

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

Final

OFFICE OF
WATER

SUBJECT: Guidance for Phase I Chemical Tests, UIC* Quality Assurance (UIC-OA) Program - (GWPG #35)

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TO: Water Supply Branch Chiefs/ Ground Water Section Chiefs
Regions I-X

Background

On September 30, 1983, the final version of the general grant regulations was published under 40 CFR Part 30. In §30.503(e) the regulations require that States and local governments receiving assistance from EPA implement a Quality Assurance (QA) program. The QA program must have: 1) a management plan identifying the State agency and/or office responsible, resources available and the person in charge of the program; and 2) a commitment on the part of the State to do all "environmentally related measurements" in accordance with scientific methods approved by EPA. This latter requirement would mean, among other things, that each entity administering a UIC program must structure all the components of its sampling and testing program, including sampling and testing by the operators, to conform with EPA accepted procedures.

In the case of Direct Implementation programs, the Director (RA) establishes criteria for QA of all environmentally related measurements submitted in support of UIC activities. The authority for QA in the UIC program is based on 40 CFR §144.28, §144.51 e) and f) and §144.52 which require adequate QA to be used when submitting data mandated in the program. Data submitted by well operators also needs to include QA elements. Furthermore, it is logical to interpret requirements for the submission of data to include intrinsically the requirement for adequacy (i.e., QA).

* See glossary of acronyms preceding attachments.

Due to the newness of some of the testing procedures used in the UIC program and the program itself, implementation will take place in three sequential phases. The first phase addresses traditional chemical tests*. The second will address widely used physical tests, and the third, less well known geophysical tests.

Purpose

The purpose of the Quality Assurance program is to develop methods of gathering chemical, physical and biological data which are scientifically accurate, legally sufficient, and reproducible. For this reason it is the intention of EPA to require States to assess the adequacy of their present data gathering - activities and to offer technical help where needed to assist States in upgrading their programs to meet federal QA standards. If a State already has a comprehensive, coordinated and effective QA program, it should submit the program to the Regional Office for evaluation. The RO may recommend some revisions to assure that the QA program is in conformance with scientific methods approved by EPA.

This guidance for Phase I will help recognized UIC agencies (i.e., State agencies, RO's) in the preparation of a QA project plan for chemical test in the UIC program. It is not the intention of EPA to modify the existing UIC delegated program in any manner. This guidance does not change the parameters which are being tested for and does not change the frequency of these tests.

Specific QA project plans may deviate from this guidance with proper justification. The EPA will evaluate those project plans in light of the overall QA program goal that environmental measurements be representative, accurate, comparable, complete, and of known quality.

This guidance was prepared by the UIC-QA workgroup which include representatives from EPA (Office of Drinking Water, UIC Regional Offices and Regional Quality Assurance Officers) and States (TX, MS and NM). It reflects the consensus of this workgroup.

* These include analyses of injection fluids, formation fluids and any other aqueous solutions in their terminal stable form or any of their intermediary forms.

Guidance

The QA project plan for chemical analysis must contain the following elements. However, if any of these are duplicated in other programs they can be incorporated by reference (e.g. NPDES, or RCRA QA programs). Furthermore, the preparer can, if warranted, consolidate some of the elements under generic headings. The RO should indicate to States what would be acceptable.

- Plan Overview
- Organization and Responsibility
- Sampling Procedures
- Sample Preservation, Stabilization and Chain of Custody
- Laboratory and Field Equipment Calibration Procedures
- Analytical Procedures
- Documentation, Data Reduction, Validation and Reporting
- Internal Quality Control Checks
- Performance and Systems Audits
- Preventive Maintenance
- Precision and Accuracy Protocols/Limits
- Data Representativeness, Comparability and Completeness
- Quality Assurance Reports
- Standard Operating Procedures (SOPs)

Attachment A gives instructions for each of the sections above.

It also gives specific examples or "boiler plate" for some of the more generic sections. These examples give the minimum acceptable conditions. References are also given which would help the State in preparing the plan and obtaining useful information. Particularly useful documents which the States and EPA could use as models are: "Guidance for the Development of a QA Plan by Regional Team" (Regions 8,9,10) and "Guidance for the Preparation of Combined Work QA Project Plans for Environmental Monitoring" (OWRS QA-1). These are available from the RQAOs.

In preparing the UIC-OA project plan for chemical tests, the UIC agency should consider only the needs and requirements of the State program. Some States, as in the case of a Class II program (oil & gas related) require very few chemical analyses by the operator, and may also include only a few chemical tests by the UIC agency in support of UIC. In such States, only the tests that are actually done in support of the UIC program should be covered. However, the preparer of the plan should give consideration not only to the primary use of the data, but also secondary uses. One example of this would be to consider possible applications in enforcement activities (secondary use) for any data submitted to support a permit application (primary use). The SQAQO should make sure that unsophisticated tests done to estimate certain parameters such as conductivity, are not used to rule out contamination episodes or to estimate TDS concentrations for permit purposes.

EPA has not established a valid test for "Compatibility" of injection fluids in injection formations. However, if a compatibility test is required under a State UIC program it must be included in the QA plan. EPA will revise this guidance in the future as compatibility tests are studied. In general, operators perform some tests to evaluate the ease of injection (e.g., whether there is precipitation of solids in the formation). Attachment "C" gives a short discussion of compatibility and a test which can be done to determine ease of injection.

RCRA and CERCLA offices should be able to provide sampling guidance for "high hazard" samples taken to analyze Class I hazardous waste injection fluids. The ROs should include this information in the guidance to be given to states that have HW facilities.

Implementation

The ROs will receive this guidance by March 1985 and will proceed immediately to introduce it to the States. Upon introduction, the States will contact all persons (i.e., affected operators, laboratories and other State offices) involved in the sampling, testing, processing and reporting of UIC chemical data. The implementation of this part of the UIC-OA program in the State should take place through the 1985 grant year. The RO's UIC section will determine the adequacy of the State QA project plan. The ROAOs should also approve the project plan. For Direct Implementation States, the ROs must send the QA project plan to the Chief, Underground Injection Control Branch in Headquarters.

The ROs will include a condition in the grant agreement or workplan with respect to the full implementation of phase I of the UIC-OA program nine months after the release of guidance by EPA. This condition should read:

"The State agrees to submit to EPA an approvable phase I OA project plan within sixty (60) days and to implement the phase I OA program within nine (9) months of the issuance of EPA guidance on the subject. The phase I OA program will follow the requirement in 40 CFR §30.503(e) and guidance provided by EPA on this subject."

generated under the guidelines of the UIC-OA after implementation of the program in the State will be deemed inadequate for UIC purposes. At this point, there is no explicit regulation requiring the owner or operator to comply with specific QA practices outlined in this and subsequent guidance. EPA and State can assure compliance with the program by including QA requirements as a part of all permits issued. Ultimately, the regulations, both State and Federal, should be amended to include requirements outlined herein.

f) How QA requirements will be disseminated to the regulated community. The preparer* should indicate what plans have been made to disseminate information. Some vehicles that could be used are:

1. Newsletters
2. Statewide meetings
3. Fact Sheets
4. Information bulletins to accompany permit applications.
5. Trade associations

*The person in the state or RO who has been charged with preparing the UIC-OA phase I plan.

II. ORGANIZATION AND RESPONSIBILITY

Instructions

The preparer must name the office or offices responsible for UIC-QA chemical tests, and indicate how the UIC-QA program will be implemented. Split responsibility can arise when the 1422 (Class I, III, IV and V) program and the 1425 (Class II) program choose to implement different UIC-QA programs.

Throughout this guidance many different responsibilities are assigned to the State Quality Assurance Officer (SQAQO). Some of these responsibilities may be delegated to other program participants (e.g. laboratory personnel), however, the SQAQO should be ultimately responsible for the adequacy of the QA program to the RO.

