Making Philadelphia a "Cool Community"

Looking at Ways to Mitigate the Urban Heat Island in the City of Philadelphia

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December 10, 2001

ABSTRACT

Climatological data consistently shows that highly urbanized areas have higher daytime temperatures than their non-urban, less dense surrounding communities. It is important for every city in the United States to implement urban heat island mitigation strategies. Most recently at the behest of the United States Environmental Protection Agency, major American cities including Los Angeles, Seattle, Chicago and Atlanta have begun Heat Island Mitigation strategies, and the City of Philadelphia has a tremendous opportunity to join the fight. This proposal aims at showing how Philadelphia can easily implement heat island mitigation strategies in conjunction with their efforts to revitalize the city for residential, commercial and industrial development. An introduction of a Heat Ombudsman is necessary to coordinate the multi-agency, wide ranging project that is needed to reduce the urban heat island in Philadelphia. Coinciding with Mayor John Street's Neighborhood Transformation Initiative and Anti-Graffiti campaign, the City of Philadelphia can be one of the first Northeastern cities to fully implement a program that will improve the city's health, energy efficiency and overall appeal to new businesses and residents.

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INTRODUCTION

North American cities are usually heavily populated areas, with hundreds of miles of black road surfaces and parking lots, combined with numerous buildings with dark colored roofs. Traditionally, American cities have up-rooted trees and green-spaces in the name of urban development. The result is that large cities in the summer have an average daytime air temperature 5°F higher than their surrounding rural areas (Bretz, et al. 1998). Haider Taha, of the Lawrence Berkeley National Laboratory showed that in the Northern Hemisphere, urban areas annually have an average of 12% less solar radiation, 8% more clouds, 14% more rainfall, 10% more snowfall, and 15% more thunderstorms than their rural surroundings. Urban pollutant concentrations can be 10 times higher that those of a "clean" atmosphere (Taha 1997). The United Stated Environmental Protection Agency (EPA) defines that a "clean" atmosphere, in the form of ground level ozone, must be at maximum .08 parts per million (ppm) within 8-hour ozone concentrations (EPA 1997). The added heat in the atmosphere serves to make chemical reactions occur closer to the ground, and more rapidly. Thus on extremely warm days, thick haze and smog surround Philadelphia. The urban heat island effect is an issue that is beginning to receive national attention. Implementation of heat island mitigation was a prominent part of former President Clinton's Climate Change Action Plan, and in 1997, the Environmental Protection agency implemented a Heat Island Reduction Initiative.

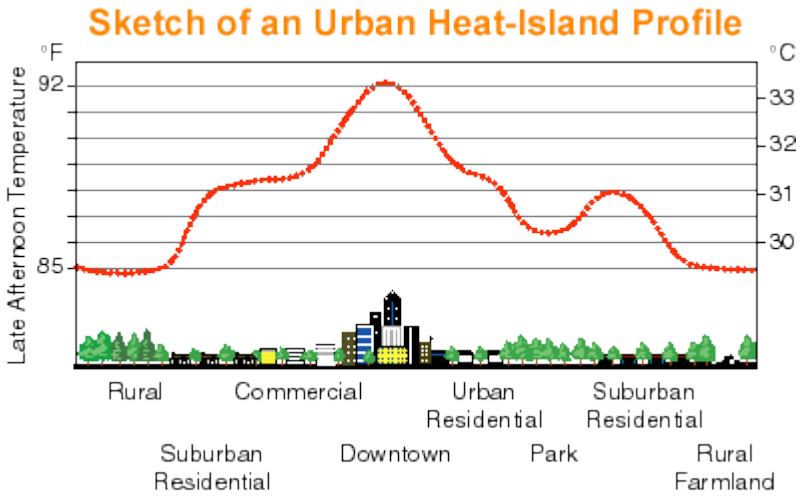


FIGURE 1: This graph is from the Urban Heat Island Group under contract from the Department of Energy in Berkley, California and shows how the average temperature varies among areas with different distributions of land use. As shown above, downtown and ancillary urban areas have a much higher late-afternoon temperature, which leads to increased atmospheric chemical reactions and increased energy costs.

The urban heat island is unavoidable in large urban areas; however, research shows that it can be mitigated. Reducing the urban heat island can save taxpayers and the city millions of dollars in energy costs. As shown graphically above, there is a significant increase in late-afternoon temperatures for urban areas, compared to their surrounding localities. Because of the increased heat in our urban areas, most people turn to air-conditioners for comfort in the summer. Air conditioning use caused by this urban air

temperature increase is responsible for 5-10% of urban peak electric demand, at a direct cost of several billion dollars nationally (Rosenfeld, et al. 1995). This extra cost goes directly to every energy consumer, simply due to the laws of supply and demand. When extra power is needed, which is often the case in the summer due to air-conditioners, power companies such as PECO Energy must buy power off the National Power Grid, which is often charged "market" prices. Since PECO will pay more for their electricity, the ratepayer will find that he or she will also pay more in their next utility bill.

While in the eyes of many, air-conditioning is seen as a luxury, its denial during some of our summer heat waves is life threatening. The heat wave of 1995 in Chicago was responsible for numerous heat-related deaths (Bretz, et al. 1998). We can all remember the deaths that occurred as recently as this past summer in Philadelphia. The victims were mainly elderly individuals who did not want to operate their air-conditioners due to the energy cost. On a hot afternoon, about 10 gigawatts of the United States air-conditioning load results from the heat island effect. This additional power generation is worth about $1 million per hour, and costs electric ratepayers about $1 billion a year (Bretz, et al. 1998). An example of how Philadelphia's energy use is affected by the heat island was shown in a press release provided by PECO Energy, the largest utility provider in the Philadelphia region. On August 9, 2001, during a mild heat wave that hit the area, PECO Energy posted a new power-generation record of 8,000 megawatts (mw) for one hour. PECO reported that the total electric output most likely exceeded 160 million kilowatt hours for the day. That same day, PECO Energy urged consumers to do whatever they could to conserve power use, as PECO was buying power from neighboring utility companies.

