

Update on EPA's Clean Water Act Review of the Coalbed Methane (CBM) Extraction Sector



**International Petroleum & Biofuels
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Presentation Overview

- Provide background on EPA's Detailed Study on the coalbed methane (CBM) extraction sector.
 - Overview of Clean Water Act (CWA), effluent guidelines, and effluent guidelines planning
 - Overview of scope and schedule for CBM Detailed Study.
- Provide update on current data gathering activities including on-going survey of CBM operators.



PA CBM Well



EPA Regulation of Discharges to Surface Waters

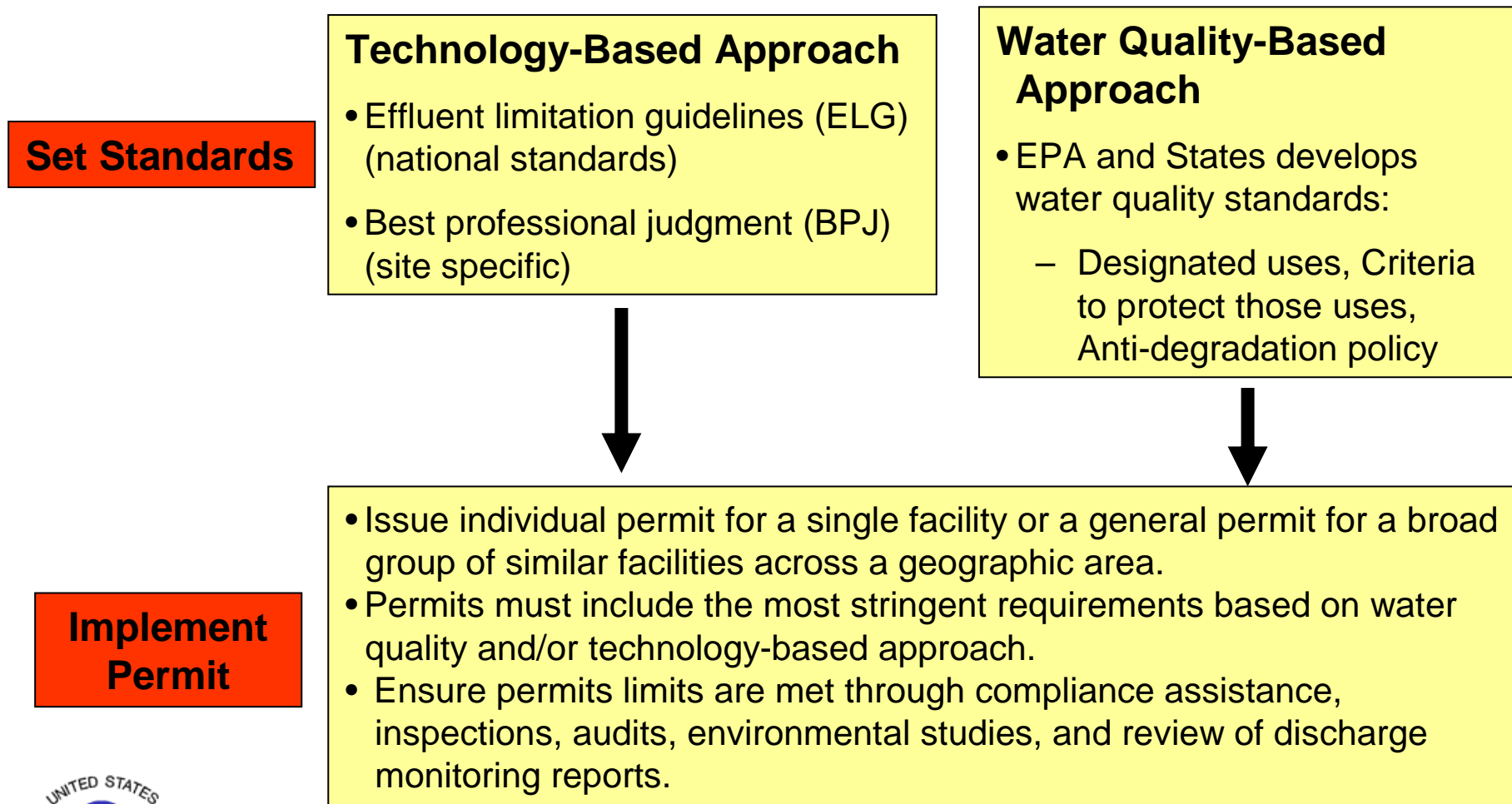
- The major environmental law governing surface water discharges is the Clean Water Act (CWA).
- Goals of the Clean Water Act are:
 - Restore and maintain the chemical, physical and biological integrity of the Nation's waters for the protection and propagation of fish, shellfish, and wildlife and provides for protection of human health and recreation in and on the water (e.g., fishing, swimming, boating); and
 - Zero discharge of pollutants to navigable (surface) waters.
- EPA and States implement the CWA through publication of regulations and discharge permits for point sources of wastewater pollution.
- Any discharge to the surface waters must comply with the more stringent of technology-based and water-quality based effluent limits.



CBM Outfall (PRB, WY)



EPA Regulation of Discharges to Surface Waters



NPDES permits should be renewed every five years.



Technology-based Approach: Effluent Guidelines

- EPA establishes effluent limitations guidelines (ELGs) for categories of U.S. industry.
- These ELGs are based on technologies that are available and economically achievable for the industrial sector.
- There are ELGs for 56 industrial categories (450 subcategories) covering more than 60,000 direct and indirect dischargers.
- The ELGs for the oil and gas extraction industry are located in EPA's Federal regulations (40 CFR 435) and were issued in stages: 1979 (onshore & beneficial use), 1993 (offshore), 1996 (coastal), and synthetic-based drilling fluids (SBF) issued in 2001.
- The Oil and Gas Extraction ELGs do not currently regulate pollutant discharges from CBM extraction operations.
 - As required by EPA regulations, NPDES Permit writers used their 'best professional judgment' to establish technology-based effluent limits. See 40 CFR 122.44(a)(1) and 40 CFR 125.3(d).
 - EPA considers CBM extraction a potential new subcategory of the Oil and Gas Extraction Category.



Effluent Guidelines Planning

- The CWA requires EPA to annually review existing ELGs and to revise such regulations “if appropriate.”
- The 1987 Clean Water Act Amendments added Section 304(m), which requires EPA to publish a plan every two years after allowing for public comment.
- In these biennial plans the Agency must announce its schedule for:
 - Performing its annual reviews of existing ELGs, and
 - Revising ELGs rulemakings initiated as a result of these annual reviews.
- More information at: <http://www.epa.gov/guide/304m>



304(m) Detailed Study: Coalbed Methane Extraction

- Rationale for Detailed Study:
 - Growing industry sector and potential impacts on the environment.
 - Impacts to surface waters from discharge of CBM produced water can depend on the quantity and quality of the CBM produced water.
- Objectives and Scope of the Detailed Study:
 - Evaluate availability and affordability of technology options for CBM produced water discharges in the current and future CBM basins.
 - Evaluate potential environmental issues associated with the discharge of CBM produced water.



