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Ambient Monitoring Case Study:

Passive Directional Dustfall Monitoring at an Industrial Mining Complex

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Project Introduction

BACKGROUND

- Regulatory dispersion modelling determined that 3 companies co-located in a shared mining basin not expected to meet 2016 “new” annual nickel air quality standard.
- Notified MECP – applied to develop Mines Technical Standard.
- Working group formed 2013 – reps from the companies (Vale, Glencore, KGHM), MECP, and consultants (Golder & RWDI).
- Tech Std component allows for Monitoring to be used to refine emission rates.

Development of a Passive Directional Dustfall Monitoring (DDM) Program

MONITORING PROGRAM DEVELOPMENT

- Key contributors to modelled nickel exceedance were predicted to be the two on-site entrance roads.

- Working Group agreed to implement ambient monitoring program to refine emission rates for the sources designated to be the key contributors.

- Four monitoring methods were considered:
  - Real-time **continuous** beta attenuation mass monitors (BAMs)
  - Hi-vols, to measure for **24-hour period** every 3 or 6 days
  - Upward facing dustfall monitors collecting **30 day** samples, and
  - Directional dustfall monitors (also **30 day** samples)

COMPARISON OF MONITORING OPTIONS

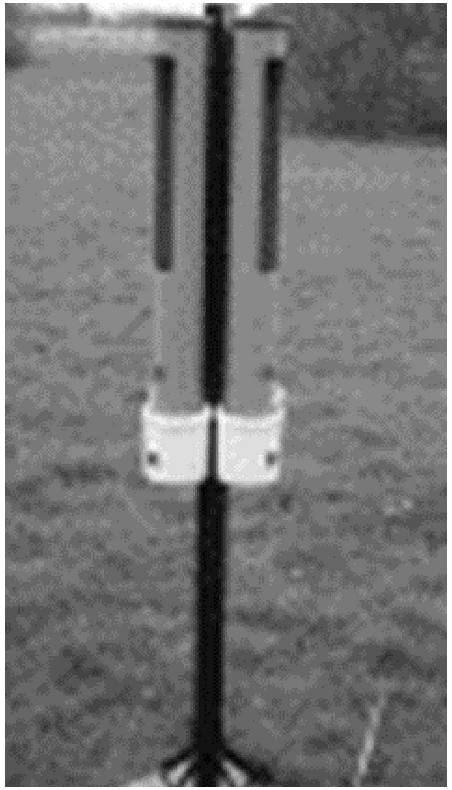
Options	Approx Cost	Continuous/ Discrete samples/ Results Availability	Need Power and Security?	Directionality	Metals ?
1. Continuous particulate monitor (e.g. BAM)	$60,000	Continuous (1 min resolution) **REAL TIME**	Yes	n/a	No
2. Hi-volume air sampler	$10,000	Discrete (24-hr sample every 3 or 6 days) – **1 MONTH DELAY**	Yes	n/a	Yes
3. "Conventional" dustfall jar	$1,000	Continuous (30 days collective) – **1 MONTH DELAY**	No	No, all wind directions over 30 days	Yes
4. Directional dust monitor	$500 - $1000	Continuous (30 days collective) – **1 MONTH DELAY**	No	Yes, 4 main quadrants over 30 days	Yes

SELECTED OPTION

- BAM and hi-vol options eliminated - high cost, power requirements + BAM didn’t measure metals.

- Eliminated upward facing dustfall canister - subject to interferences from natural materials & birds (deterrents installed) - cannot be used for source apportionment.

- **Directional dustfall monitors** chosen for study – minimal interferences, low cost, allows for source apportionment, metals analysis.



DIRECTIONAL DUSTFALL (DDF) MONITORS

- Research revealed numerous *successful* source apportionment studies at **U.K. landfill sites** and **remote Australia and S. Africa mine sites** (1960's to present).

