Technology Assessment Report
SimulProbe¨
SimulProbe Technologies, Inc.

Prepared for

The Massachusetts Strategic
Envirotechnology Partnership
STEP

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PREFACE

The STEP technology assessment process is designed to identify those technologies that will support the economic and environmental/energy goals of the Commonwealth of Massachusetts and may benefit from STEP assistance. The process is meant to be one of screening, in which technologies are evaluated by independent technical specialists. Recommendation from this process does not constitute an endorsement of the technology or of the absolute validity of the technology. Rather, STEP technical assessments attest only that, through the screening process, the reviewers feel there may be benefit to the Commonwealth of Massachusetts.

EXECUTIVE SUMMARY

SimulProbe Technologies, Inc. is a design, manufacturing and sales firm with its corporate office located in Nashville, TN. The firm also has offices in Chapel Hill, North Carolina and Sandstedt, Germany. Best Environmental Subsurface Sampling Technologies, Inc. (BESST, Inc.) Located in Mill Valley, CA is the exclusive distributor of SimulProbe® products in California and Arizona. SimulProbe was founded in 1994, by Mr. Noah Heller a geologist with a background in petroleum geology. SimulProbe provides sales and rental of 2 SimulProbe® models, peripherals such as vacuum pumps, vacuum boxes, nitrogen tanks and regulators, and consumables for the SimulProbe® tools. The SimulProbe® product is specifically designed for cost savings, through labor reduction and through improved data representation.

SimulProbe's core technology is the SimulProbe®, a simulphasic sample collection device. The product is capable of sampling intact volumes of unconsolidated to semi-consolidated earth and soil atmosphere or unconsolidated to semi-consolidated earth and soil water from proximate locations at the same time. The product is operated in the downhole end of a bore hole drilled with most conventional drilling apparatus including: hollow stem augers, air rotary casing hammer, dual tube percussion, sonic, mud rotary, and cone penetrometer (CPT). The product is driven into unconsolidated to semi-consolidated material using conventional wire line hammer, up hole hammer or push rod apparatus. Product use in a bore hole is accomplished by lowering the product to the bottom of the hole by wire line, conventional rods or direct push rods, and driving it into the soil using a hammer device. When the product has reached its terminal soil depth, the device is pulled back a short distance, whereupon the drive shoe is mechanically retracted from the soil sample container exposing the screened fluid entry ports for fluid sampling. Simulphasic sample matrices are isolated from each other and the down hole environment resulting in samples potentially more representative of in situ conditions.

Detailed operating procedures have been developed for use of the SimulProbe with different bore hole devices and for sampling different media. Several modes of operation are described for the SimulProbe®, including: soil and water or soil and atmosphere simultaneous sampling, "Drive and sniff" sampling, selective drive and soil sample (utilizing push or mud rotary drilling, SPLAT mode), inert gas flushing for rigorous natural attenuation measurements and single point pneumatic slug test to define air-flow permeability in the vadose zone.

This review has identified some limitations to the use of the product and concerns regarding its use. As an example, the product may not be suitable for collection of soil samples in areas where unconsolidated material contain significant fractions of clast supported gravels, cobbles, and other large coarse fragments. Sample contamination must be controlled by proper decontamination of the sampler between each sampling event. These limitations may be no more significant than in other conventional practices. There do not appear to be significant technical issues regarding operation of the product where operation is within specifications set by the manufacturer. Some design problems were said to be resolved and include a new, more robust, SPLAT design, greater screen surface area for water sampling, and improved welds and part shouldering.

The technology proponent suggests that SimulProbe is unique with its multiphasic capability and compatibility with multiple drilling methodologies. Other sampling devices are usually specific to a particular drilling method and/or a single specific formation media (e.g. either soil, soil gas, or ground water).

Performance data supporting the simulphasic sampling claims are documented on a case by case basis (from reported analytical and geological data contained in environmental consulting engineering firm reports). Under certain circumstances the performance of the product should not under perform compared to conventional sampling methods. The SimulProbe® SPLAT and SimulProbe® Split Core Barrel were evaluated under the USEPA ETV program in 1998. The SimulProbe® Split Core Barrel, a new product from SimulProbe, is only capable of collecting soil and does not have the simulphasic sampling capability of the Mini SimulProbe® and the Maxi SimulProbe®. Under conditions of the ETV test samples collected with the SimulProbe® Core Barrel were not statistically different from the reference method in clay soils for VOC quantification (95% C.I.) and a statistical difference was reported in sandy soils with the reference method reporting higher concentrations. SimulProbe countered the ETV results, indicating that the test was unfavorably biased because the test did not permit the use of the recommended sample sleeves, which isolate the core sample. Cost of operating the SimulProbe ranged from $2,880 to $4,860 in the clay soil compared to $13,400 for the reference method and $1,830 to $3,060 in the sandy soil compared to $7,700 for the reference method. The ETV report did not evaluate the simultaneous sampling of soil and soil water or soil gas.

The Massachusetts Contingency Plan establishes performance standards that all remedial actions must meet. Under Massachusetts' privatized cleanup program, the services of a Licensed Site Professional (LSP) are required to perform cleanups. The LSP and their client conducting the cleanup are responsible for selecting the technologies that best meet the required cleanup goals for their site. No specific cross media or energy impacts are identified with use of this technology.

Trends in remediation technology are becoming significantly more dependent upon assessment tools. This suggests a shift and significant reliance on in-situ and correlated monitoring and assessment technologies. Accelerated site characterization and monitoring techniques provided by products such as SimulProbe can benefit a variety of in-situ remediation technologies, such as sparging, air sparging, monitored natural attenuation (i.e., in-situ biodegradation.), as well as conventional ex-situ remediation technologies such as soil vapor extraction and pump and treat. It can provide some of the information necessary to assess the feasibility of these remediation technologies, efficiently select appropriate remediation design parameters and identify permanent monitoring well locations. Furthermore, the application of assessment techniques for plume visualization becomes increasingly important in complex hydrogeologic systems. Cost savings are almost always realized when recovery wells or other remedial actions are strategically placed in the contaminant plume. It is the opinion of this reviewer that market trends would favor a product like SimulProbe, where cost savings in contaminant mass estimation, monitoring and labor are paramount.

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TECHNOLOGY PROPONENT

SimulProbe Technologies Inc. is a design, manufacturing, and sales firm with its corporate offices located in Nashville, TN. Other offices are located in Chapel Hill, North Carolina and Sandstedt, Germany. Best Environmental Subsurface Sampling Technologies, Inc. (BESST, Inc.) of Mill Valley, CA, is the exclusive distributor for SimulProbe® products in California and Arizona. SimulProbe was founded in 1994 by Mr. Noah Heller who holds a Masters Degree in petroleum geology from Mississippi State University, and holds professional geologist registrations in several states including California.. Mr. Heller assigned his co-invention rights to SimulProbe when the company was started.

The company's main source of revenue comes from sales and rental of 2 SimulProbe® models, peripherals such as vacuum pumps, vacuum boxes, nitrogen tanks and regulators, and consumables for the SimulProbe® tools. The basic product model is designed as turnkey. Although field consultations, rentals and repair service are available.

The product is directly targeted to the environmental remediation market. Specifically it is used in assessment and monitoring of contaminated soil and ground water. The company correctly identifies a changing environmental market, which favors cost savings over innovation. The SimulProbe® product is marketed to reduce costs, through labor reduction, and improved data representation and accuracy. The product is designed to be compatible with several types of currently used equipment and SimulProbe envisions few barriers for introduction of its product into the market.

The company has a clear image of the environmental assessment market and customer profile, including geographic distributions in North and South America, Asia, and Western Europe. International patent rights have been applied for in 19 foreign countries. The company has developed a marketing strategy built upon a sales force targeting strategic geographical regions and a technical support system including repair service, product rental service, technical service, field consultation, and training.

The company currently subcontracts manufacturing and for the foreseeable future. SimulProbe will continue to provide quality assurance inspection, assembly, inventory, distribution and administrative tasks. SimulProbe Technologies, Inc. approached STEP in 1997 in order to obtain access to our information transfer to Massachusetts markets, business and marketing assistance.

TECHNOLOGY DESCRIPTION

The SimulProbe® is an apparatus (herein after the "product") designed for simultaneous subsurface gathering of soil and fluid (gas and aqueous). The product is capable of sampling intact volumes of unconsolidated to semi-consolidated earth and soil atmosphere or unconsolidated to semi-consolidated earth and soil water from proximate locations at the same time. The product is operated in the downhole end of a bore hole drilled with most conventional drilling apparatus including: hollow stem augers, air rotary hammers, dual tube percussion, sonic, mud rotary, and cone penetrometer (CPT). The product is driven into unconsolidated to semi-consolidated material using conventional wire line hammer, up-hole hammer or push rod apparatus.

The product comes in two outside diameters - 3.38” and 2.00” corresponding to the Maxi and Mini units, respectively. The fluid volume sample containers are 2 L and 1L for the Maxi and Mini, respectively and attach on the top of the soil collection portion of the unit. Additionally, the water canister modules are stackable for the collection of larger water volumes. The product is manufactured using durable metals and contains a single moving part relating to its method of simultaneously sampling soil and fluids – which is the unique sliding drive shoe. Ports located at the bottom of the device also allow for continuous fluid sampling. Fluids may be transferred to the surface by vacuum assist with a standard diaphragm pump for soil gas sampling. Ground water sampling may be accomplished using a stainless steel water canister module for pneumatically pressured and containerized water samples, a peristaltic pump for direct discharge at the ground surface or by using a traditional rod bailer combination. The entire unit may be attached to a down-hole pile driver device for wire transit to the bottom of the bore hole or connected to direct push or mud rotary drilling devices.

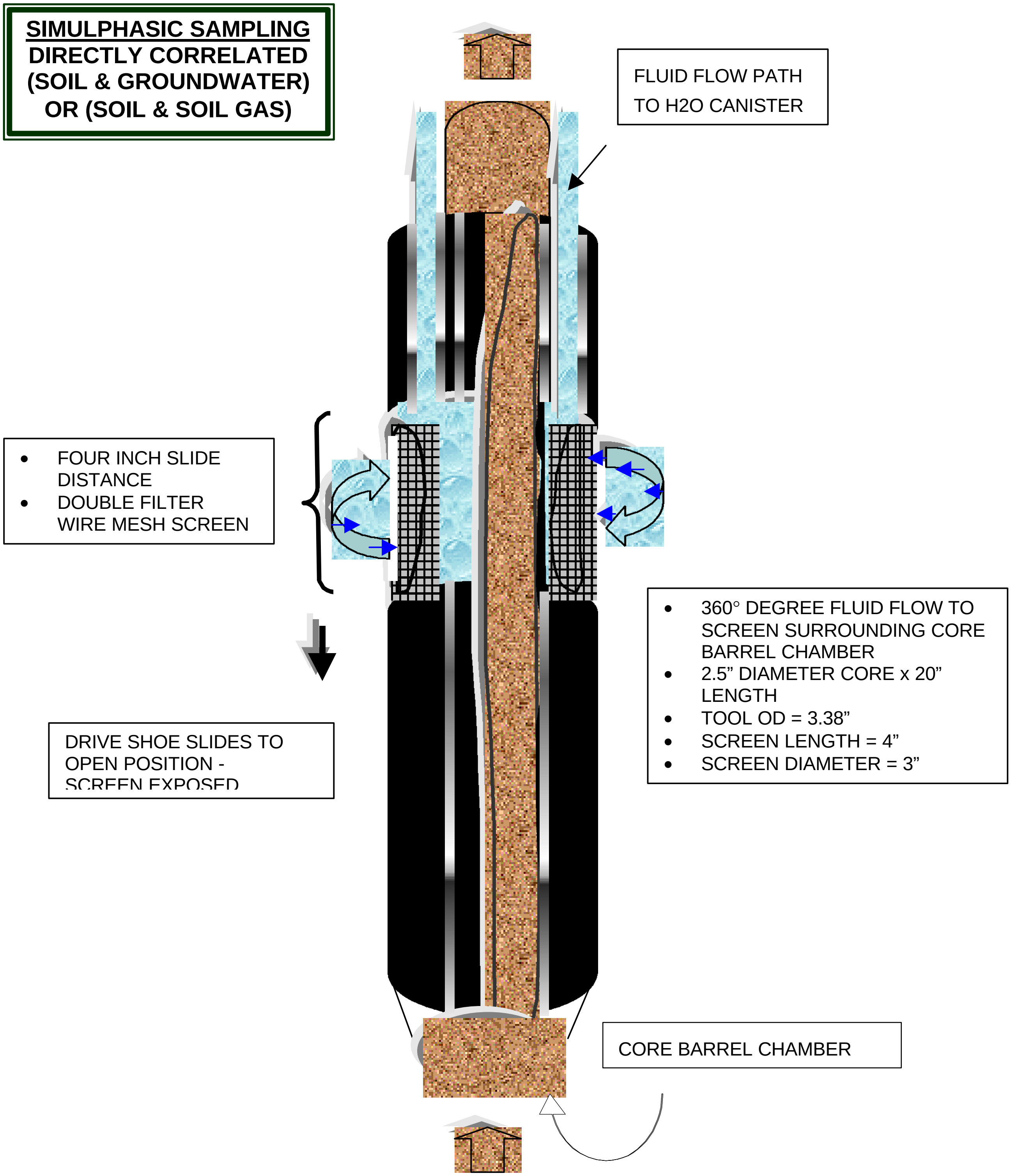
The product components are described in method and apparatus patents in detail. SimulProbe's patents include:

1) The base method and apparatus patent for the SimulProbe® technology.
2) A new base apparatus and method patent for the SimulProbe® technology which enhances the breadth of coverage from the previous base patent.
3) The method and apparatus patent for the SimulProbe® Latch Activated Tip (SPLAT).
4) Method and apparatus Patent Pending (filed patent issuance fee) for back pressurizing a fluid pneumatically while simultaneously collecting solids and fluids.
5) Method and apparatus Patent Pending (filed patent issuance fee) for monitoring and measuring physical and chemical parameters electronically and down-hole while collecting solids and fluids simultaneously.

The unit in its simplest form consists of the following basic components for soil gas and ground water modes: sliding drive shoe, soil sample container with unique riser tubes, and collar (Head) (Figure 1.) The groundwater mode includes in addition to the previous items a water canister assembly (or fluid sample container) with a pneumatically controlled one-way valve at the base of the container.

The sliding drive shoe assembly is designed to facilitate penetration into the soil with minimal disturbance to the soil sample. The sliding drive shoe assembly also is designed with a series of movable positions that facilitate simultaneously sampling for fluids and soil. The soil sample container has an inner diameter of 2.5” and 1.25” on the Maxi and Mini SimulProbe, respectively. The container is split longitudinally affording access to an intact soil core sample. Perforations are located at the downhole end of this component adjacent to the drive shoe and are fluidly connected to the Valve Head assembly located at the top of the soil sample container (core barrel). The fluid riser tubes of the soil sample container occur as two longitudinal grooves along the split half edges of each core barrel half (one groove per side per half). Precut Teflon tube inserts are placed along each groove. When the core barrel halves

Figure 1. The Maxisimulprobe Screen Extension Assembly, (after, SimulProbe Inc, 1999)



are placed together, the two halves seal around the tube inserts. At the top of the core barrel section, the riser tubes insert into the stainless steel Valve Head welded to one of the core barrel halves. The lower end of the tubes stop just short of the screened area which allows the flow of soil gas or formation water to the riser tubes. Fluids (gas or water) filling the soil sample container are vented through the exhalation port which is centrally positioned at the base of the Valve Head assembly and exits through the side of the Valve Head assembly. Since there is no connection between the exhalation port and the riser tube pathways, solids and fluids are kept completely separate. When collecting ground water a fluid sample container is screwed directly to the top of the Valve Head assembly. A one-way valve at the base of the fluid container (water canister) prevents back flow of fluids from the container after the fluid sample is collected. During deployment and retrieval of the SimulProbe® in the bore hole the one-way valve is pneumatically sealed to prevent bore hole fluids from entering the chamber and cross contaminating the fluid sample obtained from the formation. Pneumatic sealing is accomplished by passing either nitrogen or helium gas through a plastic (Teflon or polyethylene) pressurization line connected to the top of the SimulProbe® water canister. When the needed pressure is reached, the pressure is locked into the line via a three-way valve at the ground surface. The fluid sample container is fluidly isolated from the soil sample container and the outside environment.

