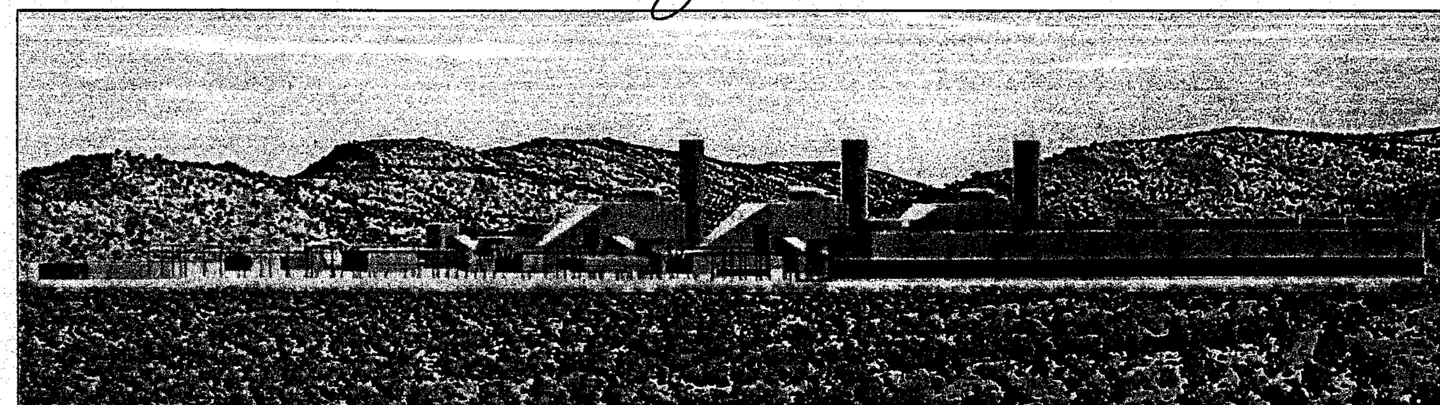
ORIGINAL

Big Sandy Energy Project

Application for a Certificate of Environmental Compatibility

Supplemental Information

1 of 2



Prepared for:

State of Arizona Power Plant and Transmission Line Siting Committee

Prepared by:

Caithness Big Sandy, L.L.C.

Date: October 19, 2000

Case No. 100

Docket No. L-00000R-00-0100

ORIGINAL

Application for a Certificate of Environmental Compatibility

Supplemental Information

Big Sandy Energy Project

Prepared for:

State of Arizona Power Plant and Transmission Line Siting Committee

Prepared by:

Caithness Big Sandy, L.L.C.

Date: October 20, 2000
Case No. 100
Docket No. L-00000R-00-0100

BEFORE THE
POWER PLANT AND TRANSMISSION LINE SITING COMMITTEE
SUPPLEMENTAL INFORMATION

IN THE MATTER OF THE APPLICATION OF CAITHNESS BIG SANDY, L.L.C. IN CONFORMANCE WITH THE REQUIREMENTS OF ARIZONA REVISED STATUTES 40-360.01 ET SEQ., FOR A CERTIFICATE OF ENVIRONMENTAL COMPATIBILITY AUTHORIZING CONSTRUCTION OF A NATURAL GAS-FIRED, COMBINED CYCLE GENERATING FACILITY IN MOHAVE COUNTY, ARIZONA, SOUTHEAST OF WIKIEUP, ARIZONA, A DISTANCE OF ABOUT FOUR MILES.	DOCKET NO.: L-00000R-00-0100

APPLICATION FOR
CERTIFICATE OF ENVIRONMENTAL COMPATIBILITY
SUPPLEMENTAL INFORMATION

EXECUTIVE SUMMARY

Caithness Big Sandy, L.L.C. (Caithness) has requested a Certificate of Environmental Compatibility (CEC) for the power plant (Plant) for the Big Sandy Energy Project (Project). This information supplements the original application submitted on March 29, 2000 and provides additional environmental baseline studies and impact analyses. The format is similar to the original application and provides updated information which has been developed since the application submittal date, indicated in bold type.

The Project consists of a baseload 720 megawatt (MW) natural gas-fired, combined cycle Plant and ancillary facilities located about four miles southeast of Wikieup, Arizona. The Project is located in the Big Sandy Valley area of east central Mohave County, Arizona (**Figure 1**). The Plant would be a privately-funded "merchant plant," which means that it is not owned by a utility and there is currently no long-term commitment or obligation by any utility to purchase the capacity and energy generated by the Plant. Caithness will instead seek to market its capacity and energy to the regional electric markets. The Plant would be interconnected to the regional electric transmission grid owned and operated by Western Area Power Administration (Western).

The Project is environmentally compatible within the meaning of Arizona Revised Statutes (ARS) §40-360.01 et seq., for the following reasons:

- The Plant would be located on a 120-acre tract of private lands owned by Caithness that is in close proximity to existing infrastructure. U.S. Highway 93 is less than four miles from the site, and two Western operated transmission lines cross the Plant site. Existing natural gas pipelines are located close enough to the Plant site that a connecting pipeline can be constructed with minimal impacts. Water supply, local access, and other infrastructure and services needed for the Project will be provided by systems being developed cooperatively by Caithness and the Mohave County Economic Development Agency (MCEDA).

- Developing the Plant at the proposed site is compatible with existing federal, state, and county land use and management plans.

- Development of the Project would not have significant adverse effects on fish, wildlife, or plants and would not adversely affect threatened and/or endangered species.

- Offsite impacts from noise generated by the construction and operation of the Plant would be minimal due to its location away from populated areas. The area is sparsely populated, and the nearest receptor is approximately one mile from the site. Estimated Project sounds at this residence would be about 52 dBA, less than and indistinguishable from most other background noises, e.g., truck traffic on Highway 93.

- Plant site access for recreational purposes would be restricted, consistent with safety considerations and regulations. The surrounding public and private lands do not receive significant recreational use.

- Preliminary screening analysis indicates that the Plant would not have significant impacts on air quality resources. The Plant is designed with state-of-the-art technology and would utilize clean-burning natural gas, making it one of the cleanest power plants in the state of Arizona. Previous experience has shown that these power plants do not cause significant air quality impacts.

- The Plant would use water from groundwater wells being developed on and west of the site in an isolated deep basin aquifer. Water withdrawal from these wells is not expected to negatively effect users of the near-surface alluvial aquifer. There are no known wells in the vicinity of the Plant site that are producing water from this deep aquifer. The Project water supply would be continuously recycled using a zero discharge system and would be disposed of by evaporation and/or provided for local agricultural use.

- The Plant and other Project components would be located and designed to minimize their visual intrusion in the area.

- The proposed natural gas supply pipeline to be constructed for the Project would be located primarily within or adjacent to existing highway and county road rights-of-way, reducing the environmental impacts associated with off-site components of the Project.

- The Plant would be located immediately adjacent to an existing 500kV transmission line, which crosses the western portion of the Plant site. Therefore, no new transmission line would be constructed; interconnection would be via a single span and 500kV switchyard located adjacent to the Plant. The absence of a new transmission line reduces the environmental impacts associated with the Project.

- The Project, in combination with the associated transmission interconnection designed and constructed by Western, would also provide the benefit of electrical generation necessary to meet expected demand and to improve electric system reliability throughout the region.

These and other factors are described in more detail in the Application and associated Exhibits.

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INTRODUCTION

Caithness Big Sandy, L.L.C. (Caithness) proposes to develop, construct, own and operate the Big Sandy Energy Project (Project), a natural gas fired, combined-cycle power plant (Plant), on private lands near Wikieup, Arizona. The Plant would be located adjacent to an existing 500 kilovolt (kV) transmission line owned by Western Area Power Administration (Western), and therefore no new transmission lines would be constructed. The Project would be a "merchant plant" which means that it is not owned by a utility and there is currently no long-term commitment or obligation by any utility to purchase the capacity and energy generated by the Plant. The Project would instead seek to market its capacity and energy to the regional electric markets. Power purchases by customers would be voluntary. Wholesale purchases and all economic costs of this Project would be borne by the Project proponent, not by any utility rate payers.

Caithness requests a Certificate of Environmental Compatibility (CEC) for construction of the generating facility. Siting of the generating facility requires approval of the Arizona State Power Plant and Transmission Siting Committee (Committee). This Application for a CEC focuses primarily on the Plant and associated facilities, including an access road, water supply wells and pipelines, natural gas pipeline, and other support features. The existing transmission line that would carry the power from the Project is owned by Western and several other entities. A natural gas pipeline lateral would be constructed between the Plant and one or more existing interstate natural gas pipelines in the area by a pipeline subcontractor. This application and associated exhibits provide descriptions of general existing conditions and potential effects of the Plant and other associated facilities. A discussion of the proposed natural gas pipeline is provided in Exhibit J - Special Factors for the information of the Committee and to support an understanding of the Project as a whole. **Western, in cooperation with the Bureau of Land Management (BLM) and as lead agencies, are currently preparing an Environmental Impact Statement (EIS) which will provide and confirm detailed analysis of conditions and potential effects of the construction and operation of the Project as presented herein. The analysis will include the assessment of potential effects both on the Plant site and in areas to be disturbed by associated facilities. A draft of the EIS will be made available to the Committee it is prepared, currently scheduled for December 2000.**

The Project would be built in two phases. Phase 1 consists of a baseload 500 megawatt (MW), natural gas-fired, combined-cycle generating facility. Phase 2 consists of a 220 MW single-shaft combined cycle generator, for a total final plant capacity of 720 MW. The combined generating facilities, together with on-site supporting infrastructure such as an administration building, warehouse storage, auxiliary boiler, water treatment facilities, cooling towers, and gas conditioning equipment comprise the power island. At final build out, the power island would occupy less than 15 acres of the 120-acre site. Water storage/evaporation ponds would be constructed that would occupy an additional 18 acres. Off-site supporting infrastructure includes: a new, three-mile County access road from U.S. Highway 93; a natural gas supply pipeline; and water pipelines which would bring water from a well field located on and within one miles of the site. Water demand for the Project is estimated at **3,000** gallons per minute average annual flow rate. A new underground gas supply pipeline would bring high-pressure gas to the Plant from interstate natural gas transmission pipelines located approximately 36 miles north of the Plant site.

Western and the BLM are preparing an EIS to evaluate the construction and operation of the electrical interconnection described above, as well as the connected actions of the construction and operation of the Plant and related infrastructure, natural gas pipelines, water supply pipelines, and the production and disposal of cooling water. The EIS is being prepared in accordance with Section 102(2) of the National Environmental Policy Act of 1969 (NEPA), 42 U.S.C. § 4332. In accordance with U.S. Department of Energy's (DOE) NEPA Implementing Procedures (10 CFR 1021, Appendices 5 and 6 to Subpart D), Western has determined that a decision on incorporating new generation into Western's system and the proposed interconnection with an existing transmission line will require preparation of an EIS. Also, the BLM has concurred with the need to prepare an EIS because of potential impacts to BLM-administered lands and resources from the construction and operation of the 6.5 miles of natural gas pipeline on federal lands. **Western and the BLM will issue separate Records of Decision (RODs) for the Project, currently scheduled for June 2001.**

This Application includes initial evaluations of relevant environmental resources and issues associated with the proposed Plant, supporting infrastructure, and associated facilities. Based on these studies of the environmental elements specified in Arizona Corporation Commission Rules of Practice and Procedure Ariz. Admin. Code R14-3-219, significant impacts are not anticipated with implementation of the proposed Project. **Detailed environmental analysis have been conducted as part of this analysis process.**

The Plant site was carefully selected from among several alternatives for the following reasons:

- The site met the criteria used by Caithness to identify the most economically and technically feasible location for the Plant. These criteria are:
    - Proximity to power markets
    - Transmission line access
    - Proximity to multiple gas supplies
    - Available private land
    - Suitability of site for construction
    - Available water
    - Proximity to Grand Canyon Buffer Zone

- Existing site access
- Proximity to a major highway

- The Plant site is on private land in an area that already contains long-established highway, natural gas, water, and electric transmission line facilities and routes.

- Most of the natural gas pipeline to be constructed for the Project can be located within the right-of-way for U.S. Highway 93 and right-of-way of sections of Mohave County's Hackberry Road **and access road to the Plant site,** and thus would not result in disturbance to areas not previously disturbed.

- The Plant site would be in conformance with the Mohave County General Plan. No residential development has taken place within one mile of the site and none is currently known to be planned.

- Based on the available investigation and analysis, no significant impacts to any threatened or endangered species have been identified or are anticipated. No critical habitat would be affected on the Plant site.

- Socioeconomic impacts of the Project are expected to be mostly favorable. The construction workforce would average about 150 persons, and the power plant would have a permanent workforce of about 22 persons. Revenues to the local economy over the first 20 years are anticipated to be in the range of $35 to $45 million, and over the second 20 years, would be approximately $75 million.

- The analyses for this Application show that several critical elements or concerns are not present or would not be affected by the siting, construction, and operation of the Plant, including: wild and scenic rivers, areas of critical environmental concern (ACEC), wetlands or riparian areas, and solid and hazardous waste. **Evaluation of the proposed natural gas supply pipeline effects to an existing ACEC, wetlands, and riparian areas have been completed and these effects are projected to be minimal.**

- The analyses that have been conducted indicate that the Project is not expected to cause any significant direct, indirect or cumulative adverse effects on land use, cultural resources, wilderness areas, biological resources, including special interest wildlife and plant species, ground or surface water quality, earth and soil resources, air quality, visual resources, or noise. Consultation with tribes regarding Native American concerns or traditional cultural properties would be initiated; no specific conflicts are currently known. No low income or minority groups would be disproportionately affected **by the Project**.

- The Plant, plus transmission improvements developed by Western, would provide new electrical generation needed to meet electric demand growth in the region. The Project is capable of providing improved reliability of electric service in the area.

1. *Name and address of the applicant:*

   Caithness Big Sandy, L.L.C.

2. *Name, address, and telephone number of a representative of the applicant who has access to technical knowledge and background information concerning this application, and who will be available to answer questions or furnish additional information:*

   Timothy C. Prenger, Project Manager
   Caithness Corporation
   7887 East Belleview Avenue #1100
   Englewood, CO 80112
   (303)228-1638 Phone
   (303)228-1639 Fax
   email: tcprenger@aol.com

3. *Date on which the applicant filed a Ten Year Plan in compliance with ARS §40-360.02, in which the facilities for which this application is made were described:*

The construction of a transmission line is not planned as part of this Project, therefore, a 10-year plan in accordance with ARS §40-360.02 is not applicable to this Project.

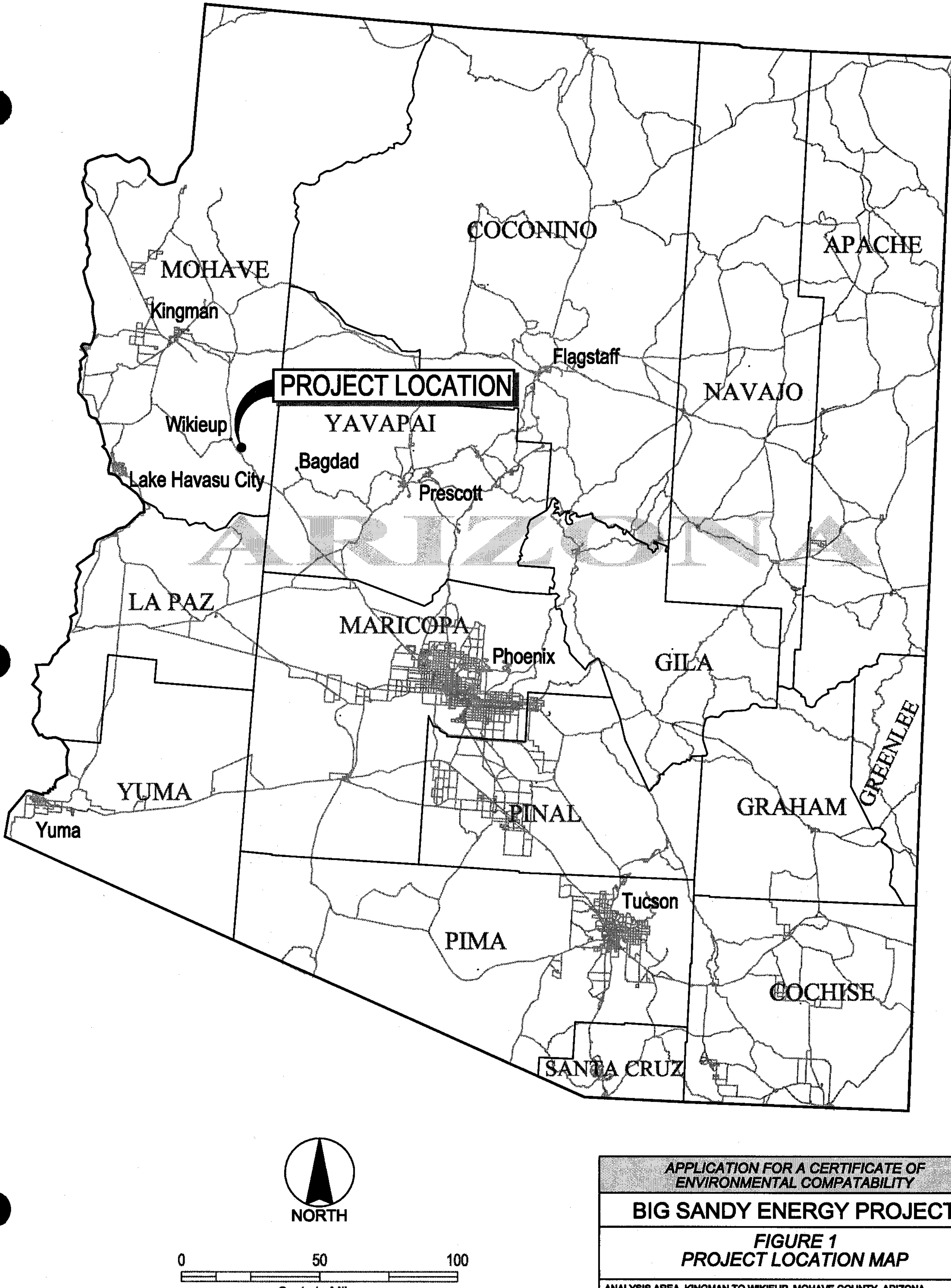
4. *Description of the proposed facilities:*

   4.1 With respect to an electric generating plant:

   4.1.1 Type of Generating Facilities:

The Plant would be located about 45 miles southeast of the City of Kingman in Mohave County, on land privately owned by Caithness. A Project location map is shown in **Figure 1**. The Plant would be constructed in two phases. Phase 1 would be a 500 MW natural gas-fired combined-cycle power plant comprising two advanced technology combustion turbines, one steam turbine, and supporting equipment. Phase 2 of the Project would consist of a third combustion turbine and steam turbine with one generator in a single shaft combined cycle arrangement resulting in 220 MW of additional capacity for a total plant capacity of 720 MW. Phase 2 is expected to be completed within 18 months of Phase 1 commercial operation.

The combined cycle plant would be one of the most efficient and cleanest burning plants to be constructed in the State of Arizona. The combustion turbines use state-of-the-art technology to efficiently burn clean natural gas with reduced NO_x and CO emissions. The Plant would be engineered to discharge not more than 3 ppm of NO_x and 10 ppm of CO during normal operation



APPLICATION FOR A CERTIFICATE OF ENVIRONMENTAL COMPATABILITY

BIG SANDY ENERGY PROJECT

FIGURE 1
PROJECT LOCATION MAP

ANALYSIS AREA KINGMAN TO WIKIEUP, MOHAVE COUNTY, ARIZONA

DATE: 10/11/00	AutoCAD File: 891-LOC.DWG
SCALE: AS NOTED	DRAWN BY: EC

(see **Exhibit B-1**). The technical details of the Plant components are described below in Section 4.1.2.

A combined cycle power facility uses a combination of combustion turbines and steam turbines to generate electricity. Exhaust heat from the combustion turbines is routed through ducts to a boiler that creates steam which is then routed to a steam turbine to produce additional electricity. Two combustion turbines in combination with one steam turbine("two on one") would be built for Phase 1. Phase 2 would add one combustion turbine and steam turbine with one generator in a single shaft combined cycle arrangement. Each combustion turbine would exhaust hot gas to a Heat Recovery Steam Generator (HRSG), which is an advanced boiler designed to recover heat from the gas. Within each HRSG would be a section containing a catalyst to reduce air pollutants contained in the combusted gas. The HRSG efficiently removes the remaining heat and pollutants in the gas and exhausts the residual through an approximately 130-foot tall stack. The stack contains emissions monitors to insure that air emissions standards are not exceeded.

A map of the 120-acre Plant site is shown in **Figure 2**. The ownership of lands abutting the site is a mixture of private and public.

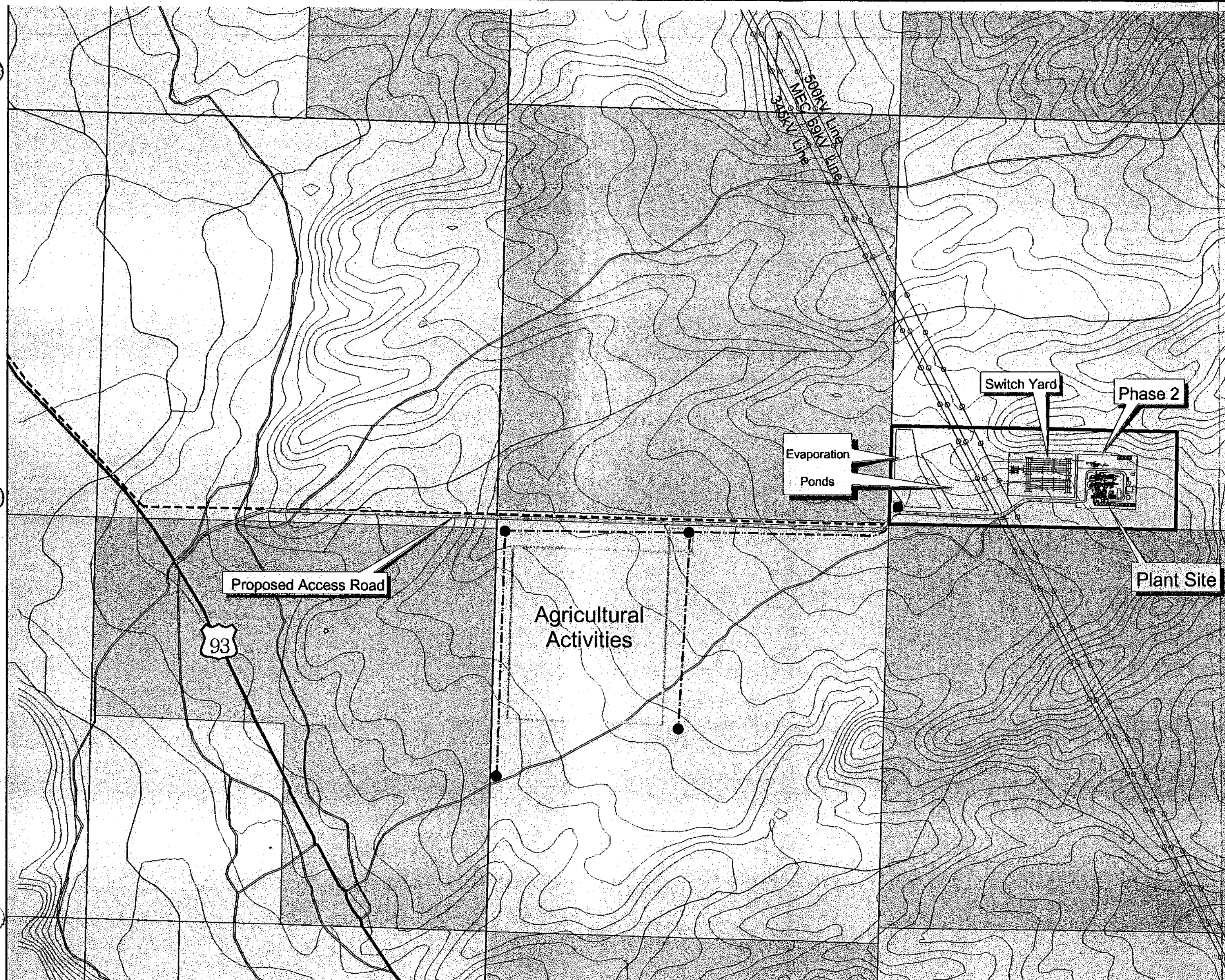
The combustion turbines and steam turbines are sited within close proximity of one another to maximize the use of shared infrastructure and to minimize system losses. The combustion turbines and supporting generating equipment are typically referred to as a "power island." The power island for the Project would cover approximately 15 acres and would contain the turbines, generators, HRSGs, stacks, auxiliary boiler, switchyard, administration building, maintenance building, cooling towers, and parking for the operating staff. Several buildings and/or enclosures would contain the mechanical and electrical equipment. The size of these buildings would vary with the final layout and design. An artist's rendering of the Projects power island is shown in **Exhibit G-1.**

The electrical switchyard for the high voltage transmission interconnection would cover approximately 12 acres and would be located adjacent to the power island next to the existing transmission line **(Figure 2)**. An 18-acre evaporation/storage pond would be located west of the switchyard within the Plant site.

Supporting infrastructure shown on **Figure 2** includes an access road, water wells and supply system, gas supply lines, and a transmission interconnection. The gas line would be constructed by a pipeline subcontractor to be selected by either Caithness or the local gas distribution company. The connection to the existing transmission line and switchyard would be constructed by Western.

4.1.2 Number and size of proposed units:

The Plant's power island shown on **Figure 2** includes the following major equipment:



LEGEND

- Proposed Well Locations
- Proposed Access Road
- Proposed Gas Pipeline
- Proposed Water Pipeline
- Primary Trunk Highway
- Light Duty Road
- Existing Transmission Line
- River/Stream

Land Status
- Private Lands
- BLM - Administerd Public Lands

Scale 1 : 4,600

250 0 250 500 750 Feet

100 0 100 200 Meters

Contour Interval 20 Feet

Transverse Mercator Projection
1927 North American Datum
Zone 12

APPLICATION FOR A CERTIFICATE OF ENVIRONMENTAL COMPATIBILITY

BIG SANDY ENERGY PROJECT

FIGURE 2
PROPOSED POWER PLANT & ANCILLARY FACILITIES

ANALYSIS AREA: MOHAVE CO., CALIFORNIA

DATE: 10/13/00 | ArcView File: F:\BIGSANDY-89\SITE-DIAGRAM.APR | DRAWN BY: MSH

Phase 1

- Two combustion turbine generator sets and auxiliaries
- One steam turbine generator set and auxiliaries
- Two triple pressure HRSG and exhaust stacks, each equipped with a selective catalytic reduction (SCR) system as necessary to meet Environmental Protection Agency (EPA) and Arizona Department of Environmental Quality (ADEQ) air standards
- Auxiliary and ancillary equipment for the balance of the plant systems, including cooling towers, administration and support buildings, water systems, fire systems, and a switchyard.

Phase 2

- One single shaft combustion turbine/steam turbine generator set and auxiliaries
- One triple pressure HRSG and exhaust stack equipped with a SCR system to meet EPA and ADEQ air standards
- Additional auxiliary and ancillary equipment for the balance of the plant system, including cooling towers, water systems, fire systems, and switchyard.

4.1.2.1 Combustion Turbines:

Each combustion turbine uses advanced combustion technology to generate approximately 165 MW each with minimal emissions. Although the turbine equipment is manufactured to be capable of burning natural gas or oil, this Plant would burn natural gas only, keeping emissions to a minimum.

The compressor and turbine, the principal components of the single-casing, single-shaft combustion turbine, have a common rotor. The turbine sits on a horizontal axis with the cold end (compressor end) attached to the generator. The turbine is housed in an enclosed metal building to protect the unit from the elements and to provide optimal noise reduction.

4.1.2.2 Air Intake System:

The air intake system provides filtered air to the combustion turbine compressor. The air intake is mounted above each combustion turbine. The intake system is equipped with a multistage, static filter system to clean particulates from the air. Silencers are installed to reduce the emissions from the combustion turbine compressor inlet. The system is provided with access for inspection and maintenance. An inlet air cooling system is provided to enhance combustion turbine performance at high local ambient air temperatures. The cooling system is installed within the inlet air filter compartment.

4.1.2.3 Exhaust Gas System:

The high-temperature combustion turbine exhaust gas would be directed through its respective HRSG for combined cycle operation. Each HRSG would be equipped with its own exhaust stack.

4.1.2.4 Generators for the Combustion Turbines:

The generators for the combustion turbines are of two-pole type. Indirect cooling is provided for the stator winding and direct cooling for the rotor winding. The primary cooling circuit is of closed-loop design. The cooling medium at the generator outlet is cooled in a secondary cooling circuit. The coolers are mounted on one side of the stator frame.

4.1.2.5 Steam Turbine and Condenser:

The steam turbine is rated at approximately 170 MW with a water-cooled condenser. The turbine is fitted with stop and control valves for the high pressure steam admission. The steam turbine and condensers are factory assembled and shipped in modules for convenient field erection. The proposed design and size of the steam turbine would provide for incremental output during peak operations, as discussed in Section 4.1.7.2.

4.1.2.6 Generator for the Steam Turbine:

An enclosed air-cooled generator would be supplied for the steam turbine. The generator is factory assembled and shipped in modules for convenient field erection.

4.1.2.7 Heat Recovery Steam Generators:

The HRSG would be of outdoor-type design with an integral exhaust stack approximately 130 feet in height. The drum-type heat recovery steam generator, with reheat, uses natural-circulation to generate steam in high (HP), intermediate (IP), and low-pressure (LP) sections. The HP, IP and LP-system is designed and arranged to receive feedwater at the specified inlet conditions and to deliver steam at the three supply pressures. It is comprised of pressure parts from the economizer inlet to the superheater outlet, and associated supports, casings, insulation, valves and equipment.

The HRSG would be equipped with a system to reduce NO_X emissions using a selective catalytic reduction (SCR) system, as needed, to satisfy air quality standards.

4.1.2.8 Instrumentation and Control (I&C):

The Plant would use a digital process control system designed for power plant application. The control interface would be located in an administration building located on site. The system is based on a hierarchical structure and programmable control system to achieve maximum Plant availability and reliability.

4.1.2.9 Switchyard and Electrical Plant:

The generator of each gas combustion turbine set is connected to the high-voltage switchyard via the generator leads and the generator step-up transformer. A unit breaker is provided in the switchyard to connect the unit to the grid.

Plant auxiliary power would be tapped from the generator leads of one of the combustion turbines. This tap supplies power to the switchgear via the unit auxiliary transformer. A generator breaker is provided between the generator and the tap to allow the grid to supply auxiliary power to the Plant via the generator step-up transformer when the combustion turbine is not operating. The generator breaker and the unit breaker(s) would be used to synchronize the gas combustion turbine to the grid.

The remaining combustion turbines have no tap on the generator leads and no generator breaker and are synchronized with the grid via the high voltage switchyard unit breaker. The Plant is provided with an auxiliary transformer, which receives power from a 69kV auxiliary source and delivers medium voltage power to the switchgear. The switchgear for the combustion turbines are tied together so that all Plant auxiliaries can be supplied from either turbine. The steam turbine generator is synchronized with the grid via the HV-switchyard unit breaker(s).

Power for control and protection systems for the combustion turbines are supplied from redundant direct current systems within the respective combustion turbine. Power for control and protection systems for the boilers, steam turbine and balance of plant are supplied from a redundant direct current system not associated with the combustion turbines.

4.1.2.10 Balance of Plant:

Fuel Systems - High pressure natural gas would be supplied at the Plant boundary from a connection pipeline to the Questar, El Paso Natural Gas, and/or Transwestern supply pipelines (see Section 4.1.3). From there it would be piped to the gas conditioning equipment skids. A metering station for each line would be constructed. The gas conditioning skids would filter gas particulates and drop out moisture contained in the gas. Pressure reduction and control valves are used to feed gas to the turbines. A fuel gas preheater is used to increase the efficiency of the Plant.

Water Systems - Cooling water would be cooled with a wet cooling tower after passing through the condenser and auxiliary cooler. Make-up water is to be supplied from the wells located on and off-site (see Section 4.1.5). Demineralized water of the required quality would be generated from the well water utilizing a reverse-osmosis system followed by a mixed bed demineralizer unit. The output of this unit would go to one storage tank with a capacity of approximately 600,000 gallons. From there it would be distributed to the various users. Waste water discharges would be collected and transferred to separate outgoing streams, which would then be discharged to evaporation ponds for proper disposal.

Condensate/ Steam System - After powering the steam turbine the exhaust steam is condensed. Deaeration of the condensate is performed in the condenser. After passing through the condensate extraction pumps the condensate passes through the condensate preheater, which is integral to the HRSGs. To enable the transfer of steam produced in the HRSGs to the condenser without having passed through the steam turbine, the steam lines are equipped with a branch to the condenser serving as a bypass. The bypass allows for short periods of operation in simple cycle mode without the steam turbine.

Auxiliary Boiler - The Plant uses an auxiliary boiler to generate steam for combined cycle startup from cold conditions. The boiler would fire natural gas to produce approximately 50,000 lb/hr of steam. The steam is used to warm the HRSGs and steam turbines to allow rapid starting of the Plant. The boiler operates for only short periods of time during outages and Plant start-up.

4.1.3 The source and type of fuel to be utilized, including a proximate analysis of fossil fuels:

The Project would use natural gas provided to the Plant from a nearby existing gas pipeline (Questar, El Paso, and/or Transwestern). An analysis of the natural gas that would be used is shown in Table 1.

Table 1
Big Sandy Energy Project
Proximate Analysis of Natural Gas Supply

Gas Compound		Percent Composition (Mole Fraction)	Ideal Net Heat Value Fraction Btu/cu. ft.
Methane	CH_4	0.96379	876.47
Ethane	C_2H_6	0.01100	17.81
Propane	C_3H_8	0.00150	3.47
I-Butane	C_4H_{10}	0.00020	0.60
N-Butane	C_4H_{10}	0.00025	0.75
I-Pentane	C_5H_{12}	0.00007	0.24
Hexane	C_5H_{12}	0.00005	0.19
Heptane	C_7H_{16}	0.00015	0.66
Octane	C_8H_{18}	0.00000	0.00
Nonane	C_9H_{20}	0.00000	0.00
Decane	$C_{10}H_{22}$	0.00000	0.00
Carbon Monoxide	CO	0.00000	0.00
Carbon Dioxide	CO_2	0.00000	0.00
Hyd. Sulfide	H_2S	0.02100	0.00

Table 1 Big Sandy Energy Project Proximate Analysis of Natural Gas Supply			
Gas Compound		**Percent Composition (Mole Fraction)**	**Ideal Net Heat Value Fraction Btu/cu. ft.**
Air	N_2O_2	0.00000	0.00
Hydrogen	H_2	0.00000	0.00
Helium	He	0.00000	0.00
Argon	Ar	0.00000	0.00
Oxygen	O_2	0.00000	0.00
Nitrogen	N_2	0.00200	0.00
Water	H_2O	0.00000	0.00
Total		1.00000	900.18

4.1.4 Amount of fuel to be utilized daily, monthly, and yearly:

At its completed Phase 2 capacity, the Plant would utilize approximately 106.4 million cubic feet (MMCF) of gas per day, 3,246 MMCF per month, and 38,960 MMCF per year.

4.1.5 Type of cooling to be utilized and the source of any water to be utilized:

4.1.5.1 Type of cooling:

The Project would utilize evaporative/wet cooling.

4.1.5.2 Source of water:

Raw water supply for all plant uses would be from deep groundwater wells to be constructed on the Plant site and/or in the immediate area. The maximum rate of usage would be approximately 5,000 gpm for all uses combined. The average annual rate of usage is expected to be about 3,000 gpm. Annual consumption of water would be about 4,850 acre-feet.

Plant equipment would be cooled by a closed cooling water system which in turn would be cooled by the evaporative cooling towers. Cooling tower blowdown would be discharged to surface evaporation ponds. The ponds would total approximately 18 acres in size. These ponds would require a permit from ADEQ for aquifer protection.

4.1.6 Proposed height of stacks and number of stacks, if any:

Phase 1 of the Project would have two stacks; each of the two HRSGs would have a stack approximately 130 feet tall. One additional HRSG stack would be added during Phase 2. The auxiliary boiler would have a stack about 30 feet tall.

4.1.7 Dates for scheduled start-up and firm operation of each unit and date construction must commence in order to meet schedules:

Firm operation of Phase 1 is scheduled for July 2002 based on startup in March 2002 and start of construction in December 2000. **Phase 2 firm operation is scheduled for July 2003 based on startup in March 2003 and start of construction in June 2001. Phase 2 firm operation is scheduled for September 2004 based on estimated startup in April 2004 and estimated start of construction in April 2003.**

4.1.7.1 Project Construction:

The Project would be constructed by a primary contractor who would perform the Engineering, Procurement & Construction (EPC). The EPC contractor would begin the plant engineering during the summer of 2000 and would place orders for long lead equipment items. The actual construction in the field would be completed in approximately 20 months. During this period, the number of construction workers could reach a maximum of approximately 350 workers on site. The Plant site property includes adequate area for construction parking, work trailers, storage and lay-down areas. Existing water and electrical power facilities are available near the site for use during construction. The primary access during construction would be from U.S. Highway 93 along the new Plant County access road.

4.1.7.2 Project Operation:

The Plant is designed for base load combined cycle operation but has the flexibility to rapidly start and stop on a daily basis. The combustion turbines can be fired in 10-15 minutes and reach full load output in one hour. This allows for daily cycling of the Project as needed to meet market demands for power. The level of output of the Plant would be determined by market factors, such as the growth in energy demands, daily wholesale energy prices, and transmission availability. The Plant, after completion of Phase 2, can perform over a range of power output from 200 to 720 MW depending on the ambient temperature conditions and mode of operations. As ambient temperatures increase, inlet cooling would be used to lower the air inlet temperatures below 50°F to maintain optimum Plant output.

The Project would include advanced control systems to monitor and control all the Plant operation systems. Approximately 22 full time staff would perform routine operation and maintenance functions. In addition, the Plant can be remotely monitored and dispatched. Many functions, including major turbine and generator maintenance, would be outsourced to other vendors.

4.1.8 To the extent available, the estimated costs of the proposed facilities and site, stated separately:

The total Phase 1 and Phase 2 cost of the **Project** is estimated to be $425 million; the cost of the Plant site is estimated to be about $300,000.

4.1.9 Legal description of the proposed site:

The Plant would be located in the SWSW, SESW, and SWSE quarters of Section 5, T15N, R12W, approximately 45 miles southeast of Kingman, AZ, and approximately 4 miles southeast of Wikieup, AZ, off Highway 93.

4.2 Description of the proposed transmission line:

No transmission line is proposed to be constructed, as the proposed Plant would be located adjacent to the existing Mead-Phoenix Project 500kV transmission line that crosses the Plant site.

5. Jurisdictions:

5.1 Areas of jurisdiction (as defined in ARS §40-360) affected by this route site:

All components of the Project would be located within Mohave County. The Plant and most of the ancillary facilities, including the access road, water wells and pipelines, and portions of the natural gas pipeline, are on private lands. **In April 2000, Mohave County approved rezoning of the 120-acre power plant site from agricultural use to heavy industrial.** Approximately 6.5 miles of the proposed gas supply pipeline right-of-way and less than half an acre of the access road cross public lands administered by the BLM.

6. Description of the environmental studies the applicant has performed:

Caithness has engaged several experienced consultants who have and will continue to conduct studies and impact evaluations for the Project. The results of the studies performed to date are included in **Exhibits A through F and I.** Studies are also being conducted under the direction of Western for the preparation of the EIS to evaluate the connection to the existing transmission line and the Plant and ancillary facilities. The BLM is coordinating studies to address potential impacts to public lands managed by the BLM. The Draft and Final EIS, currently projected for December 2000 and June 2001, respectively, would be submitted to the Committee as supplemental information when they are completed.

For the Plant site, preliminary evaluations of the existing environment were conducted for land use, air quality, visual resources, biological resources, cultural resources, noise, and socioeconomics. Potential environmental effects of implementation of the Project were also assessed. Additional analyses are being conducted for the EIS. These environmental studies of the Project area began with the collection of existing environmental data including literature, maps, and other agency data. Interviews have been conducted with appropriate agencies and organizations. Scoping to identify issues was conducted with the public and interested agencies. **Field studies of all affected areas and vicinity have been conducted by qualified resource specialists. Additionally, all potentially disturbed areas where the Plant site and other ancillary facilities are proposed have been intensively inventoried.**

Potential environmental effects are determined by comparing environmental conditions after construction of the proposed Project with the existing environment. Where appropriate, mitigation measures have been identified to minimize or eliminate impacts. Caithness would implement a number of mitigation measures as integral elements of the Project, including: selective structure placement, use of existing access, biological monitoring, water monitoring, and cultural resource monitoring.

Meetings have been held with appropriate state, Federal and local agencies as well as the general public to solicit initial input on the Project. The meetings that have been held to date are listed in **Exhibit J, Table 2-1.**

The analyses of the proposed site found that the following critical elements are not present or would not be affected by the construction of the Plant: wild and scenic rivers, Areas of Critical Environmental Concern (ACEC), riparian areas, and hazardous or solid wastes.

Analysis conducted to date indicates that no significant direct, indirect, or cumulative impacts are expected to land use, cultural resources, wilderness, biological resources (including any species of special concern), socioeconomics, earth resources, air quality, ground or surface water quality, or noise at the Plant site.

Analysis and consultation concerning Native American concerns or traditional cultural properties are being conducted as part of the EIS process. Analysis of environmental justice determined that no low income or minority populations would be disproportionately affected.

EXHIBIT A - LOCATION MAP AND LAND USE INFORMATION

As stated in Arizona Corporation Commission Rules of Practice and Procedure R14-3-219:

1. *Where commercially available, a topographic map, 1:250,000 scale, showing the proposed plant site and the adjacent area within 20 miles thereof. If application is made for alternative plant sites, all sites may be shown on the same map, if practicable, designated by applicant's order of preference.*

Exhibit A-1: Proposed Power Plant Site and Adjacent Area. This exhibit shows the location of the Big Sandy Energy Project power plant site and associated features included in this application. The proposed natural gas pipeline is shown on **Figure J-1**.

2. *Where commercially available, a topographic map, 1:62,500 scale, of each proposed plant site, showing the area within two miles thereof. The general land use plan within this area shall be shown on the map, which shall also show the areas of jurisdiction affected and any boundaries between such areas of jurisdiction. If the general land use plan is uniform throughout the area depicted, it may be described in the legend in lieu of an overlay.*

Exhibit A-2: Proposed Power Plant Site, Land Status, Planned Land Use, and Zoning. This exhibit shows the land use and zoning in and near the area around the Big Sandy Energy Project power plant site. **Mohave County approved the required Industrial Zoning for the Plant site in April 2000. Figure J-2** contains this same information for the proposed natural gas pipeline route.

3. *Where commercially available, a topographic map, 1:250,000 scale, showing any proposed transmission line route of more than 50 miles in length and the adjacent area. For routes of less than 50 miles in length, use a scale of 1:62,500. If application is made for alternative transmission line routes, all routes may be shown on the same map, if practicable, designated by applicant's order of preference.*

Exhibit A-3: The proposed Plant Site is crossed by an existing transmission line to which the Plant would be connected by a switchyard and a single span. A new transmission line is not proposed; therefore, no **Exhibit A-3** is attached. The interconnection of the Plant and the existing transmission line would be located within the Plant site (**Figure 2** of the Application).

4. *Where commercially available, a topographic map, 1:62,500 scale, of each proposed transmission line route of more than 50 miles in length showing that portion of the route within two miles of any subdivided area. The general land use plan within the area shall be shown on a 1:62,500 map required for Exhibit A-3, and for the map required by this Exhibit A-4, which shall also show the areas of jurisdiction affected and any boundaries between such areas of*

jurisdiction. If the general land use plan is uniform throughout the area depicted, it may be described in the legend in lieu of on an overlay.

Exhibit A-4: Proposed Power Plant Site - Existing Land Uses. A new transmission line is not proposed. This exhibit shows existing land uses in the vicinity of the Big Sandy Energy Project power plant site.

LAND USE

The proposed Plant site is located about 45 miles southeast of Kingman, AZ and about four miles southeast of Wikieup, AZ in Mohave County. The Plant site would be located on private land owned by Caithness. Access to the Plant site from U.S. Highway 93 would be provided by a County access road constructed on private land and/or county right-of-way. BLM-administered lands would be crossed at one section corner, and a right-of-way grant from the BLM would be required. Land ownership in the general Plant site area consists of a checkerboard pattern of private and federal lands, as shown in **Exhibit A-2**.

The Plant site would be located on an undeveloped parcel of land owned by Caithness. The 120-acre site is currently **zoned for** Industrial Use **(Exhibit A-2)**. Portions of the lands surrounding the Plant site that are owned by Caithness would still be made available for agricultural use or maintained in their natural state.

Future and planned land uses in the Plant site and vicinity are within the Rural Development Area (RDA) type defined in the Mohave County General Plan (**Exhibit A-2**). Detailed land use classes in the RDA type include rural residential, rural industrial, public parks, public lands, and non-residential uses such as neighborhood commercial, commercial recreation, light industrial, heavy industrial, and airport industrial. **Exhibit A-4** shows current land uses of the Plant site and surrounding lands, based on interpretation of recent (1996) aerial photos. The site and surrounding rural area is mostly undeveloped. **Exhibit A-5 presents a complete description of all land uses in the area.**

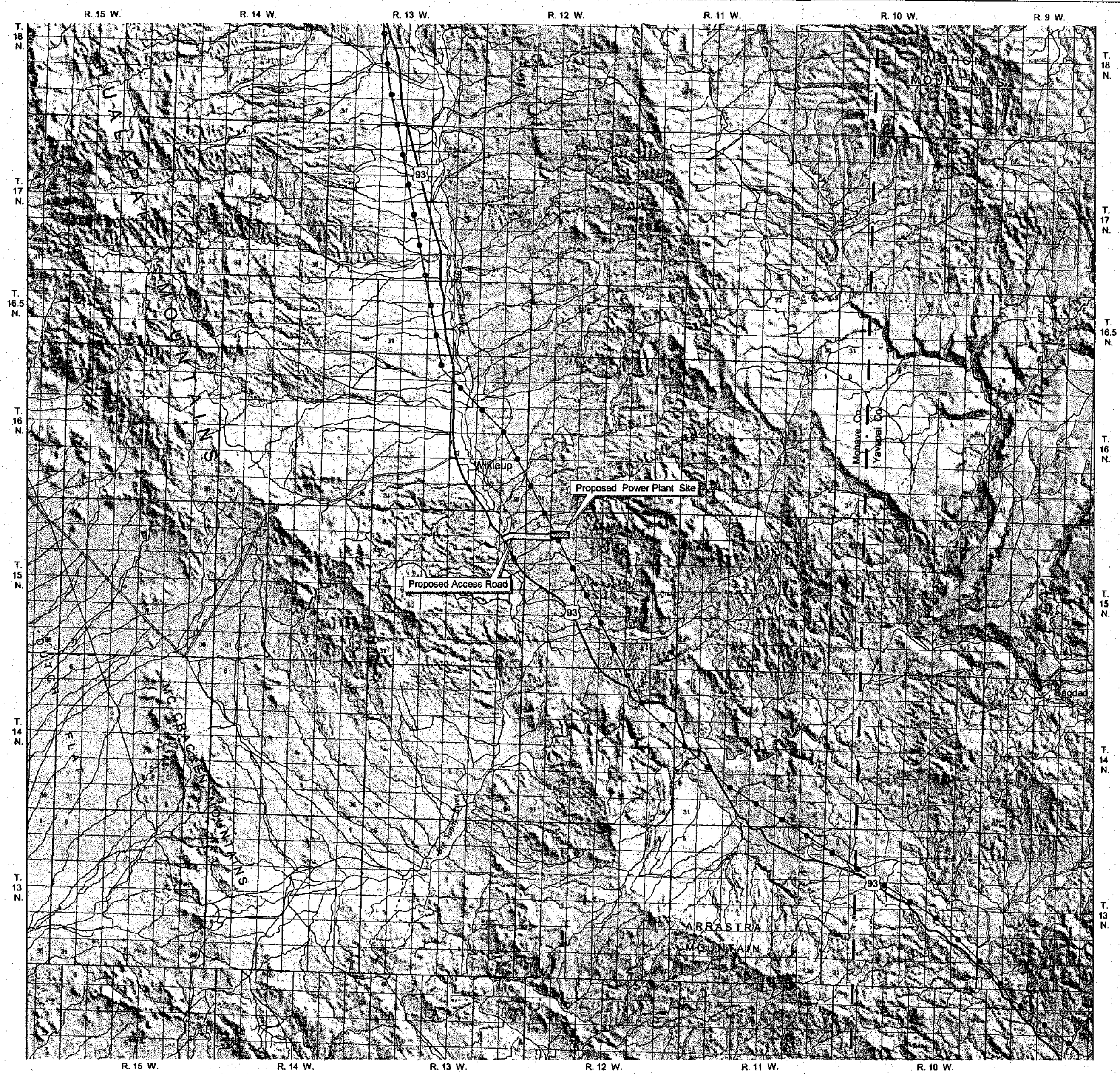
A BLM-designated right-of-way utility corridor identified in the *Kingman Resource Area Resource Management Plan (RMP) and Final Environmental Impact Statement* (BLM, 1993) crosses the southwestern portion of the Plant site **(Exhibit A-2)**. This mile-wide corridor is called the "Mead to Phoenix utility corridor." Under the RMP, large utility facilities on federal lands are restricted to these corridors; their use minimizes surface disturbance to otherwise undisturbed areas.

Public utility and infrastructure facilities are necessary elements in the development of urban, suburban, and rural land uses. The proposed Project is compatible with the future land use planning areas of rural development. As can be seen from the description of rural development areas presented earlier, a wide variety of land uses are allowed in this type of area, including light industrial and heavy industrial. Therefore, construction and operation of an electrical power plant would be fully compatible with Mohave County land use planning.

Potential Effects

The proposed Plant site **and ancillary facilities** are to be located on privately owned parcels that are surrounded by public lands managed by the BLM. The proposed access road would cross a very small portion of BLM-administered land at the point where it crosses the common corner of Sections 5, 6, 7, and 8, Township 15 North, Range 12 West. Assuming a 200-foot wide right-of-way for the road and other facilities, a maximum of one-half acre of disturbance would occur on BLM-administered lands.

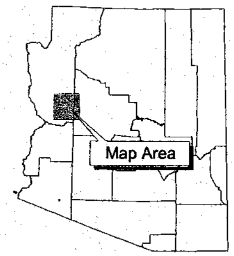
There would be no impacts to the existing land status with development of the Project; as currently planned, public, state, and private land ownership would not change. As discussed above, the Plant site is located in an area designated as a rural development area for planned land use purposes, which includes industrial uses.



LEGEND

- Primary Trunk Highway
- Light Duty Road
- River/Stream
- Existing 500kV and 345kV Transmission Lines
- Proposed Power Plant Site
- Proposed Access Road

ARIZONA



North

SCALE 1:250,000

1 0 1 2 3 4 5 6 7 8 9 10 11 12 Miles

2 0 2 4 6 8 10 12 14 16 Kilometers

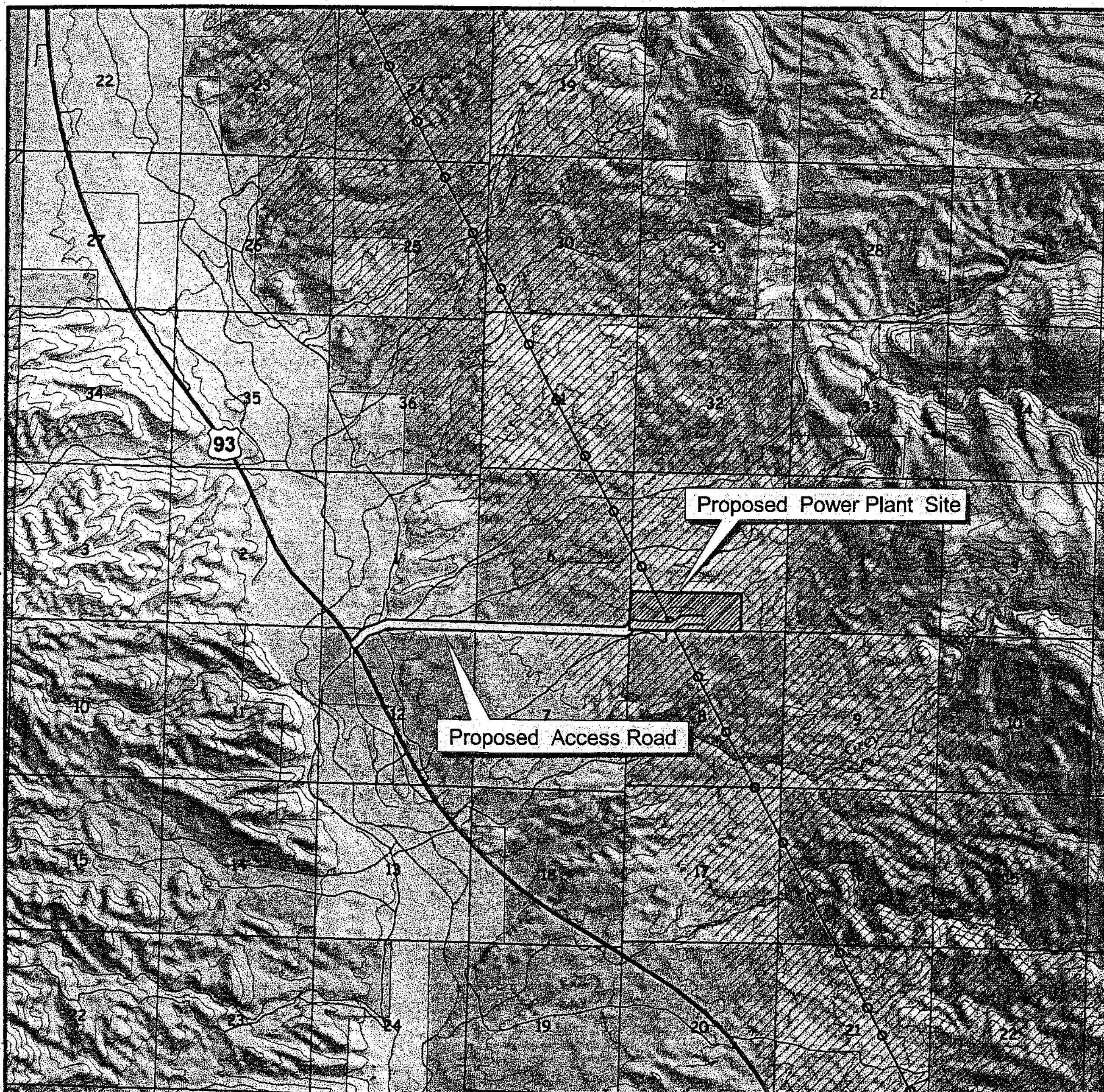
Transverse Mercator Projection
1927 North American Datum
Zone 12

APPLICATION FOR A CERTIFICATE OF ENVIRONMENTAL COMPATABILITY

BIG SANDY ENERGY PROJECT

EXHIBIT A-1
PROPOSED POWER PLANT SITE & ADJACENT AREA

DATE: 10/12/00	ArcView FILE: F:\BIG SANDY\891-EXHIBITA-1.APR
	DRAWN BY: BSN



LEGEND

- Primary Trunk Highway
- Light Duty Road
- River/Stream
- Existing 500 kV and 345 kV Transmission Lines
- BLM Designated Utility Corridor (Kingman Resource Area RMP, 1993)

Land Status

- BLM - Administered Public Lands
- Private Lands

Planned Land Use: All Lands are in Rural Development Area (Mohave County General Plan, 1995)

Zoning: All Lands are Zoned A-R (Agricultural-Residential) Except Power Plant Site which is Industrial (Mohave Co. Planning & Zoning Department)

SCALE 1:62,500

North

0.5 0 0.5 1 1.5 Miles

0.5 0 0.5 1 1.5 2 2.5 Kilometers

Contour Interval 100 Feet

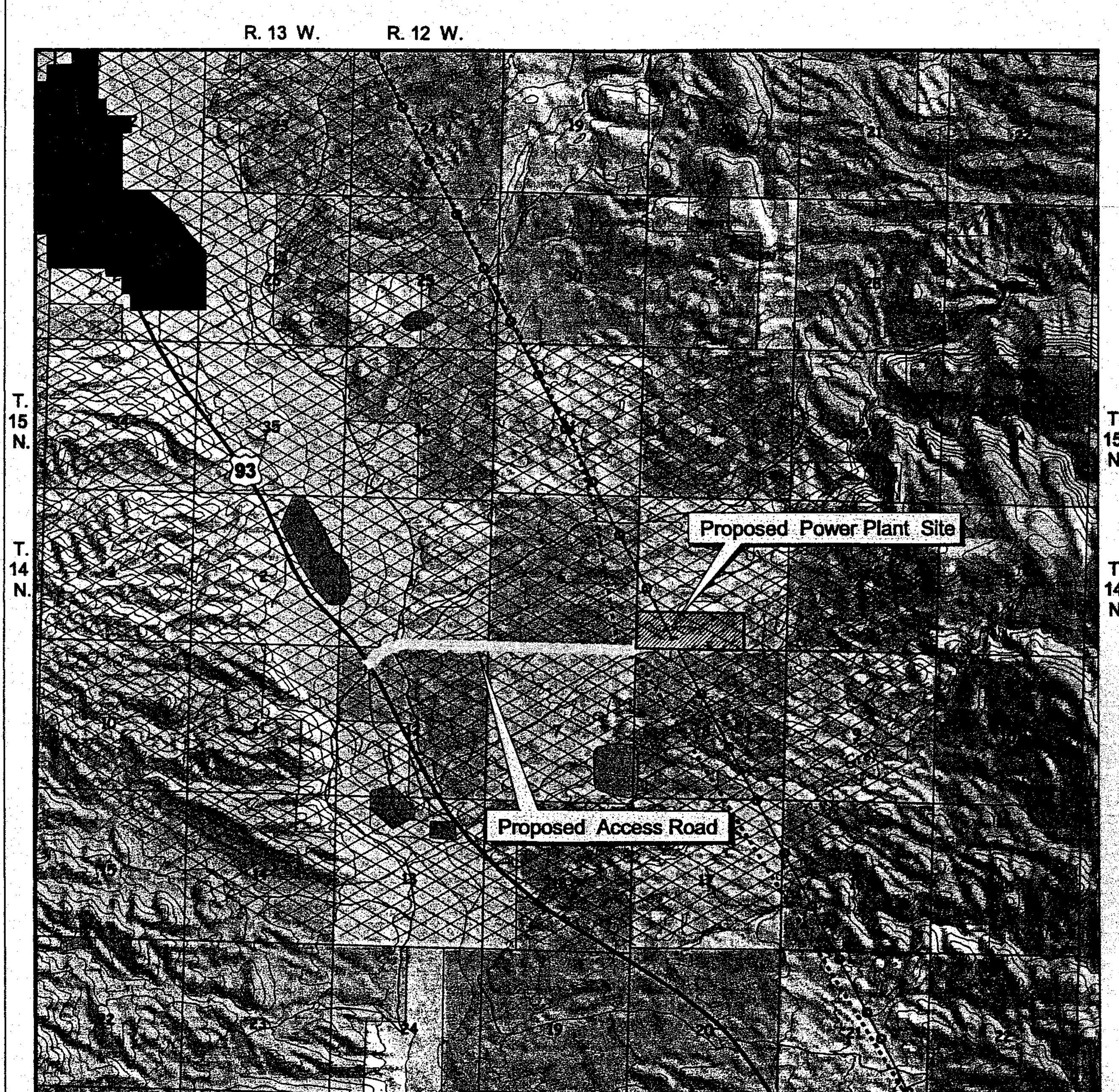
Transverse Mercator Projection
1927 North American Datum
Zone 12

APPLICATION FOR A CERTIFICATE OF ENVIRONMENTAL COMPATABILITY

BIG SANDY ENERGY PROJECT

EXHIBIT A-2
PROPOSED POWER PLANT SITE, LAND STATUS, PLANNED LAND USE & ZONING

DATE: 10/12/00	ArcView FILE: F:\BIG SANDY\881-EXHIBITA-2.APR
	DRAWN BY: BSN



LEGEND

- Primary Trunk Highway
- Light Duty Road
- River/Stream
- Existing 500 kV and 345 kV Transmission Lines
- Existing Water Pipeline

Land Status
- BLM Administered Public Lands
- Private Lands

Land Use
- Mine Area (Sand, Gravel, Zeolite)
- Urban-Residential/Agriculture
- Agriculture
- Rangeland/Desert Open Space
- Industrial

SCALE 1:62,500

North

0.5 0 0.5 1 1.5 Miles

0.5 0 0.5 1 1.5 2 2.5 Kilometers

Contour Interval 100 Feet

Transverse Mercator Projection
1927 North American Datum
Zone 12

APPLICATION FOR A CERTIFICATE OF ENVIRONMENTAL COMPATABILITY

BIG SANDY ENERGY PROJECT

EXHIBIT A-4
EXISTING LAND USE - PROPOSED POWER PLANT SITE & ACCESS ROAD

DATE: 10/12/00

DRAWN BY: SSN

EXHIBIT A-5

RECREATION/WILDERNESS/WILD AND SCENIC RIVER/ACCESS AND LAND USE

REPORT

BIG SANDY ENERGY PROJECT RECREATION/WILDERNESS/WILD AND SCENIC RIVERS/ACCESS AND LAND USE

Submitted by:

Caithness Big Sandy, LLC
7887 E. Belleview Avenue
Suite 1100
Englewood, CO 80111

September 2000

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Figures

RECREATION/WILDERNESS/WILD AND SCENIC RIVERS/ACCESS AND LAND USE

INTRODUCTION

Caithness Big Sandy, L.L.C. (Caithness) has proposed to develop, construct, own, and operate the Big Sandy Energy Project (Project), a natural gas-fired, combined-cycle power plant (Plant) near the unincorporated community of Wikieup, approximately 40 miles southeast of the City of Kingman along U.S. Highway 93 in Mohave County, Arizona. Please refer to the Big Sandy Energy Project description for a detailed description of the Project.

ANALYSIS AREA

Recreation

The analysis area and the cumulative effects area for recreation resources consists of private, state and BLM lands in a radius of 20 miles around the town of Wikieup. Portions of the Upper Burro Creek Wilderness and the Arrastra Mountain Wilderness are included in the analysis area.

Wilderness

The analysis area and the cumulative effects area for Wilderness is limited to wilderness units within 25 miles of the proposed Plant site. Wilderness within 25 miles of the Plant site includes all of Upper Burro Creek Wilderness and most of the Arrastra Mountain Wilderness.

Wild and Scenic Rivers

The analysis area and cumulative effects area for Wild and Scenic Rivers will be limited to the segment of the Big Sandy River determined to be suitable for inclusion in the National Wild and Scenic River System. Big Sandy River parallels U.S. Highway 93 less than two miles west of the Plant site. The segment suitable for inclusion is downstream of the Plant site.

Access and Land Use

The analysis area for the purpose of describing jurisdiction and land status will be the corridor defined for the proposed action and alternatives. The analysis area for the water reuse alternative and potential development activities wwill be in the west half of Section 7, T15N, R12W.

RESOURCE CONDITIONS

Recreation

Mohave County has a diverse geography, which offers a multitude of recreational opportunities. The Hualapai Mountains to the west of the Project site, the Aquarius Mountains to the east, and smaller mountain ranges to the south offer hiking, camping, hunting, ghost town touring, and other outdoor activities. The Colorado River, located along the western boundary of Mohave County, offers recreational and historical attractions as do several ghost towns and mines in the area. Activities along the rivers include fishing, boating, and other forms of water-oriented recreation.

Much of the recent growth in Mohave County, which has occurred primarily in the communities along the Colorado River and the City of Kingman, can be attributed to increased tourism. The seasonal migration of retirees during the winter months creates a demand for recreational vehicle parking and other temporary lodging. The lakes along the Colorado River draw water enthusiasts throughout the year, but particularly in the summer months. Gaming in Laughlin also attracts tourists throughout the year.

There are limited recreational opportunities in the vicinity of Wikieup. The closest recreation facility to the Plant site is the Burro Creek Recreation Site approximately 12 miles to the south. The Recreation Site includes a BLM campground, and provides a range of recreational activities that includes camping, trailhead access to backcountry hiking, an interpretive desert garden, picnicking, birdwatching, swimming, jeeping, and rockhounding. A golf course/practice range at the Coyote Canyon Country Club, on the east side of Wikieup, provides an area to hit golf balls on a practice range free for the residents of Wikieup.

Power Plant and Associated Facilities

The proposed Plant site and the associated well field and water lines are accessed from U.S. Highway 93. No known recreation activities occur at the Plant site and within the water line rights-of-way, which are located on private land historically used as rangeland.

Natural Gas Supply Line

Approximately 6.5 miles of the proposed gas pipeline route are on BLM lands. Currently, there are no developed recreation sites on BLM or private lands along the route or accessed from the highway along the pipeline route. However, the Carrow-Stephens Area of Critical Environmental Concern (ACEC) shown on **Figure 1**, contains historic resources that are exemplary of late nineteenth century farming and ranching life in northwestern Arizona. This ACEC has potential for recreational and educational development as stated in the Kingman Resource Area Proposed Management Plan and Final Environmental Impact Statement (1993). Dispersed recreation opportunities are available on BLM administered Federal lands and state lands, including hunting, off-road vehicle use and hiking. Recreation is not a major use of BLM and state lands within or adjacent to the U.S. Highway 93 corridor. Recreational opportunities for the public are generally not available on private lands in the area.

OVERSIZED
DOCUMENT

MAP

SEE SUPERVISOR
(EXHIBIT CABINET)

Wilderness

There are nine wilderness areas in the BLM's Kingman Field Office resource area. The Upper Burro Creek Wilderness and the Arrastra Mountain Wilderness lie within 10 to 15 miles of the proposed Plant site. The Wabayuma Peak and Aubrey Peak Wildernesses lie within 20 miles of the Plant site.

The Upper Burro Creek Wilderness lies along the upper reaches of Burro Creek, a free-flowing perennial stream that includes segments eligible to be studied for inclusion into the National Wild and Scenic Rivers System. The wilderness offers outstanding recreation opportunities for hiking, backpacking, camping, sightseeing, hunting, rock collecting, and horseback riding.

The Arrastra Mountain Wilderness encompasses more than 20 miles of the Big Sandy and Santa Maria rivers, which include segments eligible to be studied for inclusion into the National Wild and Scenic Rivers System. The Poachie Range, which trends northwest-southeast through the north-central portion of the wilderness, rises to nearly 5,000 feet in elevation. The wilderness contains Sonoran and Mohave desert vegetation, scenic landscapes, and unique natural features. The wilderness is difficult to access because of it's remoteness from major highways and secondary roads. Limited access from U.S. Highway 93 is by an often impassable jeep road.

Wild and Scenic Rivers

The Big Sandy River crosses U.S. Highway 93 two miles west of the proposed Plant site. A total of 28 miles of the Big Sandy River south of the highway crossing has been identified as a potential Wild and Scenic River (WSR), and is eligible to be listed on the National Rivers Inventory (NRI). The NRI provides a data base for potential additions to the National Wild and Scenic River System (NWSRS). In order to be listed on the NRI, a river must be free-flowing and possess one or more Outstandingly Remarkable Value (ORV). A river-related value must be a unique, rare, or exemplary feature that is significant at a comparative regional or national scale.

A nineteen-mile segment of the river between U.S. Highway 93 and the Signal Townsite has a potential classification as a Scenic river. Scenic rivers are those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads. The ORVs possessed by this segment include scenery, fish, and wildlife values. This segment is an important desert riparian ecosystem that provides habitat for non-game birds, fish, other wildlife and insect populations. It is an important stopover area for migrating non-game birds. The riparian area provides winter habitat for bald eagles.

Below the Signal Townsite to Alamo Lake is a nine-mile segment of the river that has a potential classification of Wild. Wild rivers are those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America. The ORVs possessed by this segment include scenery, fish, and wildlife values. The segment contains outstanding scenic qualities. Landforms of broad river channels, high banks and rolling hills combine with dense riparian vegetation and the appeal of moving water to provide a most interesting scenic resource.

The scenic quality of this segment is rated as Class A. The segment also provides outstanding opportunities for primitive recreation and is an important desert riparian ecosystem.

As described in the BLM Manual 8351 - Wild and Scenic Rivers - Policy and Program Direction for Identification, Evaluation, and Management, the BLM evaluates identified river segments for their eligibility and suitability for WSR designation through its Resource Management Plan process. The BLM must provide protective management to all eligible river segments to ensure that the existing qualities upon which their eligibility is based are not degraded.

When a river segment is determined eligible and given a tentative classification (wild, scenic, and/or recreational), its identified outstandingly remarkable values shall be afforded adequate protection, subject to valid existing rights, and until the eligibility determination is superseded, management activities and authorized uses shall not be allowed to adversely affect either eligibility or the tentative classification.

Specific management prescriptions for eligible river segments should provide protection in the following ways:

1. Free-flowing Values. The free-flowing characteristics of eligible river segments cannot be modified to allow stream impoundments, diversions, channelization, and/or rip-rapping to the extent the BLM is authorized under law.

2. River-Related Values. Each segment shall be managed to protect identified outstandingly remarkable values (subject to valid existing rights) and, to the extent practicable such values shall be enhanced.

3. Classification Impacts. Management and development of the eligible river and its corridor cannot be modified to the degree that its eligibility or tentative classification would be affected (i.e., its tentative river area classification cannot be changed from wild to scenic, or from scenic to recreational). Should a nonsuitable determination be made in the Resource Management Plan process, then the river shall be managed in accordance with management objectives as outlined in the plan document.

Access and Land Use

County Land Use Planning

The proposed Plant site (120 acres) and most of the proposed gas pipeline route are on private lands. Land use controls for private lands in Mohave County include the Mohave County General Plan, last updated in 1995, and the Mohave County Zoning Regulations (Regulations).

The Regulations adopted in 1965 include amendments current through April 1987. The Regulations establish zoning districts to implement land-use controls that limit or permit the uses to which land in any section may be put. Most of the analysis area is zoned Agricultural-Residential (A-R). The A-R zoning at the 120-acre Plant site has been rezoned as Heavy Manufacturing (M-X) by the county in coordination with the County Planning and Zoning Department. Other zoning districts in the analysis area include General (A) and Commercial zoning in the vicinity of the community of Wikieup, and Commercial (C-2) zoning adjacent to U.S. Highway 93 near the highways intersection with Interstate 40.

Land uses permitted in the A-R zone include agricultural and home occupation, single family dwellings, schools, churches, public buildings and playgrounds. Uses permitted in the General zone include various types of residences, general commercial uses, offices, agriculture, landing strips, home occupations, and signs related to uses of the property. The Commercial zone permits retail sales and services, multiple family residences or commercial residential structures, and kennels and veterinary clinics. The principal purpose of the M-X zone is to provide for heavy manufacturing uses in locations which are suitable and appropriate. Power plants are permitted in the M-X zone.

Planned Land Use

Future and planned land uses have been mapped by Mohave County in the County Plan, as shown in **Figure 2**. Planned land uses were developed to guide the types of land uses that will be developed in the county, and the areas in which specific types of development will occur. The general planning areas include Rural Development Areas, Urban Development Areas, Suburban Development Areas, and Outlying Communities. Most of the analysis area, including the 120-acre Plant site parcel and most of the proposed natural gas pipeline, is within a Rural Development Area. A portion of the analysis area is within a Suburban Development Area. The unincorporated town of Wikieup has been designated an Outlying Community. There is currently no Urban Development Area in the analysis area, however it may be a component of future growth within the town of Wikieup. An Urban Development Area is intended to provide for more intense residential and non-residential development near cities and outlying communities. Planning areas within the Project analysis area are described below.

- A rural development area is a planning area where residents presently enjoy a rural lifestyle, wide open spaces and few neighbors. Properties in these areas are generally at least five acres in size. A significant amount of land within this area type is owned by the Federal or State governments, or is included in an Indian reservation. Land use categories consistent with the rural development area include rural residential, rural industrial, public parks, and public lands. Land use categories that may be consistent with the rural development area depending on the location, natural features and surrounding uses include non-residential uses such as neighborhood commercial, commercial recreation, light industrial, heavy industrial and airport industrial.

- A suburban development area is intended for development of lower density residential neighborhoods with many of the amenities of urban areas. Suburban lot sizes range from one to five acres with a typical lot size of 2.5 acres. Land use categories consistent with suburban development areas include suburban estates, suburban residential, public parks, and public lands. Land use categories that may be consistent with the rural development area depending on the location, natural features and surrounding uses include rural residential, commercial uses, light industrial, heavy industrial, and airport industrial.

OVERSIZED
DOCUMENT

MAP

SEE SUPERVISOR
(EXHIBIT CABINET)

- Unincorporated outlying communities in Mohave County require special consideration. Development within designated communities may be urban, suburban, or rural in character. The General Plan permits the continuation of existing development patterns, including both residential and non-residential development.

Private land in most of the analysis area is largely undeveloped and used for rural residential, wildlife habitat and grazing as shown on **Figure 3 - Existing Land Use.** The unincorporated community of Wikieup is located along U.S. Highway 93 approximately 3.5 miles northwest of the Plant site. Federal lands managed by the BLM and State lands are used primarily for grazing, and a limited amount of dispersed recreational uses such as hunting and off-road vehicle use.

A parcel of privately-owned land located adjacent to the proposed natural gas pipeline corridor junction of U.S. Highway 93 with Hackberry Road is planned to be developed as a residential homesite by Silverado, a local residential development company (Silverado, 2000). The parcel is accessed from U.S. Highway 93.

Power Plant and Associated Facilities

The proposed Plant site is located on private lands. All proposed Plant facilities and associated facilities such as the access road and water line would be on private lands, with the exception of a small segment of the access road, which will cross BLM lands. Area land status is as shown in **Figure 4**.

The proposed Plant would be located on an undeveloped 120-acre parcel of land that is owned by Caithness. The surrounding rural area consists of undeveloped private and BLM lands. The Plant site is currently zoned for M-X uses. The Plant site and all associated facilities, including the water line and well field, is within the planned land use area Rural Development Area. The lands surrounding the Plant site parcel are zoned A-R.

The proposed Plant site was historically used as rangeland. BLM lands adjacent to the site in the area are managed for multiple use and provide for a variety of uses including grazing and dispersed recreation such as hunting and off-road vehicle use. Grazing and residential uses are the primary land uses on other private lands in the general area.

The proposed water supply pipeline extends west to a well field located within one mile of the proposed Plant site and is also located on private land historically used as rangeland. Outside of the Plant site parcel, the water line crosses lands zoned A-R.

Access to the Plant site from U.S. Highway 93 would be on a proposed county access road of 2.5 miles in length to be located on privately owned and BLM lands.

OVERSIZED DOCUMENT

MAP

SEE SUPERVISOR (EXHIBIT CABINET)

OVERSIZED
DOCUMENT

MAP

SEE SUPERVISOR
(EXHIBIT CABINET)

Natural Gas Transmission Line

A proposed underground pipeline would transport high-pressure natural gas to fuel the Power Plant from the existing El Paso Natural Gas Company, Transwestern and/or Questar pipelines located about 36 miles north of the Project site.

The proposed route occupies existing rights-of-ways and in areas previously or proposed to be disturbed by highway and road construction. Most of the 36-mile route to interconnect with the existing natural gas pipelines is within the existing ROW for U.S. Highway 93. The northern-most portion of the route follows Hackberry Road, a Mohave County-maintained road. The southern-most section would be located adjacent to and within the ROW of the county access road to the Plant site from U.S. Highway 93. Access to the natural gas pipeline would be from existing roads along the pipeline route.

U.S. Highway 93 was designated a North American Free Trade Agreement (NAFTA) corridor, and identified as a high priority corridor in the National Highway System Designation Act of 1995. The highway is part of the NAFTA "CANAMEX" route between Mexico and Canada.

The Arizona Department of Transportation (ADOT) is in the process of improving sections of U.S. Highway 93 south of the Project area between milepost 138 at Burro Creek and milepost 161 at the Santa Maria River. Improvements will include new passing and travel lanes, new bridges, and pavement improvements. ADOT is currently studying proposals for similar improvements on the highway segments between Burro Creek and the highway junction with Interstate 40. The construction schedule in the Arizona Department of Transportation 2000-2004 Current 5-year Program shows construction on the highway between Wikieup and Interstate 40 beginning in the years 2003 - 2004.

ENVIRONMENTAL EFFECTS

The analysis will examine the effects of the proposed action and alternatives on recreation, wilderness, wild and scenic rivers, access and land uses in the analysis area. The analysis will focus on preliminary issues that have been identified by the local community during initial public meetings for the Big Sandy Energy Project. The issues for each resource are identified as bullets in the sections below.

Recreation

- It is assumed that if the power plant is constructed, it would require an influx of people to the Wikieup area to work at the facility. The increase in population would likely result in more recreation activities on public lands in the area. How much increase in recreation use can be expected?

- What public/private land interface problems and recreation-related problems could be expected to occur on public lands as a result of this population increase?

It is not anticipated that there would be any significant increase in the population of Mohave County, or in communities such as Wikieup and Kingman, from an influx of workers employed for the construction and operation of the Plant and the associated facilities. The total labor force in the County in 1999 was 63,850 workers. The construction work force proposed for the Project is an average of 150 people over 2 years, ranging from 50 for site preparation to 350 at peak construction. It is anticipated that the majority of the required labor pool would be available in the Kingman/Yucca/Havasu area. To the extent that some specialized skill classes are not available in the area, it is assumed that these workers would migrate to the area on a temporary basis during the construction phase. The maximum project workforce of 350 workers at peak construction would constitute less than two percent of the Kingman area population of 20,000 and an immeasurably small percentage of the population of Mohave County. Most of these workers and their families already reside in the area. The workforce that is imported into the County would consist of a small number of workers temporarily employed for the duration of some phases of the construction activities. It is unlikely that these temporary employees would bring families to reside in Mohave County. There would be no significant increase in the population or in the use of existing recreational opportunities on public lands from the construction of the proposed Project.

The operation of the Plant would require a permanent workforce of 22 people. As described for the construction workforce, some of the permanent workforce may already reside in Mohave County. The workers and their families are small relative to the total population, and would not result in a significant impact to recreational uses in Mohave County.

Recreation activities are minimal to non-existent at the Plant site and along the proposed pipeline route. Hunting and other dispersed recreational activities do not occur along the route because of the proximity to grazing operations and the highway corridor. There would be no recreation activities displaced from public lands by the construction and operation of the Project.

Wilderness

- The Upper Burro Creek Wilderness and Arrastra Mountain Wilderness lie within 10-15 miles of the proposed power plant. Wabayuma Peak and Aubrey Peak Wildernesses lie within 20 miles of the Plant. The primary issue is how much impact to wilderness naturalness will be caused by introducing the power plant to the Wikieup area. Specifically, will wilderness air quality be changed?

- Will the removal of groundwater or discharge of wastewater at the power Plant site affect water quality or quantity downstream in the Big Sandy River?

- If water resources are affected, how will this impact riparian flora and fauna within Arrastra Mountain Wilderness?

Impact analysis for Wilderness will be prepared when information on the effects of the Project on air quality and water quality downstream of the Project area due to the potential effects of aquifer drawdown and water discharge are available.

Wild and Scenic Rivers

- A segment of the Big Sandy River has been determined by the BLM to be suitable for inclusion in the National Wild and Scenic River System, and BLM has recommended such to Congress. The primary issue is how much impact will the removal of groundwater or discharge of wastewater at the power Plant site affect water quality or quantity downstream in the Big Sandy River?

- If water resources are affected, how will this impact the Outstandingly Remarkable Values within the suitable segment of the Big Sandy River?

Impact analysis for Wild and Scenic Rivers will be prepared when information on the effects of the Project on water quality of the Big Sandy River downstream of the Project due to the potential effects of aquifer drawdown and water discharge are available.

Access and Land Use

- What is the connection between potential water reuse for agricultural development proposed by Mohave County Economic Development Authority and future land uses in the Wikieup area?

- What are the natural gas pipeline effects on private and public lands?

Power Plant and Associated Facilities

The proposed Plant would be located on private lands. The County would provide a ROW for the water pipelines, natural gas pipeline, and the access road on private and federal lands. The proposed access road route is consistent with Mohave County's easement recommendation of locating linear facilities along the section or half section lines.

There would be no impacts on existing land zoning status from the siting, construction, and operation of the Plant because it would be located on a parcel of land owned by Caithness that has been zone M-X for heavy industrial uses. Because there are no current plans for other types of development (such as subdivisions) in the immediate vicinity of the Plant site, no long-term impacts to planned land uses from the construction and operation of the Plant are expected. The existing land use of the Plant site (grazing) would be displaced over the lifetime of the Plant.

Access to the Plant site from U.S. Highway 93 would be on an access road constructed by Caithness and maintained by the County. The proposed access road would be used for access to the Plant site and to private lands in Section 7, T15N, R12W. The access road would be located on privately owned parcels with the exception of that portion of public lands managed by the BLM.

There would be no disruption to public access onto the surrounding lands from Project construction and use of the access road. Traffic on U.S. Highway 93 would be temporarily disrupted at the junction of the access road and U.S. Highway 93 from access road construction activities, and from construction traffic entering and exiting the highway. During the construction phase of the Plant and ancillary facilities, short-term disruption from the physical intrusion of the crew and equipment, the generation of dust and noise, and the obstruction of traffic is not expected to affect area residents because none are located near the proposed Plant. The nearest residence to the Plant site is located approximately ½-mile southwest of the Plant site boundary, and more than ¾-miles from the proposed Plant building construction activity. The residence would be affected primarily by noise generated by construction activities, although there would be some air quality impact from dust generated by construction activities and pollutants generated by Plant operations. The residence is nearly ⅓-mile south of the proposed access road and would not be disrupted by construction traffic.

Natural Gas Pipeline

The proposed Project would include the installation of new gas pipeline within or adjacent to an existing highway and County road ROW. There would be no change, and therefore no long-term impact to existing land uses within or adjacent to existing natural gas line ROW. Impacts to existing land uses would occur primarily from the implementation of construction activities of any new ROW.

Impacts would occur if construction activities impede public access to commercial uses along U.S. Highway 93 in Wikieup. Traffic on County roads crossed by the pipeline would experience relatively minor delays caused by single lane closures during construction. The remaining lanes would be capable of handling the expected traffic levels. Traffic control requirements would be established and followed. Other commercial and industrial useswould not be affected by the construction and operation of the pipeline.

Impacts to residential uses by the natural gas pipeline would occur when the sights and sounds from construction occur. Temporary increases in noise, dust, and traffic would also occur. The pipeline would be located adjacent to a planned residential development near the junction of U.S. Highway 93 and Hackberry Road.

Most of the land crossed by the proposed gas pipeline is shrub and brush rangeland within the existing U.S. Highway 93 ROW. Privately-owned rangelands outside of the highway and proposed pipeline ROWs are currently used primarily for grazing, with small areas of land used for residences and commercial uses. Public rangelands are used for grazing and wildlife habitat. Recreation, except for limited hunting and off-road vehicle use, is not a significant use of public lands along most of the proposed Project's ROW.

Planned land uses have been mapped by Mohave County to guide future development in the County. Most of the proposed natural gas line is within the County designated planned land use area of Rural Development Area. In general, planned land uses in areas crossed by proposed new natural gas line are consistent with the proposed plans.

Public facilities, including natural gas lines, are a necessary element in the development of urban, suburban and rural land uses. The proposed natural gas line would be compatible with the future land use planning areas of urban, suburban and rural development areas.

Maintenance would occur over the life of the proposed Project. Maintenance activities would consist of periodic disturbances of noise, dust, and traffic.

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EXHIBIT B - ENVIRONMENTAL REPORTS

As stated in Arizona Corporation Commission Rules of Practice and Procedure R14-3-219:

"Attach any environmental studies which applicant has made or obtained in connection with the proposed site(s) or route(s). If an environmental report has been prepared for any federal agency or if a federal agency has prepared an environmental statement pursuant to Section 102 of the National Environmental Policy Act, a copy shall be included as part of this exhibit."

An Environmental Impact Statement is being prepared by Western and the BLM that will evaluate the effects of the proposed Project. When completed, both the Draft and Final EIS will be furnished (under separate cover) as supplemental information to the Committee. Completion of the Draft and Final EIS are **currently scheduled for December 2000 and June 2001, respectively.** In addition to the EIS, Caithness is preparing applications for other permits needed for the Project. These permits are listed in **Table B-1**.

An air quality permit will be obtained from the Arizona Department of Environmental Quality (ADEQ). As part of that process, a preliminary Air Quality Impact Analysis report was prepared to address potential impacts of the Project (**Exhibit B-1**). This report concludes that ambient air pollutant concentration will be well below the National Ambient Air Quality Standards (NAAQS) and the Prevention of Significant Deterioration (PSD) allowable increase. **Application for the PSD permit will be submitted in early 2001 as onsite meteorological data collection is completed and appropriate impact modeling is confirmed. Also, there will likely be no significant visibility impacts at the closest Class I airsheds.**

Use of water for wet cooling has been an issue of concern expressed by the public during project meetings. Caithness has considered alternative sources of water to eliminate potential effects on water users in the Big Sandy basin. The initial source considered was the shallow subsurface aquifer of the Big Sandy which was not determined to be a viable source due to potential drawdown effects of area wells and surface water flow. Caithness has identified and tested a deep aquifer source and studies have concluded that an adequate supply of water for Plant cooling is available with negligible effects to other water users in the basin. A complete analysis of water supply and potential impacts is presented in Exhibit B-2.

The results of other site surveys and environmental studies for the Plant site are discussed in subsequent sections of this Application. **Exhibit A** describes land use; **Exhibit C** describes the sensitive biological resources in the area; **Exhibit D** discusses other biological resources; **Exhibit E** summarizes the results of the cultural resources survey and discusses the potential effects on the area's scenic quality; **Exhibit I** discusses the noise impacts; and **Exhibits J.1 and J.3** discuss the effects of construction and operation of the proposed natural gas pipeline and the effects on socioeconomic conditions, respectively.

Table B-1
Big Sandy Energy Project
Environmental Regulatory Requirements

Authorizing Agency	Law or Regulation	Type of Permit/ Approval/Action/Constraint
Western Area Power Administration (Western) and Bureau of Land Management (BLM)	▸ National Environmental Policy Act of 1969 (NEPA)	▸ Record of Decisions by Western for transmission line interconnection ▸ Record of Decision by BLM for ROW across public lands administered by BLM
	▸ National Historic Preservation Act (NHPA) of 1966 as amended	▸ Cultural Resources Data Recovery Plan ▸ Native American Consultations
	▸ Archaeologic Resources Protection Act (ARPA) of 1979	▸ Cultural Resources mitigation ▸ Native American Consultations
	▸ Native American Graves Protection and Repatriation Act	▸ Protection of remains and funerary objects ▸ Native American Consultations
	▸ Executive Order 11988	▸ Floodplain management
	▸ Executive Order 11990	▸ Protection of wetlands
	▸ Executive Order 12898	▸ Environmental Justice in minority populations and lower income populations
	▸ Executive Order 13007	▸ Protection of Indian sacred sites and their religious practices
	▸ Endangered Species Act	▸ Biological Assessment and consultation with USFWS
	▸ Migratory Bird Treaty Act of 1918	▸ Protection of migratory birds
Bureau of Land Management	▸ Federal Land Policy and Management Act (FLPMA)	▸ Right-of-Way Grant for pipeline crossing of public lands administered by the BLM
U.S. Army Corps of Engineers	▸ Clean Water Act	▸ Section 404 Permit authorization for pipelines and access road
U.S. Fish & Wildlife Service	▸ Endangered Species Act	▸ Section 7 Consultation, if necessary (Biological Opinion)
U.S. Environmental Protection Agency	▸ Clean Air Act	▸ Air Quality Permits to Construct and Operate (PSD/Title V) for NO_x and PM_{10} for power plant emissions

Table B-1 (continued)
Big Sandy Energy Project
Environmental Regulatory Requirements

Authorizing Agency	Law or Regulation	Type of Permit/ Approval/Action/Constraint
Arizona Corporation Commission	▸ Arizona Revised Statutes	▸ Certificate of Environmental Compatibility for siting of power plant
Arizona Department of Environmental Quality	▸ Clean Water Act	▸ National Pollutant Discharge Elimination System (NPDES)Aquifer Protection Permit (APP) for construction and operation of the evaporation ponds
		▸ Stormwater Discharge Permits for construction and operation at power plant site
		▸ Spill Prevention Control and Countermeasure Plans for construction and operation
		▸ 401 Certification
	▸ Clean Air Act	▸ Air Quality Permits to Construct & Operate (PSD and Title V) for emissions of regulated pollutants from plant (NO_x and PM_{10} excepted)
		▸ Fugitive Dust Permit
	▸ Arizona Ambient Air Quality Guidelines	▸ Toxic Air Pollutants Standards for emissions of formaldehyde
	▸ SARA Title III	▸ Community Right-to-Know Reporting
	▸ Resource Conservation and Recovery Act (RCRA)	▸ Hazardous waste and hazardous materials storage and handling permits
Arizona Game and Fish Department	▸ Fish and Wildlife Coordination Act	▸ Coordination with USFWS/BLM/Western/COE

Table B-1(continued)
Big Sandy Energy Project
Environmental Regulatory Requirements

Authorizing Agency	Law or Regulation	Type of Permit/ Approval/Action/Constraint
Arizona State Historic Preservation Office	▸ National Historic Preservation Act	▸ Permits on state-owned lands ▸ Cultural Resources consultation with Western, BLM, and COE
	▸ Archaeologic Resources Protection Act (ARPA) of 1979	▸ Cultural Resources Data Recovery Plan ▸ Native American Consultations
	▸ Native American Graves Protection and Repatriation Act	▸ Protection of remains and funerary objects ▸ Native American Consultations
Arizona State Lands Department	▸ State Statutes	▸ Right-of-way Permit for portions of pipeline crossing state lands
Arizona Department of Highways	▸ State Statutes	▸ Crossing Permit for pipeline crossings of federal and state highways ▸ Permit for use of right-of-way
Arizona Department of Agriculture	▸ Native Plant Law	▸ Salvage or Removal Permit. Notice of clearing on private lands, salvage on state lands (transmission line).
Mohave County	▸ County Ordinances	▸ Specific Use Permit ▸ Zoning Permit ▸ Septic/Sewage Package Permit ▸ Building Permit ▸ Excavation Permit (pipeline) ▸ Grading Permit

EXHIBIT B-1

AIR QUALITY TECHNICAL REPORT

Report

BIG SANDY ENERGY PROJECT AIR QUALITY TECHNICAL REPORT

Submitted by:

Caithness Big Sandy, LLL
8787 E. Belleview Avenue
Suite 1100
Englewood, CO 80111

October 2000

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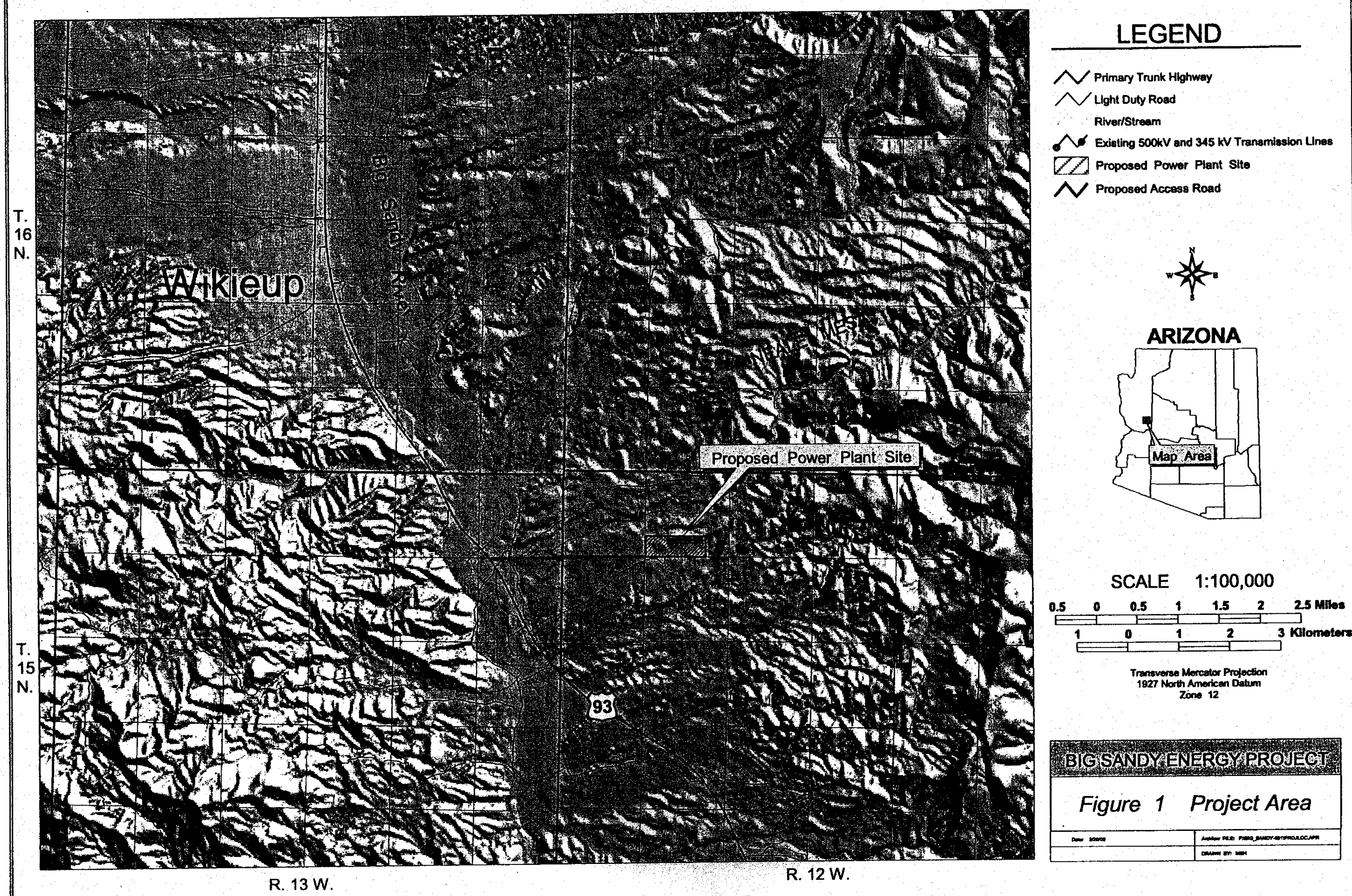
1.0 INTRODUCTION

Caithness Big Sandy Energy, L.L.C. has proposed to develop, construct, own, and operate the Big Sandy Energy Project, a natural gas-fired , combined cycle power plant near the unincorporated community of Wikieup, approximately 40 miles southeast of of the City of Kingman along U.S. Highway 93 in Mohave County, Arizona. Please refer to the Big Sandy Energy Project description for a detailed description of the Project.

This analysis presents the project description, emission rates, and air quality impact assessment for the proposed Big Sandy Energy 720-MW natural-gas fired power plant. The Big Sandy Energy Project will be constructed and operated approximately five miles southeast of Wikieup, Arizona in the Big Sandy River Valley in Mohave County (**Figure 1**).

Two phases are planned for the project. The first phase will consist of constructing and operating the facility as a 500-MW combined cycle power plant. The facility will consist of two combustion turbines (CT), two heat recovery steam generators, one steam turbine generator (STG), mechanical draft wet cooling tower for the steam turbine; a mechanical draft wet cooling tower for the inlet air cooling system (chiller) condenser cooling water, and associated support equipment. Since project emissions will be greater than 100 tons per year for all criteria pollutants, the source will be a Prevention of Significant Deterioration (PSD) source) as a fossil fuel-fired steam electric plant of more than 250 million Btu/hour heat input (40 CFR 52). Therefore, a PSD review will be required.

The second phase will consist of an upgrade to a 720-MW combined cycle power plant. The expansion will consist of one CT, one HRSG, STG, and extra mechanical draft wet cooling towers for the steam turbine and the inlet air cooling system (chiller) condenser cooling water., and associated support equipment. Big Sandy Energy is currently collecting on-site meteorological and PM_{10} data to support a potential PSD permit application in the future. Since the 720-MW phase of the project would emit the greatest amount of pollutants, this report only analyzes the air quality impacts associated with the 720-MW phase of the project.



BIG SANDY ENERGY PROJECT

Figure 1 Project Area

2.0 PROJECT DESCRIPTION

At full operating capacity, the Big Sandy Energy facility will have an electrical generation capacity of 720 MW. The power plant will consist of three Siemens V84.3A F-Class Combustion Turbine Generators (CTs), three Heat Recovery Steam Generators (HRSGs) with duct burners; two single condensing Steam Turbine Generators (STG); a mechanical draft wet cooling tower for the steam turbine; a mechanical draft wet cooling tower for the inlet air cooling system (chiller) condenser cooling water, and associated support equipment. The Plant General Arrangement Drawing, **Figure 2**, shows the arrangement of the plant. The turbine generators will be powered by pipeline-quality natural gas that will be delivered to the facility from existing pipelines located west of the plant site.

Each of the three CTs will generate approximately 160 MW. The CTs will be equipped with inlet cooling systems to increase plant output during periods of high ambient temperature conditions. The exhaust gas from each CT is routed to a triple pressure HRSG to generate steam for the STG. There is one HRSG for each CT. Steam from the three HRSGs is combined and vented to two triple pressure STGs. Duct firing will be provided in the HRSGs, and will be used to supplement steam generation capacity during conditions when the extra electricity needs to be produced. Approximately 120 MW will be produced by the steam turbine. Cooling water for the STG condenser is provided by circulating water through wet cooling towers.

The Big Sandy facility will be designed and controlled to meet the following emission limits:

- NO_x emissions will be controlled to 3.0 parts per million by volume (ppmvd) dry basis corrected to 15% oxygen. This emission level will be achieved by a combination of the dry low NO_x combustors in the CTs and a Selective Catalytic Reduction (SCR) system on the exhaust stream in the HRSG. Ammonia slip associated with SCR will be controlled to 10 ppmvd.

- CO will be controlled to 10.0 ppmvd at 15% oxygen from the CT combustors but CO will increase to 15.5 ppmvd during duct firing, and 35 ppmvd at loads less than 70 percent. These emission levels will be achieved by good combustion practices.

- VOC emissions will be controlled to 2.0 ppmvd from the CT combustors but VOC will increase to 3.1 ppmvd during duct firing. These emission levels will be achieved by good combustion practices.

- PM_{10} will be controlled to 6.5 lbs/hr from the CT combustors but PM_{10} will increase to 7.7 lbs/hr during duct firing. These emission levels will be achieved by good combustion practices and the use of natural gas as fuel.

- SO_2 will be limited by the total sulfur in the pipeline natural gas to a maximum of 3.4 lbs/hr during duct firing.

- PM_{10} emissions from the cooling towers will be minimized by high-efficiency drift eliminators.

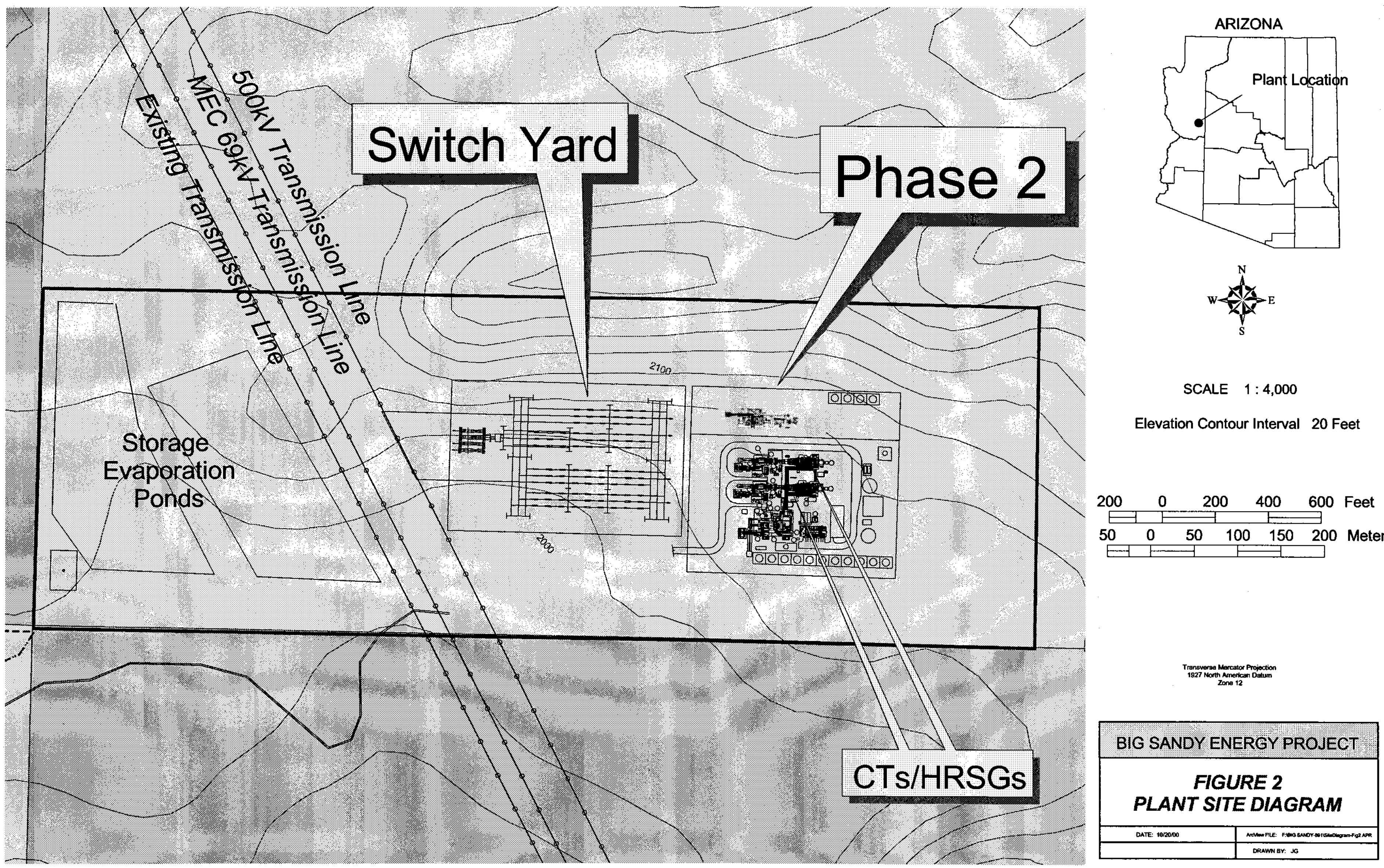


FIGURE 2
PLANT SITE DIAGRAM

This analyses reflect a combination of normal operations, normal operations that include supplemental duct firing (approximately 25 percent of operating time), and a startup/shutdown operating schedule for the CT/HRSG processes at this facility. Normal operations are defined as those where the CTs are operating above 60 percent load. Supplemental duct firing will initiated only when the CTs are operating at 100 percent load. Types of startups will include hot, warm and cold.

3.0 EXISTING AIR QUALITY

The general project area is designated unclassified/attainment for all criteria pollutants. Air quality has not been monitored near the Big Sandy project area. The area is a rural, agricultural and ranching area. The predominant source of pollutants is vehicle traffic along Highway 93, a major transportation corridor from Phoenix to northwest Arizona. No other significant stationary sources operate near the proposed site.

In absence of monitoring data at the proposed location, the Arizona Department of Environmental Quality (ADEQ) decided that PM_{10} data collected at Hillside, Yavapai County) from 1996 through 1998 would be representative of the background PM_{10} in the vicinity of the proposed Big Sandy Energy facility. The background three-year averages are 42.3 $\mu g/m^3$ as the 24-hour average and 11.3 $\mu g/m^3$ as the annual average. However, to add to the Arizona database of measured ambient pollution levels, Big Sandy Energy LLC has begun a PM_{10} monitoring program near the proposed plant location. There are no major stationary sources of NO_x or CO near the project. In lieu of measured background data, the ADEQ assumes a background value of 20 percent of the National Ambient Air Quality Standard (NAAQS) for nitrogen dioxide (NO_2) and carbon dioxide (CO). Therefore, the background NO_2 annual value is 20 $\mu g/m^3$, the 1-hour CO value is 8,000 $\mu g/m^3$ and the 8-hour CO value is 2,000 $\mu g/m^3$ (personal communication, Donna Luchesse, ADEQ).

Big Sandy Energy is also collecting meteorological data at the project location. The first three months for April, May and June 2000 are shown in **Appendix A**. For these three months, the wind flow is predominantly up and down valley, a meteorological result expected in the northwest-southeast oriented Big Sandy Valley (see **Figure 1**).

4.0 OPERATING SCENARIO

The Big Sandy Energy facility will consist of three combustion turbine generator/heat recovery steam generator (CTG/HRSG) units. These combustion turbines will be Siemens V84.3A machines or General Electric 7FAs.

In the combined cycle mode of operation, the Big Sandy Energy power plant will respond to market demands for electricity. During periods during the day or during the year, the plant may shutdown during periods of low electricity demand. When the plant commences operation after periods of being shutdown, the startup sequence will depend upon how long the turbines have been shut down. If the turbines have not been operated for more than 48 hours, the turbines and boilers are considered "cold' and the startup sequence will take approximately 3.7 hours to bring the entire power train (combustion turbines, HRSG, and steam turbine generators) to 100 percent load. If the plant has not been operated for 8 to 48 hours, it is assumed to be a warm start that would take approximately 2 hours. If the plant has only been offline for less than 8 hours, it is assumed that the equipment is "hot" and the startup sequence will only take about 1.2 hours.

During startups, the instantaneous emission rate will be greater than normal operations due to combustion and pollutant control devise inefficiencies, but will be realized for limited time periods. Emissions during cold, warm and hot starts are presented. A cold start assumes both units have been down for 48 hours, and the cold startup maximum duration is 3.68 hours. A warm start assumes both units have been down for 8 to 48 hours and the startup maximum duration will be 2.02 hours. A hot start assumes both units have been down less than 8 hours and the startup maximum duration will be 1.23 hours. Additionally, the shutdown period from normal operations will be 0.5 hours.

The operating scenario is presented as follows. The facility will experience 25 cold starts, 50 warm starts, and 100 hot starts per year for each CT. Supplemental duct firing will occur for 25 percent of these operational hours.

5.1 CT/HRSG EMISSIONS

Emissions rates were evaluated for the Siemens V84.3A combustion turbines at ambient temperatures of 20, 59 and 95 °F. The emission rates and all other performance data for the Siemens V84.3A combustion turbines are shown in **Appendix B**. Since the combustion turbines could operate at any time during the year, the emission rates for 59 °F were used to represent an overall average annual rate.

5.2 COOLING TOWER EMISSIONS

Mechanical draft cooling towers are required for the steam turbine and the inlet air cooling system. The location of these cooling towers is presented in the site arrangement in **Figure 2**.

The cooling towers employ water to cool the process water and result in an increase in both the temperature and moisture content of the air passing through it. Entrained liquid droplets in this air, known as "drift," may be carried out of the tower through the exhaust fan duct. Following evaporation of the water droplets, the dissolved solids present in the drift may be classified as PM emissions. The drift droplet TDS content is the same as the circulating water.

Cooling tower particulate emissions were first estimated based on emission calculation procedures found in Section 13.4, AP-42 (Fifth Edition 1995). These procedures were modified to account for the high-efficient cooling tower drift eliminators, which limit escaping water particles to 0.005 percent of the circulating water rate. The high efficiency drift eliminators minimize cooling tower mist and associated PM drift from the cooling tower and represent a significant increase in the control of these emissions over standard mist eliminators. The total PM_{10} emissions from the tower are calculated as follows:

Main Cooling Tower

$$\underset{\textit{Flow Rate}}{\frac{219{,}000\ \text{gal}}{\text{minute}}} \times \frac{8.34\ \text{lb H}_2\text{O}}{\text{gal}} \times \underset{\textit{Drift Rate}}{\frac{0.005\ \text{lb drift}}{100\ \text{lb H}_2\text{O}}} \times \underset{\textit{PM}}{\frac{3266\ \text{lbs}}{10^6\ \text{lb drift}}} \times \frac{60\ \text{min}}{\text{hr}} = 17.89\ \frac{\text{lb}}{\text{hr}}$$

$$17.89\ \frac{\text{lb}}{\text{hr}} \times \frac{\text{Tower}}{15\ \text{cells}}\quad 1.193\ \frac{\text{lbs PM}_{10}}{\text{hr-cell}} = \frac{0.151\ \text{gm PM}_{10}}{\text{sec-cell}}$$

Not all of this particulate mass is small enough to be PM_{10}. Data on cooling tower drift was analyzed to determine what fraction of the drift particulate mass is PM_{10}. Test data on drift particle size from typical high efficiency eliminators similar to what will be installed on the Big Sandy Energy cooling towers were obtained. The test results consisted of a drop size distribution, by mass, of the drift that escaped the high-efficiency drift eliminators in a test cell, and are summarized in **Table 1** for droplet sizes up to 110 μm. However, these data alone are not sufficient to describe particulate matter, as drift droplets begin to evaporate when they leave the tower stack. Eventually all the water evaporates, leaving a smaller, dry particle, which is equivalent to the mass of TDS in the original drift particle.

Knowing the drift particle size distribution, TDS, and density of the solids, the mass of PM_{10} emissions can be calculated. The dry particles are conservatively assumed to be spherical, and have the same density (ρ_{TDS}) as sodium chloride (2.2 g/cm^3).

Using the formula for the volume of a sphere, $V = \pi r^3/3$, and the density of pure water, $\rho_w = 1.0$ g/cm^3, the following equation can be derived which describes the particulate diameter, D_p, as a function of the drift droplet diameter, D_d:

$$Dp = 2[(D_d/2)^3 * (, \rho_w / \rho_{TDS}) * (TDS/10^6)]^{1/3}$$

Where,

TDS is in parts per million by mass (ppmw).

D_d = diameter of drift droplet, µm
D_p = diameter of solid particle, µm

Thus, for a drift droplet containing 3,266 ppmw of TDS,

$$D_p = 2[(D_d/2)^3 * (1.0/2.2) * (3{,}266/10^6)]^{1/3}$$

Reducing,

$$D_p = 0.4564 * D_d$$

The solid particle sizes corresponding to drift droplets with 3,266 total dissolved solids (TDS) are presented in **Table 1**. The TDS value is based on water chemistry calculations for the Big Sandy facility. The 3,266 TDS value is the estimate for untreated cooling tower water. By interpolating for a particle size of 10 µm, it is concluded that approximately 50 percent of the solids mass emissions are PM_{10}. Each of the 16 cooling tower cells would emit 0.576 lb/hr, or 0.0689 gm/sec. The remaining drift mass produces particulate greater than 10 µm in diameter. This conclusion is consistent with an in-depth study by Wistrom and Ovard (1973), which concluded that approximately 70% of drift droplets are deposited out for a cooling tower operating with seawater as the circulating water.

Table 1
Drift Droplet and Corresponding Solid Particulate Data

Drift Droplet Diameter (µm)	Solid Particle Size at 3,266 ppm TDS (µm)	Percent Mass Smaller
10	1.141	0.000
20	2.282	0.196
30	3.422	0.226
40	4.563	0.514
50	5.704	1.816
60	6.845	5.702
70	7.985	21.348
90	10.267	49.812
110	12.548	70.509

5.3 FACILITY EMISSIONS

Table 2 shows the total annual facility emissions that will occur.

5.4 HAZARDOUS AIR POLLUTANTS

Hazardous air pollutant (HAP) emissions are calculated using emission factors derived from the California Air Toxics Emission Factors (CATEF) database. Although the CATEF lists the minimum, mean, median, and maximum emission factors, the maximum factors are used to be conservative. The factors were selected for the source codes (SCC) 20200203 (natural gas fired industrial cogeneration turbines) and 10100601 (large natural gas fired boilers, i.e., duct firing). **Table 3** shows the maximum hourly and annual HAP emissions that will occur.

Table 2
Big Sandy Energy Project
Maximum Potential Emissions

Operational Parameters			NO_x		CO		VOC		SO_2		PM_{10}			
											Stacks		Cooling Towers (15 Cells)	
		per unit	per unit	3 units	per unit	3 units	per unit	3 units	per unit	3 units	per unit	3 units		
		Time (hrs)	lbs/hr	tons/yr	lbs/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lbs/hr	tons/yr
STARTUPS & SHUTDOWNS														
Cold Start	15	3.68	99.0	8.2	102.2	8.5	5.4	0.4	2.2	0.2	9.3	0.8	0.0	0.0
Warm Start	40	2.02	132.8	16.1	125.2	15.2	5.9	0.7	2.0	0.2	8.3	1.0	0.0	0.0
Hot Start	80	1.23	204.9	30.2	133.3	19.7	7.3	1.1	2.4	0.4	8.4	1.2	0.0	0.0
Shutdown	135	0.5	85.0	8.6	12.0	1.2	2.0	0.2	1.0	0.1	4.5	0.5	0.0	0.0
Total for Startups and Shutdowns		302		63.1		44.5		2.4		0.9		3.5		0.0
OPERATIONS														
100% Load		5085	17.4	132.7	35.4	270.0	4.0	30.5	3.2	24.4	6.5	49.6	8.9	22.7
100% Load with Duct Firing		1695	18.7	47.5	59.7	151.8	6.7	17.0	3.4	8.6	7.6	19.3	8.9	7.6
Total for Operations		6780		180.3		421.8		47.5		33.1		68.9		30.3
FACILITY TOTAL				**243.4**		**466.3**		**50.0**		**33.9**		**72.4**		**30.3**

Table 3
Big Sandy Energy Project
Maximum Hazardous Air Pollutant Potential Emissions

Substance	CAS	CT Emissions Factor (lb/MMcf)	CT Emissions (lb/hr)	Duct Burner Emission Factor (lb/MMcf)	Duct Burner Emissions (lb/hr)	Annual Emissions (tons)
1,3-Butadiene	106-99-0	1.33e-04	0.0004			0.00
Acetaldehyde	75-07-0	2.909e-01	0.8576	1.468e-02	0.0144	4.38
Acrolein	107-02-8	6.926e-02	0.2042			1.04
Benzene	71-43-2	4.716e-02	0.1390	8.698e-03	0.0009	0.71
Formaldehyde	50-00-0	4.479e-01	1.3204	6.723e-10	0.0659	6.83
Naphthalene	91-20-3	7.879e-03	0.0232			0.12
Propylene Oxide	75-56-9	5.869e-02	0.1730			0.88
Toluene	108-88-3	1.684e-01	0.4964			2.54
Xylene (Total)	1330-20-7	6.262e-02	0.1846			0.94
Total HAPs						17.45

This section describes the air quality analysis, using the Industrial Source Complex Short Term (ISCST356) dated 98356 dispersion model in conjunction with a screening meteorological data set, a representative year of nearby meteorological data, and the Building Profile Input Program (BPIP) dated 95086 to calculate building downwash, that is proposed to determine compliance with the NAAQS.

6.1 METEOROLOGICAL DATA

As previously mentioned, Big Sandy Energy is collecting meteorological data at the project site. The monitoring began in on March 24, 2000 and one year of data collection will be completed by March 23, 2001.Therefore, two sets of meteorological are used in this analysis to estimate the range of potential ambient air impacts that would occur from the operation of the Big Sandy Energy facility. The first set of meteorological data consists of screening data that contains all possible set of meteorological conditions. The second set is a year of meteorological data that was used for a previous PSD permit. This set of data was collected at a nearby location with similar topographical and meteorological settings.

6.1.1 Screening Meteorology

The screening meteorology in SCREEN3 is proposed to demonstrate the maximum impacts that could possibly occur. The Alberta, Canada, Environmental Sciences Division, Environmental Services has compiled the screening meteorology data set consisting of combinations of wind speed, atmospheric stability, and mixing height. A constant average temperature of 293 °Kelvin is used with every combination. These combinations are the values found in the SCREEN3 meteorology that are physically possible. For example, a wind speed of 10 m/s would not be included with Stability Category 1, 2, 5 or 6. Each combination is then applied to a wind direction every 10 degrees for a total of 1,872 combinations of meteorological conditions. The mechanically driven mixing height (z) is calculated using the SCREEN3 methodology as follows:

$$z = (0.3 \times u^*) / f$$

where:

u^* is the friction velocity
f = Coriolis parameter ($7.292 * 10^{-5}\,s^{-1}$)

Using a log-linear profile of the wind speed, and assuming a surface roughness length of about 0.3m, u^* is estimated from the 10-meter wind speed, u_{10}, as

$$u^* = 0.1\, u_{10} \tag{3}$$

Substituting for u^* yields:

$$z = 320 \times u$$

where:

u = the wind speed

Table 4 lists a summary of the 1,872 combinations in the screening meteorology data set.

Table 4
ISC Screening Meteorology

Stability Class	Wind Speed Classes (meters/second)	Mixing Height Classes (meters) [1]	Number of Combinations
1	1, 1.5, 2, 2.5, 3	10,000 (Unlimited)	180
2	1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5	320, 480, 640, 800, 960, 1120, 1280, 1440, 1600	324
3	1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 8	320, 480, 640, 800, 960, 1120, 1280, 1440, 1600, 2560	360
4	1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 8, 10, 12, 15, 20	320, 480, 640, 800, 960, 1120, 1280, 1440, 1600, 2560, 3200, 3840, 4800, 6400	504
5	1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5	320, 480, 640, 800, 960, 1120, 1280, 1440, 1600	324
6	1, 1.5, 2, 2.5, 3	320, 480, 640, 800, 960	180
		Total Combinations	1,872

[1]Mixing Height = 320 * wind speed
Source: Alberta, Canada, Environmental Sciences Division, Environmental Services. Available on Internet www.gov.ab.ca/env/air/

6.1.2 Meteorology from Yucca, Arizona

One year of meteorology data collected at the Ford Motor Company Proving Grounds (FMCPG) near Yucca, Arizona is presented as an estimate of the Big Sandy facility impacts. The FMCPG data is proposed to represent the meteorological conditions at the proposed Big Sandy Facility because of the similarity in topography of the two locations, similar elevations, and similar climate. The FMCPG data was approved for dispersion modeling for the Griffith Energy PSD permit application near Kingman, Arizona. The rest of this section will present the discussion concerning the validity of the FMCPG data for dispersion modeling for the Big Sandy Facility.

This data is proposed as representative of the conditions in the Big Sandy Valley for the following reasons:

- Both locations are in similarly oriented valleys (north-northwest to south-southwest),
- the elevations and adjacent topography of the valleys are similar,
- the climate (mean average temperature and precipitation) of both locations is similar,
- the Big Sandy facility is proposed in a rural environment with no major pollutant sources occurring in the Big Sandy Valley within 25 miles of the proposed facility,

- impacts associated with other natural gas power plants in Arizona (Griffith Energy in Kingman and Reliant Energy in Casa Grande) have been demonstrated to be minor.

The following discussion presents the arguments for the use of the FMCPG data.

6.1.2.1 Similar Valley Orientation and Topography

The FMCPG and the Big Sandy site are located 35 miles apart. The northwest-southeast trending Hualapai Mountain Range lies between the two locations. The Big Sandy River Valley lies between the Hualapai Mountains to the west and the Aquarius Mountains to the east. Yucca is located in the Sacramento Valley formed by the Black Mountains to the west and the Hualapai Mountains to the east. **Figure 3**, a composite of USGS digital elevation model files with 90 meter resolution, shows the topographical configuration of the two valleys.

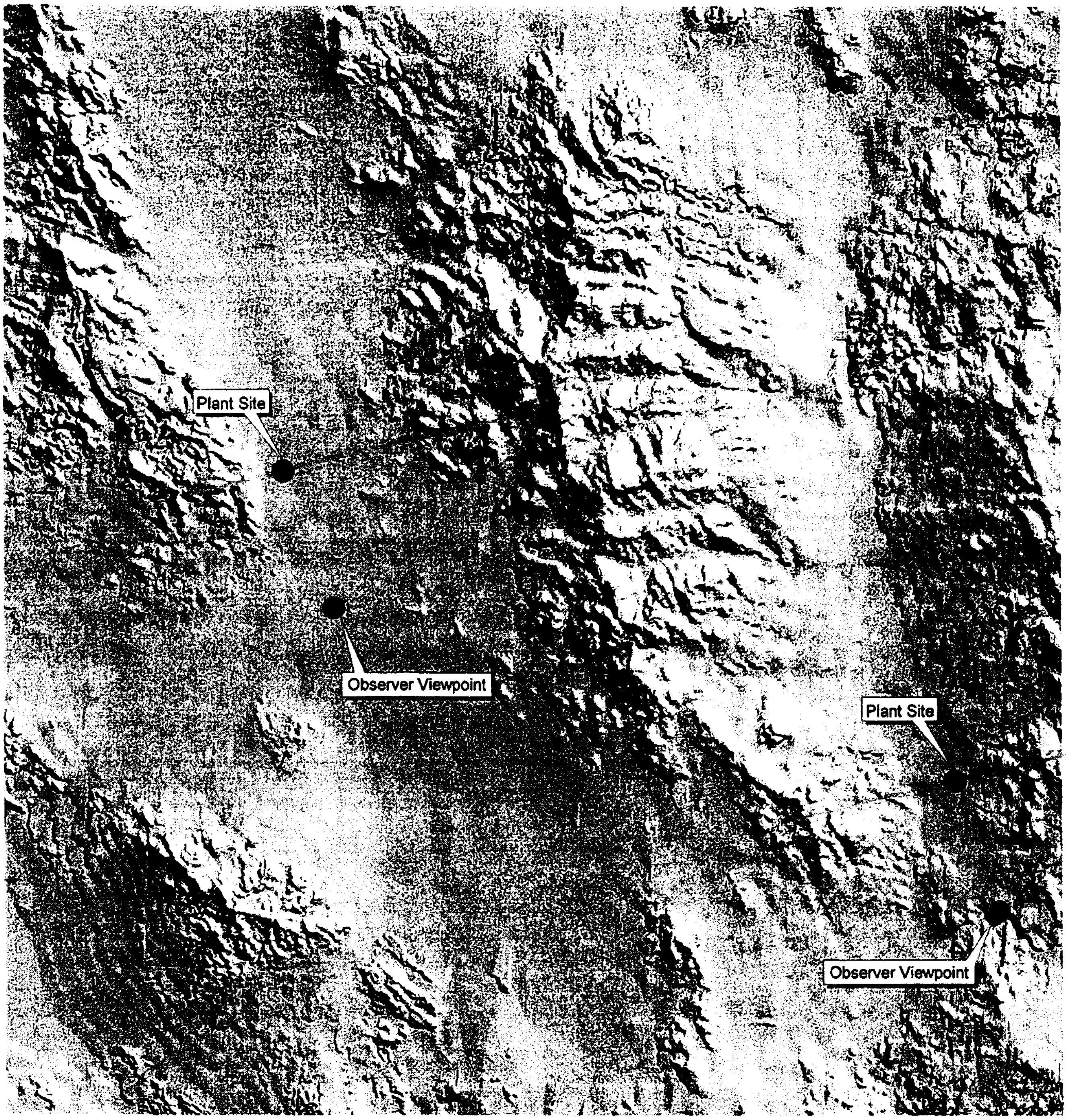
The base elevation of FMCPG is 1,950 feet (595 meters) and the base elevation of the Big Sandy Facility will be 2,070 feet (632 meters). **Figure 4** shows the cross-sections (along the cross-section lines indicated on **Figure 3**) of the two valleys to include elevations of terrain to the east and west of the two sites. The Sacramento Valley is approximately 8,000 meters wide with elevations extending to 1,200 meters to the west and 1,300 meters to the east. The Big Sandy Valley similarly is approximately 11,000 meters wide bounded by elevations 900 meters to the west and 1,300 meters to the east. The terrain slopes downward from north to south in both valleys.

A simulation of an observer viewing both valleys 12 km south of both Yucca and the proposed Big Sandy Facility is also shown on **Figure 4**. The viewing angle is shown as a direct line of sight between the "observer viewpoint" and the "plant site". Both valleys show gently sloping terrain from the west to east with rapidly increasing slopes beyond the valley floor. In both valleys, the terrain to the west becomes a fairly regular mountain ridge, but has somewhat irregular terrain to the east.

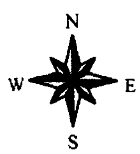
The windrose for the FMCPG (**Appendix C**) shows the predominant up-down valley flow that occurs in the Sacramento Valley. With all the topographical similarities, the wind flow at Big Sandy should be similar. Wind roses for April, May and June shown for FMCPG and the meteorological data collected so far at the Big Sandy site demonstrate the similarity of wind flow at both locations (see **Appendix C**).

6.1.2.2 Similar Climate

The FMCPG and Wikieup are both located with the Arizona Northwest Climatic Division. Although FMCPG and Wikieup are separated by the Hualapai Mountains, both areas experience a similar climate. Both Yucca and Wikieup are cooperative weather reporting locations for the National Weather Service. Yucca is Station 029645 and Wikieup is Station 092309. According to climate records obtained from the Western Regional Climate Center, the average annual temperature at Yucca is 67.2 °F and 66.0 ° F at Wikieup. Yucca experiences 10.1 inches of precipitation annually while Yucca receives 7.7 inches.



Shaded Relief Image (90 meter resolution)



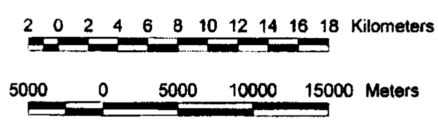
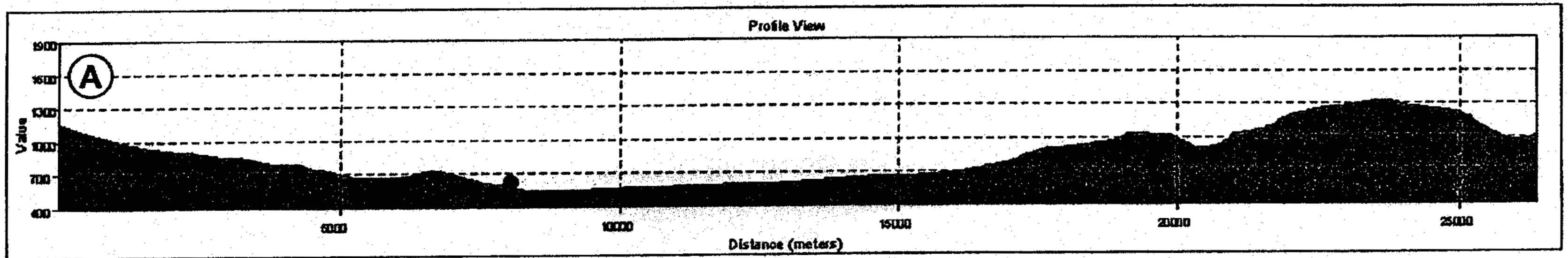


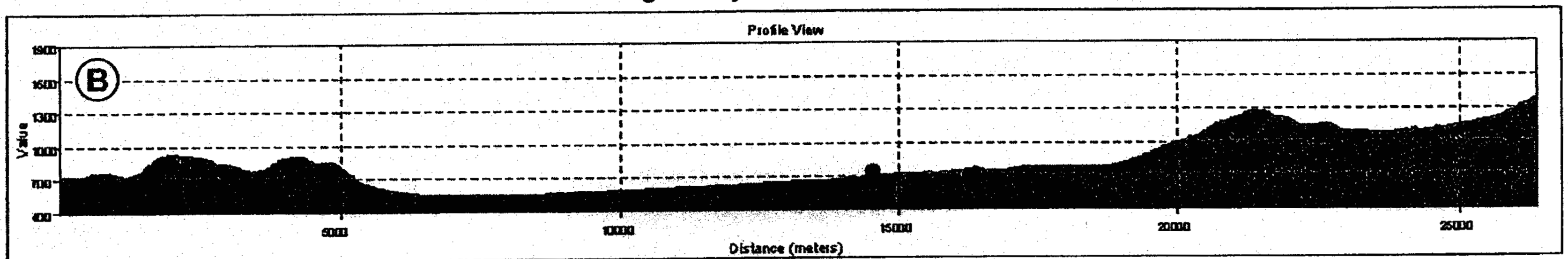
Figure 3

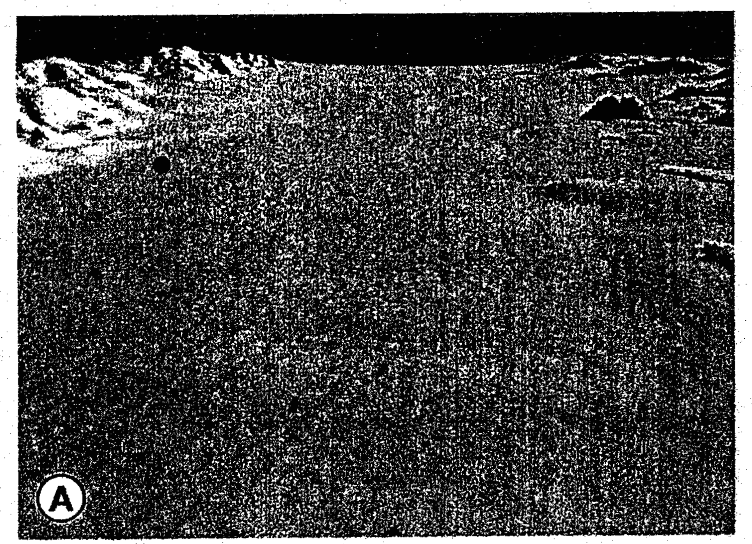
Figure 4

Yucca Cross Section



Big Sandy Cross Section





Yucca viewed from 12 km south looking NNW.

Big Sandy viewed from 12 km south looking NNW.

6.1.2.3 Lack of Significant Sources

The EPA AIRSData was checked for significant sources of NO_2, CO and PM_{10}. The nearest major sources were in Peach Springs, approximately 45 miles north of the proposed Big Sandy Facility, and in Yucca, 35 miles to the west. As previously described, the area is rural in nature with farming and ranching activities. The major source of pollutants is vehicle traffic along Highway 93 and Big Sandy Energy would include these vehicle emissions in the cumulative analysis. Therefore, the proposed Big Sandy Facility would not significantly or cumulatively interact with other sources to significantly raise regional ambient pollutant levels.

6.1.2.4 Low Emissions and Impacts

Big Sandy Energy would propose emission limits comparable to other natural gas power plants that have been permitted in Arizona recently. Both the Griffith Energy near Kingman and the Casa Grande MW power plants have been permitted with 3 ppm NO_x and 10 to 2 ppm CO. The proposed emission rate for Big Sandy is 2.5 ppm NO_x. The impact analysis for these two facilities indicated no significant ambient air impacts or increment consumption.

Table 5 summarizes the topographical and climatic similarities between FMCPG and Big Sandy.

Table 5
Comparison of General Setting between Wikieup and FMCPG

Parameter	Wikieup	Yucca
Valley Orientation	SE-NW	SE-NW
Valley Width (meters)	6,000	15,300
Proximity to Eastern Edge of Valley (meters)	1,750	9,200
Proximity to Western Edge of Valley (meters)	4,000	5,200
Elevation (meters)	670	595
Mean Annual Temperature (°F)	66.0	67.3
Mean Annual Maximum Temperature (°F)	83.8	80.7
Mean Annual Minimum Temperature (°F)	48.2	53.8
Mean Annual Precipitation (inches)	10.13	7.65

6.1.2.5 Validity and Accuracy of Data

The FMCPG meteorological data is used as environmental validation of engineering testing for Ford vehicles. The data is calibrated and maintained according to ISO-9000 and ISO-12000 standards for environmental equipment. The accuracy of the data is further validated by the National Weather Service for use as a Cooperative Weather Station. Since the proposed data has been validated for use in precise engineering studies and use in the National Weather Service nationwide climatological database, the data should be considered representative to determine NAAQS compliance in this EIS analysis.

6.2 EMISSION RATES FOR APPLICABLE AVERAGING PERIODS

6.2.1 One-hour Maximums

One-hour emission rates of 133.3 lbs/hr (16.81 gm/sec) during a hot start for each CT are used to assess CO 1-hour ambient impacts. Since all startup periods are longer than one hour, no combination of startup, shutdown, or normal emissions would be greater than the hot start CO emissions.

A 1-hour formaldehyde emission factor of 1.3863 lbs/hr (0.1748 gm/sec) during 100 percent load with duct firing was used.

6.2.2 Eight-hour Maximums

Eight-hour emission rates are required to assess CO ambient impacts. As this period is longer than any of the startup periods, it was necessary to examine all possible combinations of startups, shutdowns and normal operations.

Because of the minimum outage periods required for cold and warm starts, only a single cold or warm start could be expected during any eight-hour period. Therefore, it was determined that the highest emission rate will be a combination of a cold start and then 100% load with duct firing for the remainder of the 8-hour period. Accordingly, the emission rate will be 102.2 lbs/hr for 3.68 hours and 59.7 lbs/hr for 4.32 hours averaged for eight hours. The resultant emission rate will be 12.88 gm/sec for a 3.68 hour cold start and 7.53 gm/sec during the remaining 4.33 hours of 100 percent load with supplemental duct firing. Therefore, the eight-hour CO emission rate of 10.000 gm/sec for each CT was used to assess the eight-hour CO ambient impact.

6.2.3 24-hour Maximums

24-hour emission rates are required to assess PM_{10} ambient impacts. The startup emissions of PM_{10} are lower than the normal PM_{10} emissions. Therefore, a PM_{10} emission rate 7.6 lbs/hr (0.958 gm/sec) during 100 percent load with supplemental duct firing were used to assess the maximum 24-hour impacts. The cooling tower emission rate for each of the 15 cells is 0.0689 gm/sec, as shown in the previous section.

A 24-hour formaldehyde emission factor is 1.3863 lbs/hr (0.1748 gm/sec) during 100 percent load with duct firing.

6.2.4 Annual Maximums

The maximum annual emission rates for NO_x, PM_{10} and formaldehyde were calculated using the annual emissions listed on **Tables 2 and 3**. An annual emission rate was calculated simply by the ratio of tons per year divided by seconds per year. **Table 6** summarizes the emission rates for all applicable averaging periods. The cooling towers will operate a maximum 6,780 hours per year Therefore, the 24-hour rates are adjusted by a factor of 6780/8760 or 0.774. The annual emission rate for each cooling tower cell is 0.0533 gm/sec.

Table 6
Big Sandy Energy Dispersion Modeling Emission Rates

Pollutant	Averaging Period	Emission Rate for each CT (gm/sec)	Operating Condition
CO	1 hour	16.81	hot start
CO	8 hour	7.917	1 cold start followed by 100% load with supplemental duct firing
PM_{10}	24 hour	0.958	100% load with supplemental duct firing
PM_{10}	Annual	0.695	See Table 2
NOx	Annual	2.336	See Table 2
Formaldehyde	1 hour	0.1748	100% load with supplemental duct firing
	24 hour	0.1748	100% load with supplemental duct firing
	Annual	0.0655	See Table 3

6.3 DISPERSION MODEL SELECTION AND SETUP

The ISCST3 model, dated 98356, was used for the ambient impact analyses. The ISCST3 model is a steady-state, multiple-source, Gaussian dispersion model designed for use with stack emission sources situated in terrain where ground-level elevations can exceed the stack heights of the emission sources.

6.3.1 Model Setup

The following regulatory default options were used:

- Stack tip downwash
- Final plume rise
- Buoyancy induced dispersion
- Calm processing

- Default wind profile exponents (rural) = 0.07, 0.07, 0.10, 0.15, 0.35, 0.55
- Default vertical temperature gradients = 0.0,0.0,0.0,0.0,0.02, 0.035
- Anemometer height = 10 meters

The ISCST3 modeling employed the final plume rise option, as recommended in the USEPA Modeling Guidelines. Buoyancy-induced dispersion, which accounts for the initial buoyant growth of a plume, caused by entrainment of ambient air, was included in the modeling because of the relatively warm exit temperature and subsequent buoyant nature of the exhaust plumes. As recommended by the USEPA Modeling Guidelines, stack tip downwash was also included.

Based on the land use classification procedure of Auer (1978), land use in the region surrounding the project site is greater than 50 percent rural. Therefore, in the modeling analyses, rural dispersion coefficients were assigned.

6.4 Building Downwash and Good Engineering Practice

Building wake effects were included for all point sources and all structures and buildings at the proposed facility. The ISCST3 building wake effect inputs were generated using the Building Profile Input Program (BPIP) based on the building configuration shown in **Figure 2.** BPIP was also used to analyze Good Engineering Practice (GEP) stack heights (H_g) = H + 1.5 (L) for the point sources. The purpose is to demonstrate that the modeled stack heights do not exceed GEP limits. The BPIP input and output data is included in the attached disks.

6.5 Receptor Grid

Receptors at 25 meter intervals were placed around the facility's fence line. Outside this fence line, receptors were at 100-meter intervals to three kilometers, and 200-meter intervals from three to seven kilometers. The elevation of each receptor was determined from U.S.G.S. Digital Elevation Model electronic files. The modeling grid and associated topography is shown on **Figure 5.**

6.6 Stack Parameters

The following stack parameters were used for modeling. To insure that the most conservative modeling results (therefore the maximum impacts) are modeled, the most conservative exhaust parameters (the lowest exhaust velocity and temperature) were used. All parameters are identical for startups, 100 percent load, and 100 percent load with duct firing except the exhaust velocity and temperature. **Table 7** summarize the parameters for conditions at 59 °F, the ambient temperature nearest the mean annual temperature.

Table 7
Big Sandy Energy Exhaust Parameters

Stack Parameter	Startups	100% Load	100% Load with Duct Firing
Stack height (m)	39.6	39.6	39.6
Stack diameter (m)	5.79	5.79	5.79
Exit velocity (m/s)	17.3	22.8	23.4
Gas temperature (°K)	376	376	376

Big Sandy Topography
10-meter intervals

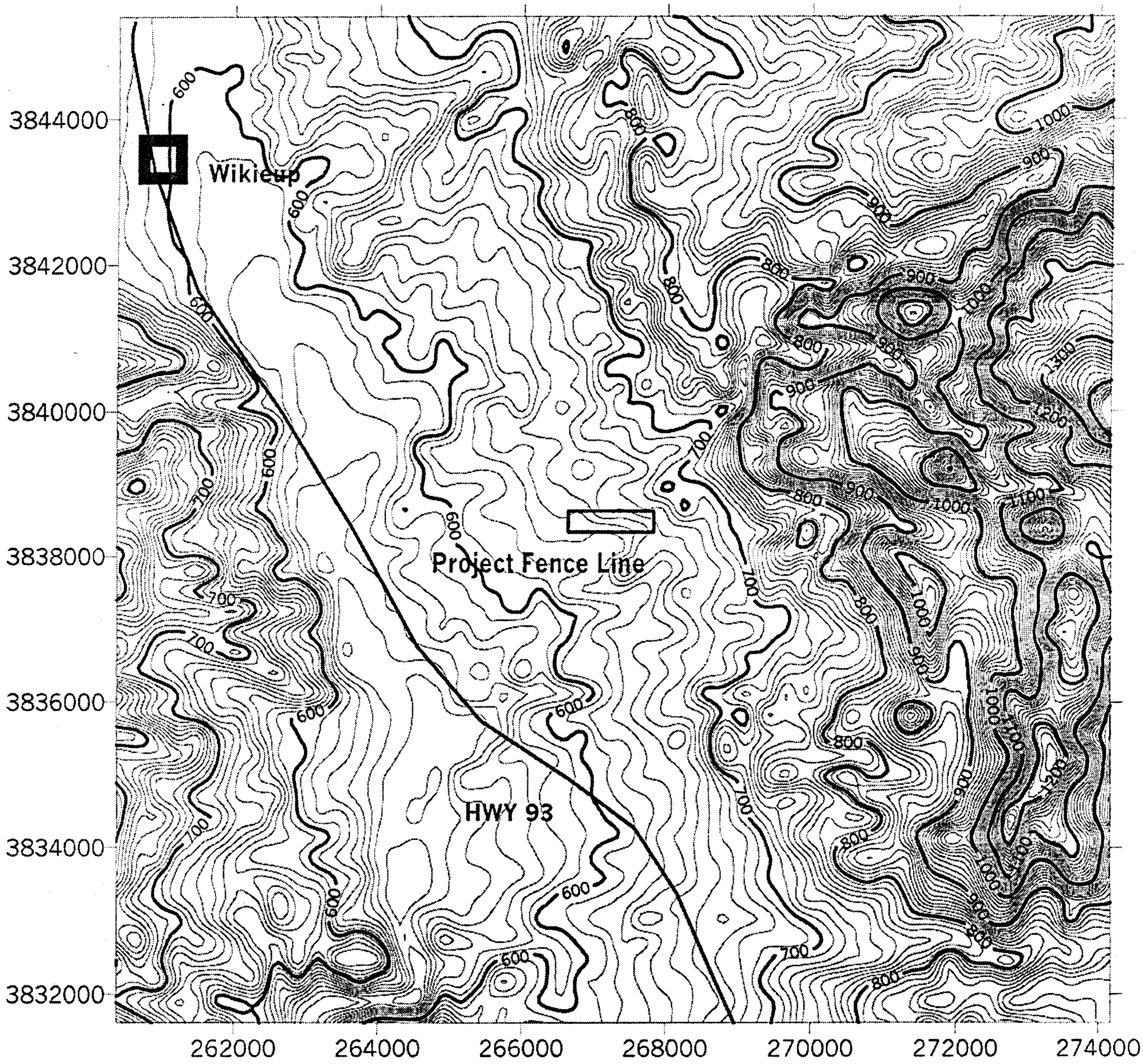


Figure 5

6.7 Conversion to Applicable Averaging Period

The ISCST356 model run produces one-hour maximum concentrations for each receptor by evaluating each meteorological condition. Therefore, this modeling technique calculates the maximum one-hour impact at each receptor that can possibly occur. To convert these maximum one-hour impacts to maximum impacts for all averaging periods, the conversion method from the EPA-approved SCREEN3 screening model is employed. The one-hour values were converted to averaging period values that corresponded to the respective ambient standards using the factors presented in "Screening Procedures for Estimating the Air Quality Impact of Stationary Sources" (EPA 454/B-95-004). These factors and their associated time periods are:

- 1.0 (1 hour) for CO and formaldehyde
- 0.9 (3 hour) for SO_2
- 0.7 (8 hour) for CO
- 0.4 (24 hour) for PM_{10}, SO_2 and formaldehyde
- 0.08 (annual) for NO_2, SO_2, PM_{10} and formaldehyde.

The modeled concentrations using the Ford data require no conversions. They are simple the model outputs.

Table 8 shows the National and Arizona ambient air quality standards which are identical for criteria pollutants. **Table 9** provides the standards for prevention of significant deterioration (PSD) increments, significant monitoring concentrations, and significant impact concentrations.

Table 8
National and Arizona Ambient Air Quality Standards

Pollutant	Averaging Time	$\mu g/m^3$
Nitrogen Dioxide	Annual average	100
Carbon Monoxide	1 hour	40,000
	8 hour	10,000
Suspended Particulate Matter (PM_{10})	24 hour	150
	Annual Arithmetic Mean	50
Sulfur Dioxide	24 hour	365
	Annual Average	80
Ozone	1 hour	235
Formaldehyde**	1 hour	20
	24 hour	12
	Annual Average	0.08

** Formaldehyde standards are Arizona Ambient Air Guidelines

Table 9
PSD Air Quality Significant Concentrations

Pollutant	Averaging Time	Class II Increment ($\mu g/m^3$)	Significant Monitoring Concentration ($\mu g/m^3$)	Significant Impact Concentration ($\mu g/m^3$)
NO_2	Annual	25	14	1
CO	1 hour	NA	NA	2,000
CO	8 hour	NA	575	500
PM_{10}	24 hour	30	10	5
	Annual	17	NA	1

Table 10 provides the results of the modeling of applicable pollutants. When the worst-case screening meteorology is used, the ambient CO impacts are well below all applicable standards. Therefore, no further analysis is required to demonstrate that no CO ambient air impacts would occur from the Big Sandy Energy Project.

The results also indicate that the NO_x ambient air impacts will be below the NAAQS and AAAQS. However, the screening analysis indicates that NO_x impacts would exceed the "significance level" for NO_x. Therefore, an analysis was completed using the meteorological data from FMCPG. The results of the FMCPG analysis show that the annual NO_x ambient air impact would decrease to 1.84 μg/m³ (1.8 percent of the NAAQS and AAAQS and 7.4 percent of the PSD Class II increment) compared to the screening level analysis of 7.66 μg/m³ for the screening analysis. However, this value would still slightly exceed the 1.0 μg/m³ significance level indicating that a full PSD Class incremental analysis will be required when the PSD application is submitted with the meteorological data being collected at the site. **Figures 6 and 7** show the distribution of NO_x ambient air concentrations for the screening and FMCPG analyses, respectively, in the vicinity of the Big Sandy Energy Project.

The results also indicate that the PM_{10} ambient air impacts will be below the NAAQS and AAAQS. However, the screening analysis indicates that PM_{10} impacts would exceed the "significance level" (see **Figure 8**). Therefore, an analysis was completed using the meteorological data from FMCPG. At first glance, the results are similar. However, as shown on **Figure 9**, the maximum 24-hour PM_{10} impacts for the FMCPG analysis would occur just to the north of the project boundary. Beyond the adjacent area affected by the cooling tower downwash conditions, the ambient air impacts are considerably below applicable NAAQS and PSD Class II significant impact levels. These results clearly demonstrate that the higher PM_{10} values are associated with downwash conditions from the cooling and chiller towers located on the northern edge of the project boundary and do not extend from the project boundary for any significant distance. The annual PM_{10} analysis shows similar results. **Figures 10 and 11** shows the results of the annual PM_{10} analysis using the screening meteorology and FMCPG meteorology, respectively. However, similar to the NO_x analysis, these 24-hour and annual PM_{10} values would still exceed the significance levels indicating that a full PSD Class incremental analysis will be required when the PSD application is submitted with the meteorological data being collected at the site.

The screening level results indicate that the 1- and 24-hour formaldehyde ambient air impacts would be below the standards of the Arizona Ambient Air Quality Guidelines. However, the screening level analysis (see **Figure 12**) indicates that the maximum value 0.24 μg/m³ has the potential to exceed the annual guideline. Therefore, an analysis was completed using the FMCPG data. The results of this analysis, shown on **Figure 13** using 1997 FMCPG meteorology, demonstrates that the maximum value encountered would be 0.06 μg/m³, a value lower than the annual guideline value of 0.08 μg/m³.

PSD regulations state that if the screening level analysis exceeds the "significance level" of pollutant ambient concentration, a refined air quality analysis must be completed. The refined analysis consists of using one year of on-site meteorological data or five years of nearby representative meteorological data. Additionally, other pollutant sources must be considered to evaluate the PSD Class II increment consumed by the project and other pollutant sources.

The screening level analysis indicates that refined modeling should be completed for NO_x and PM_{10}. During April 2000, Big Sandy Energy initiated a monitoring program at the proposed site. Meteorological and PM_{10} data will be collected for one year. The screening level analysis indicates that CO will be below significance levels and a refined analysis will not be required. Once the full year of data has been collected, the complete NO_x and PM_{10} PSD increment consumption will be completed and submitted to the Arizona Department of Environmental Quality.

