AIR QUALITY STUDY

APPENDIX F

AIR QUALITY STUDY

FOR THE PROPOSED

HOKUAO 201H HOUSING PROJECT

LANAI CITY, LANAI, HAWAII

Prepared for:

Pulama Lanai

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1.0 SUMMARY

Pulama Lanai is proposing the Hokuao 201H Housing Project on Lanai. The proposed project will include 200 single-family residential units, one-acre park, pavilion, comfort station and 100 parking stalls. This study examines the potential short- and long-term air quality impacts that could occur as a result of construction and use of the proposed development and suggests mitigation measures to reduce any potential air quality impacts where possible and appropriate. Potential impacts on the proposed development from a nearby wastewater treatment facility are also evaluated.

Both federal and state standards have been established to maintain ambient air quality. At the present time, seven parameters are regulated including: particulate matter, sulfur dioxide, hydrogen sulfide, nitrogen dioxide, carbon monoxide, ozone and lead. Hawaii air quality standards are generally comparable to the national standards although the state standards for carbon monoxide are more stringent than the national standards.

Regional and local climate together with the amount and type of human activity generally dictate the air quality of a given location. The climate of the project area is very much affected by its higher elevation. Good ventilation is received much of the time by the prevailing trade winds. Temperatures in the project area are generally very consistent and moderately cool for Hawaii due to the higher elevation. Average daily temperatures range from about 62°F to 75°F. Rainfall in the project area is moderately dry with an average of about 35 inches per year.

Except for occasional impacts from volcanic emissions (vog), the present air quality of the project area is believed to be relatively good. There is no air quality monitoring data from the Department of Health for the project area, but given the lack of air pollution sources nearby and the absence of much motor vehicle traffic, it is probable that any air pollution concentrations are well within state and national air quality standards (as is true at most other locations in the state).

If the proposed project is given the necessary approvals to proceed, it may be inevitable that some short- and/or long-term impacts on air quality will occur either directly or indirectly as a consequence of project construction and use. Short-term impacts from fugitive dust will likely occur during the project construction phases. To a lesser extent, exhaust emissions from stationary and mobile construction equipment, from the disruption of traffic, and from workers' vehicles may also affect air quality during the period of construction. State air pollution control regulations require that there be no visible fugitive dust emissions at the property line. Hence, an effective dust control plan must be implemented to ensure compliance with state regulations. Fugitive dust emissions can be controlled to a large extent by watering of active work areas, using wind screens, keeping adjacent paved roads clean, and by covering of open-bodied trucks. Other dust control measures could include limiting the area that can be disturbed at any given time and/or mulching or chemically stabilizing inactive areas that have been worked. Paving and landscaping of project areas early in the construction schedule will also reduce dust emissions. Exhaust emissions can be mitigated by moving construction equipment and workers to and from the project site during off-peak traffic hours.

After construction, motor vehicles coming to and from the proposed development will result in a long-term increase in air pollution emissions in the project area. To assess the impact of emissions from these vehicles, a computer modeling study was undertaken to estimate current ambient concentrations of carbon monoxide at intersections in the project vicinity and to predict future levels both with and without the proposed project. During worst-case conditions, model results indicated that present 1-hour and 8-hour carbon monoxide concentrations are well within both the state and the national ambient air quality standards. In the year 2026 without the project, carbon monoxide concentrations were predicted to remain unchanged. With the project in the year 2026 after full build-out, carbon monoxide concentrations compared to the without-project case were projected to remain nearly unchanged or increase very slightly, and worst-case concentrations should remain well within air quality standards. Project-related traffic should have no measurable impact on air quality in the project area. Implementing any mitigation measures for traffic-related air quality impacts is probably unnecessary and unwarranted.

Depending on the demand levels, long-term impacts on air quality are also possible due to indirect (offsite) emissions associated with a development's electrical power and solid waste disposal requirements. Quantitative estimates of these potential impacts were not made, but based on the estimated demand levels and emission rates involved, any significant impacts are unlikely. Nevertheless, incorporating energy conservation design features and promoting conservation and recycling programs within the proposed development could serve to further reduce any associated impacts and conserve the island's resources.

Potential impacts on the proposed development from the nearby county wastewater treatment facility were also investigated. The existing conditions indicate that offsite nuisance odor from this facility is probably not an issue. However, it may be prudent for the proposed residential development to maintain a buffer distance of at least 300 to 600 feet so as to avoid any future onsite odor nuisance.

2.0 INTRODUCTION AND PROJECT DESCRIPTION

Pulama Lanai is proposing to develop the Hokuao 201H Housing Project on the island of Lanai. The proposed development will be located adjacent to Lanai City on the west (see Figure 1). The project site is bordered by Fraser Avenue to the east, 12th Street to the south, the County Department of Public Works office and existing wastewater treatment plant to the west, and 9th Street to the north. The proposed residential development includes 200 single-family units, one-acre park, pavilion, comfort station and 100 parking stalls. Access to the project by vehicular traffic will be provided along Fraser Avenue at 9th Street and at 12th Street. It is anticipated that the project will be completed by the year 2026.

The purpose of this study was to evaluate the potential air quality impacts of the proposed project and recommend mitigative measures, if possible and appropriate, to reduce or eliminate any project-related degradation of air quality in the area. Potential impacts on the project from the nearby county wastewater treatment plant were also investigated. Before examining the potential impacts of the project, a discussion of ambient air quality standards is presented and background information concerning the regional and local climatology and the present air quality of the project area is provided.

