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October 9, 2001

Nancy Cole, Supervisor
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AZ CORP COMMISSION
DOCUMENT CONTROL

RE: Bowie Power Station, LLC
Docket No. L-00000-BB01-0118
(Case No. 118)

Dear Ms. Cole:

Enclosed for filing are 25 copies of the following documents:

1) A "Ground Subsidence and Earth Fissures Evaluation", dated October 8, 2001,as prepared by Kenneth Euge of Geological Consultants, Inc. [Note: copies of slides summarizing the principal conclusions of this study were previously filed on October 3,2001];

2) An October 5, 2001 legal opinion by Sheryl Sweeney of Ryley, Carlock & Applewhite discussing Arizona water law applicable to the withdrawal and use of ground water in non – Active Management Areas;

3) Letters of support for the Bowie Power Station from the City of Willcox, Arizona, the Willcox Chamber of Commerce, the Bowie Fire District, and Bowie Unified School District No. 14; and

4) Bowie Power Station Newsletter # 2, dated September, 2001, which was sent to a large mailing list of interested persons in the Bowie Power Station Project area.

Each of the aforementioned will be offered as an exhibit by Bowie Power Station, LLC during the October 11-12, 2001 hearings before the Arizona Siting Committee. Also, copies are being transmitted today to the known parties of record.

Sincerely,

Lawrence V. Robertson, Jr.

Lawrence V. Robertson, Jr.

LVR/jm
Cc: Laurie A Woodall, Chairman
Parties of Record

ORIGINAL

[redacted]

GEOLOGICAL CONSULTANTS INC.

GEOLOGICAL CONSULTANTS INC.

Kenneth M. Euge, R.G.

GROUND SUBSIDENCE &
EARTH FISSURE EVALUATION

BOWIE POWER STATION
COCHISE COUNTY, ARIZONA

Prepared for:

Mr. Ravi Murthy, P.E.
URS Corporation
7720 North 16th Street, Suite 100
Phoenix, Arizona 85020

Prepared by:

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2333 West Northern Avenue, Suite 1A
Phoenix, Arizona 85021

REGISTERED GEOLOGIST
CERTIFICATE NO.
10338
KENNETH M.
EUGE
Date Signed 10/08/01
ARIZONA U.S.A.

Project No. 2001-168

October 8, 2001

NOTICE

The geological and soils observations, findings, conclusions and recommendations presented in this report are based on (1) data from published and unpublished sources available at the time of this study and (2) photo-geological interpretation. The services provided by Geological Consultants to URS Corporation were performed in accordance with generally accepted geological principles and standard practices used by members of the geological profession in this locale at the time of this study.

It must be recognized that subsurface geologic and soils conditions may vary from place to place and from those interpreted at locations where evaluations are made by the investigator. No warranty or representation, either expressed or implied, is or should be construed regarding geological or soils conditions at locations other than those observed by the investigator.

This report was prepared in accordance with the scope of work outlined in Geological Consultants proposal for geological services dated August 17, 2001 and as authorized by URS Corporation on September 4, 2001.

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GROUND SUBSIDENCE & EARTH FISSURE EVALUATION

EXECUTIVE SUMMARY

Introduction

This report presents the results of a ground subsidence and earth fissure evaluation for the proposed Bowie Power Station site in the San Simon Valley (also referred to as the San Simon Sub-Basin) of the Safford Basin in north-central Cochise County, Arizona (Figure 1). The scope of activities to accomplish this subsidence evaluation included several tasks: (1) an overview assessment of the entire property using available geological and hydrogeological data and geological interpretation of available aerial photography; (2) compilation of historic groundwater data; (3) compilation of previously documented ground subsidence and earth fissure data; (4) analysis and interpretation of the gathered data; (5) conducting a geological reconnaissance of the project site and nearby areas; and (6) rendering of opinions and recommendations related to power station development in a subsidence area.

Geological Evaluation

The middle portion of the San Simon Sub-Basin contains more than 6,400 feet of basin sediments deposited in a closed drainage basin. The basin fill sequence from top to bottom includes a young, upper alluvial unit, a middle blue clay unit, and a lower coarse-grained interbedded stream and lake bed unit (Sketch 1). Each of these stratigraphic units has distinctive hydrogeologic properties. The upper unit and portions of the lower unit of the basin fill commonly makes up the principal groundwater aquifer of the region.

Ground Subsidence

The major human-induced factor contributing to subsidence in the vicinity of the proposed power plant site area is the removal of groundwater from the basin aquifers due to agricultural development within the San Simon Sub-Basin. As a result of the groundwater drafting, groundwater levels in the study area have dropped about 250 feet to 350 feet through the mid-1970s. In the mid-1970s and 1980s, agricultural activity in the basin slowed due to poor economic conditions. As a result, water levels in the Bowie area of the basin began to stabilize due to substantial reductions in groundwater use. Water levels have remained essentially static or have risen slightly through 2001. The current static condition can be attributed to a balance between water use and recharge in the basin.

The San Simon Valley area of the Safford basin and the proposed Bowie Power Station site are in an area of documented ground subsidence and related earth fissures associated with historic pumping of groundwater, primarily for agricultural purposes. Groundwater removal has caused the basin fill sediments to compress, causing the ground surface to be lowered over a very large area. Based on an analysis of historical level survey data from a benchmark about 1½ miles south of Bowie Power Station site, the maximum ground subsidence at the Bowie area totaled about 7.1 feet in 2001. Ground subsidence is estimated to be about 5 feet at the proposed power plant site through 2001. A linear projection of predicted residual ground subsidence from 2001 through 2035, without the plant, is about 2.21 feet or 0.065 feet per year.

Bowie Power Station proposes to pump about 5,500 acre-feet of groundwater per year for the 30-year operational life of the plant. The resulting water table drawdown analysis (URS, 2001) indicates that on the order of 50 feet of drawdown could occur in the immediate vicinity of the Power Station well field, and about 40 feet near the town of Bowie, over the operational life of the plant. The analysis of future potential the maximum ground subsidence that could be induced by plant water use over the 30-year plant life is expected to be about 2.15 feet or about 0.072 feet per year.

No previously reported earth fissures are located within or trend toward the proposed power plant site. Likewise, no evidence of earth fissures was observed during the geological reconnaissance of the site. Two earth fissures are within five miles of the proposed Bowie Power Station site. The closest earth fissure is about two miles east of the northeast corner of the Power Station property. This fissure trends in a north to northwest direction. The fissure also appears to be dormant because of the sediments that have accumulated in the fissure since it was first documented (Holtzer, 1980)

Conclusions

Assuming the hydrogeological conditions remain unchanged, the linear data plot analysis of subsidence against time suggests the residual subsidence at the project site from 2001 through 2035 could total about 2.21 feet or 0.065 feet per year. The nonlinear extrapolation of the same data set suggests the ground subsidence in the project area could be negligible by the year 2035.

It is anticipated that the maximum ground subsidence that could be induced by plant water use over the 30-year plant life is about 2.15 feet or about 0.072 feet per year. This subsidence rate is roughly equivalent to the residual subsidence rate calculated for the period 1980 to 2001 in the project area.

A comparison of projected residual ground subsidence from past groundwater pumping with the projected future potential active ground subsidence caused by pumping at the Bowie Power Station, shows comparable nonlinear diminishing rates of ground subsidence. The nonlinear trend line analysis relative to actual and projected ground subsidence suggests that, even with the plant in operation, ground subsidence in the project area could diminish to negligible levels by 2035.

Based on the results of the subsidence evaluation and estimates of future potential subsidence due to plant operations, it is our opinion the potential for earth fissure formation within the project property is negligible. In addition, the potential for earth fissure formation at the plant site is negligible because the plant site is located interior from the margin of the middle and lower basin fill units, the site is several miles from the bedrock pediment edge and a relatively small amount of ground subsidence is projected over the operational life of the plant. Finally, for similar reasons, the potential for new earth fissure formation and growth of existing fissures in adjacent off-site areas is negligible.

Ground subsidence and earth fissures in the project area should have a negligible impact on the construction and operation of the proposed power plant. Likewise, subsidence-related impacts to areas adjacent to the proposed facility should also be negligible.

Although the proposed Bowie Power Station is located within an area of residual ground subsidence, the power plant site facilities and related infrastructure can be engineered to account for future potential subsidence and operate safely.

Recommendations

Supplemental investigations at the Bowie Power Station site would be appropriate to verify, refine, or refute, as the case may be, the ground subsidence and earth fissure conditions identified by the present scope of work. Such studies could be conducted as part of the geotechnical engineering analysis in connection with the design of the facility.

In addition, representative survey benchmarks should be re-surveyed for the purpose of implementing and maintaining a ground subsidence monitoring array for the site and surrounding areas. Subsidence monitoring benchmarks should also be established within the power station site and could be integrated into a subsidence monitoring program. As part of the monitoring program for known earth fissures, the earth fissures closest to the Bowie site should be periodically monitored using direct field examinations and the results documented.

GROUND SUBSIDENCE & EARTH FISSURE EVALUATION

BOWIE POWER STATION
PINAL COUNTY, ARIZONA

1.0 INTRODUCTION

This report presents the results of a ground subsidence and earth fissure evaluation for the proposed Bowie Power Station site located about one and one-half miles north of the Town of Bowie in north-central Cochise County, Arizona (Figure 1) (Bowie Power Station L.L.C., 2001). Information contained herein completes the scope of work as outlined in Geological Consultants Inc. proposal dated August 17, 2001. The objectives of this study are to compile adequate information concerning ground subsidence and earth fissures within and adjacent to the proposed power plant site to:

1) Address questions and concerns that may arise regarding the ground subsidence phenomena.

2) Define potential impacts, if any, relative to the design, construction, and operation of the proposed power plant.

3) Make recommendations to deal with the subsidence phenomena so that the proposed power plant site development can proceed.

The scope of activities to accomplish this subsidence evaluation included several tasks. The tasks were directed to an overview assessment of the entire property using available geological and hydrogeological data, geological interpretation of available aerial photography, and a geological reconnaissance of the project area. Some of the required preparatory work, such as compiling historic groundwater data, was accomplished by URS Corporation personnel. Geological Consultants Inc. used this data to supplement its data base to accomplish the project objectives.

1.1 Scope of Work

The scope of work for the ground subsidence and earth fissure evaluation included the following activities designed to satisfy the objectives of the study:

- Research of existing geological, hydrogeological, and geophysical data and the compilation of these data and existing ground subsidence/earth fissure information concerning the site region.

- Preparation of a bibliographic listing of the references reviewed and compiled.

- Assessment of future potential ground subsidence induced by groundwater withdrawal at the site and in the site vicinity using, in part, groundwater data compiled by URS personnel and historic ground subsidence data obtained from various sources for the project region (San Simon Sub-Basin).

- Use of historical groundwater and subsidence data, combined with the preliminary predictive water use data for the power plant operations, to develop future potential ground subsidence extrapolations for the site area.

- Compilation of groundwater drawdown and basin fill characteristics that may be derived from available research sources such as the U.S. Geological Survey and the Arizona Department of Water Resources (ADWR). This information can be used to roughly estimate reasonable rates of ground subsidence that can be compared with future potential ground subsidence extrapolations.

- Examination of aerial photography available from the U.S. Geological Survey over the Internet for the study area and interpretation of the photographs to identify earth fissures that may be present in the site vicinity.

- Completion of a limited ground-truth field reconnaissance (on foot) of the known and suspect earth fissures documented in the data base, and to verify, or refute the existence of the earth fissures.

- Preparation of a synopsis of possible ground subsidence/earth fissure mitigation measures that could be engineered and constructed to mitigate ground subsidence effects.

1.2 Authorization

The subsidence and earth fissure evaluation was conducted by Mr. Jason C. Williams, G.I.T., and Mr. Kenneth M. Euge, R.G., Principal Investigator. The work was performed for URS Corporation according to the authorization and the notice to proceed given September 4, 2001 and the scope of work authorized in Geological Consultants Inc. proposal to URS Corporation dated August 17, 2001.

2.0 GEOGRAPHIC SETTING

2.1 Location

The proposed Bowie Power Station site lies within north-central Cochise County about one and one-half miles north of the town of Bowie, Arizona (Figure 1). The power station property consists of approximately 2.5 square miles of agricultural land located in all or portions of sections 20, 21, 22, 27, 28, 29, and 33 of Township 12 South Range 28 East of the Gila and Salt River baseline and meridian. The Bowie Power Station power block will be located in all of Section 28 and a portion of Section 29.

2.2 Physical Features

The site is located in the central portion a large geographic basin referred to as the San Simon Valley. The basin is bounded by the Chiricahua, Dos Cabezas, Pinalenas, and Santa Teresa Mountains to the southwest, and the Pelocillo and Gila Mountains to the northeast.

The maximum relief within the property is approximately 87 feet measured from the highest point (elevation 3,748± feet) at the northwest property boundary to the northeast property boundary (elevation 3,661± feet). The original land surface has been modified by past agricultural activity. Generally, the land surface slopes to the east-northeast, at gentle grades of 3 percent or less.

2.3 Climate and Vegetation

The climate of the area is arid to semiarid. The average annual temperature ranges from about 42° Fahrenheit (F) in January with summer maximums averaging about 79° F in July. Average daily highs range from 58° F to 95° F and lows range from 24° F to 61° F (Vogt, 1980). The precipitation is confined to essentially two seasons during the year, one in the summer and the other in the winter. Average annual rainfall is about 11 inches. Snowfall averages slightly more than four inches per year. Native vegetation including desert shrubs and grasses have been removed from the land surface within the project area due to modification of the land for cultivation.

3.0 GEOLOGICAL EVALUATION

3.1 Regional Geologic Setting

The Bowie Power Station property is located within the San Simon Valley of the Safford Basin, which is a part of structural basin or trough within the Sonoran Desert region of southeast Arizona. The Safford Basin is located in the southeastern part of the Basin and Range Province and extends from the vicinity of Rodeo, New Mexico, northwest to the vicinity of Globe (Cushman, Jones and Hem, 1947). The Basin and Range Province is one of three physiographic and structural provinces in the state of Arizona: the Colorado Plateau, the Transition Zone, and the Basin and Range. The Bowie property is located entirely within the Basin and Range Province.

