Economic, Security and Environmental Impacts of Alternative Fuel and Automotive Technologies
A Cost/Benefit Analysis of the Clean Cities Program

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NATIONAL DEFENSE COUNCI L FOUNDATION

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For more than two decades, the National Defense Council Foundation has maintained an ongoing Energy and National Security Program. While the importance of assuring abundant, affordable energy has long been recognized as a national security concern today it takes on an even more important aspect, especially where crude oil and refined products are concerned.

There are several reasons why this is the case.

First, the evolving doctrine of "Rapid Decisive Operations" cannot be implemented without the fuel necessary to power the ships, aircraft, armored and wheeled vehicles on which it depends.

Secondly, our economy is more dependent on petroleum for domestic transportation, and if workers cannot get to work, they cannot provide the materiel necessary for any military establishment.

Third, and from our perspective perhaps most important, is the fact that the financial underpinnings of international terrorism rest on two pillars: the drug trade and oil dollars. The threat terrorism poses to our nation will be diminished in direct proportion to the degree these sources of funds can be reduced. Therefore, reducing the nation's dependence on imported oil not only yields the obvious benefits in terms of economic and military security, but also directly reduces the ability of terrorists to operate.

But to accomplish this goal will require national commitment. One thing that can foster that commitment is a better understanding of the terrible economic toll our continuing oil import dependence exacts. That is why our organization has prepared this document. In the final analysis, its purpose is to show how we can eliminate external influences that manipulate our system.

We hope it will help to further understanding of this critical issue.

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SCOPE AND PURPOSE

The Clean Cities Program was established in 1993 as an initiative to mayors of 125 consolidated metropolitan areas whose jurisdictions were covered by the alternative fuel mandates contained in the Energy Policy Act of 1992. At the heart of the program were roughly 80 public/private partnerships dedicated to strengthening the alternative fuels market. Overall, Clean Cities has been among the most efficient programs aimed at encouraging the use of alternative fuels. With a program cost of less than $500 for each alternative fueled vehicle deployed.

In 2004, the Clean Cities Mission statement was revised to broaden its portfolio beyond alternative fuel vehicles. It now states that the mission of the Clean Cities Program is:

"To advance the energy, economic, and environmental security of the United States by supporting local decisions to adopt practices that contribute to the reduction of petroleum consumption in the transportation sector."

Along with this expanded portfolio, the Clean Cities Program also expanded its import reduction strategies beyond alternative fuel vehicles to encompass fuel blends, fuel economy, hybrids and idle reduction technologies as well.

In October of 2003, The National Defense Council Foundation (NDCF) published "*America's Achilles Heel: The Hidden Cost of Imported Oil*," which presented a detailed analysis of the macroeconomic consequences of America's growing dependence on crude oil and refined petroleum products from abroad. It is important to recognize that the NDCF report focused on reducing *imported* crude oil and petroleum products rather than reducing petroleum use per se. As a consequence, certain costs, such as those associated with complying with mandates and regulations aimed at addressing global warming were not considered. Similarly, the health-related costs of mobile source pollution, which could be as much as 30 cents per gallon of petroleum product consumed, are not considered. This is not to say that concerns over these costs are not legitimate. They simply are not within the scope of the NDCF analysis.

Following publication of "*America's Achilles Heel*," NDCF decided to prepare another analysis that built on its earlier findings and conclusions to provide an assessment of the macroeconomic benefits that might accrue from employing the import reduction strategies included in the Department of Energy's Clean Cities Program mission statement. In addition, NDCF was also decided to examine the potential economic benefits that might accrue at the local level by governments that employed the strategies.

While a straight-line approach to allocating benefits has been used to give a sense of the potential of the Clean Cities fleets to reduce oil imports, the actual realization of tangible reductions in some areas of expenditures, such as defense costs is unlikely to occur until the total reduction through alternative fuels reaches the level of 8% to 10%. Nonetheless, without the leadership provided by programs such as Clean Cities the threshold level will never be met.

BASIS FOR COMPARISON

At the heart of the NDCF analysis is the assumption that refined petroleum products will be replaced with either alternative fuels or technologies that otherwise reduce petroleum consumption. This is presented as an alternative to continued oil import consumption and inevitably the growth of import dependence.

RATIONALE FOR THE ANALYSIS

A key reason for performing such an analysis arises from the fact that the externalities reflected in the costs and benefits associated with oil imports are a product of market failure. The chance distribution of the bulk of global oil resources among a relative handful of nations has resulted in the evolution of an oligopoly within the oil market. The problem is further exacerbated by the fact that many of the nations with large oil reserves are governed by authoritarian regimes and have command economies that are not necessarily responsive to market signals. Consequently, this handful of nations has a disproportionate influence over supply and price that in turn jeopardizes America's economic and military security. A fuller understanding of the external economic impacts of import dependence and the factors influencing them can help to encourage the implementation of strategies leading to a reduction in the reliance on crude oil and refined products from abroad. The knowledge that these external economic impacts are the product of market failure helps foster a better understanding of why some form of market intervention is required to address their consequences.

The values assigned to external costs have been averaged. The reason for this is that oil prices are highly volatile and can vary enormously within a relatively short time frame. Using averages taken over a more extended period more accurately reflects the external costs than would using selected periods of time that could either overstate or understate their true value.

A number of other considerations also support the preparation of such an analysis. Many financial analysts argue that "oil is just another commodity" and therefore requires no special attention. Implicitly, this view assumes that normal market forces will govern oil price and supply. If it is accepted, then there would be little reason to pursue strategies to reduce import dependence as market forces would adjust to take into account changes in price or supply as well as any external costs. A simple review of history, however, demonstrates that this logic is fallacious.

Disruptions of oil supplies have had significant consequences within the U.S. economy each time they occurred. Moreover, these economic consequences have occurred even as the oil intensity of the economy has decreased as has the proportion of fuel used per vehicle mile traveled and the proportion of cost oil represented per vehicle mile traveled. The vulnerability of the U.S. economy to disruption when the flow of oil is interrupted is due to a combination of factors.

First, oil is the primary transportation fuel used in the United States. Second, although alternative fuels and transportation technologies exist, they are not currently available at a level sufficient to offset a major shortfall of supplies. Third, other options such as mass transit are either impractical for substantial segments due to population density limitations or even where demographically feasible, require heavy subsidization. For example, fares covered only 29% of the cost of bus transportation and only 48% of commuter rail costs in 2002.

The lack of available alternatives also makes oil consumption relatively price inelastic – that is to say, people do not reduce their consumption in proportion to increases in price. This is an important fact because it militates against import reduction strategies based on motor fuel tax increases and supports use of strategies such as Clean Cities that seek to encourage adoption of import reduction technologies through increasing awareness of their relative benefits. But it is more than just the lack of alternatives that makes programs such as Clean Cities important.

Another, and perhaps most important, consideration is the lack of "surge capacity" in the world oil market.

Over the past several decades, the ability of certain nations – particularly Saudi Arabia – to substantially increase oil production rapidly has served to stabilize world oil prices and supplies. However, there is good reason to doubt that such surge capacity still exists. Several analyses of Saudi Arabia's oil production capacity suggest that a lack of proper maintenance and failure to drill new development wells has sharply curtailed that nation's ability to increase its production rapidly. In addition, what slack existed in the world oil market has been largely absorbed by new demand from China and India. In the decades ahead, oil use in Asia will continue to rapidly increase, and world capacity is unlikely to keep pace. With the increasing inflexibility of the world oil market, the likelihood of a supply disruption will increase. Even if an actual disruption does not occur however, there will be increasing upwards pressure on oil prices as competition over scarce supplies intensifies.

LOCAL BENEFITS

In attempting to develop a useful tool for the estimation of local benefits, a number of concerns came into play. First among them was the wide range of resources available to local Clean Cities Coordinators. In some instances, especially where programs were relatively long-standing, resources were substantial. In others, though, there were relatively limited resources available. As a consequence, a variety of tools were developed for Clean Cities Coordinators so that they would have a series of options that matched local capabilities and still produced data sets that were relatively consistent.

A second concern was the need to produce a final product that was useful to decision makers at the local level who were more likely to be concerned with actual out-of-pocket expenditures than they were with macroeconomic impacts. This task was further complicated by the fact that acquisition costs for the various import reduction strategies

could vary widely depending on the availability of grants, manufacturer's incentives and the specific strategy employed. As a result, the tools focused on comparisons of operating costs. The differential in operating costs between the import reduction strategy and the conventional alternative provides a readily understandable figure that can be measured against any additional acquisition cost to determine the benefit that results.

The third concern was to avoid unnecessary and confusing detail. While it is possible to make highly detailed estimates that take every conceivable factor into account, such an analysis would be of necessity too cumbersome to be useful in the sorts of day-today deliberations used to make decisions at the local level. A simple dollars in – dollars out approach, makes up in utility what it may lack in precision.

For this reason, where the information is available, the preferred method for calculating the local benefits is to use the work sheets provided in the "Instructions for Using Estimation Tools" section. Clearly, the use of actual operating data will provide the most compelling evidence of the benefits that are derived from a particular strategy or technology. In some circumstances, for example where none of the import reduction strategies are currently being employed, or where access to information is restricted, it will not be possible to utilize the work sheets. In such cases, a number of alternative methods for estimation are provided.

INTRODUCTION

During the week of March 11, 2005, , U.S. imports of crude oil and refined petroleum products jumped to roughly 12.1 million barrels per day, the sixth highest import volume ever recorded,(1) continuing the trend towards an ever-greater dependence on foreign sources of supply. As a result, America is now dependent on foreign sources for roughly 60% of its petroleum requirements. (2) Moreover, crude oil imports from OPEC nations now account for almost 43.6% of total imports (3) – roughly 27.4% of domestic supplies (4) – and imports from the volatile Persian Gulf now represent almost one in eight barrels of oil Americans consume. (5) What is most important about these figures is that they represent an inexorable trend.

THE LIMITATIONS OF THE RESOURCE BASE

Underlying this trend are two geologic facts. The first is that oil is a finite resource. This is not to say that vast oil resources do not remain. Indeed, the U.S. Geologic Survey (USGS) estimates that the world still has oil reserves amounting to 859 billion barrels – a substantial amount by any measure. (6) Even this estimate, however, may understate the magnitude of the resource, because reserve figures are only part of the picture. Of greater significance over the long term is what geologists call the "resource base." While reserve figures only include potential oil bearing areas that have been identified and assessed, resource base estimates encompass all possible oil deposits. (7) Estimates of the remaining resource base currently place it anywhere between 1,500 billion and 2,000 billion barrels. (8) Not all of this oil, of course is recoverable. Recoverable reserves, although substantial, would only be sufficient to sustain current levels of world oil consumption for between 19.4 and 25.8 years, (9) or assuming that projections of near-term increases in consumption occur, from roughly 12.6 to roughly 16.8 years. (10)

But there is a second geologic fact that must be considered as well: the location of proven and potential oil deposits. Currently, some 65.3% of the World's proved oil reserves – 685.6 billion barrels – are found in the Middle East. (11) In contrast, U.S. proved reserves are just 22.4 billion barrels (12) and account for only 2.9% of the world total. (13) The U.S. resource base for oil is substantially larger, with the Department of Energy estimating that some 105.5 billion barrels of undiscovered oil remain. When extensions of existing fields and other in place reserves are factored in, DOE estimates the total petroleum resource base at 174.82 billion barrels. (14) At current production levels, U.S. proved reserves will be exhausted in roughly 10.7 years – but that assumes a continued dependence on imports for nearly 60% of consumption and no increase in demand. (15) If all requirements were met with domestic crude proved reserves would be exhausted in just over three years – and that assumes no increase in demand! (16) The entire resource base would last just over 23.8 years with the same assumptions. (17)

In order to utilize the full extent of the domestic resource base, however, it will first be necessary to gain access to it. At this time, many of the most promising areas for the discovery of new oil deposits remain off-limits to exploratory drilling due to various regulatory restrictions. These restrictions reflect a conscious trade-off between

environmental considerations and the desire to develop domestic energy resources. Unless this circumstance changes domestic production will decline even more rapidly than would otherwise be the case.

It is also important to recognize that the likelihood of identifying undiscovered oil reserves in the United States sufficient to meet all domestic needs is relatively slim. The U.S. has been drilled more extensively than any other region of the world. While there are certain areas such as the Arctic Coastal Plain and the Outer Continental Shelf that are likely to hold substantial new reserves, the most promising of these areas have been identified and are already included in current reserve and resource base estimates. Even if these resources are eventually developed they still will not provide sufficient new production to completely eliminate the need for oil imports. Still, their development remains vitally important, because it would help slow the decline of U.S. production. But, it would not reverse the trend.

Another important factor is the rapid growth in demand for refined petroleum products from China and India. China, for example is now the largest consumer of oil after the United States and this year experienced a 40% increase in oil imports over the previous year. India experienced an 11% increase in oil imports. Therefore it is clear that competition for what oil resources remain will become more and more intense with the passage of time.

Clearly, if some substitute for petroleum is not identified, the nation faces an increasing and increasingly perilous dependence on imported oil. Over the long term, the answer may lie in such things as developing a practical hydrogen fuel cell vehicle that can ultimately provide a non-polluting means of powering the automobile that relies on an inexhaustible fuel source. In the interim, however, other steps that can help the U.S. begin to address the immediate danger oil imports pose should be taken. If for no other reason, these steps are justified by the economic penalty our import dependence exacts.

Even though gasoline prices have climbed sharply during the first half of 2004, what is not well understood is that the price paid at the pump only reflects a portion of the total economic cost of high levels of petroleum imports. The simple fact is that they impose a variety of costs on society that are not reflected in the price consumers pay at the pump. Although these “hidden costs,” called “externalities” by economists, are not immediately evident, they are nonetheless real. They are reflected in such things as the cost of maintaining the military capability to defend the flow of oil from the Persian Gulf, the economic penalty associated with sending nearly $100 billion a year overseas to purchase foreign crude oil and refined products and the economic consequences of the periodic oil supply disruptions that have accompanied our nation’s oil import dependence.

There are also more general costs associated with the use of petroleum-derived fuels. These include such things as the cost of abating mobile source pollution and the health consequences of this pollution as well as the costs associated with global warming.

Resolving the nation's import dependence, however, presents a difficult problem. Over two-thirds of domestic oil consumption is accounted for by the transportation sector – particularly the automotive sector. Americans are highly dependent on the automobile for transportation and in some parts of the country alternatives such as mass transit are impractical. In addition, they often do not represent the most economically efficient solution to transportation needs. For example, in 2002, fares covered only 29% of the operating costs for bus systems and 48% for commuter rail. Further, the American public places a high value on the personal mobility automobiles represent and has been slow to embrace mass transit alternatives even where they exist.

THE ROLE OF THE TRANSPORTATION SECTOR

In 1900, there were only about 8,000 automobiles registered in the United States. (18) Five years later, that figure grew to nearly 78,000. (19) By 1925, it had risen to 17 million and by1950, more than 40 million. (20) But it was in the Post-WWII period that privately owned cars and light trucks saw their real growth. By 1970 over 108 million privately owned cars and light trucks were registered in the United States (21) and today that number has burgeoned to over 220 million, (22) making per capita vehicle ownership in the U.S. more than 47% higher than the average for the industrialized nations of Western Europe. (23)

The widespread ownership of personal vehicles by Americans has provided an unprecedented degree of mobility – and Americans make full use of it. Americans travel roughly 44% (24) more miles in their automobiles each year than do citizens of the industrialized nations in Western Europe, and more than twice the distance by citizens of Japan. (25) This is in part due to the difference between the relative population densities of the United States, Europe and Japan. But whatever the cause, this freedom of movement comes with a price.

Despite significant improvements in vehicle efficiency, increases in the number of vehicles and the number of vehicle miles traveled have negated any potential benefits. The reason is that, even though each vehicle might use less fuel per mile, there are so many more vehicles and so many more miles traveled that oil used in the transportation sector has continued to grow – and grow dramatically. This steep rise in consumption in turn has served to worsen America's oil import vulnerability.

Notably, the increase occurred during a period when most other sectors of the economy dramatically reduced or substantially curtailed their dependence on petroleum products. Between 1973 and 2001, the actual amount of oil consumed by the utility sector dropped by 76%, (26) the amount consumed in the commercial sector fell by 52% (27) and the amount consumed in the residential sector declined by 43%. (28) Although industrial oil use increased by roughly 8.5%, the increase was substantially below the 13.8% overall increase in petroleum consumption during the same period. (29)

As noted, these impressive reductions in petroleum dependence were more than offset, however, by a 46.4% increase in oil use in the transportation sector. (30)

Significantly, had the amount of oil used in the transportation sector merely remained constant, U.S. domestic oil consumption would actually have declined by some 24.3% from 1973 levels. (31) Indeed, between 1973 and 2001, the proportion of domestic petroleum consumption accounted by the transportation sector from rose from 52.3% to 67.3%. (32) During that same period, the transportation sector's share of total domestic energy use increased from 18.6% to 27.1%. (33)

To put these figures in perspective, if a substitute could be found for the petroleum used in the transportation sector, there would be no need to import oil. In fact, if necessary America could again become a net oil exporter.

