Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant

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Appendix GWMP

United States Department of Energy
Waste Isolation Pilot Plant

Carlsbad Area Office
Carlsbad, New Mexico

Groundwater Surveillance Program Plan

WP 02-1 Rev. 3
GROUNDWATER SURVEILLANCE PROGRAM PLAN

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1.0 INTRODUCTION

This is the controlling document for the Waste Isolation Pilot Plant (WIPP) Groundwater Surveillance Program (GSP). The GSP is administered as part of the WIPP Environmental Monitoring Program by the Environmental Monitoring (EM) Section of the Environment, Safety and Health (ES&H) Department.

2.0 REFERENCES

DOE Order 5400.1, General Environmental Protection Program

DOE/EH 0173T, Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance

Groundwater Protection Management Program Plan

WP 02-3, Environmental Procedures Manual

WP 10-AD, WIPP Maintenance Administrative Procedures Manual

WP 12-1, Waste Isolation Pilot Plant Safety Manual

WP 12-107, Hazard Communication Program

WP 13-1, WID Quality Assurance Program Description

WP 15-6, Purchasing Policies and Procedures Manual

WP 15-PR, Records Management Plan

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3.0 RESPONSIBILITIES

The overall organizational structure of the Westinghouse WID is described in Part I, Section 1 of the Quality Assurance Program Description (QAPD). The GSP is the responsibility of the ES&H Department. The GSP is conducted by the EM Section of this department.

The EM manager assumes responsibility for the overall design and implementation of the GSP including the following areas:

- Development and approval of specific procedures for the conduct of all GSP activities.
- Establishment of minimum qualification criteria and training requirements for all program personnel.
- Review and approval of programmatic reports.

- Oversight of appropriate levels of cooperation and consultation between the EM Section and the state of New Mexico regarding environmental monitoring.

- Preparation of the QA section of the GSP Plan.

The EM manager and staff are responsible for achieving and maintaining quality in the GSP. Job descriptions will be maintained for the EM manager, professional, technical, and administrative staff positions. All GSP data shall be reviewed and approved by the EM manager, or designee, prior to release.

The EM manager appoints a GSP Team Leader (TL), assigning the following responsibilities to the TL:

- Direct GSP per written approved procedures.

- Initiate review of programmatic plans and procedures.

- Review and evaluate sample data.

- Prepare and review programmatic reports.

- Assure that appropriate samples are collected and analyzed.

- Assure that adequate technical support is provided to the Quality and Regulatory Assurance (Q&RA) Department, when required during audits of vendor facilities.

The EM manager designates one or more scientists, engineers, or technicians who will be responsible for the following items:

- Collection and subsequent distribution of samples.

- Preparation and maintenance of appropriate data sheets and sample tracking documentation.

- Monitoring of equipment operability status.

- Reporting of equipment malfunctions.

- Reporting of nonconformance to the TL or EM manager.

- Overseeing of quality control checks of data.

- Conducting field activities in accordance with written procedures.

The Q&RA manager provides independent oversight of the GSP, via the assigned cognizant Q&RA engineer, to verify that quality objectives are defined and achieved. The Q&RA manager ensures objective, independent assessments of GSP quality performance. The Q&RA manager has been delegated authority and given organizational freedom by the WID General Manager to access work areas, identify quality problems, initiate or recommend corrective actions, verify implementation of corrective actions, and ensure that work is controlled or stopped until adequate disposition of an unsatisfactory condition has been implemented.

The EM manager assures that basic qualifications for GSP personnel are carried out in accordance with Section 2 of the QAPD.

The EM manager assures that position descriptions for assigned GSP personnel are adequately prepared. Each position description will include position purpose, principal responsibilities, nature of work, and scope.

The EM manager and/or TL assures that training is performed on an individual basis to maintain an acceptable level of proficiency by all new or temporary GSP staff and by all permanent GSP staff.

New GSP employees are required to review pertinent program documentation, become familiar with applicable procedures, and complete appropriate qualifications prior to undertaking any unsupervised GSP task. To become qualified to perform a specific task or series of tasks, an employee must demonstrate subject knowledge and practical skills and become certified in performing the task(s) by a board-certified subject matter expert (SME). Employees who have not completed the appropriate qualification card will not be allowed to conduct unsupervised GSP activities.

The EM manager, TL, or task SME may determine the need for retraining of GSP personnel. Retraining may be noted by Q&RA during any surveillance or audit or during a periodic review initiated by the EM manager, TL, or SME.

The EM manager assures that documents detailing all staff training are current and properly filed. Copies of training records shall be on file in the WID Technical Training Section.

4.0 GSP QUALITY ASSURANCE PLAN

4.1 Introduction

This section is the quality assurance (QA) plan for the WIPP GSP. The objective of this QA plan is to establish the specific QA requirements associated with the GSP. The GSP currently consists of two activities: the Water Quality Sampling Program (WQSP) and the Water Level Monitoring Program (WLMP). Technical implementation of each specific activity is controlled by an individual program plan and unique operating procedures. The GSP provides a mechanism for addressing the following:

4.1.1 Department of Energy (DOE) Order 5400.1

Chapter 3 of the DOE Order 5400.1, General Environmental Protection Program, states that "... all Department of Energy (DOE) sites will conduct a groundwater protection management program." The order requires each DOE site to provide for the design and implementation of a groundwater monitoring effort that supports resource management and complies with applicable environmental laws and regulations.

4.1.2 DOE/EH 0173T

DOE/EH 0173T, Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance, states that:

It is the policy of DOE to conduct effluent monitoring and environmental surveillance programs that are adequate to determine whether the public and the environment are adequately protected during DOE operations and whether operations are in compliance with DOE and other applicable Federal, State, and local radiation standards and requirements. It is also DOE policy that Departmental monitoring and surveillance programs be capable of detecting and quantifying unplanned releases and meet high standards of quality and credibility. It is DOE's objective that all DOE operations properly and accurately measure radionuclides in their effluent and in ambient environmental media.