**CBM Produced Water
Gathering Pipes (WY)**



CBM Detailed Study: National in Scope



Note: Alaska also has CBM reserves



CBM Detailed Study: Basin Specific

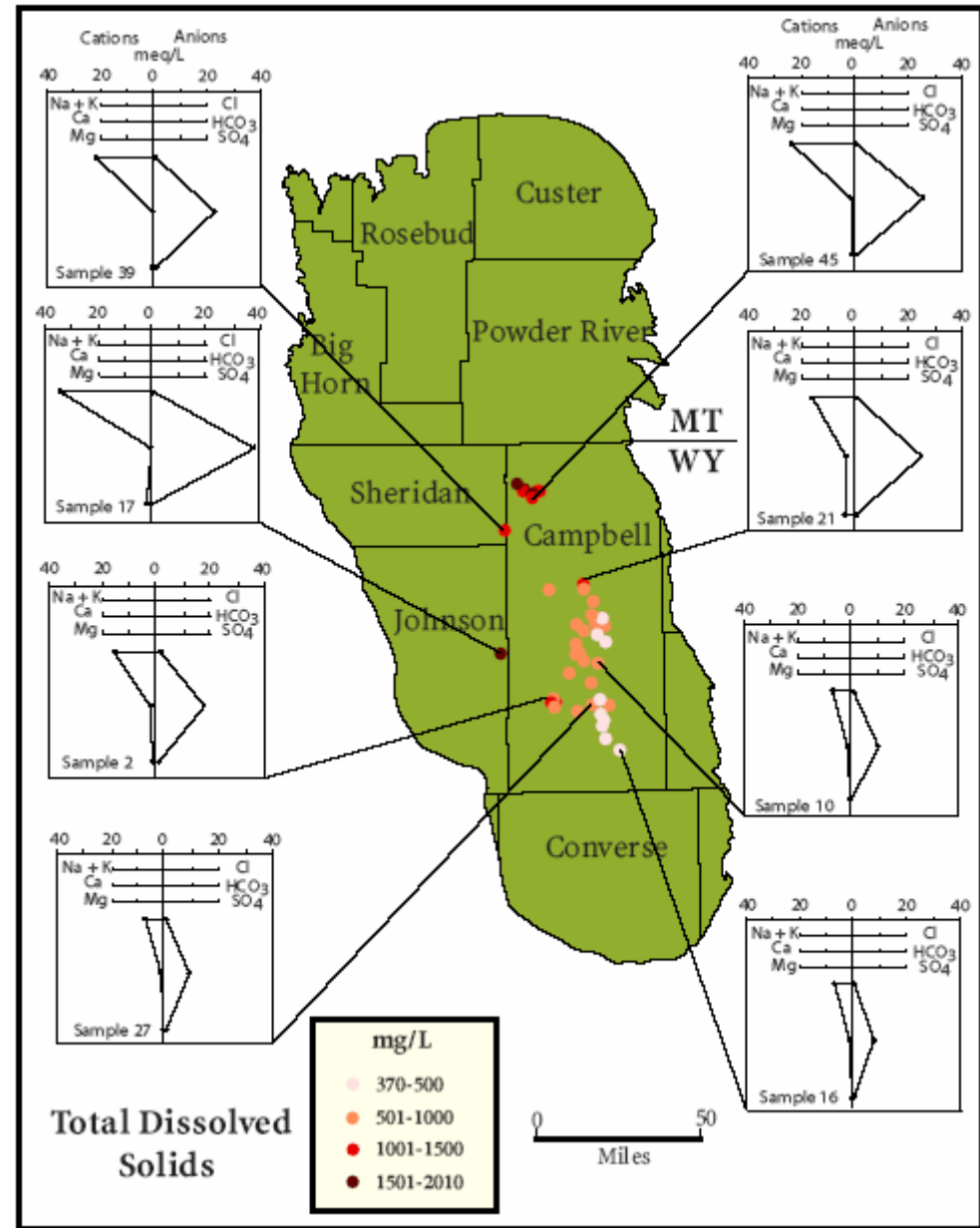
- EPA's CBM Detailed Study is national in scope. However, EPA will examine each basin separately to identify potential pollutant discharges and technology options.
- Produced water volumes can vary greatly over time, between and within CBM basins, and may be very large.
 - Production volumes range from 1,000 to 17,000 gal/day/well in the San Juan and Powder River Basins, respectively.
- Pollutants in CBM produced water also vary between basins. For example, total dissolved solids (TDS) vary widely depending on basin geology.
 - **Eastern U.S.:** TDS concentrations typically range from 500 to 27,000 mg/L with some wells over 50,000 mg/L.
 - **Western U.S.:** TDS concentrations range from 400 to 2,000 mg/L (Powder River Basin), 9,000 to 11,000 mg/L (Wind River), to approximately 50,000 mg/L (San Juan Basin).
- CBM produced water may also contain small amounts of metals and some volatile and semi-volatile organic compounds. EPA is also reviewing USGS research on sodium bicarbonate aquatic toxicity.



Example of CBM Produced Water Chemistry Changing with Geographic Location: Powder River Basin (MT/WY)

