

**MINISTRY OF ENERGY, MINES  
AND PETROLEUM RESOURCES**

**SULLIVAN MINE ACCIDENT REPORT**

**MAY 17, 2006**

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### SUMMARY OF EVENTS

On Monday, May 15, 2006 Doug Erickson, an employee of Pryzm Environmental ( an environmental contractor hired to perform water monitoring for the inactive Sullivan mine site) entered the property and proceeded to secure water samples and perform flow measurements as per previously arranged schedules. At a time later determined to be between 1345 and 1400 that afternoon, Mr. Erickson entered a sampling shed located at the toe of the reclaimed dump known as the # 1 Shaft Waste Rock Dump Monitoring building.

Mr. Erickson was reported missing on the morning of Wednesday, May 17, 2006 by [redacted]. After a series of phone calls to his employer and to TeckCominco, a search was initiated by TeckCominco personnel on site. An employee of TeckCominco (Bob Newcombe) discovered Mr. Erickson [redacted].

Mr. Newcombe notified the other TeckCominco contract employee involved in the search [redacted] and then called 911 at 0845, reported [redacted] and an ambulance was dispatched to the scene. Mr. Newcombe advised the dispatcher that he would be attempting to [redacted] Mr. Erickson following the call. Immediately after ending the 911 call, Mr. Newcombe also called [redacted] and summoned him to the scene. Prior to [redacted] arrival, Mr. Newcombe entered the building and descended into the sub-level sump where Mr. Erickson [redacted].

Between 0848 and 0858, [redacted] arrived escorting the first BC Ambulance which was dispatched to the scene. He entered the building with Kim Weitzel (BC Ambulance attendant) and she began to descend the ladder into the sump. As she was descending, she inquired of [redacted] if there was gas present.

[redacted] and, at that time, she [redacted] retreated from the building and advised the other BC Ambulance attendant, Shawn Currier, that his partner had [redacted] and Mr. Currier then entered the sump and attempted to obtain a response from Ms. Weitzel. He [redacted] the atmosphere and [redacted].

[redacted] called 911 at 0859 and reported that four people were down and that he suspected possible gas (H<sub>2</sub>S). He was directed by the 911 dispatcher to ensure that Emergency Response personnel who had subsequently been dispatched to the scene did not enter the shed and that appropriate Personal Protective measures were undertaken to prevent further casualties.

[redacted] proceeded to the main entrance to the property from the shed and at approximately 0905, while en route he met [redacted] and the Kimberley Fire/Rescue Command vehicle. He advised both parties of the possibility of the presence of gas and not to enter the shed without the use of proper protective equipment.

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The Fire Department confined space team arrived at the scene at 0915, donned their protective equipment, and proceeded to extricate the casualties.

The four casualties were removed from the shed by Kimberley Fire/Rescue personnel equipped with Self-Contained Breathing Apparatus (SCBA) by 0937. Three of the casualties were treated for \_\_\_\_\_ and were en route to Cranbrook Hospital by 0950. All attempts at \_\_\_\_\_ The fourth casualty, Mr. Erickson, was determined \_\_\_\_\_ Kimberley Ambulance Service. RCMP and Coroner were contacted at approximately 0945 and RCMP arrived on site at 1007 Coroner arrived at 1042. The fourth casualty was removed from the site at 1700.

Senior Teck Cominco managers were notified at 1007, the Ministry of Energy, Mines and Petroleum Resources (Ministry) was notified at 1020. In addition, the Emergency Response Team from TeckCominco's Trail Operations was dispatched to assist with the emergency.

In anticipation of the requirement for additional testing capabilities at the site, the Ministry requested assistance from Elk Valley Coal Corporation – Elkview Operations for gas testing equipment.

