AIR QUALITY STUDY
FOR THE PROPOSED
LIHUE PUHI MASTER PLAN
608-ACRE ZONING CHANGE

LIHUE & PUHI, KAUAI, HAWAII

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EXHIBIT J-1

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1.0 INTRODUCTION AND PROJECT DESCRIPTION

Grove Farm Properties is proposing further development of their property located at the outskirts of Lihue and in Puhi, Kauai, Hawaii. As shown in the location map presented in Figure 1, the subject site is located south of Kaumualii Highway and west of Nawiliwili Road near the existing Kukui Grove Shopping Center. The proposed project would involve approximately 600 acres of land that is currently zoned for agriculture. Elements of the proposed project include: expansion of Kukui Grove Shopping Center, development of a general commercial area west of the shopping center, development of approximately 2000 single- and multi-family residential units, and construction of an 18-hole golf course. Development of the project would begin during 1990 and continue in phases for about 10 years until the year 1999.

The purpose of this study is to describe existing air quality in the project area and to assess the potential short-term and long-term direct and indirect air quality impacts that could result from construction and use of the proposed project as planned. Measures to mitigate these impacts are suggested where possible and applicable.

2.0 AMBIENT AIR QUALITY STANDARDS (AAQS)

National Ambient Air Quality Standards (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, AAQS have been established for six pollutants. The pollutants for which AAQS have been established include particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone and lead. National AAQS are stated in terms of primary and secondary standards. 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 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 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 one exceedance per year.

State of Hawaii AAQS are in some cases considerably more stringent than comparable national AAQS. In particular, the State of Hawaii 1-hour AAQS for carbon monoxide is four times more stringent than the comparable national limit.

Under the provisions of the Federal Clean Air Act [1], the U.S. Environmental Protection Agency (EPA) is required to periodically review and re-evaluate national AAQS in light of research findings more recent than those which were available at the time the standards were originally set. Occasionally new standards are created as well. Most recently, the national standard for particulate matter has been revised to include specific limits for particulates 10 microns or less in diameter (PM-10) [2]. The State of Hawaii has not explicitly addressed the question of whether to set limits for this category of air pollutant, but national AAQS prevail where states have not set their own more stringent levels.

Hawaii AAQS for sulfur dioxide were relaxed in 1986 to make them essentially the same as national limits. It has been proposed in various forums that the state also relax its carbon monoxide standards to the national levels, but at present there are no indications that such a change is being considered.

3.0 PRESENT AIR QUALITY

Present air quality in the Puhi area could potentially be affected by air pollutants from four main types of sources: natural, industrial, agricultural and vehicular. Table 2 presents an air pollutant emission summary for Kauai for the latter three source categories which was compiled in 1980.

The only significant fixed-point stack emissions on Kauai are from sugar mills and the electric utility. Sugar mills produce more than 50 percent of the particulates, with cane field burning producing most of the rest. Sulfur dioxide is emitted mainly by the steam electric power plant located near Port Allen with much smaller amounts coming from ships using Nawiliwili Harbor. Most of the nitrogen oxides, carbon monoxide and hydrocarbons emitted on Kauai are generated by motor vehicles.

Natural sources of air pollution emissions which could also affect the project area but cannot be quantified very accurately include the ocean (sea spray), plants (aero-allergens), wind-blown dust, and perhaps distant volcanoes on the Island of Hawaii.

Table 3 is a long-term summary of air pollution measurements collected at the Kauai District Health Office in Lihue, less than two miles north of the project site. Prior to 1978 the State of Hawaii 24-hour particulate standard, which at that time was set at 100 micrograms per cubic meter (ug/m^3), was being exceeded at a rate of about once every other year. After 1978, taller stacks and wet scrubbers were installed at the nearby Lihue Mill; the particulate standard at Lihue has not been exceeded since.

Nitrogen dioxide monitoring was discontinued at the Lihue site in 1976 because of a lack of manpower, an absence of federal requirements for such monitoring, and the generally low levels that had been previously recorded. State of Hawaii Department of Health budget constraints forced a discontinuance of sulfur dioxide monitoring in October 1985, but measurements of long-term concentrations to that date had been minimal in any case. In 1986 particulate monitoring was shifted from total suspended particulates to PM-10 (particles less than 10 microns in diameter) to conform to a change in the national AAQS. The last two years of PM-10 measurements were well within allowable limits.

Unfortunately, there are no recent long-term measurements of vehicular-related pollutants (i.e., carbon monoxide, nitrogen oxides, ozone or lead) on Kauai, so current levels of these pollutants are difficult to estimate very accurately. However, due to the relatively low level of activity and development in the area and the persistent trade winds from the northeast (where there are few upwind air pollution sources), current air pollution levels are almost certainly low except, perhaps, for a few localized areas where traffic congestion may occur.

