMENTS:

A. When the well is abandoned, Form 3l60-5 **Notice of Intention to Abandon (NOI)** could be used by the holder as the initial report for the surface reclamation/restoration of the access road and well pad. Upon receipt of the NOI, the Authorized Officer shall provide the holder with the specific requirements for the reclamation/restoration of the access road and well pad.

B. The holder shall comply with all the surface reclamation/restoration required by the Authorized Officer pertaining to the access road and well pad. Liability under bond shall be retained until surface reclamation/restoration of the access road and well pad has been completed to the satisfaction of the Authorized Officer.

VI. ON LEASE - WELL REQUIREMENTS:

1. The holder shall post signs identifying the location permitted herein with the requirements contained in Onshore Oil and Gas Order #1 and 43 CFR 3162.6.

2. The following data is required on the well sign that shall be posted in a conspicuous place on the well pad. The sign shall be kept up with current identification and shall be legible for as long as the well is in existence:

   Operator Name: Yates Petroleum Corporation
   Well Name & No.: Shelly Federal #2
   Lease No.: NM-33944
   Footage: 660' FSL & 1980' FEL

3. **Upon abandonment of the well, the same information shall be inscribed on the dry hole marker with a beaded weld.**

D. The approval of the APD does not in any way imply or grant approval of any on-lease, off-lease, or off-unit action(s). It is the responsibility of the holder to obtain other approval(s) such as rights-of-way from the Roswell Field Office or other agencies, including private surface landowner(s).

E. All vehicles, including caterpillar track-type tractors, motor graders, off-highway trucks and any other types of motorized equipment that is used in the construction of the access road and well pad shall be confined to the area(s) herein approved. The drilling rig shall also be confined to the approved area(s).

4. **Containment Structure Requirement: None Required**

7. **Well Completion Requirements:**

1. If the well is completed, all areas of the well pad not necessary for operations shall be reclaimed to resemble the original contours of the surrounding terrain.

2. The reclaimed portion of the well pad shall be seeded with the seed mixture prescribed by the Roswell Field Office for the Desired Plant Community on this well site.

Common Name	Scientific Name	Pounds Pure Live Seed/Acre
Alkali sacaton	Sporobolus airoides	3.5
Black grama	Bouteloua eriopoda	2.0
Vine mesquite	Panicum obtusum	2.0
Tobosa	Hilaria mutica	1.0
Sand dropseed or Mesa dropseed or Spike dropseed or Cane bluestem	Sporobolus cryptandus S. flexuosus S. contractus Bothriochloa barbinoides	0.5
Desert or Scarlet Globemallow	Sphaeralcea ambigua or S. coccinea	1.0
Croton	Croton	1.0
Total Pounds Pure Live Seed Per Acre		11.0

Certified Weed-Free Seed

If one species is not available, increase all others proportionately.

3. The planting of the seed shall be done in accordance with the following seeding requirements:

a. Any areas devoid of vegetation shall be plowed under with soil turning equipment and the plowed surface shall be disced before seeding. Seed shall be planted using a drill-equipped planter with a

depth regulator to ensure proper depth of planting where drilling is possible. The seed mixture shall be evenly and uniformly planted over the disturbed area. Smaller/heavier seeds have a tendency to drop to the bottom of the drill and are planted first, the holder shall take appropriate measures to ensure this does not occur. Where drilling is not possible, seed shall be broadcast and the area shall be raked to cover the seed. When broadcast seeding, the pounds per acre are to be doubled.

b. The holder shall seed all the disturbed areas with the DPC seed mixture prescribed by the BLM. The seed mixture shall be planted in the amounts specified in pounds of pure live seed per acre, (Pounds of pure live seed per acre: pounds of seed X percent purity X percent germination = pounds pure live seed). There shall be no primary or secondary noxious weeds in the seed mixture. In accordance with State law(s), the seed should be tested for purity and viability within nine (9) months prior to sell. Commercial seed shall be either certified or registered seed. The seed mixture container shall be tagged in accordance with State law(s) and the certified seed tag shall be made available for inspection by the Authorized Officer.

c. The recommended time to seed is from June 15th through September 15th. The optimum seeding time is in mid-July. Successive seeding should be done either late in the fall (September 15th - November 15th, before freeze up) or early as possible the following spring to take advantage of available ground moisture. However, the holder may seed immediately after completing the well.

d. The seeding of the disturbed areas shall be repeated until vegetation is established on the well pad. The Authorized Officer shall make the determination when the revegetation growth on the disturbed areas are satisfactory.

e. The holder shall be responsible for the establishment of vegetation on the well pad. Evaluation of vegetation growth will not be made before the completion of the first growing season after seeding. The Authorized Officer reserves the right to require reseeding at a specific time if seed does not germinate after one growing season. Waiver of this requirement would be considered if diligent attempts to revegetate the disturbed areas have failed and the Authorized Officer determines that further attempts to

replant the well pad is futile.

4. Contact Richard G. Hill at (505) 627-0247 to witness the seeding operations, two (2) days prior to seeding the disturbed areas.

H. Invasive and Noxious Weeds Requirement:

1. The holder shall be held responsible should the establishment of noxious weeds begin to grow on the access road and well location. Evaluation of growth of the noxious weeds shall be made upon discovery. The Authorized Officer reserves the right to require the holder to eradicate the noxious weed species that have invaded the access road and/or well location. Waiver of this requirement would be considered if diligent attempts to eradicate the noxious weed species has failed and the Authorized Officer determines that further attempts to eradicate the noxious weed species from the access road and well location is futile.

2. The holder shall insure that the equipment and/or vehicles that will be used to construct the access road and/or well location are not polluted with invasive and noxious weed seeds. Transporting of invasive and noxious weed seeds could occur if the equipment and/or vehicles were previously used in noxious weed infested areas. In order to prevent the spread of noxious weeds and the probability that the equipment and/or vehicles are carriers of noxious weed seeds from the conduct of previous projects in noxious weed infested areas, the Authorized Officer shall require that the equipment and vehicles be washed clean prior to construction of the access road and/or well location.

I. **Painting Requirement:**

All above-ground structures not subject to safety requirements shall be painted by the holder to blend with the natural color of the landscape. The paint used shall be a color which simulates "Standard Environmental Colors" designated by the Rocky Mountain Five-State Interagency Committee. The color selected for this project is Carlsbad Canyon, Munsell Soil Color Number A 6/2.

J. **Fence Requirement: None Required**

K. **Open-vent Exhaust Stack Requirements:**

For new production equipment installed on federal leases after November 1, 1993; all open-vent exhaust stacks associated with heater-treater, separators and dehydrator units shall be modified to
prevent birds and bats from entering, and to the extent practical, to discourage perching and nesting.

VII. SPECIAL REQUIREMENT(S):

The production facilities (storage tanks, dehydrator unit,

heater/treater, separator, meter housing, stacks, expander-compressor unit, etc.) shall not be taller than ten (10) feet high for the duration of this well.

EXHIBIT C

CONDITIONS OF APPROVAL

OPERATOR'S NAME: **Yates Petroleum Corporation** LEASE NO.: **NM-33944**
WELL NAME & NO: **Shelly Federal #2**
QUARTER/QUARTER & FOOTAGE: **SW¼SE¼ and 660' FSL & 1980' FEL**
LOCATION: **Section 23, T. 9 S., R. 24 E., NMPM**
COUNTY: **Chaves County, New Mexico**

I. GENERAL CONDITIONS OF APPROVAL:

A. The **operator** shall hereafter be identified as the **holder** in these requirements. The Authorized Officer is the person who approves the Conditions Of Approval.

B. The holder shall indemnify the United Sates against any liability for damage to life or property arising from occupancy or use of public lands under this authorization.

C. The holder shall have surface use approval prior to any construction work on change(s) or modification(s) to the access road and/or well pad. The holder shall submit (Form 3l60-5), Sundry Notice and Report On Wells, an original plus one (1) copy to the Roswell Field Office, stating the basis for any changes to previously approved plans. Prior to any revised construction the holder shall have an approved Sundry Notice and Report On Wells or written authorization to proceed with the change in plans ratified by the Authorized Officer.

4. **Weed Control:** The holder shall be responsible for weed control on disturbed areas within the limits of the site. The holder is responsible for consultation with the Authorized Officer and/or local authorities for acceptable weed control methods, which include following EPA and BLM requirements and policy.

E. **Hazardous Substance:**

1. The holder shall comply with all applicable Federal laws and regulations existing or hereafter enacted or promulgated. In any event, the holder shall comply with the Toxic Substances Control Act Of 1976, as amended (15 U.S.C. 2601, et. seg.) with regard to any toxic Substances that are used, generated by or stored on the project/pipeline route or on facilities authorized. (See 40 CFR, Part 702-799 and especially, provisions on polychlorinated biphenyls, 40 CFR 761.1-761.193). Additionally, any release of toxic substances (leaks, spills, etc.) in access of the reportable quantity established by 40 CFR, Part 117 shall be reported as required by the Comprehensive Environmental Response, Compensation and Liability Act, Section 102b. A copy of any report required or requested by any Federal agency or State government as a result of a reportable release or spill of any toxic substances shall be furnished to the

Authorized Officer concurrent with the filing of the reports to the involved Federal agency or State government.

2. The holder agrees to indemnify the United States against any liability arising from the release of any hazardous substance or hazardous waste (as these terms are defined in the Comprehensive Environmental Response, Compensation and Liability Act of 1980, 42 U.S.C. 9601, et. seg. or the Resource Conservation and Recovery Act, 42 U.S.C. 6901, et. seg.) on this project/pipeline (unless the release or threatened release is wholly unrelated to the operator's activity on the pipeline). This agreement applies without regard to whether a release is caused by the operator, its agent, or unrelated third parties.

F. **Undesirable Event:**

If, during any phase of the construction, operation, maintenance, or termination of the authorization, any oil or other pollutants should be discharged, impacting Federal lands, the control and total removal, disposal, and cleaning up of such oil or other pollutants, wherever found, shall be the responsibility of the holder, regardless of fault. Upon failure of the holder to control, dispose of, or clean up such discharge on or affecting Federal lands, or to repair all damages to Federal lands resulting therefrom, the Authorized Officer may take such measures as deemed necessary to control and cleanup the discharge and restore the area, including, where appropriate, the aquatic environment and fish and wildlife habitats, at the full expense of the holder. Such action by the Authorized Officer shall not relieve the holder of any liability or responsibility.

G. **Archeological, Paleontology, and Historical Sites:**

1. Any cultural and/or paleontological resource (historic or prehistoric site or object) discovered by the holder, or any person working on the holder's behalf, on public or Federal land shall be immediately reported to the Authorized Officer. The holder shall suspend all operations in the immediate area of such discovery until written authorization to proceed is issued by the Authorized Officer. An evaluation of the discovery will be made by the Authorized Officer to determine appropriate actions to prevent the loss of significant cultural or scientific values. The holder shall be responsible for the cost of evaluation and any decision as to the proper mitigation measures will be made by the Authorized Officer after consulting with the holder.

2. The holder is hereby obligated to comply with procedures established in the Native American Graves

Protection and Repatriation Act (NAGPRA) to protect such cultural items as human remains, associated funerary objects, sacred objects, and objects of cultural patrimony discovered inadvertently during the course of project implementation. I n the event that any of the cultural items listed above are discovered during the course of the project work, the holder shall immediately halt the disturbance and contact the BLM within 24 hours for instructions. The holder or initiator of any project shall be held responsible for protecting, evaluating, reporting, excavating, treating, and disposing of these cultural items according to the procedures established by the BLM in consultation with Indian Tribes. Any unauthorized collection or disturbance of cultural resources may result in a shutdown order by the Authorized Officer.

H. **Sanitation:**

The holder shall be responsible for maintaining the site in a sanitary condition at all times; waste materials shall be disposed of promptly at an appropriate waste disposal site. "Waste" means all discarded matter including, but not limited to, human waste, trash, garbage, refuse, oil drums, petroleum products, ashes, and equipment.

I. **Tanks:**

Any open-top tank containing produced water, oil, or other fluids, shall be covered or equipped to prevent birds, bats, and other wildlife from entering the open-top tank.

J. **Other:** None

EXHIBIT D

PERMANENT RESOURCE ROAD REQUIREMENTS

OPERATOR'S NAME: **Yates Petroleum Corporation** LEASE NO.: **NM-33944**
WELL NAME & NO: **Shelly Federal #2**
QUARTER/QUARTER & FOOTAGE: **SW¼SE¼ and 660' FSL & 1980' FEL**
LOCATION: **Section 23, T. 9 S., R. 24 E., NMPM**
COUNTY: **Chaves County, New Mexico**

The holder agrees to comply with the following:

1. GENERAL REQUIREMENTS:

1. The **operator** shall hereafter be identified as the **holder** in these requirements. The Authorized Officer is the person who approves the Permanent Resource Road Requirements.

