EBL&S Development

Station Park Green

Noise and Vibration Assessment

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Noise and Vibration Assessment

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Contents

Appendices

Executive Summary

Arup has undertaken a noise and vibration assessment on behalf of EBL&S Development for the proposed Station Park Green project alternatives. The assessment is necessary to demonstrate to the City of San Mateo the impact that would arise at local sensitive land uses due to the project, and the effect the existing noise climate will have on Station Park Green.

In summary, the following conclusions have been made from the assessment:

- The predicted maximum increase in traffic noise as a result of both Station Park Green development alternatives is 2 dBL_{dn}. According to City policy this is not considered as an impact to the local sensitive land uses.
- The predicted noise level in multi-family open residential spaces internal to both Station Park Green development alternatives meets City policy.
- The measured L_{dn} at two locations on the proposed site for Station Park Green fall within the City land use compatibility rating of "Normally Unacceptable". The future developers will need to demonstrate to the City that appropriate noise mitigation measures will be included in the project.
- The Federal Transit Administration ground-borne vibration targets are achieved at the proposed residential and commercial set back distances from the Caltrain alignment.

1 Introduction

This document describes the existing noise environment in the area of Station Park Green and the potential of the proposed project alternatives to significantly alter noise levels due to project construction and operation. The noise effects of road traffic and rail have been considered.

The analysis is based on field measurements of existing airborne noise and ground-borne vibration levels, and prediction of future rail and road traffic noise levels. The existing and future conditions have been assessed against the ground-borne vibration policies provided in the City of San Mateo General Plan and Municipal Code, and noise targets given in the Federal Transit Administration's Transit Noise and Impact Assessment document.

The report has been updated since the first issue to include noise assessment of proposed project Alternative B in addition to the preferred The Plan alternative previously amended. Project Alternative B differs from The Plan alternative by providing a single story pavilion in place of a multistory building along the west boundary of the site and reconfiguring the residential blocks adjacent to Garvey Way.

The operation of project Alternative B is not expected to result in higher noise exposure to local noise sensitive receptors because the proposed land uses and traffic volumes are very similar to The Plan alternative. Therefore, all impact assessments carried out for The Plan alternative, with the exception of environmental noise to multi-family open spaces internal to the project, are considered to represent project Alternative B.

Explanation of the acoustical terminology used in this report is provided in Appendix A.

2 Acoustical Criteria and Design Goals

2.1 State of California

The following clauses are reproduced from the California Code of Regulations (2001) Title 24, Part 2, and form the basis of the acoustical criteria and goals:

- **1208A.8.2 Allowable interior noise**. Interior noise levels attributable to exterior sources shall not exceed 45 dB in any habitable room. The noise metric shall be either the day-night average sound level (L_{dn}) or the community noise equivalent level (CNEL), consistent with the noise element of the local general plan.

  NOTE: L_{dn} is the preferred metric for implementing these standards.

- **1208A.8.4 Other Noise Source**. Residential structures to be located where the L_{dn} or CNEL exceeds 60 dB shall require an acoustical analysis showing that the proposed design will limit exterior noise to the prescribed allowable interior level. The noise element of the local general plan shall be used to the greatest extent possible to identify sites with noise levels potentially greater that 60 dB.

- **1208A.8.5 Compliance.** If interior allowable noise levels are met by requiring that windows be unopenable or closed, the design for the structure must also specify a ventilation or air-conditioning system to provide a habitable interior environment. The ventilation system must not compromise the dwelling unit or guest room noise reduction.

2.2 City of San Mateo

2.2.1 Noise Element of the General Plan

The Noise Element of the City of San Mateo General Plan contains compatibility guidelines for community noise environments, and also states applicable goals and polices that should be met. The relevant applicable clauses are reproduced over the following pages.

NOISE SENSITIVE LAND USE COMPATIBILITY GUIDELINES FOR COMMUNITY NOISE ENVIRONMENTS[1]			
Day/Night External Sound Level (L_{dn}), dB			
Land Use Category	**Normally Acceptable[2]**	**Conditionally Acceptable[3]**	**Normally Unacceptable[4]**
Single-family residential	50-59	60-70	Greater than 70
Multi-family residential	50-59	60-70	Greater than 70
Multi-family Common Open Space Intended for the Use and Enjoyment of Residents	50-57	--	Greater than 67
[1] These guidelines are derived from the California Department of Health Services, Guidelines for the Preparation and Content of the Noise Element of the General Plan, 6/87. The State Guidelines have been modified to reflect San Mateo's preference for distinct noise compatibility categories and to better reflect local land use and noise conditions. It is intended that these guidelines be utilized to evaluate the suitability of land use changes only and not to determine cumulative noise impacts. Land uses other than those classified as being "noise sensitive" are exempt from these compatibility guidelines.			
[2] Normally Acceptable -- Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.			

NOISE SENSITIVE LAND USE COMPATIBILITY GUIDELINES FOR COMMUNITY NOISE ENVIRONMENTS[1]
Day/Night External Sound Level (L_{dn}), dB
[3] Conditionally Acceptable -- New construction should be undertaken only after a detailed analysis of the noise reduction requirement is made and needed noise insulation features included in the design.
[4] Normally Unacceptable -- New construction should be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design.

