Results of USA Mining Case Studies

prepared for

Task Force on Benefits of Improving Mine Safety Through Extraction and Use of CMM

2 April 2007, Geneva Switzerland

prepared by

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RESOURCES INCORPORATED

COALBED METHANE OUTREACH PROGRAM

Background

- **United Nations Economic Commission for Europe (UNECE) Task Force on Benefits of Improving Mine Safety Through Extraction and Use of Coal Mine Methane was established in 2004 under the Ad Hoc Group of Experts on Coal Mine Methane**
- **Task force is charged with developing case studies that illustrate the relationship improved mine safety and economic success of the coal mine**

Goals of Study

- Examine the relationship of mining economics to mine safety, asking the these questions:
  - Does lack of investment in aggressive mine drainage impact the overall economic performance of the mine?
  - Would increased drainage and use of CMM, which would otherwise be vented to the atmosphere, impact the overall economic performance of a gassy coal mine?
  - Will improving revenues derived from increased CMM use provide revenue and incentive to improve the mine's safety ?

Constraints of the study

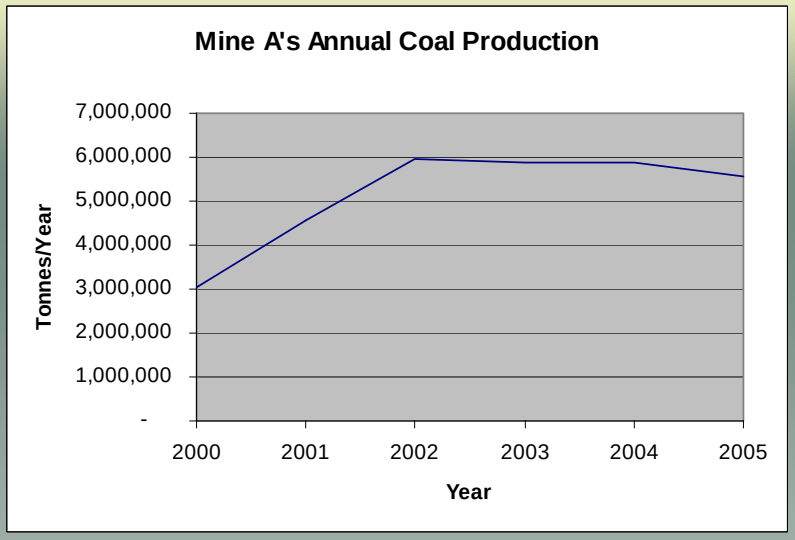
- Mining accidents must have taken place at gassy mines that are large emitters of methane;
- The mines selected should have accidents that did not result in loss of life and;
- All of the information must come from public sources;
- Sufficient financial and economic information must be present to indicate how the situation could have been improved if measures to drain and use more gas were taken;
- Economics of gas use must be examined and analyzed to determine if economic performance is increased mine safety improved.

