

**Policy Position of Texana Groundwater Conservation District
related to a Groundwater-Monitoring Program for the CO₂
Sequestration and Enhanced Oil Recovery Project at West Ranch,
Jackson County, Texas.**

Introduction

The Texana Groundwater Conservation District (DISTRICT) is charged with protecting the groundwater resources of Jackson County. The DISTRICT asserts that the nature of certain land uses and land development activities increase the risk of the groundwater resources being damaged. In particular, the DISTRICT is concerned that the injection of waste and saltwater fluids in the subsurface increases the risk of groundwater contamination.

Hilcorp Energy, Inc. (HILCORP) is implementing a large-scale, CO₂ Sequestration and Enhanced Oil Recovery (CO₂-EOR) project in Jackson County. The project includes the injection of saltwater fluids and liquid CO₂ into deep oil-bearing formations of a large, heavily depleted oil field that was originally developed in the 1930s on the West Ranch. Over the decades, many oil wells have been drilled for the purposes of recovering the oil reserves and represent potential conduits for contaminate migration.

The DISTRICT is concerned that the implementation and completion of the CO₂-EOR project represents a significant risk to the groundwater resources in and around the West Ranch Oil Field. Therefore, the DISTRICT requests that, prior to initiating fluid injection activities associated with the CO₂-EOR project, a comprehensive, groundwater-monitoring program (GMP) be established to ensure any damage or contamination of groundwater resources caused by the CO₂-EOR project is identified and corrected immediately.

The DISTRICT sponsored a technical study conducted by Venkatesh Uddameri, Ph.D., P.E. to research the potential impacts of CO₂-EOR projects on groundwater resources and design a framework for establishing a groundwater-monitoring program. The findings and recommendations resulting from the study are presented in the report titled Development of a Framework for a Groundwater Monitoring Program at a Geological Carbon Sequestration/Enhanced Oil Recovery Site (STUDY REPORT). The STUDY REPORT is incorporated into this policy as Attachment A.

The DISTRICT has identified, in this policy, the key elements that must be incorporated into a GMP to assure the program is scientifically credible, acceptable to affected parties such as adjacent landowners, and adequate for monitoring subsurface conditions enabling the early detection and correction of damage and contamination, if any, caused by the CO₂-EOR project. The elements discussed in this policy are generally supported by the findings and recommendation within the

STUDY REPORT, considered part of the general GMP framework, and should be incorporated into formal program and project plans to guide the implementation and execution of the GMP.

Organization and Administration Elements of a GMP

The administration, management, and execution of the GMP should be performed by an independent, third-party without interest in the success or failure of the CO₂-EOR project. Independence from HILCORP and its partners will likely increase the confidence in the GMP by the public, adjacent landowners and eliminate the opportunity of the project sponsors to intentionally or unintentionally influence the GMP.

Executing a comprehensive groundwater-monitoring program for a project with the size and scope of HILCORP's CO₂-EOR project is an expensive endeavor that delivers significant benefits to the project's sponsors. HILCORP should financially sponsor the implementation and execution of the GMP.

Pre-Injection-Activity Elements of a GMP

For the purpose of defining the spatial boundary of the GMP, a Monitoring Area of Interest (MAI) is defined as a 5-mile radius surrounding the CO₂-EOR project site. The MAI is comprised of two units: the area within the project site (INTER-MAI UNIT), and the area outside the project site but within the 5-mile radius (OUTER-MAI UNIT).

Prior to fluid injection activities of the CO₂-EOR project commencing, a network of groundwater-monitoring wells should be developed and documented consisting of at least sixty (60) water wells, thirty (30) wells isolated and screened across the Chicot Aquifer, thirty (30) wells isolated and screened across the Evangeline Aquifer. For each set of aquifer-specific monitoring wells, twenty (20) wells should be located within INTER-MAI UNIT located in close proximity to the CO₂-EOR injection and extraction wells, ten (10) wells should be located outside and distributed around the OUTER-MAI UNIT. The location of the monitoring wells should be distributed in a manner resulting in a spatially well-balanced configuration and have the ability to serve as early warning systems during CO₂-EOR activities.

Prior to fluid injection activities of the CO₂-EOR project commencing, a network of groundwater-monitoring wells should be developed and documented consisting of at least six (6) water wells, three (3) wells isolated and screened across the Burkeville Aquifer, three (3) wells isolated and screened across the Jasper Aquifer. For each set of aquifer-specific monitoring wells, two (2) wells should be located within INTER-MAI UNIT located in close proximity to the center of the CO₂-EOR project site, one (1) well should be located outside and down-gradient from the project site.

Prior to fluid injection activities of the CO₂-EOR project commencing, a study and report of the sediments of the Gulf Coast Aquifer within the MAI should be completed. A detailed mineralogical characterization of the formation solids should be performed at a site located within both the INNER-MAI UNIT and OUTER-MAI Unit.