Table 1: Guidelines for community noise environments

GOAL 1: Protect "noise sensitive" land uses from excessive noise levels

POLICIES:

N 1.1: Interior Noise Level Standard. Require submittal of an acoustical analysis and interior noise insulation for all "noise sensitive" land uses listed in Table N-l (Table 1) which have an exterior noise level 60 dBL_{dn} or above, as shown on Figure N-1. Maximum interior noise level shall not exceed 45 dBL_{dn} in all habitable rooms.

N 1.2: Exterior Noise Level Standard. Require an acoustical analysis for new parks, play areas, and multi-family common open space (intended for the use and the enjoyment of residents) which have an exterior noise level of 60 dBL_{dn} or above, as shown on Figure N-1. Require an acoustical analysis which uses L_{eq} for new parks and play areas. Require feasibility analysis of noise reduction measures for public parks and play areas. Incorporate necessary mitigation measures into residential project design to minimize common open space noise levels. Maximum exterior noise should not exceed 67 dBL_{dn} for residential uses and should not exceed 65 dBL_{eq} during the noisiest hour for public park uses.

GOAL 2: Minimize unnecessary, annoying or unhealthful noise.

POLICIES:

N 2.2: Minimize Noise Impact. Protect all "noise sensitive" land uses listed in tables N-1 (Table 1) and N-2 from adverse impacts caused by the noise generated on-site by new developments. Incorporate necessary mitigation measures into development design to minimize noise impacts. Prohibit long-term exposure increases of 3 dBL_{dn} or above at the common property line, or new uses which generate noise levels of 60 dBL_{dn} or above at the property line, excluding ambient noise levels.

N 2.3: Minimize Commercial Noise. Protect land uses other than those listed as "noise sensitive" in Table N-1 (Table 1) from adverse impacts caused by the on-site noise generated by new developments. Incorporate necessary mitigation measures into development design to minimize noise impacts. Prohibit new uses which generate noise levels of 65 dBL_{dn} or above at the property line, excluding ambient noise levels.

N 2.5: Railroad Noise. Promote the installation of noise barriers along the railroad corridor where "noise sensitive" land uses are adversely impacted by unacceptable noise levels [60 dBL_{dn} or above]. Promote adequate noise mitigation to be incorporated into any rail service expansion or track realignment.

Study the need of depressing the rail line or other mitigation measures to decrease noise levels prior to substantial expansion of the rail service.

2.2.2 San Mateo Municipal Code

The following clauses are reproduced from the San Mateo Municipal Code

7.30.060 SPECIAL PROVISIONS

(e) Construction, alteration, repair or land development activities which are authorized by a valid city permit shall be allowed on weekdays between the hours of 7 am and 7 pm, on Saturdays between the hours of 8 am and 5 pm, and on Sundays and holidays between the hours of 12 pm and 4 pm, or at such other hours as may be authorized or restricted by the permit, if they meet at least one of the following noise limitations:

(1) No individual piece of equipment shall produce a noise level exceeding 90 dB at a distance of 25 feet. If the device is housed within a structure or trailer on the property, the measurement shall be made outside the structure at a distance as close to 25 feet from the equipment as possible.

(2) The noise level at any point outside of the property plane of the project shall not exceed 90 dB.

2.3 Federal Transit Administration

There are no State or City criteria for acceptable levels of vibration in buildings from external sources of noise such as railways. The next appropriate source of acoustical criteria is the Federal Transit Administration (FTA). The FTA provides guidance on acceptable levels of vibration in buildings. The guidelines that are applicable for the Hayward Park Green site are in Table 2.

Ground-Borne Vibration (GBV) and Ground-Borne Noise (GBN) Impact Criteria for General Assessment		
Land Use Category	**GBV Impact Levels (VdB re 1 micro-inch / sec)**	**GBN Impact Levels (dB re 20 micro Pascal)**
	Frequent Events[1]	**Frequent Events[1]**
Category 2: Residences and buildings where people normally sleep	72 VdB	35 dBA
Category 3: Institutional land uses with primarily daytime use	75 VdB	40 dBA
Notes: 1. "Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.		

Table 2: Federal Transit Administration ground-borne noise design goals

Based on the current Caltrain schedule, the site would be classified as exposed to "frequent events" as there are more than 70 trains scheduled each day.

3 Environmental Setting

3.1 Existing Noise Receptors

Some land uses are more sensitive to noise than others. These sensitive uses are commonly referred to as sensitive receptors and normally include residences, hospitals, community parks, churches, libraries, schools, and retirement homes. Noise sensitive land uses are typically given special attention because activities at these uses are susceptible disturbance from noise.

Station Park Green would be developed on land that is currently used for retail use. The proposed project site is surrounded by urban land uses, such as residential, commercial and industrial. Residential use exists to the northeast along South Delaware Street and to the northwest along East 16th Avenue of the proposed project site. Commercial and industrial land use exists to the north southeast and west of the project site. There are also two public parks in the close vicinity of the project site, Connie Park that is along Concor Drive east of the project site, and Trinta Park that is south of the project site.

