REPORT ON AMBIENT AIR QUALITY MONITORING CONDUCTED IN THE KMA

Riverton Tyre Cell Fire

March 16-26 2014

Prepared by:
National Environment and Planning Agency
April 2014

LIST OF ACRONYMS

- AQHI- Air Quality Health Index
- AQI -Air Quality Index
- CAP – Criteria Air Pollutants
- CO_2 – Carbon Dioxide
- GHG – Green House Gases
- HVM – Heavy Metals
- JFB – Jamaica Fire Brigade
- KMA- Kingston Metropolitan Area
- MET- meteorological
- MOH - Ministry of Health
- NEPA - National Environment and Planning Agency
- NO_2 - Nitrogen Dioxide
- ODPEM – Office of Disaster Preparedness and Emergency Management
- PAH – Poly Aromatic Hydrocarbons
- PAPs-Priority Air Pollutants
- PM_{10} - Particulate Matter less than 10 microns
- $PM_{2.5}$ -Particulate Matter less than 2.5 microns
- POPs - Persistent Organic Pollutants
- SO_2 -Sulphur Dioxide
- TSP - Total Suspended Particulate Matter
- Ug/M^3 – Micrograms per meter cube
- m/s – meters per second
- USEPA - United States Environment Protection Agency
- VOC - Volatile Organic Compounds
- WHO-World Health Organization

1.0 BACKGROUND

The National Environment and Planning Agency was informed of a fire at the Riverton Solid Waste Disposal facility on 16 March 2014. The NSWMA reported that the Used Tyre Cell at the facility was on fire. All national emergency response teams from government were notified and responded accordingly, coordinated by the ODPEM. The Agency immediately activated its emergency response systems to track the impact of the fire.

1.1 FIRE SUMMARY

On the 16 March 2014 the Tyre cell which covers approximately five (5) acres (20,234m^2) of land holding an approximate 500,000 tyres was set ablaze. The Fire began at approximately 6:00am Sunday 16 March 2014 and was completely extinguished on the 26 March 2014 at 5:00pm. The smoke emitting from the landfill lasted approximately 10 days. It was reported by the Jamaica Fire Brigade (JFB) that the blaze was fully extinguished by 2:30pm on Wednesday 19 March and for the remaining six (6) days only smouldering from the addition of cover material remained. It was estimated that the majority of the 500,000 tyres combusted, excluding a few that were eventually covered by the cover material used to fight the fire, as well as tyres from the rear section of the cell.

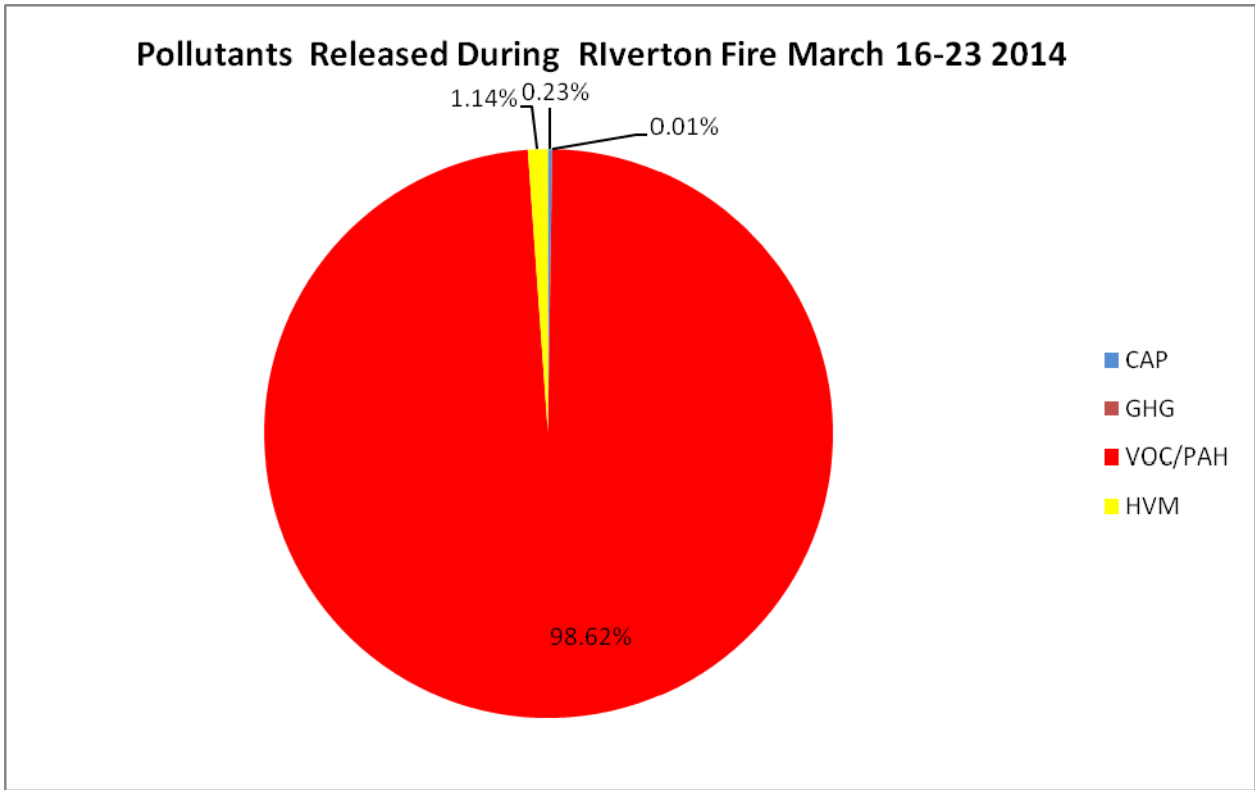
Picture taken at 9:45am Sunday 16 March 2014 By NEPA officer on Weymouth Drive intersection

Picture taken at 10:15am Sunday 16 March 2014 by NEPA officer at Queen Hill St. Andrew

1.2 AIR EMISSIONS ESTIMATION

Tyres consist mainly of rubber and metal. From published studies completed by the USEPA[1] there are over 100 species of air pollutants that may be released during a tyre open burning event such as this one. These species fall under the general categories of Organic Pollutants, Criteria Air pollutants, Particulate Metals and Green House Gases. A list of these and the individual estimates of release are provided in Appendix A. An estimated 198.48 tonnes of air emissions were released from the fire. A breakdown of the quantities is given in Figure 1. The estimate was based on the assumption that most of the cell was car tyres with an average weight of 8Kg and that the entire cell was burnt for 227hrs at an average burn rate of 2Kg/s. Emission factors were taken from USEPA AP 42 Chapter 2.5. Burn rates would vary during the duration of the fire due to fire fighting activities and the addition of cover material, which are expected to reduce the burn rate. An estimate of emissions from the cover material was not included. However, the nature of the material was reported to be limestone and so it would be expected that this would impact the quantity of CO_2 released during the fire

Figure 1: Showing quantity of air pollutants released during the fire



[1] Characterization of Emissions from the Simulated Open Burning of Tires (1989), prepared by Jeffrey V Ryan, Air and Energy Engineering Laboratory, Combustion Research Branch, Triangle Park

1.3 SAMPLING

The Agency deployed 13 air quality samplers at 8 locations within and outside of the predicted and observed major impact zone of the smoke plume of the fire. These were supported by two privately owned licensed permanent air monitoring sites. The locations and pollutants monitored for are outlined in Table 1.