Ministry staff arrived on site at 1120. The scene was secured and access into the site was controlled. Due to the unknown nature of the gas or gases involved, a safe perimeter was established approximately 200 m onto the property from the main gate access at Tadanack Road. The regional Inspector of Mines arrived at 1247 and proceeded to a vantage point approximately 200 m from the shed at the top of the resloped waste pile. In consideration of the unknown hazard, the Inspector requested that the Kimberley Fire Department conduct field sampling of possible toxic atmospheres within the capabilities of their hand-held tester. Tests were conducted for Hydrogen Sulphide (H<sub>2</sub>S), Oxygen (O<sub>2</sub>), Carbon Monoxide (CO), and Lower Explosive Limit (LEL). Testing allowed the establishment of a safe working perimeter within 30m of the shed. A further series of tests allowed a reduction of this perimeter to within 10m of the shed and determined that no gases were detected at concentrations which would pose a risk to the public. Testing continued in order to determine the atmosphere present inside the open door to the shed. The indications from these tests were that no H<sub>2</sub>S was detectable and an oxygen deficiency was present inside the doorway.

At 1500 the Chief Inspector of Mines accompanied by the Regional Director arrived on scene and assumed control of the site.

The additional testing equipment and personnel from Elkview arrived at 1620 and continued perimeter monitoring under the direction of the Ministry. Ongoing testing confirmed the oxygen-deficient atmosphere inside the shed. Although H<sub>2</sub>S was detected on two separate occasions from this testing, no sustained elevated levels were otherwise detected.

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The Ministry determined that an independent consultant may be required to assist in the determination of the cause of this accident. Rescan Environmental was retained by the Ministry to assist in the investigation. The Ministry also determined that thermographic imaging of the dump site may provide additional information establishing possible internal processes which could have caused the oxygen depletion.

The Trail Emergency Response Team arrived at 1800 and conducted additional tests for gases in the vicinity of the shed and at downstream locations suspected by Ministry personnel of having been potentially impacted. This team continued testing as directed until they were released by the Chief Inspector on May 21. Testing included four sets of bag samples on four separate occasions (2 for TeckCominco, 1 for the Ministry, and 1 for Rescan Environmental). These samples were sent to three independent laboratories and all samples confirmed an oxygen-depleted atmosphere and no presence of toxic gases. The Ministry, in conjunction with TeckCominco and the BC Ambulance Service commenced the formal investigation into the accident on May 18.

Following preliminary investigation the Ministry determined that a potential hazard may exist at other mine sites. The Chief Inspector of Mines issued a Canada-wide Hazard Alert accompanied by a Directive to BC Mines on May 25 warning of the potential hazard and requiring immediate investigation of downstream sampling locations and enclosures by all mines in BC.

In order to complete the investigation it was determined that the site needed to be left intact. Consequently, the site has been fenced, signed and access procedures established.

### **IMMEDIATE ACTIONS**

- The scene was secured to ensure that entry into or in close proximity to the shed was restricted.
- An unknown atmosphere was evidently the cause of the accident and a TeckCominco Emergency Response Team from Trail was dispatched to the Sullivan site.
- Air sampling by hand-held sensors was initiated to ensure a safe perimeter was established around the shed and to detect any levels of suspected toxic gases which may have contributed to the accident.
- Upon arrival of the Trail Emergency Response Team, samples of the atmosphere inside the shed were obtained and sent to a laboratory for analysis.
- Other sites downstream of the shed were tested to determine if any toxic gases or other life-threatening atmospheric conditions existed which could have been created by gases transported through the pipes from the shed.
- Other similar sites to the accident scene were tested for atmospheric conditions to ensure the safety of personnel in that area.

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- Thermographic imaging of the dump site was undertaken to determine if any unusual exothermic reactions were occurring within the dump which could be altering normal atmospheric conditions.
- Manned 24 hour security was initiated to ensure that entry onto the property and specifically to the accident scene was prevented.

### ACCIDENT INVESTIGATION

The formal accident investigation was initiated on May 18 by the Ministry of Energy Mines and Petroleum Resources in conjunction with TeckCominco and BC Ambulance Service.