The increase in transportation sector petroleum use is best understood in the context of evolving driving patterns. The total number of vehicle miles traveled (VMT) has increased an average of 3.6% annually since 1950. (34) More important, the average number of vehicle miles traveled per capita increased dramatically as well. Between 1975 and 2000 alone, the increase in VMT was 63.2%. (35) Part of this increase was the natural consequence of a dramatic increase in vehicle ownership. In 1960, more than one-fifth of all families only owned one automobile. (36) By the year 2000, less than ten percent did. (37)

It is not just the growth in vehicles and the number of miles traveled that is affecting transportation sector energy consumption. Another important change is in the make-up of the U.S. motor vehicle fleet.

THE GROWTH OF LIGHT TRUCK OWNERSHIP

Since the initial introduction of automobile emission control equipment, no trend has had a larger effect on transportation sector energy efficiency than the dramatic increase in the use of light trucks as personal vehicles. In 1978, light trucks accounted for just 9.8% of the total vehicle fleet. (38) By 2001, however, light trucks constituted 46.7% of personal vehicles (39) – this due primarily to the growing popularity of Sport Utility Vehicles and Minivans among suburban households. Over time, these light trucks have largely replaced the traditional station wagon as a second vehicle for suburban families. It is particularly noteworthy that, as of 2001, Sport Utility Vehicles became the leading choice among female new vehicle purchasers – the market segment that most generally guides buying decisions related to "family" transportation. (40)

The effect of this shift in the makeup of the vehicle fleet cannot be overestimated. Whereas the average fuel economy of passenger cars was 28.6 mpg in 2001, (41) the average for light trucks was only 20.9 mpg. (42) As a result, the combined fuel economy of the U.S. domestic fleet is only 24.4 mpg (43), 14.7% less (44) than the average for passenger cars alone, and 12.5% below the nominal mileage target for passenger vehicles. A contributing factor has been the availability of abundant inexpensive gasoline. Indeed, despite complaints concerning recent oil price increases, the average

retail price for unleaded regular gasoline during the week of October 20, 2004, $2.03 when adjusted for inflation, was 32.1% less than that of the peak year, 1981.

The increasing proportion of the motor vehicle fleet accounted for by light trucks has significant implications for energy consumption – especially if the per capita ownership of motor vehicles in the United States continues to increase – and persistent trends in population movement suggest that it will.

THE IMPACT OF CHANGING DEMOGRAPHICS

Many factors contributed to the growth of automobile use. Among the most significant was urban sprawl, i.e. the movement of populations out of central cities to suburbs – a trend that has continued since the end of World War II. As the population has dispersed, commuting distances have increased. Indeed, in the dozen years between 1983 and 1995 alone, commute distances grew by 36.4%. (45) In addition the time required for an average commute also increased. The movement away from central cities, however, is not the only significant demographic change to take place.

Another important trend has been the concentration of America's population in coastal areas. Although coastal areas comprise just 17% of the total U.S. land area (46) they hold 53% of the nation's population. (47) The population of these areas is currently increasing by 3,600 people per day (48) and is projected to increase by 27 million over the next dozen years. (49) This movement has created an imbalance in population densities with high concentrations on both coasts and large relatively thinly populated regions in the balance of the country. Yet, even in coastal areas, much of the population lives in relatively small communities where dependence on the automobile for transportation is the only viable option. In addition, compared with much of the world, the United States is not densely populated. Its average of 74 persons per square mile (50) remains far below Europe's 429 per square mile (51) or Asia's 300. (52) As a result, many people view automobile ownership as a necessity.

The dramatic rise in per capita income, which, for example, more than doubled in real terms between 1967 and 2000, has served to greatly facilitate the rise in automobile ownership. (53) The contribution of two-income families to this increase – which also creates an additional commuter in the family unit – has further sparked the growth of vehicle ownership.

The impact of these changes on energy use is clear. While the fuel efficiency of the U.S. passenger car fleet more than doubled between 1974 and 2001, (54) rising from an average of 12.9 mpg to 28.6 mpg, the benefits of this improvement were largely offset. (55) The savings in fuel consumption simply could not keep pace with burgeoning demand resulting from the higher number of miles traveled and the increased number of cars on the road.

Yet, it is not just the need for transportation fuels within the general economy that drive the need to reduce America's import dependence. Another, equally important concern is

the need to assure supplies of fuel for the armed forces. Always important, petroleum fuels have become an even more vital military commodity in the contemporary threat environment.

THE ROLE OF OIL IN THE NEW THREAT ENVIRONMENT

Many believed that the collapse of the Soviet Empire and the end of nearly half a century of geopolitical stalemate would dramatically end the prospects of conflict around the world. Although this dramatic event did greatly reduce the likelihood of a global thermonuclear conflagration, it did little to enhance international stability. The threat of a superpower confrontation was quickly replaced with the onset of myriad smaller conflicts in geographically diverse locations and at varying degrees of intensity. Moreover, in the new threat environment, these conflicts could arise with little warning – at times requiring troop deployments within a matter of days, or even hours.

In FM-100, the U.S. Army Statement of Doctrine, this change was acknowledged:

> *"…The global realities of today are in a period of significant change. Army forces may find themselves called upon to fight under conditions of rapid force projection, that can build to major sustained operations in war and peace or that can terminate quickly only to lead to other commitments elsewhere."* (56)

One inherent consequence of the new threat environment is that energy, and in particular refined petroleum products, while always an important military commodity, have taken on an even greater significance.

Some salient facts illustrate this point:

- A contemporary U.S. Army Armored Infantry Division comprised of 17,500 soldiers uses roughly twice the fuel of two World War II field armies which, taken together, would comprise nearly 200,000 troops. (57)

- During Operation Desert Storm, the 582,000 U.S. forces that participated consumed more than 450,000 barrels of refined petroleum products per day – more than four times the amount used daily by the entire 2 million man Allied Expeditionary Force that liberated Europe in World War II. (58)

- During Operation Iraqi Freedom, one of the key objectives was to secure that nation's oil fields. The priority given this objective underscored the importance assigned to petroleum assets by defense planners.

But even these facts do not tell the whole story.

Two important changes have also taken place within the national defense establishment since the fall of the Soviet Union. The first of these has been the reduction of troop strengths overseas and the closing of overseas bases. Throughout the Cold War period,

the U.S. military maintained substantial "forward positioned" forces at bases in Europe and the Far East. As the overall size of the military has decreased, so, too, has its forward posture. Bases in the Philippine Islands were closed and force levels throughout the rest of the world were reduced.

In addition, the military has come increasingly to rely on National Guard and Reserve components to "round out" active duty divisions. Today 48.3% (59) of America's military forces are in either Guard or Reserve units. Moreover, many comprise key functions such as chemical, biological and nuclear decontamination, medical services and civil engineering. As a consequence, they are not merely "weekend warriors" but rather integral elements of any sustained military operation. This new reality was underscored during Operation Iraqi Freedom. But, because Guard and Reserve units are by definition based in the Continental United States, or "CONUS" in military parlance, this shift in force structure further diminishes the military's forward posture. This means that there will be additional fuel requirements to transport these forces and their equipment and materiel to the theater of operations. During the first Gulf War an average of 2,400 tons of materiel were airlifted to the theater of operations daily. (60) In future conflicts the greater dependence on forces stationed in the United States are likely to greatly increase this figure. Indeed, FM-100 emphasizes *"…The CONUS base is the strategic foundation for the logistical system…"* (61)

The energy implications of this new strategic doctrine are evident in the fact that the Department of Defense accounts for nearly 91% of all petroleum consumed by the federal government. (62) Peacetime use alone is more than 277,000 barrels per day. (63) The question is what will be the source of fuel to transport these troops?

During both World War I and World War II, the United States was the world's largest oil producer, and as such was able to provide not only for its own needs, but for over eighty percent of its ally's needs as well. (64) During Operation Desert Shield/Desert Storm, the first Persian Gulf War, surge production by Saudi Arabia (65) helped offset the loss of Kuwaiti and Iraqi oil. In the future, however, domestic production would not be able to make up any substantial loss of foreign oil, and there is no assurance that overseas producers would be willing to increase their output. Therefore, as long as America remains heavily dependent on imported crude, its national security remains jeopardized. Since the bulk of U.S. petroleum use today lies in the domestic transportation sector, the answer to the question of how to address our energy vulnerability must be found there.

Given the fact that the most practical solution to the nation's import dependence problem lies in reducing transportation sector petroleum consumption the question is how to accomplish this goal?

THE CLEAN CITIES PROGRAM

The Department of Energy established the Clean Cities Program as a means of addressing this challenge. Clean Cities takes the unique approach of supporting public and private partnerships to encourage strategies that will reduce our import burden including the deployment of alternative fuel vehicles, the adoption of technologies to reduce idling and improve automotive efficiency and build supporting infrastructure. By supporting such efforts, the Clean Cities Program makes a tangible contribution to enhancing the nation's energy security, air quality and economic growth.

What is perhaps most important about the Clean Cities approach is that it relies on voluntary partnerships rather than government mandates to achieve its goals. In so doing it recognizes the fundamental fact that the transition from petroleum-derived fuels to clean-burning alternatives will only take place if it enjoys widespread public support.

Now beginning its second decade, the Clean Cities Program has established eighty coalitions in some 41 states across the nation with over 4,400 "stakeholder" participants. As of 2003, the coalitions had deployed 124,108 light duty and 27,120 heavy duty alternative fueled vehicles for a total of 151,288.

While these initial achievements may be viewed as modest within the context of a domestic privately owned vehicle fleet that exceeds 220 million units, it's real value lies in their role as a catalyst for broader acceptance of alternative fuels within the general public, local governments and the business sector, and as a proving ground for emerging alternative fueled vehicles and advanced vehicle technologies.

Yet, it would be incorrect to limit the assessment of the program's value to its role in paving the way for alternative fuels and advanced vehicle technologies. The alternative fueled vehicles deployed to date also make a substantial contribution to reducing the "hidden costs" or externalities associated with the use of petroleum derived fuels. The purpose of this analysis is to provide some sense of what that contribution is.

The analysis examines each of the individual Clean Cities coalitions on the basis the external benefits derived from four specific areas:

- Avoided Defense-Related Costs
- Avoided Economic Costs
- Avoided Environmental Costs
- Avoided Health Costs

In providing this assessment, it is hoped that this analysis will help clarify the role the Clean Cities Program plays in reducing the impact of imported crude oil and refined petroleum products on the U.S. economy.

NOTES

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(45) Sheet Pressures on Coastal Environments, p. 1 U.S. Department of Commerce, National Oceanographic and Atmospheric Administration, Washington D.C. 2001
(46) ibid.
(47) ibid.
(48) ibid. Transportation Energy Data Book p. 11-3 op. cit.
(49) ibid.
(50) Population Reference Bureau 2000 World Population Data ibid.
(51) ibid.
(52) ibid.
(53) Current Population Survey, Income Surveys Branch, U.S. Census Bureau, Washington, D.C., Table P-1
(54) Issue Brief, Library of Congress, Congressional Research Service Washington, D.C. August 9, 1999 and Automotive Fuel Economy Program, Annual Update Calendar Year 2001, Department of Transportation, National Highway Transportation Safety Administration Table II-4, Washington D.C. September, 2002
(55) ibid.
(56) FM-100 United States Army Statement of Doctrine, Department of the Army, Introduction, Washington, D.C. June, 1993
(57) Goralski, Robert, Oil and War, William Morrow & Co. 1987 and Pagonis, Lt. Gen. William G., Moving Mountains, Lessons in Military Leadership and Logistics, Harvard Business School Press, Cambridge, MA, 1991
(58) ibid.
(59) Defense Almanac, United States Department of Defense, Washington, D.C. 2003
(60) Pagonis, op. cit. ibid.
(61) FM-100 United States Army Statement of Doctrine, Department of the Army, Introduction, Washington, D.C. June, 1993
(62) Annual Energy Review 2001, page 28 Figure 1.13 U.S. Department of Energy, Energy Information Administration, Washington, D.C. November 18, 2002
(63) ibid.
(64) Goralski, Robert, Oil and War, William Morrow & Co. 1987 and Pagonis, Lt. Gen. William G., Moving Mountains, Lessons in Military Leadership and Logistics, Harvard Business School Press, Cambridge, MA, 1991op. cit
(65) Pagonis, Lt. Gen. William G., Moving Mountains, Lessons in Military Leadership and Logistics, Harvard Business School Press, Cambridge, MA, 1991 op. cit.

INSTRUCTIONS FOR USING ESTIMATION TOOLS

In order to provide each Clean Cities Coordinator with the best possible means of calculating the local and national economic benefits or costs of their fleets, a number of options for calculating these benefits or costs have been provided. These include: Estimation on the basis of national averages either in terms of a percentage of fuel and maintenance costs, estimation on the basis of national averages in terms of an estimated dollar-based fuel and maintenance differential or estimation on the basis of actual operating experience. In addition, estimation tools for calculating the potential savings from idling technologies are provided.

ESTIMATION TOOLS FOR AFVS

METHOD ONE: National Averages by Percentage Differential

Preparing an estimate of economic benefits on the basis of national percentage price differentials is most useful where there may have been fluctuations in the price of one or more fuels; where there is insufficient data on specific fuel consumption and maintenance costs to provide "real world" estimates or where a lack of local resources precludes the diversion of personnel time to a more detailed analysis. This approach is also useful when a fleet is not yet in place to provide an indication of the economic benefits that may be derived if it is deployed.

Table E-1 provides a percentage price differential for various alternative fuels and maintenance on a gallon equivalent basis. Calculating the benefit or cost is a straightforward process.

The first step is to calculate the volume of alternative fuel used on a gallon-equivalent basis.

The second step is to calculate average maintenance costs for conventional gasoline-powered vehicles.

The third step is to multiply these figures by the benefit or cost indicated in Table E-1 to determine the economic cost or benefit per vehicle by fuel type.

The fourth step is to multiply the benefit by the number of vehicles in each fuel type to obtain a total cost or benefit.

If more than one type of alternative fuel is being used, the total for each type is then added to obtain a total cost or benefit for the fleet.

METHOD TWO: National Averages by "Dollars Per Gallon" Differential

Preparing an estimate using this method is most useful when there is accurate information on fuel and maintenance costs, but where a lack of local resources or data precludes a

more detailed analysis. Because it considers actual fuel use, Method Two provides a somewhat more accurate estimate. It is also more useful in instances where there are deployed fleets.

The first step is to calculate the volume of alternative fuel used on a gallon-equivalent basis.

The second step is to calculate average maintenance costs for conventional gasoline-powered vehicles.

The third step is to multiply the volume of fuel used by the fuel cost or benefit differential factors contained in table E-2.

The fourth step is to multiply the volume of fuel used by the maintenance cost or benefit listed in Table E-2.

The fourth step is to multiply the cost or benefit by the number of vehicles in each fuel type to obtain a total benefit.

If more than one type of alternative fuel is being used, the total for each type is then added to obtain a total cost or benefit for the fleet.

METHOD THREE: National Average by Annual "Dollars Per Vehicle" Basis

This is perhaps the simplest method for estimating the relative cost or benefit of an alternative vehicle fleet. Table E-3 contains estimates of annual fuel and maintenance costs or benefits for various types of alternative fueled vehicles.

The first step is to identify the number of vehicles of each specific type contained in the fleet.

The second step is to multiply the cost or benefit factors for both fuel and maintenance by the number of appropriate vehicles.

The third step is to total the figures for each type of vehicle.

METHOD FOUR: Operating Experience

The attached form allows those Clean Cities Coordinators with somewhat more sophisticated capabilities to make a relatively precise estimate of the "real world" benefits or costs of their fleets. The form includes a number of specific categories of outlays including fuel cost, oil changes, spark plugs tune-ups, routine maintenance, special maintenance and downtime.

The first step is to complete the form for conventional vehicles to obtain a baseline on which calculations of AFV costs and benefits will be determined.

The second step is to obtain the same information for AFVs in the fleet being evaluated.

The third step is to calculate the differential by subtracting the costs cataloged in the AFV fleet for each category from the costs recorded for conventional vehicles.

The fourth step is to total the products of the calculations performed in step three to determine an overall cost or benefit.

CALCULATING NATIONAL IMPACTS

National impacts may be calculated in one of two ways: on an annual basis by vehicle type or on a "per gallon" basis.

METHOD ONE: Annual National Impacts by Vehicle Class

Calculating national impacts on an annual basis by vehicle class provides a relatively simple and straightforward means of estimating the benefits in four broad categories.