Table1: List of locations monitored on Sunday 16 March 2014-23 March 2014

Location	Sampler type	Pollutants sampled	Time of deployment	Purpose(Predicted based on Model of previous fires)
191 Old Hope Road	Mini Volume sampler Passive Organic sampler	PM_{10} VOC (46 air pollutants including benzene)	2:00pm	Background
Cross Roads NEPA Office	Hi Volume TSP sampler Passive Organic sampler	TSP VOC (46 air pollutants including benzene)	2:30Pm	Background
J. Wray and Nephew, Spanish Town Road	Mini Volume Sampler	$PM_{2.5}$	3:00pm	Major Impact zone
JPS Office, Spanish Town Road	Hi Volume Sampler Passive Organic Sampler	PM_{10} VOC (46 air pollutants including benzene)	3:15pm	Major impact zone
Mansfield Drive, Washington Gardens	Mini Volume Sampler	Pm_{10}	4:30pm	Major Impact zone
Patrick drive, Duhaney park	Mini Volume sampler Passive Organic sampler	PM_{10} VOC (46 air pollutants including benzene)	4:00pm	Impact zone
Plantain Drive, Plantation Heights	Passive Organic sampler	VOC (46 air pollutants including benzene)	6:00pm	Major Impact zone
Waterford Drive, Fire Station Portmore	Mini Volume sampler Passive Organic sampler	PM_{10} VOC (46 air pollutants including benzene)	5:00pm	Major Impact zone

In addition two licensed private operators' air monitoring sites were collecting ambient air quality data on Sunday 16 March 2014 at the locations below

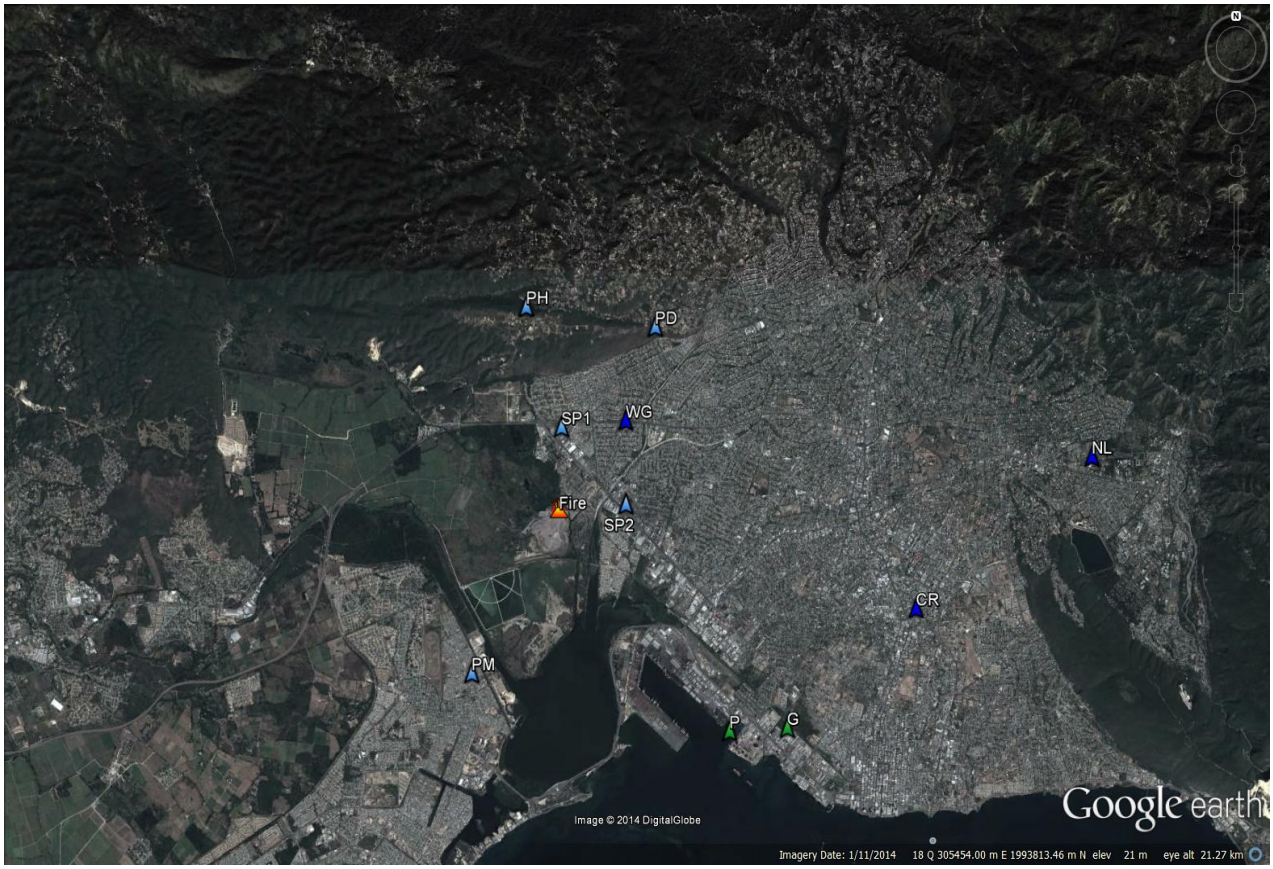
Table2: List of privately owned continuous analyzers supporting deployed network on 16 March 2014

Location	Sampler type	Pollutants sampled	Time of deployment	Purpose Predicted based on Model
Marcus Garvey Drive	SO_2, NO_2 PM10 continuous analyzers	SO_2 NO_2 PM_{10}	All day	Background
Spanish Town Road	SO_2 continuous analyzers	SO_2	All day	Impact zone

The Agency completed 26 sampling activities spread over six days 16-17, 19, 21 and 24-25 March 2014. These samples were taken using a combination of semi continuous samplers for Particulate Matter and passive samplers for Volatile Organic Compounds (VOC). The particulate samples were collected using a combination of High Volume and Mini Volume samplers. The samples were collected on filter paper at a constant flow rate, with gravimetric analysis then completed on the filter papers at the NEPA laboratory to determine concentration. VOC's were collected using a passive badge sampler with a charcoal base and analysed overseas using Gas Chromatography/ mass spectrometry (GC/MS).