#### Air Sampling

Air sampling commenced on May 17 with the use of hand-held monitors. The primary objective at the onset of sampling was to ensure that there was no danger to the public and to establish a safe working perimeter around the sampling shed. This stage of sampling was performed under the direction of Ministry personnel initially by the Kimberley Fire Department and soon after by representatives of Elk Valley Coal Corporation. After their arrival the Trail Emergency Response Team assumed responsibility for air sampling. The results from the hand-held sampling did not indicate the presence of any hazardous concentrations of sulphuric gases but pointed to low oxygen concentrations in the atmosphere, confined to the area within the shed.

Of particular note are hand-held samples and air movement measurements obtained at the mouth of the inflow pipe located near the floor of the sump. These measurements indicated air entering the shed at a velocity of 150 ft/minute (46 m/minute) with an oxygen content of 0%.

Commencing the evening of May 17, bag samples were obtained and shipped to independent laboratories for analysis to ascertain the gases present in the air. Results from the first set of samples were received on May 19 confirming the field tests which indicated that the air was oxygen-depleted and did not contain elevated levels of H<sub>2</sub>S or SO<sub>2</sub> originally rumoured to be the cause. At this time, a Press Release was issued confirming that the incident was isolated to the shed and posed no danger to the public.

Bag sampling was repeated and samples obtained for the Ministry early in the morning (0100 hrs) of May 19 were sent to an independent laboratory in Edmonton for analysis.

Additional sets of samples were obtained on May 19 by the Ministry consultant and on May 21 a second set of TeckCominco samples was taken. Both of these samples were sent to different laboratories in Vancouver.

All bag samples confirmed that the atmosphere was oxygen-depleted and showed no indications of H<sub>2</sub>S or SO<sub>2</sub>. In summary, the results indicate severely depleted oxygen levels ( 0-2%) and elevated levels of Carbon Dioxide ( 7-8 %) and Nitrogen ( 89-91%). These results are indicative of conditions from 0.5 m above floor level to the bottom of

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the sump. Samples obtained 1.5-2 m above floor level were only slightly depleted with oxygen content of 18%.

For the purposes of the preliminary investigation, bag sampling was completed on May 21. The shed was guarded and secured and a fence was put in place by May 31.

Gas analyses are included in Sections 22 and 23 of the attached Teck Cominco Accident Report.

### **Water Sampling**

Water samples were also obtained during the course of the bag sampling in the sump area of the shed. This was conducted in order to determine the level of dissolved oxygen and in consideration of the possibility that oxygen-depleted water could have contributed to the depletion of oxygen in the air.

Results from the water samples also indicate 0.0% dissolved oxygen.

Water sample results are included in Section 3.2 of the Rescan Air and Water Quality Report (Section 9 of the MEMPR report).

### **Thermographic Imaging**

When preliminary results indicated a depletion of oxygen in the air exiting the dump thoughts were directed to the possible processes which could have caused the depletion. The processes would most commonly be oxidation of minerals within the dump or biodegradation of debris covered by or deposited within the dump. The relatively sudden onset of this atmosphere could be indicative of unusual activity such as a fire within the dump and could be located by thermal imagery. Thermographic imaging of the dump was therefore conducted as directed by the Ministry by a hand-held unit provided by Elk Valley Coal Corporation. The results from this unit were inconclusive and therefore a second image was requested. This was completed as an aerial image under the direction of TeckCominco.

Results from Thermographic Imaging were received by the Ministry on June 22. Imaging showed no unusual activity within the dump.

Thermographic Imaging Results are included as Section 10, MEMPR report.

### **Carbon Analysis**

In order to confirm the processes causing the oxygen-depletion, carbon analysis of the carbon dioxide in the air samples was ordered. The analysis of the carbon isotopes contained in the carbon dioxide would determine whether the carbon was derived from oxidation of the minerals within the dump or whether it was organically derived.