How Philadelphia fits the typical Urban Heat Island Model

The City of Philadelphia, one of the oldest American cities, has seen a lot of development and redevelopment, especially since the city lifted the building height restriction in the mid 1980's. However, while the city has seen a constant fluctuation in building and development in the Center City district, it has not seen much change in the design of its structures. Most buildings that occupy the downtown landscape, with the exception of skyscrapers such as Liberty Towers and the Blue Cross building, are consistently built with black top roofs, accompanied with black-tar roads that make up the city's vehicle transportation network. While Center City is a key part of the city landscape, residential neighborhoods make up a vast majority of the city. Most "Row-Home" style neighborhoods, which are found throughout the city, consist of older buildings with traditional black-tar roofs, as shown on the next page.

FIGURE 2: This picture, taken by Rich Dunoff, shows a "typical" residential neighborhood in Philadelphia. "Row-Home" style neighborhoods such as the ones pictured dominate the South, West, North and Northeastern parts of the city. Most of these structures, built in the early to mid twentieth century, have old-style black-tar roofs.

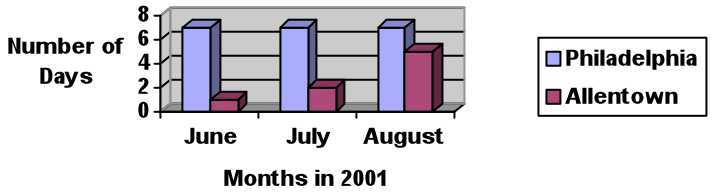
The following Satellite photograph of Philadelphia shows typical elements of the heat island problem, which mostly stems from a centralized region of structures featuring low-albedo surfaces. As the picture shows the city boundaries, especially the Center City district, are in sharp contrast in color from its more immediate surroundings.

FIGURE 3: A Visible satellite Photograph of the Central Part of Philadelphia. The Center City Region, which is in the center-left region of the photograph, is significantly darker than the greener sections shown in the Northeastern part of the City and across the river in Camden County, New Jersey

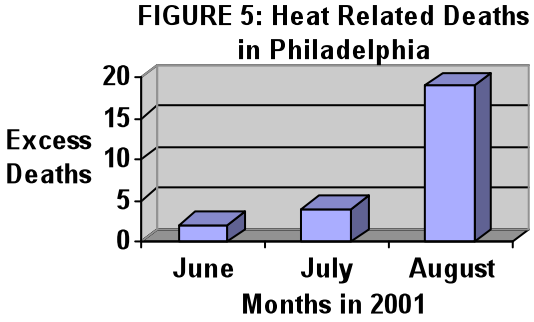
The Philadelphia Connection:

In 2001 we experienced a relatively normal summer season, with occasional outbreaks of heat. However, Climate data from the National Weather Service Forecast Office (NWSFO) in Mount Holly, New Jersey showed that ambient, daytime temperatures in Philadelphia were usually higher than nearby, less urbanized areas such as Allentown, Pennsylvania, which is an urban-suburban area just North of the Philadelphia suburbs. Official data shows that there were seven recorded days in June, July and August of 2001 when the temperatures were over an unhealthy 90^{o} Fahrenheit. This is in contrast to the one day in June, two days in July and five days in August that Allentown recorded temperatures above 90^{o}.

FIGURE 4: Number of days with a maximum temperature over 90 degrees



The Urban heat island is silent among city residents, however, this small but significant increase in average temperature leads to a considerable increase in energy consumption, which leads to an unhealthy increase in ozone and urban smog production. This increase in temperature and decrease in urban air quality is particularly dangerous to older citizens of Philadelphia, many of whom suffer from respiratory problems, or are just sensitive to heat. The elderly, and small children are the ultimate victims of the Urban Heat Island. Individuals who die during heat-related events are usually ones without access to an air-conditioner or who cannot afford to keep the air-conditioner running, and fear the increased energy costs. Dr. Lawrence Robinson of the City of Philadelphia recently cited the problem of elderly people living alone in older brick row houses with tar roofing, no air conditioning and poor ventilation. Dr. Robinson, in a recent presentation to Low-Income Home Energy Assistance Program (LIHEAP), operated by the National Center for Appropriate Technology, stated that many elderly Philadelphians succumbed to the heat inside oven-like apartments, and that some people do not use their air conditioners because of their high operating costs. The graph on the following page displays data provided by Joe Miketta of the National Weather Service in Mount Holly, New Jersey. Philadelphia experienced a spike in heat related deaths in August 2001, which occurred mostly during August 6-12. Philadelphia reached 99^{o} F on August 7, 100^{o} F and 101^{o} F on August 8 and 9, and 98^{o} F on August 10. While there was a significant heat wave in the summer of 2001, the summer months were still deemed "normal" on a climatic scale. This is in comparison to the very hot summer of 1993, when the City of Philadelphia recorded 118 heat-related deaths between July 6 and 14.



This graph is derived by the data provided by the National Weather Service in Mount Holly, New Jersey. This graph shows the excessive deaths that were attributed to heat in the City of Philadelphia during the summer months of 2001. The spike in deaths in August occurred mostly between August 6-12, 2001.

With a colonial city reaching temperatures that are higher than their surrounding localities, Philadelphia's urban center is doing an unconscious disservice to its residents by increasing the need for electricity and air-conditioners while making the city an unhealthy place to live. However, Philadelphia is not a city that will sit idly by while people lose their lives, waste millions of dollars on energy costs and suffer from numerous respiratory problems caused by a climatic phenomenon that can be successfully mitigated. With the unprecedented action that Mayor John Street and the City Council have undertaken to rebuild Philadelphia, we have a great opportunity to keep Philadelphia alive, both economically and literally.

It is important that while we continue to build and introduce new structures into the city landscape, that we consider the ramifications of the urban heat island effect, and that we practice "smart-growth" strategies. Implementing urban heat island mitigation strategies fit seamlessly with Mayor John Street's "Fight Blight" and urban revitalization programs. There are many cities across the nation that have begun programs to curb the urban heat island effect, and many have posted favorable results in energy savings, and overall pollution reduction. In order to receive the maximum benefit of urban heat island mitigation, we must begin to look at how we build our city, and how we allow structures and roadways to be built, among other things. As Mayor Street boldly acknowledges in his strategy for the Neighborhood Transformation Initiative (NTI), "Philadelphia is at a critical juncture in its civic life" (NTI 2001). The time is now for Philadelphia to look at a cost effective, citywide program aimed at reducing the urban heat island. A broad-based, multi-agency initiative coordinated by a "Heat Ombudsman" is essential to maximizing the potential of currently proven heat mitigation strategies. As Philadelphia continues to be on the cutting edge of technology and science, it is important that we seize the current opportunity of successfully implementing a wide-range of urban heat mitigation initiatives.