2. The holder shall minimize any disturbance to structures on public domain surface. Damages caused to any structure during road construction operations shall be promptly repaired by the holder. Functional use of any structure shall be maintained at all times. The holder shall make a documented good-faith effort to contact the owner prior to disturbing any structure.

3. When necessary to pass through an existing fence line, the fence shall be braced on both sides of the passageway prior to cutting and the fence shall be promptly repaired to at least it's former state or to a higher standard than it was previously constructed.

4. A professional engineer shall design the access road if the road grade exceeds 10 percent slope.

2. INGRESS AND EGRESS:

The access road shall be constructed to access the well pad on the **Southwest** corner of the well pad to comply with the planned access road route.

3. ROAD TRAVELWAY WIDTH:

The travelway of the road shall have a driving surface of 14 feet, with a maximum 30-foot wide disturbance area for road construction unless the Authorized Officer approves a different width.

4. SURFACING:

The entire length of the access road travelway shall be surfaced prior to drilling operations. **The access road travelway shall be surfaced with gravel material.** The material shall be compacted to a minimum thickness of **6**

inches for the entire length of the travelway surface on the access road. The width of surfacing shall not be less

than 14 feet of travelway surface. Prior to using any mineral materials from an existing federal pit, authorization must first be obtained from the Authorized Officer.

5. CROWNING AND DITCHING: None Required

6. DRAINAGE: No lead-off ditches are required for this road.

7. CULVERT INSTALLATION: No culverts pipes are required for this road.

8. TURNOUTS: None Required

9. CATTLEGUARDS: No cattleguards are required for this road.

10. MAINTENANCE:

a. The holder shall maintain the road in a safe, usable condition.

b. The holder shall cooperate with other authorized users in maintenance of the road(s). Failure of the holder to share maintenance costs in dollars, equipment, materials, and manpower proportionate to the holders use with other authorized users may be adequate grounds to terminate the road use. The determination as to whether maintenance expenditures have been withheld by the holder and the decision to terminate the road use shall be at the discretion of the Authorized Officer. Upon request, the Authorized Officer shall be provided with copies of any maintenance agreements entered into by the holder.

11. PUBLIC ACCESS:

Public access on this road shall not be restricted by the holder without specific written approval being granted by the Authorized Officer.

12. ROAD REHABILITATION REQUIREMENTS:

a. In sections devoid of vegetation, surfacing material may be removed for use in other approved area(s), and those sections rehabilitated. If the surfacing material is left in place, areas devoid of vegetation shall be plowed under with soil turning equipment and the plowed surface shall be disced before seeding. The road shall be recontoured to as near it's original topography, as possible.

b. The reclaimed road shall be seeded with the following **DPC seed mixture** determined by the Roswell Field Office for the reclamation area(s)):

See Exhibit B Well Drilling Requirements, VI. On Lease - Well Requirements, G. Well Completion Requirements, for the Desired Plant Community Seed Mixture that shall be used on the reclaimed access road.

c. The seed and any fertilizer involved shall be broadcast over the road bed with a spreader, than harrowed to cover the seed. Use of a seed drill planter to plant is acceptable. Appropriate measures shall be taken to ensure that the seed/fertilizer mixture is evenly and uniformly applied. There shall be no primary or secondary noxious weeds in the seed mixture. In accordance with

State law(s) the seed should be tested for purity and viability within nine (9) months prior to sell. Commercial seed shall be either certified or registered and the seed mixture container shall be tagged in accordance with State law(s).

The seed mixture tag shall be made available to the Authorized Officer for inspection. The seeding shall be repeated until a satisfactory vegetation thicket is established and this determination shall be made by the Authorized Officer. Evaluation of plant growth will not be made before the first growing season.

d. Seeding shall be done between June 15th through September 15th. However, the holder can seed the road immediately after preparing the road bed.

e. The Authorized Officer reserves the right to require reseeding at a specific time if seed does not germinate after one (1) growing season. Waiver of this requirement would be considered if diligent attempts to revegetate the road has repeatedly failed and the Authorized Officer determines that further attempts to revegetate the road would be futile.

f. **Contact Richard G. Hill at (505) 627-0247 to witness the seeding operations two (2) days before the start of the seeding process.**

13. SPECIAL REQUIREMENTS: NONE

APPENDIX E

Legal Descriptions of Public Lands and Federal Mineral
Proposed Action and Alternative A

Legal Descriptions - Public Lands and Federal Mineral Estate
Proposed Action

Note: Where listed as public lands, those tracts also contain federal minerals.

Township 8 South, Range 25 East
Section 14 - NW¼ (public lands)
Section 15 - N½ (public lands)

Township 9 South, Range 24 East
Section 1 - SE½ (public lands), NE¼, W½ (private surface, federal minerals)
Section 11 - SE¼SE¼, E½SE¼ (public lands)
Section 12 - E½, SW¼, S½NW¼ (public lands)
Section 13 – All (public lands)
Section 14 - E½E½, W½W½ (public lands)
Section 15 - NW¼, W½SW¼, W½NE¼ (public lands), SE¼NE¼, SW¼, E½SW¼ (private surface, federal minerals)
Section 22 - S½NE¼, N½SE¼, SE¼SE¼, SW¼, E½NW¼, SW¼NW¼ (public lands), N½NE¼, NW¼NW¼ (private surface, federal minerals)
Section 23 - S½, E½NE¼, W½NW¼ (public lands)
Section 24 – All (public lands)
Section 25 - E½ (private surface, federal minerals), N½SW¼, SE¼SW¼, NW¼ (public lands)
Section 26 - NE¼, NW¼SE¼, SE¼SW¼, N½NW¼ (public lands), S½NW¼ (private surface, federal minerals)
Section 27 - E½NW¼, SW¼NE¼, W½ (public lands), SW¼SE¼ (private surface, federal minerals)
Section 34 - W½NE¼, SE¼NE¼ (private surface, federal minerals)
Section 35 - N½NE¼, SW¼NE¼, NE¼NW¼ (public lands), S½SW¼ (private surface, federal minerals)

Township 9 South, Range 25 East
Section 6 - SW¼ (public lands)
Section 7 – All (public lands)
Section 17 - S½ (private surface, federal minerals)
Section 18 - SE¼ (private surface, federal minerals), W½ (public lands)
Section 19 – All (public lands)
Section 20 - E½ (public lands), W½ (private surface, federal minerals)
Section 21 - N½, E½SE¼, W½SW¼ (public lands)
Section 28 - N½NE¼ (public lands)
Section 29 - N½NW¼, SW¼NW¼ (public lands)
Section 30 - N½NE¼, S½SE¼ (public lands), W½ (private surface, federal minerals)
Section 31 - N½NE¼, SE¼NE¼, SE¼SW¼, SW¼NW¼, N½NW¼ (public lands)

Township 10 South, Range 25 East

Section 5 - Lot 4 (public lands)
Section 6 - Lot 5, W½SE¼, SW¼NW¼ (public lands)
Section 7 - Lots 1, 2, 3 and 4, N½NE¼, SE¼NE¼, E½SW¼, E½NW¼ (public lands)
Section 8 - SE¼, E½SW¼, NW¼ (public lands)
Section 17 - SW¼NW¼ (public lands)
Section 18 - SE¼NE¼ (public lands)
Section 20 - W½NE¼, NE¼SW¼, E½NW¼ (public lands)
Section 29 - E½SW¼ (public lands)
Section 32 - E½NW¼ (public lands)

Legal Description - Public Lands and Federal Mineral Estate
Alternative A

Township 9 South, Range 25 East

Section 2 - SW¼SE¼, NE¼SW¼, N½SE¼SW¼ (public lands)
Section 3 - N½, NW¼SE¼, SW¼ (all private surface, federal minerals)
Section 4 - W½NE¼, W½SE¼ (public lands), E½NE¼, E½SE¼, W½ (private surface, federal minerals)
Section 5 - N½NE¼, SW¼NE¼, W½SE¼, W½ (public lands), SW¼NE¼, E½SE¼ (private surface, federal minerals)
Section 6 - E½ (public lands)
Section 8 - SW¼NE¼, S½NW¼ (public lands), SE¼NE¼ (private surface, federal minerals)
Section 9 - W½NE¼, SW¼SE¼ (public lands), E½NE¼, NW¼ (private surface, federal minerals)
Section 10 - S½NE¼, NW¼SE¼, NE¼SW¼, SE¼NW¼ (public lands), N½NE¼, NW¼SW¼, SW¼ NW¼, N½NW¼ (private surface, federal minerals)
Section 11 - NE¼, E½SE¼, SW¼SE¼ (public lands), E½NW¼, NW¼NW¼ (private surface, federal minerals)
Section 14 - E½, SW¼, S½NW¼ (public lands)
Section 15 - E½, SW¼, S½NW¼, NE¼NW¼ (public lands)
Section 22 - S½NE¼, N½SE¼, SE¼SE¼, S½SW¼SE¼, W½ (public lands)
Section 23 - W½ (public lands)
Section 26 - N½NW¼ (public lands)
Section 27 - N½NE¼, N½NW¼ (public lands)

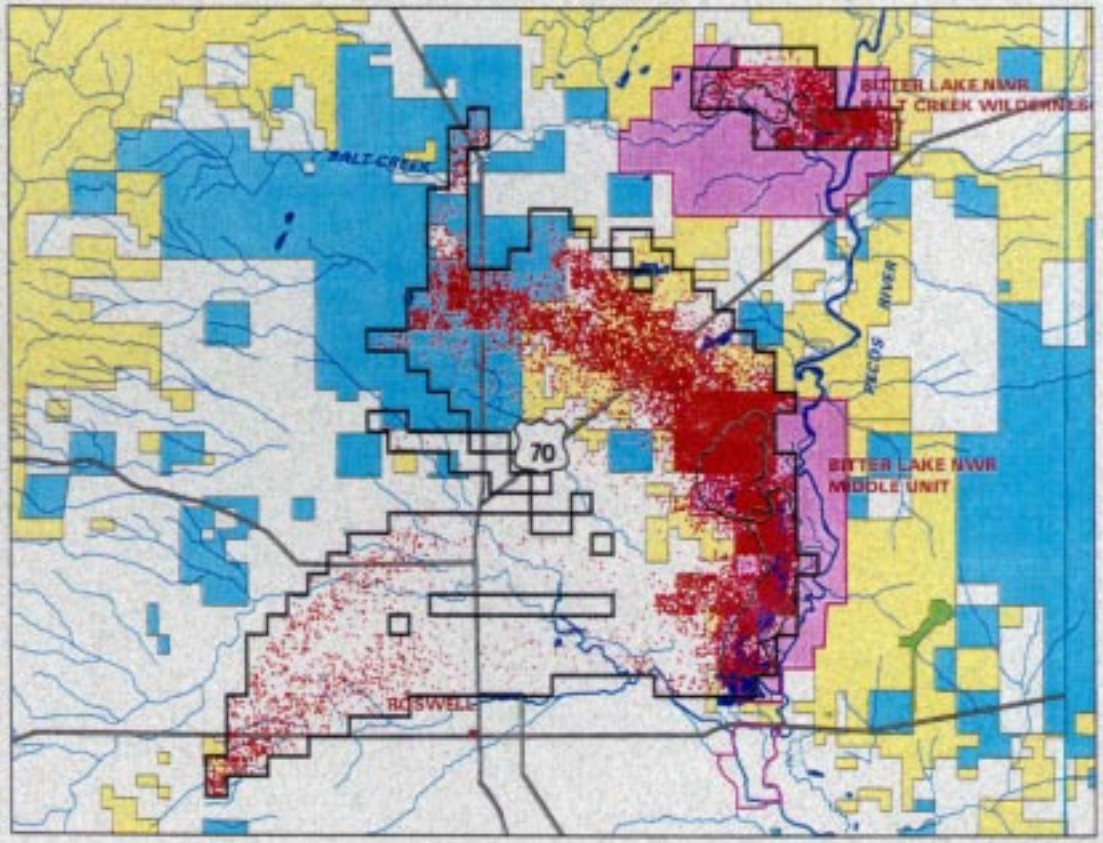
APPENDIX F

Source-Water Protection Zones
For Bitter Lake National
Wildlife Refuge

Balleau Groundwater, Inc.

