HIGHMOOR LANE, HARTSHEAD MOOR

CRICKET BALL STRIKE ASSESSMENT

LABOSPORT

BALL STRIKE ASSESSMENT– HIGHMOOR LANE – CRICKET PITCH

CLIENT	Thirteen Housing Group
SITE ADDRESS	Highmoor Lane Cleckheaton Yorkshire BD19 6LW
CLIENT CONTACT	Stuart Hutchinson

REPORT NUMBER	LSUK.24-0418_CBA	
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REPORTED BY		Michael Thelwell Special Projects Consultant
APPROVED BY		Tom Would Consultant

INTRODUCTION	To assess the potential risk of cricket balls surpassing the boundaries of a cricket pitch at Hartshead Moor Cricket Club, Labosport Ltd has reviewed the site distances and topography to analyse the risk of balls surpassing the site boundaries. The analysis uses a cricket ball trajectory model that has been developed by Labosport, in collaboration with the ECB. If required, the report will identify the height of any ball trajectory mitigation to minimise the potential risks. **Note:** This is a desk study, Labosport have not visited the site, taken measurements, or carried out a visual inspection. All measurement information has been provided by the client and any error in measurements are not the responsibility of Labosport. This assessment is undertaken on the basis of accurate data.

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Section 1 – Executive Summary of Conclusions

Executive Summary of Conclusions

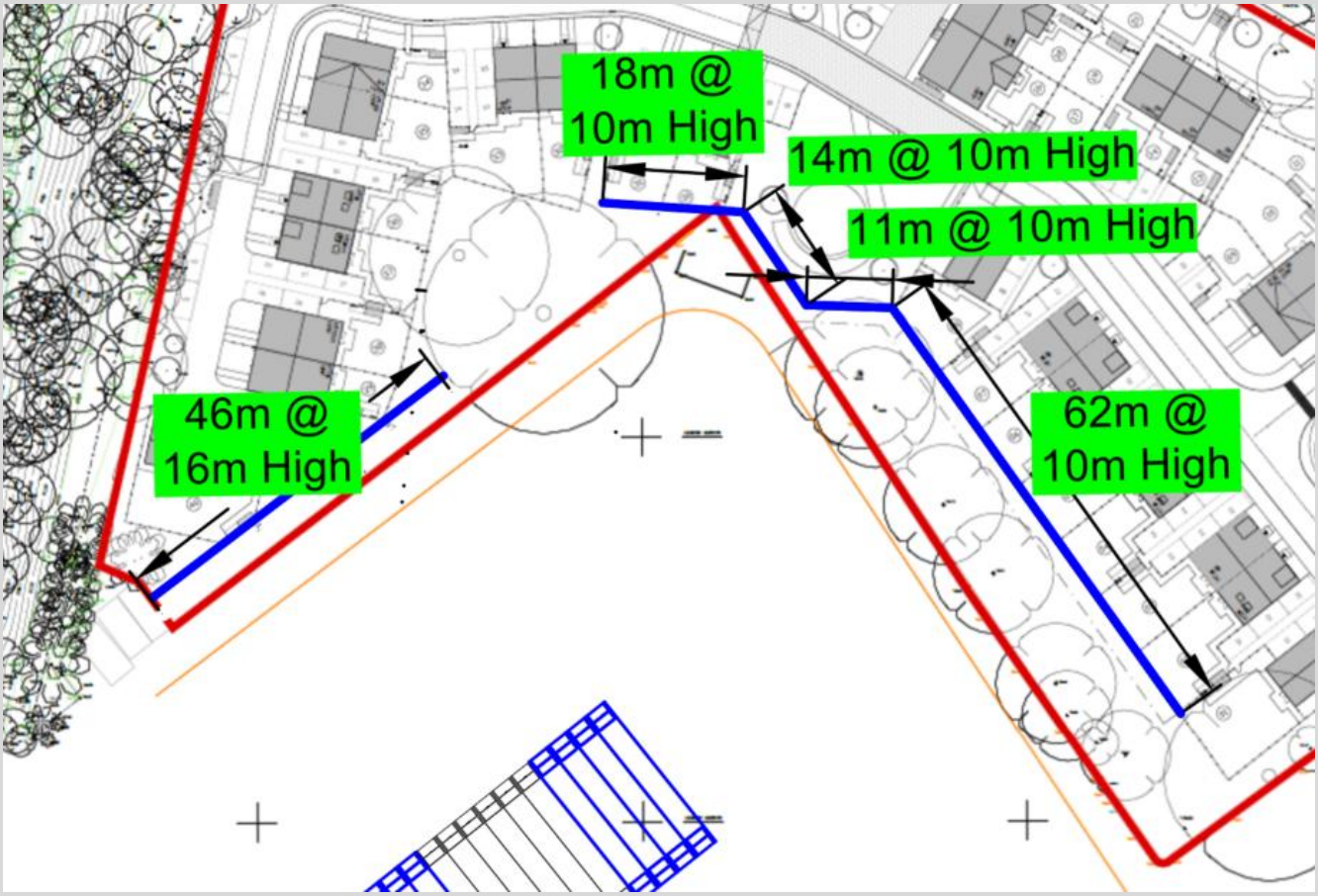
This report has been prepared to assess the potential risk of cricket balls surpassing the boundaries of a cricket pitch at Hartshead Moor Cricket Club and advise on the height and location of mitigation recommended to provide a suitable level of protection to a new proposed housing development.

