Noise Report

College Way (SR 538) @I-5

City of Mount Vernon, Skagit County

Prepared for:

City of Mount Vernon
910 Cleveland Ave
Mount Vernon, WA 98273

Prepared by:

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January 2017

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Acronyms

dB(A)	The A-weighted sound level measured in decibels. A-weighted network = a frequency-equalizing function which approximates the sensitivity of human hearing to sounds of moderate SPL.
EB	East bound traffic lane
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
L_{eq}(1h)	The equivalent sound level (the logarithmic sum of sound exposure levels) over 1 hour
mph	Miles per hour
NAC	Noise Abatement Criteria
NB	North bound traffic lane
SB	South bound traffic lane
SEL	Sound Exposure Level
SPL	Sound Pressure Level
TNM	FHWA traffic noise model – version 2.5
WB	West bound traffic lane
WSDOT	Washington State Department of Transportation

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Executive Summary

Widener & Associates undertook this study to analyze existing and predicted future traffic noise conditions in the vicinity of the proposed College Way (SR 538) @I-5 Project, located in the City of Mount Vernon. The proposed roadway improvements include widening approximately 1,200 feet of College Way (SR538) from 4 to 6 lanes at the I-5 / College Way interchange. The work will consist of new roadway channelization, adding one new eastbound through lane and one new left turn lane, replacing two traffic signals at the I-5 on and off ramps, retaining walls, pedestrian facilities and drainage improvements. The project site is located within the legal geographic area of Township 34 North; Range 4 East; Section 18. Existing land use along the project corridor is commercial.

Sound levels for the 'Existing 2016', 'No Build 2036' and 'Build 2036' conditions were derived from the Traffic Noise Model (TNM) 2.5, verified with field measurements, and compared with the Federal Highway Administration (FHWA) and the Washington State Department of Transportation (WSDOT) standards and criteria. Sound level recording and modeling was undertaken in accordance with FHWA guidelines and standards. A total of six receivers were modeled within the project area. As per WSDOT guidelines, all receivers were modeled for the worst case hourly condition in the project area as a whole (the PM peak hour). Traffic data was collected in 2016 and forecasted for 'No Build 2036', and 'Build 2036' conditions.

This study shows that noise above established thresholds (as defined by FHWA/WSDOT) occur at five locations along the project corridor. The 2036 Build scenario does not predict a substantial increase over the existing condition at any of the six receivers. The greatest increase in sound level under the 'Build 2036' condition compared to existing conditions is 2 dB at receiver 3. The greatest sound level experienced under the 'Build 2036' condition is 73 dB(A) at multiple receivers. See table below for modeled results for all conditions.

Summary of results for the Existing, No Build 2036, and Build 2036 conditions

Receivers		Existing (2016) LAeq1hr	No Build (2036) LAeq1hr	Build (2036) LAeq1hr	Impact Approach Noise Level Criteria	Impact Substantial Increase Criteria
Number	Name/Description					
V-1	Validation Site College Way	73	73	73	-	-
1	Coffee Shop	73	73	73	71	10
2	Bank	70	71	71	71	10
3	Office	71	73	73	71	10
4	Restaurant	69	69	69	71	10
5	Restaurant	71	72	72	71	10

Based on the results of this study, abatement measures were fully evaluated in accordance with FHWA and WSDOT noise abatement policy. It was concluded that none of the abatement options were reasonable and feasible due to access issues.

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1. Introduction

The purpose of this report is to document and analyze existing traffic noise conditions and predict future traffic noise conditions in the vicinity of the proposed College Way (SR 538) @I-5 Project, in Mount Vernon, WA. Sound levels for the 'Existing 2016', 'No Build 2036' and 'Build 2036' conditions were compared with the FHWA / WSDOT standards and criteria. Sound levels were derived from the FHWA approved noise model, TNM 2.5. Calculations generated by the model were verified using field measurements in accordance with FHWA and WSDOT requirements. This report was used to determine whether or not noise abatement measures should be warranted as part of the proposed project, and as appropriate, to make recommendations regarding such options.

1.1 Noise Characteristics and Measurement

1.1.1 Defining Noise

Noise is defined as unwanted sound (Maekawa and Lord., 1994; Bell *et al*., 1996; Berglund *et al.*, 1996). Noise is recognized as having both a physical and a psychological component. The physical component is set, while the psychological component (the degree of annoyance) depends on the listener and their physiological and psychological state as well as the frequency and time of the varying pattern of the sound. Low frequency (particularly anthropogenic sources) and impulse sounds are thought to result in higher levels of annoyance (Hall *et al.*, 1981; Maekawa and Lord, 1994; Bell *et al*., 1996; Berglund *et al*., 1996).

1.1.2 Measuring Noise

When measuring noise, the decibel scale, the A-weighted network, and the descriptor L_{eq} are usually used to describe and quantify the noise levels experienced by a receiver. These descriptors are described in the following paragraphs.

The decibel scale is a logarithmic scale, derived from the Pascal scale and based on sound pressure levels (the physical correlate of loudness). The threshold of human hearing is at 20 micropascals or 0 dB. A change of 20 dB corresponds to a ten-fold increase in micropascals. Thus, 20 dB is equivalent to 200 micropascals. However, the decibel scale provides a better approximation of the perception of loudness than the Pascal scale, 1 dB indicates the same fractional change in sound pressure at all levels. Generally, a 3 dB increase is barely perceptible

to human listeners. A 6 dB increase corresponds to a doubling of the sound pressure; however, a 10 dB increase is necessary for the sound to be perceived as being twice as loud (FHWA, 1995; Maekawa *et al.*, 1994; Boeker and Van Grondelle, 1995). Refer to Table 1 for examples of typical sound source levels.

Table 1: Sound Pressure Levels of Representative Sounds and Noises

Source	Decibels	Description
Large rocket engine (nearby)	**180**	
Jet take-off (nearby)	**150**	
Pneumatic riveter	**130**	**Pain threshold**
Jet take-off (60 meters)	**120**	
Construction noise (3 meters)	**110**	
Subway train	**100**	
Heavy truck (15 meters) and	**90**	**Constant exposure endangers hearing**
Niagara Falls	**80**	
Average factory	**70**	
Normal conversation (1 meter)	**60**	
Quiet office	**50**	
Quiet Library	**40**	
Soft whisper (5 meters)	**30**	
Rustling leaves	**20**	
Normal breathing	**10**	**Very quiet**
Hearing threshold	**0**	**Barely audible**

Source: Tipler 1976

The type of weighting curve used in measuring sound is important in determining the accuracy of the result as a measure of the impact of the sound on those hearing it. The frequency of sound determines the ability of the human auditory system to detect it. As the sound of a constant sound pressure level decreases in frequency from about 1 kHz or increases in frequency from about 5 kHz, its perceived loudness decreases. Therefore, in order to measure what is actually being heard by humans, measurement of sound pressure level is adjusted to account for the relative loudness of the frequency through the use of weighting networks (A, B and C) in sound level meters. Networks are based on approximate equal-loudness contours rather than the hearing threshold curve. The A-weighted network is considered to most accurately represent human perception of noise (Maekawa and Lord, 1994; Boeker and Van Grondelle, 1995; Berglund *et al.*, 1996).

The descriptor used to measure traffic-induced sound levels in this study is dB(A) L_{eq}(1h), which is defined as the equivalent A-weighted sound level [the logarithmic sum of sound exposure levels (SELs)] over 1 hour.

