

**Appendix 27.
Fountain Head Evaporator
Emissions Study**

Technical Memorandum

To: Craig Wilson | Project Mining & Infrastructure Manager

From: Sean Edwards | Engineering Lead

Subject: **Fountain Head Evaporator Emissions Study**

I. Introduction

Minetek has been engaged to perform a particulate emissions study on a proposed evaporation system to be installed at the PNX Metals Fountain Head Gold Mine, NT. The particulate emission of interest is Arsenic PM10 and PM2.5 and is to be compared to the relevant standards.

The proposed system consists of 3 x Minetek 600/300 evaporators, a 112.5L/s pump and MCC with automation, including flow/pressure/weather monitoring, to manage and log the system parameters. The system has been proposed to be installed at the Fountain Head Pit Lake for Phase 1 and then to be moved to the evaporation dam for Phase 2 a set time after.

In addition to the particulate emission study the system setup parameters will be investigated to suggest parameters to improve the runtime and evaporation efficiency.

II. Minetek Evaporation Rate, Spray Drift & Particulate Emissions Model – T-Mine

The primary purpose of employing this method is to assess and estimate airborne particulate matter as a result of mechanically enhanced evaporation. Minetek invested many months of research and laboratory testing in 2016 to develop an internal program to estimate airborne particulate emissions with consultation with the University of Queensland who developed the USA AgDRIFT model. The modelling tool became available to Minetek for use in 2017 and is proprietary to Minetek and is not commercially available.

This modelling technique calculates the expected individual droplet volume loss, for each droplet size, at 0.1 second intervals across the full theoretical trajectory. The calculation has multiple inputs of which more accurate data entry results in a higher level of confidence in the model results. As a result of the model design it calculates evaporation rates in line with the particulate assessment.

The basis of this method is that the evaporation rate can be described as a droplet diameter change proportional to time.

Whilst the program is very large and requires multiple runs to complete a full data set, in short T-Mine performs the following steps to derive expected evaporation efficiency, spray drift and particulate emissions:

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- 1) Data Entry – The following inputs are required as a minimum
 - a. Ambient temperature (dry bulb) and relative humidity are input to calculate the wet bulb temperature. This is the theoretical limit lowest temperature achieved by adiabatic evaporation of water in the air, until the air is saturated.
 - b. Windspeed
 - c. Release height
 - d. Solids concentration
 - e. Water density
 - f. Air density
 - g. Evaporator details regarding nozzle type, # of nozzles and system water pressure.

- 2) T-Mine then generates a Gaussian distribution of droplet sizes to evaluate the expected output from the evaporator (droplet diameter vs. frequency of occurrence).

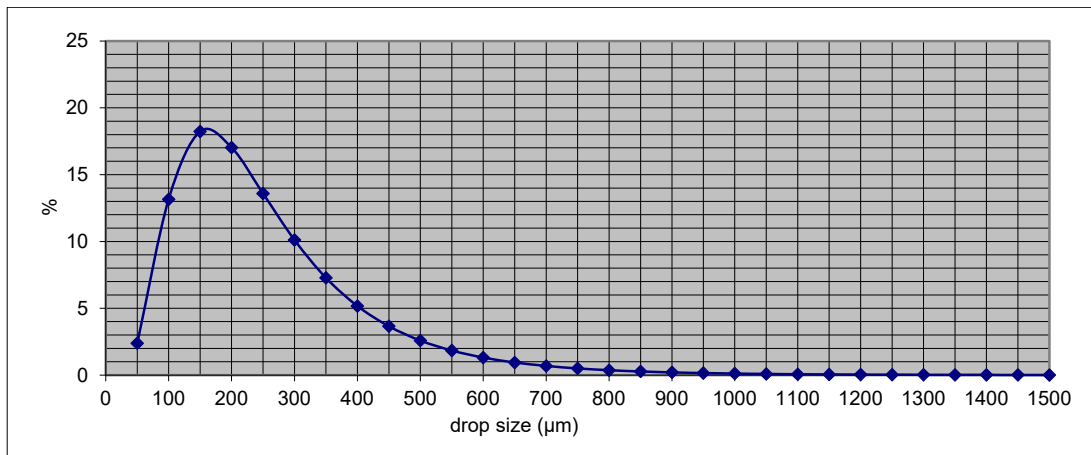


Figure 1 - Distribution showing droplet frequency by size

- 3) The program then employs the GDS (Gaussian Diffusion and Sedimentation) model developed with the University of Queensland and looks at the time in flight for each size particle within the overall evaporator spray plume. The model calculates the projectile trajectory through the parabolic function with standard fluid factors considered such as drag.

These inputs are used to then run the model to calculate the change in water droplet size ($\mu\text{m/s}$) and initial vector conditions of the droplets.

- 4) The expected horizontal distance travelled by each droplet size is then calculated and final droplet size (using the evaporation rate in step 2 and referenced formula), with end conditions being set at either impact with pond/ground or evaporation of all liquid which will result in drift of solids.

- 5) The cumulative final droplet volumes are then compared against the initial volumes, making allowance for dissolved particles, to calculate overall efficiency and spray drift distance per droplet size.
- 6) All droplets smaller than the VMDcrit (Smallest droplet size that will hit the ground) result in particulate emissions and the volume is calculated to determine the solute production rate.
- 7) The cumulative density of droplets containing the PM of interest is then determined to calculate the PM of interest solute production rate
- 8) The concentration of the PM of interest at a set distance (x,y,z) from the source is then calculated using the gaussian dispersion model and compared to the standard to verify compliance,

III. Evaporation System Parameters

1. Weather Data

The weather data used for the purpose of this analysis is hourly temperature, humidity, wind speed and wind direction data for the period 2015 – 2019 and has been obtained from the Australian Government, Bureau of Meteorology (BoM) station 14901, Douglas River Research Farm. See appendix C.

The data has been assessed to determine the following:

- Best location and orientation of the evaporators to optimise the runtime and yearly volume evaporated
- Optimal evaporation efficiency
- Maximum allowable windspeed

Once these parameters are confirmed, the year average and peak Arsenic emissions can be calculated and compared to the relevant standards.

For this study, the minimum and maximum temperature and humidity is 0/45°C and 0/95% respectively due to equipment operating limitations and precipitation.

2. Wind Speed Considerations

Two maximum windspeeds has been considered, one ensuring containment of the unevaporated droplets to the pond, and the other ensuring containment within a 500m radius.

Being smaller in size, the Fountain Head Pit Lake and the phase 1 location has been selected for calculating the maximum allowable wind speed to ensure containment. The lake has an odd shape but 320m has been used as the average distance to the opposite shore from where the evaporators are proposed to be installed. See figure 2 for the proposed phase 1 installation location.



Figure 2 – Propose evaporator installation location (Image courtesy Craig Wilson – PNx Metals)

Using the T-Mine model to track the trajectory of each droplet size, the ultimate destination of each droplet size has been determined based on a worst-case temperature/humidity combination and the maximum allowable windspeed calculated. See figure 3 for a typical instantaneous view of the travel distance per droplet size. Note that droplets that do not reach 0m (hit the ground) are droplets that evaporate to dryness and thus result in particulate emissions.

