Appendix I:
Noise Study Report

Noise Study Report
H Cycle Pittsburg Renewable Hydrogen Project

Pittsburg, CA

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1. Introduction

The following Noise Study Report has been prepared by TRC for the H Cycle Renewable Hydrogen Project proposed by HC (Contra Costa) in Pittsburg, California. Although there are no state, county, or local noise ordinance limits applicable to the facility, the results of the Noise Study presented herein demonstrate that the predicted sound levels during the construction and operation of the facility will be well below the level deemed acceptable for an industrial land use in the State of California and the City of Pittsburg, and that the facility will not cause a perceptible increase in the sound levels at any nearby noise sensitive areas during construction or operation.

1.1 Proposed Facilities

H Cycle is proposing a renewable hydrogen facility in northeastern Pittsburg, CA. The proposed facility location is an approximately 12-acre site in a General Industrial zone on a former Dow Chemical property now operated by Corteva Agrisciences. The site is bounded by a railroad easement to the south, industrial properties to the west, additional industrial property and the San Joaquin River beyond to the north, and vacant land to the east. The facility will include a variety of sound-producing equipment, including pumps, dryers, compressors, cooling fans, generators, and a ground flare system. During construction, an additional 12 acres will be used as construction laydown yards.

2. Concepts of Environmental Sound

Sounds are generated by a variety of sources (e.g., a musical instrument, a voice speaking, or an airplane that passes overhead). Energy is required to produce sound and this sound energy is transmitted through the air in the form of sound waves – tiny, quick oscillations of pressure just above and just below atmospheric pressure. These oscillations, or sound pressures, impinge on the ear, creating the sound we hear. The range of sound pressures that can be detected by a person with normal hearing is very wide, ranging from about 20 micro-pascals (μPa) for very faint sounds at the threshold of hearing to nearly 10 million μPa for extremely loud sounds, such as a jet during take-off at a distance of 300 feet. Because the range of human hearing is so wide, sound levels are reported using "sound pressure levels", which are expressed in terms of decibels. The sound pressure level in decibels is the logarithm of the ratio of the sound pressure of the source to the reference sound pressure of 20 μPa, multiplied by 20.

Table 2.1 provides some examples of common sources of sound and their sound pressure levels. All sound levels in this assessment are provided in A-weighted decibels, abbreviated "dB(A)" or "dBA." The A-weighted sound level reflects how the human ear responds to sound, by deemphasizing sounds that occur in frequencies at which the human ear is least sensitive to sound (at frequencies below about 100 hertz and above 10,000 hertz) and emphasizing sounds that occur in frequencies at which the human ear is most sensitive to sound (in the mid-frequency range from about 200 to 8,000 hertz). In the context of environmental sound, noise is defined as "unwanted sound."

Table 2.1 Examples of Common Sound Pressure Levels

Sound Level dB(A)	Common Indoor Sounds	Common Outdoor Sounds
110	Rock Band	Jet Takeoff at 1000 feet
100	Inside NYC Subway Train	Chain Saw at 3 feet
90	Food Blender at 3 feet	Impact Hammer (Hoe Ram) at 50 feet
80	Garbage Disposal at 3 feet	Diesel Truck at 50 feet
70	Vacuum Cleaner at 10 feet	Lawn Mower at 100 feet
60	Normal Speech at 3 feet	Auto (40 mph) at 100 feet
50	Dishwasher in Next Room	Busy Suburban Area at night
40	Empty Conference Room	Quiet Suburban Area at night
25	Empty Concert Hall	Rural Area at night

Sound pressure levels are typically presented in community noise assessments utilizing the noise metrics described below and expressed in terms of A-weighted decibels.

- "L_{10}" is the sound level that is exceeded for 10 percent of the time. This metric is a measure of the intrusiveness of relatively short-duration noise events that occurred during the measurement period.
- "L_{50}" is the sound level that is exceeded for 50 percent of the measurement period.
- "L_{90}" is the sound level that is exceeded for 90 percent of the time and is a measure of the background or residual sound levels in the absence of recurring noise events.
- "L_{eq}" is the is the constant sound level which would contain the same acoustic energy as the varying sound levels during the time period and is representative of the average noise exposure level for that time period.
- "L_{MAX}" is the instantaneous maximum sound level for the time period.

