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ENVIRONMENTAL INC.

AN ALTERNATIVE TO VACUUM ENHANCED MULTI-PHASE EXTRACTION

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BACKGROUND

Experience has been mainly with:

- **Above ground portion of mechanical remediation systems**
- **At sites that:**
  - **Are contaminated with light hydrocarbons**
  - **Vary greatly in size**
  - **May have Light Non-Aqueous Phase Liquid (LNAPL) present**

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VEMPE

BACKGROUND

- 10 years ago, Vacuum Enhanced Multi-Phase Extraction (VEMPE) promised **speedy and economical** remediation of volatile hydrocarbons

- But some problems have not been fully resolved

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VEMPE

DEFINITIONS

- Vacuum Enhanced Multi-Phase Extraction (VEMPE)
- Soil Vapour Extraction (SVE)
- Liquids Pumping
- Dual-Phase Extraction (DPE)
- Liquid Ring Pump (LRP)

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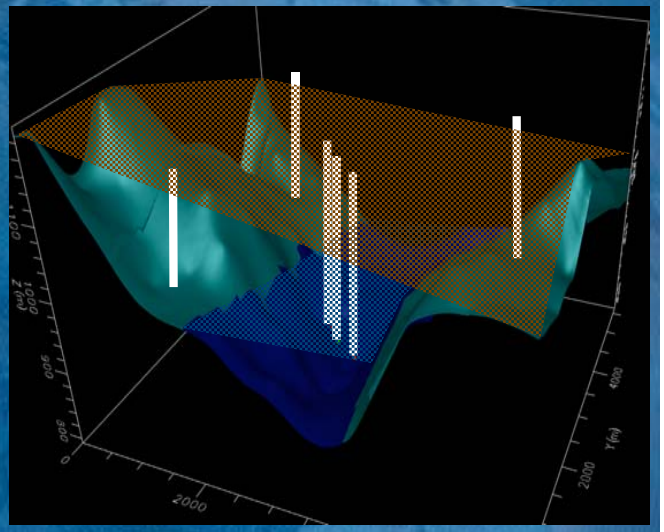
VEMPE

SYSTEM OVERVIEW

- Use vacuum to extract contaminants from the subsurface

- Wells are typically screened in both the **vadose** (unsaturated) and the **phreatic** (saturated) zones



