IDENTIFICATION OF HIGH - RISK ZONES OF BIO-MEDICAL WASTE GENERATION OF TAMIL NADU 2018 – 2021

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ABSTRACT

Interaction of micro– (internal) and macro– (surrounding) environment of human beings determines the status of health of an individual or of community at–large. On daily basis, generation and disposal of biomedical wastes has become an emerging problem not only in India but the world over. With the growth of healthcare facilities, the amount of biomedical waste produced every day is growing. If biomedical waste management is done correctly, many of the problems can be avoided. Segregation, storage, processing, transportation, and disposal of biomedical waste are all common practices undertaken as part of health care waste management. It involves interdisciplinary relationships in organizational, planning, administrative, financial, engineering, legal, and human resource creation. Medical waste management necessitates dedication from healthcare providers at all levels.

Potential implications of biomedical wastes include transmission of diseases like Hepatitis B, C, E, dengue and HIV through improperly contained contaminated sharps; proliferation and mutation of pathogenic microbial population in the municipal waste through dumping of untreated biomedical waste; physical injury and health hazards. Certain other implications include degradation of the environment aesthetically by careless disposals, having negative effect on public health; increased risk of nosocomial infections; change of microbial ecology and spread of antibiotic resistance; increased density of vector population, resulting in spread of diseases in public. Sensitization and public awareness are important to protect environment and public health globally.

The risks and value of their "contribution" are feared in a system run by reckless and untrained personnel. Also trained medical professionals, such as hospital managers, private and governmental institutes, clinics, and universities, need to be taught about the rules for disposing of biomedical waste. The importance of biomedical waste, its interaction with the ecosystem, the environmental pollutants used in the health care industry, and the effect of callousness on public health are all topics that are still largely unknown. To achieve better results, we must raise the level of training and education in biomedical waste and environmentally sustainable health care as quickly as possible, while adhering to all applicable rules and regulations. This paper discusses about the collection, segregation, treatment and disposal and its various types of biomedical waste of Tamil Nadu from 2015 – 2020.

Keywords *– Bio-Medical Waste (BMW), Source of BMW, Effective BMW Management*

1.1 INTRODUCTION

Growing medical advances and new hospital facilities for improved healthcare have increased the amount of waste generated by health care facilities. Both wastes from any medical practice in healthcare facilities, testing centers, and laboratories are referred to as "Health Care Waste" or "Bio-Medical Waste" (Babu, Parande, Rajalakshmi, Suriyakala, & Volga, 2009; Manika & Arpita, 2015; SunilKumar, Manjunath, Badami, & Pradeep, 2012). Hospital waste poses a health risk to healthcare staff, the general public, and the local flora and fauna. Waste disposal concerns in hospitals and other healthcare facilities have become a growing source of concern.

The majority of countries around the world, especially developing countries, are facing a dire situation as a result of environmental pollution caused by pathological waste generated by growing populations and the resulting rapid growth in the number of health care centers (Manika &Arpita, 2015). Biomedical waste management has been a hot topic in India recently, particularly since the Union Ministry of Environment and Forests issued the Biomedical Waste (Management and Handling) Rules, 1998, under the provision of the Environment (Protection) Act, 1986. These regulations apply to anyone who creates, collects, receives, stores, transports, treats, disposes of, or handles biomedical waste in any way (Sunil Kumar et al., 2012).

Waste management that is both safe and reliable is not only a legal requirement but also a social obligation. Lack of care, enthusiasm, understanding, and cost are only a few of the issues that can arise when it comes to proper hospital waste management. There is a need for education about the dangers of inappropriate waste disposal. Given the low level of knowledge about biomedical waste management among various categories of workers in health care facilities, an effective communication strategy is essential (Kalpana, Sathya, Vinodhini, & Devirajeswari, 2016). One of India's major achievements has been to shift the attitudes of healthcare facility operators, encouraging them to integrate good waste management practices into their everyday operations and to hire private-sector waste management services (Praveen, Sangeeta, & Anand, 2012).

Biohazardous **biomedical waste**, improperly handled and discarded, can compromise the quality of life of every living thing in the environment. It can contaminate the water supply, poison wildlife, and threaten the health of people living in communities in proximity to the medical refuse. The effects can be insidious and sometimes take years to identify – or they can be immediate, as with improperly handled and discarded sharps that injure people through cuts or needlesticks.

