

Managing Diesel Emissions at Vale Inco

2009 MASHA Mobile Equipment Symposium: Diesel Emissions

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Managing Diesel Emissions at Vale Inco

Presentation Key Points

- Why Sample for Diesel Emissions?
- Monitoring Methods
- Undiluted Sampling Protocol
- Ambient Air Sampling Strategies
- Personal Monitoring Statistics
- Maintenance
- Strategy to Reduce DPM Exposure
- Conclusion



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Why Sample for DPM?

- ***Improve the Underground Environment***
 - *Health and Safety of Workforce*

- ***Measure***
 - *Occupational Health Program ensure compliance*
 - *Undiluted testing at routine intervals*

- ***Maintenance***
 - *Poorly services or tuned engines produce more exhaust emissions*
 - *Baseline established for each engine*

- ***Legal Requirements***
 - *Ambient Air tests at the request of a worker*
 - *Investigative monitoring due to over exposure*



Diesel Emissions Monitoring Methods

- ***Atmospheric Monitoring for Diesel Particulate***
 - *RCD Method*
 - *NIOSH 5040 Method*

- ***Undiluted Engine Exhaust Monitoring***
 - *Stain Tubes*
 - *Electronic Testers*



Undiluted Measurement Protocol

- Safety
- Qualified Personnel
- Documentation
- Protocol for Repeatability



Undiluted Measurement Protocol

- Safety
- Qualified Personnel
- Documentation



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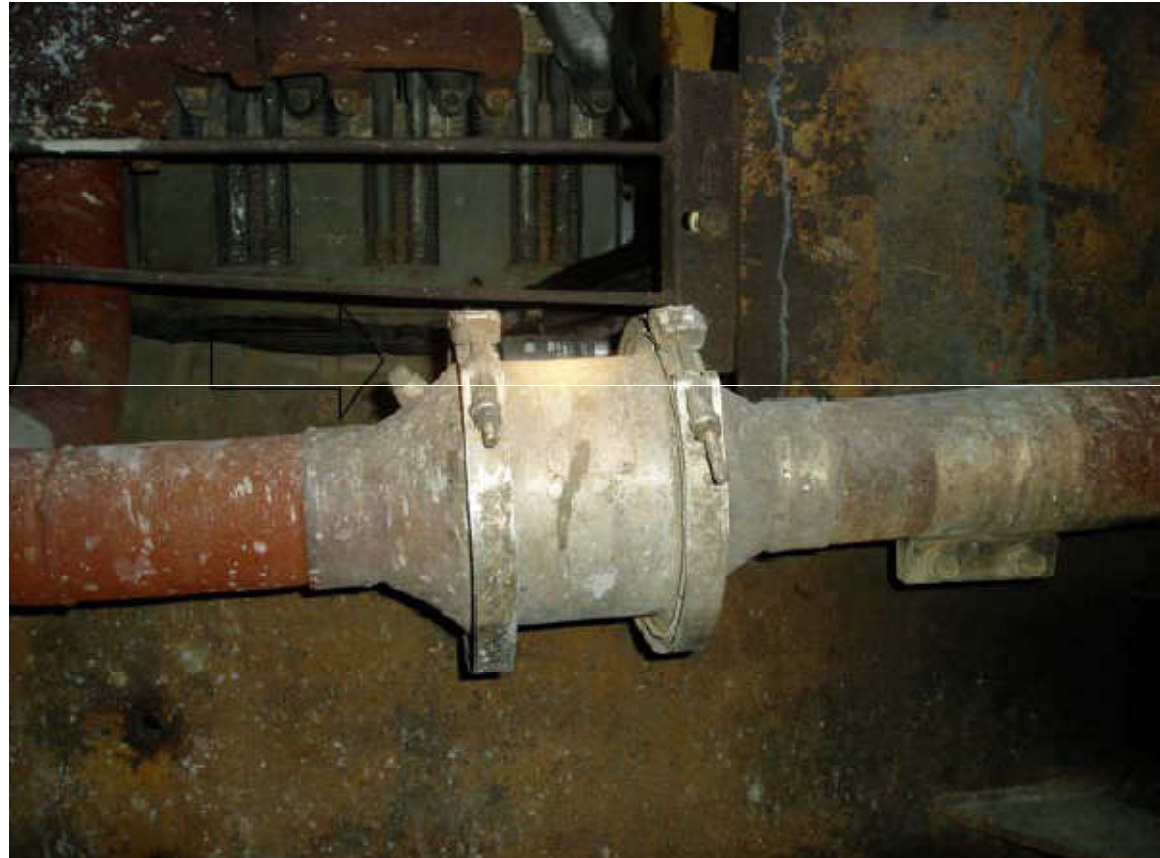
Undiluted Engine Exhaust Sampling

➤ Ecom



Undiluted Engine Exhaust Measurements

Measurement
Ports



Undiluted Measurement Protocol

Reproducible
Results



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Undiluted Engine Exhaust Sampling

- Dräger EM200
- ICx Real Time DPM monitor



Atmospheric Monitoring for Diesel Particulate

- Vale Inco has historically utilized the NIOSH system using Probability of Non Compliance (PNC) rational
- In 2007, Vale Inco moved to utilizing a Risk Based rational
- Semi-Quantitative methodology currently used to conduct our Occupational Risk Assessments.



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Risk Based Assessment

- Sampling strategy is based on sampling the identified high risk tasks
- Risk Matrix is used to score Likelihood and Impact of Exposure
- Job Task Assessment Criteria
 - ❖ Job Analysis – define different tasks within each job
 - ❖ Employee Interviews – define individual tasks and perceived level of risk to exposures
 - ❖ Task Analysis – frequency & duration
 - ❖ Historical data – exposure results available – severity
 - ❖ Mitigation Strategy – what is in place to reduce or eliminate exposure



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Impact/Consequence		
Rating	Descriptor	Health
1	Low	No adverse effect, no medical treatment.
2	Minor	Minor irritant, reversible or temporary, minor health effect.
3	Moderate	Possible human carcinogen. Respiratory sensitizer. Permanent partial disabling injury. Irreversible health damage without loss of life.
4	Major	Ill health effects. Fatal diseases. Severe life shortening. Permanent health effect with substantial disability without loss of life.
5	Catastrophic	Extremely harmful, loss of life

Impact/Consequence results		
<i>Based on Health Effect</i>		
Contaminant	Impact value	Source
Heat	3 or 4	Environment/equipment
Noise	3	Fan/equipment
Vibration	3	Equipment
Carbon Monoxide	5	Blasting/equipment
Nitrogen Dioxide	5	Blasting/equipment
Respirable Dust	2	Ore
Silica	4	Ore
Total Carbon	3	Equipment
ICP		
Inhalable Dust	2	Ore
Inhalable Nickel Insoluble	2	Ore/Depend on area
Inhalable Oil Mist	2	Equipment (hydraulic)
* similar sources therefore similar likelihood		

