Potential use of GIS in Hazardous Waste Transportation

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Presented by:

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Ryerson University, 2007

A project
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In partial fulfillment of the
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Potential use of GIS in

Hazardous Waste Transportation

Master of Engineering, 2007, Manal Youssef,

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Abstract

The objective of this project is to present a literature review of hazardous waste transportation and the impact on the environment by studying Canada's regulations and legislations and examining the potential use of GIS in reducing hazardous waste transportation. It is hard to find a specific definition for Hazardous Waste since the hazard could be generated form a wide variety of sources. Therefore, the hazardous wastes defined according to the Transportation Dangerous Goods Act as those wastes that due to their nature and quantity are potentially hazardous to the human health and the environment. Hazardous wastes usually contain explosive, volatile, toxic, radioactive and flammable materials, and that therefore, requires special techniques to handle the hazard to avoid creating environmental pollution or health hazards during packing, transportation, and disposals. The government of Canada and the environmental experts made tremendous efforts to reduce the potential hazardous resulted from handling, shipping, treatment and disposal for the hazardous waste and find out alternatives to control that hazard and avoid any environmental impact.

This paper also presented and discussed some studies that used to point out the important role of the GIS in minimizing the impact of potential hazard and reducing incidents regarding hazardous waste shipments through determination of the short and safety transportation routes.

under the legislative authority of the Transportation of Dangerous Goods

Act.

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transporter visual nazardane filiphy by this way, air, writing and again british has Waste hazardous materials can have a negative impact on the environment and to distribute one emphasism and productives the bodistion ows sitthe human health if it is not properly controlled and managed. Hazardous waste production of the incommentation of the color of the state of the second of the second of the second of has a significant impact on every thing around includes vegetation, water, air and are it committee the property and the decision of the committee of the people of the committee of the commit human health, the damage degree based on the time of the exposure to the hazard. Hazardous wastes are mainly generated from the industries Novel is subgered that their between their research in Vibral states between the SH manufacturing, hospitals, agricultures pesticides, business activities, oil spills on carrie year has in attions of the accomment colonic many his house from leading through transportation, household's activities and there are some hazardous as it glassimisms that he still of ablique allegar contained in bond of about about wastes are prohibited, which are regulated under the clean air Act, and clean considerable process of industrial a responding service service and analysis of water Act. The hazardous waste generally contains on a different substances ritinged by Commission where with programmed substitution to evolution of which where such as metal, chemical, pesticides, organics, inorganic, solid, liquid, and The very beging the arrivation of the arrivation of the control of gaseous and sometimes combination of some of them, but the biggest threat Tourne tour troughs to proved to existing date of several model will began at each obserm? comes from the chemical wastes evolved from the contaminated ground water. w annot be add bailed for shared information belong anon reserve such asset Hazardous wastes have the most important potential environmental impact. In unitario bila unito a movimo ed utilidacionese transpiración di facesim comunica the past few decades, throughout the country, the concern for hazardous waste and to technica entities relatively all the thought for the connect the connections has grown tremendously due to the dangerous that threaten public health and timing languagengiane salt dependi makampana gariperadi mang sareaw arabasandi the environment. In response to this concern, many legislatives and potentials their configurat bedaying and the analysis of the following their languages and consequences have designated to control the wastes hazard problems. Generators, to ena testi or setmenen med referre kond of materia redinere a boardoord transporters, and handlers play the most important roles of producing the and comma vietne and daily ancera has hazarable box inventeed asserbes hazardous wastes problems. Generator, are the institutions which produce the s become the treatment belowers were at boundlets recovered wastes whether manufactures or non manufacturing, which known as on site wastes hazardous waste management which present 80 - 95 percent of hazardous waste volume, about 5-20 percent of hazardous waste are transported to off site waste hazardous facilities. There are different modes of transporter waste hazardous (highway, rail way, air, water) and each mode has a commercial percent of the percent of the transporters are responsible of transport the hazardous waste from the site to any commercial facility. Handlers are a commercial agents involved in the storage, treatment, and disposal process (3).