4.0 SHORT-TERM DIRECT AND INDIRECT IMPACTS OF PROJECT CONSTRUCTION

For a project of this nature, there are two potential sources of air pollution emissions which could directly result in short-term air quality impacts during project construction: (1) fugitive dust from vehicle movement and soil excavation and (2) exhaust emissions from on-site construction equipment. Indirectly, there could also be short-term impacts from slow-moving construction equipment traveling to and from the project site and from a temporary increase in local traffic caused by commuting construction workers.

Fugitive dust emissions may arise from grading and dirt-moving activities within the project site. The emission rate for fugitive dust is nearly impossible to estimate accurately because of its elusive nature 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 [3] 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 Puhi area would probably be somewhere near this level or lower. In any case, State of Hawaii Air Pollution Control Regulations [4] require that visible emissions of fugitive dust from construction activity be essentially nil.

Adequate fugitive dust control can usually be accomplished by establishment of a frequent watering program to keep bare-dirt surfaces in work areas from becoming significant dust generators. Control regulations also require that open-bodied trucks be covered at all times when in motion if they are transporting materials likely to give rise to airborne dust. Paving of parking areas and establishment of landscaping as early in the construction process as possible can also lower the potential for fugitive dust emissions.

On-site mobile and stationary construction equipment will also emit some air pollutants in the form of 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 standard for nitrogen dioxide is set on an annual basis and is not likely to be violated by short-term construction equipment emissions. Carbon monoxide emissions from diesel engines, on the other hand, are very 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 site 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, the schedules of commuting construction workers can be adjusted to avoid peak hours in the project vicinity. Thus, most potential short-term air quality impacts from project construction are relatively easy to mitigate.

5.0 LONG-TERM DIRECT AND INDIRECT IMPACTS OF PROJECT

5.1 Roadway Traffic

By serving as an attraction for increased motor vehicle traffic on nearby roadways, the proposed project must be considered to be a potential indirect air pollution source. Motor vehicles with gasoline-powered engines are significant sources of carbon monoxide. They also emit nitrogen oxides and those burning leaded gasoline can also contribute lead to the atmosphere. The use of leaded gasoline in new automobiles is now prohibited. As older vehicles continue to disappear from the numbers of those currently operating on Kauai roadways, lead emissions are approaching zero. Nationally, so few vehicles now require leaded gasoline that the EPA is proposing a total ban on leaded gasoline to take effect immediately. Even without such a ban, reported quarterly averages of lead in air samples collected in urban Honolulu have been near zero since early 1986. Thus, lead in the atmosphere is not considered to be a problem anywhere in the state.

Federal air pollution control regulations also call for increased efficiency in removing carbon monoxide and nitrogen oxides from vehicle exhausts. By the year 1995 carbon monoxide emissions are expected to be about one fourth less than the amounts now emitted. At present, however, no further reductions in vehicular emissions have been mandated and increases in traffic levels after 1995 will result in nearly proportional increases in vehicle-related pollutant emissions.

To evaluate the potential long-term indirect air quality impact of increased roadway traffic associated with a project such as this, it is standard practice to utilize computerized atmospheric dispersion models to estimate ambient carbon monoxide concentrations along roadways leading to and from the project. Carbon monoxide is selected for modeling because it is both the most stable and the most abundant of the motor vehicle generated pollutants. Furthermore, carbon monoxide air pollution is generally considered to be a microscale problem, whereas nitrogen oxides air pollution most often is a regional issue. This is reflected in the fact the AAQS for carbon monoxide are specified on a short-term basis (1-hour and 8-hour averaging times) while the AAQS for nitrogen oxides is set on an annual basis.

Three scenarios were selected for study. The first scenario examined was for the year 1989 with present conditions. The other two scenarios studied were both for the year 2000, one without and the other with the proposed project. To begin the carbon monoxide modeling study, 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 cycling: decelerating, stopping, queueing and accelerating. For this study, three intersections along Kaumualii Highway were identified for analysis. These included the intersections of Kaumualii Highway and Nawiliwili Road, Kaumualii Highway and Nuhou Road, and Kaumualii Highway and Puhi Road. At the present time, Kaumualii Highway is a two-lane roadway with left and right turning pockets. None of the three intersections studied are currently signalized. For the year 2000 scenarios either with or without the proposed project, it is assumed that Kaumualii Highway will be widened to four lanes through the Puhi area and that signals will be provided at the Puhi Road and Nawiliwili Road intersections. For the year 2000 with project scenario, it is also assumed that a traffic signal will be installed at the intersection of Nuhou Road and Kaumualii Highway and that two left turn lanes would be provided for northbound traffic turning left from Nawiliwili Road onto Kaumualii Highway. Right turn lanes were assumed to be provided at the Kaumualii Highway/Nawiliwili Road intersection with or without the proposed project. The traffic impact assessment report for the project [5] describes the present and future configurations of these intersections and roadways in more detail.

