

Environmental Impact of the Grand Prix on Baltimore City

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Abstract

The Grand Prix of Baltimore significantly impacts the natural and built environment of the city. Over the past 4 years, there has been intense debate in Baltimore, and beyond, about the city hosting an annual leg of the Izod sponsored Indy grand prix series. Cases have been made for this event to become an annual fixture in the city's sports calendar, mainly citing the economic merits such an event would attract. The city has also documented environmental benefits from the 3 day event in the city, including improved air quality as indicated by the air quality index figures. On the other hand, environmentalists have made their case for the negative impacts the event would generate, such as the cumulative increase of greenhouse gas emissions in an already polluted metropolitan atmosphere. This study is an effort to centralize all the environmental data from the event and show that there is an improvement in the air quality as a result of the event..

Keywords: Air Quality Index, Environmental Pollution, Grand Prix of Baltimore, Green House Gas effect, Tons of Carbon dioxide equivalent.

1 Introduction

The grand prix as an event started in a small town in France in 1894. It had a backdrop as unorganized but regularly held automobile racing at the introduction of motor vehicles to the public a few years earlier, and aimed to be more of a competition between the drivers and their machines with the endurance of both at stake [1]. Vehicle manufacturers were particularly eager to

participate in the event, as supremacy in this field would not only increase popularity off the race track, but also as a platform to develop new technology for their regular vehicles. The first recorded racing event happened in July 22nd, 1894 between the cities of Paris and Rouen. However it was a gentleman by the name of James Gordon Bennett Jr. who increased the stakes of the sport, by presenting the idea of the Bennett

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Gordon Cup. This cup was an international recognition for the sport where worldwide manufactures could enter vehicles that had been entirely built in the continent they were representing. This is the juncture where the United States became a participant of the sport. In 1908, the United States became the first country outside of France to host the Grand Prix using that name (meaning grand prize), at Savannah, Georgia. At this stage, it was still not a championship event, and with this development, Italy, Spain, France and Belgium organized their own events as well. The events were bound together by a standardized collection of formulas of how fast the cars could go, how much the cars weighed, and how big the engine would be. These rules came to make the event referred to at the Formula 1 grand prix. In 1925, the first intercontinental world championship took place and was held in the USA at the Indianapolis Motor Speed way or Indy 500, the European grand prix, the French grand prix and the Italian Grand prix. In the United States, Izod is the title sponsors of the 13-city event, including Baltimore. The grand prix and the formula one organization, however, though around for over 100 years, did not place an emphasis on environmental protection as a byproduct of the event, not around the world, and not within the USA. This did not happen until the Environmental Protection Agency (EPA) introduced the National Environmental Protection Act (NEPA) in 1970 [2]. The emissions were uncontrolled, the fuels used and their disposal was unregulated, the engine sizes and vehicular engine noise levels was nowhere in the minds of the regulators. In this paper we discuss how all this has changed as a result of NEPA, and how it is positively impacting the environment. The term 'environment' refers to both the natural and built environments, and explicit distinctions shall be made in each case.

2 Methodology

For both the positive impacts of the event in Baltimore, specifics of how each data result is explained, with logic and referenced proof accompanying it, but the main method of results analysis is side by side comparisons and extrapolations to how results mesh together. For example, a positive impact of the Grand Prix of Baltimore is the improved air quality in the city of Baltimore. The results for this claim are obtained by using the reference documented data from the Environmental Protection Agency, EPA, about the daily air quality for a particular day, compare it to the air quality data for the labor day weekend when the grand prix event is held, and see the difference in air quality index values. Then, we have the Maryland Department of Transportation (MDOT) data regarding the annual average daily traffic. We then used the data to see how many vehicles are expected in the city at any given weekend, and compare this to how many vehicles are diverted away for the race event. In addition data about the number of people present and their impact on the air quality of the city, and then compare the two values obtained to see the relationship they have with the environmental air quality, and with each other. For the negative impacts, especially surface water runoff, we use an online tool by the name of L-THIA [3].. These tools, along with online journals, phone interviews with City employees in the Department of Sustainability, using techniques and calculations results for GHG emissions and the carbon footprint, and finally consulting online publications from governmental agencies such as the EPA and MDOT for the quantitative data needed for the analysis.

3 Results

3.1 Positive Impacts of the Baltimore Grand Prix

When we think of the Grand Prix, the first things we come up with ease are the negative effects of such an event. There is no denying that the burning of fuel and the speedy racing through the streets have their share of environmental detriment. But there are positive benefits in the midst of all the speed once the dust settles. For this particular case, the positives in the city of Baltimore may not be as many, or as well documented, but are quite practical and profound. We have examined the all the effects that the grand prix of Baltimore can be connected to, from financial implications, to how automotive progress in the sport benefits the environment in the long run. It is important to note that at this point, the data gathered from our research is all that is currently available, since the event is the first of its kind in the city with minimally documented analysis. We begin with the examination of the environmental benefits to the reforestation of the city, air quality through green house gas emission reduction, waste recycling, and financial benefits of the event to the socio-economical environment.