3.0 AMBIENT AIR QUALITY STANDARDS

Ambient concentrations of air pollution are regulated by both national and state ambient air quality standards (AAQS). National AAQS are specified in Section 40, Part 50 of the Code of Federal Regulations (CFR), while State of Hawaii AAQS are defined in Chapter 11-59 of the Hawaii Administrative Rules. Table 1 summarizes both the national and the state AAQS that are specified in the cited documents. As indicated in the table, national and state AAQS have been established for particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone and lead. The state has also set a standard for hydrogen sulfide. National AAQS are stated in terms of both primary and secondary standards for most of the regulated air pollutants. National primary standards are designed to protect the public health with an "adequate margin of safety". National secondary standards, on the other hand, define levels of air quality necessary to protect the public welfare from "any known or anticipated adverse effects of a pollutant". Secondary public welfare impacts may include such effects as decreased visibility, diminished comfort levels, or other potential injury to the natural or man-made environment, e.g., soiling of materials, damage to vegetation or other economic damage. In contrast to the national AAQS, Hawaii State AAQS are given in terms of a single standard that is designed "to protect public health and welfare and to prevent the significant deterioration of air quality".

Each of the regulated air pollutants has the potential to create or exacerbate some form of adverse health effect or to produce environmental degradation when present in sufficiently high concentration for prolonged periods of time. The AAQS specify a maximum allowable concentration for a given air pollutant for one or more averaging times to prevent harmful effects. Averaging times vary from one hour to one year depending on the pollutant and type of exposure necessary to cause adverse effects. In the case of the short-term (i.e., 1- to 24-hour) AAQS, both national and state standards allow a specified number of exceedances each year.

The Hawaii AAQS are in some cases considerably more stringent than the comparable national AAQS. In particular, the Hawaii 1-hour AAQS for carbon monoxide is four times more stringent than the comparable national limit. On the other hand, the current Hawaii AAQS for sulfur dioxide are probably less stringent than the national standards. During the early part of 2010, the national primary annual and 24-hour standards for sulfur dioxide were revoked in favor of a new national 1-hour standard which is considered to be more stringent than the Hawaii short-term standards. The Hawaii AAQS for sulfur dioxide have not yet been updated to bring them in line with the national standards.

In 1993, the state revised its particulate standards to follow those set by the federal government. During 1997, the federal government again revised its standards for particulate, but the new standards were challenged in federal court. A Supreme Court ruling was issued during February 2001, and as a result, the new standards for particulate were finally implemented during 2005. To date, the Hawaii Department of Health has not updated the state particulate standards.

In September 2001, the state vacated the state 1-hour standard for ozone and an 8-hour standard was adopted that was the same as the national standard. During recent years, the national standard for ozone has again been revised and made more

stringent. The Hawaii standard for ozone has not yet been amended to follow the national standard.

During the latter part of 2008, EPA revised the standard for lead making the standard more stringent. So far, the Hawaii Department of Health has not revised the corresponding state standard for lead.

During early 2010, a national 1-hour primary standard for nitrogen dioxide was implemented. To date, Hawaii has not promulgated a 1-hour standard for nitrogen dioxide, but the Hawaii annual standard for this pollutant is more stringent than the national annual standard.

4.0 REGIONAL AND LOCAL CLIMATOLOGY

Regional and local climatology significantly affect the air quality of a given location. Wind, temperature, atmospheric turbulence, mixing height and rainfall all influence air quality. Although the climate of Hawaii is relatively moderate throughout most of the state, significant differences in these parameters may occur from one location to another. Most differences in regional and local climates within the state are caused by the mountainous topography.

Lanai is a relatively small island being about 140 square miles in size. It was formed by a single-shield volcano and has the highest elevation, 3,370 feet above mean sea level, near the east-central portion of the island. The project location is at Lanai City, which is located near the center of the island (see

Figure 1) at an elevation of about 1,600 feet above mean sea level.

All of the Hawaiian Islands, including the island of Lanai, lie well within the belt of northeasterly trade winds generated by the semi-permanent Pacific high-pressure cell to the north and east. Because the project site at Lanai City is located at a higher elevation on Lanai and with good exposure to the trade winds, it receives relatively good ventilation much of the time. To a lesser extent, local winds such as land/sea breezes and/or upslope/downslope winds also influence the wind pattern for the area when the trade winds are weak or absent. At night when the trade winds are weaker, drainage winds from the upper elevations to the east may tend to move downslope and out to sea. During winter, occasional strong winds from the south or southwest occur in association with the passage of winter storm systems. Table 2 shows mean wind speed and wind direction statistics for Lanai Airport, which is located 2.5 miles to the southwest of the project area. Wind data from the Lanai Airport are likely reasonably representative of winds at the project site. As indicated in the table, ventilation is good with wind speeds above 8 mph more than 80% of the time, and the wind direction is from the east northeast or northeast nearly 80% of the time.

Air pollution emissions from motor vehicles, the formation of photochemical smog, and smoke plume rise all depend in part on air temperature. In Hawaii, the annual and daily variation of temperature depends to a large extent on elevation above sea level, distance inland and exposure to the trade winds. Average temperatures at locations near sea level generally are warmer than those at higher elevations. Areas exposed to the trade winds tend to have the least temperature variation, while inland and leeward areas often have the most. Temperature data for Lanai City

indicate that the average daily minimum and maximum temperatures for this area of Lanai are 62°F and 75°F, respectively [1]. This is cooler than many locations in the state due to the higher elevation.

Small scale, random motions in the atmosphere (turbulence) cause air pollutants to be dispersed as a function of distance or time from the point of emission. Turbulence is caused by both mechanical and thermal forces in the atmosphere. It is often measured and described in terms of Pasquill-Gifford stability class. Stability class 1 is the most turbulent and class 6 is the least. Thus, air pollution dissipates the best during stability class 1 conditions and the worst when stability class 6 prevails. In the project area, stability classes 5 or 6 typically occur during the nighttime or early morning hours when temperature inversions form due to radiation cooling or to drainage flow from the nearby higher terrain. Stability classes 1 through 4 occur during the daytime, depending mainly on the amount of cloud cover and incoming solar radiation and the trade wind flow and/or the onset and extent of sea breeze conditions.

