

**ENHANCED BIOREMEDIATION CATALOG**

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**EBS CERTIFIED iSOC PRODUCTS:** The following high-quality products and services are EBS Certified for iSOC enhanced bioremediation projects. EBS guarantees that these products will work with the iSOC system. EBS provides free phone technical service (415-381-5195) for customers. The iSOC tool itself cost \$4,250/each plus shipping and handling.

**EBS GUARANTEES AND WARRANTIES:** Original manufacturer’s warranties apply. EBS offers a 1-year guarantee that all EBS custom designed products will work for up to 1-year or will be replaced or repaired for the owner.



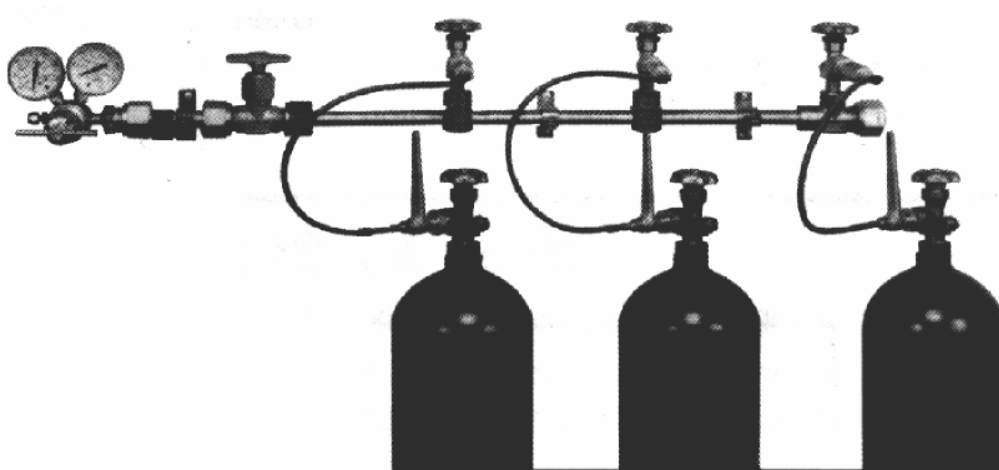
**Dual stage, 5-125 psi, low pressure oxygen regulator**

**Regulator: SPECIFY GAS (oxygen, propane, methane, hydrogen, etc.)** This custom chrome-plated regulator provides even airflow to the iSOC units. EBS-#270-80-540 4m: \$345; includes S&H



**1/4” or 6mm Polyurethane tubing for iSOC System (1/4” clear recommended)** EBS certified tubing for the iSOC system is inspected by continuous laser during production and when properly cooled and cut to length to ensure superior tolerance control and fitting to the iSOC system. **Tubing:** Specify size (1/4” or 6mm diameter) and length in feet: \$1.35 per foot; includes shipping. Tubing any length. No minimum length.

## **SIMPLEX MANIFOLDS**



**Basic Simplex Model**

### **Gas manifold (3 valves, connector and pigtails, with regulator)**

EBS offers rigid gas manifolds to allow for 3, 4, 6 or more gas cylinders to be connected together. The Simplex Model is best used when tanks are mounted against a wall or inside a trailer or shed. The manifolds are especially useful at iSOC sites where a large volume of gas is used or for remote iSOC sites where the monthly labor costs for the gas cylinder change out activities far exceed the gas rental rates. These custom manifolds have 36" flexible pigtails to connect to the gas cylinders and each comes with a gas regulator. The tanks all under the same pressure, and consequently drain at the same rate.

### **SPECIFY GAS (oxygen, propane, methane, hydrogen, etc.)**

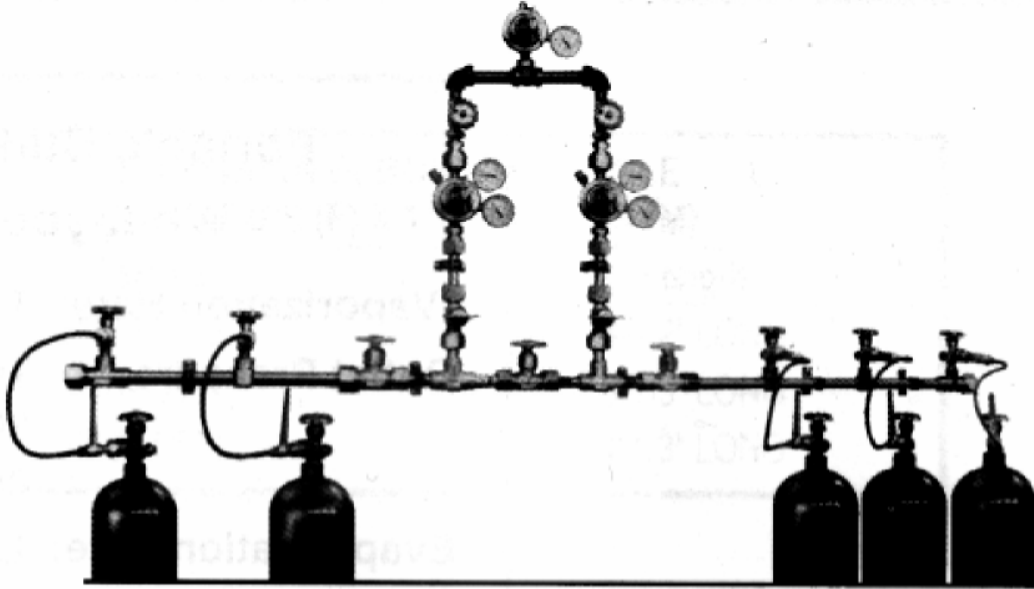
#### **“SIMPLEX-type” manifold system with regulator**