4 Existing and Future Noise Environment

4.1 Assessment Method

The analysis of existing and future noise levels have been based on noise measurements at the project site, and noise predictions using the computer program FHWA Traffic Noise Model (TNM) Version 2.5. The computer modeling only considers noise from traffic on nearby roadways. Traffic volumes used as data inputs in the TNM model were supplied by the transportation consultants.[1] It should be noted that for the purposes of this study L_{dn} is equal to the peak hour L_{eq}.

Noise level estimates of the Caltrain alignment have been based on field measurements taken near the railway alignments.

4.2 Existing Airborne Noise Levels

The existing airborne noise levels at the project site were quantified by making short-term attended and unattended ambient noise measurements using sound level meters (SLM).

The attended short-term measurements were made over 10 to 15 minute periods at five locations within the project site boundaries between 7am and 10:30pm on February 2, 2007. Unattended measurements were made using a continuously monitoring SLM that recorded 15 minute measurements over a 24 hour period between 2 and 3 February 2007. The measurement locations are shown on Figure 1. The sound level meters were checked for calibration both before and after the measurements and no drift in calibration had occurred.

State and City criteria are given in terms of the 24hr day-night sound level L_{dn}, which is calculated from airborne noise measurements. The L_{dn} values at the short-term locations have been calculated from an offset from the 24hr monitoring location, Location 3. The calculated L_{dn} values for the project site are given in Table 3 over the page.

[1] Hexagon Transportation Consultants Inc. *"Hayward Park Green Traffic Impact Assessment"*, Oct. 2007

Location	Location Description	24 Hour Day-Night Sound Level, L_{dn}, dB
L1	At the Southeast boundary of the project site approximately 35 feet from the center of Concar Drive, 450 feet from freeway 92, and approximately 740 feet from the railway line.	70
L2	At the South corner of the project site approximately 260 feet from the railway line and 30 feet from the center of Concar Drive.	64
L3	At the Southwest boundary of site approximately 242 feet from the railway line. Measurement made at five feet above grade.	66
L4	At the Northwest boundary of the project site adjacent to the American Automobile Association (AAA) parking lot and the USPS mechanic lot. Approximately 452 feet from the railway line and 432 feet to Delaware Street.	62
L5	At the North corner of the project site adjacent to Delaware Street and next to the American Automobile Association building. Approximately 42 feet to the center of Delaware Street.	71

Table 3: 24 hour day-night A-weighted sound level results, dBL_{dn}

During the survey it was noted that the measurements towards the west of the site were dominated by traffic and train noise, and measurements to the east of the site were dominated by traffic noise.

Figure 1: Airborne noise measurement location plan

4.3 Future Traffic Noise Levels

Traffic noise from vehicles associated with the proposed project and other cumulative developments that are approved as part of the 2020 plan have been modeled. Noise levels have been predicted at the locations shown in Figure 2, and the results from the predictions are tabulated in Table 4.