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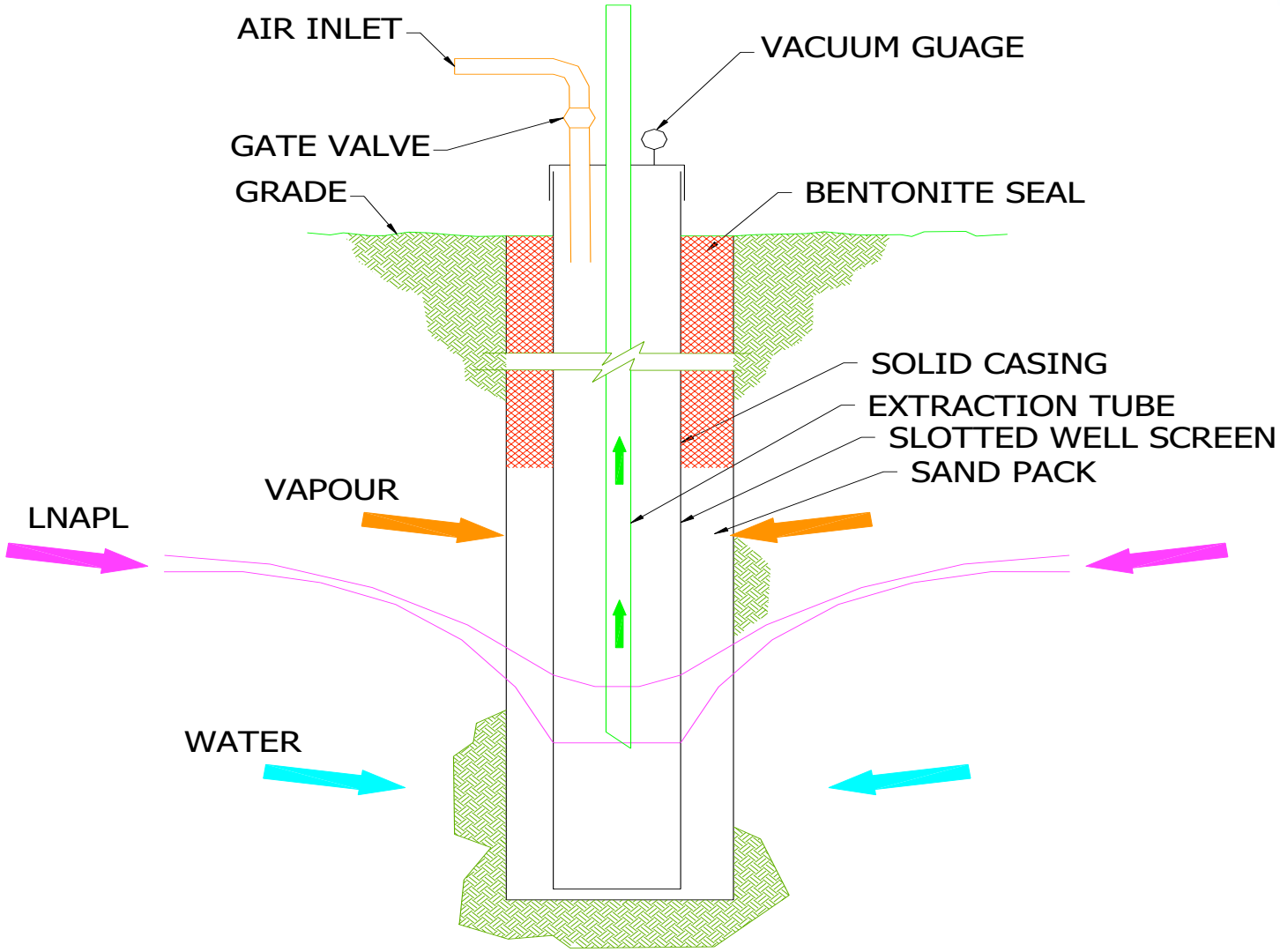
SYSTEM OVERVIEW