Continuous hourly meteorological data for the event was recovered from a privately owned site located along Spanish Town Road. Wind speed, wind direction, temperature, pressure, humidity and solar radiation were collected for the event. This data was supported by data from the meteorological office.

Figure 2 Map of Air monitoring locations



PD	Patrick Drive
PM	Portmore, Waterford
SP1	Spanish Town Road JPS office
SP2	J. Wray and Nephew Spanish Town Road
WG	Washington Gardens
PH	Plantation Heights
CR	Crossroads

NL	Old Hope Road
G	Garmex, Marcus Garvey Drive
P	Petrojam

2.0 PRESENTATION OF RESULTS

2.1 METEOROLOGY

Figure 3: Wind Rose Plot Spanish Town Road for Period 16 March -20 March 2014

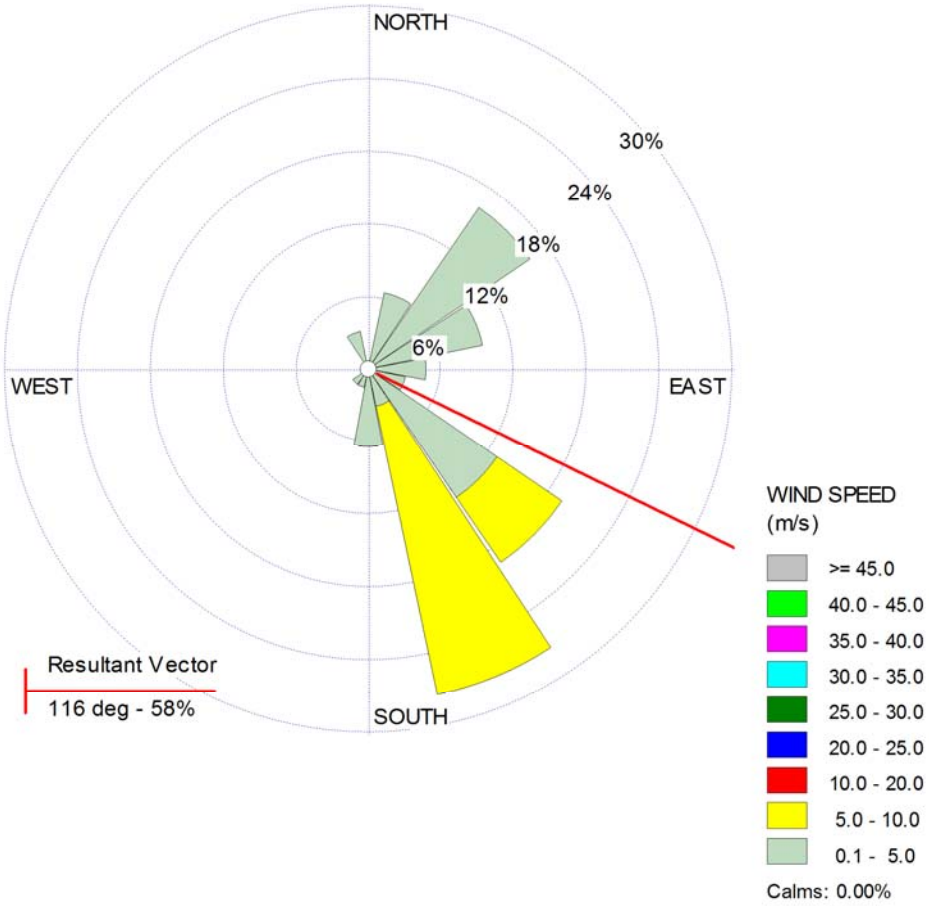


Figure 3 Indicates that the majority of the wind during the fire is from the South, these were also the winds with the greatest Intensity. Visual Observations during the fire supported this data.

2.2 PARTICULATE MATTER LESS THAN 10 MICROMETERS (PM10)#

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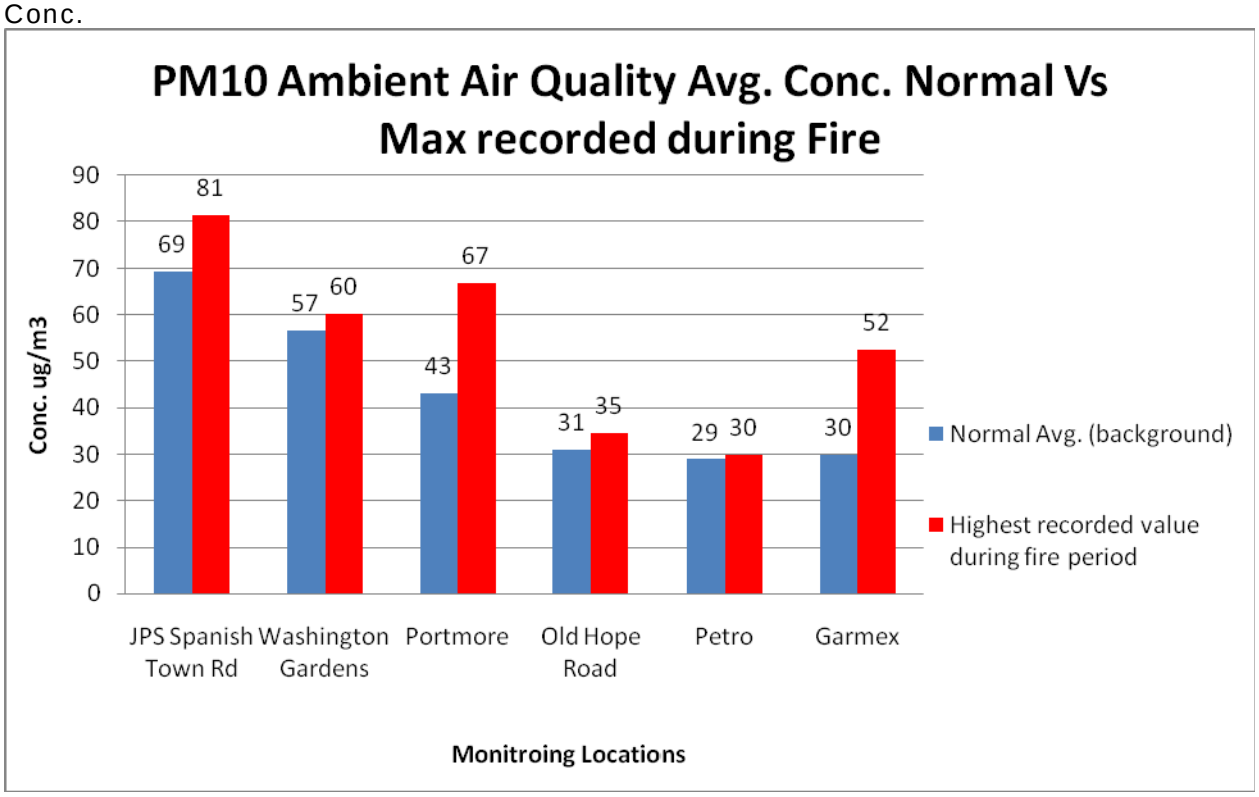
Figure 4: Graph showing average concentration of PM_{10} during fire compared to Avg. Normal Conc.