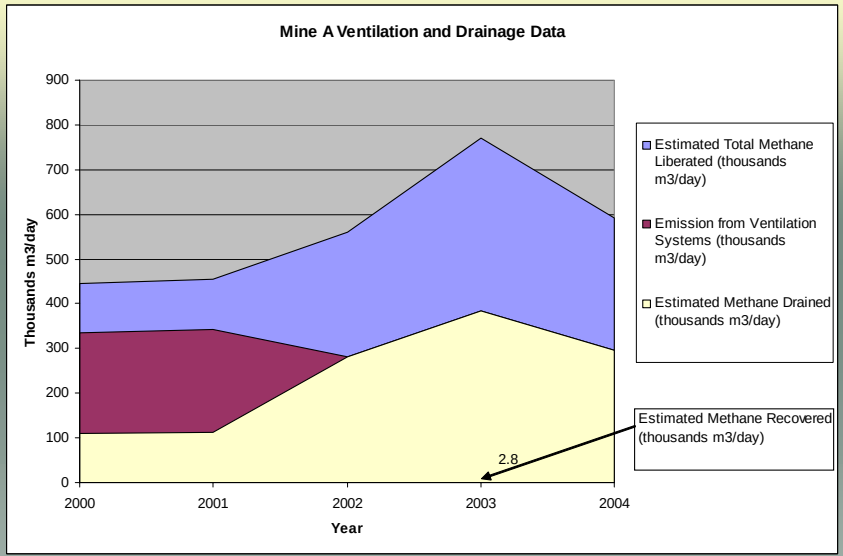
Case Study of Two Mines in the USA

- Both are gassy mines; one located in the eastern USA and one in the western USA
- Both are excellent coal mines with generally good safety records, but each have had severe difficulties with fires related to methane and spontaneous combustion

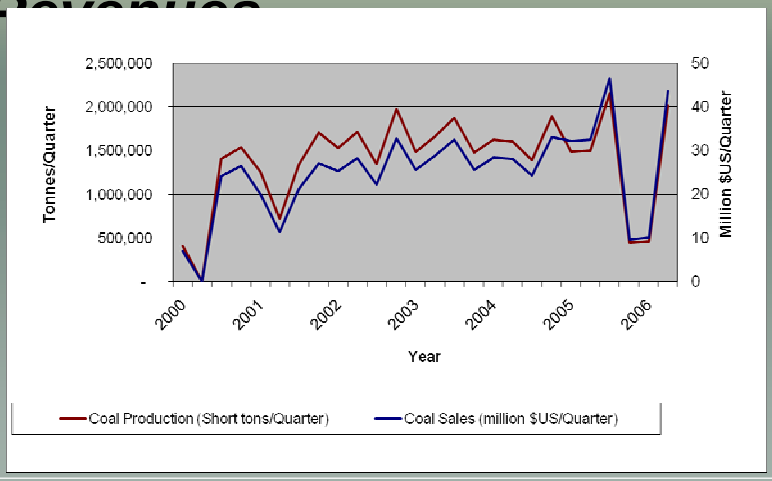
Mine "A" Production, Ventilation, and Drainage Data

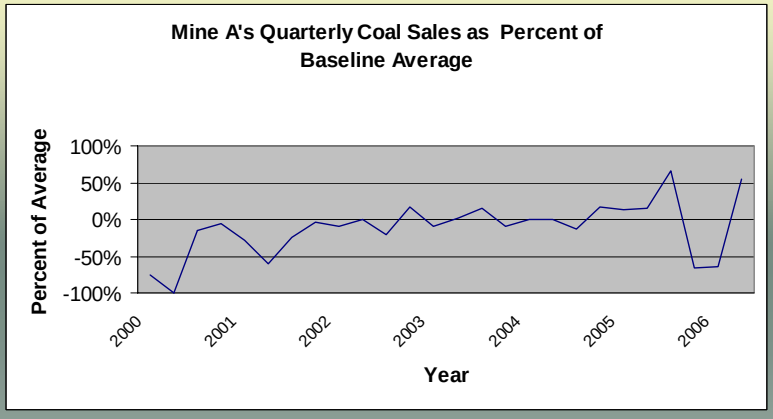
	•2000	•2001	•2002	•2003	•2004
•Coal Production (thousands metric tons/year)	3,040.1	4,556.0	5,947.7	5,888.3	5,890.7
•Estimated Total Methane Liberated (thousands m3/day)	444.6	455.9	560.7	770.2	591.8
•Emission from Ventilation Systems: (thousands m3/day)	334.1	342.6	280.3	385.1	295.9
•Estimated Methane Drained (thousands m3/day)	110.4	113.3	280.3	385.1	295.9
•Estimated Specific Emissions (m3/ton)	48.5	33.1	31.1	43.3	33.3
•Methane Recovered (thousands m3/day)	-	-	-	2.8	NA