VEMPE Extraction Well



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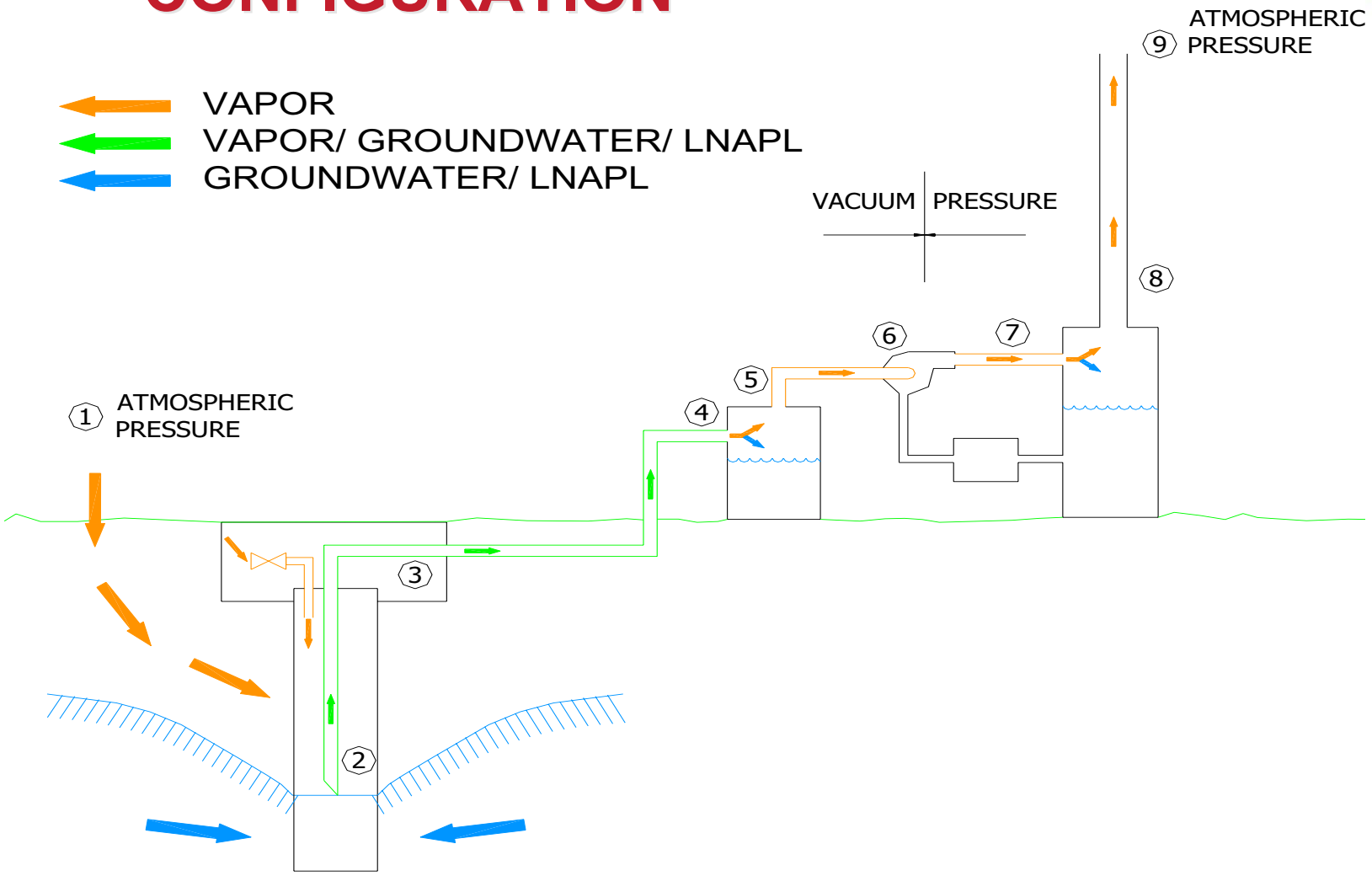
SYSTEM OVERVIEW

VEMPE SYSTEM CONFIGURATION



VEMPE

SUITABILITY

VEMPE IS MOST EFFECTIVE FOR:

- Volatile Contaminants
- LNAPL
- Contaminants Dissolved in Groundwater

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SUITABILITY

VEMPE IS LEAST EFFECTIVE FOR:

- Contaminants that are inaccessible due to **limited permeability** of the soil
- Contaminants that are chemically or physically **bound to soil** particles

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ADVANTAGES OF VEMPE

VEMPE IS POPULAR BECAUSE:

- Aggressive treatment
- Minimal equipment & piping
- Systems available off-the-shelf
- Well accepted technology

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CONCERNS WITH VEMPE

More maintenance due to:

- High operating temperatures
- Demands of VEMPE service

Consumes more power due to:

- LRP seal fluid pumping
- Bleed air at wellhead
- High piping pressure losses

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ELECTRICAL POWER CONSUMPTION COMPARISON

	VEMPE		DPE	
Vapour flow from wells	500	SCFM	500	SCFM
Bleed air flow at wellhead (30%)	150	SCFM	0	SCFM
Water flow from wells	30	l/min	30	l/min
Vacuum required at wells	10.0	“Hg	10.0	“Hg
Pressure loss in piping	3.2	“Hg	0.4	“Hg
Suction required at pump blower	13.2	“Hg	10.4	“Hg
LRP horsepower	83.4	HP		
Vapor blower horsepower			25.8	HP
Pneumatic pump air supply horsepower			2.6	HP
Total system horsepower	83.4	HP	28.4	HP
Electrical power cost	$49,800	/yr	$24,500	/yr

