

# The Impact of George Mason University's Turf Crew on the Environment

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Engineering

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### **Abstract**

The George Mason University Turf Crew is an often overlooked but essential element to the university's athletic department. They are responsible for the preparation and maintenance of all the athletic facilities on the Fairfax, Virginia campus of George Mason University. Although the Turf Crew is often overlooked, their practices are having a direct impact on the environmental quality of the region. The Turf Crew is negatively affecting the land, air, and water of the near-by region, through the methods they use. The Turf Crew is responsible for providing high quality athletic fields, yet the unfortunate trade-off is the impact that some of their practices are having on the environment. This article will provide a critical analysis of the environmentally destructive materials and practices utilized by the turf crew. Such materials as herbicides, insecticides, pesticides, and fertilizers will be discussed along with their environmental impact. The everyday practices and equipment used will also be analyzed to determine the resulting environmental impacts. Although the Turf Crew is taking steps to make their practices more environmentally friendly, they must continue to explore options that will maintain the facilities without compromising the surrounding environment.

The George Mason University (GMU) Turf Crew is an integral component of the athletic department and the university. The Turf Crew is responsible for preparing and maintaining the athletic facilities on the Fairfax, Virginia campus of GMU. The facilities are expected to be maintained at an impeccable level, a level suitable for athletics at a division one university. In order to provide first class facilities, the Turf Crew must do whatever is necessary to meet the many expectations placed upon them by the university and the administration. Often the means used to meet these expectations result in an adverse effect on the surrounding environment. The impact that the Turf Crew's practices have on the air, land, and water will be examined in this paper, along with the positive environmental steps being taken to improve the surrounding environmental conditions. The Turf Crew must become aware of the impact that they are having on the environment and continue to make strides to become more environmentally friendly.

Many of the practices performed by the Turf Crew that negatively impact the environment are a result of the work done to maintain the playing fields. The Turf Crew is responsible for eight playing fields constructed of grass which require a great amount of attention to maintain the pristine appearance that is required by the athletic department. One substance used to establish the necessary integrity and appearance of the fields is nitrogen. Nitrogen is used by the Turf Crew as a fertilizer at a rate of 4lbs/1000 ft<sup>2</sup> per year. In an interview with the director of turf management at GMU, Joshua McPherson explains that the nitrogen used is a slow release fertilizer which requires a lesser amount being placed on the fields. Slow release fertilizers have larger molecules that require microbial action for breakdown which results in the fertilizer being released over a longer

period of time (Slow Release, 2004). The addition of nitrogen is detrimental to the environment due to the possibility of it running off into nearby waterways. Extra amounts of nitrogen can cause eutrophication in slower moving waterways, like the ones found adjacent to the GMU athletic facility. Eutrophication produces a bloom in blue-green algae, which results in lesser amount of light penetration (Eutrophication, 2007). In *Nitrogen in Agriculture*, Maria Pau Vall and Claude Vidal (1999) report that eutrophication also results in a decrease in the oxygen content of the water, loss of benthic vertebrates, and the production of toxins that can be harmful to fish, cattle, and humans. The addition of nitrogen to the environment can also be dangerous if it percolates into the ground water. Excessive nitrogen is considered a health risk and requires added disinfection methods if the ground water is used as a source of drinking water. The surrounding soil is also impacted by the addition of nitrogen. If the additional nitrogen depletes the oxygen in the soil, soils are also susceptible to eutrophication which affects the fertility of the soil (Pau Vall, 1999). The use of nitrogen is also having a direct impact on the air quality of the region. Nitrogen is lost to the air as nitrous oxide which is a greenhouse gas. Nitrogen also forms other nitrous oxides which have been directly connected to the production of smog and ground level ozone (Fields, 2004). Soil eutrophication also results in increased nitrous oxide being emitted into the atmosphere (Pau Vall, 1999). The use of nitrogen as a fertilizer is significantly impacting the surrounding water, land, and air and must be closely managed to limit the negative effects it causes on the environment.