3.1.2 Environmental rejuvenation

In 2011, there was a mass protest concerning the most significant contribution which is the environmental rehabilitation that occurs during the race. Many residents complained of the persistent trend of cutting down the trees along the sidewalks of the city streets. Opponents of this actions claimed that the city was already severely deficient of trees and vegetation, and that further action in the way of tree cutting cease immediately[4]. They were also unsatisfied by the city's counter measure to replace these trees with potted ones; an option considered so as to

allow dual benefits in future of having the trees absent during subsequent events, and have them there for the rest of the year. However, proponents argued that the trees being cut were in the way of the grand prix's grand stands, and without the cutting down of these trees, the event's audience would definitely not enjoy the race. Furthermore, a majority of the trees being cut were in need of replacement anyway, so the timing was nothing if not a coincidence [5]. The grand prix's Baltimore circuit, and hence this action of tree cutting, turned out to be a good thing for the city in the long run. According to the Baltimore Sun, the city of Baltimore slashed the environmental rehabilitation budget efforts, specifically tree planting efforts by over 34.09 %, from 4.4 million dollars to 2.9 million dollars [6]. When the grand prix organizers moved to Baltimore, the race first race's organizers, Baltimore Racing Development, had estimated that they would require to cut down at least 136 trees. But according to Lionel Fisher, the general manager of the Grand Prix of Baltimore, only 31 trees were felled, over 22.8 % less than projections indicated [5]. On the same note, the race organizers pledged to plant 135 total trees over the next 3 years This will increase the number of trees in the city by over 4 times the number of those cut during the operation, which is a benefit for the city in the long run.

Scientifically, it has been proven that tree planting is one of the key actions that promote carbon offsetting, and this is largely due to the carbon cycle. Trees take in carbon dioxide, metabolizes it for growth and development, and release oxygen to the environment. This carbon dioxide intake can be from any source, from factory pollution, vehicular emissions or human exhalation. The more trees per square foot you have, the less your carbon footprint is over time. Trees

will take between 15 to 150 years to develop, and over the course of this time, they utilize the carbon dioxide in the environment. One tree can absorb up to 48 pounds of carbon dioxide per year [7]. The city of Baltimore began planting 135 trees beginning the spring of 2012. This is equivalent to a fifth of one acre, if we assume that one-acre of land can be occupied by the United States Department of Energy’s estimate of 700 trees in an acre.

One acre = 700 trees. Baltimore trees planted = 135

$$\frac{700}{135} = 5.1, \text{ hence approximately } \frac{1}{5} \text{ of an acre.}$$

1 tree’s CO₂ consumption = 48 *lbs/day*;

135 trees will consume 6,480 *lbs/day*

According to the calculations above, and a corroboration of the same by the Arbor Environmental Alliance, one acre of trees can reduce the carbon footprint about 2,365,200 *lbs/day* between a singular grand

prix event in Baltimore. This translates to over 11.82 metric tons of carbon dioxide equivalent over 5 years, or the same amount of one car being driven 26,000 miles every single day. In Baltimore, this would translate to eliminating about 5,200 miles of driving, or 2.056 metric tons of carbon dioxide equivalent (TCO₂e). It is important to remember that the grand prix is only happening for only 4 days out of the year, but these environmental benefits from tree planting and replacement will continue well after the event is over. Furthermore, there was extensive planning in relation to tree

planting in the city of Baltimore. According to a Memorandum of Understanding entered by the city of Baltimore and the initial race organizers Baltimore Racing Development to rehabilitate parts of the city that were in much need of trees [8]. **Figure 1** shows the diagrams that are part of this initial understanding between the city and the racing developers. However, the racing developer ran into some financial difficulties and was unable to fulfill the obligations of the memorandum of understanding. But the city was adamant about the need for the obligations to be fulfilled as part of the commitment to the city of Baltimore. However, this default by the race organizers turned out to be a good thing for the city, as the originally proposed 135 trees has increased to 970 trees, with 150 of these trees going to spots that the developer had agreed to fill [8]. Most of these trees would be spread in the greater city area, and would add to the already expansive tree presence in the city parks but also in the undeveloped areas. The effect, though not immediate, is expected to be massive. Not only does the city center’s landscape get a much-needed reforestation, but also the carbon footprint in one of America’s most polluted city is a great help. This proactive approach can all, if not in part, be attributed to the Grand Prix’s participation in Baltimore. **Table 1** summarizes the benefits tree planting alone will have on the city over the next few years. The evidence of the agreement and the expected effort to reforest the city is also illustrated in the city’s Memorandum of Understanding document and circuit map and contrasting existing and proposed efforts to rehabilitate the city.

Table 1 Benefits of tree planting to the city post-grand prix

Trees	Trees	% Incr	Total	Current	Projected	% Decr
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cut during event	planted after event	ease over 5 year span	Cost	Tons of CO ₂ e before (in millions) 2010	d Tons of CO ₂ e after (In millions) 2017	ease of CO ₂ e
31	970	3,031.25	\$ 41,500	9,617	8,424	19.62

Table 1 summarizes the tree planting efforts and the expected GHG emissions reduction over the next 5 years. The two most interesting numbers are the reduction of the GHG by the city, and the cost that the city of Baltimore has incurred so far for such a significant improvement of air quality. This would not be possible unless the Grand Prix of Baltimore came into town and the agreement between the organizers. This is one of the benefits that this event has brought to the city of Baltimore, which is very positive for both the natural and built environment.