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Likelihood		
Based on the likelihood of exceeding the Occupational Exposure Limit (OEL)		
1	<i>Improbable</i>	Is so unlikely, that it can be assumed that it may never exceed the %OEL. Rare
2	<i>Unlikely</i>	Remote, but exposure exceedance may occur sometime during the life of the operation. Infrequent-annually
3	<i>Possible</i>	Is likely to occur sometime in the life of the operation and may occur during non-routine operation. Occasional-monthly
4	<i>Likely</i>	Is likely to occur several times in the life of the operation. Frequent -weekly
5	<i>Certain</i>	Is likely to occur frequently. Continuous-daily

Inherent Risk - Prior to Mitigation						
Likelihood	Certain	0	0	5	0	0
	Likely	0	0	2	0	0
	Possible	0	2	5	0	0
	Unlikely	0	12	10	4	0
	Improbable	0	44	43	12	32
		Low	Minor	Moderate	Major	Catastrophic
		Impact				

Identify Additional Controls

Based on the risk-rating outcome of the qualitative risk assessment the following criteria and actions are required to control the risk. The level of acceptable risk may change based on agreed objectives, available resources, and policy.

- Low** No action required. Continue to monitor and review activities and hazards.
- Moderate** No additional controls required. Monitor and review on a routine schedule for changes. Improvements may be considered for implementation.
- High** Reduce the risk. Ensure controls are implemented and maintained. Preventative maintenance programs, work practices, and housekeeping procedures must be clearly established, written, and followed. Training on programs, practices, and procedures must be conducted on a regular basis. Collect data to verify and quantify exposure. A mitigation strategy must be developed.
- Extreme** Reduce the risk before continuing or starting the task, or use immediate temporary controls, such as personal protective equipment. A timetable for planning and implementation of additional controls should be included in a risk action plan, with responsibilities assigned, and reasonable due dates for completion. Collecting data to verify and quantify exposure. A mitigation strategy must be developed.



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Vale Inco

Interview: Hugh
Best viewed at 70% zoom

Deep

Development Miner Trackless Job Code: 243

[Summary Matrix \(click here\)](#)

Risk	Task or Process Description	Sub Task Description	Qualitative				Mitigation Strategy
			Current Impact 1-5	Current Likelihood 1-5	Current Risk Score	Current Risk Category	
Total Carbon	Pre-op check of equipment	Mobile and Fixed	3	1	3	Low	ventillation/maintenance
	Face Prep	Wet down and Scale	3	1	3	Low	ventillation/
		Mark up face	3	1	3	Low	ventillation/
	Mucking	Muck to remuck bay/ Truck	3	3	9	High	ventillation/maintenance/enclosed
		Muck to pass (ore / Waste)	3	3	9	High	ventillation/maintenance/enclosed
	Ground Support	Bolt with Jackleg/screening	3	1	3	Low	ventillation/
		Bolt with Stoper/screening	3	1	3	Low	ventillation/
		Bolt with Mclean/screening	3	1	3	Low	ventillation/
		Shotcrete	3	3	9	High	ventillation/
		Screening	3	1	3	Low	
		Swellex-Jumbo or boltex	3	3	9	High	
	Services	Services (installation or repair air, water, vent)	3	1	3	Low	ventillation/air motor
	Drilling	Drill with Jackleg	3	1	3	Low	
		Drill with Stoper	3	1	3	Low	
		Drill with Jumbo	3	3	9	High	ventillation/maintenance/enclosed
		Drill with Plugger	3	1	3	Low	
	Loading	Clean Holes	3	1	3	Low	ventillation/
		Explosive Delivery	3	1	3	Low	ventillation/
	Blasting	Load Holes	3	1	3	Low	ventillation/
		Wire Blast	3	1	3	Low	ventillation/
		Clear Areas for Blast Gases	3	1	3	Low	ventillation/



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Vale Inco Baselines Established

➤ Analysis for this presentation focuses on EC exposure for 6 main tasks:

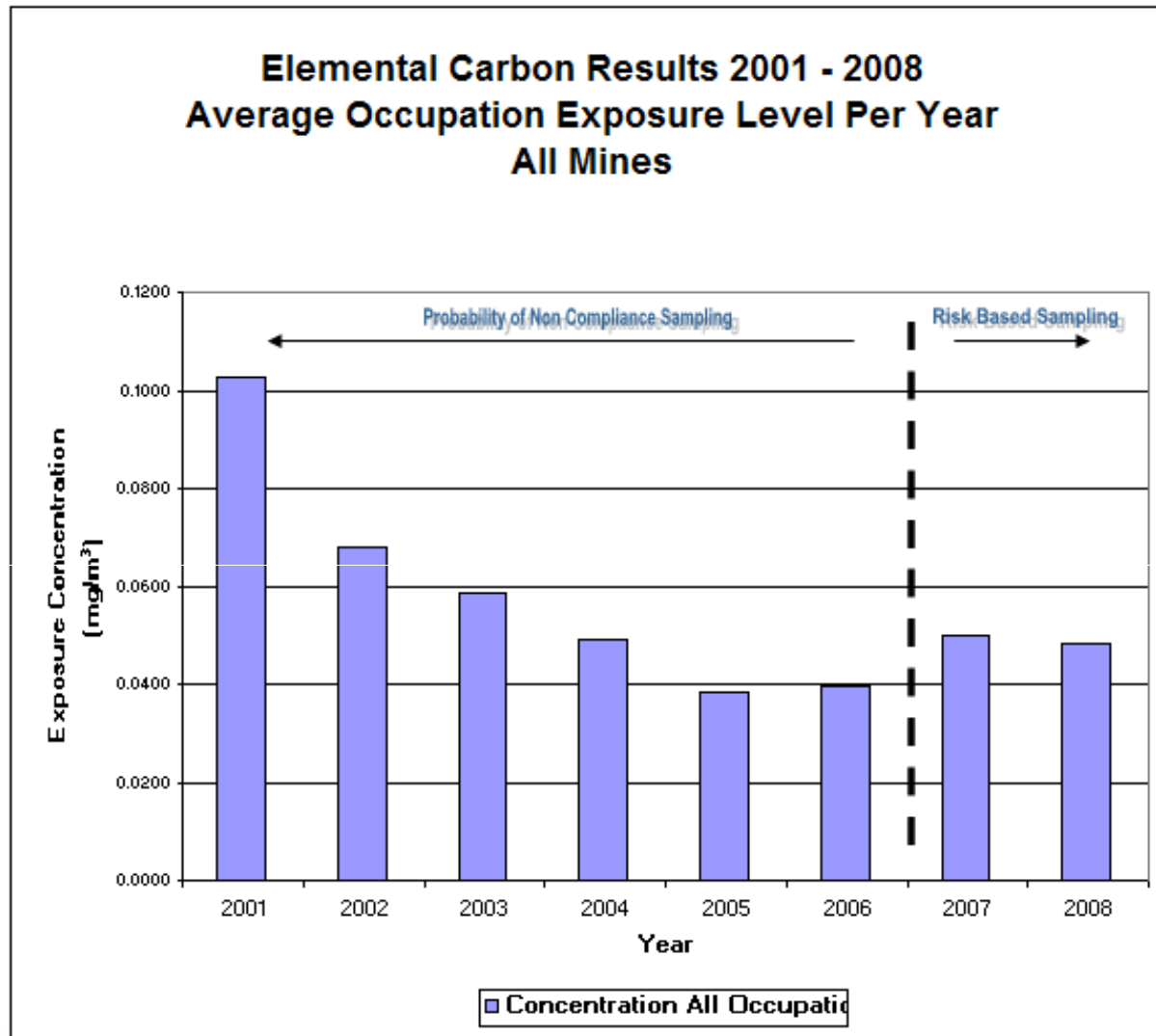
- ❖ Development Miner
- ❖ Haulage Truck Operator
- ❖ Load Haul Dump Operator
- ❖ Drilling
- ❖ Support Miner
- ❖ Maintenance