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CONCERNS WITH VEMPE

Cost of Unplanned Shutdowns

- Automatic re-starting can be difficult
- Operator attendance usually required
- Restart may take considerable time
- Can significantly increase operating costs

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VEMPE

CONCERNS WITH VEMPE

High pressure losses in collection piping

- Multi-phase flow in gathering system
- **Annular or annular mist flow regime** is required to transport liquids
- High gas velocity is required for annular or annular mist flow
- High gas velocity results in high pressure loss

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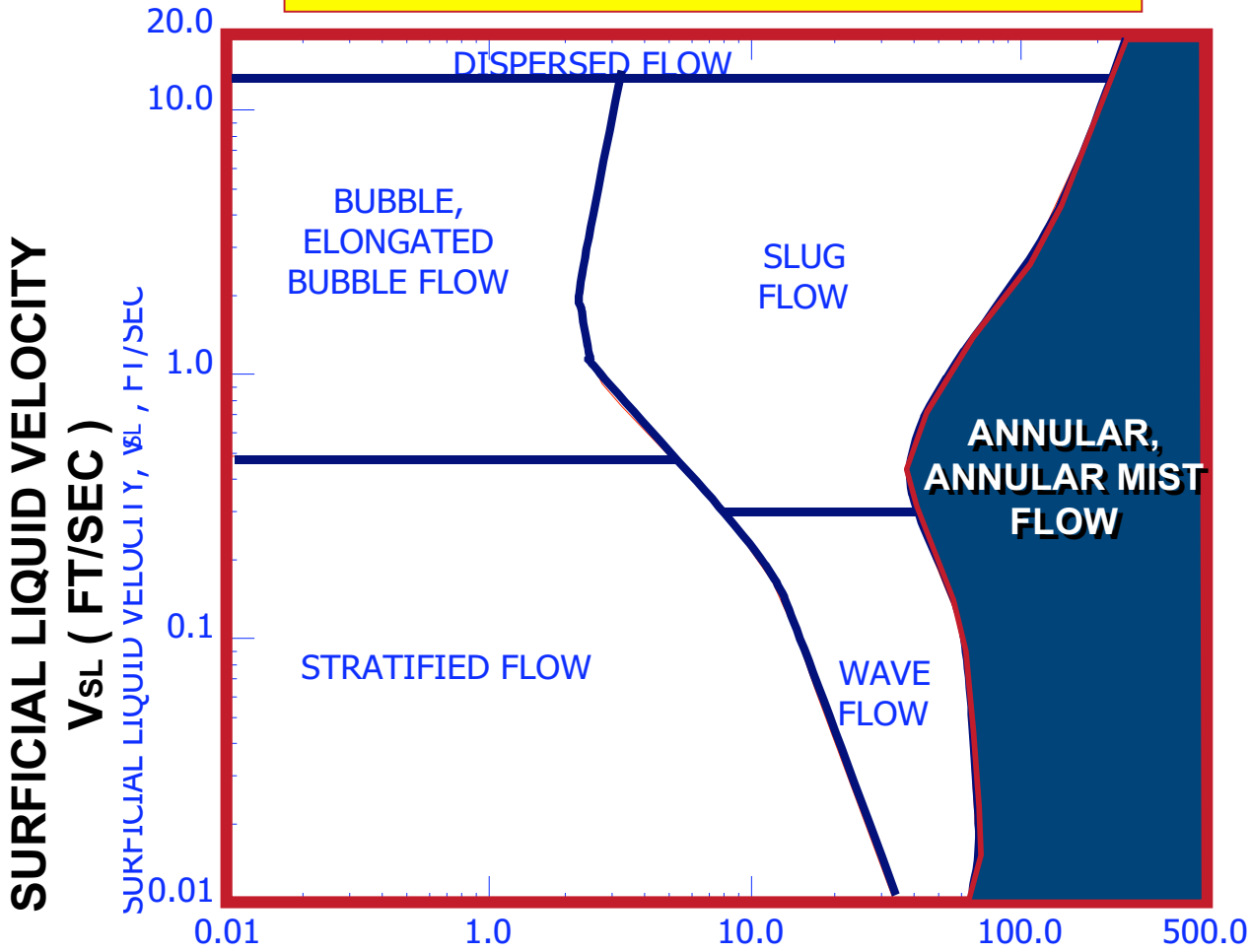
MULTI-PHASE FLOW