Additional components may be added to the product for real time sampling during transit through the bore hole or in situ. Such devices include probes for pH, dissolved oxygen, conductivity, redox potential, and temperature.

Several consumable products companion the SimulProbe, including rubber membranes, o-rings, sample sleeves, sample tubing and sample containers. The product design is described as being flexible with capability for custom applications and design changes.

The device appears to be innovative because it allows the simultaneous collection of subsurface soils and either groundwater or soil gas. Other sampling systems do not collect mixed media samples simultaneously from the same location. In addition, groundwater samples are brought to the surface at hydrostatic pressure (via back pressurization with inert gas) thereby minimizing the potential for off gassing or chemical degradation due to pressure changes associated with sampling and sample retrieval. The probe can also be used to conduct a single-point “pneumatic” slug test to “define air permeability pathways”. This allows real time evaluation of site soil conditions for SVE application.

Technical Feasibility and Operation

Simultaneous sampling is likely to be a useful tool for accelerated site characterization in the subsurface. This practice appears to offer a superior confirmation of correlated conditions in soil and fluid phases in the subsurface. Current practices for subsurface investigations require serial sampling of soil and groundwater or soil and soil atmosphere. The result is that samples do not necessarily represent the same location or temporal conditions. Additionally, the practice of soil atmosphere or soil water sampling is prone to underestimate concentrations due to volatile losses during sample transit up hole. This may result in cost overruns due to incorrect site assessment. While this problem of underestimation may be resolved using fluid transfer apparatus in conventional sampling equipment, this device is able to provide both soil and soil atmosphere or soil water from the same location at the same time. The current practice of measuring soil vapor from a soil column appears to be unsuitable as a quantitative measurement practice. SimulProbe's capability is significant and warranted due to the increasing need for accelerated site characterization and monitoring techniques to support in-situ remediation technologies, such as sparging, air sparging, monitored natural attenuation (i.e., in-situ biodegradation.), and ex-situ remediation technologies such as soil vapor extraction and pump and treat. It can provide some of the information necessary to assess the feasibility of these remediation technologies and to efficiently select permanent monitoring well locations. Assessment techniques used to establish whether conditions in the subsurface are suitable for natural attenuation require analysis of soil and soil fluids. For example, reductions in DO in the soil water and presence of contaminant daughter product may suggest that biological degradation is occurring. The technical feasibility of the product appears to fit well within current needs assessment.

Detailed operating procedures have been developed for use of the SimulProbe with different bore hole devices and for sampling different media. Several modes of operation are described for the SimulProbe. A partial listing of common applications are listed below followed by brief descriptions.

1. Soil and water or soil and atmosphere simultaneous sampling,
2. "Drive and sniff" sampling,
3. Selective drive and soil sample (utilizing push or mud rotary drilling, SPLAT mode).
4. Inert gas flushing for rigorous natural attenuation measurements.
5. The Single Point Pneumatic Slug Test to define air-flow permeability in the vadose.

Product use in a bore hole is accomplished by lowering the product to the bottom of the hole by wire line, conventional rods or direct push rods, and driving it into the soil using a hammer device. When the product has reached its terminal soil depth, the device is pulled back a short distance, whereupon the drive shoe is mechanically retracted from the soil sample container exposing the screened fluid entry ports for fluid sampling. Groundwater samples are collected by first pressurizing the water canister with nitrogen gas to prevent ambient groundwater from entering the tool as it is driven to sampling depth. The pressure in the canister is released after driving the tool ahead of the boring bottom to the new sampling horizon.

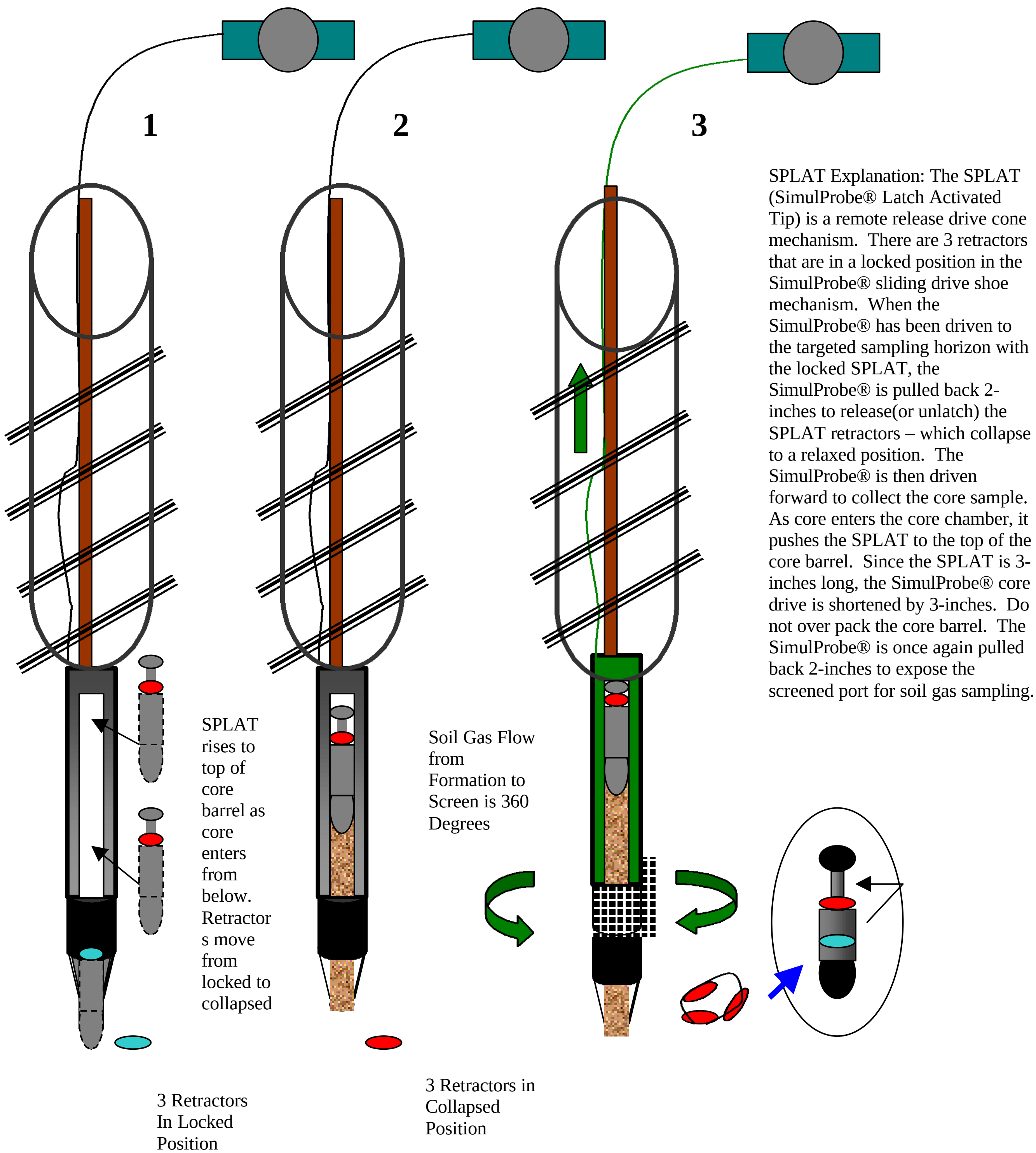
Groundwater fills the fluid container (or canister) through a one way valve located at the base of the water canister.

Once sufficient fluid is collected in the SimulProbe water canister (as determined by the its fill detection system), it is re-pressurized to prevent commingling of borehole fluids with the collected sample before the sampler is retrieved to the ground surface.. Aqueous samples can be brought to the surface by vacuum or peristaltic pumps (peristaltic sampling is limited to depths less than one atmosphere) or through the use of a rod bailer combination. Fluid samples are kept separate from the soil sample by design. Two fluid transfer tubes (riser tubes) run vertically from the base of the soil sample container to the receiving insert holes for transfer tubes located at the bottom of the Valve Head Assembly. The receiving insert holes rise through the Valve Head to the one-way pneumatic valve at the base of the water canister assembly. Soil samples are collected by driving the tool ahead of the drill bit and bore hole bottom. Soil gas samples may be brought to the surface by vacuum for inline gas chromatography or to a suitable gas storage device.

Under "drive and sniff" operation, gas samples for VOC analysis may be sampled continuously during the down-hole transit process in the borehole. Sampling at strategic elevations is accomplished by the intake of soil gas through the circumferential seam of the sliding drive shoe when it is in the closed position. The principle of the technique utilizes the self-cleaning action of soil being swiped away from the circumferential seam by undisturbed new soil as the SimulProbe® is continuously pushed forward. The circumferential seam is very thin and tight and sediment does not become trapped in the seam as the SimulProbe® is pushed forward. While the SimulProbe® is pushed forward, a vacuum is applied to the circumferential seam and fluid transfer tubes by an up hole vacuum pump which is fluidly coupled to the top of the SimulProbe® by a plastic soil gas line (typically Teflon or polyethylene). VOCs and other soil gases transfer through the seamed zone and then up to the vacuum pump at the ground surface. Soil gas constituents are monitored up hole typically with standard monitoring devices such as photo or flame ionization detectors. As the SimulProbe® advances "hot spots" may be detected. At these locations and at the same time the presence of soil gas contamination can be confirmed by the collection of a soil sample. Additionally, as the soil sample is collected inside the SimulProbe®, continuous monitoring can occur such that construction of a continuous in-situ chemical profile for the entire core sample can be obtained. This procedure provides field scientists the opportunity to be more selective about which section(s) of core samples will require more rigorous analytical test methods.

The SPLAT or SimulProbe Latch Activated Tip is one of the SimulProbe® technologies, which makes drive and sniff possible – either with direct push or conventional drilling methods (Figure 2.) As the SimulProbe® is driven downward, three SPLAT retractors (curved steel wedges) remain in a locked position against a ledge inside the drive shoe area. When the SimulProbe® is pulled back, about 1", the three retractors are released to a collapsed, unlocked position. The SimulProbe® is then driven forward to collect a soil core sample. As the soil core enters the soil sample container, the released SPLAT is pushed towards the top of the container by the core. In the direct push mode the SPLAT may be activated at any depth for soil sampling only, or for simultaneous soil gas and soil sample collection. Fluid sampling in the saturated zone is also possible under the SPLAT mode.

Figure 2 – Deploying, Sampling, and Retrieval of the SimulProbe For Cased Bore Hole or Direct Push Soil Gas Sampling Using the SPLAT Drive Cone Assembly (SimulProbe® Latch Activated Tip) (After, SimulProbe, Inc, 1999)



Other operating modes and applications exist for direct push and conventional drilling methods, including: in-situ headspace testing. Other functionalities described by the proponent include model validation (visualization of plume for example), air permeability measurements, biogenic respirometry, well design, and aquifer delineation.

Some limitations and concerns regarding use have been identified. The product may not be suitable for collection of soil samples in areas where unconsolidated material contain significant fractions of clast supported gravels, cobbles, and other large coarse fragments. Depth limitations may exist for real time measurement of soil water or gas due to lift headloss. Sample contamination must be controlled by proper decontamination of the sampler between each sampling event. These limitations may be no more significant than in other conventional practices. There do not appear to be significant technical issues regarding operation of the product where operation is within specifications set by the manufacturer. The proponent identified issues regarding mechanical failure of the earlier versions of the Mini. These problems were said to be resolved and include a new SPLAT design, greater screen surface for water sampling, and improved welds and part shouldering.

COMPETING TECHNOLOGIES

The technology proponent suggests that SimulProbe is a unique product with simulphasic capability and is compatible with multiple drilling methodologies. Other sampling devices are usually specific to a particular drilling method and/or a single specific formation media (e.g. either soil, soil gas, or ground water). The proponent suggests that while there are standard devices for sampling soil, soil water, or soil atmosphere, many companies (mostly drilling enterprises) develop proprietary devices for their own use. It is assumed that drilling companies, which machine their own drilling equipment, are not in the market of selling their devices to other drilling outfits. There are several drilling device manufacturers and instrumentation manufacturers for subsurface sampling (EPA ETV Site Characterization, Sandia National Laboratories, EPA/600/R-97/019 and 020, 1997). This reviewer is not aware of devices described therein comparable to the SimulProbe

SimulProbe considers its technology superior to conventional sampling techniques because it saves time, costs less, and provides improved data quality. The company asserts that SimulProbe saves time over conventional techniques since the tool can take simultaneous samples of two media – either soil and soil gas or soil and ground water. The proponent identified one special application of the technology for the capillary fringe zone where the tool can convert down hole in the same trip from a soil and soil gas sampler to a soil and ground water sampler. They purport that “on a typical total project cost of $2-3 million in field work, the use of SimulProbe can reduce the overall project cost by 10% and the sampling portion of the cost of the project by 80%.” The company also states that their technology improves sample quality by reducing out-gassing of volatile compounds and the tool has the ability to correlate data samples of soil, soil gas and water from the same geologic location.

DATA SUPPORTING CLAIMS

Within the current submission the performance data supporting the claims are documented on a case by case basis (in the form of analytical and geological data from numerous reports authored by environmental engineering consulting firms). The data submitted by SimulProbe® in the consulting engineering firms reports suggest that under certain circumstances the performance of the product should not vary from conventional sampling. More importantly, the data from some of the reports also suggests that sample correlation between soil and soil gas or soil and soil water may be better than available conventional techniques for similar measurements. The practical application of a side-by-side field test in a bore hole to compare accuracy and repeatability in sequentially vertical co-located samples collected from SimulProbe® and conventional samplers is not likely, since one could not collect the same sample form the same stratigraphic location. It may be possible, however, to run side by side bore hole tests, or tests in which SimulProbe® samples are collected from a bore hole which is then completed as a monitoring well – with the well screen in the same vertical location as where the SimulProbe® sample was collected. As an example, in one of the reports submitted by SimulProbe® for an Arizona TCE plume, SimulProbe® results were consistent with the monitoring well results (Levine, et al., 1997). This case history suggests an acceptable degree of accuracy and the ability of the device to remove basic uncertainty. It is this reviewers opinion that the application of this technology is for the most part mechanical and pneumatic and should not add any additional analytical error.

In August 1998, the SimulProbe SPLAT and SimulProbe® Split Core Barrel were evaluated under the US Environmental Protection Agency Environmental Technology Verification (ETV) Program (US EPA, 1998). At the time of the test the SimulProbe® Split Core Barrel was a fairly new product from SimulProbe® Technologies, Inc. and only has the capability of collecting soil. This product does not have the simulphasic sampling capability of the Mini SimulProbe® and the Maxi SimulProbe®. Under conditions of the ETV test the SimulProbe® Core Barrel had a mean sample recovery of 95% in clay soil, compared to 88% for the reference method (split spoon sampler) and 63% in sandy soil compared to 87% for the reference method. No statistical difference was reported for the SimulProbe and the reference method in clay soils for VOC quantification (95% C.I.). However, a statistical difference was reported in sandy soils with the reference method reporting higher concentrations. SimulProbe countered the ETV results, indicating that the test was unfavorably biased because the test did not permit the use of the recommended sample sleeves, which isolates the sample. Cost of operating the SimulProbe ranged $2,880 to $4,860 in the clay soil compared to $13,400 for the reference method and $1,830 to $3,060 in the sandy soil compared to $7,700 for the reference method. The ETV report did not evaluate the simultaneous sampling of soil and soil water or soil gas. This reviewer considers the ETV test to only be somewhat representative of the product's capability and may not adequately address other beneficial attributes. The USEPA ETV verification statement (EPA-VS-SCM-21) and the Technology Update (USEPA, 1998) are available on the Internet at http://www.epa.gov/etv/02/simulprobe.pdf and http://www.epa.gov/etv/02/simulprobe_report.pdf, respectively.