It is often necessary to combine the sound pressure levels from one or more sources. Because decibels are logarithmic quantities, it is not possible to simply add the values of the sound pressure levels together. For example, if two sound sources each produce 70 dB and they are operated together, their combined impact is 73 dB – not 140 dB as might be expected. Four equal 70 dB sources operating simultaneously result in a total sound pressure level of 76 dB. In fact, for every doubling of the number of equal sources, the sound pressure level goes up another three decibels. A tenfold increase in the number of sources makes the sound pressure level increase by 10 dB, while a hundredfold increase makes the level increase by 20 dB. The logarithmic combination of *n* different sound levels is calculated by the following equation:

$$L_{total}=10*\log_{10}\left(10^{\frac{L_1}{10}} + 10^{\frac{L_2}{10}} +\ldots+10^{\frac{L_n}{10}}\right)$$

Perceived changes in sound level can be slightly more subjective; the average person will not notice a change of 1-2 dB, a 3 dB increase is just barely perceptible, while a 5 dB change is clearly noticeable.

3. Noise Sensitive Areas

The facility is being proposed on an industrial property far removed from any noise sensitive areas (NSAs) such as residences, schools, or hospitals. Table 3.1 lists the closest NSAs and their approximate distance and direction from the proposed H Cycle facility. These locations are also shown in Figure 3, Noise Sensitive Area Locations.

Table 3.1 Closest Noise Sensitive Areas

NSA	Description	Approximate Distance from H Cycle Facility to NSA, feet	Direction to NSA
1	Hotel	7,500	SW
2	Residence	4,800	SW
3	Residence	5,000	SE
4	Church	5,000	SE

4. Short Term Ambient Sound Survey

A pre-construction ambient sound survey was completed at the proposed facility property on September 19th and 20th, 2023 to characterize the existing sound environment (I.e., background) in the project area. Short term sound level measurements were taken at the site property lines and within the gated property for approximately ten minutes at each location during multiple time periods.

The measurements were taken using a Larson Davis Model 831C sound level meter that meets the requirements of the American National Standards Institute (ANSI) Standards for Type I instruments. The sound level meter was calibrated before and after each monitoring period using a CAL200 acoustic calibrator. The microphone was positioned according to the ANSI Standard on a tripod 1.5 meters above ground. 7.5 meters from large reflecting surfaces, and at least 1.5 meters from tall trees.

Ambient sound level measurements were conducted on a weekday on a non-holiday week at 6 total measurement points and for a minimum of ten continuous minutes for each criterion. At the first two measuring points, data was collected in the morning (6 AM – 8 AM), afternoon (12 PM – 2 PM), and evening (5 PM – 7 PM). Four other points were collected within the gates of the property in the morning (8 AM-10 AM).

The following measurement criteria are provided in Tables 5.1-5.4 for each measurement location and for each measurement period:

- LA_{EQ}, LC_{EQ}, LA_{10}, LA_{50}, and LA_{90}
- Unweighted octave-band analysis (16, 31.5, 63, 125, 250, 500, 1K, 2K, 4K, 8K Hz)

The measurement points are listed below:

- MP-1: South side of property, outside gates
- MP-2: East side of property, outside gates
- MP-3: Northeast side of property.
- MP-4: Northwest side of property.
- MP-5: Center of property closer to the west.
- MP-6: Southwest side of property.

The proposed Project site layout, showing the location of the measurement points, is shown on Figure 1.