Samples of the air obtained through bag samples were provided to Mory M. Ghomshei, the Adjunct Professor of Mining Engineering at the University of British Columbia to

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perform this determination. The samples were analyzed at Hatch Isotope Laboratory in Ottawa.

The preliminary results were received by the Ministry on June 22 and showed that the mechanism of oxidation was chemical.

Carbon Analysis results are included as Section 8 (Sullivan Mine Gas Isotope Tracing), MEMPR report.

### **Coroner's Service**

Coincident with the gas and water testing confirming the cause of the accident, the Ministry worked with the local coroner's service to ascertain whether any preliminary results from the autopsies performed on the victims indicated the presence of toxic gases. The data which could be provided by the Coroner following the autopsies did not indicate the presence of toxic gases, however the Coroner's Office required additional neuropathology and toxicology examinations.

The Ministry received a copy of the autopsy report on July 14 which confirmed that the

The autopsy report is included as Section 12 of the MEMPE report.

### **Additional Technical Information**

As part of the investigation the Ministry requested that TeckCominco supply the following information:

- Site map
- Dump as-built
- Cross-sections of the dump
- Test-hole logs of drill holes located on surface of the dump
- Initial ground contours \*
- French-drain design and as-built\*\*
- Sampling Shed as-built
- Any relevant photographs related to the dump resloping and shed as-built
- Historical data related to past three years of water sample results
- Site map of water-sampling stations
- Site tallying and safety procedures

\* Original ground contours not available.

\*\* Design of French drain and photographs of construction supplied, as built not available.

### **Interviews**

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Interviews were scheduled and conducted beginning the morning of Thursday, May 18 and continued until Monday, May 22.

All Emergency Responders from BC Ambulance Service, Kimberley Fire and Rescue, and TeckCominco as well as \* from Pryzm Environmental and other associated mine personnel were interviewed.

The interviews were conducted by the Ministry accompanied by TeckCominco and BC Ambulance Service investigators. This included a review of the WAV Files provided to the investigating team by the BC Ambulance Service.

Key items determined were:

1. Development of a detailed timeline surrounding the accident. Of particular note are:
  - It was determined within fifteen minutes the time when Mr. Erickson entered the shed and was presumed to have been overcome by the atmosphere within.
  - The length of time which Mr. Erickson unaccounted for before notification was received that he was missing.
  - The circumstances involving the initiation of a search.
  - The time that Mr. Newcombe discovered Mr. Erickson.
  - The time that Mr. Newcombe called 911 and made a second call for assistance.
  - Within a five minute time frame the time that Mr. Newcombe entered the shed and was presumed overcome.
  - Arrival of the first responders from the BC Ambulance Service and of TeckCominco.
  - Approximate time that the responders of BC Ambulance entered the shed and were overcome.
  - Time of the second 911 call from
  - Arrival times of the confined space rescue team from Kimberley Fire/Rescue
  - Times that the victims were extricated.
  - Times that the victims were transported.

The complete timeline is included in this report as Section 2, MEMPR report.

2. The site of the accident had, until May 15, 2006 been accessed regularly and frequently by a variety of individuals without any indication of problems. This had occurred since the shed had been erected and for at least four years. The most recent access to the shed had been noted as one week prior to the accident with no problems encountered.
3. The resloping of the dump had been completed in September of 2005 and had been capped by a 1 m thick layer of till. This till had compacted in the ensuing months and required scarifying prior to an application of seed. The scarification had recently been completed (one week prior to the incident).