REGULATORY / PERMITTING ISSUES

The Massachusetts Contingency Plan (MCP - 310 CMR 40.0000, DEP's rules governing assessment and cleanup of releases of oil and/or hazardous material) establishes performance standards that all remedial actions must meet. Technology vendors should be aware that under Massachusetts' privatized cleanup program, the services of a Licensed Site Professional (LSP) are required to perform cleanups. Moreover, the LSP and their client conducting the cleanup are responsible for selecting the technologies that best meet the required cleanup goals for their site. In most cases, LSPs and their clients evaluate the applicability and cost-effectiveness of various technologies at individual sites.

Applicable State regulations identified by this reviewer include those sections of the Massachusetts Contingency Plan relating to Environmental Sampling and Analyses, attached below. Specific reference to collection techniques listed under 310 CMR 40.0017(2)(a) have not been examined by this reviewer. However, under the following section 310 CMR 40.0017(2)(b) modifications may be permitted provided they are documented. Other regulatory criteria may apply.

310 CMR 40.0000: Massachusetts Contingency Plan, DEP, May 1998

40.0017: Environmental Sample Collection and Analyses

(1) Any person undertaking response actions under the provisions of this Contingency Plan shall ensure that analytical and environmental monitoring data used in support of recommendations, conclusions, or LSP Opinions with respect to assessment, removal, or containment actions is scientifically valid and defensible, and of a level of precision and accuracy commensurate with its stated or intended use.

(2) Procedures and methodologies employed for the collection and analysis of soil, sediment, water, vapor, air, and/or waste samples shall consist of:
   - (a) methods published by the Department, EPA, the American Society for Testing and Materials (ASTM), the American Public Health Association (APHA), the National Institute for Occupational Safety and Health (NIOSH), the American Water Works Association (AWWA), and other organizations with expertise in the development of standardized analytical testing methods;
   - (b) modification of published methods, provided that all modifications are completely documented; or
   - (c) unpublished methods, including analytical screening methods, provided that such methods are scientifically valid, are of a known and demonstrated level of precision and accuracy, and are completely described and documented in response action submittals.

(3) All response action submittals to the Department under these regulations that contain the results of sample collection and analyses shall include the following information:
   - (a) the date, location, and time of sampling, and the name of the individual who collected the sample;
   - (b) specifications on any sample filtration or preservation procedures;
   - (c) the date of receipt of the sample at the laboratory, and the date(s) the sample was extracted and/or analyzed;
   - (d) the name and address of the laboratory, and the certification identification number and status of the laboratory, if certified;
   - (e) the sample matrix description and identification number(s);
   - (f) the sample preparation and/or analytical method(s) employed;
   - (g) the results of the analysis, in clearly expressed concentration units;
   - (h) the detection limit of each reported analyte based upon actual analytical conditions;

(i) details on any known conditions or findings which may effect the validity of analytical data, including unsatisfactory results obtained on quality assurance/ quality control blank, duplicate, surrogate or spiked samples; and

(j) any other information or data which may be required to explain or document provided data, including chain of custody forms, where appropriate, or other information requested by the Department based upon its review and evaluation of submitted documents.

(4) Laboratory and other reports of sampling analyses of aqueous samples shall be reported as mass per unit volume and solid samples shall be reported as mass per unit mass, on a dry weight basis, unless other reporting units are more appropriate.

(5) Any person undertaking response actions shall ensure that sample collection and analyses is performed by persons who are qualified by education, training and experience.

CROSS MEDIA IMPACTS

This method poses no greater impact on environmental quality than comparable methods for obtaining soil, water or gas samples.

ENERGY ISSUES

No specific energy issues are apparent with this product.

NEED FOR ADDITIONAL RESEARCH, DEMONSTRATION, AND STEP SUPPORT

SimulProbe has requested that STEP provide technology transfer through its regular sources and basic business assistance. This reviewer believes that there is sufficient evidence and or access to evidence that supports the claims of the proponent. While side by side testing with conventional techniques for sampling may be accomplished, a comparable simultaneous sampler was not available to test. Further more, comparisons between sampling technologies has inherent errors. Two devices cannot physically test the same sample or make truly comparable in-situ measurements. Relative differences may be achievable but not without random error. Therefore this reviewer does not believe that validation through additional testing can be offered nor is it warranted. Empirical testing of the device, with relational analysis may be warranted.

BUSINESS ANALYSIS

A business analysis was conducted based upon a "Statement of Qualifications" document prepared by SimulProbe, Inc. The corporation lists two operating offices in California and a third operating office in North Carolina, and features applications research and user education in support of their product. Intellectual property claims are made in the form of a patent awarded in 1995 for the enabling technology for their principal product, the SimulProbe. Advanced degree expertise is claimed in the fields of geology and hydrology; however, the level of this expertise as might be distributed across the firm's three current operating offices is not clear. The firm has not designated any one of their three operating sites as a site as a corporate research center and may, therefore, conduct its research on an ad hoc basis. SimulProbe Technologies, Inc. speaks of a broad external "partnership" with respect to its intellectual capital in the area of application skills, and the firm provides a list of 9 sites where projects demonstrate savings created through the use of their product, most of which appear to be based in California. It is not clear that SimulProbe Technologies, Inc. contains within itself sufficient design and engineering skills to represent a significant internal new product research capacity; rather the firm appears better positioned to understand market demands to effectively position products for adoption into use.

SimulProbe Technologies, Inc. has indicated that it has in place a Quality Management System to assure continuity of high quality client services, and has indicated that it extends "operation-specific" Quality Assurance/Quality Control management plans for specific user operations. An example of such a QA/QC plan has not been included in the materials however detailed SOPs are available. A specific Hazard Communication Plan, identified as a means of establishing compliance with OSHA Standard 29 CFR 1910 is contained in the documents reviewed by STEP. The fact that SimulProbe Technologies, Inc. recognizes the value of QA/QC and worker safety support in its documents is taken as a positive indication of quality management by the firm.

SimulProbe Technologies, Inc. has a market presence as evidenced by a list of more than 64 "clients and end-users" for their product. About a quarter of the firm's "clients and end-users" are specifically identified as operating beyond the state of California. This is taken as evidence that SimulProbe Technologies, Inc. has expanded, and appears capable of continuing to expand, its market territory beyond it's home territory. The firm lists 18 states (and 5 international markets) where its technology has been used; however, this list names only New York and New Jersey in the Northeast. Expanding into environmental service markets in "new" states reflects positively upon the firm's ability to grow towards a national standard.

On the balance, SimulProbe Technologies, Inc. appears at risk in the area of discovery science and technological product engineering; however, this risk appears largely offset by their technology acquisition strategy and their focus on marketing and client service. While cash flow data has not been provided for STEP's review, SimulProbe Technologies, Inc. does appear well positioned for commercial success with a product line that addresses a recognized and expanding market need. Accessing Licensed Site Professionals (LSPs) and their respective state professional associations may accelerate market expansion in Massachusetts. Under the Massachusetts Contingency Plan, clean up and assessments are performance based. Therefor LSPs are able to adopt technologies that are available from the market. SimulProbe Technologies, Inc. appears well positioned to address the needs of the LSP community and win their confidence through their history of successful application of their technology. The large number of 21E sites (suspected hazardous waste sites) in Massachusetts and the recent “Brown Fields” legislation can be expected to induce significant growth. Along with this growth in the area of site assessment and opportunities for cost savings should encourage investment opportunities.

SUMMARY RECOMMENDATION

Although the environmental market continues to move along at a somewhat flat pace, the trends in remediation technology are becoming significantly more dependent upon accelerated site characterization tools. Assessment products such as SimulProbe can benefit a variety of in-situ remediation technologies, such as sparging, air sparging, and monitored natural attenuation (i.e., in-situ biodegradation.) It can provide some of the information necessary to assess these technologies and to efficiently select permanent monitoring well locations. Furthermore, the application of assessment techniques for plume visualization becomes increasingly important in complex hydrogeologic systems. Cost savings are almost always realized when recovery wells or other remedial actions are strategically placed in the contaminant plume. It is the opinion of this reviewer that market trends would favor a product like SimulProbe, where cost savings in labor are paramount.

REFERENCES

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US EPA, 1998. Soil Sampling Technology, Simulprobe Technologies, Inc. Core Barrel Sampler, EPA/600/R-98/094. US EPA Office of Research and Development, Washington, DC. (http://www.epa.gov/etv/02/simulprobe_report.pdf)

APPENDICES

APPENDIX A

Review Questions and Proponent Response

The following series of questions and responses are presented here for informational purposes. Questions are presented in **bold** font and responses are in *italic*. Responses were written by SimulProbe Technologies, Inc. The italicized statements presented represent the proponent's point of view. The validity of the responses have not been verified as part of this review. The information presented here may help to clarify issues not raised in the main body of the review. Some repetition from the main body may appear here but is included to allow for continuity.

1. **The cost savings data presented for a “typical site” is questionable. In our experience there is no “typical site.” The cost of any assessment program will vary greatly with the contaminants and geology of the site. Thus, to imply the quoted cost savings figures are representative of all projects is false.**

Response: While it is true that there are many sites which are complex from a contaminant and geology stand point, the complexity of compounding errors related to erroneous and inappropriate sampling procedures and technology must be added to the mix. Additionally, I believe that there are typical sites and typical cost saving models for typical site assessment approaches. Site assessment approaches or models could be broken into three general categories or models:

1) Shallow Preliminary Assessment – Vadose Zone Only in Potential Source Areas

1.1) Vibratory Direct Push

1.2) Conventional Drilling

2) Shallow Post Preliminary Assessment – Vadose Zone and First Water Sampling in Potential Source Areas

2.1) All Direct Push

2.2) Conventional Drilling

3) Deeper Post Preliminary Assessment – Vadose Zone, First Water, and Below First Water

3.1) CPT Direct Push

3.2) Conventional Drilling

For each one of these categories, there are reasonable assumptions that can be made about the cost of sampling and drilling for soil, soil gas, and ground water ($ per foot for drilling, $ per sampling event for soil, soil gas and groundwater, etc.). In any one of these categories where there are requirements for paired sampling events, the cost of the SimulProbe® can be compared directly to the conventional methods of paired sampling using *conventional methods (colocated soil and soil gas samples collected with a split spoon and soil gas probe, colocated soil and groundwater samples collected with a split spoon and HydroPunch, etc.).*

The SimulProbe® in the groundwater mode provides numerous cost savings and advantages compared to other in-situ depth discrete groundwater samplers. For instance, the SimulProbe® in the groundwater mode eliminates the following:

a) *Eliminates drive rod deployment (including assembly and disassembly)since the SimulProbe® can be use completely independent of drive rod via wire line with a down-hole hammer.*

b) *Eliminates rod decontamination between sampling events in the same bore hole. Since the SimulProbe® groundwater sample is completely containerized in a water canister, there is never any contact with the groundwater sample and the inside of a drive rod (which is one of the problems inherent with bailers).*

c) *Eliminates leakage of bore fluids through rod joints that could then mix with bailed groundwater inside the rod. Leakage of groundwater through rod joints is a common problem in the industry – both for direct push and conventional drilling and sampling methods. With conventional rods (using hollow stem auger, dual wall percussion, etc, there can be two stages of rod leakage during a sampling event. The first stage can occur as the sampler is lowered to the bottom of the bore hole. During the rod lowering stage, the rod joints are under tension from the weight of the suspended rod. A significant amount of bore hole fluids can enter through the rod joints at this point. Second stage leakage through the rod joints can occur when the sampler is pulled back to expose the sampler's screen. Once again, the rod joints are under tension – potentially allowing bore hole fluids to enter through the rod joints and mix with the bailed ground water sample. What is the cost associated with this problem? The formation water will either be diluted with the bore hole fluids which have leaked through the joints or will be concentrated by these fluids. This problem is wide spread through out the industry.*

d) *Eliminates the cost of bailing.*

e) *Eliminates data inaccuracies related to bailing. Often times when a bailer is used, sediment grains lodge between the check ball and the check ball seat. As the bailer is raised to the ground surface, groundwater can trickle out through the unseated check ball. If the groundwater contains VOCs destined for analysis, then these VOCs could be aerated as the groundwater descends back down to the bottom of the*

f) *Eliminates volatilization of a bailed groundwater sample as it is retrieved to the ground surface. Since the SimulProbe® uses back pressurization with inert gas, the groundwater sample which is collected in the SimulProbe® water canister is pressurized to greater than the hydrostatic pressure of the bore hole fluid column. By keeping the ground water sample under pressure while it is being transported to the ground surface, VOC molecules are forced to stay in solution. At the ground surface, the ground water sample can be transferred to a VOA vial without contact with the atmosphere.*

Since the SimulProbe® eliminates many of the data errors associated with "open system" groundwater sample collection, it is only logical to assume the following from a cost stand point:

1) *Environmental consultants should be able to spend less time on average performing data reduction and analysis.*

2) *Environmental consultants should be able to minimize the successive field stages by utilizing more accurate data. In other words, they can do their job correctly from the beginning and minimize rework in the field.*

3) *More accurate results should help to reduce environmental litigation costs – since litigation typically escalates on the basis of ambiguities in data results.*

4) *More accurate assessment data provides better estimates of contaminant mass and therefore provides the foundation for more efficiently designed remediation systems. Efficiently designed remediation systems should cost less to construct and to operate over time.*

2. **Depending upon site sampling objectives, it may be necessary to install conventional monitoring wells (long term monitoring) in addition to gathering short term samples. Thus, the elimination of monitoring wells at a site doesn't immediately correlate to cost savings attributable to the use of SimulProbe® technology. It may indicate there is no need for long term monitoring. Based upon the information provided, it was unclear as to whether the SimulProbe could be installed as a long term monitoring device.**

Response: The SimulProbe® was never intended to be a permanently installed or temporarily installed long term monitoring device. In general, however, I do believe that the minimization of monitoring wells through the use of assessment technologies for proper well locating and screen placement does provide substantial cost savings. The SimulProbe® is not the only technology that can provide this advantage. Other technologies which help to minimize well installation are the Hydropunch, the BAT Probe, the Waterloo Profiler, the West Bay Multiport Monitoring Well System, and others. These technologies have applications that over lap each other and have applications with their own separate domains. Perhaps the critical issue is "how reliable is the data generated from each of these devices for the application they are being used for". If any of these devices are improperly used, then the minimal wells that were installed as a result of their use, and the intended cost savings is perhaps not really a cost savings at all.

3. **The company touts SimulProbe as being better than "conventional" techniques but "conventional" techniques are never fully defined. Therefore it was unclear where the company was comparing the tool to augured monitoring wells or small diameter driven wells. The installation techniques for each of these well types is very different. SimulProbe should make a better effort to compare and contrast their tool to each of the above well installation techniques. A comparison of advantages and disadvantages would be most useful.**

Response: I concur with this comment. With any new technology, it takes time to gather the data which permits one to properly evaluate its performance and cost savings relative to other technologies. What SimulProbe® means by conventional techniques are the following:

1) *Using sequentially paired monophasic sampling – meaning one sampling device for each type of sample in the paired event. As compared to the use of a SimulProbe® for simulphasic sampling which collects samples in parallel as opposed to sequentially, and at the same time and from the same stratigraphic horizon. In other words, one trip into the bore hole for a sample pair compared with two trips into a bore hole for a sample pair.*

2) *Using the technique of one trip per soil gas sample and soil sample with direct push or conventional (hollow stem, mud rotary, air methods) drilling compared to using "Drive and Sniff" with the SimulProbe® where one could collect multiple soil gas samples from different stratigraphic horizons in one trip – and then in the same trip collect the soil sample when a "hot spot" is detected.*

3) *Using rod and bailer combinations for vertically profiling aquifers. Here is a typical list of cost issues related to this conventional approach:*

    3.1) *Each deeper trip into the bore hole becomes more expensive then the last.*

    3.2) *Each rod must be decontaminated on the inside and outside before each new trip into the bore hole.*

    3.3) *Each trip into the bore hole requires rod assembly and disassembly.*

    3.4) *Rod joints typically leak bore hole fluids to the inside of the rod. The bore hole fluid either dilutes or increases the concentration of the water sample. The cross contamination of the sample increases the cost of the project for both assessment and remediation. As an example, if one is depending on the ground water samples to acquire an estimate of contaminant mass, then the mass estimate might be grossly affected by the cross contamination of the sample. The remediation system may be under designed or over designed depending on whether or not the sample population was generally diluted or increased in contaminant content.*

    3.5) *The bailer in and of itself will cause sample dilution from VOC loss. How much VOC loss is acceptable before a project is significantly impacted cost-wise by bad data. In other words, what is the cost of bad data using antiquated conventional methods.*

The SimulProbe® for ground water or soil gas sampling can be transported to the bottom of the bore hole completely independent of rods – using down-hole wire line hammer apparatus. Therefore, the following is eliminated:

- a) *Rod assembly and disassembly*
- b) *Rod decontamination*

c) *Rod leakage and sample cross contamination*

d) *Bailer elimination and VOC loss resulting from bailer use*

APPENDIX B

Standard Operating Procedures

STANDARD OPERATING PROCEDURES FOR THE MINI SIMULPROBE SOIL/SOIL GAS

1.0 INTRODUCTION:

The following discussion reviews the assembly, disassembly and operational procedures for the MiniSimulProbe in the soil/soil gas mode. One point of note is that there are three basic O-ring sizes when using the MiniSimulProbe in all operations. Through the course of the document these are referred to as small, medium and large or, sometimes, as smallest, medium and largest.

