# Proposed Warehouse on Kingswood Avenue, City West, Co. Dublin

## Daylight, Sunlight & Overshadowing Assessment

Project Ref: 20144

Client: Rockface Developments Limited

Date: 23/06/2022

**Report by:**
Building Performance Consulting Engineers

BPC ENGINEERS

BUILDING PERFORMANCE CONSULTING

| Rev | Description | Date: | Written By | Approved By: |
|---|---|---|---|---|
| P1-01 | Final Report | 24/02/2022 | JG | JG |
| P2-01 | Final Report | 13/05/2022 | JG | JG |
| P2-02 | Final Report | 23/06/2022 | JG | JG |

# Contents

# Glossary

**Daylight**
Part of global solar radiation capable of causing a visual sensation. (CIE, 2020) (Combined skylight and sunlight.)

**Obstruction Angle**
The angular altitude of the top of an obstruction above the horizontal, measured from a reference point in a vertical plane in a section perpendicular to the vertical plane.

**Skylight**
Part of *diffuse* sky radiation capable of causing a visual sensation. (CIE, 2020)

**Sunlight**
Part of direct solar radiation capable of causing a visual sensation. (CIE, 2020)

**Vertical Sky Component (VSC)**
Ratio of that part of illuminance, at a point on a given vertical plane, that is received directly from a sky of assumed or known luminance distribution (usually CIE standard overcast sky), to illuminance on a horizontal plane due to an unobstructed hemisphere of this sky. Usually the 'given vertical plane' is the outside of a window wall. The VSC does not include reflected light, either from the ground or from other buildings.

**Working Plane**
Horizontal, vertical or inclined plane in which a visual task lies. Normally the working plane may be taken to be horizontal, 0.85 m above the floor in houses and factories, 0.7 m above the floor in offices.

# 1 Executive Summary

The results show that the proposed development performs well against the BRE's recommendations with respect to safeguarding the daylight to neighbouring dwellings.

The results show that the proposed development has a negligible adverse impact on daylight to the neighbouring dwellings windows at Ardsolus.

The shadow images within Appendix A show minimal additional shadowing to the neighbouring dwellings at Ardsolus early in the morning due to these being located to the northwest of the proposed development.

The shadow images within Appendix A show some additional shadowing to the neighbouring offices on Kingswood Avenue due to these being located to the northwest of the proposed development.

As per the BRE guide "*In interpreting the impact of such differences, it must be borne in mind that nearly all structures will create areas of new shadow, and some degree of overshadowing of a space is to be expected.*"

Overall, the development has been designed with due consideration for safeguarding sunlight and daylight to the neighbouring dwellings and exceeds the recommendations for daylight and sunlight as set out in the BRE Guide – BR 209 *"Site Layout Planning for Daylight and Sunlight, A guide to good practice (2011)."*

# 2 Introduction

Site layout planning to achieve good daylighting and sunlighting within buildings and in the open spaces around them is an important aspect in designing new buildings or developments. Daylight animates an interior and makes it attractive and interesting, as well as providing light to work or read by. Good daylight and sunlight can contribute to making a building energy-efficient; they can reduce the need for electric lighting, while winter solar gain can reduce heating requirements.

Rockface Developments Limited intend to apply for permission for development at a 2.56 Ha site at Kingswood Road and Kingswood Avenue, Citywest Business Campus, Dublin 24. The lands are generally bounded to the south-east by Kingswood Avenue, south-west and north-west by existing built development and to the north-east by Kingswood Road.

The development will comprise the provision of a warehouse with ancillary office and staff facilities and associated development. The warehouse will have a maximum height of 18 metres with a gross floor area of 11,691 sq m including a warehouse area (10,604 sq m), ancillary staff facilities (499 sq m) and ancillary office area (588 sq m).

The development will also include: a vehicular and pedestrian entrance to the site from Kingswood Road, a separate HGV entrance from Kingswood Avenue; 64 No. ancillary car parking spaces; covered bicycle parking; HGV parking and yards; level access goods doors; dock levellers; access gates; hard and soft landscaping; canopy; lighting; boundary treatments; ESB substation; plant; and all associated site development works above and below ground.

This report provides information on the daylight and sunlight analysis undertaken for the proposed development on neighbouring dwellings at Ardsolus and offices on Kingswood Avenue, City West, Dublin.

The analysis and assessments in this report have therefore been carried in line with the recommendations of BRE's "Site Layout Planning for daylight and sunlight, a Guide to good practice" (PJ Littlefair), 2011. This guide is also known as BRE Guide BR209 and may be referenced as such or simply as the "BRE Guide" hereafter in this document.

This report assesses the proposed developments performance on sunlight/daylight to the existing neighbouring dwellings by the following means:

- Vertical Sky Component (VSC) (i.e. quantifies reduction of daylight if any)
- Overshadowing (Appendix A provides shadow plots for the existing and proposed scenarios)

# 3 Site Description

## 3.1 Location & Context

The site is a 2.56 Ha site at Kingswood Road and Kingswood Avenue, Citywest Business Campus, Dublin 24. The lands are generally bounded to the south-east by Kingswood Avenue, south-west and north-west by existing built development and to the north-east by Kingswood Road.

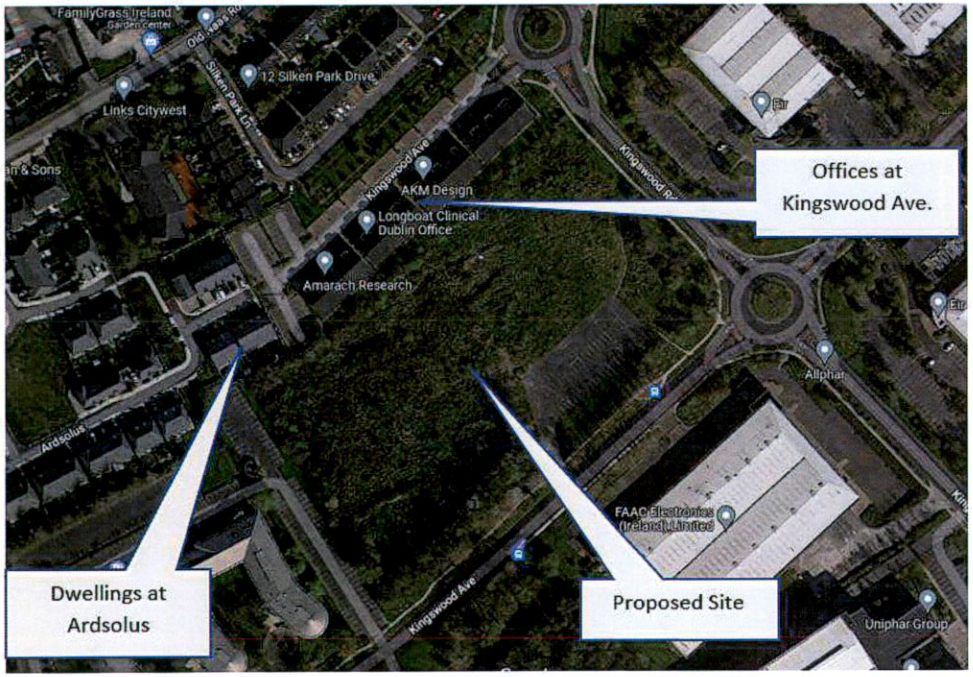



*Figure 1: Site Location*

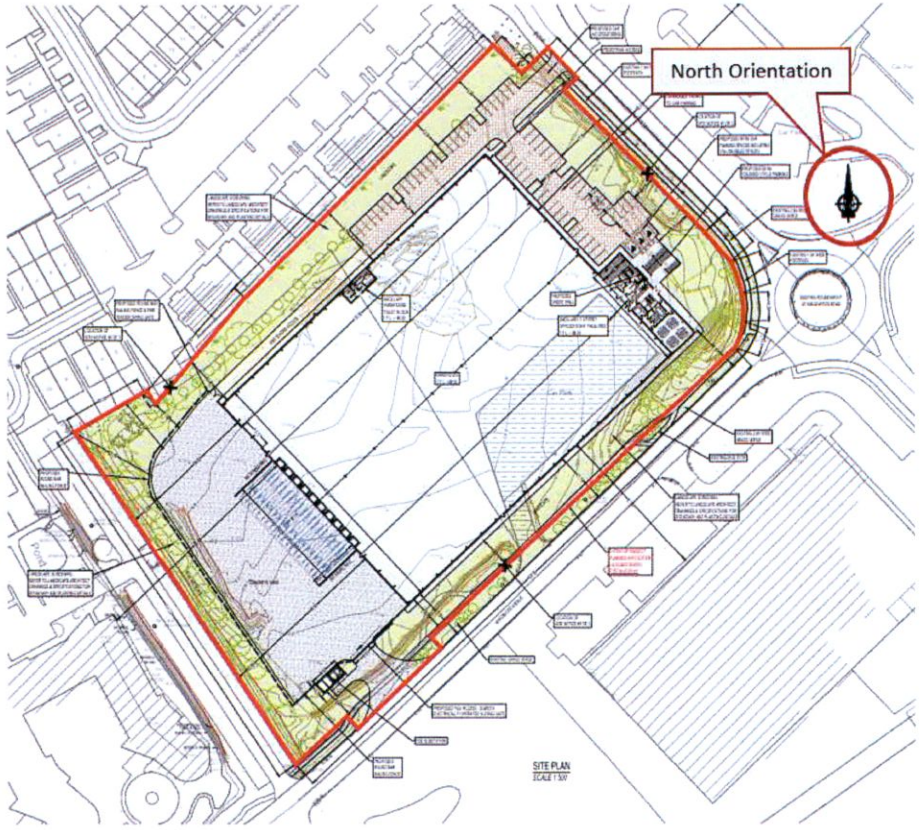



*Figure 2: Site Plan*

## 3.2 Sensitive Receptors

The BRE guide states that when assessing the potential effects of a proposed development on existing buildings, only those windows and rooms that have a 'reasonable expectation' of daylight and sunlight need to be considered. Windows and rooms which meet these criteria are considered to be 'sensitive receptors. Paragraph 2.2.2 of the BRE guide clarifies what are considered sensitive receptors with respect to sunlight and daylight as follows:

*"The guidelines given here are intended for use for rooms in adjoining dwellings where daylight is required, including living rooms, kitchens and bedrooms. Windows to bathrooms, toilets, storerooms, circulation areas and garages need not be analysed. The guidelines may also be applied to any existing nondomestic building where the occupants have a reasonable expectation of daylight; this would normally include schools, hospitals, hotels and hostels, small workshops and some offices."*

The windows to the rear of the dwellings at Ardsolus, were analysed.

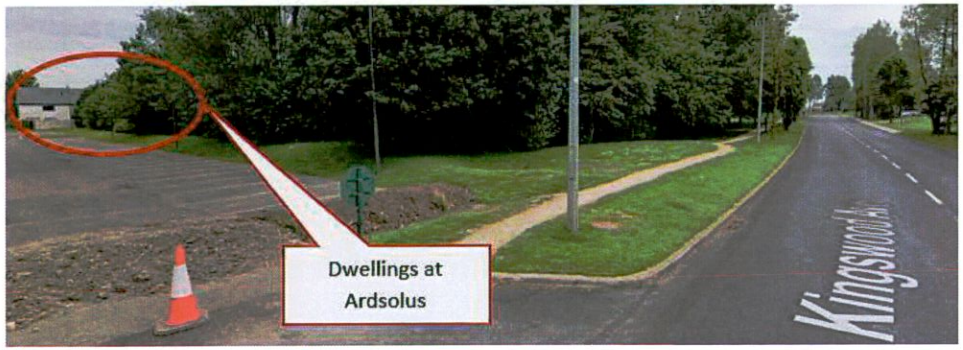



Figure 3: Neighbouring dwellings at Ardsolus to the Northwest of the proposed development


Figure 4: Satellite view of neighbouring dwellings at Ardsolus to the Northwest of the proposed development

There are also some offices located to the northwest of the proposed site at Kingswood Avenue. Offices are generally not considered as sensitive receptors such as dwellings. However, we analysed the VSC values on the offices for completeness.