Mixing height is defined as the height above the surface through which relatively vigorous vertical mixing occurs. Low mixing heights can result in high ground-level air pollution concentrations because contaminants emitted from or near the surface can become trapped within the mixing layer. In Hawaii, minimum mixing heights tend to be high because of mechanical mixing caused by the trade winds and because of the temperature moderating effect of the surrounding ocean. Low mixing heights may sometimes occur, however, at inland locations and even at times along coastal areas early in the morning following a clear, cool, windless night. Coastal areas also may experience low mixing levels during sea breeze conditions when cooler ocean air rushes in over warmer land. Mixing heights in Hawaii typically are above 3,000 feet (1,000 meters).

Rainfall can have a beneficial affect on the air quality of an area in that it helps to suppress fugitive dust emissions, and it also may "washout" gaseous contaminants that are water soluble. Rainfall in Hawaii is highly variable depending on elevation and on location with respect to the trade wind. The climate of the project area is moderately dry. Historical records from Lanai City show that this area of Lanai averages about 35 inches of precipitation per year, with the summer months being the driest [1].

5.0 PRESENT AIR QUALITY

The sources of air pollution on Lanai are relatively few. Present air quality in the project area is mostly affected by air pollutants from vehicular, industrial, natural, and/or agricultural sources. Motor vehicle traffic is minimal. The largest industrial source of air pollution in the project area is the Maui Electric power plant located at Miki Basin, about 2 miles to the southwest of the project site. Diesel fuel usage at the power plant results in emissions of nitrogen oxides, sulfur dioxide, particulate, carbon monoxide, hydrocarbons and other combustion byproducts. Immediately to the southwest of the project site is the Lanai City wastewater treatment plant operated by Maui County. Any airborne emissions from this facility are probably limited to nuisance odorants. Large agricultural areas and former pineapple fields lie to the south. The air quality in the project area has likely improved in recent years with the cessation of much of the pineapple cultivation, which sometimes resulted in significant amounts of fugitive dust and smoke. Volcanic emissions from distant natural sources on the Big Island

also affect the air quality at times during kona (south) wind conditions. By the time the volcanic emissions reach the project area, they consist mostly of fine particulate sulfate.

The Hawaii Department of Health operates a network of air quality monitoring stations at various locations around the state, but none are located on Lanai. However, some generalizations can probably be made about the present air quality based on data collected elsewhere in the state and on the fact that there are few air pollution sources on Lanai. Air quality data reported elsewhere in the state for the past several years, even in urban Honolulu, suggest that all state and federal ambient air quality standards are currently being met. Due to the abundance of sunshine and because of Hawaii’s rather isolated location in the middle of the Pacific, ozone concentrations are typically high but within standards. The same can be expected at Lanai City. Some coastal locations in the state sometimes report relatively high concentrations of very fine particulate (PM-2.5), which are likely caused by sea salt from high surf conditions. This would not be an issue for Lanai City due to the inland and high elevation situation. The close proximity of the Lanai City wastewater treatment plant could potentially be a source of hydrogen sulfide emissions and nuisance odor in the immediate project area. This will be investigated later in this report.

Given the limited air pollution sources in the project area, it is likely that air pollution concentrations are presently near natural background levels most of the time.

6.0 SHORT-TERM IMPACTS OF PROJECT

Short-term direct and indirect impacts on air quality could potentially occur during project construction. For a project of this nature, there are two potential types of air pollution emissions that could directly result in short-term air quality impacts during construction: (1) fugitive dust from vehicle movement and soil excavation; and (2) exhaust emissions from on-site construction equipment. Indirectly, there also could be short-term impacts from slow-moving construction equipment traveling to and from the project site and from the disruption of traffic due to road construction.

Fugitive dust emissions may arise from the grading and dirt-moving activities associated with land clearing and preparation work. The emission rate for fugitive dust emissions from construction activities is difficult to estimate accurately because of its elusive nature of emission and because the potential for its generation varies greatly depending upon the type of soil at the construction site, the amount and type of dirt-disturbing activity taking place, the moisture content of exposed soil in work areas, and the wind speed. The EPA [2] has provided a rough estimate for uncontrolled fugitive dust emissions from construction activity of 1.2 tons per acre per month under conditions of "medium" activity, moderate soil silt content (30%), and precipitation/evaporation (P/E) index of 50. Uncontrolled fugitive dust emissions in the project area would likely be somewhere near this level or possibly somewhat higher due to the relatively dry climate. In any case, State of Hawaii Air Pollution Control Regulations [3] prohibit visible emissions of fugitive dust from construction activities at the project boundary, and thus an effective dust control plan for the project construction phase is essential.

Adequate fugitive dust control can usually be accomplished by the establishment of a frequent watering program to keep bare-dirt surfaces in construction areas from becoming significant sources of dust. In dust-prone or dust-sensitive areas, other control measures such as limiting the area that can be disturbed at any given time, applying chemical soil stabilizers, mulching and/or using wind screens may be necessary. Control regulations further stipulate that open-bodied trucks be covered at all times when in motion if they are transporting materials that could become airborne. Haul trucks tracking dirt onto paved streets from unpaved areas is oftentimes a significant source of dust in construction areas. Some means to alleviate this problem, such as road cleaning or tire washing, may be appropriate. Paving and/or establishment of landscaping as early in the construction schedule as possible can also lower the potential for fugitive dust emissions.

On-site mobile and stationary construction equipment also will emit air pollutants from engine exhausts. The largest of this equipment is usually diesel-powered. Nitrogen oxides emissions from diesel engines can be relatively high compared to gasoline-powered equipment, but the annual standard for nitrogen dioxide is not likely to be violated by short-term construction equipment emissions. Also, the new short-term (1-hour) standard for nitrogen dioxide is based on a three-year average; thus it is unlikely that relatively short-term construction emissions would exceed the standard. Carbon monoxide emissions from diesel engines, on the other hand, are low and should be relatively insignificant compared to vehicular emissions on nearby roadways.