The main objectives of the modeling study were to estimate both current and projected levels of maximum 1-hour average carbon monoxide concentration which could be directly compared to the national and state AAQS. The traffic impact assessment report cited above indicates that current traffic volumes along Kaumualii Highway in the Puhi area peak in the afternoon between 3:30 and 4:30 pm. Morning peak-hour traffic at the intersections studied is only slightly lower, but traffic is mainly through traffic. During the afternoon peak hour, considerable queueing occurs on the cross streets that is not present in the morning. Worst-case meteorological dispersion conditions usually occur during the early morning hours. Thus, even though afternoon traffic counts may be higher, the morning peak traffic hour often causes the highest air pollution concentrations along roadways. However, in this case, due to excess emissions from the queueing of vehicles at intersections during the afternoon, the afternoon peak hour traffic most probably causes worst-case ambient concentrations.

The EPA computer model MOBILE3 [6] was used to calculate vehicular carbon monoxide emission estimates for each of the years studied. Based on recent vehicle registration figures, the present and projected vehicle mix in the project area is estimated to be 91.9% light-duty gasoline-powered vehicles, 4.2% light-duty gasoline-powered trucks and vans, 0.5% heavy-duty gasoline-powered vehicles, 1% diesel-powered trucks and buses, and 1% motorcycles. It was assumed that about 21 percent of all vehicles would be operating in the cold-start mode and that about 27 percent would be operating in the hot-start mode. These are standard, default values that are used in calculating cold/hot start emissions. National averages for "mis-fueling" were assumed. An ambient temperature of 68 degrees F was used for emission computations. This is a conservative assumption since the ambient temperature will generally be warmer than this and emission estimates given by MOBILE3 are inversely proportional to the ambient temperature.

The analysis at the Kaumualii Highway/Nawiliwili Road intersection took into consideration the large parking lot at Kukui Grove Shopping Center. Vehicles operating in parking lots emit "excess transient" emissions that are generally much higher compared to emissions from vehicles operating at stabilized engine temperatures and at higher speeds on roadways. To account for this, an excess emission analysis of the parking lot was performed. This involved in part the use of MOBILE3 to calculate cold/hot start emissions and the calculation of the portion of these emissions that would be emitted in the parking lot.

After computing vehicular carbon monoxide emissions through the use of MOBILE3, these data were then input to the computer model CALINE4 [7]. CALINE4 was developed by the California Transportation Department and the EPA to simulate vehicular movement and atmospheric dispersion of vehicular emissions. The CALINE4 model is designed to predict 1-hour average pollutant concentrations along roadways based on input traffic and emission data, roadway/receptor geometry and coincident meteorological conditions.

Input peak-hour traffic data were obtained from the traffic study cited previously. The traffic volumes given in the traffic study for the future scenarios include project traffic as well as traffic from other growth that is expected to occur in the area for the years considered.

Model roadways were set up to reflect actual roadway geometry, physical dimensions and operating characteristics. Model receptor sites were located 10 meters from the edge of the roadways near the subject intersections at a height of 1.5 meters above grade 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 atmospheric stability category. For these analyses, atmospheric stability category 4 was assumed. This is the most conservative stability category that can be used for estimating afternoon pollutant dispersion in model calculations. A surface roughness length of 100 cm was assumed with a mixing height of 500 meters. 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.

Existing background concentrations of air pollution in the project vicinity are believed to be relatively low. Hence, background contributions of carbon monoxide from sources or distant roadways not directly considered in the analysis were assumed to be fairly small. A concentration of 0.5 ppm was added to all predicted concentrations for the 1989 scenario to make allowance for background. For the year 2000 scenarios, a background concentration of 1.0 ppm was assumed.

Table 4 summarizes the final results of the modeling study in the form of the predicted maximum 1-hour carbon monoxide concentrations. These results can be compared directly to the state and the national AAQS. Predicted maximum carbon monoxide concentrations are presented in the table for three scenarios: year 1989 with existing traffic, year 2000 without traffic from the proposed project, and year 2000 with project traffic. The locations of these predicted maximum concentrations all occurred at or very near the intersections in question.

Insofar as present conditions are concerned, the highest worst-case 1-hour carbon monoxide concentration in the area was predicted to occur at the intersection of Kaumualii Highway and Nawiliwili Road. The estimated worst-case 1-hour value near this intersection was 12.6 mg/m^3. Worst-case 1-hour concentrations at the other two locations studied were 1.6 and 3.7 mg/m^3. The predicted worst-case 1-hour concentration at the Nawiliwili Road intersection for the 1989 scenario exceeds the state 1-hour AAQS but is within the national AAQS. Worst-case concentrations at the Nuhou Road and Puhi Road locations were within both standards.