MULTI-PHASE FLOW PATTERN MAP



Mmandhane, Gregory and Aziz: A Flow pattern Map for Gas-Liquid Flow in Horizontal Pipes, 1974).

DUAL-PHASE EXTRACTION (DPE)

Using Separate Vapour and Liquid Extraction Systems

Vacuum Extraction of Soil Vapour

&

Extraction of Liquid by Pumping

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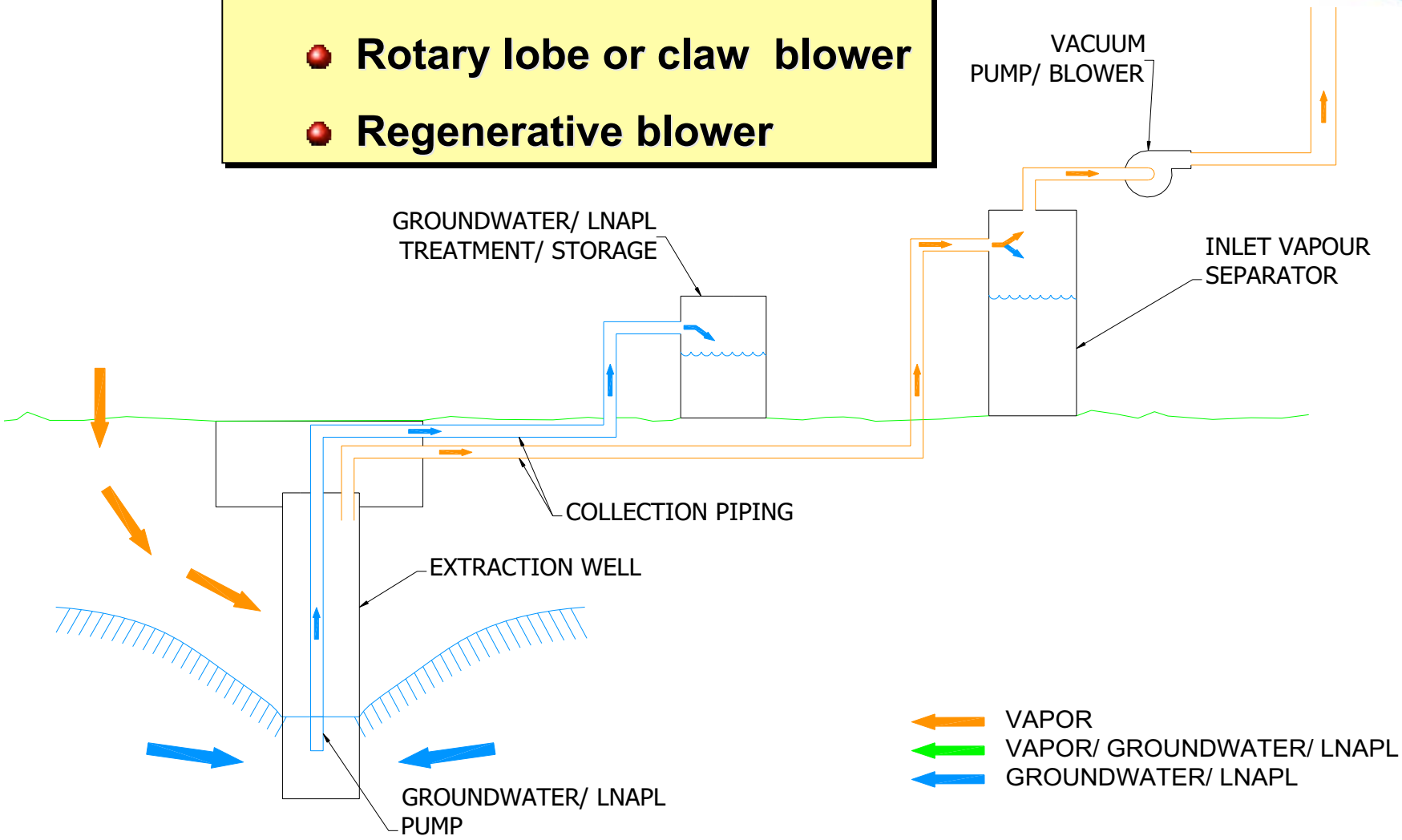
DUAL-PHASE EXTRACTION