The preparer must also indicate the various offices and agencies involved in the generation and use of UIC fluid chemical data. In some States different environmental programs will integrate many or all their field activities. In these cases, sampling for the UIC program (surveillance) may fall under the responsibilities of a separate agency. The State (or the RO in DI States) must ensure that adequate QA practices are implemented in all offices contributing to the UIC effort.

The preparer (see footnote on previous page) must also show how the State will ensure that all data generated by the operators will follow the State's QA requirements. As mentioned before,

all data submitted as part of a permit application, self-monitoring and any other UIC activity are also required to be covered by the QA program. Either the State or the RO in Direct Implementation States, must establish a program to periodically check on QA compliance by the operators.

III. SAMPLING PROCEDURES

Instructions

The State should specify in its QA plan how, when and where the sampling should be done using permit and generic requirements as a base. Some useful examples of general sampling techniques should be mentioned. Specific recommendations should also be made. The State should develop a short fact sheet to be used by operators which specifies the minimum amount of information to be included on the sample label. It should emphasize the importance of a specific description on how and where the sample was taken.

Attachment B (pages B.3 thru B.18) includes "Standard Procedures for the Collection of Ground Water Samples from Residential and Municipal Wells" which is applicable to a variety of investigations dealing with inorganic parameters.

Some general recommendations that could be made in this section follow.

Example

The sampler should coordinate with the laboratory doing the analysis to ensure proper scheduling. Attachment C gives the specified containers, preservation techniques and holding times for selected samples. After collecting all samples they should be handled as few times as possible. All personnel should use extreme care to ensure that samples are not contaminated.

Sample containers should be rinsed with sample water at least twice before using. The sampler should make sure that when warranted, the well is evacuated prior to taking ground water samples. Extreme care shall be taken to ensure that all materials in pumps, tubing, bailers and sample containers do not contaminate the sample by releasing materials that would interfere with, add to, or react with the components being tested. The same precautions should be taken to prevent any adsorption of the sample components by the materials in the pumps, tubing, bailers and/or sample containers. The type of equipment and the sample containers used in the collection and preservation of samples should be determined by investigating their compatibility with the expected components in the sample.

All samples should be taken at representative locations. If possible, injection fluid samples should be taken out of the injection line.

References

The plan preparer should reference or include relevant portions of useful publications (in accordance with copyright laws).

Some particularly useful publications are:

- * Manual of Ground Water Sampling Procedures; Available from NWWA; phone (614) 846-9355.
- * Manual of Ground Water Quality: Monitoring Methodology; EPA-600/4-76-026.
- * Test Methods for Evaluating Solid Waste - Physical/Chemical Methods; SW-846 - 2nd edition.
- * Sampling Ground Water for Organic Contaminants, EPA 600/5-80-022.
- * Handbook for Sampling and Sample Preservation of Water and Wastewater EPA-600/4-82-029.
- * U.S. Geological Survey 1977; Handbook of Recommended Methods for Water Data Acquisition. USGS Office of Water Data Coordinators, Reston, Virginia.
- * Wood, WW; 1976 Guidelines for Collection and Field Analyses of Ground Water Samples for Selected Unstable Constituents, U.S. Geological Survey Techniques for Water Resources, Investigations Book 1, Chapter D-2.
- * Standard Methods for the Examination of Water and Wastewater, Current Edition
- * Suitability of Containers for Storage of Water Samples. Water Resources Council Technical Paper 16. 39 pages, 1976.
- * "Air-lift Samplers for Zone-of-Saturation Monitoring." Morrison R.D., Brewer, P.F.; Ground-Water Monitoring Review, No. 1, Vol 1, p.52 1981
- * "Guidelines and Techniques to Obtain Valid Ground-Water Quality Samples." Claassen, H.C.; Open-File Report (USGS, 1978), 54 pages.
- * Sources of Spatial-Temporal Variability in Ground-Water Quality Data and Methods of Control" Keith, S.V.; Wilson, L.G. Fitch H.R., Esposito D.M.; Ground-Water Monitoring Review, Number 3, Volume 2, p21, 1983

* Some Observations on Field Experiences with Monitoring Wells." Hunkin, G.G.; Reed, T.A.; Branch, G.N; Ground-Water Sampling, Englewood, CA.; Ground-Water Monitoring Review, No 1, Vol 1, p. 43, 1984.

IV. SAMPLE PRESERVATION AND STABILIZATION

AND CHAIN OF CUSTODY

Instructions

The handling of samples from the sampling point to the laboratory is very important. The preparer should define adequate preservation, storage and transportation procedures and make sure that documentation of the sample will take place. The plan should require a sampling label (see Figure 1) and a bound laboratory log book to ensure that all details associated with the sampling, transportation and analyses can be retraced. The sampler should also keep a weather-proof log book in which the relevant conditions of the sampling methods are recorded. Sample wording of this section follows.

Example

All samples must have a sampling label containing at least the information shown in Figure 1. This label must remain with the sample throughout its collection, storage, transportation and analysis. When the sampler (operator) reports the analysis to the State, the sampling label should be referenced by its "Sample ID No." and date of collection and analysis. The sampler and/or the laboratory must retain all sampling labels

(NAME OF SAMPLING ORGANIZATION)

SAMPLE DESCRIPTION _____

FACILITY: _____ LOCATION: _____

WELLS: _____

DATES: _____

TIME: _____

TYPE OF FACILITY: _____ SAMPLING LOCATION: _____

SAMPLE TYPE: _____ PRESERVATIVE: _____

SAMPLED BY: _____

SAMPLE ID NO.: _____

LAB NAME _____

R
E
M
A
R
K
S

Figure 1. Example of General Sample Label

NOTE: To prevent problems if the label becomes detached from the sample container, each should be marked with the same symbol. The container can be marked with indelible ink, and if used again, the same number/symbol should be referenced on the label. There are certain types of label tape which are solvent resistant, can be ordered in a roll, preprinted, and written on or stamped with indelible ink. (Attachment "C" includes an example of a sample label.)

or the information on them for three years or as required by the State Quality Assurance Officer (QAO). Where samples may be needed for legal purposes, "chain-of-custody" procedures (as defined by the enforcement agency in the State and/or EPA) must be used.

All laboratories performing analyses of samples must retain a "laboratory log" as part of their records. This log should show the dates of sample receipt, preparation, analysis and results of the sample as well as other relevant information.

V. LABORATORY AND FIELD EQUIPMENT OPERATION AND CALIBRATION PROCEDURES

Instructions

The preparer of the QA plan should include in it the appropriate SOP and methods which will aid in assuring that both field and laboratory equipment are functioning properly.

The plan should either include or reference the written calibration procedures, the reference standards, and QC samples used. The use of these standards and samples is essential to ensure system control and to measure operator performance. A description of a continuous review process over these control systems should also be included. These control functions should include the internal laboratory activities.

Provisions for equipment maintenance, inspection, and testing procedures must be implemented. This is necessary to ensure that all facility equipment, servicing instruments, and any other ancillary items are available, properly functioning and maintained. A description of how the responsible authority monitors and controls this vital function shall be included. Preventive maintenance and inspection procedures must cover such diverse items as laboratory instruments, the facility high vacuum system, the water distillation or deionization unit, glassware washing machines, thermometers, thermostats, pressure gauges, constant voltage transformers, etc.

The State should develop a SOP for operation of field equipment used to obtain preliminary water quality data. Some such equipment may include Chloride HACH kits, field conductivity meters, portable pH meters, etc. In the plan the SQAOs should define the applicability of the field kits from their experience and manufacturers' literature. EPA intends to provide further guidance on this subject in the future.

A field and laboratory equipment check list(s) must be developed. The list(s) should include equipment operating parameters, such as temperature, pressure, flow rate, voltage, etc. In addition, to the check list(s), an equipment maintenance log book containing calibrations and repairs must be established and it must remain with the piece of equipment in the lab, or in a safe location for field equipment. Maintenance schedules should also follow manufacturer's recommendations.

The methods referenced in "Analytical Procedures" indicate the calibration procedures and frequency for the equipment used. Each laboratory involved in the analysis of UIC related samples should have a record showing the dates of calibration for the preceding three years or longer as required by the State QAO. This record should be available for inspection by the QAO.