Prior to fluid injection activities of the CO₂-EOR project commencing, water level and water quality measurement should be collected and documented at each well of the groundwater-monitoring network. Groundwater quality measurements should consist of the following items:

- Bulk Constituents: TDS, Specific Conductance, Total Hardness, and ORP;
- Major Ions: Ca, Mg, Na, K, CO₃, SO₄, HCO₃, and Cl;
- Trace Constituents: Cd, Cr, Cu, Zn, As, Ba, Sr, Mn, Ni, Cs, Fe, U, V, Mo, Al, PO₄, NO₃, and NO₂;
- Hydrocarbons: Oil and Grease, Total Petroleum Hydrocarbons (TPH), Diesel Range Organics (DRO), Benzene, Toluene, Ethylbenzene, Xylenes (BTEX)
- Radioactivity: Gross Alpha and Gross Beta particles;
- Environmental Tracers: perfluoro-1,2-dimethylcyclohexane (PDCH), perfluorotrimethylcyclohexane (PTCH), and perfluorodimethylcyclobutane (PDCB);
- Isotopes: ¹²C, ¹³C, δ¹³C-CH₄ and δ²H-CH₄.

Prior to fluid injection activities of the CO₂-EOR project commencing, localized groundwater flow gradients and directions for the Chicot Aquifer, Evangeline Aquifer, Burkeville Aquifer, and Jasper Aquifer at the project site should be calculated and documented.

Active-Injection-Activity Elements of a GMP

During the phases of the CO₂-EOR project in which fluid injection activities are conducted, Perfluorocarbon tracers should be added to injected fluids in sufficient volume as to facilitate the early detection of excursions of injected fluids.

During the phases of the CO₂-EOR project in which fluid injection and extraction activities are conducted, water level and water quality measurement should be collected and documented at each well of the groundwater-monitoring network. Groundwater quality measurements collected on a continuous basis should consist of the following items:

- Bulk Constituents: TDS, Specific Conductance, Total Hardness, and ORP;

During the phases of the CO₂-EOR project in which fluid injection and extraction activities are conducted, water level and water quality measurement should be collected and documented at each well of the groundwater-monitoring network. Groundwater quality measurements collected on a weekly basis should consist of the following items:

- Environmental Tracers: perfluoro-1,2-dimethylcyclohexane (PDCH), perfluorotrimethylcyclohexane (PTCH), and perfluorodimethylcyclobutane (PDCB);

During the phases of the CO₂-EOR project in which fluid injection and extraction activities are conducted, water level and water quality measurement should be collected and documented at each well of the groundwater-monitoring network. Groundwater quality measurements collected on a monthly basis should consist of the following items:

- Major Ions: Na and Cl;

During the phases of the CO₂-EOR project in which fluid injection and extraction activities are conducted, water level and water quality measurement should be collected and documented at each well of the groundwater-monitoring network. Groundwater quality measurements collected on a quarterly basis should consist of the following items:

- Major Ions: Ca, Mg, K, CO₃, SO₄, and HCO₃;
- Trace Constituents: Cd, Cr, Cu, Zn, As, Ba, Sr, Mn, Ni, Cs, Fe, U, V, Mo, Al, PO₄, NO₃, and NO₂;
- Hydrocarbons: Oil and Grease, Total Petroleum Hydrocarbons (TPH), Diesel Range Organics (DRO), Benzene, Toluene, Ethylbenzene, Xylenes (BTEX)
- Radioactivity: Gross Alpha and Gross Beta particles;

During the phases of the CO₂-EOR project in which fluid injection and extraction activities are conducted, water level and water quality measurement should be collected and documented at each well of the groundwater-monitoring network. Groundwater quality measurements collected on a quarterly basis should consist of the following items:

- Isotopes: ¹²C, ¹³C, δ¹³C-CH₄ and δ²H-CH₄.

Water quality sample collection, preservation and storage must follow technically defensible and properly documented protocols commonly approved by state and federal agencies for use at groundwater contamination sites. Field instruments must be properly calibrated per manufacturer specifications prior to sample collection. A laboratory analysis must be carried out in duplicate at National Environmental Laboratory Accreditation Program (NELAP) certified laboratories. A Quality Control and Quality Assurance Plan detailing, sample collection protocols, sample preservation, transportation as well as field probes and analytical methods used for analysis must be developed prior to initiation of any sampling activities and made publicly available. Water quality measurement collected on a continuous and weekly basis should be reviewed and compared to baseline and previously collected water quality data on a weekly basis to identify any potential damage or contamination of groundwater resources. Summary reports of the weekly reviews should be submitted to involved entities, agencies, and made available to the public.

Water quality measurement collected on a monthly basis should be reviewed and compared to baseline and previously collected water quality data on a monthly basis to identify any potential damage or contamination of groundwater resources. Summary reports of the monthly reviews should be submitted to involved entities, agencies, and made available to the public.

Water quality measurement collected on a quarterly basis should be reviewed and compared to baseline and previously collected water quality data on a quarterly basis to identify any potential damage or contamination of groundwater resources. Summary reports of the quarterly reviews should be submitted to involved entities, agencies, and made available to the public.

Post-Injection-Activity Elements of a GMP

For a period of time not less than three (3) years after the termination of injection and extraction activities of the CO₂-EOR project, water level and water quality monitoring activities should continue in an identical manner and frequency as the activities established for the phases of the CO₂-EOR project in which fluid injection and extraction activities are conducted.

For a period of time not less than five (5) years after the termination of injection and extraction activities of the CO₂-EOR project, water level and water quality monitoring activities should continue in an identical manner but on an annual basis as the activities established for the phases of the CO₂-EOR project in which fluid injection and extraction activities are conducted.

Post-injection monitoring results must be made public within 30 days of the sampling date.