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HYDROGEOLOGY AT THE TRANSWESTERN PIPELINE COMPRESSOR STATION NO. 5 THOREAU, NEW MEXICO

VOLUME 1

TEXT, TABLES & FIGURES

PREPARED FOR

TRANSWESTERN PIPELINE COMPANY

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• GROUND-WATER CONTAMINATION • UNSATURATED ZONE INVESTIGATIONS • WATER SUPPLY DEVELOPMENT •

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EXECUTIVE SUMMARY

An investigation of the hydrogeology at the Thoreau Compressor Station No. 5 was conducted which included compilation of existing information and collection of new data on-site. The initial on-site program included drilling three deep borings to depths of 435, 444, and 665 feet and three shallow monitor wells compacted in the alluvium near the top of bedrock. Five additional shallow monitor wells were installed.

Water-bearing formations beneath the station include alluvium, Chinle Formation, San Andres Limestone and Glorieta Sandstone. The compressor station is underlain by about 60 feet of sandy alluvium which rests on the Chinle Formation. Ground water in the alluvium occurs about 45 feet below land surface and appears to be perched on the Chinle. The Chinle is a unit roughly 1000-1300 feet thick which is comprised predominantly of low permeable mudstone and claystone. The Sonsela Sandstone Bed is a confined aquifer within the Chinle that occurs about 650 feet below land surface at the station. The base of the Sonsela is separated from the deeper San Andres Limestone-Glorieta Sandstone aquifer by approximately 400 feet of the mudstone and claystone facies of the lower Chinle. The San Andres-Glorieta system, the most important aquifer in the

area, is about 1240 feet beneath the station. The Sonsela also provides water for domestic use and stock watering.

The shallow ground water within the alluvium contains petroleum hydrocarbon components and PCB's in excess of standards at some locations in the southeast part of the station. There is no evidence of off site migration of these chemicals. The potential for the Sonsela and San Andres-Glorieta aquifers to become contaminated due to migrated from the shallow alluvial water is very low. This assessment is based primarily on the low mobility of PCB in soil and ground water and other attenuation mechanisms, and the thick sections of low permeable, clay-rich material which lie above these aquifers.

1. INTRODUCTION

1.1 Purpose

Daniel B. Stephens & Associates (DBS&A) was retained by Transwestern Pipeline Company (Transwestern) March 23, 1989 to investigate the hydrogeology at four pumping stations along the Transwestern Pipeline Company natural gas transmission line across New Mexico: Thoreau, Laguna, Mountainair, and Corona. This investigation was motivated by a release of polychlorinated biphenyl (PCB) compounds which locally contaminated soils at the compressor stations (Woodward Clyde Consultants, 1988). The PCB releases occurred when waste liquids from cleaning the pipeline were discharged into unlined pits and on soil.

The initial purpose of the hydrogeological investigation was to form a preliminary basis for evaluating the potential for PCB to contaminate ground water. The results of the initial investigations revealed the presence of contamination within a shallow alluvial aquifer beneath the Station. Additional work was required to characterize the nature and extent of the contamination.

1.2 Scope of Work

The work activities initially requested included the following general tasks:

- o Review available hydrogeologic data
- o Identify water users in the area
- o Design and complete three test wells on-site
- o Determine aquifer properties
- o Assess ground water quality
- o Prepare a final hydrogeologic report.

As a consequence of a meeting in Dallas, Texas on April 11, 1989 with representatives of Transwestern, the U.S. Environmental Protection Agency (EPA) requested additional drilling and sampling. In addition to two test wells down-gradient and one up-gradient of the contaminated soil area proposed by Transwestern, EPA requested that we collect samples of unconsolidated soil at the Thoreau station. The shallow borings would be completed with well screen and casing to monitor for possible perched or alluvial groundwater.

In the April 11 meeting the EPA also stipulated criteria which would allow the deep test wells to be considered as monitor wells. In particular, EPA indicated that well screens should be placed in the upper 20 feet of the first water-bearing zone. Alternatively, EPA recommended that water could be bailed from discrete depths where screen lengths exceeded 20 feet.

To expedite the completion of the investigation by May 19, 1989, DBS&A retained the assistance of Ground-Water Resources, Inc. (GWR) of Tucson, AZ. GWR was subcontracted primarily to supervise the deep subsurface hydrogeological investigation. The scope of work subcontracted to GWR included the development of drilling specifications, standard operating procedures, and supervision of the installation of deep test wells, geologic and geophysical logging, and water quality sampling of the deep test wells.

1.3 Methods of Investigation

The investigation began in late March with a reconnaissance of readily available literature on the site. On March 30, 1989 representatives of DBS&A and GWR inspected the local geologic and hydrologic features at the station and developed a preliminary well drilling and logging program for characterizing the principal subsurface features.

The drill sites were located in areas where no PCB soil contamination was shown in previous work by Woodward Clyde Consultants (1988). Three test wells were drilled by the air rotary method augmented with foam. One of these was completed in an aquifer at about 665 feet, and the other two were completed to about 435 to 444 feet as dry monitor wells in the vadose zone. The cuttings of each test well were identified by a geologist, and each test well was geophysically logged. Formation water samples were collected from the deep test wells by bailing (5-2A and 5-3A) and by pumping with a permanently installed submersible pump (5-1A). A total of nine shallow soil borings were completed, one shallow boring adjacent to each test well (5-1B, 5-2B, 5-3B), three along the south boundary of the station (5-4B, 5-5B, 5-6B), two just off of the south-east corner at the station (5-7B, 5-8B), and an additional boring next to the pig receiver (5-SB-1). The latter was used to collect undisturbed samples of the alluvial surficial material to characterize texture and moisture content. Six of those borings were completed as monitor wells screened across the perched zone.

Aquifer tests were conducted within selected alluvial monitor wells in order to determine the hydraulic characteristics of the alluvial water zone. Slug-type aquifer tests were conducted at 5-1B, 5-2B, and 5-3B.

In order to better define the character and extent of the shallow alluvial water zone and the underlying bedrock, several surface geophysical profiles were conducted across the southeast corner of the station property. Several seismic refraction profiles were run using portable equipment at different geophone spacings.

Water quality samples were collected from selected wells. All on-site monitor, production, and test wells were samples for various organic and inorganic constituents. Most of these wells were sampled several times each in order to investigate possible water quality variations over time, and to provide confirmation of previous sampling. In addition, water samples were collected from all off-site water supply wells within about a one mile radius of the station. These samples were analyzed for specific organic and inorganic parameters.

Information derived from the on-site investigation was integrated with local and regional hydrogeologic data. A thorough search of literature was conducted of files in the DBS&A library, the U.S. Geological Survey, the NM Bureau of Mines and Mineral Resources, the New Mexico State Engineers Office, and the New Mexico Institute of Mining and Technology library. The information included technical reports, journal articles, consulting reports, and water well inventory data bases.

1.4 Report Organization

This report is organized into two volumes. Volume 1 contains the main body of the report: the text, tables and figures. Volume 2 contains all of the appendices, including well completion details, and the results of all water chemistry sampling conducted during the project.

2. SITE DESCRIPTION

2.1 Location

The Thoreau compressor station comprises a 40 acre tract approximately 1.5 miles north-northwest of Thoreau, New Mexico in McKinley County. The station lies within Township 14 North, Range 13 West, Section 20. Public land administered by the US Bureau of Land Management and Navajo Tribal land surround the site. The station is approximately 30 miles west of Grants and 30 miles east of Gallup New Mexico, along U.S. Interstate Route 40 (Figure 1).

Thoreau, population about 950, is the principal community near the station. Residents engage mostly in travel services, ranching, and mining related activities.

2.2 Physiography and Drainage

The area of interest lies within the Colorado Plateau physiographic province. The Continental Divide is located approximately 2 miles west of the station. The land surface elevation of the station is approximately 7300 feet above mean sea level. The station is located on the north side of a broad east-west trending valley which is drained by Mitchell Draw. The Zuni Mountains lie to the south and obtain an elevation of about 9100 feet. Dominant cliffs, or cuestas, mark the northern margin of the valley.

There are no well-defined drainage channels at the station. The principal drainage, Mitchell Draw, is an ephemeral tributary of the Rio San Jose located south of the station (Figure 1). The Rio San Jose becomes perennial near Bluewater due to releases from Blue Water Lake for irrigation. The Rio San Jose feeds into the Rio Puerco and this stream, in turn, drains into the Rio Grande at Bernardo NM, about 100 miles east of Thoreau. Figure 2 shows an oblique air photo of the surficial features near the station taken during a fly-over on March 30, 1989.

2.3 Climate and Vegetation

The climate is semi-arid. Mean annual precipitation at Thoreau is about 10 to 12 inches, and gross annual lake evaporation is about 40 inches. Roughly half the precipitation falls in summer months as brief but intense thunderstorms. Snow fall is common during the winter. At the station however, the southerly exposure and high sublimation potential limit the accumulation of snow pack. In the Zuni Mountains south of Thoreau, precipitation and snow accumulations are greater; consequently, at the higher elevations the dip slopes of the Zuni Mountains support large stands of ponderosa and Douglas fir.

Figure 3 shows the general surficial features in the vicinity of the station. At the station, the land surface slopes gently to the south. The site vicinity is sparsely vegetated with native grasses, juniper and pinon pine. The near-surface soils consist mostly of unconsolidated, reddish-brown, fine sand.

3. GEOLOGY

The area of interest around the compressor station is situated in the southern part of the San Juan structural basin, a roughly circular depression of about 25,000 square miles lying mostly in northwestern New Mexico and extending into Colorado and Arizona. The area is situated within the Zuni Uplift element of the basin, a northwest-southeast trending forested upland where Precambrian rocks are exposed and Permian and younger strata dip to the north away from the uplift at from three to five degrees (Cooper and John, 1968). These sedimentary units comprise a "layercake" type of geologic setting where erosion-resistant sandstone and limestone units form cliffs and cap rocks, and siltstones and shale units form slopes and valleys.

3.1 Regional Stratigraphy

The rock-stratigraphic units of importance in the present study are the Yeso Formation, Glorieta Sandstone, San Andres Limestone all of Permian age and the Triassic Chinle Formations. Also found in the northern part of the area are the San Rafael Group and Morrison Formation of Jurassic age, the Dakota sandstone of Cretaceous age, and Quaternary alluvium. Figure 4 shows a stratigraphic column near Thoreau. Measured stratigraphic sections in the vicinity of the station are presented in Appendix A.

3.1.1 Yeso Formation

The Yeso formation of Permian age is the oldest sedimentary unit exposed near Thoreau. Smith (1954) indicates that the Yeso consists mostly of sandstone and siltstone, with interbedded limestone and mudstone. In places the sandstone beds are cemented with gypsum or calcite. The thickness of the Yeso formation is about 250 feet. The unit is exposed high on the flank of the Zuni mountains more than 12 miles south of the station.

3.1.2 Glorieta Formation

The Glorieta formation is a massive, well-sorted, cross bedded, quartz sandstone. The thickness of the Glorieta varies from about 120 to 220 feet (Smith, 1954). The unit is overlain conformably by the San Andres limestone. Outcrops occur over an extensive area on the north side of the Zuni Mountains about 9 miles south of the compressor station.

3.1.3 San Andres Formation

Near Thoreau, the San Andres formation of Permian age includes three members: a lower massive, limestone 20 to 35 feet thick; a middle sandstone 10 to 25 feet thick; and an upper massive, fossiliferous limestone 60 to 80 feet thick (Smith, 1954). Buried karst features occur in the upper limestone where sink holes are often filled with overlying Triassic sediments. The San Andres is exposed beneath the forested dipslope of the Zuni Mountains about 7 miles south of the station. Excellent outcrops also occur to the east in road cuts along Interstate 40 between Prewitt and Grants.

3.1.4 Chinle Formation

The Chinle formation is areally extensive and continuous in large areas of New Mexico, Arizona, Colorado, Utah and parts of southern Nevada. The regional stratigraphy has been studied in detail by Stewart et al. (1972). In that study, a geologic section was measured only about 11 miles southeast of the compressor station, near Prewitt, (Appendix A). The hydrogeologic map (Figure 5) shows the areal exposure of the Chinle formation near Thoreau. The Chinle Formation consists mostly of red to purple siltstone and mudstone with minor sandstone and limestone which together are more than 1000 feet thick in west-central New Mexico (Stewart et al., 1972). There are two principal units of interest which comprise the Chinle Formation near the Thoreau compressor station: the Petrified Forest Member and the Sonsela Sandstone Bed within the Petrified Forest Member.

The Petrified Forest Member is described by Stewart et al. (1972) as mostly a bright, varied-colored unit which is composed of three interfingering lithologic types: 1) structureless non-resistant claystone or clayey siltstone, 2) clayey sandstone, 3) cross-stratified, ledge-forming sandstone that is locally conglomeratic. The claystone and clayey siltstone is rich in montmorillonite so that it may swell when in contact with water. The clayey sandstone is generally fine to medium-grained sand within a matrix of montmorillonitic clay. The sandstone facies is known as the Sonsela Sandstone Bed.

The Sonsela Sandstone is areally extensive in the Colorado Plateau and covers about 24,000 square miles. The Sonsela is about 90 to 130 feet thick. Regionally, the Sonsela occurs about 800 feet below the top of the Petrified Forest Member and 300-400 feet above the base of the Petrified Forest Member. Near Thoreau the lower Chinle is about 400 feet thick (Stewart et al., 1972). The Sonsela is a coarse-grained, cross stratified sandstone with conglomerate layers. Bentonitic siltstone and claystone layers are often interbedded within the sandstone and conglomerate, so that the Sonsela Sandstone Bed may appear to consist of two to four distinct sandstone layers (Green, 1976).

In the vicinity of the station the Chinle formation lies beneath the broad, east-west trending valley, Mitchell Draw. The Sonsela Sandstone Bed outcrops on the lower forested dip slopes of the Zuni Mountains, and good exposures are formed in road cuts along I-40 (Figure 5).

3.1.5 Wingate Sandstone

The Wingate Sandstone is a light reddish-brown to orange, massive, cross-bedded, coarse-grained sandstone about 35 feet thick

(Cooper and John, 1968). The Wingate outcrops only in isolated areas along the base of the cliffs north of the site.

3.1.6 San Raphael Group

The San Rafael Group comprises rock units forming prominent reddish scarps. In ascending order the group includes the Entrada Sandstone, Todilto Limestone, Summerville Formation, and Bluff Sandstone. These units, and the overlying Morrison and Dakota Formations, are described in detail by Stone (1979), who measured a stratigraphic section along a traverse north of Prewitt. This information is given in Appendix A.

3.1.6.1 Entrada Sandstone. The Entrada Sandstone is comprised of three members forming the southern-most cliffs in the vicinity of the station: the lower sandstone member, middle siltstone member, and upper sandstone member. The lower sandstone member is a reddish-brown, well-sorted, cross-bedded, medium-grained sandstone having a thickness of about 41 feet. The middle siltstone member is a reddish-brown to orange-pink, massive unit with a thickness of about 60 feet. The upper sandstone member weathers to an orange-pink and mottled gray color. It is about 136 feet thick and is comprised of cross-bedded, well-sorted, quartz sand with calcareous cement.

3.1.6.2 Todilto Limestone. The cliffs of the Entrada Sandstone are capped by the Todilto Limestone. The lower five feet of this formation is non-calcareous and consists of thin-bedded, moderately-sorted, silt and fine sand. The overlying 12 feet is a light gray to greenish-gray, laminated limestone with some silt. Cooper and John (1968) report that gypsum occurs locally within or overlying the limestone.

3.1.6.3 Summerville Formation. The Summerville Formation generally forms a covered slope beneath the east-west trending valley between the cliffs of the underlying Todilto and Entrada and the cliffs of the overlying Bluff Formation. The unit is about 181 feet thick near Prewitt and only the upper 58 feet were exposed along the stratigraphic section traverse (Appendix A). Cooper and John (1968) describe the Summerville formation as a red-brown to light green and white, fine, interstratified sandstone, siltstone and shale. Stone (1979) describes the upper 58 feet of the formation as orange-pink fine-grained, well-sorted sandstone with a high density of vertical joints.

3.1.6.4 Bluff Sandstone. The Bluff Sandstone is characterized in this area mostly as light gray and red-brown banded cliffs (Cooper and John, 1968). The Bluff Sandstone is about 194 feet thick and consists principally of cross-bedded, medium-grained, well-sorted sandstone. The basal 33 feet includes sandstone and mudstone which is similar to the Upper Summerville except for the knobby weathering characteristic of the latter.

3.1.7 Morrison Formation

The Morrison Formation forms a steep slope overlying the San Rafael Group. In most areas the Morrison consists of three members, which in ascending order are Recapture, Westwater Canyon, and Brushy Basin Members.

The Morrison is interpreted as having been deposited in a fluvial environment, and as a result there is considerable intertonguing of facies within the formation. Cooper and John (1968) indicate that the Recapture Member is a red-brown, light green and white interstratified siltstone, shale and fine sandstone, and locally contains conglomeratic coarse-grained sand and some limestone. In southeastern McKinley County, the member is reported to range in thickness from 75 to 200 feet. However, the Recapture Member was not identified in the stratigraphic section measured near Prewitt. In the measured stratigraphic section, the Westwater Canyon Member is 427 feet thick. Cooper and John (1968) indicate the unit ranges in thickness from 30 to 270 feet. The Westwater Camper member is comprised mostly of fine to coarse sandstone. The Brushy Basin Member is comprised of greenish-gray mudstones and shales, and gray-orange, fine-grained, cross-bedded sandstones. The unit is about 142 feet thick.

3.1.8 Dakota Sandstone

The Dakota Sandstone forms a conspicuous cap rock above the slopes of the Morrison Formation. It is about 78 feet thick and consists of light red and orange-pink, very fine to medium-grained, cross-bedded sandstone with some carbonaceous shale (Stone, 1979).

3.1.9 Quaternary Alluvium

Clay, silt and sand fill the major valleys in southeastern McKinley County and attain a maximum thickness of about 150 feet. In the valley north of Prewitt along Casamero Draw the depth of alluvium is at least 100 feet (Stephens, 1983). Near Thoreau, well logs indicate that the alluvium may be up to 130 feet thick (Smith, 1954). At the site, the alluvium is about 50 to 70 feet thick, and commonly contains much clay and weathering products of the Chinle Formation near the base.

3.2 Regional Structure

The stratigraphic units described previously have relatively uniform thickness at a regional scale. The structural dip is to the north-northwest at about 3 to 4 degrees, so that the slope of the units is roughly 300 to 400 feet per mile. As a result, progressively younger strata are encountered in outcrops to the north. Figure 6 shows a geologic cross-section near Thoreau.

The formations in the vicinity of the station are not influenced by structural deformation, except for the northeast-dip monocline. The area is generally not intensely fractured or faulted. The nearest fault is the Bluewater fault zone about 6 miles east of the station (Figure 5). The zone trends north-south and has a high angle normal displacement, with the down-thrown side to the east. The throw averages less than 100 feet, but may be as much as 200 to 400 feet in places (Smith, 1954). The fault zone extends over a distance of about 15 miles and cuts across strata from Permian to Cretaceous age. However, the Bluewater fault zone does not appear to have any influence on the local geologic features at the Thoreau compressor station.

4. GROUND-WATER RESOURCES

4.1 Well Inventory

Hydrogeologic data were compiled from available information on wells in the vicinity of the site. The inventory is based mostly on data in the files of the New Mexico State Engineer, US Geological Survey, and tabulations in private consulting reports. In addition, DBS&A Personnel field-checked several wells in the Thoreau area. Well construction information, water depths, water quality indices and water use data are summarized in Table 1 for about 100 wells within about 10 miles of the compressor station (Figure 7). The New Mexico Well numbering system is shown in Figure 8. Data in the well inventory are discussed in subsequent sections of this report.

4.2 Principal Hydrogeologic Units

The ground-water system beneath the Thoreau compressor station consists essentially of the alluvium, Chinle Formation, San Andres Formation and Glorieta Sandstone in order of decreasing stratigraphic position. The principal aquifers in the region are the Sonsela Sandstone Bed in the Chinle formation, the San Andres-Glorieta aquifer, and locally, the alluvial valley fill.

4.2.1 Alluvium

Alluvium is not generally recognized as a major source of ground water in the Thoreau area. However, ground water in alluvium does occur at the Thoreau Station (Section 5.1.2); near the Escalante Generating Station about 8 miles east of the site and north of Prewitt (Stephens, 1983); and elsewhere in the Thoreau-Prewitt area (Table 1).

4.2.2 Sonsela Sandstone

The Sonsela is a confined aquifer bounded above and below by thick layers of montmorillonitic claystone and clayey siltstone which comprise aquitards. The top of the Sonsela is approximately 650 feet below land surface at the station. At the compressor station the overlying aquitard is about 590 feet thick. The underlying aquitard, which separates the Sonsela from the deeper San Andres-Glorieta aquifer, is about 400 feet thick. The Sonsela is recharged mostly where it is exposed on the dip slope of the Zuni Mountains south of the station (Figure 5). Due to confining pressure, the water level in unpumped wells is roughly about 460 feet below land surface at the station.

Regionally, there only a few aquifer pumping tests in the Sonsela to characterize transmissive and storage properties. Near Ft. Wingate, west of Thoreau, two aquifer tests are reported to have shown transmissivities of 17 and 45 feet-squared per day (f^2/d). A short-term (15 minutes) aquifer test on a stock well about 5 miles east of Thoreau suggests transmissivity there is about 12 f^2/d. An aquifer test at the Navarre well (14.13.33; Figure 7) was conducted for 680 minutes at 9.8 gpm. The analysis showed that transmissivity was at least 9 f^2/day (Geohydrology Assoc., Inc., 1979).