U.S. FISH & WILDLIFE SERVICE
P.O. Box 1306
Albuquerque, New Mexcio 87103

Source-Water Protection Zones for Bitter Lake National Wildlife Refuge



SEPTEMBER 1999

BALLEAU GROUNDWATER, INC.
901 Rio Grande Blvd. NW, Suite F-242
Albuquerque, New Mexico 87104

P.O. Box 1306
Albuquerque, New Mexcio 87103

Source-Water Protection Zones for Bitter Lake National Wildlife Refuge

Ross A. Wolford, Ph.D.

Dave M. Romero, M.S.

Steven E. Silver

W. Peter Balleau, CPG, P.Hg.

BALLEAU GROUNDWATER, INC.
901 Rio Grande Blvd. NW, Suite F-242
Albuquerque, New Mexico 87104
(505) 247-2000

Date Sept 16, 1999

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SUMMARY

Source-water protection zones are delineated at the Middle and Salt Creek Wilderness Units of the Bitter Lake National Wildlife Refuge based on an investigation of geology, aquifer properties and potentiometric levels. Data are available from records of the U.S. Fish and Wildlife Service on the Bitter Lake National Wildlife Refuge and from extensive State and Federal agency records in the Roswell Basin.

The approach to defining the source areas of groundwater feeding water features on the Bitter Lake National Wildlife Refuge involves three-dimensional reverse particle tracking. Layered geology, properties and heads were organized in a three-dimensional geographic information system. Flow rates implied by the head, hydraulic conductivity and thickness data were checked for reasonableness in terms of discharge rates at the Bitter Lake National Wildlife Refuge, Pecos River baseflow and published aquifer flow-through rates. Water seepage velocities in the aquifers are sensitive to porosity values, which is the largest uncertainty in the calculation. Effective porosity values taken from published values or estimated for this study were used with other data in an established particle-tracking program, PATH3D, to calculate displacement distances as source-water capture zones feeding the Bitter Lake National Wildlife Refuge after 10, 40, 100, and 500 years. The time delineations shown on the report plates are considered to be uncertain in the range of a factor of two. Flow-path alignment may vary by 3/4 mile. It is recognized that dispersion and mixing in the aquifer will reduce the concentration and accelerate the spread of any soluble contaminant.

Bitter Lake. Groundwater travels through the alluvium, basin-fill, Artesia Group semi-confining beds and the principal carbonate aquifer to reach the Bitter Lake National Wildlife Refuge. The carbonate aquifer is involved as a source after 40 to 100 years. The calculation assumes that average water-level conditions of 1990 represent the future.

On June 4, 1999, the U.S. Fish and Wildlife Service (FWS) authorized a study of source water for springs, sinkholes and surface water on the Middle and Salt Creek Wilderness Units of the Bitter Lake National Wildlife Refuge (the Refuge) (Figure 1 and Plate 1). Balleau Groundwater, Inc. (BGW) has used existing data to construct plan and sectional maps of each spring system, to establish the potentiometric levels and to delineate a source-protection zone in three dimensions for each unit. Existing data on the region are abundant, derived from decades of study by the State and Federal agencies in the Roswell Basin. Data files and the results of the study are provided in an electronic version of this report in the enclosed compact disk. BGW has previously reported (1995) on the interrelation of deep and shallow aquifers at the Refuge.

This study team was directed by W. Peter Balleau, CPG, P.Hg., with data management by Steven E. Silver, and with parameter estimation, programming and model calculations by Ross A. Wolford, Ph.D. and Dave M. Romero, M.S. FWS data were produced by Mr. Paul Tashjian, Hydrogeologist, who provided colleague review and comments integrated in the study.

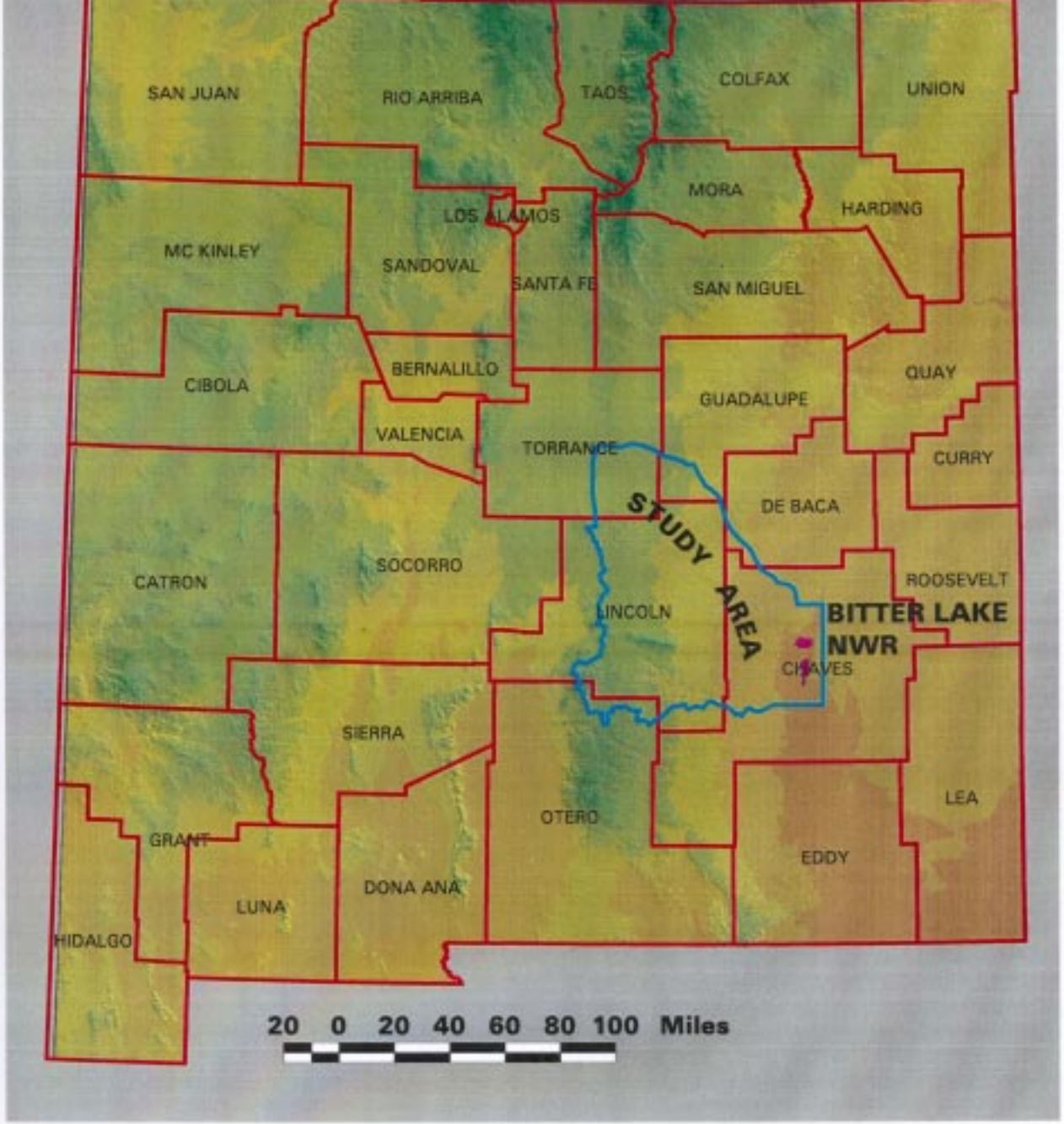
A glossary of technical terms is given below.

advective transport: The travel of solute with groundwater caused by the movement of water (with the mean flow direction and speed of the groundwater).

analytical model: A representation of a physical system that consists of a set of differential, integral, or integro-differential equations, along with their solutions.

anisotropy: The condition under which one or more of the properties of a system varies according to direction.

area of influence: The area of response to an aquifer stress.



N

GRID NORTH,
UTM ZONE 13.

U.S. FISH & WILDLIFE SERVICE/
PROTECTION ZONE

LOCALITY MAP

boundary condition: A point or zone of entry, exit or no flow of water to or from a system. Boundary conditions are topological features of a model, exercising qualitative control over model results. Boundary conditions are normally specified by a given head at the boundary (prescribed head boundary), a given flow across the boundary (prescribed flow boundary), or a mixture of the two (mixed or head dependent boundary). Examples of boundaries include surface-water bodies, pumping wells, impermeable rocks and water tables.

computer code: A set of computer instructions written in a language such as FORTRAN, C, or a spreadsheet or database language. Computer codes are used as tools in modeling, performing tasks such as reading data, performing computations, and outputting results.

Darcy velocity: See specific discharge.

digital elevation model (DEM): point elevation data stored in digital computer files consisting of grid locations (x and y) and point elevation data (z).

dip: The maximum angle formed between a geologic surface and the horizontal plane.

discharge: The net outflow rate of water from part of a hydrologic system, as in a defined channel, or, the amount of water leaving the saturated zone across the water-table surface. [L^3T^{-1}]

drawdown: The change in hydraulic head or water level over a particular time interval or due to a particular aquifer stress.

effective porosity: The percent of the total volume of a given mass of soil or rock that consists of interconnected interstices. The specific discharge divided by the mean velocity of a conservative tracer.

evapotranspiration: Exit of water from a groundwater system into the atmosphere, due to evaporation or plant transpiration processes.

GIS: Geographic information system.

head: Hydraulic head.

hydraulic conductivity (K): A coefficient of proportionality describing the rate at which water moves through a unit cross sectional area of permeable medium under a unit hydraulic gradient. Loosely called permeability.

hydraulic connection: A condition that allows interaction between points in a hydrologic system in proportion to the hydraulic gradient between them due to continuity of saturation and permeability of the system.

hydraulic gradient: The change in hydraulic head per unit distance between points of interest.

hydraulic head (h): Water level expressed as the sum of water pressure plus elevation. Also, potential energy contained in a water mass produced by elevation, pressure, velocity, solutes or molecular forces. [L]

hydraulic response: A change in water level or flow rate at one location due to a hydraulic stress at another location.

hydraulic stress: A withdrawal or addition of water, to or from, a hydrologic system that changes the pattern of flow in the system.

hydrologic model: A statement of simplified relationships abstracted from a natural hydrologic system. Model parameter specifications are developed from selected observations of the properties of interest to suit the model purpose.

hydrologic system: A space through which interrelated water moves and in which water is stored. A hydrologic system may include geologic units along with streams and recharge and discharge features.

interrelated water: Water connected by a continuous zone of saturation such that a hydraulic stress in one part of the water body can cause a hydraulic response at other locations.

isosurface: Three-dimensional surface connecting points of equal value.

model grid: A network of points or cells that is used to represent a region of space during the modeling of that region.

model: A simplified representation of selected aspects of a natural system used to simulate features and processes of interest within the natural system.

numerical model: A representation of a physical system that consists of a set of discrete equations, along with their solutions. The set of discrete equations is normally a set of relationships among the points or cells of a model grid.

parameter: A variable in the equations of an analytical or numerical model that is specified with a characteristic value for the case being studied.

porosity: The percentage of the bulk volume of a rock or soil that is occupied by interstices, whether isolated or connected. Synonymous with total porosity.

recharge: The net addition of water to a hydrologic system; also, the net amount of water added. [L^3T^{-1}]

return flow: Water returning to a system after being withdrawn or diverted from the system. Commonly refers to water returning to a stream after being diverted for irrigation.

riparian vegetation: Vegetation located on the banks of a stream or other body of surface water.

specific discharge (q): The rate of discharge of groundwater across a unit area perpendicular to the direction of flow. Also called Darcy velocity. Specific discharge has the dimensions of velocity, and can indicate particle velocity if q is divided by effective porosity. [LT^{-1}]

specific storage (S_s): The volume of water volume released from the system per unit of aquifer volume for a unit change in head. [L^{-1}]

specific yield (Sy): A ratio that represents the volume of water which an aquifer will yield by gravity drainage to the volume of the rock or soil, often stated as a percentage.

specified head: A hydraulic head that is set as a boundary condition, rather than computed as a model result.

than computed as a model result.

steady-state: A condition in which water levels and flows are not changing with time.

storage coefficient (S): The volume of water an aquifer releases or takes into storage per unit surface area of the aquifer per unit change in head. It is a dimensionless ratio of the volume of water stored per volumetric change in potentiometric surface. Storage coefficient is the product of specific storage and saturated thickness.

storativity: See storage coefficient.

stream depletion: Reduction in the flow rate of a stream due to groundwater withdrawal.

streamflow: The rate (volume of water per unit time) of flow of water at a given point of a stream.

strike: The direction of a line formed by the intersection of a geologic unit with the horizontal plane.

transient: The condition in which hydraulic head or flow rate in a hydrologic system is changing with time.

transmissivity (T): The rate at which water is transmitted through a unit width of a groundwater system under a unit hydraulic gradient. $[L^2T^{-1}]$ Equal to hydraulic conductivity times aquifer thickness.

vertical hydraulic gradient: The hydraulic gradient taken at measuring points at distinct (separate) vertical elevations.

water balance: An accounting of the inflow to, outflow from, and change in storage in, a hydrologic system during an interval of time.

water budget: a water balance

withdrawals: Removal of water from a hydrologic system for use, as from pumping wells or canal diversions.

zone of saturation: Groundwater at pressure greater than atmospheric pressure.