2. Project Description

2.1 Location

The proposed project is located within the City of Mount Vernon, Skagit County, WA. The project site is located within the legal geographic area of Township 34 North; Range 4 East; Section 18. Existing land use and zoning along the project corridor is commercial. Refer to Figure 1.

2.2 Proposed Work

The project will widen College Way (SR538) from 4 to 6 lanes at the I-5 / College Way interchange. The work will consist of new roadway channelization, adding one new eastbound through lane and one new left turn lane, replacing two traffic signals at the I-5 on and off ramps, retaining walls, pedestrian facilities and drainage improvements. The project limits are College Way from Freeway Drive to Market St., approximately 1,200 ft.

2.3 Purpose and Need

The purpose of the project is to reduce congestion on the College Way Interchange which is forecasted to result in traffic backing up the I-5 off-ramps onto the I-5 mainline by 2035.

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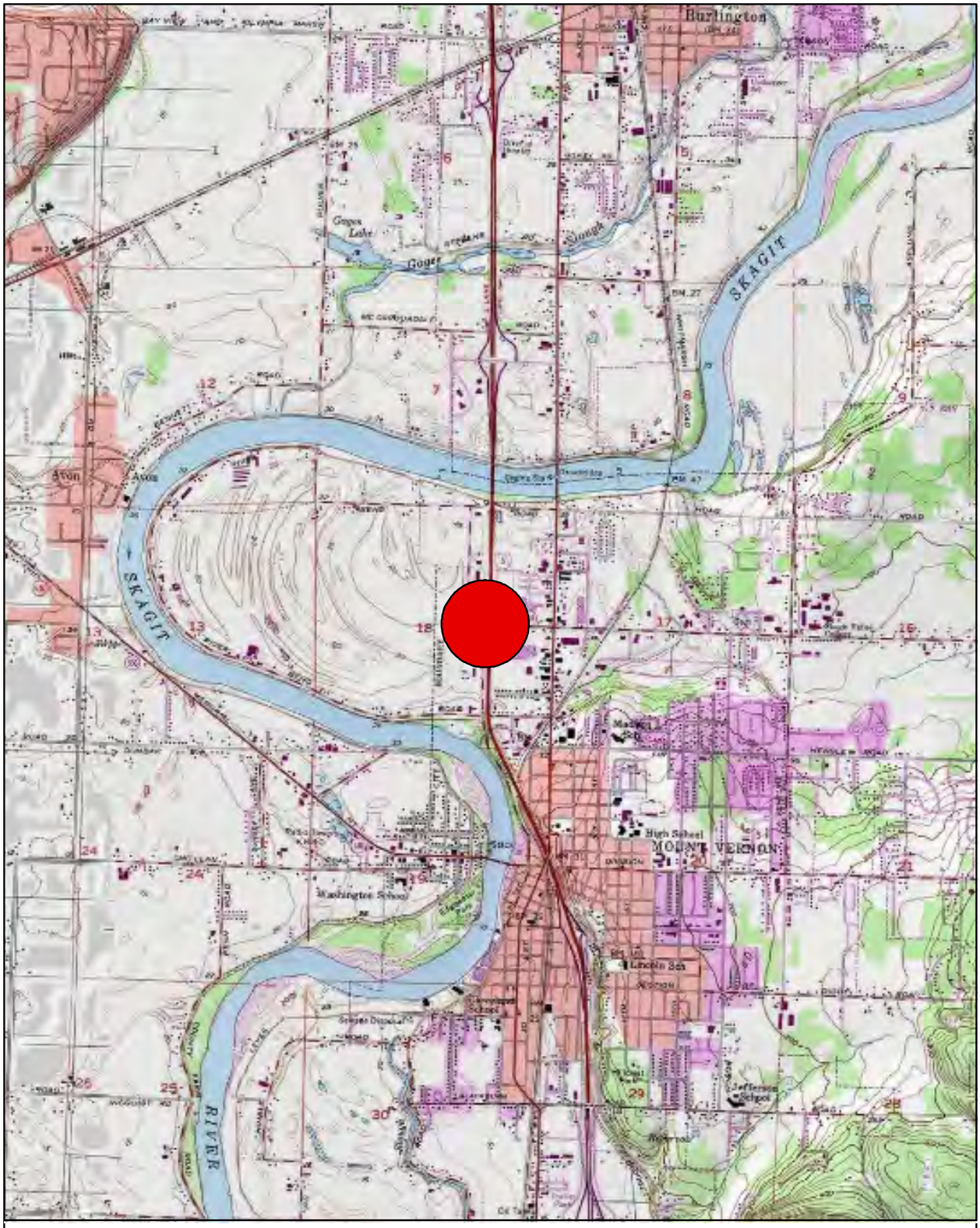

Figure 1. Vicinity Map

College Way (SR 538) @ I-5
City of Mount Vernon

January 22, 2016

Project Site

0 2,500 5,000 10,000 Feet

N

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3. Criteria for Determining Impacts

This section discusses applicable noise regulations and agency guidelines that provide the basis for evaluating potential noise impacts and mitigation or abatement for a proposed project. Noise regulations and guidelines for federally funded highway projects in Washington are established by WSDOT and the FHWA. The FHWA (23 C.F.R. §772.5(g)) defines traffic noise impacts to occur either when:

- predicted traffic noise levels approach or exceed the noise abatement criteria;
- predicted traffic noise levels substantially exceed the existing noise levels; or
- predicted traffic noise levels are severe noise levels

WSDOT has defined 'approach' to be within 1 dB(A) below the FHWA noise abatement criteria of 67 dB(A) and has defined 'substantially exceed' to be a 10 dB(A) increase over existing noise levels. A severe impact is defined as a level greater than 80 dB(A) L_{eq}(1h).

Therefore, a noise impact is determined to occur when predicted noise levels 'approach' or 'exceed' the FHWA noise abatement criteria[1] as given in Table 1 or when predicted noise levels are 10 dB(A) or greater over the existing level. For example, traffic noise impacts for Activity Category B (residences, schools etc.) would occur if predicted noise levels were to be equal or greater than 66 dB(A) L_{eq} (1h).

[1] Noise standards that specify exterior L_{eq}(h) noise levels for various land activity categories.

Table 2: FHWA noise abatement criteria

Activity Category	L_{eq}(1h) dB(A)	Description of Activity Category
A	57 (exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (exterior)	Residential (single and multi-family units)
C	67 (exterior)	Active sports centers, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreational areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	52 (interior)	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, schools, and television studios.
E	72 (exterior)	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F. Includes undeveloped land permitted for these activities.
F	-	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, retail facilities, shipyards, utilities (water resources, water treatment, and electrical), and warehousing.
G	-	Undeveloped lands that are not permitted

Source: 23 C.F.R. Part 772

Sound levels generated by any proposed project are primarily compared to the FHWA / WSDOT standards and criteria rather than to the 'Existing' condition or to the 'No Build 2036' condition. The project proponent is required to consider mitigation options when the proposed project meets or exceeds FHWA / WSDOT standards and criteria in the future build condition. In a case where the criteria are exceeded by a lesser degree as a result of the proposed project than under the 'Existing' condition, the project proponent is still required to consider mitigation options.

4. Methods

4.1 Field Data Collection

Sound levels were recorded in the field on November 2, 2016. Sound level recordings were made at one site along the project corridor between 2:45 and 3:15 pm. Refer to Figure 2 and the data sheets provided in Appendix C. Recordings were made using a Larson and Davis Type 1 Sound Level Meter (model 820) and the following variables:

- Descriptor: L_{eq}
- Integration rate: Fast
- Sample rate, 15 minutes
- Weighting, A

The timing and source of other noises perceptible above the traffic noise were also noted. The sound level meter, microphone, and calibrator were within factory calibration. Calibration certificates for the meter, microphone, and calibrator are provided in Appendix A. The microphone was placed 5 feet off the ground and the site chosen was an area of potential outdoor human use (refer to Appendix C).

