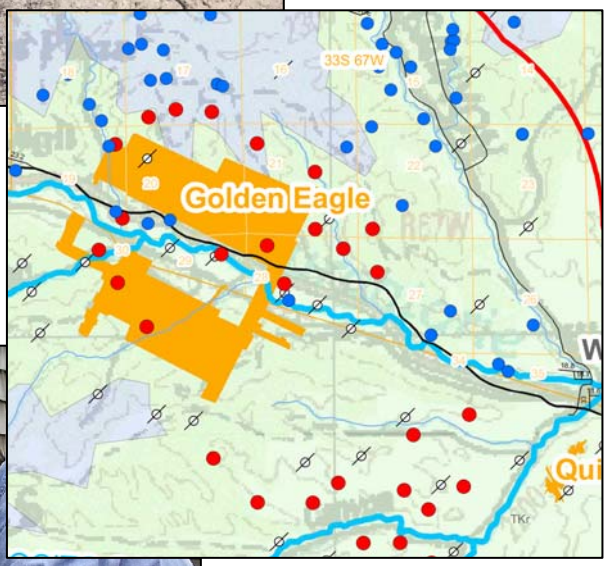
WORK PLAN
COLORADO RULE 608 COMPLIANCE
RATON BASIN, COLORADO



May 5, 2010

Prepared for:

XTO Energy, Inc.
Aztec, New Mexico

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Prepared for:
XTO Energy
382 Road 3100
Aztec, New Mexico 87410

Prepared by:
LT ENVIRONMENTAL, INC.
4600 West 60th Avenue
Arvada, Colorado 80003
(303) 433-9788

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SECTION 1.0
INTRODUCTION

LT Environmental, Inc. (LTE) has prepared this Work Plan on behalf of XTO Energy, Inc. (XTO) to outline plans for compliance with the Colorado Oil and Gas Conservation Commission (COGCC) Rule 608 with respect to XTO's operations in Las Animas County, Colorado (Project Area, Figure 1).

1.1 APPLICABILITY AND SCOPE

COGCC Rule 608 defines the necessary compliance requirements associated with the drilling and installation of coalbed methane (CBM) wells in the State of Colorado. Applicable subsections of Rule 608 for which this Work Plan was developed are listed below:

- 608(a) – Assessment and monitoring of plugged and abandoned wells within one-quarter (1/4) mile of proposed coalbed methane (CBM) well;
- 608(b) – Water well sampling; and
- 608(c) – Coal outcrop and coal mine monitoring.

Other portions of Rule 608 include subsections 608(d) through 608(f). However, plans for compliance with these portions of Rule 608 are not included in this Work Plan. Subsection 608(d) explains the requirements for the operator to collect static bottom-hole pressure surveys for production wells and proper documentation on COGCC Form 13. Bradenhead testing requirements are described in subsection 608(e). Subsection 608(f) allows for variances in Rule 608 with the cooperation and approval from COGCC, local government agencies, and operators. The full COGCC Rule 608 is included in Appendix A.

1.2 BACKGROUND INFORMATION

XTO plans to drill approximately 25 coal bed methane (CBM) wells each year for the next 3 years. The Project Area, planned CBM well locations, geology, recorded abandoned well locations, water well locations, topography, and mine features are illustrated on Figure 1.

The Project Area is located in the Raton Basin in southern Colorado. The Raton Basin is a geologic structural basin in southern Colorado and northern New Mexico. The basin is situated in Huerfano and Las Animas Counties, Colorado, and Colfax County, New Mexico. The basin has long been a source of coal production, and more recently of CBM. Much of the regional geology discussion presented herein was derived from the report *A Geologic Assessment of Natural Gas from Coal Seams in the Raton and Vermejo Formations, Raton Basin* (Stevens, et.al. 1992).

The Raton Basin is an asymmetric synclinal basin with the axis of the La Veta syncline oriented roughly north-south and passing through Weston, Colorado, immediately east of the area defined by XTO for future drilling. Raton Formation outcrops over approximately 50% of the Project Area. The discontinuous nature of the coal beds both in the subsurface and on the surface makes it

difficult to identify and/or correlate individual continuous coal beds from the subsurface producing zone to the surface coal outcrop.

XTO's planned drilling area is located on the western side of the La Veta syncline indicating that the formations encountered within the Project Area are dipping to the east. The Vermejo Formation consists of sandstone, interbedded siltstones, shales, carbonaceous shales, and coal that accumulated above the fluvial-deltaic sequences of the Trinidad Sandstone (Stevens, et al. 1992). The Vermejo Formation outcrops along the west edge of the syncline basin which equates to the west side of the Project Area. Of the more than 90,000 acre Project Area, the Vermejo Formation outcrop covers approximately 2 percent (%). The Raton and Vermejo Formations outcrop area are depicted on Figures 1and 2.

1.3 WORK PLAN ORGANIZATION

This Work Plan is divided into three sections including this introduction (Section 1.0). Section 2.0 describes the Work Plan details to achieve compliance with COGCC Rule 608. The program schedule is discussed in Section 3.0. Pertinent supporting documentation is included as attachments following the text and figures.

SECTION 2.0
RULE 608 COMPLIANCE PROGRAM

2.1 PROGRAM TASKS

The program approach to achieving Rule 608 compliance for XTO has been divided into the following six tasks:

- Task 1: Assessment of plugged and abandoned (P&A) Production Wells;
- Task 2: Water Well Sampling;
- Task 3: Ground Survey to Locate Methane Seeps on the Raton and Vermejo Formation Outcrops;
- Task 4: Infrared Aerial Imagery and Field Verification along the Vermejo Formation Outcrop and the Tercio, Vega, and Quinto Mines;
- Task 5: Field Mapping of Known Seep Areas;
- Task 6: Natural Spring Surveys; and
- Task 7: Reporting.

Each task is described further in Section 2.1.1 through Section 2.1.7 below.

2.1.1 Task 1 - Survey of Plugged and Abandoned Production Wells

Addressing surveys of P&A production wells per Rule 608(a) will be accomplished on a well by well basis. Primarily because P&A production wells in the Project Area are not uniformly distributed geographically. There is no reason to survey P&A production wells for gas seeps unless it is within the one quarter-mile buffer of a planned CBM well. Based on the COGCC existing database, most of the planned CBM well drill sites do not have any P&A production wells within the buffer area.

Records Review

All P&A production wells within the one-quarter (1/4) mile regulatory radius will have the plugging procedures assessed from COGCC existing well file notes, bond logs, and permit information. If there are no discrepancies or issues of concern identified in the plugging data, COGCC approval will be requested and, no further action will be required.

In the event that there are discrepancies or issues of concern, a field survey for methane seepage will be completed at the P&A production well. Soil gas surveys at suspect P&A production wells will be performed as the drilling schedule progresses. Surveys of P&A production wells may be grouped together depending on XTO's drilling schedule for increased efficiency. The P&A

production wells will be resurveyed one year and three years following commencement of production.

Subsurface Soil Gas Measurements

For each P&A production well location requiring survey, a traditional subsurface soil gas survey will be conducted in an area of approximately 400 feet by 400 feet around the recorded location of the P&A well using a grid sampling system. The grid spacing will be 100 feet. A subsurface soil gas measurement will also be collected at the recorded location of the P&A well.

If the actual location of the P&A production well can be determined visually, then the survey area will be reduced to within a 75-feet radius around the visible casing. One measurement point will be located at the well head and additional points at 10 feet, 25 feet and 75 feet from the well head in each cardinal direction.

If the well head is not visible but the outline of the pad or location are still visible or can be determined from other records such aerial photographs, then a survey of the pad will be conducted with a grid spacing of 50 feet with one measurement at the recorded location of the well.

A Mine Safety Appliances (MSA) GasPort® multi-gas meter, or equivalent, will be used to measure the concentrations of methane, carbon monoxide, hydrogen sulfide, and oxygen in the subsurface soil. Subsurface soil gas measurements will be collected by using a hand-driven slide hammer to drive a ½-inch diameter steel rod into the ground to depths ranging from 1 foot below ground surface (bgs) to 3 feet bgs. Occasionally, advancement of boreholes in consolidated outcrop materials will be limited. Where probe refusal occurs, measurements will be taken at the depth bored.

Once the rod is removed from the ground, a ¼-inch diameter polyethylene tubing will be inserted into the borehole. The tubing is perforated at the bottom 6-inches to allow soil gas to enter the tubing. Once the temporary tubing is in place and the borehole is sealed with native soil, the multi-gas meter will be attached to the tubing. The multi-gas meter's internal pump pulls gas from the soil, through the tubing, and into the meter's gas sensors.

The maximum concentrations of methane, carbon monoxide, and hydrogen sulfide; and the minimum concentration of oxygen at each sampling location will be recorded. Data will be recorded in a field notebook and a hand-held Trimble GeoXT® global positioning system (GPS) unit.

The multi-gas meter is capable of detecting methane in concentrations from 0 to 100%, oxygen concentrations from 0 to 25%, carbon monoxide concentrations from 0 to 1,000 ppm, and hydrogen sulfide concentrations from 0 to 100 ppm. Specifications for the multi-gas meter are included in Appendix B.

2.1.2 Task 2 - Water Well Sampling

Addressing water well sampling per Rule 608(b) will be accomplished on a well by well basis. Primarily because there are a relatively limited number of water wells in the Project Area and most are located north of Highway 12.

Water well sampling will be based on the following criteria set forth in Rule 608(b):

- If a conventional gas well or P&A production well is located within a ¼-mile of a planned XTO CBM well, then the closest two water wells within a one-half (1/2) mile radius of the conventional gas well or P&A well will be sampled;
- If there are no conventional gas wells or P&A production wells located within ¼ mile radius of a planned XTO CBM well, then any water well located within ¼-mile radius of the planned XTO CBM well will be sampled. If there are more than two water wells located within the ¼-mile radius of the planned XTO CBM well, the closest two water wells will be selected and sampled;
- If there are no water wells located within a ¼-mile radius of the planned XTO CBM well, the closest water well within a ½-mile radius of the planned XTO CBM well will be selected and sampled; or
- If there is no water well located within a ½-mile radius of the planned XTO CBM well, no sampling is required.

Water Well Identification and Access

Water wells for sampling will be selected using the very prescriptive selection method described in Rule 608. The sequencing will be based on XTO's drilling schedule.

Once the water wells are selected; the various landowners will be contacted to schedule the sampling program. The landowners will receive a letter explaining the scope of the sampling, the benefits available to the water well owners, and a request for their participation. The letter will include a self-addressed and stamped response card. The response card will ask a few short questions about the water well yield, depth, and accessibility. The card will also request a phone contact number to be used in coordinating sampling events but more importantly, information pertaining to the preferred sampling time.

The letter to landowners requesting participation in the sampling program will include information on access to the property. The response card will contain a statement agreeing to access and a signature and date. Field personnel will have copies of these response cards in the field should there be any miscommunication during the access process.

Water Well Sampling

Field observations including water well conditions will be obtained for each water sample prior to sampling the water well. The water well owner will be interviewed in an attempt to the obtain water well conditions including type of pump, casing material and size, location of water well and

access point, typical daily water use, water well yield, depth of water well and screened interval, and a brief description of the area around the water well. Some of this information will be available from the State Engineer's water well records and already incorporated into the database. This information will assist in determining if low flow purging and sampling will be required. All field data obtained will be directly input into the GPS in the field.

The water sample will be collected at the closest location to the water well system. Preference will be given to sampling points located prior to any pressure tanks or pretreatment systems such as filtration and/or water softeners. At no point will field personnel break the sanitary well seal and/or enter the well in any way. All samples will be collected from existing spigots or faucets. If a water well is not accessible via appropriate sampling points or no spigots exist, the water well will not be sampled.

Field personnel will collect field parameters of pH, specific electrical conductance (SC), and temperature during purging. Purging will be considered complete when stability is demonstrated through three consecutive measurements at three to five minute intervals where pH varies by less than 0.1 units, temperature varies by less than 0.2 degrees Celsius (C), and SC varies by less than 5% for values less than 100 micro-Siemens per cm (uS/cm) or 3% for values greater than 100 uS/cm. A flow-through cell will be utilitzed during purging for field measurements as this method provides the most accurate measurements. Low flow purging will be used if it is anticipated that the well may run dry. Equipment will be decontaminated prior to each sampling event.

Flow rates during purging will be measured using a graduated bucket and a stopwatch and recorded in the GPS. Field personnel will also note color, clarity, odors, effervescence, produced sediment, and evidence of bacterial fouling. Observations will be recorded directly in the GPS.

Once purging is complete, field personnel will initiate sampling under low flow rate conditions (approximately 1 gallon per minute) and will bypass the flow-through cell. Field personnel will record, in the GPS, the field parameters measured based on the last value recorded.

Water Analysis

The following table presents the analyses that will be performed on each groundwater sample, the laboratory method, and the sample bottle requirement:

Analyte	**Laboratory Method**	**Bottle Requirement**
Major Cations (dissolved Na, Ca, Mg, K, Fe)	EPA Method 6010/6020	500 milliliter (mL) plastic - unpreserved, filtered at laboratory
Dissolved Metals (Se, Mn)	EPA Method 6010/6020	500 mL plastic - unpreserved
Alkalinity (carbonate/bicarbonate)	EPA 300	500 mL plastic - unpreserved
Major Anions (Cl, SO_4, Br, F)	EPA 300	1-liter (L) plastic – unpreserved
Analyte	**Laboratory Method**	**Bottle Requirement**

pH	EPA 150.1	1-L plastic- unpreserved
Specific Conductance	MCA WW 120.1	500 mL plastic - unpreserved
Nitrate/Nitrite as Nitrogen (N)	EPA 353.3	250 mL plastic - preserved with sulfuric acid (H_2SO_4)
TDS	EPA 160.1	500 mL plastic – unpreserved
Dissolved Methane	RSK 175	3 40-mL VOA unpreserved
Sodium Adsorption Ratio (SAR)	LADNR 29B	300- mL plastic- unpreserved
Hydrogen sulfide	Field Test	HACH Strips
Bacteria	IRB/SRB/SLYM/ Coliform	100-mL poly
Free gas composition and carbon and hydrogen isotopes of methane	NG-2	1-liter (L) plastic – preserved w/ benzalkonium chloride

Water samples will be filled in laboratory-provided sample bottles for analysis of the parameters identified above. All water samples collected will be submitted in coolers under strict chain-of-custody documentation to the appropriate laboratory.