Indirectly, slow-moving construction vehicles on roadways leading to and from the project area could obstruct the normal flow of traffic to such an extent that overall vehicular emissions are increased, but this impact can be mitigated by moving heavy construction equipment during periods of low traffic volume. Likewise, road closures during peak traffic periods should be avoided to the extent possible to minimize air pollution impacts from traffic disruption. Thus, with careful planning and attention to dust control, most potential short-term air quality impacts from project construction can be mitigated.

7.0 LONG-TERM IMPACTS OF PROJECT

7.1 Roadway Traffic

After construction is completed, use of the proposed facilities may result in increased motor vehicle traffic in the project area, potentially causing long-term impacts on ambient air quality. Motor vehicles with gasoline-powered engines are significant sources of carbon monoxide. They also emit nitrogen oxides and other contaminates.

Federal air pollution control regulations require that new motor vehicles be equipped with emission control devices that reduce emissions significantly compared to a few years ago. In 1990, the President signed into law the Clean Air Act Amendments. This legislation required further emission reductions, which have been phased in since 1994. More recently, additional restrictions were signed into law during the Clinton administration, and these began to take effect during the next decade. The added restrictions on emissions from new motor vehicles will lower average emissions each year as older vehicles leave the state's roadways. It is estimated that carbon monoxide emissions, for example, will go down by an average of about 40 percent per vehicle during the next 10 years due to the replacement of older vehicles with newer models.

To evaluate the potential long-term ambient air quality impact of motor vehicle traffic coming to and from the proposed new development, computerized emission and atmospheric dispersion models can be used to estimate ambient carbon monoxide concentrations along roadways within the project area. Carbon monoxide is selected for modeling because it is both the most stable and the most abundant of the pollutants generated by motor vehicles. Furthermore, carbon monoxide air pollution is generally considered to be a microscale problem that can be addressed locally to some extent, whereas nitrogen oxides air pollution most often is a regional issue that cannot be addressed by a single project.

For this project, three scenarios were selected for the carbon monoxide modeling study: (1) year 2018 with present conditions, (2) year 2026 without the project, and (3) year 2026 with the project. To begin the modeling study of the three scenarios, critical receptor areas in the vicinity of the project were identified for analysis. Generally speaking, roadway intersections are the primary concern because of traffic congestion and because of the increase in vehicular emissions associated with traffic queuing. For this study, four of the key intersections identified in the traffic study were also selected for air quality analysis. These included the following intersections:

- Fraser Avenue at 9th Street
- Fraser Avenue at 12th Street
- Fraser Avenue at Kaumalapau Highway
- Kaumalapau Highway at Manele Street.

The traffic impact report for the project [4] describes the existing and projected future traffic conditions and laneage configurations of the study intersections in detail. All of these intersections are currently unsignalized, and all are expected to remain unsignalized in the future with or without the project. In performing the air quality impact analysis, it was assumed that all recommended traffic mitigation measures would be implemented.

The main objective of the modeling study was to estimate maximum 1-hour average carbon monoxide concentrations for each of the three scenarios studied. To evaluate the significance of the estimated concentrations, a comparison of the predicted values for each scenario can be made. Comparison of the estimated values to the national and state AAQS was also used to provide another measure of significance.

Maximum carbon monoxide concentrations typically coincide with peak traffic periods. The traffic impact assessment report evaluated morning and afternoon peak traffic periods. These same periods were evaluated in the air quality impact assessment.

Vehicular carbon monoxide emissions for each year studied were calculated using EPA's Motor Vehicle Emission Simulator (MOVES) computer model [5]. MOVES was configured for a project-level analysis specifically for Hawaii. Assumptions included an urban, unrestricted road type, default fuel supply and fuel formulation, and default vehicle age distribution. MOVES emission factors were generated both for idling and for moving traffic. Ambient temperatures of 70 and 90°F were used for morning and afternoon peak-hour emission computations, respectively. These are conservative assumptions since morning/afternoon ambient temperatures will often be cooler than this, and carbon monoxide emission estimates given by MOVES generally increase with

increasing temperature in the range of temperatures that occur at the project location.

After computing vehicular carbon monoxide emission factors through the use of MOVES, these data were then input to an atmospheric dispersion model. EPA air quality modeling guidelines [6] currently recommend that the computer model CAL3QHC [7] be used to assess carbon monoxide concentrations at roadway intersections. CAL3QHC was developed for the U.S. EPA to simulate vehicular movement, vehicle queuing and atmospheric dispersion of vehicular emissions near roadway intersections. It is designed to predict 1-hour average pollutant concentrations near roadway intersections based on input traffic and emission data, roadway/receptor geometry and meteorological conditions.

Although CAL3QHC is intended primarily for use in assessing atmospheric dispersion near signalized roadway intersections, it can also be used to evaluate unsignalized intersections. This is accomplished by manually estimating queue lengths and then applying the same techniques used by the model for signalized intersections. Currently, all of the study intersections are unsignalized and all were assumed to remain unsignalized for the future scenarios studied.

Input peak-hour traffic data were obtained from the traffic study cited previously. This included vehicle approach volumes, saturation capacity estimates, intersection laneage and vehicle queue length. All emission factors that were input to CAL3QHC for free-flow traffic on roadways were obtained from MOVES based on assumed free-flow vehicle speeds corresponding to the posted speed limits. Free-flow traffic speeds may sometimes be lower than the posted speed limits due to disruptions downstream, and this could result in higher carbon monoxide emissions.