4.1.3 Resource Conservation and Recovery Act (RCRA)

By virtue of a Groundwater Monitoring Waiver, prepared under 40 CFR 265, the WIPP Project is not required to monitor groundwater to comply with the U.S. Environmental Protection Agency (EPA) RCRA. The WIPP GSP provides a basis for future compliance to the RCRA, as well as any other groundwater protection-related regulations, should the need arise.

4.1.4 Final Environmental Impact Statement (FEIS) Commitments

Section J.2.2 of the FEIS states that "...long-term groundwater sampling and water level monitoring will be conducted as part of the WIPP Environmental Monitoring Program."

4.1.5 Future Land Use Decisions

Data collected from the program will aid in making future groundwater-land use decisions (i.e., designing long term and passive institutional controls for the site).

This QA plan is driven by, and is supplemental to, both the WID QAPD, WP 13-1, and implementing WIPP Q&RA procedures.

4.2 GSP Quality Assurance Requirements

The following specific Q&RA requirements are unique to the GSP.

4.2.2 Quality Assurance Program

This plan is governed by the following documents: WP 13-1, WID Quality Assurance Program Description; and WP 02-3, Environmental Procedures Manual. Steps to ensure quality are incorporated, as needed, in the technical procedures used for groundwater surveillance activities. The EM manager or assigned designee is responsible for developing and maintaining this QA plan and groundwater surveillance procedures.

In accordance with the WID QAPD, Part I, Section 1, groundwater surveillance data activities are classified as Quality Code II.

4.2.3 Design Control

The design control requirements used by Westinghouse at the WID are described in Part II, Section 6 of the QAPD. The GSP will adhere to all applicable portions of these requirements when performing design activities.

4.2.4 Procurement Document Control

Procurement is carried out in accordance with WID procurement policies and procedures, as outlined in Part II, Section 7 of the QAPD, and WP 15-6, Purchasing Policies and Procedures Manual. Both documents require specification of a quality code and design class and concurrence by the Q&RA Department with procurement documents. Technical requirements for procured items and services are developed and specified in procurement documents. If deemed necessary to ensure attainment of the required characteristics, procurement documents may require suppliers to have an adequate QA program.

4.2.5 Instructions, Procedures, and Drawings

Provisions and responsibilities for the preparation and use of instructions and procedures at the WIPP are outlined in Part II, Section 4 of the QAPD. Quality-affecting activities performed by or on behalf of groundwater surveillance are required to be performed in accordance with documented and approved procedures.

Technical procedures have been developed for each quality-affecting function performed for groundwater surveillance. The technical procedures unique to the GSP are contained in the procedures section of this manual. The procedures are as detailed as required and include, when applicable, quantitative or qualitative acceptance criteria to determine that activities have been satisfactorily accomplished.

Procedure requirements are in accordance with Section 4 of WP 13-1. Procedures will be prepared in accordance with applicable technical writer's guides.

4.2.6 Document Control

Requirements for the control of documents are outlined in Part II, Section 4 of the WID QAPD. Controls ensure that the latest approved versions of procedures are used in performing groundwater surveillance functions and that obsolete materials are removed from work areas.

4.2.7 Control of Purchased Material, Equipment and Services

WIPP policy requirements and associated responsibilities for the control of purchased material, equipment, and services are outlined in Part II, Section 7 of the QAPD. In accordance with current WIPP procurement policies and procedures, measures will be taken to ensure that procured items and services conform to specified requirements. These measures will include one or more of the following:

- An evaluation of the supplier's capability to provide items or services in accordance with the requirements, including the history of providing similar products or services satisfactorily.
- An evaluation of objective evidence of conformance, such as supplier submittal (i.e., QA plan).
- An examination and testing of items or services upon delivery.

If it is determined that additional measures are required to ensure quality in a specific procurement, additional steps may be provided in procurement documents and implemented by groundwater surveillance staff and/or the Q&RA Department. These additional assurances may include source inspection and audits or surveillance at the supplier's facilities.

4.2.8 Identification and Control of Items

Measures to ensure that only correct and accepted items are used at the WIPP are outlined in Part II, Section 8 of the QAPD. All items that potentially affect the quality of the GSP are uniquely identified and controlled to ensure that only accepted items are used.

Equipment is administered in accordance with WP 10-AD, WIPP Maintenance Administrative Procedures Manual. Calibration reports test data are maintained by the EM Department. Any "out-of-tolerance" condition is evaluated for potential impact on the validity of data. Impact evaluation and corrective actions are initiated per specific GSP instructions.

4.2.9 Control of Processes

All process control requirements of the QAPD are met by the GSP.

4.2.10 Inspection/Surveillance

Inspection and surveillance activities are conducted as outlined in Part II, Section 10 of the QAPD. The Q&RA Department is responsible for performing the applicable inspections and surveillance on the scope of work. Performance checks are performed by groundwater surveillance personnel as specified by the appropriate procedures, and by WID metrology laboratory personnel. Performance checks for the GSP are designed to determine the acceptability of purchased items and to assess degradation that occurs during use.

4.2.11 Test Control

Part II, Section 8 of the WID QAPD outlines the requirements and responsibilities of the WID for the control of tests. Tests to be performed for the GSP fall into two general categories: tests of items upon receipt and in service, and operability checks of equipment.

All tests are performed in accordance with documented and approved plans and/or procedures. Testing or experimental/monitoring plans or procedures contain the following provisions as applicable:

- Scope and/or definition or scope.
- Prerequisites such as calibrated instrumentation and supporting data; adequate test equipment and instrumentation, including accuracy requirements; completeness of item to be tested; suitable and controlled environmental conditions; and provisions for data collection and storage.
- Instructions for performing the test.
- Mandatory inspection and/or hold points to be witnessed by the WID or other designated representatives.
- Acceptance and rejection criteria.
- Methods of documenting or recording test data.
- Requirements for qualified personnel.
- Evaluation of test results by authorized personnel.

