Rio Grande Watershed Study, San Acacia Surface Water - Groundwater Investigation Data Summary

S.S. PAPADOPULOS & ASSOCIATES, INC.
Boulder, Colorado

December 10, 2010

3100 Arapahoe Avenue, Suite 203, Boulder, Colorado 80303-1050 • (303) 939-8880

Rio Grande Watershed Study, San Acacia Surface Water-Groundwater Investigation Data Summary

Prepared for:

New Mexico Interstate Stream Commission

Prepared by:

S.S. PAPADOPULOS & ASSOCIATES, INC.
Boulder, Colorado

December 10, 2010

3100 Arapahoe Avenue, Suite 203, Boulder, Colorado 80303-1050 • (303) 939-8880

Table of Contents

List of Figures

List of Tables

List of Appendices

1.0 INTRODUCTION

The New Mexico Interstate Stream Commission (NMISC) initiated plans for comprehensive investigation of surface water-groundwater conditions along the Rio Grande between San Acacia and Elephant Butte Reservoir in 2000, recognizing that understanding hydrologic conditions in this reach was critical for meeting environmental, flood management and water delivery objectives. Available hydrologic data in this reach were limited, with only a few monitoring wells present in the riparian corridor and few hydrologic studies that addressed surface water-groundwater interactions. Throughout the following decade, significant work was conducted to expand hydrologic understanding in the San Acacia reach. This report summarizes the geologic, groundwater and surface water data collected in the near-river environment in this reach during the past decade, under a series of efforts that collectively became known as the "Rio Grande Watershed Study".

The Rio Grande Watershed Study (Study) involved the installation, testing and monitoring of wells and surface-water elevation gages along transects that cross the Rio Grande and the Low Flow Conveyance Channel (LFCC) between San Acacia and Elephant Butte Reservoir. The installation and testing phase of the project was jointly funded by the New Mexico Interstate Stream Commission (NMISC) and the U.S. Army Corps of Engineers (ACOE) under Section 729 of the Water Resources Development Act (WRDA 729) and was implemented by S. S. Papadopulos & Associates, Inc. (SSPA). SSPA and NMISC developed a long-term water-level monitoring plan that was carried out by graduate students from the New Mexico Institute of Mining and Technology (NMIMT), under the direction of Dr. Robert Bowman, from 2003 through the spring of 2006. From June 2006 through mid-2010, monitoring was performed by SSPA, at which time monitoring was transitioned to the NMISC. Additionally, water quality monitoring and analysis was conducted by NMIMT graduate students during the period 2002 to 2005.

This report provides an overall description of the Study and the activities performed over the past decade, along with a compilation of data collected to date. More detailed information on the individual component activities can be found in supporting reports which are referenced or included as appendices to this report. The NMISC maintains a Microsoft Access database of all data collected under the Study. This data is public and available to anyone who requests it.

Other studies undertaken by the NMISC during the past decade to support understanding of environmental hydrology in the San Acacia reach included seepage investigations of river, drain and canal segments; geomorphology studies; ecosystem and habitat evaluations; and, the development of surface water and groundwater models. Those efforts are summarized in other reports, but in many instances, were interrelated or benefited from the data collection program summarized in this report.

2.0 BACKGROUND

The San Acacia reach of the Rio Grande is the reach extending from the San Acacia Diversion Weir to Elephant Butte Reservoir (Figure 1). Losses from the surface-water system in this reach occur due to flow overbanking, seepage to groundwater, and evapotranspiration losses associated with an extensive riparian system. Understanding losses and surface water–groundwater exchanges in this reach are important to managing water and meeting Rio Grande Compact obligations at Elephant Butte Reservoir.

The Low Flow Conveyance Channel (LFCC) plays an important role in the hydrologic system between San Acacia and Elephant Butte Reservoir. The LFCC was constructed in 1950s to convey river water to Elephant Butte when flows in the river were low, thereby reducing evaporation and more efficiently conveying water to the reservoir. The LFCC is a manmade, 50-foot wide, rock-lined channel with a bottom elevation below the river bottom elevation. It parallels the river from San Acacia diversion dam to Elephant Butte Reservoir and is the topographic low point in the valley for the majority of its length. It conveyed the full flow of the Rio Grande from San Acacia to the Elephant Butte Reservoir through most of the 1960s and 1970s. Diversions to the LFCC ceased in 1985 when lower sections of the LFCC were inundated and buried with sediment. Since then, the LFCC has carried only groundwater drainage and irrigation return flows. These flows still provide for irrigation diversions for the Middle Rio Grande Conservancy District (MRGCD) at Lemitar, Socorro, and Neil Cupp, and for the Bosque del Apache at its north boundary and at a location in the middle of the refuge.

In addition to the LFCC, agricultural drains and canals play an important role in the hydrologic system in the San Acacia reach. In this reach, active canals and drains exist only on the west side of the river, although some remnant structures still exist on the east side. The canals are generally elevated above the land surface and deliver irrigation water to farmland. The drains are significantly lower, and serve to drain any excess groundwater from the system in order to prevent water-logging of agricultural lands.

Among the most important canals and drains in this reach are the Socorro Main Canal, the Socorro Riverside Drain, and the Elmendorf Drain. The Socorro Main Canal begins at San Acacia and carries irrigation water from the north as well as river water diverted at the San Acacia Diversion Dam. The Socorro Riverside Drain parallels the Socorro Main Canal until it joins the Elmendorf Drain near Bosque del Apache. The Elmendorf Drain returns excess irrigation and drainage water to the LFCC in two locations south of Bosque del Apache.

The network of channels near the Rio Grande, including the LFCC, drains and canals, influence the occurrence of river gains and losses and the nature of groundwater conditions in the near-river zone. For this reason, the Study includes data collection from sets of shallow wells along transects oriented orthogonal to the river with varying distances to nearby channels; and, surface water elevations are collected at selected channel locations.

3.0 FIELD INVESTIGATIONS

Seven monitoring transects were installed as part of the Study in 2003 (SSPA, 2003), including both groundwater monitoring wells and surface-water staff gages (Figure 1). Five of the seven transects include wells and staff gages on both the east and west sides of the river. An additional transect, the NBB (North Bosque Boundary) transect, contains wells previously installed by the Bureau of Reclamation and surface-water staff gages installed in the river and the LFCC as part of more recent work by the NMISC.

3.1 Well Drilling and Installation

Complete drilling and installation details are provided in a Technical Memorandum (SSPA, 2003) included as Appendix A. Locations of wells and staff gages along eight transects are shown on Figures 2a to 2h. Table 1 provides the well construction details for wells drilled as part of the Study. Well coordinates and construction details are included in the Project Database. The well locations and depths were selected to facilitate evaluation of hydraulic characteristics, horizontal and vertical gradients, surface-water/groundwater interaction, and groundwater flow direction in the aquifer underlying and adjacent to the river. At each transect, at least one boring extends to, or beyond, the inferred contact between the unconsolidated materials and the underlying Santa Fe Group bedrock. This contact is generally close to 100 feet below ground surface. At five transects, a large diameter test extraction well and an adjacent set of aquifer test monitoring wells were installed to augment the standard line of wells.

Wells are identified with a standard naming convention. The first letters in the well ID indicate the transect: SAC – San Acacia, ESC – Escondida, BRN – Brown Arroyo, HWY – Highway 380 bridge, SBB – south Bosque del Apache boundary, SMC – San Marcial, SFC – South of Fort Craig. The next letter indicates whether the well is east or west of the river (E or W). After the east or west designation, the wells are numbered sequentially within each side of a transect. At many borehole locations, two wells are nested in the same borehole. The last letter indicates the approximate depth of the well, with “A”, “B” or “C” representing shallow, intermediate or deep wells, respectively. For example, well SAC-W02B is on the west side of the river at San Acacia and is an intermediate depth well.

At each transect, one deep borehole was advanced through river alluvial materials into the inferred uppermost layer of the semi-consolidated Santa Fe Group, typically, about 100 feet below ground surface. Drilling was performed with hollow stem augers. Continuous core soil samples were obtained with a split spoon sampler. Specified samples were retained for analysis by a soils physical testing laboratory. Boring logs and geologic cross sections for each transect are included in the Technical Memorandum (SSPA, 2003) in Appendix A. Photocopies of field log books are available but are not reproduced in this report.

The San Acacia transect east-side well locations were inaccessible to a large drilling rig. Monitoring wells at those locations were therefore drilled with a small, direct-push, GeoProbe rig. Geologic samples were not collected during GeoProbe drilling for these wells. However, geophysical logging for electromagnetic conductivity was performed, and the resulting geophysical logs are provided in Appendix A.

Five-foot well screens were installed in wells designated deep or intermediate, and 15-foot well screens were installed in wells designated shallow. The depth of individual screens was selected based on the lithology observed in the exploratory boreholes. In general, the shallow / water-table wells were installed across the water table with screens from approximately 5 to 20 feet below ground surface. Intermediate wells were screened at approximately 45 feet below ground surface, or midway between the water table and the screened interval of the deep monitoring well. Deep wells were screened in the interval just above the inferred Santa Fe Group, about 100 feet below ground surface. Boreholes for monitoring wells were at least 6 inches in diameter. At many locations, 10-inch borings were drilled to allow for the installation of a pair of nested monitoring wells in a single borehole. All monitoring wells were constructed with 2-inch diameter Schedule 40 PVC with 0.010-inch slot PVC screens. Monitoring well filter pack is natural pack or 20-40 silica sand. Figure 3 shows the approximate dimensions and design of the monitoring well surface completion.

Extraction wells were drilled with a combination of mud and air rotary methods. All boreholes were 13 ¾ -inch diameter to accommodate a 10-inch diameter Schedule-40 PVC well. The total depths and screened intervals were selected based on the subsurface lithology encountered at the specific transect, but total depths range from 55 to 80 ft below ground surface (bgs). Extraction well screens range from 0.030-inch to 0.090-inch slots and filter packs range from 4-8 to 10-20 silica sand.

In addition to the 138 new wells installed by the NMISC, approximately 38 additional wells have been monitored as part of the Study (Table 2). Most of these wells were field-assessed in 2001 during the planning period for the Study. This well set includes wells installed by the U.S. Bureau of Reclamation in the 1990's. Well construction logs were not located for these wells and well completions are unknown. Place-holder values have been entered into the Project Database based on an assumption that the bottom 10 feet of each well was the screened interval. However, some of the observation wells may consist solely of driven pipe open at the bottom and the openings may be subject to plugging. For this reason, data from these wells should be interpreted with caution. Several other private wells located during the course of the Study have also been monitored under this project.

3.2 Staff Gages

In November 2002, staff gages were installed at 25 locations in the Rio Grande, the LFCC, riverside drains, and other surface water bodies and conveyances (Table 3). At least one staff gage was installed in the river at each of the seven transects. The intent was to measure surface water elevations for comparison to groundwater elevations. Since rating curves were not developed for the staff gages, they do not measure discharge. In-Situ MiniTROLL data loggers were initially installed in approximately 20 of the staff gages.

Figure 4 shows a schematic of the staff gage design. The lower portion of the gage is a 1.25-inch-diameter threaded steel pipe that was driven into the channel substrate to a depth of at least five feet or to the point of refusal. A threaded reducing collar and 6-foot long section of 2-inch diameter pipe was attached above. The 2-inch pipe has approximately six pre-drilled holes of ¼ to ½-inch diameter in the area from 8-inches to 1.5 feet above the bottom of the channel to allow water inflow and outflow with changing streamflow stage conditions. A linear-scaled rule was attached to the outside of the 2-inch pipe, graduated every 0.01 foot and marked every 0.1 and 1 foot. Each gage was oriented such that the graduations were visible from the bank and the drainage holes were oriented downstream. The MiniTROLL data loggers were suspended from a bolt at the top of the pipe using Kellums grip hangars and the pipe was covered with a 2-inch threaded pipe cap.

The original staff gages were monitored beginning in 2002 but proved to be difficult to maintain and operate. The staff gages that were installed in the river worked well for low to moderate river flows; however, the gages could not stand up to high flows and debris and often bent over or simply broke off during high flow events. There are currently no staff gages in the river. Staff gages installed in the LFCC and riverside drains were able to withstand the flows but frequently collected debris and were not visible for monitoring. At a few locations, drain staff gages were damaged during ditch maintenance. Due to these problems, staff gage monitoring was discontinued between 2006 and 2009.

In 2009, SSPA rehabilitated or reinstalled the LFCC staff gages at six transects. New staff gages were installed at Escondida, South Bosque Boundary and South of Fort Craig; and, staff gages were rehabilitated at San Acacia, Brown Arroyo and Highway 380. At San Marcial, the LFCC is gaged by the U.S. Geological Survey, therefore, a staff gage was not installed at this transect.