LITERATURE REVIEW

Cities across the nation, especially in warmer climates, have already begun to tackle the urban heat island effect. Research by the Environmental Protection Agency (EPA), the National Oceanic and Atmospheric Association (NOAA), the National Aeronautics and Space Administration (NASA) and countless municipalities and governments have begun to look at ways to mitigate the urban heat island. One of the most important aspects of the urban heat island is albedo, and the amount of insolation that is received on a daily basis. Most cities are comprised of countless flattop structures with dark roofs and black asphalt pavements. Darker color materials tend to absorb heat and store it, thus making the ambient temperature warmer that it would have been, had a lighter color surface been present.

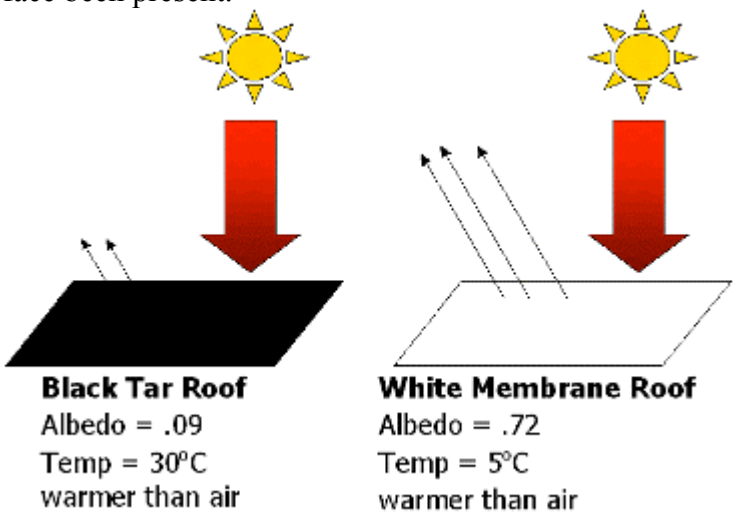


FIGURE 6: The data that is presented in the above picture is courtesy of the Berkley National Laboratory and the Heat Island Group. Represented above is a graphical interpretation of the albedo complex, and how it affects the ambient air temperature of its environment.

Many different methods have been studied by the federal government and research shows that for the urban heat island, albedo means everything, and that trees and parks can make a sizable impact on the increased temperatures that cities often see. Any city that wishes to enjoy the full benefits of mitigating the urban heat island, and potentially save dozens of lives and millions of dollars, must look seriously at effective roofing material, road pavement and urban oasis initiatives. We must then observe what other cities have done, and look into the structure of the Urban Heat Island Mitigation Program for the City of Philadelphia.

Roofing Materials Initiative:

Roofing material is a major factor in the urban heat island, and can greatly impact the energy efficiency of most buildings. NASA has identified dark roofing as a heat island contributor, and it advocates reflective (i.e., light colored) roofing materials as a mitigation strategy (Wade, 2000). In the recent article published in "American City and County," Dale Quattrochi, a senior research scientist for NASA was quoted as saying "In major cities, most air conditioning systems are located on roofs, which means they have

to work twice as hard and use more energy to cool the air going into the building because it is so hot on the roof…[Reflective roofing] can reflect 60 to 80 percent of the incoming solar radiation." (Qtd. Wade, 2000). Experiments in Florida and California have produced summer direct cooling energy savings of 10-70% (Bretz, et al. 1998). Numerous temperature measurements across the country have been taken in major cities like Philadelphia; in many buildings, simply changing the color of the roof can have a big impact. Black-tar roofs, along with other dark colored objects tend to store heat, which in turn brings heat into the building, therefore increasing the need for an air-conditioner. Berkley scientist Haider Taha conducted research with different color roofing materials, and found that white elastomeric coatings (with an albedo of .72) were 45^{o}C cooler than black coatings (with albedo of .08). A white surface with albedo of .61 was only 5^{o} warmer than the ambient air temperature, whereas conventional gravel with an albedo of .09 was 30^{o}C warmer than the air (Taha, 1997). It is important in mitigating the urban heat island, that we target roofing materials. In most cases, if high-albedo substances were used during original roof installation, or when re-roofing is necessary, the cost is negligible. Light-colored roofing generally costs the same as the commonly used black-tar roofing. The cost is only important to the homeowner or business when the roofing is replaced before it is needed. In order to maintain a low-cost initiative for homeowners and landlords, it is important that this initiative be implemented when it is economically viable, which would be when the original roof needs to be replaced, or when the structure is being built. However, for some structures the energy savings make up for the initial cost almost immediately. This was proven recently in Austin, Texas where a large retail store was documented saving $7,400 a year in energy costs for installing a reflective roof (EPA).

Road Pavement Initiative:

The urban heat island is not completely derived from the color of rooftops. Road pavement color is also a considerable contributor to the heat island. The color of the streets of Philadelphia are just as important as the color of the roofs. The City of Philadelphia can make a direct approach on decreasing the urban heat island based on the color of the pavement they choose to use on city streets. Normal "black-top" asphalt pavements are usually a rich, black color with a relatively low albedo rating. These pavement types tend to absorb mass quantities of heat, which anyone who has ever walked barefoot across a blacktop driveway can confirm. Concrete, or light colored pavements are shown to store less heat. In pavements, the use of light-colored aggregates that can increase albedo, and are suitable for asphalt mixtures include high silica, gravel, quartz, white stone, white marble and some types of granite (Bretz, et al. 1998). The Heat Island Group of Berkeley, California cited in their 1999 research that using high-albedo, softer color pavements have many ancillary effects, including better road vision at night (of road markings), and decreased sun glare on roadways (Heat Island Group). Since high albedo pavement surfaces absorb less heat, they usually last longer, since there is not a great temperature gradient, which often leads to road deterioration (Heat Island Group). The cost of these new pavements can be combined with the cost of road replacement. On the following page is a chart of expected results and costs of different pavement

materials, provided in 1998 by Sarah Bretz, Hashem Akbari and Arthur Rosenfeld of the Energy Analysis Program at the Lawrence Berkley National Laboratory.