The first step is to determine the number of heavy and light vehicles in the fleet that is being evaluated.

The second step is to multiply the number of vehicles by the estimation factors for each category of benefit contained in Table E-4.

The third step is to total the product of the calculations performed in step two. This yields a total annual benefit.

METHOD TWO: Annual National Impacts on a "Per Gallon" Basis

Calculating annual impacts on a "per gallon" basis provides a more accurate method of estimation where good information on actual fuel consumption is available.

The first step is to determine the volume of fuel consumed by the AFV fleet.

The second step is to multiply the number of gallons of fuel consumed by the "per gallon" benefits indicated in Table E-4.

The third step is to total the product of the calculations performed in step two to derive a total annual national impact.

ESTIMATING NATIONAL IMPACTS FROM IDLING TECHNOLOGIES

In order to estimate the national impacts of idling technologies it is necessary to know the rate of fuel consumption for the technology employed and the number of hours normally spent idling. If the number of hours spent idling is unknown, it is recommended that the lower, 2000 hour figures be used.

The first step is to determine the number of vehicles employing the idling technology.

The second step is to determine the rate of fuel consumption (either 1 gal/hr or 1.4 gal/hr) that best matches the technology employed.

The third step is to multiply the number of vehicles by the appropriate factor from Table E-5 for each category of benefit.

The fourth step is to total the products of the calculations performed in step three to derive a total benefit.

TABLE E-1

ESTIMATION TOOLS

FUEL PRICE AND MAINTENANCE DIFFERENTIALS

PERCENTAGE BASIS

FUEL	PRICE $ GAL EQ.	BENEFIT/COST PERCENTAGE FUEL COST	MAINTENANCE
GASOLINE	$1.80	-0-	-0-
NATURAL GAS	$1.35	-25.0%	-20.0%
PROPANE	$1.53	-15.0%	-20.0%
E-85	$1.61	-10.6%	-0-
ELECTRICITY	$0.72	-60.0%	-40.0%
DIESEL	$1.72	-0-	-0-
B-20	$2.03	+18.0%	-20%
B-100	$2.67	+55.0%	-40%

TABLE E-2

PER GALLON COST DIFFERENTIALS

DOLLAR BASIS

FUEL	COST	BENEFIT/COST PER GAL. FUEL	MAINTENANCE
GASOLINE	$1.80	-0-	-0-
NATURAL GAS	$1.35	-$0.45	-$0.36
PROPANE	$1.53	-$0.27	-$0.36
E-85	$1.61	-$0.19	-0-
ELECTRICITY	$0.72	-$1.08	-$0.90
DIESEL	$1.72	-0-	-0-
B-20	$2.03	+$0.31	-$0.36
B-100	$2.67	+$0.95	-$0.72

TABLE E-3

ANNUAL COST DIFFERENTIALS

DOLLARS PER VEHICLE BASIS

FUEL	ANNUAL COST	ANNUAL BENEFIT/COST	
		FUEL	MAINTENANCE
GASOLINE	$ 860	-0-	-0-
NATURAL GAS	$ 645	-$215	-$172
PROPANE	$ 731	-$129	-$172
E-85	$ 770	-$ 90	-0-
ELECTRICITY	$ 344	-$516	-$430
DIESEL	$ 823	-0-	-0-
B-20	$ 970	+$147	-$172
B-100	$ 1,276	+$453	-$344

TABLE E-4

ESTIMATION FACTORS FOR NATIONAL IMPACTS
BENEFIT PER VEHICLE DEPLOYED

CATEGORY	ANNUAL		PER GALLON
	LIGHT DUTY	HEAVY DUTY	
DEFENSE	$ 702	$1,404	$1.17
ECONOMIC	$1,500	$3,000	$2.50
ENVIRONMENT	$ 551	$1,102	$0.92
HEALTH	$ 227	$ 454	$0.38

TABLE E-5

IDLING TECHNOLOGY BENEFITS

PER VEHICLE DEPLOYED

	2,000 HOURS		**2400 HOURS**	
	1GAL/HR	**1.4 GAL/HR**	**1GAL/HR**	**1.4 GAL/HR**
DEFENSE	$2,340	$ 3,276	$2,808	$ 3,931
ECONOMIC	$3,000	$ 4,200	$3,600	$ 5,040
ENVIRONMENT	$1,840	$ 2,576	$2,280	$ 3,192
HEALTH	$ 760	$ 1,064	$ 912	$ 1,277
TOTAL	$7,940	$11,116	$9,600	$ 13,440

WORK SHEET

	CONVENTIONAL	ALTERNATIVE	DIFFERENCE
FUEL USE			
FUEL COST			
OIL CHANGES			
SPARK PLUGS			
TUNE UPS			
OTHER ROUTINE MAINTENANCE			
SPECIAL MAINTENANCE			
DOWNTIME			
TOTAL			

ESTIMATES OF MACROECONOMIC IMPACTS OF CLEAN CITIES FLEETS

The tables that follow represent an estimate of the macroeconomic avoided costs that are gained as a result of the deployment of the Clean Cities fleets in the cities specified and national aggregates both for total vehicles deployed and projections of potential gains in future years for each of the import reduction technologies under consideration.

TABLE D-1

PROGRAM

ATLANTA

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	2,787	731	3,518

BENEFITS**

DEFENSE	$1,956,784	$1,026,324	$ 2,983,108
ECONOMIC	$ 8,680,500	$2,193,000	$10,873,500
ENVIRONMENT	$ 1,535,637	$ 805,562	$ 2,341,199
HEALTH	$ 632,649	$ 331,874	$ 964,523
TOTAL	$12,805,570	$4,356,760	$17,162,330

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-2

PROGRAM

DENVER

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	10,279	235	10,514

BENEFITS**

DEFENSE	$ 7,215,858	$ 329,940	$ 7,545,798
ECONOMIC	$15,418,500	$ 705,000	$16,123,500
ENVIRONMENT	$ 5,663,729	$ 258,970	$ 5,922,699
HEALTH	$ 2,333,333	$ 106,690	$ 2,440,023
TOTAL	$30,631,420	$ 1,400,600	$32,032,020

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-3

PROGRAM

PHILADELPHIA

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	702	235	937

BENEFITS**

DEFENSE	$ 492,804	$ 329,940	$ 822,744
ECONOMIC	$1,053,000	$ 705,000	$1,758,000
ENVIRONMENT	$ 386,802	$ 258,970	$ 645,772
HEALTH	$ 159,354	$ 106,690	$ 266,044
TOTAL	$2,091,960	$1,400,600	$3,492,560

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-4

PROGRAM

DELAWARE

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	363	98	461

BENEFITS**

DEFENSE	$ 254,826	$ 137,592	$ 392,418
ECONOMIC	$ 544,500	$ 294,000	$ 838,500
ENVIRONMENT	$ 200,013	$ 107,996	$ 308,809
HEALTH	$ 82,401	$ 44,492	$ 126,893
TOTAL	$1,081,740	$ 584,080	$1,665,820

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-5

PROGRAM

LAS VEGAS

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	3,545	1,785	5,330

BENEFITS**

DEFENSE	$ 2,488,590	$ 2,506,140	$ 4,994,730
ECONOMIC	$ 5,317,500	$5,355,000	$10,672,500
ENVIRONMENT	$ 1,953,295	$ 1,967,070	$ 3,920,365
HEALTH	$ 804,715	$ 810,390	$ 1,615,105
TOTAL	$10,564,100	$10,638,600	$21,202,700

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-6

PROGRAM

WASHINGTON, D.C.

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	2,450	197	2,647

BENEFITS**

DEFENSE	$1,719,900	$ 276,588	$1,996,488
ECONOMIC	$3,675,000	$ 591,000	$4,266,000
ENVIRONMENT	$1,349,950	$ 217,094	$1,567,044
HEALTH	$ 556,150	$ 89,438	$ 645,588
TOTAL	$7,301,000	$1,174,120	$8,475,120

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-7

PROGRAM

BOSTON

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	1,207	57	1,264

BENEFITS**

DEFENSE	$ 847,314	$ 80,028	$ 927,342
ECONOMIC	$1,810,500	$ 171,000	$1,981,500
ENVIRONMENT	$ 665,057	$ 62,814	$ 727,871
HEALTH	$ 273,989	$ 25,878	$ 299,867
TOTAL	$3,596,860	$ 339,720	$3,936,580

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-8

PROGRAM

CENTRAL TEXAS

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	3,242	66	3,308

BENEFITS**

DEFENSE	$2,275,884	$ 92,664	$ 2,368,548
ECONOMIC	$4,863,000	$ 198,000	$ 5,061,000
ENVIRONMENT	$1,786,342	$ 72,732	$ 1,859,074
HEALTH	$ 735,934	$ 29,964	$ 765,898
TOTAL	$9,661,160	$ 393,360	$10,054,520

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-9

PROGRAM

FLORIDA GOLD COAST

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	1,351	238	1,589

BENEFITS**

DEFENSE	$ 948,402	$ 334,152	$1,282,554
ECONOMIC	$2,026,500	$ 714,000	$2,740,500
ENVIRONMENT	$ 744,401	$ 262,276	$1,006,679
HEALTH	$ 306,677	$ 108,052	$ 414,729
TOTAL	$4,025,980	$1.418,480	$5,444,460

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-10

PROGRAM

CHICAGO, IL

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	4,248	267	4,515

BENEFITS**

DEFENSE	$ 2,982,096	$ 374,868	$ 3,356,964
ECONOMIC	$ 6,372,000	$ 801,000	$ 7,173,000
ENVIRONMENT	$ 2,340,648	$ 294,234	$ 2,634,882
HEALTH	$ 964,296	$ 121,218	$ 1,085,514
TOTAL	$12,659,040	$1,591,320	$14,250,360

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-11

PROGRAM

ALBUQUERQUE

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	1,248	225	1,473

BENEFITS**

DEFENSE	$ 876,096	$ 315,900	$1,191,996
ECONOMIC	$1,872,000	$ 675,000	$2,547,000
ENVIRONMENT	$ 687,048	$ 247,950	$ 935,598
HEALTH	$ 283,296	$ 102,150	$ 385,446
TOTAL	$3,719,040	$1,341,000	$5,060,040

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-12

PROGRAM

SOUTHEAST WISCONSIN

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	1,833	246	2,079

BENEFITS**

DEFENSE	$1,286,766	$ 345,386	$1,632,150
ECONOMIC	$2,749,500	$ 738,000	$3,487.500
ENVIRONMENT	$1,009,983	$ 271,092	$1,281,075
HEALTH	$ 416,091	$ 111,684	$ 527,775
TOTAL	$5,462,340	$1,466,160	$6,928,500

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-13

PROGRAM

COLORADO SPRINGS

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	761	-0-	761

BENEFITS**

DEFENSE	$ 534,222	-0-	$ 534,222
ECONOMIC	$1,141,500	-0-	$1,141,500
ENVIRONMENT	$ 419,311	-0-	$ 419,311
HEALTH	$ 172,747	-0-	$ 172,747
TOTAL	$2,267,780	-0-	$2,267,780

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-14

PROGRAM

LONG BEACH

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	777	103	880

BENEFITS**

DEFENSE	$ 545,454	$ 144,612	$ 690,066
ECONOMIC	$1,165,500	$ 309,000	$1,474,500
ENVIRONMENT	$ 428,127	$ 113,506	$ 541,633
HEALTH	$ 176,379	$ 46,762	$ 223,141
TOTAL	$2,315, 460	$ 613,880	$2,929,340

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-15

PROGRAM

ANTELOPE VALLEY/LANCASTER, CA

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	237	52	289

BENEFITS**

DEFENSE	$ 166,374	$ 73,008	$ 239,382
ECONOMIC	$ 355, 500	$ 156,000	$ 511,500
ENVIRONMENT	$ 130,587	$ 57,304	$ 187,891
HEALTH	$ 53,799	$ 23,608	$ 77,407
TOTAL	$ 706,260	$ 309,920	$1,016,180

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-16

PROGRAM

SALT LAKE CITY

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	3,756	183	3,939

BENEFITS**

DEFENSE	$ 2,636,712	$ 256,932	$ 2,893,644
ECONOMIC	$ 5,634,000	$ 549,000	$ 6,183,000
ENVIRONMENT	$ 2,069,556	$ 201,666	$ 2,271,222
HEALTH	$ 852,612	$ 83,082	$ 935,694
TOTAL	$11,192,880	$ 1,090,680	$12,283,560

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-17

PROGRAM

BALTIMORE

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	2,376	570	2,946

BENEFITS**

DEFENSE	$ 1,667,952	$ 800,280	$ 2,468,232
ECONOMIC	$ 3,564,000	$ 1,710,000	$ 5,274,000
ENVIRONMENT	$ 1,309,176	$ 628,140	$ 1,937,316
HEALTH	$ 534,352	$ 258,780	$ 793,132
TOTAL	$ 7,080,480	$ 3,397,200	$10,477,680

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-18

PROGRAM

WEST VIRGINIA

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	370	10	380

BENEFITS**

DEFENSE	$ 259,740	$ 14,040	$ 273,780
ECONOMIC	$ 555,000	$ 30,000	$ 585,000
ENVIRONMENT	$ 203,870	$ 11,020	$ 214,890
HEALTH	$ 83,990	$ 4,540	$ 88,530
TOTAL	$1,102,600	$ 59,600	$1.162,200

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-19

PROGRAM

KENTUCKY

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	3,223	1,141	4,364

BENEFITS**

DEFENSE	$2,262,546	$1,601,964	$ 3,864,510
ECONOMIC	$4,834,500	$3,423,000	$ 8,257,500
ENVIRONMENT	$1,775,873	$1,257,382	$ 3,033,255
HEALTH	$ 731,621	$ 518,014	$ 1,249,635
TOTAL	$9,604,540	$6,800,360	$16,404,900

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-10

PROGRAM

ROGUE VALLEY

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	44	15	59

BENEFITS**

DEFENSE	$ 30,888	$ 21,060	$ 51,948
ECONOMIC	$ 66,000	$ 45,000	$111,000
ENVIRONMENT	$ 24,244	$ 16,530	$ 40,774
HEALTH	$ 9,988	$ 6,810	$ 16,798
TOTAL	$131,120	$ 89,400	$220,520

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-21

PROGRAM

SAN FRANCISCO

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	844	71	915

BENEFITS**

DEFENSE	$ 592, 488	$ 99,684	$ 692,172
ECONOMIC	$1,266, 000	$ 213,000	$1,479,000
ENVIRONMENT	$ 465,044	$ 78,242	$ 543,286
HEALTH	$ 191,588	$ 32,234	$ 223,822
TOTAL	$2,515,120	$ 423,160	$2,938,280

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-22

PROGRAM

SACRAMENTO

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	1,450	850	2,300

BENEFITS**

DEFENSE	$1,017,900	$1,193,400	$2,211,300
ECONOMIC	$2,175,000	$2,550,000	$4,725,000
ENVIRONMENT	$ 798,950	$ 936,700	$1,735,650
HEALTH	$ 329,150	$ 385,900	$ 715,050
TOTAL	$4,321,000	$5,066,000	$9,387,000

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-23

PROGRAM

SOUTH BAY (SAN JOSE)

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	442	250	692

BENEFITS**

DEFENSE	$ 310,284	$ 351,000	$ 661,284
ECONOMIC	$ 663,000	$ 750,000	$1,413,000
ENVIRONMENT	$ 243,542	$ 275,500	$ 519,042
HEALTH	$ 100,334	$ 113,500	$ 213,834
TOTAL	$1,317,160	$1,490,000	$2,807,160

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-24

PROGRAM

EAST BAY

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	1,560	337	1,897

BENEFITS**

DEFENSE	$1,095,120	$ 473,148	$1,568,268
ECONOMIC	$2,340,000	$1,011,000	$3,351,000
ENVIRONMENT	$ 859,560	$ 371,374	$1,230,934
HEALTH	$ 354,120	$ 152,998	$ 507,118
TOTAL	$4,648,800,	$2,008,520	$ 6,657,320

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-25

PROGRAM

SAN JOAQUIN VALLEY

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	693	578	1,271

BENEFITS**

DEFENSE	$ 486,486	$ 811,512	$1,297,998
ECONOMIC	$1,039,500	$1,734,000	$2,773,500
ENVIRONMENT	$ 381,843	$ 636,956	$1,018,799
HEALTH	$ 157,311	$ 262,412	$ 419,723
TOTAL	$2,065,140	$3,444,880	$5,510,020

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-26

PROGRAM

WESTERN NEW YORK

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	757	508	1,265

BENEFITS**

DEFENSE	$ 531,414	$ 713,232	$1,244,646
ECONOMIC	$1,13 5,500	$1,524,000	$2,659,500
ENVIRONMENT	$ 417,107	$ 559,816	$ 976,923
HEALTH	$ 171,839	$ 230,632	$ 402,471
TOTAL	$2,255,860	$3,027,680	$5,283,540