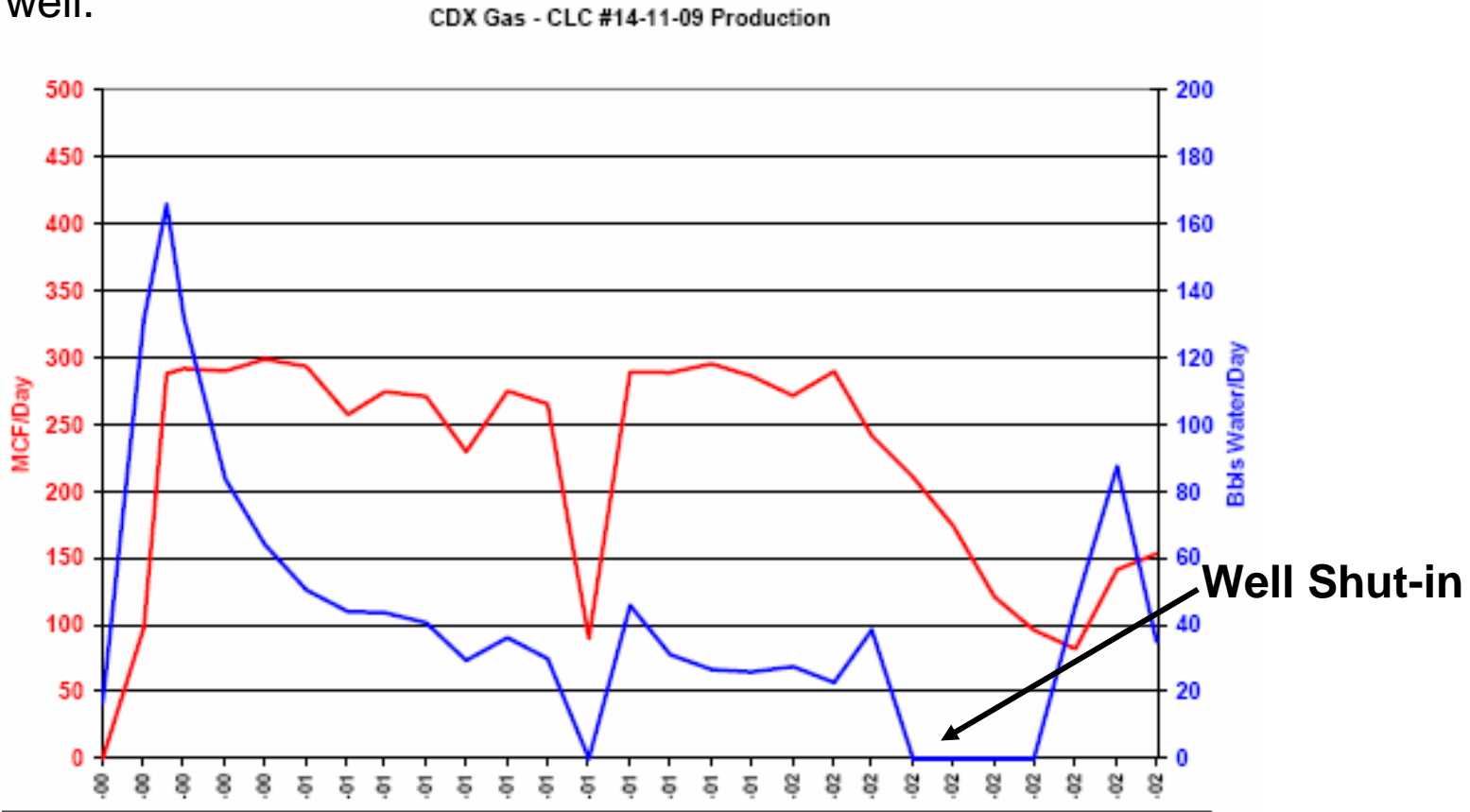


Source: USGS Open-File Report 00-372
pubs.usgs.gov/of/2000/ofr-00-372/OF00-372.pdf



Example of CBM Produced Water Discharge Volumes Changing with Time

This graph shows the increased production of water in the early life of a CBM well.



Source: Handbook on Coal Bed Methane Produced Water: Management and Beneficial Use Alternatives, ALL Consulting, <http://www.all-llc.com/CBM/BU/index.htm>, July 2003.

CWA 304(m) Detailed Study: Coalbed Methane Extraction

- Major Tasks for Data Collection and Analysis:
 - Industry survey to collect technical, economic, and environmental data from a wide range of CBM operations across the Nation.
 - Site Visits & misc. secondary data sources (e.g., DOE/EIA data)
 - Stakeholder meetings in the major CBM basins.
 - EPA has contacted over 700 people in eight states in over 70 outreach and data collection activities since 2007.
- Stakeholders:
 - So far: API, regional trade associations, individual companies, treatment technology vendors, DOE, BuRec, BLM, States, Landowners, Indian Nations
- Schedule:
 - Approval from OMB to distribute the mandatory survey on 18 February 2009.
 - First Phase (Screening Questionnaire) distributed to approximately 290 operators (that have three or more CBM wells) on February 27th.
 - Second Phase (Detailed Questionnaire) distributed to approximately 250 CBM projects on October 30th. Operators have 60 days to respond to survey.
 - EPA will analyze the survey results and identify whether to initiate a rulemaking in the final 2010 Effluent Guidelines Program Plan (October 2010).



CWA 304(m) Detailed Study: Industry Survey

- Survey data will support EPA analyses that:
 - Quantify levels of pollutants currently discharged by the industry
 - Assess potential environmental impacts.
 - Determine availability of technologies to control pollutant discharges.
 - Identify water disposal practices and prevalence of each.
 - Evaluate economic achievability of the industry to incorporate new control technologies and/or disposal and beneficial use practices.
- Unit of interest is “project”
 - Using State data (via HPDI.com) EPA estimated that there were approximately 45,000 CBM wells, but no way to link the wells into projects. Projects consist of 1 to many wells.
 - EPA used the screener questionnaire to identify business size of operator, number of projects for each operator, wells in each project, and project gas production and selected water management.
 - The detailed questionnaire was sent to statistical sample of projects.