Model roadways were set up to reflect roadway geometry, physical dimensions and operating characteristics. Concentrations predicted by air quality models generally are not considered valid within the roadway-mixing zone. The roadway-mixing zone is usually taken to include 3 meters on either side of the traveled portion of the roadway and the turbulent area within 10 meters of a cross street. Model receptor sites were thus located at the edges of the mixing zones near all intersections that were studied for all scenarios. All receptor heights were placed at 1.8 meters above ground to simulate levels within the normal human breathing zone.

Input meteorological conditions for this study were defined to provide "worst-case" results. One of the key meteorological inputs is the atmospheric stability category. For these analyses, atmospheric stability category 6 was assumed for morning scenarios and stability category 4 was assumed for afternoon cases. These are the most conservative stability categories that are generally used for estimating pollutant dispersion at rural or suburban locations for these time periods. For all cases, a surface roughness length of 100 cm was assumed and a mixing height of 1,000 meters was used. Worst-case wind conditions were defined as a wind speed of 1 meter per second with a wind direction resulting in the highest predicted concentration. Concentration estimates were calculated at wind directions of every 5 degrees.

Existing background concentrations of carbon monoxide in the project vicinity are believed to be at relatively low levels. Hence, background contributions of carbon monoxide from sources or

distant roadways not directly considered in the analysis were accounted for by adding a small background concentration of 0.5 ppm to all predicted concentrations for the existing year. The background value of 0.5 ppm was assumed to persist for the 2026 scenarios that were studied.

Predicted Worst-Case 1-Hour Concentrations

Table 3 summarizes the final results of the modeling study in the form of the estimated worst-case 1-hour morning and afternoon ambient carbon monoxide concentrations for the existing case (2018) and for each of the two future (2026) alternatives that were studied. The locations of these estimated worst-case 1-hour concentrations all occurred at or very near the indicated intersections.

As indicated in the table, the highest estimated worst-case 1-hour concentration for the present (2018) scenario was 0.7 parts per million (ppm), and this occurred during the morning near the intersection of Fraser Avenue and 9th Street. Due to the light volume of vehicle traffic, this is only slightly above the background concentration of 0.5 ppm. The predicted concentrations are well within both the national AAQS of 35 ppm and the state standard of 9 ppm.

In the year 2026 without the proposed project, the predicted highest worst-case 1-hour concentrations remained unchanged compared to the existing case. Although future traffic volumes are expected to be somewhat higher than the existing case, this will be offset by the retirement of older motor vehicles with less efficient emission control equipment. Worst-case carbon monoxide concentrations should remain well within the state and federal standards for this scenario.

As indicated in Table 3, predicted worst-case concentrations with the project in the year 2026 increased slightly at three of the four intersections studied, but the predicted worst-case 1-hour concentrations for the 2026 with-project alternative at all locations studied continued to remain well within both the national and state standards.

Predicted Worst-Case 8-Hour Concentrations

Worst-case 8-hour carbon monoxide concentrations were estimated by multiplying the worst-case 1-hour values by a persistence factor of 0.5. This accounts for two factors: (1) traffic volumes averaged over eight hours are lower than peak 1-hour values, and (2) meteorological conditions are more variable (and hence more favorable for dispersion) over an 8-hour period than they are for a single hour. Based on monitoring data, 1-hour to 8-hour persistence factors for most locations generally vary from 0.4 to 0.8 with 0.6 being the most typical. One recent study based on modeling [8] concluded that 1-hour to 8-hour persistence factors could typically be expected to range from about 0.4 to 0.5. EPA guidelines [9] recommend using a value of 0.6 to 0.7 unless a locally derived persistence factor is available. Recent monitoring data for Honolulu reported by the Department of Health [10] suggest that this factor may range between about 0.35 and 0.55 depending on location and traffic variability. Considering the location of the project and the traffic pattern for the area, a 1-hour to 8-hour persistence factor of 0.5 will likely yield reasonable estimates of worst-case 8-hour concentrations. However, it should be noted that the 8-hour concentration

estimates are generally less reliable than the 1-hour values due to the prediction methodology involved.

The resulting estimated worst-case 8-hour concentrations are indicated in Table 4. For the 2018 scenario, the estimated worst-case 8-hour carbon monoxide concentrations for the four intersections studied ranged from 0.3 to 0.4 ppm. With or without the project in 2026, the estimated worst-case 8-hour concentrations remained nearly unchanged. Thus, the estimated worst-case concentrations for the existing case as well as for the future scenarios studied were well within both the national limit of 9 ppm and the state standard of 4.4 ppm.

Conservativeness of Estimates

The results of this study reflect several assumptions that were made concerning both traffic movement and worst-case meteorological conditions. One such assumption concerning worst-case meteorological conditions is that a wind speed of 1 meter per second with a steady direction for 1 hour will occur. A steady wind of 1 meter per second blowing from a single direction for an hour is extremely unlikely and may occur only once a year or less. With wind speeds of 2 meters per second, for example, computed carbon monoxide concentrations would be only about half the values given above. The 8-hour estimates are also conservative in that it is unlikely that anyone would occupy the assumed receptor sites (within 3 m of the roadways) for a period of 8 hours.

7.2 Electrical Demand

Providing the proposed project with electrical power also will cause indirect air pollution emissions from offsite power generating facilities. The average electrical power usage of the project is estimated to be 575 kilowatt-hours per unit per month [11]. Thus, for the 200-unit project, the annual electrical demand of the project will reach approximately 1.4 million kilowatt-hours. Electrical power for the project will most probably be provided mainly by oil-fired generating facilities in the near term, but some of the project power may also be derived from photovoltaic systems, wind power or other alternative energy sources. If the electrical power needs of the proposed project are provided by fossil-fueled power facilities on the island, power generating facilities will likely be required to burn more fuel and hence more air pollution will be emitted at these facilities. Given in Table 5 are estimates of the indirect air pollution emissions that would result from the project electrical demand assuming all power is provided by burning more fuel oil at local power plants. Given the future plans for Lanai in particular and for the state as a whole to transition to renewable energy, in the long term, air pollution from electrical power usage on Lanai will likely be eliminated or substantially reduced.