The Safford Basin, including the San Simon Sub-Basin, is characterized by northwest and north trending mountains that rise abruptly from broad, elongated, deep sediment-filled valleys produced by block faulting and folding that is common to the Basin and Range Province. The geology is dominated by metamorphic, granitic, and volcanic rocks of late Tertiary and older age (Figure 2) that have provided the source material for the basin fill deposits. The Mountains surrounding the Bowie property are composed of gneisses, schists, indurated sedimentary rocks, and granitic and volcanic rock types (Barnes, 1991). Rocks underlying the basin fill are probably igneous rocks including intrusive granite and extrusive volcanic rock.

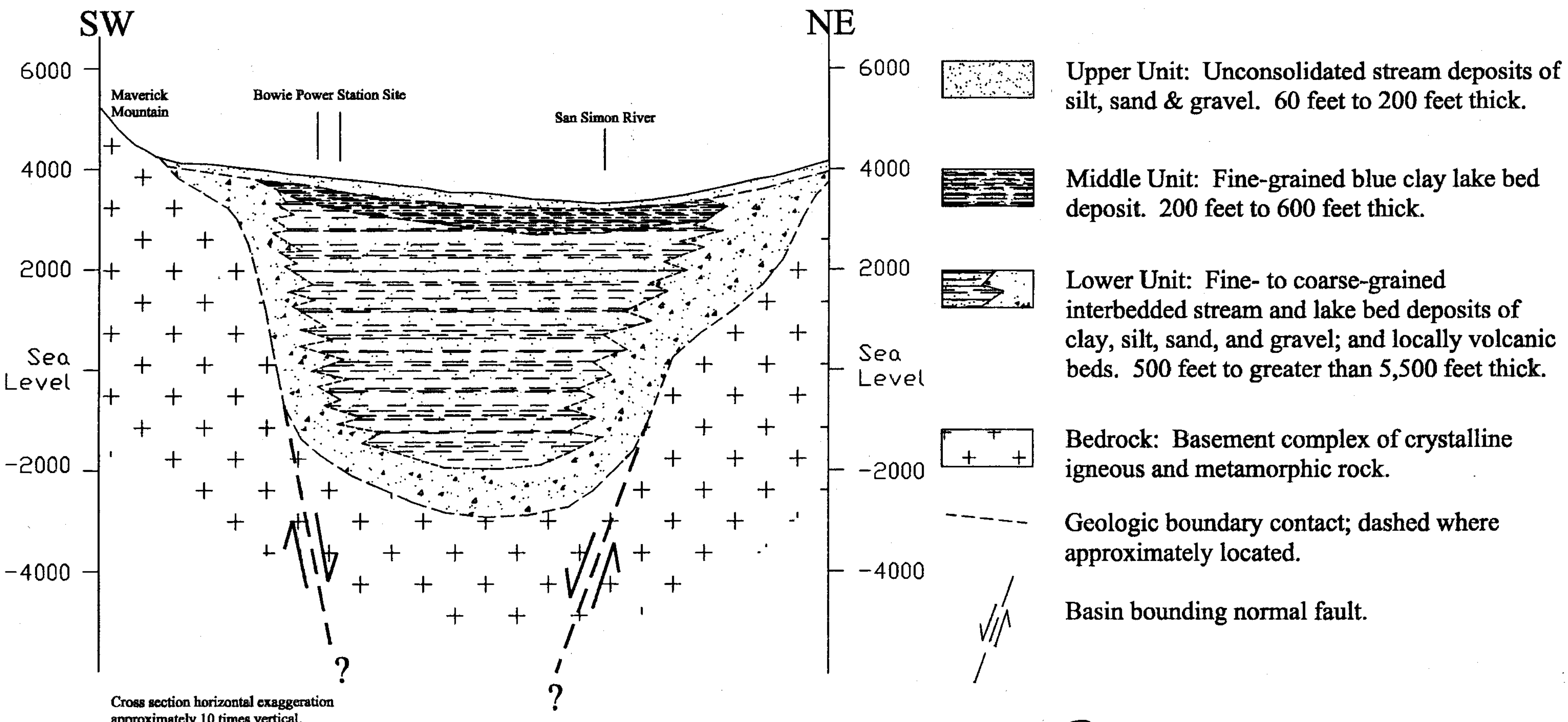
Structurally, the region has been uplifted to its present position by episodes of mountain/basin bounding fault movements (Cooley, 1977). The tectonic episodes and deformation, evident in the orientation of foliation planes and joint set discontinuities exposed in the bedrock terrain, have provided the mechanics necessary create the deep intermontane basins which were subsequently filled with sediment. The basin structure is defined by a trough that was formed by down-faulting between two nearly parallel mountain chains. The resulting structural depression is a down-thrown fault block, or graben, that is bounded by normal faults (Sketch 1). The Peloncillo Mountains, consisting of volcanic rocks and older sedimentary and granitic rocks, form the northeast side of the basin. The chain of mountains along the southwest side of the basin includes the Chiricahua, Dos Cabezas and Pinaleno Mountains composed of crystalline igneous and metamorphic rocks and older sedimentary rocks (Cushman et al, 1947).

3.2 Site Setting

The Bowie Power Station site is located in the middle portion of the San Simon Valley of the San Simon Sub-Basin. This Sub-Basin occupies a deep graben defined by northwest-trending Basin and Range faults which are concealed beneath broad alluvial fans that merge to form bajadas. The surrounding mountains are composed of gneisses and schists, indurated sedimentary rocks, granite and volcanic rocks. Around the lower slopes of the mountainous bedrock terrain, young colluvium deposits composed of erosional detritus intermingles with the young alluvium deposits of the valley floor. As the surrounding mountains eroded, the valley filled with debris (Sketch 1). The resulting alluvium has been classified as older and younger alluvial fill. The vast majority of the sediments are Pliocene and Pleistocene in age and are generally referred to as older alluvial fill (Cushman et al, 1947).

The older alluvial fill is composed of intertongued beds and lenses of clay, silt, sand, and gravel. These beds have been divided into lower, middle, and upper units. The lower unit overlies the bedrock, and consists of stream deposits interfingered with volcanic debris near the basement contact. The lower unit may exceed 7,000 feet in maximum thickness. The middle or blue-clay unit is a lacustrine deposit that was laid down at a time when a body of water, without exterior drainage, occupied a large part of the San Simon Valley. The middle unit overlies the lower unit and reaches a maximum thickness of 600 feet near San Simon. The middle unit, which acts as a confining layer and is generally encountered from 60 too 200 feet below the surface, pinches out toward the basin margins (Barnes, 1991) (Sketch 1).

The surface geology of the Bowie Power Station property is dominated by young alluvial fan deposits composed of an upper unit of mixed clay, silt, sand, and gravel. More coarse-grained soils probably occupy the former modern drainage channels that crossed the property. Some of the natural stream channels that once incised the alluvial fan surface have been removed or obscured by grading of the land surface for agricultural purposes. Coarse-grained alluvial fan deposits, although presently closest to fan apexes and the mountain fronts to the south and west, may be present locally beneath the site. Fine-grained soils, including fine sand, silt, and clay, occupy the slightly elevated terrain between the drainage channels and the fan deposits closer to the basin center.



Cross section horizontal exaggeration approximately 10 times vertical.

Note: Basin fill/bed rock boundary from Oppenheimer & Sumner, 1980. Stratigraphic relationships conceptualized from Cushman et al (1947), White (1963) and Barnes, 1991.

REGISTERED GEOLOGIST CERTIFICATE NO. 10338 KENNETH M. EUGE ARIZONA U.S.A.

Conceptual Geologic Cross Section
San Simon Valley - Middle Basin

Sketch 1
Bowie Power Station

Geological Consultants
2333 West Northern Avenue, Suite 1A Phoenix, Arizona 85021

3.2.1 Basin Stratigraphy

The San Simon Sub-Basin sediments are composed predominately of older and younger basin fill deposits. Recent alluvium deposits are found along modern stream channels. Buried stream channel deposits may be present within the site property. The three basin fill units and a mixed, marginal deposit in the project area are described below (URS, 2001):

- The upper unit consists of unconsolidated stream channel deposits of sand, silt and gravel and forms a continuous geologic unit across the basin. The thickness of the upper unit ranges from 60 to 200 feet and the driller's logs indicate that the upper unit is about 150 feet thick beneath the Bowie property. Where the upper unit is saturated in localized areas, the unit is designated as the upper aquifer.

- The middle unit (Barnes, 1991), or blue-clay unit (White, 1963), underlying the upper unit consists of dense blue clay formed by fine-grained sediments deposited during a period when a shallow lake occupied a large part of the San Simon Valley. The middle unit is about 600 feet thick along the axis of the valley, and acts as a confining layer. Near the basin margins, the middle unit pinches out and the upper and lower units merge to form the marginal zone. In the vicinity of the Bowie property, the middle unit is believed to be about 350 feet thick, extending to a depth of about 500 feet below ground surface.

- The lower unit consists of stream and lake-bed deposits of clay, silt, and gravel that overlie bedrock and in places are interbedded with volcanic debris. The unit is continuous throughout the basin and merges with the upper unit along the basin margins in the marginal zone. Groundwater occurs under confined conditions in the sand and gravel units, that interfinger with layers of dense clay, to form the lower aquifer. The lower aquifer supplies most of the groundwater used in the San Simon Valley sub-basin and would be the source of groundwater for the power plant. The thickness of the lower unit is generally unknown, but may be as much as 8,000 feet along the valley axis (Oppenheimer and Sumner, 1980). The thickness of the lower unit in the vicinity of the Bowie Property is unknown.

- The marginal zone occurs along the margins of the basin where the middle unit pinches out and the coarser materials of the upper and lower units merge. Within the marginal zone the upper and lower aquifers have merged to form a single, unconfined aquifer.

4.0 GROUND SUBSIDENCE

4.1 Overview

Ground subsidence is known to occur in alluvium-filled valleys of Arizona where agricultural activities and urban development have caused overdrafting or removal of groundwater from thick basin aquifers faster than natural recharge of the aquifer can occur. The basic cause of subsidence and lateral movement of the land surface is an increase in the intergranular pressure of the underground material. As the water table lowers, due to over-drafting, the water located in the space between the soil particles is removed. The particles will then compress under the weight of the overlying soil column. The compression of the soil is expressed as ground subsidence at the ground surface. The calculation of ground subsidence due to compression of layers in which intergranular pressure is increased is based on how the porosity, or void ratio, of the layer is reduced by an increase in intergranular pressure (Bouwer, 1978). The magnitude of subsidence is directly related to the subsurface geology, the thickness and compressibility of the alluvial sediments deposited in the valleys, and net groundwater level decline.

There are three categories of ground subsidence: (1) active subsidence; (2) residual subsidence; and (3) total subsidence. Ground subsidence induced by groundwater over-pumping is referred to as "active subsidence" and it does not immediately stop once pumping is stopped. As groundwater levels stabilize or begin to rise, the subsidence continues for some time before it gradually diminishes and stops. The ground subsidence that continues after groundwater levels stabilize or rise is referred to as "residual subsidence" and generally continues for several years. The entire ground subsidence process cannot be considered complete until residual subsidence approaches zero, whereas the cumulative drop in the land surface, known as "total subsidence" can be determined (EPA, 2001).

Although ground subsidence is a human-induced geological phenomenon that is sometimes referred to as a geologic hazard, the ground subsidence phenomenon is relatively benign when compared to other natural events such as flooding or earthquakes.

4.2 Groundwater

The major human-induced factor contributing to subsidence is the large scale removal of groundwater. Nearly all of the populated southern Arizona basins from Phoenix to Tucson have experienced at least a 100+ foot drop in groundwater level, and an area surrounding the town of Stanfield, Arizona has dropped more than 500 feet (Schumann and Genualdi, 1986). The groundwater level in the vicinity of the Bowie Power Station study area has dropped about 100 to 300 feet according to well data compiled by Schumann and Genualdi (1986), and 250 to 350 feet according to data compiled by URS (2001) (Figures 3 & 4).

Historical records indicate shallow groundwater was pumped for domestic use and livestock in the 1870s. In 1910, a deep well encountered artesian groundwater conditions that spurred agricultural development until poor economic conditions following World War I caused the abandonment of several farms. By the 1950s, artesian conditions abated to the level where pumping, probably from both the upper and lower aquifers, was required to satisfy irrigation needs. Deep well pumping from the upper aquifer began in the 1930s with the introduction of turbine pumps and electrical power. Annual water level usage, principally for agriculture, increased steadily from the early 1950s until the 1980s when rising energy costs and poor economic condition closed many of the farms. As a result, water use was reduced significantly and water levels stabilized. Records indicate the water level in the upper aquifer ranged from 30 feet to 80 feet below ground surface in 1987 (URS, 2001).

4.2.1 Groundwater Use in the San Simon Valley Sub-Basin

Two principal water-bearing zones occur in the San Simon Valley Sub-basin, and roughly correspond to the upper alluvial unit and the middle silt and clay units. These zones are referred to by the ADWR (1994) as the Upper Main Water Zone and Lower Main Water Zone, respectively. In the San Simon Valley Sub-basin, and in the Bowie Power Plant area, a third local water zone exists. This third zone is situated between the Upper Main Water Zone and the Lower Main Water Zone. This water zone designated the Significant Local Water Zone by ADWR.

Following World War II, agricultural development accelerated in the San Simon Valley sub-basin as did the water level decline in the aquifers. Annual water level usage increased steadily from the early 1950s until the 1980s, when the estimated annual pumpage in the San Simon Sub-Basin totaled 139,000 acre-feet per year. Poor economic conditions in the early 1980s resulted in cessation of most agricultural activity in the area when water use dropped to only 42,000 acre-feet per year. By the mid-1990s water use had increased slightly to about 51,400 acre-feet per year (URS, 2001). As a result of the reduction in water use in the Sub-basin, water levels began to stabilize and by 2001 the water levels had achieved essentially static conditions.

The Bowie Power Station site is located within the San Simon Valley sub-basin of the Safford basin, which is one of 14 groundwater basins located in the Southeastern Arizona Planning Area as defined by the ADWR. The agricultural lands, municipalities, and industries within the Safford Basin rely heavily on groundwater to meet their required water demands.

Agriculture in the San Simon demand center occurs primarily in the San Simon Valley along San Simon Creek. Agricultural demands in 1990 for the Safford Basin were 170,000 acre-feet. Of that amount, about 30 percent, or 51,400 acre-feet per year, are pumped from the San Simon Sub-Basin. According to ADWR (1994), long term projections are expected to be the same through year 2040.