➤ Data for this presentation is from full shift personal samples

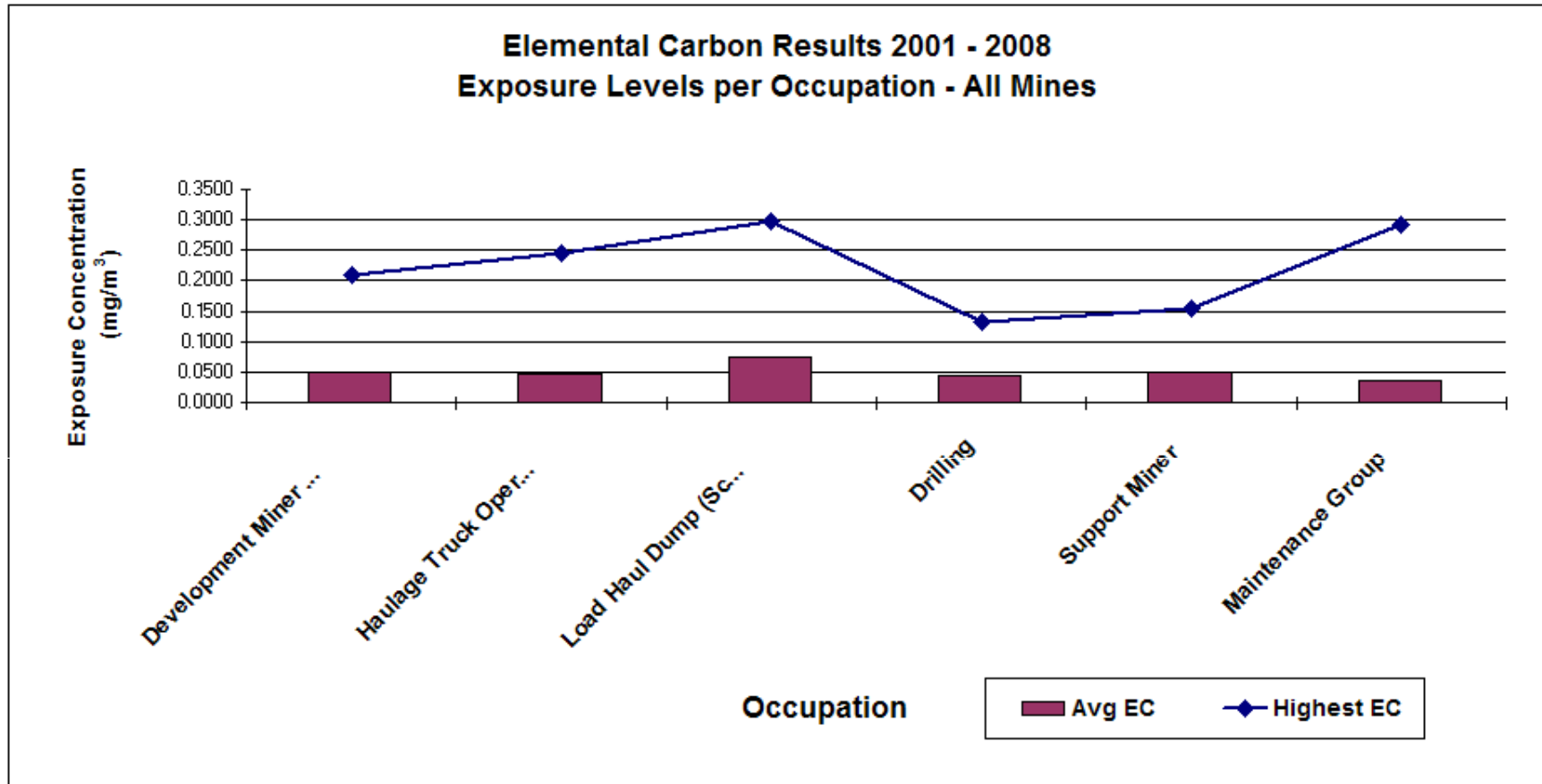
➤ Changed sampling strategy in 2007 from Probability of None Compliance to Risk based approach.