3-cylinder manifold: EBS- #1132-0947; \$1,350; includes S&H

4-cylinder manifold: EBS- #1132-1291; \$1,575; includes S&H

6-cylinder manifold: EBS- #1132-0686; \$1,950; includes S&H

## SEMI-AUTOMATIC MANIFOLDS



### **Semi-Automatic Manifold (SAM)**

EBS offers the Semi-Automatic Manifold (SAM), which is designed for uninterrupted gas supply to the iSOC system without any downtime. This is especially good for remote sites or sites requiring several tanks of gas between quarterly gas canister change outs. The SAM system is designed so that after the primary supply is depleted, a fresh reserve supply is waiting automatically to begin service. Please specify gas (oxygen, nitrogen, ethane, hydrogen, propane, etc.)

### **Semi-Automatic Manifold (SAM) with Regulator**

EBS-SAM-2 Kit: 1132-0659- 2 tanks (1 left, 1 right): \$2,550; includes S&H

EBS-SAM-4 Kit: 1132-1419- 4 tanks (2 left, 2 right): \$2,950; includes S&H

EBS-SAM-8 Kit: 1132-3671- 8 tanks (4 left, 4 right): \$3,750; includes S&H

## FLEXIBLE MANIFOLDS



EBS Certified 2 and 3-tank flexible manifold designed for the iSOC system.

The EBS designed manifolds are useful for installations in security cages, or underground vaults (which are described on pages 5 and 6 of this catalog). These high-pressure manifolds have been designed for the iSOC system and meets the high-quality requirements for safety and security.

Installation of 3-tank flexible manifold in 24" X 24" X 10" well box.

EBS Certified Flexible Manifolds: 2 tanks:	\$395 includes S/H
EBS Certified Flexible Manifolds: 3 tanks:	\$495 includes S/H
EBS Certified Flexible Manifolds: 4 tanks:	\$645 includes S/H
EBS Certified Flexible Manifolds: 5 tanks:	\$795 includes S/H

### RECOMMENDED iSOC SYSTEM CHECKLIST

Pages refer to this EBS iSOC catalog.

#### iSOC Supplies:

- \_\_\_ iSOC passive natural attenuation tools (page 1)
- \_\_\_ ¼-inch diameter clear, polyurethane tubing (page 1)
- \_\_\_ Locking and water tight well caps (page 7)
- \_\_\_ Clothes line or wire and plastic clips to hang iSOC (hardware store)
- \_\_\_ Gas regulator – 2 stage, 5-125 psi (page 1)

#### Above Ground Central Canister Storage:

- \_\_\_ Security cage or other fencing
- \_\_\_ Individual regulators (page 1) and tanks (250 cubic foot) or manifold (page 2, 3 or 4) with several tanks and one regulator.; hundreds of feet of ¼" tubing

#### Subsurface Canister Completion:

- \_\_\_ Water-tight, traffic-rated well box (24" X 24" X 10"; page 6)
- \_\_\_ (1) aluminum 150 cubic foot tank (48" X 9" diameter; page 6)
- \_\_\_ Gas regulator – 2 stage, 5-125 psi (page 1); about 50 feet of ¼" tubing
- \_\_\_ **Alternate completion** (where drilling tank pit for 150 cubic foot tank is not possible)
- \_\_\_ Water-tight, traffic-rated well box (24" X 24" X 10"; page 6)
- \_\_\_ (3) 20 cubic foot tanks (18" length, 8" diameter; \$110/ea.)
- \_\_\_ Gas regulator – 2 stage, 5-125 psi (page 1)
- \_\_\_ EBS Certified Flexible Manifolds: 3 tanks: \$495 includes S/H; about 50 foot of ¼" tubing

## **DISCUSSION ON iSOC OPERATION:**

Typically, the oxygen for a 250 cubic foot tank is about \$20. For hydrogen, the cost is about \$30 for the gas. The tank rental is about \$0.26 to \$0.35/day. If the project is planned for more than 2-3 years, it might be worth buying the tanks. For the iSOC system, the gas supply and tank rental is inexpensive. The real cost is the labor, typically billed out at \$50 to \$70/hour for a technician. From experience, low quality, supplies usually cost more in labor, due to system failures. To lower the operation and change out costs, EBS recommends the manifolds to put several tanks together. EBS suggests trying to get the change out to occur every 90+ days (1 quarter). This minimizes the chance that the tanks will run out before the technician arrives. If the iSOCs get flooded, they should be left to air-dry for about 17 days, after the filter and controller have been changed out and the water plug has been removed to drain the water inside the unit. Assume the iSOCs gas canisters will be changed out with about 20% of the gas still in the tanks. The average gas consumption is 1.25 cubic feet per day per iSOC well, or one 250 cubic foot tank will last for one well about 200 days, or about ½ of the year.