In the year 2000 without the proposed project, the worst-case 1-hour concentration at the Kaumualii Highway/Nawiliwili intersection is predicted to increase only slightly to 12.8 mg/m^3 even though traffic is expected to increase substantially. The predicted worst-case ambient carbon monoxide concentration does not increase more because vehicles with better emission-controls will be operating on the roadways by the year 2000. The predicted worst-case 1-hour concentration at the Puhi Road/Kaumualii Highway intersection was 12.1 mg/m^3, nearly the same as at Nawiliwili Road, while the worst-case concentration at Nuhou Road was only 3.4 mg/m^3. Predicted concentrations at both Nawiliwili Road and Puhi Road for the year 2000 without project scenario exceed the state AAQS but comply with the national AAQS.

The estimated highest worst-case 1-hour concentration for the year 2000 scenario with the proposed project was 16.4 mg/m^3. This would occur near the intersection of Kaumualii Highway and Nawiliwili Road and is 3.6 mg/m^3 higher than the without project scenario. Predicted worst-case concentrations at the other locations studied along Kaumualii Highway were 12.8 and 13.6 mg/m^3 at Puhi Road and Nuhou Road, respectively. The predicted concentration at Nuhou Road increases substantially compared to the without project case because of the added project traffic and because a traffic signal is assumed to be installed in the with project scenario. All predicted worst-case 1-hour concentrations in the with project case exceed the state AAQS but are within the national standard.

Worst-case 8-hour carbon monoxide concentrations were estimated by multiplying the worst-case 1-hour values by a "meteorological persistence factor" of 0.6. This procedure is recommended in EPA guidelines [8] to account for two factors: (1) traffic volumes averaged over eight hours are lower than the peak 1-hour value, and (2) meteorological dispersion conditions are more variable (and hence more favorable) over an 8-hour period than they are for a single hour. Carbon monoxide monitoring data for Honolulu suggest that the conversion factor is probably lower than 0.6 for locations in Hawaii. Thus, estimates of 8-hour concentration using this factor are likely to be conservatively high.

Estimated maximum 8-hour concentrations are indicated in Table 5. The highest estimated worst-case 8-hour carbon monoxide concentration in the project area for 1989 was 7.6 mg/m^3 at Kaumualii Highway/Nawiliwili Road. Predicted 8-hour 1989 concentrations at the other nearby intersections were 1.0 mg/m^3 at Nuhou Road and 2.2 mg/m^3 at Puhi Road. The predicted maximum values for the year 2000 without project scenario varied from 2.0 to 7.7 mg/m^3 with the highest value occurring at Kaumualii Highway and Nawiliwili Road. In the with project case, the year 2000 concentrations were estimated to range from 7.7 to 9.8 mg/m^3 with the highest concentration again at Kaumualii Highway/Nawiliwili Road. The state 8-hour AAQS is predicted to be exceeded at Nawiliwili Road in the year 1989 scenario and at both Nawiliwili Road and Puhi Road in the year 2000 without project case. All three locations would be above the state standard in the year 2000 with project scenario. All predicted worst-case 8-hour concentrations are within the limits set by the national AAQS, although the value for the with project case is very near the national standard at the Kaumualii/Nawiliwili intersection.

It should be mentioned here that the above predicted concentrations generally are "hot spot" values. That is, concentrations are not widespread but diminish rapidly with distance from the roadway.

Out of necessity, many assumptions and estimates must be made in a study of this nature concerning the operational parameters of a signalized intersection to be constructed several years in the future. The predictions given above for the future scenarios are based on rudimentary signal phasing of the intersections in question. It is likely that the optimized signal phasing resulting during final design will move traffic more effectively and hence reduce the predicted air pollution concentrations.

The results of this study also reflect several assumptions that must be made concerning worst-case meteorological conditions. As mentioned above, a worst-case wind speed of 1 meter per second with a steady direction was assumed. A steady wind of 1 meter per second blowing from a single direction for an hour is not very likely, 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.

5.2 Electrical Generation

The annual electrical demand of the project when fully developed is not expected to exceed about 20 million kilowatt-hours. This power demand would most probably be provided by the steam electric generating facility located near Port Allen and/or by sugar mill co-generation facilities. In order to meet the electrical power needs of the proposed project, the power plant and/or co-generation facilities would be required to burn more fuel and hence more air pollution would be emitted at the power generating facilities. Given in Table 6 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 the power plant. If power is supplied instead or in part by co-generation facilities, particulate emissions would likely be higher and sulfur dioxide emissions would be lower than the values given in the table.

