GREENHOUSE GAS / GLOBAL WARMING RISK ASSESSMENT
RAMONA BRANCH LIBRARY DEVELOPMENT SITE
SAN DIEGO COUNTY, CA

Submitted to:

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INTRODUCTION AND DEFINITIONS

Existing Site Characterization

The subject property consists of approximately 7.32 acres within the downtown district of Ramona, California (refer to Figure 1 on the following page). Specifically, the project site is fronted by State Route 67 (SR 67), on the northwest corner of 13th and Main Street (SR 67). Access to the site is obtained via Main Street (SR 67), as can be seen in Figure 2 on Page 3 of this report.

The development site currently exists as a vacant previously disturbed lot as can be seen in Figure 3 on Page 4 of this report. The mean topography of the site is approximately 1,420 feet above mean sea level (MSL).

Project Description

The County of San Diego Department of General Services proposes to develop a new branch library in downtown Ramona on the northwest corner of 13th and Main Street. The library building will front Main Street and have a total footprint of approximately 21,000 square-feet (19,500 square feet of net usable space), as can be seen in Figure 4 on Page 5 of this report.

At the rear of the proposed library structure will be a parking lot with 65 parking spaces, including three designated for handicapped parking. Vehicular access to the site is anticipated via a driveway off of 13th Street. The Ramona Library project will also include associated facilities such as landscaping and, potentially, internal walkways, as well as a sidewalk and pedestrian entrance to the site along Main Street.

Although the current project site is 7.32 acres in size, only a portion of the site is dedicated to the library and the remainder will be rough graded for future development of public uses that will compliment the library facility. Future facilities may include a senior center, or other healthcare or recreational facilities.

Historical Context of Global Warming

Much recent conjecture has been postulated as to the effect of the *so-called, 'Global Warming Phenomenon'* or *'Greenhouse Effect'* and its correlation to anthropogenic *'Greenhouse Gas (GHG) Emissions'*. The debate began based upon initial observations that global surface temperatures have been perceived to be steadily increasing over the past century (the period for which competent and reliable measurements have been taken).[1]

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[1] In fact, the notion that manmade global warming was a possibility has existed since the early 1880's and been the subject of debate both within the realms of scientific fact, as well as science fiction.

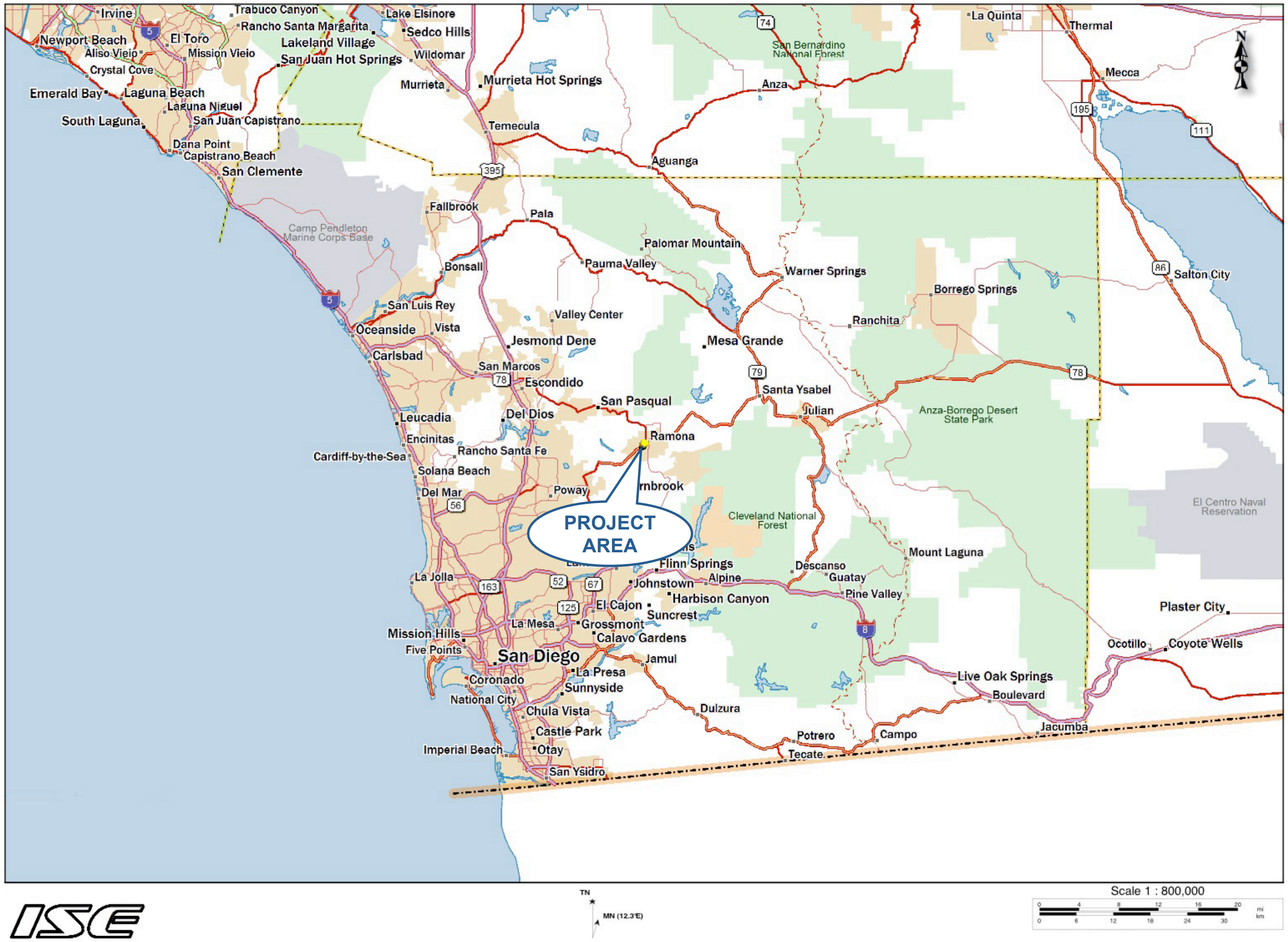

FIGURE 1: Project Vicinity Map (ISE 6/09)

FIGURE 2: Project Site Location Map and Property Boundary Extents (ISE 6/09)

