Design & Consultancy for natural and built assets

TECHNICAL ASSESSMENT

Wind Flow Analysis

35588100/NT/300916/1 Addendum 1

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Incorporating

EC HARRIS BUILT ASSET CONSULTANCY

Hyder

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VERSION CONTROL

Issue	Revision No.	Date Issued	Description of Revision: Page No.	Description of Revision: Comment	Reviewed by:
1	1	25/10/2016		First Issue	
	2	28/10/2016		Addresses comments.	

REFERENCES

Ref No	Reference Identifier	Title
1	35588100/NT/300916/1	Technical Assessment (Main Report) of the possible impact of the IFA2 Interconnector at Solent Airport Daedalus.

1 INTRODUCTION

This report is an addendum to the technical assessment of the proposed converter station to be sited adjacent to Solent Airport, Lee-on Solent [1]. The technical assessment considered aerodrome safeguarding, assessment of electromagnetic field (EMF) / radio-frequency interference (RFI) and wind effects, together with hazard identification and risk assessment. This is to provide stakeholders with the necessary safety assurance at the planning and land acquisition stage, and to provide a firm basis for the eventual detailed design development and safety justification of the converter station.

Section 7 of [1] presented an initial assessment of wind effects caused by the converter building for a bounding case. The analysis showed that instances of strong winds from the worst-case direction (75^0 EoN) is very low. The worst-case effect predicted was a 20% increase in wind velocity at ground level (1m) and 200m away to the now disused runway. A similar increase, ranging from 15% to 20% was expected to result if the same simulation was to be conducted at lesser (more realistic) wind speeds.

This addendum presents additional detailed wind analysis to assess the impact of the converter station on trailing winds on the main runway, considering both pessimistic and more realistic wind conditions. Figure 1 below shows the extent of the domain that is to be analysed in terms Computational Fluid Dynamics (CFD).

Figure 1 – CFD Domain of Analysis

2 ANALYSIS

2.1 Worst Case Wind Direction

The following results (Figure 2) shows the analysis of a range of wind angles (at 20m/s) to determine worst-case wind direction in terms of impact on the main runway (also see Appendix A for magnified images of the results).

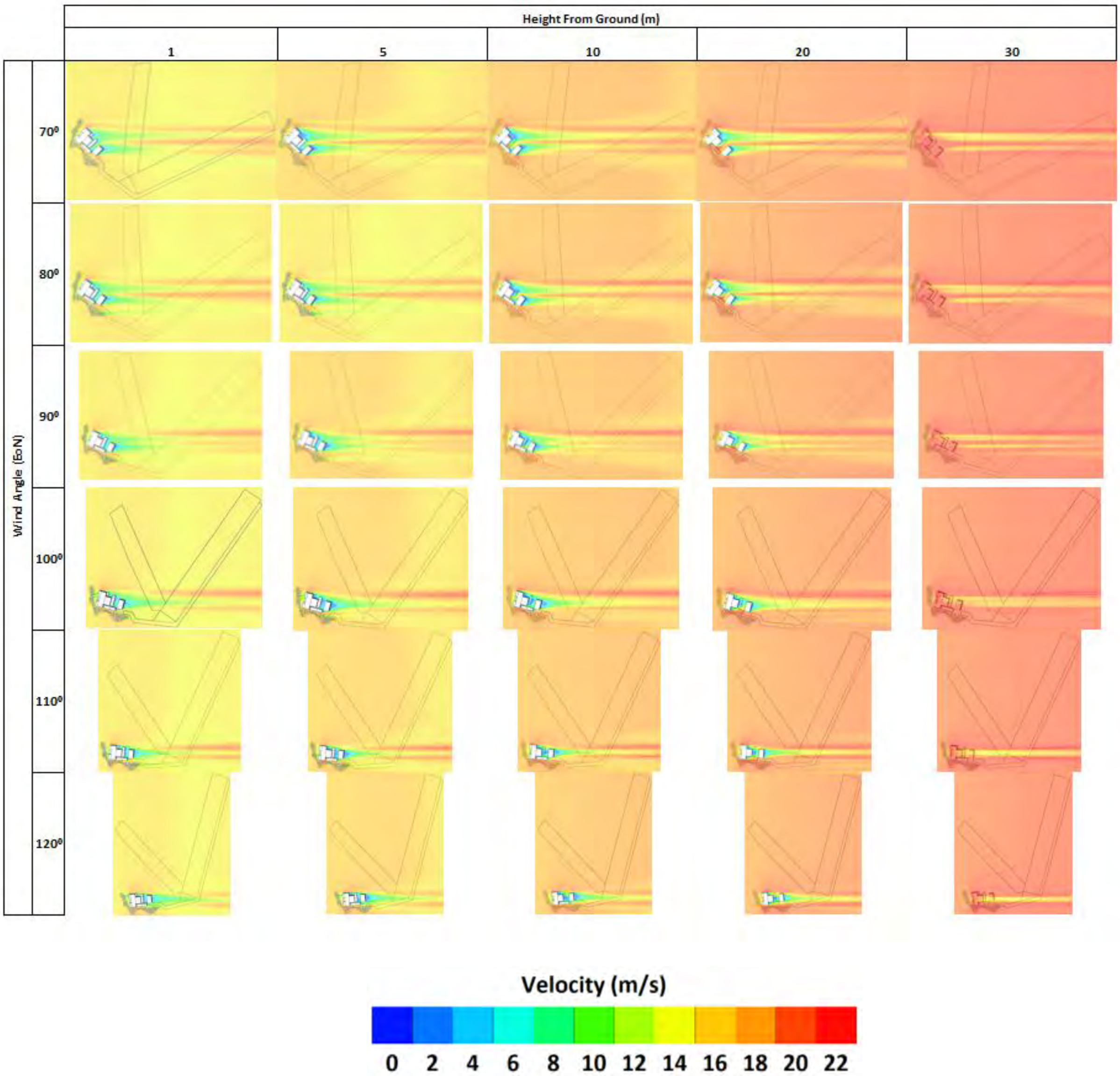


Figure 2 – Results of wind flow for a range of directions and heights (flow direction from left to right).

In order to determine the worst-case direction in terms of impact on the runway, it is necessary to consider both wind speed and the zone of impact, a higher wind speed over a larger area being the worst case. From the results above (Figure 2), it is concluded that the worst-case wind direction is at the angle of 70^0 EoN. Whilst the highest wind speed reached is similar for all angles, at 70^0 EoN, the building produces three tails of faster winds, which covers the biggest area on the main runway compared to the other angles. It is also worth noting that generally over a height of 20m above the ground, the building acts a windshield where the tails are slower than the prevailing wind direction. The angle of 70^0 EoN is therefore taken forward in the subsequent analysis as the worst-case wind direction.

2.2 Relative Increase in Wind Speeds

The following results (Figures 3a-d) show the analysis of a range of wind speeds (at the worst-case angle of 70^0 EoN) in order to assess the relative increase wind speed onto the main runway caused by the building for a range of wind speeds (5m/s, 10m/s, 15m/s, 20m/s). In the figures, the wind flow shown and the building are on the same plane (i.e. at the same distance above ground).

It should be noted that:

- the “relative increase” in wind speed is defined here as the percentage change in wind speed (due to turbulence), coming onto the building compared to the wind speed onto the main runway (note that this is generally an increase in wind speed, however in the case of the building acting as a wind shield with tails slower than the prevailing wind direction, the “relative increase” could be a negative value);

- the flow direction in all the figures is from left to right.

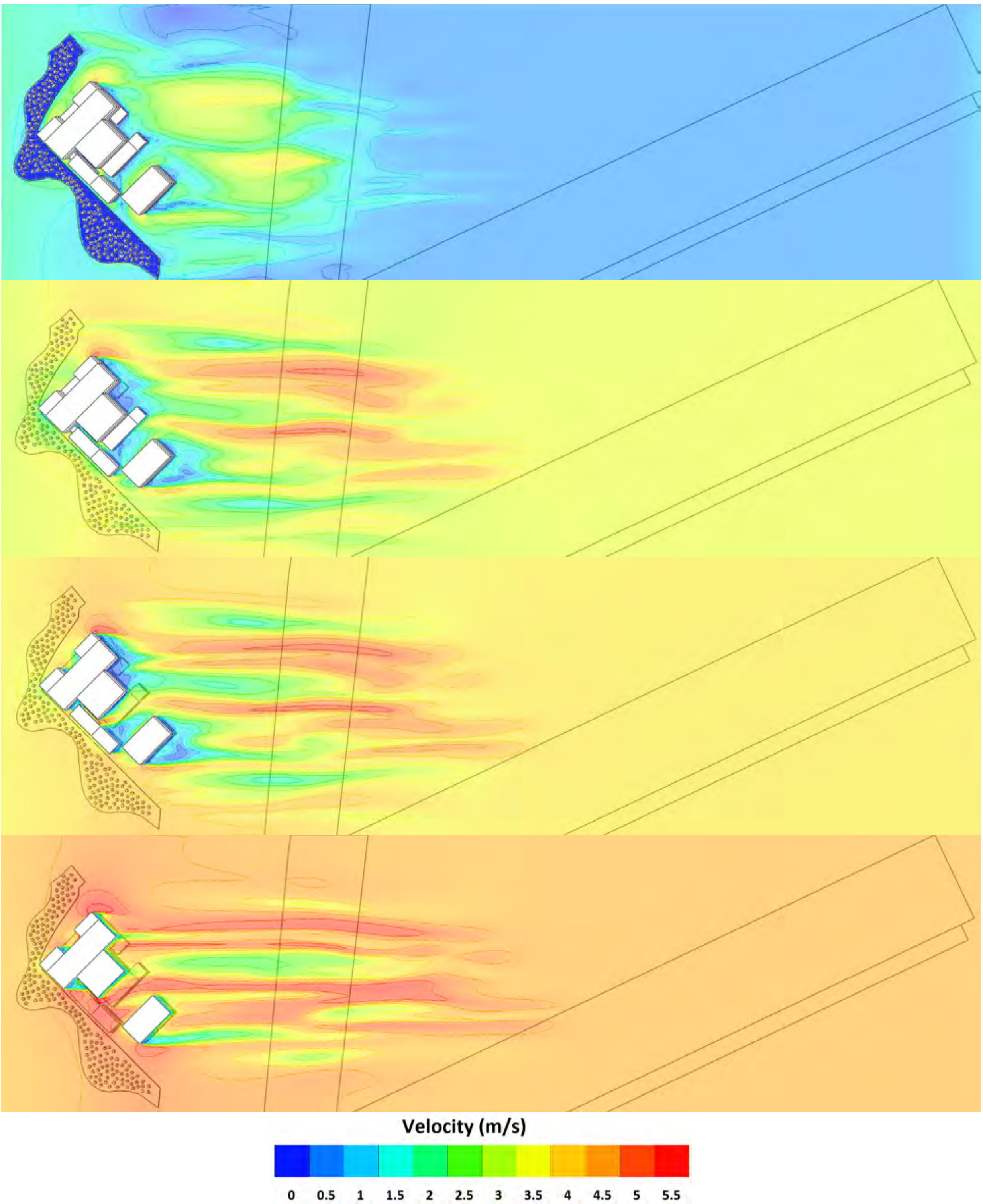


Figure 3a – Angle=70^0 , 5m/s @ 1m, 5m, 10m, and 20m.

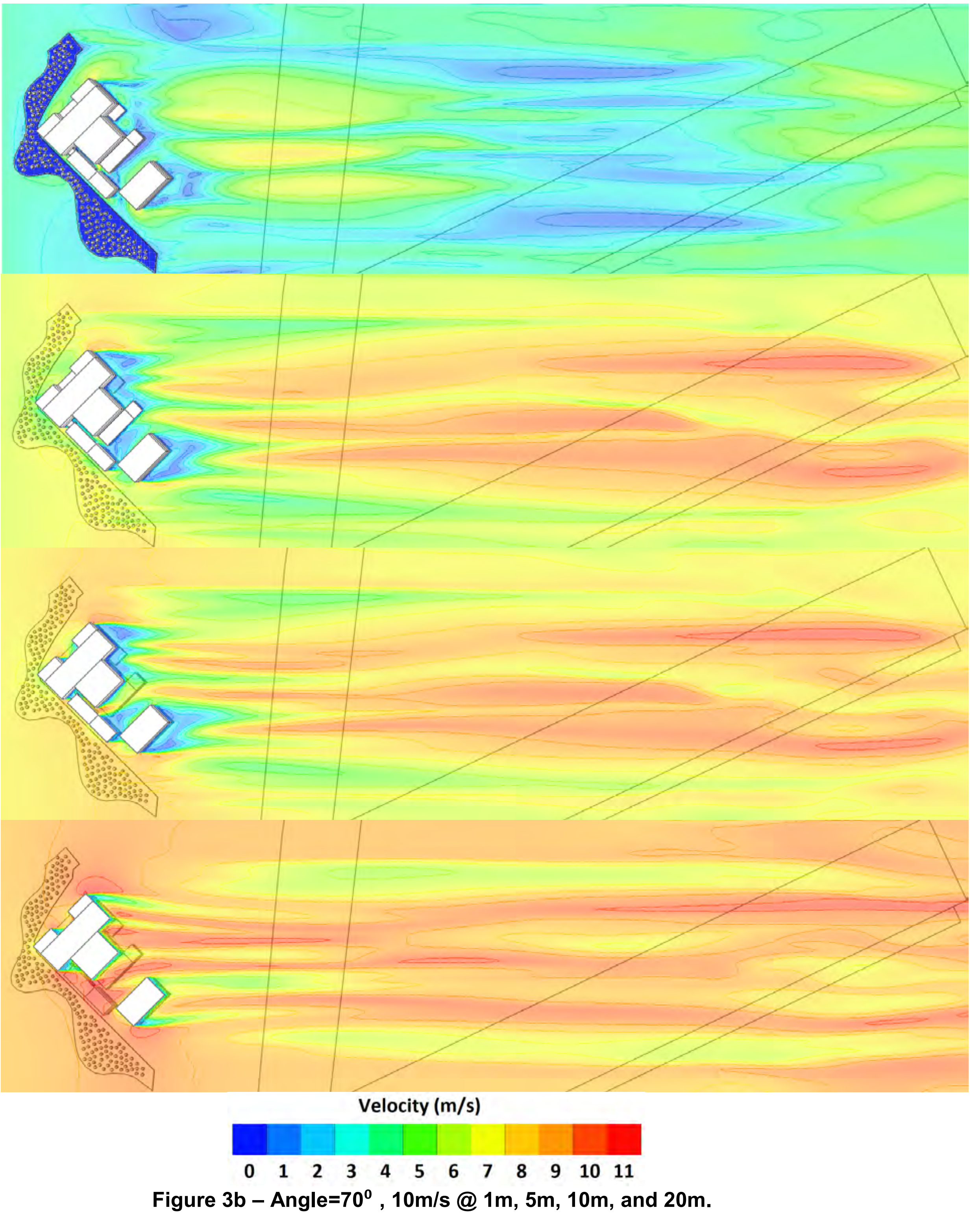


Figure 3b – Angle=70^0 , 10m/s @ 1m, 5m, 10m, and 20m.