Historical average consumptive use within the agricultural lands that will include the Bowie Power Station site is about 3.6 acre-feet per acre per year, or about 5,900 acre-feet per year. The Bowie Power Station will require about 5,500 acre-feet per year. If none of the 1,640 acres of the Power Station property are used for agricultural production, there will be a net decrease in water use by the power station as compared to the historical average pumping for the former agricultural property.

4.3 Regional Subsidence

Prior to the utilization of groundwater resources within the basins of central Arizona, the water table was higher and hydrogeologic conditions were in equilibrium. When pumping was initiated, water levels within the aquifer began to be lowered and the basin fill sediments were dewatered. In the arid southwest, the water in the aquifer is used up faster than it can be naturally replenished causing a net water table decline. As a result, the weight of the soil column is gradually increased as the buoyant effects and aquifer pressures induced by the water acting on the soil column are decreased. This condition causes increased loading stresses to consolidated portions of the thick compressible sediments, which results in the lowering (subsidence) of the land surface over a large area.

Once ground subsidence is initiated, it will continue until the causative factors, which are principally water table declines due to pumping and soil compressibility, are altered. Ground subsidence due to groundwater overdrafts is essentially irreversible. It can be arrested or stopped by reducing or halting declines in groundwater levels (combined with groundwater recharge if necessary) to prevent residual subsidence (Bouwer, 1977).

Ground subsidence was first documented in Arizona in 1934 following the releveling of first-order survey lines by the Coast and Geodetic Survey (now the National Geodetic Survey (NGS). Subsequent levels by the NGS, the U.S. Geological Survey, the U.S. Bureau of Reclamation, and the Arizona Department of Transportation has documented substantial ground surface subsidence in south central Arizona including the Salt River Valley, the Queen Creek - Apache Junction area, and the Eloy - Casa Grande - Stanfield area. As overdrafting continues, tensile stresses induced by the subsidence continue to increase until the ground breaks to form earth fissures.

The amount of ground subsidence reported through 1991 varies throughout central Arizona. Variations relate to basin shape and structure, compressibility of sediment within the basin, duration of groundwater use, volume of water pumped from the basin, natural and induced groundwater recharge, and change in water level conditions. Documented ground subsidence reported by researchers for different areas in central Arizona ranges from as little as one-half foot in the Tucson Basin to more than eighteen feet near Luke Air Force Base west of Phoenix.

Subsidence and earth fissures in urban areas can cause a variety of localized problems in central Arizona. The majority of problems have affected agricultural land. The ground subsidence has caused changes in the land surface gradient that have necessitated re-grading to reestablish proper grades for irrigation. In some localized cases, such as near Casa Grande and Queen Creek, lands have been taken out of production. Structures built across subsidence-related earth fissures may be damaged, streets crack, flow in gravity water and sewer lines can be reversed, and differential subsidence (although rare) can rupture buried utilities (Arizona Bureau of Geology and Mineral Technology, 1987).

4.3.1 Subsidence in the San Simon Sub-Basin and Bowie Project Area

Groundwater conditions in the San Simon Sub-Basin are somewhat different from other basins in Arizona affected by ground subsidence. Initial "large-scale" groundwater use in the sub-basin was provided from artesian wells. A lowering of the water table to the point where ground subsidence might be initiated lagged behind other basins that were experiencing agricultural development, such as the Picacho Basin. Ground subsidence was first documented in the Bowie area in the late 1950s.

Ground subsidence in the project area has been measured in the past by government agencies at various benchmarks along the Southern Pacific railroad alignment through the Bowie area, as well as two benchmarks along a north-trending spur of the railroad in Bowie. An early elevation vertical control survey in 1952-53 was the basis from which later ground subsidence was measured. In 1974, a second elevation survey was conducted at the same benchmarks in the area that were used in 1952-53. They discovered that at Bowie, the ground had subsided by as much as 4.7 feet over the period of 1952 to 1974 (Holtzer, 1975). A later level survey, conducted in 1979-80, recorded additional ground subsidence of about one foot for a maximum total subsidence of about 6 feet from 1952 to 1980 in the Bowie area. A GPS level survey was made of some benchmarks in the Bowie area in 2001 (A-Team/URS, 2001). The 2001 results indicate an additional 1.4 feet of ground subsidence occurred since the 1980 survey (Chart 1) or a total of 7.1 feet from 1952 to 2001. Based on the data, the land surface at benchmarks in the vicinity of the proposed Bowie Power Station site was subsiding at diminishing rates between 1952 and 2001 (Table 1).

Table 1

Cumulative Ground Subsidence and Subsidence Rates
1952 Through 2001, Benchmark P324

Year	Cumulative Subsidence (feet)	Time Period (years)	Subsidence Rate (feet per year)	Reference
1950	0	--	--	--
1974	4.70	24	0.20	Holzer, 1980
1980	5.69	6	0.165	NGS, 2001
2001	7.06	21	0.065	A-Team/URS, 2001

Interpreted subsidence contours within the Bowie Power Station site indicate that from 1952 to 1974, 2 to 3 feet of subsidence had occurred (Holtzer, 1980) (Figure 5). No recent level surveys have been conducted within the Bowie Power Station site. However, based on a comparison of recent level survey data (A-Team/URS, 2001) from a benchmark (P324) located one and one-half mile south of the site (Figure 1), with the Holtzer (1980) data, it is conceivable that the total ground subsidence from 1952 through 2001 could average about 5 feet at the plant site.

Between 1950 and 1980, active subsidence was occurring in the Bowie area due to pumping activity. Because of the leveling off of water levels in the Bowie area and the essentially static groundwater conditions within this area of the San Simon Sub-Basin, including the Bowie Power Station property, no active subsidence is occurring in the basin. However, based on the recent level survey (A-Team/URS, 2001), residual ground subsidence is likely ongoing. Table 2 includes a summary of survey leveling of benchmarks through the Bowie area along Interstate I-10 between Milepost 352 and 376 for the period 1952 through 2001.

Table 2
Ground Subsidence Summary for Benchmarks in Bowie Area, I-10 Milepost 352 to 376

	1952 to 1960		1952 to 1980		1960 to 1980		1980 to 2001	
Benchmark	Cumulative	Average Rate	Cumulative	Average Rate	Cumulative	Average Rate	Cumulative	Average Rate
EXIT 3	--	--	--	--	--	--	0.42	0.02
M324	--	0.09	2.00	0.07	1.28	0.06	--	--
N430	--	--	--	--	--	--	0.35	0.02
L324	0.67	0.67	1.24	0.04	0.57	0.57	--	--
N358	--	--	--	--	-0.60	-0.03	0.46	0.02
Q358	--	--	--	--	-0.24	-0.01	0.57	0.03
P324	--	--	5.69	0.20	--	--	1.37	0.07
X330	0.92	0.12	3.04	0.11	2.12	0.11	1.03	0.05
Y330	0.93	0.12	4.10	0.15	3.17	0.16	--	--
COTTON	--	--	--	--	1.23	0.06	1.71	0.08
COTTON RM1	--	--	--	--	1.24	0.06	--	--
108H	0.81	0.10	2.00	0.07	1.19	0.06	--	--
Z330	0.76	0.10	2.42	0.09	1.66	0.08	--	--
106H	0.66	0.08	1.71	0.06	1.05	0.05	--	--
HOLT 2 RM2	--	--	--	--	0.93	0.05	--	--
HOLT	0.64	0.08	--	--	--	--	--	--
HOLT 2 RM1	--	--	--	--	0.91	0.05	--	--
HOLT RM1	0.63	0.08	--	--	--	--	--	--
HOLT 2	--	--	--	--	0.93	0.05	0.79	0.04
Rt 86 Sta 3707	0.48	0.06	0.42	0.02	-0.06	-0.00	--	--
B331	0.48	0.06	0.18	0.01	-0.30	-0.02	--	--
C331	0.46	0.06	--	--	--	--	--	--
W330	1.37	0.17	0.96	0.03	-0.41	-0.02	--	--
V330	0.16	0.02	-0.25	-0.01	-0.41	-0.02	--	--
OLGA	--	--	--	--	-0.39	-0.02	0.01	0.0005
KARRO RM2	0.33	0.04	--	--	--	--	--	--
KARRO 2	--	--	--	--	--	--	0.07	0.003
U330	0.42	0.05	0.08	0.00	-0.34	-0.02	--	--
T330	0.44	0.06	0.18	0.01	-0.26	-0.01	--	--

4.3.2 Future Potential Ground Subsidence in Project Area

Various analytical methods may be used to predict the amount of ground subsidence and to estimate subsidence rates over time. Empirical methods can be used to extrapolate available data to deduce future subsidence trends. The amount of subsidence is available to plot against time. In this method, the amount of ground subsidence is considered a function of time, ignoring causality of the ground subsidence (Vega and others, 1984).

The reasonableness of the results using an empirical method that fits linear, quadratic, exponential, or logarithmic functions depend upon the data base used for the analysis. Fortunately, there is a reasonable amount of level survey data for the project area that can be used to calculate future potential ground subsidence trends. According to the data base, since 1952 several survey benchmarks have been resurveyed more than once (see Table 2). Although none of the survey benchmarks are within the Bowie Power Station Site, one benchmark is within one and one-half miles from the site (Benchmark P324). Data from this benchmark indicate that it documents the greatest amount of ground subsidence in the area and, therefore, would represent a conservative point of reference for calculating future potential ground subsidence at the project site.

Both a straight line trend line and a polynomial trend line have been applied to the data to develop linear and nonlinear extrapolations of ground subsidence in the project area. Assuming the hydrogeological conditions remain unchanged, the linear data plot (Chart 1) of subsidence against time suggests the residual subsidence at the project site from 2001 through 2035 could total about 2.21 feet or 0.065 feet per year. The nonlinear extrapolation of the same data set suggests the ground subsidence in the project area could be negligible by the year 2035 (Chart 2). As more survey data become available, the ground subsidence predictions may be refined.

Bowie Power Station proposes to use groundwater pumped from on-site production wells for plant operations for the projected 30-year life of the power plant. The plant operations will require approximately 5,500 acre-feet per year when fully developed and operating at base load (URS, 2001). The results of the groundwater level drawdown analysis conducted by

URS (2001) indicate drawdown will occur in the southwestern portion of the Bowie property. The calculated drawdown is about 50 feet below current static levels after 30 years.

The geological history of the San Simon Sub-Basin in terms of time of development, basin fill source material, basin fill characteristics, and the paleo-geomorphic characteristics demonstrate that it is similar to other basins in the Arizona Basin and Range Province, many of which have experienced ground subsidence. Although no detailed soil engineering data are presently available for the basin fill sediments beneath the Bowie Power Stations site, it seems reasonable to extrapolate basin fill characteristics for other basins, such as the Picacho Basin, to the San Simon Sub-Basin. Considering the similarities of the San Simon Sub-Basin and the Picacho Basin, the Bouwer (1977) method can be used to roughly estimate predicted ground subsidence. Assuming the values of ground subsidence relative to groundwater level decline for the San Simon Sub-Basin are similar to those used by Christie (1978) for the Picacho Basin (Geological Consultants, 2001), the subsidence on the order of 15 to 17 inches per 33 feet of groundwater level decline could represent a rough approximation for the San Simon Sub-Basin. Assuming these values are representative for the Bowie Power Station site, the maximum ground subsidence that could be induced by plant water use over the 30-year plant life is expected to be about 2.15 feet or about 0.072 feet per year. This subsidence rate is roughly equivalent to the residual subsidence rate calculated for the period 1980 to 2001 in the project area (Table 1).

Chart No. 3 depicts a nonlinear plot of documented ground subsidence through 2001 with the predicted additional ground subsidence for the 30-year operational life of the plant that could be induced by pumping of groundwater at the site. A comparison of projected residual ground subsidence from past groundwater pumping with the projected future potential active ground subsidence caused by pumping at the Bowie Power Station, shows comparable nonlinear diminishing rates of ground subsidence. A polynomial trend line is applied to actual ground subsidence reported for the project area and combined with the estimated projected subsidence expected from plant operation through 2035 (Chart 3). A plant start-up date of 2005 was assumed for this analysis. The trend line relative to actual projected ground subsidence suggests that, even with the plant in operation, ground subsidence in the project area could diminish to negligible levels by 2035.

4.4 Earth Fissures

Fissures occur in unconsolidated sediments, typically near the margins of alluvial valleys or near the bedrock pediment edge where groundwater levels have dropped from about 200 feet to 500 feet below ground surface (Schumann et al, 1986). The main factors relating to the development of an earth fissure are the differential consolidation of unwatered sediment over shallow bedrock irregularities coupled with groundwater withdrawal (Péwé and Larson, 1982).

Fissures are initiated underground when tensile stresses exceed the strength of the soils. The fissures then propagate upwards to intersect the ground surface. The locations of earth fissures are controlled primarily by the configuration of the buried bedrock surface, variations in the basin fill stratigraphy, and other factors. Early signs of earth fissures are small linear en echelon hairline cracks, irregularly spaced but aligned depressions, and large linear open holes (Larson and Pewe, 1982) (Figure 6). Other physical features associated with fissures are slump-related escarpments from one inch to a few inches in height, as well as a drainage pattern associated with the fissure that does not conform to the area's local drainage pattern.

Field evidence indicates the fissures are exposed after overlying sediments are eroded by surface water runoff from rainfall or irrigation (Larson and Pewe, 1982). The surface expressions of the fissures are exaggerated because the initial hairline crack is attacked by water to create wide (10 to 20 feet) and deep (more than 15 feet) erosional gullies that often have vegetation growing in them. The fissures are commonly perpendicular to natural drainage channels. The length of the fissure at the ground surface varies, usually less than one mile, but one fissure near Picacho, Arizona is more than 9 miles long. These features are easily recognizable on aerial photographs and in the field except where the land surface has been recently modified by agricultural activities or urban development.

Earth fissures cause damage to highways, railroads and canals and can require ongoing maintenance. In irrigated agricultural areas where fissures form, portions of fields are abandoned because irrigation flows are interrupted (Arizona Bureau of Geology and Mineral Technology, 1987).