The replacement staff gages were installed by pounding a two-inch-diameter steel well point into the bottom of the channel and constructing a walkway from the shore to the top of the well point. The well points were welded to the walkways to further stabilize the structures. Measuring points were surveyed at the tops of the staff gages, so that the staff gages could be monitored for water elevation using the same method employed for the groundwater wells. The USGS San Marcial LFCC staff gage was also surveyed to facilitate water elevation calculations in the project database. Solinst Levelogger Gold data loggers were installed and electronic monitoring was initiated in May 2009. Solinst Baraloggers were installed in the LFCC staff gages at the San Acacia (SAC), Highway 380 (HWY), and San Marcial (SMC) transects, to allow for compensation of the electronic data for barometric pressure changes. Monitoring of the newly reinstalled or rehabilitated staff gages has continued to the present.

4.0 GEOLOGY

The geology in the study area consists of alluvial materials associated with the Rio Grande, underlain by Quaternary to Tertiary semi-consolidated sediments of the Santa Fe Group, which consists of alluvial and colluvial rift-fill deposits. Sands and gravels were the most common materials encountered in the alluvium during drilling. However, numerous clay and silt layers were found interspersed within the sand and gravel. The contact between the unconsolidated alluvium and underlying Santa Fe Group was often difficult to identify. The Santa Fe Group materials immediately underlying the alluvium are only slightly indurated and are lithologically similar to the alluvium. The contact was inferred by an increase in drilling resistance and higher blow counts in the standard penetration tests when samples were collected.

4.1 Laboratory Grain Size Analysis and Borehole Data

Laboratory grain-size distribution and hydrometer/Atterburg Limit testing for fine-grained samples were performed on samples from most transects. Samples were collected at a minimum interval of 10 feet in the deep exploratory boreholes. The on-site geologist selected samples for lab analysis, with emphasis on samples from depths in which lithologic changes were noted. The grain-size analyses generally confirmed the observations made from inspection of geologic samples in the field by the on-site geologist. Grain size analyses and graphs depicting the grain-size distribution with depth are included in the Technical Memorandum (SSPA, 2003), reproduced in this report as Appendix A.

At the HWY, SBB and SMC deep wells, the alluvium can be described as having two major lithologic horizons: (1) an upper zone of finer-grained materials (fine-medium sand at HWY and SBB, and very-fine grained materials at SMC); and (2) a lower zone of coarse sand and gravel. The SAC transect exhibits a similar trend with coarsening towards the bottom of the drilled interval, although with a thicker, relatively uniform interval of fine-to medium grained materials between the shallow very-fine grained materials and the deep coarse-grained materials. At the SAC well, the Santa Fe Group bedrock was not encountered at the final borehole depth of 129 feet. At the ESC deep well, a shallow, relatively coarse-grained interval was encountered that is separated from the deeper coarse material by several feet of silty fine to medium sand. At the BRN transect deep well, fine and medium grained materials were interspersed above a very coarse-grained deeper horizon.

5.0 AQUIFER PROPERTIES

Field and laboratory testing was conducted to characterize the hydrologic properties of the shallow aquifer. The field tests included stepped-rate and constant-rate tests at the HWY and ESC transects in 2003; and, reconnaissance aquifer tests at three irrigation wells in 2002. These tests and the laboratory analyses are described in this section.

5.1 Aquifer Tests

As part of the Study, SSPA performed aquifer tests at extraction wells on the ESC and HWY transects and analyzed the data from the HWY test. At each location, SSPA conducted a stepped-rate test to provide information for selecting the pumping rate and other design elements of the 48-hour constant rate test. SSPA then conducted and monitored a 48-hour constant-rate pumping test. The aquifer tests at both locations and the analysis at the HWY transect are described in a report (SSPA, 2004) reproduced here as Appendix C.

At the HWY transect, groundwater was pumped from well HWY-W08EX at a rate of 76 gallons per minute. The well is 10 inches in diameter and screened from 35 to 59 feet below ground surface in unconsolidated alluvium. HWY-W08EX is located approximately 220 feet west of the Rio Grande and 190 feet east of the LFCC. Two monitoring wells were located at distances of 5 and 16 feet from the extraction well for the specific purpose of monitoring during the aquifer test. A total of thirteen monitoring points (six wells with screens across the water table, six with screens within the interval being tested, and one with a screen situated at the top of the underlying Santa Fe Group bedrock), located within 165 feet of the extraction well, were monitored during the test.

Results from the aquifer test performed at the HWY transect suggested "leaky aquifer" behavior with water-table conditions at the top of the aquifer. These results were attributed to the depositional arrangement of clay, sand, silt and gravel in the aquifer. The test was analyzed using both analytical and numerical methods; the numerical methods were preferred for ease in handling vertical heterogeneity.

After correcting the data for a declining regional groundwater table, SSPA applied two modeling approaches: a radial-flow finite-difference model (RZ model) and a MODFLOW finite-difference model. The hydraulic conductivity at the HWY location was estimated to be in the range of 65 to 70 feet per day in the upper 50 feet of the alluvial aquifer and 150 feet per day in the lower 30 feet of the alluvial aquifer. The specific yield was simulated as 0.20 at the water table. Vertical to horizontal hydraulic conductivity ratios of 0.3 to 0.7 for the deeper 60 feet and 0.05 to 0.08 for the upper 30 feet of the aquifer were derived from these analyses.

At the ESC transect, groundwater was pumped from well ESC-E05EX at a rate of 90 gallons per minute. The well is 10 inches in diameter and is screened from 30 to 49 feet below ground surface in unconsolidated alluvium. ESC-E05EX is located approximately 230 feet east of the Rio Grande. Nine wells (four with screens across the water table, four with screens within the interval being tested, and one with a screen situated at the top of the underlying Santa Fe Group bedrock), located within 60 feet of the extraction well, were monitored during the test. Two additional monitoring wells were located 1,200 feet to the east and eight wells were located across the Rio Grande to the west. These farther wells were monitored intermittently during the test. Analysis of the ESC aquifer test was deferred due to budgetary constraints. However, a cursory review indicates that the test was successful in obtaining data suitable for analysis. Barometric trends during the test indicate that barometric correction will be required. Consideration of partial penetration and vertical anisotropy will likely be important for this analysis, as was the case with the HWY test.

Prior to the drilling and testing conducted as part of this Study, the NMISC implemented reconnaissance aquifer tests at three irrigation wells (Hydrosphere, 2002). A report summarizing these tests is provided in this report as Appendix D. The wells are located near Socorro, within ¾ of a mile of the Rio Grande. The wells are approximately 100 to 120 feet deep and screened in the shallow alluvial aquifer. The wells were pumped at constant rates ranging from 350 to 1,300 gallons per minute for periods of 8 to 24 hours. The tests were analyzed using several analytical methods, resulting in a tabulation of hydraulic conductivities, ranging from 130 to 260 feet per day (Appendix D, Hydrosphere, 2002). Similarly, a series of values for specific yield are provided. In a section on “Caveats”, the Hydrosphere report emphasizes several uncertainties that may have influenced the tests and analyses.

5.2 <u>Laboratory Testing</u>

In addition to aquifer pumping tests, laboratory tests were conducted on samples from the five transects. Measured soil characteristics included porosity, percent saturation, saturated hydraulic conductivity and unsaturated hydraulic conductivity. Analyzed samples were collected from the deep, exploratory boreholes, from the first fine-grained lithologic layer that lies below the elevation of the bottom of the riverbed, being the layer that controls the interaction between the river and groundwater. A summary of the lab results for the five borehole samples and laboratory results are provided in Appendix A. Porosities ranged from approximately 40 to 50% with saturation in the 90% range. Saturated conductivities ranged from 10^{-6} to 10^{-8} cm/sec (2.8 x 10^{-5} to 2.8 x 10^{-3} ft/day).

6.0 WATER LEVELS

Water level data have been collected from 2001 through the present, both manually and by electronic data logger, from both groundwater and surface water monitoring sites. Manual data have been collected monthly from the 138 project monitoring wells and from additional existing wells. Electronic data have been collected from electronic water-level data loggers installed in selected project wells and staff gages, and downloaded approximately once every three months.

SSPA installed a total of 75 In-Situ MiniTROLL data loggers in project wells and staff gages just after completion of well and staff-gage construction in 2002 and 2003. Since then, data loggers have been rotated among sites, depending on NMISC priorities and access to specific locations. In 2009, Solinst Levelogger Gold data loggers were installed in the newly rehabilitated LFCC staff gages and in some wells that are difficult to access (Solinst Levelogger Gold data loggers have a long battery life and therefore can be downloaded less frequently).

6.1 Surface Water Levels

Approximately 20 of the 25 staff gages installed as part of this project were instrumented in 2002 with In Situ MiniTROLL data loggers. All 25 of the staff gages were also monitored by sight on a monthly basis in the early years of the project. Data gaps are present when the gages became inaccessible or inoperable for reasons discussed previously. Appendix E contains hydrographs showing the water surface elevations at the staff gages throughout the period of record.

In addition to staff gage measurements, occasional surface water elevations were measured by surveying the water surface with a standard survey rod. These locations and measurements are entered into the Project Database but are not reproduced in graphical form in this report.

6.2 Groundwater Levels

Groundwater data has been collected regularly at approximately 175 wells over the past seven years. Monthly manual data collection began at the previously existing wells in the fall of 2001. Manual and electronic data collection began at the project wells in the spring of 2003. Currently, approximately 45 of the wells are instrumented with In Situ MiniTROLL or Solinst

Levelogger Gold data loggers. All of the wells are monitored manually with a water level meter on a monthly basis and data loggers are downloaded approximately every three months. Appendix F contains hydrographs of groundwater levels at each monitored well. All measurements are included in the Project Database.

7.0 WATER CHEMISTRY

As part of Study, NMIMT graduate students conducted eleven water-quality monitoring events. In each event, field parameters were measured and samples were collected for laboratory analysis from selected wells and surface-water locations. Surface water locations were sampled using grab-sample techniques. Groundwater samples were collected using a peristaltic pump with low-flow groundwater sampling procedures in which water is purged from the well at a low flow rate (usually less than 0.5 liters per minute) until water levels and field parameters of pH, conductivity, temperature, redox potential, and dissolved oxygen stabilize. Samples analyzed at the New Mexico Bureau of Geology and Mineral Resources. Sampling events were scheduled to coincide with the summer irrigation season (June), during late irrigation (October or November), and during the winter, non-irrigation season (February).

Samples were analyzed for basic cations and anions and other constituents that provide insight on recharge and discharge pathways. Most samples were analyzed for the following constituents:

- bicarbonate,
- boron,
- bromide,
- calcium,
- chloride,
- electrical conductivity,
- fluoride,
- hardness,
- magnesium,
- nitrate,
- pH,
- phosphate,
- potassium,
- silica,
- sodium,
- sulfate, and
- total dissolved solids.

Selected samples were also analyzed for:

- alkalinity,
- aluminum,

- arsenic,
- barium,
- cadmium,
- carbonate,
- chromium,
- cobalt,
- copper,
- iron,
- lead,
- lithium,
- manganese,
- mercury,
- molybdenum,
- nickel,
- selenium,
- silver,
- strontium,
- zinc.

The results of the sampling and analysis program are provided in Appendix G and are included in the Project Database. Field measurements (electrical conductivity, pH, dissolved oxygen, temperature, and redox potential) are included in the Project Database but are not reproduced in this report. Copies of the full sampling and analysis plan and original laboratory data reports are available at the NMISC.

In addition to analytical data, Appendix G contains summary figures and tables that provide an overview of the results. Among these are Stiff diagrams, prepared by the NMIMT graduate students, depicting surface and groundwater chemistry in February and June of 2002.

8.0 USGS FLOW DATA

The USGS currently maintains four flow gages in the main channel of the Rio Grande (termed "Floodway" at San Acacia and San Marcial) and one flow gage in the LFCC between San Acacia and Elephant Butte. The names and gage numbers are:

- Rio Grande Floodway at San Acacia, NM 08354900
- Rio Grande at Bridge near Escondida, NM 08355050
- Rio Grande above US Highway 380 near San Antonio, NM 08355490
- Rio Grande Floodway at San Marcial, NM 08358400
- Rio Grande Conveyance Channel at San Marcial 08358300

The gages at San Acacia and San Marcial have periods of record that go back to October 1958 and October 1949, respectively. The gages at Escondida and Highway 380 were installed more recently with periods of record starting in April and July of 2005, respectively. Appendix H provides hydrographs showing available flow and stage data from these four gages from April 2003 to June 2010. In order to compare to groundwater and other surface water elevations, the stage at the San Acacia, San Marcial, and the LFCC at San Marcial gages are shown as elevation relative to mean sea level. The Escondida and San Antonio gages have not yet been surveyed; therefore, gage height is shown.

9.0 PROJECT DATABASE

The NMISC and SSPA have compiled the data collected under this Study into two Microsoft Access databases: the Rio Grande Field Collection Database (RGFCDB), North and South. These databases are also known as San Acacia Surface Water / Groundwater databases, and as the San Acacia Well Monitoring databases. The North database contains data collected at the San Acacia (SAC), Escondida (ESC), and Brown Arroyo (BRN) transects, and the Bureau of Reclamation (USBR) wells at Lemitar, Socorro, North Boundary of the Bosque del Apache National Wildlife Refuge (NBB), and San Marcial transects. The South database contains data from the Highway 380 (HWY), South Bosque Boundary (SBB), San Marcial (SMC), and South of Fort Craig (SFC) transects. The databases were developed in MS Access 2000.