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-27

PROGRAM

COLUMBIA/WILLAMETTE

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	650	895	1,545

BENEFITS**

DEFENSE	$ 456,300	$1,256,580	$1,712,880
ECONOMIC	$ 975,000	$2,685,000	$3,660,000
ENVIRONMENT	$ 358,150	$ 986,290	$1,344,440
HEALTH	$ 147,550	$ 406,330	$ 553,880
TOTAL	$1,937,000	$5,334,200	$7,271,200

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-28

PROGRAM

ST.LOUIS

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	1,235	488	1,723

BENEFITS**

DEFENSE	$ 866,970	$ 685,152	$1,552,122
ECONOMIC	$1,852,500	$1,464,000	$3,316,500
ENVIRONMENT	$ 680,485	$ 537,776	$1,218,261
HEALTH	$ 280,345	$ 221,552	$ 501,897
TOTAL	$3,680,300	$2,908,480	$6,588,780

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-29

PROGRAM

SOUTHWESTERN CONNECTICUT

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	229	2	231

BENEFITS**

DEFENSE	$160,758	$ 2,802	$163,566
ECONOMIC	$343,500	$ 6,000	$349,500
ENVIRONMENT	$126,179	$ 2,204	$128,383
HEALTH	$ 51,983	$ 908	$ 52,891
TOTAL	$682,420	$11,920	$694,340

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-30

PROGRAM

NORWICH

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	40	3	43

BENEFITS**

DEFENSE	$ 28,080	$ 4,212	$ 32,292
ECONOMIC	$ 60,000	$ 9,000	$ 69,000
ENVIRONMENT	$ 22,040	$ 3,306	$ 25,346
HEALTH	$ 9,080	$ 1,362	$ 10,442
TOTAL	$119,200	$ 17,880	$137,080

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-31

PROGRAM

CENTRAL NEW YORK

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	161	205	366

BENEFITS**

DEFENSE	$113,022	$ 287,820	$ 400,842
ECONOMIC	$241,500	$ 615,000	$ 856,500
ENVIRONMENT	$ 88,711	$ 225,910	$ 314,621
HEALTH	$ 36,547	$ 93,070	$ 129,617
TOTAL	$479,780	$1,221,800	$1,701,580

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-32

PROGRAM

DALLAS/FORT WORTH

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	6,252	1,008	7,260

BENEFITS**

DEFENSE	$ 4,388,904	$1,415,232	$ 5,804,136
ECONOMIC	$ 9,378,000	$3,024,000	$12,402,000
ENVIRONMENT	$ 3,444,852	$1,110,816	$ 4,555,668
HEALTH	$ 1,419,204	$ 457,632	$ 1,876,836
TOTAL	$18,630,960	$6,007,680	$24,638,640

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-33

PROGRAM

HONOLULU

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	466	251	717

BENEFITS**

DEFENSE	$ 372,132	$ 352,404	$ 679,536
ECONOMIC	$ 699,000	$ 753,000	$1,452,000
ENVIRONMENT	$ 256,766	$ 276,602	$ 533,368
HEALTH	$ 105,782	$ 113,954	$ 219,736
TOTAL	$1,388,680	$1,495,960	$2,884,640

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-34

PROGRAM

NEW HAVEN

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	175	79	254

BENEFITS**

DEFENSE	$122,850	$110,916	$233,766
ECONOMIC	$262,500	$237,000	$499,500
ENVIRONMENT	$ 96,425	$ 87,058	$183,483
HEALTH	$ 39,725	$35,866	$ 75,591
TOTAL	$521,500	$470,840	$992,340

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-35

PROGRAM

CENTRAL ARKANSAS

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	112	38	150

BENEFITS**

DEFENSE	$ 78,624	$ 53,352	$131,976
ECONOMIC	$168,000	$114,000	$282,000
ENVIRONMENT	$ 61,712	$ 41,876	$103,588
HEALTH	$ 25,424	$ 17,252	$ 42,676
TOTAL	$333,760	$226,480	$560,240

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-36

PROGRAM

PASO DEL NORTE

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	1,105	461	1,566

BENEFITS**

DEFENSE	$ 775,710	$ 647,244	$1,422,954
ECONOMIC	$1,657,500	$1,383,000	$3,040,500
ENVIRONMENT	$ 608,855	$ 508,022	$1,116,877
HEALTH	$ 250,835	$ 209,294	$ 460,129
TOTAL	$3,292,900	$2,747,560	$6,040,460

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-37

PROGRAM

PITTSBURGH

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	433	186	619

BENEFITS**

DEFENSE	$ 303,966	$ 261,144	$ 565,110
ECONOMIC	$ 649,500	$ 558,000	$1,207,500
ENVIRONMENT	$ 238,583	$ 204,972	$ 443,555
HEALTH	$ 98,291	$ 84,444	$ 182,735
TOTAL	$1,290,340	$1,108,560	$2,398,900

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-38

PROGRAM

SCAG

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	915	2,016	2,931

BENEFITS**

DEFENSE	$ 642,330	$ 2,830,464	$ 3,472,794
ECONOMIC	$1,372,500	$ 6,048,000	$ 7,420,500
ENVIRONMENT	$ 504,165	$ 2,221,632	$ 2,725,797
HEALTH	$ 207,705	$ 915,264	$ 1,122,969
TOTAL	$2,726,700	$12,015,360	$14,742,060

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-39

PROGRAM

LOS ANGELES

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	565	464	1,029

BENEFITS**

DEFENSE	$ 396,630	$ 651,456	$1,048,086
ECONOMIC	$ 847,500	$ 1,392,000	$2,239,500
ENVIRONMENT	$ 311,315	$ 511,328	$ 822,643
HEALTH	$ 128,255	$ 210,656	$ 33 8,911
TOTAL	$1,683,700	$2,765,440	$4,449,140

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-40

PROGRAM

COCHELLA VALLEY

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	459	162	621

BENEFITS**

DEFENSE	$ 322,218	$227,448	$ 549,666
ECONOMIC	$ 688,500	$486,000	$1,174,500
ENVIRONMENT	$ 252,909	$178,524	$ 431,433
HEALTH	$ 104,193	$ 73,548	$ 177,741
TOTAL	$1,367,820	$965,520	$2,333,340

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-41

PROGRAM

WELD/LORIMAR/RMND

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	437	8	445

BENEFITS**

DEFENSE	$ 306,774	$11,232	$ 318,006
ECONOMIC	$ 655,500	$24,000	$ 679,500
ENVIRONMENT	$ 240,787	$ 8,816	$ 249,603
HEALTH	$ 99,199	$ 3,632	$ 102,831
TOTAL	$1,302,260	$47,680	$1,349,940

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-42

PROGRAM

CENTRAL OKLAHOMA

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	2,814	1,143	3,957

BENEFITS**

DEFENSE	$1,975,428	$1,604,772	$ 3,580,200
ECONOMIC	$4,221,000	$2,429,000	$ 7,650,000
ENVIRONMENT	$1,550,514	$1,259,586	$ 2,810,100
HEALTH	$ 638,778	$ 518,922	$ 1,157,700
TOTAL	$8,385,720	$6,812,280	$15,198,000

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-43

PROGRAM

HAMPTON ROADS, VA

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	746	20	766

BENEFITS**

DEFENSE	$ 523,692	$ 28,080	$ 551,772
ECONOMIC	$1,119,000	$ 60,000	$1,179,000
ENVIRONMENT	$ 411,046	$ 22,040	$ 433,086
HEALTH	$ 169,342	$ 9,080	$ 178,422
TOTAL	$2,223,080	$119,200	$2,342,280

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-44

PROGRAM

SAN DIEGO

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	2,899	695	3,594

BENEFITS**

DEFENSE	$2,035,098	$ 975,780	$ 3,010,878
ECONOMIC	$4,348,500	$2,085,000	$ 6,433,500
ENVIRONMENT	$1,597,349	$ 765,890	$ 2,363,239
HEALTH	$ 658,073	$ 315,530	$ 973,603
TOTAL	$8,639,020	$4,142,200	$12.781,220

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-45

PROGRAM

LONG ISLAND

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	942	276	1,218

BENEFITS**

DEFENSE	$ 661,284	$ 387,504	$1,048,788
ECONOMIC	$1,413,000	$ 828,000	$2,241,000
ENVIRONMENT	$ 519,042	$ 304,152	$ 823,194
HEALTH	$ 213,834	$ 125,304	$ 339,138
TOTAL	$2,807,160	$1,644,960	$4,452,120

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-46

PROGRAM

DETROIT

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	782	19	801

BENEFITS**

DEFENSE	$ 548,964	$ 26,676	$ 575,640
ECONOMIC	$1,173,000	$ 57,000	$1,230,000
ENVIRONMENT	$ 430,882	$ 20,938	$ 451,820
HEALTH	$ 177,154	$ 8,626	$ 186,140
TOTAL	$2,330,36 0	$113,240	$2,443,600

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-47

PROGRAM

TRI-STATE OHIO

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	1,225	491	1,716

BENEFITS**

DEFENSE	$ 859,950	$ 689,364	$1,549,314
ECONOMIC	$1,837,500	$1,473,000	$3,310,500
ENVIRONMENT	$ 674,975	$ 541,082	$1,216,057
HEALTH	$ 278,075	$ 222,914	$ 500,989
TOTAL	$3,650,500	$2,926,360	$6,576,860

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-48

PROGRAM

EVANSVILLE, IN

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	273	197	470

BENEFITS**

DEFENSE	$191,646	$ 276,588	$ 468,234
ECONOMIC	$409,500	$ 591,000	$1,000,500
ENVIRONMENT	$150,423	$ 217,094	$ 367,517
HEALTH	$ 61,971	$ 89,438	$ 151,409
TOTAL	$813,540	$1,174,120	$1,987, 660

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-49

PROGRAM

HOUSTON, TX

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	1,990	699	2,689

BENEFITS**

DEFENSE	$1,396,980	$ 981,396	$ 2,378,376
ECONOMIC	$2,985,000	$2,097,000	$ 5,082,000
ENVIRONMENT	$1,096,490	$ 770,298	$ 1,866,788
HEALTH	$ 451,730	$ 317,346	$ 769,076
TOTAL	$5,930,200	$4,166.040	$10,096,240

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-50

PROGRAM

PORTLAND, ME

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	106	126	232

BENEFITS**

DEFENSE	$ 74,412	$176,904	$ 251,316
ECONOMIC	$159,000	$378,000	$537,000
ENVIRONMENT	$ 58,406	$138,852	$197,258
HEALTH	$ 24,062	$ 57,204	$ 81,266
TOTAL	$315,880	$750,960	$1,066,840

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-51

PROGRAM

TULSA

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	1,924	388	2,312

BENEFITS**

DEFENSE	$1,350,648	$ 544,752	$1,895,400
ECONOMIC	$2,886,000	$1,164,000	$4,050,000
ENVIRONMENT	$1,060,124	$ 427,576	$1,487,700
HEALTH	$ 436,748	$ 176,152	$ 612,900
TOTAL	$5,733,520	$2.312,480	$8,046,000

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-52

PROGRAM

MARICOPA

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	4,903	1,269	6,172

BENEFITS**

DEFENSE	$ 3,441,906	$1,781,676	$ 5,223,582
ECONOMIC	$ 7,354, 500	$3,807,000	$11,161,500
ENVIRONMENT	$ 2,701,553	$1,398,438	$ 4,099,991
HEALTH	$ 1,112,981	$ 576,126	$ 1,689,107
TOTAL	$14,610,940	$7,563,240	$22,174,180

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-53

PROGRAM

RIVERSIDE

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	851	425	1,276

BENEFITS**

DEFENSE	$ 597,402	$ 596,700	$1,194.102
ECONOMIC	$1,276,500	$1,275,000	$2,551,500
ENVIRONMENT	$ 468,901	$ 468,350	$ 937,251
HEALTH	$ 193,177	$ 192,950	$ 386,127
TOTAL	$2,535,980	$2,533,000	$5,068,980

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-54

PROGRAM

NORTHERN NEW JERSEY

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	3,410	137	3,547

BENEFITS**

DEFENSE	$ 2,393,820	$192,348	$ 2,586,168
ECONOMIC	$ 5,115,000	$411,000	$ 5,526,000
ENVIRONMENT	$ 1,878,910	$150,974	$ 2,029,884
HEALTH	$ 774,070	$ 62,198	$ 836,268
TOTAL	$10,161,800	$816,520	$10,978,320

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-55

PROGRAM

SOUTH TEXAS

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	784	383	1,167

BENEFITS**

DEFENSE	$ 550,368	$ 537,732	$1,088,100
ECONOMIC	$1,176,000	$1,149,000	$2,325,000
ENVIRONMENT	$ 431,984	$ 422,066	$ 854,050
HEALTH	$ 177,968	$ 173,882	$351,850
TOTAL	$2,336,320	$2,282,680	$4,619,000

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-56

PROGRAM

GENESEE REGION

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	77	20	97

BENEFITS**

DEFENSE	$ 54,054	$ 28,080	$ 82,134
ECONOMIC	$115,500	$ 60,000	$175,500
ENVIRONMENT	$ 42,427	$ 22,040	$ 64,467
HEALTH	$ 17,479	$ 9,080	$ 26,559
TOTAL	$229,460	$119,200	$348,660

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-57

PROGRAM

RED RIVER VALLEY

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	651	43	694

BENEFITS**

DEFENSE	$ 457,002	$ 60,372	$ 517,374
ECONOMIC	$ 976,500	$129,000	$1,105,500
ENVIRONMENT	$ 358,701	$ 47,386	$ 466,087
HEALTH	$ 147,777	$ 19,522	$ 167,299
TOTAL	$1,939,980	$256,280	$2,196,260

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-58

PROGRAM

PUGET SOUND

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	1,575	935	2,510

BENEFITS**

DEFENSE	$1,105,650	$1,312,740	$ 2,418,390
ECONOMIC	$2,362,500	$2,805,000	$ 5,167,500
ENVIRONMENT	$ 867,825	$1,030,370	$ 1,898,195
HEALTH	$ 357,525	$ 424,490	$ 782,015
TOTAL	$4,693,500	$5,572,600	$10,266,100

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-59

PROGRAM

RHODE ISLAND

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	511	60	571

BENEFITS**

DEFENSE	$ 358,722	$ 84,240	$ 442,962
ECONOMIC	$ 766,500	$180,000	$ 946,500
ENVIRONMENT	$ 281,561	$ 66,120	$ 347,681
HEALTH	$ 115,997,	$ 27,240	$ 143,237
TOTAL	$1,522,780	$357,600	$1,880,380

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-60

PROGRAM

OMAHA

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	1,042	74	1,116

BENEFITS**

DEFENSE	$ 731,484	$103,896	$ 835,380
ECONOMIC	$1,563,000	$222,000	$1,785,000
ENVIRONMENT	$ 574,142	$ 81,548	$ 655,690
HEALTH	$ 236,534	$ 33,596	$ 270,130
TOTAL	$3,105,160	$441,040	$3,546,200

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-61

PROGRAM

KANSAS CITY

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	3,659	1,537	5,196

BENEFITS**

DEFENSE	$ 2,568,618	$2,157,948	$ 4,726,566
ECONOMIC	$ 5,488,500	$4,611,000	$10,099,500
ENVIRONMENT	$ 2,016,109	$1,693,774	$3,709,883
HEALTH	$ 830,593	$ 697,798	$ 1,528,391
TOTAL	$10,903,820	$9,160,520	$20,064,340

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-62

PROGRAM

CENTRAL INDIANA

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	792	73	865

BENEFITS**

DEFENSE	$ 555,984	$102,492	$ 658,476
ECONOMIC	$1,188,000	$219,000	$1,407,000
ENVIRONMENT	$ 436,392	$ 80,446	$ 516,838
HEALTH	$ 179,784	$ 33,142	$ 212,926
TOTAL	$2,360,160	$435,080	$2,795,240

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE S-63

PROGRAM

ANN ARBOR MICHIGAN

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	284	254	538

BENEFITS**

DEFENSE	$199,368	$ 356,616	$ 555,984
ECONOMIC	$426,000	$ 762,000	$1,188,000
ENVIRONMENT	$156,484	$ 279,908	$ 436,392
HEALTH	$ 64,468	$ 115,316	$ 179,784
TOTAL	$846,320	$1,513,840	$2,360,160

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-64

PROGRAM

CAPITOL DISTRICT (ALBANY)

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	451	44	495

BENEFITS**

DEFENSE	$ 316,602	$ 61,776	$ 378,378
ECONOMIC	$ 676,500	$132,000	$ 808,500
ENVIRONMENT	$ 248,501	$ 48,488	$ 296,989
HEALTH	$ 102,377	$ 19,976	$ 122,353
TOTAL	$1,343,980	$262,240	$1,606,220