We tend to think of the possibility of pathogenic infection as the biggest risk from improperly handled biomedical waste, and while that is a significant danger, there are other potentials for harm – some of them quite significant and long-term. Hence it is the right time to understand the daily generation of Bio Medical Waste for the proper planning and Management.

1.2 Definition of Biomedical Waste

As per Biomedical Waste (Management and Handling) Rules, 1998 of India, BMW is defined as "Any waste generated during the process of diagnosis and treatment or immunization of human beings or animals or in research activities contributing to the biological production or testing" (Govt. of India, 1998). One of the major achievements of India has been modification of the health operators' attitudes to accommodate in waste management concerning health care nicely in their operation routinely (Bekir Onursal, 2003).

1.3 Sources of Biomedical Waste

Based on the training Component of the Project "Environmentally Sound Management of Medical Wastes in India" in 2018, the main sources of healthcare waste generation (Shaida & Singla, 2019) are primary and secondary sources according to the quantities produced (Srishti, 2010). Primary sources include waste generated from hospitals, medical college, nursing center, dialysis centers, maternity homes, blood bank, research labs, immunization centers, etc and secondary sources includes waste from clinics, ambulances, funeral services, slaughterhouses, educational institutes (Shaida & Singla, 2019; Srishti, 2010).

1.4 Classification of Biomedical Waste

Medical waste is divided into eight categories by the World Health Organization (WHO), including General Waste, Pathological, Radioactive, Chemical, Infectious to potentially infectious waste, sharps, Pharmaceuticals, and Pressurized Containers (Manika & Arpita, 2015; Srishti, 2010).

Various terms for infectious wastes have been used in research papers, as well as legislation and guidelines, over the years. Infectious and non-infectious wastes; medical and biological wastes; hazardous and red bag wastes; contaminated; infectious medical wastes; and managed wastes in the medical profession are among them. Essentially, both of these terms refer to the same forms of waste, even though the terms used in regulations are generally more precise (Chakraborty et al., 2014; Singh et al., 2014).

1.5 Categories of Biomedical Waste

As per the Rules the wastes come under ten categories are to be stored in four separate color containers/ bags. The wastes have to be handled using methods such as deep burial, incineration, autoclaving, microwaving, mutilation, shredding, and chemical disinfection mentioned in Table 1.1.

Table 1. Categories of Biomedical Waste

Option	Treatment & Disposal	Waste Category
Cat. No. 1	Incineration / deep burial	Human Anatomical Waste (human tissues, organs, body parts)
Cat. No. 2	Incineration / deep burial	Animal Waste Animal tissues, organs, Body parts carcasses, bleeding parts, fluid, blood and experimental animals used inresearch, waste generated by veterinary hospitals/ colleges, discharge from hospitals, animal houses)
Cat. No. 3	Local autoclaving/waving/ incineration	Microbiology & Biotechnology waste (wastes from laboratory cultures, stocks or specimens of micro-organisms live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, wastes from production of biological, toxins, dishes and devices used for transfer of cultures)
Cat. No. 4	Disinfections (chemical treatmentautoclaving/micro waving and mutilation shredding	Waste Sharps (needles, syringes, scalpels blades, glass etc. that may cause puncture and cuts. This includes both used &unused sharps)
Cat. No. 5	Incineration /destruction & drugs disposal in secured landfills	Discarded Medicines and Cytotoxic drugs (wastes comprising of outdated, contaminated and discarded medicines)
Cat. No. 6	Incineration / autoclaving/microwaving	Soiled Waste (Items contaminated with blood and body fluids including cotton, dressings, soiled plaster casts, line beddings, other material contaminated with blood)
Cat. No. 7	Disinfections by chemical treatmentwaving& mutilation shredding	Solid Waste (waste generated from disposable items other than the waste sharps such as tubing, catheters, intravenoussets etc.)
Cat. No. 8	Disinfections by chemical treatmentand discharge into drain	Liquid Waste (waste generated from laboratory & washing, cleaning, house-keeping and disinfecting activities)
Cat. No. 9	Disposal in municipal landfill	Incineration Ash (ash from incineration of any bio-medicalwaste)
Cat.No. 10	Chemical treatment is charge into drain for liquid &secured landfill for solids	Chemical Waste (chemicals used in production of biological, chemicals, used in disinfect ion, as insecticides, etc)

1.6 AIM AND OBJECTIVES OF THE STUDY

The aim of the present study is to analyse the Bio-Medical Waste generation and management of Tamil Nadu from 2018 – 2021. With this aim, the following objectives of the study are outlined.