4.4.1 Known Earth Fissures Within Project Area

The Bowie property is adjacent to an area of documented earth fissuring (Holzer, 1980; Harris, 1997). A review of published research documents and recent aerial photographs (Terraserver, 2001), combined with a field reconnaissance of the Bowie Power Station property and adjacent areas, indicates there are no previously mapped earth fissures located within or trending toward the proposed Bowie Power Station site. No evidence of earth fissures was observed during the geological reconnaissance of the site. Only two earth fissures are located within a five-mile radius of the Bowie Power Station. The one northwest-trending fissure is located Section 25, Township 12 South, Range 28 East, about two miles east of the northeast corner of the Bowie Power Station site. This earth fissure does not project toward the Bowie site. The fissure is about two miles long and extends to the south into Section 31, Township 12 South, Range 29 East and Section 6, Township 13 South, Range 29 East. The second fissure trends toward the northeast in the southeast corner of Section 25, Township 12 South, Range 28 East. This fissure is about one-quarter mile in length and projects away from the power station.

4.4.2 Potential Earth Fissures Within Project Area

Based on a review of available aerial photographs taken in 1996 of the Bowie area including the project area (Terraserver, 2001), no other earth fissures could be readily identified. However, the resolution of the photograph examined on the Internet was limited and may have obscured some smaller features. Likewise, agricultural activities throughout the property may also obscure the surface expression of earth fissures that may be present.

On September 10, 2001, Geological Consultants conducted a site visit to complete a ground-truth search for earth fissures within or trending toward the Bowie Property. Existing irrigation canals and roadways were carefully examined, as well as portions of the adjacent properties where native ground can be located. No evidence of earth fissures within or projecting toward the Bowie Power Station site was observed during the field reconnaissance.

A cursory assessment was also made using available geological and geophysical data to identify potential areas where earth fissures might develop near the site. Considering the proximity of the site to the buried bedrock pediment relative to a basin bounding fault to the west of the site, the assessment considered that boundary condition as a potential focus for earth fissure development. The maximum depth to bedrock in the Bowie Power Station vicinity is estimated to be more than 6,400 feet below a ground surface (Oppenheimer et al, 1980). Below the Bower Power Station, the bedrock depth could range from 5,000 feet to 5,700 feet below ground surface. About 1½ to 3 miles west of the west property boundary, a distinctive steep gradient change in the buried bedrock surface is depicted on Oppenheimer's (1980) Depth to Bedrock Map. This change is defined by a change in bedrock depths ranging from about 800 feet to 4800 feet below ground surface. This change occurs over a distance of about 1.6 miles and represents a slope gradient on the bedrock surface of about 0.47 feet per foot. The approximate gradient of the gentle sloped buried pediment surface closest to the mountain front is defined by a change in elevation of about 400 to 800 feet across a horizontal distance of about 1½ mile to 3 miles or about 0.025 to 0.13 feet per foot. The line, or break in slope, that defines the prominent change in gradient from the pediment to the deep basin could be the focus for future potential earth fissure development. The break in slope of the buried bedrock surface is located about 3 miles west and southwest from the Bowie Power Station site.

5.0 CONCLUSIONS

5.1 The San Simon Valley and the proposed Bowie power plant site are in an area of documented ground subsidence and related earth fissures. Ground subsidence resulted from groundwater over-drafting that started in the area in the 1930s and accelerated following World War II. Gradual over-drafting caused a lowering of the regional water table from about 250 feet to 350 feet through the late 1970s and early 1980s. Groundwater removal has caused the basin fill sediments to compress, causing the ground surface to be lowered over a very large area. Ground subsidence in the basin measured in the Bowie, Arizona area was about 7.1 feet as of 2001. Maximum ground subsidence at the Bowie Power Station site is estimated to be approximately 5 feet for the period 1952 through 2001.

Water levels within the basin, and at the Bowie Power Station site, began to stabilize and level off during the late 1970s and 1980s due to a reduction in groundwater use and because the reduced groundwater use is balanced with aquifer recharge. As a result of the relatively static groundwater levels in the Bowie area, ground subsidence rates have slowed from 0.20 feet per year in 1974 to 0.065 feet per year by 2001. Assuming the hydrogeological conditions remain unchanged, the linear data plot (Chart 1) of cumulative subsidence against time suggests the residual subsidence at the project site from 2001 through 2035 could total about 2.21 feet or 0.065 feet per year. The nonlinear extrapolation of the same data set suggests the ground subsidence in the project area could be negligible by the year 2035 (Chart 2).

5.2 Agricultural pumpage for the Bowie property since 1980 is estimated to average about 5,900 acre-feet per year. Bowie Power Station proposes to pump about 5,500 acre-feet of groundwater per year for the operational life of the plant or about 400 acre-feet per year less than the agricultural use estimate. The resulting water table drawdown is projected to be approximately 50 feet below the static water level at the start of plant operations over the 30-year operational life of the plant. The anticipated drawdown could induce some additional ground subsidence in the project area of approximately 0.072 feet per year, or a maximum of 2.15 feet, over the 30-year plant life.

Although not anticipated according to ADWR (1994), if renewed drafting of groundwater from other wells in the San Simon Sub-Basin causes a significant groundwater level decline regionally, the drop in the aquifer water table could cause an increase in regional subsidence that could exceed predictions.

5.3 The projected subsidence rate induced by the plant water use over 30 years is roughly equivalent to the residual subsidence rate calculated for the period from 1980 to 2001 in the project area.

5.4 Without the groundwater withdrawal caused by the plant, the residual subsidence in the project area is expected to be arrested by 2030. With the power plant in operation, subsidence rates in the project area are expected to drop to negligible levels by 2035.

5.5 Subsidence resulting from groundwater withdrawal related to operation of the proposed power plant is expected to have negligible effects on areas adjacent to the project property because the projected groundwater use for the plant operations is expected to be less than the current water use.

5.6 In areas where the basin fill consolidation has induced excessive tensile stress within the soil column, earth fissures have formed to relieve the stress. However, there are no previously mapped earth fissures located within or trending toward the proposed Bowie Power Station site. Only two earth fissures are located within a five-mile radius of the Bowie Power Station. The northwest- and northeast trending fissures are located Section 25, Township 12 North, Range 28 East, about two miles east of the northeast corner of the Bowie Power Station site.

5.7 Based on the results of the subsidence evaluation, the geological site reconnaissance, and estimates of future potential subsidence due to plant operations, it is our opinion the potential for earth fissure formation within the project property is negligible. In addition, the potential for earth fissure formation at the plant site is negligible because the plant site is located interior from the margin of the middle and lower basin fill units, the site is several miles from the bedrock pediment edge and a relatively small amount of ground subsidence is projected

6.0 RECOMMENDATIONS

6.1 If required for the design, construction, and safe operation of the Bowie Power Station, the following engineering design measures could be considered to address the potential future ground subsidence at the project site:

- Structural elements such as foundations and slabs should be reinforced to respond uniformly to ground subsidence and settlement.

- Infrastructure utility systems such as water lines, drainage facilities, and sewers should be designed to compensate for future potential ground subsidence to minimize the potential for grade changes and flow reversals. For the Bowie Power Station facilities, minor adjustment to design grades should be provided to compensate for the slight change in slope gradient toward the southwest that may be induced by ground subsidence.

- Constructed facilities including flood control embankments and evaporation ponds should take into consideration the 2½ feet of ground subsidence that is predicted to occur over the operating life of the facility. For conservatism, a design ground subsidence value could include the sum of the predicted residual subsidence without the plant, which is 2.21 feet based on the linear extrapolation rate of 0.065 feet per year, plus the predicted estimated subsidence induced by pumping for plant operation, which is about estimated to be 2.2 feet, equals a total design estimated ground subsidence value of about 4.4 feet.

- Operational and emergency outlets for water retaining structures should be placed at locations to compensate for the predicted ground subsidence where feasible.

- Although we do not expect it, if, following detailed site investigations one or more earth fissures are found in the plant site area, building footprints should be located to avoid the fissure trace. If the fissure cannot be avoided, special foundation treatments and structural design would be necessary within an earth fissure mitigation zone. Types of treatment could include, but are not limited to, overexcavation through the zone, structural barriers, soil reinforcement, erosion and piping protection, and post-tensioned slabs and footings.

6.2 Supplemental investigations can be conducted at the Bowie power plant site to verify, refine, or refute, the ground subsidence and earth fissure conditions identified by the present scope of work. The supplemental investigation may be conducted as part of the geotechnical engineering investigation for design of the facility. Possible supplemental subsidence and earth fissure investigations include the following:

- A more detailed site examination as part of the geotechnical site investigation for design of the facility.

- A micro gravity survey designed to cover the area within 5 miles of the Bowie Power Station site. The purpose of the gravity survey is to characterize and identify buried bedrock highs, boundaries of the blue clay unit and the lake bed deposit in the lower unit, and other geologic structures that could potentially be a focus for earth fissure development.

6.3 We recommend existing survey benchmarks be re-surveyed for the purpose of implementing and maintaining a ground subsidence monitoring array for the site and surrounding areas. Some of the survey benchmarks that have been used by other researchers to measure ground subsidence (Holtzer, 1980; Strange; 1983) should be included in the monitoring program as primary survey monuments. The off-site benchmarks could be integrated with new survey benchmarks located within the Bowie property. Secondary monuments within a five-mile radius of the property could also be incorporated into the program. A list of primary ground subsidence benchmarks, and other secondary benchmarks, will be included in the ground subsidence monitoring program.

Subject to the approval by the appropriate state agency, such as the Arizona Department of Water Resources or the Arizona Geological Survey, following the initial baseline survey, the primary subsidence monitoring stations should be surveyed at one-year intervals for the initial five years of plant operation when groundwater drafting rates are greatest. The frequency of subsequent monitoring should be established based on the results of the first five years of monitoring. Secondary monuments may be surveyed at less frequent intervals depending upon the amount of ground subsidence measured at the primary stations. Surveying of the subsidence monitoring array should be conducted using currently accepted methods and standards of practice. Survey accuracy standards should be 0.05 feet (or about 2 centimeters). Data collected should be compiled in an easy-to-use format such as Microsoft Excel. Reporting should be done at least annually with reports distributed to other interested parties including the ADWR, which currently maintains a statewide clearinghouse for subsidence monitoring data.

Implementation of a subsidence and earth fissure monitoring program should provide an adequate "early warning" system to allow the owner to evaluate these ongoing geological phenomena and assess and respond to potential hazards that might result. Additionally, other agencies may use the information gathered to develop appropriate mitigation measures to deal with potentially adverse effects that might impact other areas within the San Simon Sub-Basin.

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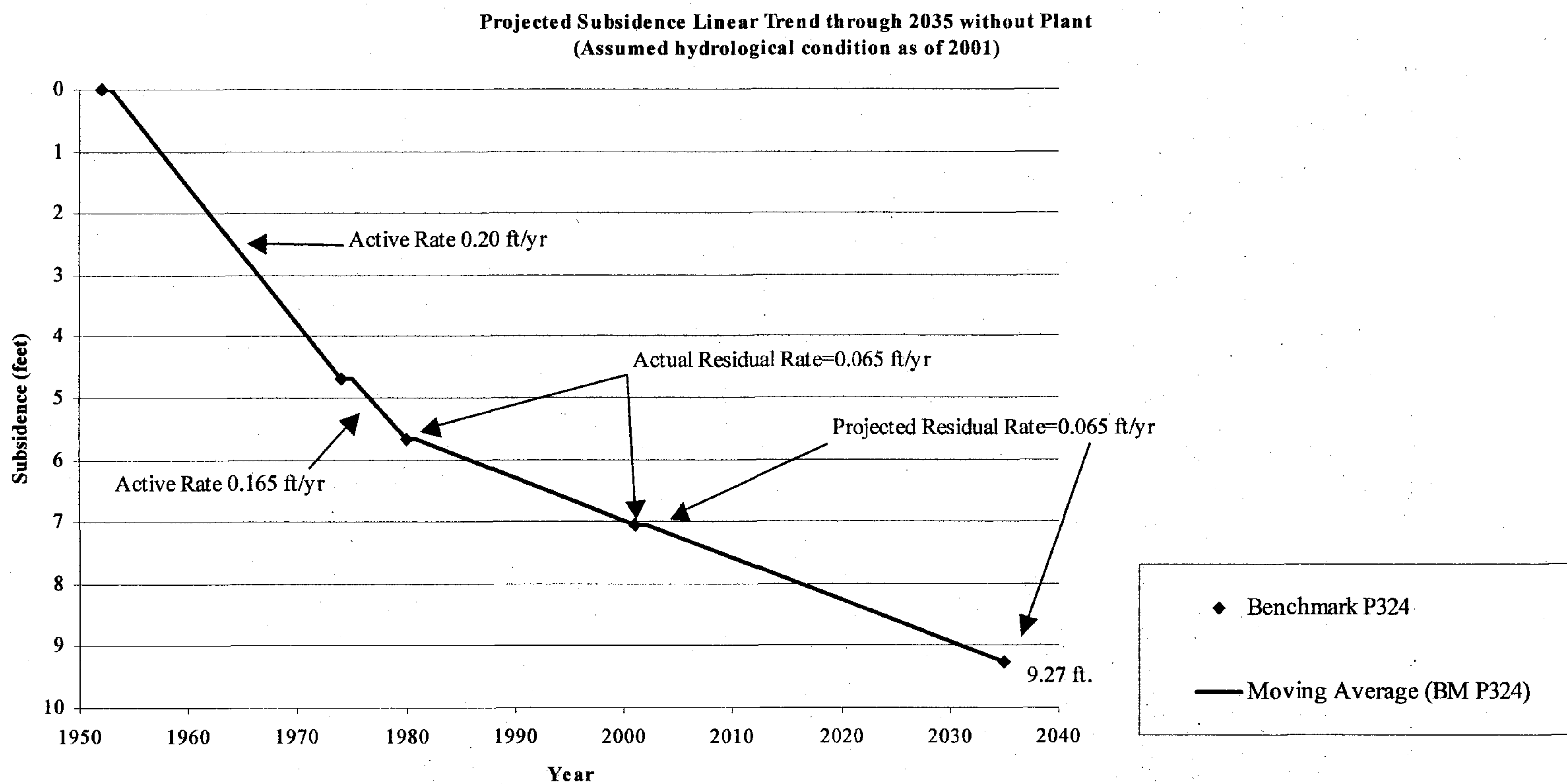
Charts