Published reports with hydrogeologic parameters and measurements for the Roswell Basin referred to for this study are listed in the references. Available transmissivity data were summarized by McAda and Morrison (1993). These values were plotted at map locations during the course of this effort.

McAda and Morrison (1993) published a compilation of baseflow-gain estimates for the Pecos River between Acme and Artesia.

Geology is described in Fiedler and Nye (1933), Mourant (1963), Havenor (1968), Kelley (1971), Summer (1972) and Welder (1983). Published maps include elevation of the top of the San Andres Limestone, the thickness of the solutionized, highly permeable San Andres Limestone, thickness of the alluvium and Artesia Group and chloride concentrations in both the shallow and carbonate aquifers. The FWS provided stage and flow data for water features on the Refuge.

COMPUTATIONAL APPROACH

Available information on aquifer transmissivities, geologic unit thickness and potentiometric heads were mapped in a three-dimensional (3D) geographic information system (GIS), ArcView 3D Analyst by Environmental Systems Research Institute, Inc. (1998). Geologic units and the principal carbonate-aquifer zone were used to define zones of hydrogeological properties. Layer thicknesses, aquifer material types and potentiometric surfaces were gridded and extracted from the GIS and placed in a format compatible with the Block Centered Flow and Basic packages used in

transmissivities, layer thicknesses, hydraulic conductivities and porosities generate velocity fields in three dimensions which are used in a numerical particle position solution to generate the pathways of the particles. The particle tracking, mathematical model (PATH3D) is described in detail by Zheng (1991).

There are differences between the approach to particle tracking used here and that of comprehensive groundwater-flow modeling. Observed, rather than modeled, heads are used. The use of observed heads is a strength of this approach. Observed heads are smoothed, but do not contain any simulation error. Reported and interpreted formation properties, rather than calibrated properties are used. Accordingly, the head and specified hydraulic properties are not calibrated for cell-by-cell balancing of flux in these calculations. One implication of this technique is that the heads and aquifer transmissivities are not necessarily compatible with flow rates at every point in the flow system (i.e., too much or too little flow velocity may be implied at a given point in the particle track). The particle tracking further assumes constant conditions based on the heads in the 20-year period 1979 through 1998. Smoothing and basing the potentiometric grid specification on recent conditions is described below. The resultant particle paths and protection zones are for baseline future conditions, represented by 1990 conditions, rather than a variable scenario projected for the future.

To check that heads and transmissivities are approximately consistent with estimated flow rates, BGW estimated, outside of the particle-track model, the transmissivities required to obtain the estimated flow rates. Flow rates implied by the parameters specified are compatible with reported aquifer flow-through, baseflow and Refuge discharge rates (Table 1).

TABLE 1. FLOWS FROM HISTORICAL ROSWELL AREA SPRINGS, BLNWR UNITS, EVAPOTRANSPIRATION, AND BASEFLOW TO THE PECOS RIVER

Feature	Discharge (AFY)	Discharge (cfs)
North Spring[1]	61,540	85
South Spring[1]	43,440	60
North Berrendo Spring[1]	15,687	21.7
Middle Berrendo Spring[1]	15,687	21.7
South Berrendo Spring[1]	15,687	21.7
Vegetation in Study Area (26,614 acres)	55,890	77
BLNWR Middle Unit[2]	5,800	8
BLNWR North Unit[3]	530	0.73
Pecos River Baseflow Gain[4]	868 / mile	1.2 / mile

1. Historical flow estimate (Fiedler and Nye, 1933, Saleem and Jacob, 1971)
2. About 75 percent of this is evapotranspired within the BLNWR Middle Unit during the summer.
3. All discharge is evapotranspired under normal conditions.
4. Approximate value for reach between Artesia and Acme (McAda and Morrison, 1993)

Regional hydrogeologic units were generalized into the six layers shown on Plates 2 and 3. Horizontal gridding varies from 2,000 to 5,000 feet in resolution. Recent alluvium is in Layer 1. Older alluvium is in Layers 1, 2 and 3 surrounding recent alluvium and overlying the Artesia Group and the San Andres Limestone. Layer 3 consists of the Artesia Group. The areal extent of the Artesia permeability zones were adapted from Maddox in New Mexico Geological Society (1969). Layers 4 and 5 represent the San Andres Limestone and the Glorieta Sandstone. The geometry of Layer 4 was adjusted to represent the solutionized fraction of the San Andres Limestone from Maddox in New Mexico Geological Society (1969, Plate 7). Layer 6 is the Yeso Formation outcrop and subcrop. Mesozoic age rocks, volcanic rocks and pre-Cambrian rocks were not gridded.

The geologic grid was parameterized by sub-sampling each cell to triangulated irregular networks (TINs) representing the top, bottom and extent of each geologic formation. Table 2 summarizes the sources used to construct each geologic layer. The sub-sampled data were averaged and a decision-tree algorithm was used to set cell properties. A MODFLOW pre-processor combines head data with the GIS geology specifications to produce a PATH3D-compatible input.

Permeability Grid Specification

Aquifer transmissivity from published sources was mapped and an average value estimated to be consistent with geologic material thicknesses, hydraulic gradients and basin-wide flow estimates. Values used are shown in Table 3.

Leakance was estimated from an aquifer test performed by Hantush (1961) on a well about one mile southwest of the South Weir. Rehfeldt and Gross (1982) used

TABLE 2. GEOLOGIC GRID SPECIFICATIONS SOURCES

Formation	Outcrop Extent Source	Outcrop Surface	Subcrop Source	Subcrop Surface Source	Formation Bottom Source	Formation Specific
Recent Alluvium	DGMONM[1]	10-m DEM	—	—	55 feet at formation axis (Kelley, 1971) average thickness = 29 feet	20 fe
Older Alluvium	DGMONM	10-m DEM	Extent of recent alluvium outcrop	Base of recent alluvium	Figure 6 (Welder, 1983)	20 fe
Artesia Group	DGMONM	10-m DEM	Kelley (1971) Summers (1972)	Base of older alluvium	Top of the San Andres Limestone	20 fe
San Andres Limestone Solutionized	DGMONM	60-m DEM	Defined by Yeso Formation outcrop Plate 7 Maddox (in NMGS, 1969) and 1988 LANDSAT image	San Andres Limestone structural contour (Kinney and others, 1968) Figure 9	Thickness from Maddox (in NMGS, 1969, Plate 7)	
San Andres Limestone Unsolutionized	DGMONM	60-m DEM	Defined by Yeso Formation outcrop	San Andres Limestone structural contour (Kinney and others, 1968) Figure 9	Top of the Rio Bonita minus the average thickness of the Rio Bonita (300 feet) (Kelley, 1971) Plate 5N Plate 2 Hydro Geo Chem, Inc. (1983) in upper Rio Hondo/Rio Ruidoso area	
Yeso Formation	DGMONM, and Dane P. Bachman (1965) Geologic map of New Mexico	60-m DEM	Defined by pre-Cambrian rock outcrops	Base of the San Andres Formation	1400 feet below formation top (Kelley, 1972) or pre-Cambrian rock surface (NMGS, 1969; Summers, 1972)	

1. DGMONM = Digital Geologic Map of New Mexico in ARCINFO format.

TABLE 3. AQUIFER PARAMETERS USED IN FLOW-PATH MODELING

Geologic Formation	Horizontal Hydraulic Conductivity (ft/d)	Vertical Hydraulic Conductivity (ft/d)	Porosity (ft^3/ft^3)
Recent Alluvium	20	0.2	0.3
Older Alluvium	3	0.3	0.25
Artesia Group	10	0.05	0.10
Solutionized San Andres Limestone	250	25	0.08
Unsolutionized San Andres Limestone	5	0.05	0.01
Yeso Formation	1	0.005	0.01

Porosity data are plentiful though variable for some aquifer materials. Kinney in New Mexico Geological Society (1969) describes a general porosity in the San Andres Limestone ranging from three to five percent. Havenor (1968) described porosities ranging from 0.5 to 38.7 percent between depths of 263 feet to 1,100 feet at a well (location 10S.24E.34). Havenor's (1968) data suggest a typical porosity of six to eight percent, but he describes cavernous conditions as common and suggests most porosity estimates are low. Summers (1972) references a porosity estimate of ten percent in the alluvium attributed to Saleem and Jacob (1971). Summers (1972) indicated that most solution porosity and permeability occurs in the upper 250 feet of the San Andres Limestone. Rabinowitz and Gross (1972) reported porosity values in the San Andres Limestone ranging from ten percent near Woods Well (about 12 miles west of Roswell) to about one percent near Roswell. The porosity estimates of Rabinowitz and Gross (1972) were based on velocity estimates from bomb-pulse tritium, measured hydraulic gradients and transmissivity. A porosity value of ten percent was reported west of Roswell near Woods Well and one percent near Roswell.

Porosity data for other formations were less available, but also less critical to computations (i.e., the longest and most common flow pathways are in the solutionized San Andres Limestone and the Artesia Group). We used ten percent for porosity in the Artesia Group. Porosity in the recent alluvium was estimated as 30 percent, in older alluvium to 25 percent, in unsolutionized San Andres Limestone at one percent and in the Yeso Formation at one percent.

Potentiometric surfaces were contoured using well data obtained from the U.S. Geological Survey (USGS) well database and data provided by the FWS for Refuge water features. A subset of these data consisting of the average of those heads reported during the 20 years 1979 through 1998 was used to contour potentiometric surfaces. The 20-year period was used because a lesser time span reduces the set of available data. Groundwater elevations are measured relatively infrequently at some locations. Older data were added to develop potentiometric surface contours for more distant areas where less data were available. Heads were smoothed by grid averaging where single data points appeared to be causing anomalies in the potentiometric surface of the San Andres Limestone and Artesia Group (Plate 4).

Potentiometric heads in the carbonate aquifer have been rising since groundwater withdrawals were reduced in the late 1970's. Berrendo well average water level was 3,529 feet for the 20-year period 1979 through 1998, 5 feet higher in 1990 and averaged 3,544 feet for the recent years 1994 through 1998. Because the 20-year averaged heads are low relative to today's water levels, five feet was added to the potentiometric head in the carbonate aquifer to simulate 1990 conditions as representative of the future. The heads used in calculations, therefore, represent typical conditions for the recent past, but not the current high water levels.

Major Springs

Table 1 shows flow quantities of interest including historical springflow estimates indicating the flow prior to extensive aquifer development (Fiedler and Nye, 1933; Saleem and Jacob, 1971).

South Spring's recharge area is believed to include a considerable area outside of the region of interest to the Refuge. Without South Spring, the historical recharge to the area would total 108,600 acre feet per year (AFY) (150 cubic feet per second or cfs). This amount is believed to be the discharge through the area included in our flow domain (Plate 1), though the majority is withdrawn by wells before reaching the Refuge.

Salt Creek Wilderness Unit

Under normal conditions, surface flow does not leave the North Unit of the Refuge except through evapotranspiration. The North Unit contains about 238 acres of riparian vegetation and 5.3 acres of water, which consumes an estimated 530 acre feet (AF) (0.73 cfs) on an annual basis (Plate 3). Peak rate of summer water loss may be over three cfs.

Regional Vegetative Use

Total flow though the flow domain is about 150 cfs based on historical springflow estimates. An approximation of the amount of irrigated agriculture and watered lawns was made based on a pixel count of vegetated areas from LANDSAT imagery (Plate 5). This suggested about 41 square miles of watered surface, which

aquifer. The return flow and any recharge apparently is recharging formerly-depleted unconfined aquifer zones, as evidenced by increases in potentiometric surfaces.