Pavement Type	Service Life	Cost $/m2	Albedo (new) %	Albedo (weathered) %
Asphalt (18cm)	15	18	5-10	15-20
Whitetopping (13cm)	25	18	35-40	25-30
Asphalt with light Aggregate (18cm)	15	18	5-10	35-40
Whitetopping with cement	25	21	70-80	40-60

FIGURE 7: These statistics were taken for city streets built in Sacramento, California, and reflect an average cost of construction material. This information shows that two major heat island mitigation techniques for pavement (Whitetopping and Asphalt with light aggregate) are shown to have the same cost, the same or greater durability, and a high-albedo surface.

While the cost of the road pavement initiative initially comes down to government agencies like PennDOT and the City Works department, we must also look at the cost it creates for local developers which seek to build large-scale parking lots to accommodate their structures. The town of Highland, Utah was noted as being one of the first cities to mandate ordinances regarding high-albedo pavements. Noting that concrete construction is often expensive for parking lots, the city gave private developers the option of building parking lots made of concrete paving with 10% interior landscaping (islands of trees, etc.) or paving with asphalt and requiring 20% interior landscape (Wade 2000). While high-albedo pavements such as concrete are a necessity for government-funded roads; there are variances that can be made for contractors facing the financial difficulty of parking-lot pavement options.

Trees and the Urban Oasis:

Trees serve as an effective urban heat island mitigator, and also serve to beautify our city streets. The presence of trees and vegetation in the urban environment not only reduces the urban heat island, but it provides aesthetic pleasures to residents and workers. Vegetation and trees, whether they are in a park or along a city street provide more than simple shade. Haider Taha proved to us that a vegetation canopy produced daytime temperatures that were cooler in the day (providing urban oases) and were warmer at night, compared to the bare ground (Taha, 1997). This is because the vegetation locks in the moisture from the air, and evapotranspiration cools the ambient air around it. Also, there is another side benefit, because of the water absorption ability of vegetation, storm water runoff drains quickly, and thus can provide a small relief to an overworked city storm sewer system (Taha, 1997). When trees soak in available water, the water then "evapotranspires" from the leaves, thus cooling the leaves and, indirectly, the surrounding air. A single properly watered tree can "evapotranspirate" 40 gallons of water in a day, offsetting the heat equivalent produced by one-hundred 100-watt lamps, burning eight hours per day (Condella 1998).

Keeping with new trends in the urban oasis field, Chicago recently underwent experiments using rooftop gardens. Widely used in Europe, "green roofs" provide tremendous energy savings by retaining up to 25% of the buildings heat in winter, and

reducing heat absorption in the summer by up to 50% (Brake, 2001). The City of Chicago recently built a rooftop garden atop their city hall. The garden roofs need as little as 2 inches of soil, and some studies have shown that 5 inches of soil on a rooftop garden can drastically reduce the need for air-conditioning (Brake, 2001). Also, "green roofs" can serve to help heat homes in the winter. Since the vegetation on the "green roof" has the ability to freeze, the temperature of the roof will never go below freezing (Holtcamp, 2001). Therefore, on many of Philadelphia's below freezing days, homes will be insulated from sub-freezing temperatures, whereas most plain roofs allow that cold air to pass through into the building.

The Winter Penalty:

Does the urban heat island keep us warmer in the winter? Implementation of heat island strategies in Philadelphia will not necessarily do anything to make the winter months colder. Since most of our mitigation strategies are based on roof color, pavement color and vegetation, there is little concern for lost heat in the winter months. If an effective "green roof" initiative is implemented, we can make the so-called "winter penalty" even more insignificant than it is now. The winter penalty is the logical rationale that if we destroy heat absorbing surfaces for cooler temperatures in the summer, that we neglect the benefit they serve in the winter. However, as common astronomy show us, the position of our Sun makes all the difference. When Philadelphia is in its summer months, we recognize that the sun is higher up in the sky, thus longer, warmer days. When we are in our summer months, the sun shines more directly over the Northern Hemisphere, thus providing strong and direct sunrays. When we are in the winter months, the sun is focused over the Southern Hemisphere, and thus we have shorter days, with colder temperatures. Since the sun is not directly overhead in the wintertime, we receive our sunrays at more of an angle than during the summer. Also, since the sun is further away from our spot on the Northern Hemisphere, the sunrays travel further to reach Philadelphia.

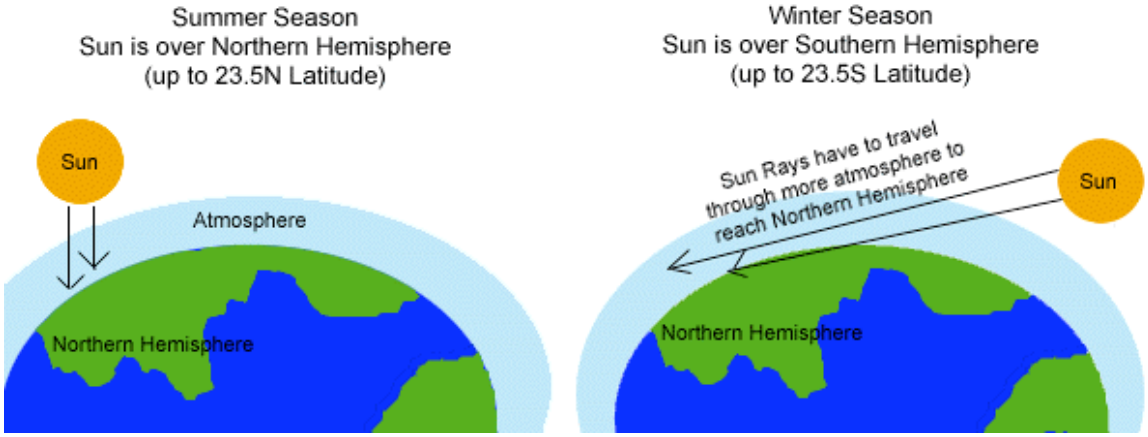


FIGURE 8: A graphical interpretation of the winter sun angle theory, and how it applies to the winter penalty of the urban heat island.