2.0 SPLAT SYSTEM:

The SimulProbe Latch Activated Tip (SPLAT) is a drive tip which enables the MiniSimulProbe to be driven without collecting a soil sample until the desired depth has been reached. To release the SPLAT, the operator simply pulls the tool back approximately 1/2 inch. The MiniSimulProbe is then driven 15 inches to collect a core. The SPLAT is recovered at the top of the soil core.

3.0 ASSEMBLY SOIL AND SOIL GAS MODE:

3.1 Place the Teflon Tubes from a MiniSimulProbe soil gas kit into the grooves along the edges of the Split Barrel Primary Half, inserting the ends of tubes into the shallow holes at the lower end of the Split Barrel Primary Half.

3.2 Insert a reed valve into the top of the Split Barrel Primary Half.

3.3 Place a set of SimulProbe encapsulated core sleeves (Note: Standard 6” core sleeves will not fit.) into the Split Barrel Primary Half and slide them down far enough to allow a short sleeve to be dropped in at the top of the core barrel. This short sleeve is where the SimulProbe Latch Activated Tip (SPLAT) will be held when you have collected a soil core. Note that the encapsulated portion of the set consists of two long sleeves and a short sleeve. They may be placed with the encapsulated short sleeve at the top or bottom, depending on your specific requirements for sample volume.

3.4 Lay the Split Barrel Cover Half on top of the Split Barrel Primary Half and slide the two halves loosely together, guiding the upper ends of the Teflon Tubes into the two holes at the top of the Split Barrel Cover Half. Snug the split halves together.

3.5 Make sure the guide pins are aligned with their corresponding holes as you slide the split halves together. If you are having difficulty getting the split halves to seat the last little bit (1/4 inch), you can screw the Shoe Sleeve onto the bottom end of the core barrel and drop the probe, Shoe Sleeve first, about 3 inches onto a wooden, plastic or other REASONABLY SOFT surface. (Do not drop the probe onto a hard surface such as concrete as this may damage the metal on the bottom edge of the Shoe Sleeve.)

3.6 Place the largest and the mid sized O-rings from a MiniSimulProbe Soil Gas kit into the grooves located on either side of the four fluid ports on the bottom of the Valve Head.

3.7 Screw the Valve Head into the top of the core barrel. Make certain that the Valve Head screws in completely so that its O-rings are fully seated against the top of the core barrel and the two split barrel halves are fully shouldered together.

3.8 Place a Conical Screen over the intake ports on the lower end of the MiniSimulProbe. (First remove the Shoe Sleeve if you used the drop method to seat the core barrel halves together.)

3.9 Screw a Teflon Ring on to the bottom end of the Split Barrel Primary Half.

3.10 Slide the Cover Sleeve over the Teflon Ring and the Conical Screen.

3.11 Screw the Shoe Sleeve on to the bottom end of Split Barrel Primary Half behind the Teflon Ring. The Shoe Sleeve will trap the Cover Sleeve onto the MiniSimulProbe.

3.12 If the SimulProbe Latch Activated Tip (SPLAT) is to be used, pull the Drive Point away from the Point Base, spreading the Retractors fully out and set the Retractors into the ledge at the end of the Shoe Sleeve.

(The core barrel should be resting on the Valve Head and pointing straight up. Lift the Cover Sleeve up until it is stopped by the Shoe Sleeve and the lower the Drive Shoe over the SPLAT. While continuing to hold the Cover Sleeve up, screw the Drive Shoe onto the Cover Sleeve and then push the Shoe/Cover Sleeve assembly down and into the fully closed position.

3.13 Slide a Gooch tube over the circumferential seam between the top of the Cover Sleeve and the bottom of the core barrel. (Both the MiniSimulProbe and the technician's gloves should be dry. Water lubricates the Gooch tube and thus reduces its ability to hold the Shoe/Cover Sleeve assemble in the closed position.) Push the Drive Tip of the SPLAT into the Drive Shoe. The shoulder of the Drive Tip should match the edge of the Drive Shoe or extend slightly beyond the edge of the Drive Shoe. If the Drive Tip can be pushed in so that its shoulder sits deeper than the edge of the Drive Shoe, it is likely that the Retractors have released. Go back to step 12 and reset the SPLAT.

3.14 Wrap Teflon tape around the threads of a 1/8" NPT x1/4 Swagelok Fitting and TIGHTLY screw the fitting into a Valve Head Insert. Place the smallest O-ring from a MiniSimulProbe Soil Gas Kit onto the groove around the outside edge of the Valve Head Insert. If the Teflon soil gas line is to be run inside hollow rods between the surface and the top of the MiniSimulProbe, the line should be pre-threaded through all of the rods and the final AW Pin or AW pin adapter at this time.

3.15 Cut a short length (1/4 inch) from the end of the Teflon soil gas line (removes any rust which may have collected in the end of the line as it was being pushed through the rods) and insert the line into the end of Swagelok Fitting with brass ferrules preset on the inside of the fitting. Tighten the nut on the Swagelok Fitting by exactly one and one quarter turns to crush its ferrules into the soil gas line. If this same line and ferrule set is used for subsequent samples, the nut should only be snugged tight with a wrench.

3.16 Push the Valve Head Insert into the bottom of the AW threads in the Valve Head and screw the Valve Head onto the AW Pin or AW adapter. This will seat the Valve Head Insert. Note: Use a slotted AW Pin if the Soil Gas Line is not to be run inside of hollow rods.

3.17 Push the Drive Tip up into the end of the Drive Shoe.

4.0 DISASSEMBLY & SAMPLE RETRIEVAL: SOIL GAS MODE:

4.1 Unscrew the MiniSimulProbe from the AW pin or rod.

4.2 Unscrew the Valve Head from the core barrel assembly. Pull the Valve Head Insert out.

4.3 Insert a large regular screw driver blade into the slot near the top of the core barrel assembly and rotate the blade. This will separate the two core barrel halves.

4.4 Remove the soil core and process it according to your sample protocols. If the bottom sleeve is difficult to remove, it can be pushed out from the bottom by removing the Shoe Sleeve and pushing up from the bottom with an empty core sleeve. If the SPLAT has been used, it will be in the top sleeve at the top of the soil core.

4.5 Use the two large Proto wrenches from the tool kit to remove the Drive Shoe from the Cover Sleeve. NEVER use a pipe wrench on the Cover Sleeve. The pipe wrench will distort the shape of the Cover Sleeve.

4.6 Unscrew the Teflon Ring. If it can't be removed by hand, grasp the edge of the ring with a pair of needle nose pliers and pull with a force parallel to the ring's threads. This will allow you to unscrew the ring without damaging its outer surface. DO NOT use a pipe wrench or similar tool to unscrew the Teflon Ring. This will ruin the ring by deeply marring its surface.

4.7 Slide the Conical Screen off and discard it. If the Screen is difficult to remove, it can be torn off by grasping it with a pair of needle nose pliers.

5.0 OPERATION: SOIL/SOIL GAS MODE USING DIRECT PUSH DRILLING METHODS

5.1 Assemble the MiniSimulProbe in the Soil/Soil Gas Mode with the SPLAT, as per Assembly sop's.

5.2 Thread a 1/4" OD, 3/16" ID Teflon soil gas line through enough drive rods to reach the maximum anticipated depth for this particular sampling event. (Note: Pure Teflon tubing is preferable to Teflon lined tubing because of the lined tubing's tendency to kink when bent.)

5.3 Thread the soil gas sample line through the AW adapter pin which is applicable to your particular direct push apparatus and screw the pin into the end of the first drilling rod.

5.4 Attach the end of the sampling line to the Swagelok Fitting and attach the MiniSimulProbe as described in the MiniSimulProbe Assembly sop for soil gas sampling.

5.5 Screw a slotted drive head on top of the first drive rod. The Teflon line will extend out through the slot while you are screwing in the drive head. Hold the line so that it does not become twisted. (The slot on the drive head will rotate relative to the Teflon line, but the Teflon line should not be allowed to rotate relative to the MiniSimulProbe and the drive rod.)

5.6 Attach the drive head, drive rod and MiniSimulProbe to the direct push drilling rig.

5.7 Check the SPLAT to be certain that it cannot be pushed up inside of the shoe, and lower the MiniSimulProbe into position with the Drive Tip resting on the soil surface.

5.8 Attach the uphole end of the Teflon soil gas line to a flow gauge equipped soil gas pump.

5.9 Begin driving the MiniSimulProbe into the soil.

5.10 If you are using the Drive and Sniff method, the first sniff can take place once the MiniSimulProbe has been driven at least 6 inches into the soil. The sniff samples can be pulled at any frequency desired, but a recommended frequency is every five feet or at every change of pushing resistance.

5.11 *To collect a sniff sample, stop the drive, purge 3 to 5 soil gas volumes or until micro purge reading have been reached through screening procedures associated with the vacuum pump and a contaminate appropriate screening device or devices. Do not pull the MiniSimulProbe back for a sniff sample, as this will release the tip. The sniff sample is collected through the circumferential seam only.

5.12 After each drive rod has been pushed into the ground, unscrew the slotted drive head from the rod, and screw on the next segment of drive rod. Be careful to prevent the Teflon line from twisting relative to the MiniSimulProbe during this process.

5.13 Attach the slotted drive head to the top of the new section of drive rod and continue to advance the MiniSimulProbe.

5.14 When you have reached an interval where you wish to collect a soil sample, stop and remove the slotted drive head and attach a slotted pull bail. As before, do not allow the Teflon line to rotate with either slotted device. (Note: The specific mechanism for pulling back on the drive rod varies from one direct drive system to another. Consult the drill operator and or manufacturer for specific details.)

5.15 Pull the drive rod and attached MiniSimulProbe back 1/4" (1 cm) to release the SPLAT.

5.16 Reattach the slotted drive head and drive forward 15" to collect a soil core.

5.17 Pull the drive rod and MiniSimulProbe back about 1/2" to expose the screen and collect a soil gas sample as per site specific sop's. This should include purging 3 to 5 MiniSimulProbe and Teflon line volumes, 30 cc and 5.43 cc/ft, respectively)

5.18 Pull the drive rods and MiniSimulProbe back to the surface. If you intend to reuse the Teflon line, be careful not to twist the Teflon line as you remove the rods.

5.19 Disassemble the MiniSimulProbe as per the disassembly Sops.

6.0 DECONTAMINATION:

Follow procedures specified in site specific work plan and/or quality assurance project plan for standard operating procedures for sampling device decontamination. A new consumable kit should be used for each sample unless otherwise specified in the work plan. Reuse of consumables may result in cross contamination of samples through incomplete decontamination or from leakage through damaged O-Rings or Reed Valves.

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STANDARD OPERATING PROCEDURES FOR IN-SITU SAMPLING WITH THE MAXI SIMULPROBE

1.0 INTRODUCTION

The SimulProbe is an in-situ sampling device which allows the simultaneous collection of either in-situ soil gas with soil core or in-situ liquid with soil core. The purpose of the tool is to collect soil samples simultaneously with liquid or gas which are directly correlative and can be economically collected in one sampling event. The directly correlative nature of the fluids and solids provides more accurate interpretations about:

(1) The relationship between contaminant distribution and stratigraphic characteristics.
(2) The opportunity to compare contaminant concentration in gas and liquid with that found in directly correlative soil core.

2.0 DESCRIPTION

The SimulProbe (see schematic) is shaped much like a split spoon sampler, but has some distinct differences. A listing of the tool's important dimensions are presented below:

(1) 3.38 inches outside diameter (OD) along the length of the entire tool; excluding the cutting edge of the Drive Shoe.
(2) The inside diameter (ID) of the core barrel is 2.5 inches.
(3) The core barrel length is 18 inches.
(4) The Drive Shoe length is 3 inches.
(5) The 2 liter stainless steel water canister is a 19 inch long modular unit to the base unit.

3.0 OPERATION: Assembly and Operating Instructions for Soil/Soil Gas Mode Using Wire-Line Down-Hole Hammer (or Up-Hole Hammer) and Up-Hole Vacuum Pump

3.1 Place clean Teflon Tubes along the slots in the edges of the Core Barrel Primary Half and push Teflon Tubes into the fluid pathway holes at the top of the slots. The lower end of the Teflon Tubes should end about 1/4 inch short of the lower end of the slots.

3.2 Insert a Reed Valve into the Core Barrel Primary Half fluid displacement port at top of the core barrel.

3.3 Place a Blue O-Ring on the bottom of a Vent Cover and push the Nipple of the Vent Cover into the bottom of the Reed Valve.

3.4 Place Encapsulated Core Sleeves into the Core Barrel Primary Half.
Note:
(1) **Do not** use standard 6”-long core sleeves as they will not allow the SimulProbe Drive Shoe to fully close. (STI MaxiSimulProbe core sleeves are 5 and 13/16 inches long.)
(2) **Do Not** remove the core sleeve encapsulation. SimulProbe core sleeves come pre-encapsulated in a polyolifin shrink-wrap. The encapsulation helps to minimize cross contamination of the sleeves prior to and after use and prevents sand locking between the bottom core sleeve and the shoe sleeve.

3.5 Place the Core Barrel Cover Half over Core Barrel Primary Half, making sure that the Teflon Tubes are in the grooves between the core barrel halves.

3.6 Clamp the core barrel halves together using the chain vise on the driller’s breakdown rack. This allows the Coupling to be easily screwed into place.

3.7 Place the Circular Screen over circumferential channel and fluid entry ports at the bottom of core barrel. The circumferential channel is the channel on the outside of the core barrel halves just above the threads to which the Coupling is later attached.

3.8 Screw the Coupling onto the bottom of the core barrel, being careful to keep you fingers back from the sharp edges of the screen.

3.9 Place the Rust-colored O-Ring into the bottom of the Cover Sleeve and insert the Shoe Sleeve, male threads first, into the bottom (threaded end) of the Cover Sleeve. Attach this assembly to the bottom of the core barrel by screwing it into the Coupling. (See schematic)

3.10 Screw the Drive Shoe onto the bottom of the Cover Sleeve.

3.11 Screw the Sampler Head into the top of the Core Barrel Primary Half; making sure to place a Black O-Ring above the threads of the Sampler Head.

3.12 Wrap Teflon tape around the pipe threads of a 3/8” NPT x 1/4” Swagelok Connector and screw it into one of the ports on top of the Sampler Head. A 3/8” NPT Plug with Teflon tape should be placed in the second port.

3.13 Close the Drive Shoe and pull a Gooch Tube over the junction between the core barrel and the Drive Shoe. A Gooch Tube is a 2 inch piece of rubber tubing which is included in your soil gas (or groundwater) kit. The purpose of the Gooch Tube is to hold the Shoe in the closed position while the tool is lowered into the borehole.

3.14 Attach the down-hole end of a vacuum line to the Swagelok fitting on the top of Sampler Head; using a 3/16 inch ID, 1/4 inch OD Teflon line.