95% protection level – Official recommendation

Orientation	Recommended mitigation height (based on professional cricket)
North	16 m
East	10 m

Please Note: This may not stop all shots from landing beyond the site boundary, but it is believed from the assessment of the ball trajectory it will significantly reduce their frequency.

The below diagram shows the proposed locations of the recommended mitigation for heights detailed above to prevent 95% of cricket ball trajectories from impacting the proposed development if played on all currently used pitches:



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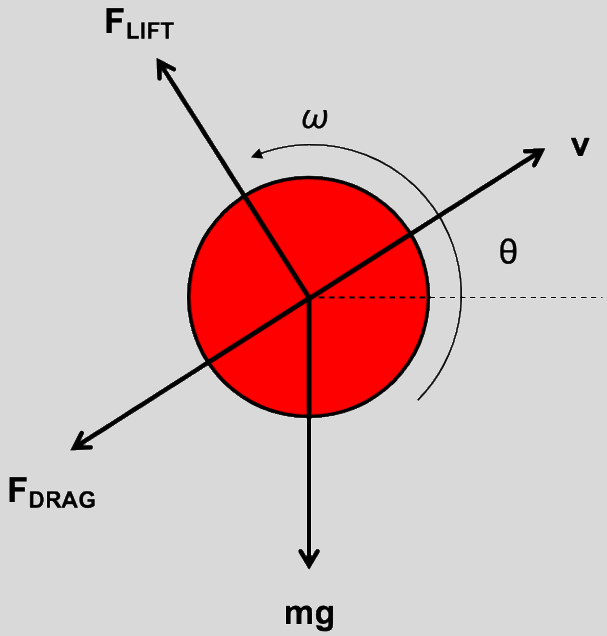
Section 2 – Cricket Ball Trajectory Model

Trajectory Model Overview

Previous work undertaken by Labosport for the England and Wales Cricket Board (ECB) led to the development of a sophisticated trajectory model to estimate the distance a ball would travel, and its trajectory given a specific velocity, angle, spin rate and atmospheric conditions (i.e. altitude).

The trajectory model uses aerodynamic principles and Newtonian physics to predict the ball flight path whilst accounting for the effect of air resistance. The model uses aerodynamic coefficients taken from published wind tunnel studies on cricket balls at different velocities.



The aerodynamic forces of drag (F_D) and lift (F_L) are proportional to the ball's velocity relative to the air flow, frontal area, air density and the drag coefficient respectively lift coefficient. The forces are defined as:

$$F_D = \frac{1}{2} C_D \rho V^2 A$$
$$F_L = \frac{1}{2} C_L \rho V^2 A$$

where C_D and C_L are the non-dimensional drag and lift coefficients, ρ is the air density in kg/m^3, V is the air stream velocity in m/s and A is the frontal area of the ball in m^2. Due to the complexity of the flight dynamics, the trajectory can only be resolved by using a numerical time step approach whereby the ball conditions are calculated at small timesteps throughout the trajectory. The conditions at time step 1 are used to calculate the conditions at time step 2; the conditions are timestep 2 are used to calculate the conditions at time step 3 and henceforth. A timestep of 0.001 seconds was used to generate high-resolution trajectory data.

Trajectory models are known to exhibit high accuracy and Labosport have undertaken extensive experimental validation of this trajectory model to refine its accuracy. However, it is not possible to simulate the full complexity of the real world and this model does not account for variations in bat/ball restitution or wind (speed and direction). Due to these limitations, the model is regarded as an indicative prediction tool.