Along with water samples, field personnel will collect free gas samples for analysis. If free gas or methane concentrations greater than 2 milligrams per liter (mg/L) is detected, compositional analysis and carbon and hydrogen isotopic analyses of methane will be performed to determine if the gas type is thermogenic, biogenic or an intermediate blend of both. These samples will be submitted to Isotech located in Champaign, Illinois.

Analysis of bacteria from the water wells will be conducted by RespirTek located in Biloxi, Mississippi. All water samples will be collected in bottles provided by the laboratory and analyzed for iron related, sulfate, reducing, slime forming, and coliform bacteria.

Data collected, including laboratory electronic data deliverables and field measurements, during water well sampling events will be imported into a Microsoft Access® database.

The data will be evaluated to determine the significant aspects of the baseline water quality assessment as related to water quality standards. A primary objective will be to evaluate the geochemical data in light of the potential or existing impacts from historic or future oil & gas exploration and production; and comparisons to existing water quality standards and existing regional water quality information.

If methane gas is present at concentrations greater than 2 mg/L in any water well sample, the gas composition and stable isotopic analysis data will be evaluated to determine the significant aspects of the baseline gas composition assessment for the Project Area.

Reports and Deliverables

At the conclusion of each water well sampling event, a letter report to each property owner and the COGCC will be prepared that summarize the sampling procedures and analytical results. The letter report will include analytical summary tables and comparisons to existing water quality standards.

A database will be developed and will include the corrected GPS coordinates, sample identifications, field measurements, landowner contact information, and laboratory analytical data. The database will be provided to the COGCC in electronic format only.

2.1.3 Task 3 - Ground Survey to Locate Methane Seeps on the Raton and Vermejo Formation Outcrops

This task will meet the requirements of Rule 608(c) and be completed in a manner similar to the initial ground survey completed by Apogee for the COGCC in 2000 and the survey performed by LTE and Apogee in 2007 for the COGCC. The focus of this approach is to identify methane seepage from the Raton Formation which outcrops over 50% of the 90,000-acre Project Area and the Vermejo Formation which outcrops over approximately 2% of the Project Area.

The technique involves using a vehicle mounted Leak Detection System (LDS) to survey the project area using the existing roadway network as a reasonable means to cover the outcrop and identify seep areas. The LDS is an infrared spectrometer (IRS) based gas analyzer designed to locate methane emission sources from mobile platforms (cars, trucks, helicopters, ATVs, etc.) in real time. The LDS system measures methane, total hydrocarbons and carbon dioxide with sub-ppm detection limits and displays the data in real time on the control computer. The LDS also incorporates a GPS that records the track taken by the survey vehicle. Wind direction and ambient temperature sensors will also be mounted on the survey vehicle. This is the same method of survey utilized by the COGCC during the past two monitoring events and appears to be the most effective method for monitoring large areas at this time. Appendix B contains the specifications of the LDS system.

Initial ground surveys will be limited to those accessible roads in the vicinity of a planned XTO CBM well that is within a 2-mile radius of a Raton or Vermejo Formation outcrop. The survey area will increase as the drilling program progresses over the next three years. This approach will meet the objective Rule 608(c) by ultimately surveying the entire XTO Project Area for methane by the third year of the drilling program.

Apogee will conduct a survey of roads, jeep trails, and lease roads of a planned XTO CBM well that is within a 2-mile radius of a Raton or Vermejo Formation outcrop using the Apogee LDS mounted on a 4-wheel drive vehicle. As the LDS is driven, any increase in methane concentration above the local background concentration will be marked and investigated to try and locate the source of the methane plume. Marking a potential seep involves recording the latitude, longitude, wind speed, wind direction, temperature, and other pertinent data about the location. If the source of the methane plume is evident (mine vent, coal outcrop, leaking gas well, etc), this information will also be recorded.

Based on discussions between XTO and COGCC, annual road surveys will be limited to areas that encompass a planned XTO CBM well that is within a 2-mile radius of a Raton or Vermejo Formation outcrop to maintain compliance with Rule 608(c). The results of the road surveys will be summarized in a report that will be submitted to the COGCC on a yearly basis.

2.4.4 Task 4 - Infrared Aerial Imagery and Field Verification along the Vermejo Formation Outcrop and the Tercio, Vega, and Quinto Mines

A regional reconnaissance for methane seepage along the Vermejo Formation outcrop and the Tercio, Vega, and Quinto Mines will be conducted using infrared (IR) aerial imagery and field verification of suspect areas. This survey method has been selected due to high topographic relief and few roads accessing this area as compared to the Raton Formation outcrop areas.

An IR camera mounted on an aircraft is used to collect high resolution, low altitude imagery. The imagery is georeferenced and rectified using digital elevation model (DEM) ortho-correction. The images are then reviewed for suspect seep areas. Suspect areas are defined as areas with IR reflectance anomalies generally caused by dead or stressed vegetation. Since methane seepage frequently affects vegetative conditions, the IR imagery can be used as the key indicator of potential seepage. Since the IR imagery cannot detect the presence or absence of methane, each suspect area identified in the imagery must be field-verified to determine if methane seepage is present.

IR imagery will be acquired by Agro Engineering, Inc. (Agro) of Alamosa, Colorado. Agro will fly the Vermejo Formation outcrop using an IR camera mounted on an aircraft at 1 meter to 1.5-meter resolution. This reconnaissance flight must be performed during the peak vegetation condition which occurs in May/June in order to be effective. Once the imagery is acquired, Agro will georeference the imagery and provide it to LTE for interpretation.

Identified suspect areas along the Vermejo Formation outcrop and in the vicinity of the three mines that appear to contain dead or stressed vegetation or an anomalous IR reflectance signature will be delineated as polygons on the imagery and uploaded to a GPS unit for field verification of methane seepage.

Upon completion of the imagery review activities, field verification of suspect areas will be conducted with the goal of identifying the presence or absence of methane seepage. The field personnel will be equipped with the aerial imagery, topographic maps, a digital camera, and a GPS.

Field personnel will visit each of the accessible suspect areas, and collect subsurface gas measurements within the suspect area using a slide hammer and four-gas meter as described in Section 2.1.1. In addition, photo-documentation of the suspect areas and a brief description of the features observed will be documented.

This method of regional reconnaissance (aerial IR imagery and field verification) has been conducted along the northern rim of San Juan Basin in Archuleta County and La Plata County in with great success since 2004.

2.1.5 Task 5 - Field Mapping of Known Methane Seeps

Field mapping of known or newly identified seeps will consist of utilizing a portable flux meter to measure the magnitude and extent of methane seepage, within the survey area. The measurements will be collected using a sampling grid approach.

To be compliant with Rule 608(c), annual detailed mapping of the previously identified 19 methane seeps within a 2-mile radius of a planned XTO CBM well will be performed. As ground surveys of the formation outcrops identify new methane seepage, the new areas identified will be added to the annual detailed mapping program.

Based on historical experience in conducting detailed methane seep mapping programs, seep mapping is best conducted in late Spring. Spring mapping will increase field work efficiency due to better weather conditions and ground conditions, but more importantly, vegetative cover will be at or near peak foliage and reduce interference from senescent conditions commonly observed during the late summer, fall, and winter months. Scheduling for methane surveys will be based on XTO planned CBM wells for that year. Any deviation from the initial drilling schedule (i.e. additional CBM wells drilled for the year) will be incorporated in the subsequent annual methane survey.

Grids for detailed mapping areas consist of varying numbers of squares, ranging in area from 2,500 square feet (ft^2) to 40,000 ft^2. In general, 50-foot and 200-foot grid spacings are used, depending on site specific needs. The smaller grid spacings are used to map known methane seep areas of relatively small extent. The grid mapping system has proven to be systematic, consistent, repeatable, and successful in delineating the areal extent of seepage.

A flux measurement will be collected at the corner of each grid square. When methane is detected along the outer edges of the mapping area, additional grid points will be developed and measured to determine the extent of methane seepage.

Full color spectrum aerial photographs are used as base maps for field use and figures for reporting. The geologic contacts depicted on the aerial photographic maps are derived from geologic maps prepared by the Colorado Geological Survey (CGS) and digitized. Accuracy of the formation contact is reduced when aerial photographs are viewed at a smaller scale.

Where appropriate, photographs of vegetative conditions, visible seeps, and sensitive receptors will be collected.

Flux Measurements

The flux of soil gases moving across the soil surface to the atmosphere is measured using the portable gas flux meter. The flux meter has been used to measure soil gas seepage on the Raton Formation in the Raton Basin in Colorado. The portable flux meter measures the flux of methane, hydrogen sulfide, and carbon dioxide by employing individual gas-specific sensors that records the increases, if any, of gas concentrations over time for a given surface area. These increases are proportional to the flux of each gas.

The flux meter components include an accumulation chamber connected by circulation tubes to the gas detector unit. At each sampling point, the accumulation chamber is placed on the ground surface to capture gas seeping from the ground. A fan in the chamber continuously mixes the gases in the chamber during the measurement process. A pump moves gases in the accumulation chamber to the detector unit. After passing through the detector unit, gases are returned to the chamber. This closed loop process allows soil gases discharging to the chamber to increase over time. Any increases in concentrations are measured and recorded automatically. No gas is allowed to escape the system. However, a vacuum is not created during the process. This enables measurement of natural seep conditions, if present. The result for each gas is reported as a mass flux in units of moles per square meter per day (moles/m^2·day).

Flux measurement accuracy can be limited by surface conditions. One of the most important factors is the quality of the seal between the accumulation chamber base and the ground surface. To ensure a proper seal between the ground surface and the chamber, field personnel will choose relatively flat surfaces where possible and place loose soil around the base of the chamber to reduce the potential for gas loss at the base of the chamber. In addition, ground disturbance will be minimized during the measurement process in order to maintain the natural seep conditions. In areas with heterogeneous surfaces, the seal is sometimes difficult to achieve. This scenario is evident at locations with poorly developed soil or where the soil surface is obscured by decayed organic matter on the forest floor.

The accuracy of the total flux estimation within the project area is influenced by the ability of the grid spacing system to represent the actual flux on a detailed level relative to the subsurface fracture system, coal quality, and stratigraphy within the Raton Formation and/or Vermejo Formation. The accuracy of the field meters also influences the flux estimation.

The methane sensor within the flux meter unit has a range of 60 parts per million (ppm) to 50,000 ppm. The flux meter methane measurement range is 0.2 to 300 moles/m^2·day. Methane fluxes below 0.2 moles/m^2·day are detectable with decreased accuracy. As a result, reporting of methane fluxes will not include values less than 0.2 moles/m^2·day.

The carbon dioxide sensor has a full-scale range of 0 to 20,000 ppm and flux measurement range of 0 to 600 moles/m^2·day at an accuracy of ±25%.

The hydrogen sulfide detector has a full-scale range of 0 to 20 ppm and a flux measurement range of 0.0025 to 0.5 moles/m^2·day at an accuracy of ±25%. The sensor is an electrochemical cell that measures hydrogen sulfide through a chemical oxidation process. The sensing process consumes a small amount of the hydrogen sulfide, which is not returned to the flux meter's accumulation chamber. Therefore, the flux meter can underestimate hydrogen sulfide flux by as much as 10%. For this reason, hydrogen sulfide values less than 0.0025 moles/m^2·day will not be reported. Information on the West Systems portable gas flux meter is provided in Appendix A.

During the measurement process, gas concentrations are recorded at 1-second intervals and directly downloaded via Bluetooth® connection to a portable digital assistant (PDA) integrated with the GPS unit (described below). Other measurements recorded include barometric pressure, temperature, date, and time.

Integrated West Systems Flux Manager® software on the GPS unit recorded the gas measurement data. The software plots the curve of gas concentration versus time for each measurement collected. The best-fit line for the curve generated is selected. The slope of the best-fit line is proportional to the flux at the measurement point.

Global Positioning System Data Management

Each sample location is recorded using a GPS unit. Soil gas sampling grids are created in ArcView® and pre-loaded into the GPS unit so field personnel could quickly and accurately position detection equipment along the project area. Soil gas measurements and other relevant field data are then stored as attributes in the GPS unit along with the associated location data. The data stored in the GPS unit will be downloaded at a later time for processing and reporting.

The GPS unit location data are collected in the World Geodetic System 1984 (WGS 84) and projected in Universal Transverse Mercator (UTM) Zone 13 North, North American Datum 1983 (NAD 83) for use in an ArcView® project file. On average, 25 GPS log points are collected for each point feature in order to obtain more accurate positioning.

Readings collected with the GPS unit can be located with 1-meter accuracy. However, the terrain and forest canopy can adversely impact GPS unit accuracy. North-facing slopes and heavily wooded areas can distort or block satellite signals. When satellite signals are limited, positioning accuracy decreases. In locations where the GPS unit can not obtain a signal, field personnel will note measurement data on their field reference maps. Specifications of the GPS unit are included in Appendix B.

Soil-Gas Analysis

During the performance of Task 4, gas samples will be collected from the various known seep areas for which no existing isotopic information exists. During the Phase II Seep Investigation conducted by the COGCC, gas samples were collected from many of the seeps in the Raton Basin. There is no reason to suspect that the isotopic composition has changed at these seep areas; therefore resampling these seeps will not be performed. Gas samples will only be collected from newly identified seeps with no isotopic data, as required by Rule 608.

The gas samples will be collected from the area within the seep with the highest observed methane concentration. Field personnel will use a hand pump attached to tubing inserted into a borehole driven by a slide hammer. The tubing will be purged of the ambient air and a Cali-5-bond® mylar bag will be filled with a sample of the gas within the borehole for analysis of the following:

- Fixed Gas Chromatography: Hydrogen (H_2), Argon (Ar), Nitrogen (N_2), Oxygen (O_2), Carbon Dioxide (CO_2), and Hydrogen Sulfide (H_2S);
- Hydrocarbon Gas Chromatography: Methane, Ethane, Propane, i-Butane, n-Butane, i-Pentane, n-Pentane, and Hexane+; and
- Isotopic Analysis: carbon and hydrogen isotopes of Methane, carbon isotopes of CO_2, and carbon isotopes of ethane and propane.

Isotopic analysis is dependent on the gas concentration present in the sample. Gas seep concentrations of methane, carbon dioxide, and ethane will vary greatly and may be insufficient to conduct isotopic analysis.

The samples will be packaged and shipped by a Department of Transportation (DOT) certified hazardous materials shipper to Isotech.