Because the sun's energy has to travel further in our atmosphere to reach us in the winter, the sunrays are not as strong as they are in the summer. Therefore, since we have shorter days and weaker rays, the temperature of the darker pavements and rooftops are

not as significant in the winter as they are in the summer. Basically, the bottom line is that because so little winter sunlight ever makes it to the roof in the first place, it does not really matter what color the roof is. White shingles therefore make the buildings cooler in the summer and yet only slightly colder in the winter, because only a relatively small amount of absorbed sunlight is foregone (Condella, 1998).

What other cities have done:

Cities across the nation have begun to implement smart-growth policies that are "cool community" friendly. While cities, including Philadelphia, with recent seminars to educate contractors about new energy efficient concrete mixtures, have begun to recognize the importance of heat island mitigation, most mitigation strategies are locked in one certain area. Many different institutions have undertaken urban heat island mitigation methods, usually in one specific area of mitigation. For example, in Chicago, City Hall saved $4,000 in air-conditioning costs for implementing green roof strategies (EPA). Los Angeles has successfully implemented cool roof retrofit benefits through the LA Department of Water and Power (EPA), and Sacramento, Davis California and Salt Lake City have implemented cool pavement incentives through City Planning and regulation ordinances. (EPA). The city of Chicago decreased carbon emissions by 3.2 to 3.9% in some cases (Jo et. al 2001) thanks in part to their vegetation initiative.

Urban heat island mitigation initiatives are relatively new in the United States, and most have not been implemented until 1997, when the EPA recognized the urban heat island as a danger to urban dwellers. Most of the proven heat island mitigation strategies take years to implement, and even longer to accurately see the benefits. In some cases, like the city of Chicago, which saved thousands of dollars in energy costs, the benefits were seen almost immediately. However, for more broad-based strategies like the one this proposal is suggesting that Philadelphia implement, the benefits might be long term.

While some cities are making efforts to adopt heat island mitigation ordinances, most cities are only seeing partial benefits because they usually focus on only one mitigation strategy. In order to successfully benefit from all of the available strategies of heat island mitigation, it is important that one person, a "Heat Ombudsman," be in place to see that Philadelphia can save every dollar and every life possible. While no notable Heat Ombudsman has been implemented in any city in the United States, it is important that we implement Heat Island mitigation strategies properly and effectively, with the least possible cost and disruption. In order for Philadelphia to fully enjoy all of the benefits of Heat Island reduction, the Heat Ombudsman is needed, in the same capacity that Patricia Smith is needed with the Neighborhood Transformation Initiative project, to make sure that the city's goals are met quickly and effectively. An aggressive approach towards the heat island effect, which this proposal is suggesting, requires the effective implementation of high-albedo road pavement and roof shingle initiatives, combined with expansive "green roof" implementation strategies and other possibilities not yet known. With roofing initiatives, we can significantly cut down on the necessity for air conditioning, saving millions of dollars and dozens of lives. With a well-integrated "green roof" initiative, we can further decrease our city's energy consumption by reducing the need for air-conditioning in the summer, and effectively holding in heat

during the winter. However, we are not limited to roofs and roads, we must also look into building effective policies with the Southeastern Pennsylvania Transportation Authority (SEPTA) and the area's mass transit system to implement benefits for riders who utilize public transportation during sweltering summer days rather than take their cars. Philadelphia and the Heat Ombudsman must continually look at new strategies to save lives and save energy by cutting down the urban heat island effect. The City of Philadelphia has always been a place for independent policy thinking, and being the birthplace of modern government, must maintain its status of being a city that implements new technology and science with highly effective, broad based program structure. The city of Philadelphia is already a cool place to live; it is time that we make Philadelphia a "cool community" for the benefit of all.

THE URBAN HEAT ISLAND MITIGATION PROJECT FOR THE CITY OF PHILADELPHIA, PENNSYLVANIA

The urban heat island effect is a silent, unwelcome dweller in Philadelphia. It blindly robs thousands of energy consumers of millions of dollars a year, while producing unhealthy, ozone filled air. Implementing proper urban heat island mitigation strategies is a large task that must be undertaken with appropriate administrative structures in order for the City to receive the maximum amount of benefits possible. It is important that we create a position within the City Planning commission that would serve as a Heat Ombudsman. One person who will have to coordinate efforts among dozens of local agencies and authorities including, but not limited to the Philadelphia Streets Department, PECO Energy, EPA Region III, PennDOT, the Department of Energy, Mayor's Office, the Office of Zoning and Urban Planning, and various local architects, developers and contractors. The Heat Ombudsman must investigate the available urban heat island mitigation strategies and see which ones can be effectively applied to the City of Philadelphia. Also, the Heat Ombudsman must look at other available methods for not only cutting down the excessive ambient air temperature caused by the Heat Island, but also looking at other ways to cut down on the products of the Heat Island, including urban smog production. The Heat Ombudsman must look at examples like Chicago, and their green-roof initiatives, and the State of Delaware, which offers free public transportation to all citizens on "code-red" ozone days. The Heat Ombudsman must investigate all available options and market them to the Philadelphia public while implementing mitigation initiatives through city-council zoning ordinances and incentive programs.

The Heat Ombudsman must work with local city developers and contractors and market high albedo, reflective roofing materials. The Heat Ombudsman must educate homeowners and contractors about the tremendous energy savings that they can experience, along with the benefit they are providing to others in the city by helping curb the heat island effect. The Ombudsman must also work with PennDOT and the City's Streets Department and try to implement high-albedo road pavement incentives. Also, incentives must be created for local contractors that are willing to build parking lots with high albedo pavements, or with significant tree cover. The Heat Ombudsman must work with the Neighborhood Transformation Initiative and help to turn abandoned lots into vibrant, urban temperature friendly parks under the vegetation initiative. Also, the Heat

Ombudsman must work with city Landscape Architects, and help to maintain and rebuild many of the city's tree-lined streets, which have recently fallen into disrepair in the Northeast.

The Heat Ombudsman must undertake education initiatives with city residents and building owners to gain support for a productive green-roof initiative. The ombudsman must work with local power utilities in finding grants and subsidies for the construction of "green roofs" within the city limits. Also grants must be secured to provide financial backing for incentives to replace current black-tar roofs with more effective, high-albedo materials. NASA and the EPA have begun programs that work with metropolitan cities to help fight the urban heat island effect. The Heat Ombudsman must create and maintain contacts with these agencies, including NOAA and the National Weather Service, in order to effectively curb the Philadelphia urban heat island.