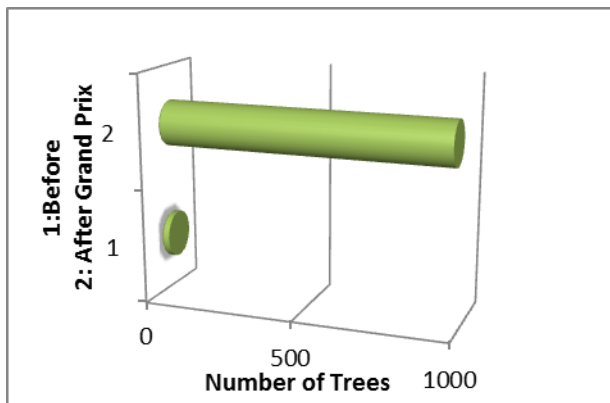


Figure 1 Graphical representation of the increase in the number of trees in the city of Baltimore over the next 5 years (2013-2017)



Figure 2 Tree planting and rehabilitation efforts underway at McKeldin Plaza

Figure 3 is a real time satellite image from the 2013 grand prix of Baltimore event. The course for the grand prix of Baltimore is approximately 2.04 miles long, covering most of the roads that surround the inner harbor and the city center. The course is not set as a straight, circular area, rather as a concentration of different regular streets all coming together to make a major course. By far, the logistics of a formula one race are by far some of the most complex and intricate. The race in Baltimore, as organized by AMS Racing was no different. On the days in question, each team has to have at least 2 working vehicles, and 3 engines. The scheduled laps for the circuit are 75, and around this 2 mile stretch of road closures and having 24 cars do it. There was a practice run and a qualification run, so in reality, the total amount of miles and time is tripled. The exact number of vehicles that are used to support the teams that participate

in the race, but each team of the 24 teams has at least 70 team members [10]. For the auxiliary transportation, in terms of the vehicle type city officials and event support



Figure 3 Grand Prix event Underway on 9/1/13

staff used, it is important to note that for data currently available is not conclusive, and can be extrapolated by assuming some of the knowledge we have learned from class. With that in mind, let us assume that each of them is given a standard passenger transport vehicle to get around the city, and add up all these numbers. We assumed that the projected 250 city officials and the race organizers also had their own vehicles [11].. There are city officials that have to ensure the closed roads remain safe, policemen and women who have to maintain law and order, businesses that have delivery trucks and employees coming in and out for deliveries, citywide public transit that brings the spectators to the race, spectators who decide to drive to the event, and finally, ambulances and emergency vehicles designated for the event. The official estimate for all these support vehicles for the 3-day event is estimated to be around 6,300 vehicles in addition to the 2,000 vehicles for the logistics operations of the event. This brings the total tally to approximately 8,300

vehicles for this weekend for all the 13 streets closed during the event [12]..

The race takes 3 days, so this traffic is recycled in the same area thrice, apart from the spectators who only come once on Sunday. There are also volunteers to be considered, and they too required transportation in and out of the city during this event. Therefore, the total average daily traffic observed in the city of Baltimore on the race portion of the streets is approximately 8,000 vehicles during this 3-day period. On a regular Baltimore day, the amount of traffic is much higher. We were able to obtain the State Highway Administration's Average Annual Daily Traffic data (AADT, 2012), which shows a yearly case-by-case, street-by-street average traffic volume. The table below shows the amount of traffic comparisons on an average day on the streets that were closed off during the grand prix race verses how it usually is on a regular day. We used the estimate of about 8,000 vehicles in the city on a daily basis on average, since all but the most essential vehicles were allowed in and out of the city streets that were closed during the racing event. These vehicles include trucks that deliver food to the restaurants around the harbor, buses that bring in the people in and out of the city during the event, personal vehicles for employees who work in the city's hotel area, emergency vehicles that are always on standby in the event's proceeding. These estimates come from the city of Baltimore's logs on the number of authorized businesses that are working in the event. According to the report, businesses around the harbor will be allowed to have extra staff for valets, cooks, delivery staff, recycling staff, and security for the 150,000 fans that will stream into the city throughout the event. It should also be noted that during the weekend event, the vehicles that are estimated in the documentation are only

allowed to use by roads around the city’s track. The track is closed to all other traffic apart from that of the traffic of the teams participating in the race. **Figure 4** shows the city report of the traffic daily averages in the city, and the **Table 2** below compares it with the grand prix weekend traffic. Also, the **Figure 5** illustrates these changes visually for the amount of traffic and the percentage decrease during that period.

