



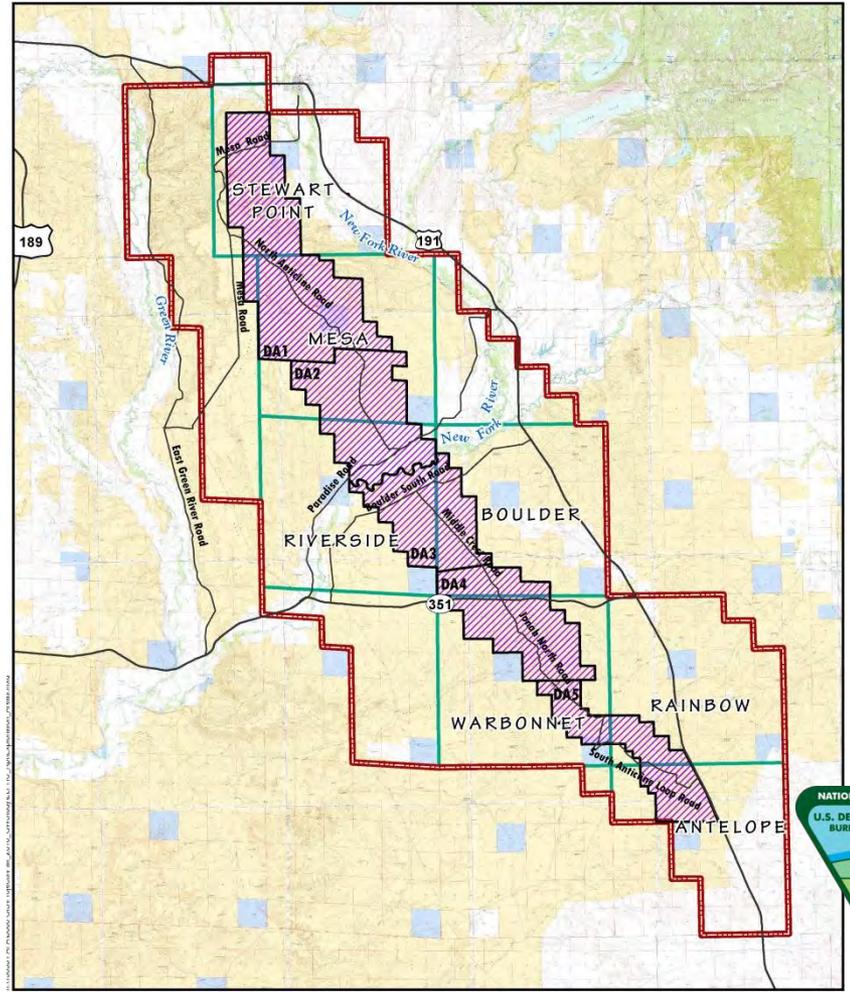
Evaluation of Potential Sources of Low-Level Petroleum Hydrocarbon Compounds Detected in Groundwater