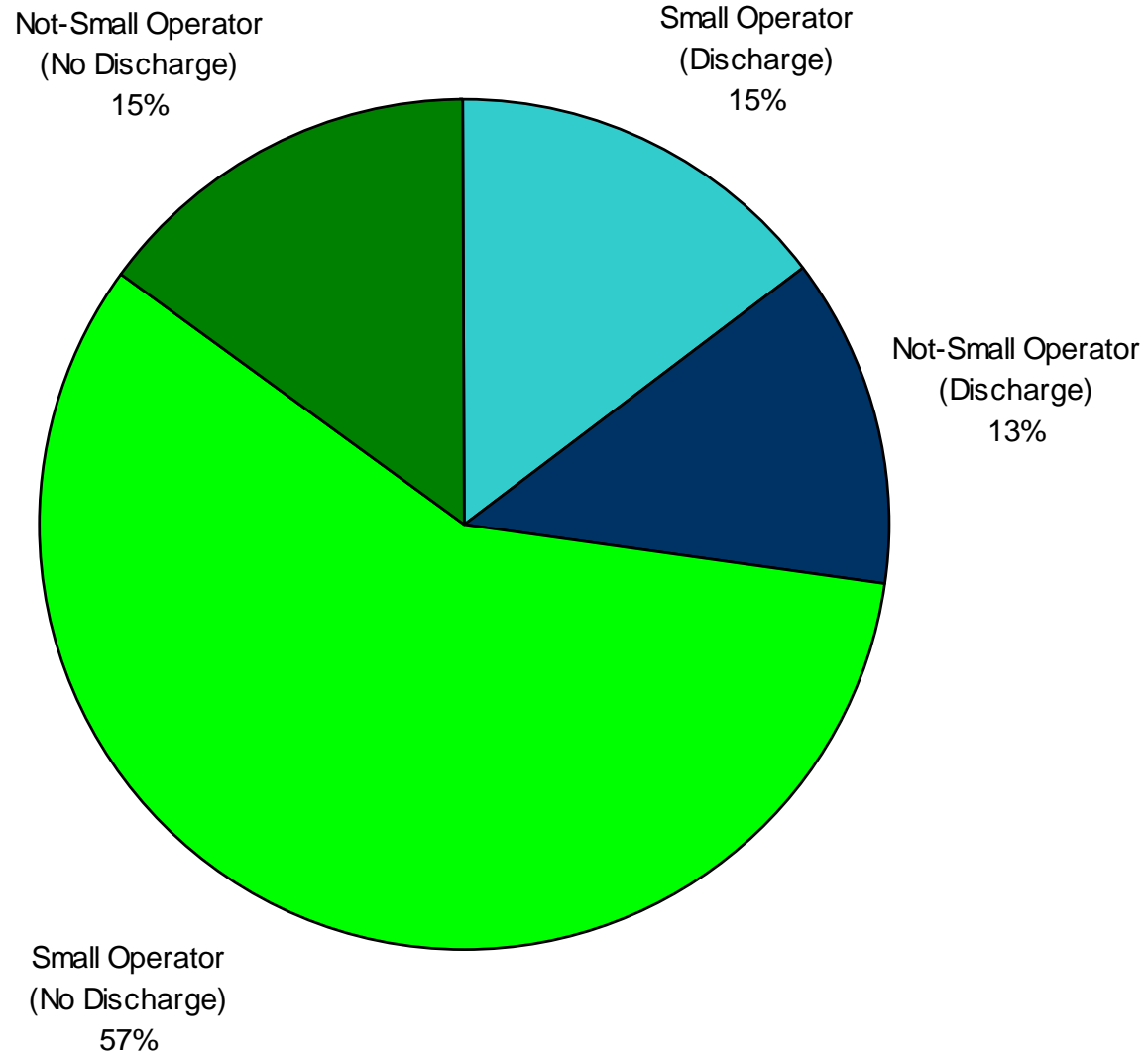


EPA CBM Detailed Study: Screener Data Summary

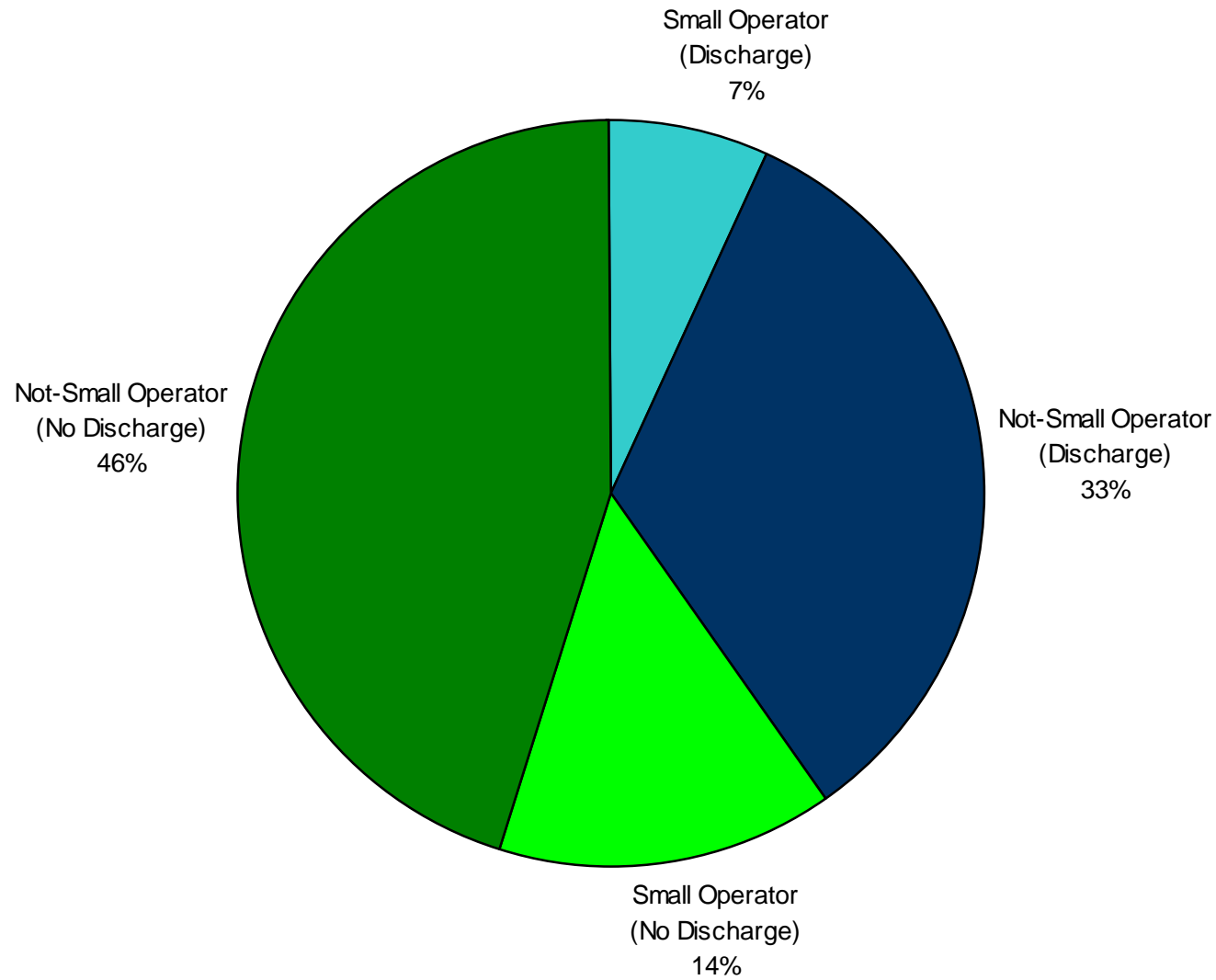
- EPA compiled data from screener questionnaires and State data to identify 216 operators managing three or more wells and 58 operators managing one to two wells (= 274 operators total).
- EPA identified that there were 56,049 CBM wells in 2008 that operators managed in 692 different CBM projects.
- This CBM production, 2.0 trillion cubic feet, represents approximately 7.7 percent of the total U.S. natural gas production in 2008.
- The 692 CBM projects are located in 16 different CBM basins across the Nation but are mainly concentrated in Wyoming, New Mexico, Alabama, and Appalachia.
- CBM projects ranged from over 2,000 CBM wells to 1 CBM well. Nationwide medium and large businesses have 28% of the projects (by number) but provide 79% of the gas production.
- EPA used these data to draw a representative sample of CBM projects. The detailed questionnaire will collect financial and technical data on approximately 250 CBM methane projects across the country.



Distribution of CBM Projects (Operator Size, Discharge Status)



Distribution of CBM Gas Production (Operator Size, Discharge Status)



CWA 304(m) Detailed Study: Industry Survey

- EPA's mailing list for the screener questionnaire was built on State data (via HPDI.com).
- EPA opted to include operators on the screener questionnaire mailing list if it was unclear about the type of gas production (conventional vs. coalbed methane).
- EPA spent considerable effort in tracking down contact information for smaller operators.
- EPA used the updated contact information for its detailed questionnaire mailing list.



EPA CBM Detailed Study: Screener Data Summary

Overall operators identified more CBM wells in their responses to the screener questionnaire (2008 data) than what EPA identified from State data (via HPDI.com) (2007 data).

Basin	# Wells (HPDI.com)	# Wells (Screener Database)
AL/FL/MS/Salt Dome/Cahaba	319	390
Anadarko	1,214	2,800
Appalachian & Illinois	4,562	6,200
Arkla	27	42
Arkoma	1,420	2,300
Wind River & Green River	308	340
Black Warrior	4,771	5,200
Cherokee/Forest City	2,311	5,300
Ft. Worth, Permian, & Texas Gulf Coast	9	15
Powder River, MT	877	900
Powder River, WY	19,295	21,000
Raton	2,736	3,700
San Juan	6,546	7,000
Uinta-Piceance	970	1,100
Total	45,365	56,000

Screener database numbers rounded to two significant figures



EPA CBM Detailed Study: Screener Data Summary

Overall operators identified more gas production (MMcf) in their responses to the screener questionnaire (2008 data) than what EPA identified from State data (via HPDI.com) (2007 data).