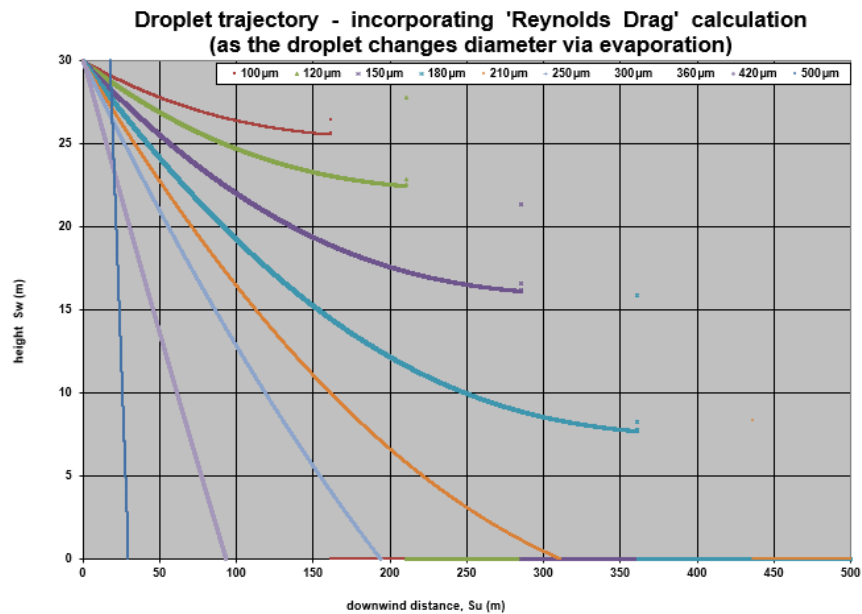


Figure 3 – Typical Droplet Trajectory

Employing this methodology, the maximum allowable windspeeds for the system while ensuring containment of the non-evaporated droplets within the 320m and 500m radii has been calculated as 6m/s and 7.6m/s respectively.

Using 7.6m/s over 6m/s results in an increase in evaporator runtime of 4% over a year of operation.

3. Wind Direction Considerations

By scrutinising the weather data, it has been found that the predominant wind direction changes based on the season and will greatly affect the evaporator runtime and thus the amount of water evaporated.

In this report the “dry season” is defined as April to August (5 months) and the “wet season” as September to March (7 months) due to the change in predominant wind direction as seen in figures 4 - 6. Note: For all weather data considered, wind speeds in excess of the maximum allowable wind speed has been disregarded as the evaporators will not be running.

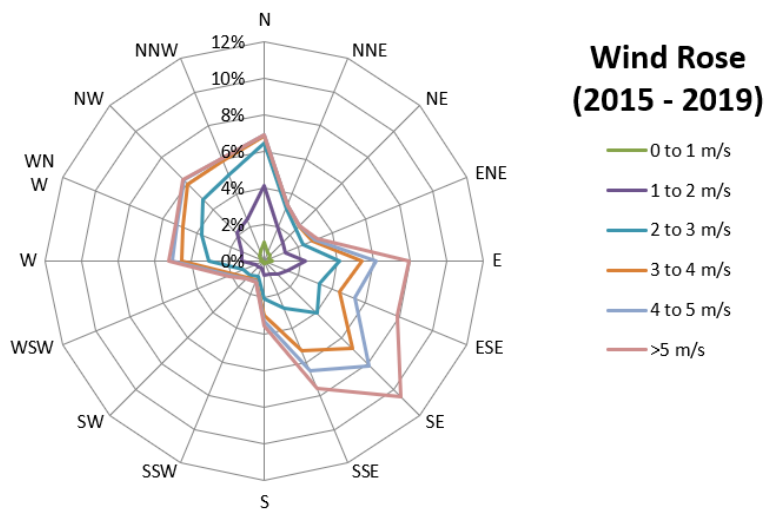


Figure 4 - All Year Wind Rose (Derived from 2015-2019 weather data received from the BoM)

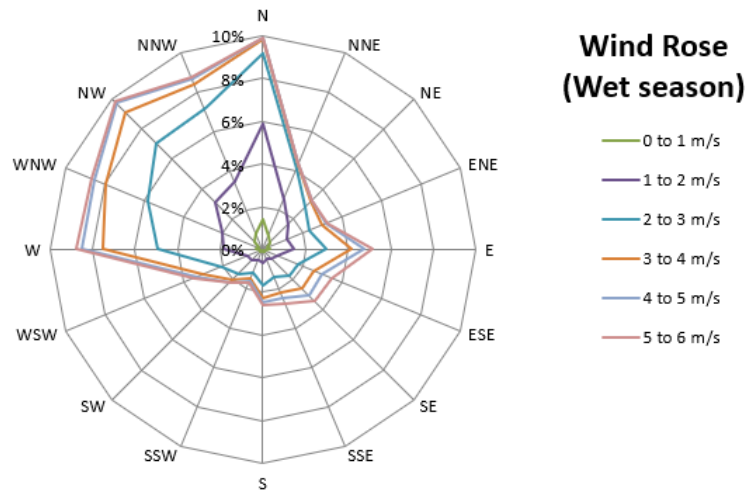


Figure 5 - Wet Season Wind Rose

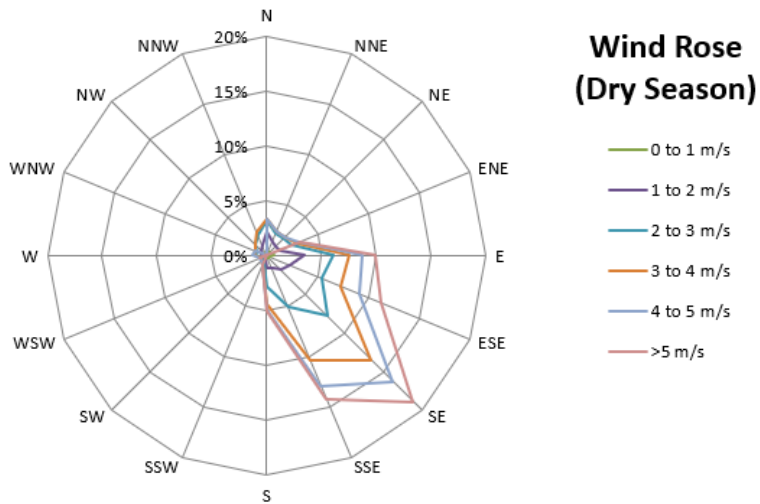


Figure 6 - Dry Season Wind Rose

Based on these findings, Minetek would propose installation of the evaporators on the North Westerly bank of the lake in the wet season, and on the South Easterly bank in the dry season, as indicated on figure 7.



Figure 7 - Proposed Phase 1 Dry/Wet season Installation Positions

Should spray drift need to be contained to the pond area, wind direction limitations can be set. The philosophy Minetek employs is a defined allowable spray arc which limits spray within two bounds as depicted in Figure 8. For the scenario where the evaporators are located North West, the limits would be defined as 50deg to 220deg and for South East 230deg to 40deg with North being 0deg.