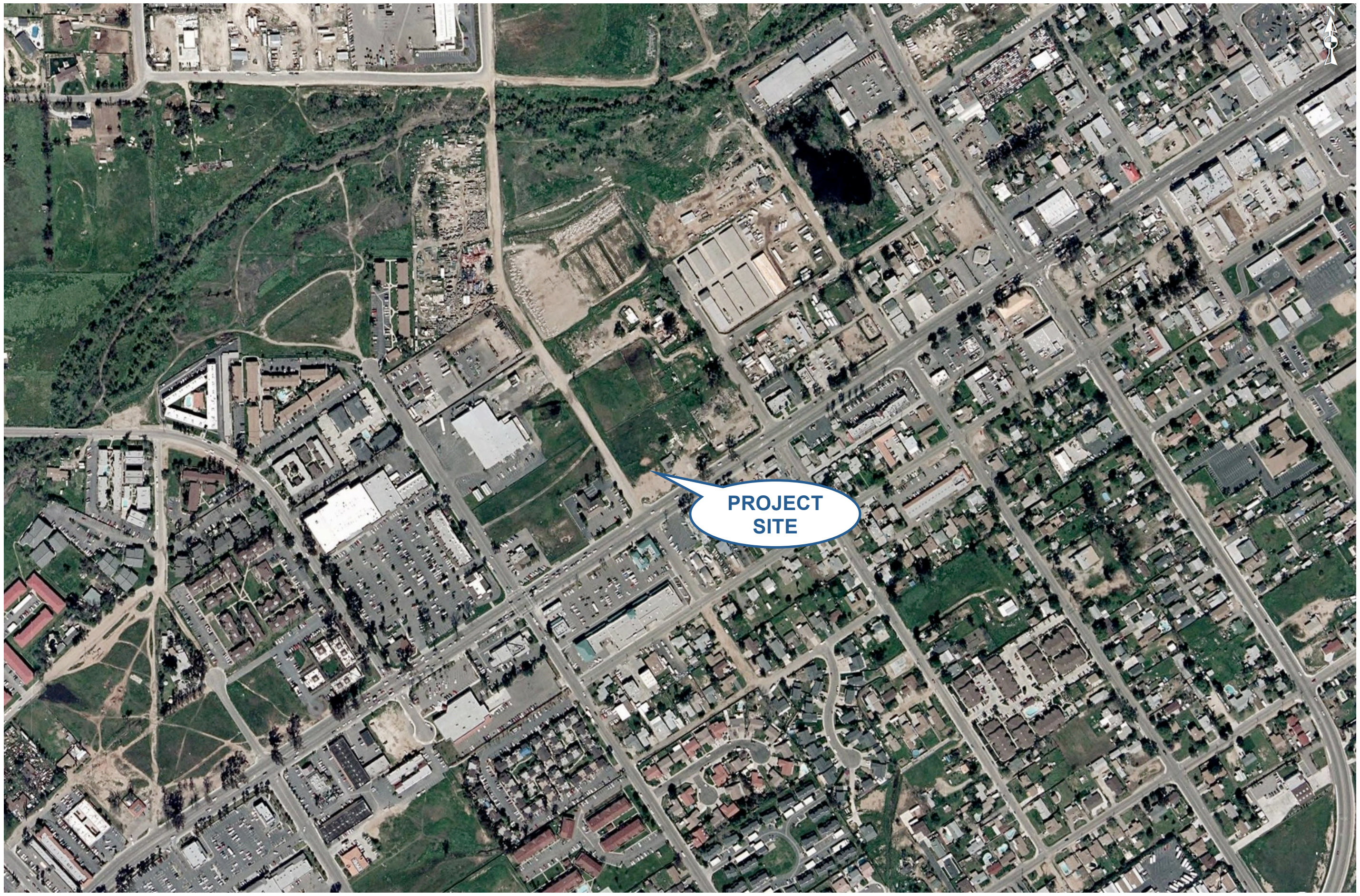

FIGURE 3: Project Site Aerial Photograph (Google Earth 6/09)

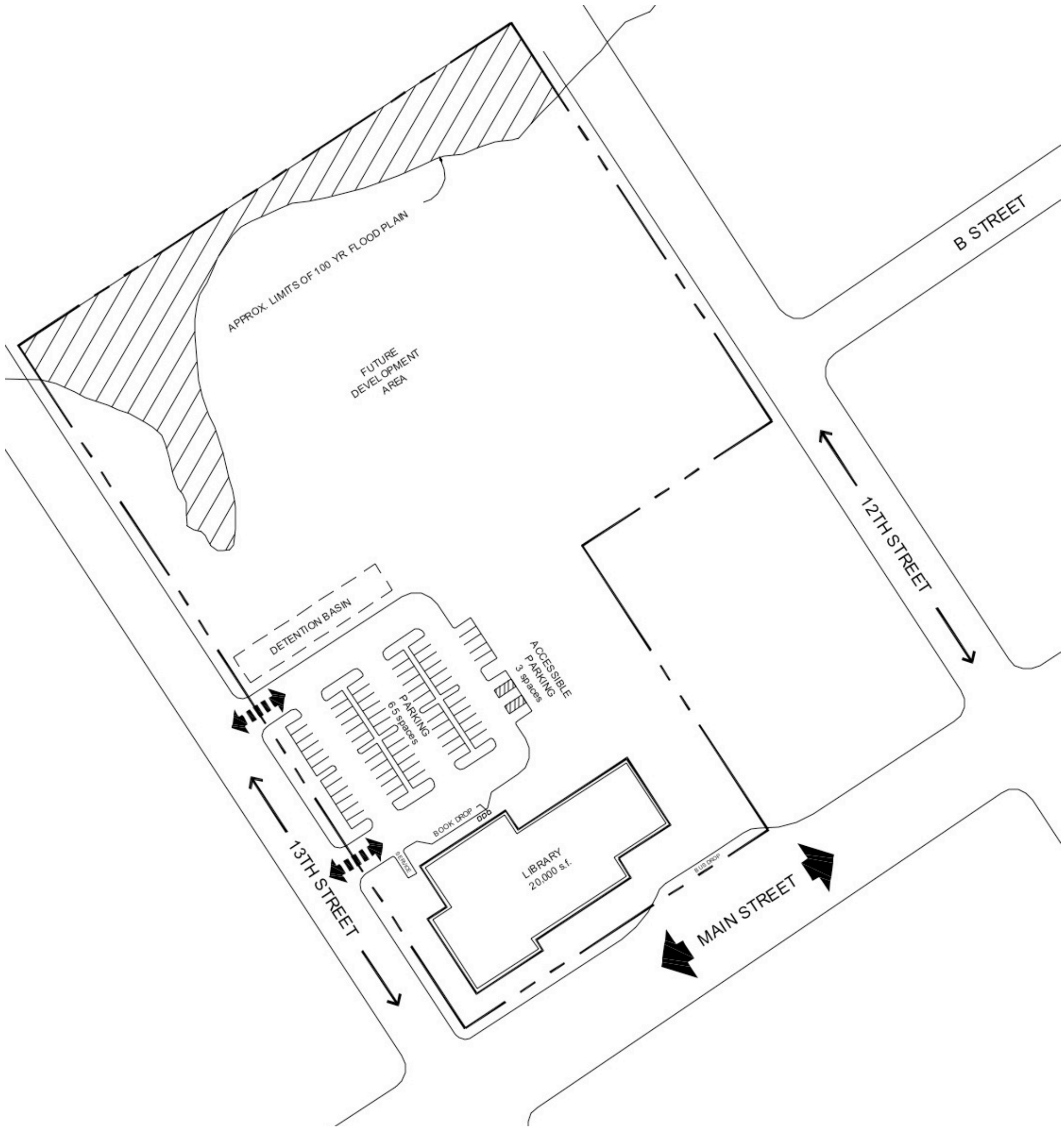

FIGURE 4: Proposed Ramona Branch Library Development Plan (HDR 5/09)

Overall, the surface temperature reported by some, has seen an increase of roughly 0.6 degrees Centigrade, as can be seen in the first pane of Figure 5 on the following page.[2,3]

Further examination of ice core records and tree ring data allowed researchers to probe far back in time to look at surface temperature variations over the past millennia (refer to the second pane of Figure 5).[4,5] The results would seem to indicate a noticeable increase in surface temperature over the past 100 years, occurring in roughly 1910 AD, becoming cyclically maximal around 1940 AD, and having a period of recurrence of slightly over 30 years.[6]

This observation led then Prime Minister Margaret Thatcher, following the United Kingdom's (UK's) General Election of 1979, to adopt what was at the time believed to be a relatively arcane and obscure theory for her pro-nuclear power generation platform: namely, the notion that Carbon Dioxide (CO_2) was the primary constituent to atmospheric warming, and that fossil-fuel {coal} burning power plants should be replaced with cleaner sources.[7]

At her insistence, the UK's *Hadley Centre for Climate Prediction and Research* was formed to advance this theory. This center ultimately became the operating agency for the IPCC's scientific Working Group I.

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[2] The majority of this increase in temperature, which is formally expressed by the United Nations as *0.6 ± 0.2 degrees Centigrade*, occurred before 1940 AD, which is the generally accepted date when anthropogenic atmospheric CO_2 levels started any noticeable increase. The data presented in the first pane of Figure 4 provides information from surface temperature stations (red bars), as well as the annual average (the black trend line). The gray bars indicate the 95-percent confidence limits on the data. The black global temperature line (which is the basis of the whole global temperature increase argument) is only as good as the bounds of the gray tick-marks (which can have errors as large as, or larger than, the data point being represented).

[3] *Source:* IPCC, 2001, *Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change* [Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson(eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 388-389.

[4] *Ibid.*

[5] The second pane of temperature trends from the IPCC report shows the same red bars (known temperature station data from the past 140 years), as well as a blue curve (which is a reconstructed temperature curve based upon ice cores and other natural evidence), and also a black curve, which is the 50-year moving average line. As in the previous graph pane, the gray marks indicate the 95-percent confidence intervals of the data. The IPCC report is very careful in its wording with respect to the historical reconstruction (which would indicate that over the past 1,000 years the temperature has been hotter, or colder, or neither – namely, it is statistically meaningless). Incidentally, this is the infamous *'hockey-stick'* graph highly touted by Al Gore as conclusive proof of anthropogenic global warming – a graph from which the UN has been very much distancing itself over the past couple of years.