Vacuum Extraction of Soil Vapour (VES) using:

- LRP
- Rotary lobe or claw blower
- Regenerative blower



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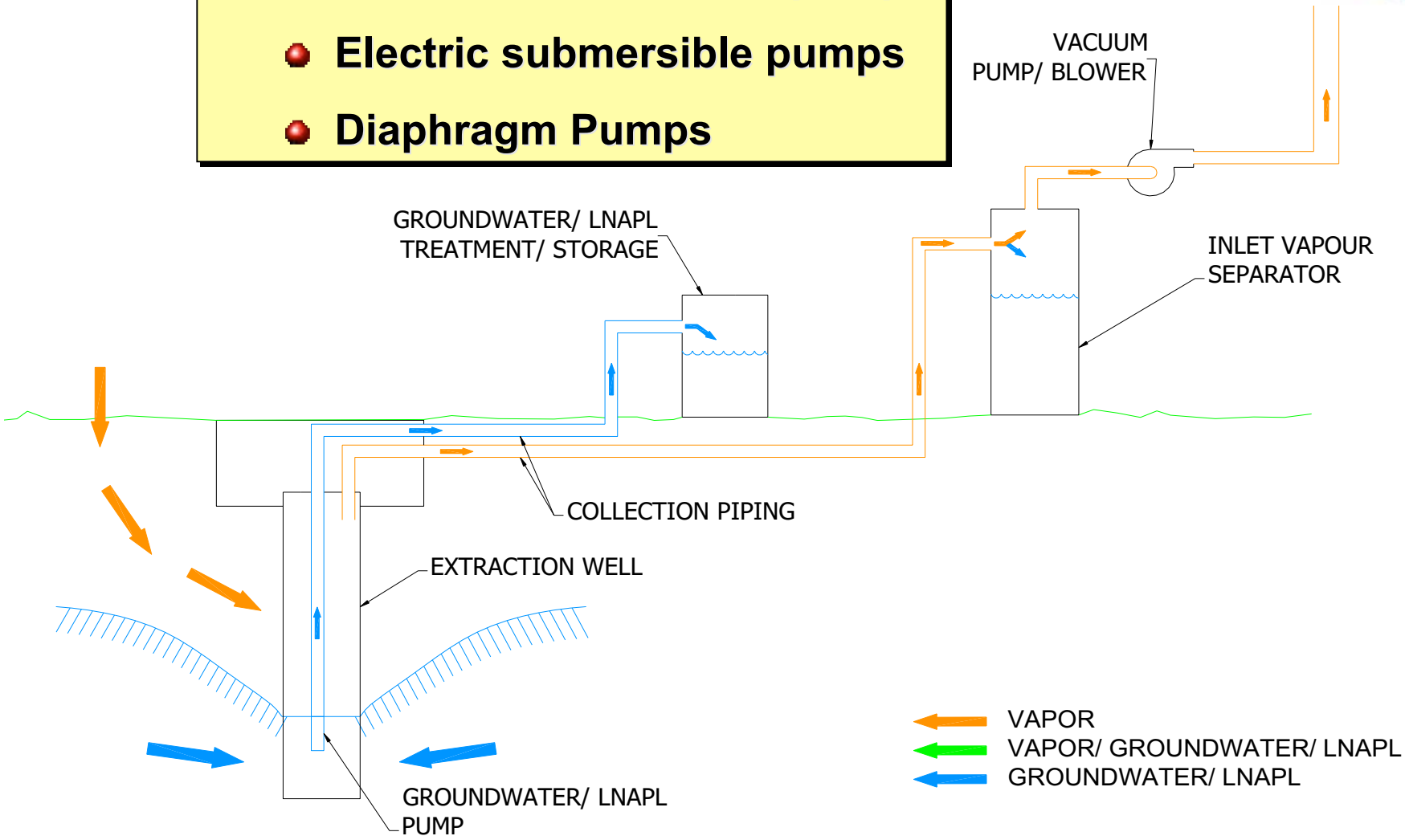
DUAL-PHASE EXTRACTION

