



Building Sustainably

# DUST MANAGEMENT BEST PRACTICES FOR CONSTRUCTION SITES

## Case Studies from FIFA World Cup Qatar 2022™ Stadiums



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### Developed By:

Gulf Organisation for Research & Development (GORD)

### In Collaboration with:

Supreme Committee for Delivery & Legacy (SC)

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اللجنة العليا  
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# TABLE OF CONTENTS

LIST OF TABLES .....	3	Best Practice 4: Crusher Operation Management.....	21
LIST OF FIGURES .....	4	Best Practice 5: Location of Batching Plant Downwind and away from Sensitive Receptors .....	23
FOREWORD - DR. YOUSEF ALHARR.....	5	Best Practice 6: Tarpaulin Used to Cover Stockpiles .....	24
FOREWORD - ENG. BODOUR AL MEER .....	6	Best Practice 7: Fog Cannons Used on Loading Areas.....	25
ACKNOWLEDGEMENTS .....	7	Best Practice 8: Milled Asphalt Used for Paving Hauling Roads .....	26
<b>1.0 INTRODUCTION .....</b>	<b>8</b>	Best Practice 9: Water Spraying of Site for Dust Suppression .....	28
1.1 Impact of Poor Air Quality on Human Health and Environment.....	8	Best Practice 10: Vehicles Washout.....	29
1.2 Particulate Matter (PM).....	9	Best Practice 11: Site Audits.....	30
1.3 Impact of Dust on Workforce Health and Productivity .....	9	Best Practice 12: GSAS Continuous Program Development.....	31
1.4 Dust from Construction Sites in Qatar .....	9	3.2 Common Practices .....	32
1.5 FIFA Endorsement and SC Commitment.....	10	Common Practice 1: Covering Stockpiles in Green Plastic Net .....	32
<b>2.0 DUST MANAGEMENT IN GSAS CONTEXT .....</b>	<b>11</b>	Common Practice 2: Covering Trucks with Green Plastic Net.....	32
2.1 FIFA World Cup Qatar 2022™ Stadiums .....	11	Common Practice 3: Road Sweepers.....	32
2.2 Dust Monitoring at Education City Stadium.....	13	Common Practice 4: Locating Stockpiles near Backfilling Areas .....	33
<b>3.0 IMPLEMENTED METHODS AND MEASURES.....</b>	<b>15</b>	Common Practice 5: Training .....	33
3.1 Best Practices.....	15	Common Practice 6: Barriers Around Dust Generating Activities .....	34
Best Practice 1: Management Principles for Effective Dust Management... 15		Common Practice 7: Indoor De-dusting Systems.....	34
Best Practice 2: Monitoring (Equipment Type, Locations, Set-up, Reporting and Timing).....	18	<b>4.0 CONCLUSION.....</b>	<b>35</b>
Best Practice 3: Application of Prime Coat on Laydown Area.....	20	<b>5.0 BIBLIOGRAPHY .....</b>	<b>36</b>

# LIST OF TABLES



Table 1: GSAS-CM certification ratings achieved by all FIFA World Cup Qatar 2022™ stadium projects.....	10
Table 2: Awarded [OE.1] levels.....	11
Table 3: PM10 and PM2.5 concentrations at Education City stadium.....	12
Table 4: Dust concentrations entering and exiting the site.....	13
Table 5: Dust concentrations per monitoring year.....	14

# LIST OF FIGURES

Figure 1: A typical site set up.....	12	Figure 19 : GSAS-CM workshops and SC knowledge-sharing sessions.....	31
Figure 2: Workflow for Dust Management Plan .....	16	Figure 20 : Covered stockpiles with plastic net .....	32
Figure 3: Location of dust monitoring points at Al Janoub Stadium .....	18	Figure 21 : Covered trucks with plastic net.....	32
Figure 4: Dust monitoring device set up.....	19	Figure 22 : Road sweepers .....	32
Figure 5: Application of prime coat on laydown area at Al Janoub Stadium .	20	Figure 23 : Stockpiles adjacent to backfill areas .....	33
Figure 6: Suppression of dust from crusher.....	21	Figure 24 : On-site training sessions on dust management .....	33
Figure 7: Selection of the right location for the crusher.....	22	Figure 25: Barriers around dust-generating equipment .....	34
Figure 8: Selection of the right location for the batching plant .....	23	Figure 26: Indoor de-dusting systems .....	34
Figure 9 : Long-term stockpiles covered with tarpaulin .....	24		
Figure 10 : Fog cannons.....	25		
Figure 11 : Hauling roads paved with milled asphalt.....	26		
Figure 12 : Plan of paved hauling roads at Stadium 974.....	27		
Figure 13 : Plan of paved hauling roads at Education City Stadium.....	27		
Figure 14 : Water spraying for dust suppression.....	28		
Figure 15 : Modified water sprayer .....	28		
Figure 16 : Ahmad Bin Ali Stadium spraying routes schedule.....	28		
Figure 17 : Water-recirculating vehicle washout at Stadium 974.....	29		
Figure 18 : Site audits teams .....	30		

## FOREWORD



**Dr. Yousef Mohammed Alhorr**

Founding Chairman,  
Gulf Organisation for Research &  
Development

Qatar is a proud host of the FIFA World Cup Qatar 2022™. Hosting a mega event requires significant construction activities, including stadiums, roads, rail infrastructure, hotels, residential and commercial buildings. Such construction activities have direct impacts on the environment, economy and human health. Qatar, at a very early stage, identified the environmental challenges and adopted green building principles in various types of projects.

Most of the major construction projects in Qatar follow the Global Sustainability Assessment System (GSAS) for Design & Build (GSAS-D&B). This green building rating system certification has major impacts on the design, materials and operational practices. Eventually, the implementation of best practices and guidelines, as identified by GSAS, helps fight global issues such as climate change and resource depletion.

There are also important local environmental issues arising from the construction phase that need to be tackled, which is why GORD has developed GSAS Construction Management (GSAS-CM). GSAS-CM looks into the onsite construction process and practices carried out by contractors and builders. This certification's guidelines have been used during the

construction of all FIFA World Cup Qatar 2022™ stadiums. The implementation of this standard has improved local environmental issues such as air quality, noise control and waste management.

The World Health Organization (WHO) considers air pollution as a major environmental risk, potentially leading to harmful impacts on human health and even resulting in deaths. These deaths are often related with the short-lived pollutants such as particulate matter. These are directly linked to respiratory diseases, cancers, strokes and heart diseases.

To reduce air pollution coming from dust, GSAS-CM provides methodologies for monitoring as well as mitigation. These have been implemented in the construction of stadiums and in many other construction sites all over Qatar.

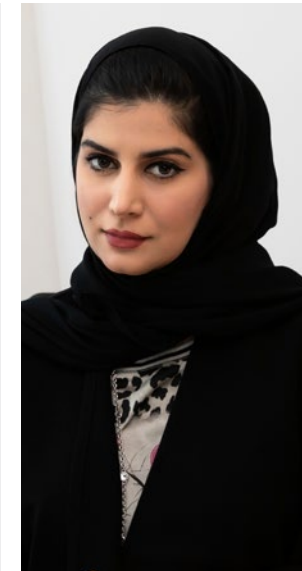
This report has been prepared to showcase best practices implemented to minimize dust at the stadium sites. Our aim is to inspire the construction sector by disseminating these best practices, and to encourage the implementation of some or all of these practices on construction sites. Our efforts come from our firm belief that improving dust management practices will contribute to a healthier life for us and our community.

## FOREWORD

Stadiums are the heart of any football tournament. These are the places where cherished memories for players, spectators and organizers are created. We have built our stadiums for the FIFA World Cup Qatar 2022™ in Qatar with long-term sustainability and environmental management as core principles. To ensure tangible and credible sustainability outcomes, we have implemented the GSAS Certification system. The GSAS system has also been endorsed by FIFA for FIFA World Cup Qatar 2022™ stadiums in Qatar.

Everyone involved in stadium construction understands the value of sustainability and environment. This was reflected during the numerous site inspections by GSAS auditors and subsequent certifications. By working together, we have created a genuine learning legacy of environmental protection and sustainable development in the design and construction sector.