[6] Recent (2007) Microwave Sounding Unit (MSU) temperature measurements made from NOAA's polar-orbiting satellite platforms of the lower troposphere indicate a *cooling* of the planet despite an incremental increase in CO_2 levels. In fact, the same satellites have shown a steady *decrease* in temperature within the tropopause of 0.314 degrees Centigrade per decade since 1979, so that now the UN's original increase of 0.6 ± 0.2 degrees Centigrade has all but disappeared.

[7] This, in historical context, was based upon what many believe to have been the Prime Minister's desire to limit the political power of the *National Union of Mineworkers* (NUM), who had played a significant role in the defeat of her Conservative Party in the 1974 election.

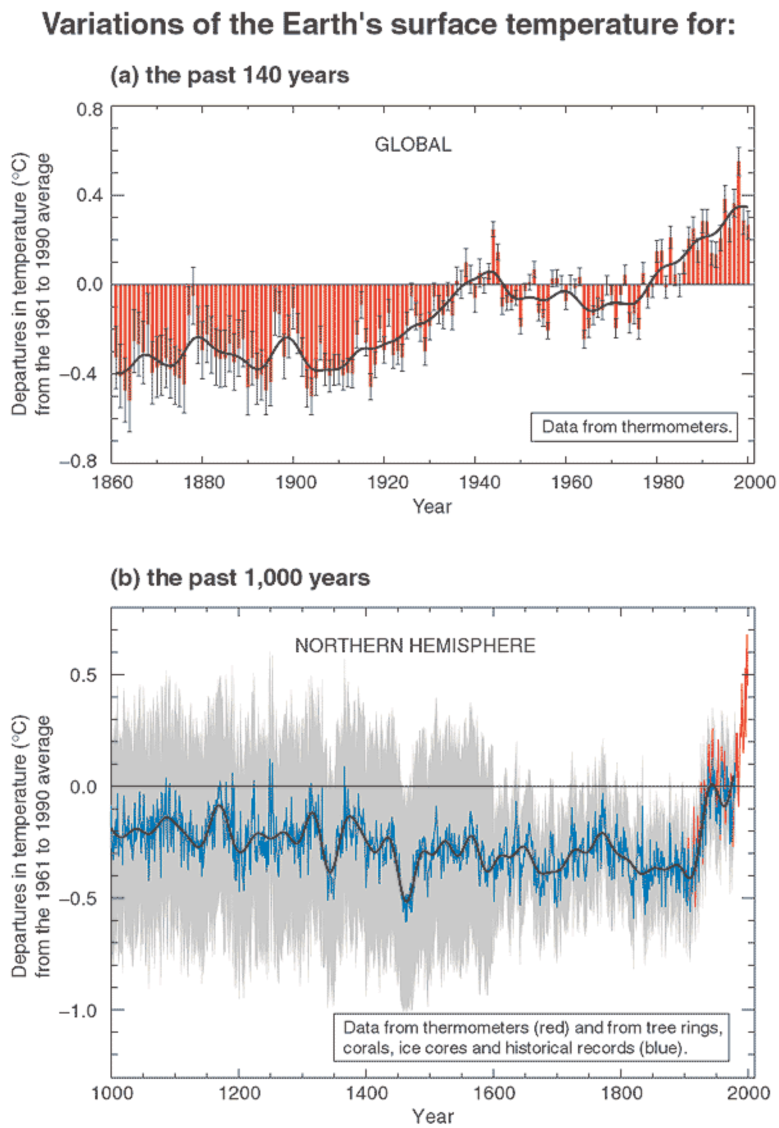

FIGURE 5: Measured/Predicted Global Temperature Variations (UN IPCC)[8]

[8] From the *Third Assessment Report of Working Group I* of the Intergovernmental Panel on Climate Change (IPCC), 2001.

Greenhouse Gases and Global Warming Potential

Greenhouse gases are defined as those naturally occurring and anthropogenic chemical compounds within the atmosphere that absorb and reflect infrared radiation emitted by the Earth's surface.[9] A numerical metric known as the *'Global Warming Potential'* (GWP) is a measure of how much a given mass of greenhouse gas is estimated to contribute to global warming relative to Carbon Dioxide (whose GWP defined as 1.0).

Naturally occurring greenhouse gases include the aforementioned carbon dioxide (CO_2), water vapor (H_2O), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3). In addition, several classes of halogenated substances that contain fluorine, chlorine, or bromine also demonstrate a 'greenhouse' gas potential. Examples of these pollutants are halocarbons, perfluorocarbons (PFC's), and sulfur hexafluoride (SF_6), etc.

Examples of the more prevalent gases are detailed below:

- Carbon dioxide (CO_2): CO_2 is a naturally occurring gas and is part of the *carbon cycle,* whereby carbon is cycled between the atmosphere, ocean, terrestrial life, and mineral reserves. The predominant source of anthropogenic carbon dioxide emissions is from the combustion of fossil fuels and hydrocarbons. Without CO_2, all life on Earth would cease to exist. Carbon Dioxide is the reference gas against which all other greenhouse gases are compared. It has a Global Warming Potential (GWP) of 1.0 and makes up approximately 3.6 percent of the global warming gases in the atmosphere today.

- Water Vapor (H_2O): Water is a chemical compound that is essential to all known forms of life and has been denoted as '*the universal solvent'*. Water vapor is the gaseous form of water comprising roughly 0.001% of all water on the planet. Without H_2O, all life on Earth would cease to exist. Although water vapor has the ability to capture roughly 10 times as much infrared energy as CO_2, its GWP was omitted from the IPCC's report.[10] Water vapor makes up approximately 95 percent of the global warming gases in the atmosphere today.

- Methane (CH_4): CH_4 is a greenhouse gas with both natural and anthropogenic sources and is believed to have been the primary atmospheric constituent during the early primordial Earth. Methane is naturally produced by the anaerobic decomposition of organic matter. Methane is also emitted during the production and distribution of natural gas and petroleum, and is released as a by-product of incomplete {low-temperature} fossil fuel combustion. It is estimated that a little more than half of the current methane emissions to the atmosphere are from anthropogenic sources. Methane has a GWP of 23 and constitutes approximately 0.36 percent of the global warming gases in the atmosphere today.

- Nitrous Oxide (N_2O): Primarily, N_2O is naturally produced by bacterial action within the soil, and anthropogenically by high temperature combustion. The result is more-or-less the production of

[9] The basic mechanism can be summarized as follows: 1) solar radiation heats the planet primarily through ultraviolet and higher energy transmission, 2) the rock {Earth} gets warm and is offset by temperature levels in the oceans (which act as a global thermostat), 3) the warm rock emits black-body radiation in the lower infrared portion of the electromagnetic spectrum, 4) most of the infrared radiation escapes the planet in accordance with the First Law of Thermodynamics, 5) a small portion of the energy is captured through molecular motion changes within the atmospheric greenhouse gases, and 6) this captured energy re-radiates back toward the rock (and space for that matter) producing a secondary heating effect. However, despite its name, this is not the same mechanism by which a greenhouse operates.

[10] In fact, the IPCC scientific panel states that about half of the projected global temperature increase from CO_2 is due to what is referred to as the *water vapor feedback effect*. In order to quantify the level of feedback due to water vapor, one needs to know the radiative efficiency of H_2O in vaporous form (i.e., the GWP). For some reason, nowhere in the IPCC report is this critical value presented.

photochemical smog. Lesser sources, such as manufacturing, wastewater treatment, and biomass burning, also produce trace amounts of this substance. N_2O has a GWP of 296, and constitutes approximately 0.95 percent of the global warming gases in the atmosphere today.

- Halocarbons (CFC's) / Perfluorocarbons (PFC's) are carbon compounds that contain fluorine, chlorine, bromine or iodine. Anthropogenic sources are the primary (if not sole) generator of these substances. These gases have GWP's ranging from slightly over 100 to as high as 22,000. These gases constitute a mere 0.072 percent of the global warming gases in the atmosphere today.