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4. Confusion with respect to the nature of the emergency. Specifically:
- The initial report was that there had \_\_\_\_\_ The first calls to both BC Ambulance and to Kimberley Fire/Rescue were specifically directed to \_\_\_\_\_ at the Sullivan Mine Site. The initial 911 call specified the exact location on the mine site but this information was not relayed to responders. This caused some confusion as to which mine access to respond to as well as where the accident site was specifically located. It is noteworthy that in a rural community, the locations provided, although possibly inconsistent with standard community addresses, would most probably be understood by the First Responders residing in those communities.
  - The description of the accident location on the mine site was initially described as a sampling shed but was, at various times, later described as a shaft, tunnel, and mine.
  - After the second 911 call from \_\_\_\_\_ in which he identifies a probable gas-related exposure and in which he speculates that it could be H<sub>2</sub>S, there were several conversations in which the nature of this gas had been confirmed as H<sub>2</sub>S and only the concentration was in doubt. The true nature of the exposure was not determined until well after the accident.
  - Site responders were working under the assumption that they were in an H<sub>2</sub>S environment. The precautions necessary for this environment were not followed. Several individuals were in very close proximity to an unknown but potentially fatal environment. This included:
    - Members of BC Ambulance Service
    - Kimberley Fire/Rescue
    - RCMP
    - TeckCominco First Aid Attendant
- In addition, required decontamination protocol was not followed.

5. Procedural inadequacies or errors.
- Pryzm Environmental did not follow their call-in procedures. This contributed to Mr. Erickson being unaccounted for until Wednesday morning.
  - TeckCominco did not have a formal (sign-in/out) tallying sheet for all workers entering the site and therefore did not comply with Section 3.2.2(1) of the Health, Safety and Reclamation Code for Mines in British Columbia requiring:

*The manager shall implement a system to account for all persons on the mining property.*

This also contributed to Mr. Erickson being unaccounted for until Wednesday morning.
  - TeckCominco did not comply with Section 3.2.3 of the Health, Safety and Reclamation Code for Mines in British Columbia requiring:

*When a worker is working alone and may not be able to secure assistance in the event of an injury or other misfortune, the manager shall ensure that a means*

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*exists for checking the well-being of the worker and that the interval between checks does not exceed 2.5 hours.*

6. It was determined that there was a requirement to review the general training program for BC Ambulance Service and the specific training records for the two BC Ambulance victims. The training which had been provided to the emergency responders was focussed on patient care without adequate attention to hazard assessment.

### DIRECT CAUSE

The accident was caused by the accumulation of oxygen-deprived atmosphere in the shed (and in particular in the sub-level excavation in the shed). This air mixture was transported through a drainage pipe feeding into the shed from the covered ditch surrounding the toe of the dump. This ditch had been designed and constructed to direct water flowing through the dump into a collection system for treatment.

### CONTRIBUTING FACTORS

The atmosphere within the dump was altered through oxidation of the rock within the dump. This process consumes oxygen within the atmosphere and creates carbon dioxide as a by-product. The resultant air mixture is heavier than air and would naturally accumulate lower in the dump. This process will continue as long as either a suitable material is available to be oxidized or available oxygen is depleted. Oxidation is a natural process which is expected in this and other operations.

The reclamation activity which had recently been completed included the construction of a rock drain at the toe of the dump. It was designed to direct water flows from within the dump to a collection pipe, into the sampling shed and connecting ultimately to a downstream treatment facility. The piping systems had been in place for several years. The rock drain which was constructed and filled with coarse rock was very substantial, measuring 2.5 metres deep and 15 metres wide and extended the full perimeter of the dump toe. In 2005, the dump was covered by a layer of glacial till which contained a high level of clay. As a result, the cover was relatively impermeable. The till cover is nominally 1 m thick and extends over the whole surface of the dump, including the rock drain. This till layer had been scarified one week prior to the accident in preparation for seeding.

The mechanism of transport has yet to be conclusively determined. The temperature for several days preceding the event was extremely hot (+ 30<sup>0</sup> C). This temperature coupled with the presumed cold temperatures within the dump may have resulted in the air flowing from the dump out to the rock drain and ultimately through the pipe.

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The shed had been in use for several years and had been accessed safely as recently as one week before the incident. This uneventful history had led to the belief that the site was safe and that no atmospheric degradation would be suspected.