The gas composition and isotopic analysis data will be evaluated to determine the significant aspects of the gas composition assessment for each seep area. The objective is to have a data set that will assist in the identification of potential sources of the gas seep and observe and evaluate seep characteristics across the Project Area.

2.1.6 Task 6 - Natural Spring Surveys

Surveys of natural springs will be performed on a well by well basis. Only natural springs identified on United States Geologicial Survey (USGS) topographic in the vicinity of a planned XTO CBM well that is within a 2-mile radius of a Raton or Vermejo Formation outcrop will be surveyed.

This work will be performed during the mid to late Spring in order to increase the potential that natural springs will be flowing. Once a spring is identified, sampling will be performed on an annual basis during the detailed mapping of known seeps within the completed survey areas.

Once a natural spring is identified, water samples will be collected. At each natural spring, field personnel will locate the position and elevation using a GPS. A discharge rate will be measured using a graduated cylinder and stop-watch. Water quality measurements, including pH, total dissolved solids (TDS), electrical conductivity (EC), oxidation-reduction potential (ORP), and temperature will be collected using a Myron L 6P Ultrameter II (Myron L). The equipment specifications for the water quality field meter are provided in Attachment B.

Water samples will be collected at natural springs in sample bottles prepared by the analytical laboratories. Each sample bottle will be labeled, indicating the project and sample identification, and the date and time of sample collection. Samples will be delivered to the laboratory under chain-of-custody controls. Water analysis for the natural springs will follow the water well sampling protocol outlined in Section 2.1.2 with the exception of dissolved methane.

2.1.7 Task 7 - Reporting

Results of surveys at P&A production wells will be reported to the COGCC on a per site basis in a letter report for compliance with Rule 608. The report will include a map showing the sample locations and results of the measurements.

At the conclusion of each sampling event and after XTO approval, letter reports to the property owners and the COGCC will be prepared that summarize the sampling procedures and analytical results. The report will include analytical summary tables and comparisons to existing water quality standards. An electronic database will be developed that provides the corrected GPS coordinates, sample identifications, field measurements, landowner contact information, and

laboratory analytical data. Letter reports will be provided to the COGCC in hardcopy and electronic format. The electronic database will be provided in electronic format only.

Results of the ground surveys, methane seep surveys, and natural spring surveys will be reported in one comprehensive report on an annual basis. The report will be prepared for submittal to the COGCC within 3 months following the completion of the field activities. The report will provide maps of the ground survey results; results of the detailed mapping of known seep areas; and findings of the natural spring surveys. Annual reporting in conjunction with the regional program implementation described above will further reduce administrative and reporting costs and provide a more manageable result to both XTO and the COGCC.

2.2 HEALTH AND SAFETY PLAN (HASP)

Potential hazards for the Project include exposure to flammable gas, toxic gas (H_2S), extreme heat and cold, dangerous wildlife, and traffic hazards to name a few. The HASP will identify the potential hazards associated with the performance of the work and outline the procedures to reduce the hazard risk and the personal protective equipment to be used to protect the field crews. All field personnel, including subcontractors, will be required to read and verify they understand the potential risks associated with the program.

SECTION 3.0
PROJECT TIMELINE

3.1 ASSESSMENT OF P&A PRODUCTION WELLS

Surveys at P&A production well locations will be performed on an as needed basis depending on permitting and drilling schedule.

3.2 WATER WELL SAMPLING

Water well sampling will be performed on an as needed basis depending on the permitting and drilling schedule. All water well sampling will be conducted in conjunction with the natural springs sampling event. Standard laboratory turn around for the water quality analysis is two weeks. If isotopic analysis is required, the standard laboratory turn around is one month. Reports will be delivered to landowners and the COGCC within two months following completion of the field activities.

3.3 GROUND SURVEY TO LOCATE METHANE SEEPS ON THE RATON AND VERMEJO FORMATION OUTCROPS

The ground survey to locate methane seeps should be conducted in the Spring or summer months. The follow-up data evaluation and reporting from Apogee will be completed within three weeks from the end of the field activities.

3.4 INFRARED AERIAL IMAGERY AND FIELD VERIFICATION ALONG THE VERMEJO FORMATION OUTCROP AND THE TERCIO, VEGA, AND QUINTO MINES

The aerial IR imagery will be most effective if conducted during late May or early June, when the vegetation is at its peak growth. This will allow for the most effective review process when determining the suspect areas that exhibit dead or stressed vegetation.

Once the areas of interest have been identified through the aerial IR imagery, field verification activities will coincide with the field mapping of known methane seeps. Suspect areas that are confirmed to have methane seeps will be added to the annual field mapping. Those areas where methane is not detected will be noted and eliminated from future mapping events.

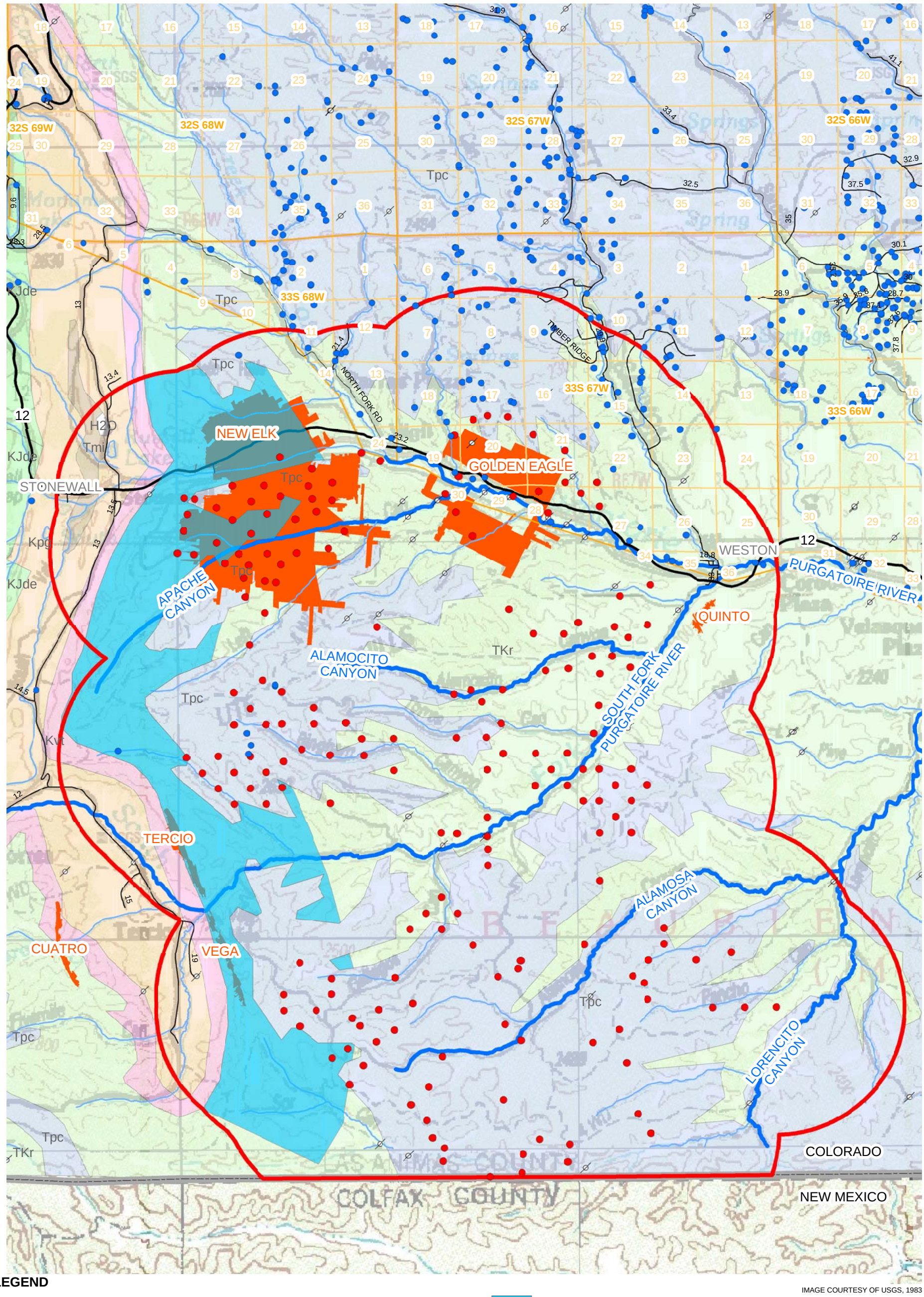
3.5 FIELD MAPPING OF KNOWN METHANE SEEP AREAS

Field mapping of the known seep areas that encompass a planned XTO CBM well that is within a 2-mile radius of a Raton or Vermejo Formation outcrop will be performed in the spring season, following the ground survey. Any soil gas samples will be collected at that time and submitted for standard turn around, which is typically one month. Additional CBM wells that are drilled after the Spring methane survey will be incorporated in the subsequent annual methane survey.

3.6 NATURAL SPRING SURVEYS

Surveys at natural spring locations will be performed on an as needed basis depending on XTO's permitting and drilling schedule. All natural springs within a 2-mile radius of planned XTO CBM wells will be sampled in the Spring time. Standard laboratory turn around for the water quality analysis is 2 weeks. If isotopic analysis is required, the standard laboratory turn around is 1 month. Reporting of the results of the spring sampling will be incorporated into the outcrop monitoring report and delivered to the COGCC within three months following completion of the field activities.

FIGURES



LEGEND

- PLANNED CBM WELL LOCATION
- ABANDONED WELL LOCATION
- WATER WELL
- PROJECT AREA
- LEWICKI MINE BOUNDARIES
- COUNTY LINE
- COLORADO STATE LINE
- TOWNSHIP AND RANGE LINES

GEOLOGIC CONTACTS (TWETO, 1979)

- Tmi - MIDDLE TERTIARY INTRUSIVE ROCKS
- Tpc - POISON CANYON FORMATION
- TKr - RATON FORMATION
- Kvt - VERMEJO FORMATION
- Kpg - PIERRE SHALE FORMATION
- KJde - DAKOTA FORMATION
- P[Ps - SANGRE DE CRISTO FORMATION

- RATON FORMATION WITHIN 2 MILES OF VERMEJO/RATON CONTACT
- ROAD
- OTHER WATER SOURCE
- MAJOR DRAINAGE

0 1.5 3 Miles

N

IMAGE COURTESY OF USGS, 1983

FIGURE 1
PROJECT AREA MAP
RATON BASIN
LAS ANIMAS, COLORADO

XTO ENERGY, INC

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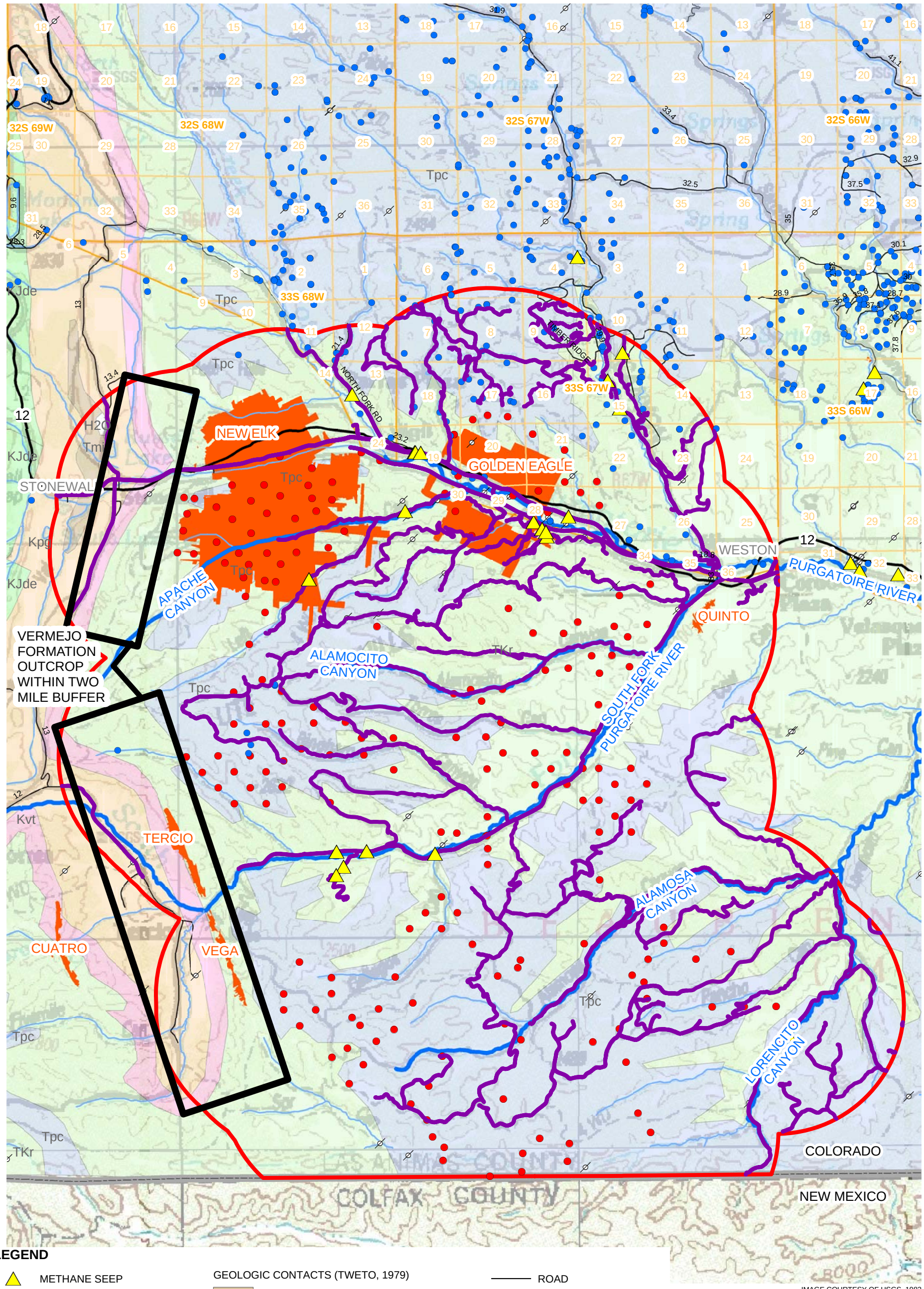

IMAGE COURTESY OF USGS, 1983

LEGEND

- METHANE SEEP
- PLANNED CBM WELL LOCATION
- ABANDONED WELL LOCATION
- WATER WELL
- PROJECT AREA
- LEWICKI MINE BOUNDARIES
- COUNTY LINE
- COLORADO STATE LINE
- TOWNSHIP AND RANGE LINES

GEOLOGIC CONTACTS (TWETO, 1979)

- Tmi - MIDDLE TERTIARY INTRUSIVE ROCKS
- Tpc - POISON CANYON FORMATION
- TKr - RATON FORMATION
- Kvt - VERMEJO FORMATION
- Kpg - PIERRE SHALE FORMATION
- KJde - DAKOTA FORMATION
- P[Ps - SANGRE DE CRISTO FORMATION

- ROAD
- APOGEE SURVEY ROUTE
- OTHER WATER SOURCE
- MAJOR DRAINAGE

0 1.5 3
Miles

N

FIGURE 2
PROPOSED SCOPE OF WORK MAP
RATON BASIN
LAS ANIMAS, COLORADO

XTO ENERGY, INC

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APPENDIX A

COGCC RULE 608

f. Smoking shall not be allowed within seventy-five (75) feet of the air and gas discharge line and burn pit.

g. All operations associated with the drilling, completion or production of a well shall be subject to the Colorado Air Quality Control Act, 25-7-101, C.R.S.