5. Short Term Sound Monitoring Results

Table 5.1 Noise Monitoring Results Summary Day 1

September 19, 2023					
Site ID	LA_{EQ}	LC_{EQ}	LA_{10}	LA_{50}	LA_{90}
Morning (6 AM – 8 AM)					
MP-1	52.1	68.7	53.5	51.7	50.7
MP-2	52.1	62.1	53.1	51.9	50.7
Afternoon (12 PM – 2 PM)					
MP-1	70.1	76.0	57.2	49.6	47.9
MP-2	52.0	71.3	53.5	47.9	46.2
Evening (5PM – 7PM)					
MP-1	77.3	80.4	55.0	48.6	47.2
MP-2	55.9	69.1	53.8	47.4	45.7

Table 5.2 Noise Monitoring Results Summary Day 2

September 20, 2023					
Site ID	LA_{EQ}	LC_{EQ}	LA_{10}	LA_{50}	LA_{90}
Morning (8AM – 10 AM)					
MP-3	47.4	66.2	48.1	47.1	46.5
MP-4	47.8	47.8	48.9	46.6	45.8
MP-5	48.9	61.1	50.1	48.7	48.7
MP-6	59.2	66.2	59.7	58.0	57.6

Table 5.3 Octave Band Analysis Summary Day 1

September 19, 2023										
Site ID	Octave Band Center Frequency (Hz)									
	16	31.5	63	125	250	500	1000	2000	4000	8000
Morning (6 AM – 8 AM)										
MP-1	50.6	52.7	53.8	49.4	47.4	42.6	43.8	30.3	26.3	24.9
MP-2	60.7	57.0	55.9	50.9	46.3	40.4	114.0	67.4	31.8	22.7
Afternoon (12 PM – 2 PM)										
MP-1	52.1	52.9	56.3	49.3	38.9	29.8	113.9	67.8	31.8	22.8
MP-2	80.9	77.2	75.0	65.6	59.4	57.4	113.9	67.4	31.3	22.7
Evening (5PM – 7PM)										
MP-1	51.8	51.3	48.9	56.0	47.8	43.5	114.1	67.9	31.8	23.1
MP-2	73.6	66.5	58.8	49.3	54.4	56.3	113.9	67.4	31.5	22.8

Table 5.4 Octave Band Analysis Summary Day 2

September 20, 2023										
Site ID	Octave Band Center Frequency (Hz)									
	16	31.5	63	125	250	500	1000	2000	4000	8000
Morning (8AM – 10 AM)										
MP-3	68.2	61.2	56.9	47.7	47.3	52.9	114.2	67.6	32.0	23.3
MP-4	102.5	70.9	53.5	47.3	57.0	52.7	49.3	32.2	28.3	30.9
MP-5	71.8	69.3	63.7	55.4	46.6	36.6	113.9	67.3	31.7	22.9
MP-6	58.7	50.6	49.6	51.9	52.8	50.7	114.0	67.4	31.7	22.7

Using the data measured in the short-term monitoring, a summary of the ambient noise measurements was created for each of the NSAs (Tables 5.5 and 5.6). In the table, the closest measuring point is listed for each NSA, and calculations for the daytime (Ld), nighttime (Ln), and combined day and night (Ldn) were completed.

Table 5.5 Ambient Noise Measurements Summary

NSA*	Measured Levels Period Average, dBA Leq		
	Day Ld	Night Ln	Day-Night Ldn
1	59.2	55.9	65.9
2	52.1	77.3	87.3
3	52.1	77.3	87.3
4	52.1	55.9	65.9

*Data is from the closest measuring point to each NSA

During the ambient noise measurements, staff took note of other noises that could be heard in the background. A summary of all of the background noise sources is provided in Table 5.6.

Table 5.6 Background Noise Measurements Summary

Morning (6 AM – 8 AM)	
MP-1	• Access gate opening • Trucks entering gate
MP-2	• Truck reversing (beeping)
Afternoon (12 PM – 2 PM)	
MP-1	• Access gate opening • Trucks entering gate • Train
MP-2	• Train Horn
Evening (5 PM – 7 PM)	
MP-1	• Train
MP-2	• Train • Train horns
Morning (8 AM – 10 AM)	
MP-3	• Pump nearby ticking
MP-4	• Train
MP-5	• Alarms heard from property on the West
MP-6	• Train • Car passing