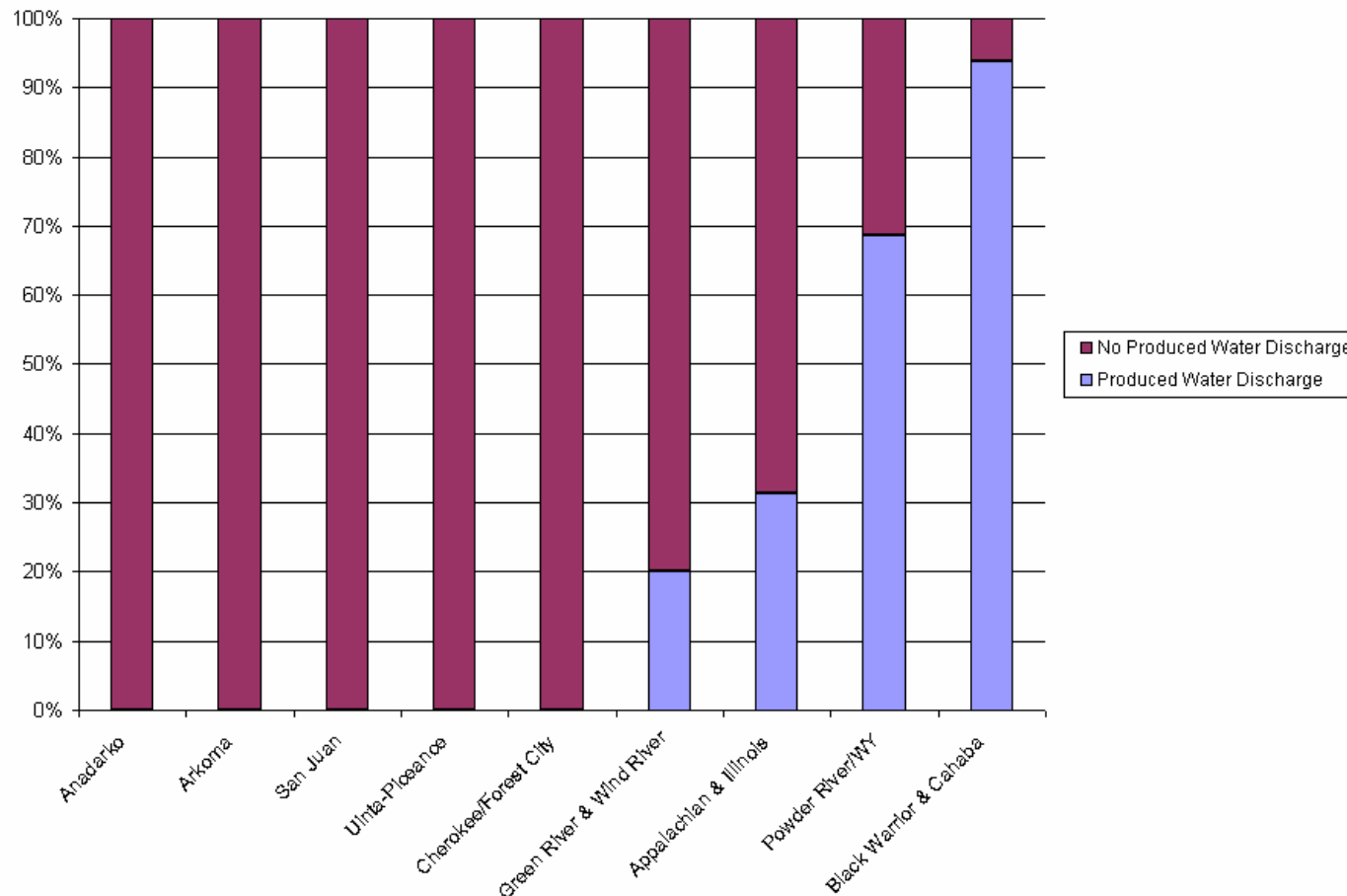
Basin	Total Gas Production (HPDI.com)	Total Gas Production (Screener Database)
AL/FL/MS/Salt Dome/Cahaba	2,763	3,800
Anadarko	11,235	19,000
Appalachian & Illinois	94,999	150,000
Arkla	138	850
Arkoma	38,853	66,000
Wind River & Green River	15,903	16,000
Black Warrior	113,235	100,000
Cherokee/Forest City	23,503	86,000
Ft. Worth, Permian, & Texas Gulf Coast	187	270
Powder River, MT	11,712	14,000
Powder River, WY	374,090	590,000
Raton	121,655	130,000
San Juan	918,825	760,000
Uinta-Piceance	82,057	70,000
Total	1,809,153	2,000,000