3.15 Attach the SimulProbe to a downhole hammer using a one-foot long AW rod and lower the SimulProbe to the bottom of the borehole.

3.16 Attach the up-hole end of the vacuum line to the vacuum pump intake.

3.17 For the drive and sniff mode, turn on the vacuum pump after driving the SimulProbe about 6 inches and use an OVM (or OVA) to monitor the vacuum pump exhaust. Hammer in the SimulProbe a total of 21 inches to collect the soil core sample, pausing where appropriate to “sniff” the vacuum pump exhaust with an OVM.

3.18 Pull SimulProbe back 1 to 2 inches to retract the sliding Drive Shoe and expose the Circular Screen.

3.19 Use vacuum pump to purge vacuum line and collect soil gas sample. The purging process is complete when the OVM readings stabilize, and the flow meter indicates that the specified purge volumes have been removed. The MaxiSimulProbe in the soil gas mode has a 200 ml purge volume. The 3/16” id Teflon line has a purge volume of 5.43 cc/ft.

3.20 Pull SimulProbe to surface for core retrieval, disassembly, and decontamination.

3.21 Preferably use SimulProbe wrenches to disassemble SimulProbe, except as noted below. (The wrenches are designed to maximize mechanical advantage and prevent damage.) The chain vise on the driller’s breakdown table may be used to hold the Cover Sleeve while removing the Drive Shoe and to hold the core barrel while removing the Coupling.

4.0 OPERATION: Assembly and Operating Instructions for Soil/Soil Gas Mode Using the Drive and Sniff Technique for Continuous and Discrete Soil Gas and Pressure Response Profiling of Soil Core

4.1 Follow assembly instructions as described in Section 3 above.

4.2 Drive the SimulProbe 4 to 6 inches below the bottom of the borehole so that the length of the drive shoe and the bottom edge of the core barrel are fully buried in the new geologic material.

4.3 Turn on the vacuum pump and purge the vacuum line until the OVM (or OVA) and vacuum pressure response readings stabilize and the flow meter indicates that sufficient volume has been purged. Then record OVM (or OVA), vacuum gauge pressure and flow meter response.

4.4 Repeat Step 3 as many time as necessary for the desired detail along the core length.

4.5 Remove the SimulProbe after it has penetrated 21 inches. Breakdown core barrel and compare geologic characteristics of the core to the OVM and pressure response logs.

5.0 OPERATION/Soil/Groundwater Mode <u>Modular Groundwater Canister</u> Assembly and Operating Instructions for Soil/Groundwater Mode Using Wire-Line Down-Hole Hammer, Modular Water Canister, and Ambient Hydrostatic Pressure

5.1 Follow Section 3.0 instructions (1) through (10) above (excluding Step 9).

5.2 Screw a Reed Valve Support, with o-ring, into the bottom of the Water Canister Base and attach silicone Reed Valve.

5.3 Place a black o-ring above the threads of the water canister base.

5.4 Screw the Water Canister Base into the top of the Core Barrel Primary Half.

5.5 Place a Black O-Ring above the threads at the bottom of the Water Canister and screw the Water Canister into the Water Canister Base.

5.6 Wrap Teflon tape around the threads of the Upper Reed Valve Support and screw it into the base of the Sampler Head.
5.7 Wrap Teflon tape around the threads of the Hex plug and screw it into the center of the Upper Reed Valve Support
5.8 Place a Black O-Ring above the Sampler Head's threads and screw the Sampler Head into the top of the Water Canister.
5.9 Close the Drive Shoe and pull a Rubber Gooch Tube over the junction between the core barrel and the Drive Shoe.
5.10 Push and snap Yellow Diaphragm (hydrostatic heads of 50 feet or less) into cutting edge of Drive Shoe. Use stainless steel Diaphragm for pressures greater than 50 feet of hydrostatic head. Then, place inside of drive shoe. If used, the stainless steel diaphragm is pushed onto the edge of a standard 2.5 inch sand catcher and placed behind the drive shoe.
5.11 Roll on latex Condom from shoe along length of probe. Be careful not to rest the weight of the probe on the Swagelok connector during this procedure. Place the second Gooch tube over the Condom; along the bottom of the drive shoe. This serves as a bumper to protect the Condom as the tool is lowered into the borehole.
5.12 Attach MaxiSimulProbe to one-foot AW rod. Be careful not to rest weight of probe on Condom covered shoe while attaching the AW rod and to the drive hammer.
5.13 Attach Teflon tube (pneumatic line) to Swagelok connector at top of probe.
5.14 Driller raises probe with winch line and lowers a few feet into casing.
5.15 Attach the up-hole end of spool to the inert gas tank regulator. The three way valve handle should be pointed towards regulator line.
5.16 With the probe suspended a few feet down inside the casing, pressurize the water canister. The rule of thumb for pressurizing is to assume 60 PSI/100 feet of hydrostatic head (pure water is approximately 43 PSI/100 feet; the additional pressure assumes suspended and dissolved solids and thus increased specific gravity). See attached tables from Groundwater and Wells, Driscoll, 1987. **Note: for safety, the SimulProbe should always be pressurized and depressurized inside the casing.**
5.17 Observe line pressure gauge on regulator. When line pressure is equal to 60 PSI/100 feet of hydrostatic head (0.6 PSI/ft), close 3-way valve on hose spool to trap pressure. Closed position is when the valve handle is at 90 degrees to 3-way valve's body. The 3-way valve is attached to the side of the hose reel and is the uphole terminus for the Teflon line. The line is attached to the center port on the "T" shaped valve. One of the two side ports is connected to the Nitrogen gas supply and the second is attached to a short (2.5') length of Teflon line. This short length is used for the inverted soda bottle method described in section 5.22. If the valve is positioned halfway between these two ports, which is 90 degrees to the 3-way valve's body, all three ports are closed to each other. Pointing the valve handle at either of the two side ports connects the central port to that side port.
5.18 Disconnect the Teflon line from the regulator and hook it onto the side of the spool.
5.19 Slowly lower the SimulProbe to the bottom of the borehole and hammer it 21 inches into subsurface to collect the soil core.
5.20 Pull the SimulProbe back 2 to 3 inches to retract the sliding Drive Shoe and expose the Circular Screen.
5.21 Open valve to allow pressure bleed off through the short length of Teflon tube attached to the valve.
5.22 Allow water to enter tool under ambient hydrostatic pressure. After the initial pressure bleed of, the fill rate can be observed by placing the open end of the Teflon tube into a bucket of water. For extremely slow fill rates, the end of the Teflon tube can be placed inside an inverted water filled bottle inside the bucket (i.e. one liter plastic soda bottle). When the bottle is full, it can be emptied and reused for additional volume measurements.
5.23 After sufficient water sample has been collected, repressurize the SimulProbe by following steps 15 through 18.
5.24 Pull the SimulProbe to a few feet below the top of the casing and depressurize. **Note: for safety, the SimulProbe should always be pressurized and depressurized inside the casing.**
5.25 Remove the SimulProbe from the casing and stand it vertically on ground.
5.26 To remove water canister, unscrew the Water Canister Base from the Core Barrel Primary Half (using spanner wrenches). Keep the Water Canister upright to minimize sample agitation, and insert a short length of 5/16-inch OD Teflon tube through the bottom of the Reed Valve to drain and collect a water sample from the bottom of the Water Canister.
5.27 Disassemble the core barrel using SimulProbe wrenches and remove the soil core.

6.0 OPERATION: Assembly and Operating Instructions for Soil/Groundwater Mode Using Wire-Line Down-Hole Hammer, Modular Water Canister and Vacuum Assist

Instructions are the same as above with the additional step of using a peristaltic or vacuum pump to lift water into the water canister. Vacuum assist is not recommended when sampling for volatile compounds.

7.0 OPERATION: No Modular Water Canister Required Soil/Groundwater Mode Using Peristaltic Pump to Pump Groundwater to Surface

This is a shallow (less than 25 feet) groundwater sampling technique for non-VOC sample collection. There is no Water Canister required when it is thought that the formation permeability is sufficient to allow water to be drawn through a peristaltic pump.

The peristaltic pump technique will only work if the piezometric water level of the formation being sampled is 25 feet or less below the ground surface. Note: Suspended and dissolved solids will increase the fluid specific gravity and thus reduce the effective depth range of a peristaltic pump.

8.0 OPERATION: Assembly and Operating Instructions for Using Soil/Groundwater Mode Using Up-Hole Hammer, Hollow NW Rods and Sample Bailer

8.1 Assemble the SimulProbe as in Section 7.0.

8.2 Attach a hollow NW rod to the top of the SimulProbe using a hollow NW/AW pin converter. This will allow fluids to pass through the Upper Reed Valve port at the bottom of the Sampler Head and into the hollow NW rods for collection by bailer.

8.3 Lower the SimulProbe to the bottom of the borehole, adding more NW rods as needed. **Use O-rings or Teflon paste between NW rod connections to prevent cross contamination from borehole fluids.**

8.4 Drive the SimulProbe 21 inches using an up-hole hammer on the top of the NW rod string.

8.5 Retract the SimulProbe 2 to 3 inches to expose the Circular Screen. The water sample will flow into the hollow NW rods.

8.6 Lower a decontaminated water level sensor inside the NW rods to determine when there is enough water to collect a sample.

8.7 Collect the water sample using a Teflon bailer.

8.8 Withdraw the SimulProbe and collect the soil core sample.

9.0 OPERATION: Assemble and Operating Instructions for Using Soil/Groundwater Mode Using Up-Hole Hammer, NW Rods/Bailer and Peristaltic Pump

The NW Rods/Bailer and Peristaltic Pump water sampling methods can be combined when sampling protocols include the collection of samples for volatile compounds and the sampled formations have shallow (<25' BGS) piezometric water levels.

9.1 Follow the instructions for sampling using hollow NW rods and a bailer, except add a peristaltic vacuum line to the Swagelok fitting on top of the Sampler Head.

9.2 Once the SimulProbe has been hammered into place and opened, the first sample should be collected by bailer for volatile compounds.

9.3 Subsequent samples can then be collected by peristaltic pump.

10. [ST1]DECONTAMINATION

Follow procedures specified in site specific work plan and/or quality assurance project plan for standard operating procedures for sampling device decontamination. Always use a new consumable kit for each sample. Reuse of consumables may result in cross contamination of samples through incomplete decontamination or from leakage through damaged O-Rings and Reed Valves.

STANDARD OPERATING PROCEDURES FOR THE SIMULPROBE ENVIRONMENTAL CORE BARREL

1.0 INTRODUCTION:

The SimulProbe Core Barrel is the first true environmental split spoon sampler which can be easily operated by wire line in cased hole or mud rotary drilling. This allows the investigator to collect soil samples with no cross contamination from boring fluids or sluff zone soils and, in the case of air drilling methods, to collect the soil sample from below the air dilution zone.

2.0 ASSEMBLY:

2.1 Place a set of SimulProbe Encapsulated Core Sleeves (Note: Standard 6" core sleeves will not fit.) into the Core Barrel Base Half and slide them down far enough to allow a short (nonencapsulated) sleeve to be dropped in at the top of the Core Barrel Base Half. This short sleeve is where the SimulProbe Latch Activated Tip (SPLAT) will be held when you have collected a soil core. Note that the encapsulated set consists of four long sleeves and one short. They may be placed with the encapsulated short sleeve at the top or bottom, depending on your specific requirements for sample volume.

2.2 Lay the Core Barrel Cover Half on top of the Core Barrel Base Half and slide the two halves snugly together.

2.3 Make sure the guide pins are aligned with their corresponding holes as you slide the split halves together. If you are having difficulty getting the split halves to seat the last little bit (1/4 inch), you can screw the Shoe Sleeve onto the bottom end of the Core Barrel Base Half and drop the probe, Shoe Sleeve first, about 3 inches onto a wooden, plastic or other REASONABLY SOFT surface. (Do not drop the probe onto a hard surface such as concrete as this may damage the metal on the bottom edge of the Shoe Sleeve.

2.4 Screw the Core Barrel Head into the top of the SimulProbe Core Barrel.

2.5 Pull a Rubber Wiper Seal on to the bottom end of the Core Barrel Base Half. The Rubber Wiper Seal should be seated in the groove just above the threaded area. The cup of the Rubber Wiper Seal must face up. (If it is faced the wrong direction, you will be unable to slide on the Cover Sleeve.

2.6 Slide the Cover Sleeve over the Rubber Wiper Seal.

2.7 Screw the Shoe Sleeve on to the bottom end of Core Barrel Base Half behind the Rubber Wiper Seal. The Shoe Sleeve will trap the Cover Sleeve onto the SimulProbe Core Barrel.

2.8 If the SimulProbe Latch Activated Tip (SPLAT) is to be used, pull the Drive Point away from the Point Base, spreading the Retractors fully out and set the Retractors into the ledge at the end of the Shoe Sleeve. (The SimulProbe Core Barrel should be resting on the Core Barrel Head and pointing straight up. Lift the Cover Sleeve up until it is stopped by the Shoe Sleeve and the lower the Drive Shoe over the SPLAT. While continuing to hold the Cover Sleeve up, screw the Drive Shoe onto the Cover Sleeve and then push the Shoe/Cover Sleeve assembly down and into the fully closed position.
If the SPLAT is not to be used, (cased hole applications only) simply screw the Drive Shoe onto the Cover Sleeve.

2.9 Slide a Gooch Tube over the circumferential seam between the top of the Cover Sleeve and the bottom of the SimulProbe Core Barrel. (Both the SimulProbe Core Barrel and the technician's gloves should be dry. Water lubricates the Gooch Tube and thus reduces its ability to hold the Drive Shoe/Cover Sleeve assemble in the closed position.) Push the tip of the SPLAT into the Drive Shoe. The shoulder of the tip should match the edge of the Drive Shoe or extend slightly beyond the edge of the Drive Shoe. If the Drive Tip can be pushed in so that its shoulder sits deeper than the edge of the Drive Shoe, it is likely that the Retractors have released. Go back to step 12 and reset the SPLAT.

2.10 If the sampler is to be used with mud rotary drilling or with cased hole drilling methods below first water, the outside of the tool should be covered with a Condom to prevent cross contamination from borehole fluids. To place the Condom on the SimulProbe Core Barrel, hold a pinch of rubber from the end of the Condom and then roll the Condom over the sampler using your other hand. A second Gooch Tube should be placed over the edge of the shoe. This acts as a bumper to protect the Condom while the SimulProbe Core Barrel is being lowered through the drive casing.

3.0 DISASSEMBLY INSTRUCTIONS:

3.1 Unscrew the SimulProbe Core Barrel from the AW pin or rod.
3.2 Unscrew the Core Barrel Head from the core barrel assembly.
3.3 Insert a large regular screw driver blade into the slot near the top of the SimulProbe Core Barrel assembly and rotate the blade. This will separate the two core barrel halves.
3.4 Remove the soil core and process it according to your sample protocols. If the bottom sleeve is difficult to remove, it can be pushed out from the bottom by removing the Shoe Sleeve and pushing up from the bottom with an empty core sleeve. If the SPLAT has been used, it will be in the top sleeve at the top of the soil core.
3.5 Use the two large Proto wrenches from the tool kit to remove the Drive Shoe from the Cover Sleeve. NEVER use a pipe wrench on the Cover Sleeve. The pipe wrench will distort the shape of the Cover Sleeve.
3.6 Remove the Shoe Sleeve from the Core Barrel Base Half, using the small Proto wrench from the tool kit. Note: If you use a pipe wrench on the Shoe Sleeve, it will be necessary to file off any resulting tooth marks off before Shoe Sleeve can be used again.

4.0 DECONTAMINATION

Follow procedures specified in site specific work plan and/or quality assurance project plan for standard operating procedures for sampling device decontamination. A new consumable kit should be used for each sample unless otherwise specified in the work plan. Reuse of consumables may result in cross contamination of samples through incomplete decontamination or from leakage through damaged O-Rings or Reed Valves.

