

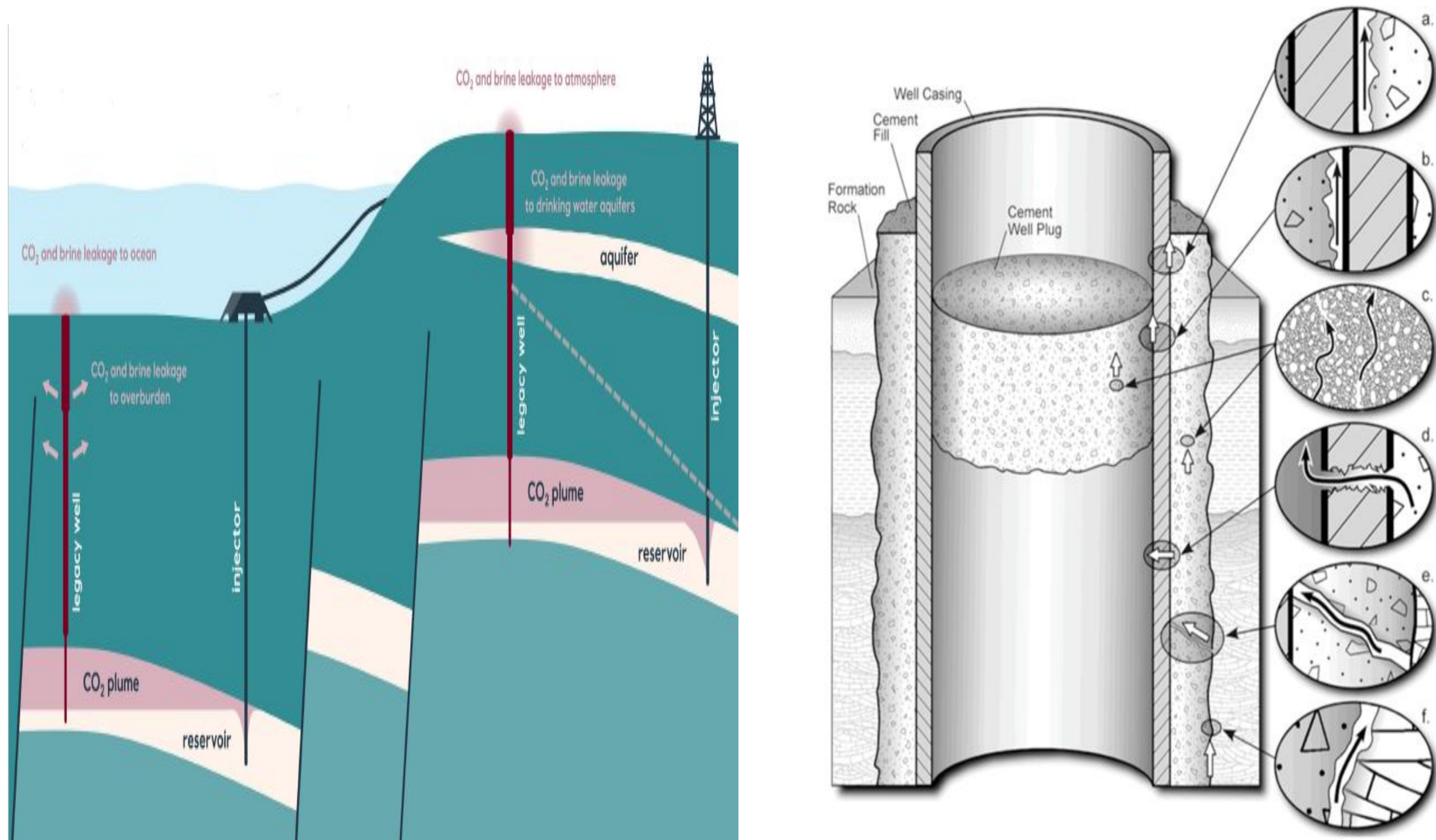
Integrated Screening Tool for Leakage Risk Assessment in Legacy Wells under CO₂ Injection

A barrier-based decision framework combining CO₂ exposure, primary barrier, secondary barrier and data uncertainty

1. INTRODUCTION

- Legacy wells risk containment leakage via uncertain barriers, incomplete data, and long-term degradation.
- Leakage risk depends on both well condition and exposure to injection-induced effects.
- CO₂ and pressure fronts can reach nearby wells via reservoir connectivity and hydraulic communication.