Sitting hazard waste facility is a very complicated issue and presents a basic political and social dilemma. Sitting hazardous waste facility is not easy since no body likes to have a hazardous waste facility in his or her community. It is therefore, the process of installing a hazardous waste management facility is very hard to achieve a compromise between the public demand for health protection and the right location from the engineering perspectives (1).

Canada has to meet the international's obligation in terms of import and export realise beautin ancertainmen sein recht bankting testaan rechtiens ein erzeit hazardous wastes trans bound movements. Canada and United States have a common principal contrava a la la matema fore constant. El para pala el terá estable el programa el la contrava common interest in environment sustainability to provide a clean and healthy PRINTS RECOVERSANT OF THE PRINT WAS IN THAT I SELECTION OF THE PRINTED FOR THE PRINTED FOR THE PRINTED FOR environment. Canada is a party of the Basel Convention on the control of the their Cheer without experient had excuenced without and yourgenerry to every super hazardous wastes trans boundary movements through the environmental sound if is engage than abelia kinal some in recome eigh as perckaren un it emmaking with management. The federal and provincial government cooperated together and (Replacement) i premiero indicali epikawa seli apireo na badancaselo sasal produced a manifest system to track wastes from generator to final site of bett in one leiten, for belled it extended i brond med given beelfound been beelforenging eigen storage, treatment and disposal, and ensure that, the safety precautions මැති වේ. වේ.වේදනය අතුරුව දෙනවාන් මුත්ව යන උනුදුවන්නේදී උනතුවුන් සිටු සහසුවල දෙනවාන් සිටුවන් information delivered to every provincial throughout the country aris in the transfer bridge use intraligation of the second assessment in the contraligation of the second as

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There is some facilities devoted just for hazardous wastes in Canada, such as: the Safety kleen Ltd. near Sarnia, in September 1997, its capacity was 7.5 million tons under the control of Environmental Assessment Act. The facility was approved without notifying public, in 1999 the facility temporary prohibited due to fights yet accorde with a solution of an according to the state of the real state of the solutions and some hazardous problems such as ground water contamination and leaching. The transported were additional resources are some expensional additional accordance to the contract area soft The other facility is Philip Service Corporation in Stony Creek, the facility approved without notifying public under the control of Environmental Assessment gendagens gendimertoment musikaben est ment bedesting ymeen Act c. It was approved as a non-hazardous landfill, but it was found that, the Tala Baliga, ibiga berakali meneri meserumi, meserukan eriki menarangan bilangan Sasarangan operator accepting hazardous wastes from USA. The ministry of the Environment tional telepot i despera especie di aterni pole especie per la competito de la competito de la competito de la decided to stop the activity immediately on that landfill in 1999, the work started o karalini. To energ agricum, elektrikari vi biba i karalini baharakari sabarakari again later (1).

The state through these acceptances of poor to be a seen to be a content of the state of the state of the second of the state of the state of the state of the second of the state of

1.1 Characteristics of Solid Wastes

A solid wastes not necessary to be in a solid physical condition it might be in a semi solid, liquid or even in a gas condition. It is very difficult to determine whether the manufacturing facility generates a hazard wastes or no, if so the materials have to meet the specifications and the definition of the hazardous wastes materials. The proper definition to the solid wastes is any materials have to go through the following

Increase the property of the control of the property of the pr

- Disposed of or abandoned in lieu of disposal.
- Burned or incinerated or recycled.
- was of reals. ◆ Considered inherently waste