*Figure 5: Neighbouring Offices on Kingswood Avenue to the Northwest of the proposed development*


*Figure 6: Satellite view of neighbouring offices on Kingswood Ave. to the Northwest of the proposed development*

# 4 Methodology & Assessment Criteria

The analyses and assessments are based on the guidelines set out in the BRE guide (BR 209) "Site Layout Planning for Daylight and Sunlight, A Guide to Good Practice" (Paul Littlefair, 2011). This guide is intended to be used in conjunction with interior lighting recommendations in BS 8206-2: 2008 'Lighting for Buildings – Part 2: Code of Practice for Daylighting', and in CIBSE Lighting guide (LG10): daylighting and window design.

It should be noted that that BS 8206: 2008 has now been withdrawn and is superseded by BS EN 17037:2018 which was officially adopted in May 2019. The UK National Annex published as part of BS EN 17037:2018, which is also relevant to Ireland, recommends minimum indoor lighting levels derived from the previous BS 8206-2:2008 targets. The BRE have stated that, "Until BR 209 is rewritten, we are adopting a flexible approach to applying the two standards" and they consider it reasonable for local authorities to accept either average daylight factors using BS 8206 or median daylight factors/median illuminances calculated using EN 17037. Taking this into account, the approach adopted in this report for assessing daylight levels in the *proposed* development is average daylight factors. (More details on the newly published British Standard BS EN 17037:2018 Daylight in buildings and BPC Engineers' approach for the "transitionary period" until the new BR209 guide is published can be found in Appendix C of this report.)

It should also be noted that although the BRE guide gives numerical guidelines, "*these should be interpreted flexibly since natural lighting is only one of many factors in site layout design.*" (Littlefair, 2011)

MBS Waldram Tools v5.0 software is used to perform the daylight calculations within the AutoCAD® environment. The software performs analysis by running calculations from a 3D CAD Model. The software fully meets all relevant guidelines set out in Building Research Establishment (BRE) document "Site Layout Planning for Daylight and Sunlight – A Guide to Good Practice" by P J Littlefair.

Throughout this report an effort will be made to differentiate between metrics used to assess skylight versus sunlight. As defined in the glossary of the BRE Guide, "Daylight" is an umbrella term that includes both skylight and sunlight—the diffuse and direct components of light from the sky respectively. Unfortunately, as can be seen from the title of the BRE Guide itself, "Site Layout Planning for *Daylight and Sunlight*" and the BS 8206 standard, the terms daylight and skylight are often used interchangeably but this report will aim to specify when daylight specifically refers to skylight or when it also encompasses sunlight.

The following sub-sections outline the methodology and assessment criteria used.

## 4.1 Existing Buildings

The proposed developments impact on daylight to the existing buildings (sensitive receptors only) is assessed using the following methodologies.

### 4.1.1 Vertical Sky Component (VSC)

Any reduction in the total amount of skylight for the existing properties is calculated by finding the VSC at the centre of each main window. The Vertical Sky Component (VSC) is the ratio of the direct sky illuminance at the vertical reference point, to the simultaneous illuminance on an unobstructed horizontal plane. Reflected light it not included.

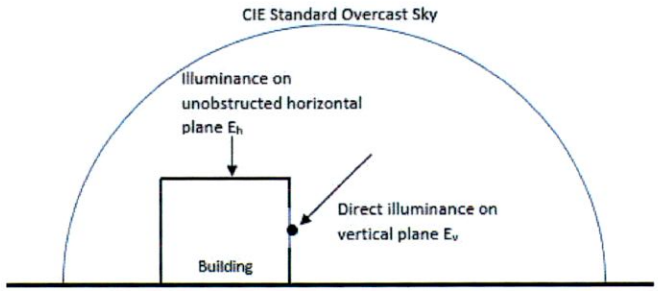



*Figure 7: Vertical Sky Component*

In the case of a floor-to-ceiling window such as a patio door, a point 1.6 m above ground (or balcony level for an upper storey) on the centre line of the window is used. The reference point is in the external plane of the window wall. Windows to bathrooms, toilets, storerooms, circulation areas and garages are not analysed.

The diffuse daylighting of any existing building may be adversely affected if:

*"the VSC measured at the centre of an existing main window [or 1.6m above bottom of glazed door] is less than 27%, and less than 0.8 times its former value."* (Littlefair, 2011)

The offices on Kingswood Avenue are located close to the proposed site boundary as illustrated in the image below.

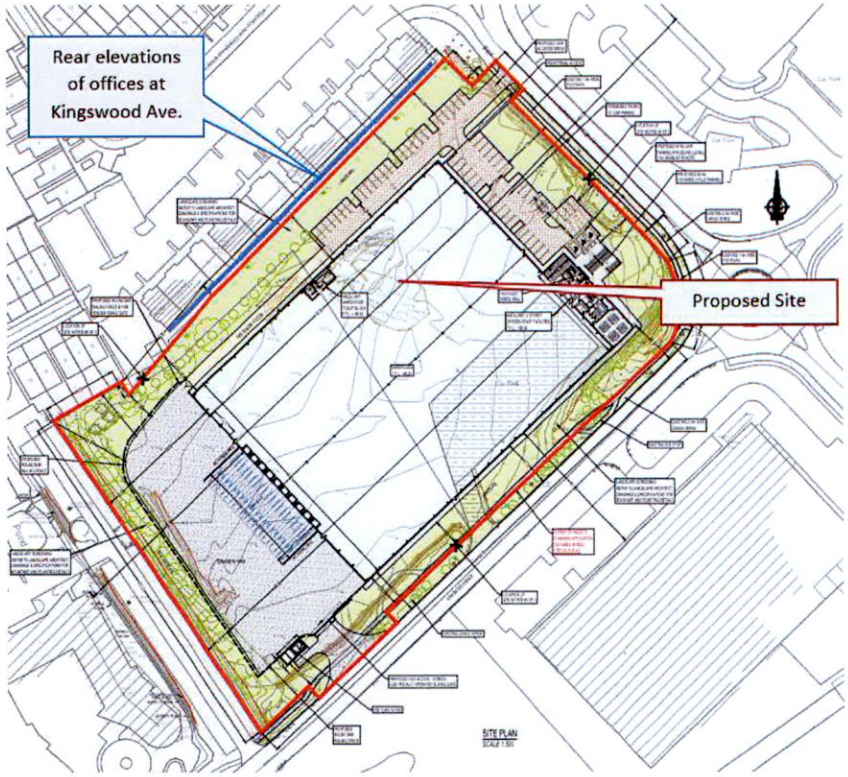



*Figure 8: Offices at Kingswood Ave.*

Section F5 of Appendix F of the BRE guide states:

*"where and existing building has windows that are unusually close to the site boundary and taking more than their fair share of light. Figure F3 shows an example, where side windows of an existing building are close to the boundary. To ensure that the new development matches the height and proportions of existing buildings, the VSC and APSH targets for these windows could be set to those for a 'mirror image' building of the same height and size an equal distance away on the other side of the boundary."* (Littlefair, 2011)

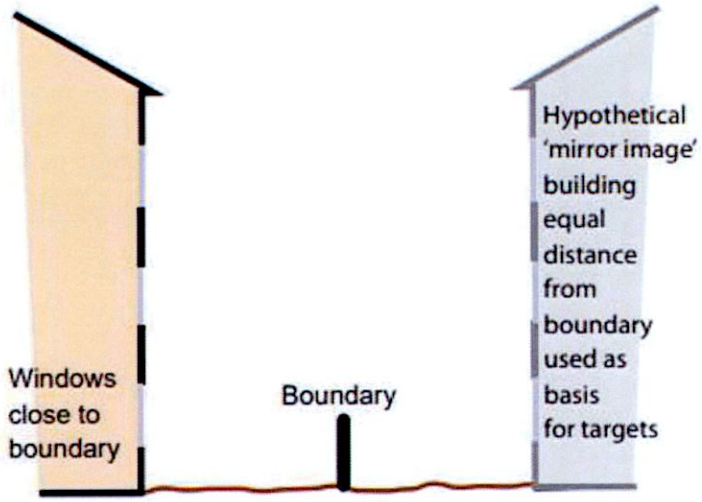



*Figure F3:* Use of a hypothetical mirror image building to set target daylight values

*Figure 9: Figure F3 from the BRE guide*

If we used the distance of the existing offices from the boundary and mirrored the offices across the boundary, table F1 of the BRE guide indicates a target resultant VSC value to be 14%. However, we have set ourselves the more onerous target for the VSC value of 21% as at this level and given the generous window sizes to the offices adequate daylight will still be achieved.

### 4.1.2 Shadow Plots

The BRE guide states:

*"Where a large building is proposed which may affect a number of gardens or open spaces it is often illustrative to plot a shadow plan showing the location of shadows at different times of day and year."*

'Before' and 'after' shadow plots are used to show the difference that the proposed building makes. In interpreting the impact of such differences, it must be borne in mind that nearly all structures will create areas of new shadow, and some degree of overshadowing of a space is to be expected.

Shadow plots were created for March 21st, June 21st and December 21st. March 21st is the equinox and as such provides the average level of shadowing that can be expected. June 21st is a summertime plot and represents the best case for shadow. December 21st is the winter solstice.

The shadow plots are purely illustrative (as opposed to other quantitative or metrics used in the analysis) and are shown in Appendix A.

## 4.2 Impact Classification

Appendix I of the BRE Guide – Environmental Impact Assessment states that the impact of a new building on its surroundings can be classified as negligible, minor, moderate or major adverse. Where the loss of skylight or sunlight fully meets the guidelines in the BRE guide, the impact is assessed as negligible or minor adverse. Where the loss of skylight or sunlight does not meet the BRE guidelines, the impact is assessed as minor, moderate or major adverse. Table 1 below provides a more detailed description of the impact classification.

*Table 1: Environmental Impact Assessment: Impact Classification*

| | |
|---|---|
| *Negligible adverse impact* | • *Loss of light well within guidelines,* ***or***<br>• *only a small number of windows losing light (within the guidelines)* ***or***<br>• *limited area of open space losing light (within the guidelines)* |
| *Minor adverse impact (a)* | • *Loss of light only just within guidelines* ***and***<br>  ○ *a larger number of windows are affected* ***or***<br>  ○ *larger area of open space is affected (within the guidelines)* |
| *Minor adverse impact (b)* | • *only a small number of windows or limited open space areas are affected*<br>• *the loss of light is only marginally outside the guidelines*<br>• *an affected room has other sources of skylight or sunlight*<br>• *the affected building or open space only has a low-level requirement for skylight or sunlight*<br>• *there are particular reasons why an alternative, less stringent, guideline should be applied* |
| *Major adverse impact* | • *large number of windows or large open space areas are affected*<br>• *the loss of light is substantially outside the guidelines*<br>• *all the windows in a particular property are affected*<br>• *the affected indoor or outdoor spaces have a particularly strong requirement for skylight or sunlight (living rooms / playground)* |

# 5 Analysis

## 5.1 Overview of Computational Models

3D models of the existing the proposed scenarios were created. The site plans and existing 3D models of the surrounding context provided by the architect were used to correctly position the surrounding buildings relative to the existing and proposed buildings.

In Figure 10 and Figure 11 the beige elements represent the existing surrounding buildings. The proposed development is shown in blue in Figure 10.