I am very pleased to share this case study report on dust management during construction. I am confident that construction projects will benefit from the best practices identified and shared in this document.



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**Eng. Bodour Al Meer**

Executive Director - Sustainability,  
Supreme Committee  
for Delivery & Legacy (SC)

## ACKNOWLEDGEMENTS

This report has been made possible through the continued efforts and support of many dedicated individuals and entities, including the Supreme Committee for Delivery & Legacy, GSAS Certified Green Professionals working at stadiums' construction sites, and the Gulf Organisation for Research & Development's technical and administration support teams.



# 1.0 INTRODUCTION

Among the essential requirements for human survival is air to breathe. However, when air is polluted, it will turn into a serious health risk. Air pollution happens when harmful substances enter the air. Unfortunately, human activities are the main contributor to this phenomenon as they intend to produce or enhance the release of a wide range of airborne substances that affect air quality. Among all air pollutants, this report is focused on particulate matter generated from dust during construction activities.

## 1.1 Impact of Poor Air Quality on Human Health and Environment

Air pollution levels in many places around the globe exceed the national air quality standards. The immediate impact of air pollution on human health is recognized by all health institutes. According to the World Health Organization (WHO):

- Reduced air pollution levels can reduce stroke, heart disease, lung cancer and both chronic and acute respiratory diseases, including asthma.
- In 2016, 91% of the world population was living in places where the WHO air quality guidelines levels were not met.
- Outdoor air pollution in both cities and rural areas was estimated to cause 4.2 million premature deaths worldwide in 2016.

The following pollutants are considered the four main constituents for poor ambient air quality based on expert evaluation of current scientific evidence:

- Particulate Matter (PM10 and PM2.5)
- Ozone (O<sub>3</sub>)
- Nitrogen Dioxide (NO<sub>2</sub>)
- Sulfur Dioxide (SO<sub>2</sub>)

## 1.0 INTRODUCTION

### 1.2 Particulate Matter (PM)

PM is a common proxy indicator for air pollution. The major components of PM are sulfate, nitrates, ammonia, sodium chloride, black carbon, mineral dust and water. It consists of a complex mixture of solid and liquid particles of organic and inorganic substances suspended in the air. While particles with a diameter of 10 microns or less, ( $\leq$  PM10) can penetrate and lodge deep inside the lungs, even more health-damaging particles are those with a diameter of 2.5 microns or less, ( $\leq$  PM2.5). PM2.5 can penetrate the lung barrier and enter the blood system.

### 1.3 Impact of Dust on Workforce Health and Productivity

The health impacts of dust exposure are very well known and researched. According to WHO, there is a close, quantitative relationship between exposure to high concentrations of small particulates (PM10 and PM2.5) and increased mortality or morbidity, both daily and over time.

Small particulate pollution has health impacts even at very low concentrations, and prolonged exposure results in higher impacts.

A growing body of research now recognizes that extended pollution exposure impacts worker productivity, especially to those in physically demanding occupations than those who have less physically demanding exertion, such as desk jobs and call centers. Recent research from the National University of Singapore also suggests that prolonged exposure reduces productivity. The research found that an increase in PM2.5, by 10 micrograms per m<sup>3</sup> sustained over 25 days, reduces daily output by 1%, thereby harming firms and workers. The health outcomes are clear, and the economic outcomes are potentially significant. A study in China estimates that PM2.5 pollution will lead to about 2% GDP loss by 2030, as the research directly correlates a monetary impact to the lowered quality of life. As worker exposure occurs during working hours, employers carry a moral and economic incentive to improve air quality.

### 1.4 Dust from Construction Sites in Qatar

Particulate matter concentrations are high in Qatar, mainly because of the desert environment. Fine particulates from the desert are dry and easily airborne to cities and town, polluting the air and affecting human health. Moreover, the country is developing rapidly thereby requiring intense construction activity, which further contributes to increased air pollution.

Organizing the FIFA World Cup Qatar 2022™ entails construction of venues and infrastructure that have the potential to further increase air pollution. These circumstances make air pollution a major area of concern for Qatar's authorities, who continuously endeavor to improve the air quality for citizens and residents.

# 1.0 INTRODUCTION

## 1.5 FIFA Endorsement and SC Commitment

The Supreme Committee for Delivery & Legacy (SC) is the organization responsible for the infrastructure development of the FIFA World Cup Qatar 2022™. FIFA's green building requirement stipulated the application of a green building certification system for new buildings. After conducting a comprehensive technical review, FIFA confirmed GSAS Design & Build 4 Star certification as a minimum requirement.

The SC went beyond FIFA's minimum requirement by delivering GSAS Design & Build, GSAS Construction Management and GSAS Operations certifications for all FIFA World Cup Qatar 2022™ stadium sites and permanent offices. The SC specified GSAS Construction Management to be achieved with a minimum rating of Class A for the construction of the stadiums. Most of the stadium construction sites have not only met this requirement but exceeded it.

Table-1 presents the current status of the stadiums in relation to GSAS Construction Management certification.

**Table 1:** GSAS-CM certification ratings achieved by all FIFA World Cup Qatar 2022™ stadium projects

Stadium	GSAS CM Rating
Ahmad Bin Ali Stadium	Class A*
Al Bayt Stadium	Class A*
Al Janoub Stadium	Class A*
Al Thumama Stadium	Class A*
Education City Stadium	Class A*
Khalifa International Stadium	Class A
Lusail Stadium	Class A*
Stadium 974	Class A*

## 2.0 DUST MANAGEMENT IN GSAS CONTEXT

Dust generated by construction activities is assessed in GSAS-CM as a standalone criterion, called “[OE.1] Dust Control” under the Outdoor Environment category. This criterion identifies methods and measures to be implemented to minimize the generation of dust. The degree of implementation of these methods and measures is determined based on the project documentation as well as site audits conducted by the certification body, GSAS Trust. Accordingly, a level is awarded to the project as follows:

- Level 0, if the degree of implementation is less than 80%.
- Level 1, if the level of implementation is equal to or greater than 80%.

In addition, a project can achieve a higher level by demonstrating through monitoring that PM10 and PM2.5 concentrations are below GSAS limits, as follows:

- Level 2, if PM10 concentration is below 150 µg/m<sup>3</sup>.
- Level 3, if PM10 concentration is below 150 µg/m<sup>3</sup> AND PM2.5 concentration is below 35 µg/m<sup>3</sup>.

Dust monitoring is carried out to check the dust generated from construction activities at three defined project stages:

- Stage 1, Enabling/Foundation
- Stage 2, Substructure & Superstructure
- Stage 3, Finishing

Higher dust concentrations are expected from the first stage, which involves intense earthworks activities. GSAS dust monitoring methodology takes into consideration the variation of dust generation in different stages.

### 2.1 FIFA World Cup Qatar 2022™ Stadiums

Table-2 represents the FIFA World Cup Qatar 2022™ Stadium projects' awarded levels for GSAS-CM Dust Control criterion:

**Table 2:** Awarded [OE.1] levels

Stadium	Stage 1	Stage 2	Stage 3
Al Bayt Stadium	3	3	3
Al Janoub Stadium	1	2	3
Ahmad Bin Ali Stadium	1	3	1
Al Thumama Stadium	3	3	3
Education City Stadium	2	3	3
Khalifa International Stadium	1	3	1
Lusail Stadium	1	3	3
Stadium 974	1	3	3

## 2.0 DUST CONTROL IN GSAS CONTEXT

Table-3 illustrates PM10 and PM2.5 48-hour average concentrations of Education City Stadium in  $\mu\text{g}/\text{m}^3$  throughout the construction stages.