The Turf Crew uses pesticides, herbicides, and insecticides on the athletic fields in order to maintain their appearance. The Turf Crew uses a brand name of pesticide

called Primomax which is chemically trinexopac-ethyl. They apply Primomax at a rate of 33 ounces/acre per year (McPherson, 2007). Pesticides are used to prevent, destroy, or repel unwanted living organisms that damage plant species. The use of pesticides can help remove mice, unwanted plant species, insects, microorganisms, and fungi (Carlile, 2006). The Turf Crew also uses a brand name of herbicides called Monument which is chemically trifloxysulfuron-sodium. They apply Monument at a rate of .33 ounces/acre per year (McPherson, 2007). Herbicides are used to remove unwanted plant species, such as weeds, from the athletic fields (Carlile, 2006). The Turf Crew uses an insecticide called Criterion which is chemically imidacloprid. They apply Criterion as needed at a rate of 1.6 ounces/acre. Insecticides are applied to kill unwanted invertebrate pests, mainly insects. Insect damage mainly occurs due to their feeding habits but can also be a result of their ability to transmit a variety of diseases to plants (Carlile, 2006).

The use of pesticides, herbicides, and insecticides has been found to directly impact the surrounding environment. The main danger caused by pesticide use occurs when the chemicals are found in the nearby water sources. This usually happens as a result of run-off but can also occur through a process known as leaching. Leaching is the matrix flow of water through soil (Carlile, 2006). The type of soil can affect the speed and quantity of leaching that occurs. Sandy soils allow for a greater flow of water and the pesticides in the water, through the soil. The danger with pesticides in the soil is the possibility of them entering into the groundwater. Water treatment facilities in the United States are required to treat for possible pesticides in the water. However, pesticides in ground water can still cause major problems for people with personal wells. Pesticides have many different effects on humans depending on the type and composition of the

material. Organophosphates and carbamates affect humans' nervous systems while others can irritate skin or result in cancer (EPA, 2007). Pesticides are also extremely dangerous when they enter into surface waters. They have been found to directly reduce the amount of non-target aquatic invertebrate species in water ways. The results of these impacts can be seen throughout the food chain of the surrounding area. Toxicity tests have shown that residues from pesticides can be found in the lowest form of aquatic life, phytoplankton and zooplankton, all the way to the largest species of fish. Pesticides in waterways have been found to impact mammals, birds, and reptiles that dwell in the surrounding area (Carlile, 2007). The impact that pesticides have on the environment is not only limited to the surrounding water but also the soil and air. Pesticides can alter the chemical make-up of the soil they enter. This occurs when microorganisms in the soil cause the organic chemicals of the pesticides to metabolize (Carlile, 2007). Pesticides enter the atmosphere mainly through volatilization from droplets produced during spraying. Once in the atmosphere, many different chemical reactions occur and produce such by-products as nitrous oxides and ozone (Carlile, 2007). The impact that these gases have on the surrounding environment can also be seen through the equipment used by the Turf Crew.

The Turf Crew uses a variety of equipment to help with the maintenance and appearance of the playing fields. They also use equipment to apply fertilizers, pesticides, insecticides, and herbicides onto the fields. The Turf Crew uses two different types of mowers; the Toro 5200 and the Toro 3100 (McPherson, 2007). The Toro 5200 is a 3-cylinder, 28 horsepower, liquid-cooled diesel engine while the Toro 3100 is a 4-cylinder, 18 horsepower, air-cooled gasoline engine (Toro, 2007). They also use two Toro

Workmen 3200 and a Toro Multi-pro 1250 (McPherson, 2007). The Toro Workmen 3200 is a 4-cylinder, 31 horsepower, counterbalanced gasoline engine utility vehicle. The Toro Multi-pro 1250 is a 20 horsepower, battery operated sprayer (Toro, 2007).