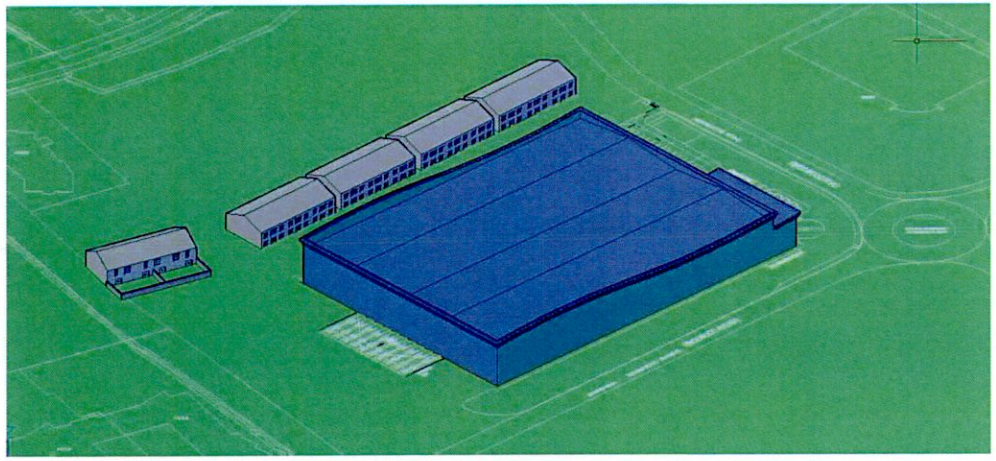


*Figure 10: Proposed Model*

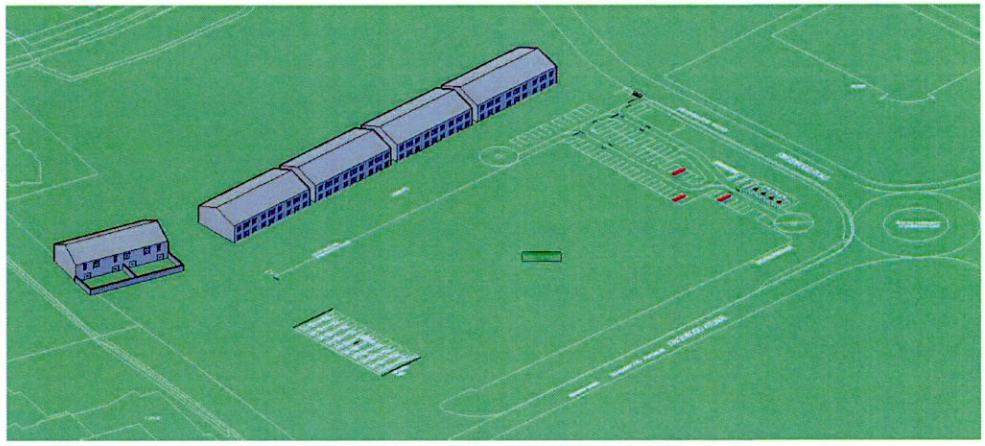


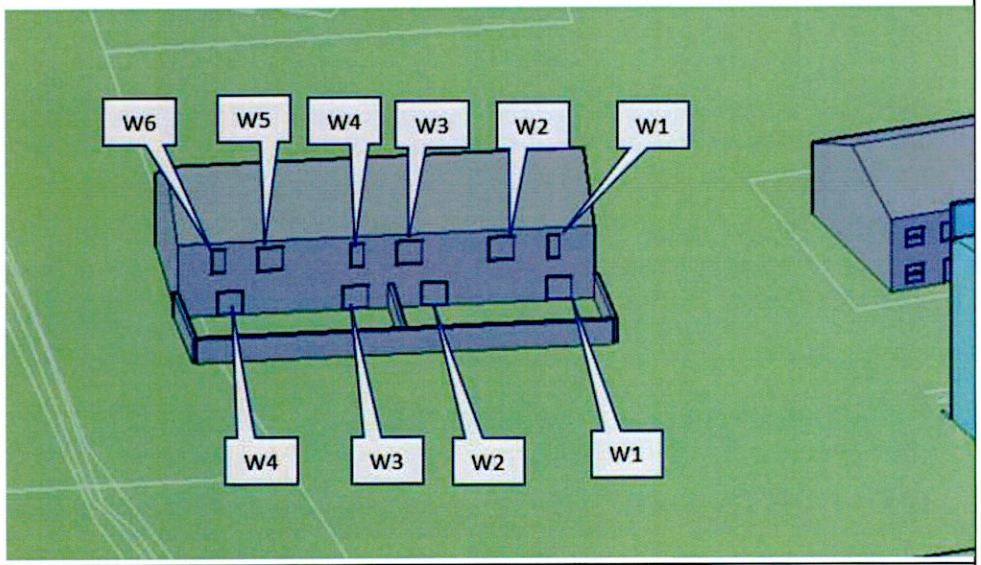
*Figure 11: Existing Model*

## 5.2 Impact on Existing Neighbouring Property

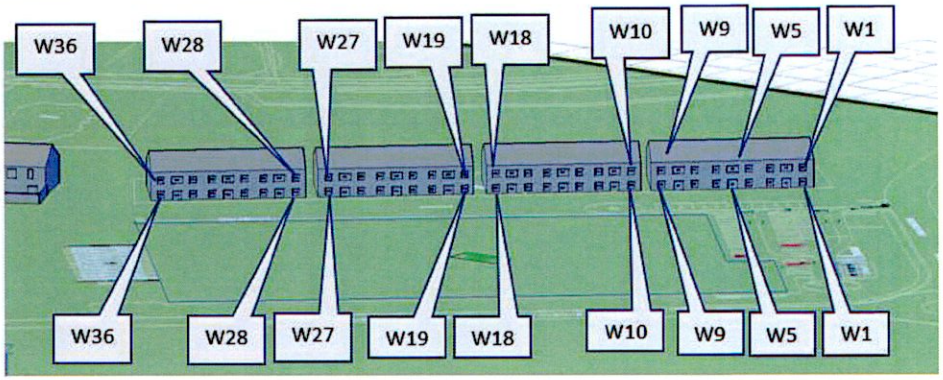
### 5.2.1 Neighbouring Properties' Details

As described under Section 4, the impact on the neighbouring buildings' access to skylight was assessed by means of VSC and the impact on sunlight availability was assessed via shadow plots in Appendix A. The specific windows are identified in the images below which are test points along the rear elevation of the dwellings at Ardsolus. The windows are labelled for reference to the VSC results.

Neighbouring Dwellings at **Ardsolus – Ground & First Floor** to the northwest of the proposed development




Neighbouring **Offices at Kingswood Avenue Ground & First Floor** to the northwest of the proposed development



## 5.2.2 VSC Analysis

### *5.2.2.1 Results*

The results of the VSC analysis are shown in table 2 below.

*Table 2: Dwellings Ardsolus VSC Results*

| Building Ref | Floor Ref | Window Ref | VSC | | | |
|---|---|---|---|---|---|---|
| | | | Existing | Proposed | Pr/Ex | Meets BRE Criteria |
| Ardsolus | Ground Floor | W1 | 35.19 | 34.48 | 0.98 | YES |
| | | W2 | 35.44 | 33.90 | 0.96 | YES |
| | | W3 | 34.92 | 34.92 | 1.00 | YES |
| | | W4 | 35.91 | 35.04 | 0.98 | YES |
| | First Floor | W1 | 39.62 | 37.38 | 0.94 | YES |
| | | W2 | 39.62 | 37.68 | 0.95 | YES |
| | | W3 | 39.62 | 38.07 | 0.96 | YES |
| | | W4 | 39.62 | 38.25 | 0.97 | YES |
| | | W5 | 39.62 | 38.49 | 0.97 | YES |
| | | W6 | 39.62 | 38.61 | 0.97 | YES |

*Table 3: Offices Kingswood Avenue VSC results*

| Building Ref | Floor Ref | Window Ref | VSC | | | |
|---|---|---|---|---|---|---|
| | | | Target | Proposed | Pr/Ex | Meets BRE Criteria |
| Offices Kingswood Ave. | Ground Floor | W1 | 21.00 | 35.66 | 1.70 | YES |
| | | W2 | 21.00 | 35.14 | 1.67 | YES |
| | | W3 | 21.00 | 34.72 | 1.65 | YES |
| | | W4 | 21.00 | 33.98 | 1.62 | YES |
| | | W5 | 21.00 | 33.63 | 1.60 | YES |
| | | W6 | 21.00 | 32.63 | 1.55 | YES |
| | | W7 | 21.00 | 31.65 | 1.51 | YES |
| | | W8 | 21.00 | 30.45 | 1.45 | YES |
| | | W9 | 21.00 | 29.47 | 1.40 | YES |
| | | W10 | 21.00 | 27.59 | 1.31 | YES |
| | | W11 | 21.00 | 26.63 | 1.27 | YES |
| | | W12 | 21.00 | 26.16 | 1.25 | YES |
| | | W13 | 21.00 | 25.59 | 1.22 | YES |
| | | W14 | 21.00 | 24.98 | 1.19 | YES |
| | | W15 | 21.00 | 24.88 | 1.18 | YES |
| | | W16 | 21.00 | 24.58 | 1.17 | YES |
| | | W17 | 21.00 | 24.17 | 1.15 | YES |
| | | W18 | 21.00 | 24.23 | 1.15 | YES |
| | | W19 | 21.00 | 24.00 | 1.14 | YES |
| | | W20 | 21.00 | 23.68 | 1.13 | YES |
| | | W21 | 21.00 | 23.82 | 1.13 | YES |
| | | W22 | 21.00 | 23.75 | 1.13 | YES |
| | | W23 | 21.00 | 23.48 | 1.12 | YES |
| | | W24 | 21.00 | 23.67 | 1.13 | YES |
| | | W25 | 21.00 | 23.65 | 1.13 | YES |
| | | W26 | 21.00 | 23.42 | 1.12 | YES |
| | | W27 | 21.00 | 23.68 | 1.13 | YES |
| | | W28 | 21.00 | 23.80 | 1.13 | YES |
| | | W29 | 21.00 | 23.71 | 1.13 | YES |
| | | W30 | 21.00 | 24.12 | 1.15 | YES |
| | | W31 | 21.00 | 24.42 | 1.16 | YES |
| | | W32 | 21.00 | 24.61 | 1.17 | YES |
| | | W33 | 21.00 | 25.33 | 1.21 | YES |
| | | W34 | 21.00 | 26.09 | 1.24 | YES |
| | | W35 | 21.00 | 26.83 | 1.28 | YES |
| | | W36 | 21.00 | 28.09 | 1.34 | YES |