Traffic data collected in the field was used to validate the model in accordance with FHWA and WSDOT requirements. Traffic data and weather conditions collected in the field at the time of the sound recording were entered into the model. The following traffic data and baseline information was collected during each 15-minute sound recording interval:

- total numbers of each traffic type (automobiles, medium trucks [2 axles and 6 tires] heavy trucks [greater than 2 axles / 6 tires], buses, and motorbikes) directionally separated;
- average speed
- temperature
- humidity

Sound levels calculated by the model were compared with those recorded in the field. The acceptable margin of error between the field recordings and the modeled results were plus or minus 2 dB(A). The difference between the field recordings and modeled results for all sites were within 2 dB(A).

4.2 Traffic Noise Model

The FHWA traffic noise model version 2.5 (TNM) was used to model the existing and future ('Build 2036' and 'No Build 2036') road traffic-induced noise environment within the project area.

4.2.1 Receivers

A total of six receivers were modeled. All of these receivers are characterized as 'Activity Category E' receivers, with the impact criterion of 71 dB(A).

Receivers were chosen based on the following factors:

1. Proximity to the existing and proposed roadway. Sites most likely to be impacted were favored.
2. Location along the corridor. Receivers were selected along the length of the project corridor and extend out from the road to such a distance to ensure that all traffic noise impacts are included. Modeling limits are extended to reach any location which reaches 65 dB(A) to ensure the full impacted area is captured.
3. Primary areas of outdoor use. Receivers were placed at sites which appeared to have the most foot traffic.
4. Sites which would be removed as a result of the proposed project or which were too close to the roadway to model were not selected.

As per WSDOT guidelines, all receivers were modeled for the worst case condition in the project area as a whole (the PM peak hour) for 2016 and 2036.

4.2.2 Traffic Data

4.2.2.1 Existing Condition

Traffic Data

Traffic data for the PM Peak Hour were 2015 forecasts provided by in a Traffic Analysis Technical Report prepared by WSDOT for additional lanes on SR 538. Annual average daily traffic (AADT) for I-5 traffic was taken from the WSDOT 2015 Annual Traffic Report. Evening peak hour was estimated as 10 percent of AADT and traffic was divided equally between directions (Refer to Appendix B). Percentages of heavy vehicles were based on the closest location in the WSDOT report where the percentages were reported. Speeds along the corridor were based on posted speed limits.

4.2.2.2 No Build 2036 Condition

Traffic numbers for 2036 were estimated using a 1% growth rate from 2015 traffic numbers used in the model. These estimates included percentages of vehicle types and were used to model the 'No Build 2036' condition. Speeds were assumed to be the same as for the 'Existing 2016' condition. Refer to Appendix B for the traffic data and the vehicle percentages used to model the 'No Build 2036' condition. The posted speed for each roadway was used, resulting in the worst hourly noise conditions.

4.2.2.3 Build 2036 Condition

Traffic numbers and vehicle percentages for the 2036 Build condition are the same as the 2036 No Build as the project is not expected to change traffic volumes in the area, only improve traffic flow through an existing choke point. Roadways will have the same posted speed. Refer to Appendix B for the data used to model the 'Build 2036' condition.

5. Results

5.1 Existing Noise Environment

5.1.1 Field Measurement

Sound levels were recorded in the field at one site on the project corridor. Data from the site was compared to the modeled results (based on traffic data collected during the sound level recording) in order to validate the model in accordance with WSDOT requirements. WSDOT requires that the modeled results and the field measurements come within plus or minus 2 dB(A) of one another. Receiver 1 was located in a parking lot for a bank on College Way. This site was chosen to represent the conditions within the project area, however it does not require noise abatement consideration. The L_{eq} levels measured in the field were 68.6 dB(A) for site one. The L_{eq} levels calculated by the model were 68.5 dB(A) for site one. Therefore, the result is within the acceptable margin of error and modeling of all receivers under all conditions (Existing, No Build, and Build) could proceed. The meter was correctly calibrated at the time of recording. The field calibration site is depicted in Figure 2.

Environmental conditions recorded during field measurements are as follows:

- Temperature, 56°F;
- Relative Humidity, 75%;

Sound levels at the field recording site was dominated by vehicular traffic. Refer to the data sheet provided in Appendix C.

Figure 2. Receiver Locations
College Way (SR 538) @ I-5
City of Mount Vernon
Skagit County, WA
S 18, T 34N, R 04E

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5.2 *Future Noise Environment*

Of the six receivers modeled, four exceeded the FHWA/WSDOT sound level criteria under all conditions and one additional receiver exceeded the criteria under 2036 conditions. Refer to Table 3 for the results of existing sound levels modeled at all receivers and to Figure 2 for the locations.

The 2036 Build scenario does not predict a substantial increase over the existing condition at any of the six receivers. The greatest increase in sound level under the 'Build 2036' condition compared to existing conditions is 2 dB at receiver 3. The greatest sound level experienced under the 'Build 2036' condition is 73 dB(A) at receivers V-1, 1, and 3.

Table 3: Summary of results for the Existing, No Build 2036, and Build 2036 conditions

Receivers		Existing (2016) LAeq1hr	No Build (2036) LAeq1hr	Build (2036) LAeq1hr	Impact Approach Noise Level Criteria	Impact Substantial Increase Criteria
Number	Name/Description					
V-1	Validation Site College Way	73	73	73	-	-
1	Coffee Shop	73	73	73	71	10
2	Bank	70	71	71	71	10
3	Office	71	73	73	71	10
4	Restaurant	69	69	69	71	10
5	Restaurant	71	72	72	71	10