Prior to the publication of this report, a quality assurance review was performed on the data in the database. However, errors may still exist, and the NMISC cannot guarantee the accuracy of all data. Inaccuracies in the data may be present because of equipment malfunctions, physical changes at the measurement site, or for other, unknown reasons. Data users are cautioned to consider this before making decisions based on these data.

Electronic access to the Project Database can be arranged through Page Pegram at the New Mexico Interstate Stream Commission, Albuquerque Office at (505) 383-4051 or page.pegram@state.nm.us.

10.0 REFERENCES AND RELATED STUDIES

The data collected and compiled in the Study have supported and complemented numerous investigations. These include NMISC investigations related to the Rio Grande Watershed Study and other studies that have provided information to support the NMISC in attaining management objectives. Similarly, the data have been invaluable to several investigations conducted as part of the Middle Rio Grande Endangered Species Act Collaborative Program. This section identifies many of these studies by topical area and includes links to electronic reports where available. The reports referenced below also include NMISC reports that relate to surface water-groundwater investigations in the Middle Rio Grande. The NMISC hosts many of these reports at their website: http://www.ose.state.nm.us/publications_isc_reports.html. For reports lacking links, readers may contact the NMISC or the ESA Collaborative Program to determine their availability.

Seepage Investigations and Flow Measurement

Field assessment of flow and seepage conditions along the Rio Grande and the low flow conveyance channel, San Acacia to Elephant Butte. (SSPA, 2001)

Assessment of Flow Conditions and Seepage on the Rio Grande and Adjacent Channels, Isleta to San Marcial, Summer 2001 (SSPA & MEI, 2002) http://www.ose.state.nm.us/water-info/mrg-geomorphology-study/FinalReport.pdf

Winter 2004 Albuquerque Seepage Study. (SSPA, 2004).

October 2007 Albuquerque Seepage Study. (SSPA, December 2007)

February 2008 Isleta Seepage Study. (SSPA, March 2008).

Middle Rio Grande Gaging Station Instrumentation (USGS & SSPA, May 2006) http://www.ose.state.nm.us/PDF/ISC/BasinsPrograms/RioGrande/MRG/disc2/NewUSGS-GagesReport.pdf

Geomorphology

Evaluation of Bar Morphology, Distribution and Dynamics as Indices of Fluvial Processes in the Middle Rio Grande, New Mexico (MEI, March 2006) http://www.ose.state.nm.us/PDF/ISC/BasinsPrograms/RioGrande/MRG/disc4/RG-BarDynamicsReport-3-14-06.pdf

Geomorphic and Sedimentologic Investigations of the Middle Rio Grande Between Cochiti Dam and Elephant Butte Reservoir (MEI, June 2002), http://www.ose.state.nm.us/water-info/mrg-geomorphology-study/geomorphology.html

Sediment Yields from Ungaged Tributaries to the Middle Rio Grande between Bernardo and Elephant Butte Reservoir, 2004 (November 2004 MEI), http://www.ose.state.nm.us/water-info/SanAcacia/SedimentTributaryReport-11-24-04.pdf

Water Supply

Middle Rio Grande Water Supply Study, Phase 3, 2004 (November 2004 SSPA) http://www.ose.state.nm.us/isc_planning_mrgwss.html

Evaluating Hydrologic Effects of Water Acquisitions on the Middle Rio Grande, 2005 (Hydrosphere) http://www.ose.state.nm.us/PDF/ISC/BasinsPrograms/RioGrande/MRG/disc2/HydrologicEffectsReportFinal.pdf

Middle Rio Grande Conservancy District Efficiency and Metering Program, 2002, (December 2002 SSPA), http://www.ose.state.nm.us/water-info/MRGCD-efficiency/index.html

Rio Grande Watershed Study- San Acacia to Elephant Butte

Exploratory and Shallow Well Drilling Rio Grande Watershed Study – Phase I San Acacia Surface Water/Groundwater Investigation (SSPA, December 2003) http://www.ose.state.nm.us/water-info/SanAcacia/DrillingReportSanAcacia.pdf

Technical Memorandum: Highway and Escondida Aquifer Testing, Rio Grande Watershed Study, Phase 1. (SSPA, January 2004)

Groundwater Models

Riparian Groundwater Models for the Middle Rio Grande: ESA Collaborative Program FY03 (SSPA, 2005)

Riparian Ground Water Models for the Middle Rio Grande: ESA Collaborative Program FY04 (March 2006 SSPA) http://www.ose.state.nm.us/publications_isc_mrg_esa_reports.html

Riparian Groundwater Model for the Cochiti Reach, Middle Rio Grande. (SSPA, 2007)

Riparian Groundwater Models for the Middle Rio Grande: ESA Collaborative Program FY07, Bosque del Apache and Ft. Craig Reaches. (SSPA, April 2008)

Riparian Groundwater Models for the Middle Rio Grande: ESA Collaborative Program FY07, Model Refinement. (SSPA, December 2008)

Linked surface water and groundwater model for Socorro and San Marcial basins between San Acacia and Elephant Butte reservoir. New Mexico Interstate Stream Commission, Upper Rio Grande Water Operation Review and EIS, Volume 2, Appendix J, Published April 2007, http://www.spa.usace.army.mil/urgwops/finaleis.asp (N. Shafike, NMISC 2005).