*Table 4: Offices Kingswood Avenue VSC results*

| Building Ref | Floor Ref | Window Ref | VSC | | | |
|---|---|---|---|---|---|---|
| | | | Target | Proposed | Pr/Ex | Meets BRE Criteria |
| Offices Kingswood Ave. | First Floor | W1 | 21.00 | 36.48 | 1.74 | YES |
| | | W2 | 21.00 | 36.12 | 1.72 | YES |
| | | W3 | 21.00 | 35.71 | 1.70 | YES |
| | | W4 | 21.00 | 35.09 | 1.67 | YES |
| | | W5 | 21.00 | 34.54 | 1.64 | YES |
| | | W6 | 21.00 | 33.95 | 1.62 | YES |
| | | W7 | 21.00 | 33.11 | 1.58 | YES |
| | | W8 | 21.00 | 32.20 | 1.53 | YES |
| | | W9 | 21.00 | 31.27 | 1.49 | YES |
| | | W10 | 21.00 | 29.72 | 1.42 | YES |
| | | W11 | 21.00 | 29.08 | 1.38 | YES |
| | | W12 | 21.00 | 28.55 | 1.36 | YES |
| | | W13 | 21.00 | 28.08 | 1.34 | YES |
| | | W14 | 21.00 | 27.75 | 1.32 | YES |
| | | W15 | 21.00 | 27.50 | 1.31 | YES |
| | | W16 | 21.00 | 27.25 | 1.30 | YES |
| | | W17 | 21.00 | 27.09 | 1.29 | YES |
| | | W18 | 21.00 | 26.96 | 1.28 | YES |
| | | W19 | 21.00 | 26.77 | 1.27 | YES |
| | | W20 | 21.00 | 26.69 | 1.27 | YES |
| | | W21 | 21.00 | 26.62 | 1.27 | YES |
| | | W22 | 21.00 | 26.57 | 1.27 | YES |
| | | W23 | 21.00 | 26.52 | 1.26 | YES |
| | | W24 | 21.00 | 26.49 | 1.26 | YES |
| | | W25 | 21.00 | 26.47 | 1.26 | YES |
| | | W26 | 21.00 | 26.46 | 1.26 | YES |
| | | W27 | 21.00 | 26.49 | 1.26 | YES |
| | | W28 | 21.00 | 26.58 | 1.27 | YES |
| | | W29 | 21.00 | 26.67 | 1.27 | YES |
| | | W30 | 21.00 | 26.82 | 1.28 | YES |
| | | W31 | 21.00 | 27.07 | 1.29 | YES |
| | | W32 | 21.00 | 27.38 | 1.30 | YES |
| | | W33 | 21.00 | 27.80 | 1.32 | YES |
| | | W34 | 21.00 | 28.42 | 1.35 | YES |
| | | W35 | 21.00 | 29.18 | 1.39 | YES |
| | | W36 | 21.00 | 30.08 | 1.43 | YES |

### 5.2.2.2 *Discussion*

The results show that the proposed development has a negligible adverse impact on daylight to the neighbouring dwellings windows at Ardsolus and the VSC results for the offices on Kingswood Avenue are all exceeded.

## 5.3 Shadow Analysis

Shadow plots have been created in Appendix A for the existing and proposed scenarios for the following key dates:

- March 21st (i.e. Equinox)
- June 21st (i.e. Summer Solstice)
- December 21st (i.e. Winter Solstice)

### 5.3.1 Discussion

The shadow images within Appendix A show minimal additional shadowing to the neighbouring dwellings at Ardsolus early in the morning due to these being located to the northwest of the proposed development.

The shadow images within Appendix A show some additional shadowing to the neighbouring offices on Kingswood Avenue due to these being located to the northwest of the proposed development.

As per the BRE guide "*In interpreting the impact of such differences, it must be borne in mind that nearly all structures will create areas of new shadow, and some degree of overshadowing of a space is to be expected.*"

# 6 Conclusion

The results show that the proposed development performs well against the BRE's recommendations with respect to safeguarding the daylight to neighbouring dwellings.

The results show that the proposed development has a negligible adverse impact on daylight to the neighbouring dwellings windows at Ardsolus.

The shadow images within Appendix A show minimal additional shadowing to the neighbouring dwellings at Ardsolus early in the morning due to these being located to the northwest of the proposed development.

The shadow images within Appendix A show some additional shadowing to the neighbouring offices on Kingswood Avenue due to these being located to the northwest of the proposed development.

As per the BRE guide "*In interpreting the impact of such differences, it must be borne in mind that nearly all structures will create areas of new shadow, and some degree of overshadowing of a space is to be expected.*"

Overall, the development has been designed with due consideration for safeguarding sunlight and daylight to the neighbouring dwellings and exceeds the recommendations for daylight and sunlight as set out in the BRE Guide – BR 209 *"Site Layout Planning for Daylight and Sunlight, A guide to good practice (2011)."*