5.3 Summary of Modeled Results

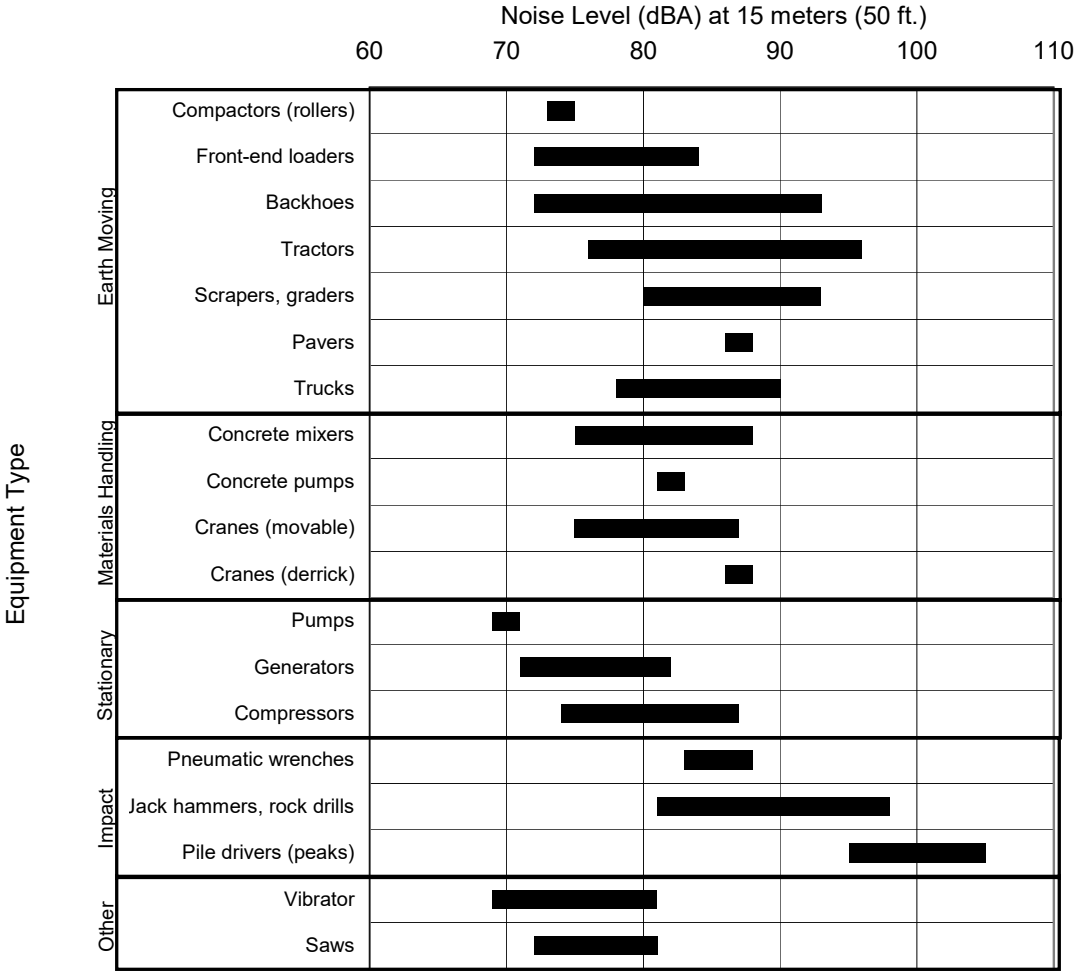
This study shows that noise above established thresholds (as defined by FHWA/WSDOT) currently occur and would continue to occur at one location along the project corridor. The 2036 Build scenario does not predict a substantial increase over the existing condition at any of the six receivers. The greatest increase in sound level under the 'Build 2036' condition compared to existing conditions is 2 dB at receiver 3. The greatest sound level experienced under the 'Build 2036' condition is 73 dB(A) at receivers V-1, 1, and 3.

Based on the results of this study, five receivers would experience traffic noise impacts (as defined by FHWA/WSDOT) as a result of the proposed project.

5.4 Construction Noise

Short-term noise impacts would occur as a result of construction activities. General construction activities (such as grading, laying base, and paving) would take place as part of the proposed project. Based on WSDOT guidance, short-term noise impacts are expected to radiate up to a maximum of one mile from the project area. Based on the data tabulated by the Environmental Protection Agency (EPA) and WSDOT, sound levels generated during construction are not expected to exceed 95 dB(A). Construction equipment sounds (usually point source) decrease about 6 dB(A) with every doubling of distance. Table 4 depicts typical construction equipment sound levels 50 feet from there source. Surrounding areas would temporarily experience higher noise levels as a result of construction.

Table 4: Typical construction equipment noise levels



Source: EPA, 1971 and WSDOT, 1991.

The City of Mount Vernon's public disturbance regulations, in chapter 9.28.060 of the municipal code, subsection F(1) lists the following:

> *F. Exemptions Other Than Residential. The following shall be exempt from the provisions of subsection A of this section, except insofar as such provisions relate to the reception of noise within Class A EDNAs between the hours of 10:00 p.m. and 7:00 a.m.:*
>
> *1. Sounds originating from temporary construction sites as a result of construction activity.*

The surrounding area is zoned for commercial use areas; potential impacts to residential areas are not expected. The construction noise from this project is exempt from the municipal code between the hours of 7 am and 10 pm and is not required to be mitigated. However, due to the potential for large traffic impacts caused by construction, nighttime work may be required. A noise variance will be obtained, if necessary. There are also some simple techniques that can be put into place to reduce the noise impacts for nearby offices or people passing through the construction area:

- Minimize construction noise by turning off engines when not in use.
- Positioning stationary noise sources such as generators and compressors as far away from receivers as possible.
- Substitute hydraulic or electric models for impact tools such as rock drills or jackhammers.

5.5 *Mitigation Needs*

As discussed in Section 3, the project proponent is required to consider mitigation options when the proposed project meets or exceeds FHWA/ WSDOT criteria/standards regardless of whether or not the criteria/standards were met or exceeded under the 'Existing' condition. As this study identifies noise impacts, mitigation measures need to be fully evaluated in accordance with FHWA and WSDOT noise abatement policy for receivers that would be impacted by the proposed project. FHWA and WSDOT require that construction of noise barriers be evaluated for feasibility and reasonableness.

Feasibility deals primarily with engineering considerations such as whether a meaningful reduction in sound levels can be achieved and whether or not abatement measures would affect property access. To be feasible, a noise wall must be constructed to achieve a reduction of at least 5 dB(A) for the majority of impacted first row receivers. Reasonableness assesses the practicality of the abatement measure including: cost, the amount of noise reduction, and future traffic levels. To be reasonable, a noise reduction of at least 7 dB(A) at one sensitive receiver must be achieved in addition to being feasible. The WSDOT noise mitigation cost per residence is given in the following table.

Table 5: Noise mitigation cost per residence

Design Year Traffic Noise Decibel Level	Allowed Cost Per Household *	Equivalent Wall Surface Area Per Household
66 dBA	$36,127	700 ft^2
67 dBA	$39,636	768 ft^2
68 dBA	$43,146	836 ft^2
69 dBA	$46,665	904 ft^2
70 dBA	$50,165	972 ft^2
71 dBA	$53,674	1040 ft^2
72 dBA	$57,184	1108 ft^2
73 dBA	$60,693	1176 ft^2
74 dBA	$64,203	1244 ft^2

*Reevaluated each year. Based on $51.61 per square foot constructed cost (WSDOT, 2011)
Note: the allowed cost per household (or residential equivalent) can be used for the full range of mitigation options including the construction of barriers and the acquisition of property.

There are four receivers which meet or exceed noise level criteria which require evaluation for noise abatement. All of these receivers are offices and restaurants which are designated as Category E receivers. In order to maintain access to these businesses and their parking lots, a noise wall is not feasible.

6. References

23 C.F.R. Part 772, *Procedures for Abatement of Highway Traffic Noise and Construction Noise*

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Appendix A: Calibration Certificates

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PCB PIEZOTRONICS
A PCB GROUP COMPANY

Certificate of Calibration and Conformance

Certificate Number 2012-166124

Instrument Model 820, Serial Number 1518, was calibrated on 31OCT2012. The instrument meets factory specifications per Procedure D0001.8160, ANSI S1.4 1983, IEC 651-Type 1 1979, and IEC 804-Type 1 1985.

Instrument found to be in calibration as received: YES
Date Calibrated: 31OCT2012
Calibration due:

Calibration Standards Used

MANUFACTURER	MODEL	SERIAL NUMBER	INTERVAL	CAL. DUE	TRACEABILITY NO.
Larson Davis	LDSigGn/2209	0277 / 0109	12 Months	20MAR2013	2012-156690

Reference Standards are traceable to the National Institute of Standards and Technology (NIST)

Calibration Environmental Conditions

Temperature: 23 ° Centigrade

Relative Humidity: 25 %

Affirmations

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the U.S. National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at Provo Engineering & Manufacturing Center. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

This calibration complies with the requirements of ISO 17025 and ANSI Z540. The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. A one year calibration is recommended, however calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of the issuer.