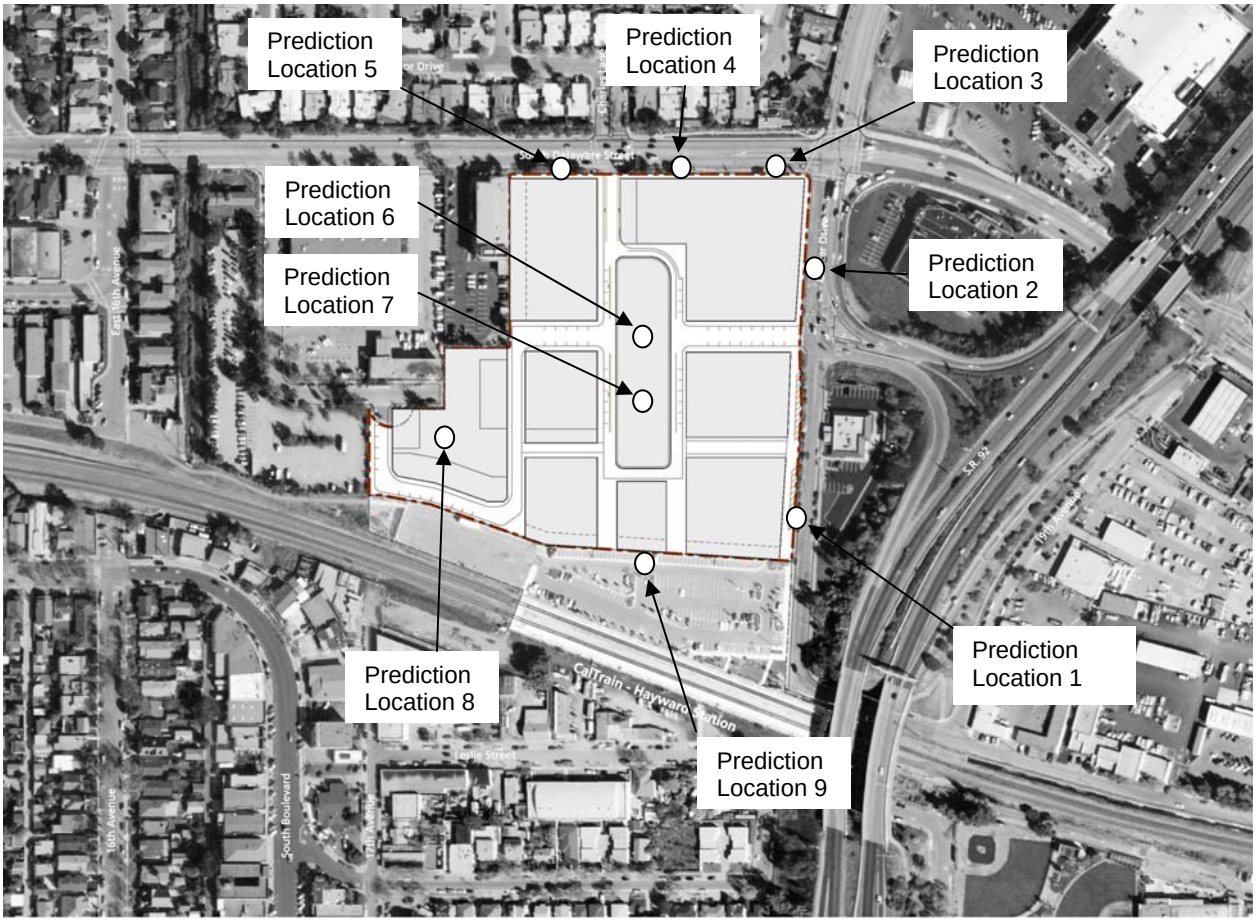

Figure 2: The Plan alternative showing FHWA TNM 2.5 road traffic noise prediction locations

Receptor	Roadway Segment	Day Night Noise Level (dBL_{dn})			
		Existing	Cumulative without Project	Cumulative with Project Option 1*	Cumulative with Project Option 2*
Prediction Location 1	Concar Drive, South of SR 92 on/off ramp	70	70	71	71
Prediction Location 2	Concar Drive, North of SR 92 on/off ramp	68	69	70	70
Prediction Location 3	West of South Delaware Street and Concar Drive Intersection	67	68	67	67
Prediction Location 4	South Delaware Street, between Charles Lane and Concar Drive	66	67	67	67

Receptor	Roadway Segment	Day Night Noise Level (dBL_{dn})			
		Existing	Cumulative without Project	Cumulative with Project Option 1*	Cumulative with Project Option 2*
Prediction Location 5	South Delaware Street, between 16th Avenue and Charles Lane	65	66	67	67
Prediction Location 6	Communal open space in middle of proposed development, direct line of sight to SR92	NA	NA	57	57
Prediction Location 7	Communal open space in middle of proposed development, direct line of sight to SR92	NA	NA	45	45
Prediction Location 8	Communal open space to the north west of the development	NA	NA	51	51
Prediction Location 9	Along the west boundary of the development	66	66	66	66

* Option 1 and Option 2 refer to different land use schemes for Station Park Green. The description of these options can be found in Hexagon Transportation Consultants Inc. *"Hayward Park Green Traffic Impact Assessment",* Oct. 2007

Table 4: Predicted traffic noise levels, dBL_{dn}

The cumulative traffic noise impact with and with out the project is assessed against the existing noise conditions and the results are tabulated in Table 5.

Receptor	Roadway Segment	Change in Day Night Noise Level (dBL_{dn})		
		Cumulative without Project	Cumulative with Project Option 1	Cumulative with Project Option 1
Prediction Location 1	Concar Drive, South of SR 92 on/off ramp	0	+1	+1
Prediction Location 2	Concar Drive, North of SR 92 on/off ramp	+1	+2	+2
Prediction Location 3	West of South Delaware Street and	+1	0	0

Receptor	Roadway Segment	Change in Day Night Noise Level (dBL_{dn})		
		Cumulative without Project	Cumulative with Project Option 1	Cumulative with Project Option 1
	Concar Drive Intersection			
Prediction Location 4	South Delaware Street, between Charles Lane and Concar Drive	+1	+1	+1
Prediction Location 5	South Delaware Street, between 16th Avenue and Charles Lane	+1	+2	+2
Prediction Location 6	Along the west boundary of the development	0	0	0

Table 5: Change in predicted cumulative day-night traffic noise levels, dBL_{dn}

The changes in program between Alternative B and the Plan Alternative will only result in minor changes to projected traffic volumes. The traffic volumes would need to change by one third for a 1dB change in predicted level; the differences between Alternative B and The Plan alternative are unlikely to result in significant changes to traffic volumes. Therefore, the traffic noise predictions for The Plan alternative are considered representative of project Alternative 2.

4.4 Rail Noise

Information regarding the potential increase in the number of trains in the year 2020 was not available. However, the *San Mateo Rail Corridor Plan & Bay Meadows Specific Plan Amendment: Transportation Impact Analysis* provides the existing number of daily riders, and an estimated increase in the year 2020. The 2020 Corridor Plan Z plus Bay Meadows estimates the number of riders to increase from 31,000 in the year 2000 to 36,000 in the year 2020. Assuming that the number of daily train operations coincides approximately with the number of daily riders, this accounts for an increase of approximately 14%. A 14% increase in the number of trains daily would result in an increase of approximately 1 dBL_{dn}.