While educating others about the benefits of urban heat island reduction, it is important that the Heat Ombudsman has a full degree in Landscape Architecture, Urban Planning, Meteorology, Climatology or Environmental Science. A person that is able to multi-task and communicate well with various governmental agencies is necessary to coordinate and garner the cooperation that is necessary to make this project a success. The Heat Ombudsman must be well versed in the workings of a major city government, and must strive to maintain the support and momentum necessary to effectively meet the goals that the Urban Heat Island Mitigation Project sets forth. The main goal of the Urban Heat Island Mitigation Project is to decrease the average summertime temperature gradient found between Philadelphia and it's neighboring suburban localities while improving the quality of life for the city's population.

The Heat Ombudsman will be a member of the Philadelphia City Planning Commission, and will operate in a position similar to that of Patricia L. Smith, director of the city's Neighborhood Transformation Initiative. Since the Heat Island Mitigation Project is a broad-based, multi-agency task that requires city financial support, it is important that the Heat Ombudsman be required to make constant progress reports to the City Council, Mayor John F. Street, and the city public record. The Heat Island Mitigation Project is one that directly affects the way of life of many Philadelphia citizens, and thus, this project must be in constant view and support of the citizens who pay for it.

The Heat Island Mitigation Project will be administered much like the city's Anti-Graffiti campaign, and more importantly, the Neighborhood Transformation Initiative. The Neighborhood Transformation Initiative (NTI) is a project created by the Mayor's office headed by Patricia L. Smith, noted as being a public-policy advocate, and known for her stance on urban renewal and redevelopment. The NTI is a multi-agency effort to rebuild the city's aging and depreciating neighborhoods, much like the urban Heat Island Mitigation Project. The NTI, which is featured as a large part of the Street Administration, is required to keep an updated timeline of progress on its website, combined with insight into the goals to "Facilitate, Eradicate, Advance, Improve, Stimulate and Leverage" in rebuilding the city's neighborhoods (NTI). Thus far, the NTI has aimed at rehabilitating 16,000 homes, cleaning 31,000 vacant lots and demolishing 14,000 hazardous buildings. The NTI's most recent success was removing 40,000 abandoned automobiles within 40 days from residential neighborhoods. The Heat Island Mitigation Project will have similar goals and infrastructure ideals as the NTI. Both are

citywide, multi-agency projects that look to restore and build citywide planning and urban growth initiatives. The City of Philadelphia has a tremendous opportunity to effectively implement urban heat island reduction strategies, which will run parallel to the city's main focus of rebuilding, and welcoming back new residents and businesses. As Mayor Street boldly acknowledges in his strategy for the NTI, "Philadelphia is at a critical juncture in its civic life. (NTI 2001)." The time is now for successful implementation of urban heat island mitigation initiatives.

The Heat Ombudsman is to make this city more comfortable to live in, more environmentally sound, cleaner, and thus make it more attractive to new businesses and residents. By integrating the Heat Ombudsman into the city administration, we stand to reduce urban smog, energy consumption, excessive temperatures and storm-water runoff while making this city more beautiful and more attractive on a national scale. With effective heat island mitigation techniques, and more importantly, someone to carry them out, research has shown a 20-40% direct energy savings is probable. At a program's maximum potential, a vigorous cool surfaces and shade tree program could save annually $10 billion in energy and equipment costs, and eliminate 27 million metric tons of CO_2 emissions (Rosenfeld 1995). The Heat Ombudsman will be responsible for researching and implementing many of the mitigation techniques already researched and tested throughout the country, as well as attempt new strategies such as discount bus fare on Code-Red Ozone days, and educational programs.

PROGRAM IMPLEMENTATION

In order to be a successful candidate for the Heat Ombudsman position, one must hold the necessary higher education along with an ability to work and communicate with others. The Heat Ombudsman must be able to multi-task and work with various government agencies and programs that range from a city to a federal government level. It is important that the Heat Ombudsman be able to maintain and create growing relationships between the goals this program has established, and the resources that are needed to carry them out. The Urban Heat Island Mitigation Program's main goal is to decrease the difference in temperature between Philadelphia and its surrounding localities. Along with this task, the program aims to educate citizens on the benefits of implementing proven urban heat island mitigation strategies, and employing the use of energy efficient and temperature friendly initiatives.

The Urban Heat Island Mitigation Program is a long-running cause that will take years to implement. Since this project is dependant on the speed and efficiency of many different organizations throughout the executive process, any proposed timeline is merely a preferable timetable for action. Because this project is implemented through many years, and quite possibly, many different administrations, it is important that the Heat Ombudsman and the Urban Heat Island Mitigation Program follow a sensible timeline for action:

TIMELINE FOR ACTION
URBAN HEAT ISLAND MITIGATION PROGRAM
PHILADELPHIA, PENNSYLVANIA

YEAR ONE:

1.) Pass a resolution through city council to create a Heat Ombudsman position in the office of the City Planning Commission, under the direct authority of the Mayor, and the Secretary of Strategic Planning and Initiatives.
2.) Allocate funds up to $196,640 from the City's general budget and transfer it to the City Planning Commission budget for the specific use of the Urban Heat Island Mitigation Program. Allow for at least $168,000 to be allocated for the following years, up to 5 years, pending a review of the program's progress.

YEAR TWO:

1.) Meet with PennDOT and City Road Engineers to look at what roads within the City limits need to be replaced, and discuss options of replacing worn roads with high-albedo materials.
2.) Begin to construct agreements with PennDOT and City Engineers to implement high-albedo pavements in future road projects.
3.) Begin to secure private and government grants to subsidize road pavement and rooftop material initiatives.
4.) Create and distribute advertising publications about the benefits of high-albedo roofing materials, and make them available to people applying for city permits requesting to make a building alteration.
5.) Begin to hold seminars with local contractors and architects about the benefits of high-albedo roofing materials.

6.) Begin to work with the City Council on passing ordinances that encourage high-albedo rooftops on new buildings and high-albedo pavements in new parking lots.