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Trajectory Scenarios
The hit angles and velocities are estimated from in-game action to cover a range of 'typical' shots ranging from 20 degrees to 50 degrees and 20 m/s (45 mph) to 50 m/s (112 mph). The exact frequency of shots resulting in a cricket ball being hit into adjacent areas is unknown and impossible to predict with certainty (player skills, type of game and many other factors can influence this) hence a proportionate approach needs to be taken to provide safety to users. In reality, there may be a "freak" shot that will result in a further than expected trajectory; however, the implications of planning for this type of worst-case approach could result in the closure of hundreds of cricket grounds across the country and hence a balanced risk mitigation strategy needs to be implemented that is proportionate. Indeed, there are risks associated with many everyday activities, but plans need to be developed to reduce risk following good practical health and safety principles including a combination of likelihood and severity. Trajectories at an angle to the pitch In scenarios where the direction of the trajectory is perpendicular to the direction of the pitch (or within 45 degrees of perpendicular), the analysis considers one trajectory scenario. This scenario is a ball trajectory played from the closest batting crease in the trajectory direction. Trajectories parallel to the pitch Where the direction of the trajectory is parallel to the direction of the pitch (or within 45 degrees), the analysis considers two trajectory scenarios; 1) a trajectory played from the closest batting crease, and 2) a trajectory played from the furthest batting crease. The type of cricket batting shots required to hit the ball from closest stumps are 'late cut' and 'late glance' shots and these do not achieve the same velocity as a 'straight drive' from the furthest batting crease. A greater emphasis is therefore placed on trajectories from the furthest batting crease.

Previous Work
Labosport Ltd have undertaken this type of boundary risk assessment for a great many other cricket grounds over the past 5 years when there have been perceived problems with cricket balls exceeding the boundary, or the potential influence of a new adjacent development to an existing club. Through this work, Labosport Ltd have developed significant expertise that supports our judgements in these matters.

Section 3 – Monte Carlo Simulation

Monte Carlo Simulation
Monte Carlo simulation is a computational technique that uses random sampling to model the probability of different outcomes in a process that involves uncertainty. It's used to analyse and predict outcomes in situations where there's inherent randomness or variability, often by simulating the process thousands or millions of times with slightly different random inputs. This allows for a probabilistic view of potential results, including the likelihood of each outcome. Since the flight of a cricket ball can vary considerably due to changes in its launch characteristics (launch speed, angle and spin), using a Monte Carlo statistical approach enables us to consider what proportion of ball trajectories across a plausible distribution of launches would be prevented from passing over a net of a given height. For this analysis, we simulated 20,000 cricket ball trajectories for each modelled ball launch scenario towards the site boundary from the cricket square, with launch velocities ranging from 20-50 m/s and launch angles ranging between 20-50 degrees to the horizontal.

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Section 4 – Site Specifics

Playing Standard of Cricket on the Site
Labosport have investigated the level of cricket that is played on this site. We have been advised that professional cricket is played on this site. Hartshead Moor CC's 1st XI currently plays in the Bradford Premier League Division 1, with some of their players being semi-professional, in addition to other clubs that Hartshead Moor CC will be playing against including both full and semi-professional players. Therefore, the level of cricket being played at this site should be classed as professional for the purposes of this assessment. For professional level cricket (1st class and international), the basis of the shot velocity is 50 m/s. For professional level cricket the basis of the 'late cut' or 'late glance' type shots is 35 m/s. It is on this basis that the recommendations in this report have been made.

Existing Mitigation
There is currently no existing mitigation around the facility. This report does not account for any existing, or planned planting (trees, hedges etc). It is our informed opinion that planting cannot be relied upon to provide protection against ball trajectories. The planting may not be sufficiently dense to stop the ball, nor homogeneous across the length. The planting may change during the seasons, or indeed be cut back or removed.

Orientation of Risk
At the instruction of the client, this boundary risk assessment only evaluate possible ball trajectories in a northernly and easternly direction towards the proposed development. The focus on the analysis is based on the shortest distances from the closest cricket pitches to the potential area of risk. Labosport have been informed that the 1st XI plays on the central six pitches on the cricket square, with the four pitches on the eastern end of the square used for 2nd XI play and practice, while the five most western pitches are used for junior and 2nd XI level play. It is on this basis that this assessment has been carried out.