4.2.12 Control of Monitoring and Data Collection Equipment

Monitoring and Data Collection (M&DC) equipment is controlled and calibrated according WP 10-AD, WIPP Maintenance Administrative Procedures Manual, to ensure continued accuracy of groundwater surveillance data. Results of calibrations, maintenance, and repair are documented. Calibration records identify the reference standard and the relationship to national standards or nationally accepted measurement systems. Records are maintained to track uses of M&DC equipment. If M&DC equipment is found to be out of tolerance, the equipment is tagged and its use ceased until corrections are made. An evaluation shall be approved by the EM manager and corrective measures will be taken, as needed.

4.2.13 Handling, Storage, and Shipping

Handling, storage, packaging, and shipping of groundwater samples are controlled in accordance with WP 10-AD, WIPP Maintenance Administrative Procedures Manual. Proper documentation is prepared and maintained for each sample to minimize damage, loss, deterioration, and extraneous exposures.

4.2.14 Inspection and Acceptance Testing

Measures used by the WID to ensure that required inspections and tests performed are outlined in Part II, Section 8 of the WID QAPD. Controls are implemented in accordance with documented procedures to ensure that items are not used prior to passing required inspections and tests. The status is identified on the items or on documents traceable to the items. Items that have not been accepted are identified as such and stored separately from accepted items. The operating status of equipment is identified on the equipment or on the equipment list. Faulty equipment is tagged and, if practicable, physically segregated from the work area.

4.2.15 Control of Nonconforming Conditions

Part II, Section 8 of the WID QAPD describes the system used at the WIPP for ensuring that appropriate measures are established to control nonconforming conditions. Nonconforming conditions connected to the GSP are identified in and controlled by documented procedures. Equipment that does not conform to specified requirements is controlled to prevent use. The disposition of defective items is documented on records traceable to the affected items. Prior to final disposition, faulty items are tagged and segregated. Repaired equipment is subject to the original acceptance inspections and tests prior to use.

4.2.16 Corrective Action

Requirements for the development and implementation of a system to determine, document, and initiate appropriate corrective actions after encountering conditions adverse to quality at the WIPP are outlined in Part I, Section 3 of the QAPD. Conditions adverse to acceptable quality are documented and reported in accordance with corrective action procedures and corrected as soon as practical. Immediate action will be taken to control work performed under conditions adverse to acceptable quality, and its results, to prevent degradation in quality.

The EM manager or designee investigates any deficiencies in groundwater surveillance activities to determine if there is an underlying root cause. All such actions are documented and reported to the Q&RA Department.

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4.2.17 Quality Assurance Records

Part I, Section 4 of the QAPD outlines the policy used at the WIPP regarding identification, preparation, collection, storage, maintenance, disposition, and permanent storage of QA records. The EM manager or designee is responsible for the preparation and distribution of records in accordance with appropriate DOE Orders, policies, and directives.

Records to be generated in the GSP are specified by procedure. QA records are identified. This is the basis for the labeling of records as "QA" on the EM Records Inventory and Disposition Schedule (RIDS).

QA records document the results of the GSP implementing procedures and are sufficient to demonstrate that all quality-related aspects are valid. The records will be identifiable, legible, and retrievable in accordance with WP 15-PR, WID Records Management Plan, and QA record procedures.

While in the custody of the GSP group, the records shall be stored in a UL listed, one-hour fire-resistant cabinet. The EM manager shall coordinate with WIPP Project Records Services (PRS) for both periodic and perpetual transfer of records to PRS.

4.2.18 Assessments

Provisions and responsibilities for assessments are outlined in Part III, Sections 9 and 10, of the QAPD. Periodic, independent assessments of the GSP shall be scheduled, planned, and performed to verify that work is performed in accordance with specified requirements. The Independent Assessment Section has the responsibility and oversight authority for appraising GSP activities for compliance with applicable environmental statutes. Assessment teams will not include members of the GSP staff. Assessments are performed in accordance with applicable assessment procedures.

5.0 GSP WATER QUALITY SAMPLING PLAN

5.1 <u>Scope</u>

This section of the WIPP GSP Plan serves as the controlling document for the WQSP. The WQSP is a subprogram of the GSP.

The WQSP was initiated in January 1985. The objective of the program is to collect representative and reproducible groundwater samples from water-bearing zones in the area of the WIPP site. The purpose of the program is to provide defensible data for meeting the requirements of site characterization, performance assessment, regulatory compliance, and permitting. A program plan that defined the basic structure and operational activities of the program was initially developed by Colton and Morse (1985). The program plan was replaced in 1987 by WP 07-2, Waste Isolation Pilot Plant Water Quality Sampling Manual. In 1991 the WQSP manual was replaced by WP 02-1, Waste Isolation Pilot Plant Groundwater Monitoring Program Plan and Procedures Manual.

5.1.1 General

From 1984 to 1990, the WQSP was designed to characterize the physical and chemical characteristics of representative groundwater samples occurring within and immediately surrounding the WIPP site. Various wells were serially sampled, three times each, to determine the representative character of the groundwater present at each location. Data collected were supplied to the ES&H Department and used to develop a baseline of water quality data as part of the Radiological Baseline Program. A nonradiological database was developed to support the background water quality characterization report. Data were also supplied to and used by Sandia National Laboratories (SNL) for site characterization and performance assessment. By the close of 1990, the groundwater of interest had been characterized, and the objective of the program shifted from characterization to surveillance.

On October 1, 1988, the ES&H Department assumed responsibility for the WQSP. Water quality sampling activities were coordinated with the Environmental Monitoring Program.