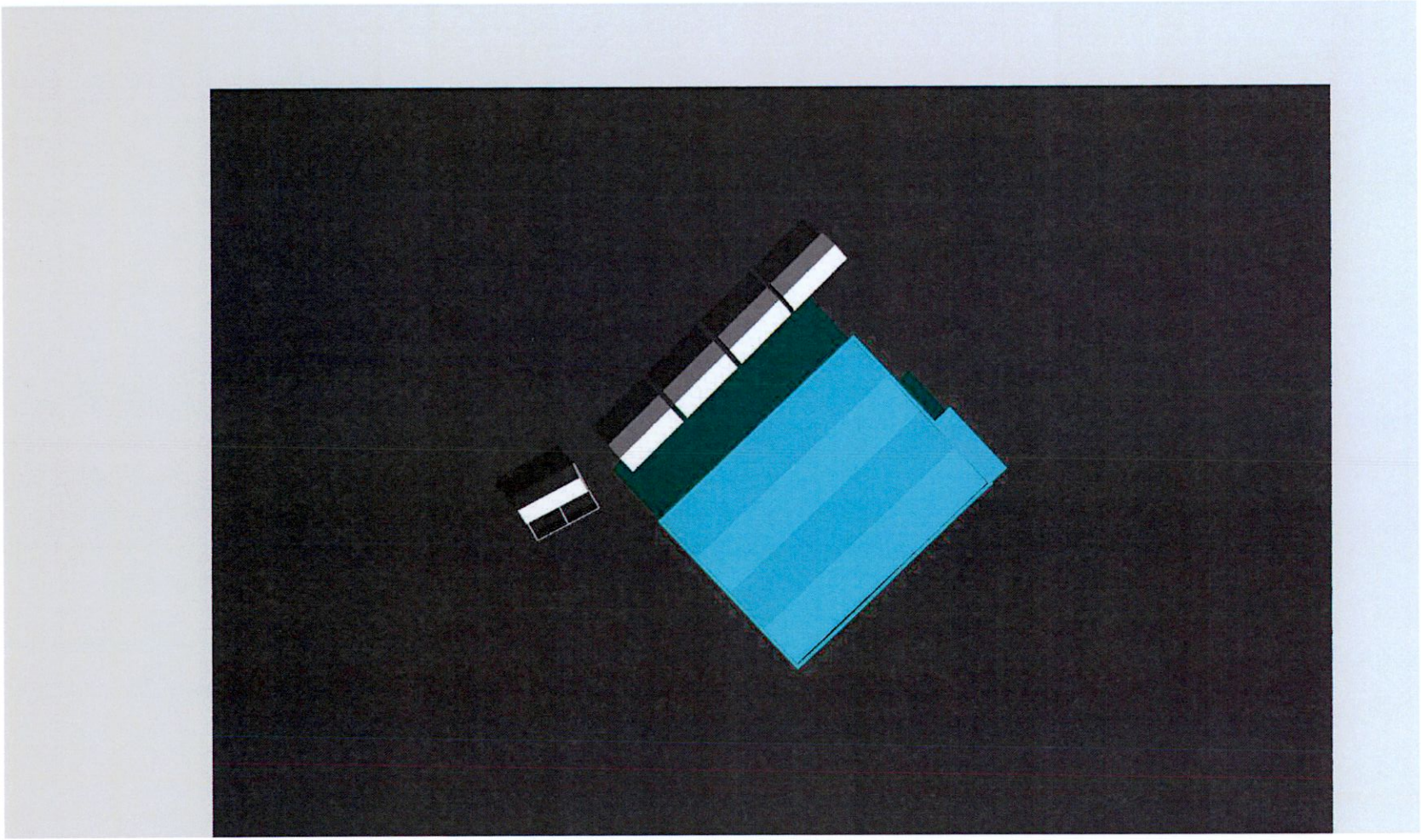
# Appendix A: Shadow Images

## A.1 March 21st

| Proposed |
| --- |

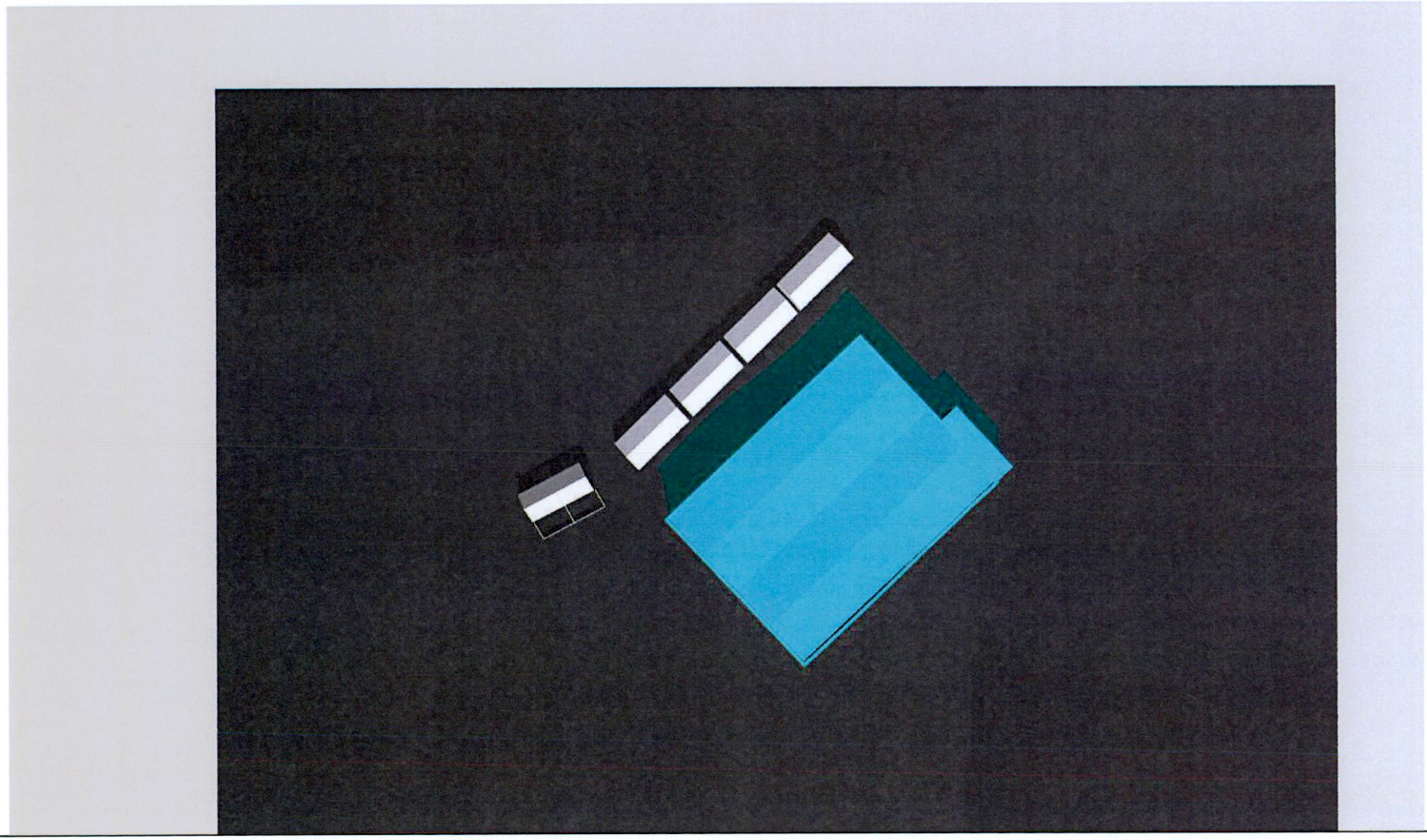
March 21st - 10:00

20144-KIN-BPC-XX-ZZ-M3-P4-01
2021-21-3--10-00



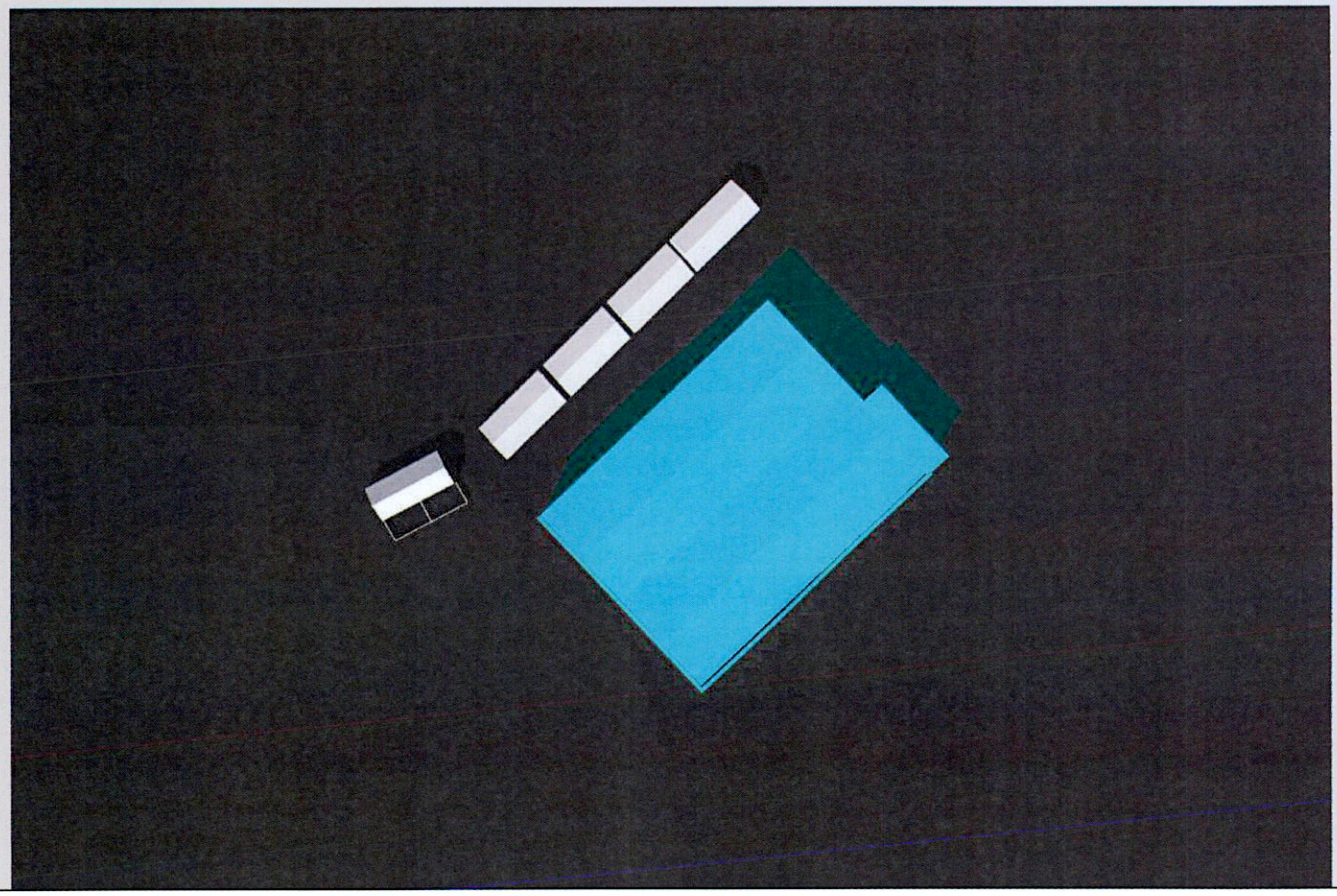
20144-KIN-BPC-XX-ZZ-M3-P4-01
2021-21-3--12-00

March 21st - 12:00



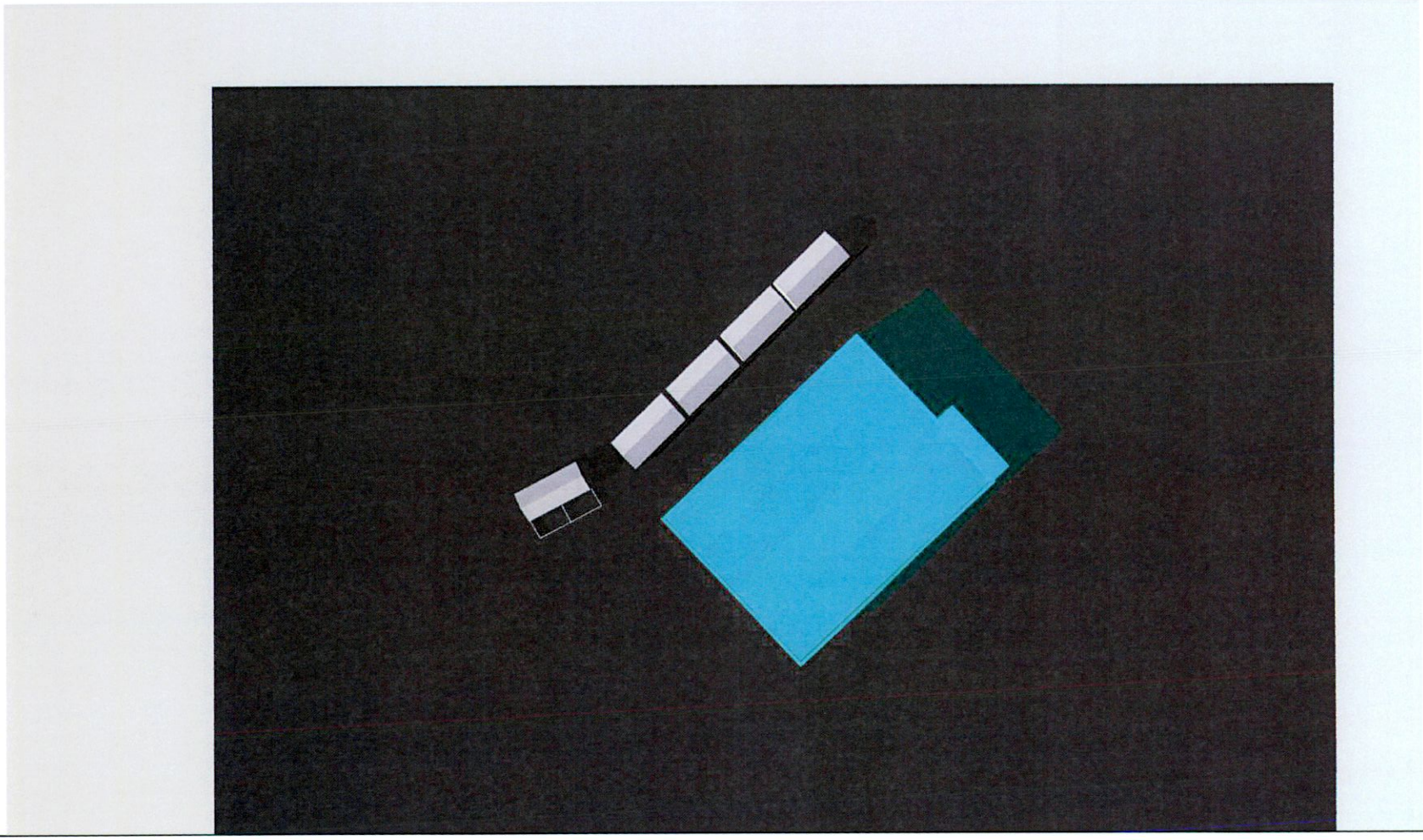
20144-KIN-BPC-XX-ZZ-M3-P4-01
2021-21-3--14-00