4.5 Environmental Noise Assessment

The noise policies in the General Plan of the City of San Mateo require:

- Exterior noise levels shall not exceed 67 dBL_{dn} for multi-family residential open spaces or 65 dBL_{Aeq} for public parks during the noisiest hour.
- Noise generated by commercial land uses must not exceed 65 dBL_{dn} (excluding ambient noise) or above at the nearest residential property line.

- Long-term noise exposure increases of 3 dBL_{dn} or above at the common property line, or new uses which generate noise levels of 60 dBL_{dn} or above at the property line, excluding ambient noise levels.

4.5.1 The Plan

Multi-Family Residential Open Spaces

The Plan alternative for Station Park Green includes two multi-family open residential spaces. A large space centered in the middle of the site, and one to the north west of the site. Both spaces will be exposed to road and rail noise from the alignments adjacent to the site.

Road traffic noise levels were predicted in both multi-family open residential spaces. The results indicate that the noise levels are below the noise policy of 65dBL_{dn} for Multi-Family Residential Open Spaces.

The noise climate along the west boundary of Station Park Green is characterized by traffic and rail noise. The field measurement location that best characterizes the noise climate along this boundary is Location 3, with a measured level of 66 dBL_{dn}. The increase in Caltrain riders is expected to increase the noise level of 1 dBL_{dn}, which would result in an estimated noise level of 67 dBL_{dn} along the west boundary of Station Park Green.

The west boundary of Station Park Green does not run parallel to the Caltrain alignment, and it is reasonable to assume that the noise level towards the north of the west boundary will be higher than at field measurement Location 3. However, the buildings along the west boundary will provide at least 5 dBL_{dn} of attenuation from rail noise.

The assessment of rail and road traffic noise to the multi-family open residential spaces internal to the project indicates that the noise policy of 67 dBL_{dn} should be achieved. No additional mitigation is required.

Figure 2 on page 8 shows a rendering of The Plan alternative.

Public Parks

There are two public parks that are in close proximity to Station Park Green that could have a noise impact as a result of the project. These are Connie Park that is along Concor Drive east of the project site, and Trinta Park that is south of Station Park Green.

Noise measurements or predictions have not been made at either of these receptors. However, the predictions of road and rail traffic noise indicate that the L_{dn} around the project site will increase by 2 dBL_{dn}. Therefore, because the increase is less than 3 dBL_{dn}, it is considered that the project is not causing an impact as these sensitive receptors.

Station Park Green Residential Land Use

The field measurements indicate that at the north east of Station Park Green along Concar Drive the noise level is 70 dBL_{dn}, and at south of Station Park Green the noise level is 71 dBL_{dn}. The City interprets 70 dBL_{dn} or greater as “Normally Unacceptable” for residential land uses, and states:

Normally Unacceptable -- New construction should be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design.

Therefore, future developers must undertake a detailed analysis of the noise requirements and include acoustical mitigation in the project to achieve the City of San Mateo's requirements.

The measured noise levels to the south, southwest, and northwest of Station Park Green are 64 dBL_{dn}, 66 dBL_{dn}, and 62 dBL_{dn} respectfully. The City interprets these noise levels as being in the category "Conditionally Acceptable" for residential land uses, and states:

Conditionally Acceptable -- New construction should be undertaken only after a detailed analysis of the noise reduction requirement is made and needed noise insulation features included in the design.

Therefore, future developers will need to include the necessary sound isolation features in the design to achieve the noise isolation standards.

Residential Land Use Exterior to Station Park Green

There are residential land uses along South Delaware Street opposite Station Park Green, and to the northwest along East 16th Avenue. The noise climate at these receptors is dominated by traffic noise. According to City code, the L_{dn} must not increase at residential land uses external to the project by more than 3 dBL_{dn}. The predicted increase in traffic noise levels in 2 dBL_{dn}. Therefore, traffic noise levels as a result of Station Park Green are not causing an impact. No mitigation required.

Mechanical Equipment

Mechanical equipment at commercial use must be controlled to 65 dBL_{dn} at the residential property line. This can typically be achieved by proper location and orientation of equipment and the incorporation of duct silencers, acoustic louvers, building parapets, and mechanical penthouses, or enclosed mechanical equipment rooms. The developer will need to implement appropriate mitigation methods to ensure that the noise ordinance is achieved.

Interior Noise Levels

To achieve the City and State interior noise requirement not exceeding 45 dBL_{dn}, the acoustical design of the buildings will need to be considered. There are some locations on Station Park Green where the noise levels are very high, and the façade will need to achieve a high sound isolation performance to meet the requirement. Table 6 provides preliminary guidance to the acoustical performance of glazing and doors based on stucco construction. It should also be noted that where the noise level is 70 dBL_{dn}, the façade of the building may require additional mass to mitigate low frequency noise break-in. A qualified acoustical consultant should be appointed to review the proposed constructions to ensure that the requirement is achieved.

Façade Location	Mitigation Measures (Exterior Windows and Doors)
North Boundary	STC 30 – 35
East Boundary	STC 35 – 40
South Boundary	STC 35 - 40
West Boundary	STC 35 - 40
Facing to internal	STC 25 - 30

Table 6: Preliminary mitigation for residential dwellings

The interior noise requirement must be achieved when rooms are ventilated. Therefore, because the external noise levels around Station Park Green are high, it will not be possible to naturally ventilate all units using operable windows. Tabulated over the page are suggested ventilation options that can meet the internal noise requirement.