Collection of groundwater quality data continues to assist the DOE in meeting performance assessment, regulatory compliance, and permitting requirements. The data also provide:

- Radiological and nonradiological water quality input to the WIPP Environmental Monitoring Program.
- A means to comply with future groundwater inventory and monitoring regulations.
- Input for making land-use decisions (i.e., designing long-term active and passive institutional controls for the site).

Groundwater exists both above and below the WIPP repository, but no hydrologic continuity exists between the repository and the groundwater. Groundwater below the repository occurring in the sandstones of the Delaware Mountain Group (Powers, et al., 1978) is isolated by bedded salt deposits in the lower part of the Salado Formation and in the underlying Castile Formation. Groundwater below the repository is not being monitored as part of this program.

Groundwater above the repository is being monitored. Groundwater exists in both the Dewey Lake Formation and the Rustler Formation. Zones monitored for background characterization within the Rustler are the Culebra and the Magenta members. These zones appear to be dolomite units isolated from one another by impermeable units. With the exception of excavated shafts at WIPP, these zones are isolated from the repository excavations by bedded salt deposits in the upper two thirds of the Salado Formation.

Postbackground surveillance is focused on the Culebra because it is the primary flow path within the Rustler formation. Databases are maintained for the Magenta so that if the need arises surveillance of the Magenta can be resumed.

The Culebra is areally persistent, but quantity and quality of water vary considerably from place to place. The dolomite is vuggy, fractured, and commonly associated with anhydride (Lambert and Mercer, 1977). The Culebra has a low hydraulic conductivity. It is a fractured unit that is best modeled as a dual-porosity media. Water yields are small and saline (Powers et al., 1978).

The Magenta is finely crystalline and dense. Like the Culebra, the Magenta has a low hydraulic conductivity through fractures and contains limited amounts of poor quality water (Powers et al., 1978).

The Dewey Lake Redbeds consist of orange-red silt stone, mud stone, and some sandstone. The Dewey Lake Redbeds do not form an aquifer, but some permeable sand lenses are present and those yield limited quantities of fresh water to a few private wells in the area around the WIPP site (Powers et al., 1978). One such sand lens has been identified within the WIPP boundary and is scheduled for surveillance as part of the WQSP.

5.2 Surveillance Well Construction

Many of the WIPP surveillance wells were drilled and completed prior to 1980. As the WIPP Project progressed, additional monitoring wells were completed in the vicinity of the site. Drilling of the bulk of WIPP surveillance wells began in 1976 and continued into 1988.

In general, all of these wells were drilled as part of the geologic site characterization and resource evaluation programs. Most WIPP surveillance wells were drilled and completed using oil field techniques. Surveillance wells at the site have been completed, generally, using two types of installations. One installation requires drilling the well to some depth below the base of the Culebra and then casing the well to the bottom of the hole. The interval of the Culebra or Magenta is then perforated to allow access to the formation for testing or sampling purposes. The second type of installation consists of drilling the hole to a depth just above the top of the Culebra, installing well casing to the bottom of the drilled hole, and coring or drilling through the Culebra interval, leaving the Culebra interval open to the formation.

These types of well completions presented problems in collecting undisturbed and representative samples from the water-bearing units. The open-hole completions have, in some cases, resulted in sediments below the Culebra being exposed in the sampling interval. In some cases, these sediments are rich in halite or other evaporite minerals, causing the water chemistry in the well bore and the water-bearing unit surrounding the well to be altered. Often, during drilling and completion of surveillance wells, fluids containing fresh water, saturated brine, and drilling fluids containing petroleum products have been introduced into the well bore. In some cases, these fluids were left standing in the well bore for extended periods of time, resulting in contamination of the surrounding formation (Crawley 1988).

Standard oil field steel well casings have been used during completion of the WIPP surveillance wells. This type of casing is easily corroded by the brackish to brine water found in the WIPP area. Based on serial sampling results, it appears that the products of well casing corrosion migrate from the well bore into the formation, resulting in a halo or plume of groundwater with altered chemistry surrounding the surveillance wells. Obtaining a representative sample has required that the surveillance wells be pumped for long periods of time to remove the contamination.

Well drilling and completion techniques such as those described above are usually not used for installation of monitoring wells employed in RCRA or other groundwater sampling programs, due to the likelihood of aquifer contamination. These practices required that the WQSP use extensive groundwater pumping in order to obtain uncontaminated water samples.

The difficulty in obtaining representative groundwater samples, due to the design of the wells used by the WQSP, necessitated the use of a serial sampling technique. Serial sampling and the associated equipment are discussed later in this section.

Seven observation wells were completed after the baseline was established using EPA recommended drilling methods and casing materials that have the potential to meet RCRA monitoring standards. Six of the wells were completed in the Culebra; one well in the Dewey Lake formation. Two years of sampling are scheduled prior to the anticipated receipt of waste. The data gathered from these wells will be compared to the existing database and the existing background data will be appended as appropriate.

The configuration of the seven new observation wells may well preclude the necessity to perform serial sampling. However, sampling of a portion of the older surveillance wells may be necessary in years to come. Therefore, a discussion of serial sampling techniques is included in this document.

5.3 Sampling Program Description

The WQSP has employed two types of sampling procedures at the WIPP: serial sampling and final sampling.

5.3.1 Serial Sampling

Serial sampling is the collection of sequential samples for the purpose of determining when the water chemistry stabilizes or reaches a steady state. Ideally, when the water chemistry stabilizes, it is assumed that the chemistry is representative of the native formation fluid, and a final sample is collected. However, in reality, serial sampling leads to the collection of water samples with reproducible chemistries which may or may not be representative of the undisturbed groundwater. The water samples may still be impacted by well construction practices and effects from the installation of downhole pumping and sampling equipment.

During the background characterization phase of the WQSP serial sample, field parameters were monitored on a daily basis. After completion of the background characterization phase, monitoring of serial sample parameters was modified by pumping each well for 48 hours prior to the start of serial sampling then comparing the serial sampling analysis results to the average last day serial sample results for previous sampling rounds. A 95 percent confidence interval was established for comparison standards.