**GAS SUPPLY: CENTRAL VERSUS INDIVIDUAL SUPPLIES** The central supply is useful if the site has space. Change out is much simpler from one central area than several areas. Many consultants prefer to use separate gas canisters with a separate regulator for each iSOC. This way, if a tank is depleted, the entire iSOC system does not become inactive, only the iSOC associated with the depleted canister is inoperable. Once flooded, it takes an iSOC 17 days to dry out and be reusable. A new controller may be needed to be replace into the iSOC tool at this point.

**ABOVE-GROUND CENTRAL SUPPLY:** For a central gas supply, EBS highly recommends a proper NFPA above-ground cage for gas canister storage which can handle 5-10 tanks for the single cage or 10-20 tanks for the double cage. These cages are designed specifically for safe storage of gases. This method would require tubing that would go to each of the iSOC wells. Typically the tubing is placed in 1" x 1" sand-lined trenches, which are covered with mortar. (See page 7 of this document). The EBS cages are brushed aluminum, and come pre-assembled.

**BELOW-GROUND CENTRAL SUPPLY:** For an underground central supply of gas, the water-tight, traffic rated boxes (48" X 48" X 18") holds up to four 250 cubic foot tanks that can be manifolded together for a central supply. (See page 6 of this document). EBS sells an aluminum 150 cubic foot custom-ordered tank (48-inches long by about 9-inches in diameter) which weighs about 80 lbs with 20 lbs of oxygen in the tank (\$545)

**GAS SUPPLY: INDIVIDUAL SUPPLY:** Individual supplies are the best for treating wells on other properties or where trenching is difficult. The perfect application for a gasoline station site would be across or even in the street. Individual gas supplies in individual wells might be a perfect solution to minimize chances for litigation from adjacent property owners who have been impacted from on-site sources. For an underground, individual supply of gas, the water-tight, traffic rated boxes (24" X 24" X 10") holds up to three 20-cubic foot tanks that can be manifolded together for an individual supply. (See page 6 of this document). Other gases (ethane, propane, hydrogen, butane, methane) have different manifolds, and regulators than oxygen. Therefore, please specify the gas to EBS when ordering.

## **UNDERGROUND WATER-TIGHT, TRAFFIC-RATED iSOC BOXES**



### **TRAFFIC-RATED iSOC WELL BOXES (Holds three 20 cu ft tanks)**

This water-sealed, traffic rated, heavy-duty steel well vault box is designed for individual iSOC installations at each well without trenching. Place the two-inch monitoring well in one of the corners. This 24" X 24" X 10" box stores up to three 20 cu ft gas canisters-enough to last for more than 48 days at 1.25 cubic foot per day per well. Remember to leave about 20% of the gas in the tank at change out time, so the iSOC is not flooded. The Heavy Duty Square/Rectangular Manhole features a 3/8" diamond plate steel cover with rust resistant coating. Boxes are traffic rated. Custom sizes are available for larger underground tank storage. For an extra \$150, well box lock area can be added to the well boxes. Custom sizes are available.

### **TRAFFIC-RATED iSOC WELL BOXES**

**EBS Model 105WT** (24" X 24" X 10" skirt) The EBS Model 105WT is a limited access manholes, which include four 3/8" flush mount stainless steel bolts. The units are also rain tight, featuring a Buna-N gasket. 80 lbs; \$475; includes S&H; 18" X 18" X 10" or 18" skirt; \$375; includes S/H.

The EBS 3-tank manifold for three 20-cu ft tanks is \$495. Regulator: \$345 includes S/H.

The EBS 150-cubic foot aluminum tank is 48" long, by 9" in diameter and weighs 80 lbs with the 20 lbs of gas: \$545 includes S/H. Due to safety, the tank is shipped empty and can be filled up at any welding supply store.

**EBS Model 160WT Custom** (48" X 48" X 18" skirt) 500 lbs., traffic rated, water-tight steel well box, with recessed locking area (for pad lock, not included). This can store up to four (250) cubic foot tanks for a central underground gas-supply area. The EBS designed product comes with a spring-loaded assist added to each well box is \$1,895 delivered. The EBS 4-tank manifold is \$645. Regulator: \$345 includes S/H.

**CUSTOM ORDERS MUST BE PAID FOR IN ADVANCE.**

## **EBS WELL PLUGS: Waterproof and secure well plugs**

For many iSOC installations, the standard locking expanding pressure well plug is the usual cap on the top of the wells. In order to use it for iSOC installation, the plug is drilled in the bottom to place a hook for the iSOC tether and a hole into the top is made for the tubing, making the plug less than functional as a secure or water-tight well cap.