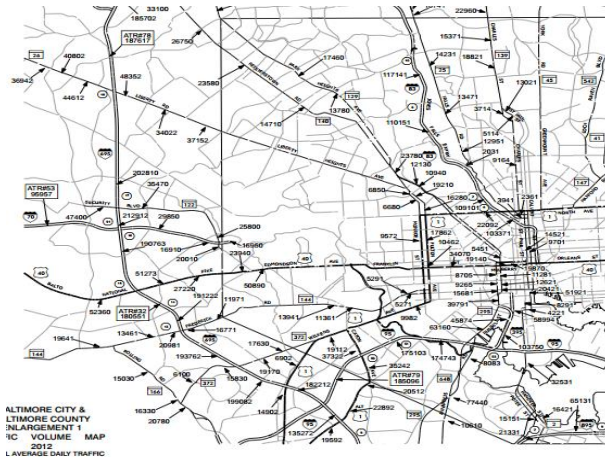


Figure 4 Baltimore city average daily traffic report

Table 2 Comparison of Average daily traffic

Street Name	Average Daily Traffic	Labor Day Traffic	% Decrease
I-395	45,874	8,000	17.43
Pratt Street	15,236	8,023	52.50
Eutaw Street	58,569	8,000	13.69
Sharp Street	25,753	8,000	31.06
Camden Street	15,987	8,000	50.04
Howard Street	53,563	8,520	15.91
Calvert Street	63,125	8,520	13.49
Light	55,258	8,000	14.47

Street			
Russell Street	63,160	8,000	12.66
Charles Street	14,521	8,000	55.09
Paca Street	18,869	8,000	42.39
Green Street	36,123	8,000	22.14
Average values	38,836	8,020	20.65

The table below gives a graphical representation of the traffic decrease per street in use during the event.

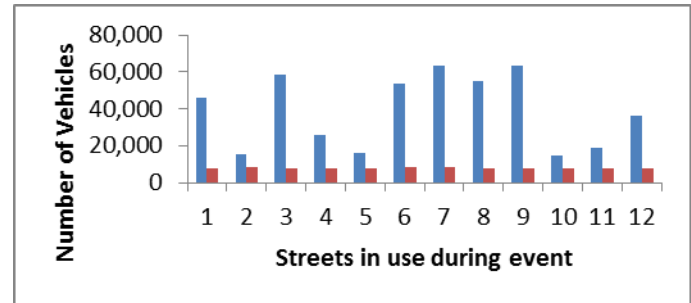


Figure 5 Comparison of Regular traffic with Labor day traffic

As can be seen in figure 5 the amount of traffic in the city of Baltimore significantly reduced. The graph shows significantly higher numbers for the daily traffic that for the three day event, which would make sense since most traffic in the city was diverted. All of this information is necessary to calculate the effect the impact the reduced traffic flow had on the environment. From the SHA figures and estimates, the closed streets had an average daily traffic flow of about 38,800 vehicles, or about 460,000 cars total in this area alone for all the 13 streets closed for the event [13]. This translates to a average value for over 1.4 million vehicles per weekend in the city of Baltimore.

For the vehicles that Baltimore residents use for their daily commute, they range from coupes to sport utility vehicles. In order to calculate the vehicular carbon footprint, we would have to know their specific gas mileage by year, make and model. But since this data concerning exactly what each driver in the city is driving and the corresponding gas mileage is unavailable, we normalized our data to about an average of 20 miles per gallon for all these vehicles. The estimated miles driven in the city of Baltimore is about 5,300 miles per day [14].. The 3 day total would be approximately 22,000 miles. However, we do have data concerning the mileage logged by each age group that drives within the city. **Table 3** shows the Federal Highway Administration’s estimate of these figures.

Table 3 Average Annual Miles per Driver by Age Group

Average Annual Miles per Driver by Age Group

Age	Male	Female	Total
16-19	8,206	6,873	7,624
20-24	17,976	12,004	15,990
25-54	18,850	11,464	15,291
55-64	15,859	7,780	11,972
65+	10,304	4,785	7,646
Average	16,550	10,142	13,476

From the data above, we estimated how much each driver travels per day. This is done by adding the estimated averages and then dividing them by the number of days in the year. The value we got is approximately 70 miles a day for the city of Baltimore. This figure was used in conjunction with the expected traffic over the Labor Day weekend to get the demand for fuel in this one weekend along the closed route. For the grand prix, the number of miles logged by the racecars was 11,016 miles in 3 days. We added an additional 2,000 miles estimated from the auxiliary services vehicles that are within the grand prix circuit to get about

13,016 miles. We used this information to calculate the total carbon footprint left behind by the two categories of cars.