**Table 3:** PM10 and PM2.5 concentrations at Education City stadium

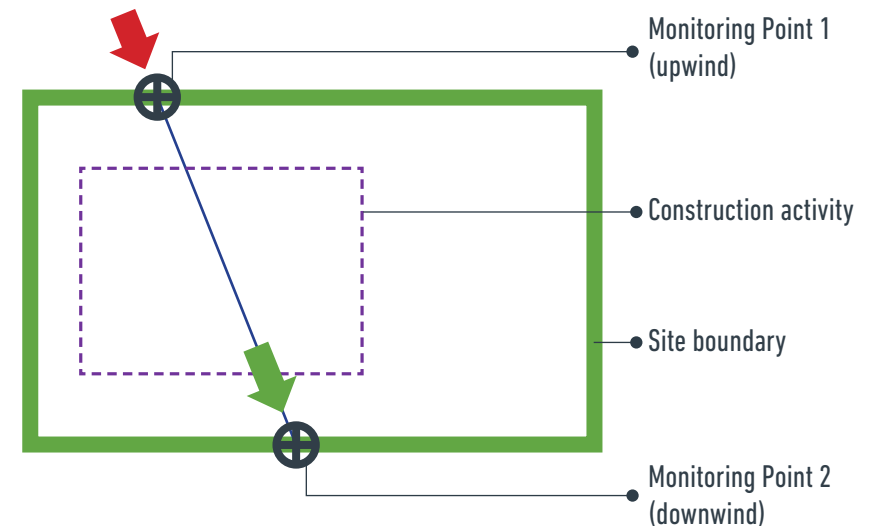
Stage 1		Stage 2		Stage 3		Overall	
PM10	PM2.5	PM10	PM2.5	PM10	PM2.5	PM10	PM2.5
69	27	36	16	36	12	47	18

The average concentrations were significantly lower than GSAS limits ( $150 \mu\text{g}/\text{m}^3$  and  $35 \mu\text{g}/\text{m}^3$  respectively). It can be observed that dust concentrations are substantially higher during stage 1, as expected.

In each stage, PM10 and PM2.5 dust concentrations are monitored for several days both at locations upwind and downwind of the construction site. Various parameters, including the 30-minute average for PM10 and PM2.5 concentrations, wind speed, wind direction and locations of the monitoring points are entered in GSAS [OE.1] Dust Control calculator. The calculator is the tool developed to filter the dust readings, excluding the dust entering the site and considering only the dust generated by the project on site. Accordingly, the calculator accounts only for the dust under the contractor's responsibility.

The calculator computes 48-hour average PM10 and PM2.5 concentrations that are compared to GSAS limits for compliance.

The calculator also allows projects to compute their contribution towards air pollution by comparing the dust concentrations entering the site in the upwind position with the concentrations exiting the site at the downwind position. Figure-1 below represents a typical site set-up.



**Figure 1:** A typical site set up

## 2.0 DUST CONTROL IN GSAS CONTEXT

Generally, in a “business-as-usual” project, where no dust control mitigation measures are considered, it is expected that the dust’s downwind concentrations are higher than upwind due to the construction activities’ significant contribution to the dust levels. However, following GSAS assessment methodology mentioned above in SC projects, it has been found that PM10 downwind concentrations are lower than upwind

concentrations, while PM2.5 concentrations are slightly higher, being the increment much lower than GSAS limit. This clearly indicates that the implemented dust mitigation methods and measures at the SC stadiums are actually reducing the dust generation and contributing positively to the air quality.

### 2.2 Dust Monitoring at Education City Stadium

An illustrative example is the Education City Stadium. Table-4 indicates that PM10 concentrations exiting the site were on average 10 µg/m<sup>3</sup> lower than concentrations entering the site. On the other hand, PM 2.5 concentrations downwind were on average 6 µg/m<sup>3</sup> higher than those upwind, which is significantly below GSAS limit (35 µg/m<sup>3</sup>).

**Table 4:** Dust concentrations entering and exiting the site

Diameter	Data Screening and Location of Monitoring Points	Stage 1 Average	Stage 2 Average	Stage 3 Average	Overall Average
PM 10	Dust entering the site at the upwind point	75	31	47	51
	Dust exiting the site to the downwind point	60	41	22	41
	Increment (downwind-upwind)	-15	10	-25	-10
PM 2.5	Dust entering the site at the upwind point	19	13	14	15
	Dust exiting the site to the downwind point	35	19	10	21
	Increment (downwind-upwind)	16	6	-4	6

Note: concentrations are expressed in µg/m<sup>3</sup>

## 2.0 DUST CONTROL IN GSAS CONTEXT

Standard dust monitoring involves measurements during specific representative days. Dust monitoring program within several stadium sites went beyond the standard set-up by conducting continuous dust monitoring. This required more sophisticated equipment installations and generated a significant amount of data.

The 24/7/365 data provides further details and insights into the dust generation patterns on construction sites.

In the case of Education City Stadium, continuous monitoring was carried out for two and half years. In order to compare to the standards, one-year period daily averages is required. Accordingly, the first year and the last year were considered for comparison. Table-5 illustrates a summary of Education City Stadium data analysis. The overall period averages are also provided for information.

**Table 5:** *Dust concentrations per monitoring year*

Parameter	First Year		Last Year		Whole Period (2.5 years)	
	PM10	PM2.5	PM10	PM2.5	PM10	PM2.5
<b>Annual Daily Average</b>	41.3	17.6	39.1	12.9	42.0	15.5
<b>Days Monitored</b>	365	365	365	365	876	876

The data shows that the PM2.5 and PM 10 concentrations were lower in the second year as compared to the first year. This is mainly due to the earthworks activities in the early stages generating more dust compared to the finishing works in the later stages.

## 3.0 IMPLEMENTED METHODS AND MEASURES

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Methods and measures implemented by the SC stadiums following GSAS-CM guidelines are described below. First are those measures that are noticeable for standing out of the standard dust mitigation practices in the region. Subsequently, are the measures that are considered as common practices in the construction sector.

### 3.1 Best Practices

#### **Best Practice 1: Management Principles for Effective Dust Management**

Many different stakeholders play their part in the dust control process of a project; proper management of the different teams and processes is the key to success.

##### **1. The Client**

The SC was committed to control dust and other environmental issues during construction. The SC included contractual requirements to develop and implement a Construction Environmental Management Plan and to achieve GSAS Construction Management certification, with a certification rating specified. The provisions included hiring professionals with GSAS-CM expertise by the Contractor, Project Management and Construction Supervision teams.

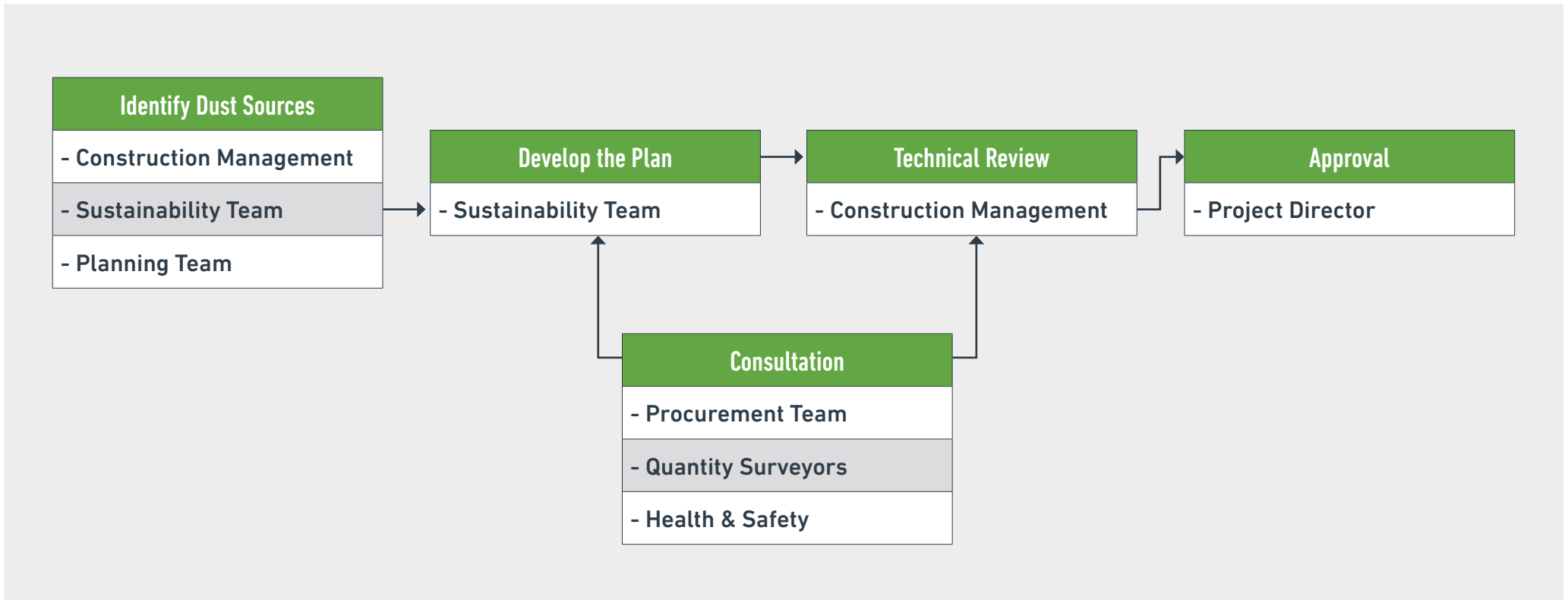
The SC established an online system to report, document and resolve any non-compliances and to document best practices on a weekly and monthly basis.



