pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Oil and Gas Management

Legacy Well Issues

Air Quality Technical
Advisory Committee
December 12, 2019

Discussion Outline

- DEP Well Plugging Program
- Well Plugging Funding and Financial Liability Estimates
- Plugging Projects
- Plugging Program Initiatives
- Path Forward

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

“Legacy Well”

Any previously undiscovered, unregistered or unpermitted historical well. The status may be active, shut-in, abandoned, or plugged.

Source: State Museum of Pennsylvania

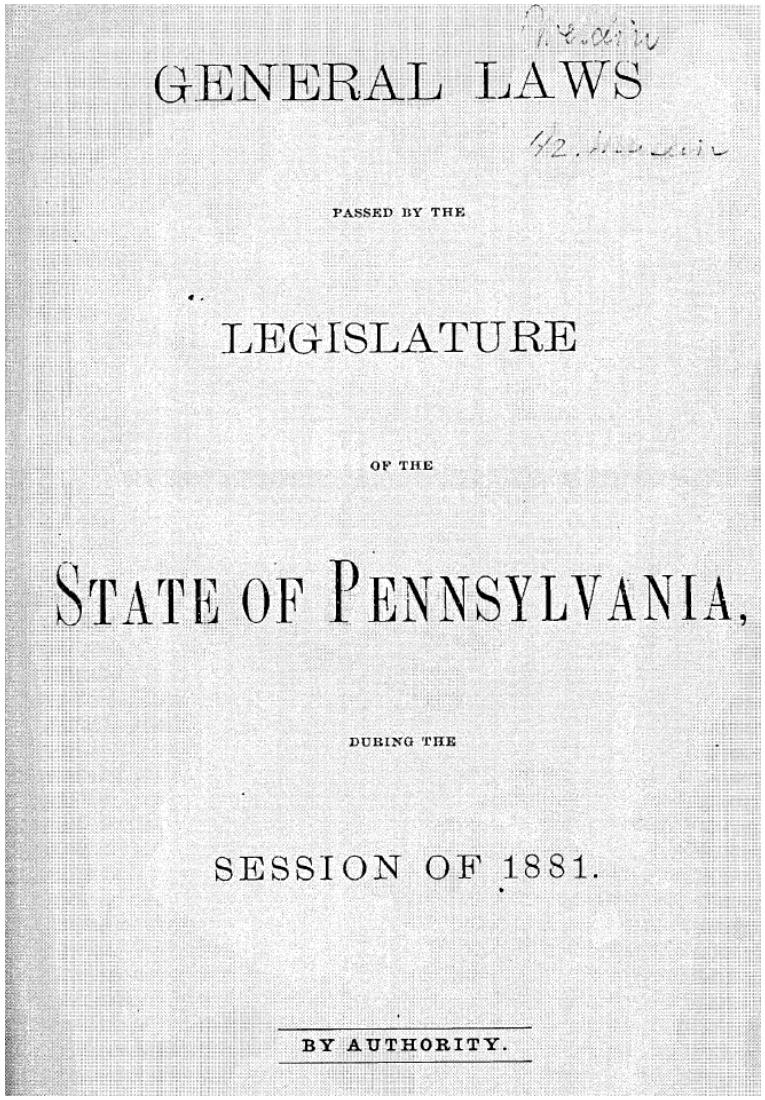
pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Regulatory History of Well Plugging

- **1859** – First commercial well drilled, “Drake well”, Titusville, PA
- **1878** – Wells first required to be plugged with wood and sediment
- **1881** – Plugging requirements updated: Fill well with sand or rock sediment and wooden plugs above third producing sand
- **1921** – Plugging requirements updated
  - Fill with sand or rock sediment and each producing strata plugged with wood plug
  - Requires venting of wells through coal layers
  - Allows for casing to be pulled with tubing and packer in place
- **1952** – API standards for cement and well plugging published
- **1956** – Well permitting begins; modern plugging requirements
- **1984** – Modern environmental plugging requirements
- **1989** – First well plugged in DEP plugging program

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Regulatory History of Well Plugging



GENERAL LAWS

PASSED BY THE

LEGISLATURE

OF THE

STATE OF PENNSYLVANIA,

DURING THE

SESSION OF 1881.

BY AUTHORITY.

No. 101.

AN ACT

Regulating the mode of plugging abandoned oil wells, and providing a penalty for the violation thereof.

Abandoned oil wells to be plugged.

SECTION 1. *Be it enacted, &c.*, That whenever any well shall have been put down for the purpose of exploring for and producing oil, upon abandoning or ceasing to operate the same, the owner or operator shall, for the purpose of excluding all fresh water from the oil-bearing rock and before drawing the casing, fill up the well with sand or rock sediment to the depth of at least twenty feet above the third sand or oil-bearing rock, and drive a round, seasoned, wooden plug at least two feet in length, equal in diameter to the diameter of the well below the casing, to a point at least five feet below the bottom of the casing, and, immediately after the drawing of the casing, shall drive a round wooden plug into the well at the point just below where the lower end of the casing shall have rested, which plug shall be at least three feet in length, tapering in form and to be of the same diameter at the distance of eighteen inches from the smaller end as the diameter of the well below the point at which it is to be driven; after it has been properly driven shall fill in on top of same with sand or rock sediment to the depth of at least five feet.

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Regulatory History of Well Plugging