The field analytical parameters found to be the most useful in identifying a steady state condition of the water chemistry include chloride, divalent cations (hardness), and alkalinity, which are analyzed by classic wet chemistry bench methods (titration). Total iron has also been found to be a useful indicator and is analyzed using spectrophotometric methods. Other serial sampling parameters analyzed in the field include measurement of pH, Eh, temperature, specific conductance, and specific gravity. Procedures for collection and analysis of serial samples are processed, approved, and maintained by the site documentation process.

5.3.2 Final Samples

Final groundwater samples are collected once evidence from serial sampling indicates that the pumped groundwater has reached a chemical steady state. Final samples are forwarded to a contract analytical laboratory for analysis.

Final samples are collected in the appropriate type of container for the specific analysis to be performed. For each parameter analyzed, a sufficient volume of sample is collected to satisfy the volume requirements of the analytical laboratory. This includes an additional volume of sample water necessary for maintaining quality control standards. All final samples are treated, handled, and preserved as required for the specific type of analysis to be performed. Details about sample collection, preservation, and volumes required for individual types of analyses are found in the applicable procedures generated, approved, and maintained by the site documentation process.

Splits of the final sample are provided to oversight agencies and WIPP stakeholders as requested by the DOE. A split of the sample is also placed in storage within the ES&H Environmental Sample storage area and held until final reports from the contract analytical laboratory have been evaluated and approved. When the final laboratory report has been approved the samples are removed from storage and destroyed.

Detailed protocols, in the form of procedures, assure that samples are collected in a consistent and repeatable fashion. Procedures applicable to water quality sampling are generated, approved, and maintained by the site documentation process.

The serial sampling process will probably not be needed with the wells completed specifically for water quality sampling. However, during the first two years of sampling, the wells will be serially sampled using an abbreviated method. It is anticipated that changes in the water chemistry from stagnated to representative will occur within the first 24 hours of the purging process. Whereas, this change usually occurred over a seven-day period with the old wells.

During the first two or three years of sampling, these wells will be serially sampled with the first sample being analyzed as soon as possible after the pump is turned on and daily there after for a period of four days or until the field parameters (chloride, divalent cations, alkalinity and iron) stabilize. Eh, pH, and conductance will be monitored continuously by using a flow cell with ion-specific electrodes and a real-time readout. After two years of sampling data have been accumulated, a decision will be made to determine if the serial sampling process can be eliminated. If serial sampling is removed from the water quality sampling well protocol, the decision to collect samples will be based on the number of well bore volumes purged and the results of continuous monitoring of temperature, Eh, pH, and conductance.

5.4 Groundwater Pumping and Sampling Systems

The water-bearing units at the WIPP are highly variable in their ability to yield water to surveillance wells. The Culebra, the most transmissive hydrologic unit in the WIPP area, exhibits transmissivities that range many orders of magnitude across the site area and has been the primary focus of the GSP. The Magenta has a lower transmissivity and yields very small quantities of water to wells. Because the water-yielding characteristics of the hydrologic units at the WIPP are variable, different types of pumping equipment are used during water quality sampling activities.

The groundwater pumping and sampling systems used to collect a groundwater sample are designed to provide continuous and adequate production of water so that a representative groundwater sample can be obtained. The wells used for water quality sampling vary in yield, depth, and pumping lift. These factors affect the duration of pumping as well as the equipment required at each well. Based upon expected yields, the wells monitored at WIPP can be divided into three categories according to flow rate: (1) high flow rate of 10 to 25 gallons per minute (gpm); (2) medium flow rate or 1 to 10 gpm; and (3) low flow rate of less than 1 gpm.

The high and medium flow rate wells may use a submersible pump-packer assembly. The low-volume wells may require a gas-driven piston pump-packer assembly. A discussion of the different pump-packer equipment is provided below.

The type of pumping and sampling system to be used in a well depends primarily on the aquifer characteristics and well construction. For example, if well construction is such that it yields contamination to the aquifer (i.e., metal casing) a packer is normally recommended to minimize purging time. If the aquifer yields adequate water to the well to be classified a high or medium production well, a submersible electric pump may be used. However, if the well is completed with the water-bearing unit uncased, a gas piston pump may be needed to minimize stress to the formation walls to prevent collapse of the formation.

Wells that are completed to water quality standards are cased and screened through the production interval with materials that do not yield contamination to the aquifer or allow the production interval to collapse under stress. An electric, submersible pump installation without the use of a packer is an acceptable installation in this instance.

The largest amount of discharge from the submersible pump takes place from a discharge pipe. In addition to this main discharge pipe a dedicated nylon sample line, running parallel to the discharge pipe, is also used. Flow through the pipe is regulated on the surface by a flow control valve and/or variable speed drive controller. Cumulative flow is measured using a totalizing flow meter. Flow from the discharge pipe is routed to a discharge tank for disposal.

The dedicated nylon sampling line is used to collect the water sample that will undergo analysis. By using a dedicated nylon sample line, the water is not contaminated by the metal discharge pipe. The sample line branches from the main discharge pipe a few inches above the pump. Flow from the sample line is routed into the sample collection area. Flow through the sample collection line is regulated by a flow-control valve. The sample line is insulated at the surface to minimize temperature fluctuations.

A gas-driven pump and sampling system can be used on any volume well. When used, the pump intake is set at a predetermined depth near or in the production zone. The pumping rate is adjusted to maintain the water level in the well above the pump intake.

The flow rate for gas driven pumps is controlled by regulating the air pressure on the pump intake or by a flow control valve. Water is continuously discharged into a water storage tank. Detailed protocol for assembling, installing, and controlling pumping and sampling systems is found in the procedures generated, approved, and maintained by the site documentation process.