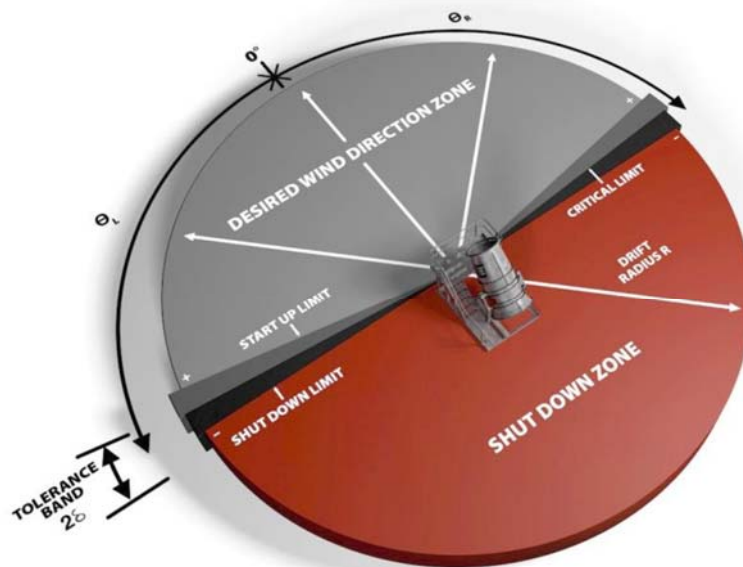


Figure 8 - Evaporator allowable spray arc

4. Operating Scenario Comparison

T-mine modelling has been performed for different scenarios based on the installation locations, maximum windspeed and wind direction limitations defined. See table 1 for a summary of the results and refer to Appendix A for monthly reports for each of the scenarios.

#	Operating location	Windspeed Limit (m/s)	Spray direction limit (°)	Evaporator Runtime (%)	Evaporator Efficiency (%)	Volume Evaporated per year (ML)
1	NW	-	-	90	39.5	1271.4
2	NW	6	-	85	39.5	1200.3
3	NW	6	50-220	47	34.6	586.9
4	SE	6	230-40	50	39	720.4
5	NW in wet season & SE in dry season	6	50-220 – NW 230-40 – SE	65	38.4	891.3
6	NW in wet season & SE in dry season	7.6	-	89	39.9	1273.4

Table 1 - Operating scenario comparison

Note: Volume evaporated per year is only the added benefit of mechanically enhanced evaporation and excludes pan evaporation.

Scenario #6 has been selected for the emissions study as it will result in the highest amount of emissions, while maintaining successful containment of non-evaporated water droplets within a 500m radius of the setup location. Operation is regardless of wind direction and measures will need to be taken to limit recirculation of droplets through the fan.

Droplets smaller than 210µm will evaporate to dryness and the percentage of droplets in comparison to the total volume is 27.7%. This is the percentage of droplets that have the potential to become emissions and more specifically, emissions of arsenic. For the simplicity of this report it is assumed that all the arsenic contained in the droplets evaporated to dryness will result in emissions regardless of the species thereof or whether it is part of an organic compound. This is seen as the worst-case scenario as in reality some of the compounds will drop to the ground and not result in drift.

IV. Particulate Emissions

Particulate emissions are caused by the drift of droplets that evaporate to dryness. In this study the drift of PM10 and PM2.5 of Arsenic is investigated. The total particulate emission is calculated from the percentage of droplets that evaporate to dryness of which all is assumed to result in drift off site.

With the evaporation runtime, efficiency and weather limitations defined, the Arsenic particulate emissions can be determined and compared to the standard limits.

1. Emission Standards and Receptors

The standards and limits that are compared to are set out in table 2.

Averaging Period	Limit ($\mu\text{g}/\text{m}^3$)	Source
1h, 99.9 th Percentile	0.09	New South Wales Approved Methods
1 Year	0.006	Queensland Air EPA
1 Year	0.003	Victoria Protocol for Environmental Management, Mining and Extractive Industries
8h, TWA	50	Safe Work Australia

Table 2 - Arsenic Emission Standard Limits

The limits are defined as measured at the sensitive receptors of which three have been identified:

- R1, Grove Hill Historic Hotel
- R2, Hayes Creek Caravan Park
- R3, Rural Residence

Only the concentration at the Grove Hill Historic Hotel Receptor, R1, will be considered for this analysis as it is the closest (>6000m) to the evaporator installation location and is in line with the dominant wind direction in the wet season and will thus be the worst case scenario. Figure 9 identifies the sensitive receptor locations and distance, as the crow flies, from the evaporator installation location to R1.

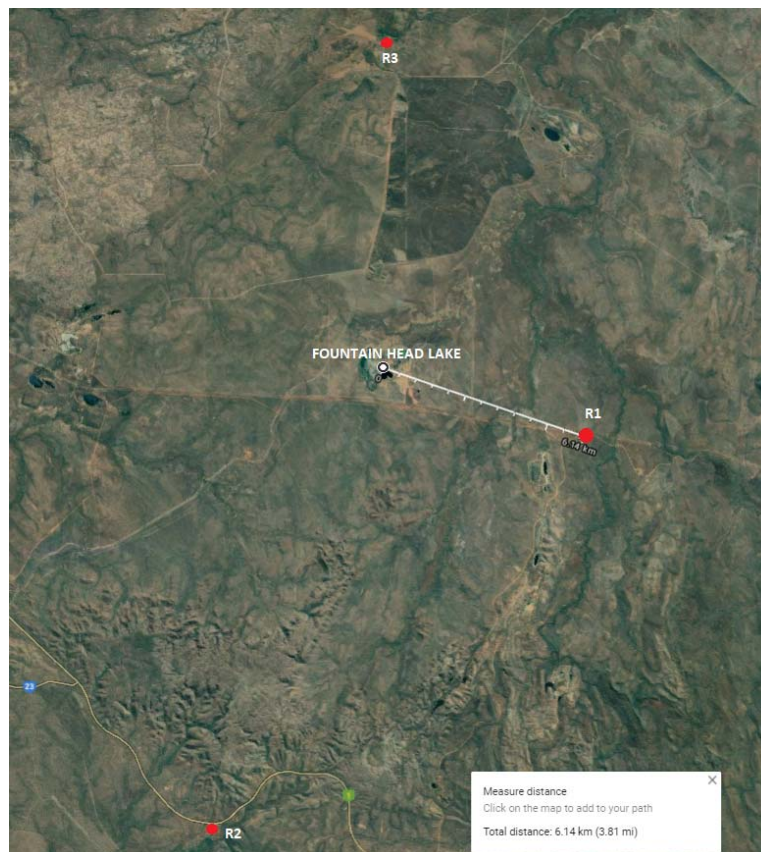


Figure 9 – Sensitive Receptor Locations

2. Analysis Parameters

Droplets evaporated to dryness are considered as particulate matter (PM) for the drift analysis and analysed using the gaussian dispersion model. The model disregards the following:

- Variable wind speed along travel path
- Complex terrain
- Spatial and temporal changes in meteorological conditions
- Deposition within plume travel time (Non-sedimenting)

For the 99.9th percentile of Arsenic analysis, the following parameters have been set to determine the solute production rate:

- Maximum windspeed used as average along travel route
- Highest evaporation rate (resulting in the highest amount of PM produced)
- Plume release height set to the peak of the evaporator spray trajectory
- 100% Evaporator Runtime
- Arsenic concentration of 784µg/L (99.9th percentile)

For the year averaged results the parameters obtained in scenario #6 and an Arsenic concentration of 526µg/L have been used.