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-65

PROGRAM

SOUTH SHORE INDIANA

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	537	299	836

BENEFITS**

DEFENSE	$ 376,974	$ 419,796	$ 796,770
ECONOMIC	$ 805,500	$ 897,000	$1,702,500
ENVIRONMENT	$ 295,887	$ 329,498	$ 625,385
HEALTH	$ 121,899	$ 135,746	$ 257,645
TOTAL	$1,600,260	$1,782,040	$3,382,300

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-66

PROGRAM

CAPITOL CLEAN CITIES CONNECTICUT

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	670	-0-	670

BENEFITS**

DEFENSE	$ 470,340	-0-	$ 470,340
ECONOMIC	$1,005,000	-0-	$1,005,000
ENVIRONMENT	$ 369,170	-0-	$ 369,170
HEALTH	$ 152,090	-0-	$ 152,090
TOTAL	$1,996,600	-0-	$1,996,600

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-67

PROGRAM

TUCSON

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	1,548	326	1,874

BENEFITS**

DEFENSE	$1,086,696	$ 457,704	$1,544,400
ECONOMIC	$2,322,000	$ 978,000	$3,300,000
ENVIRONMENT	$ 852,948	$ 359,252	$1,212,200
HEALTH	$ 351,396	$ 148,004	$ 499,400
TOTAL	$4,613,040	$1,942,960	$6,556,000

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-68

PROGRAM

NORTHEAST OHIO

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	955	655	1,610

BENEFITS**

DEFENSE	$ 670,410	$ 919,620	$1,590,030
ECONOMIC	$1,432,500	$1,965,000	$3,397,500
ENVIRONMENT	$ 526,205	$ 721,810	$1,248,015
HEALTH	$ 216,785	$ 297,370	$ 514,155
TOTAL	$2,845,900	$3,903,800	$6,749,700

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-69

PROGRAM

FLORIDA GOLD COAST

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	1,967	18	1,985

BENEFITS**

DEFENSE	$1,380,834	$ 25,272	$1,406,106
ECONOMIC	$2,950,500	$ 54,000	$3,004,500
ENVIRONMENT	$1,083,817	$ 19,836	$1,103,653
HEALTH	$ 446,509	$ 8,172	$ 454,681
TOTAL	$5,861,660	$107,280	$5,968,940

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-70

PROGRAM

MANHATTAN KANSAS

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	175	6	181

BENEFITS**

DEFENSE	$122,850	$ 8,424	$131,274
ECONOMIC	$ 262,500	$18,000	$280,500
ENVIRONMENT	$ 96,425	$ 6,612	$103,037
HEALTH	$ 39,725	$ 2,724	$ 42,449
TOTAL	$521,500	$35,760	$557,260

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-71

PROGRAM

ALAMO AREA, TEXAS

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	1,946	91	2,037

BENEFITS**

DEFENSE	$1,366,092	$127,764	$1,493,856
ECONOMIC	$2,919,000	$273,000	$3,192,000
ENVIRONMENT	$1,072,246	$100,282	$1,172,528
HEALTH	$ 441,742	$ 41,314	$ 483,056
TOTAL	$5,799,080	$542,360	$6,341,440

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-72

PROGRAM

BATON ROUGE

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	588	-0-	588

BENEFITS**

DEFENSE	$ 412,776	-0-	$ 412,776
ECONOMIC	$ 882,000	-0-	$ 882,000
ENVIRONMENT	$ 323,988	-0-	$ 323,988
HEALTH	$ 133,476	-0-	$ 133,476
TOTAL	$1,752,240	-0-	$1,752,240

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-73

PROGRAM

TRUKEE MEADOWS

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	459	35	494

BENEFITS**

DEFENSE	$ 322,218	$ 49,140	$ 371,358
ECONOMIC	$ 688,500	$105,000	$ 793,500
ENVIRONMENT	$ 252,909	$ 38,570	$ 291,479
HEALTH	$ 104,193	$ 15,890	$ 120,083
TOTAL	$1,367,820	$208,600	$1,576,420

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-74

PROGRAM

TRIANGLE, NORTH CAROLINA

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	781	101	882

BENEFITS**

DEFENSE	$ 548,262	$141,804	$ 690,066
ECONOMIC	$1,171,500	$303,000	$1,474,500
ENVIRONMENT	$ 430,331	$111,302	$ 541,633
HEALTH	$ 177,287	$ 45,854	$ 223,141
TOTAL	$2,327,380	$601,960	$2,929,340

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-75

PROGRAM

TWIN CITIES, MINNESOTA

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	16,627	277	16,904

BENEFITS**

DEFENSE	$11,672,154	$ 388,908	$12,061,062
ECONOMIC	$24,940,500	$ 831,000	$25,771,500
ENVIRONMENT	$ 9,161,477	$ 305,254	$ 9,466,731
HEALTH	$ 3,774,329	$ 125,758	$ 3,900,087
TOTAL	$49,548,460	$1,650,920	$51,199,380

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-76

PROGRAM

VERMONT

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	232	181	413

BENEFITS**

DEFENSE	$162,864	$ 254,124	$ 416,988
ECONOMIC	$348,000	$ 543,000	$ 891,000
ENVIRONMENT	$127,832	$ 199,462	$ 327,294
HEALTH	$ 52,664	$ 82,174	$ 134,838
TOTAL	$691,360	$1,078,760	$1,770,120

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-77

PROGRAM

CENTRAL OHIO

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	786	108	894

BENEFITS**

DEFENSE	$ 551,772	$151,632	$ 703,404
ECONOMIC	$1,179,000	$324,000	$1,503,000
ENVIRONMENT	$ 433,086	$119,016	$ 552,102
HEALTH	$ 178,422	$ 49,032	$ 227,454
TOTAL	$2,342,280	$643,680	$2,985,960

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-78

PROGRAM

GRANITE STATE, NEW HAMPSHIRE

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	118	173	291

BENEFITS**

DEFENSE	$ 82,836	$242,892	$ 325,728
ECONOMIC	$177,000	$ 519,000	$ 696,000
ENVIRONMENT	$ 65,018	$ 190,646	$ 255,664
HEALTH	$ 26,786	$ 78,542	$ 105,328
TOTAL	$351,640	$1,031,080	$1,382,720

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-79

PROGRAM

YELLOWSTONE/TETON

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	248	178	426

BENEFITS**

DEFENSE	$174,096	$ 249,912	$ 424,008
ECONOMIC	$372,000	$ 534,000	$ 906,000
ENVIRONMENT	$136,648	$ 196,156	$ 332,804
HEALTH	$ 56,296	$ 80,812	$ 137,108
TOTAL	$739,040	$1,060,880	$1,799,920

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-80

PROGRAM

MIDDLE GEORGIA

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	161	45	206

BENEFITS**

DEFENSE	$113,022	$ 63,180	$126,202
ECONOMIC	$241,500	$135,000	$376,500
ENVIRONMENT	$ 88,711	$ 49,590	$138,301
HEALTH	$ 35,547	$ 20,430	$ 56,977
TOTAL	$479,780	$268,200	$747,980

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-81

PROGRAM

NEW YORK

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	5,437	639	6,076

BENEFITS**

DEFENSE	$ 3,816,774	$ 897,156	$ 4,713,930
ECONOMIC	$ 8,155,500	$1,917,000	$10,072,500
ENVIRONMENT	$ 2,955,787	$ 704,178	$ 3,699,965
HEALTH	$ 1,234,199	$ 20,430	$ 56,977
TOTAL	$16,202,260	$3,808,440	$10,010,700

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-82

PROGRAM

LANSING, MICHIGAN

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	445	-0-	445

BENEFITS**

DEFENSE	$ 312,390	-0-	$ 312,390
ECONOMIC	$ 667,500	-0-	$ 667,600
ENVIRONMENT	$ 245,195	-0-	$ 245,195
HEALTH	$ 101,015	-0-	$ 101,015
TOTAL	$1, 326,100	-0-	$1,326,100

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-83

PROGRAM

FLORIDA SPACE COAST

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	1,172	52	1,224

BENEFITS**

DEFENSE	$ 822,744	$ 73,008	$ 895,752
ECONOMIC	$1,758,000	$156,000	$1,914,000
ENVIRONMENT	$ 645,772	$ 57,304	$ 703,076
HEALTH	$ 266,044	$ 23,608	$ 289,652
TOTAL	$3,492,560	$309,920	$3.802,480

*Most recent data as reported to the United States Department of Energy

** Current dollars

TABLE D-84

PROGRAM

NATIONAL SUMMARY

	LIGHT DUTY	HEAVY DUTY	TOTAL
# VEHICLES*	124,108	27,120	151,288
		BENEFITS**	
DEFENSE	$ 87,123,816	$ 38,076,480	$125,200,290
ECONOMIC	$186,162,000	$ 81,360,000	$267,522,000
ENVIRONMENT	$ 68,383,508	$ 29,886,240	$ 98,269,748
HEALTH	$ 28,127,516	$ 12,312,480	$ 40,434,996
TOTAL	$369,841,830	$161,635,200	$531,477,030

*Most recent data as reported to the United States Department of Energy
** Current dollars

TABLE D-85

PROJECTED ECONOMIC BENEFITS

ALTERNATIVE FUEL VEHICLES

YEAR

CATEGORY	2005	2010	2015	2020
DEFENSE	$ 674,577,070	$1,049,261,800	$2,198,965,800	$ 3,348,669,800
ECONOMIC	$1,441,403,800	$2,242,012,500	$4,698,645,000	$ 7,155,277,500
ENVIRONMENT	$ 529,475,620	$ 339,565,920	$1,725,968,900	$ 2,628,371,900
HEALTH	$ 218,132,470	$ 339,291,220	$ 711,061,610	$ 1,082,831,900
TOTAL	$2,863,588,000	$4,454,131,400	$9,334,641,300	$14,215,150,000

TABLE D-86

PROJECTED ECONOMIC BENEFITS

ALTERNATIVE FUEL BLENDS

YEAR

CATEGORY	2005	2010	2015	2020
DEFENSE	$ 779,861,200	$ 4,665,394,400	$ 5,782,598,600	$ 6,885,847,800
ECONOMIC	$1,666,371,000	$ 9,998,610,000	$12,355,980,000	$14,713,350,000
ENVIRONMENT	$ 612,113,610	$ 3,672,822,700	$4,538,763,300	$ 5,404,703,900
HEALTH	$ 252,183,380	$ 1,513,122,900	$ 1,869,871,600	$ 2,226,620,300
TOTAL	$3,310,529,100	$19,863,949,000	$24,547,212,000	$29,230,520,000

TABLE D-87

PROJECTED ECONOMIC BENEFITS

HYBRID ELECTRIC VEHICLES

	YEAR			
	2005	2010	2015	2020
CATEGORY				
DEFENSE	$ 453,783,330	$2,209,010,000	$ 9,405,332,100	$16,602,235,000
ECONOMIC	$ 453,783,330	$2,209,010,000	$20,096,863,000	$34,474,862,000
ENVIRONMENT	$ 356,174,660	$1,733,852,600	$ 7,382,247,80	$13,031,099,000
HEALTH	$ 146,736,200	$ 714,309,420	$ 3,041,325,300	$ 5,368,529,000
TOTAL	$1,926,316,600	$9,377,279,100	$39,925,768,000	$69,476,725,000

TABLE D-88

PROJECTED ECONOMIC BENEFITS

FUEL ECONOMY IMPROVEMENTS

YEAR

CATEGORY	2005	2010	2015	2020
DEFENSE	$ 89,680,500	$ 538,083,000	$1,793,610,000	$ 3,049,137,000
ECONOMIC	$191,621,000	$1,149,750,000	$3,832,500,000	$ 6,515,250,000
ENVIRONMENT	$ 70,390,250	$ 422,341,500	$1,407,805,000	$ 2,393,268,500
HEALTH	$ 28,999,280	$ 173,995,500	$ 579,985,000	$ 985,974,500
TOTAL	$380,695,000	$2,284,170,000`	$7,613,900,000	$12,943,629,000

TABLE D-89

PROJECTED ECONOMIC BENEFITS

IDLING TECHNOLOGIES AND PRACTICES

	YEAR			
	2005	2010	2015	2020
CATEGORY				
DEFENSE	$102,594,490	$ 615,925,670	$ 943,973,780	$1,272,082,200
ECONOMIC	$219,219,000	$1,316,080,500	$2,017,038,000	$2,718,09,000
ENVIRONMENT	$ 80,526,446	$ 480,440,000	$ 740,925,290	$ 996,415,300
HEALTH	$ 33,175,142	$ 199,166,840	$ 305,245,080	$ 411,325,360
TOTAL	$435,515,507	$2,614,621,900	$4,007,182,000	$5,399,787,800

TABLE D-90

TOTAL PROJECTED ECONOMIC BENEFITS

BY PROGRAM GOALS

YEAR

CATEGORY	2005	2010	2015	2020
ALTERNATIVE FUEL VEHICLES	$ 2,867,588,000	$ 4,454,131,300	$ 9,334,641,300	$ 14,215,150,000
ALTERNATIVE FUEL BLENDS	$3,310,529,100	$19,863,949,000	$24,547,212,000	$ 20,230,520,000
HYBRID ELECTRIC VEHICLES	$1,926,316,600	$ 9,377,279,000	$39,925,768,000	$ 69,476,725,000
FUEL ECONOMY	$ 380,695,000	$ 2,284,170,000	$ 7,613,900,000	$ 12,943,629,000
IDLING TECHNOLOGIES	$ 435,515,507	$ 2,610,621,900	$4,007,182,000	$ 5,399,787,000
PROGRAM GOALS TOTAL	$8,916,642,200	$38,584,150,000	$85,428,703,000	$131,265,790,000

TABLE D-91

PROJECTED EMISSION REDUCTIONS

ALL EMISSIONS BY PROGRAM GOALS

(SHORT TONS)

	YEAR			
	2005	2010	2015	2020
CATEGORY				
ALTERNATIVE FUEL VEHICLES	206,938	321,879	674,659	1,027,259
ALTERNATIVE FUEL BLENDS	239,235	1,435,671	1,773,391	2,112,235
HYBRID ELECTRIC VEHICLES	139,693	677,693	2,885,242	5,093,008
FUEL ECONOMY	27,511	165,066	550,219	935,373
IDLING TECHNOLOGIES	31,473	188,945	289,579	390,214
PROGRAM GOALS TOTAL*	644,362	2,789,254	6,172,998	9,558,089

*Totals may vary from sum of individual components due to rounding.

TABLE D-92

PROJECTED EMISSION REDUCTIONS

HYDROCARBON EMISSIONS BY PROGRAM GOALS

(SHORT TONS)

	YEAR			
	2005	2010	2015	2020
CATEGORY				
ALTERNATIVE FUEL VEHICLES	19,027	29,595	62,022	94,450
ALTERNATIVE FUEL BLENDS	21,966	131,982	163,099	194,205
HYBRID ELECTRIC VEHICLES	12,799	62,309	265,279	462,268
FUEL ECONOMY	2,529	15,177	50,589	85,991
IDLING TECHNOLOGIES	2,894	17,384	26,625	35,878
HYDROCARBON GOALS TOTAL*	59,215	256,215	567,614	878,792

*Totals may vary from sum of individual components due to rounding.

TABLE D-93

PROJECTED EMISSION REDUCTIONS

CARBON MONOXIDE EMISSIONS BY PROGRAM GOALS

(SHORT TONS)

	YEAR			
	2005	2010	2015	2020
CATEGORY				
ALTERNATIVE FUEL VEHICLES	164,945	256,561	537,682	818,980
ALTERNATIVE FUEL BLENDS	190,688	1,144,174	1,413,936	1,683,698
HYBRID ELECTRIC VEHICLES	110,957	540,172	2,299,751	4,059,508
FUEL ECONOMY	21,982	131.570	438,566	745,562
IDLING TECHNOLOGIES	25,086	150,603	237,540	311,030
PROGRAM GOALS TOTAL*	513,658	2,223,080	4,927,475	7,618,600

*Totals may vary from sum of individual components due to rounding.

TABLE D-94

PROJECTED EMISSION REDUCTIONS

NOX EMISSIONS BY PROGRAM GOALS

(SHORT TONS)

	YEAR			
	2005	2010	2015	2020
CATEGORY				
ALTERNATIVE FUEL VEHICLES	22,966	35,723	74,865	114,007
ALTERNATIVE FUEL BLENDS	26,551	159,311	196,872	234,433
HYBRID ELECTRIC VEHICLES	15,449	75,212	320,210	565,233
FUEL ECONOMY	3,053	18,319	61,065	103,810
IDLING TECHNOLOGIES	3,493	20,970	32,138	43,307
PROGRAM GOALS TOTAL*	71,512	309,535	685,150	1,060,790

*Totals may vary from sum of individual components due to rounding.