Mine A's Annual Coal Production
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
-
Tonnes/Year
2000
2001
2002
2003
2004
2005
Year


Mine A Ventilation and Drainage Data
900
800
700
600
500
400
300
200
100
0
Thousands m3/day
2000
2001
2002
2003
2004
Year
Estimated Total Methane Liberated (thousands m3/day)
Emission from Ventilation Systems (thousands m3/day)
Estimated Methane Drained (thousands m3/day)
Estimated Methane Recovered (thousands m3/day)
2.8

Mine "A" Quarterly Coal Production and Sales Revenues





Summary of Mine "A" Losses

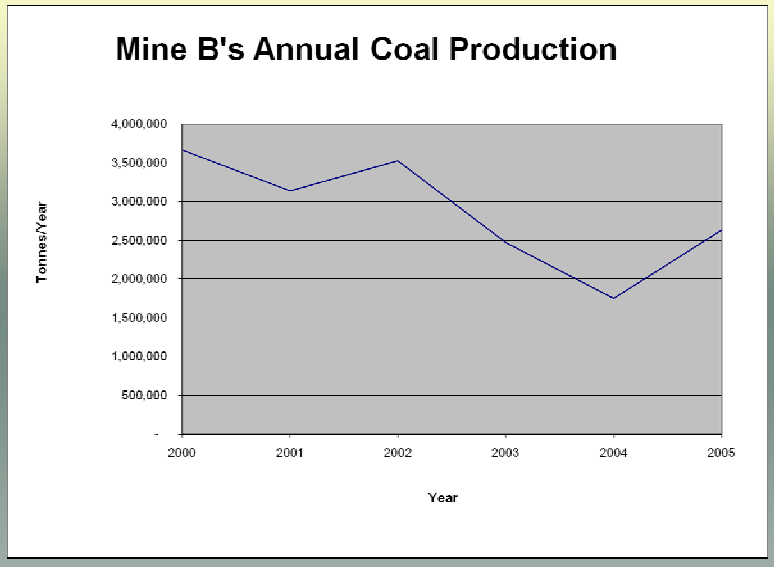
Year	MSHA Penalties Paid	Lost Coal Production (millions $)	Total Loss Due to Methane Fires/Gas Outages Before Insurance Recovery (millions $)	Net Loss Due to Methane Fires/Gas Outages After Insurance (millions $)
2000	$25,945	41	43	12
2001	$47,732	2	11	2
2002	$28,234	-	-	-
2003	$80,822	-	-	-
2004	$39,818	-	-	-
2005	$42,279	27	33	53
2006	NA	18	30	
Total	$265,000	88	117	67

Mine "A" Pro Forma Power Plant Economics Based on 2004 Drainage

	Gas Turbine, Simple Cycle	Gas Turbine, Combined Cycle	Internal Combustion
Power Plant Size (MW)	52	78	52
Efficiency Assumed	0.4	0.6	0.4
kWh/year (million)	454	680	454
Electricity Sales/Year (million $US)	0.38	36.74	24.50
Installed Cost :High Estimate (million $US)	39.35	59.03	52.87
OPEX (million $US/ year)	4.54	6.80	9.07
NPV High CAPEX Estimate (million $US)	38.9	108.5	44.0
IRR High CAPEX Estimate	73%	73%	42%