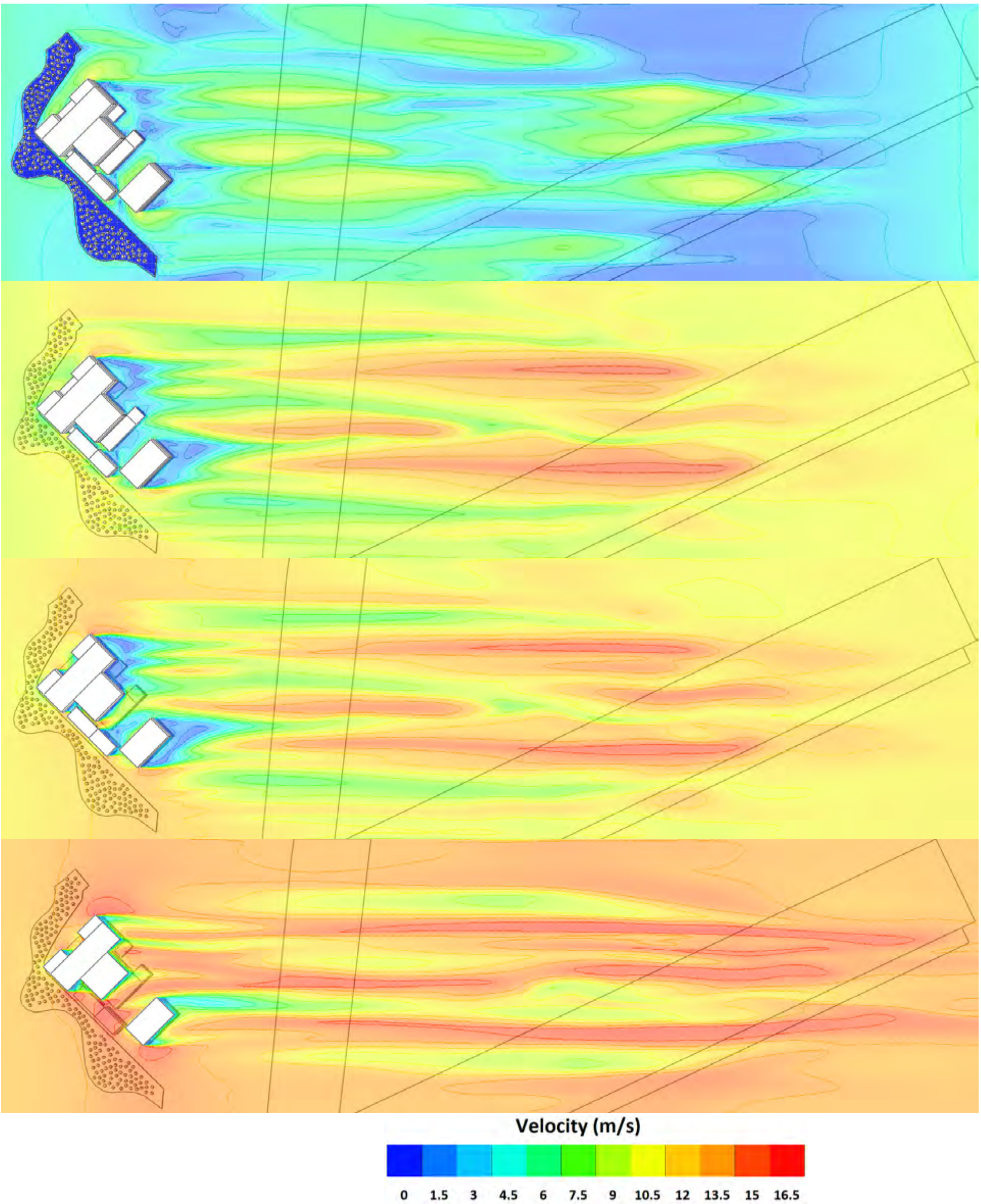


Figure 3c – Angle=70^0 , 15m/s @ 1m, 5m, 10m, and 20m.

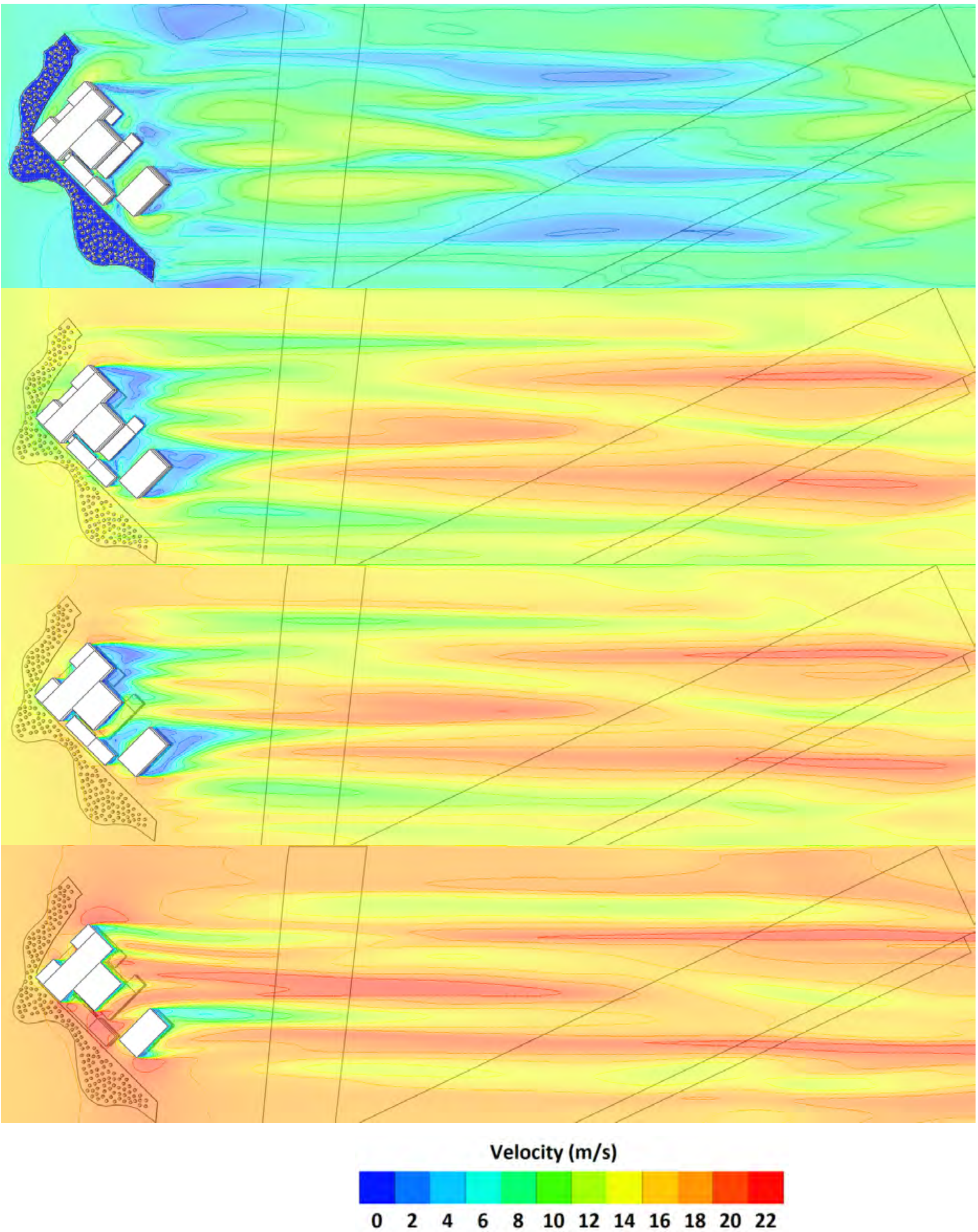


Figure 3d – Angle=70^0 , 20m/s @ 1m, 5m, 10m, and 20m.

Figure 3e below shows a summary of the relative increase in wind speed against height for the various wind speeds analysed above in the main take-off and landing areas of the runway.

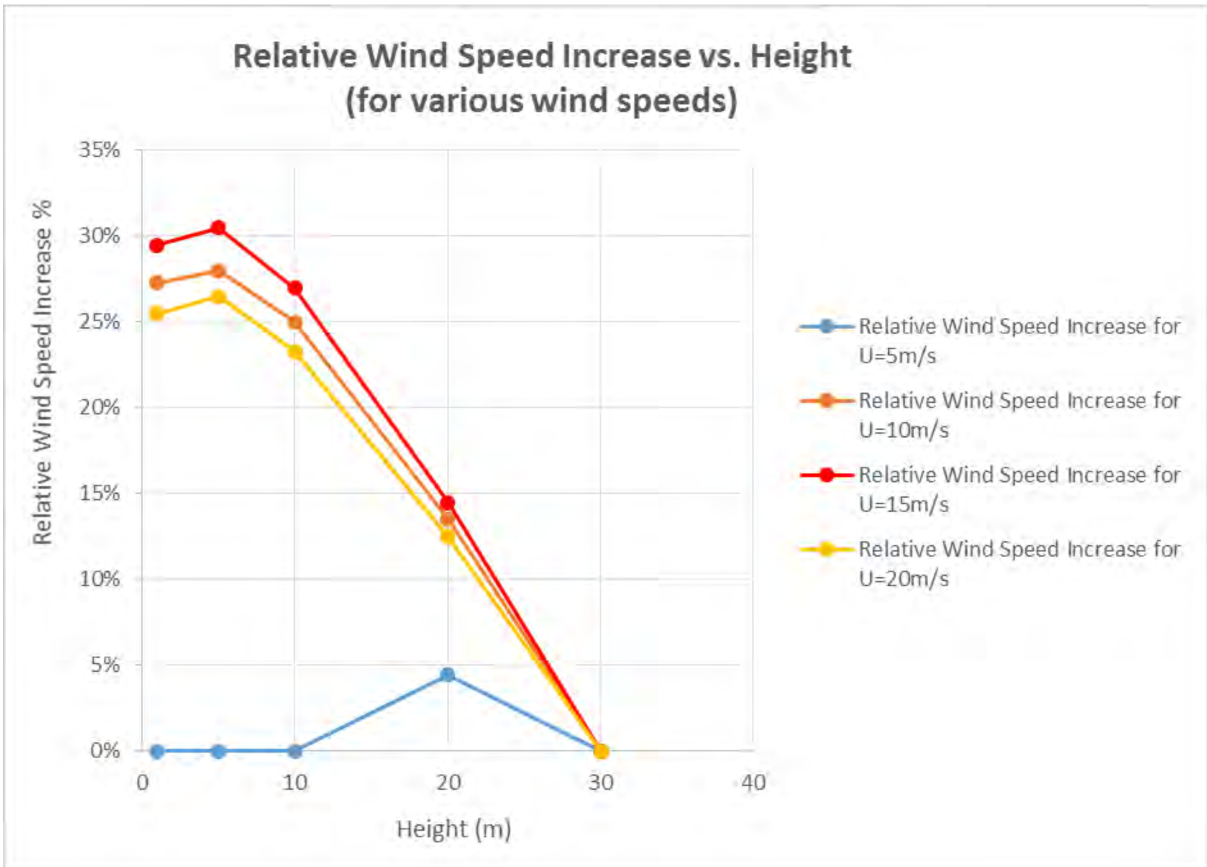


Figure 3e – Relative Wind Speed Increase vs Height (for various wind speeds)

The main observations from Figures 3a-e are as follows:

- The highest relative increase in wind speed onto the main runway caused by the building is a maximum of 30%, which occurs at a height of 5m above the ground in the case of a 15m/s wind speed. For wind speeds of 10m/s and 20m/s the highest relative increase in wind speed shown in Figure 3e is 27% and 26% respectively, however it reaches a maximum of 30% beyond the main take-off / landing area.
- For low wind speeds like 5m/s, the building has little to no impact on the main runway at the wind direction of 70º EoN.

These results are evaluated in Section 3 below.

3 EVALUATION OF RESULTS

The previous analysis in [1] considered wind effects on the disused runway with pessimistic assumptions in terms of wind angle and wind speed, allowing for strong gusts of wind. The effects on the main runway were not assessed as the runway is further away from the building than the disused runway. The analysis predicted a relative increase in wind speed of up to 20%.