### 3.0 IMPLEMENTED METHODS AND MEASURES

#### 2. The Contractor

The Contractor has the main role in the implementation of dust control measures. Success in achieving the goal requires an integrated approach from several departments within the Contractor’s organization. Therefore, full commitment from the Project Manager is paramount throughout the construction stages as follows:



**Figure 2:** Workflow for Dust Management Plan

## 3.0 IMPLEMENTED METHODS AND MEASURES

### ► Planning

Planning stage is of great importance. Some of the measures in the following sections of this report were only possible to implement because they were identified at this stage, e.g. the location of stockpiles and batching plant in relation to prevailing wind and nearby sensitive receptors.

During planning of the construction process, potential dust sources were identified by the Construction Management, Sustainability and Planning teams.

The Sustainability team developed a Dust Control Plan within the wider Construction Environmental Management Plan to meet GSAS-CM requirements. The plan was then reviewed by the Construction Management team to ensure it was technically feasible and to identify the potential impacts that mitigation measures may have in the construction program and logistics of the site. Other teams such as those of Procurement, Quantity Surveyors and Health and Safety were also consulted during the development of the plan. Finally, the Project Director reviewed and approved the plan.

### ► Procurement and Subcontracting

All relevant subcontractors were trained and made aware of the Dust Control Plan. The requirements of GSAS-CM, the CEMP and the Environmental Permit for the site were cascaded down to all relevant subcontracting contracts, in order to bind the subcontractors to the implementation of the dust control measures related to their construction activities.

### ► Construction Phase

The necessary resources to execute the mitigation measures on site were provided generally from the Construction Management and the Logistics teams. The key activities of the Environmental team were to:

- Obtain the environmental permits required by the local authorities for some dust related activities and mitigation measures like crushers, vehicles washouts and use of treated sewage effluent (TSE) for dust suppression.
- Train the workers on dust control measures pertaining to their roles.
- Supervise and audit the implementation of the measures on site.
- Conduct the dust levels monitoring.
- Perform data collection and reporting.
- Report to the Project Director about the dust control status.

## 3.0 IMPLEMENTED METHODS AND MEASURES

### Best Practice 2: Monitoring (Equipment Type, Locations, Set-up, Reporting and Timing)

Dust monitoring plays a key role in dust control management. It provides the necessary data to analyze if the dust control measures are being effective and it helps in identifying potential dust generating activities.

Below are some practices for dust monitoring observed on SC sites that helped in obtaining reliable and useful data.

#### Equipment Characteristics and Settings

- Monitoring equipment that monitored both PM10 and PM2.5 concentrations simultaneously. This saved work and money.
- Monitoring devices that measured wind speed and wind direction. This data helped in identifying if the dust concentrations at a given time are generated from site or from off-site activities, and it is mandatory as per GSAS dust monitoring methodology.
- Timely calibrations of the equipment following the manufacturers recommendations.
- Daily checks of the data to identify possible abnormalities in the readings that may indicate failures in the equipment.
- Continuous electrical power supply to the devices from either solar power or construction grid instead of batteries. This avoided losing data for some time.
- Devices set to provide the parameter averages every 30 minutes. This

helped populate the GSAS [OE.1] Dust Control calculator easily.

- Devices set to a high frequency of readings, one reading per minute is advisable. The higher the quantity of data, the higher the accuracy of the analysis.



**Figure 3:** Location of dust monitoring points at Al Janoub Stadium

## 3.0 IMPLEMENTED METHODS AND MEASURES

### Equipment Location

- Using at least two devices simultaneously, one upwind and one downwind the construction activities. This enabled the projects to make use of the data to calculate the dust generated by their construction site. Note that using only one monitoring device is also possible, but required a lot more resources, as the monitoring period is double.
- Observing the weather forecast for the forecasted wind direction to better choose the optimal upwind and downwind locations of the devices.
- Locating the monitoring devices as close as possible to the site boundary; note that the target was to measure the dust concentrations being generated from the construction site and affecting the neighboring sensitive receptors.
- Locating the monitoring devices above the fence to ensure they caught the dust entering the site when the wind was blowing from an off-site direction.
- Avoiding locating the equipment too close to the exhaust from generators and hauling roads with heavy traffic, as this could lead to abnormally high readings of PM2.5. The target was to measure the dust concentrations leaving the site, which is why the monitoring devices should be located along the boundary, far enough from the dust sources to measure dust already dissipated in the air within the site.



**Figure 4:** Dust monitoring device set up

### 3.0 IMPLEMENTED METHODS AND MEASURES

#### Best Practice 3: Application of Prime Coat on Laydown Area

Machinery moving materials in the laydown area generate dust, unless the area is paved, which is usually not the case during construction. In the case of the stadium sites, laydown areas were also utilized to assemble large façade elements, which required extra movement of materials. Dust is also expected to be generated during windy days from non-paved laydown areas.

As a case study, Al Janoub Stadium considered the possibility of spreading asphaltic emulsion on the laydown area to stabilize the soil and mitigate

the dust generation. However, this posed the problem of soil contamination as the emulsion would have to be removed after the job completion. To avoid this environmental and economic problem, the project team located the laydown area at the future parking lot location. This way, the asphaltic emulsion would serve as the prime coat for the asphalt paving works. This solution provided a paved laydown area reducing dust generation significantly.



**Figure 5:** Application of prime coat on laydown area at Al Janoub Stadium

## 3.0 IMPLEMENTED METHODS AND MEASURES

### Best Practice 4: Crusher Operation Management

A sustainable good practice implemented across the SC stadiums was the reuse of excavated materials as fill materials. Crushers processed excavated rubble and rocks by breaking it into smaller-sized aggregates and fine materials making it suitable for backfilling. This breaking of materials generated small particulate matter that can be blown away by the wind and generate clouds of dust.

To minimize the amount of dust generated from crushers, several best practices were implemented on site. For example, here are the measures taken at Al Thumama and Al Janoub Stadiums.