To comply with this requirement it is necessary for all laboratories doing tests required in the UIC program to agree:

- To retain calibration logs for three years
- To retain laboratory logs for three years
- To retain sampling labels or information on them for three years
- To perform all analytical tests in accordance with methods specified in this plan.

Example

[Due to the diversity of equipment used in laboratories, it would be impossible to present a representative example. The State should prepare this section in accordance with the type of laboratory equipment it has available. Some equipment which would be used universally in labs includes items like balances and thermometers. Balances should be zeroed each time they are used and calibrated annually, and thermometers should be calibrated at least annually.]

[Field equipment, especially the so called "kits", should be periodically checked against more sophisticated lab equipment

and calibrated every time they are taken out. For example, titration equipment used for chloride determination should be checked against amperometric titrators or more complex/accurate equipment.]

VI. ANALYTICAL PROCEDURES

Instructions

The preparer should use this section to give the operators the range of acceptable procedures. All these procedures must have been approved by EPA and the State.

Example

All water quality tests required in the UIC program must be done in accordance with the following methods:

1. Inorganic compounds, water quality measurements: 40 CFR Part 136 "Guidelines Establishing Test Procedures for the Analysis of Pollutants," §136.3, Table I. This list references the accepted methods to test waters for inorganic contaminants. It also includes some physical tests (temperature, specific gravity, etc.). This document is available from the SOAO.
2. Organic compounds, water quality measurements "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater": EPA-600/4-82-057 July 1982; available from the Center for Environmental Research Information (CERI)
26 West St. Clair Street,
Cincinnati, Ohio 45268.
Phone: (513) 684-7562 or FTS 684-7562.

NOTE: This publication provides procedures that are as uniform and cost effective as possible (with some minor compromises) for the analysis of some organic pollutants. It also provides references that would be helpful to the analyst.

3. Methods for the analysis of inorganic compounds. "Methods for Chemical Analysis of Water and Wastes": EPA-600/4-79-020, March 1979; available from Center for Environmental Research (CERI), 26 West St. Clair Street, Cincinnati, Ohio 45268. NOTE: This reference is included in 1. above and provides acceptable analytical methods.
- 4.* Other analyses not covered above should be performed in accordance with the most recent edition of "Standard Methods for the Examination of Water and Wastewaters": American Public Health Association, American Water Works and the Water Pollution Control Federation. Other analyses not covered above should be performed by the best available methods.
- 5.* For Class II programs, analyses which require a high degree of accuracy must be done as explained above or in accordance with "API Recommended Practice for Analysis of Oil-Field Waters" API RP 45.

Note: Techniques already approved and used for other programs (RCRA, CERCLA, NPDES, PWSS, etc.) should be deemed acceptable for the same type of analyses.

* The preparer of the plan should make it clear that the use of the last two references above (Nos. 4 and 5) is adequate until EPA approves specific tests to be used.

VII. DOCUMENTATION, DATA REDUCTION, VALIDATION AND REPORTING

Instructions

The QA program should include documentation of all samples. The preparer of the QA plan should prepare SOPs in which the type of record to be maintained and the method of storage are defined.

The preparer should also include those mathematical and/or statistical procedures which should be used by the generators of data to convert raw data into final form. Cross-checking procedures should also be indicated. If the data are to be entered into a computer system, the SOP should explain the procedure to do so.

Validation procedures can be incorporated into the State's data gathering effort by split sample analyses, duplicate sample analyses, spiked addition recoveries and intra and inter laboratory comparisons. Validation procedures are described in the EPA document "Calculation of Precision, Bias and MDL for Chemical and Physical Measurements" (March 30, 1984) which is available from the RQAOs.

The State Quality Assurance Officer (SQAQO) should prepare written instructions to validate data. Analyses of outliers* (as determined by SQAQO) should be done routinely. An adequate

*Data which are significantly different from other expected results

matrix presentation or other graphical display of the data can help to identify outliers.

The SQAQO should consider the establishment of a formal laboratory certification program. This could be done either by the incorporation of UIC related laboratories into other certification programs such as the one for PWSS or the creation of a new program which could be expanded in the future to include all State environmental programs. The ROs must use labs certified for other programs (NPDES, PWSS), if available, for samples taken to support DI programs. The States should also use these labs where applicable.

The State or RO should determine what its needs are in this area and include them in the project plan. The RQAQO should be consulted for assistance.

VIII. INTERNAL QUALITY CONTROL CHECKS

Instructions

The preparer of the State QA plan should require all laboratories to check their results. Only data of known quality (precision, accuracy, etc.) will be acceptable to EPA. These checks must be done as explained in standard EPA Quality Control publications (see references below) or by using other reliable methods. Sample wording to this effect is shown in the following example.

Example

All laboratories performing analyses of UIC samples should maintain a program to frequently check their results with

expected ones. This could be done by selecting representative samples of analytical results for the particular area or type of injection fluid whenever possible. Any radical variation should be investigated. A regular program of instrument calibration should be developed and followed. Quality Control criteria are explained in "Handbook for Analytical Quality Control in Water and Wastewater Laboratories": EPA-600/4-79-019, March 1979 available from:

Center for Environmental Research Information (CERI),
26 West St. Clair Street,
Cincinnati, Ohio 45268
PHONE: (513) 684-7562 or FTS 684-7562.

NOTE: This publication provides information on quality control measures such as control of the quality of the reagents, standardization of titrants, monitoring of instruments' response, etc.

Practices such as those listed below must be implemented in laboratories to ensure adequate quality control.

1. Standard Curve Data - Where applicable, standard curves must be checked and calibrated at least monthly. This requirement applies to atomic emission, ion chromatographic and colorimetric methods. Atomic absorption curves should be obtained daily.

2. Standardization of Titrants - When standard solutions (titrants) are used for quantitative analyses to determine the concentration of pollutants, these titrants must be standardized monthly or more frequently if the method requires it. Traceability to the National Bureau of Standards should be established for all reagent chemicals used as standards in the calibration of equipment.
3. Electrochemical Methods - Electrochemical instruments must be standardized each day (or shift) in which they are used. These standardization procedures can be found either in the methods text used or manufacturer's instructions for the instrument.
4. Analytical Balances - Because the balances are the primary standard in the laboratory, care must be taken to ensure their accuracy. Each balance should be serviced annually. In addition, Class 'S' weights must be weighed weekly to document accuracy or to detect problems so corrective action can be taken.
5. Duplicate Analyses - Duplicate analyses must be done on at least ten percent (10%) of the UIC samples received. If there are less than 10 samples in a batch, 1 duplicate analysis should be done.

Results of these analyses must fall within the acceptance limits for precision defined in the "Precision and Accuracy Protocols/Limits" Section XI.

6. Spiked Sample Analyses - Spiked sample analysis allows the laboratory personnel to evaluate the accuracy of the sampling method performed on a routine basis. A spiked sample is created by adding a known amount of the constituent being analyzed to a representative portion of the original sample. The amount of spike should be approximately equal to the concentration of the analyte in the original sample. At least 10% spikes or 1 per batch (if less than 10 samples per batch) must be run.

The Regional Quality Assurance Office will make documents available outlining the instructions for preparation of spiked samples and to evaluate the results of such analyses. Section IX outlines how to obtain "QC Samples" to assess performance.

7. Preparation of a Quality Control Manual - Each laboratory should prepare a QCM to document the responsibilities of the laboratory personnel. Also, all QC checks should include acceptance/rejection criteria.

IX. PERFORMANCE AND SYSTEMS AUDITS

Instructions

We recommend that the SQAQO make periodic visits to laboratories doing analyses of UIC water (fluid) samples. These visits may be done as part of the evaluation audits for several programs

(i.e., NPDES, PWSS, RCRA, etc.). The visits could include evaluation of laboratory quality control procedures as well as their interface with sampling practices. SQAO visits should be included in program work plans following recommendations by the ROAO. The laboratories should also analyze Q.C. samples periodically. These samples will be provided by EPA and made available to laboratories through the SQAOs. These samples would be reflective of everyday samples received in the laboratory and the concentrations would be known to the SQAO. The SQAO should request these QC samples from the ROAO. Appendix "D" includes an order form to obtain Q.C. Samples. This form should be sent to the ROAO.