There are three production wells at the compressor station which tap the Sonsela aquifer. Geologic logs and well completion details of these wells, referred to as Transwestern Pipeline Company (TPC) Well #1, Well #2 and Well #3 (87, 88, 89 on Figure 7), are provided in Appendix B. TPC well #2 is completed to 1350 feet and appears to be open to both the Sonsela and San Andres Glorieta. A 12-hour pumping test at 30 gpm on TPC well #3 by Layne-Texas was conducted shortly after the well was completed in 1960. The analysis is reported to have shown that the transmissivity is about 9 f^2/d. The Sonsela was also tested by pumping TPC Well #1 while measuring drawdown in both the pumped well and in TPC Well #3 about 720 feet away (Geohydrology Associates, Inc. 1979). The test was conducted for 24 hours at a constant discharge rate of 22 gallons per minute (gpm). Measurements of drawdown and recovery were obtained. The average transmissivity from this test is reported to be about 10 f^2/d and the storage coefficient is about 2×10^{-5}.

Shomaker (1981) also attempted to test all three of the Transwestern Pipeline production wells (Appendix C); but, only one was successful. While pumping TPC Well #3 at 25 gpm for about 24 hours, the transmissivity was in the range of 20 to 29 f^2/day and the storage coefficient was about 4×10^{-5}.

In the Thoreau area where the combined sandstone thickness is 60 to 70 feet, sustained well yields in the Sonsela are usually no more than 10 to 20 gallons per minute.

4.2.3 San Andres - Glorieta Aquifer

The San Andres formation (limestone and interbedded sandstone) are Glorieta sandstone comprise a simple hydrogeologic unit, based on water level and aquifer performance data. This north-dipping aquifer is regionally significant, inasmuch as it produces large quantities of water to wells. Ground water in the San Andres-Glorieta aquifer is under confined conditions, except in the outcrop areas south of Thoreau. The lower zone of the Chinle contains about 300 feet of bentonitic mudstone and siltstone which create a low permeable aquitard above the San Andres-Glorieta aquifer. In places, the confining pressure is sufficient to cause flowing wells. At the Thoreau compressor station, there are no flowing wells, but TPC Well #2, which penetrates the San Andres-Glorieta aquifer, has a static level at least 900 feet above the top of the aquifer (Shomaker, 1981). The static level in the San Andres-Glorieta aquifer at TPC Well #2 and near Thoreau is about

120 feet above that in the overlying Sonsela sandstone aquifer in the Chinle Formation (Shomaker, 1981).

The aquifer properties of the San Andres-Glorieta aquifer are highly variable. This is due mostly to variability in cementation in the sandstone facies, jointing, and karst limestone features. Regionally, the transmissivity of this aquifer ranges from less than 1 to as much as 200,000 f^2/d, and hydraulic conductivity ranges from about 0.005 to 1530 f/d (White and Kelly, 1989). Well yields east of Thoreau are reported to be as much as 2000 gallons per minute (Gordon, 1961).

Because this aquifer occurs about 1200 feet below land surface at the station and upward flow components, the occurrence of ground water in the San Andres-Glorieta aquifer does not appear to be susceptible to seepage through soils at the station.

4.3 Ground-Water Movement

Water level elevations in wells near the compressor station, shown in Table 1 were used to determine the general direction of ground-water flow in the shallow aquifer (Figure 5). Based on water level elevations in the six on-site shallow monitor wells (Section 5.1.2), the potentiometric surface of the alluvial aquifer slopes approximately south to southwest with a gradient of about 0.03 ft/ft.

Recharge to the Sonsela Sandstone Bed occurs by infiltration of runoff and snowmelt where the unit outcrops in the Zuni Mountains. From the recharge area ground-water flows down-dip to the north; however, there is an eastward component of flow controlled by topography in Mitchell Draw where the Sonsela may occur under unconfined conditions. Locally, ground-water movement in the Sonsela is much more complex, due to the influence of discharge by wells at the compressor station and near Thoreau. Water level declines due to pumping have been about several tens of feet in the past 20 years or so in the Thoreau area. For instance, in TPC Well #3 the static water depth was 317 feet below land surface in 1960; however, prior to an aquifer testing 1981 the pre-pumping water depth was 384 feet (Shomaker, 1981). Even greater drawdowns occur periodically in production wells when they are pumping. During the 24 hour pumping test of TPC Well #3 at 25 gpm, the water level declined 276 feet. Undoubtedly, a significant portion of this drawdown can be attributed to well losses; nevertheless, drawdown of the potentiometric surface of more than 100 feet can be expected locally. Consequently, the direction of ground-water flow in the confined portion of the Sonsela can be significantly influenced by pumping. These flow directions may also change over time, depending on the distribution of production wells and the direction and rate of pumping.

In the San Andres-Glorieta aquifer the direction of ground-water flow near Thoreau is northeast, away from recharge areas in the Zuni Mountains (White and Kelly, 1989). The horizontal hydraulic head gradient is about 0.001. The hydraulic head in the San Andres-Glorieta aquifer is generally more than 100 feet greater than that in the overlying Sonsela aquifer. This information suggests that there is a tendency for ground water to flow upward from the San Andres-Glorieta to the Sonsela. The low vertical hydraulic conductivity of the lower Chinle would cause the rates of upward flow to be quite small.

Communication between the San Andres-Glorieta and Sonsela aquifers also can occur through deep wells which are screened across both aquifers. Such is the case at the compressor station at TPC Well #2. Shomaker (1981) noted unusual water level fluctuations in the three on-site production wells which be attributed in part to upward flow in the wellbore from the San Andres-Glorieta aquifer. Unless these wells were pumped heavily for sustained periods, it is not likely that ground water near the station could flow downward from the Sonsela.

4.4 Water Quality

The chemical quality of ground water from selected wells is summarized in Table 2. Ground water within the shallow alluvium is of generally good to moderate quality, within total dissolved solids concentrations ranging from about 800 to 1000 mg/l. This water is typically of the sodium to calcium bicarbonate type.

The chemical quality of the Sonsela Sandstone Bed is also good. Near Thoreau the Sonsela typically has a total dissolved solids concentration of less than about 800 mg/l. In the on-site wells screened within the Sonsela ground water is mostly a sodium bicarbonate type, and total dissolved solids concentrations are typically less than about 600 mg/l.

Ground water elsewhere within the Chinle Formation is not of as high quality as the Sonsela Bed. The total dissolved solids concentration within on-site test wells 5-2A and 5-3A which are completed within the Chinle Formation above the Sonsela Bed is greater than 20,000 mg/l. Similarly the total dissolved solids concentration at well #33 (Table 1) is also quite high, about 13,400 mg/l; this well is completed within the Chinle Formation presumably above the Sonsela Bed and is approximately 6 miles east of the station. The water at these locations is of the sodium-chloride type.

In general the ground-water quality in the San Andres-Glorieta aquifer is relatively good. The total dissolved solids concentration near Thoreau is less than about 700 mg/l. The water tends to be a calcium-sulfate-bicarbonate type. The high hardness and sulfate (up to 295 mg/l) are attributed to dissolution of limestone and gypsum.

4.5 Water Use

The San Andres-Glorieta aquifer is a principal aquifer in the region. Ground water is used for small-scale irrigation, industrial and domestic water supply. The village of Thoreau, population about 950, is served mostly by water from the San Andres-Glorieta aquifer. Wells in this aquifer also supply water to the Escalante Power Plant near Prewitt. The inventory of wells (Table 1) shows those wells which produce from the San Andres-Glorieta aquifer.

The Sonsela sandstone bed is also a valuable aquifer. It is used mostly for individual domestic water supplies stock watering and industry. There are numerous private wells which tap the Sonsela in the Thoreau area. The Sonsela provides most of the domestic water for the village of Prewitt, population 400, located about 10 miles east of Thoreau.

Three wells are located at the Thoreau compressor station No. 5 which produce water from the Sonsela. TPC Well #2 penetrates both the Sonsela and San Andres-Glorieta aquifers. This water is used mostly for domestic and industrial purposes on-site; however, water is also made available to off-site users. The maximum combined water production from these wells is about 122 acre-feet per year.

The shallow alluvial perched-water zone is a very minor source of water in the area. Only about 20 water wells in the Thoreau area are known or suspected to be screened at least partially within the alluvium. These wells are typically used for domestic purposes. The nearest of these wells, well #104 on Table 1 is about 2 miles south-southeast of the station. Such a great distance from the Compressor Station makes it unlikely that the uses of alluvial ground water at this location may be affected by the presence of contamination within the shallow water under the station.

5. RECENT HYDROGEOLOGIC INVESTIGATIONS

The field characterization conducted by DBS&A included investigation of the hydrogeology at and near the station using a variety of surface and subsurface techniques. These included:

* Drilling, lithologic sampling, and geophysical logging several deep hydrogeologic test holes. Conversion of the test holes to test wells and collection of water quality samples;
* Drilling, lithologic sampling, and soil-fluid chemistry sampling of several shallow boreholes. Completion of the boreholes as monitor wells and subsequent aquifer testing and water quality sample collection;
* Conducting several surface seismic refraction profiles on-site;
* Water quality sample collection from all known water supply wells, including on-site production wells and private off-site, water supply wells maintained by the Navajo Tribe, the Thoreau High School, and the Village of Thoreau.

5.1 On-Site Hydrogeologic Conditions

The subsurface on-site investigation included test drilling, geologic logging of cuttings, geophysical logging, and aquifer testing. Two types of test drilling were conducted: deep test wells and shallow soil borings. Table 3 is a summary of well completion data. Water level data are included in Appendix D. Three deep test wells, designated 5-1A, 5-2A, and 5-3A were drilled to depths of 667, 435, and 444 feet, respectively, at locations shown in Figure 9. These deep test wells were drilled by Joe Salazar Drilling Company of Grants, NM using air-rotary with foam with Gardner Denver model 1500 and 2000 rigs. The shallow soil borings (5-1B through 5-8B and 5-SB-1) were drilled by Western Technologies, Inc. of Albuquerque, NM, using a hollow-stem auger rig (CME, Model 75).

In the on-site well numbering system, the first number refers to the compressor station number, the second number designates the general drilling site within the compressor station, and the letter designates the specific well at the drill site. For example, site 5-1 has two wells, A and B, designated as 5-1A and 5-1B, respectively. The "A" series wells are deep wells screened within the Chinle Formation. The "B" series wells are shallow, screened within the alluvium.

5.1.1 Test Wells

The initial purpose of the deep test wells was to delineate the first occurrence of ground water within the alluvium or within the Chinle Formation. Owing to the nature of the formation and drilling rig characteristics, the cuttings had to be removed by the use of foam. As a result, it was difficult to detect zones of subsurface moisture from drilling cuttings and fluid returns during drilling of the deep test holes.

During drilling of the first boring, 5-1A, ground water was not detected until the boring penetrated the Sonsela Sandstone Bed at about 650 feet below land surface. Before the surface casing was cemented in-place just below the alluvium-Chinle contact at 82 feet, the boring was left open overnight. No perched ground water was noted by measurements with an electric sounder. This boring was terminated at 665 feet and was completed with 40 feet of screen (Appendix E). The upper 15 feet of the screen are located above the top of the Sonsela. Appendix F shows the geologic logs of all the new borings on-site, and the geophysical logs at the deep test wells.

The geologic and geophysical logs (Appendix F) suggest that the stratigraphy at the station is fairly continuous between our new borings, and that the local scale geologic conditions are completely consistent with regional geologic data presented previously in Section 3.1.4. The new information is also similar to geologic data from existing production wells on-site (Appendix B). Ground water was not noted during drilling by air rotary methods in the 650 feet of claystone, mudstone and alluvium above the Sonsela. Therefore, borings 5-2A and 5-3A were completed to depths of only 435 and 444 feet, respectively (Appendix F). These two wells contained 20 feet of well screen. After the cased and screened holes were bailed clean of drilling fluids, these borings were nearly dry. However, the depth to water in test well 5-2A was 425.5 feet below top of casing on May 15 and eventually rose to 340 feet by October 2, 1989. The depth to water in test well 5-3A was 425.5 feet on May 16, 1989 and eventually rose to 296 feet by October 2, 1989.

5.1.2 Soil Borings

Three shallow soil borings were drilled within 15 feet of the deep test wells (Figure 9); these are designated as 5-1B, 5-2B and 5-3B, respectively. In addition, several other shallow soil borings were drilled near the south-east corner of the property (5-4B, 5-5B, 5-6B, 5-7B, 5-8B, 5-SB-1). Continuous undisturbed samples were attempted at each of the first three borings; samples were collected in plastic liners about 2.5 feet in length and by split spoon sampling. Split ring samples were collected at five foot intervals in the other borings. The logs of the borings (Appendix F) show that the recovery of sample was very good. The core samples were brought to our soil laboratory where they were analyzed for moisture content. Figure 10 shows the moisture content profile as determined from samples collected while drilling 5-3B. Water content increases markedly at a depth of about 45 to

50 feet where the water table occurs. Appendix F includes textural description of the material at each boring. Sampler refusal was encountered in boring 5-3B at about 78 feet within the Chinle Formation. The hole was cemented to within about 14 feet of the water table, and 2 inch PVC casing was set above the cement, opposite to what was believed to be the principal water-producing zone. However, EPA refused to accept this design, so the hole was cemented and abandoned. As a replacement, a completely new boring was drilled to 58 feet and sampled in the same area. Subsequent soil borings at other sites were drilled to the top of the Chinle, which is the apparent perching layer (Appendix F). Because of difficulties encountered during construction, wells 5-2B and 5-4B also were redrilled immediately adjacent to their original boreholes. (Well 5-4AB on Figure 9 is the abandoned initial well at 5-4B). All of these wells were constructed of 2-inch, flush-threaded PVC casing, which was screened across the shallow water table and fully penetrated the alluvial water zone.

Figures 11 and 12 show north-south and east-west cross-sections based on lithologic logs developed during construction of the shallow monitor wells (Appendix F). Figure 11 includes Woodward-Clyde Consultants wells RI-1 and RI-4. Water was encountered at about 44 to 48 feet below land surface (Table 3) at all DBS&A borings except 5-7B and 5-8B. At these two sites on the east side of the site, the auger rig was unable to drill past about 32 to 36 feet and no free water was encountered. Based on the lithology of samples collected from the bottom of the boreholes, it appears that both of these holes terminated at, or just above, the upper contact of the Chinle.

The source and extent of the shallow ground water in the alluvium is not known at present, but the areal extent appears to be limited to where the alluvium has filled deeper erosional surfaces cut into the surface of the Chinle. Structural cross-sections (Figures 11 and 12) suggest the contact between the alluvium and the Chinle Formation is topographically higher to the southeast. Whether wells 5-7B and 5-8B are located on an isolated prominence or on the edge of a paleo-alluvial valley is unclear at this time.

5.1.3 Geophysical Investigation

On December 12th, 1989, several seismic refraction profiles were conducted to assess the feasibility of using seismic methods to map the areal extent of the saturated alluvium and the topography of the Chinle subsurface. Representative data collected during the surface geophysical work is included in Appendix G.

Seismic profiles were run at both 15 foot and 30 foot geophone spacings, using an EG&G 12-channel seismograph with a 20 pound sledgehammer energy source. Reverse profiles were run at both spacings, with the east end of the profiles fixed at Well 5-6B, and extending west along the south chain-link fence near the existing wells, for maximum lithologic control.

Analysis of seismic records with a 30 foot spacing indicate a seismic velocity for the alluvium of about 1450 feet per second.

A deeper layer of higher velocity was not indicated. Based on field results with a 30 foot spacing a 15 foot geophone spacing was used in an attempt to obtain better response and resolution.

Analysis of the seismic records with a 15 foot geophone spacing confirms the seismic velocity of the alluvium at approximately 1450 feet per second, which is a reasonable value for dry sands and gravels.

Analysis of selected profiles with a 15 foot geophone spacing reveal a lower seismic boundary at about 40 to 50 feet below ground level, with a seismic velocity of approximately 6500 feet per second, which could be attributed to either the saturated sands and gravels of the alluvium or the Chinle Formation. Thus, it may be difficult to reliably discriminate between the saturated alluvium and the Chinle with sufficient resolution at a 15 foot geophone spacing.

Results of the feasibility study indicate the need to incorporate a larger energy source and possibly a smaller geophone spacing to enhance penetration and resolution in order to reliably determine the existence of saturated alluvium.

5.1.4 Aquifer Testing

Three of the shallow alluvial wells (5-1B, 5-2B, 5-3B) were selected for aquifer testing in order to determine the hydraulic properties of the alluvial water zone. These tests were slug-type tests conducted by instantaneously adding a predetermined volume water of known quality to the well and monitoring the water level decline as water flows from the well bore into the surrounding formation. Further information on this type of aquifer testing is available in Lohman (1979).

The results from the slug tests at wells 5-2B and 5-3B were used for the present analysis. The data collected during the slug testing at well 5-1B exhibited anomalous behavior, and were not amenable to further analysis. Data for all slug tests are included in Appendix H. The data from wells 5-2B and 5-3B matched the type curves reasonably well, and provide the following results:

Well 5-2B: early time match point = 68 seconds
transmissivity (early time) = 65 gpd/f

late time match point = 113 seconds
transmissivity (late time) = 39 gpd/f

storativity = 0.1

Well 5-3B: match point = 30 seconds
transmissivity = 150 gpd/ff
storativity = 0.0001

Based on this analysis, it appears that the transmissivity of the shallow alluvial water zone is between about 40 to 150 gpd/f. The hydraulic conductivity of the alluvium ranges from 1.2 to 1.9 feet per day, based upon a saturated thickness of 4.6 feet in 5-2B and 12.6 feet in 5-3B. The determination of storativity is highly sensitive to noise within the data set. Because of this, storativity is typically the most difficult parameter to accurately measure. The value of 0.1 given in the above analysis for 5-2B appears to be the most reasonable estimate for storativity, based on the soil texture and hydrogeologic conditions at the station.

The average rate of ground water movement in the alluvial water zone is approximately 208 feet per year, based upon a hydraulic conductivity of 1.9 f/d, hydraulic gradient of 0.03, and an effective porosity of 0.1.

5.2 Water Quality

Water quality samples were collected from selected on-site and off-site wells in order to determine the presence and possible extent of ground-water contamination, and to provide information on the general chemistry of the ground water near the station. The ground-water samples were analyzed for organic and inorganic constituents. Table 4 summarizes the water quality sampling conducted and lists the analyses performed. Appendix I contains details on the water sampling protocol and documentation on the procedures followed during sample collection and handling. Table 5 summarizes the results of the water quality analyses. Full reports from the analytical chemistry laboratory are included in Appendix J.

5.2.1 On-Site Wells

All on-site wells were sampled during the course of the investigation. On-site production wells, test wells, and monitor wells were included in the sampling program. Most of the on-site wells were sampled more than once in order to provide an assessment of possible water quality changes through time, and to confirm the results of previous analyses (Table 5). Figure 13 shows a Durov plot of the major water quality parameters in the on site wells.

The Durov plot indicates that the shallow alluvial water is sodium-calcium-bicarbonate type, of generally good to moderate quality; the water in the upper portion of the Chinle Formation is sodium-chloride type, at very poor quality; the water in the Sonsela Bed is sodium-bicarbonate type, at good quality.

The on-site production wells (TPC-1, TPC-2, TPC-3) were sampled at the well-head using the dedicated submersible production pumps. Three casing volumes were purged from each well and indicator parameters were measured (Appendix I) prior to sample collection. The results (Table 5) indicate that the water from the on-site production wells does not contain any detectable concentrations of volatile organic or organo-chlorine compounds, including PCB. The specific conductivity of the water, as measured in the field during well purging, was ranged between 560 to 790 μmhos/cm, which indicates that the water is of good to moderate quality.

The on-site deep test wells were sampled during the program. Test well 5-1A was purged and sampled using the dedicated submersible pump that had been installed shortly after well completion. Three casing volumes were purged and the indicator parameters were measured prior to sample collection. The results for test well 5-1A in the Sonsela Sandstone Bed (Table 5) indicate that the water is of very good quality, with the concentration of total dissolved solids of about 400 mg/l. No volatile or semi-volatile organic compounds were detected, nor were any organo-chlorine compounds, including PCB. The laboratory reported the presence of bis(2- ethylhexyl) phthalate at 12 µg/l, however this is a common plasticizer and common laboratory contaminant. The presence of bis(2-ethylhexyl) phthalate in 5-1A is likely due to laboratory contamination. Bis(2-ethylhexyl) phthalate was also reported in 5-2A and 5-3A and is also attributed to laboratory contamination. Test wells 5-2A and 5-3A were sampled using a rig bailer for purging and a hand-operated bailer for sample collection. Because the recovery rate for these wells is extremely low (the wells take far greater than the recommended 2 hours to recover), these wells were bailed to dryness only once prior to sample collection. The results indicate that the water quality of these wells is extremely poor due to high salinity. The concentration of total dissolved solids concentration in 5-2A and 5-3A is greater than 20,000 mg/l. In addition, the water in test well 5-2A contains benzene, toluene, and ethylbenzene in detectable quantities. The benzene concentration in 5-2A exceeds the state and federal standard of 10 µg/l. None of these, or any other organic compounds were detected in test well 5-3A (except bis(2-ethylhexyl) phthalate).

The source of the organic compounds at 5-2A is unclear at this time. The uniquely poor quality of the water within wells 5-2A and 5-3A (Table 5; Figure 13), which are the only wells in the area that are screened exclusively within the upper Chinle, suggests that the source of most of the water at 5-2A is at depth within the upper Chinle Formation. However, it remains possible that downward leakage along fractures and fissures within the upper Chinle from the shallow, alluvial water zone above 80 feet has contributed to the presence of organic compounds at 5-2A. The fact that the water quality at 5-2A (TDS = 20,700 mg/l) is slightly better than at 5-3A (TDS = 26,300 mg/l) lends support to the possibility that the water at 5-2A is the result of dilution with less saline water from above. The base of the borehole is approximately 175 feet above the top of the Sonsela Sandstone aquifer.