Figures

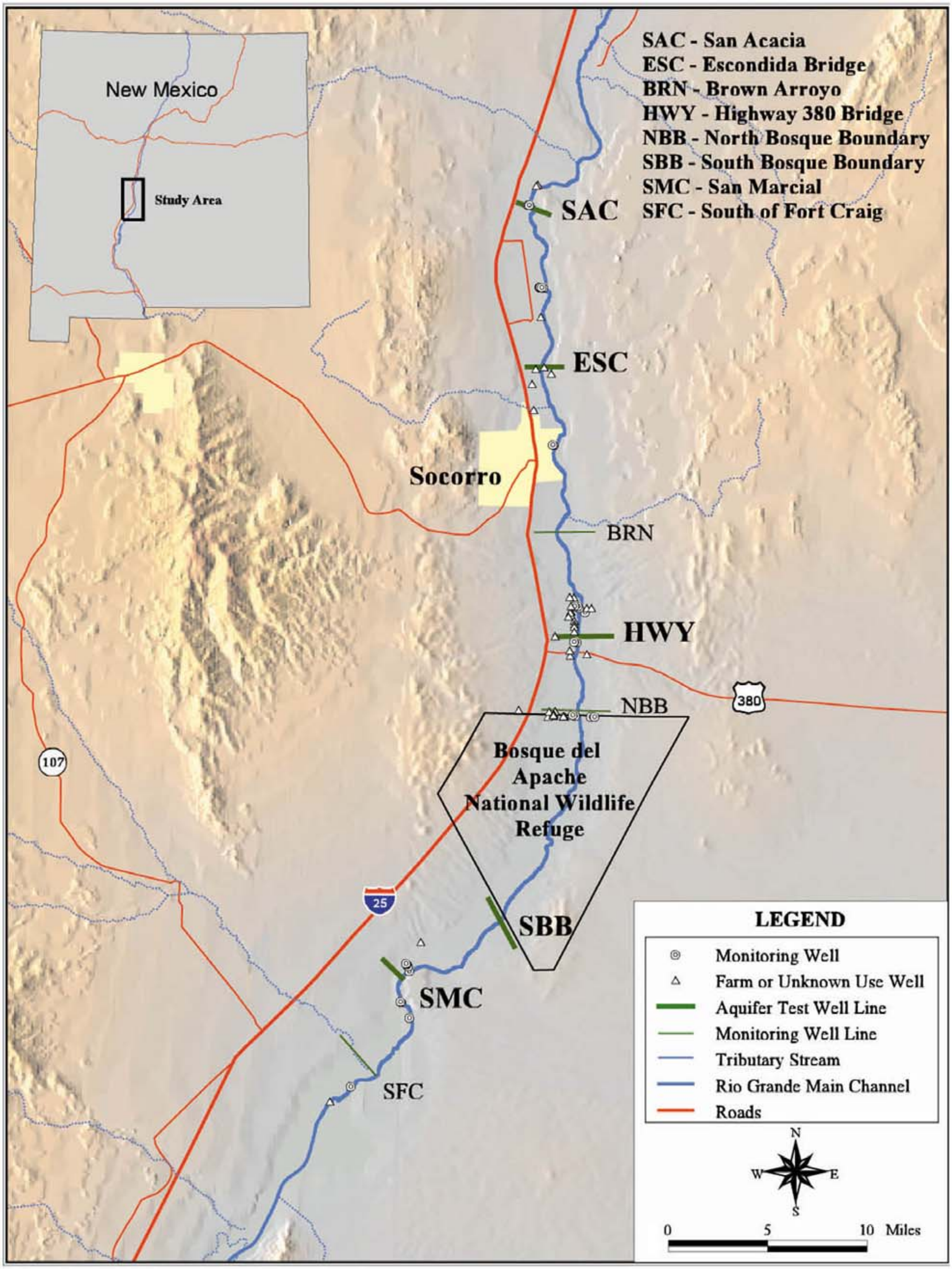

Figure 1. Map of Study Area Showing Well Transects

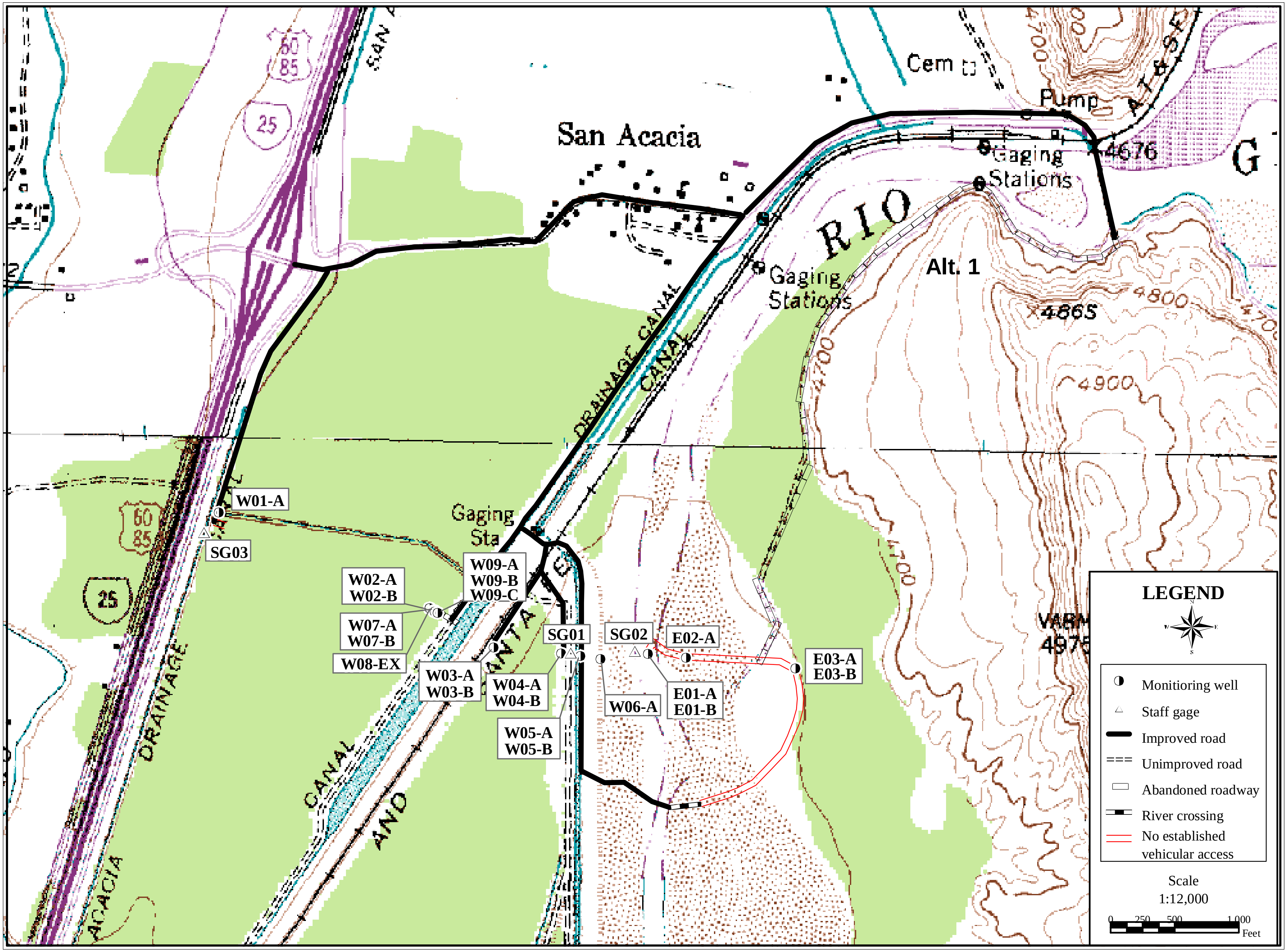

Figure 2a. San Acacia (SAC) Transect Well Locations and Access Roads

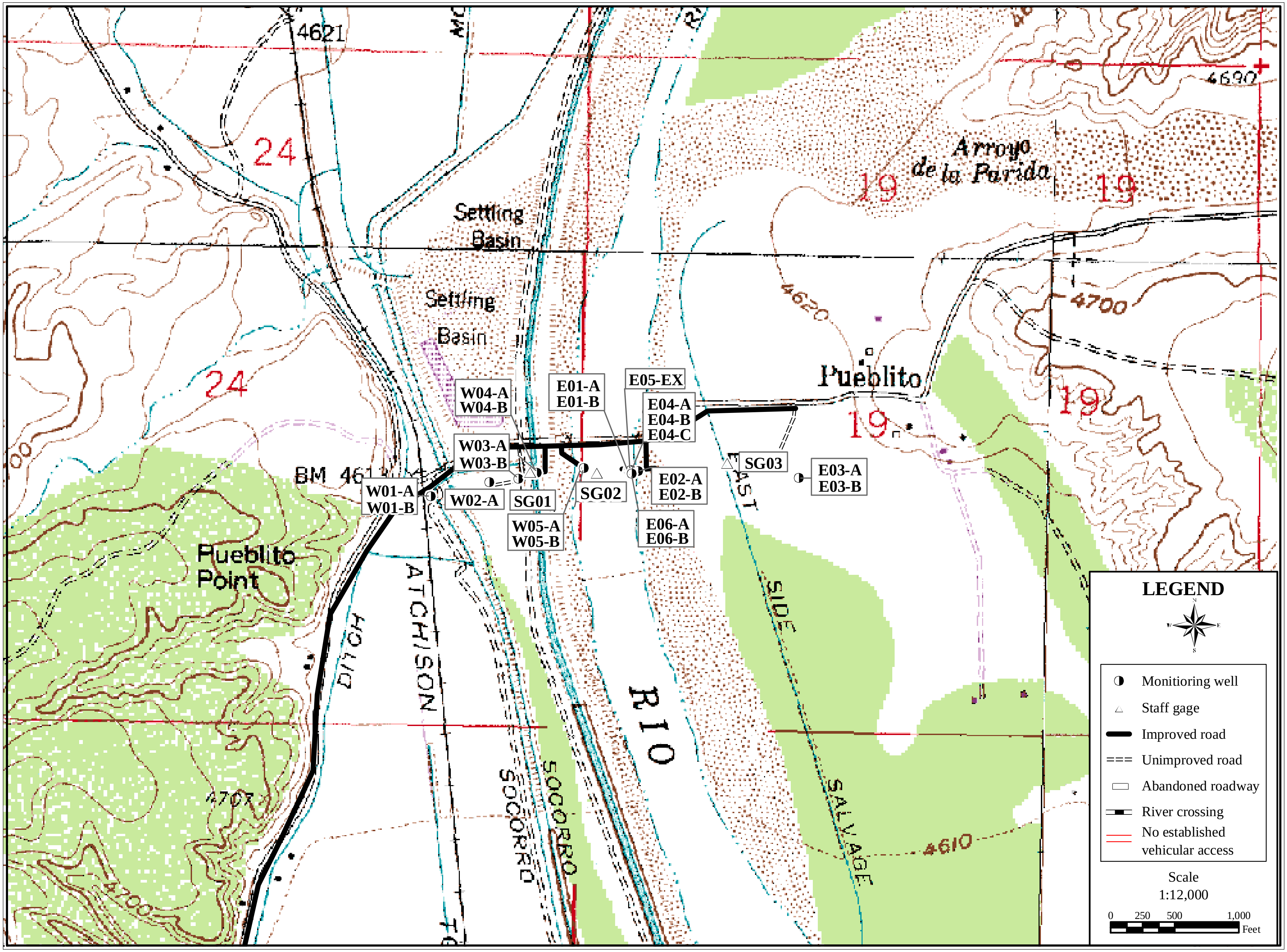

Figure 2b. Escondida (ESC) Transect Original Well Locations and Access Roads

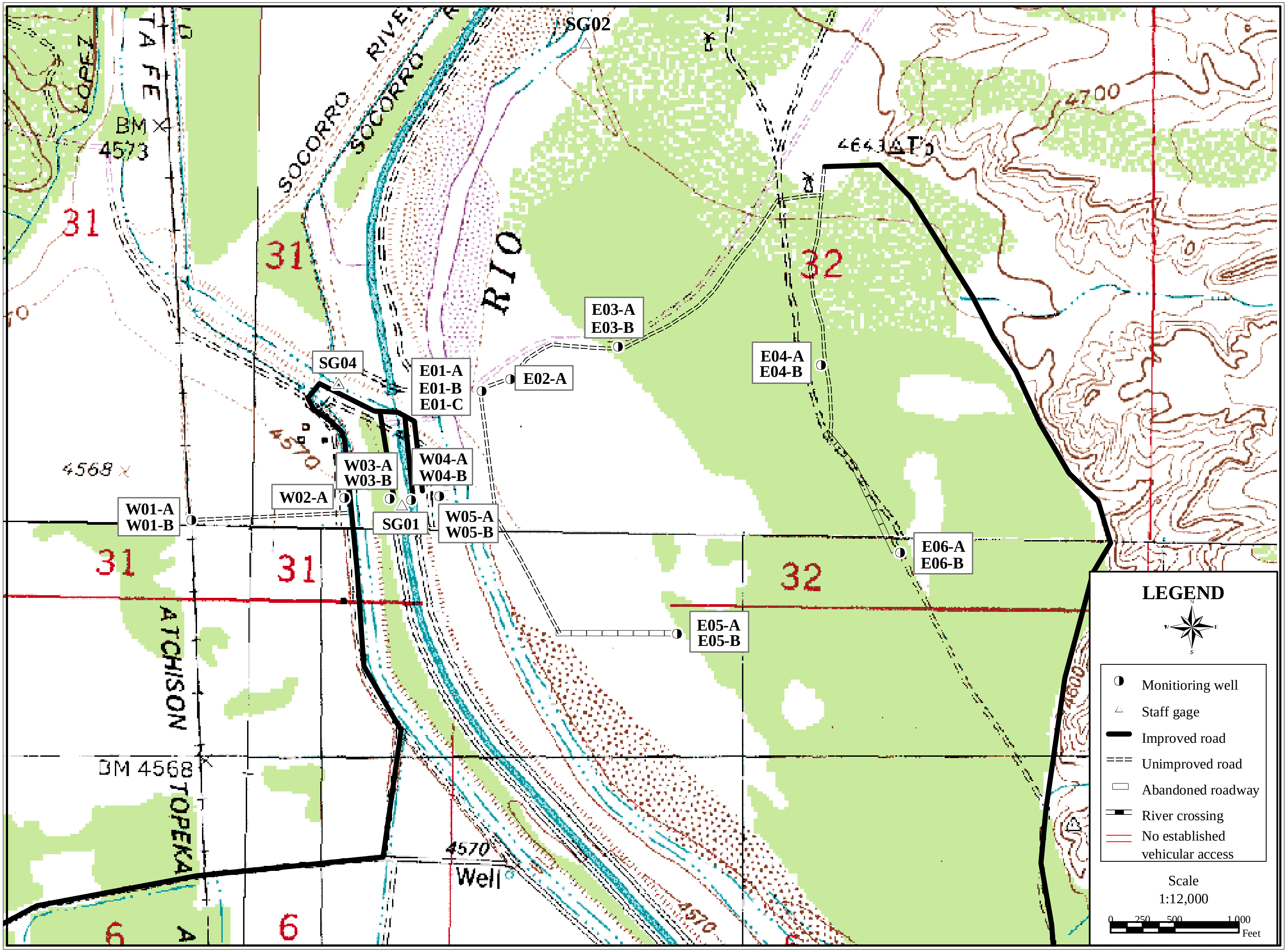

Figure 2c. Brown Arroyo (BRN) Transect Well Locations and Access Roads

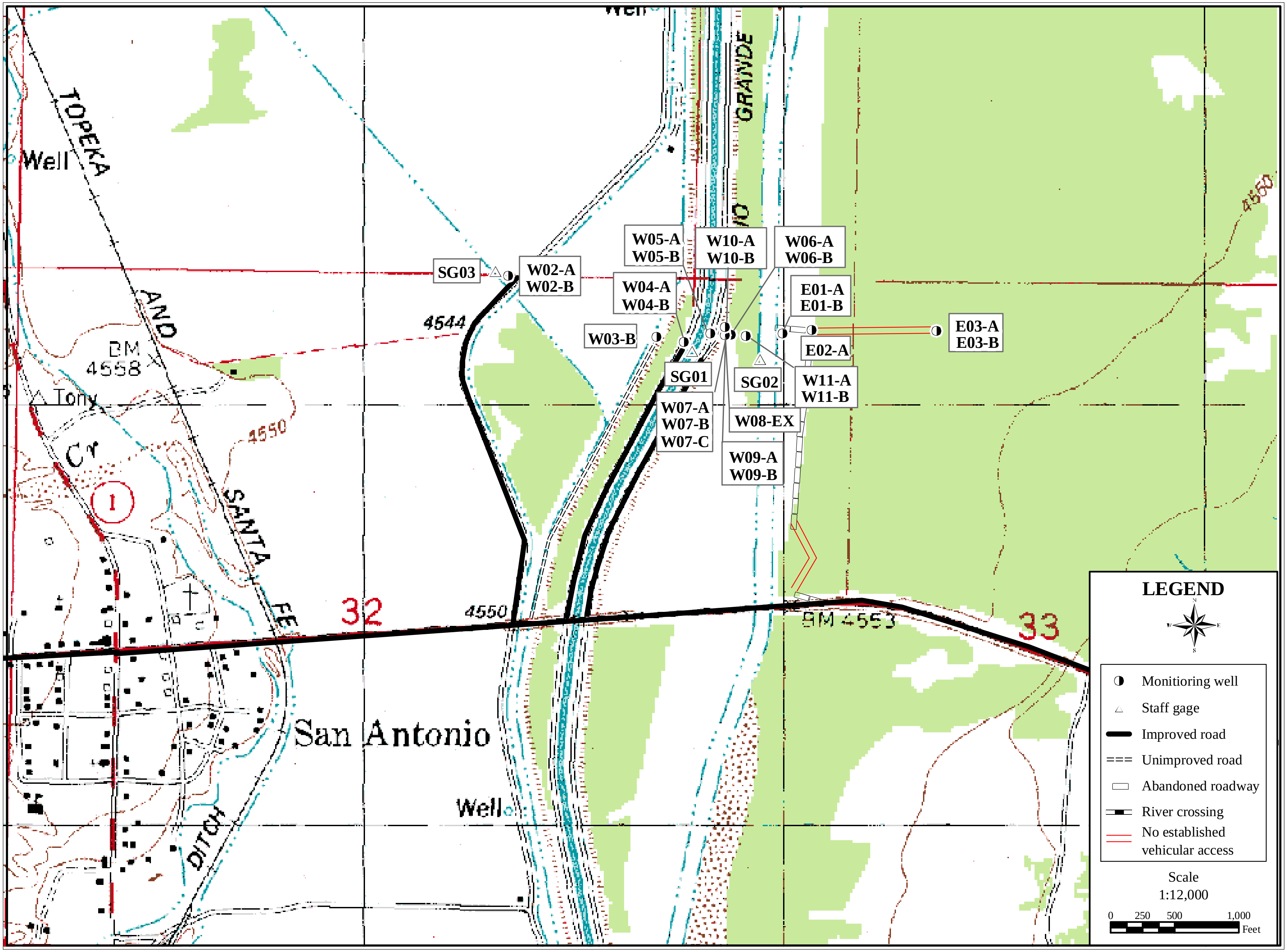

Figure 2d. Highway 380 Bridge (HWY) Transect Well Locations and Access Roads

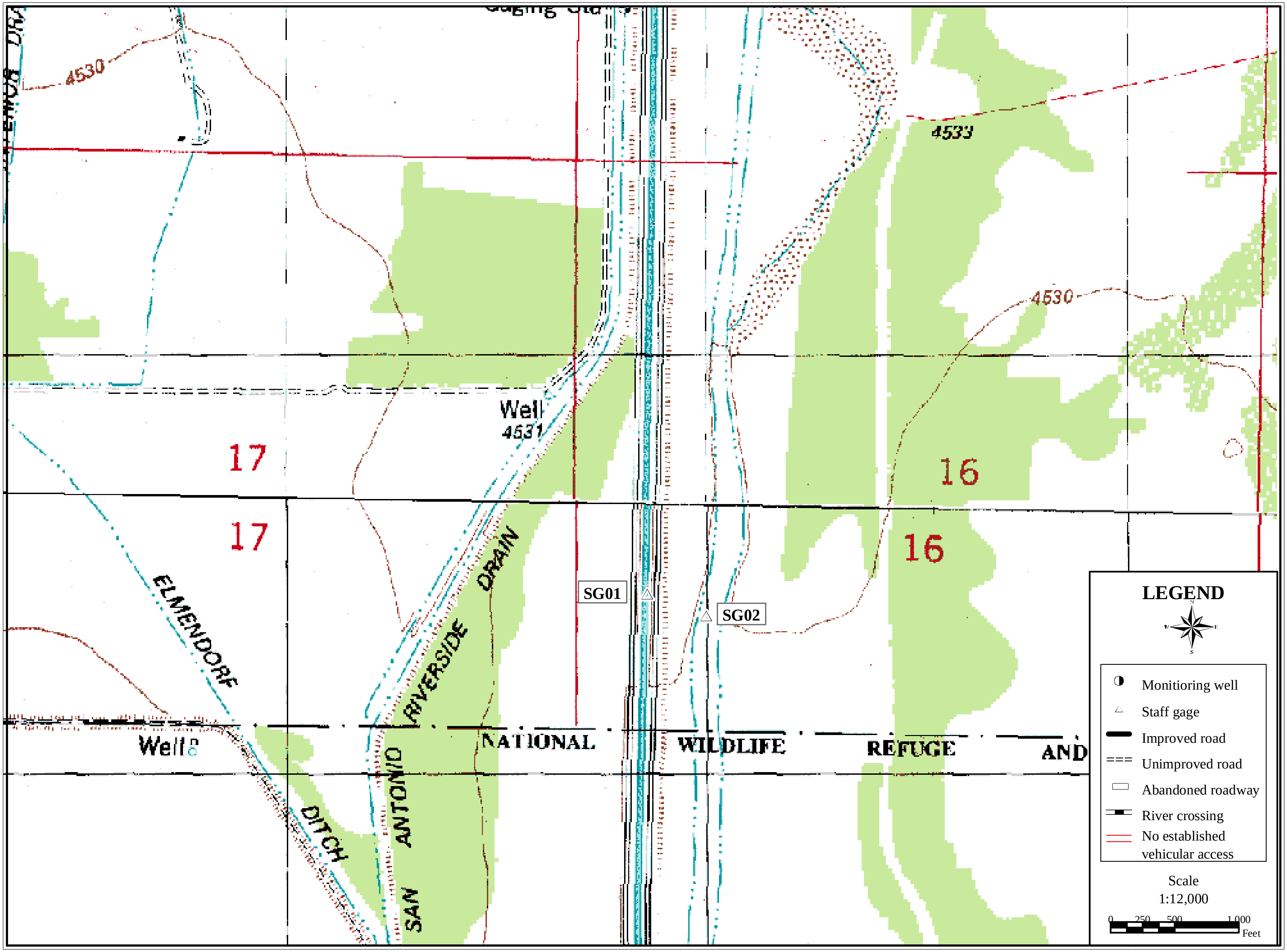

Figure 2e. North Boundary Bosque (NBB) Transect Well Locations and Access Roads

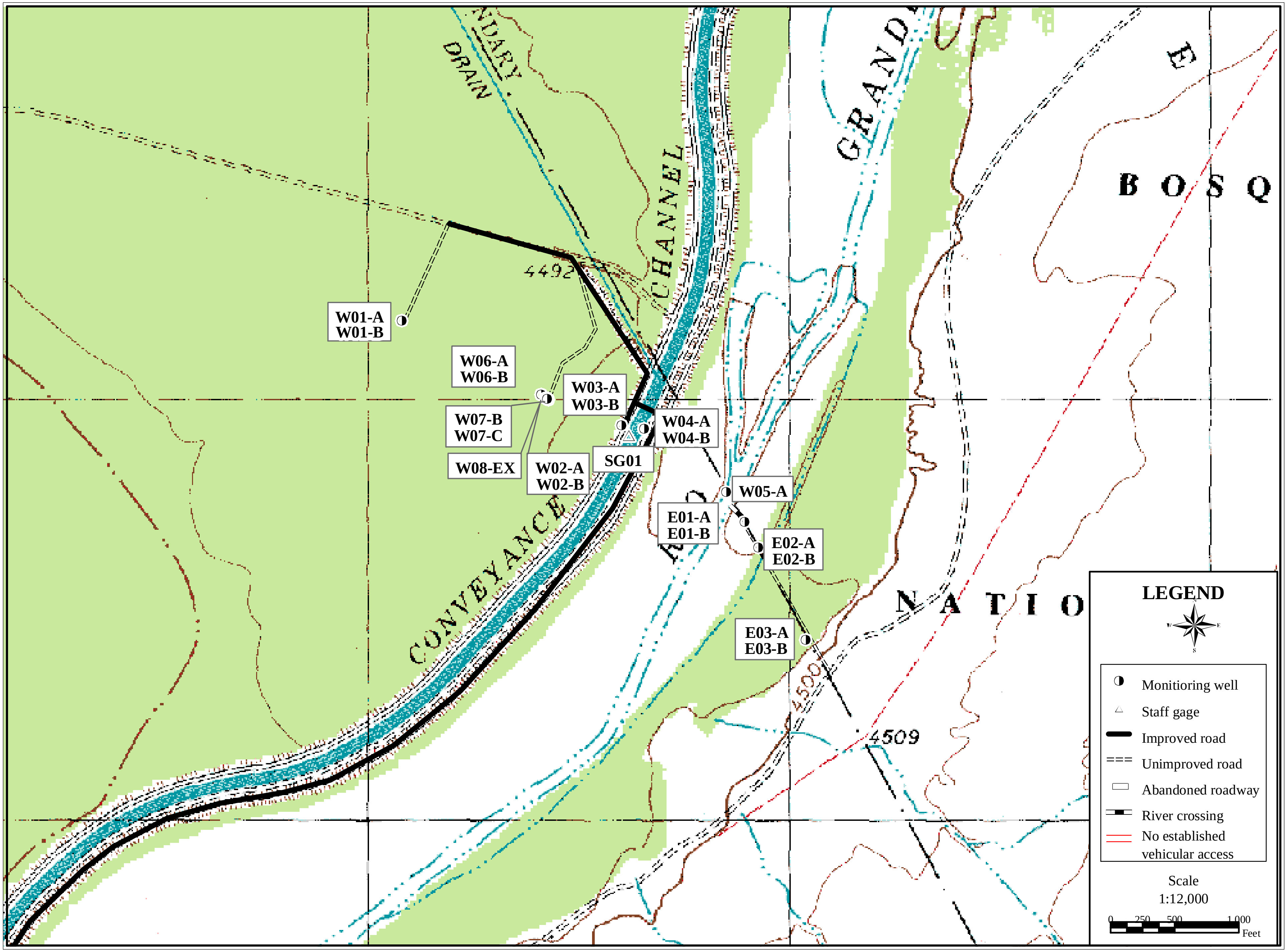

Figure 2f. South Boundary Bosque (SBB) Transect Well Locations and Access Roads

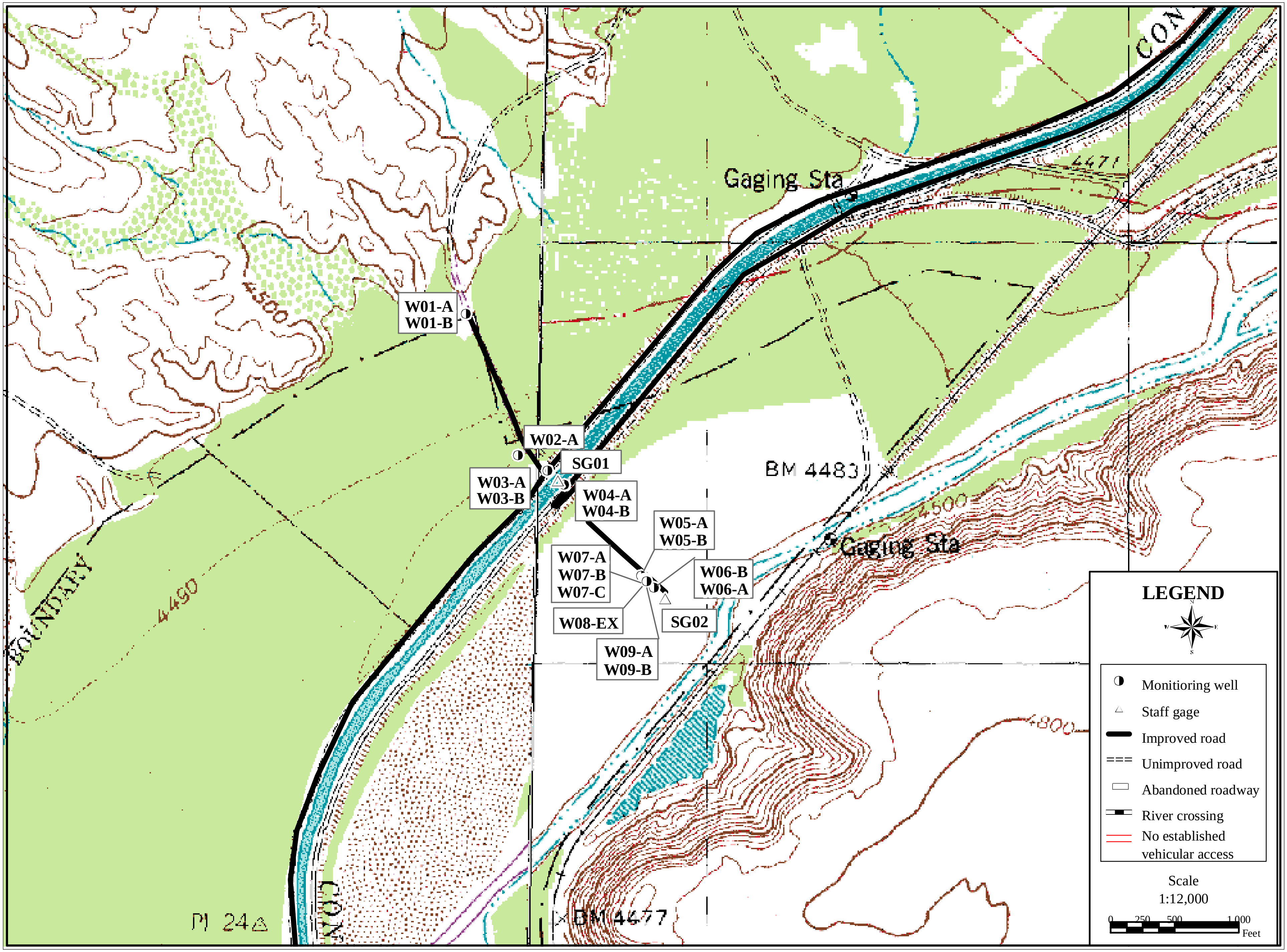

Figure 2g. San Marcial (SMC) Transect Well Locations and Access Roads

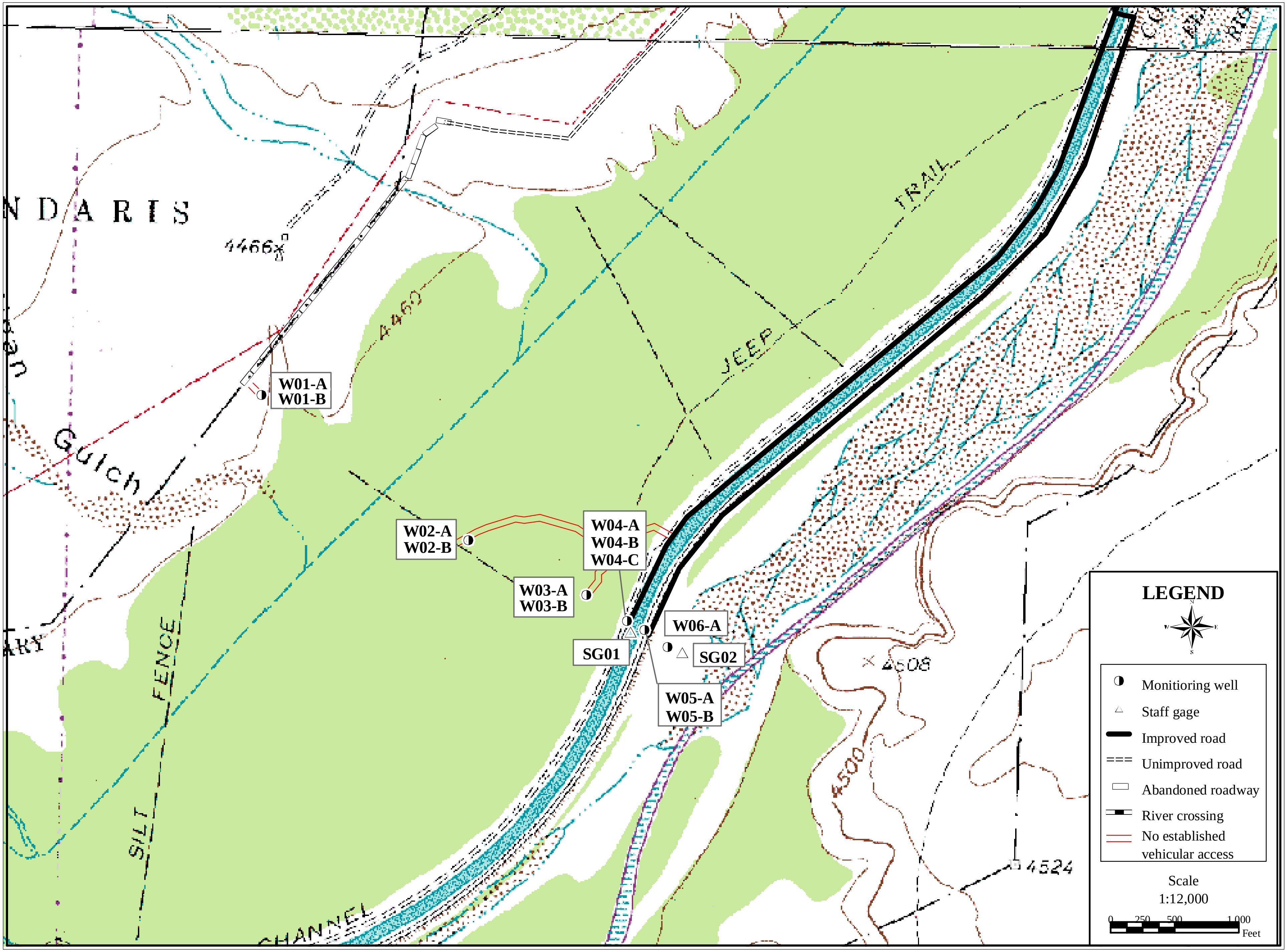

Figure 2h. South Of Ft. Craig (SFC) Transect Well Locations and Access Roads

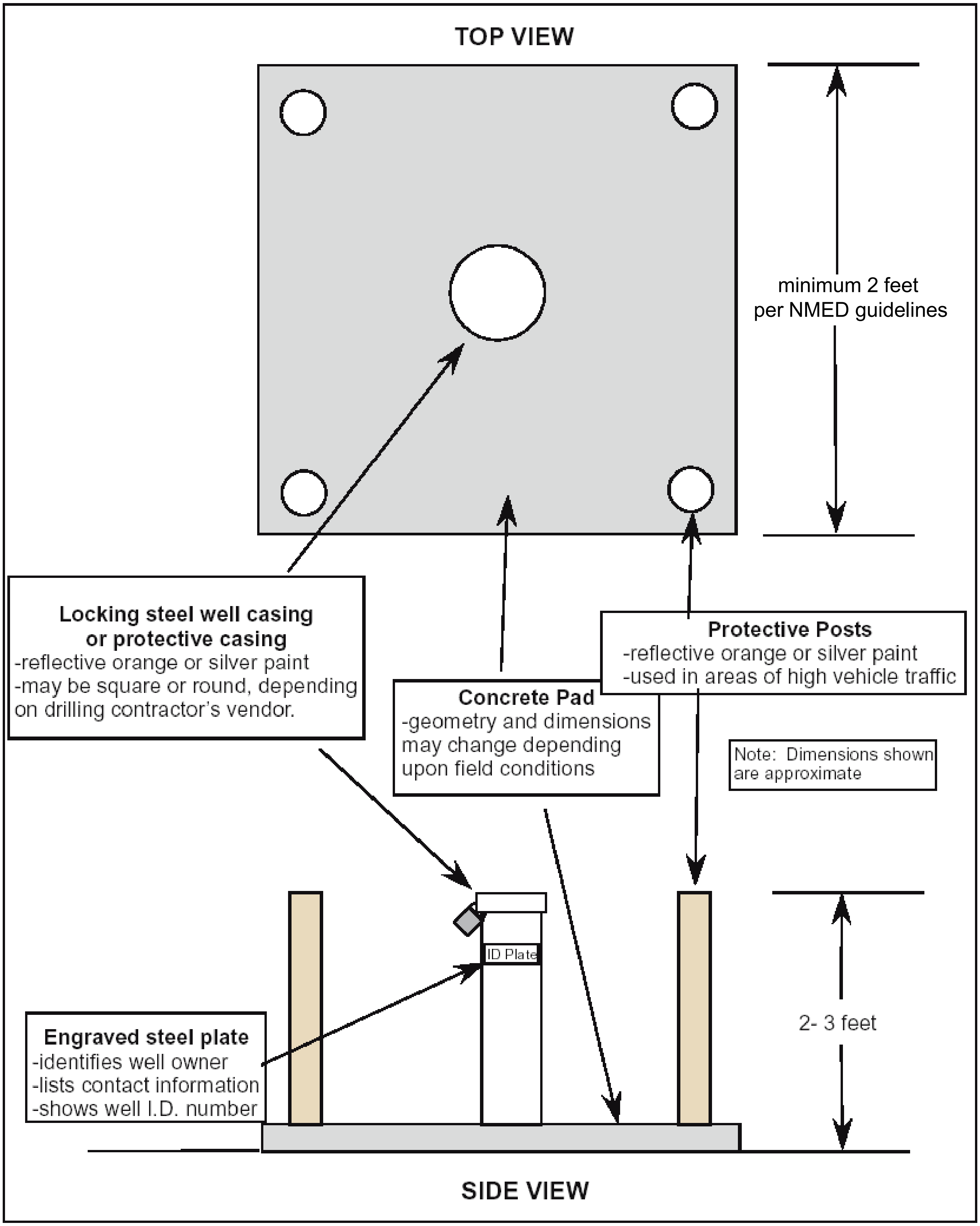