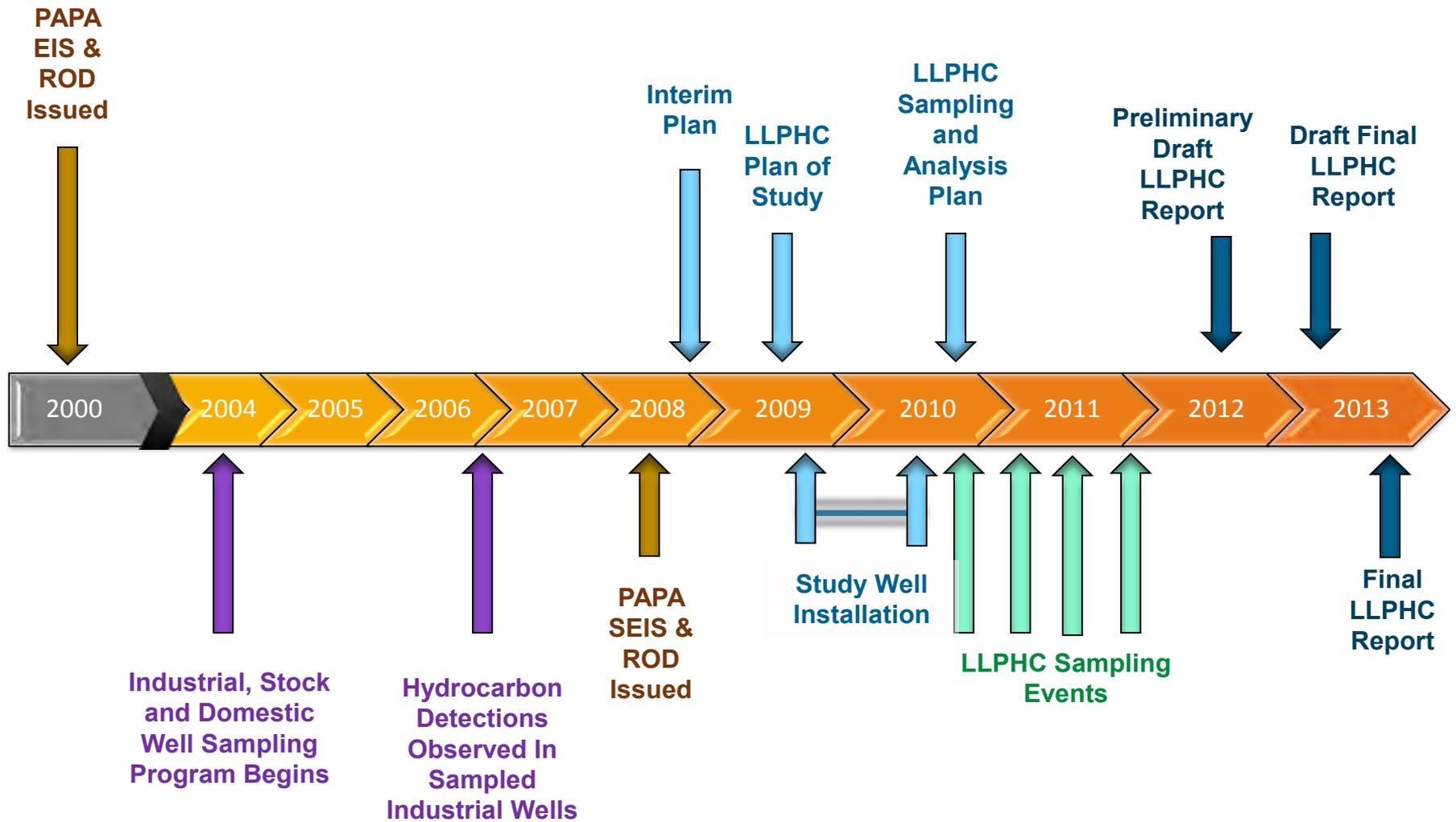
Pinedale Anticline Project Area
Sublette County, Wyoming



Together Again – How We Got Here

- Discovery (2006-7)
- Decision (2008)
- Plans (2008-10)
- Execution (2010-12)
- Findings (2012)
- Next Steps (2012-13)