All on-site shallow monitor wells were sampled during the program, except those wells which are dry (5-7B, 5-8B). Monitor wells 5-1B, 5-2B, 5-3B, 5-4B, 5-5B, 5-6B were purged and sampled using dedicated bladder-type sampling pumps (Well Wizard, QED Corp., Ann Arbor, MI) which were installed in each well shortly after well completion. At least 3 casing volumes were purged from each well and indicator parameters were monitored prior to sample collection at each well, except 5-1B and 5-4B which are poor producers and recover only very slowly. Monitor wells 5-1B and 5-4B were pumped to dryness once before sample collection. Documentation of water quality procedures is included in Appendix I. The results (Table 5) indicate the presence of PBC at wells 5-1B and 5-6B. PCB concentration ranged from 2.0 and 100 mg/l at 5-1B to 180 μg/l at 5-6B. Volatile hydrocarbons occur at 5-1B (toluene 6.3 μg/l), 5-2B (benzene 1800 to 2700 μg/l, toluene 2000 to 5000 μg/l, and ethylbenzene 250 μg/l), 5-4B (benzene <5 μg/l to

21 μg/l, [methylene chloride is a common laboratory contaminant, so the presence of 9.5 μg/l for the sample collected January 26, 1990 is presumed to be due to laboratory contamination]), 5-5B (ethylbenzene <5 μg/l to 8.7 μg/l), and 5-6B (benzene <5 μg/l to 15 μg/l, toluene <5 μg/l to 35 μg/l, and ethylbenzene <5 μg/l to 25 μg/l). These compounds exceed applicable state and federal standards at well 5-1B (PCB state and federal standard of 1.0 μg/l), 5-2B (benzene and toluene state and federal standards of 10 μg/l and 750 μg/l, respectively), 5-4B (benzene on December 1, 1989), and 5-6B (PCB, benzene on October 3, 1989).

The source of organics and PCB appears to be on site. The most likely source is from within the area around the waste oil impoundment and possibly the sump at the base of the pig receiver.

5.2.2 Off-Site Wells

All nearby private and public water supply wells within about one mile of the station were sampled. The off-site wells that were sampled include: Navajo Tribal Utility Wells #1 and #2 (NTUA #1 [16T-529] and NTUA #2 [16T-614], listed in Table 1 as wells 83 and 85, respectively); Thoreau water supply well # 2 (Thoreau #2, listed in Table 1 as well 122); Thoreau High School well #1 (THHS #1, listed on Table 1 as well 100); and the Windmill well (WND, also known as 16B-39, listed in Table 1 as well 97). These wells were sampled by allowing the faucets or discharge outlets to run for at least 10 minutes prior to sample collection. Water storage and purged water discharge limitations prevented verifiable purging of three casing volumes immediately prior to sample collection. Only Navajo Tribal Utility Well # 2 can be verified as having three casing volumes purged prior to sample collection; the remainder of the off-site wells sampled are operated nearly continuously as water supply wells, and it is highly likely that they are continuously purged of stagnant water and the samples were representative of the ground water. The results of chemical analysis of the samples (Table 5) indicate that there are no detectable levels of volatile organics or PCB's within any of the water.

6. POTENTIAL FOR OFF-SITE GROUND-WATER CONTAMINATION

The results of water quality samples collected from shallow alluvial monitor wells 5-1B through 5-6B indicate that the alluvial water beneath the site contains concentrations of various organic compounds in excess of state and federal standards. The exact source of these compounds is unknown at present. However, information presented by Woodward-Clyde Consultants (1988) indicates that the PCB has been found in the soil to depths of about 40 feet in the southeast corner of the station (Figure 14). This is in the same area that the alluvial water exists at approximately 44 feet below land surface. Transport of PCB through soil most likely occurred when there was free liquid present within the condensate impoundment. This source has not existed for about he past 10 years or more (G. Wassell, ENRON Corp., personal communication). The presence of benzene, toluene, and ethylbenzene is probably natural gas condensate, but it is possible there is a different source, such as gasoline. However, there are no known uses of refined petroleum products or underground storage tanks in the area.

PCB is highly absorbed in soils and is relatively immobile in ground water. In a study performed by Farquhar et al. (1979), a soil sample contaminated with PCB (Aroclar 1242) was found to have a sorption capacity of about 0.07 g/g soil. Moreover, the stability of the sorption capacity was investigated; the soil was found to retain 99.97% when desorbed with water. Griffin et al. (1977) found that a wide variety of geologic materials adsorbed greater than 90% of PCB isomeric mixtures from solution at concentrations near their solubility limit in water. In a related study, Tucker et al. (1975) found that less than 0.05% of the total PCB (Aroclar 1016) available was leached from the soil by percolating with water. The more chlorinated the compound, the less readily it is leached from soil. Farquhar et al. (1979) found that 0.11 to 0.55% desorption occurred in a highly contaminated soil. These studied indicate that PCB will move only very slowly in soil and ground water. Benzene, toluene, and ethylbenzene are not as readily sorbed, and are considered quite mobile in the soil and ground water. Volatilization and in-situ, natural biodegradation are the major mechanisms for attenuation of these compounds within the soil and ground water.

Nevertheless, it appears that PCB and petroleum hydrocarbon contamination occurs within the shallow alluvial aquifer beneath the southeast corner of the station as a result of an on site source. Because of the moderately high concentrations of these compounds in several of the wells and the close proximity to the southern boundary of the site, it is likely that off-site migration has occurred, or will occur in the near future. However, it is also likely that dispersive mixing and the natural attenuation mechanisms mentioned above will limit the potential for extensive off-site migration, and should serve to prevent contaminant migration to existing downgradient wells. The closest downgradient well currently in use is the Thoreau High School Well #2, located 1/2 mile south of the site. This well is producing from the San Andres-Glorieta system, but it is not known at this time whether this well is also open to the alluvium.

Based on the information available at this time, the potential pathways of the shallow alluvial water to the deeper aquifers could include very slow leakage across nearly 600 feet of the low permeable upper Chinle Formation, or channeling along improperly cemented wells and within natural or drilling-induced fractures. If chemicals were to reach the Sonsela immediately beneath the station, it is expected that they would be contained on site by hydrodynamic capture from the three Transwestern Pipeline Co. on-site production wells. In addition, because the potentiometric surface in the San Andres-Glorieta system is greater than that in the Sonsela, ground water in the Sonsela could not move downward into the deeper aquifer.

7. CONCLUSIONS

Based on information contained within this report, the following general conclusions are offered:

1. Ground water occurs in alluvium about 45 feet beneath the station. PCB and certain petroleum hydrocarbon compounds occur within the alluvial water beneath the station.

2. The direction of ground water flow in the alluvium is to the south and southwest at a rate of about 208 feet per year. The closest downgradient water well currently in use is 1/2 mile south of the site.

3. The Sonsela Sandstone Bed of the Chinle Formation and the San Andres-Glorieta are the principal aquifers used for water supply in the area. The Sonsela and San Andres-Glorieta Aquifers lie about 650 and 1200 feet beneath the station, respectively.

4. There is currently no evidence of downward migration of PCB or petroleum hydrocarbons into the Sonsela or the San Andres-Glorieta Aquifers, or lateral off-site migration within any of the ground-water zones.

5. There is a very low potential for contamination of the Sonsela and San Andres-Glorieta Aquifers due to on-site sources.

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TABLE 1. INVENTORY OF WELLS NEAR THOREAU, N.M.

AQUIFER
Qal: Alluvium
Jm : Morrison Fm
Jsr: San Rafael Gp
Jmw: Westwater Cyn Mbr of the Morrison Fm
Je: Entrada SS
Tr W: Wingate SS
Tr C: Chinle Fm
Pg : Glorieta SS
Psa : San Andres LS
Py : Yeso Fm
Kd : Dakota SS
Km : Mancos Shale

USE
A: ABANDONED
C: CONSTRUCTION
D: DOMESTIC
I: IRRIGATION
M: MUNICIPAL
SN: SANITARY
N: INDUSTRIAL
O: OBSERVATION
S: STOCK
U: UNUSED
X: EXPLORATORY

SOURCE:
Cooper and John (1968)
State Engineer's Office, Well Records
Inquiry to Navajo Tribe
USGS database
USGS topographic maps

SITE NUMBER	LOCATION	OWNER	DEPTH TO WATER ft	DATE MEASURED	DEPTH OF HOLE ft	SURFACE ELEVATION ft above MSL	SURFACE ELEVATION ft above MSL	CONTRIBUTING AQUIFER	USE	SOURCE
1	13 N. 12 W. 3 .1420	ELKINS RANCH	49	08/04/61		6855	6806	Tr C	U	C/J
2	13 N. 12 W. 4 .3430	BIA	19	06/03/59	24	6940	6921	Tr C	D,S	C/J
3	13 N. 12 W. 8 .1210	C. WILLIAMS	54		124	7005	6951	Tr C	D	C/J
4	13 N. 12 W. 8 .1213	STONECIPHER/WILLIAMS	124	09/24/82	144	7000	6876	Psa, Pg		NAVAJO
5	13 N. 12 W.10 .2420	BIA	74	12/03/48	215	6930	6856	Tr C	S	C/J
6	13 N. 12 W.12 .1420	ELKINS RANCH	41	08/04/61	165	6820	6779	Tr C	S	C/J
7	13 N. 12 W.12 .4240	B. B. SOUTH	62	06/04/59	182	6825	6763	Tr C	D	C/J
8	13 N. 12 W.12 .4410	BIA	80	06/25/48	475	6840	6760	Tr C	D	C/J
9	13 N. 13 W. 1 .	PRUITT	610	12/06/48	835	6980	6370	Psa, Pg		NAVAJO
10	13 N. 13 W. 1 .2210	AT&SF RAILROAD	FLOWING	07/10/61	707	6995		Psa, Pg	U	C/J
			FLOWING	06/25/48	707	6995				NAVAJO
11	13 N. 13 W. 1 .2223	AT&SF RAILROAD	15	06/08/87	725	7005	6990	Psa, Pg	U	USGS
			FLOWING	06/25/48		7005				NAVAJO
12	13 N. 13 W. 1 .2223A	AT&SF RAILROAD	18	06/14/84	930	7005	6987	Pg, Tr C	U	USGS
			FLOWING	06/25/48	930	7005				NAVAJO
13	13 N. 13 W. 2 .4200	ARTHUR CARVER	90	11/18/82	170	7080	6990	Tr C	S	ST ENGR
14	13 N. 13 W. 3 .1000	RICO MOTOR CO.	113	09/15/88	350	7110	6997	Tr C	D	ST ENGR
15	13 N. 13 W. 3 .3330	TOBE TURPEN	217	04/09/87	497	7170	6953		D	ST ENGR
16	13 N. 13 W. 4 .1110	EL PASO NATURAL GAS CO.	66	09/12/76	810	7195	7129	Psa, Pg	N, D	ST ENGR
17	13 N. 13 W. 4 .1113	EL PASO NATURAL GAS CO. #3	19	04/21/82	870	7180	7161	Psa, Pg		NAVAJO
18	13 N. 13 W. 4 .1220	BYRON & MARSHA TURPEN	140	10/19/83	310	7180	7040	Tr C	D	ST ENGR
19	13 N. 13 W. 4 .1431	DEMPSE ANDERSON	79	06/12/84	600	7210	7131	Psa,Pg	D, S	USGS
20	13 N. 13 W. 4 .1440	DAVE HUFFMAN	120	06/03/59	210	7190	7070	Tr C		C/J
21	13 N. 13 W. 4 .2112					7120		Psa,Pg		NAVAJO
22	13 N. 13 W. 4 .2420	KEATING & CAREY LAND	116	05/26/79	617	7000	6884	Psa, Pg	D, S	ST ENGR
23	13 N. 13 W. 4 .4220	PAUL LAPAIRE	220	01/12/88	615	7150	6930	Psa, Pg	D	ST ENGR
24	13 N. 13 W. 4 .4440	JOE KEATING	165	05/18/78	500				D	ST ENGR
25	13 N. 13 W. 5 .1000	JOSEPH RADOSEVICH	70	05/03/84	220	7000	6930	Psa, Pg	D	ST ENGR
26	13 N. 13 W. 5 .1140	DONALD KIMBLER	FLOWING	06/03/59	625	7215		Psa, Pg		C/J
27	13 N. 13 W. 5 .1200					7000				USGS
28	13 N. 13 W. 5 .2110	WILSON BROCK	FLOWING	07/20/61	717	7180		Psa, Pg		NAVAJO
29	13 N. 13 W. 5 .2140	TOBE TERPIN	50	07/10/84	717	7195	7145	Psa, Pg	D, S	USGS
30	13 N. 13 W. 5 .2210	WILSON BROOK	FLOWING	07/20/61	695	7160		Psa, Pg		C/J
31	13 N. 13 W. 6 .2244	FLOYD ATCHISON	23	07/10/84	648	7230	7207	Psa, Pg	D, S	USGS
32	13 N. 13 W. 6 .2322	FLOYD ATCHINSON	FLOWING	06/16/82	648	7260				NAVAJO
33	13 N. 13 W. 6 .3330	ATCHISON			648	7450				ST ENGR
34	13 N. 13 W. 8 .4440	CLAY HARDIN	FLOWING	07/19/61	504	7325		Psa, Pg		C/J
35	13 N. 13 W. 9 .4110	CLAY HARDIN	47	06/04/59	71	7255	7208	Tr C		C/J
36	13 N. 13 W.20 .2230	CLAY HARDIN	16	12/11/62	350	7495	7479	Psa, Pg	S	C/J, NAVAJO
37	13 N. 13 W.21 .3310	CLAY HARDIN	20	06/04/59	30	7425	7405	Qal	U	C/J
38	13 N. 13 W.22 .1333	CHARLIE BASS	-8	09/26/86	300	7415	7421	Pg	S	USGS
		CLAY HARDIN	16	06/01/59	54	7415	7399	Qal	S	C/J
39	13 N. 13 W.26 .1430	FORD & WILLIAMS RANCH	10	06/02/59	17	7410	7400	Qal	D,S	C/J
40	13 N. 13 W.26 .1433	VIRGIL FORD	22	09/24/82	25	7420	7398	Psa, Pg		NAVAJO
41	13 N. 13 W.26 .3333	VIRGIL FORD	FLOWING	09/24/82	350	7445		Psa, Pg		NAVAJO
42	13 N. 13 W.27 .1300	A & G CARVER	FLOWING	/ 67	198	7460		Psa, Pg		NAVAJO
43	13 N. 13 W.27 .2300	A & G CARVER	FLOWING	/ /72	125	7430		Psa, Pg		NAVAJO
44	13 N. 13 W.27 .4000					7430				USGS
45	13 N. 13 W.27 .4312	LEE CARVER	FLOWING	06/12/84	150	7430		Psa, Pg	S	USGS
46	13 N. 13 W.27 .4340	V.O. STALLING	4	06/02/59	12	7440	7436	Qal	D	C/J
47	13 N. 13 W.27 .4400	A & G CARVER	FLOWING	/ /63	150	7435		Psa, Pg		NAVAJO
48	13 N. 13 W.27 .4433	LEE CARVER	FLOWING	06/12/84	150	7445		Psa, Pg	D, S	USGS
49	13 N. 13 W.28 .1312	LEE CARVER	FLOWING	06/12/84	130	7470		Psa, Pg	S	USGS
		LEE CARVER	FLOWING	/ /62	130	7470				NAVAJO

TABLE 1. INVENTORY OF WELLS NEAR THOREAU, N.M.

AQUIFER Qal: Alluvium; Jm: Morrison Fm; Jsr: San Rafael Gp; Jmw: Westwater Cyn Mbr of the Morrison Fm; Je: Entrada SS; Tr W: Wingate SS; Tr C: Chinle Fm; Pg: Glorieta SS; Psa: San Andres LS; Py: Yeso Fm; Kd: Dakota SS; Km: Mancos Shale

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SOURCE: Cooper and John (1968); State Engineer's Office, Well Records; Inquiry to Navajo Tribe; USGS database; USGS topographic maps

SITE NUMBER	LOCATION	OWNER	DEPTH TO WATER ft	DATE MEASURED	DEPTH OF HOLE ft	SURFACE ELEVATION ft above MSL	SURFACE ELEVATION ft above MSL	CONTRIBUTING AQUIFER	USE	SOURCE
		V.O. STALLING	FLOWING	09/04/62	130	7470		Psa	S	C/J
50	13 N. 13 W.30 .1220	D. KIMBLER	11	06/01/59	12	7500	7489	Psa, Pg		NAVAJO
51	13 N. 13 W.30 .1223	D.L. KIMBLER	21	06/12/84		7500	7479	Psa, Pg	U	USGS
			11	06/01/59	12	7510	7499	Qal, Psa	D,S	NAVAJO, C/J
52	13 N. 13 W.30 .2140	CHARLES BASS	11	06/01/59	70	7510	7499	Psa	I,S	C/J
53	13 N. 13 W.33 .4310	CHARLES BASS	217	06/03/59	310	7700	7484	Pg	S	C/J
54	13 N. 13 W.34 .1220	LEE CARVER	33	06/12/84	141	7470	7437	Psa, Pg	S	USGS
			34	/ /72	141	7470	7436	Psa, Pg		NAVAJO
55	13 N. 14 W. 5 .1311	CONT. DIV. TRAINING CTR	375	07/10/79	1500	7660	7285	Psa, Pg		NAVAJO
56	13 N. 14 W. 5 .3110	CONTINENTAL DIVIDE						Psa, Pg		NAVAJO, USGS
57	13 N. 14 W.16 .1440	ROBERT ALLEN	73	07/10/84	431	7660	7587	Pg	D, S	USGS
			80	09/23/79	431	7660	7580			NAVAJO, ST ENGR
58	13 N. 14 W.16 .3220	ROBERT ALLEN	109	07/10/84	450	7670	7561	Pg	U	USGS
59	13 N. 14 W.25 .2140	USDA FOREST SERVICE	93	10/18/79	160	7580	7487	Psa, Pg		NAVAJO
60	14 N. 12 W. 5 .3000	NAVAJO TRIBE 16P 371						Psa, Pg		NAVAJO
61	14 N. 12 W. 8 .3310	BIA				7240		Qal	D,S	C/J
		NAVAJO				7250		Qal		UNAPPRVD
62	14 N. 12 W. 9 .2210	ELKINS RANCH	500	09/05/62	762	7380	6880	Tr W	S	C/J, UNAPPRVD
63	14 N. 12 W.14 .1420	ELKINS RANCH	245	09/05/62	430	7090	6845	Tr W	S	C/J
64	14 N. 12 W.14 .1430	ELKINS RANCH	245	09/05/62	430	7090	6845	Tr W		UNAPPRVD
65	14 N. 12 W.19 .4310	CROSSLANDS FOUNDATION, INC			784	7120		Tr C		C/J, UNAPPRVD
66	14 N. 12 W.20 .1110	BUREAU OF INDIAN AFFAIRS (BIA)	95	07/17/61	430	7150	7055	Tr C	U	C/J, UNAPPRVD
67	14 N. 12 W.20 .1110A	BIA	4	07/21/61	12	7150	7146	Qal		C/J, UNAPPRVD
68	14 N. 12 W.20 .1120	CHRISTIAN REFORMED MISSION	33	07/21/61	38	7150	7117	Qal		C/J, UNAPPRVD
69	14 N. 12 W.20 .1210	CHRISTIAN REFORMED MISSION	400	09/08/55	731	7150	6750	Tr C	U	C/J
					700					UNAPPRVD
70	14 N. 12 W.23 .3110	PLAINS ELECTRIC CO			1790	7020		Pg	N	USGS
71	14 N. 12 W.23 .3222	PLAINS ELECTRIC CO			1724	6930		Pg	N	USGS
72	14 N. 12 W.23 .3240	PLAINS ELECTRIC CO			1555	6980		Pg	N	USGS
73	14 N. 12 W.23 .3330	PLAINS ELECTRIC CO	450	06/06/80	1450	6940	6490	Pg	C, N	ST ENGR
74	14 N. 12 W.23 .4440	PLAINS ELECTRIC CO	300	07/30/80	1500			Pg	C	ST ENGR
75	14 N. 12 W.26 .2430	PLAINS ELECTRIC								ST ENGR
76	14 N. 12 W.32 .1111	AT&SF RAILROAD	FLOWING	/ /63	707	6980		Tr C, Pg		DAN, UNAPPRVD
77	14 N. 12 W.32 .1111A	AT&SF RAILROAD	FLOWING	05/12/61	725	6980		Tr C, Pg		DAN, UNAPPRVD
78	14 N. 12 W.32 .1111B	AT&SF RAILROAD	FLOWING	11/17/61	930	6980		Tr C, Pg		DAN, UNAPPRVD
79	14 N. 12 W.32 .1400	AT&SF RAILROAD	FLOWING	/ /10	715	6020		Pg		DAN, UNAPPRVD
80	14 N. 12 W.32 .4344	ELKINS RANCH	53	06/24/48	200	6905	6852	Tr C		C/J, UNAPPRVD
81	14 N. 13 W. .	MARVIN SMALL	105		130					ST ENGR
82	14 N. 13 W. 5 .3000	NAVAJO TRIBE (16P-371)	300	02/20/64	1350	8640	8340	Jsr		DAN, UNAPPRVD
83	14 N. 13 W.19 .1000	NAVAJO TRIBE (16T-529)	228	03/20/64	1708	7380	7152	Pg		DAN, UNAPPRVD
84	14 N. 13 W.19 .1140					7370				USGS QUAD
85	14 N. 13 W.19 .1212	NAVAJO TRIBE (16T-614)				7400		Psa, Pg		NAVAJO
86	14 N. 13 W.20 .4100					7340				USGS
87	14 N. 13 W.20 .4310	TRANSWESTERN PIPELINE CO. #	317		735	7323	7006	Tr C	N, D, I	C/J
				04/21/82	665					NAVAJO