PM_{10} are fine particles which may consist of Particulate Heavy Metals (HVM). They are known to affect the health of human beings by attacking the upper respiratory system. Figure 4 shows that during the fire, PM_{10} concentrations increased over 24 hours at most of the locations sampled. Portmore and Garmex recorded the greatest change; up to 54% and 75% increase over the normal background average. The site located at Marcus Garvey Drive recorded its highest daily concentration year to date during the period of the fire. The Spanish Town Road monitoring location showed an 18% increase and provided the best indication of the fires impact in the most threatened zone of influence. On a daily basis, most of these locations closest to the Riverton site are already severely threatened by regular sources of air pollution, including traffic. This impact increased during the fire based on the air monitoring results.

Figure 5: Showing air monitoring results during fire period

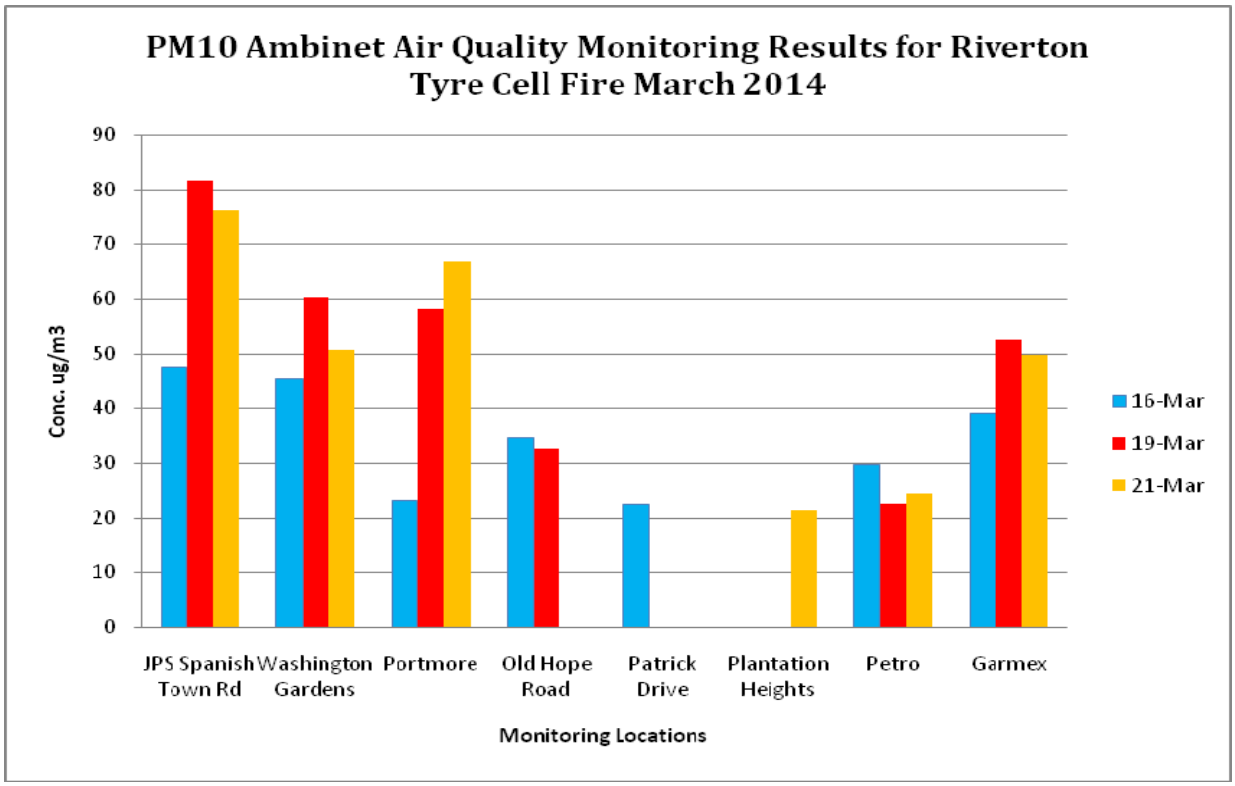


Figure 5 provides a clear picture of how tyre fires impact air quality. As expected based on similar case studies of tyre fires across the world, the air pollution and impact on air quality increases as the fire continues to lose energy and smoulder. Greater emissions are generated when the fire loses energy and is being extinguished. The graph clearly shows that after day 3 of the fire when it had lost its energy and was smouldering the impact had increased. There was no recorded exceedance of the daily Jamaica Ambient Air Quality Standard during the fire. However an increase in excess of the background concentration of up to 18% in the threatened zone was recorded, impacting the zone negatively.