5.5 Pressure Monitoring Systems

Regardless of which pump is used when sampling a well that was drilled for the geologic site characterization and resource evaluation program, a packer is used to isolate the pump intake from contaminated well-bore fluid that exists in the well above the sampling zone. If the packer seal is not good, contaminated water from above the packer can leak into the formation water being sampled and bias analytical results. If the packer has a good seal the pressure above the inflated packer should remain constant.

Pressure above the packer is monitored using transducers and/or bubblers to verify that the seal on the packer is good. Pressure below the packer is monitored to ensure that water levels do not fall below the pump intake. Periodic checks of the pressures are conducted during field sampling to verify packer seal integrity. These field checks are recorded on Field Activity Log Forms.

Wells drilled to water-quality specifications do not require the installation of a packer because sample biases due to well construction deficiencies are not present. However, pressures will be monitored in the formation to maintain water level above the pump intake. Procedures governing the installation and use of pressure monitoring devices are generated, approved, and maintained by the site documentation process.

5.6 Sample Analysis

The mobile field laboratory provides a work place for conducting field sampling and analyses. The laboratory is positioned near the wellhead, is climate controlled, and contains the necessary equipment, reagents, glassware, and deionized water for conducting the various analyses.

Two types of water samples are collected: serial samples and final samples. Serial samples are taken at regular intervals and analyzed in the mobile laboratory for various physical and chemical parameters (called field parameters). The serial sample data are used to determine the chemical steady state conditions of the groundwater, as a direct function of the volume of the water being pumped from the well. Interpretation of the serial sampling data enables the TL to make a determination of when steady state conditions are attained in the pumped groundwater.

Final samples are collected when the serially sampled field parameters have achieved a steady state. If one or more of the field parameters do not stabilize, and there is reason to believe it will not, the TL may choose to collect the final sample regardless of this instability in the field parameter(s).

The objective of the serial sampling effort is to obtain representative water samples in a reproducible manner. By definition, a representative groundwater sample is a sample of undisturbed groundwater. A groundwater sample is considered to be representative of the undisturbed groundwater only if it is chemically identical to the undisturbed groundwater (i.e., completely unaltered by the effects of drilling, postdrilling processes and reactions, and sampling procedures). Obtaining a representative groundwater sample is a theoretical ideal. For example, the redox potential of the aquifer groundwater, Eh, is likely to change as a result of pressure decreases (gas loss) and contamination by atmospheric oxygen that occurs during the sampling process. The ratios between the different oxidation states of a multivariant element may change, and the total concentration of that element may also change during sampling due to precipitation.

To determine how close the pumped groundwater is to being representative, a comparison is made by monitoring the same selected field parameters which were used to initially define the background characteristics of the water. When these parameters appear stable, then the determination is made that the water sample is representative. *Stability is usually defined as ± 5 percent of the average of preceding parameter* measurements made on the final day of sampling for previous rounds.

When stability has been determined, a final sample is collected. The final sample is considered to be as representative a sample of the undisturbed groundwater as can possibly be obtained considering the analytical and technical means at hand.

5.6.1 Serial Samples

Serial samples are collected and analyzed in the mobile laboratory to detect and monitor the chemical variation of the groundwater as a function of the volume of water pumped. The purpose of implementing this rigorous serial sampling and analysis program is to ascertain when the pumped groundwater has reached a chemical steady state. Once serial sampling begins, the frequency at which serial samples are collected and analyzed is left to the discretion of the TL. The serial sampling frequency is based upon the site-specific conditions existing at each well, but usually is performed a minimum of three times during a sampling round.

The three field parameters of temperature, Eh, and pH are determined by either an "in-line" technique, using a self-contained flow cell, or an "off-line" technique, in which the samples are collected from a nylon sample line at atmospheric pressure. The iron, divalent cation, chloride, alkalinity, specific conductance, and specific gravity samples are collected from the nylon sample line at atmospheric pressure.

New polyethylene containers are used to collect the serial samples from the nylon sample line. Serial sampling water collected for solute and specific conductance determinations is filtered through a 0.45 µm filter membrane using a stainless steel, in-line filter holder. Filtered water is used to rinse the sample bottle prior to serial sample collection. Unfiltered groundwater is used when determining temperature, pH, Eh, and specific gravity. Sample bottles are properly identified and labeled.

The filtered sample collected for solute analyses is immediately analyzed for iron and alkalinity, as these two solution parameters are extremely sensitive to changes in the ambient water-sample pressure and temperature. The sample aliquot needed for the other chemical parameter analyses may be taken from a second filtered sample bottle. Temperature, pH, and Eh, when not measured in a flow cell, are measured at the approximate time of serial sample collection; these samples are collected from the unfiltered sample line.

Experience gained from the serial sampling of wells has shown that samples to be analyzed for chloride and divalent cations can be stored for one week prior to analysis with confidence that the analytical results will not be altered.

Upon completion of the collection of the final sample suite, the serial sample bottles accrued throughout the duration of the pumping of the well are discarded. No serial sample bottles will be reused for sampling purposes of any sort. However, serial samples may be archived for a period of time depending upon the need. Procedures for sample collection and analysis are generated, approved, and maintained by the site documentation process.

5.6.2 Final Samples

The final sample is collected once the pumped groundwater has achieved a chemically steady state. A serial sample is also collected and analyzed for each day of final sampling. Sample preservation, handling, and transportation methods are designed to maintain the integrity and representativeness of the final samples.

Prior to collecting the final samples, the collection team must consider the analyses to be performed so that proper shipping or storage containers can be assembled.

Final samples are sent to contract laboratories and analyzed for general chemistry, radionuclides, metals, and selected volatile organic compounds that are specific to the waste anticipated to arrive at WIPP. Gases and redox-couples were analyzed during the baseline study, but these data are not needed for environmental monitoring and are no longer obtained on a routine basis.

Water samples are collected at atmospheric pressure using either the filtered or unfiltered nylon sampling lines branching from the main sample line. The samples are collected in new and unused glass and plastic containers.