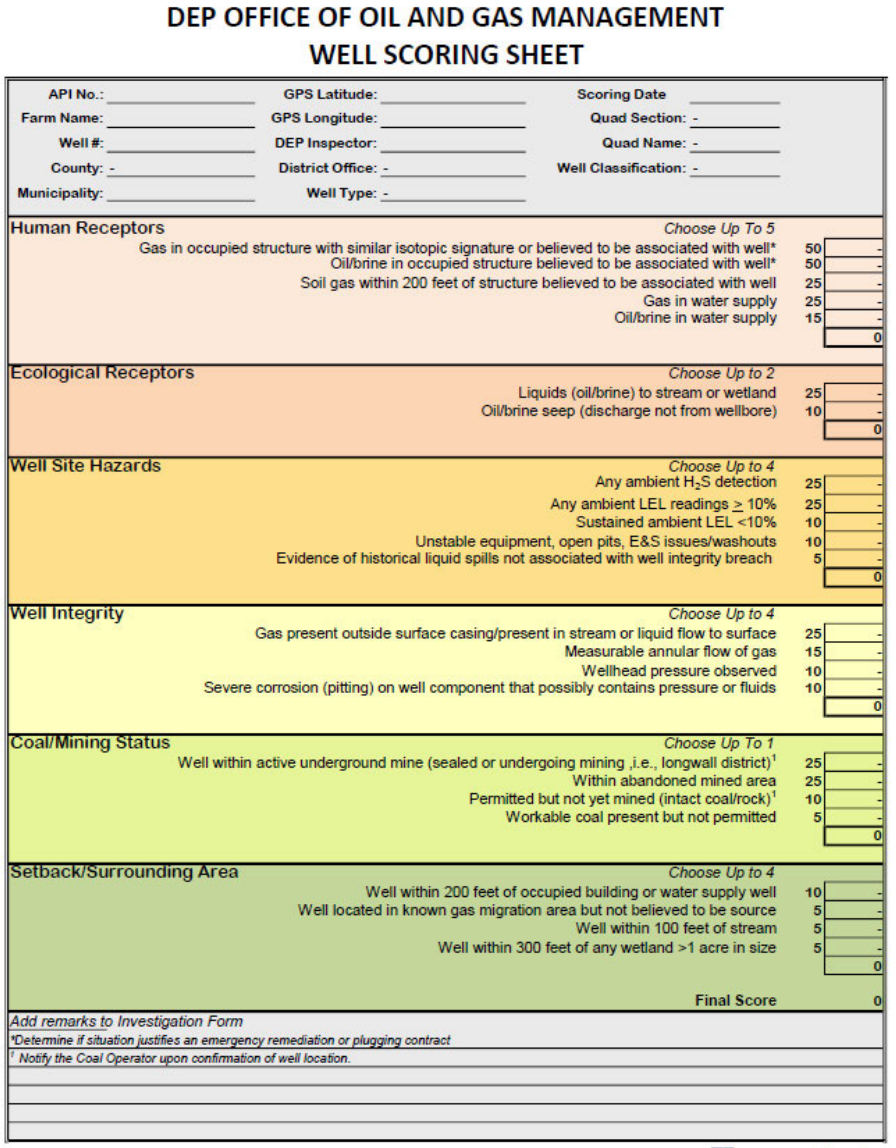
pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Current DEP Plugging Program

1. Abandoned/Orphan well is identified
2. Field inspection performed by OGI: wells are assigned score based on environmental/health and safety concerns, now including methane emissions
3. Wells are selected for plugging (high-risk focus)
4. Contracts are generated/bid out
5. Winning bidder plugs wells
6. Wells are inspected by OGI during plugging operations, and before contract is closed out
7. Wells re-inspected 1 year post-plugging

Well Plugging Prioritization

- Risk Score Based on
  - Human Receptors
  - Ecological Receptors
  - Well Site Hazards
  - Well Integrity
  - Coal/Mining Status
  - Setback/Surrounding



DEP OFFICE OF OIL AND GAS MANAGEMENT
WELL SCORING SHEET

API No.:		GPS Latitude:		Scoring Date	
Farm Name:		GPS Longitude:		Quad Section:	-
Well #:		DEP Inspector:		Quad Name:	-
County:	-	District Office:	-	Well Classification:	-
Municipality:		Well Type:	-		

Human Receptors	*Choose Up To 5*		
	Gas in occupied structure with similar isotopic signature or believed to be associated with well*	50	
	Oil/brine in occupied structure believed to be associated with well*	50	
	Soil gas within 200 feet of structure believed to be associated with well	25	
	Gas in water supply	25	
	Oil/brine in water supply	15	
			0
Ecological Receptors	*Choose Up to 2*		
	Liquids (oil/brine) to stream or wetland	25	
	Oil/brine seep (discharge not from wellbore)	10	
			0
Well Site Hazards	*Choose Up to 4*		
	Any ambient H_2S detection	25	
	Any ambient LEL readings ≥ 10%	25	
	Sustained ambient LEL <10%	10	
	Unstable equipment, open pits, E&S issues/washouts	10	
	Evidence of historical liquid spills not associated with well integrity breach	5	
			0
Well Integrity	*Choose Up to 4*		
	Gas present outside surface casing/present in stream or liquid flow to surface	25	
	Measurable annular flow of gas	15	
	Wellhead pressure observed	10	
	Severe corrosion (pitting) on well component that possibly contains pressure or fluids	10	
			0
Coal/Mining Status	*Choose Up To 1*		
	Well within active underground mine (sealed or undergoing mining ,i.e., longwall district)[1]	25	
	Within abandoned mined area	25	
	Permitted but not yet mined (intact coal/rock)[1]	10	
	Workable coal present but not permitted	5	
			0
Setback/Surrounding Area	*Choose Up to 4*		
	Well within 200 feet of occupied building or water supply well	10	
	Well located in known gas migration area but not believed to be source	5	
	Well within 100 feet of stream	5	
	Well within 300 feet of any wetland >1 acre in size	5	
			0
	Final Score		0

Add remarks to Investigation Form

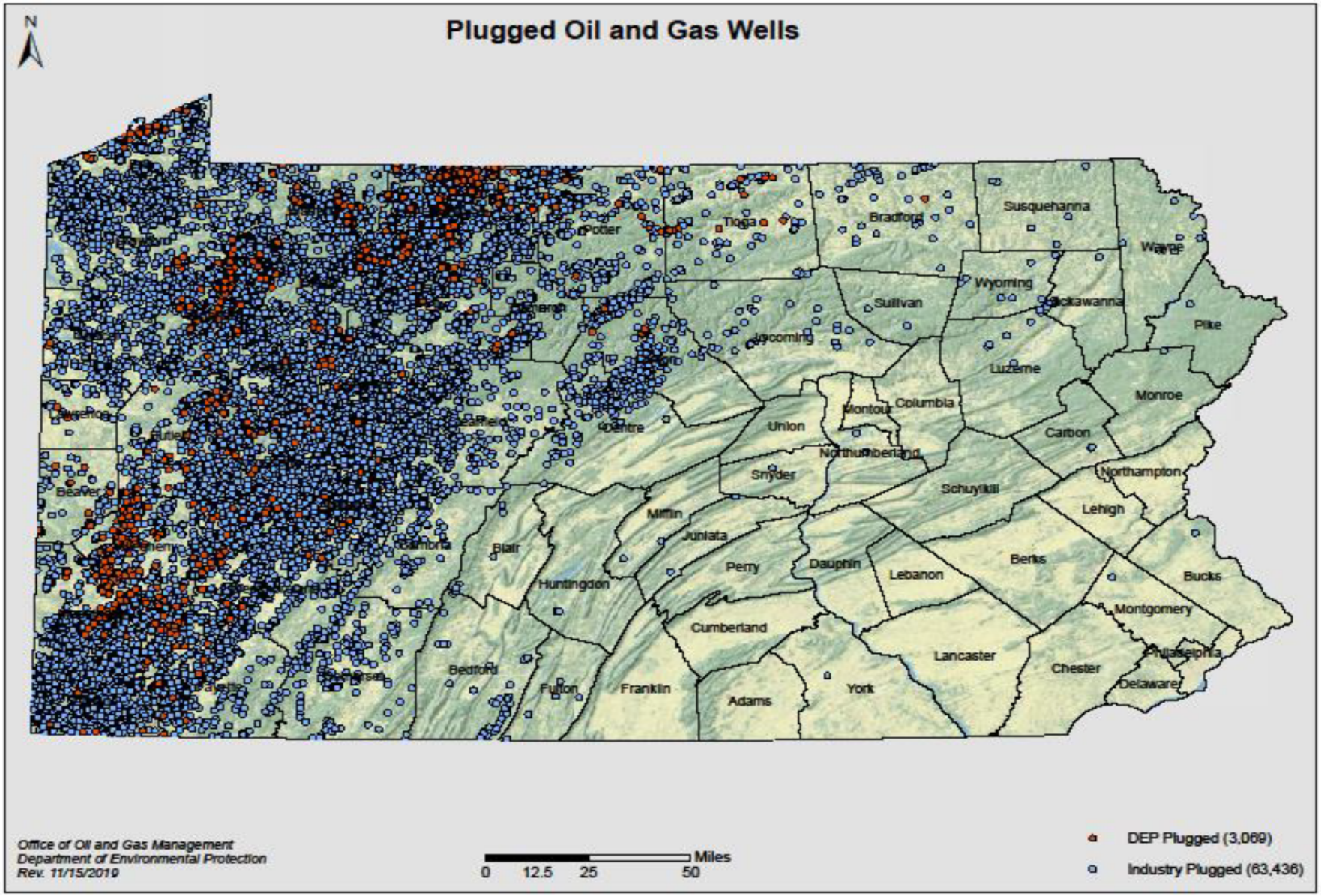
**Determine if situation justifies an emergency remediation or plugging contract*