The SQAO can also recommend candidates to the ROAO for the "Performance Evaluation Program." The Performance Evaluation Program sends "blind" samples to the participating labs. The labs perform the analysis and send the result to the Environmental Monitoring and Support Laboratory (EMSL). EMSL evaluates the results and informs the ROAO. Participation in this program is limited.

Example

All laboratories and other parties participating in the collecting, transporting and analyzing of chemical samples for the UIC program are subject to audit visits by the State QA Officer. These visits would concentrate on assuring that the activity being performed is in accordance with the State's QA plan and scientific principles.

The SOAO would provide the laboratories with "QC Samples". These samples would have a composition known to the analyst. The analysis of the sample and reporting of the findings would indicate to the lab and the SOAO the quality of the work done in the lab and any shortcomings.

The State QA Officer should assist any participant that requires assistance in improving performance. Please refer to the front of this plan for the name and address of the State Quality Assurance Officer.

X. PREVENTIVE MAINTENANCE

Instructions

The preparer of this plan should draw upon his/her own experience in chemical analysis to decide what preventive maintenance is needed. The plan should at least call for laboratories and field units to perform the maintenance required in the operational manuals for the equipment used. Another important consideration would be the availability of critical spare parts for the equipment. The State QA Officer may want to require a list of such parts from each of the participating laboratories.

Example

All laboratories and field units participating in the collection of environmentally related data for the State UIC program must have a preventive maintenance program. A log must be kept documenting the maintenance. A good practice would be to have a list of critical spare parts available at the location where the equipment is kept/stored and for it to be available to the SOAO.

XI. PRECISION AND ACCURACY PROTOCOLS/LIMITS

Instructions

Estimates of data precision and accuracy must be developed in accordance with EPA guidelines entitled, "Calculating Data Quality Indicators" and "Establishing Achievable Data Quality Goals". These guidelines and updates are available from the RQAOs.

Laboratory personnel should be consulted with regard to the selection of analytical methods. The respective detection limits and statement of precision and accuracy for the optional methods should be provided. Once the methods are selected, the detection, precision, and accuracy requirements for these should be incorporated into the QA plan. Along with each requirement, there should be a protocol to monitor whether these requirements were met. For example, intra-laboratory precision can be monitored by using replicate samples. Accuracy can be monitored with the use of field blinds, spikes, surrogate spikes, National Bureau of Standards' Standard Reference Materials (SRMs), EPA QC reference samples, etc. Wherever possible criteria should be set for the "total measurement". This

could be accomplished for example, with the use of field spikes and replicate samples. As a minimum, acceptance criteria should be within plus or minus two standard deviations of the precision and accuracy data published for the parameter by EPA.

The written and other material mentioned above are available from the Regional Quality Assurance Officer (RQAO).

Example

[The SQAO should follow the recommendations above. Boiler-plate language does not lend itself to this situation].

XII. DATA REPRESENTATIVENESS COMPARABILITY AND COMPLETENESS

Instructions

Data "representativeness" is a qualitative element which refers to a sample or a group of samples that reflect the characteristic of the waste stream at the sampling point. It also includes how well the sampling point represents the actual parameter variations which are under study. For example, the representative point to sample the injection fluid is at the most immediate place before injection and not at a point before dilution, treatment, sedimentation and mixing. The permit would most likely specify sampling points at a facility. The preparer of the project plan should provide some guidelines on the proper sampling location in accordance with local treatment and construction practices. A SOP can be developed for this purpose.

"Comparability" is also a qualitative characteristic which must be considered in QA program planning. Depending on the end use of data, comparability must be assured for the project in terms of sampling plans, analytical methodology, quality control, data reporting, etc. For example, in the example above for representativeness, in order to have comparability, all samples must be taken from the same location in the waste stream and at the same time. Another comparability issue would be that data should be reported in comparable units.

"Completeness" is defined as the amount of valid data obtained from a measurement system compared to the amount that was expected and needed to be obtained in meeting the project data goals. The determination of data completeness is the responsibility of the sampler (reporting party) as determined by guidance and requirements specified by the SOAO. For example, if unexpected events such as breakdown of equipment, weather conditions and poor quality of reagents caused 70% of the required test to be scrapped, the reporting party (operator) should qualify the results obtained. This by no means releases the operator from the reporting requirements under the UIC program.

Example

[The SOAO should prepare this section following the principles defined above. This section is not amenable to boiler-plate language].

XIII. QUALITY ASSURANCE REPORTS

Instructions

The preparer of this plan should obtain agreement from the SOAO and the Director of the UIC program (State or RO) as to the

schedule for reporting. A logical alternative would be to integrate QA reporting with annual UIC reporting by the State or to consolidate all QA reports for chemical tests for all environmental programs administered by a single agency. The report should indicate to EPA that the State is applying adequate QA techniques for all its environmentally related measurements. The State should agree to report to EPA on:

- o Program highlights
- o Number and name of participating laboratories
- o Types of fluid quality tests performed
- o Future plans
- o Training
- o Number of laboratories visited by the SQAQ.
- o Evaluation of performance audit studies

The reports should be sent to the Regional UIC program office and the RQAQ.

An example of the reporting requirements applicable to laboratories and other participating parties follows. This reporting would help the SQAQ when reporting to EPA.

Example

All participants in the UIC-QA program must report their activities to the SQAQ. These reports should contain at least the following elements:

- o Name and location of unit
- o Types of analysis done and samples taken
- o Number and types of tests done in the reporting period.

- o Future plans
- o Training
- o Evaluation of performance audit studies

The reports should be sent to the SQAQO (see beginning of plan) by no later than January 15 of each year for the preceding year.

XIV. STANDARD OPERATING PROCEDURES (SOPs)

Instructions

Standard Operating Procedures (SOPs) are very effective in assuring that certain complex and repetitive tasks are done in the same manner every time. The laboratories, samplers and/or operators should prepare SOPs. The State should decide which of these SOPs should be sanctioned by the SQAQO.

The SOP should provide step by step instructions on the handling of the sample, chain of custody, preservation and analytical procedures if warranted. It should be written at the level of the user and available at each working station.

Example

An SOP should be prepared by the operators, samplers and laboratory personnel for each procedure that is done repeatedly or routinely. The SOP should be written in simple terms as to be understandable to the person doing the work.

The operator may develop as many SOPs as needed, however, all SOPs used to develop UIC reporting data should be sanctioned by the SQAQO as necessary. The SQAQO will, at the request of the operator, provide guidance on the preparation of specific SOPs. All SOPs should follow scientific and EPA approved methods and procedures as well as equipment recommendations when applicable.

ATTACHMENT B

- o Examples of Completed Sample Labels
- o Standard Procedures for the Collection of Ground-Water Samples from Residential and Municipal Wells

Example of Complete Sample Label (1)

(NAME OF SAMPLING ORGANIZATION)

SAMPLE DESCRIPTION Formation

STATE: MT COUNTY: _____

FACILITY OR FIELD: Cedar Creek Anticline

LEGAL LOCATION: SW, SE, Sect. 19, T4N, R62E

NAME OF SAMPLE SOURCE: Carter Oil

TYPE OF SOURCE: Potential Oil Reservoir

GEOLOGIC SOURCE: Darwin SAMPLE INTERVAL: 8320-8349

DATE: 11/14/41 TIME: _____

SAMPLING LOCATION: Insitu/Drill Stem SAMPLE TYPE: Formation Water

FIELD TEMP OF SAMPLE: 153° F FIELD PH: _____

Remarks: Drill stem test (DST) flowed for 1 1/2 hours sample appears to be contaminated with mud filtrate. See completion report for details of DST (attached).

