

ATTACHMENT 9

Homewood Hilton Suites

Sunnyvale, CA

Sun Shadow Study

RWDI # 1604045

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SUBMITTED TO

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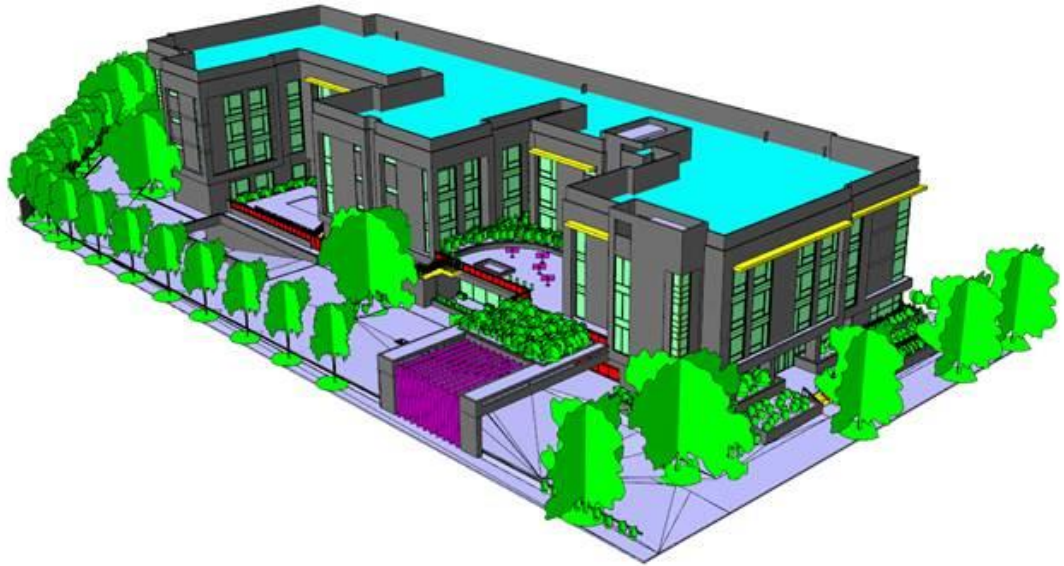
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1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained by Awbrey Cook Rogers McGill to conduct a shadow study for the proposed Homewood Hilton Suites in Sunnyvale, CA. The objective of this study was to quantify the shadow impact of the proposed building on the roofs of the nearby Walgreens and Panda Express buildings as required by the City of Sunnyvale.

2. BUILDING AND SITE INFORMATION

The proposed building will be four stories tall and located southwest of the intersection of E El Camino Real and Maria Lane in Sunnyvale, CA. The Panda Express and Walgreen buildings are located to the NW of the site, as shown in Image 1. Surroundings comprise of one to two story commercial and residential buildings that would not cast a shadow on the areas of concern.



Image 1: Aerial View of Site and Surroundings
(Courtesy of GoogleEarth™)

3. METHODOLOGY

Computer Model

This study involved the use of a three-dimensional (3D) computer model of the proposed development with the Panda Express and Walgreens buildings in place. The model was created in accordance with the following information provided by Awbrey Cook Rogers McGill:

- Revit model and site plans received on July 21, 2016; and,
- Survey data received on July 25, 2016.

The roofs of the Panda Express and Walgreens buildings were modelled as 149.97 ft high based on the survey data. The 3D model was used to produce renderings of the shadows cast by the proposed development on the roofs of the adjacent buildings.

Shadow Area Calculation

The study surfaces, i.e. the roofs of the Panda Express and Walgreens buildings, was broken up into numerous small sub-surfaces, each approximately 1 sq. ft in area so that the spatial distribution of daylight could be assessed. Next, the sun's position in the sky relative to the site was computed. Virtual "rays" were then drawn from this position to each of the sub-surfaces. The rays are then tested to see if they are obstructed by the Homewood Hilton Suites building, and thus are in shadow.

This process is repeated at 1-minute increments from 9am to 3pm at every day in a year. The percentage of the hours each subsurface is in shadow is computed. The area-weighted average percentage of hours shadowed is then calculated for each of the roofs in question, yielding the overall result.

4. RESULTS

The detailed quantitative results of the shadow analysis are shown in Tables 1 and 2 for the Panda Express building and the Walgreens building, respectively. The tables present the percentage of roof area shaded for each hour from 9am to 3pm on the 21st day of every month.

On an annual average basis, we found no shadowing from the Hilton on the Walgreen roof and an average shadow percentage of 11.2% on the Panda Express roof (Image 2a). On average, less than 10% of the Panda Express roof is shaded for approximately 71% of the hours presented (Table 1). If a similar hourly analysis is performed for the cumulative solar energy incident on the roofs, we find that the net reduction in incident solar energy on the roof is only 8.3% (Image 2b) indicating that while the overall frequency of shadowing is above the 10% target, net loss in potential solar energy is not.

