



*Energy &  
Environmental  
Research  
Center*

# *Gas Dehydration Glycols in the Subsurface Environment*

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Calgary, Alberta*

# Program Funding

DOE-NETL	\$800,000
GRI	\$800,000
Environment Canada	\$105,000
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Total	\$1,705,000

- Period of performance is Oct. 1, 2000 - Sept. 30, 2003
- Funding shown in Canadian dollars using 65% exchange rate



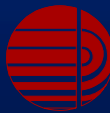
# *Program Goals and Objectives*

## Goals:

- Develop techniques for the management and/or remediation of wastes associated with natural gas production and processing.

## Objectives:

- Develop data to predict the subsurface transport and fate of gas production and processing wastes.
- Integrate data into Risk Based Corrective Action (RBCA) models and develop Environmentally Acceptable Endpoints (EAE) criteria for glycol-based dehydration wastes.



# *Background*

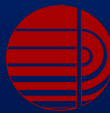
- Glycol-based dehydration units are used to remove water from the natural gas stream.
  - Located at wellheads & transmission/distribution facilities
  - Over 40,000 dehydration units in United States
  - Triethylene glycol (TEG), diethylene glycol (DEG), and ethylene glycol (EG) are most commonly used



# Background

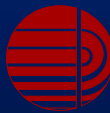
## Key Results of 2000-2001 Laboratory Research

- Condensates and glycols commonly occur together, sometimes in concentrations that are above water quality standards.
- Glycols appear to significantly enhance the mobility of condensates, including BTEX, in soils from North Dakota, New Mexico, Louisiana, and Alberta.
- Glycols that are high in BTEX (“rich” glycols) are less biodegradable than pure glycols.
- Soil conditions affect biodegradability and magnitude of cosolvency effect.



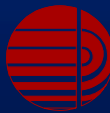
# *2002 Field-Based Studies*

- Sites with historical data for condensates and glycol
- Sites with different soil types



# *Field Work Plan*

- Collect and analyze sediment samples.
- Collect and analyze water samples from existing monitoring wells.
- Install new wells where deemed necessary.
- Sampling points selection based on historical data.



# *Analytical Work Plan*

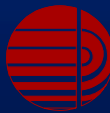
- Glycol determinations in sediments and water conducted at EERC using GC/MS.
- BTEX determinations in water conducted by commercial lab using GC/FID.





# Research Sites

- Wind River Basin of Wyoming
  - Natural gas compressor station
  - Sandy subsurface
  - Average depth to groundwater = 15 ft
- Northern Alberta
  - Natural gas processing plant
  - Gravel pad on muskeg (clay, high organic content)
  - Average depth to groundwater = 3 ft



# Glycol in Groundwater (mg/L) Wyoming Site

<u>Well#</u>	<u>June 2002</u>		<u>September 2002</u>	
	<u>DEG</u>	<u>TEG</u>	<u>DEG</u>	<u>TEG</u>
• 3	1	10	ND	6
• 4	64	1390	104	3051
• 6	ND	ND	ND	ND
• 12	241	3352	300	3484
• 16	ND	ND	ND	ND
• 18	2	8	ND	6

ND = Non detect (detection limit was 1 mg/L)

Values shown are the mean of triplicate runs of each sample.

EG was not detected in any sample.



# *Glycol in Groundwater (mg/L)*

## *Wyoming Site*

September 2002

<u>Well#</u>	<u>DEG</u>	<u>TEG</u>
• 20	ND	ND
• 21	ND	ND
• 22	9	189
• 23	10	200
• 24	5	78
• 25	ND	ND

ND = Non detect (detection limit was 1 mg/L)

Values shown are the mean of triplicate runs of each sample.

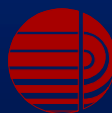
EG was not detected in any sample.



## Glycols in Water - Alberta Site

Well	EG (mg/L)		DEG (mg/L)		TEG (mg/L)	
	<u>June</u>	<u>Oct</u>	<u>June</u>	<u>Oct</u>	<u>June</u>	<u>Oct</u>
MW 00-1	ND	ND	ND	ND	ND	ND
MW 00-3	ND	ND	ND	ND	ND	ND
MW 01-10	ND	ND	ND	ND	ND	ND
MW 01-11	ND	ND	ND	ND	ND	ND

ND = Non Detect (Detection Limit was 5 mg/L)



# *Glycol in Soil (ppm)*

## *Wyoming Site*

June 2002

<u>Location (depth)</u>	<u>DEG</u>	<u>TEG</u>
• P1 (14')	<1	<1
• P2 (20')	<1	<1
• P3 (16')	<1	<1
• P4 (14')	<1	<1
• P5 (17')	<1	<1
• P6 (15')	<1	<1
• P7 (20')	<1	<1
• P8 (19')	<1	<1



# *Glycol in Soil (ppm)*

## *Alberta Site*

June 2002

<u>Location (depth)</u>	<u>EG</u>	<u>DEG</u>	<u>TEG</u>
• HA1 (2')	22	<1	<1
• HA2 (3')	7581	43	63
• HA3 (2')	<1	<1	<1
• SB2 (2')	<1	<1	<1
• SB2 (13')	23	<1	<1
• SB3 (2')	<1	<1	<1
• SB3 (8')	<1	<1	<1
• SB3 (10')	11200	28	64
• SB3 (13')	1040	<1	<1
• SB4 (2')	<1	<1	<1
• SB4 (8')	255	<1	<1
• SB4 (13')	56	<1	<1



# *Comparison of Organic Carbon in Soil Wyoming site vs. Alberta site*

	<u>TOC (%) Range</u>
Wyoming	0.02 - 0.16
Alberta	0.35 - 7.9



# *Key Observations*

- In Wyoming glycol was found in the groundwater, but not the sediments.
- In Alberta glycol was found in the sediments but not the groundwater.
- Glycol degrading microbes were present in sufficient numbers in the subsurface at both sites to suggest attenuation was occurring.

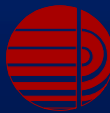


# ASTM Colorimetric vs. GC Analytical Methods

WY Well#	Colorimetric	GC	
	Total Glycol	DEG	TEG
• 3	400	0	0
• 4	150	104	3051
• 6	600	0	6
• 12	400	300	3484
• 16	ND	0	0
• 18	300	0	6
• 20	ND	0	0
• 21	ND	0	0
• 22	ND	9	189
• 23	200	10	200
• 24	600	5	78
• 25	ND	0	0

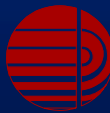
# *Explanation for Differences*

- Interferences are cited in ASTM method description. Method was originally developed for automotive industry.
- False positives caused by aldehydes and/or other organic compounds.
- False negatives caused by lack of ability to detect DEG and TEG.



# Conclusions

- Nature of the sediment (TOC) controls the partitioning of glycol.
- Glycol transport in the subsurface does not appear to be overly extensive or particularly problematic compared to condensates.
- Glycols do not appear to affect the transport and fate of condensate plumes.
- Commercial lab analytical techniques may not provide accurate assessment of glycol occurrence.



# *Project Benefits*

- Previously unavailable data allows for scientifically-based decisions regarding the management and/or remediation of subsurface glycol contamination.
- Data can be used to develop EAE or RBCA protocols for gas processing wastes.
- The use of ASTM method for glycol analysis in soil and water should be reconsidered.