"AS RECEIVED" data same as shipped data.
Tested with PRM828-2422

Signed: Ron Harris
Technician: Ron Harris

Provo Engineering and Manufacturing Center, 1681 West 820 North, Provo, Utah 84601
Toll Free: 888.258.3222 Telephone: 716.926.8243 Fax: 716.926.8215
ISO 9001-2008 Certified

PCB PIEZOTRONICS
A PCB GROUP COMPANY

Certificate of Calibration and Conformance

Certificate Number 2012-165547

Instrument Model CAL200, Serial Number 4920, was calibrated on 19OCT2012. The instrument meets factory specifications per Procedure D0001.8190.

Instrument found to be in calibration as received: NO
Date Calibrated: 19OCT2012
Calibration due:

Calibration Standards Used

MANUFACTURER	MODEL	SERIAL NUMBER	INTERVAL	CAL. DUE	TRACEABILITY NO.
Larson Davis	2559	2504	12 Months	13DEC2012	18736-1
Larson Davis	2900	0661	12 Months	06APR2013	2012-157399
PCB	1502B02FJ15PSIA	1428	12 Months	10APR2013	3416909125.00
Hewlett Packard	34401A	3146A10352	12 Months	28AUG2013	5778699
Larson Davis	PRM902	0480	12 Months	07SEP2013	2012-163567
Larson Davis	MTS1000/2201	0111	12 Months	07SEP2013	SM070912-3
Larson Davis	PRM915	0112	12 Months	08OCT2013	2012-164811

Reference Standards are traceable to the National Institute of Standards and Technology (NIST)

Calibration Environmental Conditions

Environmental test conditions as shown on calibration report.

Affirmations

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the U.S. National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at Provo Engineering & Manufacturing Center. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

This calibration complies with the requirements of ISO 17025 and ANSI Z540. The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. A one year calibration is recommended, however calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of the issuer.

See "As Received" data.

Signed: Scott Montgomery
Technician: Scott Montgomery

Provo Engineering and Manufacturing Center, 1681 West 820 North, Provo, Utah 84601
Toll Free: 888.258.3222 Telephone: 716.926.8243 Fax: 716.926.8215
ISO 9001-2008 Certified

PCB PIEZOTRONICS
A PCB GROUP COMPANY

Certificate of Calibration and Conformance

Certificate Number 2012-166114

Instrument Model PRM828, Serial Number 2422, was calibrated on 31OCT2012. The instrument meets factory specifications per Procedure D0001.8135.

Instrument found to be in calibration as received: NO
Date Calibrated: 31OCT2012
Calibration due:

Calibration Standards Used

MANUFACTURER	MODEL	SERIAL NUMBER	INTERVAL	CAL. DUE	TRACEABILITY NO.
Agilent Technologies	34401A	MY41044529	12 Months	26JAN2013	5522640
Larson Davis	LDSigGn/2209	0277 / 0109	12 Months	20MAR2013	2012-156690

Reference Standards are traceable to the National Institute of Standards and Technology (NIST)

Calibration Environmental Conditions

Temperature: 23 ° Centigrade

Relative Humidity: 25 %

Affirmations

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the U.S. National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at Provo Engineering & Manufacturing Center. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

This calibration complies with the requirements of ISO 17025 and ANSI Z540. The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. A one year calibration is recommended, however calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of the issuer.

"AS RECEIVED" unavailable due to unit failure.

Signed: Ron Harris
Technician: Ron Harris

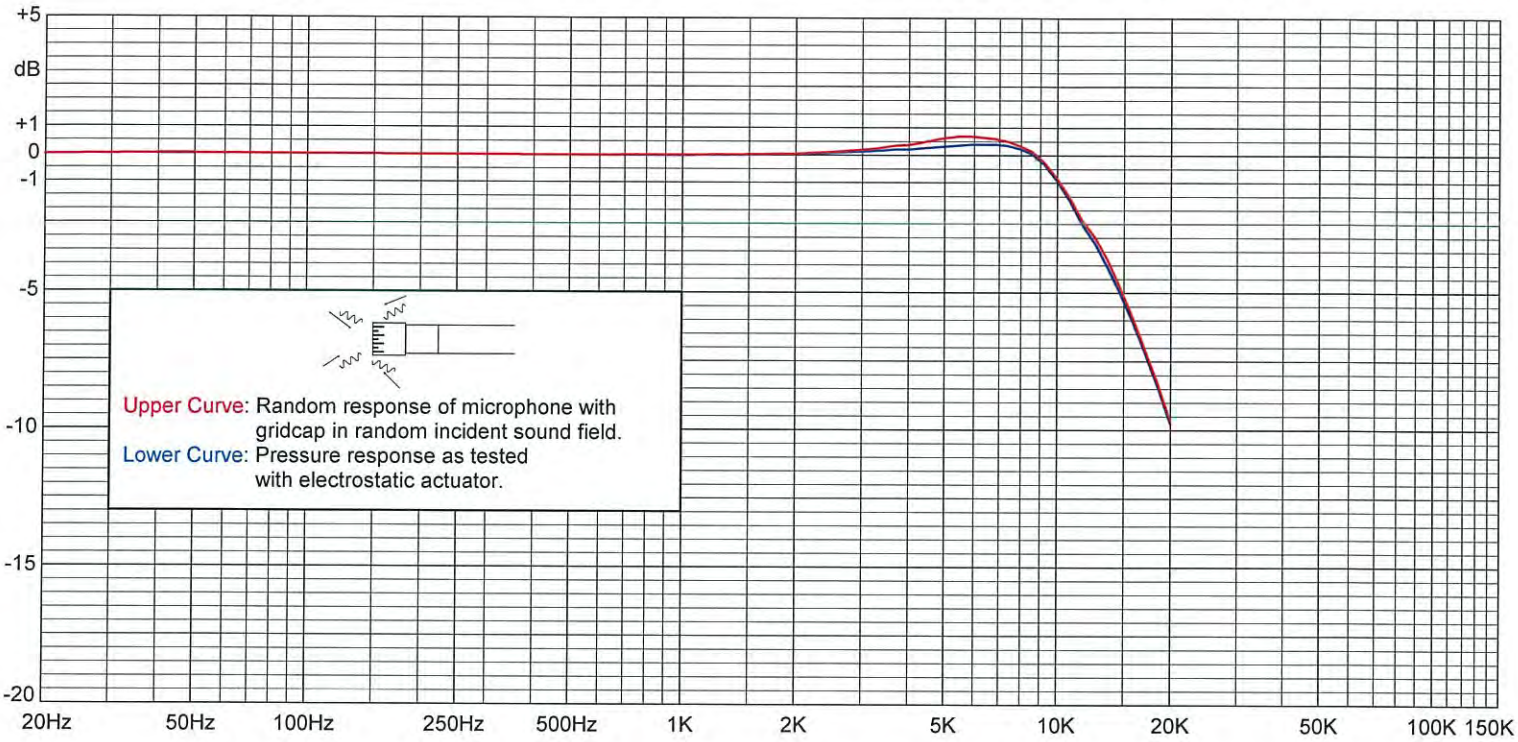
Provo Engineering and Manufacturing Center, 1681 West 820 North, Provo, Utah 84601
Toll Free: 888.258.3222 Telephone: 716.926.8243 Fax: 716.926.8215
ISO 9001-2008 Certified