3. Results

The particulate emissions have been determined using the T-mine model and compared to the different standard limits. Results are summarised in table 3 and calculations can be found in appendix B.

Arsenic PM Considered	Concentration (µg/m ³) @ R1	Compliance Limit (µg/m ³)	Compliant?
99.9th percentile water Arsenic content (784µg/L)			
PM10	0.00264	0.09 / 50	Yes
PM2.5	0.00025		Yes
Annual average Arsenic content (526µg/L)			
PM10	0.001352	0.006 / 0.003	Yes
PM2.5	0.000129		Yes

Table 3 - Particulate Emission Summary

The Arsenic concentration at R1, and thus R2 & R3, will comply to the relevant standards should the system be installed.

V. Summary

Using the T-Mine model it can be demonstrated that the arsenic emissions produced by the proposed Minetek Evaporation System can comply with the limits set out by the relevant standards as measured at the sensitive receptors. This can be achieved while running the system 24h per day and 12 months per year without excessive limits on the operation.

APPENDIX A – Evaporation Efficiency/Runtime Reports



Scenario # 1

Site/Location: PNX Metals: Fountain Head, -13.460085, 131.505553
 Project Scope: PM2.5 & PM10 Study

Weather Data Source: http://www.bom.gov.au/climate/averages/tables/cw_014901_All.shtm
 Weather Data Location: Douglas River Research Farm

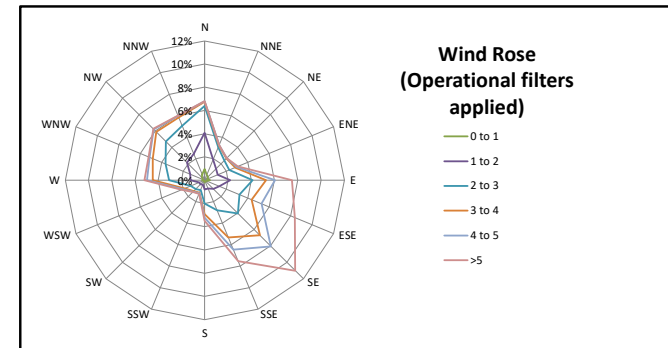
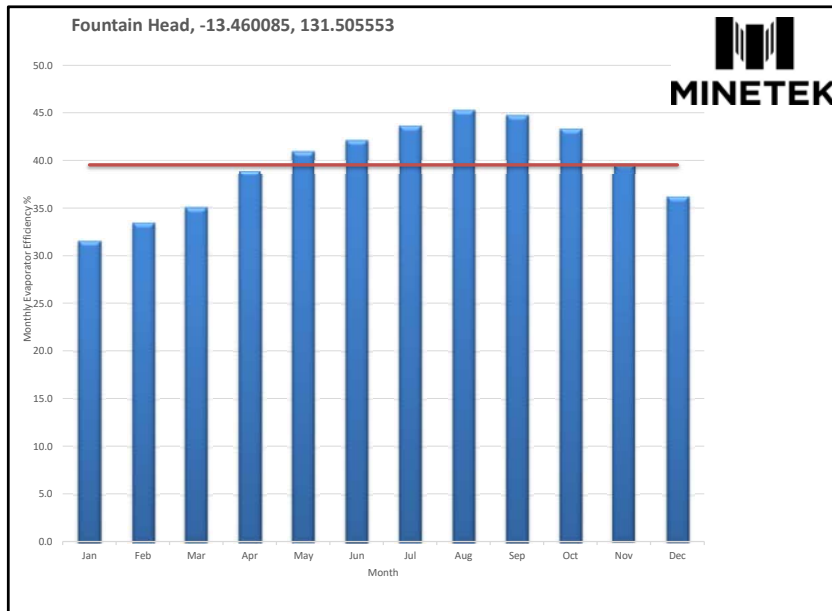
Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Relative Humidity (%):	79.6	77.2	74.7	66.0	58.2	55.0	51.6	48.3	53.2	59.7	67.5	73.5
Average Temperature (°C):	28.5	28.8	29.0	27.4	25.0	23.0	22.7	24.0	27.6	29.7	29.7	29.3
Average Wind Speed (m/s):	2.1	2.0	1.9	2.1	2.8	3.1	2.8	2.5	2.2	2.2	1.9	1.9

Efficiency Estimate (%):	31.5	33.4	35.0	39.0	40.9	42.1	43.5	45.3	44.8	43.3	39.6	36.1
Estimated Run Time (%):	77%	80%	80%	92%	96%	96%	97%	94%	89%	99%	92%	88%
Estimated Run Time (h/d avg):	18.5	19.2	19.2	22.0	23.1	23.1	23.2	22.6	21.2	23.7	22.1	21.0
Water Volume Evaporated (ML):	73.2	72.5	84.5	104.1	118.3	118.1	126.8	128.4	115.3	128.7	106.0	95.4

Average Evaporation Efficiency per Evaporator Unit (%): 39.5
 Average Evaporation Run Time (%): 90%

Yearly Water Volume Evaporated (ML): 1271.4
 Average Run Time (h/d): 21.6

Comments: Evaporation efficiency is estimated to be between 31.5% (Jan) and 45.3% (Aug) with an annual average of 39.5%.
 The study includes the months January to December, operating from 12:00 AM to 11:59 PM
 The study includes operation from 0 degrees to 359 degrees wind direction.
 Temperature and Humidity limitations are 0-45°C and 0-95% respectively.





Scenario # 2

Site/Location: PNX Metals: Fountain Head, -13.460085, 131.505553
 Project Scope: PM2.5 & PM10 Study

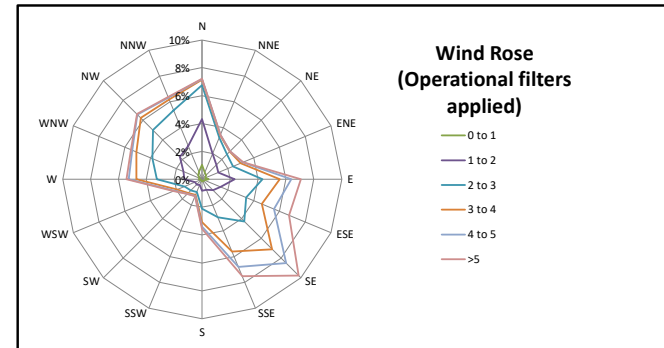
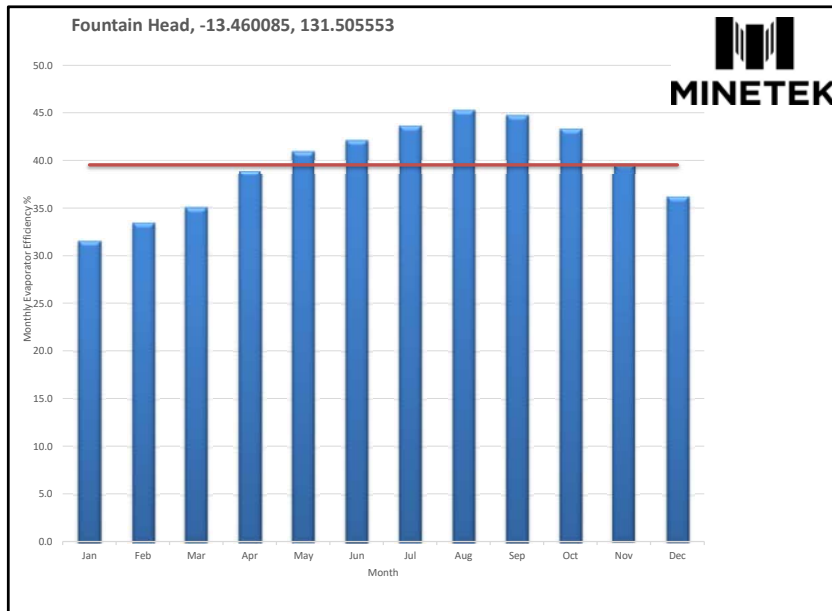
Weather Data Source: http://www.bom.gov.au/climate/averages/tables/cw_014901_All.shtml
 Weather Data Location: Douglas River Research Farm

Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Relative Humidity (%):	79.6	77.1	75.1	67.7	62.0	57.9	54.3	50.8	55.4	60.6	67.6	73.5
Average Temperature (°C):	28.5	28.8	29.0	27.2	24.3	22.2	22.1	23.5	27.2	29.5	29.7	29.3
Average Wind Speed (m/s):	2.1	1.9	1.8	1.9	2.2	2.5	2.3	2.1	2.0	2.0	1.8	1.8

Efficiency Estimate (%):	31.5	33.4	35.0	39.0	40.9	42.1	43.5	45.3	44.8	43.3	39.6	36.1
Estimated Run Time (%):	76%	79%	78%	87%	85%	85%	87%	87%	84%	96%	91%	87%
Estimated Run Time (h/d avg):	18.3	19.0	18.8	20.9	20.5	20.4	20.9	20.9	20.1	22.9	21.8	20.9
Water Volume Evaporated (ML):	72.4	71.8	82.6	98.5	105.0	104.1	114.1	118.6	109.4	124.4	104.8	94.6

Average Evaporation Efficiency per Evaporator Unit (%): 39.5
 Average Evaporation Run Time (%): 85%
 Yearly Water Volume Evaporated (ML): 1200.3
 Average Run Time (h/d): 20.4

Comments: Evaporation efficiency is estimated to be between 31.5% (Jan) and 45.3% (Aug) with an annual average of 39.5%.
 The study includes the months January to December, operating from 12:00 AM to 11:59 PM
 The study includes operation from 0 degrees to 359 degrees wind direction.
 Temperature and Humidity limitations are 0-45°C and 0-95% respectively.
 Maximum allowable windspeed is 6m/s





Scenario # 3

Site/Location: PNX Metals: Fountain Head, -13.460085, 131.505553
 Project Scope: PM2.5 & PM10 Study

Weather Data Source: http://www.bom.gov.au/climate/averages/tables/cw_014901_All.shtml
 Weather Data Location: Douglas River Research Farm

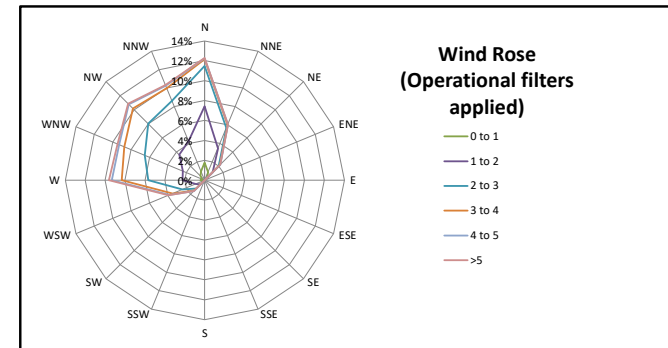
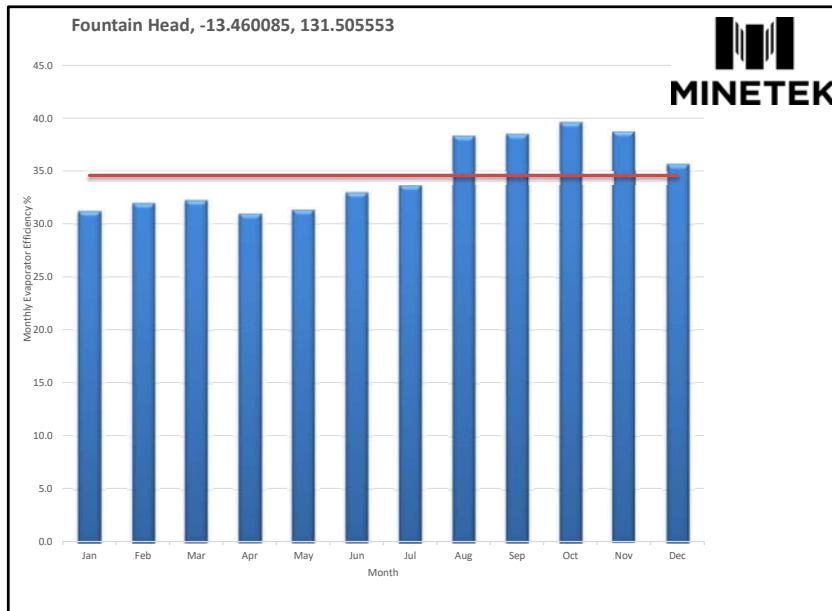
Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Relative Humidity (%):	79.6	78.6	78.1	79.1	77.7	74.2	72.5	65.5	67.2	66.4	68.6	73.7
Average Temperature (°C):	28.5	28.5	28.5	25.7	23.0	20.6	19.3	22.2	25.8	28.5	29.5	29.3
Average Wind Speed (m/s):	2.0	1.8	1.5	0.7	0.5	0.6	0.6	1.0	1.3	1.6	1.7	1.7

Efficiency Estimate (%):	31.2	31.9	32.2	30.9	31.3	32.9	33.6	38.3	38.5	39.6	38.7	35.7
Estimated Run Time (%):	61%	61%	51%	36%	25%	18%	25%	38%	50%	66%	68%	67%
Estimated Run Time (h/d avg):	14.6	14.7	12.2	8.7	5.9	4.4	6.1	9.1	12.1	15.9	16.3	16.2
Water Volume Evaporated (ML):	57.2	53.1	49.4	32.7	23.3	17.4	25.7	43.9	56.3	79.1	76.7	72.2

Average Evaporation Efficiency per Evaporator Unit (%): 34.6
 Average Evaporation Run Time (%): 47%

Yearly Water Volume Evaporated (ML): 586.9
 Average Run Time (h/d): 11.4

Comments: Evaporation efficiency is estimated to be between 30.9% (Apr) and 39.6% (Oct) with an annual average of 34.6%.
 The study includes the months January to December, operating from 12:00 AM to 11:59 PM
 The study includes operation from 50 degrees to 220 degrees wind direction.
 Temperature and Humidity limitations are 0-45°C and 0-95% respectively.
 The maximum allowed windspeed is 6m/s





Scenario # 4

Site/Location: PNX Metals: Fountain Head, -13.460085, 131.505553
 Project Scope: PM2.5 & PM10 Study