LEAKAGE PATHWAY CONCEPT



Benson et al. 2005)

Gasda et al. 2004)

Current challenge

- NRAP: physics-based (pressure, plume, flow)
- REX-CO₂: decision-tree logic
- Arbad (AoR) : risk matrix

Research gap

- Depend on simulations or specific scenarios
- Focus mainly on well integrity (not always exposure)

Need

Develop a screening tool consistent across different datasets and fields to classify leakage risk, prioritize legacy wells and support decisions

2. METHODOLOGY

Process workflow

Well data + Barrier output + Screening Tool → Risk class



CORE LOGIC

CO₂ Exposure + Primary Barrier + Secondary Barrier → Overall Risk

WELL TYPE

P&A Cased

P&A Open

Shut-in

CO₂ EXPOSURE

- Reservoir connectivity
- Distance to injector
- Pressure propagation
- Plume migration

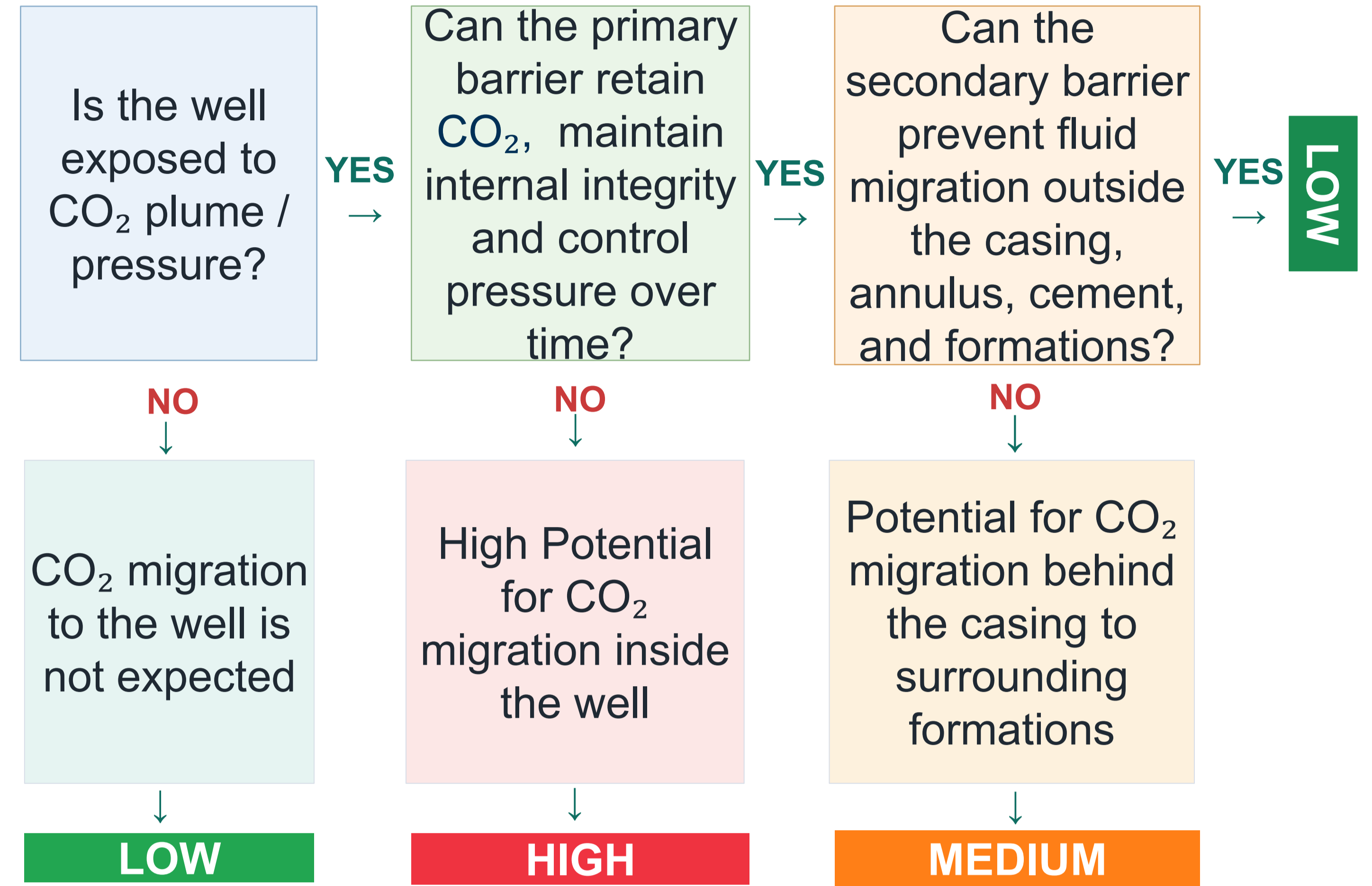
PRIMARY BARRIER

- Reservoir isolation
- Caprock isolation
- CBL/Logs
- Porous layers isolated
- Tubing / packer / plugs
- SCP
- Internal leakage indicators

SECONDARY BARRIER

- Surface plugs
- Shallow leakage indicators
- Flushing losses
- Wellhead conditions
- Behind-casing flow