The more detailed analysis within this report has indicated that for higher wind speeds 10, 15, and 20m/s, localised increases in wind speed of up to 30% can occur. This is because the more detailed analysis takes account of a longer distance downstream of the wind flow. Due to the continuity of the flow, the higher wind speeds have developed further downstream. See Figure 4 below for an illustration of this continuity phenomena.

At wind speeds less than 5m/s that are coming from the direction of the building onto the main runway (worst-case being 70^0 EoN), there is no building wake impact. Similarly, with wind speeds more than 5m/s that are coming from the direction of the building onto the main runway at 30m or more above the ground, there is no significant building wake impact.

The potential impact of the above results for aircraft is discussed below.

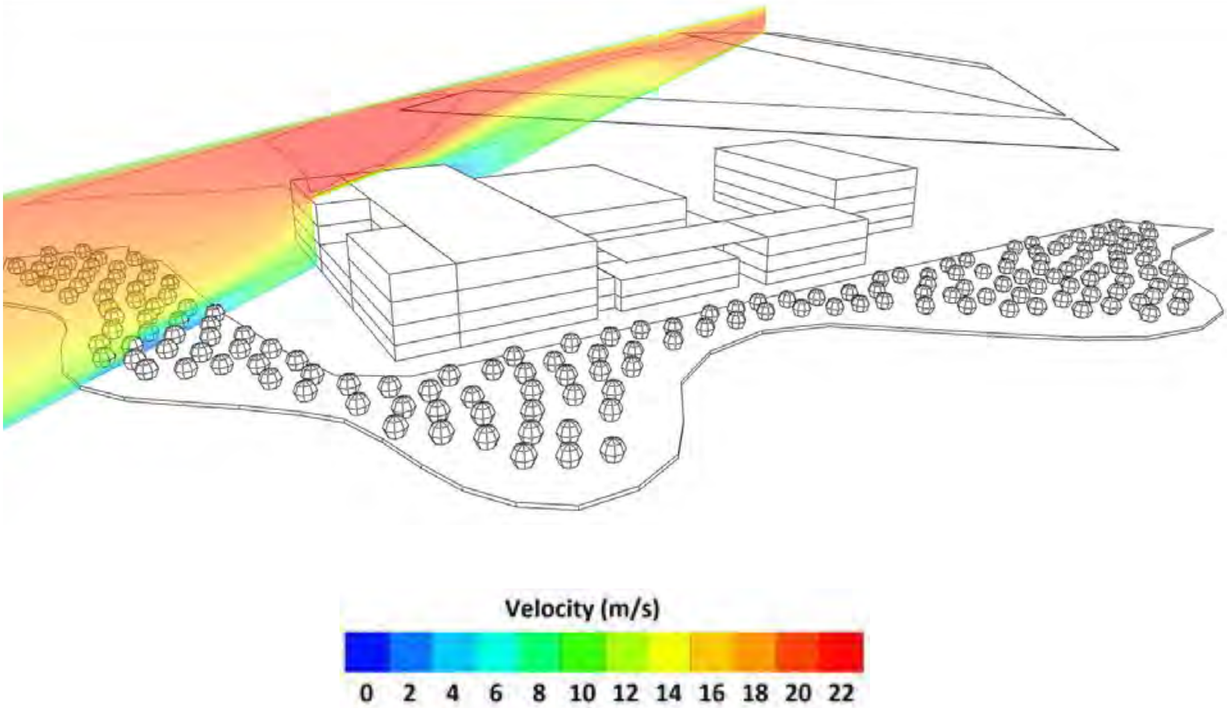


Figure 4 – Angle=70^0, 20m/s.

It was confirmed at the Hazard Identification and Risk Assessment study reported in [1] that localised changes in wind patterns are easily managed by good airmanship and reports issued to airport management through Notice to Airmen (NOTAMs) if necessary. It was also confirmed that pilots will quickly become familiar with any changes in wind patterns and adapt their flying accordingly.

Aircraft are unlikely to take off or land during strong gusts of wind. However, based on the results presented here, at wind speeds in excess of 5m/s that are coming from the direction of the building onto the main runway (worst case being 70^0 EoN), pilots need to assume a worst case relative increase in wind speed of 30%, when flying less than 30m above the ground. Recommendation R5 of the Main Report [1] is re-iterated below for further analysis to be undertaken to confirm this for the final design and future airport plans with appropriate advice be included in NOTAMs accordingly.

4 CONCLUSION

The detailed wind effects analyses that been carried out consider the impact of the converter station on the main runway and cover a realistic range of wind directions and wind speeds. The worst-case wind direction is at the angle of 70^{o} EoN. This is because at this angle the building produces three tails of faster winds, which covers the biggest area on the main runway compared to the other angles.

The highest relative increase wind speed onto the main runway caused by the building is a maximum of 30%, which occurs at a height of 5m above the ground in the wind speeds cases of 10, 15, and 20m/s. At low wind speeds like 5m/s, the building has little to no impact on the main runway at the wind direction of 70º EoN. Similarly, at wind speeds more than 5m/s that are coming from the direction of the building onto the main runway, there is no significant building wake impact above 30m above the ground.

It was confirmed at the Hazard Identification and Risk Assessment study reported in [1] that localised changes in wind patterns are easily managed and that Pilots quickly become familiar with any changes in wind patterns and adapt their flying accordingly through good airmanship.

Aircraft are unlikely to take off or land during strong gusts of wind. However, based on the results presented here, at wind speeds in excess of 5m/s that are coming from the direction of the building onto the main runway (70^{o} EoN), pilots need to assume a worst case 30% relative increase in wind speed, when flying less than 30m above the ground.

The conclusions of the main report [1] are therefore supported by this analysis i.e. risks are expected to be acceptable as defined in CAP 760 [8] for current airport operations with any localised impacts managed through airmanship and reports to airport management to be included in Notice to Airmen (NOTAMs) if necessary. There is a recommendation arising from this work that further analysis be undertaken to confirm the results for the final design and when future airport development plans are finalised, with appropriate advice issued accordingly to pilots. This recommendation was originally captured in Recommendation R5 of the Main Report [1] and is expanded upon below:

R5	Wind effects due to the converter station are expected to be limited with any change in the wind patterns easily managed for existing airport traffic through familiarisation, awareness and generally good airmanship. Consideration should be given to repeating the analysis for the final design of the converter station, future development plans for the area and any future aircraft types using the airport. Appropriate advice should be derived and issued to pilots accordingly e.g. through NOTAMs.

5 APPENDIX A

Magnified images of the results in Figure 2 for a wind velocity of 20m/s are shown below.

Figure A1 Angle=70^0 @ 1m

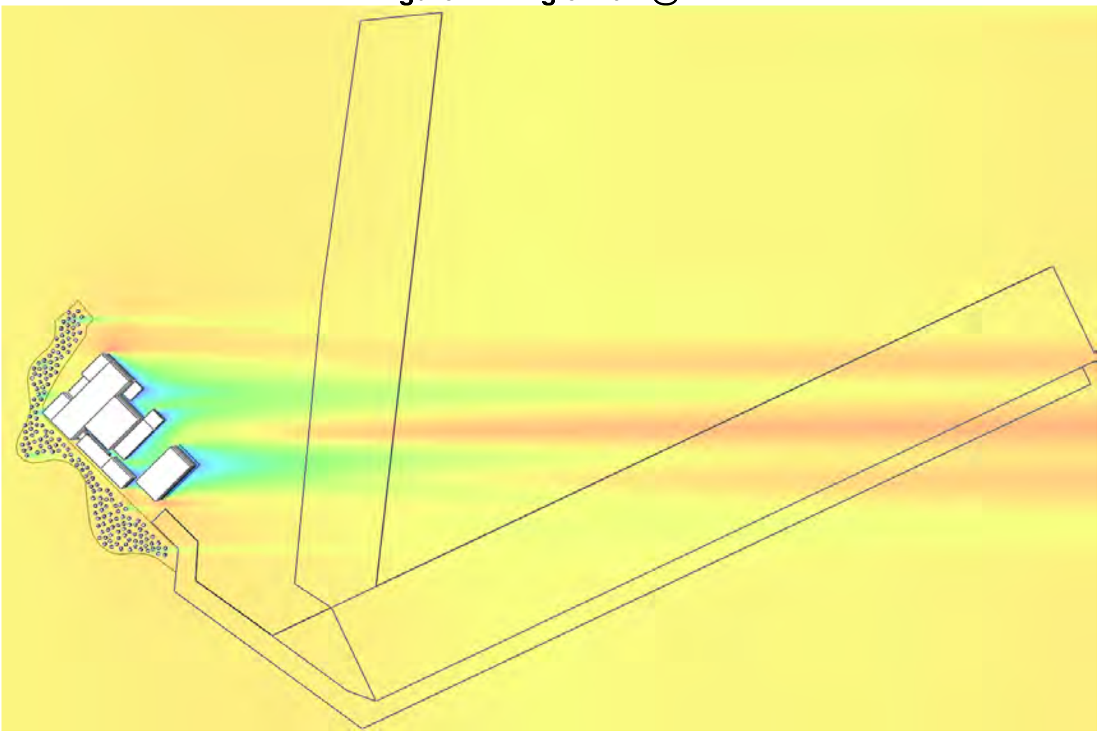
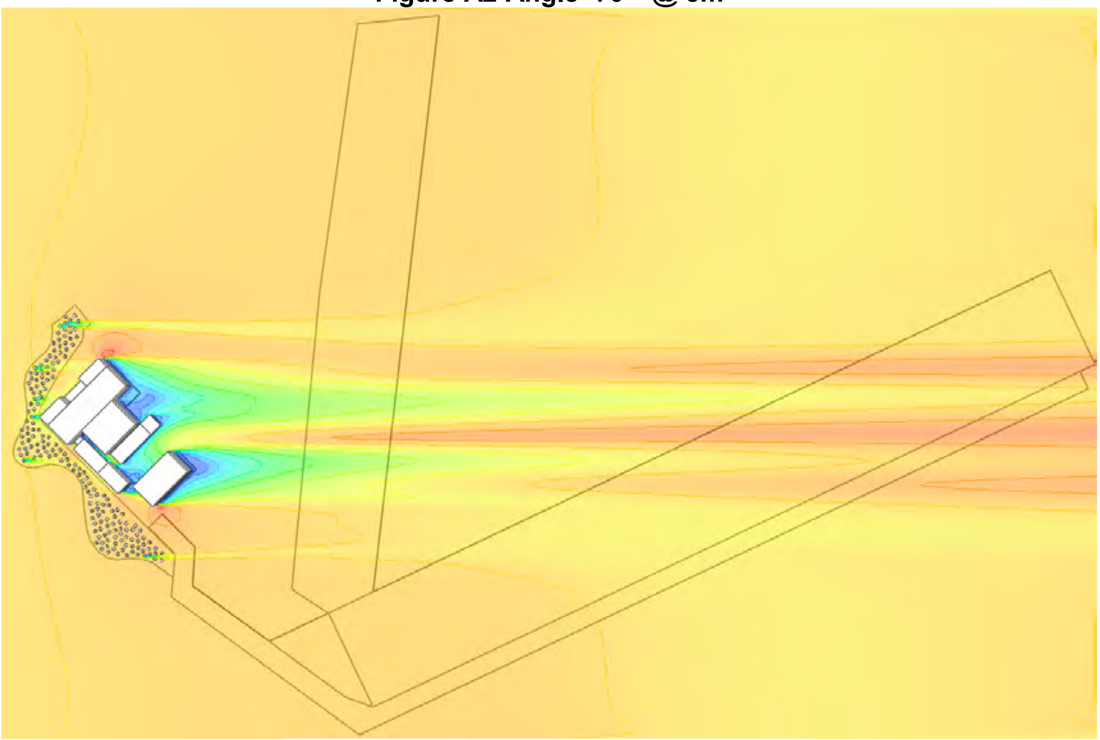