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AQUIFER Qal: Alluvium; Jm : Morrison Fm; Jsr: San Rafael Gp; Jmw: Westwater Cyn Mbr of the Morrison Fm; Je: Entrada SS; Tr W: Wingate SS; Tr C: Chinle Fm; Pg : Glorieta SS; Psa : San Andres LS; Py : Yeso Fm; Kd : Dakota SS; Km : Mancos Shale

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SOURCE: Cooper and John (1968); State Engineer's Office, Well Records; Inquiry to Navajo Tribe; USGS database; USGS topographic maps

SITE NUMBER	LOCATION	OWNER	DEPTH TO WATER ft	DATE MEASURED	DEPTH OF HOLE ft	SURFACE ELEVATION ft above MSL	SURFACE ELEVATION ft above MSL	CONTRIBUTING AQUIFER	USE	SOURCE
88	14 N. 13 W.20 .4321	TRANSWESTERN PIPELINE CO. #	309	01/11/60	746	7312	7003	Tr C	N, D, I	C/J, UNAPPRVD
89	14 N. 13 W.20 .4322	TRANSWESTERN PIPELINE CO. #	338	02/16/60	1350	7307	6969	Psa, Pg	N, D, I	C/J, UNAPPRVD
90	14 N. 13 W.20 .4323					7300				USGS
91	14 N. 13 W.23 .1410					7230				USGS QUAD
92	14 N. 13 W.23 .2230	NAVAJO TRIBE 16T 575	320	05/18/73	1100			Psa, Pg		NAVAJO
93	14 N. 13 W.23 .3220					7200				USGS QUAD
94	14 N. 13 W.25 .1334	BIA	160	07/11/61	677	7140	6980	Tr C		C/J
95	14 N. 13 W.27 .3420	BIA 16T-352	153	07/20/61	435	7140	6987	Tr C		C/J
		NAVAJO 16T 541	46	11/11/55	1220					NAVAJO
96	14 N. 13 W.27 .3422	BIA				7150		Psa, Pg		NAVAJO
97	14 N. 13 W.28 .1230	BIA	386	06/04/59	730	7130	6744	Tr C		C/J
98	14 N. 13 W.28 .3430	PHILLIPS URANIUM CO	200	10/30/78	440	7170	6970	Tr C	X	ST ENGR
99	14 N. 13 W.29 .2100	THOREAU H.S.			1242	7260		Psa, Pg		NAVAJO
100	14 N. 13 W.29 .2341	THOREAU H.S.	173	04/15/82		7245	7072	Psa, Pg		NAVAJO
101	14 N. 13 W.30 .2222	THOREAU WATER & SANITATION DIST	220	09/30/86	1370	7279	7059	Psa, Pg	M	ST ENGR
102	14 N. 13 W.31 .2200	JEROME ENGLISH			248	7180		Tr C	D	ST ENGR
103	14 N. 13 W.31 .4200	MAYBERRY	180	07/11/85	370	7185	7005	Tr C	D	ST ENGR
104	14 N. 13 W.32 .2420	MARIA RAMIREZ	65	07/19/61	150	7130	7065	Tr C		C/J
105	14 N. 13 W.32 .3220	CHARLES BASS	140		183	7150	7010	Tr C		C/J
106	14 N. 13 W.32 .3220A	PAUL DUNNING	125	07/19/61	175	7150	7025	Tr C		C/J
107	14 N. 13 W.33 .1000	CHIQUITA MAHLER	85		320	7160	7075	Tr C	D, N	ST ENGR
108	14 N. 13 W.33 .1130	A.J. MAHLER			247	7160		Tr C	D	C/J
		THOREAU COMMUNITY	FLOWING	03/13/75	790	7160		Psa, Pg		NAVAJO
109	14 N. 13 W.33 .1223	BIA #2				7160		Psa, Pg		NAVAJO
110	14 N. 13 W.33 .1230	MCKINLEY COUNTY				7155		Tr C		C/J
111	14 N. 13 W.33 .1240	BIA	122	07/30/48	505	7150	7028	Tr C		C/J
112	14 N. 13 W.33 .1240	THOREAU PM 2	FLOWING	05/26/55	1250	7150				NAVAJO
113	14 N. 13 W.33 .1240A	BIA	FLOWING	06/21/52	1250	7150		Pg		C/J
114	14 N. 13 W.33 .1241	BIA	111	04/21/82		7150	7039			NAVAJO
115	14 N. 13 W.33 .1320	BIA	79	07/19/61		7150	7071	Tr C		C/J
116	14 N. 13 W.33 .1320A	ELMER BOWMAN			280	7150		Tr C		C/J
117	14 N. 13 W.33 .1320	CHIQUITA MAHLER	85		252	7160	7075	Tr C	D, N	ST ENGR
118	14 N. 13 W.33 .1410	O. CARTER	60		227	7150	7090	Tr C	D	C/J
		LEBECK & WALKER			227	7150				ST ENGR
119	14 N. 13 W.33 .1430	CLAY HARDIN			230	7150		Tr C		C/J
120	14 N. 13 W.33 .1430A	AT&SF RAILROAD				7150		Tr C		C/J
121	14 N. 13 W.33 .2110	BIA	116	09/18/52	420	7160	7044	Tr C		C/J
122	14 N. 13 W.33 .2123	THOREAU MDWCSWEA	73	12/09/77	1150	7150	7076	Tr C, Pg, Py	M	ST ENGR
123	14 N. 13 W.33 .2200	REX EBY	127	07/07/88	375	7140	7013	Tr C	D	ST ENGR
124	14 N. 13 W.33 .2220	NOT BIA WELL				7145		Psa, Pg		NAVAJO
125	14 N. 13 W.33 .2221	A.J. MAHLER	85	04/15/82	460	7150	7065	Psa, Pg		NAVAJO
126	14 N. 13 W.33 .2240	R.P. WALDIE	120	02/19/81	343	7145	7025	Tr C	D	ST ENGR
127	14 N. 13 W.33 .2310	SOUTHWEST INDIAN MISSION	138	07/19/61		7145	7007	Tr C		C/J
128	14 N. 13 W.33 .3000	THOREAU S.C.	31	10/03/62	1201	7120	7089	Psa, Pg		NAVAJO
129	14 N. 13 W.33 .3140	J.J. RODOSEVICH			235	7120		Tr C		C/J
130	14 N. 13 W.33 .3142	THOREAU WATER & SAN DIST. 1				7120		Psa, Pg		NAVAJO
131	14 N. 13 W.33 .3330	EL PASO NAT GAS	37	06/29/61	870	7148	7111	Psa, Pg	N, D	NAVAJO, C/J
			FLOWING	08/25/53	870	7148		Psa, Pg	N, D	ST ENGR
132	14 N. 13 W.33 .3331	EL PASO NAT. GAS #1				7140		Psa, Pg		NAVAJO
133	14 N. 13 W.33 .3332	EL PASO NAT. GAS #2	24	12/ /72		7140	7116	Psa, Pg		NAVAJO
		EL PASO NAT. GAS #2	84	06/ /73		7140	7056	Psa, Pg		NAVAJO
		EL PASO NAT. GAS #2	140	07/ /74		7140	7000	Psa, Pg		NAVAJO

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- Qal: Alluvium
- Jm : Morrison Fm
- Jsr: San Rafael Gp
- Jmw: Westwater Cyn Mbr of the Morrison Fm
- Je: Entrada SS
- Tr W: Wingate SS
- Tr C: Chinle Fm
- Pg : Glorieta SS
- Psa : San Andres LS
- Py : Yeso Fm
- Kd : Dakota SS
- Km : Mancos Shale

USE
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SOURCE:
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SITE NUMBER	LOCATION	OWNER	DEPTH TO WATER ft	DATE MEASURED	DEPTH OF HOLE ft	SURFACE ELEVATION ft above MSL	SURFACE ELEVATION ft above MSL	CONTRIBUTING AQUIFER	USE	SOURCE
		EL PASO NAT. GAS #2	120	07/ /75		7140	7020	Psa, Pg		NAVAJO
		EL PASO NAT. GAS #2	105	08/ /76		7140	7035	Psa, Pg		NAVAJO
		EL PASO NAT. GAS #2	138	07/ /78		7140	7002	Psa, Pg		NAVAJO
134	14 N. 13 W.33 .3340	EL PASO NAT GAS	41	06/29/61	870	7147	7106	Psa, Pg	N, D	NAVAJO, C/J
			FLOWING	09/05/53	870	7147		Psa, Pg	N, D	ST ENGR
135	14 N. 13 W.34 .1230	RALPH & KATHRYN MAYNARD	110	03/16/75	320	7115	7005	Tr C	S, I	ST ENGR
136	14 N. 13 W.34 .3110	BIA	81	06/04/59	98	7105	7024	Tr C	U	C/J
137	14 N. 13 W.35 .1330	TIETJEN RANCH (FRANCES RENEAU)	160	04/07/88	402	7070	6910	Tr C	D	ST ENGR
138	14 N. 13 W.35 .1330	TIETJEN RANCH (FRANCES RENEAU)	140	05/28/82	288	7070	6930		S	ST ENGR
139	14 N. 14 W.10 .3330	NAVAJO NATION	5	03/28/84	1730	7280	7275	Psa, Pg	S	USGS
140	14 N. 14 W.17 .3331	ELIM HAVEN, INC	FLOWING	04/14/82		7180		Psa, Pg		NAVAJO
141	14 N. 14 W.18 .0000									USGS
142	14 N. 14 W.18 .1100	NAVAJO LODGE	FLOWING	03/19/56	792	7120		Psa, Pg		NAVAJO
143	14 N. 14 W.18 .1100	AL LAVASEK				7120		Psa, Pg		NAVAJO
144	14 N. 14 W.18 .1130	SHERWOOD STAUPER	FLOWING	06/25/80	792	7140		Psa, Pg		NAVAJO
145	14 N. 14 W.18 .1131	SHERWOOD STAUPER	FLOWING	04/14/82		7140		Psa, Pg		NAVAJO
146	14 N. 14 W.18 .2313	SAVAGE	35	04/15/82		7110	7075	Psa, Pg		NAVAJO
147	14 N. 14 W.18 .2344	PINO	84	04/14/82		7125	7041	Psa, Pg		NAVAJO
148	14 N. 14 W.18 .4123	ANDREASEN			206	7155		Psa, Pg		NAVAJO
149	14 N. 14 W.18 .4421	WALLACE #1	FLOWING	04/14/82		7150		Psa, Pg		NAVAJO
150	14 N. 14 W.19 .4000	FLOYD BURNHAM #2	FLOWING	10/ /54	841			Psa, Pg		NAVAJO
151	14 N. 14 W.19 .4110	BURNHAM	6	06/17/82				Psa, Pg		NAVAJO
152	14 N. 14 W.20 .2130					7165				USGS QUAD
153	14 N. 14 W.20 .2331	WALLACE #2	FLOWING	04/14/82		7210		Psa, Pg		NAVAJO
154	14 N. 14 W.21 .	TURNEY	0	06/ /78	750			Psa, Pg		NAVAJO
155	14 N. 14 W.21 .4124	NORTHCUTT	FLOWING	04/15/82		7200		Psa, Pg		NAVAJO
156	14 N. 14 W.21 .4213	TURNEY	FLOWING	04/15/82		7200		Psa, Pg		NAVAJO
157	14 N. 14 W.21 .4214	WHITING BROS	FLOWING	04/14/82		7190		Psa, Pg		NAVAJO
158	14 N. 14 W.22 .	LATHAM	330	08/ /81				Psa, Pg		NAVAJO
159	14 N. 14 W.22 .1100	LATHAM	330	/ /50	410	7200	6870	Psa, Pg		NAVAJO
160	14 N. 14 W.22 .2310					7240				USGS QUAD
161	14 N. 14 W.22 .3311	A.P. GONZALES	FLOWING	04/14/82		7225		Psa, Pg		NAVAJO
162	14 N. 14 W.22 .3313	EBRIGHT				7235		Psa, Pg		NAVAJO
163	14 N. 14 W.22 .3410	A.P. GONZALES	FLOWING	07/16/56	735	7220		Psa, Pg		NAVAJO
164	14 N. 14 W.25 .3320	NM STATE HIWAY DEPT	162	03/24/87	445	7200	7038	Tr C	D, SN	ST ENGR
165	14 N. 14 W.25 .3323	NM STATE HIGHWAY DEPT	29	06/08/84	862	7210	7181	Psa, Pg	N, D, SN	USGS
166	14 N. 14 W.25 .4130					7200				USGS QUAD
167	14 N. 14 W.27 .4440		FLOWING			7280				USGS QUAD
168	15 N. 12 W.19 .1410	MRS. OLLIE MORRIS	33	07/12/61	53	7290	7257	Km	U	C/J, UNAPPRVD
169	15 N. 12 W.19 .2110	MRS. OLLIE MORRIS	22	07/12/61	31	7270	7248	Km		UNAPPRVD
170	15 N. 12 W.19 .2120	MRS. OLLIE MORRIS	22		31	7240	7218	Km	U	C/J, UNAPPRVD
171	15 N. 12 W.19 .2200	SMITH LAKE MISSION	355	06/08/55	679	7250	6895	Kd		UNAPPRVD
172	15 N. 12 W.19 .2230	MRS. OLLIE MORRIS			1100	7305		Jmw	D,S	C/J
173	15 N. 12 W.19 .2230	SMITH LAKE TP	9	06/08/55	1100	7280	7271	Kd, Jmw		UNAPPRVD
174	15 N. 12 W.20 .1410	SMITH LAKE TP	600	11/30/72	1100	7260	6660	Jmw		UNAPPRVD
175	15 N. 12 W.22 .1000	USIS HASSEL WELL		09/08/55	1000	7140		Kd		UNAPPRVD
176	15 N. 13 W.21 .1400	WESTERN NUCLEAR	676	01/28/82	1308	7610	6934	Je		USGS
177	15 N. 13 W.22 .1111	NAVAJO NATION	655	07/ /85	1275	7520	6865	Jm, Jsr	D, S	USGS
178	15 N. 13 W.25 .1423	WESTERN NUCLEAR	635	10/27/88	3102	7484	6849	Psa, Pg	M	USGS
			550	09/29/79	3102	7484	6934			ST ENGR

TABLE 2. Summary of Existing Ground-Water Quality Information from Selected Wells near Thoreau

All units are mg/l unless otherwise noted.
- No well number assigned.
* Includes potassium
\+ Nitrate dissolved as NO3
S Spring
From Cooper and John (1968), and USGS Database

LOCATION	DATE OF COLLECTION	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE AS HCO_3	CARBONATE AS CO_3	SULFATE	CHLORIDE	FLUORIDE	SILICA	HARDNESS AS $CaCO_3$	HARDNESS NON-CARBONATE	DISSOLVED SOLIDS RESIDUE AT 105 Degrees C	TEMPERATURE Degrees C	pH UNITS	SPECIFIC CONDUCTANCE MICRO-MHOS/CM AT 25 Degrees C	SODIUM ABSORPTION RATIO	NITRATE DISSOLVED AS N
13 N.12 W.12 .4410	06/23/48	45	17	104 *		332	0	102	15	4	12	182	0	462	14	8	727		0.5 +
13 N.13 W. 1 . 221	06/25/48					271			5						17		762		
13 N.13 W. 1 .2223	11/20/86	100	33	15	1	258	0	190	5	0	10	390	180	258	18	7	700	0	
13 N.13 W. 1 .2223A	06/23/48	125	37	23 *		256		285	5	0		464		615	19		889		
	08/04/61	128	33	27	2	252	0	294	4	0	15	456	250	627	19	7	905	1	0
	12/11/62	129	32	28	2	250	0	295	6	1	11	453	248	627	19	8	901	1	0
	08/20/63	120	38	23 *		250	0	290	5	0	11	460	250		20	8	903	0	0
13 N.13 W. 5 . 120	12/07/33	140	58	36		230	0	440	15	1		590	400					1	2
13 N.13 W. 8 . 444	07/19/61	78	19	10	1	261	0	63	8	0	16	272	58	323	17	7	529	0	0
13 N.13 W.22 .1333	09/04/85	63	20	77	2			150	7	1	10	240	0	477	13	8	762	2	
	07/25/86	62	20	79	2	280		150	7	1	10	240	6	472	13	7	725	2	
13 N.13 W.27 . 400	06/26/63	87	11			290	0		8			260	25		12	8	481		
13 N.13 W.28 . 131	09/04/62	76	15	7	1	273	0	32	7	0	16	250	26	289	12	8	479	0	0
	12/11/62	76	14	8	1	267	0	33	10	0	14	248	29	288	12	8	476	0	0
13 N.13 W.34 . 233S	09/04/62	72	16	6	1	290	0	11	8	0	14	244	6	272	11	8	462		0.8 +
	12/11/62	77	16	8	1	300	0	12	8	0	14	260	14	284	10	8	487	0	0
13 N.14 W. 5 . 311	05/29/63	67	14	20	1	260	0	48	5	0	12	220	12			7	490	1	0
14 N.12 W. 9 . 221	09/05/62	3	1	254	2	395	29	115	34	7	10	9	0	656	15	9	1040	38	1
14 N.12 W.14 . 142	09/05/62	7	1	195	3	322	31	54	37	1	19	21	0	527	17	9	825	20	5
14 N.12 W.14 . 143	09/05/62	7	1	200	3	320	31	54	37	1	19	21	0			9	825	20	5
14 N.12 W.17 . 333S	11/15/48	2	3	219 *		436	0	77	33	1		18	0	559	7		881		2
14 N.12 W.20 . 111	05/11/50	12	13	897 *		408	45	509	770	2	6	84	0	2460	12		4130		0
14 N.12 W.20 . 112	03/09/53					110	0		4600			370	0				13400		
14 N.12 W.20 . 121	11/15/48	7	11	910 *		500	0	520	760			63	0	2470	12		4380		1
	03/09/53					114	0		4650	3		373	280				13400		
14 N.13 W.19 . 1	03/20/64	10	2	150 *		240	0	92	44	1	7	35	0		17	8	687		0

TABLE 2. Summary of Existing Ground-Water Quality Information from Selected Wells near Thoreau

All units are mg/l unless otherwise noted.
- No well number assigned.
* Includes potassium
+ Nitrate dissolved as NO3
S Spring
From Cooper and John (1968), and USGS Database

LOCATION	DATE OF COLLECTION	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE AS HCO_3	CARBONATE AS CO_3	SULFATE	CHLORIDE	FLUORIDE	SILICA	HARDNESS AS $CaCO_3$	HARDNESS NON-CARBONATE	DISSOLVED SOLIDS RESIDUE AT 105 Degrees C	TEMPERATURE Degrees C	pH UNITS	SPECIFIC CONDUCTANCE MICRO-MHOS/CM AT 25 Degrees C	SODIUM ABSORTPTION RATIO	NITRATE DISSOLVED AS N
	07/14/70	31	14	170	0	220	8	72	150	0		140	0			9	1000	7	0
14 N.13 W.20 . 410	07/12/61	0	1	160	2	261	32	50	31	0	14	3	0	425	20	9	701	40	0
14 N.13 W.20 .4321	03/13/75	2	0	150	2	330		58	15	0	9	4	0				661	33	
14 N.13 W.20 .4322	03/13/75	44	5	43	3	270		40	4	0	10	130	0		20		480	7	
14 N.13 W.20 .4323	07/12/61	0	1	160	2	260	32	50	31	0	14	3	0			9	701	40	0
14 N.13 W.25 .1334	03/01/66	3	>0	140	>0	230	36	24	26	0		8	0				560		0
	09/30/71	2	>0	140	>0	240	32	30	20	1		5	0			9	580		0
14 N.13 W.27 .3422	12/06/67	180	29	10	>0	250	>0	360	17	0		570	360			7	1000	0	
	04/07/72	180	28	7	>0	250	>0	360	10	0		560	360			8	1030	0	0
	03/13/75	150	28	11	2	180	0	350	5	0	16	490	350			7	1020	0	
14 N.13 W.28 . 123	12/03/48	1	1	141 *		244	16	54	19	0		5	0	353	17		576		0
	02/05/54					222	26		16								581		
14 N.13 W.33 . 124	08/18/48	26	10	760 *		254	9	515	705	1		106	0	2160	15		3590		1
	08/18/48					260	0		720				0				3700		
	08/19/48	18	4	867 *		246	7	534	705	1		60	0	2260			3630		1
	09/08/51					248	8		735						14		3710		
	09/08/51												0				3810		
	09/08/51					230	18		680				0		14		3540		
	09/08/51					230	14		760				0		14		3810		
	06/30/52	140	29	10 *		260	0	240	5	0	11	470	260	568			836		0
	04/03/53	7	1	299 *		323	13	170	148	0	9	22	0	808			1350		0
	07/18/61	120	25	29	2	260	0	230	14	0	12	400	190	560	14	7	842	1	0
	09/30/64	120	22	39		270	0	220	28	0	12	390	170	574		7	879	1	0
14 N.13 W.33 . 124A	06/20/52						64		310	0			0			12	9220		
	06/30/52	136	29	9.9 *		265	0	245	5	0	11	458	242	568			836		0 +
	07/18/61	124	25	29	2	265	0	230	14	0	12	412	195	567	14	7	842		0 +