5.3 Solid Waste Disposal

Solid waste generated by the project when fully occupied would likely amount about 20 tons of refuse per day. Most if not all of this refuse would be trucked away from the community and either landfilled or burned at another location. Approximately 10 truck trips per day would be required to dispose of the waste. If all refuse is landfilled as presently seems likely, the only air pollution emissions associated with solid waste disposal would be due to exhaust fumes from the trucks and heavy equipment used to place the refuse in the landfill. If, on the other hand, all or part of the refuse is burned at a municipal incinerator, disposal of solid waste from the project would also result in the emissions of particulate, carbon monoxide and other contaminants from the incineration facility. Table 7 gives emission factors for municipal refuse incinerators (without controls) in terms of pounds of air pollution per ton of refuse material charged. Thus, air pollutant emission rates in terms of pounds per day, for example, can be estimated by multiplying the emission factors given in the table by the number of tons per day of refuse that is burned.

5.4 Golf Course Pesticide Usage

Once the project is completed and the golf course is in use, it will be necessary to regularly apply various chemical fertilizers and pesticides to maintain grass quality. AAQS have not been established for any of the pesticides presently in use, although most of them carry warning or caution labels on their containers. The primary purpose of these labels is to provide occupational safety and health guidance regarding proper handling and application. The primary risk of using these chemicals is to the applicator rather than to individuals at possible receptor sites downwind, since these individuals should encounter airborne concentrations of these chemical substances only in greatly diluted form if at all. There are, however, certain precautions that must be followed by pesticide applicators in order to prevent significant downwind drift when spraying. Primary among these are the use of a coarse rather than a fine spray and application under low wind speed conditions when the wind direction will not contribute to drift towards the clubhouse area or to nearby residences. Provided that proper safety precautions are followed, the potential for serious air quality degradation from chemical spraying for golf course maintenance will likely be minimal.

6.0 SUMMARY OF IMPACTS AND MITIGATIVE CONSIDERATIONS

6.1 Impacts Summary

The major short-term air quality impact of the project will be project construction and the potential emission of significant quantities of fugitive dust. Uncontrolled fugitive dust emissions from construction activities are estimated to amount to about 1.2 tons per acre per month. 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 vehicles used by construction workers traveling to and from the project.

All long-term air quality impacts associated with the proposed project are indirect. The primary long-term air pollution impact will arise from the increased motor vehicle traffic associated with the project. Increased levels of carbon monoxide concentrations along roadways leading to and from the proposed development will be the main problem, especially near intersections along Kaumualii Highway. Based on mathematical modeling of projected vehicular traffic and atmospheric dispersion calculations, it is predicted that carbon monoxide concentrations in the vicinity of the project will unavoidably increase, but the predicted highest concentrations should remain within the national ambient air quality standards set by the U.S. Environmental Protection Agency. However, the more stringent State of Hawaii ambient air quality standards for carbon monoxide may be exceeded in "hot spot" areas near Kaumualii Highway. Because the state standard has been set so low, it is probably exceeded at nearly any intersection in the state that has even moderate traffic volumes. It is worth noting here that, although the national AAQS allow higher levels of carbon monoxide, the national standards were developed after extensive research with the objective of defining levels of air quality that would protect the public health with an adequate margin of safety.

Another potential long-term, indirect air quality impact of the project will be the increase in air pollution emissions at power generating facilities due to the increase in power that will have to be generated to meet the electrical power demand of the development. Assuming low-sulfur fuel oil is used to generate the required power, it is estimated that power plant emissions of sulfur dioxide would increase by about 50 tons per year, nitrogen oxides emissions would increase by about 15 tons per year, and emissions of particulate matter, carbon monoxide and volatile organics would increase by less than 5 tons per year each.

Solid waste generated by the project could also potentially result in indirect long-term air quality impacts if the refuse is incinerated rather than landfilled. The present practice on Kauai is to landfill solid waste, and this appears to be the most likely scenario for the future. If all refuse from the project were to be incinerated rather than landfilled, carbon monoxide and particulate matter would be the two primary air pollution by-products. It is estimated that carbon monoxide emissions would amount to about 120 tons per year, and emissions of particulate matter would amount to about 50 tons per year or less depending on the emission control equipment.

Pesticides will be used on the project golf course to maintain grass quality. During high wind conditions and/or if improper application techniques are employed, airborne drift could potentially contaminate nearby, downwind areas.

6.2 Mitigative Considerations

Strict compliance with State of Hawaii Air Pollution Control Regulations regarding establishment of a regular dust-watering program and covering of dirt-hauling trucks will be required to effectively mitigate fugitive dust emissions from construction activities. Twice daily watering is estimated to reduce dust emissions by up to 50 percent. Paving of parking areas and establishment of landscaping early in the construction schedule will also help to control dust. Increased vehicular emissions due to disruption of traffic by construction equipment and/or commuting construction workers can be alleviated by moving equipment and personnel to the site during off-peak traffic hours.