Figure A2 Angle=70^0 @ 5m



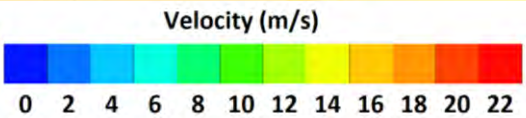


Figure A3 Angle=70^0 @ 10m

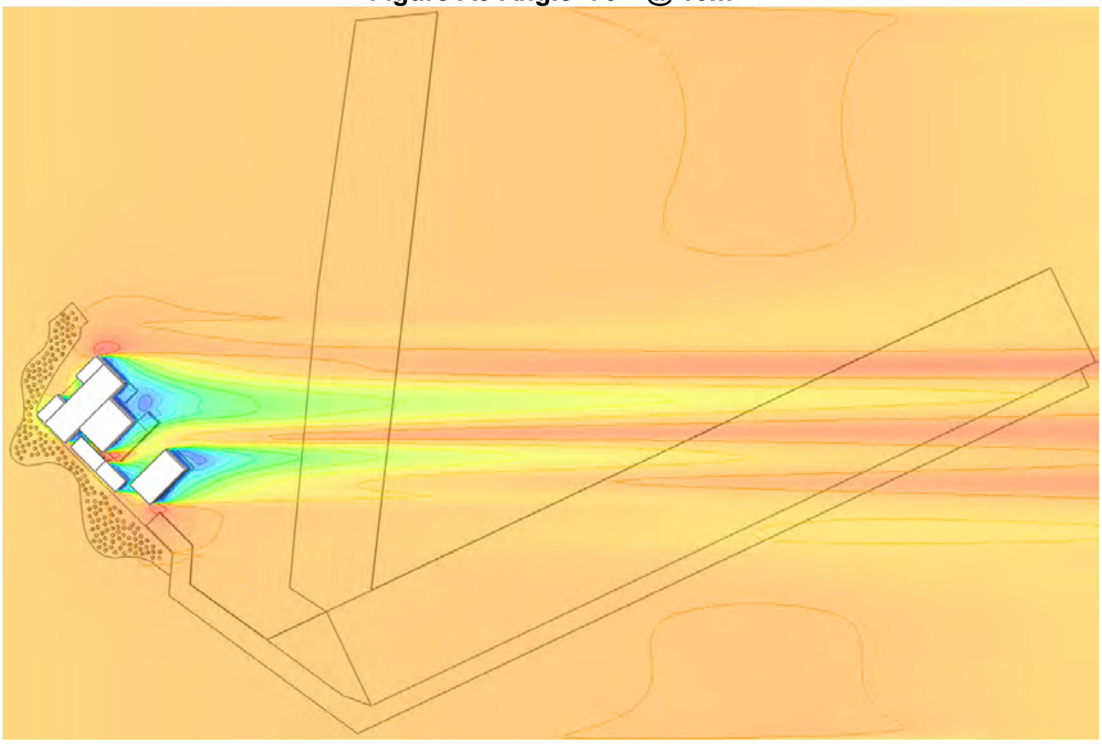
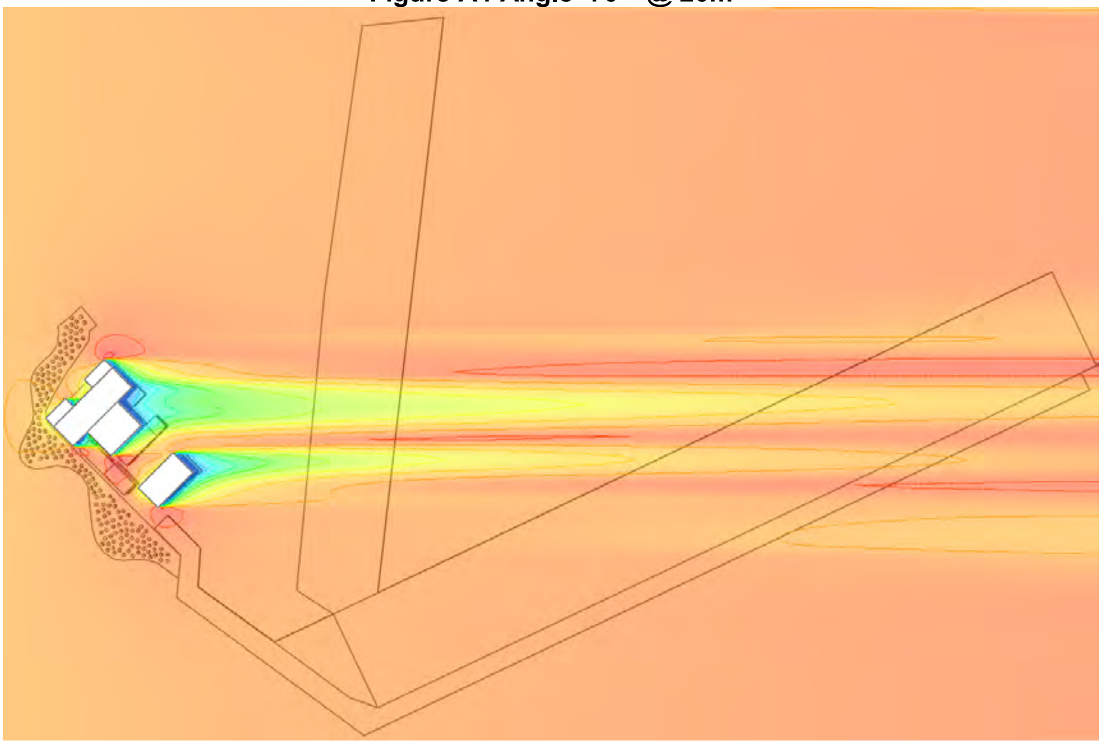


Figure A4 Angle=70^0 @ 20m



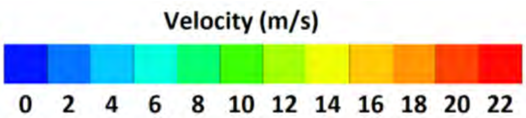


Figure A5 Angle=70^0 @ 30m

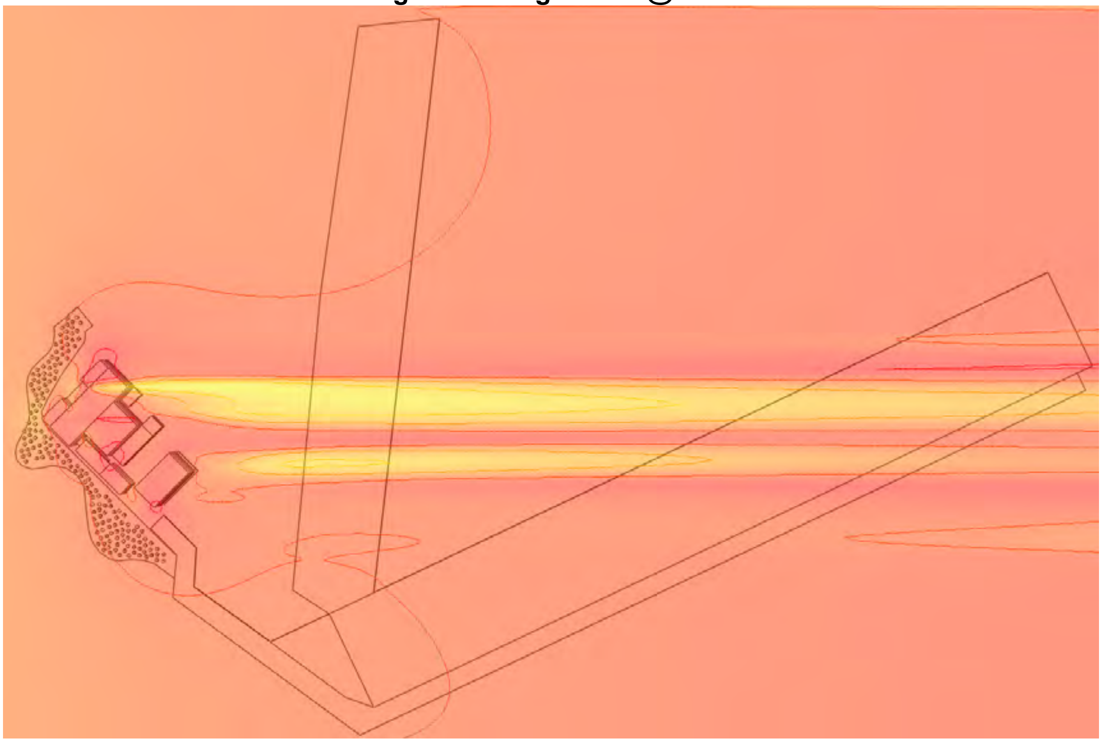
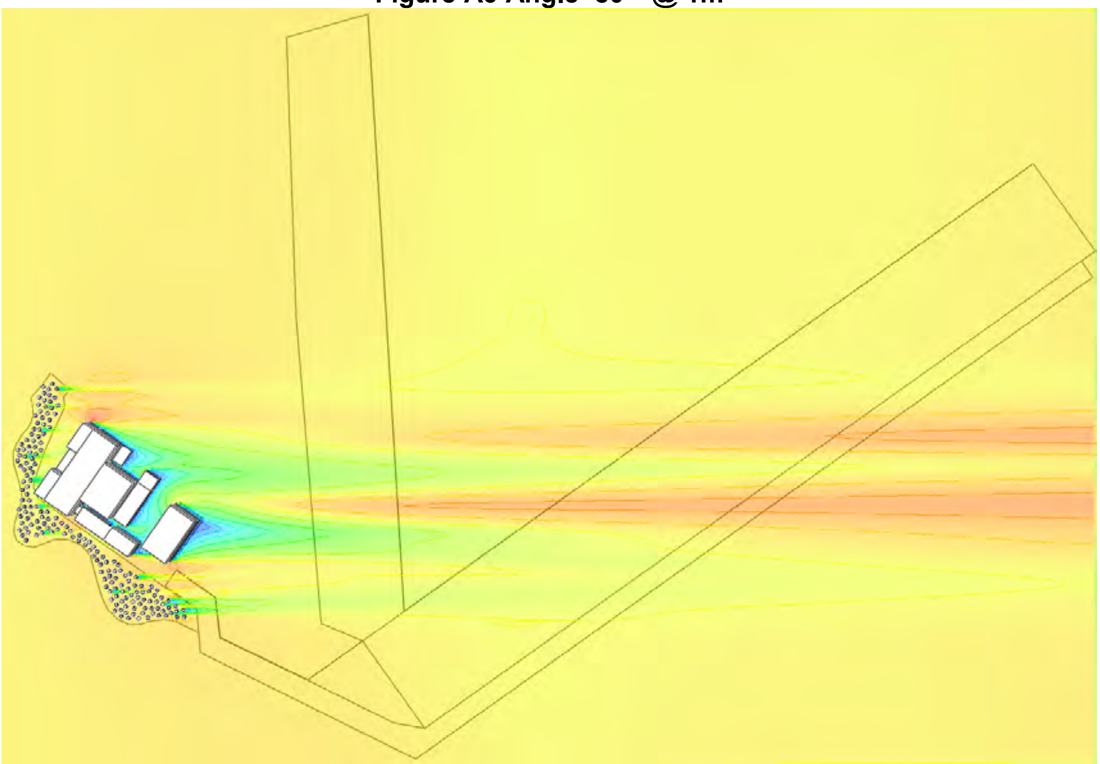


Figure A6 Angle=80^0 @ 1m



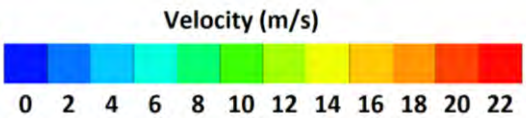


Figure A7 Angle=80^0 @ 5m

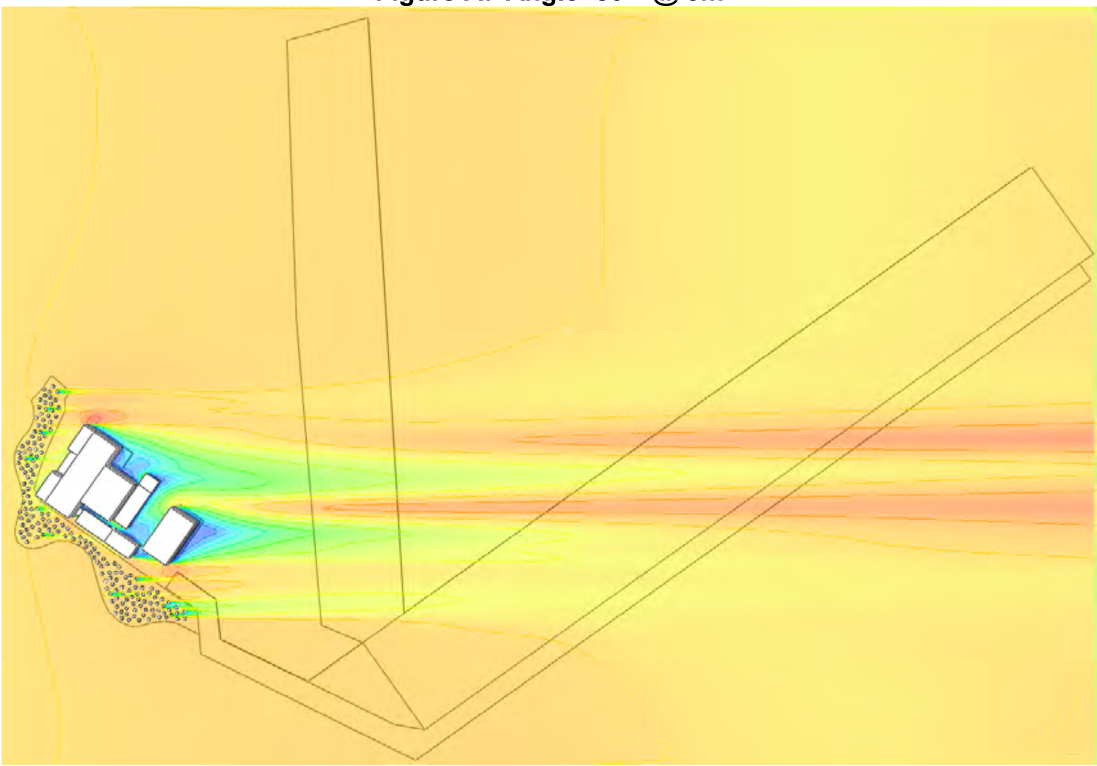
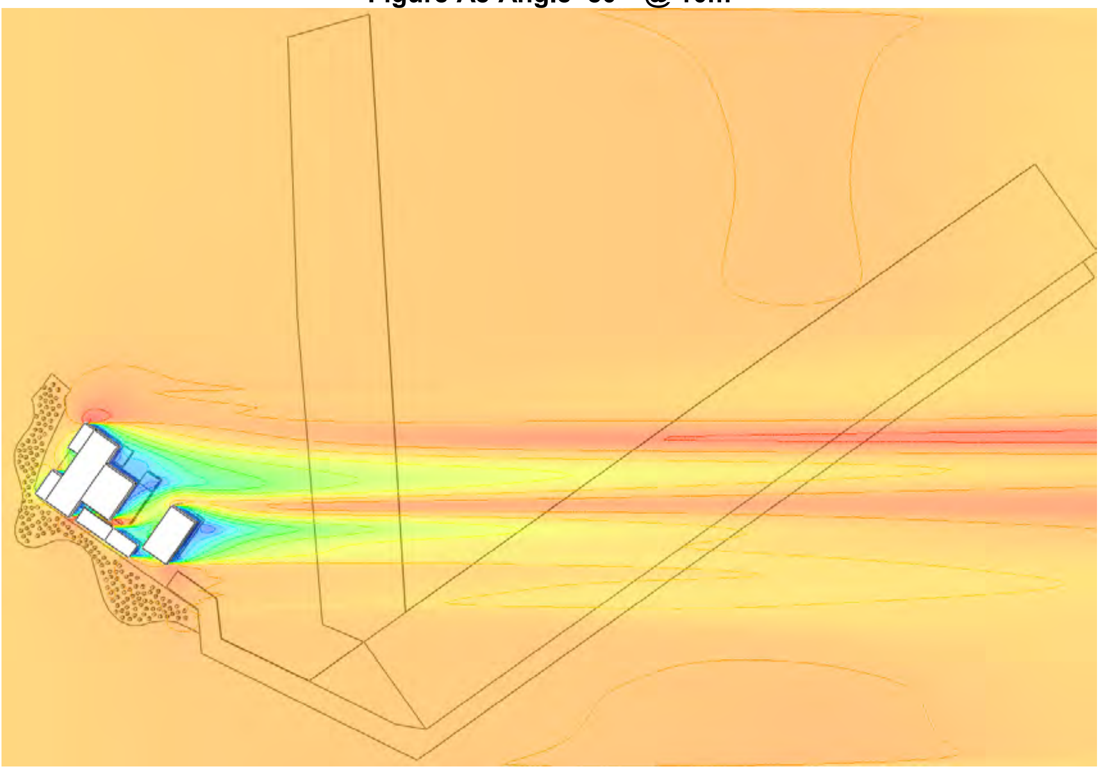