Solar insolation is lowest in the morning and evening when the sun is low in the sky and highest during the midday hours. Conversely, shadows are longest in the morning and evening hours and shortest during midday. The times of the day when the proposed project is causing the largest shadows are when the sun is lower in the sky and thus provides less energy to a PV or solar thermal system than the shadowing would indicate, as indicated by the lower percentage reduction in incident solar energy (8.3%). It appears that the Sunnyvale 10% area criterion does not take this into account. Therefore, in the true context of the performance of solar PV or thermal systems, the criterion over-estimates the impact of shadows from lower solar angles and under-estimates the impact of shadows from short-term mid-day shadowing, when solar power generation is at its highest.

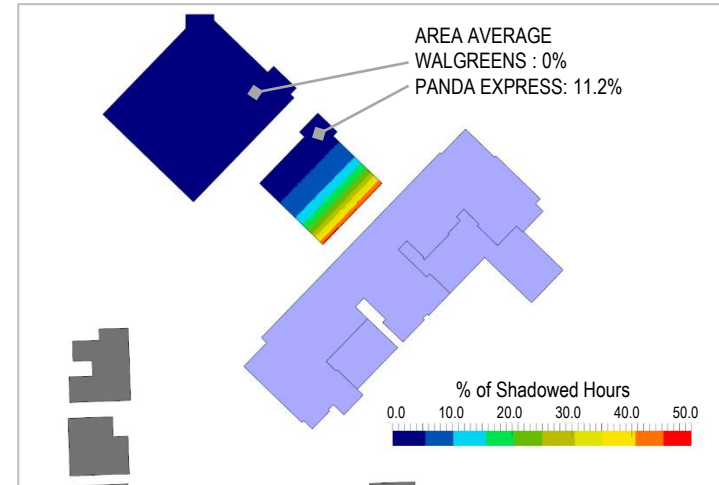


Image 2a: Percentage of Area Shaded

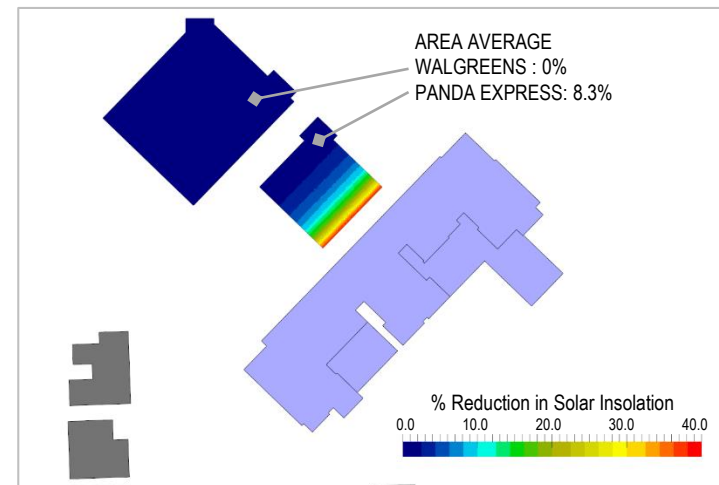


Image 2b: Percentage Reduction in Solar Insolation

4. RESULTS

Table 1: Percentage of Roof Area Shaded – Panda Express

MONTH	TIME							Average
	9:00	10:00	11:00	12:00	13:00	14:00	15:00	
Jan	79.95%	47.40%	29.05%	15.85%	4.33%	0.00%	0.00%	29.35%
Feb	49.71%	29.12%	15.65%	4.85%	0.00%	0.00%	0.00%	16.51%
Mar	26.85%	13.88%	3.99%	0.00%	0.00%	0.00%	0.00%	7.43%
Apr	11.10%	2.50%	0.00%	0.00%	0.00%	0.00%	0.00%	2.26%
May	3.22%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.54%
Jun	1.54%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.26%
Jul	4.44%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.74%
Aug	12.02%	3.15%	0.00%	0.00%	0.00%	0.00%	0.00%	2.52%
Sep	23.42%	11.48%	2.28%	0.00%	0.00%	0.00%	0.00%	6.18%
Oct	39.62%	23.00%	11.01%	1.59%	0.00%	0.00%	0.00%	12.50%
Nov	64.35%	39.35%	23.66%	11.39%	1.35%	0.00%	0.00%	23.28%
Dec	85.69%	52.40%	33.05%	19.26%	7.11%	0.02%	0.00%	32.83%
Average	33.49%	18.52%	9.89%	4.41%	1.07%	0.00%	0.00%	11.20%

Table 2: Percentage of Roof Area Shaded – Walgreens

MONTH	TIME							Average
	9:00	10:00	11:00	12:00	13:00	14:00	15:00	
Jan	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Feb	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Mar	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Apr	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
May	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Jun	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Jul	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Aug	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Sep	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Oct	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Nov	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Dec	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Average	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

5. APPLICABILITY OF RESULTS

The results presented in this report pertain to the model of the proposed project generated using the architectural design information provided by Awbrey Cook Rogers McGill, mentioned in Section 3. Should there be any design changes that deviate from current model, the results presented may change. Therefore, if changes in the design are made, it is recommended that RWDI be contacted and requested to review their potential effects on sun/shadow conditions.