1. To find the district wise Bio-Medical Waste Generation of Tamil Nadu from 2018 – 2021.
2. Categorise the generation of Bio-Medical Waste into High, Moderate and Poor.

3. Identification of High-Risk Zones of Bio-Medical Waste Generation.

1.7 MATERIALS AND METHODS

The data and materials are collected from secondary sources information. The study is also based on a survey of existing literature, news stories, and reports of information obtained from public reports and official websites by the government and not government agencies. The information presented here comes from multiple sources published on the WHO, the Ministry of Health and Family Welfare websites (MoHFW).

1.8 BIO-MEDICAL WASTE OF GENERATION OF TAMIL NADU 2018 – 2021

With the emphasis on hygiene and sanitation during the COVID-19 pandemic, several hospitals have the sight of colour-coded bags with disposable masks, PPE kits, bed linen, and single-use medical tools such as syringes and glass vials, as the governments continue to improve standard operating procedures (SOPs) for safe treatment of COVID-19. The Central Pollution Control Board (CPCB) reported that more than 6000 tonnes of COVID-19 BMW were generated between March 2020 and May 2021 in Tamil Nadu (Table 1.2). Cities like Thanjavur and Tiruchi, which have hospitals catering to a larger intake of patients, have reported high use of use-and-throw materials.

Several central districts of Tamil Nadu have been witnessing an increase in Bio-Medical Waste (BMW) generation by hospitals. The volume of discarded masks and PPE kits has definitely increased during the pandemic. Before COVID-19, we used to collect around one and a half tonnes of BMW per day. “Before COVID, winter used to be a peak season for BMW generation, because of flu and fevers.

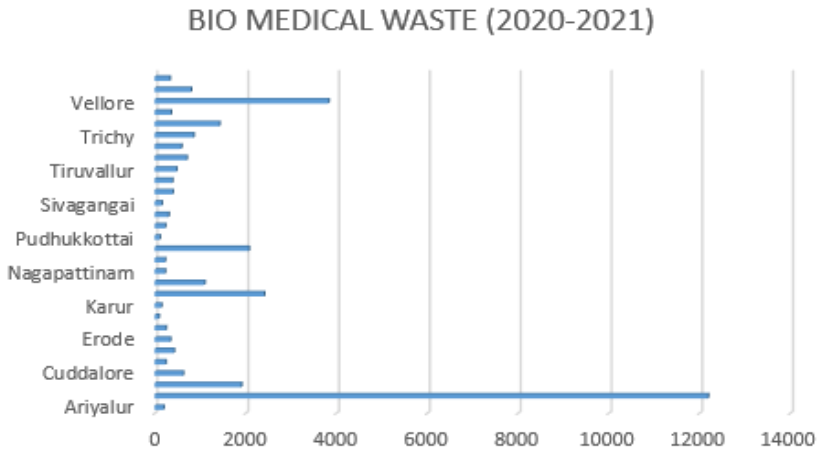

FIGURE 1.1

TABLE 1.2

GENERATION OF BIO-MEDICAL WASTE (2020 – 2021)

S. No	District Office	Quantity of Generation of Bio-Medical Wastes (kg / day)
Chennai Zone		
1	Ambattur	342.76
2	Chennai	9671.24
3	Maraimalainagar	2515
4	Sriperumbudur	1096
5	Gummidipoondi	37.5
6	Tiruvallur	537.5
Vellore Zone		
7	Vellore	3828
8	Vaniyambadi	476
9	Dharmapuri	237.27
10	Villupuram	795
11	Hosur	245
12	Tiruvannamalai	701
Salem Zone		
13	Erode	161.30
14	Namakkal	131.40
15	Perundurai	178.70
16	Salem	302.46
17	Karur	145.00
18	Kumarapalayam	93.60
Coimbatore Zone		
19	Coimbatore South	1550
20	Coimbatore North	1950
21	Tiruppur North	400
22	Tiruppur South	353
23	Ooty	120
Trichy Zone		
24	Ariyalur & Perambalur	194.2
25	Trichy	855
26	Pudhukottai	108.17
27	Thanjavur	393.86
28	Nagapattinam	224.17
29	Cuddalore	623
Madurai Zone		
30	Madurai	2406.92
31	Theni	385
32	Sivagangai	153.11
33	Ramanathapuram	230.16
34	Dindigul	421.24
Tirunelveli Zone		
35	Tirunelveli	1424
36	Thoothukudi	584.33
37	Nagercoil	1069.49
38	Virudhunagar	329.37
	Total	**35269.74**

