

INNOVATION IN THE OILFIELD:

How Best Management Practices Have Reduced the Impacts of Shale Development

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OUTLINE

- Introduction
 - BMP Purpose
 - Benefits of BMPs
- BMP Process
 - BMP Development
 - BMP Theory in Action
- BMP Examples
- BMP Management



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INTRODUCTION

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What BMPs ARE and ARE NOT.

ARE:

- *Technologies, practices, and procedures used to avoid, minimize, or mitigate impacts.*
- Facilitate regulatory compliance.

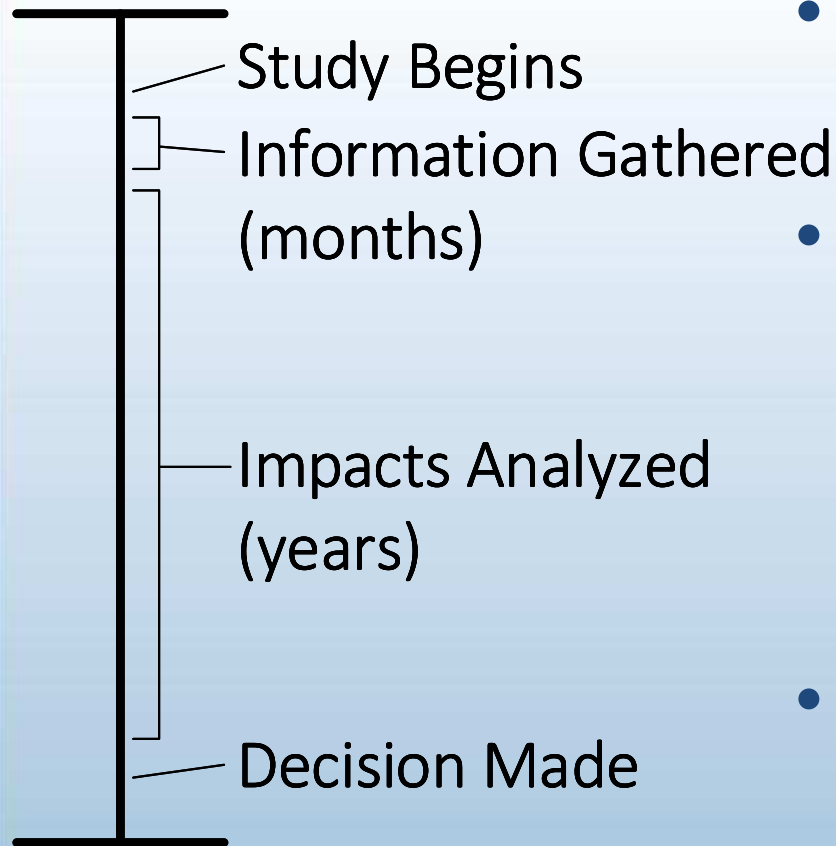
ARE NOT:

- Assurance of 100% impact avoidance
- Universally Applicable



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Regulatory Process Limitations



- Impacts analyzed based on a snapshot of the practices at a **single point in time**.
- Analysis and review of original practices, while **new practices evolve** due to:
 - Technology
 - Research
 - Training
- Decisions made based on practices that are **outdated or non-existent**.