Made of high-impact, corrosion-proof Delrin plastic, the EBS well plug is professional looking and simplifies the installation of the iSOC. The EBS well plug is placed at the top of 2-inch or 4-inch diameter PVC wells. Three small screws attach the well cap firmly onto the top of the casing. The hook has been designed into the base of the well cap. An o-ring seals the bottom assembly to the well casing, and the top cap also has an o-ring for a water-tight seal. A standard security lock can be placed on the sides where the top and bottom assembly holes line up. A well ID strip is included that hangs on the hook, to verify the well number and well depth. For the iSOC application, please drill the 1/4" hole into the location of your choice for the iSOC tubing (top or side).

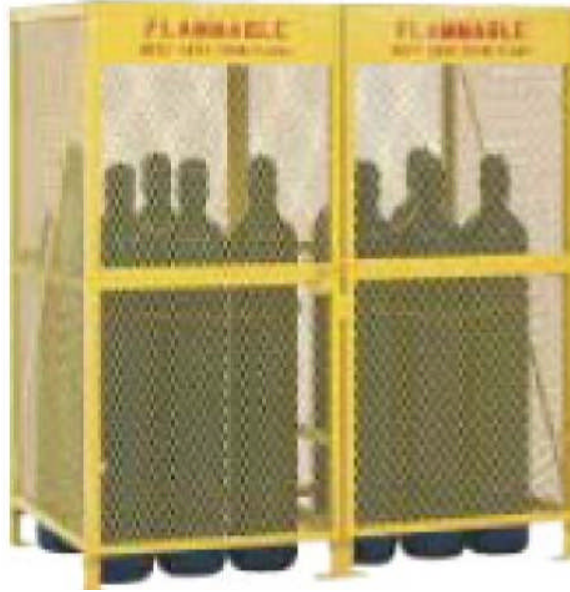


EBS Well Caps: 2-inch diameter: \$39.50/each, includes S&H (with or without 1/4" hole)

EBS Well Caps: 4-inch diameter: \$49.50/each, includes S&H (with or without 1/4" hole)

Optional solid brass locks: please call

## SECURITY GAS STORAGE CABINETS



**Double Gas Cylinder Storage Unit (up to 10-20 cylinders)**  
The EBS cages are brushed aluminum, and come pre-assembled.

### **Secure and Safe Gas Storage**

Custom designed for security and safety, these units are perfect for iSOC cylinder storage. The gas cylinders are stored vertically. EBS selected these units for the iSOC application due to their durability. These units also have the proper safety signage. The aluminum cabinets are constructed of 14 gauge expanded metal sides and an 11-gauge top. The padlock assembly allows security of the cylinders. Footplates allow for securing the unit to the floor. Cabinets conform to OSHA Subpart 1910.110 requirements and NFPA 5 8-79 standards. The all-aluminum units are shipped already set up and ready for the iSOC system installation.

**NOTE:** For lower shipping costs, EBS recommends the brushed aluminum units. Yellow steel cabinet is shown above. EBS uses a variety of manufacturers, depending on backlog and scheduling. The quality of units and prices are similar. EBS reserves the right to substitute manufacturers.

**EBS Pre-Assembled, Brushed Aluminum Vertical Cylinder Storage Cabinets: EBS Single Cabinet:** 5 - 10 gas cylinder storage: includes chains and proper signage, 65" to 70" high, 32.5" wide, 39" deep; 71 lbs; \$1,350; includes S&H

**EBS Double Cabinet:** 10 - 20 gas cylinder storage: includes chains and proper signage, 65" to 70" high, 65" wide, 39" deep; 148 lbs; \$1,975; includes S&H

**PRESSURE ALARM SYSTEMS**



**Remote Alarm System (left) and Pressure Switch (right)**

**Pressure Alarm and Pressure Switch System Kit**

The remote alarm systems are designed to provide warning of service interruption when used with the manifolds. Used in conjunction with a pressure switch, the alarm system will provide both a visual or audio/visual warning of cylinder depletion for one or two gas manifold systems. Once activated, a visual only alarm will change from “green” indicator for normal operation to a “red” indicator for depleted cylinders. This is not an auto-dialer unit. The alarm has a 90 DB buzzer that is wired into the unit. The pressure switch (one for each header); are designed to activate remote alarm systems on the manifold systems. Once the minimum pressure is reached, the pressure switch will activate the remote alarm upon depletion.

**Remote Alarm System (left) and Pressure Switch:**

EBS Remote Alarm and Pressure Switch Kit: \$3,250; includes S&H

**AUTO-DIALER UNITS:** Auto-dialer units are available. Please call for more information. For more remote sites with electricity (or solar), a cell-phone or telephone line can be connected for office notification of pressure conditions.

**SPECIFY GAS (oxygen, propane, methane, butane, hydrogen, etc.)**

**MULTIPROBE METERS: DO, ORP, pH, conductivity, and temperature.**

**YSI 556 Multiprobe System: A versatile, multiparameter handheld instrument**

Rugged and reliable, the YSI 556 MPS (Multiprobe System) combines the versatility of an easy-to-use, easy-to-read handheld unit with all the functionality of a multiparameter system. EBS has tested dozens of meters over the years, and this one is the best for enhanced bioremediation parameter studies.