The long-term projected impacts of carbon monoxide emissions from vehicular traffic associated with the completed development assume widening of Kaumualii Highway and improvement of intersections in the nearby vicinity of the project. Intersection improvements will include signalization and provision for dedicated turning lanes. Optimization of signal phasing during final design will likely reduce the air quality impacts predicted by this study. Carpooling and/or bus service is another possibility for lessening traffic-related air pollution. Further, as this project will be completed some years hence, it is conceivable that the efficiency of motor vehicle engines and/or emission control equipment will be improved or that vehicles will be developed which burn cleaner fuels before project completion. With regard to the latter, vehicles burning methanol or compressed natural gas or powered by electrical motors are some of the possibilities for technological development that are currently being contemplated. Lastly, even without technological breakthroughs, it is also possible that at some point in the future the State may decide to adopt a motor vehicle inspection and maintenance program which would ensure that emission control devices are properly maintained, and thereby reduce emissions.

Indirect emissions from project electrical demand could be reduced somewhat by utilizing solar energy design features to the maximum extent possible. This might include installing solar water heaters on all new homes, designing homes so that window positions maximize indoor light without unduly increasing indoor heat, and using landscaping to provide afternoon shade to cut down on the use of air conditioning. Use of wind power generating units by the utility instead of fuel-burning facilities would also lessen indirect emissions from project electrical demand.

Solid waste from the project will probably be landfilled, and thus any related air quality emissions would be minimal. If it were to be burned in a municipal incinerator, particulate emissions resulting therefrom could be reduced substantially if the incinerator is fitted with pollution control equipment, i.e., electrostatic precipitators or fabric filters. Conservation and recycling programs could also reduce solid waste which would reduce any related air pollution emissions proportionately. Another possibility for the future is that a garbage-to-energy facility similar to the one currently being built on Oahu might be developed on Kauai. Although this would result in air pollution emissions, the emissions would be offset by the reduced fuel oil that would need to be burned to meet project electrical demand.

Compliance with existing safety guidelines for the spraying of chemicals for golf course maintenance should mitigate potential air quality impacts from this activity.

REFERENCES

1. U.S. Congress. Clean Air Act Amendments of 1977 (P.L. 95-95), Section 109, National Ambient Air Quality Standards, August 1977.

2. U.S. Environmental Protection Agency. Revisions to National Ambient Air Quality Standards for Particulate Matter, Federal Register, Vol. 52, p. 2463, July 1, 1987.

3. Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Fourth Edition Including Supplement A, AP-42, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1985.

4. State of Hawaii. Hawaii Administrative Rules, Chapter 11-60, Air Pollution Control.

5. Lihue Puhi Master Plan, 608-Acre Zoning Change, Traffic Impact Assessment Report, Pacific Planning & Engineering, Inc., April 1989.

6. User's Guide to MOBILE3 (Mobile Source Emissions Model), EPA 460/3-84-002, U.S. Environmental Protection Agency, June 1984.

7. CALINE4 - A Dispersion Model for Predicting Air Pollutant Concentrations Near Roadways, FHWA/CA/TL-84/15, California State Department of Transportation, November 1984 with July 1985 Revisions.

8. Guidelines for Air Quality Maintenance Planning and Analysis; Indirect Sources, Volume 9 Revised, U.S. Environmental Protection Agency, September 1978.

9. Compilation of Air Pollutant Emission Factors, Second Edition, AP-42, U.S. Environmental Protection Agency, Research Triangle Park, NC, August 1977.