Source – Tamil Nadu Pollution Control Board - Annual report 2020-2021

TABLE 1.3

DISTRICT WISE BIO MEDICAL WASTE CATEGORIZATION

S.NO	DISTRICT	2018	2021	RISK
1.	ARIYALUR	MODERATE	LOW	LOW
2.	CHENNAI	HIGH	HIGH	HIGH
3.	COIMBATORE	HIGH	HIGH	HIGH
4.	CUDDALORE	HIGH	MODERATE	MODERATE
5.	DHARMAPURI	LOW	LOW	LOW
6.	DINDIGUL	HIGH	MODERATE	MODERATE
7.	ERODE	HIGH	MODERATE	MODERATE
8.	KRISHNAGIRI	LOW	LOW	LOW
9.	KANYAKUMARI	HIGH	LOW	LOW
10.	KARUR	LOW	LOW	LOW
11.	MADURAI	HIGH	HIGH	HIGH
12.	KANCHIPURAM	HIGH	HIGH	HIGH
13.	NAGAPATTINAM	MODERATE	LOW	LOW
14.	NAMAKKAL	LOW	LOW	LOW
15.	NILGIRIS	LOW	HIGH	HIGH
16.	PUDUKKOTTAI	LOW	LOW	LOW
17.	RAMANADHAPURAM	LOW	LOW	LOW
18.	SALEM	MODERATE	MODERATE	MODERATE
19.	SIVAGANGAI	LOW	LOW	LOW
20.	THANJAVUR	MODERATE	MODERATE	MODERATE
21.	THENI	LOW	MODERATE	MODERATE
22.	TIRUVALLUR	HIGH	MODERATE	MODERATE
23.	TIRUVANNAMALAI	MODERATE	HIGH	HIGH
24.	THOOTHUKUDI	MODERATE	MODERATE	MODERATE
25.	TRICHY	MODERATE	HIGH	HIGH
26.	TIRUNELVELI	MODERATE	HIGH	HIGH
27.	TIRUPPUR	MODERATE	MODERATE	MODERATE
28.	VELLORE	HIGH	HIGH	HIGH
29.	VILLUPURAM	MODERATE	HIGH	HIGH
30.	VIRUDHUNAGAR	LOW	MODERATE	MODERATE

The Bio-Medical Waste generation of two different periods 2018- 2019 and 2020 – 2021is analysed (Table 1.3). From the 2018 - 2019 it is clearly understood that the districts Dindigul, Madurai, Vellore, Kanyakumari, Cuddalore, Erode, Kanchipuram, Coimbatore, Thiruvallur and Chennai comes under the High Generation of Bio-Medical Waste. The districts Thoothukudi, Tiruppur, Nagapattinam, Ariyalur, Villupuram, Thirunelveli, Thanjavur, Salem, Thiruvannamalai, Trichy comes under Moderate Generation of Bio-

Medical Waste, the districts Ramanathapuram, Virudhunagar, Nilgiris, Karur, Krishnagiri, Sivagangai, Namakkal, Pudukottai, Dharmapuri, Theni comes under Low Generation of Bio-Medical Waste. (Table 1.2). By using the criteria table, the result was identified as High, Moderate and Low Risk zones of Bio-Medical waste. The maximum Bio-Medical Waste generation of 2019 is high in Chennai district. The minimum Bio-Medical Waste generation of 2019 is low in Theni district. In the same manner, the maximum Bio-Medical Waste generation of 2021 is high in Chennai district. The minimum Bio-Medical Waste generation of 2021 is low in Krishnagiri district.