March 21st - 14:00



March 21st - 16:00

20144-KIN-BPC-XX-ZZ-M3-P4-01
2021-21-3--16-00

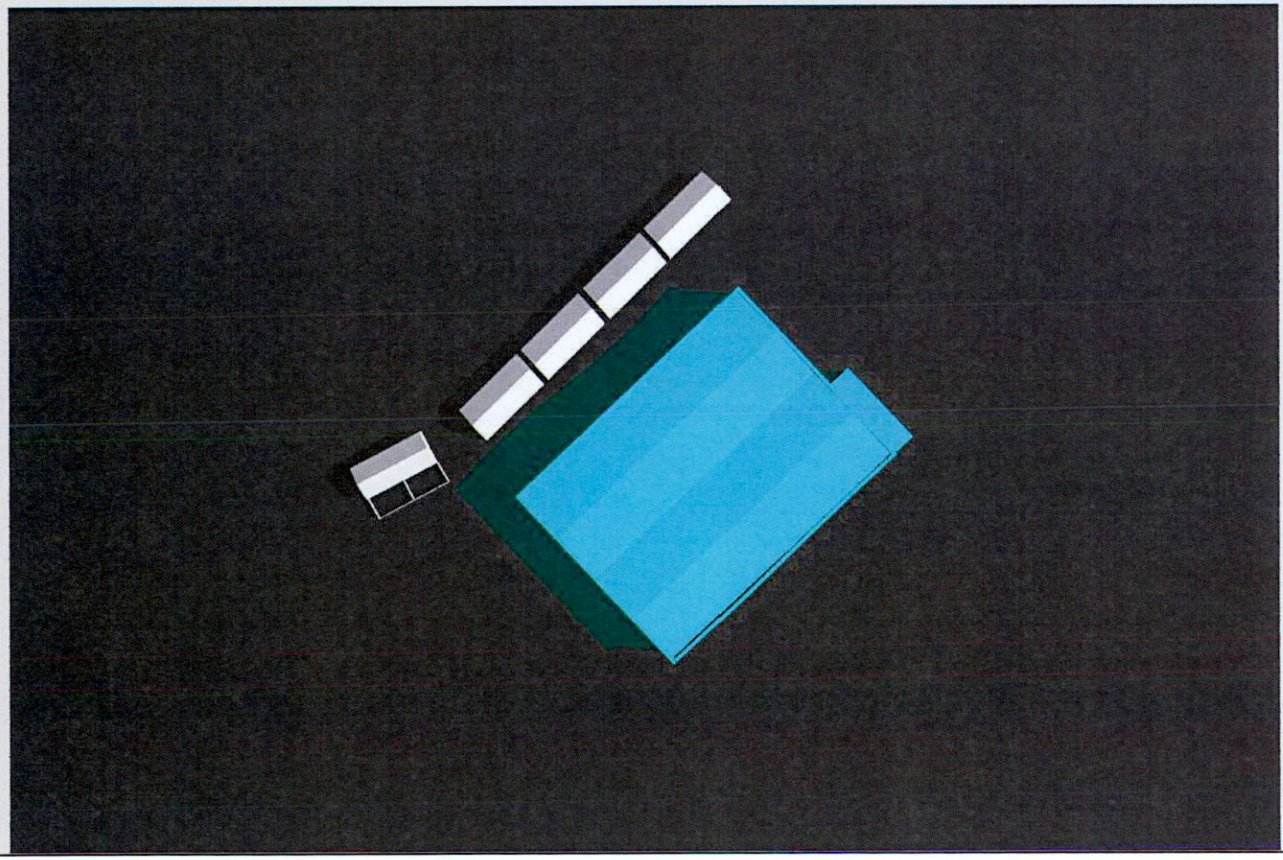


## A.2 June 21st

**Proposed**

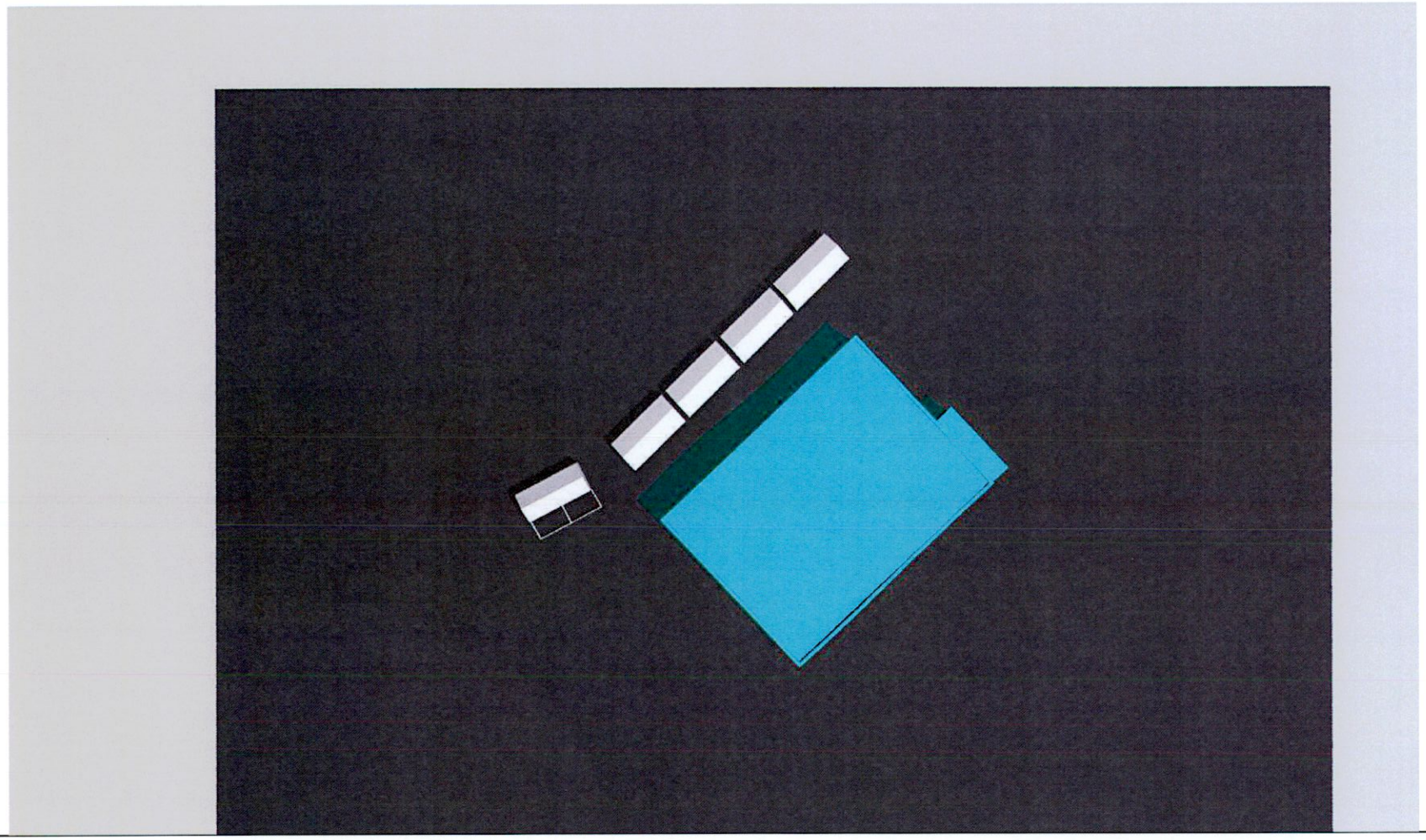
June 21st - 8:00

**20144-KIN-BPC-XX-ZZ-M3-P4-01**
**2021-21-6--08-00**



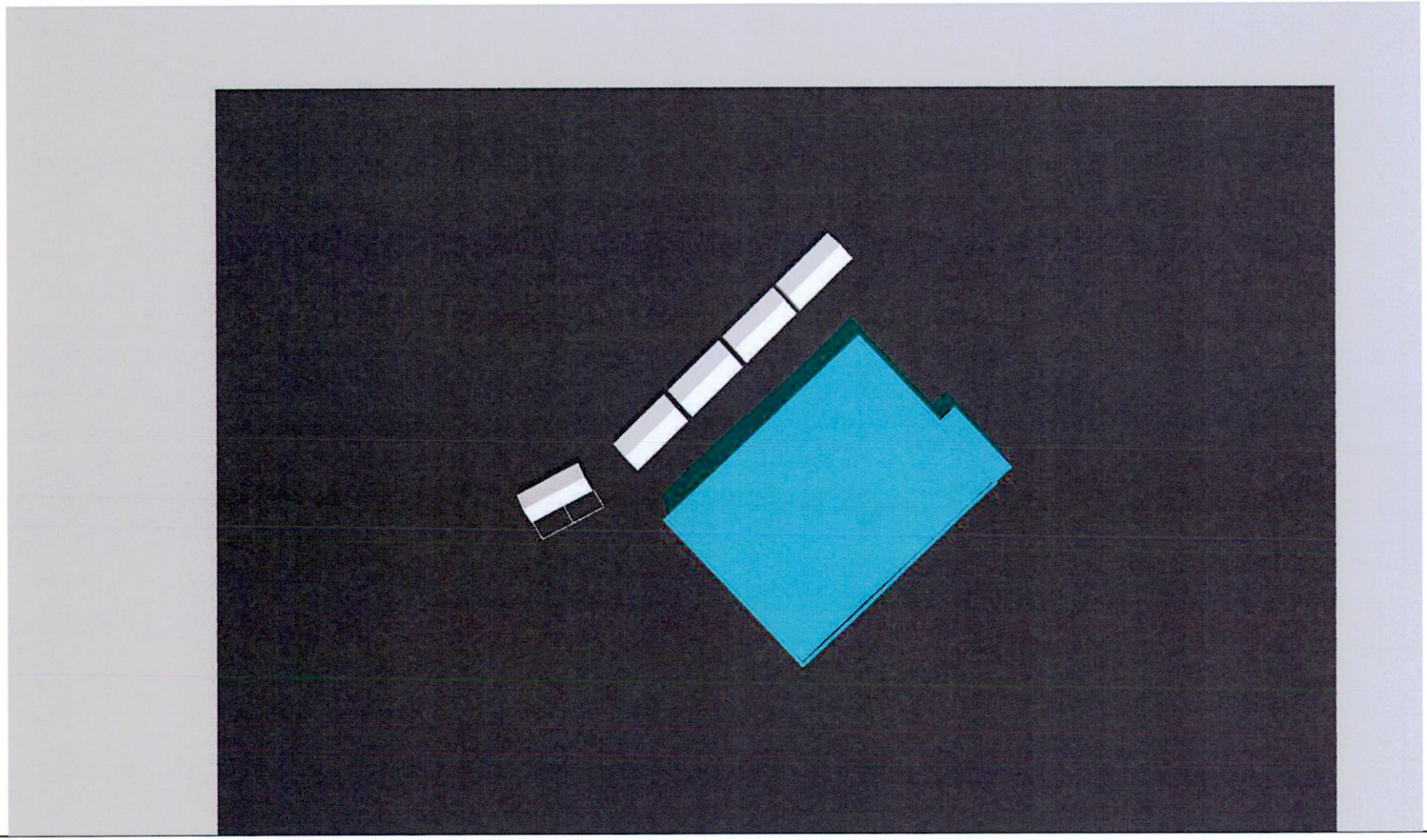
20144-KIN-BPC-XX-ZZ-M3-P4-01
2021-21-6--10-00

June 21st - 10:00



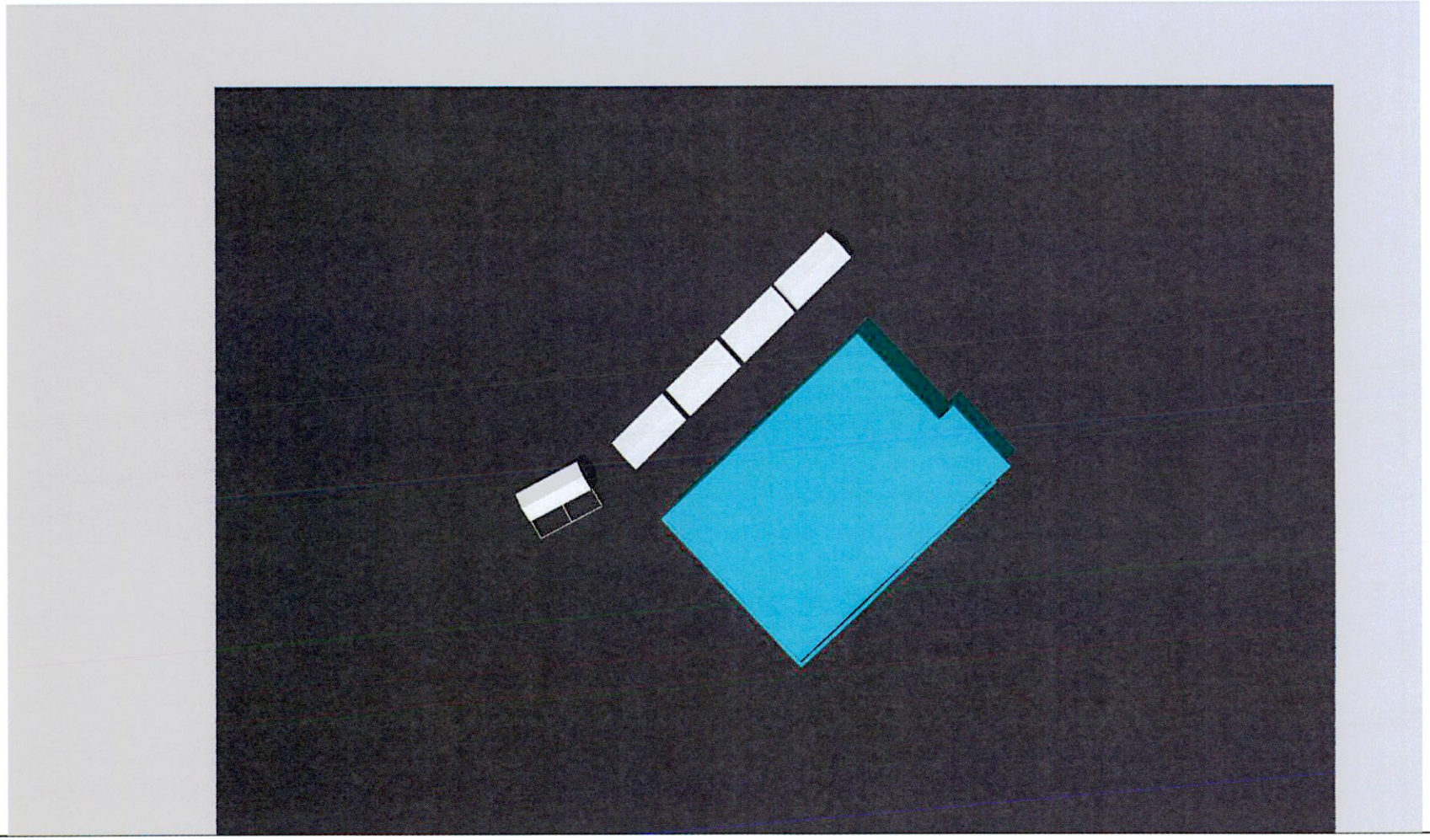
20144-KIN-BPC-XX-ZZ-M3-P4-01
2021-21-6--12-00