Figure A8 Angle=80^0 @ 10m



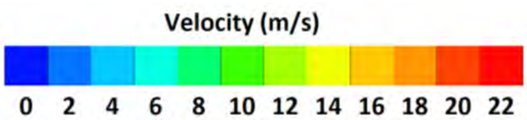


Figure A9 Angle=80^0 @ 20m

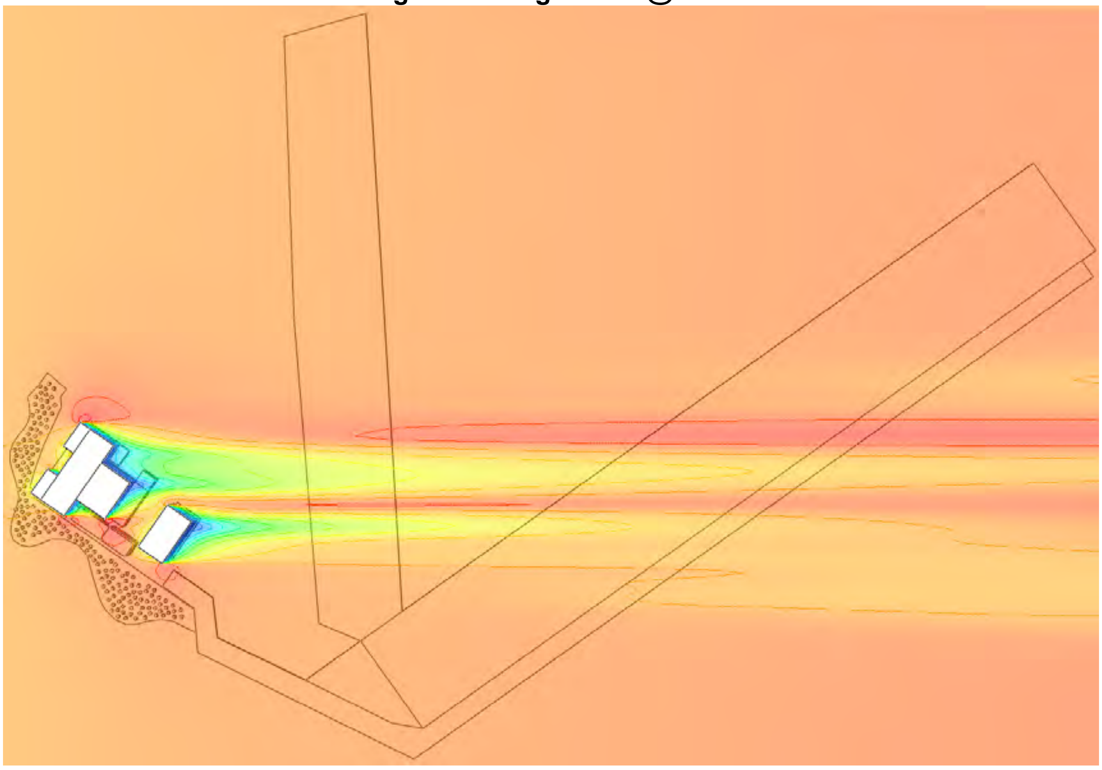
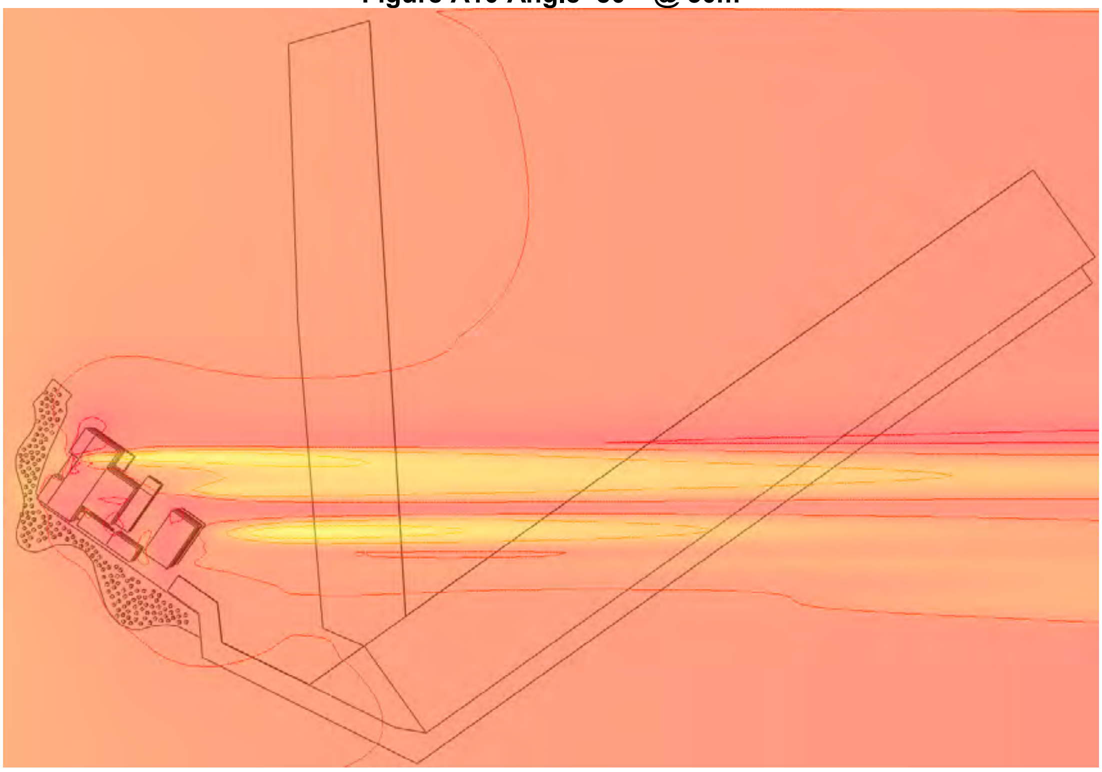