The impacts that the Toro 5200 has on the environment mainly result from the use of diesel as a fuel source. The burning of diesel causes a great impact on the surrounding air quality. Diesel engines are more efficient than gasoline engines, 45% to 30% respectively, but result in greater levels of emissions. The main emissions of diesel engines are nitrogen oxides (NO<sub>x</sub>) and particulate matter (PM) (Weinhold, 2002). NO<sub>x</sub> are highly reactive gases that contain both nitrogen and oxygen. They are formed by fuel burning at extremely high temperatures, such as the combustion found in a diesel and gasoline engines (EPA, 2007). NO<sub>x</sub> emissions result from both the fuel burning and high temperature combustion. When the fuel is burned, NO<sub>x</sub> is formed when the nitrogen molecules bond with the fuel molecules. Nitrogen molecules in the air are converted to thermal NO<sub>x</sub> as a result of high temperature combustion (Schobert, 2002). The impact of NO<sub>x</sub> on the surrounding environment is the danger it can cause to the air, land, and water. NO<sub>x</sub> is one of the main ingredients for the formation of ground level ozone, nitrate particles, and acid aerosols. All of these directly decrease the air quality and can cause respiratory problems in humans and animals (EPA, 2007). NO<sub>x</sub> also contributes to the formation of nitrogen dioxide (NO<sub>2</sub>) which is a toxic gas if concentrated. NO<sub>2</sub> results in photochemical smog and can cause irritation to lungs and eyes. NO<sub>2</sub> can also lower resistance to respiratory infections (Schobert, 2002). NO<sub>x</sub> can impact the quality of the surrounding land because they aid in the formation of acid rain. Acid rain is the mixture of wet and dry deposition that contains higher amount of NO<sub>x</sub> and sulfur dioxides. It can

be extremely detrimental to forests, often resulting in the death of trees and sensitive soils. Acid rain also impacts the surrounding aquatic habitats. The acid rain runs off the land into nearby streams and results in a significant decrease in pH levels of the streams. The nearby soils release aluminum into the water which is very dangerous and toxic for aquatic species (EPA, 2007).

PM is a complex mixture of very small particles and liquid droplets (EPA, 2007). PM occurs in a large range of sizes and is mainly composed of inorganic chemical constituents but can also contain organic pollutants. PM can be found in nature as either primary or secondary in origin. Secondary PM is directly related with NO<sub>x</sub> as it is formed as part of the nitrogen cycle (Krupa, 1997). PM can be either “inhalable course particles” which have a diameter larger than 10 micrometers or “fine particles” which are 2.5 micrometers in diameter or smaller (EPA, 2007). The main concerns with PM are the impact it has on the surrounding air quality and the health effects it can have on humans. Fine particles have been found to be especially dangerous to humans and are linked to different cardiovascular and reproductive problems. They have also been linked to diabetes (Weinhold, 2002). PM smaller than 10 micrometers, can cause several respiratory problems such as irritation of the airways, decreases lung functions, and development of chronic bronchitis. PM also impacts the air quality by causing reduction in visibility. PM does not only impact the surrounding air quality but also impacts the surrounding land and water. PM can deplete nutrients in soils and can damage forests and farmland. PM can result in a change in the nutrient balance and acidity of waterways (EPA, 2007). It is clear that diesel engines can have a major impact on the quality of the surrounding environment.