Screener database numbers rounded to two significant figures



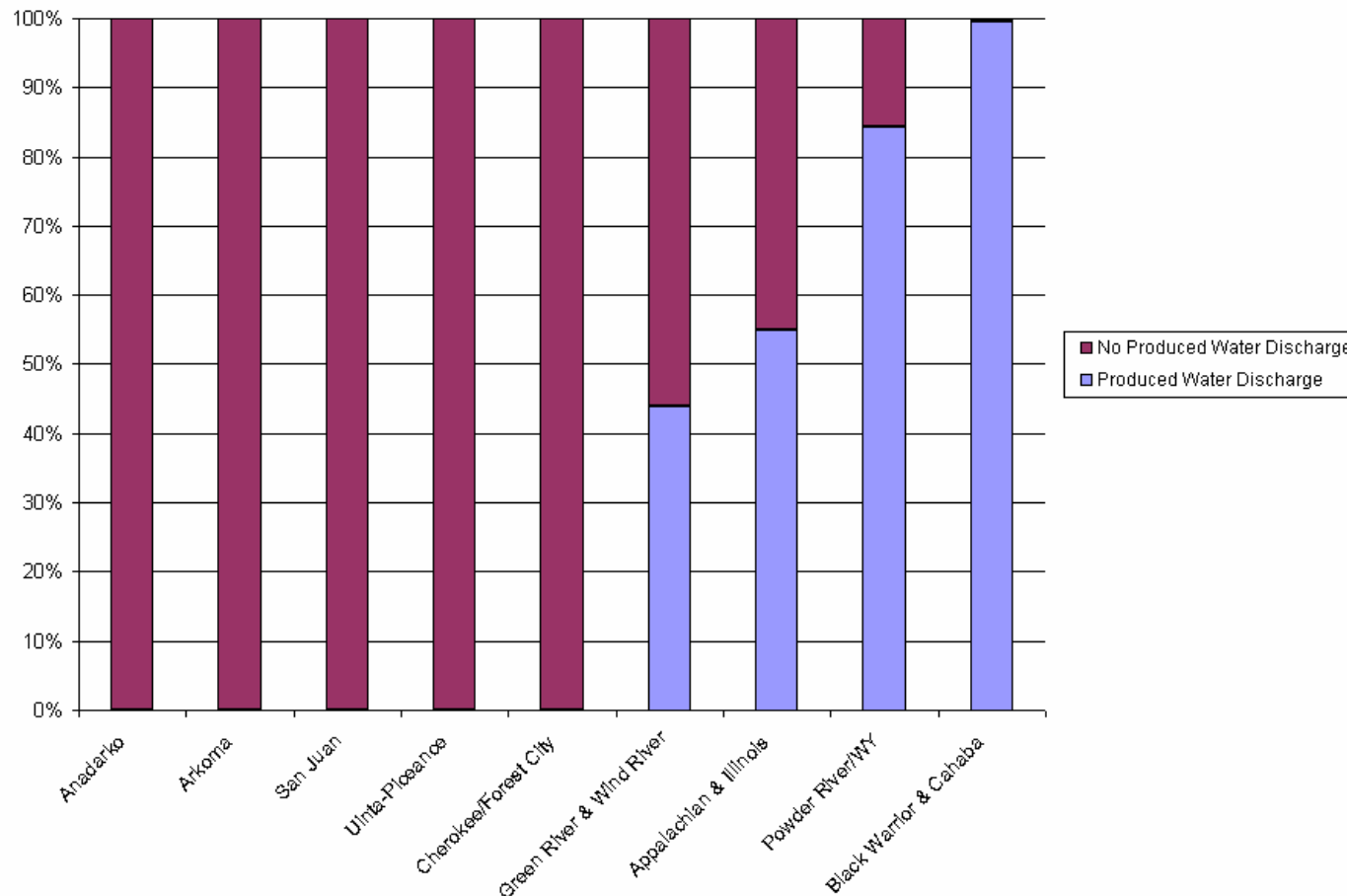
EPA CBM Detailed Study: Screener Data Summary

Produced Water Management Method for Selected Basins
(Percentage of Reported CBM Projects)



EPA CBM Detailed Study: Screener Data Summary

Produced Water Management Method for Selected Basins
(Percentage of Reported CBM Production)



CWA 304(m) Detailed Study: Industry Survey

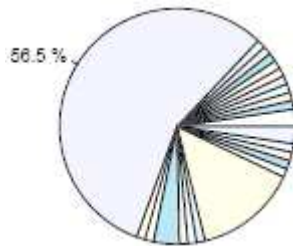
- Stratification variables for selecting detailed questionnaire respondents include:
 - Basin: Geological and regional differences
 - + Collapsed small basins within state
 - + Split Powder River Basin into Montana, Wyoming
 - Business size: Small business impacts
 - Discharge practices within two basins:
 - + Powder River Basin in Wyoming
 - + Appalachian
 - + Most other basin tend to have one main method for produced water management (discharge or zero discharge).
- In the final design of the survey draw EPA focused on basins with dischargers.
- EPA also excluded basins from the draw that could not be used to model potential future CBM basins and were entirely composed of zero dischargers.



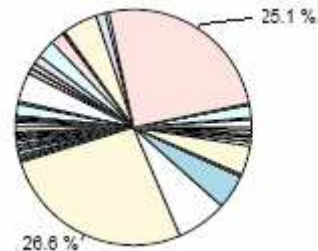
CWA 304(m) Detailed Study: Industry Survey

- EPA used pie charts in evaluating the potential burden of the detailed questionnaire on operators (in terms of number of projects and gas production).
- For example, the following charts show the distribution of small businesses that discharge produced water in the Powder River Basin, Wyoming:
 - One operator had 48 of the 85 projects.
 - Two operators contributed 50% of the gas.

% projects/operator:

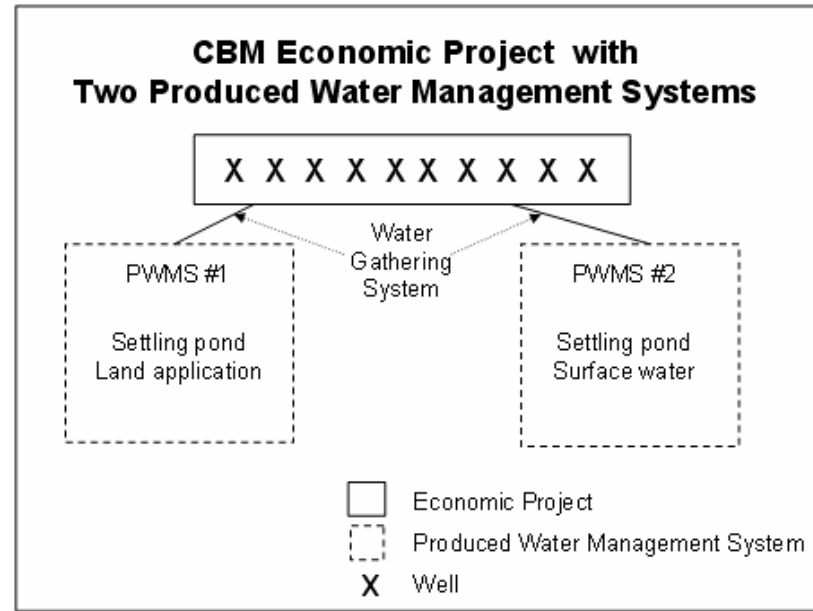
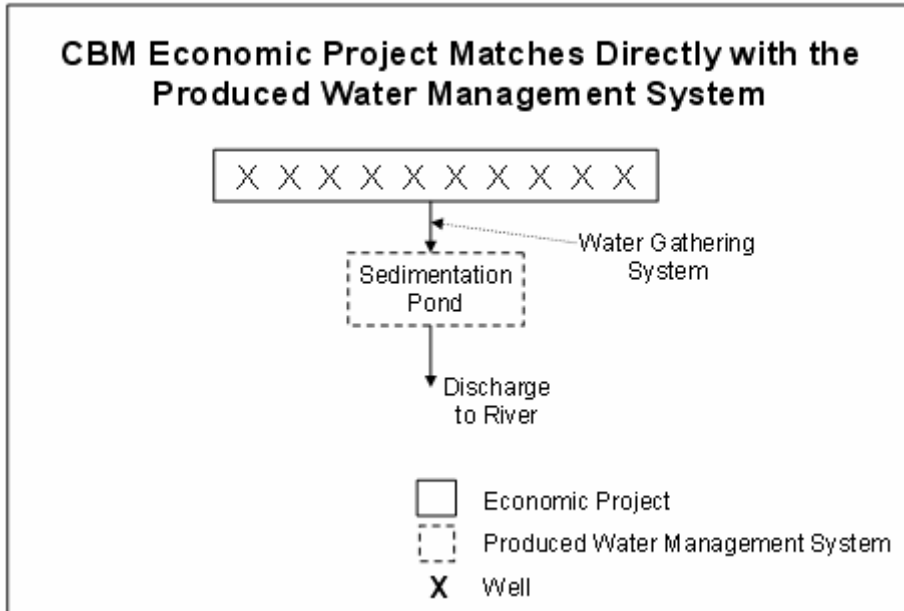


%gas/operator:



CWA 304(m) Detailed Study: Industry Survey

The detailed questionnaire will capture different configurations of produced water management for the selected CBM projects.