External noise level, dBL_{dn}	Suggested Ventilation Method
> 65	Sealed façade mechanical ventilation
55 - 65	Sound attenuating passive ventilators
< 55	Openable windows

Table 7: Suggested residential ventilation method

Class A designated commercial office space may require sound-rated window and exterior door assemblies to reduce noise levels to meet the expectations of tenants. Appropriate STC ratings for design depend on the proximity to the railway or roadways, window area, and desired interior noise levels. It is recommended that the criterion for commercial offices be 45 dBL_{eq} during the peak hour. This target criterion is more appropriate for commercial offices use due to the typical hours of operation. The design of commercial offices space should include appropriate mitigation measures to ensure that the target noise criterion is achieved.

4.5.2 Project Alternative B

Project Alternative B differs from The Plan alternative by providing a single story pavilion in place of a multistory building along the west boundary of the site. A rendering of project Alternative B is shown in Figure 3 below.

Figure 3: Rendering of project Alternative 2

The potential impact to project Alternative 2 by providing a single story pavilion building in place of a multistory building is reduced screening of environmental noise to the central multi-family open residential space. The following analysis verified the pavilion would provide sufficient noise attenuation for San Mateo's noise policy for multi-family open space to be achieved.

The worst case vehicular traffic noise prediction at Location 9, which is along the west boundary of the proposed site, is 62 dBL_{dn}. The predicted increase in rail noise along the west boundary of the site is 67 dBL_{dn}. Therefore, the resulting noise level at Location 9 from both vehicular traffic and rail noise is 68 dBL_{dn}.

Noise from vehicular traffic and railways diminishes at a rate of 3 dB per doubling of distance. The distance between the boundary of the site and the boundary of the central multi-family open space is short compared to the distance to the nearest road or rail alignment. Therefore, it is prudent to assume the noise level at the boundary of the central multi-family open space, without any intervening structures providing screening, is 68 dBL_{dn}

Analysis has been undertaken to determine how much screening the pavilion will provide to the central multi-family open space. The screening of noise by the pavilion has been determined using the traffic noise computer (FHWA TNM 2.5) model that was developed for the traffic noise predictions. The following methodology was implemented to determine noise attenuation by the pavilion:

- Update the traffic noise computer model geometry based on project Alternative B.
- Carry out noise predictions using the computer model in the communal park with and without the pavilion (based on 2020 Cumulative Future Scenario traffic volumes) to determine future noise levels and potential noise attenuation.
- Modify the traffic noise model to only include a line source along the Caltrain alignment to simulate rail noise; then undertake noise predictions in the park with and without the pavilion to verify potential noise attenuation. To aim to simulate noise from the wheels of a train the line source was modeled at 2 feet above grade. The structure of the pavilion was modeled as a line 60 feet wide and 10 feet tall.
- Calculate the noise level in the communal park based on rail and vehicular traffic noise, and determine whether San Mateo's noise policy can be achieved.

Based on the noise prediction methodology, the results indicate that the pavilion will attenuate rail and vehicular traffic noise sources by approximately 4dB. The predicted noise level at the west boundary of the site from rail and vehicular is 68 dBL_{dn}. Therefore, based on the pavilion providing 4 dB of attenuation, the predicted noise level in the communal park is 64 dBL_{dn}, which meets the noise policy of San Mateo.

5 Construction Noise

5.1 Assessment Method

Construction noise impacts have been evaluated using US EPA reference noise levels for various construction equipment and activities. Construction noise and vibration impacts have been carried out following the guidance defined in the Federal Transit Administration's (FTA's) *Transit Noise and Vibration Impact Assessment* (May 2006).

5.2 Assessment for Construction Noise

During construction of the proposed project, noise levels would be produced by the operation of heavy-duty equipment and various other construction activities. Similar to other projects in the area, pile driving could be used in conjunction with drilling for foundations of the buildings. Construction noise levels were estimated using FTA methodology, which provides a formula for calculating noise levels from multiple pieces of equipment operating at multiple locations using reference noise levels for individual pieces of equipment. [2] The noise levels associated with equipment that may be used during the various project construction phases are shown in Table 8.

Estimated Construction Noise Levels (in dBA)			
Construction Equipment	**8-hour Leq**		
	25 feet	**50 feet**	**75 feet**
Demolition			
Track Hoe	96	90	87
Crane	94	88	85
Excavator /	91	85	82
Water Truck	94	88	85
Site Work			
Crawler Tractor	91	85	82
Grader	91	85	82
Loader	91	85	82
Compactor	88	82	79
Water Truck	94	88	85
Pile Driver	107	101	98
Foundation			
Backhoe	86	80	77
Loader	91	85	82
Forklift	85	79	76
Water Truck	94	88	85
Utilities			
Back Hoe	86	80	77
Water Truck	94	88	85
Forklift	85	79	76
Slab on Grade			
Skip Loader	88	82	79
Bobcat Tractor	90	84	81
Forklift	85	79	76
Steel Erection			
Crane	94	88	85
Air Compressor	87	81	76
Generator	87	81	78
Forklift	85	79	78
Decking/Slabs			
Generator	87	81	78
Forklift	85	79	76
Concrete Pump	88	82	79
Completion			

[2] Federal Transit Administration's *Traffic Noise and Vibration Impact Assessment* document, May 2006, pages 12-3

Estimated Construction Noise Levels (in dBA)			
Construction Equipment	**8-hour Leq**		
	25 feet	**50 feet**	**75 feet**
Forklift	85	79	76
Notes: Noise levels calculated from equations defined by the Federal Transit Administration's Transit Noise and Vibration Impact Assessment document, May 2006, pages 12-2 to 12-7. Source: PBS&J/EIP, 2007.			