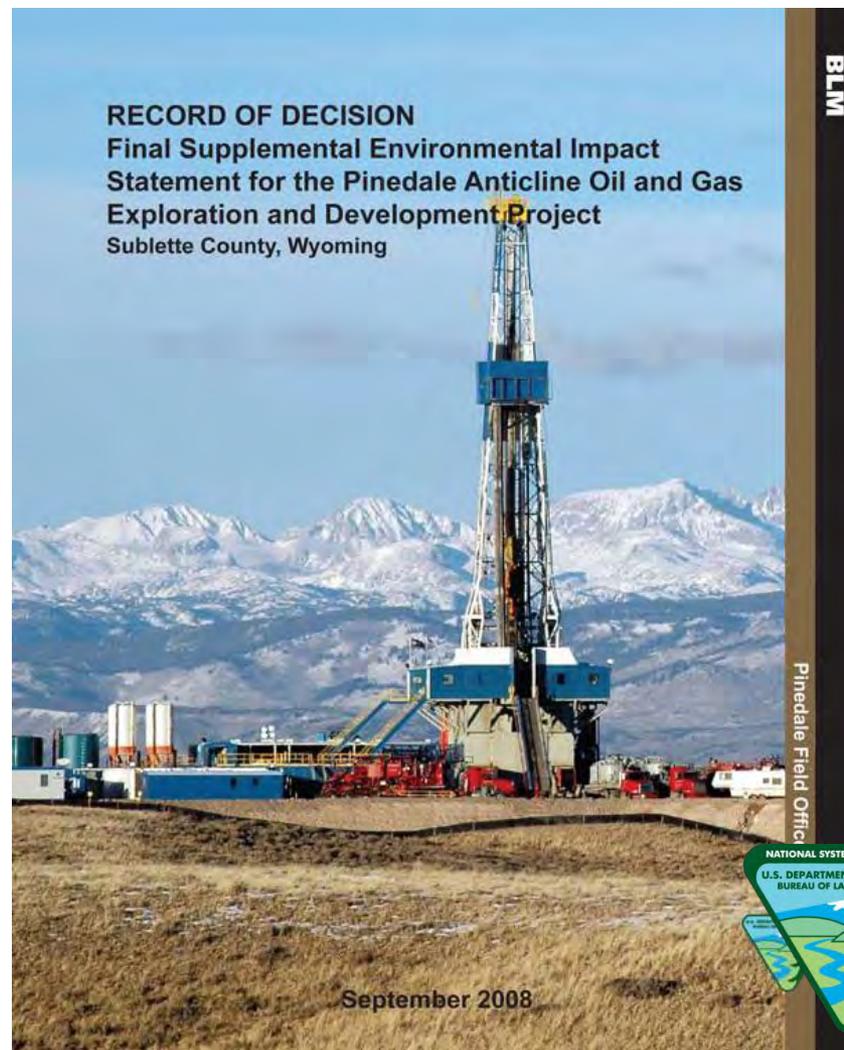
Discovery 2006 - 2007

- Annual GW monitoring began in 2004
- 2006 detection of low-level petroleum hydrocarbons
- By early 2007 all WSW re-sampled
- Approximately 70+ samples exhibited low-level detections



SEIS Decision – Groundwater Resources

- ROD – Mitigation Measures for Groundwater Resources
- The Guide – BLM's Regional Framework for Water Resources Monitoring Related to Energy Exploration and Development
- Three Steps
 - 1) Compile Existing Information
 - 2) Develop and Implement Interim GW/APPMMP
 - 3) Finalize GW/APPMMP



Interim Plan – Three Tasks

1. **Characterize** the Groundwater System
2. **Augment** the Existing Monitoring Program
3. **Identify Mitigation** for all Potential Sources of Contamination

POLLUTION PREVENTION AND MITIGATION




FINAL

INTERIM GROUNDWATER/AQUIFER
POLLUTION PREVENTION, MITIGATION
AND MONITORING PLAN

PINEDALE ANTICLINE OIL AND GAS
EXPLORATION AND DEVELOPMENT PROJECT

Sublette County, Wyoming



AMEC Geomatrix **DECEMBER 2008**




Task 3, Interim Plan

IDENTIFY MITIGATION FOR POTENTIAL SOURCES OF CONTAMINATION

- Evaluate Potential Sources of Low-Level Petroleum Hydrocarbon Compound Detections (Subtask 3A)
- Evaluate Potential Operational Sources of Contamination (Subtask 3B)
- Develop Recommended Mitigation Measures, as necessary (Subtask 3C)