The use of the Toro 3100 and Toro Workmen 3200 by the Turf Crew mainly impact the environment due to gasoline as a fuel source. Gasoline engines can have an equivalent or even greater impact than diesel engines on the surrounding environments. Similar to diesel engines, gasoline engines also depend on internal combustion of fuel but the heat for gasoline engines come from the ignition process (Weinhold, 2002). The emissions that result from the use of a gasoline engine include NO<sub>x</sub>, PM, Carbon Monoxide (CO), and Hydrocarbons (HC). CO is a colorless and odorless gas that occurs as a result of incomplete burning of hydrogen-based fuels (EPA, 2007). The release of CO can occur if unburned hydrocarbons make it through the engine without being burned or whenever gasoline evaporates. Gasoline can evaporate from fuel tanks or fuel lines, but mainly occurs during refueling (Schobert, 2002). The majority of CO is emitted when air-to-fuel ratios are low, such as start-up (EPA, 2007). The major impact that CO has on the environment is on air quality. CO is very dangerous when humans are exposed to it in both short and long durations. It chemically bonds with hemoglobin in the blood of humans and forms carboxyhemoglobin (Krupa, 1997). The carboxyhemoglobin reduces the blood's capacity to carry oxygen to organs and tissues. CO can also cause impaired exercise capacity, manual dexterity, learning disabilities, and respiratory problems (EPA, 2007). CO has also been found to cause increased severity of cardiovascular disease which can result in chest pain, a lower amount of blood being supplied to the heart, and even death (Krupa, 1997).

Hydrocarbon's impact on the surrounding environment mainly stems from the reaction that occurs when they are exposed to sunlight. HC and NO<sub>x</sub> are ingredients in the creation of ground level ozone when they are in the presence of sunlight. Ground

level ozone is detrimental to the air quality and surrounding environment (EPA, 2007). The presence of ozone significantly increases respiratory rates and pulmonary resistance of both humans and animals. Ground level ozone also decreases the amount of air during intake and alters respiratory mechanisms (Krupa, 1997). Humans can experience wheezing, coughing, and breathing problems when exposed to ozone. Ground level ozone also results in a greater susceptibility to respiratory illnesses such as bronchitis and pneumonia. The impact that ground level ozone has on the surrounding environment directly affects plants and ecosystems. Ground level ozone can interfere with sensitive plant species' ability to reproduce and store food. This can make plants more vulnerable to diseases, insects and other pollutants. Ground level ozone can also damage the foliage of plants and trees making them less visually appealing. The presence of ground level ozone can result in lower crop yields and can reduce forest growth. This can potentially impact the diversity of species within an ecosystem (EPA, 2007). The impact that the pollutants of gasoline burning have can directly be seen in the surrounding environment. CO, HC, NO<sub>x</sub>, and PM all severally affect ecosystems by altering the air quality, vegetation, and water bodies in the region.

Although many of the practices of the George Mason Turf Crew negatively impact the surrounding environment, they are becoming more aware and are starting to take the appropriate steps. One positive step is the use of slow release fertilizers. Slow release fertilizers have larger molecules that require microbial action for breakdown which result in the fertilizer being released over a longer period. The use of slow release fertilizers reduces the amount of fertilizer that is lost through run-off (Slow Release, 2004). The Turf Crew is also collaborating with the Virginia Polytechnic Institute and

State University to conduct research on water usage reduction. The maintenance of the athletic fields require a large amount of water and the Turf Crew is taking a proactive approach to attempt to reduce the amount of water they use. The Turf Crew is also being environmentally cautious by choosing to use manual labor over chemicals. They will often hand pick weeds on the athletic fields so herbicides do not have to be used. Finally, the Turf Crew is purchasing new Toro equipment that is going to be available in 2008. The new equipment will use bio-diesel which will result in a reduction in the amount of pollutants released as a result of the burning of diesel. The Turf Crew is currently attempting to locate a source of bio-diesel to use when their new equipment arrives (McPherson, 2007).

The George Mason Turf Crew is a vital aspect of the university's athletic department. They are required to maintain the athletic facilities at an impeccable level. As a result of this demand, several of their practices are negatively impacting the surrounding air, land, and water. The Turf Crew is faced with the task of adequately meeting the demand of the athletic department while limiting the amount of impact they have on the surrounding environment. They are currently taking several positive steps to limit the impact they have on the environment but must continue to evaluate their practices. The Turf Crew must not be satisfied with the steps they have taken and must continue to stay proactive in altering their practices to become more environmentally friendly.

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