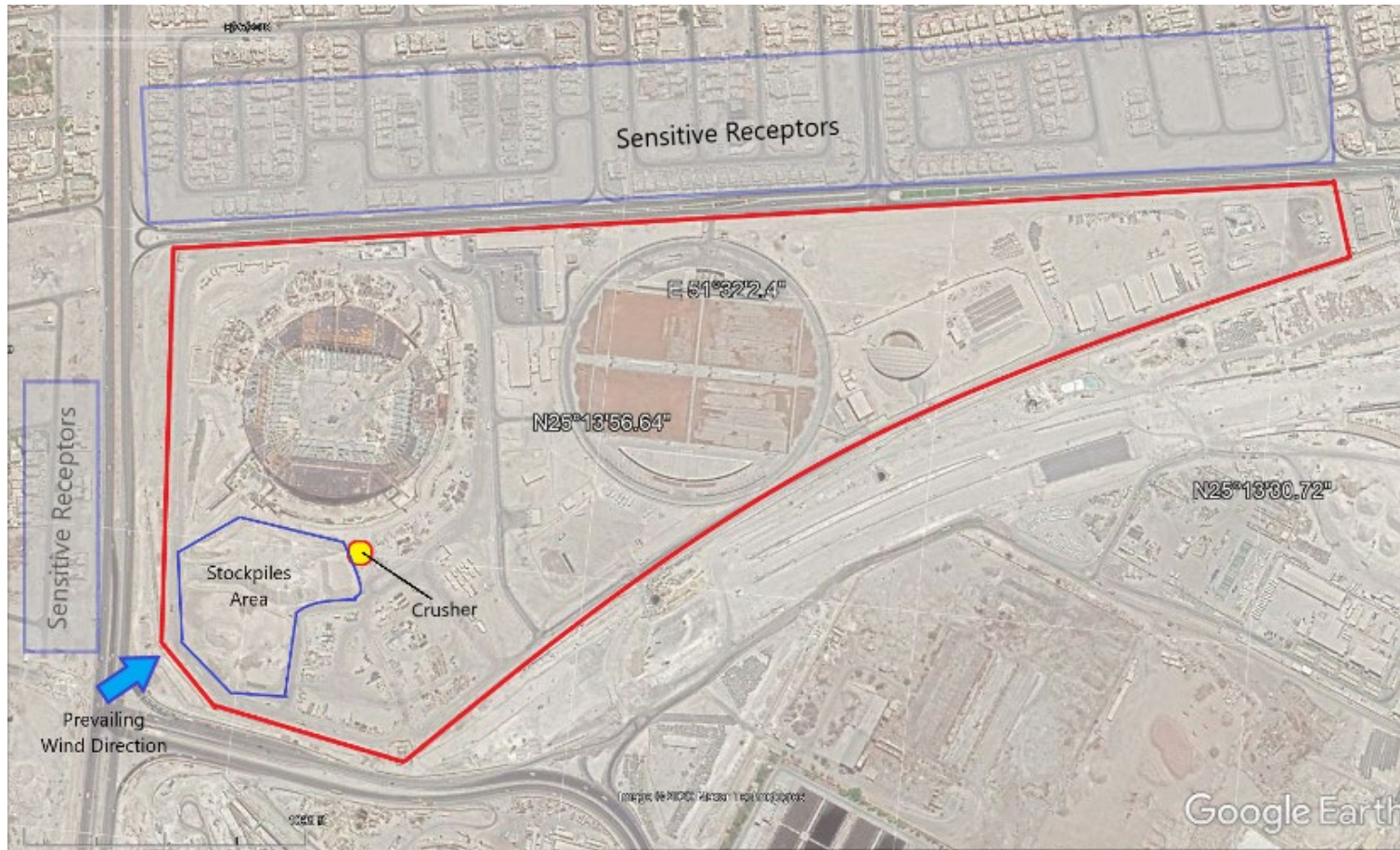


**Figure 6:** *Suppression of dust from crusher*

- Excavated materials were pre-wetted to reduce the expected dust during crushing.
- Screens were installed covering the crusher from the sides and the top to enclose the generated dust within the crusher space.
- Sprinklers were installed on the top and sides of the crusher to spray water on the outer surface of the screen during crushing. The sprinklers are considered as second defense to capture the dust escaping the screen.

### 3.0 IMPLEMENTED METHODS AND MEASURES

- The crusher was located downwind of the stockpiles for them to work as a barrier to block the wind.
- The crusher was located considering the prevailing wind direction to avoid the dust escaping the screen to reach sensitive receptors.



**Figure 7:** Selection of the right location for the crusher

### 3.0 IMPLEMENTED METHODS AND MEASURES

#### Best Practice 5: Location of Batching Plant Downwind and away from Sensitive Receptors

In large concrete structure projects, it is very common to have a batching plant on site to secure the supply of concrete. Batching plants are one of the main sources of dust from construction sites. Concrete is composed of a mix of materials including cement, gravel and sand. Cement powder is typically stored in silos, which, if not properly insulated, letting cement dust out in the air. The unloading, transportation and downloading of gravel and sand into the hoppers generate a great quantity of dust. Unfortunately, pre-wetting the aggregates can result in adding too much water to the mixture, thereby decreasing the concrete’s strength. This makes dust generation from batching plants almost unavoidable. Therefore, the location of the batching plant is a very important mitigation measure to prevent the unavoidable dust affecting sensitive receptors.

This is one of those measures that need to be considered at the beginning of the construction phase when planning the logistics of the site.

At Lusail Stadium, for example, there is a residential area located northeast of the site. Workers’ accommodation on site and temporary offices were also considered as sensitive receptors. As the prevailing winds in the area come from the northwest, it was decided to locate the workers’ accommodation and temporary offices near the north boundary of the site and the batching plant downwind, at the southeast corner of the site.

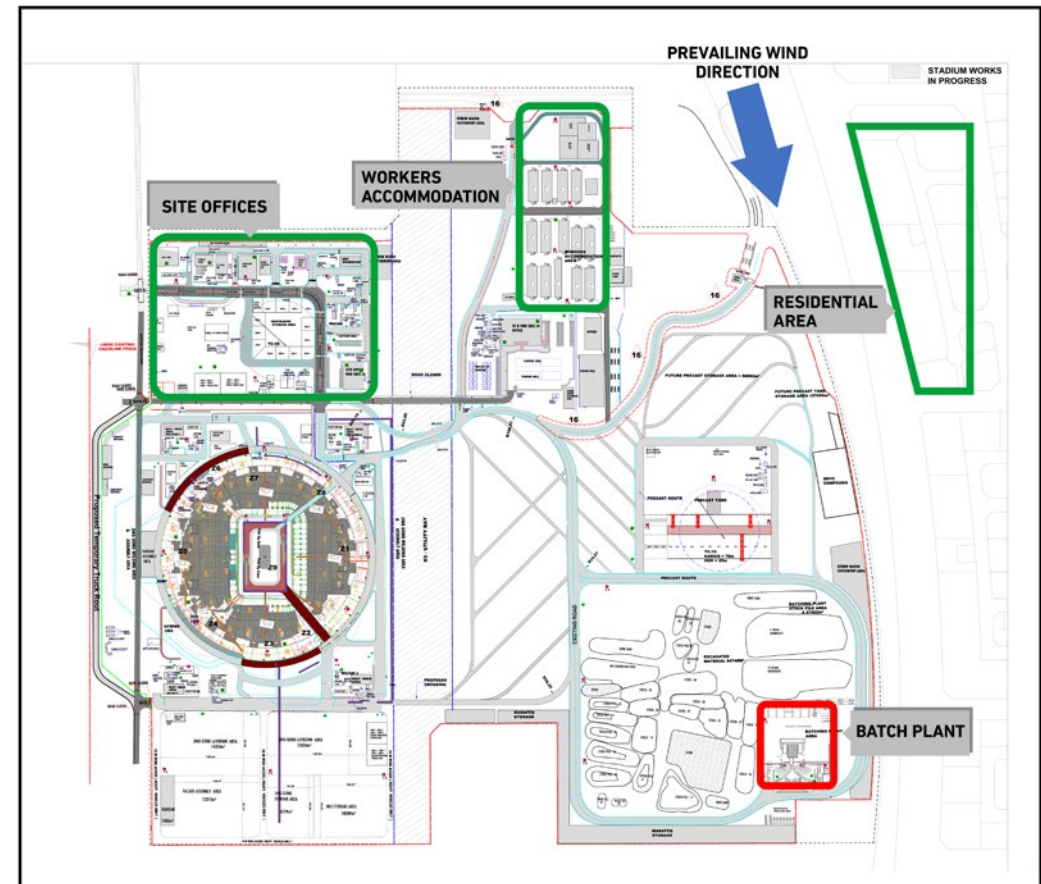


Figure 8: Selection of the right location for the batching plant



## 3.0 IMPLEMENTED METHODS AND MEASURES



**Figure 9 :** Long-term stockpiles covered with tarpaulin

### Best Practice 6: Tarpaulin Used to Cover Stockpiles

In SC stadiums construction sites, excavated materials were stockpiled short-term and long-term. Wind blowing away dust from unprotected stockpiles is one of the main dust sources in construction sites. Traditionally, stockpiles are covered with a green plastic mesh which eventually gets damaged by the wind and sunlight, thereby reducing its effectiveness.