Evaluation of Potential Sources of LLPHC

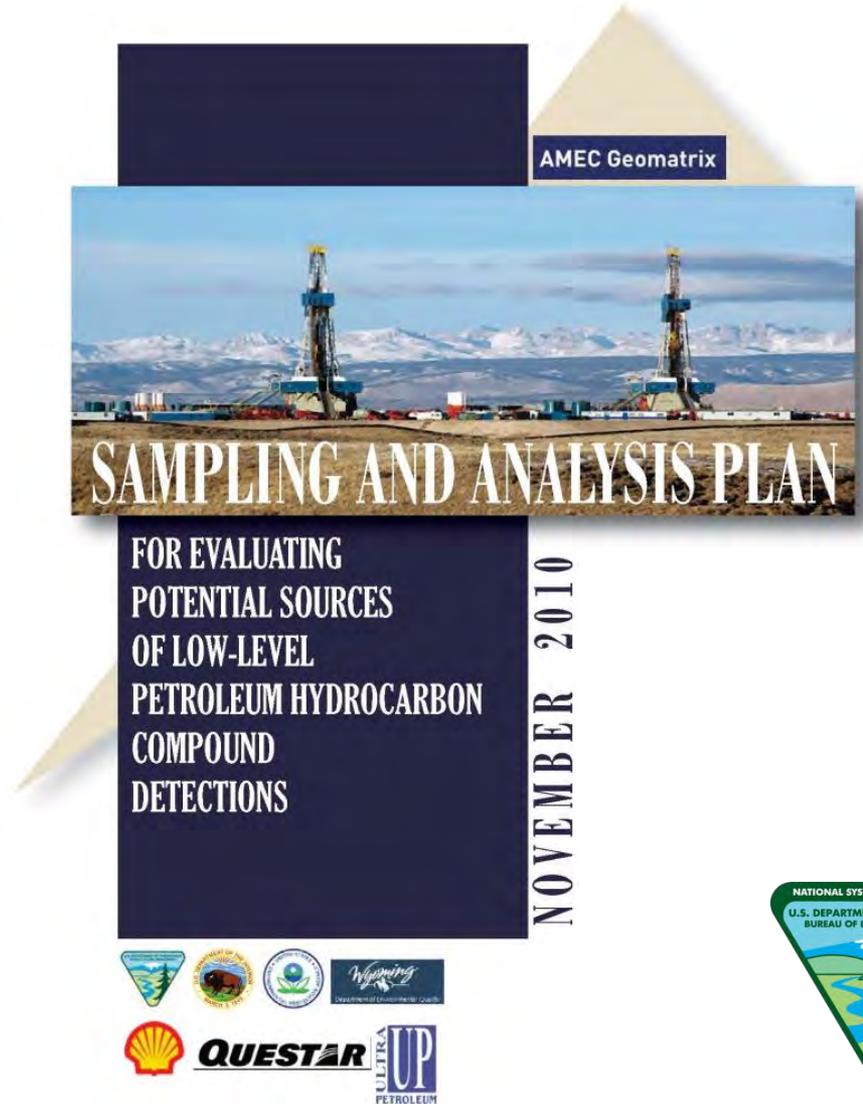
Planning Documents:

- ✓ Plan of Study (May 2009)
- ✓ Sampling and Analysis Plan (November 2010)

Prescribed Approach

Reviewed by:

- BLM
- DEQ
- EPA
- Operators



Low-Level . . . defined

Low-level petroleum hydrocarbon detections are considered those that are below applicable groundwater standards.

11/06/2009 10:30 am



Sampling and Analysis Plan (Nov 2010)

- **Background (history, setting, existing WQ)**
- **Potential PHC Sources Identified**
- **Technical Approach Defined & Described**
- **Procedures Outlined (field, analytical, QC/QA)**