A complete listing of known greenhouse gases and their associated GWP is shown starting below in Table 1.

TABLE 1: Known Greenhouse Gases and Global Warming Potential[11]

Pollutant Name	Chemical Formula	GWP Relative to CO_2 (100 year horizon)
Carbon Dioxide	CO_2	1
Dibromomethane	CH_2Br_2	1
R-13I1 (Trifluoroiodomethane)	FIC-13I_1	1
R-E170 (Dimethyl ether)	CH_3OCH_3	1
Methyl Bromide	CH_3Br	5
Dichloromethane	CH_2Cl_2	10
R-161 (HFC-161, Fluoroethane)	HFC-161	12
R-40 (Methyl Chloride)	CH_3Cl	16
Methane	CH_4	23
Chloroform	$CHCl_3$	30
2,2,3,3,3-Pentafluoro-1-propanol	$CF_3CF_2CH_2OH$	40
R-152 (HFC-152, 1,1-Difluoroethane)	HFC-152	43
2,2,2-Trifluoro-ethanol	$(CF_3)CH_2OH$	57
R-41 (HFC-41, Methyl fluoride)	HFC-41	97
R-123 (HCFC-123, Dichlorotrifluoroethane)	HCFC-123	120
R-152a (HFC-152a, 1,1-Difluoroethane)	HFC-152a	120
1,1,1-Trichloroethane	CH_3CCl_3	140
1,1,1,3,3,3-Hexafluoro-2-Propanol	$(CF_3)_2CHOH$	190
R-21 (Dichlorofluoromethane)	HCFC-21	210
Nitrous Oxide	N_2O	296
HFC-143, 1,1,2-Trifluoroethane	HFC-143	330

[11] Source: *Climate Change 2001: The Scientific Basis*. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change, IPCC 2001.

TABLE 1 (cont.): Known Greenhouse Gases and Global Warming Potential[12]

Pollutant Name	Chemical Formula	GWP Relative to CO_2 (100 year horizon)
Methyl perfluoroisopropyl ether	$(CF_3)_2CFOCH_3$	330
Bromodifluoromethane	$CHBrF_2$	470
R-32 (HFC-32, Difluoromethane)	HFC-32	550
R-124 (HCFC-124, 2-Chloro-1,1,1,2-Tetrafluoroethane)	HCFC-124	620
R-141b (HCFC-141b, 1,1-Dichloro-1-fluoroethane)	HCFC-141b	700
HFE-143a	HFE-143a	750
HFC-134, 1,1,2,2-Tetrafluoroethane	HFC-134	1,100
R-12B1 (Difluorochlorobromomethane, Halo 1211)	Halon-1211	1,300
R-134a (HFC-134a, 1,1,1,2-Tetrafluoroethane)	HFC-134a	1,300
R-22 (Chlorodifluoromethane)	HCFC-22	1,700
Carbon Tetrachloride	CCl_4	1,800
R-142b (HCFC-142b, 1-Chloro-1,1-difluoroethane)	HCFC-142b	2,400
R-125 (HFC-125, Fc-125, Pentafluoroethane)	HFC-125	3,400
R-143a (HFC-143a, 1,1,1-Trifluoroethane)	HFC-143a	4,300
R-11 (Trichlorofluoromethane)	CFC-11	4,600
R-14 (Carbon Tetrafluoride)	CF_4	5,700
R-113 (1,1,2-Trichloro-1,2,2-Trifluoroethane)	CFC-113	6,000
R-E134 (HFE-134, 1,1,1',1'-Tetrafluorodimethyl ether)	HFE-134	6,100
R-13B1 (Trifluorobromomethane, Halo 1301)	$CBrF_3$	6,900
R-115 (Chloropentafluoroethane)	CFC-115	7,200
C_3F_8 (Perfluoropropane)	C_3F_8	8,600
C_4F_{10} (Perfluoro-n-Butane)	C_4F_{10}	8,600
C_5F_{12} (Perfluoropentane)	C_5F_{12}	8,900
C_6F_{14} (Perfluorohexane)	C_6F_{14}	9,000
R-114 (Freon 114, 1,2-Dichlorotetrafluoroethane)	CFC-114	9,800
R-C318 (Freon 318, Octafluorocyclobutane)	$C\text{-}C_4F_8$	10,000
R-12 (Freon 12, Dichlorodifluoromethane)	CFC-12	10,600
Nitrogen Trifluoride; Trifluoramine	NF_3	10,800
R-116 (Perfluoroethane; Hexafluoroethane)	C_2F_6	11,900
R-23 (HFC-23, Trifluoromethane)	HFC-23	12,000
R-13 (Chlorotrifluoromethane)	CFC-13	14,000
R-E125 (HFE-125, Pentafluorodimethyl ether)	HFE-125	14,900
Sulfur Hexafluoride	SF_6	22,200

[12] Source: *Climate Change 2001: The Scientific Basis*. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change, IPCC 2001.

THRESHOLDS OF SIGNIFICANCE

California Environmental Quality Act (CEQA) Thresholds

Section 15382 of the California Environmental Quality Act (CEQA) guidelines defines a significant impact as,

> *"… a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project including land, air, water, minerals, flora, fauna, ambient noise, and objects of historic or aesthetic significance."*

Although Global Warming and the associated greenhouse gas effects are not explicitly defined under CEQA and yet to have any defined set of significance standards, the Section above is sufficiently broad enough in definition to allow its discussion within the air quality topic of CEQA.

The California Global Warming Solutions Act (AB 32)

Operating under the assumption that Global Warming is a real phenomenon and that atmospheric carbon is the single largest contributor to the phenomenon, the California State Legislature passed the *California Global Warming Solutions Act of 2006* (Assembly Bill 32, or AB 32) which requires the California Air Resources Board (CARB) to develop regulations and market mechanisms that will ultimately reduce California's greenhouse gas emissions by 25 percent by 2020.

Mandatory caps will begin in 2012 for significant sources and ratchet down to meet the 2020 goals. Specifically, AB 32 requires CARB to:

1) Establish a statewide greenhouse gas emissions cap for 2020, based on 1990 emissions by January 1, 2008.
2) Adopt mandatory reporting rules for significant sources of greenhouse gases by January 1, 2009.
3) Adopt a plan by January 1, 2009 indicating how emission reductions will be achieved from significant greenhouse gas sources via regulations, market mechanisms and other actions.
4) Adopt regulations by January 1, 2011 to achieve the maximum technologically feasible and cost-effective reductions in greenhouse gas, including provisions for using both market mechanisms and alternative compliance mechanisms.
5) Convene an Environmental Justice Advisory Committee and an Economic and Technology Advancement Advisory Committee to advise CARB.
6) Ensure public notice and opportunity for comment for all CARB actions.
7) Prior to imposing any mandates or authorizing market mechanisms, CARB must evaluate several factors, including but not limited to, impacts on California's economy, the environment and public health; equity between regulated entities; electricity reliability; conformance with other environmental laws; and that the rules do not disproportionately impact low-income communities.

For the purposes of analysis within this report, it will be sought to quantify the aggregate greenhouse gas emissions due to the proposed project action as well as quantify the net heating effect to the State of California. Mitigation measures and/or recommendations designed to reduce statewide emissions by a minimum of 25-percent are provided at the end of this report.

ANALYSIS METHODOLOGY

Greenhouse Gas Compilation Approach

Diesel Powered (Compression Ignition) Equipment Contribution

Greenhouse gas emissions associated with diesel engine combustion from mass grading construction equipment will be assumed to occur for engines running at the correct fuel to air ratios.[13] Of principal interest are the emission factors for CO_2 and NO_X[14]. For a four-stroke diesel-cycle engine, the combustion byproducts are approximately 1.5-percent-by-volume O_2, 0.5-percent-by-volume CO, and 13.5-percent-by-volume CO_2.[15] Thus, the ratio of CO_2 to CO production in a properly mixed diesel stroke would be 13.5/0.5 or 27:1.

Operational Motor Vehicle (Spark Ignition) Contribution

Greenhouse gas emissions associated with motor vehicle trips for the proposed project were calculated by multiplying the appropriate emission factor (in grams per mile) times the estimated trip length and the total number of vehicles. Appropriate conversion factors were then applied to provide aggregate emission units of pounds per day.