SIMPLIFIED DECISION LOGIC

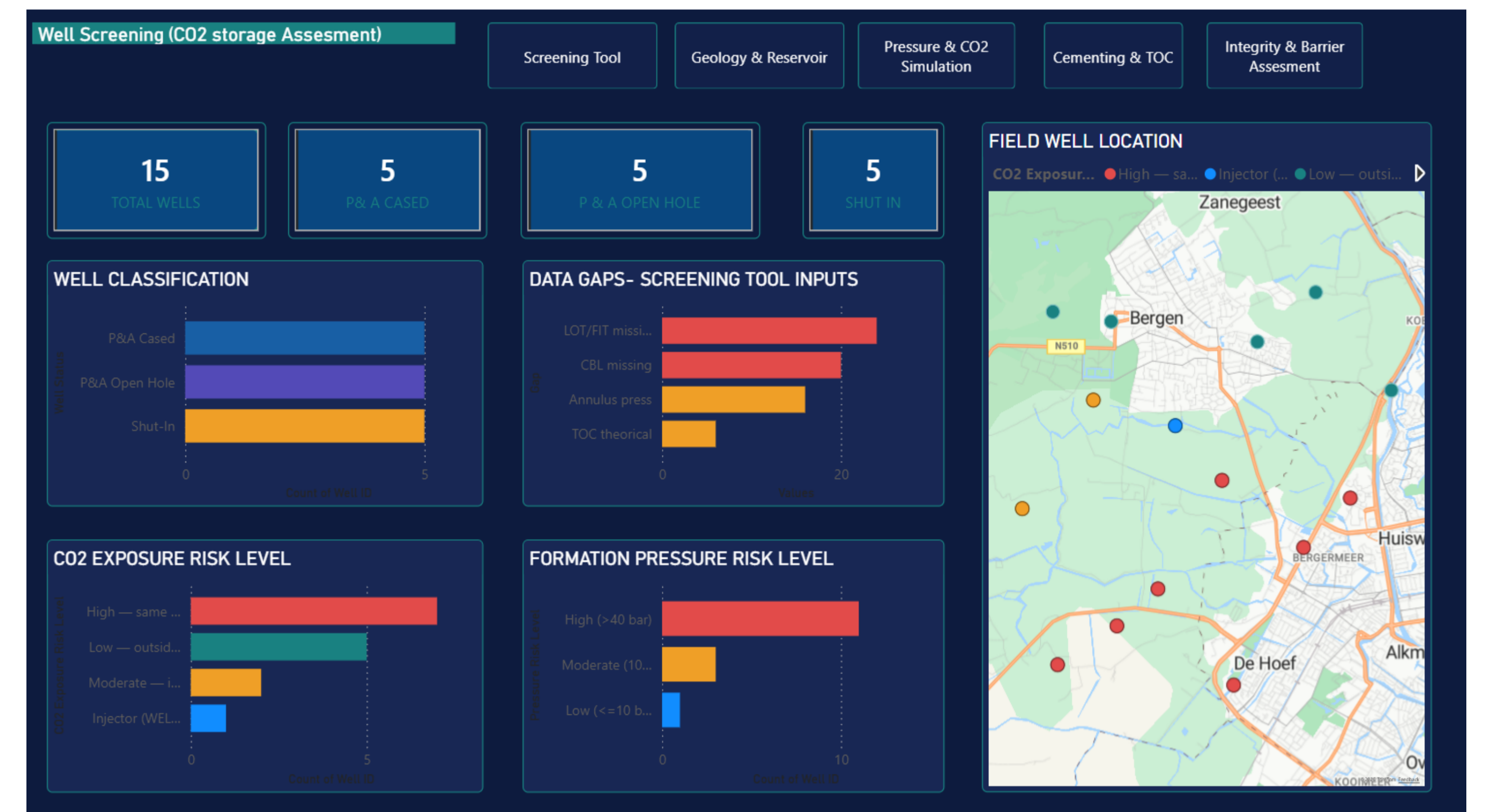


3. RESULTS & SCREENING OUTPUT

Data Analytics



Python



LEGACY WELL LEAKAGE RISK SCREENING TOOL FOR CO₂ STORAGE

Barrier-based decision framework · CO₂ Exposure · Primary & Secondary Barrier

0 Wells Evaluated

WELL NAME / API NUMBER

e.g. W-1, API 42-123-456

WELL STATUS

P&A (Cased Hole)

P&A (Open Hole)

Shut-In

WORK IN PROGRESS - NOVELTY — TIME-DEPENDENT RISK PERSPECTIVE

- Validate logic with case-study wells.
- Integrate time-dependent permeability $k(t)$.
- Develop a universal user-friendly digital interface.

Key message: risk can change with time and exposure conditions.

CO₂-cement interaction → permeability change $k(t)$ → leakage potential $\gamma(t)$ → leakage rate $Q(t)$ → Risk(t)



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WIP WELL
INTEGRITY
PLATFORM

Research Interests

- Carbon Capture and Storage (CCS)
- Geothermal Projects
- Digitalization
- Well Integrity

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