Table 10
Big Sandy Energy Screening Model Predicted Maximum Air Quality Impacts

		Using Screening Meteorology				Using FMCPG 1997 Meteorology			
Pollutant	Period	Maximum Impact (µg/m³)	Percent of NAAQS and AAAQS (%)	Percent of Class II Increment (%)	Exceeds Significant Impact?	Maximum Impact (µg/m³)	Percent of NAAQS and AAAQS (%)	Percent of Class II Increment (%)	Exceeds Significant Impact?
NO_2	Annual	10.9	10.9	43.6	Yes	2.3	2.3	9.2	YES
CO	1 hour	785.2	2.0	NA	No	NA	NA	NA	NA
	8 hour	258.9	2.6	NA	No	NA	NA	NA	NA
PM_{10}	24 hour	28.9	19.3	96.3	Yes	27.8	18.5	92.7	YES
	Annual	4.3	8.6	25.3	Yes	2.2	4.4	12.9	YES
Formaldehyde	1 hour	8.1	40.5 [1]	NA	NA	NA	NA	NA	NA
	24 hour	3.2	26.7 [1]	NA	NA	NA	NA	NA	NA
	Annual	0.24	300 [1]	NA	NA	0.06	75.0 [1]	NA	NA

[1] Formaldehyde standards are Arizona Ambient Air Guidelines

Big Sandy Annual NO2
Screening Meteorology
(micrograms / cubic meter)

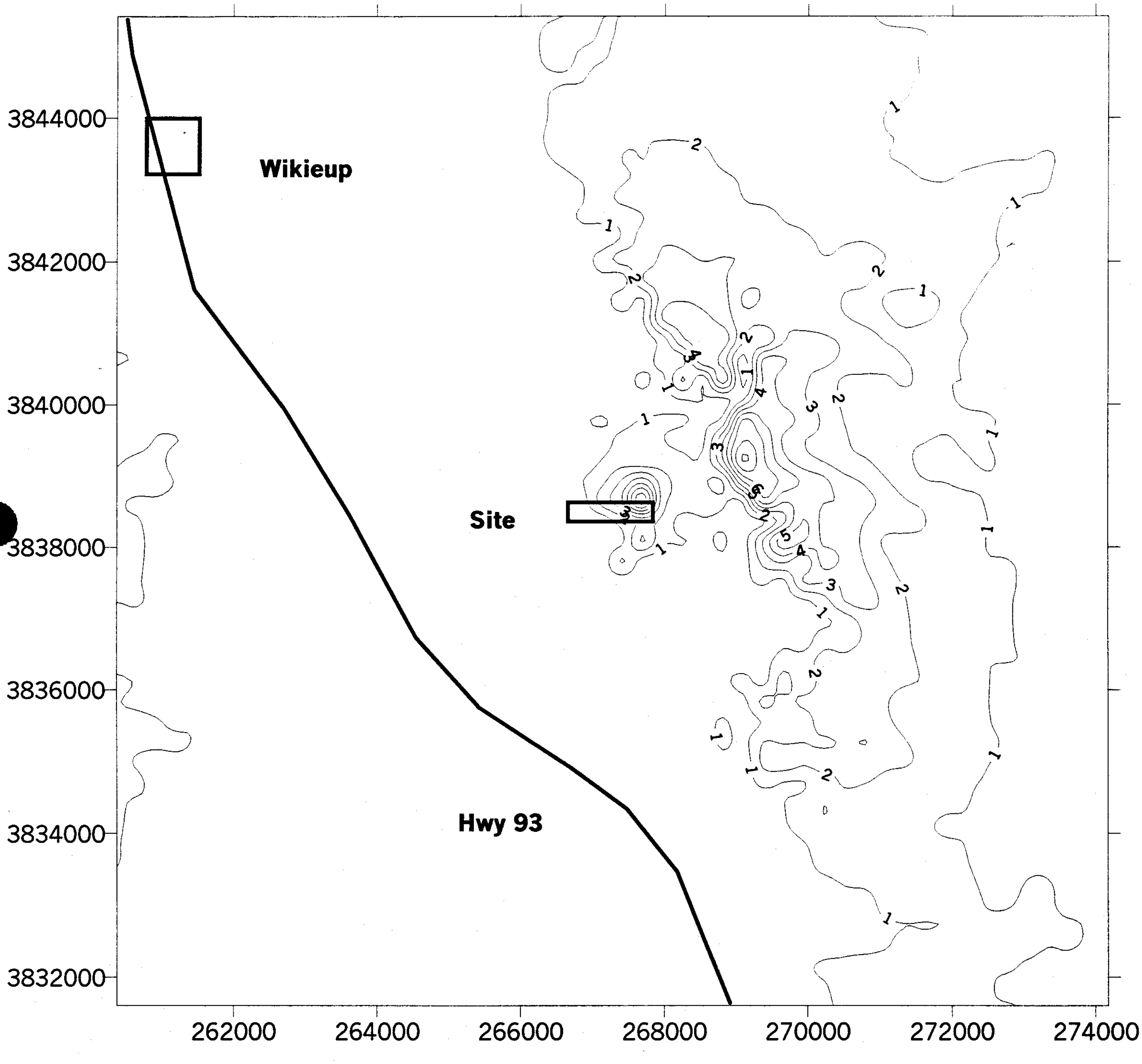


Figure 6

Big Sandy Annual NO2
FMCPG Meteorology
(micrograms / cubic meter)

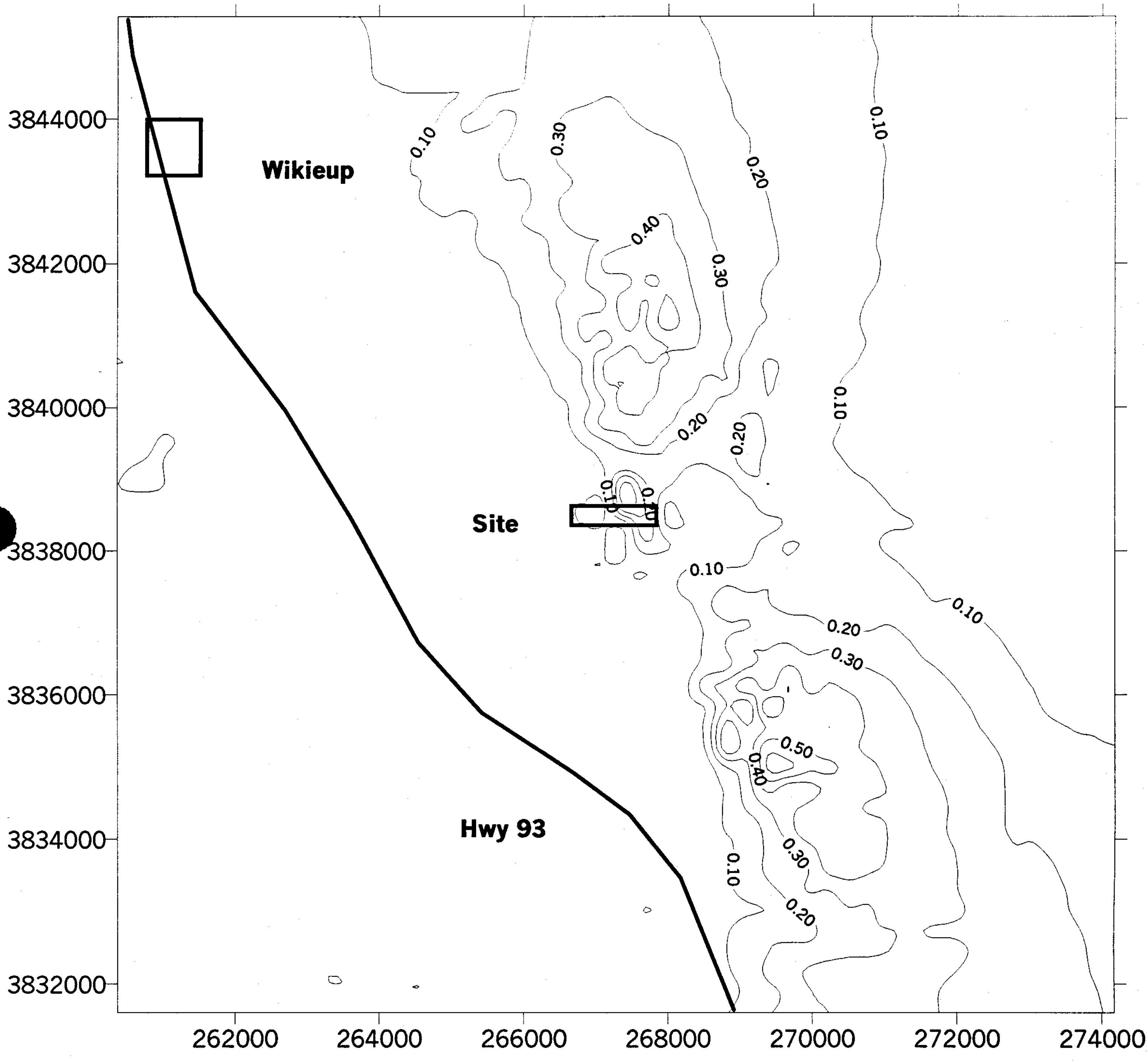


Figure 7

Big Sandy 24-Hour PM10
Screening Meteorology
(micrograms / cubic meter)

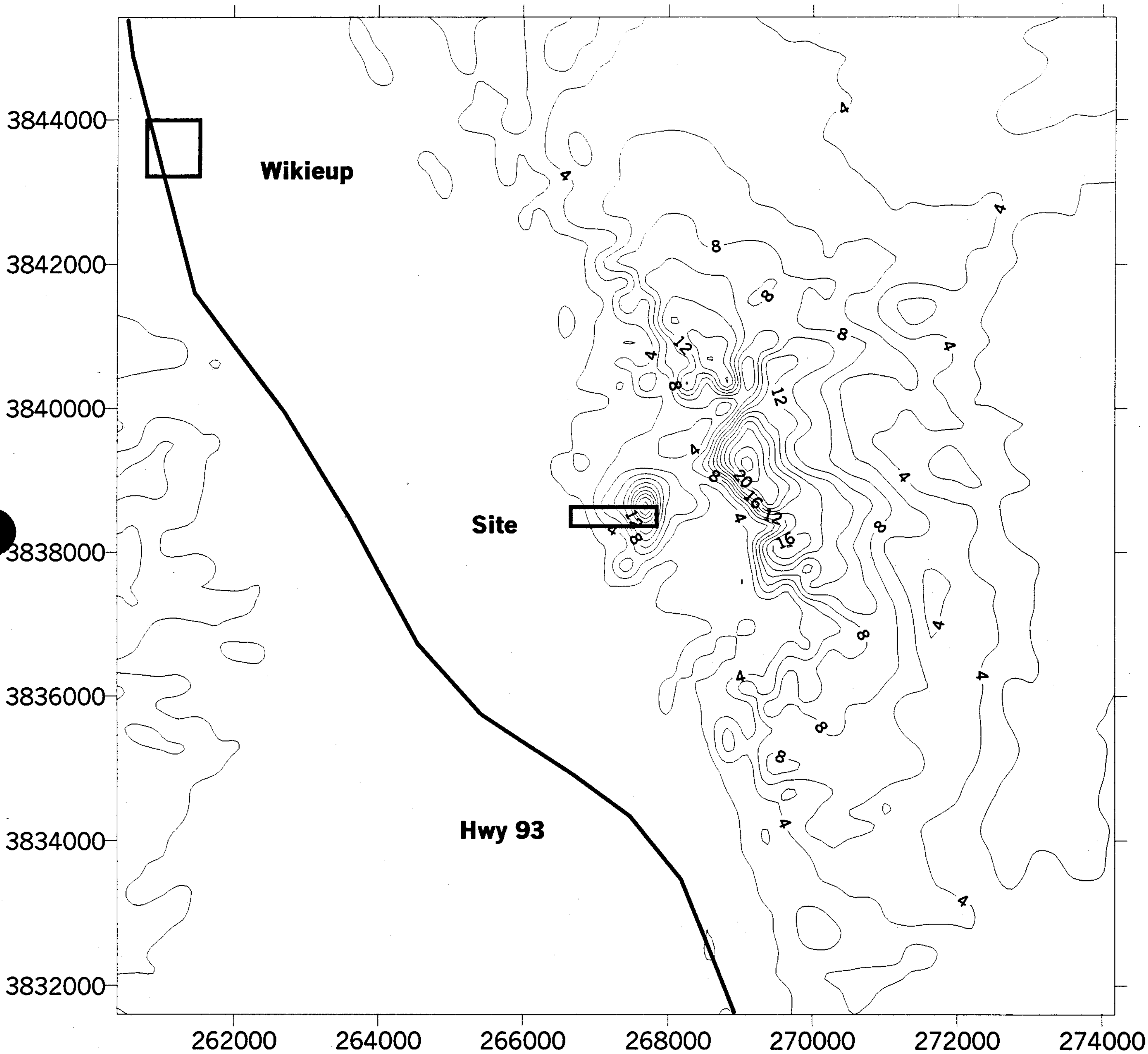


Figure 8

Big Sandy 24-Hour PM10
FMCPG Meteorology
(micrograms / cubic meter)

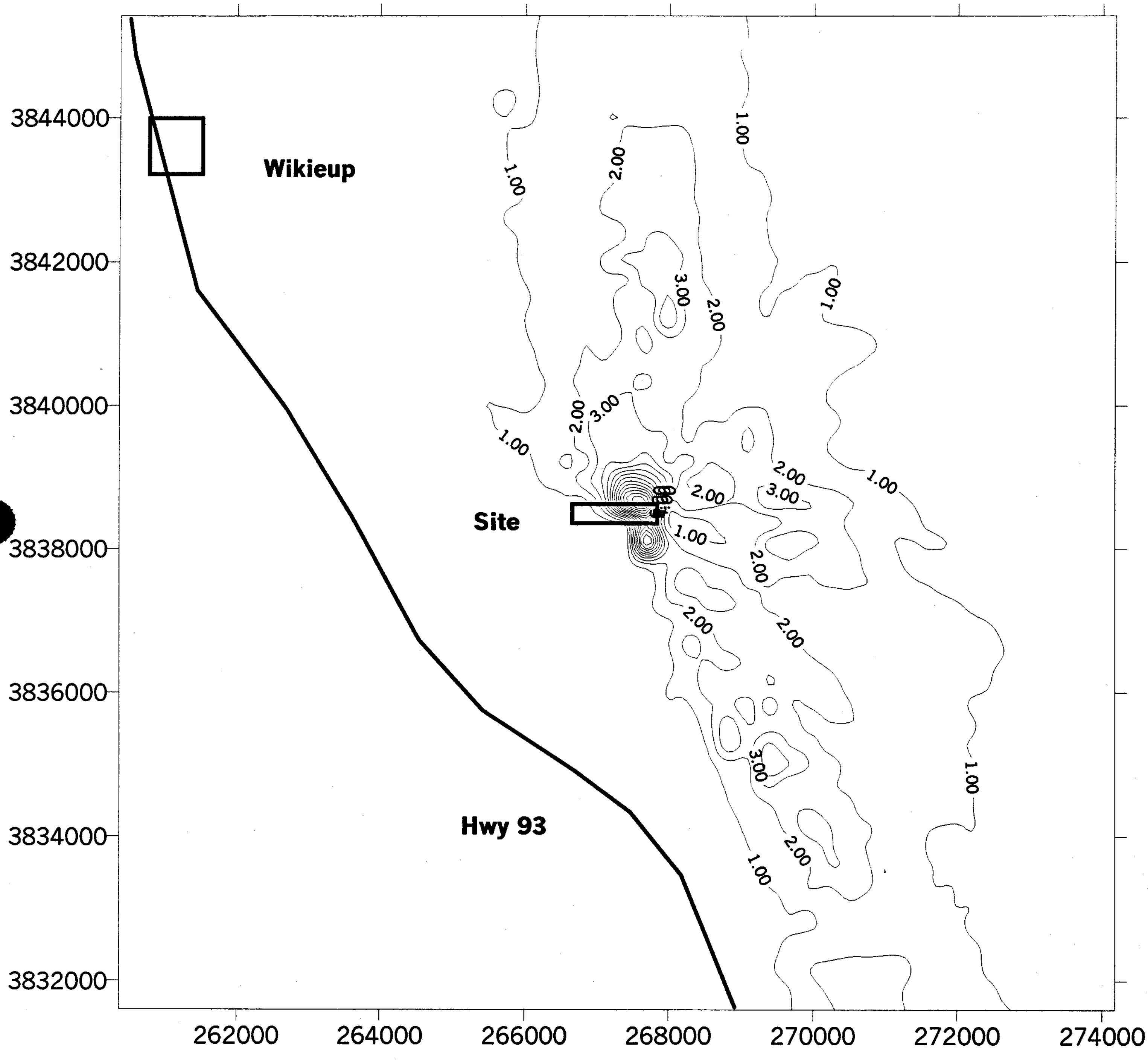


Figure 9

Big Sandy Annual PM10
Screening Meteorology
(micrograms / cubic meter)

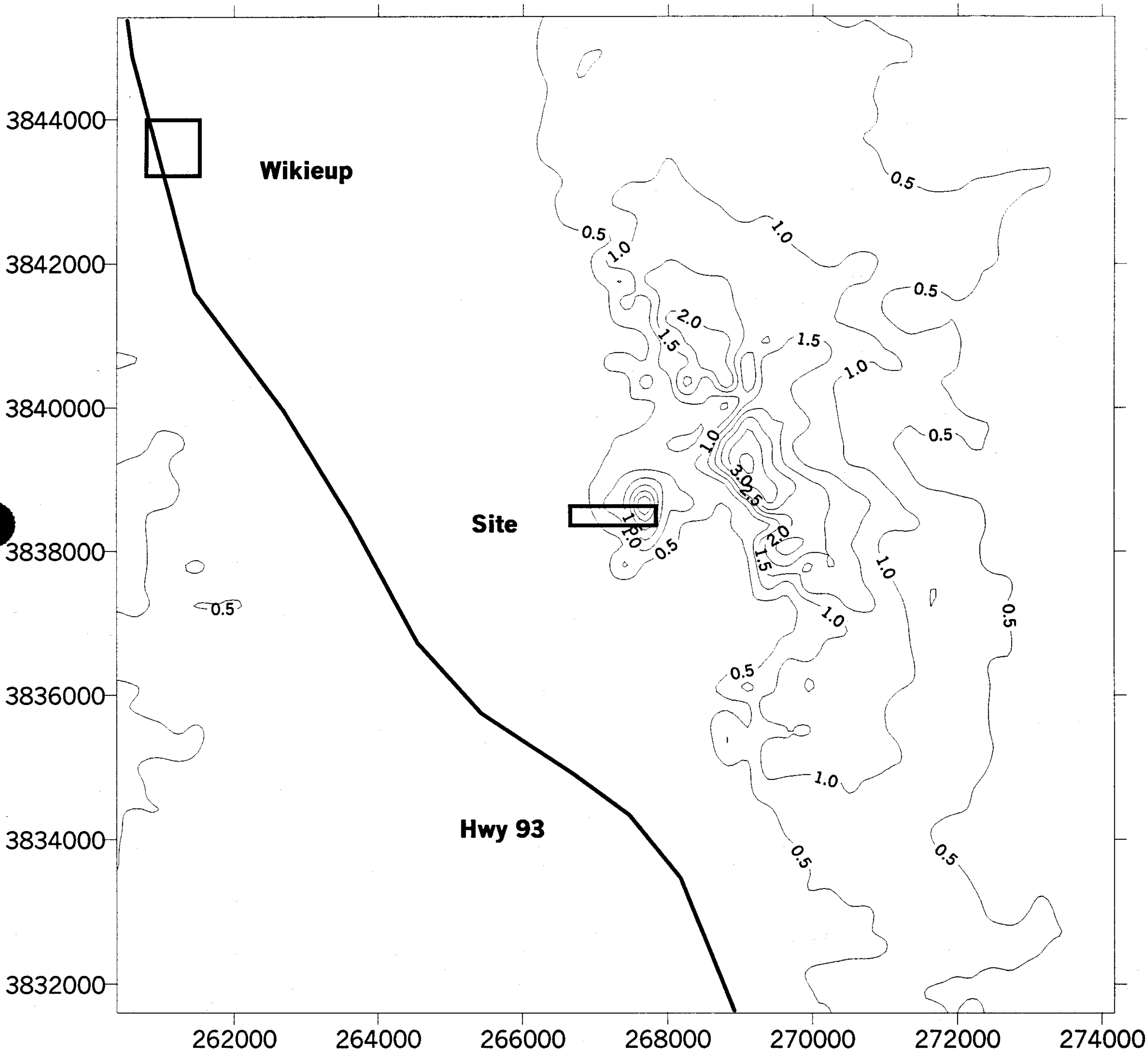


Figure 10

Big Sandy Annual PM10
FMCPG Meteorology
(micrograms / cubic meter)

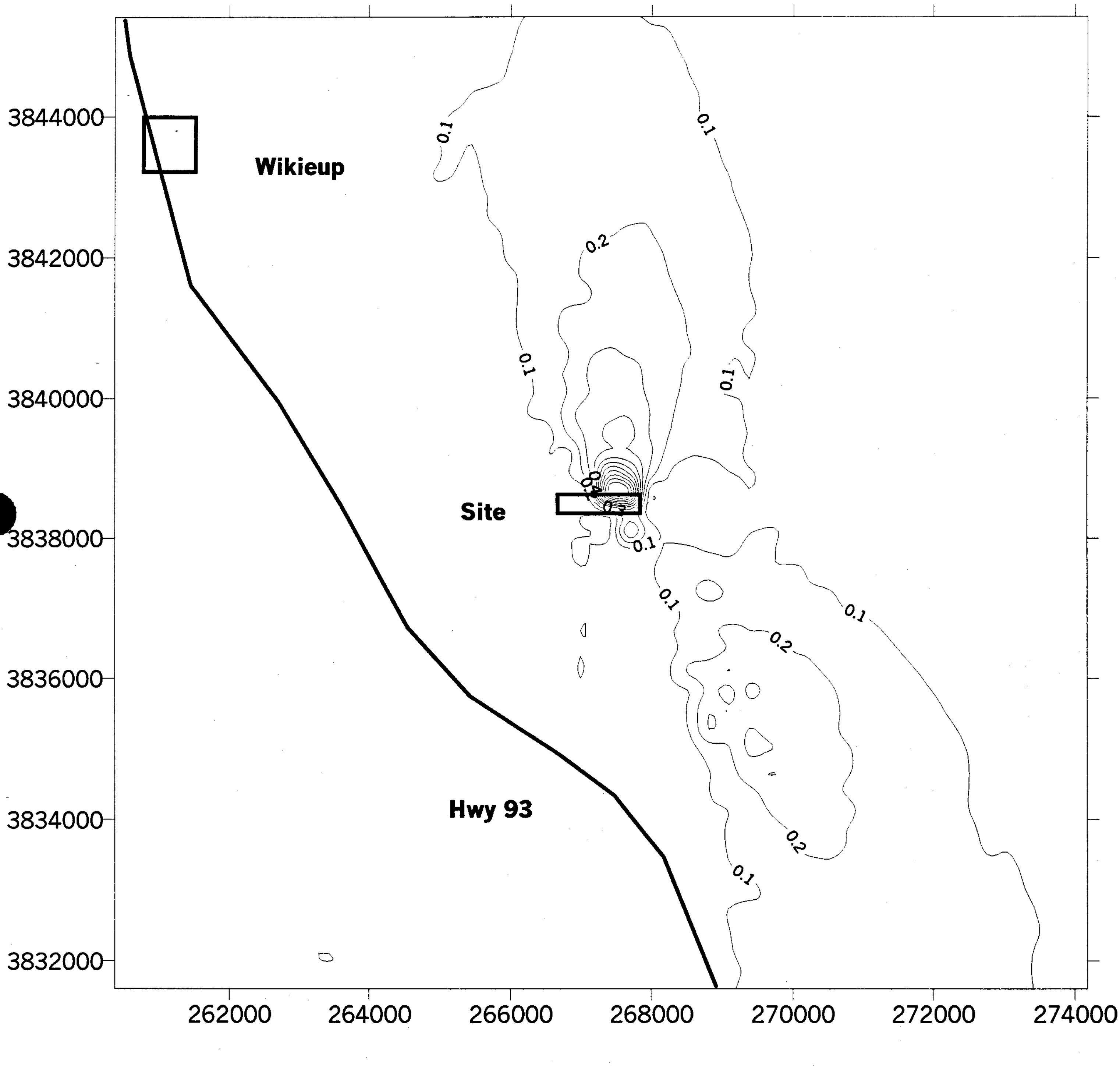


Figure 11

Big Sandy Annual Formaldehyde Screening Meteorology (micrograms/cubic meter)

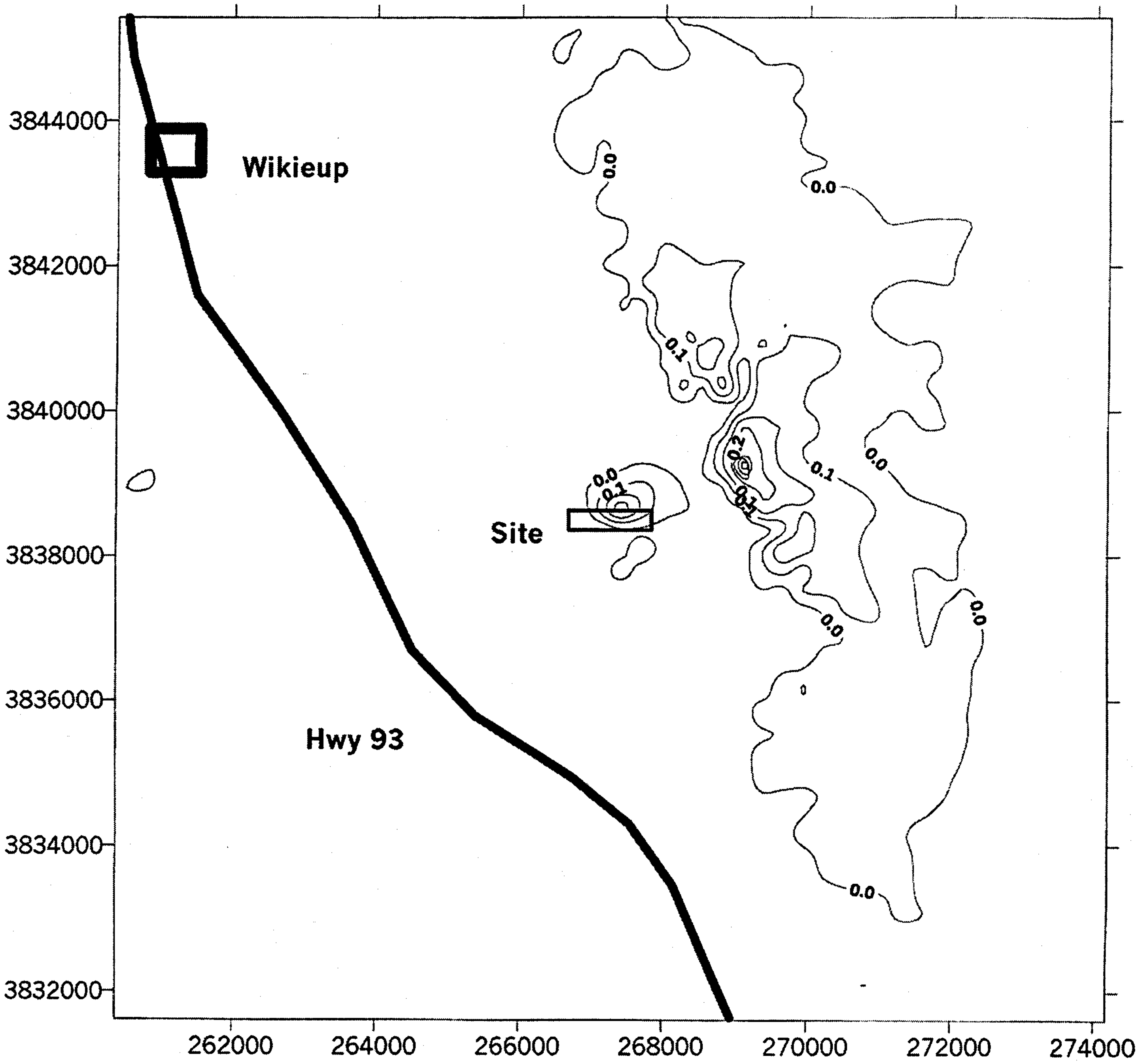


Figure 12

Big Sandy Annual Formaldehyde
1997 FMCPG Meteorology
(micrograms/cubic meter)

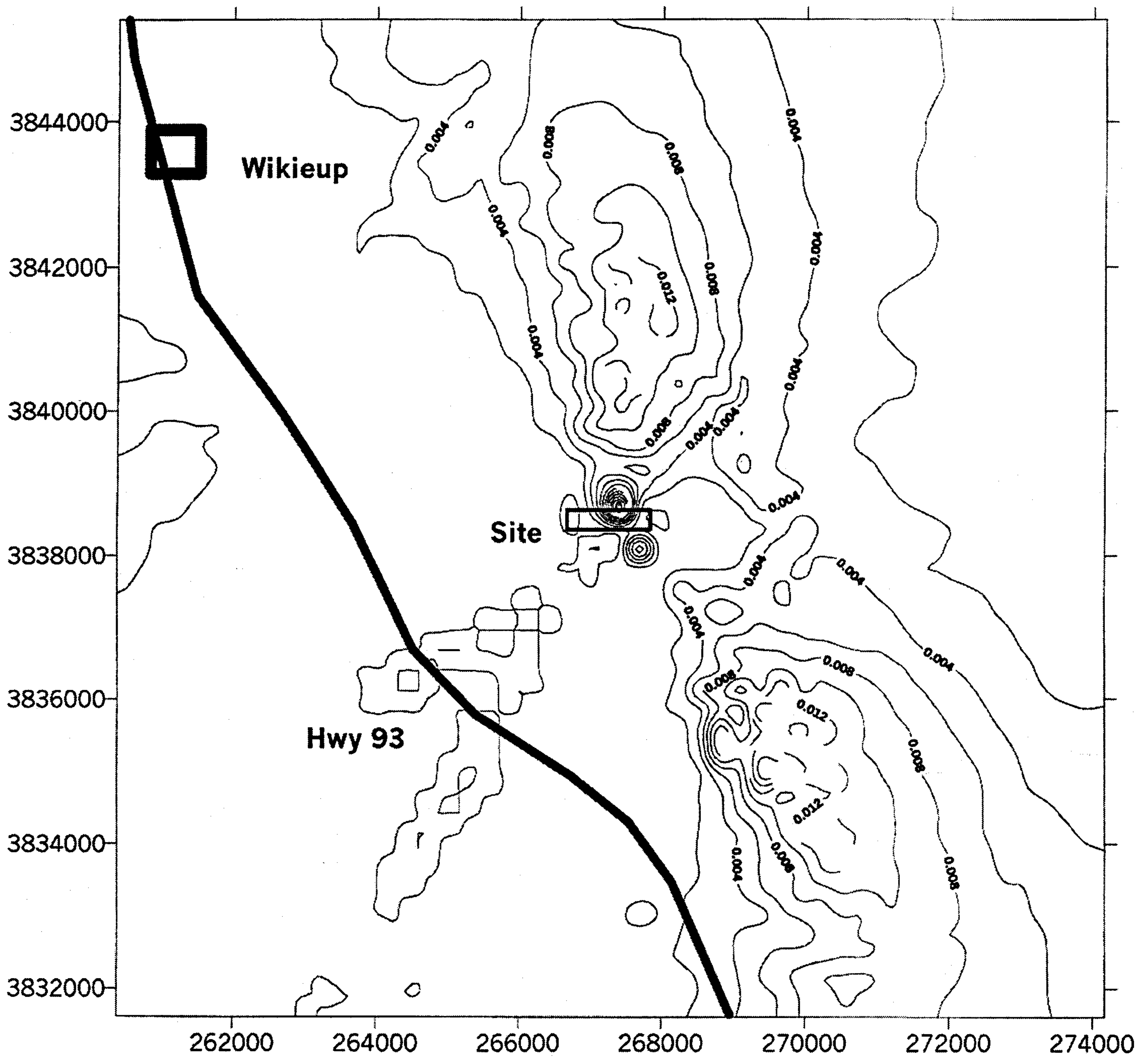


Figure 13

8.0 CONSTRUCTION IMPACT ANALYSIS

Gaseous emissions from construction vehicles and equipment would be short term and minor for the expected 120-day duration of the pipeline construction. Localized NO_x and CO would be slightly elevated for the duration of the project. However, the construction project would not have a significant impact on regional air quality levels for the following reason. The maximum length of construction would be 500 to 1,000 feet at any time. Therefore, construction air quality impacts would be contained to a maximum of one-mile segments as construction continued along the right-of-way. Accordingly, any one location would only be affected for short periods of the 120-day construction period. The slightly elevated NO_x and CO ambient levels would cease after construction is complete.

PM_{10} emissions, as fugitive dust, would result from soil disturbance during the 75-day pipeline construction period. Dust generated after several days without precipitation would be controlled by watering the right-of-way. After construction is complete, the right-of-way would be revegetated. To control dust during extended dry periods during construction and revegetation, PSC would water exposed soils to minimize the impacts. As a result of the small area disturbed (14.5 acres), the short construction period, and PSC's mitigation efforts to control dust, the fugitive dust impacts would be minimal and short-term.

During the 18-22 month construction period for the Big Sandy Energy Facility, gaseous emissions (NO_x, CO, SO_2, and PM_{10}) would be generated in the exhaust of heavy construction equipment such as graders, excavators, dozers, scrapers, tractors, water trucks, tractors, and air compressors. Additionally, PM_{10} would be generated in fugitive dust emissions from earth clearing and grading, and vehicular traffic on the site. All of the construction-related emissions would be short-term for the duration of the construction.

PM_{10} emissions can be estimated using an emission factor from the EPA document AP-42, Volume I, Stationary Sources, Section 13.2.3. General construction activities would produce 1.2 tons/acre/month of total suspended particulates (TSP). The Big Sandy Facility would be constructed on approximately an 80-acre area. Accordingly, the maximum monthly TSP emissions during the early phase of the project when most earth clearing would occur would be:

1.2 ton/acre/month * 80 acres = 96 tons/month * 2000 lb/ton / (30.4 * 24) hr/month = 263 lbs/hour.

This emission factor represents the total particulates that would be generated by construction activities. Approximately 36 percent of TSP is PM_{10}. Therefore, the PM_{10} emissions would be 34.5 tons/month or 94.7 lbs/hour. Furthermore, approximately 50 percent of the construction area would be disturbed by activities on any given day. As a result, PM_{10} emissions would be further reduced to 17.25 tons/month or 47.35 lbs/hour. The application of water or chemicals on exposed areas would reduce emissions another 50 percent. The resultant PM_{10} emissions would be 8.62 tons/month, or 23.7 lbs/hour.

To assess the ambient air impacts from construction-related fugitive dust, the ISCST390 dispersion model was used with the construction area of 80 acres as an area source. Receptors were placed beyond the construction boundary every 100 meters out to one kilometer, then every 300 meters out to 1.5 kilometers. For input into the model, the emissions rate was calculated as:

(23.7 lbs/hr * 454 gm/lb * 1/3600 hours/sec) / (80 acres * 4046 m^2/acre)

= 0.000009233 grams/sec/m^2.

The results of the modeling (**Figure 8**) showed that the highest 24-hour average concentration off the construction site would be over 150 $\mu g/m^3$ at and just beyond the project boundary. Likewise, te screening analysis indicates that construction-related PM_{10} would exceed the annual NAAQS at locations on the project boundary and just beyond. These results represent the maximum impacts when the most earth-clearing and grading would occur initially. After the site has been prepared, foundations have been constructed, and roads graveled, the fugitive dust impacts would be considerably less.

During construction, vehicles would generate exhaust emissions. **Table 11** summarizes the total anticipated CO, NO_xPM_{10}, SO_2, and PM_{10} emissions that would be generated during construction. Emission factors were obtained from the EPA document AP-42,Volume II, Emission Factors for Mobile Sources.

The total emissions per month were based on an assumed hourly vehicle use of 168 hours per month. The vehicle was assumed to operate 21 days per month and 8 hours per day. For a conservative estimate, construction equipment was assumed to operate 200 hours per month, and trucks were assumed to operate at either 100 or 150 hours per month.

The total annual emissions of 50.77 tons per year would be about five percent of Project emissions. Since the Project emissions have been demonstrated to not exceed National Ambient Air Quality Standards, it follows that construction-related project emissions would not cause any exceedances.

Big Sandy Energy
24-hr Construction PM10
Screening Meteorology
(micrograms/cubic meter)

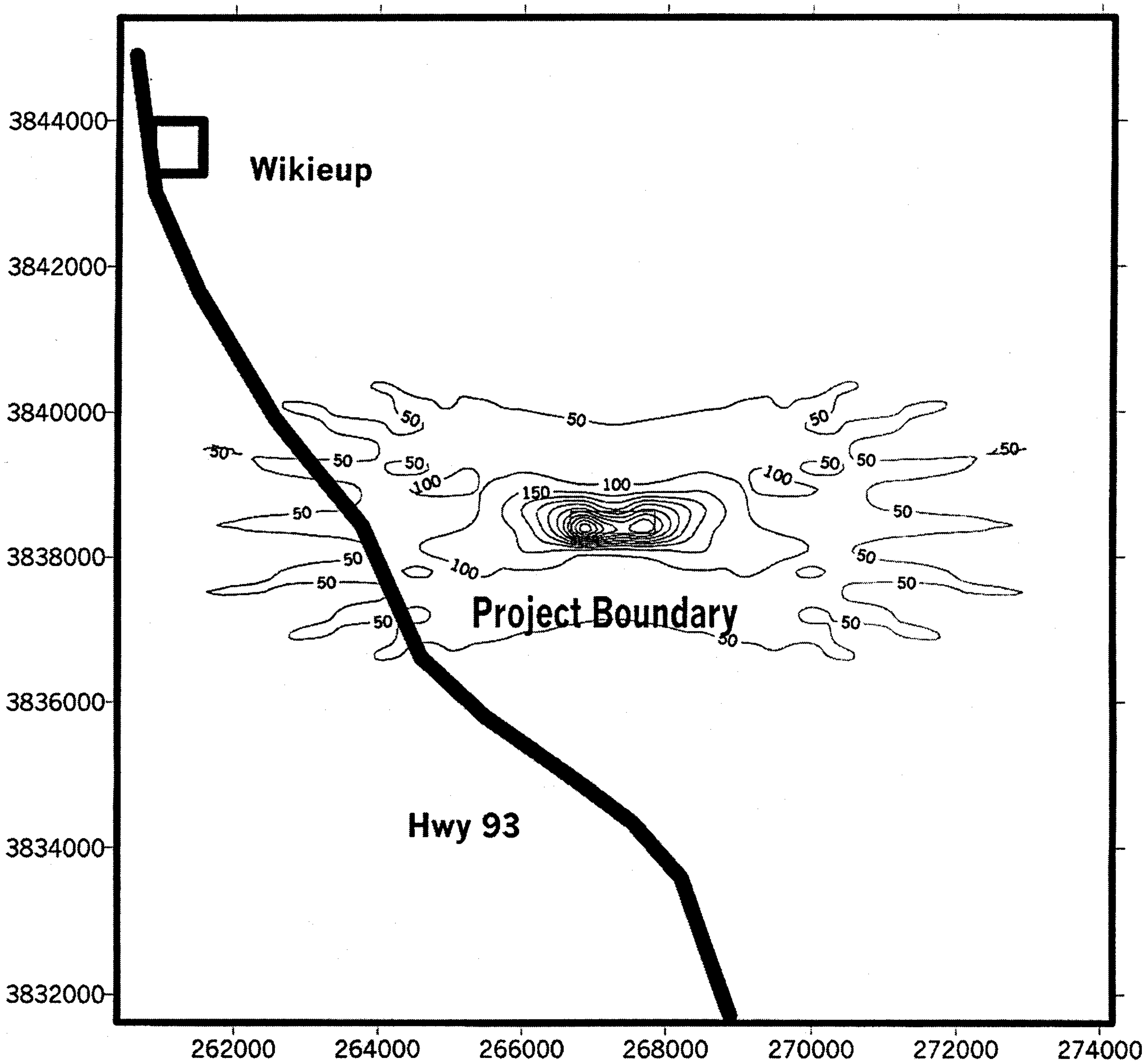
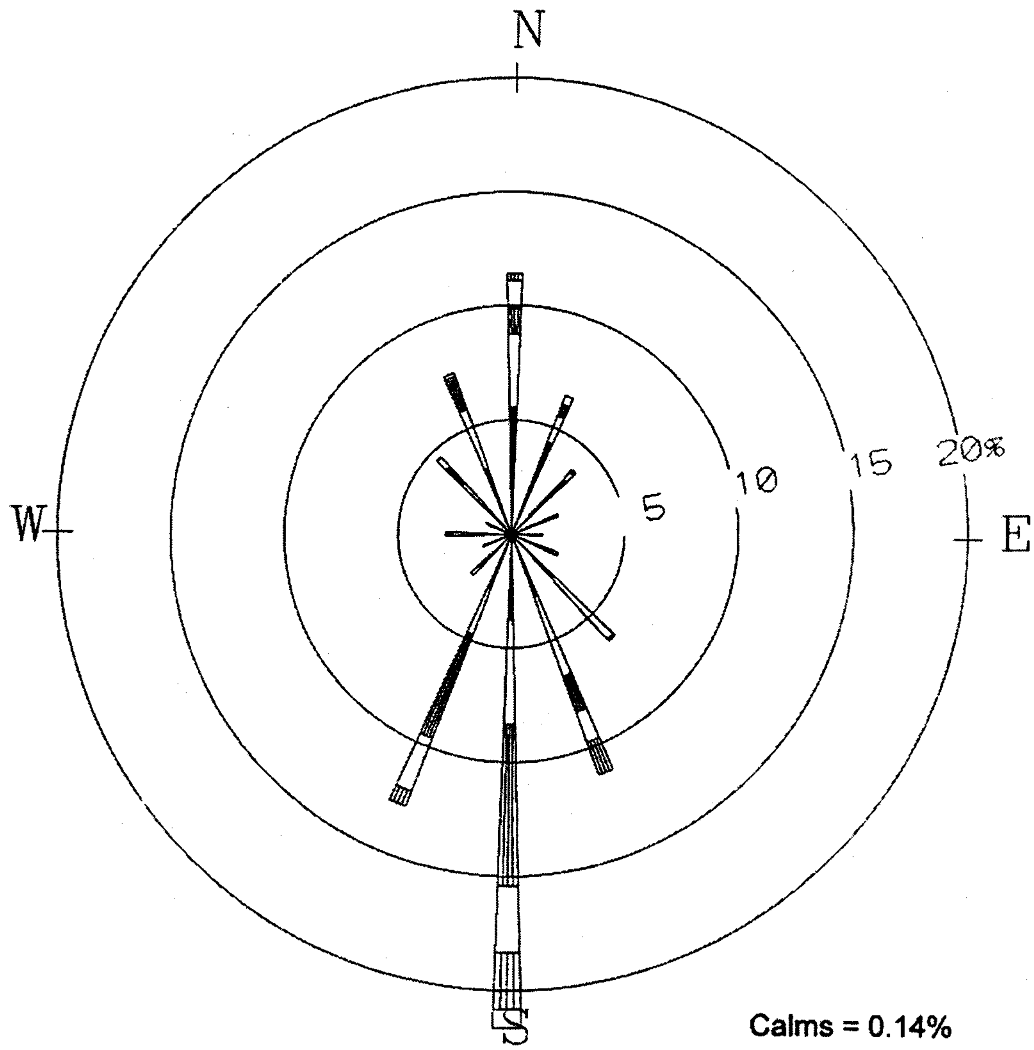


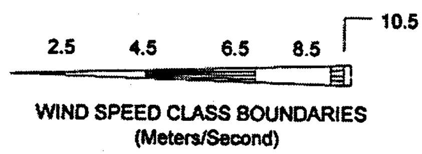
Figure 14

Table 11 Exhaust Emissions From Construction Vehicles*									
		Emissions							
Vehicle Type	**Operation**	**Carbon Monoxide**		**Nitrogen Oxides**		**Sulfur Dioxide**		**Particulates PM_{10}**	
	(hrs/mos)	**lb/hr**	**tons/ month**	**lb/hr**	**tons/ month**	**lb/hr**	**tons/ month**	**lb/hr**	**tons/ month**
Light & Medium Truck (gasoline)[a,b]	150	0.331	0.025	0.056	0.004	0.025	0.002	0.058	0.004
Heavy Truck (gasoline) [a,c]	100	0.730	1.655	0.098	0.005	0.005	0.003	0.128	0.006
Heavy Truck (off highway)	200	1.794	0.179	4.166	0.417	0.454	0.045	0.256	0.026
Light Tractor (track type)	200	0.346	0.035	1.26	0.13	0.137	0.014	0.112	0.011
Heavy Tractor (wheel type)	200	3.59	0.359	1.269	0.127	0.090	0.009	0.136	0.014
Cranes	200	0.675	0.068	1.691	0.169	0.143	0.014	0.139	0.014
Heavy Equipment (miscellaneous)[d]	200	0.675	0.068	1.691	0.69	0.143	0.014	0.139	0.014
TOTAL	**1,250**	**8.141**	**2.389**	**10.231**	**1.659**	**0.992**	**0.105**	**0.782**	**0.078**
TOTAL Emissions:	4.231 Tons Per Month; 50.77 Tons Per Year.								

* All vehicles are diesel powered, except as noted.
[a] For gasoline powered vehicles, emission rate (lb/h) is based on a gram per mile EPA emission factor and the speed shown under footnote [b] or [c].
[b] Assumes an average vehicle speed of 15 mph.
[c] Assumes an average vehicle speed of 10 mph.
[d] Includes trenchers, pavers, and compact loaders.

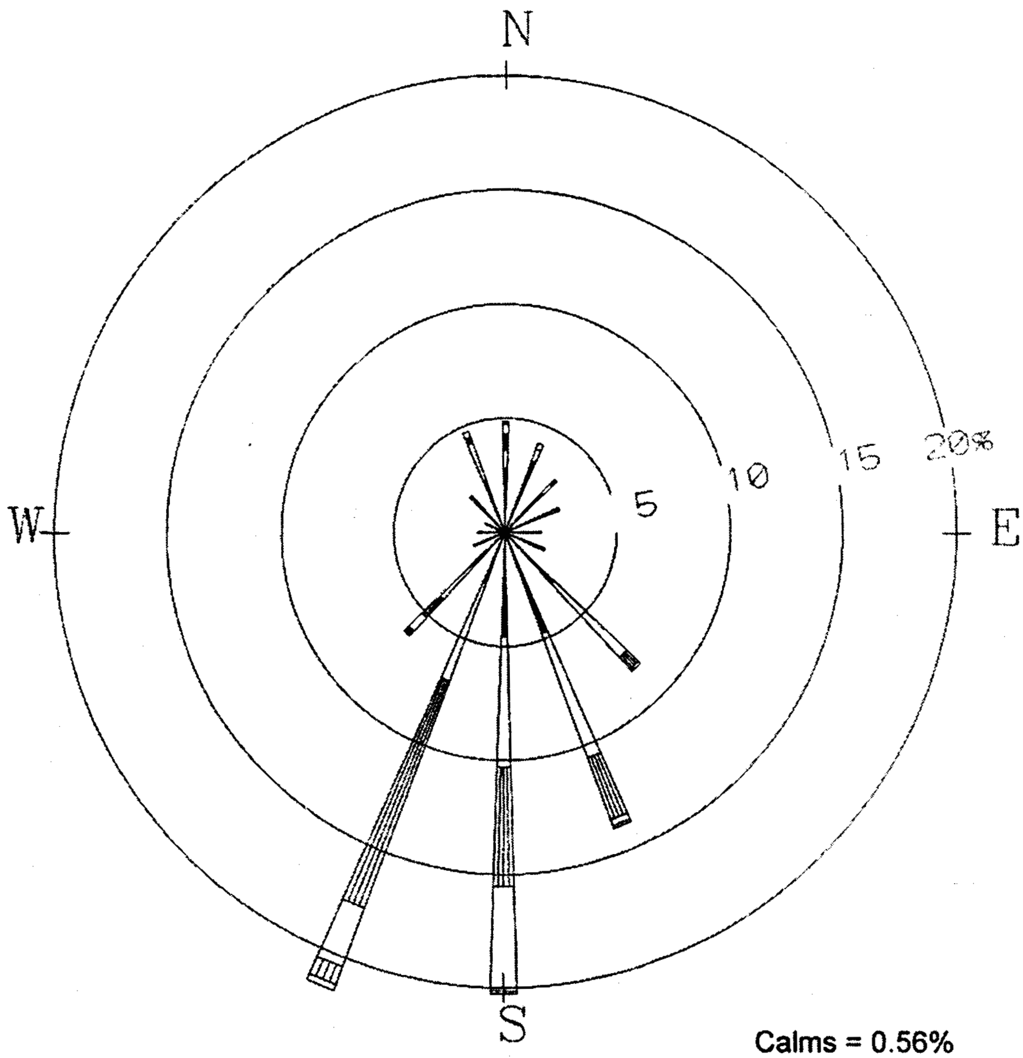
APPENDIX A
PRELIMINARY BIG SANDY METEOROLOGICAL DATA



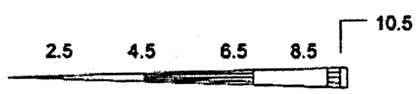


NOTES:
DIAGRAM OF THE FREQUENCY OF OCCURRENCE FOR EACH WIND DIRECTION. WIND DIRECTION IS THE DIRECTION FROM WHICH THE WIND IS BLOWING.

Big Sandy April 2000



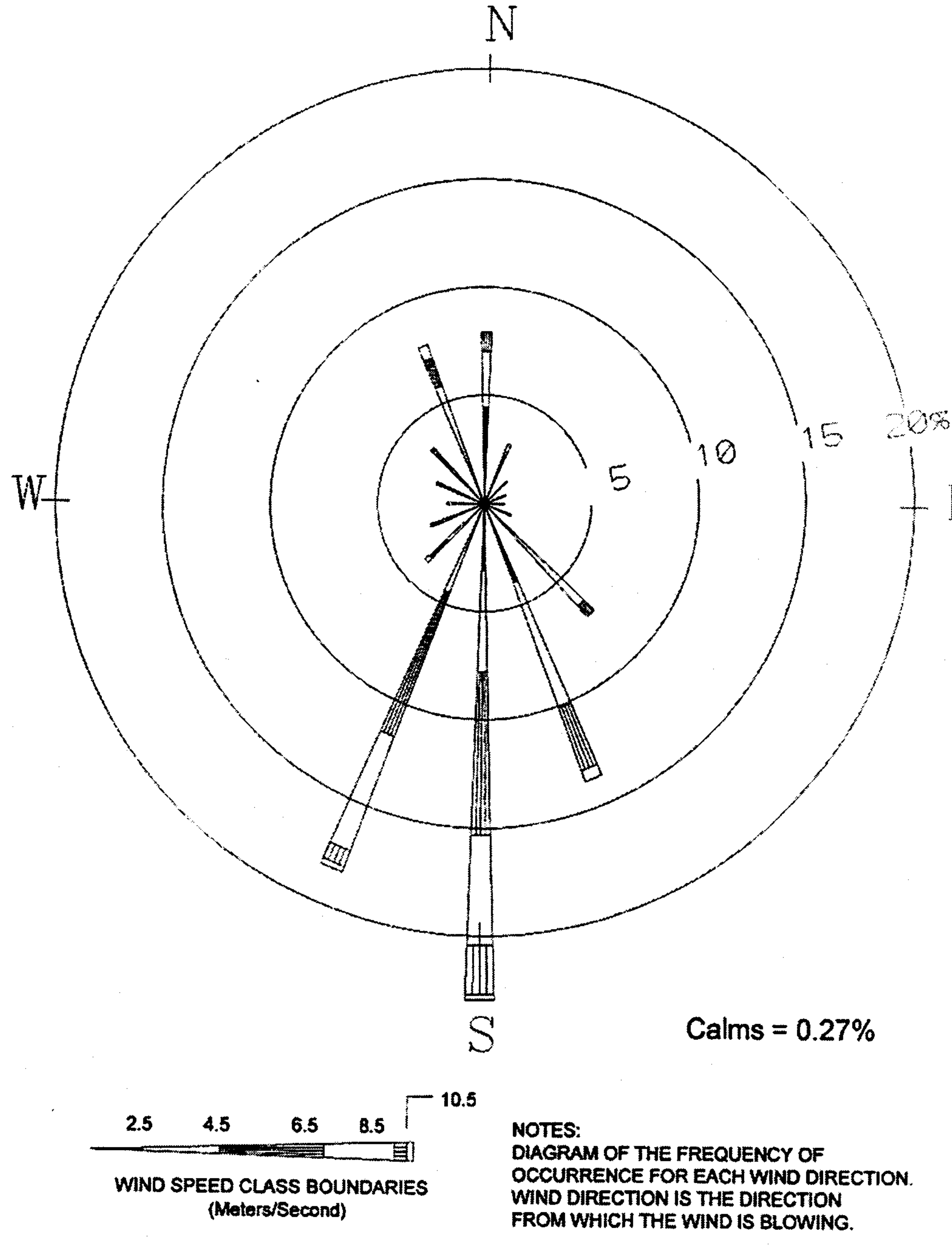
Calms = 0.56%



WIND SPEED CLASS BOUNDARIES
(Meters/Second)

NOTES:
DIAGRAM OF THE FREQUENCY OF OCCURRENCE FOR EACH WIND DIRECTION.
WIND DIRECTION IS THE DIRECTION FROM WHICH THE WIND IS BLOWING.

Big Sandy June 2000



Big Sandy May 2000

APPENDIX B
SIEMENS V84.3A COMBUSTION TURBINE PERFORMANCE DATA

Siemens V84.3A Combustion Turbine Performance Data

Pollutant	Mol Wt lb/lbmol
NO2	46
CO	28
VOC (as CH4)	16

Fuel S Content	0.75	gr/100dscf	1.071	lb/MMdscf
Stack Diameter	18	feet		

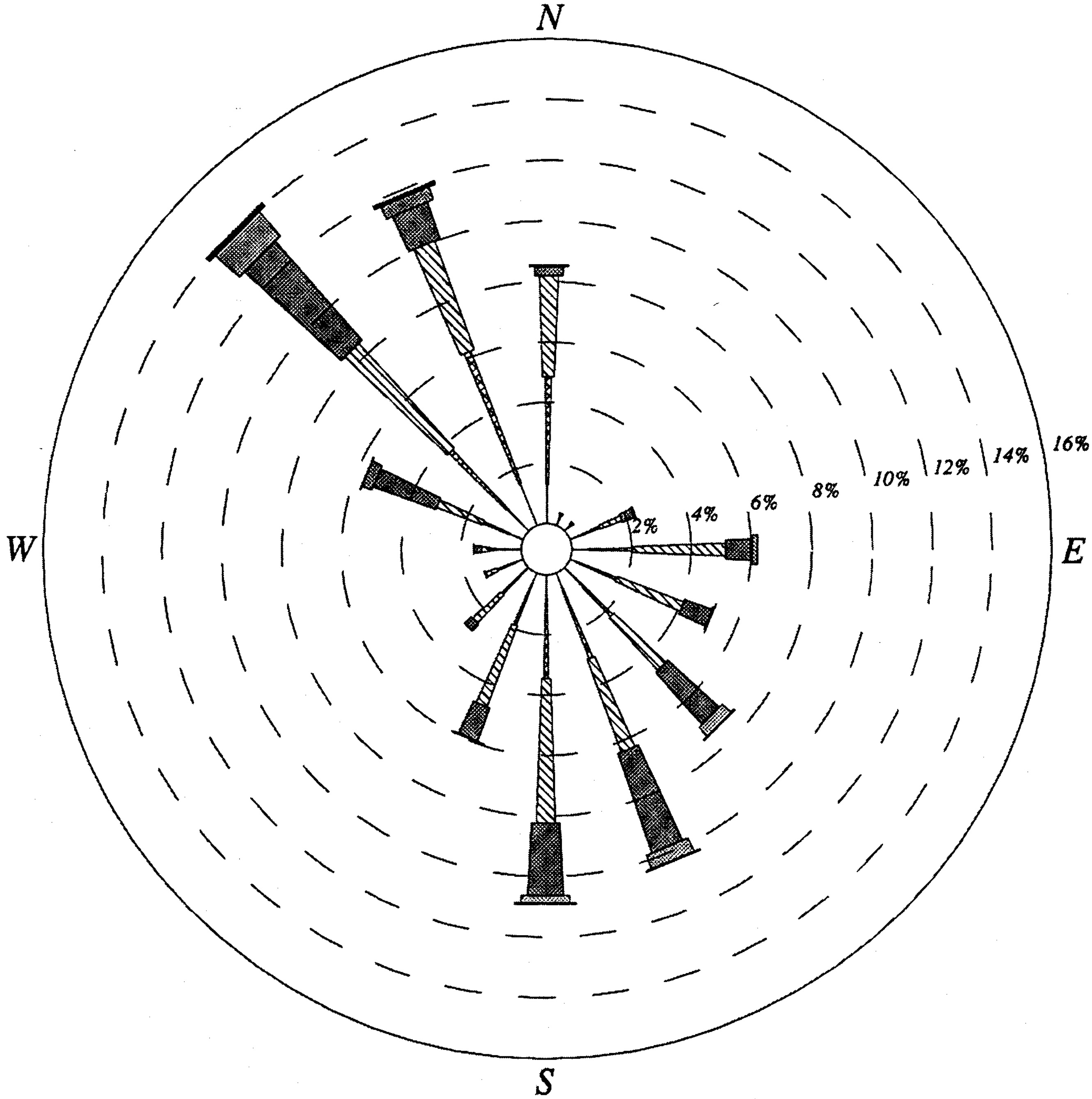
Engine	Load	Cooling	Ambient Temp (F)	Ambient RH (%)	CT Output (kW)	CT Heat Rate (LHV) (BTU/kWh)	CT Heat Constant (LHV) (BTU/h)	DF Heat Constant (LHV) (BTU/h)	Fuel Usage (scf/hr)	Exhaust Flow (lb/hr)	Exhaust Flow (scfm)	Exhaust Flow (acfm)	Exhaust Flow scfm@15%O	Exhaust Velocity (ft/sec)	Exhaust Velocity (m/sec)	Exhaust Temp (F)
V84.3A	Base (100%) + DF	Chiller - On	95	60	170,800	8,156	1,393,000,000	120,000,000	1,507,723	3,344,000	731,816	1,121,726	783,286	73.5	22.4	200
V84.3A	**Base (100%)**	**Chiller - On**	**95**	**60**	**170,800**	**8,156**	**1,393,000,000**	**0**	**1,388,142**	**3,338,600**	**709,872**	**1,088,091**	**754,204**	**71.3**	**21.7**	**200**
V84.3A	Base (100%) + DF	Chiller - Off	59	60	170,800	8,664	1,479,800,000	98,000,000	1,572,297	3,551,200	765,666	1,173,612	812,677	76.9	23.4	200
V84.3A	***Base (100%)***	***Chiller - Off***	***59***	***60***	***170,800***	***8,664***	***1,479,800,000***	***0***	**1,474,639**	***3,546,800***	***745,727***	***1,143,049***	***755,782***	74.9	22.8	***200***
V84.3A	Base (100%)	Chiller - Off	20	60	180,049	8,966	1,614,300,000	0	1,608,670	3,761,200	788,778	1,209,037	807,949	79.2	24.1	200
V84.3A	80%	Chiller - On	95	60			1,182,500,000	0	1,178,376	2,929,300	622,536	954,222	650,693	62.5	19.0	200
V84.3A	80%	Chiller - Off	59	60			1,251,500,000	0	1,247,135	3,098,400	651,891	999,218	675,709	65.4	19.9	200
V84.3A	80%	Chiller - Off	20	60			1,360,300,000	0	1,355,556	3,271,300	686,545	1,052,335	720,330	68.9	21.0	200
V84.3A	60%	Chiller - On	95	60			979,400,000	0	975,984	2,548,000	541,150	829,473	552,512	54.3	16.6	200
V84.3A	**60%**	**Chiller - Off**	**59**	**60**			**1,032,700,000**	**0**	**1,029,098**	**2,687,200**	**564,993**	**866,020**	**572,611**	**56.7**	**17.3**	**200**
V84.3A	60%	Chiller - Off	20	60			1,117,800,000	0	1,113,901	2,825,200	592,485	908,160	606,885	59.5	18.1	200

Engine	Load	Cooling	Ambient Temp (F)	Ambient RH (%)	NOx Conc ppmvd@15%O2	NOx as NO2 (lb/hr)	CO Conc ppmvd@15%O2	CO (lb/hr)	UHC Conc ppmvd@15%O2	UHC (lb/hr)	PM (lb/hr)	SO2 (lb/hr)	CARB Formald (lb/hr)	Elev (ft)	Site Pressure (psia)	Fuel Heat (LHV) (BTU/lb)	Fuel Heat (LHV) (BTU/scf)
V84.3A	Base (100%) + DF	Chiller - On	95	60	3.0	18.1	16.8	61.6	3.1	6.5	7.7	3.2	0.675	2130	13.76	22500	1003.5
V84.3A	**Base (100%)**	**Chiller - On**	**95**	**60**	3.0	**17.4**	**10.0**	**35.3**	**2.0**	**4.0**	**6.5**	**3.0**	**0.622**	**2130**	**13.76**	**22500**	**1003.5**
V84.3A	Base (100%) + DF	Chiller - Off	59	60	3.0	18.7	15.5	58.9	3.1	6.7	7.5	3.4	0.704	2130	13.76	22500	1003.5
V84.3A	***Base (100%)***	***Chiller - Off***	***59***	***60***	3.0	***17.4***	***10.0***	***35.4***	***2.0***	***4.0***	***6.5***	***3.2***	***0.660***	2130	13.76	22500	1003.5
V84.3A	Base (100%)	Chiller - Off	20	60	3.0	18.6	***10.0***	37.8	1.1	2.4	6.5	3.4	0.721	2130	13.76	22500	1003.5
V84.3A	80%	Chiller - On	95	60	3.0	15.0	***10.0***	30.5	1.2	2.1	6.4	2.5	0.528	2130	13.76	22500	1003.5
V84.3A	80%	Chiller - Off	59	60	3.0	15.6	***10.0***	31.6	1.1	2.0	6.4	2.7	0.559	2130	13.76	22500	1003.5
V84.3A	80%	Chiller - Off	20	60	3.0	16.6	***10.0***	33.7	1.1	2.1	6.5	2.9	0.607	2130	13.76	22500	1003.5
V84.3A	60%	Chiller - On	95	60	3.0	12.7	35.0	90.5	3.4	5.0	6.3	2.1	0.437	2130	13.76	22500	1003.5
V84.3A	**60%**	**Chiller - Off**	**59**	**60**	3.0	**13.2**	**35.0**	**93.8**	**3.3**	**5.1**	**6.4**	**2.2**	**0.461**	**2130**	**13.76**	**22500**	**1003.5**
V84.3A	60%	Chiller - Off	20	60	3.0	14.0	35.0	99.4	3.3	5.4	6.4	2.4	0.499	2130	13.76	22500	1003.5

APPENDIX C
WIND INFORMATION FOR FMCPG

1997 FMCPG

January 1-December 31; Midnight-11 PM



CALM WINDS 4.80%

WIND SPEED (KNOTS)

NOTE: Frequencies indicate direction from which the wind is blowing.

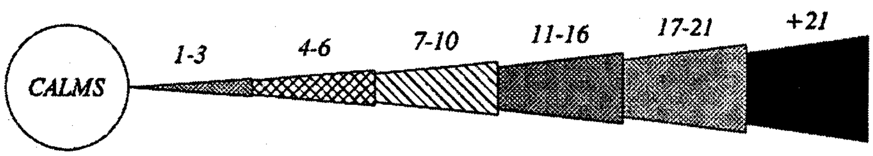


EXHIBIT B-2

WATER RESOURCE ANALYSIS

REPORT

WATER RESOURCES OF THE SOUTHERN PORTION OF THE BIG SANDY VALLEY, WIKIEUP, MOHAVE COUNTY, ARIZONA

Submitted by:

Caithness Big Sandy, LLC
7887 E. Belleview Avenue
Suite 1100
Englewood, CO 80111

October 2000

REGISTERED GEOLOGIST
CERTIFICATE NO.
4788
PAUL A.
MANERA
Date Signed 10/19/00
ARIZONA U.S.A.

Paul A. Manera

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EXECUTIVE SUMMARY

A water resources investigation was conducted in the southern portion of the Big Sandy Valley, south of Wikieup, to determine if adequate water resources exist for the development of the proposed Big Sandy Energy Project, a gas fired power plant. The investigation consisted of the testing of the alluvial aquifers in the valley, an exploration drilling program that culminated in the defining of three separate aquifers in the southern end of the basin, an Upper Aquifer consisting of the Upper Basin fill and Recent Stream and Flood Plain deposits, a Middle Aquifer consisting of the Lower Basin fill and the discovery of a confined basaltic aquifer, apparently limited to the southern end of the basin.

One production well was completed in the Lower (confined) Aquifer and seven observation wells were completed in the Upper, Middle and Lower Aquifers to allow monitoring of the effects of withdrawal from the Lower Aquifer.

The results of investigation indicates that a minimum volume of 1,420,281 million acre feet of water is stored in the Lower Aquifer. Nine and three-quarters percent of the volume of water in storage in the confined basaltic aquifer will provide water for the life of the Big Sandy Energy Project. This determination was made based upon geologic research to determine the aquifer areal extent and the results of an aquifer pumping test. These results were obtained through a water balance calculation.

The results of the investigation indicates that withdrawal from the confined basaltic aquifer would not impact other aquifers in the area. Drawdown was not apparent in any of the wells in either the overlying Middle Aquifer or the Upper Alluvial aquifer. The Upper Alluvial aquifer is utilized for almost all the water supplies in the valley.

The only impact that was determined from the results of the investigation is the probability that water flow will be reduced or cease from the Cofer Hot Spring over a period of time as a result of the withdrawal from the confined aquifer. This impact appears likely since the spring emanates from the same volcanic formation that is proposed for development.

A monitoring program is proposed to be established in which six of the existing observation wells would be equipped with pressure transducers and dataloggers. The dataloggers would collect one water level point per day per well. The data would be downloaded and reviewed on a quarterly basis and a report of this data and analysis would be issued annually.

The conclusions reached on the basis of this investigation are:

- the Lower (confined) Basaltic Aquifer is a heretofore undocumented aquifer which has not been utilized by any wells or withdrawal;
- the Lower (confined) Basaltic Aquifer and its recharge area has a minimum areal extent of approximately 57 square mile of which 31 square miles is within the Big Sandy Basin and the remaining 26 square miles, forming the recharge area, consists of the Volcanic Rocks of Sycamore Creek to the east of the basin;

- the minimum volume of water in storage in the Lower (confined) Basaltic Aquifer is 1.4 million acre feet;

- the maximum demand of the power plant over the 40 year period of the proposed project is 193,561 acre feet;

- recharge to the Lower (confined) Basaltic Aquifer will replace 55,854 acre feet in the 40 year life of the project;

- during the life of the project, the project will withdraw 9.75 percent of the volume of water in storage;

- withdrawal from the Lower (confined) Basaltic Aquifer does not effect the water levels in the Middle or Upper Aquifers, therefore, the withdrawal to satisfy the demand of the project will not impact the existing wells which penetrate only the Upper Aquifer or the Recent Stream and Flood Plain alluvial fill;

- there is sufficient water available in the Lower (confined) Basaltic Aquifer to satisfy the demands of the project for 40 years without depleting the aquifer and without impacting the existing wells.

INTRODUCTION

Caithness Big Sandy, L.L.C. purchased the Banegas Ranch located in the southern end of the Big Sandy River Valley near Wikieup in southeastern Mohave County, Arizona with the intention of developing a gas fired power plant in Section 5, T. 15 N., R. 12 W. Gila and Salt River Base and Meridian.

The Ranch property consists of portions of Sections 5 and 7, T. 15 N., R. 12 W., Sections12 and 13, T. 15 N., R. 13 W. and Section 36, T. 16 N., R. 13 W.

This report is the result of the exploration program to determine the potential of developing a sufficient quantity of water to supply the project for a forty year time period within the property boundaries. The location of the project is depicted on **Figure 1.**


R. 13 W.
Wikieup
Project Site
T. 16 N.
T. 15 N.
93
LEGEND
Well
Highway
Secondary Road
River/Stream
Transverse Mercator Projection
1927 North American Datum
Zone 12
N
Project Area
SCALE 1 : 100,000
BIG SANDY ENERGY PROJECT
FIGURE 1
PROJECT LOCATION

LITHOLOGIC UNITS

The descriptions of the lithologic units in that portion of the Big Sandy Basin extending from Deluge and Tule Wash (T. 16 ½ N) south to the Big Sandy River outlet through Signal Gorge were obtained from earlier studies (Davidson, 1973, Sheppard and Gude, 1972 and Moyer, 1982) with modifications based on field observation and description length (refer to Davidson and or Sheppard and Gude for complete descriptions of the rock units). The lithologic units from the oldest to the youngest are:

Granitic Gneiss

The granitic gneiss forms the core of both the Aquarius Mountains on the east and the Hualapai Mountains forming the western boundary of the Big Sandy basin. The granitic gneiss appears to underlie the sedimentary and volcanic rocks filling the basin. The granitic gneiss is considered to be Pre-cambrian in age (Wilson and Moore, 1959) with dikes and small intrusive bodies of granitic composition of younger age.

The gneiss of the Aquarius Mountains is a banded and foliated light-yellow to yellowish-white granodiorite. The main dark mineral is chloritized biotite mica. The granodiorite generally is medium grained and uniform in texture, although it contains a few segregations of very coarse granodiorite and bands of pegmatite. The gneiss that forms the Hualapai Mountains consists of banded and foliated, fine to medium grained light yellow granodiorite, coarse to pegmatic pink granite to granodiorite, banded quartzite and schistose rocks that contain more dark minerals than most of the gneiss outcrops.

Arkosic Gravel

The arkosic gravel is exposed in a few scattered outcrops in the southeastern part of the area. The most extensive exposures are near the confluence of Cane Springs Wash and the Big Sandy River and along Bitter Creek. The arkosic gravel underlies dated volcanic rocks and probably is Oligocene and Miocene in age.

The arkosic gravel in most of the area is reddish-brown, planar to lenticular bedded, semiconsolidated, and composed entirely of fragments of graodiorite and granodiorite gneiss. No volcanic rock fragments were noted in the unit except in the upper few inches, where the unit is directly overlain by an andesite flow.

Volcanic Rocks of the Sycamore Creek

The centers of volcanic activity extruding the volcanic rocks of Sycamore Creek appear to have been faults and vents in the Aquarius Mountains. The volcanic rocks crop out extensively along Sycamore Creek and eastward into the Aquarius Mountains. The aggregate thickness of the volcanic rocks exceeds 1,000 feet in the Aquarius Mountains and in other places east of the Big Sandy River. The age of the volcanic rocks of Sycamore Creek are placed at Oligocene and Miocene based on lithologic similarities to volcanic rocks in the Paulden and Milk Creek areas to the east of the study area.

The volcanic rocks consist mainly of andesitic flow, flow breccia, tuff and agglomerate. Rhyolitic flows, welded tuff and volcanic conglomerate are present but significantly less common than the andesitic rocks. The flows and flow breccia are generally dark greenish gray. The tuff and agglomerate are white to light grey.

The volcanic rocks encountered in the drill cuttings in Sections 5 and 7, T. 15 N., R. 12 W. appear to be cinders or scoriaceous flows. These materials have been exposed to extended saturation and flow of ground water as illustrated by the presence of water deposited copper minerals observed in the drill cuttings.

Volcanic Rocks of the Kaiser Spring Area

The volcanic rocks of the Kaiser Spring area rest directly on the Precambrian gneiss and granodiorite forming the crystalline basement. Small areas of arkose and laucustrine deposits are present directly on the basement complex which are covered by the volcanics.

The volcanic rocks are predominantly thick tuff units with interbedded ash flows and basalt flows. The tuff units have been subdivided by Moyer (1982), based on lithic types, into the basement lithic tuff, the basement and basalt lithic tuff and the lava lithic tuff. Basaltic eruptions filled the Burro Creek channel and spilled over the tuff platform forming a thick sequence of basalt layers on top of the tuff units.

Lower Basin Fill

The lower basin fill, composed of sedimentary rocks, crops out extensively along dissected ridges east of the Hualapai Mountains and is exposed in canyons and low ridges in most of the area east of the Big Sandy River. As much as 3.000 feet of the unit is exposed, but the total thickness is unknown.

The lower basin fill includes the flat lying Big Sandy formation member of Sheppard and Gude (1972) and a more extensive moderately tilted and faulted sedimentary deposit. The Big Sandy formation member crops out in the southern and central parts of the valley of the Big Sandy River and the moderately tilted and faulted sedimentary deposit is the main unit of outcrop in the Big

Sandy area. Sheppard and Gude (1972, p. 5)describe the Big Sandy formation as follows "The Big Sandy formation consists chiefly of green and brown laucustrine mudstone or a calcareous silty or sandy variant. These rocks grade laterally into coarser clastic rocks, including conglomerate." The more extensive sedimentary deposit ranges from a sandy gravel to silt and marl. Sheppard and Gude (1972) believe that the Big Sandy formation unconformably overlies the more steeply dipping surrounding sediment, mainly because the Big Sandy formation is flat lying and the surrounding sedimentary deposit generally is more tilted and faulted, however, no exposed contact between these two units has been observed in the field.

The lower basin fill is Pliocene in age based on vertebrate fossils (Lance, 1960, p. 156) found in the Big Sandy formation. Sheppard and Gude (1972) stated that the Big Sandy formation is definitely Pliocene and probably late Pliocene in age.

That lower basin fill encountered by the drill in Section 7, T. 15 N., R. 12 W. consisted of the Big Sandy formation overlying layers of granitic sand and gravel alternating with layers of volcanic sands and gravel. The granitic sand and gravel are usually reddish in color while the volcanic rocks are predominantly light to dark grey.

In Section 5, T. 15 N., R. 12 W., the Big Sandy formation rests directly on the volcanic rocks of Sycamore Creek.

Upper Basin Fill

The upper basin fill is present mainly along the central axis of the basin. The thickness of the upper basin fill is about 300 feet thick at Wikieup and extends downstream in the Big Sandy River bed to the Signal Gorge. The upper basin fill presumably is Pleistocene in age.

The upper basin fill is a silty gravel to a sandy silt that is loosely consolidated. The upper basin fill overlies the lower basin fill in an erosional unconformity and is itself eroded and overlain by the alluvium of the present day stream system. During deposition of the upper basin fill, the streamflow direction was toward the present course of the Big Sandy River and then southward toward the present outlet. The drainage system was through going, as is the present system, but the streams were aggradational and sediment was deposited in a broad trough carved into the faulted lower basin fill.

Stream and Flood-Plain Alluvium

The stream and flood-plain alluvium is an unconsolidated deposit of Holcene gravel and sand that underlies the streams and their flood-plain. The alluvium commonly is bounded by steep stream-cut banks as much as 15 feet high. The alluvium ranges from 30 feet to 50 feet thick.

The alluvium consists of lenses of sandy gravel, sand and silt. The unit is pale brown and contains well rounded to subrounded grains of quartz and feldspar and eroded detritus from all the older formations in the area.

Regional Geology

The Big Sandy River basin is one of the typical northwest - southeast trending valleys in the Sonoran Desert Section of the Basin and Range Province of Fenneman (1931 p. 328). Lease (1981) describes the regional geology of the area in the following manner.

> "The geology of the province is very complex. In the Sonoran Desert section of the province, block faulting began as early as the Oligocene and continued into late Cenozoic time. It was during this time that the many basins were formed between the block faulted mountain ranges and were filled with fluvial and lacustrine sediments and volcanics of various types and compositions. Each of the basins records a complex geologic history since it was formed by Basin and Range faulting and even though the overall geologic history of the basins is similar, each basin appears to be a distinctly separate geologic feature.
>
> In the Arizona portion of the Basin and Range Province, east of the Colorado river, the late Pre-cambrian and Paleozoic sedimentary rocks are thin, consequently, the exposed cores of the mountain ranges are predominantly Pre-cambrian to Mesozoic intrusive and metamorphic rock types.
>
> The area of study has undergone multiple tectonic events. Only the latter two events have affected Tertiary basin fill sediments, first, early Tertiary (Laramide) uplift created high relief, then erosion stripped vast amounts of detritus from the uplands, dissecting and exposing Mesozoic, Paleozoic and later Pre-cambrian rocks throughout the area. The detrital materials were transported by streams and deposited in intermontane basins and vallleys. This was accompanied and followed by high-angle, normal faulting, which is present everywhere in the desert and mountain regions of Arizona. Most of these faults are middle and late Tertiary age, although some predate the Laramide orogeny and others are as young as Pleistocene. The early Tertiary basin deposits were tilted by the later faulting and covered by later Tertiary deposits. In some basins these fluvial and lacustrine sediments, accumulated to thicknesses of thousands of feet. Sedimentation during Tertiary time was accompanied by volcanic activity, and locally, volcanic flows are present in the sedimentary column. The effects of basement topography, discontinuous faulting, and volcanic activity were intermittently dammed streams, which created lakes, playas and swamps. These effects and/or climatic changes resulted in the sporadic intercalation of lacustrine/paludal limestone, siltstone, clay and mudstone beds within the predominantly fluvial sequence.
>
> The second tectonic event reactivated Basin and Range type faulting and continued intermittently throughout the Quaternary. Both uplift and erosion were renewed. The resulting abundant detritus deeply buried the earlier Cenozoic basin fill sequence under younger, predominantly fluvial and minor lacustrine deposits.
>
> The stratigraphic relationships of the valley fill sediments are complex. Depositional facies change over short distances and local unconformities are common. These factors make surface and subsurface correlations difificult."

Geology of the Southern Portion of the Big Sandy Basin

The Big Sandy Valley is a graben extending from approximately ten miles south of Wikieup northward to Interstate 40. The basin in this area is roughly five miles wide at the southern end and widens to ten miles north of Wikieup. The graben extends both south and north beyond these limits, however, the graben becomes shallower and less pronounced to the south and the Basin narrows to the north as it passes into the Hualapai basin.

During the Laramide tectonic disturbance, the graben was formed by the uplifting and tilting of the Pre-cambrian rocks to form the Hualapai Mountains on the western boundary and the Aquarius Mountains on the eastern boundary with the central block of Pre-cambrian rock downthrown in relation to the two mountain ranges. Normal faulting occurs on both sides of the graben. The bounding fault on the west side of the Aquarius Mountains may be a southerly extension of the Grand Wash fault system (Young, 1979).

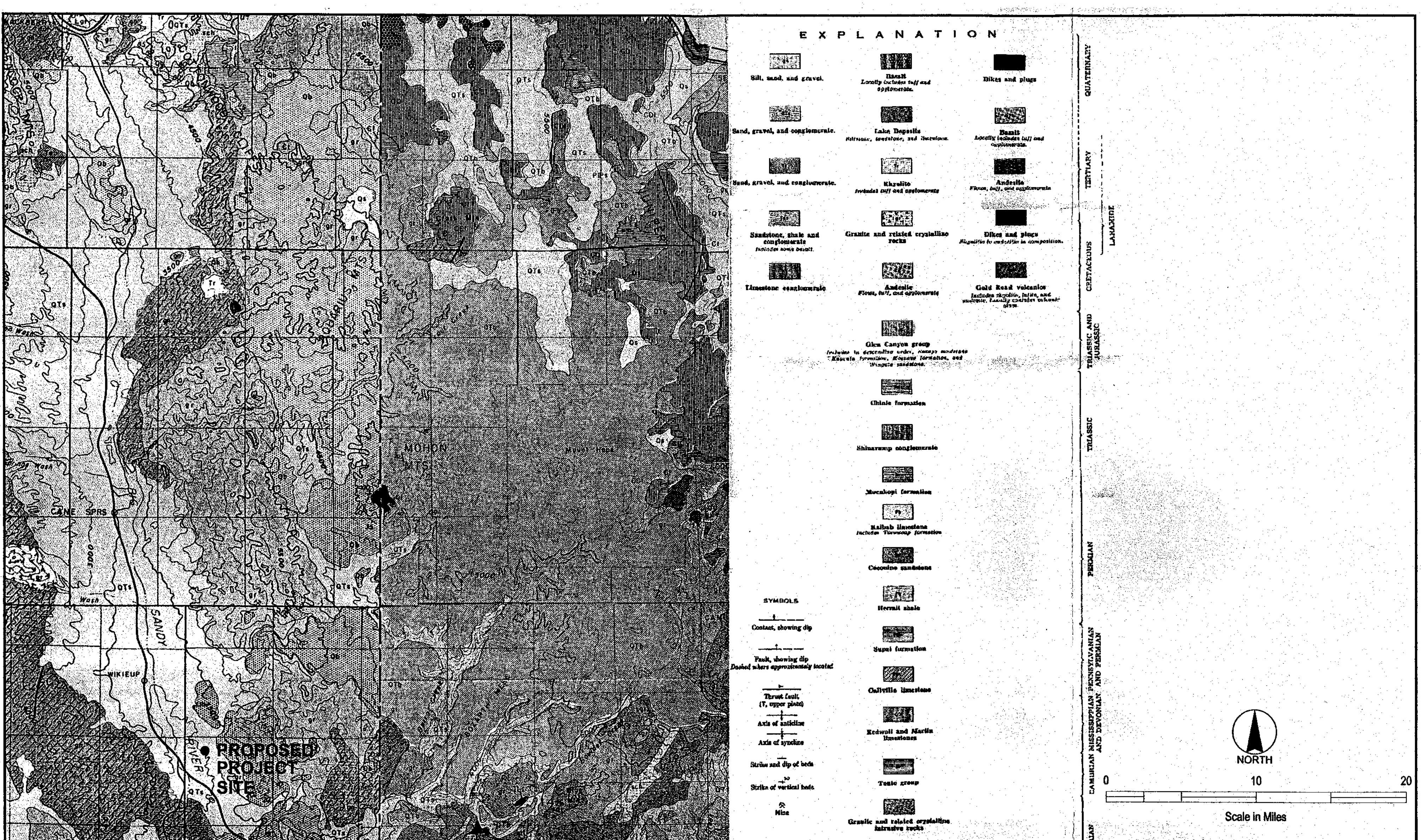
The southern portion of the Big Sandy basin, that portion of the basin south of Deluge and Tule Washes, differs from the northern portion of the basin, in that various forms of extruded volcanic rocks intermingle with the alluvial sequence. In general, there were two areas of volcanic activity, the Volcanic Rocks of Sycamore Creek in the study area and the Volcanics of the Kaiser Spring area (Moyer, 1982) to the south.

Moyer (1982) states:

> *"That this region (the Kaiser Spring area) was a crystalline highland is evident in the paucity of fluvial or alluvial arkosic sediments. A thin, local, high-alumina basalt was deposited unconformably on the on the basement rocks probably during middle Tertiary time, although no age date has been obtained for this unit (p. 24)."*

thus indicating that the alluvial materials are absent at the southern end of the Big Sandy basin and that the Kaiser Springs volcanics effectively dams the southern end of the basin. **Figure 2** is a geological map of the area of study.

During the period, June through October, 1979, the Department of Energy (DOE) drilled 18 test holes in northwestern Arizona to determine the lateral extent of uranium-bearing, paludal/ lacustrine deposits. Six of these test holes were located in the Big Sandy Valley. Based on the drill hole cutting log data (Lease, 1981), the thickness of the alluvial fill in the basin exceeds 5,008 feet in



BIG SANDY ENERGY PROJECT

FIGURE 2
GEOLOGIC MAP

ANALYSIS AREA KINGMAN TO WIKIEUP, MOHAVE COUNTY, ARIZONA

DATE: 10/1/00	AutoCAD File: 891-GEOLOGY.DWG
SCALE: AS NOTED	DRAWN BY: EC

Section 8 T. 16 N., R. 13 W. and Section 12, T. 16 N., R.14 W. (PQ-25 and PQ-10), north of Wikieup. The depth to the top of the basement complex and, consequently, the thickness of the alluvial fill in the area south of Wikieup, in the study area, is approximately 3,500 feet in Sections 12 (PQ-26) and 28 (PQ-29) T. 15 N., R. 12 W. The locations of six test holes PQ-10 and PQ-25-29 are shown on (**Figure** 3) and the lithologic logs for PQ-25, PQ-26, and PQ-29 are included in **Appendix A.**

The lithologic log of PQ 26, located in Section 12, T. 15 N., R. 13 W., within one mile of Test Site 2 (northwest corner of Section 12, T. 15 N., R. 12W) does not appear to encounter either the Wikieup formation or the volcanic aquifer.

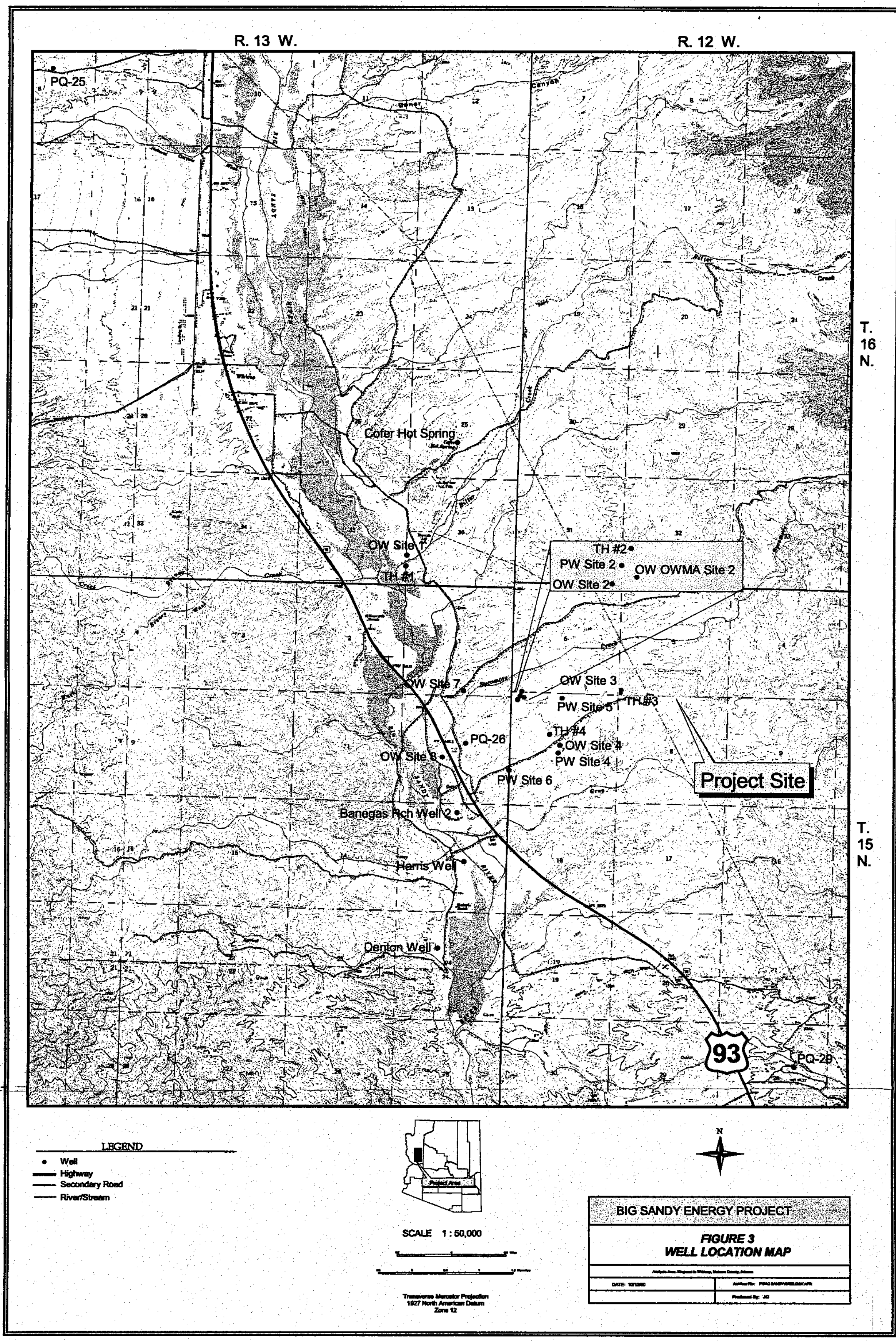
Results of the Exploration Drilling Program

The exploration drilling program was established to determine the presence of a sufficient volume of ground water to satisfy the demand of the proposed electrical power generating plant.

Initially, four test holes were drilled, logged, geophysically logged when possible and abandoned. Test Hole 1 was drilled in the Big Sandy flood plain in Section 36, T. 16 N., R. 13 W. The drill encountered only the Upper Basin fill with possibly some Recent stream deposits on the top. Test Holes 2 and 4 were drilled in the northwest quarter of Section 7, T. 15 N., R. 12 W. Both wells penetrated or encountered the Wikieup formation, the Lower Basin fill and a confined aquifer in the Volcanic Rocks of Sycamore Creek. The confined aquifer was encountered at a depth of 1,135 feet in both holes. Test Hole 3 penetrated 600 feet of the Wikieup formation and 600 feet of the Volcanics Rocks of Sycamore Creek. It is believed that the volcanics penetrated in Test Hole 3 are in the confined aquifer, however, the collar elevation is higher than the piezometric surface elevation; therefore, the well does not flow under artesian pressure.

Based on this information, additional drilling, including one production well, additional piezometric wells in the confined aquifer, observation wells in the Lower Basin fill, Upper Basin fill and Recent Stream and Flood-Plain Alluvium, was instituted.

The Tertiary basin fill sequence in the southern portion of the Big Sandy basin, based on four test holes, a production well and seven piezometric wells, from bottom to top are: volcanic rocks of Sycamore Creek, Lower Basin fill (sand and gravel facies), Lower Basin fill (Wikieup formation facies), Upper Basin fill and Recent Stream Bed and Flood Plain alluvium.


R. 13 W.
R. 12 W.
T. 16 N.
T. 15 N.
PQ-25
Cofer Hot Spring
OW Site 1
TH #1
TH #2
PW Site 2
OW OWMA Site 2
OW Site 2
OW Site 7
OW Site 3
PW Site 5
TH #3
TH #4
PQ-26
OW Site 4
OW Site 8
PW Site 4
PW Site 6
Project Site
Banegas Rch Well 2
Harris Well
Denton Well
93
PQ-29
LEGEND
Well
Highway
Secondary Road
River/Stream
Project Area
SCALE 1 : 50,000
Transverse Mercator Projection
1927 North American Datum
Zone 12
N
BIG SANDY ENERGY PROJECT
FIGURE 3
WELL LOCATION MAP

AQUIFERS

There are at least three separate aquifers in the Big Sandy Basin south of Wikieup. These, from upper to lower, are:

The Upper Aquifer	composed of the Recent Stream and Flood-Plain Alluvium and the underlying Upper Basin fill. In the southern portion of the basin, this aquifer is partially saturated in the entrenched riverbed and flood plain of the Big Sandy River.
The Middle Aquifer	composed of the Older Basin fill. The Middle Aquifer is saturated in most of the southern portion of the Big Sandy basin.
The Lower Aquifer	composed of the Volcanic Rocks of Sycamore Creek. Four hundred and fifty (450) feet of these volcanics were penetrated by the drill. However, only 300 feet or 66 percent of the volcanic penetrated was considered aquifer as a conservative consideration The confined aquifer is fully saturated with a piezometric surface elevation of 2,079 feet.

Prior drilling by the Department of Energy (Lease, 1981) penetrated 3,500 feet of alluvial fill or volcanic materials in the area south of Wikieup. As this work was completed to determine the presence of uranium, the water producing potential of the material was not documented. Drilling completed as part of the exploration program for the present project (Caithness Big Sandy Energy Project) only tested the formations to a depth of 1,600 feet. The volcanics or alluvial fill below 1,600 have not been penetrated by drilling during the exploration program in the area of study. Therefore, the presence and productivity of those potential aquifers is not documented at this time.

Aquicludes

Two known aquicludes, which separate the three known aquifers, are present in the study area. These are the:

Wikieup formation

The Wikieup formation (Sheppard and Gude, 1982), a lacustrine clay, varying in thickness from 200 feet to more than 600 feet, is the upper member of the Lower Basin fill. Observation Well 8 (OW8) was drilled and perforated entirely in the clay. The clay appears dry, although it did yield water after 24 hours indicating low permeability, and consequently, an aquiclude.

Top of the Volcanic Rocks of Sycamore Creek

The aquiclude, forming the top of the confined aquifer, is only indirectly known. The drill slows only slightly when it encounters the top of the confined layer and the cuttings are extremely fine. The aquiclude appears to be about ten feet thick and volcanic in nature. The fact that the artesian flow starts as soon as the layer is penetrated, signifies the presence of the aquiclude. **Figure 4** depicts an idealized stratigraphic column.

Extent of the Confined Aquifer

The probable limits of the confined aquifer, based on the geological information available, are:

- The western boundary is approximately one half mile west of Site 2, i.e. one half the distance between Site 2 and PQ-26 (PQ-26 does not appear to have encountered the confined aquifer or the Volcanic Rocks of Sycamore Creek)

- The northern boundary trends across the basin near Wikieup (Section15, T. 16 N., R. 13 W). The rationale for this is that waters issued from Cofer Hot Spring (Section 25, T. 16 N., R.13 W.) are similar in chemical composition to waters collected from Test Site 2, therefore the confine aquifer extends north of Cofer Hot Spring but not as far north as PQ-25 (Section 8, T. 16 N., R. 13 W.) which penetrates primarily the Wikieup formation and does not encounter volcanic rocks or confined water.

- The southern boundary is located near the end of the Big Sandy Basin formed by the Volcanic Rocks of Kaiser Spring. The volcanic rocks are present in PQ-29 indicating that the southern boundary is south of PQ-29. The collar elevation is above the piezometric surface, therefore, there is no record of artesian flow.

- Eastward, the Volcanic Rocks of Sycamore Creek rise to the surface, evidenced in Test Hole 3, where they were encountered at 600 feet and become exposed one mile east of Test Hole 3, extending eastward for an additional six miles.

These relationships are depicted on **Figure 5**.

The exposed Volcanic Rocks of Sycamore Creek appear to be the recharge area for the confined aquifer present under Sections 5 and 7, T. 15 N., R. 12 W. The calculated area of the confined aquifer without the recharge area is 30.85 square miles and the recharge area is 26.19 square miles. The areal extent is depicted on **Figure 6.**

Aquifer	Lithology	Thickness	Formation	Aquifer/Aquiclude
Upper Aquifer	Sand/ Gravel	40 Ft.	Alluvium	(Upper Aquifer)
	Clay	200-600 Ft.	Wikieup Formation	(Aquiclude)
Middle Aquifer	Sand/ Gravel, some clay	735 Ft.	Intrusive and extrusive sand and granite with some clay layers	(Aquifer)
	Basalt	10-15 Ft.	Basaltic Aquiclude	(Aquiclude)
Confined (Lower) Aquifer	Basalt	450+ Ft.	Basalt aquifer	(Aquifer)

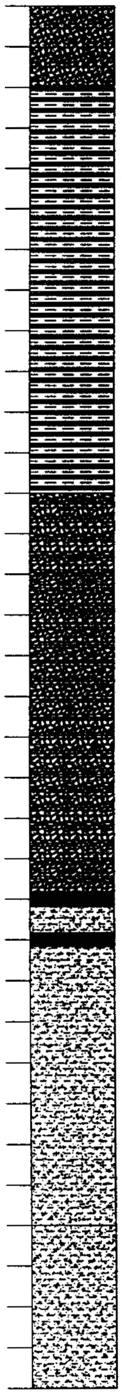


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FIGURE 4
IDEALIZED STRATIGRAPHIC COLUMN

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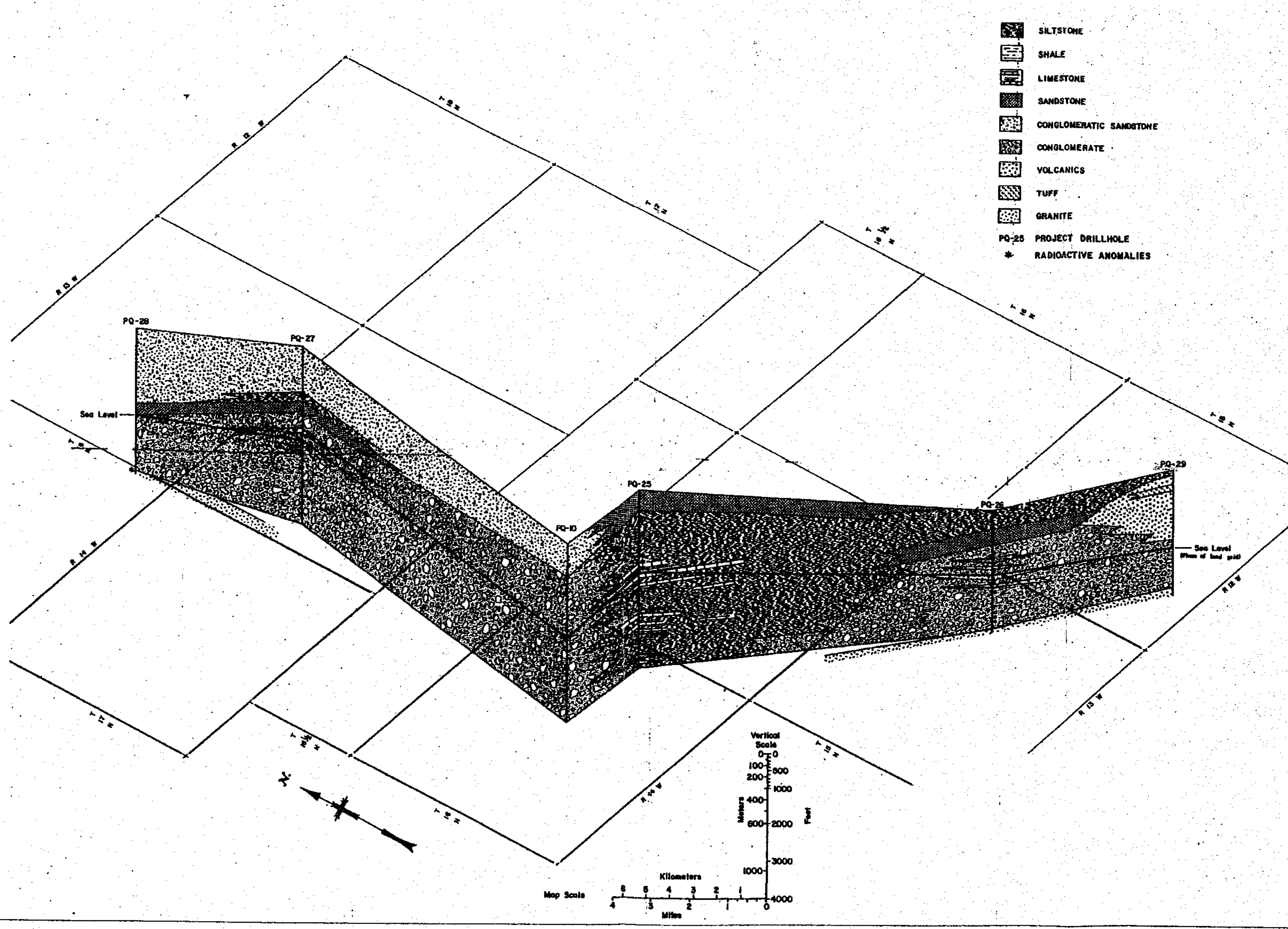

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FIGURE 5
FENCE DIAGRAM OF DRILL HOLES
after lease, 1982

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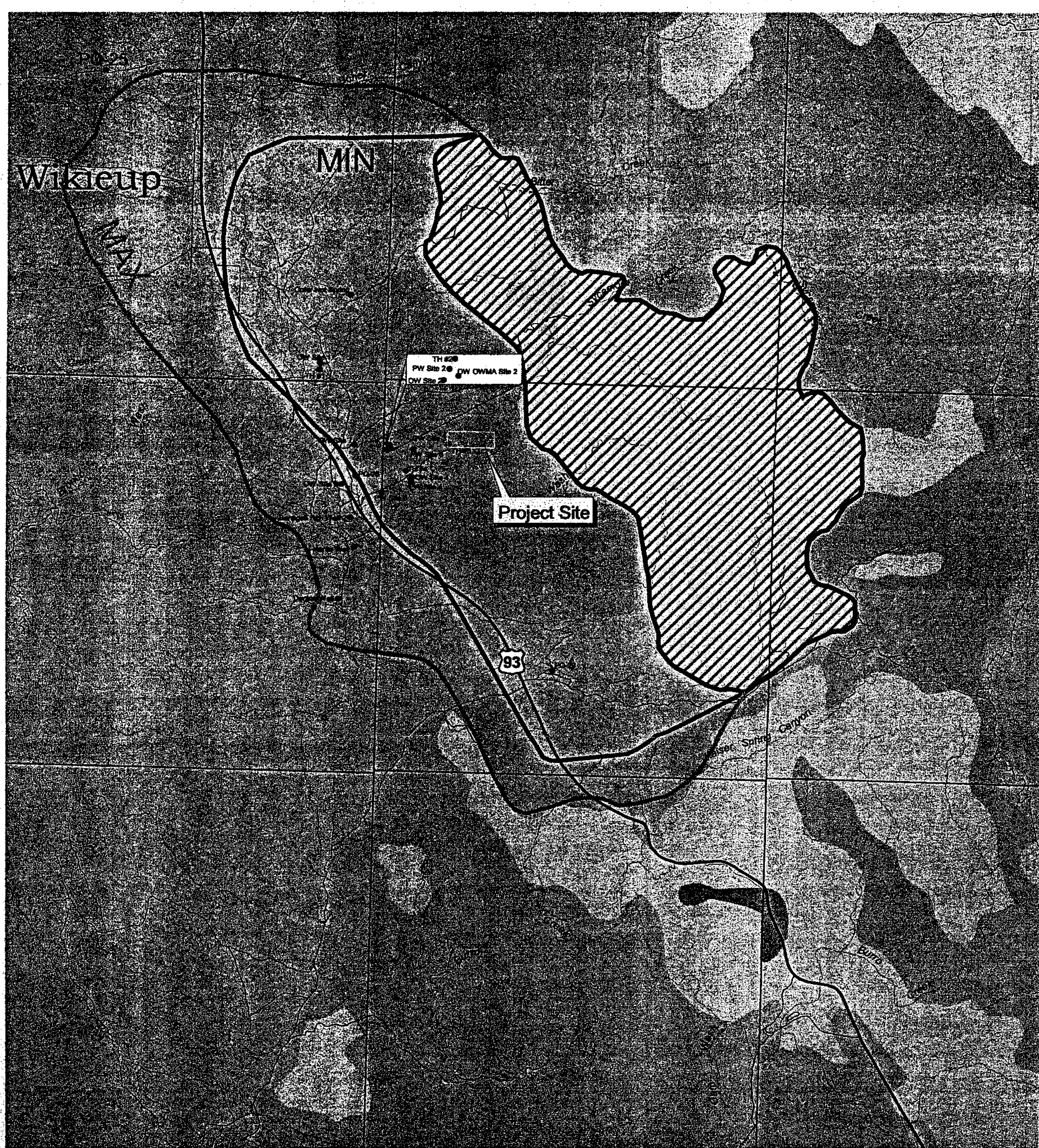
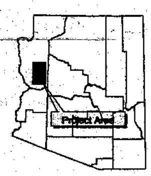


LEGEND

- Well
- Highway
- Secondary Road
- Minimun Aquifer Area
- Maximum Aquifer Area
- Aquifer Recharge Zone

Geology

- Basalt
- Granite and related crystalline intrusive rocks
- Granite gneiss
- Sand, gravel, and conglomerate
- Silt, sand, and gravel



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Transverse Mercator Projection
1927 North American Datum
Zone 12

N

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FIGURE 6
MAP OF AQUIFER EXTENT

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WATER QUALITY

Results of the chemical analysis of water samples collected from the initial flow of the confined water from well OW4, located in the SE1/4, SE1/4, NW1/4 of Section 7, T. 15 N., R. 12 W. states a total dissolved solids content of 746 milligrams per liter (mg/l) with all constituents, with the exception of arsenic and fluoride, falling within the Drinking Water Standards of the Arizona Department of Environmental Quality.

The reported arsenic content was reported as 0.08 mg/l in one analysis and 0.141 mg/l in another. In both cases, this exceeds the limit for drinking water of 0.05 mg/l. Additional analysis will be made to confirm the arsenic content of the confined water. The reported fluoride content was reported as 3.7 mg/l in both analyses. Although within the acceptable limits of 4.0 mg/l, the fluoride is high for long term human consumption. The temperature of the water in the confined aquifer was 96 degrees Fahrenheit when collected in the field as shown on the Chain of Custody Record.

The water quality is satisfactory for industrial use. Additional water samples were collected from the various aquifers as part of the test hole drilling program. The analytical data associated with these samples is included with the analyses of OW4 in **Appendix B.**

SUBSURFACE INVESTIGATIONS AND AQUIFER TESTING

Aquifer testing was performed at the proposed Big Sandy Energy Project to determine the potential for development and impacts that could be associated with the utilization of groundwater for the project. The aquifer tests were performed as part of a comprehensive assessment of the hydrologic resources of the proposed site.

The assessment was conducted in a phased approach:

- The initial phase of investigation was conducted by testing the Recent Stream Bed and Flood Plain alluvium and possibly a portion of the Upper Basin fill via a shallow well (Banegas Well) located in the SW1/4, NW1/4, NE1/4 of Section 13, T. 15 N., R. 13 W.

- The second phase of the investigation was conducted by drilling a series of test borings to determine the lithology and potential for water resources in deeper lithologic units. The results of the test drilling indicated the potential for a deep aquifer source.

- These results initiated a third phase of investigation to determine the potential for the development of this deeper aquifer. This third phase consisted of the installation of several wells to monitor the shallow and middle aquifers and to test and monitor the deeper aquifer.

- Testing was subsequently conducted in a fourth phase of investigation. This series of investigations is summarized below.

Big Sandy Alluvium Aquifer Test

A pump test was conducted on an existing well (Banegas Well) on October 29-30, 1999. A report was issued detailing results of this test on November 2, 1999. The test consisted of pumping water from this well at a rate of 387 gallons per minute (gpm) for a period of 1,635 minutes. The well pumped during the test had a total depth of 105 feet and was reportedly perforated in the bottom 20 feet. A second well located 200 feet from the pumping well was utilized as an observation well. This second well has a total depth of 60 feet, and the perforated interval is unknown.

The analyses of the drawdown in the pumped well indicates a transmissivity (T) value of 204,000 gpd/ft for the first 300 minutes and then the T value decreases to 2,064 gpd/ft for the remainder of the pumping period. The T value calculated from the data obtained from the observation well was 65,500 gpd/ft

The T values 204,000 gpd/ft during the early portion of the pumped well data and the 65,500 gpd/ft from the observation well data fall within the reported values of T of the stream bed alluvium in the Big Sandy Basin (Davidson, 1973). The change in the T values exhibited during this test may have resulted from the dewatering of a thin layer of the alluvium leaving only the lacustrine clay deposits to supply water to the well, or a hydrologic boundary may have impacted the pumping rate. Copies of the data and analyses are included in **Appendix C.**

Test Hole Drilling Program

Following the testing of the well screened in the Big Sandy Alluvium, an exploration drilling program was initiated. The investigation was completed and a report issued in March 22, 2000. The investigation consisted of the drilling of four test holes to determine the lithology and potential for development of groundwater. Specific results can be found in the report "Results Test Hole Drilling Program Wikieup, Mohave County, Arizona" included as **Appendix D.**

The test borings were drilled by means of the dual wall, air rotary drilling method. The drill cutting samples were logged and downhole geophysical logs were performed when possible. The test boring drilling program indicated that the subsurface materials below 400 feet to a minimum depth of 1200 feet were water bearing and offered a reasonable potential for the development of sufficient ground water to satisfy the demands of the energy plant.

Test Hole 1 was located in Section 36, T 16 N, R 13 W. This test hole was drilled to a total of 700 feet and encountered layers of intrusive igneous sand and gravel alternating with layers of sandstone. The sandstone as described by Lease (1981) consists of a siltstone and sandstone, very fine to fine-grained, white to medium gray, friable to well cemented with calcite, micaceous. Water was encountered at approximately 20 feet below grade with water volumes increasing with depth. At 700 feet below grade, the hydrostatic head of the confined water forced the drilling fluid out of the hole and a flow of 15 gpm occurred.

Test Hole 2 was located in Section 7 (NW1/4, NW1/4, NW1/4), T 15 N, R 12 W. This test hole was drilled to a depth of 1,155 feet below grade and encountered clay to a depth of 350 feet. Below the clay layer, alternating layers of granitic sand and gravel and volcanic sand and gravel were encountered to 1,135 feet. At 1,135 feet a cap rock on top of a volcanic rock was encountered and penetrated to the total depth of the boring. Water was encountered immediately below the clay, but the piezometric head was below the collar elevation until encountering the volcanic layer at 1,135 feet where water began to flow under artesian conditions. The volcanic layer appears to be confined.

Test Hole 3 was drilled in Section 5 (SW1/4, SW1/4, SW1/4), T 15 N, R 12 W. The lithology encountered during the drilling of this well was igneous intrusive sand and gravel (Upper Basin fill) from surface to 55 feet, clay (Wikieup formation Lower Basin fill facies) from 55 to 160 feet, and volcanic (extrusive) igneous rocks or sand and gravel to a total depth of 780 feet (total depth of the boring). The static water level in the hole was approximately 20 feet below surface as the collar elevation was 21 below the collar elevation, consequently, there was no artesian flow.

Test Hole 4 was drilled in Section 7 (SE1/4, SE1/4, NW/14), T 15 N, R 12 W. The test hole extended to a total depth of 1,200 feet with the initial 120 feet consisting of granitic sand and gravel (Upper Basin fill). The Wikieup fill was encountered from 120 feet, and from 300 feet to a depth of 1,135 feet, alternating layers of volcanic sand and gravel, granitic sand and gravel, with some clay was penetrated. At 1, 135 feet below grade a volcanic layer was penetrated which was under artesian conditions. The flow rate under artesian conditions was in excess of 125 gpm with a close in pressure of 39 psi.

On the basis of the results of the test boring program, the most likely area to develop a well field appears to be in the western half of Section 7 and possible on the plant site in Section 5, T 15 N, R 12 W. Subsequent to this investigation, a series of wells were drilled to investigate the potential for the development of the basaltic artesian aquifer.

Developmental Well Drilling and Installation

Developmental well drilling and installation was performed based upon the results of the test hole program. The objective of the developmental program was to investigate the potential of the volcanic confined aquifer as a groundwater source and to provide a network of wells that could provide information regarding potential impacts of withdrawal of the proposed groundwater development.

Based upon the test hole drilling program, a number of wells were installed to assess the potential for the development of the confined basaltic aquifer and the potential for impacts to the overlying aquifers. A total of four wells were installed in the lower aquifer, one well in the middle aquifer, and three wells were installed in the upper (alluvial) aquifer. One of the wells indicated as being installed in the upper (alluvial) aquifer, MW8, was actually installed in lacustrine clay, the upper member of the Lower Basin fill. The four lower aquifer wells were installed to determine the hydrologic properties of this aquifer via aquifer testing. The wells installed in the middle and upper aquifers were installed to determine potential impacts on these aquifers associated with the development of the lower aquifer.

Each of the wells was installed utilizing reverse circulation rotary drilling techniques. Locations of the wells is presented on **Figure 3**. Completions of the wells are detailed on **Table 1**. Lithologic logs and well construction diagrams are included in **Appendix D.**

Aquifer Step-Drawdown Test

On August 28, 2000 a step-drawdown test was performed on Production Well 2 (PW2). The test was conducted by pumping the well over a 24-hour period with the discharge rate being increased every six hours. The steps consisted of an artesian free flow at 760 gallons per minute (gpm), and pumping discharge rates of 1,204 gpm, 1,800 gpm, and 2,100 gpm.

In addition to monitoring the pumped well, a number of observation wells were monitored to observe the responses of the pumping of PW2. The observation wells that were monitored isolated all three of the aquifers, the lower confined aquifer, the middle aquifer, and the upper aquifer. Each of the wells was equipped with an In-Situ Troll or Mini-Troll in-well datalogger and transducer. The dataloggers in wells in the middle aquifer (OWMA2 and OW3) and the lower aquifer (PW2 and OW4) were all set with logarithmic data collection time schedules that were synchronized to the start of the test. The results of the aquifer test proved that OW3 was penetrated in the confined basaltic aquifer.

Table 1
Well Data
Big Sandy Energy Project

Well Designation (Currently Drilled/ Installed)	Township	Range	Section	1/4 1/4 Section	Latitude	Longitude	Collar Elevation feet	Purpose (monitor/ production/ exploration)
Test Hole #1	16N	13W	36	SW1/4,NW1/4,SW1/4	34 40' 43.4"	113 34' 54"		Exploration
Test Hole #2	15N	12W	7	NW1/4,NW1/4,NW1/4	34 39' 44.6"	113 33' 44.6"		Exploration
Test Hole #3	15N	12W	5	SW1/4,SW1/4,SW1/4	34 39' 45.3"	113 32' 47.5"		Exploration
Test Hole #4	15N	12W	7	SE1/4,SE1/4,NW1/4	34 39' 39.2"	113 33' 24.5"		Exploration
Obs Well at Site 1	16N	13W	36	SW1/4,NE1/4.SW1/4	34 40' 48.6"	113 34' 53.5	1,884.73	Piezometric
Obs Well OWMA at Site 2	15N	12W	7	NW1/4,NW1/4,NW1/4	34 39' 41.7"	113 33' 43.2"	1,994.47	Piezometric
Prod Well at Site 2	15N	12W	7	NW1/4,NW1/4,NW1/4	34 39' 42.4"	113 33' 45.4"	1,991.03	Production
Obs Well OWC at Site 2	15N	12W	7	NW1/4,NW1/4,NW1/4	34 39' 40.4"	113 33' 46.9"	1.981.32	Piezometric
Obs well at Site 3	15N	12W	5	SW1/4,SW1/4,SW1/4	34 39' 46.7"	113 32' 47.2"	2,100.36	Piezometric
Ob Well at Site 4	15N	12W	7	SE1/4,SE1/4,NW1/4	34 39' 19.0"	113 33' 21.6"	1,991.22	Piezometric
Obs Well at Site 7	15N	13W	1	SW1/4, SW1/4, SE1/4	34 39' 44.2"	113 34'18.2"	1,931.58	Piezometric
Obs Well at Site 8	15N	13W	12	NE1/4,NE1/4,SW1/4	34 39' 11.7"	113 34' 29.6"	1,852.58	Piezometric
Planned Wells								
Prod Well at Site 4	15N	12W	7	SE1/4,SE1/4,NW1/4	34 39' 39.2"	113 33' 24.5"		Production
Prod Well at Site 5	15N	12	7	NE1/4,NE1/4,NW1/4	24 39' 41.7	113 33' 21.0"		Production
Prod Well at Site 6	15N	12W	7	SW1/4,NW1/4,SW1/4	34 39' 06.3"	113 33' 50.6"		Production
Other Wells								
Harris Well	15N	13W	13	NW1/4,NW1/4,SE1/4	34 38' 21.9"	113 34' 15.2"	1,784.05	Piezometric
Denton Well	15N	13W	24	SE1/4,SE1/4,NW1/4	34 37' 39.8"	113 34' 29.3"	1,782.93	Piezometric
Banegas Rch Well 2	15N	13W	13	SW1/4,NW1/4,NE1/4	34 38' 45.2"	113 34' 20.1"	1,786.99	Piezometric

Table 1 (continued)
Well Data
Big Sandy Energy Project

Well Designation (Currently Drilled/ Installed)	Aquifer	Depth (Feet)	Casing Diameter	Borehole Diameter	Screened Interval (Feet)	Gravel Pack (annulus) feet	Cement annulus feet	Lithologic Unit
Test Hole #1		700	None	6 7/8		0	0	Alluvium
Test Hole #2		1,155	None	6 7/8		0	0	Alluvium
Test Hole #3		780	None	6 7/8		0	0	Volcanics
Test Hole #4		1,200	None	6 7/8		0	0	Alluvium
Obs Well at Site 1	Upper	110	5"	9 7/8	20-110	15 - 110	0 - 15	Alluvium
Obs Well OWMA at Site 2	Middle	730	3"	6 7/8	393 - 693	315 - 693	0 - 315	Alluvium
Prod Well at Site 2	Confined	1,500	20"/12"	28"/17.5"*	1,135 - 1,600	1,135 - 1,600	0 - 1,135	Volcanics
Obs Well OWC at Site 2	confined	1,600	5"	12 1/4	1,140 - 1,600	1,119 - 1,600	0 - 1,119	Volcanics
Obs well at Site 3	Middle	1,200	12"	17 1/2	578 - 1,180	565 - 1,200	0 - 565	Volcanics
Ob Well at Site 4	Confined	1,500	3"	12 1/4	1,070 1,500	1,070 - 1,500	0 - 1,070	Volcanics
Obs Well at Site 7		190	3"	6 7/8	20 - 190	20 - 190	0 - 20	Lakebed clay
Obs Well at Site 8	Upper	150	5"	9 7/8	90 - 150	30 - 150	0 - 30	Alluvium
Planned Wells								
Prod Well at Site 4	Confined	1,800	20"		1,400 1,800			
Prod Well at Site 5	Confined	1,500	20"		1,100 1,500			
Prod Well at Site 6	Confined	1,500	20"		1,100 1,500			
Other Wells								
Harris Well	Upper	<200	8"		unk			Alluvium
Denton Well	Upper	100			unk			Alluvium
Banegas Rch Well 2	Upper	105			85 105			Alluvium

Table 1 (continued)
Well Data
Big Sandy Energy Project

Well Designation (Currently Drilled/ Installed)	Artesian Flow/Pressure (gpm/psi)	Date Drilled	Actual or Projected Water Levels
Test Hole #1	0	Dec-00	Plugged
Test Hole #2	125/30	Feb-00	Plugged
Test Hole #3	0	Feb-00	Plugged
Test Hole #4	140/29	Mar-00	Plugged
Obs Well at Site 1	0	Sep-00	12
Obs Well OWMA at Site 2	0	Aug-00	85.3
Prod Well at Site 2	765/38	Aug-00	Flowing
Obs Well OWC at Site 2	unk/38	Sep-00	Flowing
Obs well at Site 3	0	Jun-00	16
Ob Well at Site 4	125/38	Jun-00	Flowing
Obs Well at Site 7	0	Aug-00	114
Obs Well at Site 8	0	Aug-00	63.8
Planned Wells			
Prod Well at Site 4			
Prod Well at Site 5			
Prod Well at Site 6			
Other Wells			
Harris Well	0		39.6
Denton Well	0		42.2
Banegas Rch Well 2	0		20.3

The dataloggers in the observation wells in the upper unit (OW1, OW7, OW8, Banegas, and Harris) were set to take data at arithmetic intervals during the test with initiation of data collecting prior to the start of the test program. In addition, a piezometer was installed in the Big Sandy alluvium approximately 2 mile south of the boundary of Sections 12 and 13, T 15 N, R 13 W. This piezometer was also set to obtain water levels at 30-minute intervals throughout the testing period. Down stream (approximately 100 feet) of the piezometer a v-notch weir was installed to measure flow in the Big Sandy River. Photographs of the pumping test apparatus, v-notch weir installation, and piezometer are attached.

Prior to the test, a heavy rainfall event occurred. This rain commenced on the morning of August 27th and continued throughout the day. The rain resulted in runoff in the washes, and visually increased flow in the Big Sandy River. The v-notch weir was installed in the Big Sandy River as previously described on August 28, 2000. No readings from this weir or the piezometer are included in this data, since on the morning of August 29th, a second rainfall event started at 0700 hours and continuing throughout the remainder of the test (1400 hours). Based on visual observation, this event appeared larger than the event on August 27th. The weir and piezometer were removed the morning of August 29th to avoid a potential loss of these devices from the resultant flow in the river. River measurements during this test would have reflected these storm events, and influences from pumping would not have been distinguishable in the data.

Aquifer Testing Protocol

A protocol was developed for the constant rate test as a result of the consensus among the hydrologists that represent URS Consultants, State of Arizona, Bureau of Land Management, Western Area Power Administration, U. S. Fish and Wildlife Service, Manera, Inc. and Greystone Environmental Consultants. The aquifer test was designed to determine the aquifer parameters of the lower confined aquifer and to determine whether flow exists between the lower, middle and upper aquifers. The generalized sequence of aquifers (from surface to depth) at the proposed site are an unconfined upper alluvial aquifer (underflow of the Big Sandy River), a middle aquifer, and a lower confined aquifer. Separating the upper unconfined aquifer from the middle aquifer is a layer of lacustrine clay ranging in thickness from 150 feet to more than 500 feet. Separating the middle and lower aquifers is a basalt or well indurated volcanic layer.

Aquifer Testing Well Array

The aquifer test consisted of removal of water from well PW2, while measuring responses in the surrounding wells. Prior to the constant rate pumping test, baseline monitoring and a step-drawdown test were conducted. The wells that were selected for the test are presented in **Table 2.**

Baseline Monitoring

Measurements of depth to water were conducted daily to establish a baseline for the water levels in the wells and flow at the surface station. Along with the depth to water, the time, date and weather conditions were noted. This data collection commenced approximately two weeks prior to the test.

Table 2 Aquifer Test Wells Proposed Big Sandy Energy Project Wikieup, Arizona				
Upper Aquifer Wells	**Screened Interval**	**Drilled Depth**	**Datalogger Yes/No**	**Logging Schedule**
OW1	20 to 150	150	Yes	Arithmetic
OW7	70 to 200	200	Yes	Arithmetic
OW8	20 to 150	150	Yes	Arithmetic
Benagus Well	85 to 105	105	Yes	Arithmetic
Middle Aquifer Wells				
OWMA2	540-1000	1000	Yes	Log
Lower Aquifer Wells				
PW2	1100 to 1500	1500	Yes	Log
OW2	1100 to 1500	1500	Yes	Log
OW4	1070 to 1500	1500	Yes	Log
OW3	578 - 1180	1200	Yes	Log

For the wells that were not yet installed, measurements were conducted as the wells were installed. Daily measurements continued throughout the step-drawdown and constant rate tests.

Data from the baseline monitoring was included within plots for the aquifer test. This data was added at the time when recorded, and hydrographs generated. These hydrographs indicate the overall trend within monitor wells from the time prior to the test, through test and through recovery. Examination of the data plots indicates that groundwater elevations within the middle aquifer and upper (alluvial) aquifer wells were not affected by the aquifer test. Copies of the hydrographs are included as **Appendix F**.

Constant Rate Test

The constant rate test was to be performed at 2,000 gpm based upon the results of the step drawdown test and as agreed upon by the hydrology team. The average discharge over the period of the testing program was 1,931 gpm. The test consisted of pumping PW2 at a constant rate while observing and recording the responses in the observation wells. The observation wells that were utilized are listed on **Table 2**. No impacts to the upper (alluvial) aquifer wells were apparent during the test.

During the various phases of the aquifer test, the discharge water was dispersed by means of large sprinkler guns. These guns were positioned in Section 7, T 15 N, R 12 W.

For each well, a pressure transducer and an in-situ data logger was installed. Within **Table 2**, the schedule of data collection and the wells that were equipped with data loggers is detailed. These data loggers are devices that measure the depth to water in the well and record this level at prescribed intervals. For all the wells, except as noted, a logarithmic time scale was utilized for the data collection. All logarithmic transducers were set to start at a time synchronized with the start of pumping. Pump flow measurements were also obtained utilizing a continuous rate flow meter and totalizer. Redundant water level measurements were taken by hand to provide a backup to the electronic data gathering. Time intervals that are obtained by hand were of a greater time interval than those taken by electronic means and were for backup purposes only. Following the aquifer pumping test, data was gathered during the recovery of the aquifer.

Aquifer Test Analyses

Aquifer test analyses was conducted utilizing AQTESOLV, Aquifer Test Solver software. The methods utilized for the analyses of the test were Theis and Cooper-Jacob. Both of these methods are for confined aquifers. The Theis methodology assumes the following:

- The aquifer has infinite areal extent.
- The aquifer is homogeneous, isotropic and of uniform thickness.
- The aquifer potentiometric surface is initially horizontal.
- The pumping rate is constant.
- The pumping well is fully penetrating.
- The flow to the pumping well is horizontal.
- The aquifer is confined.
- The flow is unsteady.
- Water is release instantaneously with a decline in hydraulic head.
- The diameter of the well is very small so that storage in the well can be neglected.

The Cooper-Jacob solution makes the same assumptions as Theis but also assumes:

- Values of u are small (i.e. radius from the pumping well to the observation well is small and time since pumping began is large)

These methods of analyses were chosen since the aquifer is confined and of an areal extent that is great enough for no boundary conditions to be apparent in the test data. Although many of conditions specified by the methodology are not met, these two methodologies represent the closest approximation to the site conditions. In addition, several examples exist witihin the literature where these conventional methodologies of analyses have been utilized (Singhal and Gupta, 1999).

Hydrologic Parameters

The hydraulic characteristics of basalts and volcanic rocks are dependent on the rate of cooling, viscosity of the magma and the degassing that occurs during cooling (Singhal and Gupta, 1999). The openings that impart porosity and permeability to basaltic rocks are scoariae, breccia zones, cavities, shrinkage cracks or columnar joints, gas vesicles, lava tubes and fractures and lineaments (Stearns, 1942; UNESCO, 1975). The variation in permeability encompasses almost nine orders of magnitude (Singhal and Gupta, 1999).

The results of the Big Sandy Energy Project aquifer test analyses indicate transmissivity values (T) of lower aquifer ranging from 12,520 ft^2/day to 12,960 ft^2/day utilizing the Cooper-Jacob methodology. The T values determined by the Theis methodology ranged from 10,105 ft^2/day to 11,193 ft^2/day. These values present a standard deviation of 184 for the Cooper-Jacob analyses and a corresponding standard deviation of 448 for the Theis analyses. Average transmissivity of the Cooper-Jacob analyses is 12,709 ft^2/day and the corresponding average of the Theis results is 10,689 ft^2/day.

The low standard deviations of the results of the aquifer test and the directional variation of the well array indicates that the aquifer is highly homogeneous with regard to transmissivity. The relatively close results between the two types of analyses combined with the low standard deviation of the data provide a high degree of confidence in the T values.

The storativity values associated with these same wells ranges over four orders of magnitude. The values were 0.29 for OWC2, 0.00057 from OW3, and 0.00118 from OW4 utilizing the Cooper-Jacob analyses. Similar results are provided by the Theis-based analyses. Although the values vary widely, only the value from the well OWC2 is not within the normal range for a confined basaltic aquifer. The other two values are more representative of the typical basaltic aquifers. A summary of the transmissivity and storativity values from each of the analyses and each is well is presented in **Table 3** and a summary of typical values from other basaltic aquifers is provided in **Table 4.**

Table 3
Transmissivity and Storativity Values
Big Sandy Energy Project
Wikieup, Arizona

Well Name	Theis Value		Cooper- Jacob Value	
	Transmissivity (ft2/day)	Storativity	Transmissivity (ft2/day)	Storativity
OWC2	10770	0.3816	12520	0.2971
OW3	11193	0.00069	12647	0.00057
OW4	10105	0.00163	12960	0.00118

Table 4
Typical Transmissivities and Storage Values
Big Sandy Energy Project
Wikieup, Arizona

Rock Type	Age	Location	T (ft^2/day)	S
Basalt	Miocene	Columbia Snake River Area, USA	2173 - 24511 avg - 55198	2×10^{-2} 6×10^{-2}
Basalt	Miocene Quaternary	Gran Canaria,Spain	538 - 3228	--
Basalt (fractured)	Pleistocene-Holocene	Mexico	6509 - 9307	--
Basalt	Pliocene	Republic of Djibouti	365 - 54876	10^{-2} - 10^{-4}

(modified from Singhal and Gupta, 1999)

Further analyses of the data was performed by utilizing the Cooper-Jacob straight line analyses. This analyses evaluates the data from all observation wells to determine the transmissivity and storativity. This analyses was performed on the two distant wells, OW3 and OW4, since the storativity value determined by the well OWC2 is considered suspect. The results of the Cooper-Jacob straight line method indicated a transmissivity value of 163,000 g/day/ft or 21,791 ft^2/day. While this value is higher than the values determined from the individual observation wells, the value does add confidence that the transmissivity of the aquifer is high. A copy of the analyses of the individual observation wells and the straight line determination is included in **Appendix G.**

In addition to transmissivity, hydraulic conductivity can be determined utilizing the equation T=kb, where T is transmissivity, k is the hydraulic conductivity and b is the aquifer thickness. Utilizing the transmissivity values derived from the aquifer testing and the aquifer thickness (300 ft) as determined by the test drilling, the hydraulic conductivity values were determined. Hydraulic conductivity of the aquifer ranged from 41.7 ft/day to 43.2 ft/day by the Cooper-Jacob analyses. Correspondingly, the results of the Theis analyses ranged from 33.7 ft/day to 37.3 ft/day. **Table 5** summarizes the hydraulic conductivity values as determined by aquifer testing. These hydraulic conductivities are within the normal ranges for basaltic aquifers. For comparative purposes, hydraulic conductivities of differing basalt types are presented on **Table 6.**

Table 5
Hydrualic Conductivity Values
Big Sandy Energy Project
Wikieup, Arizona

Well Name	Theis Value	Cooper- Jacob
	Hydraulic Conductivity (ft/day)	Hydraulic Conductivity (ft/day)
OWC2	35.9	41.7
OW3	37.3	42.2
OW4	33.7	43.2

Table 6
Typical Conductivity and Porosity Ranges for Basalt
Big Sandy Energy Project
Wikieup, Arizona

Basalt type	Porosity (%)	Hydraulic Conductivity (ft/day)
Dense	0.1-1	10^{-6}-10^{-2}
Vesicular	5-11	10^{-3}-10^{-2}
Fractured, weathered	10-17	10^{-3}-10^{4}

(modified from Singhal and Gupta, 1999)

Based upon the values of hydraulic conductivity determined from the aquifer test, the basalt type would appear to be fractured and or weathered. The corresponding porosity of the aquifer would therefore appear to range from 10-17 percent. In consideration that the hydraulic conductivity of the aquifer is 10^{1}, a conservative porosity of 13-14% could be assumed.

Examination of the hydrographs from the middle aquifer and alluvial aquifer wells in the area does not indicate any influence from the pumping test. No calculation can be made regarding the transmissivity of these aquifers from this test data, nor can any vertical hydraulic conductivity value be derived for the confining layers that exist between these aquifers. The test indicates that little, if any interconnection may exist between the basaltic aquifers and the other aquifers in the Big Sandy Valley. Copies of the hydrographs from all wells are included in **Appendix F.**

PROJECTED EFFECT OF WITHDRAWAL

Based upon the results of the geological research and the aquifer testing, a simplified water balance for the aquifer was utilized to determine the potential impacts to the aquifer. For the models a average withdrawal rate of 3,000 gpm was utilized.

In the first methodology, the minimum and maximum extent of the aquifer (as estimated in the geology section) is utilized along with the estimated porosity and aquifer thickness to determine the volume of water in storage. For each of the aquifer minimum and maximums:

Minimum extent:

Area of the aquifer

$57.04\ mi^2 \times 27878400\ ft^2/mi^2 = 1.59 \times 10^9\ ft^2$

Volume of the aquifer

$1.59 \times 10^9\ ft^2$ (aquifer extent) x 300 feet (assumed aquifer thickness) = $4.77 \times 10^{11}\ ft^3$ (aquifer volume)

$4.77 \times 10^{11}\ ft^3$ (aquifer volume) x 7.48 gallons/ft^3 = 3.56×10^{12} aquifer volume in gallons

Water Stored in the Aquifer

3.56×10^{12} gallons (aquifer volume) x 0.13 porosity = 4.6×10^{11} gallons, or 4.6×10^{11} / 325,851 (gallons per acre foot) = 1,420,281 acre feet of water stored in the aquifer

Maximum extent:

Area of the aquifer

$80.14\ mi^2 \times 27878400\ ft^2/mi^2 = 2.24 \times 10^9\ ft^2$

Volume of the aquifer

$2.24 \times 10^9\ ft^2$ (aquifer extent) x 300 feet (assumed aquifer thickness) = $6.73 \times 10^{11}\ ft^3$ (aquifer volume)

$6.73 \times 10^{11}\ ft^3$ (aquifer volume) x 7.48 gallons/ft^3 = 5.03×10^{12} aquifer volume in gallons

Water Stored in the Aquifer

5.03×10^{12} gallons (aquifer volume) x 0.13 porosity = 6.54×10^{11} gallons, or

6.54×10^{11} / 325,851 = 2,004,000 acre feet of water stored in the aquifer

Therefore the volume of water stored in the aquifer is between 1,420,000 acre feet and 2,004,000 acre feet.

Water enters the aquifer through recharge. Assuming that recharge only occurs as a result of precipitation directly on the outcrop, then a conservative estimate of the average annual recharge to the aquifer can be made. Meteorological data from Wikieup indicates that 10.00 inches of precipitation occurs on an annual basis (Western Regional Climate Center, 2000). Recharge in basaltic aquifers in arid regions is approximately 10 % of the annual rainfall (UNESCO, 1975). Therefore:

Recharge Zone Area:

$26.19\ mi^2 \times 27878400\ ft^2/mi^2 = 7.3 \times 10^8\ ft^2$

Annual Recharge Volume:

$7.3 \times 10^8\ ft^2$ (recharge area) x 0.8333 ft (precipitation in feet) x 0.10 (percentage to the aquifer) = $6.08 \times 10^7\ ft^3$ of water as total annual recharge to the aquifer.

$6.08 \times 10^7\ ft^3$ (total recharge in ft^3) x 7.48 g/ft^3 = 4.55×10^8 gallons, or

4.55×10^8 / 325,851 = 1,396 acre feet of annual recharge.

Discharge from the aquifer is assumed to be equal to the amount of recharge into the aquifer. The recharge rate equates to approximately 865gpm. Some discharge does occur through springs in the area such as Cofer Hot springs. The total amount of discharge is also assumed to be 865 gpm.

Estimation of Water Use by Simplified Water Balance Methods

One very conservative method to determine potential drawdown in the aquifer is assume the aquifer receives no recharge and to subtract the water needs for the facility from the amount of water in storage in the aquifer. While this is not a realistic scenario, this does illustrate the requirements and available supplies in a simple manner. Considering that the facility requires a maximum of 3,000 gpm or approximately 4,850-feet/year for approximately 40 years, and the total water volume in the aquifer is approximately 1.4 million acre feet (lowest estimate), then:

Total Facility Requirements:

3,000 gpm x 1440 minutes/day x 365 days/year x 40 years / 325,851 gallons/acre feet = 193,561 acre feet

Total Amount of Water Remaining Stored in the Aquifer (Minimum Extent):

1,420,000 acre feet (minimum stored in aquifer) - 193,561 acre feet (required for plant) = + 55,854 acre feet (recharge) = 1,282,293 acre feet (remaining stored in aquifer)

Percentage of Water in the Aquifer Utilized (Minimum Extent):

1,282,293 acre feet (remaining stored in the aquifer) / 1,420,767 acre feet (stored in the aquifer) = 9.75 percent utilized leaving 90.25 % of the original volume of water in storage.

This calculation includes the volume of water that would recharge the aquifer during the forty years of operations. In addition, this calculation was performed based upon the minimum extent of the aquifer believed to exist.

POTENTIAL IMPACTS ASSOCIATED WITH AQUIFER DEVELOPMENT

The aquifer proposed for development is a highly confined aquifer that does not appear to interconnected to the overlying aquifers. This lack of interconnection is evidenced in the hydrographs of measurements made in the observation wells in the Upper and Middle Aquifers, which shows no change in the trend of the water levels prior to, during and following the pumping test. Therefore, withdrawal from the Lower (confined) aquifer appears not to impact the Upper Aquifer or the flow in the Big Sandy River and consequently, will not impact the existing wells which presently penetrate only the Recent Stream and Flood Plain and the Upper Basin fill deposits. Further, it appears that the Middle Aquifer will not be effected.

Only one naturally occurring discharge point of the confined aquifer has been clearly identified through pump testing and water quality analyses. This natural discharge point issues as Cofer Hot Springs. The only impact determined from the investigation that will probably occur as withdrawal from the Lower (confined) Aquifer continues is that flow will be reduced or cease from the Cofer Hot Spring. No other currently identified springs will likely be impacted.

The Owner of Cofer Hot Spring has agreed to negotiate mitigation that will compensate for loss of flow.

PROPOSED MONITORING PROGRAM

To verify the projections made as part of this assessment of the ground water potential of the area, a monitoring program is proposed. This monitoring program is designed to verify the drawdowns and potential impacts in the Upper Alluvial, Middle and Lower aquifers. The monitoring program will utilize both existing and proposed wells.

Currently, wells exist in the Upper Alluvial Aquifer at sites 1, 7, and 8. One Middle Aquifer well exists at Site 2. In addition to these wells, Lower Aquifer wells exist at site 4 and site 2. Each of these well is proposed to be utilized as part of the proposed monitoring program. In addition to these wells, it is proposed that an additional monitoring well be installed near Cofer Hot Springs. This well will be screened in the lower aquifer and will be utilized for monitoring the lower aquifer.

Water levels in these wells will be monitored over the period of operations on a daily basis by means of transducers and data loggers. The equipment for each well will consist of an In-Situ® Troll, Mini-Troll or similar device. The water level values will be downloaded and analyzed on a quarterly basis. Repairs and or replacement of the equipment will be performed during the download periods.

The data derived from the monitoring program will be summarized and presented in an Annual Hydrology Report. This report will analyze the previous years data and project the probable drawdown for the coming year. As part of this analysis, the impact, if any, on the Middle or Upper Aquifer will be determined. The report will be available to the agencies and the public at the beginning of each monitoring year.

CONCLUSION

The conclusions reached on the basis of this investigation are:

- the Lower (confined) Basaltic Aquifer is a heretofore undocumented aquifer which has not been utilized by any wells or withdrawal;
- the Lower (confined) Basaltic Aquifer and its recharge area has a minimum areal extent of approximately 57 square mile of which 31 square miles is within the Big Sandy Basin and the remaining 26 square miles, forming the recharge area, consists of the Volcanic Rocks of Sycamore Creek to the east of the basin;
- the minimum volume of water in storage in the Lower (confined) Basaltic Aquifer is 1.4 million acre feet;
- the maximum demand of the power plant over the 40 year period of the proposed project is 193,561 acre feet;
- recharge to the Lower (confined) Basaltic Aquifer will replace 55,854 acre feet in the 40 year life of the project;
- during the life of the project, the project will withdraw 9.75 percent of the volume of water in storage;
- withdrawal from the Lower (confined) Basaltic Aquifer does not effect the water levels in the Middle or Upper Aquifers, therefore, the withdrawal to satisfy the demand of the project will not impact the existing wells which penetrate only the Upper Aquifer or the Recent Stream and Flood Plain alluvial fill;
- there is sufficient water available in the Lower (confined) Basaltic Aquifer to satisfy the demands of the project for 40 years without depleting the aquifer and without impacting the existing wells.

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APPENDIX A
LITHOLOGIC LOGS

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APPENDIX C
BIG SANDY ALLUVIAL AQUIFER TEST RESULTS

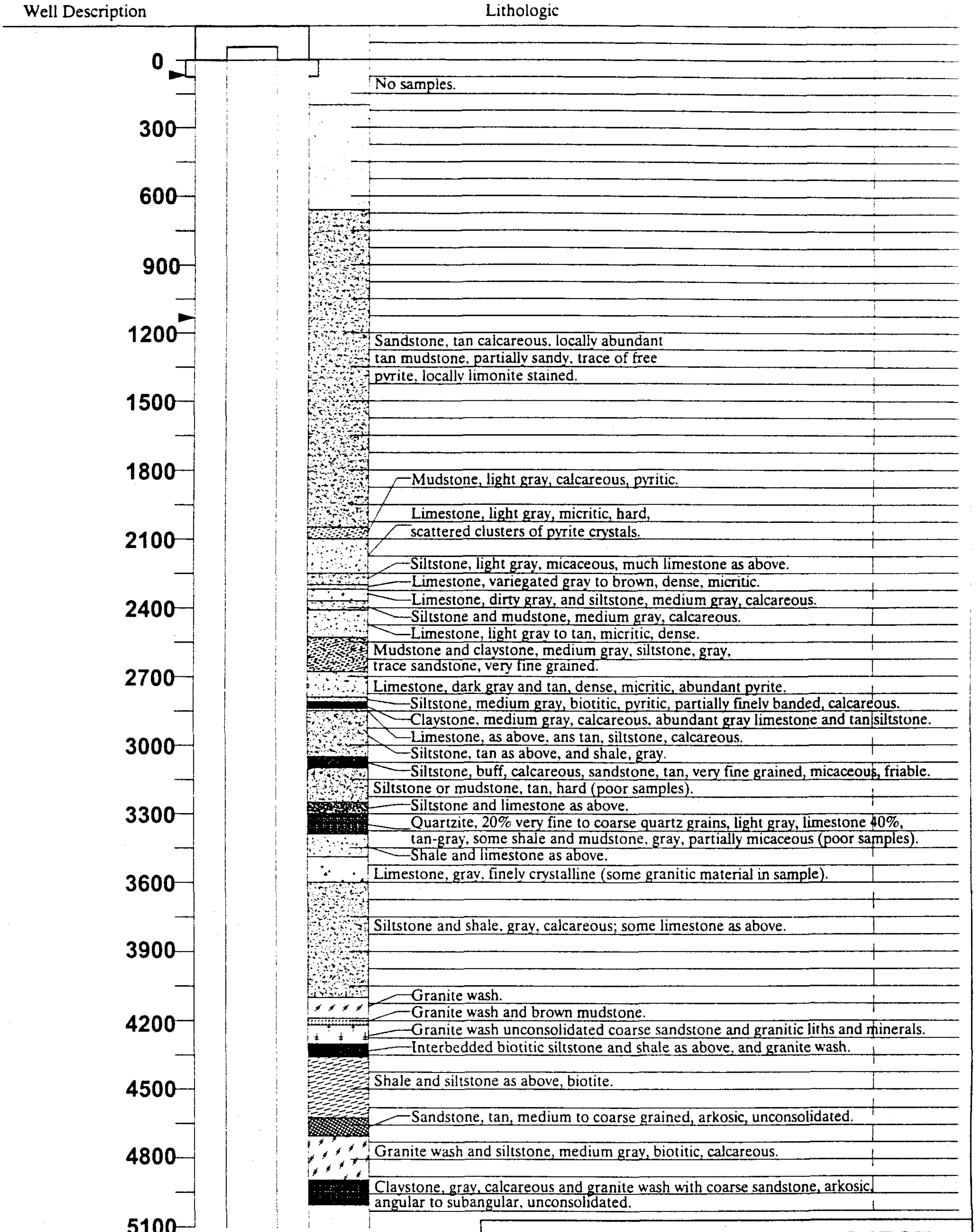
APPENDIX D
TEST HOLE DRILLING RESULTS

APPENDIX E
LITHOLOGIC LOGS AND WELL CONSTRUCTION DIAGRAMS

APPENDIX F
WELL HYDROGRAPHS

APPENDIX G
AQUIFER TEST ANALYSES PLOTS AND DATA

APPENDIX A
LITHOLOGIC LOGS



BIG SANDY ENERGY PROJECT

OBS WELL SITE PQ-25
AFTER LEASE, 1982
LITHOLOGIC LOG

DATE: 10/16/00	AutoCAD File:891_pq-25.dwg
SCALE: AS NOTED	DRAWN BY: MM

MANERA INC.

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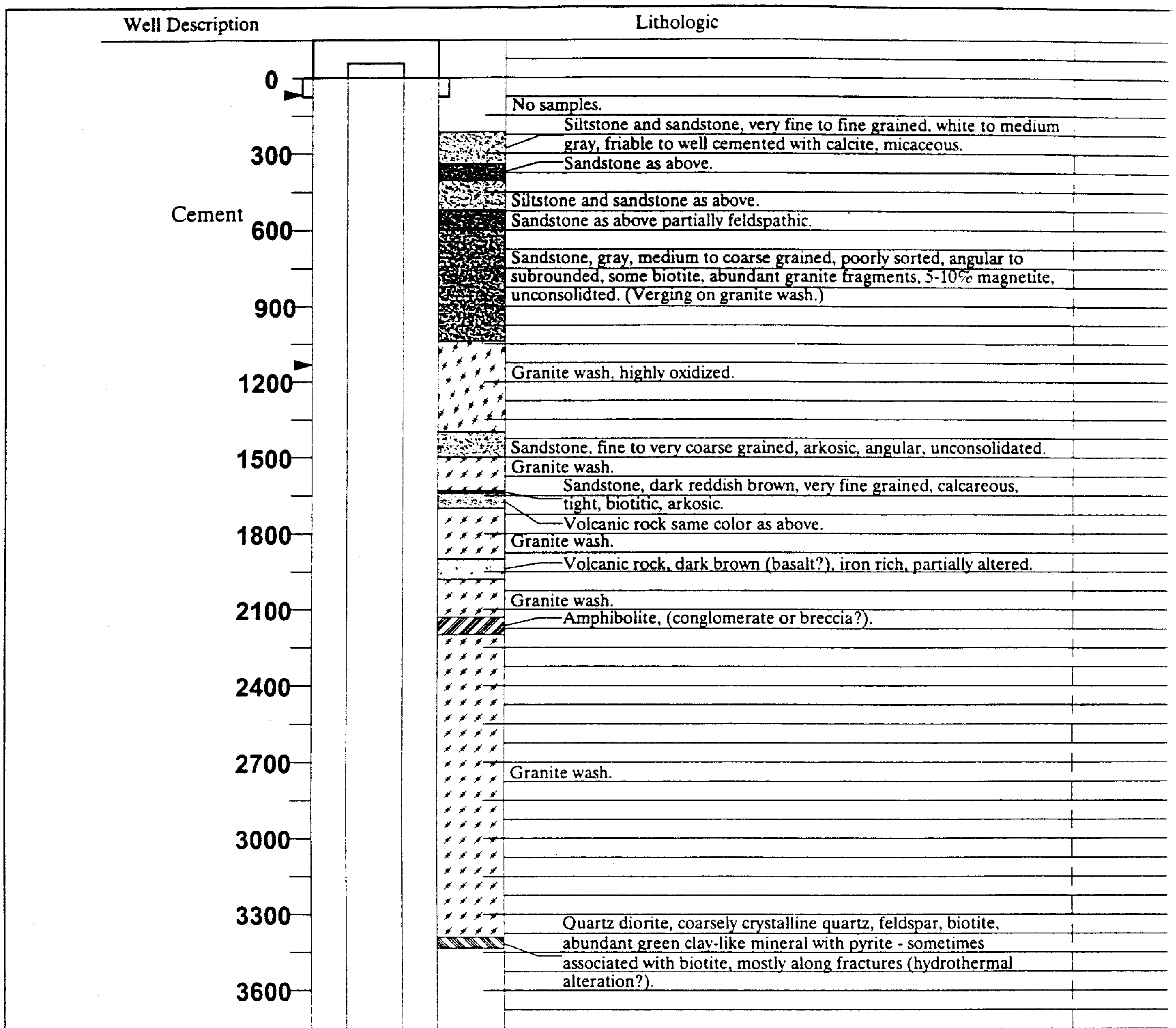
10/16/00



MANERA INC.

BIG SANDY ENERGY PROJECT

OBS WELL SITE PQ-26
AFTER LEASE, 1982
LITHOLOGIC LOG

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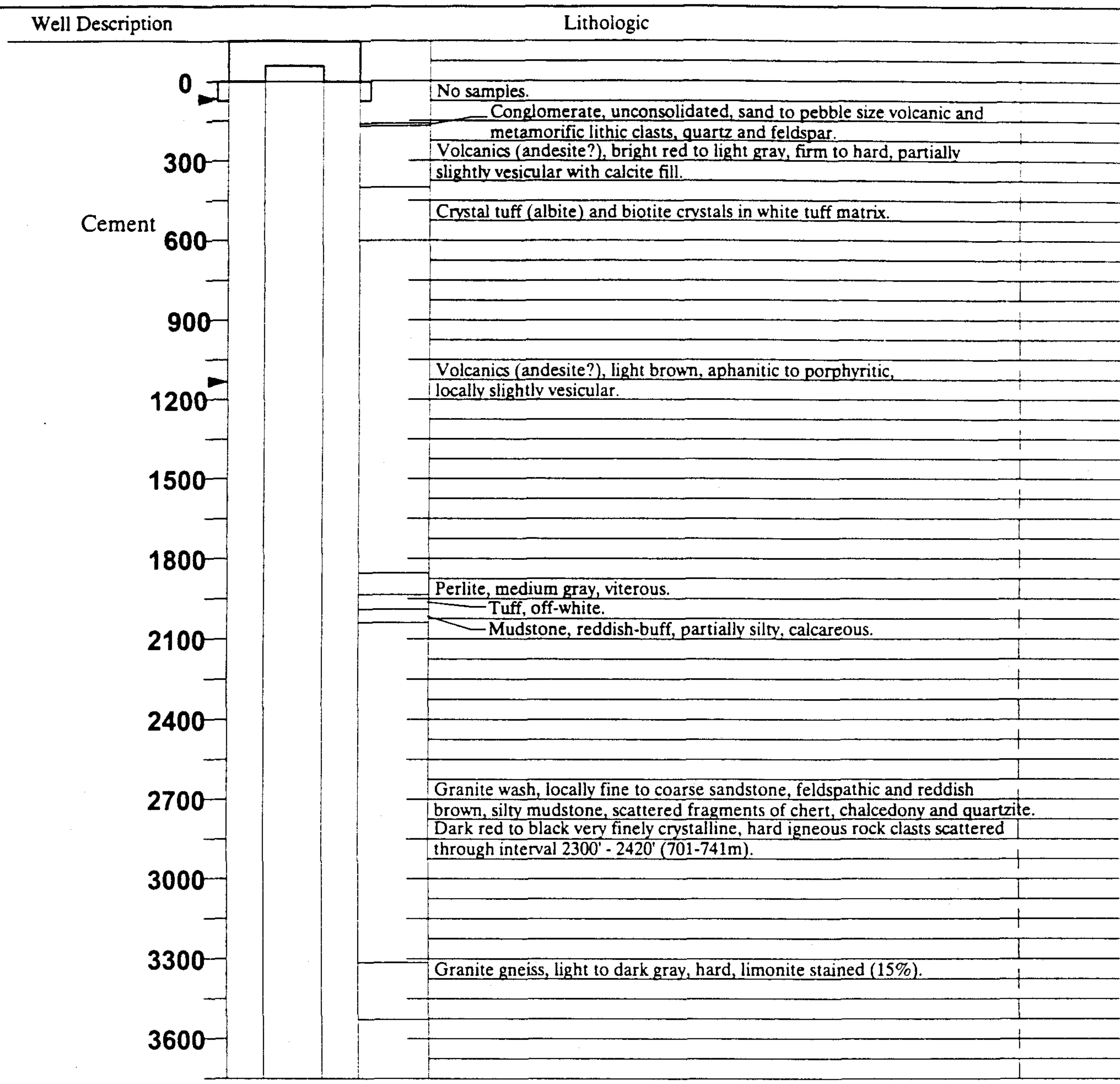
10/16/00



MANERA INC.

BIG SANDY ENERGY PROJECT

OBS WELL SITE PQ-29
AFTER LEASE, 1982
LITHOLOGIC LOG

DATE: 10/16/00	AutoCAD File:891_pq-29.dwg
SCALE: AS NOTED	DRAWN BY: MM

APPENDIX B
LABORATORY ANALYSIS

BOLIN LABORATORIES • INC

Legend Technical Services of Arizona

17631 N. 25th Avenue ■ Phoenix, Arizona ■ 85023 ■ (602) 942-8220 ■ fax (602) 942-1050 ■ ADHS# AZ0004

Manera Inc.
8316 N. 53rd Street
Paradise Valley, AZ 85253-2512

Received: 5/25/00
Reported: 6/19/00
Invoice No: 065879

Attn: Paul A. Manera

Project Name: MCEDA Big Sandy

Matrix: Drinking Water
Sample No: 0005-04716-001
Sample ID: Big Sandy 4B (B15-12 7BDD Deep Mntr)
Time Sampled: 13:00
Date Sampled: 5/25/2000

PARAMETER	METHOD	RESULTS	UNITS	PQL	DATE ANALYZED
Colilert	SM 9223B	0	P/A		5/27/00
Antimony	EPA 200.9	<0.004	mg/L	0.004	5/31/00
Arsenic	EPA 200.9	0.141	mg/L	0.05	6/09/00
Barium	EPA 200.7	0.06	mg/L	0.01	6/12/00
Beryllium	EPA 200.7	<0.002	mg/L	0.002	6/12/00
Calcium	EPA 200.7	48.	mg/L	10	6/12/00
Cadmium	EPA 200.9	<0.0002	mg/L	0.0002	6/01/00
Chromium	EPA 200.7	<0.005	mg/L	0.005	6/12/00
Copper	EPA 200.7	<0.015	mg/L	0.015	6/12/00
Hardness, Calcium	EPA 200.7	120		2.5	6/12/00
Hardness, Total (Ca & Mg)	SM 2340B	178		7.	6/15/00
Lead	EPA 200.9	<0.005	mg/L	0.005	5/30/00
Langlier Index	CALCULATION	0.120		-5	6/12/00
Magnesium	EPA 200.7	14.	mg/L	1.	6/15/00
Mercury	EPA 245.1	<0.0002	mg/L	0.0002	5/31/00
Nickel	EPA 200.7	<0.02	mg/L	0.02	6/12/00
Selenium	EPA 200.9	<0.005	mg/L	0.005	5/30/00
Sodium	EPA 200.7	195.	mg/L	20	6/12/00
Thallium	EPA 200.9	<0.001	mg/L	0.001	6/07/00
Total Alkalinity (as CaCO3)	SM 2320B	252.	mg/L	2.	6/07/00
Asbestos	EPA 100.2	<.2	MFL	.2	5/25/00
Cyanide, Total	SM4500 CNE	<0.01	mg/L	0.01	6/01/00
Fluoride	SM 4500-FC	3.7	mg/L	0.1	6/01/00
Nitrogen as Nitrite	SM4500 NO2B	<0.1	mg/L	0.1	5/26/00
Nitrate plus Nitrite	SM 4500-NO3 F	1.3	mg/L	0.1	5/26/00
Nitrogen as Nitrate	CALC.	1.3			5/26/00
pH	EPA 150.1	7.6	Std Unit		5/26/00
Sulfate	EPA 300.0	154.	mg/L	30	5/31/00
Total Dissolved Solids	SM 2540C	746.	mg/L		5/30/00
1,2-Dibromoethane (EDB)	EPA 504.1	<0.00001	mg/L	0.00001	6/02/00
1,2-Dibromo-3-Chloropropane	EPA 504.1	<0.00002	mg/L	0.00002	6/02/00
Extraction	EPA 504.1				5/31/00

BOLIN LABORATORIES • INC

Legend Technical Services of Arizona

17631 N. 25th Avenue • Phoenix, Arizona • 85023 • (602) 942-8220 • fax (602) 942-1050 • ADHS# AZ0004

Matrix: Drinking Water
Sample No: 0005-04716-001

Time Sampled: 13:00
Date Sampled: 5/25/2000

PARAMETER	METHOD	RESULTS	UNITS	PQL	DATE ANALYZED
Aldrin	EPA 508	<0.00002	mg/L	0.00002	6/02/00
Lindane (HCH-gamma)	EPA 508	<0.00002	mg/L	0.00002	6/02/00
Chlordane	EPA 508	<0.0001	mg/L	0.0001	6/02/00
Dieldrin	EPA 508	<0.00002	mg/L	0.00002	6/02/00
Endrin	EPA 508	<0.00001	mg/L	0.00001	6/02/00
Heptachlor	EPA 508	<0.00003	mg/L	0.00003	6/02/00
Heptachlor Epoxide	EPA 508	<0.00002	mg/L	0.00002	6/02/00
Hexachlorobenzene	EPA 508	<0.0001	mg/L	0.0001	6/02/00
Methoxychlor	EPA 508	<0.00003	mg/L	0.00003	6/02/00
Propachlor	EPA 508	<0.00005	mg/L	0.00005	6/02/00
Toxaphene	EPA 508	<0.0001	mg/L	0.0001	6/02/00
PCB's, Total	EPA 508	<0.0001	mg/L	0.0001	6/02/00
PCB 1016	EPA 508	<0.00008	mg/L	0.00008	6/02/00
PCB 1221	EPA 508	<0.0001	mg/L	0.0001	6/02/00
PCB 1232	EPA 508	<0.0001	mg/L	0.0001	6/02/00
PCB 1242	EPA 508	<0.0001	mg/L	0.0001	6/02/00
PCB 1248	EPA 508	<0.0001	mg/L	0.0001	6/02/00
PCB 1254	EPA 508	<0.0001	mg/L	0.0001	6/02/00
PCB 1260	EPA 508	<0.0001	mg/L	0.0001	6/02/00
Extraction	EPA 508				6/01/00
Surrogate:	EPA 508				6/02/00
***Decachlorobiphenyl	EPA 508	78	% Recovery		6/02/00
***Tetrachloro-m-xylene	EPA 508	103	% Recovery		6/02/00
Dalapon	EPA 515.1	<0.001	mg/L	0.001	6/06/00
Dicamba	EPA 515.1	<0.0005	mg/L	0.0005	6/06/00
2,4-D	EPA 515.1	<0.0001	mg/L	0.0001	6/06/00
Pentachlorophenol	EPA 515.1	<0.00004	mg/L	0.00004	6/06/00
2,4,5-TP (Silvex)	EPA 515.1	<0.0002	mg/L	0.0002	6/06/00
Dinoseb	EPA 515.1	<0.0002	mg/L	0.0002	6/06/00
Picloram	EPA 515.1	<0.0001	mg/L	0.0001	6/06/00
Extraction	EPA 515.1				5/31/00
***DCAA	EPA 515.1	79	% Recovery		6/06/00
Alachlor	EPA 525.2	<0.001	mg/L	0.001	6/09/00
Atrazine	EPA 525.2	<0.0015	mg/L	0.0015	6/09/00
Benzo (a) pyrene	EPA 525.2	<0.0001	mg/L	0.0001	6/09/00
Bis(2-ethylhexyl)adipate	EPA 525.2	<0.003	mg/L	0.003	6/09/00
Bis(2-ethylhexyl)phthalate	EPA 525.2	<0.003	mg/L	0.003	6/09/00
Butachlor	EPA 525.2	<0.001	mg/L	0.001	6/09/00
Hexachlorocyclopentadiene	EPA 525.2	<0.001	mg/L	0.001	6/09/00
Metolachlor	EPA 525.2	<0.001	mg/L	0.001	6/09/00
Metribuzin	EPA 525.2	<0.001	mg/L	0.001	6/09/00
Simazine	EPA 525.2	<0.001	mg/L	0.001	6/09/00

BOLIN
LABORATORIES • INC
Legend Technical Services of Arizona

17631 N. 25th Avenue ▪ Phoenix, Arizona ▪ 85023 ▪ (602) 942-8220 ▪ fax (602) 942-1050 ▪ ADHS# AZ0004

Matrix: Drinking Water
Sample No: 0005-04716-001

Time Sampled: 13:00
Date Sampled: 5/25/2000

PARAMETER	METHOD	RESULTS	UNITS	PQL	DATE ANALYZED
Extraction	EPA 525.2				6/07/00
Surrogate:	EPA 525.2				6/09/00
***Pyrene-d10	EPA 525.2	102.	% Recovery		6/09/00
***Triphenylphosphate	EPA 525.2	112.	% Recovery		6/09/00
***Perylene-d12	EPA 525.2	99.9	% Recovery		6/09/00
Glyphosate	EPA 547	<0.02	mg/L	0.006	6/07/00
Endothall	EPA 548.1	<0.009	mg/L	0.009	6/03/00
Extraction	EPA 548.1				6/01/00
Diquat	EPA 549.1	<0.0004	mg/L	0.0004	6/01/00
Extraction	EPA 549.1				5/30/00
Dioxin	EPA 1613	<5.0 x 10(-9)	mg/L		6/07/00
Gross Alpha	CO-PRECIP.	12.1 +/- 1.7	pCi/L		6/02/00
Temperature, Field		96	Degrees C		5/25/00
Chloromethane	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Vinyl Chloride	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Bromomethane	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Chloroethane	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
1,1-Dichloroethylene	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Dichloromethane	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
MTBE	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
trans 1,2-Dichloroethylene	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
1,1-Dichloroethane	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
cis 1,2-Dichloroethylene	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
2,2-Dichloropropane	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Chloroform	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
1,1,1-Trichloroethane	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
1,1-Dichloropropene	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Carbontetrachloride	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
1,2 Dichloroethane	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Benzene	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Trichloroethylene (TCE)	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
1,2-Dichloropropane	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Dibromomethane	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Bromodichloromethane	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
cis 1,3-Dichloropropene	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Toluene	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
trans-1,3-Dichloropropene	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
1,1,2-Trichloroethane	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
1,3-Dichloropropane	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Tetrachloroethylene (PCE)	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Dibromochloromethane	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Chlorobenzene	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00

BOLIN LABORATORIES • INC

Legend Technical Services of Arizona

17631 N. 25th Avenue • Phoenix, Arizona • 85023 • (602) 942-8220 • fax (602) 942-1050 • ADHS# AZ0004

Matrix: Drinking Water
Sample No: 0005-04716-001

Time Sampled: 13:00
Date Sampled: 5/25/2000

PARAMETER	METHOD	RESULTS	UNITS	PQL	DATE ANALYZED
1,1,1,2-Tetrachloroethane	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Ethylbenzene	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Styrene	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Bromoform	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
1,1,2,2-Tetrachloroethane	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
1,2,3-Trichloropropane	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Bromobenzene	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
2-Chlorotoluene	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
4-Chlorotoluene (para)	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
1,3-Dichlorobenzene (meta)	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
1,4-Dichlorobenzene (para)	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
1,2-Dichlorobenzene (ortho)	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
1,2,4-Trichlorobenzene	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Xylenes, Total	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Total Trihalomethanes	EPA 524.2	<0.0005	mg/L	0.0005	6/06/00
Surrogate:	EPA 524.2				6/06/00
***1,2-dichlorobenzene-d4	EPA 524.2	115	% Recovery		6/06/00
***4-Bromofluorobenzene	EPA 524.2	117	% Recovery		6/06/00
Radium 226	EPA 903.1	0.5 +/- 0.2	pCi/L		6/08/00

Asbestos analyzed by Fiberquant, Phx AZ, #AZ0904.
Dioxin performed by Pace Analytical Services, Minn. MN, #AZ
Radiochemistry analyzed by Lucas Labs, Sedona AZ, #AZ0141.
EPA Methods 508, 515, and 524 analyzed by ATEL, Melmore OH, #AZ0117.

NOTE:
Interpretation of Colilert Results:

0 = Negative for Coliform bacteria
1 = Positive for Coliform bacteria and Negative for E.coli (fecal bacteria)
2 = Positive for Coliform bacteria and Positive for E.coli (fecal bacteria)

Melissa Evans

Authorized Signatory

DRINKING WATER RADIOCHEMICAL ANALYSIS REPORT
>>>> INFORMATION PROVIDED BY THE SYSTEM <<<<

Received 05/31/00

Manera

[-] [_
System ID System name

[05/25/00] [13:00] (24 hr)
Sample date: mm/dd/yy Sample time

_______________ [_] [_]
Owner/Contact FAX # Owner / Collector Name / Phone #

COMPLIANCE SAMPLE TYPE

- ☐ Reduced Monitoring/Grab sample
- ☐ Composite of four quarterly samples
- ☐ Quarterly

SAMPLE COLLECTION POINT/ID

Point of Entry # [__]
Surface [____]
Well [____]

Date Q1 collected [____]
Date Q2 collected [____]
Date Q3 collected [____]
Date Q4 collected [____]

RADIOCHEMICAL ANALYSES: RESULTS BY THE LABORATORY

Analysis Method	MCL value	MDL (pCi/L)	Contaminant name	Cont. code	Analysis Date	Result ± 2σ	Exceeds MCL
	15 pCi/L		**Gross Alpha, Adjusted***	4000			☐
		3	Gross Alpha, Measured	4002	06/02/00	12.1 ± 1.7	
			Uranium	4006			
			Radon	4004			☐
	5 pCi/L		**Combined Radium (226+228)**	4010			☐
417		1	Radium 226	4020	06/08/00	0.5 ± 0.2	
419		1	Radium 228	4030			
	4 mrem/y		**Gross Beta, Dose**	4100			☐
			Gross Beta, Measured	4101			
999	20,000**	1,000	Tritium	4102			
	8**	2	Strontium-90	4174			

MDL Method (Analytic) Detection Limit, 1.96 σ, from counting, Statutory, not to exceed.
* Adjusted Gross Alpha is measured gross alpha minus radon 222 and/or combined uranium.
** Lifetime exposure at these concentrations is assumed to result in a radiation dose of 4 mrem/y.
*** Trigger for Identification of Man Made Nuclides in addition to Tritium, and Strontium

>>>>> LABORATORY INFORMATION <<<<<

Sample ID WS-10226

[AZ0141] [Lucas Laboratory, Inc
Lab ID Lab name

[signature] Authorized Signature

Bolin 0005-04716-001
Comments

Requested by: BOLIN LABORATORIES, INC.

Date Water System/Requestor notified June 9, 2000
Revised November 12, 1999

ATEL

Aqua Tech Environmental Laboratories, Inc.

MTBE added

- CERTIFICATE OF ANALYSIS -

Client #: I1097 **Report Date:** 16-Jun-00

Bolin Laboratories Inc

17631 N 25th Ave

Phoenix, AZ 85023 **Phone:** (602) 942-8220 **Ext:**

FAX: (602) 942-1050

Attn: Celeste Washington

Our Lab#: MEL00-08449 **Your Sample ID:** 0005-04716-001

Date Logged In: 6/6/00 **Sample Source:** SDWA/WTP's

Sample Type: Water **Client Project #:**

Project #: **Date Submitted to Lab:** 6/6/2000 **PO#:** 00-0950-SM

- COLLECTION INFORMATION -

Date/Time/By: 5/25/00 1:00 PM

EPA Method	Analyst	Prep Date	Analysis Date
524.2	SLC		6/6/00

CAS Number	Parameter	Result	Typical Report Limit
71-43-2	Benzene	< 0.5 ug/l	0.5
108-86-1	Bromobenzene	< 0.5 ug/l	0.5
74-97-5	Bromochloromethane	< 0.5 ug/l	0.5
75-27-4	Bromodichloromethane	< 0.5 ug/l	0.5
75-25-2	Bromoform	< 0.5 ug/l	0.5
74-83-9	Bromomethane	< 0.5 ug/l	0.5
104-51-8	n-Butylbenzene	< 0.5 ug/l	0.5
135-98-8	sec-Butylbenzene	< 0.5 ug/l	0.5
98-06-6	tert-Butylbenzene	< 0.5 ug/l	0.5
56-23-5	Carbon tetrachloride	< 0.5 ug/l	0.5
108-90-7	Chlorobenzene	< 0.5 ug/l	0.5
75-00-3	Chloroethane	< 0.5 ug/l	0.5
67-66-3	Chloroform	< 0.5 ug/l	0.5
74-87-3	Chloromethane	< 0.5 ug/l	0.5
95-49-8	2-Chlorotoluene	< 0.5 ug/l	0.5
106-43-4	4-Chlorotoluene	< 0.5 ug/l	0.5
96-12-8	1,2-Dibromo-3-chloropropane	< 0.5 ug/l	0.5
124-48-1	Dibromochloromethane	< 0.5 ug/l	0.5
106-93-4	1,2-Dibromoethane (EDB)	< 0.5 ug/l	0.5
74-95-3	Dibromomethane	< 0.5 ug/l	0.5
95-50-1	1,2-Dichlorobenzene	< 0.5 ug/l	0.5

6878 S. STATE ROUTE 100 • P.O. BOX 76 • MELMORE, OH 44845-9998
PHONE 419-397-2659 • 1-800-858-8869 • FAX 419-397-2229

ATEL

Aqua Tech Environmental Laboratories, Inc.

- CERTIFICATE OF ANALYSIS -

CAS Number	Parameter	Result	Typical Report Limit
541-73-1	1,3-Dichlorobenzene	< 0.5 ug/l	0.5
106-46-7	1,4-Dichlorobenzene	< 0.5 ug/l	0.5
75-71-8	Dichlorodifluoromethane	< 0.5 ug/l	0.5
75-34-3	1,1-Dichloroethane	< 0.5 ug/l	0.5
107-06-2	1,2-Dichloroethane	< 0.5 ug/l	0.5
75-35-4	1,1-Dichloroethene	< 0.5 ug/l	0.5
156-59-2	cis-1,2-Dichloroethene	< 0.5 ug/l	0.5
156-60-5	trans-1,2-Dichloroethene	< 0.5 ug/l	0.5
78-87-5	1,2-Dichloropropane	< 0.5 ug/l	0.5
142-28-9	1,3-Dichloropropane	< 0.5 ug/l	0.5
594-20-7	2,2-Dichloropropane	< 0.5 ug/l	0.5
563-58-6	1,1-Dichloropropene	< 0.5 ug/l	0.5
	1,3-Dichloropropene (cis&trans)	< 0.5 ug/l	0.5
100-41-4	Ethylbenzene	< 0.5 ug/l	0.5
87-68-3	Hexachlorobutadiene	< 0.5 ug/l	0.5
98-82-8	Isopropylbenzene	< 0.5 ug/l	0.5
99-87-6	p-Isopropyltoluene	< 0.5 ug/l	0.5
75-09-2	Methylene chloride	< 0.5 ug/l	0.5
91-20-3	Naphthalene	< 0.5 ug/l	0.5
103-65-1	n-Propylbenzene	< 0.5 ug/l	0.5
100-42-5	Styrene	< 0.5 ug/l	0.5
630-20-6	1,1,1,2-Tetrachloroethane	< 0.5 ug/l	0.5
79-34-5	1,1,2,2-Tetrachloroethane	< 0.5 ug/l	0.5
127-18-4	Tetrachloroethene	< 0.5 ug/l	0.5
108-88-3	Toluene	< 0.5 ug/l	0.5
87-61-6	1,2,3-Trichlorobenzene	< 0.5 ug/l	0.5
120-82-1	1,2,4-Trichlorobenzene	< 0.5 ug/l	0.5
71-55-6	1,1,1-Trichloroethane	< 0.5 ug/l	0.5
79-00-5	1,1,2-Trichloroethane	< 0.5 ug/l	0.5
79-01-6	Trichloroethene	< 0.5 ug/l	0.5
75-69-4	Trichlorofluoromethane	< 0.5 ug/l	0.5
95-63-6	1,2,4-Trimethylbenzene	< 0.5 ug/l	0.5
108-67-8	1,3,5-Trimethylbenzene	< 0.5 ug/l	0.5
96-18-4	1,2,3-Trichloropropane	< 0.5 ug/l	0.5
75-01-4	Vinyl chloride	< 0.5 ug/l	0.5
95-47-6	o-Xylene	< 0.5 ug/l	0.5
108383/106	m&p Xylenes	< 0.5 ug/l	0.5
1634-04-4	Methyl-tert-butylether	< 5.0 ug/l	5

Your Sample ID: 0005-04716-001 *Lab Number MEL00-08449*

6878 S. STATE ROUTE 100 • P.O. BOX 76 • MELMORE, OH 44845-9999
PHONE 419-397-2659 • 1-800-858-8869 • FAX 419-397-2229

ATEL

Aqua Tech Environmental Laboratories, Inc.

- CERTIFICATE OF ANALYSIS -

--- Surrogate Recoveries ---

QC Lab#	EPA Method	Surrogate Name	Percent Recovery	Lower Limit	Upper Limit
MEL00-08449	524.2	1,2-Dichlorobenzene-d4 (Surr)	115 %R	70	130
MEL00-08449	524.2	Bromofluorobenzene (BFB) (Surr)	117 %R	70	130

End of Report

Report Approved By: Karen J. Plott

Karen J. Plott

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PHONE 419-397-2659 • 1-800-858-8869 • FAX 419-397-2229

ATEL

Aqua Tech Environmental Laboratories, Inc.

- CERTIFICATE OF ANALYSIS -

Client #: I1097 **Report Date:** 12-Jun-00

Bolin Laboratories Inc
17631 N 25th Ave
Phoenix, AZ 85023

Phone: (602) 942-8220 **Ext:**

FAX: (602) 942-1050

Attn: Celeste Washington

Our Lab#: MEL00-08195 **Your Sample ID:** 0005-04716-001

Date Logged In: 5/31/00 **Sample Source:** SDWA/WTP's

Sample Type: Water **Client Project #:**

Project #: **Date Submitted to Lab:** 5/31/2000 **PO#:** 00-0911-SM

- COLLECTION INFORMATION -

Date/Time/By: 5/25/00 1:00 PM

EPA Method	Analyst	Prep Date	Analysis Date
508	SH	6/1/00	6/2/00

CAS Number	Parameter	Result	Typical Report Limit
309-00-2	Aldrin	< 0.02 ug/l	0.02
58-89-9	gamma-BHC (Lindane)	< 0.02 ug/l	0.02
57-74-9	Chlordane(Total)	< 0.10 ug/l	0.1
60-57-1	Dieldrin	< 0.02 ug/l	0.02
72-20-8	Endrin	< 0.01 ug/l	0.01
76-44-8	Heptachlor	< 0.03 ug/l	0.03
1024-57-3	Heptachlor epoxide	< 0.02 ug/l	0.02
118-74-1	Hexachlorobenzene	< 0.10 ug/l	0.1
77-47-4	Hexachlorocyclopentadiene	< 0.10 ug/l	0.1
72-43-5	Methoxychlor	< 0.03 ug/l	0.03
1918-16-7	Propachlor	< 0.05 ug/l	0.05
8001-35-2	Toxaphene	< 0.10 ug/l	0.1
12674-11-2	Aroclor 1016	< 0.08 ug/l	0.08
11104-28-2	Aroclor 1221	< 0.10 ug/l	0.1
11141-16-5	Aroclor 1232	< 0.10 ug/l	0.1
53469-21-9	Aroclor 1242	< 0.10 ug/l	0.1
12672-29-6	Aroclor 1248	< 0.10 ug/l	0.1
11097-69-1	Aroclor 1254	< 0.10 ug/l	0.1
11096-82-5	Aroclor 1260	< 0.10 ug/l	0.1

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PHONE 419-397-2659 • 1-800-858-8869 • FAX 419-397-2229

ATEL

Aqua Tech Environmental Laboratories, Inc.