CHART 1



Projected Subsidence Linear Trend through 2035 without Plant
(Assumed hydrological condition as of 2001)
Subsidence (feet)
0
1
2
3
4
5
6
7
8
9
10
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
Year
Active Rate 0.20 ft/yr
Active Rate 0.165 ft/yr
Actual Residual Rate=0.065 ft/yr
Projected Residual Rate=0.065 ft/yr
9.27 ft.
Benchmark P324
Moving Average (BM P324)

CHART 2

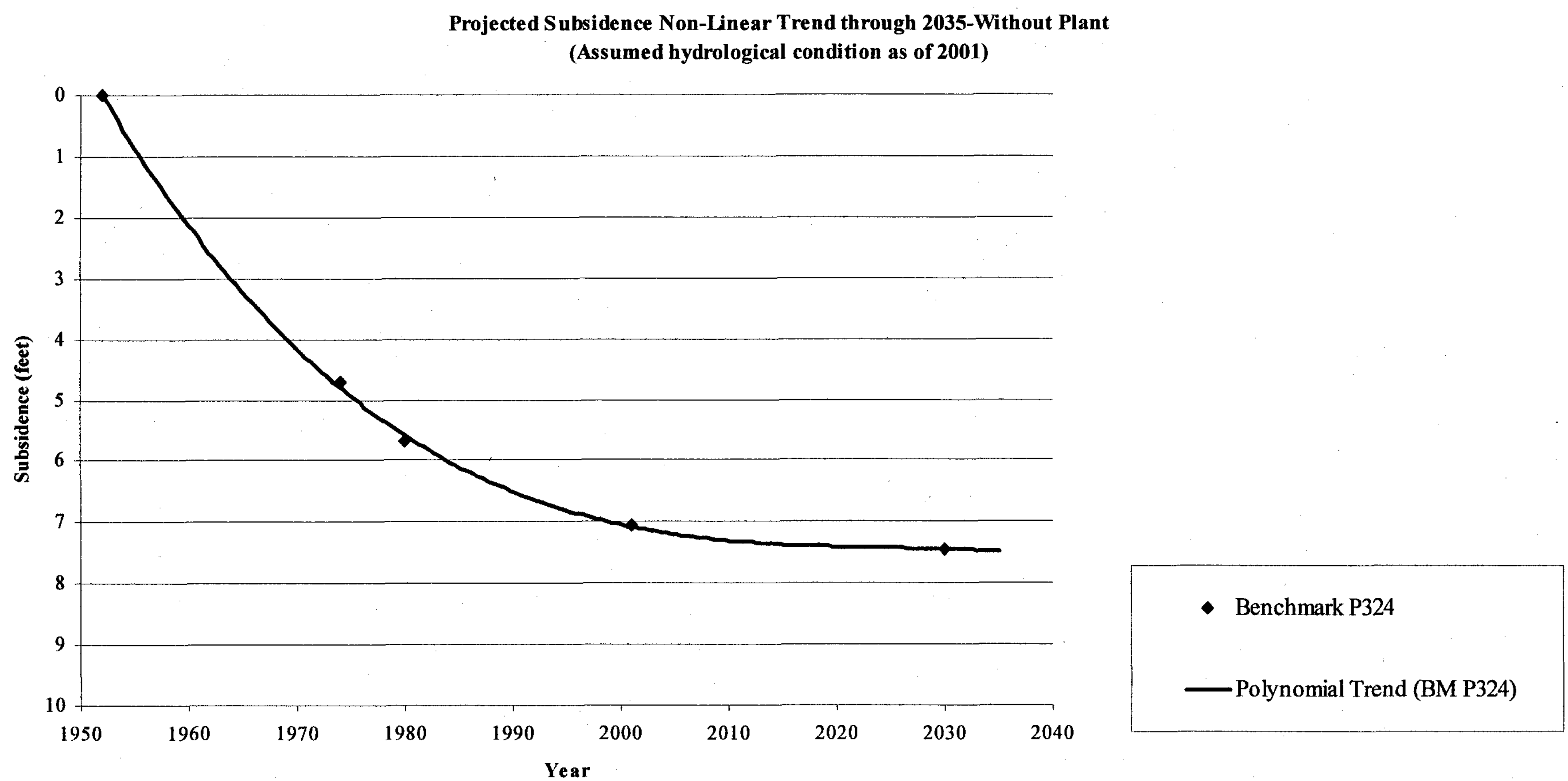
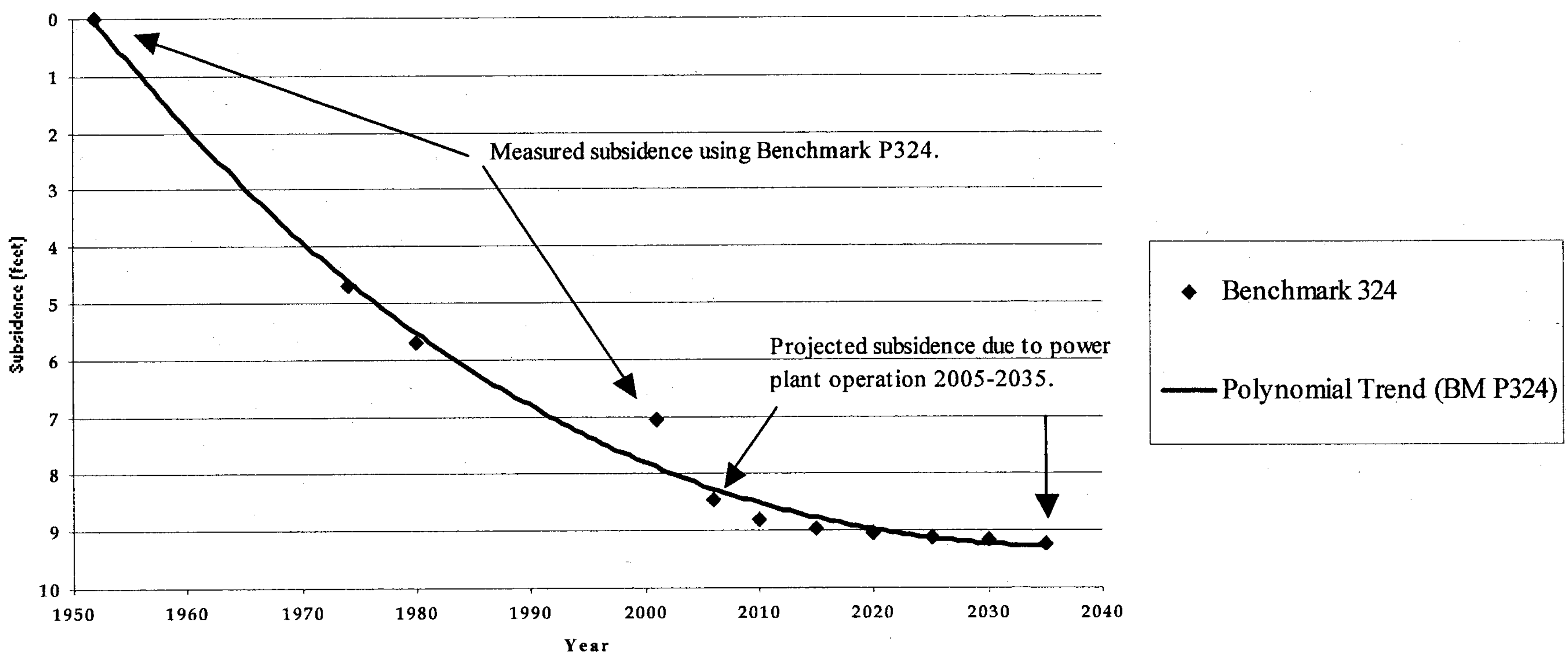
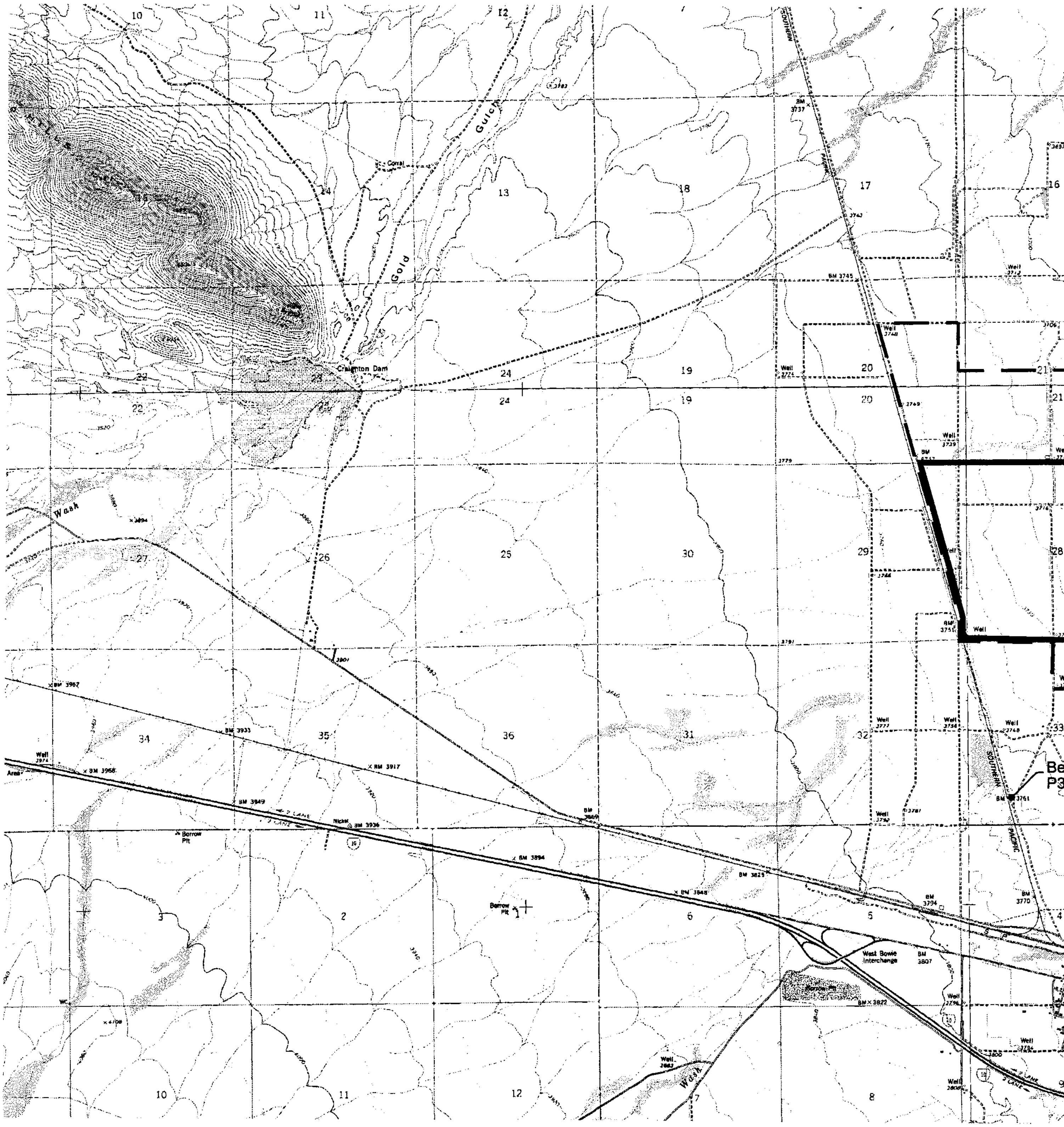

Projected Subsidence Non-Linear Trend through 2035-Without Plant
(Assumed hydrological condition as of 2001)
Subsidence (feet)
0
1
2
3
4
5
6
7
8
9
10
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
Year
Benchmark P324
Polynomial Trend (BM P324)

CHART 3

Actual & Projected Ground Subsidence Trend 1952-2035 - Bowie Power Station Area



Figures



Reference: USGS Topographic Quad
Fisher Hills, Az 1979
Ryan Draw, Az 1974
Bowie, Az 1974
Luzena, Az 1979

LEGEND:

SITE BOUNDARY

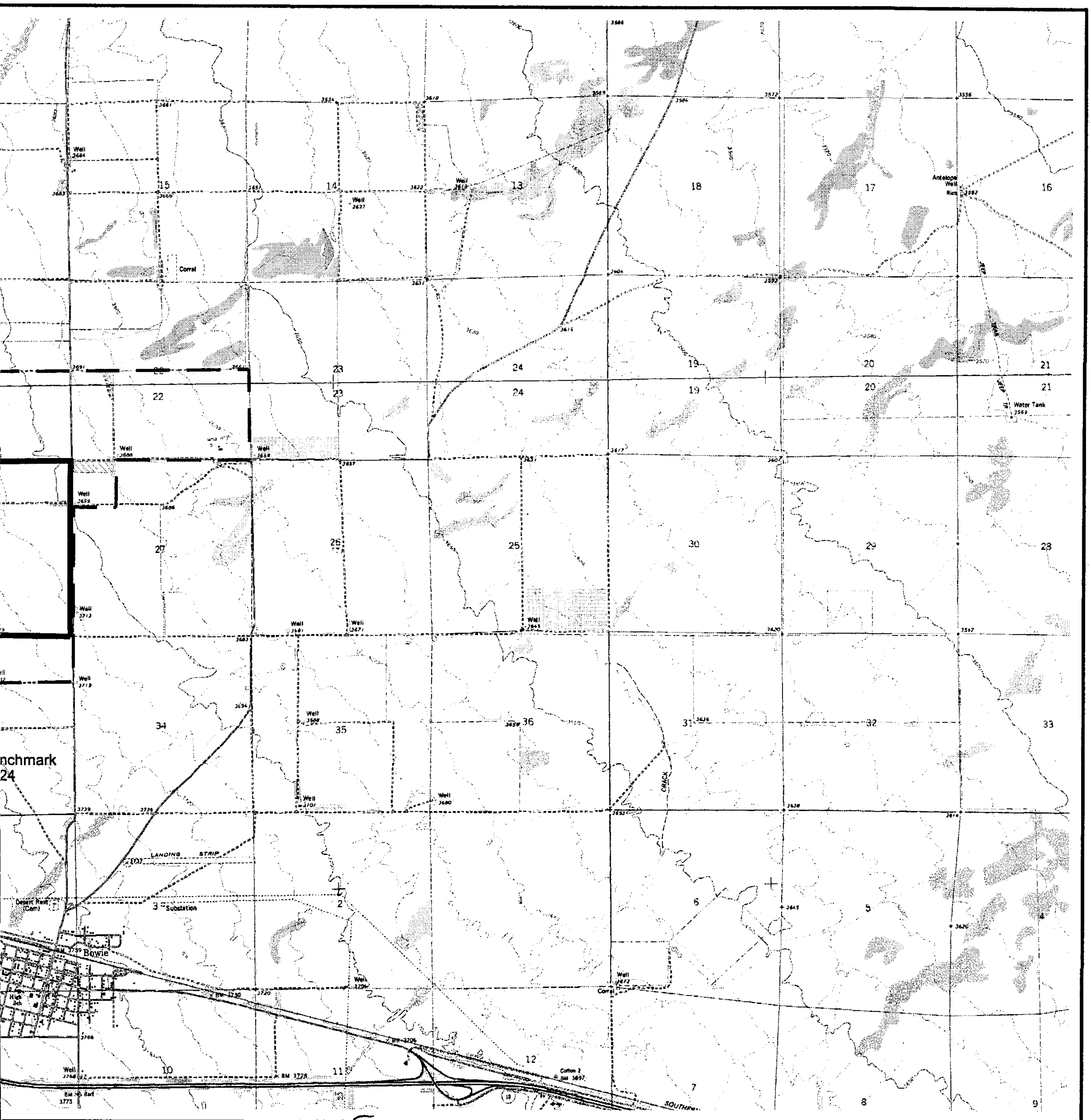
PROPERTY BOUNDARY

0 1

Scale in Miles

A15050.DWG 10-8-01 XREF:4686\001QUADS.DWG IMAGES:32109C5, 32109C4, 32109D4, 32109D5

E1-47034002.00



2

REGISTERED GEOLOGIST
CERTIFICATE NO.
10338
KENNETH M.
EUGE
Date Signed 10/08/01
ARIZONA U.S.A.