Figure A10 Angle=80^0 @ 30m



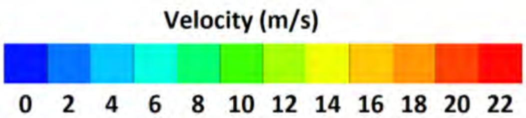


Figure A11 Angle=90^0 @ 1m

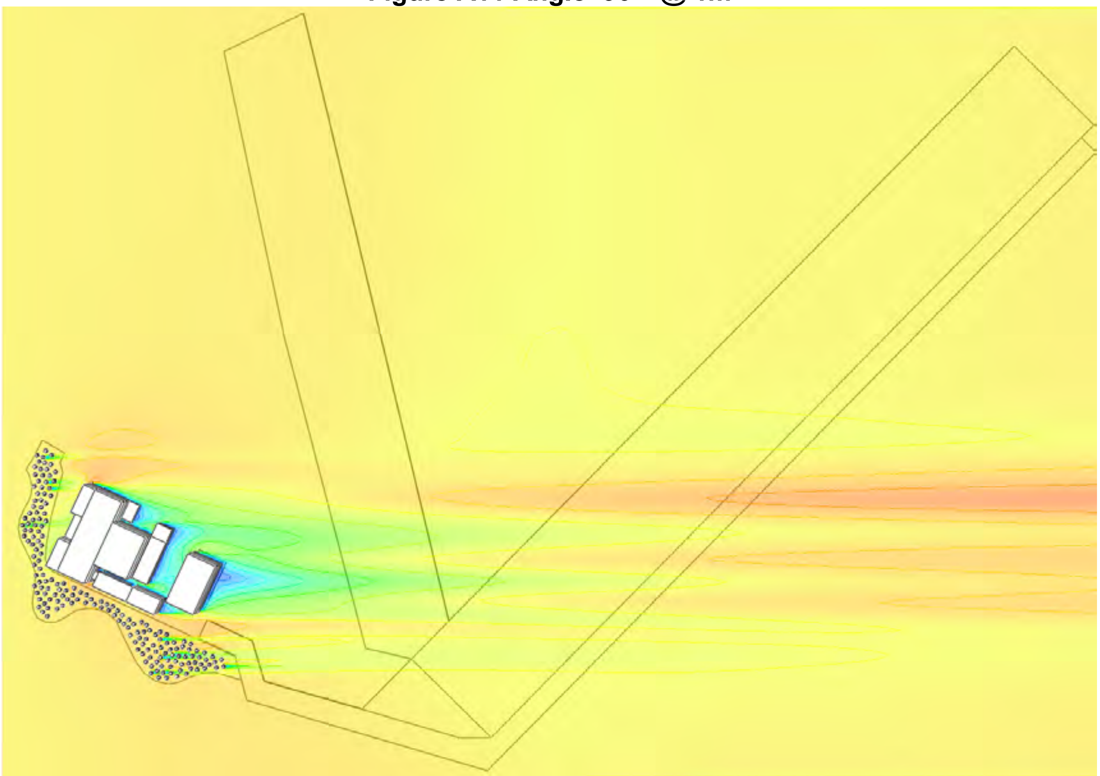


Figure A12 Angle=90^0 @ 5m

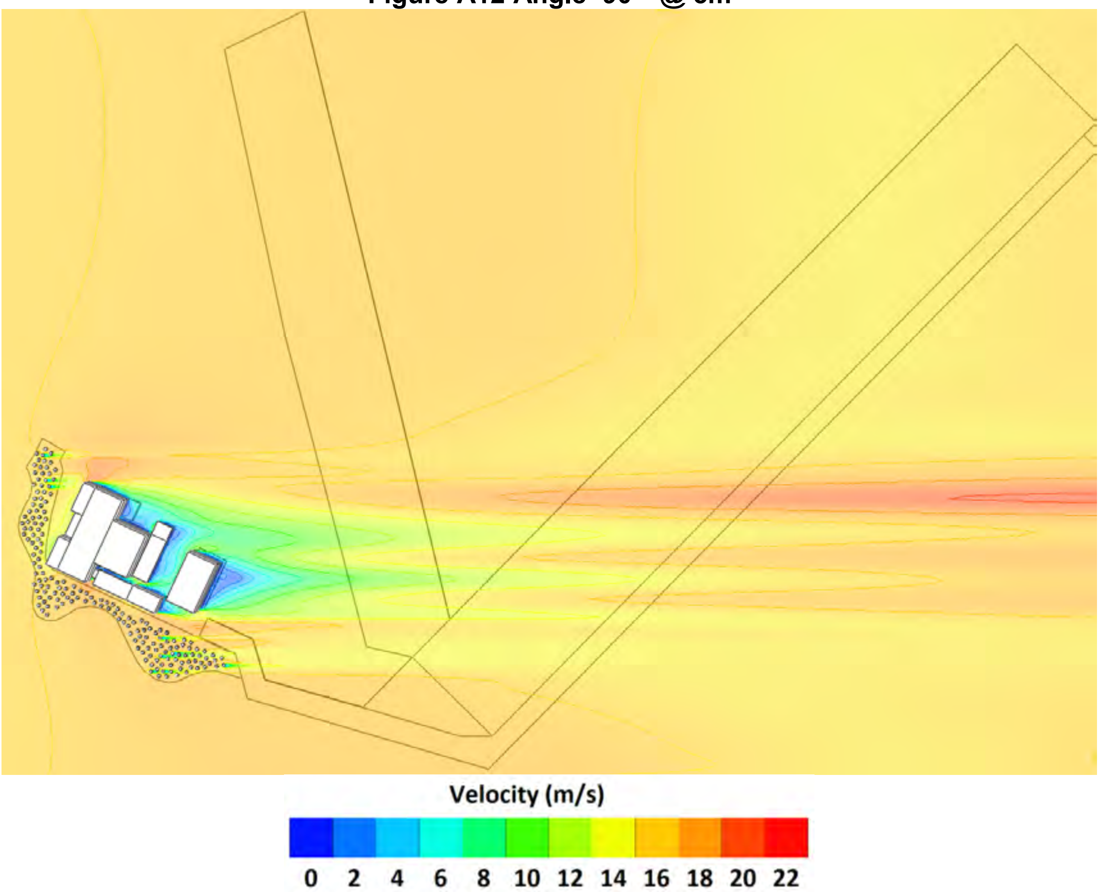


Figure A13 Angle=90^0 @ 10m

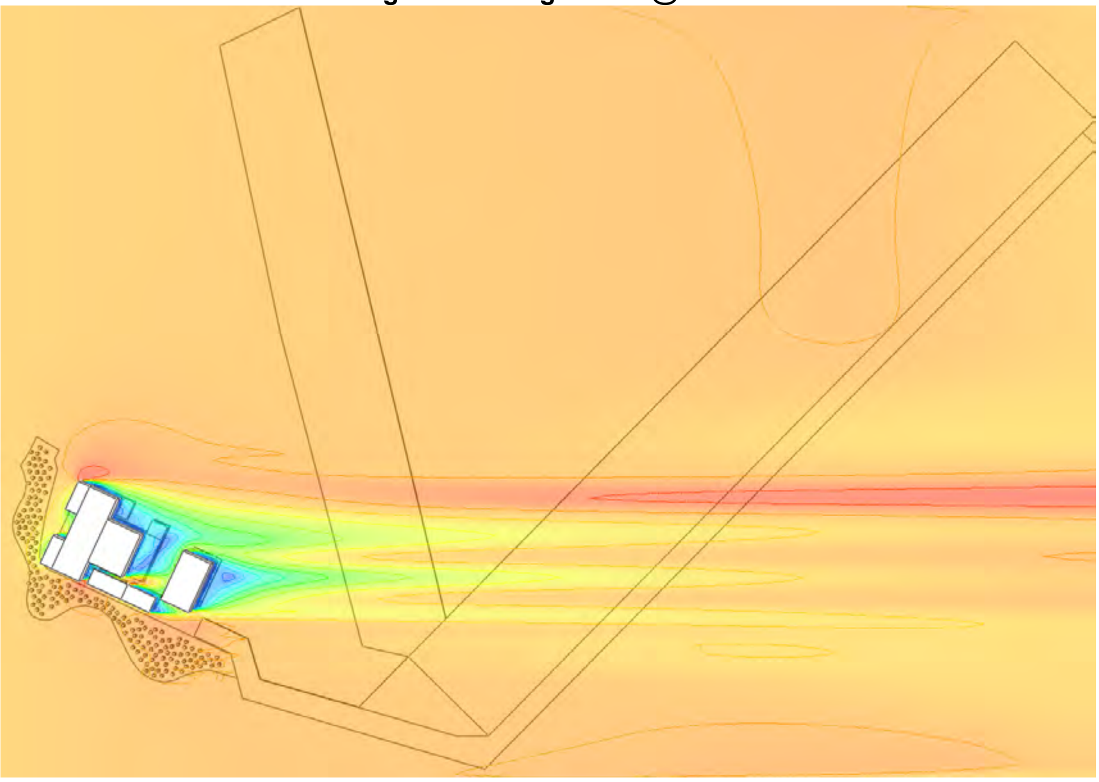
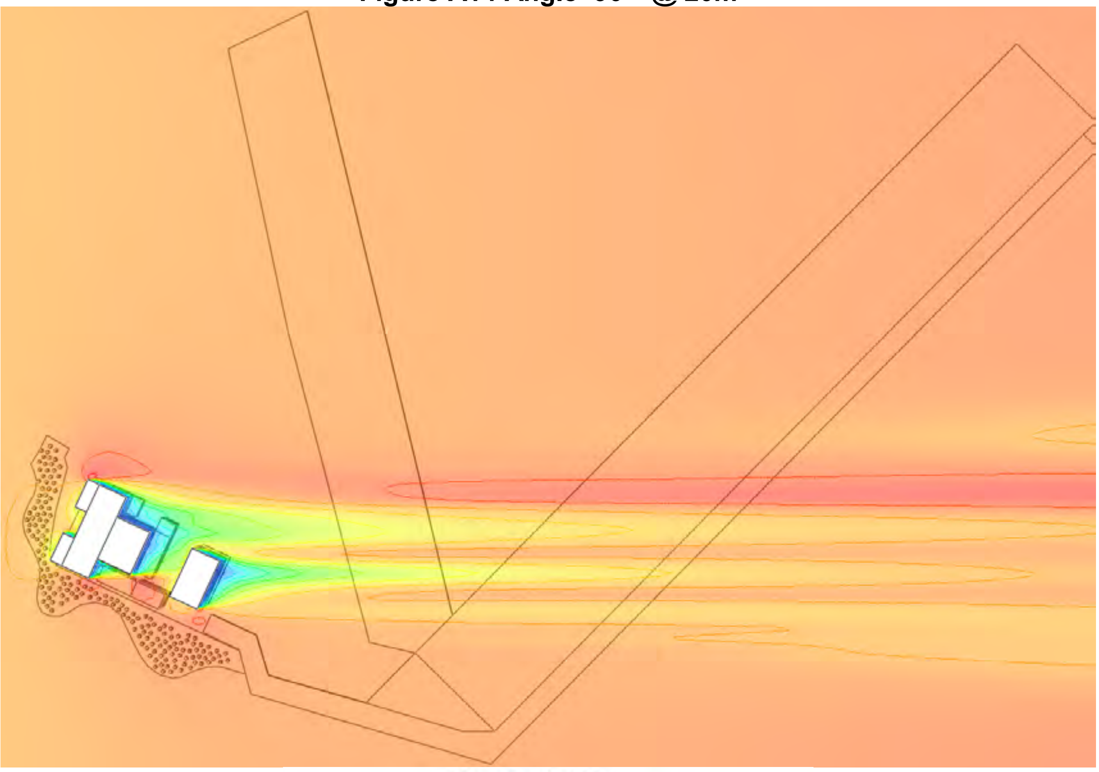