5.0 OPERATION: Direct Push Drilling:

5.1 Assemble the SimulProbe Core Barrel as per assembly SOPs. Do not use the Condom.
5.2 Attach the SimulProbe Core Barrel to the end of the push rod. You will need to use a adapter sub if your push rods do not use AW threads.
5.3 Push to the beginning of the interval that you wish to sample and stop.
5.4 Pull the rods and attached SimulProbe Core Barrel back 2 to 3 inches.
3.17Drive forward 27 inches and then pull the tool back to the surface to retrieve the core. Do not overdrive the SimulProbe Core Barrel. Over packing the SimulProbe Core Barrel, as with any split spoon sampler, may make disassembly very difficult.

6.0 OPERATION: Mud Rotary Drilling:

6.1 Using a system with a hollow coring bit, drill to within two feet of the interval which you wish to sample and pull the coring tool back to the surface.
6.2 Attach the SimulProbe Core Barrel, with a Condom, to a five foot section of AW rod and attach the rod to the anvil of a narrow wire line hammer. (300 lb. hammer is recommended)
6.3 Lower the SimulProbe Core Barrel to the bottom of the boring, carefully mark the cable, and begin driving the Sampler. DO NOT backhammer while driving, as this may release the SPLAT prematurely.
6.4 Drive the SimulProbe Core Barrel at least 18 inches before releasing the SPLAT. This will usually be deep enough to get out of the infiltration zone.
6.5 Release the SPLAT by back hammering about 2 to 3 inches.
6.6 Drive forward 27 inches and then pull the tool back to the surface to retrieve the core. Do not overdrive the SimulProbe Core Barrel. Over packing the SimulProbe Core Barrel, as with any split spoon sampler, may make disassembly very difficult. If you use Encapsulated Core Sleeves, the only portion of the core cross contaminated with drilling mud should be the soil in the Drive Shoe.

7.0 OPERATION: Cased Hole Drilling Methods:

7.1 Drill to the interval which you wish to sample and pull the bit (if any) to the surface. In vadose zone sampling with air drilling methods, consider stopping about two feet short of the intended sampling zone to avoid air stripping the sample.

7.2 Attach the SimulProbe Core Barrel (If below first water, use a Condom to prevent cross contamination from borehole water) to a five foot section of AW rod and attach the rod the anvil of a narrow wire line hammer. (300 lb. hammer is recommended)

7.3 Lower the SimulProbe Core Barrel to the bottom of the boring, carefully mark the cable, and begin driving the Sampler. DO NOT backhammer while driving, as this may release the SPLAT prematurely.

7.4 Drive the SimulProbe Core Barrel to the intended sampling interval and release the SPLAT by back hammering about 2 to 3 inches.

7.5 Drive forward 27 inches and then pull the tool back to the surface to retrieve the core. Do not overdrive the SimulProbe Core Barrel. Over packing the SimulProbe Core Barrel, as with any split spoon sampler, may make disassembly very difficult. If you use Encapsulated Core Sleeves, the only portion of the core cross contaminated with borehole water should be the soil in the Shoe.

STANDARD OPERATING PROCEDURES FOR THE MINI SIMULPROBE

1.0 INTRODUCTION:

The following discussion reviews the assembly, disassembly and operational procedures for the MiniSimulProbe in the soil/soil gas and the soil/groundwater modes. One point of note is that there are three basic O-ring sizes when using the MiniSimulProbe in all operations. Through the course of the document these are referred to as small, medium and large or, sometimes, as smallest, medium and largest.

2.0 SPLAT SYSTEM:

The SimulProbe Latch Activated Tip (SPLAT) is a drive tip which enables the MiniSimulProbe to be driven without collecting a soil sample until the desired depth has been reached. To release the SPLAT, the operator simply pulls the tool back about 1/2 inch. The MiniSimulProbe is then driven 15 inches to collect a core. The SPLAT is recovered at the top of the soil core.

The SPLAT is always used with direct push drilling to allow the tool to be pushed to the desired interval before collecting a soil sample and with mud rotary drilling to prevent cross contamination of the samples with drilling mud. The SPLAT may also be used in cased hole applications; to eliminate sluff from the soil sample, to minimize the risk of cross contaminating the soil sample with sluff or borehole fluids, or to drive several feet ahead of the bottom of the borehole before collecting a sample. It is also recommended that the SPLAT be used with air drilling methods in order to get beyond the air dilution rind in order to collect more representative samples.

3.0 ASSEMBLY SOIL AND SOIL GAS MODE:

3.1 Place the Teflon Tubes from a MiniSimulProbe soil gas kit into the grooves along the edges of the Split Barrel Primary Half, inserting the ends of tubes into the shallow holes at the lower end of the Split Barrel Primary Half.

3.2 Insert a reed valve into the top of the Split Barrel Primary Half

3.3 Place a set of SimulProbe encapsulated core sleeves (Note: Standard 6" core sleeves will not fit.) into the Split Barrel Primary Half and slide them down far enough to allow a short sleeve to be dropped in at the top of the core barrel. This short sleeve is where the SimulProbe Latch Activated Tip (SPLAT) will be held when you have collected a soil core. Note that the encapsulated portion of the set consists of two long sleeves and a short sleeve. They may be placed with the encapsulated short sleeve at the top or bottom, depending on your specific requirements for sample volume.

3.4 Lay the Split Barrel Cover Half on top of the Split Barrel Primary Half and slide the two halves loosely together, guiding the upper ends of the Teflon Tubes into the two holes at the top of the Split Barrel Cover Half . Snug the split halves together.

3.5 Make sure the guide pins are aligned with their corresponding holes as you slide the split halves together. If you are having difficulty getting the split halves to seat the last little bit (1/4 inch), you can screw the Shoe Sleeve onto the bottom end of the core barrel and drop the probe, Shoe Sleeve first, about 3 inches onto a wooden, plastic or other REASONABLY SOFT surface. (Do not drop the probe onto a hard surface such as concrete as this may damage the metal on the bottom edge of the Shoe Sleeve.)

3.6 Place the largest and the mid sized O-rings from a MiniSimulProbe Soil Gas kit into the grooves located on either side of the four fluid ports on the bottom of the Valve Head.

3.7 Screw the Valve Head into the top of the core barrel. Make certain that the Valve Head screws in completely so that its O-rings are fully seated against the top of the core barrel and the two split barrel halves are fully shouldered together.

3.8 Place a Conical Screen over the intake ports on the lower end of the MiniSimulProbe. (First remove the Shoe Sleeve if you used the drop method to seat the core barrel halves together.)

3.9 Screw a Teflon Ring on to the bottom end of the Split Barrel Primary Half.

3.10 Slide the Cover Sleeve over the Teflon Ring and the Conical Screen.

3.11 Screw the Shoe Sleeve on to the bottom end of Split Barrel Primary Half behind the Teflon Ring. The Shoe Sleeve will trap the Cover Sleeve onto the MiniSimulProbe.

3.12 If the SimulProbe Latch Activated Tip (SPLAT) is to be used, pull the Drive Point away from the Point Base, spreading the Retractors fully out and set the Retractors into the ledge at the end of the Shoe Sleeve. (The core barrel should be resting on the Valve Head and pointing straight up. Lift the Cover Sleeve up until it is stopped by the Shoe Sleeve and the lower the Drive Shoe over the SPLAT. While continuing to hold the Cover Sleeve up, screw the Drive Shoe onto the Cover Sleeve and then push the Shoe/Cover Sleeve assembly down and into the fully closed position.
If the SPLAT is not to be used, (cased hole applications only) simply screw the Drive Shoe onto the Cover Sleeve.

3.13 Slide a Gooch tube over the circumferential seam between the top of the Cover Sleeve and the bottom of the core barrel. (Both the MiniSimulProbe and the technician's gloves should be dry. Water lubricates the Gooch tube and thus reduces its ability to hold the Shoe/Cover Sleeve assemble in the closed position.) Push the Drive Tip of the SPLAT into the Drive Shoe. The shoulder of the Drive Tip should match the edge of the Drive Shoe or extend slightly beyond the edge of the Drive Shoe. If the Drive Tip can be pushed in so that its shoulder sits deeper than the edge of the Drive Shoe, it is likely that the Retractors have released. Go back to step 12 and reset the SPLAT.

3.14 Wrap Teflon tape around the threads of a 1/8" NPT x1/4 Swagelok Fitting and TIGHTLY screw the fitting into a Valve Head Insert. Place the smallest O-ring from a MiniSimulProbe Soil Gas Kit onto the groove around the outside edge of the Valve Head Insert. If the Teflon soil gas line is to be run inside hollow rods between the surface and the top of the MiniSimulProbe, the line should be pre-threaded through all of the rods and the final AW Pin or AW pin adapter at this time.

3.15 Cut a short length (1/4 inch) from the end of the Teflon soil gas line (removes any rust which may have collected in the end of the line as it was being pushed through the rods) and insert the line into the end of Swagelok Fitting with brass ferrules preset on the inside of the fitting. Tighten the nut on the Swagelok Fitting by exactly one and one quarter turns to crush its ferrules into the soil gas line. If this same line and ferrule set is used for subsequent samples, the nut should only be snugged tight with a wrench.

3.16 Push the Valve Head Insert into the bottom of the AW threads in the Valve Head and screw the Valve Head onto the AW Pin or AW adapter. This will seat the Valve Head Insert. Note: Use a slotted AW Pin if the Soil Gas Line is not to be run inside of hollow rods.

3.17 Push the Drive Tip up into the end of the Drive Shoe.

4.0 MUD ROTARY METHOD:

4.1 Follow assembly steps 1 to 13 above. What follows is the assembly description for using a Water Canister as an extension rod for soil gas sampling in a mud boring. A MiniSimulProbe Groundwater Kit is required for this method.

4.2 Wrap Teflon tape around the threads of a 1/8" NPT x1/4 Swagelok Fitting and TIGHTLY screw the fitting into a Bottom Reed Valve Support. Place a small O-ring from a MiniSimulProbe Groundwater Kit onto the groove on the bottom of the Reed Valve Support and screw it into a Water Canister Base.

4.3 Place a small O-ring from a MiniSimulProbe Groundwater Kit onto the groove on the bottom of the Water Canister Base's AW threads. Place a large O-ring from the Groundwater Kit onto the groove on the top edge of the Water Canister Base.

4.4 Place a large O-ring from a groundwater kit onto the groove on the bottom of a Water Canister Sampler Head.

4.5 Starting from the top and working down, thread the Teflon soil gas line through all of the rods, the final AW pin, the Water Canister Sampler Head, and a one liter size Water Canister. Screw the AW pin, the Water Canister Sampler Head and the Water Canister together.

4.6 Cut a short length (1/4 inch) from the end of the Teflon soil gas line (removes any rust which may have collected in the end of the line as it was being pushed through the rods) and insert the line into the end of Swagelok Fitting with brass ferrules preset on the inside of the fitting. Tighten the nut on the Swagelok Fitting by exactly one and one quarter turns to crush its ferrules into the soil gas line. If this same line and ferrule set is used for subsequent samples, the nut should only be snugged tight with a wrench.

4.7 Screw the Water Canister assembly onto the Water Canister Base. Turn the Water Canister, not the Water Canister Base so as not to twist the soil gas line.

4.8 Screw the MiniSimulProbe onto the bottom of the Water Canister Base, turning the MiniSimulProbe, not the Water Canister Base.

4.9 Push the Drive Tip up into the end of the Drive Shoe.

4.10 Roll a Condom over the tool from the Drive Shoe end.
4.11 Place a Gooch Tube over the bottom of the Condom.

5.0 ASSEMBLY FOR SOIL/GROUNDWATER MODE: PERISTALTIC PUMP METHOD

Groundwater samples can be collected from the MiniSimulProbe using several methods. In general, the MiniSimulProbe should be assembled as per the instructions for the Soil/Soil Gas mode, steps 1 through 13; with the additional steps described in subsequent sections.

5.1 The MiniSimulProbe should be assembled as described in the Soil/Soil Gas assembly directions. The soil gas sample line is used to draw the water sample to the surface. This method can be used with either direct push or cased hole drilling methods. Note: This method will only work when the peizometric surface of the water in the formation to be sampled is less than 25 feet below ground surface. If the water is highly turbid, the suspended solids will increase the specific gravity of the water and can reduce the effective depth to as little as 10 feet below ground surface.
5.2 Attach the MiniSimulProbe to a downhole hammer as per the SOP for collecting soil gas samples.
5.3 This method may not be appropriate if the analytes of interest are volatile substances. The vacuum created by the Peristaltic Pump may pull such analytes out of solution.

6.0 ASSEMBLY FOR SOIL/GROUNDWATER MODE: WATER CANISTER METHOD

6.1 The MiniSimulProbe should be assembled as described in the Soil/Soil Gas assembly directions, steps 1 through 13.
6.2 Place one of the small O-rings from a MiniSimulProbe Groundwater Kit around the groove located at the bottom of the Water Canister Base's male AW threads.
6.3 Place a O-ring from a MiniSimulProbe Groundwater Kit into the groove located at the top edge of the Water Canister Base.
6.4 Place one of the small O-rings at the top of the threads of the Bottom Reed Valve Support and screw it into the top of the Water Canister Base. Snug the Reed Valve Support into place with a wrench. (If it is only hand tightened, it can vibrate loose when the MiniSimulProbe is driven with a rapid fire (vibratory) type of hammer.)
6.5 Screw the Water Canister Base onto one end of the Water Canister.
6.6 Place one large O-ring around each of the two O-ring grooves of the Mini-Head Insert. Wrap Teflon tape around the threads of a Swagelok Fitting and TIGHTLY screw the fitting into a Mini-Head Insert. If the Teflon Nitrogen Gas Line is to be run inside hollow rods between the surface and the top of the MiniSimulProbe, the line should be pre-threaded through all of the rods and the final AW Pin or AW pin adapter at this time.
6.7 Place one of the large O-rings in the groove on the bottom of the Water Canister Sampler Head and screw it into the top of the Water Canister.
6.8 Push the Mini-Head Insert into the top of the Water Canister Sampler Head and seat it into place by screwing the AW Pin in on top of the Mini-Head Insert.
6.9 Screw the assembled MiniSimulProbe's Valve Head onto the bottom of the Water Canister Base. (Make sure the o-ring on the end of the Water Canister Base's threads is in place.)
6.10 If the water sample is to be collected from a cased hole with standing borehole water or a mud boring, the outside of the MiniSimulProbe should be covered by a MiniSimulProbe Condom. This prevents cross-contamination of the water or soil sample with borehole fluids. Then, a Gooch Tube should be placed around the bottom end of the condom to serve as a bumper for the Condom as the probe is lowered into the casing.

7.0 ASSEMBLY FOR SOIL/GROUNDWATER MODE: ROD AND BAILER METHOD

7.1 Assemble the MiniSimulProbe as per the soil and soil gas assembly SOP, omitting the Valve Head Insert, Swagelok Fitting and Soil Gas Line.
7.2 Attach the MiniSimulProbe to a hollow AW pin (not slotted) and seal the junctions between the AW pin and MiniSimulProbe and between the AW pin and AW rods with O-rings. (Additional O-rings available on request.)

7.3 Attach the MiniSimulProbe to hollow AW rods and use an uphole hammer to drive the tool.

7.4 If the water sample is to be collected from a cased hole with standing borehole water or a mud boring, the outside of the MiniSimulProbe should be covered by a MiniSimulProbe Condom. This prevents cross-contamination of the water or soil sample from borehole fluids as the tool is being lowered to the bottom of the boring.

8.0 DISASSEMBLY & SAMPLE RETRIEVAL: SOIL GAS MODE:

8.1 Unscrew the MiniSimulProbe from the AW pin or rod.

8.2 Unscrew the Valve Head from the core barrel assembly. Pull the Valve Head Insert out.

8.3 Insert a large regular sc5rew driver blade into the slot near the top of the core barrel assembly and rotate the blade. This will separate the two core barrel halves.

8.4 Remove the soil core and process it according to your sample protocols. If the bottom sleeve is difficult to remove, it can be pushed out from the bottom by removing the Shoe Sleeve and pushing up from the bottom with an empty core sleeve. If the SPLAT has been used, it will be in the top sleeve at the top of the soil core.