- Simultaneously measures dissolved oxygen, pH, conductivity, temperature, and ORP
- Field-replaceable electrodes, easy to use DO membranes
- Compatible with EcoWatch ® for Windows ® data analysis software
- Stores over 49,000 data sets, time and date stamped, interval or manual logging
- Three-year warranty on the instrument; one-year on the probes
- GLP assisting, records calibration data in memory
- Available with 4, 10, and 20 m cable lengths
- IP-67, impact-resistant, waterproof case
- RS-232 interface for PC connection



**YSI 556 Multiprobe System**

- YSI 556 display with PC cable and soft-sided case; DO, ORP, temp, pH, and conductivity; 20 meter (65 ft) of cable. The instrument comes standard with YSI 5061, a soft-sided carrying case with enough space for the YSI 556 MPS, a 20-meter cable, and calibrating supplies. The hand strap can be connected on either the right or left side of the instrument. The YSI 556 Multiprobe System is \$3,695 includes S&H. Additional cable is available.
- Optional Flow Cell - The 5083 flow cell can be used for groundwater applications or anytime water is pumped. \$376; includes S&H

## DO & ORP METERS



### Dissolved Oxygen (DO) meters and ORP Meters

- Galvanic type probe with short response time - always ready for immediate use without the need for polarization & stabilization time.
- Measuring range - 0-200.0 ppm
- Waterproof - submersible and will float if dropped in the water.
- Excellent probe stability - one daily calibration check is sufficient.
- Tough membrane - can be wiped clean with cloth or paper towel.
- Long life probe - can be stored dry, does not need regular renovation, only change membrane when necessary.
- Easily exchanged membrane - no more fumbling and struggling.
- Compact and convenient - has a detachable clip for use on a belt or clipboard.
- Display can be illuminated (back-lit).
- Reliable power source - standard 9 volt battery with more than 1,000 operating hours and a low battery indicator.
- Comes with accessories as standard - Belt clip, Service kit including a spare membrane cap, membranes, electrolyte and tool.

### **Downhole DO & ORP Meters: Pont Four Handy Alpha:**

For 50 ft.: DO meter: \$1,350; Additional wire: \$2/ft., includes S/H

ORP meter: \$1,450; Additional wire: \$2/ft., includes S/H

Optional waterproof case: \$150/ea., includes S/H

Temperature option: \$300/meter. Additional wire: \$2/ft., includes S/H

## ENHANCED BIOREMEDIATION SERVICES



### **EBS performs microcosm bench tests to evaluate subsurface conditions**

#### **Laboratory Monitoring of iSOC Bioremediation Enhancement**

EBS offers laboratory monitoring of microbiological parameters to validate iSOC bioremediation enhancement in the field. Both aerobic and anaerobic biodegradation processes can be characterized and followed over time to document changes in dissolved gas concentrations, macronutrients, and total bacterial populations as well as contaminant-degrading subpopulations of naturally occurring bacteria.

#### **Aerobic Microbial Parameter Profiling (Groundwater)**

Indirect indicators provide a view into the biological and geochemical conditions at a particular point in time. Bacterial enumeration for total aerobic heterotrophic bacteria, contaminant-degrading bacteria (e.g., gasoline/BTEX, diesel, oil, MTBE), macronutrients (ammonia nitrogen, o - phosphate), alkalinity (speciated), biological oxygen demand, chemical oxygen demand, total inorganic carbon, total organic carbon, total dissolved solids, sulfate, and nitrate. Report of the findings provided.

EBS recommends performing this test prior to treatment to obtain a background level. Once that is done, resample for indirect indicators in 6 to 12 months, or if problems develop. EBS recommends 2 or 3 wells within the core of the plume and 1 or 2 wells upgradient (background) or cross gradient. A sample downgradient of the core of the plume sometimes provides information regarding the leading edge of the plume. Cost: \$1,200/well analyzed. The recommended field-testing may be added to contract – please call: DO, ORP, pH, temperature, conductivity, total iron and ferrous iron. Please supply a map of the site, concentration data over time. The analysis is included as well as a detailed report.

#### **Anaerobic Microbial Parameter Profiling (Groundwater)**

Same description as above, but with dissolved methane, manganese (II), and specific chlorinated solvent degraders. Cost: \$1,900/well analyzed. Recommend field testing may be added to contract – please call: DO, ORP, pH, temperature, conductivity, total iron and ferrous iron). Please supply a map of the site, concentration data over time. The analysis is included as well as a detailed report.

**Aerobic and Anaerobic Microcosm Studies for Contaminant Biodegradation** Bench tests are performed to document the biodegradation of a variety of contaminants. Bench tests consist of sample groundwater enhanced with essential macronutrients, pH buffer and oxygen in sealed glass serum bottles. Microcosm bench tests are uniformly spiked with target contaminants and then sacrificed at time zero and an endpoint (e.g., 7 days, 14 days, 30 days) for GC-MS analysis of the target chemicals before vs. after enhanced bioremediation. Includes concurrent negative (abiotic) and positive controls. These studies are not recommended for routine chemicals. The biodegradation of TPH-g, TPH-d, BTEX, MTBE and TBA are already well studied and documented in the literature. A bench test is generally not recommended for these compounds, unless specific site conditions inhibit microbial growth. For more recalcitrant or less well known compounds such as perchlorate, arsenic, chromium, PCE, TCE, 1,4-dioxane, PCBs, nitrate or others, bench tests are a way to optimize conditions in the laboratory and try out various pH settings, gases or liquid additions, or other variables. Includes concurrent negative (abiotic) control. Costs: \$1,900 to \$ 10,000+, depending on the number of tests, analyses, specific compounds, etc.