Before the final sample is taken, all plastic and glass containers are rinsed with the pumped groundwater, either filtered or unfiltered, dependent upon analysis protocol. When the rinsing procedure is completed, the final sample is collected.

5.7 <u>Sample Preservation, Tracking, Packaging and Transportation</u>

Many of the chemical constituents that are measured are not chemically stable and need to be preserved. Samples requiring acidification are treated with either high purity hydrochloric acid, nitric acid, or sulfuric acid (ULTREX or equivalent), depending upon the standard method of treatment required for the particular parameter suite.

The procedure used by the contract laboratory to which the samples are being sent prescribes the type and amount of preservative which should be used. This information is recorded on the Final Sample Checklist for use by field personnel when final samples are being collected.

The sample tracking system at WIPP uses uniquely numbered Chain of Custody Forms and Request for Analysis Forms. The primary consideration for storage or transportation is that samples must be analyzed within the prescribed holding times for the parameters of interest. Procedures for sample tracking and preservation are generated, approved, and maintained by the site documentation process.

The prescribed transport temperature for the organic samples is four degrees Celsius. This temperature must be maintained until the sample reaches the contracted laboratory.

Insulated shipping containers packaged with reusable blue ice are used to keep the samples cool during transport to the contract laboratory. Hold times for specific analytical parameters require samples to be shipped by express air freight. The coolers are packaged to meet Department of Transportation and International Air Transportation Association commercial carrier regulations.

5.8 Quality Assurance, Records Management and Document Control

All aspects of quality assurance, records management, and control of documents generated as a result of WQSP are governed by the QAPD; WP 15-PR, Records Management Plan; and implementing procedures generated, approved, and maintained by the site documentation process.

A chemistry laboratory notebook is maintained in the mobile laboratory to record the overall conditions at the well, the analytical difficulties or problems experienced, and any information which may be pertinent to future interpretation and scientific use of the field data. The original notebook is kept in the field laboratory. A copy of the notes made for each sampling round is kept in a fire-resistant file cabinet.

All field data collected are organized into a data book. The typical field data book contains the following:

- A copy of all of the notes entered into the laboratory notebook concerning the sampling round.
- A copy of all chain of custody forms and request for analysis forms used to distribute the final samples.
- A copy of the completed final sample checklist.
- A copy of all standardization forms.
- A hard copy printout of all computer data entries.
- A copy of all of the Serial Sampling Report Forms submitted for the sampling round.

- A copy of all worksheets used to prepare the data for entry into the computer.
- A written summary report containing a description of the well completion data, a brief summary of serial sampling results, and general observations.
- A copy of all Field Sketch Plan Forms.
- A copy of all Field Activity Log Forms.
- A computer printout of all data logger information, if a data logger was used.
- Validated Check Print copies of all data sheets.

A contract laboratory data book is made for each contract laboratory used to analyze samples from a particular well. The contract laboratory data book contains at a minimum:

- A copy of the contract laboratory analytical report.
- A copy of the computer data generated.

Data collected as a result of WQSP activities are summarized and reported on an annual basis in the Site Environmental Report. Raw data are stored in fireproof cabinets in the EM Section for a period of two years and then turned over to PRS for storage in accordance with the RIDS.

5.9 Calibration Requirements

The equipment used to collect data for the WQSP is to be calibrated in accordance with WP 10-AD, WIPP Maintenance Administrative Procedures Manual. The metrology laboratory is responsible for calibrating needed equipment on schedule, in accordance with written procedures. The EM Section is responsible for maintaining current calibration records for each piece of equipment.

6.0 WATER LEVEL MONITORING PLAN

6.1 Scope

This section of the WIPP GSP serves as the controlling document for the WLMP. The WLMP is a subprogram of the GSP. The quality assurance activities of the WLMP are in strict accordance with the QAPD and the quality assurance implementing procedures specific to environmental monitoring are found in WP 02-3, Environmental Monitoring Procedures Manual.

Water level monitoring will continue through the postoperational phase of the WIPP. This plan addresses the activities of the WLMP during the preoperational and operational phases of the WIPP. Postoperational activity plans will be formulated at a later date and will address the objectives of water level monitoring as required at the time of decommissioning.

6.2 Introduction

This program will continue the collection and documentation of water level data initiated by the U.S. Geological Survey (Richey, 1987) and SNL (Stensrud et al., 1988) as part of the WIPP Site Characterization Program.

As currently planned, water level measurements will be conducted using hydrologic test wells that were constructed for the site characterization and WQSP. These test wells are distributed geographically both within and surrounding the WIPP site. The frequency of measurement is subjectively defined by the need to record the dynamic nature of the potentiometric surface through time.

On October 1, 1988, the ES&H Department assumed responsibility for Groundwater Level Monitoring Activities. At that time a WLMP plan was still being developed. In June of 1989, an initial plan was finalized entitled WP 07-2, WIPP Water Level Monitoring Program Plan, IT Corp. (June 1989). WP 07-2 was subsequently replaced in 1990 by WP 02-1, Groundwater Monitoring Program Plan and Procedures Manual.

Collection of groundwater-level data assists the DOE in meeting performance assessment, regulatory compliance, and permitting requirements. These data also provide:

- Data collection as required by the Environmental Monitoring Plan.
- A means to fulfill commitments made in the FEIS.
- A means to comply with future groundwater inventory and monitoring regulations.
- Input for making land use decisions, (i.e., designing long-term active and passive institutional controls for the site).
- Assistance in understanding any changes to readings from the water-pressure transducers installed in each of the shafts to monitor water conditions behind the liners.
- An understanding of whether or not the horizontal and vertical gradients of flow are changing over time.