Figure 3. Diagram showing approximate dimensions and design of monitoring well surface completion

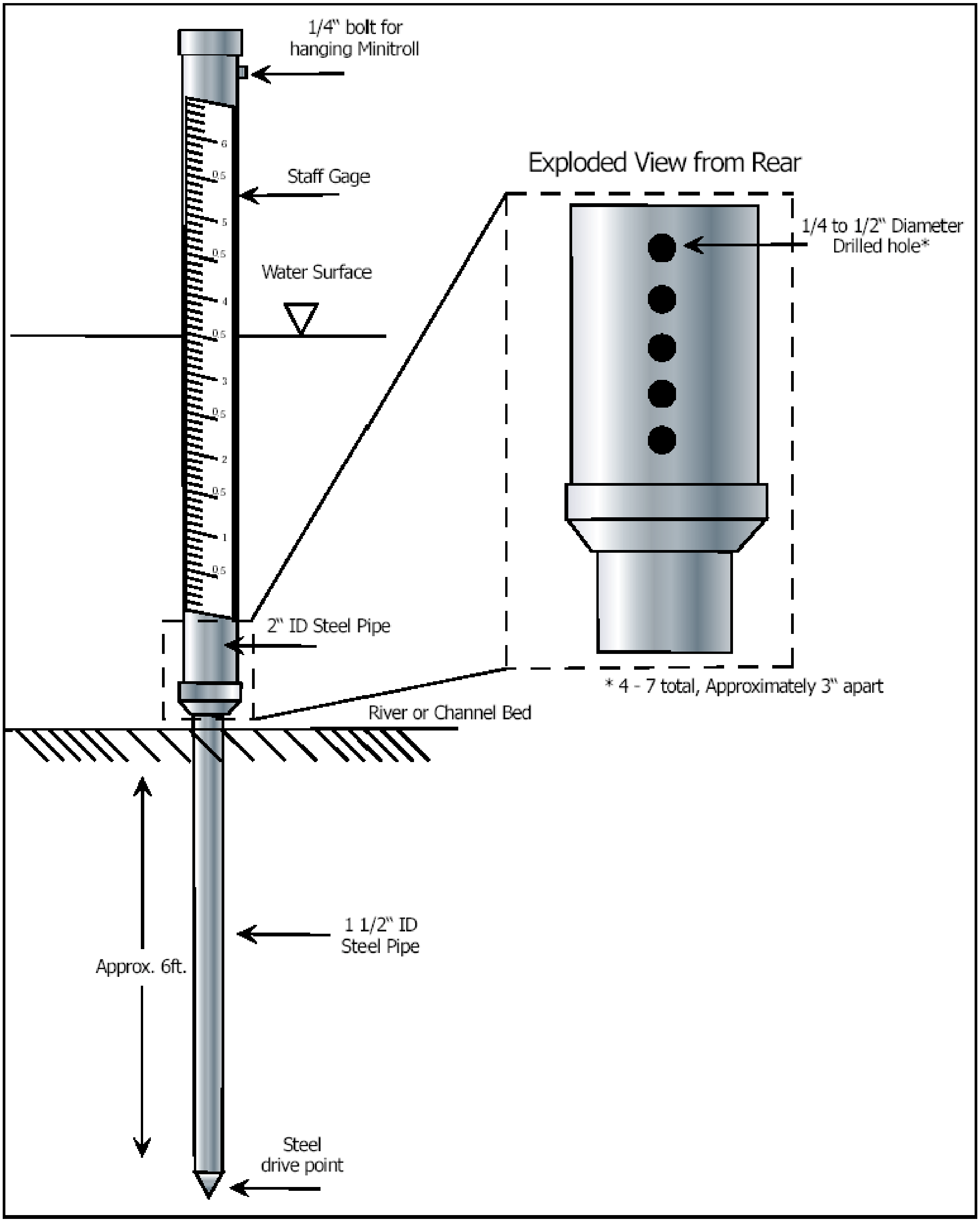

Figure 4. Staff Gage Construction Diagram

Tables

Table 1
Middle Rio Grande Watershed Study
Well Construction Details

Transect	Well ID	Surface Elevation (ft amsl)	Total Depth (ft bgs)	Borehole Diameter (in)	Casing Diameter (in)	Screened Interval[1]	Filter Pack[2]	Lower Seal	Upper Seal
Brown Arroyo	BRN-E01A	4575.92	19.2	10	2	4.0-19.0	1.9-21.2	21.2-23.4	0.5-1.9
	BRN-E01B	4575.92	49.7	10	2	44.5-49.5	42.2-50	NA	38.7-42.2
	BRN-E01C	4575.91	81.2	8	2	75.9-80.9	71.3-83	NA	63-72.2
	BRN-E02A	4575.3	19.2	10	2	4.0-19.0	2.0-19.2	NA	0.6-2.0
	BRN-E03A	4573.47	18.8	10	2	4.3-18.6	2.0-20.9	20.9-23.5	0-2
	BRN-E03B	4573.47	49.5	10	2	43.7-8.7	42.2-50	NA	20.9-23.5
	BRN-E04A	4571.08	16.7	10	2	2.3-16.5	1.5-21.2	21.2-23.8	0-1.5
	BRN-E04B	4571.08	49.2	10	2	44.7-49.7	42-50	NA	38.5-42
	BRN-E05A	4572.1	19.2	10	2	4.0-19	1.7-20.5	20.5-24.4	0.4-1.7
	BRN-E05B	4572.1	49.2	10	2	44.5-49.5	41.9-49.5	NA	38.3-41.9
	BRN-E06A	4572.71	19.2	10	2	4.0-19.0	1.9-22.2	22.2-23.7	0.4-1.9