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BMP PROCESS

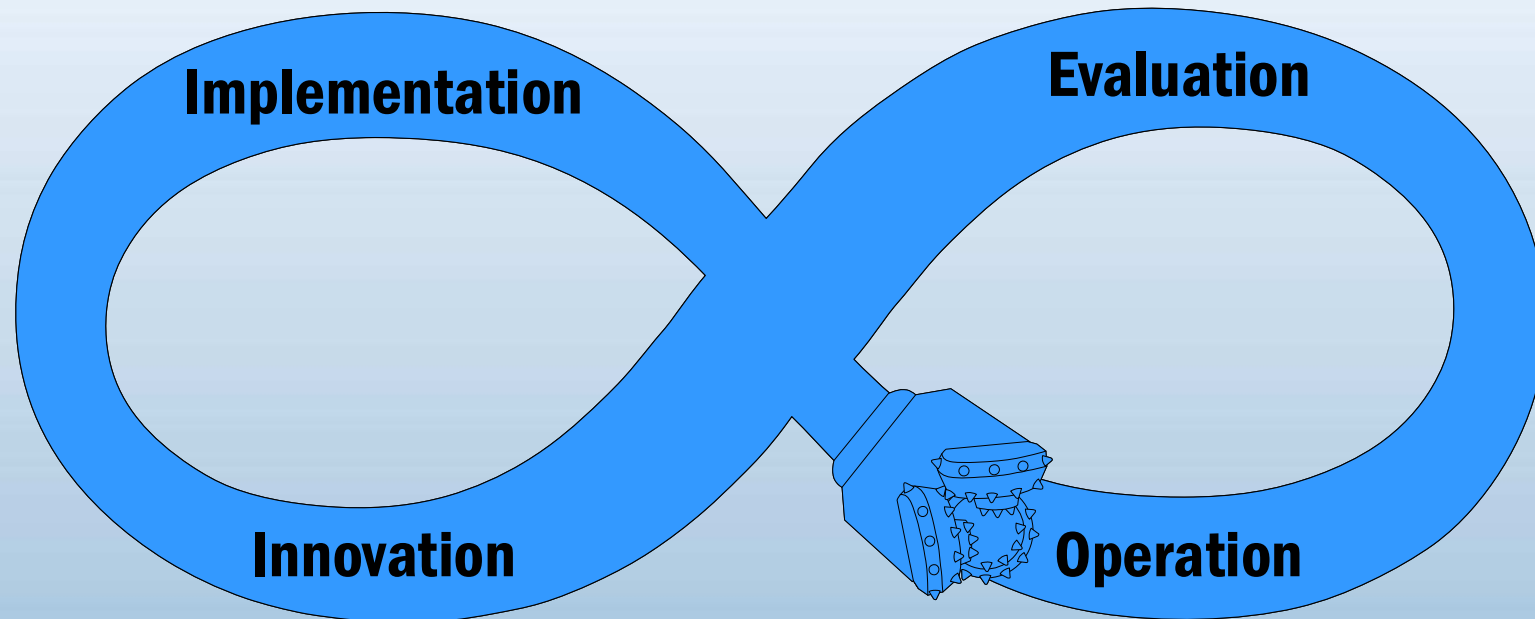
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BMP Process

- Continuously identify problems and implement solutions.
- Adapt solutions to site specific issues and conditions.



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What Drives BMP Evolution??

Innovation initiated by Drivers of Change or new Inputs.

Drivers of Change

- \$\$ (Cost savings/Profit/Investors)
- Litigation Risk
- Public Pressure
- Regulatory Compliance
- Landowner Relations
- Environmental Concern