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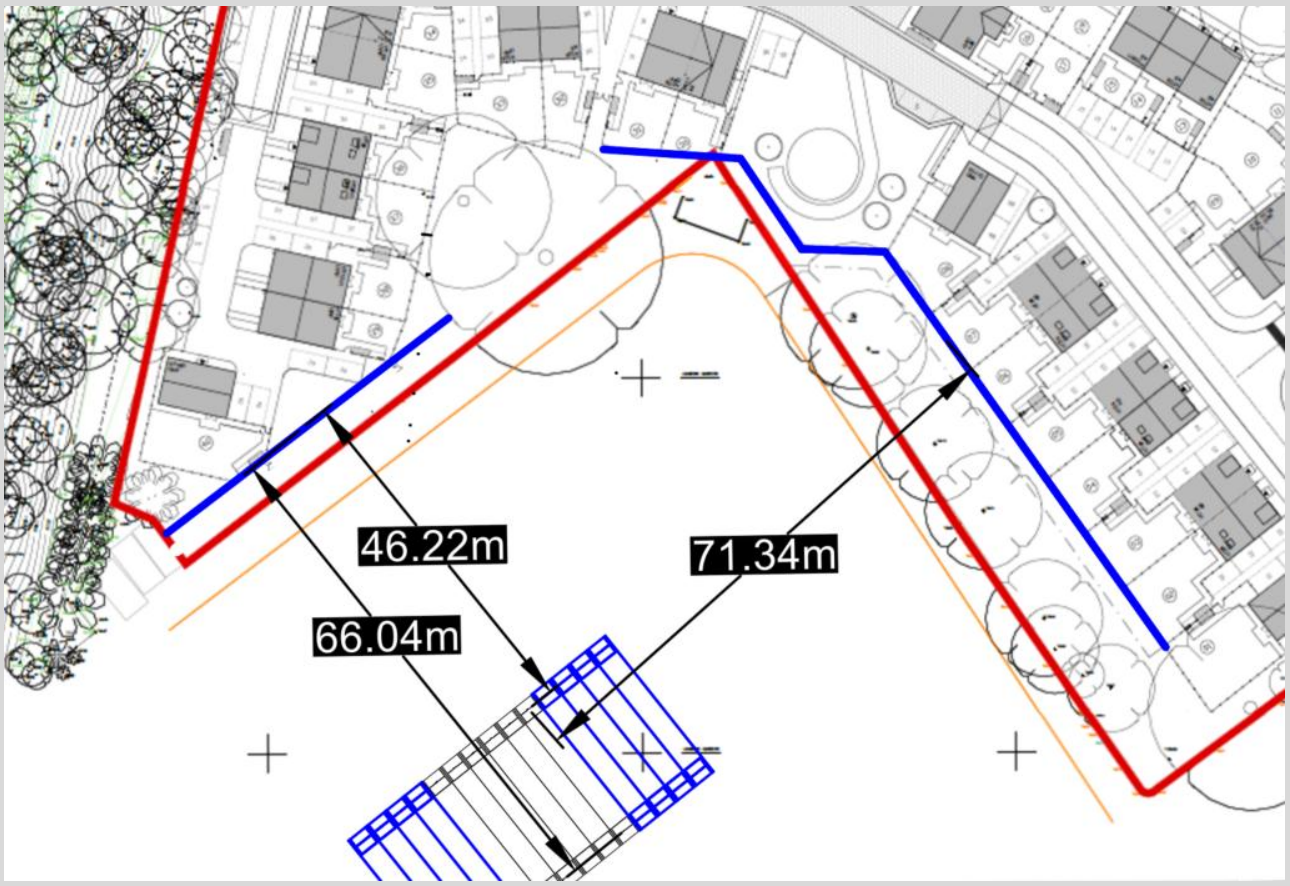
Section 5 – Site Measurements

Site Measurements



The above diagram illustrates the minimum distances from the cricket square to the site boundaries. Note as this is a risk assessment the worst-case scenarios are considered; consequently, the shortest measured (and calculated) distance is used for the study. The pitches highlighted in blue above are those used for 2nd XI, junior and practice level cricket. The following distances have been used to calculate the projected height of the ball for different shot conditions as specified below:

Measured Distance	Shortest Boundary (m)
North – Closest stump to site boundary	Circa 46.22 m
North** – Furthest stump to site boundary	Circa 66.04 m
East – Closest stump to site boundary	Circa 71.34 m

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Section 6 – Estimated Ball Height

Estimated Ball Height (Using the Projection Modelling Tool)