Site Location Map

Figure 1
Bowie Power Station

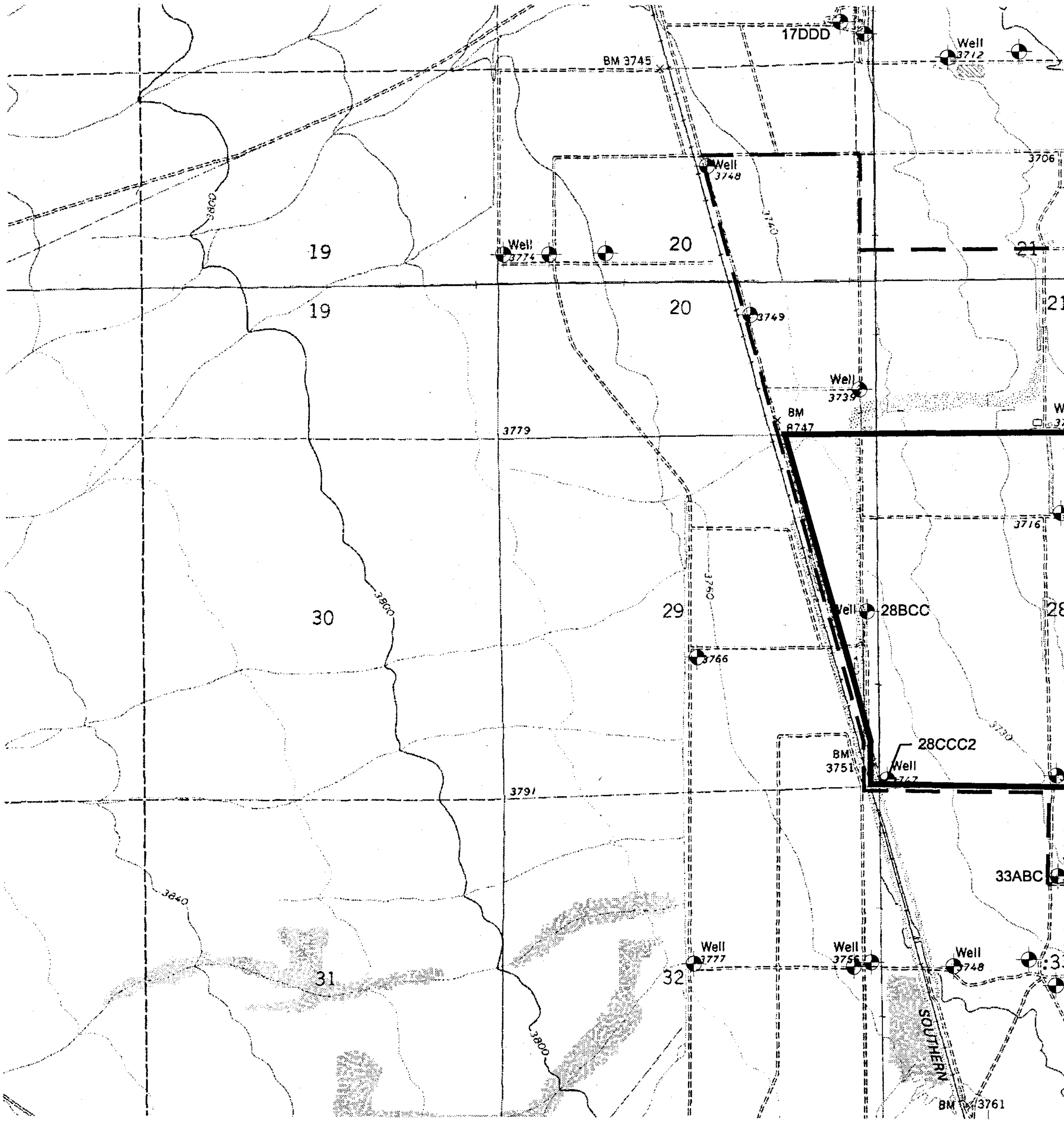
Geological Consultants Inc.
2333 West Northern Avenue, Suite 1A Phoenix, AZ 85021

OVERSIZED MAP

-Bowie Power Station General Geologic Map Figure 2

<u>TO REVIEW SEE DOCKET SUPERVISOR</u>

DOCKET L-00000BB-01-0118-00000



Reference: USGS Topographic Quad
Fisher Hills, Az 1979
Ryan Draw, Az 1974
Bowie, Az 1974
Luzena, Az 1979

LEGEND:

EXISTING WELL
SITE BOUNDARY
PROPERTY BOUNDARY

N

0 1/2

Scale in Miles

A15053.DWG 9-19-01 XREF:46866\001QUADS.DWG IMAGES:32109C5, 32109C4, 32109D4, 32109D5

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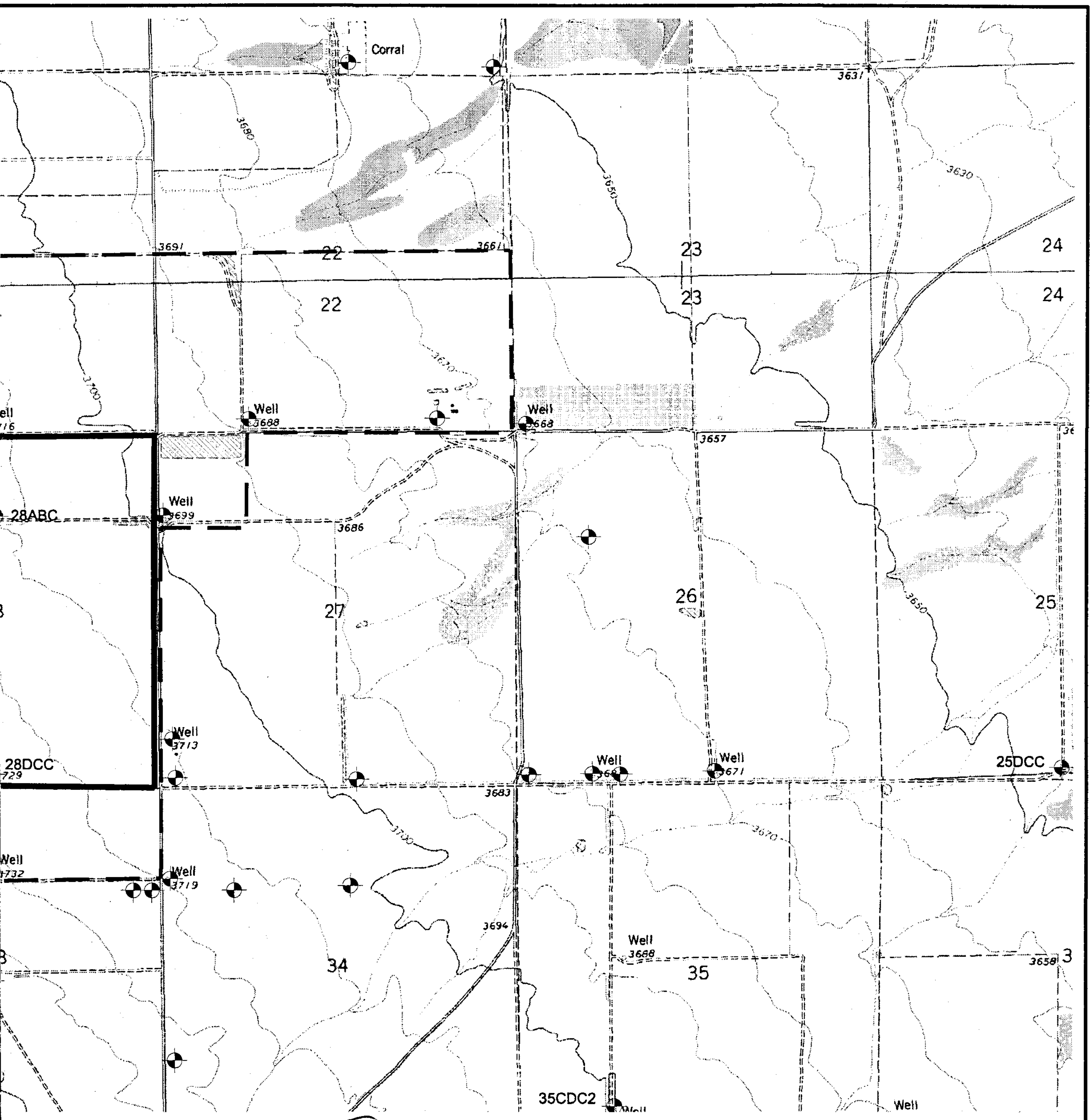


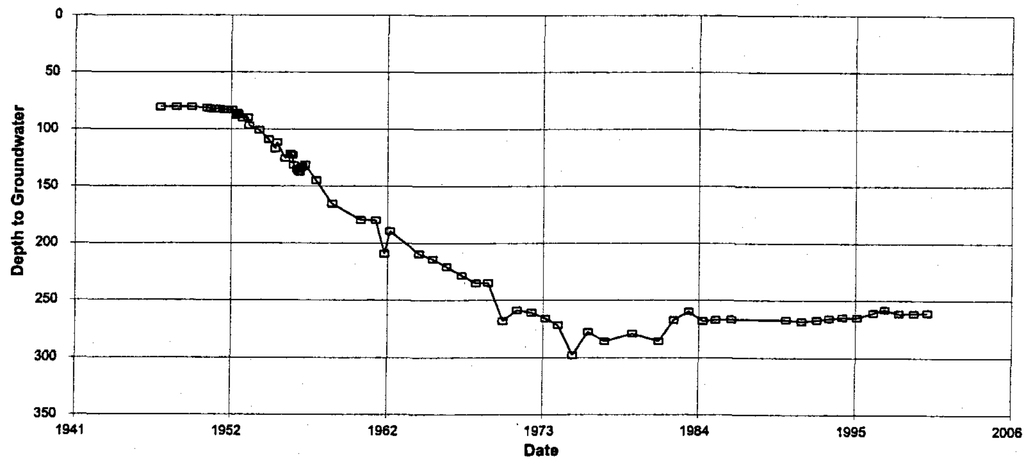
REGISTERED GEOLOGIST
CERTIFICATE NO.
10338
KENNETH M.
EUGE
Date Signed 10/09/01
ARIZONA U.S.A.

Well Location Map

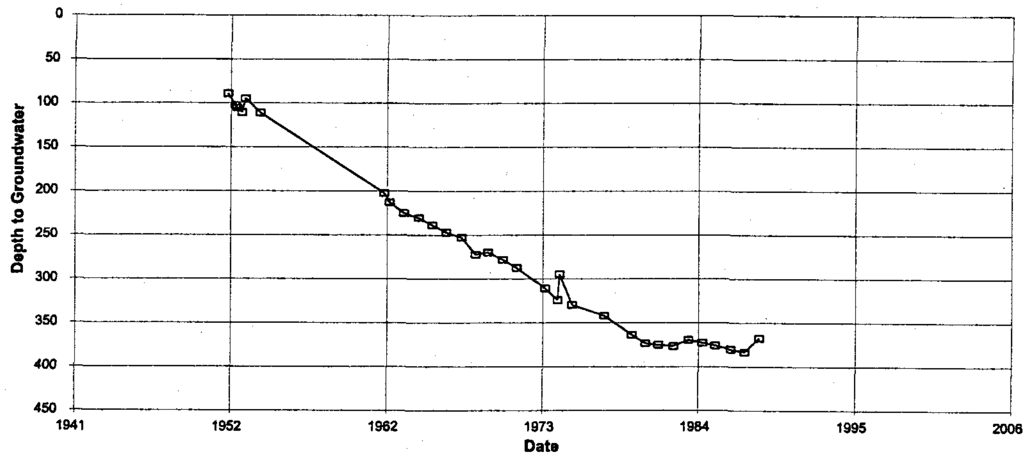
Figure 3
Bowie Power Station

Geological Consultants Inc.