### **Nutrient Evaluation**

Nutrients are frequently a limiting factor for microbial growth. Many hydrocarbon sites have depleted nutrients within the core of the plume. Without the nutrients, the microbes can not metabolize the remaining residual contaminants. EBS provides nutrient evaluations of groundwater.

Calculations of nutrient requirement for typical ¼ acre site: \$500

Formulation of site-specific nutrients, development of delivery plan and dosing, and nutrients: \$450

Optional orthophosphate and ammonia as nitrogen test for groundwater: \$150/for both

### **EBS Aerobic Microcosm Study**

Using a representative water sample, the standard EBS aerobic microcosm study using a 250 ml glass serum bottles with the Teflon septum is performed in 30 days, with three data points in time. The aerobic heterotrophic plate count, specific hydrocarbon degraders, DO, ORP, Fe<sup>total</sup>, Fe<sup>+2</sup>, pH, conductivity, and temperature would be measured from the groundwater containers. Initial target chemical concentrations would be analyzed. A detailed report is prepared for the project. Cost: \$4,500/sample for the aerobic microcosm study.

### **EBS Anaerobic Microcosm Study**

Same procedures as above, but with a longer period (60 to 90 days). The cost is \$4.950/sample for the anaerobic microcosm study.

### **Purpose of the EBS Well Test:**

The EBS well test evaluates the microbial response to the increasing of dissolved oxygen or other gases in the vertical bench test well which is designed to take representative groundwater from a site and place it in a similar vertical water column with an iSOC device. This bench test does not show advective or diffusive conditions.

### **Types of Tests:**

Aerobic (with oxygen): hydrocarbons, MTBE, benzene, vinyl chloride, arsenic Anaerobic: (with hydrogen, propane or other gases): solvents, perchlorate, most metals (chromium, lead, zinc, cadmium, others)

Co-metabolic (with oxygen and alkane gas): some solvents, other chemicals

Options: Bench testing with addition of nutrients, change in pH, or other factors

Optional control sample: water sample in identical bench test well, without iSOC gas infusion.

**Equipment:**

EBS has a bench test facility in Point Richmond, where 2-inch diameter PVC well casings up to 35 foot high are mounted vertically in the laboratory with a relatively constant temperature. The well casings simulate wells and are filled with groundwater to the height of the water column in the wells at the prospective site. The bench test wells are sealed with standard locking well caps.

**Sample Volume:**

The bench-testing well would be filled to the typical water height of the water column in the wells at the prospective site. EBS requests about 3 to 5 gallons of representative or the highest concentration of groundwater for the bench test, depending on the water column height in the field. For soil related tests, soil placed in a 1-2 gallon bucket is enough.

**Measurements:**

Initial Sampling:

For gasoline and hydrocarbons: The aerobic heterotrophic plate count, specific hydrocarbon degraders, DO, ORP, Fe<sup>total</sup>, Fe<sup>+2</sup>, pH, conductivity, and temperature would be measured from the groundwater containers. Initial target chemical concentrations would be analyzed.

Bench Test Well Set-Up:

The groundwater from the field would be filled to the level of the normal and representative water column in the field, and an iSOC would be installed and turned on, simulating the field conditions. A cap would be placed on the top of the well.

Final Sampling:

The iSOC would run with 100% oxygen for 30 days, and the same analysis would be run: The aerobic heterotrophic plate count, specific hydrocarbon degraders, DO, ORP, Fe<sup>total</sup>, Fe<sup>+2</sup>, pH, conductivity, and temperature would be measured at day 1. Final target chemical concentrations would be analyzed.

**Typical Project Costs:**

\$1,950/well aerobic 30-day bench test. Includes technician, bench test well use and initial and final readings: DO, ORP, Fe<sup>total</sup>, Fe<sup>+2</sup>, pH, sulfate, nitrate, conductivity, and temperature. Price includes the iSOC, tubing, regulator and gases for iSOC bench test. Price includes the proper profiling and disposal of used bench test liquids at InStrat, Inc. in Rio Vista, California. Additional months for the bench tests: \$500/well per month (assume no additional analytical). Anaerobic or cometabolic bench test surcharge: \$200/well

\$1,450/well for a negative control well (well with representative groundwater, without the iSOC), the costs would be the same, except the rental of the iSOC, regulator, tubing and setup. Anaerobic or cometabolic bench test surcharge: \$200/well

