



CASE STUDY

LiORA California Regulator Risk-Based Management

Executive Summary

LiORA's sensor system for continuous monitoring of hydrocarbon depletion successfully supported regulatory approval for risk-based site management at a historical pipeline spill site in California. Through strategic deployment of soil sensors monitoring temperature, pressure, humidity, CO₂, CH₄, O₂, and hydrocarbon concentrations, LiORA provided real-time quantification of Natural Source Zone Depletion (NSZD) rates and plume stability data. This comprehensive dataset enabled presentation of a robust, data-driven case to California regulatory agencies, ultimately gaining state approval for sensor-based monitoring and risk-based site management approaches.

Project Background

Site Overview

A historical pipeline spill site in California required a comprehensive evaluation of natural attenuation processes and continuous monitoring to assess plume stability. The site's regulatory complexity demanded robust scientific evidence to support risk-based management decisions.

Regulatory Collaboration

The Consultant worked directly with LiORA and a California regulatory agency to establish monitoring protocols and demonstrate sensor technology capabilities for environmental assessment and ongoing site management.

Assessment Objectives

The project aimed to:

- Quantify Natural Source Zone Depletion rates through continuous monitoring;
- Assess plume stability in downgradient areas;
- Support risk-based management approach with robust scientific data; and
- Gain regulatory acceptance for sensor-based monitoring technology.

LiORA Solution

Strategic Sensor Deployment

LiORA installed 3 soil sensors strategically positioned to monitor critical site parameters:

- **Multi-Parameter Monitoring:** Sensors continuously logged CO₂, CH₄, O₂, and VOC concentrations within the hydrocarbon oxidation zone above the groundwater table.



- **Source Zone Coverage:** Sensors placed to monitor NSZD processes in contaminated source areas.
- **Downgradient Assessment:** Monitoring network designed to assess plume stability and migration potential.

Comprehensive Data Collection

The monitoring system provided continuous assessment of natural attenuation processes, real-time NSZD rate quantification, plume stability assessment, natural attenuation effectiveness evaluation and provided an early warning system for contamination changes.

Key Results

NSZD Rate Quantification

LiORA's monitoring system provided precise measurement of natural attenuation:

- **Real-Time Depletion Rates:** Continuous monitoring enabled accurate quantification of NSZD processes occurring at the site.
- **Scientific Validation:** Multi-parameter monitoring provided robust scientific evidence of natural attenuation effectiveness.
- **Temporal Resolution:** Continuous data collection captured variations in NSZD rates over time, providing a comprehensive understanding of natural processes.

Plume Stability Assessment

Comprehensive monitoring demonstrated site stability:

- **Migration Monitoring:** Downgradient sensors provided continuous assessment of plume migration potential.
- **Early Detection:** Real-time monitoring enabled immediate detection of any changes in contaminant behavior.
- **Stability Confirmation:** Long-term monitoring data demonstrated plume stability and natural attenuation effectiveness.

Regulatory Success

State Agency Approval

LiORA's collaborative approach achieved significant regulatory milestones:

- **Technology Acceptance:** California regulatory agencies approved LiORA sensor technology for environmental monitoring applications.
- **Risk-Based Management:** Comprehensive monitoring data supported approval for risk-based site management approach.
- **Precedent Setting:** Successful collaboration established template for sensor-based monitoring in California regulatory framework.



Data-Driven Decision Making

Robust monitoring data enabled confident regulatory decisions:

- **Scientific Evidence:** Multi-parameter monitoring provided compelling scientific evidence for natural attenuation effectiveness.
- **Risk Assessment:** Continuous monitoring data supported comprehensive risk assessment and management decisions.
- **Regulatory Confidence:** Real-time data provided agencies with confidence in site management approaches.

Technical Innovation

Multi-Parameter Monitoring

LiORA's comprehensive monitoring approach provided superior site intelligence:

- **Hydrocarbon Oxidation Zone:** Targeted monitoring of the critical zone above the groundwater table where natural attenuation processes occur.
- **Process Understanding:** Multi-parameter monitoring enhanced understanding of natural attenuation mechanisms.
- **Quality Assurance:** Continuous monitoring provided high-quality data for regulatory decision-making.

Real-Time Analytics

Advanced data processing transformed monitoring data into actionable insights:

- **NSZD Calculations:** Real-time processing of multi-parameter data enabled immediate NSZD rate calculations.
- **Trend Analysis:** Continuous monitoring revealed temporal patterns in natural attenuation processes.
- **Predictive Capability:** Historical data supported predictions of future site behavior under natural attenuation.

Strategic Impact

Regulatory Framework Development

The project will contribute to regulatory framework evolution:

- **Best Practice Integration:** Successful implementation will inform regulatory best practices for sensor-based monitoring.
- **Technology Standards:** Collaboration to establish standards for continuous monitoring in environmental applications.
- **Risk-Based Approaches:** Project success to support broader adoption of risk-based management approaches.



Market Validation

Regulatory approval provided significant market validation:

- **Technology Credibility:** State agency approval established LiORA technology credibility.
- **Competitive Advantage:** Regulatory acceptance provided competitive advantage in California market.
- **Replication Potential:** Successful approach created template for similar regulatory collaborations.

Benefits and Value

Enhanced Site Management

Continuous monitoring provided superior site management capabilities:

- **Proactive Approach:** Real-time monitoring enabled proactive response to changing site conditions.
- **Cost Optimization:** Risk-based management approach optimized resource allocation.
- **Regulatory Compliance:** Continuous monitoring exceeded regulatory requirements for site oversight.

Scientific Advancement

The project advanced understanding of natural attenuation processes:

- **Process Quantification:** Precise measurement of NSZD rates enhanced scientific understanding.
- **Temporal Resolution:** Continuous monitoring provided unprecedented temporal resolution of natural processes.
- **Validation Methods:** Multi-parameter monitoring validated natural attenuation assessment methods.

Lessons Learned

Early and ongoing collaboration with regulatory agencies proved essential for successful technology adoption and risk-based management approval.

High-quality, continuous monitoring data provides the scientific foundation necessary for regulatory confidence in risk-based management decisions.

Comprehensive monitoring of multiple parameters enhances understanding of natural attenuation processes and provides more robust evidence for regulatory decisions.



Future Applications

Successful regulatory approval opens opportunities for broader deployment across California contaminated sites.

The collaborative approach provides template for similar regulatory partnerships in other jurisdictions.

Ongoing development will enhance sensor capabilities and expand monitoring parameters to provide even more comprehensive site assessments.

Conclusion

LiORA's successful collaboration with California regulatory agencies demonstrates the effectiveness of continuous monitoring in supporting risk-based site management decisions. Through the strategic deployment of multi-parameter soil sensors, LiORA provided the robust scientific evidence necessary to quantify NSZD rates and assess plume stability.

The project's success in gaining state approval for sensor-based monitoring and risk-based management approaches establishes LiORA as a leader in regulatory collaboration and technology acceptance. The comprehensive dataset generated through continuous monitoring provided regulators with the confidence necessary to approve innovative site management approaches.

This case study validates LiORA's approach to building data-driven cases for risk-based site management, demonstrating how continuous monitoring can transform regulatory decision-making from an assumption-based to an evidence-based approach.