8.5 Use the two large Proto wrenches from the tool kit to remove the Drive Shoe from the Cover Sleeve. NEVER use a pipe wrench on the Cover Sleeve. The pipe wrench will distort the shape of the Cover Sleeve.

8.6 Unscrew the Teflon Ring. If it can’t be removed by hand, grasp the edge of the ring with a pair of needle nose pliers and pull with a force parallel to the ring’s threads. This will allow you to unscrew the ring without damaging its outer surface. DO NOT use a pipe wrench or similar tool to unscrew the Teflon Ring. This will ruin the ring by deeply marring its surface.

8.7 Slide the Conical Screen off and discard it. If the Screen is difficult to remove, it can be torn off by grasping it with a pair of needle nose pliers.

9.0 DISASSEMBLY & SAMPLE RETRIEVAL: GROUNDWATER MODE:

9.1 If the Nitrogen Gas pressure system has been used, bleed off the residual pressure before removing the MiniSimulProbe from the borehole. **Note: For safety, the SimulProbe should always be pressurized and depressurized inside the casing/drill string or soil boring.**

9.2 Unscrew the MiniSimulProbe from the rod, leaving the AW pin on the Water Canister Sampler Head. Carry the probe UPRIGHT to the sample collection area. Disconnect the Water Canister Base from the Valve Head. This portion should be disassembled as per the Soil Gas Mode instructions above.

9.3 To Collect a water sample, insert a short length of Teflon Tube into the bottom of the Water Canister Base and up through the Reed Valve. The sample will flow out of the tube. Flow rate can be controlled simply by crimping the tube. If the sample flows too slowly, loosen or remove the Water Canister Sampler Head from the top of the Water Canister. A water sample may also be collected with a water sampling syringe by inserting the needle through the bottom of the Reed Valve and withdrawing the sample.

9.4 After the water sample has been collected, remove the Water Canister Base from the Water Canister and unscrew the Reed Valve Support from the top of the Waster Canister Base. Remove and discard the reed valve and o-rings.

9.4 Remove the AW pin from the Water Canister Sampler Head and push the Mini-Head Insert out by pushing up from the bottom. Disconnect the Nitrogen Gas line and discard the O-rings.

10.0 DECONTAMINATION:

Follow procedures specified in site specific work plan and/or quality assurance project plan for standard operating procedures for sampling device decontamination. A new consumable kit should be used for each sample unless otherwise specified in the work plan. Reuse of consumables may result in cross contamination of samples through incomplete decontamination or from leakage through damaged O-Rings or Reed Valves.

11.0 OPERATION: SOIL/SOIL GAS MODE USING DIRECT PUSH DRILLING METHODS

11.1 Assemble the MiniSimulProbe in the Soil/Soil Gas Mode with the SPLAT, as per Assembly sop’s.

11.2 Thread a 1/4" OD, 3/16" ID Teflon soil gas line through enough drive rods to reach the maximum anticipated depth for this particular sampling event. (Note: Pure Teflon tubing is preferable to Teflon lined tubing because of the lined tubing's tendency to kink when bent.)
11.3 Thread the soil gas sample line through the AW adapter pin which is applicable to your particular direct push apparatus and screw the pin into the end of the first drilling rod.
11.4 Attach the end of the sampling line to the Swagelok Fitting and attach the MiniSimulProbe as described in the MiniSimulProbe Assembly sop for soil gas sampling.
11.5 Screw a slotted drive head on top of the first drive rod. The Teflon line will extend out through the slot while you are screwing in the drive head. Hold the line so that it does not become twisted. (The slot on the drive head will rotate relative to the Teflon line, but the Teflon line should not be allowed to rotate relative to the MiniSimulProbe and the drive rod.)
11.6 Attach the drive head, drive rod and MiniSimulProbe to the direct push drilling rig.
11.7 Check the SPLAT to be certain that it cannot be pushed up inside of the shoe, and lower the MiniSimulProbe into position with the Drive Tip resting on the soil surface.
11.8 Attach the uphole end of the Teflon soil gas line to a flow gauge equipped soil gas pump.
11.9 Begin driving the MiniSimulProbe into the soil.
11.10 If you are using the Drive and Sniff method, the first sniff can take place once the MiniSimulProbe has been driven at least 6 inches into the soil. The sniff samples can be pulled at any frequency desired, but a recommended frequency is every five feet or at every change of pushing resistance.
11.11 To collect a sniff sample, stop the drive, purge 3 to 5 soil gas volumes, and screen the vacuum pump with the contaminate appropriate screening device or devices. Do not pull the MiniSimulProbe back for a sniff sample, as this will release the tip. The sniff sample is collected through the circumferential seam only.
11.12 After each drive rod has been pushed into the ground, unscrew the slotted drive head from the rod, and screw on the next segment of drive rod. Be careful to prevent the Teflon line from twisting relative to the MiniSimulProbe during this process.
11.13 Attach the slotted drive head to the top of the new section of drive rod and continue to advance the MiniSimulProbe.
11.14 When you have reached an interval where you wish to collect a soil sample, stop and remove the slotted drive head and attach a slotted pull bail. As before, do not allow the Teflon line to rotate with either slotted device. (Note: The specific mechanism for pulling back on the drive rod varies from one direct drive system to another. Consult the drill operator and or manufacturer for specific details.)
11.15 Pull the drive rod and attached MiniSimulProbe back 1/4" (1 cm) to release the SPLAT.
11.16 Reattach the slotted drive head and drive forward 15" to collect a soil core.
11.17 Pull the drive rod and MiniSimulProbe back about 1/2" to expose the screen and collect a soil gas sample as per site specific sop's. This should include purging 3 to 5 MiniSimulProbe and Teflon line volumes, 30 cc and 5.43 cc/ft, respectively)
11.18 Pull the drive rods and MiniSimulProbe back to the surface. If you intend to reuse the Teflon line, be careful not to twist the Teflon line as you remove the rods.
11.19 Disassemble the MiniSimulProbe as per the disassembly Sops.

12.0 OPERATION: SOIL/SOIL GAS MODE USING CASED HOLE DRILLING METHODS

12.1 Assemble the MiniSimulProbe in the Soil/Soil Gas Mode without the SPLAT, as per Assembly sop's.
12.2 Attach the MiniSimulProbe to a slotted AW pin with the Teflon soil gas sampling line extending out the slot.
12.3 Attach the MiniSimulProbe to the drill rig's wire line hammer by rotating the hammer as the AW pin is threaded into the hammer's bottom. (It is easier to rotate the hammer than to rotate the MiniSimulProbe and Teflon line reel together.) Note: the wire line hammer must be attached to the rig's cable with a bearing type swivel. This minimizes twisting problems with the cable and the Teflon soil gas line on deeper sampling events.
12.4 Use several plastic wire ties to secure the Teflon line to the anvil portion of the hammer. Tighten the wire ties enough to hold the Teflon line in place, but do not crush the Teflon line. Duct tape works particularly well for this purpose, if permitted by project specific requirements.
12.5 Lower the SimulProbe into the borehole, being careful not to pinch the Teflon soil gas line between the top of the drive casing and the bottom of the hammer.

12.6 Maintain slight tension on the Teflon soil gas sample line as the MiniSimulProbe is lowered to the bottom of the borehole and as it is driven into the subsurface with the downhole hammer.
12.7 Mark the cable and drive the MiniSimulProbe a total of 18 inches into the formation.
12.8 Pull the MiniSimulProbe back 1/2 inch to expose the Conical Screen and connect the Teflon soil gas sample line to a vacuum pump.
12.9 Purge 3 to 5 Teflon line and MiniSimulProbe volumes of gas from the system prior to soil gas screening or sample collection. The volume of 3/16" ID tubing is 5.43 cc/ft. The purge volume of the MiniSimulProbe is 30 cc.
12.10 Disconnect the Teflon soil gas sample tubing from the vacuum pump and pull the MiniSimulProbe back to the surface. If you intend to reuse the tubing, it should be reeled up at the same rate as the MiniSimulProbe to prevent kinking.
12.11 Disassemble the MiniSimulProbe as per disassembly sop's and collect the soil sample.
12.12 If your sampling protocols allow the Teflon soil gas sample tubing to be reused, it should be purged with ambient air or an inert gas such as nitrogen. If the inside of the tubing is wet, it should be purged until completely dry.

13.0 OPERATION: SOIL/SOIL GAS MODE / MUD ROTARY INTRODUCTION:

SimulProbe soil gas sampling with mud rotary offers the benefits of mud rotary drilling, low cost, electronic logging, etc., with the technical advantages of soil/soil gas SimulPhasic samples. The method for this unusual sampling approach is to use the SPLAT to drive well beyond the mud infiltration zone before attempting to collect samples.

13.1 Assemble the MiniSimulProbe with water canister assembly used as an extension as per section 4 of this SOP.
13.2 Attach the MiniSimulProbe to a wireline (downhole) hammer and secure the Teflon Soil Gas Line to the side of the hammer's anvil using two or three plastic tie wraps (or duct tape, if permitted on the site). A 300 LB hammer is recommended to overcome the viscosity and bouancy effects of the drilling mud on the hammer's movement. The Hammer should have at least 0.5 inches of clearance inside of the drill rod to allow space for the Teflon line.
13.3 Lower the MiniSimulProbe slowly down the inside of the drill string while maintaining a small amount of tension on the Teflon line as it is reeled out. It is important that slack Teflon line not be allowed to enter the borehole. (Extra Teflon line can become tangled on the hammer.) If you think that extra tubing has entered the borehole, do not be afraid to pull up on the line. The Swagelok fitting connection will withstand significant amounts of tugging.
13.4 When you reach the bottom of the borehole, carefully mark the Hammer cable to measure the drive distance.
13.5 Begin driving the MiniSimulProbe. It is very important that the operator does not backhammer (lifting the hammer so far that it pulls the tool back at the top of the hammer stroke) while driving the MiniSimulProbe. Back hammering may cause the SPLAT to release prematurely.
13.6 Stop when you have driven the MiniSimulProbe at least 2.5 feet; although drive distances of 3 to 4 feet are recommended. This decreases the chance of mud leakage along the micro-annulus. An AW rod may be used to extend the drive distance. This will keep the hammer inside of the drill string. Backhammer the MiniSimulProbe about 1/2 inch to release the SPLAT.
13.7 Drive forward 15 inches to collect a soil core.
13.8 Pull the MiniSimulProbe back 1/2 inch to expose the screen.
13.9 Purge 3 to 5 volumes of gas from the system prior soil gas screening or sample collection. The volume of 3/16" ID tubing is 5.43 cc/ft. The purge volume of the MiniSimulProbe is 30 cc. Collect the soil gas sample.
13.10 Disconnect the Teflon soil gas sample tubing from the vacuum. If you intend to reuse the tubing, it must be pressurized to keep boring mud out while the MiniSimulProbe is being retrieved to the surface. Use a Nitrogen gas tank and regulator to pressurize the line to greater than borehole pressures before pulling it out of the formation. A good rule of thumb is about .75 PSI per foot of drilling mud. Once the tool is in the mud, the gas supply should be cut off, the valve on the reel closed and the line disconnected from the regulator. The excess pressure in the line will bleed off as the tool is withdrawn through the borehole. Be

careful to reel up the line at the same rate as the MiniSimulProbe is being lifted in order to prevent kinking of the line.

13.11 When the MiniSimulProbe reaches the surface, open the valve on the tube reel to be certain that all of the line pressure has bled off during the trip up the borehole. This should be done prior to disassembly.

13.12 Disassemble the MiniSimulProbe as per disassembly Sop's and collect the soil sample.

13.12 If your sampling protocols allow the Teflon soil gas sample tubing to be reused, it should be purged with ambient air or an inert gas such as nitrogen. If the inside of the tubing is wet with condensation, it should be purged until completely dry. If it is wet with boring mud, consider discarding the wet section. The mud may adsorb contaminates from the soil gas in subsequent samples.

14.0 OPERATION: SOIL/GROUNDWATER SAMPLING / DIRECT PUSH

14.1 Assemble the MiniSimulProbe in the Soil/Groundwater Mode with the SPLAT, as per Assembly sop's.

14.2 Thread a 1/4" OD, 3/16" ID Teflon soil gas line through enough drive rods to reach the maximum anticipated depth for this particular sampling event. (Note: Pure Teflon tubing is preferable to Teflon lined tubing because of the lined tubing's tendency to kink when bent.)

14.3 Thread the soil gas sample line through the AW adapter pin which is applicable to your particular direct push apparatus and screw the pin into the end of the first drilling rod.

14.4 Attach the end of the sampling line to the Swagelok Fitting and attach the MiniSimulProbe as described in the MiniSimulProbe Assembly sop for Groundwater sampling.

14.5 Screw a slotted drive head on top of the first drive rod. The Teflon line will extend out through the slot while you are screwing in the drive head. Hold the line so that it does not become twisted. (The slot on the drive head will rotate relative to the Teflon line, but the Teflon line should not be allowed to rotate relative to the MiniSimulProbe and the drive rod.)

14.6 Attach the drive head, drive rod and MiniSimulProbe to the direct push drilling rig.

14.7 Check the SPLAT to be certain that it cannot be pushed up inside of the shoe, and lower the MiniSimulProbe into position with the Drive Tip resting on the soil surface.

14.8 Attach the uphole end of the Teflon soil gas line to a three way valve and attach one branch of the valve to a Nitrogen Gas Tank Regulator

14.9 Begin driving the MiniSimulProbe into the soil.

14.10 Once the MiniSimulProbe has been pushed below the soil surface, but before first water is encountered, pressurize the water canister. A good rule of thumb for pressurizing is to assume 0.6 PSI/foot of anticipated hydrostatic head at your intended sampling depth. (pure water is approximately 43 PSI/100 feet; the additional pressure assumes suspended and dissolved solids and thus increased specific gravity) See attached tables from Groundwater and Wells, Driscoll, 1987. **Note: for safety, the SimulProbe should always be pressurized and depressurized below ground surface.**

14.11 Resume driving the MiniSimulProbe. After each drive rod has been pushed into the ground, unscrew the slotted drive head from the rod, and screw on the next segment of drive rod. Be careful to prevent the Teflon line from twisting relative to the MiniSimulProbe during this process.

14.12 Attach the slotted drive head to the top of the new section of drive rod and continue to advance the MiniSimulProbe.

14.13 When you have reached an interval where you wish to collect a groundwater sample, stop and remove the slotted drive head and attach a slotted pull bail. As before, do not allow the Teflon line to rotate with either slotted device. (Note: The specific mechanism for pulling back on the drive rod varies from one direct drive system to another. Consult the drill operator and or manufacturer for specific details.)

14.14 Pull the drive rod and attached MiniSimulProbe back 1/2" to release the SPLAT.

14.15 Reattach the slotted drive head and drive forward 15" to collect a soil core.

14.16 Pull the drive rod and MiniSimulProbe back about 1/2" to expose the screen, shut off the nitrogen gas pressure and open the valve to allow the pressure to bleed off.

14.17 Allow water to enter tool under ambient hydrostatic pressure. After the initial pressure bleed of, the fill rate can be observed by placing the up-hole end of the Teflon line into a bucket of water. For extremely slow fill rates, the end of the Teflon line can be placed inside an inverted water filled bottle inside the bucket (i.e. one liter plastic soda bottle). When the bottle is full of displaced air from the Water Canister it can be emptied and reused for additional volume.

14.18 After sufficient water sample has been collected, repressurize the SimulProbe by following step 10.

14.19 Pull the SimulProbe back to a few feet below the ground surface and stop. Open the valve and bleed off the system pressure. **Note: for safety, the SimulProbe should always be pressurized and depressurized below ground surface.**

14.20 Pull the drive rods and MiniSimulProbe back to the surface and unscrew the MiniSimulProbe from the first rod, leaving the AW pin on the Water Canister Sampler Head.

14.21 To collect the water sample, follow the Disassembly & Sample Retrieval SOP for the Groundwater Mode.

14.22 After collecting the water sample, disassemble the core barrel and collect the soil sample.

14.23 Disassemble the MiniSimulProbe as per the disassembly Sops.

15.0 OPERATION: SOIL/GROUNDWATER SAMPLING / MUD ROTARY

Water sampling with mud rotary drilling poses numerous problems to obtaining high quality environmental samples. The first problem is to lower a sampling device through a mud column with cross contaminating the inside and out side surfaces of the tool with potentially contaminated mud. The second problem is driving the tool beyond the mud infiltrate. The third problem is obtaining a proper soil seal around the tool as it is driven into undisturbed materials. Finally, the fourth problem is retrieving the tool to the surface without cross contaminating the samples.