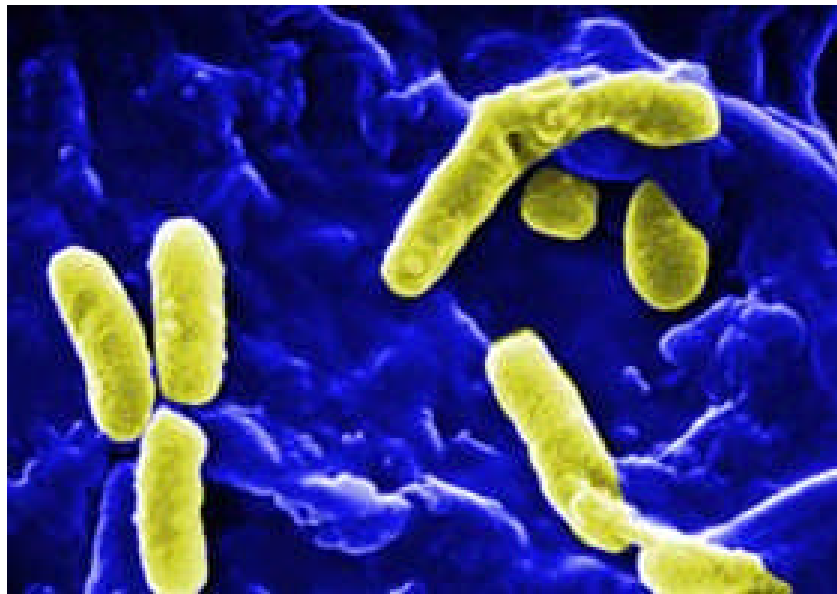
Estimated \$250 to \$500; depending on the analysis; Cost plus 15%. Laboratory bills can be paid directly by the client for a \$50 handling fee. Additional analysis such as nutrients (ammonia as nitrogen or orthophosphate) can be added to the contract.

EBS also performs soil and groundwater bench tests with soil and groundwater and chemical oxidizers (ozone, permanganate, hydrogen peroxide, Fenton's Reagent, persulfate, percarbonate and

others), metals stabilizers, pH adjusters and other treatment chemicals using the wells or soil columns and recirculating systems. It is better to optimize conditions in the laboratory before going into the field with an in-situ project.

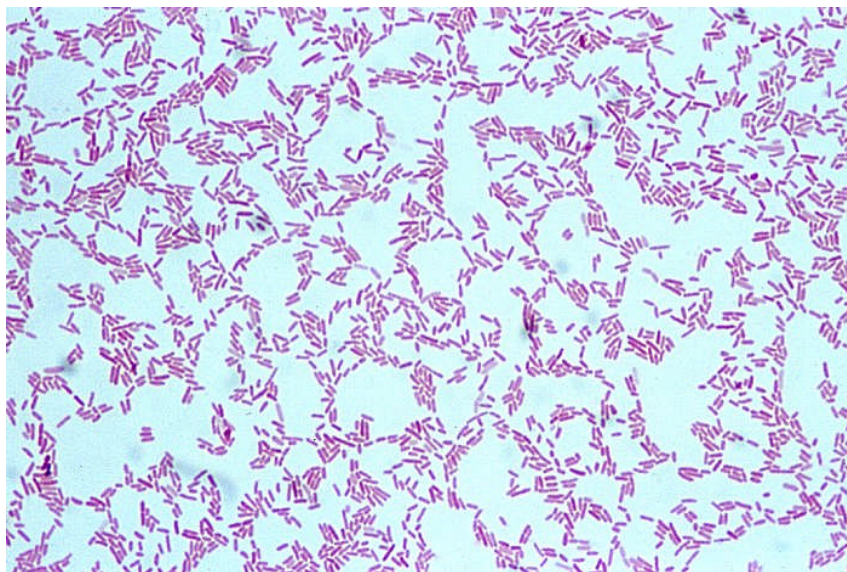
**Custom Laboratory Services:**

Custom in-situ delivery and microcosm studies and other specialized research projects can be designed. EBS offers technical consulting services for well placement and delivery evaluation by James A. Jacobs, R.G., CHG. Complimentary treatments (chemical oxidation using ozone, Fenton's Chemistry, or other oxidizers), can also be evaluated in the lab. EBS charges an hourly rate of \$150 per hour. Laboratory technical services are available at a rate of \$90 per hour.



<http://de.wikipedia.org/wiki/Bild:Pseudomonas.jpg>

Pseudomonas bacteria (close up, above).



**Viability of Micro-organisms** (from [http://www.resa.net/nasa/extreme\\_chart.htm](http://www.resa.net/nasa/extreme_chart.htm))