	BRN-E06B	4572.71	54.2	10	2	49.0-54.0	46.3-55.2	NA	43.4-46.3
	BRN-W01A	4570.9	19.8	10	2	4.8-19.8	2.2-21.2	21.2-23.5	1.0-2.2
	BRN-W01B	4570.9	46.7	10	2	41.7-16.7	39-47	NA	36-39
	BRN-W02A	4570.95	19.5	10	1	4.0-19.0	2.2-20.0	NA	1.1-2.2
	BRN-W03A	4574.31	19.4	10	2	4.4-19.4	3.0-20.0	20-23.5	0.9-2.5
	BRN-W03B	4574.31	51	10	2	45.5-50.5	43.5-52.5	NA	40.5-43.5
	BRN-W04A	4571.22	21.2	10	2	6.0-21.0	4.0-22.4	22.4-25	1.5-4.0
	BRN-W04B	4571.22	50.8	10	2	46.7-50.6	43.8-52.5	NA	41-43.8
	BRN-W05A	4575.89	20	10	2	5.0-20.0	3.5-21	21-24	1-3.5
	BRN-W05B	4575.89	51	10	2	46-51	43-52	NA	40.5-43
Escondida	ESC-E01A	4617.86	19.7	10	2	4.5-19.5	3.1-23	23-26.2	0.8-3.1
	ESC-E01B	4617.86	49.2	10	2	44-49	39.3-51	NA	34.6-39.3
	ESC-E02A	4618.3	20.2	10	2	4.75-19.75	3-23.2	23.2-26	0.5-3.0
	ESC-E02B	4618.3	49.8	10	2	44.3-49.3	39.2-51	NA	35.3-39.2
	ESC-E03A	4610.79	13.5	10	2	3.0-13.0	2.0-16.3	16.3-18.9	1.0-2.0
	ESC-E03B	4610.79	45	10	2	39.5-44.5	34.4-46	NA	32.3-34.4
	ESC-E04A	4618.21	20	10	2	5.0-20.0	2.7-22.9	22.9-26.1	0.6-2.7
	ESC-E04B	4618.21	50.7	10	2	45.5-50.5	41.6-52	NA	38.7-41.6
	ESC-E04C	4618.1	83.9	8	2	78.4-83.4	72.6-84	NA	62.5-72.6