At Lusail Stadium, long-term stockpiles were covered with 40 feet by 40 feet tarpaulin sheets forming a thick cover for a more stable stockpile. The following advantages have been found when comparing tarpaulin with the green plastic mesh:

- It is capable of withstanding adverse wind conditions and sunlight, making it more durable.
- It holds moisture much better, helping the stability of the stockpile.
- It helps save huge quantities of water that is needed to wet the soil.
- It requires less maintenance.
- It has a lower long-term cost. Although the tarpaulin's material cost is higher, it needs to be replaced only once every two to three years, while the green mesh must be replaced once every three to four months. Furthermore, maintenance costs of tarpaulin are lower, which makes it more economical if it is to be used for more than one year, depending on the project.

## 3.0 IMPLEMENTED METHODS AND MEASURES

### Best Practice 7: Fog Cannons Used on Loading Areas

Loading and unloading of soil and aggregates is one of the main dust generating activities in construction sites. Dust is easily blown away by the wind when the soil is dry. Wetting the soil is an effective mitigation measure.

At Stadium 974 and Lusail Stadium, cannons were used to spray water in the loading areas rather than using the typical hose. The cannons sprayed

pressurized water pumped through a series of jet nozzles. They were placed near loading areas and water was pumped out and dissipated in the air to capture the dust from having the chance to spread. They can also be directed to the stockpiles to pre-wet the soil. They have a lower water consumption compared to traditional spraying methods while achieving the desired dust control.



Figure 10 : Fog cannons

## 3.0 IMPLEMENTED METHODS AND MEASURES

### Best Practice 8: Milled Asphalt Used for Paving Hauling Roads

Hauling roads are necessary in large construction sites like stadiums. Sand and clay-based roads are considered among the main dust generators at construction sites and therefore, best practices are needed to eliminate the potential dust. Typically, water is sprayed on such roads for dust suppression. However, paving hauling roads is a more effective way of dust suppression and results in saving large quantities of water.

Education City Stadium and Stadium 974 projects paved the hauling roads and pedestrian pathways with milled asphalt. Milled asphalt is a waste material sourced when re-paving roads. During the process, the asphalt is milled into small fragments that can be easily spread and compacted as a final layer on hauling roads.

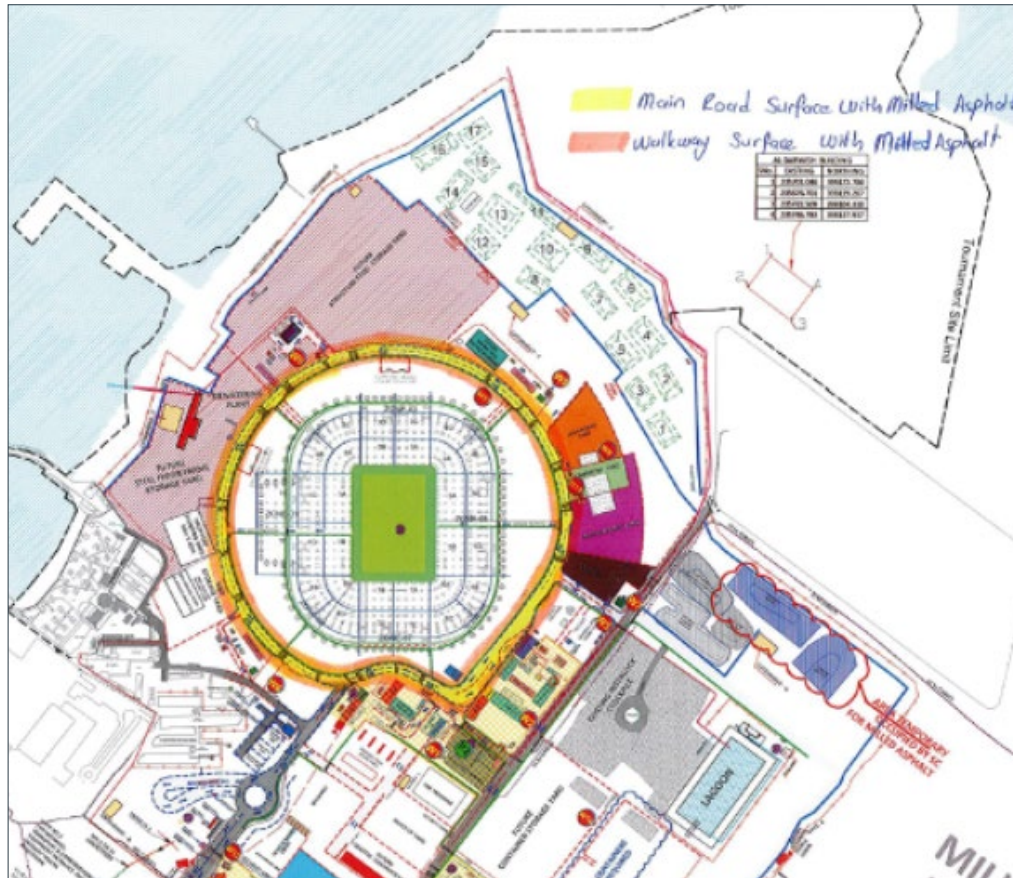
Overall, the use of milled asphalt has several benefits including the following:

- It is very effective in preventing dust generation as the aggregates are bond with bitumen.
- It is affordable and efficient material.
- Its use diverts waste from landfills, hence reducing the burden on the environment.
- It saves a huge quantity of water that is generally used to spray on dirt hauling roads.
- It required less maintenance and repair compared to dirt hauling roads.
- It prevents mud during the rainy seasons.