Larson Davis

Larson-Davis 1/2" Microphone Calibration Chart
Model: 2560 Serial Number: 2405

Open Circuit Sensitivity @ 1015.1 mbar & 251.19 Hz
-27.42 dB re 1V/Pascal
42.55 mV/Pascal
+1.40 K_0(-dB re 50 mV/Pascal)
Expanded Uncertainty @ ~95% confidence level
0.18 dB

Capacitance @ 251.2 Hz
19.9 pF
Test Conditions:
Polarization Voltage **200** V
Ambient Pressure **1015.1** mbar
Temperature **22.8** °C
Relative Humidity **27.4** %



Frequency Response (0 dB @ 251.19 Hz)
Random and actuator response with reference to level at 251.19 Hz

Freq (Hz)	Upper (dB)	Lower (dB)	Freq (Hz)	Upper (dB)	Lower (dB)	Freq (Hz)	Upper (dB)	Lower (dB)	Freq (Hz)	Upper (dB)	Lower (dB)	Freq (Hz)	Upper (dB)	Lower (dB)
19.95	-0.02	-0.02	316.23	0.00	-0.00	926.12	0.00	-0.01	2712.27	0.15	0.11	7943.28	0.35	0.25
25.12	0.00	0.00	341.45	0.00	-0.00	1000.00	0.00	-0.01	2928.64	0.18	0.12	8576.96	0.14	0.06
31.62	0.01	0.01	368.69	-0.01	-0.01	1079.78	0.01	-0.00	3162.28	0.23	0.15	9261.19	-0.27	-0.33
39.81	0.02	0.02	398.11	-0.01	-0.01	1165.91	0.01	-0.00	3414.55	0.28	0.17	10000.00	-0.85	-0.93
50.12	0.02	0.02	429.87	-0.01	-0.01	1258.93	0.01	0.00	3686.95	0.35	0.22	10797.75	-1.54	-1.64
63.10	0.02	0.02	464.16	-0.01	-0.01	1359.36	0.02	0.01	3981.07	0.37	0.21	11659.14	-2.37	-2.52
79.43	0.01	0.01	501.19	-0.01	-0.01	1467.80	0.02	0.01	4298.66	0.45	0.25	12589.25	-2.97	-3.19
100.00	0.01	0.01	541.17	-0.01	-0.01	1584.89	0.03	0.02	4641.59	0.55	0.29	13593.56	-3.77	-4.04
125.89	0.01	0.01	584.34	-0.01	-0.01	1711.33	0.03	0.02	5011.87	0.62	0.32	14677.99	-4.78	-5.00
158.49	0.01	0.01	630.96	-0.01	-0.01	1847.85	0.04	0.03	5411.70	0.68	0.36	15848.93	-5.90	-6.06
199.53	0.00	0.00	681.29	0.00	-0.01	1995.26	0.05	0.04	5843.41	0.69	0.39	17113.28	-7.11	-7.21
251.19	0.00	0.00	735.64	0.00	-0.01	2154.43	0.07	0.05	6309.57	0.65	0.40	18478.50	-8.30	-8.42
271.23	0.00	-0.00	794.33	0.00	-0.01	2326.31	0.10	0.08	6812.92	0.60	0.40	19952.62	-9.65	-9.73
292.86	0.00	-0.00	857.70	0.00	-0.01	2511.89	0.12	0.09	7356.42	0.51	0.36			

Abraham Ortega 24OCT2012
Larson-Davis Model 9700 ES Microphone Calibration System