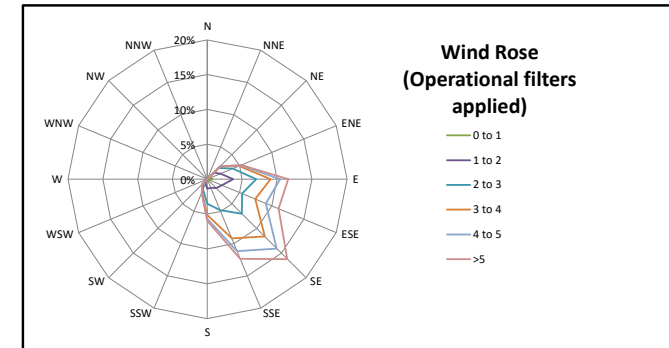
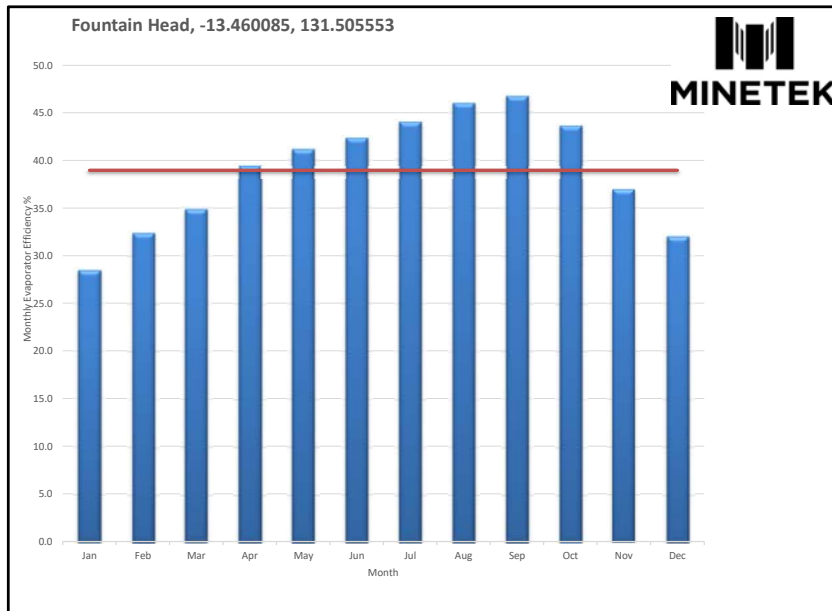
Weather Data Source: http://www.bom.gov.au/climate/averages/tables/cw_014901_All.shtml
 Weather Data Location: Douglas River Research Farm

Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Relative Humidity (%):	82.8	77.9	74.6	66.1	60.8	56.9	52.5	47.8	49.9	58.9	71.5	78.4
Average Temperature (°C):	27.6	28.3	28.7	27.1	24.1	22.1	22.1	23.0	27.1	29.3	28.7	28.1
Average Wind Speed (m/s):	1.3	1.3	1.7	2.0	2.3	2.6	2.4	2.1	1.9	1.7	1.4	1.1

Efficiency Estimate (%):	28.4	32.4	34.8	39.4	41.1	42.3	44.0	46.0	46.7	43.7	36.9	32.0
Estimated Run Time (%):	22%	27%	39%	68%	73%	75%	75%	63%	48%	43%	34%	32%
Estimated Run Time (h/d avg):	5.4	6.6	9.3	16.4	17.5	18.0	17.9	15.2	11.5	10.4	8.3	7.6
Water Volume Evaporated (ML):	19.2	24.0	40.4	78.3	90.4	92.2	98.9	87.4	65.1	57.0	37.0	30.4

Average Evaporation Efficiency per Evaporator Unit (%): 39.0
 Average Evaporation Run Time (%): 50%
 Yearly Water Volume Evaporated (ML): 720.4
 Average Run Time (h/d): 12.0

Comments: Evaporation efficiency is estimated to be between 28.4% (Jan) and 46.7% (Sep) with an annual average of 39%.
 The study includes the months January to December, operating from 12:00 AM to 11:59 PM
 The study includes operation from 230 degrees to 40 degrees wind direction.
 Temperature and Humidity limitations are 0-45°C and 0-95% respectively.
 The maximum allowed windspeed is 6m/s





Scenario # 5

Site/Location: PNX Metals: Fountain Head, -13.460085, 131.505553
 Project Scope: PM2.5 & PM10 Study

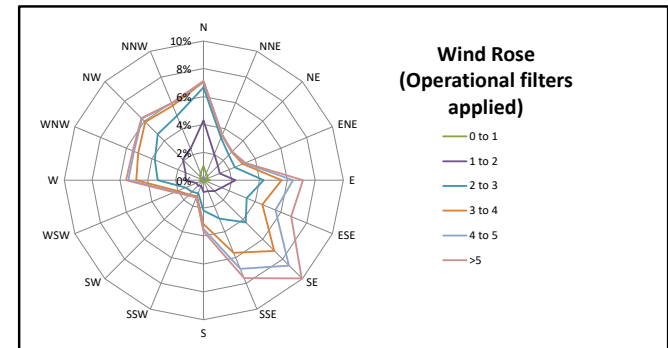
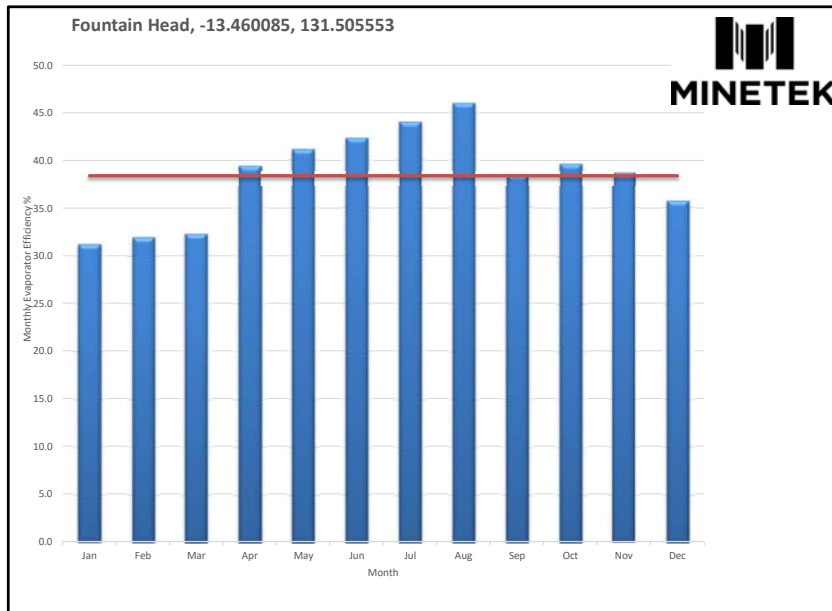
Weather Data Source: http://www.bom.gov.au/climate/averages/tables/cw_014901_All.shtml
 Weather Data Location: Douglas River Research Farm

Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Relative Humidity (%):	79.1	76.6	74.5	67.1	61.5	57.5	53.9	50.4	54.9	60.1	67.1	73.0
Average Temperature (°C):	28.6	28.9	29.1	27.3	24.4	22.3	22.2	23.6	27.4	29.6	29.8	29.4
Average Wind Speed (m/s):	2.1	1.9	1.9	1.9	2.3	2.6	2.3	2.1	2.0	2.0	1.9	1.8