Table 1, continued
Middle Rio Grande Watershed Study
Well Construction Details

Transect	Well ID	Surface Elevation (ft amsl)	Total Depth (ft bgs)	Borehole Diameter (in)	Casing Diameter (in)	Screened Interval[1]	Filter Pack[2]	Lower Seal	Upper Seal
Escondida (cont.)	ESC-E05EX	4618.93	55.3	13.8	10	30.4-49.2	26.0-51	NA	22.6-26.0
	ESC-E06A	4618.53	20.5	10	2	5.0-20.0	3.1-23.5	23.5-25.8	0.8-3.1
	ESC-E06B	4618.53	50.5	10	2	45.0-50.0	38.9-52	NA	35.7-38.9
	ESC-W01A	4616.32	20.5	10	2	5.0-20.0	2.8-23.1	23.1-26.3	1.0-2.75
	ESC-W01B	4616.32	51	10	2	45.5-50.5	41-52	NA	32.5-41
	ESC-W02A	4616.89	19.5	8	2	4.0-19.0	2.5-21	NA	1.0-2.5
	ESC-W03A	4615.45	20.2	10	2	4.8-19.8	2.5-21.5	21.5-24.7	0.9-2.5
	ESC-W03B	4615.45	50	10	2	44.5-49.5	40.1-50	NA	35.8-40.1
	ESC-W04A	4615.58	16.5	10	2	6.5-16.5	2.2-16.5	18.3-20.8	0.5-2.2
	ESC-W04B	4615.58	50.2	10	2	44.4-49.7	39.7-51	NA	31-39.75
	ESC-W05A	4618.05	19.2	10	2	4.0-19.0	2.0-23.2	23.2-25.8	1.0-2.0
	ESC-W05B	4618.05	51	10	2	45.5-50.5	38.5-52	NA	32.7-38.5
Highway 380	HWY-E01A	4553.67	19.2	10	2	4.0-19.0	3.0-23.3	23.3-25.2	1.0-3.0
	HWY-E01B	4553.67	50.2	10	2	45-50	39.7-50.5	NA	35.5-39.7
	HWY-E02A	4552.06	19.5	10	2	4.0-19.0	2.5-20	NA	1.0-2.5
	HWY-E03A	4551.11	18.7	10	2	3.5-18.5	1.5-21.1	21.1-23.3	0-1.5
	HWY-E03B	4551.11	50.5	10	2	45-50	41.8-51.5	NA	36.7-41.8
	HWY-W02A	4548.06	19.5	10	2	4.0-19.0	1.0-23.1	23.1-26.1	0-1.0
	HWY-W02B	4548.06	49.5	10	2	44.0-49.0	42.1-50.5	NA	39.4-42.1
	HWY-W03B	4547.23	49.5	10	2	44.0-49.0	38.6-50.5	NA	37.8-38.6
	HWY-W04A	4549.29	19.5	10	2	4.0-19.0	3.0-21.3	21.3-25.4	0-3.0
	HWY-W04B	4549.29	49.5	10	2	44.0-49.0	41.2-50.5	NA	37.4-41.2
	HWY-W05A	4550.05	20	10	2	4.5-19.5	2.0-23.3	23.3-25.5	0.5-2.0
	HWY-W05B	4550.05	50	10	2	44.5-49.5	41.9-50.5	NA	37.9-41.9
	HWY-W06A	4550.05	19.2	10	2	4.0-19.0	1.7-22.7	22.7-23.9	0.4-1.7
	HWY-W06B	4550.05	49.2	10	2	44.0-49.0	41-50	NA	37.4-41
	HWY-W07A	4551.47	19.9	10	2	5.0-20.0	3.0-21.0	21.0-24.0	1.0-3.0
	HWY-W07B	4551.47	49.5	10	2	44.0-49.0	42.0-51.0	NA	38.2-41.8
	HWY-W07C	4551.49	91.5	8	2	86.0-91.0	52-92.5	NA	70.4-82

Table 1, continued
Middle Rio Grande Watershed Study
Well Construction Details

Transect	Well ID	Surface Elevation (ft amsl)	Total Depth (ft bgs)	Borehole Diameter (in)	Casing Diameter (in)	Screened Interval[1]	Filter Pack[2]	Lower Seal	Upper Seal
Highway 380 (cont.)	HWY-W08EX	4550.53	64.6	13.8	10	35.1-58.9	32.0-61.0	NA	28.5-32.0
	HWY-W09A	4550.24	19.8	10	2	3.5-18.5	3.0-20.0	20.0-22.0	1.0-3.0
	HWY-W09B	4550.24	49.5	10	2	44.0-49.0	41.8-50	NA	38.2-41.8
	HWY-W10A	4551.43	19	10	2	4.0-19.0	2.3-23.2	23.2-26.6	0.8-2.3
	HWY-W10B	4551.43	49	10	2	44.0-49.0	40.4-50	NA	37.5-40.4
	HWY-W11A	4555.44	21.5	10	2	6.7-21.0	3.0-23.0	24.0-26.0	0-3.0
	HWY-W11B	4555.44	54.5	10	2	49.8-54.0	47.6-55	NA	42.5-47.6
San Acacia	SAC-E01A	4658.31	18.7	2.125	1	3.5-18.5	0.2-18.7	NA	None
	SAC-E01B	4658.28	50.2	2.125	1	45.0-50.0	0.2-50.8	NA	None
	SAC-E02A	4663.7	21.2	2.125	1	6.0-21.0	0.2-21.5	NA	None
	SAC-E03A	4664.57	21.7	2.125	1	6.5-21.5	0.3-21.7	NA	None
	SAC-E03B	4664.53	55.7	2.125	1	50.5-55.5	0.3-56	NA	None
	SAC-W01A	4662.37	18.5	10	2	3.0-18.0	2.0-19.1	19.1-26.8	1.0-2.0
	SAC-W01B		49.5	10	2	44.0-49.0	36.3-49	NA	33.8-36.3
	SAC-W02A	4677.1	35.5	10	2	20.0-35.0	16.8-36.0	36-42	13.6-16.8
	SAC-W02B	4677.1	59.2	10	2	53.7-58.7	51-59.2	NA	43.2-51
	SAC-W03A	4663.34	19	10	2	4.0-19.0	2.5-19.5	19.5-21	1-2.5
	SAC-W03B	4663.34	51	10	2	45.5-50.5	42.8-51.5	NA	36.0-42.8
	SAC-W04A	4662.36	18.2	10	2	3.2-18.2	2.2-20.8	20.8-23.1	1.0-2.2
	SAC-W04B	4662.36	49.4	10	2	44.0-49.0	38-49.5	NA	33.7-38.0
	SAC-W05A	4663.35	22	10	2	7.0-22.0	3.7-24.2	24.2-25.5	2.3-3.7
	SAC-W05B	4663.35	51	10	2	45.5-50.5	41.5-52	NA	40.3-41.5
	SAC-W06A	4655.16	9	Drive point	1	6.0-9.0	0.2-9	NA	None
	SAC-W07A	4677.46	34	10	2	18.5-33.5	16.6-35	NA	13.7-16.6
	SAC-W07B	4677.46	59	10	2	53.5-58.5	49-60	NA	45.5-49
	SAC-W08EX	4677.31	80.5	13.8	10	46.0-74.9	43.5-77.0	NA	41.0-43.5
	SAC-W09A	4677.87	34	10	2	18.5-33.5	14.5-38	38-40	10-14.5
	SAC-W09B	4677.87	59	10	2	53.5-58.5	51-60	NA	48.2-51.0
	SAC-W09C	4677.87	98.6	8	2	93.1-98.1	87.8-99	NA	77.0-87.8

Table 1, continued
Middle Rio Grande Watershed Study
Well Construction Details

Transect	Well ID	Surface Elevation (ft amsl)	Total Depth (ft bgs)	Borehole Diameter (in)	Casing Diameter (in)	Screened Interval[1]	Filter Pack[2]	Lower Seal	Upper Seal
South Boundary Bosque del Apache									
	SBB-E01B	4498.81	48.7	10	2	43.5-48.5	40-49.5	NA	38-40
	SBB-E02A	4498.26	20.2	10	2	5.0-20.0	2.8-23.2	23.2-26	1.0-2.8
	SBB-E02B	4498.26	48.7	10	2	43.5-48.5	38.9-49.5	NA	32.5-38.9
	SBB-E03A	4495.48	18.2	10	2	3.0-18.0	2.0-23.7	23.7-24.5	1.0-2.0
	SBB-E03B	4495.48	46.7	10	2	41.5-46.5	39.5-47	NA	39.0-39.5
	SBB-W01A	4484.47	20.2	10	2	5.0-20.0	2.8-22.5	22.5-25.8	0.8-2.8
	SBB-W01B	4484.47	49.7	10	2	44.5-49.5	39.7-50.5	NA	33-39.7
	SBB-W02A	4487.96	20.2	10	2	5.0-20.0	3-24.8	24.8-29.5	1.0-3.0
	SBB-W02B	4487.96	49.2	10	2	44.0-49.0	29.5-49.5	NA	None
	SBB-W03A	4488.81	20.2	10	2	5.0-20.0	2.8-24.5	24.5-26.3	0.9-2.8
	SBB-W03B	4488.81	45.2	10	2	42.0-47.0	39.7-47.5	NA	36.3-39.7
	SBB-W04A	4493.86	24.2	10	2	9.0-24.0	5.4-26.4	26.4-28.7	3.3-5.4
	SBB-W04B	4493.86	53.2	10	2	48.0-53.0	43.8-54	NA	41.5-43.8
	SBB-W05A	4498.66	19.7	8	2	4.5-19.5	2.0-27.0	22.3-27	0.5-2.0
	SBB-W06A	4488.1	20.2	10	2	5.0-20.0	3.0-22.0	22.0-24.0	1.0-3.0
	SBB-W06B	4488.1	49.2	10	2	44.0-49.0	42.5-50	NA	39.0-42.5
	SBB-W07B	4488.19	49.2	8	2	44.0-49.0	42.0-51.0	51-76.5	38.5-42.0
	SBB-W07C	4488.19	86.3	8	2	81.3-86.3	42.0-51.0	NA	51.0-76.5
	SBB-W08EX	4487.9	67.1	13.8	8	37.0-62.0	35.1-63.5	NA	32.1-35.1
South of Fort Craig	SFC-W01A		20.5	10	2	5.0-20.0	3.0-29.4	29.4-30	0.5-3.0
	SFC-W01B	4462.68	50.5	10	2	45.0-50.0	35-50.5	NA	30-35
	SFC-W02A	4457.58	19.1	10	2	3.9-18.9	2.0-20.0	20.0-23.9	0.5-2.0
	SFC-W02B	4457.58	49.2	10	2	44.0-49.0	39.3-51	NA	34.7-39.3
	SFC-W03A	4458.08	20.2	10	2	5.0-20.0	1.5-21.0	21.0-25.2	0.5-1.5
	SFC-W03B	4458.08	49.7	10	2	44.5-49.5	35-5.05	NA	32.0-35.0
	SFC-W04A	4456.64	18.2	10	2	3.0-18.0	2.0-23.2	23.2-25.3	1.0-2.0
	SFC-W04B	4456.64	50.2	10	2	45.0-50.0	38.7-51	NA	32.8-38.7

Table 1, continued
Middle Rio Grande Watershed Study
Well Construction Details

Transcect	Well ID	Surface Elevation (ft amsl)	Total Depth (ft bgs)	Borehole Diameter (in)	Casing Diameter (in)	Screened Interval[1]	Filter Pack[2]	Lower Seal	Upper Seal
South of Fort Craig (cont.)	SFC-W04C	4456.88	84.5	8	2	79.0-84.0	62.0-85.5	NA	40.0-62.0
	SFC-W05A	4457.17	19.5	10	2	4.0-19.0	3.0-20.0	20.0-25.5	0.5-3.0
	SFC-W05B	4457.17	49.5	10	2	44.0-49.0	38-50.5	NA	28.3-38.0
	SFC-W06A	4464.17	11.3	Drive point	1.5	8.0-11.0	1.0-11.8	NA	none
San Marcial	SMC-W01A		20.2	10	2	5.0-20.0	2.0-25.0	25.0-26.0	1.0-2.0
	SMC-W01B	4468.71	50.2	10	2	45.0-50.0	39.5-50.5	NA	35.0-39.5
	SMC-W02A	4471.29	19.5	10	2	4.3-19.3	2.0-20.0	NA	0.5-2.0
	SMC-W03A	4473.72	20.2	10	2	5.0-20.0	3.0-22.0	22.0-22.5	1.0-3.0
	SMC-W03B	4473.72	49.7	10	2	44.5-49.5	38.2-50.5	NA	32.4-38.2
	SMC-W04A	4470.91	20.2	10	2	5.0-20.0	3.0-23.0	23.0-25.2	1.0-3.0
	SMC-W04B	4470.91	50.2	10	2	45.0-50.0	37.9-50.5	NA	33.6-37.9
	SMC-W05A	4476.65	17.7	10	2	2.5-17.5	1.0-23.9	23.9-26.7	0.2-1.0
	SMC-W05B	4476.65	54.2	10	2	49.0-54.0	46.2-54	NA	44.7-46.2
	SMC-W06A	4477.05	18.2	10	2	3.0-18.0	1.2-22.0	22.0-29.3	0.4-1.2
	SMC-W06B	4477.05	54.7	10	2	49.5-54.5	46.8-55.5	NA	43.7-46.8
	SMC-W07A	4476.63	18.7	10	2	3.5-18.5	1.3-20.6	20.6-23.8	0.4-1.3
	SMC-W07B	4476.63	54.7	10	2	49.5-54.5	44.6-55.5	NA	42.3-44.6
	SMC-W07C	4476.8	76.7	8	2	71.5-76.5	66.8-77.5	NA	46.8-66.8
	SMC-W08EX	4476.79	74.5	14.75	10	44.6-69.6	42.5-72.1	NA	39.6-42.5
	SMC-W09A	4476.57	18.7	10	2	3.5-18.5	1.4-24.0	24.0-27.2	0.3-1.4
	SMC-W09B	4476.57	54.7	10	2	49.5-54.5	46.7-55.5	NA	38.3-46.7