[1] Notify the Coal Operator upon confirmation of well location.

Revised: July 2019

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

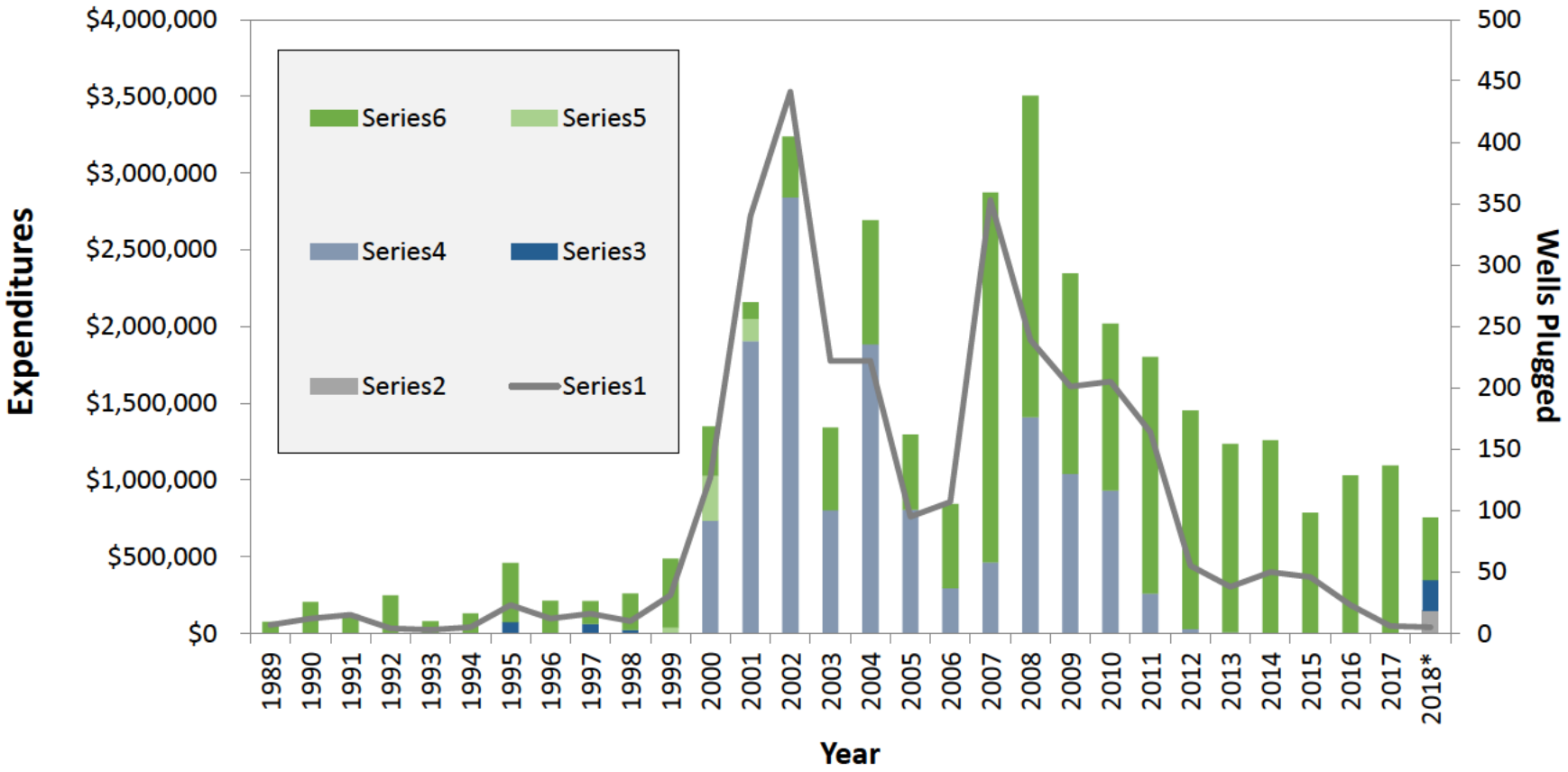
Plugged Oil and Gas Wells



A Brief Overview of the Legacy Well Story

DEP Plugging Program Funding

- Since 1985, DEP has received $150-$250 surcharges for every drilling permit



DEP Plugging Program

Oil and Gas Act of 1984

- Established Abandoned Well Fund
  - $50 Permit Surcharge

Act 78 of 1992

- Established Orphan Well Plugging Fund
  - $100 Permit Surcharge on Oil Wells
  - $200 Permit Surcharge on Gas Wells

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Well Count in Pennsylvania

- Dilmore et al. (2015) and Engelder (2017) have estimated that somewhere between 330,000 and 350,000 wells were likely drilled in the commonwealth between 1859 and 2016
- Kang et al.'s (2016) estimate more than doubles the upper end of this range

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Plugging Liabilities in Pennsylvania