- CERTIFICATE OF ANALYSIS -

EPA Method	Analyst	Prep Date	Analysis Date
515.1	DAW	5/31/00	6/6/00

CAS Number	Parameter	Result	Typical Report Limit
75-99-0	Dalapon	< 1.0 ug/l	1
1918-00-9	Dicamba	< 0.50 ug/l	0.5
94-75-7	2,4-Dichlorophenoxyacetic acid (2,4-D)	< 0.10 ug/l	0.1
88-85-7	Dinoseb	< 0.20 ug/l	0.2
87-86-5	Pentachlorophenol	< 0.04 ug/l	0.04
1918-02-1	Picloram	< 0.10 ug/l	0.1
93-72-1	Silvex	< 0.20 ug/l	0.2

--- Surrogate Recoveries ---

QC Lab#	EPA Method	Surrogate Name	Percent Recovery	Lower Limit	Upper Limit
MEL00-08195	508	Decachlorobiphenyl (Surr)	78 %R	70	130
MEL00-08195	508	Tetrachloro-m-xylene (Surr)	103 %R	70	130
MEL00-08195	515.1	DCAA (Surr)	79 %R	70	130

End of Report

Report Approved By: Karen J. Plott

Karen J. Plott

Your Sample ID: 0005-04716-001

Lab Number MEL00-08195

6878 S. STATE ROUTE 100 • P.O. BOX 76 • MELMORE, OH 44845-9999
PHONE 419-397-2659 • 1-800-858-8869 • FAX 419-397-2229

Manera -

Pace Analytical™

Pace Analytical Services, Inc.
1700 Elm Street - Suite 200
Minneapolis, MN 55414

Tel: 612-607-1700
Fax: 612-607-6444

Drinking Water Analysis Results
2,3,7,8-TCDD -- USEPA Method 1613

Sample ID..................0005-04716-001
Client..........................Bolin Laboratories
Lab Sample ID............2059532

Date Collected.............05/25/2000
Date Received.............05/31/2000
Date Extracted.............06/01/1999

	Sample 0005-04716-001	**Method** Blank	**Lab** Spike	**Lab** Spike Dup
[2,3,7,8-TCDD]	**ND**	ND	--	--
PRL	5 pg/L	5 pg/L	--	--
Spike Recovery	--	--	104%	108%
Spike Recovery Limit	--	--	73-146%	73-146%
RPD			-3.4%	
IS Recovery	**100%**	89%	90%	91%
IS Recovery Limits	31-137%	31-137%	25-141%	25-141%
CS Recovery	**101%**	101%	102%	105%
CS Recovery Limits	42-164%	42-164%	37-158%	37-158%
Filename	A00607E_1	A00605J_13	A00605J_10	A00605J_11
Analysis Date	06/07/2000	06/05/2000	06/05/2000	06/05/2000
Analysis Time	11:20	22:41	20:53	21:29
Analyst	MASB	MASB	MASB	MASB
Volume	1.000L	1.004L	1.014L	1.047L
Dilution	NA	NA	NA	NA
ICAL Date	05/23/2000	05/23/2000	05/23/2000	05/23/2000
CCAL Filename	A00607A_1	A00605J_8	A00605J_8	A00605J_8

!	= Outside the Control Limits
ND	= Not Detected
PRL	= Pace Reporting Limit
Limits	= Control Limits from Method 1613 (10/94 Revision), Tables 6A and 7A
RPD	= Relative Percent Difference of Lab Spike Recoveries
IS	= Internal Standard
CS	= Cleanup Standard

Project No.............00-1033174

Marana ✓

FIBERQUANT
ANALYTICAL SERVICES

Determination of Asbestos in Water using TEM

JobNumber:	**2000-2558**

Client: **BOLIN LABORATORIES INC**
17631 N 25TH AVE

PHOENIX, AZ 85023-0000
Office Phone: (602) 942-8220
FAX: (602) 942-1050

 # Samples: 2 TEM **Rec:** 5/26/00 **Method:** EPA 100.1 TEM Water
Client Job: 0005-04715, 04716 **PO Number:** 00-0906-SM **Routing Number:** -
Date Analyzed: 6/7/00

Method and Analysis Information:

Samples are analyzed using the protocols given in EPA method 100.1, as amended by the 1993 EPA guidence. Samples should be un-preserved water in 1 L containers having about 200 ml headspace for shaking. There is a 48 hr deadline between the time the sample is taken and the time it is filtered to minimize loss of asbestos fibers due to biological interference. Each sample is shook for 1 minute, and ultrasonicated for at least 10 minutes, shaking every 5 minutes to disperse any fibers that are present. A measured amount of sample is then filtered through a 0.1 um pore size polycarbonate filter, backed by a 5 um pore size MCE filter and a glass frit. Several volumes of liquid may be filtered for each sample in order to assure that a properly loaded sample is obtained. A portion of each resulting filter (and blanks) is then coated with 100-200 um of carbon in a Denton 502A Carbon Evaporator. The carbon encapsulates all of the larger and most of the smaller particulate on the filter. Three mm square pieces of the coated filter are placed on three or more copper TEM grids, and the original filter material is dissolved away in a Jaffe wick and/or condensation washer. The finished replica in carbon containing the particulate is then examined on a Phillips 300 transmission electrom microscope at 10,000 to 20,000x magnification. All asbestos fibers >10um in length are tabulated and characterized as asbestos or non-asbestos using a combination of morphology, electron diffraction characteristics, and elemental composition. The result is calculated in millions of fibers per liter (MFL). The grid is scanned until 20 grid openings have been observed, or until an analytical sensitivity (the hypothetical observation of one fiber) of 0.2 MFL has been reached. The nominal 20 grid opening cut-off is used for those samples containing so much non-asbestos particulate that the desired analytical sensitivity is impractical to attain.

The method was designed to determine EPA drinking water compliance. The standard for drinking water is <7 MFL as measured by this method.

Overall, the coefficient of variation can be expected to be approximately 0.5 for analyses in which >20 asbestos fibers have been counted, ranging up to 1.00 for analyses in which only a few asbestos fibers are counted.

The analysis was performed under an ongoing quality assurance program which includes: Lab blanks, prepared with each set of samples, and analyzed at the rate of one per 25 samples analyzed. Each analyst has suitable background credentials, such as at least a bachelor's degree in geology or chemistry, and has undergone extensive 2-6 month training in TEM techniques and mineralogy specific to TEM asbestos analysis before being allowed to perform client analyses. Unknown reference samples are routinely identified to ensure that each analyst can collect and correctly interpret TEM information. The TEM is aligned and its performance checked daily. Magnification, electron diffraction pattern size, and analytical performance characteristics are calibrated routinely. Samples are re-analyzed sometimes by the same analyst and sometimes by a different analyst in order to determine accuracy and precision. The total of QC analyses (blanks + recounts) are greater than 10% of analyzed samples. Each analyst participates in interlab round robins and proficiency testing in order to show correlation to other lab's analyses. Because TEM samples are not analyzed in batches, which would be traditional for most water analyses, and not every blank is read, and not every sample has a duplicate or replicate analysis associated with it, it is not possible to include a traditional QC report with the analysis. QC reports are produced monthly, and are available on request. Fiberquant is accredited by NVLAP to perform TEM analysis of asbestos in air samples, and has been found to be proficient in the EPA water proficiency program. Accreditation or proficiency does not imply endorsement by the EPA, any other United States governmental agency or any private agency or association. Each lab analysis refers only to the sample tested, and may not, due to the sampling process, be representative of the material sampled. This report may not be reproduced except in full and with the approval of Fiberquant Analytical Services.

Job Analysis Notes:

	Date	Time
Received:	5/26/00	12:20
Filtered:	5/26/00	18:10
Analyzed:	6/7/00	19:10

Analysis Results:

Lab Number	Client Number	Date	Filtered Vol (ml)	#GOs	GO Area	MFL	AsbestosType	Sensitivity (MFL)
							-Job Number:	2000-2558
2000-2558- 1	0005-04715-001	5/25/00	90	6	0.00667	<.2	-	.2
2000-2558- 2	0005-04716-001	5/25/00	20	20	0.00667	<.2	-	.2

07-Jun-00

Analyst: DAVID M. SCHALLER

Larry S. Pierce, Approved Accreditation Signatory

QA Report:	Job Number:	2000-2558

1. Calibrations	
TEM magnification, date of last.	5/4/00
TEM camera constant, date of last.	5/31/00
EDS performance check (k-factors, resolution, low-e perf.), date of last.	1/20/00
TEM stage drift, minimum beam size, date of last.	1/20/00
plasma asher, date of last.	5/19/00
2. Blanks (1/25 samples required)	X not required this job ______ str/mm2
3. Recounts (1/17 samples required)	X not required this job ______ Rel%Diff
4. Analyst Performance	
NVLAP proficiency testing	X current
verified counts, cum. % true positives	89.3
verification of diffraction pattern identifications, cum. % correct	99.5
verification of EDS spectra, cum. % correct	94.9

N SOU

Bolin Laboratories Inc.

❑ 17631 N. 25th Ave. Phoenix AZ 85023
(602) 942-8220 • Fax(602) 942-1050

❑ 4837 East Fifth Street, Suite 103, Tucson AZ 85711
(520) 327-1234 • Fax(520) 327-0518

Please Print Clearly

6116

DRINKING WATER CHAIN OF CUSTODY RECORD

Page ______ of ______

Laboratory Sample No. 0005-04716

CLIENT INFORMATION

Client Name	Address	City	State	Zip	Phone	Fax
MANERA INC.	8316 N 53RD ST	Paradise Vly	AZ	85253	480 948-9818	480 596-8776

System Name	PWS#	Contact	P.O. No.	Fax Results ❑ QC Report ❑
MCEDC BIG SANDY		PAUL MANERA		6/15/0

IOC OPTIONS

IOC's I: Sb, As, Ba, Be, Cd, Cr, Hg, Ni, Se, Tl, Cn, F

IOC's II (New Source): Sb, As, Ba, Be, Ca, Cd, Cr, Cu, Pb, Hg, Mg, Ni, Se, Na, Tl, Ca Hardness, Total Hardness, Alk, Asbestos, Cn, F, Langelier, NO_2, NO_3, pH, SO_4, TDS, Temp (in field) 96°F

REQUESTED ANALYSIS

Client's Sample Identification	Date	Time	POE # / DWR #	Compliance	No. of Containers	pH ✓ (Bolin Use Only)	Coliform	IOC's (see left)	IOC's II (see left)	Asbestos	Lead/Copper	Nitrate (NO_3)	Nitrite (NO_2)	Radiochemical	Sodium (Na)	Sulfate (SO_4)	524 (TTHM)	524 (VOC's)	504	508	515	525	531	547	548	549	1613 (Dioxin)	508A (PCB Detects)	
Big Sandy 48 D(15-12)7000 DELP MONITOR	5/25	13:00					X		X					X				X	X	X	X	X	X	X	X	X	X		-01
																													-02

SOC's: 504, 508, 515, 525, 531, 547, 548, 549, 1613 (Dioxin), 508A (PCB Detects)

PLEASE INDICATE IF BOLIN SHOULD COMPOSITE SAMPLES.

Comments: NEW SOURCE APPROVAL
*pH not measured in the field
resample - notified Paul 5/26 sa

TURN AROUND TIME

❑ Standard 10 - 15 Day
❑ Other
* Laboratory Authorization Required for Rush *

SAMPLE CONDITION UPON RECEIPT

No. of Containers	3	
Temperature	2°C	
Custody Seals	Y	N (circled)
Seals Intact	Y	N
Preserved	Y (circled)	N

RELINQUISHED BY / SAMPLES RECEIVED BY

	Relinquished By	Date/Time	Samples Received By	Date/Time
①	Signature: [signature]	Date 5-25-00	Signature: [signature]	Date 5/25/00
	Sampler Printed Name: Paul S. Manera	Time 17:30	Printed Name: [illegible] Swanson	Time 1730
②	Signature	Date	Signature	Date
	Printed Name	Time	Printed Name	Time
③	Signature	Date	Signature	Date
	Printed Name	Time	Printed Name	Time

WHITE-LAB YELLOW-LAB PINK-CLIENT

BOLIN
LABORATORIES • INC
Legend Technical Services of Arizona

17631 N. 25th Avenue ▪ Phoenix, Arizona ▪ 85023 ▪ (602) 942-8220 ▪ fax (602) 942-1050 ▪ ADHS# AZ0004

Manera Inc.
8316 N. 53rd Street
Paradise Valley, AZ 85253-2512

Received: 7/21/00
Reported: 8/08/00
Invoice No: 067337

Attn: Paul A. Manera

Project Name: Manera Inc.

Matrix: Groundwater
Sample No: 0007-06417-001
Sample ID: Big Sandy 4BMO4 B(15-12)7 bdd

Time Sampled: 9:15
Date Sampled: 7/21/2000

PARAMETER	METHOD	RESULTS	UNITS	PQL	DATE ANALYZED
pH	EPA 150.1	7.6	Std Unit		7/24/00
Conductivity	SM 2510B	1320.	umhos/cm	10.	7/26/00
Total Dissolved Solids	SM 2540C	684.	mg/L		7/27/00
Solids, Total Suspended	EPA 160.2	<1.	mg/L		7/25/00
Calc. Bicarbonate (CaCO3)	SM 2320B	244.	mg/L		7/25/00
Total Alkalinity (as CaCO3)	SM 2320B	244.	mg/L	2.	7/25/00
Calc. Carbonate (CaCO3)	SM 2320B	0.0	mg/L		7/25/00
Nitrogen as Nitrite	SM4500 NO2B	<0.1	mg/L	0.1	7/21/00
Nitrate plus Nitrite	SM 4500-NO3 F	1.2	mg/L	0.1	7/24/00
Nitrogen as Nitrate	CALC.	1.2	mg/L		7/21/00
Hydroxide Calculation	SM 2320B	0.0	mg/L		7/25/00
Total Phosphorous as P	EPA 365.3	0.06	mg/L	0.05	7/26/00
Total Phosphate	CALCULATION	0.2	mg/L	0.15	7/26/00
Alkalinity, Phenolphthalein	SM 2320B	0.0	mg/L		7/25/00
Nitrogen, Total	CALCULATION	1.82	mg/L		7/31/00
Fluoride	SM 4500-F C	3.7	mg/L	0.1	7/28/00
Silica Dioxide	CALCULATION	10	mg/L	0.02	8/01/00
Nitrogen as Ammonia	EPA 350.1	0.14	mg/L	0.1	7/25/00
Total Kjeldahl Nitrogen	EPA 351.3	0.62	mg/L	0.03	7/25/00
Metals Digestion for ICP	EPA 200.7				
Metals Digestion for GFAA	SM 3030E				
Aluminum	EPA 200.7	<0.5	mg/L	0.5	7/27/00
Barium	EPA 200.7	0.06	mg/L	0.01	7/27/00
Boron	EPA 200.7	1.08	mg/L	0.01	7/27/00
Cadmium	EPA 200.7	<0.002	mg/L	0.002	7/27/00
Calcium	EPA 200.7	55	mg/L	0.01	7/27/00
Chromium	EPA 200.7	<0.01	mg/L	0.01	7/27/00
Copper	EPA 200.7	<0.01	mg/L	0.01	7/27/00
Iron	EPA 200.7	0.82	mg/L	0.01	7/27/00
Magnesium	EPA 200.7	16	mg/L	0.01	7/27/00
Nickel	EPA 200.7	<0.01	mg/L	0.01	7/27/00
Potassium	EPA 200.7	8.8	mg/L	0.1	7/27/00

BOLIN LABORATORIES • INC
Legend Technical Services of Arizona

17631 N. 25th Avenue ▪ Phoenix, Arizona ▪ 85023 ▪ (602) 942-8220 ▪ fax (602) 942-1050 ▪ ADHS# AZ0004

PARAMETER	METHOD	RESULTS	UNITS	PQL	DATE ANALYZED

Matrix: Groundwater
Sample No: 0007-06417-001 Time Sampled: 9:15
Sample ID: Big Sandy 4BMO4 B(15-12)7 bdd Date Sampled: 7/21/2000

PARAMETER	METHOD	RESULTS	UNITS	PQL	DATE ANALYZED
Silica	EPA 200.7	19	mg/L	0.05	7/31/00
Sodium	EPA 200.7	232	mg/L	1	7/31/00
Strontium	EPA 200.7	<0.01	mg/L	0.01	7/31/00
Zinc	EPA 200.7	0.06	mg/L	0.01	7/27/00
Arsenic	SM 3113 B	0.08	mg/L	0.03	7/27/00
Lead	SM 3113B	0.03	mg/L	0.03	7/27/00
Selenium	SM 3113B	<0.02	mg/L	0.02	7/27/00
Tin	EPA 200.7	<0.02	mg/L	0.02	7/27/00
Mercury	EPA 245.1	<0.0002	mg/L	0.0002	7/27/00

Metals, Reactive Silica, Ammonia and TKN were analyzed by Aquatic Consulting, Tempe AZ. #AZ0003.

Melissa Cran

Authorized Signatory

BOLIN LABORATORIES · INC

☐ 17631 N. 25th Ave. Phoenix AZ 85023 (602) 942-8220 · Fax(602) 942-1050

☐ 4837 East Fifth Street, Suite 103, Tucson AZ 85711 (520) 327-1234 · Fax(520) 327-0518

acc 7/31/00

CHAIN OF CUSTODY RECORD

Laboratory Sample No. 00007-4-00417

Page 1 of 1

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CLIENT INFORMATION

Client Name	Address	City	State	Zip	Phone	Fax
MANERA INC.	8316 N 53RD ST.	Paradise Valley	AZ	85253	480 948-9818	480-596-8726

Project Name	Project Number	Contact	P.O. No.	Fax Results ☑ QC Report ☐ Special Detection Limits ☐
Caithness Big Sandy		Paul Manera		

SAMPLE TYPE CODES

DW=Drinking Water S=Soil/Solid
WW=Wastewater T=Travel Blank
SW=Surface Water F=Food
GW=Groundwater G=Sludge
O=Other

TURN AROUND TIME

☐ Standard 10 - 15 Day
☐ Other

★ Laboratory Authorization Required for Rush ★

REQUESTED ANALYSES

Client's Sample Identification	Date	Time	Sample Location	Composite	Grab	Sample Type	Compliance	No. of Containers	pH ✓ (Bolin Use Only)	Mets*	pH	Cond.	TDS TSS	Bicarb (Alk)	NO3 NO2 Nitrite	CN TP	Alk P-Alk	NH3 TKN TN	F					
Big Sandy, 4B 2004 B(15-12)7bdd	7-21-00	0915	B(15-12)7BDD							X	X	X	X	X	X	X	X	X	X					001

ID on Results

TO ENSURE COMPLETION OF ANALYSIS, SAMPLES MUST BE RECEIVED AT LEAST 3 HOURS PRIOR TO THE HOLD TIME EXPIRATION

Comments / Special Instructions: * Ca, Mg, Na, K, ~~#~~, Si(T), Si(R) Fe, Al, As, Ba, B, Cd, Cu, Cr, Pb, Hg, Ni, Se, Stron, Tin, Zn

SAMPLE CONDITION UPON RECEIPT

No. of Containers	4	
Temperature	6.5°C	
Custody Seals	Y	N
Seals Intact	~~Y~~	~~N~~
Preserved	Y	N

RELINQUISHED BY / **SAMPLES RECEIVED BY**

	Relinquished by		Samples Received by	
①	Signature: Paul Manera	Date: 7-21-00	Signature: Monique Miranda	Date: 7/21/00
	Sampler Printed Name: Paul S. Manera	Time: 2:25 PM	Printed Name: Monique Miranda	Time: 14:25
②	Signature	Date	Signature	Date
	Printed Name	Time	Printed Name	Time
③	Signature	Date	Signature	Date
	Printed Name	Time	Printed Name	Time

WHITE-LAB YELLOW-LAB PINK-CLIENT

BOLIN LABORATORIES · INC

☐ 1001 N. 2nd Ave. Phoenix AZ 85023 (602) 942-8220 • Fax(602) 942-1050
☐ 4837 East Fifth Street, Suite 103, Tucson AZ 85711 (520) 327-1234 • Fax(520) 327-0518

CHAIN OF CUSTODY RECORD

Page 1 of 1

Laboratory Sample No. 0007-0417

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CLIENT INFORMATION

Client Name	Address	City	State	Zip	Phone	Fax
MANERA INC.	8516 N 53RD ST	Paradise Valley	AZ	85253	480948-9818	480-596-8728

Project Name	Project Number	Contact	P.O. No.	Fax Results ☐ QC Report ☐ Special Detection Limits ☐
CATTLENESS BIG SANDY		PAUL MANERA		

SAMPLE TYPE CODES

DW=Drinking Water S=Soil/Solid
WW=Wastewater T=Travel Blank
SW=Surface Water F=Food
GW=Groundwater G=Sludge
O=Other

TURNAROUND TIME

☐ Standard 10 - 15 Day
☐ Other

★ Laboratory Authorization Required for Rush ★

REQUESTED ANALYSIS

Client's Sample Identification	Date	Time	Sample Location	Composite	Grab	Sample Type	Compliance	No. of Containers	pH ✓ (Bolin Use Only)	NITRATE	pH	CONDUCTIVITY	TDS	Bicarbonate	ALKALINITY	CL	Total Hardness	NH3	F							
Big Sandy 4B 0004	7-21-00 9:15		B(15-12)7BDD							X	X	X	X	X	X	X	X	X	X							01
B(15·12)7bdd																										

ID on Results

TO ENSURE COMPLETION OF ANALYSIS, SAMPLES MUST BE RECEIVED AT LEAST 3 HOURS PRIOR TO THE HOLD TIME EXPIRATION

Comments / Special Instructions: * Ca, Mg, Na, K, ~~pH~~, SiO2, Fe, Al, As, Ba, B, Cd, Cu, Cr, Pb, Hg, Ni, Se, Silver, Tin, Zn

SAMPLE CONDITION UPON RECEIPT

No. of Containers	4	
Temperature		
Custody Seals	Y	N
Seals Intact	Y	N
Preserved	Y	N

WHITE-LAB YELLOW-LAB PINK-CLIENT

RELINQUISHED BY / SAMPLES RECEIVED BY

	Relinquished By		Samples Received By	
①	Signature Paul Manera	Date 7-21-00	Signature	Date 7/21/00
	Sampler Printed Name PAUL J. MANERA	Time 2:25 PM	Printed Name	Time
②	Signature	Date	Signature	Date
	Printed Name	Time	Printed Name	Time
③	Signature	Date	Signature	Date
	Printed Name	Time	Printed Name	Time

BOLIN
LABORATORIES • INC
Legend Technical Services of Arizona

17631 N. 25th Avenue • Phoenix, Arizona • 85023 • (602) 942-8220 • fax (602) 942-1050 • ADHS# AZ0004

Manera Inc.
8316 N. 53rd Street
Paradise Valley, AZ 85253-2512

Received: 7/24/00
Reported: 8/30/00
Invoice No: 068160

Attn: Paul A. Manera

Project Name: Manera Inc.

Matrix: Groundwater
Sample No: 0007-06444-001
Sample ID: Big Sandy MD4 BC(15-13) 7bdd
Time Sampled: 12:45
Date Sampled: 7/24/2000

PARAMETER	METHOD	RESULTS	UNITS	PQL	DATE ANALYZED
Sulfate	EPA 375.4	180.	mg/L	25	7/27/00
Chloride	SM 4500-CL B	189.	mg/L	5.0	7/25/00
Carbon Dioxide	SM4500 CO2	4.	mg/L	2	7/25/00
Silt Density Index	DuPont 491	82			8/22/00
Turbidity	EPA 180.1	5.3	N.T.U.	1.0	7/25/00
Biochemical Oxygen Demand	EPA 405.1	2. F	mg/L		7/24/00
Total Organic Carbon	SM 5310C	<1.0	mg/L	1.0	7/25/00
Cyanide, Total	SM4500 CNE	<0.01	mg/L	0.01	7/26/00
Coliform, Fecal (MF)	SM 9222D	<10	CFU/100mL	10	7/24/00
Chromium, hexavalent	SM 3500-CR D	<0.015	mg/L	0.015	7/24/00
Phenolics, Total	EPA 420.1	<0.0050 S	mg/L	0.0050	7/28/00

S = Spike or surrogate recovery outside acceptance criteria. Blank spike recovery was acceptable.
F = The oxygen depletion for the BOD seed was outside laboratory acceptance criteria. The associated GGA check standard was acceptable.
Total Recoverable Phenolics analyzed by Transwest Geochem, Phoenix AZ, #AZ0133.
Carbon Dioxide and Silt Density Index analyzed by Aquatic Consulting, Tempe AZ. #AZ0003.

Melissa Cran

Authorized Signatory

BOLIN LABORATORIES · INC

☐ 17631 N. 25th Ave. Phoenix AZ 85023 (602) 942-8220 · Fax(602) 942-1050

☐ 4837 East Fifth Street, Suite 103, Tucson AZ 85711 (520) 327-1224 · Fax(520) 327-0518

CHAIN OF CUSTODY RECORD

Laboratory Sample No. 0007-02444

Please Print Clearly

Page 1 of 1

CLIENT INFORMATION

Client Name	Address	City	State	Zip	Phone	Fax
MANERO INC.	8316 N 53RD ST	Paradise Valley	AZ	85253	480 948-9818	480 596 8276

Project Name	Project Number	Contact	P.O. No.	Fax Results ☑ QC Report ☐ Special Detection Limits ☐
CAITHNESS BIG SANDY		PAUL MANERO		[illegible] 8/7/00

SAMPLE TYPE CODES

DW=Drinking Water S=Soil/Solid
WW=Wastewater T=Travel Blank
SW=Surface Water F=Food
GW=Groundwater G=Sludge
O=Other

TURN AROUND TIME

☐ Standard 10-15 Day
☐ Other

Laboratory Authorization Required for Rush

REQUESTED ANALYSES

Client's Sample Identification	Date	Time	Sample Location	Composite	Grab	Sample Type	Compliance	No. of Containers	pH ✓ (Bolin Use Only)	Spec. Cond.	Carbon dioxide	Silt density	Turbidity	BOD	TSS	CAL	Fecal	Cold	Phenol							
Big Sandy MD 4 B(15-13) 7bdd	7-27-00	12:45																								-001

TO ENSURE COMPLETION OF ANALYSIS, SAMPLES MUST BE RECEIVED AT LEAST 3 HOURS PRIOR TO THE HOLD TIME EXPIRATION

Comments / Special Instructions:

SAMPLE CONDITION UPON RECEIPT

No. of Containers	7
Temperature	24°C
Custody Seals	Y N
Seals Intact	Y N
Preserved	Y N

WHITE-LAB YELLOW-LAB PINK-CLIENT

	RELINQUISHED BY		SAMPLES RECEIVED BY	
①	Signature: Paul Manero	Date: 7-27-00	Signature: [illegible]	Date: 7-27
	Sampler Printed Name: Paul S. Manero	Time: 15:15	Printed Name: [illegible]	Time: 15:14
②	Signature	Date	Signature	Date
	Printed Name	Time	Printed Name	Time
③	Signature	Date	Signature	Date
	Printed Name	Time	Printed Name	Time

Zalco Laboratories, Inc.
4309 Armour Avenue
Bakersfield, CA 93308

Test Hole 1
SW¼ Sec 36 T16N R13E
Confined Water 400'-700'

GENERAL MINERAL & PHYSICAL & INORGANIC ANALYSIS (9/99)

te of Report: 00/01/21 Sample ID No.0001181-1
boratory Signature Lab
me: ZALCO LABORATORIES, INC. Director:
me of Sampler:T. DeRoucher Employed By: Coso Operating
te/Time Sample Date/Time Sample Date Analyses
llected:99/12/18/0900 Received @ Lab:00/01/13/1100 Completed:00/01/20

stem System
me:COSO OPERATING COMPANY Number: 15CXX15
me or Number of Sample Source:Well Pump Test

User ID: 15C Station Number:
Date/Time of Sample: |99|12|18|0900| Laboratory Code: 7625
YY MM DD TTTT YY MM DD
Date Analysis completed: |00|01|20|
Submitted by:________ Phone #:________

MCL	REPORTING UNITS	CHEMICAL	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3) (mg/L)	00900	140	
	mg/L	Calcium (Ca) (mg/L)	00916	36	
	mg/L	Magnesium (Mg) (mg/L)	00927	13	
	mg/L	Sodium (NA) (mg/L)	00929	260	
	mg/L	Potassium (K) (mg/L)	00937	15	
Total Cations		Meq/L Value: 14.55			
	mg/L	Total Alkalinity (AS CaCO3) (mg/L)	00410	250	
	mg/L	Hydroxide (OH) (mg/L)	71830	0	
	mg/L	Carbonate (CO3) (mg/L)	00445	0	
	mg/L	Bicarbonate (HCO3) (mg/L)	00440	310	
*	mg/L+	Sulfate (SO4) (mg/L)	00945	190	.5
*	mg/L+	Chloride (Cl) (mg/L)	00940	140	
45	mg/L	Nitrate (as NO3) (mg/L)	71850	2.4	2.0
**	mg/L	Fluoride (F) Temp. Depend. (mg/L)	00951	3.8	.1
Total Anions		Meq/L Value: 13.22			
	Std.Units+	PH (Laboratory) (Std.Units)	00403	8.1	
***	umho/cm+	Specific Conductance (E.C.) (umho/cm)	00095	1300	
****	mg/L+	Total Filterable Residue@180C(TDS)(mg/L)	70300	900	
	Units	Apparent Color (Unfiltered) (Units)	00081	40	
	TON	Odor Threshold at 60 C (TON)	00086	< 1.0	
	NTU	Lab Turbidity (NTU)	82079	83	
0.5	mg/L+	MBAS (mg/L)	38260	< 0.05	

* 250-500-600 ** 0.6-1.7 *** 900-1600-2200 **** 500-1000-1500

INORGANIC CHEMICALS 0001181-1

MCL	REPORTING UNITS	CHEMICAL	ENTRY #		ANALYSES RESULTS	DLR
50	ug/L	Arsenic (As) (ug/L)	01002		31	2.0
1000	ug/L+	Copper (Cu) (ug/L)	01042	<	50	50.0
300	ug/L+	Iron (Fe) (ug/L)	01045		27000	100.0
50	ug/L+	Manganese (Mn) (ug/L)	01055		280	30.0
5000	ug/L	Zinc (Zn) (ug/L)	01092		290	50.0
		ADDITIONAL ANALYSES				
1000	ug/L	Nitrite as Nitrogen(N) (ug/L)	00620	<	400	400

+ Indicates Secondary Drinking Water Standards

boratory comments and description of any additional components found:

sed on the above analyzed constituents the submitted water sample

. not with Title 22 specifications for safe drinking water.

e following is exceeded: Iron, Manganese, Fluoride, Color, Turbidity

Test Hole #2

AQUATIC CONSULTING & TESTING, INC.

1525 W. University Drive, Suite 106
P.O. Box 1510
Tempe, Arizona 85281
Phone: (480) 921-8044 • FAX: (480) 921-0049

Lic. No. AZ0003

LABORATORY REPORT

Client: Manera, Inc.
8316 N. 53rd St.
Paradise Valley, AZ 85253

Date Submitted: 1/31/00
Date Reported: 03/09/00

Attn: Paul Manera

Sample Type: Drinking Water
Sample Time: 01/28/00 17:00

Client ID: BS2
ACT Lab No.: BG00950

RESULTS

Parameter	Analysis Date Start	End	Method No.	Result	Unit
kalinity	2/25/00	2/25/00	SM 2320	276.	mg/L as $CaCO_3$
nloride	2/25/00	2/25/00	325.3	140.	mg/L
Cyanide	2/7/00	2/7/00	SM4500CN CE	<0.01	mg/L
uoride	2/1/00	2/1/00	SM4500F C	3.5	mg/L
Silica	2/11/00	2/11/00	SM4500Si DE	6.21	mg/L as SiO_2
ulfate	2/28/00	2/28/00	375.4	212.	mg/L
tal Hardness	2/25/00	2/25/00	130.2	182.	mg/L as $CaCO_3$
Antimony	2/11/00	2/11/00	200.9	<0.003	mg/L
senic	2/11/00	2/11/00	200.9	<0.005	mg/L
arium	2/8/00	2/8/00	200.7/6010	0.11	mg/L
Beryllium	2/3/00	2/3/00	200.7/6010B	<0.002	mg/L
admium	2/3/00	2/3/00	200.7	<0.002	mg/L
Calcium	2/28/00	2/28/00	200.7	60.	mg/L
hromium	2/3/00	2/3/00	200.7	<0.01	mg/L
opper	2/7/00	2/7/00	200.7	<0.01	mg/L
Iron	2/28/00	2/28/00	200.7	0.17	mg/L
ead	2/25/00	2/25/00	200.9	<0.005	mg/L
agnesium	2/28/00	2/28/00	200.7	18.	mg/L
Manganese	2/7/00	2/7/00	200.7	0.05	mg/L
ercury	2/9/00	2/9/00	245.1	<0.0002	mg/L
Nickel	2/3/00	2/3/00	200.7	<0.01	mg/L

Sample Type: Drinking Water
Sample Time: 01/28/00 17:00

Client ID: BS2
ACT Lab No.: BG00950

RESULTS

Parameter	Analysis Date Start	Analysis Date End	Method No.	Result	Unit
Selenium	2/10/00	2/10/00	200.9	<0.005	mg/L
Silver	3/1/00	3/1/00	200.9	<0.002	mg/L
Sodium	2/28/00	2/28/00	200.7	229.	mg/L
Thallium	2/3/00	2/3/00	200.9	<0.001	mg/L
Zinc	2/28/00	2/28/00	200.7	<0.01	mg/L
Total Dissolved Solids	2/25/00	2/25/00	160.1	811.	mg/L

Reviewed by: Frederick A. Amalfi

Frederick A. Amalfi, Ph.D.
Laboratory Director

bma

AQUATIC CONSULTING & TESTING, INC.

1525 W. University Drive, Suite 106
P.O. Box 1510
Tempe, Arizona 85281
Phone: (480) 921-8044 • FAX: (480) 921-0049

Lic. No. AZ0003

LABORATORY REPORT

Client: Manera, Inc.
8316 N. 53rd St.
Paradise Valley, AZ 85253

Date Submitted: 2/11/00
Date Reported: 03/03/00

Attn: Paul Manera

Sample Type: Aqueous
Sample Time: 02/10/00 17:00

Client ID: B(15-12) 5ccc
ACT Lab No.: BG01481

RESULTS

Parameter	Analysis Date Start	Analysis Date End	Method No.	Result	Unit
Alkalinity	2/18/00	2/18/00	SM 2320	265.	mg/L as CaCO3
Cyanide	2/22/00	2/22/00	SM4500CN CE	<0.01	mg/L
Fluoride	2/17/00	2/17/00	SM4500F C	4.0	mg/L
Langelier Index	2/15/00	2/15/00	SM2330 D	See Attached *	
Nitrate + Nitrite - N	2/16/00	2/16/00	SM4500NO3 E	1.43	mg/L as N
Nitrite - N	2/11/00	2/11/00	SM4500NO2 B	<0.01	mg/L as N
Silica	2/11/00	2/11/00	SM4500Si DE	5.97	mg/L as SiO2
Sulfate	2/28/00	2/28/00	375.4	208.	mg/L
Total Hardness	2/16/00	2/16/00	130.2	182.	mg/L as CaCO3
Antimony	2/17/00	2/17/00	200.9	<0.003	mg/L
Arsenic	2/16/00	2/16/00	200.9	0.048	mg/L
Barium	2/18/00	2/18/00	200.7/6010	0.04	mg/L
Beryllium	2/18/00	2/18/00	200.7/6010B	<0.002	mg/L
Cadmium	2/18/00	2/18/00	200.7	<0.002	mg/L
Calcium	2/18/00	2/18/00	200.7	42.	mg/L
Chromium	2/18/00	2/18/00	200.7	<0.01	mg/L
Copper	2/18/00	2/18/00	200.7	<0.01	mg/L
Lead	2/15/00	2/15/00	200.9	<0.005	mg/L
Magnesium	2/18/00	2/18/00	200.7	16.	mg/L
Mercury	2/25/00	2/25/00	245.1	<0.0002	mg/L
Nickel	2/18/00	2/18/00	200.7	<0.01	mg/L

Sample Type: Aqueous
Sample Time: 02/10/00 17:00

Client ID: B(15-12) 5ccc
ACT Lab No.: BG01481

RESULTS

Parameter	Analysis Date Start	End	Method No.	Result	Unit
Selenium	2/16/00	2/16/00	200.9	<0.005	mg/L
Sodium	2/23/00	2/23/00	200.7	234.	mg/L
Thallium	2/18/00	2/18/00	200.9	<0.001	mg/L
pH	2/11/00	2/11/00	150.1	8.3	SU
Total Dissolved Solids	2/15/00	2/15/00	160.1	770.	mg/L

Reviewed by: Frederick A. Amalfi

Frederick A. Amalfi, Ph.D.
Laboratory Director

bma

APPENDIX C
BIG SANDY ALLUVIAL AQUIFER TEST RESULTS

PRELIMINARY EVALUATION

of the

WATER RESOURCES

of the

BIG SANDY BASIN

MOHAVE COUNTY, ARIZONA

Manera, Inc.
8316 North 53rd Street
Paradise Valley, Arizona 85253
Telephone 480-948-9818

Registered Professional Engineer, (Geological)
CERTIFICATE NO
6607
PAUL A.
MANERA
Date Signed 11/2/99
ARIZONA, USA

Paul A. Manera

November 2, 1999

INTRODUCTION

Location of Study Area

The general area of this investigation consists of the southern portion of the Big Sandy River basin south of Wikieup, Mohave County, Arizona. Specifically, the property held in fee consists of the:

SW1/4 of Section 5;
W1/2 of Section 7, and;
W1/2, SW1/4 of Section 18, all in T. 15 N., R. 12 W, and;
E1/2 of Section 12;
NW1/4, the E1/2 of the NW1/4 and the E1/2 of the SE1/4 of Section 13, all in T. 15 N., R. 13 W.

The area is shown on Figure 1.

Scope of Work

Due to time constraints, the scope of this study was to generate a preliminary evaluation of the water available to the property based on the available data and testing of existing water sources.

One pumping test was run on a well on the Ranch property, located in the SW1/4, NW1/4, NE1/4 of Section 13, T. 15 N., R. 13 W.

Much of this report is based on previous literature, particularly that of Davidson (1973) with the testing program used as corroborating data.

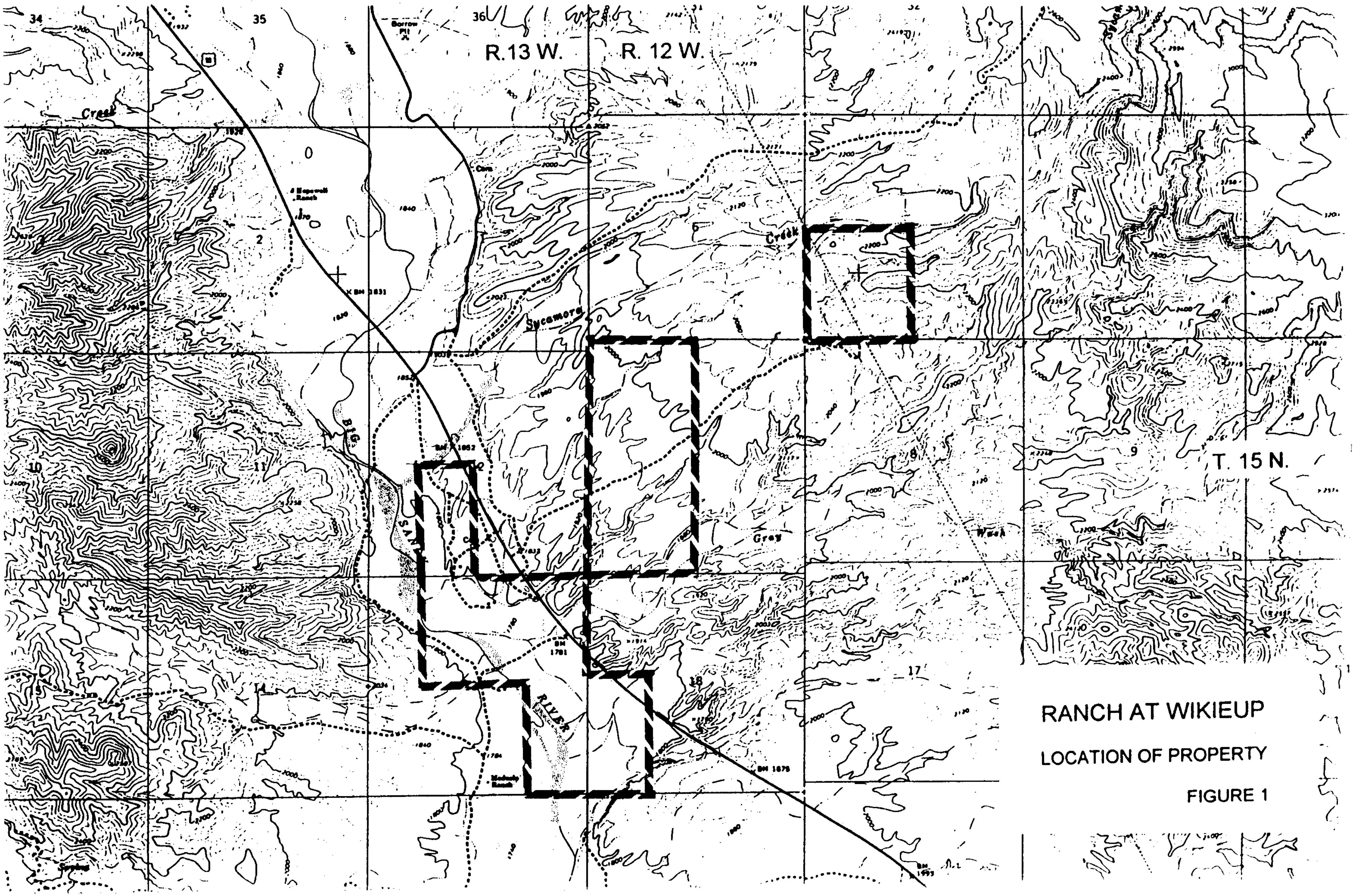
GEOHYDROGLOGY

Description of Geology

The reader is referred to Appendix A for a description of the rocks types and geology of the basin.

Abstract

The following abstract is taken from the report "Water Resources Appraisal of the Big



RANCH AT WIKIEUP

LOCATION OF PROPERTY

FIGURE 1

Sandy Area, Mohave County, Arizona" (E. S. Davidson, 1973, Arizona Water Commission Bulletin 6, included as Appendix A)

The Big Sandy area comprises 700 square miles in the valley of the Big Sandy River in southeastern Mohave County, Arizona. The area is mainly grazing land, except for a small amount of irrigated pasture and cropland in the central valley. The area is drained to the south by the Big Sandy River and is bounded on the east and west by mountains composed of crystalline rocks.

The central valley is underlain by several hundred to a few thousand feet of semiconsolidated to unconsolidated deposits that store large amounts of ground water; the principal water-yielding units are the stream and flood plain alluvium, the upper basin fill, the lower basin fill, and the arkosic gravel. In the southern part of the area ground water from the sedimentary deposits drains into the channel of the Big Sandy River and supplies moisture to the dense vegetation along the river. Ground water is replenished by recharge along the mountain fronts and by intermittent flow in the main stream channels in the central valley. The depth to ground water below the land surface ranges from less than 1 foot in places along the Big Sandy River to 750 feet in the northern part of the area.

The mean annual precipitation ranges from 10 inches in the central valley to 20 inches in the mountains and is equivalent to about 1 million acre feet of water in the 1,770 square mile drainage basin of the Big Sandy River upstream from the granite gorge near Wikieup. About 4.6 percent of the precipitation leaves the area as surface water and ground water outflow; the rest of the precipitation is lost to evaporation or is transpired by vegetation. In general streamflow is intermittent and occurs only in response to precipitation or snowmelt.

Ground water and surface water generally are of good chemical quality except for the fluoride content; calcium, magnesium, and bicarbonate are the dominant dissolved ions, and the dissolved solids content of the water ranges from 350 to 800 mg/l (milligrams per liter) in most of the area. However, fluoride concentrations in the ground water generally are more than 1.2 mg/l but in some places exceed 2.0 mg/l; a fluoride concentration of more than 1.4 mg/l is cause for rejection of the supply[for drinking purposes in light of the mean annual air temperature in the study area. [*The allowable fluoride content for drinking water has been raised to 4.0 mg/l, with some caveats].*

The average surface water outflow is about 24,900 acre feet per year. The total ground water outflow - which comprises evapotranspiration in an area of dense riparian growth, consumptive use for irrigation and public supply, and underflow is about 21,500 acre feet per year. Only a few thousand acre feet of water per year is used by the inhabitants in the area, and the available water resources will support considerable additional development.

Additional ground water supplies are available in many undeveloped parts of the Big Sandy area; in areas where ground water has been developed most wells do not penetrate the entire saturated thickness of the aquifer. The greatest potential for future ground water development is in the stream and flood plain alluvium, the upper basin fill, and the lower basin fill in the area along the Big Sandy River from Cane Springs Wash to the granite gorge south of Wikieup. In addition, the upper basin fill and arkosic gravel may support greater ground water development west of the Big Sandy River.

Basin Outflow

Basin outflow occurs in two forms, surface flow and ground water flow.

Surface Outflow

In general, the Big Sandy River flows only in response to precipitation, but from Wikieup south though the granite gorge outlet to the basin, perennial flow occurs in the river. Based on measurements by Kam (Davidson, 1973) during the period 1959 -1964, the perennial flow through the granite gorge is about 1,800 acre feet per year. The approximate long term mean annual flow of the Big Sandy River at the granite gorge was calculated to be 24,900 acre feet (Davidson, 1973).

Ground Water Outflow

The total ground water outflow is estimated to be 21,500 acre feet per year of which approximately 800 acre feet discharges through granite gorge, 2,300 acre feet is utilized for domestic and irrigation use and the remaining 18,400 acre feet is transpired by the riparian vegetation along the river.

Riparian Use

The amount of acreage covered by riparian vegetation, adjusted to a basis of 100 percent density, is about 4,600 acres. The evapotranspiration rate for riparian vegetation in the Big Sandy River area is estimated to be 5 acre feet per acre giving an evapotranspiration loss of 18,400 acre feet per year.

Water In Storage

The amount of recoverable ground water in storage to a depth of 700 feet below the ground surface was based on the thickness of the aquifer and the specific yield of the aquifer. Based on a specific yield of 15 percent, and eliminating those areas where the thickness of the aquifer was less than 200 feet or was primarily silt or clay, the estimated volume of recoverable ground water in storage in the Big Sandy River basin is 13 million acre feet.

Change in Water Levels

The water levels in the shallow wells of the Big Sandy basin have remained relatively constant since 1945, with variations measured in only a few feet. This reflects the fact that there is little withdrawal from the basin for domestic and irrigation purposes and that seasonal variations in recharge are minor, even in dry periods.

Pumping Test Analysis

A pumping test was conducted on an existing well located in the SW1/4, NW1/4, NE1/4 of Section 13, T. 15 N., R. 13 W. on October 29 - 30, 1999.

The total depth of the well was measured as105 feet and the owner stated the casing was perforated only in the bottom 20 feet of the well. A second well, with a total depth of 60 feet, located approximately 200 feet from the pumped well, was used as an observation well during the testing period.

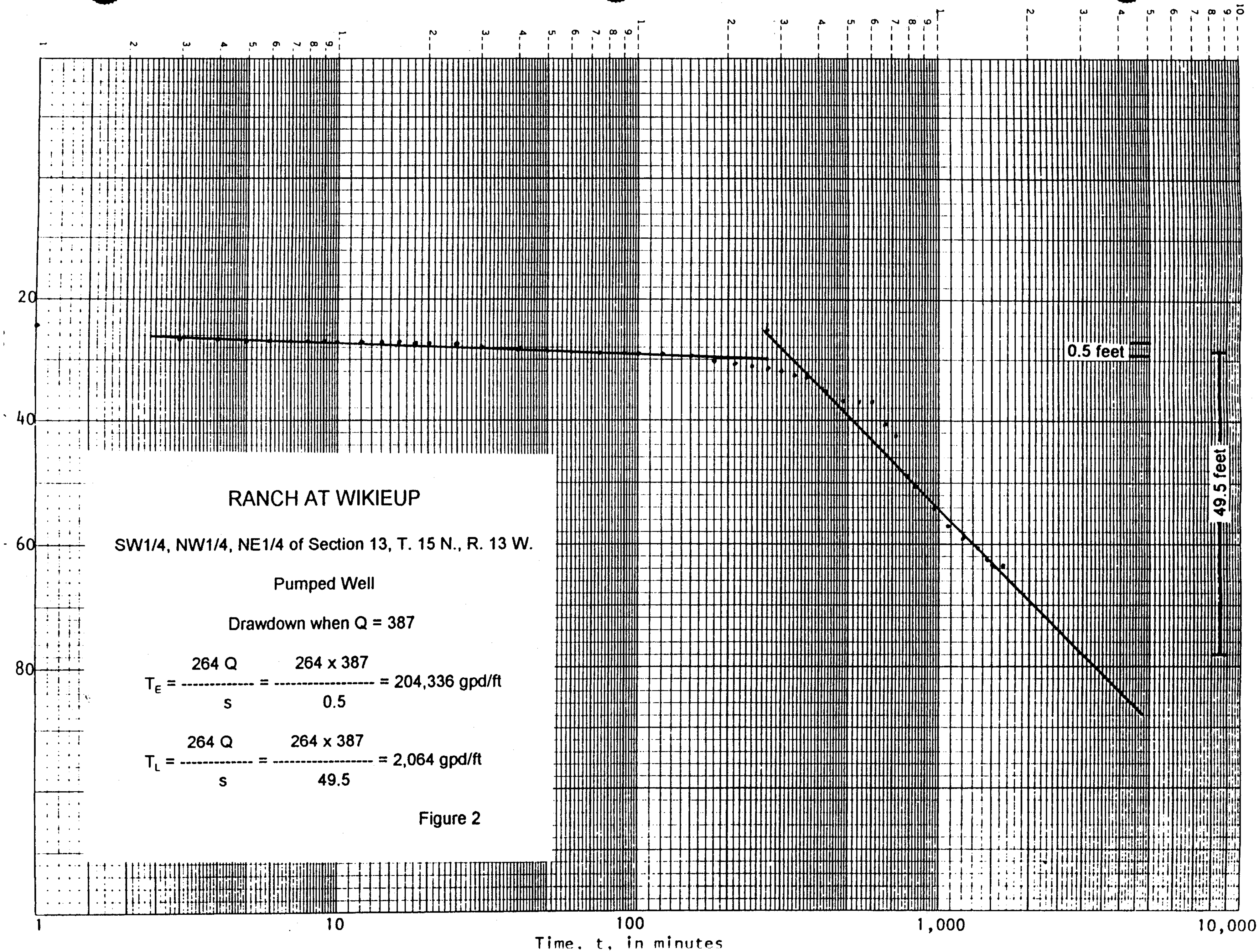
The pump was run at an average discharge of 387 gallons per minute (gpm) for a period of 1,635 minutes.

Analysis of the drawdown in the pumped well, Figure 2, shows a transmissivity (T) value of 204,000 gpd/ft for the first 300 minutes, then the T value drops to 2,064 gpd/ft for the remainder of pumping period. The T value calculated from the observation well data, Figure 3, collected during the test was 65,500 gpd/ft.

The T values 204,000 gpd/ft during the early portion of the pumped well data and the 65,500 gpd/ft from the observation well data fall within the reported values of T of the stream bed alluvium in the Big Sandy basin (Davidson, 1973). The radical change in the value of T when the pumping level dropped below 30 feet is not so clear cut. The possible reasons for this change are that the cone of depression dewatered a thin layer of stream alluvium leaving only the underlying lacustrine deposits to supply water to the well or there may have been a hydrologic boundary which impacted the pumping level.

Considering the T values of the alluvial fill, it is expected that perforating the entire casing below the water level would allow the development of shallow wells capable of yielding approximately 300 gpm in the streambed and floodplain alluvial fill.

The field data sheets are included as Appendix B.



RANCH AT WIKIEUP

SW1/4, NW1/4, NE1/4 of Section 13, T. 15 N., R. 13 W.

Pumped Well

Drawdown when Q = 387

$$T_E = \frac{264\ Q}{s} = \frac{264 \times 387}{0.5} = 204{,}336 \text{ gpd/ft}$$

$$T_L = \frac{264\ Q}{s} = \frac{264 \times 387}{49.5} = 2{,}064 \text{ gpd/ft}$$

Figure 2

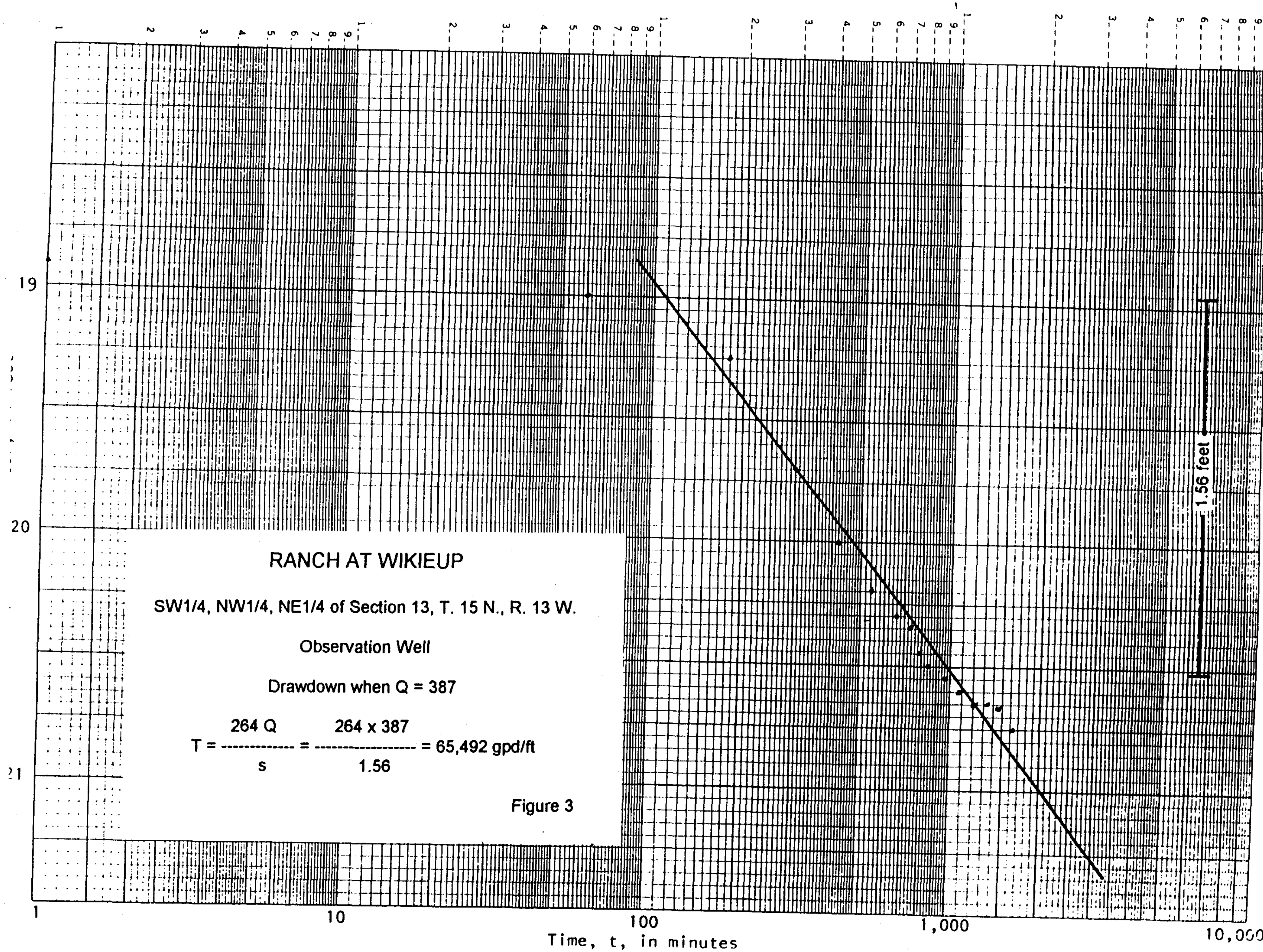

RANCH AT WIKIEUP
SW1/4, NW1/4, NE1/4 of Section 13, T. 15 N., R. 13 W.
Observation Well
Drawdown when Q = 387
$$T = \frac{264\,Q}{s} = \frac{264 \times 387}{1.56} = 65{,}492 \text{ gpd/ft}$$
1.56 feet
19
20
21
1
10
100
1,000
10,000
Time, t, in minutes

Figure 3

CONCLUSIONS

The following conclusions were predicated on review of the available data. As additional data becomes available, these conclusions may be modified.

1. The perennial flow of 1,800 acre feet of water per year plus a portion of the long term average annual flow of 24,900 acre feet of water which flow out of the basin through the granite gorge can be harvested by diversion from the river at the Ranch property in Sections 12 and13, T. 15 N., R. 13 W. This assumes that surface water rights for such diversion are held.;

2. The ground water outflow through the granite gorge in the amount of 800 acre feet per annum can be harvested at the Ranch property by withdrawal from shallow wells.;

3. Clearing the riparian vegetation from the property for the purpose of planting crops will release approximately 5 acre feet for every acre cleared of pheatophytes. Assuming clearing 640 acres would release 3,200 acre feet which could be harvested at the Ranch property, through withdrawal from shallow wells in the stream alluvium.

4. Then, the estimated total volume available at the Ranch property consists of:

• perennial flow	1,800 acre feet
• long term mean annual flow	500
• ground water outflow	800
• riparian release	3,200
potential harvest	6,300 acre feet

RECOMMENDATIONS

It is recommended that one or more test wells be drilled to a minimum depth of 1,600 feet or until crystalline bedrock is encountered. The test hole should then be logged with a suite of downhole logging tools to determine the types of subsurface materials present and their water yielding characteristics.

Should results of the test hole indicate a potential aquifer, then a deep production well can be drilled and completed to determine the yield of the deep aquifers.

An estimated price for such a well is included as Appendix C.

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APPENDIX A

Water Resources Appraisal of the Big Sandy Area, Mohave County, Arizona

ARIZONA WATER COMMISSION
BULLETIN 6

WATER-RESOURCES APPRAISAL OF THE BIG SANDY AREA MOHAVE COUNTY, ARIZONA

BY E. S. DAVIDSON

PREPARED BY THE GEOLOGICAL SURVEY
UNITED STATES DEPARTMENT OF THE INTERIOR

PHOENIX, ARIZONA DECEMBER 1973

CONTENTS

ILLUSTRATIONS

[Plates are in pocket]

WATER RESOURCES APPRAISAL OF THE BIG SANDY AREA, MOHAVE COUNTY, ARIZONA

By

E. S. Davidson

ABSTRACT

The Big Sandy area comprises 700 square miles in the valley of the Big Sandy River in southeastern Mohave County, Ariz. The area is mainly grazing land, except for a small amount of irrigated pasture and cropland in the central valley. The area is drained to the south by the Big Sandy River and is bounded on the east and west by mountains composed of crystalline rocks.

The central valley is underlain by several hundred to a few thousand feet of semiconsolidated to unconsolidated deposits that store large amounts of ground water; the principal water-yielding units are the stream and flood-plain alluvium, the upper basin fill, the lower basin fill, and the arkosic gravel. In the southern part of the area ground water from the sedimentary deposits drains into the channel of the Big Sandy River and supplies moisture to the dense vegetation along the river. Ground water is replenished by recharge along the mountain fronts and by intermittent flow in the main stream channels in the central valley. The depth to ground water below the land surface ranges from less than 1 foot in places along the Big Sandy River to 750 feet in the northern part of the area.

The mean annual precipitation ranges from 10 inches in the central valley to 20 inches in the mountains and is equivalent to about 1 million acre-feet of water in the 1,770-square-mile drainage basin of the Big Sandy River upstream from the granite gorge near Wikieup. About 4.6 percent of the precipitation leaves the area as surface-water and ground-water outflow; the rest of the precipitation is lost to evaporation or is transpired by vegetation. In general streamflow is intermittent and occurs only in response to precipitation or snowmelt.

Purpose of the Investigation and Scope of the Report

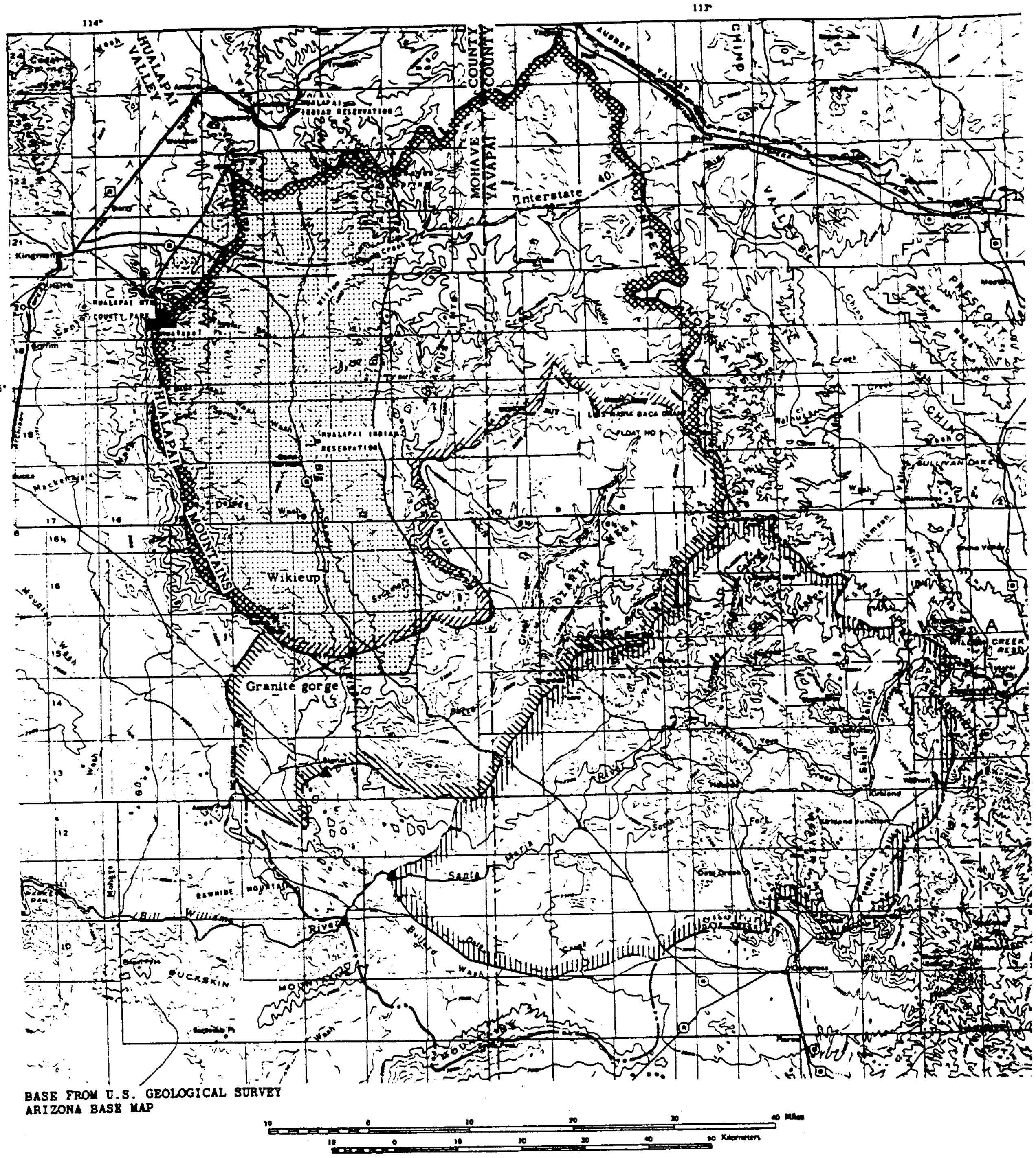
The U.S. Geological Survey in cooperation with the State of Arizona conducted a water-resources investigation in the Big Sandy area to determine the availability, chemical quality, and use of water and to evaluate the potential for additional water development. When the investigation was started in 1959, the State Land Department represented Arizona in the cooperative water-resources investigation program; the newly formed Arizona Water Commission now represents the State in the cooperative program.

The report describes the distribution, lithology, and the water-yielding characteristics of the rock units in the Big Sandy area. The distribution, outflow, storage, and chemical quality of the ground water are described in the detail warranted by the available data; most of the available chemical-quality data and the pertinent water-level data for wells and springs are shown in plates 1 and 2. Brief descriptions of the flow characteristics and the chemical quality of water in the Big Sandy River are included. The report gives estimates of the 1970 water use in the area and indicates that additional water supplies can be obtained by drilling in unexplored areas, by penetrating the entire saturated thickness of the aquifer, and by an intensive well-development program along the Big Sandy River. The report was prepared under the general supervision of H. M. Babcock, district chief of the U.S. Geological Survey in Arizona.

Location and Description of the Area

The Big Sandy area occupies 700 square miles in the southeastern part of Mohave County in northwestern Arizona (fig. 1). About 150 people live in the area on a year-round basis; the principal population center is Wikieup, which is about 120 miles northwest of Phoenix and about 40 miles southeast of Kingman. The area is traversed from north to south by U.S. Highway 93, which is the principal highway between Kingman and Phoenix. The northern part of the area will be traversed by the east-west Interstate Highway 40, which was partly completed in 1973 (fig. 2).

The Big Sandy area is bounded by the Hualapai and Peacock Mountains on the west and by the Cottonwood Cliffs and the Aquarius



Contour interval 500 feet

Datum is mean sea level

E X P L A N A T I O N

Streamflow-gaging station

Boundary of Bill Williams River drainage upstream from gaging station

Boundary of Santa Maria River drainage upstream from gaging station

Boundary of Big Sandy River drainage upstream from gaging station

Boundary of Big Sandy River drainage upstream from granite gorge near Wikieup

Common boundary of Big Sandy River drainage upstream from granite gorge and gaging station

Area of report

FIGURE 2.--TOPOGRAPHIC MAP SHOWING DRAINAGE BASINS IN AND ADJACENT TO THE BIG SANDY AREA.

Mountains on the east (fig. 2). The northern boundary of the study area is in T. 23 N., and the southern boundary is in T. 15 N.

Methods of the Investigation

The approximate extent of each water-yielding unit was defined by reconnaissance geologic mapping. The mapping was done on aerial photographs north of 35° lat, on aerial photographs and topographic maps south of 35° lat, and then was transferred to a planimetric base.

An attempt was made to inventory all wells and springs in the area, but some springs and stock wells in the mountains were not inventoried. All well and spring locations are described in accordance with the well-numbering system used in Arizona, which is explained and illustrated in figure 3. Water levels in wells were measured where possible, and a few aquifer tests were conducted, mostly in the central part of the area. Water samples were collected from many wells and springs for chemical analysis. Drillers' logs of wells were examined to determine the water-yielding potential of the rock units and to correlate the rock units penetrated with the units exposed at the land surface. Drill cuttings from new wells were examined to determine the subsurface lithology, and three holes were augered to bedrock in the south end of the area, where the Big Sandy River enters the granite gorge.

The flow of the Big Sandy River through the granite gorge at the south end of the area was measured many times, and these measurements were used to compute the probable annual perennial flow of the river. Additional streamflow measurements were made in Trout and Willow Creeks. Water samples were collected from Trout and Willow Creeks and from the Big Sandy River for chemical analysis.

The fieldwork on which this report is based was done in 1969-70 by E. S. Davidson and F. E. Arteaga, in 1959-60 by William Kam and R. S. Stulik, and in 1939-40 by R. B. Morrison, all of the U. S. Geological Survey. The quantitative surface-water data were compiled by Otto Moosburner of the U. S. Geological Survey.

Previous Investigations

Hydrologic studies by several investigators were helpful in evaluating the water resources in the Big Sandy area. Morrison (1940) described the ground-water resources of the Big Sandy Valley, and Morrison (1941) and Gillespie and others (1966) prepared compilations of the basic hydrologic data available for the area. The flow regimen of Cottonwood Wash—now called Willow Creek—and the changes in the regimen as a result of the removal of riparian growth were described by Bowie and Kam (1968). Additional water-resources data were available from the files of the U. S. Geological Survey offices in Phoenix and Tucson, Ariz.

Acknowledgments

The author gratefully acknowledges Dr. W. D. Sellers and Ms. M. S. Rae of the Institute of Atmospheric Physics, University of Arizona, who provided a statistical analysis of temperature data for Wikieup. Dr. P. E. Damon of the Department of Geosciences, University of Arizona, kindly determined the age of a basalt flow by the potassium-argon method in the Big Sandy area from a sample collected by the author.

PHYSICAL SETTING

The Big Sandy area is an elongate broad north-trending valley bounded by mountains; the central valley contains more than 2,000 feet of unconsolidated sedimentary rocks, and the mountains are composed of granitoid crystalline rocks. Volcanic rocks overlie the granitic rocks in the mountains in the southeastern and northern parts of the area and are interlayered with sedimentary units in some parts of the central valley.

On the west side of the area, the Hualapai Mountains are more than 6,000 feet above mean sea level, and Hualapai Peak is at a maximum altitude of 8,266 feet; on the east, the Aquarius Mountains are from 5,000 to 6,000 feet above mean sea level (fig. 2). The Cottonwood Cliffs on the east and the Peacock Mountains on the northwest are about 6,000 feet above mean sea level. The bed of the Big Sandy River is about 4,000

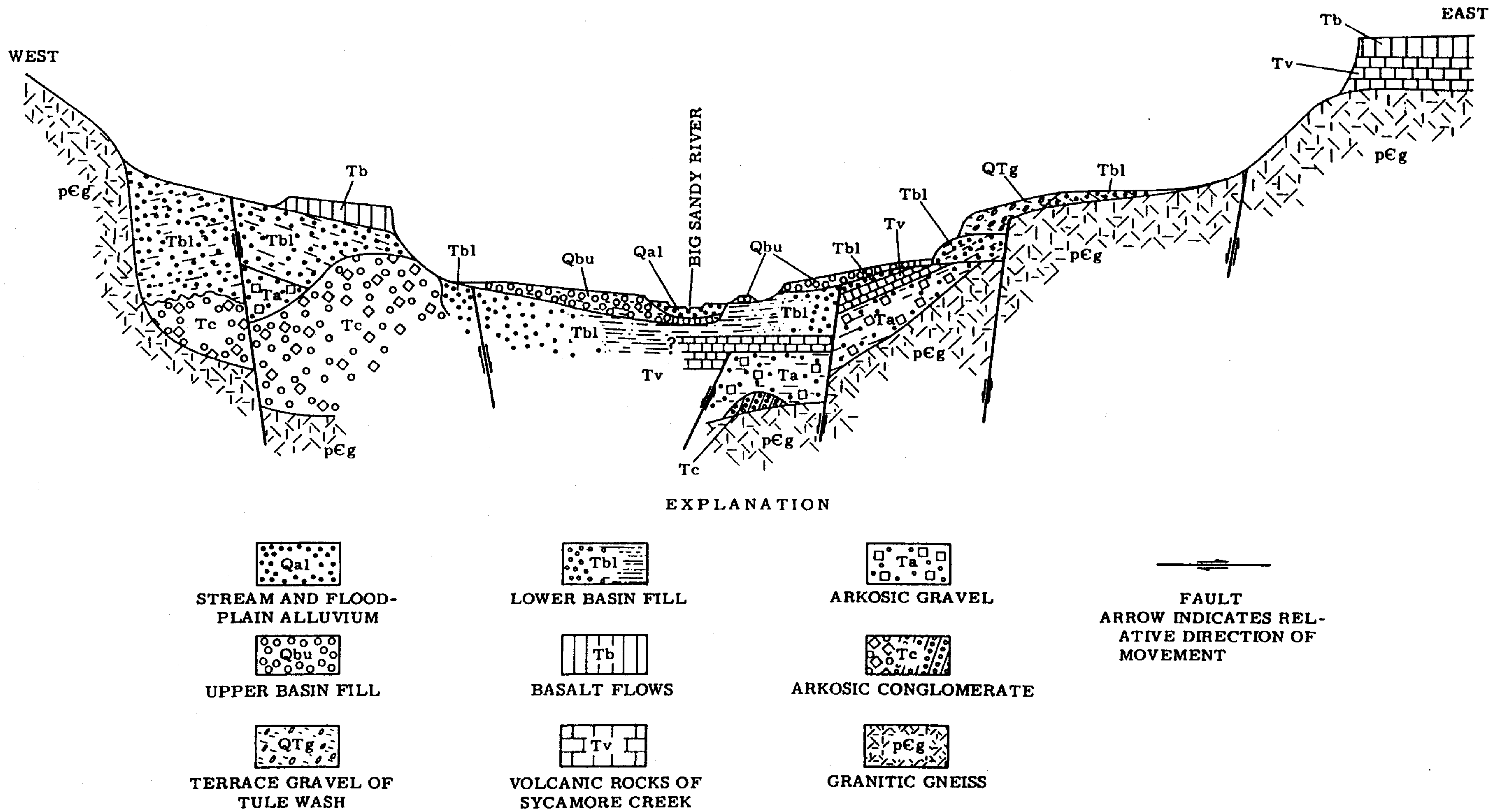


FIGURE 4. --DIAGRAMMATIC SECTION OF THE BIG SANDY AREA.

The granitic gneiss yields a few gallons per minute of water to wells and springs only where the unit is moderately or strongly fractured and recharge is available from rainfall, snowmelt, or runoff. In general, the water in the granitic gneiss has a small dissolved-solids content and is of good chemical quality for most uses. The dissolved-solids content in the ground water ranges from about 400 to 2,500 mg/l (milligrams per liter); however, a dissolved-solids content of 2,500 mg/l is unusual. Magnesium, calcium, sulfate, bicarbonate, and, less commonly, chloride are the dominant constituents. The fluoride content ranges from 1.6 to 4.4 mg/l (table 1).

Arkosic Conglomerate

Dark-reddish-brown arkosic conglomerate crops out west of the Big Sandy River. The outcrops are small, and similar rocks have not been identified elsewhere in the area. Because of the appearance, structural position, and strong silica cementation of the rock, it is assumed to be early Tertiary in age.

The arkosic conglomerate consists of angular to subrounded pebbles and boulders of granite and granodioritic gneiss set in a medium- to coarse-grained arkosic sand matrix. The fragments are strongly cemented with silica and are heavily stained with reddish-brown to black iron and manganese oxide. Although the bedding is distinct, the fragments are so angular that the rock resembles a talus breccia. The pebbles and boulders were derived locally from the gneissic rock of the Hualapai Mountains. The bedding attitude of the arkosic conglomerate and the overlying arkosic gravel is similar, but the contact between the two units is erosional and disconformable. The lower contact is not exposed, but the arkosic conglomerate probably overlies an erosional surface on the granitic gneiss.

The arkosic conglomerate apparently is limited in occurrence and is practically impermeable where exposed. No wells or springs are known to occur in the unit.

Table 1. --Chemical analyses of water in the Big Sandy area—Continued

Location	Date of collection	Probable water-yielding unit	Depth of well (feet)	Approximate depth to water (feet below land surface)	Temperature (°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (calculated)	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio (SAR)	Specific conductance (micromhos at 25°C)	pH	Remarks
(B-16-13) con.																							
27bab	10- 7-59	Upper basin fill	95	42R	21	49	61	18	102		352	0	77	52	2.6	1.2	536	228	0	2.9	840	7.7	W.
27bdd	10- 6-59	Upper basin fill; lower basin fill	116	30R	23	45	56	22	142		332	0	103	108	2.8	1.6	643	232	0	4.1	1,040	7.5	W.
34bc	8-18-67	Lower basin fill	-----	--------	25	22	79	24	67	5.7	342	0	110	48	1.0	2	527	296	0	1.7	800	7.8	W; Dutt and McCreary, 1970; well could not be located.
35bcd	10- 7-59	Lower basin fill	74	40R	27	48	54	26	151		374	0	129	82	3.7	1.8	680	240	0	4.2	1,060	7.4	W.
(B-16-14)																							
8aba	7-29-69	Granitic gneiss	-----	--------	----	44	40	33	43		123	0	43	126	1.6	-----	392	234	133	1.2	791	7.7	S; Cowboy Spring.
36acad	7-24-69	Granitic gneiss	-----	64	27	35	81	28	79		313	0	63	116	1.8	-----	558	318	61	1.9	935	7.9	W.
(B-16½-13)																							
27cdbb	10- 6-60	Upper basin fill; stream and flood-plain alluvium	117	32	20	45	58	16	56		295	0	36	36	1.2	.9	394	212	0	1.7	614	8.0	W.
(B-16½-14)																							
26cbac2	7-16-69	Lower basin fill	225	122R	----	26	114	67	9.0		80	0	320	126	1.2	-----	702	560	494	.2	1,390	7.6	W.
32bdaa	7-17-69	Granitic gneiss; stream and flood-plain alluvium	-----	--------	24	40	54	70	103		268	14	214	125	2.5	-----	754	425	32	2.2	1,265	8.5	S.
(B-17-13)																							
10aaa	11-30-67	Upper basin fill	98	77	----	46	66	20	69	3.0	338	0	49	46	1.5	-----	466	245	0	1.9	781	7.4	W.
11abb	11-16-60	Stream and flood-plain alluvium; upper basin fill	89	21	18	46	44	15	44		277	0	18	14	.8	1.1	319	172	0	1.5	529	7.3	W.
23baa	6- 3-59	Stream and flood-plain alluvium; upper basin fill	115	21	20	54	52	17	56		293	0	25	35	1.1	1.1	385	198	0	1.7	597	7.4	W.
31dabb	7-16-59	Lower basin fill	147	121	27	33	122	62	71		408	0	246	82	3.0	-----	820	560	225	1.3	1,215	8.2	W.
(B-17-14)																							
23bad	8-27-59	Granitic gneiss	-----	--------	26	48	78	13	44		318	0	33	33	1.8	.7	408	250	0	1.2	629	7.6	S.
(B-18-13)																							
14c	6-23-60	------------------	-----	--------	30	60	24	11	54		180	16	13	24	.7	.2	291	106	0	2.3	418	8.7	F; Trout Creek; sample from irrigation ditch, flow 0.11 cfs.

Table 1. --Chemical analyses of water in the Big Sandy area—Continued

Location	Date of collection	Probable water-yielding unit	Depth of well (feet)	Approximate depth to water (feet below land surface)	Temperature (°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (calculated)	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio (SAR)	Specific conductance (micromhos at 25°C)	pH	Remarks
(B-20-13) con.																							
22dddc	7-25-69	Granitic gneiss	125R	80R	27	35	44	22	51		263	5	23	42	1.2	-----	352	200	0	1.6	552	8.3	W.
(B-20-14)																							
7ddaa	7-25-69	Lower basin fill; granitic gneiss(?)	260	130R	22	20	94	17	85		174	0	177	111	2.6	-----	593	306	163	2.1	1,095	8.1	W.
19bdab	7-15-69	Granitic gneiss; lower basin fill	165	26	18	30	590	157	15		128	0	900	780	3.5	-----	2,540	2,120	2,015	.2	4,410	7.5	W; abandoned well at edge of cattle corral.
21acab2	7-15-69	Lower basin fill; granitic gneiss(?)	230	60	20	26	152	68	26		68	0	518	80	2.9	-----	906	660	604	.4	1,490	7.8	W; two wells at site; sample from newer well.
32baaa	7-15-69	Lower basin fill; granitic gneiss(?)	102R	--------	----	24	80	51	30		106	0	166	148	2.2	-----	553	410	323	.6	1,025	7.9	W.
33bdad	7-15-69	Lower basin fill; stream and flood-plain alluvium	130R	11	18	28	53	24	28		89	0	171	22	3.2	-----	373	230	157	.8	591	7.5	W.
(B-21-11)																							
29b	2- 1-71	------------------	-----	--------	11	40	51	24	15	3.4	272	0	12	20	.3	-----	300	228	5	.4	476	8.2	F; Willow Creek; flow 1.02 cfs.
	6- 2-71	------------------	-----	--------	16	36	52	25	16	3.8	279	0	12	23	.3	-----	305	234	6	.5	498	8.1	F; Willow Creek: flow 0.53 cfs.
(B-21-13)																							
10ccac	3- 4-44	Granitic gneiss(?)	-----	614	----	------	18	27	28		212	0	15	15	-----	8.0	-------	156	-----	------	410	----	W.
24bcdc	11-17-60	Arkosic gravel(?); lower basin fill	400±	377	22	46	28	22	32		185	0	20	38	1.1	3.8	282	162	10	1.1	450	7.4	W.
30cadd	7-25-69	Granitic gneiss; arkosic gravel(?)	820	663	29	39	16	73	625		948	24	119	530	4.4	-----	1,900	342	0	14.5	3,300	8.4	W.
(B-21-14)																							
24dacb	5- 4-60	Arkosic gravel	980	685	31	43	24	21	48		244	0	17	11	5.2	4.2	293	145	0	1.7	457	7.8	W.

Well (B-16-13)27abc

Probable unit penetrated and rock description	Thickness (feet)	Depth (feet)
Stream and flood-plain alluvium:		
Sand and gravel	34	34
Calcium carbonate cemented stream and flood-plain alluvium:		
Hardrock	6	40
Upper basin fill:		
Sand and gravel	65	105
Silt facies of the lower basin fill:		
Clay, brown	20	125
Tuffaceous agglomerate of the volcanic rocks of Sycamore Creek(?):		
Gravel, white	5	130
Oxidized top of andesitic flow in the volcanic rocks of Sycamore Creek(?):		
Clay, red	20	150

Most of the irrigation and domestic wells along the flood plain of the Big Sandy River obtain their water from both the upper basin fill and the stream and flood-plain alluvium; wells that are more than about 40 feet deep probably tap ground water in the upper basin fill. The unit probably is capable of yielding as much as 1,000 gpm of water to wells, and specific capacities of tested wells generally range from 100 to 120 gpm per foot of drawdown. The transmissivity determined from two aquifer tests near Wikieup ranges from about 13,000 to 20,000 cubic feet to 40,000 cubic feet per day per foot (250,000 to 300,000 gpd per foot). Many wells in Tps. 16 and $16\frac{1}{2}$ N., R. 13 W. tap both the alluvium and the underlying upper basin fill; the wells that have the largest yields obtain their water from both units. The water from shallow wells drilled in the alluvium is similar in chemical quality to that of the low flows in the Big Sandy River. The dissolved-solids content in the ground water ranges from about 300 to 900 mg/l (table 1), and the water generally is a mixed calcium magnesium sodium bicarbonate type. The fluoride content generally is between 1.5 and 2 mg/l. The sulfate and chloride content of water in the alluvium increases south of Wikieup, probably because of upward leakage of poor-quality water through the fine-grained deposits of the lower basin fill.

HYDROLOGY

The only source of water in the Big Sandy area is the precipitation that falls within the drainage basin; of this precipitation, 95 percent or slightly more is evaporated from the land surface or near-surface soil or is transpired by plants. The small amount of precipitation that does not return to the atmosphere flows out of the area in the channel of the Big Sandy River or is recharged to the ground-water reservoir, where it eventually is transpired by plants or is discharged to become base flow in the Big Sandy River. Most of the flow of the Big Sandy River is not utilized by the inhabitants of the area; the flow moves downstream to become part of the flow of the Bill Williams and Colorado Rivers (fig. 1).

The mean annual precipitation at Wikieup is 9.5 inches (M. S. Rae, Institute of Atmospheric Physics, University of Arizona, oral commun., 1971). In the central valley the normal annual precipitation for 1931-60 ranged from 10 to 14 inches, 4 to 6 inches of which fell from May through September (University of Arizona, 1965a; 1965b). Precipitation increases proportionately to altitude, and at Hualapai County Park—a small area in the highest part of the Hualapai Mountains—the normal annual precipitation for 1931-60 was about 20 inches, almost 8 inches of which fell from May through September (University of Arizona, 1965a; 1965b).

Summer precipitation results mainly from convective thunderstorms that cool moist air blown over Arizona from the Gulf of Mexico (Green and Sellers, 1964). The precipitation is very localized, intense, and showery. Infrequent large storms that originate as tropical hurricanes off the west coast of Mexico occur in late August, September, and

The approximate long-term mean annual flow in the 1,770-square-mile area of the Big Sandy River drainage at the granite gorge near Wikieup (fig. 2) is

$$\frac{1,770}{2,800} \times 39,400 = 24,900 \text{ acre-feet.}$$

As a check, calculations based on probable runoff from precipitation show that the probable range of mean annual flow is between 20,000 and 28,000 acre-feet per year (Moosburner, written commun., 1970). The mean annual flows of the small tributaries were not calculated owing to insufficient data. The mean annual flow of the Big Sandy River at the granite gorge is taken as 24,900 acre-feet.

The dissolved-solids content in the streamflow increases progressively toward the southern outlet of the Big Sandy area. Only the low flows—most of which are perennial—have been sampled for chemical analysis, but floodflow probably has a smaller dissolved-solids content than low flow. Generally, the low flows are a mixed sodium calcium magnesium bicarbonate type, and the fluoride content ranges from about 1 to 2 mg/l (table 1). In the northern part of the Big Sandy area low flows contain from about 300 to 500 mg/l dissolved solids (table 1), and in the Big Sandy River south of Wikieup the dissolved-solids content of the low flow increases to about 900 mg/l. Although all the ion concentrations increase southward in the low flow of the Big Sandy River, the increase in sulfate and chloride is greater than the increase in bicarbonate because of the sulfate and chloride in the ground water that mixes with the flow of the Big Sandy River.

Ground Water

Most of the ground water is stored in void spaces in the sedimentary rocks; much smaller amounts of water per unit area are stored in the other rock units. The ground water seeps very slowly through the rocks to discharge points along the Big Sandy River and at the south end of the area. The streamflow that results from snowmelt and precipitation replenishes the ground water by infiltration, primarily along the bases of the Hualapai and Aquarius Mountains, along the channels of the major tributaries to the Big Sandy River, and along the Big Sandy River where the water table is below the channel.

volume of water that will drain by gravity to the volume of aquifer. The ratio is the specific yield of the aquifer and is expressed in percent in this report. The amount of recoverable ground water in storage was not estimated in areas where the aquifer is known to be less than 200 feet thick or where it consists entirely of silt or finer grained material. Based on comparisons with similar aquifers in southern Arizona, the specific yield is estimated to be 15 percent in Tps. $16\frac{1}{2}$-19 N. where the average depth to water is not more than 50 feet below the land surface and 10 percent where the average depth to water is more than 50 feet. The amount of water that can drain to wells is the product of specific yield and the volume of the aquifer. The estimated amount of recoverable ground water from the water table (pl. 2) to a depth of 700 feet below the land surface is 13 million acre-feet.

Movement and depth to water.--Ground water moves downgradient generally in the same direction as the streamflow in the Big Sandy area. Several springs issue along the Big Sandy River, Cane Springs Wash, and Deluge Wash where the water table locally intersects the land surface; but only along the Big Sandy River is ground water consistently near the surface during most of the year. Few wells have been drilled beyond the flood plain, and, therefore, the shape of much of the regional water table is inferred. The contours that reflect the shape of the water table are restricted to the general area of the aquifer and are compatible with the assumption that all wells and most springs penetrate or intercept the same body of ground water (pl. 2). The general movement of ground water is downgradient at right angles to the water-table contours. Where ground water is recharged mainly in the upgradient part of the aquifer and the amount of recharge and the thickness of the aquifer are similar, the water-level gradient can be used to estimate the relative hydraulic conductivity of the aquifer from place to place; under these conditions, the gentler the gradient the greater the hydraulic conductivity.

The water-level gradient is southward at 30 to 70 feet per mile in the central valley (pl. 2). On the east side of the area, water-level data are extremely sparse, but the gradient toward the central valley seems to be about 200 feet per mile. The gradient on the west side of the central valley is about 200 feet per mile except south of Cane Springs Wash, where the gradient is about 400 feet per mile, probably owing to the low hydraulic conductivity of the aquifer. In the northwestern part of the area the gradient is 300 to 500 feet per mile, which is also indicative of low hydraulic conductivity of the aquifer. In the extreme northern part of the area the water-level gradient is only 30 feet per mile, but judging from is the dominant ion in much of the water (table 1). The sodium concentration is about equivalent or slightly greater than that of calcium and magnesium in some of the water samples analyzed. The source of the sodium probably is the lower basin fill, particularly the silt and marl facies that contain interbeds of sodium zeolites. Where the aquifer consists of sand or finer material, the sodium content of the water is likely to be greater than that of water in sandy gravel or coarser material, and the ionic concentration of sodium may be greater than that of calcium and magnesium combined.

Fluoride concentrations in the ground water generally are greater than 1.2 mg/l (table 1), and in many of the water samples analyzed the fluoride content is greater than 2.0 mg/l (table 1). Limits of acceptability for fluoride in drinking water differ according to the annual average maximum daily air temperature (U.S. Public Health Service, 1962). Based on the annual average maximum daily air temperature at Wikieup, which is 83.4°F (W. D. Sellers, oral commun., 1971), the optimum fluoride content in drinking water is 0.7 mg/l; the presence of fluoride in average concentrations of 1.4 mg/l or more is cause for rejection of the water for public supply (U.S. Public Health Service, 1962, p. 8). Analyses indicate that most of the ground water south of T. 16½ N. contains more than 1.4 mg/l but less than 3 mg/l fluoride. North of T. 16½ N., ground water contains less than 1.8 mg/l fluoride and generally contains less than 1.4 mg/l fluoride except in the northwestern part of the area and near the Peacock Mountains. The fluoride content ranges from 1.1 to 3.2 mg/l in the northwestern part of the area and from 4.4 to 5.2 mg/l near the Peacock Mountains.

The ground water in the Big Sandy area is suitable for irrigation use because it is not highly mineralized and the sodium concentrations generally are smaller than those of calcium and magnesium. The water in much of the area contains fluoride in amounts greater than 1.4 mg/l, which is grounds for rejection of the water for public supply (U.S. Public Health Service, 1962, p. 8).

Ground-water outflow.--Ground-water outflow comprises primarily natural consumptive use and secondarily use by people. As used in this report, the term "outflow" is the total discharge of ground water from the area. The dominant loss of ground water is to the atmosphere through transpiration by riparian vegetation; the consumptive use of water pumped for irrigation and for public supply and underflow out of the area account for the small remainder of ground-water outflow. The small

The volume of water pumped for irrigation and public supply is small and varies from year to year. About 530 acres of grain and alfalfa is irrigated fairly regularly, and 100 to 200 acres of pasture is irrigated from time to time (J. N. McDougal, Mohave County Extension Agent, and C. Williams, Soil Conservation Service, oral commun., 1970). The consumptive use of ground water for irrigation is estimated to be about 2,300 acre-feet per year. About 150 inhabitants live in the area, and, assuming a use of 175 gallons per day per person, about 30 acre-feet per year is used for domestic supply.

A small amount of underflow leaves the south end of the area through the stream and flood-plain alluvium along the Big Sandy River. The volume of underflow is the product of the hydraulic conductivity of the aquifer, the hydraulic head into the cross section, and the saturated cross-sectional area. The saturated cross-sectional area is calculated at about 9,000 square feet, based on data from three auger holes bored to the granitic gneiss at the cross section (Kam, written commun., 1966). The hydraulic conductivity is estimated to be about 1,000 cubic feet per day per square foot (8,000 gpd per square foot)—a transmissivity of about 27,000 cubic feet per day per cross-sectional foot (200,000 gpd per foot) for the average 25-foot thickness of aquifer. The hydraulic gradient is about 10 feet in a horizontal distance of 1,000 feet. Integrating the hydraulic conductivity across the saturated cross-sectional area and multiplying by the hydraulic gradient gives an underflow of about 800 acre-feet per year.

The annual ground-water discharge is about 21,500 acre-feet and comprises about 18,400 acre-feet of evapotranspiration, 2,300 acre-feet of pumpage (consumptive use), and 800 acre-feet of underflow. In addition, ground water is forced to the surface in the Big Sandy River near and south of Wikieup (Kam, written commun., 1966), and about 1,800 acre-feet per year leaves the area as perennial flow.

ADDITIONAL WATER DEVELOPMENT

Additional water supplies can be developed in several parts of the Big Sandy area, either by drilling additional wells or by deepening existing wells. The flood plain of the Big Sandy River is the most accessible and convenient area from which additional water can be obtained, but wells, leveled fields, and buildings in this area may be destroyed during major floods. The main water-yielding units along the flood plain are

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APPENDIX B

Pumping Test, Field Data Sheets

RANCH AT WIKIEUP

SW1/4, NW1/4, NE1/4 of Section 13, T. 15 N., R. 13 W.

Pump Test Data

October 29-30, 1999

Well 105 feet total depth
Perforated area, 20 feet at bottom of well
Static Water Level 24 feet
Average discharge = 386.85 gpm

Date Time	Pumping Level in feet	Drawdown in feet	Time Since Start minutes	Remarks
10/29/99				
0800	24.00	-0-	-0-	Pump on, meter 027691 x 1000
0801	24.50	.50	1	
0802				
0803	26.60	2.60	3	
0804	26.80	2.80	4	
0805	26.90	2.90	5	
0806	27.10	3.10	6	
0807	27.15	3.15	7	
0808	27.30	3.30	8	
0809	27.35	3.35	9	
0810	27.40	3.40	10	
0812	27.45	3.45	12	
0814	27.50	3.50	14	
0816	27.55	3.55	16	
0818	27.60	3.60	18	
0820	27.65	3.65	20	
0825	27.80	3.80	25	
0830	28.00	4.00	30	
0840	28.20	4.20	40	
0850	28.50	4.50	50	
0900	28.70	4.70	60	
0915	28.90	4.90	75	

Date Time	Pumping Level in feet	Drawdown in feet	Time Since Start minutes	Remarks
0930	29.10	5.10	90	
0945	29.20	5.20	105	
1000	29.60	5.60	120	
1030	29.90	5.90	150	
1100	30.50	6.50	180	
1130	30.80	6.80	210	
1200	31.20	7.20	240	
1230	31.55	7.55	270	
1300	32.00	8.00	300	
1330	32.55	8.50	330	
1400	33.33	9.33	360	
1500	35.20	11.20	420	
1600	36.80	12.80	480	
1700	37.10	13.10	540	
1800	37.55	13.55	600	
1900	40.40	16.40	660	
2000	42.40	18.40	720	
2100	49.10	25.10	780	
2200	50.70	26.70	840	
2400	54.10	30.10	960	
10/30/99				
0200	57.40	33.40	1,080	
0400	59.20	35.20	1,200	
0600	60.60	36.60	1,320	
0800	62.40	38.40	1,440	Temperature 20 degrees C.
0900	62.80	38.80	1,500	
1145	62.80	38.80	1,635	Pump off, meter 028323.5 x 1000

28,323,500 - 27,691,000 = 632,500 / 1635 = 386.85 gpm average discharge during test.

RANCH AT WIKIEUP

SW1/4, NW1/4, NE1/4 of Section 13, T. 15 N., R. 13 W.

Observation Well Data

Approximately 200 feet South of Pumped Well

October 29-30, 1999

Total Depth of Well 60 feet, Perforations Unknown

Date Time	Water Level in feet	Residual Drawdown in feet	Time Since Start in minutes	Remarks
10/29/99				
0735	18.90	-0-	-0-	Static Water Level
0800			-0-	Pump on
0900	19.00	.10	60	
1100	19.25	.35	180	
1300	19.70	.80	300	
1500	20.00	1.10	420	
1700	20.20	1.30	540	
1900	20.30	1.40	660	
2000	20.35	1.45	720	
2100	20.45	1.55	780	
2200	20.50	1.60	840	
2400	20.55	1.65	960	
10/30/99				
0200	20.60	1.70	1,080	
0400	20.65	1.75	1,200	
0600	20.65	1.75	1,320	
0800	20.66	1.76	1,440	
1145	20.75	1.85	1,635	

APPENDIX C

Estimated Cost, Test Hole

Layne Christensen Company
12030 E. Riggs Road
Chandler, Arizona 85249
Office: 602.895.9336
Fax: 602.895.9536

Project Estimate

Company:	Manera Inc	Date:	October 20, 1999
Contact:	Paul Manera	Project:	Kingman, AZ
Address:		Location:	Kingman, AZ
City:		Estimated By:	Koal C. Hirschi
State:		Proposal Number:	429
Zip Code:		Estimated Footage:	1500
Phone:	948-9818	Average Depths:	1500
FAX:	596-8776	Number of Holes:	1

Description	Unit	Quantity	Cost	Total
Mobilization and Demobilization drilling crew and equipment	L.S.	1	$1,200.00	$1,200.00
Furnish and install 20' of 6" LCS surface casing	L.S.	1	$1,600.00	$1,600.00
Drill 5 1/2" Reverce Circulation air rotary				
0-500 feet	Foot	500	$12.50	$6,250.00
500-1000 feet	Foot	500	$14.50	$7,250.00
1000-1500 feet	Foot	500	$16.50	$8,250.00
Miscellaneous drill rig time to move between holes, haul water, split-spoon sample, clean site, water sampling, etc.	Hour	30	$265.00	$7,950.00
Abandonment with a cement bentonite grout (if required)	Foot	0	$4.50	$0.00
Client directed Stand-by time	Hour	0	$225.00	$0.00
Per Diem Per Crew Day	Day	5	$225.00	$1,125.00
Miscellaneous materials and equipment consumed on project.	Cost + 20%			
			Total Estimated Cost	$33,625.00

1) Subject to review of HASP and terms and conditions.
2) Availability of manpower and equipment.
3) Actual cost based upon actual quantities consumed.
4) Utility clearance by others.
5) Storage, transport and disposal of drill cuttings by others.

Comments:

Estimate to drill test holes
Cost per test hole + cost of downhole Logging

APPENDIX D
TEST HOLE DRILLING RESULTS

RESULTS

TEST HOLE DRILLING PROGRAM

WIKIEUP, MOHAVE COUNTY, ARIZONA

CAITHNESS BIG SANDY, L.L.C.

MANERA, INC.
8316 NORTH 53RD STREET
PARADISE VALLEY, AZ 85253
TELEPHONE (480) 948-9818

Registered Professional Engineer, (Geological)
CERTIFICATE NO.
6607
PAUL A.
MANERA
Date Signed
ARIZONA, U.S.A.

Paul A. Manera

March 22, 2000

INTRODUCTION

Caithness Big Sandy, L.L.C. (Caithness) proposes to construct a gas fired, electrical generating plant southeast of Wikieup, Mohave County, Arizona. Caithness Big Sandy, L.L.C. purchased one thousand plus acres with the intention of siting the plant on property in the southwest quarter of Section 5, T. 15 N., R. 12 W., G&SR B&M and using the remaining land, as required to develop the water supply required for the generating plant. The property purchased is illustrated on Figure 1.

Initially, the surface flow and underflow, comprising the total "surface" flow of the Big Sandy River was measured in Section13, T. 15 N., R. 13 W. to determine if sufficient surface water was present to satisfy the Surface Water Rights appurtenant to the land purchased. Although the water supply that could be harvested from the Big Sandy River appeared sufficient to satisfy the demand of the proposed plant, the results of the removal of this volume of water from the river was unacceptable to Caithness.

Davidson (1973) stated that the central valley (of the Big Sandy basin) is underlain by several hundred to a few thousand feet of semiconsolidated to uncosolidated deposits that store large amounts of ground water. He further states "wells drilled into gravel in the lower basin fill yield small of water, however naturally developed or gravel packed and screened wells may increase yields from this unit. Caithness elected to test the alluvial fill of the basin to determine if there was sufficient ground water to supply the demands of the plant and to determine the effect of withdrawal of this volume of water on the flow of the Big Sandy River.

This report presents the preliminary results of the first phase of that determination.

PURPOSE AND SCOPE OF PHASE 1

Caithness authorized the drilling, downhole logging and abandonment of one test hole with a target depth of 1,500 feet. Based on the results of the drilling of the first test hole, two additional wells were authorized. Upon completion of the third test hole, one additional test hole was authorized expand the known lateral extent of the aquifer.

The purpose of the test holes was to determine the types of subsurface formations present, the presence or absence of water in the subsurface formations, the quality of the water encountered and some concept of the value of additional testing.

METHODOLOGY

It was elected to drill a 5.75 inch diameter slim hole using the dual wall, reverse circulation drilling method. This method is normally fast drilling, clean drill cutting samples can be obtained and formation water samples can be collected for analysis.

LOCATION OF THE TEST SITES

The locations of the test holes and the rationale for selecting these sites were:

<u>Test Hole 1</u> SW corner, NW1/4, SW1/4 of Section 36, T. 16 N., R. 13 W.

This site was near the river and on the western edge of the lacustrine clay deposits termed the Big Sandy formation (Sheppard and Gude,

1972) shown on Figure 2. Prior to drilling the thickness of the Big Sandy formation was not known.

Test Hole 2 — NW1/4, NW1/4, NW1/4 of Section 7, T. 15 N., R. 12 W.

The westernmost point on the upland property and closest point on the upland property to the center of the basin.

Test Hole 3 — SW1/4, SW1/4, SW1/4 of Section 5, T. 15 N., R. 12 W.

The point on the Plant Site nearest the center of the basin.

Test Hole 4 — SE1/4, SE1/4, NW1/4 of Section 7, T. 15 N., R. 12 W.

Extended the known lateral extent of the subsurface materials which would allow the drilling and construction of four production wells in the northwest quarter of Section 7.

The four test hole sites are illustrated on Figure 1.

RESULTS OF DRILLING

Test Hole 1

The materials encountered during the drilling of Test Hole 1 consisted of layers of intrusive igneous rocks alternating will layers of a sandstone describe by Lease (1981 as a siltstone and sandstone, very fine to fine grained, white to medium gray, friable to well cemented with calcite, micaceous. A few particles of igneous extrusive rocks were seen in the sand and gravel layers.

Water was encountered at approximately 20 feet and the volume of water continued to increase with depth. At 400 feet the hydrostatic head of the water required a weighting material to be added to the drilling fluid to maintain drilling capability. When the drill reached 700 feet the hydrostatic head of the confined water pushed the drilling fluid out of the hole and a flow of approximately 15 gallons per minute (gpm) occurred. Drilling terminated at 700 feet.

A water sample was collected and analyzed by Zalco Laboratories. The total dissolved solids contained in the water was reported to be 900 milligrams per liter (mg/l). Water samples for this and all test holes are representative of the water quality in the formation, however, as the samples were taken during the drilling process, the minor constituents such as iron, manganese and turbidity and color may not be representative of clean water from the formation which will be delivered following cleaning of the well by pumping or long term flow.

The lithologic log and the results of the chemical analysis of the water from Test Hole 1 is included as Appendix A.

Test Hole 2

The Big Sandy formation lacustrine clays extend from the surface (with the exception of a thin layer of sand and gravel concentrated at the surface) to a depth of 350 feet.

Below the clay, alternating layers of igneous intrusive (granitic) sand and gravel alternated with igneous extrusive (volcanic) rocks to the total depth of the test hole at 1,155 feet.

Although water was encountered directly below the clay, the hydrostatic head was limited above a depth of 1,060 feet. At that depth the bit penetrated a volcanic layer that apparently formed a confining layer, at which time the well began to flow under artesian pressure. Drilling continued to the total depth of 1,155 feet.

The well was downhole logged by Geophysical Logging Services.

A water sample was collected for submission for analysis. Aquatic Consulting and Testing, Inc. submitted the results of the analysis. The total dissolved solids content of this water was reported as 811 mg/l. The manganese and iron contents in the waters from Test Hole 2 were significantly lower than in the waters of Test Hole 1.

The artesian flow from this well was measured as 125 gpm with a closed in pressure of 30 pounds per square inch (psi).

The water temperature was measured at 37 C (99 F).

All data sheets for Test Hole 2 are included as Appendix B.

Test Hole 3

The Big Sandy formation lacastrine clay is present from 55 feet to 160 feet. Above the clay is a layer of igneous intrusive sand and gravel mixed with clay. Below the clay, 160 feet to the total depth of 780 feet, all materials encountered are volcanic (igneous extrusive) rocks or sand and gravel. The volcanic materials had a wide range of color from almost white, pink, red, purple, brown, a wide range of gray and black.

The test hole was downhole logged from the surface to approximately 375 feet, where the hole was bridged. The drill pipe was extended through the bridge and the bottom of the hole, 650 feet to 780 feet was logged. The gamma and density logs were made through the drill pipe. Therefore, the density and gamma are correct for the entire depth of the hole, and the remaining logs are accurate from the surface to 375 feet and from 650 to 780 feet.

A water sample was collected for submission for analysis. Aquatic Consulting and Testing, Inc. submitted the results of the analysis. The total dissolved solids content of this water was reported as 770 mg/l. The analysis indicates a high sodium sulphate water and pH of 8.3.

The static water level in this well rose to 20 feet but did not flow.

The water temperature was measured at 37 C (99 F).

All data sheets for Test Hole 3 are included as Appendix C.

Test Hole 4

The materials encountered in Test Hole 4 consisted of a hundred feet of granitic sand and gravel with the Big Sandy formation lacastrine clay extending from 120 feet to 260 feet with transition zones both above and below the clay. Below 300 feet to the total

b. The well at Site 4 would be cemented off to a depth of 1,070 feet , then perforated from 1,070 feet to 1,250 feet to observe the effect of pumping on the confined aquifer.

2. Three shallow, 250 feet, piezometric wells would be drilled and perforated from the surface to 250 feet to observe if the upper aquifer has been isolated from the effect of withdrawal from the lower aquifer(s);

   a. One well would be located at Site 2;

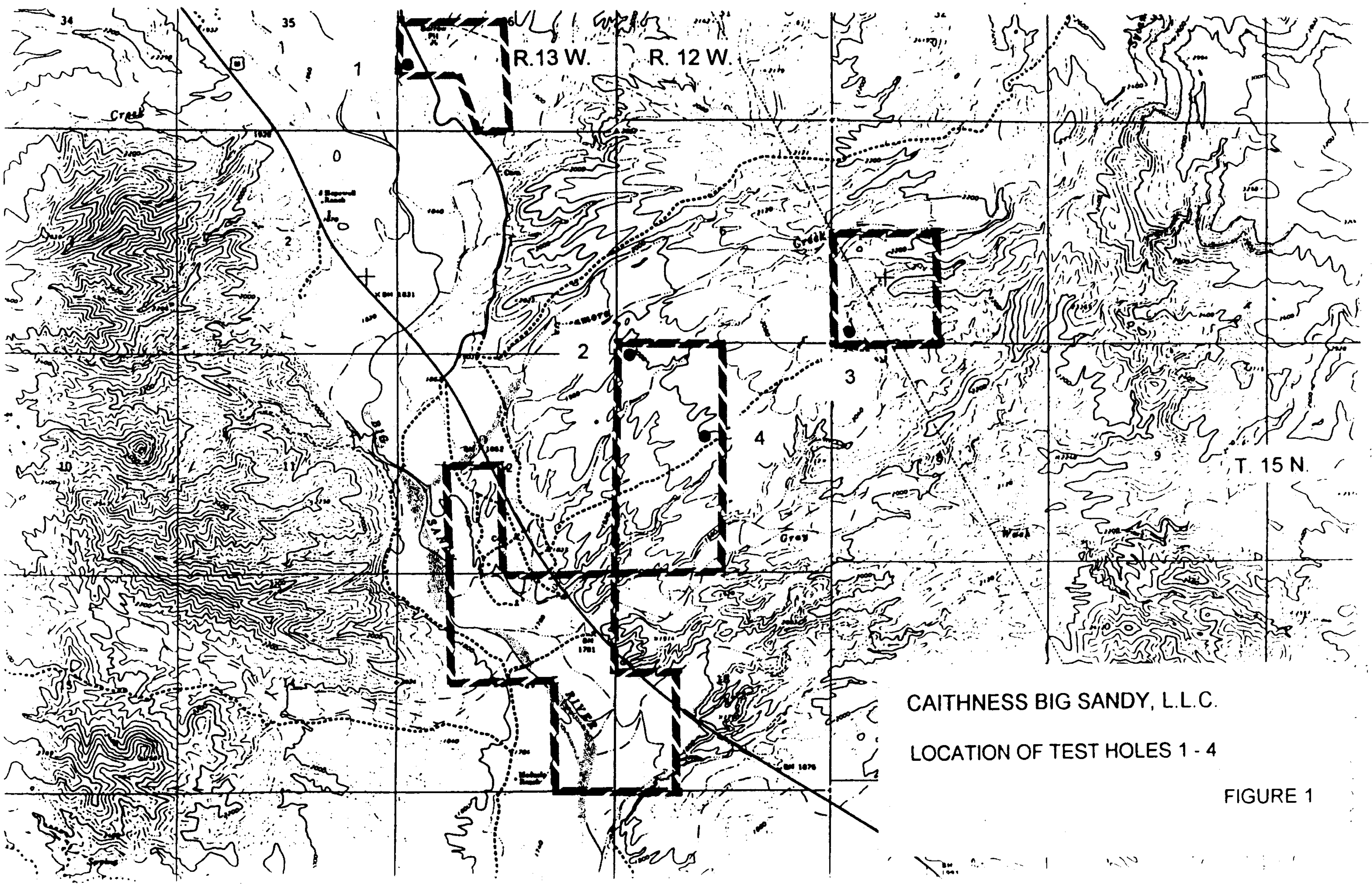
   b. Locations for the remaining two shallow piezometric wells have not yet been determined;

3. Five deep, 1,500 feet total depth, production wells would be drilled;

   a. The first production well would be on the plant site in Section 5, T. 15 N., R. 12 W. This well would be completed and tested prior to the drilling and construction of the remaining wells;

   b. The remaining four wells would be located at the four comers of the northwest quarter of Section 7, T. 15 N., R. 12 W. unless the results of the testing of the first production well indicates that a greater spacing than one half mile is required.

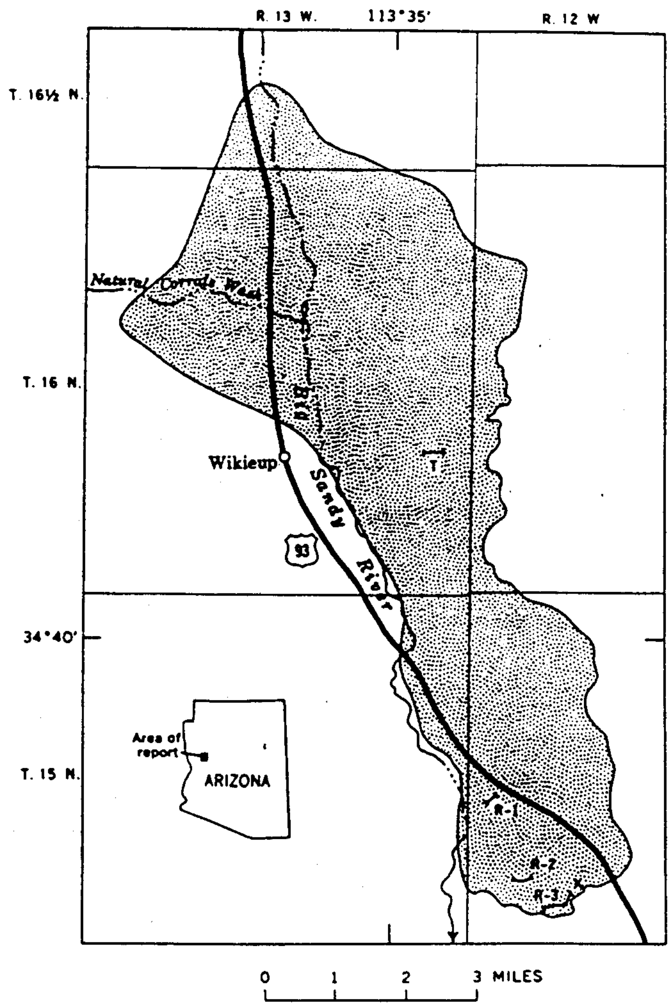
The generalized design of the piezometric wells are included as Appendix E.



CAITHNESS BIG SANDY, L.L.C.

LOCATION OF TEST HOLES 1 - 4

FIGURE 1



MAP SHOWING THE DISTRIBUTION OF THE

BIG SANDY FORMATION (Stippled)

FIGURE 2

CAITHNESS BIG SANDY L.L.C.

TEST HOLE 1

SW1/4, NW1/4, SW1/4 of Section 36, T. 16 N., R. 13 W.

LITHOLOGIC LOG

December 1999

Depth feet	Percent S & G	Average Size, in	Maximum Size, in	Description
0 - 95	75 - 80	1/8	1	Granitic sands and gravels, coarse, acidic igneous intrusive rock particles, somewhat stained with iron oxides. Large percentage of free quartz. Occasional particles of acidic volcanics
95 - 120	-	-	-	Sandstone, cream to light gray
120- 160	75 - 80	1/8	½	Granitic sands and gravels
160 - 180	-	-	-	Sandstone, cream to light gray
180 - 190	75 - 80	1/8	3/4	Granitic sands and gravels
190 - 210	-	-	-	Sandstone, cream to light gray
210 - 220	75 - 80	1/8	3/4	Granitic sands and gravels
220 - 310	-	-	-	Sandstone, cream to light gray
310 - 460	75 - 80	1/8	½ - 1	Granitic sands and gravels
460 - 480	-	-	-	Sandstone, darker gray
480 - 700	75 - 85	1/8	½ - 1	Granitic sands and gravels

Note: Lease (1981) describes the sandstone as "siltstone and sandstone, very fine to fine grained, white to medium gray, friable to well cemented with calcite, micaceous."

LOG BY MANERA, INC.

Test Hole 1
SW¼ Sec 36 T1LN R13 EX
Confined Water 400'-700'

Zalco Laboratories, Inc.
4309 Armour Avenue
Bakersfield, CA 93308

GENERAL MINERAL & PHYSICAL & INORGANIC ANALYSIS (9/99)

te of Report: 00/01/21 Sample ID No.0001181-1
boratory Signature Lab
me: ZALCO LABORATORIES, INC. Director:
ne of Sampler:T. DeRoucher Employed By: Coso Operating
te/Time Sample Date/Time Sample Date Analyses
llected:99/12/18/0900 Received @ Lab:00/01/13/1100 Completed:00/01/20

stem System
ne:COSO OPERATING COMPANY Number: 15CXX15
ne or Number of Sample Source:Well Pump Test

User ID: 15C Station Number:
Date/Time of Sample: |99|12|18|0900| Laboratory Code: 7625
YY MM DD TTTT YY MM DD
Date Analysis completed: |00|01|20|
Submitted by:______ Phone #:______

MCL	REPORTING UNITS	CHEMICAL	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3) (mg/L)	00900	140	
	mg/L	Calcium (Ca) (mg/L)	00916	36	
	mg/L	Magnesium (Mg) (mg/L)	00927	13	
	mg/L	Socium (NA) (mg/L)	00929	260	
	mg/L	Potassium (K) (mg/L)	00937	15	
Total Cations		Meq/L Value: 14.55			
	mg/L	Total Alkalinity (AS CaCO3) (mg/L)	00410	250	
	mg/L	Hydroxide (OH) (mg/L)	71830	0	
	mg/L	Carbonate (CO3) (mg/L)	00445	0	
	mg/L	Bicarbonate (HCO3) (mg/L)	00440	310	
*	mg/L+	Sulfate (SO4) (mg/L)	00945	190	.5
*	mg/L+	Chloride (Cl) (mg/L)	00940	140	
45	mg/L	Nitrate (as NO3) (mg/L)	71850	2.4	2.0
**	mg/L	Fluoride (F) Temp. Depend. (mg/L)	00951	3.8	.1
Total Anions		Meq/L Value: 13.22			
	Std.Units+	PH (Laboratory) (Std.Units)	00403	8.1	
***	umho/cm+	Specific Conductance (E.C.) (umho/cm)	00095	1300	
****	mg/L+	Total Filterable Residue@180C(TDS)(mg/L)	70300	900	
	Units	Apparent Color (Unfiltered) (Units)	00081	40	
	TON	Odor Threshold at 60 C (TON)	00086	< 1.0	
	NTU	Lab Turbidity (NTU)	82079	83	
0.5	mg/L+	MBAS (mg/L)	38260	< 0.05	

* 250-500-600 ** 0.6-1.7 *** 900-1600-2200 **** 500-1000-1500

CAITHNESS BIG SANDY L.L.C.

TEST HOLE 2

NW1/4, NW1/4, NW1/4 of Section 7, T. 15 N., R. 12 W.

LITHOLOGIC LOG

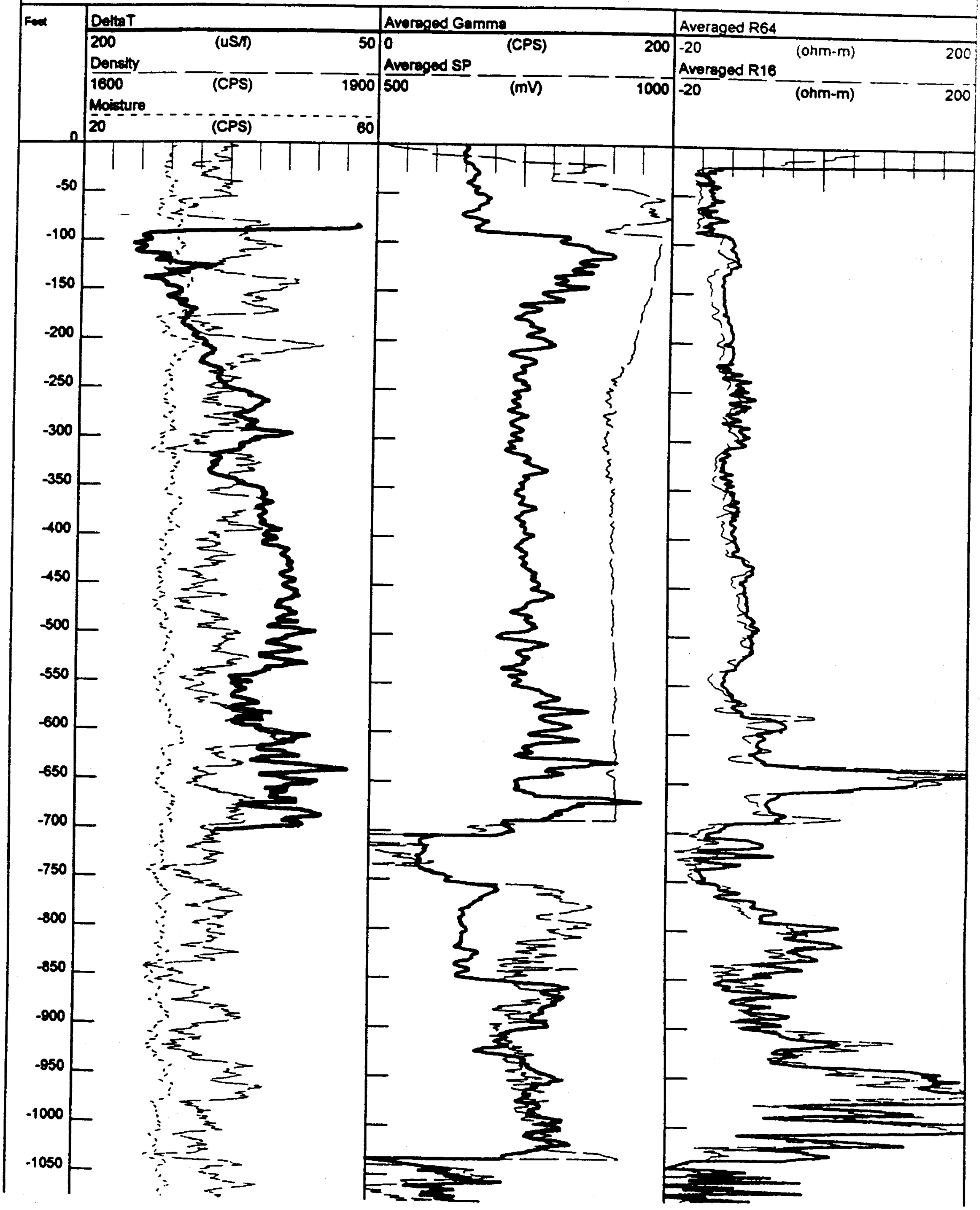
FEBRUARY, 2000

Depth feet	Percent S & G	Average Size, in	Maximum Size, in	Description
0 - 50	85	1/8	½	Granitic sand and gravel
50 - 350	-	-	-	Gray lacustrine clay
350 - 400	60	1/8	1/4	Clay with igneous sand and gravel
400 - 700	80	1/8	1/4	volcanic sand and gravel
700 - 715	-	-	-	Dark red clay
715 - 780	80	1/8	1/4	Red volcanics, sand and gravel ?
780 - 840	80	1/8	1/4	Red volcanics with malachite
840 - 860	80	1/8	1/4	Red volcanics with zeolites
860 -1,030	80	1/8	1/4	Igneous intrusive sand and gravel
1,030 - 1,060	50	1/8	1/4	Clay with intrusive sand and gravel
1,060 - 1,155	80	1/8	1/4	Volcanics, confined water

Artesian flow = 125 gpm
Closed in pressure = 30 psi

LOG BY MANERA, INC.

Well Name: Big Sandy Test Well # 2
Location: NW1/4,NW1/4,NW1/4, S. 7, T. 15N, R.12W
Reference: Ground Surface



AQUATIC CONSULTING & TESTING, INC.

1525 W. University Drive, Suite 106
P.O. Box 1510
Tempe, Arizona 85281
Phone: (480) 921-8044 • FAX: (480) 921-0049

Lic. No. AZ0003

LABORATORY REPORT

Client: Manera, Inc.
8316 N. 53rd St.
Paradise Valley, AZ 85253

Date Submitted: 1/31/00
Date Reported: 03/09/00

Attn: Paul Manera

Sample Type: Drinking Water
Sample Time: 01/28/00 17:00

Client ID: BS2
ACT Lab No.: BG00950

RESULTS

Parameter	Analysis Date Start	End	Method No.	Result	Unit
Alkalinity	2/25/00	2/25/00	SM 2320	276.	mg/L as CaCO3
Chloride	2/25/00	2/25/00	325.3	140.	mg/L
Cyanide	2/7/00	2/7/00	SM4500CN CE	<0.01	mg/L
Fluoride	2/1/00	2/1/00	SM4500F C	3.5	mg/L
Silica	2/11/00	2/11/00	SM4500Si DE	6.21	mg/L as SiO2
Sulfate	2/28/00	2/28/00	375.4	212.	mg/L
Total Hardness	2/25/00	2/25/00	130.2	182.	mg/L as CaCO3
Antimony	2/11/00	2/11/00	200.9	<0.003	mg/L
Arsenic	2/11/00	2/11/00	200.9	<0.005	mg/L
Barium	2/8/00	2/8/00	200.7/6010	0.11	mg/L
Beryllium	2/3/00	2/3/00	200.7/6010B	<0.002	mg/L
Cadmium	2/3/00	2/3/00	200.7	<0.002	mg/L
Calcium	2/28/00	2/28/00	200.7	60.	mg/L
Chromium	2/3/00	2/3/00	200.7	<0.01	mg/L
Copper	2/7/00	2/7/00	200.7	<0.01	mg/L
Iron	2/28/00	2/28/00	200.7	0.17	mg/L
Lead	2/25/00	2/25/00	200.9	<0.005	mg/L
Magnesium	2/28/00	2/28/00	200.7	18.	mg/L
Manganese	2/7/00	2/7/00	200.7	0.05	mg/L
Mercury	2/9/00	2/9/00	245.1	<0.0002	mg/L
Nickel	2/3/00	2/3/00	200.7	<0.01	mg/L

Sample Type: Drinking Water
Sample Time: 01/28/00 17:00

Client ID: BS2
ACT Lab No.: BG00950

RESULTS

Parameter	Analysis Date Start	Analysis Date End	Method No.	Result	Unit
Selenium	2/10/00	2/10/00	200.9	<0.005	mg/L
Silver	3/1/00	3/1/00	200.9	<0.002	mg/L
Sodium	2/28/00	2/28/00	200.7	229.	mg/L
Thallium	2/3/00	2/3/00	200.9	<0.001	mg/L
Zinc	2/28/00	2/28/00	200.7	<0.01	mg/L
Total Dissolved Solids	2/25/00	2/25/00	160.1	811.	mg/L

Reviewed by: Frederick A. Amalfi
Frederick A. Amalfi, Ph.D.
Laboratory Director

bma

AQUAT'^ CONSULTING & TESTING, INC.
1525 W. ...versity Drive, Suite 106 • Tempe, AZ 85281
Phone: (480) 921-8044 • Fax: (480) 921-0049

CHAIN OF CUSTODY

PAGE____ OF ____

Client: Manera Inc.
Address: 8316 N 53RD ST
Street
Paradise Valley, AZ
City, State, Zip
Phone/Fax: 4809489818
Contact: Paul Manera
Sampler Signature: [signature]

Remarks: See attached * - w/ Silica

Sample ID	Date	Time		Metals* / TCLP	TDS / TSS / TS / SETT	O+G / TPHC / MBAS	BOD / COD	Tot. P / O-PO_4	Nitrate + Nitrite / Nitrate / Nitrite	TKN / Ammonia	VOC / THM's	ICC'S *			Tot. Coliform: P/A	Tot. Coliform: MPN	Fecal Coliform	Colilert (24hr)	Plate Count		Acute	Chronic	AWET (SWRO)	MPA		ACID	NONE	OTHER	Laboratory Number
BSS	1/28	17:00																											BG00980

Sample Receiving:
Intact: X Yes ____ No
Temp: 20°C
Preserved: 1 Yes 12 No
Total # containers: 3

1. Relinquished By: [signature]	2. Relinquished By:	3. Relinquished By:
Date/Time 31 JAN 00 17:05	Date/Time	Date/Time
1. Received By: [signature]	2. Received By:	3. Received By:
Date/Time 1-31-00 17:05	Date/Time	Date/Time

* Using the "Remarks:" area, please specify which metals are to be analyzed.

By signing this chain of custody, the designated client and agent agree to pay Aquatic Consulting & Testing, Inc. for all services rendered in conjunction with the submitted samples within 30 days of invoice. It is the client's responsibility to note purchase order numbers or other

White-Laboratory Yellow-Report Pink-Client

APPENDIX C

TEST HOLE 3

CAITHNESS BIG SANDY L.L.C.

TEST HOLE 3

SW1/4, SW1/4, SW1/4 of Section 5, T. 15 N., R. 12 W.

LITHOLOGIC LOG

February, 2000

Depth feet	Percent S & G	Average Size, in	Maximum Size, in	Description
0 - 55	85	1/8	½	Granitic sand and gravel with a few particles of volcanic materials
55 - 160	< 5	-	-	Greenish-tan clay
160 - 210	50	1/8	1/4	Transition, clay to sand and gravel
210 - 280	85	1/8	1/4	Volcanic layers, various colors ranging from greenish gray to gray black
280 - 340	85	1/8	1/4	Scoreaceous volcanics, gray black with copper (malachite) deposits on the particles
340 - 370	-	-	-	Dense brown clay
370 - 390	65	1/8	1/4	Brown volcanic materials
390 - 440	85	1/8	1/4	Gray-black volcanics
440 - 500	80	1/8	1/4	Light gray volcanics
500 - 520	80	1/8	1/4	Pink volcanics
520 - 550	80	1/8	1/4	Light gray volcanics
550 - 600	80	1/8	1/4	Greenish white volcanics
600 - 630	80	1/8	1/4	Brown volcanics
630 - 650	80	1/8	1/4	Gray green volcanics
650 - 710	80	1/8	1/4	White to purple volcanics
710 - 780	80	1/8	1/4	Red to red-purple volcanics

Static Water Level = 20 + or - feet

Note:

The materials from 210 feet to the total depth of 780 feet consisted of a volcanic series which varied in color from almost white through pink, gray green, gray, brown, black.

The size and maximum size is probably the result of the bit rather than the materials being sand and gravel and the percent sand and gravel reflects the volume cut that was not pulverized.

LOG BY MANERA, INC.

AQUATIC CONSULTING & TESTING, INC.

1525 W. University Drive, Suite 106
P.O. Box 1510
Tempe, Arizona 85281
Phone: (480) 921-8044 • FAX: (480) 921-0049

Lic. No. AZ0003

LABORATORY REPORT

Client: Manera, Inc.
8316 N. 53rd St.
Paradise Valley, AZ 85253

Date Submitted: 2/11/00
Date Reported: 03/03/00

Attn: Paul Manera

Sample Type: Aqueous
Sample Time: 02/10/00 17:00

Client ID: B(15-12) 5ccc
ACT Lab No.: BG01481

RESULTS

Parameter	Analysis Date Start	End	Method No.	Result	Unit
Alkalinity	2/18/00	2/18/00	SM 2320	265.	mg/L as CaCO3
Cyanide	2/22/00	2/22/00	SM4500CN CE	<0.01	mg/L
Fluoride	2/17/00	2/17/00	SM4500F C	4.0	mg/L
Langelier Index	2/15/00	2/15/00	SM2330 D	See Attached *	
Nitrate + Nitrite - N	2/16/00	2/16/00	SM4500NO3 E	1.43	mg/L as N
Nitrite - N	2/11/00	2/11/00	SM4500NO2 B	<0.01	mg/L as N
Silica	2/11/00	2/11/00	SM4500Si DE	5.97	mg/L as SiO2
Sulfate	2/28/00	2/28/00	375.4	208.	mg/L
Total Hardness	2/16/00	2/16/00	130.2	182.	mg/L as CaCO3
Antimony	2/17/00	2/17/00	200.9	<0.003	mg/L
Arsenic	2/16/00	2/16/00	200.9	0.048	mg/L
Barium	2/18/00	2/18/00	200.7/6010	0.04	mg/L
Beryllium	2/18/00	2/18/00	200.7/6010B	<0.002	mg/L
Cadmium	2/18/00	2/18/00	200.7	<0.002	mg/L
Calcium	2/18/00	2/18/00	200.7	42.	mg/L
Chromium	2/18/00	2/18/00	200.7	<0.01	mg/L
Copper	2/18/00	2/18/00	200.7	<0.01	mg/L
Lead	2/15/00	2/15/00	200.9	<0.005	mg/L
Magnesium	2/18/00	2/18/00	200.7	16.	mg/L
Mercury	2/25/00	2/25/00	245.1	<0.0002	mg/L
Nickel	2/18/00	2/18/00	200.7	<0.01	mg/L

Sample Type: Aqueous
Sample Time: 02/10/00 17:00

Client ID: B(15-12) 5ccc
ACT Lab No.: BG01481

RESULTS

Parameter	Analysis Date Start	Analysis Date End	Method No.	Result	Unit
Selenium	2/16/00	2/16/00	200.9	<0.005	mg/L
Sodium	2/23/00	2/23/00	200.7	234.	mg/L
Thallium	2/18/00	2/18/00	200.9	<0.001	mg/L
pH	2/11/00	2/11/00	150.1	8.3	SU
Total Dissolved Solids	2/15/00	2/15/00	160.1	770.	mg/L

Reviewed by: Frederick A. Amalfi

Frederick A. Amalfi, Ph.D.
Laboratory Director

bma

Sample Calculation

Langelier Index

Measured Characteristics of the water	
Sample ID	BG01481
Calcium (mg/L)	42
pH	8.3
Temperature (C)	20
Alkalinity (mg/L as CaCO3)	265
TDS (mg/L)	770
Calculated Langelier Index	
Langelier Index	0.630
[If the Index is Negative, the water may be corrosive]	
Saturation Index	7.670
Ryzner (stability) Index	7.040
(>6.0 = corossive; <6.0 = Scale forming)	
Calculated Data	
Ionic Strength	0.019
Activity Coeff (m)	0.869
Activity Coeff (d)	0.571
Ca (moles/L)	0.00105
Alkalinity (moles/L)	0.00265
pK2	10.378
K2	4.19E-11
K2'	7.33E-11
pK2'	10.135
pKs	8.267
Ks	5.41E-09
Ks'	1.66E-08
pKs'	7.780
pCa	2.979
pHs	7.670

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1525 W. [illegible]ersity Drive, Suite 106 • Tempe, AZ 85281
Phone: (480) 921-8044 • Fax: (480) 921-0049

CHAIN OF CUSTODY

Client: Manera Inc
Address: 8316 N 53rd St
Street
Paradise Valley 85253
City, State, Zip
Phone/Fax: 4809489818
Contact: Paul A. Manera
Sampler Signature: Paul A Manera

Remarks: See attached *

Sample	Date	Time	Type	Metals* / TCLP	TDS / TSS / TS / SETT	O+G / TPHC / MBAS	BOD / COD	Tot. P / O-PO$_4$	Nitrate + Nitrite / Nitrate / Nitrite	TKN / Ammonia	VOC / THM's	IOC's + Silica		Tot. Coliform: P/A	Tot. Coliform: MPN	Fecal Coliform	Colilert (24hr)	Plate Count		Acute	Chronic	AWET (SWRO)	MPA	ACID	NONE	OTHER	Laboratory Number
B(15-12) 5ccc	2/10	1700	G																								BG01481

Sample Receiving:
Intact: X Yes ____ No
Temp: 14°C
Preserved: ____ Yes 1 No
Total # containers: 1

1. Relinquished By: Paul A Manera	2. Relinquished By:	3. Relinquished By:
Date/Time Feb 11-00 1330	Date/Time	Date/Time
1. Received By: [illegible signature]	2. Received By:	3. Received By:
Date/Time 2-11-00 1330	Date/Time	Date/Time

*** Using the "Remarks:" area, please specify which metals are to be analyzed.**

By signing this chain of custody, the designated client and agent agree to pay Aquatic Consulting & Testing, Inc. for all services rendered in conjunction with the submitted samples within 30 days of invoice. It is the client's responsibility to note purchase order numbers or other responsib[illegible] [illegible]

White-Laboratory Yellow-Report Pink-Client

APPENDIX D

TEST HOLE 4

CAITHNESS BIG SANDY L.L.C.

TEST HOLE 4

SE1/4, SE1/4, NW1/4 of Section 7, T. 15 N., R. 12 W.

LITHOLOGIC LOG

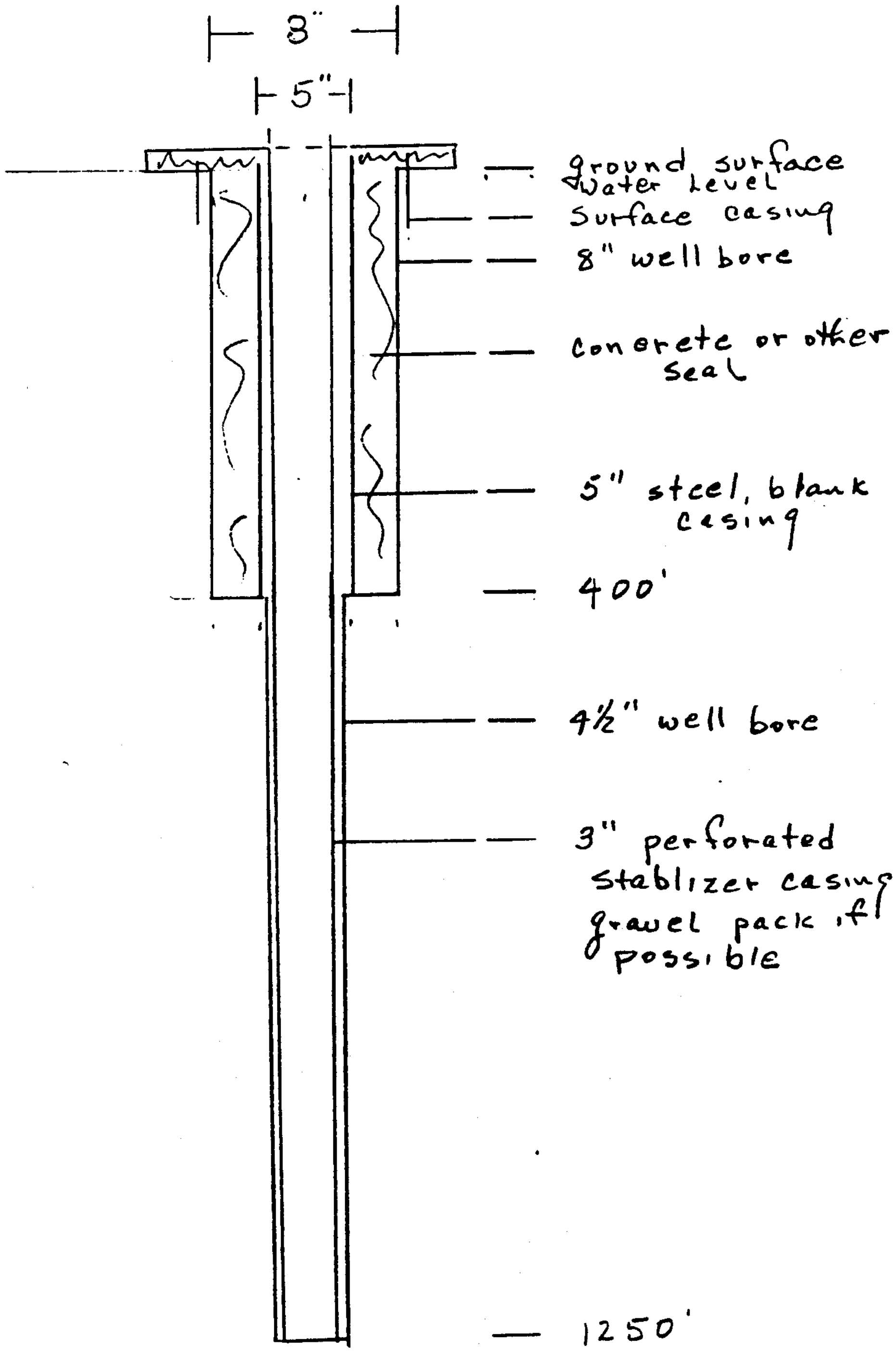
March, 2000

Depth feet	Percent S & G	Average Size, in	Maximum Size, in	Description
0 - 100	85	1/8	½	Granitic sand and gravel
100 - 120	50	1/8	1/4	Transition, sand to clay
120 - 260	< 5	-	-	Greenish-tan clay
260 - 300	50	1/8	1/4	Transition, clay to sand and gravel
300 - 415	80	1/8	1/8	Volcanic ash
415 - 420	-	-	-	Basalt layer
420 - 570	80	1/16	1/8	Volcanic sand and gravel, large amount of quartz
570 - 600	80	1/16	1/4	Granitic sand and gravel
600 - 650	80	1/16	1/4	Reddish-brown igneous intrusive sand and gravel
650 - 720	80	1/16	3/4	Volcanic sands and gravels or fractured rocks, with deposition of copper minerals
720 - 890	80	1/16	½	Gabbro type igneous intrusive sand and gravels, large percentage of dark minerals.
890 - 930	80	1/16	3/8	Pink granitic sand and gravel
930 - 1,060	80	1/16	3/8	Sand and gravel composed of a mixture of intrusive and extrusive rocks, color brownish red
1,060 - 1,120	-	-	-	Basalt flow
1,120 - 1,190	80	1/16	1/4	Reddish black igneous intrusive sand and gravel
1,190 - 1,200	-	-	-	Basalt flow

LOG BY MANERA, INC.

APPENDIX E

PIEZOMETRIC WELL DESIGN

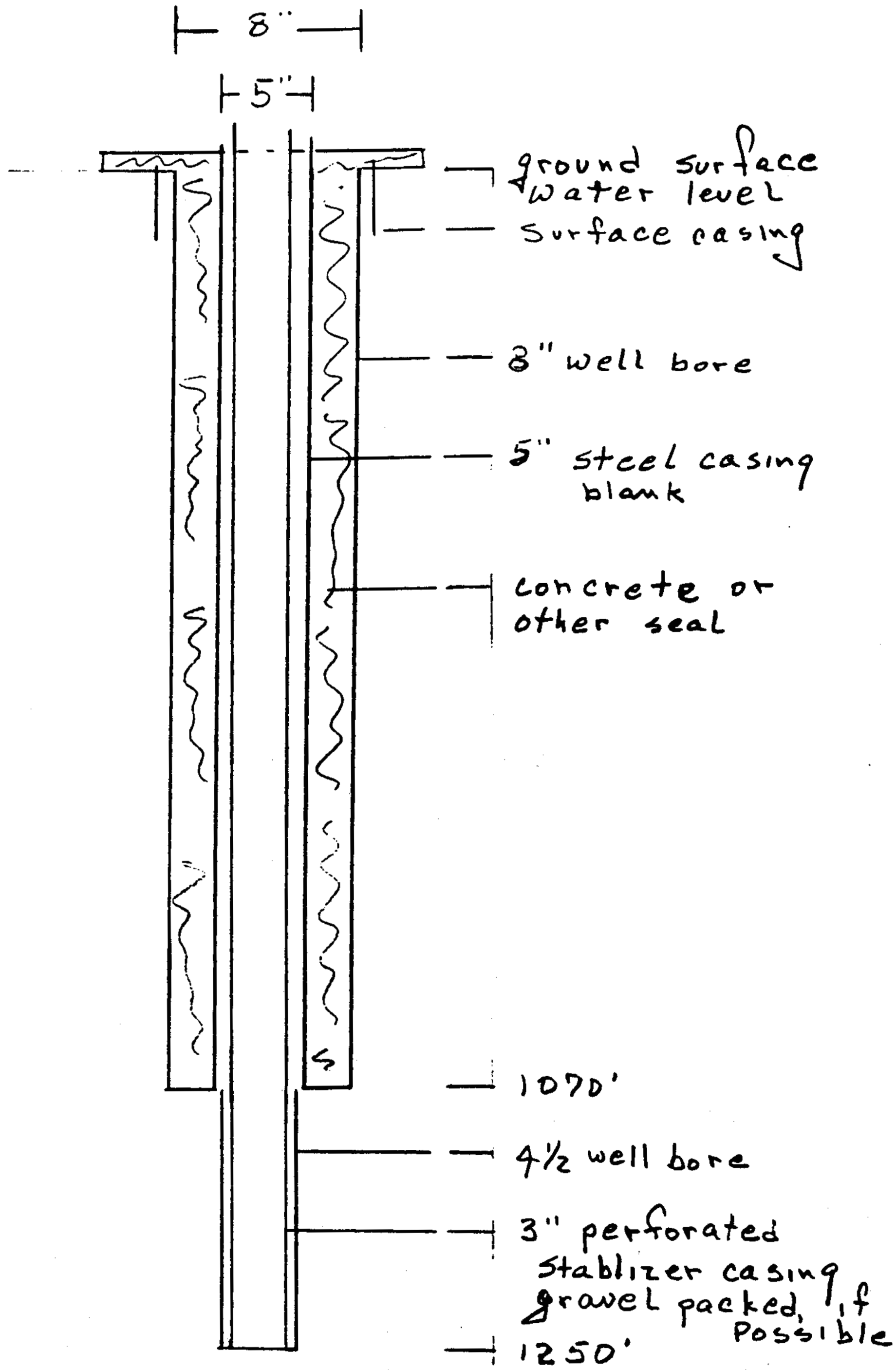


SCHEMATIC DESIGN

MONITORING WELLS AT WIKIEUP

WELL AT TEST SITE 2

Northwest corner of Section 7, T. 15 N., R. 12 W.

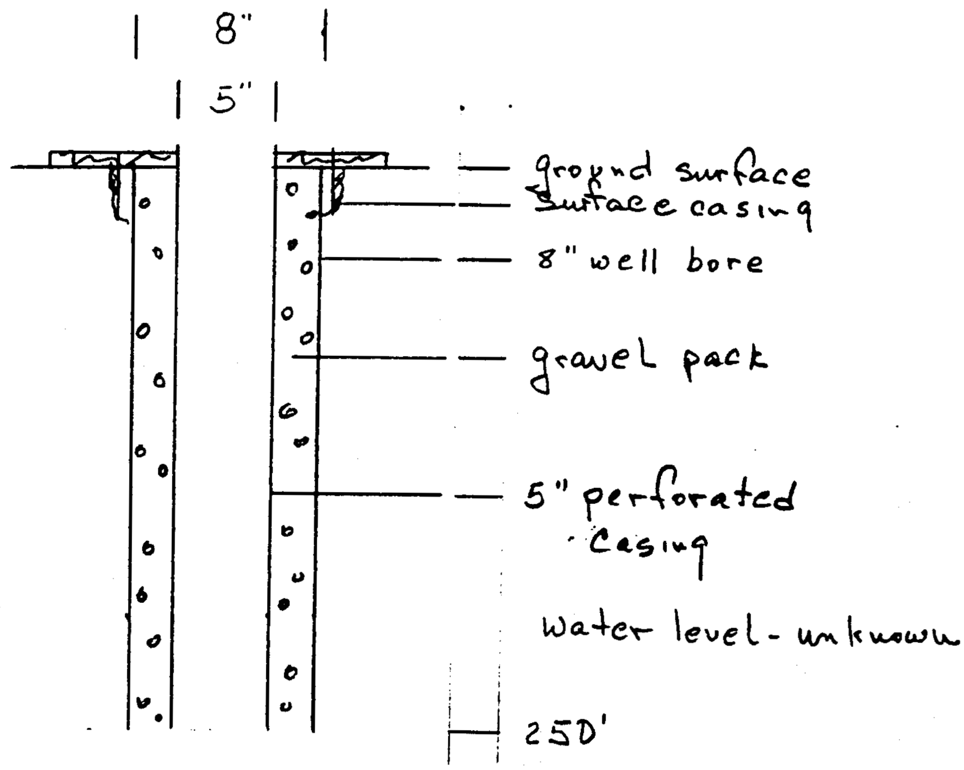


SCHEMATIC DESIGN

MONITORING WELLS AT WIKIEUP

WELL AT TEST SITE 4

Center of Section 7, T. 15 N., R. 12 W.



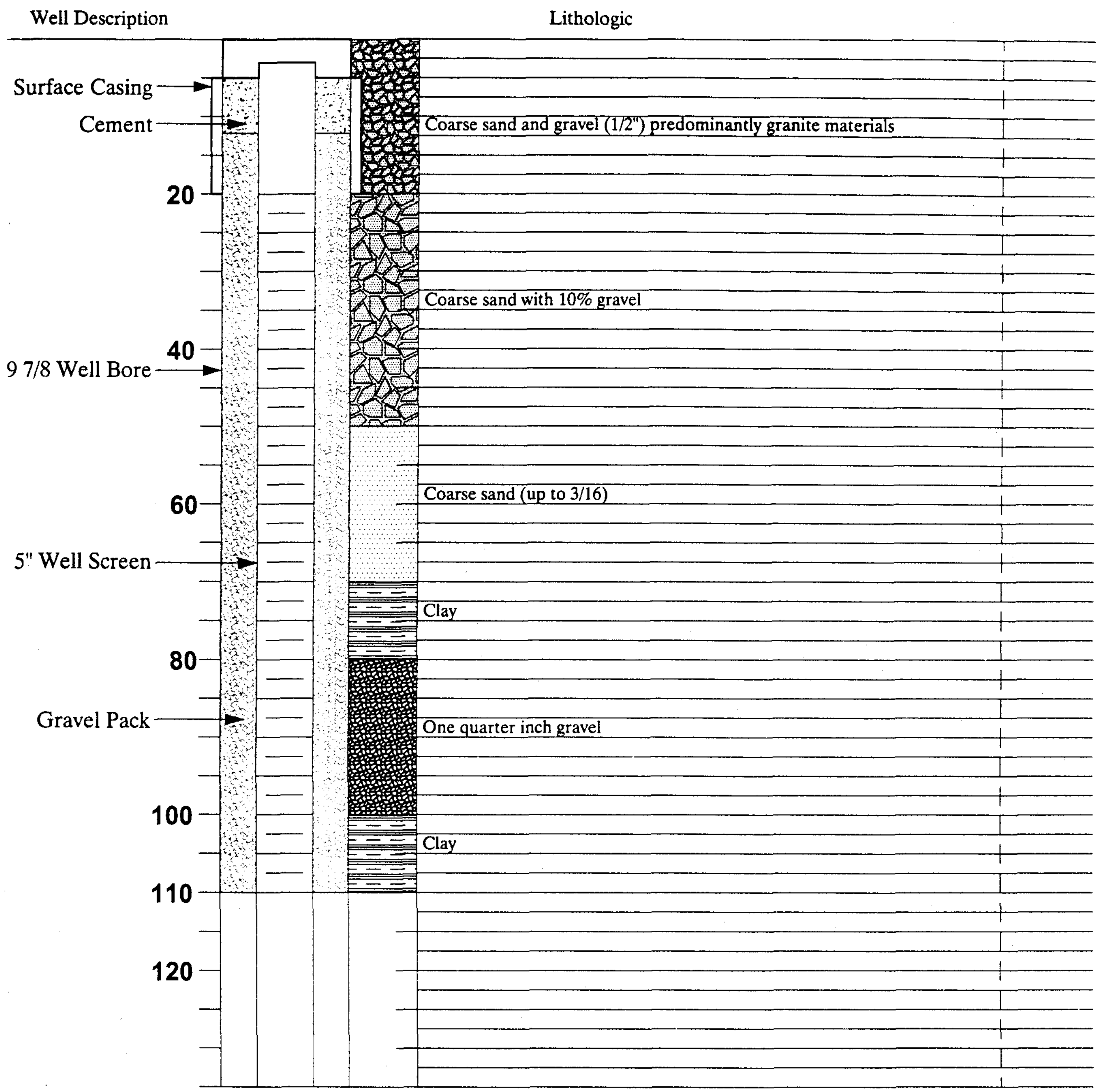
SCHEMATIC DESIGN

MONITORING WELLS AT WIKIEUP

General Design of Shallow Wells

Sites to be Determined

APPENDIX E
LITHOLOGIC LOGS AND WELL CONSTRUCTION DIAGRAMS



BIG SANDY ENERGY PROJECT	
OSB WELL SITE 1 LITHOLOGIC AND WELL COMPLETION LOG	
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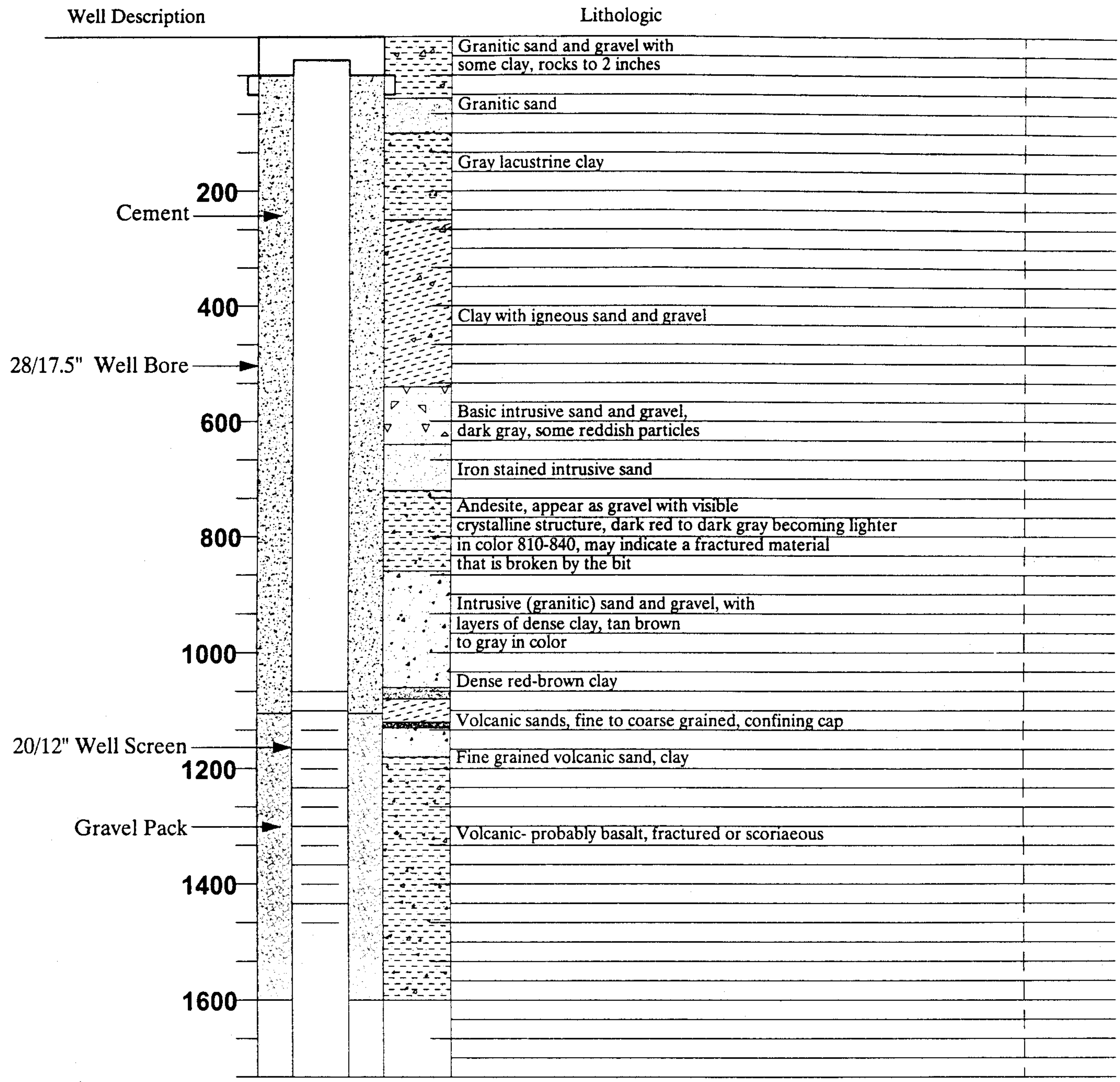
SCALE: AS NOTED	DRAWN BY: EC

891_obs-1.dwg

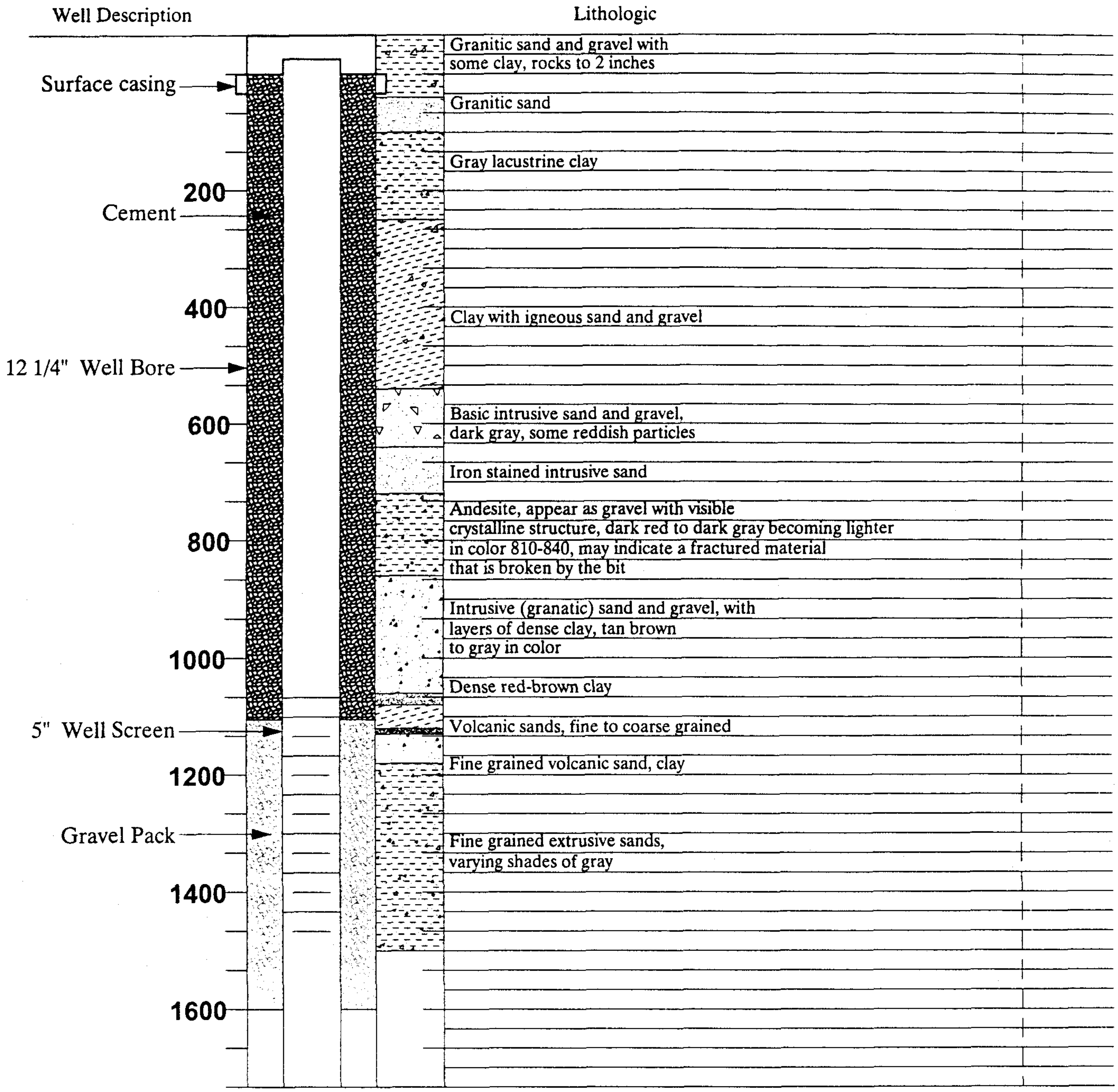


BIG SANDY ENERGY PROJECT

PROD. WELL SITE 2
LITHOLOGIC AND WELL COMPLETION LOG

DATE: 10/13/00	AutoCAD File:891_prod-2.dwg
SCALE: AS NOTED	DRAWN BY: MM

891_prod-2.dwg
10/11/00



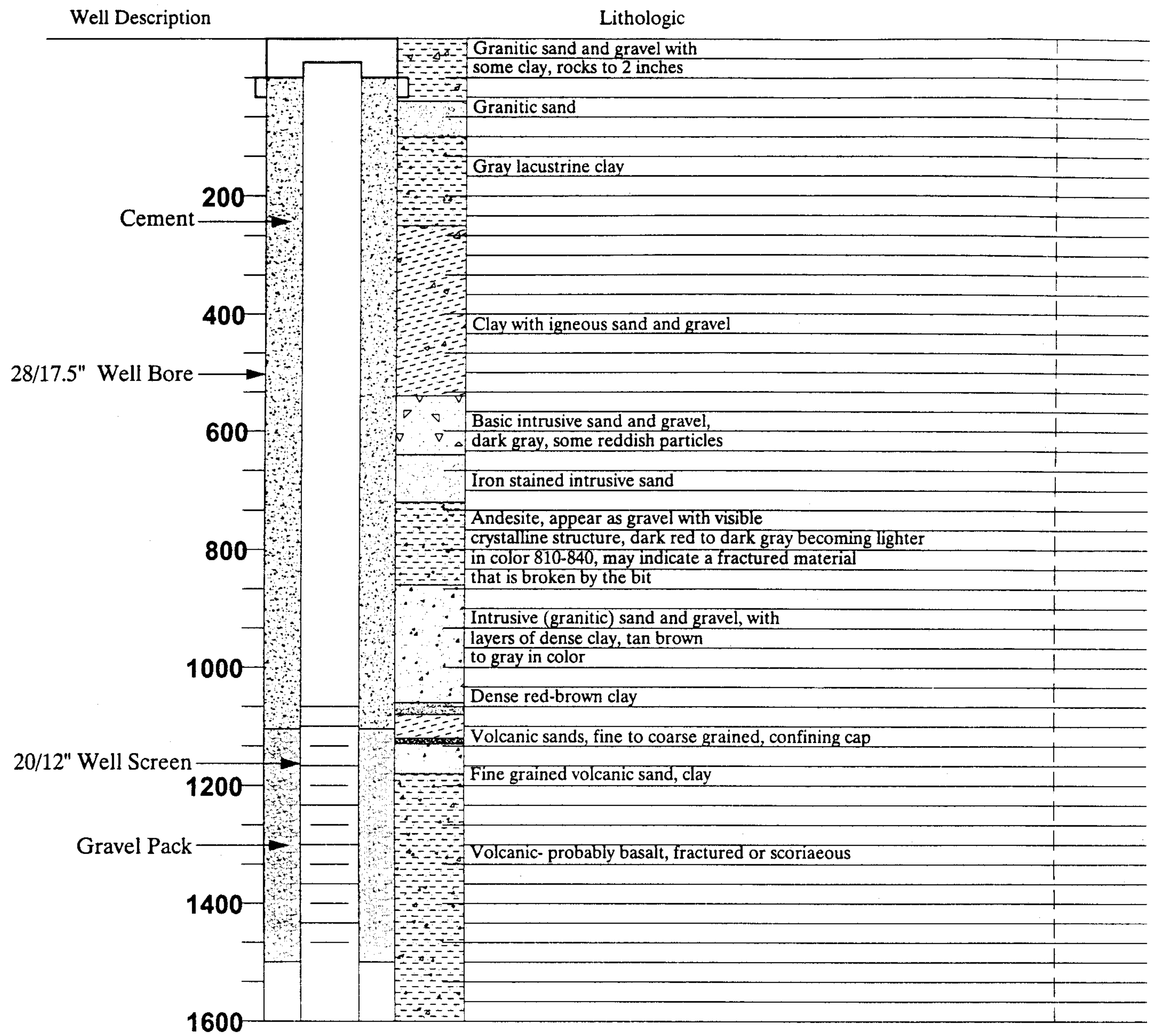
BIG SANDY ENERGY PROJECT

OBS WELL OWC SITE 2
LITHOLOGIC AND WELL COMPLETION LOG

DATE: 10/13/00	AutoCAD File:891_owc-2.dwg
SCALE: AS NOTED	DRAWN BY: MM

MANERA INC.