Pecos River Baseflow

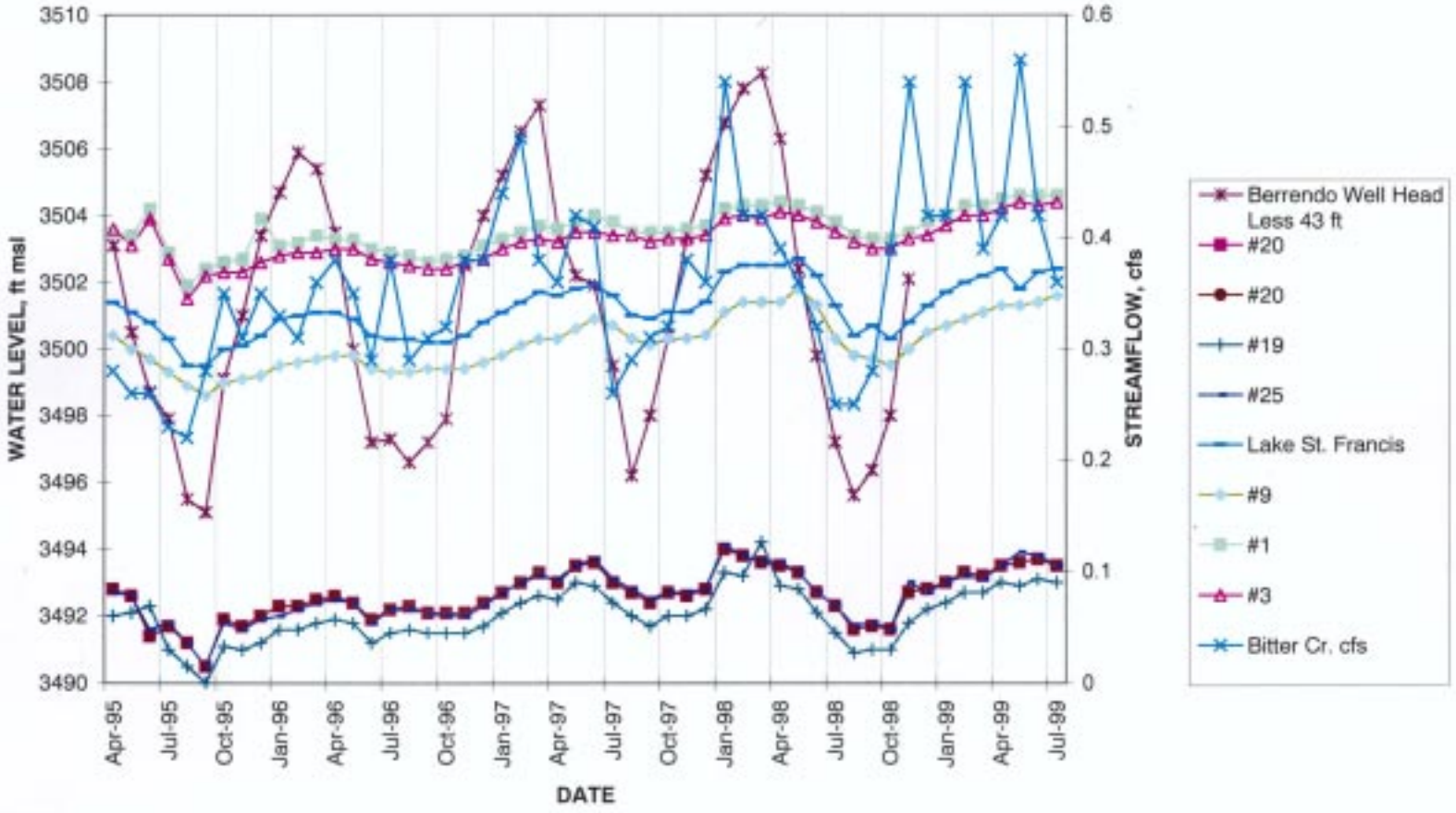
McAda and Morrison (1993) published estimates of baseflow gains in the Pecos River between Acme and Artesia for 1905 through 1989. Example values include an average of 1.74 cfs per mile (cfs/mi) for the period 1938 through 1950, 1.04 cfs/mi from 1951 through 1960, 0.57 cfs/mi for the period 1970 through 1979 and 0.73 cfs/mi for the period 1981 through 1987. Patterns over time show a decrease in baseflow gain as groundwater pumping increased until 1978, and increasing baseflow gains since groundwater pumping decreased after 1978. Summers (1972) reported evapotranspiration from riparian plants and open water evaporation averaged 0.54 cfs/mi between Santa Rosa and Red Bluff Reservoir. Combined with baseflow gain, these values suggest that the Pecos River gained about 1.2 cfs/mi from groundwater additions in the 1980's and gained about 1.5 cfs/mi in the 1950's.

Middle Unit

Flows reaching the Middle Unit of the Refuge are much reduced from natural conditions. Based on measured winter discharges at the South Weir, groundwater discharge at the Refuge is about eight cfs (Figure 2).

The Middle Unit of the Refuge occupies a width of about five miles of the aquifer contributing flow to the Pecos River. To match average 1950's baseflow gains for the Pecos River (and ignoring flows from the east side of the Pecos River, which are minimal), the South Weir at the Refuge would have to average about 7.5 cfs, less losses

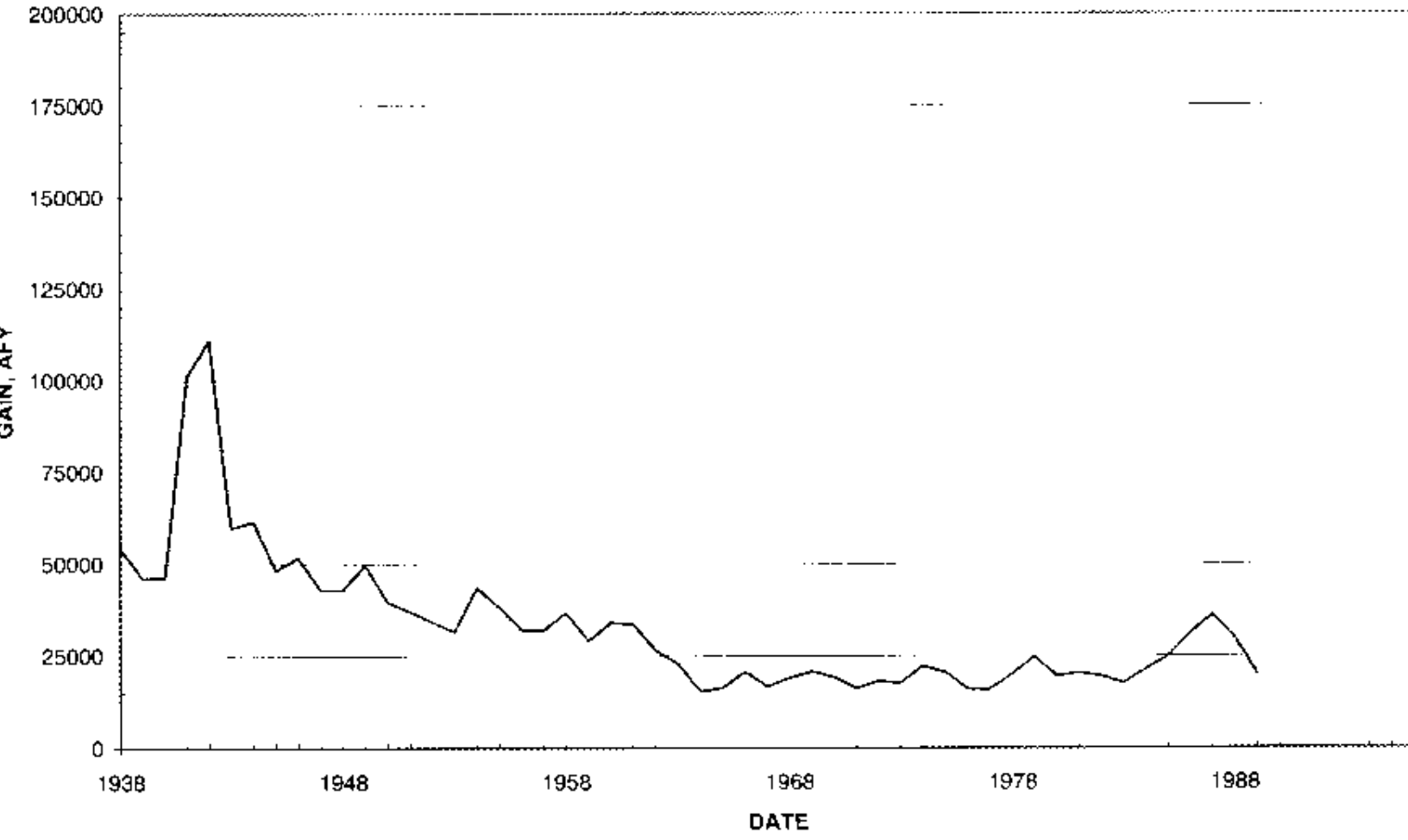
FIGURE 2
POTENTIOMETRIC HEAD AT BERRENDO WELL, SINKHOLE WATER ELEVATIONS, AND FLOWS IN BITTER CREEK AND AT THE SOUTH WEIR



identical to the typical eight cfs observed in winter months (when evapotranspiration is minimal) during the 1950's. The Refuge includes a variable area of open water and riparian vegetation. Vegetation is 460 acres on the Middle Unit. The combined area is about 943 acres. Open water evaporation is about 70 inches per year in the Roswell area (U.S. Department of Commerce, 1968). Assuming the open water and riparian/wet areas average 800 acres, annual evaporation averages 6.4 cfs, or about the same amount the flow at the South Weir varied between winter and summer in the 1950's (BGW, 1995). Summer peak loss rates are higher, but are made up from water stored year round. The flow from the South Weir in the 1950's, when adjusted for local evapotranspiration losses, is near the average expected gain for other reaches of the Pecos River. Today's baseflow gain from the Refuge area remains near the average gain in other reaches of the Pecos River (Figure 3).

The aquifers beneath the Refuge Middle Unit include a shallow aquifer in alluvium, basin-fill and the Artesia Group overlying a porous, solutionized San Andres Limestone carbonate aquifer. The less permeable Yeso Formation underlies the San Andres Limestone. Between the two aquifers, the Artesia Group forms a zone of low vertical permeability. Portions of the Artesia Group have significant horizontal permeability and function as part of the shallow aquifer. The confining beds of the Artesia Group dip to the east, causing thinning and outcrop several miles to the west of the Refuge. The Artesia Group is wedge-shaped, reaching a regional thickness of about 300 feet beneath the Refuge, and increasing in thickness to the east. East of the Pecos River the transmissivity of the Artesia Group decreases significantly, the groundwater is more saline and head gradients are westward toward the Pecos River. Water-quality trends suggest that some intrusion of saline water from the east occurred during peak drawdown of the carbonate aquifer, but currently water quality is improving. At the location of the Middle Unit lakes, heads in the confined, deep aquifer are 20 to 30 feet greater than the surface elevation of the lakes, resulting in upward flow through the

FIGURE 3
BASEFLOW GAIN TO THE PECOS RIVER BETWEEN ACME AND ARTESIA
(AFTER MCADA AND MORRISON, 1993)



and mounding of water from irrigation return flow on top of the Artesia Group. The result is that gradients are locally reversed, indicating downward flow from the shallow to the deep aquifer.

Welder (1983) displayed the surface of the water table in the shallow aquifer for several periods including 1938, 1950 and 1969. The surface of this water table had a slope of 0.0028 in 1938, 0.0024 in 1950 and 0.0019 in 1969. Some of the flow in the lakes is derived from water moving through the shallow aquifer in addition to local upwelling from the carbonate aquifer.

Where gradient and discharge are known, aquifer transmissivity can be calculated for a given region. Measured winter discharge in the 1950's at the South Weir typically peaked at about eight cfs (BGW, 1995). Combining a flow of eight cfs with Welder's (1983) gradient for 1950 over a tributary-aquifer width of five miles results in a required transmissivity of 11,000 square feet per day (ft^2/d) for the South Weir's flow to travel entirely within the alluvial aquifer. This suggests that if transmissivity in the alluvial aquifer is 11,000 ft^2/d, all flow from the South Weir could be accounted for from the alluvial aquifer. Transmissivity values for the nine wells nearest the Refuge Middle Unit that were completed in the shallow aquifer have transmissivity values between 130 and 15,030 ft^2/day. The San Andres Limestone feeds the alluvium from below. A smaller component of local surficial recharge adds to the flow in the alluvium derived from San Andres Limestone source. Refuge discharge apparently is horizontally transmitted but predominantly vertically derived.