Table 8: Estimated construction noise levels

There are sensitive land uses surrounding the proposed project site, specifically residential land uses to the northeast along South Delaware Street and to the northwest along East 16th Avenue. Construction noise would affect surrounding uses to varying degrees throughout the construction of the proposed project, including site grading, excavation for infrastructure and building foundations, pile driving, building construction, and paving and landscaping installation.

The San Mateo Municipal Code, Title VII - Health, Sanitation & Public Nuisances, Chapter 7.30: Noise Regulations, limits construction activity to the period between the hours of 7.00 am and 7.00 pm on weekdays, on Saturdays between the hours of 8.00 am and 5.00 pm and on Sundays and holidays between the 12.00 pm and 4.00 pm. Since typical sleeping hours fall outside of the time during which construction must occur, construction noise would not be expected to disturb the sleep of nearby residents. Office and commercial land uses in the vicinity of the proposed project would be open during the day when construction would occur. The noise from construction could disturb people working in these buildings, making it difficult to concentrate.

To ensure that disturbance to the local community from construction related activities on or off the construction site, the contractor should follow the guidance set out below:

- Whenever construction occurs adjacent to occupied residences (on or offsite), temporary barriers shall be constructed around the construction sites to shield the ground floor of the noise-sensitive uses. These barriers shall be of ¾-inch medium density plywood sheeting, or equivalent, and shall achieve a Sound Transmission Class of STC 30, or greater, based on certified sound transmission loss data taken according to ASTM Test Method E90 or as approved by the City of San Mateo Building Official.
- Construction activities shall comply with the City of San Mateo Noise Ordinance, which limits such activity to the hours of 7:00 am to 7:00 pm Monday through Friday, the hours of 8:00 am to 5:00 pm on Saturday, and 12:00 pm to 4pm on Sundays and holidays, or at such other hours as may be authorized or restricted by the permit, if they meet at least one of the following noise limitations:
    1. No individual piece of equipment shall produce a noise level exceeding 90 dB at a distance of 25 feet. If the device is housed within a structure or trailer on the property, the measurement shall be made outside the structure at a distance as close to 25 feet from the equipment as possible.
    2. The noise level at any point outside of the property plane of the project shall not exceed 90 dB.
- Construction equipment staging areas shall be located as far as feasible from residential areas while still serving the needs of construction contractors.

- Quieter “sonic” pile-drivers shall be used, unless engineering studies are submitted to the City that show this is not feasible and cost-effective, based on geotechnical considerations.
- Activities that generate high noise levels, such as pile driving and the use of jackhammers, drills, and impact wrenches, shall be restricted to the hours of 7:00 am to 7:00 pm Monday through Friday, unless it can be proved to the satisfaction of the City that the allowance of Saturday work on certain onsite parcels (i.e. those as far from noise-sensitive uses as possible) would not have an adverse noise impact.

6 Assessment of Ground-Borne Vibration

6.1 Assessment Method

The assessment of ground-borne vibration to sensitive receptors at the project site has been undertaken following the guidance given in FTA *Transit Noise and Vibration Impact Assessment* (May 2006). The FTA guidance manual sets out methods for vibration impact assessment and impact significance criteria. The criteria are given in terms of VdB referenced to one micro-inch per second (considered to be the threshold of human perception to vibration). The guidance manual includes three different levels of detail for ground-borne vibration assessment:

- Screening Assessment: A standard table of impact distances is used to determine if ground-borne vibration from the project may affect sensitive land uses. More detailed analysis is required if any sensitive land uses are within the screening distances.
- General Assessment: An extension of the screening procedure and uses adjustments to account for factors such as distance from track and structural properties of the sensitive receptor. The general level deals only with the overall vibration velocity level and the A-weighted sound level. It does not consider the frequency spectrum of the vibration or noise.
- Detailed Assessment: Is the most complex assessment method, and is generally only required if vibration is considered to be a significant issue at the project site.

A General Assessment of ground-borne vibration has been undertaken, because the west boundary line of the site is within 200 feet of the Caltrain alignment, and because the proposed project includes residential dwellings.

6.2 Field Measurements

The main source of ground-borne vibration to the project site is from the Caltrain alignment that is to the west of Station Park Green. The levels of vibration were ascertained by making grade level measurements adjacent to the railway line.

A total of 9 Caltrain pass-bys were measured at a location 20 feet from the Caltrain alignment. No freight trains were observed. The range of root mean squared rms ground-borne vibration levels is given in Table 9 over the page.