891_owc-2.dwg
10/11/00



BIG SANDY ENERGY PROJECT

OSB WELL OWMA SITE 2
MIDDLE AQUIFER
LITHOLOGIC AND WELL COMPLETION LOG

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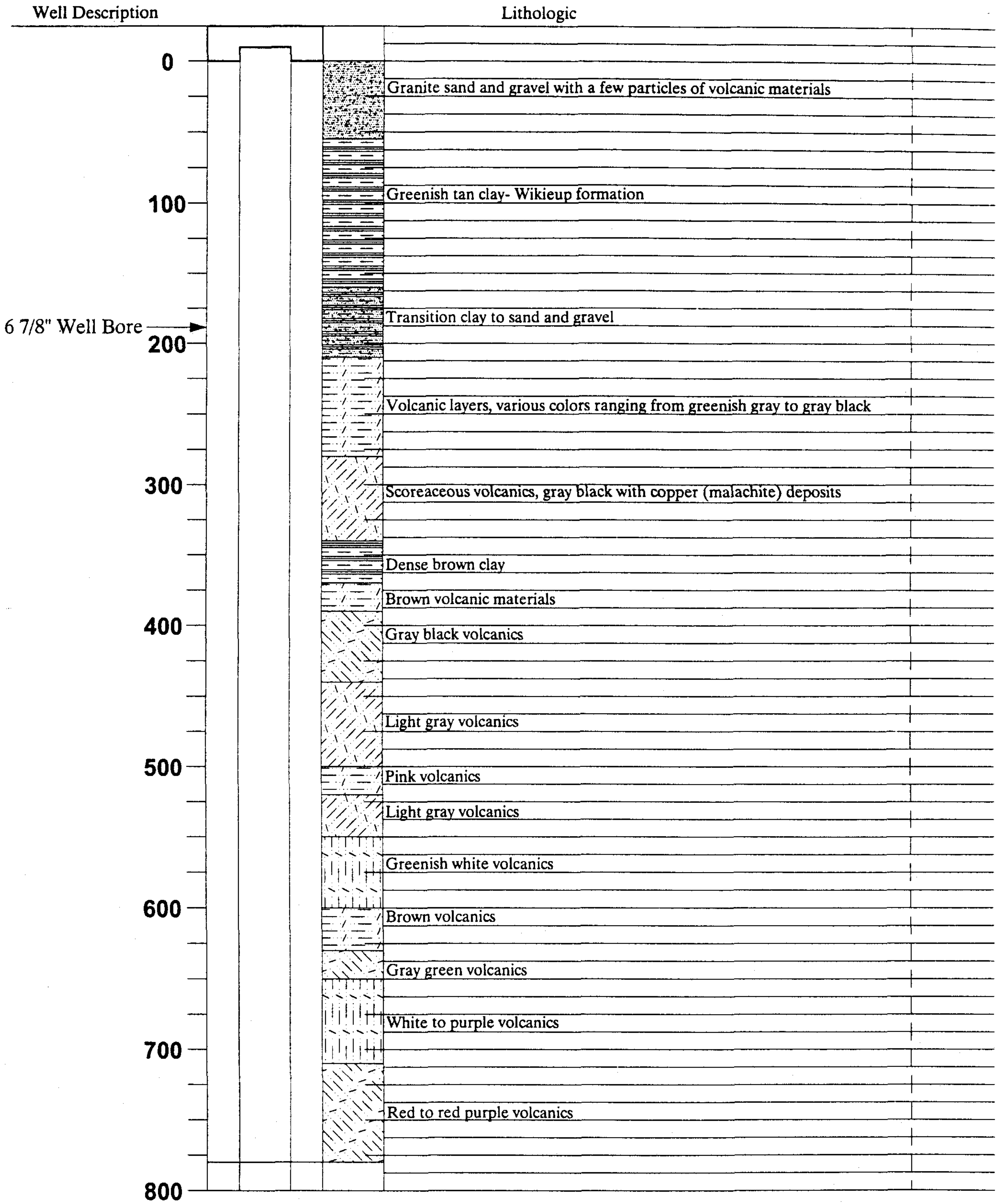
SCALE: AS NOTED	DRAWN BY: MM

891_prod-2.dwg
10/11/00



MAKERA INC.

BIG SANDY ENERGY PROJECT

TESTHOLE #3
LITHOLOGIC AND WELL COMPLETION LOG

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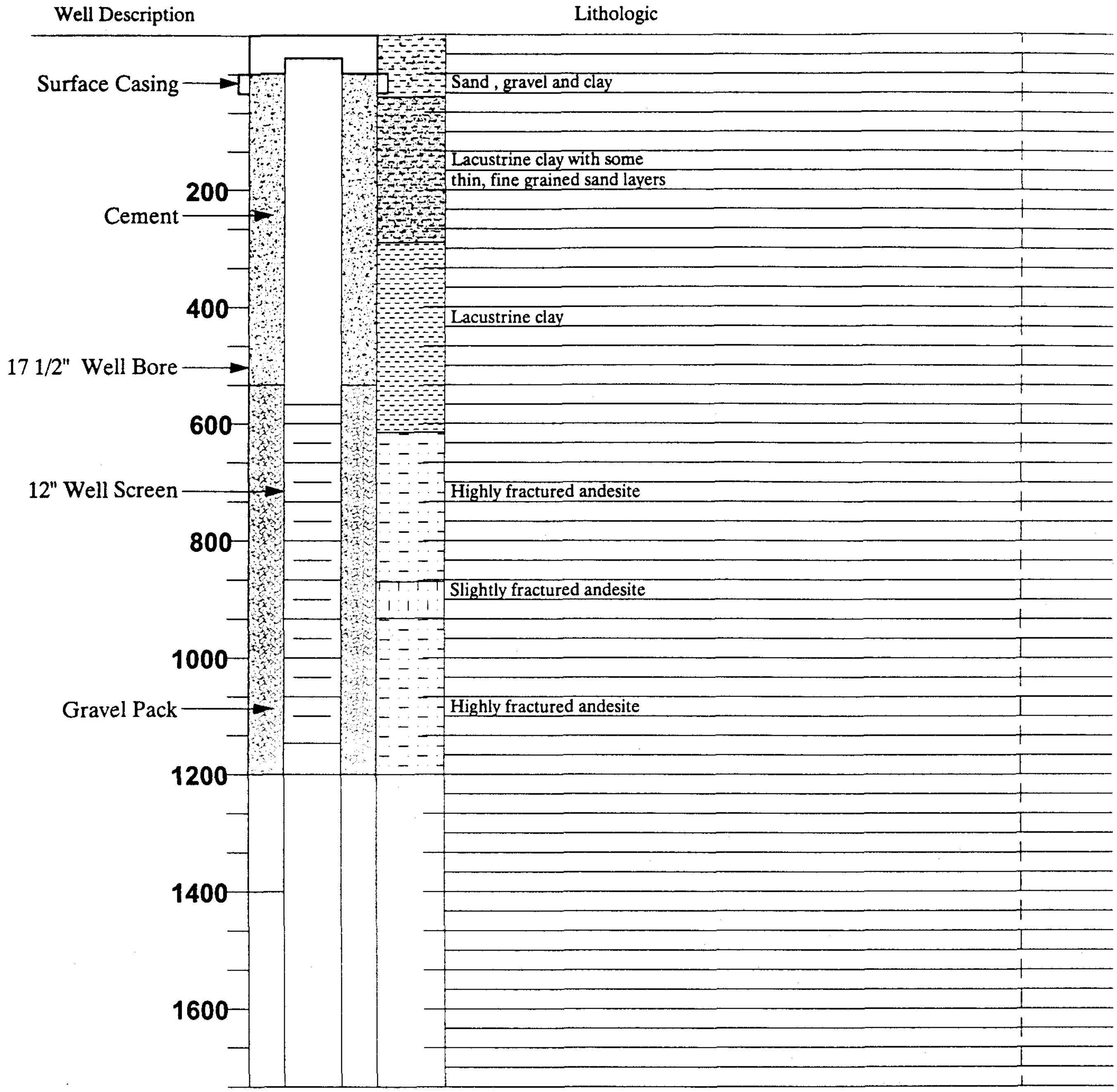
SCALE: AS NOTED	DRAWN BY: EC

891_test-hole-3.dwg



MANERA INC.

BIG SANDY ENERGY PROJECT

OBS WELL SITE 3
LITHOLOGIC AND WELL COMPLETION LOG

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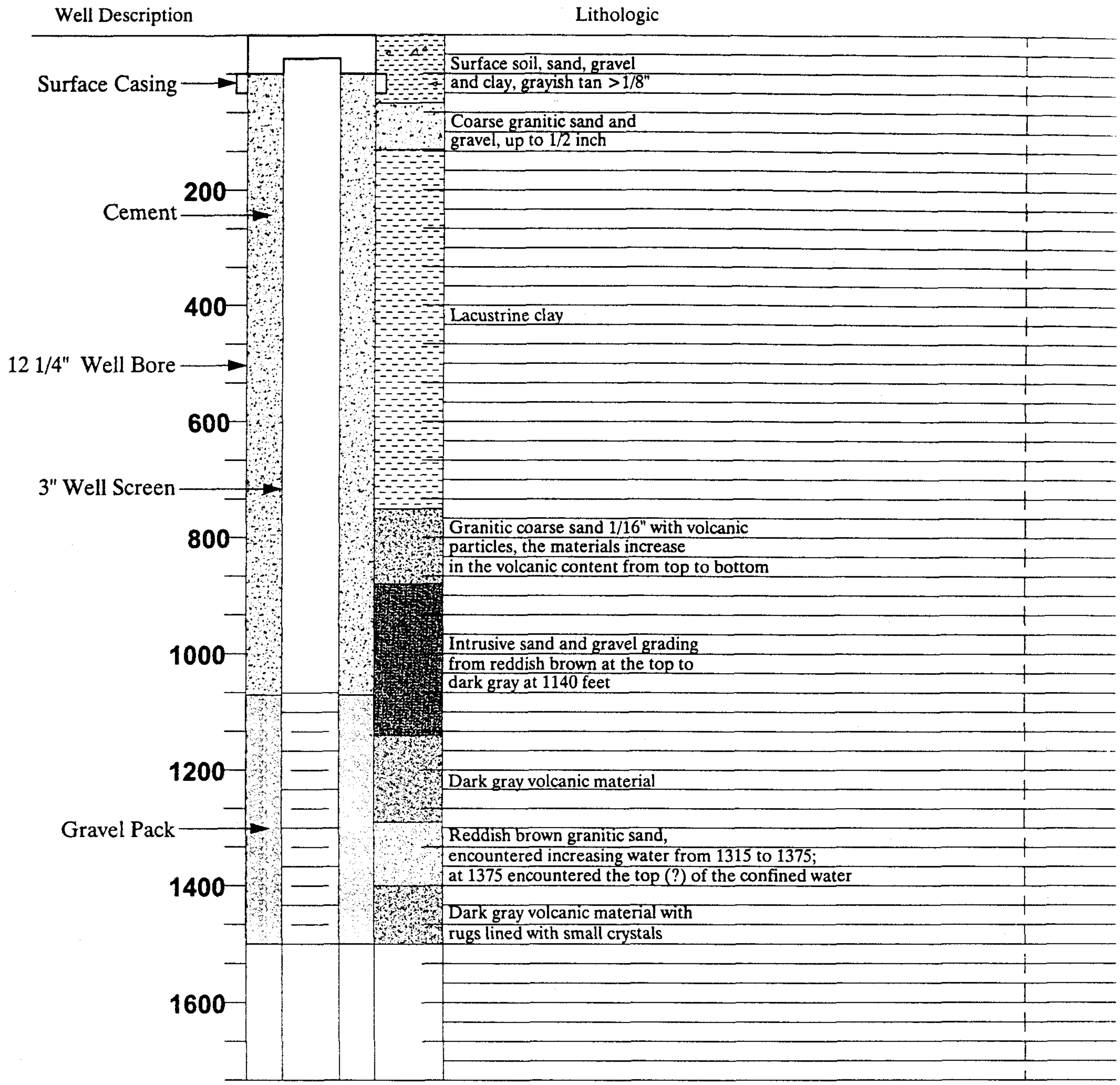
891_obs-3.dwg



BIG SANDY ENERGY PROJECT

OBS WELL SITE 4
LITHOLOGIC AND WELL COMPLETION LOG

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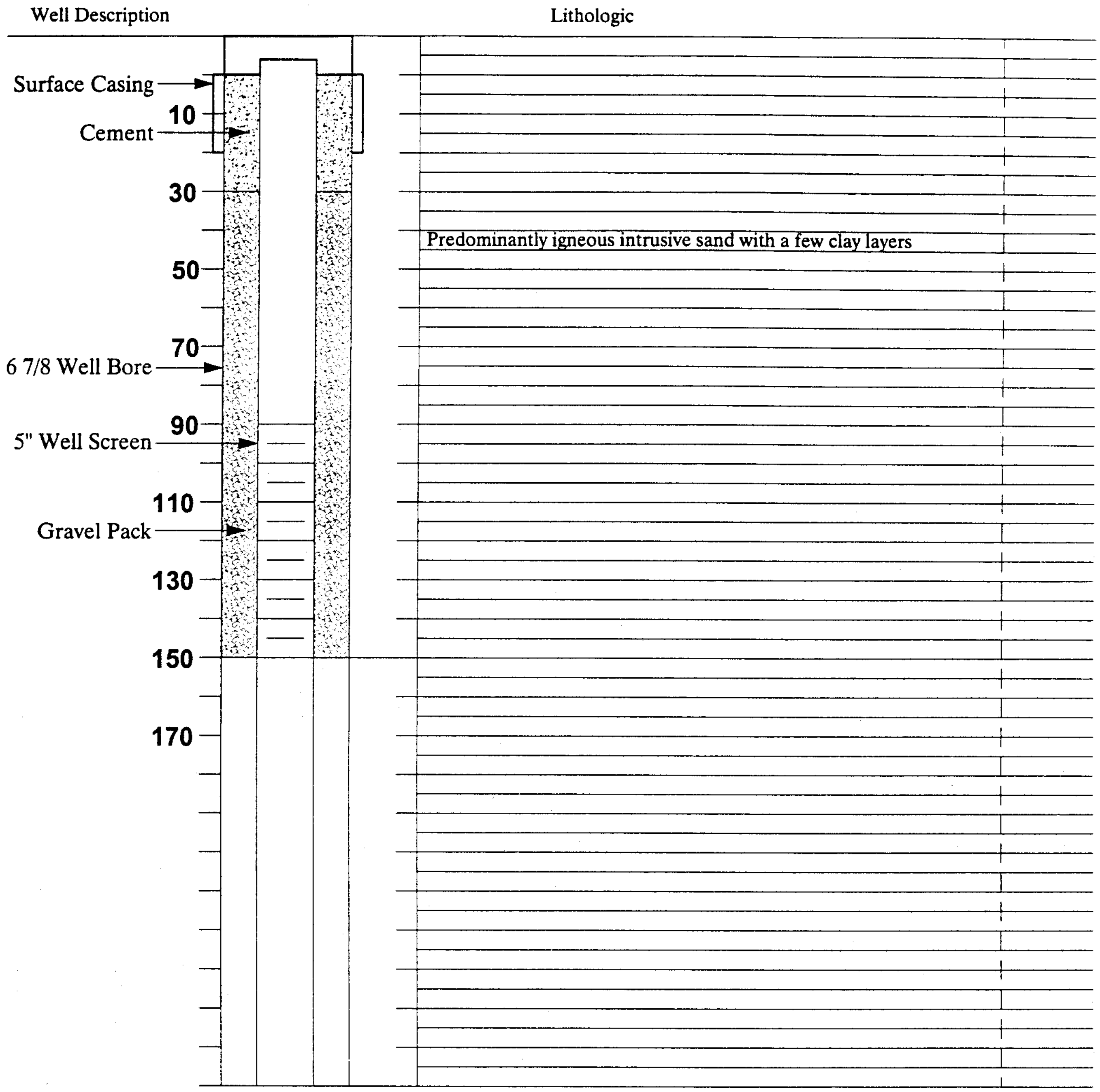
SCALE: AS NOTED	DRAWN BY: MM

891_obs-4.dwg
10/11/00



BIG SANDY ENERGY PROJECT

OBS WELL SITE 8
LITHOLOGIC AND WELL COMPLETION LOG

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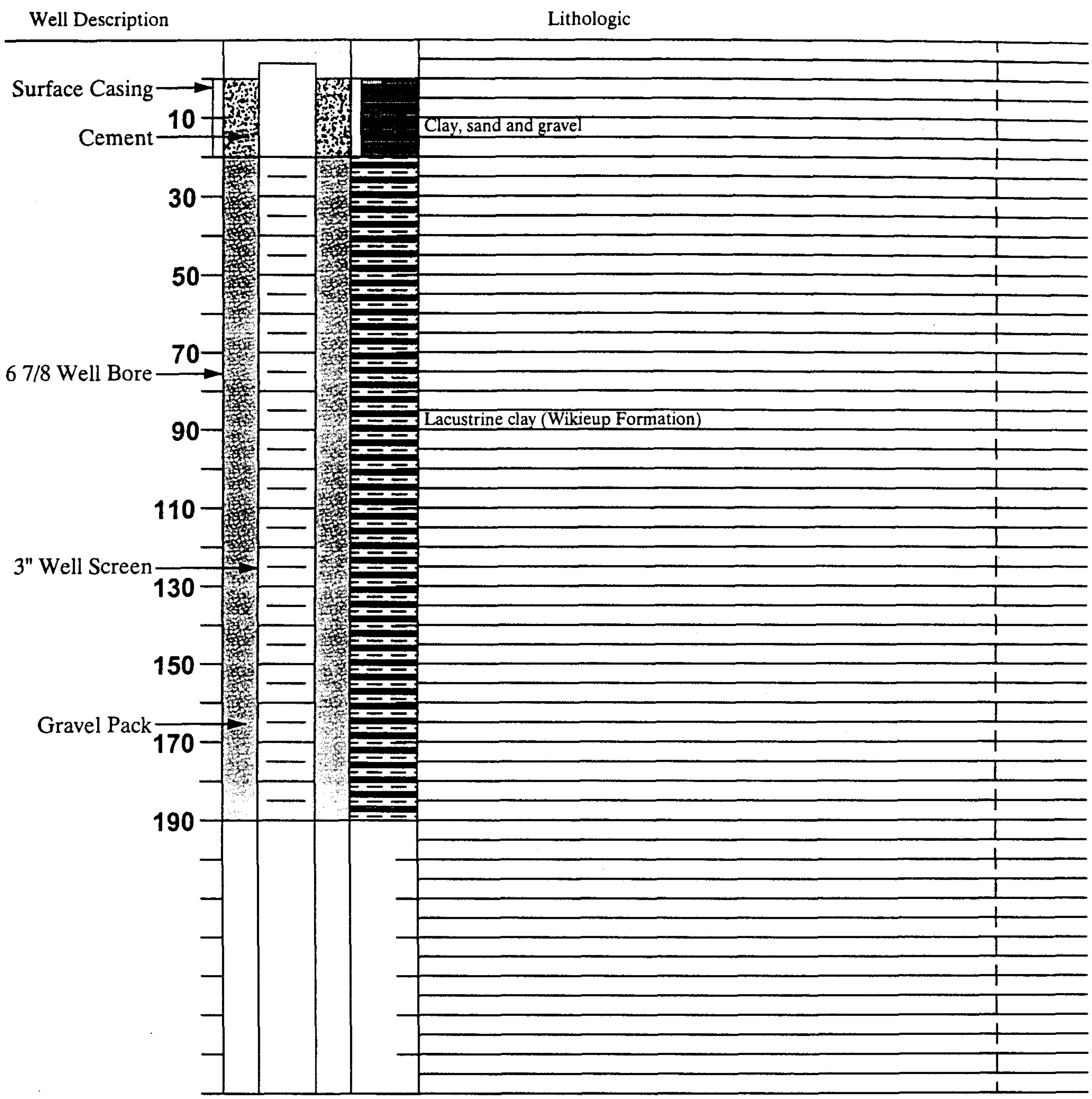


BIG SANDY ENERGY PROJECT

OBS WELL SITE 7
LITHOLOGIG AND WELL COMPLETION

DATE: 10/13/00	AutoCAD File:891_ob7.dwg
SCALE: AS NOTED	DRAWN BY: EC

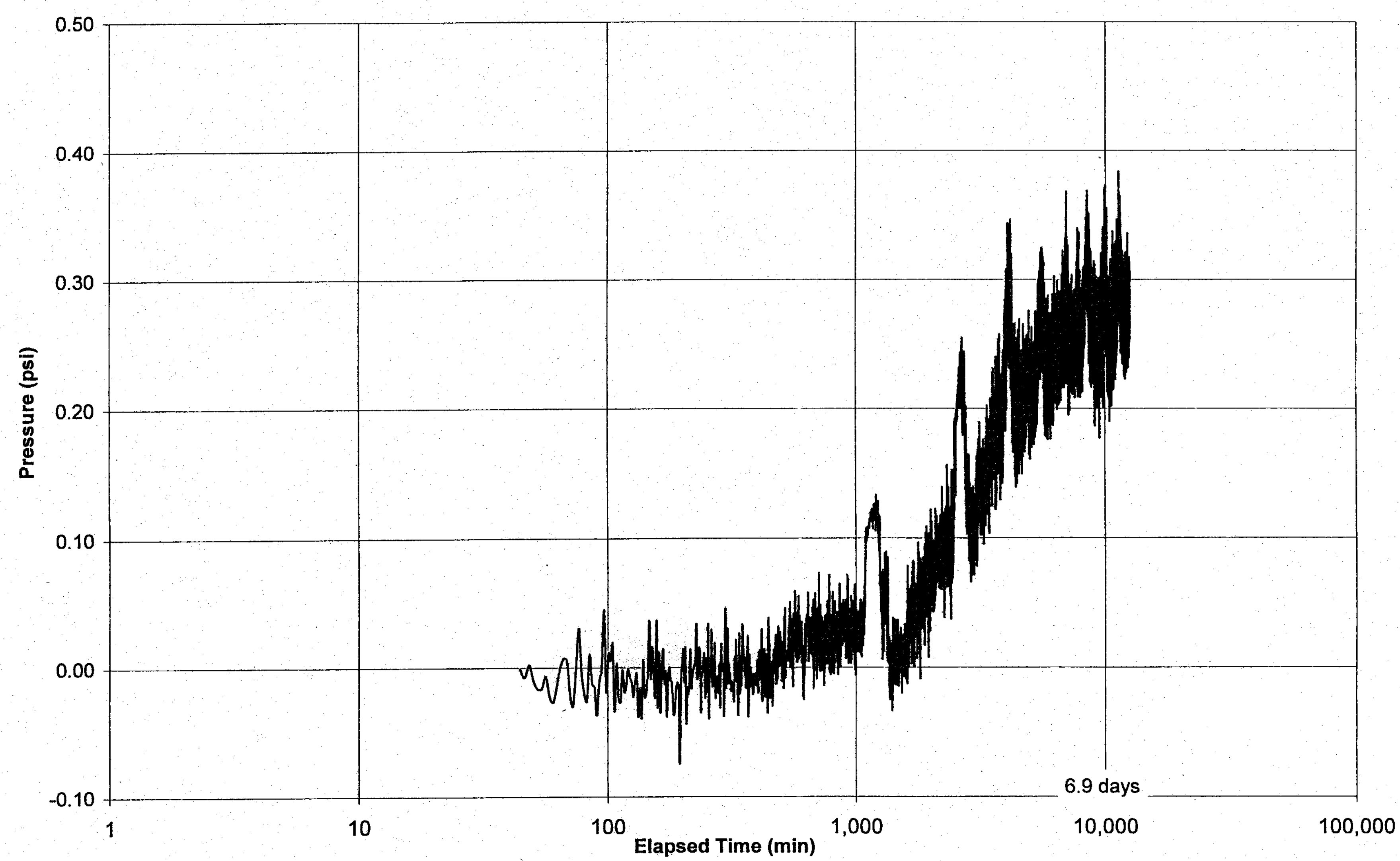
MANERA INC.

891_obs-7.dwg

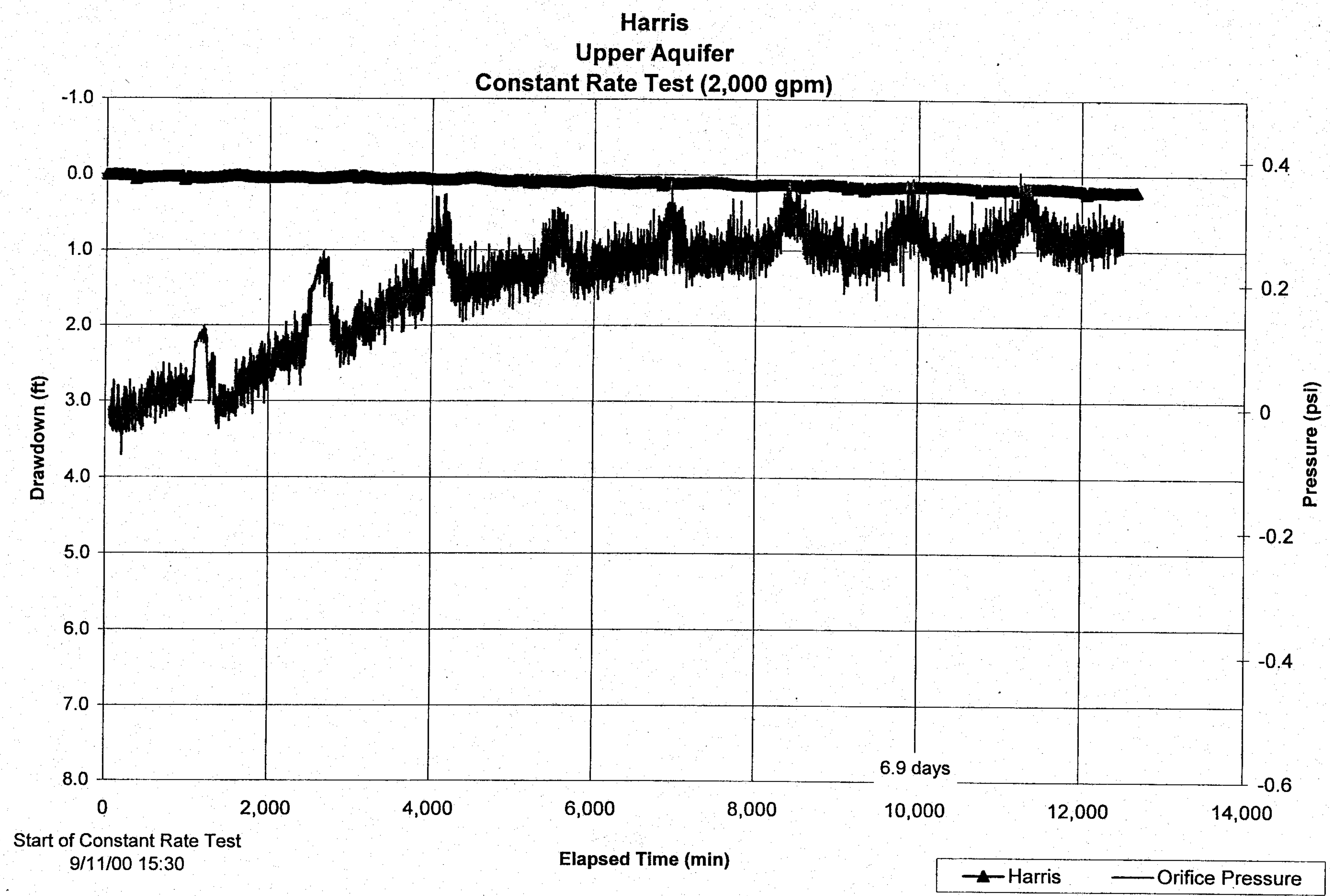
APPENDIX F
WELL HYDROGRAPHS

Big Sandy Aquifer Test
Constant Rate Test
Start Time : 9-11-00 15:30

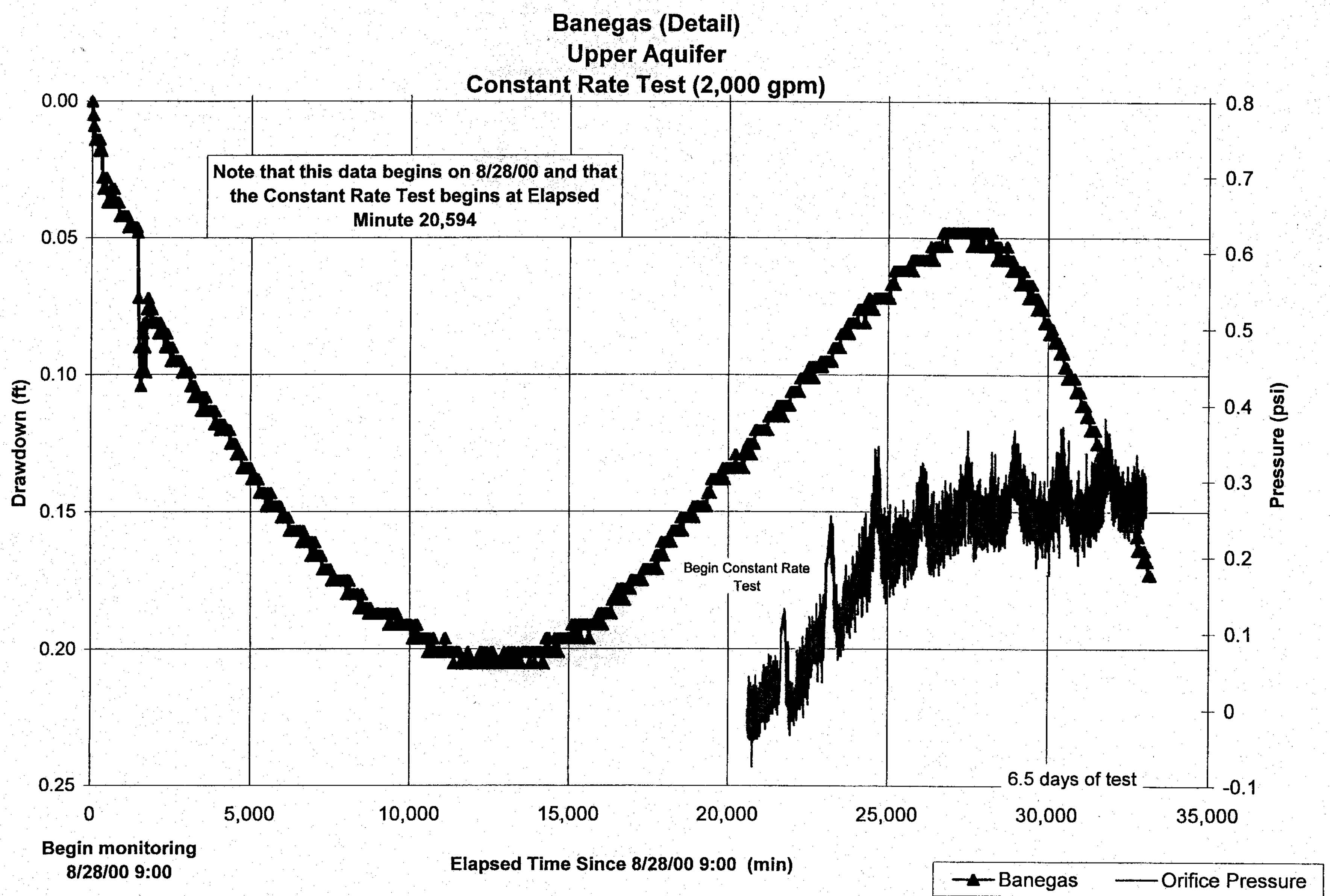
PW2 Orifice Pressure
Constant Rate Test (2,000 gpm)



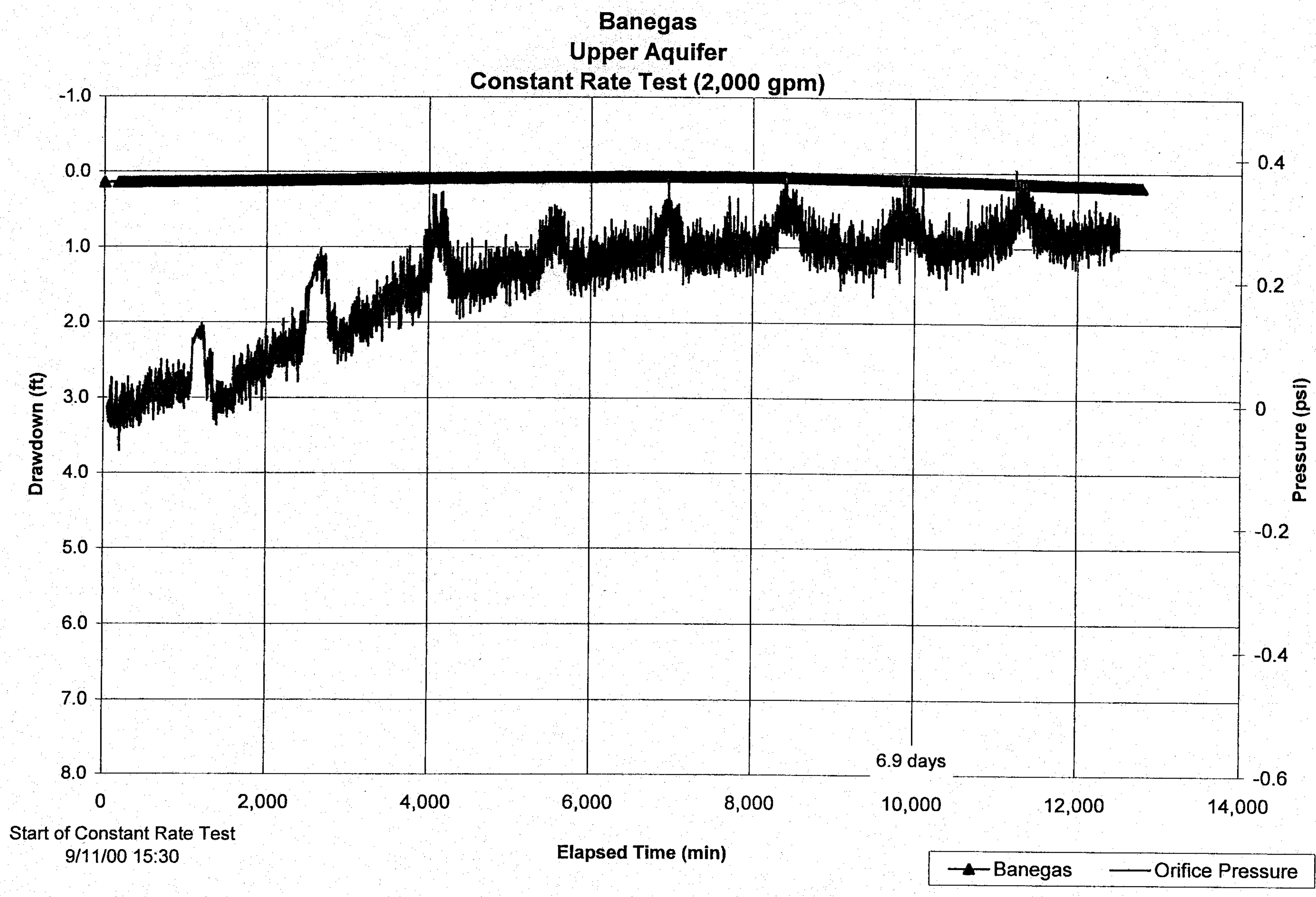
Big Sandy Aquifer Test
Constant Rate Test
Start Time : 9-11-00 15:30



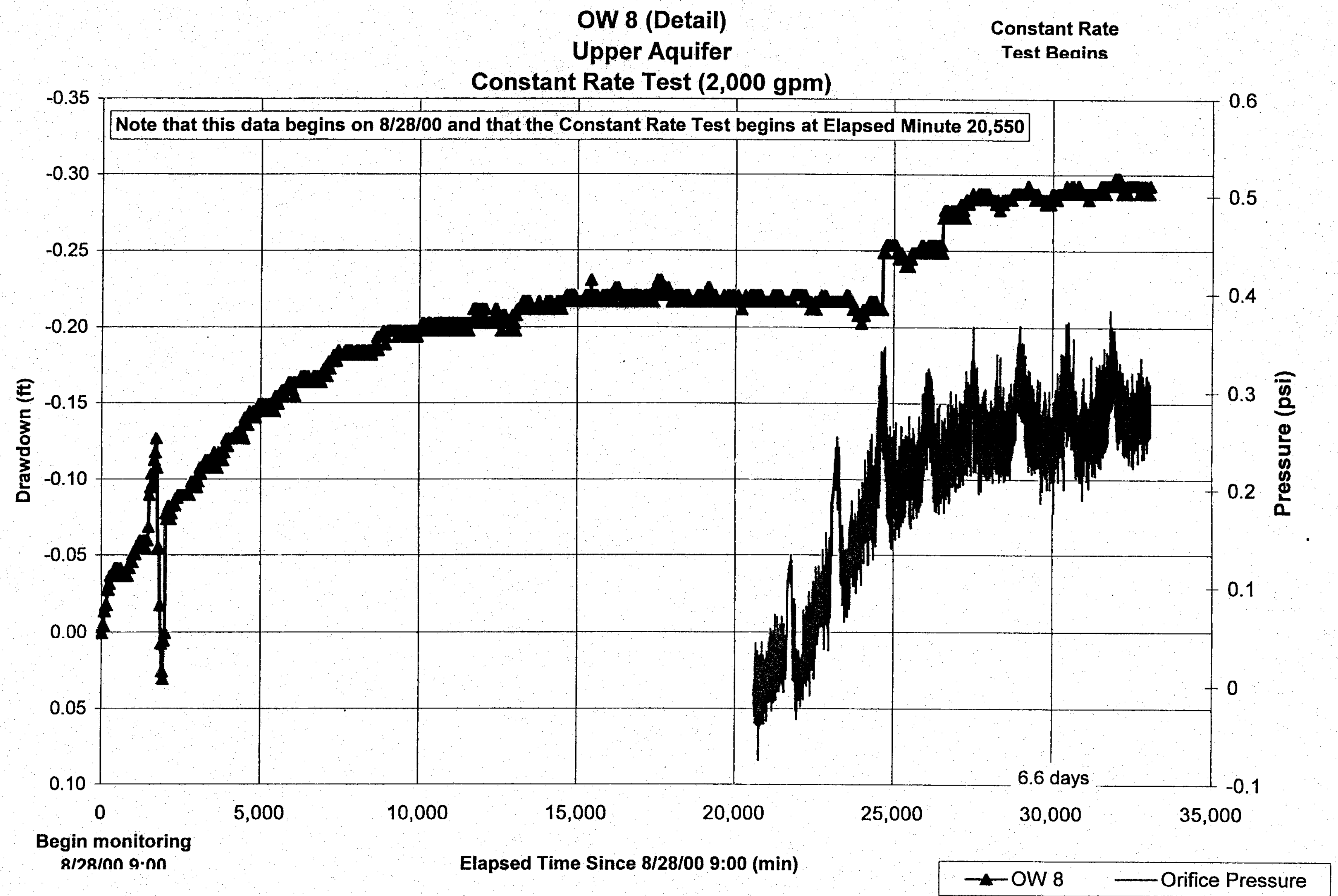
Big Sandy Aquifer Test
Constant Rate Test
Start Time : 9-11-00 15:30



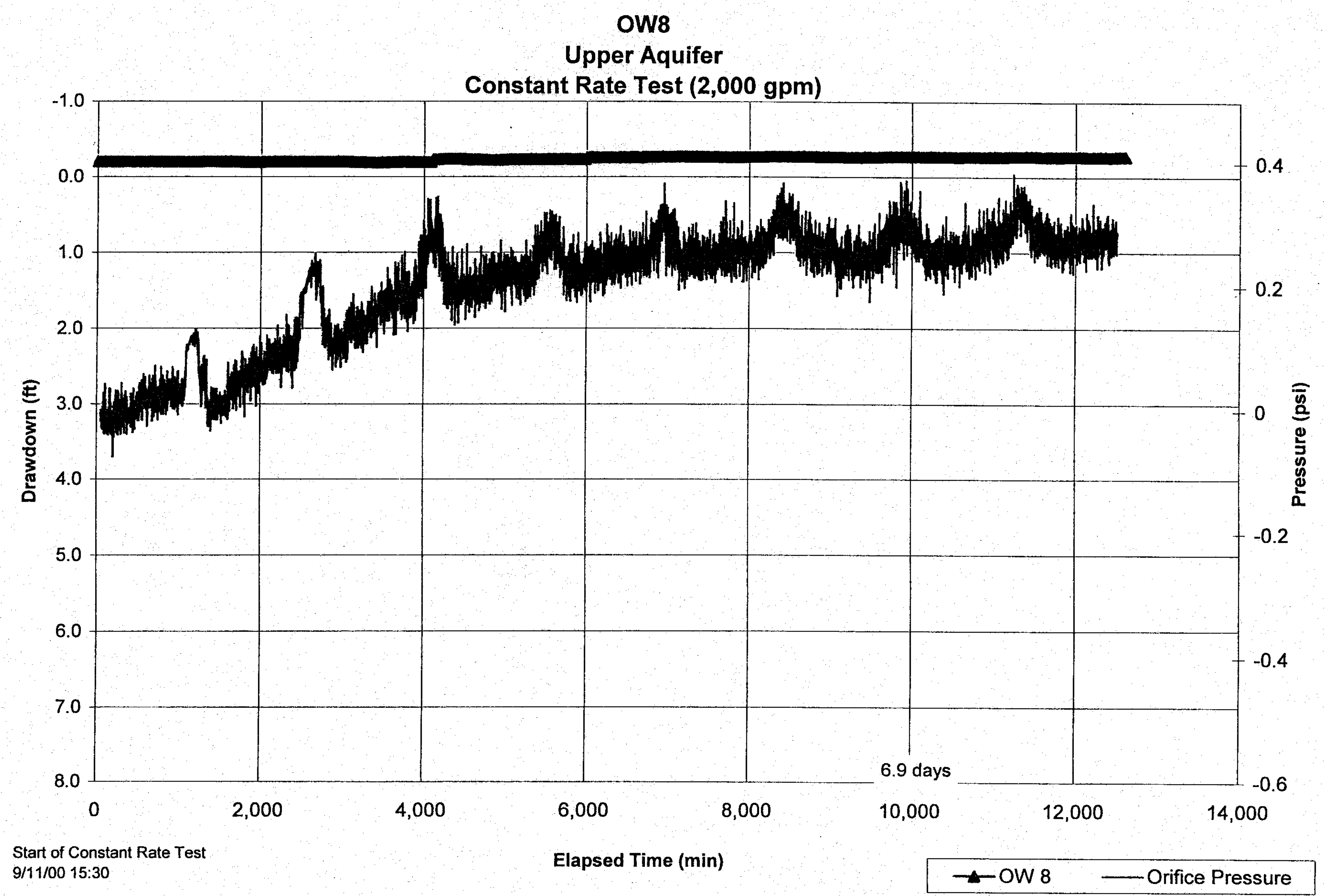
Big Sandy Aquifer Test
Constant Rate Test
Start Time : 9-11-00 15:30



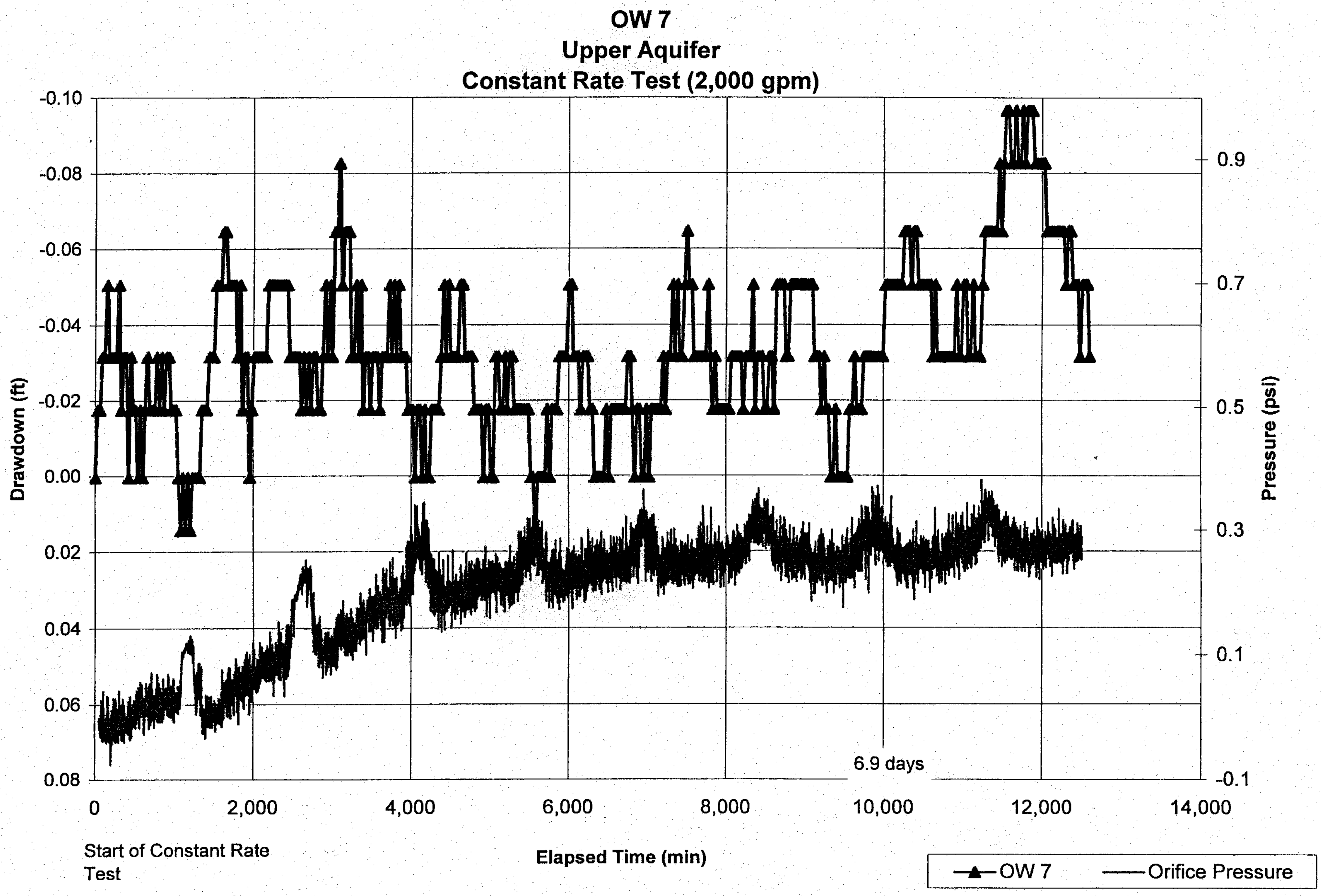
Big Sandy Aquifer Test
Constant Rate Test
Start Time : 9-11-00 15:30



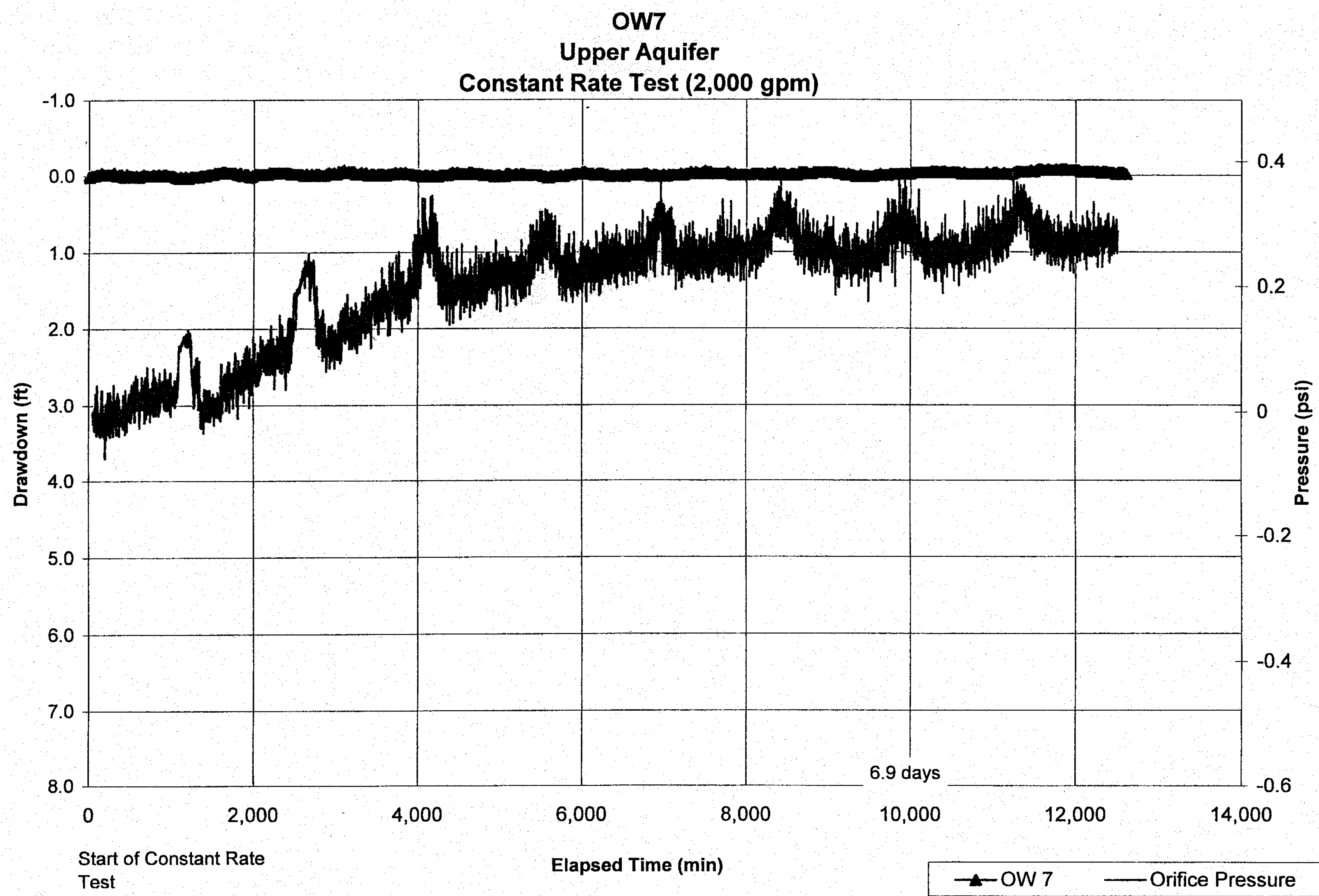
Big Sandy Aquifer Test
Constant Rate Test
Start Time : 9-11-00 15:30



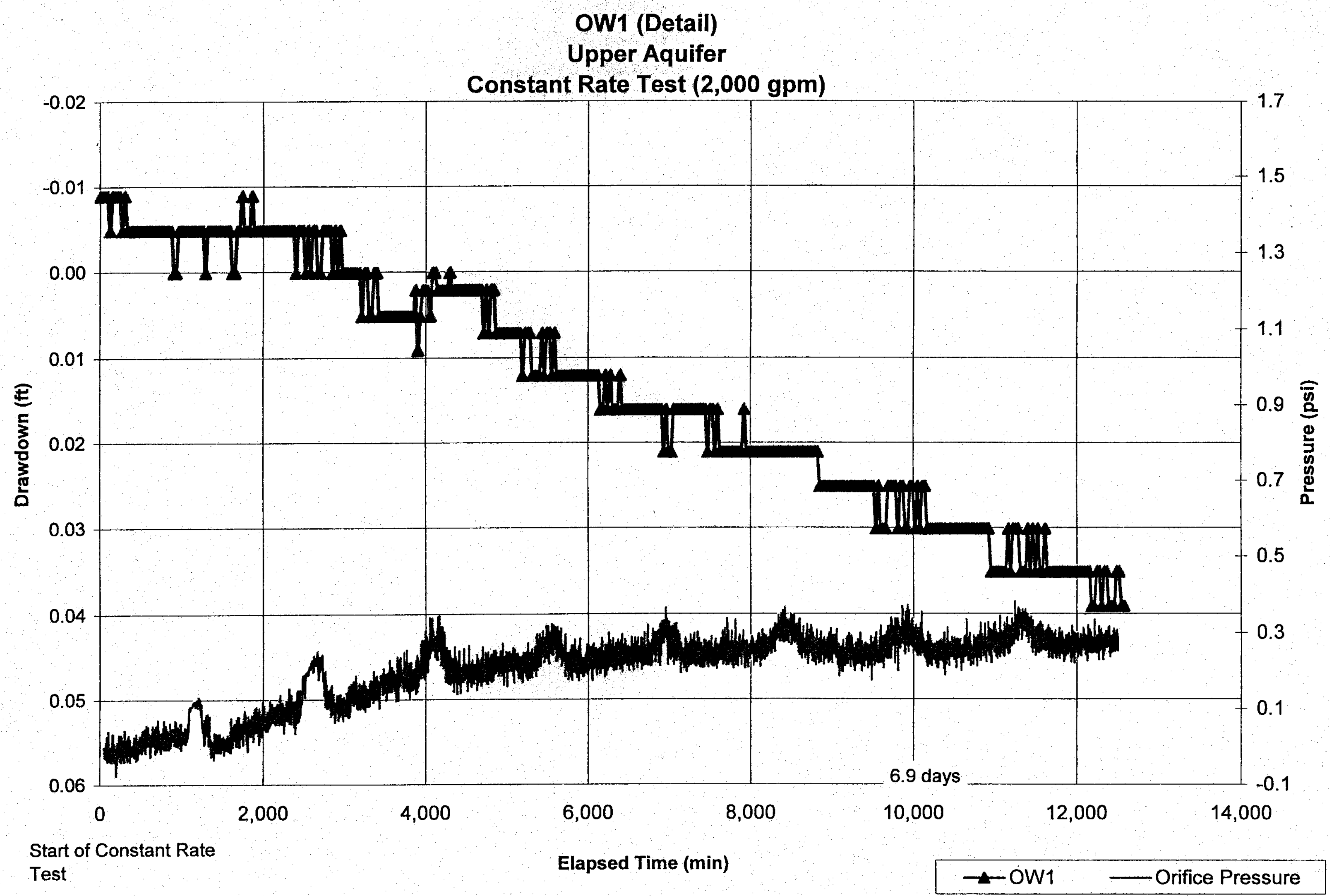
Big Sandy Aquifer Test
Constant Rate Test
Start Time : 9-11-00 15:30



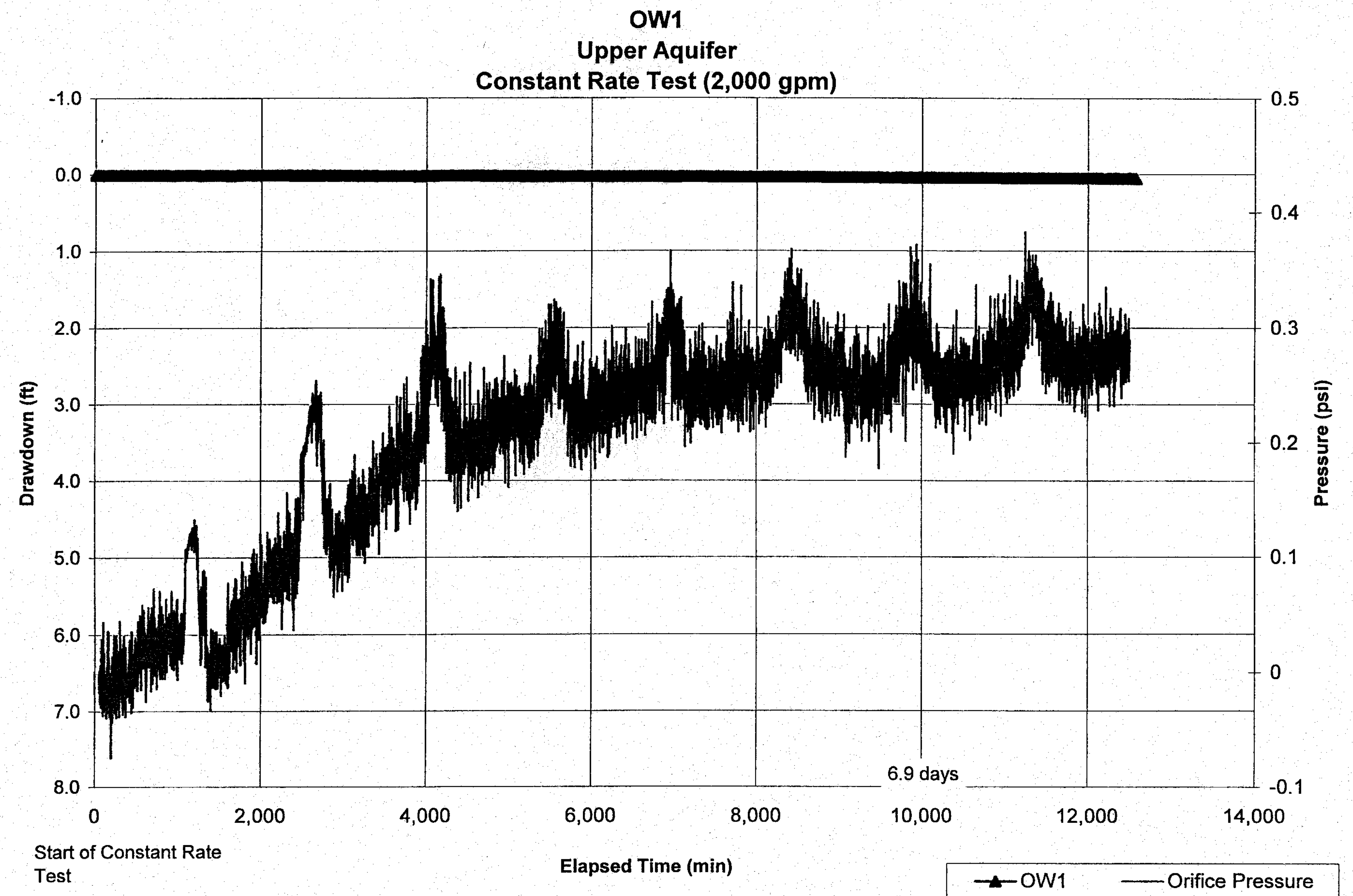
Big Sandy Aquifer Test
Constant Rate Test
Start Time : 9-11-00 15:30



Big Sandy Aquifer Test
Constant Rate Test
Start Time : 9-11-00 15:30

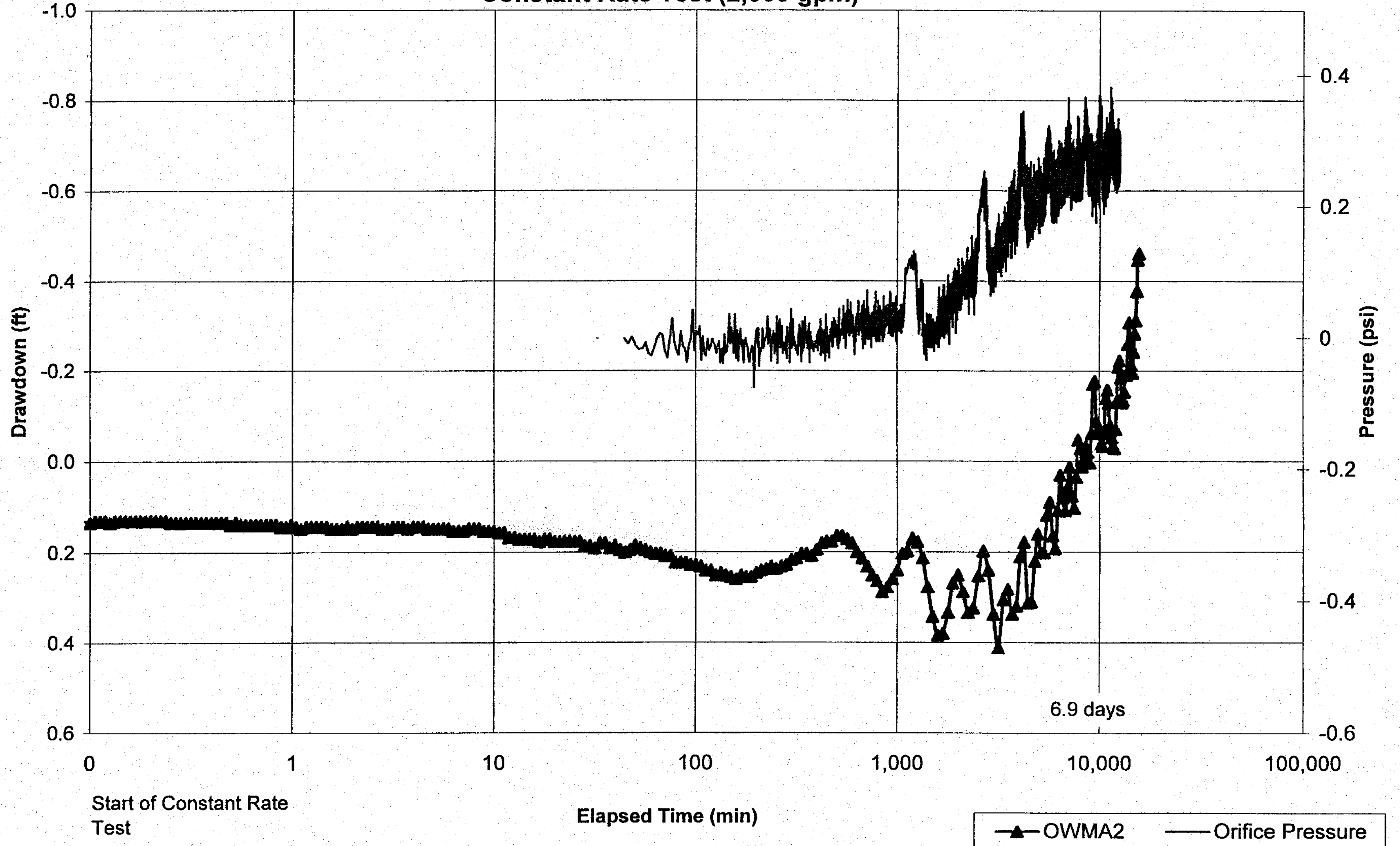


Big Sandy Aquifer Test
Constant Rate Test
Start Time : 9-11-00 15:30

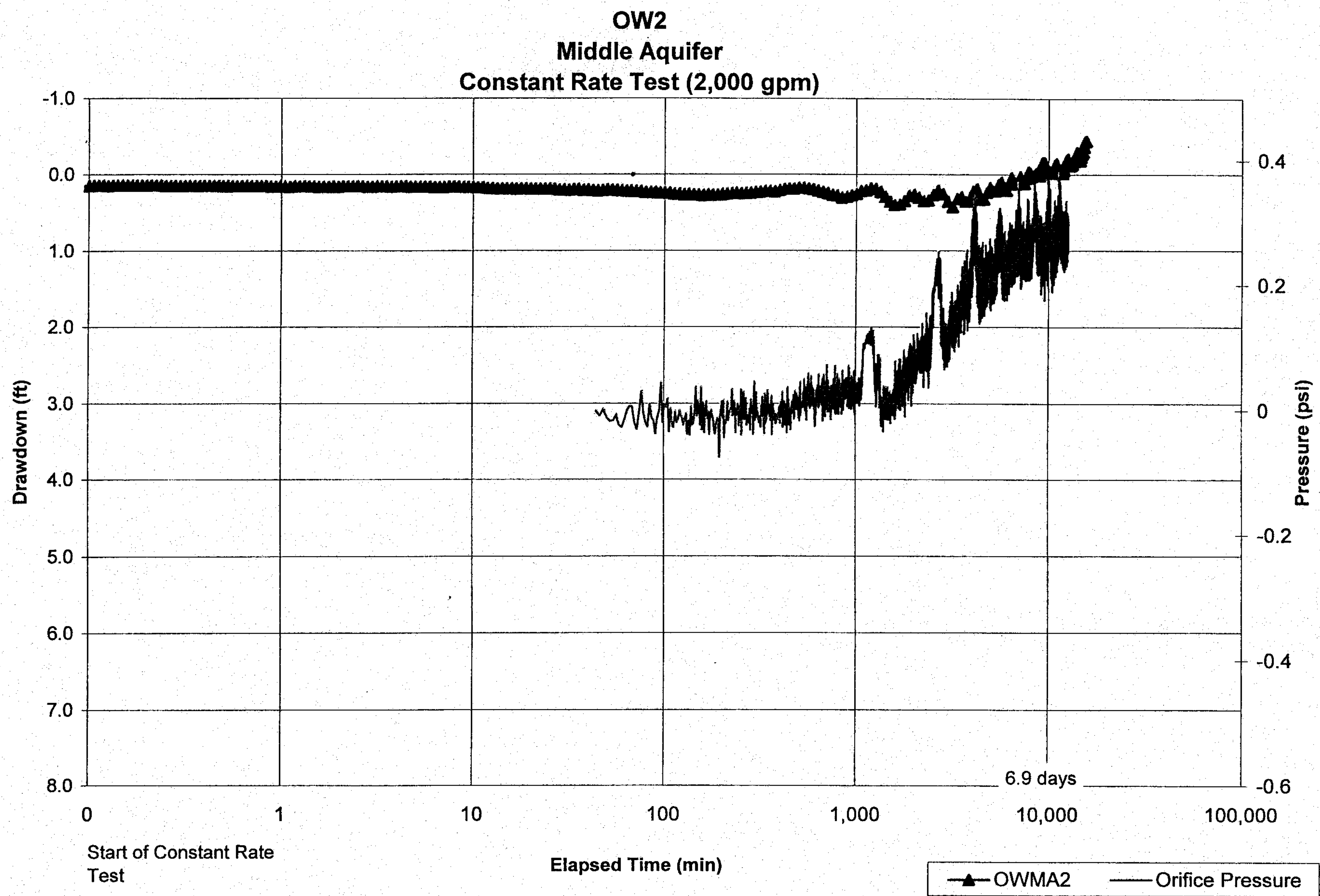


Big Sandy Aquifer Test
Constant Rate Test
Start Time : 9-11-00 15:30

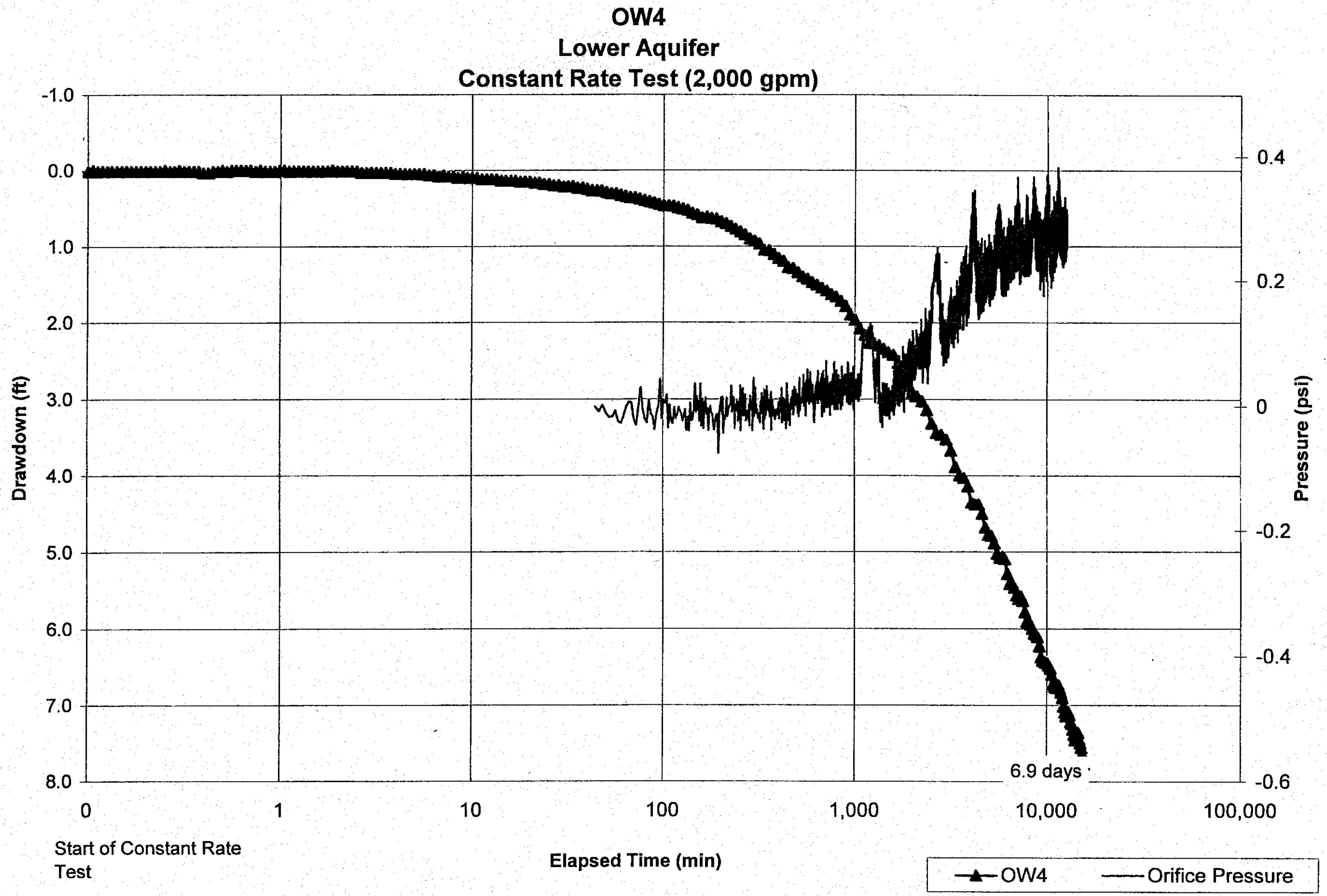
OW2
Middle Aquifer
Constant Rate Test (2,000 gpm)



Big Sandy Aquifer Test
Constant Rate Test
Start Time : 9-11-00 15:30

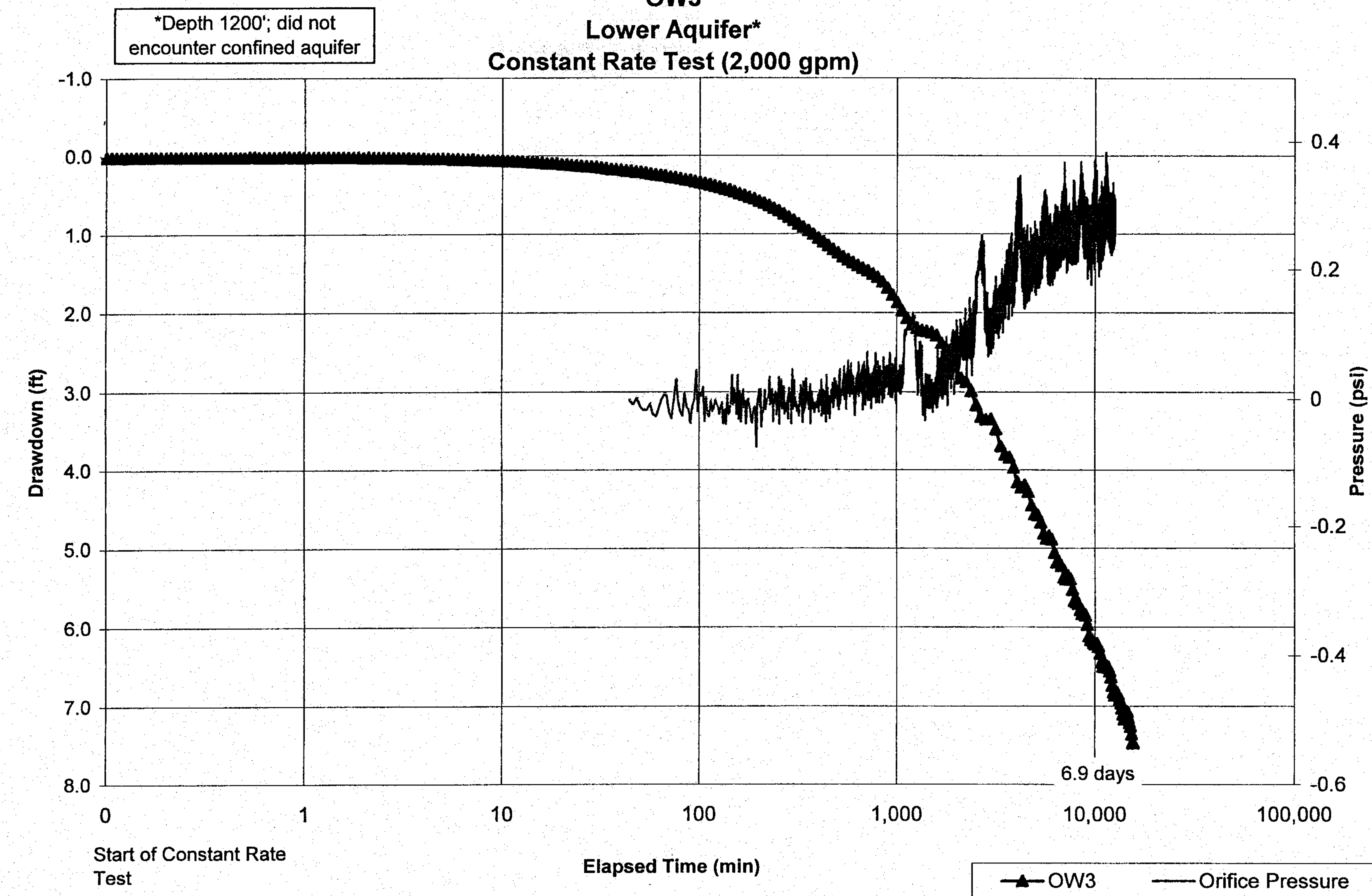


Big Sandy Aquifer Test
Constant Rate Test
Start Time : 9-11-00 15:30

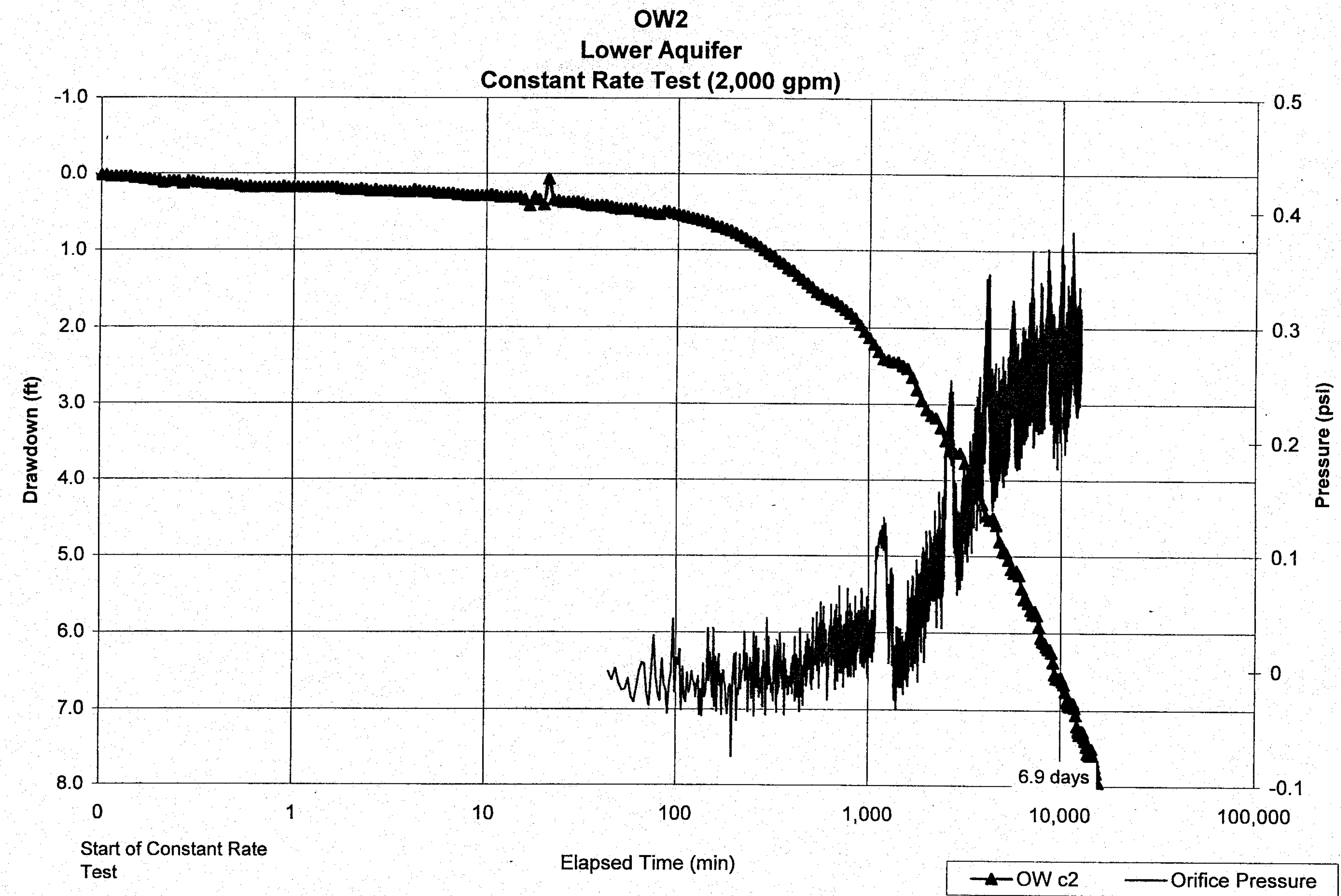


Big Sandy Aquifer Test
Constant Rate Test
Start Time : 9-11-00 15:30

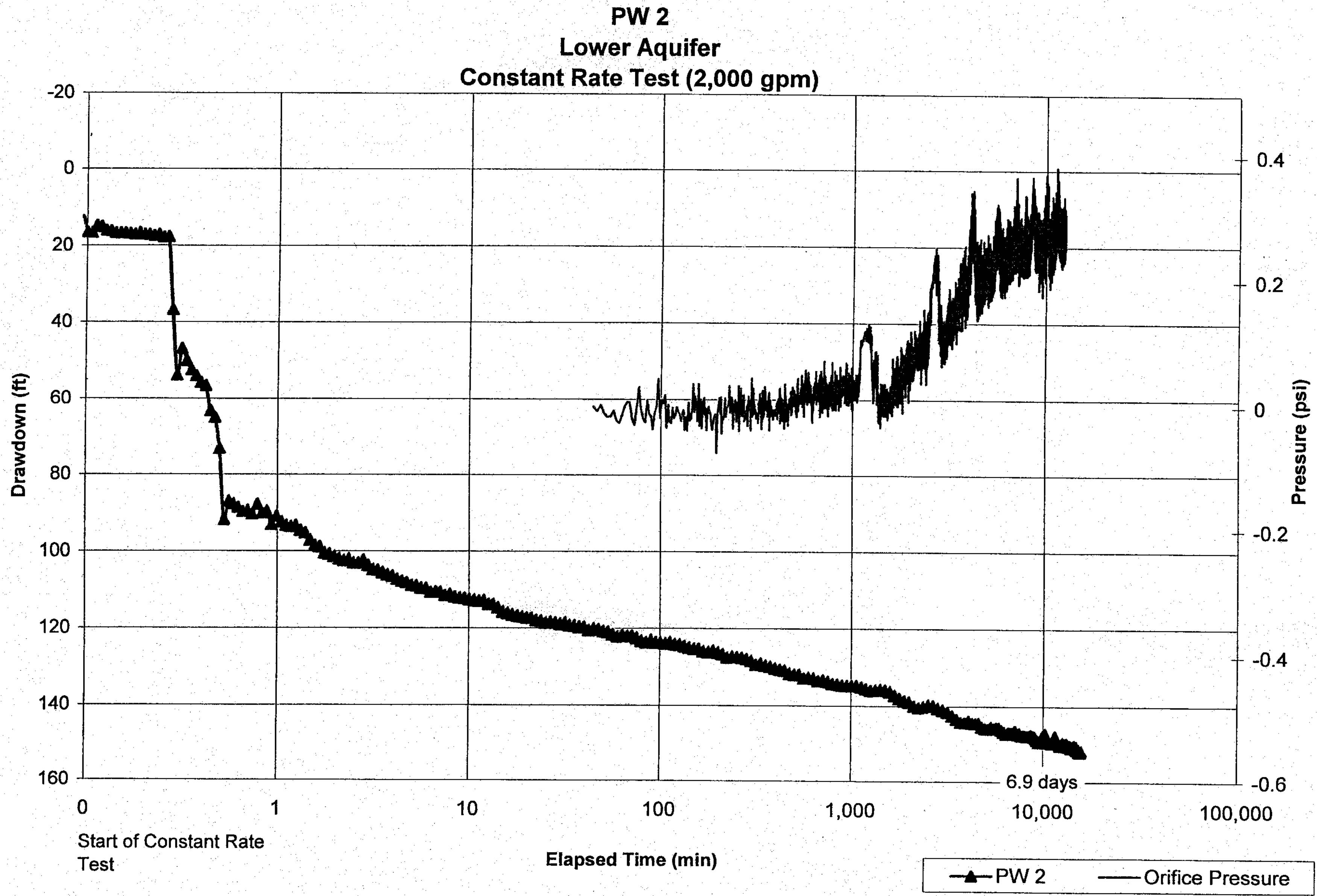
OW3
Lower Aquifer*
Constant Rate Test (2,000 gpm)



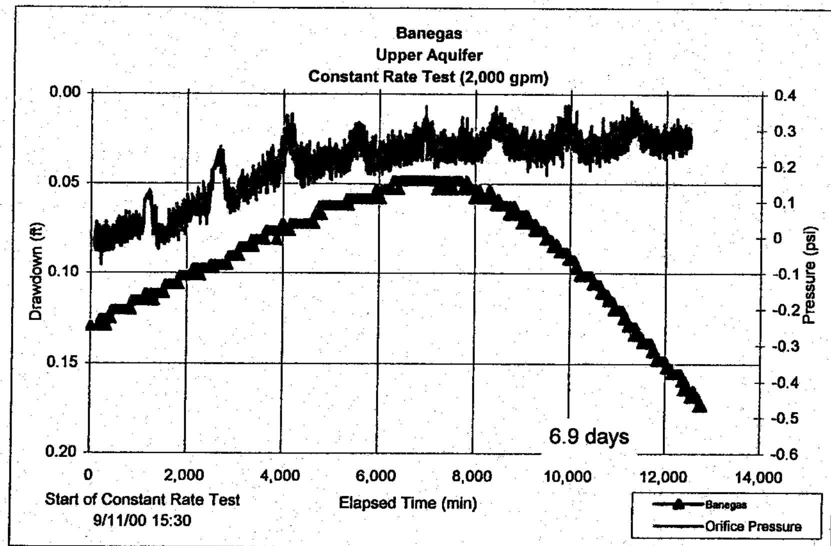
Big Sandy Aquifer Test
Constant Rate Test
Start Time : 9-11-00 15:30

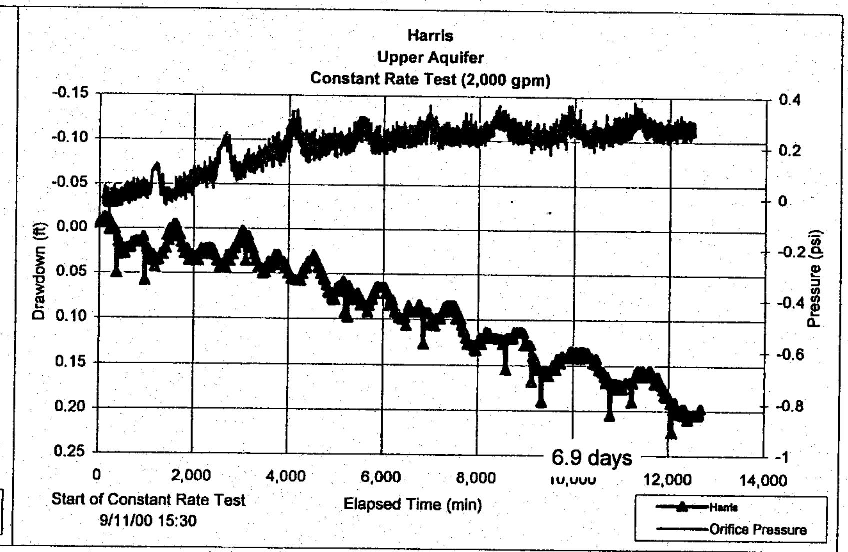


Big Sandy Aquifer Test
Constant Rate Test
Start Time : 9-11-00 15:30

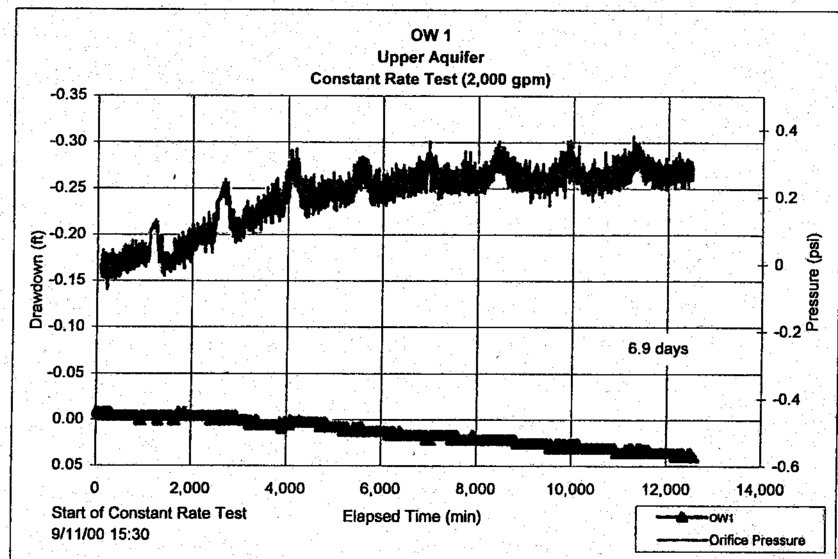


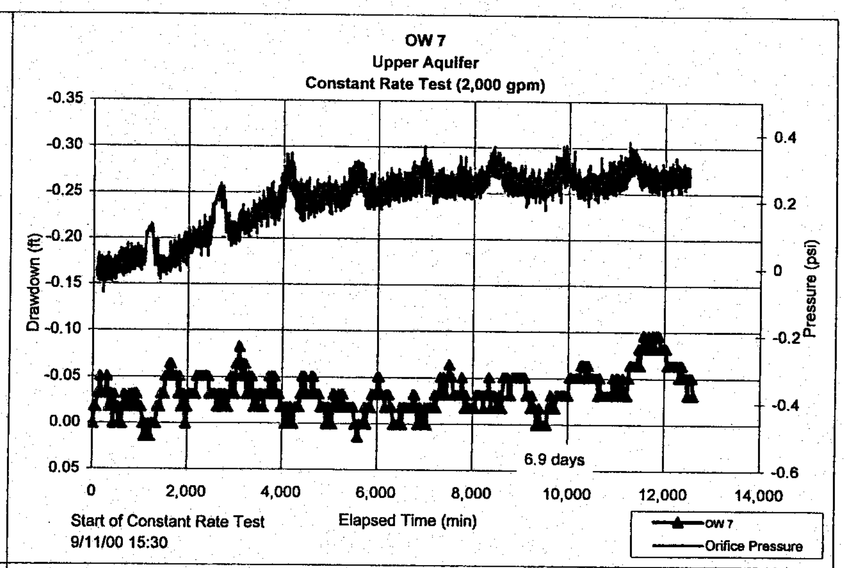
Private Wells
Upper Aquifer

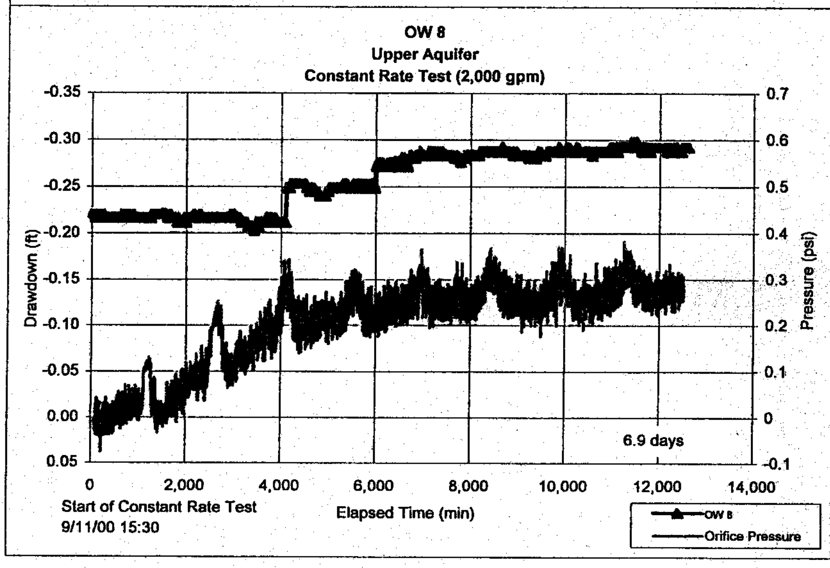




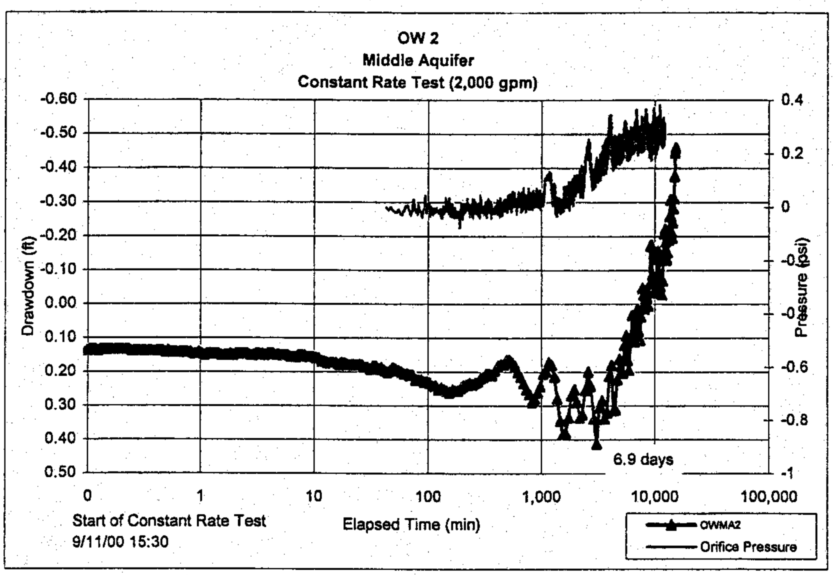
Upper Aquifer Observation Wells
Constant Rate Test - 10 days
Begin 9/11/00



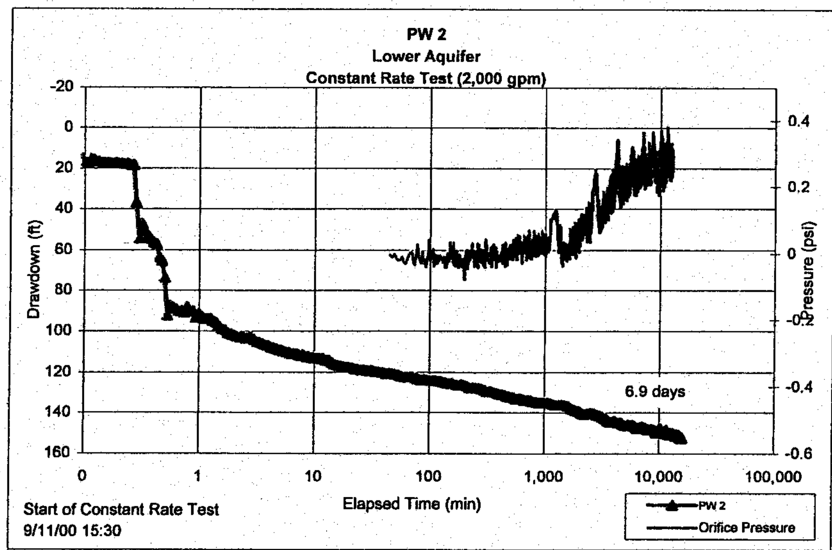


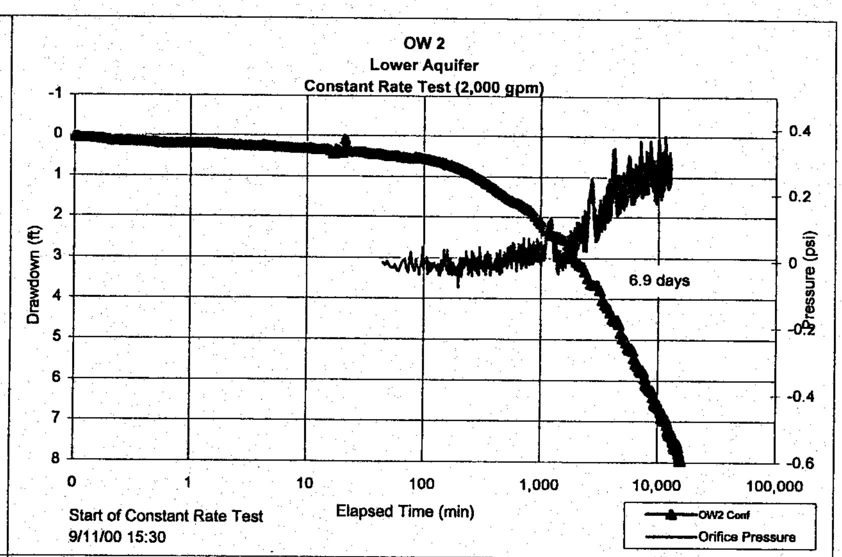


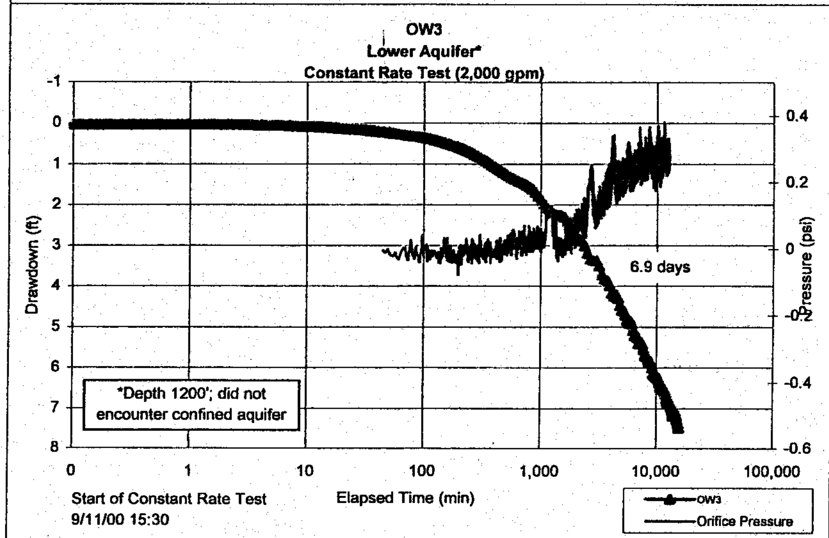
Middle Aquifer Well
Constant Rate Test - 10 days
Begin 9/11/00

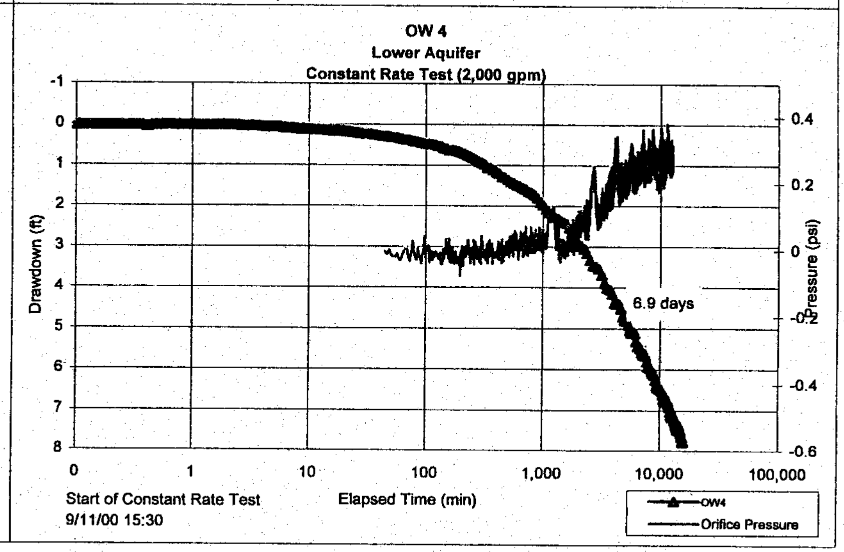


Lower Aquifer Wells
Constant Rate Test - 10 days
Begin 9/11/00

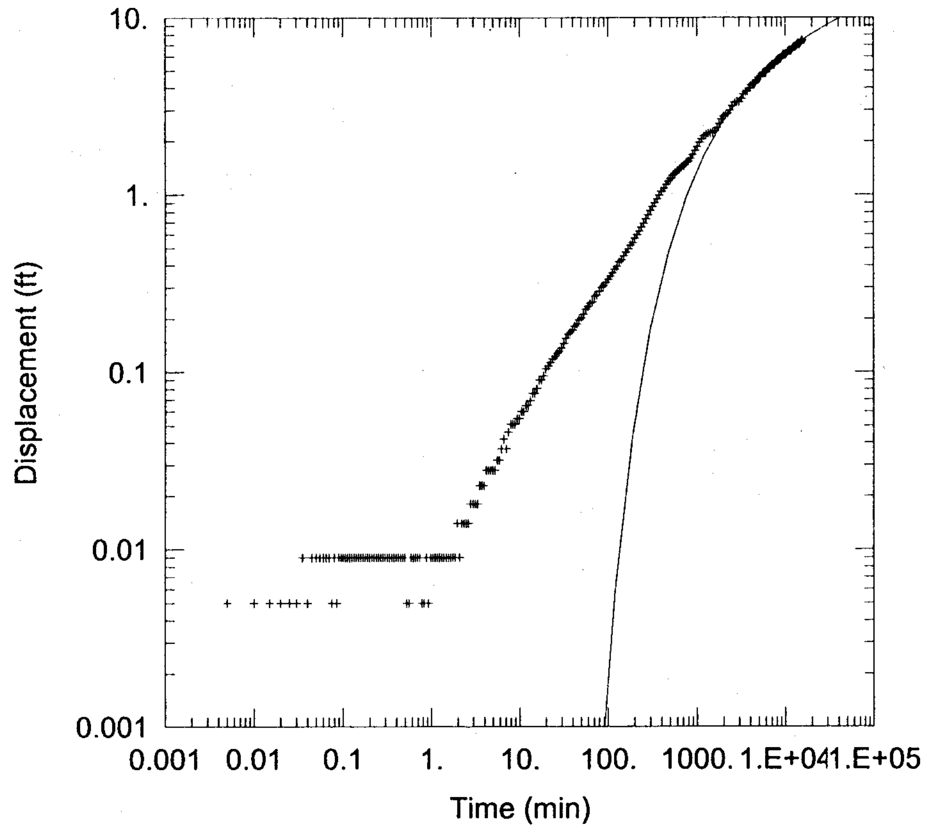








APPENDIX G
AQUIFER TEST ANALYSES PLOTS AND DATA



BIG SANDY ENERGY PROJECT

Data Set: C:\891-06\OW3.aqt
Date: 10/09/00 Time: 12:42:01

PROJECT INFORMATION

Company: Manera, Inc.
Client: Caithness
Project: 891-06
Test Location: Wikieup, Arizona
Test Well: PW2
Test Date: 9/11/00

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 7.773 ft^2/min
S = 0.0006952

AQUIFER DATA

Saturated Thickness: 300. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW 1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
+ OW3	4880	0

Data Set: C:\891-06\OW3.aqt
Title: Big Sandy Energy Project
Date: 10/09/00
Time: 12:42:16

PROJECT INFORMATION

Company: Manera, Inc.
Client: Caithness
Project: 891-06
Location: Wikieup, Arizona
Test Date: 9/11/00
Test Well: PW2

AQUIFER DATA

Saturated Thickness: 300. ft
Anisotropy Ratio (Kz/Kr): 1.

PUMPING WELL DATA

Number of pumping wells: 1

Pumping Well No. 1: PW 1

X Location: 0. ft
Y Location: 0. ft

No. of pumping periods: 2

Pumping Period Data

Time (min)	Rate (cu. ft/min)	Time (min)	Rate (cu. ft/min)
0.	256.7	1.584E+04	256.7

OBSERVATION WELL DATA

Number of observation wells: 1

Observation Well No. 1: OW3

X Location: 4880. ft
Y Location: 0. ft

No. of observations: 269

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.005	0.005	5.915	0.032	1059.1	1.963
0.01	0.005	6.266	0.037	1121.9	2.058
0.015	0.005	6.64	0.042	1188.4	2.136
0.02	0.005	7.035	0.037	1258.8	2.18
0.025	0.005	7.453	0.046	1333.4	2.212

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.03	0.005	7.896	0.051	1412.4	2.221
0.035	0.009	8.366	0.051	1496.1	2.235
0.04	0.005	8.865	0.051	1584.8	2.274
0.045	0.009	9.391	0.055	1678.7	2.371
0.05	0.009	9.95	0.055	1778.2	2.514
0.055	0.009	10.54	0.06	1883.5	2.664
0.06	0.009	11.17	0.06	1995.1	2.763
0.065	0.009	11.83	0.065	2113.4	2.819
0.07	0.009	12.53	0.065	2238.6	2.863
0.075	0.005	13.28	0.069	2371.2	2.98
0.08	0.009	14.07	0.076	2511.8	3.158
0.085	0.005	14.91	0.076	2660.6	3.305
0.09	0.009	15.79	0.081	2818.3	3.342
0.095	0.009	16.73	0.09	2985.3	3.338
0.1	0.009	17.72	0.09	3162.1	3.469
0.1058	0.009	18.78	0.095	3342.1	3.686
0.112	0.009	19.89	0.104	3522.1	3.794
0.1185	0.009	21.07	0.108	3702.1	3.831
0.1255	0.009	22.32	0.113	3882.1	3.956
0.1328	0.009	23.65	0.118	4062.1	4.143
0.1407	0.009	25.05	0.122	4242.1	4.21
0.149	0.009	26.54	0.127	4422.1	4.182
0.1578	0.009	28.12	0.131	4602.1	4.265
0.1672	0.009	29.79	0.136	4782.1	4.445
0.177	0.009	31.55	0.145	4962.1	4.558
0.1875	0.009	33.43	0.155	5142.1	4.572
0.1985	0.009	35.41	0.164	5322.1	4.666
0.2102	0.009	37.51	0.168	5502.1	4.807
0.2227	0.009	39.74	0.173	5682.1	4.869
0.2358	0.009	42.1	0.182	5862.1	4.835
0.2498	0.009	44.6	0.187	6042.1	4.879
0.2647	0.009	47.24	0.198	6222.1	5.047
0.2803	0.009	50.05	0.203	6402.1	5.172
0.297	0.009	53.01	0.212	6582.1	5.172
0.3147	0.009	56.16	0.226	6762.1	5.218
0.3333	0.009	59.49	0.235	6942.1	5.363
0.3532	0.009	63.02	0.245	7122.1	5.388
0.3742	0.009	66.76	0.249	7302.1	5.349
0.3963	0.009	70.72	0.268	7482.1	5.386
0.4198	0.009	74.91	0.272	7662.1	5.52
0.4447	0.009	79.35	0.286	7842.1	5.656
0.4697	0.009	84.06	0.3	8022.1	5.674
0.4963	0.009	89.05	0.307	8202.1	5.693
0.5247	0.005	94.33	0.321	8382.1	5.774
0.5547	0.005	99.92	0.334	8562.1	5.824
0.5863	0.009	105.8	0.348	8742.1	5.82
0.6213	0.009	112.1	0.362	8922.1	5.845
0.658	0.009	118.8	0.381	9102.1	5.958
0.6963	0.009	125.8	0.394	9282.1	6.103
0.738	0.009	133.3	0.418	9462.1	6.15
0.7813	0.005	141.2	0.429	9642.1	6.154

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.828	0.005	149.5	0.452	9822.1	6.184
0.8763	0.009	158.4	0.475	1.E+04	6.203
0.928	0.005	167.8	0.494	1.018E+04	6.203
0.983	0.009	177.7	0.521	1.036E+04	6.24
1.041	0.009	188.3	0.537	1.054E+04	6.325
1.103	0.009	199.4	0.57	1.072E+04	6.433
1.168	0.009	211.3	0.597	1.09E+04	6.484
1.238	0.009	223.8	0.625	1.108E+04	6.491
1.311	0.009	237.	0.66	1.126E+04	6.479
1.39	0.009	251.1	0.692	1.144E+04	6.486
1.473	0.009	266.	0.734	1.162E+04	6.5
1.561	0.009	281.7	0.773	1.18E+04	6.542
1.655	0.009	298.4	0.814	1.198E+04	6.618
1.753	0.009	316.1	0.86	1.216E+04	6.722
1.858	0.009	334.9	0.9	1.234E+04	6.805
1.968	0.014	354.7	0.946	1.252E+04	6.849
2.085	0.009	375.7	0.992	1.27E+04	6.839
2.21	0.014	398.	1.04	1.288E+04	6.816
2.341	0.014	421.6	1.086	1.306E+04	6.844
2.481	0.014	446.6	1.135	1.324E+04	6.904
2.63	0.014	473.	1.186	1.342E+04	6.948
2.786	0.018	501.1	1.227	1.36E+04	7.012
2.953	0.018	530.8	1.276	1.378E+04	7.088
3.13	0.018	562.2	1.317	1.396E+04	7.151
3.316	0.018	595.6	1.352	1.414E+04	7.125
3.515	0.023	630.8	1.389	1.432E+04	7.056
3.725	0.023	668.2	1.421	1.45E+04	7.061
3.946	0.023	707.8	1.453	1.468E+04	7.139
4.181	0.028	749.8	1.497	1.486E+04	7.197
4.43	0.028	794.2	1.539	1.504E+04	7.25
4.693	0.028	841.3	1.596	1.522E+04	7.342
4.973	0.028	891.1	1.675	1.54E+04	7.451
5.27	0.028	943.9	1.765	1.558E+04	7.462
5.583	0.032	999.9	1.859		

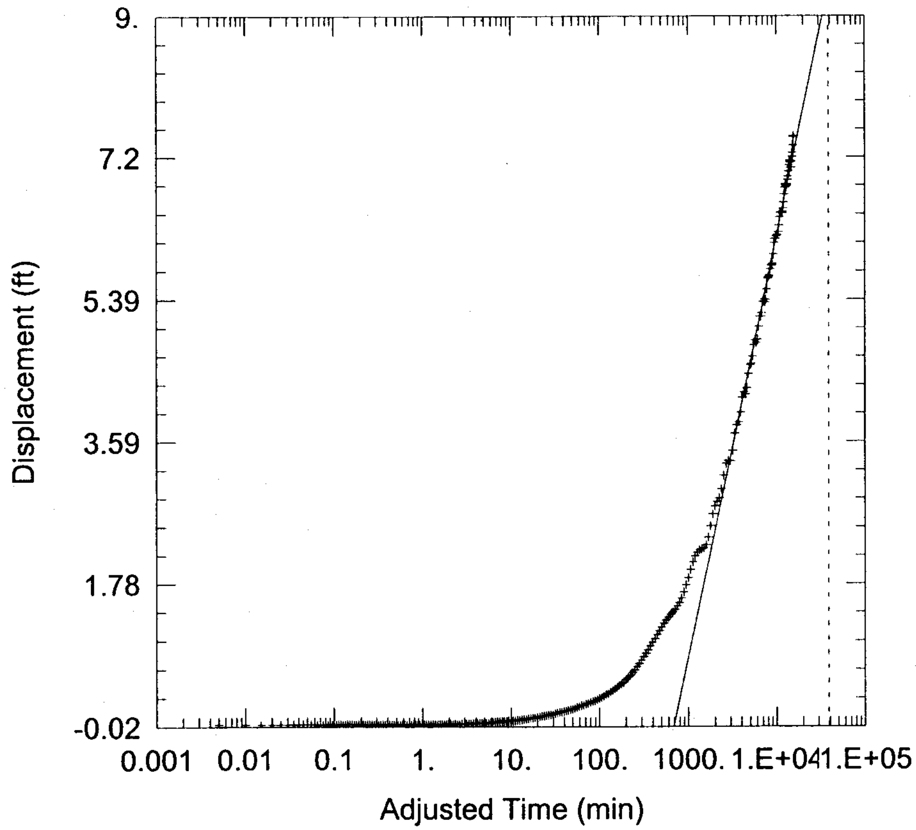
SOLUTION

Aquifer Model: Confined
Solution Method: Theis

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
T	7.773	ft^2/min
S	0.0006952	



BIG SANDY ENERGY PROJECT

Data Set: C:\891-06\OW3.aqt
Date: 10/09/00 Time: 12:44:56

PROJECT INFORMATION

Company: Manera, Inc.
Client: Caithness
Project: 891-06
Test Location: Wikieup, Arizona
Test Well: PW2
Test Date: 9/11/00

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Jacob

T = 8.783 ft^2/min
S = 0.0005753

AQUIFER DATA

Saturated Thickness: 300. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW 1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
+ OW3	4880	0

Data Set: C:\891-06\OW3.aqt
Title: Big Sandy Energy Project
Date: 10/09/00
Time: 12:45:42

PROJECT INFORMATION

Company: Manera, Inc.
Client: Caithness
Project: 891-06
Location: Wikieup, Arizona
Test Date: 9/11/00
Test Well: PW2

AQUIFER DATA

Saturated Thickness: 300. ft
Anisotropy Ratio (Kz/Kr): 1.

PUMPING WELL DATA

Number of pumping wells: 1

Pumping Well No. 1: PW 1

X Location: 0. ft
Y Location: 0. ft

No. of pumping periods: 2

Pumping Period Data

Time (min)	Rate (cu. ft/min)	Time (min)	Rate (cu. ft/min)
0.	256.7	1.584E+04	256.7

OBSERVATION WELL DATA

Number of observation wells: 1

Observation Well No. 1: OW3

X Location: 4880. ft
Y Location: 0. ft

No. of observations: 269

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.005	0.005	5.915	0.032	1059.1	1.963
0.01	0.005	6.266	0.037	1121.9	2.058
0.015	0.005	6.64	0.042	1188.4	2.136
0.02	0.005	7.035	0.037	1258.8	2.18
0.025	0.005	7.453	0.046	1333.4	2.212

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.03	0.005	7.896	0.051	1412.4	2.221
0.035	0.009	8.366	0.051	1496.1	2.235
0.04	0.005	8.865	0.051	1584.8	2.274
0.045	0.009	9.391	0.055	1678.7	2.371
0.05	0.009	9.95	0.055	1778.2	2.514
0.055	0.009	10.54	0.06	1883.5	2.664
0.06	0.009	11.17	0.06	1995.1	2.763
0.065	0.009	11.83	0.065	2113.4	2.819
0.07	0.009	12.53	0.065	2238.6	2.863
0.075	0.005	13.28	0.069	2371.2	2.98
0.08	0.009	14.07	0.076	2511.8	3.158
0.085	0.005	14.91	0.076	2660.6	3.305
0.09	0.009	15.79	0.081	2818.3	3.342
0.095	0.009	16.73	0.09	2985.3	3.338
0.1	0.009	17.72	0.09	3162.1	3.469
0.1058	0.009	18.78	0.095	3342.1	3.686
0.112	0.009	19.89	0.104	3522.1	3.794
0.1185	0.009	21.07	0.108	3702.1	3.831
0.1255	0.009	22.32	0.113	3882.1	3.956
0.1328	0.009	23.65	0.118	4062.1	4.143
0.1407	0.009	25.05	0.122	4242.1	4.21
0.149	0.009	26.54	0.127	4422.1	4.182
0.1578	0.009	28.12	0.131	4602.1	4.265
0.1672	0.009	29.79	0.136	4782.1	4.445
0.177	0.009	31.55	0.145	4962.1	4.558
0.1875	0.009	33.43	0.155	5142.1	4.572
0.1985	0.009	35.41	0.164	5322.1	4.666
0.2102	0.009	37.51	0.168	5502.1	4.807
0.2227	0.009	39.74	0.173	5682.1	4.869
0.2358	0.009	42.1	0.182	5862.1	4.835
0.2498	0.009	44.6	0.187	6042.1	4.879
0.2647	0.009	47.24	0.198	6222.1	5.047
0.2803	0.009	50.05	0.203	6402.1	5.172
0.297	0.009	53.01	0.212	6582.1	5.172
0.3147	0.009	56.16	0.226	6762.1	5.218
0.3333	0.009	59.49	0.235	6942.1	5.363
0.3532	0.009	63.02	0.245	7122.1	5.388
0.3742	0.009	66.76	0.249	7302.1	5.349
0.3963	0.009	70.72	0.268	7482.1	5.386
0.4198	0.009	74.91	0.272	7662.1	5.52
0.4447	0.009	79.35	0.286	7842.1	5.656
0.4697	0.009	84.06	0.3	8022.1	5.674
0.4963	0.009	89.05	0.307	8202.1	5.693
0.5247	0.005	94.33	0.321	8382.1	5.774
0.5547	0.005	99.92	0.334	8562.1	5.824
0.5863	0.009	105.8	0.348	8742.1	5.82
0.6213	0.009	112.1	0.362	8922.1	5.845
0.658	0.009	118.8	0.381	9102.1	5.958
0.6963	0.009	125.8	0.394	9282.1	6.103
0.738	0.009	133.3	0.418	9462.1	6.15
0.7813	0.005	141.2	0.429	9642.1	6.154

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.828	0.005	149.5	0.452	9822.1	6.184
0.8763	0.009	158.4	0.475	1.E+04	6.203
0.928	0.005	167.8	0.494	1.018E+04	6.203
0.983	0.009	177.7	0.521	1.036E+04	6.24
1.041	0.009	188.3	0.537	1.054E+04	6.325
1.103	0.009	199.4	0.57	1.072E+04	6.433
1.168	0.009	211.3	0.597	1.09E+04	6.484
1.238	0.009	223.8	0.625	1.108E+04	6.491
1.311	0.009	237.	0.66	1.126E+04	6.479
1.39	0.009	251.1	0.692	1.144E+04	6.486
1.473	0.009	266.	0.734	1.162E+04	6.5
1.561	0.009	281.7	0.773	1.18E+04	6.542
1.655	0.009	298.4	0.814	1.198E+04	6.618
1.753	0.009	316.1	0.86	1.216E+04	6.722
1.858	0.009	334.9	0.9	1.234E+04	6.805
1.968	0.014	354.7	0.946	1.252E+04	6.849
2.085	0.009	375.7	0.992	1.27E+04	6.839
2.21	0.014	398.	1.04	1.288E+04	6.816
2.341	0.014	421.6	1.086	1.306E+04	6.844
2.481	0.014	446.6	1.135	1.324E+04	6.904
2.63	0.014	473.	1.186	1.342E+04	6.948
2.786	0.018	501.1	1.227	1.36E+04	7.012
2.953	0.018	530.8	1.276	1.378E+04	7.088
3.13	0.018	562.2	1.317	1.396E+04	7.151
3.316	0.018	595.6	1.352	1.414E+04	7.125
3.515	0.023	630.8	1.389	1.432E+04	7.056
3.725	0.023	668.2	1.421	1.45E+04	7.061
3.946	0.023	707.8	1.453	1.468E+04	7.139
4.181	0.028	749.8	1.497	1.486E+04	7.197
4.43	0.028	794.2	1.539	1.504E+04	7.25
4.693	0.028	841.3	1.596	1.522E+04	7.342
4.973	0.028	891.1	1.675	1.54E+04	7.451
5.27	0.028	943.9	1.765	1.558E+04	7.462
5.583	0.032	999.9	1.859		

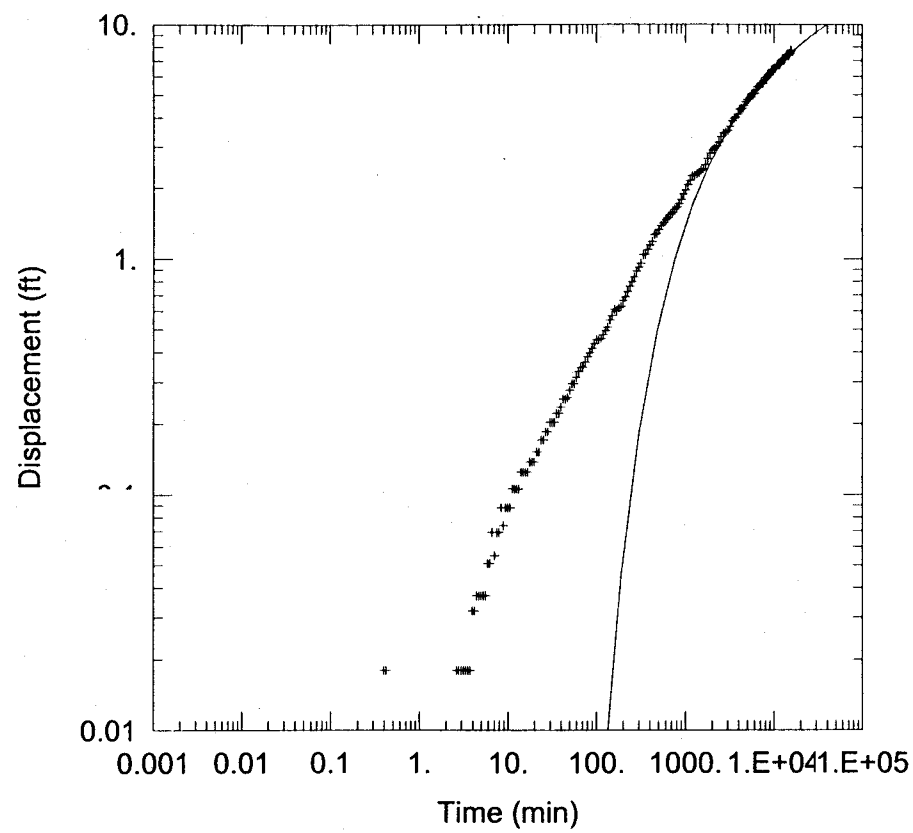
SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Jacob

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
T	8.783	ft^2/min
S	0.0005753	



BIG SANDY ENERGY PROJECT

Data Set: C:\891-06\OW4.aqt
Date: 10/11/00 Time: 16:50:36

PROJECT INFORMATION

Company: Manera, Inc.
Client: Caithness
Project: 891-06
Test Location: Wikieup, Arizona
Test Well: PW2
Test Date: 9/11/00

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 1.105E+04 ft^2/day
S = 0.001636

AQUIFER DATA

Saturated Thickness: 300. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW 1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
+ OW4	3150	0

Data Set: C:\891-06\OW4.aqt
Title: Big Sandy Energy Project
Date: 10/11/00
Time: 16:51:00

PROJECT INFORMATION

Company: Manera, Inc.
Client: Caithness
Project: 891-06
Location: Wikieup, Arizona
Test Date: 9/11/00
Test Well: PW2

AQUIFER DATA

Saturated Thickness: 300. ft
Anisotropy Ratio (Kz/Kr): 1.

PUMPING WELL DATA

Number of pumping wells: 1

Pumping Well No. 1: PW 1

X Location: 0. ft
Y Location: 0. ft

No. of pumping periods: 2

Pumping Period Data

Time (min)	Rate (cu. ft/min)	Time (min)	Rate (cu. ft/min)
0.	256.7	1.584E+04	256.7

OBSERVATION WELL DATA

Number of observation wells: 1

Observation Well No. 1: OW4

X Location: 3150. ft
Y Location: 0. ft

No. of observations: 269

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.005	0.	5.915	0.051	1059.1	2.062
0.01	-0.014	6.266	0.051	1121.9	2.145
0.015	-0.014	6.64	0.069	1188.4	2.251
0.02	0.	7.035	0.055	1258.8	2.256
0.025	-0.014	7.453	0.069	1333.4	2.284

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.03	-0.014	7.896	0.069	1412.4	2.325
0.035	-0.014	8.366	0.088	1496.1	2.371
0.04	-0.014	8.865	0.074	1584.8	2.404
0.045	-0.014	9.391	0.088	1678.7	2.51
0.05	-0.014	9.95	0.088	1778.2	2.657
0.055	-0.014	10.54	0.088	1883.5	2.814
0.06	0.	11.17	0.106	1995.1	2.897
0.065	0.	11.83	0.106	2113.4	2.953
0.07	0.	12.53	0.106	2238.6	3.017
0.075	-0.014	13.28	0.106	2371.2	3.128
0.08	-0.014	14.07	0.125	2511.8	3.303
0.085	0.	14.91	0.125	2660.6	3.428
0.09	-0.014	15.79	0.125	2818.3	3.451
0.095	0.	16.73	0.125	2985.3	3.511
0.1	0.	17.72	0.138	3162.1	3.658
0.1058	-0.014	18.78	0.138	3342.1	3.871
0.112	0.	19.89	0.138	3522.1	3.981
0.1185	0.	21.07	0.152	3702.1	4.014
0.1255	0.	22.32	0.152	3882.1	4.129
0.1328	0.	23.65	0.171	4062.1	4.341
0.1407	0.	25.05	0.171	4242.1	4.369
0.149	0.	26.54	0.185	4422.1	4.369
0.1578	0.	28.12	0.185	4602.1	4.489
0.1672	0.	29.79	0.203	4782.1	4.669
0.177	0.	31.55	0.203	4962.1	4.766
0.1875	0.	33.43	0.203	5142.1	4.779
0.1985	0.	35.41	0.221	5322.1	4.876
0.2102	0.	37.51	0.221	5502.1	5.015
0.2227	0.	39.74	0.235	5682.1	5.07
0.2358	0.	42.1	0.254	5862.1	5.052
0.2498	-0.014	44.6	0.254	6042.1	5.084
0.2647	0.	47.24	0.258	6222.1	5.278
0.2803	0.	50.05	0.277	6402.1	5.407
0.297	-0.014	53.01	0.295	6582.1	5.398
0.3147	0.	56.16	0.295	6762.1	5.453
0.3333	0.	59.49	0.314	6942.1	5.554
0.3532	0.	63.02	0.332	7122.1	5.601
0.3742	0.	66.76	0.346	7302.1	5.568
0.3963	0.018	70.72	0.346	7482.1	5.628
0.4198	0.018	74.91	0.364	7662.1	5.776
0.4447	0.	79.35	0.383	7842.1	5.9
0.4697	0.	84.06	0.397	8022.1	5.914
0.4963	-0.014	89.05	0.415	8202.1	5.933
0.5247	0.	94.33	0.434	8382.1	5.993
0.5547	-0.014	99.92	0.452	8562.1	6.053
0.5863	-0.014	105.8	0.452	8742.1	6.067
0.6213	-0.014	112.1	0.457	8922.1	6.099
0.658	-0.014	118.8	0.475	9102.1	6.219
0.6963	-0.014	125.8	0.494	9282.1	6.362
0.738	0.	133.3	0.512	9462.1	6.403
0.7813	-0.014	141.2	0.549	9642.1	6.413

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.828	0.	149.5	0.572	9822.1	6.431
0.8763	0.	158.4	0.609	1.E+04	6.436
0.928	0.	167.8	0.6	1.018E+04	6.468
0.983	-0.014	177.7	0.618	1.036E+04	6.505
1.041	-0.014	188.3	0.627	1.054E+04	6.588
1.103	0.	199.4	0.664	1.072E+04	6.703
1.168	0.	211.3	0.687	1.09E+04	6.74
1.238	0.	223.8	0.724	1.108E+04	6.759
1.311	0.	237.	0.761	1.126E+04	6.735
1.39	0.	251.1	0.798	1.144E+04	6.722
1.473	0.	266.	0.835	1.162E+04	6.763
1.561	0.	281.7	0.886	1.18E+04	6.819
1.655	0.	298.4	0.918	1.198E+04	6.892
1.753	0.	316.1	0.955	1.216E+04	7.003
1.858	-0.014	334.9	1.038	1.234E+04	7.081
1.968	0.	354.7	1.043	1.252E+04	7.132
2.085	0.	375.7	1.093	1.27E+04	7.1
2.21	0.	398.	1.144	1.288E+04	7.077
2.341	0.	421.6	1.181	1.306E+04	7.118
2.481	0.	446.6	1.264	1.324E+04	7.206
2.63	0.018	473.	1.278	1.342E+04	7.234
2.786	0.018	501.1	1.329	1.36E+04	7.308
2.953	0.018	530.8	1.384	1.378E+04	7.372
3.13	0.018	562.2	1.416	1.396E+04	7.446
3.316	0.018	595.6	1.462	1.414E+04	7.4
3.515	0.018	630.8	1.495	1.432E+04	7.34
3.725	0.018	668.2	1.536	1.45E+04	7.349
3.946	0.032	707.8	1.569	1.468E+04	7.437
4.181	0.032	749.8	1.619	1.486E+04	7.483
4.43	0.037	794.2	1.652	1.504E+04	7.543
4.693	0.037	841.3	1.707	1.522E+04	7.63
4.973	0.037	891.1	1.776	1.54E+04	7.746
5.27	0.037	943.9	1.882	1.558E+04	7.764
5.583	0.037	999.9	1.951		

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
T	1.105E+04	ft^2/day
S	0.001636	

AUTOMATIC ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	Std. Error	
T	1.105E+04	967.4	ft^2/day
S	0.002866	0.0002485	

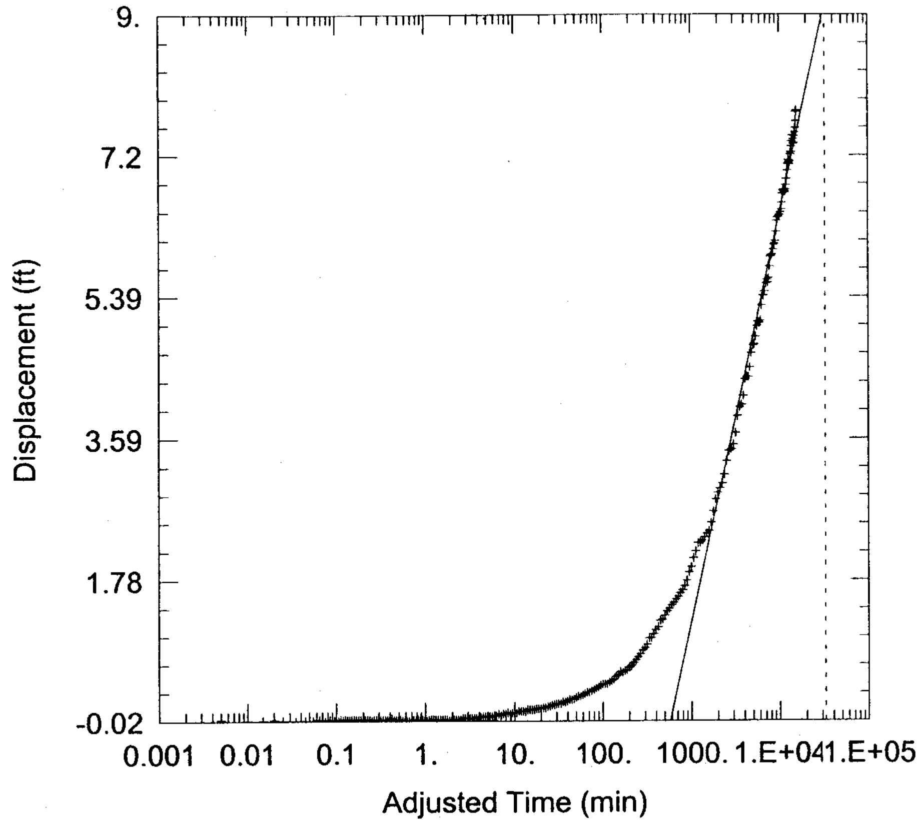
Parameter Correlations

	T	S
T	1.00	-0.88
S	-0.88	1.00

Residual Statistics

for weighted residuals

Sum of Squares ... 207.6 ft^2
Variance........... 0.7775 ft^2
Std. Deviation ..... 0.8818 ft
Mean.............. 0.6261 ft
No. of Residuals... 269.
No. of Estimates... 2



BIG SANDY ENERGY PROJECT

Data Set: C:\891-06\OW4.aqt
Date: 10/11/00 Time: 16:51:49

PROJECT INFORMATION

Company: Manera, Inc.
Client: Caithness
Project: 891-06
Test Location: Wikieup, Arizona
Test Well: PW2
Test Date: 9/11/00

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Jacob

T = 1.296E+04 ft^2/day
S = 0.001181

AQUIFER DATA

Saturated Thickness: 300. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW 1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
+ OW4	3150	0

Data Set: C:\891-06\OW4.aqt
Title: Big Sandy Energy Project
Date: 10/11/00
Time: 16:52:00

PROJECT INFORMATION

Company: Manera, Inc.
Client: Caithness
Project: 891-06
Location: Wikieup, Arizona
Test Date: 9/11/00
Test Well: PW2

AQUIFER DATA

Saturated Thickness: 300. ft
Anisotropy Ratio (Kz/Kr): 1.

PUMPING WELL DATA

Number of pumping wells: 1

Pumping Well No. 1: PW 1

X Location: 0. ft
Y Location: 0. ft

No. of pumping periods: 2

Pumping Period Data

Time (min)	Rate (cu. ft/min)	Time (min)	Rate (cu. ft/min)
0.	256.7	1.584E+04	256.7

OBSERVATION WELL DATA

Number of observation wells: 1

Observation Well No. 1: OW4

X Location: 3150. ft
Y Location: 0. ft

No. of observations: 269

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.005	0.	5.915	0.051	1059.1	2.062
0.01	-0.014	6.266	0.051	1121.9	2.145
0.015	-0.014	6.64	0.069	1188.4	2.251
0.02	0.	7.035	0.055	1258.8	2.256
0.025	-0.014	7.453	0.069	1333.4	2.284

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.03	-0.014	7.896	0.069	1412.4	2.325
0.035	-0.014	8.366	0.088	1496.1	2.371
0.04	-0.014	8.865	0.074	1584.8	2.404
0.045	-0.014	9.391	0.088	1678.7	2.51
0.05	-0.014	9.95	0.088	1778.2	2.657
0.055	-0.014	10.54	0.088	1883.5	2.814
0.06	0.	11.17	0.106	1995.1	2.897
0.065	0.	11.83	0.106	2113.4	2.953
0.07	0.	12.53	0.106	2238.6	3.017
0.075	-0.014	13.28	0.106	2371.2	3.128
0.08	-0.014	14.07	0.125	2511.8	3.303
0.085	0.	14.91	0.125	2660.6	3.428
0.09	-0.014	15.79	0.125	2818.3	3.451
0.095	0.	16.73	0.125	2985.3	3.511
0.1	0.	17.72	0.138	3162.1	3.658
0.1058	-0.014	18.78	0.138	3342.1	3.871
0.112	0.	19.89	0.138	3522.1	3.981
0.1185	0.	21.07	0.152	3702.1	4.014
0.1255	0.	22.32	0.152	3882.1	4.129
0.1328	0.	23.65	0.171	4062.1	4.341
0.1407	0.	25.05	0.171	4242.1	4.369
0.149	0.	26.54	0.185	4422.1	4.369
0.1578	0.	28.12	0.185	4602.1	4.489
0.1672	0.	29.79	0.203	4782.1	4.669
0.177	0.	31.55	0.203	4962.1	4.766
0.1875	0.	33.43	0.203	5142.1	4.779
0.1985	0.	35.41	0.221	5322.1	4.876
0.2102	0.	37.51	0.221	5502.1	5.015
0.2227	0.	39.74	0.235	5682.1	5.07
0.2358	0.	42.1	0.254	5862.1	5.052
0.2498	-0.014	44.6	0.254	6042.1	5.084
0.2647	0.	47.24	0.258	6222.1	5.278
0.2803	0.	50.05	0.277	6402.1	5.407
0.297	-0.014	53.01	0.295	6582.1	5.398
0.3147	0.	56.16	0.295	6762.1	5.453
0.3333	0.	59.49	0.314	6942.1	5.554
0.3532	0.	63.02	0.332	7122.1	5.601
0.3742	0.	66.76	0.346	7302.1	5.568
0.3963	0.018	70.72	0.346	7482.1	5.628
0.4198	0.018	74.91	0.364	7662.1	5.776
0.4447	0.	79.35	0.383	7842.1	5.9
0.4697	0.	84.06	0.397	8022.1	5.914
0.4963	-0.014	89.05	0.415	8202.1	5.933
0.5247	0.	94.33	0.434	8382.1	5.993
0.5547	-0.014	99.92	0.452	8562.1	6.053
0.5863	-0.014	105.8	0.452	8742.1	6.067
0.6213	-0.014	112.1	0.457	8922.1	6.099
0.658	-0.014	118.8	0.475	9102.1	6.219
0.6963	-0.014	125.8	0.494	9282.1	6.362
0.738	0.	133.3	0.512	9462.1	6.403
0.7813	-0.014	141.2	0.549	9642.1	6.413

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.828	0.	149.5	0.572	9822.1	6.431
0.8763	0.	158.4	0.609	1.E+04	6.436
0.928	0.	167.8	0.6	1.018E+04	6.468
0.983	-0.014	177.7	0.618	1.036E+04	6.505
1.041	-0.014	188.3	0.627	1.054E+04	6.588
1.103	0.	199.4	0.664	1.072E+04	6.703
1.168	0.	211.3	0.687	1.09E+04	6.74
1.238	0.	223.8	0.724	1.108E+04	6.759
1.311	0.	237.	0.761	1.126E+04	6.735
1.39	0.	251.1	0.798	1.144E+04	6.722
1.473	0.	266.	0.835	1.162E+04	6.763
1.561	0.	281.7	0.886	1.18E+04	6.819
1.655	0.	298.4	0.918	1.198E+04	6.892
1.753	0.	316.1	0.955	1.216E+04	7.003
1.858	-0.014	334.9	1.038	1.234E+04	7.081
1.968	0.	354.7	1.043	1.252E+04	7.132
2.085	0.	375.7	1.093	1.27E+04	7.1
2.21	0.	398.	1.144	1.288E+04	7.077
2.341	0.	421.6	1.181	1.306E+04	7.118
2.481	0.	446.6	1.264	1.324E+04	7.206
2.63	0.018	473.	1.278	1.342E+04	7.234
2.786	0.018	501.1	1.329	1.36E+04	7.308
2.953	0.018	530.8	1.384	1.378E+04	7.372
3.13	0.018	562.2	1.416	1.396E+04	7.446
3.316	0.018	595.6	1.462	1.414E+04	7.4
3.515	0.018	630.8	1.495	1.432E+04	7.34
3.725	0.018	668.2	1.536	1.45E+04	7.349
3.946	0.032	707.8	1.569	1.468E+04	7.437
4.181	0.032	749.8	1.619	1.486E+04	7.483
4.43	0.037	794.2	1.652	1.504E+04	7.543
4.693	0.037	841.3	1.707	1.522E+04	7.63
4.973	0.037	891.1	1.776	1.54E+04	7.746
5.27	0.037	943.9	1.882	1.558E+04	7.764
5.583	0.037	999.9	1.951		

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Jacob

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
T	1.296E+04	ft^2/day
S	0.001181	

AUTOMATIC ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	Std. Error	
T	5.662E+04	5211.1	ft^2/day
S	0.002866	0.001308	

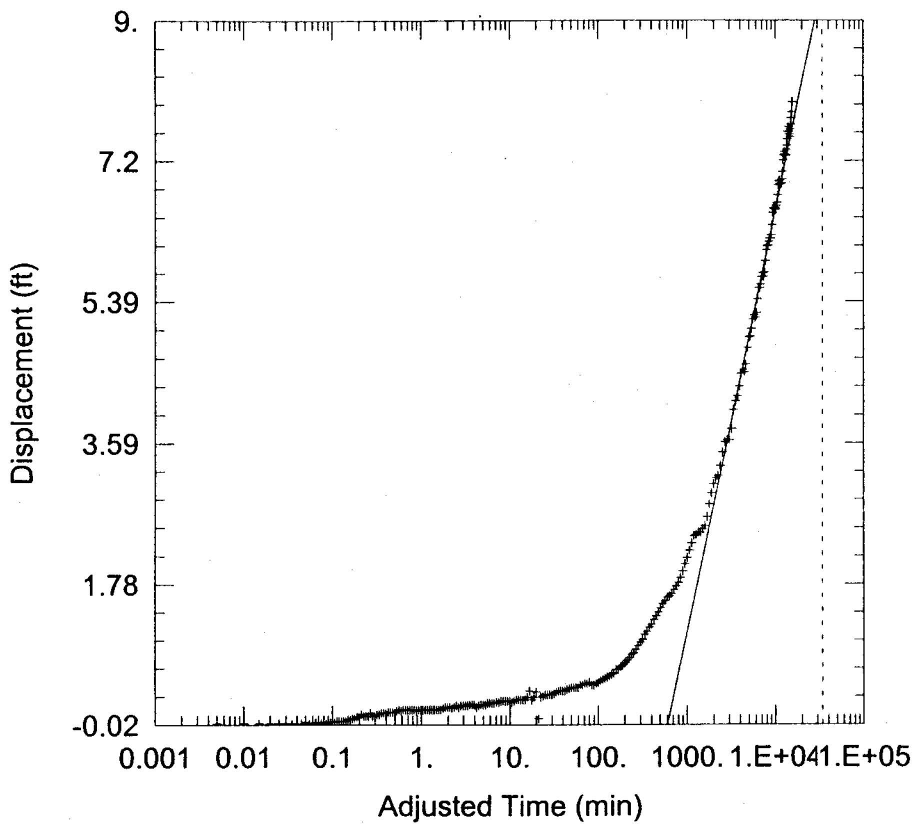
Parameter Correlations

	T	S
T	1.00	0.55
S	0.55	1.00

Residual Statistics

for weighted residuals

Sum of Squares ... 2790.3 ft^2
Variance........... 10.45 ft^2
Std. Deviation ..... 3.233 ft
Mean .... 2.878 ft
No. of Residuals... 269.
No. of Estimates... 2



BIG SANDY ENERGY PROJECT

Data Set: C:\891-06\OWC2.aqt
Date: 10/09/00 Time: 12:38:18

PROJECT INFORMATION

Company: Manera, Inc.
Client: Caithness
Project: 891-06
Test Location: Wikieup, Arizona
Test Well: PW2
Test Date: 9/11/00

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Jacob

T = 1.252E+04 ft^2/day
S = 0.2971

AQUIFER DATA

Saturated Thickness: 300. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW 1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
+ OWC2	200	0

Data Set: C:\891-06\OWC2.aqt
Title: Big Sandy Energy Project
Date: 10/09/00
Time: 12:38:44

PROJECT INFORMATION

Company: Manera, Inc.
Client: Caithness
Project: 891-06
Location: Wikieup, Arizona
Test Date: 9/11/00
Test Well: PW2

AQUIFER DATA

Saturated Thickness: 300. ft
Anisotropy Ratio (Kz/Kr): 1.

PUMPING WELL DATA

Number of pumping wells: 1

Pumping Well No. 1: PW 1

X Location: 0. ft
Y Location: 0. ft

No. of pumping periods: 2

Pumping Period Data

Time (min)	Rate (cu. ft/min)	Time (min)	Rate (cu. ft/min)
0.	256.7	1.584E+04	256.7

OBSERVATION WELL DATA

Number of observation wells: 1

Observation Well No. 1: OWC2

X Location: 200. ft
Y Location: 0. ft

No. of observations: 269

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.005	0.	5.915	0.254	1059.1	2.214
0.01	0.	6.266	0.254	1121.9	2.307
0.015	0.	6.64	0.254	1188.4	2.399
0.02	0.	7.035	0.268	1258.8	2.413
0.025	0.	7.453	0.268	1333.4	2.44

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.03	0.	7.896	0.281	1412.4	2.44
0.035	0.	8.366	0.281	1496.1	2.487
0.04	0.	8.865	0.281	1584.8	2.523
0.045	0.	9.391	0.281	1678.7	2.639
0.05	0.014	9.95	0.281	1778.2	2.8
0.055	0.	10.54	0.268	1883.5	2.943
0.06	0.	11.17	0.281	1995.1	3.059
0.065	0.014	11.83	0.3	2113.4	3.137
0.07	0.	12.53	0.3	2238.6	3.169
0.075	0.	13.28	0.3	2371.2	3.299
0.08	0.014	14.07	0.3	2511.8	3.469
0.085	0.	14.91	0.3	2660.6	3.603
0.09	0.014	15.79	0.332	2818.3	3.631
0.095	0.014	16.73	0.411	2985.3	3.631
0.1	0.014	17.72	0.3	3162.1	3.769
0.1058	0.014	18.78	0.332	3342.1	4.009
0.112	0.028	19.89	0.397	3522.1	4.12
0.1185	0.028	21.07	0.06	3702.1	4.184
0.1255	0.028	22.32	0.332	3882.1	4.309
0.1328	0.028	23.65	0.346	4062.1	4.466
0.1407	0.028	25.05	0.364	4242.1	4.521
0.149	0.046	26.54	0.364	4422.1	4.489
0.1578	0.046	28.12	0.364	4602.1	4.59
0.1672	0.06	29.79	0.364	4782.1	4.802
0.177	0.06	31.55	0.378	4962.1	4.932
0.1875	0.078	33.43	0.397	5142.1	4.946
0.1985	0.078	35.41	0.411	5322.1	5.042
0.2102	0.111	37.51	0.411	5502.1	5.162
0.2227	0.092	39.74	0.411	5682.1	5.218
0.2358	0.092	42.1	0.411	5862.1	5.185
0.2498	0.092	44.6	0.429	6042.1	5.245
0.2647	0.125	47.24	0.443	6222.1	5.421
0.2803	0.092	50.05	0.457	6402.1	5.564
0.297	0.092	53.01	0.457	6582.1	5.564
0.3147	0.111	56.16	0.457	6762.1	5.61
0.3333	0.111	59.49	0.457	6942.1	5.702
0.3532	0.125	63.02	0.489	7122.1	5.757
0.3742	0.125	66.76	0.489	7302.1	5.711
0.3963	0.125	70.72	0.507	7482.1	5.767
0.4198	0.138	74.91	0.507	7662.1	5.914
0.4447	0.138	79.35	0.521	7842.1	6.057
0.4697	0.138	84.06	0.489	8022.1	6.103
0.4963	0.138	89.05	0.489	8202.1	6.117
0.5247	0.157	94.33	0.507	8382.1	6.163
0.5547	0.171	99.92	0.521	8562.1	6.205
0.5863	0.157	105.8	0.54	8742.1	6.205
0.6213	0.171	112.1	0.554	8922.1	6.246
0.658	0.171	118.8	0.572	9102.1	6.376
0.6963	0.171	125.8	0.586	9282.1	6.532
0.738	0.171	133.3	0.604	9462.1	6.583
0.7813	0.171	141.2	0.618	9642.1	6.579

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.828	0.171	149.5	0.637	9822.1	6.592
0.8763	0.157	158.4	0.683	1.E+04	6.569
0.928	0.171	167.8	0.683	1.018E+04	6.62
0.983	0.171	177.7	0.715	1.036E+04	6.657
1.041	0.171	188.3	0.734	1.054E+04	6.754
1.103	0.171	199.4	0.766	1.072E+04	6.883
1.168	0.171	211.3	0.798	1.09E+04	6.929
1.238	0.171	223.8	0.83	1.108E+04	6.943
1.311	0.171	237.	0.877	1.126E+04	6.892
1.39	0.171	251.1	0.895	1.144E+04	6.902
1.473	0.171	266.	0.941	1.162E+04	6.902
1.561	0.171	281.7	0.992	1.18E+04	6.957
1.655	0.171	298.4	1.038	1.198E+04	7.054
1.753	0.189	316.1	1.07	1.216E+04	7.201
1.858	0.203	334.9	1.135	1.234E+04	7.266
1.968	0.203	354.7	1.167	1.252E+04	7.312
2.085	0.203	375.7	1.227	1.27E+04	7.275
2.21	0.189	398.	1.259	1.288E+04	7.257
2.341	0.203	421.6	1.324	1.306E+04	7.271
2.481	0.221	446.6	1.375	1.324E+04	7.34
2.63	0.203	473.	1.421	1.342E+04	7.391
2.786	0.221	501.1	1.472	1.36E+04	7.469
2.953	0.221	530.8	1.532	1.378E+04	7.566
3.13	0.221	562.2	1.564	1.396E+04	7.626
3.316	0.221	595.6	1.615	1.414E+04	7.561
3.515	0.235	630.8	1.629	1.432E+04	7.529
3.725	0.235	668.2	1.661	1.45E+04	7.497
3.946	0.235	707.8	1.712	1.468E+04	7.594
4.181	0.203	749.8	1.758	1.486E+04	7.658
4.43	0.221	794.2	1.804	1.504E+04	7.741
4.693	0.235	841.3	1.868	1.522E+04	7.82
4.973	0.235	891.1	1.951	1.54E+04	7.944
5.27	0.235	943.9	2.044	1.558E+04	7.944
5.583	0.254	999.9	2.122		

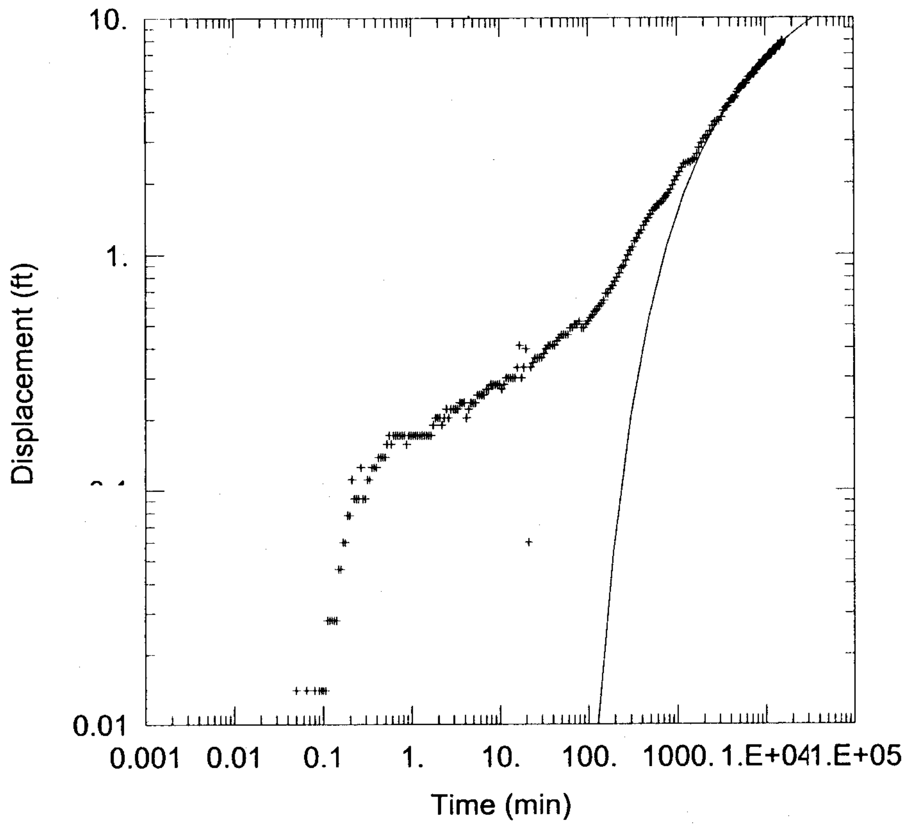
SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Jacob

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
T	1.252E+04	ft^2/day
S	0.2971	



BIG SANDY ENERGY PROJECT

Data Set: C:\891-06\OWC2.aqt
Date: 10/09/00 Time: 12:39:33

PROJECT INFORMATION

Company: Manera, Inc.
Client: Caithness
Project: 891-06
Test Location: Wikieup, Arizona
Test Well: PW2
Test Date: 9/11/00

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 1.077E+04 ft^2/day
S = 0.3816

AQUIFER DATA

Saturated Thickness: 300. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW 1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
+ OWC2	200	0

Data Set: C:\891-06\OWC2.aqt
Title: Big Sandy Energy Project
Date: 10/09/00
Time: 12:39:49

PROJECT INFORMATION

Company: Manera, Inc.
Client: Caithness
Project: 891-06
Location: Wikieup, Arizona
Test Date: 9/11/00
Test Well: PW2

AQUIFER DATA

Saturated Thickness: 300. ft
Anisotropy Ratio (Kz/Kr): 1.

PUMPING WELL DATA

Number of pumping wells: 1

Pumping Well No. 1: PW 1

X Location: 0. ft
Y Location: 0. ft

No. of pumping periods: 2

Pumping Period Data

Time (min)	Rate (cu. ft/min)	Time (min)	Rate (cu. ft/min)
0.	256.7	1.584E+04	256.7

OBSERVATION WELL DATA

Number of observation wells: 1

Observation Well No. 1: OWC2

X Location: 200. ft
Y Location: 0. ft

No. of observations: 269

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.005	0.	5.915	0.254	1059.1	2.214
0.01	0.	6.266	0.254	1121.9	2.307
0.015	0.	6.64	0.254	1188.4	2.399
0.02	0.	7.035	0.268	1258.8	2.413
0.025	0.	7.453	0.268	1333.4	2.44

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.03	0.	7.896	0.281	1412.4	2.44
0.035	0.	8.366	0.281	1496.1	2.487
0.04	0.	8.865	0.281	1584.8	2.523
0.045	0.	9.391	0.281	1678.7	2.639
0.05	0.014	9.95	0.281	1778.2	2.8
0.055	0.	10.54	0.268	1883.5	2.943
0.06	0.	11.17	0.281	1995.1	3.059
0.065	0.014	11.83	0.3	2113.4	3.137
0.07	0.	12.53	0.3	2238.6	3.169
0.075	0.	13.28	0.3	2371.2	3.299
0.08	0.014	14.07	0.3	2511.8	3.469
0.085	0.	14.91	0.3	2660.6	3.603
0.09	0.014	15.79	0.332	2818.3	3.631
0.095	0.014	16.73	0.411	2985.3	3.631
0.1	0.014	17.72	0.3	3162.1	3.769
0.1058	0.014	18.78	0.332	3342.1	4.009
0.112	0.028	19.89	0.397	3522.1	4.12
0.1185	0.028	21.07	0.06	3702.1	4.184
0.1255	0.028	22.32	0.332	3882.1	4.309
0.1328	0.028	23.65	0.346	4062.1	4.466
0.1407	0.028	25.05	0.364	4242.1	4.521
0.149	0.046	26.54	0.364	4422.1	4.489
0.1578	0.046	28.12	0.364	4602.1	4.59
0.1672	0.06	29.79	0.364	4782.1	4.802
0.177	0.06	31.55	0.378	4962.1	4.932
0.1875	0.078	33.43	0.397	5142.1	4.946
0.1985	0.078	35.41	0.411	5322.1	5.042
0.2102	0.111	37.51	0.411	5502.1	5.162
0.2227	0.092	39.74	0.411	5682.1	5.218
0.2358	0.092	42.1	0.411	5862.1	5.185
0.2498	0.092	44.6	0.429	6042.1	5.245
0.2647	0.125	47.24	0.443	6222.1	5.421
0.2803	0.092	50.05	0.457	6402.1	5.564
0.297	0.092	53.01	0.457	6582.1	5.564
0.3147	0.111	56.16	0.457	6762.1	5.61
0.3333	0.111	59.49	0.457	6942.1	5.702
0.3532	0.125	63.02	0.489	7122.1	5.757
0.3742	0.125	66.76	0.489	7302.1	5.711
0.3963	0.125	70.72	0.507	7482.1	5.767
0.4198	0.138	74.91	0.507	7662.1	5.914
0.4447	0.138	79.35	0.521	7842.1	6.057
0.4697	0.138	84.06	0.489	8022.1	6.103
0.4963	0.138	89.05	0.489	8202.1	6.117
0.5247	0.157	94.33	0.507	8382.1	6.163
0.5547	0.171	99.92	0.521	8562.1	6.205
0.5863	0.157	105.8	0.54	8742.1	6.205
0.6213	0.171	112.1	0.554	8922.1	6.246
0.658	0.171	118.8	0.572	9102.1	6.376
0.6963	0.171	125.8	0.586	9282.1	6.532
0.738	0.171	133.3	0.604	9462.1	6.583
0.7813	0.171	141.2	0.618	9642.1	6.579

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.828	0.171	149.5	0.637	9822.1	6.592
0.8763	0.157	158.4	0.683	1.E+04	6.569
0.928	0.171	167.8	0.683	1.018E+04	6.62
0.983	0.171	177.7	0.715	1.036E+04	6.657
1.041	0.171	188.3	0.734	1.054E+04	6.754
1.103	0.171	199.4	0.766	1.072E+04	6.883
1.168	0.171	211.3	0.798	1.09E+04	6.929
1.238	0.171	223.8	0.83	1.108E+04	6.943
1.311	0.171	237.	0.877	1.126E+04	6.892
1.39	0.171	251.1	0.895	1.144E+04	6.902
1.473	0.171	266.	0.941	1.162E+04	6.902
1.561	0.171	281.7	0.992	1.18E+04	6.957
1.655	0.171	298.4	1.038	1.198E+04	7.054
1.753	0.189	316.1	1.07	1.216E+04	7.201
1.858	0.203	334.9	1.135	1.234E+04	7.266
1.968	0.203	354.7	1.167	1.252E+04	7.312
2.085	0.203	375.7	1.227	1.27E+04	7.275
2.21	0.189	398.	1.259	1.288E+04	7.257
2.341	0.203	421.6	1.324	1.306E+04	7.271
2.481	0.221	446.6	1.375	1.324E+04	7.34
2.63	0.203	473.	1.421	1.342E+04	7.391
2.786	0.221	501.1	1.472	1.36E+04	7.469
2.953	0.221	530.8	1.532	1.378E+04	7.566
3.13	0.221	562.2	1.564	1.396E+04	7.626
3.316	0.221	595.6	1.615	1.414E+04	7.561
3.515	0.235	630.8	1.629	1.432E+04	7.529
3.725	0.235	668.2	1.661	1.45E+04	7.497
3.946	0.235	707.8	1.712	1.468E+04	7.594
4.181	0.203	749.8	1.758	1.486E+04	7.658
4.43	0.221	794.2	1.804	1.504E+04	7.741
4.693	0.235	841.3	1.868	1.522E+04	7.82
4.973	0.235	891.1	1.951	1.54E+04	7.944
5.27	0.235	943.9	2.044	1.558E+04	7.944
5.583	0.254	999.9	2.122		

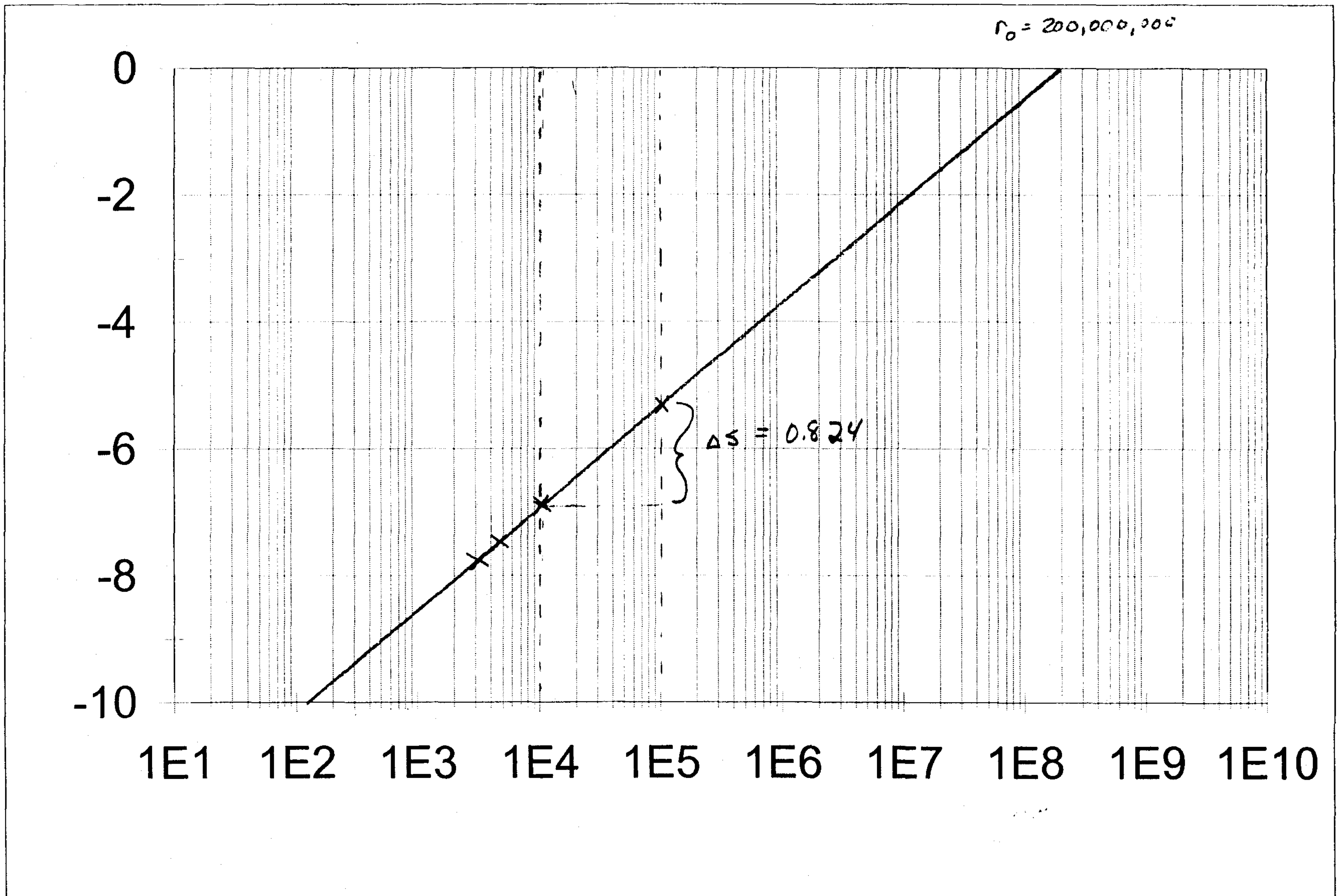
SOLUTION

Aquifer Model: Confined
Solution Method: Theis

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
T	1.077E+04	ft^2/day
S	0.3816	



$T = \frac{70\,Q}{\Delta s}$ $T = \frac{70\,(1920\text{ gpm})}{0.824}$ $T = 163\,106$ gpd/ft $S = \frac{Tt}{640\,r_0^2}$ $S = \frac{163\,106\,(15590)}{640\,(200,000,000)^2}$

$S = 3.9 \times 10^{-11}$

EXHIBIT C - AREAS OF BIOLOGICAL WEALTH

As stated in Arizona Corporation Commission Rules of Practice and Procedure R14-3-219:

"Describe any areas in the vicinity of the proposed site or route which are unique because of biological wealth or because they are habitats for rare and endangered species. Describe the biological wealth or species involved and state effects, if any, the proposed facilities will have thereon"

BIOLOGICAL WEALTH

The area of interest supporting biological resources in the vicinity of the proposed Project includes the Plant site, ancillary facilities, and the proposed route for the natural gas pipeline along U.S. Highway 93 and Mohave County Hackberry Road and Plant access road. The area supports a complex mosaic of upland Sonoran and Mojave Desert vegetation with xeroriparian vegetation along numerous washes of the Big Sandy basin, and small areas of agricultural and developed lands. A complete description of the vegetation communities of the Project area is presented in Exhibit C-1. The proposed Plant site is located near the transition between Sonoran Desert and Mojave Desert vegetation.

The Sonoran Desert vegetation at the south end of the Project area in the vicinity of the Plant site is characterized by creosote bush flats, interrupted by upland desert scrub on rocky slopes. Creosote bush (*Larrea tridentata*) and white bursage (*Ambrosia dumosa*) are the dominant plant species in the flats, with species such as brittlebush (*Encelia farinosa*), ocotillo (*Fouquieria splendens*), box thorn (*Lycium* spp.), galleta grass (*Hilaria rigida*), rhatany (*Krameria* spp.), and cacti (*Opuntia* spp.) being found in lower densities. Saguaros (*Carnegia gigantea*) are present in very low densities in the flats, but can be more abundant on rocky slopes.

The Mojave Desert vegetation, which covers the majority of the Project area along the proposed pipeline route, is dominated by creosote bush and white bursage, with a lesser component of Joshua tree (*Yucca brevifolia*), bladder sage (*Salazaria mexicana*), galleta grass, cacti, catclaw (*Acacia greggii*), and saltbush (*Atriplex* spp.).

Numerous washes with varying densities of xeroriparian vegetation, including the Big Sandy River, are found in the vicinity of the Plant site and access road. Dominant vegetation in these areas includes ironwood (*Olneya tesota*), mesquite (*Prosopis* spp.), palo verde (*Cercidium floridum*), and tamarisk (*Tamarix* spp.). **Small areas of wetlands have been delineated on the Plant site and at the proposed pipeline crossing of the Big Sandy River. Delineation of wetlands and waters of the U.S. is contained in Exhibit C-2.**

Agricultural and developed areas are very limited within the area and are found primarily near Wikieup. Non-native, weedy, and crop species are typically dominant in these areas.