607. HYDROGEN SULFIDE GAS

a. When well servicing operations take place in zones known to contain at or above one hundred (100) ppm hydrogen sulfide gas, as measured in the gas stream, the operator shall file a hydrogen sulfide drilling operations plan (United States Department of the Interior, Bureau of Land Management, Onshore Order No. 6, November 23, 1990).

b. When proposing to drill a well in areas where hydrogen sulfide gas in excess of one hundred (100) ppm can reasonably be expected to be encountered, the operator shall submit as part of the Form 2, Application-for-Permit-to-Drill, a hydrogen sulfide drilling operations plan (United States Department of the Interior, Bureau of Land Management, Onshore Order No. 6, November 23, 1990).

c. Any gas analysis indicating the presence of hydrogen sulfide gas shall be reported to the Commission and the local governmental designee.

608. COALBED METHANE WELLS

a. **Assessment and monitoring of plugged and abandoned wells within one-quarter (1/4) mile of proposed coalbed methane (CBM) well.**

(1) Based upon examination of the Commission and other publicly available records, operators shall identify all plugged and abandoned (P&A) wells located within one-quarter (1/4) mile of a proposed coalbed methane (CBM) well. The operator shall assess the risk of leaking gas or water to the ground surface or into subsurface water resources, taking into account plugging and cementing procedures described in any recompletion or P&A report filed with the Commission. The operator shall notify the Director of the results of the assessment of the plugging and cementing procedures. The Director shall review the assessment and take appropriate action to pursue further investigation and remediation if warranted and in accordance with Colorado Revised Statute 34-60-124(4)(A).

(2) Operators shall use reasonable good faith efforts to obtain access to all P&A wells identified under Rule 608.a.(1) above to conduct a soil gas survey at all P&A wells located within one-quarter (1/4) mile of a proposed CBM well prior to production from the proposed CBM well and again one (1) year and thereafter every three (3) years after production has commenced. Operators shall submit the results of the soil gas survey to the Director within three (3) months of conducting the survey or advise the Director that access to the P&A wells could not be obtained.

b. **Water well sampling.**

(1) If a conventional gas well or P&A well exists within one-quarter (1/4) mile of a proposed CBM well, then the two (2) closest water wells within a one-half (1/2) mile radius of the conventional gas well or the P&A well shall be sampled ("Water Quality Testing Wells"). If possible, the water wells selected should be on opposite sides of the conventional gas well or the P&A well not exceeding a one-

half (1/2) mile radius. If water wells on opposite sides of the conventional gas well or the P&A well cannot be identified, then the two (2) closest wells within a one-half (1/2) mile radius of the conventional gas well or the P&A well shall be sampled. If two (2) or more conventional wells or P&A wells are located within one-quarter (1/4) mile of the proposed CBM well, then the conventional well or the P&A well closest to a proposed CBM well shall be used for selecting water wells for sampling.

If there are no conventional gas wells or P&A wells located within a one-quarter (1/4) mile radius of the proposed CBM well, then the selected water wells shall be within one-quarter (1/4) mile of the proposed CBM well. In areas where two (2) or more water wells exist within one-quarter (1/4) mile of the proposed CBM well, then the two (2) closest water wells shall be sampled. If possible, the water wells selected should be on opposite sides of the proposed CBM well. If water wells on opposite sides of the proposed CBM well cannot be identified, then the two (2) closest wells within one-quarter (1/4) mile radius shall be sampled. If two (2) water wells do not exist within a one-quarter (1/4) mile radius, then the closest single water well within either a one-quarter (1/4) mile radius or within a one-half (1/2) mile radius shall be selected.

If no water well is located within a one-quarter (1/4) mile radius area as described above or if access is denied, then a water well within one-half (1/2) mile of the proposed CBM well shall be selected. If no water wells meet the foregoing criteria, then sampling shall not be required. If the Commission has already acquired data on a water well within one-quarter (1/4) mile of the conventional well or the P&A well, but it is not the closest water well, then it shall be given preference in selecting a water well to be tested.

(2) The "initial baseline testing" described in this section shall include all major cations and anions, total dissolved solids (TDS), iron, manganese, selenium, nitrates and nitrites, dissolved methane, field pH, sodium adsorption ration (SAR), presence of bacteria (iron related, sulfate reducing, slime, and coliform), and specific conductance. Hydrogen sulfide shall also be measured using a field test method. Field observations such as odor, water color, sediment, bubbles, and effervescence shall also be included. The location of the water well shall be surveyed in accordance with Rule 215.

(3) If free gas or a dissolved methane concentration level greater than two (2) milligrams per liter (mg/l) is detected in a water well, gas compositional analysis and stable isotope analysis of the methane (carbon and deuterium) shall be performed to determine gas type. If the test results indicate biogenic gas, no further isotopic testing shall be done. If the test results indicate thermogenic or a mixture of thermogenic and biogenic gas, then the operator shall submit to the Director an action plan to determine the source of the gas. If the methane concentration increases by more than five (5) mg/l between sampling periods, or increases to more than ten (10) mg/l, the operator shall notify the Director and the owner of the water well immediately.

(4) Operators shall make a good faith effort to conduct initial baseline testing of the selected water wells prior to the drilling of the proposed CBM well; however, not conducting baseline testing because access to water wells cannot be obtained shall not be grounds for denial of an Application for Permit-to-Drill, Form 2. Within one (1) year after completion of the proposed CBM well, a "post-completion" test shall be performed for the same analytical parameters listed above and repeated three (3) and six (6) years thereafter or in accordance with the requirements of field rules developed pursuant to Rule 608.f. If the methane concentration

increases by more than five (5) mg/l between sampling periods or increases to more than ten (10) mg/l, the operator shall prepare an action plan to determine the source of the gas and notify the Director and the water well owner immediately. If no significant changes from the baseline have been identified after the third test (i.e. the six-year test), no further testing shall be required. Additional "post-completion" test(s) may be required if changes in water quality are identified during follow-up testing. The Director may require further water well sampling at any time in response to complaints from water well owners.

(5) Copies of all test results described above shall be provided to the Commission and the water well owner within three (3) months of collecting the samples. The analytical data and surveyed well locations shall also be submitted to the Director in an electronic data deliverable format.

c. **Coal outcrop and coal mine monitoring.**

(1) If the CBM well is within two (2) miles of the outcrop of the stratigraphic contact between the coal-bearing formation and the underlying formation, or within two (2) miles of an active, inactive, or abandoned coal mine, the operator shall make a good faith effort to obtain the access necessary to survey the outcrop or mine prior to drilling the CBM well to determine whether there are gas seeps and springs or water seeps that discharge from the coal-bearing formation in the area.

(2) If a gas seep is identified during the survey, then its location and areal extent shall be surveyed in accordance with Rule 215 and the concentration of the soil gas shall be determined. If possible, a sample of gas shall be collected from the seep for compositional analysis and stable isotope analysis of the methane (carbon and deuterium). Thereafter, the operator will inspect the gas seep, survey its areal extent, and measure soil gas concentrations annually, if access can be obtained. The operator shall submit the results of the outcrop or mine monitoring to the Commission and the landowner within three (3) months of its completion of the field work. The analytical data shall also be submitted to the Director in an electronic data deliverable format.

(3) If a gas seep is identified during the survey, the Director shall advise the landowners, local government, Colorado Geological Survey (CGS), and the Colorado Division of Reclamation, Mining, and Safety (DRMS), as appropriate, of the findings. In collaboration with state, local, and private interests, the CGS, DRMS, and the Commission may elect to develop a geologic hazard survey and determine whether the area should be recommended to be designated as a geologic hazard in accordance with Colorado Revised Statute 34-1-103 and 24-65.1-103.

(4) If the CBM well is within two (2) miles of the outcrop of the stratigraphic contact between the coal-bearing formation and the underlying formation, the operator shall survey the outcrop, review publicly available geologic and hydrogeologic data, and interview landowners to identify springs or water seeps that discharge from the coal-bearing formation.

If such a water feature is identified, then the operator shall survey its location and areal extent in accordance with Rule 215, measure the flow rate, photograph the feature, and collect and analyze a water sample in accordance with Rule 608.b.(2). Thereafter, the operator will inspect, survey the areal extent of, and measure the flow rate of the spring or water seep annually, if access can be obtained. The operator shall submit the results of the spring or water seep monitoring to the Commission and the landowner within three (3) months of its

completion of the field work. The analytical data shall also be submitted to the Director in an electronic data deliverable format.

d. **Prior to producing - static bottom-hole pressure survey.** Prior to producing the well, the operator shall obtain a static bottom-hole pressure test on at least the first well drilled on a government quarter (1/4) section. The survey shall be conducted by either a direct static bottom-hole pressure measurement or by a static fluid level measurement. The data acquired by the operator and a description of the procedures used to gather the data shall be reported on a Bottom Hole Pressure, Form 13, and submitted with the Completed Interval Report, Form 5A, filed with the Director. After reviewing the quality of the static bottom-hole pressure data and the adequacy of the geographic distribution of the data, or at the request of the operator, the Director may vary the number of wells subject to the static bottom-hole pressure survey requirement. If an application for increased well density or down spacing is filed with the Commission, then additional testing may be required.

e. **Bradenhead testing.** Upon completion of any well, and on wells presently completed, the operator shall equip the bradenhead access to the annulus between the production and surface casing, as well as any intermediate casing, with approved fittings to allow safe and convenient determination of pressure and fluid flow. This rule shall apply to all wells, regardless of function, completed for CBM production or below the coal-bearing formation. All wells capable of production, injection, or observation shall be tested by the operator for pressure and flow, with results submitted to the Director on a bradenhead test report, Form 17, and to other applicable regulatory agencies. Bradenhead tests shall be performed on all wells on a biennial basis. Remedial requirements shall be determined by the appropriate regulatory agency. The bradenhead testing requirement shall not apply if the operator demonstrates to the satisfaction of the Director annular cement coverage greater than fifty (50) feet above the base of surface casing and zonal isolation is confirmed by reliable evidence such as a cement bond log or cementing ticket indicating that the height of cement coverage is fifty (50) feet above the base of the surface casing, and zonal isolation is confirmed by two consecutive bradenhead tests preceded by a minimum shut-in period of seven (7) days each.

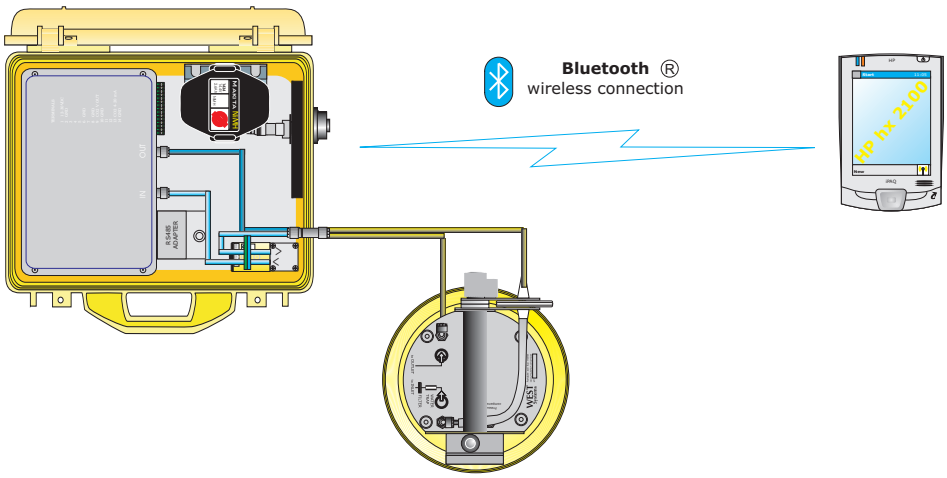
f. **Locally specific field orders.** The provisions of this Rule 608 may, with the Director's approval, be modified or superseded on a basin, region, or county specific basis by field orders developed by the Commission in consultation with affected parties, including operators, county governments, and other state or local agencies, taking into account the goals of the 600-Series Rules and particular local geologic and operational conditions. In addition, the operator or other affected party shall have the right to file an application with the Commission to develop field orders for the basin, region, or county that modify the Rule 608 requirements as provided herein, which application shall set forth an explanation of good cause for the development of such orders.

APPENDIX B

EQUIPMENT SPECIFICATION SHEETS

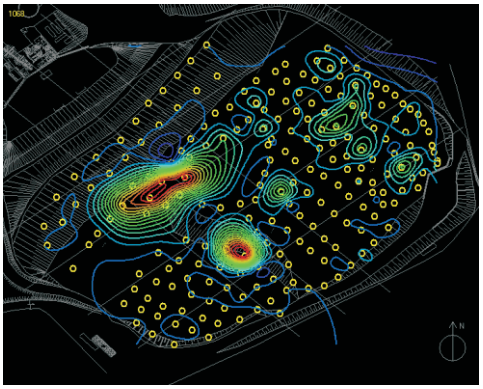
WEST Systems portable soil flux meter
for Carbon dioxide, Methane and Hydrogen sulfide fluxes

The WEST Systems Fluxmeter is a portable instrument for the measurement of soil gas diffuse degassing phenomena that uses the accumulation chamber method.