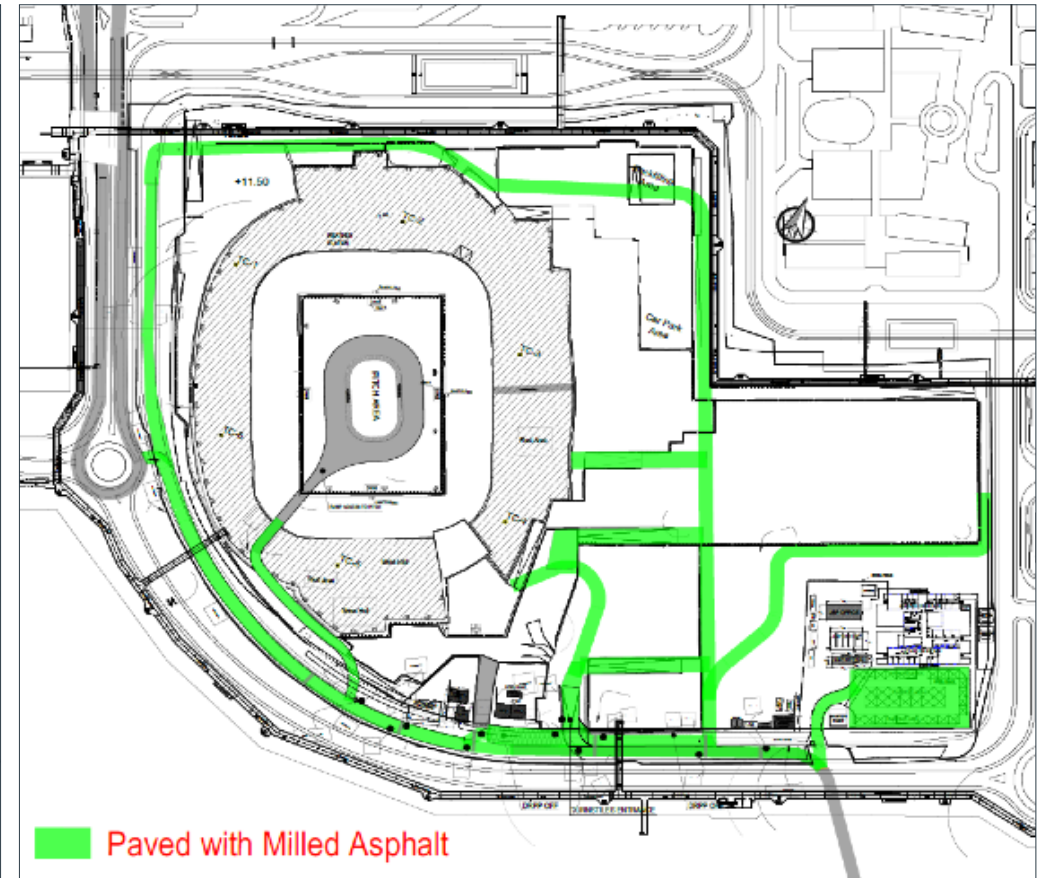


Figure 11 : Hauling roads paved with milled asphalt

### 3.0 IMPLEMENTED METHODS AND MEASURES



**Figure 12 :** Plan of paved hauling roads at Stadium 974



**Figure 13 :** Plan of paved hauling roads at Education City Stadium

### 3.0 IMPLEMENTED METHODS AND MEASURES

#### Best Practice 9: Water Spraying of Site for Dust Suppression

Non-paved hauling roads and open areas on construction sites are dust sources, especially on windy days. A traditional mitigation measure is to spray water on these areas several times a day via tankers or any other suitable way. Effective dust suppression requires large quantities of water, which is an undesired environmental problem. Across the SC projects, water consumption was reduced by implementing the following measures:

- Discharged water from dewatering was used where available (Stadium 974, Al Janoub Stadium, Al Thumama Stadium and Education City Stadium).
- Treated Sewage Effluent (TSE) was used instead of potable water in all the stadiums. TSE water was pre-treated through chlorination in the tanker and quality tests were performed regularly to ensure the water met the sanitary standards.
- Tankers' trips and routes were scheduled to improve efficiency of the process.
- Tankers' fixtures were modified to improve their efficiency and for wider spread of water.



Figure 14 : Water spraying for dust suppression

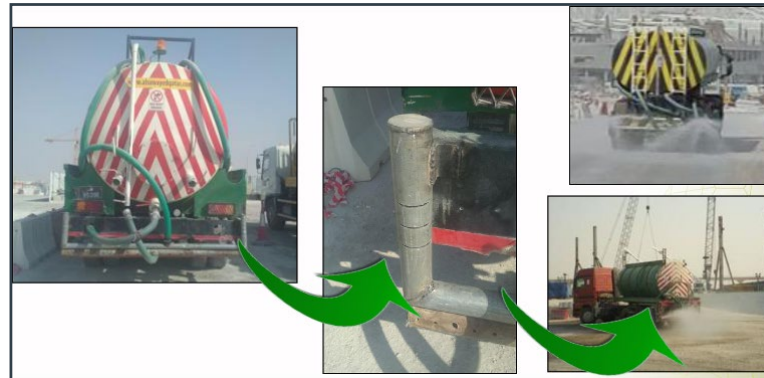


Figure 15 : Modified water sprayer



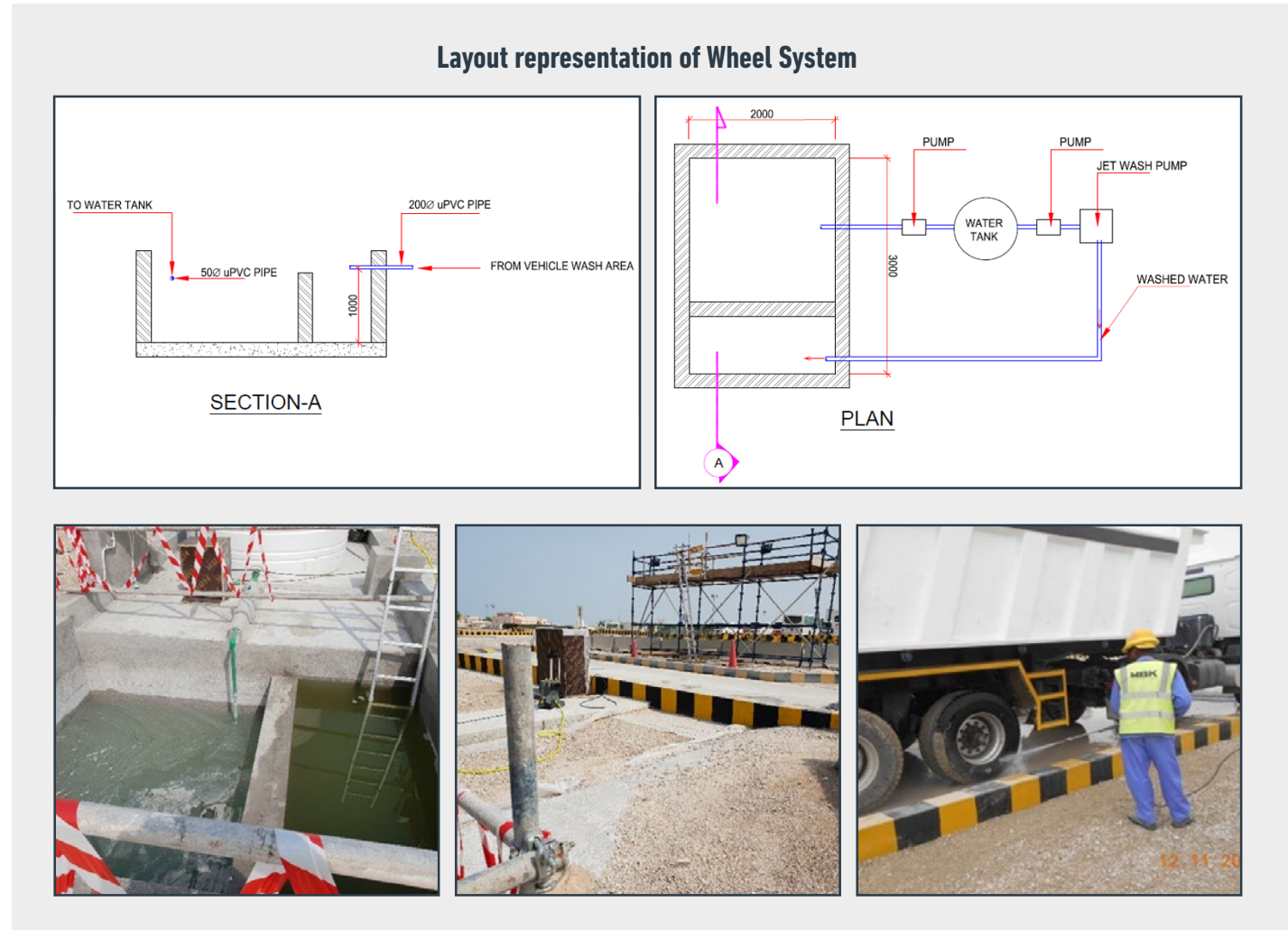
Figure 16 : Ahmad Bin Ali Stadium spraying routes schedule

### 3.0 IMPLEMENTED METHODS AND MEASURES

#### Best Practice 10: Vehicles Washout

Mud and dirt onto public roads adjacent to construction sites is also a source of dust as vehicles pass over it, grinding it into smaller particles that can be blown away by the wind. Typical mitigation measures include the installation of wash bays for trucks including all necessary wash systems, and rumble grids near the exits of the construction sites. Wash bays are more effective than rumble grids, but they require large quantities of water.

At some of the stadiums, like Stadium 974, this problem was solved by recirculating the water used for washing. The wash bay was also provided with a sedimentation tank to remove the soil particulate from the water and making it suitable for recirculation through the pumps and pipelines.



**Figure 17 :** Water-recirculating vehicle washout at Stadium 974

## 3.0 IMPLEMENTED METHODS AND MEASURES

### Best Practice 11: Site Audits

GSAS Trust conducted four site audits per stadium. One of the main subjects for assessment was dust control measures. Audits helped project teams to stay focused and perform a continuous supervision of mitigation measures. The stages auditing system resulted in the improvement of dust control throughout the project life.