June 21st - 12:00



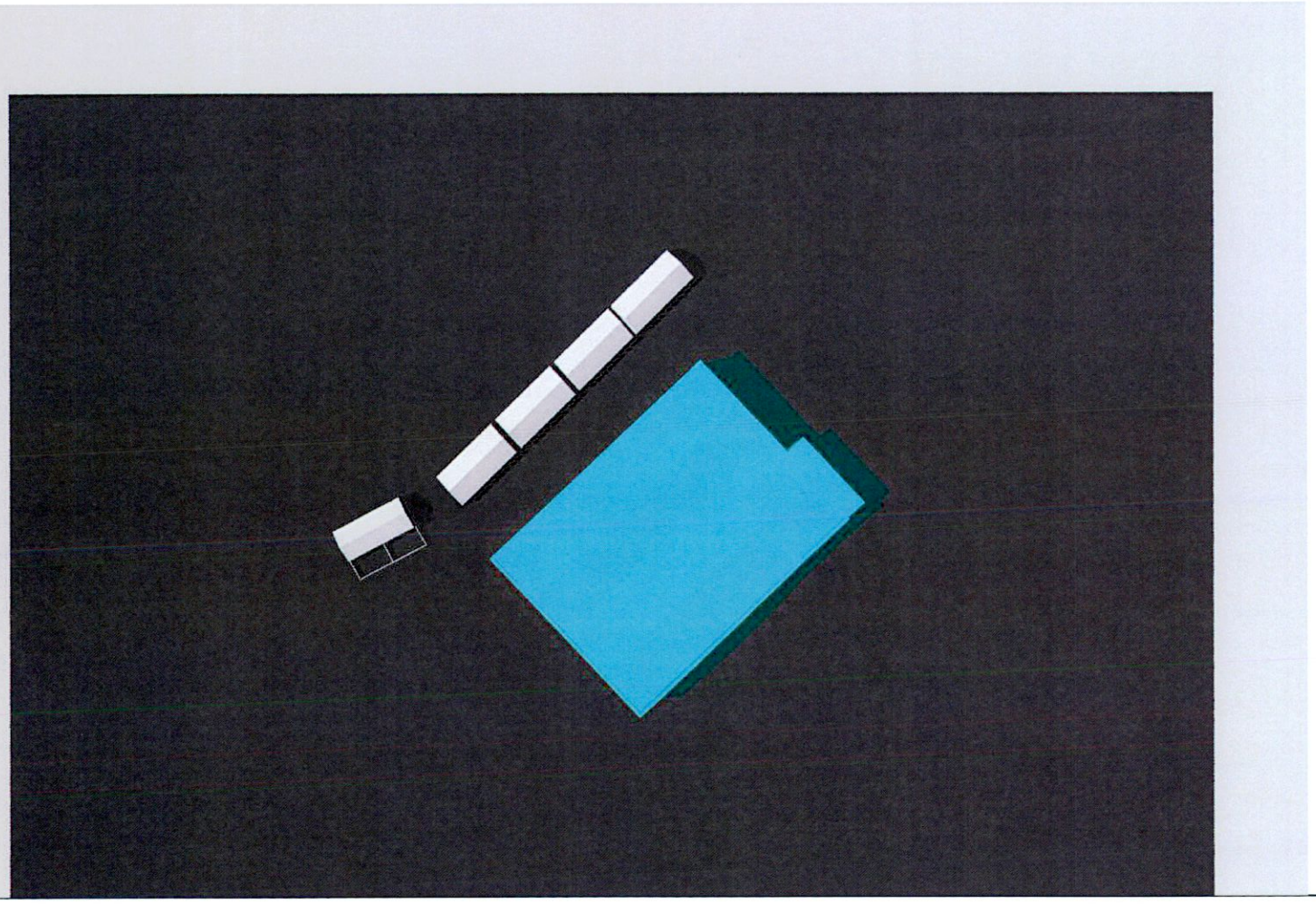
20144-KIN-BPC-XX-ZZ-M3-P4-01
2021-21-6--14-00

June 21st - 14:00



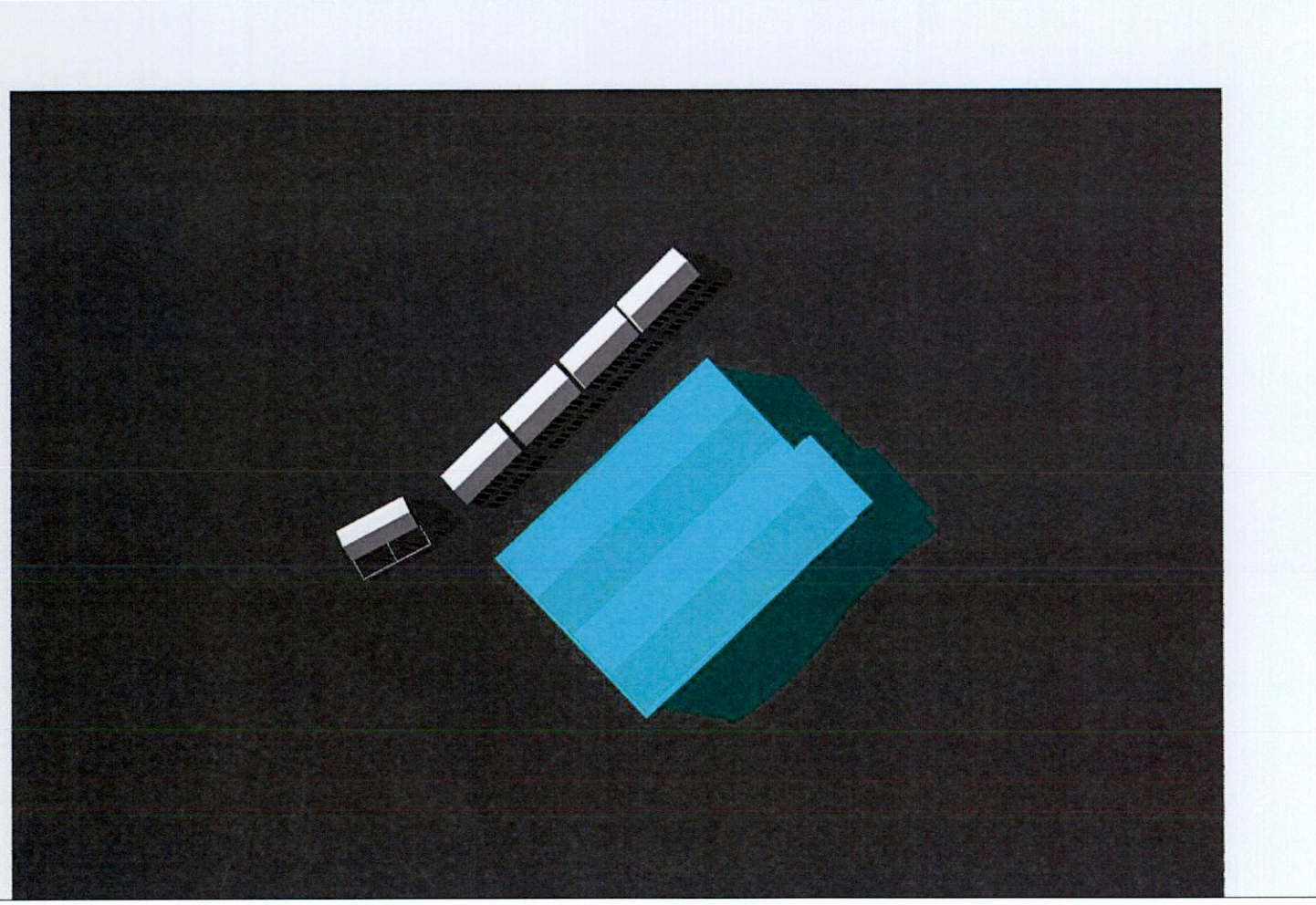
20144-KIN-BPC-XX-ZZ-M3-P4-01
2021-21-6--16-00