North Orientation

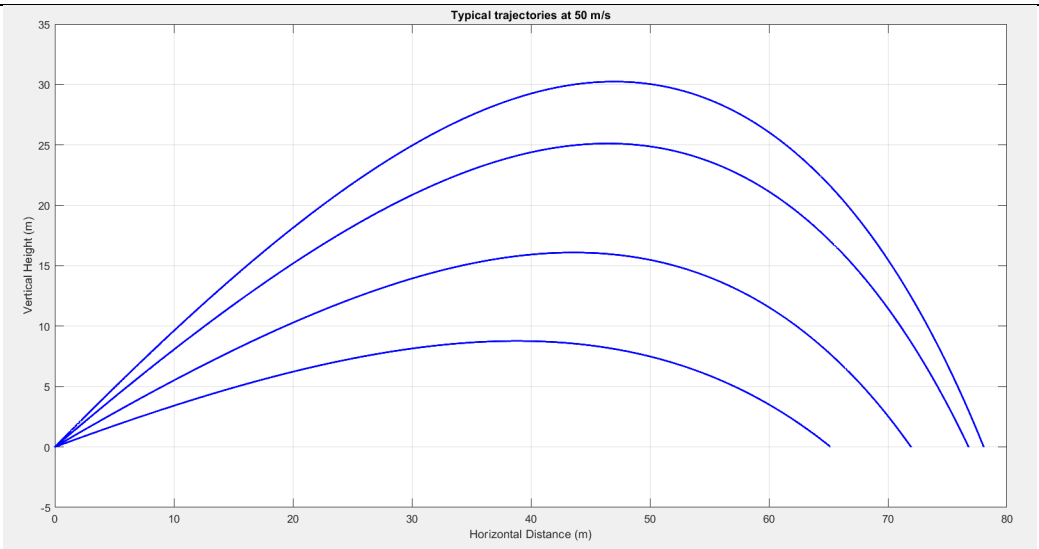
Estimated Ball Height @ 46.2 m		Angle (degrees)						
		20	25	30	35	40	45	50
Velocity (m/s)	20	0	0	0	0	0	0	0
	25	0	0	0	0	0	0	0
	30	0	0	0	1.2	2.1	2.1	0
	35	0	3.6	6.4	9.2	11.6	12.9	12.6
	40	4.2	7.6	11.1	14.4	17.5	20.1	21.8
	45	6.5	10.4	14.1	17.8	21.6	25.1	28.1
	50	8.5	12.3	16.3	20.4	24.5	28.7	32.6
Estimated Ball Height @ 66.0 m		Angle (degrees)						
		20	25	30	35	40	45	50
Velocity (m/s)	20	0	0	0	0	0	0	0
	25	0	0	0	0	0	0	0
	30	0	0	0	0	0	0	0
	35	0	0	0	0	0	0	0
	40	0	0	0	0	0	0	0
	45	0	0	4.2	6.8	8.5	7.6	2.2
	50	1.8	6.1	10.4	14.2	16.9	17.9	15.2

East Orientation

Estimated Ball Height @ 71.3 m		Angle (degrees)						
		20	25	30	35	40	45	50
Velocity (m/s)	20	0	0	0	0	0	0	0
	25	0	0	0	0	0	0	0
	30	0	0	0	0	0	0	0
	35	0	0	0	0	0	0	0
	40	0	0	0	0	0	0	0
	45	0	0	0	0	0	0	0
	50	0	2.7	6.5	9.6	11.2	9.9	4.7

See below and Appendix A for example trajectories.