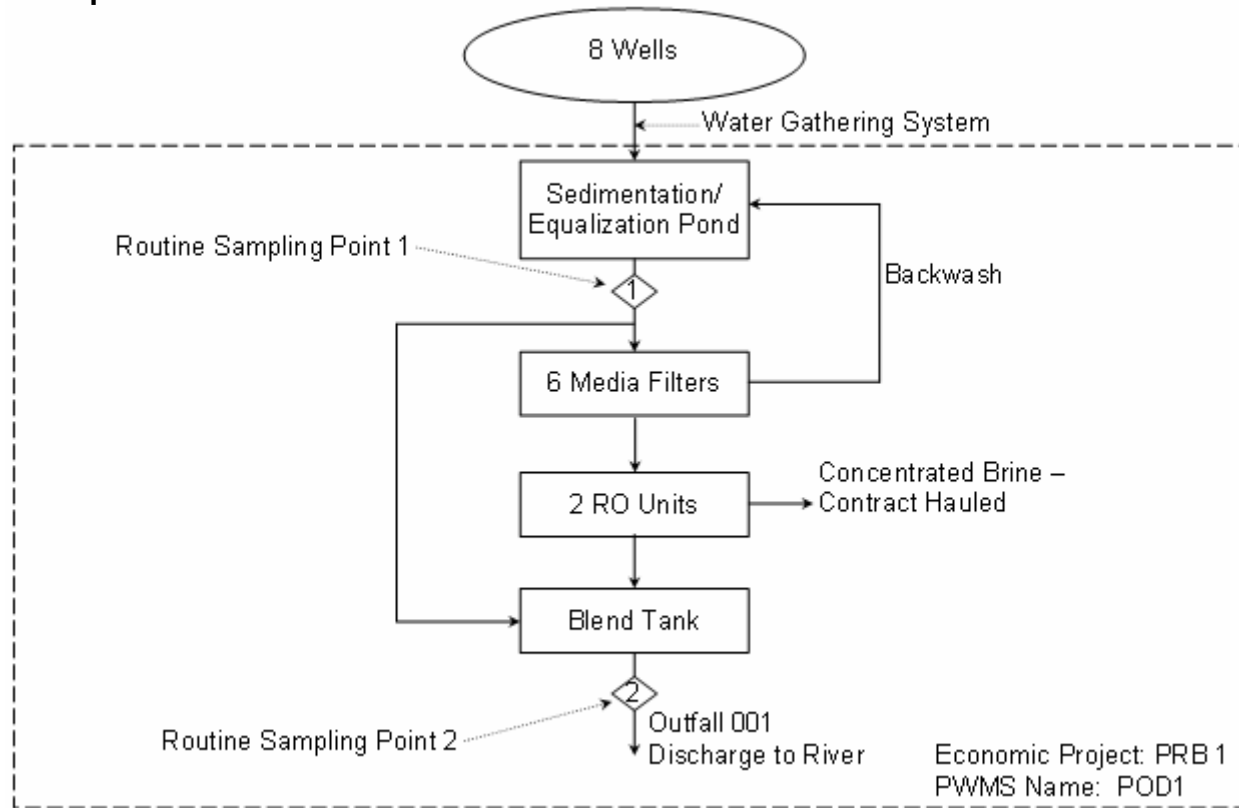


EPA is also using the detailed questionnaire to identify CAPEX and OPEX, management of treatment residuals, and produced water characteristics (volume and pollutant concentrations).



CWA 304(m) Detailed Study: Industry Survey

EPA will use the different configurations of produced water management to identify the current industry practices and evaluate alternative management options.

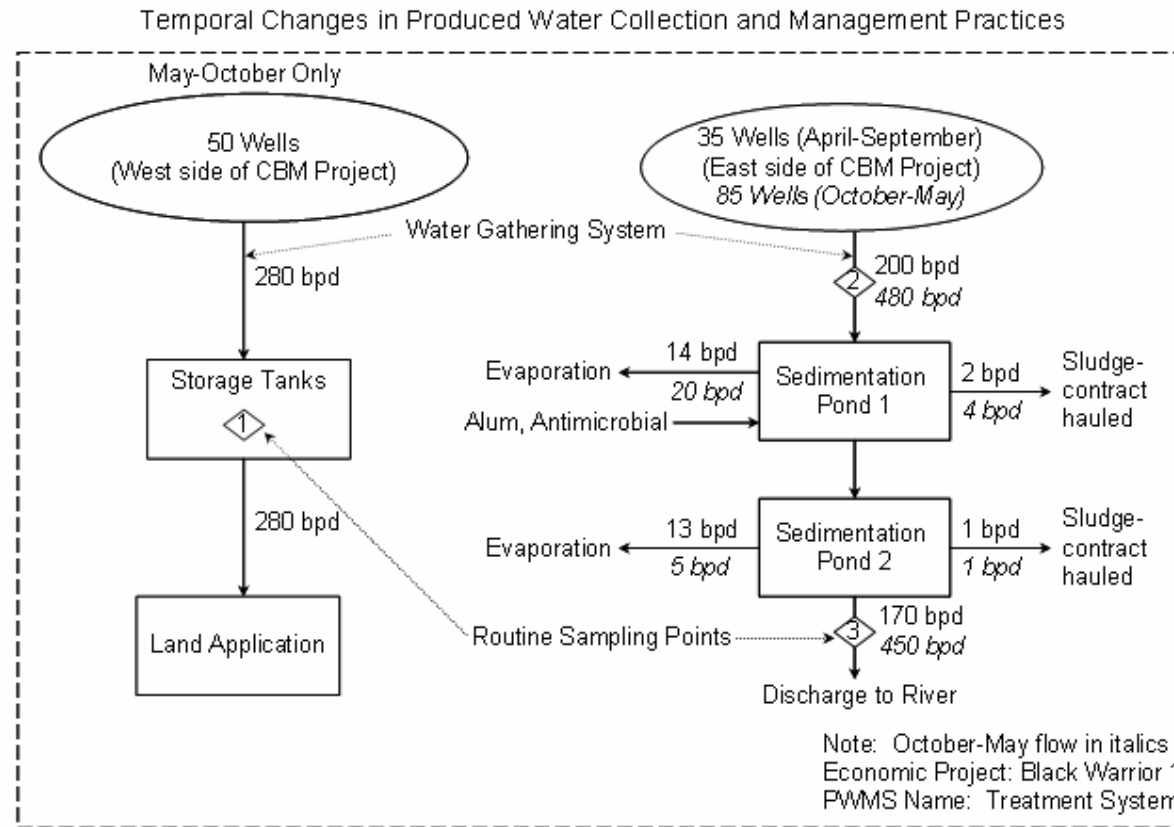


Example Diagram



CWA 304(m) Detailed Study: Industry Survey

EPA will use the survey weights to estimate incremental compliance costs for alternative management options.