Inputs

- External Information
- Technology
- Training
- Internal Experience

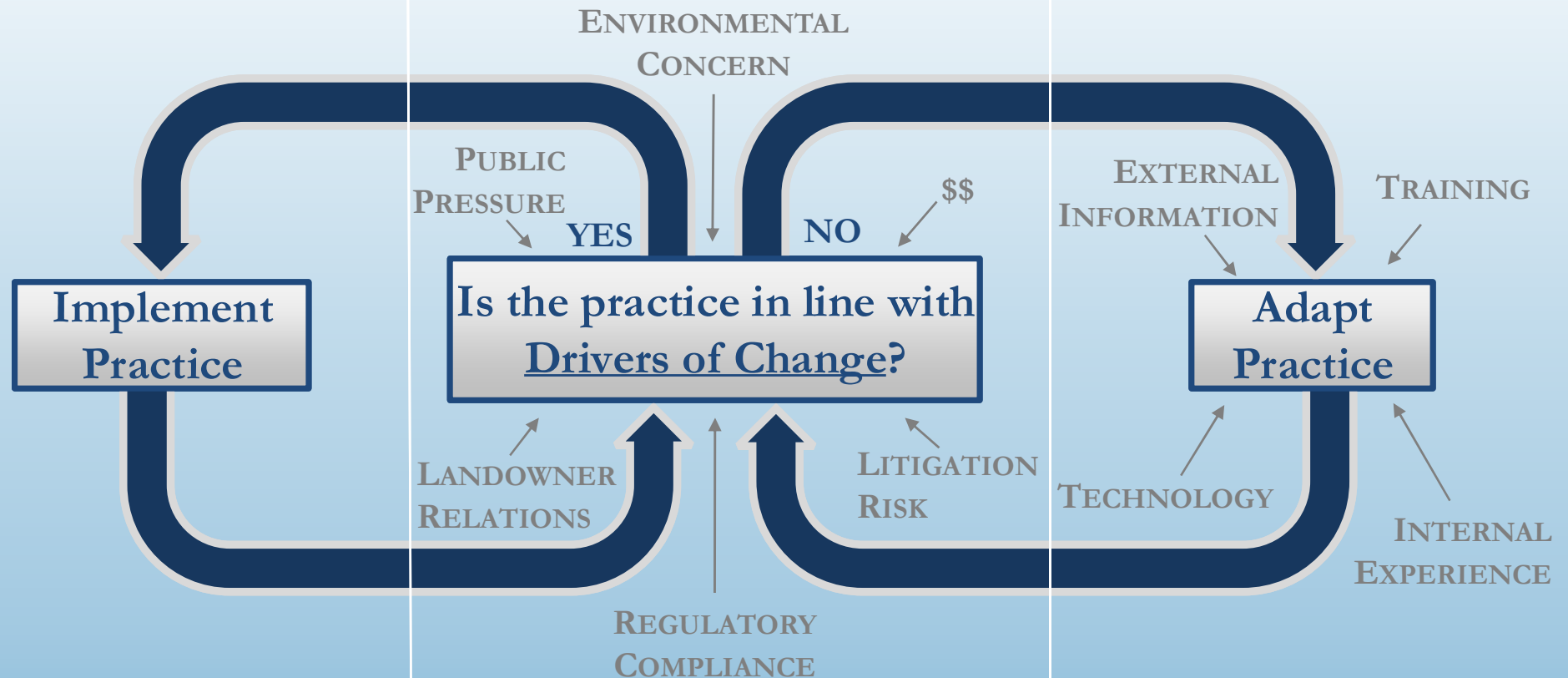
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BMP Theory / Process

OPERATION

EVALUATION

INNOVATION



Example: Fresh Water Transfer Piping

BMP: Switching from aluminum pipe, which has a tendency to leak at joints, to HDPE or “lay flat” pipe.

Benefit:

- Fewer leaks
- Increased durability



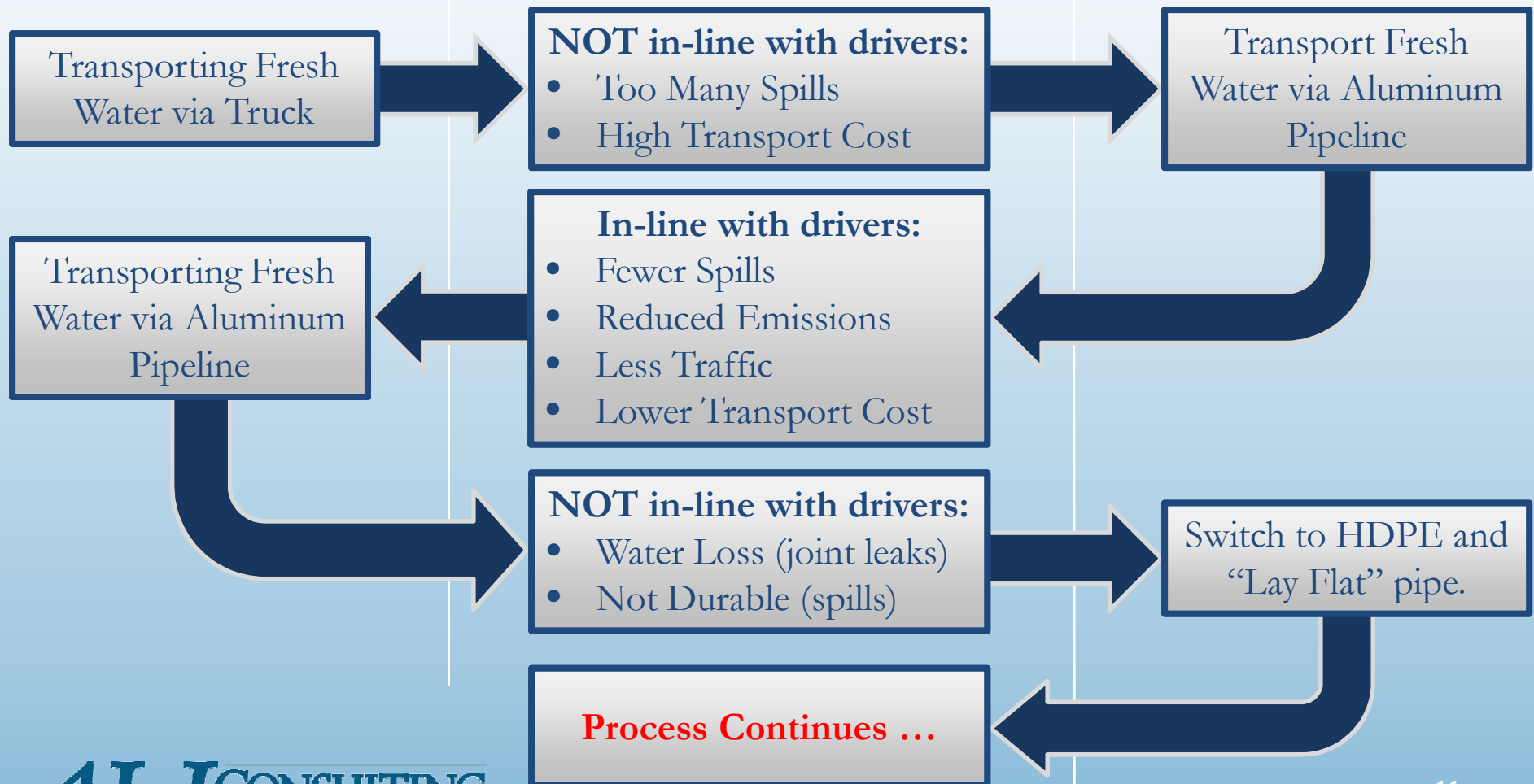
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BMP Theory in ACTION

OPERATION

EVALUATION

INNOVATION



BMP EXAMPLES

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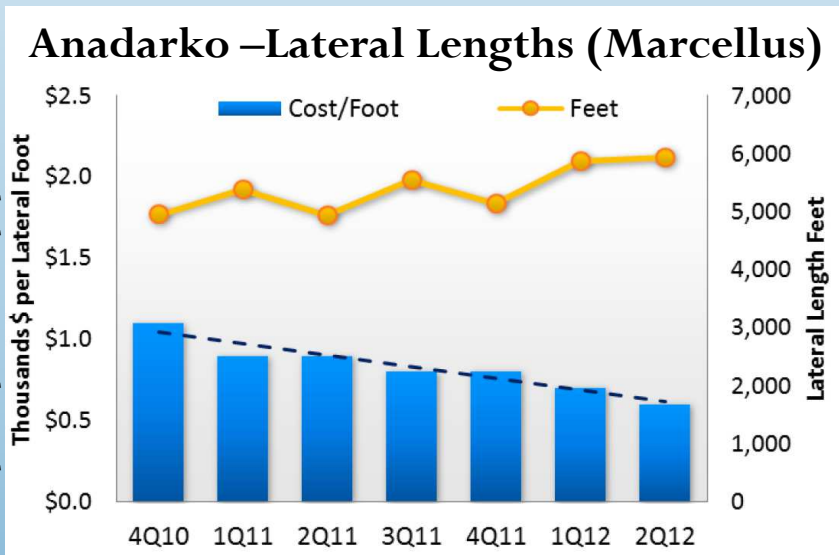
Longer Laterals

BMP: Operators are finding that increasing lateral lengths leads to improved economics (higher production at lower cost).