- 113,000 active permits and 13,000 wells on O&A list means between 100,000 to 560,000 legacy wells that have not yet been accounted for – “best-fit” estimate is **200,000** wells remaining to plug

- Total potential liability: **$6.6 BILLION**

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

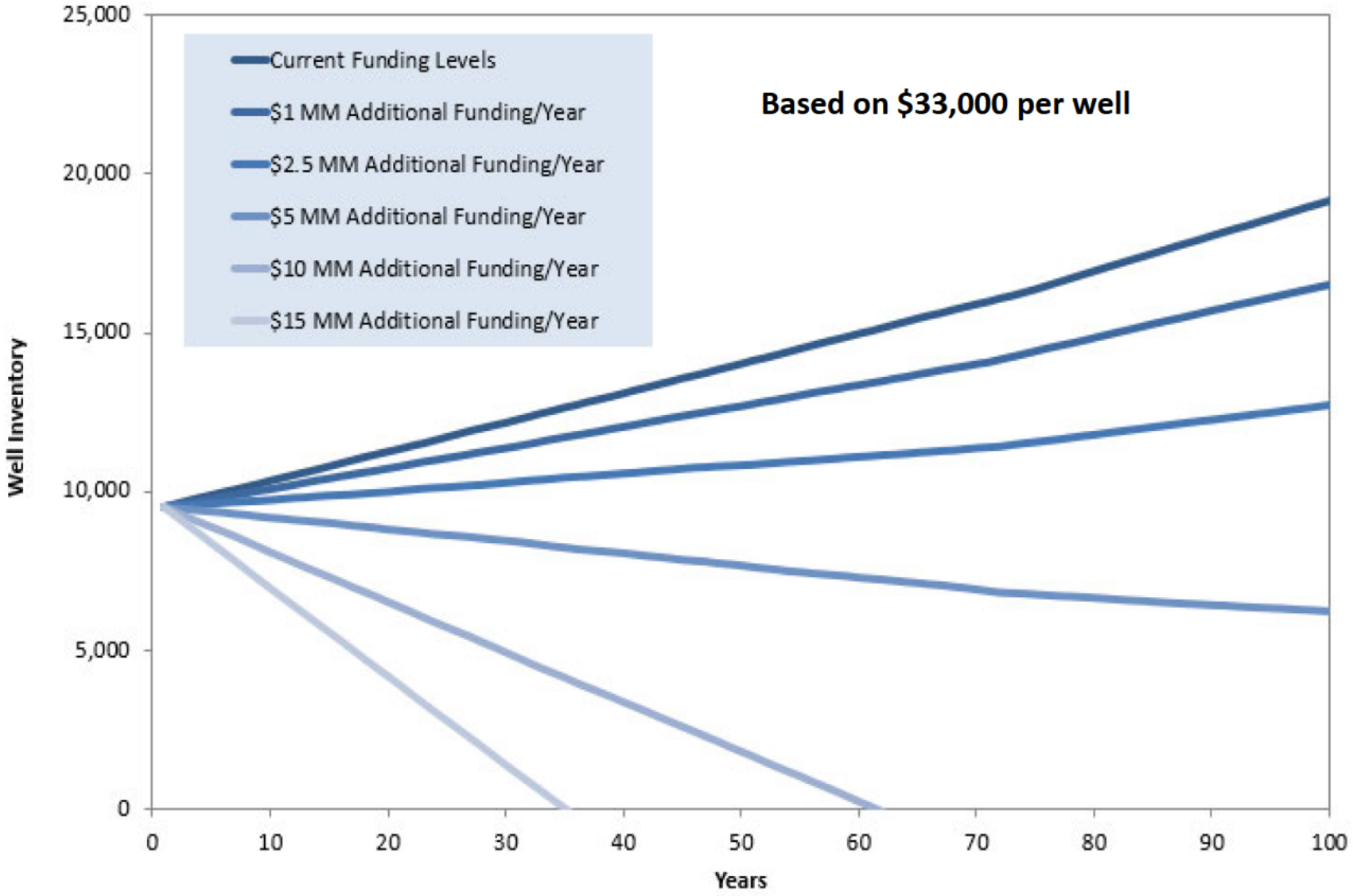
Liability Forecasting

Cost Modeling

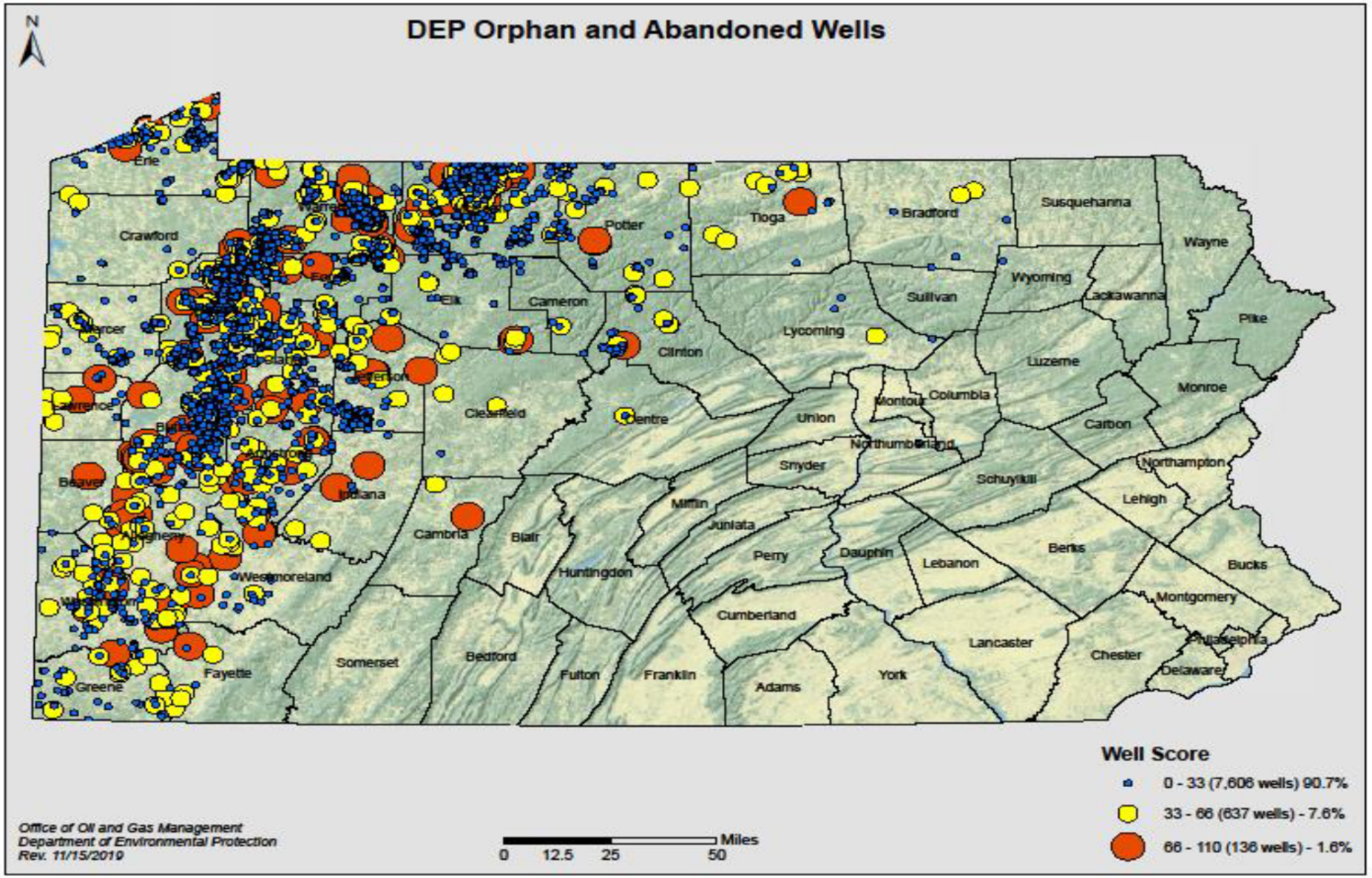
- A conservative estimate of $33,000 per well has been derived from reviewing contract costs.
- Liability forecasting changes significantly based on per-well cost assumptions
  - At $33,000 per well, DEP's plugging liability ranges somewhere between $280 MM (8,500 wells) and $6.6 B (200,000 wells)