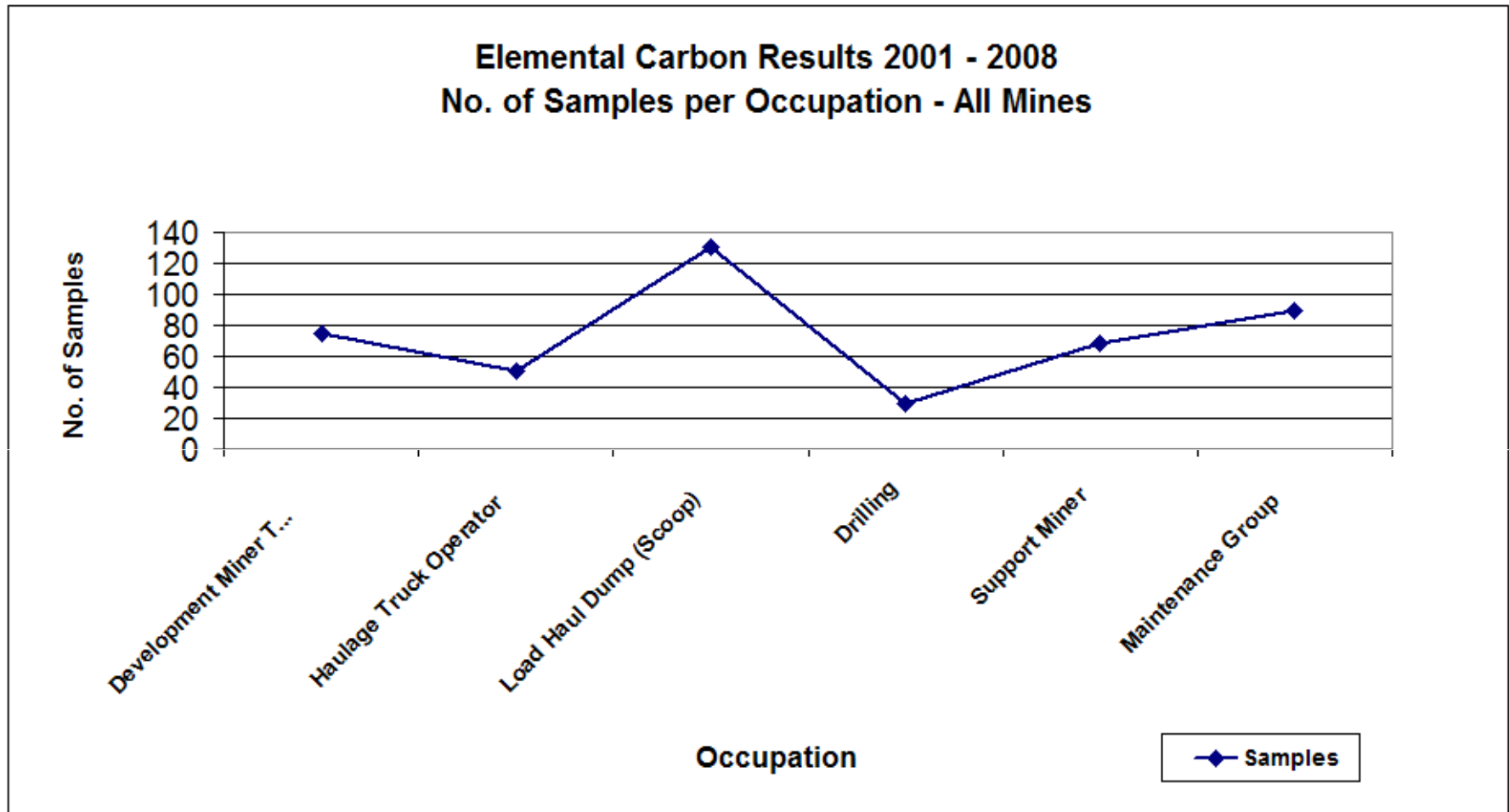
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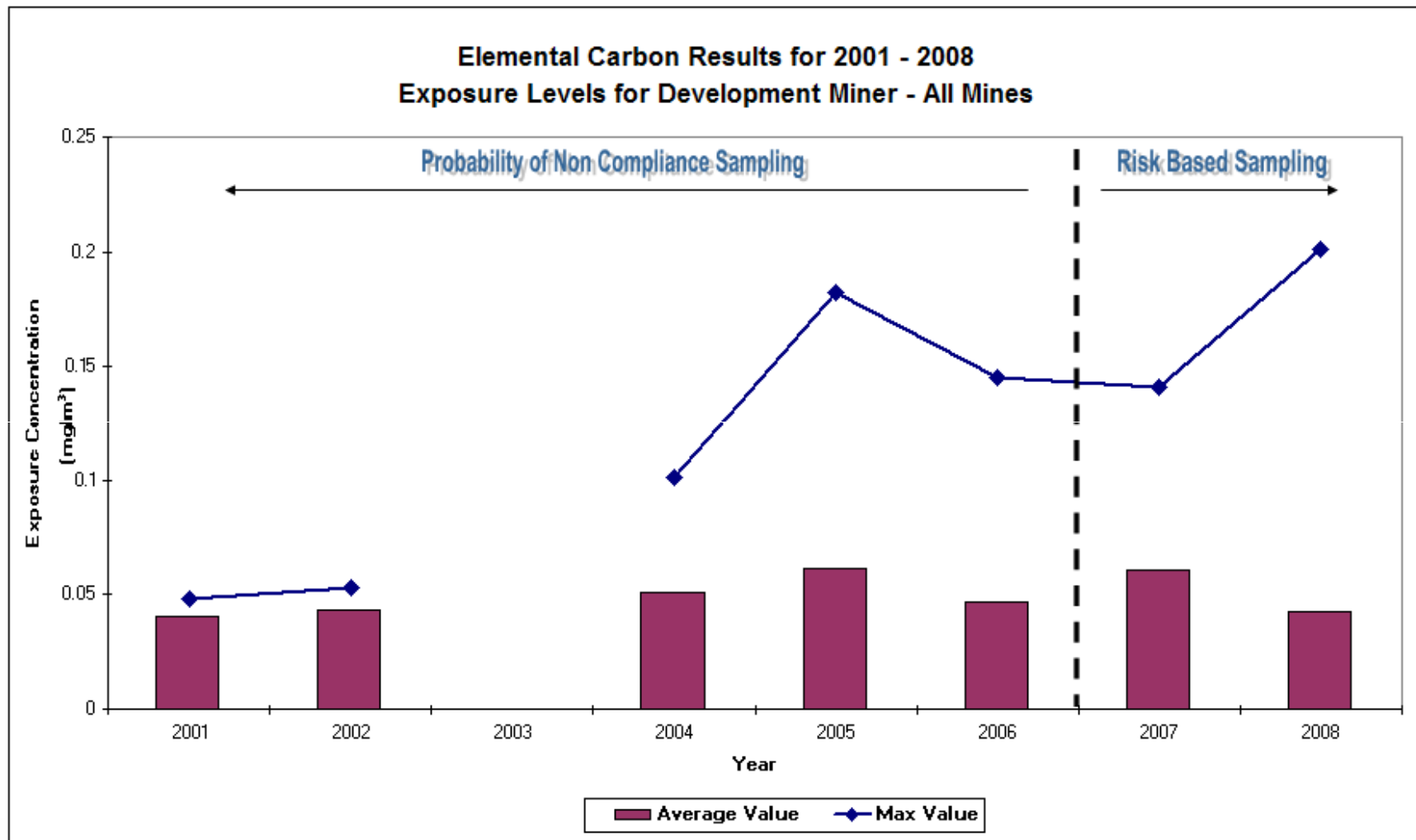
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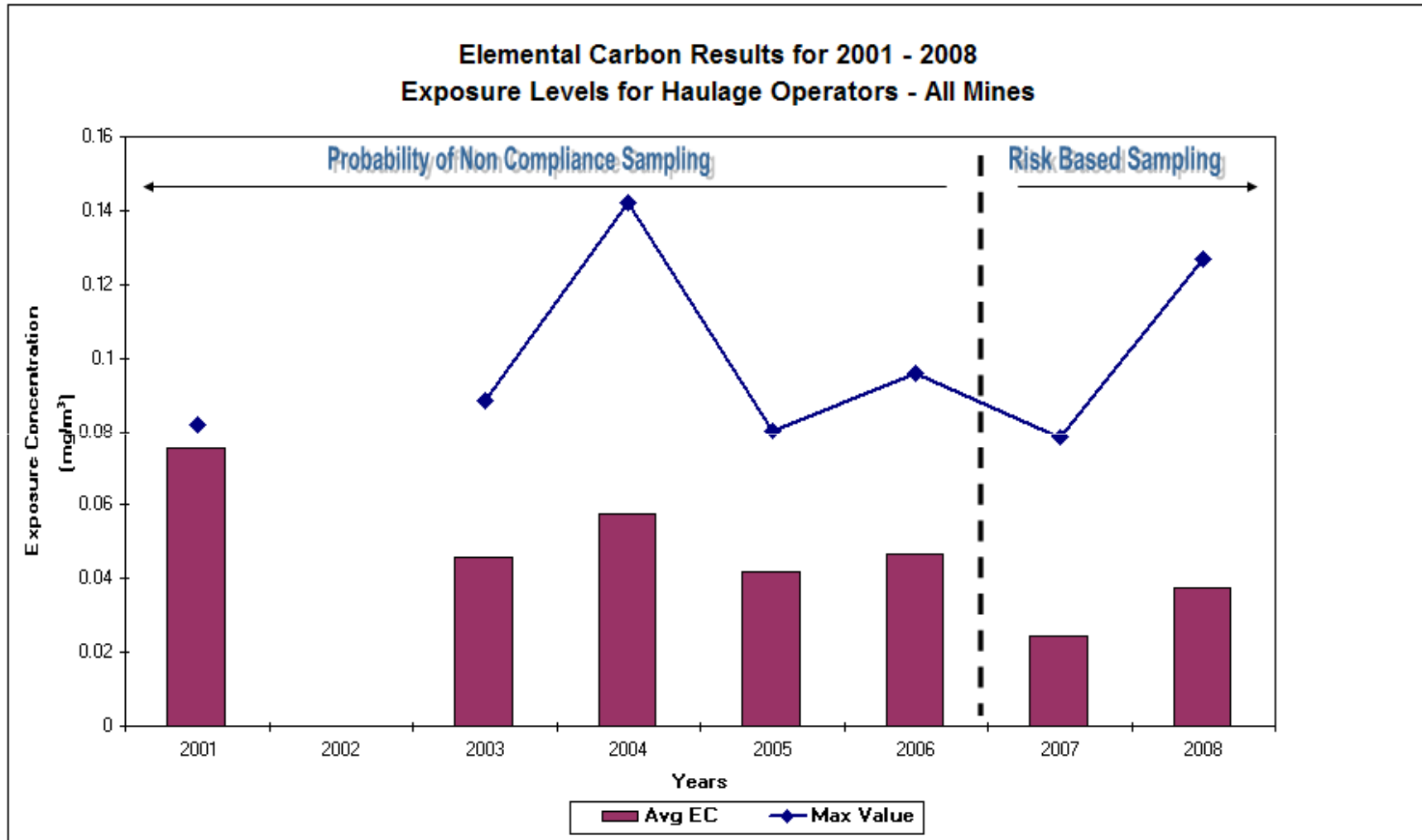