If the material is not solid wastes it can't be considered be a hazardous

1.2 Hazardous Wastes Materials

Hazardous waste is not acceptable no matter what due to the damage that affect e egyptekken formet der film**etor**ke it steller formet et 60 f. h. it blie kommitte et en en en et et et en k the environment includes vegetation, water, air, and human health, the amount of entre trouver present committee to expression in the present in the contract of the contract o damages based on the degree of exposure to the hazard. Hazardous wastes are Karagaran panggapa, terhasan penggapan Page darah panen bahda apatagan 191 mapa pangga mainly generated from the industries manufacturing, hospitals wastes, and the first the participant of a gat. The contrades the second of the participant of the contrades of the agricultures crops and pesticides, mining overburden returned to the mine side. านี้ ชาวารทาง (1 เมษายายาม 1 เมษายนความ (1 โดย 1 fly ash waste, bottom ash waste, slag waste, flue gas emission control waste . Portuginal lagradicida (folographica la templatrata desistato), percor i la colorida contracto de la colorida generated form combustion of coal or fossil fuels, produce crude oil, natural gas. geothermal energy, oil spills through transportation, solid wastes from the extraction, beneficiation, minerals, cement kiln dust waste, discarded wood, business activities, drilling fluids, household's activities. The hazardous wastes generally is comprised of different substances such as metal, chemical, pesticides, organics, inorganic, solid, liquid, and gaseous and sometimes combination of some of them. and there are some hazardous wastes are prohibited, which are regulated under the clean air Act, and clean water Act. The hazardous wastes materials could be very dangerous due to the physical, chemical or biological activities and its consequences. For examples, Ignitable wastes such as crude oils and its product could cause fire easily. Corrosive wastes such as steel or other metal materials could be very dangers since it reacts easily with other wastes and cause rust and contamination, added to the probability of causing injuries from the sharp edges due to the rust and

Herbora Arthur Barbora, Barbora Michael Burren Barbara (1906) (1906) Harris Arbara (1906)

en de la mangar gregor gapon, engla ettengga anti 1992 til holl vill gold fill monde flevor av værere e

corrosions. Chemical wastes such as reactive wastes, which is very harmful on the human life and the environment, it cause explosions, or produce toxic gases. Toxic wastes could be solid or liquid or gas, the dangerous based on the degree of exposure. Explanation of the hazardous wastes characteristics in details as following (27).

deligned to a come, between personal and expressed continue of differ will be a

1.3 Characteristics of Hazardous Waste Materials

1.3.1 Ignitability moderners as which have the all years are according to

An ignitable waste materials cause fire hazard during shipment, transportation, treatment and etc. The waste materials considered ignitable if the following characteristics exist:

- Liquid and has a flash point less than 140° F or 60° c these are
 moderate flammable, and less than −18° C is extremely flammable
- ◆ Not liquid and is able under a certain temperature and pressure cause fire through friction, absorption of moisture or, when ignited and cause very bad burn (2).

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1.3.2 Corrosively

A corrosive wastes is capable of deteriorate the containers, damage human issue, dissolve toxic components of other wastes. The waste materials considered corrosively if the following characteristics exist.

◆ The waste materials contain pH less than or equal to 2 or greater

than or equal to 12.5

★ The waste materials corroding SAE 1020 steel at a rate greater than 0.25 inches per year at a temperature of 130 F (2).

1.3.3 Reactivity

A reactive waste materials are chemically unstable, it react very quickly if it expose to air or mixed with water and also have the ability of liberate toxic gases, and the ability to explode. Therefore, the reactive wastes require a special handling and storage. The reactive wastes have the following characteristics:

- ♦ Unstable and easy to change its characteristics State of the characteristics
- ♦ Quick react with water and air
- Sometimes generate potentially explosive mixtures with water
- ◆ Generate toxic gases or vapors which could be very dangerous on the human health and have a negative impact on the environment
- ◆ If exposed to pH between 2 and 12.5, it generates toxic gases or fumes could cause a negative effect on the environment
- It has tendency of explosive reaction due to the quick react with the other wastes especially if it exposed to high temperatures or pressures