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Liability Forecasting



Plugging Liabilities in Pennsylvania



Plugging Liabilities in Pennsylvania

High Risk

- Unknown risks to public health, safety and the environment
- Wells located within 1,500’ of hydraulic fracturing present a significant risk of communication (“area of review” regulations in Chapter 78a)
- Wells are not being maintained in any way which creates highest risk and cost to plug/remediate

Plugging Liabilities in Pennsylvania

- What can happen when an orphan or abandoned well is not properly plugged?

  Discharges of oil and/or brine to land surface or surface water, or impacts to groundwater

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Plugging Liabilities in Pennsylvania

Intermediate Risk

- Approximately 51,000 active status conventional wells with production or mechanical integrity reporting non-compliance (~5,400 operators)
  - February 15 annually, hydrocarbons and waste produced
  - February 15 annually, mechanical integrity assessment
- Likely high number of abandoned wells
- Includes many home use wells
- Wells may not be properly maintained which creates significant risk and cost to plug/remediate

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Plugging Liabilities in Pennsylvania

Lowest Risk

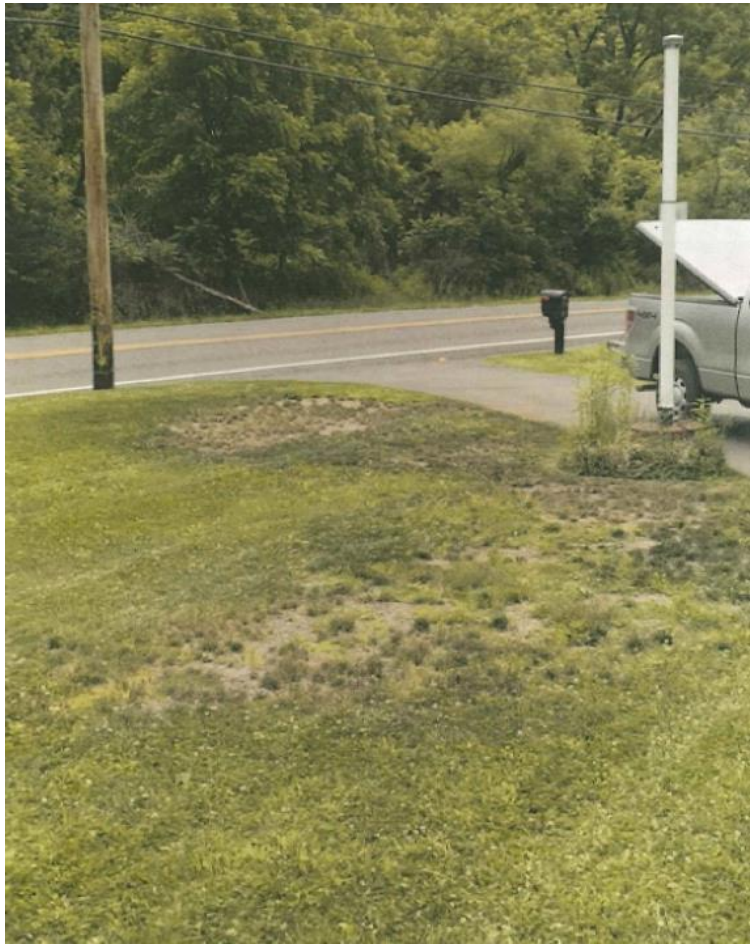
- Active status conventional wells in compliance with production or mechanical integrity reporting
- Active status unconventional wells (11,975 as of 3/22/19)
- Low risk with some unknowns or integrity issues
- Significant impact of low commodity prices
- Bond coverage for wells drilled after April 1985