2.3 TOTAL SUSPENDED PARTICULATES

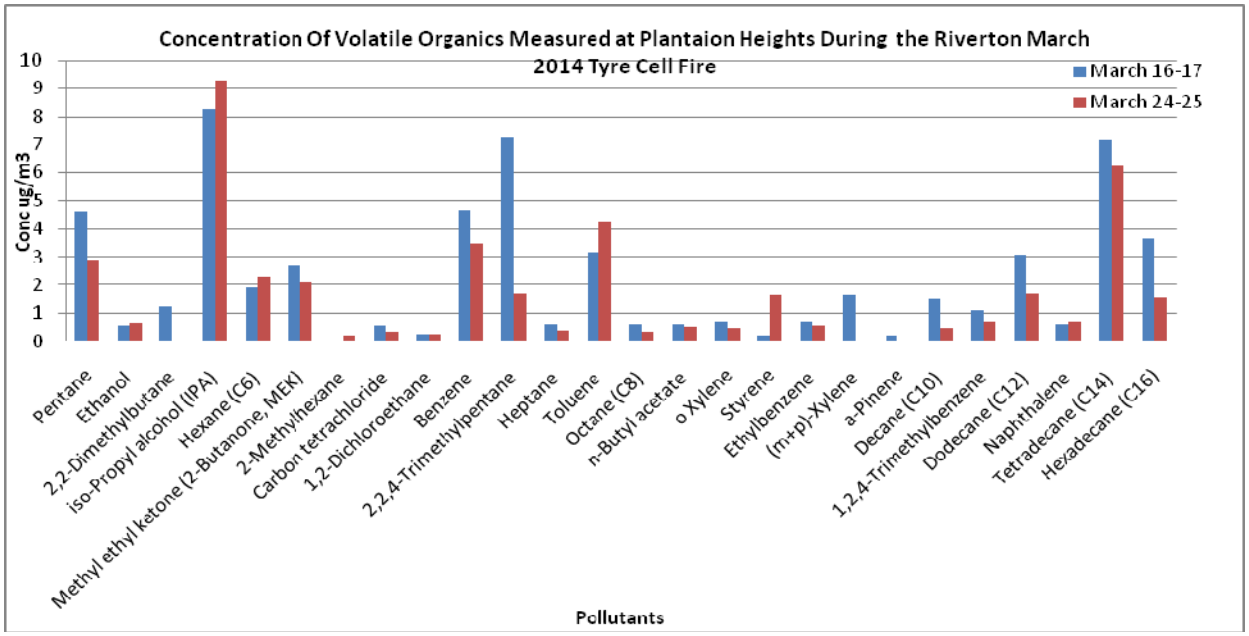
TSP is a portion of the large courser particulate matter that creates poor air quality. The maximum recorded daily concentration for TSP was 83µg/m3. The impact recorded at the site indicated an increase over the year to date average concentrations of 7%. There was no recorded exceedance of the daily Jamaica Ambient Air Quality Standard.

2.4 PARTICULATE MATTER LESS THAN 2.5 MICROMETERS ($PM_{2.5}$)

$PM_{2.5}$ sampling was done at one site along Spanish Town Road. Data collected during the fire reveal that the background levels were not significantly impacted at this location. The maximum concentration recorded was 38µg/m3. The normal daily average at this location recorded since January 2014 is in 42µg/m3. This area is however considered to be threatened by mobile emissions on a daily basis during peak traffic hours.

2.5 VOLATILE ORGANIC COMPUNDS (VOC)

Figure 6: Showing concentration of VOC measured at Plantation Heights During the Fire



One of the highest concentrations of volatile organic compounds was detected at the Plantation Heights monitoring site. The graph shows a comparison between the start and the end of the fire. From emissions data, benzene and benzene compounds are some of the greatest contributors to the overall emissions from the fire. The graph shows these compounds to be declining towards the end of the fire, indicating that the fire did increase the level of organic pollutants in the air, creating a negative impact.

Figure 7: Showing VOC results at all six (6) monitoring locations during the Riverton fire

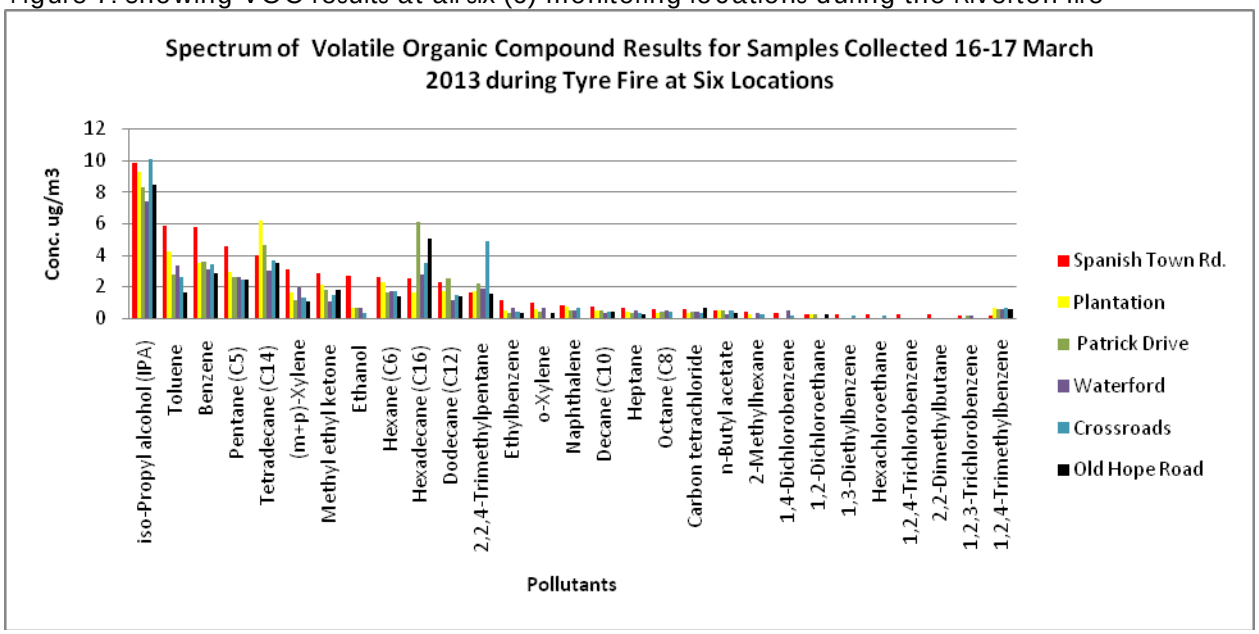


Figure 8: Showing Background VOC levels against VOC concentrations recorded at Spanish Town Road during the Riverton fire