This method studied for soil respiration in agronomy (Parkinson) and for soil degassing in volcanic areas (R. Cioni et al.), has been designed by WEST Systems to obtain a portable instrument that allows the performance of measurements with very good accuracy in a short time. The instrument allows a wide range evaluation of the amount of soil gas flux and can be utilized for the evaluation of biogas degassing (landfills), for the survey of non visible degassing phenomena in volcanic and geothermal areas as well as soil respiration rate in agronomy. In the picture below, the results of the degassing survey of a landfill.

Portable fluxmeter



Methane flux contour linees

a group of researchers during a flux mapping fieldwork, using the WS-LI820 flux meter
Courtesy of United States Geological Survey

West Systems Srl
Via Molise 3 - Zona Ind. Gello - 56025 Pontedera (PI) Italy
Phone +39 0587 294216 www.westsystems.com
Fax +39 0587 296068 g.virgili@westsystems.com

WEST Systems

Portable soil flux meter

Common physical characteristics:
Total Weight = 8.3 Kg/16 lbs. to be carried on the back using the backpack-like support vest. The field operator will also have to carry one of the accumulation chambers and the palmtop:

Warm Up
Only at instrument cold start-up a warm-up time of 20 minutes is required. The typical measurement time ranges from 2 to 4 minutes and the autonomy of the instrument is about 4 hours with a single NiMH 14.4 Volts, 2.6 A/h battery. The instrument comes with two interchangeable batteries.

Accumulation Chamber specifications:
- Accumulation chamber A diameter : 200 mm / Height: 100 mm / weight: 1.5 Kg/3.3 lbs
- Accumulation chamber B diameter : 200 mm / Height: 200mm / weight : 2.2 Kg /4.84 lbs

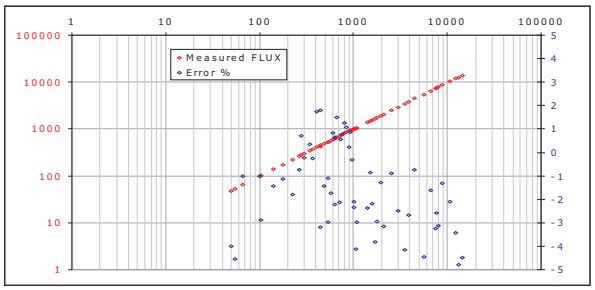
Palm top computer: PocketPC Color Display based on Windows Mobile operating system.
- PalmTop with cables, 0.3 Kg/0.7 lbs.
- Size 125mm (4.8") x 82mm (3.2") * 25 mm (1").

Software The instrument is supplied with a custom software, FluxManager, which allows recording and visualization of the increase in concentration of the target gas in the accumulation chamber, and then the flux calculations. The obtained measurements can be saved on the palmtop computer and then transferred to a desktop PC with a USB connection or using a SD card.

The instrument is supplied complete with:
- backpack-like support vest
- Carrying case for transport and storage
- 2 batteries NiMH 14.4 Volts 2.6 A/h and 1 NiMH battery charger Accumulation chamber A and B
- Palmtop Pocket PC
- User Manual, in English
- FLUX Manager Software for Windows Mobile, in English

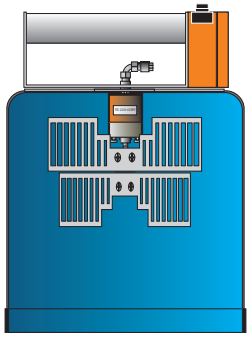
The standard flux meter configuration is supplied with a single gas detector, normally the carbon dioxide detector. The fluxmeter can host two sensors by the way special releases, based on specific customer request, it can be supplied with a maximum of 3 sensors.

Finally we improved the connection between the instrument and the palmtop that now is based on BlueTooth wireless embedded device.



The measured carbon dioxide flux vs imposed flux (grams m^{-2} day^{-1});
The error % vs imposed flux (in blue).

The instrument is extremely versatile and allows measurement of flux in 2/4 minutes. In the picture: Soil bio-gas flux monitoring in a landifll.



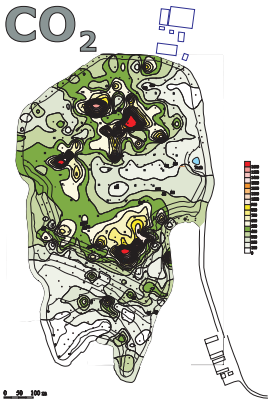
Accumulation Chamber Type B

The accumulation chambers

In the normal use of instrument only the chamber B is used. To extend the instrument sensitivity to very low fluxes the accumulation chamber A is supplied.

	Type A	Type B
net area m^2	0.0314	
net volume m^3	0.003	0.006

West Systems Srl
Via Molise 3 - Zona Ind. Gello - 56025 Pontedera (PI) Italy
Phone +39 0587 294216 www.westsystems.com
Fax +39 0587 296068 g.virgili@westsystems.com



CO_2 - LI820

LI820 based Carbon dioxide fluxmeter

The CO_2 Fluxmeter is equipped with the LICOR LI-820 the most accurate and reliable portable carbon dioxide detector. The LI-820 is a double beam infrared sensor compensated for temperature variation in the range from -10 to 45°C and for atmospheric pressure variation in the range 660-1060 HPa. Accuracy 2% repeatability ±5ppm. The full scale range can be set to 1000 , 2000, 5000 or 20000 ppmV of carbon dioxide. The characteristics of precision refer to the sensor set to a full scale range of 20000 ppmV. If a very high sensitivity is required, the detector can be set to 1000 or 2000 ppm full scale value to measure with very high precision fluxes in the range from 0 to 10 moles m^{-2} day^{-1}

CO_2 FLUX Measurement range:
from 0 up 600 moles m^{-2} day^{-1}

The accuracy depends on the measured flux:

0 to 0.5 moles m^{-2} day^{-1}	25% (Acc.ch.A)
0.5 to 1 moles m^{-2} day^{-1}	15% (Acc.ch.A or B)
1 to 150 moles m^{-2} day^{-1}	10% (Acc.ch.B)
150 to 300 moles m^{-2} day^{-1}	10% (Acc.ch.B)
300 to 600 moles m^{-2} day^{-1}	20% (Acc.ch.B)

WS-DRAGER CO_2

WS-DRAGER: CO_2 Flux measurement:

A double beam infrared sensor compensated for temperature variation in the range from -20 to 65°C. Accuracy 3%. The full scale value can be set from 2,000 to 300,000 ppm of carbon dioxide. Carbon Dioxide flux measurement range from 0.5 to 1500 moles/m^2 per day.

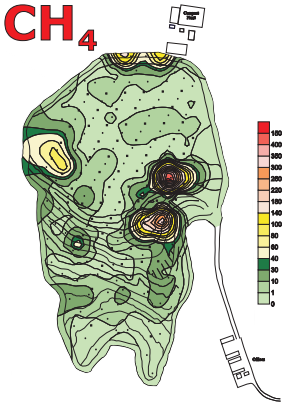
The precision depends on the measured flux:

range:0.5 – 5 moles/m^2 per day 25% (Acc. chamber A)

5-350 moles/m^2/day 10% (Acc. chamber B)

350-600 moles/ m^2/day 25% (Acc. chamber B)

600-1500 moles/ m^2/day 25% (Acc.Ch.B / F.S.=10%)



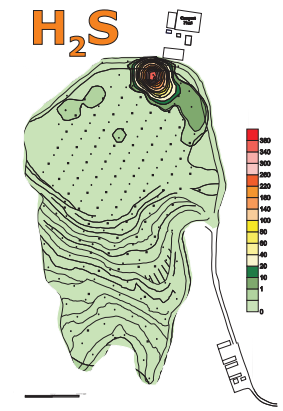
WS-HC CH^4

Methane fluxmeter

The methane sensor is an IR spectrometer. The full-scale range is 50000ppm, accuracy of 5% of reading, and repeatability is 2% of span. Detection limit 60 ppm, resolution 22 ppm. The detector was designed to measure the not controlled emissions of landfill, but it can be used to detect methane emission from coal or wherever the 0.2 moles/m^2/day detection limit is acceptable.

Methane Flux measurement range
from 0.2 up 300 moles m^{-2} day^{-1}
The fluxmeter is provided with 2 accumulation chambers and the accuracy depends on the measured flux:

0.2 to 10 moles m^{-2} day^{-1}	25% (Acc.Ch.A)
10 to 150 moles m^{-2} day^{-1}	15% (Acc.Ch.A)
150 to 300 moles m^{-2} day^{-1}	20% (Acc.Ch.B)



H_2S - WEST

Hydrogen sulfide

The hydrogen sulphide detector is a electrochemical cell with the following specifications:
The full-scale range is 20ppm, with a precision of 3% of reading, and the repeatability is 1.5% of span with a zero offset of 0.3%.

H_2S Flux measurement range: from 0.0025 to 0.5 moles/m^2 per day.
The precision depends on the measured flux:
0.0025 – 0.05 moles/m^2 per day 25% (Acc. Chamber A)
0.05 – 0.5 moles/m^2 per day 10% (Acc. Chamber B)

NOTE: The hydrogen sulphide flux evaluation can be affected by the presence of large quantities of water in both liquid and vapour phases.

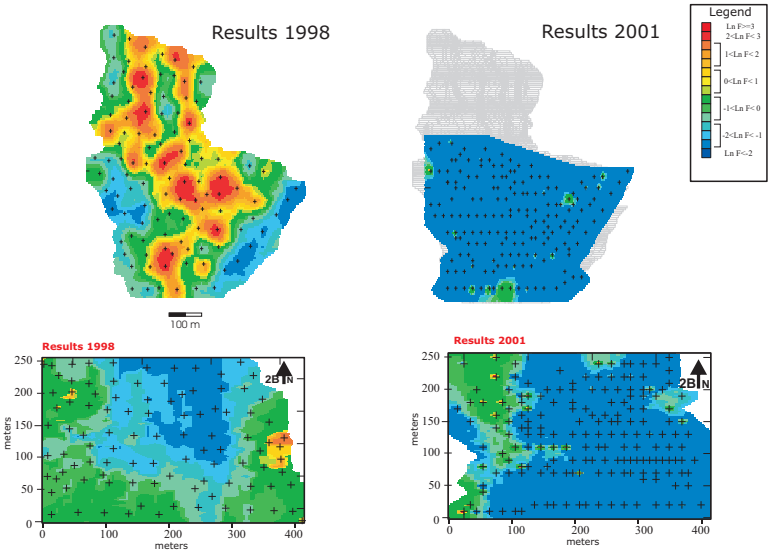
We thanks to N.Lima et al. for the maps.

West Systems Srl
Via Molise 3 - Zona Ind. Gello - 56025 Pontedera (PI) Italy
Phone +39 0587 294216 www.westsystems.com
Fax +39 0587 296068 g.virgili@westsystems.com

WEST Systems

Application on a landfill: mapping the biogas non controlled emissions.

The figure shows the compare between the results of the measurement regime of a land/fill undertaken in 1998 and 2001: the mapping performed in 1998 gave clear indications of the areas which required intervention to improve the cover and the capture system.
The interventions were performed only where necessary with a significant economic savings.
The measurement regime of 2001 indicates without any doubt that the intervensions were efficient and state-of-the-art.



The obtained results:

- Minor atmospheric emissions;
- Higher quantity and better quality of biogas for cogeneration;
- Optimisation of management costs.

Continuous soil flux monitoring

WEST Systems produces a soil gas station for the continuous monitoring of carbon dioxide and hydrogen sulfide flux, soil temperature , soil water content, soil pressure gradient, soil heat flux and meteorological parameters.
For more information contact your local representative, visit our web site or e-mail to: g.virgili@westsystems.com

Local sales representative

H.Q.

West Systems Srl
Via Molise 3 - Zona Ind. Gello - 56025 Pontedera (PI) Italy
Phone +39 0587 294216 www.westsystems.com (or .it)
Fax +39 0587 296068 g.virgili@westsystems.com (or .it)

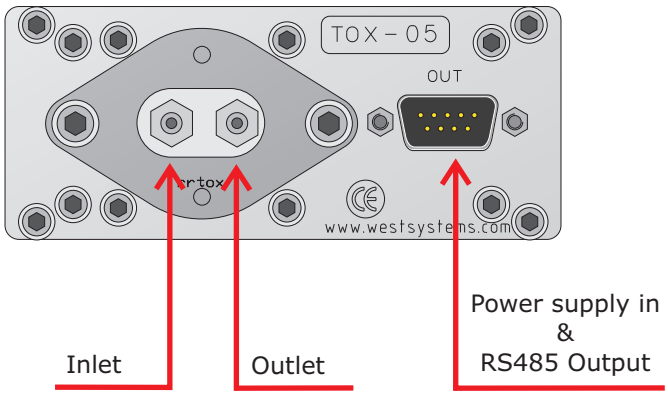
Japan

SHOKO CO., LTD.
7-13,1-chome, Shibakoen, Minato-ku Tokyo
105-8432, Japan
TEL : 03-3459-5106 FAX : 03-3459-5081
WEB SITE http://www.shoko.co.jp
e-mail s-isotope@shoko.co.jp

West Systems Srl
Via Molise 3 - Zona Ind. Gello - 56025 Pontedera (PI) Italy
Phone +39 0587 294216 www.westsystems.com
Fax +39 0587 296068 g.virgili@westsystems.com

WEST Systems

Hydrogen Sulfide Detector



Pin	Signal
1	Gnd
2	+VDC
3	Gnd
4	RS485-B
5	RS485-A
6	Gnd
7	+12V
8	Gnd
9	RS485-B

Legenda
Gnd: Ground reference for power supply and RS485
+VDC: 10-28 Volts Power supply input
RS485-A: Digital signal output A
RS485-B: Digital signal output B

Sensor specifications
Ambient conditions:
Air temperature -40°C to 65 °C
Air pressure 700 hPa to 1300 hPa
Air RH 5% - 95% non condensating.
Expected sensor life > 24 months.
Chemical cell order code: WEST H2S-BH
Detector order code: WEST TOX-05-H2S-BH
Factory calibration : 20 ppm
RMS Noise <= 0.02 ppm
Zero Offset <= 0.2 ppm
Max Overrange >= 200 ppm

The chemical cell reaction is:

$$H_2S + 2O_2 = H_2SO_4$$

the gas sample specific consuption is very low:

2.5×10^{-10} moles/Sec per ppm

Due to this consuption the H2S flux is methodically understimated by a -10% with the AccumulationChamber A and by a -5% when using the accumulation chamber B. Then we advise to use the accumulation chamber B except when the flux is very very low.