Referred to these characteristics, there is a special requirements are required during the storage or transportation or improper land disposal to avoid any problem might cause a tremendous damages to the human life and the environment as well. Therefore, awareness and a good understanding of the wastes characteristic and regulations are very essential to get involved in hazardous wastes process (2).

so the provided standard souther CHAPTER 2 Misso members and the

Causes and Consequences of Hazardous Wastes

2.1 Causes and Consequences of Spills

- ◆ The spill result in release of flammable liquid of gases could cause fires and explosions
- Spills result in a release of toxic liquids could have a bad impact on
 the human health and the environment
- ◆ Spill can reach sanitary or storm sewers and cause contaminations

recommendated for the testing and all great propalations after a testifications and the contract of the contra

2.2 Causes and Consequences of Fires radial and report the research to be referred

- impact on the environment which have a bad'
 - ◆ Spreading of the fire could ignite other materials and spread the fire to other off site areas and increase environmental damages
- The property and archemical political could—cause contaminated migration with shorter (believed as testing).

2.3 Causes and Consequences of Explosions

allow modes and the least translation and the modes on day along the

- - ◆ The explosions could release flying materials or shock waves could be very dangerous and cause human death

♦ The explosion could ignite other hazardous materials and cause more damages, which is going to be hard to control (27).

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2.3.1 Storage

Environmental issues and health hazard can be generated during the storage of hazardous waste. Particularly the chemical wastes, proper storage is very important to ensure safety. The storage must be subjected to safety precaution. Storage facilities have to be guided by the federal and provincial government, the guidelines include regulations and conditions have to be followed. For example, tanks or containers must be labeled or marked clearly and show the sign of hazardous wastes words. Generators who accumulate wastes they must have the following on site

- Alarm system and internal communication on site → →
 - c♦ in Fire extinguishers: (see some chain in the part of the control of the c
- Telephone or two way radio at the scene of operations capable of contact somebody outside the site and a street contact.
 - ♦ Fire control equipments such as foam, inert gas, or dry chemicals or any extinguish materials
- ◆ Spill control equipment and regulations
 - ♦ Water at adequate pressure to help during fires or sprinkler system
- ◆ Special protective clothing and gloves
 - ◆ Decontamination equipments (2).

2.3.2 Shipping was and no board too bot about square mathematers?

The Transportation of Dangerous Goods legislate regulations to control hazardous waste transportation by classifying the hazardous with respect the harm of the materials, and the documents should be carried with waste shipment and the safety precautions that needed in case of emergency. The regulations are same in all Canada, even though there are some considerable changes between the provinces. The generators of hazardous wastes have too meet their obligations under the local jurisdictions regulatory of hazardous wastes in the way of shipping hazardous wastes onsite. The federal government in Canada has made a tremendous effort of enactment of the Transportation Dangerous Goods Act. This act mainly applies on the hazard wastes. The Act includes prohibition of transportation of dangerous goods by any mood of the transportation unless they meet all the requirements and the safety standard. The wastes should placed in containers has standard specification as following. First, the date should be clearly written in each container for inspection. Second, E.L.A. Treatments. each container has to be labeled to show the text of hazardous waste. Third, and to emission editionally and the respect to the property of the distribution of the contract of the contrac generators comply with the requirements of the treatments, storages, wastas. Arophilingly, reduce the hazard on the environment and on breith as transportations and disposals. Fourth, containers uses for holding hazardous Impleytic and Spanistic implement to traince and Spanistic Applications for the property of them wastes have to be in very good conditions to prevent leak especially for ecrops reacoust blank and small stabanous balos only utamous of bear morning? accumulated wastes that stay on site for long time. Fifth, the containers should terdirefounds. The chemical rearroom is used to reduce a vegot, solid, espenbe in good conditions to stand the handling and shipping and the long travel solvects, and axidation to reduce some companent. Notopogst teasoner, used in distance. Packing has to be according to the specification to avoid any leak or of the force of the properties are propertied as the contract the properties of the causing problem during the trips. There are four packing group levels used in the interave venovientan or exidetion. Euripermone, more is a extensió of our Transportation Danger Goods and that based on the degree of the hazard involved in the wastes as following:

- > Level I for very dangerous wastes and used a highest packing level
- Level II for dangerous and used medium packaging level
- Level III for moderate dangerous and used a lowest packing level
- Level X specific packaging level that based on the physical and chemical

the properties of the wastes (4) and the master of the matter of the matter of the matter of the master of the mas

The used containers have to be closed during the storage time it. In two cases first, if the container contains a flammable materials, the emerging vapor might cause a fire. Second, open container will be subjected to spill during movement. The only time allowed to be open is during storage or adding and removing the wastes. For waste materials such as acids and caustics require plastic drums, steel drums with liners or drums of stainless steel. Using funnels are often used to minimize losses when filling containers with liquid wastes to prevent spills.

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DENT process to consider the large of the color of the color section seems to be colored to be colored.

2.3.3 Treatment

The main objective of the waste hazard treatment is reducing the volume of the assessment and assessment and the assessment of the vigorous and treatment and on health as well. Treatment could be chemical, physical, biological or thermal. The physical treatment used to separate the solid materials from the liquid through some assessment and assessment and treatment is used to reduce a vapor, solid, steam, solvents, and oxidation to reduce some component. Biological treatment used in order to disaggregate the biological objects. Thermal treatment involves heat to increase vaporization or oxidation. Furthermore, there is a potential of gas

generation and migration as a result of the chemical reaction and microbial decomposition of the waste organic materials that significantly has a negative impact on the environment. Leachate also is a significant consequence on the environment and it should be properly treated. Selection of effective treatment method for leachate is primary based on the cost, and the nature of the leachate. The optimum method used for leachate treatment is incineration through activated carbon adsorption and aerobic and anaerobic biological treatment.

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Landfill Disposal

Traditionally landfill is one of the main methods of disposal used for treated or untreated wastes. Several elements must be considered in order to choose a place for installing landfill such as: land topographic, geologic, hydrogeology, climatologically and population density and a synthetic or soil based liner has to be installed in order to prevent migration and leachate collections of hazardous waste, removal system is required. Landfill site has to meet a certain specifications to be environmentally satisfactory. For example, the groundwater surface level has to be away from the landfill to avoid contamination, also considering leachate migration. In other words, water surface run off from the site must be prevented from reaching ground water supplies. There are specific regulations and safety precautions must exist in the hazardous wastes facility to ensure adequate storage, the facility should be cool, dry and well ventilated area. Leaks is the biggest obstacles facing the below ground landfills even with all technology available, leaks leads to a accumulation of contaminated leachate with hazardous wastes and eventually penetrate the liners and reach the groundwater. To prevent leakage, the facility has to be dry and the best way of that are the aboveground landfills since the landfill contains on aboveground leachate collection landfill, a drain system consisting of stable aggregates connected with a proper system of collection pipes and the base must be overlain by a low permeability liner system. This design approved an efficiency of preventing leaks, eliminating the driving force behind the migration of contaminants due to the immediate remove by gravitational drainage, if there is a leachate the cover is often expose to breach so, it indicates on the system integrity. The problem with the aboveground landfill is the potential of erosion of the topsoil cover due to the slope on the aboveground landfill and the run off.

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3.1 Social issues related to the landfills

Installing landfill present a big issue, is very difficult people to accept the idea of constructing landfill in their community due to the nuisances such as dust; odour, noise, and visual intrusion. In addition to the landfill traffic can disturb people properties and it is not good to be close to any recreational or any community services. Therefore, the nature, the value, and extent of the community will be affected. However, increasing public opposition to the sitting of such facilities, In both Canada and USA has brought social issues. In other words, the social aspects generate more problems than the technical ones. Therefore, the focus to solve the social issues has the priority of consideration.