7.3 Solid Waste Disposal

Solid waste generated by the proposed development is estimated to amount to 542 lbs per unit per month [11]. Thus, when fully completed and occupied, solid waste from the proposed project is not expected to exceed about 650 tons per year. Currently, all solid waste on the island is buried at a solid waste landfill. Thus, assuming this continues to be the method for solid waste disposal, the only associated air pollution emissions that will occur will be from trucking the waste to the landfill and from heavy equipment used to bury it. These emissions should be relatively minor.

8.0 WASTEWATER TREATMENT PLANT

Potential impacts on the project could occur from the nearby Lanai City Wastewater Treatment Plant. Wastewater treatment plants generally are not considered significant sources of air pollution, but they can result in the release of small amounts of airborne odorous compounds. The types and amounts of compounds in the air are generally not considered hazardous to human health, but when they occur at sufficiently high concentrations at offsite locations, they can be detected by smell and potentially constitute a nuisance for nearby residents and businesses. Odorous compounds commonly associated with wastewater treatment systems include hydrogen sulfide, ammonia and volatile organic compounds (VOC). These compounds are typically emitted into the atmosphere from wastewater collection, treatment and storage systems through volatilization at the liquid surface. Emissions can occur by diffusive or convective mechanisms, or both. The compounds volatize, or diffuse into the air, in an attempt to reach equilibrium between aqueous and vapor phases. Convection occurs when air flows over the water surface, sweeping the vapors from the water surface into the air. The rate of volatilization relates directly to the speed of the air flow over the water surface. Other factors that can affect the rate of volatilization include wastewater surface area, temperature and turbulence; wastewater retention time; wastewater depth; the concentration of organic compounds in the wastewater and their physical properties; the presence of a mechanism that inhibits volatilization; and a competing mechanism, such as biodegradation.

Mathematical models are available to estimate volatilization rates at wastewater treatment facilities when very detailed information is available concerning the effluent, the plant design and the site characteristics. Such information is not currently available for this project, but even if it were, it is likely that such estimates would be of limited usefulness for evaluating the potential odor impacts of the facility. The uncertainty of the estimates combined with the uncertainties of atmospheric dispersion estimates and human odor response would make it difficult to quantitatively and accurately evaluate the odor potential of the proposed plant. A qualitative evaluation may provide the best results.

As suggested above, temperature is a factor in the rate of volatilization. Temperatures at the project site will be relatively warm, which will tend to promote volatilization, but cooler compared to many locations in Hawaii due to the higher elevation (1,500 feet). As indicated in Section 4, the average daily temperature can be expected to range from about 62 to 85 degrees Fahrenheit. As indicated in Table 2, winds at the site can be expected to be predominantly trade winds from the northeast with speeds in the 10 to 25 mph range. The prevalent "fresh" winds could potentially promote volatilization at the plant, but they will also tend to enhance the dilution and dispersion of the emissions at downwind locations. With trade wind conditions, which occur about 80 percent of the time, emissions will be carried toward locations to the southwest. The proposed project will be situated to the northeast of the wastewater treatment facility and thus will be upwind most of the time. From an atmospheric dispersion perspective, it is probable that the worst case for offsite odor impacts will occur during nighttime situations when the trade winds are weak or absent and dispersion conditions are poor. Occasional light winds from the south or southwest, which occur less than about 1 percent of the time, will tend to carry airflow over the wastewater treatment facility and toward the proposed project.

As shown in Table 1, the Hawaii Department of Health has established an air quality standard for hydrogen sulfide set at 0.025 ppm for a one-hour average. Thus, concentrations of hydrogen sulfide cannot exceed this standard at locations offsite of the wastewater treatment facility without being in violation of state regulations. However, it should be noted that adherence to this standard will not necessarily avoid problems of offsite odor nuisance. The hydrogen sulfide odor threshold for sensitive individuals can be as low as about 0.005 ppm, and this pertains to an instantaneous concentration.

If it is assumed that the hydrogen sulfide concentration at the wastewater treatment plant fence line does not exceed the maximum allowable (0.025 ppm for a one-hour average), atmospheric dispersion calculations can be performed to estimate the maximum downwind distance where the concentration would likely fall below the odor threshold (0.005 ppm for a period of a few minutes). This is accomplished using the Gaussian dispersion equation for a ground-level source. Assuming worst-case dispersion conditions (light wind and stability class F), it is estimated that this distance could extend to about 300 to 600 feet.

On October 26, 2016, a site visit was made to the Lanai City Wastewater Treatment Plant, and the entire perimeters of both the main plant and the auxiliary facility were surveyed using a Jerome Model 631-X portable hydrogen sulfide analyzer. The Jerome Model 631-X is a is very sensitive instrument and capable of measuring ambient concentrations of hydrogen sulfide as low as 0.003 ppm. Wind conditions during the survey were typical moderate trade winds from the northeast at about 10 to 15 mph. Hydrogen sulfide measurements were collected during mid-morning all along the plant perimeters, which included both upwind and downwind locations. In summary, there were no measurable hydrogen sulfide concentrations at any location along the plant perimeters, i.e., the Jerome analyzer continuously displayed less than 0.003 ppm. Further, there was no noticeable odor present at any location along the plant perimeters.