Example of Complete Sample Label (2)

(NAME OF SAMPLING ORGANIZATION)

SAMPLE DESCRIPTION Produced Water

STATE: WY COUNTY: Carbon

FACILITY OR FIELD: Wertz Oil Field

LEGAL LOCATION: Section 6, T26N, R89W

NAME OF SAMPLE SOURCE: Wertz #47

TYPE OF SOURCE: Producing Oil Well

GEOLOGIC SOURCE: Tensleep, Amsden, Darwin, and Madison

SAMPLE INTERVAL: Multiple perforation from 5867 to 6587

DATE: 12/28/81 TIME: 2:30 pm

SAMPLING LOCATION: Heater Treater SAMPLE TYPE: Formation Water

FIELD TEMP OF SAMPLE: 60°F FIELD PH: 7.2

PRESERVATIVE: _____

Comments: Heater Treater (HT) is receiving water and oil only from well #47. HT is pumped every 4-5 days. HT was pumped out 4 days prior to sampling (see attached sampling location description).

STANDARD PROCEDURES FOR THE COLLECTION OF GROUND-WATER SAMPLES FROM RESIDENTIAL AND MUNICIPAL WELLS*

INTRODUCTION

This document outlines procedures for the collection of representative ground-water samples from residential and municipal wells. It specifically addresses monitoring of ground-water quality in relation to the subsurface injection of salt water. As such, the procedures presented address only inorganic parameters and do not consider the more difficult task of sampling for organics.

The collection of representative ground-water samples is neither a straightforward or easily accomplished task. In fact, many feel that it is impossible to collect a ground-water sample that is truly representative of aquifer water quality conditions due to changes which may occur during sample collection, preparation, preservation and storage prior to analysis. However, certain procedures can be adopted that will maximize the integrity of the sample. This document presents in a step-by-step manner procedures which will ensure not only the collection of ground-water samples which are representative as possible but also allow for maximum efficiency in sample collection. The following procedures are divided into five sections. These are:

1. Obtaining background information.
2. Obtaining laboratory information and materials.

* This material was obtained from the state of Arizona and Paul Osborne of EPA Region VIII who helped in its preparation while working for the state.

3. Sample collection, preparation, preservation and storage.
4. Field measurements of in situ parameters.
5. Chain of custody procedures.

1. OBTAINING BACKGROUND INFORMATION

The necessary first step in the collection of ground-water samples is to obtain background information on the liquid suspected of affecting the ground-water quality and specifics of the area and wells to be sampled. This information can then be used to design a sampling program which will provide the maximum efficiency of sampling and improve the quality of the collected data. Information to be obtained during this first phase includes:

o Identification of parameters for analysis:

For salt water waste streams, the principal parameters of interest are pH, specific conductance, alkalinity, Ca, K, Mg, Na, Cl, and SO_4^{-2} . Additionally, salt water may contain various trace metals. Collection of samples for these metals will affect the sampling protocol with respect to preparation and preservation of the samples. If possible, any other constituents in the injected stream should be identified in advance. This will allow for development of an appropriate scheme for preparation and preservation of the samples for metal analysis if necessary. The procedures discussed in the following sections will differentiate between

the principal parameters of the wastes and the metals.

o Scheduling

Proper scheduling of sampling periods for residential municipal wells is important in obtaining representative samples. It is important that a municipal well be sampled while it is pumping, because water that has been held stagnant in the well casing will not be representative of the aquifer being sampled. Be sure to collect samples from residential wells when the water is at equilibrium with the aquifer. This will depend upon the water usage at the residence. It is best not to take a sample immediately after heavy usage (after morning showers) or after a long period of little or no usage (usually late to mid-afternoon). When sampling a group of residential wells in a particular area, be sure to sample them over a relatively short period of time. When collecting more than one round of samples, make the sample periods consistent with respect to the time of day the samples are taken.

o Accessibility

When sampling residential and municipal wells, site accessibility is normally not a problem, especially since only a limited amount of equipment has to be brought

on-site. However, accessibility of the well can cause major problems. Before attempting to sample a residential well, determine if the well is physically accessible for sampling. For municipal wells, check to see if a spigot or valve is available from which a sample can be taken. In both cases, be sure that the sampling port or spigot is positioned as close to the wellhead as possible and before any type of treatment unit, such as a water softener or filtration.

o Materials

Contact the owner or operators of the wells to determine what tools, valves, hoses, etc., will be needed. Wrenches may be needed for opening and closing faucets or spigots. Often ports or valves on municipal wells may be too large and their use may result in a high volume flow which will make sampling difficult. In this case, it will be necessary to reduce the flow by using appropriate fittings. Obtain information from the operator on the size of the fittings required and on accessibility of the sampling spigot. It may be convenient to attach a section of hose to the line, especially in very cramped quarters.

2. OBTAINING LABORATORY INFORMATION AND MATERIALS

The importance of communicating with laboratory personnel responsible for analysis of the samples prior to sample collection cannot be overemphasized. They can be an important source of information and materials if they understand the specifics of the sampling program. This will not only improve the efficiency of the program, but also the accuracy and completeness of the results. It will be necessary to establish with the laboratory the procedures and analyses which you wish to conduct. The laboratory personnel may be able to lend guidance or give suggestions pertaining to particular problem areas which may develop, and provide written instructions from the laboratory for any nonroutine procedures pertaining to sample preparation, preservation and storage.

o Sample bottles

Once the laboratory knows the analyses to be conducted, they will be able to supply the appropriate bottles and preservatives or inform you as to what you should obtain. The size of the bottle will depend on the analysis to be conducted and the analytical methods to be employed. Be sure to collect sufficient samples for duplicate analyses should they be required. The type of bottles will depend upon the suspected constituents. For the constituents of salt water, linear polyethylene

bottles are best. Wide-mouth bottles will provide easy access during both sampling and analysis. The amount of the sample needed varies according to the method to be used in the analysis and the preservation methods.

o Sample Care

In choosing a laboratory it may be necessary to weigh the efficiency of using one near the sampling site versus the greater degree of reliability of a well-known but distant laboratory to which samples must be shipped. If the latter option is used, make sure that the logistics of transport, shipping, and pickup have been fully worked out so that the chain-of-custody is not compromised and that sample preservation times are not exceeded.

3. SAMPLE COLLECTION, PREPARATION, PRESERVATION, AND STORAGE

One important goal of sample collection is to obtain a representative sample of aquifer water by minimizing changes that may occur in the field while the sample is collected, preserved and stored. Seemingly small departures in collection techniques can significantly affect the results of the tests. Care in handling and cleanliness must be maintained from the time the sample is taken until it is delivered to the laboratory. Consistency is the key to quality control. The following outlined procedures, if adhered to, should produce

samples that are as close as practically possible to representative aquifer conditions.

o Well Evacuation

As previously mentioned, it is important to remove stagnant water from a well that has not recently been pumped prior to taking a sample. This is because standing water that has been exposed to the atmosphere or has been in contact with the well casing or pump, even for short periods of time, will react with these substances, and its chemical composition will be altered. Contact with air will affect pH, alkalinity, and specific conductance. Changes in these parameters will in turn oxidize certain metal constituents and cause them to precipitate.

The amount of water that should be removed from the well is dependent on the diameter and depth of the well, the depth to ground water, and the yield of the well. A general rule is to evacuate three to five times the volume of water from a well which has been inoperative. The measurement of the well volume and water level should be conducted in the following fashion:

- Measure well casing inside diameter.

- Determine the static water level. This should be expressed as feet below ground surface or below casing elevation depending upon information available. (Note that the water indicator used may have to be cleaned before use in each well.)
- Determine the total depth of the well.
- Calculate the number of linear feet of static water (difference between static water level and total depth of well).
- Calculate the static volume.

The sample should be taken as the water level is rising in the well bore, i.e., as the well is filling with fresh water from the aquifer.