Table 2
Pre-Existing Well Locations

Location ID	Date Surveyed	Longitude[1]	Latitude[1]	UTM Easting[2]	UTM Northing[2]	Ground Surface Elevation, feet
W-109.49-2	10/5/2001	-106.887501	34.1829329	326096.274	3783847.436	4637.58
W-109.49-3	10/5/2001	-106.88908	34.1829231	325950.7205	3783849.023	4637.23
W-109.49-4	10/5/2001	-106.88977	34.18312	325887.5298	3783872.05	4643.3
W-109.49-5	10/5/2001	-106.88928	34.1826	325931.6231	3783813.543	4636.94
W-114.60-2	10/5/2001	-106.89978	34.24273	325088.2281	3790500.197	4660.12
W-114.60-3	10/5/2001	-106.88905	34.18292	325953.4794	3783848.639	4660.25
W-68.72-1	10/6/2001	-106.99219	33.68203	315368.5703	3728479.912	4477.53
W-68.72-2	10/6/2001	-106.99353	33.68547	315251.7007	3728863.799	4472.83
W-68.72-3	10/6/2001	-106.99475	33.68701	315141.8957	3729036.766	4470.91
W-68.72-4	10/6/2001	-106.99522	33.68747	315099.3092	3729088.621	4470.45
W-68.72-5	10/6/2001	-106.99479	33.68705	315138.2731	3729041.274	4470.15
W-68.72-6	10/6/2001	-106.99481	33.68703	315136.3761	3729039.092	4470.24
W-83.98-1	10/5/2001	-106.83467	33.87012	330343.7508	3749067.691	4537.94
W-83.98-3	10/5/2001	-106.85129	33.87042	328806.8972	3749128.531	4533.04
W-83.98-4	10/5/2001	-106.85371	33.87102	328584.2328	3749199.105	4532.91
W-87.62-1	10/5/2001	-106.8514	33.92421	328904.2591	3755093.915	4553.93
W-87.62-2	10/5/2001	-106.85196	33.92419	328852.4482	3755092.631	4547.28
W-87.62-3	10/5/2001	-106.85315	33.92445	328742.9559	3755123.451	4546.61
W-87.62-4	10/5/2001	-106.85378	33.92469	328685.1946	3755151.118	4546.5
W-91.28-1	10/5/2001	-106.84461	33.9463	329576.0238	3757532.358	4554.4
W-91.28-3	10/5/2001	-106.84985	33.94941	329097.9431	3757885.975	4556.64
W-91.28-3.5	10/5/2001	-106.85085	33.95066	329008.0242	3758026.266	4554.56
W-91.28-4	10/5/2001	-106.85396	33.95055	328720.3797	3758019.258	4554.13
W-99.59-1	10/5/2001	-106.87431	34.06794	327077.929	3771072.03	4598.13
W-99.59-3	10/5/2001	-106.87428	34.06801	327080.8401	3771079.743	4598.38
W-99.59-4	10/5/2001	-106.87424	34.06811	327084.7351	3771090.765	4598.37
W-Cather						
W-EB-11-19	10/6/2001	-106.99869	33.65906	314716.6561	3725944.229	
W-EB-11-20	10/6/2001	-106.99938	33.65952	314653.6547	3725996.48	
W-EB-13	10/6/2001	-106.99176	33.64796	315335.5984	3724700.857	
W-EB-22-18	10/6/2001	-107.04162	33.59689	310599.3316	3719127.504	
W-Found Well	10/6/2001	-107.05966	33.58578	308900.6187	3717928.593	
W-NMED	8/12/2002					
W-OMW-3	8/12/2002	-106.904974	34.0729595	324107.6	3763589.6	4611.28666
W-OMW-9	8/12/2002					
W-Perini1	6/13/2002	-106.866864	33.935885	327627.6882	3763524.876	4549.207
W-Sichler1	8/14/2002	-106.853896	33.9318728			4549.0359
W-Thomas1	2/18/2002	-106.875995	34.1134282	326784.2923	3763540.286	4607.972
SAC-W10B	5/1/2004	-106.904216	34.2463848	324647	3791115	
W-NMED	5/1/2004	-106.903495	34.0988984	324408	3774757	4659.16
W-OMW-9	5/1/2004	-106.907509	34.0888614	324017	3773651	4654.59
W-Cather	5/1/2004	-106.878818	33.8997957	326280	3752635	4590.17
SAC-W01B	5/1/2004	-106.909887	34.2484229	324129	3791351	4662.32
SAC-W01A	5/1/2004	-106.909888	34.2484235	324129	3791351	4662.32

[1]Decimal Degrees, WGS 84
[2]UTM, NAS 83. Zone 13

Table 3
Surface Water Staff Gage Locations

Location ID	Longitude[1]	Latitude[1]	UTM Easting[2]	UTM Northing[2]	Monument ID
BRN-SG01	-106.87171	34.00054	327137.23	3763600	
BRN-SG02	-106.867889	33.997846	327528.6373	3763287.721	
BRN-SG03	-106.8672	34.01052	327573.99	3764699	
BRN-SG05	-106.8734	34.00312	326986.37	3763889	
D-109.49	-106.889958	34.18301	325869.5306	3783860.173	W-109.49-4
D-AL0	-106.857092	33.948093	328426.0994	3757751.839	M-ML1
D-AL1	-106.866604	33.935262	327520.938	3756345.088	M-LLDR4
D-LLDI1	-106.880821	34.014725	326368.4822	3765181.448	M-LLDI1
D-LLDI2	-106.887283	33.997028	325735.6197	3763229.816	M-LLDI2
D-LLDI3	-106.886746	33.984734	325760.1241	3761865.572	M-LLDI3
D-LLDI4	-106.874147	33.977843	326909.829	3761080.432	M-SADI1
D-LLDR1	-106.876185	33.992076	326750.6778	3762661.874	M-LLDR1
D-LLDR2	-106.869029	33.97452	327376.2043	3760702.788	M-LLDR2
D-LLDR3	-106.866134	33.958836	327611.9542	3758958.554	M-LLDR3
D-LLDR4	-106.866291	33.935272	327549.9432	3756345.588	M-LLDR4
D-ML0	-106.857468	33.960919	328417.0977	3759175.093	M-SRD4
D-ML1	-106.857041	33.948034	328430.6002	3757745.338	M-ML1
D-ML2	-106.866213	33.935223	327556.9444	3756339.587	M-LLDR4
D-SADI0	-106.871457	33.995838	327194.8799	3763070.787	M-SRD2
D-SADI1	-106.8741	33.977798	326914.3298	3761074.931	M-SADI1
D-SADI2	-106.870506	33.958627	327207.5623	3758942.793	M-SADI2
D-SADI3	-106.872349	33.939564	326998.6292	3756831.845	M-SADI3
D-SADI4	-106.86419	33.91868	327710.6945	3754502.046	M-SADI4
D-SRD1	-106.8729	34.002334	327074.8585	3763793.916	M-SRD1
D-SRD2	-106.871065	33.995896	327231.3864	3763076.788	M-SRD2
D-SRD3	-106.862408	33.975573	327990.0216	3760808.384	M-SRD3
D-SRD4	-106.857105	33.960948	328450.6037	3759177.593	M-SRD4
D-SRD5	-106.853046	33.937231	328778.1621	3756540.623	M-SRD5
D-SRD6	-106.856737	33.918844	328400.0947	3754507.761	M-SRD6
D-SRD-87.62	-106.853877	33.924588	328676.1439	3755139.873	W-87.62-4
D-SRD-91.28	-106.851335	33.950569	328962.695	3758016.886	W-91.28-3.5
ESC-SG01	-106.88894	34.1203	325791.05	3776911	
ESC-SG02	-106.88722	34.12031	325949.72	3776909	
ESC-SG03	-106.88387	34.12056	326259.23	3776931	
HWY-SG01	-106.85285	33.92443	328726.76	3755128	
HWY-SG02	-106.8511	33.92428	328888.24	3755109	
HWY-SG03	-106.85794	33.92606	328259.46	3755317	
L-109.49	-106.888628	34.182758	325992.3221	3783830.189	W-109.49-3
L-114.60	-106.900518	34.2426	325019.9887	3790487.397	W-114.60-3
L-68.72	-106.99459	33.68669	315155.8519	3729001.299	W-68.72-3
L-83.98	-106.850843	33.870296	328848.4501	3749113.885	W-83.98-3
L-87.62	-106.852875	33.924243	328767.6602	3755099.866	W-87.62-3
L-91.28	-106.85049	33.950501	329040.7089	3758007.885	W-91.28-3.5
L-99.59	-106.874993	34.067974	327014.5445	3771077.001	W-99.59-1

Table 3, continued
Surface Water Staff Gage Locations

Location ID	Longitude[1]	Latitude[1]	UTM Easting[2]	UTM Northing[2]	Monument ID
L-LFCC10	-106.871803	34.001711	327174.8763	3763723.404	M-LFCC10
L-LFCC2	-107.003018	33.630547	314254.2423	3722789.75	M-LFCC2
NBB-SG01	-106.85086	33.87307	328808.08	3749429	
NBB-SG02	-106.84934	33.87262	328947.79	3749377	
R-109.49	-106.883659	34.182745	326449.6284	3783819.61	W-109.49-2
R-114.60	-106.898303	34.242607	325223.9349	3790484.442	W-114.60-2
R-68.72	-106.996115	33.678469	314996.9048	3728091.662	M-RGSM
R-83.98	-106.849253	33.871275	328997.4835	3749220.486	M-RGNBB
R-87.62	-106.850837	33.924075	328955.6938	3755078.362	W-87.62-1
R-91.28	-106.848014	33.949104	329267.2493	3757848.856	W-91.28-3
R-99.59	-106.872475	34.067787	327247.2388	3771052.345	W-99.59-1
R-RGBA	-106.870365	34.00203	327308.4001	3763755.909	M-RGBA
R-RGCOR	-107.051932	33.585822	309618.1787	3717919.073	M-RGCOR
R-RIVUSNC2	-106.854535	33.957612	328681.4056	3758803.422	M-RIVUSNC2
SAC-SG01	-106.90074	34.24555	324961.63	3790821	
SAC-SG02	-106.89908	34.24561	325114.64	3790825	
SAC-SG03	-106.91026	34.24799	324089.9	3791108	
SBB-SG01	-106.91495	33.72317	322570.2	3732915	
SBB-SG02	-107.00003	33.68148	314596.31	3728441	
SFC-SG01	-107.01796	33.61234	312784.23	3720806	
SFC-SG02	-107.01663	33.61192	312906.74	3720757	
S-LFCC10	-106.871803	34.001711	327174.8763	3763723.404	M-LFCC10
SMC-SG01	-107.00003	33.68148	314596.31	3728441	
SMC-SG02	-106.99722	33.679	314851.52	3728161	
SAC-SG01	-106.9007242	34.24545886	324967	3791007	
SAC-SG02	-106.8989214	34.2461408	325134	3791079	
BRN-SG01	-106.8716828	34.00059044	327144	3763801	
BRN-SG02	-106.8700505	34.0010905	327296	3763853	
SMC-SG03	-106.9963019	33.67681889	314936	3728111	
SMC-SG02	-106.9972592	33.67898253	314852	3728353	
HWY-SG01	-106.8528502	33.92443108	328730.585	3755322.955	
SBB-SG01	-106.9149432	33.7231643	322574.772	3733108.132	
SFC-SG01	-107.0178614	33.61213834	312797.111	3720977.285	
SMC-SG01			315296.08	3720977.29	
SBB-SG01			322575.57	3733108.84	
SAC-SG01	-106.9007271	34.24545588	324966.584	3791006.328	
ESC-SG01	-106.8889746	34.1201917	325791.566	3777093.913	
BRN-SG01	-106.8716851	34.00058871	327143.521	3763800.415	

[1]Decimal Degrees, WGS 84
[2]UTM, NAS 83. Zone 13