SAP – Technical Approach

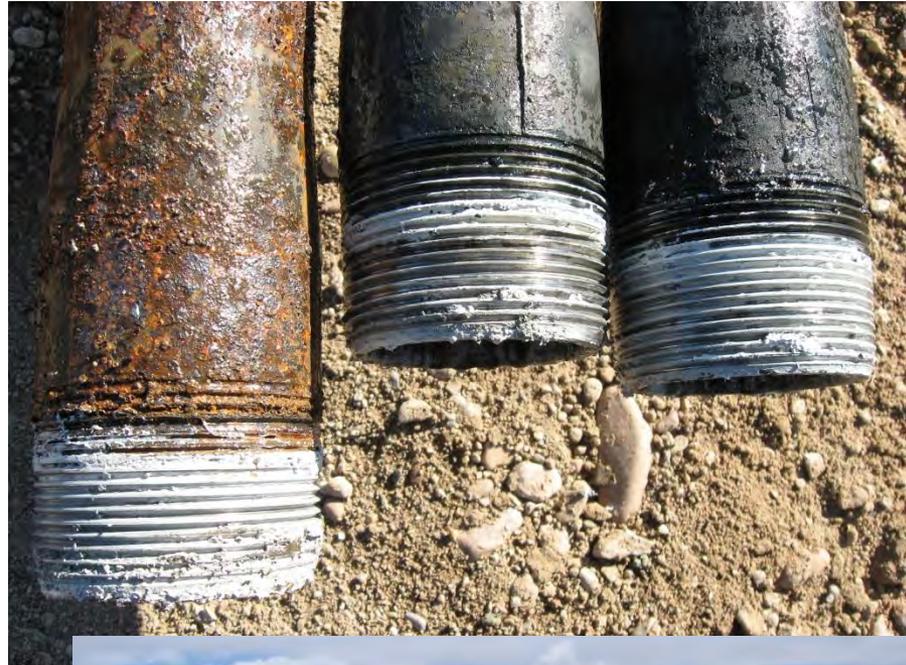
SAMPLE TYPES

- Potential PHC Source Materials
- Gas Samples
- Groundwater Samples



SAP – Source Material Samples

1. Drilling Mud
2. Condensate
3. Produced Water
4. Flowback Fluid
5. Pump Installation
Mts.
6. LNAPL
7. Carbonaceous Shale



SAP – Gas Samples

1. Casing Gas (Water Wells)



2. Natural Gas (Production Wells)



SAP – Groundwater Samples

Four Groups:

- 1. Control wells
- 2. LEL wells
- 3. PHC wells
- 4. Study wells



SAP – Groundwater Samples

37 Wells identified for sampling activities

- 27 credible/suitable industrial water supply wells.
 - 6 control wells
 - 21 had previous detections and/or documented presence of combustible gas in well casings
- 10 “study” wells specifically installed under the Interim Plan.

Of the 37 proposed, 3 wells could not be sampled:

- Petrogulf 36-9 – access was denied (PHC)
- Antelope 15-4 – is plugged and abandoned (LEL)
- T-2-SW – it was dry (SAP)



SAP – Sample Analysis

- Inorganics
- Metals
- Purgeable and Extractable Hydrocarbons
- VOCs and SVOCs
- Stable Isotopes
- Hydrocarbon Gas Composition
- Thermal Maturity (carbonaceous shale)

Energy Laboratories, Inc., Isotech Laboratories, Precision Analysis, Questar Applied Technologies, Intertek Westport Technology Center