June 21st - 16:00



20144-KIN-BPC-XX-ZZ-M3-P4-01
2021-21-6--18-00

June 21st – 18:00

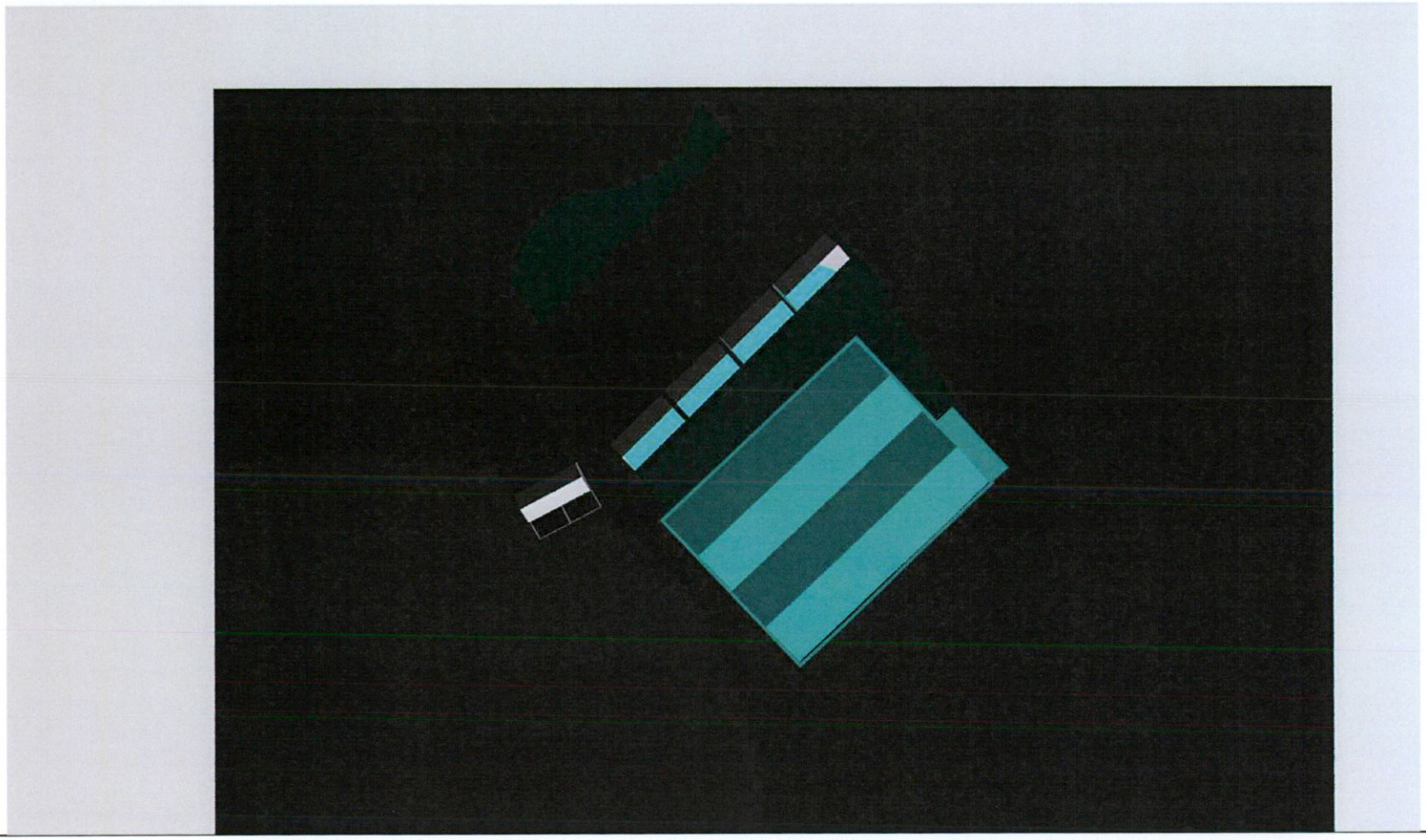


## A.3 December 21st

**Proposed**

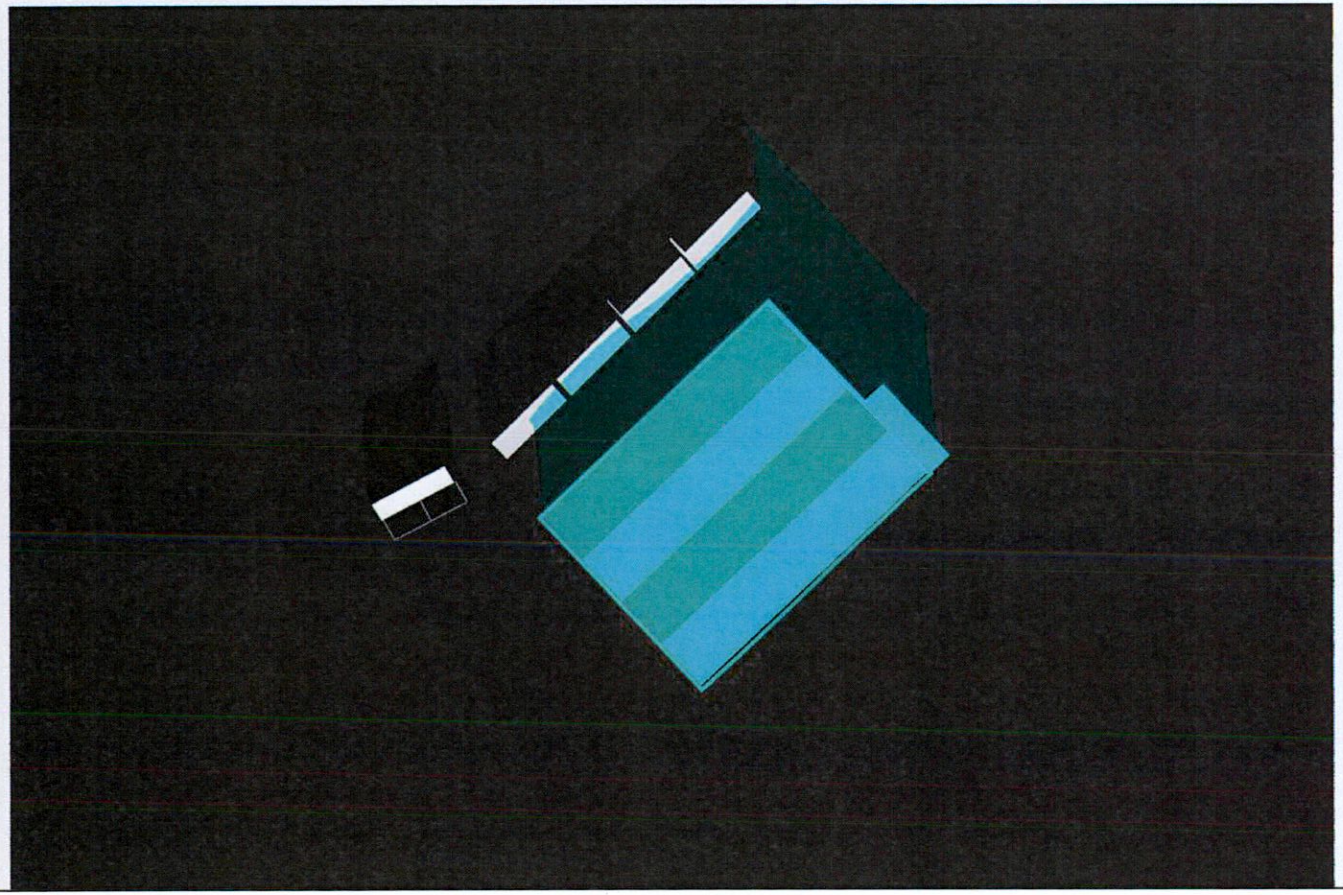
December 21st - 10:00

20144-KIN-BPC-XX-ZZ-M3-P4-01
2021-21-12--10-00



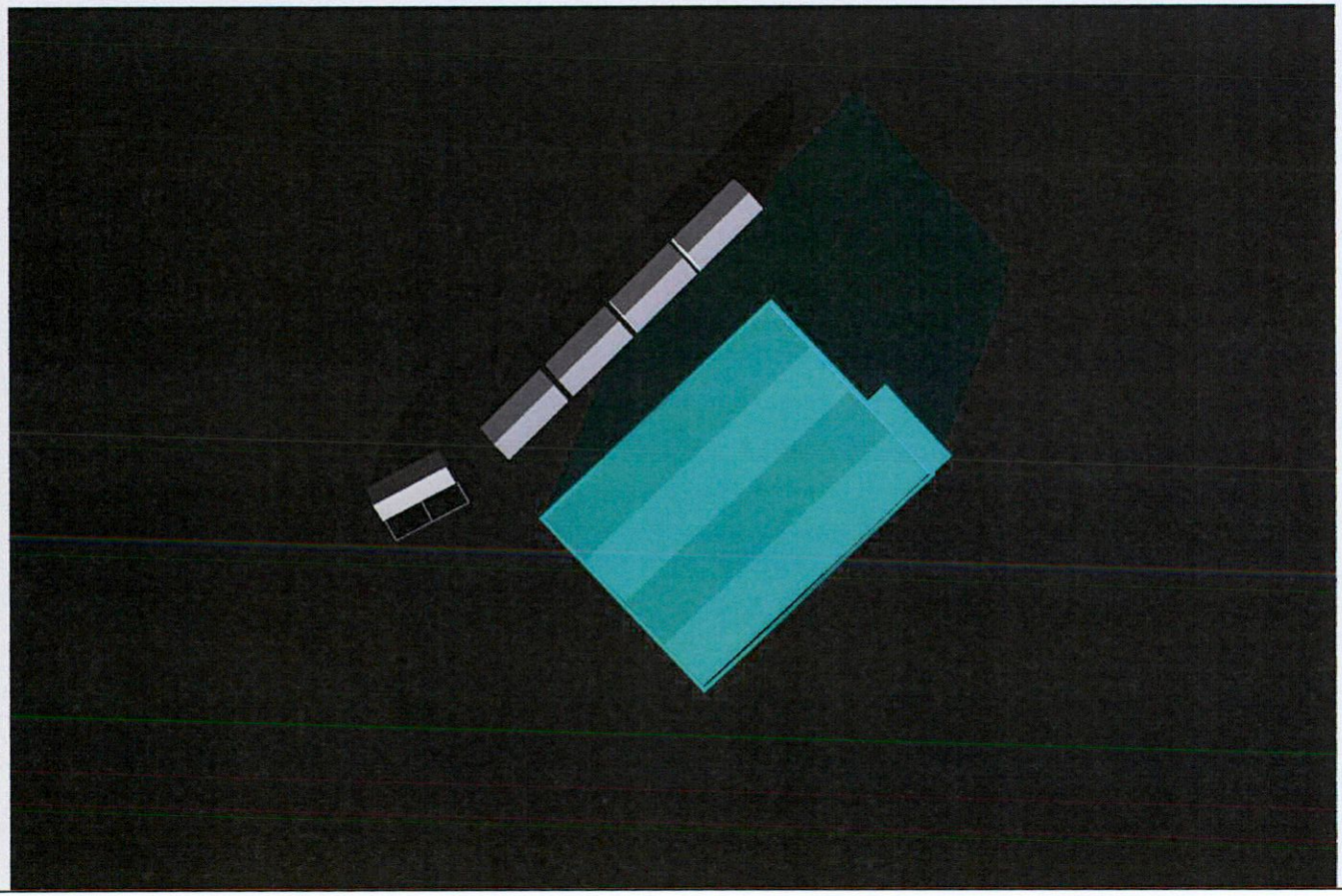
20144-KIN-BPC-XX-ZZ-M3-P4-01
2021-21-12--12-00

December 21st - 12:00



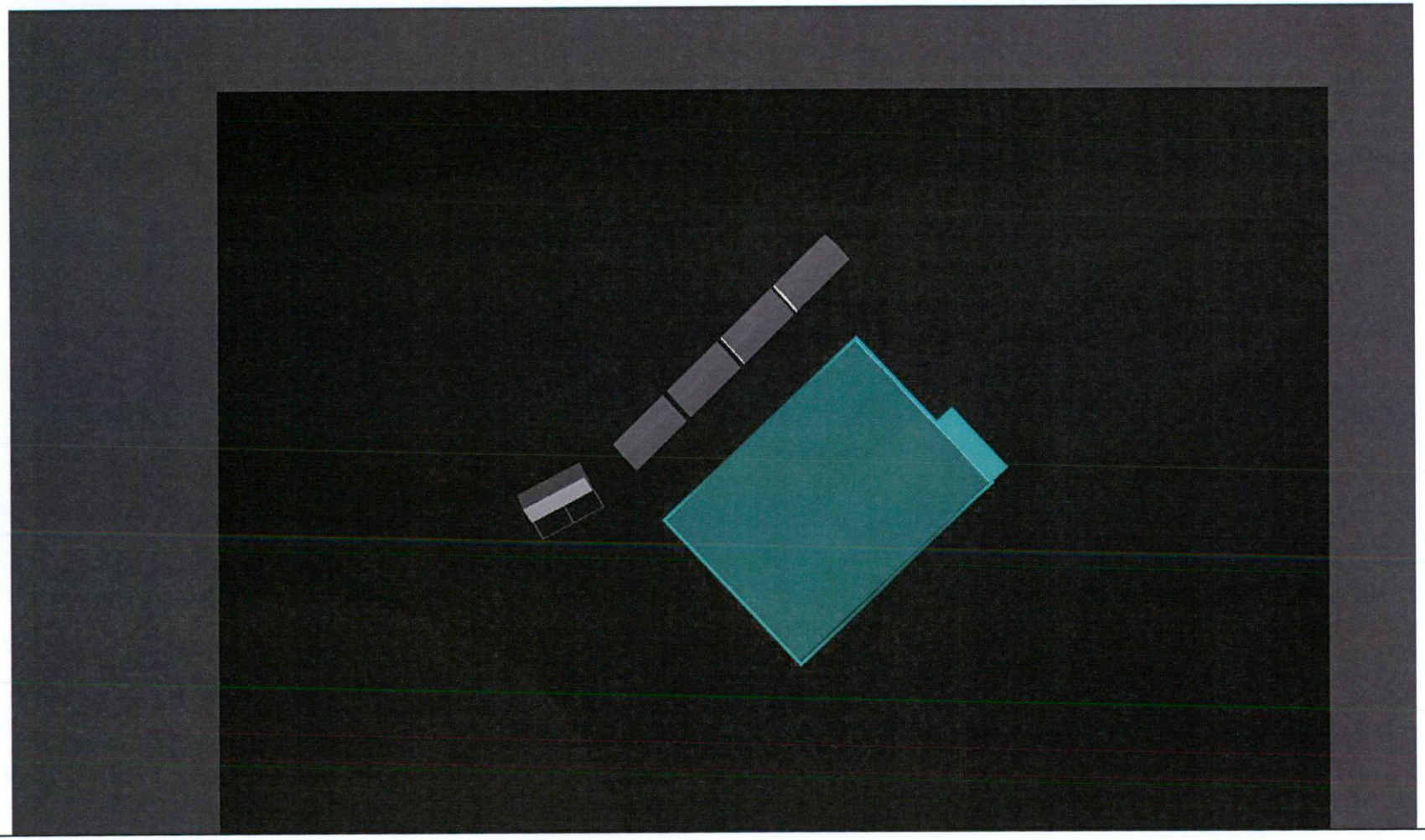
20144-KIN-BPC-XX-ZZ-M3-P4-01
2021-21-12--14-00

December 21st - 14:00



20144-KIN-BPC-XX-ZZ-M3-P4-01
2021-21-12--16-00

December 21st - 16:00



# 7 Bibliography

CIE. (2020). *CIE S 017:2020 ILV: International Lighting Vocabulary, 2nd edition.* CIE.

Littlefair, P. (2011). *Site Layout Planning for Daylight and Sunlight, A Guide to Good Practice.* Watford: IHS BRE Press.


www.bpcengineers.com

BUILDING PERFORMANCE CONSULTING