Hantush (1957, 1961) published vertical leakance values obtained for the Artesia Group from aquifer tests in the area. These values were interpreted into vertical hydraulic conductivities by Rehfeldt and Gross (1982). One of the Hantush tests was

ft^2). With this value, the local vertical hydraulic gradient at the Refuge area required to discharge eight cfs vertically through a 25-square mile (mi^2) Artesia Group is 0.015, or approximately equal to the hydraulic gradient currently observed in the area.

Groundwater Velocity

Rabinowitz and Gross (1972) used bomb-pulse tritium measurements to estimate hydraulic parameters in the Roswell Basin. Velocity was estimated at about 58 to 70 ft/d near Wiggins and Pollard based on arrival times of the pulse of tritium. Travel time near Woods Well about 12 miles west of Roswell apparently was much slower. This was attributed to low transmissivity in the unconfined parts of the aquifer.

Average groundwater velocity can be calculated from porosity, aquifer dimensions and the volume of water moving through an area. For example, assume the solutionized San Andres Limestone aquifer just west of the Refuge is 50 feet thick, and five cfs passes through a cross-sectional width of five miles of this material prior to rising to the surface-water features near the Refuge. Five cfs passing through a slice of this cross-sectional area of flow with a porosity of eight percent, therefore, moves at a velocity of:

$$\frac{5\ ft^3\ sec^{-1}(86{,}400\ sec\ day^{-1})}{(5\ mi)5{,}280\ ft\ mi^{-1}(50\ ft)0.08} = 4.09\ ft\ day^{-1}$$

This velocity is inversely proportional to porosity. With a porosity of 0.8 percent instead of eight percent, the velocity would be 40.9 ft/d.

In the area west of the large, historical springs at the edge of the confined aquifer, the aquifer is about 200 feet thick and flows at about 125 cfs from a width of about 20

Travel times from deep layers to the surface are much slower than to the historical springs. If the Artesia Group feeding the Refuge is assumed to occupy a five-mi x five-mi area and a porosity of ten percent, the velocity for eight cfs across the Artesia Group vertically would be:

$$\frac{8\ \mathrm{ft^3\ sec^{-1}(86{,}400\ sec\ day^{-1})365\ days}}{25\ \mathrm{mi^2(5280)^2\ ft^2 mi^{-2}(0.1)}} = 3.6\ \mathrm{ft/yr}$$

or 41 years to cross a 150 feet thickness.

Therefore, the travel time for water to move from an external source in groundwater to the Refuge lakes and sinkholes is expected to be dominated by the travel time required to move upward from depth.

These calculations illustrate that the flow rates, gradients, and hydraulic properties used in the particle-track model are reasonably characteristic of broader regional behavior.

WATER LEVELS AND FLOWS ON BLNWR

Water levels measured at seven sinkholes, streamflow discharge in Bitter Creek and Berrendo well records are shown in Figure 2. Two distinct patterns are observed. The monthly high-flow and low-flow periods in Bitter Creek coincide in time with high water levels in sinkholes 19, 20 and 25. In contrast, monthly flows in Bitter Creek correlate best with water levels in Lake St. Francis when the creek flows are lagged two

rises to 0.56.

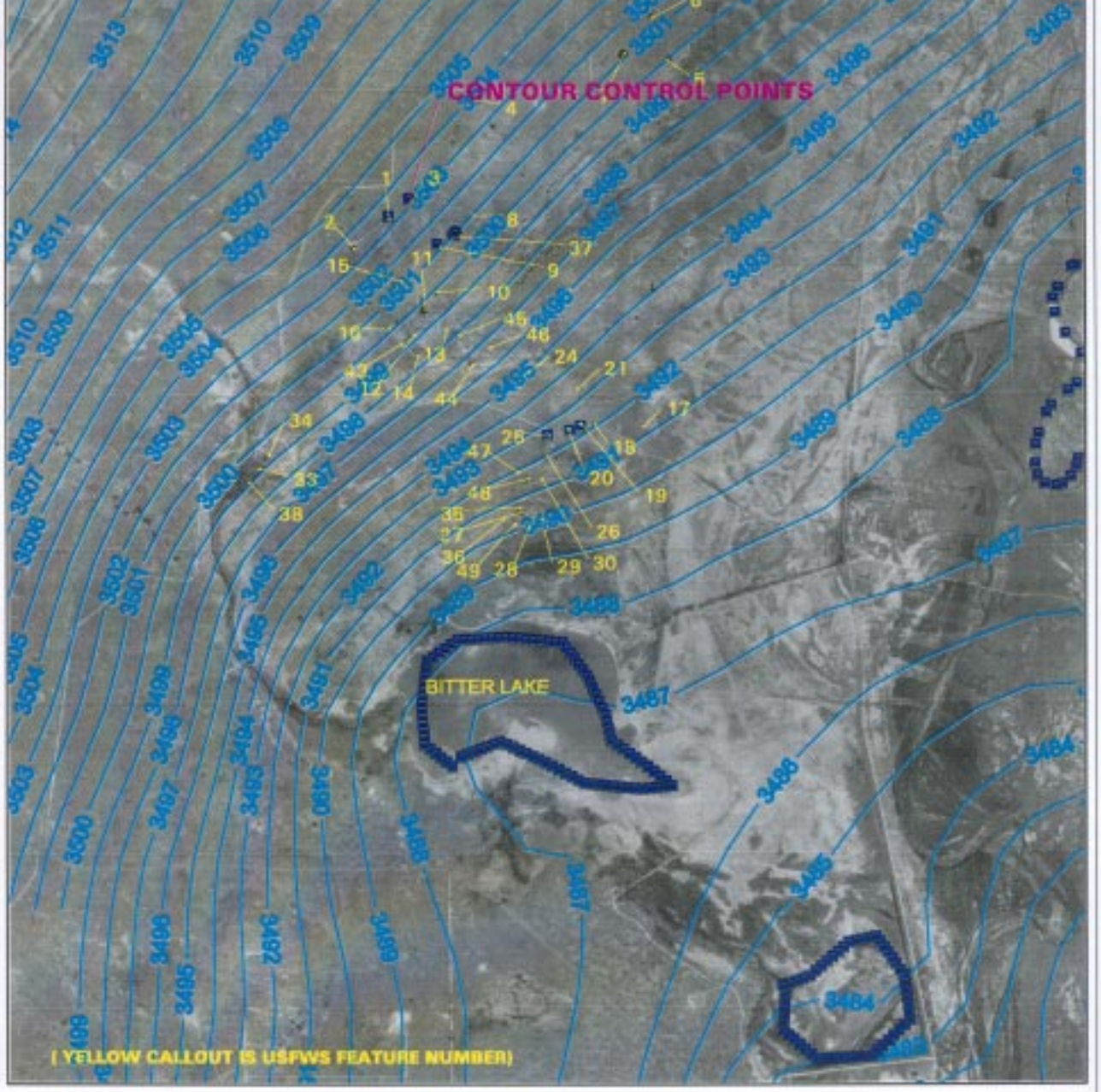
Bitter Creek flows also are correlated with heads measured in the Berrendo Well. The R^2 from regression value for this relationship is about 0.54 with or without a one-month lag. Lag is probably small, less than one month, but is masked by the one-month reporting frequency for the well.

Lake levels are an outcrop of the water table in the shallow aquifer, and are shown to fit with related data from wells and other surface-water expressions (Figures 4 and 5, Plate 4).

The plot of water-table contours of the shallow aquifer (Figures 4 and 5) shows that the hydraulic gradient is steeper in the vicinity of Lake St. Francis than it is near the Bitter Creek streamflow gage or sinkholes 19, 20 or 25 (Plate 1). Lower transmissivity is probable in the area of Lake St. Francis. This conclusion is supported both by the steeper gradients and the delayed response to head changes relative to sinkholes nearer Bitter Lake.

REVERSE PARTICLE TRACKING

The PATH3D model receives steady-state or transient conditions as input and tracks mathematical particles backward in time to the origin of the aquifer's recharge sources. For the model runs, 1,086 particles were randomly located in a one-quarter mile buffer zone around each surface-water feature, around the perimeter of each surface-water feature and at a single location in the center of each surface-water feature.



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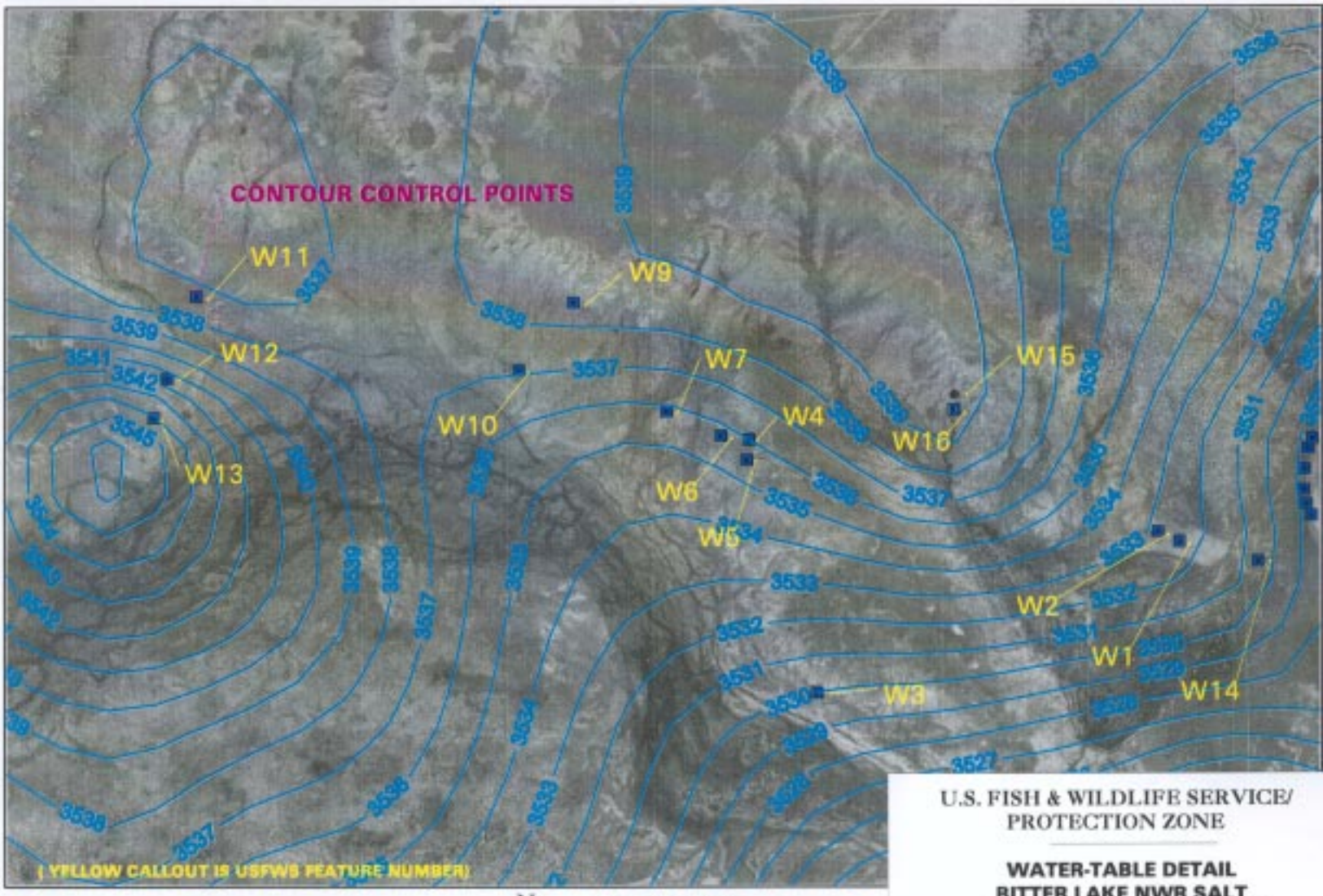
GRID NORTH,
UTM ZONE 13, NAD83.
OCTOBER 1997,
USGS DIGITAL
ORTHOPHOTOGRAPHY

U.S. FISH & WILDLIFE SERVICE/
PROTECTION ZONE

WATER-TABLE DETAIL
BITTER LAKE NWR MIDDLE UNIT

Date: 6/9/99 Produced By: SSS Checked By: WPH File Name: AREA.apr	**FIGURE 4**	BGW