Figure A14 Angle=90^0 @ 20m



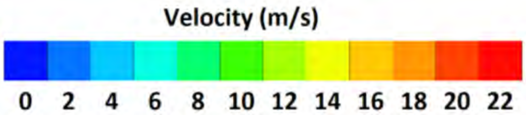


Figure A15 Angle=90⁰ @ 30m

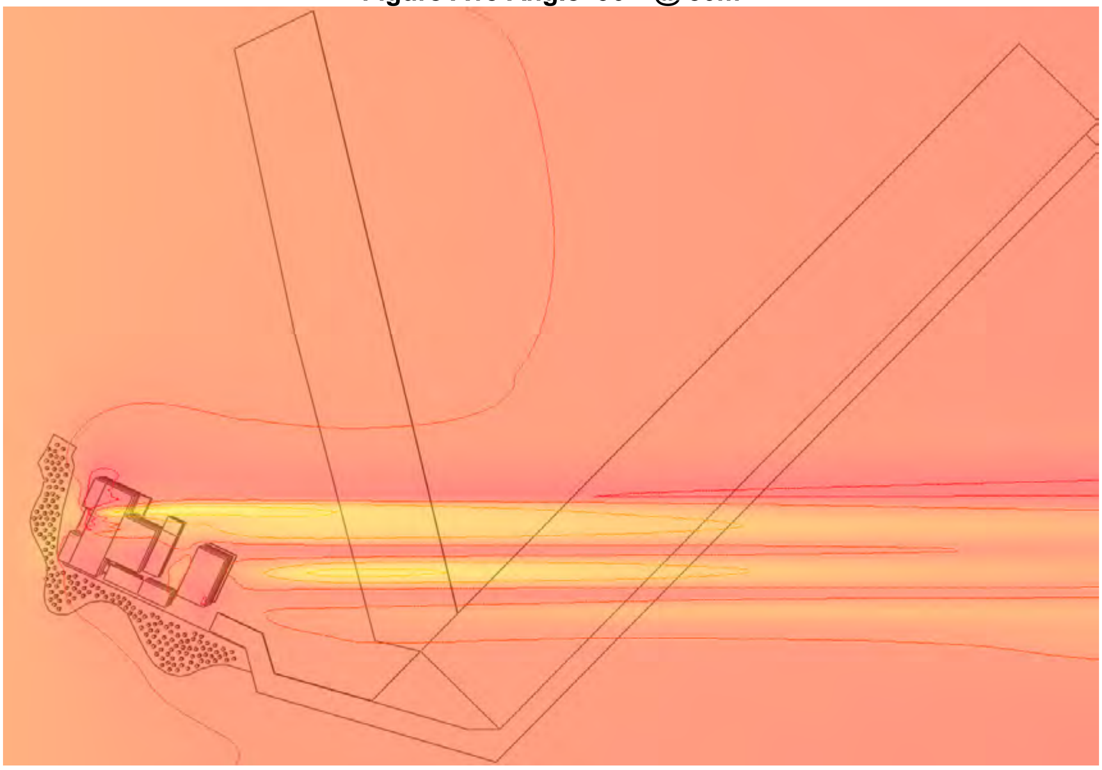


Figure A16 Angle=100⁰ @ 1m

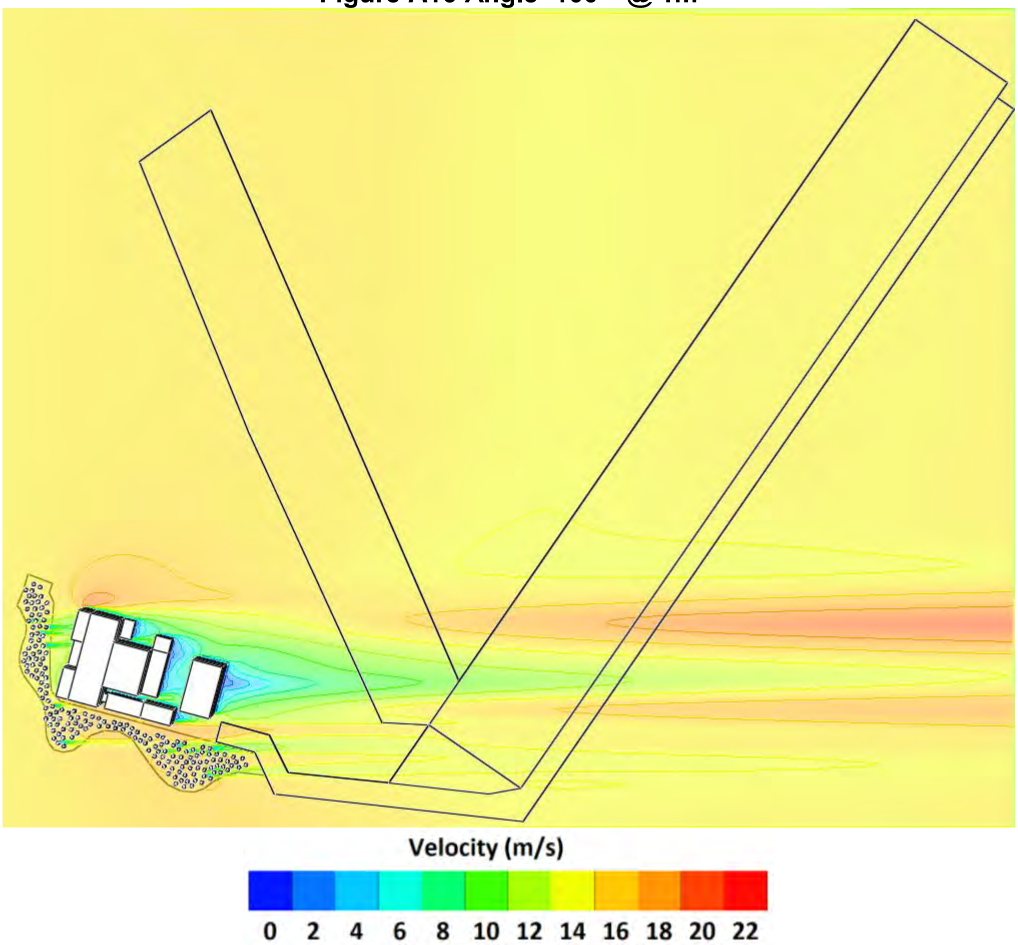


Figure A17 Angle=100⁰ @ 5m

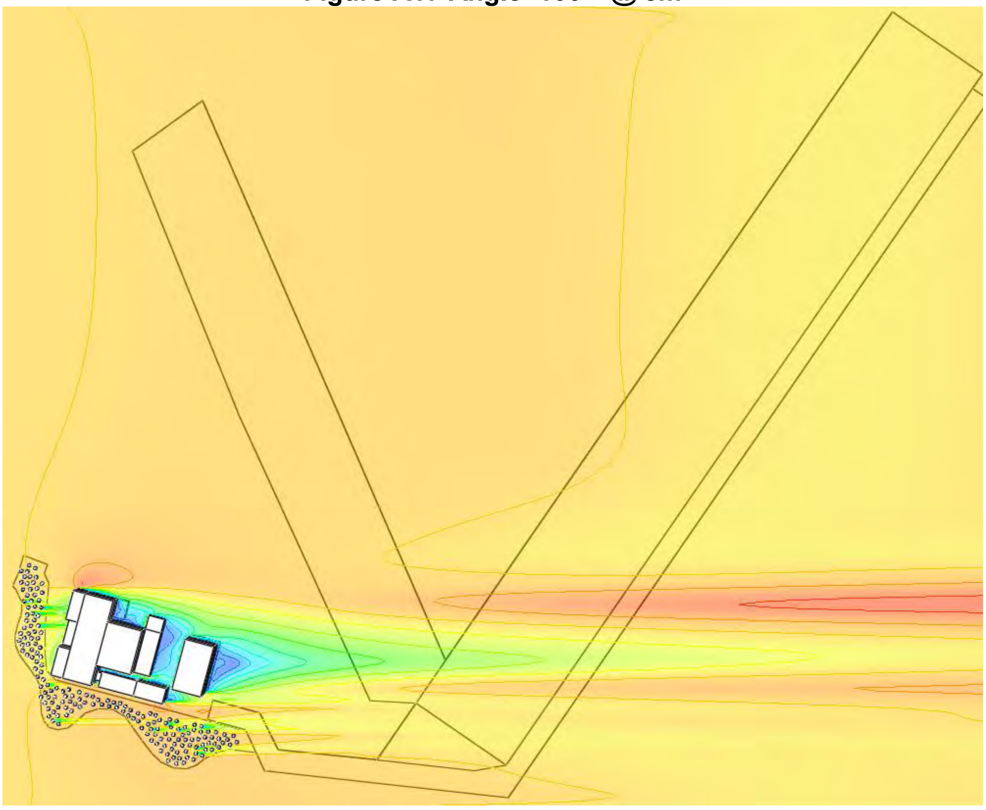


Figure A18 Angle=100⁰ @ 10m

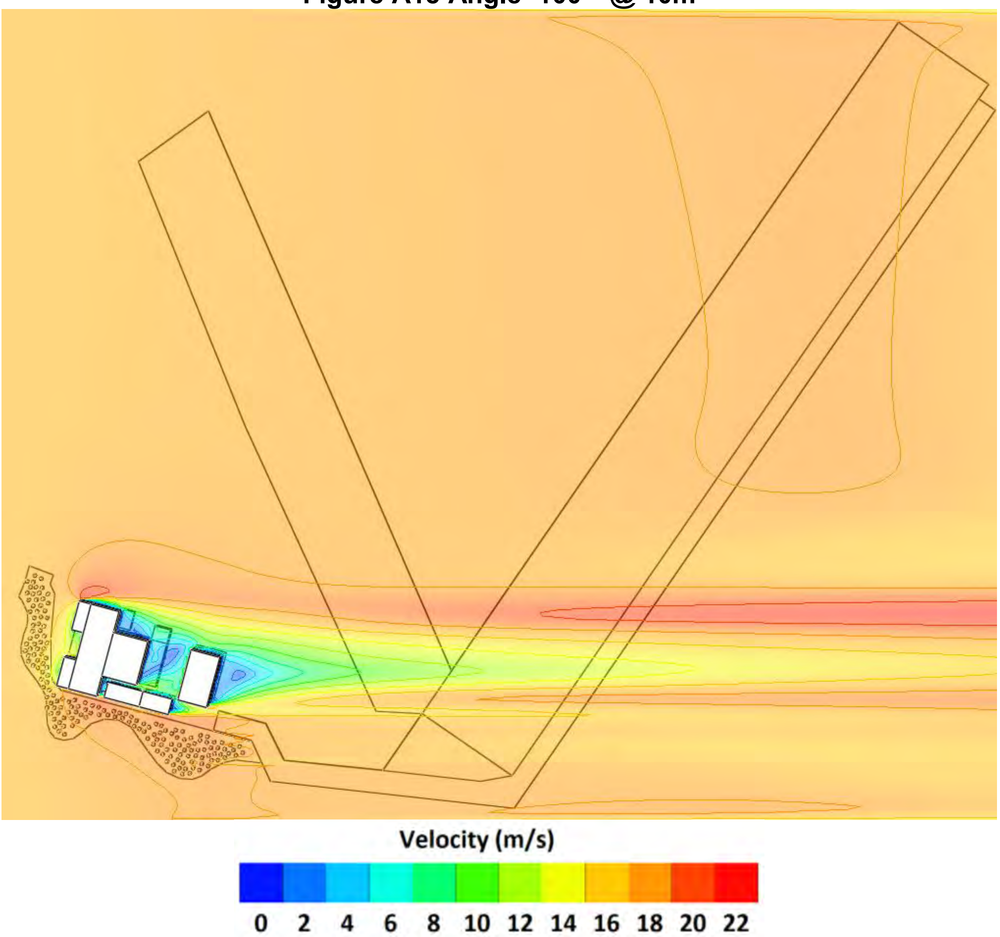


Figure A19 Angle=100^{0} @ 20m

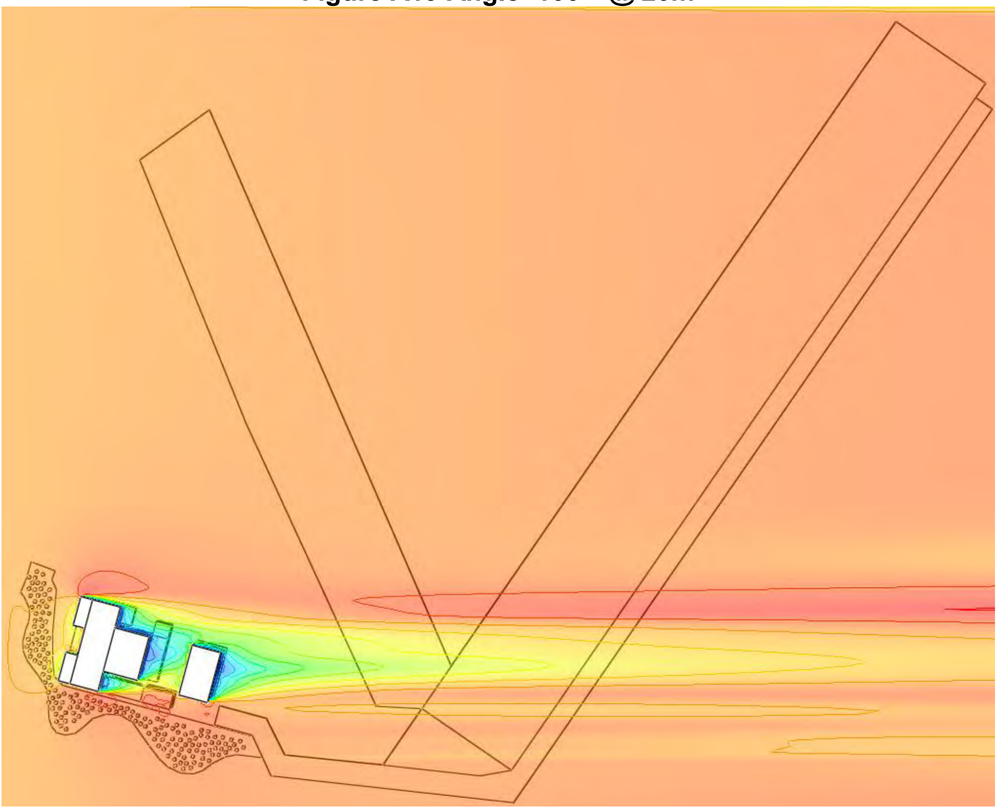


Figure A20 Angle=100^{0} @ 30m

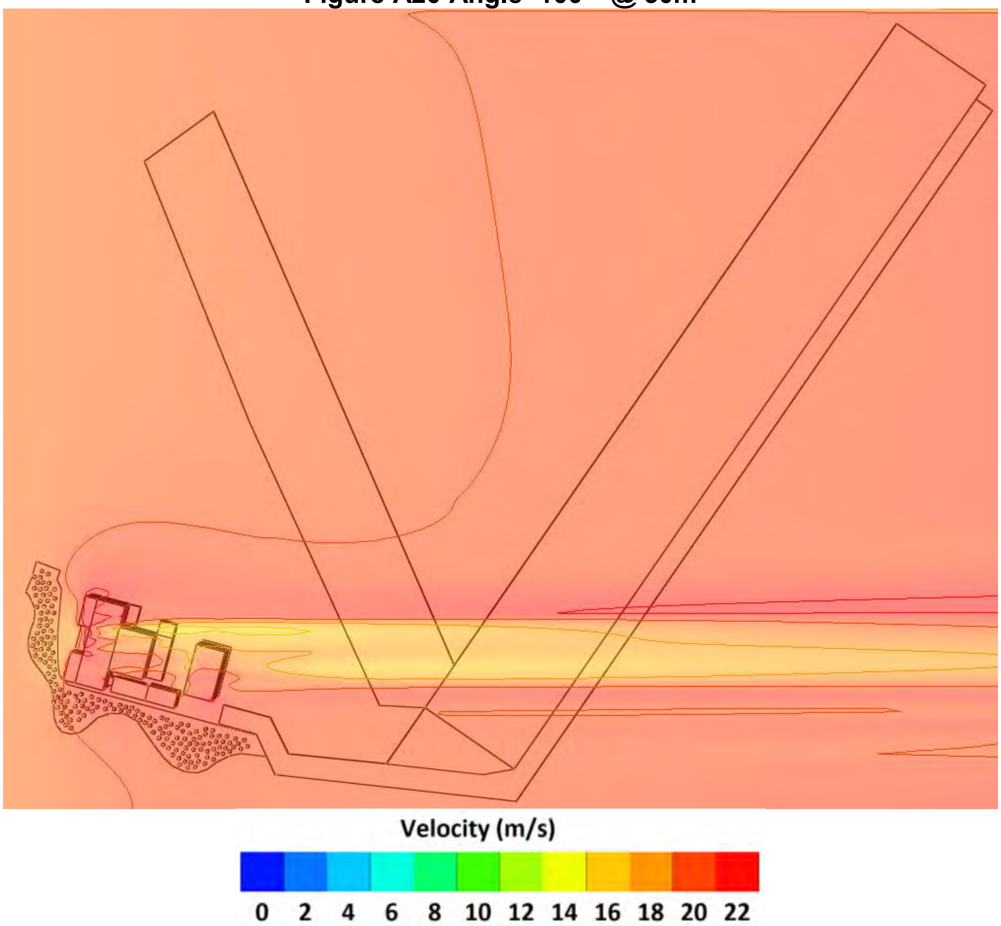
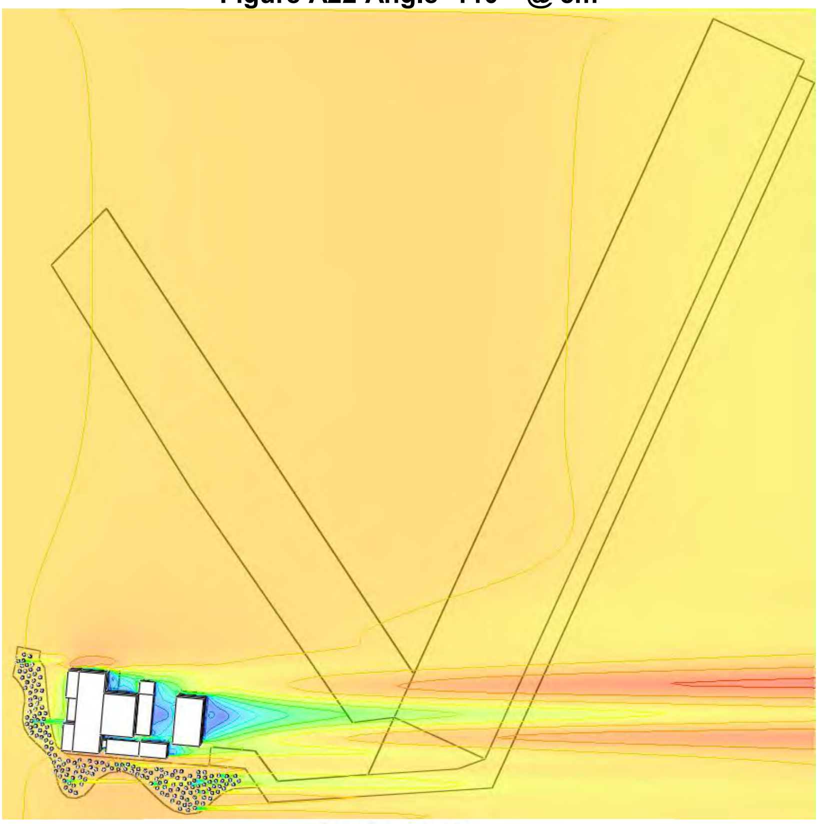