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Managing a Looming Crisis

DEP Emergency Contracts

- Antaki Well: $425,000



Managing a Looming Crisis

DEP Emergency Contracts

- Antaki Well:$14,000

Managing a Looming Crisis

DEP Emergency Contracts

- John Barron Well: $179,000

Managing a Looming Crisis

DEP Emergency Contracts

- John Barron Well: $179,000

Managing a Looming Crisis

DEP Emergency Contracts

- John Barron Well: $179,000

Managing a Looming Crisis

DEP Emergency Contracts

- Monahan Well: $160,000

Managing a Looming Crisis

DEP Emergency Contracts

- Monahan Well: $160,000

Managing "Priority" and "Opportunity" Wells

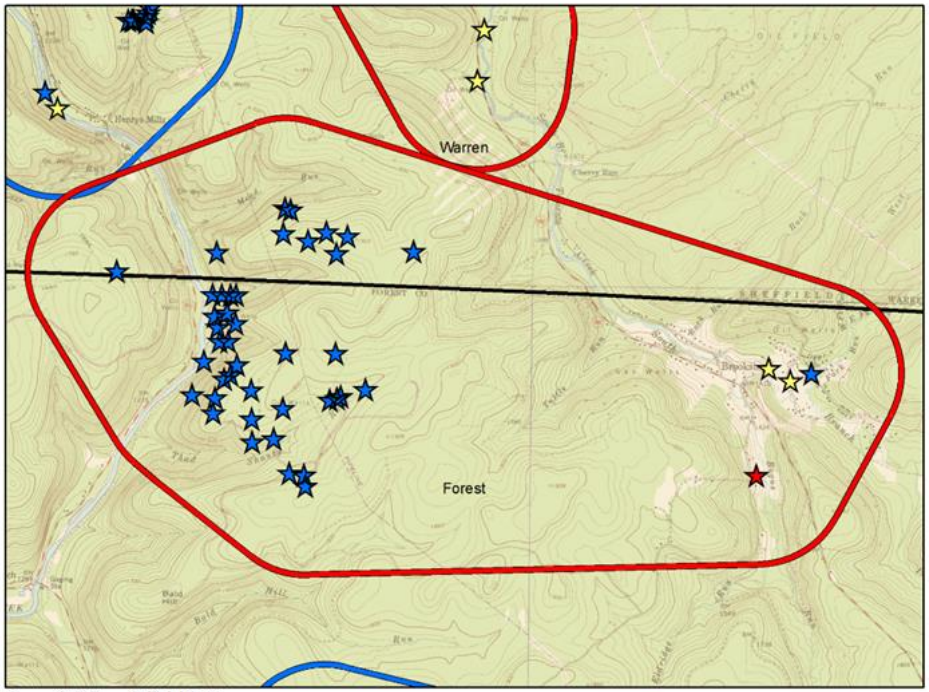
How can resources be extended most effectively?

- As the summary tables below indicate, it is estimated that plugging all 120 Priority Wells individually would cost approximately $5.7 million
- By grouping "priority" (high risk) wells with other nearby "opportunity" wells, 13x the number of wells could be plugged for only 7x the total cost

Well Scores	Number of Wells	Sum of Low Cost 2017	Sum of High Cost 2017
High (>66)	120	$2,664,157.00	$5,777,969.01
Intermediate (34 - 66)	509	$10,604,050.39	$19,758,784.01
Low (<34)	7540	$94,606,792.86	$192,934,105.08
Grand Total	8169	$107,875,000.25	$218,470,858.10

Column1	Number of Projects	Number of Wells in Project	Sum of Low Cost 2017	Sum of High Cost 2017
Grand Total	85	1565	$20,281,920.20	$40,742,308.41

Example Partnership Projects



Plugging Project Name: 197L

Priority Ranking: 19 / 85

Opportunity Ranking: N/A

Number of Abandoned / Orphan Wells: 45

Estimated Number of Water Supplies: 2

Estimated Number of Residents: 105

Environmental Justice Area: Yes

Project Value (Low): $674,521.59

Project Value (High): $1,318,357.56

High Resolution Cost Control: Yes

Congressional District:
Thompson, Glenn W. (5)

House District:
Rapp, Kathy L. (65)

Senate District:
Hutchinson, Scott E. (21)

Designated Use Streams (miles):

Cold Water Fishery: 5.5

Trout Stocking: 0

Warm Water Fishery: 0

High Quality: 8.3

Exceptional Value: 0

Recreational Areas (acres):

State or National Parks: 0

State or National Forest: 3119.7

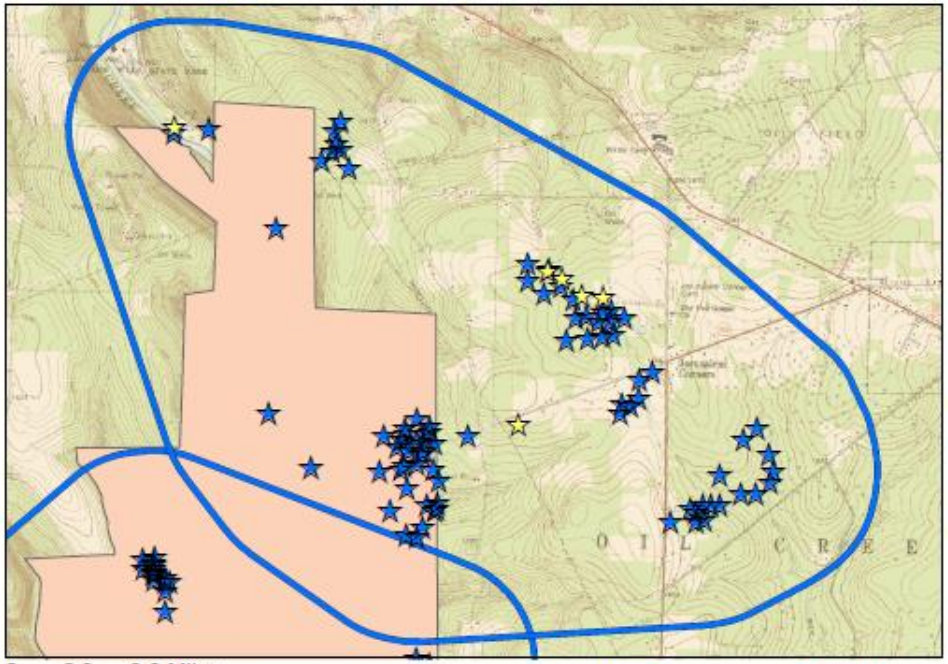
Fish and Game / State Game Lands: 0

Project Facts:

This project profile considers water resources, sensitive environments, recreational areas, and commonwealth residents in the vicinity of abandoned and orphan wells that DEP is responsible for plugging. These characteristics were used to rank this project relative to many other potential plugging projects throughout Pennsylvania. The project profile provides key statistics on the number of abandoned and orphan wells, water supplies, residents, legislative districts, stream miles, and recreational areas for the location. It also assigns a project value and assesses whether or not the location coincides with an Environmental Justice area. Project value information was developed in consideration of historical DEP plugging contract amounts. If the project falls in an area where DEP has completed a greater amount of prior work, the project is designated as having "High Resolution Cost Control."

Example Partnership Projects

Plugging Project Name: 161L



Project Facts:
This project profile considers water resources, sensitive environments, recreational areas, and commonwealth residents in the vicinity of abandoned and orphan wells that DEP is responsible for plugging. These characteristics were used to rank this project relative to many other potential plugging projects throughout Pennsylvania. The project profile provides key statistics on the number of abandoned and orphan wells, water supplies, residents, legislative districts, stream miles, and recreational areas for the location. It also assigns a project value and assesses whether or not the location coincides with an Environmental Justice area. Project value information was developed in consideration of historical DEP plugging contract amounts. If the project falls in an area where DEP has completed a greater amount of prior work, the project is designated as having "High Resolution Cost Control."