Appendix M

WS-HC detector

WS-HC Hydrocarbon Flux measurement:
The HydroCarbon detector is based on a double beam infrared spectrometer able to detect methane, hexane , propane and other molecules with HC linkages. The instrument comes calibrated for the methane. *The instrument requires a frequent **zero base-line** calibration that will be done using atmospheric air. The calibration requires 20 second*.

Detector specifications:

Accuracy 5%

Repeatibility 2%

Resolution 22 ppm (Methane equivalent)

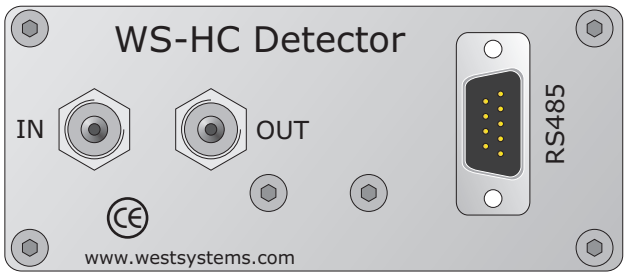
Full scale range is 50000 ppm of methane.

Detection limit 60 ppm.

Methane flux measurement range from 0.1 to 150 moles/m^2 per day.
The precision depends on the measured flux:

```
range 0.1  5      moles/ m^2 per day ±25%
      5 - 150     moles/ m^2 per day ±10%
```

The measurement of very low fluxes (< 0.1 moles/m^2/day) is possible but the error will increase due to the low detector sensitivity.



RS485 Connector	DB9 Male panel
Pin 1	Gnd
Pin 2	+Power supply
Pin 3	Gnd
Pin 4	RS485 B
Pin 5	RS485 A
Pin 6	Gnd
Pin 7	+Power supply
Pin 8	Gnd
Pin 9	RS485 B

The gas fittings can be used with rilsan 6x4 mm tubes or silicon 5x3.2 tubes. Please respect inlet and outlet ports.

LI-820 Specifications

CO_2 Specifications

Measurement Range: 0-1000 ppm, 0-2000 ppm with 14 cm bench; 0-5000 ppm, 0-20000 ppm with 5 cm bench

Accuracy: < 2.5% of reading with 14 cm bench; 4% of reading with 5 cm bench

Calibration Drift

[1]Zero Drift: < 0.15 ppm / °C

[2]Span Drift at 370 ppm: < 0.03% / °C

[3]Total Drift at 370 ppm: <0.4 ppm / °C

RMS Noise at 370 ppm with 1 sec Signal Filtering: < 1 ppm

[1] Zero drift is the change with temperature at 0 concentration
[2] Span drift is the change after re-zeroing following a temperature change
[3] Total drift is the change with temperature without re-zeroing or re-spanning

Measurement Principle: Non-Dispersive Infrared

Traceability: Traceable gases to WMO standards from 0-3000 ppm. Traceable gases to EPA protocol gases from 3000 to 20000 ppm

Pressure Compensation Range: 15 kPa-115 kPa

Maximum Gas Flow Rate: 1 liter/minute

Output Signals: Two Analog Voltage (0-2.5 V or 0-5 V) and Two Current (4-20 mA)
Digital: TTL (0-5 V) or Open Collector

DAC Resolution: 14-bits across user-specified range

Source Life: 18000 hours

Power Requirements: Input Voltage 12-30 VDC
1.2A @ 12V (14 W) maximum during warm-up with heaters on
0.3 A @ 12 V (3.6 W) average after warm-up with heaters on

Supply Operating Range: 12-30 VDC

Operating Temperature Range: -20 to 45 °C

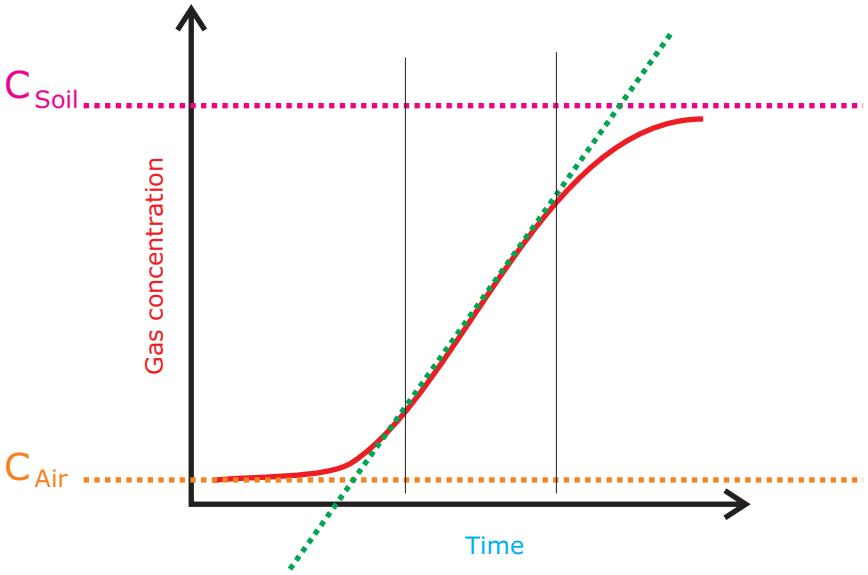
Relative Humidity Range: 0 to 95% RH, Non-Condensing

Dimensions: 8.75" x 6" x 3" (22.23 x 15.25 x 7.62 cm)

Weight: 2.2 lbs (1 kg)

Quantifying the flux

How explained in the chapter 3 the flux is proportional to the concentration increase ratio ppm/sec. The proportionality factor depends on the chamber volume/surface ratio as well as the barometric pressure and the air temperature inside the accumulation chamber.



There are two methods to carry out the field work, in both cases for each measurement you have to record the type of accumulation chamber used, the barometric pressure, and the air temperature.
The variation of few mBar of the pressure and or few degrees of temperature do not affect the evaluation of flux very much, then you can use a mean value for both parameters. Of course that depends on the accuracy you want to reach for the evaluation of flux.
The instrument measures the barometric pressure, using the embedded pressure sensor of the LICOR, with a good accuracy. A platinum Pt100 or a thermo-couple thermometer can be used to measure the air temperature as well as the soil temperature.

Choosing the flux measurement unit

The first measurements made, 10 years ago, with the accumulation chamber was expressed in cm/sec which is a speed, the speed of carbon dioxide flowing out from the soil. During the last ten years several units have been used by volcanologist and by geochemistry researchers. The most common unit is grams/squaremeter per day, but using the same instrument for two gas species to express the flux using this unit means to have two different conversion factors. Actually we use the unit **moles/squaremeter per day** that has two advantages: A single conversion factor for every gas specie and an easy conversion of the flux in grams/sm per day simply multiplying the result expressed in moles/sm per day for the molecular weight of the target gas.

From the [tools][settings] menu you can set the accumulation chamber factor in the "A.c.K." field.

If this factor is set to 1 the instrument will give you results expressed in ppm/sec, that's simply the slope of the curve in the selected interval.

If you set the A.c.K to a value different from 1 the instrument will give you the results expressed in moles per square meter per day.

Please see next page.

Quantifying the flux

Method 1: Measuring the slope

Set the Accumulation Chamber factor to 1 in order to have the flux measurement expressed in the slope unit "ppm/sec" and translate it in the desired unit with a post processing.
Using this method you can focus only on the accumulation chamber interfacing with the soil, the flux curve shape and the other aspects of the measurement, putting off choosing the correct accumulation chamber factor.

Method 2: Measuring the flux directly in moles/sm/day.

To get the results directly in moles/sm/day you have to set the Accumulation Chamber factor to the correct value, taking it from the tables.
For each measurement, if there are variations in the air temperature, or of the barometric pressure, or if you changed the accumulation chamber you have to select the [tools][settings] menu and put the correct accumulation chamber factor in the "A.c.K." field. This operation can be "critical". In any case on the saved files you'll find the results of flux evaluation expressed in both units , the raw ppm/sec and the moles/sm/day computed with the A.c.K. you set.

The accumulation chamber factors

Here following the formula used to compute the A.c.K.:

$$K = \frac{86400 \cdot P}{10^6 \cdot R \cdot T_k} \cdot \frac{V}{A}$$

Where

- **P** is the barometric pressure expressed in mBar (HPa)
- **R** is the gas constant 0.08314510 bar L K^{-1} mol^{-1}
- **T_k** is the air temperature expressed in Kelvin degree
- **V** is the chamber net volume in cubic meters
- **A** is the chamber inlet net area in square meters.

The dimensions of the A.c.K. are

$$K = \frac{moles \cdot meter^{-2} \cdot day^{-1}}{ppm \cdot sec^{-1}}$$

In the table the conversion factors vs temperaure and barometric pressure for the Accumulation Chamber Type A and B are reported.

An example:

You're using the accumulation chamber B, the slope of the flux curve is 2.5 ppm/sec, the barometric pressure is 1008 mBar (HPa) and the air temperature is 22 °C.
From the table B get the value that correspond to the barometric pressure and temperature. In this case I get the value computed for 25°C and 1013 mBar : 0.696.

Then the flux is: 2.5 x 0.696= 1.74 moles per square meter per day.

Gasport® Gas Tester

The Gasport Gas Tester is designed for gas utility workers to detect methane and certain toxic gases. It is a reliable, simple, versatile tool to help your service technicians get the job done quickly! With multiple ranges and sensing capabilities built into one rugged housing, the Gasport Tester simplifies your work by reducing the number of meters you have to carry on the job.

Applications

The Gasport Tester's poison-tolerant methane sensor provides three measurement ranges for your daily service needs:

- Open air, safety sampling
- Small, in-home leak detection
- Street/outdoor service line leak detection

Features and Benefits

- **Proven in field use–rugged and reliable**
  Less costly to maintain, less time in repair
- **Multiple functions in one instrument**
  No need to buy, carry & maintain multiple instruments
- **New, poison-tolerant combustible gas sensor**
  Reduces meter ownership costs
- **User-selectable, "silent" operation mode**
  Reduces customer disturbances and worries
- **Fast warm up time**
  Fastest warm up time in industry saves time
- **Can monitor up to four gases at a time**
  Fewer instruments to carry
- **Show all gas concentrations simultaneously**
  Eliminates guesswork on what reading is displayed
- **Autoranging methane sensor**
  Automatically switches between 0-5% and 5-100% methane ranges
- **Gas readings recorded for later retrieval**
  Can double check readings after job is done
- **Simple manual or automated calibration options**
  Reduces training time and helps ensure accuracy
- **Intrinsically safe**
  Meets safety standards for work in hazardous areas
- **Lifetime warranty on case and electronics**
  Reduced maintenance and lifetime costs

Specifications

Gas	Range	Resolution
Methane	0–5000 ppm	50 ppm
Methane	0–100% LEL or 0–5% CH_4	1 % LEL or 0.1% CH_4
Methane	5–100% CH_4	1% CH_4
Oxygen	0–25%	0.1%
Carbon Monoxide	0–1000 ppm	1 ppm
Hydrogen Sulfide	0–100 ppm	1 ppm

Battery types: NiCd and Alkaline
Case material: Impact resistant, stainless-steel-fiber-filled polycarbonate
Operating temperature: normal -10 to 40°C; extended -20 to 50°C
Operating humidity: Continuous: 15-95% RH, non-condensing
Intermittent duty: 5-95% RH, non condensing
Warm up time: Less than 20 seconds to initial readings
Datalog capacity: 12 hours
Input: 3 clearly marked, metal domed keys
Warranty: Case and Electronics: Lifetime
Sensors and consumable parts: 1 year

The answer for gas utilities' gas detection needs

Gasport® Gas Tester

Ordering Information

Battery Chargers

Part No.	Description
494716	Omega 120 VAC 50/60Hz
495965	Omega 220 VAC 50/60Hz
801759	Omega 110/220 VAC, Five Unit, 50/60Hz
800525	Omega 8 - 24VDC for vehicle use

Battery Packs

Part No.	Description
496990	Standard NiCd Rechargeable
800526	Alkaline, Type C
711041	Alkaline, with Thumbscrews
800527	Heavy Duty NiCd Rechargeable

Sensors

Part No.	Description
813693	Combustible Gas
480566	O2
812389	CO
812390	H2S

Protective Boots

Part No.	Description
804955	Black, for NiCd Battery Packs
802806	Orange, for NiCd Battery Packs
806751	Black, for Alkaline Battery Packs
806750	Orange, for Alkaline Battery Packs
806749	Black, for HD NiCd Battery Packs
806748	Orange, for HD NiCd Battery Packs
812833	Yellow Soft Carrying Case with Harness
711022	Black padded Vinyl Carrying Case with Harness

Sampling Equipment

Part No.	Description
800332	Probe - 1 ft., plastic
800333	Probe - 3 ft., plastic
803561	Probe - 3 ft., plastic (holes 2" from end) (bar hole probe)
803962	Probe - 3 ft., plastic (holes 2" from handle) (solid probe)
803848	Probe - Hot Gas Sampler
710465	Sampling Line - 5 ft., coiled
497333	Sampling Line - 10 ft.
497334	Sampling Line - 15 ft.
497335	Sampling Line - 25 ft.

Sampling Accessories

Part No.	Description
801582	Replacement Filter, Probe, pkg. of 10
801291	External Filter Holder
014318	Charcoal Filter
711039	Line Scrubber Filter Holder
711059	Line Scrubber Replacement Cartridges, Box of 12
808935	Dust Filter, Pump Module
802897	Water Trap (Teflon) Filter, Pump Module

Calibration Check Equipment

Part No.	Description
477149	Calibration Kit Model RP with 0.25 lpm Regulator
491041	Calibration Gas - methane, 2.5%
473180	Calibration Gas - 300 ppm CO
813718	Calibration Gas - methane, 2.5% oxygen, 15%60 ppm CO
813720	Calibration Gas - methane, 2.5% oxygen, 15%300 ppm CO 10 ppm H2S
710288	Gasmiser™ Demand Regulator 0 - 3.0 lpm

Accessories

Part No.	Description
804679	Data Docking Module Kit. Includes the Data Docking Module, MSA Link Software and Instruction Manual

Approvals

The Gasport Gas Tester has been designed to meet intrinsic safety testing requirements in certain hazardous atmospheres.