CASE HISTORY

To assure that the utility of the estimation tools for Clean Cities coordinators a test was conducted in cooperation with the Las Vegas Clean Cities Coalition. The program coordinator was provided with a set of estimation tools and instructions and asked to utilize them to evaluate the fleets in his program and then provide an assessment of material in regard to several specific criteria and the rationale underlying their selection. The criteria selected included:

- Basis for defining the vehicle population
- Methods of calculation
- Clarity of instructions language
- Ease of use
- Value of the data provided
- Accuracy of the data

RATIONALE UNDERLYING THE SELECTED CRITERIA

Basis for Defining the Vehicle Population

An important consideration in designing the estimation tools was the fact that there is a significant range of capabilities and resources among the various Clean Cities programs. In order to be of use the estimation tools had to be simple enough for use in programs of limited resources as well as those with more substantial financial and analytical capabilities

The estimation tools use two basic factors as a basis for defining the vehicle populations being analyzed: fuel type and vehicle type. The vehicle type criterion was limited to two broad categories, e.g. light (10,000 GVWR or less) vs. heavy (over 10,000 GVWR) vehicles.

The rationale underlying the selection of light vs. heavy vehicles as one of the evaluation factors was that most fleet managers are familiar with these categories and routinely use them in reference to their own fleets. It was determined that any further differentiation would result in a needlessly complex system of evaluation that would require an inordinate amount of time and effort to implement. This complexity would turn make it unlikely that fleet managers would be willing to use the estimation tools.

The decision to use fuel type as a criterion was based in the fact most decisions concerning the use of alterative fuel vehicles are considered in terms of the perceived benefits of the fuel they use in relation to local circumstances. For example, decision makers in agricultural regions have generally looked more favorably on alcohol-based fuels as an alternative due to the secondary effects production of fuel alcohol may have on the local farm economy. In contrast, more urbanized areas have tended to favor other options such as natural gas.

Methods of Calculation

A total of seven different methods of calculating three different elements of potential benefits from various import reduction strategies are included in the estimation tools. These include four means of calculating local benefits for alternative fuel vehicles, two methods of calculating the "national impacts" (externalities) of the strategies, and one method for calculating the benefits of idling technologies.

The rationale for including a range of methods for performing the calculations to produce estimated benefits in each of the three categories was to provide for the varying levels of resources and data that exist among the various Clean Cities programs while at the same time assuring that the evaluations would have a common basis for purposes of comparison.

Clarity of Instructions Language

For the estimation tools to be of value, it is important that users are able to apply them correctly. For this to occur, it is essential that the instructions accompanying the estimation tools be clear, concise and readily understandable. It was viewed as particularly important that the directions provide a step-by-step description of the process that could readily be followed without any special training or any knowledge of advanced mathematics.

Ease of Use

Ease of use is another critical requirement for the estimation tools. If the tools are too complex or are difficult to employ Clean Cities coordinators may be unwilling to use them.

Value of the Data Provided

The purpose of the estimation tools is to provide a means by which Clean Cities coordinators can assist local decision makers in evaluating the potential benefits of the various import reduction strategies. This can only be accomplished if the data that is generated from the analysis performed using the estimation tools is of value in their deliberations.

Accuracy of the Data

Since it is anticipated that local decision makers will be committing real resources on the basis of the data generated through using the estimation tools to assess potential local and national benefits resulting from implementing the various import reduction strategies, it is vital that the data be as accurate as possible. Otherwise scarce local resources could be misallocated.

INTERVIEW RESULTS

An extended interview was conducted with Dan Hyde, the Las Vegas Regional Clean Cities coordinator to obtain an assessment of each of the criteria listed above that were selected for evaluating the estimation tools. The results of the interview follow.

Basis for Defining the Vehicle Population

It was the view of the Las Vegas Regional Clean Cities coordinator that the selection of fuel type and vehicle type as a basis for defining the vehicle population was appropriate. He also agreed with the concept of limiting the differentiation of vehicle types to light and heavy. As a practical matter, this is how most fleet managers view their fleets.

Methods of Calculation

The Las Vegas Regional Clean Cities coordinator agreed that the use of a range of methods of calculation.

Clarity of Instructions Language

The Las Vegas Regional Clean Cities coordinator found the language used in the instructions clear and understandable.

Ease of Use

No problems were identified with the work sheet or tables of factors in terms of ease of use.

Value of the Data Provided

The Las Vegas Regional Clean Cities coordinator believed that the data provided would be useful stating "…we can derive some useful statistics that compares conventional with alternative fuels."

Accuracy of the Data

A major concern was that the results obtained by using the estimation tools provide data that accurately reflected "real world" outcomes. The Las Vegas Regional coordinator believed that the estimation tools would achieve this objective. This belief was reinforced by the results that were obtained by using the estimation tools to analyze the "real world benefits of the Regional Clean Cities fleet operated by the City of Las Vegas.

RESULTS OF THE LAS VEGAS ANALYSIS

BACKGROUND

The Las Vegas Clean Cities program is among the oldest, most advanced and most active in the nation. Originally established in 1993, the Las Vegas program now includes some 125 stakeholders encompassing 85 public organizations and nearly 40 private organizations. There are currently a total of 6,175 alternative fueled vehicles operating by various fleets under the aegis of the Las Vegas Regional Clean Cities Coalition. These include 4,280 light duty and 1,895 heavy duty vehicles. Some 29 public and 21 private fueling facilities are maintained to service these fleets. The breakdown by fuel type is as follows:

LIGHT DUTY		
CNG	1,874	
PROPANE	735	
BIODIESEL	950	
ETHANOL	502	
ELECTRIC	6	
NEV'S		207
OTHER		6
HEAVY DUTY		
CNG	7	
PROPANE	1	
BIODIESEL	1,887	

For purposes of this study, only those vehicles operated by the City of Las Vegas were included in the analysis. The financial and consumption data used for the analysis covered the period between July 1, 2003 and June 30, 2004, and were therefore the most recent available. An analysis of the data derived through application of the estimation tools follows:

FUEL COST AND MAINTENANCE SAVINGS DATA

FUEL COST

Three types of fuel were analyzed using the estimation tools: reformulated gasoline (RFG), a 20% biodiesel blend (B20) and natural gas.

RFG

The City of Las Vegas has used reformulated gasoline (RFG) exclusively for the past year. Currently, it's oxygenate content is 5.7% for the period between April 1st and September 30th each year, and between 7% and 8% for the period between October 1st and March 31st annually. Prior to the introduction of RFG, the City used conventional 87 octane unleaded regular gasoline as a vehicle fuel. At an average of $1.85 per gallon over the past twelve months, RFG carried a premium of 23.3% over the average $1.50 cost of a gallon of 87 octane unleaded regular gasoline. The actual cost of RFG was within the range of the figure of $1.80 used in compiling the national estimation factors.

B20

The B20 blend has been used by the City of Las Vegas in its entire mainline fleet diesel powered vehicles and equipment for the past three years. The only exceptions are the Fire Apparatus and EMS units which are powered by standard Type 2 diesel fuel. At an average price of $1.33 per gallon, the B20 blend sells for roughly 23.3% more than the average $1.09 per gallon price of conventional Type 2 diesel. This figure is also within the range of the 20% premium assigned to B20 blends in the national estimation factors, although the nominal price is substantially lower than the one used in the national estimates. The difference between the two nominal prices, however, is most likely a factor of rising fuel costs during most of 2004.

Natural Gas

The Las Vegas Regional Clean Cities Coalition opted to have a central supplier provide compressed natural gas to a number of fleets. As part of the agreement, a surcharge was added to the supplier's natural gas acquisition cost to underwrite the cost of providing fueling facilities. Because of this surcharge, the gallon-equivalent price of natural gas ($1.48/gal) is slightly (1.9%) than the average price for conventional petroleum-derived fuels ($1.452/gal). When the acquisition cost for the central supplier ($0.60/gal) is compared to the average for conventional fuels, it sells for almost 60% less.

The comparison of the gallon-equivalent cost of natural gas with the average cost of conventional fuels, may, however, be flawed for another reason.

Generally, natural gas is used as a substitute for gasoline. As a result, including lower-priced diesel in the comparison may not be valid. The average for price conventional

fuels, however, includes both diesel and RFG. When the gallon equivalent price of natural gas is compared to RFG only ($1.85/gal), it sells for 25% less per gallon-equivalent. This figure is consistent with the national data included in the estimation tools.

Overall, the analysis of fuel costs for the City of Las Vegas fleets generated results that were within the range of national factors used in the estimation tools. Both B20 and natural gas were shown to provide substantial savings in fuel cost over RFG, although both were more expensive than conventional Type 2 diesel, but not prohibitively so.

MAINTENANCE COSTS

Unlike fuel costs, substantial savings were evident in regard to the maintenance costs for all of the fuels considered in comparison to conventional petroleum-derived fuels.

RFG

Maintenance costs for RFG were compared to those experienced with the use of conventional 87 octane unleaded regular gasoline. Significant savings were realized with the use of RFG. Of particular note was the fact that the need to change spark plugs was reduced by half. Downtime for vehicles powered by RFG was also reduced by half. Overall, the estimated 48.2% reduction in maintenance costs was consistent with the anecdotal evidence acquired through interviews with various fleet managers who said that maintenance costs were reduced on average 50%. This figure however is significantly higher than the 20% reduction in maintenance costs attributed to alternative fuels in the national estimation tools. This substantial variance however may also be the product of the quality of personnel, length of experience and commitment of the City of Las Vegas alternative fuel vehicle program.

B20

The maintenance costs for B20 were compared with conventional Type 2 diesel. As with RFG, substantial savings were realized. Among the most significant was a reduction in the need for oil changes by 53.6%. Routine maintenance was reduced by nearly 36%. It is also noteworthy that downtime for vehicles was reduced by two-thirds. Overall the 46.5% reduction in maintenance costs was within the anecdotal data, but as with RFG significantly higher than the factors provided in the national estimates. As with RFG, it is not certain to what extent these greater savings are a product of the unique qualifications of the City of Las Vegas personnel.

Natural Gas

Natural gas evidenced the most substantial reductions in maintenance costs: 72%. This is more than three times the factor used in the national estimates and almost 50% greater than anecdotal reports of reductions in maintenance costs. Since the City of Las Vegas has been using natural gas as its principal alternative fuel for over a decade, some portion

of the remarkable performance may be attributed to experience and the quality of personnel. Yet, it also suggests that very substantial savings in maintenance costs will be realized by any jurisdiction opting for natural gas as an alternative fuel option.

CONCLUSIONS

On the basis of the test of the estimation tools using the City of Las Vegas fleet, a number of conclusions can be reached. However, it is necessary to inject a note of caution. The City of Las Vegas has one of the most advanced and well-run alternative fuel vehicle programs in the nation. It also is one of the oldest, with more than a decade of experience. Therefore, it is uncertain whether all of the results would be replicated in a program with less experience or fewer resources. Also, because the City does not operate any E85 vehicles, no data on alcohol fuels was included in the analysis. Despite these limitations, though, the exercise was still useful as a preliminary field test of the estimation tools. With that caveat, the following conclusions can be reached:

First, the best approach to obtaining accurate results is to employ the worksheets to compile "real world" comparison data on alternative fuels currently in use.

Second, the estimation tools appear to provide an accurate assessment of fuel costs, but also appear to underestimate the savings realized through lower maintenance costs. At the same time, however, the more conservative estimates used in the estimation tools are intended to take into account new programs which might lack the experience, supplier relationships and trained personnel that more established programs such as that in Las Vegas enjoy.

Third, based on the Las Vegas data, it would appear that introducing alternative fuel vehicles into a fleet can result in substantial "real world" economic benefits for local jurisdictions.

Summary tables of the results of the analysis of the City of Las Vegas fleet follow.

TABLE LV-1

MAINTENANCE: LIGHT DUTY GASOLINE POWERED

(ACTUAL DOLLARS SPENT)

	CONV	RFG	(PREMIUM)
DIFFERENTIALS			
FUEL USE (GAL)	250,000	325,000	
FUEL COST	375,000	601,250	
% (PREMIUM)/DISCOUNT FOR ALT FUEL			(23.3%)

	CONV	RFG	BENEFIT
DIFFERENTIALS			
OIL CHANGES	350,000	225,000	125,000
SPARK PLUGS	65,000	32,000	33,000
TUNE UPS	72,000	54,000	18,000
ROUTINE MAINT.	450,000	265,000	185,000
UNSCH. MAINT	300,000	65,000	235,000
DOWNTIME	2 days	1 day	1 day
TOTALS	1,237,000	641,000	596,000
% SAVED COMPARED TO CONVENTIONAL FUEL			48.2%

TABLE LV-2

MAINTENANCE: HEAVY DUTY VEHICLES DIESEL POWERED

(ACTUAL DOLLARS SPENT)

	CONV	B20	(PREMIUM)
DIFFERENTIALS			
FUEL USE (GAL)	200,000	675,000	
FUEL COST	218,000	898,000	
% (PREMIUM)/DISCOUNT FOR ALT FUEL			(22%)

	CONV	B20	BENEFIT
DIFFERENTIALS			
OIL CHANGES	250,000	116,000	134,000
SPARK PLUGS	NA	NA	NA
TUNE UPS	NA	NA	NA
ROUTINE MAINT	350,000	225,000	125,000
UNSCH MAINT	225,000	100,000	125,000
DOWNTIME	3 DAYS	1 DAY	2 DAYS
TOTALS	825,000	441,000	384,000

% SAVED COMPARED TO CONVENTIONAL FUEL 46.5%

TABLE LV-3

MAINTENANCE - LIGHT DUTY NATURAL GAS (CNG)

(ACTUAL DOLLARS SPENT)

	CONV	B20	(PREMIUM)
DIFFERENTIALS			
FUEL USE (GAL)	575,000	175,000	
FUEL COST	835,000	259,000	
% (PREMIUM)/DISCOUNT FOR ALT FUEL			(19.3%)
% DISCOUNT COMPARED TO RFG			25%

DIFFERENTIALS	**RFG/CONV**	**CNG**	**BENEFIT**
OIL CHANGES	575,000	125,000	450,000
SPARK PLUGS	97,000	25,000	72,000
TUNE UPS	126,000	50,000	76,000
ROUTINE MAINT	715,000	225,000	490,000
UNSCH MAINT	365,000	100,000	265,000
DOWNTIME	4 DAYS	1 DAY	3 DAYS
TOTALS	1,878,000	525,000	1,353,000

% SAVED COMPARED TO CONVENTIONAL FUEL 72.0%

APPENDIX ONE METHODOLOGY

The National Defense Council analysis of the potential benefits of using alternative fuels consists of four discrete elements:

- Avoided Defense Related Costs
- Avoided Direct and Indirect Economic Costs
- Avoided Environmental Remediation Costs
- Avoided Health Costs

GENERAL CHARACTERISTICS

Data used in preparing the calculations was all derived from U.S. government sources such as the U.S. Department of Energy's Energy Information Administration, the U.S. Department of Commerce Bureau of Economic Analysis and the Centers for Disease Control and Prevention in Atlanta, GA. The specific methodology for each category follows.

CALCULATING AVOIDED DEFENSE COSTS

THE STRATEGIC CONTEXT

Prior to discussing the elements employed in calculating the avoided defense costs arising from a reduction in foreign oil imports, it is first necessary to understand the overall strategic context within which such costs are generated. It is this context that provides the rationale for assuming that a reduction in oil imports would result in a reduction in outlays for national defense. This context includes several key elements.

First is the critical role petroleum fills as a military commodity.

A new warfighting concept, "Rapid Decisive Operations" has evolved that envisions lightening strikes at future adversaries employing a combination of airlift, rapid sealift and pre-positioned resources. As a recent white paper by the Joint Forces Command noted:

> *"We can no longer plan on having months or even weeks to deploy massive theater forces into a region rich in unthreatened infrastructure, while delaying offensive action until favorable force ratios have been achieved."* (1)

But implementing this approach means that in the future the military requirement for refined petroleum products will be even greater than it is today. The recent action to liberate Iraq, Operation Iraqi Freedom, illustrates this point. During Operation Desert Shield/Storm, the first Persian Gulf War, it was necessary to provide an average of 35.5 gallons of fuel per day per soldier. (2) In contrast, during Operation Iraqi Freedom, the Defense Logistics Agency purchased some 300 million gallons of oil to provide for the first thirty days of operations in anticipation of implementing the "Rapid Decisive Operations concept. (3) This works out to a daily requirement per soldier of 41.7 gallons –

an increase of 17.5%. (4) In no small measure, the increase was a reflection of the lightening dash to Baghdad by the U.S. Army's U.S. 3rd Infantry Division – an assault unmatched in history in speed and daring, and a textbook example of "Rapid Decisive Operations."