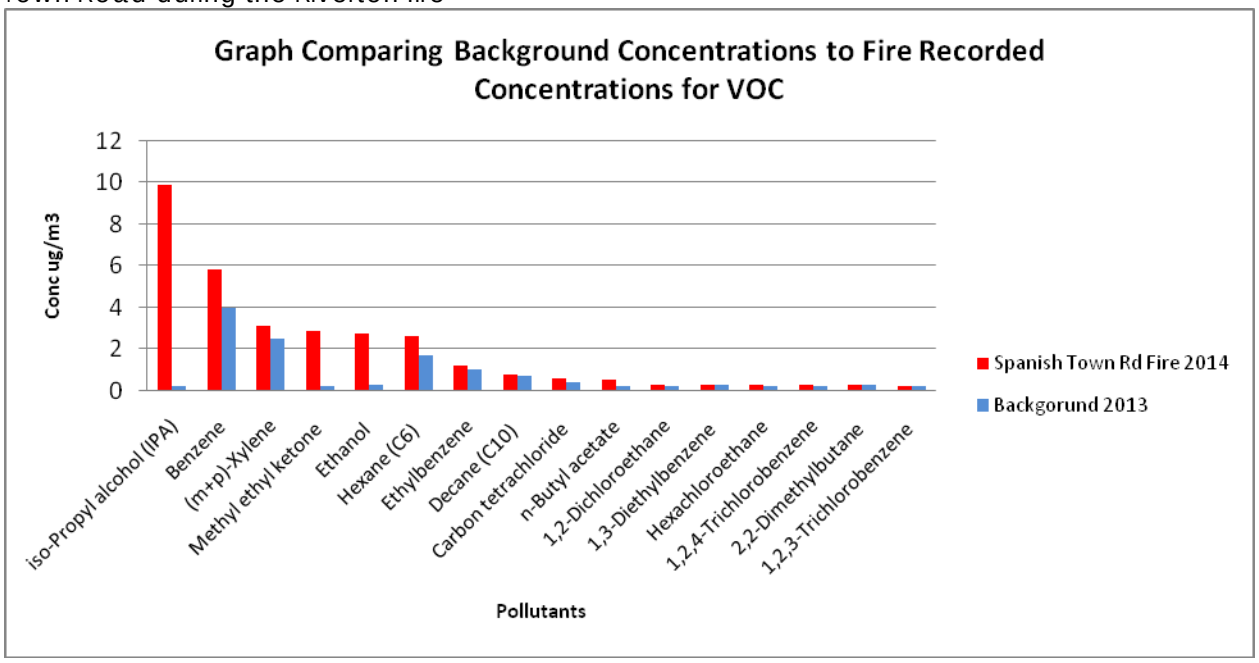


Figure 8 provides a comparison between the recorded values of organics in Kingston and St. Andrew during March 2013 compared to those recorded at the greatest impact zone during the March 2014 Tyre Cell fire. For Benzene and compounds of benzene the impact increased levels to between 30 and 48%. This increase may be classified as a significant impact. Figure 7 indicates that for almost all pollutants recorded during the fire, Spanish Town Road recorded the highest average concentrations over 24 Hours. The data also shows that Spanish Town Road recorded a broader spectrum of pollutants than any other location monitored during the fire.

2.6 SULPUR DIOXIDE AND NITROGEN DIOXIDE

Figure 9: Showing the Sulphur Dioxide trends during the Riverton fire

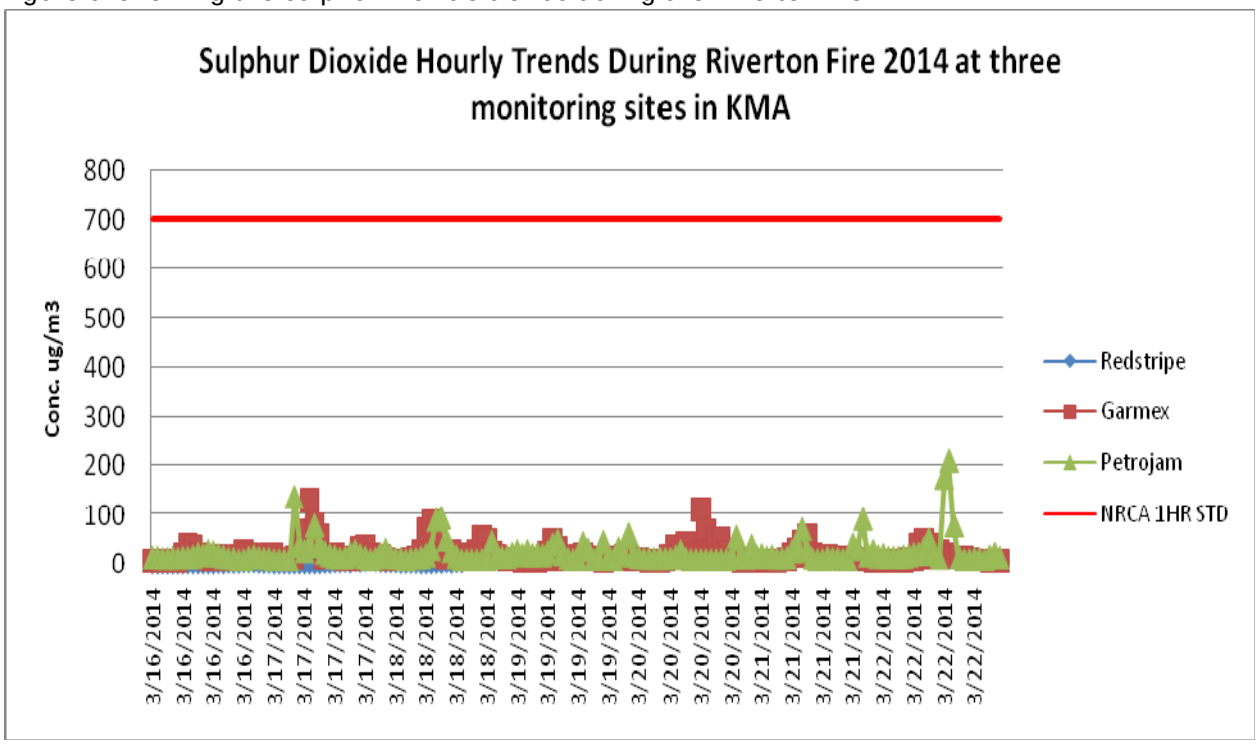
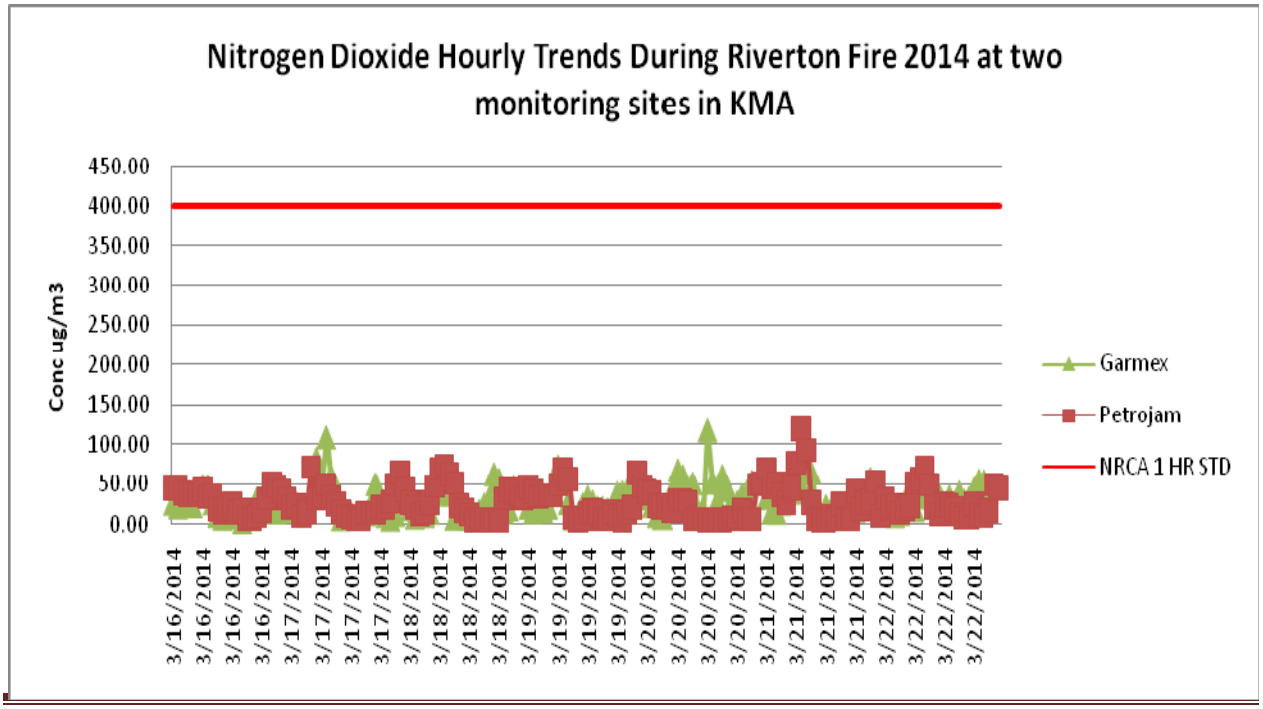