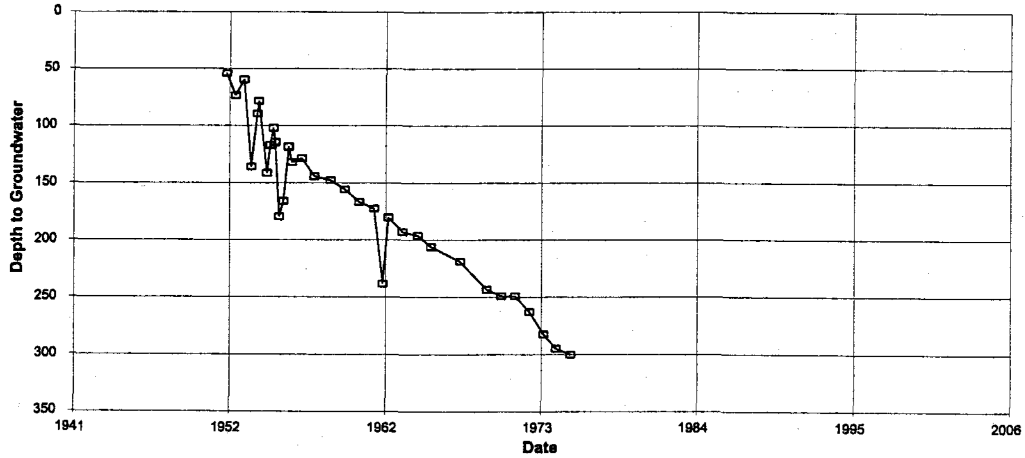
2333 West Northern Avenue, Suite 1A Phoenix, AZ 85021



Well No. 17DDD



Well No. 33ABC1



Well No. 35CDC2

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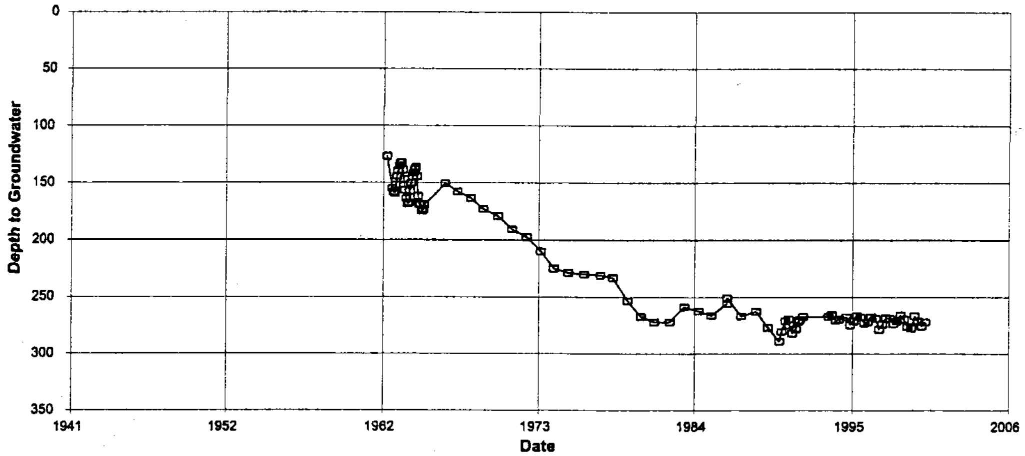
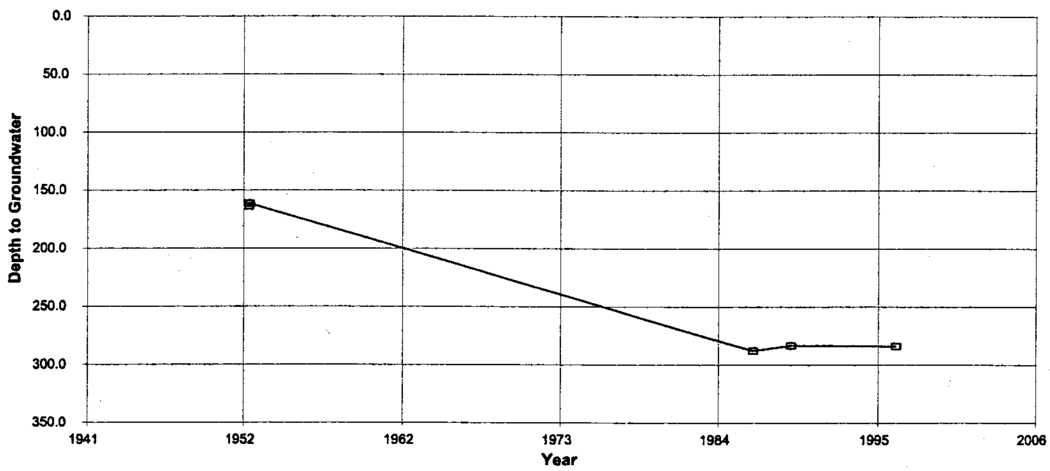
Well No. 25DCC



Well No. 04CCC1



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CERTIFICATE NO.
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KENNETH M.
EUGE
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ARIZONA U.S.A.

Well Hydrographs

Figure 4
Bowie Power Station

Geological Consultants Inc.
2333 West Northern Avenue, Suite 1A Phoenix, AZ 85021

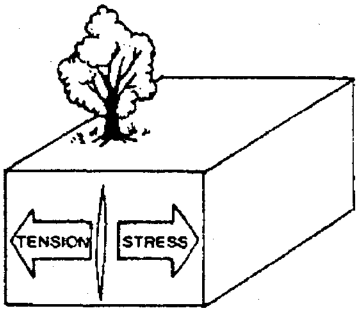
OVERSIZED MAP

-Bowie Power Station
Regional Ground Subsidence and Earth Fissure Map

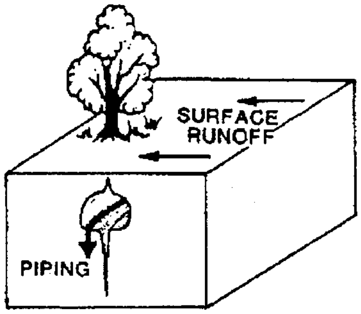
Figure 5

TO REVIEW SEE DOCKET SUPERVISOR

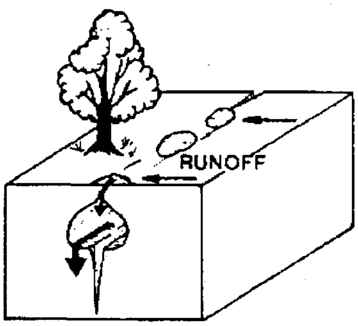
DOCKET
L-00000BB-01-0118-00000



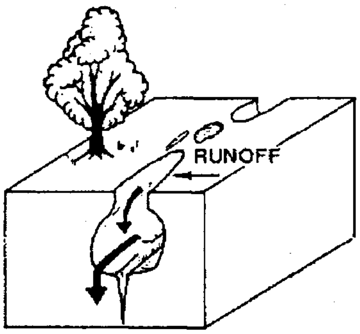
1. Lateral stresses induce tension cracking



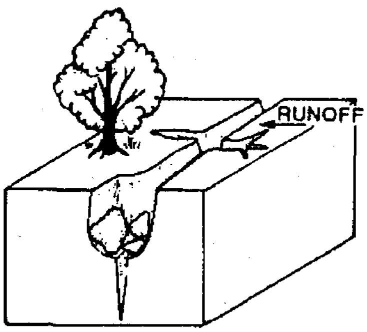
2. Surface runoff and infiltration enlarge crack through subsurface piping



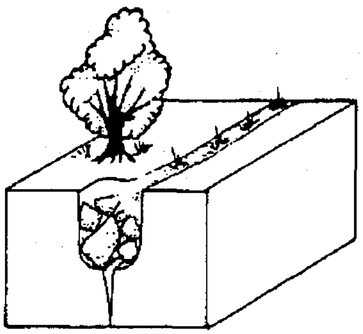
3. As piping continues, fissure begins to appear at surface as series of potholes and small cracks



4. As infiltration and erosion continue, fissure enlarges and completely opens to surface as tunnel roof collapses



5. The entire fissure is opened to the surface and enlargement continues as fissure walls are widened, extensive slumping and side-stream gullying occur



6. Fissure becomes filled with slump and runoff debris and is marked by vegetation lineament and slight surface depression, it may become reactivated upon renewal of tensile stress

(From Pewe, 1982)

REGISTERED GEOLOGIST
CERTIFICATE NO.
10338
KENNETH M.
EUGE
Date Signed 10/08/01
ARIZONA U.S.A.

Generalized Sequence of Earth Fissure Development

Figure 6
Bowie Power Station

Geological Consultants Inc.
2333 West Northern Avenue, Suite 1A Phoenix, AZ 85021

A15051.DWG 10-5-01

ORIGINAL

MEMORANDUM

Ryley Carlock & Applewhite
A PROFESSIONAL ASSOCIATION

Date: October 5, 2001

To: Tom Wray, General Manager, SouthWestern Power Group II, L.L.C.

From: Sheryl Sweeney, Esq.

Subject: Bowie Project Water Overview

Arizona Corporation Commission
DOCKETED
OCT 0 9 2001
DOCKETED BY

I. BACKGROUND

You have indicated that at a special open meeting of the Arizona Corporation Commission on October 3, 2001, Commissioner Spitzer inquired as to the nature of Arizona law governing groundwater withdrawals in non-active management areas ("AMA"). The purpose of this memo is to provide an overview of Arizona law which is both responsive to Commissioner Spritzer's inquiry and specific to the proposed Bowie Power Station Project (the "Project").

As further background to our analysis, it is our understanding that the proposed plant will be supplied with water pumped from wells located on the Project site.

II. DISCUSSION

A. REASONABLE AND BENEFICIAL USE

Outside of an AMA,[1] the owner of land overlying groundwater has the right to capture the groundwater percolating beneath the land and put the land to reasonable use (often referred to as the doctrine of reasonable use). *Town of Chino Valley vs. City of Prescott*, 131 Ariz. 78, 638 P.2d 1324 (1981); *Cherry v. Steiner*, 543 F.Supp 1270 (D.Ariz. 1982); *Bristor v. Cheatham*, 75 Ariz. 227, 225 P.2d 173 (1953). This legal principle has been codified in A.R.S. § 45-453.1, which states that "in areas outside of active management areas, a person may withdraw and use groundwater for reasonable and beneficial use . . .", subject to statutory limitations on the transportation of water away from the land. While there appear to be no reported Arizona cases addressing the use of groundwater for power generation, the use of water for power generation clearly is recognized as a beneficial use. For example, A.R.S. § 45-464.E., authorizes the creation of Type 2 water rights (within an AMA) for electrical generating facilities. The annual amount of such a right would be the amount determined to be reasonable to meet the operational requirements of the facility for a full year.

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AZ CORP COMMISSION
DOCUMENT CONTROL

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[1] We have confirmed that the Project is not located within an AMA.

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10/5/01

In that regard, the Third Management Plan ("TMP") for the Phoenix AMA imposes the following conservation requirements on large scale (more than 25 MW) power plants constructed after 1984:

1. An annual average of 15 or more cycles of concentration shall be achieved at fully operational cooling towers during periods when the power plant is generating electricity.

2. Blowdown water shall be discharged on a continuous basis, and make-up water shall be provided on a continuous basis.

3. The maximum amount of wastewater feasible excluding blowdown water and sanitary wastewater, shall be diverted to the cooling process.

TMP § 6-503. While these requirements are not applicable to the Project, because it is not located within an AMA, they provide a guide to what could be considered the most restrictive measure of "reasonableness." Thus, if the Project can meet these standards, it appears that the reasonable use requirements clearly would be satisfied.

B. TRANSPORTATION

Groundwater withdrawn can be put to use on the land from which it is withdrawn and can be transported within a subbasin of a groundwater basin (or within a groundwater basin if there are no subbasins) without payment of damages to surrounding water users. A. R. S. § 45-544.A.1(a). The water can be transported between subbasins, subject to the payment of damages, but cannot be transported away from a groundwater basin. A. R. S. § 45-544.A.1(b) and A.2. The Project is located entirely within the San Simon Valley subbasin of the Safford Basin. Therefore, the withdrawal of water from the Project site for use on the Project site will not give rise to a statutory claim for damages.

C. CONVERSION

In non-AMA areas, a groundwater use can be converted from an irrigation to an industrial use at will, subject only to the doctrine of reasonable use and any applicable limitations on the transportation of water away from the land from which it is withdrawn. There are no applications or permits required for the conversion.

D. WELLS

When an existing well is conveyed, a notice of change of ownership must be filed with the Arizona Department of Water Resources ("ADWR"). A. R. S. § 45-593.C. In addition, if the type of use changes (e.g., from irrigation to industrial), the owner of the well should file a notice of change of well information with ADWR, to ensure that the new use is of record.

In order to drill a new well outside of an AMA, a notice of intention to drill must be filed with the Arizona Department of Water Resources ("ADWR"), describing the location and characteristics of the proposed well, and the name and license number of the well driller. A.R.S. § 45-596.C. Assuming that the information in the notice of intent is complete, ADWR will notify the applicant that it may proceed to drill the new well. A.R.S. § 45-596.D.

III. CONCLUSION

In light of the foregoing, and with specific reference to the Project, it would appear that the Project's proposed use of groundwater is in accordance with all applicable Arizona law.

BOWIE POWER STATION, L.L.C.

DOCKET NO. L-00000-BB01-0118

EXHIBIT # A- ____

COPY

City of Willcox
Office of the City Manager
Larry D. Rains
101 S. Railroad Avenue, Suite B
Willcox, AZ 85643

Telephone (520) 384-4271 ext. 302
Fax (520)384-2590
email lrains@willcoxcity.org

July 24, 2001

Director of Utilities
Arizona Corporation Commission
1200 West Washington Street
Phoenix, AZ 85007

Re: Certificate of Environmental Compatibility for the Bowie Power Station.

DOCKET NO. L-00000BB01-0118

To Whom It May Concern:

Please accept this letter as notice that the City of Willcox is aware of the Bowie Power Station project and the impacts that this industry will have on our Community. The Southwestern Power Group II has made presentations to our local elected and appointed officials, the Chamber of Commerce members, as well as have held public forums to hear comments from the local citizens. It is our opinion that they have utilized the most practical methods of noticing our Community of the project and impacts of such activity.

Throughout this process, the City of Willcox has been supportive of said project. Although the project will not transpire within our incorporated city limits, we anticipate a positive economic impact from this organization and industry. Additionally, Southwestern Power Group II has taken a very activity role in Community citizenship. We look forward to the long-term partnerships that can evolve with the project.

The City of Willcox strongly encourages you to consider and support the Certificate of Environmental Compatibility and Bowie Power Station project.

Should you have any questions regarding this matter, please contact me at your convenience.