1.9 BIO-MEDICAL WASTE MANAGEMENT

Bio-medical waste management refers to the processes and systems in place for the proper handling and disposal of bio-medical waste. Biomedical waste is any waste generated during the diagnosis, treatment, or immunization of human beings or animals, or in research activities related to these processes. It can include infectious materials, sharps (such as needles and scalpels), laboratory waste, and other types of waste that pose a potential risk to public health and the environment.

Proper biomedical waste management involves the segregation, collection, transportation, and treatment of this waste in a way that minimizes the risk of exposure to infectious materials and prevents contamination of the environment. This can be achieved through the use of proper handling and storage techniques, as well as the use of technologies such as incineration, autoclaving, and microwave treatment to sterilize and dispose of the waste. The management of biomedical waste is regulated by laws and regulations at the local, national, and international levels.

The management of bio-medical waste in India is regulated by the Bio-Medical Waste Management Rules, which were formulated in 1998 and amended in 2016. These rules provide guidelines for the segregation, collection, transportation, and treatment of biomedical waste. According to the rules, all healthcare facilities, including hospitals, nursing homes, clinics, and laboratories, are required to properly segregate biomedical waste and store it in designated containers.

1.10 STRATEGIES FOR IMPROVING BIO-MEDICAL WASTE MANAGEMENT IN INDIA

First, it is important for healthcare facilities to implement proper bio-medical waste management practices and to educate their staff about the importance of these practices. This can include providing training on bio-medical waste segregation, as well as implementing systems for the safe collection and transportation of bio-medical waste. Second, there is a need to increase public awareness about the importance of proper biomedical waste disposal.

This can be achieved through campaigns and educational programs aimed at the general public and healthcare workers.

Finally, the use of available technologies for the treatment and disposal of biomedical waste can help to improve the management of this waste in India. Technologies such as incineration, autoclaving, and microwave treatment can effectively sterilize biomedical waste and make it safe for disposal.

1.11 PROCESS OF BIOMEDICAL WASTE DISPOSAL

In a nutshell, the management and disposal of biomedical waste start with the collection and segregation of waste products at the source itself. Afterward, the collected and segregated waste is transferred to waste treatment facilities, which engage in the final phases of waste disposal by incorporating techniques like disinfecting, autoclaving, etc. Following are the steps that should be taken for proper disposal and management of biomedical waste:

1.11.1 Collection and Segregation

It is mandatory to collect and segregate waste at the site of the generation itself to avoid any spillage or risks afterward. Furthermore, it also ensures effective waste disposal. The aim is to keep injurious and infected waste materials separate from the non-contagious waste. For easy segregation, colored biomedical waste containers such as pedal bins and non-chlorinated plastic bags are widely used. Color coding of biomedical waste containers is – yellow, red, blue and black.

Color coding & type of container for disposal of bio-medical waste

Color Coding	Type of Container -I Waste Category	Treatment options as per Schedule I

Yellow	Plastic bag Cat. 1, Cat. 2, and Cat. 3, Cat. 6.	Incineration/deep burial
Red	Disinfected container/plastic bag Cat. 3, Cat. 6, Cat. 7.	Autoclaving/Microwaving/ Chemical Treatment
Blue/White translucent	Plastic bag/puncture proof Cat. 4, Cat. 7. Container	Autoclaving/Microwaving/ Chemical Treatment and destruction/shredding
Black	Plastic bag Cat. 5 and Cat. 9 and Cat. 10. (solid)	Disposal in secured landfill

The yellow-colored bags are non-chlorinated and are made to carry human or animal tissues, organs, body parts, solid contaminated waste such as cotton, dressing, linens, and others. The red non-chlorinated plastic bags are meant to carry microbiology and biotechnology waste and other laboratory waste products.

They are also used to carry sharps such as needles, glass syringes, etc. that may cause cuts or punctures. The blue non-chlorinated plastic bags carry chemical waste and the black non-chlorinated plastic bags are created to carry waste such as paper, kitchen waste, food, and other non-infectious wastes. It is necessary to train the biomedical waste handlers to ensure proper handling of waste, and avoid injury and accidents. Also, the colored plastic bags should be kept in their respective biomedical bins.

1.11.2 Storage and Transportation

Biomedical waste bin trolleys are used to transport waste from the site of generation to the central storage area and further to the biomedical treatment facility. It is recommended that plastic bins should be tied, labeled and sent for disposal when they are 75% full. There should be less manual handling of these waste bags, in order to avoid injury and infection through needle pricks. It is also very important to avoid close contact with plastic bags or plastic bins during their storage and transportation.