SAP – Five Sampling Events

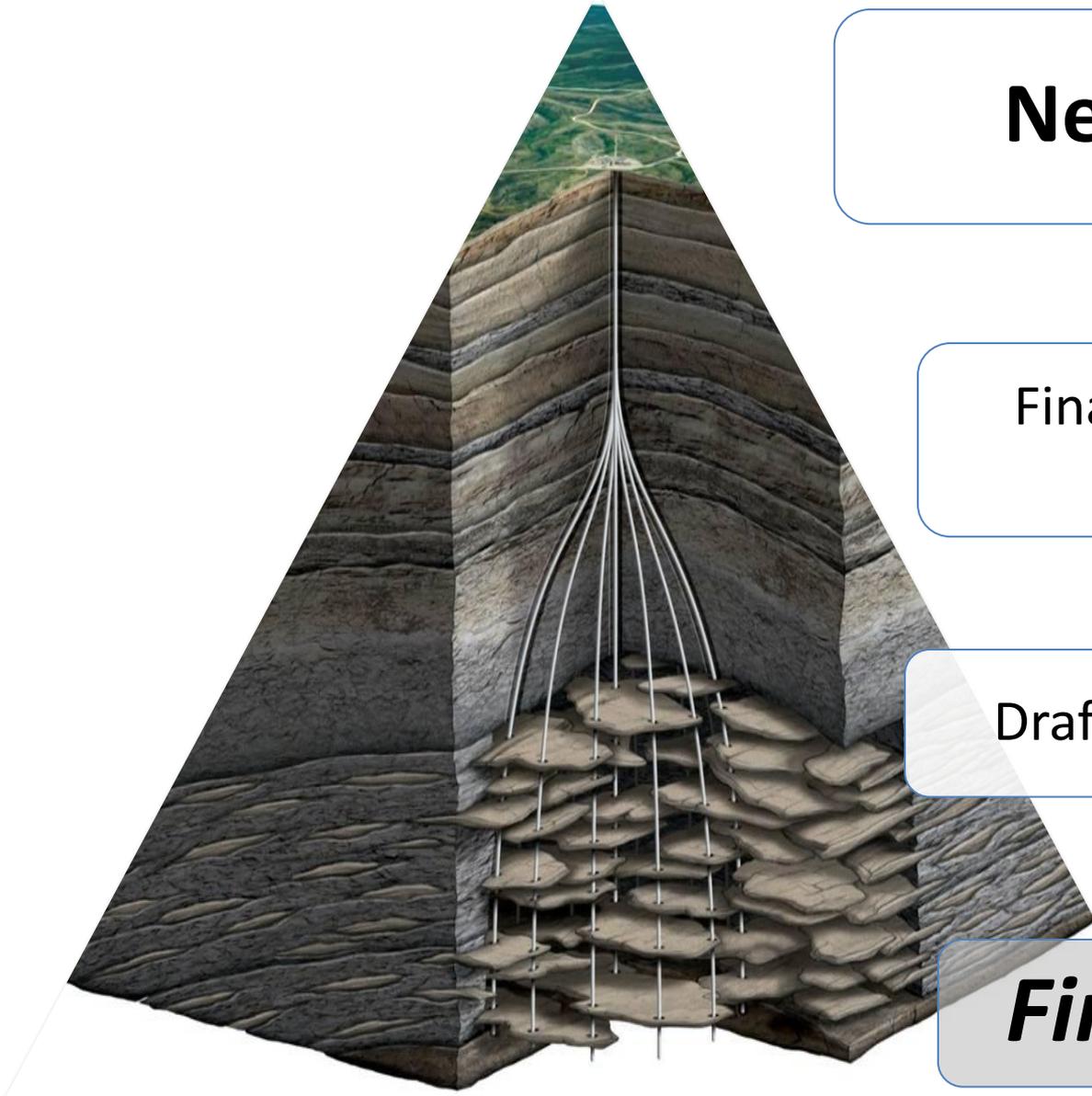
1. Sep 2010 (pump installation materials [dope])
2. Nov-Dec 2010
 - Groundwater – Industrial water supply wells
 - Potential Source Materials – LNAPL, condensate, produced water, drill mud
 - Gas – water well casing gas, NG production wells
3. Feb-Mar 2011 (flowback fluid)
4. Jun 2011 (groundwater from study wells)
5. Feb 2012 (follow-up groundwater and gas)



SAP – Results

- ❖ Final LLPHC Source Evaluation Report is expected for release in late September/early October.
- ❖ Final Numerical Model Technical Report is expected for release in late September/early October.
- ❖ A meeting in Pinedale, to discuss both reports is being planned.





Next Steps



Finalize LLPHC Report



Draft Final GWP



Final GWP



Final Groundwater Plan

Will incorporate results of the:

- Final Hydrogeologic Data Gaps report
- Numerical Model Solute and Advective Transport scenarios
- Low Level Petroleum Hydrocarbon Compound Source Evaluation Results

Final Plan will include:

- Monitoring Network
- Sampling and Analysis Plan
- Mitigation Measures and/or Pollution Prevention Actions

Agencies will use this information to formulate a recommendation regarding the ROD-imposed Water Well Moratorium.