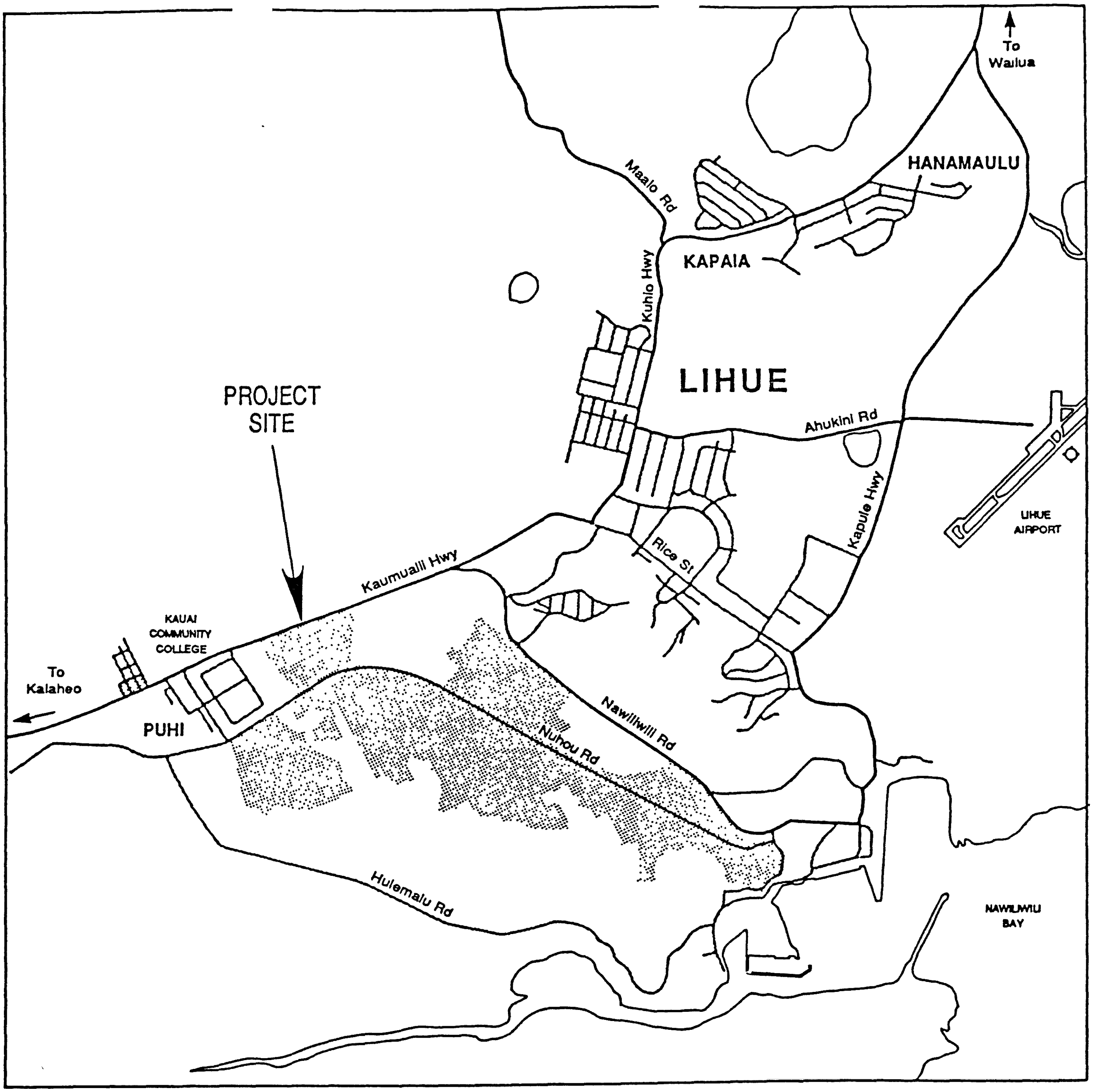

Figure 1. Project Location Map and Roadway Network

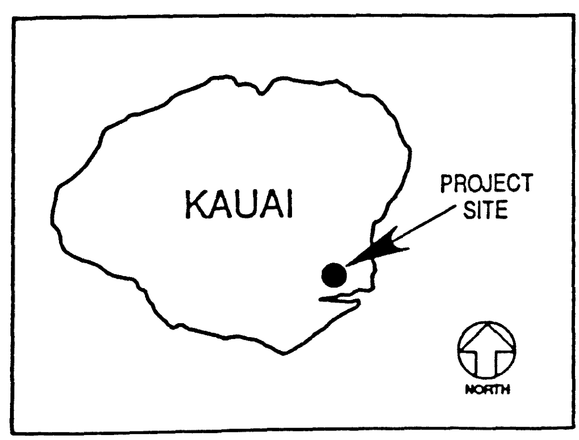

Table 1

SUMMARY OF STATE OF HAWAII AND NATIONAL AMBIENT AIR QUALITY STANDARDS (AAQS)

Pollutant (units)	Averaging Time	Maximum Allowable Concentration: National Primary	National Secondary	State of Hawaii
Suspended Particulate Matter (ug/m^3)	Annual	-	-	60[a]
	24 Hours	-	-	150[b]
Particulate Matter[c] (ug/m^3)	Annual	50	50	-
	24 Hours	150[b]	150[b]	-
Sulfur Dioxide (ug/m^3)	Annual	80	-	80
	24 Hours	365[b]	-	365[b]
	3 Hours	-	1300[b]	1300[b]
Nitrogen Dioxide (ug/m^3)	Annual	100	100	70
Carbon Monoxide (mg/m^3)	8 Hours	10[b]	-	5[b]
	1 Hour	40[b]	-	10[b]
Ozone (ug/m^3)	1 Hour	235[b]	235[b]	100[b]
Lead (ug/m^3)	Calendar Quarter	1.5	1.5	1.5

[a]Geometric mean
[b]Not to be exceeded more than once per year
[c]Particles less than or equal to 10 microns aerodynamic diameter