CARB estimates on-road motor vehicle emissions by using a series of models called the *Motor Vehicle Emission Inventory* (MVEI) Models. Four computer models, which form the MVEI, are *CALIMFAC, WEIGHT, EMFAC*, and *BURDEN*.[16] They function as follows:

- The *CALIMFAC* model produces base emission rates for each model year when a vehicle is new and as it accumulates mileage and the emission controls deteriorate.
- The *WEIGHT* model calculates the relative weighting each model year should be given in the total inventory, and each model year's accumulated mileage.
- The *EMFAC* model uses these pieces of information, along with the correction factors and other data, to produce fleet composite emission factors.
- Finally, the *BURDEN* model combines the emission factors with county-specific activity data to produce to emission inventories.

[13] The ratio whereby complete combustion of the diesel fuel occurs.

[14] It will be assumed that the project would generate trace-, if not negligible-, levels of methane (CH_4), ozone (O_3), fluorine (F_2), chlorine (Cl_2), bromine (Br_2) and/or constituent compounds. NO_x emissions are stoichiometrically composed of roughly 30-percent nitrous oxide (N_2O) by volume and 70-percent nitric oxide (NO), which is the free radical form that immediately combines with ozone (O_3) to form nitrogen dioxide (NO_2) more commonly known as *smog*.

[15] Source: Holtz, J.C., Elliott, M.A., *The Significance of Diesel-Exhaust-Gas Analysis, Transactions of the ASME, Vol. 63, February 1941*.

[16] The module named *EMFAC* should not be confused with the entire EMFAC 2007 program itself (which calls the subroutines *CALIMFAC, WEIGHT, EMFAC, and BURDEN* to determine the final emission inventory for a particular area).

For the current analysis, the *EMFAC 2007 Model v2.3* of the MVEI[17] was run using input conditions specific to the San Diego air basin to predict vehicle emissions based upon the estimated year 2013 project completion date (i.e., the earliest date whereby any significant completion of the project is anticipated).

The aggregate greenhouse emission factors from the CARB *EMFAC 2007* model are provided as an attachment at the end of this report. Of principal interest are the emission factors for CO_2 and NO_X.

For the analysis, a mix ratio consistent with the Caltrans ITS Transportation Project-Level Carbon Monoxide Protocol was used. This consisted of the following air standard Otto-Cycle engine vehicle distribution percentages:

Light Duty Autos = 69.0	Light Duty Trucks = 19.4
Medium Duty Trucks = 6.4	Heavy Duty Trucks = 4.7
Buses = 0.0	Motorcycles = 0.5

Small Engine and Natural Gas Fired (External Combustion) Contribution

Finally, operational fixed greenhouse gas sources under the CEQA analysis context within this report would consist entirely of small gasoline engines used with landscaping equipment, as well as emissive sources from natural gas powered appliances (such as hot water heaters). An aggregate greenhouse gas tabulation of these sources, consistent with the *SCAQMD CEQA Handbook* and current EPA protocols, will be provided.[18,19]

Projected Greenhouse Gas Emissions Budget and Warming Effects Analysis

To address the net perceived greenhouse gas emissions and global warming potential of the project per AB 32, the entire State of California will be modeled as a thermodynamically closed system, subject only to increasing CO_2 concentrations and their equivalents (denoted as CO_{2e}). This approach creates a type of *Urban Heat Island* dependant only on CO_2 whereby the effective temperature increase on the State due to the proposed project action can be quantified using the methodology identified in the U.N.'s Third Assessment Report of the Intergovernmental Panel on Climate Change.[20]

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[17] This is the most current CARB vehicle emissions model approved for use within the State of California. Any subsidiary program (such as the previously discussed *URBEMIS* program) uses this model to determine the applicable vehicle emission factors.

[18] Ibid.

[19] The analysis presented herein uses the same methodology identified in the CARB *URBEMIS* model, although providing a greater level of detail. The technical details are provided in the SCAQMD CEQA Handbook Tables A9-12 and A9-12A, -B as well as the EPA's AP-42 emission generation document previously referenced.

[20] An Urban Heat Island (or UHI) is a developed area that is significantly warmer than its undeveloped surroundings. The temperature difference usually is larger at night than during the day, and larger in winter than in summer, due to the re-radiation of solar energy by paved surfaces and buildings, and waste heat generated by energy usage and building heating and cooling. Water vapor will be completely ignored from the analysis (as is done in the United Nations source document).

The analysis presented herein is consistent and in accordance with the *First Law of Thermodynamics*.[21] Mitigation measures consistent with State of California's policy implementation of AB 32 will be provided at the end of the report.

FINDINGS

Greenhouse Gas Emission Tabulation

Diesel Powered (Compression Ignition) Equipment Contribution

The Ramona Branch Library project would utilize a worst-case contingency of equipment required to mass grade the site for a maximum period of 30-days. Previous analysis of the required equipment and subsequent emissions budget has been examined within the projects *Air Quality Conformity Assessment*.[22] The pertinent findings are shown below, in Table 2.

TABLE 2: Construction Vehicle GHG Emission Levels – Ramona Branch Library Site (Tier O)

		Emission Rates (in pounds)			
Construction Phase	**Equipment Classification**	**CO**	**NO_X**	**$CO_2 = 27 \cdot CO$**	**$N_2O = 0.3 \cdot NO_X$**
Mass Grading	Dozer - D8 Cat	10.8	27.6	8,748.0	248.4
Mass Grading	Loader	9.0	13.2	7,290.0	118.8
Mass Grading	Water Truck	2.4	8.4	1,944.0	75.6
Mass Grading	Dump/Haul Trucks	5.8	20.2	4,698.0	181.8
Mass Grading	Scraper	29.7	51.3	24,057.0	461.7
	SUM (Σ):	**57.7**	**120.7**	**46,737.0**	**1,086.3**

Since N_2O has a GWP of 296 with respect to CO_2, this result can be expressed as an *equivalent* CO_2 level (sometimes denoted as CO_{2e}) of 321,544.8 pounds. Thus the final equivalent CO_2 GHG load due to the project would be the summation of this value and the direct CO_2 production shown in Table 2, above, or 368,281.8 pounds CO_{2e} while mass grading activities commence.

Operational Motor Vehicle (Spark Ignition) Contribution

Motor vehicles are the primary source of greenhouse gas emissions associated with the proposed project development. Typically, uses such as the proposed project do not directly emit significant amounts of greenhouse gases from onsite activities. Rather, vehicular trips to and from these land uses are the significant contributor.

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[21] Simply expressed, the *First Law of Thermodynamics* states that for any thermodynamic system, the sum of the heat 'h' contained within the system (or that it receives) plus the work 'w' that the system is capable of (or receives) is equal to the total internal energy 'E' of the system. The first law of thermodynamics basically states that a thermodynamic system can store energy in two different forms (namely heat and/or work) and that this internal energy is conserved.

[22] Source: *Air Quality Conformity Assessment – Ramona Branch Library Development Site – San Diego County, CA, ISE Project #09-005, Investigative Science and Engineering, Inc., 6/14/09.*

The aggregate project emission levels are shown below in Table 3. The proposed project site is expected to have a total trip generation level of 975 ADT.[23] The average vehicle trip length would be five-miles, with a median running speed of 45 MPH.

TABLE 3: Operational Vehicle GHG Levels – Ramona Branch Library Site

		Total Emissions (pounds per day)	
Vehicle Classification	**Trip ADT**	**CO_2**	**N_2O**
Light Duty Autos (LDA)	673	2,113.9	0.5
Light Duty Trucks (LDT)	189	745.6	0.2
Medium Duty Trucks (MDT)	62	333.6	0.2
Heavy Duty Trucks (HDT)	46	708.7	1.2
Buses (UBUS)	0	0.0	0.0
Motorcycles (MCY)	5	6.9	0.0
Total:	**975**	**3,908.8**	**2.1**

Again, since N_2O has a GWP of 296 with respect to CO_2, the *equivalent* CO_{2e} level would be 621.6 pounds for N_2O. The final equivalent daily CO_{2e} load due to vehicular traffic would be 4,530.4 pounds.