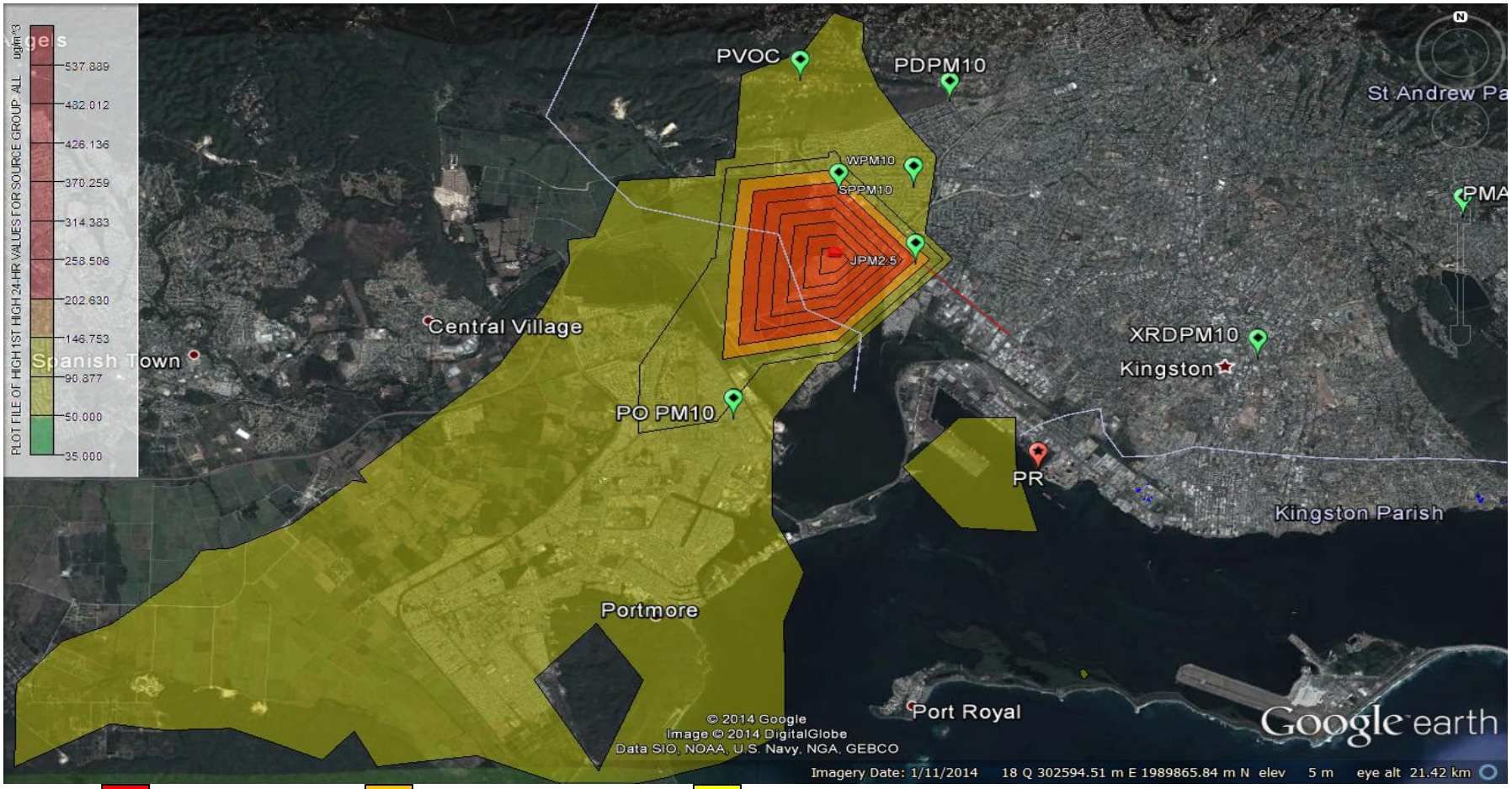
Figure 10: Showing Nitrogen Dioxide trends during the Riverton fire



The Sulphur Dioxide and Nitrogen Dioxide concentrations monitored during fire did not record a significant impact during the fire as shown in Figures 9 and 10.