Threatened, endangered, proposed, and candidate plant and wildlife species likely to occur in the Project area were identified by the U.S. Fish and Wildlife Service (USFWS). Wildlife of Special Concern species were identified by the Arizona Game and Fish Department (AGFD), and Highly Safeguarded Protected Native Plants were identified by the Arizona Department of Agriculture. Sensitive Species were identified by the Bureau of Land Management (BLM) in their Resource

Management Plan. **Special Status Species are those species which are declining in number throughout their range and for which specific threats to existing populations or habitat have been identified. Table C-1 presents the Special Status Species potentially occurring within the region, listed by both common and scientific name, habitat associations, and status.**

The variety of vegetation types present in the area provides habitat for a number of federal and state listed Special Status Species. **The extent of occurrence of Special Status Species in the area and their relationship to the proposed facilities has been determined through literature review and site specific studies. Surveys for Special Status Species have been conducted during baseline studies for the EIS to determine the location and extent of their occurrence and habitat. Specific studies for the southwestern willow flycatcher, western yellow-billed cuckoo, bat species, nesting raptors, and native fish have been conducted. Results of these surveys are presented in Exhibits C-3, Wildlife Resources, and C-4, Aquatic Resources.**

Potential Effects

The primary potential effects of the proposed Project include short-term disturbance of vegetation and disturbance, injury, or mortality of wildlife species along the pipeline alignment, and both short- and long-term similar impacts to vegetation and wildlife at the Plant site and along the access road. The Plant site is adjacent to an existing transmission line; therefore, no additional transmission lines will be constructed as part of this Project.

The proposed natural gas pipeline alignment is located adjacent to an existing highway. Clearing of the pipeline alignment would not increase the fragmentation of the existing vegetation in the area. The entire route will be surveyed for Special Status Species prior to construction. Site-specific mitigation measures will be implemented that avoid any impacts to federally-listed threatened and endangered species, and minimize any impacts to state and federal listed sensitive species. Upon completion of construction, the alignment will be revegetated and will be available as wildlife habitat or other uses compatible with current or planned highway right-of-way. No long-term impacts to vegetation or wildlife are anticipated along the pipeline alignment.

The Plant site is located in upland desert scrub vegetation, some of which will be cleared during construction. The natural gas pipeline and the new access road will be built in the same right-of-way from the highway to the Plant site to minimize impacts. Following construction, areas outside of the power island, switchyard, and access roadwell field that were disturbed during construction will be revegetated. Areas occupied by surface facilities will not be revegetated, and these areas will be lost as wildlife habitat. The entire site will be surveyed for Special Status Species prior to construction. Site-specific mitigation measures will be implemented that avoid any impacts to federally-listed threatened and endangered species, and minimize any impacts to state and federal listed sensitive species. Compared to the total amount of habitat available in the Project area, the amount of long-term disturbance and habitat loss at the Plant site is considered minimal.

The construction and operation of the Project is not expected to have any adverse effect on any federally listed threatened or endangered species, or any state or BLM designated sensitive species. Further, the permanent loss of suitable habitat for these species in the Project area will be negligible in extent.

Table C-1
Big Sandy Energy Project
Special Status Species That May Occur in the Project Area

Common Name (*Scientific Name*)	Federal Status[1]	State Status[2]	Habitat Types Utilized			
			Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural/ Developed
BIRDS						
Bald eagle (*Haliaeetus leucocephalus*)	T	SC		✔	✔	✔
Common black hawk (*Buteogallus anthracinus*)	SS	SC	✔	✔	✔	✔
Cooper's hawk (*Accipiter cooperii*)	SS	SC		✔	✔	
Ferruginous hawk (*Buteo regalis*)	SS	SC	✔	✔	✔	✔
Golden eagle (*Aquila chrysaetos*)	SS	SC	✔	✔	✔	✔
Merlin (*Falco columbarius*)	SS	SC	✔	✔	✔	✔
Mountain plover (*Charadrius montanus*)	PT	SC				✔
Peregrine falcon (*Falco peregrinus*)		SC	✔	✔	✔	✔
Sharp-shinned hawk (*Accipiter striatus*)	SS	SC		✔	✔	
Southwestern willow flycatcher (*Empidonax trailii extimus*)	E	SC			✔	
Western bluebird (*Sialia mexicana*)	SS	SC		✔	✔	✔
Yellow-billed cuckoo (*Coccyzus americanus*)	SS	SC			✔	
Zone-tailed hawk (*Buteo albonotatus*)	SS	SC	✔	✔	✔	✔
MAMMALS						
Big free-tailed bat (*Tadarida macrotis*)	SS	SC	✔	✔	✔	
California leaf-nosed bat (*Macrotis californicus*)	SS	SC	✔	✔	✔	
Cave myotis (*Myotis velifer*)	SS	SC	✔	✔	✔	
Fringed myotis (*Myotis thysanodes*)	SS	SC		✔	✔	

Table C-1 (continued)
Big Sandy Energy Project
Special Status Species That May Occur in the Project Area

Common Name (*Scientific Name*)	Federal Status[1]	State Status[2]	Habitat Types Utilized			
			Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural/ Developed
Greater western mastiff bat (*Eumops perotis californicus*)	SS	SC	✔	✔	✔	
Occult little brown bat (*Myotis lucifugus occultus*)	SS	SC	✔	✔	✔	
Small-footed myotis (*Myotis ciliolabrum*)	SS	SC	✔	✔	✔	
Townsend's big-eared bat (*Plecotus townsendii*)	SS	SC	✔	✔	✔	
Reptiles						
Desert night lizard (*Xantusia vigilis vigilis*)	SS	SC	✔	✔		
Desert rosy boa (*Lichanura trivirgata gracia*)	SS	SC	✔	✔		
Desert tortoise (*Gopherus agassizii*)	SS	SC	✔	✔	✔	
Gila monster (*Heloderma suspectum*)	SS	SC	✔	✔	✔	✔
AMPHIBIANS						
Arizona toad (*Bufo microscaphus microscaphus*)	SS	SC			✔	
Lowland leopard frog (*Rana yavapaiensis*)	SS	SC			✔	
FISH						
Desert sucker (*Catostomus clarki*)	SS	SC			✔	
Longfin dace (*Agosia chrysogaster*)	SS	SC			✔	
Roundtail chub (*Gila robusta*)	SS	SC			✔	
Sonoran sucker (*Catostomus insignis*)	SS	SC			✔	
Speckled dace (*Rhinichthys osculus*)	SS	SC			✔	
PLANTS						

Table C-1 (continued)
Big Sandy Energy Project
Special Status Species That May Occur in the Project Area

Common Name (*Scientific Name*)	Federal Status[1]	State Status[2]	Habitat Types Utilized			
			Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural/ Developed
Arizona necklace (*Sophora arizonica*)	SS		✔	✔	✔	
Crownless milkweed vine (*Cynanchum utahense*)	SS		✔	✔		
Linear-leaf sand spurge (*Stillingia linearifolia*)	SS		✔	✔	✔	
Sand cholla (*Opuntia pulchella*)	SS		✔	✔		
Thorn Milkwort (*Polygala acnathoclada*)	SS		✔	✔		

1 Federal Status: E = Endangered; T = Threatened; PT = Proposed for Threatened Listing; SS = BLM Sensitive Species
2 State Status: SC = Species of Special Concern; HS = Highly Safeguarded Protected Native Plants.

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EXHIBIT C-1

VEGETATION TECHNICAL REPORT

REPORT

BIG SANDY ENERGY PROJECT
VEGETATION TECHNICAL REPORT

Submitted by:

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September 2000

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INTRODUCTION

Caithness Big Sandy, L.L.C. proposes to develop, construct, own, and operate the Big Sandy Energy Project (Project), combined-cycle power plant (Plant) near the unincorporated community of Wikieup, approximately 40 miles southeast of the City of Kingman, along U.S. Highway 93 in Mohave County, Arizona. Please refer to the Big Sandy Energy Project Description for a detailed description of the Project.

The purpose of the study was to inventory the vegetative resources within an analysis area for the Project and delineate the vegetation communities that may be affected by the proposed Project and alternatives. Particular emphasis was placed on federal- and state-listed species, sensitive plant species identified by the Bureau of Land Management (BLM), and highly diverse habitats, including floodplains and wetlands. The resource surveys conducted in May and June of 2000 provided sufficient baseline detail for creating a vegetation map.

ANALYSIS AREA

The analysis area **(Figure 1)** for the Project includes: the 120-acre Plant site and its access corridor (200 feet in width); 2) the 320-acre ranch site southwest of the Plant site and the western half of section 7 (Township 15 North, Range 13 West); and 3) alternative pipeline routes that parallel U.S. Highway 93 and Hackberry Road and parallel the Mead-Phoenix Project 500 kV transmission line require approximately 36 miles of gas pipeline. A one-mile buffer around each site and alternative pipeline route is included in the analysis area. Analysis begins in the Knight Creek/Big Sandy River Corridor north of Interstate 40 (T21N, R13W) and follows U.S. Highway 93 to the proposed site located in Section 5, T15N, R12W. The analysis area is generally confined to the Knight Creek/Big Sandy River floodplain and closely adjacent uplands that might be affected by any changes in the hydrology of the Big Sandy River.

BACKGROUND RESEARCH

A literature search was conducted to identify the vegetation communities that may be present in the analysis area and the typical species found in these communities. Existing vegetation maps, and satellite imagery were compiled into initial maps of riparian and vegetation communities that are present in the analysis area. Arizona GAP data were not used in this effort due to a lack of sufficient resolution for thorough analysis of Project effects. Special emphasis was placed on locating known and potential areas of habitat for Arizona State and BLM sensitive plant species, particularly old lakebed deposits in the Knight Creek/Big Sandy Valley. **Table 1** contains a preliminary list of federally-listed plant species obtained from the U.S. Fish and Wildlife Service (USFWS). The Arizona State list includes all species listed in the Arizona Department of Agriculture's List of Highly Safeguarded Protected Native Plants.

OVERSIZED
DOCUMENT

MAP

SEE SUPERVISOR
(EXHIBIT CABINET)

Table 1
USFWS and BLM Listed Special Status Plant Species That May Be Present in the Analysis Area

Common Name	Scientific Name
Arizona cliffrose	*Purshia subintegra*
Arizona necklace	*Sophora arizonica*
Crownless milkweed vine	*Cynanchum utahense*
Linear-leaf sand spurge	*Stillingia linearifolia*
Sand cholla	*Opuntia pulchella*
Thorn milkwort	*Polygala acnathoclada*

Data sources that were utilized include:

- Initial vegetation mapping based on recent LANDSAT satellite imagery.
- Initial field-based vegetation community descriptions including lists of dominant plant species present in each community.
- Plant Species that may Occur in the Project area (Table D-1 from the ACC application).
- Ecological/range site information from the NRCS Soil Survey, Soil Survey Area 627.
- U.S. Fish and Wildlife Service lists of Threatened, Endangered, Proposed, and Candidate species.
- Arizona Department of Agriculture List of Highly Safeguarded Protected Native Plants.

FIELD SURVEY METHODS

Detailed field surveys were conducted to confirm and refine the descriptions of vegetation communities in the analysis area. The species list of plants occurring in each vegetation community, as determined during the baseline data collection, was confirmed and expanded as necessary, based on a detailed inventory of species present in each community. The riparian/wetland vegetation within the areas potentially affected by the proposed action and alternatives was identified and recorded.

The data relevant to the two-mile wide study corridors and the Plant site were refined through field inspections of approximately 90% of the analysis area. Surveys were conducted from existing roads, trails and washes or on foot. Photographs were taken and recorded. The inventory, rather than attempting to account for all species of plants in the study area, was aimed at accounting for those individual species and habitats of notable concern. This includes dominant and common associate species that define vegetative communities as well as listed species of concern. The analysis area was surveyed for presence of Arizona State and BLM sensitive species as listed in **Table 1.** When reviewing the inventory results of the vegetation studies, refer to the accompanying species tables (**Tables 3 to 7** contained at the end of this document) and the vegetation map (**Figure 1**).

RESULTS

Nearly the entire study area consists of upland Mohave and Sonoran Desert vegetative communities, with scattered occurrences of juniper communities. Associations of creosotebush and bursage are the dominant features except in some regions of higher elevation. Paloverde dominated woodlands with saguaro and other cacti are common at lower elevations. Complex intergradations of Sonoran and Mohave desert plant communities exist in the vicinity of Wikieup and Cane Springs. At higher elevations, the desert communities give way to conifer woodlands of juniper with scattered pinyon pine. In some areas, crucifixion thorn is the dominant species, replacing creosotebush and paloverde.

The remaining lowland, fluvial habitats of the study area are floristically characterized by Mohave and Sonoran wash communities. Within these major vegetative communities are local, limited occurrences of riparian (stream-side or wash-side) scrub and riparian woodlands. Very small emergent plant communities are locally present along the Big Sandy River, and at other scattered localities (e.g., irrigation ditches and springs). Other communities present include floodplain woodlands ranging from mesquite-saltcedar-arrowweed communities to broadleaf riparian forests of willow and cottonwoods along the Big Sandy River and such streams as Burro Creek, Trout Creek, Cane Springs, and Sycamore Creek. Ephemeral drainages may support stands of catclaw or complex mixes of mesquite-catclaw-desert willow and a variety of other shrubs.

The limits of a particular vegetation community are determined by climate (minimum seasonal temperatures, minimum seasonal precipitation). The actual boundaries, therefore, are often tenuous and commonly determined by local phenomena - elevation, longitude, slope exposure, cold air drainages, soil porosity, etc. Accordingly, local microclimates may result in the unusual occurrence of one or more communities in an area, contributing to the overall diversity of the greater area. Maps depicting vegetation communities are based primarily on natural vegetation. Even when one recognizes prescribed units of natural vegetation, it may be difficult to draw a line separating them. It soon becomes apparent that the various classifications of vegetation often form broad ecotones, intergrading over a considerable area. The vegetation communities identified here are those in the hierarchical classification system developed by Brown (1994), primarily for southwest ecosystems.

Particularly difficult to resolve, and to delineate for mapping purposes, are the ecotones between Sonoran and Mohave desertscrub. These difficulties are resolved in many cases by drawing an arbitrary line through the approximate center of the discontinuous phase between these ecosystems.

Figure 1 delineates vegetation communities within the analysis area, including riparian/wetland areas. Dominant plant species were used to delineate the communities. The Project and alternatives, including 1 mile buffers around the analysis area are also delineated on the map. No Arizona State and BLM sensitive plant species were observed in the Project area. Vegetation community naming is adapted from Brown (1994). Several more detailed vegetation map units were created to better delineate site-specific vegetation communities. The vegetation communities, including riparian areas, and other map units that were used to delineate vegetative cover in the analysis area are included in **Table 2**. A total of 17 community types were identified in the approximately 80,000 acres surveyed and mapped. Plant species nomenclature was based on Kearney et al. (1960).

Table 2
Vegetation Community Acreages Present in the Analysis Area

	Community Types	Acreage
A	Great Basin Conifer Woodland	5,373.9
B	Mohave Desertscrub Ecosystem: Mixed Scrub	4,777.8
C	Mohave Desertscrub Ecosystem: Catclaw Series	694.5
D	Disturbed/Urban Areas	1,024.2
E	Great Basin Ecosystem: Mixed Scrub Series	397.9
F	Great Basin Ecosystem: Rabbitbrush Series	95.4
G	Mohave Desertscrub Ecosystem: Mesquite Series	889.0
H	Mohave Desertscrub Ecosystem: Creosotebush	20,717.8
I	Mohave Riparian Ecosystem: Wash Series	831.6
J	Flood-damaged Wash	1,972.6
K	Sonoran Riparian Ecosystem: Sonoran Wash	585.5
L	Sonoran Desertscrub Ecosystem: Arizona Upland	37,100.3
M	Sonoran Desertscrub Ecosystem: Mesquite Series	2,657.6
N	Sonoran Riparian Ecosystem:	166.6
O	Mohave Desertscrub Ecosystem: Joshua Tree	1,219.5
P	Sonoran Riparian Ecosystem: Saltcedar/Mesquite	1,253.9
Q	Sonoran Riparian Ecosystem: Burrobush Series	63.0
	Total Acreage:	79,822.0

The following sections briefly describe each of the major vegetation communities within the analysis area relative to their botanical species composition and geographic occurrence.

A. Great Basin Conifer Woodland Ecosystem: Pinyon/Juniper Series

Pinyon-juniper and juniper woodlands are the characteristic features of this vegetation community. These trees rarely exceed 12 meters in height and are typically openly spaced. The shorter, bushier junipers are generally more prevalent in the analysis area than pinyon pines, which occur more frequently at higher elevations. The understory is composed of grasses (e.g., galleta and grama), groundsel, blackbrush, turpentine broom, and snakeweed. Rabbitbrush, Mormon tea, and jojoba may also be subdominant associates. Several cacti are represented in the Great Basin Conifer Woodland as well. **Table 3** is a listing of some common plant species that occur within the Great Basin Conifer Woodlands. There is very limited occurrence of this community in the north end of the study area.

B. Mohave Desertscrub Ecosystem: Mixed Scrub Series

Major dominant plants occurring within Mohave desertscrub include creosotebush, brittlebush, white bursage and desert holly. These species exhibit codominance and are quite variable throughout the analysis area. Cacti are also well represented in the mixed scrub community. Mohave Desertscrub ranges from the north edge of the analysis area to a transition zone with Sonoran Desertscrub near Cane Springs Wash. **Table 4** is a listing of some common plant species that occur within the Mohave Desertscrub plant community.

C. Mohave Desertscrub Ecosystem: Catclaw Series

Drier washes traversing creosotebush flats are commonly dominated along the edges by trees such as catclaw, mesquite, and desert willow. This series is specifically dominated by catclaw which forms dense woodlands. Woodlands occur along the riparian areas in dry washes of the Big Sandy River and its associated streams. Associate shrub species may include bebbia, wolfberry, and burrobush.

D. Disturbed/Urban Areas

This map unit was used to define disturbed and urban areas such as gravel pits, agriculture, buildings, ranches and larger highway corridors.

E. Great Basin Ecosystem: Mixed Scrub Series

The mixed scrub division of the Great Basin woodland is dominated by crucifixion thorn, pygmy cedar, white rhatany, and other shrub species. This community occurs at higher elevations on the north end of the Project area only. It is often associated with pinyon/juniper woodlands.

F. Great Basin Ecosystem: Rabbitbrush Series

A small portion of the north end of the analysis area site consists of a community dominated by rabbitbrush. This community is associated with pinyon/juniper and Mohave desertscrub communities. It was encountered in only one location in the analysis area (**Table 2**).

G. Mohave Desertscrub Ecosystem: Mesquite Series

The mesquite series of the Mohave riparian areas is the most common riparian community in the northern section of the analysis area. Mesquite forms dense woodlands in dry washes and streams of the Big Sandy River valley. A mix of catclaw and mesquite occurs in some floodplain areas as well.

Table 3
Common Plant Species of the Great Basin Conifer Woodland Ecosystem
Pinyon-Juniper Community

Scientific Name	Common Name	Family
Aristida purpurea	Purple three-awn	Poaceae
Aristida adscensionis	Six-weeks three-awn	Poaceae
Bouteloua hirsuta	Hairy grama	Poaceae
Canotia holacantha	Crucifixion thorn	Celastraceae
Ceanothus greggii	Buckbrush	Rhamnaceae
Chilopsis linearis	Desert willow	Bignoniaceae
Chrysothamnus nauseosus	Rubber rabbitbrush	Asteraceae
Echinocereus engelmanii	Hedgehog cactus	Cactaceae
Ephedra trifurca	Mormon tea	Ephedraceae
Erioneuron pulchellum	Fluffgrass	Poaceae
Gutierrezia sarothrae	Small-headed snakeweed	Asteraceae
Hilaria rigida	Big galleta	Poaceae
Juniperus osteosperma	One-seed juniper	Cupressaceae
Krameria grayi	White rhatany	Krameriaceae
Opuntia basilaris	Beavertail	Cactaceae
Opuntia engelmannii	Engelmann prickly pear	Cactaceae
Opuntia leptocaulis	Christmas cholla	Cactaceae
Opuntia acanthocarpa	Buckhorn cholla	Cactaceae
Peucephyllum schotti	Pygmy cedar (Desert fir)	Asteraceae
Pinus monophylla	Pinyon pine	Pinaceae
Salazaria mexicana	Bladdersage	Lamiaceae
Simmondsia chinensis	Jojoba	Simmondsiaceae
Yucca baccata	Banana yucca	Agavaceae

Table 4
Common Plant Species of the Mohave Desertscrub Ecosystem

Scientific Name	Common Name	Family
Acacia greggii	Catclaw	Fabaceae
Ambrosia dumosa	White bursage	Asteraceae
Aristida adscensionis	Six-weeks three-awn	Poaceae
Aristida purpurea	Purple three-awn	Poaceae
Atriplex hymenelytra	Desert holly	Chenopodiaceae
Bouteloua hirsuta	Hairy grama	Poaceae
Bromus madritensis	Red brome	Poaceae
Canotia holacantha	Crucifixion thorn	Celastraceae
Chrysothamnus nauseosus	Rubber rabbitbrush	Asteraceae
Coleogyne ramosissima	Blackbrush	Roseaceae
Echinocereus engelmanii	Hedgehog cactus	Cactaceae
Encelia farinosa	White brittlebush	Asteraceae
Encelia frutescens	Brittlebush	Asteraceae
Ephedra viridis	Mormon tea	Ephedraceae
Eriogonum inflatum	Desert trumpet	Polygonaceae
Eriogonum fasciculatum	Wild buckwheat	Polygonaceae
Erioneuron pulchellum	Fluffgrass	Poaceae
Ferocactus cylindraceus	Barrel cactus	Cactaceae
Gutierrezia sarothrae	Small-headed snakeweed	Asteraceae
Hilaria rigida	Big galleta	Poaceae
Krameria grayi	White rhatany	Krameriaceae
Larrea tridentata	Creosotebush	Zygophyllaceae
Mammillaria microcarpa	Arizona fishhook cactus	Cactaceae
Opuntia echinocarpa	Silver cholla	Cactaceae
Opuntia erinacea	Prickly-pear cactus	Cactaceae
Opuntia acanthocarpa	Buckhorn cholla	Cactaceae
Opuntia basilaris	Beavertail	Cactaceae
Opuntia leptocaulis	Christmas cholla	Cactaceae

Table 4 (continued)
Common Plant Species of the Mohave Desertscrub Ecosystem

Scientific Name	Common Name	Family
Opuntia ramosissima	Diamond cholla	Cactaceae
Phoradendron californicum	Desert mistletoe	Viscaceae
Salazaria mexicana	Bladdersage	Lamiaceae
Sphaeralcea ambigua	Desert globemallow	Malvaceae
Thamnosma montana	Turpentine broom	Rutaceae
Yucca baccata	Banana yucca	Agavaceae
Yucca schidigera	Mohave yucca	Agavaceae

H. Mohave Desertscrub Ecosystem: Creosotebush Series

Creosotebush is a wide-ranging dominant and was the second most common type in the analysis area (**Table 2**). Most often it is the only tall shrub in the community. However, creosotebush has common associations with white bursage, bladdersage, brittlebush, and white rhatany.

I. Mohave Riparian Ecosystem: Wash Series

Riparian wash scrublands occur along drainages throughout the analysis area. Vegetation along such washes ranges from very sparse to moderately dense and well-developed. Generally, washes in the Mohave desertscrub community do not contain a large variety of different species; nor do they contain the larger individuals that are found on adjacent inter-wash sites. Most washes are dominated by burrobrush, along with shrubby species such as bebbia, bladdersage and rabbitbrush. Seldom is there continuous cover along the banks of washes. **Table 5** contains common plant species that may be found in the Mohave Riparian communities.

J. Flood-damaged Wash

This community is different from the riparian wash communities because the vegetation has not reestablished itself entirely, following catastrophic flooding in 1993. Typically there is 40-80% bare sand and the vegetation that is present is sparsely distributed. Species that may be present are burrobush, tree tobacco, sandpaper plant and seep willow. Flood damaged communities are also easily invaded by saltcedar saplings.

Table 5
Common Plant Species of the Mohave Riparian Ecosystem

Scientific Name	Common Name	Family
Acacia greggii	Catclaw	Fabaceae
Ambrosia dumosa	White bursage	Asteraceae
Aristida adscensionis	Six-weeks three-awn	Poaceae
Aristida purpurea	Purple three-awn	Poaceae
Atriplex hymenelytra	Desert holly	Chenopodiaceae
Bouteloua hirsuta	Hairy grama	Poaceae
Bromus madritensis	Red brome	Poaceae
Canotia holacantha	Crucifixion thorn	Celastraceae
Chrysothamnus nauseosus	Rubber rabbitbrush	Asteraceae
Coleogyne ramosissima	Blackbrush	Roseaceae
Echinocereus engelmanii	Hedgehog cactus	Cactaceae
Encelia farinosa	White brittlebush	Asteraceae
Encelia frutescens	Brittlebush	Asteraceae
Ephedra viridis	Mormon tea	Ephedraceae
Eriogonum inflatum	Desert trumpet	Polygonaceae
Eriogonum fasciculatum	Wild buckwheat	Polygonaceae
Erioneuron pulchellum	Fluffgrass	Poaceae
Ferocactus cylindraceus	Barrel cactus	Cactaceae
Gutierrezia sarothrae	Small-headed snakeweed	Asteraceae
Hilaria rigida	Big galleta	Poaceae
Krameria grayi	White rhatany	Krameriaceae
Larrea tridentata	Creosotebush	Zygophyllaceae
Mammillaria microcarpa	Arizona fishhook cactus	Cactaceae
Opuntia echinocarpa	Silver cholla	Cactaceae
Opuntia erinacea	Prickly-pear cactus	Cactaceae
Opuntia acanthocarpa	Buckhorn cholla	Cactaceae
Opuntia basilaris	Beavertail	Cactaceae
Opuntia leptocaulis	Christmas cholla	Cactaceae

Table 5 (continued)
Common Plant Species of the Mohave Riparian Ecosystem

Scientific Name	Common Name	Family
Opuntia ramosissima	Diamond cholla	Cactaceae
Phoradendron californicum	Desert mistletoe	Viscaceae
Salazaria mexicana	Bladdersage	Lamiaceae
Sphaeralcea ambigua	Desert globemallow	Malvaceae
Thamnosma montana	Turpentine broom	Rutaceae
Yucca baccata	Banana yucca	Agavaceae
Yucca schidigera	Mohave yucca	Agavaceae

K. Sonoran Riparian Ecosystem: Sonoran Wash Series

The Sonoran wash community is comprised of a dense shrub layer. In these areas where riparian woodlands have been eliminated (for example the flood damage of 1993), scrublands dominated by burrobush, arrowweeds, seep willows and saltcedar are present. **Table 6** is a listing of the common plant species that are found in the Sonoran Riparian areas.

L. Sonoran Desertscrub Ecosystem: Arizona Upland Subdivision

The Arizona Upland Subdivision of the Sonoran Desertscrub is a very complex ecosystem with many species of shrubs and cacti along with several tree species. This was the most dominate community type encountered during the survey (**Table 2**). The most characteristic plant association in this subdivision is the mixed paloverde-cactus scrub. Low growing leguminous trees (e.g. catclaw, mesquite and paloverde) occur commonly, frequently above a complex shrub/cactus understory composed of white bursage, creosotebush and many other species. The saguaro and ocotillo are also found as a characteristic species. The larger shrub and tree species are often restricted to washes and form the common riparian scrub associations mentioned in this section. **Table 7** is a listing of the common plant species that are found in the Sonoran Desertscrub within the analysis area.

M. Sonoran Desertscrub Ecosystem: Mesquite Series

Washes in Sonoran riparian areas are dominated by mesquite. This community type occurs on a large portion of the analysis area that is adjacent to the Big Sandy River.

N. Sonoran Riparian Ecosystem: Cottonwood/Willow Series

Cottonwood/willow series are characteristic of interior southwestern riparian deciduous forests and woodlands. Interior riparian deciduous forests are highly diverse assemblages that occur on permanent or semi-permanent (seasonally intermittent) streams throughout the analysis area.

Table 6
Common Plant Species of the Sonoran Riparian Ecosystem

Scientific Name	Common Name	Family
Acacia greggii	Catclaw	Fabaceae
Amsinckia intermedia	Fiddlehead	Boraginaceae
Anemopsis californica	Yerba-mansa	Saururaceae
Baccharis sarothroides	Desert broom	Asteraceae
Baccharis salicifolia	Seepwillow	Asteraceae
Bebbia juncea	Sweetbush	Asteraceae
Cercidium microphyllum	Foothill paloverde	Fabaceae
Encelia farinosa	White brittlebush	Asteraceae
Eriogonum inflatum	Desert trumpet	Polygonaceae
Eriogonum deflexum	Skeleton weed	Polygonaceae
Erioneuron pulchellum	Fluffgrass	Poaceae
Hymenoclea salsola	Burrobush	Asteraceae
Juncus acutus	Rush	Juncaceae
Larrea tridentata	Creosotebush	Zygophyllaceae
Lycium andersonii	Anderson wolfberry	Solanaceae
Nicotiana obtusifolia	Desert tobacco	Solonaceae
Nicotiana glauca	Tree tobacco	Solonaceae
Petalonyx thurberi	Sandpaper plant	Loasaceae
Pluchea sericea	Arroweed	Asteraceae
Populus fremontii	Fremont's cottonwood	Salicaceae
Prosopis glandulosa	Honey mesquite	Fabaceae
Psilotrophe cooperi	Paperdaisy	Asteraceae
Ranunculus aquaticus		Ranunculaceae
Salix gooddingii	Goodding's black willow	Salicaceae
Salvia columbariae	Chia	Lamiaceae
Sarcostemma cynanchoides	Climbing milkweed	Asclepiadaceae
Scirpus americana	Three-square	Cyperaceae
Senecio douglasii	Thread-leaf groundsel	Asteraceae
Senna covesii	Senna	Fabaceae
Tamarix ramosissima	Saltcedar/Tamarisk	Tamaricaceae
Ziziphus obtusifolia	Graythorn	Rhamnaceae

Table 7
Common Plant Species of the Sonoran Desertscrub Ecosystem

Scientific Name	Common Name	Family
Acacia greggii	Catclaw	Fabaceae
Ambrosia dumosa	White bursage	Asteraceae
Amsinckia intermedia	Fiddlehead	Boraginaceae
Aristida purpurea	Purple three-awn	Poaceae
Canotia holacantha	Crucifixion thorn	Celastraceae
Carnegiea gigantea	Saguaro cactus	Cactaceae
Cercidium microphyllum	Foothill paloverde	Fabaceae
Echinocereus engelmanii	Hedgehog cactus	Cactaceae
Encelia farinosa	Brittlebush	Asteraceae
Ephedra viridis	Mormon tea	Ephedraceae
Eriogonum inflatum	Desert trumpet	Polygonaceae
Eriogonum fasciculatum	Wild buckwheat	Polygonaceae
Eriogonum deflexum	Skeletonweed	Polygonaceae
Erioneuron pulchellum	Fluffgrass	Poaceae
Ferocactus cylindraceus	Barrel cactus	Cactaceae
Fouquieria splendens	Ocotillo	Fouquieriaceae
Hilaria rigida	Big galleta	Poaceae
Krameria grayi	White rhatany	Krameriaceae
Larrea tridentata	Creosotebush	Zygophyllaceae
Lycium andersonii	Anderson wolfberry	Solanaceae
Mammillaria microcarpa	Arizona fishhook cactus	Cactaceae
Opuntia basilaris	Beavertail	Cactaceae
Opuntia phaeacantha	Prickly-pear cactus	Cactaceae
Opuntia acanthocarpa	Buckhorn cholla	Cactaceae
Opuntia leptocaulis	Christmas cholla	Cactaceae
Opuntia bigelovii	Teddy-bear cholla	Cactaceae
Phoradendron californicum	Desert mistletoe	Viscaceae
Prosopis glandulosa	Honey mesquite	Fabaceae
Salazaria mexicana	Bladdersage	Lamiaceae
Salvia columbariae	Chia	Lamiaceae
Senecio douglasii	Thread-leaf groundsel	Asteraceae
Senna covesii	Senna	Fabaceae
Verbena goodingii	Desert verbena	Verbenaceae
Yucca baccata	Banana yucca	Agavacea

They are typically found on floodplain soils and are dominated by Fremont's cottonwood and Gooding's willow. In many situations, this vegetation is being slowly replaced by introduced saltcedar. In this forest type, cottonwood-willow associations typically occur at the streams edge or on the first floodplain terrace and are flanked by dense mesquite woodlands (or bosques) on the second, slightly higher terrace.

O. Mohave Desertscrub Ecosystem: Joshua Tree Series

The Joshua tree is an endemic to the Mohave Desert, although it typically makes contact with the Sonoran Desert in west-central Arizona near the Project site. Because of the varied contacts made with other ecosystems, the Joshua tree may be in codominance with creosotebush and paloverde. In the analysis area, Joshua trees occur near the Town of Wikieup.

P. Sonoran Riparian Ecosystem: Saltcedar/Mesquite Series

In the Sonoran riparian areas, saltcedar is rapidly overtaking much of the native vegetation. Although there are a few small, pure stands of saltcedar in the Project area, most saltcedar occurs within mesquite or other riparian associated woodlands. This is the most abundant community in the analysis area of the southern portion of the Big Sandy River.

Q. Sonoran Riparian Ecosystem: Burrobush Series

Along washes, especially those damaged by floods, burrobush (*Hymenoclea salsola*) occurs as a series in nearly pure stands. In the analysis area, this community is most abundant in Cane Springs wash, but is found in several other washes and along the Big Sandy River in smaller patches. This community type accounted for the least encountered type in the analysis area (**Table 2**).

The proposed power Plant site and access road are located in the Sonoran Desertscrub: Arizona Upland Series Community type. The two natural gas pipeline corridors examined included the proposed Highway 93/Hackberry Road alternative and the 500 kV Transmission Line Route alternative. A total of nine community types were crossed by the proposed Highway 93/Hackberry Road alternative and a total of eight types are crossed by the 500kV Transmission Line Route alternative. Types crossed are listed below and are identified on **Figure 1**.

Highway 93/Hackberry Road Alternative

- Sonora Desertscrub Ecosystem: Arizona Upland Series[1]
- Flood Damaged Wash Series
- Sonora Riparian Ecosystem: Cottonwood/Willow Series
- Disturbed/Urban Areas
- Sonora Riparian Ecosystem: Saltcedar/Mesquite Series
- Mohave Desertscrub Ecosystem: Creosotebush Series[2]
- Mohave Desertscrub Ecosystem: Mesquite Series[3]
- Mohave Desertscrub Ecosystem: Catclaw Series
- Mohave Desertscrub Ecosystem: Mixed Scrub Series

500kV Transmission Line Route Alternative

- Sonoran Desertscrub Ecosystem: Arizona Upland Series[1]
- Flood-damaged Wash
- Mohave Desertscrub Ecosystem: Mesquite Series
- Sonoran Riparian Ecosystem: Saltcedar/Mesquite Series
- Mohave Desertscrub Ecosystem: Creosotebush Series[2]
- Mohave Riparian Ecosystem: Wash Series
- Mohave Desertscrub Ecosystem: Mixed Scrub Series
- Great Basin Conifer Woodland Ecosystem: Pinyon/Juniper Series[3]

[1]Indicates the most abundant community type crossed by the gas line.
[2]Indicates the second most abundant community type crossed by the gas line.
[3]Indicates the third most abundant community type crossed by the gas line.

RECLAMATION

The primary objectives of reclamation efforts are to minimize the visual effects of the disturbance, minimize the total land disturbed, control erosion, and promote revegetation. To increase the potential for successful revegetation of disturbed areas, several means of reestablishing vegetation are necessary including the replanting of salvaged state-sensitive plants and seeding of recommended and available species. Reclamation is successful when a vegetative cover that is similar to pre-construction conditions and adjacent vegetation communities is reestablished, ultimately restoring vegetative productivity for wildlife habitat and livestock grazing.

To control erosion, all washes and intermittent drainages encountered should be stabilized with erosion control fabric, mulch, or other materials. Excess rock may be utilized in areas with high erosion potential, steep slopes, and drainage basins. Plant material grubbed during construction can be shredded and redistributed for use as mulch. Native seeds in the mulch will help promote the regrowth of the natural plant species. Additional seeding should use a commercially available seed mixture containing seeds of appropriate native species.

Selection of plant species for revegetation is based on existing species occurrence and community composition, establishment potential, growth characteristics, soil stabilizing qualities, palatability to wildlife and livestock, commercial availability, post-construction land use objectives and agency recommendations. Several seed mixtures designed to replace dominant species in corresponding community types will be necessary. Fall seeding is recommended to enhance germination success by planting before the winter and spring precipitation events.

Post reclamation monitoring of the project areas should commence one full growing season after final reseeding. Precipitation is the most limiting factor and will ultimately determine overall success rates. Monitoring efforts should focus on identifying failed seeding areas, failure/success ratios of salvaged plants, erosion areas, noxious weed infestations, relative cover, diversity, and grazing or browse problems. Any failed reclaimed areas will be reseeded until permanent vegetation establishment is achieved.

SALVAGE

This section discusses the different categories of plants as defined by the Arizona Department of Agriculture (ADA) during the creation of the ADA's List of Protected Native Plants. **Highly safeguarded** protected native plants (includes parts of plants, seeds and fruit) are species whose prospects for survival in Arizona are in jeopardy or which are in danger of extinction. This category also includes plants federally-listed as endangered or thereatened. **Salvage restricted** porotected native plants are not included in the highly safeguarded category but are subject to damage by theft or vandalism. All species in the following families are salvage restricted: *Agavaceae, Cactaceae, Liliaceae,* and *Ordhidaceae.* **Salvaged assessed** protected native plants have sufficient value if salvaged to support the cost of salvage. **Harvest restricted** protected native plants are not included in the highly safeguarded catetory but are subject to excessive harvesting or overcutting because of their intrinsic value.

Landowners have the right to destroy or remove plants growing on their land, but 20 to 60 days prior to the destruction of any protected native plants, landowners are required to notify the Arizona Department of Agriculture (ADA). The landowner also has the right to sell or give away any plant growing on the land. However, protected native plants may not be legally possessed, taken or transported from the growing site without a permit from the ADA.

No Highly Safeguarded plants from the ADA List of Protected Native Plants were observed within the vicinity of the project area. However several salvage restricted, salvage assessed, and harvest restricted species were observed. **Table 8** include native protected plant species that occur in the project area.

Preconstruction surveys for protected native plants will be necessary after the ROW has been staked and flagged. If any such plants are present they should be flagged for salvage. Salvage Restricted native plants should be salvaged by the construction contractor, where feasible. Salvage options include: removal and stockpiling for replanting during reclamation. This involves selecting healthy plants for relocation to a temporary nursery along the length of the project corridor. Replanting will take place after construction and grading are complete.

Table 8
Native Protected Plant Species that Occur in the Project Area

Scientific Name	Common Name	Family	Protected Native Plant Category[1]
Atriplex hymeneltrya	Desert holly	Chenopodiaceae	SR
Canotia holacantha	Crucifixion thorn	Celastraceae	SR
Carnegiea gigantea	Saguaro cactus	Cactaceae	SR
Cercidium microphyllum	Foothill palo verde	Fabaceae	SA

Table 8 (continued)
Native Protected Plant Species that Occur in the Project Area

Scientific Name	Common Name	Family	Protected Native Plant Category[1]
Chilopsis linearis	Desert willow	Bignoniaceae	SA
Echinocereus engelmanii	Hedgehog cactus	Cactaceae	SR
Ferocactus cylindraceus	Barrel cactus	Cactaceae	SR
Fouquieria splendens	Ocotillo	Fouquieriaceae	SR
Mammillaria microcarpa	Arizona fishhook cactus	Cactaceae	SR
Nolina microcarpa	Beargrass	Agavaceae	HR, SR
Opuntia echinocarpa	Silver cholla	Cactaceae	SR
Opuntia basilaris	Beavertail	Cactaceae	SR
Opuntia arbuscula	Pencil cholla	Cactaceae	SR
Opuntia phaeacantha	Prickly-pear cactus	Cactaceae	SR
Opuntia leptocaulis	Christmas cholla	Cactaceae	SR
Opuntia acanthocarpa	Buckhorn cholla	Cactaceae	SR
Opuntia engelmannii	Engelmann prickly pear	Cactaceae	SR
Opuntia bigelovii	Teddy-bear cholla	Cactaceae	SR
Prosopis glandulosa	Honey mesquite	Fabaceae	SA, HR
Prosopis pubescens	Screwbean mesquite	Fabaceae	SA, HR
Yucca schidigera	Mohave yucca	Agavaceae	HR SR
Yucca brevifolia	Joshua tree	Agavaceae	SR
Yucca baccata	Banana yucca	Agavaceae	HR SR

[1]SA=Salvage assessed; HR=Harvest restricted; SR=Salvage restricted

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EXHIBIT C-2

WETLANDS AND WATERS OF THE U.S.

REPORT

WETLANDS AND WATERS OF THE UNITED STATES PROJECT REPORT

Submitted by:

Caithness Big Sandy, LLC
7887 E. Belleview Avenue
Suite 1100
Englewood, CO 80111

September 2000

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Figures

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INTRODUCTION

Caithness Big Sandy, L.L.C. (Caithness) has proposed to develop, construct, own, and operate the Big Sandy Energy Project (Project), and natural gas-fired, combined-cycle power plant (Plant) near the unincorporated community of Wikieup, approximately 40 miles southeast of the City of Kingman along U.S. Highway 93 in Mohave County, Arizona. For the purposes of this analysis, potential disturbance is defined as the study area for wetlands and waters of the United States related to the Plant, associated facilities, and the natural gas pipeline. Please refer to the Big Sandy Energy Project description for a detailed description of the Project.

Greystone was contracted by Caithness to identify and delineate wetlands and stream crossings that would be impacted by the construction of the power plant, ancillary facilities, and an approximately 36-mile long 16-inch natural gas pipeline in the Big Sandy River valley southeast of Kingman, Arizona. The proposed pipeline is entirely within Mohave County, and runs from the vicinity of Interstate 40 south along the alignment of Highway 93 to a location 4.75 miles southeast of Wikieup, where it will supply the proposed natural gas-fired power plant. The predominant land uses along the route include agriculture, open space, and livestock grazing.

WETLANDS

Methods

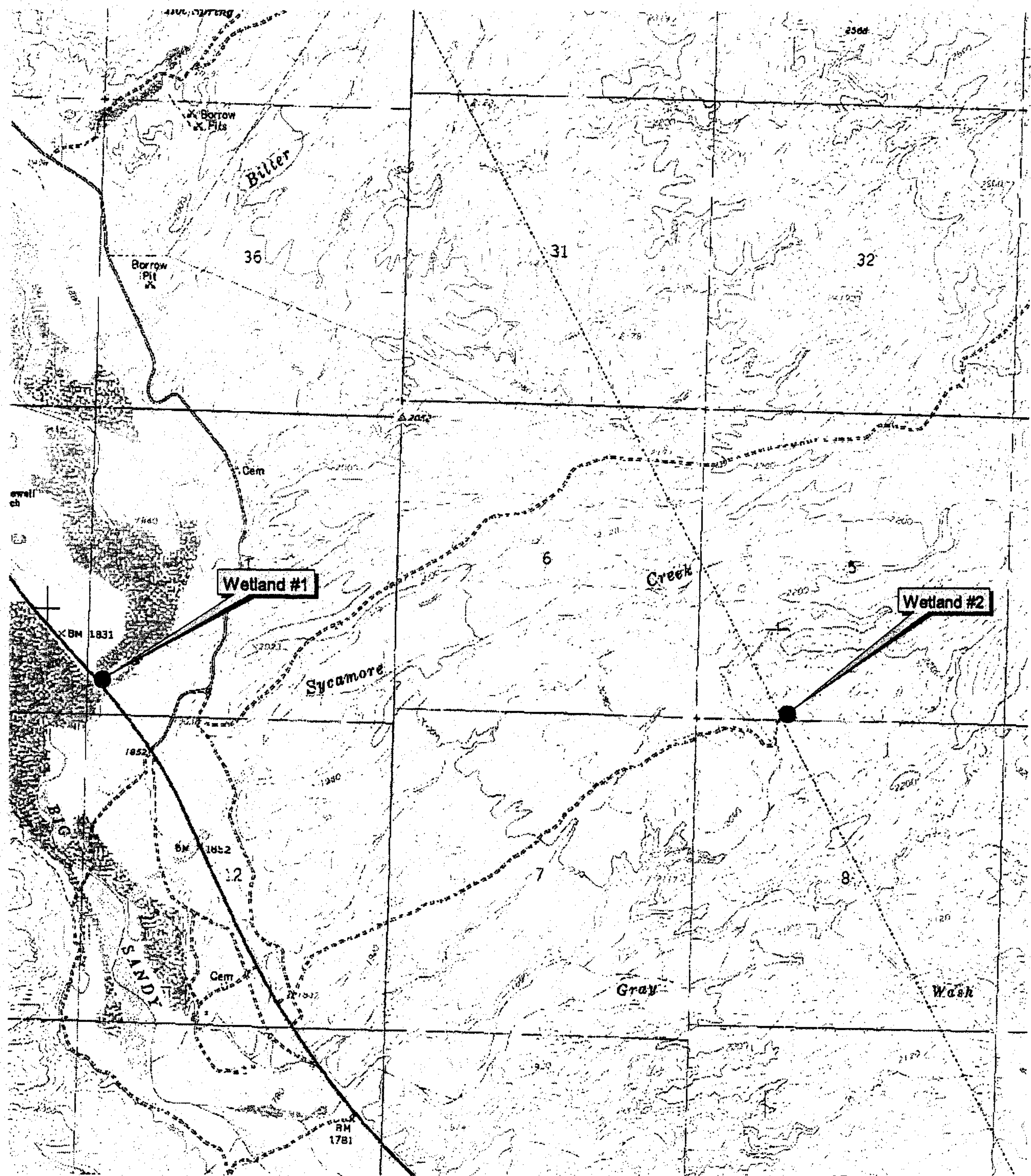
Wetlands were delineated in accordance with the Corps of Engineers (COE) 1987 Wetland Delineation Manual. A Munsell soil color chart (Munsell 2000) was used to determine soil matrix and mottle characteristics. Wetlands in the project area were classified using the USFWS Wetland Classification System (Cowardin et al. 1979).

A pre-field review of USGS topographic maps aided in determining stream and wetland locations. Supplemental information gathered on an initial field investigation by Greystone in June 2000 confirmed or modified these preliminary determinations as well as identified surrounding land uses.

USGS quadrangle maps were used while conducting on-site investigations. Fieldwork was conducted on July 31 and August 1, 2000. All potential wetlands, as identified by off-site investigations and initial fieldwork, were inspected on the ground and routine wetland delineations were conducted. The evaluations of wetland components were completed on 1987 COE routine wetland determination data forms. The boundaries of each wetland that was delineated were marked using pin flags and flagging tape and subsequently mapped.

Results

Two potential wetland sites were identified within the project area (**Figure 1**). The location, wetland type, size, and approximate crossing distance for each of these jurisdictional wetlands is shown in Table 1 and summarized briefly below. Completed wetland delineation forms and sketch maps for each jurisdictional wetland are included in **Appendix A**.



LEGEND

● Delineated Wetlands

1 0 1 Miles

N

BIG SANDY ENERGY PROJECT

FIGURE 1
WETLAND LOCATION MAP

ANALYSIS AREA: MOHAVE CO., ARIZONA	
DATE: [illegible]	ArcView FILE: C:\BigSandy\WOUS.APR
PLOT SCALE: 1" = 2,500'	DRAWN BY: CDF

Table 1
Wetland Delineation Results Summary

Wetland Number	Legal Location	Acreage	Wetland Type	Comments
1	T15N R13E Sec. 1 SWSW	0.234	R3 UB/US 2/3 G & P EM/SS B	Big Sandy River
2	T15N R12E Sec. 5 SWSW	0.562	PEMB & PEMJ	Highly variable hydrology

Wetland Descriptions

Wetland #1

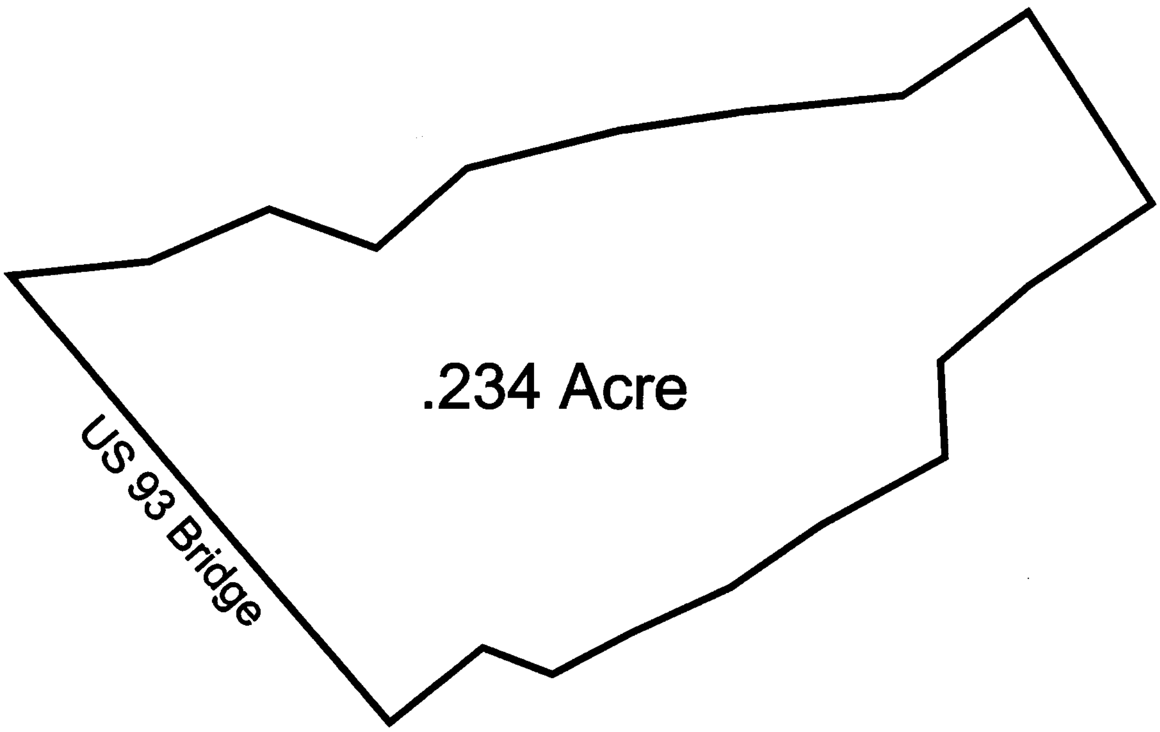
This wetland (**Figure 2**) is classified as a narrow strip of riverine/upper perennial/unconsolidated bottom/unconsolidated shore/intermittently exposed with a sand and mud bottom along the Big Sandy River. Surrounding this narrow strip is a wider area of palustrine/emergent/intermittently flooded wetlands within the floodplain of the Big Sandy River. Most of the floodplain is not classified as wetlands due to lack of suitable wetland vegetation, hydrology, and/or soils.

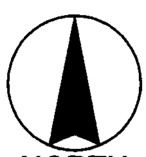
Dominant vegetation species include seep-willow (*Baccharis glutinosa* and *B. sarothroides*), bermuda grass (*Cynodon dactylon*), Olney's bulrush (*Scirpus americanus*), saltcedar (*Tamarix ramosissima*), and screwbean mesquite (*Prosopis pubescens*). Vegetation composition has been altered, favoring upland and disturbance resistant species, by heavy continuous livestock grazing within the wetland area. The remnant presence of other wetland plant species, such as spiny rush (*Juncus acutus*, FACW), least spikerush (*Eleocharis acicularis*, OBL), Fremont's cottonwood (*Populus fremontii*, FACW), and Goodding's willow (*Salix gooddingii*, OBL) suggest that this wetland may have once been of higher quality.

The area classified as wetlands is approximately equal to the average annual floodplain, as evidenced by a minor flood event originating in tributaries some distance upstream on the evening of August 1, 2000. This flood event deposited sediment and vegetation debris to a maximum depth of 1 inch over the previously delineated wetland area, but did not reach the adjacent uplands. Drift lines, sediment deposits, and drainage patterns in wetlands were all observed, as were saturated and inundated (along the river channel) soils.

The soil profile, as described in the attached wetland delineation form (**Appendix A**), reflects this periodic inundation in the thin surface clay layer covering a more histic layer perhaps resulting from a time period of higher water tables. Typical wetland soil indicators such as a slight sulfidic odor, aquic moisture regime, and gleyed or low chroma colors were observed in soil pits within this wetland. Photographs of wetland #1 are presented in Appendix A on **Figures A-1** and **A-2**.

T15N, R13W
Section1





0 350" 700'
Scale (ft)

GREYSTONE®

WETLAND #1

Big Sandy River
US 93 Bridge Crossing

Scale:1"=350'	Date: 8.25.00	Figure 2

Wetland #2

This wetland (**Figure 3**) is a small and unusual area associated with a small spring on the southwestern edge of the proposed power plant site. Previous water quality testing has shown water at this spring to be very high in arsenic. This wetland has been classified as palustrine/emergent /intermittently flooded/saturated. The wetland continues downstream of the spring area, but was not delineated for its entire distance, as it entered another landowner's property that will not be impacted by the proposed project.

A portion of the spring area has been fenced to exclude livestock and has developed a dense thicket of saltcedar, Goodding's willow, and cattail (*Typha latifolia*). The portion outside of the fence has been heavily grazed resulting in dominance by bermuda grass and Olney's bulrush. Other plant species such as least spikerush and seaside buttercup (*Ranunculus cymbalaria*, OBL) were found scattered throughout the grazed area.

Hydrology in this wetland is highly variable. Some areas contain ponded water or remain saturated near the surface throughout the year, while other areas are saturated early in the growing season but dry up during the hottest summer months. The boundary as delineated includes observations of soil inundation and saturation made in both May and August 2000. In addition, this wetland contains a drainage pattern along the normally dry wash channel. Oxidized rhizospheres were also seen along roots from a depth of 6 to 14 inches.

The soil parent material around this wetland appears to be an altered (possibly hydrothermally) volcanic tuff or similar material. This alteration has resulted in the development of unusual pink and green matrix and mottle colors (**Appendix A**). Other than unusual colors, the soils showed typical wetland indicators such as a histic epipedon, sulfidic odor, aquic moisture regime, gleyed or low chroma colors, and high organic content in the surface layers of sandy soils. The heavy grazing use of the unfenced part of this wetland has resulted in substantial trampling and soil compaction within the wetland. Photographs of wetland #2 are presented in Appendix A on **Figures A-3** and **A-4**.

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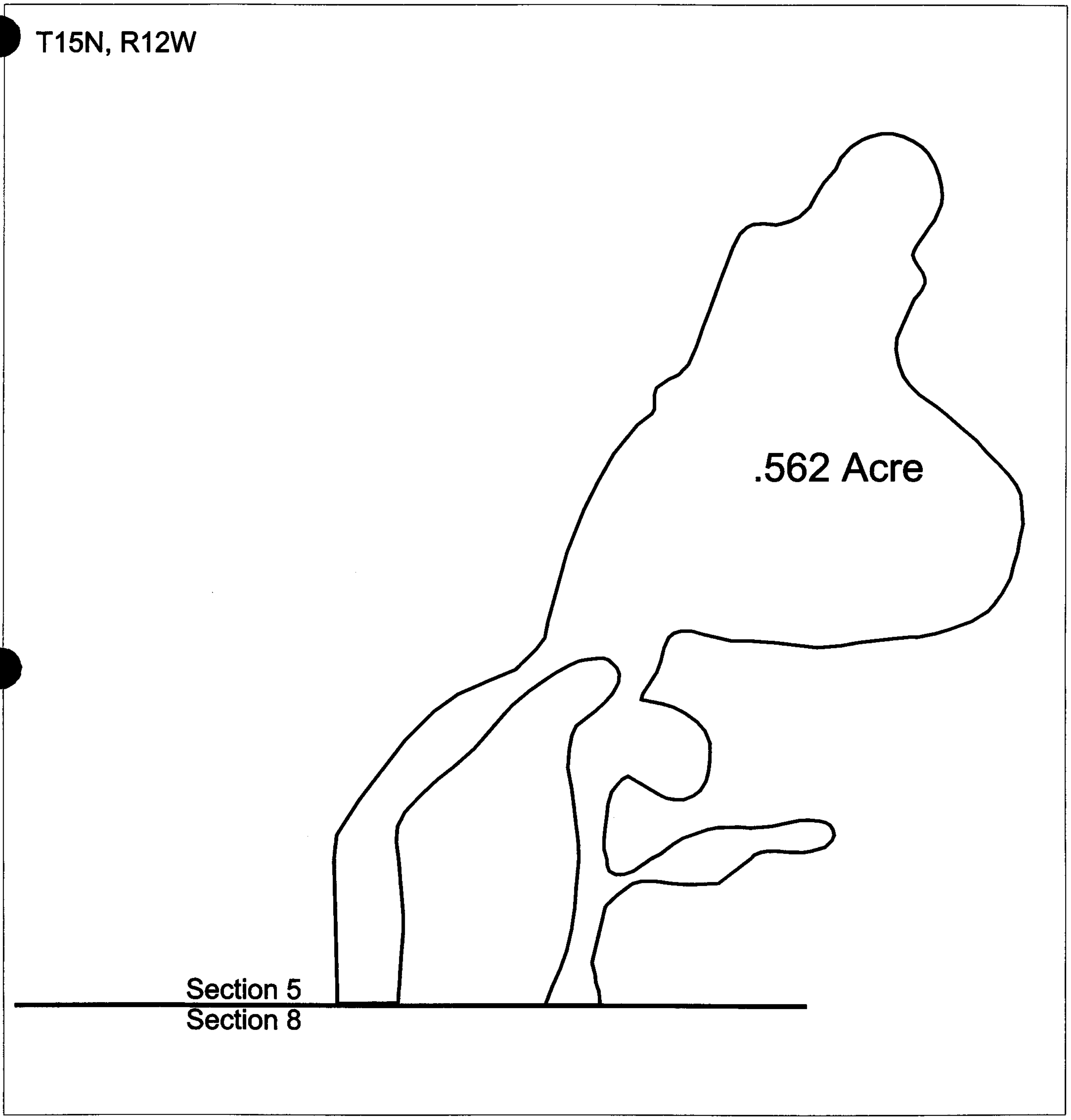
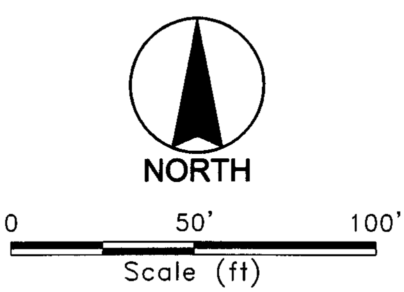




GREYSTONE®

WETLAND #2

Spring/Seep
Proposed Plant Site

Scale:1"=50'	Date: 10.1.00	**Figure 3**

U.S. Fish and Wildlife Service, National and Regional Interagency Review Panels. 1994. National List of Plant Species that Occur in Wetlands, Region 6 - South Plains and Region 7 - Southwest. Grand Haven, Michigan: Resource Management Group, Inc.

METHODS

Individual stream channel crossings along the proposed pipeline route (U.S. Highway 93 corridor) and alternative pipeline route (transmission-line corridor) were identified, measured, and plotted onto USGS quadrangle maps on August 1 through August 3, 2000. Two survey crews, each consisting of two biologists, drove the length of each potential corridor, stopping at each recognizable waterway. Stream channels were also surveyed within the proposed power-plant site, the western half of Section 7 (T15N, R12W), and along the proposed power-plant access road.

All waterways greater than two feet in width or having recognizable bank development, characterized by a definable ordinary high-water mark (OHWM), were identified as a qualifying Water of the United States (WUS). At each potential WUS, width and depth of OHWM was measured, and general characteristics of the drainage, such as presence of riparian or terrestrial vegetation in the channel and dominant channel substrate, were described.

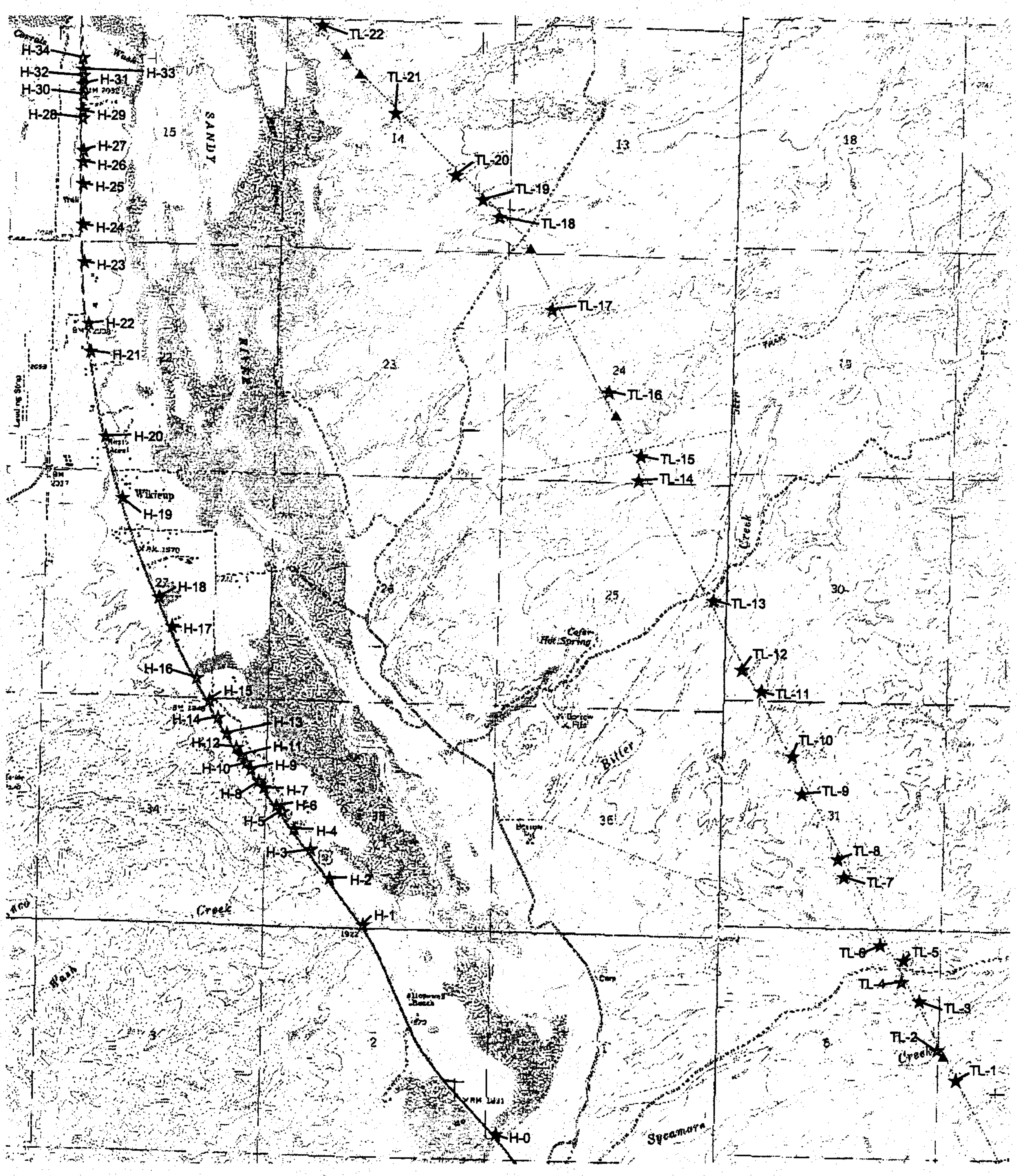
Results

All waterways identified as a qualifying WUS received a site identification number. **Figures 4** through **11** show the location of each WUS crossing. **Tables 2** and **3** present the width, depth, and projected impact area of each numbered WUS along the highway and transmission-line corridors, respectively. Additionally, marginal WUS along the transmission-line corridor were marked on the field maps. These include any minute drainage that is less than two feet wide or was lacking any stream bank development. No marginal WUS sites were identified along the highway corridor because these minor channels are consolidated into the larger channels before entering the highway culverts.

Data gathered during the water-crossings survey was used to determine the total potential temporary disturbance for each potential pipeline corridor. The calculation to determine disturbance acreage for each crossing assumes a 50-foot construction corridor.

Proposed Action - U.S. Highway 93 Corridor

The total disturbance area along the U.S. Highway 93 corridor is estimated to be 3.56 acres. A complete list of each crossing surveyed is presented in **Table 2**. ID Numbers correspond to the locations presented on **Figures 4** through **10**.



LEGEND

★ Qualifying Waters of the U.S.

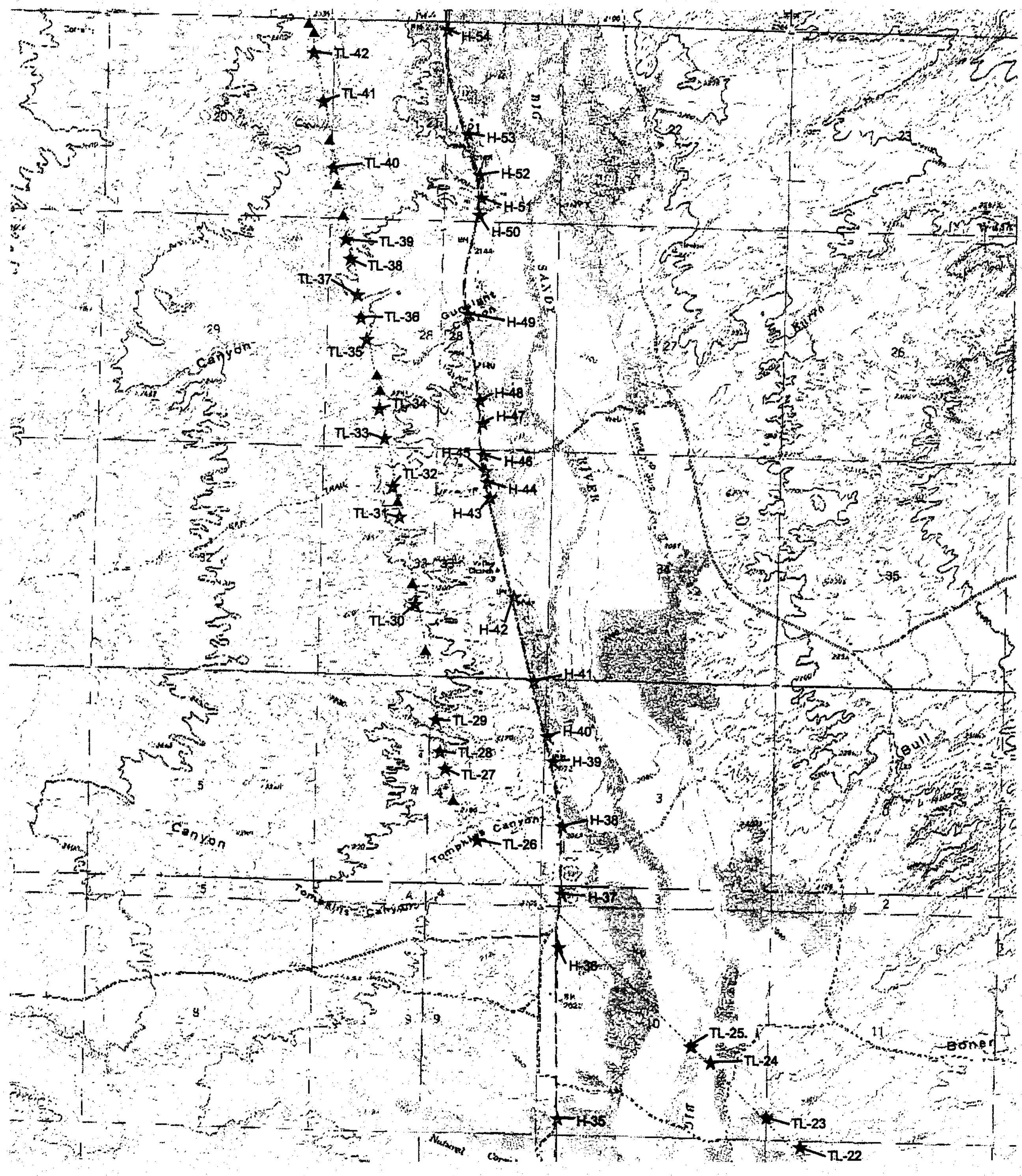
▲ Marginal Waters of the U.S.

1 0 1 Miles

BIG SANDY ENERGY PROJECT

FIGURE 4
WATERS OF THE UNITED STATES
MAP 1 OF 7

ANALYSIS AREA: MOHAVE CO., ARIZONA



LEGEND

★ Qualifying Waters of the U.S.

▲ Marginal Waters of the U.S.

1 0 1 Miles

N

BIG SANDY ENERGY PROJECT

FIGURE 5
WATERS OF THE UNITED STATES
MAP 2 OF 7

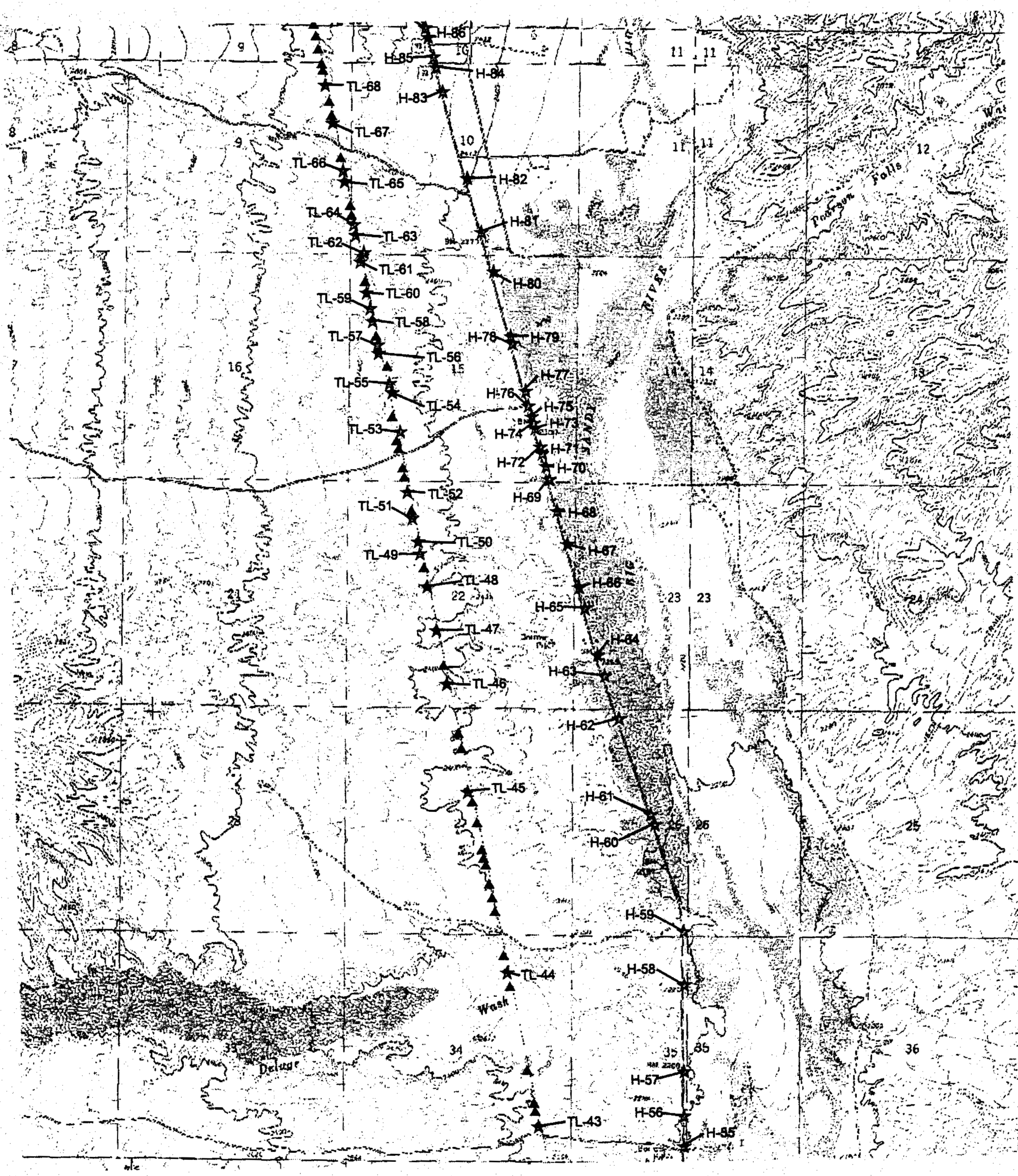
ANALYSIS AREA: MOHAVE CO., ARIZONA

DATE: 08/08/00

ArcView FILE: C:\BigSandy\WOUS.APR

PLOT SCALE: 1" = 3,333'

DRAWN BY: CDF



LEGEND

★ Qualifying Waters of the U.S.

▲ Marginal Waters of the U.S.

1 0 1 Miles

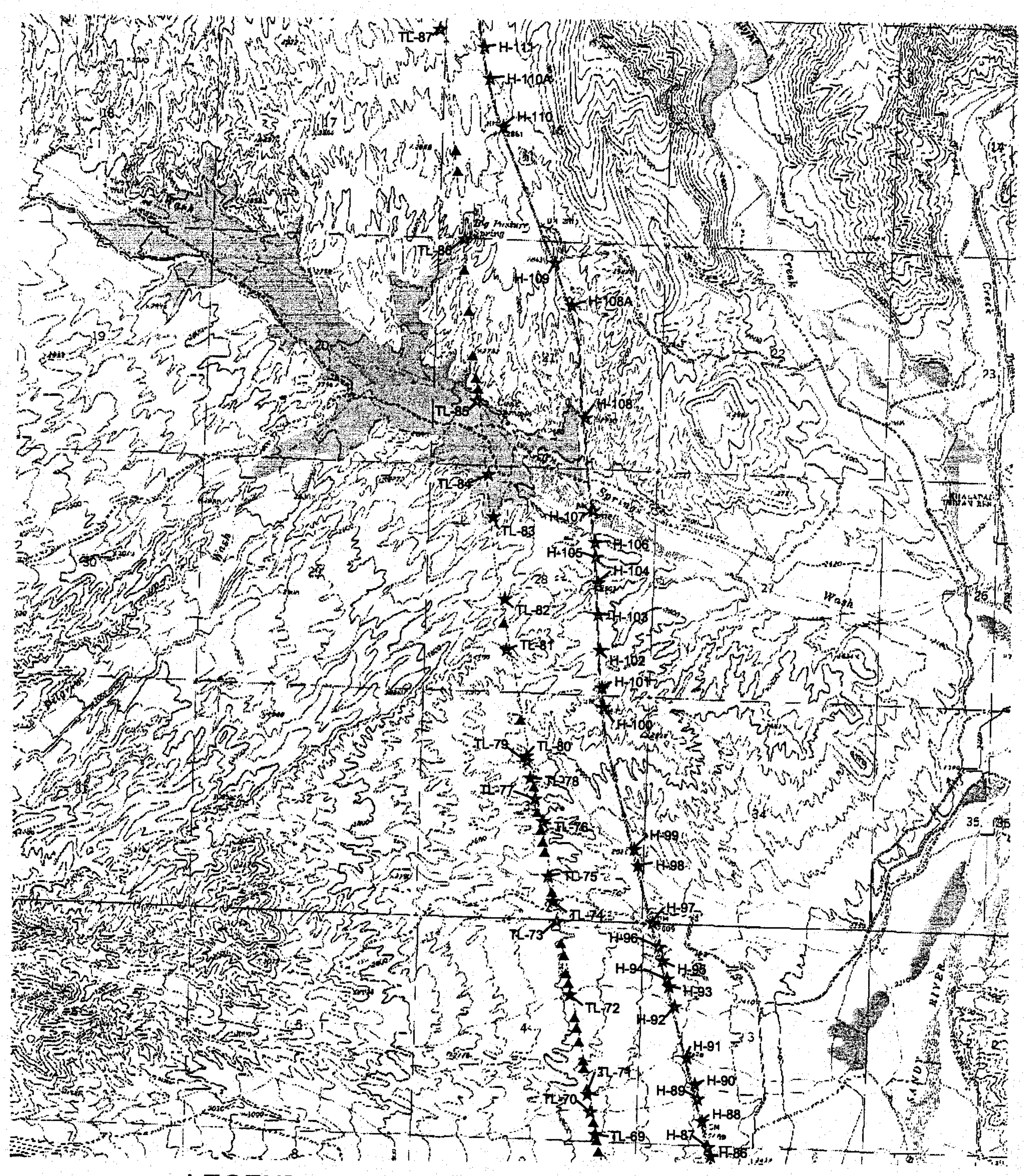
N

BIG SANDY ENERGY PROJECT

FIGURE 6
WATERS OF THE UNITED STATES
MAP 3 OF 7

ANALYSIS AREA: MOHAVE CO., ARIZONA

DATE: 08/08/00 | ArcView FILE: C:\BigSandy\WOUS.APR
PLOT SCALE: 1" = 3,333' | DRAWN BY: CDF



LEGEND

★ Qualifying Waters of the U.S.

▲ Marginal Waters of the U.S.

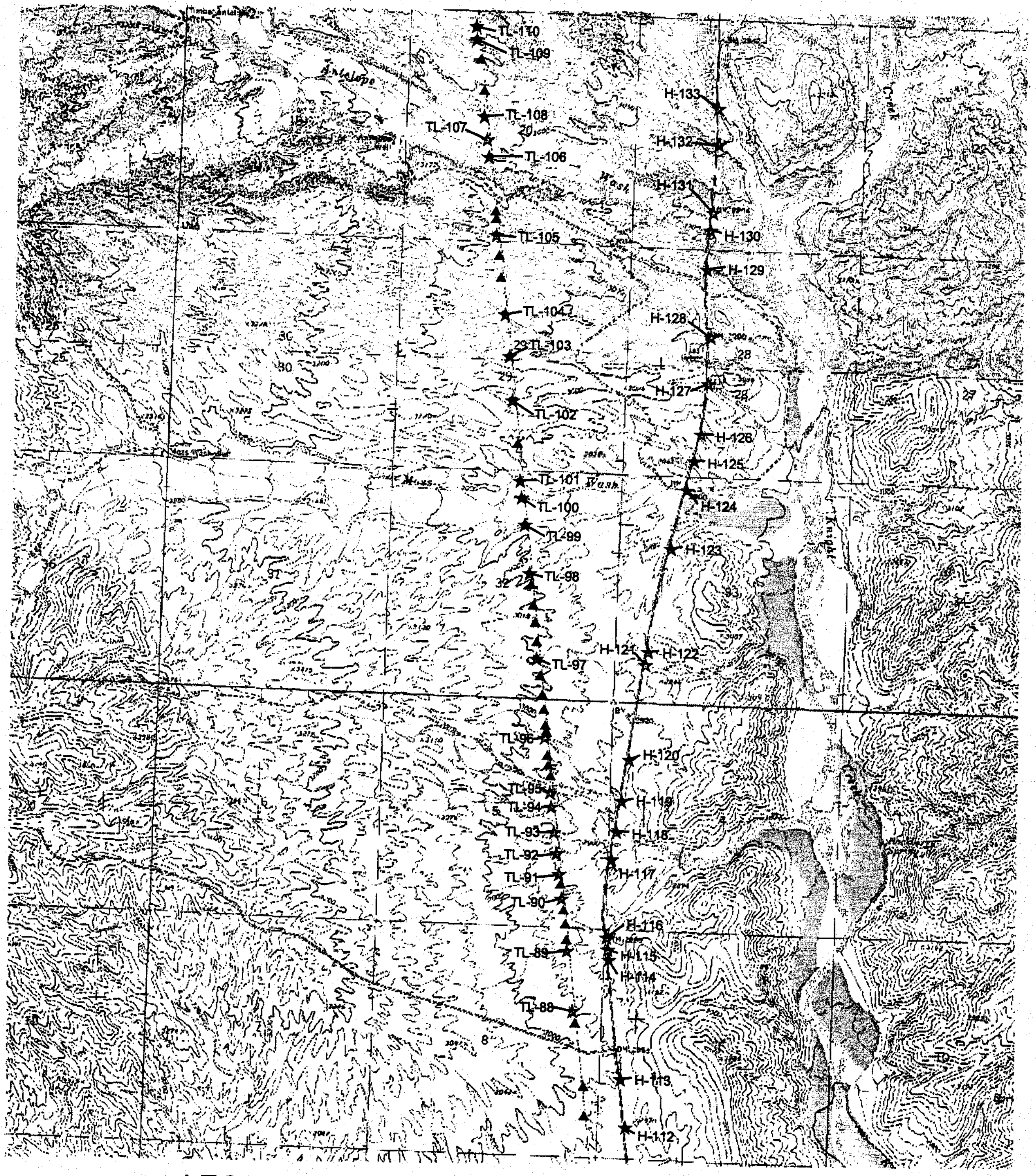
1 0 1 Miles

N

BIG SANDY ENERGY PROJECT

FIGURE 7
WATERS OF THE UNITED STATES
MAP 4 OF 7

ANALYSIS AREA: MOHAVE CO., ARIZONA	
DATE: 08/08/00	ArcView FILE: C:\BigSandy\WOUS.APR
PLOT SCALE: 1" = 3,333'	DRAWN BY: CDF



LEGEND

★ Qualifying Waters of the U.S.

▲ Marginal Waters of the U.S.

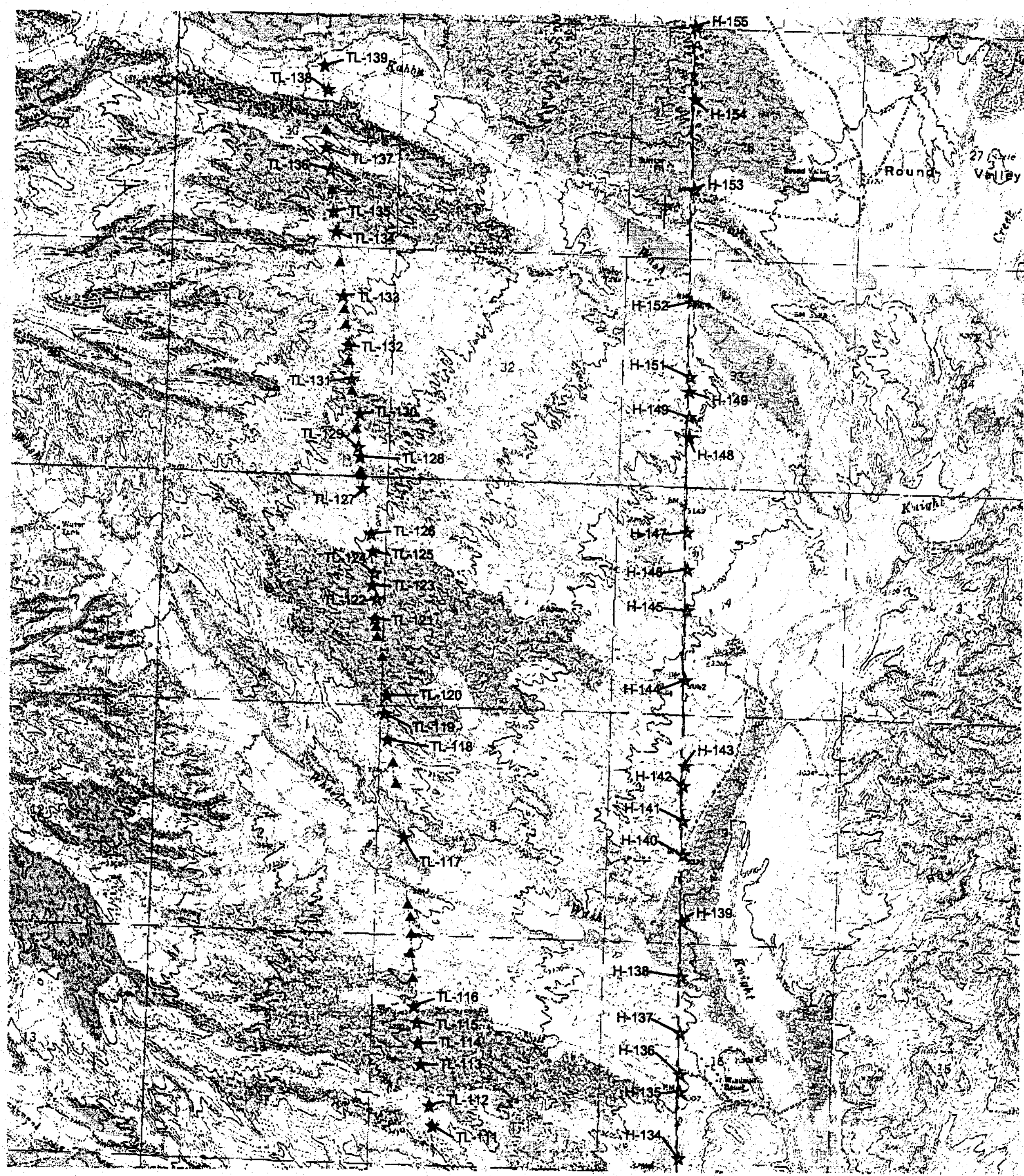
1 0 1 Miles

N

BIG SANDY ENERGY PROJECT

FIGURE 8
WATERS OF THE UNITED STATES
MAP 5 OF 7

ANALYSIS AREA: MOHAVE CO., ARIZONA	
DATE:	ArcView FILE:
PLOT SCALE: 1" = 3,333'	DRAWN BY: CDF



LEGEND

★ Qualifying Waters of the U.S.

▲ Marginal Waters of the U.S.

1 0 1 Miles

N

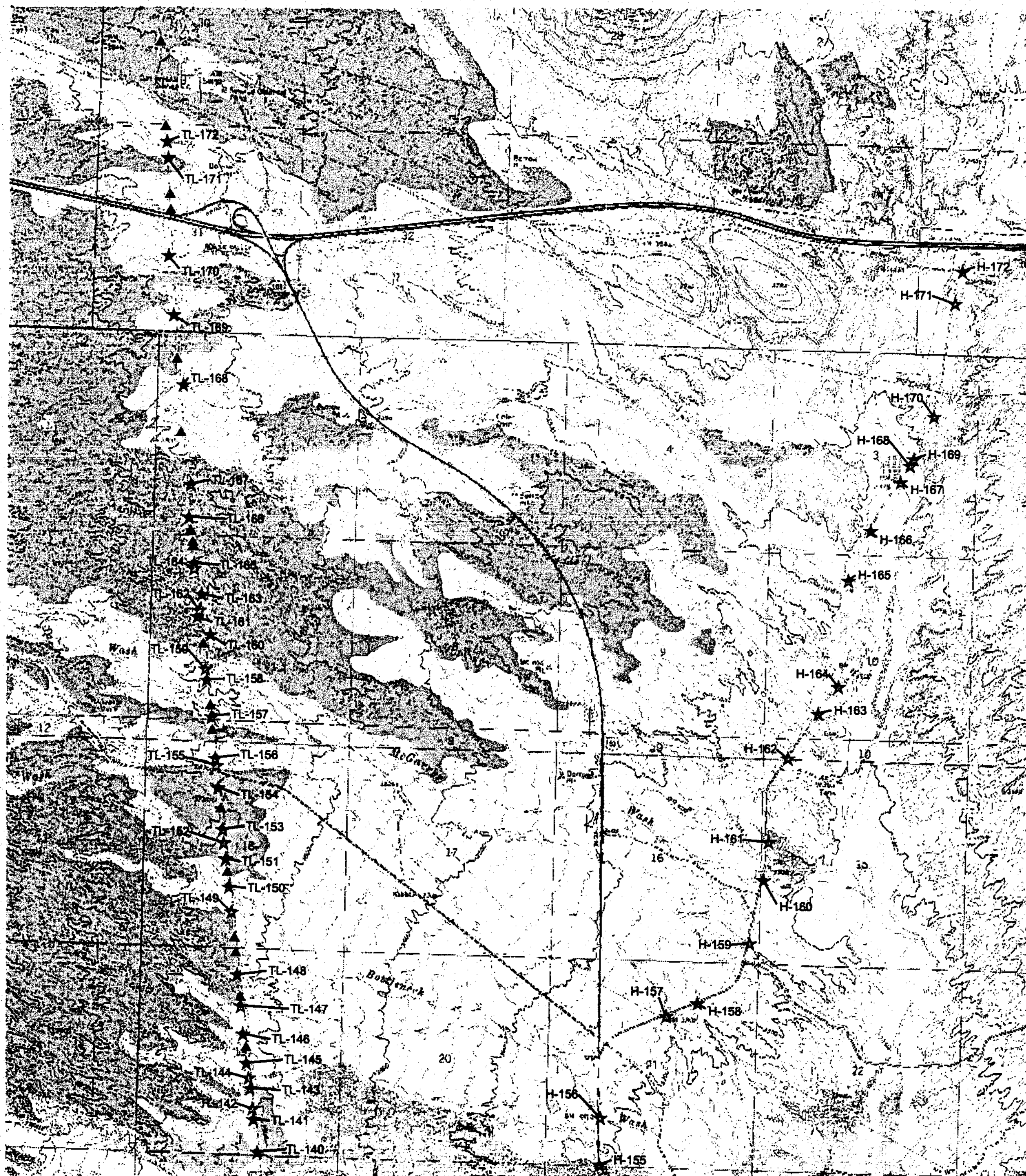
BIG SANDY ENERGY PROJECT

FIGURE 9
WATERS OF THE UNITED STATES
MAP 6 OF 7

ANALYSIS AREA: MOHAVE CO., ARIZONA

DATE: 08/09/00 | ArcView FILE: C:\BigSandy\WOUS.APR

PLOT SCALE: 1" = 3,333' | DRAWN BY: CDF



LEGEND

★ Qualifying Water of the United States

▲ Marginal Waters of the United States

1 0 1 Miles

N

BIG SANDY ENERGY PROJECT

FIGURE 10
WATERS OF THE UNITED STATES
MAP 7 OF 7

ANALYSIS AREA: MOHAVE CO., ARIZONA	
DATE: [illegible]	ArcView FILE: [illegible]
PLOT SCALE: 1" = 3,750'	DRAWN BY: CDF

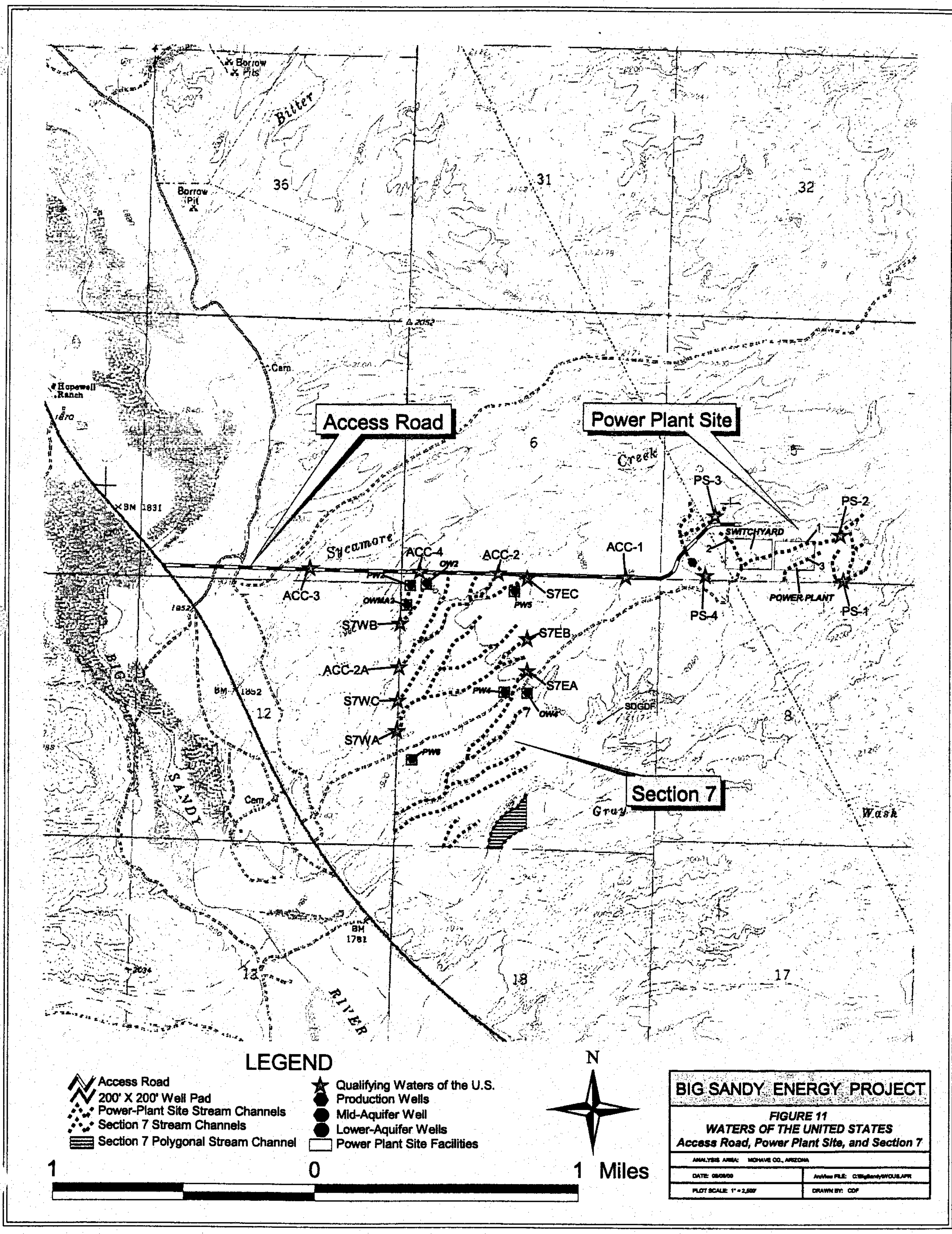

Borrow Pits
Bitter
36
31
32
Borrow Pit
Hopewell Ranch
Access Road
Power Plant Site
6
5
Creek
PS-3
PS-2
SWITCHYARD
Sycamore
ACC-4
ACC-2
ACC-1
ACC-3
S7EC
PS-4
POWER PLANT
PS-1
S7WB
S7EB
ACC-2A
S7EA
S7WC
S7WA
12
7
8
SDGDF
Section 7
Gray
Wash
BIG
SANDY
RIVER
13
18
17
LEGEND
Access Road
200' X 200' Well Pad
Power-Plant Site Stream Channels
Section 7 Stream Channels
Section 7 Polygonal Stream Channel
Qualifying Waters of the U.S.
Production Wells
Mid-Aquifer Well
Lower-Aquifer Wells
Power Plant Site Facilities
N
1
0
1 Miles
BIG SANDY ENERGY PROJECT
FIGURE 11
WATERS OF THE UNITED STATES
Access Road, Power Plant Site, and Section 7

Table 2
Waters of the United States
U.S. Highway 93 Corridor

ID Number	Width (inches)	Depth (inches)	Impact Area* (acres)
H-0	216	5	0.021
H-1	3096	1	0.296
H-2	48	6	0.005
H-3	36	4	0.003
H-4	36	4	0.003
H-5	60	6	0.006
H-6	24	4	0.002
H-7	36	6	0.003
H-8	48	4	0.005
H-9	48	4	0.005
H-10	24	8	0.002
H-11	36	4	0.003
H-12	72	4	0.007
H-13	48	3	0.005
H-14	72	8	0.007
H-15	1404	14	0.134
H-16	48	6	0.005
H-17	72	3	0.007
H-18	48	3	0.005
H-19	84	8	0.008
H-20	216	6	0.021
H-21	144	4	0.014
H-22	72	12	0.007
H-23	492	8	0.047
H-24	252	9	0.024
H-25	276	7	0.026
H-26	48	11	0.005
H-27	60	4	0.006
H-28	36	16	0.003
H-29	24	6	0.002

Table 2 (continued)
Waters of the United States
U.S. Highway 93 Corridor

ID Number	Width (inches)	Depth (inches)	Impact Area* (acres)
H-30	72	4	0.007
H-31	24	5	0.002
H-32	96	5	0.009
H-33	72	3	0.007
H-34	60	4	0.006
H-35	1476	14	0.141
H-36	36	3	0.003
H-37	24	8	0.002
H-38	192	37	0.018
H-39	72	19	0.007
H-40	24	12	0.002
H-41	12	6	0.001
H-42	24	2	0.002
H-43	24	3	0.002
H-44	108	3	0.010
H-45	84	9	0.008
H-46	36	4	0.003
H-47	264	8	0.025
H-48	24	6	0.002
H-49	576	10	0.055
H-50	576	18	0.055
H-51	144	7	0.014
H-52	132	9	0.013
H-53	504	11	0.048
H-54	132	12	0.013
H-55	48	15	0.005
H-56	108	8	0.010
H-57	108	4	0.010
H-58	48	6	0.005
H-59	1764	14	0.169

Table 2 (continued)
Waters of the United States
U.S. Highway 93 Corridor

ID Number	Width (inches)	Depth (inches)	Impact Area* (acres)
H-60	144	13	0.014
H-61	732	16	0.070
H-62	216	6	0.021
H-63	432	3	0.041
H-64	528	11	0.051
H-65	60	4	0.006
H-66	36	6	0.003
H-67	612	27	0.059
H-68	216	6	0.021
H-69	36	12	0.003
H-70	36	22	0.003
H-71	36	13	0.003
H-72	36	5	0.003
H-73	72	7	0.007
H-74	36	6	0.003
H-75	24	12	0.002
H-76	24	6	0.002
H-77	288	6	0.028
H-78	204	4	0.020
H-79	216	4	0.021
H-80	648	14	0.062
H-81	216	7	0.021
H-82	108	28	0.010
H-83	48	19	0.005
H-84	36	4	0.003
H-85	180	4	0.017
H-86	72	3	0.007
H-87	480	8	0.046
H-88	24	12	0.002
H-89	396	4	0.038

Table 2 (continued)
Waters of the United States
U.S. Highway 93 Corridor

ID Number	Width (inches)	Depth (inches)	Impact Area* (acres)
H-90	48	6	0.005
H-91	228	4	0.022
H-92	84	4	0.008
H-93	12	4	0.001
H-94	72	24	0.007
H-95	24	18	0.002
H-96	36	19	0.003
H-97	396	8	0.038
H-98	96	3	0.009
H-99	576	3	0.055
H-100	48	4	0.005
H-101	24	26	0.002
H-102	72	43	0.007
H-103	48	37	0.005
H-104	36	26	0.003
H-105	60	4	0.006
H-106	228	4	0.022
H-107	2040	13	0.195
H-108	168	4	0.016
H-108A	36	6	0.003
H-109	24	12	0.002
H-110	336	8	0.032
H-110A	36	4	0.003
H-111	12	2	0.001
H-112	24	6	0.002
H-113	12	4	0.001
H-114	36	13	0.003
H-115	168	6	0.016
H-116	144	4	0.014
H-117	264	3	0.025

Table 2 (continued)
Waters of the United States
U.S. Highway 93 Corridor

ID Number	Width (inches)	Depth (inches)	Impact Area* (acres)
H-118	252	4	0.024
H-119	168	3	0.016
H-120	72	3	0.007
H-121	252	3	0.024
H-122	48	5	0.005
H-123	48	4	0.005
H-124	780	30	0.075
H-125	132	3	0.013
H-126	36	4	0.003
H-127	24	3	0.002
H-128	204	3	0.020
H-129	48	4	0.005
H-130	48	3	0.005
H-131	36	5	0.003
H-132	588	6	0.056
H-133	564	4	0.054
H-134	96	11	0.009
H-135	108	8	0.010
H-136	48	32	0.005
H-137	264	4	0.025
H-138	432	7	0.041
H-139	348	8	0.033
H-140	204	6	0.020
H-141	36	4	0.003
H-142	36	12	0.003
H-143	468	8	0.045
H-144	108	4	0.010
H-145	72	7	0.007
H-146	264	9	0.025
H-147	24	15	0.002

Table 2 (continued)
Waters of the United States
U.S. Highway 93 Corridor

ID Number	Width (inches)	Depth (inches)	Impact Area* (acres)
H-148	132	5	0.013
H-149	48	3	0.005
H-150	72	12	0.007
H-151	36	14	0.003
H-152	720	6	0.069
H-153	24	42	0.002
H-154	36	4	0.003
H-155	144	9	0.014
H-156	540	2	0.052
H-157	108	3	0.010
H-158	36	40	0.003
H-159	84	8	0.008
H-160	204	14	0.020
H-161	36	16	0.003
H-162	180	26	0.017
H-163	72	4	0.007
H-164	180	3	0.017
H-165	324	14	0.031
H-166	84	8	0.008
H-167	2040	8	0.195
H-168	192	28	0.018
H-169	276	7	0.026
H-170	120	16	0.011
H-171	36	28	0.003
H-172	72	7	0.007
	TOTAL		**3.561**

*Impact Area based upon 50-foot construction corridor

Table 3
Waters of the United States
Transmission-line Corridor

ID Number	Width (inches)	Depth (inches)	Impact Area* (acres)
TL-1	80	7	0.008
TL-2	770	3	0.074
TL-3	126	6	0.012
TL-4	36	3	0.003
TL-5	42	2	0.004
TL-6	96	4	0.009
TL-7	163	7	0.016
TL-8	72	2	0.007
TL-9	30	2	0.003
TL-10	123	4	0.012
TL-11	99	6	0.009
TL-12	144	2	0.014
TL-13	1068	12	0.102
TL-14	154	9	0.015
TL-15	120	10	0.011
TL-16	162	20	0.015
TL-17	54	12	0.005
TL-18	154	14	0.015
TL-19	54	8	0.005
TL-20	36	10	0.003
TL-21	188	6	0.018
TL-22	106	4	0.010
TL-23	79	8	0.008
TL-24	471	6	0.045
TL-25	8700	18	0.832
TL-26	474	4	0.045
TL-27	24	4	0.002
TL-28	418	6	0.040
TL-29	111	3	0.011
TL-30	66	2	0.006
TL-31	52	2	0.005

Table 3 (continued)
Waters of the United States
Transmission-line Corridor

ID Number	Width (inches)	Depth (inches)	Impact Area* (acres)
TL-32	168	3	0.016
TL-33	24	2	0.002
TL-34	24	2	0.002
TL-35	170	3	0.016
TL-36	344	5	0.033
TL-37	24	2	0.002
TL-38	180	1	0.017
TL-39	48	3	0.005
TL-40	96	4	0.009
TL-41	146	10	0.014
TL-42	121	3	0.012
TL-43	149	2	0.014
TL-44	289	9	0.028
TL-45	357	6	0.034
TL-46	203	5	0.019
TL-47	615	12	0.059
TL-48	237	10	0.023
TL-49	30	8	0.003
TL-50	30	8	0.003
TL-51	182	11	0.017
TL-52	144	6	0.014
TL-53	123	12	0.012
TL-54	341	9	0.033
TL-55	30	6	0.003
TL-56	582	5	0.056
TL-57	120	3	0.011
TL-58	178	6	0.017
TL-59	20	12	0.002
TL-60	30	4	0.003
TL-61	36	3	0.003

Table 3 (continued)
Waters of the United States
Transmission-line Corridor

ID Number	Width (inches)	Depth (inches)	Impact Area* (acres)
TL-62	141	3	0.013
TL-63	211	3	0.020
TL-64	180	2	0.017
TL-65	262	4	0.025
TL-66	36	2	0.003
TL-67	167	5	0.016
TL-68	30	2	0.003
TL-69	42	2	0.004
TL-70	189	3	0.018
TL-71	66	2	0.006
TL-72	142	3	0.014
TL-73	158	4	0.015
TL-74	285	5	0.027
TL-75	78	3	0.007
TL-76	30	3	0.003
TL-77	24	7	0.002
TL-78	42	3	0.004
TL-79	148	4	0.014
TL-80	72	3	0.007
TL-81	236	2	0.023
TL-82	18	4	0.002
TL-83	164	7	0.016
TL-84	24	6	0.002
TL-85	433	10	0.041
TL-86	139	9	0.013
TL-87	30	4	0.003
TL-88	48	2	0.005
TL-89	196	5	0.019
TL-90	30	4	0.003
TL-91	154	4	0.015

Table 3 (continued)
Waters of the United States
Transmission-line Corridor

ID Number	Width (inches)	Depth (inches)	Impact Area* (acres)
TL-92	96	1	0.009
TL-93	30	2	0.003
TL-94	103	2	0.010
TL-95	87	2	0.008
TL-96	243	2	0.023
TL-97	89	3	0.009
TL-98	30	2	0.003
TL-99	276	3	0.026
TL-100	482	14	0.046
TL-101	96	2	0.009
TL-102	69	4	0.007
TL-103	36	2	0.003
TL-104	224	5	0.021
TL-105	82	3	0.008
TL-106	283	9	0.027
TL-107	244	5	0.023
TL-108	72	2	0.007
TL-109	118	4	0.011
TL-110	24	2	0.002
TL-111	48	6	0.005
TL-112	264	4	0.025
TL-113	84	2	0.008
TL-114	42	3	0.004
TL-115	42	3	0.004
TL-116	375	4	0.036
TL-117	480	2	0.046
TL-118	96	11	0.009
TL-119	48	2	0.005
TL-120	97	6	0.009
TL-121	162	7	0.015

Table 3 (continued)
Waters of the United States
Transmission-line Corridor

ID Number	Width (inches)	Depth (inches)	Impact Area* (acres)
TL-122	60	4	0.006
TL-123	24	26	0.002
TL-124	78	10	0.007
TL-125	132	5	0.013
TL-126	161	4	0.015
TL-127	18	1	0.002
TL-128	36	10	0.003
TL-129	72	1	0.007
TL-130	48	1	0.005
TL-131	36	10	0.003
TL-132	36	2	0.003
TL-133	80	5	0.008
TL-134	100	3	0.010
TL-135	100	3	0.010
TL-136	72	10	0.007
TL-137	142	4	0.014
TL-138	432	18	0.041
TL-139	144	4	0.014
TL-140	48	4	0.005
TL-141	120	2	0.011
TL-142	72	2	0.007
TL-143	108	3	0.010
TL-144	240	14	0.023
TL-145	120	4	0.011
TL-146	84	1	0.008
TL-147	206	6	0.020
TL-148	60	3	0.006
TL-149	172	2	0.016
TL-150	376	4	0.036
TL-151	72	2	0.007

Table 3 (continued)
Waters of the United States
Transmission-line Corridor

ID Number	Width (inches)	Depth (inches)	Impact Area* (acres)
TL-152	108	3	0.010
TL-153	84	2	0.008
TL-154	83	2	0.008
TL-155	257	2	0.025
TL-156	192	12	0.018
TL-157	104	10	0.010
TL-158	150	2	0.014
TL-159	120	2	0.011
TL-160	101	3	0.010
TL-161	161	4	0.015
TL-162	18	4	0.002
TL-163	71	2	0.007
TL-164	36	6	0.003
TL-165	460	11	0.044
TL-166	542	4	0.052
TL-167	338	18	0.032
TL-168	576	6	0.055
TL-169	267	19	0.026
TL-170	269	7	0.026
TL-171	420	8	0.040
TL-172	300	8	0.029
		TOTAL	**3.407**

*Impact Area based upon 50-foot construction corridor

Alternative Action - Transmission-line Corridor

The total disturbance area along the transmission-line corridor is estimated to be 3.41 acres. A complete list of each crossing surveyed is presented in **Table 3**. ID Numbers correspond to the locations presented on **Figures 4** through **10**.

Power Plant Access Road

A list of each qualifying water-crossing surveyed along the proposed access road is presented in **Table 4**. ID Numbers correspond to the locations presented on **Figure 11**.

Table 4
Waters of the United States
Power Plant Access Road

ID Number	Width (inches)	Depth (inches)	Impact Area*
ACC-1	85	4	0.097
ACC-2	222	12	0.254
ACC-2A	146	6	0.167
ACC-3	960	12	1.102
ACC-4	108	5	0.124
	TOTAL		**1.744**

*Impact Area based upon 50-foot construction corridor

Power Plant and Section 7

Potential WUS within the extent of the power plant site and the western half of Section 7 are presented on **Figure 11**. Data measured at points along the periphery of these two areas is shown on **Table 5**.

Table 5
Waters of the United States
Power Plant Site, and Section 7

ID Number	Width (inches)	Depth (inches)
PS-1	110	10
PS-2	117	6
PS-3	103	4
PS-4	29	6
S7WA	520	8
S7WB	60	4
S7WC	48	4
S7EA	72	4
S7EB	71	8
S7EC	48	8

Construction of two distinct facilities are planned within the plant site boundary; the switchyard and the power plant. The total WUS disturbance area for both facilities is estimated to be 0.573 acres (**Table 6**). The average width of drainage numbers 2 and 3 was estimated by averaging the width of all drainages measured within the plant site boundary. Drainage ID numbers correspond to the drainages presented on **Figure 11.**

Table 6
Waters of the United States
Total Disturbance - Power Plant Site

Drainage ID	Avg. Width (inches)	Length (feet)	Disturbance (ft^2)	Disturbance (acres)
Switchyard				
1	117	699	6,815	0.156
2	90	701	5,258	0.121
Power Plant				
1	117	845	8,239	0.189
3	90	622	4,665	0.107
			TOTAL	0.573

Construction of three well pads in the western half of Section 7 will potentially disturb 0.096 acres of qualifying WUS (**Table 7**). The WUS length across each well pad was calculated by centering a 200 by 200 foot box on each well point. The location of each of the following wells is displayed on **Figure 11**.

TABLE 7
Waters of the United States
Total Disturbance - Section 7 Well Pads

Well ID	WUS Width (feet)	WUS Length (feet)	Disturbance (ft^2)	Disturbance (acres)
Production Well				
PW2	9	217	1,953	0.045
PW4	N/A	N/A	N/A	N/A
PW5	N/A	N/A	N/A	N/A
PW6	N/A	N/A	N/A	N/A
Middle Aquifer Well				
OWMA2	9	113	1,017	0.023
Lower Aquifer Well				
OW2	5	243	1,215	0.028
OW4	N/A	N/A	N/A	N/A
			TOTAL	0.096

CONCLUSION

Construction of this pipeline is not expected to temporarily disturb more than 4 acres of Waters of the United States. The entire project corridor will be subject to approval of a Nationwide Permit 12. Among the requirements to attain a Nation-Wide Permit (NWP) 12, the following need to receive particular attention:

Water Quality

On State or Tribal Land where a water quality management plan is not required, the NWP 12 must include a water quality management plan. The plan must include design criteria and techniques that will ensure that the authorized work does not result in more than minimal degradation of water quality. Two important components of the plan address stormwater management and the establishment and maintenance of vegetation buffers.

Notification of the District Engineer (U.S. Army Corps of Engineers)

The notification must include: name, address, and telephone number(s) of the Prospective permittee; location of the proposed project; and brief description of the proposed project.

Designated Critical Resource Waters

With exceptions, the discharge of dredged or fill material into waters of the United States are not authorized. The only concern for the purposes of this project is the existence of critical habitat for Federally listed Threatened or Endangered species downstream of the project area.

Fills Within the 100-year Floodplain

Permit complications can be avoided if no dredge or fill material is left in the 100-year floodplain. During construction, excavated material can be temporarily side-cast for up to 30 days.

During a telephone conversation with Marjorie Blaine, the USACE Regulatory Branch Project Manager for Mohave County, it was indicated that a NWP 12 could be issued without notification if the following conditions are met:

- Do not change the pre-construction contours of the drainages crossed.
- Can temporarily side-cast within a 30-day time period.
- Need to re-vegetate and stabilize any streamslopes.
- Avoid construction through 500 linear feet of any stream channel.

APPENDIX A
WETLAND DELINEATION FORMS

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

PEMJ/B

Project/Site: Spring at Big Sandy Plant Site	Date: 31 July 2000
Applicant/Owner: Caithness	County: Mohave
Investigator(s): C. Florian, M. Schweich, S. Fowlk, J. Hedlund	State: Arizona

Do Normal Circumstances exist on the site? ___ Yes ✓ No
Is the site significantly disturbed (Atypical Situation)? ___ Yes ✓ No
Is the area a potential Problem Area? ✓ Yes ___ No
(If needed, explain on reverse or attach separate sheet.)
Water level seasonally variable, dry weather and grazing appear to have substantially decreased the area of wetland vegetation.

Community ID: ______
Transect ID: ______
Plot ID: ______

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Cynodon dactylon	herb.	FACU	9.		
2. Typha latifolia	herb.	OBL	10.		
3. Scirpus americanus	herb.	OBL	11.		
4. Tamarix ramosissima	tree	NI	12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 67%

Remarks:
1. Assume presence of wetland vegetation? ✓ Yes ___ No
2. Rooted emergent vegetation present? ___ Yes ✓ No

HYDROLOGY

__ Recorded Data (Describe in Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

✓ No Recorded Data Available

Field Observations:
- Depth of Surface Water: 0-12 (in.)
- Depth to Free Water in Pit: >14 (in.)
- Depth to Saturated Soil: 0-8 (in.)

Wetland Hydrology Indicators:
Primary Indicators:
- ✓ Inundated only in excavated spots
- ✓ Saturated in: ___ Upper 12" ___ *13-18"*
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- ✓ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ✓ Oxidized Root Channels in: ✓ Upper 12" ___ *13-18"*
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Observations and Remarks:
1. *Filamentous or sheet forming algae present?* ___ *Yes* ✓ *No*
2. *Slope:* ✓ *0-2%; or* ___ *> 2%*
3. *Oxidized rhizospheres:* ___ *new roots only;* ___ *old roots only;* ✓ *new and old roots, or* ___ *none*
4. *Flooding:* ___ *none, flooding not probable;* ✓ *rare, unlikely but possible under unusual weather conditions;* ___ *occasional, occurs on an average of once or less in 2 years, or* ___ *frequent, occurs on an average of more than once in 2 years.*
5. *Duration:* ✓ *very brief, if < 2 days;* ___ *brief, if 2-7 days, or* ___ *long, if > 7 days*
6. *Site ponds water?* ___ *Yes* ✓ *No* Except where excavated

Surface water covers 10% of wetland, soils saturated to surface in 70% of wetland

*All additions in italics are by Huffman & Associates, Inc.

SOILS

Map Unit Name (Series and Phase): No data available Taxonomy (Subgroup): ______	Drainage Class[1]: ______ Permeability[2]: ______ Run off[3]: ______ Field Observations: Confirm Mapped Type? ___ Yes ___ No

Profile Description:

	Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance[4]/ Contrast[5]	Texture[6], Concretions, Structures[7], etc.
Pit #1	0-6		2.5Y5/2	n/a		sandy clay loam
	6-14		10R6/2	10Y7/1	abundant/distinct	sandy clay loam
Pit #2	0-1.5		5GY4/1	n/a	n/a	sandy clay loam
	1.5-5		N3/0	n/a	n/a	sandy clay loam
	> 5		n/a	n/a	n/a	solid cobble

Hydric Soil Indicators:

___ Histosol
✓ Histic Epipedon Pit #2 only
✓ Sulfidic Odor Pit #2 only
✓ Aquic Moisture Regime
___ Reducing Conditions
✓ Gleyed or Low-Chroma Colors
___ Concretions
✓ High Organic Content in Surface Layer in Sandy Soils Pit #2 only
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Observations and Remarks:
1. Smell: ___ Neutral; ___ Slightly Fresh or ___ Freshly Plowed Field Smell
2. Site: ___ Irrigated; ___ Land leveled; ___ Ditch Drained; ___ Pumped ___ Graded to drain via slope
3. Soils: ✓ do ___ do not become frequently ponded or saturated for long (> 7 days) to very long durations (> 30 days) during the growing season

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ✓ Yes ___ No
Wetland Hydrology Present? ✓ Yes ___ No
Hydric Soils Present? ✓ Yes ___ No

Is this Sampling Point Within a Wetland? ✓ Yes ___ No

Remarks:
1. Possible water of the U.S.? ✓ Yes ___ No
2. Possibly exempt from Corps/EPA regulation? ___ Yes ✓ No (If yes, check item(s) below).
(a) ___ Non-tidal drainage and irrigation ditches excavated on dry land
(b) ___ Artificially irrigated areas which would revert to upland if the irrigation ceased.
(c) ___ Artificial lakes or ponds created by excavating and/or diking dry land to collect and retain water and which are used exclusively for such purposes as stock watering, irrigation, settling basins, or rice growing.
(d) ___ Artifical reflecting or swimming pools or other small ornamental bodies of water created by excavating and/or diking dry land to retain water for primarily aesthetic reasons.
(e) ___ Waterfilled depressions created in dry land incidental to construction activity and pits excavated in dry land for the purpose of obtaining fill, sand, or gravel unless and until the construction or excavation operation is abandoned and the resulting body of water meets the definition of waters of the United States (see 33 CFR 328.3(a)).

Approved by HQUSACE 3/92*

NOTE:
[1] Drainage class: Excessively drained (ED), Somewhat excessively drained (SED), Well drained (WD), Moderately well drained (MWD), Somewhat poorly drained (SPD), Poorly drained (PD), or Very poorly drained (VPD).
[2] Permeability: Very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), or very rapid (more than 20 inches).
[3] Runoff: Slow, moderate or rapid.
[4] Mottle abundance: Few, common, or many.
[5] Mottle contrast: Faint, distinct, or prominent.
[6] Texture: Sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, or clay.
[7] Structure: Platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), or granular.

**All additions in italics are by Huffman & Associates, Inc.*

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: US 93 Crossing of Big Sandy River	Date: 31 July 2000
Applicant/Owner: Caithness	County: Mohave
Investigator(s): C. Florian, M Schweich, S. Faulk, J. Hedlund	State: Arizona

Do Normal Circumstances exist on the site? ✓ Yes ___ No
Is the site significantly disturbed (Atypical Situation)? ___ Yes ✓ No
Is the area a potential Problem Area? ___ Yes ✓ No
(If needed, explain on reverse or attach separate sheet.)

Community ID: ______
Transect ID: ______
Plot ID: ______

PEM/SS B & R3UB/US 4/3 G

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Baccharis glutinosa	shrub	FACW	9.		
2. Baccharis sarothroides	shrub	FAC-	10.		
3. Cynodon dactylon	herb	FACU	11.		
4. Scirpus americanus	herb	OBL	12.		
5. Tamarix ramosissima	tree	NI	13.		
6. Prosopis pubescens	tree	FAC+	14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 60%

Remarks: Vegetation altered towards upland species by heavy grazing
1. Assume presence of wetland vegetation? ✓ Yes ___ No
2. Rooted emergent vegetation present? ___ Yes ✓ No

HYDROLOGY

___ Recorded Data (Describe in Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

✓ No Recorded Data Available

Field Observations:
- Depth of Surface Water: 0-6 (in.)
- Depth to Free Water in Pit: >14 (in.)
- Depth to Saturated Soil: 6-8 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ✓ Inundated along channel
- ✓ Saturated in: ✓ Upper 12" ___ *13-18"*
- ___ Water Marks
- ✓ Drift Lines
- ✓ Sediment Deposits
- ✓ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ✓ Oxidized Root Channels in: ✓ Upper 12" ___ *13-18"*
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Observations and Remarks:
1. *Filamentous or sheet forming algae present? ___ Yes ✓ No*
2. *Slope: ✓ 0-2%; or ___ > 2%*
3. *Oxidized rhizospheres: ___ new roots only; ___ old roots only; ✓ new and old roots, or ___ none*
4. *Flooding: ___ none, flooding not probable; ___ rare, unlikely but possible under unusual weather conditions; ___ occasional, occurs on an average of once or less in 2 years, or ✓ frequent, occurs on an average of more than once in 2 years.*
5. *Duration: ___ very brief, if < 2 days; ___ brief, if 2-7 days, or ✓ long, if > 7 days*
6. *Site ponds water? ✓ Yes ___ No*

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*All additions in italics are by Huffman & Associates, Inc.

SOILS

Map Unit Name (Series and Phase): No data available Taxonomy (Subgroup): ______	Drainage Class[1]: ______ Permeability[2]: ______ Run off[3]: ______ Field Observations: Confirm Mapped Type? ___ Yes ___ No

Profile Description:

	Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance[4]/ Contrast[5]	Texture[6], Concretions, Structures[7], etc.
Pit #1	0-2		10YR3/1	n/a	n/a	silty clay loam
	2-3½		N2.5/0	n/a	n/a	sandy clay
	3½-4½		—	—	—	cobble
	4½-14		—	—	—	sand
Pit #2	0-2		10YR	n/a	n/a	silty clay loam
	2-4		N2.5/0	n/a	n/a	silty clay loam
	4-14+		—	—		sand

Hydric Soil Indicators:
- ___ Histosol
- ___ Histic Epipedon
- ✓ Sulfidic Odor slight
- ✓ Aquic Moisture Regime
- ___ Reducing Conditions
- ✓ Gleyed or Low-Chroma Colors
- ___ Concretions
- ✓ High Organic Content in ~~Surface~~ second Layer in Sandy Soils, between surface clay and deeper sands
- ___ Organic Streaking in Sandy Soils
- ___ Listed on Local Hydric Soils List
- ___ Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

Observations and Remarks: Soil layers reflect flood events

1. Smell: ___ *Neutral;* ___ *Slightly Fresh or* ___ *Freshly Plowed Field Smell*
2. Site: ___ *Irrigated;* ___ *Land leveled;* ___ *Ditch Drained;* ___ *Pumped* ___ *Graded to drain via slope*
3. Soils: ✓ *do* ___ *do not become frequently ponded or saturated for long (> 7 days) to very long durations (> 30 days) during the growing season*

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ✓ Yes ___ No Wetland Hydrology Present? ✓ Yes ___ No Hydric Soils Present? ✓ Yes ___ No	Is this Sampling Point Within a Wetland? ✓ Yes ___ No

Remarks:
1. Possible water of the U.S.? ✓ *Yes* ___ *No*
2. Possibly exempt from Corps/EPA regulation? ___ *Yes* ✓ *No* *(If yes, check item(s) below).*
(a) ___ *Non-tidal drainage and irrigation ditches excavated on dry land*
(b) ___ *Artificially irrigated areas which would revert to upland if the irrigation ceased.*
(c) ___ *Artificial lakes or ponds created by excavating and/or diking dry land to collect and retain water and which are used exclusively for such purposes as stock watering, irrigation, settling basins, or rice growing.*
(d) ___ *Artifical reflecting or swimming pools or other small ornamental bodies of water created by excavating and/or diking dry land to retain water for primarily aesthetic reasons.*
(e) ___ *Waterfilled depressions created in dry land incidental to construction activity and pits excavated in dry land for the purpose of obtaining fill, sand, or gravel unless and until the construction or excavation operation is abandoned and the resulting body of water meets the definition of waters of the United States (see 33 CFR 328.3(a)).*

Approved by HQUSACE 3/92*

NOTE:
[1] *Drainage class: Excessively drained (ED), Somewhat excessively drained (SED), Well drained (WD), Moderately well drained (MWD), Somewhat poorly drained (SPD), Poorly drained (PD), or Very poorly drained (VPD).*
[2] *Permeability: Very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), or very rapid (more than 20 inches).*
[3] *Runoff: Slow, moderate or rapid.*
[4] *Mottle abundance: Few, common, or many.*
[5] *Mottle contrast: Faint, distinct, or prominent.*
[6] *Texture: Sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, or clay.*
[7] *Structure: Platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), or granular.*

**All additions in italics are by Huffman & Associates, Inc.*

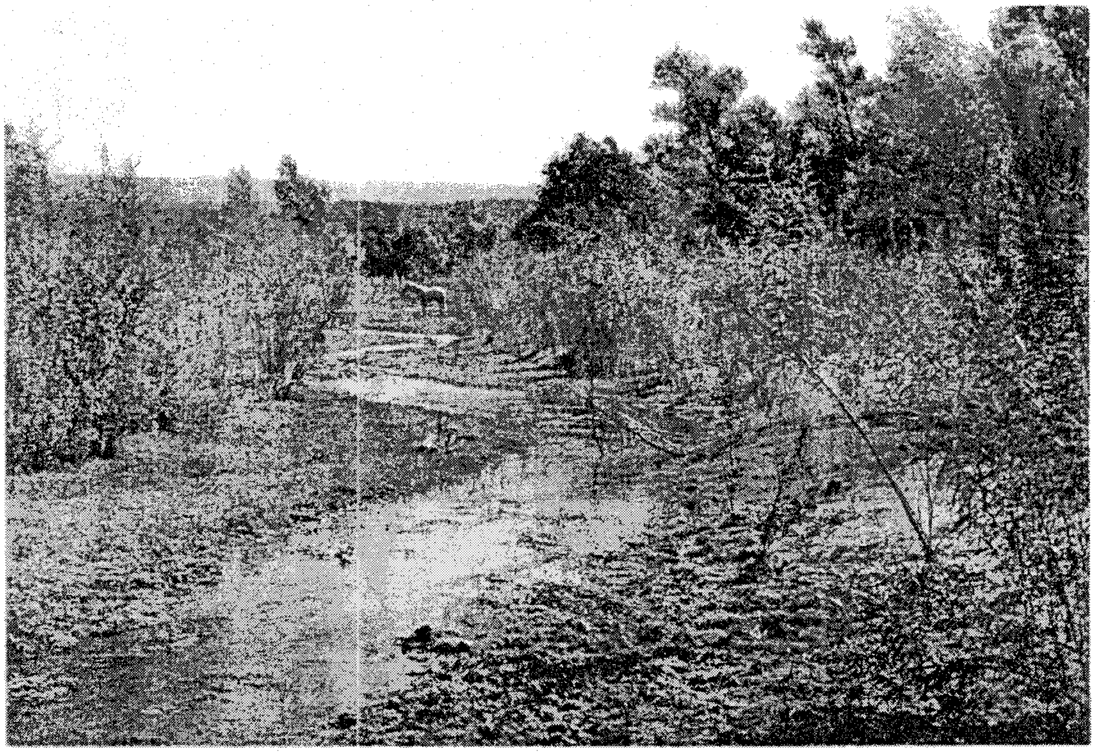


Figure A-1
Big Sandy River - View East From Bridge

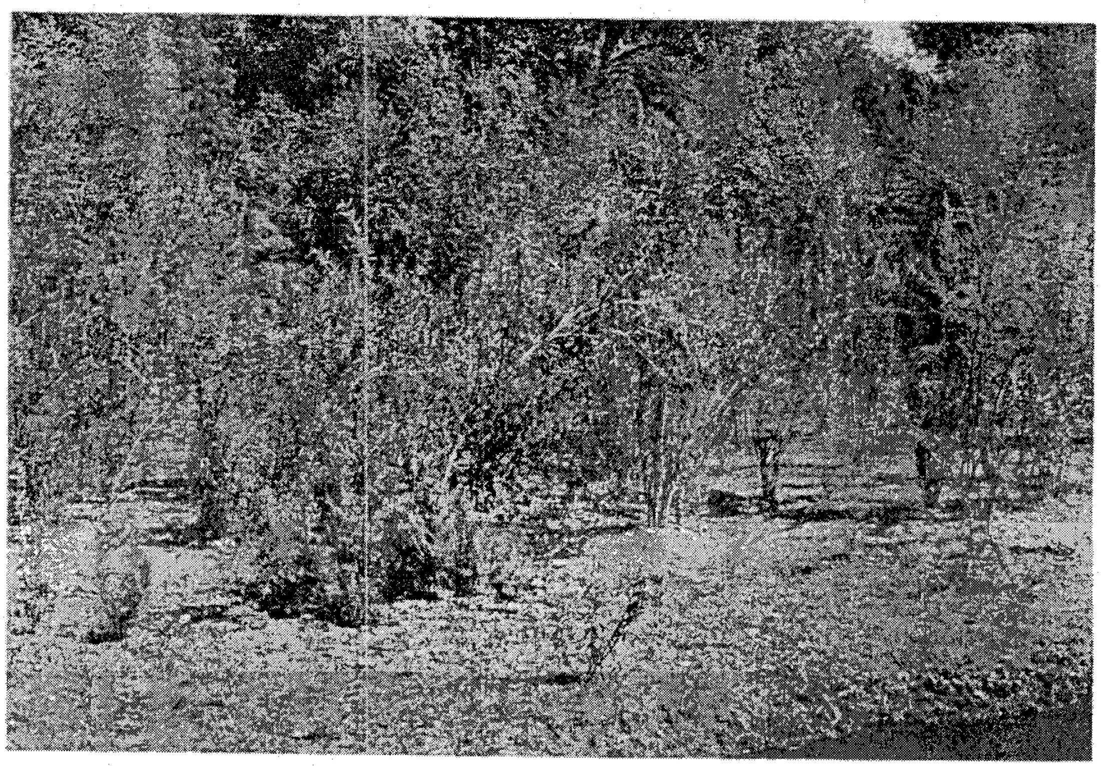


Figure A-2
Big Sandy River - View of North/West Bank

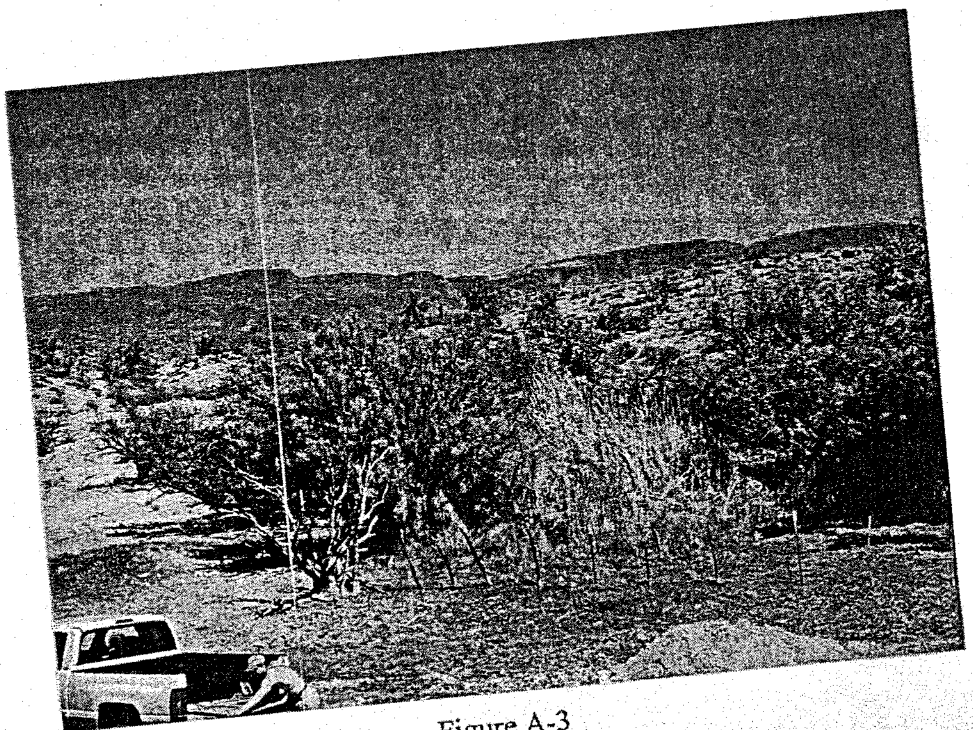


Figure A-3
Plant Site Spring - View Looking East

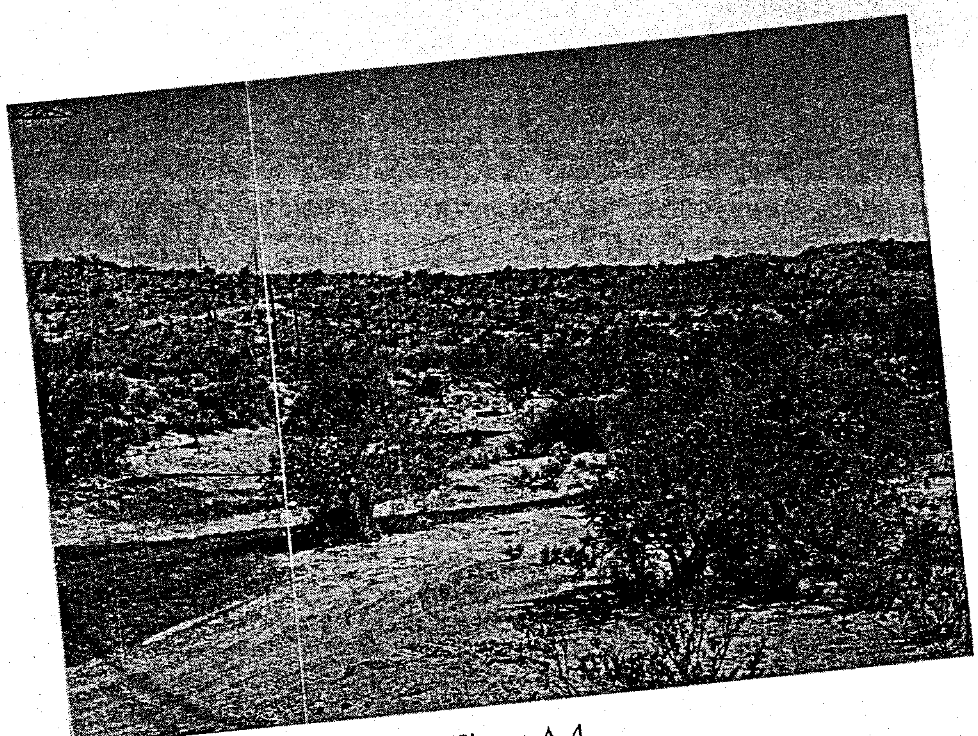


Figure A-4
Plant Site Spring - View Looking South

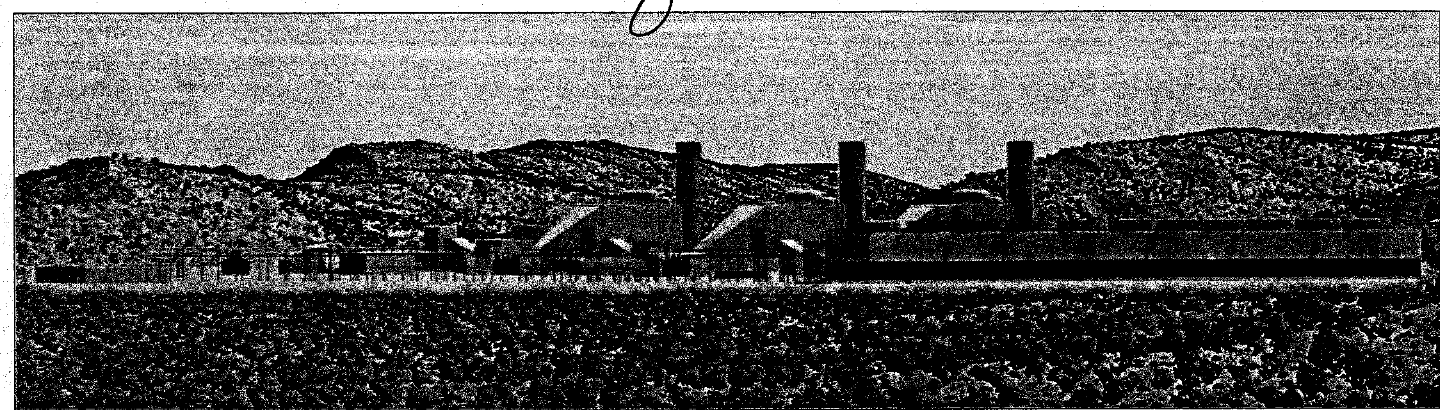
ORIGINAL

Big Sandy Energy Project

Application for a Certificate of Environmental Compatibility

Supplemental Information

2 of 2



Prepared for:

State of Arizona Power Plant and
Transmission Line Siting Committee

Prepared by:

Caithness Big Sandy, L.L.C.

Date: October 20, 2000
Case No. 100
Docket No. L-00000R-00-0100

ORIGINAL

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EXHIBIT C-3

WILDLIFE REPORT

REPORT

BIG SANDY ENERGY PROJECT WILDLIFE REPORT

Submitted by:

Caithness Big Sandy, LLC
7887 E. Belleview Avenue
Suite 1100
Englewood, CO 80111

August 2000

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Appendices

1.0 WILDLIFE OBSERVATIONS

1.1 INTRODUCTION

Big Sandy, L.L.C. (Caithness) proposes to develop, construct, own, and operate the Big Sandy Energy Project, a natural gas-fired power plant on private lands near Wickieup, Arizona. The purpose of this study was to inventory the wildlife resources within the proposed project area and its alternatives.

1.2 ANALYSIS AREA/LOCATION

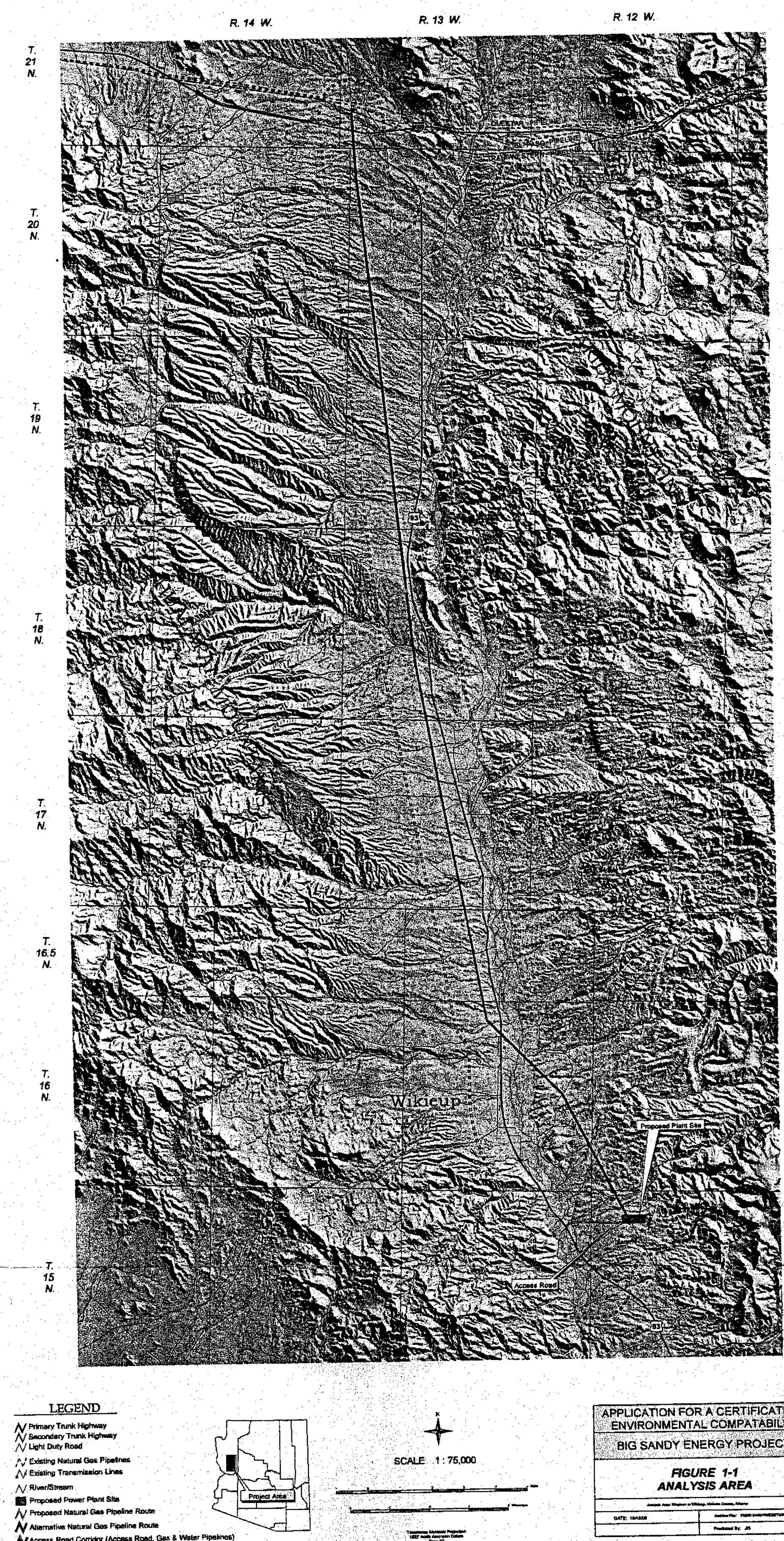
The analysis area (**Figure 1-1**) for the Project includes: 1) the 120-acre Plant site (Township 15 North, Range 12 West, Section 5) and its access corridor (200 feet in width); 2) the proposed pipeline route that parallels U.S. Highway 93 and Hackberry Road; and 3) the alternative natural gas pipeline route that parallels the Mead-Phoenix 500 kV transmission line. Both pipelines would require about 36 miles of pipe to connect natural gas sources to the power plant. A one-mile buffer around each site and alternative pipeline route is included in the analysis area. Analysis begins in the Knight Creek/Big Sandy River Corridor north of Interstate 40 (Township 21North, Range 13West) and follows U.S. Highway 93 and the Mead-Phoenix 500 kV transmission line south to the proposed Plant site.

1.2.1 Site Description

The area supports a complex mosaic of upland Sonoran and Mojave Desert vegetation with xeroriparian vegetation along several washes, and small areas of agricultural and developed lands. The proposed Plant Site is located near the transition between Sonoran Desert and Mojave Desert vegetation. Several washes with varying densities of xeroriparian vegetation, including the Big Sandy River, are found in the vicinity of the Plant Site and access road. Riparian areas along the Big Sandy are very dynamic; the Arizona Game and Fish Department (AGFD) considers the riparian habitat located along the Big Sandy River as Resource Category I, which is the highest value to Arizona's fish and wildlife. Two small areas of wetlands also occur in the analysis area. Agricultural and developed areas are very limited within the area and are found primarily near Wikieup. Non-native, weedy, and crop species are typically dominant in these areas.

1.3 METHODS

A literature search was conducted to identify the wildlife habitat communities present in the analysis area and the typical species found in these communities. Between May and August 2000, field inventory for wildlife species was conducted concurrently with raptor nesting surveys, yellow-billed cuckoo surveys, southwestern willow flycatcher surveys, vegetation surveys, fisheries survey and other necessary site visits to the project area. Particular emphasis was placed on federal- and state-listed species, important game species, and highly diverse, important wildlife habitats. This report



APPLICATION FOR A CERTIFICATE OF ENVIRONMENTAL COMPATABILITY

BIG SANDY ENERGY PROJECT

FIGURE 1-1
ANALYSIS AREA

Produced By: JS

provides a compilation of all wildlife observations, summary of special status species surveys, as well as species that may occur in the project area. Floodplain and wetland communities were focal points for wildlife observations due to their significance for wildlife habitat in the analysis area.

1.4 RESULTS

The wildlife resources within the project study area are typically upland in nature. While aquatic and semi-aquatic species occur within the area, their habitats are restricted. The major wildlife groups within the project study area include big game and large mammals, small mammals, raptors, songbirds, reptiles and amphibians. The results of fisheries surveys are included in a separate report.

1.4.1 Large Mammals

Big game species that were observed in the project site or in the vicinity include mule deer (*Odocoileus hemionus*), and desert bighorn sheep (*Ovis canadensis nelsoni*). Other large mammals observed include feral burros (*Equus asinus*), javelina (*Dicotyles tajacu*), coyote (*Canis latrans*) and raccoon (*Procyon lotor*). Habitats occupied include Mohave desert scrub, Sonoran desert scrub, xeroriparian wash, and great basin conifer woodland. **Table 1-1** provides a list of mammal species that may occur in the project area.

1.4.2 Small Mammals

Small mammals expected to occur through the project study area are also included in **Table 1-1**. Information on bat species is included in Chapter 2 of this report. The bulk of the mammal species present are most likely small rodents that are largely nocturnal. Species that were observed on site or in the vicinity of the project area include desert cottontail rabbit (*Sylvilagus audubonii*), black-tailed jackrabbit (*Lepus californicus*), Kangaroo rat *(Dipodonys sp.)*, and packrat (*Neotoma albigula*).

1.4.3 Birds

Bird species expected to occur within the project study area are listed in **Table 1-2**. Bird species observed on site or in the vicinity of the project area are also included in **Table 1-2**. A separate raptor nesting survey is provided in Chapter 3. The number of individuals and diversity of species varies by season and habitat, but in general, bird species are more common in diverse natural communities and less common in disturbed and agricultural areas.

Table 1-1
Large and Small Mammal Species That May Occur in the Project Area

Common Name	Scientific Name	Vegetation types occupied			
		Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural / Developed
Desert shrew	*Notiosorex crawfordi*	✔	✔	✔	
Desert cottontail	*Sylvilagus audubonii*	✔	✔	✔	✔
Black-tailed jack rabbit	*Lepus californicus*	✔	✔	✔	✔
Cliff chipmunk	*Eutamias dorsalis*		✔		
Harris' antelope squirrel	*Ammospermophilus harrisii*	✔	✔	✔	
Rock squirrel	*Spermophilus variegatus*	✔	✔		
Round-tailed ground squirrel	*Spermophilus tereticaudus*	✔	✔		
Botta's pocket gopher	*Thomomys bottae*	✔	✔	✔	✔
Arizona pocket mouse	*Perognathus amplus*	✔	✔	✔	
Rock pocket mouse	*Perognathus intermedius*	✔	✔		
Desert pocket mouse	*Perognathus penicillatus*	✔	✔	✔	
Ord's kangaroo rat	*Dipodomys ordii*		✔	✔	✔
Merriam's kangaroo rat	*Dipodomys merriami*	✔	✔		
Western harvest mouse	*Reithrodontomys megalotis*	✔	✔	✔	
Cactus mouse	*Peromyscus eremicus*	✔	✔		
Deer mouse	*Peromyscus maniculatus*		✔	✔	
Brush mouse	*Peromyscus boylii*		✔	✔	✔
Southern grasshopper mouse	*Onychomys torridus*	✔	✔		
White-throated wood Rat	*Neotoma albigula*	✔	✔		
Desert wood rat	*Neotoma lepida*	✔	✔		
Stephan's wood rat	*Neotoma stephensi*		✔		
Coyote	*Canis latrans*	✔	✔	✔	✔
Kit fox	*Vulpes macrotis*	✔	✔	✔	✔
Gray fox	*Urocyon cinereoargenteus*	✔	✔	✔	
Racoon	*Procyon lotor*			✔	✔
Ringtail	*Bassariscus astutus*	✔	✔	✔	
Badger	*Taxidea taxus*	✔	✔	✔	

Table 1-1
Large and Small Mammal Species That May Occur in the Project Area

Common Name	Scientific Name	Vegetation types occupied			
		Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural / Developed
Western spotted skunk	*Spilogale gracilis*		✔	✔	
Mountain lion	*Felis concolor*		✔	✔	
Bobcat	*Felis rufus*		✔	✔	
Collared Peccary (javelia)	*Tayassu tajacu*	✔	✔	✔	
Mule Deer	*Odocoileus hemionus*	✔	✔	✔	

Table 1- 2
Bird Species That May Occur in the Project Area

Common Name	Scientific Name	Vegetation types occupied and season of occurrence[1]				
		Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural/ Developed	Observed in the Project Area
Black-crowned night heron	*Nycticorax nycticorax*			R		
Green heron	*Butorides virescens*			R		
Cattle egret	*Bubulcus ibis*			R	R	
Great blue heron	*Ardea herodias*			W		
Canada goose	*Branta canadensis*			W	W	
Mallard	*Anas platyrhynchos*			W		
Turkey vulture	*Cathartes aura*	R	R	R	R	✔
Northern harrier	*Circus cyaneus*	W	W	W	W	✔
Cooper's hawk	*Accipiter cooperii*	R	R	R	R	✔
Red-tailed hawk	*Buteo jamaicensis*	R	R	R	R	✔
Swainson's hawk	*Buteo swainsoni*	S	S	S	S	
American kestrel	*Falco sparverius*	R	R	R	R	✔
Prairie falcon	*Falco mexicanus*	R	R	R	R	
Gambel's quail	*Callipepla gambelii*	R	R	R	R	✔
Killdeer	*Charadrius vociferus*			R	R	
Spotted sandpiper	*Actitis macularia*			W		
Rock dove	*Columba livia*				R	
Mourning dove	*Zenaida macroura*	R	R	R	R	✔
White-winged dove	*Zenaida asiatica*	S	S	S	S	✔
Inca dove	*Scardafella inca*			R	R	

Table 1-2
Bird Species That May Occur in the Project Area

Common Name	Scientific Name	Vegetation types occupied and season of occurrence[1]: Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural/ Developed	Observed in the Project Area
Greater roadrunner	*Geococcyx californicus*	R	R	R	R	✔
Barn owl	*Tyto alba*			R	R	✔
Great horned owl	*Bubo virginianus*	R	R	R		✔
Western screech-owl	*Otus kennicottii*		R	R	R	
Lesser nighthawk	*Chordeiles acutipennis*	S	S	S	S	✔
Common nighthawk	*Chordeiles minor*	S	S	S	S	✔
Common poorwill	*Phalaenoptilus nuttallii*	S	S	S	S	
White-throated swift	*Aeronautes saxatilis*	R	R			
Black-chinned hummingbird	*Archilochus alexandri*	S	S	S	S	
Costa's hummingbird	*Calypte costae*	S	S	S		✔
Anna's hummingbird	*Calypte anna*	R	R	R	R	✔
Gila woodpecker	*Melanerpes uropygialis*	R	R	R	R	
Northern flicker	*Colaptes cafer*			R	R	✔
Ladder-backed woodpecker	*Dendrocopos scalaris*	R	R	R	R	✔
Black phoebe	*Sayornis nigricans*			R	R	✔
Say's phoebe	*Sayornis saya*	R	R	R	R	
Vermilion flycatcher	*Pyrocephalus rubinus*			R		
Brown-crested flycatcher	*Myiarchus tyrannulus*	S	S	S		✔
Ash-throated flycatcher	*Myiarchus cinerascens*	S	S	S	S	✔
Southwestern willow flycatcher *	*Empidonax traillii extimus*			S		✔
Western kingbird	*Tyrannus verticalis*	S	S	S	S	✔
Loggerhead shrike *	*Lanius ludovicianus*	R	R	R	R	✔
Bell's vireo	*Vireo bellii*			S		
Gray vireo	*Vireo vicinior*	S	S	S		✔
Common raven	*Corvus corax*	R	R	R	R	✔
Horned lark	*Eremophila alpestris*	R	R	R	R	
Cliff swallow	*Petrochelidon pyrrhonota*	S	S	S	S	✔

Table 1- 2
Bird Species That May Occur in the Project Area

Common Name	Scientific Name	Vegetation types occupied and season of occurrence[1]				
		Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural/ Developed	Observed in the Project Area
Northern rough-winged swallow	*Stelgidopteryx serripennis*	S	S	S	S	
Violet-green swallow	*Tachycineta thalissina*	S	S	S	S	✔
Verdin	*Auriparus flaviceps*	R	R	R		✔
House wren	*Troglodytes aedon*			R	R	✔
Bewick's wren	*Thryomanes bewickii*		W	W		
Cactus wren	*Campylorhynchus brunneicapillus*	R	R			
Rock wren	*Salpinctes obsoletus*	R	R	R		
Canyon wren	*Catherpes mexicanus*	R	R	R		
Golden-crowned kinglet	*Regulus satrapa*		W	W		
Ruby-crowned kinglet	*Regulus calendula*		W	W		
Blue-gray gnatcatcher	*Polioptila caerulea*		W	W		
Black-tailed gnatcatcher	*Polioptila melanura*			R		✔
Mountain bluebird	*Sialia currucoides*	W	W	W		
Townsend's solitaire	*Myadestes townsendi*		W	W		
Hermit thrush	*Catharus guttatus*			W		
American robin	*Turdus migratorius*			W	W	
Northern mockingbird	*Mimus polyglottos*	R	R	R	R	✔
Sage thrasher	*Oreoscoptes montanus*		W			
Bendire's thrasher	*Toxostoma bendirei*	S	S		S	
Curve-billed thrasher	*Toxostoma curvirostre*	R	R	R		
Crissal thrasher	*Toxostoma crissale*			R		
LeConte's thrasher	*Toxostoma lecontei.*	R	R			
European starling	*Sturnus vulgaris*			R	R	
Cedar waxwing	*Bombycilla cedrorum*			W	W	
Phainopepla	*Phainopepla nitens*	R	R	R	R	✔
Orange-crowned warbler	*Vermivora celata*			W		
Virginia's warbler	*Vermivora virginiae*		S			
Lucy's warbler	*Vermivora luciae*			S		
Yellow-rumped warbler	*Dendroica coronata*			W		
Yellow warbler	*Dendroica petechia*			S	S	✔

Table 1-2
Bird Species That May Occur in the Project Area

Common Name	Scientific Name	Vegetation types occupied and season of occurrence[1]				
		Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural/ Developed	Observed in the Project Area
Common yellowthroat	*Geothlypis trichas*			S	S	
Yellow-breasted chat	*Icteria virens*			S		✔
Western tanager	*Piranga indoviciana*			S		✔
Summer tanager	*Piranga rubra*			S		✔
Green-tailed towhee	*Pipilo chlorurus*		W	W		
Canyon towhee	*Pipilo fuscus*	R	R			
Abert's towhee	*Pipilo aberti*	R	R	R		
Spotted towhee	*Pipilo maculatus*			W		
Rufous-crowned sparrow	*Aimophila ruficeps*		R			
Chipping sparrow	*Spizella passerina*			W	W	
Brewer's sparrow	*Spizella breweri*		W	W	W	
Lark sparrow	*Chondestes grammacus*		R	R	R	
Black-chinned sparrow	*Spizella atrogularis*	W	W			
Black-throated sparrow	*Aimophila bilineata*	R	R			
Sage sparrow	*Amphispiza belli*	W	W			
Fox sparrow	*Passerella iliaca*			W		
Savannah sparrow	*Passerculus sandwichensis*	W	W	W	W	
Lincoln's sparrow	*Melospiza lincolnii*			W		
Song sparrow	*Melospiza melodia*			R		
Vesper sparrow	*Pooecetes gramineus*		W		W	
White-crowned sparrow	*Zonotrichia leucophrys*			W	W	
Dark-eyed junco	*Junco hyemalis*	W	W	W	W	
Blue grosbeak	*Guiraca caerulea*			S	S	✔
Black-headed grosbeak	*Pheuticus melanocephalus*			S	S	✔
Western meadowlark	*Sturnella neglecta*	R	R	R	R	
Red-winged blackbird	*Agelaius phoeniceus*			R		✔
Great-tailed grackle	*Quiscalus mexicanus*			R	R	
Brewer's blackbird	*Euphagus cyanocephalus*	W	W	W	W	
Brown-headed Cowbird	*Molothrus ater*			R	R	✔
Hooded oriole	*Icterus cucullatus*	S	S	S	S	

Table 1-2
Bird Species That May Occur in the Project Area

Common Name	Scientific Name	Vegetation types occupied and season of occurrence[1]				Observed in the Project Area
		Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural/ Developed	
Bullock's oriole	*Icterus bullockii*			S	S	
Scott's oriole	*Icterus parisorum*	S	S	S	S	
House finch	*Carpodacus mexicanus*				R	
American goldfinch	*Carduelis tristis*			W	W	
Lesser goldfinch	*Carduelis psaltria*			R	R	✔
House Sparrow	*Passer domesticus*				R	

[1]Season of occurrence: R = year round resident; S = summer; W = winter.

*Special Status Species

1.4.4 Reptiles and Amphibians

Reptile and amphibian species expected to occur in the project study area are included in **Table 1-3**. The lizard and snake species are most likely to occur in open, upland habitats such as the desert scrub communities. The toad and frog species are more likely to be found in riparian and wetland habitat and closely adjacent uplands. Reptile and amphibian species that were observed on site or in the vicinity of the project area include the Sonoran mud turtle (*Kinosternon sonoriense*), desert iguana (*Dipsosaurus dorsalis*), zebra-tailed lizard (*Callisaurus draconoides*), common garter snake (*Thamnophis sirtalis*), and western diamondback rattlesnake (*Crotalus atrox*), and chuckwalla (*Sauromalus obesus*). Numerous Arizona toads (*Bufo microscaphus*) were also observed near the spring at the proposed plant site. Arizona toads and chuckwallas are Special Status Species (see **Table 1-4**).

Table 1-3
Reptile and Amphibian Species That May Occur in the Project Area

Common Name	Scientific Name	Vegetation types occupied			
		Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural/ Developed
Couch's spadefoot toad	*Scaphiopus couchi*	✔	✔	✔	
Great Plains toad	*Bufo cognatus*	✔	✔	✔	✔
Red-spotted toad	*Bufo punctatus*			✔	

Table 1-3
Reptile and Amphibian Species That May Occur in the Project Area

Common Name	Scientific Name	Vegetation types occupied: Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural/ Developed
Bullfrog	*Rana catesbeiana*			✔	
Sonoran mud turtle	*Kinosternon sonoriense*			✔	
Western banded gecko	*Coleonyx variegatus*	✔	✔		
Common chuckwalla	*Sauromalus obesus*	✔	✔		
Desert iguana	*Dipsosaurus dorsalis*	✔	✔		
Zebra-tailed lizard	*Callisaurus draconoides*	✔	✔	✔	
Long-nosed leopard lizard	*Gambelia wislizenii*	✔	✔		
Desert collared lizard	*Crotaphytus insularis*	✔	✔	✔	
Desert spiny lizard	*Sceloporus magister*	✔	✔	✔	
Tree lizard	*Urosaurus ornatus*	✔	✔	✔	
Long-tailed brush lizard	*Urosaurus graciosus*	✔	✔		
Side-blotched lizard	*Uta stansburiana*	✔	✔	✔	
Desert horned lizard	*Phrynosoma platyrhinos*	✔	✔		
Western whiptail	*Cnemidophorus tigris*	✔	✔	✔	
Western blind snake	*Leptophlops humilis*	✔	✔	✔	
Spotted leaf-nosed snake	*Phyllorhynchus decurtatus*	✔	✔		
Coachwhip	*Masticophis flagellum*	✔	✔		✔

Table 1-3
Reptile and Amphibian Species That May Occur in the Project Area

		Vegetation types occupied			
Common Name	**Scientific Name**	**Sonoran Desert Scrub**	**Mojave Desert Scrub**	**Xeroriparian Wash**	**Agricultural/ Developed**
Western patch-nosed snake	*Salvadora hexalepis*	✔	✔		
Gopher snake	*Pituophis melanoleucus*	✔	✔	✔	✔
Glossy snake	*Arizona elegans*	✔	✔		
Common kingsnake	*Lampropeltis getulus*	✔	✔	✔	
Long-nosed snake	*Rhinocheilus lecontei*	✔	✔		
Ground snake	*Sonora semiannulata*	✔	✔	✔	
Banded sand snake	*Chilomeniscus cinctus*	✔	✔	✔	
Western shovel-nosed snake	*Chionactis occipitalis*	✔	✔	✔	
Night snake	*Hypsiglena torquata*	✔	✔		
Lyre snake	*Trimorphodon biscutatus*	✔	✔		
Western diamondback rattlesnake	*Crotalus atrox*	✔	✔	✔	
Sidewinder	*Crotalus cerastes*	✔	✔		
Speckled rattlesnake	*Crotalus mitchelli*	✔	✔		
Mojave Rattlesnake	*Crotalus scutulatus*	✔	✔		

Table 1-4
Special Status Species That May Occur in the Project Area

Common Name (*Scientific Name*)	Federal Status[1]	State Status[2]	Habitat Types Utilized: Sonoran Desert Scrub	Habitat Types Utilized: Mojave Desert Scrub	Habitat Types Utilized: Xeroriparian Wash	Habitat Types Utilized: Agricultural/ Developed
BIRDS						
Bald eagle (*Haliaeetus leucocephalus*)	T	SC		✔	✔	✔
Common black hawk (*Buteogallus anthracinus*)	SS	SC	✔	✔	✔	✔
Cooper's hawk (*Accipiter cooperii*)	SS	SC		✔	✔	
Ferruginous hawk (*Buteo regalis*)	SS	SC	✔	✔	✔	✔
Golden eagle (*Aquila chrysaetos*)	SS	SC	✔	✔	✔	✔
Swainson's hawk (*Buteo swainsoni*)	SS	SC	✔	✔	✔	✔
Merlin (*Falco columbarius*)	SS	SC	✔	✔	✔	✔
Western Burrowing Owl (*Athene cunicularia hypugea*)	SS		✔	✔	✔	✔
Mountain plover (*Charadrius montanus*)	PT	SC				✔
Peregrine falcon (*Falco peregrinus*)	SS	SC	✔	✔	✔	✔
Sharp-shinned hawk (*Accipiter striatus*)	SS	SC		✔	✔	
Southwestern willow flycatcher (*Empidonax trailii extimus*)	E	SC			✔	
Western bluebird (*Sialia mexicana*)	SS	SC		✔	✔	✔
Yellow-billed cuckoo (*Coccyzus americanus*)	SS	SC			✔	

Table 1-4
Special Status Species That May Occur in the Project Area

Common Name (*Scientific Name*)	Federal Status[1]	State Status[2]	Habitat Types Utilized			
			Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural/ Developed
Zone-tailed hawk (*Buteo albonotatus*)	SS	SC	✔	✔	✔	✔
White-faced ibis (*Plegadis chihi*)	SS				✔	
Loggerhead shrike (*Lanius ludovicianus*)	SS		✔	✔	✔	✔
MAMMALS						
Big free-tailed bat (*Tadarida macrotis*)	SS	SC	✔	✔	✔	
California leaf-nosed bat (*Macrotis californicus*)	SS	SC	✔	✔	✔	
Cave myotis (*Myotis velifer*)	SS	SC	✔	✔	✔	
Fringed myotis (*Myotis thysanodes*)	SS	SC		✔	✔	
Greater western mastiff bat (*Eumops perotis californicus*)	SS	SC	✔	✔	✔	
Occult little brown bat (*Myotis lucifugus occultus*)	SS	SC	✔	✔	✔	
Small-footed myotis (*Myotis ciliolabrum*)	SS	SC	✔	✔	✔	
Long-eared myotis (*myotis evotis*)	SS		✔	✔	✔	✔
Long-legged myotis (*Myotis volans*)	SS		✔	✔	✔	✔
Townsend's big-eared bat (*Plecotus townsendii*)	SS	SC	✔	✔	✔	
Allen's big-eared bat (*Idionycteris phyllotis*)	SS		✔			
Western yellow bat (*Lasiurus xanthinus*)	SS	SC	✔			

Table 1-4
Special Status Species That May Occur in the Project Area

Common Name (Scientific Name)	Federal Status[1]	State Status[2]	Habitat Types Utilized			
			Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural/ Developed
Mexican long-tongued bat (*Choeronycteris mexicana*)	SS		✔			✔
Spotted bat (*Euderma maculatum*)	SS		✔	✔	✔	✔
REPTILES						
Desert night lizard (*Xanthusia vigilis vigilis*)	SS	SC	✔	✔		
Arizona skink (*Eumeces gilberti arizonensis*)	SS	SC	✔		✔	
Chuckwalla (*Sauromalus obesus*)	SS	SC	✔	✔		
Desert rosy boa (*Lichanura trivirgata gracia*)	SS	SC	✔	✔		
Desert tortoise (*Gopherus agassizii*)	SS	SC	✔	✔	✔	
Gila monster (*Heloderma suspectum*)	SS	SC	✔	✔	✔	✔
AMPHIBIANS						
Arizona toad (*Bufo microscaphus microscaphus*)	SS	SC			✔	
Lowland leopard frog (*Rana yavapaiensis*)	SS	SC			✔	

[1]Federal Status: E = Endangered;

[2]State Status: PT = Proposed for Threatened listing;
SC = Species of Special Concern
SS = BLM Sensitive Species
T = Threatened;

1.5 SPECIAL STATUS WILDLIFE SPECIES

Special Status Species are those species which are declining in number throughout their range and for which specific threats to existing populations or habitat have been identified. The Bureau of Land Management Kingman field office provided a list of Special Status Species that may occur in the project area (**Appendix A**). BLM Sensitive species, state-listed species (identified by the Arizona Game and Fish Department's *Wildlife of Special Concern in Arizona*), federal candidate species, and federally-listed threatened or endangered species are all Special Status Species. **Table 1-4** presents the Special Status Species potentially occurring within the region, listed by both common and scientific name, habitat associations, and status.