<u>Small Engine and Natural Gas Fired (External Combustion) Contribution</u>

Landscaping equipment utilized in the course of maintenance of the grounds typically would consist of five horsepower four-stroke lawnmowers and small weed trimmers having two-stroke engines with an approximate 30 to 50 cubic-centimeter displacement. Assuming the ultimate user purchases cleaner burning engines new from the store, the emissions rates specified by CARB[24] are shown below, in Table 4 (in pounds per day per unit).

TABLE 4: GHG Emission Rates for Small Engine Equipment

Pollutant	Single-Family Emissions Pounds Per DU/Day	Multi-Family/Retail Emissions Pounds Per DU/Day
CO_2	0.70938	33.99111
N_2O	0.00004	0.00150

CO_2 emissions rate based upon stoichiometric ratio with CO for a typical small Otto-cycle engine.
DU = Dwelling unit for single- and multifamily projects, commercial space unit for retail uses.

[23] Source: *Traffic Impact Analysis – Ramona Library, Ramona, CA – Linscott, Law & Greenspan, 5/14/09.*

[24] These are hybrids of the emission factors utilized by the *CARB URBEMIS* model.

For the purposes of analysis, the proposed library structure will be treated as a single {CARB-classified} retail space with a usable floor area of 19,500 square-feet.[25] This equates to the following small engine produced emission levels in pounds per day for the aggregate of the proposed project development plan:

Retail/Commercial Equivalent Small Engine Emissions	CO_2 = 34.0 pounds/day	N_2O = 0.0 pounds/day

Similarly, natural gas consumption (typically due to usage of water heaters and central heating units for this type of proposed use) would produce the following approximate total pounds of combustion emissions:

$$GHG_{combustion} = ER \times \left[\frac{NU \times UR}{30} \right] \times 1x10^{-6}$$

where, GHG = The greenhouse gas under examination (i.e., CO_2 or N_2O)

ER = Emissions rate of criteria pollutant per million-cubic-feet of natural gas consumed.[26]

CO_2 = 116,765 pounds/MM Cubic-feet

N_2O = 28.2 pounds/MM Cubic-feet

NU = Total number of units per land use type (i.e., residential/commercial),

UR = Specific natural gas usage rate per development type (Single-Family = 6,665 ft^3/month, Multi-family = 4,011.5 ft^3/month, Retail Space = 2.9 ft^3/SF/month),

For the aforementioned project plan, this would equate to the following natural gas fired emission levels in pounds per day:

Retail/Commercial Equivalent Natural Gas Emissions	CO_2 = 220.1 pounds/day	N_2O = 0.1 pounds/day

The N_2O *equivalent* CO_{2e} level for both of the above activities would be 16.2 pounds per day. The final equivalent CO_2 GHG load due to the above cited onsite uses would be 270.3 pounds CO_{2e} per day.

[25] These are equivalent classifications based upon the nature of the proposed land use.

[26] The free and complete burning of natural gas, which is primarily composed of methane (CH_4), is $CH_4 + 2O_2 \Rightarrow 2H_2O + CO_2 + heat\uparrow$. From a mass balance standpoint one pound of CH_4 can produce 2.75 pounds of CO_2 by the above chemical equation. Since, one cubic-foot of CH_4 weighs 0.04246 pounds, the amount of CO_2 produced per cubic-foot of natural gas burned would therefore be 0.1167 pounds. N_2O generation will be assumed to be a fractional component of total NO_x generation as previously discussed (i.e., $N_2O = 0.3NO_x$).

Projected Project Greenhouse Gas Emissions Budget

The projected greenhouse gas emission budget for the proposed project would be the summation of the individual sources identified under the previous section. Thus, the total budget would equate to the following levels shown in Table 5, below.

TABLE 5: GHG Emission Budget for Ramona Branch Library

Project Scenario	Total Project Emissions CO_{2e}		Total Project Emissions Pounds per ...
Construction Operations	368,281.8		total construction period
Vehicle Emissions	4,530.4	= 4,800.7	day
Small Engine / Natural Gas	270.3		day

The total aggregate construction GHG emissions would be 368,281.8 pounds CO_{2e}. The total operational GHG emissions would be 4,800.7 pounds of equivalent CO_{2e} per day. Thus, the total emissions would be expressed as 368,281.8 + 4,800.7/day pounds of CO_{2e}.

The vehicular CO_{2e} level shown above should be put into contrast against statewide vehicular CO_2 emissions, which have an estimated reference calendar year 2009 level of 551,310 tons per day.[27] Under this comparison, the net contribution of the proposed project to the overall daily vehicular-generated CO_{2e} level would be:

$$CO_{2e}\ Contribution_{Project,\%} = \frac{4,530.4}{(551,310 \times 2,000)} = 4.1088x10^{-6} = 0.0004\%$$

The proposed project action would generate an inconsequential CO_2 increase compared to the net vehicular trip generation for the baseline year.[28] This would be deemed as non-impactive under the commonly accepted definition of this term within CEQA.

[27] Per the *EMFAC 2007* statewide tabulation for calendar year 2009, which is provided as an attachment to this report.

[28] The baseline year was selected for informational purposes and comparison to a common point of reference. For future years, the CO_2 level is expected to increase yielding an even smaller percentage than that shown.

Projected Warming Effects Due to Project Equivalent CO_{2e}

The proposed Ramona Branch Library project would contribute a total of 4,800.7 pounds of CO_{2e} per day. Assuming all CO_{2e} mixing occurs within the Troposphere[29], the thermodynamic system consisting of the boundaries of the State of California would have a volume[30] of,

$$V_{\underset{California}{\text{system}}} = 104{,}765{,}440 \text{ acres} \times \frac{43{,}560 \text{ sq-ft}}{\text{acre}} \times 37{,}000 \text{ ft} = 1.6884x10^{17}\,\text{ft}^3$$

Since one part-per-million-by-volume (ppmv) of CO_2 equals 1.12315x10^{-7} pounds-per-cubic-foot at *Standard Temperature and Pressure* (STP), the daily increase in CO_{2e} concentration due to the proposed project action within the State of California would be,

$$CO_{\text{Conc}_{\text{System}}} = \frac{4{,}800.7 \text{ pounds}}{1.6884\text{x}10^{17}\ \text{ft}^3} \times \frac{1 \text{ ppmv } CO_2}{1.12315\text{x}10^{-7}\ \dfrac{\text{pounds}}{\text{ft}^3} @\text{STP}} = 2.53x10^{-7}\,\text{ppmv/day}$$

This equates to a 0.00000025 ppmv/day CO_{2e} increase within our Tropospheric system bounded by the land mass limits of the State of California. Given this, the yearly concentration increase in CO_{2e} due to the proposed project action would be 0.0000924 ppmv/year. Substituting the previously cited construction total from above, it can similarly be shown that the aggregate concentration due to the totality of construction grading would be 0.00001942 ppmv to our system. Thus, we can rewrite our CO_{2e} forcing equation in terms of the number of elapsed years (Δyear) from the completion of construction of the project as:

$$\begin{aligned} CO_{\text{Conc}_{\text{System}}\text{/year}} &= 0.00001942 \text{ ppmv} + 0.0000924 \text{ ppmv/year} \\ &= 0.00001942 + 0.0000924\ \Delta\text{year} \quad (\mathit{in\ ppmv}) \end{aligned}$$

The net change in radiative forcing due to a change in CO_{2e} is defined within the IPCC report[31] as,

$$\Delta F = \alpha\, Ln\left(\frac{C}{C_0}\right)$$

---

[29] The troposphere is the lowest portion of Earth's atmosphere and contains approximately 75% of the atmospheric mass of the planet and almost all of its water vapor and GHG's. The average depth of the troposphere is approximately seven miles (≈37,000 feet). For the purposes of analysis we will assume that all mixing occurs at sea level (which produces the greatest atmospheric concentrations and subsequent radiative forcing).

[30] The area within the State of California is approximately 163,696 square miles (104,765,440 acres) which, when multiplied by the height of the tropopause, roughly equates to 1.6884x10^{17} ft^3. This is also the jurisdictional boundary of AB 32.

[31] Source: *Third Assessment Report of Working Group I* of the Intergovernmental Panel on Climate Change (IPCC), 2001.

where, ΔF is the change in the radiative forcing (in W/m^2),
α is the atmospheric forcing coefficient = 5.35, [32]
C is the baseline plus project CO_2 and CO_{2e} concentrations (in ppmv), and,
C_0 is the baseline CO_2 concentration (commonly taken as 380 ppmv).

