existing noise levels is considered a substantial increase. Therefore, at residential areas a traffic noise impact is defined as either of the following:

- an absolute peak-hour exterior noise level of 66 dBA; or
- a 10-dBA increase above peak-hour background levels.

2 METHOD OF ANALYSIS

This report has been prepared in accordance with Title 23 Code of Federal Regulations, Chapter 1, Subsection 772 (23 CFR 772), and additional guidance provided by WSDOT. The report was prepared using the same methodology used to prepare the noise impact analysis for the North Spokane Freeway Final Environmental Impact Statement (WSDOT 1997). The following method was used to evaluate potential noise impacts associated with the project:

- Existing activities, developed lands, and undeveloped lands for which development is planned, designed, or programmed and that may be affected by noise from the proposed highway were identified from field surveys and aerial photographs of the alignment corridor.

- Short-term (20-minute) sound level measurements typical of existing conditions were collected at selected representative locations throughout the project area and used to characterize the existing noise environment throughout the project corridor.

- Traffic noise levels were estimated using the FHWA Traffic Noise Model (TNM) Version 1.1.

- Traffic noise impacts were identified using the relative and absolute criteria specified in 23 CFR Part 772.

- Noise abatement measures for reducing or eliminating noise impacts were identified and considered using WSDOT guidelines for determining feasibility and reasonableness.

2.1 Assumed Traffic Conditions

The focus of the noise analysis is on the peak noise hour (afternoon rush) hour for the design year 2020, when the entire project would be completed. The primary reason for using this approach is that noise abatement measures, if needed, can be justified based on the worst-case buildout conditions.

Because the traffic volumes and roadway types vary within the NSC/US 2 interchange, segments of the freeway were analyzed separately. For each segment analyzed, each lane of traffic was individually delineated in the model. The proposed interchange would have two primary roadway types: at-grade (with receivers either at-grade or higher than the roadway), and elevated (viaduct or on fill). For at-grade segments the TNM ground type was set to "lawn" to simulate ground attenuation for acoustically soft ground. For elevated segments, the TNM ground type was set to "pavement" to reduce ground attenuation.

The original noise discipline report (Jones & Stokes 2000) described the portion of the NSC between Farwell Road and Garden Street as Segment 8. For this analysis Segment 8 was divided into sub-segments to evaluate noise impacts at key locations within the interchange. Traffic volume and speed data used as input to the noise prediction model were provided by WSDOT. Table 3 shows the peak-hour traffic volumes that were used.

Table 3. Peak-Hour Traffic Volumes

Freeway Sub-Segment	Peak-Hour Traffic Volume (vehicles/hour)
8A – West of Garden Street	Northbound – 1,895 Southbound – 963
8B – Garden Street to Shady Slope Road	Northbound – 1,895 Southbound – 661
8C – Shady Slope Road to Farwell Road	Northbound – 1,667 Southbound – 661
8D – South of Farwell Road	Northbound – 2,938 Southbound – 1,120
8H – Interchange ramps	NSC to US 2 – 1,271 US 2 to NSC – 1,136

A traffic speed of 60 miles per hour was assumed. The traffic noise model requires assumptions about the percentage of automobiles (two-axle, four-tire vehicles), medium trucks (two-axle, six-tire vehicles), and heavy trucks (three or more axles). The vehicle mix used in this analysis was the same as that used for the North Spokane Freeway Environmental Impact Statement noise impact analysis (WSDOT 1997):

- automobiles – 87.3%;
- medium trucks – 7.6%; and
- heavy trucks – 5.1%.

Traffic noise levels were modeled using the FHWA TNM Version 1.1. The TNM model estimates acoustic intensity at receiver locations based on the level of sound energy generated from a series of interconnected straight-line roadway segments.

2.2 Baseline Noise Monitoring

Baseline noise monitoring was conducted throughout the project area in September 1999 to quantify existing noise conditions at representative residential locations near the interchange.

Ambient noise monitoring was conducted using Larson-Davis Model 700 and 812 sound-level meters. The instruments fully comply with the American National Standards Institute (ANSI) standard S1.4-1983 for Type 2 (Model 700, general purpose) and Type 1 (Model 812, precision purpose). Instrument calibration was verified with a Larson-Davis acoustic calibrator before

each measurement session. At each monitoring position, the meter was held by a tripod that placed it approximately 1.5 meters (5 feet) above the supporting surface.