TABLE 2. Summary of Existing Ground-Water Quality Information from Selected Wells near Thoreau

All units are mg/l unless otherwise noted.
- No well number assigned.
* Includes potassium
+ Nitrate dissolved as NO3
S Spring
From Cooper and John (1968), and USGS Database

LOCATION	DATE OF COLLECTION	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE AS HCO_3	CARBONATE AS CO_3	SULFATE	CHLORIDE	FLUORIDE	SILICA	HARDNESS AS $CaCO_3$	HARDNESS NON-CARBONATE	DISSOLVED SOLIDS RESIDUE AT 105 Degrees C	TEMPERATURE Degrees C	pH UNITS	SPECIFIC CONDUCTANCE MICRO-MHOS/CM AT 25 Degrees C	SODIUM ABSORPTION RATIO	NITRATE DISSOLVED AS N
14 N.13 W.33 . 141	12/06/48	26	7	217 *		334	13	184	50	1		94	0	672			1090		2
14 N.13 W.33 . 211	01/13/51					200	32		96	3		26	0				1910		
	01/16/51					300	0		42			30	0				1040		
	01/23/51					340	31		18	0		52	0				908		
	01/24/51	1	1	196 *		356	12	103	16	1	8	18	0	518	14		837		0
	01/24/51					370	15		26				0		14		853		
	01/27/51					390	0		18				0		14		888		
	01/27/52					400	0		19				0		14		882		
	01/27/51	13	3	207 *		394	6	127	19	0	9	44	0	579	14		935		0
14 N.13 W.33 . 314	12/06/48	52	11	85 *		261	14	64	34	0		174	0	398			679		2
14 N.13 W.33 . 334	07/19/61	90	15	10	1	280	0	72	5	0	13	286	56	344	19	7	563		0
14 N.14 W.18 . 0	05/24/56	75	25	7 *		290	0	61	4	0	7	290	53		19	7	549		0
15 N.12 W.19 . 233	09/02/49	29	9	66 *		237	0	44	7	1	15	110	0	290			468		2.3 +
15 N.13 W.22 .1111	11/27/83	82	17	47 *		230	0	170	7	1	13	270	86			8	688		0
	05/08/64	3	1	160 *		290	12	68	25	1	12	11	0			9	690		0
	09/24/70	3	>0	200	0	220	60	110	37	2		8	0			10	930		0
	03/20/74	2	1	200	>0	210	8	120	35	2	12	10	0			10	940	28	1
15 N.13 W.25 .1423	02/24/82	50	18	13	3			84	3	1	15	200	43		20	7	470	0	
	09/06/85	49	20	15	3			78	3	0	15	210	56		18	8		1	

Table 3 - Summary of Well Completion Data

Well Number	Elevation+ Top of Casing (feet)	Below Land Surface (feet)	Screen Diameter (inches)	Screened Interval (feet)	Water Level Below Top of Casing (10/2/89) (feet)	Formation
5-1A	7289.72	690	6	627-667	465.25	Sonsela
5-1B	7286.08	53	2	38-53	45.06	Alluvium
5-2A	7290.40	450	6	415-435	339.98	Upper Chinle
5-2B	7288.47	55.5	2	37.5-52.5	47.96	Alluvium
5-3A	7301.84	450	6	424-444	296.17	Upper Chinle
5-3B	7300.15	58	2	41-56	44.01	Alluvium
5-4B	7288.79	58.7	2	38.7-58.7	48.81	Alluvium
5-5B	7287.23	59.5	2	39.5-59.5	47.20	Alluvium
5-6B	7285.71	57.5	2	37.5-57.5	43.62	Alluvium
5-7B	7276.98	32.8	2	12.8-32.8	Dry	Alluvium (Dry)
5-8B	7282.13	36.2	2	16.2-36.2	Dry	Alluvium (Dry)

+ Based on 1989 Condor Survey, B-series wells corrected for 0.25 foot difference from top of casing to top of vault.

Table 4 - Summary of Water Quality Sampling

Rocky Mountain Analytical Lab Report Number	Report Date	Sample ID	Well Number	Sample Date	608	624	625	Priority Metals	General Inorganics	Remarks
RMAL 004839	06-15-89	5-1	5-1 A	05-8-89	x	x	x	x	x	
		5-1 A	5-1 A	05-8-89	x	x	x			Replicate Sample
		Field Blank	N/A	05-8-89	x	x	x			
		Trip Blank	N/A	05-8-89		x				
RMAL 005102	07-19-89	5-3 B	5-3 B	05-23-89	x	x	x	x	x	Tentatively identified compounds quantified
		5-3 BA	5-3 B	05-23-89	x	x	x			Tentatively identified compounds quantified, replicate sample
		5-2 BB	5-2 B	05-23-89	x	x	x	x		Tentatively identified compounds quantified
		Field Blank	N/A	05-24-89	x	x	x			
		Trip Blank	N/A	05-24-89		x				
		Trip Blank	N/A	05-24-89		x				
RMAL 006099	08-22-89	5-2 B	5-2 B	08-08-89	x	x				
		5-1 B	5-1 B	08-08-89	x					Well not purged prior to sample collection
		5-2 BA	5-2 B	08-08-89	x	x				replicate sample
RMAL 006385	09-08-89	5-2 A	5-2 A	08-31-89		x				Well not purged prior to sample collection
		Trip Blank	N/A	09-01-89		x				
RMAL 006689	10-17-89	5-4 B @ 30.5'	N/A	09-18-89		8020				Soil Sample Collected at 30.5 ft while drilling 5-4 B
		5-4 B @ 52'	N/A	09-18-89		8020				Soil Sample Collected at 52 ft while drilling 5-4 B
		5-5 B @ 30.5'	N/A	09-19-89		8020				Soil Sample Collected at 30.5 ft while drilling 5-5 B
		5-5 B @ 52'	N/A	09-20-89		8020				Soil Sample Collected at 52 ft while drilling 5-5 B
		Trip Blank	N/A	09-21-89		x				
RMAL 006720	10-17-89	5-6 B @ 32.5-32.75'	N/A	09-21-89		8020				Soil Sample Collected at 32.5 to 32.75 ft while drilling 5-6 B
		5-6 B @ 54.25-54.5'	N/A	09-2-89		8020				Soil Sample Collected at 54.25 to 54.5 ft while drilling 5-6 B
		Trip Blank	N/A	09-23-89		x				
RMAL 006801	10-18-89	5-8 B @ 30.5'	N/A	09-25-89		8020				Soil Sample Collected at 30.5 ft while drilling 5-8 B
		5-7 B @ 30.5'	N/A	09-25-89		8020				Soil Sample Collected at 30.5 ft while drilling 5-7 B
RMAL 006865	10-24-89	5-5 BA	5-5 B	10-03-89		x				Replicate Sample
		Field Blank	N/A	10-03-89		x				
		5-5 B	5-5 B	10-03-89		x				
		5-6 B	5-6 B	10-03-89		x				
		Trip Blank	N/A	10-04-89		x				
RMAL 006889	10-24-89	Trip Blank	N/A	10-05-89		x				
		R1-1	WCC R1-1	10-06-89		x				Condensate Bailed from bottom of Woodward-Clyde Well R1-1
		5-4 B B	5-4 B	10-06-89		x				
		5-4 B BA	5-4 B	10-06-89		x				Replicate Sample
		Field Blank	N/A	10-06-89		x				

Table 4 - Summary of Water Quality Sampling

Rocky Mountain Analytical Lab Report Number	Report Date	Sample ID	Well Number	Sample Date	608	624	625	Priority Metals	General Inorganics	Remarks
RMAL 007674	12-20-89	5-3 B-1 TO 5-3 B-5	5-3 B	11-29-89	x	x				
		5-5 B-1 TO 5-5 B-5	5-5 B	11-30-89	x	x				
		SUPC-1 TO SUPC-5	TPC-2	11-30-89	x	x				
		5-2 B-1 TO 5-2 B-5	5-2 B	11-30-89	x	x				
		Trip Blank	N/A	11-27-89		x				
RMAL 007776	01-11-90	5UPE	TPC-1	12-06-89	x	x				
		5-1 A	5-1 A	12-06-89			x	x	x	
		5-TANK	N/A	12-06-89	x	x				Temporary Holding Tank for Purged Water
		NTUA #2	NTUA #2	12-07-89	x	x		x	x	Navajo Tribal Utility Well #2
		NTUA #1	NTUA #1	12-07-89	x	x		x	x	Navajo Tribal Utility Well #1
		THOREAU #2	THOREAU #2	12-07-89	x	x		x	x	Thoreau Municipal Supply Well #2
		5-3 A	5-3 A	12-07-89	x	x	x	x	x	
		5-2 A	5-2 A	12-07-89	x	x	x	x	x	
RMAL 007681	01-11-90	SUPW-1 thru -5	TPC-1	12-01-89	x	x				
		5-1 A-1 thru -5	5-1 A	12-01-89	x	x				
		5-6 B-1 thru -5	5-6 B	12-01-89	x	x				
		5-6 B A-1 thru -5	5-6 B	12-01-89	x	x	x			Replicate Sample
		5-1 B-1 thru -5	5-1 B	12-01-89	x	x	x			
		5-4 B-1 thru -5	5-4 B	12-01-89		x				
		Trip Blank	N/A	12-01-89						
RMAL 007827	01-11-90	Trip Blank	N/A	12-01-89		x				
		THHS-1 thru -7	THHS	12-12-89	x	x		x	x	Thoreau High School Well #1
		WND-1 thru -7	WND	12-12-89	x	x		x	x	Windmill Well (Navajo Well # 16B-39)
RMAL 008151	02-13-90	5-2 A-1,2,3,4,5	5-2 A	01-26-90	x	x	x		x	
		5-4 B-1,2	5-4 B	01-26-90	x	x				
		5-6 B-1,2	5-6 B	01-26-90	x	x				

Table 5. Summary of the Results of Water Quality sampling

Thoreau On Site Wells Semi Volatile Organics (EPA 625)

Concentrations in ut/l

ND: Not Detected
R : Replicate Sample
1 : Reporting Limits 10 Times Listed Values

Parameter	Reporting Limit (ug/l)	5-1 A			5-2 A		5-3 A	5-2 B			5-3 B	
		5/8/89	5/8/89 R	12/6/89	12/7/89	1/26/90	12/7/89	5/23/89 [1]	8/8/89 [1]	8/8/89 R [1]	5/23/89	5/23/89 R
Phenol	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethyl) ether	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chlorophenol	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl)-ether	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-di-n-propylamine	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isophorone	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethoxy)-methane	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphalene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloronapthalene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethyl phthalate	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitrophenol	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diethyl phthalate	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chlorphenyl phenyl ether	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Diphenylhydrazine	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Bromophenyl phenyl ether	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorbenzene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-butyl phthalate	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorathene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Butyl benzyl phthalate	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3'-Dichlorbenzidine	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl) phthalate	10	ND	ND	12	580	ND	31	ND	ND	ND	ND	13
Chrysene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-octyl phthalate	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)floranthene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)floranthene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 5. Summary of the Results of Water Quality Sampling (Continued)

Thoreau On Site Wells Volatile Organics (EPA 624)

Concentrations in ug/l

ND: Not Detected
R : Replicate Sample

1: Reporting Limit 25 ug/l
2: Reporting Limit 1000 ug/l

3: Reporting Limits 5 Times Listed Values
4: Reporting Limits 40 Times Listed Values

5: Reporting Limits 50 Times Listed Values
6: Reporting Limits 100 Times Listed Values

Parameter	Reporting Limit (ug/l)	5-1 A			5-2 A			5-3 A	5-1 B	5-2 B				5-3 B			5-4 B				5-5 B			5-6 B				TPC 1	TPC 2	TPC 3
		5/8/89	5/8/89 R	12/1/89	8/31/89	12/7/89 3	1/26/90	12/7/89	12/1/90	5/23/89 4	8/8/89 6	8/8/89 R 6	11/30/89 5	5/23/89	5/23/89 R	11/29/8 9	10/6/89 3	10/6/89 R 3	12/1/89	1/26/90	10/3/89	10/3/89 R	11/30/89	10/3/89	12/1/89	12/1/89 R	1/26/90	1/30/90	12/6/89	12/1/89
Chloromethane	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethan	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethene (cis/trans)	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethene	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorodibromomethane	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	5.0	ND	ND	ND	ND	ND	42	ND	ND	1800	2500	2700	1800	ND	ND	ND	ND	ND	18	21	ND	ND	ND	15	7.4	5.2	ND	ND	ND	ND
cis-1,3-Dichloropropene	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloroethyl vinyl ether	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	5.0	ND	ND	ND	ND	490	210	ND	6.3	2000	4700	5000	3100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	35	ND	ND	ND	ND	ND
Chlorobenzene	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	5.0	ND	ND	ND	ND	56	24	ND	ND	ND	ND	ND	250	ND	ND	ND	ND	ND	ND	ND	8.7	ND	ND	ND	21	25	8.3	ND	ND	ND

Table 5. Summary of the Results of water Quality Sampling (Continued)

Thoreau On Site Wells Organic Chlorine Pesticides/PCB's (EPA 608)

Concentrations in ug/l

ND: Not Detected
R : Replicate Sample
1 : Reporting Limits 100 Times Listed Values

Parameter	Reporting Limit (ug/l)	5-1 A			5-2 A		5-3 A	5-1 B		5-2 B				5-3 B			5-4 B		5-5 B	5-6 B			TPC 1	TPC 2	TPC 3
		5/8/89	5/8/89 R	12/1/89	12/7/89	1/26/90	12/7/89	8/8/89	12/1/90	5/23/89	8/8/89	8/8/89 R	11/30/89	5/23/89	5/23/89 R	11/29/89	12/1	1/26	11/30	12/1 [1]	12/1 [1] R	1/26	11/30	12/6	12/1
alpha-BHC	0.050	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	0.050	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta-BHC	0.050	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-BHC (Lindane)	0.050	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	0.050	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aldrin	0.050	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	0.050	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	0.050	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	0.10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDE	0.10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	0.10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	0.10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	0.10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin aldehyde	0.10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
alpha-Chlordane	0.50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-Chlordane	0.50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toxaphene	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor 1016	0.50	ND	ND	ND	ND	ND	ND	2.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor 1221	0.50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	180	160	100	ND	ND	ND
Aroclor 1232	0.50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor 1242	0.50	ND	ND	ND	ND	ND	ND	ND	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor 1248	0.50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor 1254	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor 1260	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 5. Summary of the Results of Water Quality Sampling (Continued)

Thoreau On Site Wells Disolved Metals and General Inorganics

Concentrations in mg/l

ND: Not Detected
1 : Reporting Limits 20 Times Listed Values
2 : Reporting Limit 0.5 mg/l

Parameter	Reporting Limit (mg/l)	Analytical Method	5-1 A		5-2 A		5-3 A	5-2 B		5-3 B
			5/8/89	12/1/89	12/7/89 [1]	1/26/90	12/7/89 [1]	5/23/89	8/8/89	5/23/89
Antimony	0.05	200.7	ND	ND	ND	NM	ND	ND	ND	ND
Arsenic	0.005	203.2	ND	ND	ND	NM	ND	0.029	0.025	ND
Barium	0.01	200.7	0.006	0.02	ND	NM	ND	0.44	0.53	0.15
Beryllium	0.002	200.7	ND	ND	ND	NM	ND	ND	ND	ND
Boron	0.02	200.7	0.19	0.15	1.7	NM	1.4	0.87	0.84	0.25
Cadmium	0.005	200.7	ND	ND	ND	NM	ND	ND	ND	ND
Calcium	0.2	200.7	0.8	1.1	1300	NM	750	118	134	50
Chromium	0.01	200.7	ND	ND	ND	NM	ND	ND	ND	ND
Copper	0.01	200.7	ND	ND	ND	NM	ND	ND	ND	ND
Iron	0.1	200.7	ND	0.06	12	NM	ND	ND	2.8	ND
Lead	0.005	239.2	0.004	0.006	ND	NM	ND	ND	ND	ND
Magnesium	0.2	200.7	ND	ND	140	NM	83	22	23	13
Manganese	0.01	200.7	0.005	0.02	5.9	NM	3.3	1.4	2.0	0.27
Mercury	0.0002	245.1	ND	ND	ND	NM	ND	ND	ND	ND
Molybdenum	0.02	200.7	ND	ND	ND	NM	ND	ND	ND	ND
Nickel	0.04	200.7	ND	ND	ND	NM	ND	ND	ND	ND
Potassium	5	200.7	ND	ND	ND	NM	ND	ND	ND	ND
Selenium	0.005	270.2	0.008	0.009	ND	NM	ND	ND	ND	0.010
Silica as SiO_2	0.2	200.7	9.1	11	ND	NM	ND	24	23	20
Silver	0.01	200.7	ND	ND	ND	NM	ND	ND	ND	ND
Sodium	5	200.7	152	172	8820	NM	6660	190	184	285
Strontium	0.05	200.7	0.02	ND	50	NM	29	1.1	1.2	0.98
Thallium	0.01	279.2	ND	ND	ND	NM	ND	ND	ND	ND
Zinc	0.01	200.7	0.03	1.5	0.2	NM	ND	ND	ND	ND
Alkalinity, Bicarbonate $CaCO_3$ at pH 4.5	5	310.1	201	208	28	39	31	1510	774	588
Alkalinity, Carbonate $CaCO_3$ at pH 8.3	5	310.1	28	42	ND	ND	ND	1510	ND	ND
Chloride	3	300.0	19	37	10700	NM	1600	17	11	224
Fluoride	0.1	340.2	0.4	0.4	0.4	NM	0.2	0.2	0.2	0.2
Nitrate as N	0.1	300.0	0.9	0.8	3.7	3.2	3.8	0.6	ND [2]	8.6
pH	--	150.1	8.7	8.9	6.9	7.23.2	6.5	7.4	7.1	7.8
Sulfate	5	300.0	48	48	1290	NM	796	7.0	ND	102
Total Dissolved Solids	10	160.1	392	400	20700	NM	26300	910	827	1010

Table 5. Summary of the Results of Water Quality Sampling (Continued)

Thoreau Off Site Wells Volatile Organics (EPA 624)

Concentrations in ug/l

ND: Not Detected

Parameter	Reporting Limit (ug/l)	NTVA #1 12/7/89	NTVA #2 12/7/89	THOREAU #2 12/7/89	THHS 12/12/89	WND 12/12/89
Chloromethane	10	ND	ND	ND	ND	ND
Bromomethane	10	ND	ND	ND	ND	ND
Vinyl chloride	10	ND	ND	ND	ND	ND
Chloroethane	10	ND	ND	ND	ND	ND
Methylene chloride	5.0	ND	ND	ND	ND	ND
1,1-Dichloroethene	5.0	ND	ND	ND	ND	ND
1,1-Dichloroethane	5.0	ND	ND	ND	ND	ND
1,2-Dichloroethene (cis/trans)	5.0	ND	ND	ND	ND	ND
Chloroform	5.0	ND	ND	ND	ND	ND
1,2-Dichloroethane	5.0	ND	ND	ND	ND	ND
1,1,1-Trichloroethene	5.0	ND	ND	ND	ND	ND
Carbon tetrachloride	5.0	ND	ND	ND	ND	ND
Bromodichloromethane	5.0	ND	ND	ND	ND	ND
1,2-Dichloropropane	5.0	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	5.0	ND	ND	ND	ND	ND
Trichloroethene	5.0	ND	ND	ND	ND	ND
Chlorodibromomethane	5.0	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	5.0	ND	ND	ND	ND	ND
Benzene	5.0	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	5.0	ND	ND	ND	ND	ND
2-Chloroethyl vinyl ether	10	ND	ND	ND	ND	ND
Bromoform	5.0	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	5.0	ND	ND	ND	ND	ND
Tetrachloroethene	5.0	ND	ND	ND	ND	ND
Toluene	5.0	ND	ND	ND	ND	ND
Chlorobenzene	5.0	ND	ND	ND	ND	ND
Ethylbenzene	5.0	ND	ND	ND	ND	ND

Table 5. Summary of the Results of Water Quality Sampling (Continued)

Thoreau Off Site Wells Organics Chlorine Psticides/PCB's (EPA 608)

Concentrations in ug/l

ND: Not Detected

Parameter	Reporting Limit (ug/l)	NTVA #1	NTVA #2	THOREAU #2	THHS	WND
		12/7/89	12/7/89	12/7/89	12/12/89	12/12/89
alpha-BHC	0.050	ND	ND	ND	ND	ND
beta-BHC	0.050	ND	ND	ND	ND	ND
delta-BHC	0.050	ND	ND	ND	ND	ND
gamma-BHC (Lindane)	0.050	ND	ND	ND	ND	ND
Heptachlor	0.050	ND	ND	ND	ND	ND
Aldrin	0.050	ND	ND	ND	ND	ND
Heptachlor epoxide	0.050	ND	ND	ND	ND	ND
Endosulfan I	0.050	ND	ND	ND	ND	ND
Dieldrin	0.10	ND	ND	ND	ND	ND
4,4'-DDE	0.10	ND	ND	ND	ND	ND
Endrin	0.10	ND	ND	ND	ND	ND
Endosulfan II	0.10	ND	ND	ND	ND	ND
4,4'-DDT	0.10	ND	ND	ND	ND	ND
Endrin aldehyde	0.10	ND	ND	ND	ND	ND
alpha-Chlordane	0.50	ND	ND	ND	ND	ND
gamma-Chlordane	0.50	ND	ND	ND	ND	ND
Toxaphene	1.0	ND	ND	ND	ND	ND
Aroclor 1016	0.50	ND	ND	ND	ND	ND
Aroclor 1221	0.50	ND	ND	ND	ND	ND
Aroclor 1232	0.50	ND	ND	ND	ND	ND
Aroclor 1242	0.50	ND	ND	ND	ND	ND
Aroclor 1248	0.50	ND	ND	ND	ND	ND
Aroclor 1254	1.0	ND	ND	ND	ND	ND
Aroclor 1260	1.0	ND	ND	ND	ND	ND