Sampling from residential/municipal wells can be a very straightforward procedure if the well is pumped regularly. For most residential wells, water should be run for two minutes prior to sample collection. In most cases residential samples can be taken outside without entering the house. Besides being convenient, outdoor faucets usually supply a more representative sample by intercepting water from the well before it has entered the water tank or water softener. The faucet should be checked, however, to ensure that it is, in fact, the most direct outlet from the pump. Samples from leaky or faulty spigots, or spigots that contain screens or aeration devices, are to be avoided.

Since municipal wells are high volume water producers, there is no necessity for evacuating the well. However, the lines from the wellhead to the sampling port must be evacuated. For most residential and municipal wells, the samples generally can be collected either directly into the sample bottles, or in cases where sample filtration is called for, samples can be placed directly into the filter apparatus.

o Sample Storage

Choosing a sample container is of primary importance. The material of construction must be nonreactive with the sample and especially with the particular parameter to be tested. In general, there are three types of construction materials: plastic, glass, and teflon. Samples collected for metals and general water quality parameters are stored in plastic bottles. Samples collected for organic analysis are routinely placed in glass bottles of various types and sizes depending upon the particular analysis to be conducted. In most cases, bottles will be supplied by the laboratory conducting the analysis.

o Rinsing

Just prior to filling, the sample containers are rinsed with the water to be sampled. Enough water is run into the container to rinse the inside and is then dumped out. The lid is rinsed also. Care is taken not to rest the lid on the ground or touch the inside of the lid after rinsing. Rinsing is, of course, omitted if the container is pretreated with preservative. Care should be taken not to come in contact with the sample fluid.

o Filling Sample Containers

Bottles should be filled quickly to minimize mixing with air. It is helpful to allow the water to overflow the container to prevent small bubbles from forming.

o Filtering

Whether or not a sample is to be conditioned prior to preservation and storage depends upon the analyses to be conducted and the type of sample collected. Whether or not a sample is to be filtered will depend upon the analyses to be conducted. If dissolved metal constituent concentrations are to be measured,

ground-water samples must be filtered in the field immediately after collection. Ground waters tend to be more in a reducing environment than they would be under standard atmospheric conditions, and as such, precipitation will occur if the sample is not filtered and preserved with nitric acid immediately after withdrawal.

Filtering is necessary if the sample is to be analyzed for dissolved constituents. It is not required if a total analysis of the sample will be performed. Certain metals are adsorbed by suspended sediments and if filtering does not take place they tend to raise the concentration of these constituents in the analysis. The ions Ca^{+2} , K^{+} , Mg^{+2} , Na^{+} , Cl^{-} and SO_4^{-2} tend to be relatively stable; therefore, sampling for their presence does not require filtering. However, for certain sophisticated testing methods the sample should be filtered prior to analysis. Filtering through a 0.45 micron pore size membrane should be performed if the elements Fe, Mn, Mg, Cd, Cu, As, Se, or B are involved. This is done with a device called a vacuum filter. A funnel may be helpful to direct the flow of water into the filter unit. Once the sample has been filtered, it can be transferred to the sample container. Before taking the next sample, the filter unit is rinsed with a very dilute acid solution, followed with deionized water. Also, a new filter paper is inserted.

o Sample Preservation

Complete preservation of any sample is difficult because it may be impossible to completely stabilize every constituent within a sample. At best, preservation techniques can only retard the chemical and biological changes that continue after the sample is removed from its environment. If the sample environment is significantly different from atmospheric conditions, the sample may undergo changes which will render it nonrepresentative of its original environment. Methods of preservation are relatively limited and are intended to retard biological action, retard hydrolysis of chemical compounds and complexes, and reduce volatility of constituents. Generally, preservation methods are limited to pH control, chemical addition, refrigeration, and freezing. Table 1 in Attachment D gives recommended container types, preservatives, and holding times for a variety of standard water chemical parameters.

Sample preservation should be performed in the field immediately after sample collection and preparation. In many cases where pH control or additions of reagents are required, separate bottles and chemical preservatives may be supplied by the laboratory. In other cases, the reagents or preservatives may be placed in the sample bottle prior to delivery to the site.

4. FIELD MEASUREMENTS OF IN SITU PARAMETERS

The parameters of temperature, pH, Eh (redox potential), and Ec (electrical conductivity) begin to change rapidly as soon as the sample is removed from the well. In some cases, it may be desirable to perform in situ measurements before the samples are brought to the lab. Field measurements of Eh and pH are made in a closed, air-tight flow-through cell whenever possible. The closed cell prevents the sample from reacting with the atmosphere and a stirring mechanism ensures that the sample is consistent throughout. Numerous devices for measuring field parameters are available from various manufacturers. Follow the equipment manual for the particular piece of equipment you are using. The required equipment is vulnerable to precontamination and physical abuse; thus it is important that meters for measuring pH, Eh, and Ec are calibrated periodically as recommended by the manufacturer with the appropriate liquid standards. Allow sufficient time for the electrode to stabilize before recording the measurement. The probe or thermometer should be cleaned and rinsed with distilled water following each use.

5. CHAIN-OF-CUSTODY PROCEDURES

In any activity that may be used to support litigation, the sampler must be able to provide the chain-of-possession

and custody of any samples which either are offered as evidence or for which the samples for test results are introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed or destroyed. The primary objective of these procedures is to create an accurate written record which can be used to trace the possession and handling of a sample from the moment of its collection through analysis and its introduction as evidence.

A sample is defined as being in someone's "custody" if:

- It is in one's actual possession, or
- It is in one's view, after being in one's physical possession, or
- It is in one's physical possession and then locked up so that no one can tamper with it, or
- It is kept in a secured area, restricted to authorized personnel only.

The number of persons involved in collecting and handling samples should be kept to a minimum. Field records should be completed at the time the sample is collected and should be signed or initialed, including the date and time, by the sample collector(s). Field records should contain the following information:

- Unique sampling or log number.
- Date and time
- Source of sample (including name, location and sample type).

- Preservative used.
- Analysis required.
- Name of collector (s).
- Pertinent field data (pH, DO, chlorine residual, specific conductance, temperature, redox potential, etc.).
- Serial number on seals and transportation cases.

Each sample must be labeled using waterproof ink and sealed immediately after it is collected. Labels should be filled out before collection to minimize handling of sample container.

The sample container should then be placed in a transportation case along with the chain-of-custody record form, pertinent field record, and analysis request form as needed. The transportation case should be sealed or locked. A locked or sealed chest eliminates the need for close control of individual samples. However, on those occasions when the use of a chest is inconvenient, the collector should seal the cap of the individual sample container with tape in a way that any tampering would be easy to detect.

When transferring the samples, the transferee must sign and record the date and time on the chain-of-custody record which should have been prepared according to enforcement requirements. Custody transfers made to a sample custodian in the field should account for each sample although samples may be transferred as a group. Every person who takes custody must fill in the appropriate section of the chain-of-custody record. To minimize custody records, the number of custodians in the chain-of-possession should be minimized.

ATTACHMENT C
COMPATIBILITY

COMPATIBILITY IN THE HYDROGEOLOGICAL ENVIRONMENT*

In designing an injection well, injection fluid and formation fluid interactions must be accounted for. These interactions may lead to severe reduction in formation permeability or to a loss of structural integrity within the formation itself. Fluid and formation compatibility problems are specific to the particular formation and waste involved. Their prediction and solution require site-specific studies. Specific problems associated with such compatibility include plugging of the injection formation with suspended solids, precipitation and polymerization of the waste fluid, growth of biologic organisms within the formation, and dissolution of the formation matrix.

In some cases, the injection fluid may react directly with the rock matrix. One common problem is the swelling of clays from contact with the injection fluid. Affected clays can significantly reduce the permeability of the formation. In other instances, polar-organic compounds can be adsorbed by the rocks, particularly silicates, and can significantly reduce the permeability of the formation.

The injection of acids may result in dissolution of the rock matrix. In the case of certain cemented material, dissolution can result in the migration of particles which then block pore spaces and reduce permeability. Dissolution of the confining

* This material was extracted from various reports prepared by Geraghty and Miller, Inc. for EPA-ODW under contract #68-01-5971. This material only addresses compatibility in what relates to "ease of injection". It does not address more complex problems such as waste interactions, chemical gradients, etc. EPA will develop criteria on these in the future

formation can allow the migration of injection fluid from out of the injection formation. In addition, under certain conditions CO₂ gas can be formed which may interfere with injection and may cause "blow-outs".