Table 2

AIR POLLUTION EMISSIONS INVENTORY FOR
COUNTY OF KAUAI, 1980

Source Category	Percent of Total County Emissions				
	Particulate	Sulfur Oxides	Nitrogen Oxides	Carbon Monoxide	Hydrocarbons
Steam Electric Power Plants	1.9	64.5	25.2	0.4	0.3
Gas Utilities	0.0	0.0	0.0	0.0	0.0
Fuel Combustion in Agricultural Industry	51.3	9.0	8.0	0.0	0.0
Refinery Industry	0.0	0.0	0.0	0.0	0.0
Petroleum Storage	0.0	0.0	0.0	0.0	0.0
Metallurgical Industries	0.0	0.0	0.0	0.0	0.0
Mineral Products Industry	2.4	0.4	1.5	0.0	0.0
Municipal Incineration	0.0	0.0	0.0	0.0	0.0
Motor Vehicles	3.9	12.0	53.8	58.4	50.5
Construction, Farm and Industrial Vehicles	0.5	1.9	6.3	1.5	1.1
Aircraft	0.2	1.4	3.8	3.3	2.7
Vessels	0.2	10.8	1.4	0.1	0.5
Agricultural Field Burning	39.6	0.0	0.0	36.3	44.9
Total in Percent	100.0	100.0	100.0	100.0	100.0
Total in Tons per Year	3129	698	2678	34,179	3773

Source: State of Hawaii, Department of Health

Table 3

AMBIENT AIR QUALITY MEASUREMENTS
AT KAUAI DISTRICT HEALTH OFFICE, LIHUE[a,b]

Year	Particulates Range	Particulates Mean	Sulfur Dioxide Range	Sulfur Dioxide Mean	Nitrogen Dioxide Range	Nitrogen Dioxide Mean
1973	16-173	39	<5-8	<5	<20-49	<20
1974	13-110	37	<5	<5	<20-86	<20
1975	16-96	40	<5-13	<5	<5-31	7
1976	20-112	37	<5	<5	<5-17	11
1977	12-84	34	<5	<5	discontinued	
1978	22-124	37	<5	<5		
1979	16-86	39	<5	<5		
1980	16-98	38	<5	<5		
1981	18-83	37	<5	<5		
1982	15-87	34	<5	<5		
1983	24-90	39	<5	<5		
1984	13-91	34	<5	<5		
1985[c]	17-76	34	<5-8	<5		
1986[d]	11-42	22	discontinued			
1987[d]	11-42	22				

[a] 24-hour averages, micrograms per cubic meter.
[b] Sampling site located about 2 miles north of project site. Frequency of sampling was approximately every six days yielding about 50 samples per year.
[c] Sampling for particulates and sulfur dioxide discontinued in October 1985.
[d] Particulate sampling for 1986 and 1987 are PM-10 only.

Table 4

ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS
ALONG ROADWAYS NEAR LIHUE PUHI
(milligrams per cubic meter)

Roadway Intersection	Year/Scenario		
	1989/ Present	2000/ Without Project	2000/ With Project
Kaumualii Highway and Nawiliwili Road	12.6	12.8	16.4
Kaumualii Highway and Nuhou Road	1.6	3.4	13.6
Kaumualii Highway and Puhi Road	3.7	12.1	12.8

Hawaii State AAQS: 10
National AAQS: 40

Table 5

ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS
ALONG ROADWAYS NEAR LIHUE PUHI
(milligrams per cubic meter)

Roadway Intersection	Year/Scenario 1989/ Present	2000/ Without Project	2000/ With Project
Kaumualii Highway and Nawiliwili Road	7.6	7.7	9.8
Kaumualii Highway and Nuhou Road	1.0	2.0	8.2
Kaumualii Highway and Puhi Road	2.2	7.3	7.7

Hawaii State AAQS: 5
National AAQS: 10

Table 6

ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM LIHUE PUHI PROJECT ELECTRICAL DEMAND[a]

Air Pollutant	Emission Rate (tons/year)
Particulate	1.5
Sulfur Dioxide	50
Carbon Monoxide	3.5
Volatile Organics	0.2
Nitrogen Oxides	15

[a]Based on U.S. EPA emission factors for industrial boilers [9]. Assumes electrical demand of 20 million Kw-hrs per year and low sulfur oil used to generate power.

Table 7

UNCONTROLLED AIR POLLUTION EMISSION FACTORS FOR MUNICIPAL REFUSE INCINERATORS (lb/ton)[a]

Air Pollutant	Emission Factor
Particulate	14
Sulfur Oxides	2.5
Carbon Monoxide	35
Organics	1.5
Nitrogen Oxides	3

[a]Emission factors are given in terms of weight of material emitted per unit weight of refuse material charged.
[b]Assumes incinerator equipped with settling chamber and water spray.

Source: U.S. Environmental Protection Agency [3]