Typical day in the city (closed section)

Average miles driven per driver = 70 miles

Average number of drivers in the city per day = 460,000

Average miles per gallon = 20 mpg

$$\frac{460,000 \text{ drivers} \times 20 \frac{\text{miles}}{\text{gallon}}}{70 \text{ miles}} = 131,428.6 \frac{\text{drivers}}{\text{gallon}}$$

Labor day weekend

Average miles driven = 13,016 miles

Average number of drivers in the city = 8,000

Average vehicular mileage (Race cars + Auxiliary vehicles) = 8.9 mpg

$$\frac{8,000 \text{ drivers} \times 8.9 \frac{\text{miles}}{\text{gallon}}}{13,016 \text{ miles}} = 17.8 \frac{\text{drivers}}{\text{gallon}}$$

The demand for fuel is seen to dramatically reduce over the span of the three days. Even as bad as the average mpg for the grand prix race cars is, only an estimated average of about 18 drivers need fuel to go through this section. This is a significant drop from over 113,000 over a typical weekend. This is significant since burning gasoline releases green house gases into the city’s atmosphere. We calculated how much GHG and TCO_{2e} is generated from both phases momentarily. The information we have for the Formula 1 cars and the regular vehicles, we calculated the carbon footprint of these vehicles. To do this, we had to get the carbon footprint of the vehicles. To do this, we reviewed how to calculate the carbon

footprint of vehicles. The set of equations below show how we calculated the carbon footprint [15].

$$CO_2 = (\text{Distance Traveled} + \text{Fuel Usage}) \times \text{Emission Factor}$$

$$CH_4 = (((\text{Distance Traveled} + \text{Fuel Usage}) \times CH_4 \text{ Emission Factor}) \times GWP_{CH_4}$$

conversion)

$$N_2O = (((\text{Distance Traveled} + \text{Fuel Usage}) \times N_2O \text{ Emission Factor}) \times GWP_{N_2O}$$

conversion)

For car emissions, they are calculated by dividing the miles driven by the fuel efficiency of the vehicle. This number is then multiplied by the CO₂ emissions coefficient, 19.36 lbs CO₂/gallon of gasoline, and then divided by 2204.6 lbs/metric ton to obtain the tons of CO₂ emitted from car travel [16].

$$\left(\frac{\text{Miles Driven}}{\text{Fuel Efficiency}} \times 19.36 \left(\frac{\text{lbs CO}_2}{\text{gallon}} \right) \right) \div 2204.6 = CO_2 \text{ Emissions (tonnes)}$$

To calculate the carbon footprint of the, the online calculation tool was used [17]. Using the data that we gathered from our research, we substituted the numbers and found out how much daily carbon emissions the event was generating. This number was compared to the monthly data for average traffic, and the results are as follows:

Mileage: miles
 Choose vehicle:

 Or enter efficiency: g/km (+15%)

Total Car Footprint = 10.93 metric tons of CO₂e

Regular weekend

Mileage: miles
 Choose vehicle:

 Or enter efficiency: g/km (+15%)

Total Car Footprint = 3.27 metric tons of CO₂e

Labor Day weekend

Based on the daily average air quality data from the Baltimore office of environmental sustainability the air quality improved or declined during this four-day event, compared to other weekends in the year. To ensure fairness, 12 random weekends from different months were compared to the Labor Day weekend. To get the data, the boxes in **figure 4** have the day, date, year and the Air Quality Index (AQI) for the city of Baltimore, with records spanning over the last 33 years [2]. The records have the major greenhouse gas emissions data concerning the nitrogen emissions, carbon emissions, ozone emissions, and sulfur. These are mainly from various sources around the city, including the people, transportation, construction, etc. For this study, we were interested in finding out the total air quality. This enabled us to determine how a 3 day

absence of major traffic and people in the city during the grand prix. Additionally, we only needed the last 3 years. **Table 4** shows an example of the AQI datasheet for 2013, **Figure 5** is a graph of random examples over the year, and a summary table 4 that has the results of our findings.

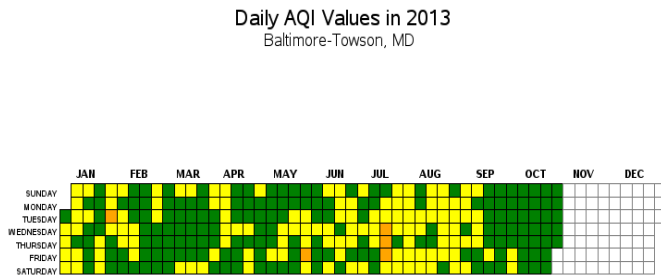


Figure 4 Daily Air Quality Index in 2013

Table 4 Air Quality Index

Month	Regular weekend	Grand prix weekend
March	41.33	22.00
April	38.00	22.00
May	38.33	22.00
June	38.67	22.00
July	31.33	22.00
August	37.33	22.00
September	35.69	22.00