To avoid interaction problems, the injection and confining formations should have their respective formation fluid and rock matrices tested for compatibility with the proposed injection (or similar) fluid. Drilling a borehole offers an excellent opportunity to collect data relevant to a number of important parameters of the formations penetrated. The following are the major fluid and rock matrix sampling techniques:

A. Drill Cuttings

Drilling techniques produce cuttings which can be collected and analyzed. Cuttings produced during drilling accumulate in the hole and are removed at intervals by bailing. In rotary drilling, the cuttings are collected from the "shaleshaker". The cuttings obtained provide samples representative of the formations penetrated.

Cuttings are normally examined at the site under low-power magnification to identify rock type, grain size, color, and mineralogy. Testing the samples with acid can be used to determine carbonate material. Exposing cuttings to the injection fluid will allow other useful observations regarding compatibility.

Cuttings must be disposed-of properly once they have outlived their usefulness.

B. Coring

Geologic cores taken while drilling provide lithologic and hydrologic information superior to that obtained from the analysis of drill cuttings. Coring is accomplished through the use of a special drilling bit and a coring barrel which is attached to the end of the drill pipe. As the bit cuts into the rock, an inner core is left intact and pushed into the core barrel.

Techniques are also available to take cores from the sides of a borehole after drilling is completed. These sidewall cores are generally taken to provide information about formations from which cores were not taken during drilling. Sidewall coring is accomplished by driving a wireline coring device which contains small hollow cylinders into the formation by an explosive charge. Sidewall coring is limited to relatively soft materials.

Examination of conventional cores can provide substantial amounts of data valuable to the design and the construction of injection wells. Visual examination of cores can reveal fractures, bedding features, and solution cavities; laboratory examination can determine porosity, grain size, permeability, and formation-fluid quality. In situ behavior of the injection and confining formations can be simulated in the laboratory using conventional core samples and representative injection fluid.

Data obtained from sidewall cores are not as reliable as those obtained from conventional cores due partly to the relatively small size of the sample. Formations are disturbed substantially during coring, and the more permeable formations sampled have generally been invaded with drilling fluid.

C. Fluid Sampling

Some of the methods for obtaining formation-fluid samples are drill-stem testing, swabbing, bailing, and air-lift.

Drill-stem testing is a technique whereby a zone in an open borehole is isolated by an expandable packer or packers and fluid from the formation allowed to flow through a valve into a drill pipe. Similar to this, there is a device which can be lowered into the borehole on a wire line rather than on a drill pipe. In this case, the sample is limited to the amount that can be contained in the testing device (no more than 5 gallons).

Swabbing is a method of producing fluid similar to pumping a well. In swabbing, fluid is lifted from the borehole through drill pipe, casing, or tubing by a swab that falls freely downward through the pipe and its contained fluid, but which seats against the pipe walls on the up-stroke, drawing a volume of fluid above it as it is raised. Swabbing is preferable to drill-stem testing where unconsolidated formations cause testing to be difficult. Swabbing may also be used in conjunction with drill-stem testing

to increase the volume of fluid obtained. The advantage of swabbing is that it can be continued until all drilling mud has been drawn from the pipe, thus allowing the chemistry of the formation water sampled to reach a steady state. This procedure helps to insure that a representative sample of formation water is obtained.

Bailing may be used to obtain formation water samples, but care must be taken to insure that the water sample is representative of the formation of interest and not of another formation also draining into the borehole. This problem is reduced in holes in which casing is driven since the casing acts to isolate the lowest formation from the other water-producing formations.

In air-lift (or gas-lift) sampling, fluid can be obtained by injecting gas under pressure into the well. The gas forces the fluids in the well to rise to the surface. This method has representativeness limitations similar to those encountered with bailing.

II. COMPATIBILITY TEST FOR EASE OF INJECTION

A. Scope and Application

1. This method is designed to qualitatively determine the compatibility of waters by mixing two representative samples and evaluating the effects over a specific time.
2. The method is only applicable to the UIC program and is an approximation of the interactions which may occur in the injection zone.

B. Summary of Method

1. Equal volumes of injection and formation fluids are mixed together under controlled laboratory conditions. The mix is then allowed to stand undisturbed for 20 days and is visually observed periodically. In addition, portions of the samples are analyzed for iron and calcium before mixing to determine if these constituents are being precipitated.

C. Comments

1. Because this is a qualitative method, experience in performing the test is invaluable.

D. Sample Handling and Preservation

1. Samples must be taken in 1 liter polyethylene or glass containers. Care should be taken to eliminate air spaces in the bottles;
2. Samples must be refrigerated or chilled to 4°C with ice during storage or transit. Maximum holding times prior to beginning analysis is 48 hours.
3. The subsurface environment should be simulated to reflect actual conditions as much as possible.

E. Equipment

1. pH meter
2. Refrigerator
3. 3 or 4 liter glass beaker with watch glass
4. The equipment and reagents necessary for the analysis of iron and calcium.

F. Procedure

Before mixing the pH and the concentration of iron and calcium should be determined.

1. Carefully pour 1 liter of each sample of water together in the three or four liter beaker. Mix thoroughly with a glass rod. Allow solids to settle.
2. Using a serological pipette, remove enough of the mixture from the supernatant to analyze pH, iron and calcium. Cover mixture with watch glass.
3. Obtain the pH, iron and calcium concentrations by an acceptable technique and enter these values on the sample record form along with any observations of the mixture.

4. Carefully place beaker in refrigerator.

5. On days 3, 7, 11, 14, and 20, repeat steps 2. and 3..

H. Precision and Accuracy

There are no proven methods for evaluating the precision or accuracy for compatability. The precision and accuracy for pH, iron and calcium determinations is listed in Section VI of the UIC Quality Assurance Criteria.

COMPATIBILITY

SAMPLE RECORD FORM

Injection Water Sample Number:

Aquifer Water Sample Number:

Date Sampled:

Time Sampled:

Date Test Began:

Time Test Began

Analyst

	Date	pH	Ca	Fe	Observations
Day 1					
Day 3					
Day 7					
Day 14					
Day 20					

Refrigerator Temperature =

(Acceptable range = 2-5°C)

ATTACHMENT D

Containers, Preservatives and Holding Times
Quality Control Sample Ordering Form
Sample Preservation and Maximum Holding for Class II wells

Table I. Required Containers, Preservation Techniques, and Holding Times

Measurement Table/Parameter	Container	Preservative	Maximum Holding Time
<u>Bacterial Tests</u>			
Coliform, fecal and total	P, G	Cool, 4°C 0.008% Na ₂ S ₂ O ₂ 5	6 hours
Fecal streptococci	P, G	Cool 4°C 0.008% Na ₂ S ₂ O ₂ 5	6 hours
<u>Inorganic Tests</u>			
Acidity	P, G	Cool, 4°C	14 days
Alkalinity	P, G	Cool, 4°C	14 days
Ammonia	P, G	Cool, 4°C H ₂ SO ₄ to pH<2	28 days
Biochemical oxygen demand	P, G	Cool, 4°C	48 hours
Biochemical oxygen demand carbonaceous	P, G	Cool, 4°C	48 hours
Bromide	P, G	None required	28 days
Chemical oxygen demand	P, G	Cool, 4°C H ₂ SO ₄ to pH<2	28 days

Table I. Required Containers, Preservation Techniques, and Holding Times

Measurement Table/Parameter	Container	Preservative	Maximum Holding Time
<u>IB (Cont.) Inorganic Tests</u>			
Chloride	P, G	None required	28 days
Chloride residual	P, G	None required	Analyze immediately
Color	P, G	Cool 4°C	48 hours
Cyanide, total and amenable to chlorination	P, G	Cool 4°C NaOH to pH > 12 0.6g ascorbic acid	14 days ⁶
Fluoride	P	None required	28 days
Hardness	P, G	HNO ₃ to pH < 2	6 months
Hydrogen ion (pH)	P, G	None required	Analyze immediately
Kjeldahl and organic Nitrogen	P, G	Cool, 4°C H ₂ SO ₄ to pH < 2	28 days
<u>Metals</u>			
Chromium VI	P, G	Cool, 4°C	24 hours
Mercury	P, G	HNO ₃ to pH < 2	28 days