The only federally listed threatened or endangered wildlife species which may occur within the project study area are the southwestern willow flycatcher and the southern bald eagle. Bald eagle roost areas are typically located in riparian habitats and other areas with dense stands of large trees. Bald eagles typically require high, isolated cliff faces near rivers, streams, or riparian areas. There are no known bald eagle nest sites within the project study area and no nests or individuals were observed during the nesting raptor survey (Chapter 3). However it is possible that bald eagles may occur on the Big Sandy River in some winters. Southwestern willow flycatcher survey information is provided in Chapter4.

According to the Special Status Species list provided by the BLM, surveys will not be required for the following species:

Desert tortoise	(*Gopherus agassizii*)
Gila monster	(*Heloderma suspectum*)
Arizona skink	(*Eumeces gilberti arizonensis*)
Chuckwalla	(*Sauromalus obesus*)
Rosy boa	(*Lichanura trivirgata*)
Mountain plover	(*Charadrius montanus*)
Western bluebird	(*Sialia mexicana*)

1.6 REFERENCES

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U. S. Fish and Wildlife Service. 1999. List of threatened and endangered species for the state of Arizona. Downloaded from: http://endangered.fws.gov/statl-r2.html on February 8, 2000.

2.0 BAT SURVEY

2.1 INTRODUCTION

A small spring is located in the southwest quarter of the southwest quarter of Section 5, Township 15 North, Range 12 West on the edge of the proposed plant site. This spring and associated wetland have developed a small area of wetland/riparian type vegetation and represent the only natural open water source on the plant site. The next nearest water source that might attract feeding bats is approximately two miles west along the Big Sandy River. Because of the rarity of open water and riparian vegetation in the project area which might support large insect population on which bats could feed, the need for a bat survey at this spring was identified. (BLM 2000)

The Highway 93 bridge over the Big Sandy River within the project area has been documented as a night roost for several bat species (Brown and Berry 1999). Recognizing the possible use of suitable bridges and culverts as day and night roosts, a need to characterize bat use of these structures within the exposed utility corridor was identified.

2.2 METHODS

Prior to field work, a list of bat species that may occur in the project area was researched (**Table 2-1**). Mist net bat surveys were conducted in the night of July 31, 2000 over a small spring on the southwestern edge of the proposed plant site. Mist netting was conducted using standard methodologies. Nets were placed over a strip of riparian vegetation created by the spring. Details of net placement, operation, and weather parameters are shown on the bat netting record form in **Appendix B**. Following removal from nets, all bats were identified, relevant measurements and observations were made, and bats released unharmed.

An evaluation of potential roosting and feeding habitats along the proposed utility corridors was performed. Utility corridors are proposed to extend northward to US40 following Highway 93 or an existing transmission line **(Figure 1-1)**. The plant site, western half of Section 7, access road, and all alternative corridors were examined for evidence of roosting bats. Specifically, features such as caves, adits, shafts, abandoned structures, bridges, and other structures that might provide day or night roost opportunities for bats were examined. Observations were limited to these types of features that were in close proximity to the project area and that may be directly disturbed

Table 2-1
Bat Species That May Occur In The Project Area[1]

Common Name	Scientific Name	Vegetation types occupied			
		Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural / Developed
Yuma myotis	*Myotis yumanensis*	✔	✔	✔	✔
Long-legged myotis	*Myotis volans*	✔	✔	✔	✔
California myotis	*Myotis californicus*	✔	✔	✔	✔
Small-footed myotis*	*Myotis ciliolabrum*	✔	✔	✔	✔
Western pipistrelle	*Pipistrellus hesperus*	✔	✔	✔	✔
Big brown bat	*Eptesicus fuscus*	✔	✔	✔	✔
Pallid bat	*Antrozous pallidus*	✔	✔	✔	✔
Brazilian free-tailed bat*	*Tadarida brasiliensis*	✔	✔	✔	✔
Pocketed free-tailed bat	*Tadarida femorosacca*	✔	✔	✔	✔
California leaf-nosed bat*	*Macrotus californicus*	✔		✔	✔
Cave myotis*	*Myotis velifer*	✔	✔	✔	✔
Spotted bat	*Euderma maculatum*	✔	✔	✔	✔
Western mastiff bat*	*Eumops perotis*	✔	✔	✔	✔

[1] Cockrum (1996)
* Special Status Species

by construction or other activities associated with this project. Stipulations on Greystone's Scientific Collecting Permit issued by the Arizona Game and Fish Department required that night roost areas not be entered; therefore all surveys were conducted during daylight hours when night roosts were not in use. Evidence of occupation, such as guano accumulation and urine staining of the structure was used to determine bat use.

The amount of night roost use was rated primarily on the amount of guano accumulated. It is important to note that guano accumulation does not indicate a particular level of use on a given night or over a given season, but rather the cumulative amount of use since the ground underneath the roost was last scoured by flooding. Most of the structures had not been scoured for an extended period of time, as evidenced by accumulation of wind-blown debris, spider webs, etc. Thunderstorm events on the nights of August 1 and 2, 2000, during the survey period, resulted in the scouring of a number of structures immediately prior to survey.

2.3 RESULTS

2.3.1 Mist netting

Detailed survey results can be found on the bat mist netting record form in **Appendix B.** Nets were open for a total of three hours and fifteen minutes, starting shortly after the first observation of a flying bat in the evening. A total of four individuals representing three species, including Yuma myotis (*Myotis yumanensis*), pallid bat (*Antrozous pallidus*), and California leaf-nosed bat (*Macrotus californicus*) were captured. Many more bats were seen, but avoided capture. During the first hour of netting, a large number of bats were observed feeding in the area. During this first hour, two Yuma myotis bats were captured. Bats continued to feed at this site throughout the survey period, but at reduced levels compared to the first hour. Both the pallid bat and California leaf-nosed bat were captured during this later period. Moths and other flying insects were abundant throughout the survey period.

2.3.2 Roost surveys

Roost surveys were generally limited to bridges and concrete box culverts along the Highway 93 alternative corridor. No artificial structures that might provide bat roosting opportunities were observed at the plant site, in the western half of Section 7, along the access road, or along the transmission line corridor. No caves or other natural features that might provide high quality roosting habitat were observed. A total of 69 features (6 bridges, 63 concrete box culverts) were examined for signs of bat use.

Of the six bridges investigated, one had no use, four had light use, and one (the Highway 93 bridge over the Big Sandy River) had heavy use. Guano accumulation was heaviest under the northernmost two segment of the bridge. In addition to heavy night roosting activity under this bridge, approximately 15 bats were seen using the northernmost segment of the bridge as a day roost. As required in Scientific Collecting Permit issued by the Arizona Game and Fish Department, this day roost was not disturbed; thus the species utilizing it were not identified. It appeared that there were two different species: two larger groups of smaller bats, probably *Myotis* sp., and several individual bats, perhaps pallid bats.

Of the 63 concrete box culverts investigated, 22 had no use, 33 had light use, 7 had moderate use, and one had heavy use. Culverts closer to the Big Sandy River or other water features (e.g. Cane Springs Wash) tended to have a higher level of use than those farther from water. The one heavy use culvert was given this rating because it had been scoured the evening of 1 August 2000, and when surveyed during the day on 3 August 2000, already had a substantial accumulation of fresh guano. This accumulation was much greater than accumulations in other culverts rated light that had not been scoured for an extended period of time. Species using these culverts were not determined.

2.4 REFERENCES

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3.0 NESTING RAPTOR SURVEY

3.1 INTRODUCTION

The purpose of the nesting raptor survey was to address issues raised by the local community during initial public meetings for the Project. To address these issues, Greystone conducted a survey according to BLM approved protocols within an analysis area for the Project to identify any potentially sensitive areas regarding nesting raptors. Particular emphasis was placed on several sensitive areas identified by the BLM. The May 8-12, 2000 surveys included flying the entire Project area in a helicopter, and ground-truthing sensitive areas identified while in the air for the presence of raptors and raptor nests. This survey provided sufficient baseline data for the identification of existing raptor nests and areas of high raptor nesting potential.

3.1.1 Analysis Area

The analysis area (**Figure 1-1**) for the Project includes: 1) the 120-acre Plant site (Township 15 North, Range 12 West, Section 5) and its access corridor (200 feet in width); 2) the proposed pipeline route that parallels U.S. Highway 93 and Hackberry Road; and 3) the alternative natural gas pipeline route that parallels the Mead-Phoenix 500 kV transmission line. Both pipelines would require about 36 miles of pipe to connect natural gas sources to the power plant. A one-mile buffer around each site and alternative pipeline route is included in the analysis area. Analysis begins in the Knight Creek/Big Sandy River Corridor north of Interstate 40 (T21N, R13W) and follows U.S. Highway 93 and the Mead-Phoenix 500 kV transmission line south to the proposed Plant site.

3.1.2 Background Research

A literature search was conducted to identify which raptor species might be present in the analysis area. USGS 7.5 minute quad maps were reviewed prior to the field survey to help identify areas with a high raptor nesting potential such as cliff areas and high density cottonwood trees. Aerial photos of the analysis area helped identify areas with mesquite and cottonwood. The BLM was also consulted to help identify other areas which may not have been apparent through the literature review process. **Table 3-1** contains a preliminary list of raptors potentially occurring in the analysis area obtained from Millsap (1981) and personal communication with the BLM (McClure and Peck 2000).

Table 3-1
Species Identified by the BLM That May Be Present in the Analysis Area

Common Name	Scientific Name
Elf owl	*Micrathene whitneyi*
Western screech owl	*Otus kennicottii*

Table 3-1
Species Identified by the BLM That May Be Present in the Analysis Area

Common Name	Scientific Name
Barn owl	*Tyto alba*
Burrowing owl	*Athene cunicularia*
Great horned owl	*Bubo virginianus*
Common raven	*Corvus corax*
Sharp-shinned hawk	*Accipiter striatus*
Cooper's hawk	*Accipiter cooperii*
Red-tailed hawk	*Buteo jamaicensis*
Swainson's hawk	*Buteo swainsoni*
Zone-tailed hawk	*Buteo albonotatus*
Ferruginous hawk	*Buteo regalis*
Harris hawk	*Parabuteo unicinctus*
Common black hawk	*Buteogallus anthracinus*
Golden eagle	*Aquila chrysaetos*
Bald eagle	*Haliaeetus leucocephalus*
American kestrel	*Falco sparverius*
Mississippi kite	*Ictinia mississippiensis*

Data sources that were utilized include:

- BLM Technical Note 355, Distributional Status of Falconiformes in Westcentral Arizona...with Notes on Ecology, Reproductive Success, and Management, August 1981, by Brian A. Millsap (Millsap 1981).
- List of Species Potentially Occurring within the analysis area, personal communication with Rebecca Peck and Don McClure, BLM (McClure and Peck 2000).
- U.S. Fish and Wildlife Service list of Threatened, Endangered, Proposed, and Candidate species.

3.2 METHODS

Detailed field surveys were conducted to locate raptor nests and high potential raptor nesting areas within the analysis area. These methods were approved by the BLM prior to conducting the surveys. The survey was organized into two phases: Phase I - Helicopter survey, and Phase II - Ground-truthing.

Phase I - Helicopter Survey

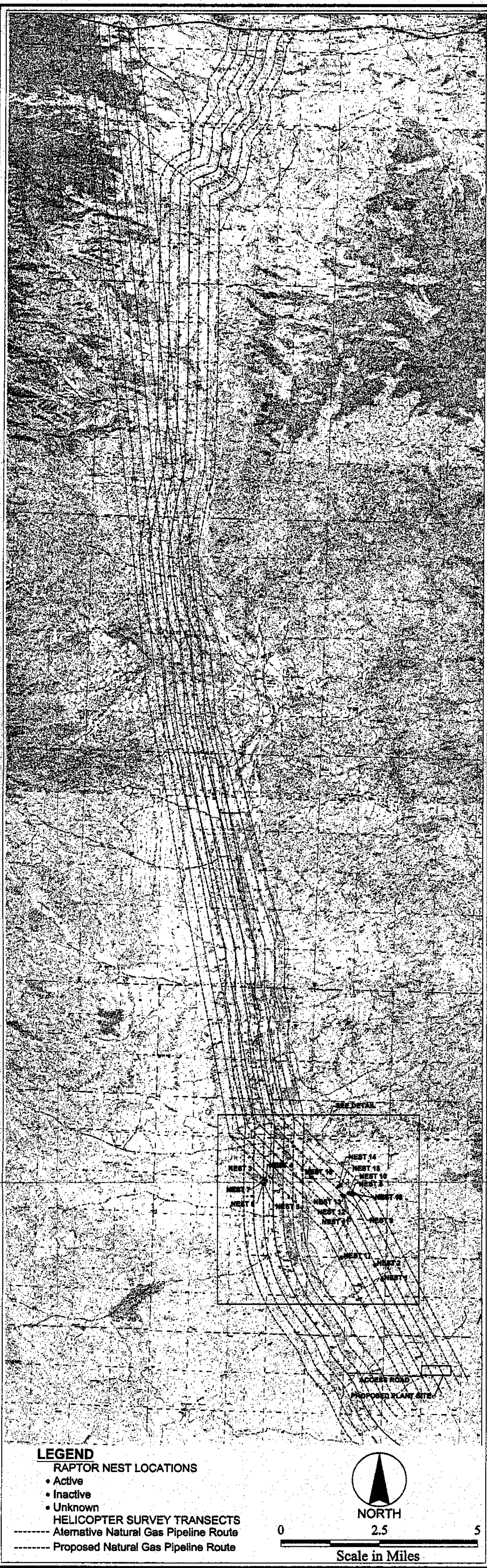
- Aerial surveys using a helicopter were conducted by two qualified biologists
- Observations were made from an altitude of 300 to 500 feet above ground level
- Flights were flown at an airspeed of approximately 40 to 50 knots
- One mile buffer zones to either side of the proposed natural gas pipeline corridors and the proposed Plant site were surveyed, giving a two mile wide survey corridor **(Figure 1-1)**
- Landscape and vegetation features (trees, cliffs, etc.) that are likely to provide raptor nest sites were closely investigated
- Parallel transects separated by ¼ mile were flown to ensure complete buffer zone coverage (**Figure 3-1**)
- Any nests located by aerial surveys, and any suspected nest sites that could not be confirmed by aerial observation were ground-truthed to determine nest/fledgling status (where appropriate)
- Standard nesting forms were completed for each nest or potential nest to document status (**Appendix A**)
- The beginning and end of each transect was surveyed using a GPS unit

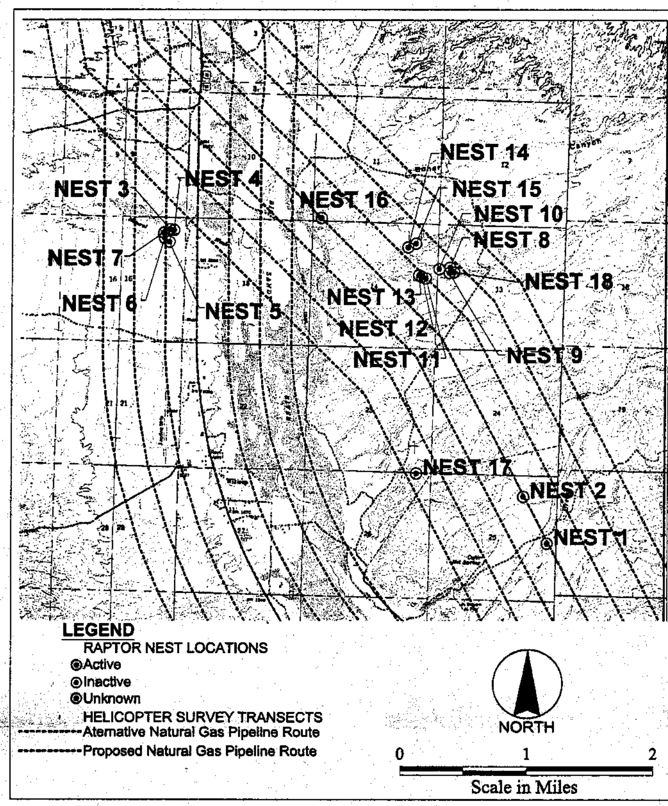
Phase II - Ground-truthing

- Areas of high raptor nesting potential were noted during the aerial survey and were later ground-truthed to determine the status of any raptor nests, when accessible
- GPS points were taken at each nest and potential nest **(Figure 3-1)**

3.3 RESULTS

The BLM has identified four habitats of special concern to be surveyed (McClure and Peck 2000). These habitats include: Riparian and aquatic habitats (cottonwood/willow series), mesquite bosque habitats (mesquite series), areas with saguaro cactus (scattered throughout the Arizona Upland Subdivision), and Natural Corrals (and other cliff areas). These habitats were the focus of both the helicopter survey and the ground-truthing effort. Locations of all nests are presented on **Figure 3-1**.





Big Sandy Raptor Nest Locations

Nest#	UTM Coordinates
1	265080 E, 3842280 N
2	264780 E, 3842880 N
3	260270 E, 3846330 N
4	260320 E, 3846320 N
5	260260 E, 3846170 N
6	260200 E, 3846220 N
7	260190 E, 3846290 N
8	263840 E, 3845840 N
9	263830 E, 3845770 N
10	263700 E, 3845820 N
11	263530 E, 3845700 N
12	263480 E, 3845720 N
13	263440 E, 3845740 N
14	263300 E, 3846100 N
15	263400 E, 3846150 N
16	262200 E, 3846480 N
17	263420 E, 3843180 N
18	263890 E, 3845780 N

BIG SANDY ENERGY PROJECT

FIGURE 3-1
RAPTOR NEST AND TRANSECT LOCATIONS

ANALYSIS AREA KINGMAN TO WIKIEUP, MOHAVE COUNTY, ARIZONA

DATE: 6/28/00	AutoCAD File: 891 raptor survey.dwg
SCALE: AS NOTED	DRAWN BY: EC

3.3.1 Phase I - Helicopter Survey

Three important habitat types were identified as having a high potential for nesting raptors during the aerial surveys, the third of which being artificial. The first habitat type was the mesquite series and cottonwood/willow series which occur along the Big Sandy River corridor. These two distinct habitat types were lumped together since they occur interspersed with each other throughout the Big Sandy River corridor. This entire corridor was flown, and all large trees were either circled and/or buzzed at a close distance so the biologists could see into the trees. No nests were identified in this habitat type, and no raptors flushed out of any trees when the helicopter was close by. The trees were fully leafed-out at the time of the survey not allowing for a good line of sight into the trees. Good

quality habitat of this type begins on the Big Sandy River at Township 17 North, Range 13 W, Sections 10 and 11 and continues south to the proposed Plant site around Township 15 North, Range 13 West, Sections 11 and 12.

The second habitat identified as having a high potential for nesting raptors was the tributary drainage areas that support sandstone cliffs and the Natural Corrals area. These cliffs support a high proportion of ledges and cavities which provide excellent nesting opportunities for raptors and other birds. All of these side canyons were flown to get a close look at the cliffs. The flight did not reveal any nests, but several areas were identified as having a high potential of supporting raptor nests. Areas of this type of habitat occur sporadically along the length of the analysis area, but the best areas occur in Township 16 North, Range 13 West, Sections 11, 12, 13, and 14; Township 16 North, Range 13 West, Sections 24, 25, and 26; and at Natural Corrals in Township 16 North, Range 13 West, Sections 9, 15, and 16. All potentially suitable raptor nesting habitat was flown along the length of the Project.

A third type of suitable habitat identified as being important to raptors is the Mead-Phoenix 500 kV transmission line power poles. These poles provide a good substrate on which to build nests, and also provide excellent perches from which to hunt from. Several nests (Nests 1, 2, and 16) were identified on transmission line towers during the aerial survey, but no birds were observed (**Figure 3-1**). These nests were later ground checked.

3.3.2 Phase II - Ground-truthing

Two types of raptor nesting habitats were ground-truthed as a result of the aerial survey. The cliff areas mentioned above and the transmission line power poles were identified as having the highest priority for ground-truthing for two reasons. Both of these habitat types provide high quality nesting sites for raptors, and access was easier allowing for much more ground to be covered.

The cliff areas were ground-truthed on foot. The first area searched was the Natural Corrals area in Township 16 North, Range 13 West, Sections 9, 15, and 16. The bases of the cliffs were walked, and when nests were found they were photographed and a nesting form was completed(**Appendix**

C). A total of five nests were found in this area (nests 3, 4, 5, 6, and 7). Of these, nest 7 was the only active nest. No adult raptors or nestlings were present, but eggs may have been present in the nest. There was fresh whitewash and fresh pellets underneath the nest indicating it was likely active. Judging from the species of birds observed in this area throughout the week, it was probably a raven nest. The status of Nest 4 was unknown. There was an old pellet on the ground below it, and whitewash was prevalent. Several adult feathers were found underneath the nest (possibly turkey vulture). This might have been an active nest earlier this year, but if it was, it has been abandoned. Throughout the Natural Corrals area several old pellets and bleached bones scattered many of the cliff bases indicating that this area has been heavily utilized by raptors in the past. It was not being heavily utilized during the spring of 2000.

The second area searched was the drainage and associated cliff areas ½ mile south of Boner Canyon in Township 16 North, Range 13 West, Sections 12, 13, and 14. A total of nine nests were found in this area (nests 8, 9, 10, 11, 12, 13, 14, 15, and 18). Of these, nest 18 was the only active nest. An adult raven flushed from the nest as it was approached, and another adult raven was in the area. The nest contained no nestlings, and it is assumed that the adult was incubating eggs.

The third area searched was a large cliff area in Township 16 North, Range 13 West, Sections 24, 25, and 26. Only one nest was found here (nest 17), but due to the height of the cliffs, more nests could have been overlooked. This cliff is about 1 mile in length and overlooks a large open area which would provide raptors excellent hunting opportunities, and the height of the cliffs would provide good nest protection from predators.

The transmission line was the second habitat type that was extensively ground-truthed. Most of it was driven, and portions were walked. A total of three nests were found on power poles (Nests 1, 2, and 16). Of these, only Nest 16 was active. Two adult ravens were tending to two nestlings. The nestlings looked like they were several weeks away from fledging.

Mesquite bosque habitats and associated cottonwood/willow habitats were not extensively ground-truthed due to the difficulty of access and extremely dense vegetation. No nests were found in these habitats during ground-truthing surveys.

Saguaro cactus was identified by the BLM (McClure and Peck 2000) as another important nesting substrate for small raptors and other birds. Since saguaro grows loosely interspersed with many different habitats, no areas of high importance were identified; however, saguaros were always investigated during the ground-truthing phase. No nests were found in any saguaros throughout the analysis area.

3.3.3 Incidental Sightings

Perhaps the most important part of this raptor survey was recording incidental sightings while driving, flying, and hiking. Very few raptors were seen throughout the week. These and other similar species are listed in **Table 3-2**.

Table 3-2
Incidental Raptor, Vulture, and Raven Sightings

Common Name	Scientific Name	Number Seen	Location
Red-tailed hawk	*Buteo jamaicensis*	4	Soaring above proposed plant site
Turkey vulture	*Cathartes aura*	>50	Throughout analysis area
Sharp-shinned hawk	*Accipiter striatus*	2	Mesquite bosque
Cooper's hawk	*Accipiter cooperii*	1	Mesquite bosque
Common raven	*Corvus corax*	>50	Throughout analysis area

The drought conditions over the past year almost certainly have had an effect on the low density of raptors. Generally the prey base is first affected by drought. Only a few prey species were observed throughout the week (a few rabbits). Where there is a low density of prey species, there is also a low density of raptors. As seen in **Table 3-2**, the only raptors observed were four red-tailed hawks, two sharp-shinned hawks, and one Cooper's hawk. These observations were dominated by the common raven and the turkey vulture.

3.5 SUMMARY

Although good nesting habitat for raptors exists in the analysis area, very few raptors were observed. Three nests were located during the aerial survey, fifteen more were located from the ground, and very few raptors were observed throughout the week. Of the eighteen nests found, only three were active, and these were all common raven nests.

Since the mesquite bosque and cottonwood/willow series could not be thoroughly ground-truthed, and because sharp-shinned and Cooper's hawks were seen in this habitat type, it can be assumed that raptor nests are present within these habitats in the Big Sandy River corridor within the analysis area.

There are no timing restrictions or disturbance or buffer zones around raptor nests required by either the USFWS or the Arizona Game and Fish Department in the Project area (Humphrey 2000, Driscoll 2000). However, under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA), any act (i.e., construction) should not occur in such a way as to disturb or cause the abandonment of any nest.

3.6 REFERENCES

Driscoll, J. 2000. Personal communication [telephone conversation on June 30, 2000 with Patrick Golden, Biologist, Greystone, regarding raptor nest timing restrictions and buffer ones in the State of Arizona and in the Project area]. Non-game biologist, Arizona Game and Fish Department, Phoenix, Arizona.

Humphrey, J. 2000. Personal communication [telephone conversation on June 30, 2000 with Patrick Golden, Biologist, Greystone, regarding federal recommendations on raptor nest timing restrictions and buffer zones in the State of Arizona and in the Project area]. iologist, U.S. Fish and Wildlife Service, Phoenix, Arizona.

McClure, D. and R. Peck. 2000. Memorandum to Dave Swanson and John Bridges, WAPA, dated May 9, 2000 regarding raptor nesting survey protocols and raptor species list. McClure and Peck work for the Bureau of Land Management in Kingman, AZ.

Millsap, B. 1981. Distribution and Status of Falconiformes in Westcentral Arizona...with Notes on Ecology, Reproductive Success, and Management. BLM Technical Note 355. U.S. Department of the Interior.

4.0 SOUTHWESTERN WILLOW FLYCATCHER SURVEY

4.1 INTRODUCTION

The southwestern willow flycatcher (*Empidonax traillii extimus*) is a federally-listed endangered species and is considered a Species of Special Concern in Arizona. Southwestern willow flycatchers (SWWIFLs) typically nest in cottonwood-willow vegetation associations along streams, rivers, or other wetland areas where dense stands of willows occur. These areas may also have an overstory of cottonwoods. Tamarisk can also be a significant component of SWWIFL nesting habitat. Surface water or saturated soils are almost always present in, or adjacent to, nesting areas during the breeding season. Nests are generally located in thickets of shrubs that are approximately 13 to 23 feet tall with a high percentage of canopy cover and dense foliage (Tibbets et al. 1994). Males sing repeatedly from exposed perches while on the breeding grounds. The SWWIFL is best identified by vocalizations, due to its similarity in appearance with other flycatchers in the genus *Empidonax*.

4.1.1 PURPOSE

For the Big Sandy Energy Project, surveys for the SWWIFL are required in habitats that may be influenced by the proposed action or alternatives. The following is a brief summary of the study area, methods, and results.

4.1.2 ANALYSIS AREA/LOCATION

The U.S. Fish and Wildlife Service (USFWS) and the Bureau of Land Management (BLM) initially suggested potential SWWIFL survey locations that may be directly impacted by the proposed action or alternatives. These crossings or areas that parallel the Big Sandy River or its tributaries include the following sections (all in Range 13 West):

- Township 15 North, Section 1: Big Sandy Bridge crossing up to 1 mile upstream
- Township 15 North, Section 2: Big Sandy Bridge crossing up to 1 mile downstream
- Township 15 North, Section 11, 12, and 13: Caithness property
- Township 16 North, Section 15: tributary crossing
- Township 16 North, Section 10: Mead-Liberty and Mead-Phoenix crossing of Big Sandy River
- Township 16.5 North, Section 21, 28, and 33: tributary crossings and areas parallel to Highway 93
- Township 17 North, Section19, 23, 26, and 35: tributary crossings and areas parallel to Highway 93
- Township 18 North, Section 28: tributary crossing

Several of these potential SWWIFL survey locations were removed from consideration due to lack of suitable habitat, following guidance from the agencies. The habitat at these locations were evaluated and determined suitable within a two-mile stretch of the Big Sandy River centered on the Big Sandy Bridge on US Highway 93 (**Figure 1-1**). Although potential SWWIFL habitat may exist beyond one mile north and south of the Big Sandy Bridge, these habitats are not expected to be influenced by the proposed activities and thus were not surveyed.

SWWIFL potential habitat along the Big Sandy River is dominated by native riparian vegetation, primarily Goodding willow (*Salix gooddingi*), Fremont cottonwood (*Populus fremonti*), and non-native tamarisk (*Tamarix ramosissima*). Non-native vegetation was estimated to comprise 50 percent or more of the riparian community.

4.2 METHODS

A total of three rounds of SWWIFL surveys were conducted within the project area (between approximately one mile upstream and one mile downstream from the US Highway 93 bridge crossing of the Big Sandy River). The survey protocol requires a minimum of three surveys with at least one survey during each of the three distinct periods (Period 1: May 15-31, Period 2: June 1-21, and Period 3: June 22-July 10). The SWWIFL survey was conducted in compliance with the USFWS recommended protocol (Sogge 1997). This protocol utilizes tape-recorded SWWIFL calls and listening stations to determine the presence or absence of SWWIFL individuals. Recent discussions with the USFWS (Beaty 2000) identified a preference to add two additional surveys to Period 3 (for a total of 5 surveys for the entire season) and to extend Period 3 to July 17.

The upstream survey consisted of two survey loops. One survey loop centered around the boundary line between Section 36, Township 16 North, Range 13 West and Section 1, Township 15 North, Range 13 West. The second survey loop began at the US 93 bridge traversing upstream ½ mile and returning to the US 93 bridge. The downstream survey also consisted of two survey loops. Loop #1 began at the head of a diversion canal in the northeast corner of Section 11, Township 15 North, Range 13 West, and traversed southward along the canal to upland habitat and returned northward along the riverbed. Loop #2 of the downstream survey began at the head of the diversion canal, traversed northward along the south bank to the US 93 bridge, crossed the river to the north bank, and worked along the north bank back to the start point. Each survey loop was designed to locate calling points adjacent to all suitable habitats (dense thickets/patches of willow, cottonwood, and tamarisk) within the project area.

4.3 RESULTS

Figures 4-1 through 4-5 provide SWWIFL locations within the project area. Territories were estimated by observing and/or hearing calling male SWWIFLs and observing calling males in close association with female SWWIFLs. Pairs were estimated by observing male/female interactions,

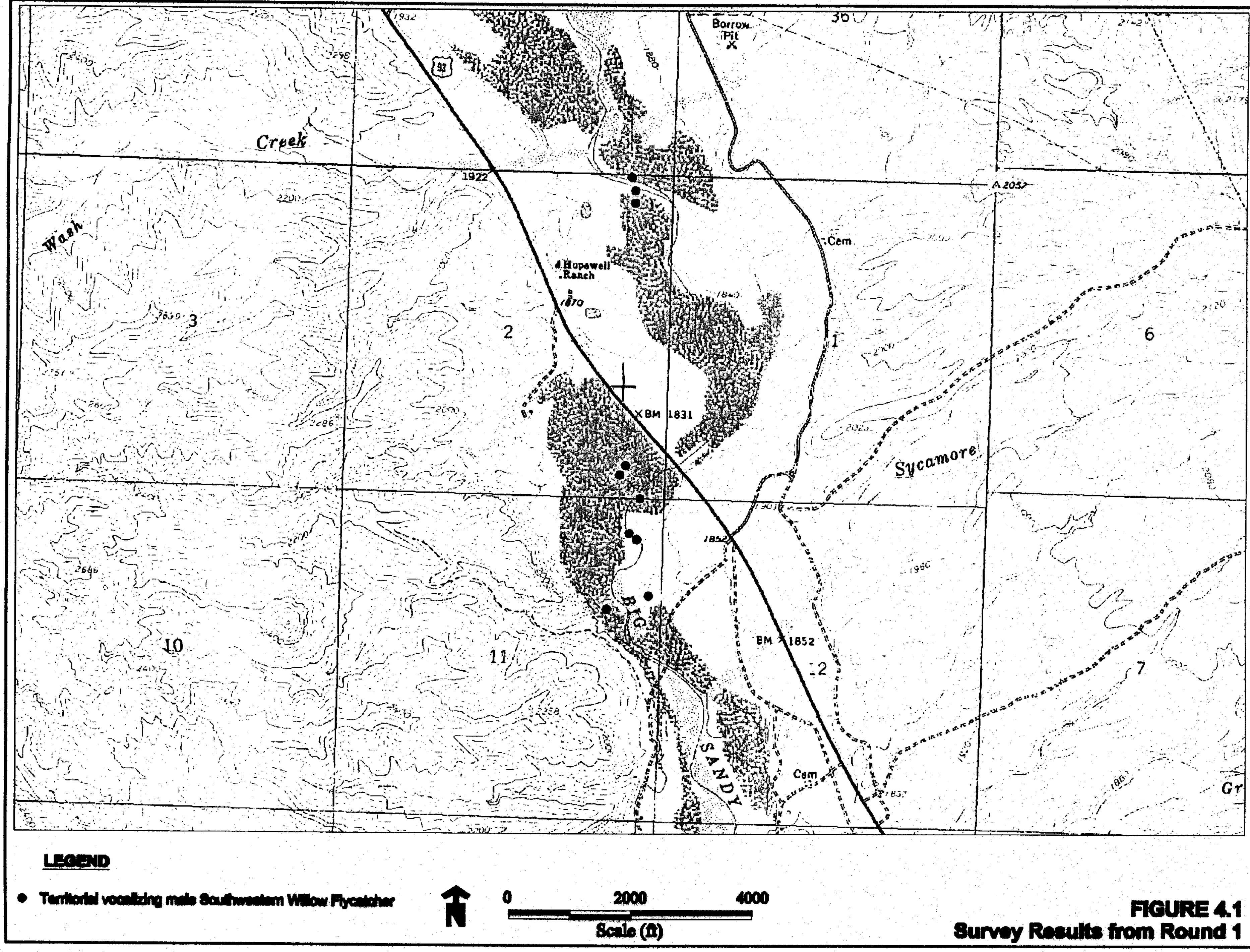
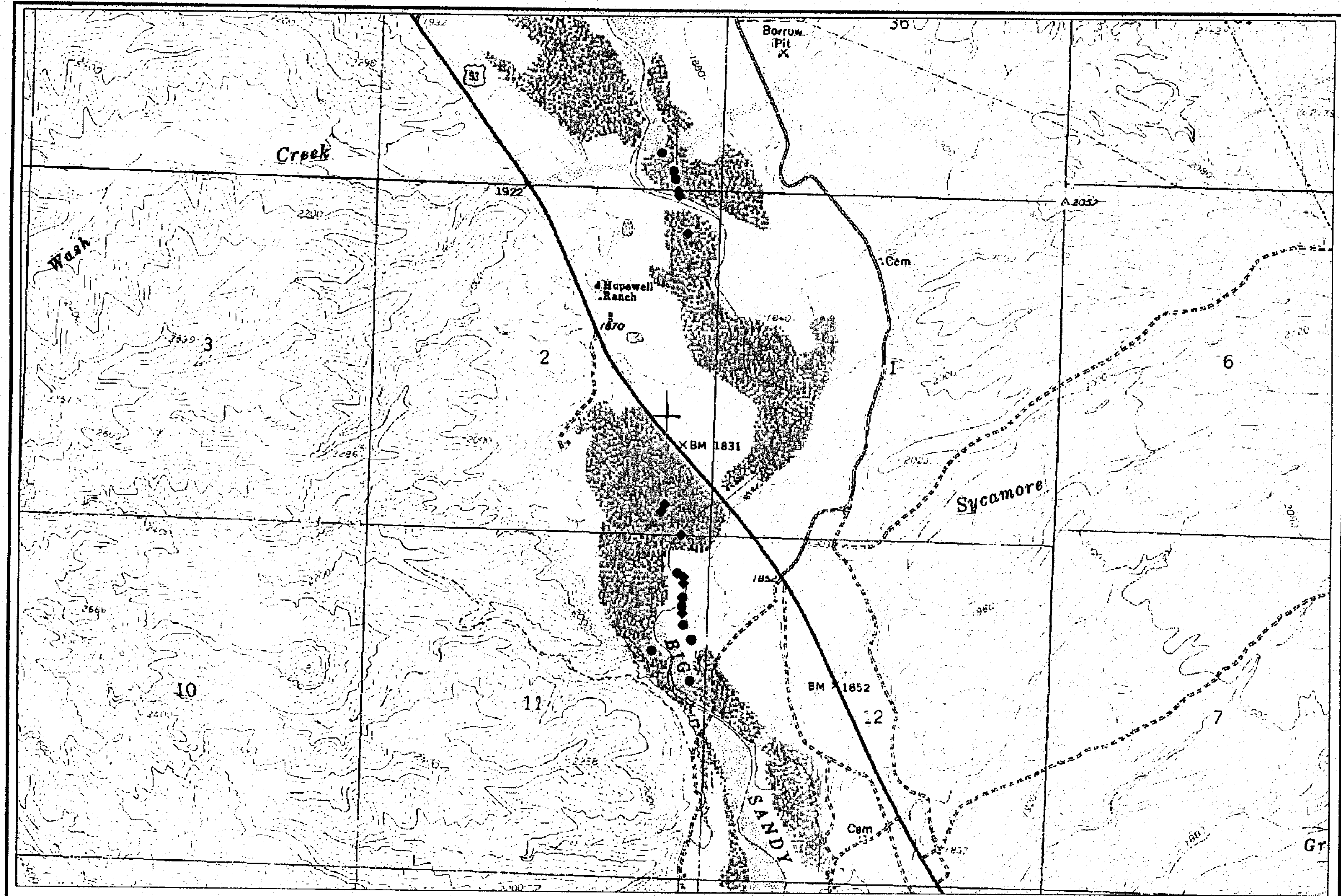


FIGURE 4.1
Survey Results from Round 1



LEGEND

- ● Territorial vocalizing male Southwestern Willow Flycatcher
- ◆ Nesting Pair

N

0 2000 4000

Scale (ft)

FIGURE 4.2
Survey Results from Round 2

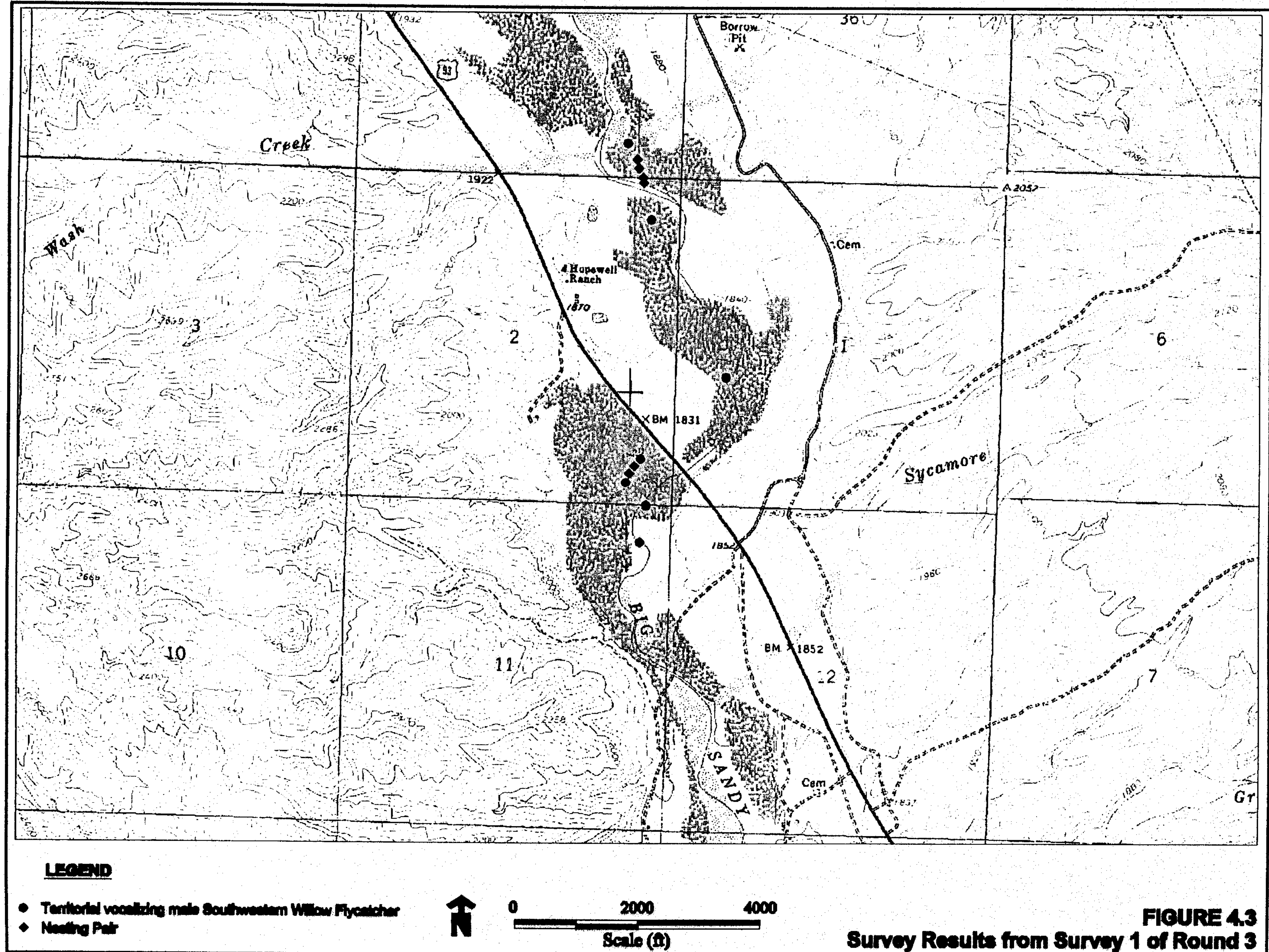
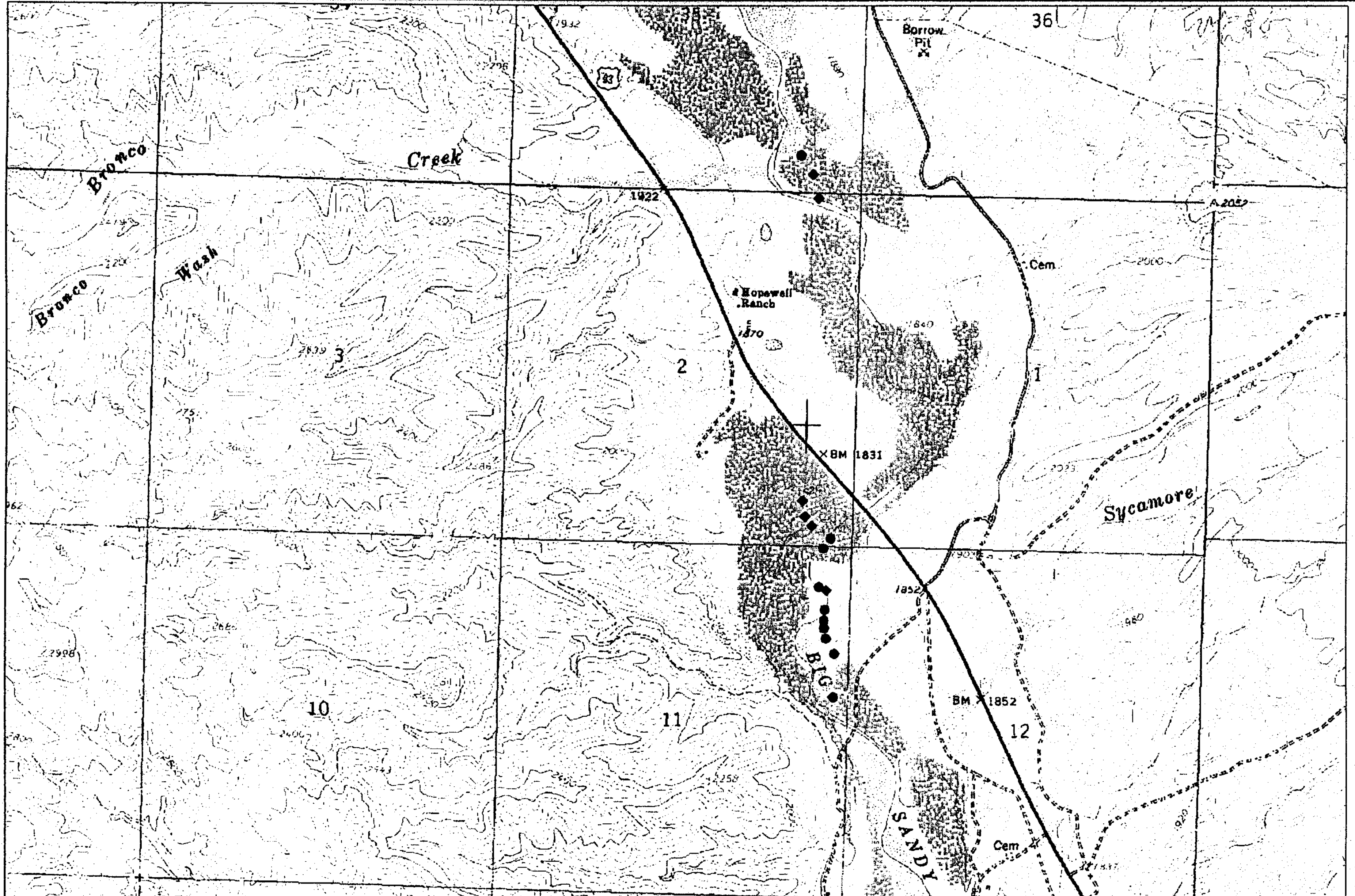


FIGURE 4.3
Survey Results from Survey 1 of Round 3



LEGEND

- ● Territorial vocalizing male Southwestern Willow Flycatcher
- ◆ Nesting Pair

N

0 2000 4000
Scale (ft)

FIGURE 4.4
Survey Results from Survey 2 of Round 3

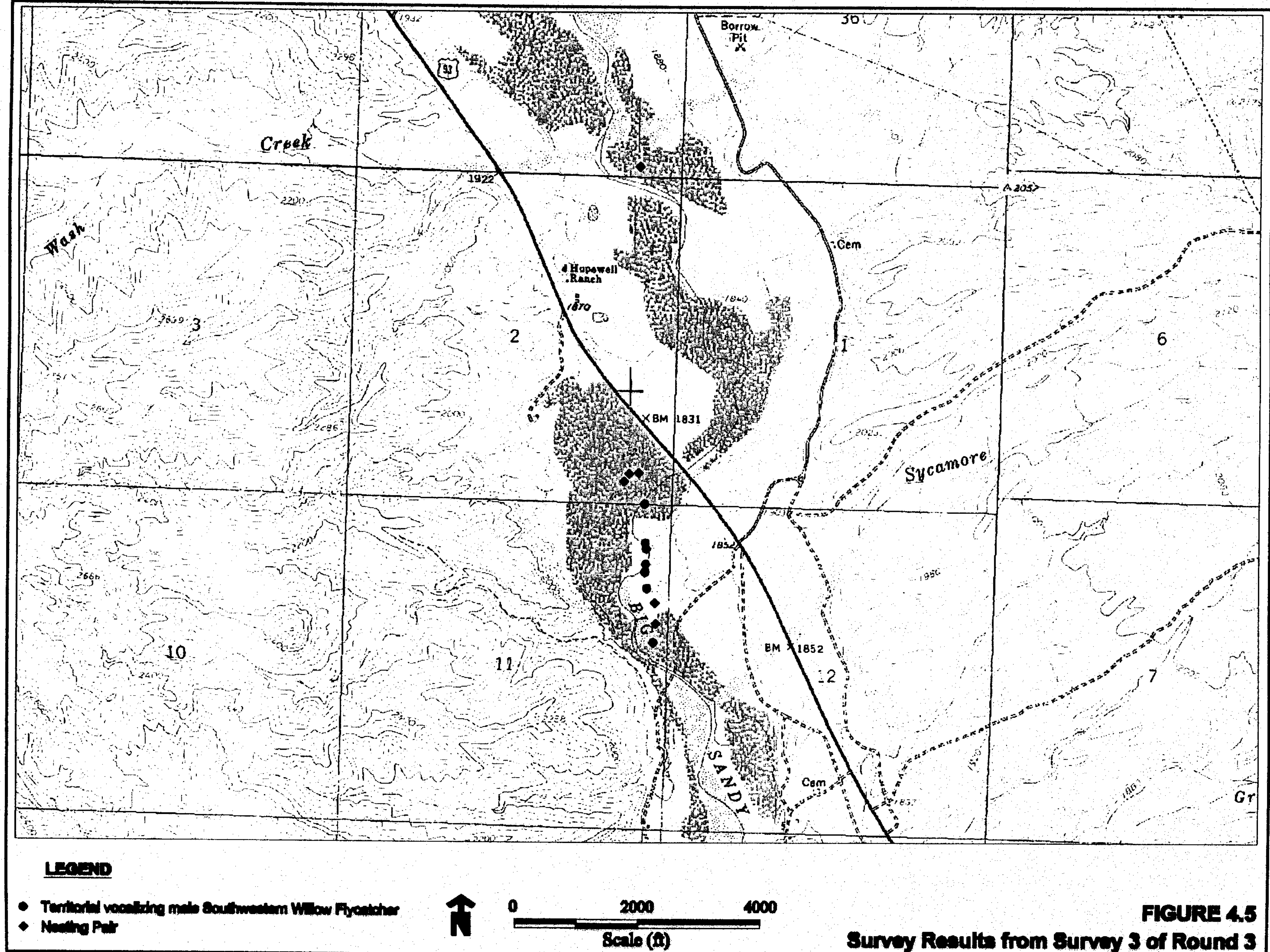


FIGURE 4.5
Survey Results from Survey 3 of Round 3

audible female "whits" in response to male calls, and observing feeding behavior between adults and juvenile SWWIFLs. The results of each complete survey are provided in **Table 4-1**.

In summary, a total of 85 SWWIFLs were detected over the course of five complete surveys. It is estimated that a maximum of 76 territories and 34 pairs occur within the survey areas. The occupied habitat could provide suitable nesting substrate for some time (EcoPlan 2000). SWWIFL survey forms are included in **Appendix D**.

Table 4-1
Results of Southwestern Willow Flycatcher Surveys

Round	Date	Loop	# SWWIFLs found	Estimated territories	Estimated pairs
1	May 30	upstream #1	3	3	0
	May 30	downstream #1	2	unknown	0
	May 31	downstream #2	6	5	unknown
2	June 14	upstream #1	7	7	3
	June 14	upstream #2	0	-	-
	June 15	downstream #1	10	10	3
	June 15	downstream #2	3	3	3
3, #1	June 26	downstream #1	1	1	0
	June 26	downstream #2	5	5	2
	June 27	upstream #1	10	4	4
	June 27	upstream #2	1	1	0
3, #2	July 5	downstream #1	8	8	unknown
	July 5	downstream #2	5	5	3
	July 6	upstream #1	3	3	2
	July 6	upstream #2	0	-	-
3, #3	July 13	downstream #1	8	8	2
	July 13	downstream #2	4	4	3
	July 14	upstream #1	1	1	1
	July 14	upstream #2	0	-	-

4.4 REFERENCES

Beaty, Greg (USFWS) 2000. Personal Communication regarding Southwestern Willow Flycatcher Surveys.

EcoPlan Associates. 2000. Letter from EcoPlan Associates, Inc., Mesa, Arizona to Greystone regarding southwestern willow flycatcher survey resluts. Dated August 2, 2000.

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Tibbets, T.J., M. K. Sogge. and S.J. Sferra. 1994. A survey protocol for the southwestern willow flycatcher (Empidonax trallii extimus). USDI National Park Service and Colorado Plateau Research Station, Northern Arizona University. Technical Report NPS/NAUCPRS/NRTR-94/04. Denver, CO.

5.0 WESTERN YELLOW-BILLED CUCKOO SURVEY

5.1 ABSTRACT

In February 1998 steps were taken to formally recognize the western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) as a federally endangered subspecies (Laymon 1998). The western yellow-billed cuckoo has experienced a significant reduction in its preferred riparian habitats in the west and now occurs in only a fraction of its historical range (Corman et al. 2000). As a species with potential protective status, Big Sandy Energy Project conducted an evaluation of its occurrence within the proposed project areas and corridors. Information from this effort will supplement the associated environmental impact statement (EIS). A tape-playback method using the "kowlp" call (Laymon 1998) was used to elicit responses from mated individuals that are typically quiet and secretive birds. Surveys were conducted within one mile north and south of the Big Sandy Bridge on Highway 93 and in habitat adjacent to the crossing of the Big Sandy River and the existing Mead-Phoenix 500 kV transmission line. Habitat was deemed marginal for a variety of reasons including small patch size, low vegetation density, and the lack of permanent surface water at some of the surveyed areas. No western yellow-billed cuckoo were observed or heard calling during this survey effort.

5.2 INTRODUCTION

5.2.1 Purpose

As part of the Big Sandy Energy Project, surveys for the western yellow-billed cuckoo (WYBC) were conducted for habitats that may experience impacts resulting from the proposed actions. The following is a summary of species description, study area, methodology, and results relevant to the field survey conducted in August 2000.

5.2.2 Description

The yellow-billed cuckoo (*Coccyzus americanus*) is a summer resident throughout much of the United States, southern Canada, and northern Mexico. Differences in morphology, migration, and nesting have led many biologists to consider the western yellow-billed cuckoo a separate subspecies (*Coccyzus americanus occidentalis*). A final determination has not been reported regarding the classification of the western yellow-billed cuckoo as a subspecies.

The WYBC utilizes riparian habitats for breeding, nesting, and feeding. These habitats have experienced serious decline in the western U.S. resulting in a reduction of the current WYBC range to a fraction of its historical range (Corman et al. 2000). Currently, known breeding populations of the WYBC are restricted to Arizona, California, New Mexico, and Texas. A study by Gaines (1974) identified vegetative density, distance to water, and length and width of habitat area as important habitat parameters for the occurrence of breeding WYBCs.

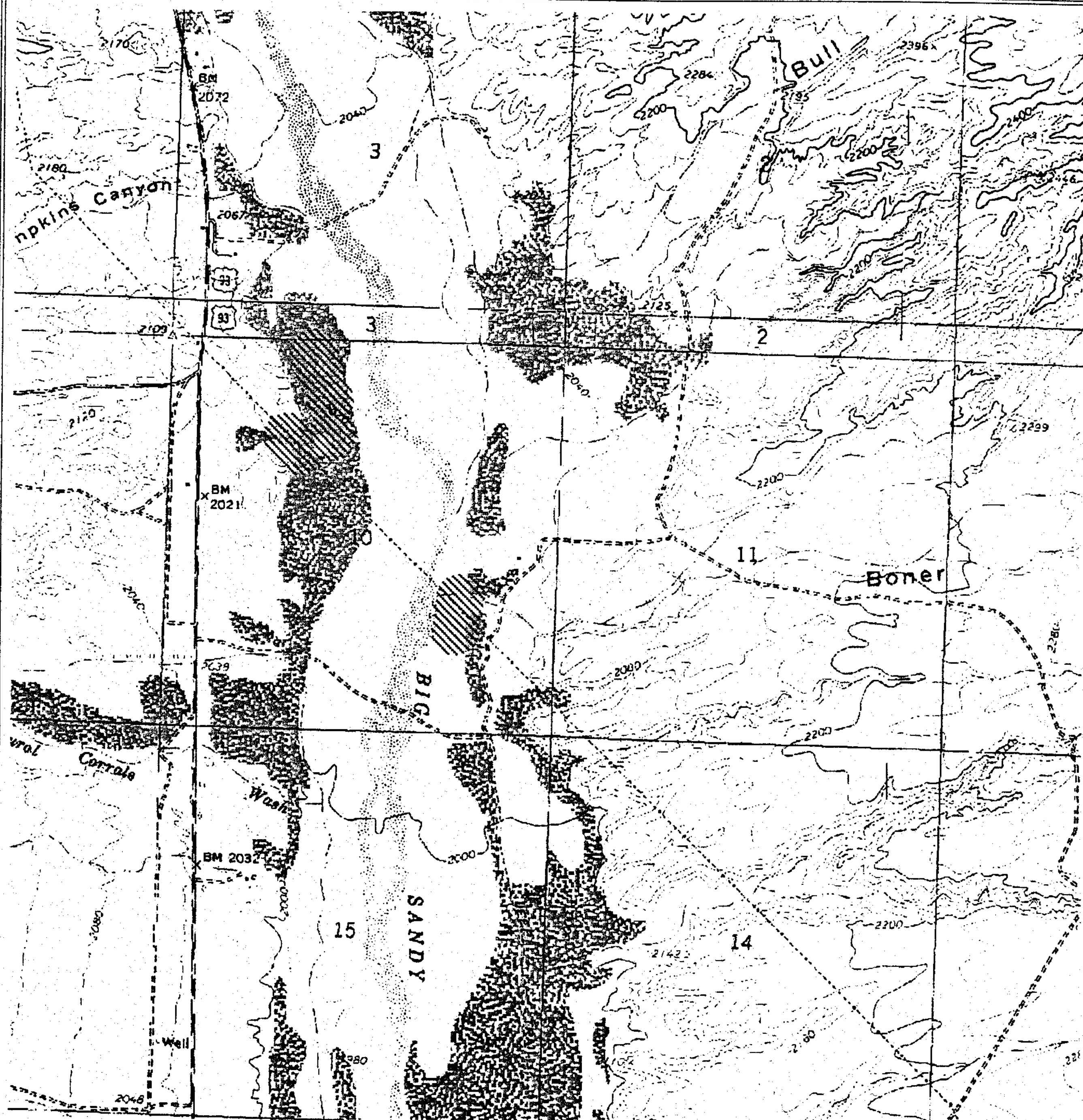
The Arizona Game and Fish Department (AGFD) conducted an extensive evaluation of WYBC occurrence during 1998 and 1999. Study sites were restricted to perennial, intermittent, and ephemeral drainages that were less than 1500 m in elevation. At each study site a tape-recorded call of the WYBC was played in order to elicit a response from breeding residents. During the two season sampling effort, the WYBC was detected along 25 drainages in Arizona. This AGFD study surveyed three locations along the Big Sandy River. A total of seven individuals were detected above the confluence of the Big Sandy River and the Santa Maria River. These detections are approximately 24 miles south of the Project site. No detections were recorded at Rock Tank Canyon (Yavapai County) or Trout Creek (Mohave County).

5.2.3 Study Area

The initial study area included all areas associated with the proposed plant site (S ½ of Section 5, T15N, R12W, Quad name: Wikieup Ariz) and the buffer zones associated with each of the utility corridors (proposed and alternative). Habitats within these areas were mapped, characterized and evaluated for WYBC suitability. Based on habitat suitability and potential for impact resulting from construction, two areas were identified for WYBC surveys. These survey areas include the habitat along the river at the Big Sandy Bridge on Highway 93 (SW ¼ of Section 1, T15N, R13W, Quad name: Wikieup Ariz) and the habitat adjacent to the intersection of the existing Mead-Phoenix 55 kV transmission line and the Big Sandy River (NW ¼ of Section 10, T16N, R15E, Wikieup Ariz). Survey stops were surveyed with GPS equipment and these data are depicted in **Figures 5-1 and 5-2,** respectively.

As of August 2, 2000, flowing water was observed within one mile north and south of the Big Sandy Bridge. Habitat within one mile up- and downstream of the Big Sandy Bridge was surveyed. Dominant vegetation along this corridor consisted of tamarisk (*Tamarix ramosissima*), screwbean mesquite (*Prosopis pubescens*), Goodding's willow (*Salix gooddingi*), and Fremont cottonwood (*Populus fremontii).* Habitat patches in this area tended to be linear, narrow, and adjacent to the watercourse. Habitat dimensions were variable among patches, but tended to be less than 10m wide. Canopy height varied between 3-10 meters. The combination of flowing water, the occurrence of developed overstory, and the potential for impact in this area was sufficient to warrant the survey of this habitat.

During the survey conducted on August 3, 2000 no flowing water was observed at the crossing of the Big Sandy River and the existing Mead-Phoenix 500 kV transmission line. A large mesquite bosque exists north of the intersection of the river and transmission line and south of Highway 93. This bosque is relatively contiguous with several two-track roads bisecting it. This survey area was not adjacent to any known water (the Big Sandy River is dry in this reach) and vegetation density through much of the patch was variable. Despite these characteristics, this bosque was surveyed because the documented occasional use of mesquite bosques by WYBCs and the proximity to a proposed utility crossing.



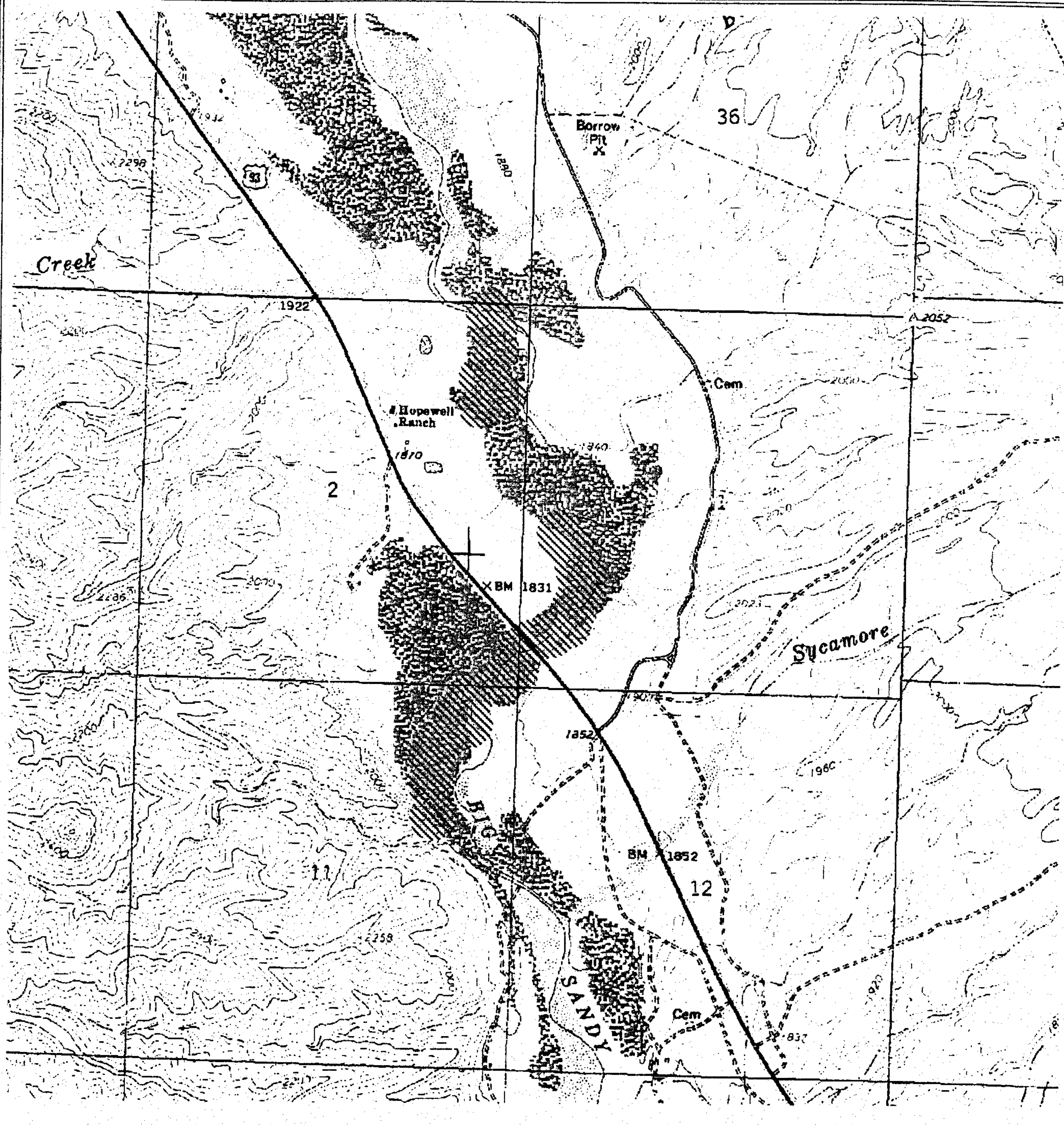
LEGEND

Western Yellow-Billed Cuckoo Survey Area

1000 0 1000 2000 Feet

N

BIG SANDY ENERGY PROJECT	
FIGURE 5.1 WESTERN YELLOW-BILLED CUCKOO NORTH SURVEY AREA	
ANALYSIS AREA: MOHAVE CO., ARIZONA	
DATE: 08/24/00	ArcView FILE: C:\BIGSANDY\CUCKOO.APR
PLOT SCALE: 1" = 2,000'	DRAWN BY: CDF



LEGEND

Western Yellow-Billed Cuckoo Survey Area

1000 0 1000 2000 Feet

N

BIG SANDY ENERGY PROJECT	
FIGURE 5.2 WESTERN YELLOW-BILLED CUCKOO SOUTH SURVEY AREA	
ANALYSIS AREA: MOHAVE CO., ARIZONA	
DATE: 08/24/00	ArcView FILE: C:\BIGSANDY\CUKOO.APR
PLOT SCALE: 1" = 2,000'	DRAWN BY: CDF

5.4 METHODS

This survey effort followed the protocol prepared by Stephen Laymon (1998). This protocol was also used by AGFD during their 1998 and 1999 efforts. This method utilizes a tape-recorded contact call ("kowlp") to elicit responses from mated male and female cuckoos. Because the recorded call is a breeding contact call, it is most effective during the breeding season. Therefore, surveys should be conducted between 15 June and 10 August. Surveys for this effort were conducted August 2 and 3, 2000. Surveys were started at 0600 and finished prior to 1100 or when air temperatures exceeded 100° Fahrenheit. Survey stops were separated by 100m and taped-calls were played 5 times at each stop. A thirty second listening period separated each playing round of calls.

5.5 RESULTS

A total of 26 playing stops were used near the Big Sandy Bridge; 16 stops north of the bridge and 10 stops south of the bridge. Nine playing stops were used near the crossing of the Big Sandy River and the existing transmission line, north of Wikieup, Arizona. No WYBCs were observed or heard responding to the tape-recorded calls at the Big Sandy Bridge or at the Big Sandy River and transmission line crossing.

5.6 REFERENCES

Corman, T.E. and R.T. Magill. 2000. Western yellow-billed cuckoo in Arizona: 1998 and 1999 Survey Report. Tech. Report 150. Nongame and Endangered Wildlife Program. Arizona Game and Fish Department.

Gaines, D. 1974. Review of the status of the yellow-billed cuckoo in California: Sacramento Valley Populations. Condor 76:204-209.

Laymon, S.A. 1998. Yellow-billed cuckoo survey and monitoring protocol for California. Unpublished.

APPENDIX A
SPECIES OF SPECIAL CONCERN

MEMORANDUM

To: Don McClure, Project Manager

From: Rebecca Peck, Wildlife Biologist

Date: 5-18-00

Subject: Big Sandy Energy Project: Species of Special Concern.

A species list has been developed for species of special concern. Surveys should be done for many of these particular species. In **addition**, the proponent should **request** a species list from the Arizona Game and Fish Department *and* the USFWS. To avoid confusion, the BLM sensitive species list does not include species that are listed by these two agencies. The BLM is nonetheless responsible for the management of all of these species habitats on public lands.

Required surveys:

1. BLM Sensitive Species List for Arizona* - surveys required.

Plants:

Antelopebrush (*Purshia glandulosa*)
Aquarius milkvetch (*Astragalus newberryi var. aquarii*)
Aravaipa woodfern (*Thelypteris puberula var. sonorensis*)
California flannelbush (*Fremontodendron californica*)
Nevin birdsbeak (*Cordylanthus nevinii*)
Parish phacelia (*Phacelia parishii*)
Shrubby senna (*Senna (Cassia) armata*)
Striped horsebrush (*Tetradymia argyraea*)
Three hearts (*Tricardia watsonii*)

Fish:

Longfin dace *(Agosia chrysogaster)*
Desert sucker (Catostomus [Pantosteus] clarki)
Sonora sucker (Catostomus insignis)
Speckled dace *(Rhinichthys osculus)*

Birds:

Western burrowing owl *(Athene cunicularia hypugea)*
Loggerhead shrike (Lanius ludovicianus)
White-faced ibis *(Plegadis chihi)*

Mammals:

Mexican long-tongued bat *(Choeronycteris mexicana)*
Spotted bat *(Euderma maculatum)*
Allen's (Mexican) big-eared bat *(Idionycteris phyllotis)*

Small-footed myotis *(Myotis ciliolabrum)*
Long-eared myotis *(Myotis evotis)*
Fringed myotis *(Myotis thysanodes)*
Cave myotis *(Myotis velifer)*
Long-legged myotis *(Myotis volans)*
Big free-tailed bat *(Nyctinomops macrotis)*
Califonia leaf-nosed bat *(Macrotus californicus)*
Arizona Myotis *(Myotis lucifugus occultus)*

*List developed from Instruction Memorandum No. AZ-2000-018: the following is a clarification of the list.

Some bats were not included on the list that were only identified with roost site protection problems. All roost sites may be very sensitive and require special habitat management or special consideration, regardless of the species that occupy them. Some raptors were not included that have fairly specific nesting requirements. Raptors, particularly nesting raptors, may require special habitat management or special consideration, on their own merits, because of their characteristic low population sizes and widely dispersed distributions.

To relieve possible confusion, some clarification of the several types of species status may help. BLM Sensitive species, State-listed species (by a State agency, in this case, Arizona Game and Fish Department's *Wildlife of Special Concern in Arizona*), Federal Candidate species, and Federally-listed threatened or endangered species are all *Special Status Species* covered by MS 6840. By policy, BLM has certain responsibilities for all Special Status Species. BLM Sensitive species are not covered by any other "safety net" of status designation. Therefore, the Arizona BLM Sensitive Species List does not include species that are already Federally-listed or State-listed.

2. <u>State-listed species surveys</u> that will be required. The following is a list developed by the BLM Kingman Field Office. This is only a "heads up" list and should not be taken as comprehensive. A list should be requested from the Arizona Game and Fish Department.

<u>Birds:</u>

Common black hawk (*Buteogallus anthracinus*)
Cooper's hawk (*Accipiter cooperii*)
Ferruginous hawk (*Buteo regalis*)
Golden eagle (*Aquila chrysaetos*)
Merlin (*Falco columbarius*)
Peregrine falcon (*Falco peregrinus*)
Sharp-shinned hawk (*Accipiter striatus*)
Southwestern willow flycatcher (*Empidonax trailii extimus*)
Swainson's hawk (*Buteo swainsoni*) - breeding population only

Yellow-billed cuckoo (*Coccyzus americanus*)
Zone-tailed hawk (*Buteo albonotatus*)

<u>Mammals:</u>

Big free-tailed bat (*Tadarida macrotis*)
California leaf-nosed bat (*Macrotis californicus*)
Cave myotis (*Myotis velifer*)

Fringed myotis (*Myotis thysanodes*)
Greater western mastiff bat (*Eumops perotis californicus*)
Occult little brown bat (*Myotis lucifugus occultus*)
Small-footed myotis (*Myotis ciliolabrum*)
Townsend's big-eared bat (*Plecotus townsendii*)
Western yellow bat (*Lasiurus xanthinus*)Desert night lizard (*Xantusia vigilis vigilis*)

<u>Amphibians:</u>

Arizona toad (*Bufo microscaphus microscaphus*)
Lowland leopard frog (*Rana yavapaiensis*)

<u>Fish:</u>

Roundtail chub (*Gila robusta*)

<u>Plants:</u>

Arizona necklace (*Sophora arizonica*)
Linear-leaf sand spurge (*Stillingia linearifolia*)
Sand cholla (*Opuntia pulchella*)
Thorn Milkwort (*Polygala acnathoclada*)

3. <u>Federally-listed species required surveys</u>. The proponent needs to request a list. These are the known federally-listed species that occur or may occur within the analysis area:

Southwestern willow flycatcher	- *Empidonax traillii extimus*
Arizona Cliffrose	- *Purshia subintegra* (Big Sandy Valley lake bed habitat)
Southern bald eagle	- *Haliaeetus leucocephalus*

4. <u>Bat roost surveys</u> - surveys of features such as caves, adits, shafts, abandoned structures, bridges, that may contain bat roosts should be conducted beginning at the junction of I-40 and US 93 following the project down US93 to one mile to either side of the project area and all alternatives, the plant area, and one mile to either side of the Big Sandy River, Alamo Lake, and the Bill Williams River to the Colorado River.

Surveys will not be required of the following species. Analysis of impacts and mitigation, if any, for these species will need to be done.

Desert tortoise (*Gopherus agassizii*)
Gila monster (*Heloderma suspectum*)
Arizona skink (*Eumeces gilberti arizonensis*)
Chuckwalla (*Sauromalus obesus*)
Rosy boa (*Lichanura trivirgata*
Mountain plover (*Charadrius montanus*) (does not breed in the project area)
Western bluebird (*Sialia mexicana*) (does not breed in the project area)
Crownless milkweed vine (*Cynanchum utahense*)

—Addendum to:

6.0 Riparian/Wetland Resources

Materials available:

BLM Field forms of 1988 and 1989 Riparian Inventory (RACE -Riparian Area Condition Evaluation) of the Big Sandy River below the US 93 Bridge and the Bill Williams River.

BLM field forms of 1998, 1999 Riparian Inventory (PFC- Proper Functioning Condition) of portions of the Big Sandy River below the US 93 bridge.

10.0 Wildlife and Fisheries Resources

Elements and Tasks:

Desert tortoise surveys will not be needed.

Materials Available:

Arcview data of desert tortoise habitat area and categorizations

Desert Tortoise Habitat Management on the Public Lands: A Rangewide Plan, 1988. Bureau of Land Management.

Instruction Memorandum No. AZ-92-46, Strategy for Desert Tortoise Habitat Management on Public Lands in Arizona– New Guidance on Compensation for the Desert Tortoise, July 13, 1992.

11.0 Threatened and Endangered (T&E) Species

Materials Available:

ArcView data of willow flycatcher habitat mapped to date on some areas of public land on the Big Sandy River, below the US 93 bridge.

APPENDIX B
BAT MIST NETTING FORM

Site ID #: 1 1

BAT NETTING RECORD

Date: 31 July 2000 Locality: Big Sandy Plant Site, SE 1/4 OF SW 1/4 OF SW 1/4 OF Sec. 5, T. 15N, R. 12W

Habitat Type: Sonoran Desert Scrub/Wetland Site Elevation: 2080 (ft) ______ (m) Recorder(s): M. Schweich, S. Faulk, C. Florian, J. Hedlund

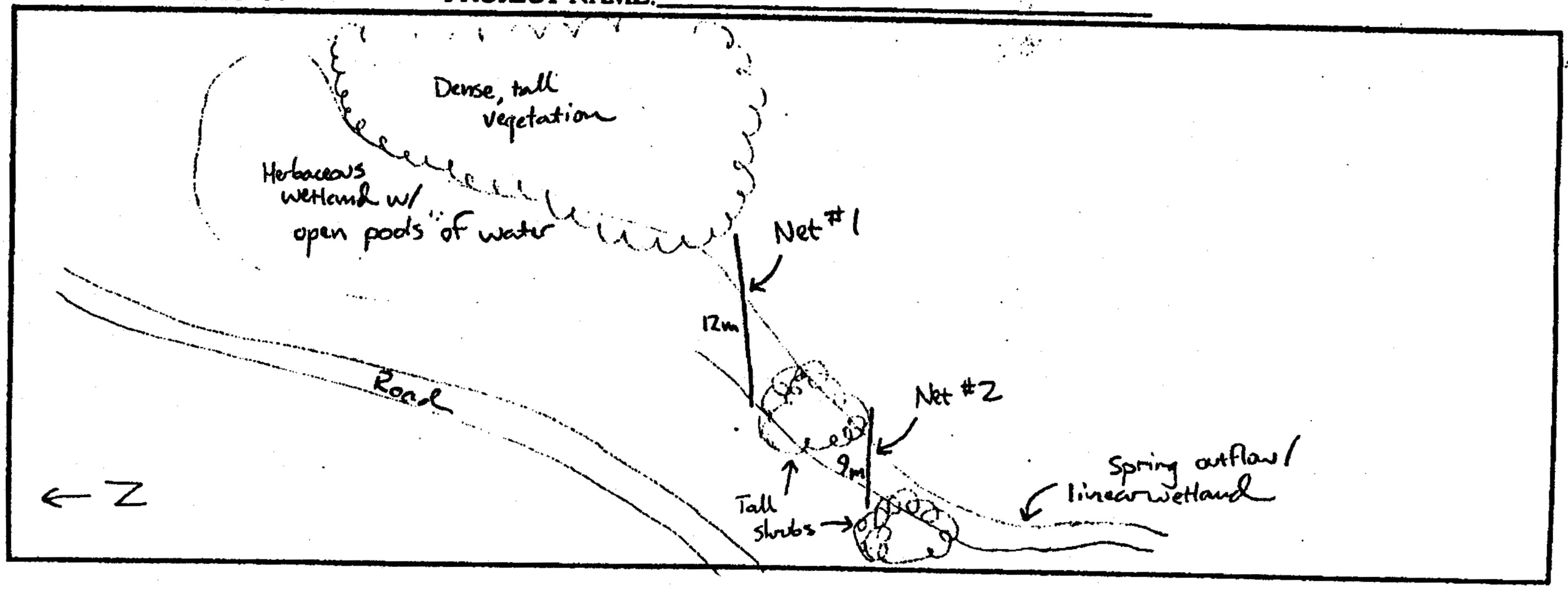
Start % Cloud Cover: 5% Start Temp: ______ C 94° (F) Start % Humidity: 45% Start Wind mph: Ø

End % Cloud Cover: Ø End Temp: ______ C 85° (F) End % Humidity: 47% End Wind mph: Ø

Net(s) Opened (Time): 2015 Net(s) Closed (Time): 2330 Total # Nets Set: 2

Net #:	Position (Directional; N,S,E,W):	Size: (m)	Ht of Poles: (m)	Ht of Net: (m)	#Bats Netted:
1	EW	12	5	4	3
2	EW	9	5	4	1

DIAGRAM OF SET-UP PROJECT NAME: ______



	Net/Bag	C. Time	R. Time	Species	Sex	Age	RC	TW	FA (mm)	Ear (mm)	Wt. (G)	Foot (mm)	Notes	Pelage	Capture Data
1	1 / 1	2018	0038	Myotis yumanensis	M F	A J	P L RM NR	0	39.5	10.6	4.5	—		E G P	Ht in Net: 0.6 (m) Guano collected: Y N Flight Dir.: US Ectos: Y N
2	2 / 2	2042	0033	Myotis yumanensis	M F	A J	P L RM NR	0	39.4	9.7	4.5	—		E G P	Ht in Net: 1.3 (m) Guano collected: Y N Flight Dir.: DS Ectos: Y N
3	1 / 3	2155	0021	Antrozous pallidus	M F	A J	P L RM NR	0	53.0	26.2	12.5	—		E G P	Ht in Net: 0.8 (m) Guano collected: Y N Flight Dir.: DS Ectos: Y N
4	1 / 4	2250	0012	Macrotus californicus	M F	A J	P L RM NR	0	53.2	24.3	31.0	—		E G P	Ht in Net: 0.8 (m) Guano collected: Y N Flight Dir.: DS Ectos: Y N
5	/				M F	A J	P L RM NR							E G P	Ht in Net: ____ (m) Guano collected: Y N Flight Dir.: ____ Ectos: Y N
6	/				M F	A J	P L RM NR							E G P	Ht in Net: ____ (m) Guano collected: Y N Flight Dir.: ____ Ectos: Y N
7	/				M F	A J	P L RM NR							E G P	Ht in Net: ____ (m) Guano collected: Y N Flight Dir.: ____ Ectos: Y N
8	/				M F	A J	P L RM NR							E G P	Ht in Net: ____ (m) Guano collected: Y N Flight Dir.: ____ Ectos: Y N

Created September 28, 1995 By: Wendy Philpott, Pineridge Ranger District, Sierra National Forest

RELEASE: Use Military Time SEX: M(ale) or F(emale) (Circle One) AGE: A(dult) or J(uvenile) (Circle One) TW = Toothwear (0,1,2,3,4,5) FA = Forearm Length

RC: P(regnant) (P1, P2, P3), L(actating), RM (Reproductive Male) ,or N(non)- R(eproductive) (Circle One) FOOT = Length from calcar to tip of claw

PELAGE: Condition E(xcellent), G(ood), or P (oor)

APPENDIX C
RAPTOR NEST SURVEY FORMS

RAPTOR NESTING SURVEY - SUMMARY SHEET

OBSERVER: Golden / Fleming DATE: 5/10/80 TIME: 1130 - 1500. MILES: 35 mile transects

LOCATION: Alternative ~~transmission line~~ route (Transmission line route). Big Sandy Energy Project

TYPE OF SURVEY: Car ( ): Plane ( ): Helicopter (X): Foot ( ): Other ( )

HABITAT: Variable - see veg. report
Cottonwood trees and cliff areas were the focus of the flight

WEATHER: Sky Clear : Wind 30 mph : Temperature: 75°-80°F

RAPTORS OBSERVED (NOT AT NEST)

Turkey vultures
Ravens
Red-tailed hawk

PREY OBSERVED

Rabbits

* Activity and habitat data on separate observation form.

NESTING AREAS SEARCHED

NEW	KNOWN	SITE NO.	SPECIES	STRUCTURE DESCRIPTION	ACTIVITY	PRODUCTION
X		Canyons east of natural corrals on South end	Ø	Sandstone cliffs / rock ledges / trees	Ø	-0-

RAPTOR NESTING SURVEY - SUMMARY SHEET

OBSERVER: Golden / Fleming DATE: 5/10/00 TIME: 0800 - 1130 MILES: 35 mile transects

LOCATION: Proposed pipeline route, Big Sandy Energy Project

TYPE OF SURVEY: Car ( ): Plane ( ): Helicopter (X):
Foot ( ): Other ( )

HABITAT: Variable - see veg. report
Cottonwood trees and cliff areas were the focus of the flight

WEATHER: Sky Clear : Wind 30 mph : Temperature: 75°F - 100°F

RAPTORS OBSERVED (NOT AT NEST)

Turkey vultures
Ravens
Red-tailed hawk

PREY OBSERVED

Rabbits

* Activity and habitat data on separate observation form.

NESTING AREAS SEARCHED

NEW	KNOWN	SITE NO.	SPECIES	STRUCTURE DESCRIPTION	ACTIVITY	PRODUCTION
X		Big Sandy corridor	∅	Cottonwood trees/ Mesquite Bosques	∅	∅
X		Natural Corrals	∅	Sandstone cliffs	∅	∅
X		Canyons east of natural corrals	∅	Sandstone cliffs/ Rock ledges	∅	∅

RAPTOR NESTING SURVEY - SUMMARY SHEET

OBSERVER: Golden / Fleming DATE: 5/11/00 TIME: 0700 MILES: N/A

LOCATION: T16N R13W Sec. 25 NESE

TYPE OF SURVEY: Car ( ): Plane ( ): Helicopter ( ): Foot(X): Other ( )

HABITAT: Rock cliff

WEATHER: Sky Clear : Wind 1-2 mph : Temperature: 85°F

RAPTORS OBSERVED (NOT AT NEST)

Turkey Vultures

Ravens

PREY OBSERVED

Lizards

* Activity and habitat data on separate observation form.

NESTING AREAS SEARCHED

NEW	KNOWN	SITE NO.	SPECIES	STRUCTURE DESCRIPTION	ACTIVITY	PRODUCTION
X		Nest 1	? Small Raptor	Stick nest in rock crevice	Unoccupied	

RAPTOR NEST AND HABITAT REPORT FORM

Species: Unk Observer: Golden / Fleming Date: 5/11/10

Nest Number: Nest 1 Land Ownership: Federal___ State___ Private___

Location: Twp. 16N; Range 13W; Section 25; ¼ Sec. NESE Elevation: 2040 ft (m)

Description of Nest Site

Description of Location: Steep draw with 20 - 30 ft. cliffs on Bitter Ck.

Dominant Habitat of Area: Mesquite, creosote bush

Specific Habitat at Nest: Cliff crevice

Nest Substrate: Cactus needles, grass, dirt

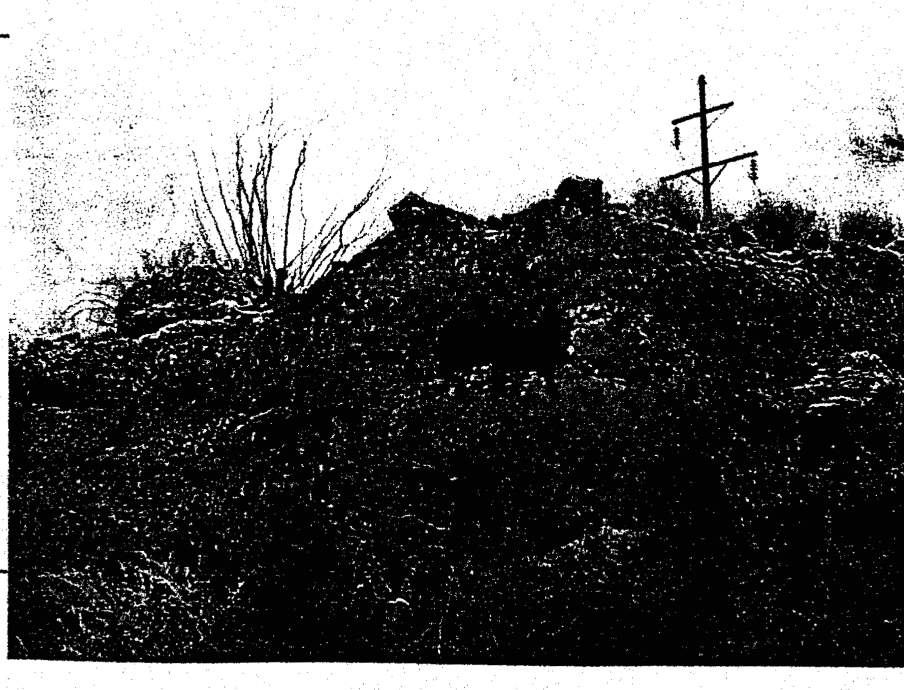
Height of Substrate (m): 0.5 Height of Nest Above Ground (m): 5

Exposure of Nest: 0 % Active:___ Inactive X Adult Activity:___

Number of Eggs: N/A or Number of Young: N/A

Percent and Kind of Feathers on Young:___

Additional Remarks: Owl feather found on ground. No whitewash



RAPTOR NESTING SURVEY - SUMMARY SHEET

OBSERVER: Golden/Fleming DATE: 5/11/10 TIME: 0800. MILES: N/A

LOCATION: T16N R8W Sec. 25 NWNE

TYPE OF SURVEY: Car ( ): Plane ( ): Helicopter ( ):
Foot(X): Other ( )

HABITAT: Transmission Line pole in desert

WEATHER: Sky Clear : Wind 1-2 mph : Temperature: 80°F

RAPTORS OBSERVED (NOT AT NEST)

Turkey Vultures
Ravens

PREY OBSERVED

Ø

* Activity and habitat data on separate observation form.

NESTING AREAS SEARCHED

NEW	KNOWN	SITE NO.	SPECIES	STRUCTURE DESCRIPTION	ACTIVITY	PRODUCTION
X		Nest 2	?	T. Line pole	Unoccupied	

RAPTOR NEST AND HABITAT REPORT FORM

Species: ______ Observer: [illegible] Date: [illegible]

Nest Number: [illegible] Land Ownership: Federal___ State___ Private___

Location: Twp. [illegible]; Range [illegible]; Section [illegible]; ¼ Sec. [illegible] Elevation: [illegible] (m)

Description of Nest Site

Description of Location: T [illegible] pole

Dominant Habitat of Area: Mesquite [illegible]

Specific Habitat at Nest: Pole

Nest Substrate: Sticks

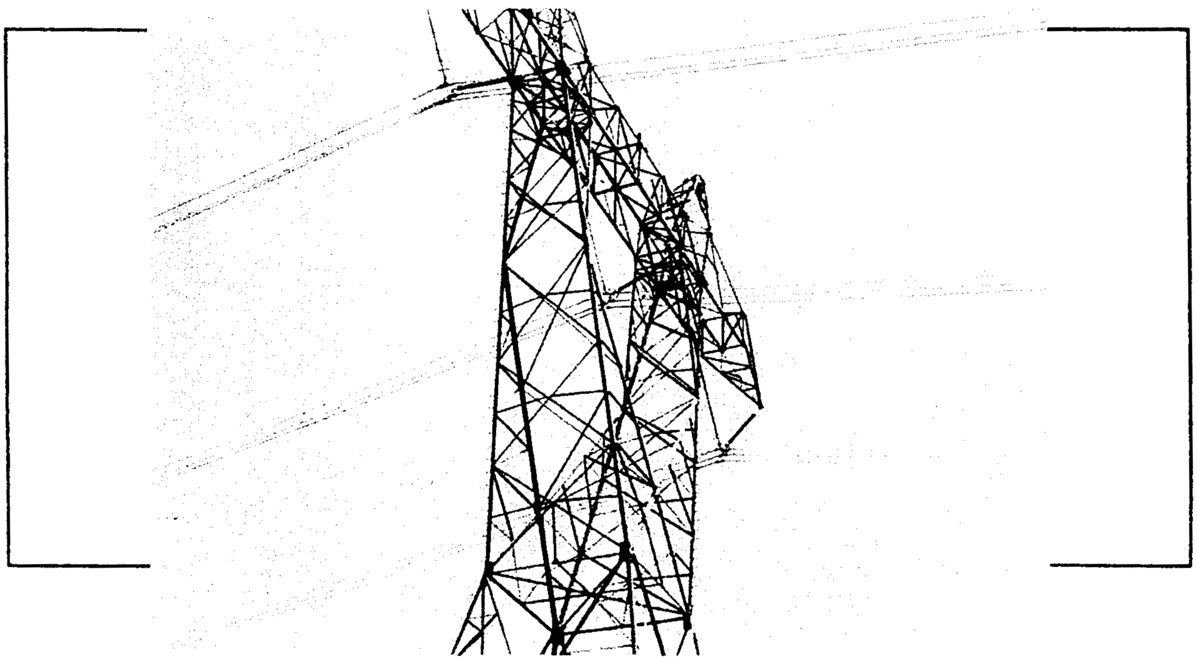
Height of Substrate (m): 0.25 Height of Nest Above Ground (m): 50 ft

Exposure of Nest: 100% Active:___ Inactive X Adult Activity: ______

Number of Eggs: NA or Number of Young: NA

Percent and Kind of Feathers on Young: NA

Additional Remarks: Whitewash on ground around pole, no pellets



RAPTOR NESTING SURVEY - SUMMARY SHEET

OBSERVER: Golden / Fleming DATE: 5/11/10 TIME: 1700 MILES: NA

LOCATION: T16N R13W Sec. 16 NE NE

TYPE OF SURVEY: Car ( ): Plane ( ): Helicopter ( ):
Foot(X): Other ( )

HABITAT: Natural corrals, creosote / mesquite surrounded by cliffs on 3 sides

WEATHER: Sky clear : Wind 0 : Temperature: 105 °F

RAPTORS OBSERVED (NOT AT NEST)

Ø

PREY OBSERVED

Ø

* Activity and habitat data on separate observation form.

NESTING AREAS SEARCHED

NEW	KNOWN	SITE NO.	SPECIES	STRUCTURE DESCRIPTION	ACTIVITY	PRODUCTION
X		Nest 3	NA	Sandstone cliff	Inactive	Ø

RAPTOR NEST AND HABITAT REPORT FORM

Species: NA Observer: Golden / Fleming Date: 5/11/00

Nest Number: Nest 3 Land Ownership: Federal___ State___ Private___

Location: Twp. 16N; Range 13W; Section 16; ¼ Sec. NENE Elevation: 2080 ft (m)

Description of Nest Site

Description of Location: Natural corrals; cliffs in lowlands

Dominant Habitat of Area: Creosote

Specific Habitat at Nest: Sandstone crevice, ground nest

Nest Substrate: Sticks

Height of Substrate (m): 0.25 Height of Nest Above Ground (m): 0

Exposure of Nest: 25 % Active:___ Inactive X Adult Activity:___

Number of Eggs: NA or Number of Young: NA

Percent and Kind of Feathers on Young: NA

Additional Remarks: Whitewash present on cliff above. 2 old feathers found (probably TV)

RAPTOR NESTING SURVEY - SUMMARY SHEET

OBSERVER: Golden/Fleming DATE: 5/11/00 TIME: 0730 MILES: NA

LOCATION: T16N R13W sec 26 NENE

TYPE OF SURVEY: Car ( ): Plane ( ): Helicopter ( ):
Foot(X): Other ( )

HABITAT: Cliff crevice

WEATHER: Sky clear : Wind 0 : Temperature: 85°F

RAPTORS OBSERVED (NOT AT NEST)

Ø

PREY OBSERVED

Ø

• Activity and habitat data on separate observation form.

NESTING AREAS SEARCHED

NEW	KNOWN	SITE NO.	SPECIES	STRUCTURE DESCRIPTION	ACTIVITY	PRODUCTION
X		Nest 4	Unk.	Sandstone crevice	Unknown	

RAPTOR NEST AND HABITAT REPORT FORM

Species: Golden / Fleming Observer: Golden / Fleming Date: 5/11/00

Nest Number: Nest 4 Land Ownership: Federal___ State___ Private___

Location: Twp. 16N; Range 13W; Section 16; ¼ Sec. NENE Elevation: 2080 ft (m)

Description of Nest Site

Description of Location: # Cliff crevice in Natural corrals

Dominant Habitat of Area: Creosote

Specific Habitat at Nest: Cliff crevice

Nest Substrate: Sticks

Height of Substrate (m): 0.5 Height of Nest Above Ground (m): 5-6

Exposure of Nest: 0 % Active: ? Inactive___ Adult Activity: NA

Number of Eggs: NA or Number of Young: NA

Percent and Kind of Feathers on Young: NA

Additional Remarks: Old pellet below, whitewash prevalent, feathers on ground below. Possibly active + abandoned

RAPTOR NEST AND HABITAT REPORT FORM

Species: Unk. Observer: Golden / Fleming Date: 5/11/80

Nest Number: Nbit 5 Land Ownership: Federal__ State__ Private__

Location: Twp. 16N; Range 13W; Section 16; ¼ Sec. NE NE Elevation: 2080 ft. (m)

Description of Nest Site

Description of Location: Natural corrals

Dominant Habitat of Area: Creosote

Specific Habitat at Nest: cliff crevice

Nest Substrate: Sticks

Height of Substrate (m): 0.5 Height of Nest Above Ground (m): 4

Exposure of Nest: 25 % Active:__ Inactive X Adult Activity: NA

Number of Eggs: NA or Number of Young: NA

Percent and Kind of Feathers on Young: NA

Additional Remarks: Whitewash + old bleached bones scattered below. Probably not used this year.

RAPTOR NESTING SURVEY - SUMMARY SHEET

OBSERVER: Golden/Fleming DATE: 5/11/00 TIME: 1830. MILES: NA

LOCATION: T16N R13W NE NE

TYPE OF SURVEY: Car ( ): Plane ( ): Helicopter ( ):
Foot (X): Other ( )

HABITAT: Rock crevice, ground

WEATHER: Sky clear : Wind 0 : Temperature: 105 °F

RAPTORS OBSERVED (NOT AT NEST)

Ø

PREY OBSERVED

Ø

* Activity and habitat data on separate observation form.

NESTING AREAS SEARCHED

NEW	KNOWN	SITE NO.	SPECIES	STRUCTURE DESCRIPTION	ACTIVITY	PRODUCTION
X		Nest 6	?	Sticks, sandstone crevice	IN.	

RAPTOR NEST AND HABITAT REPORT FORM

Species: NA Observer: Golden / Fleming Date: 5/11/00

Nest Number: Nest 6 Land Ownership: Federal___ State___ Private___

Location: Twp. 16N ; Range 13W ; Section 16 ; ¼ Sec. NE NE Elevation: 2080 Ft. (m)

Description of Nest Site

Description of Location: Natural corrals

Dominant Habitat of Area: Creosote

Specific Habitat at Nest: Sandstone crevice

Nest Substrate: Sticks

Height of Substrate (m): 0.5 Height of Nest Above Ground (m): 0

Exposure of Nest: 0% Active:___ Inactive X Adult Activity: NA

Number of Eggs: NA or Number of Young: NA

Percent and Kind of Feathers on Young: NA

Additional Remarks: Whitewash around nest on ground

RAPTOR NESTING SURVEY - SUMMARY SHEET

OBSERVER: Golden/Fleming DATE: 5/11/00 TIME: 1900. MILES: NA

LOCATION: T16N R13W, sec. 16 NENE

TYPE OF SURVEY: Car ( ): Plane ( ): Helicopter ( ):
Foot (X): Other ( )

HABITAT: Rock ledge

WEATHER: Sky clear : Wind 0 : Temperature: 85°F

RAPTORS OBSERVED (NOT AT NEST)

Ø

PREY OBSERVED

Ø

* Activity and habitat data on separate observation form.

NESTING AREAS SEARCHED

NEW	KNOWN	SITE NO.	SPECIES	STRUCTURE DESCRIPTION	ACTIVITY	PRODUCTION
X		Nest 7	?	Sandstone crevice	Active	?

RAPTOR NEST AND HABITAT REPORT FORM

Species: Unknown Observer: Golden/Fleming Date: 5/11/00

Nest Number: Nest 7 Land Ownership: Federal___ State___ Private___

Location: Twp. 16N; Range 13W; Section 16; ¼ Sec. NENE Elevation: 2080 ft (m)

Description of Nest Site

Description of Location: Natural corrals

Dominant Habitat of Area: Creosote

Specific Habitat at Nest: Rock ledge

Nest Substrate: Sticks

Height of Substrate (m): 0.5 Height of Nest Above Ground (m): 4

Exposure of Nest: 25% Active: X Inactive___ Adult Activity: NA

Number of Eggs: NA or Number of Young: NA

Percent and Kind of Feathers on Young: NA

Additional Remarks: New whitewash & pellets underneath, very well kept, no birds seen but looks active. Might be eggs on nest. No nestlings

(Photograph)

(Topographic Map)

NESTING REPORT FORM

Species: Unknown Site No. Nest 7

Date	Observer	No. Adults	a/ Prehatch Occupied	a/ Status Active	No. Eggs	No. Yg.	b/ Age Class	Use of Alternate Nests	Comments
5/1/80	Golden/Fleming	0	Unk.	Yes	Unk.	0	Ø		Fresh whitewash + pellets underneath, well tended

a/ Record as: yes, no or ? Under both columns

b/ Record age or class (Class I = all downy, no feathers; Class II = feathers visible, down patches on body; Class III = body feathered, down remaining on head; Class IV = completely feathered; Class V = fledged).

RAPTOR NESTING SURVEY - SUMMARY SHEET

OBSERVER: Golden/Fleming DATE: 5/12/00 TIME: 0700. MILES: NA

LOCATION: T16N R13W Sec. 13 SWNW

TYPE OF SURVEY: Car (X): Plane ( ): Helicopter ( ):
Foot( ): Other ( )

HABITAT: Mesquite, cliff crevice

WEATHER: Sky Clear : Wind 1-2 mph : Temperature: 80°F

RAPTORS OBSERVED (NOT AT NEST)

Ø

PREY OBSERVED

Ø

- Activity and habitat data on separate observation form.

NESTING AREAS SEARCHED

NEW	KNOWN	SITE NO.	SPECIES	STRUCTURE DESCRIPTION	ACTIVITY	PRODUCTION
X		Nest 8	?	Sandstone crevice	IN	—

RAPTOR NEST AND HABITAT REPORT FORM

Species: N/A Observer: Golden / Fleming Date: 5/12/00

Nest Number: Nest 8 Land Ownership: Federal___ State___ Private___

Location: Twp. 16N; Range 13W; Section 13; ¼ Sec. [illegible] Elevation: 2160 ft (m)

Description of Nest Site

Description of Location: 3 drainages south of Beaver Canyon

Dominant Habitat of Area: Mesquite / Creosote / Paloverde

Specific Habitat at Nest: Crevice in Sandstone cliff

Nest Substrate: Sticks

Height of Substrate (m): 0.25 Height of Nest Above Ground (m): 3

Exposure of Nest: 0% Active:___ Inactive X Adult Activity: NA

Number of Eggs: NA or Number of Young: NA

Percent and Kind of Feathers on Young: N/A

Additional Remarks: No whitewash, not used for at least 1 year

RAPTOR NESTING SURVEY - SUMMARY SHEET

OBSERVER: Golden/Fleming DATE: 5/12/00 TIME: 0730 MILES: N/A

LOCATION: 3 drainages South of Burro Canyon

T16N R13W Sec. 13 SWNW

TYPE OF SURVEY: Car ( ): Plane ( ): Helicopter ( ):
Foot (X): Other ( )

HABITAT: Mesquite, cliff ledge

WEATHER: Sky clear : Wind 3 mph : Temperature: 80°F

RAPTORS OBSERVED (NOT AT NEST)

Ø

Saw Ravens flying around

PREY OBSERVED

Ø

* Activity and habitat data on separate observation form.

NESTING AREAS SEARCHED

NEW	KNOWN	SITE NO.	SPECIES	STRUCTURE DESCRIPTION	ACTIVITY	PRODUCTION
X		Nest 9	?	Rock ledge on cliff	IN	

RAPTOR NEST AND HABITAT REPORT FORM

Species: NA Observer: Golden/Fleming Date: 5/12/00

Nest Number: Nest 9 Land Ownership: Federal___ State___ Private___

Location: Twp 16N; Range 13W; Section 13; ¼ Sec. SW/NW Elevation: 2150 ft (m/ft)

Description of Nest Site

Description of Location: 3 drainages South of Bruce Canyon

Dominant Habitat of Area: Mesquite rock cliffs

Specific Habitat at Nest: Rock Ledge on cliff

Nest Substrate: Sticks

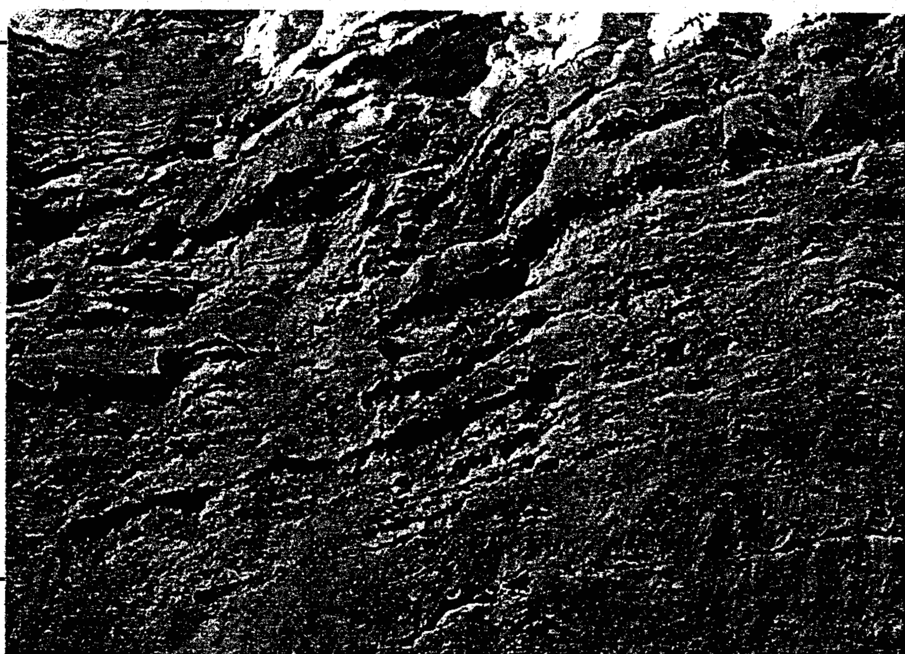
Height of Substrate (m): 0.25 Height of Nest Above Ground (m): 10

Exposure of Nest: 75% Active:___ Inactive X Adult Activity: NA

Number of Eggs: NA or Number of Young: NA

Percent and Kind of Feathers on Young: NA

Additional Remarks: Small nest 1-2 yrs old



RAPTOR NESTING SURVEY - SUMMARY SHEET

OBSERVER: Gollen / Fleming DATE: 5/12/10 TIME: 0800 MILES: NA

LOCATION: T 16N R 8W Sec. 13 SWNW

TYPE OF SURVEY: Car ( ): Plane ( ): Helicopter ( ):
Foot (X): Other ( )

HABITAT: Mesquite / Sage / Rock

WEATHER: Sky Clear : Wind 0 : Temperature: 85°F

RAPTORS OBSERVED (NOT AT NEST)

Ø

PREY OBSERVED

Ø

* Activity and habitat data on separate observation form.

NESTING AREAS SEARCHED

NEW	KNOWN	SITE NO.	SPECIES	STRUCTURE DESCRIPTION	ACTIVITY	PRODUCTION
X		Nest 10	?	Rock crevice	IN	

RAPTOR NEST AND HABITAT REPORT FORM

Species: NA Observer: Golden / Fleming Date: 5/12/00

Nest Number: Nest 10 Land Ownership: Federal___ State___ Private___

Location: Twp. 16N; Range 13W; Section 13; ¼ Sec. SWNW Elevation: 2140 ft (m)

Description of Nest Site

Description of Location: 3 drainages south of Boner Canyon

Dominant Habitat of Area: Mesa / Sage / Rock

Specific Habitat at Nest: Rock crevice

Nest Substrate: Sticks / Coarse grass

Height of Substrate (m): 0.25 Height of Nest Above Ground (m): 1

Exposure of Nest: 50% Active:___ Inactive X Adult Activity: N/A

Number of Eggs: NA or Number of Young: NA

Percent and Kind of Feathers on Young: NA

Additional Remarks: Possible packrat nest, but larger sticks exist — maybe was raptor (owl) ~~or~~ & packrat took over.

RAPTOR NESTING SURVEY - SUMMARY SHEET

OBSERVER: Golden/Fleming DATE: 5/12/90 TIME: 0830 MILES: NA

LOCATION: T16N R13W Sec. 14 SENE

TYPE OF SURVEY: Car ( ): Plane ( ): Helicopter ( ):
Foot (X): Other ( )

HABITAT: Mesquite/Sage/Rock

WEATHER: Sky Clear : Wind 3mph : Temperature: 90°F

RAPTORS OBSERVED (NOT AT NEST)

Ø

PREY OBSERVED

Ø

* Activity and habitat data on separate observation form.

NESTING AREAS SEARCHED

NEW	KNOWN	SITE NO.	SPECIES	STRUCTURE DESCRIPTION	ACTIVITY	PRODUCTION
X		Nest 11	?	Rock crevice	IN	

RAPTOR NEST AND HABITAT REPORT FORM

Species: NA Observer: Golden / Fleming Date: 5/12/00

Nest Number: Nest 11 Land Ownership: Federal___ State___ Private___

Location: Twp. 16N; Range 13W; Section 14; ¼ Sec. SENE Elevation: 2130 ft. (m)

Description of Nest Site

Description of Location: 3 drainage south of Boner canyon

Dominant Habitat of Area: Mesqi / Sage / Rock

Specific Habitat at Nest: Rock crevice

Nest Substrate: Sticks / Coarse grass

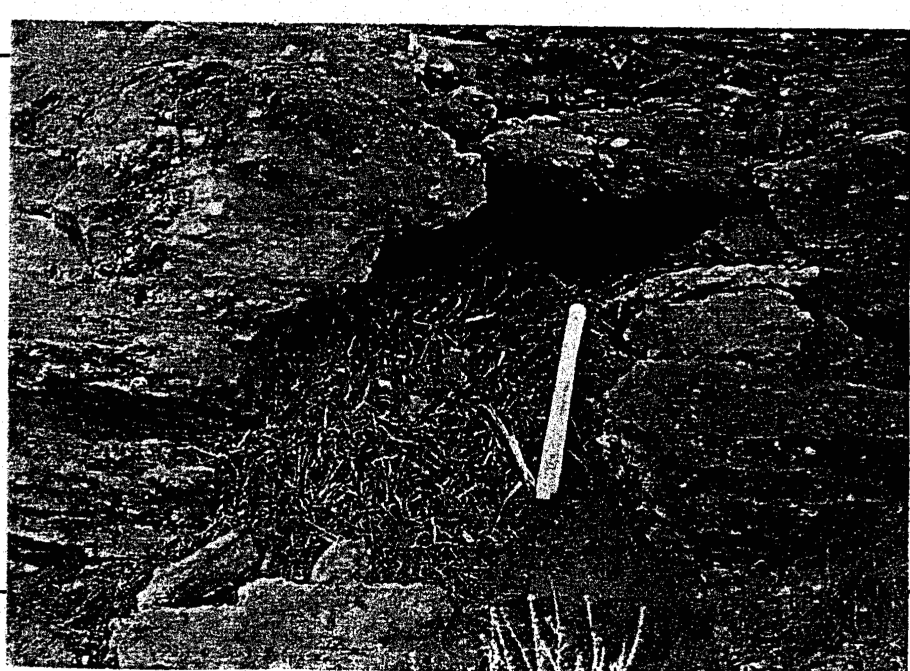
Height of Substrate (m): 0.5 Height of Nest Above Ground (m): 1

Exposure of Nest: 50% Active:___ Inactive X Adult Activity: NA

Number of Eggs: NA or Number of Young: NA

Percent and Kind of Feathers on Young: NA

Additional Remarks: Same as Nest 10



RAPTOR NESTING SURVEY - SUMMARY SHEET

OBSERVER: Golden/Fleming DATE: 5/12/00 TIME: 0830 MILES: NA

LOCATION: T16N R13W Sec. 14 SENE

TYPE OF SURVEY: Car ( ): Plane ( ): Helicopter ( ): Foot(X): Other ( )

HABITAT: Mesquite / Sage / Rock

WEATHER: Sky Clear : Wind 3mph : Temperature: 90°F

RAPTORS OBSERVED (NOT AT NEST)

∅

PREY OBSERVED

∅

* Activity and habitat data on separate observation form.

NESTING AREAS SEARCHED

NEW	KNOWN	SITE NO.	SPECIES	STRUCTURE DESCRIPTION	ACTIVITY	PRODUCTION
X		Nest 12	?	Rock overhang	IN	

RAPTOR NEST AND HABITAT REPORT FORM

Species: NA Observer: Golder / Fleming Date: 5/12/00

Nest Number: Nest 12 Land Ownership: Federal___ State___ Private___

Location: Twp. 16N ; Range 13W ; Section 14 ; ¼ Sec. SENE Elevation: 2130 ft (m)

Description of Nest Site

Description of Location: S drainage South of Bower canyon

Dominant Habitat of Area: Mesa / Sage / Rock

Specific Habitat at Nest: Rock overhang

Nest Substrate: Sticks, coarse grass

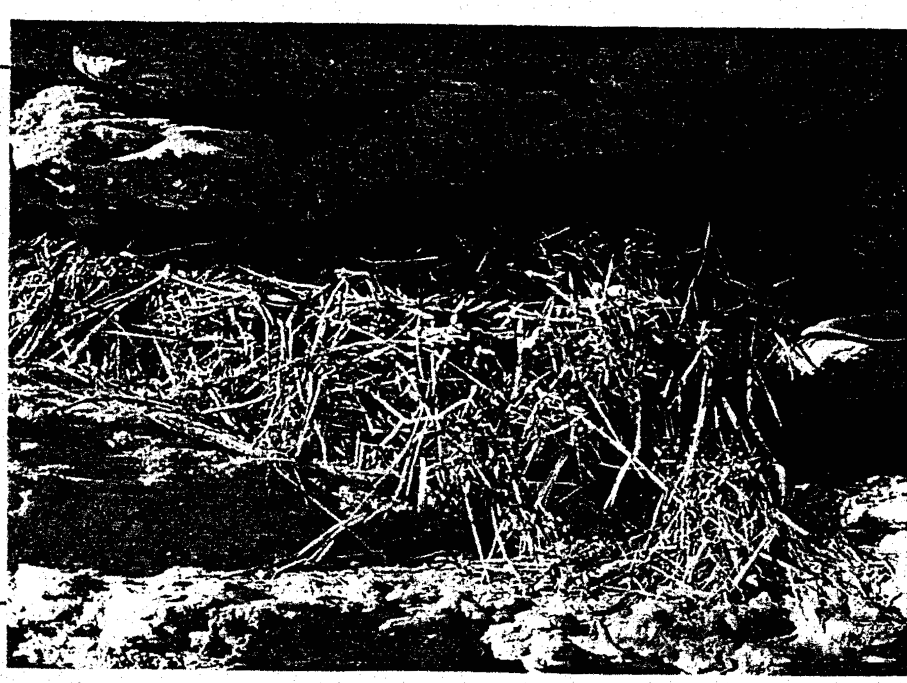
Height of Substrate (m): 0.5 Height of Nest Above Ground (m): 1

Exposure of Nest: 0% Active:___ Inactive X Adult Activity: NA

Number of Eggs: NA or Number of Young: NA

Percent and Kind of Feathers on Young: NA

Additional Remarks: Probable packrat nest, used to be raptor nest + could be in the future.



RAPTOR NEST AND HABITAT REPORT FORM

Species: NA Observer: Golden / Fleming Date: 5/12/00

Nest Number: Nest 13 Land Ownership: Federal__ State__ Private__

Location: Twp. 16N; Range 13W; Section 14; ¼ Sec. SENE Elevation: 2120 ft (m)

Description of Nest Site

Description of Location: 3 drainages south of Boner canyon

Dominant Habitat of Area: Mesq / Sage / Rock

Specific Habitat at Nest: Rock crevice

Nest Substrate: Sticks / course grass

Height of Substrate (m): 0.5 Height of Nest Above Ground (m): 1

Exposure of Nest: 25% Active:__ Inactive X Adult Activity: NA

Number of Eggs: NA or Number of Young: NA

Percent and Kind of Feathers on Young: NA

Additional Remarks: See nest 11 + 10

(Photograph)

(Topographic Map)

RAPTOR NESTING SURVEY - SUMMARY SHEET

OBSERVER: Golden/Fleming DATE: 5/12/00 TIME: 0930 MILES: NA

LOCATION: T16N R13W Sec. 14 NENE

TYPE OF SURVEY: Car ( ): Plane ( ): Helicopter ( ):
Foot(X): Other ( )

HABITAT: Mesq./Creosote/Sage/Rock

WEATHER: Sky Clear : Wind 3 mph : Temperature: 90°F

RAPTORS OBSERVED (NOT AT NEST)

Ø

PREY OBSERVED

Ø

* Activity and habitat data on separate observation form.

NESTING AREAS SEARCHED

NEW	KNOWN	SITE NO.	SPECIES	STRUCTURE DESCRIPTION	ACTIVITY	PRODUCTION
X		Nest 14	?	Rock crevice	IN	

RAPTOR NEST AND HABITAT REPORT FORM

Species: NA Observer: Golden / Fleming Date: 5/12/00

Nest Number: Nest 14 Land Ownership: Federal___ State___ Private___

Location: Twp. 16N; Range 13W; Section 14; ¼ Sec. NE NE Elevation: 2120 ft (m)

Description of Nest Site

Description of Location: 2 drainages south of Burro creek

Dominant Habitat of Area: Mesa / Creosote / Sage / Rock

Specific Habitat at Nest: Rock crevice

Nest Substrate: Sticks

Height of Substrate (m): 0.15 Height of Nest Above Ground (m): 2

Exposure of Nest: 0% Active:___ Inactive X Adult Activity: NA

Number of Eggs: NA or Number of Young: NA

Percent and Kind of Feathers on Young: NA

Additional Remarks: Nest is 2 - 3 yrs. old.

RAPTOR NESTING SURVEY - SUMMARY SHEET

OBSERVER: Golden / Fleming DATE: 5/12/00 TIME: 1000 MILES: NA

LOCATION: T16N R13W Sec 14 NENE

TYPE OF SURVEY: Car ( ): Plane ( ): Helicopter ( ): Foot (X): Other ( )

HABITAT: Mesq. / Creosote / sage / Rock

WEATHER: Sky Clear : Wind 3mph : Temperature: 95°F

RAPTORS OBSERVED (NOT AT NEST)

Ø

PREY OBSERVED

Ø

* Activity and habitat data on separate observation form.

NESTING AREAS SEARCHED

NEW	KNOWN	SITE NO.	SPECIES	STRUCTURE DESCRIPTION	ACTIVITY	PRODUCTION
X		Nest 15	Ø	Rock crevice	IN	

RAPTOR NEST AND HABITAT REPORT FORM

Species: ø Observer: Golden / Fleming Date: 5/12/00

Nest Number: Nest 15 Land Ownership: Federal__ State__ Private__

Location: Twp. 16N; Range 13W; Section 14; ¼ Sec. NENE Elevation: 2160 ft (m)

Description of Nest Site

Description of Location: 2 drainages South of Bear canyon

Dominant Habitat of Area: Mesq. / Creo. / sage / Rock

Specific Habitat at Nest: Rock crevice

Nest Substrate: Sticks / coarse grass

Height of Substrate (m): 0.5 Height of Nest Above Ground (m): 1

Exposure of Nest: 0° Active:__ Inactive X Adult Activity: NA

Number of Eggs: NA or Number of Young: NA

Percent and Kind of Feathers on Young: NA

Additional Remarks: Old raptor nest, probably packrat nest now, could be transformed back to raptor nest in future.

RAPTOR NESTING SURVEY - SUMMARY SHEET

OBSERVER: Golden / Fleming DATE: 5/13/00 TIME: 1000 MILES: NA

LOCATION: T 16N R13W Sec. 11 SW SW

*TYPE OF SURVEY: Car ( ): Plane ( ): Helicopter ( ):
Foot(X): Other ( )

HABITAT: T. line pole surrounded by creosote & Big Sandy River on west side

WEATHER: Sky Clear : Wind 5 mph : Temperature: 100°F

RAPTORS OBSERVED (NOT AT NEST)

Ravens

PREY OBSERVED

Ø

* Activity and habitat data on separate observation form.

NESTING AREAS SEARCHED

NEW	KNOWN	SITE NO.	SPECIES	STRUCTURE DESCRIPTION	ACTIVITY	PRODUCTION
X		Nest 16	Raven	T. Line pole	AC	2 young

NESTING REPORT FORM

Species: Raptor Site No. Nest 16

Date	Observer	No. Adults	a/ Prehatch Occupied	a/ Status Active	No. Eggs	No. Yg.	b/ Age Class	Use of Alternate Nests	Comments
5/13/00	Golden/Fleming	2	No	Yes	Ø	2	Ø		

a/ Record as: yes, no or ? Under both columns

b/ Record age or class (Class I = all downy, no feathers; Class II = feathers visible, down patches on body; Class III = body feathered, down remaining on head; Class IV = completely feathered; Class V = fledged).

RAPTOR NEST AND HABITAT REPORT FORM

Species: Raven Observer: Golden / Fleming Date: 5/13/00

Nest Number: Nest 16 Land Ownership: Federal___ State___ Private___

Location: Twp. 16N; Range 13W; Section 11; ¼ Sec. SWSW Elevation: 2040 ft (m)

Description of Nest Site

Description of Location: T. line pole

Dominant Habitat of Area: Creosote / mesq. (Bill Williams River)

Specific Habitat at Nest: T. line pole

Nest Substrate: Sticks

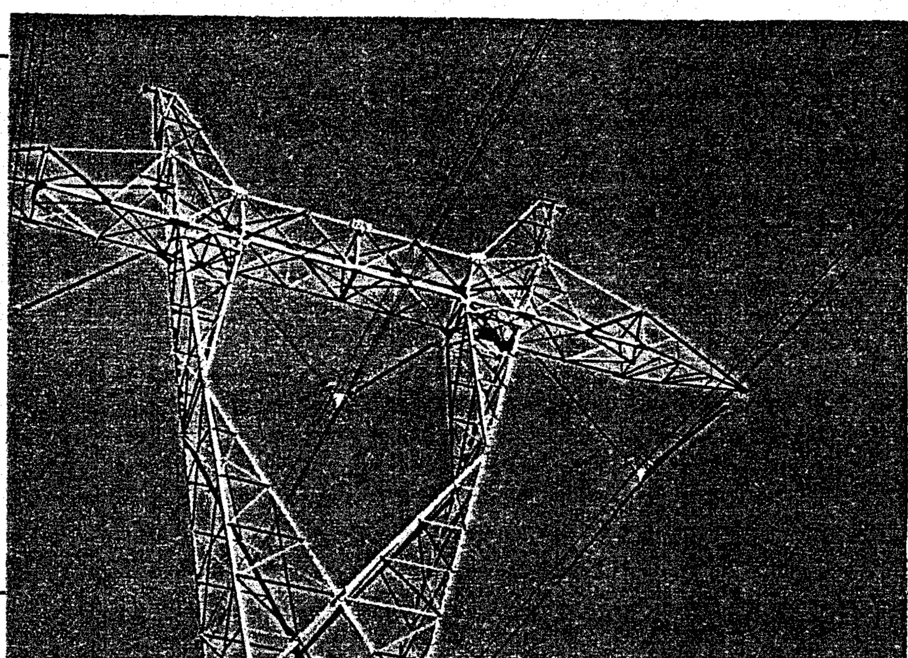
Height of Substrate (m): 0.5 Height of Nest Above Ground (m): 70 ft

Exposure of Nest: 100% Active: X Inactive___ Adult Activity: Flying & scolding

Number of Eggs: 0 or Number of Young: 2

Percent and Kind of Feathers on Young: ∅ couldn't see

Additional Remarks:



RAPTOR NESTING SURVEY - SUMMARY SHEET

OBSERVER: Golden/Fleming DATE: 5/13/00 TIME: 1030 MILES: NA

LOCATION: T16N R13W Sec. 26 NENE

TYPE OF SURVEY: Car ( ): Plane ( ): Helicopter ( ):
Foot(X): Other ( )

HABITAT: Creosote / cliffs

WEATHER: Sky clear : Wind 5mph : Temperature: 105° F

RAPTORS OBSERVED (NOT AT NEST)

TV

PREY OBSERVED

Ø

* Activity and habitat data on separate observation form.

NESTING AREAS SEARCHED

NEW	KNOWN	SITE NO.	SPECIES	STRUCTURE DESCRIPTION	ACTIVITY	PRODUCTION
X		Nest 17	Ø	cliff	IN	

RAPTOR NEST AND HABITAT REPORT FORM

Species: ⊖ Observer: Golden / Fleming Date: 5/13/50

Nest Number: West 17 Land Ownership: Federal___ State___ Private___

Location: Twp. 16N; Range 13W; Section 26; ¼ Sec. NENE Elevation: 2000 ft (m)

Description of Nest Site

Description of Location: Cliff area

Dominant Habitat of Area: Creosote / cliffs

Specific Habitat at Nest: Rock ledge

Nest Substrate: Sticks

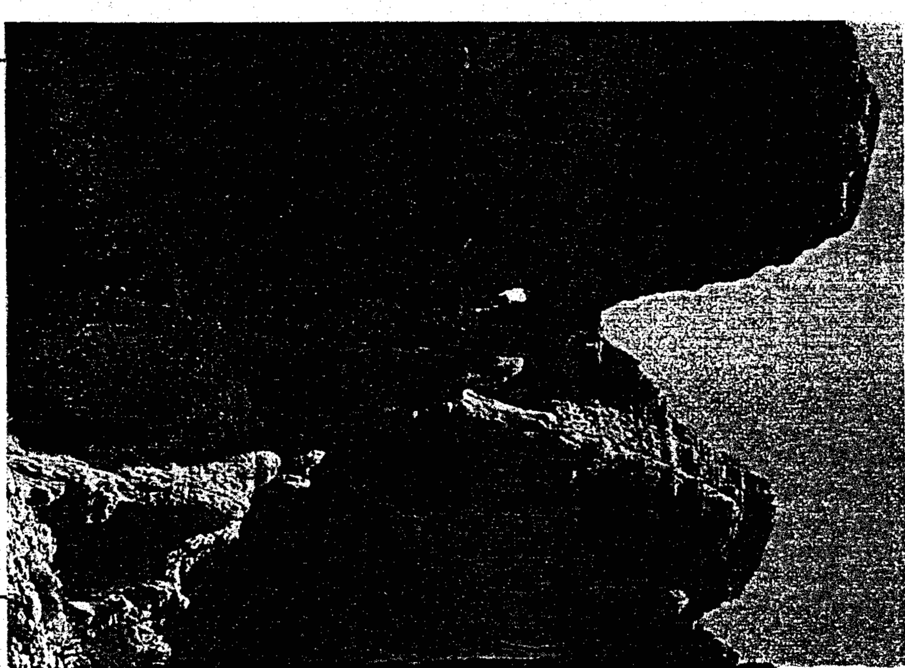
Height of Substrate (m): 0.5 Height of Nest Above Ground (m): 80 ft

Exposure of Nest: 100% Active:___ Inactive X Adult Activity: NA

Number of Eggs: NA or Number of Young: NA

Percent and Kind of Feathers on Young: NA

Additional Remarks: Very good habitat - W/o birds



RAPTOR NESTING SURVEY - SUMMARY SHEET

OBSERVER: Golden/Fleming DATE: 5/12/00 TIME: 0800 . MILES: NA

LOCATION: T16N R13W Sec. 13 SWNW

TYPE OF SURVEY: Car ( ): Plane ( ): Helicopter ( ):
Foot(X): Other ( )

HABITAT: Mesquite / Cliffs

WEATHER: Sky Clear : Wind 0-1 mph : Temperature: 80°F

RAPTORS OBSERVED (NOT AT NEST)

Ravens

PREY OBSERVED

0

* Activity and habitat data on separate observation form.

NESTING AREAS SEARCHED

NEW	KNOWN	SITE NO.	SPECIES	STRUCTURE DESCRIPTION	ACTIVITY	PRODUCTION
Y		Nest 18	Ravens	Cliff	AC	

NESTING REPORT FORM

Species: Raven Site No. Nest 18

Date	Observer	No. Adults	a/ Prehatch Occupied	a/ Status Active	No. Eggs	No. Yg.	b/ Age Class	Use of Alternate Nests	Comments
5/12/00	Golden/Fleming	2	Yes	Yes	?	0	Ø		

a/ Record as: yes, no or ? Under both columns

b/ Record age or class (Class I = all downy, no feathers; Class II = feathers visible, down patches on body; Class III = body feathered, down remaining on head; Class IV = completely feathered; Class V = fledged).

RAPTOR NEST AND HABITAT REPORT FORM

Species: Raven Observer: Golden/Fleming Date: 5/12/00

Nest Number: Nest 18 Land Ownership: Federal___ State___ Private___

Location: Twp. 16N; Range 13W; Section 13; ¼ Sec. SWNW Elevation: 2160 ft (m)

Description of Nest Site

Description of Location: 3 drainages south of Burro canyon

Dominant Habitat of Area: mesquite/cliff

Specific Habitat at Nest: Rock ledge

Nest Substrate: Sticks

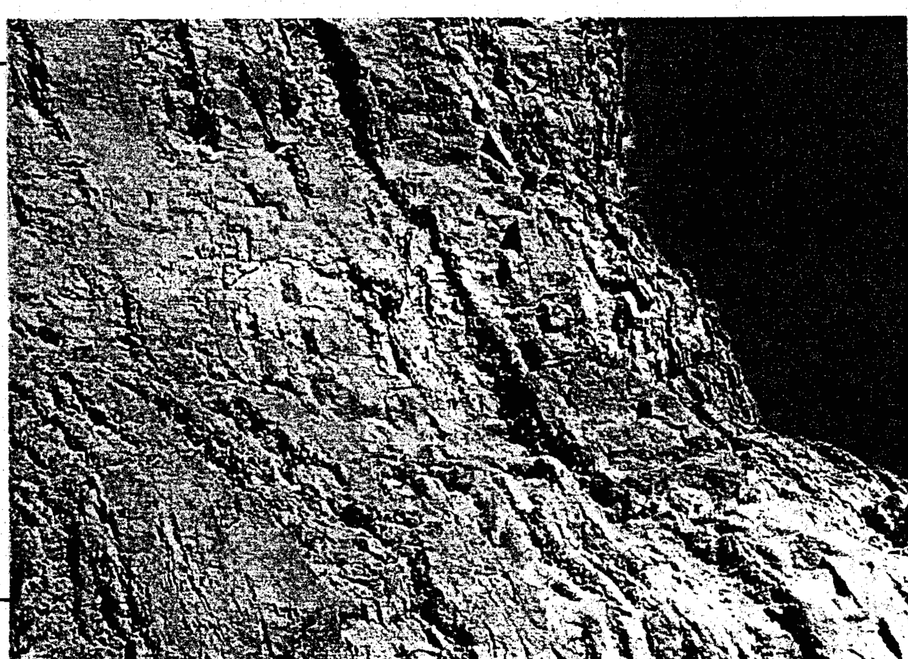
Height of Substrate (m): 0.5 Height of Nest Above Ground (m): 10

Exposure of Nest: 100% Active: X Inactive___ Adult Activity: Flying/Flushed

Number of Eggs: ? or Number of Young: Ø

Percent and Kind of Feathers on Young: Ø

Additional Remarks: Sitting on eggs still?



APPENDIX D
SOUTHWESTERN WILLOW FLYCATCHER SURVEY FORMS

Fill in the following information completely. Submit original form. Retain copy for your records.

Name of Reporting Individual Tom Ashbeck Phone # 480-733-6666

Affiliation EcoPlan Associates Email EcoPlan@aol.com

Site Name Big Sandy - Downstream of US93

Did you verify that this site name is consistent with that used in previous years? Yes No (circle one)

Management Authority for Survey Area (circle one): Federal Municipal/County State Tribal Private

Name of Management Entity or Owner (e.g., Tonto National Forest) BLM

Length of area surveyed: ~~2~~ 1.5 Mi. (specify units, e.g., miles = mi, kilometers = km, meters = m)

Did you survey the same general area during each visit to this site this year? Yes / No If no, summarize in comments below.

If site was surveyed last year, did you survey the same general area this year? Yes / No If no, summarize in comments below.

Not surveyed last year.

Vegetation Characteristics: Overall, are the species in tree/shrub layer at this site comprised predominantly of (check one):

- ☐ Native broadleaf plants (entirely or almost entirely, includes high-elevation willow)
- ■ Mixed native and exotic plants (mostly native)
- ☒ Mixed native and exotic plants (mostly exotic)
- ☐ Exotic/introduced plants (entirely or almost entirely)

Identify the 2-3 predominant tree/shrub species: Goodding Willow, Tamarisk, Fremont Cottonwood

Average height of canopy: 12 feet (specify units)

Was surface water or saturated soil present at or adjacent to site? Yes No (circle one)

Distance from the site to surface water or saturated soil: <100 feet (specify units)

Did hydrological conditions change significantly among visits (did the site flood or dry out)? Yes No (circle one)

If yes, describe in comments section below.

Remember to attach a xerox copy of a USGS quad/topographical map (REQUIRED) of the survey area, noting the survey site and location of WIFL detections. You may also include a sketch or aerial photograph showing details of site location, patch shape, survey route in relation to patch, and location of any willow flycatchers or willow flycatcher nests detected. Such sketches or photographs are welcomed, but DO NOT substitute for the required USGS quad map.

Comments (attach additional sheets if necessary): Two survey loops included: 1, along irrigation canal @ Junction w/ River to upland vegetation + back along river channel. 2, along South side of river from canal to bridge then north to patch on NW quadrant of bridge

Willow Flycatcher Survey and Detection Form (rev. 4/98)

Site Name Big Sandy River, Downstream of US93 Was site surveyed in previous year? Yes (No)
If yes, what site name was used? ______

County Mohave State AZ USGS Quad Name Wikieup, Ariz

Is copy of USGS map marked with survey area and WIFL sightings attached (as required)? ☒ *Yes* ☐ *No*

Site Coordinates: Start: N 3838221 E 2632210 UTM
Loop#1 Stop: N 3838221 E 2632210 UTM Zone 12
Elevation 1800 feet / meters (circle one)

Loop#2 Start N 3838221 E 2632210
STOP N 3838221 E 2632210

*** Fill in additional site information on back of this page ***

	Survey # Observer(s)	Date (m/d/y) Survey time	Number of WIFLs Found	Estimated Number of Pairs	Estimated Number of Territories	Nest(s) Found ? Y or N	Cowbirds Detected? Y or N	Presence of Livestock, Recent sign Y or N	Comments about this survey (e.g., evidence of pairs or breeding, number of nests, nest contents or number of fledges seen; potential threats)
Loop#1 1st	1 T.J. McMichael	Date 5/30/00 start 0500 stop 0900 total hrs 4	2	?	?	N	Y	Y	No Comments
2nd Loop#2	2 T.J. McMichael	Date 5/31/00 Start 0430 Stop 0930 total hrs 5	6	?	5	N	Y	Y	1 WIFl repeat of 5/30 survey.
Loop#1 2nd	3 T.Ashbeck	Date 6-15-00 Start 0520 Stop 0830 total hrs 3:10	10	3	10	N	Y	Y	pairs ID'd by ♀ whits + inter. w/ ♂
2nd Loop#2	T.J. McMichael	Date 6-15-00 start 0508 stop 0830 total hrs 3:30	3	3	3	N	Y	Y	3 WIFls in same Location as 1st survey; obs 1 ♂ Singing
Loop#1 3rd Rnd 1	T.J. McMichael	Date 6-26-00 start 0500 stop 0930 total hrs 4:30	1	?	1	N	Y	Y	1 WIFl; whits heard but No fitz-bew

Overall Site Summary (Total only resident WIFLs) Total survey hrs 20.10	Adults	Pairs	Territories	Nests	Were any WIFLs color-banded? Yes (No) If yes, report color combination(s) in the comments section on back of form
	22	6	19	N	

Name of Reporting Individual Tom Ashbeck Date Report Completed 7-20-00

Willow Flycatcher Survey and Detection Form (rev. 4/98)

Site Name Big Sandy River DS @ U.S 93 Was site surveyed in previous year? Yes No
If yes, what site name was used? ______

County Mohave State Az USGS Quad Name Wikieup, Ariz

Is copy of USGS map marked with survey area and WIFL sightings attached (as required)? ☐ *Yes* ☐ *No*

Site Coordinates: Start: N______ E______ UTM
Stop: N______ E______ UTM Zone ______
Elevation 1800 feet / meters (circle one)

***** Fill in additional site information on back of this page *****

	Survey # Observer(s)	Date (m/d/y) Survey time	Number of WIFLs Found	Estimated Number of Pairs	Estimated Number of Territories	Nest(s) Found ? Y or N	Cowbirds Detected? Y or N	Presence of Livestock, Recent sign Y or N	Comments about this survey (e.g., evidence of pairs or breeding, number of nests, nest contents or number of fledges seen; potential threats)
Loop #2 3rd Rnd #1	1. T. Ashbeck	Date 6-26-00 start 0503 stop 0805 total hrs 3:02	5	2	5	N	Y	Y	3 WIFLs may have been det. on 6-15.00
Loop #1 3rd 2nd < : 2	2. T Ashbeck	Date 7-5-00 Start 0543 Stop 0845 total hrs 3:02	8	?	8	N	N	Y	Vocalizations seem less aggresive (i.e. Low volume); difficult to det. pairing
Loop #2	3. S. Hale	Date 7-5-00 Start 0530 Stop 0830 total hrs 3.0	5	3	5	N	Y	Y	2 additional ♂'s found w/in patch w/ 3 previously detected
Loop #1 3rd Rnd #3	T. Ashbeck	Date 7-13-00 start 0530 stop 0830 total hrs 3.0	8	2	8	N	Y	Y	only 2 pairs confirmed, possibly more but no evidence to confirm
Loop #2	T.J. McMichael	Date 7/13/00 start 0530 stop 0930 total hrs 4.0	4	3	4	N	Y	Y	Obs 3 individuals that did not vocalize, 1 vocalized

Overall Site Summary (Total only resident WIFLs)	Adults	Pairs	Territories	Nests	Were any WIFLs color-banded? Yes No
Total survey hrs 16:04	30	10	30	0	If yes, report color combination(s) in the comments section on back of form

Name of Reporting Individual Tom Ashbeck Date Report Completed 7-20/00

Total: 36:14 52 16 49 0

Fill in the following information completely. Submit original form. Retain copy for your records.

Name of Reporting Individual Tom Ashbeck Phone # 480-733-6666

Affiliation EcoPlan Email EcoPlan @ aol.com

Site Name Big Sandy Upstream of US93

Did you verify that this site name is consistent with that used in previous years? Yes No (circle one)

Management Authority for Survey Area (circle one): Federal Municipal/County State Tribal Private

Name of Management Entity or Owner (e.g., Tonto National Forest) BLM + unk. private owner

Length of area surveyed: ≈1.5mi (specify units, e.g., miles = mi, kilometers = km, meters = m)

Did you survey the same general area during each visit to this site this year? Yes / No If no, summarize in comments below.

If site was surveyed last year, did you survey the same general area this year? Yes / No If no, summarize in comments below.

Not previously surveyed

Vegetation Characteristics: Overall, are the species in tree/shrub layer at this site comprised predominantly of (check one):

- ☐ Native broadleaf plants (entirely or almost entirely, includes high-elevation willow)
- ☐ Mixed native and exotic plants (mostly native)
- ☒ Mixed native and exotic plants (mostly exotic)
- ☐ Exotic/introduced plants (entirely or almost entirely)

Identify the 2-3 predominant tree/shrub species: Tamarisk (Salt Cedar), Fremont Cottonwood, Goodding Willow

Average height of canopy: 12 feet (specify units)

Was surface water or saturated soil present at or adjacent to site? Yes No (circle one)

Distance from the site to surface water or saturated soil: Avg= 20feet (specify units)

Did hydrological conditions change significantly among visits (did the site flood or dry out)? Yes No (circle one)

If yes, describe in comments section below.

Remember to attach a xerox copy of a USGS quad/topographical map (REQUIRED) of the survey area, noting the survey site and location of WIFL detections. You may also include a sketch or aerial photograph showing details of site location, patch shape, survey route in relation to patch, and location of any willow flycatchers or willow flycatcher nests detected. Such sketches or photographs are welcomed, but DO NOT substitute for the required USGS quad map.

Comments (attach additional sheets if necessary): Survey included 2 loops: 1, along dense patch ≈ 1 mile upstream of bridge to 1/2 mile ~~[illegible]~~ upstream of bridge 2, from bridge upstream to 1/2 mile + back along river channel

Willow Flycatcher Survey and Detection Form (rev. 4/98)

Site Name Big Sandy River Upstream of US 93 Was site surveyed in previous year? Yes (No)
If yes, what site name was used? ____

County Mohave State AZ USGS Quad Name Wikieup, Ariz

Is copy of USGS map marked with survey area and WIFL sightings attached (as required)? ☒ *Yes* ☐ *No*

Site Coordinates: Start: N 3840080 E 263160 UTM
Loop#1 Stop: N 3839820 E 263190 UTM Zone 12
Elevation 1800 feet / meters (circle one)

Loop#2 Start N 3838658 E 263429
Stop N 3838658 E 263429

*** Fill in additional site information on back of this page ***

Survey # Observer(s)	Date (m/d/y) Survey time	Number of WIFLs Found	Estimated Number of Pairs	Estimated Number of Territories	Nest(s) Found ? Y or N	Cowbirds Detected? Y or N	Presence of Livestock, Recent sign Y or N	Comments about this survey (e.g., evidence of pairs or breeding, number of nests, nest contents or number of fledges seen; potential threats)
1st < 2nd Loop#1 — 1 Geo. A. Ruffner/ S. Faulk	Date 5/30/00 start 0445 stop 0845 total hrs 4	3	?	3	N	Y	Y	3 counter calling ♂'s ≈ 1 mile upstream of bridge Large unoccupied patch between det. pts.
Loop#2 — 2 T.J. McMichael	Date 6/14/00 Start 0500 Stop 0845 total hrs 3:45	0	0	0	N	Y	Y Horses/ Cattle	—
2nd < 2nd Loop#1 — 3 T. Ashbeck	Date 6/14/00 Start 0525 Stop 0900 total hrs 3:35	7	3	7	N	Y	Y	—
Loop#2 — T.J. McMichael	Date 6-27-00 start 0500 stop 0825 total hrs 3:25	1	?	1	N	Y	Y	Very vocal ♂ WIFL; moved around continuously
3rd < 3rd Rnd #1 Loop#1 — T. Ashbeck	Date 6-27-00 start 0504 stop 0800 total hrs 2:56	(4 pairs 2 indiv.) 10	4	4	N	Y	Y	1 WIFL obs. but did not call; sex unknown; 1 calling ♂ obs

Overall Site Summary (Total only resident WIFLs)	Adults	Pairs	Territories	Nests	Were any WIFLs color-banded? Yes (No)
Total survey hrs 17.68	21	7	15	0	If yes, report color combination(s) in the comments section on back of form

Name of Reporting Individual Tom Ashbeck Date Report Completed 7-20-00

Willow Flycatcher Survey and Detection Form (rev. 4/98)

Site Name Big Sandy River - Upstream of U.S. 93 Was site surveyed in previous year? Yes No
If yes, what site name was used? ______

County Mohave State Az USGS Quad Name Wikieup, Ariz

Is copy of USGS map marked with survey area and WIFL sightings attached (as required)? ☐ *Yes* ☐ *No*

Site Coordinates: Start: N______ E______ UTM
Stop: N______ E______ UTM Zone ______

Elevation 1800 feet / meters (circle one)

***** Fill in additional site information on back of this page *****

	Survey # / Observer(s)	Date (m/d/y) / Survey time	Number of WIFLs Found	Estimated Number of Pairs	Estimated Number of Territories	Nest(s) Found? Y or N	Cowbirds Detected? Y or N	Presence of Livestock, Recent sign Y or N	Comments about this survey (e.g., evidence of pairs or breeding, number of nests, nest contents or number of fledges seen; potential threats)
Loop#1	1 T. Ashbeck	Date 07-6-00 start 0530 stop 0830 total hrs 3.0	3	2	3	N	Y	Y	1 WIFI only whitod 2 others still counter calling Fewer det. than 6/27
3rd Rnd #2 Loop#2	2 S. Hale	Date 7-6-00 Start 0515 Stop 0820 total hrs 3:05	0	0	0	N	Y	Y	—
Loop#1 3rd Rnd	3 T.J. McMichael	Date 7-14-00 Start 0530 Stop 0915 total hrs 3:45	1	1	1	N	Y	Y	One WIFI Fitz-bewing; others previously recorded probably present but silent
#3 Loop#2	T. Ashbeck	Date 7-14-00 start 0530 stop 0730 total hrs 2.0	0	0	0	N	Y	Y	—
		Date start stop total hrs							

Overall Site Summary (Total only resident WIFLs)	Adults	Pairs	Territories	Nests	Were any WIFLs color-banded? Yes No
Total survey hrs ______	12	11	12	0	If yes, report color combination(s) in the comments section on back of form

Name of Reporting Individual Tom Ashbeck Date Report Completed 7-20-00

Totals: 33 18 27 0

EXHIBIT C-4

AQUATIC RESOURCES BASELINE TECHNICAL REPORT

REPORT

BIG SANDY ENERGY PROJECT AQUATIC RESOURCE BASELINE TECHNICAL REPORT

Submitted by:

Caithness Big Sandy, LLC
7887 E. Belleview Avenue, Suite 1100
Englewood, CO 80111

September 2000

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Figures

Tables

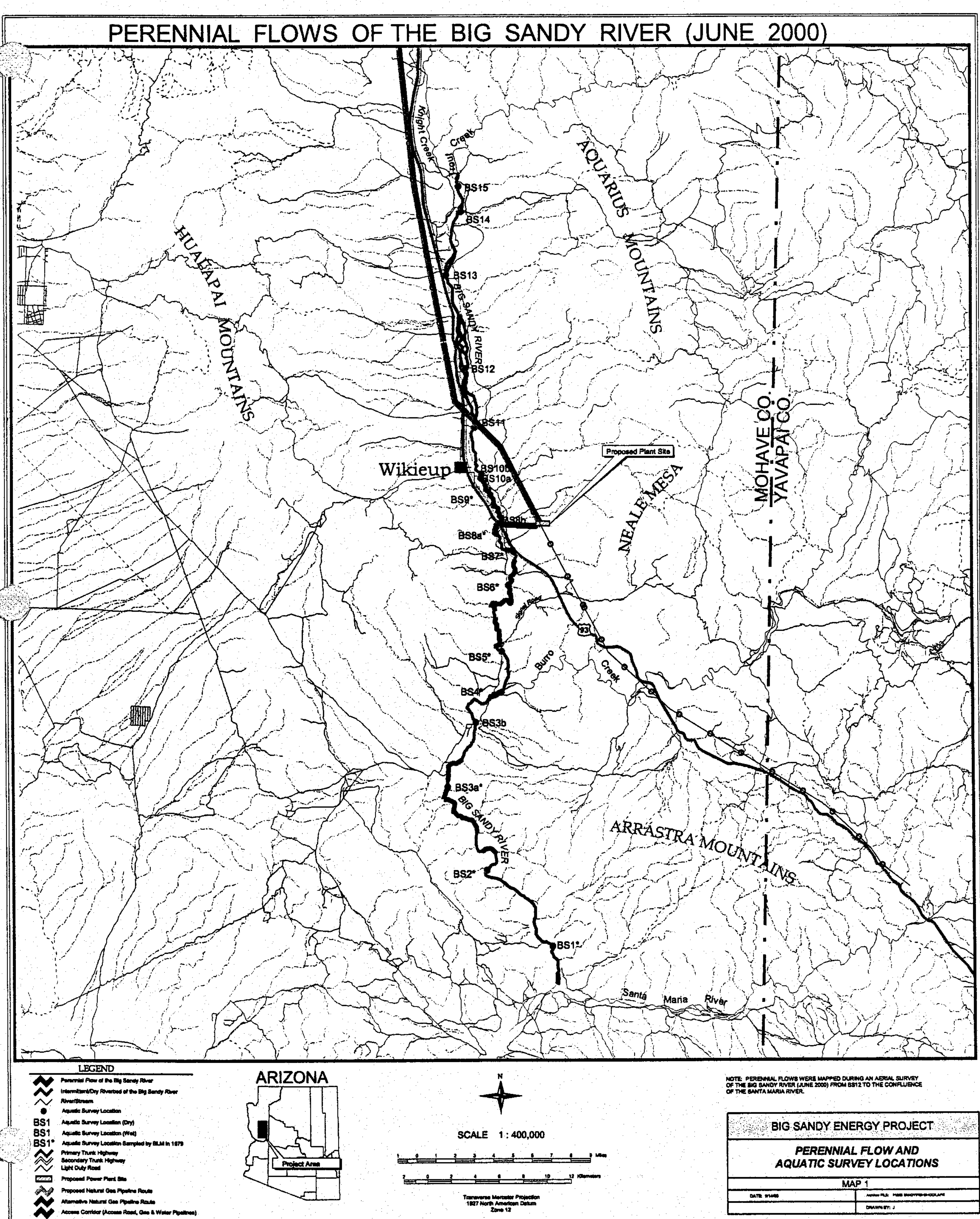
Appendices

1.0 INTRODUCTION

The analysis described in this report was conducted to provide supporting information for the Big Sandy Energy Project Environmental Impact Statement (EIS). It provides a description of the existing conditions for aquatic resources within the analysis area.

The analysis area for the aquatic resources is the entire Big Sandy River (**Map 1**). This river originates at the confluence of Trout and Knight creeks and extends 37.8 miles downstream to Alamo Lake (approximately its confluence with the Santa Maria River). The Big Sandy River's total drainage area is approximately 2, 810 square miles.

The analysis area includes waters within the proposed project area and the potentially affected waters downstream. Waters upstream of any potential project impacts were also included as part of the analysis area for additional information.


PERENNIAL FLOWS OF THE BIG SANDY RIVER (JUNE 2000)
Knight Creek
Creek
BS15
BS14
BS13
BIG SANDY RIVER
BS12
BS11
HUALAPAI MOUNTAINS
AQUARIUS MOUNTAINS
Wikieup
BS10b
BS10a
BS9*
BS8b
BS8a*
BS7*
BS6*
Proposed Plant Site
NEALE MESA
MOHAVE CO.
YAVAPAI CO.
93
BS5*
Burro
Creek
BS4*
BS3b
BS3a*
BIG SANDY RIVER
BS2*
ARRASTRA MOUNTAINS
BS1*
Santa Maria River
LEGEND
Perennial Flow of the Big Sandy River
Intermittent/Dry Riverbed of the Big Sandy River
River/Stream
Aquatic Survey Location
BS1 Aquatic Survey Location (Dry)
BS1 Aquatic Survey Location (Wet)
BS1* Aquatic Survey Location Sampled by BLM in 1979
Primary Trunk Highway
Secondary Trunk Highway
Light Duty Road
Proposed Power Plant Site
Proposed Natural Gas Pipeline Route
Alternative Natural Gas Pipeline Route
Access Corridor (Access Road, Gas & Water Pipelines)
ARIZONA
Project Area
N
SCALE 1 : 400,000
Miles
Kilometers
Transverse Mercator Projection
1927 North American Datum
Zone 12
NOTE: PERENNIAL FLOWS WERE MAPPED DURING AN AERIAL SURVEY OF THE BIG SANDY RIVER (JUNE 2000) FROM BS12 TO THE CONFLUENCE OF THE SANTA MARIA RIVER.
BIG SANDY ENERGY PROJECT
PERENNIAL FLOW AND AQUATIC SURVEY LOCATIONS
MAP 1
DRAWN BY: J

2.0 METHODS

Aquatics resource information was acquired from the following sources: 1) resource management agencies published and unpublished data; 2) general literature for the fish species occurring in the area; and 3) a field data collection conducted by Greystone specifically for the proposed project in June, 2000. Greystone received data compiled by the BLM and Arizona Game and Fish Department (AG&FD) between 1977 and 1997 (AG&FD 1990; AG&FD 1993; AG&FD 1977-1992; BLM 1994; Fresques et al.1997; Kepner 1979; and Morgan et al.1997). These data are included in **Appendix A**. These data were reviewed and compared with the 2000 survey. This included the review and determination of the status, occurrence and use of habitats for fish within the analysis area.

The primary objective of the 2000 survey was to revisit the 10 sites (monitoring sites) that were sampled by the BLM in 1979 (Kepner 1979) and the AG&FD in 1996 (Fresques et al.1997). This served the dual purpose of establishing updated baseline aquatic resource data and to continue to monitor any changes in the aquatic resource over the 21-year period. Due to the lack of specific BLM survey locations direct comparisons cannot be made, as the 2000 survey sites may not have been at the exact same locations (each of the sites was within the same 1/4 section as the 1979 and 1996 sites). The sites were specifically identified using a GPS so that the sites could be reproduced in future years. Field drawings of each site were also made for each site. Refer to **Map 1** for sampling station locations and **Appendix B** for legal descriptions including GPS coordinates.

In addition to these 10 revisited sites, 8 new sites were established to provide specific project-related information and to document dry conditions in the upper reaches of the Big Sandy River. The 10 monitoring sites are labeled sequentially (BS1-10). Any new sites that were added within the 10 monitoring site stream section were labeled with the monitoring number just downstream and adding "b" (e.g., BS3a = existing monitoring site, BS3b = new site). A qualitative sample of Burro Creek at the Burro Creek campground was also conducted for additional information.

Greystone conducted the field inventory of Big Sandy on June 14-17, 2000. The aquatic resource data collected included aquatic habitat, water quantity and quality, fish, macroinvertebrates, amphibians, and reptiles. The following sections provide the methods used to collect these data.

2.1 Aquatic Habitat

General aquatic habitat parameters were described qualitatively during the field survey. This included identifying stream habitat types (pool, riffle, run), dominant substrates, and riparian community composition. At each site upstream, downstream, and cross-section photographs were taken in the middle of the surveyed reach to document habitat conditions.

2.2 Water Quantity and Quality

The presence or absence of surface water was documented at each of the 18 sites. The entire Big Sandy River, from the Knight Creek/Trout Creek confluence to the Santa Maria River, was flown in order to map which sections of the stream had perennial surface water (**Map 1**). Because the flight found that BS1, BS2, and BS3a were in sections of the river without surface water, these three sites were not visited. Because of the substantial and long-term drought conditions experienced prior to the survey, it was assumed that any surface water present during the survey was perennial.

At the sites with surface water, flow was determined using the float and timer method (Harrelson et al. 1994). At each site, a cross sectional area was calculated by dividing the cross-section into subsections and taking depths within each subsection. Three sponges were timed through a length of stream that was at least two to three channel widths long. This is repeated three times to get an average velocity. This velocity is multiplied by 0.95 to correct for the roughness of the channel. This average velocity is multiplied by the cross sectional area to get discharge.

General field water quality parameters were taken at each site with water. These included pH, conductivity, water temperature, and dissolved oxygen.

2.3 Fish

Fish population data were collected at the sites with surface water. Consistent with the 1979 and 1996 surveys, representative reaches of at least 60 feet were electroshocked at each site using a Smith Root B-12 backpack electroshocker. As with the 1979 survey, a one-pass/minimum population method was used. Fish were stunned, netted, identified to species, enumerated, and then released into the stream unharmed. A fish collection permit was obtained from the AG&FD prior to conducting the survey.

2.4 Macroinvertebrates

Macroinvertebrate population data were collected at the three sites that had surface water present during the survey using the number of replicates and type of sampler recommended and used by the USFS (Mangum 1994). The sites were quantitatively sampled by taking three replicate samples from riffle or run habitats using a Surber sampler, which encloses an area of one square foot and has a mesh net size of 500 µm. At each site, as similar of substrate type as possible was sampled to provide quantitative comparison between sites. Each site's specific sampling location was marked on a map and described in field notes. Contents of the samples were emptied into a standard number 35 (500 µm) sieve for washing and preserved with 90 percent ethyl alcohol for transport to the laboratory. The data were collected and processed using a method modified from EPA's Rapid Bioassessment Protocol, level III (Plafkin et al.1989; Barbour et al. 1999).

In the laboratory, macroinvertebrate samples were lightly rinsed in a standard number 35 sieve and transferred to a white pan. For samples with less than 300 organisms, all were removed from the sample. If samples had greater than 300 organisms, a fraction of the sample was sorted that had a minimum of 300 individuals in that sorted fraction. For these fractioned samples, the appropriate coefficient was used to adjust the abundance of taxa to equal a full sample. Specimens were then preserved in alcohol for identification. Macroinvertebrates were identified to the lowest practical taxonomic level, enumerated, and recorded on laboratory bench sheets. Organisms were identified using available keys.

Several macroinvertebrate metrics were calculated including total abundance, species richness (number of taxa), EPT taxa, percent contribution of the dominant taxon, percent chironomidae, ratio of EPT and chironomidae abundances, Shannon diversity index, evenness, Hilsenhoff Biotic Index, and Community Tolerance Quotient. Definitions of the metrics used are:

Abundance - Under certain types of stresses, this value may be increased (by tolerant organisms) or reduced (by lowering the number of nontolerant organisms).

Total Number of Taxa - The total number of taxa (richness) reflects the health of the community. Richness generally increases with increasing biotic condition. Bahls et al. (1992) found average values for Montana streams to be 34 for mountain and foothill streams, and 29 for plains streams.

EPT Taxa - The total number of distinct taxa within the orders Ephemeroptera, Plecoptera, and Trichoptera. This value summarizes taxa richness within the insect orders that are generally considered to be sensitive to pollution. However, individual EPT taxa displays a wide range of tolerances to pollution. Bahls et al. (1992) found average values for Montana streams to be 22 for mountain streams, 16 for foothills, 6 for plains.

% Dom. Taxon - The percent contribution of the most numerous taxon found. Undisturbed environments generally support communities having large numbers of species with no individual species present in overwhelming abundance. Plafkin et al. (1989) suggests that the dominant taxon in minimally-impacted streams should account for less than 20 percent of the community. However, Bahls et al. (1992) found average values for Montana streams to be 29 for mountain streams and 35 for foothills and plains streams.

% Chironomidae - The percent contribution of the family Chironomidae. Disproportionate dominance of this generally tolerant group usually indicates poor biotic condition. Bahls et al. (1992) found average values for Montana streams to be 9 for Mountain streams, 18 for foothills, and 23 for plains.

EPT/Chironomidae - The ratio of the total number of organisms in orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) with the number of organisms in the family Chironomidae. Skewed populations having a disproportionate number of the tolerant chironomids relative to the more sensitive EPT group may indicate environmental stress (Plafkin et al. 1989).

Shannon H ($\log_2$) - Shannon and Weaver (1963). A diversity index where relative abundances of the different taxa are taken into account. In general, values of 3-5 indicate clean water, 1 to 3 moderately polluted water, and values below 1 indicate heavily polluted water (Platts et al. 1983).

Evenness (e) - Lloyd and Ghelardi (1964). The measure of how evenly the individuals are distributed among species. Equitability (evenness) is very sensitive to slight changes in community structure (Weber 1973). Values greater than 0.5 are considered to characterize natural stream communities. Even slight levels of degradation have been found to reduce evenness below 0.5, and generally below 0.3 (Klemm 1990).

HBI - (Modified Hilsenhoff Biotic Index) Hilsenhoff (1987) and Plafkin et al. (1989). The HBI summarizes the benthic community's overall tolerance to pollution. Although it was designed as an index of organic enrichment, it is also believed to be a good indicator of enrichment by inorganic nutrients (Bahls et al. 1990). The following values are the typical ratings: 0.00-3.75 (excellent), 3.76-4.25 (very good), 4.25-5.00 (good), 5.01-5.75 (fair), 5.76-6.50 (fairly poor), 6.51-7.25 (poor), and 7.26-10.00 (very poor). Bahls et al. (1992) found average values for Montana streams to be 2.5 for mountain streams, 3.8 for foothills, and 7.0 for plains.

CTQ - (Community Tolerance Quotient) Winget and Mangum (1979). Similar to the HBI, each individual organism in a sample has a preassigned tolerance value. Mean values for a sample range from 40 to 108; the higher numbers indicate more tolerant communities and may show stressed conditions depending upon the capability and potential of that stream. Unlike HBI, the CTQ was developed for use in Western streams to assess nonpoint source pollution. Bahls et al. (1992) found average values for Montana streams to be 51 for mountain streams, 75 for foothills, and 98 for plains.

2.5 Amphibians and Reptiles

A presence/absence survey for amphibians and reptiles was also conducted at each site with surface water. This included species identification of all specimens observed per site.

3.0 RESULTS AND DISCUSSION

3.1 Aquatic Habitat

In general, the Big Sandy River has a low gradient, broad floodplains, sandy substrates, and run habitat types. The dominant substrate at all sites was sand. Very few pools or riffles were observed. Run habitat was by far dominant. Exceptions were at BS4 and BS9. BS4 habitat consisted of a small flowing run habitat flowing to a dry section and then several isolated pools connected to the ground water. BS9 consisted of essentially one very large pool because the stream had been damned up causing very low flow (.05 cfs).

Riparian vegetation within the flowing reaches was typically dominated by thickets of mesquite and tamarisk, with some sections (e.g., BS7, BS8a, BS8b) also containing large amounts of fremont cottonwood, Goodding willow and seep willow. The exotic tamarisk have invaded and displaced the native riparian species in much of the Big Sandy River System.

3.2 Water Quantity and Quality

The survey documented that twelve of the eighteen sites were dry, with only BS4, BS6, BS8a, BS8b, BS9, and BS10a containing water. Because of the substantial and long-term drought conditions experienced prior to the survey, it was assumed that any surface water present during the survey was perennial surface water. The entire upper portion of the Big Sandy from just south of Wikieup (BS10b) upstream to its origination (BS15) was dry (**Map 1**). A spring and issue pond within the channel of Big Sandy just south of Wikieup (BS10a) was the start of perennial flows. From this point downstream to its confluence with the Santa Maria River, the Big Sandy had surface flow sporadically.