Figure A21 Angle=110^0 @ 1m

Figure A22 Angle=110^0 @ 5m



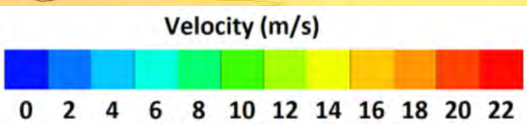


Figure A23 Angle=110^0 @ 10m

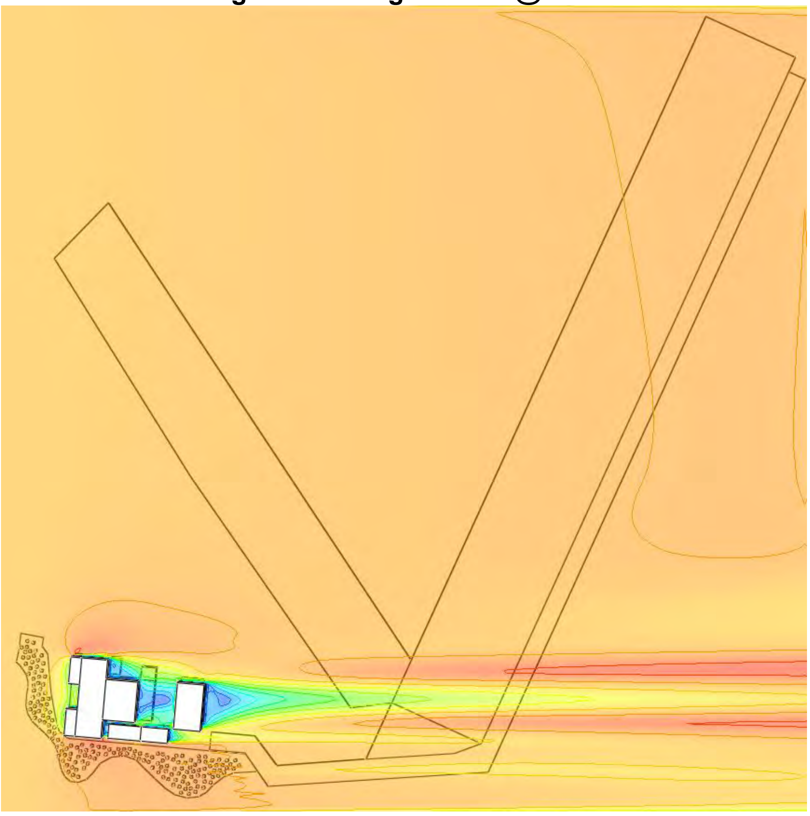
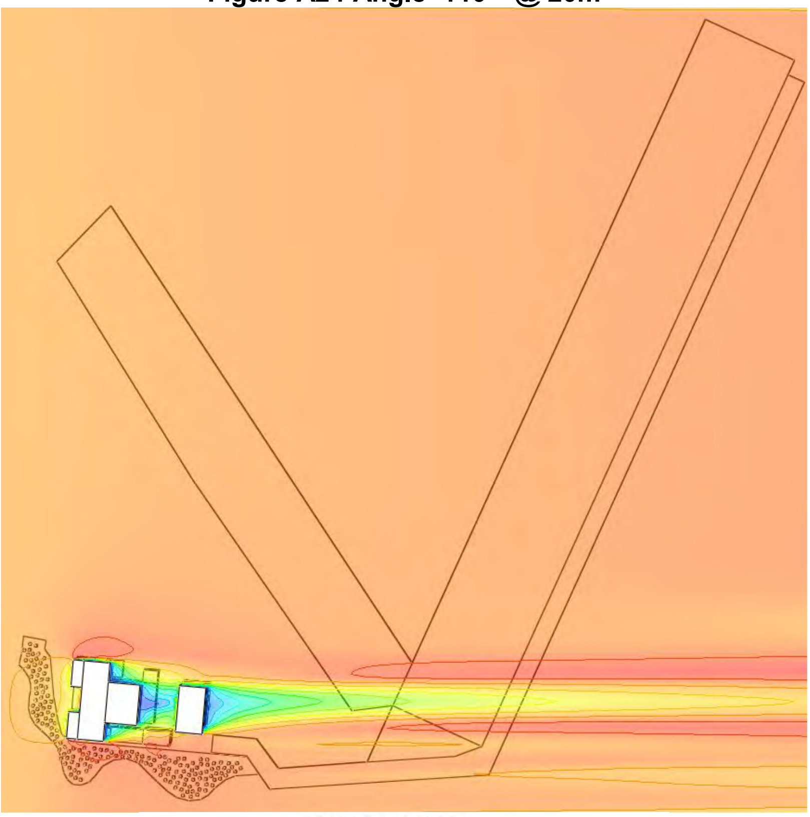


Figure A24 Angle=110^0 @ 20m



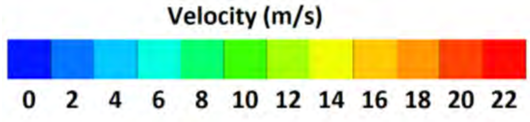


Figure A25 Angle=110^0 @ 30m

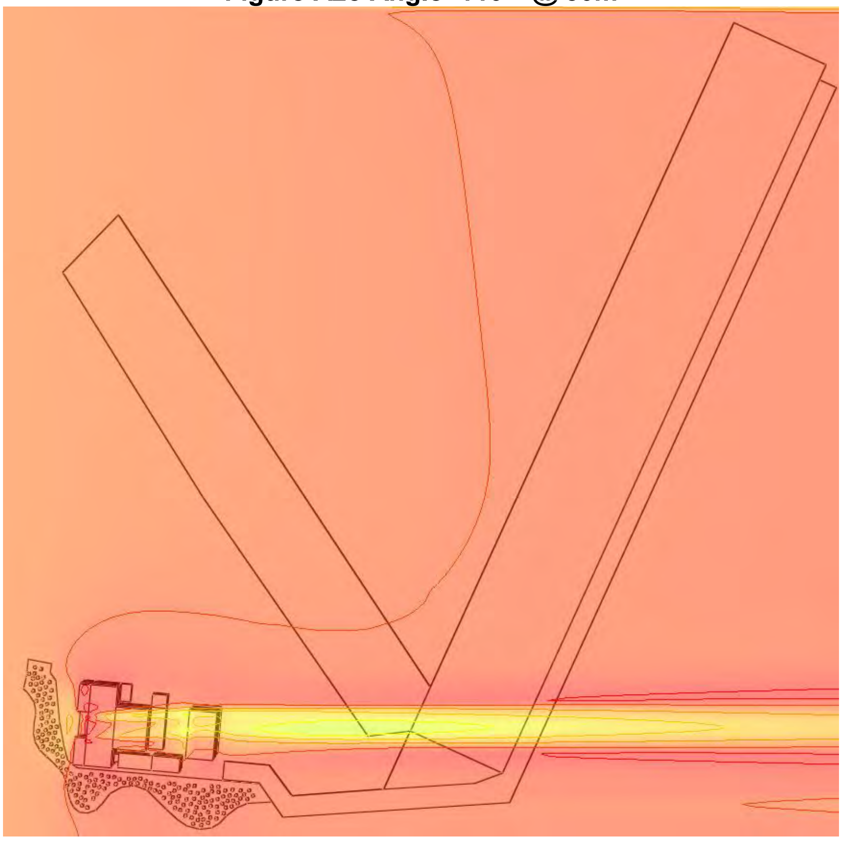


Figure A26 Angle=120^0 @ 1m

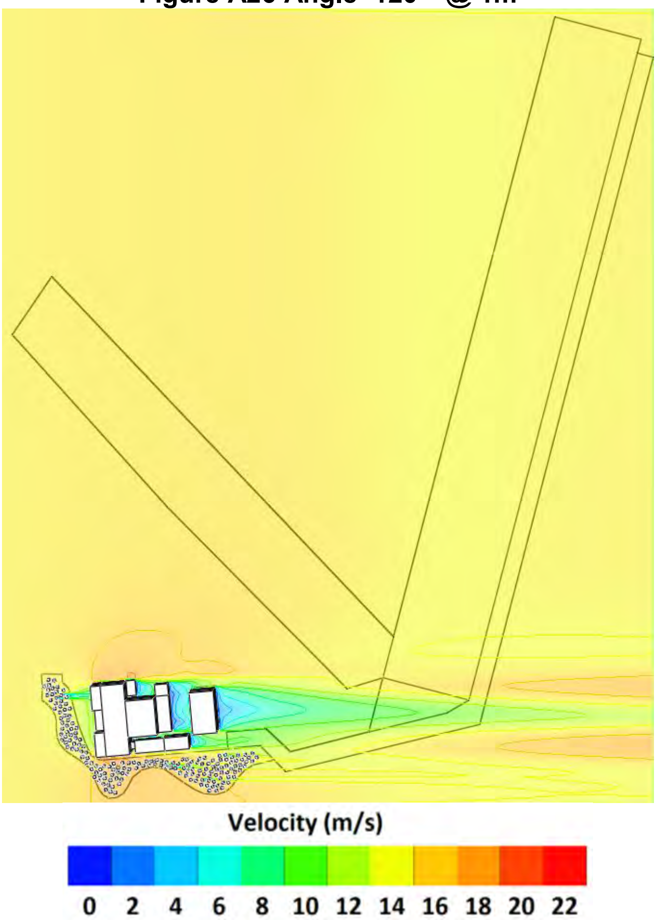


Figure A27 Angle=120^0 @ 5m

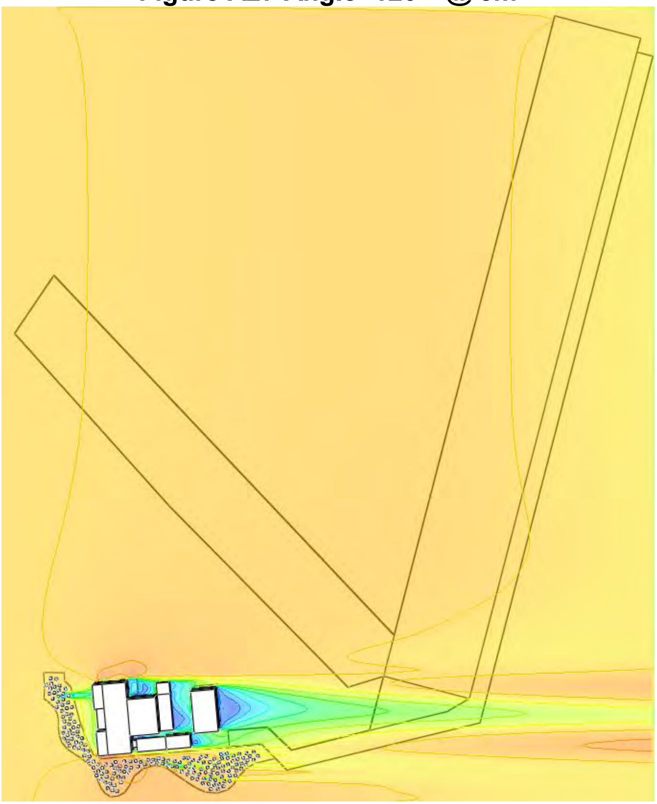


Figure A28 Angle=120^0 @ 10m

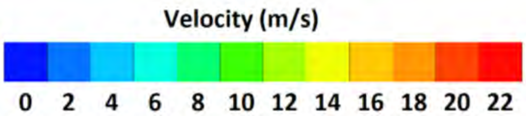


Figure A29 Angle=120⁰ @ 20m

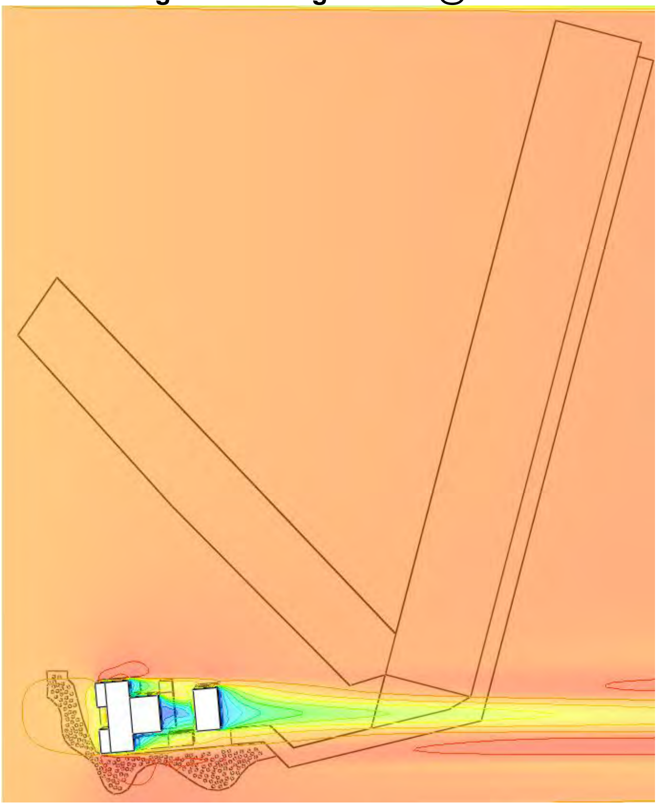
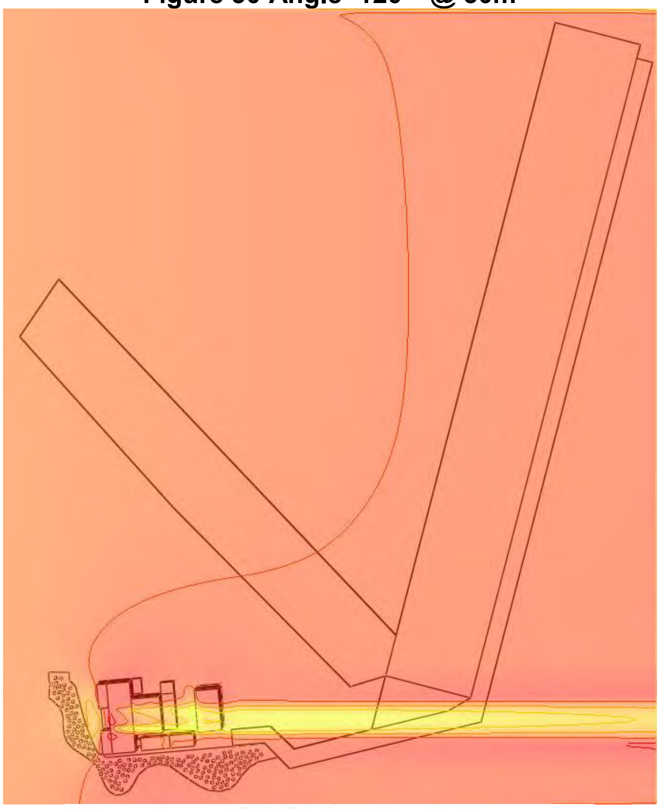
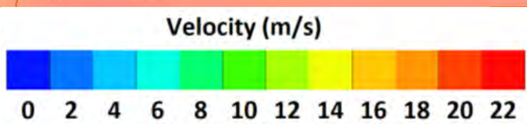


Figure 30 Angle=120⁰ @ 30m





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