Predicted Impact Zone March 16-20 2014

Map 1: AERMOD Simulation model run of the fire PM_{10} impact on March 16-20 2014



CONC. PM10 = >200ug/m3	CONC. PM10 = 150-200ug/m3	CONC. PM10 = 50-149ug/m3
INDEX RATING: **VERY HIGH RISK***	INDEX RATING: **HIGH RISK***	INDEX RATING: **MOERATE -HIGH RISK***

Index ratings were based on USEPA & Canadian air quality indices

2.7 DISPERSION MODELLING

The predicted PM_{10} impact zones for Sunday 16 March 2014 are displayed in map 1. The model was based on meteorological data gathered from a weather station located along Spanish Town Road and information gathered from NSWMA about the size of the Tyre cell. The model predicts the worst case fall out of PM_{10} for Sunday 16 – 20 March 2014. The assumptions made in the model were:

- The entire tyre cell was on fire
- The cell burnt at its highest burn rate for the entire period
- An initial vertical height of 300m for the plume

The model did not consider the cooling down activities carried out by the fire fighting teams. However, these assumptions would not affect the predicted zones of impact greatly. However, these assumptions would lead to an overestimation of the predicted concentration of PM_{10} in these zones. This was consistent with the data gathered from the fire period

ANALYSIS OF FINDINGS

The analysis focuses mainly on the PM_{10} data as the results showed that ambient air quality with respect to PM10 , within 1km radius of the site was ranked as "very high risk" while at distance over 1 km it was ranked as "high risk".

PM Data Analysis

No exceedance of The 24 hour Standard of 150ug/m^3 was recorded during the fire with the maximum recorded concentration on Spanish Town Road of 81ug/m3 on 19 March 2014. The data revealed that from the 16-21 March 2014 all monitoring locations within the greatest impact zone to the North and south of the site were impacted by PM_{10} (Figure 5).

The PM_{10} concentration 1km away from the disposal site in the northern direction recorded the highest value. At 1.5 – 2km, the second highest concentration was recorded while the lowest concentration was recorded at 4.5km (Map1). Data gathered indicates 18% increase over the normal background concentrations along Spanish Town Road

Permanent stations that recorded annual averages for PM_{10} during 2013 all showed an impact during the fire with increases of up to 75%. The Marcus Garvey and Portmore stations, which are the closest of the four permanent stations, showed greatest impact.

SO_2 Data Analysis

The maximum hourly average of SO_2, recorded at Marcus Garvey Drive, was 209µg/m^3 .This was recorded on 21 March 2014 (Table 9). The highest 24 hour average for SO_2 (34µg/m^3) was recorded on 21 March 2014. The 24 hour average for these stations is usually in the mid 20µg/m3 based on data collected in 2010 to 2013. For the period the average concentration was 22µg/m3 which was consistent with the normal station annual average concentration form 2010-2013.

NO_2 Data Analysis

The maximum hourly average of NO_2 recorded at the same sites was 120µg/m^3. This was recorded on 21 March 2014 (Figure 10). The 24 hour average for these stations also averaged in the mid 20's for the past three years (2010-2013). During the period of the fire, the Average was within this range, suggesting limited impact on NO_2 ambient levels at these two locations.

VOC

Forty six VOCs were detected from the analysis done on the samples of the six locations. From this only twenty seven were detected above the lower concentration limit of the analysis method of 0.2µg/m3. Benzene and compounds of benzene were used as the best indicator of the impact of these hazardous air pollutants from the fire. Benzene and compounds of benzene showed an increase of 30%-48% over the normal background concentrations within 4Km of the dump fire. The highest recorded benzene level was 5.81µg/m3 at the Spanish Town Road location. The 30-48% increase above normal background concentrations recorded in 2013 indicates that the fire had a significant impact on the VOC levels up to 4Km from the dump in the northerly direction

Meteorological Data Analysis

The wind rose plot show that during the period of the fire approximately 58% of the winds were blowing from south east. Winds with the highest speeds were from the South East also up to a maximum of 10m/s.

The direction of the wind is consistent with the data gathered from the fire. The terrain to the north of the dump prevented impact from spreading further to the north.

CATEGORIZATION OF RISK

The areas which experienced the greatest impact of the fire are shown in Table 4. The wind factor, discussed previously, would have influenced the areas of greatest impact.

Table 4: Showing the areas determined to have received the greatest impact

	ZONES	
	VERY HIGH RISK	**HIGH RISK**
Communities and Places	• Riverton Meadows • Berger Paints facility • JPSCO Office • Seaview Gardens • Cooreville Gardens • Cooreville Basic School • Lower Sections of Weymouth Drive • Riverton Community Center • Riverton surrounding communities • All Facilities up to 1Km along Spanish Town Road in the North and Northwest direction of the dump	• Washington Gardens • Duhaney Park Primary • Edith Dalton James High • Hendricks Basic School • Duhaney Park Police Station • Lower sections of Duhaney Park Drive • All facilities along the Spanish Town Road up to 2 km in the East and South East direction of the dump

CONCLUSION

The general conclusion based on the results of the monitoring exercise is that the fire at the Riverton Solid Waste Disposal Site on 16 – 26 March 2014 had a negative impact on the ambient air quality in Kingston and St. Andrew and Portmore regions. The data collected gives a reasonable indication of the impact to inform decisive actions and inform the public on the risk posed to air quality from the event.

The basis of the conclusion is as follows:

1. The data showed that during the fire, ambient air concentrations of PM_{10}, within a 1km radius of the site, were considered to be Very High Risk according to the USEPA and Canadian Air Quality Index definition.

2. At distances up to a 2km radius the air quality with respect to PM_{10} was "High Risk" according to the same Canadian and USEPA Air Quality Index

3. Based on the data gathered during the fire no exceedance of the daily Jamaica Ambient Air Quality Standards was recorded. The highest recorded daily average for PM_{10} was 81µg/m3.

4. VOC Samples showed that benzene and benzene compounds had a significant impact up to 4Km away from the dump. The maximum concentration recorded was 5.81µg/m3. The average concentrations recorded showed a 30-48% increase in ambient levels over normal levels measured during 2013

5. The PM_{10} monitoring and dispersion modelling indicates that limited impact was experienced to the north east of Kingston and St. Andrew mainly because of the meteorology during the fire