It is not known what effect withdrawal of groundwater from twelve wells located along the upper Big Sandy has on the surface water quantity in the drainage. These wells were installed in the late 1970's. A series of five pumps move water through a single pipeline to the Bagdad Mine. Each is capable of pumping 1,400 gallons per minute, but is variable depending on demand (Kepner 1979).

Map 1 presents the perennial surface water throughout the analysis area. In general, aquatic habitat in Big Sandy was poor with very low flows being the primary limiting factor. **Table 1** presents the flows for each site and **Appendix C** presents the calculation data. The highest flow recorded during the survey was 3.26 cubic feet per second (cfs) located at BS6. The drainage is subject to spates, with the highest measured discharge being 35,000 cfs in March of 1978.

An important flow-related observation between the 1979, 1996, and 2000 surveys was that the original 1979 survey, nine of the ten sites sampled were wet and supported fish (the tenth site had no fish data, but it is unknown if it was wet or dry). During both the 1996 and 2000 survey, five of these nine sites were dry (**Table 1**).

Table 1
Big Sandy Energy Project
Aquatic Resources Sampling Results
from Sites in the Big Sandy River
June 13-16, 2000

Fish Species	BS1 #	BS1 RA	BS2 #	BS2 RA	BS3a #	BS3a RA	BS4 #	BS4 RA	BS5 #	BS5 RA	BS6[2] #	BS6[2] RA	BS7 #	BS7 RA	BS8a #	BS8a RA	BS8b #	BS8b RA	BS9[2] #	BS9[2] RA	BS10a[2] #	BS10a[2] RA	Total #	Total RA
	Site[1]																							
Family Centrarchidae (sunfish)																								
Green sunfish	Dry		Dry		Dry		1	0.2	Dry				Dry						3	0.6			4	0.2
Family Cyprinidae (minnows)																								
Common carp							130	25.2															130	4.9
Longfin dace*							10	1.9			2	0.9			65	8.7	78	56.9			63	12.2	218	8.2
Red shiner							24	4.7							7	0.9					41	7.9	72	2.7
Family Ictaluridae (catfish)																								
Black bullhead																			35	6.8			35	1.3
Yellow bullhead							7	1.4			2	0.9											9	0.3
Family Poeciliidae (livebearers)																								
Mosquitofish							343	66.6			223	98.2			672	90.3	59	43.1	474	92.6	412	79.8	2183	82.3
Total Abundance							**515**	100.0			**227**	100.0			**744**	100.0	**137**	100.0	**512**	100.0	**516**	100.0	**2651**	100.0
Total # Species							**6**				**3**				**3**		**2**		**3**		**3**		**7**	
Minimum Population (fish/100m)							**844**				**1081**				**2657**		**761**		**1679**		**1147**		**8169**	
Amphibian/Reptile Species																								
Lowland leopard frog[3]							A				A				A		P		A		P			
Arizona toad[3]							P				A				P		A		A		A			
Sonoran mud turtle[3]							A				A				A		P		A		A			
Water Quality																								
pH (s.u.)							9.44				7.71				7.70		X[4]		8.34		7.17			
Conductivity (μs/cm)							507				1149				1311		X[4]		832		602			
Dissolved oxygen (mg/l)							—				8.42				8.59		X[4]		4.30		3.46			
Temperature (°C)							31.6				28.8				24.1		X[4]		19.9		23.2			
Flow (cfs)			0		0		0.05		0		3.26		0		2.35		X[4]		0.99		0.33			

Note:
\# = Number of individuals; RA = Percent relative abundance.
*Species native to Big Sandy River System
[1] Sites BS3b, BS10b, BS11, BS12, BS13, BS14, and BS15 were all dry and were added to the 2000 survey to document dry conditions.
[2] mosquitofish populations at this site were underestimated because juveniles were not effectively electroshocked due to large amounts of algae.
[3] The scientific names for these species are: Lowland leopard frog (Rana yavapaiensis), Arizona toad (Bufo microscaphus microscaphus), Sonoran mud turtle (Kinosternon sonoriense)
[4] Because this was an additional site very close to BS8a, flow and water quality data were not collected at this site

In general, water quality at the sites was acceptable for aquatic production (**Table 1**). However, temperature was very high at BS4 (31.6°C) and BS6 (28.8°C) and dissolved oxygen was quite low at station BS10a (3.46 mg/l).

3.3 Fish

Seven fish species were found in the Big Sandy River during the 2000 survey (**Table 1**). Species found include longfin dace, common carp, green sunfish, mosquitofish, red shiner, black bullhead, and yellow bullhead. Of these, only the longfin dace is native. Although not found in 1996 or 2000, roundtail chubs likely occur in limited numbers within the Big Sandy River because it was found in1994 by the BLM.

This 1994 survey sampled at approximately the BS6 site at approximately one mile upstream and found no roundtail chubs. However, at a site approximately 1 mile downstream of BS6, one roundtail chub was found. Also, at a site approximately ½ mile downstream of BS3a, thirteen roundtails were collected. That flowing section of Big Sandy was not sampled in 2000, but was documented to be flowing during the aerial flight, suggesting the reach could still contain roundtails.

The absence of roundtails in the Big Sandy during both the 1996 and 2000 survey is most likely due to drought conditions present in the region. Both surveys found 5 of the 10 1979 sites dry compared to at least 9 of the sites having water (and fish) in 1979 (**Table 2**). The AG&FD found roundtails in Trout Creek in 1996, which suggests that, during wetter years, distribution of roundtail chub may expand throughout the Big Sandy drainage from Trout Creek recruitment.

Other species found in previous surveys and; therefore, potentially still occuring in the Big Sandy, include Sonora sucker, desert sucker, fathead minnow, and speckled dace. Furthermore, any fish species that occur in the Big Sandy River tributaries (Trout Creek, Burro Creek, and Santa Maria River) could occur in the Big Sandy due to recruitment from these tributaries. All fish species collected from the Big Sandy River Basin from 1977 to present are summarized per tributary in **Table 3**.

There has been a significant shift in species composition over the 21-year period, with the percentage of nonnative fish increasing. Red shiner, mosquitofish, carp, green sunfish, yellow bullhead, and black bullhead were collected in 2000 at areas where they were not found in the 1979 and 1996 surveys. Two of the three native species found in 1979 were not found during the 1996 or 2000 surveys (Sonora sucker and roundtail chub). Native fish comprised 57.8 percent of the total fish collected in 1979, but only 8 percent in 2000.

Mosquito fish populations are especially increasing. They were not found in 1979, were common but never dominant in 1996, and was the dominant species found at all monitoring sites in 2000 (**Table 2**). Furthermore, in 1979 the native longfin dace was the dominant species found in all but the lower three sites and was not dominant at any of them in 2000.

Table 2

Big Sandy Energy Project
Relative Abundance of Fish Species for the 10 Established Monitoring Sites (BLM 1979, AG&FD 1996, and Greystone 2000 Surveys)

	Site[1]																																
	BS1			BS2			BS3a			BS4			BS5			BS6			BS7			BS8a			BS9			BS10a			Total		
Species	'79	'96	'00	'79	'96	'00	'79	'96	'00	'79	'96	'00	'79	'96	'00	'79	'96	'00	'79	'96	'00	'79	'96	'00	'79	'96	'00	'79	'96	'00	'79	'96	'00
Family Catastomidae (suckers)																																	
Sonora sucker*	Unknown	Dry	Dry	7.0	Dry	Dry	16.0	Dry	Dry	3.0	Dry		0.5	Dry	Dry	3.0				Wet - No Fish Caught	Dry					Not Sampled					4.9	0.0	0.0
Family Centrarchidae (sunfish)																																	
Green sunfish				20.0			6.0			1.5		0.2															0.6				4.9	0.0	0.2
Family Cyprinidae (minnows)																																	
Common carp				1.0						1.5		25.2																			0.3	0.0	4.9
Longfin dace*				8.0			2.0			2.5		1.9	81.0			97.0	79.8	0.9	100.0			100.0	100.0	8.7	98.0			100.0	69.5	12.3	50.5	82.3	8.2
Red shiner				60.0			53.0			82.0		4.7	17.0											0.9	2.0					7.9	33.0	0.0	2.7
Roundtail chub*				1.5			5.0			8.0			1.5																		2.4	0.0	0.0
Family Ictaluridae (catfish)																																	
Black bullhead							1.0																				6.8				0.6	0.0	1.3
Yellow bullhead				2.5			17.0			1.5		1.4						0.9													3.3	0.0	0.3
Family Poeciliidae (livebearers)																																	
Mosquitofish												66.6					20.2	98.2						90.4			92.6		30.5	79.8	0.0	17.7	82.3
TOTAL				100.0			100.0			100.0		100.0	100.0			100.0	100.0	100.0				100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0	99.9	100.0	100.0

Notes:
[1] Due to the lack of specific BLM survey locations direct comparisons cannot be made, as the 1979, 1996, and the 2000 survey sites may not have been at the exact same locations (each of the sites were within the same 1/4 section as the1979 and 1996 sites).

Table 3
Distribution of Fish Species in the Big Sandy River Basin
1997 to 2000

Common and Scientific Names		Watershed			
Common name	Scientific name	Big Sandy River	Trout Creek[1]	Burro Creek[2]	Santa Maria River[3]
Family Catastomidae (suckers)					
Desert sucker*	*Pantosteus clarki*		x	x	x
Sonora sucker*	*Catostomus insignis*	x^2	x	x	x
Family Centrarchidae (sunfish)					
Green sunfish	*Lepomis cyanellus*	$x^{1,2}$	x	x	x
Smallmouth bass	*Micropterus dolomieui*			x	
Family Cyprinidae (minnows)					
Common carp	*Cyprinus carpio*	$x^{1,2}$		x	
Fathead minnow	*Pimephales promelas*			x	x
Longfin dace*	*Agosia chrysogaster*	$x^{1,2}$	x	x	x
Red shiner	*Cyprinella lutrensis*	$x^{1,2}$	x	x	x
Roundtail chub*	*Gila robusta robusta*	x^2	x	x	x
Speckled dace	*Rhinichthys osculus*		x	x	
Family Ictaluridae (catfish)					
Black bullhead	*Ameirus melas*	$x^{1,2}$	x	x	x
Yellow bullhead	*Ameiurus natalis*	$x^{1,2}$	x	x	x
Family Poeciliidae (livebearers)					
Mosquitofish	*Gambusia affinis*	x^1		x	x

Notes:
*Species native to Big Sandy River System
x^1=Species captured during June 2000 survey
x^2=Species captured between 1977 and 1997
[1] Data taken from AG&FD 1977-1992 and Fresques et al. 1997
[2] Data taken from Morgan et al. 1997, AG&FD 1993, and Kepner 1979
[3] Data taken from Fresques et al. 1997 and Kepner 1979

For additional information, Burro Creek was qualitatively sampled at the Burro Creek campground. The habitats consisted of four large, deep, bedrock pools with no surface flow between the pools. Species collected included common carp, green sunfish, red shiner, and yellow bullhead. A notable difference between this site and the Big Sandy sites was that no longfin dace or mosquitofish was collected.

3.4 Macroinvertebrates

Macroinvertebrate bioassessment metrics for the study sites are presented in **Table 4**. General taxa and abundance data are presented in **Appendix D**. The 2000 survey data focused on a specific microhabitat at each site to allow quantitative monitoring, rather than attempting to gather a comprehensive taxa list for the system. The 1979 survey sampled a variety of habitats including backwaters. This data is included in **Appendix E** to provide a taxa list. Unfortunately, the BS4 sample was damaged in shipping and was not able to be reliably processed.

The communities found in Big Sandy Creek are generally comprised of species considered tolerant of environmental stress. This stress is probably due to the habitat limitations described above including low to intermittent base flows. Most of the metrics generally indicate poor to fair aquatic community health (**Table 4**). The number of EPT taxa found were considerably less than are typical of high water quality streams. Diversity at all sites was rated as "fair" and biotic condition (exemplified by HBI) ranged from "poor" to "fair" ratings. Given Big Sandy Creek's limited quality aquatic habitat and intermittent flows throughout most of its length, the fair metric ratings found represent conditions that would be expected.

3.5 Amphibians and Reptiles

Amphibians were found throughout the Big Sandy River at the sites with surface water. The two species found were the lowland leopard frog and the Arizona toad. **Table 1** presents the occurrence per site for these species. In addition to the amphibians, a Sonoran mud turtle was found at the highway 93 bridge (BS-8b) site.

Table 4
Macroinvertebrate Bioassessment Metrics for Big Sandy River Sites, Arizona

	Sampling Sites[1]			
	BS-4	BS-8b	BS-9	BS-10a
General Metrics[2]				
Total Abundance (# / ft^2)	35	13	63	206
Total Number of Taxa	14	7	11	19
# EPT Taxa	1	2	1	1
% EPT Taxa	11.4	61.5	4.8	1.3
% Dominant Taxon	34.3	53.8	66.0	67.2
% Chironomidae		2.6	2.1	3.2
EPT/Chironomidae Ratio	---	24.00	2.25	0.40
Diversity Indices				
Shannon (H)	2.75	1.90	1.88	2.09
Evenness (e)	0.64	0.57	0.36	0.26
Biotic Indices				
HBI	7.2	4.9	5.0	5.4
CTQ	99.1	78.6	105.1	78.5
% Composition Per Order				
Ephemeroptera	11.4	61.5	4.8	1.3
Plecoptera	0.0	0.0	0.0	0.0
Trichoptera	0.0	0.0	0.0	0.0
Odonata	35.2	5.1	2.7	8.7
Diptera	8.6	2.6	3.2	3.2
Coleoptera	0.0	0.0	1.6	78.2
Hemiptera	1.0	0.0	0.0	0.6
Miscellaneous Taxa	39.0	2.6	87.8	7.9

Notes:

[1] For sample site locations, refer to Map 1. Sample dates: BS-4=6-15-00, BS-8b=7-13-00, BS-9=6-16-00, BS-10a=7-13-00.

[2] Refer to the methods section for definitions of metrics.

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APPENDIX A
PREVIOUS FISH SURVEY DATA ON THE BIG SANDY RIVER, 1977 - 1997

NATIVE FISH SURVEYS OF THE BIG SANDY, HASSAYAMPA, AND SANTA MARIA RIVER DRAINAGES

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Technical Report
Fisheries Region III
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Kingman, Arizona 86401

January 1997

Background

The Bureau of Land Management (BLM) conducted intensive fishery surveys of the Big Sandy, Santa Maria and Hassayampa River Drainages in 1979-80 (Kepner 1979-1980). Since that time, fishery investigations of these rivers have been sporadic, and although many of the survey sites used by BLM coincide with those used by Arizona Game and Fish Department Region III, a complete sampling within one year has not been performed. This study was initiated to replicate the BLM surveys for each of these streams for comparative data. Roundtail chub (Gila robusta), a species of special concern in Arizona, were evaluated and their distribution within each drainage compared to BLM's data. Findings may support or refute future proposals to list the roundtail chub as a threatened or endangered species within Arizona.

Methods

A total of 35 sites on 10 streams were surveyed (see attached map) and results compared to sites within the same ¼ section as previously sampled by the BLM in 1979-80 (Table 1). A minimum 18.27m (60 ft.) reach within each site was sampled to duplicate the BLM's relative effort. Sites were classified as either pool, riffle or run (Appendix A). Substrate type was classified from a visual approximation following the modified Cummins (1962) and Hynes (1970) classification used by BLM (Table 2). Fish were collected using a backpack electroshocker and three seines, including a 1.82m x 1.21m straight seine (.32 cm mesh), a 6.09m x 1.82m bag seine (.32 cm mesh) and a 13.70m x 1.82m bag seine of .64 cm mesh with a .32 cm mesh bag. Fish distribution and relative density was determined for native and nonnative fish species and was expressed as catch per unit of effort which was calculated based on the number of fish per 60 seconds of active electrofishing time and number of fish per area seined (expressed in square meters).

Results

Big Sandy River: Nine sites were sampled on October 8 and 9, 1996 beginning at 584.77m in elevation and ending at 359.39m. Five of these sites were dry. The four sites containing water were comprised mainly of run and riffle habitat types with few pools. Substrate was comprised entirely of sand. A total of 73.09m of stream was sampled during 943 seconds of active electrofishing time. One scheduled site was not sampled due to private property access denial.

Fishes: Two species of fish were collected at the four sites surveyed (Table 3). Longfin dace (Agosia chrysogaster) was the most abundant species collected followed by mosquitofish (Gambusia affinis). Site specific data are located in Appendix C.

Table 1. Fish Survey Sites on the Big Sandy, Santa Maria, and Hassayampa River Drainages, 1979-80 and 1996.

Stream	Township	Range	Section	1/4 Section	Elevation	
Big Sandy River	16	13	26	NW	1920	AG+FD ~~14~~ 1
Big Sandy River	15	13	11	NE	1800	AG+FD ~~15~~ 2
Big Sandy River	15	13	13	NE	1780	AG+FD ~~16~~ 3
Big Sandy River	15	13	25	NE	1720	AG+FD ~~17~~ 4
Big Sandy River*	14	13	12	SW	1580	AG+FD ~~18~~ 5
Big Sandy River*	14	13	26	NW	1480	AG+FD ~~19~~ 6
Big Sandy River*	13	13	16	SE	1400	AG+FD ~~20~~ 7
Big Sandy River*	12	13	11	NW	1230	AG+FD ~~21~~ 8
Big Sandy River*	12	12	32	NE	1180	AG+FD ~~22~~ 9
Blind Indian Creek*	11	2	31	SE	3580	
Cottonwood Canyon*	13	5	7	SE	3685	
Hassayampa River*	12	3	14	NW	4115	
Hassayampa River*	12	3	22	NE	4035	
Hassayampa River*	12	3	33	NE	3900	
Hassayampa River	11	3	9	NE	3740	
Kirkland Creek	13	6	9	SE	3490	
Kirkland Creek	14	7	36	SE	3180	
Kirkland Creek	14	7	34	NE	2695	
Milk Creek*	11	3	36	NW	3530	
Minnehaha Creek*	10	3	24	NW	3315	
Santa Maria River	13	8	11	SW	2240	
Santa Maria River	13	8	21	NW	2160	
Santa Maria River	13	8	30	SW	2120	
Santa Maria River	13	9	35	NE	1960	
Santa Maria River	12	9	10	SE	1800	
Santa Maria River	12	9	28	NW	1720	
Santa Maria River*	12	10	36	NW	1540	
Santa Maria River*	11	10	5	SW	1440	
Santa Maria River*	11	10	7	SW	1380	
Santa Maria River*	11	11	14	SW	1320	
Santa Maria River	11	11	17	NE	1280	
Sycamore Creek*	14	7	21	SE	2640	
Trout Creek	19	12	35	NW	3200	
Trout Creek	18	13	13	NW	2500	
Trout Creek	18	13	23	SE	2440	

* Denotes sites that were found to be DRY during 1996 survey efforts

Table 2. Substrate Particle Size Classification[1]

Substrate Type	Particle Size (range in mm)
Sapropel	Reduced organic sediment
Detritus	Organic particulate matter
Clay	< 0.004
Silt	0.004 - 0.063
Sand	0.063 - 2.0
Gravel	2.0 - 64.0
Cobble	64.0 - 152.0
Rubble	152.0 - 305.0
Boulder	> 305.0
Bedrock	Exposed solid rock mass

1 = Modified from Cummins (1962) and Hynes (1970)

Table 3. Fish species collected, percent relative abundance, and catch per unit effort for surveys of the Big Sandy River, October 1996.

Species	Number Collected	Relative Abundance %	Catch Per Unit Effort (total effort = 943 seconds)
Longfin Dace	265	82.3	16.86
Mosquitofish	57	17.7	3.62
Total	322	100	20.48

Hassayampa River: Four sites were sampled on the Hassayampa river on August 8, 1996 beginning at an elevation of 1253.29m and ending at 1139.08m. Of the four sites surveyed, only 1 site contained water. This site was a shallow, narrow riffle. Substrate consisted of gravel and sand. An 18.27m section was electrofished for 237 seconds.

Fishes: Only longfin dace were collected at this site (Table 4).

Table 4. Fish species collected, percent relative abundance, and catch per unit effort for surveys of the Hassayampa River, August 1996.

Species	Number Collected	Relative Abundance %	Catch Per Unit Effort (total effort = 237 seconds)
Longfin Dace	33	100	8.35
Total	33	100	8.35

Kirkland Creek: Three sites were surveyed on Kirkland Creek on September 17 and 18, 1996 beginning at an elevation of 1062.94m and ending at 804.06m. Kirkland Creek is a tributary to the Santa Maria River and was comprised mainly of run habitat with some riffle areas. No pools were sampled. Substrate consisted of cobble and cobble embedded with sand. A total of 54.82m of stream was electrofished for 1906 seconds. Two scheduled sites were not sampled due to private property access denial.

Fishes: Four species of fish were collected representing two Families (Table 5). Longfin dace were the most abundant species collected followed by green sunfish (Lepomis cyanellus). Red shiners (Cyprinella lutrensis) were the least common species collected. Site specific data are located in Appendix C.

Comparisons to BLM Findings From 1979-80.

BIG SANDY RIVER

Big Sandy River survey data collected by the BLM in 1979-80 included 8 fish species representing 4 families. Native fish collected were longfin dace, roundtail chub, and Sonora sucker. Nonnative fishes collected were carp (Cyprinus carpio), red shiner, green sunfish, yellow bullhead (Ameiurus natalis), and black bullhead. Native fish comprised 57.8% of the total fishes collected.

Comparatively, our surveys did not detect several species previously collected by the BLM, including native roundtail chub and Sonora sucker. Native longfin dace and nonnative mosquitofish were the only two species collected. Native longfin dace made up 83.1% of all fish collected. A species occurrence comparison table is located in Appendix B.

The decrease in species diversity is most likely due to drought conditions present in the region. Many sites were dry and the stream was intermittent throughout its length. During our survey, suitable habitat was lacking for many of the fishes collected by BLM. Flows were intermittent and depths shallow at most sites. The lack of roundtail chub is of some concern, however, their presence in Trout Creek (a major tributary to the Big Sandy) is encouraging. During wetter years, distribution of roundtail chub may expand throughout the drainage.

HASSAYAMPA RIVER

Hassayampa River fish survey data collected by the BLM in 1979-80 included 3 species representing 2 families. Native fish collected were longfin dace, and desert sucker. Nonnative fishes collected were fathead minnow (Pimephales promelas). No roundtail chub were collected. Native fish made up 99.9% of the total fishes collected.

Comparatively, during our surveys only native longfin dace were collected. Our surveys did not detect the presence of desert sucker and fathead minnow. This decline in species diversity could be the result of several factors. First, the BLM surveyed a total of 26 sites on the Hassayampa River compared to only four that fell within our geographical area of investigation. Second, drought conditions that have been persistent in recent years have caused severe reductions in surface flow in many streams. Only one of four sites surveyed had water. No roundtail chub were collected. A species occurrence comparison table is located in Appendix B.

HASSAYAMPA TRIBUTARIES

Blind Indian, Milk, and Minnehaha Creek data were not represented separately by the BLM in 1979-80 reports. Any fish collected in these streams were included into the Hassayampa River mainstem.

Our surveys were limited to one site on each of the three streams. All sites were dry and from visual observations it appeared that no portions of these streams were watered within at least ¼ mile in each direction.

and intermittent, but sufficient enough to sustain fishes. Roundtail chub appear to be thriving in the system, however, continued monitoring is recommended to ensure that adequate recruitment for self-sustaining populations is occurring. A species occurrence comparison table is located in Appendix B.

TROUT CREEK

Trout creek fish survey data collected by the BLM in 1979-80 included 7 species representing 4 families. Native fish collected were longfin dace, roundtail chub, speckled dace (Rhinichthys osculus), desert sucker, and Sonora sucker. Nonnative fishes collected were green sunfish and black bullhead. Native fish made up 98.9% of the total fishes collected.

Comparatively, our survey showed similar species assemblages as seen by the BLM. However, red shiner which was not previously collected during BLM survey efforts, showed up in our surveys. Native fishes made up 69.9% of the total fishes collected. Stream flow was good and diverse habitat was present. Roundtail chub appear to be doing well, however, continued monitoring is encouraged to determine if sufficient recruitment is occurring to sustain a viable population within the drainage. Nonnative fish numbers appear to be on the rise. This is most likely due to competitive factors. A species occurrence comparison table is located in Appendix B.

CONCLUSIONS

On all streams surveyed the percentage of nonnative fishes appears to be on the rise. Red shiner, fathead minnow, yellow bullhead, and mosquitofish were all seen in stream sections where they were not previously encountered. The exception was the Hassayampa River where only native longfin dace were collected. The percentage of native fishes appears to be decreasing in each system as well. Roundtail chub collections appear similar to BLM findings in the Santa Maria River. Numbers of roundtail chub collected were lower for Trout Creek, and no roundtail chub were collected in either the Big Sandy River or Kirkland Creek.

It is important to note that only 3 roundtail chub were collected by the BLM in 1979-80 from 12 sites in Kirkland Creek. No roundtail chub were collected in the Hassayampa River by the BLM or during our survey efforts.

Due to the lack of site specific BLM survey data, it is difficult to directly compare our survey results with the BLM's. It is possible that the BLM collected fish at sites not surveyed during our efforts due to our geographic area of consideration and denial of access to private lands.

Recommendations

These streams are all small and remote in nature. The potential of a viable nonnative sport fishery being developed in any of these streams is minimal. Although nonnatives are becoming more established in each system, they are not found in numbers or sizes to accommodate a recreational fishery. Green sunfish and bullhead catfish are the two nonnative sportfish predominate in these streams. The dynamic nature of desert streams and the frequency of flash flood events tend to keep these and other nonnative fish populations in check. These streams should be maintained as native fisheries. Angling for roundtail chub should not be discouraged as these native fishes may be found in sizes large enough to accommodate some angling effort. Introductions of nonnative fishes should be discouraged.

Because of the delicate nature of these streams and the ever present factor of drought, it is important that instream flows be maintained. Diversions, impoundments and groundwater withdrawals should be discouraged. Changes in flow regime are likely to result in altered physicochemical water quality and replacement of native fishes with lentic-adapted introduced species (Kepner 1980). Water rights issues are often complex when dealing with small streams of this nature. Plans are to research water rights for these streams in the next year. This information will help to determine where progress may be made in sustaining instream flows for these and other streams in the region.

Current drought conditions have caused reductions in surface water flows in several streams in the region. We would recommend the re-surveying of these streams within 3 to 5 years. This may help to represent more "normal" precipitation and climate trends, and give biologists a better understanding of the population dynamics with relation to weather patterns.

It is important that these streams continue to be monitored in order to determine changes in the native fish community. Roundtail chub numbers appear to be holding their own, however the increasing trend towards nonnative fishes may have an impact.

Appendix A. Percent pool, riffle, and run for each site surveyed.

Stream	Site	Pool	Riffle	Run
Big Sandy River	1	10	0	90
	2	0	25	75
	3	0	50	50
	4	0	50	50
	5 DRY	0	0	0
	6 DRY	0	0	0
	7 DRY	0	0	0
	8 DRY	0	0	0
	9 DRY	0	0	0
Blind Indian Creek	1 DRY	0	0	0
Cottonwood Canyon	1 DRY	0	0	0
Hassayampa River	1 DRY	0	0	0
	2 DRY	0	0	0
	3 DRY	0	0	0
	4	0	100	0
Kirkland Creek	1	0	40	60
	2	0	30	70
	3	0	0	100
Milk Creek	1 DRY	0	0	0
Minnehaha Creek	1 DRY	0	0	0
Santa Maria River	1	0	20	80
	2	0	50	50
	3	60	40	0
	4	0	20	80
	5	20	40	40
	6	80	0	20
	7 DRY	0	0	0
	8 DRY	0	0	0
	9 DRY	0	0	0
	10 DRY	0	0	0
	11	100	0	0
Sycamore Creek	1 DRY	0	0	0
Trout Creek	1	20	10	70
	2	0	10	90
	3	0	50	50

Appendix B. Species occurrence comparing BLM surveys of 1979-80 and our 1996 surveys.

Species	Big Sandy 79-80	Big Sandy 96	Hassayampa 79-80	Hassayampa 96	Kirkland 79-80	Kirkland 96	Santa Maria 79-80	Santa Maria 96	Trout 79-80	Trout 96
Longfin Dace	X	X	X	X	X	X	X	X	X	X
Roundtail Chub	X				X		X	X	X	X
Red Shiner	X					X	X			X
Fathead Minnow			X			X		X		
Speckled Dace									X	X
Green Sunfish	X				X	X	X	X	X	X
Desert Sucker			X		X		X	X	X	X
Sonora Sucker	X				X		X	X	X	X
Black Bullhead	X				X				X	X
Yellow Bullhead	X						X			
Carp	X									
Mosquitofish		X						X		

Appendix C. Fish survey data by site for the Big Sandy River, Hassayampa River, Kirkland Creek, Trout Creek, and the Santa Maria River.

Big Sandy River

Site	Elevation (ft.)	Species	Number	Comments
1	1920	**Longfin Dace** Mosquitofish	91 40	Run area with large pool in front of culvert road crossing.
2	1860	--	--	Private Property. Access denied
3	1800	**Longfin Dace**	107	2-3 ft. wide run section.
4	1780	0	0	Water present but no fish collected. Water stagnant.
5	1720	**Longfin Dace** Mosquitofish	67 17	4-5 ft. wide run section.
6	1580	0	0	DRY
7	1480	0	0	DRY
8	1400	0	0	DRY
9	1230	0	0	DRY
10	1180	0	0	DRY

Bold = Native Fishes

Hassayampa River

Site	Elevation (ft.)	Species	Number	Comments
1	4115	0	0	DRY
2	4035	0	0	DRY
3	3900	0	0	DRY
4	3740	**Longfin Dace**	33	Stream 20 inches wide 1-3 inches deep riffle

Bold = Native Fishes

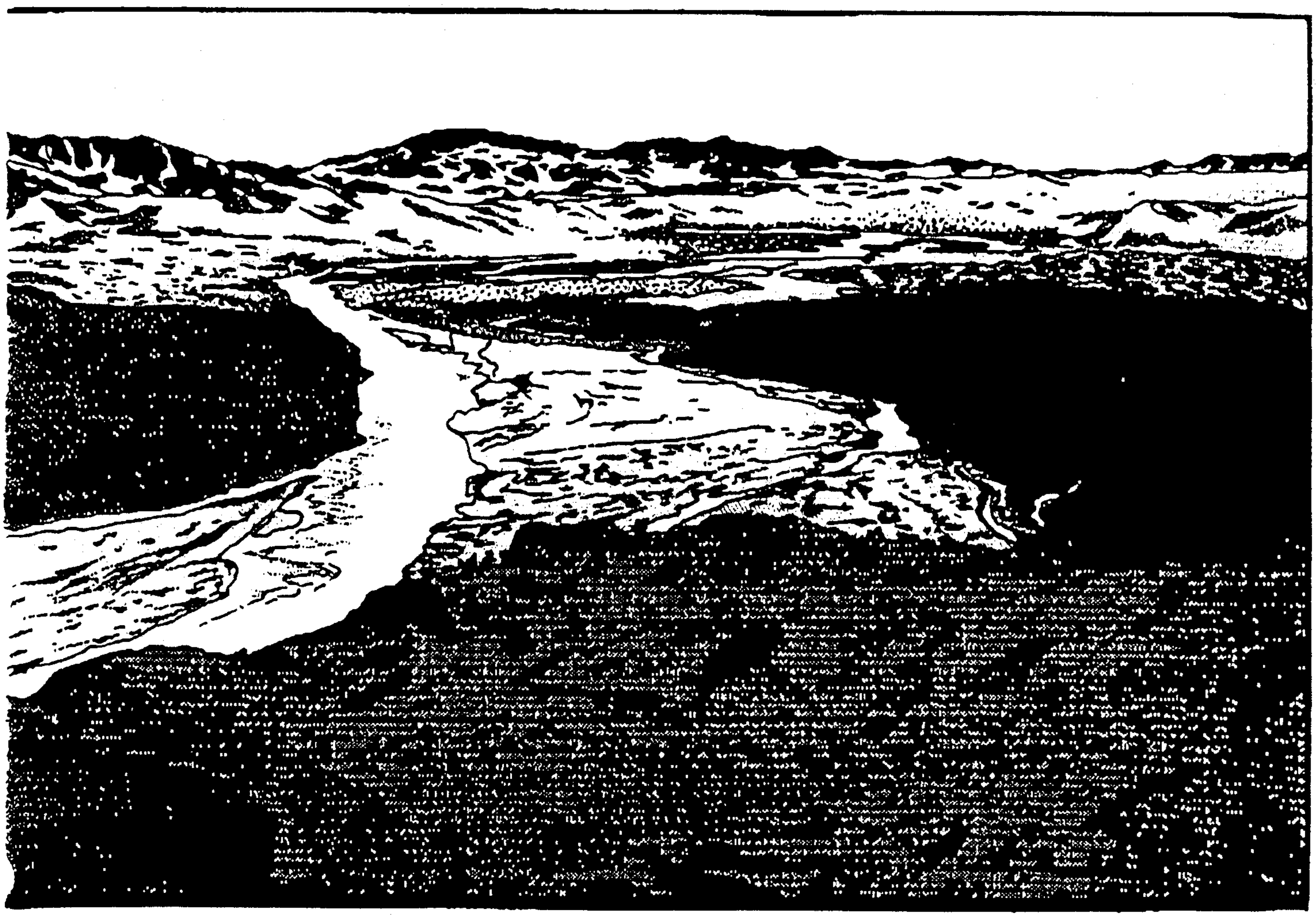
TECHNICAL NOTE 352

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

AQUATIC INVENTORY OF THE UPPER BILL WILLIAMS DRAINAGE

YAVAPAI AND MOHAVE COUNTIES , ARIZONA

by WILLIAM G. KEPNER



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METHODS

A total of 64 stations was sampled on 3 major watersheds between December 1978 and February 1979. Each of the watersheds, Santa Maria River, Burro Creek, and Big Sandy River, was distinctive, and data are separately presented. Legal descriptions of sampling sites are included in Appendix 1. More than 168 stream-miles were surveyed, with sampling stations positioned at roughly equivalent, 2.5-mile intervals along each watercourse, depending on access. Stations were designated on U.S. Geological Survey (USGS) topographic maps prior to field investigations, to eliminate bias, and included federal, state, and private lands due to multi-ownership status of the planning units. Each station was sampled through a 60-ft. reach to insure uniformity in sampling, and was subsequently classified as either a pool, run, or riffle using the following criteria:

- pool - deeper, placid, and slower-moving section of a stream;
- run - shallow trough, generally sand and/or gravel substrate, smooth laminar flow of slow to moderate velocity (intermediate between a pool and a riffle);
- riffle - shallow waters with moderate to high velocity but not necessarily high discharge, flow more turbulent, generally pebble, cobble, or larger substrate.

Instantaneous discharges were estimated using the Embody (1927) cork-float method, for which width, stream velocities, and depths are obtained, the last two at selected intervals across the station. A visual approximation of substrate types was categorized following Hynes (1970) and stream gradients were estimated through use of an Abney level. Description of the riparian vegetation types (Brown and Lowe, 1974a and 1974b; Brown, *et al*. 1979) and condition was recorded for each transect in addition to a narrative for adjacent, non-riparian climax communities. Any land use impacts, *e.g*. livestock grazing or mining operations, were added to the reach description. Field notes and maps are on file at the Phoenix District Office of BLM.

Water quality was monitored at each station through use of Hach Model CA-10WR and NI-12 field test kits; water temperatures were measured with a pocket thermometer (°F). Chemical parameters included dissolved oxygen (DO, mg/l), carbon dioxide (CO_2, mg/l), hydrogen-ion concentration (pH), and nitrate-nitrogen (NO_3^--N, mg/l). In addition, water samples from selected stations were analyzed at the Water Quality Branch (Fisheries Management Division) of the Arizona Game and Fish Department for chloride (Cl^- mg/l), hardness (as $CaCO_3$ mg/l), ammonia (NH_4^+ mg/l), phosphate-phosphorus ($PO_4^=$-P mg/l), sulfate ($SO_4^=$ mg/l), turbidity

(Jackson Turbidity Units [JTU]), and total dissolved solids (TDS). Other information with regards to water quality was obtained from monthly sampling by the USGS under contract with the Arizona State Office of BLM.

Macrofaunal sampling of benthic communities was undertaken to define associations of macroinvertebrate species in each watershed. The sampling approach was not intended to meet statistical requirements for quantification, but rather to identify trends in distribution and diversity with inference to environmental stresses or quality. Wherever possible, specimens were identified to the species level (Appendix 2).

Fish were collected by 115 volt, A.C., backpack electrofishing equipment and 1/8-inch mesh seines. Specimens were preserved in 10% formalin and later transferred to 50% isopropanol. Identifications followed Minckley (1973); all specimens were deposited in the Collection of Fishes, Arizona State University, Tempe.

Big Sandy River

Description.

The Big Sandy River originates at the confluence of Knight and Trout creeks approximately 16.5 miles north of Wikieup, Arizona. It flows 37.8 miles south from an elevation of 2,420 ft. before entering Alamo Lake at 1,170 ft. The Big Sandy drainage is normally perennial below Wikieup and throughout Trout Creek, its major upper tributary. Trout and Knight creeks drain the Aquarius Mountains and the north half of the Mohon Mountains; Burro Creek drains the mesas to the east. The total drainage area, excluding the Burro Creek watershed, is estimated at 2,123 square miles (pers. comm., Paul Rohne, Jr., USGS, Phoenix District Files).

The Big Sandy River is in a broad, alluvial valley between granitic mountain blocks. It is almost totally accessible via U.S. Highway 93 or maintained county roads, except at the lower reaches below the old townsite of Signal. The valley fill consists of deep, loosely consolidated, mixed alluvia that are well sorted and nearly level to gently sloping within the floodplain. Mean annual precipitation is 6 to 10 in. and the mean air temperature varies between 56 and 67°F (Richmond and Richardson, 1974).

Trout Creek is similar to Burro Creek, having incised Precambrian granitic gneiss and recent Tertiary volcanics. Topography is rugged and characterized by moderate to steep slopes, deeply cut narrow canyons, and shallow well-drained soils over granitic hills and mountains. Rock outcroppings are common and access is restricted. Mean annual precipitation is 8 to 12 in. (Richmond and Richardson, 1974), and supports desertscrub vegetation typical of the low desert hillsides, e.g. palo verde and saguaro. Riparian vegetation is mostly grouped stands of either cottonwood or Goodding willow, with a seep willow understory.

Trout Creek is much narrower and deeper than the Big Sandy River and a much more heterogeneous system for aquatic life (Table 8). Riffles, runs, and pools are well represented, providing a diversity of habitats. Banks are often cut, but stable, and stream substrate varies from cobble/gravel bottoms to small boulders. Trout Creek lacks a streamflow gauge and discharge data are largely unavailable, however Davidson (1973) reports average discharge near its confluence with Knight Creek may be as much as 3 $ft.^3$/sec. or approximately 2,000 acre-ft./yr. Stream velocities recorded during the present study averaged 2.5 ft./sec. (range 1.9 to 3.3 ft./sec.).

In contrast, the Big Sandy River is characterized by lower gradient and is essentially a broad, shallow, sandy run with no pools or riffles. Average width was 183.9 ft. (range 98.8 to 347.5 ft.) with mean depth and gradient 4.5 in. (range 1.25 to 10.0 in.) and 0.45° (range 0.2 to 0.6°), respectively. Flow was swift and laminar during the study period, averaging 2.2 ft./sec. (range 1.6 to 4.7 ft./sec.). In an 11-year period from 1966 to 1977, average discharge recorded at USGS gaging station No. 4244.5 (located 15 miles upstream from the confluence of the Big Sandy and Santa Maria rivers and 17 miles south of Wikieup) was 45.9 $ft.^3$/sec. or 33,250 acre-ft./yr.

The drainage is subject to spates, with the highest measured discharge, 35,000 $ft.^3/sec.$, recorded in March 1978.

Substrate in the Big Sandy River was characterized by loosely consolidated sand of uniform particle size. Stream sediments were continually shifting over the bottom and the water remained visibly turbid. Banks usually consisted of mixed particle sizes, but were dominated by sand which was stabilized by rooted trees, shrubs, and grasses. In other areas, the channel has been widened and deeply scoured by floodwaters, and banks have been cut up to 15 ft. in vertical height (Davidson, 1973). Cut and undercut banks with overhanging vegetation or flood debris were common throughout the drainage and provide cover for aquatic organisms.

Riparian vegetation near Wikieup was typically dominated by dense thickets of mesquite and tamarisk, with a scattering of cottonwood and Goodding willow. Mesquite and tamarisk stands became thinner downstream where banks were heavily vegetated by arrow-weed (Tessaria sericea), seep willow, and burro brush.

Mature stands of tamarisk have invaded and displaced many native riparian species of the Big Sandy floodplain. Tamarisk was introduced into the United States during the 1820s (Horton, 1964) as an ornamental, but quickly escaped cultivation and has become established around reservoirs and along most streams and rivers in the arid Southwest. It can survive long periods of inundation and is a prolific seed producer (Warren and Turner, 1975). Seeds are produced biseasonally in Arizona (Horton, 1957; Horton and Flood, 1962; Warren and Turner, 1975) and readily germinate within 24 hours after imbibing water (Reynolds and Alexander, 1974). Its current status along the Big Sandy appears orientated towards an advanced successional stage and the trend, historically, has been the establishment of a disclimax community.

Non-riparian vegetation adjacent to the Big Sandy River includes microphyllous trees and shrubs with numerous cacti. Palo verde, saguaro, and creosote bush were the most frequently encountered desertscrub species associated with foothills, but other species, e.g. buckhorn cholla and teddy bear cholla, were also common.

Water Quality.

Water quality in Trout Creek and the Big Sandy River was acceptable for good aquatic production (Tables 8 and 9). Water quality parameters met or exceeded state and federal surface water standards of the AWQCC and EPA with few exceptions. Fecal coliform counts from the Big Sandy varied above and below the state standard (200/100 ml) during a 1977 to 1978 sampling by USGS, Phoenix; the mean was 120/100 ml. Total $PO_4^{=}$-P levels in both the Big Sandy and Trout Creek were above the EPA (1977a) standard. The source of elevated $PO_4^{=}$-P is probably particulate materials derived from runoff over Tertiary basalts of the headwaters, plus ionization of bound forms which may enter the system, as occurred elsewhere in the upper Bill Williams basin.

The Big Sandy River lacked large standing crops of aquatic macrophytes and algae so that orthophosphates were not taken up and assimilated from the system. DO values in the Big Sandy were high (9 to 11 mg/l) and stable, and waters were hard (mean 880 mg/l as $CaCO_3$) and alkaline (pH = 8.5). Ca^{++}, Mg^{++}, and HCO_3^- were the dominant dissolved ions, and total dissolved solids (mean 592 mg/l) and fluoride concentrations (mean 1.2 mg/l) were typically high (USGS, Phoenix, Contract No. YA-515-IA7-41, 1977/1978). Water temperatures were suitable for aquatic life but should be expected to increase in summer, with pronounced variation occurring in some areas where riparian vegetation was totally lacking. Trout Creek is subject to canyon shading which may help ameliorate summer water temperatures.

It is not known what affect withdrawal of water from the 12 wells located along the Big Sandy may have on water quality or quantity of that system. The wells are owned and operated by the Cyprus-Bagdad mining company. A series of five pumps move water through a single pipeline to the mine. Each is capable of pumping 1,400 gallons per minute, but their operation is variable depending upon demand. Substantial withdrawals are capable of reducing instream flows, thus increasing conductivity and total dissolved solids from a lack of dilution by surface waters. Other risks include reduction or elimination of the riparian vegetation in areas where the water table is drawn down.

Macroinvertebrates.

Macroinvertebrates of the Big Sandy River mainstream were similar to those present in the Santa Maria River (Appendix 3). There were no riffles, and bottoms were swept clean by shifting sand particles. The invertebrate fauna reflected the instability of the aquatic habitat and the influx of catastrophic drift. Much of the diversity and abundance indicated for the Big Sandy macroinvertebrate community was a result of collections from quiet backwater areas near Wikieup or, primarily, as downstream drift from productive upstream tributaries (Trout and Burro creeks).

Only 18 taxa were collected from Trout Creek but more than 35 taxa were taken from the Big Sandy River where the dominant species included the odonate, Progomphus borealis, the hydrophilid, Tropisternus ellipticus, and the naucorid, Ambrysus cf. puncticollis. Many species, e.g. Baetis sp., Mesocapnia frisoni, Hydropsyche sp., Corydalus cognata, and Ambrysus spp., were present only as result of catastrophic drift during spates, particularly from Burro Creek, and would not be expected to occur in the Big Sandy River under low flow conditions.

Progomphus borealis was typically collected in sandy runs throughout the watershed. Eleven other odonates including two members of the suborder Zygoptera (damselflies), Enallagma praevarum and Ischnura barberi, were taken from backwaters connected to the mainstream of the Big Sandy. Such lentic areas offer refuge against spates and predation by fishes and supported some of the most productive and diverse invertebrate populations in the basin.

Table 9. CHEMICAL/PHYSICAL DATA FOR THE BIG SANDY RIVER, ARIZONA; MEANS FOLLOWED BY RANGES (IN PARENTHESES).*

Drainage area ($mi.^2$)**	2,123.0	
Mean width (ft.)	183.9	(98.8 - 347.5)
Mean depth (in.)	4.5	(1.25 - 10)
Mean stream gradient	0.45°	(0.2 - 0.6°)
Mean stream velocity (ft./sec.)	2.2	(1.6 - 4.7)
Mean discharge ($ft.^3$/sec.) ***	45.9	(0 - 35,000)
Total Dissolved Solids (TDS), mg/l	413	(370 - 500)
Total Hardness, mg/l as $CaCO_3$	880	(560 - 1180)
Water Temperature, °F	59	(44 - 71)
pH	8.5	(8.5)
Dissolved Oxygen (DO), mg/l	10	(9 - 11)
Carbon Dioxide (CO_2), mg/l	15	(10 - 15)
Ammonia (NH_4^+), mg/l	1.45	(0.7 - 2.12)
Nitrate-nitrogen (NO_3^--N), mg/l	2.7	(2.0 - 3.0)
Total Phosphate ($PO_4^=$-P), mg/l	2.68	(1.94 - 3.7)
Sulfate ($SO_4^=$), mg/l	67	(52 - 80)
Chloride (Cl^-), mg/l	47.3	(35.5 - 71.0)

* Diurnal samples at 10 stations, 26 February 1979 to 6 March 1979.
** Excluding Burro Creek watershed.
*** USGS water resources data for record period, March 1966 to 1977.

Adult Tropisternus ellipticus were abundant throughout the Big Sandy along the cut banks, and were found in shallow waters among the aquatic macrophytes and flood debris. Their distribution largely reflects their food habits, adults being herbivores and/or detritivores. Tropisternus adults and larvae are important food sources for certain ducks, which prey upon them heavily, and other aquatic birds. They are also utilized by fish, frogs, and toads as diet items (Usinger, 1956).

The dominant ephemeropteran was Callibaetis sp., a baetid mayfly typical of still or slow-moving waters. They exhibit a wide range of physico-chemical tolerances and were typically found clinging to vegetation in the backwater areas of the Big Sandy. The nymphs are herbivorous, feeding primarily on diatoms and other algae.

Ambrysus is the dominant naucorid hemipteran genus in the western United States. Ambrysus cf. puncticollis is common in the Southwest, and in Arizona is previously known from the Colorado River drainage (LaRivers, 1951). It is relatively large in size and a voracious predator that feeds on aquatic insect larvae. Under normal circumstances, Ambrysus is found in small eddies or areas of broken flow and in well-oxygenated waters with rocky, cobble bottoms. Its dominance in the lower reaches of the Big Sandy River, in habitats not typical for the species, is clearly the result of catastrophic drift from Burro Creek.

Excluding the productive backwaters, macroinvertebrate populations of the Big Sandy were depauperate with little diversity. Terrestrial drift from the dense mesquite/tamarisk stands near Wikieup was, however, relatively high, and contributed significantly to the available prey-base for the fishes, depending on season.

Ichthyofauna.

Seven species of fishes representing four families were collected from Trout Creek (Table 10). This is the first record from that stream for introduced species, green sunfish and black bullhead. Fishes in Trout Creek were distributed similarly as those in Burro Creek, with upper reaches exclusively occupied by native species and introduced forms inhabiting the lower reaches above the confluence with the Big Sandy. All seven species were collected at the mouth of Trout Creek, but longfin dace was clearly dominant, comprising 65.6% of the total. Roundtail chub was the second-most abundant species in Trout Creek, accounting for 12.9% of the total fishes collected. Roundtail chubs dominated upper reaches of Trout Creek and occupied similar habitats to those in Burro Creek. Although Trout Creek has no salmonid populations, roundtail chubs are frequently called "Verde trout" by local residents and are probably responsible for the name of the stream. The two native suckers, and speckled dace, were present in substantial numbers throughout Trout Creek. Hybrids, Catostomus insignis x Pantosteus clarki, have previously been taken in the drainage (Arizona State University, Museum of Fishes, Catalogue No. 2357), but were not collected in the current study.

Four families and eight species of fishes were collected from the Big Sandy River (Table 10). This represents seven species more than indicated by previous museum records (Arizona Game and Fish Department, Phoenix). All former collections were made at or near Wikieup, where longfin dace predominate. Additions are probably the result of outflow from perennial tributaries to the Big Sandy during flood stages, especially Burro Creek, and they may well disappear in other than the wettest years.

Only 3 of the 8 species are native to the drainage, Agosia chrysogaster, Catostomus insignis, and Gila r. robusta, with the remaining introduced species representing elements of sport fishery or bait bucket transfers. As with Trout Creek, no member of the ichthyofauna is protected under federal or state listings for threatened, endangered, or sensitive species.

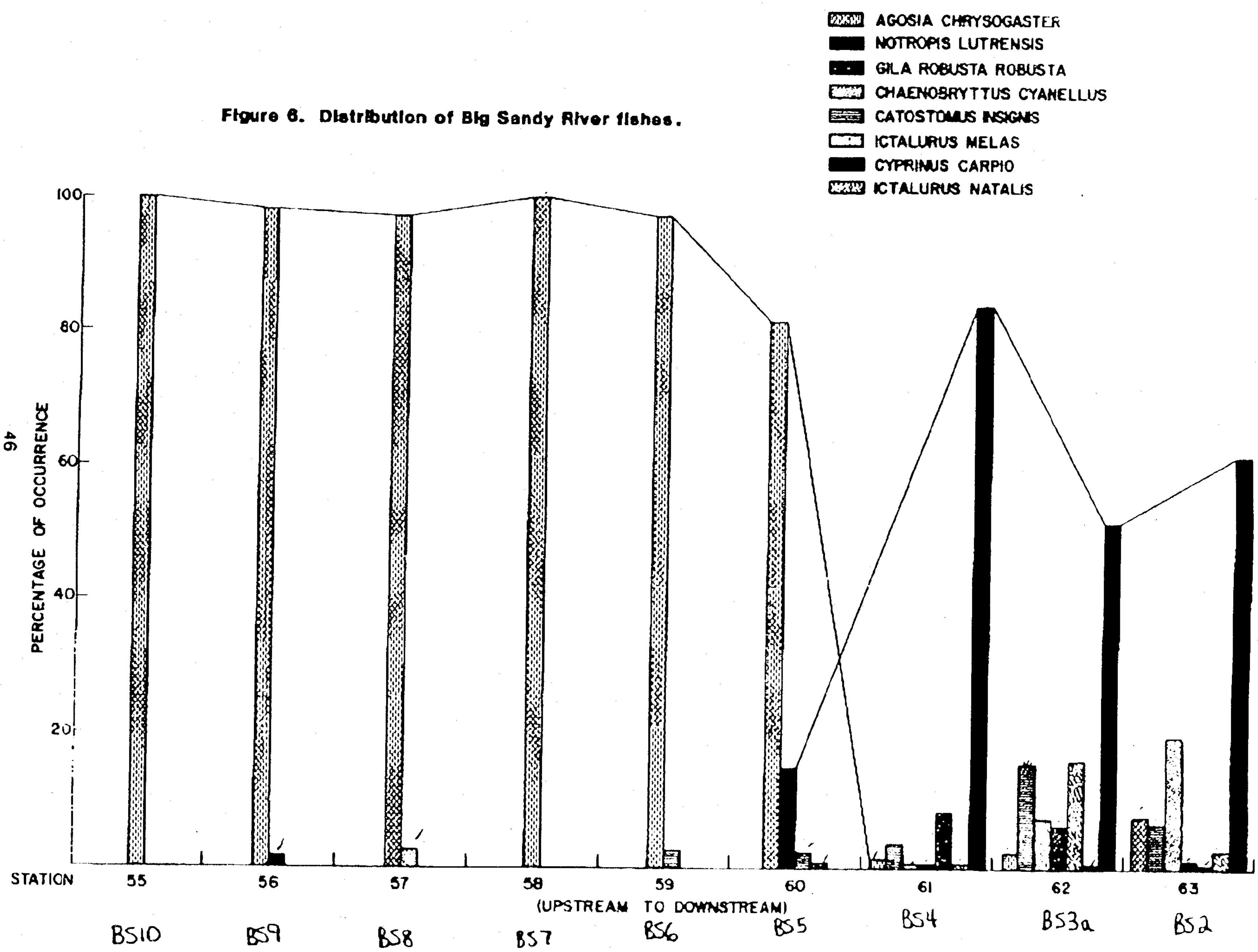
Longfin dace were the most abundant species in the Big Sandy River, accounting for 50.5% of the total samples. They occurred at every station and were associated with cut banks where cover was provided by overhanging vegetation, or were in open water, presumably foraging on the invertebrates associated with drift. Total lengths ranged between 26 and 88 mm., indicating the presence of more than one year class. Males were frequently collected in breeding condition, with nuptial tubercles present on the head, operculum, and all fins except the caudal. Females were distended posteriorly, presumably gravid with ova. Longfin dace were dominant at all upper stations above the confluence of Burro Creek and represented more than 89% of all fishes collected there (Figure 6). Its numbers declined precipitously after the confluence with Burro Creek, representing only 4.1% of the total samples from lower stations.

Red shiners exhibited their dominance below Burro Creek and accounted for 64% of all fishes collected from the lower reaches. Overall, red shiners were the second-most abundant species, representing 33% of the total fish caught in the Big Sandy River.

Although yellow bullhead and carp are common in Alamo Lake, diversity of the lower reaches of the Big Sandy River results from the outwash of Burro Creek populations, including native roundtail chub, during spates (Figure 6). A possible exception was Gila sucker, which occurred in the Big Sandy River at sites above the confluence. Gila suckers in the Big Sandy were not as robust or large (total length 71 to 110 mm.) as those which inhabited pools of Burro Creek, but were nevertheless, able to survive along cut banks and scoured areas where cover and organic debris were present. They typically feed on aquatic and terrestrial drift along stream margins and pool bottoms, and infrequently visit riffle areas. Schreiber (1978) reported a generalized diet of several food items, principally baetid ephemeropteran nymphs and chironomid dipterans, in Aravaipa Creek, Arizona.

No evidence of black grub, gyrodactyliasis, or ichthyophthiriasis was recorded in any of the fishes from the Big Sandy River, whereas incidence of parasitism was extremely high in native fishes of Trout Creek. Fishes in the upper reaches of the creek were plagued with heavy infestations of black grub, Uvulifer amblopiltis, and to some extent the monogenetic trematode, Gyrodactylus sp. In addition, longfin dace at the mouth of Trout Creek were

Figure 6. Distribution of Big Sandy River fishes.



Multiple-use.

Water quality in the Big Sandy River and Trout Creek was within levels outlined in the federal and state surface water standards with few exceptions. Most of the water is suitable for aquatic life and irrigation, but may be fair to objectionable for use as public drinking water due to the high concentrations of TDS and fluoride.

Standing crop of the Big Sandy ichthyofauna was reduced as compared to Trout Creek, but nevertheless was significant in areas with stable, cut banks with lush, riparian vegetative cover. The apparent lack of abundance of fishes in the Big Sandy assemblage is attributable to the lack of diversity in aquatic habitat rather than any chemical/physical parameter.

Present water usage in the Big Sandy Valley is mainly for agriculture, with significantly less water use for livestock and domestic purposes. Farming along the Big Sandy River is currently geared to produce crops which can be used by cattle. More than 3,800 acres of alfalfa, grain, and pasture are irrigated regularly from pumped ground water sources (USGS, 1977). Additional water requirements, due to changes in crop patterns or irrigation demands, are not anticipated in the area and withdrawals will probably remain at the current level. Although most surface flow is not utilized by the Big Sandy community, only 4.6 percent of the precipitation which falls within the basin leaves the area as surface and ground water flow, the remainder being lost to evapotranspiration (Davidson, 1973).

In addition to water use for domestic, agricultural, and mining purposes, the Big Sandy drainage is used by resident and migratory wildlife and for livestock grazing. Both cattle and burros graze along the drainage and damage to the vegetation from overutilization and trampling is apparent. Burros are more common near the lower reaches of the Big Sandy, above Alamo Lake, and their numbers remain unregulated.

Water consumption by wildlife may be negligible, but the drainage nevertheless represents significant habitat for herons, egrets, and shorebirds. It is also an important part of the flyway for migratory waterfowl.

The Big Sandy River receives little impact from public recreation. There are no opportunies available for swimming, wading, and fishing and there are no camping or picnicking areas. Hunting is important seasonally, but a sport fishery is nonexistent nor feasible, and is expected to remain so.

Table 10. TROUT CREEK AND BIG SANDY RIVER FISH COLLECTIONS.

	Total Length (range in mm)	Percentage of Occurrence	Total N
TROUT CREEK			
Family Cyprinidae			
Agosia chrysogaster - longfin dace *	27 - 87	65.6	315
Gila robusta robusta - roundtail chub *	38 - 131	12.9	62
Rhinichthys osculus - speckled dace *	38 - 62	7.7	37
Family Catostomidae			
Pantosteus clarki - Gila mountain-sucker *	53 - 98	7.1	34
Catostomus insignis - Gila sucker *	69 - 255	5.6	27
Family Centrarchidae			
Chaenobryttus cyanellus - green sunfish	48 - 110	0.8	4
Family Ictaluridae			
Ictalurus melas - black bullhead	191	0.2	1
			480
BIG SANDY RIVER			
Family Cyprinidae			
Agosia chrysogaster - longfin dace *	26 - 88	50.5	553
Gila robusta robusta - roundtail chub *	43 - 85	2.4	26
Notropis lutrensis - red shiner	20 - 59	33.0	361
Cyprinus carpio - carp	81 - 110	0.3	3
Family Catostomidae			
Catostomus insignis - Gila sucker *	71 - 110	4.9	54
Family Centrarchidae			
Chaenobryttus cyanellus - green sunfish	33 - 108	4.9	54
Family Ictaluridae			
Ictalurus natalis - yellow bullhead	59 - 139	3.3	36
Ictalurus melas - black bullhead	55 - 148	0.6	7
			1,094

* Native fishes

Big Sandy River

Stat. 55 Ariz., Mohave Co., T16N R13W NW¼ Sec. 26 BS10a AG+FD 1
elev. 1920', at Wikieup

Stat. 56 Ariz., Mohave Co., T16N R13W SE¼ Sec. 35 BS9
elev. 1860'

Stat. 57 Ariz., Mohave Co., T15N R13W NE¼ Sec. 11 BS8a AG+FD2
elev. 1800'

Stat. 58 Ariz., Mohave Co., T15N R13W NE¼ Sec. 13 BS7 AG+FD 3
elev. 1780'

Stat. 59 Ariz., Mohave Co., T15N R13W NE¼ Sec. 25 BS6 AG+FD 4
elev. 1720'

Stat. 60 Ariz., Mohave Co., T14N R13W SW¼ Sec. 12 BS5 AG+FD5
elev. 1580', at Signal Road

Stat. 61 Ariz., Mohave Co., T14N R13W NW¼ Sec. 26 BS4 AG+FD6
elev. 1480', below the confl. of Burro Creek

Stat. 62 Ariz., Mohave Co., T13N R13W SE¼ Sec. 16 BS3a AG+FD7
elev. 1400', at USGS Gaging Station

Stat. 63 Ariz., Mohave Co., T12N R13W NW¼ Sec. 11 BS2 AG+FD 8
elev. 1230'

Stat. 64 Ariz., Mohave Co., T12N R12W NE¼ Sec. 32 BS1 AG+FD9
elev. 1180'

Alamo Lake

Stat. 65 Ariz., Mohave Co., T11N R12W NE¼ Sec. 8
elev. 1170'

TR - ...

Arizona Game & Fish Dept. Stream Surveys - Region III

Stream	Date	Location	Species
Trout Ck.	6/14/77 AG+F01 → 1	T18N,R13W,S11	Green Sunfish, Longfin Dace, Roundtail Chub, Sonora Sucker
	AG+F02 → 2	T19N,R12W,S35	Green Sunfish, Desert Sucker, Roundtail Chub, Sonora Sucker
Trout Ck.	AG+F03 → 3 12/78 to 4 2/79 2 AG+F04 AG+F02	T18N,R13W,S23 T18N,R13W,S13 T19N,R12W,S35	Longfin Dace, Roundtail Chub, Desert Sucker, Sonora Sucker, Green Sunfish, Black Bullhead
Trout Ck.	8/5/85 3 AG+F03	T18N,R13W,S23	Longfin Dace, Green Sunfish
	AG+F05 → 5	T18N,R13W,S14	Green Sunfish, Longfin Dace, Desert Sucker, Sonora Sucker, Roundtail Chub, Black Bullhead
	AG+F02 → 2	T19N,R12W,S35	Roundtail Chub, Desert Sucker, Sonora Sucker, Longfin Dace
Trout Ck.	AG+F06 8/6/85 6	T19N,R11W,S29	Roundtail Chub, Desert Sucker, Sonora Sucker, Longfin Dace, Black Bullhead
	AG+F07 → 7	T19N,R11W,S27	Roundtail Chub, Desert Sucker, Sonora Sucker, Longfin Dace, Green Sunfish, Black Bullhead
Trout Ck.	AG+F05 10/15/88 5	T18N,R13W,S14	Sonora Sucker, Roundtail Chub, Desert Sucker, Longfin Dace, Yellow Bullhead
Trout Ck.	AG+F08 → 5/16/90 8	(New Byner Ranch Road Crossing) T18N,R12W,S4	Sonora Sucker, Desert Sucker, Roundtail Chub, Longfin Dace, Green Sunfish, Black Bullhead
? Trout Ck.	5/18-20/92	T16N,R11W,S26, 27,34,35	Sonora Sucker, Desert Sucker, Speckled Dace, Roundtail Chub

Stream	Date	Location	Species
Trout Ck. 8 AGFO8	7/21/92 8/14/92	T18N,R12W,S4 "	Desert Sucker, Sonora Sucker, Speckled Dace, Longfin Dace, Black Bullhead

Big Sandy River Stream Survey - 16 May 90

1.) Bartmus Road crossing 0900h
Agosia chrysogaster - YOY

2.) 1st road crossing upstream off Upper Trout Creek Road 0930h
Agosia chrysogaster - Adults & YOY
Catostomus insignis - YOY

Burro Creek Fishery Survey - Sept. 15-16, 1993

Species	Number	Effort (m2)	Location	
Giro	135	9 102.64	T16N, R10W, S24	SE 1/4 NE 1/4
Cain	19		(Negro Ed Quad.)	NE 1/4 SE 1/4
Rhos	5	AG+FD09		above ?? Road X'ing
Chcy Green Sunfish -	1			
Giro	90	10 96.62	T15N, R10W, S28	
Cain	89		(Grayback Mtns. Quad.)	N 1/2 NW 1/4
Agch	57	AG+FD10		below Boulder Confluence
Cyca	6			
Icme	2			
Cylu	23			
Pipr	4			
Cain	465	11 333.33	T15N, R10W, S29	
Pipr	89		(Grayback Mtns. Quad.)	SW 1/4
Icna	3	AG+FD11		above & below
Chcy	2			Mohave/Yavapai County line
Cylu	44			
Giro	229	12 66.59	T14N, R10W, S7	SW 1/4
Cain	149		(Grayback Mtns. Quad.)	above 6-mile X'ing
Agch	88	AG+FD12		
Rhos	2			
Cyca K.C.	11			
Chcy	1			
Giro	72	13 114.70	T14N, R10W, S18	
Cain	58		(Grayback Mtns. Quad.)	NW 1/4
Pacl	5	AG+FD13		below 6-mile X'ing
Agch	11			
Rhos	1			
Chcy	1			

FALL FISH COUNT DATA SHEET

Page____ of ____

SAMPLE ID # (FC####) ____________ DATE (yymmdd) 94/10/17 TIME: 1015

SITENAME BIG SANDY RIVER below WIKIEUP

QUADNAME GREENWOOD PEAK (01-03) SIGNAL MOUNTAIN (04)

TOWNSHIP AND RANGE T15N, R13W SECTION 24 SPECIFICS EFFORTS 01, 02

LOCATION:(general directions-how to get to site) Highway 93 North of Wickenburg. ≈ 2 mi past SIGNAL RD., turn West going down wash road to B.S. River

PARTICIPANTS: D. Langhorst, S. Markman, F. Mueller, B. Peck, B. Boyette

EFFORT LOCATIONS (number and where sampled at the site) Site on West side of River

EFFORT # 01 Vegetated silty run ~ .25 mi upstream of Wash (where truck parked)

EFFORT # 02 Sandy/gravel run just upstream of Wash (SE 1/4 Sec. 24)

EFFORT # 03 Eddie pool along cliff ~ 1 mi. downstream of 02 (middle of SE 1/4 Sec. 25)

EFFORT # 04 Run ~ .75 mi downstream of Stream Gauge (T. 13 N., R. 13W., NW 1/4 Sec. 21)

Effort # (same as above)	01	02	03	04
Subhabitat type (run, riffle, pool)	RUN	RUN	EDDIE POOL	RUN
Length of subhabitat (meters)	16'	16'	16'	50'
Average Width of subhabitat	3'	9.1'	8'	16'
Average Depth of subhabitat	.56'	.20'	.35'	.54'
Stream Flow (circle one)	none slow moderate fast — slow; 1 ft/sec	none slow moderate fast — slow; .71 ft/sec	none slow moderate fast — moderate; 1.8 ft/sec	none slow moderate fast — slow
Gear type (seine, net or shock)	B.P. SHOCKER	B.P. SHOCK	B.P. SHOCK	B.P. SHOCK
Shocking seconds (if shocked)	Ø	Ø	Ø	Ø
seine or net dimensions	Ø	Ø	Ø	Ø
# of seine hauls within subhabitat	4 Shocking passes in site	4 Passes at site	1 Pass	3 Shocking Passes
Total distance sampled in this effort	16'	16'	16'	50'

COMMENTS: ____________

FISH DATA - B. SANDY

#'s are Totals of All Shocking "passes"

SITE 01 (VEGETATED SILTY RUN .25 mi Above ...

	# CAPTURED	# MEASURED	Avg. Total Length (mm)	Range
Ictalurus natalis (Yellow bullhead)	1	1	251	
Agosia chrysogaster (Longfin dace)	142	85	54	35-6 6
Gambusia affinis (Mosquitofish)	13	13	27	20-4 4

SITE 02 (SANDY, GRAVEL RUN at WASH, SE 1/4 SEC. 24

Agosia chry.	125	55	40	29-6 6
Gambusia aff.	2	2	31	27-3 3

SITE 03 (EDDIE POOL ALONG CLI SE 1/4 SEC. 25

Agosia chry. ✓	341	30	65	54-7 7
Gila robusta ✓	1	1	173	

captured at this site Oct. 4 '94

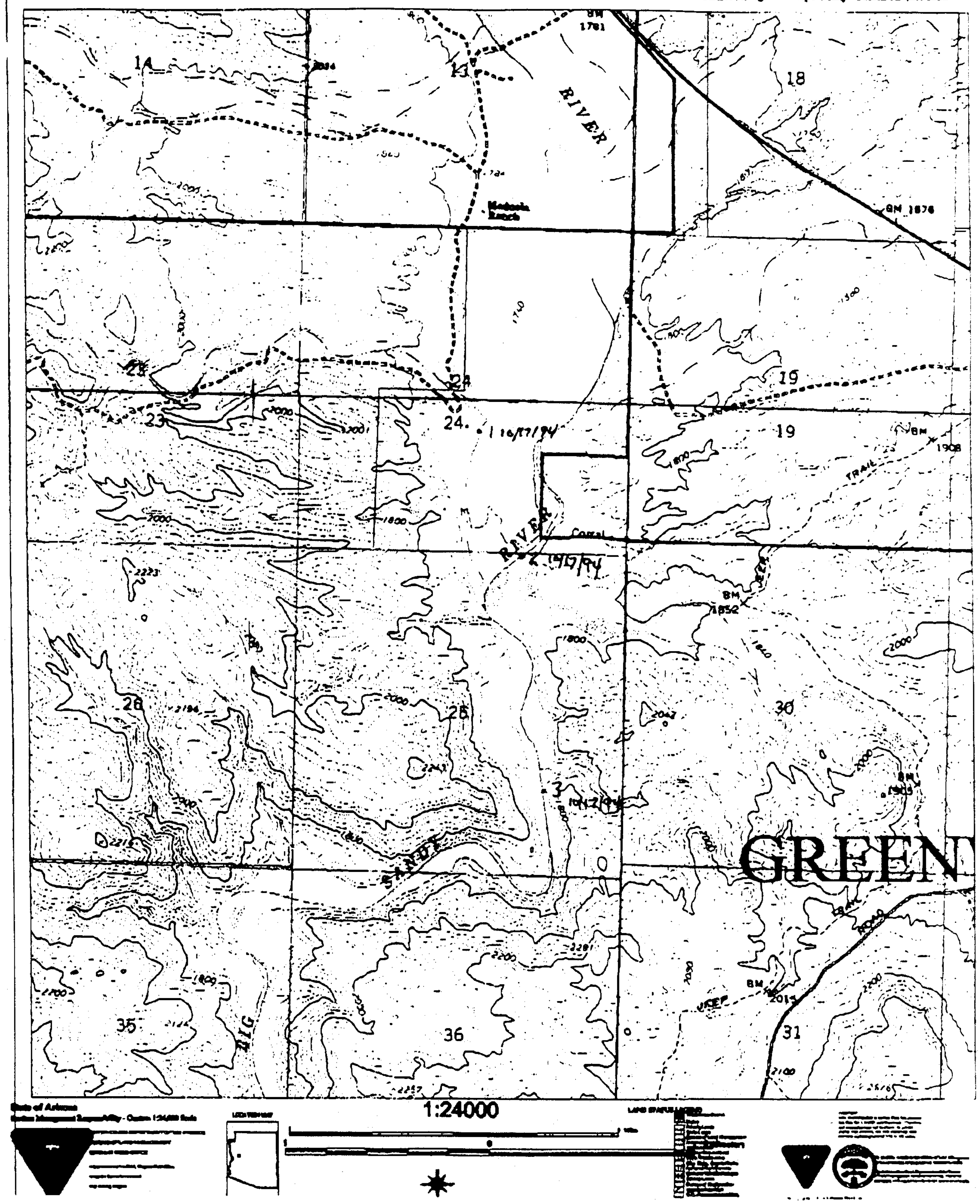
SITE 04 (RUN downstream of Gag T. 13 N, R. 13W, NW 1/4 S. 2

Gila robusta ✓	13	13	163	134-1 1
Agosia chrys ✓	278	30	65	54-7 7
Gambusia affin	860	43	30	14-4 45
Ictalurus nat	8	8	126	93-16 16

Preliminary Map

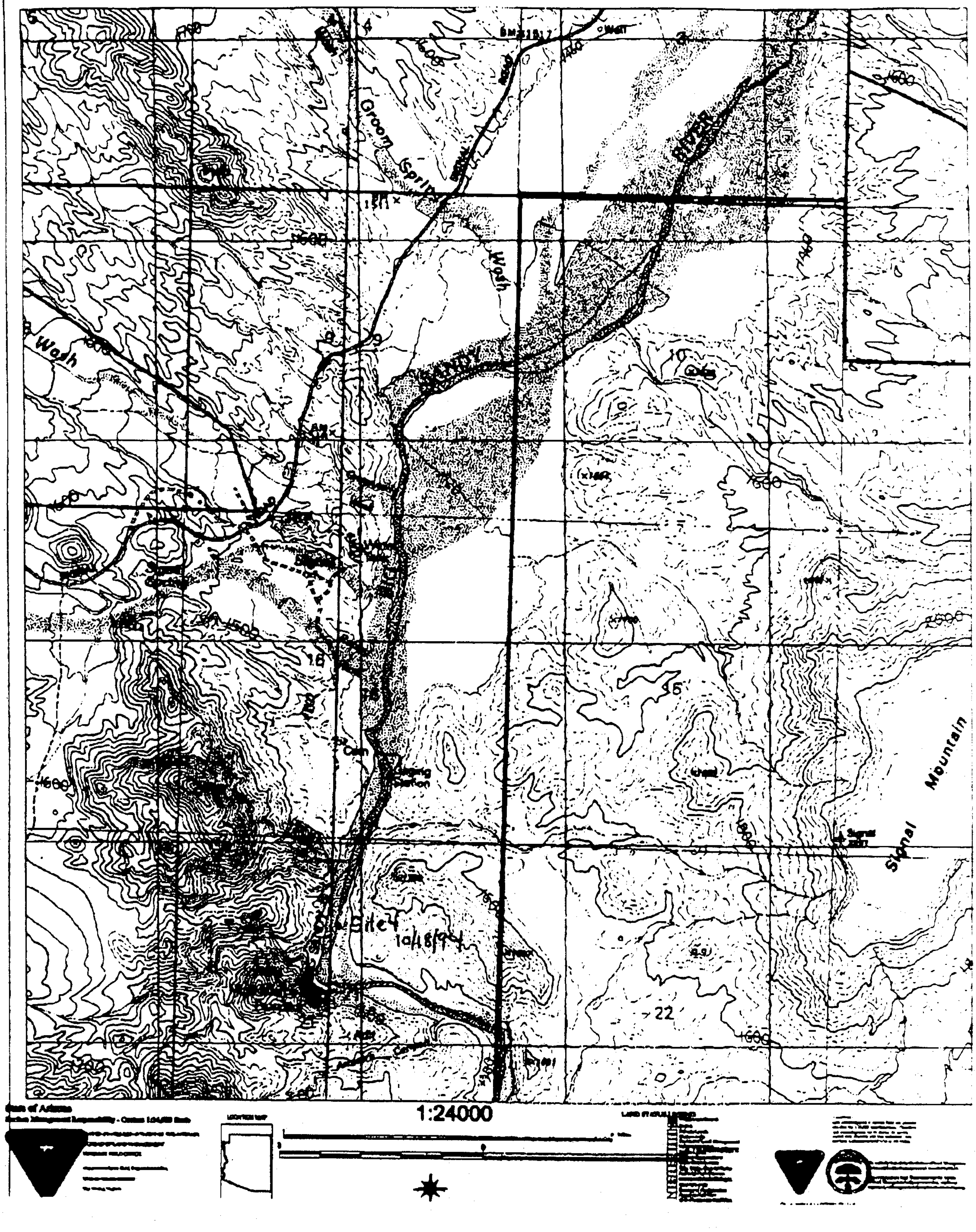
State of Arizona

Surface Management Responsibility - Custom 1:24,000 Scale



Preliminary Map

State of Arizona



APPENDIX B
LEGAL DESCRIPTIONS AND GPS SPECIFIC POINTS FOR EACH SITE, JUNE 2000

Appendix B - Legal Descriptions and GPS Specific Points for Each Site, June 2000

	Legal Description					GPS Coordinates (UTM NAD 27, Zone 12)	
Site	Quad Name	Township	Range	Section	1/4 Section	Northing	Easting
BS15	Tom Brown Canyon	18N	13W	26	NE	260256	3866822
BS14	Tom Brown Canyon	18N	13W	35	NE	260458	3864714
BS13	Gunsight Canyon	17N	13W	14	SW	259217	3859391
BS12	Tule Wash	16.5N	13W	27	SW	260795	3851577
BS11	Wikieup	16N	13W	10	SE	261473	3846561
BS10B	Wikieup	16N	13W	26	NW	262119	3842603
BS10A	Wikieup	16N	13W	26	SW	262051	3842310
BS9	Wikieup	16N	13W	35	NE	262864	3840928
BS8B	Wikieup	15N	13W	1	SW	263540	3838518
BS8A	Wikieup	15N	13W	11	NE	263275	3837705
BS7	Wikieup	15N	13W	13	NE	264696	3836226
BS6	Greenwood Peak	15N	13W	25	NE	264304	3833287
BS5	Greenwood Peak	14N	13W	12	SW	263716	3827722
BS4	Greenwood Peak	14N	13W	23	SE	263099	3824058
BS3B	Greenwood Peak	14N	13W	35	NW	261512	3821746
BS3A	Signal Mountain	13N	13W	16	SE	259131	3816339
BS2	Signal Mountain	12N	13W	11	NW	262354	3809324
BS1	Artillery Peak	12N	13W	32	NE	267782	3802986

APPENDIX C
BIG SANDY RIVER DISCHARGE CALCULATION INFORMATION, JUNE 2000

Station:	BS4			Date:	06/15/00
	Distance from LEW (ft)	Cell Depth (ft)	Cell Width (ft)	Cell XS Area (ft^2)	Total XS area (ft^2)
LEW	0.0	0	0	0	
	0.5	0.1	0.75	0.08	
	1.0	0.1	0.50	0.05	
	1.5	0.1	0.55	0.06	
REW	1.8	0	0	0	0.18
	Flow Times (sec)			Avg Time (sec)	13.14
T1	14.39			Flow Distance (ft)	4
T2	9.09			Velocity (ft/s)	0.29
T3	15.95			**Flow (cfs)**	**0.05**

Station:	BS10a			Date:	06/15/00
	Distance from LEW (ft)	Cell Depth (ft)	Cell Width (ft)	Cell XS Area (ft^2)	Total XS area (ft^2)
LEW	0.0	0	0	0	
	0.5	0.4	0.75	0.30	
	1.0	0.4	0.50	0.20	
	1.5	0.3	0.55	0.17	
REW	1.8	0	0	0	0.665
	Flow Times (sec)			Avg Time (sec)	23.12
T1	23.19			Flow Distance (ft)	12
T2	22.89			Velocity (ft/s)	0.49
T3	23.28			**Flow (cfs)**	**0.33**

Station:	BS6			Date:	06/15/00
	Distance from LEW (ft)	Cell Depth (ft)	Cell Width (ft)	Cell XS Area (ft^2)	Total XS area (ft^2)
LEW	0.0	0	0	0	
	0.5	2.0	0.75	1.50	
	1.0	2.1	0.50	1.05	
	1.5	2.2	0.50	1.10	
	2.0	2.1	0.50	1.05	
	2.5	0.7	0.45	0.32	
REW	2.7	0	0	0	5.015
	Flow Times (sec)			Avg Time (sec)	17.56
T1	16.41			Flow Distance (ft)	12
T2	20.1			Velocity (ft/s)	0.65
T3	16.17			**Flow (cfs)**	**3.26**

Station:	BS8a			Date:	06/14/00
	Distance from LEW (ft)	Cell Depth (ft)	Cell Width (ft)	Cell XS Area (ft^2)	Total XS area (ft^2)
LEW	1.0	0	0	0	
	2.0	0.2	1.50	0.30	
	3.0	0.4	1.00	0.40	
	4.0	0.3	1.00	0.30	
	5.0	0.5	1.00	0.50	
	6.0	0.4	1.00	0.40	
	7.0	0.4	1.00	0.40	
	8.0	0.2	0.70	0.14	
REW	8.2	0	0	0	2.44
	Flow Times (sec)			Avg Time (sec)	34.54
T1	35.51			Flow Distance (ft)	35
T2	34.31			Velocity (ft/s)	0.96
T3	33.79			**Flow (cfs)**	**2.35**

Station:	BS9			Date:	06/16/00
	Distance from LEW (ft)	Cell Depth (ft)	Cell Width (ft)	Cell XS Area (ft^2)	Total XS area (ft^2)
LEW	0.0	0	0	0	
	2.0	0.4	3.50	1.40	
	5.0	0.3	3.00	0.90	
	8.0	0.3	3.00	0.90	
	11.0	0.3	3.00	0.90	
	14.0	0.5	3.00	1.50	
	17.0	0.3	3.00	0.90	
	20.0	0.2	2.50	0.50	
	22.0	0.3	3.00	0.90	
REW	24.0	0	0	0	7.9
	Flow Times (sec)			Avg Time (sec)	75.68
T1	75.68			Flow Distance (ft)	10
T2	--			Velocity (ft/s)	0.13
T3	--			**Flow (cfs)**	**0.99**

APPENDIX D
MACROINVERTEBRATE TAXA AND ABUNDANCE DATA FOR BIG SANDY RIVER STUDY SITES, JUNE 2000

Appendix D

Macroinvertebrate Taxa and Abundance Data for Big Sandy River Sites, Arizona

Site ID: BS-4 Sampler Type: Surber
Sample Date: 06-15-00 Habitat: Lotic

TAXA	# Individuals	%RA
EPHEMEROPTERA		
Baetis	12.0	11.4
TOTAL	12.0	11.4
ODONATA		
Gomphidae	2.0	1.9
Libellulidae	1.0	1.0
Macrothemis	2.0	1.9
Amphiagrion	4.0	3.8
Argia	28.0	26.7
TOTAL	37.0	35.2
NON CHIRONOMID DIPTERA		
Setacera	8.0	7.6
Tipula	1.0	1.0
TOTAL	9.0	8.6
COLEOPTERA		
Berosus cf. *punctatissimus*	4.0	3.8
Coleoptera	1.0	1.0
TOTAL	5.0	4.8
HEMIPTERA		
Ambrysus puncticollis	1.0	1.0
TOTAL	1.0	1.0
MISC. TAXA		
Erpobdella punctata	4.0	3.8
Myzobdella lugubris	1.0	1.0
Physa	36.0	34.3
TOTAL	41.0	39.0
GRAND TOTAL	105	100

Notes:
%RA = percent relative abundance (% composition)

Appendix D

Macroinvertebrate Taxa and Abundance Data for Big Sandy River Sites, Arizona

Site ID: BS-8b | Sampler Type: Surber

Sample Date: 7-13-00 | Habitat: Lotic

TAXA	# Individuals	%RA
EPHEMEROPTERA		
Leptohypes	3.0	7.7
Baetis	21.0	53.8
TOTAL	24.0	61.5
ODONATA		
Cordullidae	2.0	5.1
TOTAL	2.0	5.1
CHIRONOMID DIPTERA		
Diamesinae	1.0	2.6
TOTAL	1.0	2.6
COLEOPTERA		
Laccophilus maculosus shermani	10.0	25.6
Coleoptera	1.0	2.6
TOTAL	11.0	28.2
MISC. TAXA		
Oxus	1.0	2.6
TOTAL	1.0	2.6
GRAND TOTAL	39	100

Notes:
%RA = percent relative abundance (% composition)

Appendix D

Macroinvertebrate Taxa and Abundance Data for Big Sandy River Sites, Arizona

Site ID: BS-9 Sampler Type: Surber

Sample Date: 6-16-00 Habitat: Lotic

TAXA	# Individuals	%RA
EPHEMEROPTERA		
Baetis	9.0	4.8
TOTAL	9.0	4.8
ODONATA		
Argia	5.0	2.7
TOTAL	5.0	2.7
NON CHIRONOMID DIPTERA		
Ceratopogonidae	1.0	0.5
Psychodidae	1.0	0.5
TOTAL	2.0	1.1
CHIRONOMID DIPTERA		
Diamesinae	4.0	2.1
TOTAL	4.0	2.1
COLEOPTERA		
Berosus cf. *punctatissimus*	1.0	0.5
Peltodytes cf. *callosus*	2.0	1.1
TOTAL	3.0	1.6
MISC. TAXA		
Hyalella azteca	124.0	66.0
Physa	13.0	6.9
Planorbidae	14.0	7.4
Sphaeriidae	14.0	7.4
TOTAL	165.0	87.8
GRAND TOTAL	188	100

Notes:
%RA = percent relative abundance (% composition)

Appendix D

Macroinvertebrate Taxa and Abundance Data for Big Sandy River Sites, Arizona

Site ID: BS-10a
Sampler Type: Surber
Sample Date: 7-13-00
Habitat: Lotic

TAXA	# Individuals	%RA
EPHEMEROPTERA		
Tricorythodes	8.0	1.3
TOTAL	8.0	1.3
ODONATA		
Anisoptera	4.0	0.6
Gomphidae	4.0	0.6
Cordulegaster	2.0	0.3
Zygoptera	8.0	1.3
Argia	36.0	5.8
TOTAL	54.0	8.7
CHIRONOMID DIPTERA		
Tanypodinae	8.0	1.3
Diamesinae	12.0	1.9
TOTAL	20.0	3.2
COLEOPTERA		
Berosus cf. *punctatissimus*	24.0	3.9
Hygrotus	4.0	0.6
Thermonectus marmoratus	4.0	0.6
Laccophilus maculosus shermani	416.0	67.2
Peltodytes cf. *callosus*	36.0	5.8
TOTAL	484.0	78.2
HEMIPTERA		
Ambrysus puncticollis	4.0	0.6
TOTAL	4.0	0.6
MISC. TAXA		
Lumbriculidae	4.0	0.6
Erpobdella punctata	1.0	0.2
Hyalella azteca	12.0	1.9
Physa	24.0	3.9
Sphaeriidae	8.0	1.3
TOTAL	49.0	7.9
GRAND TOTAL	619	100

Notes:
%RA = percent relative abundance (% composition)

APPENDIX E
1979 MACROINVERTEBRATE TAXA LIST FOR THE BIG SANDY RIVER (Kepner 1979)

APPENDIX 3. DISTRIBUTION OF AQUATIC INSECT COLLECTIONS FROM THE UPPER BILL WILLIAMS DRAINAGE, YAVAPAI AND MOHAVE COUNTIES, ARIZONA, DECEMBER 1978 TO MARCH 1979.

Taxon	Conger Creek	Francis Creek	Boulder Creek	Burro Creek	Big Sandy River	Trout Creek	Santa Maria River
Order Ephemeroptera							
Family Tricorythidae							
Tricorythodes sp.		X		X		X	X
Leptohypes sp.		X		X			
Family Leptophlebiidae							
Choroterpes kossi	X						
Paraleptophlebia sp.		X		X			
Family Baetidae							
Baetis sp.	X	X		X	X	X	
Callibaetis sp.					X		
Pseudocloeon sp.				X			
Order Odonata							
Suborder Anisoptera							
Family Gomphidae							
Gomphus confraternus confraternus		X					
Progomphus borealis				X	X		X
Erpetogomphus compositus				X	X		
Family Aeschnidae							
Aeschna (Hesperaeschna) californica					X		
Family Libellulidae							
Paltothemis cf. *lineatipes*			X	X	X		
Pachydiplax longipennis					X		
Brythemis simplicicollis					X		
Sympetrum pallipes					X		
Macrothemis sp.					X		
Libellula cf. *comanche*					X		
Libellula cf. *saturata*					X		

APPENDIX 3. Continued.

Taxon	Conger Creek	Francis Creek	Boulder Creek	Burro Creek	Big Sandy River	Trout Creek	Santa Maria River
Suborder Zygoptera							
Family Coenagrionidae							
Hyponeura lugens				X			X
Hesperagrion sp.				X			
Argia sp.				X			
Enallagma cf. *praevarum*				X	X		
Ischnura cf. *barberi*				X	X		
Order Plecoptera							
Family Capniidae							
Mesocapnia frisoni		X		X	X	X	X
Mesocapnia arizonensis		X		X			X
Mesocapnia sp.	X	X					
Order Hemiptera							
Family Gerridae							
Gerris remigis	X						
Family Microvelidae							
Microvelia gerhardi					X	X	X
Family Notonectidae							
Notonecta lobata	X						
Family Belostomatidae							
Abedus herberti		X	X	X	X	X	X
Family Corixidae							
Graptocorixa serrulata				X	X	X	X
Family Gelastocoridae							
Gelastocoris oculatus				X			X
Family Naucoridae							
Ambrysus puncticollis				X	X		X

APPENDIX 3. Continued.

Taxon	Conger Creek	Francis Creek	Boulder Creek	Burro Creek	Big Sandy River	Trout Creek	Santa Maria River
Ambrysus occidentalis				X	X		
Ambrysus arizonus					X		
Order Diptera							
Family Tabanidae							
Tabanus sp.		X		X	X	X	X
Family Chironomidae							
Subfamily Tanypodinae		X		X	X	X	X
Subfamily Diamesinae		X		X	X	X	X
Subfamily Tendipedinae							
Tribe Calopsectrini		X		X	X	X	X
Tribe Tendipedini		X		X	X	X	X
Family Tipulidae							
Tipula sp.		X		X		X	
Family Simuliidae							
Simulium sp.		X		X		X	X
Family Culicidae							
Culex sp.		X		X	X		
Order Coleoptera							
Family Gyrinidae							
Gyrinus plicifer	X						X
Family Hydrophilidae							
Tropisternus ellipticus	X	X		X	X	X	X
Tropisternus lateralis					X		
Berosus cf. *punctatissimus*	X			X			X
Helochares cf. *normatus*		X					
Hydrochara cf. *lineata*		X					
Family Dytiscidae							
Hygrotus sp.	X	X		X	X	X	X

APPENDIX 3. Continued.

Taxon	Conger Creek	Francis Creek	Boulder Creek	Burro Creek	Big Sandy River	Trout Creek	Santa Maria River
Hygrotus sp. 2				X			X
Eretes sticticus	X	X					
Thermonectus marmoratus		X					
Laccophilus maculosus shermani				X	X		X
Family Haliplidae							
Peltodytes cf. *callosus*				X	X		X
Family Dryopidae							
Helichus immsi		X		X	X		X
Family Psephenidae							
Psephenus minckleyi		X		X		X	
Psephenus murvoshi		X		X		X	
Order Megaloptera							
Family Corydalidae							
Corydalus cognata	X	X		X	X	X	X
Order Trichoptera							
Family Hydropsychidae							
Hydropsyche sp.		X		X	X		X
Family Helicopsychidae							
Helicopsyche sp.		X		X			
Order Lepidoptera							
Family Pyralidae							
Parargyractis jaliscalis				X			

EXHIBIT D - BIOLOGICAL RESOURCES

As stated in Arizona Corporation Commission Rules of Practice and Procedure R14-3-219:

"List the fish, wildlife, plant life and associated forms of life associated with the vicinity of the proposed sites or route and describe the effects, if any, other proposed facilities will have thereon."

The Technical Reports provided in Exhibit C contain lists of plant life, mammals, birds, and reptiles and, amphibians, and fish that may potentially occur in or in the vicinity of the Project area, defined here as the Plant site, ancillary facilities and natural gas pipeline. **Special Status Species, including federally-listed threatened, endangered, proposed, candidate, and sensitive species; state-listed wildlife of special concern, and highly safeguarded native plant species are also discussed in Exhibit C. They are not included in the following lists.**

Potential Effects

The primary potential effects of the proposed Project include short-term disturbance of vegetation and disturbance, injury, or mortality of wildlife species along the pipeline alignment, and both short- and long-term similar impacts to vegetation and wildlife at the Plant site and along the access road. The Plant site is adjacent to an existing transmission line; therefore, no additional transmission lines will be constructed as part of this Project.

The pipeline alignment is located adjacent to an existing highway. Clearing of the alignment will not increase the fragmentation of the existing vegetation in the area. The alignment will be revegetated using appropriate native plants and methods and will be available as wildlife habitat following completion of construction. No long-term impacts to vegetation or wildlife are anticipated along the pipeline alignment.

The Plant site is located in upland desert scrub vegetation, some of which will be cleared during construction. The pipeline from the highway to the Plant site and the new access road will be built in the same location in order to minimize impacts. Following construction, areas outside of the Plant site and access road that were disturbed during construction will be revegetated. The road and Plant site will not be revegetated, and this area will be lost as wildlife habitat. Compared to the total amount of habitat available in the Project area and the limited amount of long-term disturbance, habitat loss at the Plant site is considered minimal.

Construction of the proposed plant and access road may adversely impact individuals of wildlife and plant species that occur within the Plant site through direct mortality and loss of habitat. Ground clearing activities may result in the removal of habitat including nesting and burrowing sites, thermal cover, and food sources for small mammals and reptiles. There is also the potential for an increase in road mortality of diurnal animals during the construction and operation of the Project. Although some individuals of both plant and animal species may be impacted by construction and operation, the proposed Project will not adversely affect any plant or wildlife species as a whole, nor substantially alter the biodiversity of the Project area or ecosystems within this area.

Table D-1
Big Sandy Energy Project
Plant Species That May Occur in the Project Area

Scientific Name	Common Name	Vegetation types present in			
		Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural / Developed
TREES					
Cercidium floridum	Blue palo verde			✔	
Cercidium microphyllum	Foothill palo verde	✔		✔	
Chilopsis linearis	Desert willow		✔	✔	
Juniperus osteosperma	Utah juniper		✔		
Olneya tesota	Ironwood			✔	
Prosopis glandulosa	Honey mesquite	✔		✔	
Prosopis pubescens	Screwbean			✔	
Psorothamnus spinosus	Smoke tree			✔	
Salix gooddingii	Black willow			✔	
Tamarix parviflora	Tamarisk			✔	
Tamarix ramosissima	Tamarisk			✔	
Yucca brevifolia	Joshua tree		✔		
SHRUBS					
Acacia greggii	Catclaw		✔	✔	
Agave deserti	Desert agave	✔			
Ambrosia dumosa	White bursage	✔	✔		
Artemisia spinescens	Bud-sage		✔		
Atriplex canescens	Four-wing saltbush	✔	✔		
Atriplex confertifolia	Shadscale		✔		
Atriplex hymenelytra	Desert-holly	✔	✔	✔	
Atriplex polycarpa	Allscale	✔	✔		
Chrysothamnus viscidiflorus	Yellow Rabbitbrush		✔		
Coleogyne ramosissima	Black brush		✔		
Encelia farinosa	Brittlebush	✔	✔		
Ephedra fasciculata	Mormon tea	✔	✔		
Ephedra nevadensis	Mormon tea	✔	✔		
Ephedra viridis	Green ephedra	✔	✔		
Eriogonum fasciculatum	California buckwheat	✔	✔		
Fouquieria splendens	Ocotillo	✔	✔	✔	
Grayia spinosa	Hop-sage	✔	✔		
Gutierrezia sarothrae	Snake-weed		✔		
Hymenoclea salsola	Cheese bush	✔	✔	✔	
Krameria erecta	Pima rhatany	✔	✔		

Table D-1 (continued)
Big Sandy Energy Project
Plant Species That May Occur in the Project Area

Scientific Name	Common Name	Vegetation types present in			
		Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural / Developed
Krameria grayi	White rhatany	✔	✔		
Kraschenìnnikovia lanata	Winter fat		✔		
Larrea tridentata	Creosote bush	✔	✔		
Lycium andersonii	Anderson box-thorn		✔	✔	
Menodora spinescens	Green-fire		✔		
Peucephyllum schottii	Pygmy cedar	✔	✔		
Pluchea sericea	Arrow weed			✔	
Salazaria mexicana	Bladder sage	✔	✔	✔	
Sphaeralcea ambigua	Apricot mallow	✔	✔		
Thamnosma montana	Turpentine broom	✔	✔		
Yucca schidigera	Mojave yucca	✔	✔		
CACTI					
Carnegiea gigantea	Saguaro	✔			
Echinocactus polycephalus var. polycephalus	Clustered barrel cactus	✔			
Echinocereus engelmannii	Hedgehog cactus	✔	✔		
Ferocactus cylindraceus	Barrel cactus	✔	✔		
Opuntia acanthocarpa	Buckhorn cholla	✔	✔		
Opuntia bigelovii	Teddy-bear cholla	✔			
Opuntia echinocarpa	Silver cholla	✔	✔		
Opuntia erinacea	Mojave prickly-pear		✔		
Opuntia ramosissima	Pencil cholla	✔	✔		
FORBS					
Allionia incarnata	Trailing four o'clock	✔	✔		
Eriogonum inflatum	Desert trumpet	✔	✔	✔	✔
Halogeton glomeratus	Halogeton	✔	✔		✔
Gaura coccinea	Wild honeysuckle		✔		
Kochia scoparia	Kochia	✔	✔		✔
Salsola tragus	Russian thistle	✔	✔		✔
GRAMINOIDS					
Aristida purpurea	Three-awn	✔	✔		
Bouteloua aristidoides	Needle grama	✔	✔	✔	
Bouteloua eriopoda	Black grama		✔	✔	
Bromus madritensis	Foxtail chess	✔	✔		✔
Erioneuron pulchellum	Fluff grass	✔	✔		

Table D-1 Continued
Big Sandy Energy Project
Plant Species That May Occur in the Project Area

Scientific Name	Common Name	Vegetation types present in			
		Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparia n Wash	Agricultural / Developed
Hilaria jamesii	Galleta		✔		
Hilaria rigida	Big galleta	✔	✔	✔	✔
Oryzopsis hymenoides	Indian rice-grass	✔	✔		

Table D-2
Big Sandy Energy Project
Mammal Species That May Occur In The Project Area

Common Name	Scientific Name	Vegetation types occupied			
		Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural / Developed
Desert shrew	*Notiosorex crawfordi*	✔	✔	✔	
Yuma myotis	*Myotis yumanensis*	✔	✔	✔	✔
Long-legged myotis	*Myotis volans*	✔	✔	✔	✔
California myotis	*Myotis californicus*	✔	✔	✔	✔
Small-footed myotis	*Myotis leibii*	✔	✔	✔	✔
Western pipistrelle	*Pipistrellus hesperus*	✔	✔	✔	✔
Big brown bat	*Eptesicus fuscus*	✔	✔	✔	✔
Pallid bat	*Antrozous pallidus*	✔	✔	✔	✔
Brazilian free-tailed bat	*Tadarida brasiliensis*	✔	✔	✔	✔
Pocketed free-tailed bat	*Tadarida femorosacca*	✔	✔	✔	✔
Desert cottontail	*Sylvilagus audubonii*	✔	✔	✔	✔
Black-tailed jack rabbit	*Lepus californicus*	✔	✔	✔	✔
Cliff chipmunk	*Eutamias dorsalis*		✔		
Harris' antelope squirrel	*Ammospermophilus harrisii*	✔	✔	✔	
Rock squirrel	*Spermophilus variegatus*	✔	✔		
Round-tailed ground squirrel	*Spermophilus tereticaudus*	✔	✔		
Botta's pocket gopher	*Thomomys bottae*	✔	✔	✔	✔
Arizona pocket mouse	*Perognathus amplus*	✔	✔	✔	
Rock pocket mouse	*Perognathus intermedius*	✔	✔		

Table D-2 (continued)
Big Sandy Energy Project
Mammal Species That May Occur In The Project Area

Common Name	Scientific Name	Vegetation types occupied			
		Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural / Developed
Desert pocket mouse	*Perognathus penicillatus*	✔	✔	✔	
Ord's kangaroo rat	*Dipodomys ordii*		✔	✔	✔
Merriam's kangaroo rat	*Dipodomys merriami*	✔	✔		
Western harvest mouse	*Reithrodontomys megalotis*	✔	✔	✔	
Cactus mouse	*Peromyscus eremicus*	✔	✔		
Deer mouse	*Peromyscus maniculatus*		✔	✔	
Brush mouse	*Peromyscus boylii*		✔	✔	✔
Southern grasshopper mouse	*Onychomys torridus*	✔	✔		
White-throated wood Rat	*Neotoma albigula*	✔	✔		
Desert wood rat	*Neotoma lepida*	✔	✔		
Stephan's wood rat	*Neotoma stephensi*		✔		
Coyote	*Canis latrans*	✔	✔	✔	✔
Kit fox	*Vulpes macrotis*	✔	✔	✔	✔
Gray fox	*Urocyon cinereoargenteus*	✔	✔	✔	
Racoon	*Procyon lotor*			✔	✔
Ringtail	*Bassariscus astutus*	✔	✔	✔	
Badger	*Taxidea taxus*	✔	✔	✔	
Western spotted skunk	*Spilogale gracilis*		✔	✔	
Mountain lion	*Felis concolor*		✔	✔	
Bobcat	*Felis rufus*		✔	✔	
Collared Peccary (Javelina)	*Tayassu tajacu*	✔	✔	✔	
Mule Deer	*Odocoileus hemionus*	✔	✔	✔	

Table D-3
Big Sandy Energy Project
Bird Species That May Occur In The Project Area

Common Name	Scientific Name	Vegetation types occupied and season of occurrence[1]			
		Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural / Developed
Black-crowned night heron	*Nycticorax nycticorax*			R	
Green heron	*Butorides virescens*			R	
Cattle egret	*Bubulcus ibis*			R	R
Great blue heron	*Ardea herodias*			W	
Canada goose	*Branta canadensis*			W	W
Mallard	*Anas platyrhynchos*			W	
Turkey vulture	*Cathartes aura*	R	R	R	R
Northern harrier	*Circus cyaneus*	W	W	W	W
Red-tailed hawk	*Buteo jamaicensis*	R	R	R	R
Swainson's hawk	*Buteo swainsoni*	S	S	S	S
American kestrel	*Falco sparverius*	R	R	R	R
Prairie falcon	*Falco mexicanus*	R	R	R	R
Gambel's quail	*Callipepla gambelii*	R	R	R	R
Killdeer	*Charadrius vociferus*			R	R
Spotted sandpiper	*Actitis macularia*			W	
Rock dove	*Columba livia*				R
Mourning dove	*Zenaida macroura*	R	R	R	R
White-winged dove	*Zenaida asiatica*	S	S	S	S
Inca dove	*Scardafella inca*			R	R
Greater roadrunner	*Geococcyx californicus*	R	R	R	R
Barn owl	*Tyto alba*			R	R
Great horned owl	*Bubo virginianus*	R	R	R	
Western screech-owl	*Otus kennicottii*		R	R	R
Burrowing owl	*Athene cunicularia*	R	R		R
Lesser nighthawk	*Chordeiles acutipennis*	S	S	S	S
Common poorwill	*Phalaenoptilus nuttallii*	S	S	S	S
White-throated swift	*Aeronautes saxatilis*	R	R		
Black-chinned hummingbird	*Archilochus alexandri*	S	S	S	S
Costa's hummingbird	*Calypte costae*	S	S	S	
Anna's hummingbird	*Calypte anna*	R	R	R	R

Table D-3 (continued)
Big Sandy Energy Project
Bird Species That May Occur In The Project Area

Common Name	Scientific Name	Vegetation types occupied and season of occurrence[1]			
		Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural / Developed
Gila woodpecker	*Melanerpes uropygialis*	R	R	R	R
Northern flicker	*Colaptes cafer*			R	R
Ladder-backed woodpecker	*Dendrocopos scalaris*	R	R	R	R
Black phoebe	*Sayornis nigricans*			R	R
Say's phoebe	*Sayornis saya*	R	R	R	R
Vermilion flycatcher	*Pyrocephalus rubinus*			R	
Brown-crested flycatcher	*Myiarchus tyrannulus*	S	S	S	
Ash-throated flycatcher	*Myiarchus cinerascens*	S	S	S	S
Western kingbird	*Tyrannus verticalis*	S	S	S	S
Loggerhead shrike	*Lanius ludovicianus*	R	R	R	R
Bell's vireo	*Vireo bellii*			S	
Common raven	*Corvus corax*	R	R	R	R
Horned lark	*Eremophila alpestris*	R	R	R	R
Cliff swallow	*Petrochelidon pyrrhonota*	S	S	S	S
Northern rough-winged swallow	*Stelgidopteryx serripennis*	S	S	S	S
Verdin	*Auriparus flaviceps*	R	R	R	
House wren	*Troglodytes aedon*			R	R
Bewick's wren	*Thryomanes bewickii*		W	W	
Cactus wren	*Campylorhynchus brunneicapillus*	R	R		
Rock wren	*Salpinctes obsoletus*	R	R	R	
Canyon wren	*Catherpes mexicanus*	R	R	R	
Golden-crowned kinglet	*Regulus satrapa*		W	W	
Ruby-crowned kinglet	*Regulus calendula*		W	W	
Blue-gray gnatcatcher	*Polioptila caerulea*		W	W	
Black-tailed gnatcatcher	*Polioptila melanura*			R	
Mountain bluebird	*Sialia currucoides*	W	W	W	
Townsend's solitaire	*Myadestes townsendi*		W	W	
Hermit thrush	*Catharus guttatus*			W	
American robin	*Turdus migratorius*			W	W
Northern mockingbird	*Mimus polyglottos*	R	R	R	R

Table D-3 (continued)
Big Sandy Energy Project
Bird Species That May Occur In The Project Area

Common Name	Scientific Name	Vegetation types occupied and season of occurrence[1]			
		Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural / Developed
Sage thrasher	*Oreoscoptes montanus*		W		
Bendire's thrasher	*Toxostoma bendirei*	S	S		S
Curve-billed thrasher	*Toxostoma curvirostre*	R	R	R	
Crissal thrasher	*Toxostoma crissale*			R	
LeConte's thrasher	*Toxostoma lecontei.*	R	R		
European starling	*Sturnus vulgaris*			R	R
Cedar waxwing	*Bombycilla cedrorum*			W	W
Phainopepla	*Phainopepla nitens*	R	R	R	R
Orange-crowned warbler	*Vermivora celata*			W	
Virginia's warbler	*Vermivora virginiae*		S		
Lucy's warbler	*Vermivora luciae*			S	
Yellow-rumped warbler	*Dendroica coronata*			W	
Yellow warbler	*Dendroica petechia*			S	S
Common yellowthroat	*Geothlypis trichas*			S	S
Yellow-breasted chat	*Icteria virens*			S	
Summer tanager	*Piranga rubra*			S	
Green-tailed towhee	*Pipilo chlorurus*		W	W	
Canyon towhee	*Pipilo fuscus*	R	R		
Abert's towhee	*Pipilo aberti*	R	R	R	
Spotted towhee	*Pipilo maculatus*			W	
Rufous-crowned sparrow	*Aimophila ruficeps*		R		
Chipping sparrow	*Spizella passerina*			W	W
Brewer's sparrow	*Spizella breweri*		W	W	W
Lark sparrow	*Chondestes grammacus*		R	R	R
Black-chinned sparrow	*Spizella atrogularis*	W	W		
Black-throated Sparrow	*Aimophila bilineata*	R	R		
Sage sparrow	*Amphispiza belli*	W	W		
Fox sparrow	*Passerella iliaca*			W	
Savannah sparrow	*Passerculus sandwichensis*	W	W	W	W
Lincoln's sparrow	*Melospiza lincolnii*			W	
Song sparrow	*Melospiza melodia*			R	

Table D-3 (continued)
Big Sandy Energy Project
Bird Species That May Occur In The Project Area

Common Name	Scientific Name	Vegetation types occupied and season of occurrence[1]			
		Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural / Developed
Vesper sparrow	*Pooecetes gramineus*		W		W
White-crowned Sparrow	*Zonotrichia leucophrys*			W	W
Dark-eyed junco	*Junco hyemalis*	W	W	W	W
Blue grosbeak	*Guiraca caerulea*			S	S
Western meadowlark	*Sturnella neglecta*	R	R	R	R
Red-winged blackbird	*Agelaius phoeniceus*			R	
Great-tailed grackle	*Quiscalus mexicanus*			R	R
Brewer's blackbird	*Euphagus cyanocephalus*	W	W	W	W
Brown-headed Cowbird	*Molothrus ater*			R	R
Hooded oriole	*Icterus cucullatus*	S	S	S	S
Bullock's oriole	*Icterus bullockii*			S	S
Scott's oriole	*Icterus parisorum*	S	S	S	S
House finch	*Carpodacus mexicanus*				R
American goldfinch	*Carduelis tristis*			W	W
Lesser goldfinch	*Carduelis psaltria*			R	R
House Sparrow	*Passer domesticus*				R

[1] Season of occurrence: R = year round resident; S = summer; W = winter.

Table D-4
Big Sandy Energy Project
Reptile and Amphibian Species That May Occur In The Project Area

Common Name	Scientific Name	Vegetation types occupied			
		Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural / Developed
Couch's spadefoot toad	*Scaphiopus couchi*	✔	✔	✔	
Great Plains toad	*Bufo cognatus*	✔	✔	✔	✔
Red-spotted toad	*Bufo punctatus*			✔	
Bullfrog	*Rana catesbeiana*			✔	
Sonoran mud turtle	*Kinosternon sonoriense*			✔	
Western banded gecko	*Coleonyx variegatus*	✔	✔		
Common chuckwalla	*Sauromalus obesus*	✔	✔		
Desert iguana	*Dipsosaurus dorsalis*	✔	✔		
Zebra-tailed lizard	*Callisaurus draconoides*	✔	✔	✔	
Long-nosed leopard lizard	*Gambelia wislizenii*	✔	✔		
Desert collared lizard	*Crotaphytus insularis*	✔	✔	✔	
Desert spiny lizard	*Sceloporus magister*	✔	✔	✔	
Tree lizard	*Urosaurus ornatus*	✔	✔	✔	
Long-tailed brush lizard	*Urosaurus graciosus*	✔	✔		
Side-blotched lizard	*Uta stansburiana*	✔	✔	✔	
Desert horned lizard	*Phrynosoma platyrhinos*	✔	✔		
Western whiptail	*Cnemidophorus tigris*	✔	✔	✔	
Western blind snake	*Leptophlops humilis*	✔	✔	✔	
Spotted leaf-nosed snake	*Phyllorhynchus decurtatus*	✔	✔		
Coachwhip	*Masticophis flagellum*	✔	✔		✔
Western patch-nosed snake	*Salvadora hexalepis*	✔	✔		
Gopher snake	*Pituophis melanoleucus*	✔	✔	✔	✔
Glossy snake	*Arizona elegans*	✔	✔		
Common kingsnake	*Lampropeltis getulus*	✔	✔	✔	
Long-nosed snake	*Rhinocheilus lecontei*	✔	✔		
Ground snake	*Sonora semiannulata*	✔	✔	✔	
Banded sand snake	*Chilomeniscus cinctus*	✔	✔	✔	

Table D-4 (continued)
Big Sandy Energy Project
Reptile and Amphibian Species That May Occur In The Project Area

Common Name	Scientific Name	Vegetation types occupied			
		Sonoran Desert Scrub	Mojave Desert Scrub	Xeroriparian Wash	Agricultural / Developed
Western shovel-nosed snake	*Chionactis occipitalis*	✔	✔	✔	
Night snake	*Hypsiglena torquata*	✔	✔		
Lyre snake	*Trimorphodon biscutatus*	✔	✔		
Western diamondback rattlesnake	*Crotalus atrox*	✔	✔	✔	
Sidewinder	*Crotalus cerastes*	✔	✔		
Speckled rattlesnake	*Crotalus mitchelli*	✔	✔		
Mojave Rattlesnake	*Crotalus scutulatus*	✔	✔		

EXHIBIT E- SCENIC AREAS, HISTORIC SITES AND STRUCTURES, ARCHAEOLOGICAL SITES

As stated in Arizona Corporation Commission rules of Practice and Procedure R14-3-219:

"Describe any existing scenic areas, historic sites and structures or archaeological sites in the vicinity of the proposed facilities and state the effects, if any, the proposed facilities will have thereon."

SCENIC AREAS/VISUAL RESOURCES

The proposed Project occurs in a transition area between the Basin and Range and the Colorado Plateau physiographic provinces. The landscape of the general area is characterized by mountain ranges trending north and south with long, linear valleys between ranges. Geologic formations provide a diverse, scenic terrain. The Project area lies within the valley of the Big Sandy River, between the Hualapai and Aquarius Mountains. The valley consists of a broad panorama of open, flat terrain vegetated with desert scrub. The upland terrain is incised with drainages that flow to the river, creating an undulating landscape. The Hualapai Mountains on the west and the Aquarius Mountains on the east side of the valley provide a scenic backdrop to the views of the valley.

The proposed Plant site is located on private lands approximately 2.0 miles east of U.S. Highway 93. The surrounding landscape, as seen from the highway, consists of sparsely vegetated, flat terrain backdropped by nearby mountains. **A complete description of the area and analysis of potential effects is contained in Exhibit E-1.**

The Mohave County General Plan has developed Scenic Resource Goals to preserve, protect and enhance scenic routes and vistas that characterize the rural beauty of Mohave County. In order to implement the goal, the County has identified key scenic routes through the County. The proposed Plant site is located within the viewshed of the scenic route that extends from Wikieup south along U.S. Highway 93 to the Mohave County boundary.

The BLM has inventoried visual resources on public lands in the Kingman Resource Area according to the Visual Resource Management (VRM) system. The VRM system is the basic tool used by the BLM to inventory and manage visual resources according to a classification system. VRM classes are objectives that outline the amount of disturbance an area can tolerate before it no longer meets the objectives of that class. There are four VRM classes (I through IV), each of which combines an evaluation of visual quality, visual sensitivity of the area, and view distances. In practice, these classes describe the different degrees of modification allowed in the visual environment on BLM-managed lands. Based on the VRM mapping available from the BLM's Resources Management Plan (1993), the Plant site is located within VRM Class III.

Approximately 6.5 miles of the natural gas pipeline corridor are located on BLM lands that are predominantly Class IV, with some Class III lands at the Carrow-Stephens Ranch. In Class III lands, contrasts to the basic elements caused by a management activity are evident, but should remain subordinate to the existing landscape in terms of scale, but should repeat the form, line, color and texture of the characteristic landscape.

The proposed natural gas pipeline will create a low impact to the visual quality of the landscape that will occur only during construction of the pipeline and persist until revegetation is complete. The new natural gas transmission pipeline will occur within existing rights-of-way for its entire length. Most of the pipeline will be located immediately adjacent to U.S. Highway 93 and a segment of Mohave County's Hackberry Road.

Potential Effects on Scenic Quality

Impacts to visual resources for the development of the Plant site will result from changes to the physical setting and visual content of the landscape, and from effects on the landscape as viewed from sensitive viewpoints. The proposed facilities will introduce new elements into the landscape, and will alter the form, line, color, and texture which characterize the existing landscape.

A visual analysis of the 60-foot buildings and 130-foot tall stacks at the Plant site was conducted by incorporating the Project components into USGS Digital Elevation Models (DEM). Image processing software was then used to determine points on the DEM where the Project components may be visible based only on line of sight. However, this method does not take into consideration obstruction to visibility, factors such as heat dissipation, and assumes an infinite depth of field.

Within the Big Sandy Valley, the stacks will create a linear and vertical form that would be visible based solely on line-of-sight from most of the west half of the valley, from the river bed to the upper portions of the Hualapai Mountains, and from portions of the western slope of the Aquarius Mountains. The geometric, rectangular block forms of the Plant buildings would only visible again based on line-of-sight from the upper portions of the Hualapai Mountains and from the area immediately surrounding the Plant site. The stacks and buildings will also be visible from higher elevations in the area south of the Big Sandy Valley. However, the ability of the unaided eye to see either the stacks on buildings will be reduced and ultimately lost at distances greater than three or four miles.

The steam plume created by the cooling towers, when present, would be visible from most of the Big Sandy Valley due to the contrast of the light-colored plume with darker mountainous background. The visual impact from the steam plume from the towers will range from low to high, depending on temperature and humidity conditions. In the desert environment in the Project area, the temperature and humidity conditions suitable for creation of a visible plume will occur only intermittently and most commonly in the cooler weather periods. Because of the high temperatures and low humidity in the area, steam from the cooling towers would normally dissipate quickly.

The plant buildings may be visible from the highway but will be painted to harmonize with landscape colors. The buildings will create a low to moderate contrast with the surrounding landscape that may be seen by viewers in Wikieup, on U.S. Highway 93.

Sensitive viewpoints consist of locations from which a significant number of people who may have a concern for scenic resources will view a landscape or will be exposed to Project activities. Sensitive viewpoints are generally located on transportation routes, residential areas and recreational use areas.

In the vicinity of the Plant site, the stacks may be visible to travelers on U.S. Highway 93, but the Plant buildings would not be seen from the highway. Likewise, the stacks may be visible from the town of Wikieup but the Plant buildings would not be visible.

The Burro Creek Wilderness area is located about ten miles east of the Plant site, and the Arrasta Mountain Wilderness Area is located approximately 13 miles to the south. The preliminary visual analysis conducted for this Project indicates that the Plant site would not be visible based on line-of-sight from the Burro Creek Wilderness Area and could only be visible (line-of-sight) from very small portions of the higher mountains on the north end of the Arrasta Mountain Wilderness Area. While the Plant site itself will not be obvious from these areas, the steam plume, when present, may be visible to recreationists within the wilderness areas due to contrasting colors of plume and background.

Several Areas of Critical Environmental Concern (ACEC) have been identified by the BLM in the area. Based on the line-of-sight analysis, the stacks may be visible from the Carrow Stephens ACEC, a historic ranch located near the Big Sandy River about five miles north of Wikieup. The stacks may also be visible (line-of-sight) from higher portions of the Clay Hills, Big Sandy, and McCracken Mountains ACECs located south and southwest of the Plant site. These make only a small fraction of the total area of the ACECs. Again, the greater distances to the Plant site from these ACECs would likely preclude the viewer from being able to see the facilities.

HISTORIC SITES AND STRUCTURES AND ARCHAEOLOGICAL SITES

Cultural resources in the vicinity of the Plant site and **ancillary facilities,** including both historic and archeological sites, are discussed in **Exhibit E-2.**

EXHIBIT E-1

VISUAL RESOURCES

REPORT

BIG SANDY POWER PROJECT
VISUAL RESOURCES

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September 2000

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FIGURES

INTRODUCTION

Caithness Big Sandy, L.L.C. (Caithness) has proposed to develop, construct, own, and operate the Big Sandy Energy Project (Project), a natural gas-fired, combined-cycle power plant (Plant) near the unincorporated community of Wikieup, approximately 40 miles southeast of the City of Kingman along U.S. Highway 93 in Mohave County, Arizona. Please refer to the Big Sandy Energy Project description for a detailed description of the Project.

The analysis will examine the effects of the proposed action and alternatives on the visual resources viewshed affected by the proposed Project, including the U.S. Highway 93 corridor and the town of Wikieup in Mohave County, Arizona. The analysis will focus on issues that have been identified for the Big Sandy Energy Project. The issues identified for visual resources are:

- BLM considers the landscape along much of the U.S. Highway 93 corridor between Interstate 40 and Burro Creek to be of high quality, and manages it as such. The primary issue is how much impact the introduction of the proposed power plant and ancillary facilities will have on the visual quality of the highway corridor.

- Will the facility add light pollution?

ANALYSIS AREA

The visual resources analysis area (Project area) for the proposed action and alternatives consists of federal, private and state lands within a five-mile radius of the power plant location, and within 1 mile of the proposed gas pipeline. The cumulative effects area is the U.S. Highway 93 corridor between Interstate 40 and the Santa Maria River, including lands within the viewshed of the highway.

SOURCES OF DATA/METHODS OF DATA COLLECTION

The visual resources of the Kingman Resource Area have been assessed and inventoried by the BLM using the Visual Resource Management System (VRM) guidelines. The Visual Resource Management Class(es) (VRM Classes) in the analysis area were identified from the BLM's Resource Management Classes map (Map 19) in the Kingman Resource Area RMP and Final EIS and ArcView themes provided by the BLM. Data collected for preparation of the landscape and visual resource assessment included color photographs of the proposed Plant site and gas pipeline taken from several viewpoints.

RESOURCE CONDITIONS

The Project area is in a transition area between the Basin and Range and the Colorado Plateau physiographic provinces. The landscape is characterized by mountain ranges trending north and south with long, linear valleys in between the ranges. Geologic formations provide a diverse, scenic terrain. The Project area lies within the Big Sandy River Valley, between the Hualapai Mountains to the west and the Aquarius Mountains to the east. The valley is a narrow, north to south trending floodplain. Outside of riparian areas, the floodplain is vegetated with mostly desert shrub. The landscape on both sides of U.S. Highway 93, particularly south of Wikieup, is characterized by steep-sided low ridges and hills alternating with gullies and canyons. Incised drainages and canyons drain to the Big Sandy River from the Hualapai and Aquarius Mountains. The surrounding mountain ranges provide a scenic backdrop to views of the valley. The north part of the Project area is characterized by panoramic views of broad open, flat to undulating terrain vegetated with desert scrub. South of Wikieup, the views are more limited in scope by the rugged terrain.

Existing visual modification to the natural setting of the Project area consists of transportation routes, utilities, residences, agricultural uses, and commerical enterprises. Cleared/altered land and structures associated with grazing activities and rural residential uses are evident along U.S. Highway 93.

Power Plant and Associated Facilities

The Plant site is located on private land east of U.S. Highway 93. The surrounding landscape consists of sparsely vegetated, flat to gently rolling terrain backdropped by the Aquarius Mountains to the east as seen from the highway. The Plant site is situated in a drainage bottom surrounded by ridges to the south and north, hilly terrain to the west, and the Aquarius Mountains to the east.

The primary views towards the Plant site are from travel routes adjacent to the area. Travel routes include U.S. Highway 93, a north-south highway adjacent to the west side of the Big Sandy River, county roads, and other unimproved local roads that access the area from the highway. The Upper Burro Creek Wilderness is twelve miles southeast of the Plant site, and is the nearest wilderness to the Project area. The Arrastra Mountain Wilderness is approximately 13 miles south of the Plant site. Views of the Plant site from these wilderness areas are likely indistinct at best because of the distances. Other wilderness areas in Mohave County are more than 20 miles from the Plant site.

While there are no specific visual regulations for private lands in the area, the Mohave County General Plan has developed Scenic Resource Goals to preserve, protect and enhance scenic routes and vistas that characterize the rural beauty of Mohave County. In order to implement the goal, the county has identified key scenic routes through the county. U.S. Route 93 is a scenic route south of Wikieup.

The BLM manages visual resources on their lands in the area using their Visual Resource Management system. Most BLM lands that would be affected by the Project have been classified as Class IV under this system which indicates relatively low visual quality.

BLM lands within the U.S. Highway 93 viewshed corridor are managed with VRM Class II. BLM lands to the east of the highway corridor, including BLM lands adjacent to the Plant site, are managed with BLM Class III.

Natural Gas Supply Line

The landscape along the proposed natural gas pipeline corridor segments is characterized by flat to slightly rolling terrain, and vegetation consisting of grasses and desert shrubs. The one-mile wide corridor includes U.S. Highway 93, existing transmission lines, and commercial and residential developments. U.S. Highway 93 is one of the primary transportation routes through Mohave County, connecting the cities of Phoenix and Las Vegas. Other existing roads include county roads (paved and unpaved) and numerous two-track 4-wheel-drive roads. The town of Wikieup supports a concentration of commercial and residential uses along the proposed pipeline corridor.

The overall scenic quality along the proposed pipeline corridor is moderate, primarily because the landscape as viewed from U.S. Highway 93 is typical of landscapes throughout Mohave County. There are no unique landscape features to provide contrast and variety in the landscape. In general, the corridors have a low level of viewer sensitivity to modification of the existing environment. A significant number of viewers reside in Wikieup and travel on U.S. Highway 93. Viewer sensitivity is somewhat high along the pipeline corridor, primarily because the line crosses through a rural area typified by grazing and scattered residential uses. Other than the highway, the landscape in this area has not been modified by industrial development, and has a low capacity to absorb additional man-made development.

KEY OBSERVATION POINTS

Analysis of the Project viewshed (see **Figure 1**) was used to determine the Key Observation Points (KOPs). Four KOPs were selected to represent the views of the Project area as seen by a significant number of people at locations from which the Project area would be visible. Because the Plant site is screened from many viewpoints by the terrain, there are few locations within the analysis area that provide direct views of the Plant site that would be seen by a significant number of people. The analysis area is sparsely populated, and the only concentration of people (approximately 200) reside in Wikieup or are travelers on U.S. Highway 93. The KOPs are described below.

- KOP 1 - U.S. Highway 93 at the Mobil Service Station near the south end of Wikieup. The KOP will provide a direct line-of-sight to the approximately upper one-third of the proposed 130-foot stacks at the Plant site. The Plant site (ground and proposed 60-foot tall buildings) is blocked from views at any location in Wikieup and all of U.S. Highway 93 north of Wikieup by a tall ridge on the north side of the Plant site that extends across the viewshed from the Aquarius Mountains to a point east of the highway. This location represents views of the Plant site as seen by travelers on the highway and by residents of Wikieup. The Plant site is in the middleground distance zone, with terrain that ranges from horizontal to diagonal. Vegetation appears as grey-green stippled areas interspersed with light tan rock and soil.

OVERSIZED
DOCUMENT

MAP

SEE SUPERVISOR
(EXHIBIT CABINET)

- KOP 2 - Chicken Springs Road approximately 3 miles west of the intersection with U.S. Highway 93 in Wikieup. The KOP is approximatley seven miles northwest of the Plant site. Local residents and a few travelers use Chicken Springs Road. The KOP is one of the few locations in the Project area from which potential viewers are provided a direct line of sight to the topographic "bowl" of the Plant site that is not screened by the surrounding ridge terrain. The Plant site is between the middleground and background distance zones, with undulating, horizontal terrain that appears to be uniformly textured, with dark to medium grey-brown colors.

- KOP 3 - U.S. Highway 93 at the intersection of Burro Creek Crossing road at milepost 132. The Arizona Department of Transporation construction yard is also at this location. This location is a high point along the highway that is about 3.5 miles south of the Plant site, and provides a panoramic view of the Plant site and surrounding landscape. Most of the Plant site is blocked from view by an east-to-west trending ridge on the south side of the site. The Plant site as seen from KOP 3 is in the middleground distance zone, and is characterized by horizontal, undulating terrain. Vegetation appears as grey-green stippled areas interspersed with light tan rock and soil.

- KOP 4 - South of the Carrow Stephens Area of Critical Environmental Concern (ACEC) on U.S. Highway 93 near milepost 119, approximately eight miles northwest of the Plant site. The location is a high point along the highway, and provides a broad, scenic panorama of the Big Sandy Valley backdropped by the Aquarius Mountains to travelers on the highway. There is no location along the highway that provides an unobstructed view of the Plant site that is not blocked by the surrounding rugged terrain. The Plant site is in the background distance zone, with undulating, horizontal terrain that appears to be uniformly textured, with dark to medium grey-brown colors.

ENVIRONMENTAL EFFECTS

Impacts to visual resources from the development of the proposed Big Sandy Power Plant may result from changes to the BLM's Visual Resource Management system by converting acres within the existing VRM classes, by altering the physical setting and visual quality of the landscape, and by effects on the landscape as experienced from sensitive viewpoints, including travel routes and popular use areas. The proposed facilities and associated access roads would introduce new elements into the landscape, and would alter the existing form, line, color, and texture which characterize the existing landscape.

Impacts to visual resources are considered significant if they substantially change or degrade the character of the landscape as seen from sensitive viewpoints, or if the allowable modification to the landscape prescribed for the BLM VRM classifications cannot be met.

This Project has direct and indirect effects to the visual quality from several persepectives - land owners, recreationists, and travelers on local roads and highways. According to theVisual Resource Management Classes map (Map 19) in the Kingman Resource Area RMP and Final EIS, the proposed Project area is managed with VRM classes II, III, and IV. The Project area includes all land within a 5-mile radius of the powerplant location and within 1 mile of the proposed gas pipeline.

Power Plant and Associated Facilities

Impacts to the visual resources of the Project area from the development of the proposed Plant and the ancillary facilities would occur as short-term disturbance of the landscape by project construction activities, and as the long-term addition of proposed facilities to the landscape. These effects result from changes to the physical setting and visual quality of the landscape and how the landscape is experienced from sensitive viewpoints including travel routes and communities. Over the long-term, the proposed facilities would introduce new elements into the landscape that would alter the existing form, line, color, and texture of the existing landscape.

Short-term impacts from construction to the visual character of the Project area's landscape would likely occur over a two-year period. Activities typically would take place five to 7 days a week. There would also be traffic associated with moving equipment over public highways and local roads. These visual intrusions would be noticeable to travelers on U.S. Highway 93 and to commercial businesses and residences along the highway in the town of Wikieup.

Long-term impacts would result from the addition of the power plant, switchyard, access road, and the water storage /evaporation pond to the landscape. The taller features of the Plant constitute a visual impact at some observation points because there would be a noticeable change to a previously undeveloped landscape. The proposed location is on private land approximately 2.25 miles east of U.S. Highway 93, and would be partially within the viewshed of travelers on the highway and from Wikieup.

The only features of the Plant that would be visible from viewpoints along U.S. Highway 93 are the upper portions of the proposed 130-foot stacks. The two stacks of Phase I and additional, third stack for Phase II would create linear and vertical forms that would be obvious to viewers at some locations on the highway. The Plant buildings would be screened from all views on the highway by the ridges and hilly terrain that surround the Plant site. The stacks would be painted desert colors to harmonize with the landscape, which would decrease the contrast with the surrounding landscape. The Plant would be visible, but indistinct to east-bound viewers traveling on the higher elevations of Chicken Springs Road. The wilderness areas to the south and east of the Plant site would not provide views of the proposed facilities because the Plant would be at too great a distance to be visible from any viewpoint in the wilderness areas. The nearest, Upper Burro Creek Wilderness, is 12 miles east of the Project area.

A steam plume created by the cooling tower would be visible from viewpoints on U.S. Highway 93, Wikieup, and possibly as far away as the wilderness areas. The visual impact from the plume would vary depending on temperature and humidity conditions. Normally, steam from the cooling towers would dissipate quickly and a plume would not form. The temperature and humidity conditions suitable for creation of a visible plume would occur intermittently and infrequently throughout any year during the life of the Plant. It is estimated that suitable conditions for plume creation would occur a few times annually, primarily during the winter months. When a plume does form, it may create an obvious contrast with the existing landscape. Portions of U.S. Highway 93 south of

Wikieup are designated by Mohave County as a scenic route. The plume may be intermittently and infrequently visible to travelers along the highway both north and south of Wikieup. The plume may also be visible to the town of Wikieup, including residential areas. The plume may also be visible during the infrequent periods of time to recreationists in the Upper Burro Creek Wilderness twelve miles east of the Project area and the Arrastra Mountains Wilderness, thirteen miles to the south. The plume would not be visible to recreationists in other wilderness areas in Mohave County, because they are located more than 20 miles from the Plant site.

The visual impact from the construction and operation well field and water pipelines would be limited to viewers traveling on the county-maintained Plant access road. The facilities would be screened from views on U.S. Highway 93 by vegetation and the terrain. The drill rigs may be seen from some locations along the highway for a relatively brief period of time during drilling operations. The well pads for each of the five proposed water wells would consist of a disturbed area large enough for equipment access and truck turn-around areas, however, the well pads would not be visible from any location other than the access road. Existing desert shrub along the waterlines would be disturbed by installation of the lines. Once the lines are installed and the land within the construction ROWs is reclaimed, the visual impact resulting from construction would continue until vegetation has been reestablished on disturbed areas.

Plant facilities would be lit at night in order to enhance the safety of Project personnel and the public. Night-lighting would increase the visibility of Project facilities to all viewpoints. The primary impact of night-lighting would be increased distance from which the proposed facilities would be visible. The light, glare or backscatter illumination visible to sensitive viewpoints would be minimized by the use of directional shielding of lights. The off-site visibility and potential glare of the lighting would be restricted by existing topography that screen the facilities, the screening structures to be placed around the facility's major equipment, specification of non-glare fixtures, and placement of lights to direct illumination into only those areas where it is needed.

FAA requires that any permanent object that exceeds an overall height of 200 feet above ground level or exceeds any obstruction standard contained in FAR Part 77 (2000a) be lighted with a flashing lighting system. Because the proposed stacks are 130 feet in height and more than three nautical miles from the nearest airport (as per FAR Part 77), blinking safety lights would not need to be installed (FAA 2000b).

Figures 2 through **5** each depict a simulation of Project facilities that would be visible from each KOP. KOPs were selected to represent viewpoints from the transportation routes and the town of Wikieup.

- KOP 1 - The 130-foot stacks would be the only Plant facility visible to viewers at this KOP. The stacks would be painted with colors that harmonize with the desert landscape and would be a minor feature in the landscape as seen from this KOP. The steam plume, when present, would be the most visible feature of the facility as viewed from KOP 1.

- KOP 2 - The Plant facilities are difficult to discern from the surrounding landscape at the seven-mile distance of the KOP from the Plant site. The facilities may be visible to east-bound travelers on the road. The distance of the facilities from the KOP would reduce any contrast with the surrounding natural landscape of the blocky, geometric and rectangular forms and the vertical/horizonal lines of the Plant facilities. The Plant buildings would be painted with colors that harmonize with the desert landscape, which would further minimize the contrast of the building with the surrounding landscape. The steam plume, when present, would be the most visible feature of the facility as viewed from KOP 2.

- KOP 3 - The Plant buildings would not be visible from KOP 3 becuase they would be screened from view by ridges and hilly terrain between the Plant facilities and the KOP. The 130-foot stacks may be seen from this viewpoint as linear, vertical, parallel structures that contrast with the surrounding, predominatly undulating, horizontal terrain. The stacks would be painted with colors that harmonize with the desert landscape, which would minimize the contrast of the vertical lines of the stacks with the surrounding landscape. The steam plume, when present, would be the most visible feature of the facility as viewed from KOP 3.

- KOP 4 - The 130-foot stacks would be the only structures that would be visible from the KOP. The view of other facilities would be blocked by the ridges and rugged terrain that surrounds the Plant site. The steam plume, when present, would be the most visible feature of the facility as viewed from KOP 4.

Natural Gas Pipeline

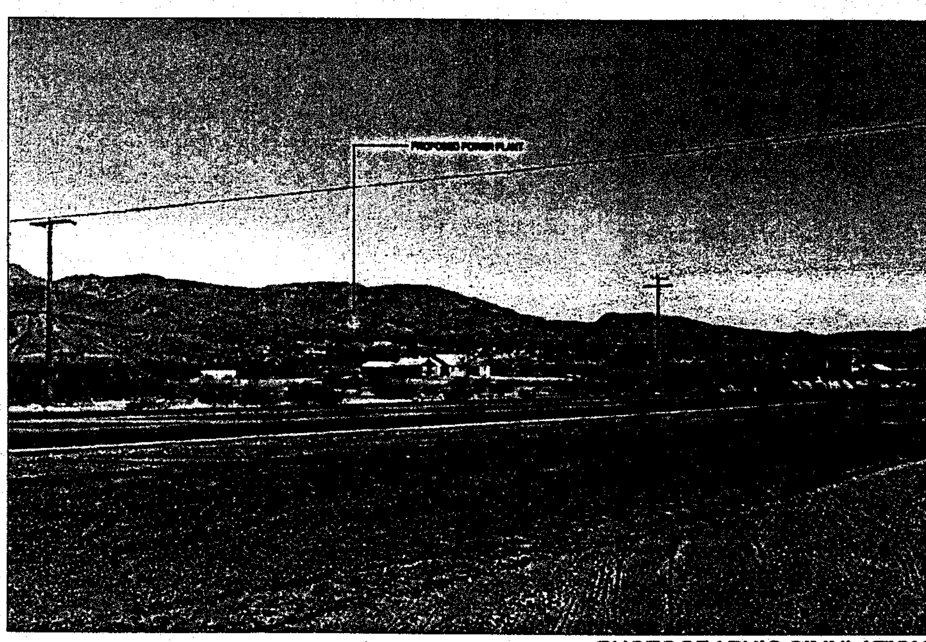
Impacts to the visual resources from the construction and operation of the proposed natural gas pipeline would be primarily short-term and construction related. Most of the proposed 36-mile pipeline route is sited within or adjacent to the existing ROW for U.S. Highway 93 in a corridor that has been previously or is proposed to be disturbed by highway and road construction. The northern portion of the proposed pipeline would be installed within or adjacent to an existing county road ROW (Hackberry Road).

Portions of the pipeline ROW would be cleared of vegetation and graded as necessary to provide a level surface for construction equipment. Materials removed during grading and trenching would be stockpiled next to the trench. After pipe installation, the trench would be backfileed with previously excavated materials and the ROW would be regraded to its approximate pre-construction contour. The revegetation of areas disturbed by construction with salvaged and stockpiled plants would be determined jointly with ADOT or the appropriate land management agency or owner.

Once the pipeline is installed and the land within the ROWs is reclaimed, the visual impact resulting from construction would continue until vegetation has been reestablished on disturbed areas. Approximately 6.5 miles of the pipeline ROW is on BLM lands designated as Visual Resource Management (VRM) Class IV. Class IV objectives provide for major modification of the landscape, and allow management activities to dominate the landscape. The construction and operation of the gas pipeline would be consistent with VRM Class IV objectives because there would no significant long-term visual impact from pipeline disturbance as it would share a portion of the existing highway ROW and adjacent disturbance, which is a dominant linear feature in an otherwise natural landscape. Once the disturbed portions of the ROW are re-contoured and revegetated, the pipeline would not comprise a modification of the landscape.

EXISTING CONDITION

View from Wikieup Mobil Station looking southeast to plant site.

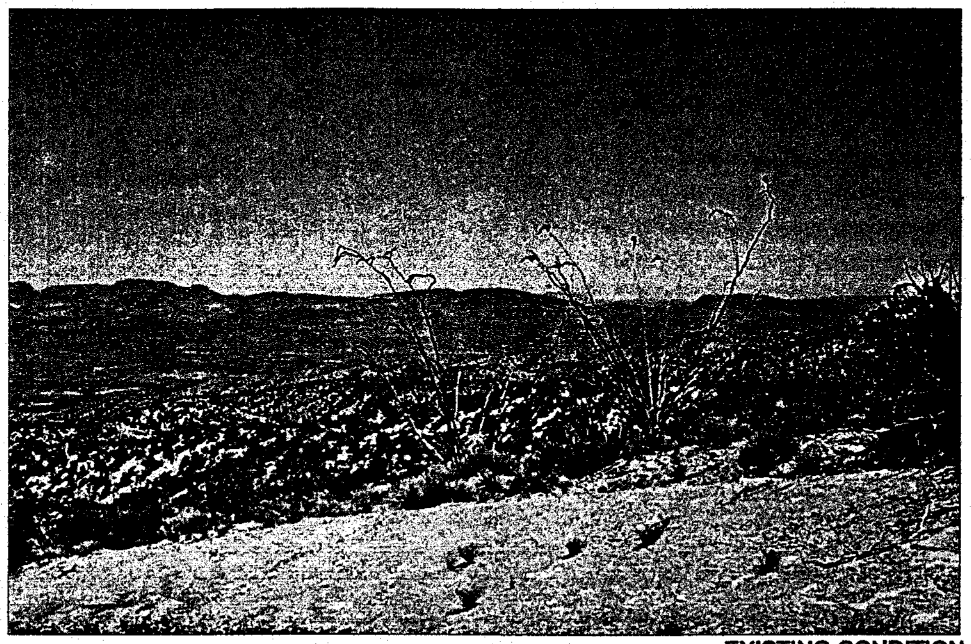


PHOTOGRAPHIC SIMULATION

The simulation depicts the power plant stacks and the plume as it will appear under the worst case scenario.

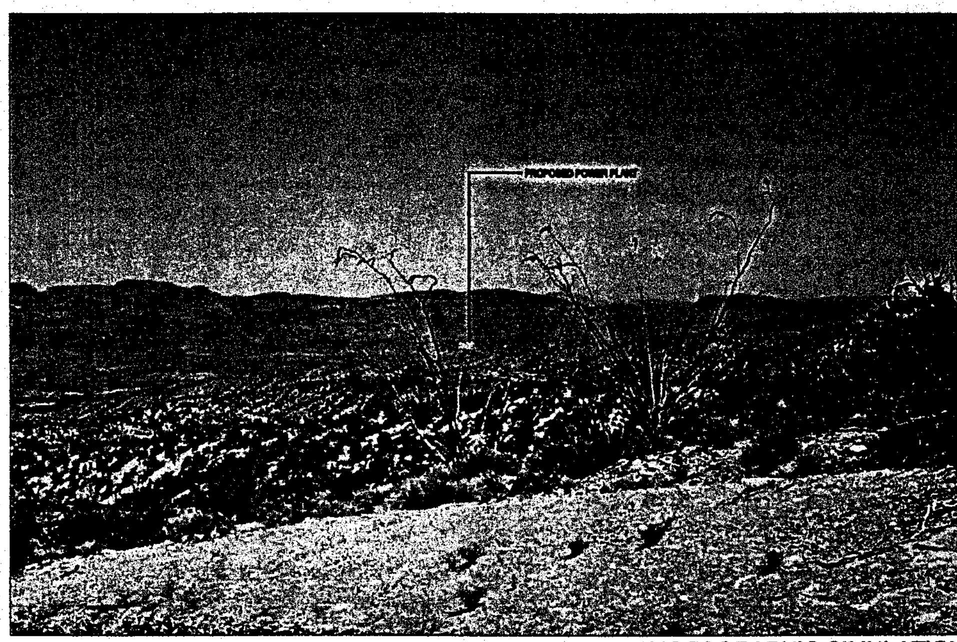
The plant buildings are concealed behind a ridge and will not be visible from this KOP.

BIG SANDY ENERGY PROJECT	
KOP 1	
DATE: 7/11/00	AutoCAD File:PHOTOS.DWG
SCALE:NTS	DRAWN BY: EC



EXISTING CONDITION

View from Chicken Springs Road about 7 miles northwest of the plant site. The KOP is at a high elevation that overlooks the plant site and the surrounding landscape.



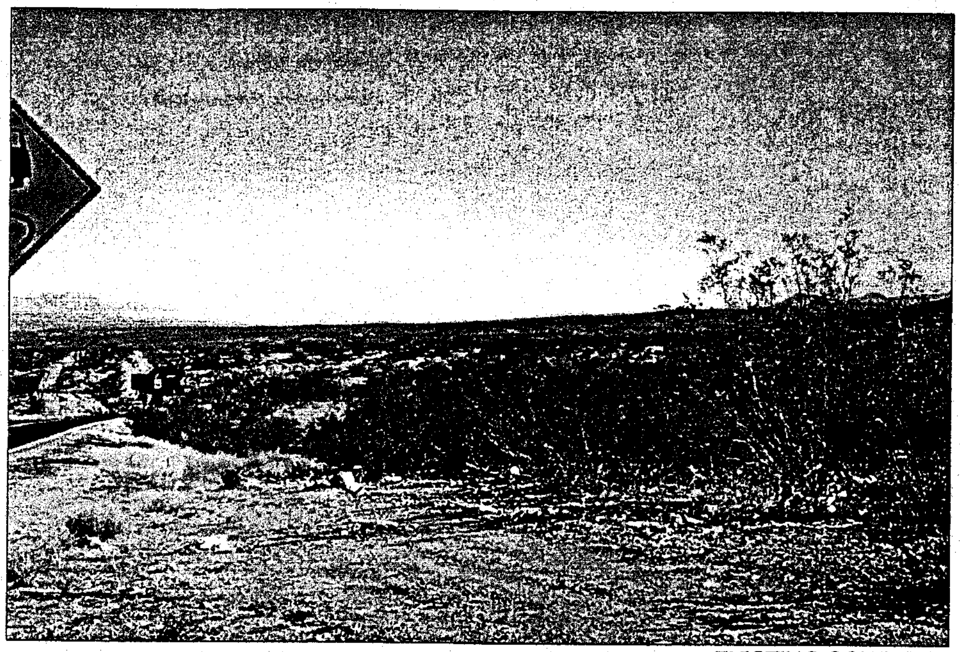
PHOTOGRAPHIC SIMULATION

The plant buildings will be in the background view as seen from the KOP. The scale of the plant is small relative to the surrounding landscape, and contrasts of color, line and form are weak because of the distance. The plume is depicted as it will appear under the worst senario.

BIG SANDY ENERGY PROJECT

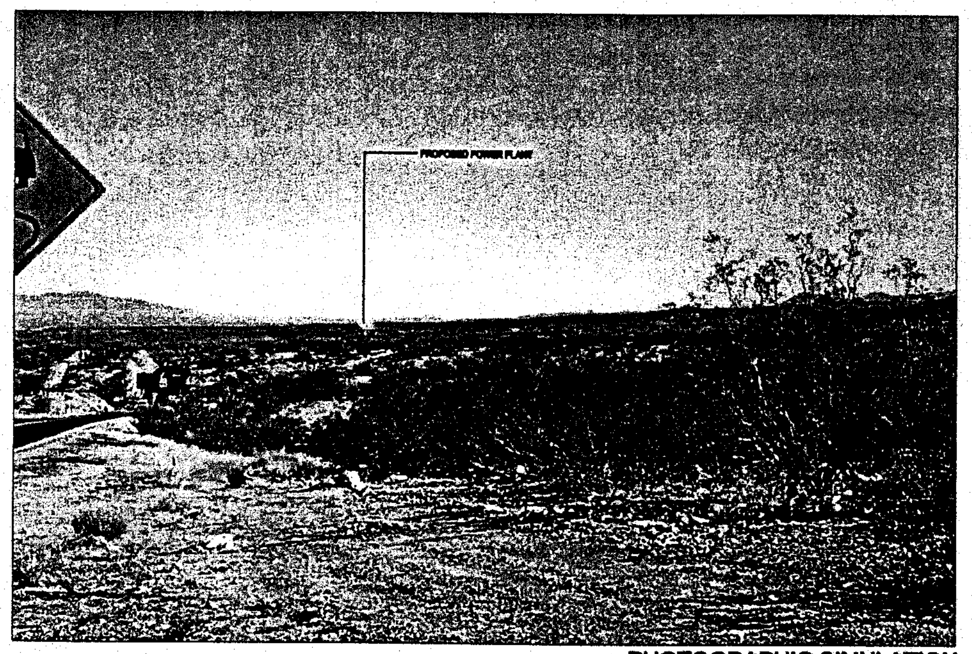
KOP 2

DATE: 7/11/00	AutoCAD File:PHOTOS.DWG
SCALE:NTS	DRAWN BY: EC



EXISTING CONDITION

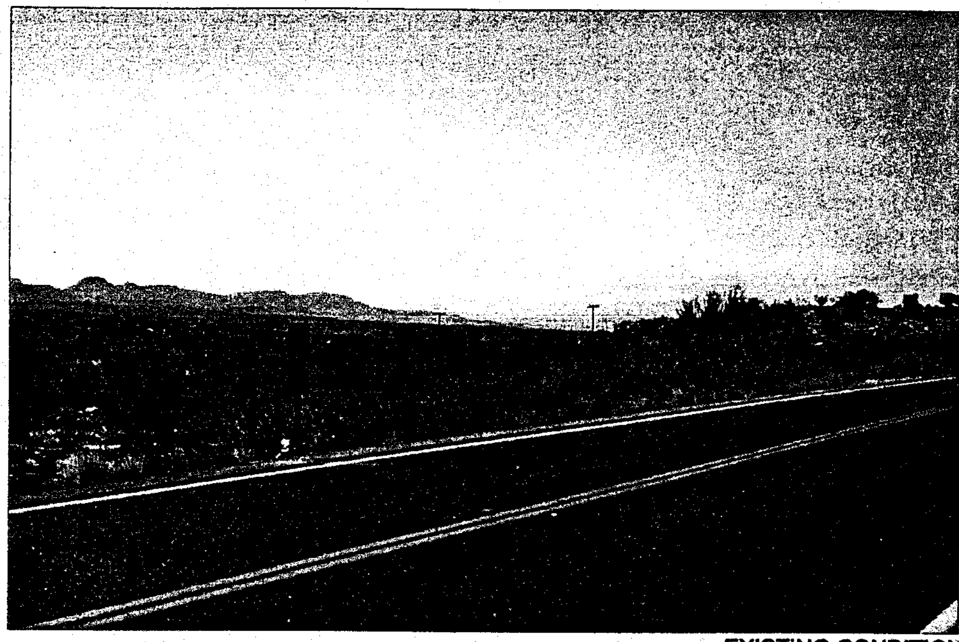
View from Highway 93 at Burro Creek Crossing 3.5 miles south of the plant site provides a panoramic view of the site.



PHOTOGRAPHIC SIMULATION

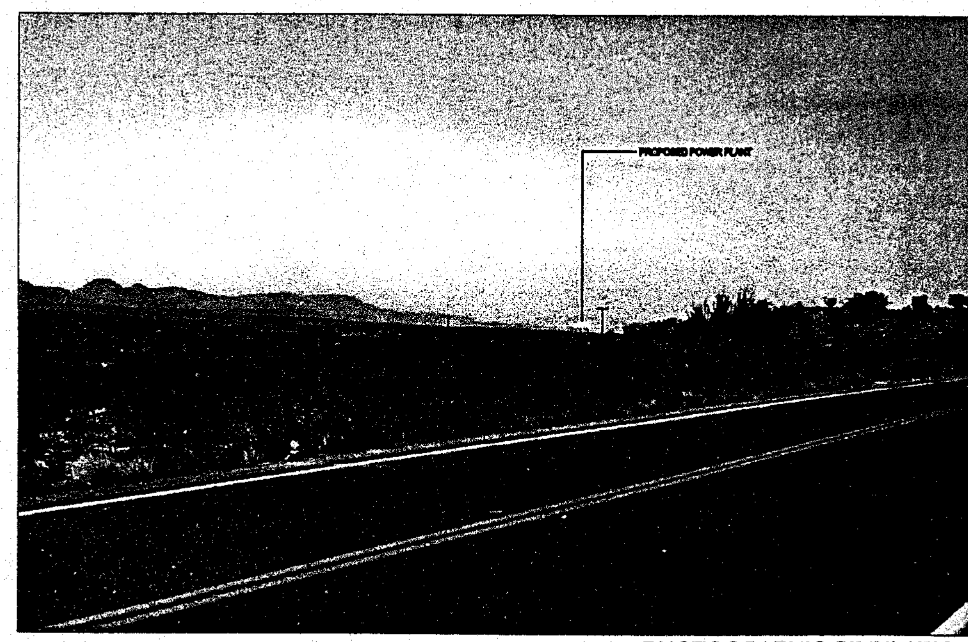
The simulation depicts the power plant stacks and the plume as it will appear under the worst case scenario. The other plant buildings will be concealed by a low ridge.

BIG SANDY ENERGY PROJECT	
KOP 3	
DATE: 7/11/00	AutoCAD File:PHOTOS.DWG
SCALE:NTS	DRAWN BY: EC



EXISTING CONDITION

The view is from KOP 4 on Highway 93 on the south side of Carrow Stephens ACEC 8 miles northwest of the plant site.



PHOTOGRAPHIC SIMULATION

The plant building will be screened from view by the topography. The power plant stacks will be obscured by distance. The simulation depicts the plume as it would appear under the worst case scenario.

BIG SANDY ENERGY PROJECT	
KOP 4	
DATE: 7/11/00	AutoCAD File:PHOTOS.DWG
SCALE:NTS	DRAWN BY: EC

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EXHIBIT E-2

CULTURAL RESOURCES REPORT

EXHIBIT E-2
CULTURAL RESOURCES REPORT

SCENIC AREAS, HISTORIC SITES AND STRUCTURES, AND ARCHAEOLOGICAL SITES

HISTORIC SITES AND STRUCTURES AND ARCHAEOLOGICAL SITES

Methods

Since the submittal of the original application, additional studies have been initiated to assess potential environmental impacts of the project in compliance with the National Environmental Policy Act. These studies, which are being conducted on behalf of the Western Area Power Administration (Western) and the Bureau of Land Management (BLM), include consideration of cultural resources and also are intended to address requirements of the National Historic Preservation Act.

The cultural resources records review included in the original submittal has been expanded to encompass areas within 3 miles of the power plant site, well field, access roads, and alternative routes being considered for a natural gas pipeline. This search area encompasses approximately 317.5 square miles. Information about prior cultural resource studies and previously recorded archaeological and historical sites was collected from files maintained by the State Historic Preservation Office, Arizona State Museum, Museum of Northern Arizona, and BLM Kingman Field Office and Arizona State Office.

In addition, an intensive pedestrian field survey of the proposed power plant site, well field, four observation wells, and three access roads has been completed. Approximately 558 acres were surveyed, including 520 acres of private land and 38 acres of public land administered by the BLM.

Western, having assumed lead federal agency responsibilities for complying with Section 106 of the National Historic Preservation Act, also initiated consultation with six tribal governments to solicit information about traditional cultural places and other cultural resources that may be of concern to those Indian communities. The groups contacted include the Hualapai Tribe, Yavapai-Prescott Indian Tribe, Yavapai-Apache Tribe, Fort Mojave Indian Tribe, Colorado River Indian Tribes, and Hopi Tribe. The project area is within the traditional territory used primarily by the Hualapai Tribe and arrangements were made for the Hualapai Cultural Resource Department to conduct an ethnographic study and participate in the cultural resource survey. Western is continuing to consult with the other tribes.

Findings

The reports of the cultural resource survey and ethnographic study are still in preparation but the preliminary results are summarized here.

The records search identified about 50 prior cultural resource projects within the approximately 6-mile-wide search area encompassing the proposed plant site and related facilities including wells, roads, and alternate alignments being considered for the natural gas pipeline along U.S. Highway 93 and the Mead-Phoenix 500kV transmission line. Approximately 100 archaeological and historical sites have been recorded within this area. About 40 percent of these sites reflect centuries of Hualapai occupation and the earlier Cerbat and possibly Cohonina cultures. Approximately 10 of these sites are camps and habitation locations, and most of the others are scatters of artifacts that represent shorter-term activities. Three of the sites have petroglyphs, and one is identified as a burial ground. The other 60 percent of the site inventory reflects Euro-American settlement and includes primarily ranches, roads, and scatters of trash.

The prior surveys included inventories along the Mead-Phoenix 500kV transmission line and U.S. Highway 93, but very little of the plant site and nearby well field had been surveyed, and therefore additional field survey was conducted at those locations. That field survey resulted in the discovery of mostly widely scattered artifacts. A total of 51 such finds were designated as isolated occurrences (IOs) (Table E-2-1). Most of the IOs are flaked stone—primarily locally available chert that was used by the aboriginal groups who occupied the region to make cutting and scraping tools. Some sherds of broken aboriginal ceramic vessels also were discovered. A few isolated artifacts and rock cairns of historic Euro-American origin also were found.

Table E-2-1
Isolated Occurrences

IO No.	Area (meters^2)	Description
1	1	1 butterscotch chert flake, 1 purplish-brown chert flake
2	3	2 butterscotch chert flakes
3	1	1 chalcedony flake, 1 utilized butterscotch chert flake, 1 piece butterscotch chert shatter
4	9	1 core with 40-50 pieces of reduction and some debitage; poor quality pink and yellow chert with chalcedony inclusions
5	12	1 silt stone flake, 1 butterscotch chert flake, 1 piece butterscotch chert shatter
6	1	1 Prescott Gray sherd, 1 tertiary flake, 1 secondary flake; both butterscotch chert
7	4	1 reddish chert tertiary flake, 2 chalcedony tertiary flakes
8	<1	1 green siltstone tertiary flake
9	1	12 quartzite flakes, 1 butterscotch chert primary flake
10	14	4 butterscotch chert tertiary flakes
11	14	18 Tizon Brown sherds, 1 grayware sherd (possibly Prescott Gray)
12	<1	1 butterscotch chert primary flake
13	1	1 obsidian flake, 1 basalt hammerstone
14	~3 feet	1 historic rock cairn
15	<1	1 purple/red chert utilized flake
16	1	2 purple chert flakes, 1 butterscotch chert flake
17	<1	1 green/black chert flake
18	120	1 possible hammerstone, 2 flakes, 2 pieces of shatter, 12 pieces of debitage; all a reddish chert
19	<1	1 butterscotch/black chert modified flake
20	1	2 cores, 1 secondary flake; all red/butterscotch mottled chert

Table E-2-1 Isolated Occurrences		
IO No.	Area (meters^2)	Description
21	1	1 cairn, 1 secondary flake, 1 tertiary flake, 2 pieces of shatter; all butterscotch chert
22	25	2 butterscotch chert flakes, 1 purple chert flake
23	~3 feet	1 historic rock cairn
24	~3 feet	1 historic rock cairn with pipe through center and metal can on top
25	<1	1 ignimbrite secondary flake (retouched)
26	~1 foot	1 historic harness ring
27	1	1 ignimbrite tertiary flake, 1 butterscotch chert flake
28	4	1 chalcedony knife base, 1 butterscotch chert tertiary flake
29	<1	1 butterscotch chert tertiary flake
30	1	1 variegated chalcedony and reddish chert tertiary flake
31	1	3 butterscotch chert flakes
32	10	2 butterscotch chert flakes, 1 piece chalcedony shatter, 1 chocolate-colored chert tertiary flake
33	40	4 butterscotch chert tertiary flakes, 1 piece butterscotch chert shatter, 1 reddish chert tertiary flake, 1 transparent/black flake
34	50	2 cores, 1 reddish chert tertiary flake, 1 secondary flake, 1 tertiary flake; both butterscotch chert
35	<1	1 butterscotch chert tertiary flake
36	~29 feet	1 historic wooded wagon bed
37	<1	1 red/brown chert flake
38	<1	1 obsidian projectile point
39	1	1 silt stone primary flake, 1 smashed historic can
40	<1	1 butterscotch chert primary flake
41	<1	1 obsidian primary flake
42	~29 feet	trash scatter
43	1	1 tertiary flake, 1 large utilized flake; both are butterscotch chert
44	<1	1 reddish chert/chalcedony secondary flake
45	1	1 white/orange chert tertiary flake, 1 complete aqua beer bottle (circa 1890's), 1 ceramic crock
46	<1	1 brown chert tertiary flake
47	<1	1 brown chert tertiary flake
48	<1	1 brown chert tertiary flake
49	~3 feet	1 historic rock cairn
50	1	1 brown/white chert tertiary flake, 1 core, 1 piece of shatter; both are butterscotch chert
51	1	1 chalcedony core, 1 reddish chert tertiary flake

Six finds were designated and recorded as archaeological sites (Table E-2-2). Three are located within the proposed power plant site parcel, two are near Observation Well 8 and adjacent to a road that provides access to that well location, and one is along the proposed new access road into the plant site. Three of these sites reflect aboriginal occupation of the region, two are historic Euro-American sites, and one contains both Indian and historic Euro-American components.

Table E-2-2 Cultural Resources Inventory							
ASM Site Number	**Size**	**Site Type**	**Function**	**Cultural Affiliation**	**Temporal Affiliation**	**Features**	**NRHP Eligibility Recommendation (Criterion)**
AZ M:6:46	36,075 meters^2	artifact scatter	making stone tools	aboriginal	unknown	lithic reduction locale	potentially eligible (D)
AZ M:6:47	49,200 meters^2	artifact scatter with features	aboriginal campsite; and historic livestock watering at spring	Hualapai; Euro-American	AD 700 to present	fence, well, 2 concrete troughs, metal cattle tank, 2 rock alignments, 2 artifact concentration s	eligible (D)
AZ M:6:48	15 meters^2	rock alignment	possible wikieup ring	aboriginal/ Hualapai?	unknown	none	eligible (D)
AZ M:6:49	9,600 feet^2	trash scatter	trash disposal	Euro-American?	1930s	none	not eligible
AZ M:6:50	1,575 feet^2	trash scatter	trash disposal	Euro-American?	unknown	none	not eligible
AZ M:6:51	460 meters^2	artifact scatter with feature	resource procurement and processing	aboriginal	unknown	cleared circle	eligible (D)

Four of the six archaeological sites are evaluated as having potential to yield important information about the aboriginal and Euro-American history of the region, and therefore are eligible for the National Register of Historic Places (under Criterion D). The two other sites composed of historic trash scatters appear to lack significant historic values. Three of the significant sites will not be affected by construction of the proposed project. The fourth site is located around a spring at the edge of the power plant site. Although the plant is being designed to avoid direct impacts on the spring, it appears that part of the surrounding archaeological site will be disturbed by construction of the plant.

Specific inventories for the natural gas pipeline have not yet been undertaken because a specific right-of-way has not been selected. The prior surveys along the two alternate corridors do provide information about the extent of potential effects on archaeological and historical sites. Surveys along the Mead-Phoenix 500kV transmission line reported four archaeological sites and two historic era roads. One of these sites is the remnants of a significant Hualapai seasonal campsite, and one of the roads, the Hillside to Kingman Highway, has been recommended as National Register-eligible for its informational values (Criterion D). Two of the sites and the other road appear to have no significant historic values and a third site could not be relocated.

Prior surveys along U.S. Highway 93 encompass a corridor about 5 to 10 times wider than has been surveyed along the transmission line. Almost 50 sites plus 12 historic era roads and remnants of a telephone line have been recorded in this area, but approximately 40 percent of these sites and roads appear to have no significant historic values. (Formal consultations regarding National Register eligibility have not been conducted for most of these sites.) The pipeline construction corridor is likely to be about 100 feet wide and is likely to affect some but certainly not all of the sites recorded along the highway corridor.

Both the transmission line and highway corridors cross through the Carrow-Stephens Ranch Area of Critical Environmental Concern, which the BLM designated to protect a historic ranch and other historical and archaeological resources. The historic ranch buildings and structures would be avoided.

Conclusion

The proposed plan is likely to disturb a portion of one significant archaeological site, and several others could be affected by construction of the associated natural gas pipeline. Western and BLM, in conjunction with preparing an environmental impact statement for the proposed power plant project, have drafted a memorandum of agreement to comply with Section 106 of the National Historic Preservation Act. This agreement is being developed in consultation with the State Historic Preservation Office and interested tribal groups to stipulate how cultural resources will continue to be considered as planning of the project continues. The agreement will require additional field survey as project plans (particularly regarding the natural gas pipeline route) become more specific and evaluation of archaeological and historical resources subject to impacts is conducted. Plans to avoid or mitigate any identified adverse impacts also will be developed and implemented in consultation with all signatories of the agreement. The potential is high for satisfactorily mitigating any adverse impacts through minor project modifications or studies to recover important archaeological and historical information prior to construction.