Table I. Required Containers, Preservation Techniques, and Holding Times

Measurement Table/Parameter	Container	Preservative	Maximum Holding Time
IB(Cont.) Metals, except above	P, G	HNO ₃ to pH<2	6 months
Nitrate	P, G	Cool 4°C	48 hours
Nitrate-nitrite	P, G	Cool 4°C H ₂ SO ₄ to pH<2	28 days
Nitrite	P, G	Cool, 4°C	48 hours
Oil and grease	P, G	Cool 4°C H ₂ SO ₄ to pH<2	28 days
Organic carbon	P, G	Cool, 4°C HCl or H ₂ SO ₄ to pH<2	28 days
Orthophosphate	P, G	Filter immediately Cool, 4°C	48 hours
Oxygen, Dissolved Probe	G Bottle and Top	None required	Analyze immediately
Winkler	G Bottle and Top	Fix on site and store in dark	8 hours
Phenols	G only	Cool, 4°C H ₂ SO ₄ to pH<2	28 days

Table I. Required Containers, Preservation Techniques, and Holding Times

Measurement Table/Parameter	Container	Preservative	Maximum Holding Time
IB (Cont.) Phosphorus (elemental)	G	Cool, 4°C	48 hours
Phosphorus, total	P, G	Cool, 4°C H ₂ SO ₄ to pH<2	20 days
Residue, total	P, G	Cool, 4°C	7 days
Residue, Filterable	P, G	Cool, 4°C	7 days
Residue, Non-filterable(TSS)	P, G	Cool, 4°C	7 days
Residue, settleable	P, G	Cool, 4°C	48 hours
Residue, volatile	P, G	Cool, 4°C	7 days
Silica	P	Cool, 4°C	28 days
Specific conductance	P, G	Cool, 4°C	28 days
Sulfate	P, G	Cool, 4°C	28 days
Sulfate	P, G	Cool, 4°C add zinc acetate plus sodium hydroxide to pH>9	7 days
Sulfite	P, G	None required	Analyze immediately
Surfactants	P, G	Cool, 4°C	48 hours
Temperature	P, G	None required	Analyze immediately
Turbidity	P, G	Cool, 4°C	48 hours

Sample Preservation and Maximum Holding Times Specific to Class II Well Samples

The sampling preservation and maximum holding times are defined to maintain the integrity of the samples so that accurate and reliable data will be generated by the laboratories analyzing such samples. It is incumbent on the sampling teams to understand these requirements and plan the sampling projects so that the requirements are met. It is also necessary that the laboratory personnel understand the requirements and notify clients when there are problems so that corrective action can be taken.

Sampling containers should be made from polyethylene with polyethylene lined lids. Glass is required only when dissolved oxygen samples are stabilized in the field and titrated later. Glass sample bottles may be used for all other sample types but polyethylene lined lids are necessary.

When filtration is required, it should be performed on-site. If conditions preclude field filtration, the samples must be delivered to facilities and filtered within four(4) hours. Samples should be chilled to 4°C during transit.

Table II summarizes preservation and holding times for some tests.

TABLE II

Parameter	Preservation Technique	Maximum Holding Time
Major Cations (Na ⁺ , K ⁺ , Ca ⁺² , Mg ⁺²)	HNO ₃ to pH<2.0	6 months
Major Anions (Cl ⁻ , SO ₄ ⁼ , F ⁻ , Br ⁻)	Chill to 4°C	1 month
Trace Metals (Fe, Mn, Zn, Pb, Hg)	HNO ₃ to pH < 2.0	6 months
Alkalinity	Chill to 4°C	14 days
Sulfide	Chill to 4°C 2nd Zn Acetate Reagent per liter, NaOH to pH>9.0	7 days
pH	None	1 hour maximum
Dissolved Oxygen	Meter method - none Winkler method - add MnSO ₄ and Azide - NaOH reagents	determine on-site 8 hours
Specific Conductance	Chill to 4°C	28 days
Total Dissolved Solids	Chill to 4°C	7 days
Compatibility	Chill to 4°C	48 hours

Note: Holding time and preservation requirements for other parameters may be obtained from the RQAOs.

PRINT OR TYPE.

QUALITY CONTROL SAMPLE REQUEST

Telephone _____

City _____ State _____ Zip Code _____

Name of Laboratory Director _____
Indicate Programs for which QC samples are requested: Ambient Monitoring
 Drinking Water Wastewater Toxics (TSCA) Solid Waste/Hazardous Wastes (RCRA)

WATER QUALITY/WATER POLLUTION SAMPLES

- Demand
- API Reference Oils
 - Arabian Light Crude
 - Prudhoe Bay Crude
 - South Louisiana Crude
 - No. 2 Fuel (high arom.)
 - No. 6 Fuel (high visc.)
 - Bunker C
- LAS
- Mineral
- Mun. Digested Sludge
- Nutrients
- Oil & Grease
- Pesticides in Fish
- PCBs in Fish
- PCBs in Sediments
- Phenols (4AAP Method)
- Residues
- Other _____

PCBs in Oils

- Aro. 1016 in Capac.
- Aro. 1016 in Hydraul.
- Aro. 1016 in Trans.
- Aro. 1242 in Capac.
- Aro. 1242 in Hydraul.
- Aro. 1242 in Trans.
- Aro. 1254 in Capac.
- Aro. 1254 in Hydraul.
- Aro. 1254 in Trans.
- Aro. 1260 in Capac.
- Aro. 1260 in Hydraul.
- Aro. 1260 in Trans.
- Trace Metals WP - I
- Trace Metals WP - II
- Trace Metals WP - III
- Trace Metals in Fish
- Volatile Organics
- Other _____

WATER SUPPLY SAMPLES

- WS Corrosivity/Sodium
- WS Herbicides
- WS Nitrate/Fluoride
- WS Chl. Hyd. Pest. I
- WS Chl. Hyd. Pest. II
- WS Res. Free Chlorine
- WS Temik
- WS Trace Metals
- WS Trihalomethanes
- WS Turbidity
- Other _____
- Other _____

PRIORITY POLLUTANTS/HAZARDOUS WASTES/TOXIC CHEMICALS

- n-Alkanes
- Aromatic Purgeables
- Chlorinated Hydrocarbons
- Chl. Hyd. Pest. WP - I
- Chl. Hyd. Pest. WP - II
- Chl. Hyd. Pest. WP - III
- Cyanide
- Dichlorobenzenes
- EP Metals
- GC/MS Acids
- GC/MS Base Neutrals - I
- GC/MS Base Neutrals - II
- GC/MS Base Neutrals - III
- GC/MS Pesticides - I
- GC/MS Pesticides - II
- GC/MS Purgeables - I
- GC/MS Purgeables - II
- GC/MS Purgeables - III
- GC/MS Purgeables - IV

- Haloethers
- Halo. Purgeables - I
- Nitroaro. & Isophorone
- PCBs (specific Aroclors)
 - Aroclor 1016
 - Aroclor 1221
 - Aroclor 1232
 - Aroclor 1242
 - Aroclor 1248
 - Aroclor 1254
 - Aroclor 1260
 - Aroclor 1252
- Phenols (GC)
- Phthalate Esters
- Polynuclear Aromatics I
- Polynuclear Aromatics II
- Polynuclear Aro. SRM 1647
- Other _____
- Other _____

BIOLOGICAL SAMPLES

- Chlorophyll Fluoro.
- Chlorophyll Spectro.
- Phytoplankton
- Simulated Plankton
- Other _____
- Other _____

REQUESTED: _____

DATE SHIPPED: _____



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