Table 5. Summary of the Results of Water Quality Sampling (Continued)

Thoreau Off Site Wells Disolved Metals and General Inorganics

Concentrations in mg/l

ND: Not Detected
+ : Total Metals
NM: Not Measured

Parameter	Reporting Limit (mg/l)	Analytical Method	NTVA #1 12/7/89	NTVA #2 12/7/89	THOREAU #2 12/7/89	THHS 12/12/89 +	WND 12/12/89 +
Arsenic	0.005	203.2	ND	ND	ND	ND	ND
Boron	0.02	200.7	0.03	0.03	0.05	0.05	0.16
Calcium	0.2	200.7	42	41	141	72	0.7
Iron	0.1	200.7	2.3	0.5	2.0	0.8	0.3
Lead	0.005	239.2	NM	NM	NM	ND	ND
Magnesium	0.2	200.7	19	19	26	19	ND
Manganese	0.01	200.7	0.02	0.01	0.01	0.02	ND
Mercury	0.0002	245.1	NM	NM	NM	ND	ND
Potassium	5	200.7	ND	ND	ND	ND	ND
Selenium	0.005	270.2	NM	NM	NM	ND	ND
Sodium	5	200.7	25	23	10	16	124
Thallium	0.005	279.2	NM	NM	NM	ND	ND
Alkalinity, Bicarbonate $CaCO_3$ at pH 4.5	5	310.1	186	199	211	206	190
Alkalinity, Carbonate $CaCO_3$ at pH 8.3	5	310.1	ND	ND	ND	ND	20
Chloride	3	300.0	16	4	5	14	4
Nitrate as N	0.1	300.0	ND	ND	ND	0.7	ND
pH	–	150.1	7.8	7.7	7.4	7.8	8.6
Total Dissolved Solids	10	160.1	240	220	550	320	330
Sulfate	5	300.0	21	15	241	NM	NM

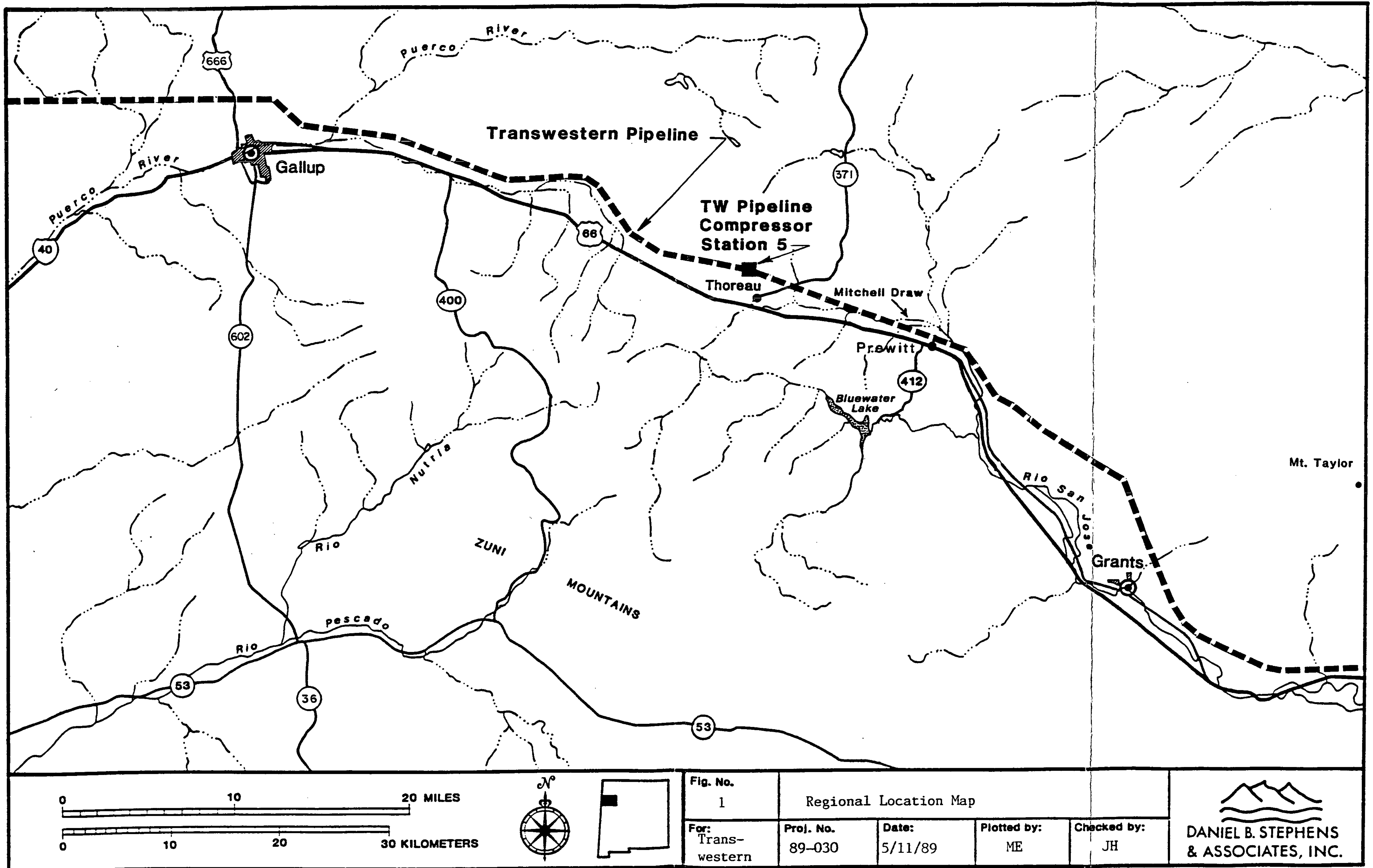


Fig. No.	Regional Location Map			
1				
For: Trans-western	Proj. No. 89-030	Date: 5/11/89	Plotted by: ME	Checked by: JH

DANIEL B. STEPHENS & ASSOCIATES, INC.

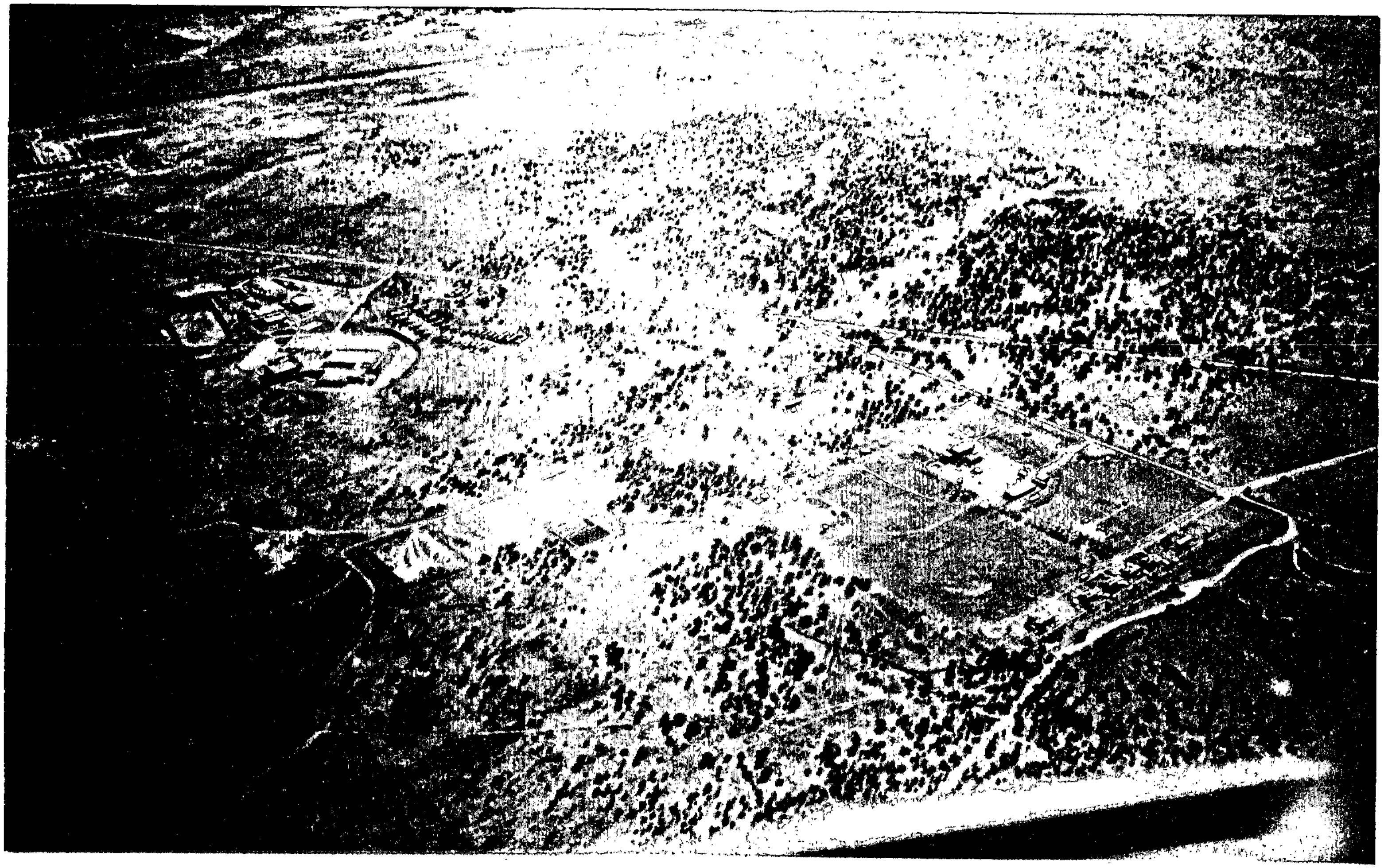


Figure 2 - Oblique Air Photo of Thoreau Station; View to the Southwest
(Station in Right Foreground)

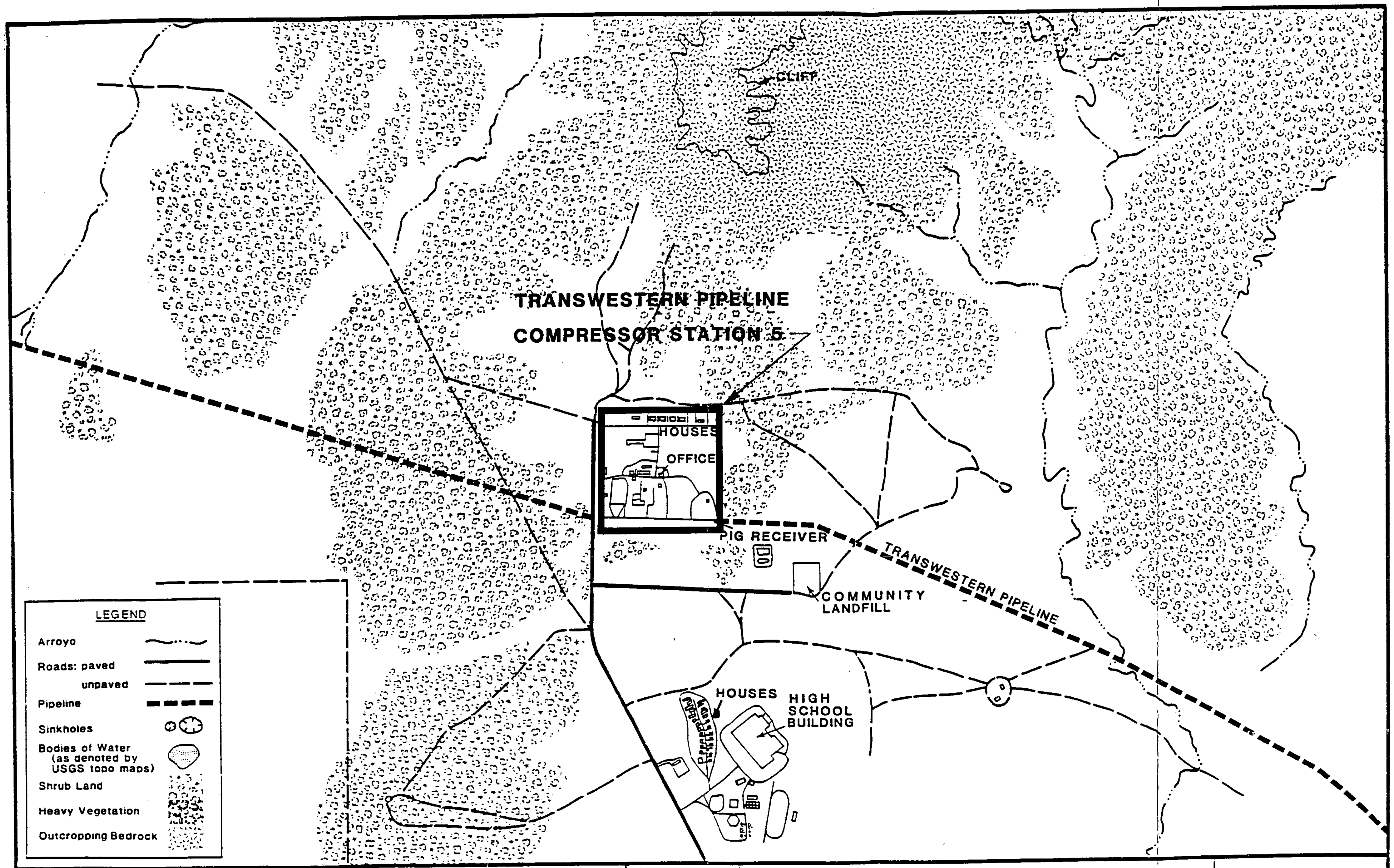
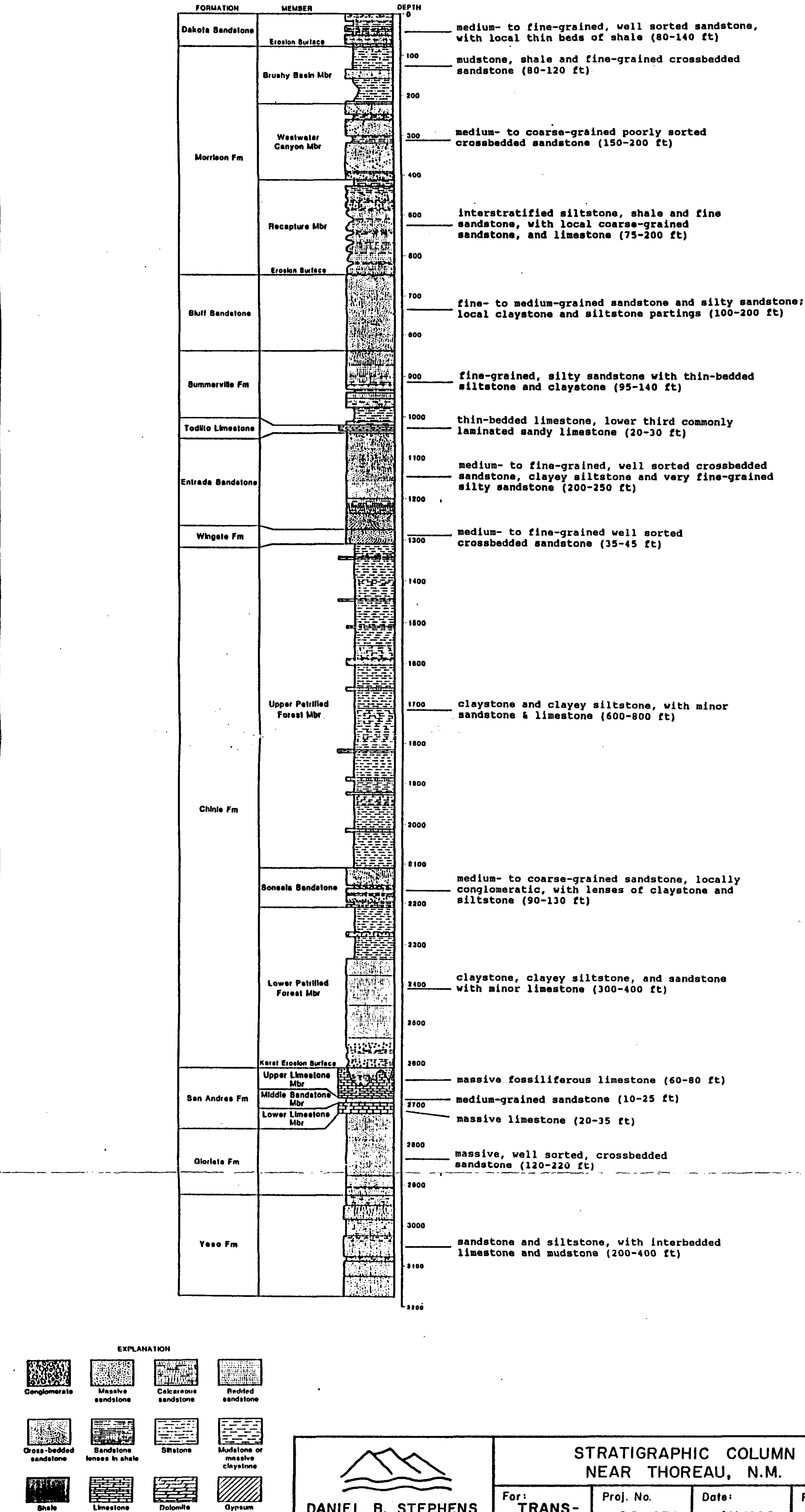


Fig. No. 3

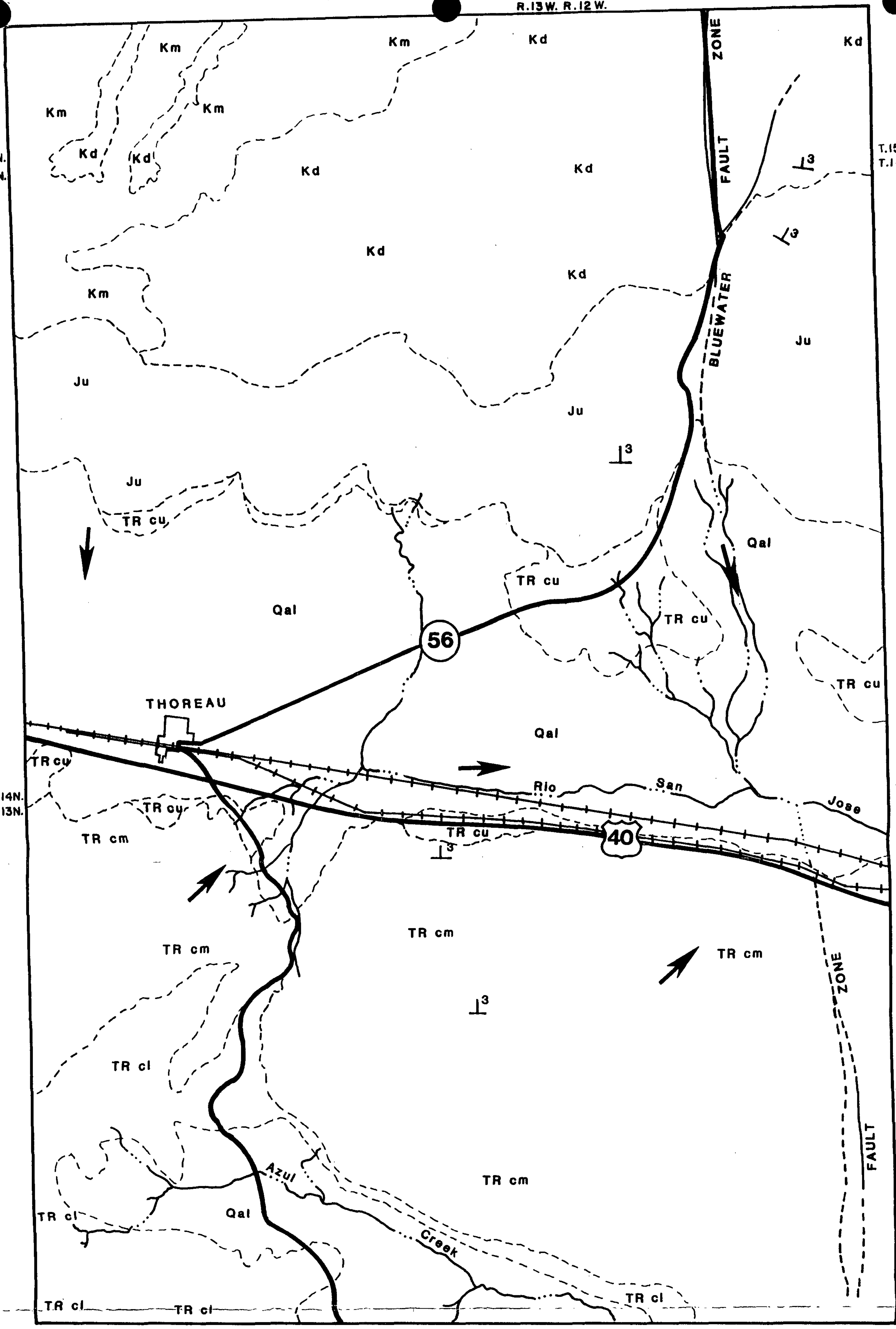
Surficial Features at Compressor Station 5

For:	Proj. No.	Date:	Plotted by:	Checked by:
Trans-western	89-030	5/11/89	ME	JH

DANIEL B. STEPHENS & ASSOCIATES, INC.