Furthermore, surface air temperature sensitivity factors cited by the IPCC have a global average of approximately 0.1 °C/W/m^2. Thus, the net yearly increase in temperature for the first year of operation due to the proposed project CO_{2e} emissions would be,

$$\Delta T_{\text{Project}_{\textit{First Year}}} = 0.1 \frac{^{\circ}\text{C}}{\text{W/m}^2} \times 5.35\ Ln\left(\frac{380 + 0.00001942 + 0.0000924\ \Delta\text{year}}{380}\right) \text{W}/\text{m}^2$$

$$= 0.1 \frac{^{\circ}\text{C}}{\text{W/m}^2} \times 5.35\ Ln\left(\frac{380 + 0.00001942 + 0.0000924\ (1)}{380}\right) \text{W}/\text{m}^2$$

$$= 1.5743\text{x}10^{-7}\ ^{\circ}\text{C}$$

Remembering that the above expression is logarithmic in nature, one could iterate the above solution to determine the time required for the proposed redevelopment plan project to increase the temperature within the State of California one degree Centigrade under the worst-case closed-system condition identified above. This one-degree-Centigrade increase due to the proposed project under consideration would occur in approximately 22,545,245 years.

CONCLUSIONS / RECOMMENDATIONS

Project-Related Greenhouse Gas Budget / Global Warming Potential

The proposed Ramona Branch Library project site was shown to produce an aggregate equivalent greenhouse gas load of 368,281.8 + 4,800.7/day pounds of CO_{2e}. The local annual warming effect due to this level of project emissions was found to be $1.5743\text{x}10^{-7}$ °C, which would be deemed non impactive using the generally accepted definition of this term under CEQA. The net contribution on the planet as a whole would be deemed insignificant.[33]

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[32] Carbon dioxide contributes approximately 32 watts per square-meter (W/m^2) of long-wave radiative forcing to the climate system under a clear-sky condition, out of a total of 125 watts per square-meter for all atmospheric gases under the same conditions. The total radiative forcing from the Sun as of 1997 was 342 W/m^2.

[33] Ninety-percent (90%) of the atmosphere of the planet Earth resides within 16 kilometers (16,000 meters) of the surface. Thus, the volume of the atmosphere is roughly $8.2\text{x}10^9$ km^3 ($8.2\text{x}10^{18}$ m^3 or $2.9\text{x}10^{20}$ ft^3). The mass of the atmosphere is roughly $5.3\text{x}10^{21}$ grams or $1.17\text{x}10^{19}$ pounds. Although the project's contribution is mathematically a finite number, it is also asymptotically driven to zero in its bounded limit. Thus, the net temperature contribution of the proposed project to the planet as whole is physically zero and in fact could not even be directly measured using modern scientific instrumentation.

Compliance with AB 32 CO_2 Reduction Strategies

Consistent with the intent of AB 32, the proposed project would be required to demonstrate that it has policies in place that would assist in providing a statewide goal of 25-percent reduction in CO_2 by the year 2020. To this end, the following greenhouse gas offset measures have been shown to be effective by CARB and should be implemented wherever possible:

Diesel Equipment (Compression Ignition) Offset Strategies:

1) Use electricity from power poles rather than temporary diesel power generators.
2) Construction equipment operating onsite should be equipped with two to four degree engine timing retard or precombustion chamber engines.
3) Construction equipment used for the project should utilize EPA Tier 2 or better engine technology.

Vehicular Trip (Spark Ignition) Offset Strategies:

4) Encourage commute alternatives by informing construction employees and customers about transportation options for reaching your location (i.e. post transit schedules/routes).
5) Help construction employees rideshare by posting commuter ride sign-up sheets, employee home zip code map, etc.
6) When possible, arrange for a single construction vendor who makes deliveries for several items.
7) Purchase Carbon Offsets to compensate for miles traveled by construction vehicles.
8) Plan construction delivery routes to eliminate unnecessary trips.
9) Keep construction vehicles well maintained to prevent leaks and minimize emissions, and encourage employees to do the same.
10) Provide car/van pool parking for construction employees.
11) Sell bus or light rail passes on-site or at a discount to construction employees.

Onsite Energy Offset Strategies:

12) Complete regularly scheduled maintenance on your HVAC (heating, ventilation and air conditioning) system.
13) Use an energy management system to control lighting, kitchen exhaust, refrigeration and HVAC.
14) Install occupancy sensors for lighting in low occupancy areas.
15) Retrofit incandescent bulbs with compact fluorescent lights.
16) Install ultra efficient ballasts to dim lights to take advantage of daylight.
17) Upgrade existing fluorescent lighting with T-8 lamps with electronic ballasts (T-8 systems consume up to 40% less energy than conventional T-12 systems).
18) Install a programmable thermostat to control heating and air conditioning.
19) Insulate all major hot water pipes.

20) Insulate refrigeration cold suction lines.

21) Use weather stripping to close air gaps around doors and windows.

22) Select electrical equipment with energy saving features (e.g. *Energy Star*®).

23) Plant native shrubs or trees near windows for shade.

24) Convert hot water heaters to on-demand systems.

25) Reduce the number of lamps and increase lighting efficiency by installing optical reflectors or diffusers.

26) Install ceiling fans in homes where applicable.

CERTIFICATION OF ACCURACY AND QUALIFICATIONS

This report was prepared by Investigative Science and Engineering, Inc. (ISE) located at 1134 D Street, Ramona, CA 92065. The members of its professional staff contributing to the report are listed below:

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ISE affirms to the best of its knowledge and belief that the statements and information contained herein are in all respects true and correct as of the date of this report. Should the reader have any questions regarding the findings and conclusions presented in this report, please do not hesitate to contact ISE at (760) 787-0016.

Content and information contained within this report is intended only for the subject project and is protected under 17 U.S.C. §§ 101 through 810. Original reports contain non-photo blue ISE watermark at the bottom of each page.

Approved as to Form and Content:

Rick Tavares, Ph.D.
Project Principal
Investigative Science and Engineering, Inc.

APPENDICES / SUPPLEMENTAL INFORMATION

EMFAC 2007 EMISSION FACTOR TABULATIONS – SCENARIO YEAR 2013

```
Title     : San Diego County Subarea Winter CYr 2013
Version   : Emfac2007 V2.3 Nov 1 2006
Run Date  : 2009/05/04 13:32:43
Scen Year: 2013 -- All model years in the range 1969 to 2013 selected
Season    : Winter
Area      : San Diego
*****************************************************************************************
     Year: 2013 -- Model Years 1969 to 2013 Inclusive -- Winter
     Emfac2007 Emission Factors: V2.3 Nov 1 2006

     County Average                          San Diego                 County Average

                        Table   1:  Running Exhaust Emissions (grams/mile)

     Pollutant Name: Oxides of Nitrogen       Temperature:  50F  Relative Humidity:  40%
```

Speed MPH	LDA	LDT	MDT	HDT	UBUS	MCY	ALL
10	0.362	0.567	1.025	14.012	22.793	1.326	1.077
15	0.322	0.499	0.911	10.805	18.464	1.319	0.891
20	0.291	0.449	0.831	9.317	15.725	1.325	0.789
25	0.269	0.412	0.777	8.754	14.069	1.340	0.735
30	0.253	0.386	0.744	8.353	13.213	1.363	0.698
35	0.242	0.369	0.728	8.102	13.016	1.394	0.675
40	0.235	0.360	0.728	7.999	13.443	1.432	0.666
45	0.233	0.358	0.744	8.051	14.558	1.478	0.670
50	0.234	0.363	0.778	8.273	16.534	1.530	0.689
55	0.240	0.376	0.833	8.694	19.708	1.591	0.724
60	0.250	0.398	0.914	9.358	24.673	1.661	0.779
65	0.265	0.431	1.031	10.339	32.469	1.741	0.862