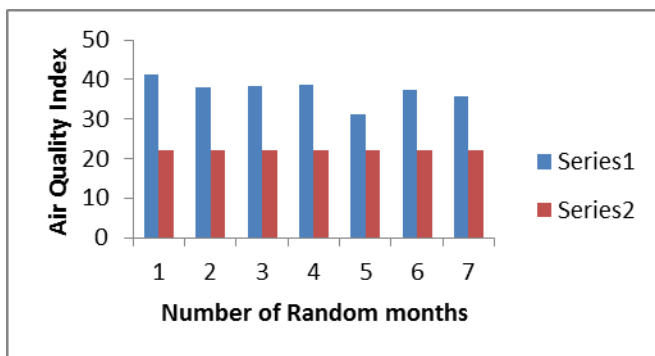


Figure 5 Comparison of Daily Air Quality

The results shown above are calculated as follows

- Determine the days of the week that you would like to get the data of. In this case, we are interested in the Labor Day weekend air quality data.
- The data is enclosed in each of the individual boxes for the year. Each box represents a day and a date. Specifically, we wanted the data on the Labor Day weekends for the city of Baltimore over the last 3 years. We got this data directly for each of the days of the weekend by simply selecting the corresponding boxes.
- Random selection of any other weekends in the year within this 3-year span is key. Having a random selection ensures that we get fair and unpredictable comparisons against the weekend of interest.
- Get the average of all the three Labor Day weekends and use this value to compare against as many other random weekends as possible. In our case, we used 7 random months within the 3-year span that the grand prix has been held in the city.
- Draw scientific conclusion that either qualify or disqualify the hypothesis that the air quality of the city of Baltimore improved during the Grand Prix of Baltimore.

As the table 4 shows, the air quality in the city’s inner harbor significantly improved, where the level of greenhouse emissions was drastically reduced during this one weekend, as compared to every other random month chosen for comparison. The average air quality index of 7 randomly picked and distributed months in the city of Baltimore is 37.24. During the grand prix of Baltimore weekend, the Air Quality Index values are approximately 22. This is a reduction of over 40%. And it cannot be a coincidence that the AQI values reduce when traffic and

population in the city is reduced. This, in addition to all the other factors, prove that the grand prix of Baltimore helped the city of Baltimore achieve better air quality and reduced greenhouse emissions.

3.1.3 Recycling

Recycling is the development of products from the used materials like glass, paper, and plastic. The purpose of recycling is to increase the life of a product that has been pre-owned and possibly worn. Recycling practices have the potential to save \$20million dollars per year [18]. Recycling is also helpful to the environment. For example, recycling products like paper can reduce the amount of trees that need to be cut down and reduce the pollution generated when producing paper from scratch[19]. The use of recycled products also decreases the energy needed for reproduction, therefore decreasing the carbon footprint. The Maryland Recycling Act requires that, depending on population, Baltimore City and Counties recycle between fifteen and twenty percent of its solid waste. The goal is to reach twenty to thirty-five percent by the end of 2015. Baltimore City Department of Public Works is in control of the city's recycling efforts. In 2011, Baltimore City recycled 26,000 tons of material, which averages to about 71 tons per day. When compared to 147,000 tons total of trash collected, it is about 17.68 percent [20].

The Circuit of the Americas 2012 Formula 1 United States Grand Prix made recycling efforts in order to improve how the environment was impacted by the event. The event took place in November 2012 in Texas and was very successful in their efforts. Support organizations such as the processing company Texas Disposal Systems, Sodexo (Circuit catering company), Ecology Solutions, and other volunteers collaborated to help with the

waste diversion. There was one section of the event that was able to divert 64 percent of the waste in that area. In the end were able to divert a total of 19.8 percent of their total generated waste from the landfill. About 14.6 percent was recycled, 2.4 percent were composited, and 2.8 percent turned out to be surplus food that was later sent to Capital Area Food Bank. If Baltimore were to implement the strategies used at this particular Grand Prix, in relation to the voluntary collaboration of local organizations, then it would be possible for the negative environmental impact of the event to be minimized[19].

The Baltimore Grand Prix has made several efforts to contribute to GREEN initiatives during the event. 1200 recycle bins were placed along the track to urge anyone in attendance to recycle. Green Street Academy students and Constellation Energy's Eco-Team worked the event to assist with recycling efforts. The volunteers oversaw heavily congested areas and encouraged the attendees to separate recyclables from actual trash. Statistical data is not available for the amount of waste collected and diverted. If 25-gallon recycle bins were used at the event, then there is a potential for 30,000 gallons of trash to be recycled of all of the bins are filled up. That is 944.74 tons of recyclable material. Even if each bin is only filled up halfway, that is still potentially 472.37 tons over the weekend[21].

3.1.4 Economic Impact

One of the major impacts that the Baltimore Grand Prix has had on the city is in relation to finances. The event has brought in large amounts of revenue into the city while allowing it to be showcased to outsiders that wouldn't have seen it otherwise. Money is donated to different causes throughout the city and consumers spend hundreds over the

weekend event. Consumer costs may include tolls, parking, food, gas, hotels, and most importantly, tickets. For the past three years, businesses, such as restaurants and souvenir shops, within walking distance of the Grand Prix have thrived during Labor Day weekend. That does not include any expenses that may accumulate once you get into the event.

According to a study done by Forward Analytics, about the 2012 Baltimore Grand Prix, more than 131, 000 spectators attended the event and the total spending by them was an estimated \$22,230,000. **Table 6** below shows an estimation of the breakdown of spectator spending[20].