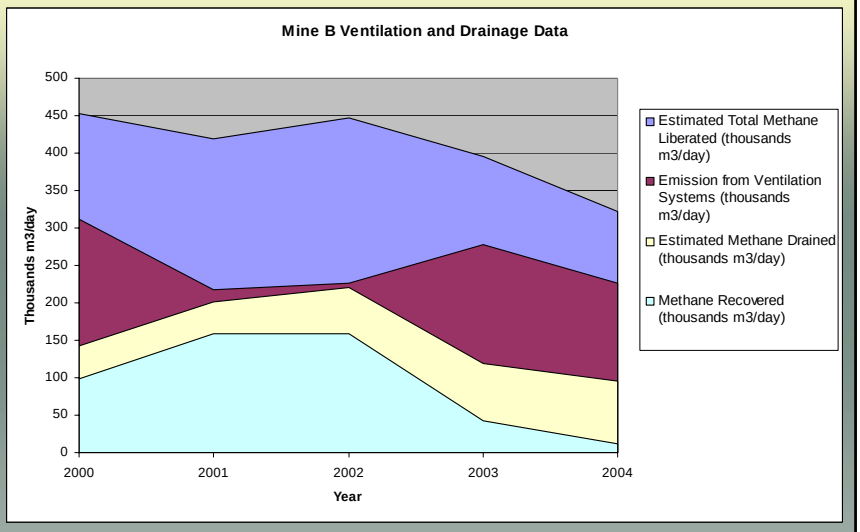
Mine "A" Pipeline Pro Forma Economics Based on 2004 Drainage

Annual Gas Drainage (million m^3)	Gathering CAPEX (million $US)	Gathering OPEX (million $US)/year	Processing CAPEX (million $US)	Processing OPEX Costs/year (million $US)	Compress-ion CAPEX (million $US)	Compress-ion OPEX (million $US) /year
108	5.31	0.78	5.60	0.93	2.90	0.09
Transport CAPEX (million $US)	**Transport OPEX (million $US) /year**	**Pipeline Injection CAPEX (million $US)**	**Total CAPEX (million $US)**	**Gas Sales per Year (million $US)**	**Net Present Value (million $US)**	**Internal Rate of Return**
3.00	0.12	0.50	17.31	30.10	65.7	152%

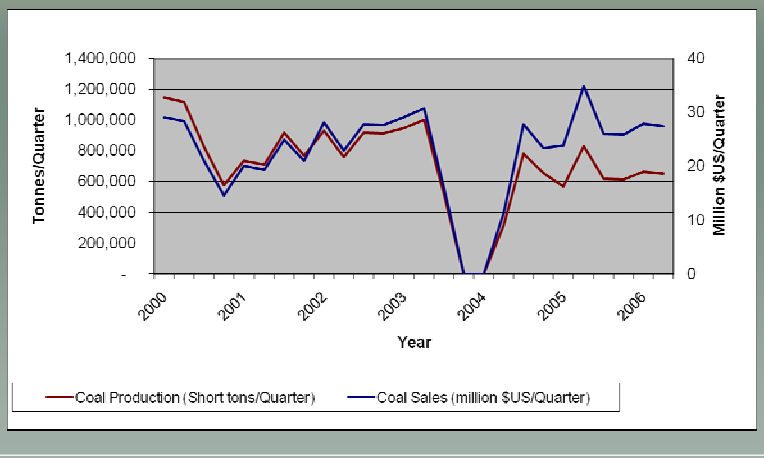


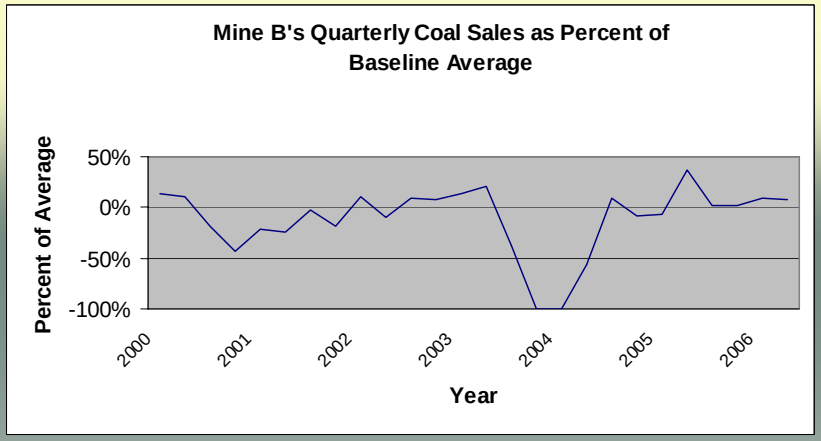
Mine "B" Production, Ventilation, and Drainage Data