In the coming era of mobility warfare and lightning strikes, the military requirement for oil will only increase. The development of armaments such as the Joint Direct-Attack Munitions or "JDAM" that allow military units to operate under the cover of precisely targeted air support vastly increases mobility and the ability to maneuver – and concomitantly consume more fuel. In Operation Desert Storm, only about 7% of the bombs used were precision-guided munitions. (5) During Operation Allied Force in Kosovo, the proportion of precision weapons jumped to 30% (6) and in Operation Enduring Freedom in Afghanistan to 60%. (7) In Operation Iraqi Freedom, virtually all of the bombs dropped were precision-guided munitions.

It is not just actual combat operations that will require greater use of energy under the new operational doctrine. The movement of both troops and, to a lesser degree, materiel will rely increasingly on air transport that is far more fuel-intensive than sea transport. The need for increased reliance on air transport will be further heightened as the size of the Armed Forces is reduced and it becomes necessary to shift troops and equipment from one theater of operations to another as new threats emerge. This requirement was also illustrated during recent military operations as troops were moved from Afghanistan to Iraq.

In addition to increased requirements for refined petroleum products in direct combat the need for refined petroleum products, is also increased as a consequence of new logistical requirements. These new requirements arise from two factors. The first of these is the growing reliance on reserve components.

Today, almost half of U.S. Armed Forces are comprised of reserve components. By their very nature, these forces are based in the Continental United States (CONUS). (8) Therefore, in the event that reserve units are deployed, transport – much of it air transport – will be required to move their personnel and equipment to the theater of operations. This, in turn will correspondingly result in an increased need for fuel.

The second is that, as noted, the number of U.S. forces "forward positioned" e.g. stationed abroad has been dramatically reduced since their peak of around 300,000 (9) during the Cold war to around 100,000 today. (10) This means that as with reserves, many components of the active duty force will also be deployed from CONUS bases in the event of conflict.

The combined impact of these new factors such as the doctrine of Rapid Decisive Operations, the increased reliance on reserves and the reduction of overseas troop strength is to greatly increase mobility requirements, and with them the need for fuel. Moreover, for the foreseeable future this fuel will have to be in the form of traditional petroleum derived products such as JP4, JP8 and diesel.

It is this need for crude oil and refined petroleum products that gives rise to the second contextual element establishing the link between defense outlays and oil imports: The critical importance of Persian Gulf oil supplies.

Although oil is produced in many places around the world, the huge volume of Middle East production – roughly 30% of the world total (11) – and the vast size of the oil reserves located there – roughly two-thirds of the world total (12) – endow the region with a unique importance. By virtue of its oil resources the Middle East also contains most of the world's "surge" oil production – the ability to increase the flow to offset shortages elsewhere. This capacity was demonstrated most dramatically during Operation Desert Shield/Storm, the first Persian Gulf War, when increased production from Saudi Arabia and other Gulf producers made up the loss of production from Iraq and Kuwait. (13) These facts underscore why, the "oil is just another commodity" approach to petroleum resources is flawed. It fails to distinguish between events that are primarily economic in nature and those that have military significance.

During the half-century between 1951 and 2000, world oil supplies were disrupted no less than fourteen times. (14) The sources of disruption ranged from the nationalization of Iranian oil fields in May of 1951 to OPEC production cuts intended to shore up falling oil prices between April of 1999 and March of 2000. (15) Throughout that period, American military intervention only occurred twice – in 1987 when the U.S. re-flagged and provided escorts to Kuwaiti oil tankers to protect them from attack during the Iran-Iraq war, and in 1990 following Iraq's invasion of Kuwait.

More recently, when striking oil workers in Venezuela virtually shut down that nation's production in December of 2002, no military action was even contemplated. This, despite the fact that Venezuela is one of the major sources for U.S. oil imports, and that at its peak, the production loss approached 2 million barrels per day. (16)

Clearly, a distinction is made between supply disruptions that are the result of a direct military threat, and those that result from other causes. But even the presence of a military threat does not appear to be sufficient cause to contemplate a U.S. response. Guerillas in Colombia routinely destroy sections of oil pipeline there and are dealt with by local forces. In Mexico, another major source of U.S. imports, action by both insurgent and criminal elements is often directed against oil production facilities in the Yucatan Peninsula. As with the Venezuelan strike, however, these incidents do not spark a U.S. military response. Rather, they are treated as Mexican internal security problems.

Why do military threats to the Persian Gulf warrant a military response while threats to other regions do not?

The simple answer is that the magnitude of the Gulf's production and reserves make it uniquely important. Because of this fundamental fact, while losses from other oil producing areas can readily be offset by surge production from the Gulf, the loss of production from the Gulf could not be made up by surge production in other regions. This

prospect raises the specter of shortfalls sufficient to seriously hinder, or even paralyze the ability of the Armed Forces to operate.

Indeed, the critical importance of the Persian Gulf's oil resources has been recognized by every President since Franklin Roosevelt. On February 14, 1945, Roosevelt met with King Ibn Saud, founder of the modern Saudi State aboard the USS Quincy on the Great Bitter Lake in the Suez Canal. While details of the discussions remain largely a matter of speculation, it is believed that the two leaders reached an agreement whereby the United States would protect the kingdom in exchange for access to Saudi Arabia's oil. Whether or not a formal agreement was reached in 1945, however, every President since Roosevelt has made the protection of Saudi oil resources a matter of official policy. Since the Nixon Administration, this policy has been officially recognized through a series of Presidential National Security Decision Documents and other statements by each of his successors.

For example, in his January 21, 1980 State of the Union address, President Carter said:

> *"Let our position be absolutely clear: An attempt by any outside force to gain control of the Persian Gulf region will be regarded as an assault on the vital interests of the United States and such an assault will be repelled by any means necessary, including military force."*

(*The complete Text of President Carter's January 21, 1980 State of the Union Address establishing the "Carter Doctrine" is available in Appendix 6*)

Three years later in response to Iraqi threats to close the Straits of Hormuz that provide access to the Persian Gulf, President Reagan issued NSDD 114 which stated:

> *"It is present United States policy to undertake whatever measures may be necessary to keep the Strait of Hormuz open to international shipping. Accordingly, U.S. military forces will attempt to deter and, if necessary defeat any hostile efforts to close the Strait to international shipping. Because of the real and psychological impact of a curtailment in the flow of oil from the Persian Gulf on the international economic system, we must assure our readiness to deal promptly with actions aimed at disrupting that traffic."*

In February of 1996, in his statement of national security policy, "*A National Strategy of Engagement and Enlargement*," President Clinton stated:

> *"The experiences of the two oil shocks and the Gulf War show that an interruption of oil supplies can have a significant impact on the economies of the United States and its allies. Appropriate economic responses can substantially mitigate the balance of payments and inflationary impacts of an oil shock; appropriate security policy responses to events such as Iraq's invasion of Kuwait can limit the magnitude of the crisis."*

It should be noted that the statements of a long succession of Presidents concerning the importance of the Persian Gulf's oil supplies and our strategic interest in the region have been far more than empty words. They have often been backed up by military action. During the four years of the George H.W. Bush Administration U.S. forces were employed in the Persian Gulf 10 times *in addition to* the first Gulf War. During the Administration of President William Clinton, there were 19 military actions in the region including 12 in Iraq, 5 in Kuwait and 2 in Saudi Arabia. In other words, the twelve years encompassing the first the George H.W. Bush and Clinton Administration witnessed forty military operations in the Persian Gulf, including one major regional conflict. More important, the growing pace of conflict reflected the continuation of a break from America's traditional Middle East posture that began in 1980.

To illustrate, during the 59 years between the end of the First World War and the Iranian Hostage Crisis, U.S. Forces were sent overseas a total of 83 times including two major conflicts. Only six of those deployments, however were to the Middle East and of those, only one, the failed Iranian Hostage Rescue could reasonably be categorized as a full-scale combat operation. In contrast, during the thirteen years between 1981 and 1993, U.S. forces were deployed overseas a total of 38 times with 16 of the deployments encompassing missions to the Middle East, and 13 of the 16 combat operations that were in some way related to the protection of oil supplies.

The question that naturally arises concerning the changing nature of overseas U.S. troop deployments is what caused it? The answer lies in a number of factors.

The first of these was a change in doctrine, dating from the Carter Administration that called for U.S. military intervention, if necessary, to protect Middle East oil supplies. This new doctrine marked a significant shift from the "Nixon Doctrine" which relied on military assistance rather than direct military intervention to address regional conflicts.

The second factor was the advent of a threat to the flow of Middle East oil arising from the advent of governments hostile to the West in several nations located there. These included Iran and Iraq.

The third was the growing importance of Middle East oil supplies within the world oil market. Although other sources of supply had developed in countries such as Mexico and Canada, the reserves located in the Middle East assured the region a dominant role in the world oil market for the foreseeable future.

The fourth factor was the increasing dependence of the United States on oil imports in general and Middle East oil supplies in particular.

What is important about all of these factors is that they ultimately have provided the rationale for the expanded military outlays required to maintain the capability to intervene militarily if necessary to protect the flow of oil from the Persian Gulf. The question to be answered therefore is: how much of an added defense burden does the need to protect Persian Gulf oil supplies create?

CALCULATING THE DEFENSE BURDEN

There are actually three ways of calculating the defense-related costs of oil imported from the Middle East. The first method is to take actual budget outlays and then determine the proportion that could properly be allocated to the defense of Middle East oil supplies.

A second method is to use the United States Department of State, Bureau of Arms Control "cost per member of the armed forces" figure and then multiply this factor by the appropriate number of service members.

A third method is to limit the analysis to the number of individuals actually serving in the Middle East region at any given moment.

For purposes of this report, the first method was selected. Calculations were prepared, however, using all three approaches as a basis for comparison.

The first step in the process is to establish the baseline from which cost components will be derived. The first step in accomplishing this task is to determine the size of the Department of Defense Budget. This information is included in the National Defense Budget Estimates for FY 2003, published by the Office of the Under Secretary of Defense (Comptroller) in March 2002. Commonly referred to as the "Greenbook," this may be found on line at:

http://www.dtic.mil/comptroller/fy2003budget.

Once the aggregate budget is determined, it must then be examined to isolate those elements that should properly be included in the cost calculus.

There are seven budgetary areas. These include:

Personnel
Operations and Maintenance
Procurement
Research Development, Training and Engineering (RDT&E)
Revolving and Management Funds
Military Construction
Family Housing

In FY 2003, the Defense Department has allocated $94.296 billion for Personnel and $150.444 billion for Operations and Maintenance. (17) Taken together, these two budget elements total $244.74 billion. Of this, $243.24 is allocated to conventional forces. In addition, the Special Operations Budget for FY 2003 is $4.5 billion (18), $158 million is assigned to pre-positioned equipment and materiel (19), $360 million to Strategic Mobility (20) and $1.1 billion (21) to Southwest Asia contingencies.

These aggregate figures for each of these areas can be found in Table 1-3 of the "Greenbook."

For purposes of this analysis outlays from the Personnel and Operations and Maintenance were the primary focus. Certain Persian Gulf-specific outlays and Military Construction and subcategories, however, were considered because of their specific relevance to the protection of oil flows from that region.

Once the aggregate amount for each of the categories is determined, the next step is to establish the proportion of the total expenditures that can properly be assigned to the protection of Persian Gulf Oil. The first step in performing this analysis is to determine which military organizations are charged with this responsibility. To do this, it is first necessary to review the Department of Defense Order of Battle to identify which DOD elements are responsible for the Persian Gulf. It is important to note that every President since Franklin Roosevelt has seen protecting the flow of oil from the Gulf as an important strategic objective, and that every President since Dwight Eisenhower has made it a matter of national policy. Copies of various Presidential Decision Documents and State Department Cables are attached that underscore this point.

Although the detailed, official DOD Order of Battle is no longer available as a result of security measures instituted following the initiation of hostilities in Iraq, a close equivalent is available through information available on the web at:

http://www.globalsecurity.org.

Upon reviewing the DOD Order of Battle, it is evident that the principal responsibility for protecting Middle East oil flows falls upon the Central Command. Its mission statement which can be found on its website at:

http://www.centcom.mil, says:

"Activated by President Ronald Reagan on Jan.1, 1983, USCENTCOM is the permanent successor to the Rapid Deployment Joint Task Force, a temporary organization created by President Jimmy Carter in 1980 to project American power in the Middle East and East Africa."

The question, then is how much of its budget is dedicated to the Middle East, and how much of that, in turn, can be allocated to the protection of oil flows.

In order to determine the relative proportions, it is necessary to review CENTCOM's operations over the years since its creation. Major operations included missions to Somalia and Afghanistan as well as the Persian Gulf War. More recently, missions included Operation Southern Watch, the maintenance of "no-fly" zones in Iraq as well as other operations focused on the Middle East. Although DOD sources regarding

operations have been restricted following initiations of hostilities with Iraq, most are listed on the Global Security website.

A review of actual operations, including the constituent elements involved in them made it possible to allocate a proportion of CENTCOM's budget to the defense of Middle East Oil.

Once this proportion was established, it was applied to the Operations and Maintenance figures for CENTCOM contained in the FY 2003 budget material.

In addition to the Personnel, Operations and Maintenance figures, certain other activities were also included in the total assigned to protecting Middle East Oil. These include the cost of pre-positioned materiel located at Camp Doha. A comprehensive list of this equipment was obtained through review of procurement data and other sources and then assigned a cost on the basis of reported prices for the specific items included in the pre-positioned equipment. These figures are available through various congressional sources.

Another component of the cost is comprised of certain "contingency operations" provided for in the DOD revolving fund, including Operation Southern Watch and similar military actions that specifically related to oil were included, as were the procurement costs of several new naval vessels acquired to store propositioned equipment.

Figures for these items are available through the "Greenbook."

A final element was a portion of the Special Operations Budget not included in the overall Central Command Budget.

These elements were then totaled to determine the final cost of defending Middle East Oil. They do not include costs associated with Operation Iraqi Freedom.

CALCULATING AVOIDED ECONOMIC COSTS

The underlying assumption of the analysis of economic cost is that to the extent money sent overseas to purchase foreign oil is not offset by purchases of U.S. goods and services, a net loss to the U.S. economy occurs. This premise is supported by the fact that oil producing states have increasingly directed their purchases to European and Asian producers at the expense of U.S. firms. Therefore the starting point for the calculus is the Energy Trade Deficit as reported by the United States Department of Energy. This information can be found in Table 1-5 of EIA's Monthly Energy Review as well as the EIA Petroleum Supply Annual.

It is important to understand that unlike defense costs, the economic costs of imported oil are not limited to imports from the Persian Gulf. Rather, they apply to imports from any region of the world.

Averaging the most recent three years for which data were available yields an annual deficit of approximately $99 billion. This provides a baseline for successive calculations. The standard Bureau of Economic Analysis RIMS II multiplier was applied to this total to estimate the primary and secondary effects on employment and income of the transfer of wealth.

In addition, a second level of analysis was performed using the historic investment rates for the oil and gas industries. EIA's publication "Performance Profiles of Major Energy Producers 2002" illustrates the importance of this data. According to EIA, oil and gas companies invested almost $13 billion on oil exploration and development in 2002 while net income stood at $20.6 billion. This level of investment is in keeping with the industry's history of investing roughly two-thirds of its net income annually. Applying this historic rate to the revenues sent abroad to purchase imported oil would yield net profits of approximately $13 billion or investment on the order of $8.6 billion. (22) Applying a multiplier of 1.7 to the 8.6 billion of projected investment yields a total economic impact of roughly $14.6 billion. This figure represents a loss to the economy of investment of oil company profits that would otherwise have taken place in the absence of the flow of capital abroad. Applying a minimal 1.4 multiplier to the $99 billion sent overseas to purchase foreign oil yields a secondary economic impact of $39.6 billion. This figure represents the investment that would have been generated by the secondary economic activity associated with a $99 billion increment of GDP. Taken together these figures total $54.2 billion which is completely consistent with the RIMS II results. The same holds true for employment effects.

CALCULATING AVOIDED TAX CONSEQUENCES

A loss of tax revenues also accompanies the lost revenues from employment and investment that would otherwise have been generated by the money spent to purchase overseas oil. The simple fact is that if the economic activity does not take place within our shores, it cannot be taxed. To calculate the impact on taxes, the average annual wage was determined by consulting the Bureau of Labor Statistics tables for specific industrial wages related to oil and energy production to provide a wage base for estimating federal income taxes. These can be found on the Bureau of Labor Statistics website at:

http://www.bls.gov/oes/2002/oessrci.htm.

Estimates of the effective tax rate calculated by the Urban Institute-Brookings Institute Tax Policy Center were then used as a basis for the estimation. These tables can be found in *Appendix 10* or on the organization's website at:

http://www.taxpolicycenter.org/TaxModel/tmdb/TMTemplate.cfm?topic3id=41&DocTypeID=1.

The 2001 effective tax rate for median income earners (i.e. 15%) was used as a basis for calculations of tax losses from wages.