9.0 CONCLUSIONS AND RECOMMENDATIONS

Existing Conditions

Although there are no published ambient air quality data available for Lanai to characterize existing conditions, with only a few air pollution sources and little motor vehicle traffic, it is likely that state and federal ambient air quality standards are currently being met in the project area. It is probable that air quality conditions have improved in recent years with the cessation of pineapple-growing operations and the dust and smoke that resulted therefrom. Volcanic haze from distant sources on Hawaii Island may sometimes reach the project area with kona wind conditions, which may affect sensitive individuals.

Short-Term Impacts and Mitigation

The major potential short-term impact of the project on air quality will occur from the emission of fugitive dust during construction. Uncontrolled fugitive dust emissions from construction activities are estimated to amount to about 1.2 tons per acre per month, depending on rainfall and other factors. To control dust, active work areas and any temporary unpaved work roads should be watered at least twice daily on days without rainfall. Use of wind screens and/or limiting the area that is disturbed at any given time will also help to contain fugitive dust emissions. Wind erosion of inactive areas of the project that have been disturbed could be controlled by mulching or chemical

stabilization. Dirt-hauling trucks should be covered when traveling on roadways to prevent windage. A routine road cleaning and/or tire washing program will also help to reduce fugitive dust emissions that may occur as a result of trucks tracking dirt onto paved roadways in the project area. Establishment of landscaping early in the construction schedule will also help to control dust.

During construction phases, emissions from engine exhausts (primarily consisting of carbon monoxide and nitrogen oxides) will also occur both from on-site construction equipment and from the disruption of normal traffic flow. Increased vehicular emissions due to the disruption of traffic can be alleviated by minimizing road closures during peak traffic hours.

Long-Term Impacts and Mitigation

After construction of the proposed project is completed and it is fully occupied, carbon monoxide concentrations in the project area should remain nearly unchanged with or without the project compared to the existing case, and worst-case concentrations should remain well within both the state and the national ambient air quality standards. Implementing any air quality mitigation measures for long-term traffic-related impacts is probably unnecessary and unwarranted.

Supplying the project with electric power may result in indirect (off site) emissions of air pollution at electric utility facilities, but the increased emissions will be very minimal. Nevertheless, indirect emissions from project electrical demand could likely be reduced somewhat by incorporating energy-saving features into project design requirements. This might include the use of solar water heaters; using energy-efficient lighting systems; designing homes so that window positions maximize indoor light and ventilation; using landscaping where feasible to provide afternoon shade to cut down on the use of air conditioning; installation of insulation and double-glazed doors and windows to reduce the effects of the sun and heat; providing movable, controlled openings for ventilation at opportune times; and possibly installing automated room occupancy sensors.

Disposal of solid waste from the project could result in some offsite emissions related to landfill operations, but any air pollution emissions will likely be minimal. Promoting conservation and recycling programs within the proposed development could serve to further reduce any indirect air quality impacts and would help to conserve the island's resources.

Impacts on the Project

Ambient air quality standards are generally designed to protect human health and do not guard against nuisance odor issues. While the State of Hawaii does have an ambient air quality standard for hydrogen sulfide as indicated in Table 1, compliance with this standard at the nearby wastewater treatment facility property line will not necessarily prevent nuisance odor complaints at offsite locations. The Hawaii standard is set at a value of 0.025 ppm a one-hour average. Sensitive individuals can detect hydrogen sulfide at concentrations as low as 0.005 ppm for periods shorter than one hour. Human odor response is nearly instantaneous. While existing conditions suggest that offsite odor nuisance is not an issue, it may be prudent for the proposed project to maintain a buffer distance of at least 300 to 600 feet from the wastewater treatment plant boundary.