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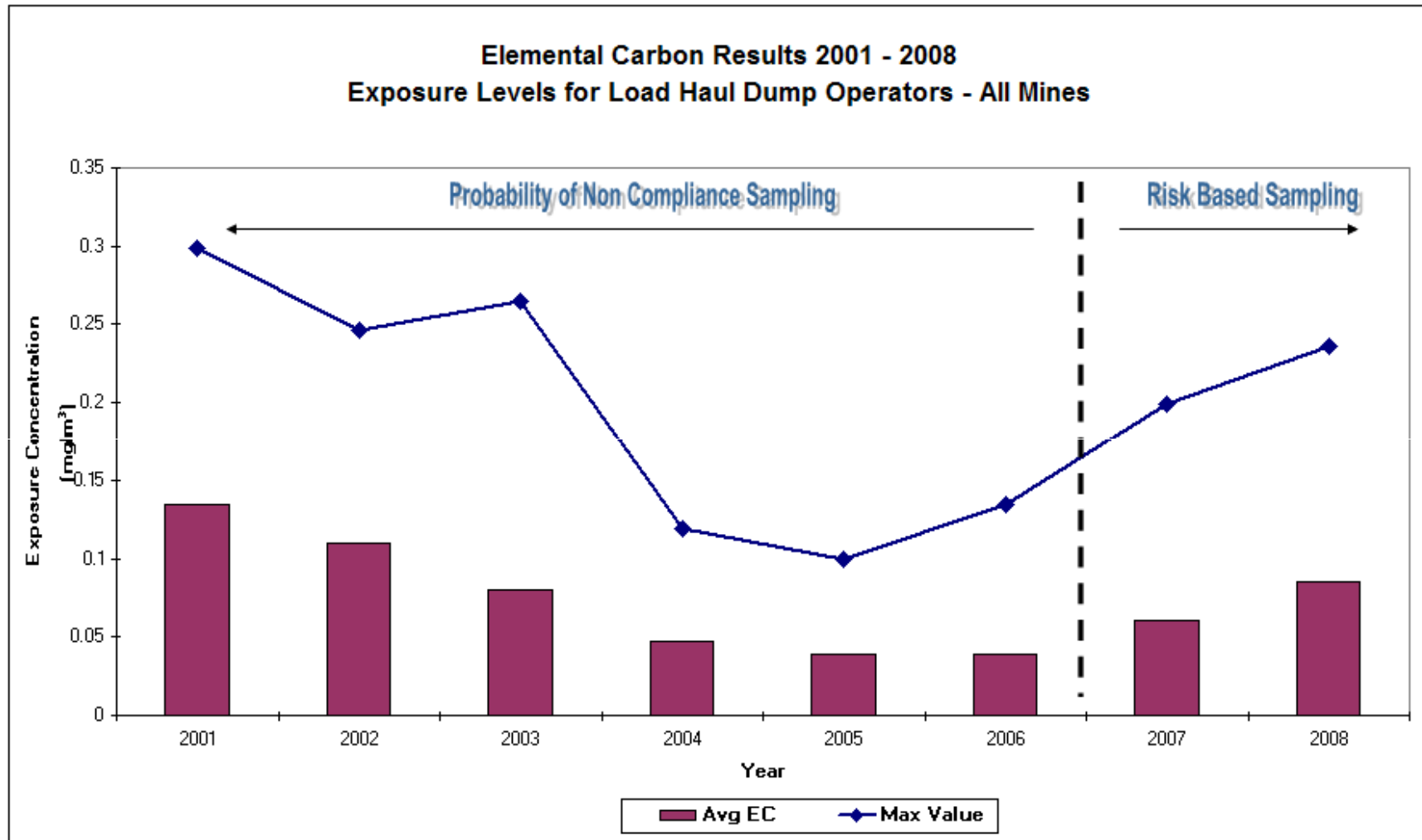
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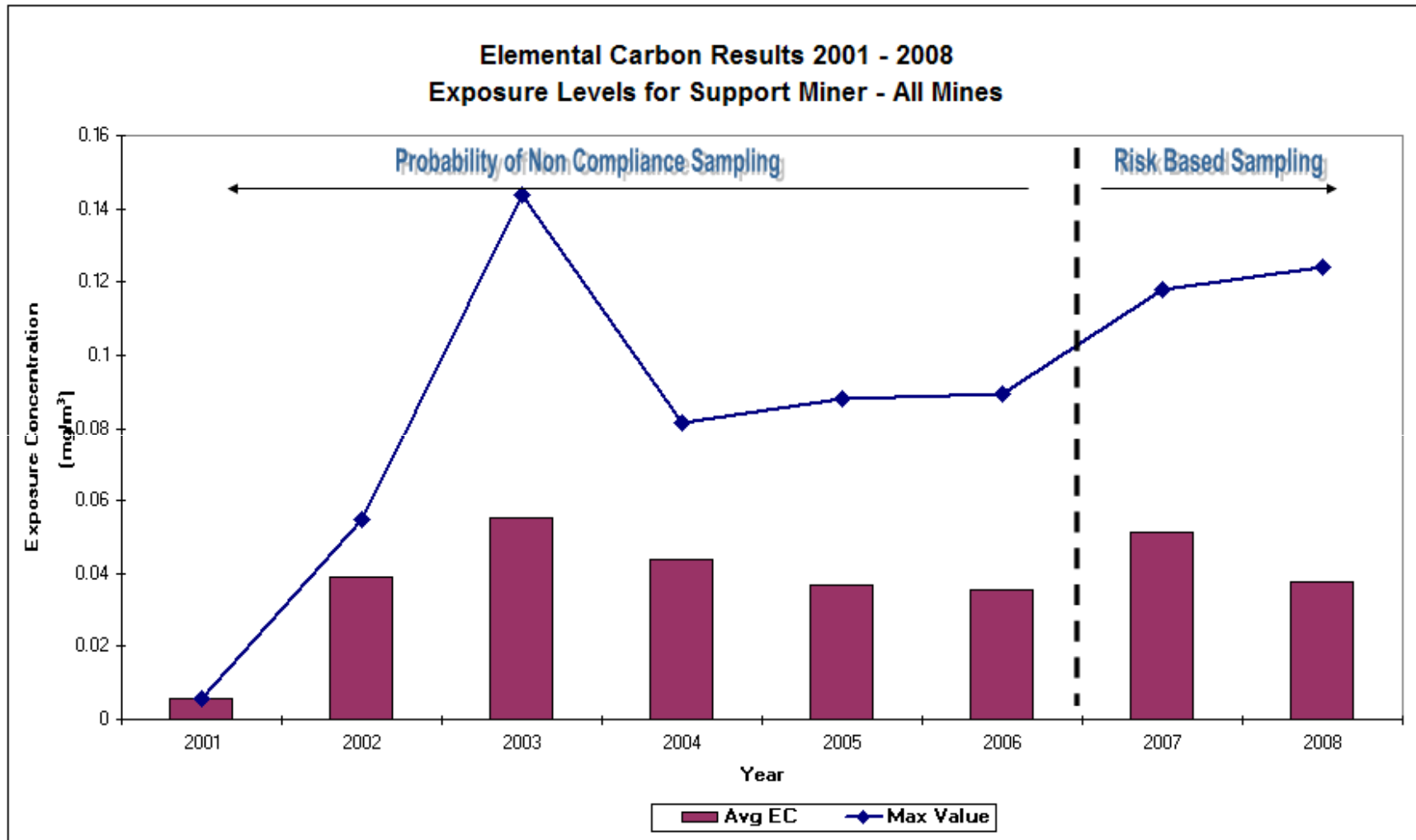
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