## Microorganisms with Particular Physiological and Nutritional Characteristics

Physiological Characteristic	Description
<b>Temperature</b>	
Psychrophile/ facultative psychrophile	Optimal temperature for growth is 15 °C or lower, maximal temperature is approximately 20 °C, and minimal temperature is 0 °C or lower
Psychrotroph	Capable of growing at 5 °C or below, with maximal temperature generally above 25 °C to 30 °C; term in this case is a misnomer because it does not indicate nutritional characteristics
Mesophile	Generally defined by optimal temperature for growth, which is approximately 37 °C; frequently grows in the range from 8 °C to 10 °C and from 45 °C to 50 °C
Thermophile	Grows at 50 °C or above
Hyperthermophile	Grows at 90 °C or above, although optimal temperature for growth is generally above 80 °C; maximal growth of pure cultures occurs between 110 °C and 113 °C, although the maximum (113 °C) may well increase as further research is done
<b>Oxygen</b>	
Aerobe	Capable of using oxygen as a terminal electron acceptor; can tolerate a level of oxygen equivalent to or higher than the 21 percent oxygen present in an air atmosphere and has a strictly respiratory-type metabolism
Anaerobe	Grows in the absence of oxygen; some anaerobes have a fermentative-type metabolism; others may carry out anaerobic respiration in which a terminal electron acceptor other than oxygen is used
Facultative anaerobe	Can grow aerobically or anaerobically—characteristic of a large number of genera of bacteria including coliforms such as <i>Escherichia coli</i>
Microaerophile	Capable of oxygen-dependent growth but only at low oxygen levels; cannot grow in the presence of a level of oxygen equivalent to that present in an air atmosphere (21 percent oxygen)
<b>pH</b>	
Acidophile	Grows at pH values less than 2
Alkalophile	Grows at pH values greater than 10
Neutrophile	Grows best at pH values near 7
<b>Salinity</b>	
Halophile	Requires salt for growth: extreme halophiles (all are archaea), 2.5 M to 5

	M salt; moderate halophiles, usually low levels of NaCl as well as 15 to 20 percent NaCl
<b>Hydrostatic pressure (100 atmospheres per 1,000-m depth)</b>	
Barophile	Obligate barophiles, no growth at 1 atmosphere of pressure; barotolerant bacteria, growth at 1 atmosphere but also at higher pressures. A number of deep-sea bacteria are called barophilic if they grow optimally under pressure and particularly if they grow optimally at or near their in situ pressure (0.987 atm = 1 bar = 0.1 megapascal [Mpa])
<b>Nutrition</b>	
Autotroph	Uses carbon dioxide as its sole source of carbon
Heterotroph	Unable to use carbon dioxide as its sole source of carbon and requires one or more organic compounds
Chemoorganoheterotroph	Derives energy from chemical compounds and uses organic compounds as a source of electrons
Chemolithoautotroph	Relies on chemical compounds for energy and uses inorganic compounds as a source of electrons. Five classes: hydrogen bacteria, iron bacteria, sulfur bacteria, ammonia oxidizers, and nitrite oxidizers. Specific nutritional groups of bacteria that do not clearly fit in this category include obligate methane oxidizers and the carbon monoxide oxidizers. There are also photoorganoheterotrophs and photolithoautotrophs among the anoxygenic photosynthetic bacteria.
Mixotroph	Capable of growing both chemoorganoheterotrophically and chemolithoautotrophically; examples include some of the hydrogen bacteria and some species of <i>Thiobacillus</i> (sulfur-oxidizing bacteria)
Oligotroph	Can develop at first cultivation on media containing minimal organic material (1 to 15 micrograms carbon per liter) and grow on such media in subsequent cultivation
Copiotroph	Requires nutrients at levels 100 times those of oligotrophs

**NOTES:** California residents to pay appropriate sales taxes on top of listed prices. Shipping and Handling (S&H) is included in the prices. Standard shipping is 5-day ground. Expedited (UPS 2nd Day Air) is available for an additional cost.

**PAYMENT:** EBS accepts credit cards (MasterCard and Visa) and checks. EBS does not accept company purchase orders, unless special arrangements are made in advance. For ordering or questions, please contact: Jim Jacobs at 415-381-5195. **PRICES SUBJECT TO CHANGE WITHOUT NOTICE.**

### **INSTALLATION OF THE iSOC SYSTEM**

EBS performs the installation of iSOC systems on the west coast. For larger iSOC projects, nationwide, please contact Jim Jacobs (415-381-5195) at EBS about an installation bid, by an EBS-certified and trained iSOC installer. The price of installation includes all the equipment and start-up of the system as well as the collection of background geochemical indicators for appropriate wells.

### **iSOC RENTALS AND RECYCLING/BUY-BACK**

EBS does buy back iSOC and iSOC equipment. EBS recycles the equipment (newer iSOCs only, without the control panels), cages, manifolds, regulators, etc. The equipment undergoes a thorough decontamination process, retesting and recertification by EBS. The equipment would then have an EBS warranty. The equipment is then available for rental through EBS for a modest monthly fee. Please call Olivia Jacobs at 510-590-1099 for more information.

### **CONSULTING TO CONSULTANTS**

EBS does provide consulting on iSOC systems and enhanced bioremediation projects, nationwide on an hourly basis of \$150/hr. Since 2002, EBS has worked with numerous environmental consultants, viewing previously collected data and evaluating the potential for bioremediation at specific sites.

### **FREE WORKPLANS AND DRAWINGS**

EBS has provided consultants and land owners with free aerobic and anaerobic workplans on the [www.ebsifno.com](http://www.ebsifno.com) web site. In addition, professional drawings are included related to the installation and operation of the iSOC system. Material Safety Data Sheets for various gases is included and many iSOC case studies are also presented on the web site under "Enhanced Bioremediation."

More information can be obtained at [www.isocinfo.com](http://www.isocinfo.com) or [www.gasinfusion.com](http://www.gasinfusion.com)

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