6. Construction Noise Modeling

Short-term increases in sound levels could occur during construction. Standard construction equipment will be used in the construction of the facility, with a pile driver being used during certain aspects of the construction. However, weather conditions, site conditions, specialized construction techniques, emergencies, or other atypical circumstances may necessitate nighttime work or extended work on Sundays. To be conservative in the construction noise calculations, the loudest twenty pieces of Project construction equipment was included in the noise model as operating at the same time. The highest sound levels during construction are expected during the early earthmoving phase. Equipment that may be used during this phase would include bulldozers, excavators, graders, and 35-ton offroad trucks. Based on the Project equipment usage predictions, a sound level calculation was performed using the Federal Highway Administration's Roadway Construction Noise Model version 1.1 (FHWA, 2006).

H Cycle utilized the construction equipment listed below:

- Pile Driver
- Cranes
- Forklift s
- Excavators
- Loader/Backhoes
- Payloaders
- Graders
- Rollers
- Trucks (flatbed, dump, etc)
- Lifts

Table 6.1 summarizes the results of the construction noise modeling.

Table 6.1 Sound Level Increases During Construction

	Measured Existing Ambient Sound Levels, dBA	Predicted Sound Level - Single Daytime Shift	Construction Plus Ambient	Temporary Increase in Sound Level, dB
NSA	Day (Ld)	Day (Ld)	Day (Ld)	Day (Ld)
1	59.2	57.7	61.5	2.3
2	52.1	60.3	60.9	8.8
3	52.1	60.8	61.3	9.2
4	52.1	60.3	60.9	8.8

As shown above, the RCNM model predicts that there will be significant temporary increases in sound levels at the closest nearby NSAs during Project construction activities. Again, this model is assuming all equipment is operating at the same time and that will be temporary and only during daytime construction hours.

7. Operational Noise Impacts

This section describes the methods, assumptions, and results of the Cadna-A® noise modeling used to predict future sound levels during operation of the proposed renewable hydrogen production facility.

7.1 Noise Model Inputs

Noise modeling was conducted to predict future sound levels at the nearby NSAs during facility operation, both with and without the gas flare in operation. The Cadna-A model was used for this purpose. An industry standard, Cadna-A was developed by DataKustik GmbH to provide an estimate of sound levels at distances from sources taking into account sound power levels from stationary and mobile sources, the effects of terrain features including relative elevations of noise sources, intervening objects including buildings and sound barrier walls, and ground effects due to pavement and unpaved ground.

The International Standards Organization current standard for outdoor sound propagation (ISO 9613 Part 2 – "Attenuation of sound during propagation outdoors") was used within Cadna-A. This standard provides a method for calculating environmental noise in communities from a variety of sources with known emission levels. The method contained within the standard calculates the attenuation over the entire sound path under weather conditions that are favorable for sound propagation, such as for downwind propagation or "under a well-developed ground-based temperature inversion." Application of conditions that are favorable for sound propagation yields conservative estimates of operational noise levels in the surrounding area.

The site layout and existing topography was used to create a terrain model that represents the topography during facility operation. The inputs to the model are 2-foot contours, based on United States Geographic Survey ("USGS") 3DEP topographic data. The model conservatively assumed continuous operation of all sound sources. A search radius of 8,000 feet from each receptor was used in the model to ensure that all noise sources contributing to the predicted facility noise levels were modeled at every NSA.

Table 7.1 lists the source octave band sound power levels for the proposed equipment. Table 7.2 lists overall sound power levels for individual area and point sources modeled across the site, using the "Other Equipment" octave band profile, scaled as necessary. Separate modeling cases were considered with the gas flare active and inactive. All other equipment is assumed to be continuously operating.

Table 7.1 Equipment Octave Band Sound Power Levels

Component	Octave Band Center Frequency (Hz)									Total	
	31.5	63	125	250	500	1000	2000	4000	8000	dB	dBA
Gas Flare[1]	-	97.5	91.6	106.1	108.5	104.7	108.9	109.7	-	124.8	115.0
Other Equipment[2]	-	82.5	86.0	83.8	81.1	79.4	77.4	74.5	72.5	90.5	85.0

[1]Based on client provided specification of 115 dBA using typical gas flare octave band profile.
[2]Based on client provided specification of 85 dBA using cooling fan octave band profile.