Efficiency Estimate (%):	31.2	31.9	32.2	39.4	41.1	42.3	44.0	46.0	38.5	39.6	38.7	35.7
Estimated Run Time (%):	61%	61%	51%	68%	73%	75%	75%	63%	50%	66%	68%	67%
Estimated Run Time (h/d avg):	14.6	14.7	12.2	16.4	17.5	18.0	17.9	15.2	12.1	15.9	16.3	16.2
Water Volume Evaporated (ML):	57.2	53.1	49.4	78.3	90.4	92.2	98.9	87.4	56.3	79.1	76.7	72.2

Average Evaporation Efficiency per Evaporator Unit (%): 38.4
 Average Evaporation Run Time (%): 65%
 Yearly Water Volume Evaporated (ML): 891.3
 Average Run Time (h/d): 15.6

Comments: Evaporation efficiency is estimated to be between 31.2% (Jan) and 46% (Aug) with an annual average of 38.4%.
 The study includes the months January to December, operating 24h/d
 This study includes operation of the system from the NW in the wet season, and SE in the dry season
 Temperature and Humidity limitations are 0-45°C and 0-95% respectively.
 The maximum allowed windspeed is 6m/s





Scenario # 6

Site/Location: PNX Metals: Fountain Head, -13.460085, 131.505553
 Project Scope: PM2.5 & PM10 Study

Weather Data Source: http://www.bom.gov.au/climate/averages/tables/cw_014901_All.shtm
 Weather Data Location: Douglas River Research Farm

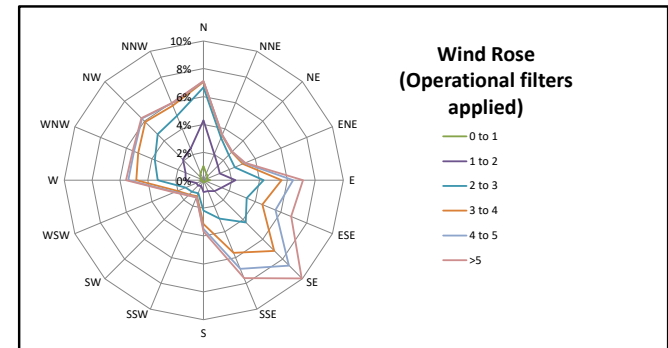
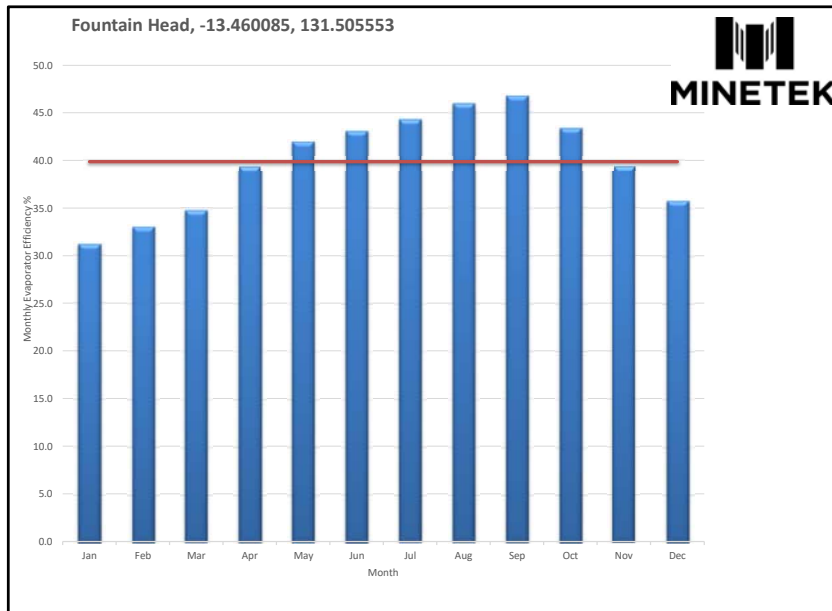
Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Relative Humidity (%):	79.1	76.6	74.5	67.1	61.5	57.5	53.9	50.4	54.9	60.1	67.1	73.0
Average Temperature (°C):	28.6	28.9	29.1	27.3	24.4	22.3	22.2	23.6	27.4	29.6	29.8	29.4
Average Wind Speed (m/s):	2.1	1.9	1.9	1.9	2.3	2.6	2.3	2.1	2.0	2.0	1.9	1.8

Efficiency Estimate (%):	31.1	33.0	34.7	39.3	42.0	43.1	44.3	46.0	46.7	43.3	39.4	35.8
Estimated Run Time (%):	77%	80%	79%	91%	92%	93%	94%	93%	94%	98%	92%	87%
Estimated Run Time (h/d avg):	18.5	19.2	19.0	21.8	22.1	22.3	22.6	22.3	22.6	23.5	22.1	20.9
Water Volume Evaporated (ML):	72.2	71.5	83.1	103.8	116.3	117.2	125.7	129.1	127.3	128.0	105.3	94.1

Average Evaporation Efficiency per Evaporator Unit (%): 39.9
 Average Evaporation Run Time (%): 89%

Yearly Water Volume Evaporated (ML): 1273.4
 Average Run Time (h/d): 21.4

Comments: Evaporation efficiency is estimated to be between 31.1% (Jan) and 46.7% (Sep) with an annual average of 39.9%.
 The study includes the months January to December, operating 24h/d
 This study includes operation of the system from the NW in the wet season and SE in the dry season, operating regardless of wind direction.
 Temperature and Humidity limitations are 0-45°C and 0-95% respectively.
 The maximum allowed windspeed is 7.6m/s



APPENDIX B – Particulate Emission Reports



Site/Location: PNX Metals: Fountain Head, -13.460085, 131.505553
 Scope: 99.9th Percentile Arsenic Emissions

Weather Data Source: http://www.bom.gov.au/climate/averages/tables/cw_014901_All.shtml
 Weather Data Location: Douglas River Research Farm

PM (µm)	Droplet (µm)	Cd	E1 (kg/yr)	E2 (kg/yr)
2.5	39.95	2.19	28.427	2.843
10	159.81	23.05	299.063	29.906
25	399.53	73.70	956.306	95.631