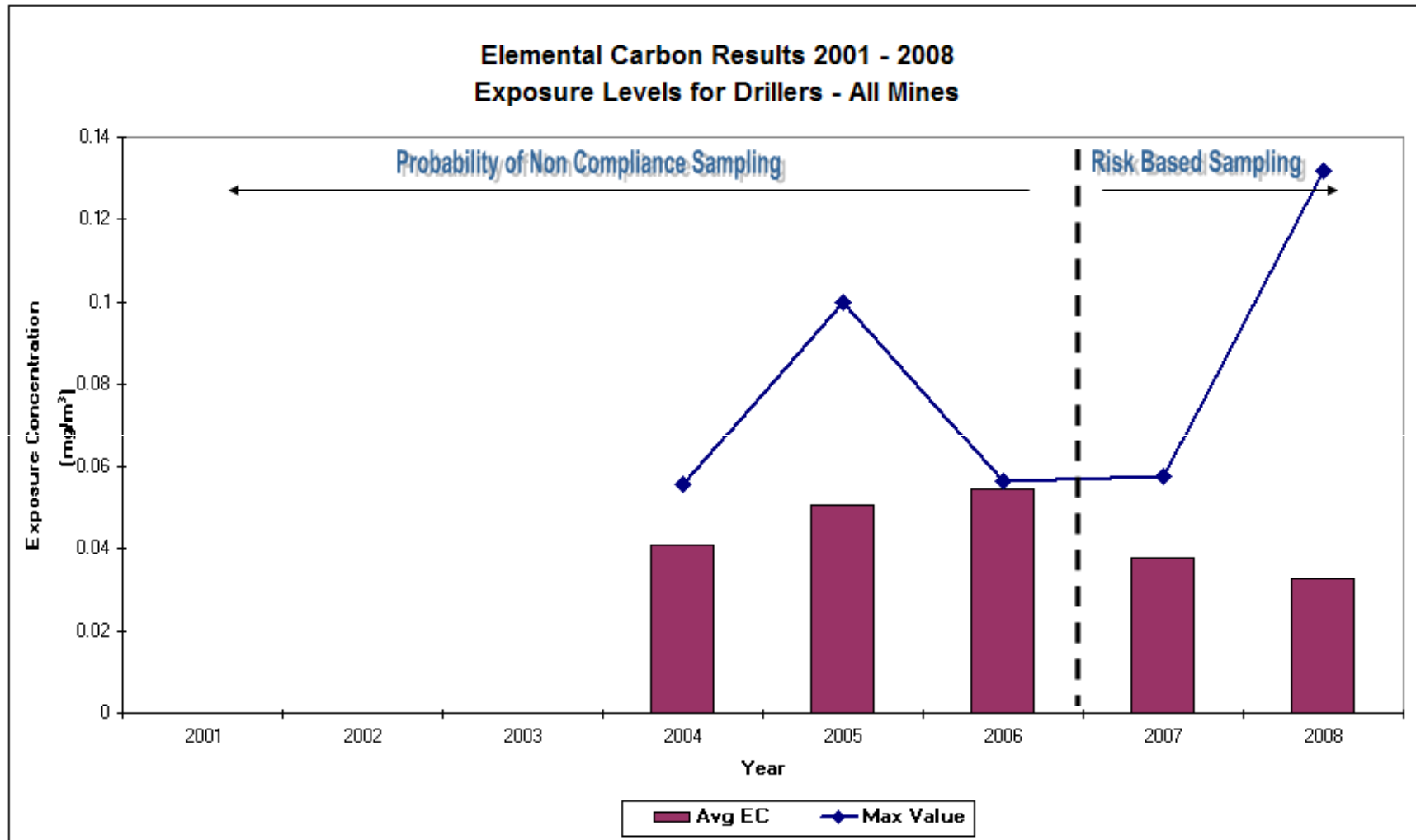
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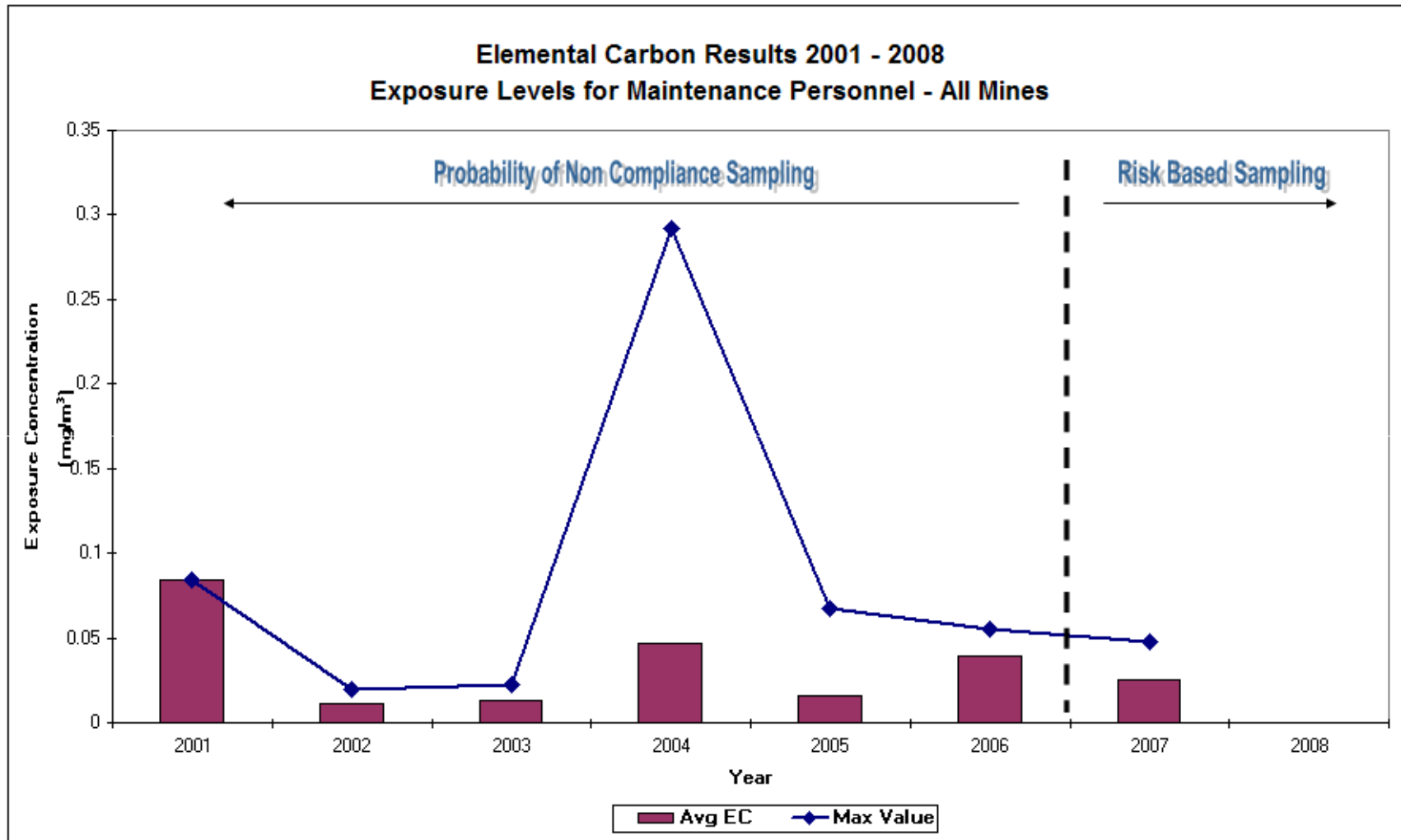
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EC Sample Distribution