- Not commercially available; built to specs provided in published literature:
  - *Total height 60"*
  - *Cylinders + jars 30" combined ht.*
  - *Oriented in four compass directions*

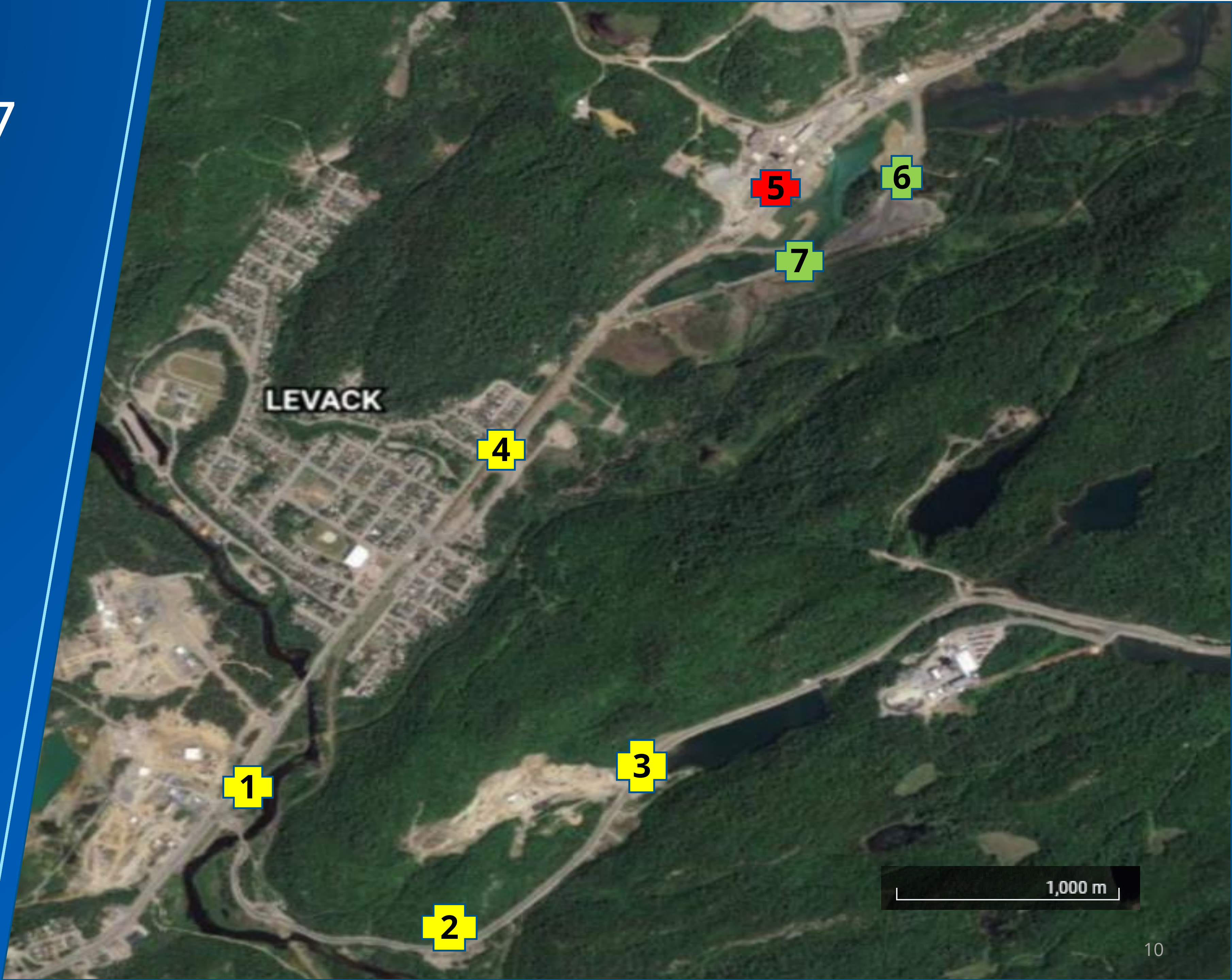
- Samples collected in jars lined with plastic inserts – jars twist on/off bottom of each compartment.

SITE SELECTION AND SET-UP

- Site visit was undertaken (Working Group members).
- Six road-side locations were chosen (7th added later) – roadside because model indicated that roads were key contributors to modelled exceedance.
- Units and jars were available for use from previous studies undertaken by the companies.
- Consideration was given to MECP Operations Manual siting criteria; ensured clear fetch to target source (not able to meet in all directions).

Location of 7 monitoring stations

- Sites 1 & 4 Entrance Roads
- Sites 2, 3 Mine Rds
- Site 5 Crushing Plant
- Site 6 – 7 Rail loadout road/area



DIRECTIONALITY & ANALYSIS

Predominant wind directions determined from MECP approved Glencore on-site met station data; DDF openings set to face NE, NW, SW, SE.

Lab analysis – 30-day samples submitted to an independent lab for total dustfall analysis and ICP-MS metals analysis of As, Cd, Cr, Co, Cu, Pb, Mn, Mg, Ni and Se.