Location	Location Description	Measured Range of Ground-Borne Vibration Level (rms VdB re 1 micro-inch/sec)
V1	20 feet from railway track located in the Hayward Park station parking lot.	52 – 68

Table 9: Typical range of root mean squared (rms) ground-borne vibration levels

6.3 Assessment for Residential and Commercial Land Uses

The nearest residential and commercial land uses to the Caltrain alignment are on the west side of the proposed project site. The nearest setback distances for residential land use are over the page.

Land Use	Setback Distance from Caltrain
Town house	140 feet
Multistory residential	150 feet
Commercial	160 feet

Table 10: Nearest residential and commercial setback distances from Caltrain alignment

The vibration assessment has been carried out using the worst case results from the ground-borne vibration field measurements, and following the General Assessment calculation method provided in the FTA guidance manual. The FTA calculation methodology takes adjustment factors for coupling loss between the building foundation and the underlying soil, a floor to floor propagation loss, and an amplification gain factor due to structural resonances. The following FTA adjustment factors have been applied:

- Coupling loss to foundations for a masonry town house: -7dB
- Coupling loss to foundations for a three to four story masonry town house: -10dB
- Coupling loss to foundation for multistory masonry commercial land use: -10 dB
- Floor to floor propagation loss: -2 dB
- Amplification factor: +6 dB

Table 11 over the page shows the predicted ground-borne vibration levels and the FTA ground-borne vibration level target.

Land Use	Level in Building	FTA ground-Borne Vibration Level Target VdB (re 1 micro-inch/second)	Predicted Ground-Borne Vibration Level VdB (re 1 micro-inch/second)
Town house	Grade	72	67
Multistory residential	1	72	62
Commercial	Grade	75	64

Table 11: Predicted ground-borne vibration levels VdB rms re 1 micro-inch/sec

The ground-borne vibration predictions indicate that the FTA ground-borne vibration targets are achieved. No mitigation required.

7 Conclusions

- The predicted maximum increase in traffic noise as a result of both Station Park Green development alternatives is 2 dBL_{dn}. According to City policy this is not considered as an impact to the local sensitive land uses.
- The predicted noise level in multi-family open residential spaces internal to both Station Park Green development alternatives meets City policy.
- The measured L_{dn} at two locations on the proposed site for Station Park Green fall within the City land use compatibility rating of “Normally Unacceptable”. The future developers will need to demonstrate to the City that appropriate noise mitigation measures will be included in the project.
- The Federal Transit Administration ground-borne vibration targets are achieved at the proposed residential and commercial set back distances from the Caltrain alignment.

Appendix A

Acoustical Terminology

dB(A)

The unit generally used for measuring environmental, traffic or industrial noise is the A-weighted sound pressure level in decibels, denoted dB(A). An A-weighting network can be built into a sound level measuring instrument such that sound levels in dB(A) can be read directly from a meter. The weighting is based on the frequency response of the human ear and has been found to correlate well with human subjective reactions to various sounds. It is worth noting that an increase or decrease of approximately 10 dB corresponds to a subjective doubling or halving of the loudness of a noise, and a change of 2 to 3 dB is subjectively barely perceptible.

EQUIVALENT CONTINUOUS SOUND LEVEL (L_{eq})

An index for assessment for overall noise exposure is the equivalent continuous sound level, L_{eq}. This is a notional steady level which would, over a given period of time, deliver the same sound energy as the actual time-varying sound over the same period. Hence fluctuating levels can be described in terms of a single figure level.

DAY-NIGHT AVERAGE SOUND LEVEL (L_{dn})

The day-night average sound level L_{dn} describes a receiver's cumulative noise exposure from all events over a full 24hrs, with events between 10pm and 7am increased by 10 dB to account for greater night-time sensitivity to noise.

TYPICAL LEVELS

Some typical noise levels are given below:

Noise Level dB(A)	Example
130	Threshold of pain
120	Jet aircraft take-off at 300 ft
110	Chain saw at 3 ft
100	Inside disco
90	Heavy lorries at 15 ft
80	Sidewalk of busy street
70	Loud radio (in typical domestic room)
60	Office or restaurant
50	Domestic fan heater at 3 ft
40	Living room
30	Theatre
20	Remote countryside on still night
10	Sound insulated test chamber
0	Threshold of hearing

Table A1: Typical noise levels

VIBRATION

Vibration may be expressed in terms of displacement, velocity and acceleration. Velocity and acceleration are most commonly used when assessing structure-borne noise or human comfort issues respectively. Vibration amplitude may be quantified as a peak value, or as a root mean squared (rms) value.

Vibration amplitude can be expressed as an engineering unit value e.g. 1 inch s^{-1} or as a ratio on a logarithmic scale in decibels:

vibration velocity level, VdB = 20 log (V/V_{ref}).

(where the preferred reference level, V_{ref}, for vibration velocity = 10^{-6} inch s^{-1} rms)

120 VdB	=	1 inch s^{-1} rms
100 VdB	=	0.1 inch s^{-1} rms
80 VdB	=	0.01 inch s^{-1} rms

The decibel approach has advantages for manipulation and comparison of data.