The Gasport Gas Tester is approved by MET (an OSHA Nationally Recognized Testing Laboratory [NRTL]) for use in Class I, Division I, Groups A, B, C, D; Class II, Division I, Groups E, F, G; and Class III Hazardous locations. Gaspor tGas Testers sold in Canada are approved by CSA for use in Class I, Division I, Groups A, B, C, and D locations.

Contact MSA at 1-800-MSA-2222 for more information or with questions regarding the status of approvals.

Gasport Gas Tester Kits

	LEL Display	O_2	CO	H_2S	Alarms Always	Alarms Optional	Leak Detect Page	Peak	Alkaline Battery	NiCd Battery	5ft Coiled Line	1ft Probe	Part No.
4-Gas, Selectable, NiCd	•	•	•	•		•	•	•		•	•	•	711489
4-Gas, Selectable, Alkaline	•	•	•	•		•	•	•	•		•	•	711490
3-Gas, Selectable, NiCd	•	•	•			•	•	•		•	•	•	711493
3-Gas, Selectable, Alkaline	•	•	•			•	•	•	•		•	•	711494
2-Gas, Selectable, NiCd	•		•			•	•	•		•	•	•	711495
2-Gas, Selectable, Alkaline	•		•			•	•	•	•		•	•	711496
4-Gas, Alarms On, NiCd	•	•	•	•	•		•	•		•	•	•	711491
4-Gas, Alarms On, Alkaline	•	•	•	•	•		•	•	•		•	•	711492

Assemble-to-Order (ATO) System: You Make the Choices

The ATO System makes it easy to "custom order" the Gasport Gas Tester, configured exactly the way you want it. You can choose from an extensive line of base instrument components and accessories. To obtain a copy of the "ATO System and Price Information for the Gasport Gas Tester," call toll-free 1-800-MSA-2222, and request Bulletin 0804-28. **To obtain a copy of the ATO via FAX, call MSA QuickLit Information Service at 1-800-672-9010. At the prompt, request QuickLit Document #2345 (ATO for Gasport Gas Tester).**

ID 08-04-27-MC / May 2000

Corporate Headquarters
P.O. Box 426
Pittsburgh, PA 15230 USA
Phone (412) 967-3000
www.MSAnet.com

U.S. Customer Service Center
1-800-MSA-2222

MSA International
Phone (412) 967-3354
FAX (412) 967-3451

Offices and representatives worldwide
For further information:

ULTRAMETER II™

OVER 50 YEARS

MYRON L COMPANY

Water Quality Instrumentation

Accuracy • Reliability • Simplicity

ULTRAMETER II™

Advanced Design • Superior Performance

MADE IN USA

OVER 50 YEARS

pH/ORP Sensor protective cap

Four-digit display for full 9999 readings, with autoranging capability up to 200 mS/200 ppt

Powerful microprocessor based surface-mount circuitry

Display prompts for simple pH calibration

Memory for 100 readings with Date & Time Stamp

Real Time Clock

Factory calibrations stored in microprocessor

Conductivity

Resistivity

TDS

Temperature

pH

ORP

CE

ULTRA-FAST ULTRA-EASY ULTRA-POWERFUL

Since 1957, the Myron L Company has designed and manufactured highly reliable analytical instruments for a wide variety of applications. Thousands of professionals around the world rely every day on the performance of our instruments. Demanding uses range from boiler water testing to ultrapure water control to medical instruments for artificial kidney machines.

We are proud of the trust our handheld instruments and monitor/controllers have earned in the past. Our product line has evolved to a new level of outstanding performance and value in analytical instruments: the Ultrameter II series. While priced like affordable single-parameter instruments, the Ultrameter II does the job of three, four or even six instruments.

Accuracy You Can Trust

Both Ultrameter II models deliver performance of ±1% of reading (not merely full scale). This high level of accuracy has been achieved through advanced four-electrode conductivity cell technology, a unique pH/ORP sensor and powerful microprocessor-based circuitry. With displayed values of up to 9999, the full four-digit LCD ensures resolution levels never before possible in such affordable instruments. Factory calibrated with NIST traceable solutions, each Ultrameter II may be supplied with both certification of traceability and NIST traceable solutions for definitive calibration.

Fast and accurate in the laboratory, both Ultrameter II models are rugged enough for daily in-line controller checks in hostile process applications.

Innovative Engineering

The Ultrameter II is a prime example of how high-tech engineering can greatly simplify and streamline a task. Whether in the lab, industrial plant, or in a remote field location, merely:

1. Fill the cell cup
2. Push a parameter key
3. Take the reading

Temperature compensation and range selection are both rapid and automatic. The Ultrameter II is a true one-hand operation instrument.

Easy to Calibrate

All calibrations are quickly accomplished by pressing the or keys to agree with our NIST traceable Standard Solution. When calibration is necessary, display prompts simplify pH calibration and make sure the correct buffer is being used. Plus, all parameters (excluding factory-set temperature) have an internal electronic setting that can be used for field calibration and as a check on pH/ORP sensor life.

Advanced Features

- Fully automatic temperature compensation
- User adjustable temperature compensation (up to 9.99%/°C) which also allows TC to be disabled for applications requiring non-compensated readings.
- User adjustable conductivity/TDS conversion ratio for greater accuracy when measuring solutions not contained in the microprocessor.
- Auto-shutoff maximizes the life of the single 9V battery to more than 100 hours/5000 tests.
- Non-volatile microprocessor provides data back-up, even when the battery is changed. This assures all calibrations and memory data will be retained.
- Extended life pH/ORP sensor is user replaceable in the field.

High Performance at a Low Cost

Beyond their affordable purchase price, Ultra-Fast, Ultra-Easy, Ultra-Powerful Ultrameter II's save both time and money. Measure for measure, Ultrameter II's give you a better return on your investment than any other handheld instrument. To see for yourself, contact your distributor or the Myron L Company today.

Multiple Applications

Irrigation Water

Hydroponics

Laboratories

Homeland Security

Reverse Osmosis

Deionization

Wastewater

Cooling Towers

Environmental

Desalination

Fountain Solutions

BENEFITS DESIGNED TO SAVE YOU TIME & MONEY

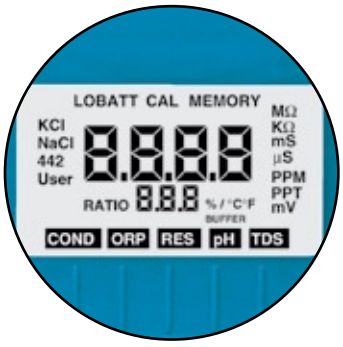
Built-in IR Port allows you to conveniently download your data to a computer. **(Requires Myron L uDock™ Accessory Package)**

Ample memory provides increased flexibility to record and store 100 separate readings.

Real Time Clock with Date & Time Stamp allows you to maintain the integrity of each individual reading.

The advanced four-electrode cell for conductivity/resistivity/TDS eliminates polarization, allowing greater accuracy and stability with minimal maintenance.

The pH/ORP sensor chamber provides protection to a unique porous liquid-junction.



The large capacity KCl reservoir guarantees extended life.

A custom LCD helps simplify calibration and operation by using annunciators and prompts to indicate various conditions.

IP67/NEMA 6 rated Ultrameter II's are waterproof and buoyant and can be fully immersed to 3 feet/1 meter.

Features

Ultrameter II™ Models	4PII Conductivity TDS, Resistivity Temperature	6PII Conductivity, TDS Resistivity, pH ORP, Temperature
Autoranging	•	•
Adjustable Temp. Compensation	•	•
Adjustable Cond/TDS ratio	•	•
Memory (100 readings)	•	•
Date & Time Stamp	•	•
pH Calibration Prompts		•
Low battery indicator	•	•
Auto-off	•	•

Specifications

Display	4 Digit Liquid Crystal Display
Dimensions LxWxH	196 x 68 x 64 mm/ 7.7 x 2.7 x 2.5 inches
Weight	352 g/12.4 oz.
Case/conductivity cell material	VALOX*
Cell capacities	pH/ORP: 1,2 ml/0.04 oz. Cond/TDS/Res: 5 ml/0.2 oz.
Power	9V alkaline battery
Battery life	>100 hours (5000 readings)
Operating/storage temperature	0 – 55°C/32 – 132°F
Protection ratings	IP67/NEMA 6 Waterproof to 1 meter/3 feet

*™GENERAL ELECTRIC

Parameters

	Conductivity	TDS	Resistivity	pH	ORP	Temperature
Ranges	0–9999 µS/cm 10–200 mS/cm in 5 autoranges	0–9999 ppm 10–200 ppt in 5 autoranges	10 KΩ–30 MΩ	0–14 pH	±999 mV	0–71°C 32–160°F
Resolution	0.01(<100 µS) 0.1(<1000 µS) 1.0(<10 mS) 0.01(<100 mS) 0.1(<200 mS)	0.01(<100 ppm) 0.1(<1000 ppm) 1.0(<10 ppt) 0.01(<100 ppt) 0.1(<200 ppt)	0.01(<100 KΩ) 0.1(<1000 KΩ) 0.1(>1 MΩ)	±0.01 pH	±1 mV	0.1°C/F
Accuracy	±1% of reading	±1% of reading	±1% of reading	±0.01 pH	±1 mV	±0.1°C
Auto Temperature Compensation	0–71°C 32–160°F	0–71°C 32–160°F	0–71°C 32–160°F	0–71°C 32–160°F	—	—
Adjustable Temperature Compensation to 25°C	0–9.99%/°C	0–9.99%/°C	0–9.99%/°C	—	—	—
Conductivity/TDS Ratios Preprogrammed	KCl, 442*, NaCl	KCl, 442*, NaCl	—	—	—	—
Adjustable Conductivity/TDS Ratio Factor	0.20–7.99	0.20–7.99	—	—	—	—

*442 Natural Water Standard ™ Myron L Company

Accessories

uDock™ Accessory Package includes uDock™, USB cable and Macintosh/PC application software for downloading data. MODEL: U2CIP

Certificates confirming the NIST traceability of an Ultrameter II are available (must be specified when placing instrument order). MODEL: MC

Conductivity Standard Solutions are necessary to maintain accuracy and for periodic calibration of conductivity/TDS parameters. All Standard Solutions are NIST traceable for your complete confidence. RECOMMENDED VALUES: KCl-7000 (7 mS), 442-3000 (TDS), or NaCl-14.0 (mS) available in 2 oz/59 ml, 1 qt/1 L, and 1 gal/3,8 L.

pH Buffers are necessary to maintain accuracy and for periodic calibration of pH and ORP parameters. Calibration with pH 7 Buffer is especially important. All pH 4, 7, and 10 Buffers are NIST traceable and are available in 2 oz/59 ml, 1 qt/1 L, and 1 gal/3,8 L.

pH Sensor Storage Solution
Available in 2 oz/59 ml, 1 qt/1 L, and 1 gal/3,8 L.
MODEL: SS20Z, SSQ and SSG

Certificate of NIST traceability for pH Buffer or Conductivity Standard Solutions are available (must be specified when placing solution order). MODEL: SC

Hard protective case (small)
MODEL: UPP

Hard protective case (kit) with three buffers (pH 4, 7, and 10), one pH/ORP storage solution, and two standard solutions, (KCl-7000 and 442-3000). All bottles are 2 oz/59 ml.
MODEL: PKU

Soft protective case is constructed of padded Nylon and features a belt clip for hands-free mobility.
MODEL: UCC (Blue)
UCCDT (Desert Tan)

Replacement pH/ORP sensor user-replaceable, features a unique/porous liquid-junction.
MODEL: RPR

Built on Trust

Founded in 1957, Myron L Company is one of the world's leading manufacturers of water quality instruments. Because of our policy of continuous product improvement, changes in design and the specifications in this brochure are possible. You have our assurance any changes will be guided by our product philosophy: Accuracy, Reliability, Simplicity.

Limited Warranty

All Myron L Ultrameter II's have a Two (2) Year Limited Warranty. The pH/ORP sensors have a Six (6) Month Limited Warranty. Warranty is limited to the repair or replacement of the Ultrameter II only, at our discretion. Myron L Company assumes no other responsibility or liability.

MYRON L COMPANY
Water Quality Instrumentation
Accuracy • Reliability • Simplicity

www.myronl.com

2450 Impala Drive
Carlsbad, California 92010-7226 USA
Tel: +1-760-438-2021
Fax: +1-800-869-7668 / +1-760-931-9189

Apogee Scientific, Inc.

Advanced Engineering and Environmental Technologies

Leak Detection System

Apogee provides services and system sales for detecting methane and total hydrocarbon leaks from pipelines, production and storage facilities, landfills, and coal seam seeps.

System Features:

- An advanced, innovative system that is sensitive, fast, and rugged
- Measures methane, total hydrocarbons, and carbon dioxide simultaneously at sub-ppm concentrations
- Monitoring rates of 50 samples/second
- Leak locations determined by GPS
- Advanced software allows for immediate processing of data
- Can be mounted on helicopters or ground vehicles

System Benefits

- Improved system safety and integrity
- Saves time with fast mobile detection
- Saves money
- Maximizes accuracy with no false positives
- Simplifies reporting
- Operates easily, anywhere

2895 West Oxford Avenue, Suite 1 Englewood, Colorado 80110-4397 Phone: 303-783-9599 Fax: 303-783-9607 apogee-sci.com

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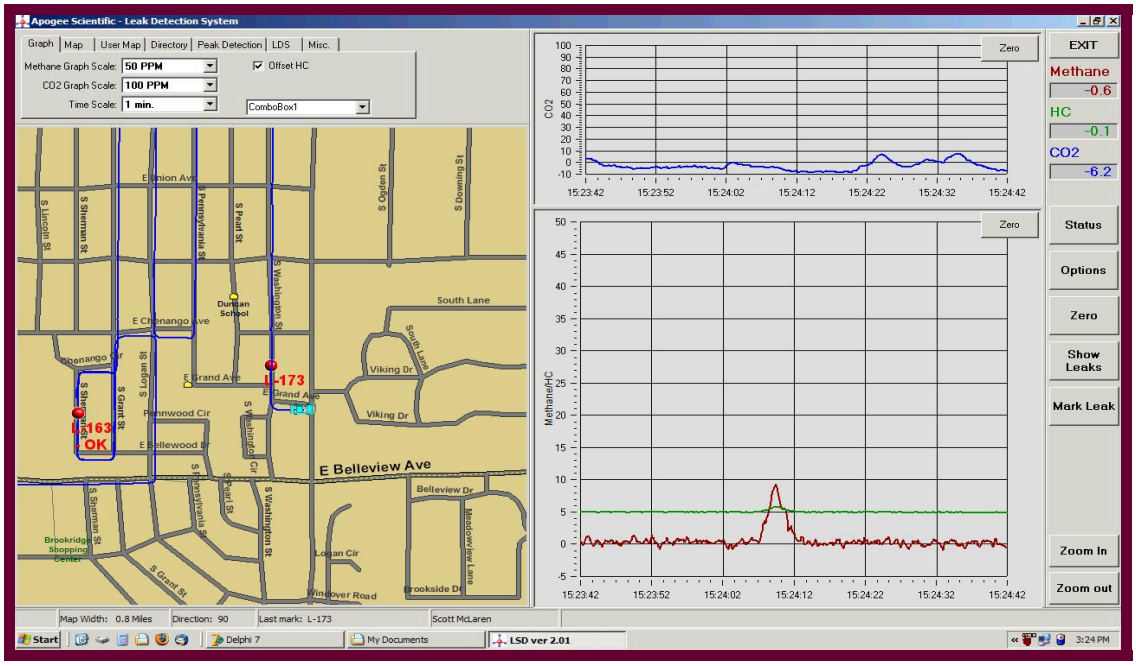

A snapshot of the Leak Detection System computer screen. The real-time map on the left shows the route the vehicle has taken (green line) and the methane leaks detected by the system (red circles). On the right the methane (red line), total hydrocarbons (green line), and CO_2 (blue line) concentrations are plotted in real time.