Dust in the jars was “in-solution” (rainwater) – lab required to dry sample first before analysis.

THE MONITORS ON-SITE

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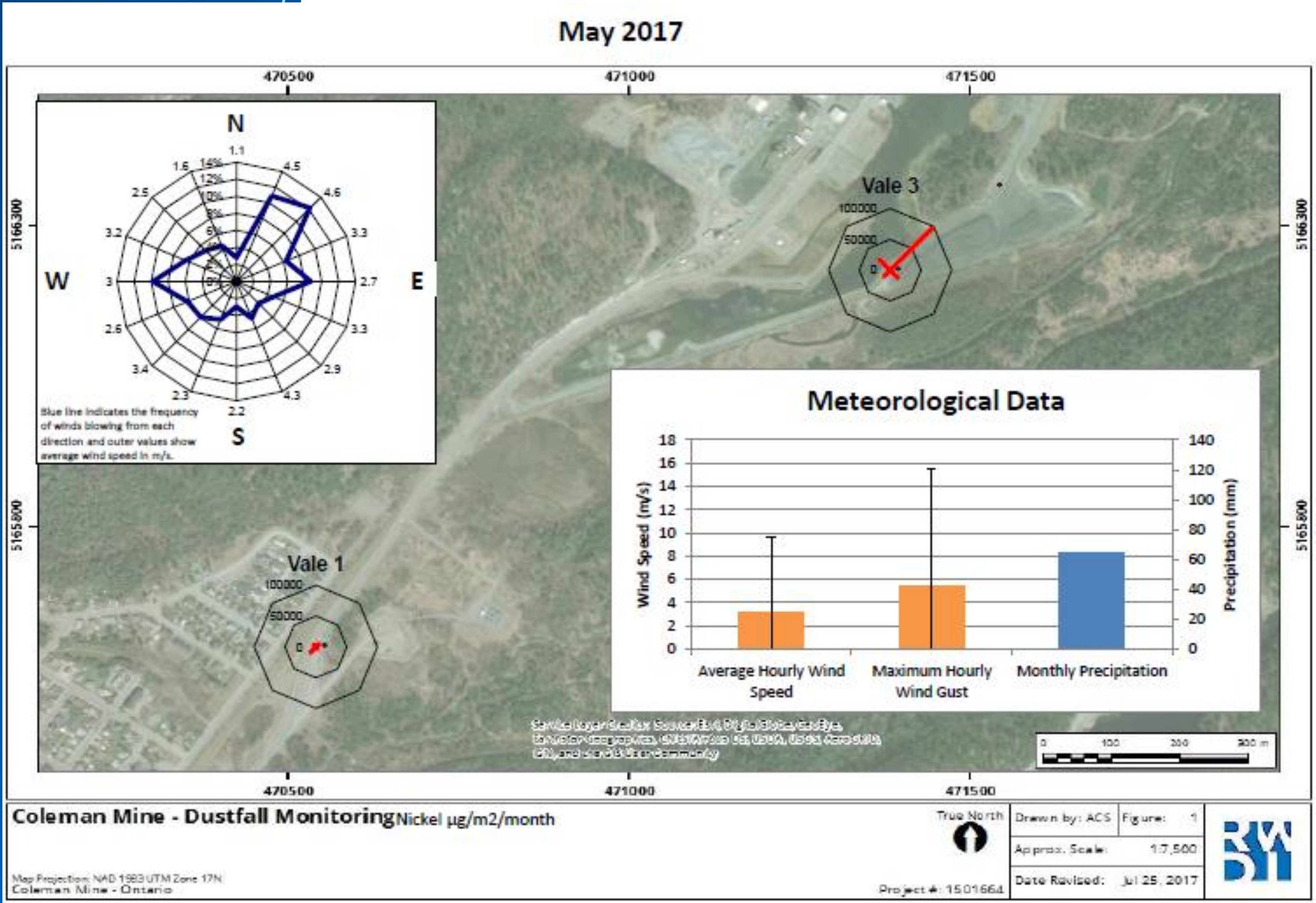
Rail load-out sampling location 6