1.11.3 Treatment

Primarily, there are two steps involved in treating biomedical waste:

***Pre-Treatment*:** To minimize harmful emissions, waste materials made from rubber, plastics, and metals are disinfected before incineration.

***Final Disposal*:** Final disposal is done through incineration, or secured landfilling, or even deep burial. Incineration is done through dry oxidation at high temperatures, thereby

vaporizing any moisture and volatile components. This also helps in reducing the volume and weight of the waste. Human, animal waste and dressing material may be easily submitted for incineration.

There are three types of incinerators – single chamber furnaces, double chamber pyrolytic incinerators, and rotary kilns. They are eco-friendly, cost-effective and easy to construct. Also, these incinerators are suitable for healthcare centers and hospitals in rural areas too.

1.12 EFFECTS OF BIO MEDICAL WASTE ON ENVIRONMENT

When a healthcare worker reports to work, one of the foremost things on his or her mind is being affected by biohazardous waste, also referred to as biomedical waste or infectious waste. This waste contains material that is infectious including blood-soaked materials, scalpel blades, needles and other waste that is contaminated with body fluids or medications such as chemo drugs. Medical waste pollution does not affect just humans, though. It also affects the environment.

1.13 CAUSES OF MEDICAL WASTE

Medical waste is caused by medical facilities not properly separating and disposing of the waste. In some cases, the facility may not be at fault, but the delivery service or the medical waste processing plant may be at fault. In this case, the medical facility is still fined. Medical facilities may avoid medical waste problems by properly separating and storing medical waste, and ensuring that the company they use for disposal abides by all state laws. Each person in the healthcare industry, regardless of his or her position, is responsible for ensuring that medical waste is properly stored and disposed of, including those treating medical waste.

Even in today's day and age, and with all of the knowledge of how medical waste affects people and the environment, some medical facilities and treatment companies still improperly dispose of medical waste, whether from poor training or purposeful improper disposal.

1.14 HAZARDS ASSOCIATED WITH HOSPITAL WASTE

The effects of medical waste on human health and on the environment are astronomical. It could cause severe illness or even death. If medical waste ends up close to wildlife refuges such as parks, lakes and other natural habitats, whole populations of wildlife could be wiped out if the medical waste is pharmaceuticals. Medications, especially those that are brightly colored, are attractive to birds and other animals.Groundwater is easily

contaminated with medical waste that hasn't been properly treated. Once it gets into the groundwater, it may be ingested by animals and humans. Landfills are made to keep all waste in a controlled area. Some may have liners to keep the waste from seeping into the environment. Throwing sharps away could puncture these liners, which then allows liquids from waste – household and improperly processed medical waste – to seep into the groundwater and soil.

Sometimes the tools and devices doctors use for diagnostic purposes are radioactive. If any disposable tool or device is improperly disposed of, radioactivity will enter the landfills and other areas. The radioactive particles are dangers to humans and animal. Radioactive disease is just one of the diseases caused by medical waste. Other disease humans may contract include AIDS, cholera, typhoid, Hepatitis B and SARS. Finally, some the pollutants from medical waste may become airborne if the waste is not incinerated at the proper temperature. If these pollutants are carrying airborne diseases, anyone who breathes the pollution could be affected.

1.15 CONCLUSION

According to the findings of this report, biomedical waste is one of the most hazardous wastes generated by humans. In India, dealing with biomedical waste has become a difficult task. Biomedical waste management has been identified as a source of concern by both government and non-government organizations. Any healthcare facility that produces biomedical waste must set up the necessary treatment facilities to ensure proper waste treatment and disposal, reducing the risk of biomedical hazards being exposed to workers, patients, physicians, and the general public. For proper management of biomedical wastes lack of concern and awareness as well as cost factors are the certain problems/limitations. Safe and efficient biomedical waste management is not only a legal requirement but also a social obligation. In the present-day world of one health the proper management of biomedical wastes is of significant importance. This will ensure maintenance of ecological balance; biodiversity as well as health of global community as a whole. By prioritizing biomedical waste management, we can protect public health and the environment and ensure a safer and healthier future for all.

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