There are some other methods of disposal used for special hazardous wastes to produce the second second wastes to produce the second se

3.2 Sea Disposal moved to heavening a tief a near that self is a seem accommodate

The radioactive materials is widely used in medicine and industry, and it is apparent that nuclear industry potentially produce a huge amount of contaminated radioactive materials, it is also apparent that the radioactive is the most dangerous and undesirable wastes. Researchers found that the most convenient and inexpensive way of disposal the radioactive wastes is into the

sea waster. Many studies have shown that, for a small amount of radioactive materials dissolved in a huge amount of water, the wastes will be diluted and the effect will dramatically reduced. In spite of, these good results a lot of objection and issues generated from both political and environmental aspects.

3.3 Sewer disposal

The large a mount of water carried by the sewers provides a good dilution of the hazardous wastes. Thereby, the danger will be eliminated. However, In spite of these good results this way also not widely used since once the radioactive materials entered the sewers, they lost control on it.

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3.4 Transportation Modes

The federal government in Canada has made a tremendous effort of enactment 一类的1.1960 (14) 1.400 (A) 740 (15) 11 (A) 444 (A) (A) (A) of the Transportation Dangerous Goods Act. This act mainly applies on the describer en der der de marcilla de la compañ hazard wastes. The Act includes prohibition of transportation of dangerous goods าว สมานักกระบางวัด เรียว (ปก. ยากครับ สมาย เดาแพลการมักระยาการับ ยุพระจ by any mood of the transportation unless they meet all the requirements and April and severe for a local of the name is the independence and the common series which " standards for safety. The main objective of the Act is to achieve the uniformity of or no alterna e disposite no foca legislation across Canada and internationally to control the transportation of hazardous wastes. The Act has a list comprised of hazard Goods includes a miscellaneous class of hazardous products, substances and some dangerous organisms. Each province applies the regulations in such a way that match with its own system. For instance, the regulations for waste disposal facilities will be left to the provinces to control it. For example, In Ontario, the Environmental Protection Act, controls the industrial wastes transportation throughout the province. It provides forms must be filled out from shippers, carriers and receivers. However, all the regulations for the hazardous wastes transportation controlled and legislated under the federal government. There is a tremendous focus on drivers training, to increase the awareness of the environmental impact. Selecting a transportation mode essentially based on the consideration of the relative cost and risks of all alternatives transportation modes. Transportation of Dangerous Goods Act sets out requirements to control the hazardous wastes transportation, and provides remedy tools in case of any incidents occur.

engy of I come Decree but there you be as yo becaused element because

index of places, so a period exists and return selected be narraneous numbers of **3.4.1 Rail Transport**

Requirements for the transportation of hazardous wastes by rail in Canada and USA have to follow the regulations known as Red Book, which established by the CTC through the Railway Transport Committee; this book includes all the safety requirements and standards, the classification of all dangerous goods and application forms for Hazard Information Emergence Response (HIER), for all cargo, shippers must fill it out, and also forms for report accidents such as incidents, leakages, etc.

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of the interpretary to agent the institution of the expension the section of

3.4.2 Marine Transport The last works word section open on this profession section for flower

Requirements and regulations for transportation hazard waste by water are established through International Marine Organization (IMO) under the federal government. The regulations known as dangerous goods shipping regulations, which include, packages, carrying, Marking and inspections of dangerous goods

on ships, storing. Waste hazard transportation by marine shipment involve a very large quantities of hazard in a small number of trips and that due to the large capacity of the tanks used, the capacity ranged from 30,000 to 600,000 gallons. Some studies have shown that marine transportation doesn't appear to be feasible for hazardous wastes transportation because it is costly compared with other alternatives modes.