DANIEL B. STEPHENS & ASSOCIATES, INC.	STRATIGRAPHIC COLUMN NEAR THOREAU, N.M.				Fig. No. 4
	For: TRANS-WESTERN	Proj. No. 89-030	Date: JAN.1990	Plotted by: RF/ME	Checked by: JH



FROM SMITH (1954),
COOPER AND JOHN (1968)

LEGEND

Qal :	Alluvium	TR cu :	Upper Forest Mbr.
Km :	Mancos Shale	TR cm :	Sonsela Sandstone Bed
Kd :	Dakota Sandstone	TR cl :	Lower Petrified Forest Mbr.
Ju :	Jurassic (Undifferentiated)		

Geologic Contact

Stream (Dashed Where Ephemeral)

State/Federal Highway or Road

Fault (Dashed Where Approximate, Dotted Where Uncertain)

Direction of Ground-Water Flow

Strike and Dip of Strata

Railroad

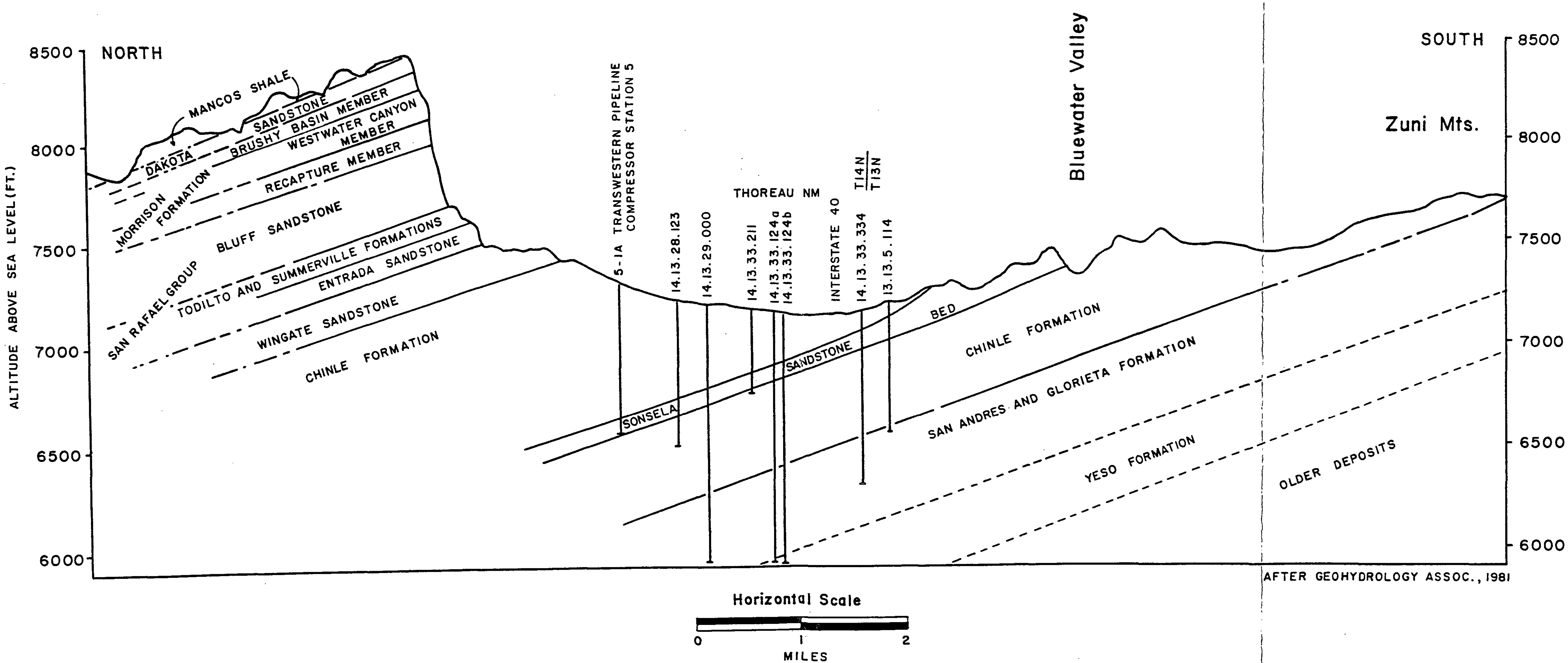
SCALE

0 1 2

MILES

N

DANIEL B. STEPHENS & ASSOCIATES, INC.	GEOLOGY AND SHALLOW GROUND WATER FLOW DIRECTIONS				Fig. No. 5
	For: TRANS-WESTERN	Proj. No. 89-030	Date: 2-21-90	Plotted by: EE	Checked by: JH



DANIEL B. STEPHENS & ASSOCIATES, INC.	Geologic Cross-Section Near Thoreau, NM				Fig. No. 6
	For: Transwestern	Proj. No. 89-030	Date: 2/19/90	Plotted by: EE	Checked by: JH

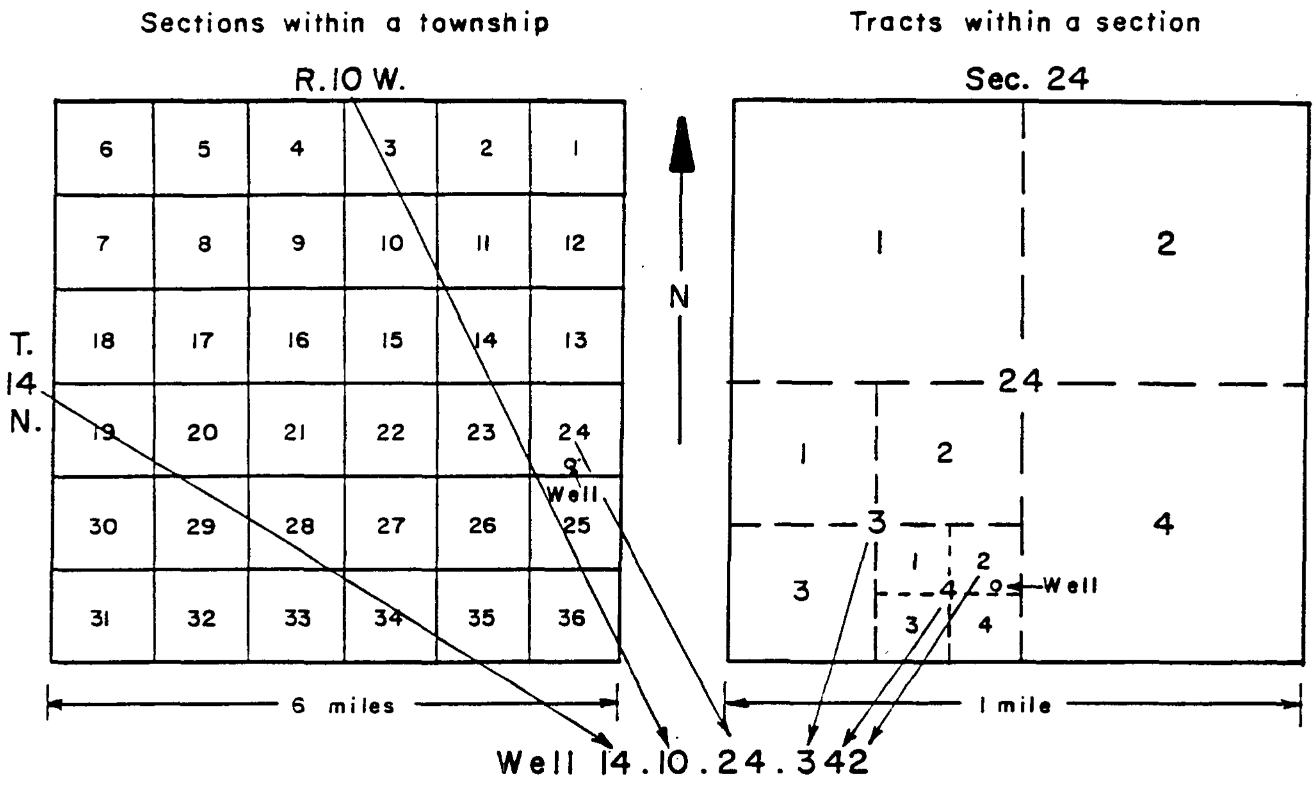
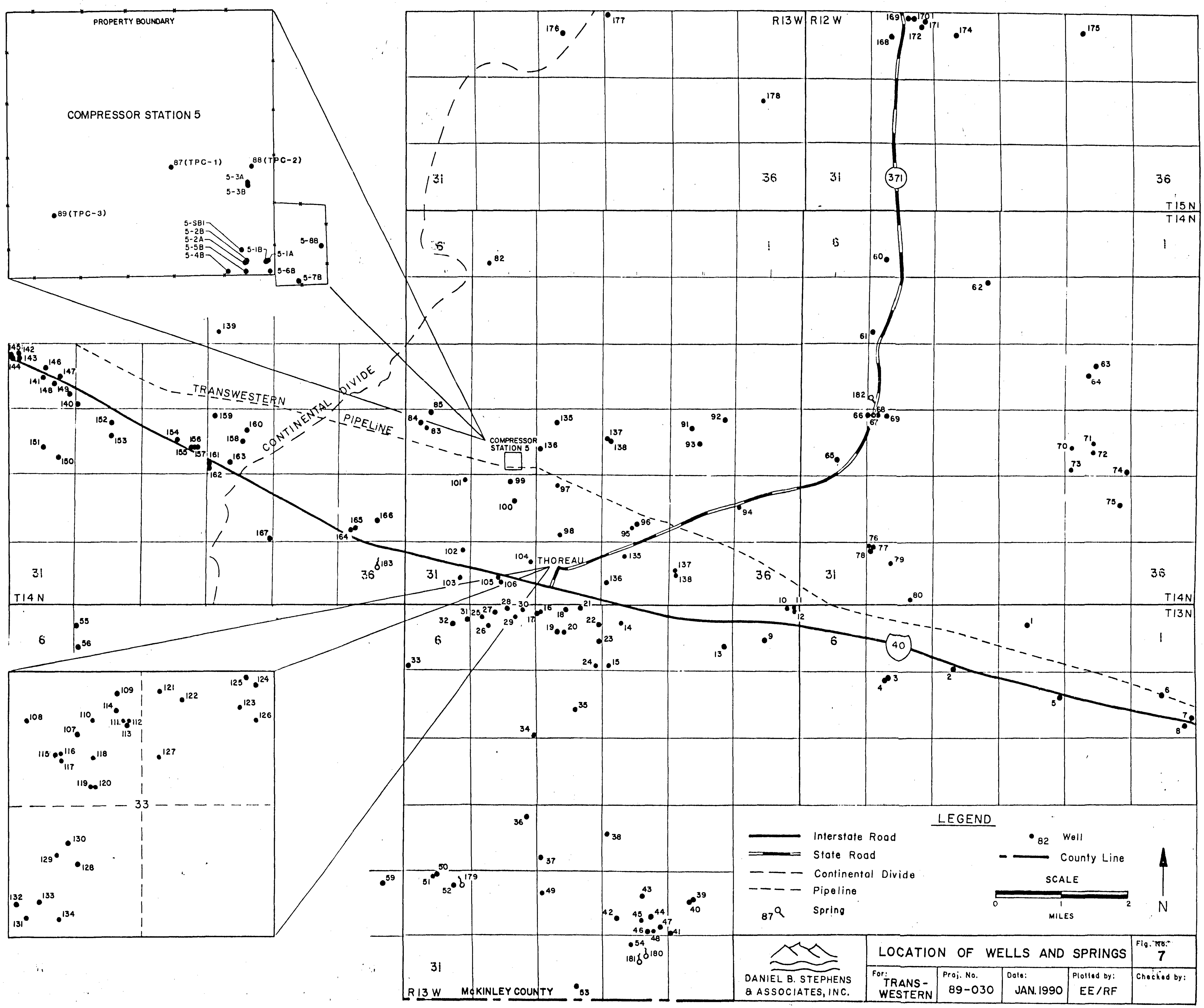


Figure 8 - New Mexico well numbering system.
From Cooper and John (1968)

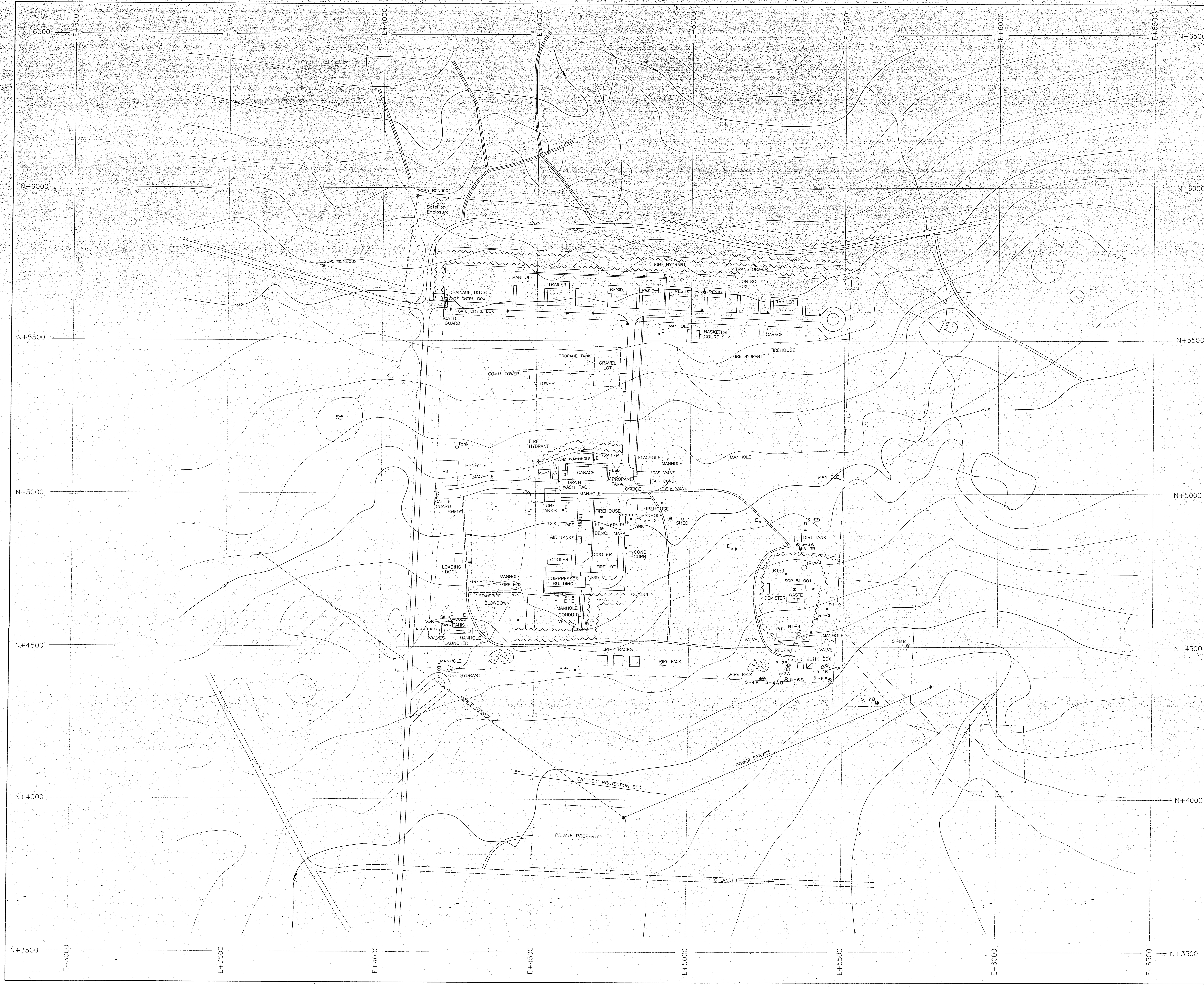


LOCATION OF WELLS AND SPRINGS

Fig. No. 7

DANIEL B. STEPHENS & ASSOCIATES, INC.

For:	Proj. No.	Date:	Plotted by:	Checked by:
TRANS-WESTERN	89-030	JAN. 1990	EE/RF	



LEGEND

- BARBED WIRE FENCE
- CHAIN LINK FENCE
- DRAINAGE
- GRAVEL ROAD
- PAVED ROAD
- DIRT PILE
- DRILL HOLE
- CULVERT
- E ELECTRIC
- GATE
- ESD EMERGENCY SHUTDOWN
- T TELEPHONE
- LIGHT
- WELL
- JUNCTION BOX
- MONITOR WELL
- BERM
- SAMPLE LOCATION
- BENCH MARK
- CONTOUR LINE

CONDOR GEOTECHNICAL SERVICES, INC.

TRANSWESTERN PIPELINE
Compressor Station No.5
Thoreau, New Mexico

FIGURE 9.

TEST WELL AND SOIL BORINGS AT THOREAU STATION NO. 5.

Date: 9/25/89

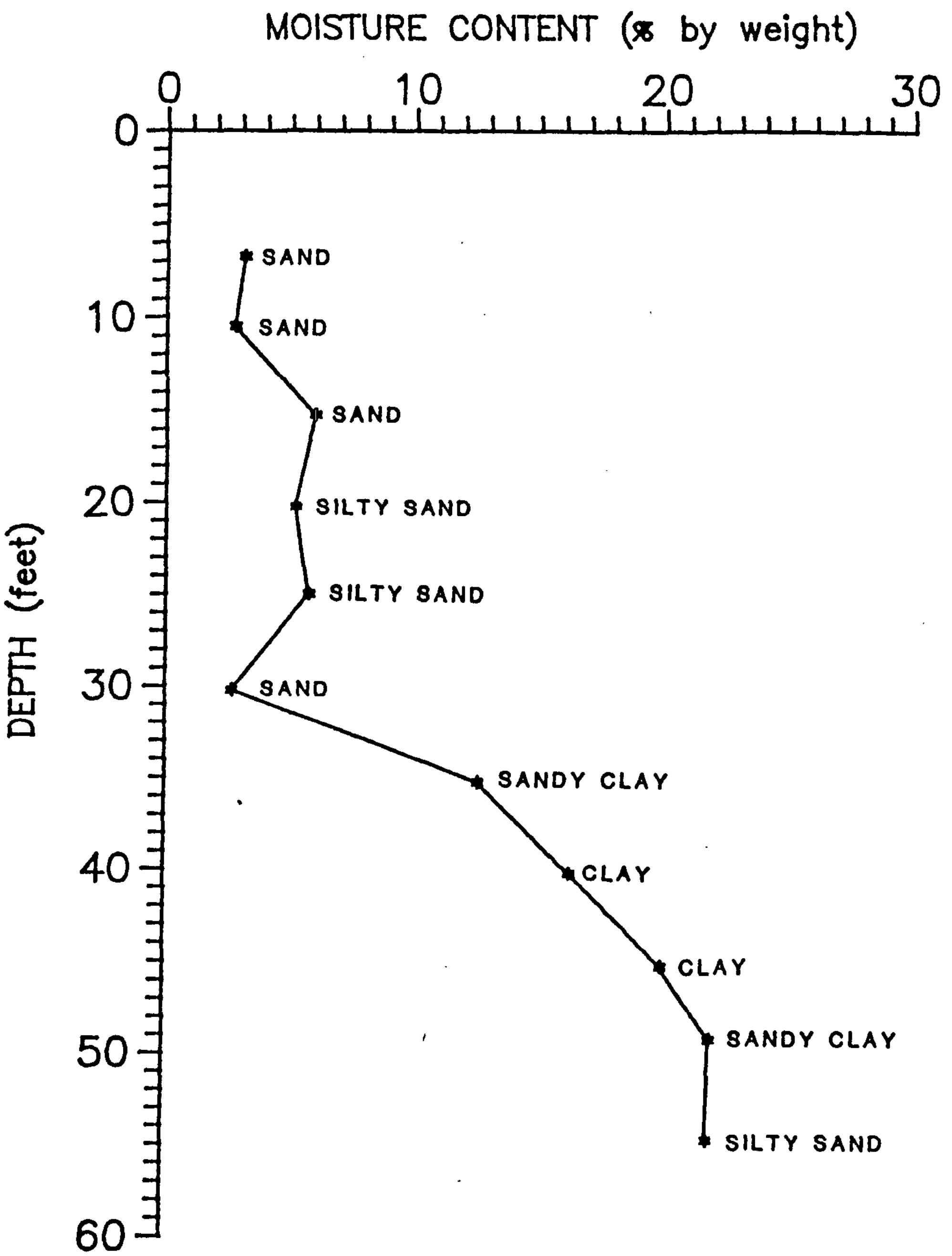
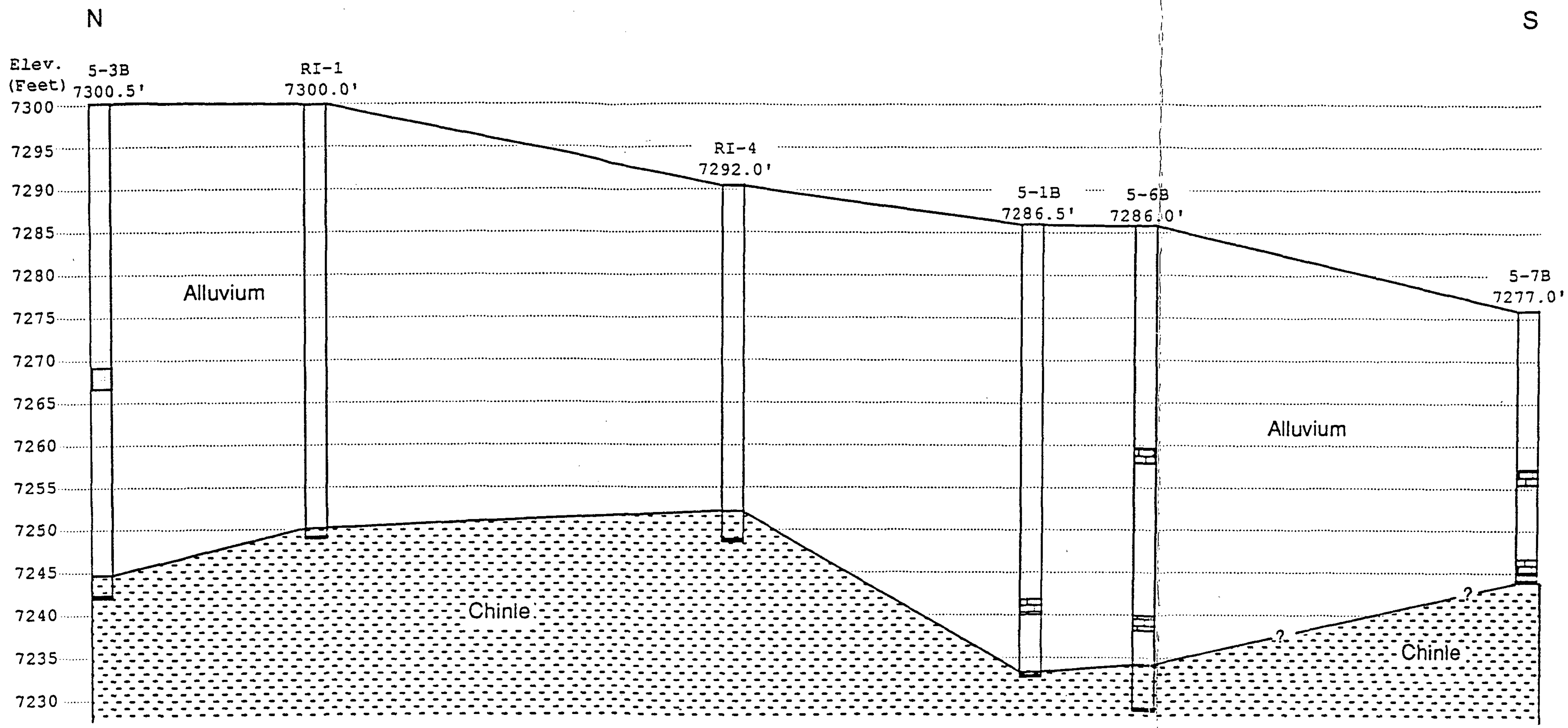
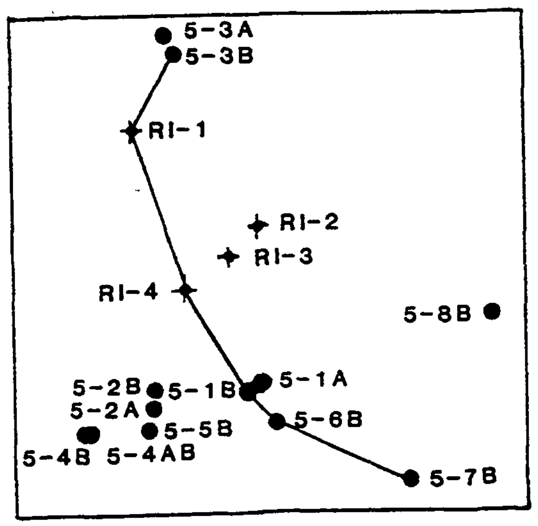