The use of SPLAT, the SimulProbe Condom, and the encapsulated core sleeves with the MiniSimulProbe solves these problems. The SPLAT, Condom, and the Encapsulated Sleeves keep the drilling mud out of the inside of the MiniSimulProbe as it is being lowered through the drill string. As the tool is driven into the formation, the Condom is torn away. The SPLAT permits soil core collection to begin below the infiltration zone. The encapsulated core sleeves prevent mud from leaking into the core sleeves as the tool is driven into the soil. The water sample is collected from sediments below the infiltrated zone and is then sealed inside the water Canister by the SimulProbe Nitrogen back pressuring system as the MiniSimulProbe is hoisted to the surface.

15.1 Assemble the MiniSimulProbe as per Section 3 of this SOP.

15.2 Attach the MiniSimulProbe to a wireline (downhole) hammer and secure the Teflon Nitrogen Gas Line to the side of the hammer’s anvil using two or three plastic tie wraps (or duct tape, if permitted on the site). A 300 LB hammer is recommended to overcome the viscosity and bouancy effects of the drilling mud on the hammer’s movement. The Hammer should have at least 0.5 inches of clearance inside of the drill rod to allow space for the Teflon line.

15.3 Attach the up-hole end of the SimulProbe water sampling spool to the inert gas tank regulator. The three way valve handle should be pointed towards line leading to the regulator.

15.4 With the probe suspended a few feet down inside the casing, pressurize the Water Canister. The rule of thumb for pressurizing is to assume 75 PSI/100 feet of hydrostatic head (pure water is approximately 43 PSI/100 feet; the additional pressure assumes suspended and dissolved solids and thus increased specific gravity). See attached tables from Groundwater and Wells, Driscoll, 1987. **Note: for safety, the SimulProbe should always be pressurized and depressurized inside the casing/drill string.**

15.5 Observe the line pressure gauge on the regulator. When line pressure is equal to about 75 PSI/100 feet of hydrostatic head (0.75 PSI/ft), close the 3-way valve on the hose spool to trap the pressure. The closed position is when the valve handle is at 90 degrees to 3-way valve body. Note: The exact pressure will depend on the specific gravity (mud weight) of the drilling mud being used on the project. Use the attached chart from Driscol to calculate the correct pressure for the mud used in the boring during the sampling event. Mud weights should be checked before each sampling event as they may change.

15.6 Disconnect the Teflon line from the regulator and hook it on to he side of the spool.

15.7 Lower the MiniSimulProbe slowly down the inside of the drill string while maintaining a small amount of tension on the Teflon line as it is reeled out. It is important that slack Teflon line not be allowed to enter the borehole. (Extra Teflon line can become tangled on the hammer.) If you think that extra tubing has entered the borehole, do not be afraid to pull up on the line. The Swagelok fitting connection will withstand significant amounts of tugging.

15.8 When you reach the bottom of the borehole, carefully mark the hammer cable to measure the drive distance.

15.9 Begin driving the MiniSimulProbe. It is very important that the operator does not backhammer (lifting the hammer so far that it pulls the tool back at the top of the hammer stroke) while driving the MiniSimulProbe. Back hammering may cause the SPLAT to release prematurely.

15.10 Stop when you have driven the MiniSimulProbe at least 2.5 feet; although drive distances of 3 to 4 feet are recommended. This decreases the chance of mud along the micro-annulus. Use an AW rod to extend the drive distance. This will keep the hammer inside of the drill string.) Backhammer the MiniSimulProbe about 1/4 to 1/2 of an inch. This will release the SPLAT.

15.11 Drive forward 17 inches to collect a soil core.

15.12 Pull the MiniSimulProbe back 1/2 inch to expose the screen.

15.13 Open valve to allow pressure bleed off.

15.14 Allow water to enter tool under ambient hydrostatic pressure. After the initial pressure bleed of, the fill rate can be observed by placing the up-hole end of the Teflon line into a bucket of water. For extremely slow fill rates, the end of the Teflon line can be placed inside an inverted water filled bottle inside the bucket (i.e. one liter plastic soda bottle). When the bottle is full of displaced air from the Water Canister it can be emptied and reused for additional volume.

15.15 After sufficient water sample has been collected, repressurize the SimulProbe by following steps 3 through 5.

15.16 Pull the SimulProbe back to a few feet below the top of the drill string and stop. Open the valve and bleed off the system pressure. **Note: for safety, the SimulProbe should always be pressurized and depressurized inside the casing/drill string.**

15.17 Lift the hammer and MiniSimulProbe out of the drill string and unscrew the MiniSimulProbe from the hammer anvil, leaving the AW pin on the Water Canister Sampler Head.

15.18 To collect the water sample, follow the Disassembly & Sample Retrieval SOP for the Groundwater Mode.

15.19 After collecting the water sample, disassemble the core barrel and collect the soil sample.

15.20 Disassemble the MiniSimulProbe and decontaminate it according to site specific procedures.

16.0 OPERATION: SOIL/GROUNDWATER / CASED HOLE DRILLING METHODS

16.1 Assemble the MiniSimulProbe as per section 6 of this sop.

16.2 Attach the MiniSimulProbe to a wireline (downhole) hammer and secure the Teflon Nitrogen Gas Line to the side of the hammer’s anvil using two or three plastic tie wraps (or duct tape, if permitted on the site). Hammer weights up to 300 lbs may be used to drive the MiniSimulProbe.

16.3 Attach the up-hole end of the SimulProbe water sampling spool to the Nitrogen Gas Regulator. The three way valve handle should be pointed towards regulator line.

16.4 With the probe suspended a few feet down inside the casing, pressurize the water canister. A good rule of thumb for pressurizing is to assume 60 PSI/100 feet of hydrostatic head (pure water is approximately 43 PSI/100 feet; the additional pressure assumes suspended and dissolved solids and thus increased specific gravity). See attached tables from Groundwater and Wells, Driscoll, 1987. **Note: for safety, the SimulProbe should always be pressurized and depressurized inside the casing/drill string.**

16.5 Observe line pressure gauge on regulator. When line pressure is equal about 60 PSI/100 feet of hydrostatic head (0.65 PSI/ft), close 3-way valve on hose spool to trap pressure. The closed position is when the valve handle is at 90 degrees to 3-way valve body.

16.6 Disconnect the Teflon line from the regulator and hook it on to he side of the spool.

16.7 Lower the MiniSimulProbe slowly down the inside of the casing while maintaining a small amount of tension on the Teflon line as it is reeled out. It is important that slack Teflon line not be allowed to enter the borehole. (Extra Teflon line can become tangled on the hammer.) If you think that extra tubing has entered the borehole, do not be afraid to pull up on the line. The Swagelok fitting connection will withstand significant amounts of tugging.

16.8 When you reach the bottom of the borehole, carefully mark the hammer cable to measure the drive distance.

16.9 Begin driving the MiniSimulProbe. It is very important that the operator does not backhammer (lifting the hammer so far that it pulls the tool back at the top of the hammer stroke) while driving the MiniSimulProbe. Back hammering even once will cause the SPLAT to release prematurely.

16.10 Stop when you have driven the MiniSimulProbe at least 2.5 feet. (Deeper drive distances are recommended. This decreases the chances that borehole fluids will follow the micro-annulus and cross contaminate your sample. Use an AW rod to extend the drive distance, if needed.) Backhammer the

MiniSimulProbe about 1/4 to 1/2 of an inch. This will release the SPLAT. (Alternatively, if you only want to collect a water sample, you can drive down as much as 30 inches, pull back to open the shoe and expose the screen and collect the water sample. Continue with step 13.)

16.11 Drive forward 17 inches to collect a soil core.

16.12 Pull the MiniSimulProbe back 1/2 inch to expose the screen.

16.13 Open valve to allow pressure bleed off.

16.14 Allow water to enter tool under ambient hydrostatic pressure. After the initial pressure bleed of, the fill rate cab be observed by placing the up-hole end of the Teflon line into a bucket of water. For extremely slow fill rates, the end of the Teflon line can be placed inside an inverted water filled bottle inside the bucket (i.e. one liter plastic soda bottle). When the bottle is full, it can be emptied and reused for additional volume.

16.15 After sufficient water sample has been collected, repressurize the SimulProbe by following steps 3 through 5.

16.16 Pull the SimulProbe back to a few feet below the top of the drill casing and stop. Open the valve and bleed off the system pressure. **Note: For safety, the SimulProbe should always be pressurized and depressurized inside the casing/drill string.**

16.17 To collect the water sample, follow the disassembly SOP for the Groundwater Mode. Section 9.

16.18 After collecting the water sample, disassemble the core barrel and collect the soil sample as described in section 8 of the soil gas SOP.

16.19 Disassemble the MiniSimulProbe and follow your site specific decontamination procedures.

SIMULPROBE LATCH ACTIVATED TIP (SPLAT) ASSEMBLY AND MAINTENANCE

1.0 ASSEMBLY:

Note: This section assumes that the tip is undamaged and has been disassembled in order to change the red o-ring. See the maintenance and repair section for instructions on replacing damaged Retractors.

1.1 Insert a small red o-ring into the internal o-ring groove in the bottom of the Point Bases' center hole.

1.2 Insert the shaft of the Point Set into the top of the Point Base. When the end reaches the small red o-ring, screw the threaded portion through the red o-ring so that the threads do not abrade the o-ring. Once the threads are past the o-ring, push the Point Set until the threads are fully exposed.

1.3 Thread the short length of vinyl tubing onto the end of the Point Set. Stop with the tube extending about 1/8 inch beyond the threads.

1.4 Screw the tube covered Point Set into the back of the Drive Tip until it stops. There will still be several threads and a short bit of tubing extending out the back of the Drive Tip.

1.5 Cut off the excess tubing so that the end of the tubing is flush with the back of the Tip.

2.0 DISASSEMBLY:

Since the only component of the SPLAT to come into direct contact with the soil sample is the bottom of the tip, it is generally not necessary to completely disassemble the SPLAT for decontamination between samples. However, it is a good idea to replace the internal O-ring after every fifty or so sampling events.

2.1 Remove the Black O-ring from the Tip.

2.2 Unscrew the Drive Tip from the Point Set. The end of the Point Set's threads will be covered with a short length of vinyl tubing.

2.3 Cut the tubing off of the Point Set and pull the Point Base off of the Point Set.

2.4 Remove the small red o-ring from inside of the Point Base.

3.0 MAINTENANCE AND REPAIR:

Retractor replacement: SimulProbe Technologies will repair damaged SPLATs for a nominal labor charge plus parts and shipping. Damaged Retractors can be replaced by a careful technician in the field.

3.1 Disassemble the SPLAT as per SOP above.

3.2 Grasp the damaged Retractor by the spring and unscrew the spring from the Retractor. The hole is threaded with standard right hand threads. The coils of the spring screw into the hole.

3.3 Insert the blade of a SimulProbe tip screwdriver down the inside of the spring of a new Retractor, starting at the Retractor and pushing it to the free end of the spring.

3.4 Slide the notch at the end of the screwdriver over the segment of wire which is bent across the end of the spring.

3.5 Put slight downward tension on the screw driver and rotate it clockwise about two turns. This will compress the radius of the spring slightly.

3.6 Holding this tension, start to screw the end of the spring into the hole of the Point Base. It takes 4 to 5 rotations to reach the bottom of the hole.

3.7 Remove the screw driver and then unscrew the Retractor a partial rotation to get back to the position where the curve of the outside radius of the Retractor is parallel to the curve of the outside radius of the Point Base. In other words, make sure the Retractor is in the normal operating position.

STANDARD OPERATING PROCEDURES
FOR THE SIMULPROBE VACUUM BOX

1.0 INTRODUCTION:

The SimulProbe Vacuum Box is designed to allow you to collect a soil gas sample directly from the soil gas line into a Tedlar Bag without first passing the sample through a pump. This eliminates the question of cross contamination from the pump's interior parts (rubber diaphragm, filters, gauges, etc.) or the need to disassemble and decontaminate the pump after each sample. The concept is simple: The pump is used to evacuate the air from around the outside of the bag, causing natural atmospheric pressure to push the soil gas sample directly in the Tedlar Bag from the soil gas tubing.

2.0 ASSEMBLY:

2.1 Connect the Whitey Valve (valve with black handle) to the metal fitting on the side of the Vacuum box.

2.2 Connect the White and red plastic valve to the plastic port on the side of the Vacuum box. The long silicon rubber tube should connect the metal T-fitting to the barbed nipple on the side of the white and red plastic valve. Set the control on the on the valve so that the middle black arrow points at the barbed nipple with the silicon rubber tube attached. Make sure that the red plug on the end of the valve is snug.

2.3 Connect the line from the SimulProbe, SVE well, or other soil gas source to the compression fitting on the bottom of the Whitey Valve. This fitting is designed to connect to/4 OD tubing using Swagelok ferrels. Brass Ferrels are fine for this application.

2.4 Connect the line from the Vacuum pump the barbed nipple on the bottom of the Stainless Steel T-fitting.

2.5 Point the handle of the Whitey Valve away from the Vacuums box and toward the T-fitting. This routes the soil gas directly to the pump and bypasses the Tedlar bag.

2.6 Attach the Tedlar Bag to the end of the Teflon Tube inside of the Vacuums box. (Insert the inlet tube of the Tedlar Bag into the end of the Teflon Tube which extends in from the metal fitting.)

2.7 Open the Tedlar Bag's small plastic valve.

2.8 Wipe the O-ring groove at the top edge of the Vacuums box base with a clean, damp paper towel or soft cloth and place the o-ring in the groove. (This assures a good seal.) Wipe the bottom edge of the Vacuum box top and place it on the base, making sure that the edge of the Tedlar bag is clear of the seal.

3.0 OPERATION:

3.1 Make sure that the arrow on the handle of the Whitey Valve is pointed away from the Vacuums box. This is the purge position.

3.2 Purge the volume of gas required by your project specific requirements. The flow indicator on the SimulProbe Vacuum Pump can be used to measure the purge if the flow rate is five liters per minute or less. If the flow rate is greater than five LPM, the valve on the flow meter can be used to choke the flow back to the range of the meter, if exact measurements are required.

3.3 During the purge, check the Tedlar Bag. If it shows any inflation, the connection between the Whitey Valve and the Vacuum Box is leaking. Tighten the knurled nut to stop the leak.

3.4 To collect a gas sample, simply turn the control on the Whitey valve so that the arrow points at the Vacuum Box and the Tedlar Bag. This is the fill position. The pump is now pulling air out of the Vacuum Box, causing the soil gas sample to flow into the bag.

3.5 Do not overfill the Tedlar Bag or it will break. As the bag approaches being full, choke back the pump by closing down the valve on the Vacuum Pump's flow meter.

3.6 Turn the Whitey Valve back to the purge position. (Arrow pointing away from the Tedlar Bag.) Shut off the pump, remove the red plug on the red and white plastic valve to relieve any residual Vacuum. Replace the red plug, open the Vacuum Box and close the Tedlar Bag's valve. Pull the Tedlar Bag off of the Teflon Tube.

3.7 To purge the valve of any residual soil gas in preparation for the next soil gas sample, simply place the Vacuums Box top back on the base, disconnect the soil gas line from the valve, remove the red plug from the plastic valve and turn on the Vacuum Pump. Run the Vacuum Pump for several minutes with the Whitey Valve's black handle pointed at the Vacuum Box at first and then away from the Vacuum Box. Shut off the Vacuum Pump and replace the red plug.

4.0 MAINTENANCE:

Wash the Vacuum box in mild, cool soap solutions only. DO NOT use organic solvents on the Vacuum Box under ANY circumstances as they will significantly weaken the polycarbonate material of the Vacuum Box. Inspect the Vacuum Box before each use. If it shows any sign of cracking, DO NOT USE IT.