Appendix B: Data Used in Model

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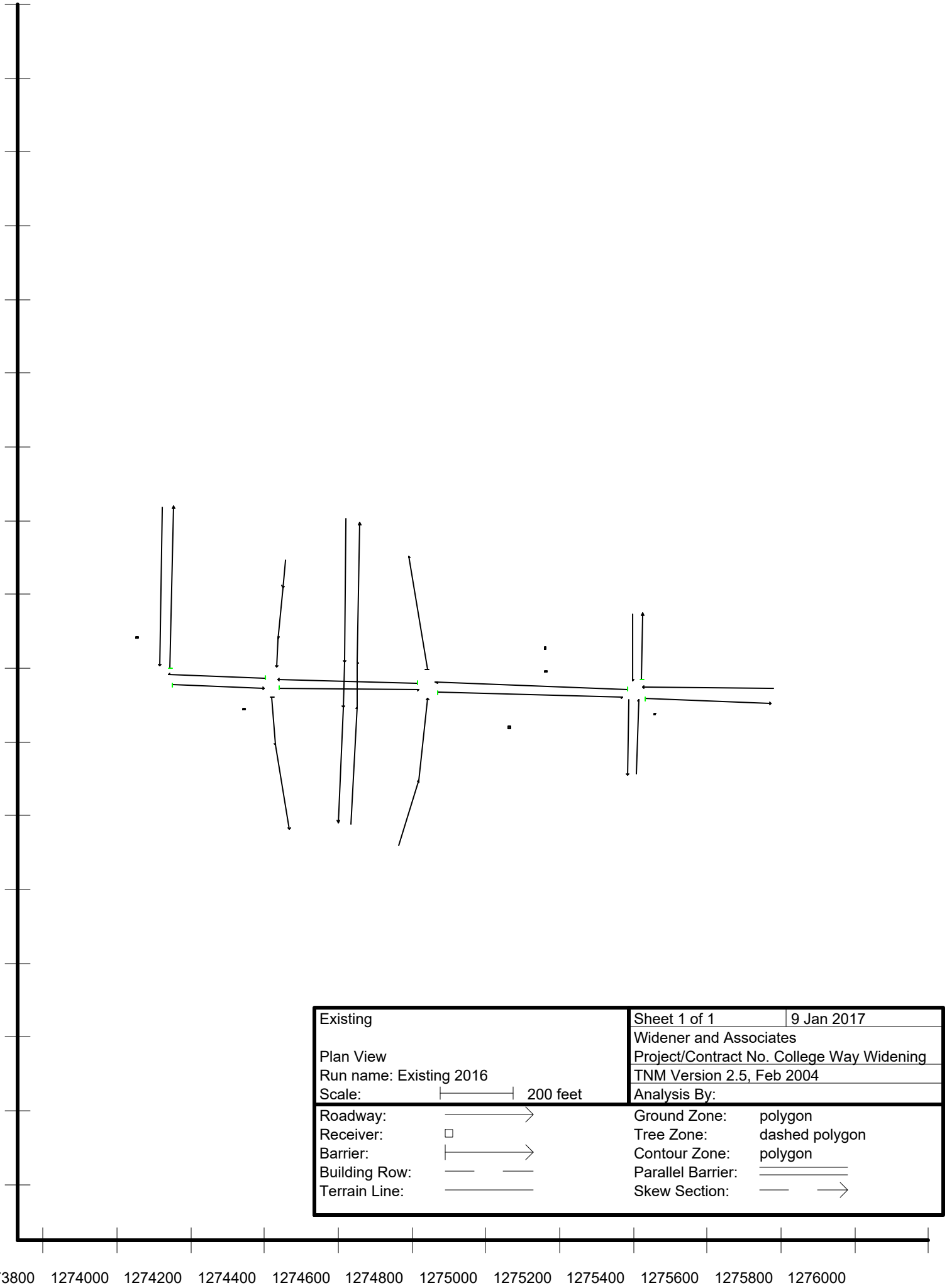
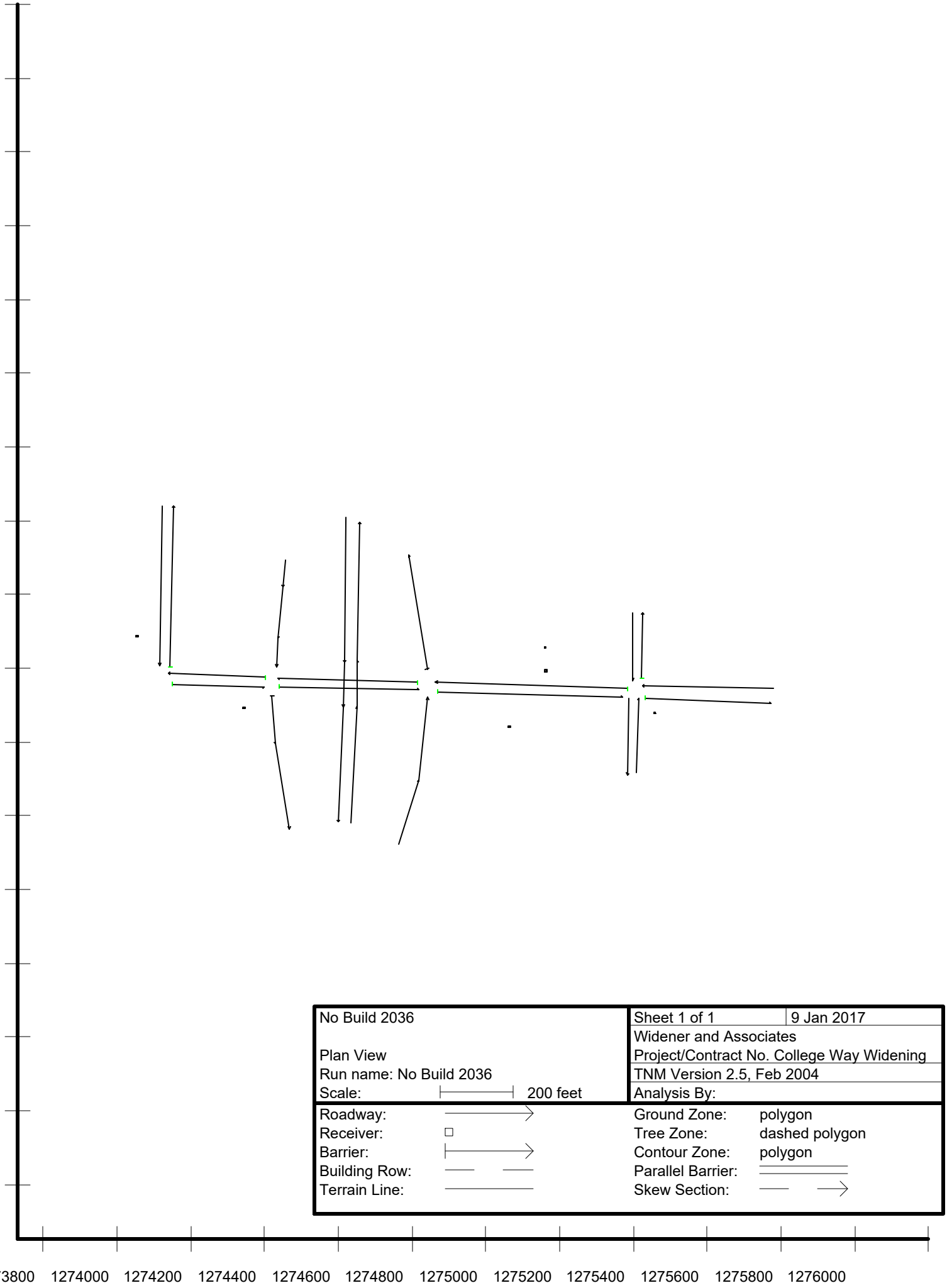
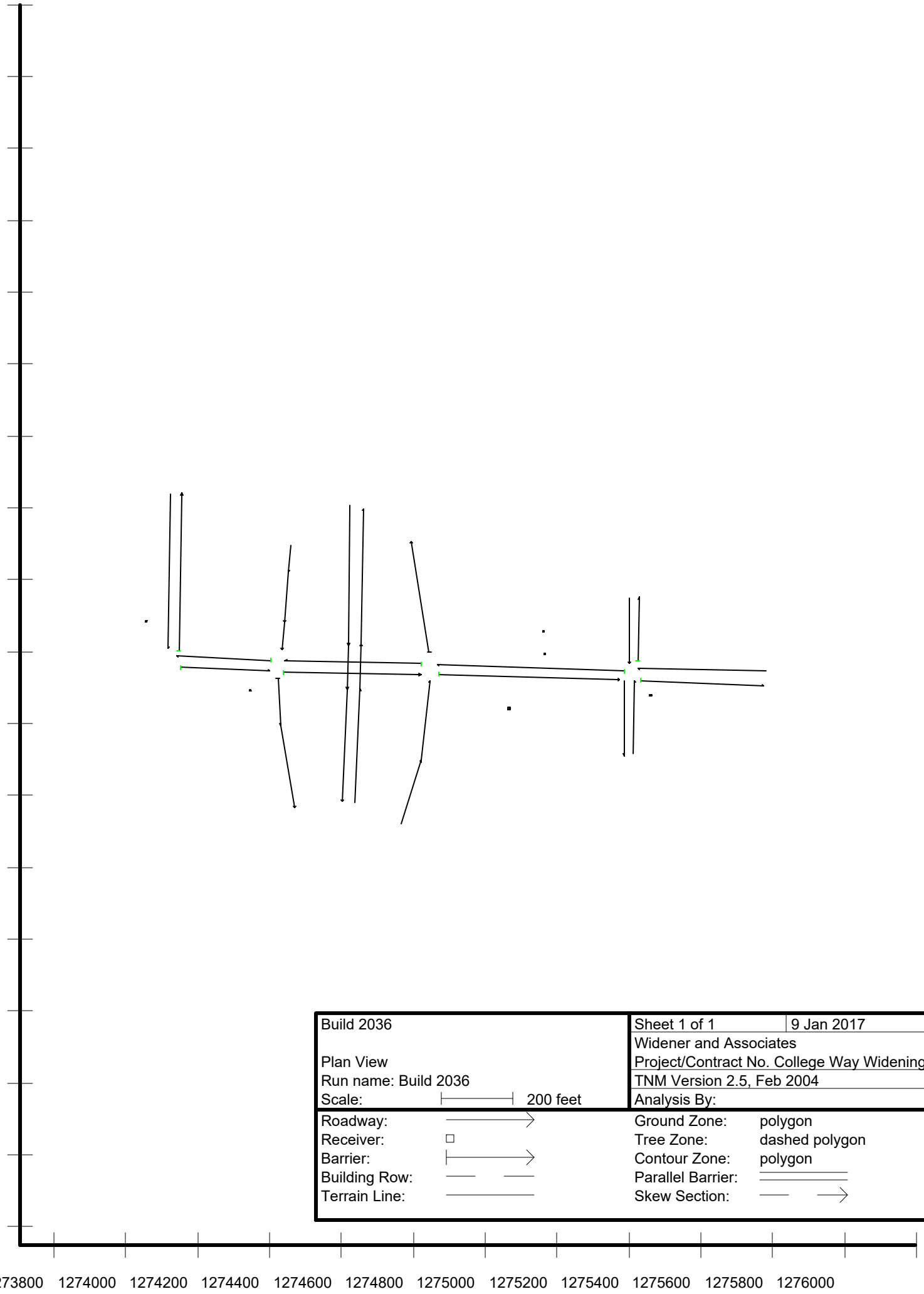