Example Diagram



Coalbed Methane Technology Options (Examples)

- CBM produced water of a suitable quality can be used for beneficial use. Key controls are TDS and Sodium Adsorption Ratio (SAR).
 - Beneficial use technologies include sub-drip irrigation, irrigation, livestock watering all either with or without treatment.



CCIX resin contract chamber
(Powder River Basin, WY)



Irrigation with CBM Produced Water (Powder River Basin, WY)

- Treatment options include iron oxidation (aeration), coagulation/precipitation, reverse osmosis (RO), countercurrent ion exchange (CCIX), fixed bed ion exchange, precipitation, surface impoundments, downhole separation, and re-injection.
 - Reduces TDS, SAR, and metals content.
 - Iron oxidation is typically performed at discharge locations as part of BMPs to reduce discoloration of discharge point.

Coalbed Methane Technology Options (Examples)

- EPA and WYDEQ staff visited ten different newer treatment technology sites in Wyoming (June 2009).
- This recent trip supplements the five trips to eight States that EPA took in October 2007. In total EPA has visited over 30 CBM projects with varying forms of produced water management (e.g., re-injection, treatment and discharge, beneficial use).



Trucked Produced Water, Wyoming

- Treatment systems recently visited by EPA include:
 - Fixed Bed Ion Exchange (PRB, WY)
 - Fluidized Bed Ion Exchange (Pilot Scale) (PRB, WY)
 - Aeration and Upflow Mixed Media Filtration (PRB, WY)
 - Ozone and Activated Carbon Pretreatment with Reverse Osmosis (PRB, WY)
 - Barium and SAR Removal via Chemical Precipitation (PRB, WY)
 - Commercial Facility Providing Organic and Inorganic Treatment (Pinedale, WY)
 - Thermal Distillation (Pinedale, WY)
 - Evaporation and Disposal Commercial Facility (Sublette County, WY)

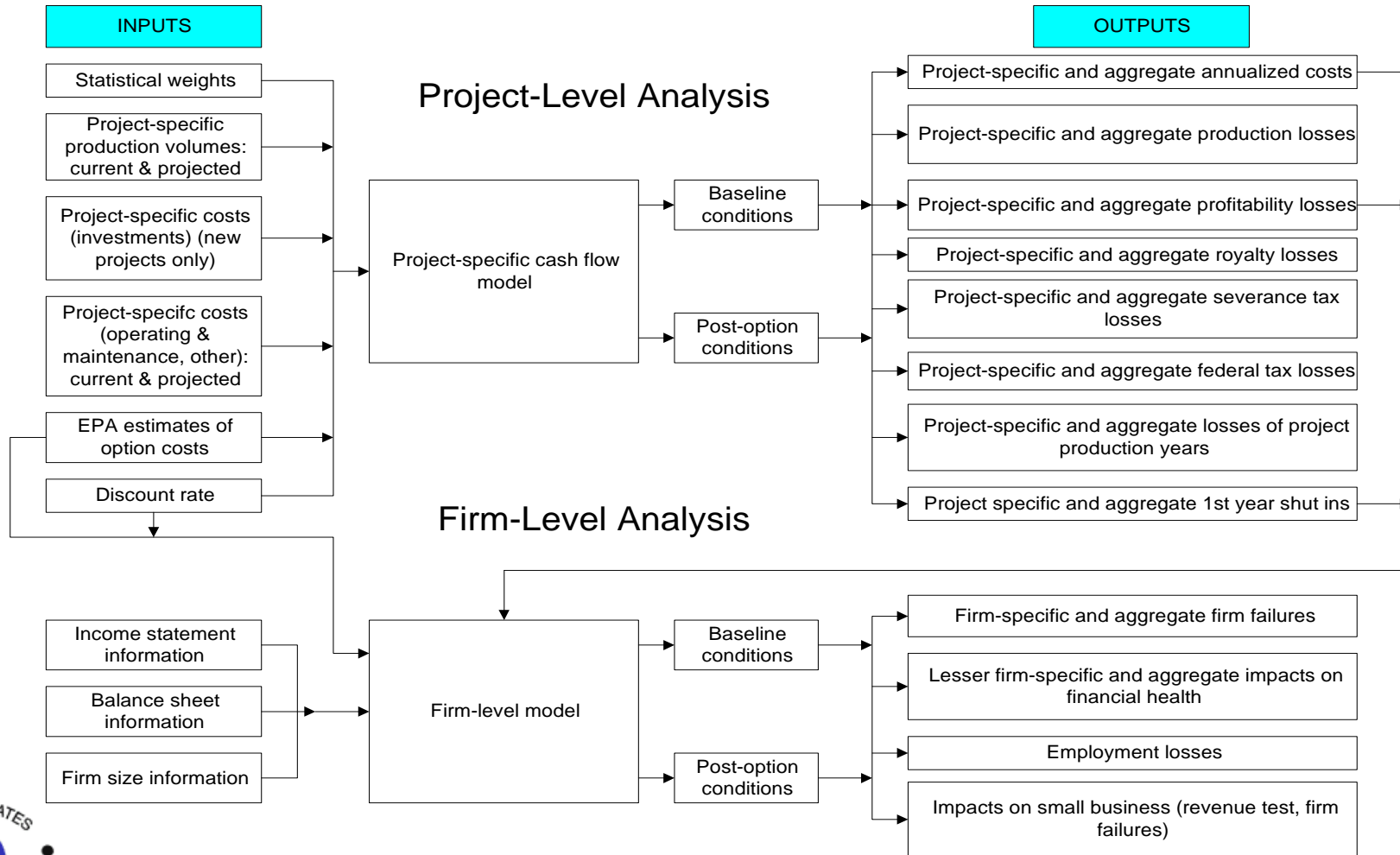


EPA CBM Economic Analysis

- EPA examines the costs of different technology options and the potential economic impacts.
- These pollution control options could be costly, with multiple impacts on CBM projects and operators.
- EPA would like to address the following issues with respect to the potential economic impacts of CBM produced water treatment costs:
 - Production losses
 - Firm failures
 - Employment impacts resulting from production losses and firm failures
 - Impacts on small businesses
- The magnitude of such impacts can be directly or indirectly estimated using **production-level** and **firm-level** economic and financial modeling.
- These models require detailed economic and financial data as inputs to accurately reflect potential impacts.



EPA CBM Economic Analysis



For more information on EPA's study on CBM...

- More information is available on EPA's website at:
 - <http://www.epa.gov/guide/cbm/>.
- EPA project lead is Mr. Carey Johnston, 202-566-1014, johnston.carey@epa.gov.
- FYI – there are other related studies underway on the topic of CBM produced water management:
 - National Research Council (BLM funding)
[<http://www8.nationalacademies.org/cp/projectview.aspx?key=48996>]
 - Bureau of Reclamation (potential for re-use of CBM produced water)
 - Colorado School of Mines (DOE funding)