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Figure 1 - Project Location

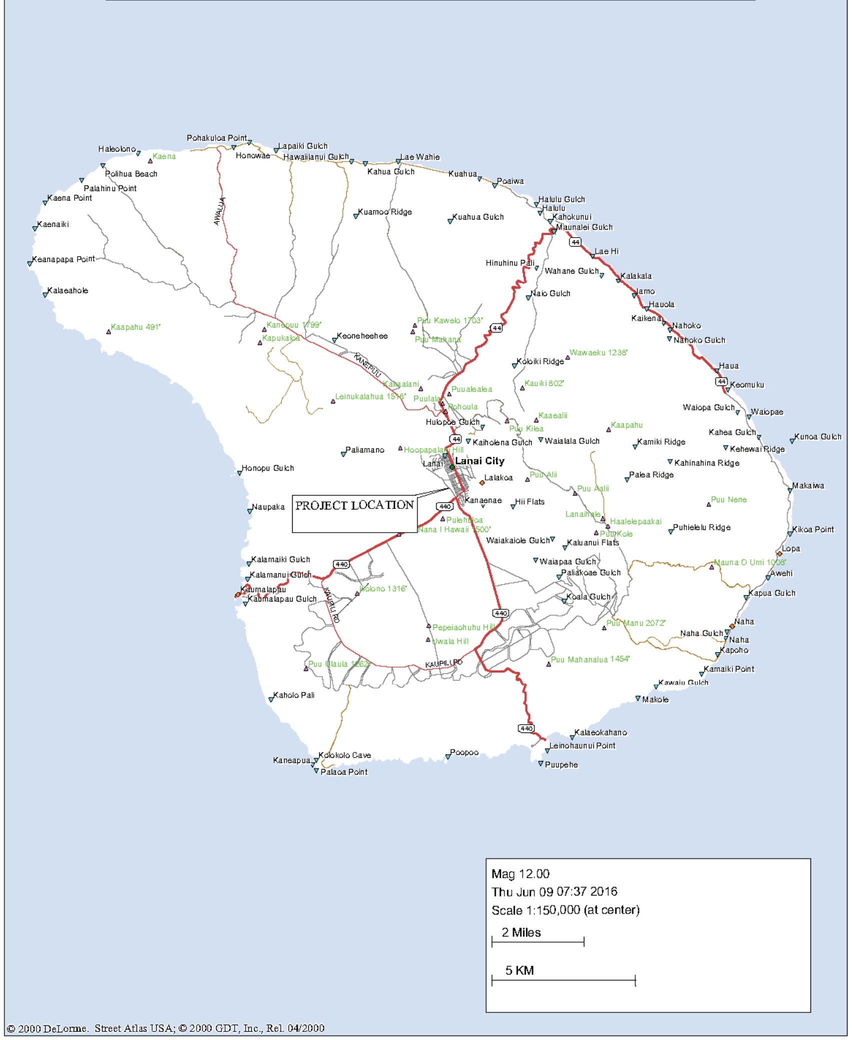

Table 1

SUMMARY OF STATE OF HAWAII AND NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Units	Averaging Time	Maximum Allowable Concentration		
			National Primary	National Secondary	State of Hawaii
Particulate Matter (<10 microns)	$\mu g/m^3$	Annual	–	–	50
		24 Hours	150[a]	150[a]	150[b]
Particulate Matter (<2.5 microns)	$\mu g/m^3$	Annual	12[c]	15[c]	–
		24 Hours	35[d]	35[d]	–
Sulfur Dioxide	ppm	Annual	–	–	0.03
		24 Hours	–	–	0.14[b]
		3 Hours	–	0.5[b]	0.5[b]
		1 Hour	0.075[e]	–	–
Nitrogen Dioxide	ppm	Annual	0.053	0.053	0.04
		1 Hour	0.100[f]	–	–
Carbon Monoxide	ppm	8 Hours	9[b]	–	4.4[b]
		1 Hour	35[b]	–	9[b]
Ozone	ppm	8 Hours	0.070[g]	0.070[g]	0.08[g]
Lead	$\mu g/m^3$	3 Months	0.15[h]	0.15[h]	–
		Quarter	1.5[i]	1.5[i]	1.5[i]
Hydrogen Sulfide	ppm	1 Hour	–	–	0.025[b]

[a] Not to be exceeded more than once per year on average over three years.
[b] Not to be exceeded more than once per year.
[c] Three-year average of the weighted annual arithmetic mean.
[d] 98th percentile value of the 24-hour concentrations averaged over three years.
[e] Three-year average of annual fourth-highest daily 1-hour maximum.
[f] 98th percentile value of the daily 1-hour maximum averaged over three years.
[g] Three-year average of annual fourth-highest daily 8-hour maximum.
[h] Rolling 3-month average.
[i] Quarterly average.

Table 2

ANNUAL WIND FREQUENCY FOR LANAI AIRPORT (%)

Wind Direction	Wind Speed (mph)									Total
	1-4	4-8	8-13	13-19	19-25	25-32	32-39	39-47	>47	
N	0.1	0.5	0.4	0.3	0.1	0.0	0.0	0.0	0.0	1.5
NNE	0.2	0.6	0.7	0.1	0.0	0.0	0.0	0.0	0.0	1.6
NE	0.2	1.3	5.4	11.7	9.4	2.0	0.1	0.0	0.0	30.1
ENE	0.2	1.6	11.1	23.2	11.0	1.1	0.0	0.0	0.0	48.2
E	0.3	1.2	1.2	0.1	0.0	0.0	0.0	0.0	0.0	2.8
ESE	0.4	1.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.6
SE	0.3	0.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.2
SSE	0.2	0.6	0.3	0.1	0.0	0.0	0.0	0.0	0.0	1.2
S	0.2	0.9	0.7	0.4	0.1	0.0	0.0	0.0	0.0	2.3
SSW	0.2	1.5	0.9	0.4	0.2	0.0	0.0	0.0	0.0	3.2
SW	0.2	1.3	0.5	0.1	0.0	0.0	0.0	0.0	0.0	2.1
WSW	0.1	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.9
W	0.1	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.6
WNW	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.5
NW	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.4
NNW	0.1	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.7
Calm	0.5									0.5
Total	3.5	12.8	22.5	36.5	20.8	3.1	0.1	0.0	0.0	100

Notes: Based on data collected from June 2006 until June 2016.

Source: Desert Research Institute, Western Regional Climate Data Center.

Table 3

ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR HOKUAO 201H HOUSING PROJECT (parts per million)

Roadway Intersection	Year/Scenario					
	2018/Present		2026/Without Project		2026/With Project	
	AM	PM	AM	PM	AM	PM
Fraser Avenue at 9th Street	0.7	0.6	0.7	0.6	0.7	0.6
Fraser Avenue at 12th Street	0.6	0.5	0.6	0.5	0.7	0.6
Fraser Avenue at Kaumalapau Highway	0.6	0.6	0.6	0.6	0.7	0.7
Kaumalapau Highway at Manele Street	0.6	0.6	0.6	0.6	0.7	0.7

Hawaii State AAQS: 9
National AAQS: 35

Table 4

ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR HOKUAO 201H HOUSING PROJECT (parts per million)

Roadway Intersection	Year/Scenario		
	2018/Present	2026/Without Project	2026/With Project
Fraser Avenue at 9th Street	0.4	0.4	0.4
Fraser Avenue at 12th Street	0.3	0.3	0.4
Fraser Avenue at Kaumalapau Highway	0.3	0.3	0.4
Kaumalapau Highway at Manele Street	0.3	0.3	0.4

Hawaii State AAQS: 4.4
National AAQS: 9

Table 5

ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM HOKUAO 201H HOUSING PROJECT ELECTRICAL DEMAND[a]

Air Pollutant	Emission Rate (tons/year)
Particulate	<1
Sulfur Dioxide	3.5
Carbon Monoxide	<1
Nitrogen Oxides	1.4

[a]Based on U.S. EPA emission factors for utility boilers [2]. Assumes demand of 1.4 million kw-hrs per year of electrical power use, 33% energy conversion efficiency and low-sulfur distillate oil used to generate power.