Primary County: Venango
Primary Municipality: OILCREEK
Priority Ranking: N/A
Opportunity Ranking: 11 / 415
Number of Abandoned / Orphan Wells: 85
Estimated Number of Water Supplies: 17
Estimated Number of Residents: 254
Environmental Justice Area: No
Project Value (Low): $904,566.35
Project Value (High): $1,665,306.37
High Resolution Cost Control: Yes
Congressional District:
Thompson, (5)
House District:
James, (64)
Senate District:
Hutchinson, (21)

Designated Use Streams (miles):

Cold Water Fishery: 16.3
Trout Stocking: 0
Warm Water Fishery: 0
High Quality: 0
Exceptional Value: 0

Recreational Areas (acres):

State or National Parks: 1228.7
State or National Forest: 0
Fish and Game / State Game Lands: 0

Plugging Program Initiatives

- Collaboration and Partnerships Critical
- Good Samaritan Act/COGWA
- Commonwealth Financing Authority
  - Orphan and Abandoned Well Plugging Program
- DCNR Addressing Funding Gaps
  - State Forests and State Parks and wells in the vicinity
- Oil Spill Liability Trust Fund
- Developers/Municipalities

CFA OAWP Program Summary

CFA Distribution of Marcellus Legacy Fund

Program	2013					2014				
	# Apps	# Appr Apps	Amt of Grant	Percent Approval Rate	Percent of Total $	# Apps	# Appr Apps	Amt of Grant	Percent Approval Rate	Percent of Total
GREENWAYS, TRAILS AND RECRATION (GTR)	206	107	$14,648,964	51.94%	55.93%	301	67	$9,294,334	22.26%	62.14%
FLOOD MITIGATION	19	4	$655,866	21.05%	2.50%	33	9	$2,338,039	27.27%	15.63%
WATERSHED RESTORATION AND PROTECTION	57	31	$5,105,930	54.39%	19.50%	49	13	$1,256,797	26.53%	8.40%
ABANDONED MINE DRAINAGE ABATEMENT & TREATMENT (AMDAT)	34	12	$5,091,447	35.29%	19.44%	13	4	$1,541,610	30.77%	0.94%
ORPHAN OR ABANDONED WELL PLUGGING	**2**	**2**	**$225,000**	**100.00%**	**0.86%**	**1**	**1**	**$139,999**	**100.00%**	**1.22%**
BASELINE WATER QUALITY DATA (BWQD)	8	2	$463,342	25.00%	1.77%	7	1	$181,895	14.29%	1.22%
SEWAGE FACILITIES PROGRAM	0	0	$0	0.00%	0.00%	57	7	$205,041	12.28%	1.37%
Grand Total	**326**	**158**	**$26,190,549**			**461**	**102**	**$14,957,715**		

Program	2015					2016				
	# Apps	# Appr Apps	Amt of Grant	Percent Approval Rate	Percent of Total $	# Apps	# Appr Apps	Amt of Grant	Percent Approval Rate	Percent of Total $
GREENWAYS, TRAILS AND RECRATION (GTR)	309	89	$11,167,747	28.80%	66.22%	254	66	$8,766,477	25.98%	65.38%
FLOOD MITIGATION	40	12	$2,975,847	30.00%	17.65%	27	8	$1,821,325	29.63%	13.58%
WATERSHED RESTORATION AND PROTECTION	38	8	$1,019,097	21.05%	6.04%	36	11	$1,986,538	30.56%	14.82%
ABANDONED MINE DRAINAGE ABATEMENT & TREATMENT (AMDAT)	13	3	$1,080,491	23.08%	6.41%	8	2	$563,191	25.00%	4.20%
ORPHAN OR ABANDONED WELL PLUGGING	**3**	**0**	**$0**	**0.00%**	**0.00%**	**11**	**1**	**$129,715**	**9.09%**	**0.97%**
BASELINE WATER QUALITY DATA (BWQD)	4	2	$469,912	50.00%	2.79%	0	0	$0	0.00%	0.00%
SEWAGE FACILITIES PROGRAM	22	3	$151,000	13.64%	0.90%	13	4	$141,647	30.77%	1.06%
Grand Total	**429**	**117**	**$16,864,094**			**349**	**92**	**$13,408,893**		

Program	2017					2018				
	# Apps	# Appr Apps	Amt of Grant	Percent Approval Rate	Percent of Total $	# Apps	# Appr Apps	Amt of Grant	Percent Approval Rate	Percent of Total $
GREENWAYS, TRAILS AND RECRATION (GTR)	234	81	$9,862,804	34.62%	63.75%	286	90	$10,586,673	31.47%	65.36%
FLOOD MITIGATION	30	13	$2,994,521	43.33%	19.36%	43	12	$2,866,069	27.91%	17.69%
WATERSHED RESTORATION AND PROTECTION	23	11	$1,830,000	47.83%	11.83%	36	15	$1,993,662	41.67%	12.31%
ABANDONED MINE DRAINAGE ABATEMENT & TREATMENT (AMDAT)	1	0	$0	0.00%	0.00%	3	1	$500,000	33.33%	3.09%
ORPHAN OR ABANDONED WELL PLUGGING	**5**	**3**	**$657,503**	**60.00%**	**4.25%**	**4**	**1**	**$20,624**	**25.00%**	**0.13%**
BASELINE WATER QUALITY DATA (BWQD)	1	0	$0	0.00%	0.00%	8	0	$0	0.00%	0.00%
SEWAGE FACILITIES PROGRAM	10	4	$125,147	40.00%	0.81%	13	4	$231,328	30.77%	1.43%
Grand Total	**304**	**112**	**$15,469,975**			**393**	**123**	**$16,198,356**		

Program	Total # Apps	Total # Appr Apps	Total Amt of Grants	Percent Approval Rate	Percent of Total $
GREENWAYS, TRAILS AND RECRATION (GTR)	1,590	500	$64,326,999	31.45%	62.40%
FLOOD MITIGATION	192	58	$13,651,667	30.21%	13.24%
WATERSHED RESTORATION AND PROTECTION	239	89	$13,192,024	37.24%	12.80%
ABANDONED MINE DRAINAGE ABATEMENT & TREATMENT (AMDAT)	72	22	$8,776,739	30.56%	8.51%
ORPHAN OR ABANDONED WELL PLUGGING	**26**	**8**	**$1,172,841**	**30.77%**	**1.14%**
BASELINE WATER QUALITY DATA (BWQD)	28	5	$1,115,149	17.86%	1.08%
SEWAGE FACILITIES PROGRAM	115	22	$854,163	19.13%	0.83%
Grand Total	**2,262**	**704**	**$103,089,582**		