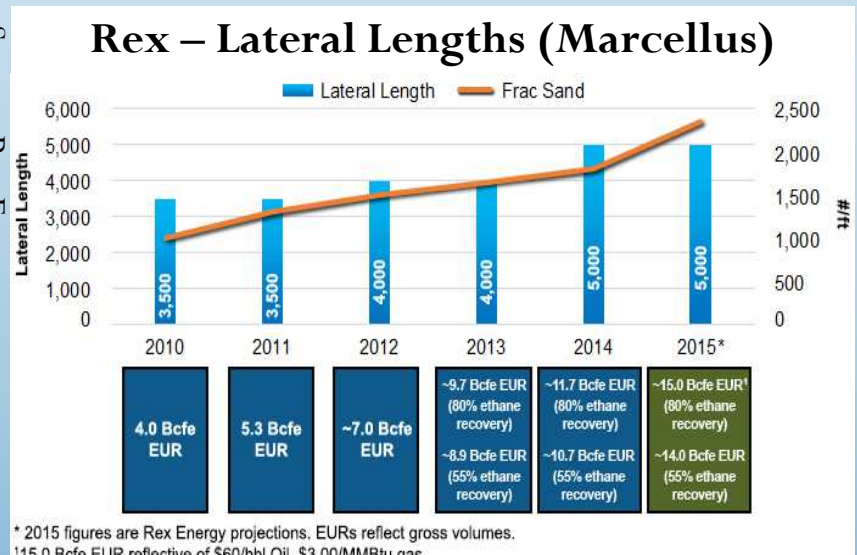
Benefits:

- Increased Profit/Cost ratio
- Reduced land disturbance
- Reduced community impact
- Reduced emissions

Source: Anadarko Quarterly Update



Source: Rex Energy



Increasing Drilling Efficiencies

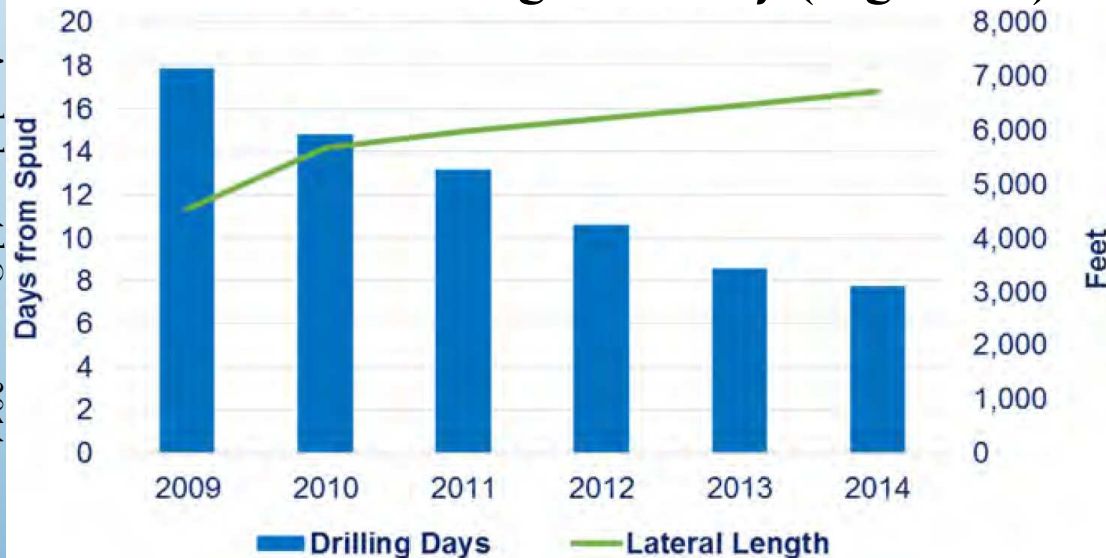
BMP: Using skid- and walking-rigs and process efficiencies to decrease drilling times.