Respectfully,

Larry D. Rains
City Manager

cc: Southwestern Power Group II
Mayor and City Council

L 00000 BB01-0118

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AZ CORP COMMISSION
DOCUMENT CONTROL

Bowie USD #14
315 W. 5th Street
Bowie, AZ 85605

COPY

Attn: Director of Utilities
Arizona Corporation
Commission
1200 West Washington
Phoenix, AZ 85007

JUL 30 2001

July 24, 2001

Dear Director,

The Southwest Power Group plans to construct a new station in Bowie and we at Bowie Schools are quite excited about the project. As you probably know, Bowie is a tax-poor area and in order to finance our school district we must charge our property owners probably the highest school tax rate in Arizona at $11.50 per $100.00 A.V. The new generating plant, when constructed and in operation, will mean that tax rate can drop dramatically while at the same time provide more money to operate our schools.

The Southwest Power Group has kept us informed from the very beginning and has asked for our input along the way. We encourage you to approve their permit.

Sincerely,

Dr. T.R. Ellis, Superintendent

Arizona Corporation Commission
DOCKETED

AUG 0 8 2001

DOCKETED BY	

Cc: Southwest Power Group
4350 E Camelback Rd., Suite B-175
Phoenix, AZ 85018
Attn: Jonathan Bruser

"Wings Over Willcox"

Willcox Chamber

WILLCOX NOW of

Commerce and Agriculture

Travel the "Magic Circle of Cochise"

July 26, 2001

Director of Utilities
Arizona Corporation Commission
1200 West Washington Street
Phoenix, Arizona 85007

Re: CEC for Bowie Power Station Application

To Whom It May Concern:

The Willcox Chamber of Commerce and Agriculture supports Southwestern Power Group II's above mentioned application. The Chamber of Commerce has attended several local meetings in which the project was discussed in detail. The Chamber of Commerce is aware of the impacts of construction and when the plant is fully operational.

The Chamber asks the Commission to find in favor of this application. If you have any questions please do not hesitate to contact the Chamber of Commerce at your earliest convenience.

Sincerely,

Eddie Browning

Eddie Browning, Executive Director
Willcox Chamber of Commerce and Agriculture

(520) 384-2272 ◆ (800) 200-2272 ◆ (520) 384-0293 Fax
willcoxchamber@vtc.net ◆ www.willcoxchamber.com
1500 North Circle I Road
Willcox, Arizona 85643

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2001 AUG -8 P 3:20

AZ CORP COMMISSION
DOCUMENT CONTROL

BOWIE FIRE DIST.
P.O. BOX 241
BOWIE AZ. 85605
PHONE(520)847-2553
FAX(520)847-1129

To whom it may concern: this is a letter of support for the proposed Power Plant in the town of Bowie . We here at the Bowie Fire Dist. feel that it will be a great asset to the town. We also feel that with out this plant the town will soon die out. It is the option of the members of the Bowie Fire Dist.& the people of this town that this Plant will help to save this town as well as help it to grow. The people from the plant have been more then forth coming about all the plains & needs they would have over the cores of the consternation and operation of the Plant. They have also been very forth coming about any and all ever mental & economic impacts it will have on the Town of Bowie and the people that live in here. They have been more then willing to meet with and answer any & all questions from all members of the community. We at the Bowie Fire Dist. Hope that you take all of this in to confederation when you make any dissection.

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AUG 06 2001

ARIZONA CORP. COMM.
TUCSON, AZ.

Sincerely,
Chief Michael Bovee
Bowie Fire Dist.

BOWIE POWER STATION
NEWSLETTER #2 • SEPTEMBER 2001

BOWIE POWER STATION

The Arizona Power Plant and Transmission Line Siting Committee will hold a hearing on the Bowie Power Station Project's application for a certificate of environmental compatibility.

DATES: Thursday, October 11, and Friday, October 12

TIME: 9:00 a.m.

PLACE:
Best Western Plaza Inn
1100 W. Rex Allen Dr.
Willcox, Arizona

For updated project information, call toll free, 1-877-576-7477

This is the second in a series of newsletters designed to keep the community and interested parties informed about the progress of the proposed Bowie Power Station. Since the announcement of the project in January 2001, SouthWestern Power Group II (SWPG) and Bowie Power Station, LLC have been conducting detailed environmental and engineering studies, working on design plans for the generating facility, initiating permitting processes, narrowing alternatives for the associated transmission line, and meeting with various members of the public to gather input and feedback.

OVER 100 ATTEND PUBLIC MEETINGS

On April 25 and 26, 2001, two public open house meetings were held in Willcox and Bowie, respectively. At the beginning of the evening, attendees had the opportunity to review informational displays and speak individually with project team members. Following this portion of the meeting was a presentation and lengthy question/answer session to address the comments and questions presented by the audience. Some of the questions were about the construction schedule, air quality, sources of water and natural gas, impacts on the community during construction, and plans for the land around the plant, among many others. The "quick facts" section on page 2 and information in Newsletter #1* offer explanations of many of these subjects. Overall, community members expressed their support of the project, citing the positive economic benefits that will occur for the area.

***Newsletter #1 may be requested by calling toll free 1-877-576-7477**

Tom Wray, SWPG, responds to audience questions at the public meeting in Bowie on April 26, 2001.

BOWIE POWER STATION

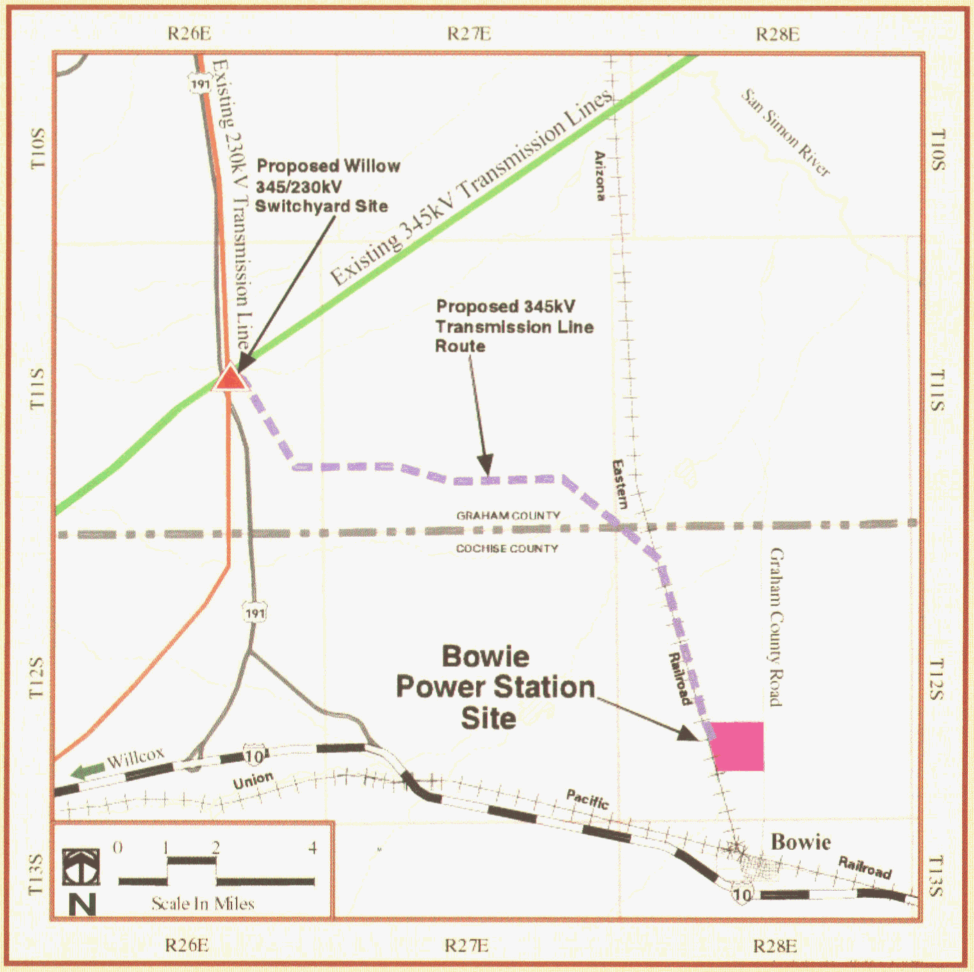
QUICK FACTS

- During construction: average of 200 jobs created, up to 300 at peak
- Substantial tax revenues for local schools and communities
- Up to 1,000 megawatts (MW) total capacity (phased in over time)
- Fueled by clean-burning natural gas
- Built with two 500 MW blocks, each with two combustion turbines supporting one steam turbine generator
- Construction expected to begin in late 2002
- First unit expected to be in operation in late 2004
- One double-circuit 345 kilovolt (kV) transmission line extending about 14 miles northwest of the plant will be required
- A 345kV switchyard will be built at the plant site; a 345/230kV switchyard will be built at the point where the new transmission line connects with existing lines in southern Graham County
- Air emissions in compliance with U.S. Environmental Protection Agency and Arizona Department of Environmental Quality standards
- State-of-the-art technology with lowest achievable emissions
- Sound reduction methods to minimize noise
- Groundwater use will be less than existing agricultural water use

TRANSMISSION LINE ROUTE SELECTED

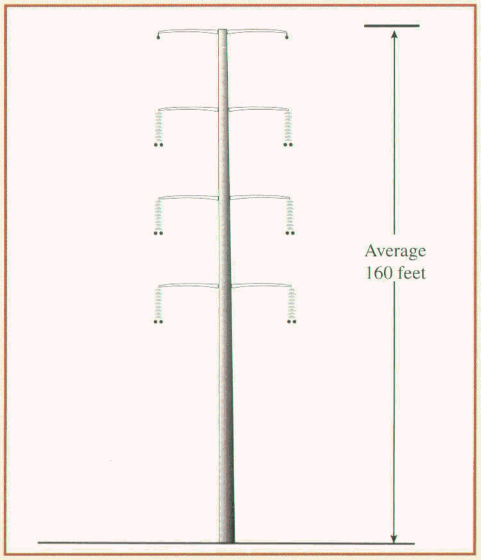
The Bowie Power Station Project involves the construction of a double-circuit 345 (kV) kilovolt transmission line, which will extend about 14.3 miles northwest from the facility to interconnect with existing transmission lines north of the Cochise/Graham County line. In the final stage of development, the 345kV/230kV "Willow" switchyard will be built at that location.

Factors such as environmental compatibility, electrical system requirements, engineering, costs, and public input were studied extensively as steps in the process of selecting a preferred route for the power line, which is shown below. The figure on page 3 illustrates a single-pole structure, typically 160 feet in height, which is expected to be used along this route.



PERMITTING PROCESS CONTINUES - First hearing on October 11-12

In July, an application for a certificate of environmental compatibility (CEC) was filed with the Arizona Corporation Commission (ACC), which is the first major step in the permitting process. In our state, all proposed power plants and certain types of transmission lines must be approved by the ACC. Prior to the application reaching the ACC, it is considered by the Arizona Power Plant and Transmission Line Siting Committee, which will hold a hearing on the Bowie project in Willcox on October 11 and 12, 2001. Beginning at 9:00 a.m., the meetings generally conclude in the late afternoon each day. Please see page 1 for location details.



Typical double-circut 345kV structure

The process to obtain an air quality permit from the Arizona Department of Environmental Quality and the U.S. Environmental Protection Agency is also underway and should be completed in late 2002. The project planners are working with Cochise County to obtain the necessary zoning and special use permits and identify appropriate uses for the surrounding lands. Also, an Aquifer Protection Permit will be required prior to construction of the lined evaporation ponds.

CULTURAL RESOURCES HIGHLIGHTS

As part of the environmental studies for the proposed generation facility, a team of archaeologists researched the history of Bowie and the surrounding areas and have learned some interesting facts. This highlight is on the past principal mode of long-distance transportation—the railroads.

The summer of 1880 was the dawn of the railroad days in Bowie. Like other parts of the United States, the area blossomed as the Southern Pacific Railroad came to town. Construction workers were needed to build not only the railroad north of town, but also other facilities such as the Bowie Depot, a hotel, a freight house, water tanks, and additional buildings to support the railroad operations.

The combination of the newly developed town services and Bowie's position on the main route for the southern transcontinental railroad meant people from all over the country could visit, fueling the area's growing economy. Also critical at the time, mail delivery was much quicker and efficient.

In 1899, the Gila Valley Globe & Northern Railroad (GVG&N) linked Bowie with the rich mining areas of central Arizona, including the city of Globe. The tons of ore mined in Globe were transported to Bowie via the GVG&N, then loaded on cars headed for the Southern Pacific Railroad. During the early 1900s, these mining operations were so successful that the tracks were heavily crowded with both passenger and freight trains. Innovative and necessary in its days, the railroads began to decline as the U.S. highway system developed.

The Southern Pacific Train Depot at Bowie, pictured below, was a key landmark in Bowie's development.

Courtesy of Margaret Gates

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Power Group LLC
An Energy Company - Alliance Builder

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Suite B175
Phoenix, AZ 85018

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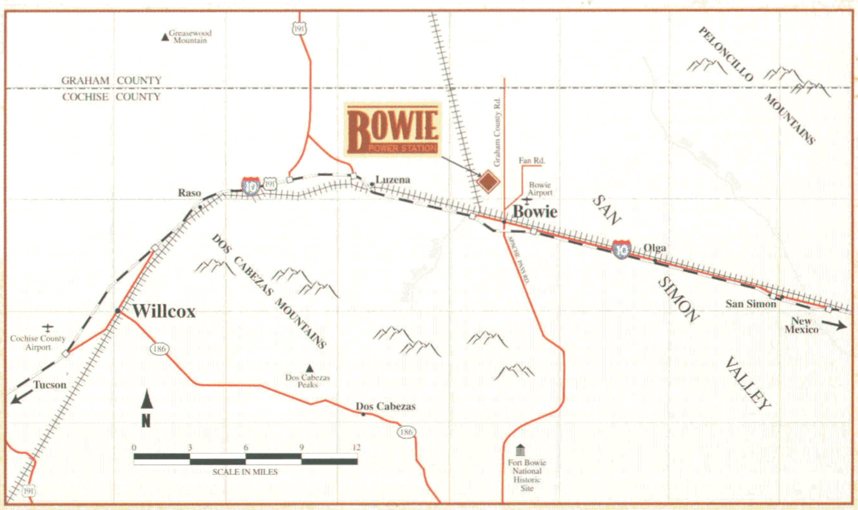
BOWIE
POWER STATION

IMPORTANT NEWS ABOUT THE BOWIE POWER STATION!



Project Area Map