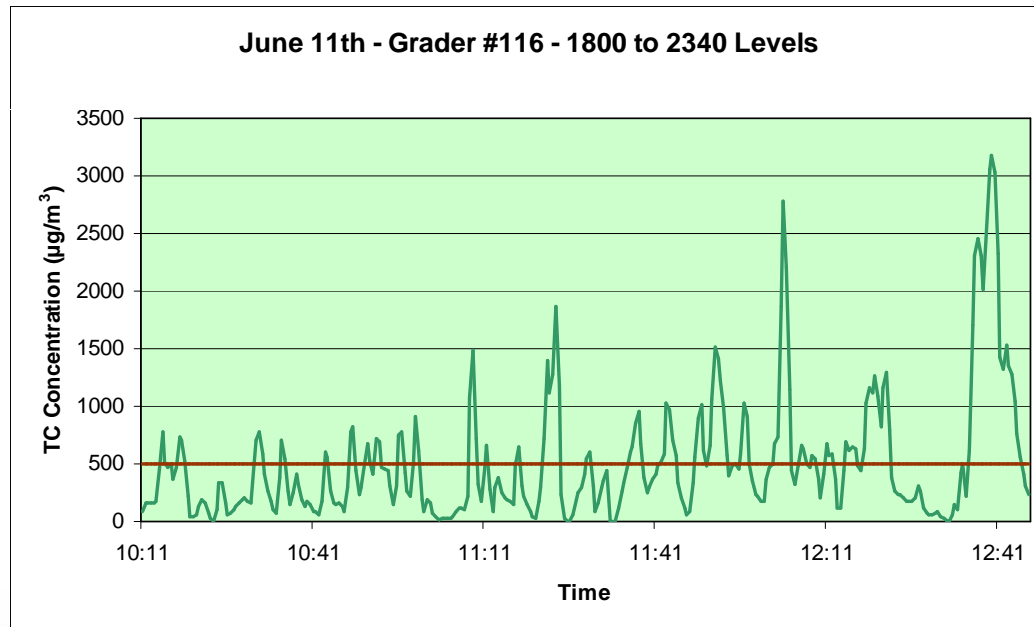
Task	Number of Samples	No. of Samples by Range of EC - mg/m ³						Average mg/m ³
		0.0 to 0.082	0.082 to 0.098	0.098 to 0.123	0.123 to 0.2	0.2 to 0.308	> 0.308	
Development Miner	75	61	5	5	3	1		0.0495
Haulage Operator	51	43	4	1	3			0.0473
LHD Operator	131	97	3	11	13	7		0.0737
Drillers	30	27		2	1			0.0432
Support Miner	68	61	3	2	2			0.0496
Maintenance Personnel	90	85	1	1	2	1		0.0372
Totals	445	374	16	22	24	9	0	0.0501
Percentage of Total		84	4	5	5	2	0	