Benefits:

- Reduced emissions
- Reduced operating costs
- Reduced community impact

Source: Anadarko – 4th Quarter 2014

Anadarko – Drilling Efficiency (Eagleford)



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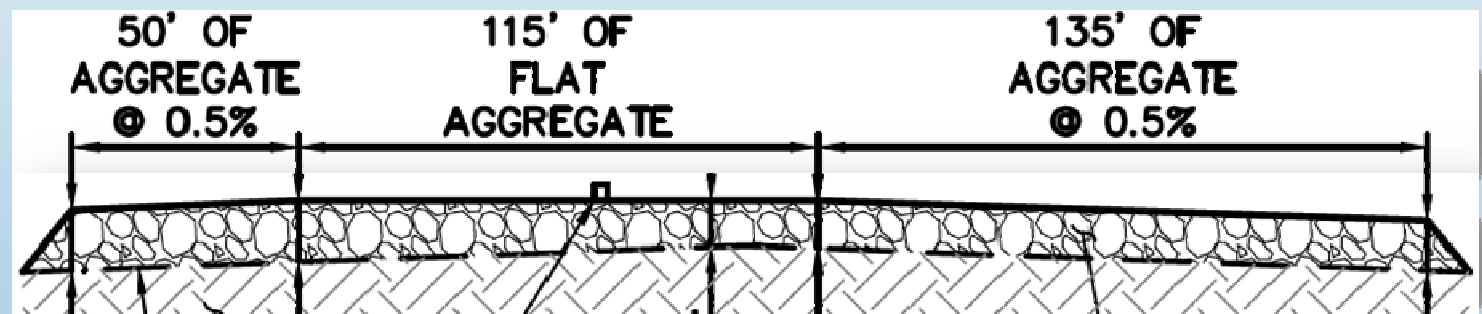
Well Pad Construction

BMP: Improved well pad design which include pad drains, perimeter berms, and multiple layers of ground cover to contain contaminated fluids on the pad in the case of a spill.

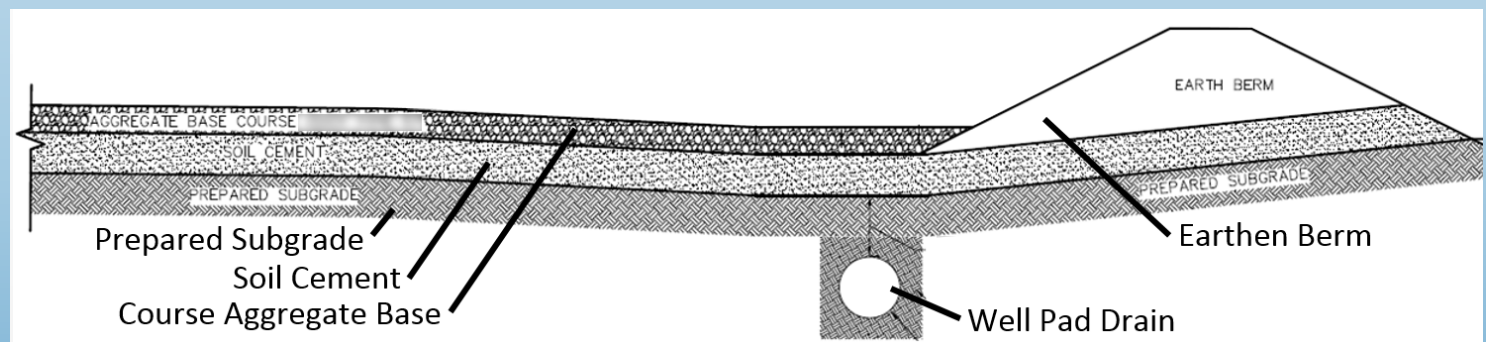
Benefits:

- Reduced water quality impacts
- Increased well pad stability

Previous



Current

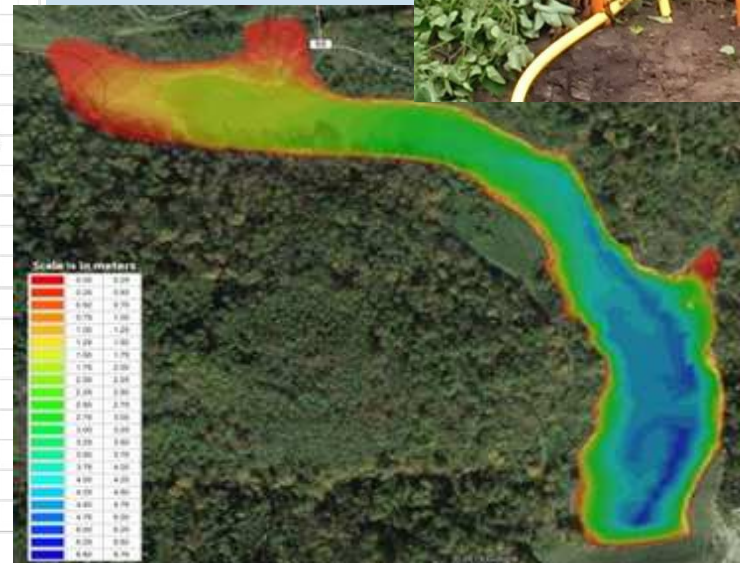
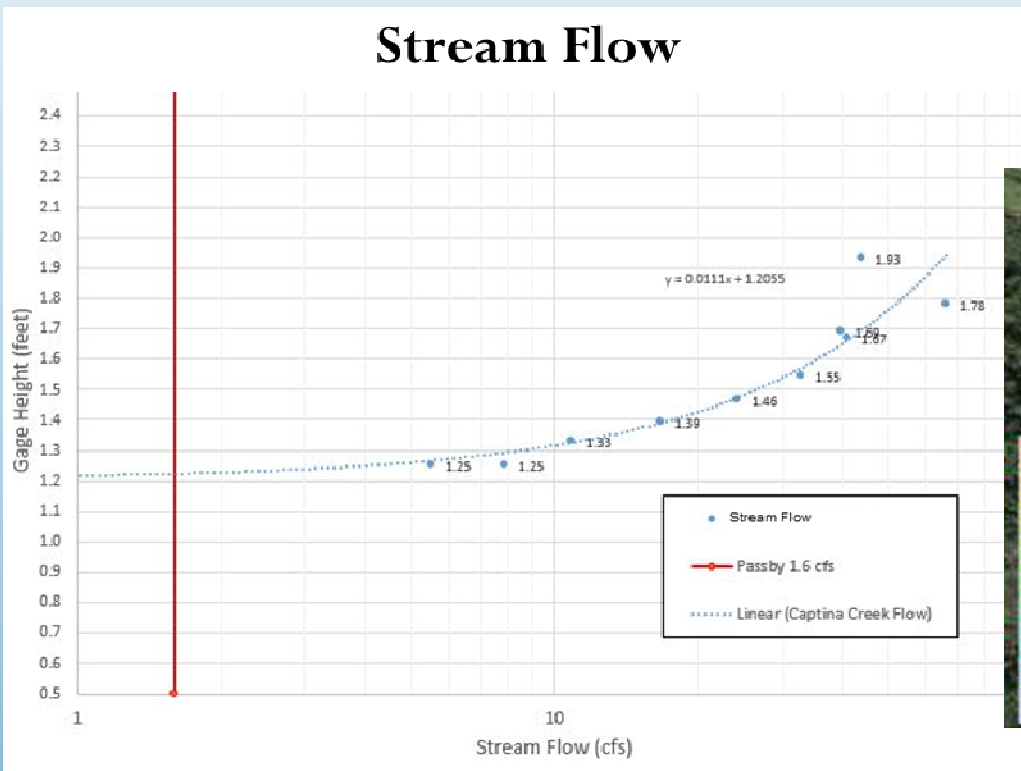


Water Monitoring

BMP: Monitoring water availability in real time (telemetry) using stream flow and pond level modeling.

Benefits:

- Precise knowledge of water availability.
- Immediate pond leak notification.



BMP MANAGEMENT

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How do we manage BMPs?

What constitutes effective BMP management??

1. Continuously updated repository.
 - Add new BMPs
 - Update existing BMPs
 - Delete outdated BMPs
2. Organization-wide communication and integration.