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UTM ZONE 13, NAD83.
OCTOBER 1997,
USGS DIGITAL
ORTHOPHOTOGRAPHY

U.S. FISH & WILDLIFE SERVICE/
PROTECTION ZONE

WATER-TABLE DETAIL
BITTER LAKE NWR SALT CREEK WILDERNESS UNIT

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FIGURE 5

BGW

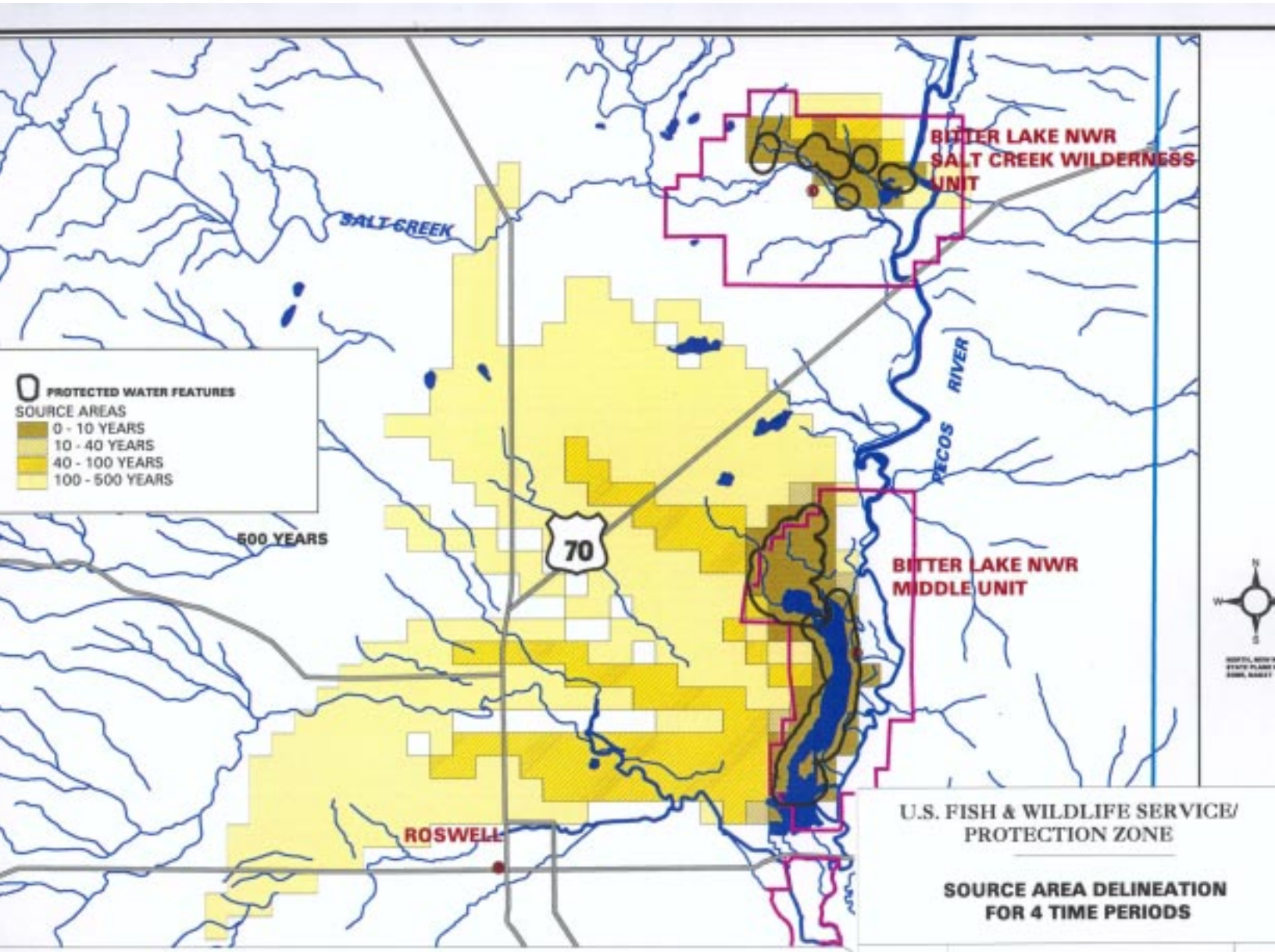
the water table. These were tracked backwards in time for a period of 500 years at 2.5-year time increments. According to particle-track counts, about 24 percent of sources originate in the alluvium and 76 percent from deeper units.

Protection Zones

The computed particle tracks and travel time to different locations indicates rapid horizontal movement and slow vertical movement as discussed above. Overall results for 500 years are shown in Plate 6. Source-water zones for periods of 10 years, 40 years, 100 years and 500 years are shown in cross section on Plate 7 and in perspective in Plate 8. The source areas for the four time periods are delineated on Figure 6 as protection zones enclosing any particle sources arriving at the Refuge in less than 10, 40, 100 or 500 years. Figure 7 shows the same zones overlying a land status map by the U.S. Bureau of Land Management.

Strength of Source

The particle-tracking procedure provides an indication of the relative loading of water delivered to the Refuge from different points in the protection zone. Particle positions each year tag equal volumes of water expected to arrive at the Refuge over 500 years. Cumulative particle-years of residence in each cell in the grid are dot-mapped on Figure 8. The dot density represents the distribution of proportional parts of the total volume of water arriving at the Refuge during the 500 years. A dense pattern indicates a source area of relatively strong and long-duration contribution of the load of water to the Refuge.



U.S. FISH & WILDLIFE SERVICE/
PROTECTION ZONE

**SOURCE AREA DELINEATION
FOR 4 TIME PERIODS**

OURCE AREA DELINEATIONS DO NOT DESCRIBE CONTAMINANTS ARRIVING
T THE WATER FEATURE THROUGH DISPERSION PROCESSES. DUE TO THE UNCERTAINTY OF
OROSITY VALUES, TIME PATHS COULD DIFFER BY A FACTOR OF 2. THUS THE DELINATION FOR
00 YEARS COULD REASONABLY REPRESENT THE RANGE OF 250 TO 1,000 YEARS.

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FIGURE 6

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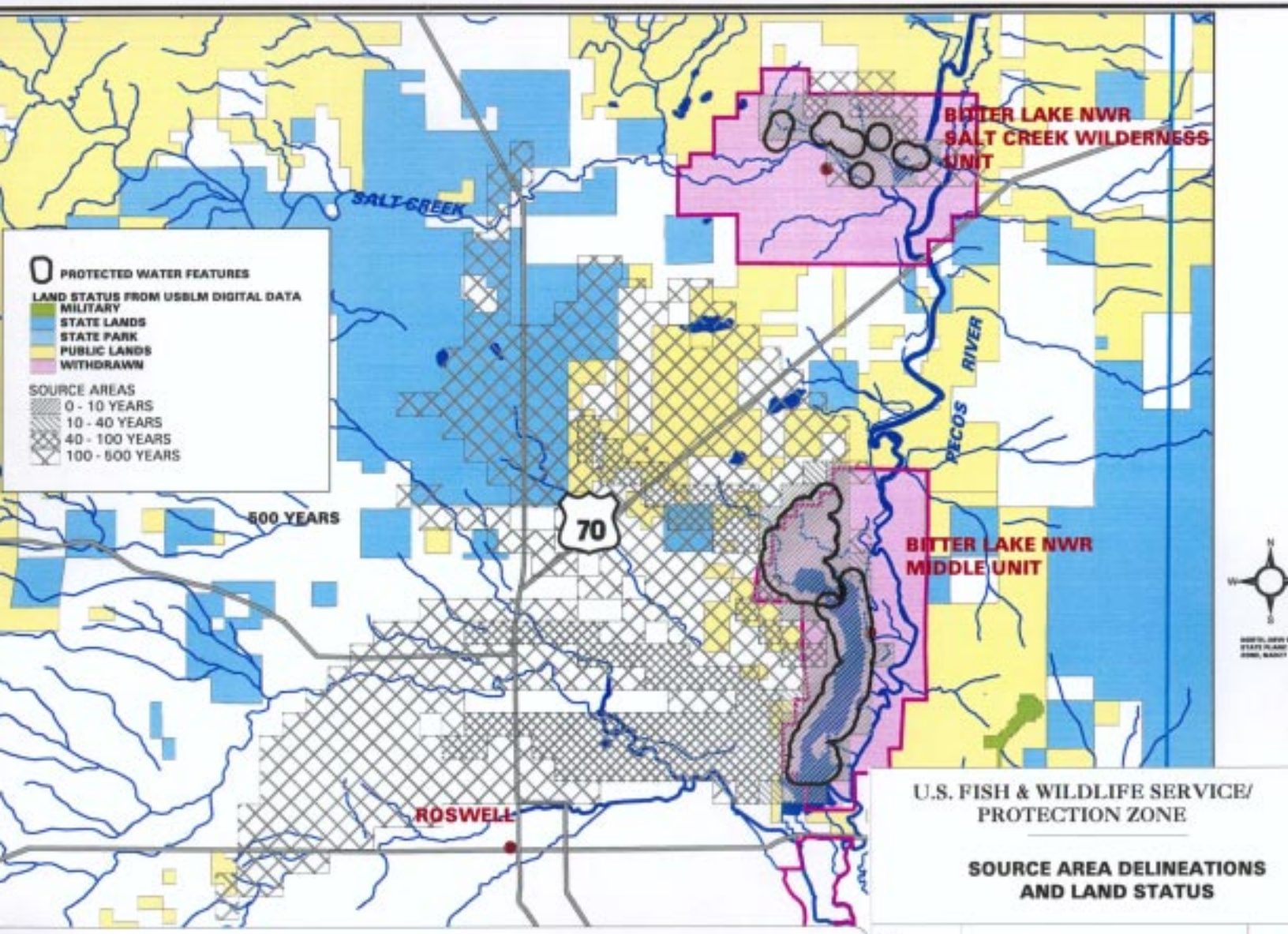

U.S. FISH & WILDLIFE SERVICE/
PROTECTION ZONE

SOURCE AREA DELINEATIONS AND LAND STATUS

SOURCE AREA DELINEATIONS DO NOT DESCRIBE CONTAMINANTS ARRIVING AT THE WATER FEATURE THROUGH DISPERSION PROCESSES. DUE TO THE UNCERTAINTY OF POROSITY VALUES, TIME PATHS COULD DIFFER BY A FACTOR OF 2. THUS THE DELINATION FOR 500 YEARS COULD REASONABLY REPRESENT THE RANGE OF 250 TO 1,000 YEARS.

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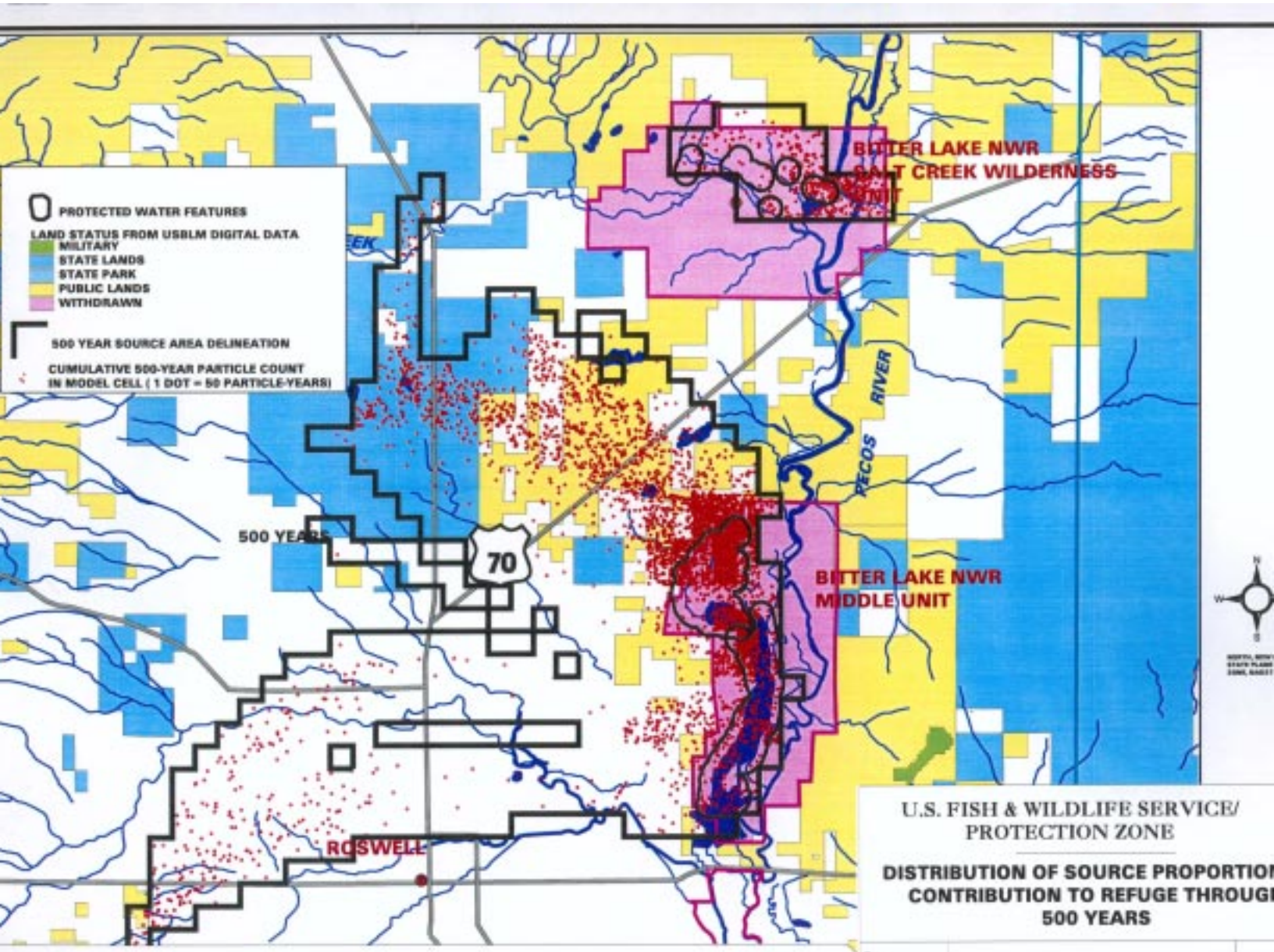
FIGURE 7