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Maintenance

- *Well Serviced engines*
- *Preventative, Predictive, Planned, Reactive*
- *Replacement of Old engines*



- TCavg. = $506\mu\text{g}/\text{m}^3$



Natural Resources
Canada

Ressources naturelles
Canada



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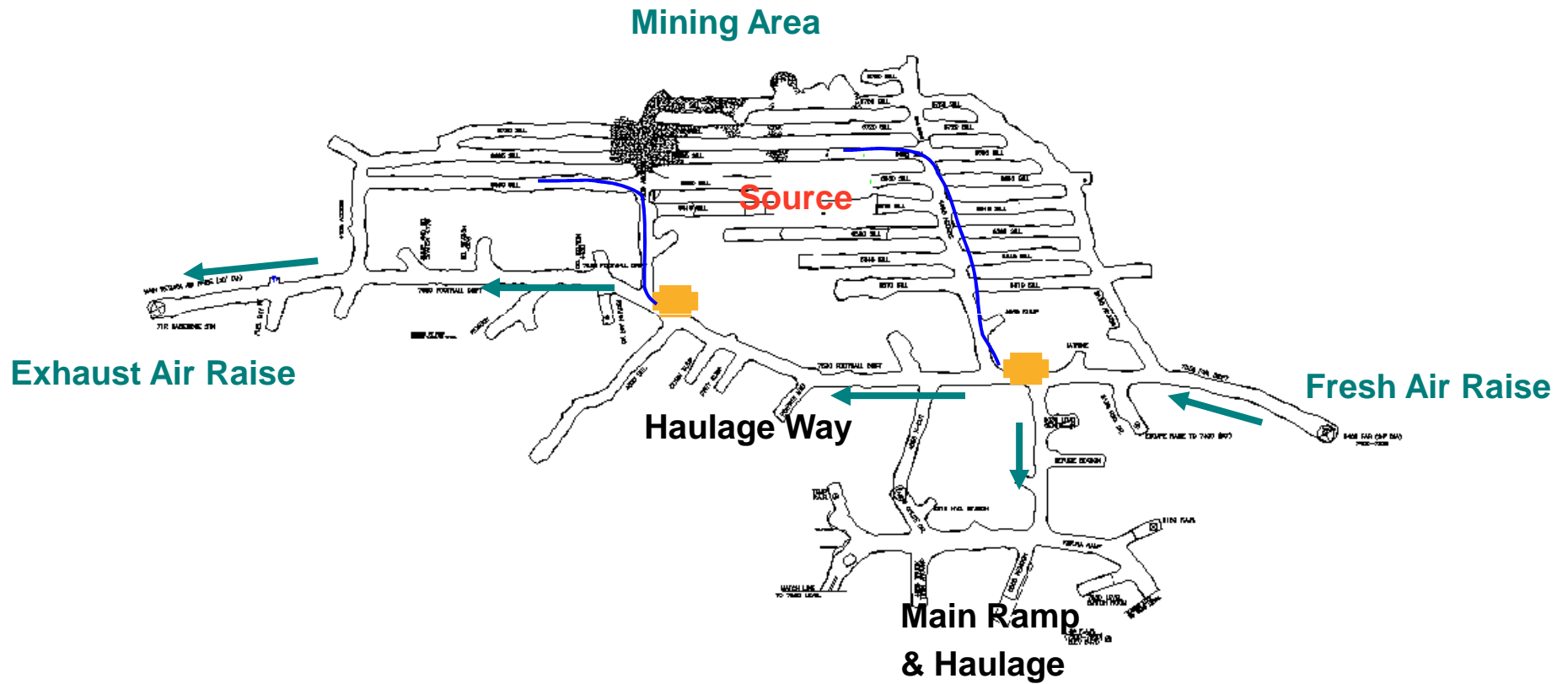
Strategy to Reduce EC Exposure

Vale Inco has been working towards reducing DPM to improve the air quality of the underground environment through the following initiatives:

- *Dilution: design, installation and maintenance of good auxiliary ventilation systems.*
- *Engine Maintenance: High standard is key to reducing DPM at the source.*
- *Engine Design: Cleaner modern engines*
- *Fuel: The use of ultra low sulphur diesel fuel.*
- *Lube Oils: Reduces ash in the exhaust.*
- *Diesel Particulate Filters: Investigation of reliable cost effective diesel particulate filters*

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Example of Level Ventilation System



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Conclusion

1. Sampling for diesel emissions is required for control and continued improvement.
2. Sampling consists of a combination of ambient and undiluted engine exhaust methods.
3. Investigations show that exposure limits can be exceeded if engines and ventilation systems are not well maintained.
4. Reduction of diesel emissions is a combination of strategies.
5. It is our responsibility to reduce employees exposure to diesel emissions to as low as reasonably achievable.