BMP Repository

Database framework for BMP Management

- Searchable (keyword, category, etc.)
- Easily Updated & Distributed
- Drill Down Structure
 - Reduces need to wade through extensive list
 - Multiple paths to same BMP

BMP DATABASE

keywords ...

> Affected Resource

> Development Activity

> Location

> Change Driver

Search

Reset

> Water Sourcing

> Water Management

> Air Quality

> Drilling & Hydraulic Fracturing

> **Waste Management**

> Waste Treatment

> Facilities

> Radiation Protection

> ...

> Waste Management Plan

> **Produced Water Management**

> Drill Cutting Management

> Haz. Waste Management

> Waste Minimization

> Waste Segregation

> On-Site Recycling/Treatment

> ...

> Transportation

> **Storage**

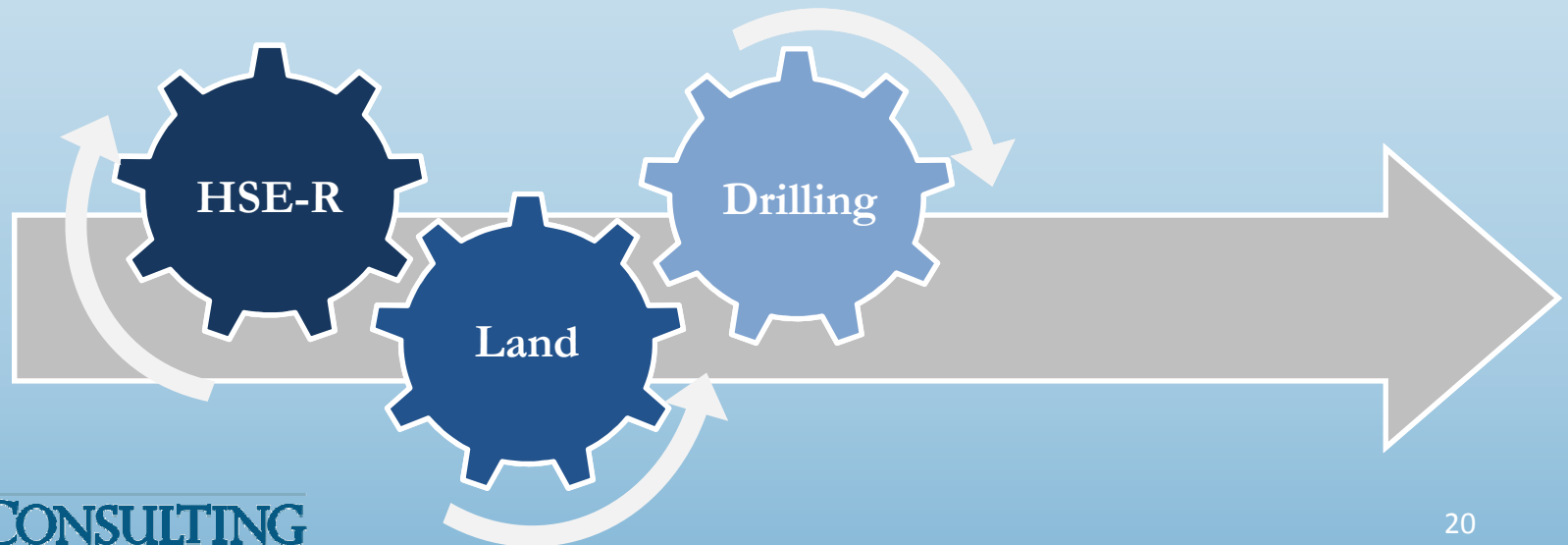
> Treatment/Recycling

> Disposal

> ...

Communication & Integration

- Communicate BMPs to all functional groups:
 - Disseminate changes to all groups
 - Continuous Training & Education
- Integrate BMPs into operational processes.
 - Coordination between groups to properly ensure proper employment



Summary

- Decisions to ban or limit oil and gas development are being made based on practices that are out of date.
- Practices are being continuously improved and adapted to reduce impacts while allowing development of important resources.
- Proper implementation of the BMP process has and will allow for continuous improvement of oil and gas development practices.



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