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3.4.3 Air Transport

Hazard waste transported by air is very small and limited since it is very expensive compared to the other modes. In addition to the price penalty for extra handling that required for loading and unloading. Obviously, some waste hazard materials are not allowed to transport by air such flammable materials, irritants and corrosive materials, Air transportation is attractive only for some sensitive items, normally shipped in a small quantities. The hazardous wastes have to meet all the requirements and provisions of the United Nations Committee of Experts on the Transport of Dangerous Goods and the International Atomic Energy Agency's regulations for the safe Transport of Radioactive Materials. hazard waste transported materials have to meet all the requirements, regulations and standards of the International Air Transport Association. As a result of these regulations and the price, studies have shown that the air oga ografije kenoem og boek geometrije of begjoot begjood kan 🕏 transportation mode is not considered as a good option for hazardous wastes The sale of the face of the contract of the contract of the contract of the first field of the transportation. articles and gradients attack the control of the same and the financial graff to come our

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3.4.4 High way Transport

& materación Requirements of hazard waste transported by highway have to meet the 49 code of Federal Motor Carrier Safety Regulations, State and local laws, the cargo tanks used to carry the hazardous materials are made of steel or aluminum alloy the capacity ranged from 4000 to 12000 gallons, usually base on the regulations of the existing road weight law. The truck mode is more likely to be the favored mode of hazardous wastes transportation. requised from all pactices include generator, drivers, operators of the stompest 3.4.5 Pipeline Transport program sorted a great of elegended has almost used It is often used in USA to transport crude oil or other row materials, but not much for hazard waste, because simply it is not economical or practical. Studies have shown that, there is a major attraction of pipeline transportation because the lower risk of spills compared to the other mode such as truck or train. ecureaments and requiribles by handing, steelig, murificaling, hanging, edi sen gode cherif alesen TRANSPORT MODE describ den gebesti pelisua Visco at it salensy authoric Transport Mode protein Number, and electrosis and viscous 221 Road grisof protect as gets with a serval popular total bevalue to be to be to be to be to be no his sele menne undervirundanskir esti en redsitson 14 alla esti svivresto sestamo Marine Pipeline od the a bon abote philocom tings to being evilogity as a Non-transportant, side interest to be between at broom your Figure 3.1 number of Hazardous Waste Transportation Modes (Environment Canada, 2001) sed to mak bedweeds and his exister largering and grifflends till shower oril eduber bas tratico el trabogal yesa el ella colleburaren bas caraldelutera maker income the appropriate and provide an importable of the color of the contract of the con

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Regulations and Precautions for Hazardous Wastes Transportation

The federal government provides a framework for the hazardous wastes. management regulations and, proper planning in order to handle hazard wastes. problems is very essential. The regulation of wastes begins from generation and covers transportation, and continues to the wastes treatment and disposal. It is required from all parties include generator, drivers, operators of the storages, treatments and disposals to have a better understanding to the regulations and safety iprecautions: For a example; idrivers have a to a be levell, prepared, and knowledgeable with OSHA 29 CFR 1910.120 Hazardous Waste Operations. Health: & Safety: Training: Program: and be: familiar with: HazMat, D.O.T., and Security Awareness training Drivers calso have to be conversant with the requirements and regulations for handling, storing, manifesting, transporting, labeling, treating and disposing of hazardous waste. Drivers should know use the toxicity characteristics leaching procedure to identify hazardous waste. It is very vital, if the initial spill controlled and treated in the earlier stages before losing control, otherwise the effect continues as the hazardous waste enters the air or groundwater and the damage will spread to the surrounding areas and it will be very hard to control it. Chemical spill problem requires an effective plan of spill control to identify a control procedure in order to reduce the degree of the subset national electric comments to estimate delicated in hazard. By identifying the principal cause of the chemical spill at the manufactures and transportation site is very important to control and reduce the hazard effect. Emergency report plays an important key role in the hazard waste transportation process, incident, spill, or leak occur must be reported in order to notify the rescue team includes the fire department, local and provincial police or RCMP detachments can provide immediate assistance. In order to facilitate emergency response measures, carriers must keep the documents that contain waybills, invoices that listed the materials involved, united nation serial number, emergency response number.