FIGURE NUMBER: 10	Soil Moisture Content Profile and Texture at Boring 5-3B				DANIEL B. STEPHENS & ASSOCIATES, INC.
FOR: Transwestern	PROJECT NO: 89-030	DATE: 5/15/89	PLOTTED BY: LAS	CHECKED BY: JAH	



Horizontal Scale in Feet

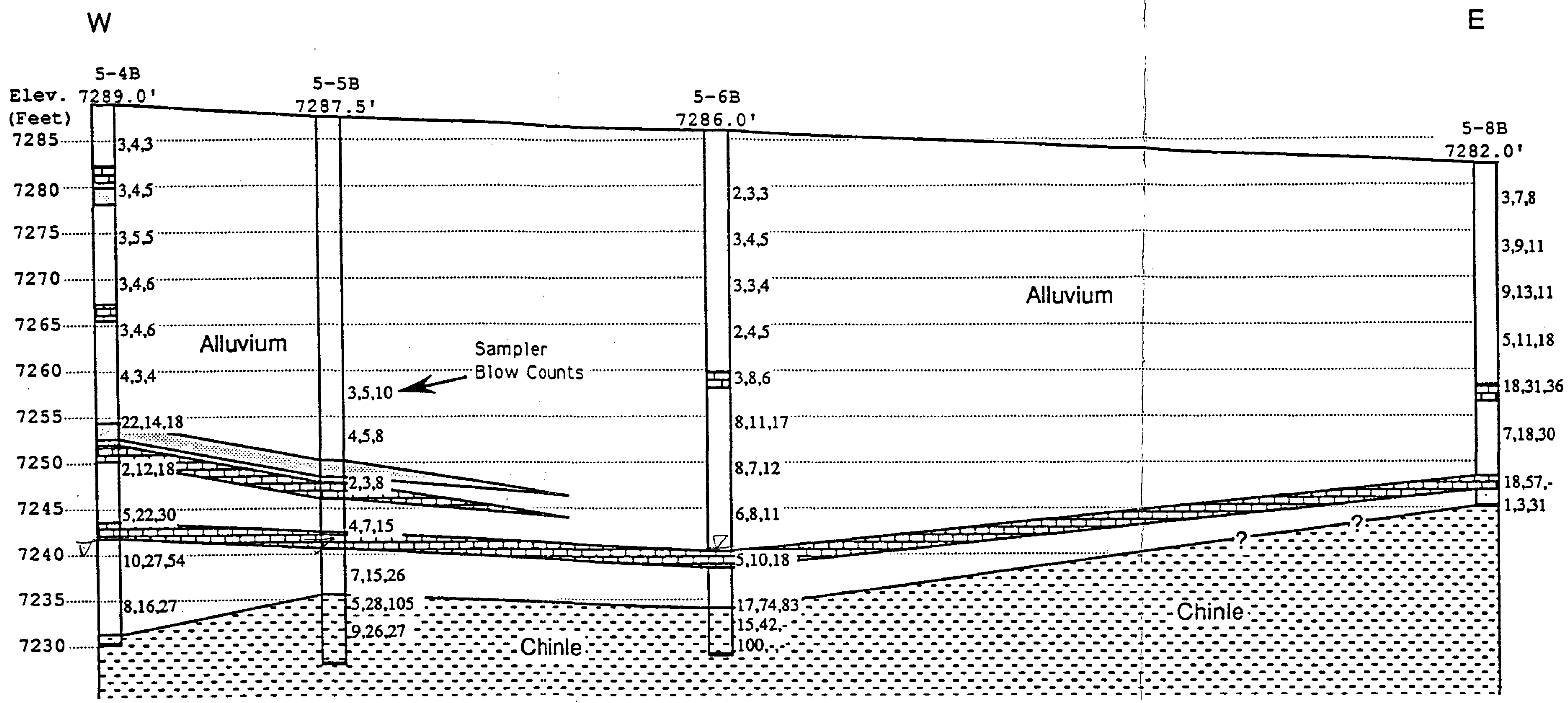
0 50 100

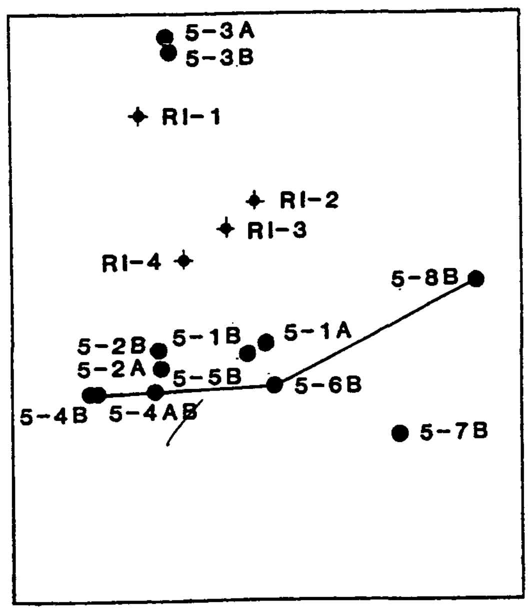


LEGEND

- Alluvial Sand And Silt
- Marker Sand Witnin Alluvium
- Limestone Clasts Witnin Alluvium
- Chinle Formation
- Geologic Contact (Queried Where Uncertain)

DANIEL B. STEPHENS & ASSOCIATES, INC.	North-South Cross Section Across Station 5				Fig. No. 11
	For: Trans-Western	Proj. No. 89-030	Date: 2/21/90	Plotted by: EE	Checked by: JH





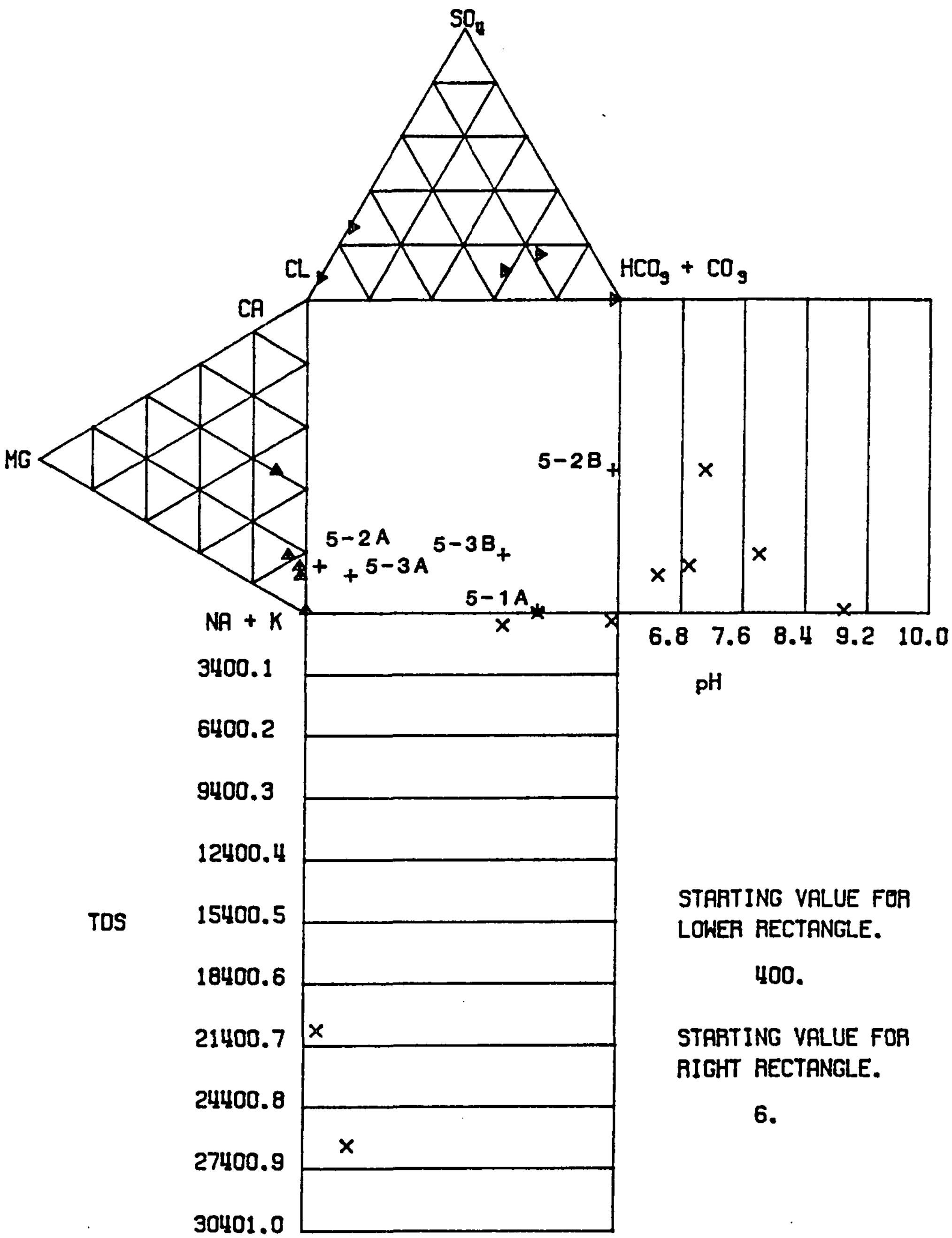
LEGEND

- Alluvial Sand And Silt
- Marker Sand Within Alluvium
- Limestone Clasts Within Alluvium
- Chinle Formation
- Geologic Contact (Queried Where Uncertain)

Horizontal Scale in Feet

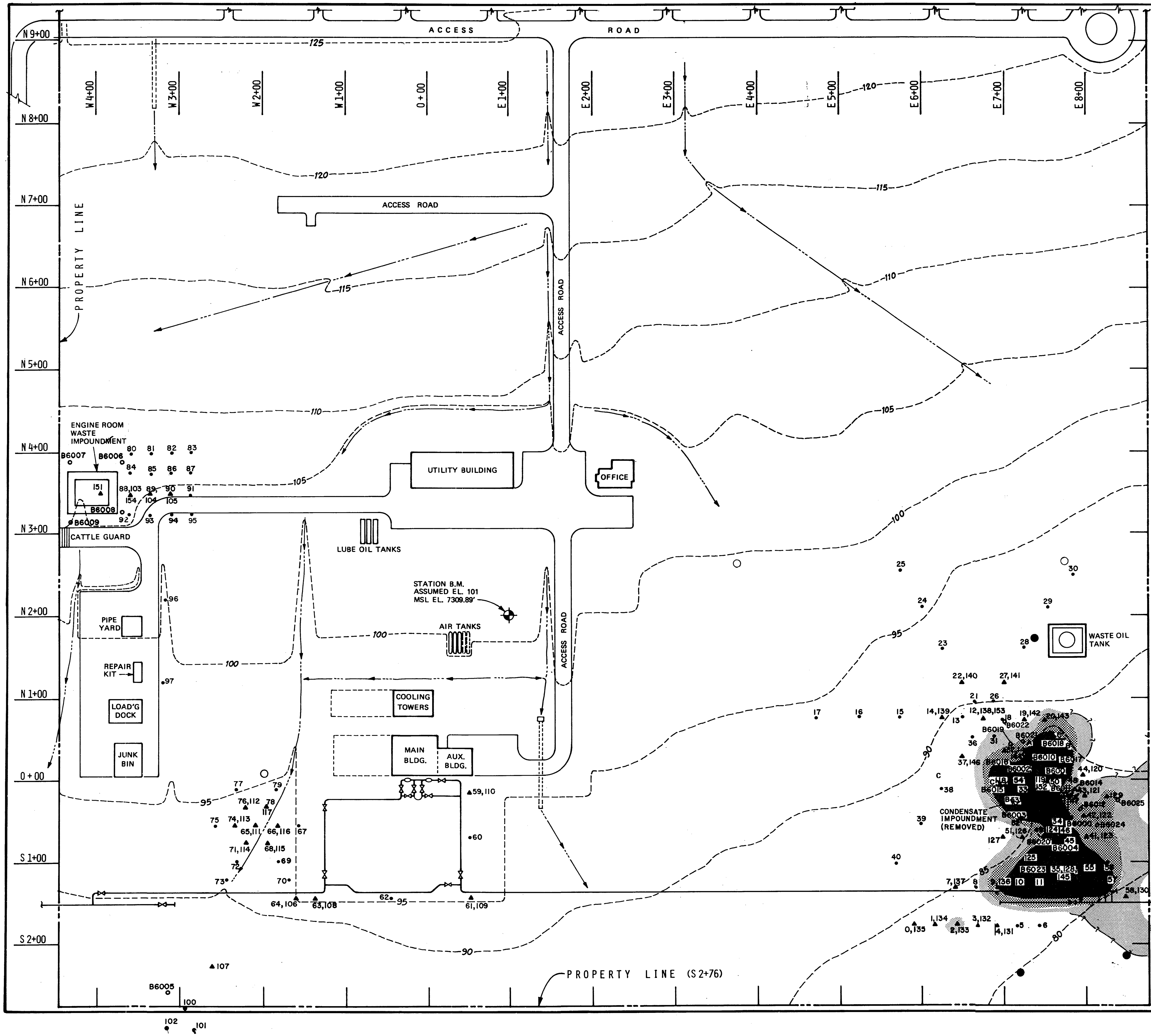
0 50 100

DANIEL B. STEPHENS & ASSOCIATES, INC.	East-West Cross Section Across Station 5				Fig. No. 12
	For: Trans-Western	Proj. No. 89-030	Date: 2/21/90	Plotted by: EE	Checked by: JH



Durov Plot – Station #5

Figure 13 - Durov Plot of Major Ion Analysis of Selected Wells



APPROVED FOR REMEDIAL PLANNING

Limitations: Extent of Contamination

1. The estimates were based on interpretation of available data. These estimates should be re-evaluated as additional information is obtained.
2. The station's facilities may not be completely representative on this plate. For additional station specifications, station personal should be consulted for details.

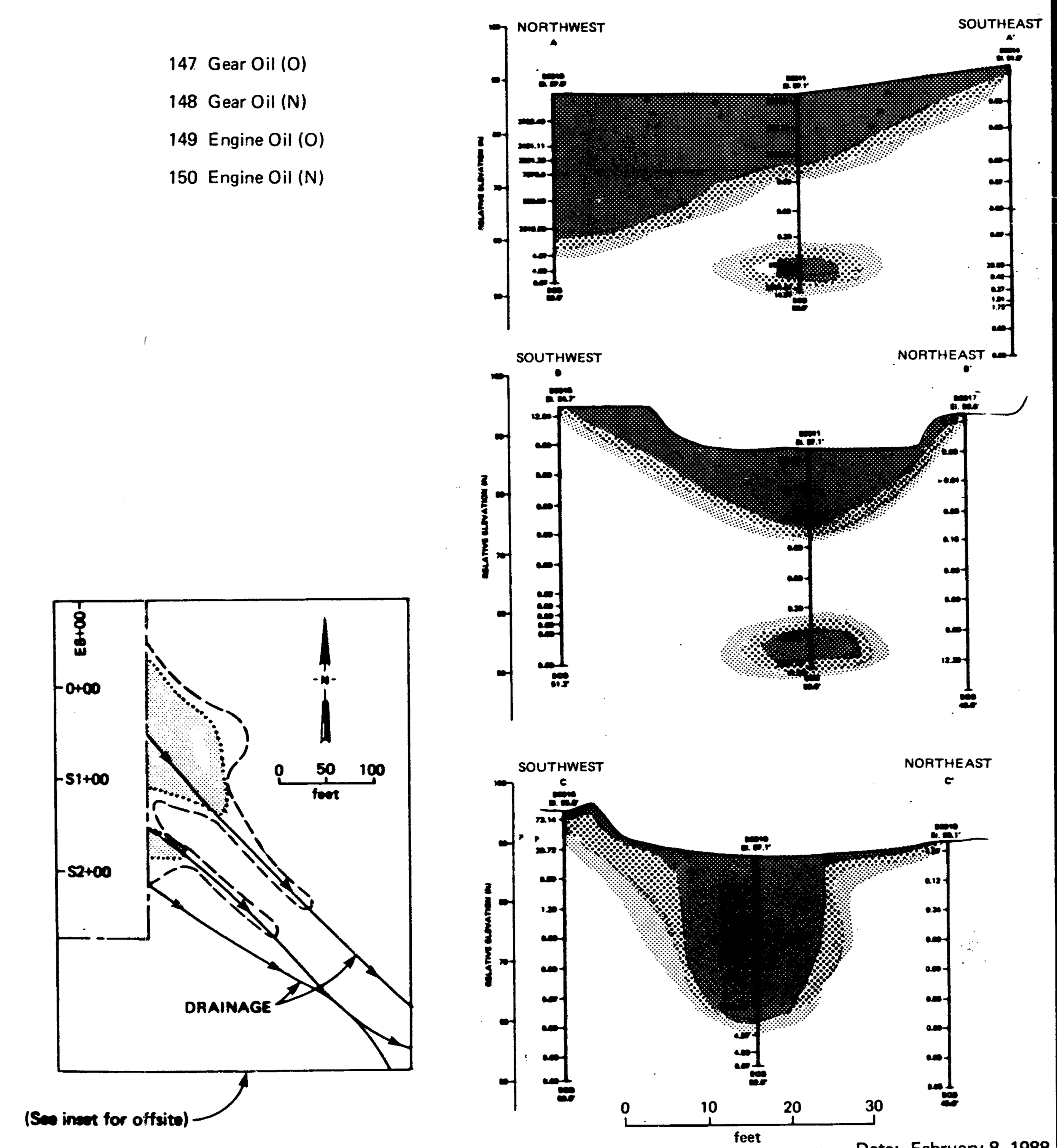
0 30 60 120 180 240 feet

N

LEGEND

- Surface Sample Analyzed by PCB Test Kit Only
- Surface Sample Analyzed by Gas Chromatograph
- Boring Locations
- Transwestern Pipeline Company Well Locations
- Contaminated Area > 25 mg/kg PCB
- > 50 mg/kg PCB
- Test Well Locations
- > 200 mg/kg PCB

147 Gear Oil (O)
148 Gear Oil (N)
149 Engine Oil (O)
150 Engine Oil (N)



Date: February 8, 1988

CONCENTRATION OF PCB IN SOIL AT TRANSWESTERN PIPELINE COMPRESSOR STATION 5

Daniel B. Stephens & Associates, Inc.

Project No. 89-030

From Woodward-Clyde Consultants, 1988

FIGURE 14.