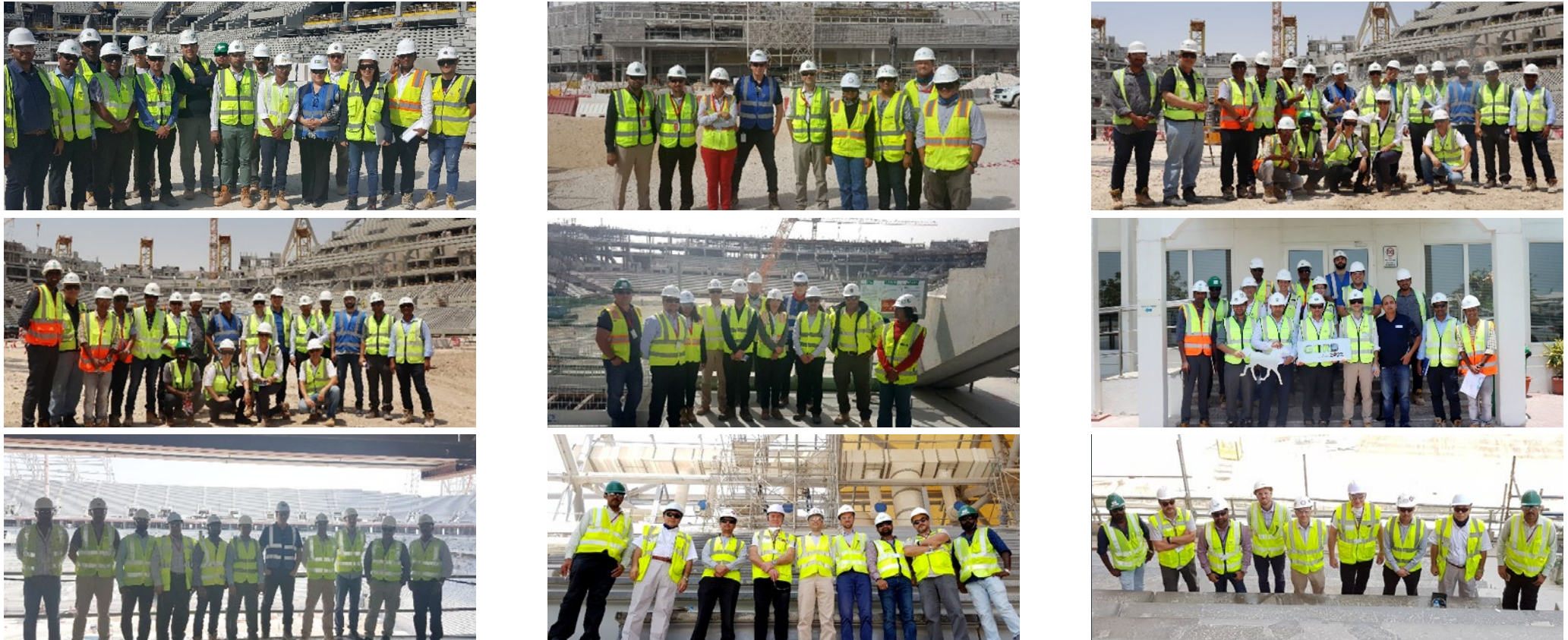


Figure 18 : Site audits teams

## 3.0 IMPLEMENTED METHODS AND MEASURES

### Best Practice 12: GSAS Continuous Program Development

Sustainability and environmental team members kept themselves updated with the latest information related to the sustainability issues and challenges by attending GSAS continuous education programs, delivered by the Global Sustainability Academy at GORD. This practice was an off-site action undertaken to ensure the awareness of the most updated sustainability best practices.

The SC also organized a program-wide knowledge sharing program where Environment and Sustainability staff visited other sites and learnt from each other's best practices.



**Figure 19 :** GSAS-CM workshops and SC knowledge-sharing sessions



## 3.0 IMPLEMENTED METHODS AND MEASURES

### 3.2 Common Practices

#### Common Practice 1: Covering Stockpiles in Green Plastic Net

Wind can blow fine particulates away from dry exposed surfaces of soil stockpiles. To mitigate the dust generation, a traditional solution is covering the long-term stockpiles with a green plastic net that captures the fine particulate; this was implemented across the SC stadiums.

SC projects performed necessary maintenance works as the net can be damaged by strong winds and sunlight. This is the reason why the net is degraded and must be replaced approximately every four months.



**Figure 20 :** Covered stockpiles with plastic net

#### Common Practice 2: Covering Trucks with Green Plastic Net

Trucks transport soil in open dump boxes that, if not protected, are exposed to friction with the air blowing away clouds of dust.

In SC stadiums projects, the moving vehicles and dump trucks were covered with a green plastic net before leaving the site. The net captures the flying particulate before leaving the dump box.



**Figure 21 :** Covered trucks with plastic net

#### Common Practice 3: Road Sweepers

Due to the frequent movement of vehicles from and to the construction site, soil and mud may spread on the internal and adjacent roads. Vehicles pass over the soil and mud grinding it into fine particulates that can be blown away by the wind, thus generating dust.

To mitigate this problem, SC projects used road sweeping equipment that removed the soil and mud from the road surfaces.



**Figure 22 :** Road sweepers

## 3.0 IMPLEMENTED METHODS AND MEASURES

### Common Practice 4: Locating Stockpiles near Backfilling Areas

Trucks transporting soil on site generate dust from grinding the dirt on hauling roads and from their dump boxes.

The SC stadium projects mitigated this impact by locating stockpiles near the backfilling areas, which reduced the distances that trucks need to cover within the site and therefore the dust generation. This measure must be planned at the beginning of the project when the logistics of the site is established.

### Common Practice 5: Training

Mitigation measures are eventually implemented by staff and workers on site. Also, workers are involved in the dust generation from their daily activities on site. This makes training and awareness on dust mitigation key for successful dust control on site.

SC stadium projects are implemented comprehensive training programs that include all staff and workers on site. Special training was provided to staff and workers who were involved in the main dust generating activities, like machinery operators and drivers.



**Figure 23 :** Stockpiles adjacent to backfill areas



**Figure 24 :** On-site training sessions on dust management

## 3.0 IMPLEMENTED METHODS AND MEASURES

### Common Practice 6: Barriers Around Dust Generating Activities

Some dust generating activities are carried out in a permanent location by stationary equipment, which allows the use of temporary barriers as an effective way of isolation to mitigate the spread of dust.

SC stadium projects were not only effectively isolating outdoor equipment such as crushers, as we have seen, but also indoor equipment like saw-cutting tables used for blocks and tiles. This also had the benefit of improving the indoor air quality which results in healthier working environment.



**Figure 25:** Barriers around dust-generating equipment

### Common Practice 7: Indoor De-dusting Systems

Dust develops through different work processes in the construction of indoor areas which may have adverse effects of human exposure. Health and Safety standards recommend that the indoor environment should be free of hazardous pollutants and contaminants.

To achieve this requirement, temporary ventilation and dedusting systems were installed in the SC stadiums projects. The fine impurities (dust and contaminants) were removed using pneumatic air compressors.



**Figure 26:** Indoor de-dusting systems

## 4.0 CONCLUSION

Air quality still remains one of the greatest environmental concerns, and dust from construction is a major contributor to this issue. Based on this report, it is clear that dust emissions can be reduced drastically through effective management practices throughout the construction process, starting at the planning stage. The best practices mentioned in this report are efficient, cost-effective and easy to implement.

The measurable impacts of these practices were evident during the construction of stadiums and have been monitored and verified by third-party auditors as part of the GSAS Construction Management certification.

With construction of the centerpieces for the FIFA World Cup Qatar 2022™ Qatar nearing completion, the knowledge built during the construction of the stadiums is invaluable. Going forward, the opportunity to host the FIFA World Cup Qatar 2022™ in Qatar brings many opportunities to learn and to improve. This includes how dust from construction sites is managed.

This report is an effort to create a legacy of knowledge and to make it available to the wider audience within the construction sector.

We very much encourage others to consider these best practices as well as the GSAS Construction Management certification to improve the air quality by reducing dust emissions.



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