Droplet size that reached the ground (VMDcrit) = 210µm

Operational Parameters & Limits		Notes	
Evaporator Type		600/300	
No of Units	ul	3	
Volume flowrate per evaporator	Q L/s	37.4	Minetek Evaporator model volume flow rate
Effective amount evaporated	η	46.7%	Peak Minetek Evaporator Efficiency
Evaporator "Runtime"		100%	Runtime Considered For TWA
Months of Operation per Year	mo/yr	12	Operating months
Hours of Operation per Day	hr/d	24	Operating hours
Allowable spray direction: Start-End	°	(Variable)	Specified limitations on spray direction
Temperature Range: Min-Max	°C	0-45	Operational Temperature Limits
Humidity Range: Min-Max	%	0-95	Operational Humidity Limits
Plume Properties			
Maximum Plume Height	h m	22.5	Minetek Evaporator Plume Height
Initial conc invol. (ppm)	ppm	0.784	99.9th Percentile Arsenic per client supplied water quality data
Solute Density	p kg/m ³	1.00	Client specified solute density
Droplet size relative to PM size	D' x PM size	15.98	$= (1/(PPM/10^6))^{1/3}$
Initial conc invol. (mg/L)	D' mg/L	0.00078	$= TDS \times Solute\ Density$
Total solute production rate	e g/s	0.04115	$= Flowrate \times Concentration\ (mg/L) \times Runtime \times Evaporation\ Efficiency \times No.\ of\ Units$
Droplet size associated with PM of concern			
PM	µm	10	Client defined PM of interest
Droplet Size that contain PM of concern	µm	159.81	$= PM \times D'$
Cumulative density (%)	Cd %	23.05	Based on weather data and Minetek evaporator spray droplet size distribution, this is the percentage that will result in drift
PM10 emission rate	E1 g/s	0.009483	$= e \times cumulative\ density / CF$
Suppression Factor	kg/yr	299.063	
PM10 emission rate - suppressed	E2 kg/yr	29.91	90% Considers suppression offered by non-evaporated droplets $= E1 \times Supression\ Factor$
PM10 drift rate - suppressed, Arsenic	%	2.30	$= E2 / e\ (t/yr)$

PM = size of particulate matter produced
 Droplet = the size of the droplet that will produce that PM
 VMDcrit = The droplet size that will hit the ground (i.e. not result in drift).
 Cd = Percentage of droplets that will result in drift
 E1 = Non-suppressed emission rate
 E2 = Suppressed emission rate

PM10 emission concentration @ x,y,z	
Axial measurement distance	x 6000 m
Lateral distance off plume	y 0 m
Distance off ground	z 0 m
PM origin height	h 22.5 m
Avg wind speed enroute	u 6.00 m/s
PM10 emission rate - Arsenic	0.000948 g/s
Pascalli Stability Category E	
Gaussian distribution factors	a Use tables
	b Use tables
	c 6.25
	d 0.54287
Deviation angle	θ 0.092
Std. deviation y	σy 257.8 m
Std. deviation z	σz 70.0 m
PM10 Concentration @ x,y,z	C(x,y,z) 0.00264782 µg/m ³

PM2.5 emission concentration @ x,y,z	
Axial measurement distance	x 6000 m
Lateral distance off plume	y 0 m
Distance off ground	z 0 m
PM origin height	h 22.5 m
Avg wind speed enroute	u 6.00 m/s
PM2.5 emission rate - Arsenic	0.0000901 g/s
Pascalli Stability Category E	
Gaussian distribution factors	a Use tables
	b Use tables
	c 6.25
	d 0.54287
Deviation angle	θ 0.092
Std. deviation y	σy 257.8 m
Std. deviation z	σz 70.0 m
PM2.5 Concentration @ x,y,z	C(x,y,z) 0.00025169 µg/m ³



Site/Location: PNX Metals: Fountain Head, -13.460085, 131.505553
 Project Scope: Year Average Arsenic Emissions

Weather Data Source: http://www.bom.gov.au/climate/averages/tables/cw_014901_All.shtml
 Weather Data Location: Douglas River Research Farm

PM (µm)	Droplet (µm)	Cd	E1 (kg/yr)	E2 (kg/yr)
2.5	39.95	2.19	14.520	1.452
10	159.81	23.05	152.751	15.275
25	399.53	73.70	488.449	48.845

Droplet size that reached the ground (VMDcrit) = 210µm

Operational Parameters & Limits			Notes
Evaporator Type		600/300	
No of Units	ul	3	
Volume flowrate per evaporator	Q	L/s	37.4 Minetek Evaporator model volume flow rate
Effective amount evaporated	η	%	39.9% Year Average Evaporation Efficiency
Yearly Evaporator "Runtime"		89%	Year Average Runtime
Months of Operation per Year		12	Operating months
Hours of Operation per Day		24	Operating hours
Allowable spray direction: Start-End		°	(Variable) Specified limitations on spray direction
Temperature Range: Min-Max		°C	0-45 Operational Temperature Limits
Humidity Range: Min-Max		%	0-95 Operational Humidity Limits
Plume Properties			
Maximum Plume Height	h	m	22.5 Minetek Evaporator Plume Height
Initial conc invol. (ppm)		ppm	0.526 Annual Average Arsenic per client supplied water quality data
Solute Density	p	kg/m ³	1.00 Client specified solute density
Droplet size relative to PM size	D'	x PM size	15.98 = (1/(PPM/10 ⁶)) ^(1/3)
Initial conc invol. (mg/L)		mg/L	0.00053 = TDS x Solute Density
Total solute production rate	e	g/s	0.02102 = Flowrate x Concentration (mg/L) x Runtime x Evaporation Efficiency x No. of Units
Droplet size associated with PM of concern			
PM		µm	10 Client defined PM of interest
Droplet Size that contain PM of concern		µm	159.81 = PM x D'
Cumulative density (%)	Cd	%	23.05 Based on weather data and Minetek evaporator spray droplet size distribution, this is the percentage that will result in drift
PM10 emission rate	E1	g/s	0.004844 = e x cumulative density / CF
		kg/yr	152.751
Suppression Factor		%	90% Considers suppression offered by non-evaporated droplets
PM10 emission rate - suppressed	E2	kg/yr	15.28 = E1 x Supression Factor
PM10 drift rate - suppressed, Arsenic		%	2.3048 = E2 / e (t/yr)

PM = size of particulate matter produced
 Droplet = the size of the droplet that will produce that PM
 VMDcrit = The droplet size that will hit the ground (i.e. not result in drift).
 Cd = Percentage of droplets that will result in drift
 E1 = Non-suppressed emission rate
 E2 = Suppressed emission rate

PM10 emission concentration @ x,y,z		
Axial measurement distance	x	6000 m
Lateral distance off plume	y	0 m
Distance off ground	z	0 m
PM origin height	h	22.5 m
Avg wind speed enroute	u	6.00 m/s
PM10 emission rate - Arsenic		0.000484 g/s
Pascalli Stability Category		E
Gaussian distribution factors	a	Use tables
	b	Use tables
	c	6.25
	d	0.54287
Deviation angle	Θ	0.092
Std. deviation y	σy	257.8 m
Std. deviation z	σz	70.0 m
PM10 Concentration @ x,y,z	C(x,y,z)	0.001352 µg/m ³

PM2.5 emission concentration @ x,y,z		
Axial measurement distance	x	6000 m
Lateral distance off plume	y	0 m
Distance off ground	z	0 m
PM origin height	h	22.5 m
Avg wind speed enroute	u	6.00 m/s
PM2.5 emission rate - Arsenic		0.0000460 g/s
Pascalli Stability Category		E
Gaussian distribution factors	a	Use tables
	b	Use tables
	c	6.25
	d	0.54287
Deviation angle	Θ	0.092
Std. deviation y	σy	257.8 m
Std. deviation z	σz	70.0 m
PM2.5 Concentration @ x,y,z	C(x,y,z)	0.0001286 µg/m ³

APPENDIX C – Weather data

2020	Q1	10,000	10.0	10.0	10.0
2020	Q2	10,000	10.0	10.0	10.0
2020	Q3	10,000	10.0	10.0	10.0
2020	Q4	10,000	10.0	10.0	10.0