Extraction of Liquid by Pumping using:

- Pneumatic down-hole pumps
- Electric submersible pumps
- Diaphragm Pumps



ADVANTAGES OF DPE

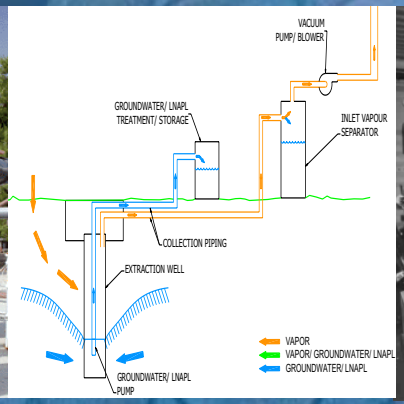
- ✓ Energy efficient
- ✓ Electric load split among several motors
- ✓ Can be designed so VES system operates independently of Liquids Pumping system
- ✓ Restarting can be automated
- ✓ Reduced pressure losses in wells and vapour collection piping

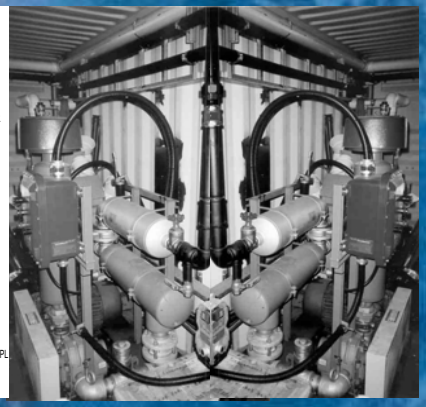
DPE

DISADVANTAGES OF DPE

- Higher Capital Cost

- More Complex System





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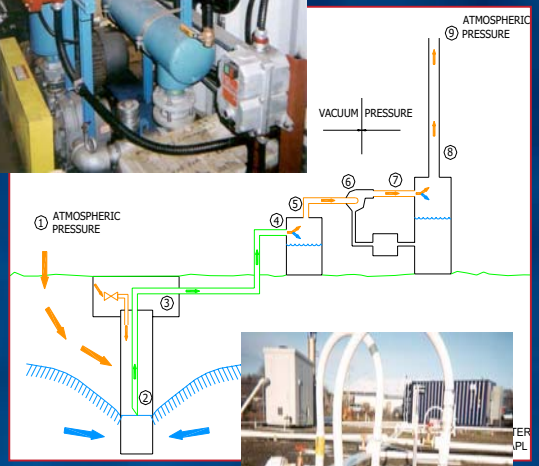
SUMMARY



- VEMPE has become the **Technology of Choice** for sites where it is desirable to extract both soil vapour and subsurface liquids
- VEMPE also has **Drawbacks**

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SUMMARY

DPE offers the Most Advantage where:

- Large vapour and liquid flows are anticipated
- It is desirable to substitute a rotary lobe or rotary claw blower for an LRP
- Access for maintenance and operations personnel is difficult
- Application of only vacuum or only liquid pumping to different areas at different times

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Think Outside the Box

There is more than One Solution to any Problem

Thank You For Your Time

Your Canadian Environmental Business Partner
For The Long Term