6.3 Objective

The objective of the WLMP is to extend the documented record of water-level fluctuations in the Culebra and Magenta members of the Rustler Formation in the vicinity of the WIPP facility. Water-level data will also be collected from wells completed in other water-bearing zones overlying and underlying the WIPP repository horizon when access to those zones is possible. This includes, but is not limited to, the Bell Canyon Formation, the Forty Niner member of the Rustler, the contact zone between the Rustler and Salado Formations, and the Dewey Lake Red Beds, when access to these zones is possible.

The scope of the program is subject to change depending upon the following:

- Data trends
- Performance assessment program needs
- Environmental Monitoring Program needs
- Regulatory compliance needs

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Water level measurements will be taken monthly in at least one accessible completed interval at each available well pad. At well pads with two or more wells completed in the same interval, quarterly measurements will be taken in the redundant wells.

Water level monitoring will continue through the life of the WIPP Project. It may be deemed necessary to temporarily increase the frequency of monitoring to effectively document naturally occurring or artificial perturbations that may be imposed on the hydrologic systems at any point in time. This will be conducted in selected key wells by increasing the frequency of the manual water-level measurements or by monitoring water pressures with the aid of electronic pressure transducers and remote data-logging systems.

One of the postulated contaminate pathways to the biosphere in the event of a release is believed to be in the water-bearing zones of the Rustler Formation, more specifically, the Magenta and Culebra members. The Culebra is believed to be the more conductive of the two (Mercer, 1983) and has received the most attention in site characterization studies. Other water bearing zones in the vicinity of the WIPP site, in which a limited number of hydrologic test wells have been completed, include the Dewey Lake Red Beds, the Rustler/Salado Contact, the Forty Niner Member of the Rustler, and the Bell Canyon Formation. All of the above listed zones will be monitored as part of this program plan, subject to availability.

Water level fluctuations of confined water bearing units may result from a variety of hydrologic phenomena (Freeze and Cherry, 1979) and (Davis and DeWeist, 1966). These include:

- Changes in groundwater storage (e.g., groundwater recharge)
- Changes in atmospheric pressure
- Deformation of the water bearing zone (e.g., earthquakes and earth tides)

- Disturbances within or adjacent to a well (e.g., groundwater pumping and shaft construction)

Interpretation of water level measurements and corresponding fluctuations over time is complicated at the WIPP by spatial variation in fluid density both vertically in well bores and areally from well to well. To monitor the hydraulic gradients of the hydrologic flow systems at the WIPP accurately, actual water level measurements and the densities of the fluids in the well bores must be known. When both of these parameters are known, equivalent freshwater heads can be calculated. The concept of freshwater head is discussed in Lusczynski (1961) where the following definition is provided:

> Fresh water head at a given point in groundwater of variable density is defined as the water level in a well filled with fresh water from that point to a level high enough to balance the existing pressure at that point. Fresh water heads define hydraulic gradients along a horizontal.

A discussion explaining the calculation of freshwater heads from midformation depth at WIPP can be found in Haug, et al. (1987).

A Pressure Density Survey Program (PDSP) has been conducted to determine the actual variation in density gradients existing in the test wells. The PDSP measured the actual midformation pressures of the Culebra. Data from this program have identified those wells in which some adjustment to measured water level values must be accounted for in order to calculate the measured water levels accurately in terms of equivalent freshwater heads.

6.4 Field Methods

To obtain an accurate groundwater level measurement, a calibrated water level measuring device is lowered into a test well and the depth to water is recorded from a known reference point. When using an electrical conductance probe, the depth to water can be determined by reading the appropriate measurement markings on the embossed measuring tape when the alarm is activated at the surface. Specific procedures regarding the specific activities governing the Water Level Monitoring Program are generated, approved, and maintained by the site documentation process.

6.5 Records and Document Control

All incoming data will be processed in a timely manner to assure data integrity. The data management process for water level measurements begins with completion of the field data sheets. Date, time, tape measurement, equipment identification number, calibration due date, initial of the field personnel, and equipment/comments are recorded on the field data sheets. If, for some unexpected reason, a measurement is not possible (i.e., a test is under way that blocks entry to the well bore), then a notation as to why the measurement was not taken is recorded in the comment column. Personnel also use the comment column to report any security observations (i.e., well lock missing).

Data recorded on the field data sheets and submitted by field personnel are subject to guidelines outlined in WP 02-3, Environmental Procedures Manual. The data are entered onto a computerized worksheet. The worksheet calculates water level in both feet and meters relative to the top of casing and also relative to mean sea level.

A check print is made of the worksheet printout. The check print is used to verify that data taken in the field is properly reported on the database printout. A minimum of 10 percent of the spreadsheet calculations are randomly verified on the check print to ensure that calculations are being performed correctly. If errors are found, the worksheet is corrected. The data contained on the computerized worksheet are translated into a database file. A printout is made of the database file. The data each month are then compiled into report format and transmitted to the appropriate agencies as requested by the DOE.

A computerized database file is maintained for all groundwater level data. Monthly and quarterly data are appended into a yearly file. Upon verification that the yearly database is free of errors, it is appended into the project database file. A printed copy of the project database is maintained in the ES&H EM fire-resistant storage area current through December of the preceding year.

6.6 Reporting

Data collected from this program are reported in the Annual Site Environmental Report (ASER). The ASER includes all applicable information that may affect the comparison of water level data through time. This information will include but is not limited to:

- Well configuration changes that may have occurred from the time of the last measurement (i.e., plug installation and removal, packer removal and reinstallation, or both; and the type and quantity of fluids that may have been introduced into the test wells).

- Any pumping activities that may have taken place since publication of the last annual report (i.e., water quality sampling, hydraulic testing, and shaft installation or grouting activities).

6.7 Calibration Requirements

The equipment used in taking groundwater level measurements is to be calibrated in accordance with WP 10-AD, WIPP Maintenance Administrative Procedures Manual. The WID metrology laboratory is responsible for calibrating needed equipment on schedule, in accordance with written procedures. The EM Section is responsible for maintaining current calibration records for each piece of equipment.