For more information, please contact:

John Wurster
Vice President
Sales & Marketing

Phone: 303-783-9599, x24
Cell: 303-518-3473
Fax: 303-783-9607

LDS is mounted on ATV and can be installed in truck, helicopter or other vehicle.

[Mighty Probe] [Mighty Probe Lite] [Slide Adapter] [Smart Stick] [Striking Head] [Hammer Probe] [Water Probe]

Hammer Probe

The integrated slide hammer makes driving this probe into the hardest ground easy. More effective than striking a probe with a maul.

The sliding head has been specifically designed to minimize the number of pinch points, reducing the risk of injuries.

Comfortable 16" handles are made from 1" diameter steel tubing allowing ample room for the hands. The dual handles (spread 7 1/2" apart) provide greater control and improved ergonomics.

All internal pieces of the head assembly are manufactured from high strength impact resistant tool steel. This steel is designed for minimal distortion, ensuring a long lasting probe.

The tips are heat treated alloy steel and create a small clearance hole for the 1/2" shafts.

The Hammer is powder coated a bright blue for high visibility and a long lasting finish.

Part No.	Length	Cost
HMP36	36"	$125.00
HMP42	42"	$126.00
HMP48	48"	$127.00
HMP54	54"	$128.00
HMP60	60"	$129.00

FEATURES:

Highlights:

- 18" stroke
- 28" overall length
- 13 lbs. total weight
- 16" long handles on each side for easy lifting,

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www.TandTtools.com

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Catalog v7.pdf

control, and safety
- High strength impact resistant tool steel for a long life
- Specially designed head minimizes pinch points

Shaft:

- 1/2" high quality steel alloy resists bending and bowing
- Head and shaft are threaded to ensure a secure connection and ease of replacement

Tip:

- Special alloy steel
- Heat treated for longer life
- Tapered edges make penetration and withdrawal easier
- Provides clearance for the 1/2" steel shaft
- Threaded for easy replacement

WARNING!

The **Slide Hammer Probe** ***DOES NOT*** provide protection from electrical shocks. For insulated capabilities, please refer to the **Mighty Probe**(τμ).

[Mighty Probe] [Mighty Probe Lite] [Slide Adapter] [Smart Stick] [Striking Head] [Hammer] [Water Probe]

DATASHEET

GeoXH handheld

KEY FEATURES

- Real-time H-Star technology for decimeter to subfoot accuracy in the field
- High-resolution VGA display for crisp and clear map viewing
- Bluetooth and wireless LAN connectivity options
- 1 GB onboard storage plus SD slot for removable cards
- Windows Mobile version 6 operating system
- Rugged handheld with all-day battery

YOUR ULTIMATE SOLUTION FOR HIGH-ACCURACY ASSET MANAGEMENT

For high-accuracy GIS data collection and asset relocation, the Trimble® GeoXH™ handheld is the ultimate integrated solution. Engineered with H-Star™ technology, the GeoXH handheld delivers decimeter (10 cm) to subfoot (<30 cm) accuracy when you need it, making it the ideal device for electric and gas utilities, water and wastewater services, land reform projects, and other applications where on-the-spot positioning is crucial.

The unique GeoExplorer® 2008 series combines a Trimble GPS receiver with a rugged handheld computer, built for all-day use and packed with connectivity options. Technology this clever has never been more convenient.

Subfoot accuracy when you need it

When your GIS database requires the highest levels of accuracy, the GeoXH handheld is the answer. Using revolutionary Trimble H-Star technology, the GeoXH handheld delivers real-time subfoot (<30 cm) accuracy with the internal antenna, and decimeter (10 cm) accuracy with an optional Zephyr™ external antenna. Back-office data processing is eliminated, streamlining asset inventories and as-built mapping jobs.

Need to relocate assets in the field? The GeoXH handheld has you covered. Buried and hidden assets can be tracked down with ease, as the real-time high accuracy gets you straight to the point. Cables and pipes can be excavated without wasted effort or risk of damage to nearby assets.

Packed full of power

With a powerful 520 MHz processor, 128 MB RAM, and 1 GB of onboard storage, the GeoXH handheld is a high performance device designed to work as hard as you do. The handheld gives you all the power you need to work with maps and large data sets in the field, and its high resolution VGA display allows for crisp and clear viewing of your data.

The GeoXH handheld is powered by the industry-standard Windows Mobile® version 6 operating system so you can choose a software solution designed for your field requirements, whether off-the-shelf or purpose-built.

The Windows Mobile 6 operating system includes familiar Microsoft® software, including Word Mobile, Excel Mobile, and Outlook® Mobile, giving you all the tools you need for a seamless exchange of data between the field and the office.

Get the data you need, when you need it

With the GeoXH handheld you have the flexibility to work exactly the way you want to. Use the built-in wireless LAN connection to access your organization's secure network and get the most up-to-date information. And with Bluetooth® wireless technology, the GeoXH handheld offers wireless connection to a Bluetooth-enabled cellular phone for access to the Internet to receive real-time corrections from a VRS™ network and background map data. You can also wirelessly connect to other devices such as Bluetooth-enabled laser rangefinders and barcode scanners for convenient cable-free solutions that keep you productive in the field.

Built for the field

The GeoXH handheld has an integrated battery, good for a full day's work; simply charge the battery overnight and you're ready to go again. The GeoXH handheld will last the distance, and its rugged design can take a lot of punishment. Rain, hail or shine, it's built to keep working, whatever the weather throws at you.

When accuracy is critical

Rugged design and powerful functionality are the hallmarks of the GeoExplorer series. And now with H-Star technology providing decimeter to subfoot accuracy in real time, the 2008 series GeoXH handheld is your ultimate solution for high-accuracy asset management.

When accuracy is critical, the GeoXH handheld delivers—with unprecedented efficiency and reliability, when and where you need it.

Trimble

GeoXH handheld

STANDARD FEATURES

System
- Windows Mobile 6 (Classic edition)
- VGA display (480 x 640), sunlight-readable color touchscreen
- Integrated Bluetooth 1.2 wireless technology
- Integrated 802.11b/g wireless LAN
- Ergonomic cable-free handheld
- Rugged and water-resistant design
- All-day internally rechargeable Li-ion battery
- Marvell 520 MHz XScale processor
- 128 MB RAM
- 1 GB non-volatile Flash data storage
- Sealed SD/SDHC card slot
- Integrated speaker and microphone

GPS
- Integrated high-performance GPS/SBAS[1] receiver and L1/L2 antenna
- H-Star technology for subfoot (<30 cm) real-time or postprocessed accuracy
- Decimeter (10 cm) accuracy with an optional external Zephyr antenna
- RTCM and CMR real-time correction support
- TSIP and NMEA[2] protocol support
- EVEREST™ multipath rejection technology

Standard Software
- GPS Controller for control of integrated GPS and in-field mission planning
- GPS Connector for connecting integrated GPS to external ports
- Microsoft Office Mobile
- Transcriber (handwriting recognition)

Standard Accessories
- Support module
- AC Power supply with International adapter kit
- USB data cable
- Stylus (x 2)
- Screen protectors (2-pack)
- Quick Start Guide
- Getting Started CD
- Hand strap
- Pouch

OPTIONAL FEATURES

Optional Software
- TerraSync™ software
- Trimble GPScorrect™ extension for ESRI ArcPad software
- GPS Pathfinder® Tools Software Development Kit (SDK)
- GPS Pathfinder Office software
- Trimble GPS Analyst™ extension for ESRI ArcGIS Desktop software

Optional Accessories
- Power/serial clip (9-pin RS-232 serial connector and power input)
- Vehicle power adaptor[3]
- Li-ion external power kit[3]
- Null modem cable[3]
- Backpack kit
- Hard carry case
- Zephyr antenna kit
- 2 meter range pole
- Range pole bracket
- GeoBeacon™ receiver
- Anti-glare screen protectors (2-pack)

TECHNICAL SPECIFICATIONS

Physical
Size ..... 21.5 cm x 9.9 cm x 7.7 cm (8.5 in x 3.9 in x 3.0 in)
Weight ..... 0.81 kg (1.79 lbs) with battery
Processor ..... 520 MHz Marvell PXA-270 XScale processor
Memory ..... 128 MB RAM and 1 GB internal Flash storage
Battery ..... Internal 7500 mAh lithium-ion
27.8 Watt-hours, rechargeable in unit
Power usage
Low (no GPS or backlight) ..... 1.8 Watts
Normal (with GPS and backlight[4]) ..... 3.2 Watts
High (with GPS, backlight[4], Bluetooth, and wireless LAN)[5] ..... 4.3 Watts

Environmental
Operating temperature ..... –20 °C to +60 °C (–4 °F to 140 °F)
Storage temperature ..... –30 °C to +70 °C (–22 °F to 158 °F)
Casing ..... Dust-proof and resistant to heavy wind-driven rain per IP 65 standard
Slip-resistant grip, shock and vibration resistant
Drop ..... 0.9 m (3 ft) MIL-STD-810F, Method 516.5, Procedure IV

Input/Output
Expansion ..... SD card slot (SD or SDHC storage cards)
Display ..... 8.9 cm (3.5 in) VGA (480 x 640 pixel) TFT, 16 bit (65,536) colors
LED backlight
Interface ..... Touch screen, 10 hardware control keys, power status LED
Audio system events, warnings, and notifications
Soft Input Panel (SIP) virtual keyboard and handwriting recognition software
Audio ..... Microphone and speaker, record and playback utilities
I/O ..... USB 1.1 client via support module
Serial via optional 9-pin RS-232 power/serial clip adaptor
Radios[6] ..... Bluetooth 1.2, Wireless LAN 802.11b/g

GPS
Channels ..... 26 (12 L1 code and carrier, 12 L2 carrier, 2 SBAS)
Integrated real-time ..... SBAS[1] (dual-channel tracking)
Update rate ..... 1 Hz
Time to first fix ..... 30 seconds (typical)
Protocols
Data output ..... TSIP, NMEA-0183 v3.0 (GGA, VTG, GLL, GSA, ZDA, GSV, RMC)[2]
Real-time corrections ..... RTCM 2.x, RTCM 3.0, CMR, CMR+

Accuracy (HRMS)[7] after differential correction
Real-time positioning
H-Star[8] with internal antenna (within a VRS network, or <80 km) .. Subfoot (<30 cm)
H-Star[8] with optional Zephyr antenna
Short baseline (within a VRS network, or <30 km) ..... 10 cm
Long baseline (30–80 km) ..... Subfoot (<30 cm)
Code corrections (SBAS[1] or external correction source) ..... Submeter
Postprocessed positioning
H-Star[8] with internal antenna (<80 km, or 3 bases within 200 km) . Subfoot (<30 cm)
H-Star[8] with optional Zephyr antenna
Short baseline (<30 km) ..... 10 cm
Long baseline (30–80 km, or 3 bases within 200 km) ..... 20 cm
Code postprocessed ..... Submeter

1 SBAS (Satellite Based Augmentation System). Includes WAAS available in North America only, EGNOS available in Europe only, and MSAS available in Japan only.
2 NMEA output of real-time H-Star corrected data is not supported.
3 Power/serial clip also required.
4 With backlight at default setting (50% brightness).
5 Power draw will vary depending on radio usage.
6 Bluetooth and wireless LAN type approvals are country specific. GeoExplorer 2008 series handhelds have Bluetooth and wireless LAN approval in the U.S. and in most European countries. For further information please consult your local reseller.
7 Horizontal Root Mean Squared accuracy, 1-sigma (63%). Requires data to be collected with minimum of 5 satellites, maximum PDOP of 6, minimum SNR of 39 dBHz, minimum elevation of 15 degrees, and reasonable multipath conditions. Ionospheric disturbances, multipath signals or obstruction of the sky by buildings or tree canopy may degrade precision by interfering with signal reception. Except when using VRS corrections, accuracy varies with proximity to base station by +1 ppm for postprocessing and real-time.
8 H-Star specified accuracy is typically achieved within 2 minutes. Requires data to be collected using Trimble field software.

Specifications subject to change without notice.

Bluetooth

YOUR LOCAL TRIMBLE OFFICE OR REPRESENTATIVE

NORTH & SOUTH AMERICA
Trimble Navigation Limited
10355 Westmoor Drive
Suite #100
Westminster, CO 80021
USA
+1-720-587-4574 Phone
+1-720-587-4878 Fax

EUROPE & AFRICA
Trimble GmbH
Am Prime Parc 11
65479 Raunheim
GERMANY
+49-6142-2100-0 Phone
+49-6142-2100-550 Fax

ASIA-PACIFIC & MIDDLE EAST
Trimble Navigation
Singapore PTE Limited
80 Marine Parade Road
#22-06 Parkway Parade
Singapore, 449269
SINGAPORE
+65-6348-2212 Phone
+65-6348-2232 Fax

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www.trimble.com