Cricket ball trajectories @ 50 m/s



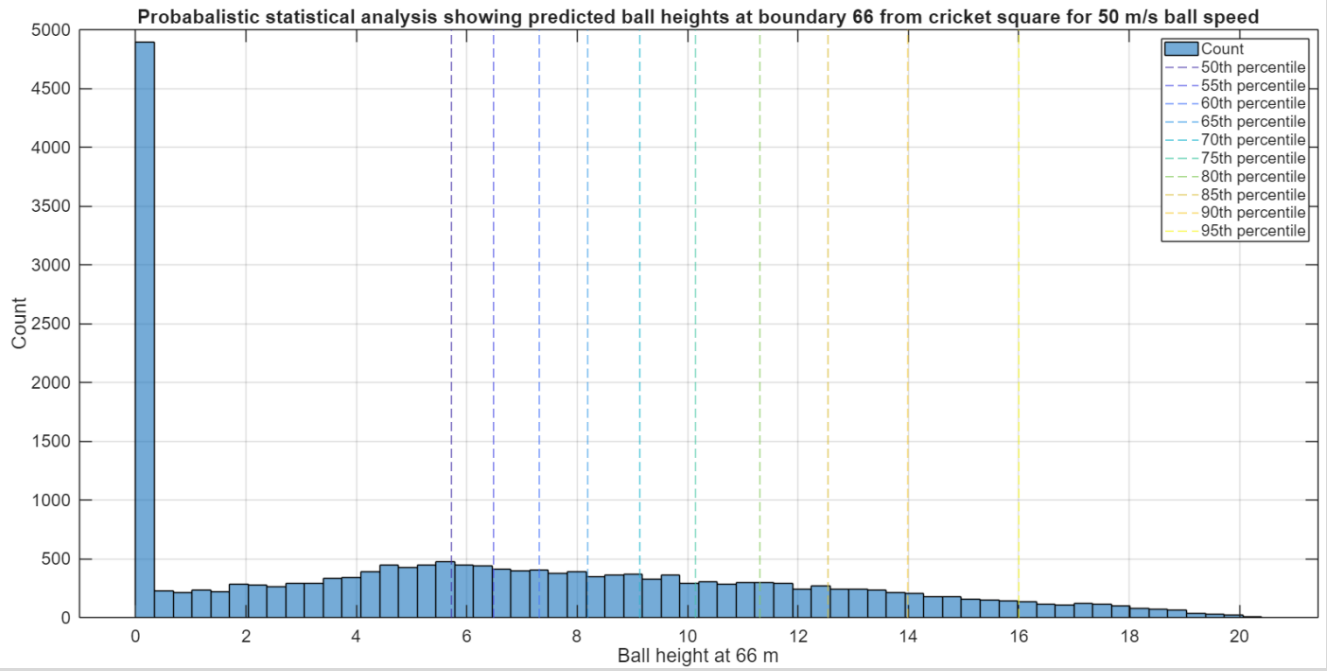
Section 7 – Risk Assessment Discussion

Risk Assessment Discussion

This report has been prepared to assess the potential risk of cricket balls surpassing the boundaries of a cricket ground at Hartshead Moor Cricket Club and to advise on the height and location of mitigation recommended to provide a suitable level of protection.

Mitigation Recommendations – North Orientation

Distance	Distance to boundary	Mitigation height (majority of risk removed)	Mitigation height (vast majority removed)	Overall mitigation height recommendation
Closest stump to site boundary @ 35 m/s	46.22 m	11 m high	13 m high	**16 m high**
Furthest stump to site boundary @ 50 m/s	66.04 m	16 m high	18 m high	



According to a Monte Carlo statistical simulation, the levels of protection provided by different heights of netting are as follows:

- 50th percentile net height: 5.72 m
- 55th percentile net height: 6.48 m
- 60th percentile net height: 7.31 m
- 65th percentile net height: 8.19 m
- 70th percentile net height: 9.13 m
- 75th percentile net height: 10.14 m
- 80th percentile net height: 11.31 m
- 85th percentile net height: 12.54 m
- 90th percentile net height: 13.99 m
- 95th percentile net height: 16.00 m

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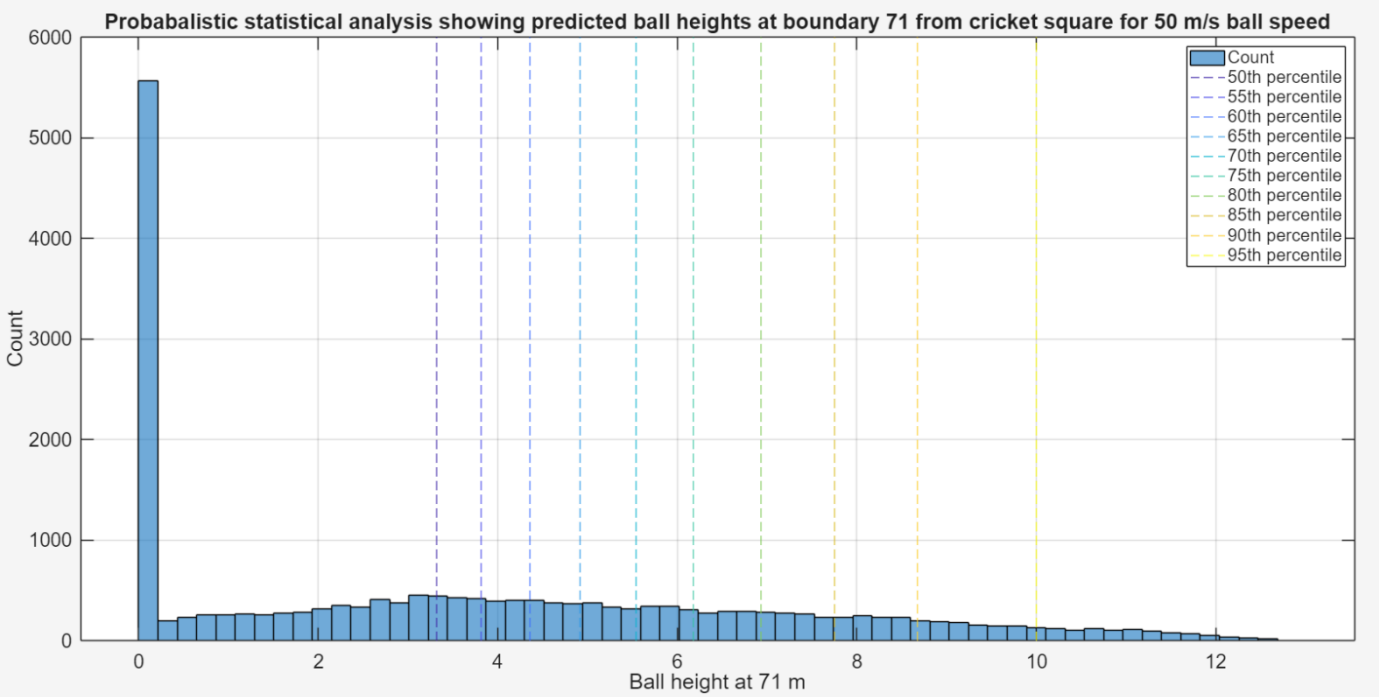
Mitigation Recommendations – East Orientation