YEAR THREE:

1.) Effectively implement high-albedo roofing and pavement ordinances into the Philadelphia master plan and local zoning ordinances.
2.) Begin to research incentives that can be provided to local contractors implementing urban heat island mitigation strategies, including variances from other ordinances.
3.) Meet with City Engineers and Landscape Architects to research what city areas need trees, and begin to implement a time-line for planting and maintaining those trees.
4.) Work with the Philadelphia Parks Department and the Neighborhood Transformation Initiative in converting abandoned lots into lush parks.
5.) Work with the City Works Department in implementing a strategy for maintaining trees and parks.
6.) Begin to educate residents and building owners about creating "green roofs" atop their home or building.
7.) Research grants that are available with NOAA, PECO Energy and the EPA in implementing "green roof" initiatives, and make that money available to citizens interested in participating in the "green roof" initiative.
8.) Continue initiatives that began in years preceding.

YEAR FOUR:

1.) Begin to heavily advertise "green roof" possibilities, and work with Licenses and Inspections to implement policies on regulating "green roofs" that will be built on private structures.
2.) Work with SEPTA and local cab companies on subsidizing public transportation costs on days that reach over 90^{o} F.
3.) Begin to look at new research regarding urban heat island mitigation strategies, and how they can be implemented in Philadelphia.
4.) Work with local suppliers of building materials and publicly identify which materials are temperature friendly, and what materials are best suited for "green-roofs"
5.) Continue to build support for local "green roofs" and surpass 100 green roofs in the City of Philadelphia by the end of year five.
6.) Continue initiatives that began in years preceding.

YEAR FIVE:

1.) Work with the National Weather Service, NOAA and the EPA in evaluating temperature data within the city during the summer months of year five, and determine if the Urban Heat Island Mitigation Program has been successful in lower the average temperature gradient between Philadelphia and surrounding municipalities.
2.) Discuss with the City Council the progress the program has made, and evaluate the financial status of the program.

3.) Revise budget, and propose to the City Council what funds are needed to continue the Urban Heat Island Mitigation Program.
4.) Review and revise all implementation strategies up to this date, and determine what changes, expansions and eliminations need to be made.
5.) Surpass 100 "green roofs" in the city of Philadelphia by the end of this year.
6.) Continue initiatives that began in years preceding.
7.) Create a new timeline outlining the next five years of the Urban Heat Island Mitigation Program.

During the five years outlined above, the Heat Ombudsman must make quarterly reports to the City Council and the Mayor of the progress of the program, and what goals have been accomplished. Also, once a year, a report needs to be created and filed with City Records Office and local libraries detailing the expenses of the program, and what progress it has made since its inception.

As is evident in the timeline for action, the cooperation of various agencies and organizations is necessary to successfully implement cost effective and efficient urban heat island mitigation strategies. The cooperation of PennDOT and the City Works Department is necessary for the success of the road pavement initiative. The cooperation and approval by the city zoning and hearing boards, and the city planning commission are necessary to successfully implement road pavement initiatives on privately owned parking surfaces. Also, cooperation is necessary from these agencies to promote and mandate necessary roofing color regulations. The City Parks Department and the Neighborhood Transformation Initiative need to work with the Heat Ombudsman in creating tree landscapes that benefit local citizens with aesthetic and cooling qualities.

A program that is as aggressive as the Philadelphia Urban Heat Island Mitigation Program needs a competent, educated, and logical leader to effectively implement the timeline and goals set for this program. A program of this magnitude needs leadership and proactiveness, and this can only be accomplished with the Heat Ombudsman Position.

Research that has been conducted shows that a city that chooses to implement an aggressive policy towards the urban heat island stands to benefit from millions of dollars saved in energy costs and dozens of lives saved. The cost of the urban heat island is directly sent to every Philadelphia citizen that pays his or her electric bill in the sweltering summer months. However, in order for a viable program to cut down the costs to local residents, the city must undertake certain financial obligations to successfully benefit from a wide-ranging heat island reduction program. While the cost of implementing heat island mitigation strategies is small to homeowners and taxpayers directly, a direct cost must be digested by the city in order to cut down the temperature gradient between Philadelphia and its surrounding suburban areas.

BUDGET

Estimated expenditures for the first year of program operation.

(1) Employees	
Heat Ombudsman Position	$65,000.00
Support Staff (2 people @ $16.50/hr.)	$68,640.00
(2) Supplies	$10,000.00
(3) Seminars, Educational Pieces	
Seminar Supplies, Samples, Ed. Pieces	$12,000.00
Seminar Rooms	$ 0.00
(4) Marketing Materials	$10,000.00
(5) Transportation	
Common Sedan/SUV	$29,000.00
Average Fuel Expense	$2,000.00
Total Estimated of City Costs	$196,640.00

While the cost of actually implementing urban heat island mitigation initiatives is quite low for the contractors and citizens, the City most consider the operational expense of running an Urban Heat Island Mitigation Project. Since this project is housed within the City Planning Commission, the project office is designed to be inside the City Planning Office, which is located at 1515 Arch Street. Since this is already a city owned property, such expenses as rent and utilities are digested in the City Planning Commission budget.

BUDGET JUSTIFICATION

(1) The staff, is of course, the most important aspect of this project's success. The Heat Ombudsman must be a person with a College degree in Landscape Architecture, Urban Planning, Meteorology, Climatology or Environmental Science. The chosen candidate must also be able to communicate to both governmental and citizen groups, being able to effectively communicate the goals, status, and need for the Urban Heat Island Mitigation Program.

Also necessary is two available staff members. These positions are necessary to assist the Heat Ombudsman in maintaining contacts with the many agencies and departments that the Ombudsman must work with. The support staff must also be able to create necessary documents to be included in presentations and reports that this project must administer to the City government and local residents.

(2) The city must also provide a reasonable budget for supplies including at least three computers (average price $1,100) and at least three printers (average price $300). These computers would be used specifically for this project, and therefore would need to be separated from the City Planning Commission budget. Also, supplies including pens, paper, telephones, staplers and common office supplies are necessary to successfully complete this project.