Table 7.2 Equipment Sound Power Levels

Component	Type	Height (ft. AGL)	Total dBA
OMNI Package[1]	Area	3.28	96.0
Switchgear Yard[2]	Area	3.28	74.0
BMH Package[3]	Area	3.28	94.7
Hydrogen Offtake Area[4]	Area	3.28	75.0
VPSA[4]	Area	3.28	75.0
Dryer[4]	Area	23.0	85.0
Sulfur Removal[4]	Area	3.28	75.0
Cooling Tower	Point	30.0	85.0
Gas Flare	Point	65.0	115.0
Other Equipment (pumps, compressors, mixers, conveyors)	Point	3.28	75-87

[1]Based on manufacturer specification of 85 dBA at 1m from package boundary
[2]Based on client provided specification of 74 dBA
[3]Based on manufacturer specification of 77.7 dBA at 2m
[4]Based on client provided specification of 75dBA at package boundary

7.2 Noise Model Results

Tables 7.3 and 7.4 summarize the predicted operational sound levels at each of the monitoring points and NSA locations, the total predicted sound levels at each location, and the predicted increase in the sound level at each location.

Table 7.3 Operational Noise Modeling Results – Gas Flare Active (dBA)

NSA	Existing	Modeled	Total	Increase
1	59.2	26.6	59.2	< 0.1
2	52.1	27.5	52.1	< 0.1
3	52.1	27.4	52.1	< 0.1
4	52.1	26.9	52.1	< 0.1
MP	Existing	Modeled	Total	Increase
1	52.1	47.8	53.5	1.4
2	52.1	51.3	54.7	2.6
3	47.4	59.5	59.8	12.4
4	47.8	64.8	64.9	17.1
5	48.9	59.6	60.0	11.1
6	59.2	63.7	65.0	5.8

Table 7.4 Operational Noise Modeling Results – Gas Flare Inactive (dBA)

NSA	Existing	Modeled	Total	Increase
1	59.2	7.2	59.2	< 0.1
2	52.1	12.3	52.1	< 0.1
3	52.1	12.6	52.1	< 0.1
4	52.1	11.6	52.1	< 0.1
MP	Existing	Modeled	Total	Increase
1	52.1	39.8	52.3	0.2
2	52.1	43.8	52.7	0.6
3	47.4	48.9	51.2	3.8
4	47.8	43.9	49.3	1.5
5	48.9	52.1	53.8	4.9
6	59.2	63.4	64.8	5.6

As shown on Tables 7.3 and 7.4, the results of the noise modeling conducted predict that there will be imperceptible increases in the sound levels at the closest nearby NSAs and at the property line during facility operation when the gas flare is inactive. When the gas flare is active, there will be imperceptible increases in the sound levels at the nearby NSAs but perceptible increases in the sound levels at some property line locations. However, according to the State of California General Plan Guidelines, which have been adopted by the City of Pittsburg, an Ldn sound level of 75 dBA or less is considered acceptable for an industrial land use, and the predicted sound levels at the facility property line during operation with the flare both active and inactive will still be well below that level, and thus maintain sound levels deemed acceptable for an industrial land use.

8. Noise Mitigation

Construction will generally occur during daylight hours, which will significantly mitigate noise impacts to neighbors. All contractors will be required to utilize sound control devices no less effective than those provided by the manufacturer and maintain equipment in accordance with manufacturer's recommendations. No equipment will have unmuffled exhausts and equipment idling will be kept to a minimum.

Operational sound levels will cause minimal (<1 dBA) noise level increases at the closest NSA locations due primarily to the distance from the facility sound sources to the NSAs. Furthermore, the predicted sound level increases over the current sound levels at the property line during normal facility operation (gas flare inactive) will be imperceptible, and the sound levels at the property line during facility operation at all times will be well below the level deemed acceptable for an industrial use by the State of California and the City of Pittsburg. Therefore, no additional sound mitigation is expected to be necessary during facility operation.