	2000	2001	2002	2003	2004
Coal Production (thousands metric tons/year)	3,329	2,847	3,200	2,241	1,591
Estimated Total Methane Liberated (thousands m^3/day)	453	419	447	396	322
Emission from Ventilation Systems: (thousands m^3/day)	312	218	227	278	226
Estimated Methane Drained (thousands m^3/day)	142	201	221	119	96
Estimated Specific Emissions (m^3/ton)	45.1	48.7	46.3	58.4	50.2
Methane Recovered (thousands m^3/day)	99.1	159	159	42.5	11.1



Mine "B" Quarterly Coal Production and Sales Revenues





Summary of Mine "B" Losses

Year	MSHA Penalties Paid	Lost Coal Production (million metric tons)	Lost Coal Production (millions $)	Additional Costs	
2003	$11,186	1	35	Borehole injected NOx foam fire suppression*	$150,000 Plus cost of drilling
2004	$41,314	2	54		
Total	$52,500	3	89	Jet engine exhaust gas	$ USD (several million)

Mine "B " Pro Forma Power Plant Economics Based on 2004 Drainage

	Gas Turbine, Simple Cycle	Gas Turbine, Combined Cycle	Internal Combustion
Power Plant Size (MW)	15	22	15
Efficiency Assumed	0.4	0.6	0.4
kWh/year (million)	131	197	131
Electricity Sales/Year (million $US)	0.11	10.64	7.09
Installed Cost :High Estimate (million $US)	11.40	17.10	15.31
OPEX (million $US/ year)	1.31	1.97	2.63
NPV High CAPEX Estimate (million $US)	2.6	25.6	8.1
IRR High CAPEX Estimate	17%	60%	27%

Mine "B" Pipeline Pro Forma Economics Based on 2004 Drainage

Annual Gas Drainage (million m^3)	Gathering CAPEX (million $US)	Gathering OPEX (million $US)/year	Processing CAPEX (million $US)	Processing OPEX Costs/year (million $US)	Compress-ion CAPEX (million $US)	Compress-ion OPEX (million $US) /year
26	1.54	0.23	1.62	0.27	0.84	0.03
Transport CAPEX (million $US)	**Transport OPEX (million $US) /year**	**Pipeline Injection CAPEX (million $US)**	**Total CAPEX (million $US)**	**Gas Sales per Year (million $US)**	**Net Present Value (million $US)**	**Internal Rate of Return**
3.00	0.12	0.50	7.50	8.72	13.9	77%

Conclusions

- Mines "A" and "B" suffered heavy loss of coal sales due to lack of more aggressive and costly drainage and use programs. But the study showed:
  - Pro forma economic evaluation demonstrates recovery and use projects are profitable at both mines. Rights of gas ownership, land use and local markets will dictate which options are best for each mine.
  - Savings from accrued by avoiding costs of mine accidents could support additional capital costs for expanded drainage and use
- Increased investment in CMM use and drainage will increase mine safety

Conclusions, continued

- Fines assessed by safety authorities are much smaller than economics losses and have little overall impact
- Additional case studies should be developed for mines in other countries
- Lack of transparency and availability of data is a barrier to more widespread analysis
- Conflicts over gas ownership and access to gas pipelines and power transmission facilities are significant barriers to recovering and using CMM

Recommendations

- Conflicts over gas ownership, and access to gas pipelines and power transmission facilities should be addressed to remove barriers to recovering and using CMM
- Government safety authorities should collect more economic data and information related to mining accidents and make it available to public
- Large insurance companies should consider the economic consequences of mining accidents and offer incentives to increase drainage and use of CMM
- Government supported revolving funds supplying low cost capital should be created to encourage additional investment in CMM drainage and use