### CONCLUSIONS

1. The accident was caused by the accumulation of oxygen-depleted air within the shed. This atmosphere was unexpectedly mobilized from within the dump, entering the shed through the drainage pipe installed to direct water from the collection ditch to a treatment facility.
2. The lack of any prior indication of a hazard at this sampling shed contributed to Doug Erickson and Bob Newcombe entering the shed without concern for a potentially hazardous environment.
3. Kim Weitzel entered the shed with the understanding that she was responding to  
On her way down the ladder she noticed the second victim. Presence of the second victim raised concern in her mind such that she asked if gas was present. By the time she asked that question it was too late to extricate herself.
4. Lack of basic hazard recognition training and experience contributed to the loss of Shawn Currier. Mr Currier entered the shed to render assistance to his partner immediately after Kim Weitzel was overcome.

### RECOMMENDATIONS

#### Sullivan Mine Site

1. Implement the Directives issued by the Chief Inspector of Mines on May 25, 2006 related to identification of hazards downstream of dump sites. In addition, ensure that workers entering confined space environments downstream of waste dump sites are qualified in air sampling or accompanied by someone qualified in air sampling and that proper samples are taken and a safe atmosphere determined prior to entering these environments.
2. Sullivan Mine Operations shall develop and implement a tallying procedure to include all workers on site which will meet the requirements of Section 3.2.2(1) of the HSRC.
3. Sullivan Mine Operations shall develop and implement a procedure to ensure that a check is made to ensure the wellbeing of workers who may be working alone and that this check is made in accordance with Section 3.2.3 of the HSRC.
4. Develop and implement a monitoring program to determine the mechanism of mobilization of the atmosphere from within the dump out to the shed.

#### Other Mine Sites in BC

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1. All mines in BC shall implement the Directives issued by the Chief Inspector of Mines on May 25, 2006 related to identification of hazards downstream of dump sites.
2. All mine sites in BC, including non-producing mine sites, shall review the access procedures developed for that site and ensure that a tallying procedure is implemented in accordance with Section 3.2.2 (1).
3. Workers on all mine sites shall be subject to a check made in accordance with Section 3.2.3 of the HSRC.
4. Entrances to mine sites in BC shall be signed to include Contact Information to ensure that all persons entering a mine site are under the supervision of a qualified person.
5. When entering into agreements with Emergency Responders from off the mine site, the Manager shall provide information which identifies hazards which may be encountered on the mine site and where the likelihood of encountering these hazards might occur.

### **Emergency Responders (non mine site) i.e. BC Ambulance Service, Fire and Rescue, RCMP, Coroner's Service**

1. All responders to mine sites shall be accompanied by a qualified representative of the mine appointed by the Mine Manager.
2. Emergency responders who may be called upon to assist in an emergency at a mine site shall be:
  - Familiarized with the hazards which may be encountered on the mine site and where these hazards might be encountered.
  - Trained to recognize and safeguard against the hazards identified above.

### **Ministry of Energy, Mines, and Petroleum Resources (THE MINISTRY)**

1. Incorporate the requirements of the Chief Inspector's Directive of May 25, 2006 as regulations within the Health, Safety, and Reclamation Code (HSRC).
2. Modify the Chief Inspector's Directive of May 25, 2006 to include the following:
  - Any opening (culvert or large pipe) with the potential to act as a conduit for transport of a hazardous atmosphere from within a mine waste dump shall be tested to ensure the atmosphere at the mouth of the opening is safe.
3. Modify the requirement of Section 1.3.1 of the HSRC to include site access contact information.
4. Include in the HSRC the requirement to advise emergency responders of the hazards which may be encountered on a mine site and the possible locations of these hazards.
5. Modify the requirement for notification of fatality to the Ministry (Section 1.7.1(1)) to Immediate.
6. Modify Section 37 (3.1(b)) of the Mines Act to increase the time limit for laying an information for an offence from 6 months to 1 year after completion of the Chief Inspectors report or three years from date of occurrence.