EXHIBIT F - RECREATIONAL PURPOSES AND ASPECTS

As stated in Arizona Corporation Commission Rules of Practice and Procedure R14-3-219:

"State the extent, if any, the proposed site or route will be available to the public for recreational purposes, consistent with safety considerations and regulations, and attach any plans the applicant may have concerning the development of the recreational aspects of the proposed site or route"

RECREATIONAL PURPOSES AND ASPECTS

Neither the Applicant nor land management agencies have proposed any plans for the development of recreational facilities associated with the Plant site. The construction, operation and maintenance of the proposed Plant and associated facilities will be consistent with safety considerations, and will not be open to public access. Recreational use of any lands crossed by the pipelines, water lines, or other Project components would continue to be controlled by any individual or agency currently managing recreation areas or recreation opportunities. **Recreation resources in the Project area are further discussed in Exhibit A-5.**

There are currently no developed recreation areas within the Plant site, and no significant recreation occurs around the proposed Plant location. Dispersed activities such as hunting and off-road vehicle uses do occur on public lands in the general area.

EXHIBIT G - CONCEPTS OF TYPICAL FACILITIES

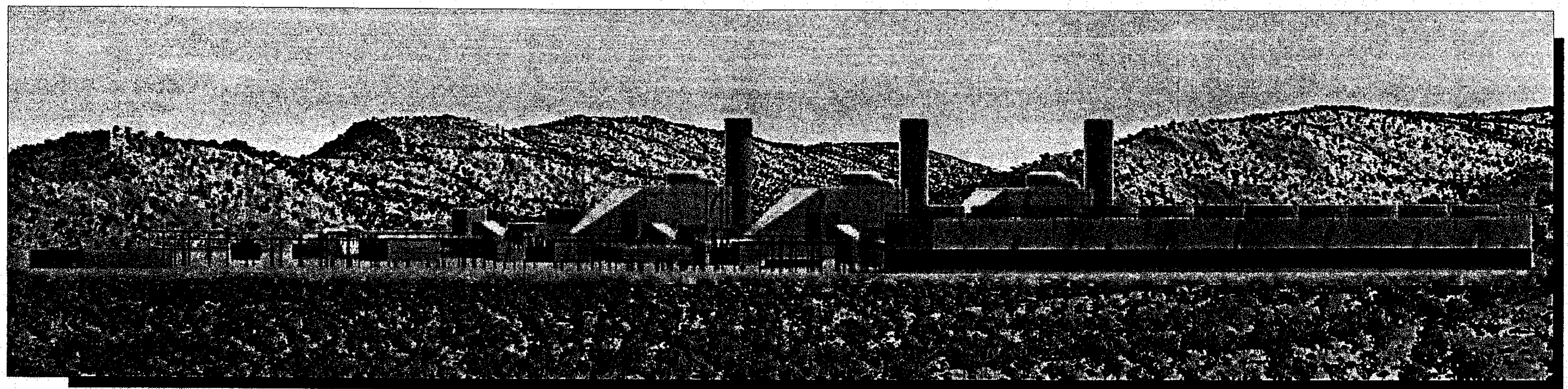
As stated in Arizona Corporation Commission Rules of Practice and Procedure R14-3-219:

"Attach any artist's or architect's conception of the proposed plant or transmission line structures and switchyards which applicant believes may be informative to the committee"

Exhibit G-1 is an artist's rendering of the Plant as seen from several points of view.

EXHIBIT G-1

ARTIST'S RENDITION OF POWER PLANT



VIEW FROM SOUTHWEST LOOKING NORTHEAST

APPLICATION FOR A CERTIFICATE OF ENVIRONMENTAL COMPATABILITY

BIG SANDY ENERGY PROJECT

EXHIBIT G-1
ARTIST'S RENDERING OF POWER PLANT

ANALYSIS AREA KINGMAN TO WIKIEUP, MOHAVE COUNTY, ARIZONA	
DATE: 10/18/00	AutoCAD File: BIGSANDY-VIEWS3.DWG
SCALE:NTS	DRAWN BY: EC

EXHIBIT H - EXISTING PLANS

As stated in Arizona Corporation Commission Rules of Practice and Procedure R14-3-219:

"To the extent applicant is able to determine, state the existing plans of the state, local government, and private entities for other developments at or in the vicinity of the proposed site or route."

Existing and planned land uses are described in **Exhibit A.** **Exhibits A-2 and A-4** depict in detail the existing and future land uses within the Plant area. **In April 2000, Mohave County approved rezoning of the 120-acre power plant site from agricultural use to heavy industrial.** There are no known existing or planned developments of government or private entities at or near the proposed Plant site that will be in conflict with the proposed facilities.

EXHIBIT I - ANTICIPATED NOISE/INTERFERENCE WITH COMMUNICATION SIGNALS

As stated in Arizona Corporation Commission Rules of Practice and Procedure R14-3-219:

"Describe the anticipated noise emission levels and any interference with communication signals which will emanate from the proposed facilitie."

Discussions of environmental noise do not focus on pure tones. Commonly heard sounds have complex frequency and pressure characteristics. Accordingly, sound measurement equipment has been designed to account for the sensitivity of human hearing to different frequencies. Correction factors for adjusting actual sound pressure levels to correspond with human hearing have been determined experimentally. For measuring noise in ordinary environments, "A-Weighted" correction factors are employed. The filter de-emphasizes the very low and very high frequencies of sound in a manner similar to the response of the human ear. Therefore, the A-Weighted decibel (dBA) is a good correlation to a human's subjective reaction to noise.

The following discussion sets a basis of familiarity with known and common noise levels. A quiet whisper at five feet is 20 dBA; a residential area at night is 40 dBA; a residential area during the day is 50 dBA; a large and busy department store is 60 dBA; a typical construction site is 80 dBA; a subway train at 20 feet is 90 dBA; and a jet takeoff at 200 feet is 120 dBA.

A typical gas-fired power plant generating 720MW has a characteristic noise level of under 75 dBA at 400 feet from the buildings. This noise level varies somewhat depending on which side of the power plant the receptor is located. A receptor on the side of the plant with the switch yard or the cooling towers would experience somewhat higher noise levels at 400 feet than on the other sides of the plant. By comparison, vehicles traveling on the highways can produce noise levels of 60-65 dBA at a point 50 feet from the roadway, depending on traffic volume.

The nearest noise receptor (residence) to the proposed Plant will be approximately one mile to the southwest. Rural areas typically have background levels from 40 to 45 dBA. The noise from the Plant would be approximately 52 dBA at the nearest residence. The actual noise level will vary with wind direction and velocity. **A complete assessment of this analysis is presented in Exhibit I-1.**

No communication interference will be caused by the Plant.

EXHIBIT I-1

NOISE TECHNICAL REPORT

REPORT

BIG SANDY ENERGY PROJECT
NOISE TECHNICAL REPORT

Submitted by:

Caithness Big Sandy, LLC
7887 E. Belleview Avenue
Suite 1100
Englewood, CO 80111

September 2000

TABLE OF CONTENTS

Figures

Tables

1.0 INTRODUCTION

Caithness Big Sandy, L.L.C. (Caithness) has proposed to develop, construct, own, and operate the Big Sandy Energy Project (Project), a natural gas-fired, combined-cycle power plant (Plant) near the unincorporated community of Wikieup, approximately 40 miles southeast of the City of Kingman along U.S. Highway 93 in Mohave County Arizona. Please refer to the Big Sandy Energy Project description for a detailed description of the Project.

This technical report describes the existing noise in the general vicinity of the Big Sandy Energy Project and the noise that can be expected with the construction and operational phases of the Project.

Noise is generally described as unwanted sound. Discussions of environmental noise do not focus on pure tones because commonly heard sounds have complex frequency and pressure characteristics. Accordingly, sound measurement equipment has been designed to account for the sensitivity of human hearing to different frequencies. Correction factors for adjusting actual sound pressure levels to correspond with human hearing have been determined experimentally. For measuring noise in ordinary environments, A-Weighted correction factors are employed. The filter de-emphasizes the very low and very high frequencies of sound in a manner similar to the response of the human ear. Therefore, the A-weighted decibel (dBA) is a good correlation to a human's subjective reaction to noise. The dBA measurement is on a logarithmic scale. The apparent increase in "loudness" doubles for every 10 dBA increase in noise (Bell, 1982). Taking a baseline noise level of 50 dBA in a daytime residential area, noise of 60 dBA would be twice as loud, 70 dBA would be four times as loud, and 80 dBA would be eight times as loud.

The following discussion sets a basis of familiarity with known and common noise levels. A quiet whisper at five feet is 20 dBA; a residential area at night is 40 dBA; a residential area during the day is 50 dBA; a large and busy department store is 60 dBA; rush hour traffic at 100 feet from the road is 60-65 dBA; Interstate traffic at 200 feet is 65 dBA; a heavy truck at 50 feet is 75 dBA; and a typical construction site is 80 dBA. At the upper end of the noise spectrum, a jet takeoff at 200 feet is 120 dBA (Harris, 1991).

2.0 EXISTING NOISE

The ambient noise in the vicinity of the Big Sandy Energy project area is typical of a rural area. Noise was measured for a 24-hour period on June 9, 2000. Noise was measured within 150 feet of the nearest residence to the proposed power plant located more than two-thirds mile to the southwest of the site. A Metrosonics DB3080 noise meter, set to record the average noise in 30-minute intervals, was used to measure the noise. The general background noise was 42.5 dBA. The exception was when construction activities (water well drilling and pipeline trench construction) were occurring from 8:00 am to noon. During this time, the average background noise was about 58 dBA. The graphical representation of the 24-hour noise survey is shown on **Figure 1**. During the

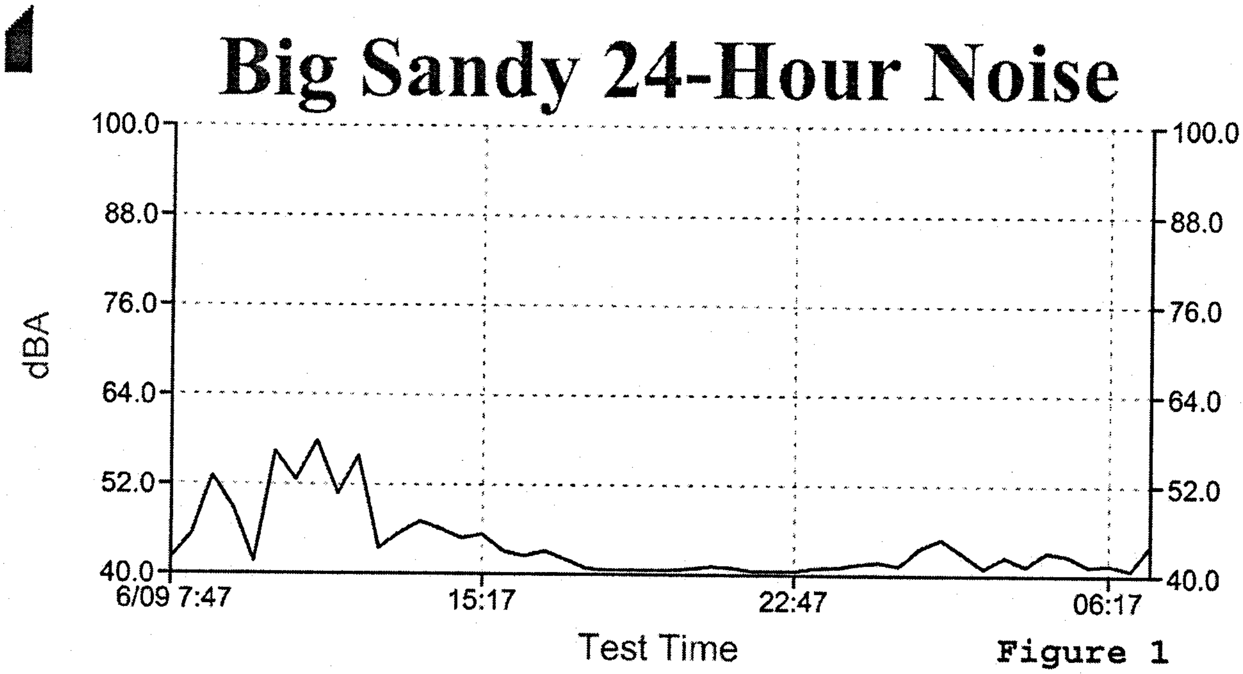


Figure 1

OverAll Lav = 45.9dB

Lav

Big Sandy Noise

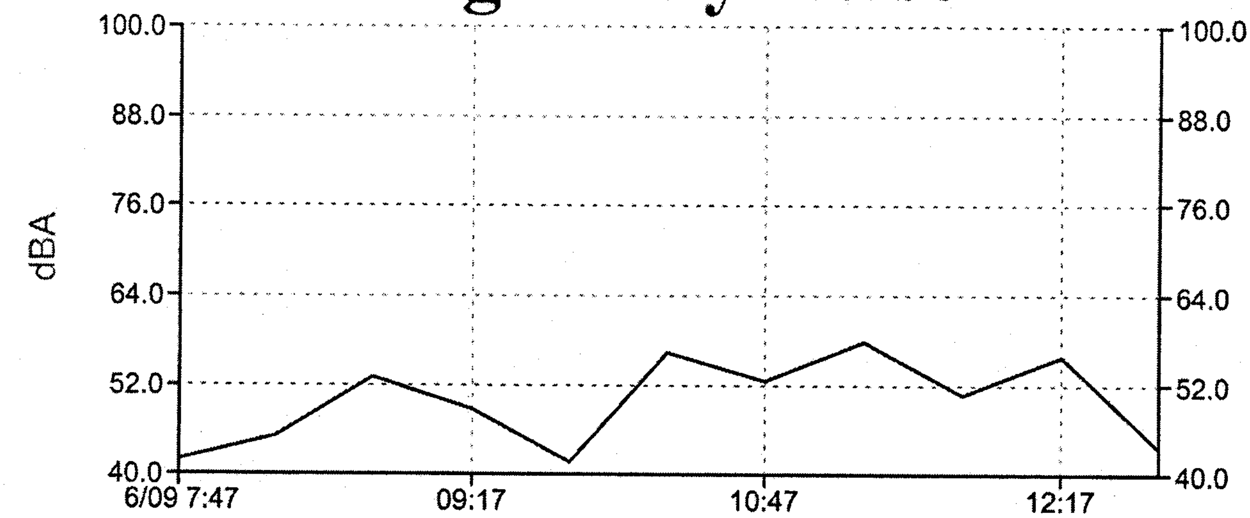


Figure 2

OverAll Lav = 51.8dB **During Construction Activities**

Big Sandy Noise

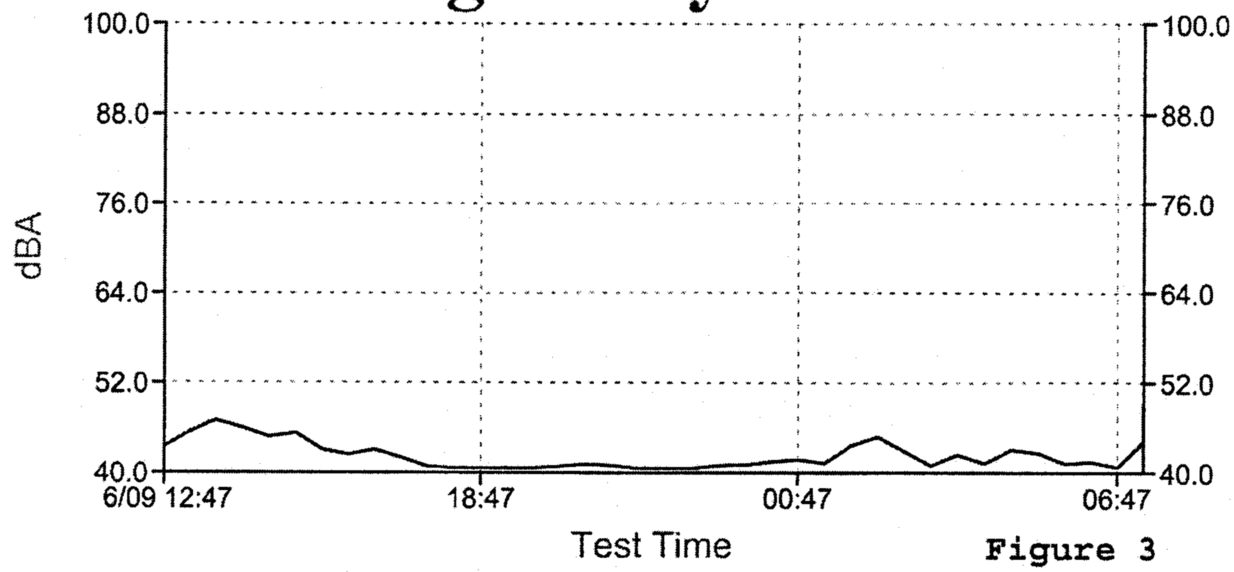
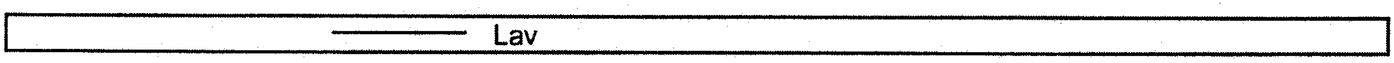


Figure 3

OverAll Lav = 42.5dB **No Construction Activities**



24-hour period, the average noise was 45.9 dBA. **Figure 2** shows the noise level (51.8 dBA) from 8:00 am to noon when construction was occurring. **Figure 3** shows the background noise (42.5 dBA) recorded from noon until 8:00 am the next morning in the absence of construction activities. This is the typical background noise level for the general project area.

3.0 NOISE IMPACTS

The ambient noise level at a given distance from a noise source was estimated using the following relationship (Harris, 1991):

$$L_2 = L_1 - 20 \log (R_2/R_1)$$

where:

L_2 = noise level at a selected distance R_2 from the source;

L_1 = noise level measured at a distance R_1 from the source.

3.1 Construction Noise

Noise during the construction phase would result from the operation of construction equipment and vehicles. Not all construction equipment would operate continuously so an average construction site noise level is assumed to be 85 dBA. The noise levels emanating from the construction site of various construction equipment are shown in **Table 1** along with the expected noise levels at 500, 1000, 2000, 3000 and 4000 feet from the construction activities.

Using the noise propagation formulation, noise levels would fall below 55 dBA, a noise level established by the EPA as the maximum noise level that does not adversely affect public health and welfare (EPA, 1974) at approximately 1500 feet from the construction activities. As shown on **Figure 4**, the nearest residence would be approximately 3700 feet southwest of the construction site. The noise at this location produced by construction activities would be 48 dBA, a level 6 dBA higher than the measured noise at the residence. However, this noise level would still be below the generally acceptable noise level of 55 dBA determined by EPA studies.

Noise levels above the background level of this rural environment would occur during the 120-day pipeline construction phase. However, all pipeline construction would occur during daytime hours when the noise would be less disruptive to the human environment. The maximum length of pipeline construction would be 500 to 1,000 feet at any time. Therefore, pipeline construction noise would be somewhat contained to one-mile segments it continued west to east along the right-of-way. Therefore, any one location would only be affected for short periods during the 120-day pipeline construction period. Additionally, the pipeline would be constructed near Highway 93. Construction noise would only be noticeable during lulls in highway traffic. When construction is complete, the operation of the pipeline would have no noise impact.

Table 1
Noise Impacts of Various Types of Construction Equipment

Equipment Type	Measured Noise Level at 50 Feet (dBA)	Predicted Noise Level at 1000 feet (dBA)	Predicted Noise Level at 2000 feet (dBA)	Predicted Noise Level at 3000 feet (dBA)	Predicted Noise Level at 4000 feet (dBA)
Crane	88	62	56	52	50
Backhoe	85	59	53	49	47
Pan Loader	87	61	55	51	49
Bulldozer	89	63	57	53	51
Fuel and Lubrication Truck	88	62	56	52	50
Water Truck	88	62	56	52	50
Motor Grader	85	59	53	49	47
Vibrator/Roller	80	54	48	44	42
Mechanic Truck	88	62	56	52	50
Flat Bed Truck	88	62	56	52	50
Dump Truck	88	62	56	52	50
Flat Bed Trailer	88	62	56	52	50
Tractor	80	54	48	44	42
Concrete Truck	86	60	54	50	48
Concrete Pump	82	56	50	46	44
Front End Loader	83	57	51	47	45
Road Scraper	87	61	55	51	49
Air Compressor	82	56	50	46	44
Average Construction Site	85	59	53	49	47

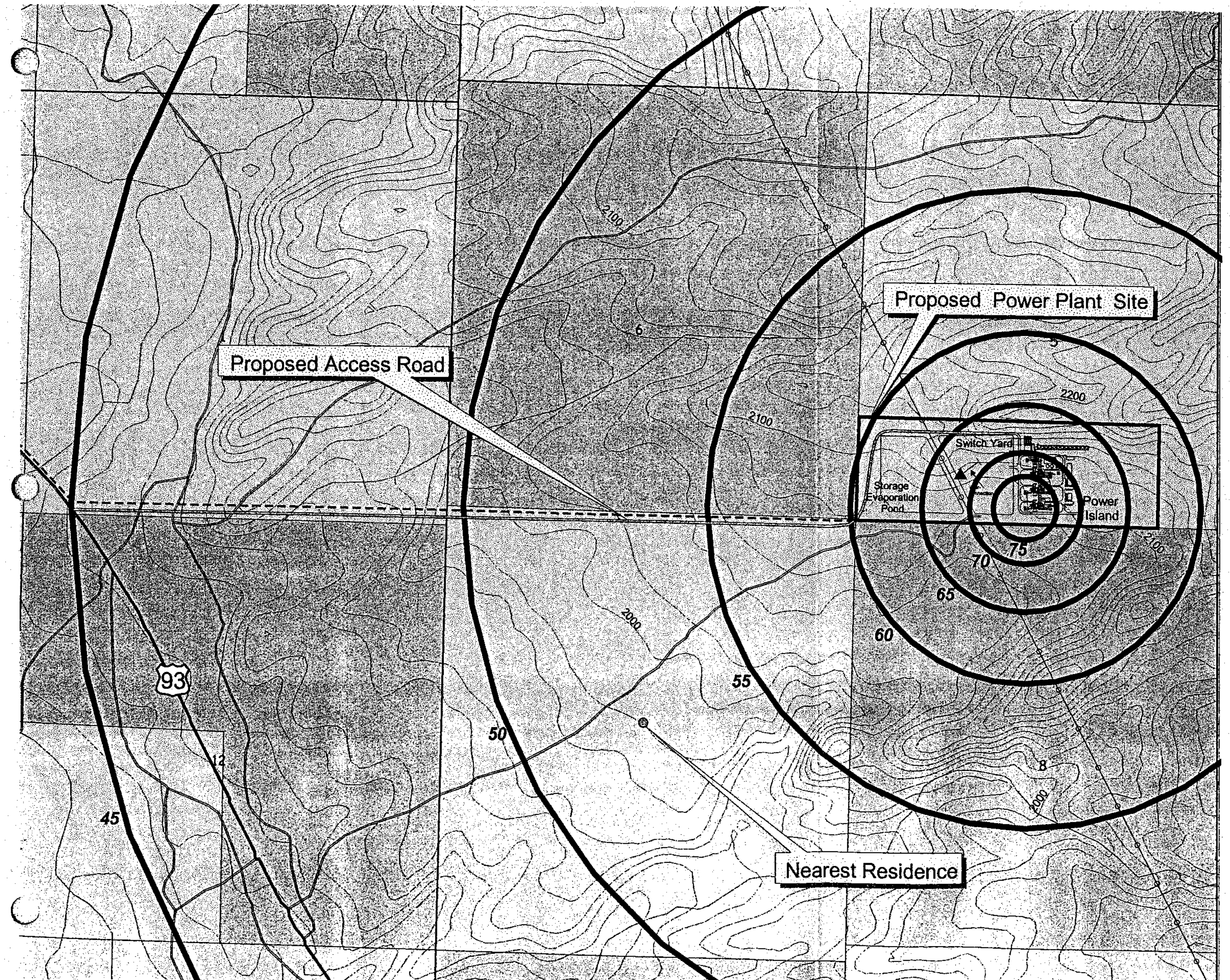
3.2 Operational Noise

A typical gas-fired power plant generating 720 MW of power has a characteristic noise level of 75 dBA at 400 feet from the main facilities. Using this source noise and the noise propagation equation, the following **Table 2** shows the noise levels that can be expected at various distance from the Big Sandy property boundary.

Table 2
Predicted Noise Levels from Big Sandy Power Plant

Distance (feet)	Noise Level (dBA)
400	75
700	70
1300	65
2200	60
4000	55
5445 (nearest residence)	52.3
7100	50
12000	45

Figure 4 shows the predicted noise levels to the nearest 5 dBA near the power plant. The noise analysis indicates that the average noise level at the nearest residence to the proposed power plant would be 52.3 dBA, or 2.7 dBA below the noise level established by the EPA as the maximum noise level that does not adversely affect public health and welfare. Since this level exceeds the measured noise (42.5 dBA) of the general area, the power plant would be the dominant noise source within two miles of the plant.



N
W E
S

SCALE 1 : 15,000

800 0 800 1600 Feet

300 0 300 600 Meters

Noise Impact Contour
Values in A-Weighted Decibels
(dBA)

Elevation Contour Interval 20 Feet

Transverse Mercator Projection
1927 North American Datum
Zone 12

BIG SANDY ENERGY PROJECT

FIGURE 4
NOISE IMPACTS

DATE: 8/15/00	ArcView FILE: F:\BIG SANDY-891\LARGEFIGURE2B.APR
	DRAWN BY: JG

REFERENCES

Bell, Lewis H. 1982 Bell, Industrial Noise Control, Fundamentals and Aplications, Marcel Dekker, New York, NY, 1982.

EPA 1974. U.S. Environmental Protection Agency. Information on Noise Levels Identified as Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety. EPA-550/9-74-004, Arlington, VA, 1974.

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EXHIBIT J - SPECIAL FACTORS

EXHIBIT J.1 NATURAL GAS SUPPLY PIPELINE

The following information is presented to the Committee to provide an understanding of Caithness' planned interconnection to a fuel supply, in the form of natural gas, for the Project (Project). The Project will initially consist of a baseload 500 megawatt (MW), natural gas-fired, combined cycle generating facility (Power Plant) and on-site supporting infrastructure and access roads. As part of Phase 1 of the Plant's construction, two gas-fired combustion turbines and one steam generator will be constructed for the production of the initial 500 MW of power. One additional combustion turbine and one steam turbine will be added as part of Phase 2 within approximately 18 months of initial Plant operations to bring the generation up to the 720 MW. The Power Plant will be located in a 120-acre parcel within the southern half of Sec 5, T15N, R12W. Electrical power will be introduced to the adjacent 500kV Mead-Phoenix transmission line, that passes through the southwest corner of Section 5, by way of a 500kV substation and a short single span interconnection.

Part of the Project is a proposed underground pipeline that will transport high-pressure natural gas to fuel the Power Plant from the existing Questar, El Paso Natural Gas Company, and/or Transwestern pipelines located about 36 miles north of the Project site (Figure J-1).

Impacts associated with construction and operation of the natural gas pipeline will be evaluated in the EIS being prepared by Western and the BLM for the proposed Project. The proposed route shown on **Figure J-1** may be modified slightly to address issues that may arise during the EIS process, ADOT right-of-way permitting process, or Mohave County right-of-way or easement approval process.

The criteria used by Caithness to identify the proposed natural gas pipeline route described here include:

- Suitable gas supply
- Multiple gas supply sources
- Economical routing of pipeline, including terrain considerations, stream crossings, other topographic constraints, and reclamation requirements
- Existing right-of-way or utility corridor
- Minimize new disturbance
- Minimize effects to sensitive resources

Specifically, the proposed route meets these criteria for the following reasons:

OVERSIZED
DOCUMENT

MAP

SEE SUPERVISOR
(EXHIBIT CABINET)

- Multiple gas supply pipelines are located at or near the northern terminus of the proposed gas pipeline route. There are currently two gas pipelines owned by El Paso Natural Gas Company (EPNGC), two pipelines owned by Transwestern, and a fifth pipeline **owned by Questar** that may be converted from oil to natural gas in the near future.

- The proposed route occupies existing right-of-ways and in areas previously or proposed to be disturbed by highway and road construction. Most of the 36-mile route to interconnect with the existing natural gas pipelines is within the existing right-of-way for U.S. Highway 93. The northern-most portion of the route follows Hackberry Road, a Mohave County-maintained road. The southern-most section will be located adjacent to and within the right-of-way of the access road to the Plant site from U.S. Highway 93. The access road will be constructed on private lands.

- The Arizona Department of Transportation (ADOT) is in the process of obtaining the necessary permits and approvals to widen U.S. Highway 93 in a section that begins south of Wikieup and ends at the intersection of U.S. Highway 93 and Interstate 40. The proposed pipeline will be located within the revised ROW. Preliminary design and environmental studies conducted for the highway upgrade can provide information to be used to site the gas pipeline within the new right-of-way.

- Most of the proposed pipeline corridor will be located within or near the Mead-Liberty 345kV and Mead-Phoenix 500kV transmission lines right-of-way and BLM-designated utility corridor (BLM, 1993).

- No significant impacts to any threatened or endangered species are anticipated. Class III desert tortoise habitat occurs along portions of the corridor. Mitigation measures specified by the BLM will be implemented on BLM-managed lands to minimize adverse effects on the desert tortoise.

- The proposed pipeline route will cross portions of the Carrow-Stephens Area of Critical Environmental Concern (ACEC). Effects to this ACEC will be minimized by routing the pipeline around sensitive features to the extent practicable and by implementing mitigation measures specified by the BLM.

- Adverse socioeconomic impacts from construction of the pipeline will be minimal. The small construction work force will be accommodated in the Kingman/Wikieup area.

The following sections provide general information on the natural gas pipeline, including general location, description of the pipeline, construction methods, re habilitation of disturbed areas, and permits and approvals required for the Project.

DESCRIPTION OF THE PROPOSED NATURAL GAS SUPPLY PIPELINE

New Pipeline Construction Procedures:

A new buried natural gas pipeline would be constructed to transport high pressure natural gas to the generating facility to fuel the gas fired turbines. The 16 inch steel pipeline would be installed from the existing Questar, El Paso, and/or Transwestern gas transmission pipelines located north of Interstate 40, about **39** miles north of the plant site.

Proposed pipeline routing would generally run within, parallel or adjacent to the existing Mohave County road, U.S. Hwy 93 or plant access road. The pipeline would cross private lands and public lands administered by the BLM and the Arizona State Land Department.

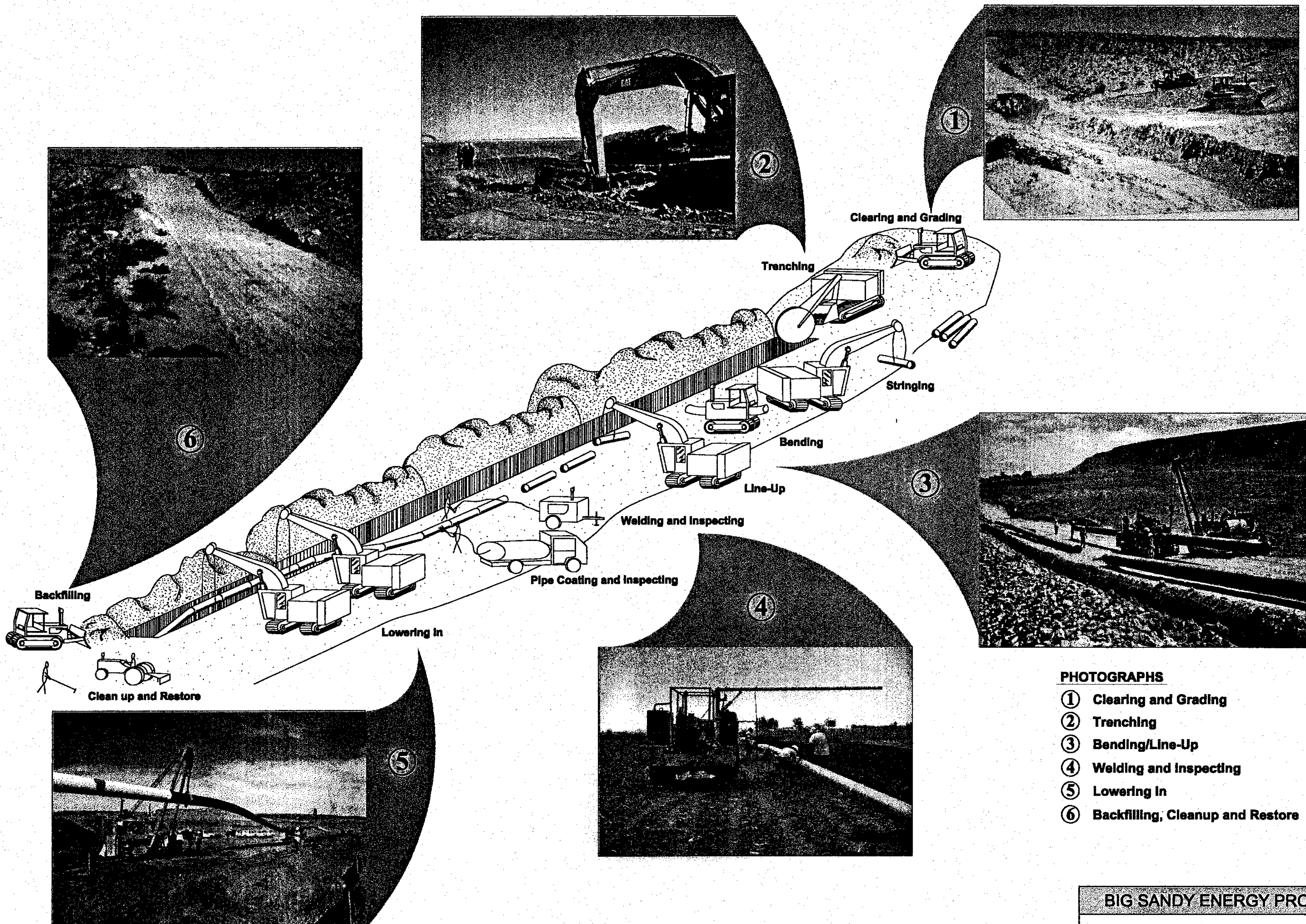
The new pipeline would consist of 16 inch diameter steel pipe with a minimum wall thickness of 0.281 inches (16"OD x 0.281"WT API-5L X-52). Thicker wall pipe would be used at road crossings, river crossing, and through the community of Wikieup. Pipe would be externally coated with fusion bonded epoxy for corrosion protection.

The pipeline would be designed and constructed in accordance with "Part 192–Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards" (49 CFR 192). Installation within the Highway 93 corridor would confirm to requirements of the "Arizona Department of Transportation Guide for Accommodating Utilities on Highway Rights-Of-Way". (ADOT). In addition, the U. S. Department of Transportation Federal Highway Administration "Manual on Uniform Traffic Control Devices" (MUTCD) would be followed for all work within or adjacent to the Highway 93 or Interstate 40 (I-40) corridor.

As the pipeline route would parallel or lie within portions of an existing Mohave County Road (Hackberry Road) and State of Arizona (Hwy 93) highway, the pipeline company would consult with these agencies regarding future highway development plans to insure the pipeline would not interfere with planned road expansion, relocation, or reconstruction plans. In areas due to highway or terrain conditions, the pipeline may deviate from the corridor and would be located on adjacent land, but still generally parallel to the road corridor. These segments would be identified as design of pipeline construction is completed.

As the pipeline is generally routed through rural countryside, cross country pipeline construction methods would be used for installation. A typical cross country pipeline construction spread is shown in **Figure J-2,** and would be the sequence followed for construction. An additional specialized construction crew would be required to install the pipeline at the Big Sandy River Crossing.

Prior to the start of construction, the pipeline company would complete engineering surveys of the right of way (ROW) centerline and extra work spaces, and finalize ROW easement or lease agreements. Other pipeline or utility operators would be notified through the Arizona Blue Stakes system to locate lines or pipes along the pipeline corridor, and line crossing stipulations obtained from these operators.



PHOTOGRAPHS

1. Clearing and Grading
2. Trenching
3. Bending/Line-Up
4. Welding and Inspecting
5. Lowering In
6. Backfilling, Cleanup and Restore

BIG SANDY ENERGY PROJECT

FIGURE J-2

Pipeline Construction Sequence Representative Photos of Activities/ Conditions along a Pipeline Construction Spread

The first phase of construction would involve staking the pipeline centerline, construction ROW and extra temporary work spaces. Temporary gates would be installed at each fence crossing. For work within the highway corridor, barricades, signage and signals would be placed as required by the ADOT. The ROW would then be cleared of vegetation and brush, and graded where necessary to create a level work surface.

Figure J-2 Pipeline Construction

Generally a 75 ft wide construction right of way would be required to be available for the pipeline installation. Within the Hwy 93 corridor, the pipeline would be installed approximately 10 ft from the east right-of-way fence, and construction would utilize the available corridor east of the highway.

The pipeline company would adopt the FERC's Upland Erosion Control, Revegetation, and Maintenance Plan for the management of excavated soils, slope stabilization, and ROW restoration and rehabilitation. In addition, specific restoration requirements of the highway agency would be adopted for final site rehab. The pipeline company also would implement the following general procedures, as well as additional procedures that may be required by land management agencies or local soil conservation authorities for site-specific soil and slope stabilization issues:

* Topsoil would be stripped and segregated in any agricultural or residential areas, as necessary or as requested by individual landowners during easement negotiations.

* Where topsoil has been stripped, trench spoil would be maintained separate from topsoil.

* The trench would be dug deep enough to allow for at least 3 feet of cover in standard soil conditions to meet minimum 49 CFR 192 safety standards. Within ADOT and Mohave County road corridors, the trench would be dug to allow for a minimum of 5 feet of cover over the buried pipeline, in compliance with the ADOT requirements.

* Trenching would be accomplished using rotary ditching machine or backhoe.

* If necessary, blasting may be required in areas where bedrock is encountered.

After trenching, individual sections of pipe would be hauled to the construction site and laid adjacent to the trench along the ROW (pipe stringing).

After trenching and pipe stringing, individual sections of pipe would be bent as necessary to fit the contours of the trench. Pipe ends would then be aligned and welded together and the completed pipe placed on temporary supports along the edge of the trench. All welds would then be visually and radiographically inspected and repaired if necessary. The welds would then be field coated to protect the pipeline against corrosion. Coating the welded joints would complete the external coating of the pipeline. The entire pipeline coating would then be inspected by an electronic device (external holiday detector) to locate and allow for repair of defects in the external coating.

The pipe would then be lowered into the trench by sideboom tractors and the trench backfilled with the previously excavated soil using a padding machine, bladed equipment or backhoes.

After installation, the pipeline would be hydrostatically tested to verify the integrity of the completed steel pipeline system. In accordance with 49 CFR 192 regulations, the hydrostatic test pressure would range from 1.1 to 1.5 times the pipeline's maximum operating pressure. To accomplish this integrity testing, the pipeline would be hydrostatically tested in sections, at locations to be determined based upon elevation change, and water transferred across sections after testing. An estimated 1 million gallons of water would be used to fill about ½ of the completed pipeline for testing, and then transferred for subsequent testing. Water for hydrostatic testing would be obtained from the Big Sandy well field. After testing, the water would be returned to the Big Sandy Plant site for disposal.

Concurrent with hydrostatic testing, the work areas would be final graded and restored. Topsoil would be returned to its original horizon. Original land contours would be restored as near as practical in all areas. In non-agricultural areas, permanent erosion control berms (waterbars or slope breakers) would be installed on slopes. The ground surface would be prepared for seeding, and planted with a seed mixture based upon consultation with land management agencies, local conservation authorities and respective landowners. In agricultural lands, any existing terraces or swales would be restored and seeded. Annual croplands would not be seeded unless requested by the landowner. Surplus construction material and debris would be removed and disposed of in appropriate facilities, and private property, such as fences, gates and driveways would be restored to a condition equal to or better than the preconstruction condition.

After hydrostatic testing, the pipeline would be dried, and block valves, taps and meter interconnect facilities would be installed. The pipeline would then be purged and packed with natural gas for service.

<u>Aboveground Facility Construction Procedures</u>:

Pipeline Meter Station Interconnect Facility:

Gas measurement interconnect facilities would be installed at the north terminus of the pipeline, at its tie into the gas transmission pipelines. These facilities would consist of isolation valves, control valves, meter equipment, and filter separator, and would be located within new 75 ft x 100 ft fenced and graveled sites adjacent to the Hackberry Road. The meter facilities would be enclosed within small buildings on the site. In addition, a small communication tower (height = 15 ft) would be included within each fenced site. Existing electric power service is available within 100 ft of each site. Access to each pipeline meter interconnect facility would be from the Mohave County (Hackberry) Road.

Plant Meter Interconnect Facility:

At the southern terminus of the pipeline, a gas measurement facility would be installed at the Big Sandy Plant site. This facility would consist of isolation valves, control valves, meter equipment and filter separator, and would be installed within the plant complex.

Block Valves and Valve Tap:

Two mainline block valves would be installed along the route of the new 16 inch pipeline. Each would consist of a buried 16 inch valve, with blowdown piping and valves and a wheeled operator extending above ground. The valves would be installed within a 10' x 20' fenced location. Construction of meter and regulator facilities and service pipelines to Wikieup or Carrow-Stephens, including required valve taps, would be accomplished by an outside gas company. These valve taps could be installed on the 16-inch pipeline and enclosed within a 10' x 20' fenced area, at a location to be selected near Wikieup.

<u>Special Construction Techniques:</u>

Wetland and Water Body Crossings:

The pipeline company would adopted the Federal Energy Regulatory Commission's "Wetland and Water Body Construction and Mitigation Procedures" (FERC Procedures) for construction work within or across the Big Sandy River and wetland area at Hwy 93 MP 127.3. Standard cross-country construction techniques would be used for most of the open-cut crossings of dry drainage, washes identified as non-wetland riparian areas. For any drainage that contain water at the time of crossing, open-cut crossings would be accomplished by using conventional bucket-type excavation equipment operating from the banks or from within the waterbody. Open-cut crossings typically would require temporary work space on both sides of the crossing. The excavation, pipeline installation, and backfilling across the waterbody and banks would be completed as quickly as possible. Caithness would obtain Section 404 permits from the U.S. Corps of Engineers for crossing of dry washes and drainage.

A wetlands area would be crossed by the pipeline construction at the Big Sandy bridge. Installation of the pipeline across wetland areas would also be performed in accordance with the FERC Procedures. Staging areas and extra work space would be located at least 50 feet away from the wetland boundaries, where topographic conditions permit, and would be limited in size to the minimum area needed for prefabrication of the pipeline. Storage of hazardous materials, chemicals, fuels and lubricating oils would be prohibited within 100 feet of wetland boundaries. The pipeline company would develop a "Hazardous Materials Management and Spill Prevention and Countermeasure Plan" (HMMSPC Plan), which includes more detailed information on the use of hazardous materials, and handling of hazardous materials encountered during construction activities.

Construction equipment operating within wetlands would be limited to that needed to dig the trench, install the pipe, backfill the trench and restore the ROW. Directional drilling under the Big Sandy River may be used. All other construction equipment would use access roads on upland areas to the maximum extent practicable. Where use of upland access roads is infeasible or impracticable, nonessential construction equipment would be permitted to pass through the wetlands only once, using the ROW.

Sediment filter devices would be installed at the base of the slope leading to a wetland. If there is no slope, sediment filter devices would be installed as necessary to prevent spoil from flowing off the ROW into the wetland or to prevent sediment from flowing from the adjacent upland into the wetland.

During clearing, woody riparian/wetland vegetation would be cut at ground level and removed from the wetland, leaving the root systems intact. In most areas, removal of stumps and roots would be limited to the area directly over the trench. This would promote more rapid regeneration of woody wetland vegetation. To facilitate revegetation of wetlands, the top 1 foot of soil would be stripped from over the trench, except in areas with standing water or saturated soils.

The Big Sandy River is the only perennial stream crossed by the proposed pipeline. Installation of the pipeline across the Big Sandy is proposed to be accomplished by open cut methods, due to the very narrow width of the flowing waterway crossing and associated riparian wetlands. The crossing installation would be completed during time of low flow and would be performed in accordance with the Corps of Engineers Section 404 permit and the FERC Procedures. Pipeline construction staging, welding and installation activities at the Big Sandy crossing would require additional work areas, with an additional space of 100 ft (width) by 300 ft (length) required on each side of the crossing.

Blasting:

It is not expected to encounter bedrock during trenching operations, however if bedrock is encountered and mechanical ripping is not feasible, blasting may be required. If blasting is required, applicable Federal, state and local stipulations would be observed, and necessary permits and authorizations would be obtained. The pipeline company would take measures to prevent damage to property and livestock during blasting operations, including the use of blasting mats. Notification of owners of nearby buildings would be required.

The pipeline company would coordinate any blasting operations adjacent to public highways with ADOT, and would comply with ADOT guidelines regarding blasting operations. Federal blasting regulations are administered by the U.S. Bureau of Alcohol, Tobacco, and Firearms (27 CFR 55), and U.S. Department of Labor, Occupational Safety and Health Administration (29 CFR 1910.109-1926.914).

Road and Highway Crossings:

Construction of the 16-inch pipeline to the Questar pipeline would require crossing of Interstate 40 highway, at approximately MP 75 on the I-40 highway corridor. I-40 is proposed to be crossed by installing the pipe within the Mohave County Hackberry Road and through the ADOT I-40 underpass located at the Hackberry Road (approx I-40 MP 75). A heavy wall section of pipe would be installed within the road way, with a minimum cover of 5 ft. Other specific ADOT or Mohave County requirement would be followed for the pipeline installation at the highway underpass. Temporary extra work areas would be required at each end of the highway crossing location.

Existing smaller (county) roads and various access roads would be crossed by trenching (open cut crossing). Open cut crossings typically would be completed within 1 work day, and alternate vehicular routes would be provided for traffic during pipeline construction. After pipe installation and backfilling, the roadway would be restored to original conditions.

Electric Power Transmission Line Crossing:

The 16-inch pipeline would cross the existing electric transmission line corridor (Mead-Liberty 234-kV and Mead-Phoenix 500-kV overhead lines) at approximately Hwy 93 MP 120.7. Although the pipeline crossing would be accomplished within the Hwy 93 corridor at this location, appropriate permit and stipulations would be obtained from the Western Area Power Administration for this pipeline installation.

Extra Work Areas:

Based upon preliminary site inspection, locations where additional work areas would be required for construction are as follows:

Location	Area
North terminus–Questar Southern Trails Interconnect	100 ft x 200 ft
South of I-40 Underpass Crossing	100 ft x 200 ft
Crossing & Interconnect–El Paso Pipelines–north side	100 ft x 200 ft
Crossing & Interconnect–Transwestern Pipelines–south side	100 ft x 200 ft
Big Sandy Wash along Hackberry Road	100 ft x 100 ft
Peacock Wash along Hackberry Road	100 ft x 100 ft
Stream Crossing along Hackberry Road	100 ft x 100 ft
McGarry's Wash along Hackberry Road	100 ft x 100 ft
Junction Hwy 93 & Hackberry Road	100 ft x 200 ft
Vicinity of Wikieup–north side	100 ft x 200 ft
Vicinity of Wikieup–south side	100 ft x 200 ft
Big Sandy River–north side	100 ft x 300 ft
Big Sandy River–south side	100 ft x 300 ft
Junction Hwy 93 south terminus	100 ft x 200 ft

Rehabilitation of Disturbed Areas

Areas disturbed by pipeline construction will be reclaimed by recontouring and reseeding. Following construction, a clean-up crew will remove all construction materials and debris from the site. Disturbed areas of the right-of-way will then be regraded to the approximate pre-construction contour, except for a slight crown of soil to compensate for the natural subsidence of the back-fill.

Permits and Approvals Needed for the Pipeline

The segments of ROW to be obtained by Caithness from the BLM for crossings of BLM-administered lands will total approximately 34,340 feet (6.5 miles) in length. A 50-foot-wide construction corridor is proposed. The proposed ROW to be obtained by Caithness Big Sandy L.L.C. across BLM-administered lands would comprise approximately 39.4 acres. No surface facilities are currently planned for the BLM-administered lands under discussion.

Utility/pipeline ROW within the U.S. Highway 93 ROW will be obtained from the Arizona Department of Transportation (ADOT) for state and private lands crossed by the pipeline within the U.S. Highway 93 ROW. The pipeline will be routed in that dedicated right-of-way.

The remaining utility/pipeline ROW needed for the pipeline will be obtained by MCEDA and Mohave County for construction of the pipeline across state and private lands along Hackberry Road and across state, private, and BLM-administered lands in Section 12, T15N, R13W and Sections 6 and 8, T15N, R12W.

Other permits and approvals that will be needed by the Caithness Big Sandy Project for natural gas pipeline construction include:

- Native Plant Permit, Arizona Department of Agriculture, for clearing and salvage of native plants;
- Zoning Approval by Mohave County;
- Excavation/Grading Permit, Mohave County Planning & Zoning, for road construction;
- Permit to Build in Roadway, Mohave County Public Works Department, for access road construction;
- 404 Permit, US Army Corps of Engineers, for stream/wash crossings;
- An approval in the ROD(s) for Western's EIS that addresses impacts to the environment for the overall Caithness Big Sandy Projects;
- Biological Assessment for USFWS;
- Cultural Resources clearance for SHPO;
- An ADOT highway crossing permit; and
- A ROW permit for utility to be constructed in an ADOT ROW.

Caithness and its contractors will design, construct, operate, and maintain the proposed facilities in accordance with the U.S. Department of Transportation's (DOT) regulations at Title 49, Code of Federal Regulations (CFR) Part 192, Transportation of Natural Gas and Other Gas by Pipeline Minimum Federal Safety Standards and other applicable Federal and State regulations. The standards imposed are in accordance with the Natural Gas Pipeline Safety Act of 1968, as amended.

ENVIRONMENTAL STUDIES

LOCATION AND LAND USE

The gas pipeline would cross lands that are a mixture of land ownership, including private, Federal (BLM), and State Trust lands (**Figure J-1**). Land in the general area is currently zoned for agricultural-residential use with minor areas of commercial zoning and "general" use, as shown on **Figure J-3**. BLM lands are managed under applicable multiple use regulations to provide for a variety of uses, including grazing and dispersed recreation such as hunting and off-road vehicle use. The gas line occurs primarily within a BLM-designated utility corridor on BLM-managed lands, as shown on **Figure J-3**.

Current land uses are shown on **Figure J-4**. Most of the area is classified as rangeland/open space, with some areas of low density residential in the vicinity of Wikieup and the intersection of U.S. Highway 93 and Interstate 40. Irrigated/fallow farmland occurs in the vicinity of the Big Sandy River, and scattered residences and commercial establishments occur throughout the valley. Some industrial uses such as gravel pits and mining are found on private lands.

Future and planned land uses in the general area have been mapped by Mohave County in its *General Plan* (Mohave County, 1995) and are shown in **Figure J-4**. The pipeline right-of-way falls within three planning area types: rural development areas, suburban development areas, and outlying communities.

<u>Rural Development Areas</u> (RDA) - This is defined as an area where residents enjoy a rural lifestyle, wide open spaces, and few neighbors. Most of the land in Mohave County and in the area of the proposed gas pipeline is in this area type. Properties in these areas are generally five acres in size, and many are larger. A significant amount of land in this type is owned by the federal and state governments, or is included in an Indian reservation. Detailed land use classes within the rural development area type are: rural residential, rural industrial, public parks, public lands, non-residential uses such as neighborhood commercial, commercial recreation, light industrial, heavy industrial, and airport industrial.

<u>Suburban Development Areas</u> (SDA) - The SDA is intended for development of lower density residential neighborhoods with many of the amenities of urban areas. Suburban lot sizes range from one to five acres, with a typical lot size of 2.5 acres. Neighborhood commercial uses will be permitted at appropriate locations where they are compatible with adjacent uses and infrastructure. Detailed land use classes within the suburban development area type are: suburban estates, suburban residential, public facilities, public parks, and public lands.

<u>Outlying Communities</u> - Unincorporated outlying communities in Mohave County require special consideration. Development within designated communities may be urban, suburban, or rural in character. The General Plan permits the continuation of existing development patterns, including both residential and non-residential development. The town of Wikieup in the south end of the pipeline corridor has been designated an outlying community by Mohave County.

OVERSIZED DOCUMENT

MAP

SEE SUPERVISOR
(EXHIBIT CABINET)

OVERSIZED DOCUMENT

MAP

SEE SUPERVISOR
(EXHIBIT CABINET)

Another planning area type used by Mohave County in its general plan is the 'Urban Development Areas' type, which is intended to provide for more intense residential and non-residential development near cities and in outlying communities. While not present within the natural gas pipeline corridor, it may be a component of future growth within the town of Wikieup.

Most of the lands within the natural gas pipeline corridor are within the rural development area planning type. As can be seen from the description of rural development areas presented above, a wide variety of land uses are allowed in this type of area, including light industrial and heavy industrial. Therefore, a natural gas pipeline will be fully compatible with County land use planning in this corridor. Public utility and infrastructure facilities, including pipelines, are necessary elements in the development of urban, suburban and rural land uses, and thus are compatible with the future land use planning in the area.

AIR QUALITY IMPACT ANALYSIS

Impacts to air quality are not expected to occur with the natural gas pipeline. Minor impacts associated with construction of the pipeline may occur due to land disturbance and associated dust, but once construction is complete and the area reclaimed, no further impacts are expected.

CULTURAL RESOURCES

Cultural resources include historical or archaeological objects, sites, buildings, structures, districts, or traditional cultural properties. In order to determine what cultural resources have been recorded along the gas pipeline corridor from the Big Sandy Plant site to the tie-in to an existing gas pipeline at Interstate 40, a literature review was conducted of the draft cultural resources inventory report (Moreno and Hoffman, in progress) and the draft Environmental Assessment for expansion of U.S. Highway 93 between Wikieup and Interstate 40 (Sverdrup Civil, in progress). In addition, the records at the Arizona State Museum were reviewed for the northern portion of the pipeline along Hackberry Road and the southern portion from the Plant site to U.S. Highway 93 that were not covered by the U.S. Highway 93 expansion cultural resources inventory. The objective of the files search was to identify previous surveys and any known cultural resources that might occur within the area of potential effect (APE) of the proposed gas pipeline. The APE is considered to be a 100-foot-wide corridor for the pipeline/access road extending approximately two miles west from the Plant site to U.S. Highway 93, the pipeline that extends approximately 36 miles north along the U.S. Highway 93 right-of-way, and the pipeline that parallels Hackberry Road approximately 4.5 miles northeast from U.S. Highway 93 to Interstate 40.

There were over 60 archaeological and historic sites identified within or adjacent to the approximate 38.5-mile gas pipeline APE during the records review. The prehistoric sites include prehistoric aboriginal camps, structures, and petroglyphs (rock art). The historic sites consist of irrigation ditches, road alignments, residences, trash dumps, ranch features, cemeteries, a telephone line, and historic aboriginal camps. Of the sites recorded within or near the U.S. Highway 93 corridor, six significant prehistoric and 24 significant historic sites are eligible or potentially eligible for the NRHP. In addition, four potentially significant resources are on record but need further evaluation before this determination can be made. The remaining sites are not eligible for the NRHP.

Approximately 7 percent of the recorded sites are aboriginal scatters of flaked stone artifacts, groundstone artifacts, ceramic sherds, and/or features. Most of these sites appear to be associated with hunting and gathering, food processing, and ceremonial activities. Approximately 93 percent of the sites are historic. Residences (homesteads and farmsteads), trash dumps, and ranch features are the most common site type, followed by roads or bridges. Most of the sites date from the early 1900s to 1950s. This area is not known to contain traditional cultural properties.

Based on information available from files searches and recent investigations in the area, fewer than 30 significant prehistoric or historic cultural resources have the potential to be impacted by the construction of the gas pipeline.

Mitigation Measures

Several potential mitigation measures can be implemented to reduce impacts to cultural resources associated with the construction of the gas pipeline. These might include:

- Avoidance of significant archaeological sites, historic sites, or structures
- Development of a treatment plan that addresses cultural resources recorded
- Monitoring for substance cultural resources during construction
- Data recovery (excavation or archival recording) for sites that cannot be avoided

In the event of the discovery of unanticipated cultural material or unmarked human remains, the construction contractor will be required to cease work in the immediate vicinity of the find and take appropriate measures to protect the remains from further intentional or inadvertent disturbance. A qualified archaeologist will be contacted to assess the remains, and the State Historic Preservation Officer will be notified within 24 hours of the discovery and preliminary assessment.

BIOLOGICAL WEALTH

Biological wealth, including Special Status Species, in the vicinity of the natural gas pipeline are discussed in Exhibit C.

BIOLOGICAL RESOURCES

Biological resources in the vicinity of the natural gas pipeline are discussed in Exhibit D.

SCENIC AREAS/VISUAL RESOURCES

The natural gas pipeline corridor lies in the U.S. Highway 93 right-of-way located within the valley of the Big Sandy River, between the Hualapai and Aquarius Mountains. Throughout the corridor, the upland terrain is incised with drainages that flow to the river, creating a undulating landscape. The existing roadway along which the pipeline will be installed generally conforms to the topography, with few large cut slopes. The subtle rise in elevation differences leave broad, panoramic views of the valley along the corridor. Within Wikieup, buildings are mainly one-story concrete block (with some use of stucco) or aluminum mobile homes. Gas stations and commercial enterprises catering to roadway travelers predominate in this small community. Other notable features along the study corridor include the Carrow-Stephens Ranch, Williams Nut Farm, and Luchia's Restaurant.

The proposed natural gas pipeline would be located within the right-of-ways for existing or proposed highways and roads. The pipeline would be buried and any disturbed ground would be immediately reclaimed. Therefore, visual effects associated with the pipeline would occur in areas already disturbed by road construction and would be temporary in nature.

RECREATIONAL PURPOSES AND ASPECTS

The proposed pipeline crosses the Carrow-Stephens ACEC, a historic ranch that is managed by the BLM as an Area of Critical Concern (ACEC). The pipeline will avoid the ACEC to the extent practicable, and no impacts to this site are anticipated.

The construction, operation and maintenance of the proposed pipeline will be consistent with safety considerations. Recreational ûse of any lands crossed by the pipeline would continue to be controlled by any individual or agency currently managing recreation areas or recreation opportunities.

References Cited

Moreno, J., and T. Hoffman. (In progress). *Cultural Resource Survey of the Proposed US 93 Wikieup to I-40 Design Alternatives, Mohave County, Arizona.* Prepared by Archaeological Consulting Services, Ltd. for Arizona Department of Transportation.

Sverdrup Civil, Inc. (In progress). *Draft Environmental Assessment US 93 - Wikieup to Interstate 40*, prepared for Arizona Department of Transportation.

EXHIBIT J.2 AGENCY AND PUBLIC COORDINATION

As part of the permitting process, Caithness Big Sandy L.L.C. and several of the relevant agencies conducted agency and public meetings on the proposed Project to provide information to federal, state, and local government agencies and private entities, to solicit information, to obtain comments, and to identify issues pertinent to the Project. A summary of the agency and public meetings conducted for the Project to date are summarized in **Table J.2-1**.

The agency(ies) responsible for conducting the EIS for the proposed Project **have** will develop**ed** a public participation plan that will guide scoping activities for the EIS. These activities, to be described in detail in the EIS document, will include public and agency meetings and consultations, Native American consultations, public contact letters, public response comments and public notices, and other activities designed to involve the public in the Project. **Materials distributed at public meetings are provided in Exhibit J-2-1.**

Table J.2-1
List of Agency & Public Meetings
Big Sandy Energy Project

Wikieup Public Meeting Public Information Meeting required for re-zoning	December 27, 1999
Western Area Power Administration Kick-off Meeting Introduction and Contracting Meeting	January 7, 2000
Western Engineering and Environmental Field Reconnaissance/Meeting Requested jointly by Caithness and Western	January 12, 2000
Caithness Project Introduction Meetings BLM, ACC, ADEQ Air & Water Offices Requested by Caithness	January 18 & 19, 2000
Wikieup Issues Meeting Meeting with Wikieup spokesmen to identify issues. Special purpose meeting requested jointly by Caithness and Wikieup spokesmen	January 18, 2000
Mohave County Planning and Zoning Commission Public Meeting to Receive Comments on Re-zoning. Special purpose meeting requested by Planning and Zoning Commission	February 3, 2000
Mohave County Planning and Zoning Commission Vote for Recommendation of Re-zoning	February 10, 2000
Mohave County Public Land Use Committee Provided Project Description Information Caithness request to be included in agenda	February 15, 2000
ADOT Meeting ADOT Right-of-Way Permit Scoping	February 16, 2000
Western/BLM Project Meeting Provided information for the EIS Process	March 10, 2000
Western/BLM Project Meeting Provided information for the EIS to cooperating agencies	March 23, 2000
ADEQ Air Quality Meeting Provided updated information	April 5, 2000

Table J.2-1 (continued)
List of Agency & Public Meetings
Big Sandy Energy Project

Mohave County Board of Supervisors Meeting Rezoning Approval Meeting	April 17, 2000
Western/BLM Project Meeting Solicited Public Comment in Project for EIS	May 3, 2000
Western/BLM Project Meeting Discussed scope of the EIS	June 14, 2000
Western/BLM Project Meeting Discussed hydrologic components of the Project	July 13, 2000
Western/BLM Project Meeting Discussed biological components of the Project	July 14, 2000
Hualapai Tribal Council Meeting Discussed Tribal involvement on the EIS as a cooperating agency	August 8, 2000
Western/BLM Public Workshop Provided information and received comment on Project	August 29, 2000
Hualapai Tribal Council Meeting Provided information and received comment on Project	August 30, 2000
U.S. Fish and Wildlife Service Meeting Provided information and received comment on Project	August 31, 2000
Western/BLM Project Meeting Solicited Public Comment in Project for EIS	May 3, 2000
Western/BLM Project Meeting Discussed scope of the EIS	June 14, 2000
Western/BLM Project Meeting Discussed hydrologic components of the Project	July 13, 2000
Western/BLM Project Meeting Discussed biological components of the Project	July 14, 2000
BBQ Big Sandy Valley Community Development Appreciation	July 15, 2000

Table J.2-1 (continued)
List of Agency & Public Meetings
Big Sandy Energy Project

Hualapai Tribal Council Meeting Discussed Tribal involvement on the EIS as a cooperating agency	August 8, 2000
Tribal Council Elders Site Visit	August 9, 2000
Western/BLM Public Workshop Provided information and received comment on Project	August 29, 2000
Hualapai Tribal Council Meeting Provided information and received comment on Project	August 30, 2000
WAPA/BLM/G&F Site Visit/TourU.S. Fish and Wildlife Service Meeting Provided information and received comment on Project	August 31, 2000
Board of Supervisors Meeting	September 5, 2000

APPENDIX J-2-1

PUBLIC INFORMATION

Big Sandy Energy Project

This is the second newsletter prepared and distributed for the Big Sandy Energy Project. Since the first issue was distributed in April 2000, public and agency "scoping" of issues to be addressed in the Environmental Impact Statement was completed; several agencies have joined Western Area Power Administration and the Bureau of Land Management as cooperating agencies to assist in preparing of the EIS; URS Corporation was selected by Western and BLM to prepare the required EIS; and BLM selected a project manager to manage the EIS preparation. Additional information about these activities is detailed in this newsletter. Copies of the previous issue, as well as other information about the Big Sandy Energy Project, are posted for viewing on Western's "Big Sandy Energy Project" web site (**www.wapa.gov/bigsandy/ bigs.htm**) or may be obtained by contacting the Western or BLM project managers listed at the end of this newsletter.

Project background

Caithness Big Sandy LLC proposes to construct the Big Sandy Energy Project, a 720-megawatt natural gas-fired generating facility, on private lands near Wikieup, Ariz. Caithness, a private energy development and operating company, has applied to the Western for an interconnection with the existing Mead-Phoenix Project 500-kilovolt Transmission Line and applied for permits to build portions of a natural gas supply pipeline along U.S. Highway 93 to Interstate 40 and a permanent access road and ater pipeline system across public lands managed by the BLM [see map pages 4 and 5].

Based on Caithness' applications, Western and BLM have determined that they must prepare an EIS to comply with the requirements of the National Environmental Policy Act, and together will be co-lead agencies. The EIS will study potential impacts to the human and natural environment from building and operating all aspects of the Big Sandy Energy Project, including the gas-fired generation facility, the electrical switchyard, the natural gas supply pipeline, the ground water supply well field and pipelines, an access road, possible agricultural activities associated with reuse of the ground water used by the generation facility, and other associated facilities.

Project description

The project would be a merchant plant—meaning it would not be owned by a utility or by a utility affiliate selling power to its utility, nor is it supported by a long-term power purchase agreement with a utility. Caithness would instead sell power on a short- and mid-term basis to customers and the spot market. Power purchases by customers would be voluntary and all economic costs would be borne by Caithness.

The project would consist of two phases. The first phase would feature a 500-MW natural gas-fired, combined cycle powerplant and on-site supporting infrastructure, including an administration building, warehouse storage, water treatment and storage facilities, cooling towers, water storage/evaporaon ponds, gas conditioning equipment, and a new access road; a 500-kV switchyard with electrical equipment to accommodate an interconnection with the Mead-Phoenix Project 500-kV Transmission

The second phase would consist of an additional 220-MW combined-cycle powerplant adjacent to the first phase powerplant. Agricultural activities (such as row or field crops or aquaculture/hydroponic facilities) which would use the waste water discharged by the generation facility's cooling towers are being considered by the Mohave County Economic Development Authority, Inc., on private land in Section 7, Township 15 North, Range 12 West.

The generating facility and infrastructure would be built on private property owned by Caithness in Section 5, Township 15 North, Range 12 West, about 4 miles southeast of Wikieup, and about 2 miles east of U.S. Highway 93 crossing the Big Sandy River. The ground water supply wells, which would provide approximately 3,200 acre-feet of potable and cooling water annually to the generating facility from a deep (1,100 feet) aquifer, would be completed nearby on private property located in Section 7, Township 15 North, Range 12 West. A buried natural gas pipeline would bring high-pressure natural gas to the generating facility to fuel the gas-fired turbines from at least one natural gas transmission pipeline located about 36 miles north of the powerplant site near Interstate 40. It would be constructed parallel, within and/or adjacent to U.S. Highway 93 and Mohave County roads and utility easements. A pipeline routing parallel to the Mead-Phoenix Project 500-kV Transmission Line also is being considered. The pipeline would cross private and public lands administered by the BLM and the Arizona State Land Department.

The licensing and permitting for the project is expected by Caithness to be completed in April 2001 when construction of the first phase would begin. Commercial operation is scheduled to begin in November 2002. The second phase is planned to be completed in March 2004.

Scoping results

The principal purpose of scoping is to identify public and agency issues and alternatives to be considered in the EIS. BLM and Western hosted a public scoping meeting on May 3, 2000, in Wikieup. Thirty-eight people attended, representing agencies, the Wikieup community and interested parties. Copies of flipchart notes taken at the scoping meeting, as well as a table which presents the comments/questions received at the meeting and how they will be addressed in the environmental process, are posted on Western's "Big Sandy Energy Project" web site (**www.wapa.gov/bigsandy/bigs.htm**).

In addition to the public scoping meeting, BLM and Western representatives met with the Arizona Department of Water Resources, the chair of the Arizona Power Plant and Transmission Line Siting Committee under the Arizona Corporation Commission, the Arizona State Land Department, the Arizona Game and Fish Department, and the U.S. Fish and Wildlife Service. Discussions with other agencies with jurisdiction or interest in the project also occurred.

BLM and Western received more than 45 comment response sheets and/or letters and numerous requests to be on the project mailing list. BLM and Western have used the scoping results to define the issues that will be addressed in the EIS. The major issues that will be addressed in the EIS include:

- Short-term and long-term direct and indirect effects of ground water production from the deep aquifer and use for power plant cooling, including effects on future water supplies in the Wikieup area and stream flows in the Big Sandy River.

- Direct and indirect effects to wildlife and fishery resources and habitats, including the endangered Southwest willow flycatcher and wetland and riparian habitats.
- Direct and indirect effects to the community and values of Wikieup from construction activity, air pollutant emissions, future land use changes, landscape changes, noise and taxation changes.
- Direct and indirect effects to water quality and use in the project area, including any effects from the proposed natural gas pipeline construction.
- Effects to cultural resources and traditional cultural values and uses of the area by Native Americans.
- Effects to existing land uses from the natural gas pipeline construction.

Suggestions for alternative generating facility locations and cooling methods also were received during the scoping period. BLM and Western, with assistance from URS technical experts, are currently evaluating the feasibility of these alternatives to determine if they should be subjected to full analysis in the EIS. The results of this evaluation, as well as environmental studies conducted to date, will be presented at an environmental studies workshop scheduled to be conducted in Wikieup Aug. 29.

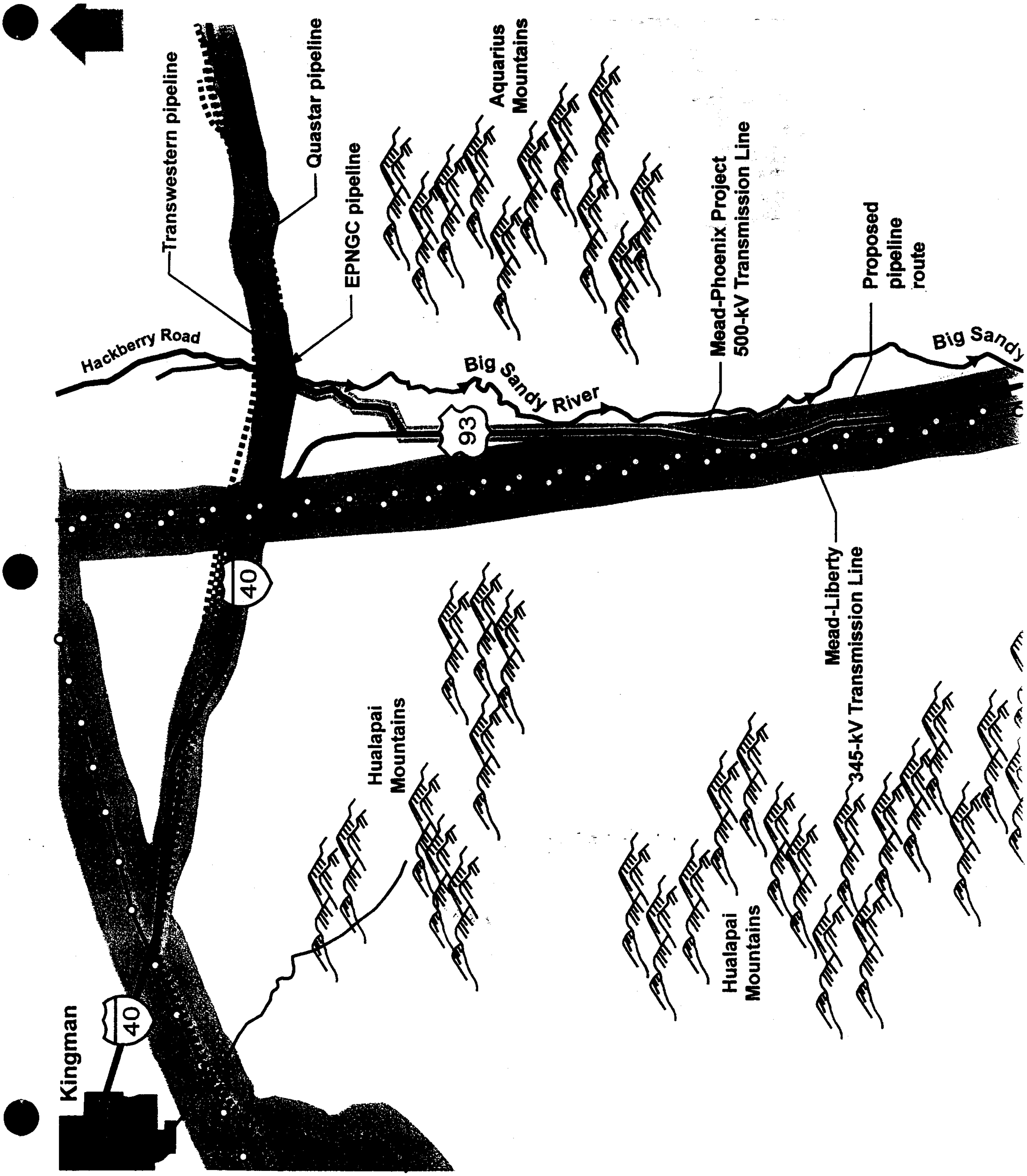
Cooperating Agencies

BLM and Western are co-lead agencies jointly responsible for preparing the EIS. Cooperating agencies are those which may have jurisdiction by law or special expertise with respect to any environmental impact involved in a proposed project and which agree to provide this information, guidance and expertise and assist in for preparing the EIS. Currently, the following have agreed to be cooperating agencies preparing the EIS:

- Arizona Department of Transportation
- Mohave County (through the Planning and Zoning Department)
- Arizona Game and Fish Department
- U.S. Fish and Wildlife Service
- Arizona Department of Water Resources
- Hualapai Tribe

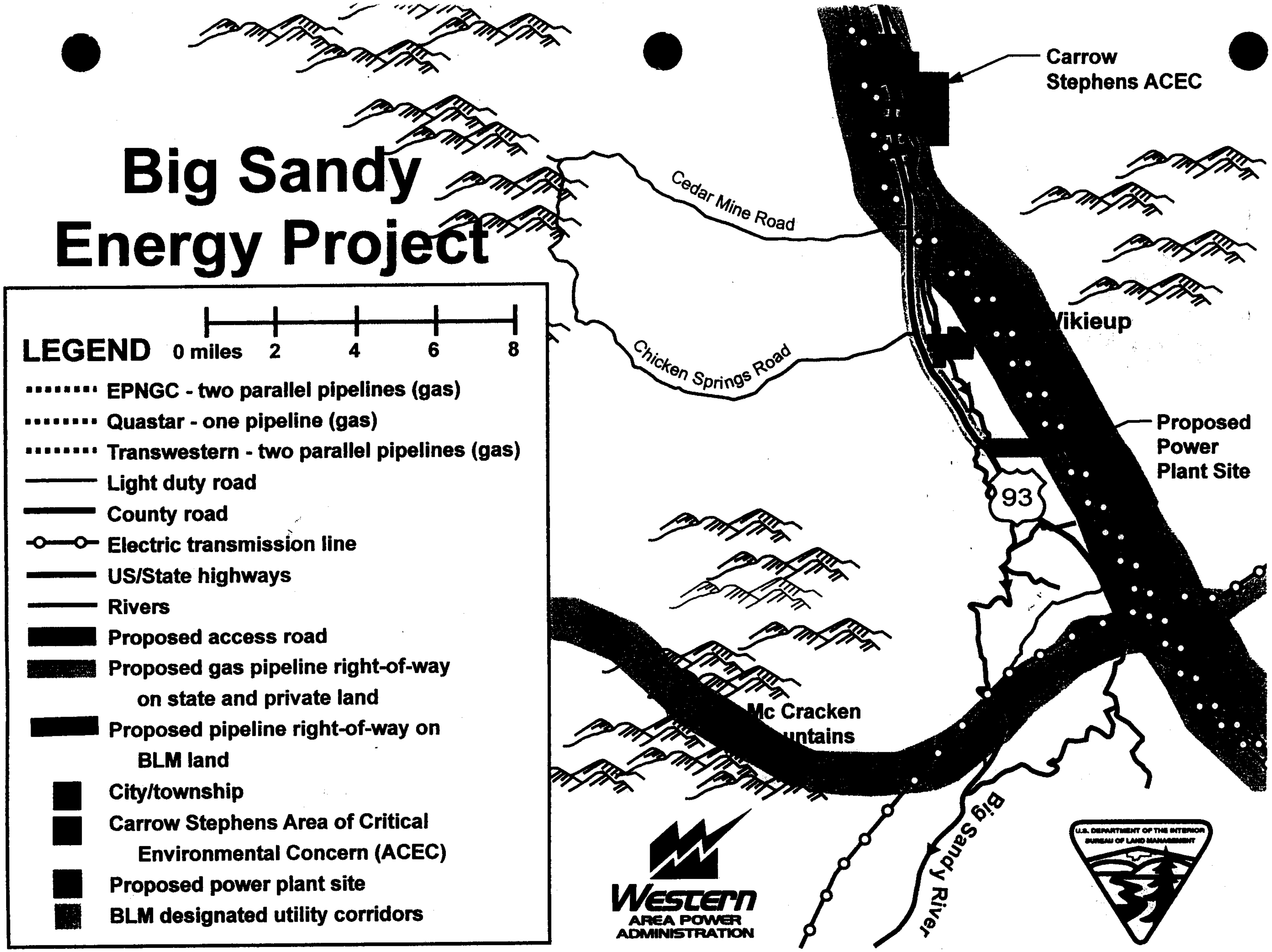
In addition, the following also are considering joining as cooperating agencies in preparing the EIS:

- U.S. Army Corps of Engineers
- Arizona Department of Environmental Quality.



Quastar pipeline
Transwestern pipeline
EPNGC pipeline
Aquarius
Mountains
Hackberry Road
Big Sandy River
93
Mead-Phoenix Project
500-kV Transmission Line
Proposed
pipeline
route
Big Sandy
40
Mead-Liberty
345-kV Transmission Line
Hualapai
Mountains
Hualapai
Mountains
Kingman
40

Big Sandy Energy Project



EIS Preparation

On May 14, 2000, BLM and Western issued a request for proposals from qualified environmental companies to prepare the Big Sandy Energy Project EIS. Based on evaluation of proposals received, BLM and Western selected URS to prepare the EIS. URS is an international environmental consulting firm with more than 13,000 employees in the United States. The company has substantial experience in evaluating the hydrologic effects of ground water development projects such as the Big Sandy Energy Project. The URS EIS preparation team will work out of URS offices in Phoenix, Tucson and Denver. The contract was awarded on June 7, 2000, and URS has been hard at work reviewing the available project and environmental information and developing the EIS Preparation Plan, which will describe the activities necessary to collect the additional information needed to analyze the potential effects of the project and complete the EIS.

Two technical meetings were recently held specifically to review the available hydrology and biology data and determine additional data collection needs. Representatives from BLM, Western, ADWR, FWS, URS, and AGFD, met with Caithness hydrologists to:

- review the scoping comments received related to hydrology.
- discuss the available information concerning the hydrology of the Wikieup–Big Sandy River valley (including the data collected by Caithness) which would help determine if the water from a deep (greater than 1,100 feet) aquifer that Caithness plans to use for the Big Sandy Energy Project is isolated from the upper aquifer tapped by other water users and connected to the Big Sandy River (and would thus not adversely affect these other waters).
- discuss Caithness' ongoing water well drilling, testing, sampling and monitoring program to determine if it is adequate and sufficient to answer the questions asked during scoping.

Based on BLM, FWS, ADWR and URS hydrologists' input received at the meeting, BLM and Western requested several changes and/or additions to Caithness' proposed well testing, sampling and monitoring program to increase the breadth of and confidence in the data to make the determination of possible affects and answer the scoping comments. BLM and Western also requested that URS collect some additional water samples, and undertake an update of the 1973 water balance for the basin. Caithness will continue to update the BLM, Western and cooperating agencies on the status of and schedule for the well testing program, currently scheduled to commence in mid to late August. Caithness will also provide all of the raw test data from the initial well test to the BLM, Western and cooperating agencies. These organizations will review the data and provide specific recommendations for the testing, sampling and monitoring to be conducted during the subsequent longer-term test. BLM, Western, FWS, URS, AGFD and Caithness biologists also met to review the scoping comments received related to biology and discuss the biology data collected by Caithness for the Big Sandy Energy Project to determine if it is adequate and sufficient to answer the questions asked during scoping.

BLM and Western determined that the biology information collected, if supplemented with pre-construction surveys, would likely be sufficient to answer the scoping questions, if the determination is made and validated that the Big Sandy Energy Project would not adversely affect either the waters or flow of the Big Sandy River. The biologists will review the conclusions of the hydrologists following the conclusion of the well flow tests to determine if such a finding is adequately supported.

Ongoing Public Participation

Formal public scoping for the EIS closed on June 2, 2000. However, coordination and involvement with the public and appropriate Federal, state, local and tribal government agencies will continue, and comments on the proposed project and EIS will be accepted throughout the NEPA process.

As part of this ongoing process, Western and BLM have scheduled a public workshop (see next paragraph), and will provide for public review of, and conduct hearings on, the draft EIS once it is published. In addition, public review of the final EIS during a 30-day waiting period will be encouraged, as will public review of the independent BLM and Western Records of Decision.

A public information workshop will be held Aug. 29 at 6 p.m. at the Owens Whitney School, 14109 Chicken Springs Road, Wikieup, to present the project alternatives that will be addressed in the EIS as well as the results of environmental baseline studies conducted to date. The results of the workshop will be used to help BLM and Western define impact levels for the impact analysis.

Project Contacts

Following a competitive bidding process, on June 7, 2000, BLM selected Dr. Dwight Carey of Environmental Management Associates, Inc., of Brea, Calif. to be the BLM Project Manager preparing the EIS for the Big Sandy Energy Project.

Project-related comments or questions should be directed to:

Mr. John Holt
Environmental Manager,
Desert Southwest Customer Service Region
Western Area Power Administration
P.O. Box 6457
Phoenix, AZ, 85005-6457
(602) 352-2592
Fax: (602) 352-2630
e-mail: holt@wapa.gov

OR:

Dr. Dwight Carey
BLM Project Manager
Kingman Field Office
Bureau of Land Management
2475 Beverly Avenue
Kingman, AZ 86401
(520) 692-4437
Fax: (520) 692-4414
e-mail: dlcarey@emacorp.com
Direct Phone No.: (714) 529-3695
Cell Phone No.: (714) 267-9906
Direct Fax No.: (714) 529-8543

Questions may be directed to Mr. Holt or Dr. Carey or submitted with the enclosed response sheet. You may also visit Western's "Big Sandy Energy Project" web site (**www.wapa.gov/bigsandy/bigs.htm**) to obtain current information about the Big Sandy Energy Project.

New EIS schedule

Milestone dates for the Big Sandy Energy Project EIS have been updated as follows:

Public Information Workshop	*August 2000*
Draft EIS Public review	*January - February 2001*
Draft EIS Public hearing	*February 2001*
Distribute Final EIS	*May 2001*
Records of Decision	*June 2001*

Please plan to attend a public information workshop in Wikieup Aug. 29, 2000

Visit www.wapa.gov/bigsandy/bigs.htm to get ongoing information about the Big Sandy Project.

UNITED STATES DEPARTMENT OF ENERGY
Western Area Power Administration
P.O. Box 281213
Lakewood, CO 80228-1213

Do you have any questions?

ou have requested to be added to the mailing list, you will receive future project information. If you wish to be added or removed from the mailing list, please indicate below and return this response sheet.

- ❑ **Yes**—add my name to the mailing list to receive future information
- ❑ **No**—please remove my name from your mailing list

If you have any questions or wish to be contacted regarding the Environmental Impact Statement, please complete this response sheet and return as addressed on the other side, or call one of the agency contacts listed below. Please note, you do not need to provide postage when returning this response sheet.

Please include question(s) in the space provide below. Any additional questions that cannot be addressed on this sheet can be sent to one of the project contacts listed on the back.

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If you have previously requested a copy of the draft Environmental Impact Statement or the executive summary, you will receive it when available. If you did not request a copy and wish to receive a copy, please return this response sheet.

❑ Send me the complete draft EIS ❑ Only send me the executive summary

Please date and provide your name, phone number, address, and e-mail address (if available). Fold this sheet with any attachments inside so the pre-address side is exposed. Tape to secure before mailing.

Name: ______________________ *Date:* ______________

Address: ______________________________________

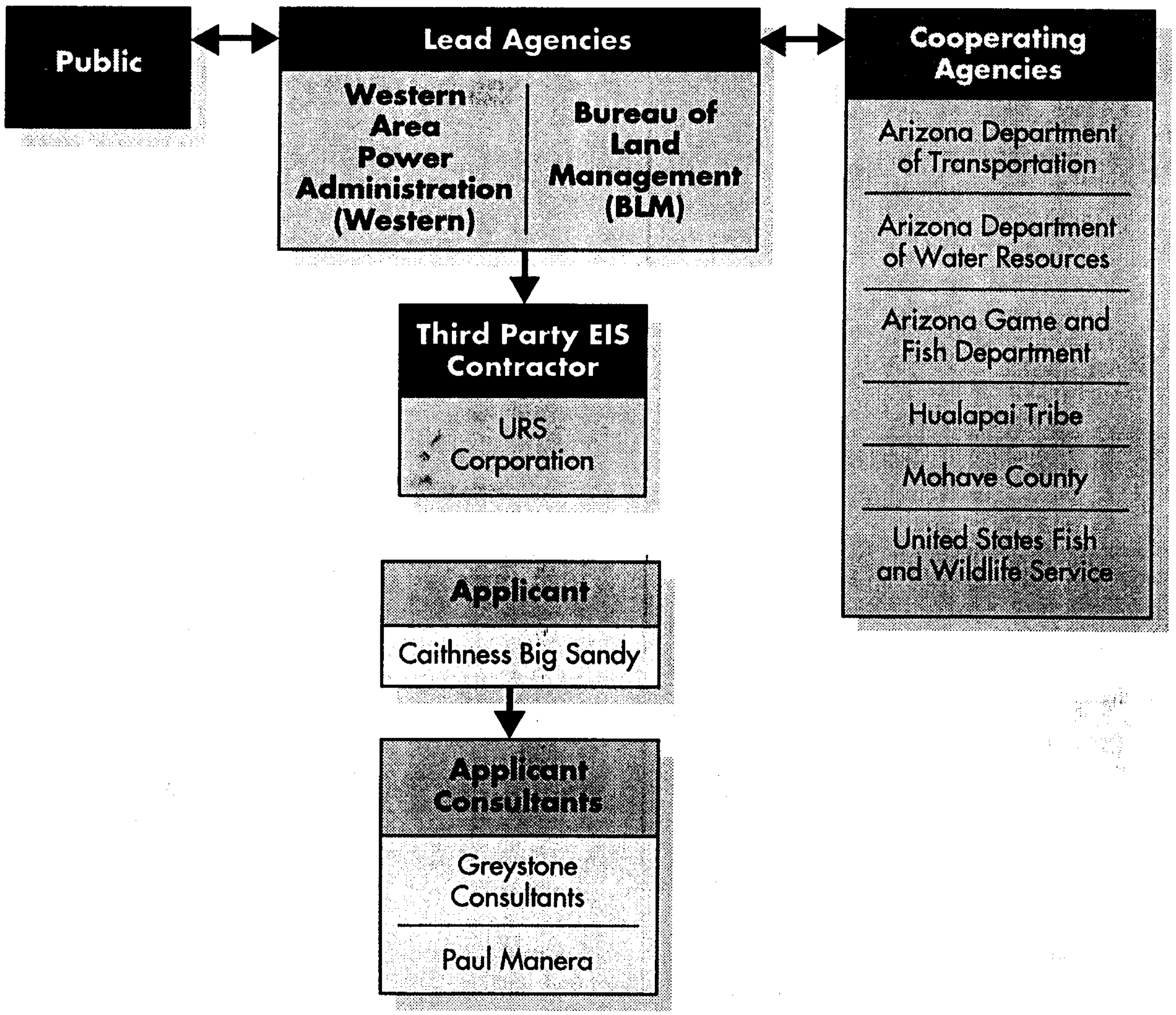
City, State: ______________ *Zip Code:* ______________

Phone: ______________ *E-mail:* ______________

AGENDA

- **Introductions**
- **Purposes of this Meeting**
  - *Update community members and interested parties on the status of environmental studies for the Big Sandy Energy Project EIS.*
  - *Address how issues and concerns identified during the scoping process will be addressed in the environmental studies.*
  - *Share the intent of the hydrology studies and any results known at the time of the meeting.*
  - *Describe the environmental process for the project.*
  - *Provide opportunities for the public to ask questions about the studies and process.*
- **EIS Process Overview**
- **Reasons for Agency Action**
- **Project Overview**
- **Scoping Issues/Concerns**
- **Alternatives**
- **Hydrology**
- **Environmental Studies**
- **Closing**

EIS ROLES AND RESPONSIBILITIES



Public - individuals and organizations provide BLM and Western with comments during the scoping period, attend public meetings or workshops, review and comment on the draft EIS, and attend public hearings on the draft EIS

Lead Agencies - BLM and Western seek public input and comments, supervise the EIS process, direct URS Corporation, and respond to Caithness Big Sandy's application and requests

Cooperating Agencies - assist BLM and Western in preparing the EIS

Third-Party Contractor - URS Corporation conducts impact analyses and prepares EIS documents, as directed by BLM and Western

Applicant - Caithness Big Sandy has applied to Western for interconnection with an existing transmission line, and to BLM for request to use public lands managed by the BLM

Applicant Consultants - conduct studies and prepare documents for Caithness Big Sandy

Western AREA POWER ADMINISTRATION

Big Sandy Energy Project EIS

EIS PROCESS

Notice of Intent

↓

Scoping Period

↓

WE ARE HERE ⇨ **Draft EIS**

- Purpose and need
- Proposed action
- Determine alternatives
- Collect existing information and conduct studies
- Characterize affected environment
- Analyze impacts
- Prepare document

↓

Comment Period and Public Hearings

↓

Final EIS

↓

Record of Decision

REASONS FOR AGENCY ACTION

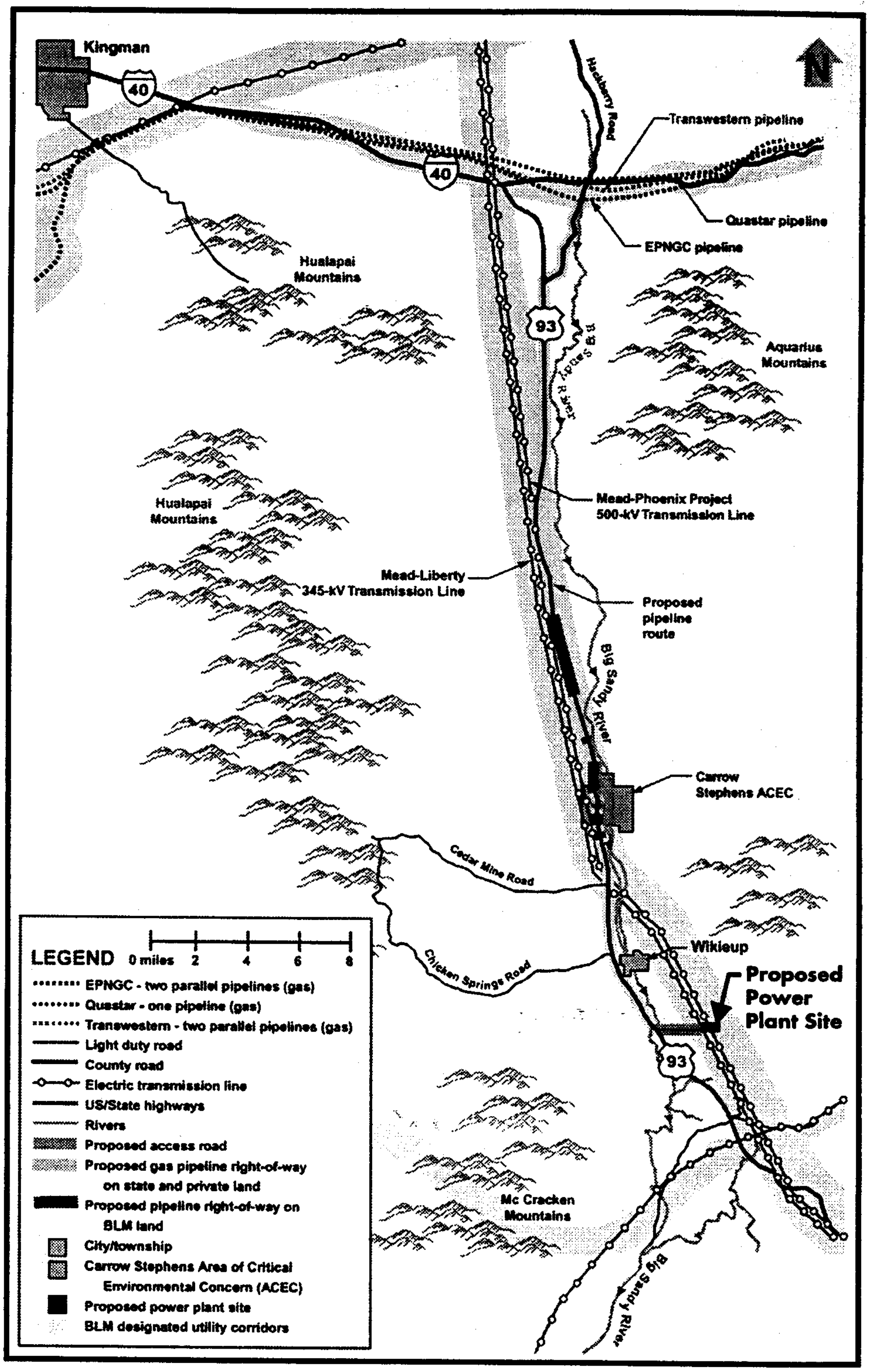
The reasons for agency action are for:

- *Western to respond to Caithness Big Sandy's request for interconnection to the existing Mead-Phoenix transmission line, to ensure area transmission system reliability and voltage support criteria are maintained or improved*

- *BLM to respond to Caithness Big Sandy's request for permits to use public lands managed by BLM for portions of a proposed natural gas pipeline, a permanent access road, and water pipeline system*

- *Western and BLM to address the potential environmental consequences associated with the proposed project*

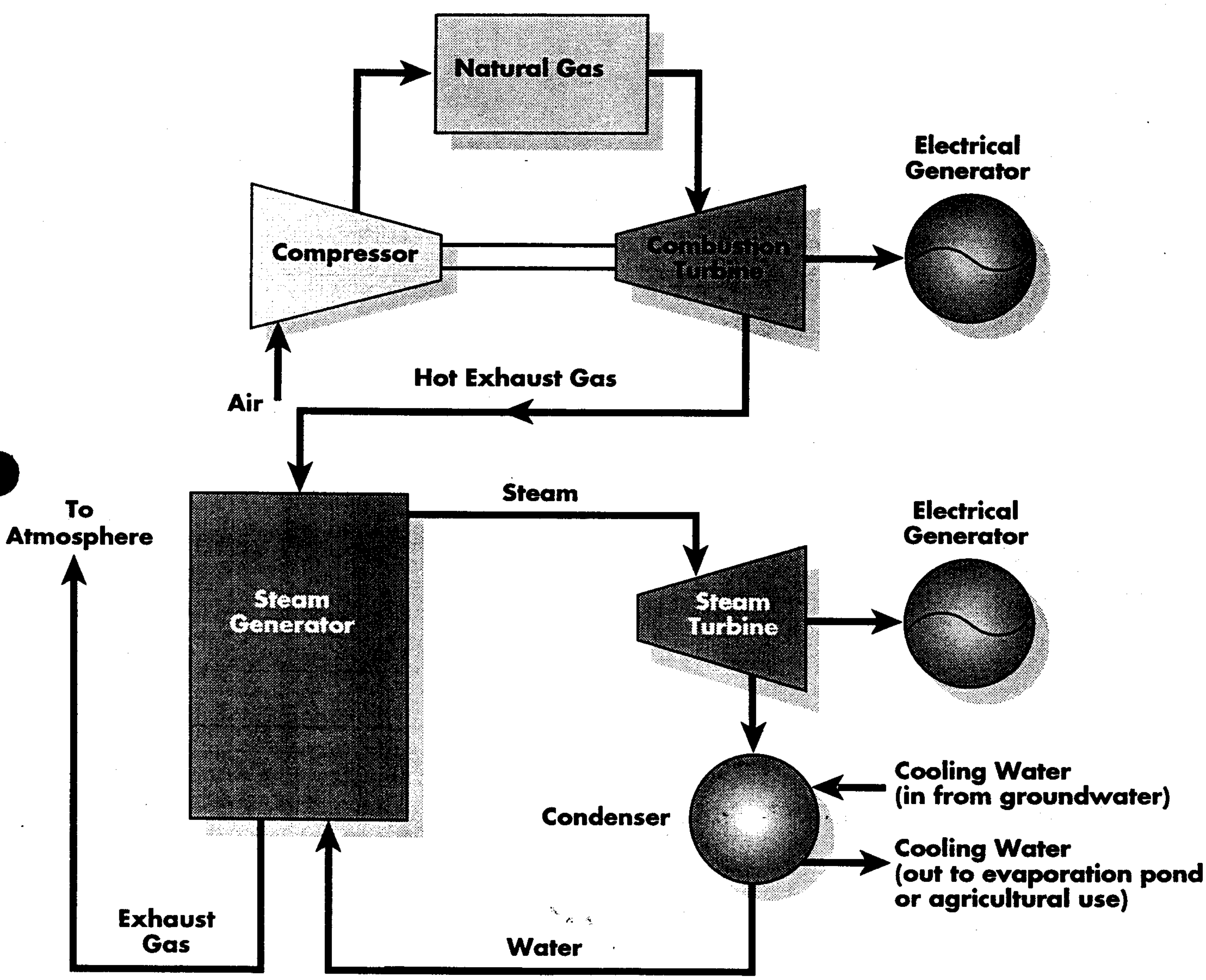
PROJECT LOCATION



Western AREA POWER ADMINISTRATION

Big Sandy Energy Project EIS

POWER PLANT

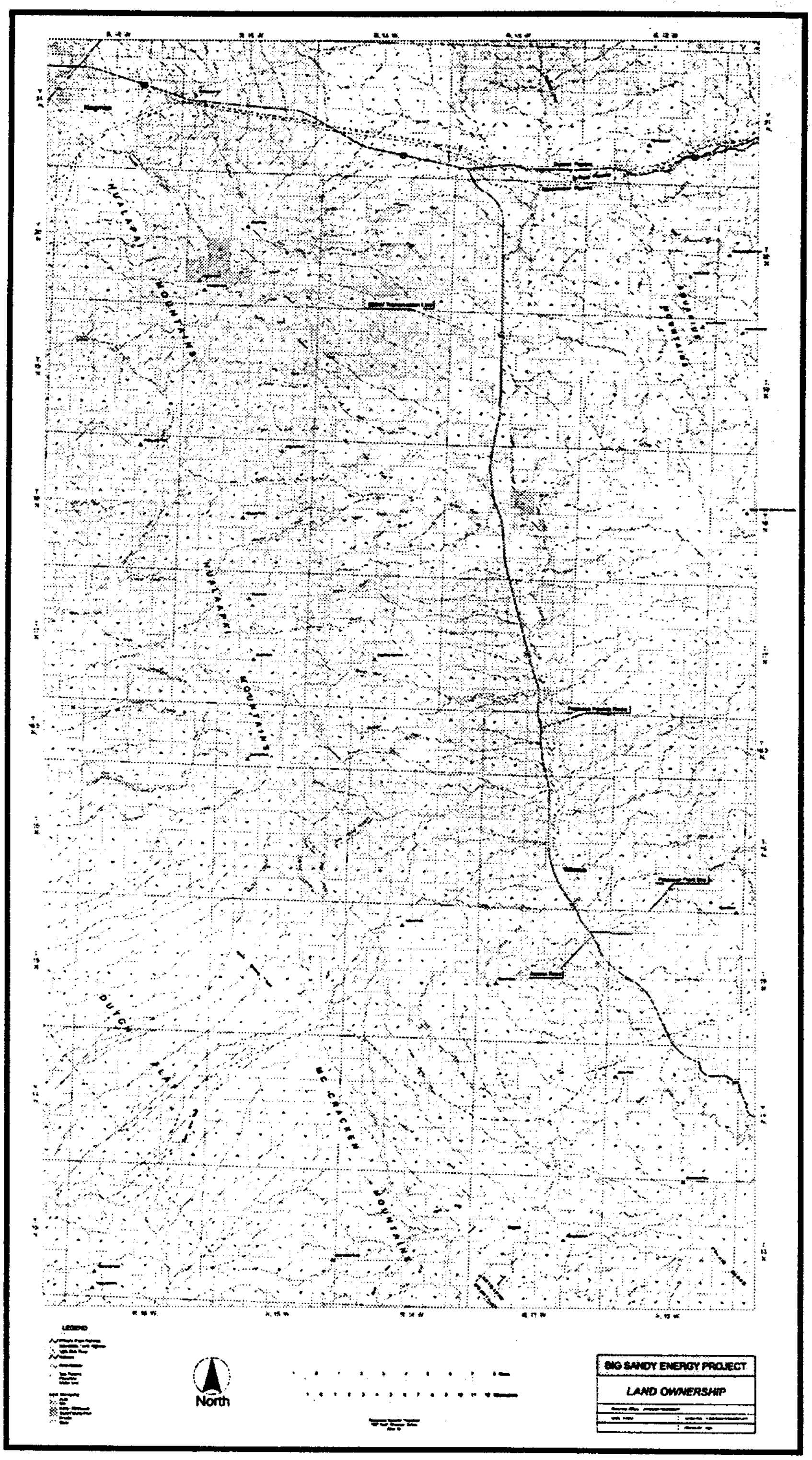

Natural Gas
Electrical Generator
Compressor
Combustion Turbine
Hot Exhaust Gas
Air
To Atmosphere
Steam
Electrical Generator
Steam Generator
Steam Turbine
Cooling Water (in from groundwater)
Condenser
Cooling Water (out to evaporation pond or agricultural use)
Exhaust Gas
Water

PRELIMINARY ALTERNATIVES

- ***No Action Alternative (required by Federal regulations, provides basis for comparison)***
- ***Power Plant Site***
  - *Section 5 (proposed action)*
  - *Section 27*
  - *Section 21*
  - *Section 17*
  - *Section 4*
  - *I-40 Corridor*
  - *Lake Havasu area*
- ***Power Plant Cooling***
  - *Wet cooling (proposed action)*
  - *Dry cooling*
  - *Wet - dry hybrid cooling*
- ***Water Supply/Reuse***
  - *Ground water from the lower aquifer via deep wells (proposed action)*
  - *Ground water from the upper aquifer via shallow wells*
  - *Phelps Dodge/Bagdad water pipeline*
  - *Colorado River water*
- ***Natural Gas Pipeline Corridor***
  - *U.S. 93/Hackberry Road (proposed action)*
  - *Mead Phoenix Transmission Line Right-of-Way*
  - *McCracken Mountains*

Notes: Additional alternatives may be developed.
Some alternatives will be eliminated from detailed analysis based on purpose and need, and technical and economic

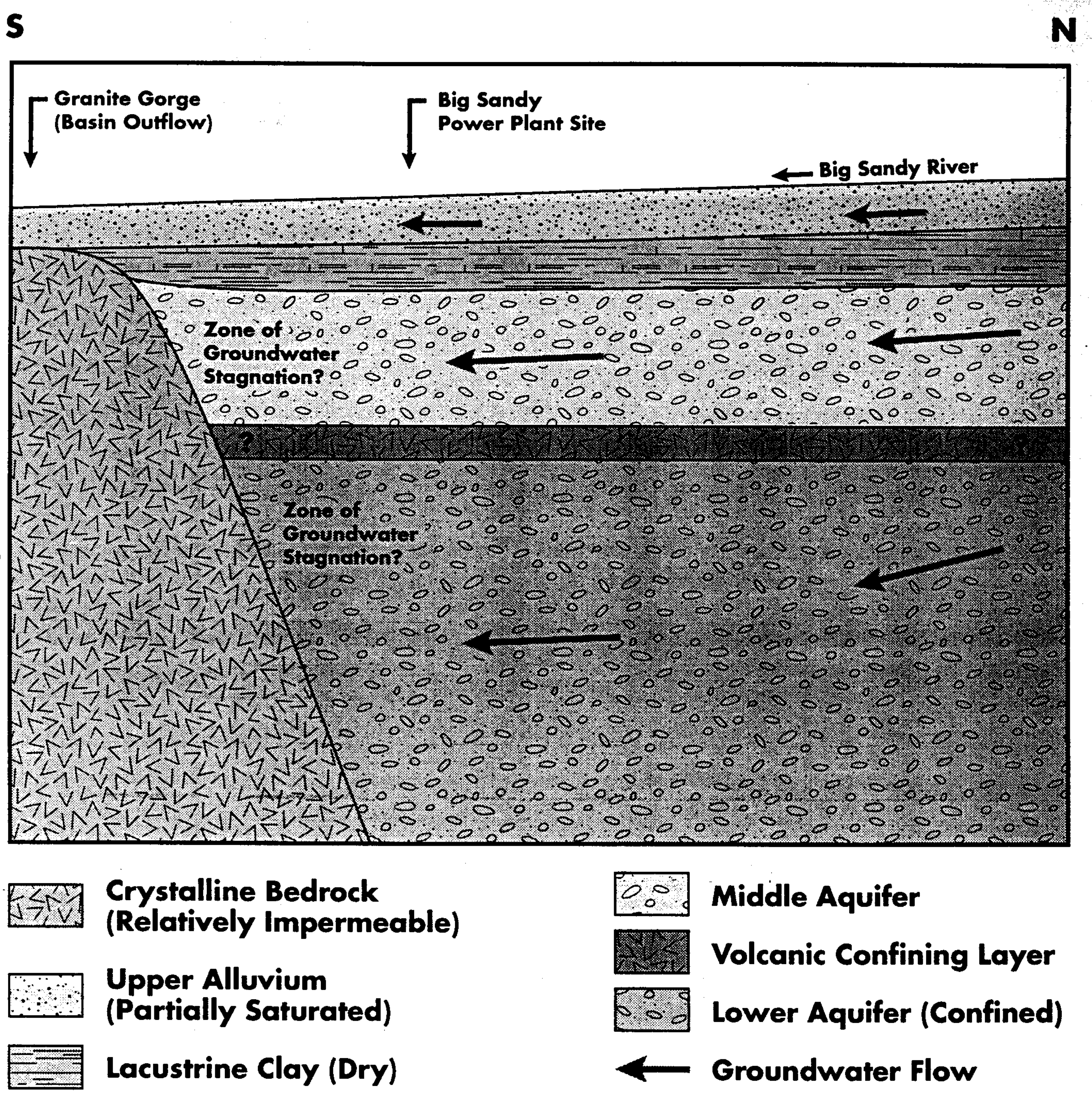
LAND USE



Western AREA POWER ADMINISTRATION

Big Sandy Energy Project EIS

DIAGRAMMATIC CROSS-SECTION OF THE BIG SANDY BASIN

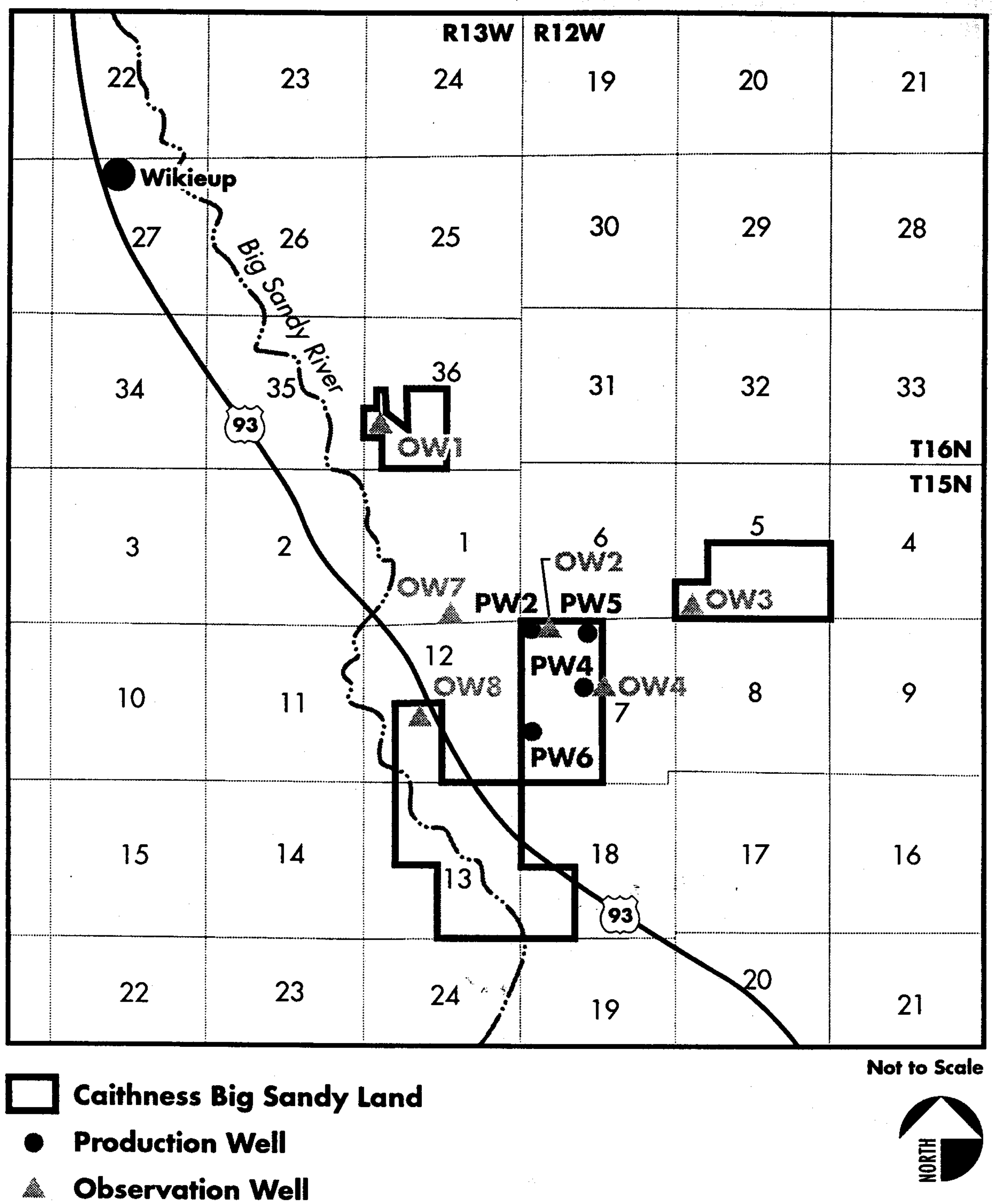


NOT TO SCALE

Western AREA POWER ADMINISTRATION

Big Sandy Energy Project EIS

PRODUCTION AND MONITORING WELLS



Big Sandy Energy Project EIS

Western Area Power Administration

BIG SANDY ENERGY PROJECT EIS -- SUMMARY OF MAY 3, 2000 PUBLIC SCOPING MEETING

Verbatim Flipchart Notes from Scoping Meeting	Actual Question/Comment Heard at Scoping Meeting	Response Provided at Scoping Meeting and/or Answers to Questions
Quest. for Caithness	N/A	N/A
Normal water req. for each phase?	How much water would be required for each phase?	The estimated average water demand for both phases is 3200-acre feet per year. The EIS will address water consumption impacts.
Why is water from Baghdad not feasible?	Cyprus-Bagdad has offered water for the plant site. What is happening with that?	Cyprus-Bagdad has offered to Caithness to study what options would be available and feasible for using water pumped from the Big Sandy floodplain for the Cyprus-Bagdad mine. The Cyprus-Bagdad pipeline parallels the transmission line corridor near the proposed plant site. The EIS will address the Cyprus-Bagdad water supply options.
Why Gas source from North now? (Orig. from West)	Why has the proposed natural gas (NG) source changed from the El Paso Natural Gas Company transmission line to the west to the NG supply lines to the north. Initially, the route to the west was described as better because of the existing NG supply line right-of-way.	Caithness changed the proposed route to the north because of the McCracken Mountains Area of Critical Environmental Concern and associated desert tortoise habitat and opportunities to utilize the U.S. Highway 93 right-of-way. Upon completion of the scoping process and preliminary environmental inventory, Western and BLM will determine NG pipeline routing alternatives that will be addressed in the EIS.
Still considering a tap for Wikieup?	Will there be a tap of the proposed NG pipeline to supply NG to Wikieup?	Providing NG to the Wikieup area is not part of the proposed action. However, Caithness' proposal will do nothing to preclude a NG supply company from providing service to the Wikieup area.
What are the ton per yr of pollution?	How many tons of air pollutants will be emitted from the 720 MW power plant? Caithness has this information and should share it at the scoping meeting.	The EIS will discuss the impacts on air resources, including the amount of air pollutants emitted by the proposed power plant. Western and BLM will independently evaluate and verify the air modeling results in consultation with the Arizona Department of Environmental Quality. Preliminary studies indicate that the maximum yearly potential emissions from the

Verbatim Flipchart Notes from Scoping Meeting	Actual Question/Comment Heard at Scoping Meeting	Response Provided at Scoping Meeting and/or Answers to Questions
		generating facility will be about 213.4 tons of oxides of nitrogen (NO_x), 254 tons of carbon monoxide, 45.2 tons of volatile organic compounds (VOCs), 33.9 tons of sulfur dioxide, 72.4 tons (from NG combustion) and 34.7 tons (from the cooling towers) of PM-10, and a total of 17.45 tons hazardous air pollutants.
My land is being crossed pipeln No more lines on my land	Concerns were expressed about the proposed NG pipeline crossing private land. A ranch owner does not want any more pipelines across his ranch. There would be problems burying the pipeline with Hackberry Road.	Western and BLM will explore routing alternatives to minimize impacts on private lands. The routing alternatives will be addressed in the EIS.
Light pollution looked at, pointed down possibly	What about light pollution? Will the power plant's light cause pollution? Can the lights be designed to minimize light pollution?	Caithness will need to comply with the Mohave County Dark Sky Ordinance, which includes requirements for shielding and filtering. The EIS will address the effects of power plant lighting and possible mitigation measures.
Where is the power going? Anything to County	Will the County get any of the power produced by the power plant or will it all be shipped out?	The proposed project would be a merchant plant, selling power on the open market. Citizen's Utilities and Mohave Power Cooperative serve Mohave County. Citizen's and Mohave Power Cooperative could pursue purchasing power from the Big Sandy Energy Project or numerous other power suppliers in a deregulated utility environment.

Verbatim Flipchart Notes from Scoping Meeting	Actual Question/Comment Heard at Scoping Meeting	Response Provided at Scoping Meeting and/or Answers to Questions
Set parameters must be met? Guidebk ARE THERE Provide website	Are there set parameters that must be studied? Where is this information available?	The EIS will meet the requirements of the CEQ Regulations for Implementing NEPA (40CFR 1500-1508), the DOE NEPA Implementing Procedures (10 CFR 1021, as amended), the Department of the Interior NEPA Implementing Regulations (517DM 1-7), and the BLM NEPA Manual and Handbook (MS 1790, H-1790-1). The CEQ and DOE regulations and related guidelines are available at http://tis.eh.doe.gov/nepa/
Close consultation re: Effects to Res. Trad. & Cultural values & interests TRIBAL CONCERNS Coop Agency?	The Hualapai Tribe wants close consultation with Western and BLM considering concerns about impacts to reservation and cultural and traditional values, for example natural resources and plants. The Hualapai Tribe requested to be a cooperating agency.	Western and BLM invited the Hualapai Tribe to be a cooperating agency, and the Hualapai Tribal Council passed a resolution to become a cooperating agency.
Oppose to the project (TRIBE) No mention on draw down Big Sandy HABITAT Crit. Native Species Natrl Res's Air Quality process	Dr. Kerry Christensen with the Hualapai Tribe is opposed to the project. Issues with the aquifer drawdown and its effects on the Big Sandy River and associated species habitat, including the southwestern willow flycatcher need to be addressed. What will be the specific drawdown of the Big Sandy? How does the air permitting process work for a two-phase project?	The EIS will address the effects of water pumping on the Big Sandy River and associated wildlife habitats and natural resources. The purpose of the EIS is to analyze the concerns and issues raised during scoping. The drawdown of the aquifer will be addressed in the EIS. The air quality permitting process will address both phases of the project. If the second phase is not implemented within a time specified by the ADEQ, a new application will need to be submitted for the second phase.

Verbatim Flipchart Notes from Scoping Meeting	Actual Question/Comment Heard at Scoping Meeting	Response Provided at Scoping Meeting and/or Answers to Questions
What happens if our wells go dry? 50 yrs	What happens if existing wells in the Wikieup area go dry? In 5, 10, or 15 years?	The EIS process involves assessing the impacts to environmental resources, including ground water resources. If impacts are identified, the process is designed to mitigate impacts. The EIS will address the effects of water pumping on existing wells in the Wikieup area. Following the impact assessment, a determination of appropriate monitoring and potential mitigation will be developed and presented in the EIS.
Criteria for water draw down?	How do you test a well for drawdown? How do you test a well for using water for a 10 to 50 year period?	Western and BLM will rely on hydrologists to define tests for determining drawdown. Western and BLM will independently evaluate and verify any tests conducted by Caithness addressing water drawdown effects. A pump test protocol has been developed and reviewed by several hydrologists. The protocol includes pumping water from a production well and observing effects in nearby observation wells. The test will be implemented in late August or early September. The results will be used, together with a basin-wide water budget, to help assess long term impacts.
What happens to water being used?	What happens to the water that is used for the power plant?	Ninety to 95% of the water used for cooling evaporates. About 5% of the water will be discharged to evaporation ponds or used for beneficial agricultural purposes. A detailed water balance for the project is being developed.
Scenic Highway what hap to it?	What will happen to the scenic highway designation on US Highway 93?	ADOT is a cooperating agency and the impacts on designation will be discussed with ADOT. No effect on the scenic highway designation is expected. The EIS will address the visual resource impacts of the project, including views from US Highway 93.

Verbatim Flipchart Notes from Scoping Meeting	Actual Question/Comment Heard at Scoping Meeting	Response Provided at Scoping Meeting and/or Answers to Questions
Water is a crit resource, bring MC into crit res. comm. for proper water use	Referencing a recent Arizona Republic article, a Hualapai tribal representative suggested bringing Mohave County into the State's groundwater critical resource committee. What are the existing ground water management goals?	Mohave County is a cooperating agency on the EIS. However, BLM and Western cannot influence what the county will do regarding participation in state committees.
Endangered species in Wikieup? (US)	What about the threatened and endangered species that live in Wikieup -- the humans? What about the impacts of lack of water on the people in Wikieup?	The EIS will address impacts to the community of Wikieup, including air, water, social and economic impacts.
BigSandy as Wild/Scenic River Will this effect its status?	Will the proposed Big Sandy Energy Project effect the status of the Big Sandy River as a wild and scenic river?	The portion of the Big Sandy River north of the U.S. Highway 93 bridge does not have the potential to be designated. A portion from the bridge downstream has potential for designation. The EIS will address impacts to the Wild and Scenic River designation. The hydrology studies will determine potential impacts, and all will be disclosed in the EIS.
How is Western paid for this? No compensation? What is the trans. tariff rate	Will Western make a profit from the Big Sandy Project? Who will pay Western's salaries? Does Western receive compensation for granting the interconnection? What is the transmission tariff rate?	Western, as a Federal agency, does not make a profit. Western, in considering applications for interconnection or transmission service, must ensure that its costs for studying the interconnection are not borne by its customers or the public. Therefore, all of Western's costs in addressing the applications are borne by the applicant. The EIS will address Western's policies on open transmission access and include information on the transmission tariff. The transmission tariff rate for firm point-to-point transmission service on the Intertie 500-kV transmission system is currently $17.23/kW-year.

Verbatim Flipchart Notes from Scoping Meeting	Actual Question/Comment Heard at Scoping Meeting	Response Provided at Scoping Meeting and/or Answers to Questions
HB2324 Net Tax Revenue to MC?	What is the net tax revenue that Mohave County will receive?	The EIS will address the socioeconomic impacts to Mohave County, including taxation.
Potential for this p. to prov. benefits?	What are the potential benefits that this project could provide?	The EIS will address the socioeconomic impacts to Mohave County, including taxation.
How much really comes to Wikieup for comm. imprvmt?	The County has not addressed how $4.5 million in tax revenue will be addressed. How much will come to Wikieup from County taxes? Will all go to the County seat or will some go to Wikieup?	The EIS will address the socioeconomic impacts to Mohave County and to Wikieup, including taxation.
Will neg. comm. from the commun. be effective in this process? Will they be considered	There was local opposition to the rezoning, but the Board of Supervisors voted for it. How effective will local voices be?	All comments will be addressed during the EIS process. The decision makers will consider all comments received. Local comments have been useful in helping BLM and Western define issues for the EIS.
Will the local comm. comments have more weight? For example, Case Grande	Will the local community have greater weight than other comments? Will information be provided on what happened with the Cassia Grande power plant?	All comments will be considered equally. BLM and Western will collect information on the Casa Grande power plant and determine if it relates to the proposed project.
Where are the decision makers in the process. Who makes the decision? Mike Hacskaylo Administrator	Why are not the decision makers at the scoping meeting? Why aren't people at the scoping meeting who can answer questions.	The decision makers are Mike Hacskaylo, Western's Administrator and John Christensen, BLM Kingman Field Office Manager. The EIS process is intended to disclose the positive and negative impacts for the decision makers review.
Concern that the process doesn't happen in conjunction w/answers Decisions w/held until after voting	There is a concern that the decisions have already been made and public input will not be considered.	Western, BLM and the Federal cooperating agencies cannot make a decision until the EIS process is complete.
Touch on Env. Justice in such an area	Environmental Justice is an issue because there are small populations.	The EIS will address potential environmental justice impacts to low income and minority populations, not small populations.

Verbatim Flipchart Notes from Scoping Meeting	Actual Question/Comment Heard at Scoping Meeting	Response Provided at Scoping Meeting and/or Answers to Questions
Pres. Council asks to supp. sustainability Renewables & How Western should be add. this, taking account. Why not more participants in renew.	Based on Presidential mandates, what is Western doing to support sustainable energy and renewables?	Western does have a renewable energy program. However, this program is not related to the purpose and need for the Big Sandy Energy Project. Western will share what it is doing to support sustainable energy and renewables with interested parties.
How could MC use fresh water for power plant - Why is this a good idea?	How and why does Mohave County want to use good, fresh groundwater and let others use the effluent? Does the tax revenue provide more benefit than loss of a precious resource? Why not use other types of water resources?	Mohave County has approved with conditions the use of water for power plant use when the Board of Supervisors approved the rezoning for the power plant. The EIS will not attempt to assign monetary values to different resources.
Who is on the env. study? How are they selected? Who funds? Not lowest Want an impartial decision maker bidder? Include tribe in dec.	Who is going to be on the environmental studies team and how are they going to be selected? Important not to select the lowest bidder. The tribe needs to be included in the environmental studies.	Western and BLM have selected URS to conduct the environmental studies based on its technical qualifications. URS will be working with the Hualapai tribe in conducting environmental studies. The Hualapai Tribe is a cooperating agency.
How far away can the location be changed before the process starts over? What is process? Is it shortened?	How far away can Caithness move the plant before the (County rezoning) process is voided?	The rezoning applies to 120-acre parcel. If the plant moves outside of the 120-acre parcel, Caithness would have to apply for rezoning.
No rubber stamp for EIS team	Realistic, important decision needed on environmental contract. There should not be a rubber stamp of the environmental studies team. The environmental studies team has to make impartial decisions.	Caithness, BLM and Western have executed a memorandum of understanding that affirms that BLM and Western will independently direct the EIS contractor.

Verbatim Flipchart Notes from Scoping Meeting	Actual Question/Comment Heard at Scoping Meeting	Response Provided at Scoping Meeting and/or Answers to Questions
If plant goes in & there is an effect on the water-at what point would you stop?	If the power plant is constructed and it has an effect on the area's water supply, at what point would Caithness stop generating electricity?	A pump test protocol has been developed and reviewed by several hydrologists. The protocol includes pumping water from a production well and observing effects in nearby observation wells. The test will be implemented in late August or early September. The results will be used, together with a basin-wide water budget, to help assess long term impacts. The results will dictate whether monitoring and mitigation is needed to protect the area's water supply.
Addressing where the water is coming from-source Aquifer recharge?	Will Western and BLM address where the water is coming from? The aquifer recharge? Will isotope testing be conducted?	BLM and Western will address where water is coming from and aquifer recharge and will conduct isotope testing.
In comp. - other ppts & solar/wind generation using less water Dry cooling	The studies need to compare the environmental impacts of the proposed power plant to other generation types (e.g. solar and wind). Will the studies address a dry cooling option, as being used in a Boulder City, Nevada power plant?	BLM and Western are still developing the alternatives that will be addressed in the EIS, including alternative generation technologies and cooling options. Alternatives selected for detailed review in the EIS must substantially meet the purpose and need for the project and be technically and economically feasible..
Detailed hydrolog. study	A detailed hydrological study is needed.	See response to similar comments above.
Sugg. that the closer you are to the project more you are against it. Plant. Bullhead City or Lake Havasu	Why can't the plant be located closer to Bullhead City or Lake Havasu City where water is available.	The EIS will address the availability of water from the Colorado River. BLM and Western are still developing the alternatives that will be addressed in the EIS.
If power leaving Wikieup why is it benefit ?	If the power is leaving Wikieup, why is the project a benefit to the Wikieup area.	The EIS will address both the potential benefits and negative impacts to the Wikieup area.

EXHIBIT J.3 SOCIOECONOMICS

Adverse socioeconomic impacts are expected to be minor and limited to the construction period for the Project. The construction work force would average approximately 150 persons over 2 years (ranging from 50 for site preparation to 350 at peak construction) and would be accommodated in the Kingman/ Wikieup areas and in workers' personal trailers or motorhomes. Short-term socioeconomic benefits would be derived from the Project, as the construction work force will increase revenues in the retail and service sectors of the Mohave County regional economy.

The power plant will have a permanent workforce of 22 persons, which will be accommodated in the Kingman/Wikieup area. In the long-term, socioeconomic benefits would be derived as the available power will provide greater reliability of service in area communities and would contribute to the stability of Western's regional power grid, benefitting the communities that depend on it. The Plant would also provide 22 high-paying jobs to the local communities.

The Kingman/Wikieup area will gain some economic benefit from the expenditures for construction of the Project. Revenues to the local economy over the first 20 years are anticipated to be in the range of $35 to $45 million, and, over the second 20 years, will be approximately $75 million.

The Project will be located about 45 miles southeast of the City of Kingman and about 4 miles southeast of Wikieup on land privately owned Caithness. Ownership of lands abutting the site is mixed between private and public lands managed by the BLM. The Project is located 4.5 miles from any current residential development in the town of Wikieup, although scattered residences in the area are as close a one mile from the Plant. Visual and noise impacts to nearby residents are expected to be minor.

APPENDIX J-3-1

SOCIAL AND ECONOMIC CONDITIONS

REPORT

BIG SANDY ENERGY PROJECT SOCIAL AND ECONOMIC CONDITIONS

Submitted by:

Caithness Big Sandy, LLC
7887 E. Belleview Avenue
Suite 1100
Englewood, CO 80111

September 2000

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INTRODUCTION

Caithness Big Sandy, L.L.C. (Caithness) has proposed to develop, construct, own, and operate the Big Sandy Energy Project (Project), a natural gas-fired, combined-cycle power plant (Plant) near the unincorporated community of Wikieup, approximately 40 miles southeast of the City of Kingman along U.S. Highway 93 in Mohave County, Arizona. For purposes of this analysis, Mohave County is defined as the study area for socioeconomic issues related to the Plant, associated facilities and the natural gas pipeline. Please refer to the Big Sandy Energy Project description for a detailed description of the Project.

SOCIAL AND ECONOMIC CONDITIONS

The City of Kingman is the county seat and population center of the County. Mohave County also contains the incorporated cities of Colorado City, Bullhead City and Lake Havasu, along with several unincorporated communities. Kingman provides access to health care, trade, and other services to the surrounding rural area, including Wikieup and the U.S. Highway 93 corridor.

Wikieup is primarily a residential community surrounded by rural, largely undeveloped lands that consist of a land-ownership checkerboard pattern of BLM, state, and private lands. Many residents commute to Kingman for employment, retail, and other community services.

Population

Arizona has been one of the fastest growing states in the United States. While the nation's growth rate was 9 percent from 1980 to 1990, Arizona's population grew by an approximate 34.9 percent from 1980 to 1990. Mohave County's population has also grown rapidly at a rate of about 67 percent from 1980 to 1990. From 1990 to 1996, Mohave County had a 41.8 percent increase in population, which was the highest in Arizona. From 1980 to 1990, the City of Kingman had a 22.2 percent increase in population. The other major cities in Mohave County (Bullhead City, Colorado City, and Lake Havasu City), have experienced an average 73.7 percent increase (see **Table 1**). The increase in population has been fueled by job availability, lifestyle and temperate climate. The current population of the community of Wikieup is an estimated 200 residents.

Historically, the above population rates depict stable growth. This trend is expected to continue for future population rates as well. The Department of Economic Security's population projections (**Table 2**) estimate that from 1990 to 2000, Arizona would have increased its population by over 26 percent, Mohave County would have increased its population by almost 58 percent, and Kingman would have increased its population by more than 52 percent.

Table 1
1980 to 1999 Population Comparison

Area	1980	1990	1999*
ARIZONA	2,716,546	3,665,228	4,924,350
Mohave County	55,865	93,497	142,925
Mohave County Major Cities:			
Kingman	9,257	12,722	20,000
Bullhead City	10,719	21,951	29,315
Colorado City	1,439	2,426	4,365
Lake Havasu	15,909	24,363	41,045

* Estimated figures.
Source: Arizona Department of Economic Security

Table 2
Population Projections

Year	Kingman	Mohave County	Arizona
2005	22,845	171,504	5,553,849
2010	25,225	194,403	6,145,108

Source: 1997 Department of Economic Security Population Estimate

Mohave County's 1998 demographic estimate indicates that the majority of the residents are between the ages of 25 and 64 years. According to Mohave County's 1994 *General Plan*, Kingman's median age in a 1990 demographic census was 36.9, Mohave County's median age was 40.7, while Arizona's median age was 32.2. In addition, residents of Mohave County and Kingman comprise a fairly homogenous population, with a very low percentage of minorities. **Table 3** illustrates Mohave County's age distribution. **Table 4** illustrates the ethnic distribution in Mohave County and Kingman.

Table 3
Mohave County Age Distribution (1998)

Age	Number	Percentage of Total
0-4	8,079	6.19%
5-17	20,780	15.91%
18-24	7,515	5.75%
25-44	30,788	23.57%
45-64	35,495	27.17%
65+	27,961	21.41%

Source: U.S. Department of the Census, 1998 Population Estimate

Table 4
Mohave County Ethnic Composition (1998)

Race	Mohave County	Percent
White	125,766	96.29%
African American	529	0.41%
Native American	3,123	2.39%
Asian or Pacific Islander	1,200	0.92%
Other	0	0.00%
Totals	130,618	100.00%
Hispanic Heritage*	8,488	6.50%

* Persons of Hispanic Heritage may be of any race
Source: U.S. Department of the Census

Local Economy, Labor and Employment

In 1999, the civilian labor force for Mohave County consisted of 63,850 individuals, of which 4.5 percent, or 2,900 individuals, were unemployed. The majority of jobs in Mohave County's labor force are in trade and service industries, as illustrated in **Table 5**. During the years from 1995 through 1999, the largest gains in job growth have been in eating and drinking establishments, hospitals, and grocery stores. In recent years, the changing industry mix has been toward less diversification and greater dependence on government and tourism. Many residents of the county are employed in Laughlin, Nevada, and are included in Mohave County's job statistics (Arizona Department of Economic Security 2000).

Table 5
Mohave County Employment Distribution (1999)

Employment	Labor Force	Percentage of Total
Mining and Quarrying	175	0.48%
Construction	3,150	8.64%
Manufacturing	3,300	9.05%
Trans., Comm., and Pub. Util.	1,775	4.87%
Trade	11,700	32.10%
Finance, Ins., and Real Estate	1,400	3.84%
Service and Miscellaneous	9,900	27.16%
Government	6,200	17.01%
Area Total	37,600	100.00%

Source: Arizona Department of Economic Security, 2000

According to the Mohave County General Plan, the County's employment rates have increased from 1986 to 1991, at an average annual rate of 7.2 percent, from 25,675 to 36,400, while unemployment declined from 9.6 percent to 6.25 during this period. By 1994, the unemployment rate was 8.7 percent, and fell to 4.50 percent by 1999, as shown in **Table 6**. Most of this employment growth occurred outside the County. The most significant factor in the increase in employment opportunities was the hotel/casino industry in Laughlin, Nevada. Laughlin provides 11,000 primarily low-paying service sector jobs and most of these jobs are held by Mohave County residents (Mohave County 1995 General Plan).

Table 6
Mohave County Labor Force Statistics

	Total Labor Force	Total Employment	Unemployment Rate
1994	55,150	50,375	8.70
1999	63,850	60,950	4.50

Source: Arizona Department of Economic Security, 2000

The rapid growth in the late 1980s also spawned increases in the number of retail trade and construction jobs in Mohave County. Mohave County's 1995 *General Plan* policies encourage expanding retail and construction jobs, along with the expansion of production and distribution jobs and service-industry jobs to provide diversification in the workforce. The focus of the county is to provide for more long-term economic stability by reducing the importance of Laughlin in the local economy.

The State of Arizona and Mohave County have developed targeted incentives to promote the growth of existing industries and enhance the recruitment of new industry. These incentives include:

- Locally Issued Private Activity Bonds
- Small Business Innovation Research Grants
- Enterprise Zones
- Foreign Trade Zones
- Research and Development Tax Credit
- Arizona Technology Authority Commerce & Economic Development Commission
- Job Training
- Revolving Energy Loans for Arizona
- Pollution Control Tax Credits
- Environmental Technology Assistance
- Construction Tax Credits
- Defense Restructuring Program

The City of Kingman is a regional trade, service and distribution center for northwestern Arizona. Its location relative to Los Angeles, Las Vegas, Phoenix, Laughlin and the Grand Canyon has made tourism, manufacturing/distribution and transportation leading industries.

The major employers in Mohave County include:

Employer	Type of Business
Allied Signal, Inc.	Manufacturer of Fluorine Products
Cyprus Climax Metals Co.	Copper Ore
General Cable	Miscellaneous Fabricated Wire Products
Goodyear	Manufacturer of Aircraft Components
Kingman Regional Medical Center	General Medical & Surgical Hospital
Mohave Community College	College
Northstar Steel	Rebar Manufacturer, Steel Recycling
Praxair, Inc.	Industrial Gases
Smith's Food and Drug Centers	Retail Grocery Store

Source: Mohave County Economic Development Authority, Inc. 1999

Taxes

Arizona has a general sales tax of 5 percent. The state real property tax rate is $0.47 per $100 of assessed valuation. The statewide average of real property tax rates per $100 of assessed valuation is $13.26, while Kingman's tax rate was $10.2200 in 1999 (Arizona Department of Revenue 2000). In addition, the cities of Bullhead City, Kingman and Lake Havasu City have a city sales tax of 2 percent. Also, Colorado City and Kingman have an additional two percent tax on hotel and motel stays. **Table 7** illustrates tax rate breakdowns for an incorporated city and unincorporated city, with or without fire protection.

Table 7
Real Property Tax Rates (per $100 assessed valuation)

	City	Unincorporated without Fire Protection	Unincorporated with Fire Protection
State of Arizona (School Equalization)	0.5300	0.5300	0.5300
Mohave County	1.7500	1.7500	1.7500
Mohave Community College	0.8522	0.8522	0.8522
Mohave Union High School	2.2024	2.2024	2.2024
Kingman Elementary School District 4	2.3513	2.3513	2.3515
City of Kingman	0.6703	0.0000	0.0000

Source: Mohave County Economic Development Authority

Between 1990 and 1996, Kingman increased its taxable sales amount from $159,035,500 to $299,863,750 (Arizona Department of Revenue 2000). This increase may be attributed to the increase in total personal income in Mohave County and within the state as illustrated below in **Table 8**.

Table 8
Total Personal Income (in millions)

Area	1994	1995	1996
Arizona	$79,867	$87,527	$94,607
Mohave County	$1,886	$1,998	$2,163

Source: U.S. Department of Commerce; www.bea.doc.gov/remd2/svy_az.thm

Corporate Income Tax in Arizona is a flat tax rate of 9 percent. The minimum amount collected by Arizona for Corporate Income Tax is $50 (Arizona Department of Revenue).

Property taxes are an important source for locally-based revenue. They are based on assessed valuations which is determined by certain percentages of full value by the County Assessor's office. **Table 9** illustrates different classes of property and their assessment ratios. For example, commercial and industrial property tax rate is 25 cents for each $100 of assessed valuation. Property includes all types of business equipment, ranging from heavy machinery to typewriters. Secured and unsecured personal property and construction in progress are exempt from taxation. Arizona has adopted a 4-year accelerated depreciation schedule for business property to encourage capital investment in the state.

Table 9
Assessment Ratio by Class

Classes	Description	Assessment Ratio % of Full Cash Value
Class 2	Telephone & Telegraph Companies, Gas, Water and Electric Utility Companies	25*
Class 3	Commercial and Industrial Property (including machinery and equipment)	25
Class 11	Leased Improvements on Government Property	1

* Reduced 1 percent per year from 1997 until 1999.
Source: Mohave County Economic Development Authority, Arizona Department of Revenue

To make up for the limited property tax base that results from government owned lands, the Federal government makes payments in lieu of taxes to local governments. These payments are limited in the total amount payable to any county by a formula based on the county's population and Federal acreage.

Housing

Household statistics in Mohave County indicate that average household sizes have been decreasing since the 1980s and the relative proportion of single parent households is increasing. The trend toward smaller household sizes means that more dwelling units would be needed to house the increasing Mohave County population. In 1980, Mohave County had 28,356 dwelling units. This figure had almost doubled in 1990, with 50,822 dwelling units. More than 97 percent of the County's building permit activity has been attributable to single-family dwellings and mobile or manufactured homes. Single-family homes accounted for 32 percent of new structures between 1985 and 1993, manufactured homes accounted for 66 percent, and the remaining 2 percent of the new construction permits were issued for commercial, industrial, multi-family or public buildings. New construction in South Mohave Valley, the Lake Havasu area and the Kingman area were primarily responsible for the increase in single-family permits (Mohave County 1995 General Plan). As illustrated below in **Table 10**, the types of housing units demanded in Mohave County changed between 1980 and 1990.

Since the 1980s, housing purchase prices and rental costs have increased, with median home prices increasing by 54 percent, and median monthly rents increasing 36 percent. While personal income in the County has been steadily increasing, housing affordability varies from one community to another. As illustrated in **Table 11**, housing is much less affordable in the western part of the County, particularly near Bullhead City. Because of this, many people who work in Bullhead City live 40 to 60 miles away in Golden Valley or Kingman.

Table 10
Types of Housing Units

	1980		1990	
Housing Types	**Total Units**	**% of Total**	**Total Units**	**% of Total**
Single-family (detached)	14,378	50.71	22,460	44.19
Single-family (attached)	263	0.93	1,091	2.15
Duplex	608	2.14	631	1.24
Manufactured home	2,118	7.47	4,633	9.12
Mobile home	10,989	38.75	21,653	42.61
Other			354	0.69
Total	28,356	100.00	50,822	100.00

Source: Mohave County 1995 General Plan

Table 11
1990 Median Home Value and Rent by City

Place	Median Home Value	Median Monthly Rent
Kingman	$63,200	$311
Bullhead City	$97,400	$423
Lake Havasu City	$83,500	$403
Colorado City	$52,100	$175
Peach Springs	$35,400	$99

Source: Mohave County 1995 General Plan

Mohave County is not the only county in Arizona with housing affordability issues. It is estimated that 25 percent of the households in Arizona are either paying more than 30 percent of their income for housing, living in substandard housing or living in over-crowded housing. This represents up to 400,000 households. The three highest counties in Arizona paying more than one-third of their income on housing are the counties of Coconino, Navajo, and Apache paying 31.0 percent, 33.2 percent, and 48.2 percent, respectively. Mohave County has 20.8 percent of its population paying more than 30 percent of their income for housing (Arizona Department of Commerce, Office of Housing and Infrastructure Development (HID)). A typical mortgage lender's "rule of thumb" indicates that one can afford a home that costs 2.8 times annual income. An annual household income of $27,000 is required to afford the median-priced home in Mohave County. Housing costs for renters should not exceed 30 percent of gross income. An annual household income of $16,000 is needed to afford the median rent in Mohave County. Most County households can afford to pay the median rent, but cannot afford the median priced home.

The Office of HUD is creating ways to make housing available to everyone with special needs. This is accomplished with special programs such as the Arizona Housing Trust Fund, Low Income Housing Tax Credits, HOME, State of Arizona Public Housing Authority, Project Intervention and the Office of Special Needs Housing.

Temporary housing, consisting of rentals and motels, is widely available in Kingman and in the Bullhead City/Lake Havasu area. Temporary housing in Wikieup is limited to two motels.

Public Utilities and Services

Electricity

Electricity is available from two electric suppliers holding franchise rights within Mohave County (**Table 12**). In addition, some electric power consumers have decided to generate electricity on site, to secure a low-cost, reliable supply. Electric power in the Wikieup area is supplied by the Mohave Electric Cooperative (Bullhead City, 1999).

Table 12
Mohave County Electric Suppliers

Provider	Citizens Utilities Electric (Citizens)	Mohave Electric Cooperative (MEC)
Service Area	7,500 square miles serving the cities of Lake Havasu and Kingman and the surrounding areas north to the Hoover Dam, with approximately 42,000 customers.	1,300 square miles providing electricity to 27,000 services in Bullhead City and parts of Mohave, Coconino and Yavapai counties.
Capacity and Demand	Citizens has no generating capabilities, but does have full-requirement contracts with Arizona Public Services.	MEC purchases wholesale power from Arizona Electric Power Cooperative (AEPCO), and is one of the six owners in this generation and transmission cooperative. MEC also receives Federal hydropower from the Western Area Power Administration grid.

Source: Mohave County Economic Development Authority, Inc.

It has been noted that electrical system improvements would be needed in the area to provide additional capacity and enhance system reliability to meet the needs associated with projected growth. Mohave County and others commissioned Western Area Power Administration (Western) to study the types of system improvements that would be needed. In 1995, Western produced the Northwest Arizona Transmission Study which verified that transmission system improvements and additional local generation would be needed to meet future demands. In addition, one of the local utilities, Citizens Utilities has shown that transmission improvements and generation would be needed in the area and has obtained approvals and permits to build some of the necessary facilities. Citizens Utilities is in the process of selling its Arizona electric businesses, including the operations in Mohave County, to Cap Rock Energy Corp., a new investor-owned utility (Arizona Department of Economic Security, 2000).

Natural Gas

An abundant supply of natural gas is available in Mohave County. Three major open-access interstate pipelines serve the County: EPNGC, TPC, and Questar. El Paso has more than 475 miles of transmission lines and Transwestern has over 200 miles of pipe. Questar is in the process of converting its liquids pipeline to natural gas. Firm transportation capacity to Mohave County from major supply basins is available on these pipeline systems.

Direct access to natural gas reserves from El Paso and Transwestern can be obtained from three major supply basins: San Juan, Permian and Anadarko. Other interconnects with these basins allow access to reserves in Canada, Gulf Coast, Piceance Basin and Rocky Mountain supplies located in Utah and Wyoming. Reserve life for these basins exceed 25 years.

Gas can be purchased either from the regulated distribution companies that serve the County, Southwest Gas Corporation and Citizens Utilities, or from other non-regulated energy companies.

Urban/Domestic Water

Domestic water in Mohave County is supplied through a Colorado River allocation and supplemented with groundwater. Because of Mohave County's proximity to the source of supply and the low delivery costs, users enjoy a significant advantage for farming, municipal and industrial development. The County of Mohave supplies water through American Water Works, Inc. and improvement districts (Mohave Valley Chamber of Commerce). American Water Works, Inc. recently purchased its water and wastewater businesses in Mohave County from Citizens Utilities.

Each of the major cities in Mohave County has a well-designed water transmission and distribution system and has the ability to supply water for the next 200 years. The City of Kingman regulates its own water resources. **Table 13** illustrates Kingman's water resources in units of millions of gallons per day (MGD). Water system service in rural Mohave County (including Wikieup) is supplied primarily by wells or other authorized suppliers. Well permits are obtained from the Arizona Department of Water Resources.

Table 13
Kingman's Water Resources

	Groundwater/wells
Capacity	12 MGD
Average Demand	9 MGD
Storage Capacity	8.4 million gallons above ground

Source: Mohave County Economic Development Authority, Inc.

Wastewater

Wastewater treatment facilities serve Bullhead City, Kingman, Lake Havasu and the immediate surrounding areas. **Table 14** illustrates Kingman's Wastewater Treatment system. Each of the systems has capacity to meet the growing needs of the community. Wastewater treatment in rural areas (including Wikieup) consist of septic tanks and leaching fields. Mohave County regulates wastewater disposal throughout rural Mohave County.

Table 14
Kingman's Wastewater Treatment System

Treatment Plant	Secondary treatment - aeration lagoons
Capacity	2.0 MGD would expand to 3.0 MGD when needed
Average Demand	1.1 MGD

Source: Mohave County Economic Development Authority, Inc.

Solid Waste Disposal

Mohave County currently operates two municipal solid waste landfills. Each landfill encompasses 160 acres and has a life expectancy of more than 35 years. These facilities are strategically located in the northern and southern sections of the County.

There are currently no hazardous waste treatment, storage or disposal facilities in Mohave County. There are hazardous waste treatment and storage facilities in the Phoenix area that are regulated by the Arizona Department of Environmental Quality.

Educational System

Mohave County has eight school districts, with six districts in the principal population centers. Kingman has eight schools serving its residents. There were a total of 6,100 students enrolled in Kingman schools in the 1997 school year. There are approximately 3,351 students enrolled in five elementary schools (pre-Kindergarten through sixth grade). There are 931 students enrolled in the one junior high school, Kingman Junior High School, and 1,818 students enrolled in two high schools, Kingman High School North and South. Owens Elementary District is the only school district that serves Wikieup. There were 44 students enrolled in Owens-Whitney Elementary School as of September, 1999 (Arizona Department of Education, 2000).

Mohave County Community College serves the residents of Mohave County and neighboring communities in California, Nevada, and Utah from its campuses in Bullhead City, Kingman and Lake Havasu City and from the North Mohave Center in Colorado City.

Health Care

Mohave County is served by four major hospitals with additional clinics and extended care facilities strategically located throughout the county. Kingman currently has one general hospital, Kingman Regional Medical Center (KRMC), nine outpatient treatment clinics, and three adult care services (MCEDA). The closest medical and emergency care facilities for residents of Wikieup are in Kingman.

Ambulance service for Mohave County is provided by River Medical Ambulance Service. Each major city in the County has a regional district that the service covers. Kingman's service follows U.S. Highway 93 from Golden Valley through Kingman to Yucca (River Medical Ambulance Service).

KRMC has an Arizona Department of Public Safety helicopter based on the hospital campus. The helicopter, Ranger 33, provides search and rescue, highway medivacs, non-highway medivacs and law enforcement duties (KRMC).

Law Enforcement

The County is served by a Sheriff's Department and a Police Department in each of the major cities and throughout the unincorporated areas. However, the large geographic area makes this a formidable task. The police-to-population ratio is 3.5 sworn officers per 1,000 citizens.

Fire Protection

Seventeen fire districts operate in Mohave County. They provide services to most of the County's urbanized areas. In addition to these districts, Lake Havasu City and Kingman each operate municipal fire districts. Firefighters, many of whom are volunteers, are responsible for their jurisdictions, but often provide services beyond their service boundaries. Most of the fire districts have large, primarily rural service areas. The district's resources (equipment, personnel, water supplies and revenues) are limited (Mohave County 1995 General Plan).

Wikieup and the proposed plant site are served by the Pinion Pine Fire Department, which provides fire protection, EMS, search and rescue, and extrication services to an area of approximately 50 square miles, including the area along U.S. Highway 93 south of Interstate 40 (Pinion Pine Fire Department 2000).

POTENTIAL EFFECTS TO SOCIAL AND ECONOMIC VALUES

Socioeconomic issues raised by the local community during initial public meetings for the Project are described below.

- Potential benefits to local community, including power availability and use of tax revenues from the project.
- Future natural gas availability for Wikieup when required for proposed action.
- Affects on livelihood of Wikieup residents.

These issues are discussed in the following sections.

Labor, Employment and Local Economy

The proposed Plant may affect the local labor market and economy in a variety of ways. Project-related employment includes both direct and indirect employment. Direct employment effects are classified as the actual number of employees required to build and operate the Plant. Indirect effects involve support industries which provide services to the power generation industry. The local economy would be affected by direct project spending and induced economic effects which occur as a result of employees and businesses spending income within the area.

Project-related employment would occur in two phases. The first phase includes the employment of a labor force for construction of the Plant and natural gas pipeline, followed by a smaller level of employment required for operation and management of the facility. Construction of the proposed facilities is anticipated to occur over an 18- to 24-month period and would require a variety of tradesmen and contractors. The construction workforce would range from 40-130 employees for the first several months during site preparation, leading to a peak employment level which would occur at month 12, with an estimated employment level of 350. The employment force would include both skilled and non-skilled workers.

Caithness expects that about 22 permanent workers would be needed for operation of the Plant. This would include full-time operational and maintenance staff.

It is anticipated that the majority of the required labor pool would be available in the Kingman/Yucca/Havasu area. To the extent that some specialized skill classes are not available in the area, it is assumed that these workers would migrate to the area on a temporary basis during the construction phase. Wages for the labor pool have not been defined.

The Kingman/Yucca/Havasu/Wikieup area would gain some economic benefit from the expenditures for construction of the proposed Plant. Revenues to the local economy over the first 20 years are anticipated to be in excess of $50 million.

Although an agreement for the treatment of local property taxes has not been reached, the proposed Plant would increase the assessed value of the Plant parcel, equating to a substantial increase in property tax revenues to Mohave County. In addition, a variety of other state and local tax payments would be incurred with Plant construction, producing additional revenues to various agencies.

The Project would not have any direct growth-inducing effects because the Plant is designed to sell power on the open market and not necessarily to local users. Indirect growth-inducing effects would occur from the improved reliability of electric service in Mohave County, and possibly the increased availability of natural gas for the residents of Wikieup. These improvements could, in turn, attract new businesses and increase the potential for economic and population growth in the Wikieup area.

Population and Housing

It is expected that the majority of construction workers are available within the Kingman/Yucca/Havasu area. Once the construction of the nearby Griffith Power Plant is completed, an experienced work force would be available for the Project. It is not anticipated that the Project would require a large influx of new employees into the region, therefore local or regional population impacts are anticipated to be minimal. While some employees with specialized skills may not be available within the region and may come from outside the area, it is expected that these workers would be required for a short time only, and would not relocate permanently.

The potential demand for new permanent housing is expected to be minimal. In-migrating or weekly commuting construction workers could affect temporary housing stock such as motels or weekly rentals. The existing housing stock in Wikieup is limited, and would not be sufficient to house the project workforce. However, it is anticipated that workers would be accommodated in personal trailers on land owned by Caithness on the south side of Wikieup. It is expected that Caithness would provide sufficient housing for workers for the duration of construction.

Public Utilities and Services

Potential impacts to public services during construction could result from on-site construction activities. These impacts could result from construction related demands for police, fire, medical and other emergency services. It is not expected that these effects would be significant, with the implementation of standard construction health and safety measures, including site fencing, an on-site fire protection system, a worker safety program, and communication equipment to alert local emergency services when necessary.

The proposed natural gas transmission additions may have beneficial effect to the Big Sandy Valley by providing gas service for commercial and residential use which is currently not available. While the Plant itself would not necessarily provide electrical power to the local area, the transmission interconnection that would tie the Plant to the regional transmission grid would also solve some of the electric reliability problems experienced in the area and projected to worsen without system improvements. Existing residents and businesses would benefit from the increased reliability of power in the area.

Solid wastes would be generated primarily by construction. Operational wastes would be generated mostly from operations employees and would be minimal. The amount of wastes generated from construction and operation would be too small to affect the life expectancy of the two municipal solid waste facilities currently operated by Mohave County. The Project would dispose of hazardous materials by supplier of the material or at a hazardous waste facility either in Phoenix or another location. No significant amounts of hazardous waste are anticipated to be generated. In the event that water would be disposed to a brine disposal pond, the resulting solids would not be removed from the brine disposal pond in order to maintain the integrity of the liner. Pond operations and reclamation would be approved through the Aquifer Protection Permit issued by the Arizona Department of Environmental Quality.

A fire protection system would be developed for the Plant as part of its safety program.

Since a large influx of in-migrating employees is not anticipated in the region, there is expected to be minimal effects to public utilities and services in Wikieup or other local communities resulting from increased population effects. Most construction workers would not work for the entire projected 18-24 months of construction activities, and would not move their families to Wikieup. Local schools are not expected to experience significant increases in enrollment from construction workers' children.

ENVIRONMENTAL JUSTICE

Executive Order 12898, "Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations" published in the Federal Register (59 FR 7629), requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.

To determine whether the proposed Project has any disproportionate adverse impacts to minority and low-income populations, the following process was implemented. First, possible impacts to human populations created by the proposed Project were identified. Second, the area which the proposed Project would or may have an effect to human populations was delineated. Third, the appropriate unit of geographic analysis was identified (UGA). The UGA is a geographical unit, larger than the affected area, and provides baseline statistics of minority and low-income populations. Population statistics for the affected area are compared with those in the UGA. If minority and low-income statistics in the affected area are comparable or lower than those in the UGA then it is determined that the possible effects of the proposed project would not have a disproportionate impact to low-income and minority populations. The UGA used in this report is Mohave County. Demographic data for Mohave County is presented in **Table 15**. The table summarizes the racial characteristics and the percentage of the population below the poverty level for the total Mohave County 1990 population.

Fourth, demographic information for the affected areas was gathered and analyzed. This information was obtained from the U.S. Census Bureau and the Arizona Department of Economic Security and is presented using the U.S. Census Bureau's measurement units, tracts and block groups within tracts. If the demographic information, when compared with the UGA demographic data, revealed minority and/or low-income populations being disproportionately affected by the Project, then further investigation was made to identify the specific locations of any minority and low-income populations within the census block groups. The results from this four-step analysis demonstrate that the proposed Project would not have a disproportionately adverse effect on minority and low-income populations.

Table 15
Demographic Information for Mohave County

Total Pop.	Total Hispanic (#/%)*		White (#/%)		Black (#/%)		American Indian, Eskimo & Aleut (#/%)		Asian & Pac. Islander (#/%)		Other (#/%)		Below Poverty (#/%)	
93,497	4,637	*5%*	89,088	*95%*	136	*0.1%*	2,139	*2%*	668	*0.7%*	1,466	*2%*	13,049	*14%*

Source: U.S. Census Bureau, 1990
* Persons of Hispanic Heritage may be of any race

Natural Gas Pipeline

Possible effects to human populations arise from right-of-way clearing, establishment of construction staging areas, and pipeline installation. These potential effects include loss of cultural resources, visual impacts to scenic and recreational landscapes, and an increase in noise and safety hazards related to pipeline construction.

The proposed natural gas supply pipeline would be located within existing highway and county road rights-of-way, reducing the environmental impacts associated with pipeline construction. The area of potential effect with respect to environmental justice issues for the pipeline is the pipeline right-of-way (ROW) corridor of 50 feet in width. The entire length of the line is approximately 36 miles. The unincorporated community of Wikieup is located adjacent to Highway 93 and the pipeline corridor near the south end of the pipeline route. There are no other communities that would be affected by the installation of the pipeline.

The pipeline corridor crosses through two census tracts and their associated block groups, as shown in **Table 16**. The table summarizes the census tracts and their associated block groups that contain a portion of the pipeline corridor and the corresponding demographic data for these tracts and block groups.

All of the demographic data for census tracts and associated block groups crossed by the pipeline ROW corridor are similar to the Mohave County demographic data with the exception of low-income community composition. In Mohave County, 14 percent of the population is comprised of individuals below the poverty line. The proposed natural gas line is located in census tracts and block groups in which individuals below the poverty line comprise, on average, over 19 percent of the total population in those census tracts.

Demographic data for census tracts 9508 and 9523 reveal a possible disproportionate impact to low-income populations because of the high poverty rates in the affected block groups within the census tracts. However, the majority of the population in these tracts reside in rural residences, as indicated by land use maps, U.S.G.S. topographic maps, site visits, and 1999 aerial photographs. These residences are sparsely scattered within the two census tracts. The pipeline would not have a disproportionate effect on minority and low-income populations in the rural portions of the tracts, because any potentially affected residence is outside of the area of potential impact.

Table 16
Demographic Information for Census Tract and Block Groups Included in the Big Sandy Natural Gas Pipeline

Tract-Block Group	Total Pop.	Hispanic (#/%)		White (#/%)		Black (#/%)		American Indian, Eskimo & Aleut (#/%)		Asian & Pac. Islander (#/%)		Other (#/%)		Below Poverty (#/%)	
9508-1	112	11	*9.8%*	98	*87.5%*	0	*0.0%*	14	*12.5%*	0	*0.0%*	0	*0.0%*	0	*0.0%*
9523-1,2	223	23	*10.3%*	200	*89.7%*	0	*0.0%*	4	*1.8%*	0	*0.0%*	19	*8.5%*	65	*29.1%*
Total	335	34	*10.1%*	298	*89.0%*	0	*0.0%*	18	*5.4%*	0	*0.0%*	19	*5.7%*	65	*19.4%*

Source: U.S. Census Bureau, 1990.

The community of Wikieup is located in census tract 9523. There are an estimated 200 structures located within the community of Wikieup. Wikieup is comprised of a mix of low and middle income residents, and it is assumed that some of the residents could be part of a low income population due to relatively inexpensive land values in the area. It is not anticipated that the proposed pipeline installation would produce additional impacts to the human populations in this area because the impacts from pipeline installation are primarily temporary and construction-related.

To ensure residents in this area are provided ample opportunity to provide their input regarding the proposed project, Caithness has issued news releases about the proposed project, and has held public meetings. Caithness has also contacted landowners along the pipeline to inform them of the proposed construction activities and request their input. In addition, a mailing list from the attendees of the public meetings and land ownership information has been compiled and used to mail newsletters that provide information about the progress of the project.

Given the lack of effect the proposed natural gas supply pipeline would have on human populations in general, and given Caithness's efforts to secure participation and input from the residents of this area regarding the proposed pipeline, it has been determined that the proposed project would not have disproportionate effects on low-income and minority populations.

Power Plant and Associated Facilities

The area of potential effect for the proposed power plant and associated facilities include the power plant site, the proposed well field located between ½ and one mile west of the plant site, the water pipeline connecting the Big Sandy well field with the power plant and a 2.25 mile access road connecting the power plant with U.S. Highway 93. The combination of these facilities along with the possible air quality and groundwater impacts create an area of potential effect with a three to five mile radius.

The power plant and the associated facilities are located entirely within census tract 9523, block group 1. The demographic characteristics of block group 1 in the census tract are summarized in **Table 17**. The population within the block group is characterized by a disproportionately large number of low-income individuals possibly being impacted by the proposed power plant and associated facilities. However, review of land use maps, U.S.G.S. topographic maps and 1992 and 1997 aerial photography reveals that Wikieup, the nearest community to the proposed facilities, is

Table 17
Demographic Information for Census Tract 9523, Block Group 1 Included in the Area of Potential Effect for Power Plant and Associated Facilities

Tract-Block Group	Total Pop.	Hispanic (#/%)		White (#/%)		Black (#/%)		American Indian, Eskimo & Aleut (#/%)		Asian & Pac. Islander (#/%)		Other (#/%)		Below Poverty (#/%)	
9523-1	94	19	*20.2%*	75	*79.8%*	0	*0.0%*	0	*0.0%*	0	*0.0%*	19	*20.2%*	38	*40.4%*

Source: U.S. Census Bureau, 1990

3.5 miles northwest of the plant site. Outside of Wikieup, the closest residence to the Plant site is about ½-mile to the southwest.

The Plant would use water from groundwater wells being developed on and west of the site in an isolated deep basin aquifer. Water withdrawal from these wells is not expected to negatively affect users of the near-surface alluvial aquifer due to the confining layer between the two aquifers. There are no known wells in the vicinity of the Plant site that are producing water from this deep aquifer. Therefore, there would be no impacts to the water supply of residents from potential aquifer drawdown.

Impacts specific to area residences would be primarily visual impacts. The 130-foot tall stacks at the Plant site would be visible from some residences in Wikieup and the surrounding rural area. Most of the land outside of Wikieup and the U.S. Highway 93 corridor within a thirteen mile radius is public land, and contains no residences. Plant facilities would be considered to be in the background of viewsheds and impacts would be minor. To mitigate any remaining visual impacts, the Plant would be painted with desert colors. Air quality impacts would occur only in a small area around the Plant, which is fueled by natural gas and would not cause significant air quality impacts. Air quality permits would be obtained for all emission sources which would be within regulatory limitations.

While there are no Indian reservations in the Project area, BLM/Western has contacted the Haulapai Indian Tribe and others who have historically resided in the Project area to ensure that no cultural resources or sacred sites would be adversely affected by the proposed Project.

The remaining individual tract data is roughly comparable to the Mohave County demographic data. The percentages which reflect the race and ethnicity composition of the entire population in the area of potential effect are very similar to those provided in the county data. Given this correlation, it is concluded that the proposed power plant and associated facilities would not have a disproportionate adverse effect on the health and environment of minority and low-income communities.

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