Distance	Distance to boundary	Mitigation height (majority of risk removed)	Mitigation height (vast majority removed)	Overall mitigation height recommendation
Closest stump to site boundary @ 50 m/s	71.34 m	10 m high	12 m high	**10 m high**



According to a Monte Carlo statistical simulation, the levels of protection provided by different heights of netting are as follows:

- 50th percentile net height: 3.32 m
- 55th percentile net height: 3.82 m
- 60th percentile net height: 4.36 m
- 65th percentile net height: 4.92 m
- 70th percentile net height: 5.54 m
- 75th percentile net height: 6.18 m
- 80th percentile net height: 6.93 m
- 85th percentile net height: 7.75 m
- 90th percentile net height: 8.67 m
- 95th percentile net height: 10.00 m

Section 8 – Conclusions

Conclusions

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95% protection level – Official recommendation

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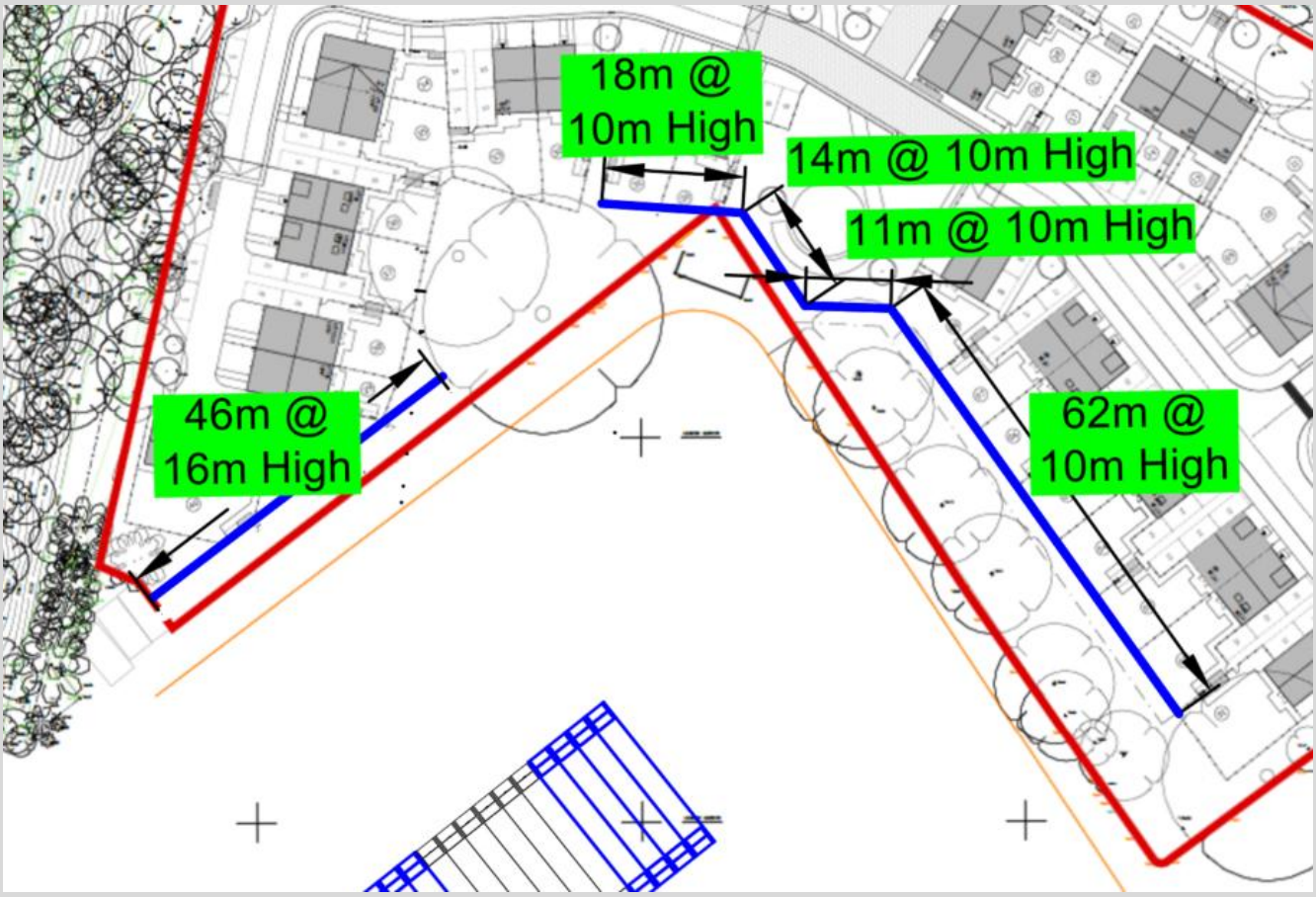