Existing
Plan View
Run name: Existing 2016
Scale:
200 feet
Sheet 1 of 1
9 Jan 2017
Widener and Associates
Project/Contract No. College Way Widening
TNM Version 2.5, Feb 2004
Analysis By:
Roadway:
Receiver:
Barrier:
Building Row:
Terrain Line:
Ground Zone: polygon
Tree Zone: dashed polygon
Contour Zone: polygon
Parallel Barrier:
Skew Section:
1273800
1274000
1274200
1274400
1274600
1274800
1275000
1275200
1275400
1275600
1275800
1276000

Existing

	Total	Cars	Heavy Trucks Perecentage	Heavy Trucks
College Way 1				
EB	955	926	3	29
WB	951	922	3	29
Freeway Drive				
NB	695	674	3	21
SB	780	757	3	23
College Way 2				
EB	1243	1206	3	37
WB	994	964	3	30
SB on-ramp	604	586	3	18
SB off-ramp	854	794	7	60
NB on-ramp	1050	977	7	74
NB off-ramp	674	627	7	47
College Way 3				
EB	1186	1150	3	36
WB	1540	1494	3	46
Market Street 1				
NB	634	615	3	19
SB	530	514	3	16
Market Street 2				
NB	381	370	3	11
SB	182	177	3	5
College Way 4				
EB	1043	1012	3	31
WB	1072	1040	3	32
I-5				
NB	2850	2651	7	200
SB	2850	2651	7	200



No Build 2036		Sheet 1 of 1	9 Jan 2017
		Widener and Associates	
Plan View		Project/Contract No. College Way Widening	
Run name: No Build 2036		TNM Version 2.5, Feb 2004	
Scale:	200 feet	Analysis By:	
Roadway:		Ground Zone:	polygon
Receiver:		Tree Zone:	dashed polygon
Barrier:		Contour Zone:	polygon
Building Row:		Parallel Barrier:	
Terrain Line:		Skew Section:	



Build 2036		Sheet 1 of 1	9 Jan 2017
		Widener and Associates	
Plan View		Project/Contract No. College Way Widening	
Run name: Build 2036		TNM Version 2.5, Feb 2004	
Scale:	200 feet	Analysis By:	
Roadway:		Ground Zone:	polygon
Receiver:		Tree Zone:	dashed polygon
Barrier:		Contour Zone:	polygon
Building Row:		Parallel Barrier:	
Terrain Line:		Skew Section:	

Build and No Build 2036

	Cars	Heavy Trucks
College Way 1		
EB	1130	32
WB	1126	32
Freeway Drive		
NB	823	23
SB	923	26
College Way 2		
EB	1471	41
WB	1176	33
SB on-ramp	715	20
SB off-ramp	969	66
NB on-ramp	1192	81
NB off-ramp	765	52
College Way 3		
EB	1404	39
WB	1823	51
Market Street 1		
NB	750	21
SB	627	18
Market Street 2		
NB	451	13
SB	215	6
College Way 4		
EB	1234	35
WB	1269	36
I-5		
NB	3234	220
SB	3234	220

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Appendix C: Sound Level Data Sheets

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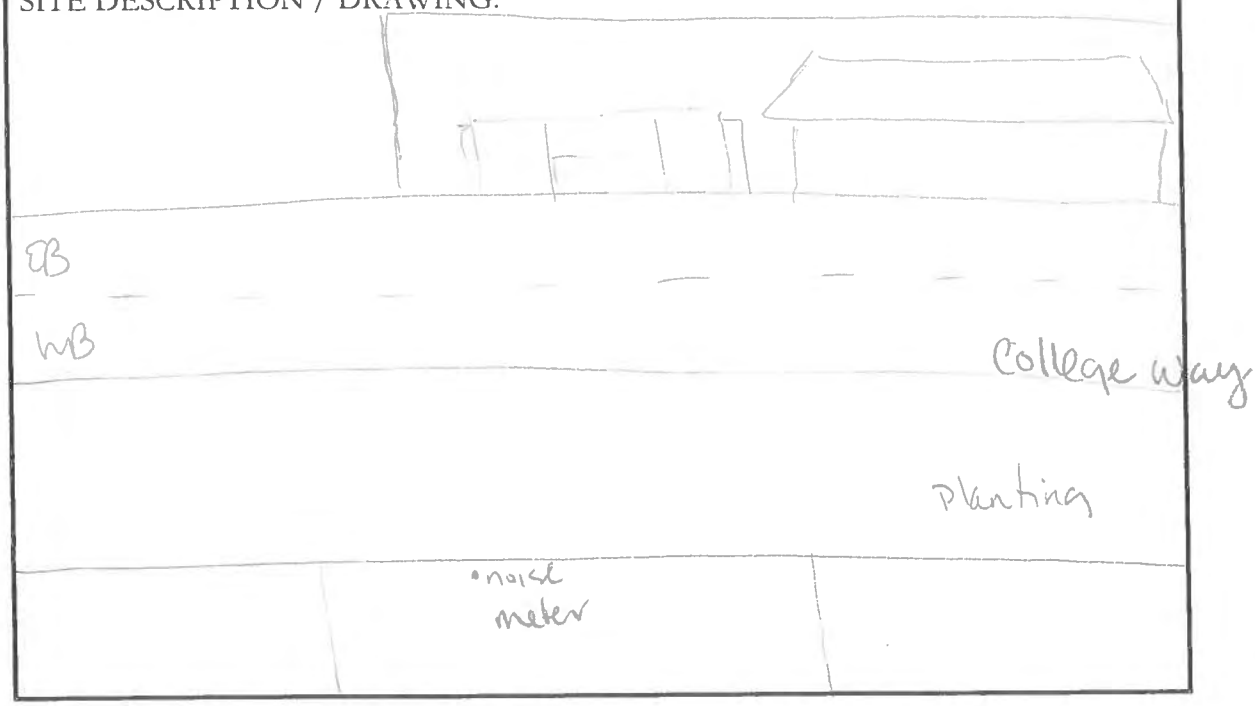
Sound Level Data Collection Sheet

DATE/TIME: 11/2 3:15pm	LOCATION: College Way
PROJECT NO.:	PERSONNEL: Christina Neff
SITE: 1	WIND SPEED: 5-10 mph WIND. DIR: SE
REL. HUMIDITY: 75	TEMP: Dry Bulb 56 Wet Bulb

EQUIPMENT MODEL:	SERIAL NO.:
CALIBRATION: Initial_____ Final_____	PROBLEMS:
DESCRIPTOR:	INTEGRATION RATE:
WEIGHTING:	SAMPLE RATE:

SITE DESCRIPTION / DRAWING:



SOUND LEVEL 1: 68.6	SOUND LEVEL 2:

NOTES:

Traffic Counts

College Way

Site Number: 1 Timing Number: 1

3.15pm

Direction of Traffic: EB

Temp:
Wind Speed:

Relative Humidity:
Wind Direction:
Distance for Timed Cars:

Heavy Trucks	Medium Trucks	Cars	Bus	Bikes	Timed Cars
1	1111	20 × ~~1111~~ ~~1111~~ 1 ~~1111~~ ~~1111~~			
	4	230			

Direction of Traffic:

Distance for Timed Cars:

Heavy Trucks	Medium Trucks	Cars	Bus	Bikes	Timed Cars
1	11	20 × ~~1111~~ ~~1111~~ 11 ~~1111~~ ~~1111~~ 111			
	2	253			