Short-term (20-minute) noise monitoring was conducted at the locations shown in Figure 1. Noise monitoring was conducted for approximately 20 minutes at each location. The monitoring results are summarized in Table 4. Note that the noise readings at the interchange were taken during mid-afternoon rather than during either the morning or evening rush hours. Therefore, it is likely that the measured noise levels are lower than the peak-hour levels.

Table 4. Summary of Noise Monitoring Results Near NSC/US 2 Interchange

Test Number and Position	Land Use in Vicinity of Test Location	Date	Start Time	Interval Leq
31. Free United Methodist Church (between Farwell and US 2)	single-family residential, church	9/15/99	9:45 a.m.	53.6
32. Center/Cherry	single-family residential	9/15/99	10:15 a.m.	51.3
33. Lacy/Wilkinson Court	single-family residential	9/15/99	10:30 a.m.	61.4
34. Pittsburgh/Garden	single-family residential	9/15/99	11:00 a.m.	47.9
35. Garden (midblock)	single-family residential	9/15/99	11:15 a.m.	44.7
36. Carlson Court (east end of cul-de-sac)	single-family residential	9/16/99	10:00 a.m.	51.4
37. Crestline (75 feet from Farwell)	single-family residential, school	9/16/99	10:30 a.m.	54.1
38. Crestline/Center	single-family residential, school	9/16/99	11:00 a.m.	46.0
39. Center/Perry	single-family residential	9/16/99	11:20 a.m.	43.8
40. Center/Pittsburgh	single-family residential, school	9/16/99	11:40 a.m.	45.3
41. Pittsburgh/Winger	single-family residential	9/16/99	12:00 p.m.	45.0
42. Winger (500 feet west of Shady Slope)	single-family residential	9/16/99	12:30 p.m.	47.9
43. Winger (just east of Crestline)	single-family residential	9/16/99	1:00 p.m.	43.1
44. Shady Slope/Center (just north of Center)	single-family residential, open space	9/16/99	1:20 p.m.	52.8

2.3 Modeling Limitations

The TNM model uses simplified assumptions for sound propagation. While some allowance is possible for the type of ground cover, the shielding effects of scattered houses and other obstructions that are not aligned in rows parallel to the highway cannot be directly modeled in the program. These effects are estimated and the resulting noise levels adjusted through the use of a shielding factor. While this technique has proven effective for locations close to the

roadway, noise level predictions beyond approximately 250 meters (820 feet) have an increasing margin of error. For this reason, no attempt is made to predict noise levels beyond 250 meters (820 feet).

3 OPERATIONAL IMPACTS

The focus of the impact analysis is on the afternoon peak-hour traffic flows for the design year 2020 when the entire project would be completed. Under this approach, noise abatement measures, if needed, can be justified based on the conditions that would occur with completion of the entire project.

To determine if predicted noise levels associated with the project would be 10 dBA or more greater than existing levels (a substantial increase according to WSDOT criteria), both modeled noise levels and noise monitoring results are used to characterize existing levels throughout the project corridor. For example, the measured baseline noise level at monitoring site 44 at the Shady Slope Road neighborhood was 52.8 dBA. Future traffic noise levels at the Shady Slope neighborhood exceeding 62.8 dBA (52.8 plus 10) are considered a substantial increase.

Table 5 and Figure 2 summarize the results of the noise impact analysis for the NSC/US 2 interchange. The analysis addresses individual segments within the alignment, the type of roadway, and the distance to the 66-dBA impact limits and "substantial increase" levels for both sides of the roadway. Figure 2 shows the approximate distances to the 66-dBA contour and the "10-dBA substantial increase" contour without construction of any special noise walls, but accounting for natural noise attenuation from roadway embankments. Table 5 summarizes the number of residences potentially affected by predicted traffic noise levels that approach or exceed the noise abatement criteria or by a substantial increase in traffic noise resulting from the proposed project. The evaluation of the number of impacted residences was done by inspecting aerial photographs with ground surveys to determine which identified structures were houses.

3.1 Sub-Segments 8C/8H (Shady Slope Neighborhood)

As shown in Figure 1, a residential neighborhood is on the northeast side of the NSC between Shady Slope Road and US 2. This neighborhood could be affected by noise from the elevated section of the NSC overpass and the proposed new connecting ramp between westbound US 2 and southbound NSC. The proposed connecting ramp passes close to existing homes. The eastern half of the connecting ramp is in a depressed roadway that provides a natural noise barrier, but the western half of the ramp is either at grade or on an elevated ramp. Without construction of special noise walls the neighborhood would be partially shielded by two roadway embankments: the Shady Slope Road overpass, and the sidewall of the depressed roadway on the east end of the connecting ramp.