Pollutant Name: Carbon Dioxide   Temperature: 50F Relative Humidity: 40%

Speed MPH	LDA	LDT	MDT	HDT	UBUS	MCY	ALL
10	714.172	892.022	1248.478	2309.996	2451.449	211.845	898.691
15	560.238	700.309	965.890	1953.375	2350.106	182.614	709.670
20	456.147	570.669	779.787	1705.435	2288.401	161.438	582.211
25	385.470	482.646	656.020	1605.474	2250.052	146.371	498.618
30	338.083	423.629	574.368	1528.771	2226.160	136.167	442.368
35	307.748	385.848	522.768	1470.888	2211.783	130.073	406.110
40	290.736	364.660	494.193	1429.394	2204.216	127.731	385.484
45	285.055	357.585	484.971	1403.091	2202.127	129.135	378.179
50	290.057	363.815	493.964	1391.662	2205.160	134.655	383.454
55	306.312	384.060	522.322	1395.570	2213.833	145.124	401.997
60	335.720	420.686	573.746	1416.201	2229.688	162.030	436.060
65	381.881	478.176	655.327	1456.277	2255.754	187.852	489.928

EMFAC 2007 EMISSION FACTOR TABULATIONS – STATEWIDE REFERENCE (2009)

```
Title    : Statewide totals Subarea Winter CYr 2009 Default Title
Version  : Emfac2007 V2.3 Nov 1 2006
Run Date : 2008/02/26 12:23:35
Scen Year: 2009 -- All model years in the range 1965 to 2009 selected
Season   : Winter
Area     : Statewide totals Grand Total
I/M Stat : See county detail
Emissions: Tons Per Day
```

	Light Duty Passenger Cars				Light Duty Trucks				Medium Duty Trucks				Heavy Duty Trucks					Urban	Motor-	All
													Gasoline Trucks			Diesel	Total HD	Buses	cycles	Vehicles
	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Total	Trucks	Trucks			
Vehicles	205436.	13032100.	45267.	13282800.	145209.	8098640.	168203.	8412050.	29829.	2784520.	186869.	3001210.	26299.	284035.	310334.	470939.	781274.	14487.	883451.	26375300.
VMT/1000	3259.	447499.	1040.	451798.	2886.	297458.	5315.	305659.	658.	110826.	8343.	119827.	259.	6297.	6556.	50830.	57386.	1742.	7642.	944054.
Trips	819673.	82194800.	250503.	83264900.	592263.	51031600.	1035230.	52659100.	270260.	28336100.	2283090.	30889500.	533808.	3136470.	3670270.	6937980.	10608300.	57946.	1766730.	179246000.
Total Organic Gas Emissions																				
Run Exh	24.41	46.36	0.22	70.99	21.90	41.90	0.51	64.32	5.95	22.69	2.04	30.68	2.20	6.82	9.01	59.30	68.31	2.27	32.30	268.88
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.60	0.02	0.63	0.03	0.18	0.21	6.69	6.90	0.00	0.00	7.53
Start Ex	5.58	54.24	0.00	59.82	4.06	39.68	0.00	43.75	2.26	24.44	0.00	26.71	8.08	7.29	15.36	0.00	15.36	0.08	5.45	151.16
Total Ex	29.99	100.60	0.22	130.80	25.97	81.58	0.51	108.07	8.22	47.74	2.06	58.02	10.30	14.29	24.59	65.99	90.58	2.35	37.75	427.58
Diurnal	1.31	10.72	0.00	12.04	0.88	6.52	0.00	7.39	0.06	1.72	0.00	1.79	0.02	0.07	0.08	0.00	0.08	0.00	1.80	23.10
Hot Soak	3.99	20.13	0.00	24.12	2.91	12.48	0.00	15.39	0.39	3.89	0.00	4.29	0.41	0.18	0.59	0.00	0.59	0.01	1.26	45.66
Running	18.40	54.75	0.00	73.15	8.28	62.83	0.00	71.11	1.24	25.43	0.00	26.67	2.82	2.49	5.31	0.00	5.31	0.05	5.58	181.88
Resting	0.66	5.03	0.00	5.69	0.43	3.08	0.00	3.51	0.04	0.86	0.00	0.90	0.01	0.02	0.02	0.00	0.02	0.00	0.68	10.80
Total	54.36	191.23	0.22	245.81	38.46	166.49	0.51	205.47	9.95	79.65	2.06	91.66	13.55	17.04	30.60	65.99	96.59	2.42	47.08	689.02
Carbon Monoxide Emissions																				
Run Exh	285.68	1119.39	0.89	1405.96	252.77	1087.16	3.37	1343.31	99.84	408.93	9.21	517.99	57.70	115.43	173.13	226.19	399.31	15.19	379.20	4060.96
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	3.42	0.18	3.63	0.17	1.05	1.22	28.32	29.55	0.00	0.00	33.18
Start Ex	28.07	589.66	0.00	617.73	20.55	485.31	0.00	505.86	14.28	281.33	0.00	295.61	56.66	119.09	175.75	0.00	175.75	1.04	19.85	1615.84
Total Ex	313.75	1709.05	0.89	2023.69	273.32	1572.47	3.37	1849.17	114.17	693.67	9.39	817.23	114.53	235.57	350.10	254.51	604.62	16.23	399.05	5709.98
Oxides of Nitrogen Emissions																				
Run Exh	17.86	127.75	1.76	147.37	15.60	158.87	8.99	183.46	5.03	77.93	50.20	133.16	1.68	29.08	30.76	866.90	897.66	32.24	11.88	1405.78
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.50	0.54	0.00	0.01	0.01	44.07	44.09	0.00	0.00	44.63
Start Ex	1.32	37.45	0.00	38.77	0.95	36.71	0.00	37.66	0.40	40.53	0.00	40.93	0.93	12.69	13.62	0.00	13.62	0.11	0.63	131.72
Total Ex	19.19	165.20	1.76	186.15	16.56	195.57	8.99	221.12	5.43	118.50	50.71	174.64	2.62	41.78	44.39	910.98	955.37	32.35	12.51	1582.13
Carbon Dioxide Emissions (000)																				
Run Exh	1.83	183.43	0.41	185.67	1.60	150.57	2.03	154.21	0.48	80.77	4.76	86.02	0.19	4.61	4.80	97.36	102.16	4.32	1.12	533.50
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.03	0.14	0.01	0.04	0.04	2.60	2.64	0.00	0.00	2.78
Start Ex	0.18	6.60	0.00	6.78	0.13	5.07	0.00	5.20	0.07	2.64	0.00	2.70	0.12	0.13	0.24	0.00	0.24	0.00	0.10	15.04
Total Ex	2.00	190.04	0.41	192.46	1.73	155.64	2.03	159.40	0.55	83.53	4.79	88.86	0.32	4.77	5.09	99.95	105.04	4.33	1.22	551.31
PM10 Emissions																				
Run Ex.	0.12	5.49	0.14	5.75	0.10	7.01	0.30	7.41	0.02	2.66	0.47	3.16	0.01	0.06	0.07	33.03	33.10	0.50	0.33	50.24
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	1.02	1.02	0.00	0.00	1.02
Start Ex	0.01	0.56	0.00	0.57	0.01	0.66	0.00	0.67	0.00	0.25	0.00	0.25	0.01	0.01	0.02	0.00	0.02	0.00	0.03	1.55
Total Ex	0.13	6.05	0.14	6.33	0.11	7.67	0.30	8.07	0.03	2.91	0.48	3.41	0.01	0.07	0.09	34.05	34.13	0.50	0.36	52.81
TireWear	0.03	3.95	0.01	3.98	0.03	2.62	0.05	2.70	0.01	1.06	0.11	1.17	0.00	0.08	0.09	1.65	1.73	0.02	0.03	9.64
BrakeWr	0.05	6.19	0.01	6.25	0.04	4.11	0.07	4.23	0.01	1.53	0.12	1.66	0.00	0.10	0.11	1.34	1.45	0.02	0.05	13.65
Total	0.20	16.19	0.17	16.56	0.18	14.40	0.42	15.00	0.04	5.50	0.70	6.24	0.02	0.26	0.28	37.03	37.31	0.54	0.44	76.09
Lead	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
SOx	0.02	1.85	0.00	1.88	0.02	1.52	0.02	1.56	0.01	0.81	0.05	0.87	0.01	0.05	0.05	0.95	1.01	0.04	0.02	5.38

INDEX OF IMPORTANT TERMS