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Further Notes

This report does not recommend the specific design of a mitigation system, however options could include;

- Ball stop netting
- Rigid panel fencing
- Permanent or temporary fencing structures

The best place to see some examples/get some quotes for the type of netting required for the site would be the Sports and Play Construction Association (SAPCA) website: https://sapca.org.uk/members/

If you go to this webpage and filter by 'Cricket Netting Facilities', you should be presented with a list of potential member companies and their contact details/websites.

It is recommended the client discuss design options with the relevant stakeholders including the LPA, the ECB and the cricket club.

In addition, the client may wish to consider alternative mitigation options such as the location and orientation of the cricket square, controlling the level of cricket played on the site, or defining the location of junior and senior cricket pitches. It is recommended that the client discusses any such plans with the ECB and other relevant organisations along with the club to ensure that plans are suitable in mitigating the risk but also practicable for the cricket club's day to day use.

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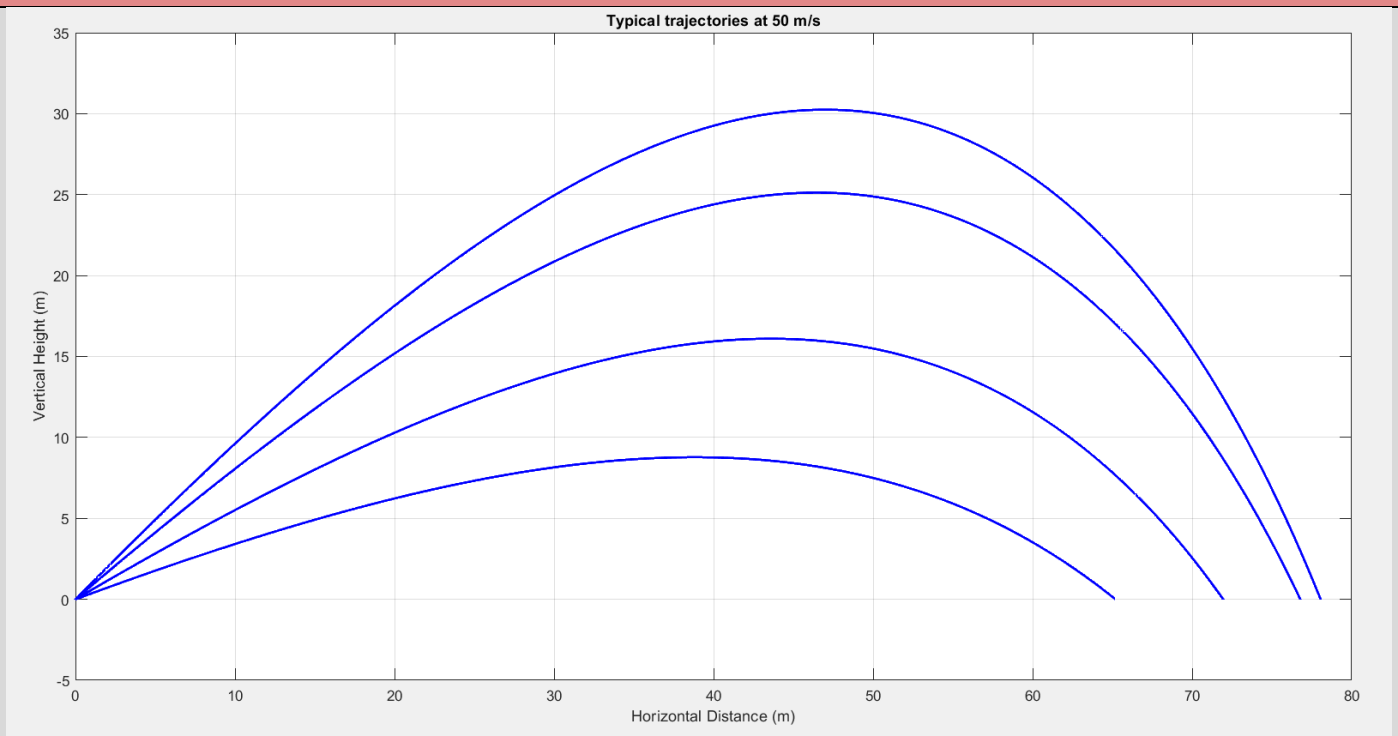
Appendix A – Typical Example Trajectories

Cricket ball trajectories @ 50 m/s



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