BGW



U.S. FISH & WILDLIFE SERVICE/
PROTECTION ZONE

DISTRIBUTION OF SOURCE PROPORTION CONTRIBUTION TO REFUGE THROUGH 500 YEARS

OURCE AREA DELINEATIONS DO NOT DESCRIBE CONTAMINANTS ARRIVING T THE WATER FEATURE THROUGH DISPERSION PROCESSES. DUE TO THE UNCERTAINTY OF OROSITY VALUES, TIME PATHS COULD DIFFER BY A FACTOR OF 2. THUS THE DELINATION FOR 00 YEARS COULD REASONABLY REPRESENT THE RANGE OF 250 TO 1,000 YEARS.

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FIGURE 8

BGW

Dispersion and dilution reduce concentrations of contaminants with distance and time. As contaminated water moves through an aquifer, a plume widens laterally as it moves forward. Assuming the solutionized San Andres Limestone is 50 feet thick with a porosity of 0.08 as it approaches the Refuge from one mile, and flows at five cfs (the remaining three cfs presumed to be in the overlying formations), and the cross-sectional width of this flow field is five miles, then the velocity of flow though the aquifer would be about 4.1 ft/d. Assuming a generic solution with a unit concentration is added continuously to the aquifer at a specified rate along a vertical line source, and using the USGS model POINT2 (Wexler, 1992) with conservative estimates of the longitudinal dispersivity and transverse dispersivity (100 feet and 10 feet, respectively) in conjunction with the above scenario to predict near steady-state concentrations at various distances, then the results in Table 4 show that concentrations are diluted to ten percent or less of source concentration in traveling 0.25 to two miles, depending on the flow rate of the source. Dilution with water stored in the Artesia Group will further reduce these concentrations as the water moves vertically.

The risk of significant impact to the Refuge caused by surface-water or groundwater contamination depends on the concentration of the contaminant release, the rate of discharge of that release and the total mass of contaminant released. The computations above suggest that concentrations from a release are attenuated by distance and that distances of more than a few miles cause large dilution and attenuation. Dispersion accelerates the spread of contaminants, while diluting them.

TABLE 4. RELATIVE CONCENTRATION OF CONTAMINANT IN 50-FOOT ARTESIA GROUP WITH DISTANCE FROM THE SOURCE (PERCENT OF SOURCE CONCENTRATION)[1]

Distance from Source (ft)	Percent of Source Concentration with Source Rate of 5 gpm	Percent of Source Concentration with Source Rate of 1 gpm
1,000	30	6
5,000	14	2.7
10,000	9	1.9

1. Based on results from POINT2 model (Wexler, 1992)

Flow

Flow rates are reasonably well constrained by historical data and by current observations. Storage accretion, however, is neglected in the steady-state computation of particle tracks. Flow beneath the Refuge equals measured winter discharge at the South Weir. Published baseflow gains to the Pecos River indicate regional average contributions of groundwater to the river. It is expected that the flow estimates used are in error by 50 percent or less. Consequently, travel-time errors due to errors in flow estimation are on the order of 50 percent or less.

System Geometry

The thickness and elevation of aquifer materials used is based on the work of others as described above. These thickness values were compiled in the form of generalized contours with control points. The gridded geology is as accurate as the published mapping at various scales permits after being discretized to a scale of 2,000 feet to 5,000 feet. Discretization requires that a single value be adopted to represent conditions at the selected resolution. Discretization errors are considered small.

Porosity

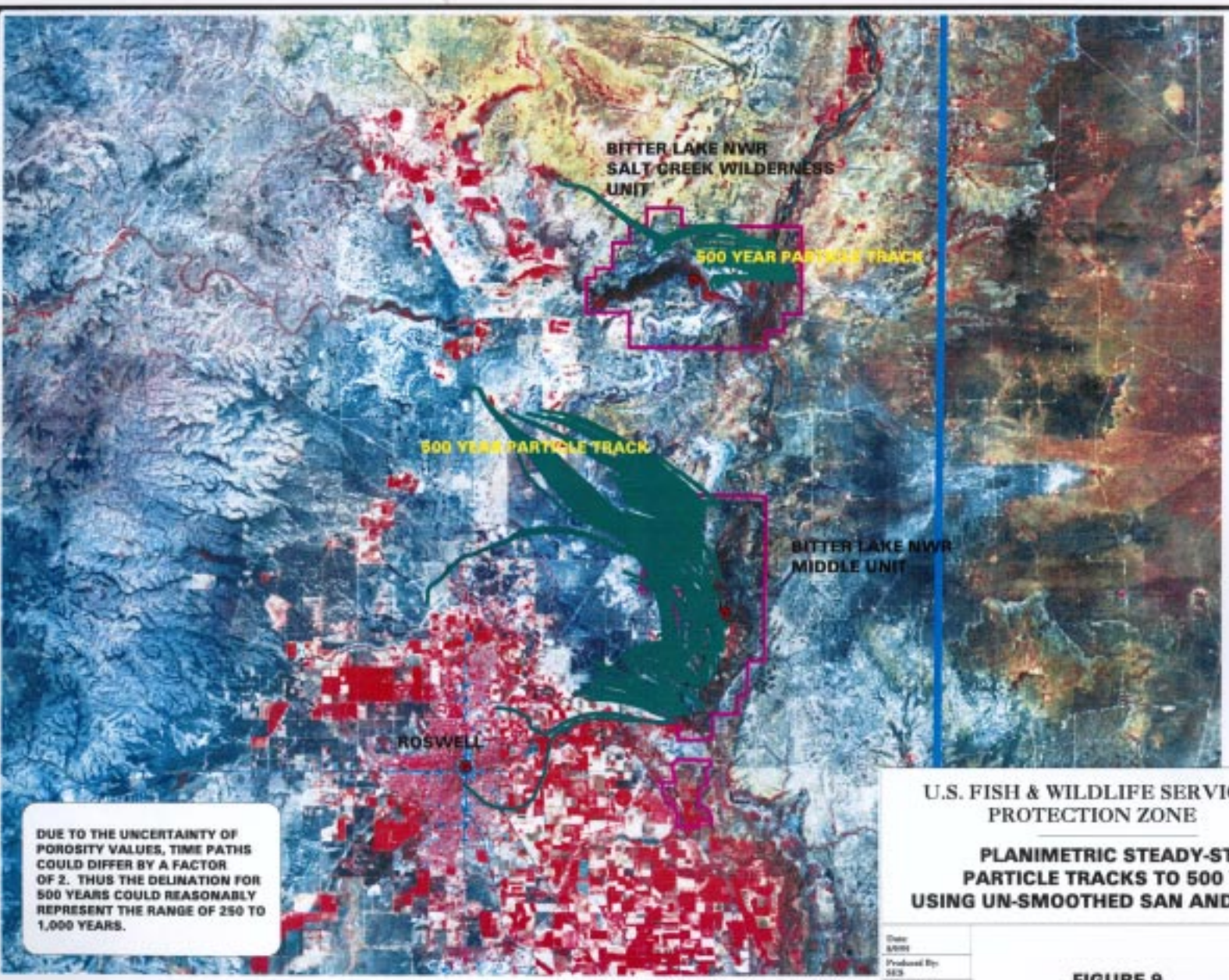
Particle-velocity estimates are inversely proportional to the specified porosity of the formations. Limited aquifer porosity data are available for the San Andres Limestone and Artesia Group in the immediate vicinity of the Refuge. Published sources suggest values for the San Andres Limestone ranging from one percent to ten percent or more. This indicates a range of travel times in the horizontal-flow direction

to the surface. In these areas, porosity estimates are less uncertain, and probably are within 50 percent of true values. It is not known whether a preferred, higher velocity pathway exists between the lower aquifer and the surface-water features at the Refuge. If such a pathway exists, travel times through the Artesia Group may be significantly less than shown. Overall uncertainty in the travel time-zone delineation may be a factor of two.

Grid Smoothing

The potentiometric data are scattered due to various years of collection and other factors. The data also reflect variations in the aquifers character with more or less permeable, fractured, solutionized or stressed features on a local scale. The particle tracking assumes that uniform properties apply to broad zones of the geologic system. Integrating the variability evident in the head data would require high-resolution model calibration. In this study, the head data are smoothed, rather than the permeability data being refined, and some information is lost in the process of obtaining a uniform density of both data sets.

To get an indication of the effect on results, the particle tracks were re-calculated without smoothing (Figure 9). Many unsmoothed tracks terminate at local mounds in the head surface that may indicate artifacts of the scatter in the data. Particle tracks are not appreciably different at 40 years but can vary several miles at 500 years depending on the resolution of the data used for the calculation. The difference in final position of smoothed and unsmoothed tracks indicates the uncertainty in that factor. About 1/3 of particles are unaltered by smoothing, 1/2 terminate at less than a 3/4-mile different position and 90 percent at less than a two-mile different position. Accordingly, the 500-year particle tracks may be viewed as having typically 3/4-mile uncertainty in final location and alignment.



U.S. FISH & WILDLIFE SERVICE/
PROTECTION ZONE

PLANIMETRIC STEADY-STATE
PARTICLE TRACKS TO 500 YEA
USING UN-SMOOTHED SAN ANDRES

Date:
Produced By:
Checked By:
File Name:

FIGURE 9

The particle-track method does not address some aspects of aquifer dispersion. To account for that factor, the particle track can be viewed as a band of spreading and mixing zones rather than as bright lines.

Local Conditions

The calculations in this study use regional data gridded on a scale of 2,000 to 5,000 feet. Questions about local features on a smaller scale would require site-specific data.

1. Data are sufficient for delineating directions, timing and proportional contribution of groundwater-sources into the Middle and Salt Creek Wilderness Units of the Refuge.

2. The time lines associated with the flow paths depend on porosity and other factors that remain relatively uncertain, therefore, the displacement schedule for capture-protection zones is reliable to a factor of two. The mapping of proportional contribution is less sensitive to uncertainties. The alignment of flow paths is reliable at 40 years, but may vary typically 3/4 mile at 500 years

3. Groundwater discharge to the surface-water features on the Salt Creek Wilderness Unit is about 0.73 cfs, and on the Middle Unit is about eight cfs.

4. Water levels and flow in the Middle Unit are correlated with a zero- to two-month lag in water-level response. The lag is seen in potholes northwest of Bitter Lake. Berrendo well water levels are directly correlated with flow in the Middle Unit.

5. Concentrations of water bodies in the flow system are expected to be diluted during seepage transport from sources upgradient from the Refuge units. An example using plausible coefficients suggests that a source 0.2 miles away is reduced to 30 percent, one mile is 14 percent and two miles is nine percent of its original concentration. Increasing the source's flow rate or concentration has a proportional effect in increasing concentration at distance.

improvement may be moderate considering other uncertainties.

7. Specific scenarios of contamination sources can be superimposed on the model-derived flow field.

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