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

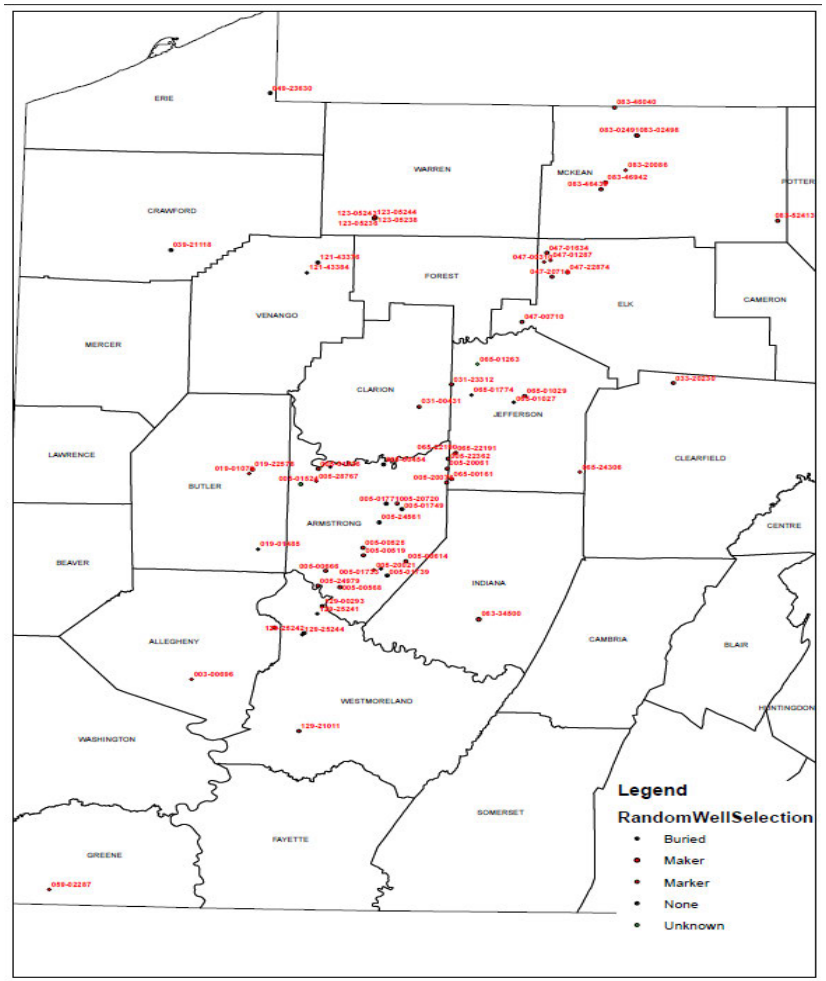
Ongoing Work

Plugging Program Initiatives

- BOGPPM Plugging Program modernization and enhanced outreach
  - Website
  - Social media
  - DCNR partnership
- Cross-program work
  - GHG emissions factors and estimates (EPO and Air Quality)
- Academia
  - GHG emissions factors and estimates (Kang at McGill)
  - Integrity concerns (Brantley at PSU)
  - Property values (Weber at Pitt)

Attainable Bottom Field Study

Investigate plug effectiveness in wells not plugged to total depth

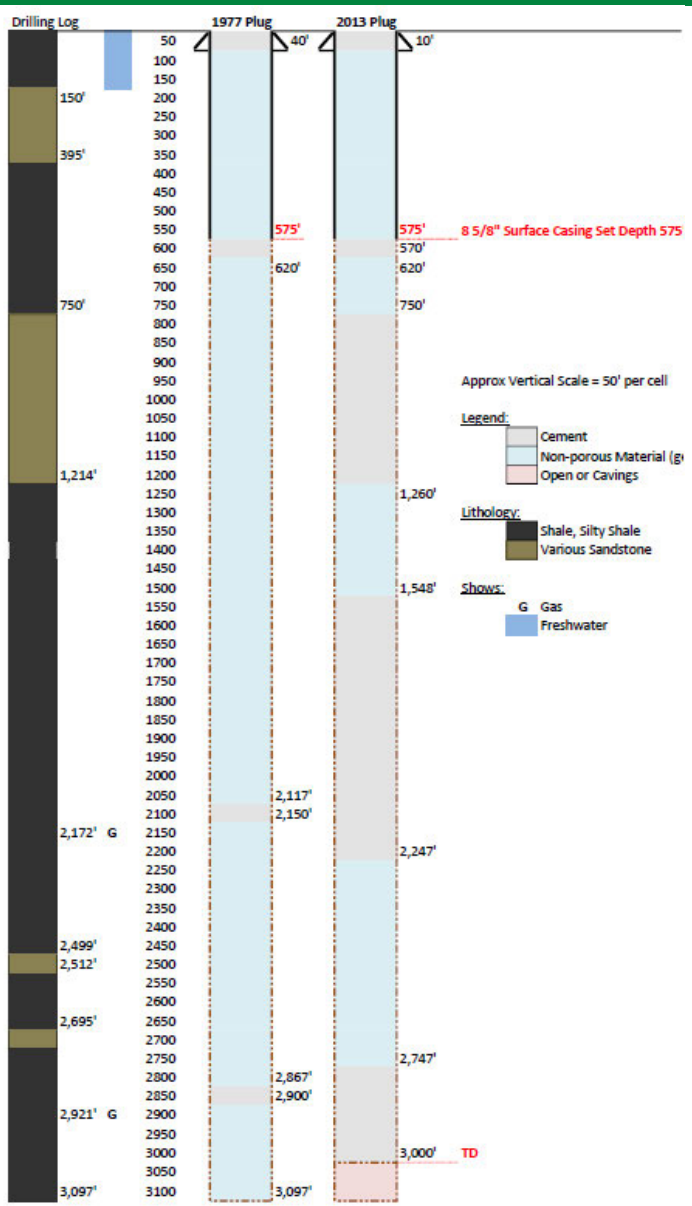


Cornplanter State Forest Emissions

Quantify emissions to be reduced through area-wide plugging project

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Leaking Plug Study



Analyze well and plug characteristics to identify potential contributing factors of known leaking plugs

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Research Partnerships

- McGill University (Kang)
  - Utilized highly sensitive meters to determine a high occurrence of leaking abandoned and plugged wells
  - Isotopic signatures support deep, oil-associated origin
  - In some cases, gas was found outside of the outermost well casing
  - DEP is currently working to understand the construction and/or plugging details at the identified leaking wells

Moving Forward

Summary

- Historic legacy challenge must be met
- Overall liability has been defined
- Economic opportunity
- Focused responses
- Delivering protection

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Oil and Gas Management

Thank You!

Kurt Klapkowski
Director
kklapkowsk@pa.gov

Bureau of Oil & Gas Planning & Program Mgmt
717.772.2199

Acknowledgments

M. Seth Pelepko, Harry Wise, Serena Oldhouser, Kevin Bogdan, Crystal Magon, Doug Catalano, Rick Swank, Lindsay Byron, and Stew Beattie