(3) An important aspect of this project is the required educational seminars that are necessary to make heat island mitigation strategies common and accepted among Philadelphia residents, developers and contractors. It is expected that most of these sessions be held within the City Planning Commission conference facilities in their administration building. Funds are needed to obtain samples of high-albedo roofing materials and pavement materials to aid in the educational process. Also, necessary funding is required for such accessory expenses as food and presentation materials to be given to those people completing an educational seminar.

(4) For successful implementation, such items as pamphlets, reports and other necessary marketing materials are required in order to properly market this project. Similar to the marketing initiative that the NTI is currently undertaking, the project's success depends on its marketability to the people of Philadelphia, and depends on the amount of people that are willing to implement urban heat island mitigation strategies. Therefore, it is imperative that the proper marketing strategies are utilized in order to successfully implement this project.

(5) Since this project requires a presence at many different construction sites within the city, it is imperative that a specific vehicle be set aside for this program to use. While the vehicle will be owned and operated by the City Planning Commission, its cost and fuel costs will be deducted from the urban heat island program's budget. It is expected that a normal, mid-sized sedan, or perhaps an SUV, dependant on how many pre-site visits would be necessary, would be purchased. Fuel expenditures are expected to fluctuate throughout the year, and a modest estimate of $2,000 is representative of the normal fuel cost per year of a typical American-made vehicle.

While this up-front cost is necessary for the first and subsequent years of this project, we are in essence spending little to gain a lot. Research has shown that an aggressive program, as detailed in the provided timeline, can save $10 billion annually in energy and equipment costs, and eliminate 27 million metric tons of CO_2 emissions (Rosenfeld 1995). While Philadelphia is still unsure about to what extent we will see the benefits of the Urban Heat Island Mitigation Program, we do know that the recent 8,000 mw record that PECO Energy set in August 2001 translates into thousands of dollars of excessive energy costs, and thousands of tons of extra CO_2 emissions into the Philadelphia landscape. Data from recent heat-related events, including over 118 deaths in 1993, prove that the money budgeted for this program is money well spent.

DISCUSSION

The Urban Heat Island Mitigation Program is a far-reaching program designed to ease the city's climate back to a more natural state. While some initiatives may see results almost immediately, a full and accurate account of the effectiveness of this program will not be seen until years after the first reflective roof is installed. It is important during the duration of this project that constant progress reports are made, and that research into the Climatological data of Philadelphia is conducted. It is important to take periodic temperature readings and compare those results to readings made before the program was implemented. The Heat Ombudsman must work with the National Weather Service in obtaining temperature reports at the month's end, and compare them with different regions throughout the city, using different methods of heat island mitigation. While some individual buildings may see results in a matter of weeks, the city overall is not expected to see significant results for years, because of the size of the area that we are seeking to alter. That is why it is important that the Heat Ombudsman continue to build support and justify the Urban Heat Island Mitigation Program to the public. It is imperative that the Heat Ombudsman file reports on a quarterly basis to the Mayor and City Council detailing where the project is in the preset timeline, and what financial resources have been utilized. Also, on a yearly basis, the Heat Ombudsman must complete yearly reports scientifically detailing the progress that the project has made in altering our heat island. These reports will be based on information provided from the National Weather Service, as well as reports from local planning agencies regarding the status of new urban heat ordinances. It is currently built into the 5 year plan that on the 5th year, a total review of the Urban Heat Island Mitigation Project be made, and come under the scrutiny of the City Planning Commission and City Council to make sure that the Heat Ombudsman and his/her staff is completing the required objectives efficiently and successfully.

APPENDIX A

JOB REQUIREMENTS
HEAT OMBUDSMAN POSITION
URBAN HEAT ISLAND MITIGATION PROGRAM
CITY OF PHILADELPHIA, PENNSYLVANIA

The position of the Heat Ombudsman is to be filled by a person who has a reputable scientific background as well as excellent communication skills. A College degreed individual that must adhere to the timeline set forth in the project, and reach the city's goals of mitigating the urban heat island effect, as determined by the temperature gradient experienced between Philadelphia and it's non-urban surroundings. The Heat Ombudsman must complete the following tasks as part of his/her position.

- Meet with PennDOT and City Road Engineers to look at what roads in the City of Philadelphia are scheduled to be resurfaced, and explore cool pavement possibilities.
- Begin long-term construction agreements with PennDOT and the City Streets Department about utilizing cool pavement material.
- Create and maintain working contacts with the following agencies:
    - Southeastern Pennsylvania Transportation Authority (SEPTA)
    - National Weather Service, Mount Holly, NJ
    - Environmental Protection Agency, Region III
    - Neighborhood Transformation Initiative
    - Mayor John F. Street
    - PECO Energy
    - Philadelphia Works Department
    - Department of Licenses and Inspections
    - Philadelphia Planning Commission
    - Philadelphia Zoning Board
    - Local Contractors (start with contractors currently applying for permits in the city to build or modify structures)
    - Other agencies the Heat Ombudsman deems necessary
- Create and distribute advertising materials regarding cool pavements, cool roofs, and "green roofs" to people applying for building modification permits.
- Schedule and hold education seminars to educate local businesses, citizens and contractors about the benefits of heat island mitigation.
- Acquire monthly climatic data for the city and surrounding areas from the National Weather Service and other environmental agencies.
- Prepare and present all findings and progress the project has made to the City Council and the Mayor on a quarterly basis.
- Prepare and compile financial, scientific and progress reports about the Urban Heat Island Mitigation Program, and make them available through the Philadelphia Library System.

- Prepare and present urban heat island information to any media or public outlet that requests it.
- Contact other cities that have successfully implemented urban heat island mitigation initiatives, and research any new approaches available.
- Work with the Philadelphia Works Department and design a process of planting and maintaining trees along urban streets and in local parks.
- Work on implementing and publicizing "Code Red Ozone Days" as deemed by the Environmental Protection Agency.
- Acquire and develop necessary research to support successful implementation of the Urban Heat Island Mitigation Program.
- Delegate projects and needs to available support staff as necessary.
- Continue to apply for new grants and subsidies that are available for the City or the public regarding energy efficiency and urban heat island mitigation.
- Follow desired program timeline and make necessary adjustments.

The duties listed here serve as the basis of the Urban Heat Island Mitigation Program. It is imperative that the Heat Ombudsman remain aware of any new duties that may be needed in the successful implementation of the Urban Heat Island Mitigation Program.

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