Table 6 Spectator Spending in 2012

Spectator Spending in 2012

Expense	Cost (USD)
Food and Drinks in Restaurants	4,420,000
Retail	3,120,000
Hotel Accommodations	7,230,000
Tourists Attractions	1,600,000
Nightlife	2,890,000
Transportation and Parking	2,970,000
Direct Impact of Spectator Spending	22,230,000

Table 6 does not state the cost of tickets into the event. An article in the Baltimore Business Journal gives a listing of the different ticket pricing based on seating the number of days one plans to attend the event. General admission tickets for the 2012 Grand Prix of Baltimore ranged from \$15 to \$85 for a three-day pass. With 131, 000 spectators, revenue from ticketing alone could be anywhere from \$1,965,000 to \$11,135,000 [21]. That is if all of the spectators purchase general admission tickets. For those that prefer reserved seating in the grandstands, the ticket cost between \$145 and \$185[22].

The expenses of vendors from out of town

also contributed to the generated revenue for the city of Baltimore during the Grand Prix. Their costs of travel were estimated to be \$125, 200 in 2012 and about \$47,900 of that amount was from hotel stays. An article written in CBS Baltimore has an estimation of about \$1.3 million in taxes going to the city and state as a result of the event. The total revenue generated by the event to be contributed to the city of Baltimore had an overall positive impact on the city's environment. Race On donated \$50,000 to communities nearby the event that were affected by the Grand Prix of Baltimore festivities. Those neighboring communities include Federal Hill Community Association, Harbor walk Townhouse Association, Inc., Kennedy Krieger Institute, Ulman Cancer Fund, Living Classroom, etc. Also, in 2012, there was a Pre-Grand Prix event that was developed to raise money for the Ulman Cancer Fund, a non-profit organization in Baltimore. The event was called the "Yellow Party," and took place the night before the Grand Prix. In 2012, the event raised \$30,000 for the cause and it is expected to increase in 2013. The statistics for 2013 however are not available yet. According to Marty Conaway's article "What is best way to measure Grand Prix's economic impact?" a spokesperson from the Maryland department of business and economic development said that a \$420,000 grant was presented to Baltimore. The purpose of the grant was to cover expenses for marketing and bringing in influential people from around the country to Baltimore. This will allow for top planners and leader to see Baltimore at its best. This could lead to more exposure for what the city of Baltimore has to offer[22].

3.2 Negative Impacts

The Baltimore Grand Prix has many negative consequences in relation to the environment. The issues that surface are

noise pollution, exhaust emissions, spectator littering, traffic detours/road closures, and fluid runoff.

3.2.1 Noise Pollution

Harris, Miller, Miller, and Hanson Incorporated conducted a noise study on the Baltimore Grand Prix in 2010-2011. The approach requests full disclosure. Reference measurements were made on cars in similar Grand Prix races in Long Beach, California and Denver, Colorado. Current ambient noise measurements were taken in the area under study. A noise study that showed conclusive findings and full modeling was completed. Existing noise measurements were taken in the closest residential areas. Two locations were the communities enclosed by Russell Street, Paca Street, Washington Boulevard, and 395. The levels were at 60 and 70 dBA. Old Otterbein Methodist church, a historic site, was another location where existing levels were taken. The church is on West Conway Street. Its existing sound level is 67 dBA. The levels during racing most near the track itself exceeded 100 dBA. About 700 feet away from the track, noise levels were between 90 and 100 dBA. At a distance of at least 1000 feet from the track, the noise level was 80 -90 dBA. However, the racecars are exempt from the city rules that cover noise. In commercial areas such as downtown Baltimore, 61 dBA is the limit along property lines. When a permit is granted, the operators of the event can raise the standard allowable levels by another 25 decibels. This would bring the limit to 86 dBA. The Health Department gave the Grand Prix a “temporary exemption from the maximum permissible sound levels” for all activities. The City Health Department also gave a press release that fans should wear earplugs during the racing action[23].

3.2.2 Businesses Affected

Another negative consequence of the Baltimore Grand Prix is the misperception about traffic shutdown. This has had an effect on many businesses directly outside the race area. The Little Italy and Fells Point area had drastic changes in their Labor Day weekend patronage. The Baltimore Grand Prix brings about 100,000 people to the Inner Harbor Area; however, those patrons usually stay very close to the race area when dining or shopping. Also, there is a misconception that Baltimore City is entirely shut down due to the race; therefore, creating even less business for surrounding areas. The Labor Day weekend is usually a busy day when families go out for the last summer time fun experience. This has been on the downfall since the Grand Prix has come to Baltimore.

- SuCasa Furniture Store in Fells Point – reported a 70 percent decrease in sales during the Grand Prix weekend in comparison to other weekends
- Zelda Zen Boutique in Fells Point – reported a 90 percent decrease in sales during the Grand Prix weekend in comparison to other weekends

Most news reports and signage on roadways are misplaced in that traffic in surrounding areas of downtown is easily navigated with not much congestion. It is not clear to most people who hear about the busy downtown area that Fells Point, Federal Hill, Little Italy, Canton and Harbor East are outside of the race area and are not affected[24].

3.2.3 CO₂ Emissions during the Baltimore Grand Prix

Carbon Dioxide is a chemical compound that is naturally occurring in our world. It is made up of a single carbon atom that is covalently double bonded to two oxygen atoms. Its chemical formula is CO₂. This gas

is the result of hydrocarbon/coal combustion, sugar fermentation, and through respiration of all living organisms. Environmental impacts of carbon dioxide are important to recognize and study. Carbon dioxide is a greenhouse gas; meaning it helps in collecting the heat radiation from the surface of the earth that would without it, leave the atmosphere. However, large increases in atmospheric carbon dioxide add to the increased rate of global warming. This, in turn, results in human-induced climate change.