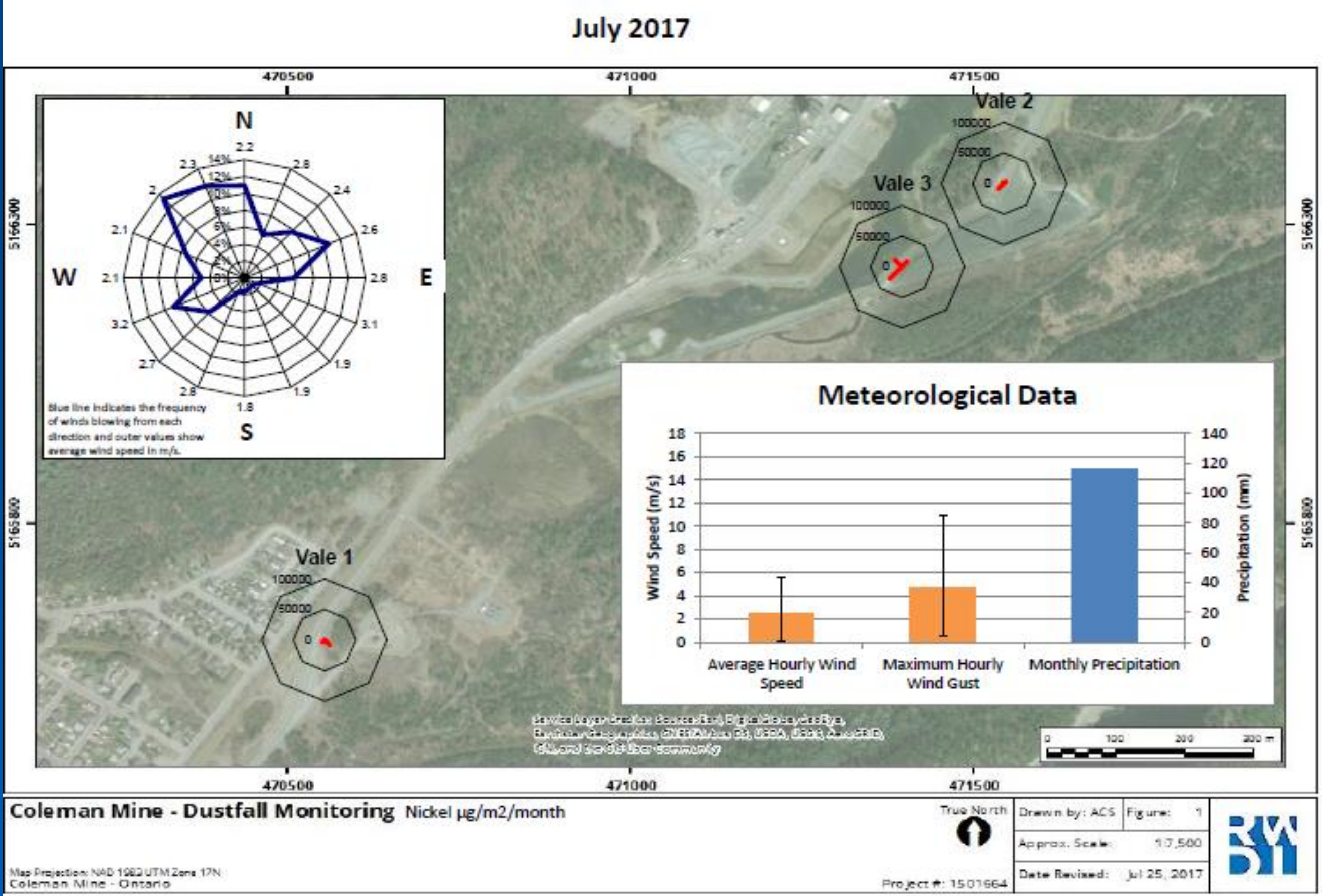
Rail load-out sampling location 7 beside train

Results and Conclusions

Results - Nickel May 2017



Results -Nickel July 2017



FINDINGS & ACTIONS

Findings	Actions
Unexpected: Haul road to rail loadout yard found to be **significant** source of nickel (measured in May)	Re-evaluated DMP – added controls – much lower contribution in subsequent months
Unexpected: Outdoor crushing operation also **significant** source of nickel.	Re-evaluated DMP – added controls – much lower contribution in subsequent months
Verified: Front roads were **not significant** sources of nickel.	Adjusted emission rates - increased % controls assumed for modelling

CONCLUSIONS

- For this study, **directional dustfall monitors = best choice** to verify key sources of fugitive dust, nickel and other metals.
- Semi-quantitative assessment provided **verification of key contributors**
- **Adjustments and updates** to each Company's DMP and to the emission rates for sources to be modelled at the site.
- **Monitoring program = small cost and effort, large gain (refinement/ insight)**.

Thank-you

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