The same source was used for corporate tax rates. The 2002 average marginal corporate rate of 32% was used. These tables can be found in *Appendix 10* or on the organization's website at:

http://taxpolicycenter.org/TaxModel/TMDB/TMTemplate.cfm?Docid=485

State tax burdens were calculated for both corporations and individuals on the basis of data from the Tax Foundation. Because a number of different state taxes including, income, sales and property taxes are involved and vary significantly from state to state, a national average state tax burden of 10.5% was used. Tables can be found in *Appendix 10* or on their website at:

http://www.taxfoundation.org/statelocal03.html

CALCULATING THE COST OF OIL SUPPLY DISRUPTIONS

Unlike most other areas of economic activity, America's reliance on oil imports carries with it one unique cost: the economic toll imposed by oil supply disruptions. Although it is true that supplies of almost any product can be disrupted by external events, such circumstances rarely have economic consequences across the broader economy. Further, they rarely are caused by specific intent, but rather are the byproduct of some external factor. In the case of oil, however, supply disruptions have broad consequences throughout the economy. In addition, oil supply disruptions can be caused by specific intent to gain some political or military objective. They therefore warrant separate consideration when calculating the economic impact of import dependence.

A number of factors were considered when calculating the cost of oil supply disruptions. These included the impact of the disruptions on employment, inflation, interest rates and GPD. The basic approach was to examine the trends in place in each of these areas for several years prior to the disruption and several years afterwards, and compare these trends with the time period encompassing the events. The resulting difference for each was used to calculate the "cost" for the supply disruption for each particular category of economic impact.

All statistics regarding changes in employment were obtained from the Bureau of Labor Statistics tables. For this analysis we used data encompassing a period three years prior to and three years following each of the supply disruptions. The historic data from 1913 on are available on their website in the table: "*Consumer Price Index All Urban Consumers - (CPI-U) U.S. city average All items"* at:

ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt

Statistics regarding changes in inflation rates were obtained from the Bureau of Labor Statistics. Detailed data are also available in this table on their website at:

ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt

Statistics regarding historic interest rates were obtained from the Federal Reserve Board of Governors. Tables can be found on their website *"Selected Interest Rates"* at:

http://www.federalreserve.gov/releases/h15/data.htm

Figures on GDP were obtained from the Federal Reserve Board of Governors and can be found in a series of reports titled *"Flow of Funds Accounts"* on their website at:

http://www.federalreserve.gov/releases/z1/current/data.htm

It should be noted that the oil supply disruptions considered for the purposes of this analysis included the 1973 Arab Oil Embargo, the oil strikes in Iran immediately prior to the fall of the Shah and the Iranian Oil Boycott, and the period encompassing the first Persian Gulf War.

The value of the impacts on each of the four areas analyzed in each period was totaled and converted to current dollars and then amortized over the thirty-year period encompassing the years from the first event to 2003.

CALCULATING AVOIDED ENVIRONMENTAL REMEDIATION COSTS

The first step in the calculation of avoided environmental remediation costs entailed the determination of the reduction in the amount of specific pollutants achieved by various control technologies. Emissions data from the GREET Model for reformulated gasoline were used as a base for calculating the reductions in terms of grams per mile that could be achieved through various alternative fuel vehicle configurations. Average vehicle miles traveled, as reported in the *"Transportation Energy Data Book (TEDB) Edition 22,"* published by Oak Ridge National Laboratory were used as a basis for calculating annual reductions. The TEDB is available on line at:

http://www-cta.ornl.gov/data/Index.html

The specific reductions in emissions were calculated on the basis of data from a variety of sources. These include the California Energy Commission report*, "The ABC's of AFV's', 5th Edition,"* which can be found on their website at:

http://www.energy.ca.gov/afvs/reports/ABCsintro.html;

the Congressional Research Service Report *"Alternative Transportation Fuels and Vehicles: Energy, Environment and Development Issues"* by Brent D. Yacobucci, and the Alternative Fuels Fact sheets available from the National Renewable Energy Laboratory's Alternative Fuel Data Center.

A number of sources were consulted to determine the value of avoided pollution costs including:

"Emission Reduction Offsets Transaction Cost Summary Report for 2002," California Environmental Protection Agency, March 2003

"Sources and Control of Oxides Emissions," California Environmental Protection Agency, Air Resources Board, August, 1997

"Cost Effectiveness of Alternative Diesel Fuel Options," Gary Yowell, Alternative Diesel Fuel Symposium, Sacramento, California, August, 19-20, 2003.

After reviewing the range of costs for removal of specific pollutants, the difference between the least cost and next highest cost was calculated on a grams per mile basis. This differential was determined to be the "avoided cost" and then applied to individual vehicle types on the basis of their relative performance in reducing specific pollutants assuming that the traveled a distance annually equal to the national average for vehicle miles traveled.

CALCULATING AVOIDED HEALTH COSTS

Avoided health costs were derived on the basis of the Centers for Disease Control and Prevention estimate of health-related problems associated with mobile source pollution. The aggregate figure developed by the CDC was reduced to account for non-vehicular mobile sources such as lawnmowers, portable generators and heavy equipment. The resulting figure was divided by the annual vehicle miles traveled by private and commercial vehicles to derive a per-mile estimate. The per-mile estimate was then applied to various vehicle configurations on the basis of their relative reduction in mobile source pollutants.

In addition to the macroeconomic benefits, a series of factors were developed for estimating the local benefits derived from the various technologies.

METHODOLOGY FOR DETERMINING LOCAL BENEFITS

In designing a framework for determining the benefits that would be derived at the local level from the various import reduction strategies and approaches, it quickly became evident that more than one method of calculating such benefits would be required. The reason for this was that there was a wide variance among the individual Clean Cities Programs in terms of analytical capabilities, human and financial resources and fleet configuration. Therefore, it was decided to provide a series of options that could be employed at the local level. These options are in addition to the methodology employed for this report.

In order to maintain a consistent, useful and reliable dataset it was further determined that the best approach was to concentrate on specific items that would be relevant to local decision makers attempting to assess the merits of various alternative fuel and alternative fuel vehicle strategies for their communities. The specific items selected were fuel and

maintenance costs. The validity of this approach was confirmed by discussions with individual fleet managers who indicated that these items, rather than life-cycle costs were their primary concern when considering economic factors.

The fuel cost and maintenance factors were developed through a review of the existing literature and interviews with individual fleet operators. Included among the authorities reviewed were:

Summary Results from the National Renewable Energy Laboratory's Vehicle Evaluation Data Collection Efforts Peg Whalen, Kenneth Kelly Rob Motta John Broderick., May 1996, National Renewable Energy Laboratory.

UPS Delivers with Alternative Fuels, Clean Cities Fact Sheet July 1999

Bi-monthly newsletter Vol XXVII NO. 5 October 2003 McHenry County Illinois, Conservation District

Audit Report on Opportunities to Increase Savings Through the Use of Natural Gas Vehicles (Report Number Ca-AR-99-001) Audit Report, Office of the Inspector General United States Postal Service, September 30, 1999

Tests Demonstrate Safety of Natural Gas Vehicles for King County Police, US Department of Energy, Argonne National Labs, 11/1997 Taking An Alternative Route, Fueling the Future.

"Hertz Puts You In the Drivers Seat and Methanol in the Tank" DOE Argonne National Laboratory April 1997

"*Waste Management's Trucking Fleet, Final Results"* DOE National Renewable Energy Lab, January 2001

"Electric Busses Energize Downtown Chattanooga" DOE Argonne National Laboratory, August 1997

Emissions From Conventional and Alternative Fuel Vehicles, Timothy E Lippman and Mark A. Delucchi, University of California, Davis August 2001

A number of important facts were uncovered in the course of this research.

First, in the early stages of alternative fuel vehicle programs it was not uncommon to have maintenance costs that were higher than conventional vehicles. This phenomenon was primarily the result of a lack of familiarity on the part of maintenance personnel with the vehicles as well as the lack of well-developed sources of spare parts. Normally after a period of roughly six months maintenance costs were significantly reduced and usually below those associated with conventional fuels. It was determined that the maintenance cost factors would be based on a mature program with the caveat that initially costs

would be substantially greater while maintenance personnel were familiarized with the new vehicle technologies and parts supplier relationships were established.

Maintenance costs for Alternative Fueled vehicles were measured against national averages are reported in the latest edition of the Department of Energy's *Transportation Data Energy Book* **Table 10-12. Automobile Operating Costs Per Mile**. It should be noted that insufficient data were available to calculate maintenance costs for Hybrid Electric Vehicles, and therefore, their benefits only reflect fuel differentials. In addition, since Hybrid electrics are a recent addition to the automobile fleet, all are still under warranty and therefore, most major maintenance items should be covered by manufacturers.

Fuel costs were calculated on the basis of national reporting through the Alternative Fuels Data Center operated by the United States Department of Energy and the Energy Information Administration's reporting on prices for refined petroleum products. Authorities consulted for this data include:

Annual Energy Review 2002, United States Department of Energy, Washington, D.C. October 2003,

Annual Energy Outlook 2004, United States Department of Energy, Washington, D.C. January 2004

The Alternative Fuels Price Report, United States Department of Energy, Alternative Fuels Data Center

These figures were confirmed by direct contact with Clean Cities Coordinators and industry representatives.

Data on heavy-duty truck idling strategies were derived from a variety of sources including both academic reviews and direct conversations with fleet operators. Included among the authorities reviewed were:

Potential Benefits of Utilizing Fuel Cell Auxiliary Power Units in Lieu of Heavy-Duty Truck Engine Idling, University of California, Davis Paper UCD ITS REP 0101, Year 2001

ANL/ESD-43 Analysis of Technology Options to Reduce the Fuel Consumption of Idling Trucks, Frank Stodolsky, Linda Gaines and Anant Vyas Center For Transportation Research, Energy Division, Argonne National Labs, June 2000

Estimates of truck idling strategy annual benefits were based on the amount of fuel displaced under four different scenarios, each based on actual operating experience. The scenarios estimated gains based on 2,000 and 2,400 hours of idling time per long-haul Class 8 vehicle, at fuel consumption levels of 1 gallon per hour and 1.4 gallons per hour.

A series of forms has also been developed so that those individual program coordinators who wish to do so may create estimates of local benefits based on their actual operating experience. In using these forms, coordinators may employ the estimation tools based on national averages which are appended below or use data from local experience on the appended form.

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(1) Joint Forces Command, A Concept for Rapid Decisive Operations, Version ROD II, 2002
(2) Pagonis, Lt. Gen. William G., Moving Mountains, Lessons in Leadership and (3)Logistics from the Gulf War, Harvard Business School Press, Boston, MA, 1991
(4) Scarborough, Rowan, US Forces Outran Water, MREs in Rush to Baghdad, Washington Times, Washington, D.C., April 25, 2003
(5) The estimate is based on published reports of troop strength.
(6)Thompson, Mark, The Tools of War, Time Magazine, October 21, 2002
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(9) Source: U.S. Department of Defense
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(11) British Petroleum Statistical Review of World Energy, 2002
(12) ibid.
(13) Copulos, Milton, Surge Production During Operation Desert Storm, The National Defense Council Foundation, Alexandria, VA May, 1993
(14) Source United States Department of Energy, Energy Information Administration chart: Global Oil Supply Disruptions Since 1951
(15) ibid.
(16) Source: Petroleos de Venezuela.
(17) Source: Department of Defense Budget
(18) ibid.
(19) ibid.
(20) ibid.
(21) ibid.
(22) Source: The Tax Policy Center, Washington, D.C.

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ABOUT THE NATIONAL DEFENSE COUNCIL FOUNDATION

For a quarter-century, the National Defense Council Foundation (NDCF) has occupied a unique position within the public policy community. Through an emphasis on field research and on-site observation, NDCF has established itself as singularly authoritative in the subject areas it addresses. More important, by combining both academic and direct-action programs, NDCF is able to turn its policy objectives into tangible accomplishments that now span more than two decades. A few examples illustrate this point:

When high transportation costs jeopardized the provision of vital humanitarian aid to conflict-ridden Central America in the early 1980s, NDCF helped draft and then lobbied through the "*Denton Amendment*." This law permitted the transport of such aid in military aircraft on a space-available basis. This enabled NDCF to deliver more than 183 tons of vital medical supplies to the war-torn region.

When a powerful Congressional Committee Chairman attempted to saddle the Department of Defense with a $1.2 billion boondoggle to line the pockets of favored businesses in his District, NDCF took him on. Our report on the issue gained the attention of the New York Times and forced a repeal of the measure.

When the Republic of the Philippines faced the prospect of a Marxist takeover in the wake of the Marcos' government collapse, NDCF worked behind the scenes using its long-standing military contacts to assure their support of more moderate elements and of a democratic transition of power.

When earthquakes ravaged El Salvador, NDCF was the first NGO on the scene delivering over $100,000 worth of antibiotics and other vital medical supplies directly to the hardest hit areas. In the first few months after the disaster, NDCF accounted for fully 10% of all humanitarian aid delivered to that nation.

When narco-guerillas threatened to topple the fragile democracy in Colombia, NDCF took the lead in lobbying through legislation to provide desperately needed helicopters and other equipment to the National Narcotics Police. Recognizing NDCF's key role in

obtaining the assistance, it presented our Executive Director, MAJ F. Andy Messing Jr. with its highest civilian award.

In some 45 countries on five continents, NDCF has been on the scene, obtaining vital "*unfiltered*" information for decision-makers, bringing millions of dollars in vital medical aid to the victims of conflict and working to encourage democratic, pro-western policies. Moreover, it has done so with a remarkable degree of efficiency.

Unlike some organizations, NDCF does not maintain a large paid staff. The Foundation is able to do this because it is blessed with a broad range of individuals willing to volunteer their services to help advance the goals NDCF promotes. Such important tasks as Command Pilot, Pharmacist, Medical Advisor and Legal Counsel are all performed by individuals who forego compensation.

But NDCF's efficiency with its cash budget only tells half of the story. The Foundation also solicits extensive in-kind contributions of medical supplies from leading pharmaceutical companies, clinics and individual medical practitioners. This allows it to "*leverage*" its cash donations, using them for transportation and other essential services. On average nine out of every ten dollars donated to NDCF are in the form of in-kind contributions. Therefore*, for each dollar donated, up to ten dollars in aid or other program activities is generated*.

In short, NDCF has been where the action is – not just as academic observers, but as direct participants in the process. In the weeks and months ahead, NDCF will continue to employ its unique approach of academic and direct-action programs to promote peace, freedom and national security.

ABOUT THE AUTHOR

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President, NDCF

For more than three decades, Milton R. Copulos has been a prominent figure in national political circles. He served as a Cabinet-level advisor in the Bush and Reagan Administrations, working closely with the Secretaries of Defense, Energy, Interior and Commerce, as well as the Director of Central Intelligence. While working for the Reagan White House, Copulos authored a number of important studies including the *National Critical Minerals Report* and *Advanced Materials Program Plan*, the Department of Energy's assessment of the Soviet natural resource base as well as a number of classified documents. He was also a participant in the *Defense Industrial Base Initiative* and the principal consultant to the Department of Defense on the *Defense Environment Initiative*.

As a prominent expert on natural resources, national defense and international politics, Copulos is frequently called upon to lecture at universities and other academic institutions around the nation. He has been a visiting lecturer at the Massachusetts Institute of Technology, the University of Maryland Graduate School of Nuclear Engineering and the University of Dallas Graduate School of Management. He was also selected as faculty for the prestigious *Salzburg Seminar* in American Studies sponsored by Harvard University in Salzburg, Austria. He is also the only individual to be asked to deliver the prestigious "*Management Classics*" lecture at the University of Dallas.

A prolific author, Copulos has published more than 700 articles, books and monographs. His writing has appeared in such prominent national news media as the *Washington Post*, *The Los Angeles Times* and *The Chicago Tribune*. He is also a frequent contributor to periodicals such as *Insight Magazine*, *VFW Magazine* and *Regulation Magazine*. His book "*Energy Perspectives*" was a Washington Post best seller, and for four years he wrote a nationally syndicated column distributed by the *Heritage Features Syndicate*. He also has appeared on nationally broadcast news and information programs including such programs as FOX News Network's "*FOX and Friends*", CNN's "*Crossfire*", and "*War Room with Wolf Blitzer*" as well as local broadcasts for major network affiliates. He has also acted as an on-air military analyst for MSNBC.

Because of his internationally recognized expertise in foreign affairs, Copulos has often been asked to meet with foreign leaders. Included among them are individuals such as President Fidel Ramos of the Republic of the Philippines and President Rauf Dentkash of the Turkish Republic of Northern Cyprus.

A veteran of two tours of duty in Vietnam, Copulos was awarded the Bronze Star and Army Commendation Medals, as well as five battle stars. He is a graduate of The American University in Washington, D.C. and lives in Crofton, Maryland.