- Baltimore Grand Prix attendance – 130,000 people[25]

A normal intake of breath is normal atmospheric composition, as such contains 0.0360% CO₂ or 0.18ml of CO₂ intake. However we breathe out about 5% CO₂ or 25ml with an average of 13,000 breaths a day. That's 325,000ml (325L) of CO₂ Which means by the end of the day, a person on average will exhale 1kg of CO₂. Grand Prix spectators averaged around 130,000 people. Therefore, during the race weekend, there was about 130,000 kg of CO₂ exhaled into the atmosphere.

Comparisons:

Now add 6 billion living people so we can say humans exhale 6 billion kg of CO₂ a day.

Compare that to the fact that as a rough estimate, the burning of one liter of gasoline produces about 2.4 pounds (1.08kg) of CO₂. A really good north American car will get 40mpg which is still only 18km to the liter, which means for every 18 km that you drive, you will release 2.4 lbs. (1.08 kg) of CO₂ or roughly what you breathe in a day[16].

- Grand Prix vehicles – 33 vehicles

Specification of Engine:

The IndyCar Series regulations call for a normally aspirated, fuel-injected, aluminum alloy cylinder block V8 engine. The displacement is 3.5 liters (213.6 cubic inches). Although the series is open to any manufacturer who is willing to produce such a power plant, Honda is currently the sole engine manufacturer. Twenty-one cars used E-10 fuel while 11 used E-85 fuel and one used Isobutanol. Exhaust and evaporative emissions are released from E-85 vehicles. The type of emissions from E-85 vehicles will be somewhat similar to that of gasoline vehicles; however, the amount of emissions will be less. The plants that are used in the ethanol production process take CO₂ out of the air. This cancels out the carbon dioxide emitted by the racecars resulting in a carbon dioxide net gains of zero. The negative impact of E-85 usage in vehicles is in agriculture. Production of ethanol from corn pushes up the world food prices for this commodity. In turn, corn becomes unaffordable or unavailable to many countries and people[26].

3.2.4 Runoff

Motor vehicles pollute through the runoff of oil, chemicals, brake dust and automotive fluids. The downtown Baltimore area produces runoff that flows to the storm drain and sewer systems as well as directly into the Inner Harbor. It's main point of exit will be into the Chesapeake Bay. An L-THIA Basic Model was used to calculate the normal runoff produced for the downtown vicinity. L-THIA generated the estimated runoff volumes and depths, and expected nonpoint source pollution loadings to the bay. An area of .402 square miles was used with a Soil type of D. Group D soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This type has the highest

runoff potential, as should a commercial area [27].

3.3 Proposed Solutions

Though the negative impacts of the Baltimore Grand Prix have a noticeable effect on the environment, there are many steps that can be taken as preventative measures. For example, if improvements are made to the sanitation methods used during the event, the aftermath effects may not be as extreme. Issues like runoff and possible animal hazards will have decreased because there will not be as much garbage left lying around after the event. Another recommendation is to recycle the water that is used to wash the cars of the event. While recycling methods are being made, there is always a room to make them better. The event could adopt "GREEN" sponsors to help raise money for the cause and to assist with increasing consumer participation in Eco-Friendly initiatives. There is no way to decrease the noise level at the actual event however the impact that it has on spectators and those out side of the event can be decreased. Most people aren't aware of the noise levels limits in which damage will begin to occur, so by educating fans about acceptable noise levels and passing out free ear plugs there is a chance that damage can be prevented. Also, to stop how noise pollution is affecting surrounding areas, a temporary noise barrier wall could be created during the weekend of the event.

4 Conclusion

There is no denying that the Grand Prix of Baltimore has tremendous impacts on both the natural and built environments in the city. We have seen the negative impacts of potential fatalities from such a high speed race on public streets, the hazard to the inner harbor and the Chesapeake bay from trash

and run off from the event, the elevated levels of noise pollution, and the disrupted way of life for millions of Baltimore residents who live, work and recreate in the city. However, the positive benefits outweigh the negative impacts. The amount of revenue raised in a weekend is in the order of millions, where both local restaurants and businesses benefit from the city's exemptions during this period. Race fans get another pass time to enjoy during the labor day weekend, and the social environment in the city comes alive. This in turn builds a steady customer base for the businesses in the vicinity. As seen in the numbers above for revenue generation, the event creates both temporary and permanent employment opportunities. Perhaps the most standout benefit is the air quality improvement from the additional hundreds of trees being planted, whose impact will last well into the next few decades, and the improved AQI values from reduced traffic and congestion during the 3 day event. These positives are more beneficial to the city than all the negative impacts, and they can certainly improve over time as the event takes roots in the city. We would recommend that the Grand Prix be held in the city in the future, should the opportunity arise in 2016. The city of Baltimore and the environment surely stands to benefit from the event as grows.

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