4.1 Transportation of Dangerous Goods Regulations

The Transportation of Dangerous Goods Regulations are divided into 13 parts as following (Transport of Hazardous Wastes Manual)

◆ Part 1 contains definitions of the specialized terms used in the regulations

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- Part 2 contains information about how and when the regulations should be applied, and provide exemption to that regulations
- Part 3 contain information about the classifications of the classifications of the classifications goods. There are 9 classes of dangerous goods as
- Class 1 explosives materials include substances
 - i. Substances with a mass explosion hazard
- a mass explosion hazard
- Substances that have a fire hazard along with either a minor blast hazard or both, but not a mass explosion hazard

- iv. Substances that represent no significant hazard
- - > Class 2 for gases include and the management of the war war as an expense of
 - economic de la como fei. La **Flammable gases** de rate del conferencia de la conferencia del conferencia de la conferencia del confer
 - ii. Non flammable, non toxic, non corrosive gases
 - iii. Poisonous gases
 - en vita i medit a la delli serengen dili italian farta gazzan dili italia iv. Corrosive gases
 - ➤ Class 3 Flammable Liquids
- i. Liquids with a closed cup flash point of less than -18° C.

 These are extremely flammable
- ii. Liquids with a closed cup flash point of not less than –

 18° C, but less than 23° C, these are very flammable
- iii. Liquids with a closed cup flash point not less than 23° C, but less than 37.8° C. For international air transport, the flash point is not less than 23° C, but less than 60.5° C. For waste and international marine transport, the flash point is not less than 23° C, but less than 61° C, these are moderate flammable
 - > Class 4 Flammable Solids, Substances that on contact with water emit flammable gases include
- i. Solids which under normal circumstances are readily ignitable and burn persistently, or which cause or

from manufacturing or processing

Substances diable, to spontaneous combustion, under the many data are lizble to spontaneous heating to the point where they ignite

combustible on contact with water or water vapor

➤ Class 5 Oxidizing Substances and Organic Peroxides

Substances that cause or contribute to the combustion of material array yielding arraygen or oxidizing substances, whether contain the substance itself is the property of the

Class 6 Poisonous Substances and Infectious Substances

inhalation, by skin contact, or by ingestion,

Organisms that are reasonably believed to be infectious to humans or animals, and the toxins or such organisms.

74 KBq/kg within the meaning of the Atomic Energy

Control Act. Radioactive materials are classified by the atomic energy control board

- Class 8 Corrosive Substances that cause visible necrosis of the skin, or that corrode steel or non clad aluminum, or are wastes that have a pH factors less than 2 or greater than 12.5
 - ➤ Class 9 Miscellaneous Substances
- Substances or products that present sufficient danger to warrant regulation; but that cannot be assigned to
 - iii. Environmentally hazardous substances
- iv. Wastes that present sufficient danger to warrant regulation, but that cannot be assigned to any other class (Transport of Hazardous Wastes Manual)
 - ◆ Part 4 shows the documents that the generator and the receivers should use during the process of handling, shipping and transportation
- Part 5 describes the precaution includes safety signs and symbols that must be placed on the containers
- ◆ Part 6 and 7 describe safety standards and requirements
- ◆ Part 8 and 9 describe the government responsibilities under the Transportation Dangerous Goods Act and regulations include procedures to stop the transportation dangerous goods, and performing inspections

◆ There are also 12 schedules containing regulations, lists of specifications for the hazardous wastes and information about the methods should used on test the materials.

4.2 Safety Precautions & regulations

4.2.1 Toxic Solvent Spills

- ♦ In case of major spills of hazardous materials that produces toxic fumes, the area should be cleared until the ambient air changes
 - Provide sufficient ventilation or breathing equipments, sand could be good since it can absorb the spill

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4.2.2 Major Spill of Corrosive Liquids

- The ambient area should be flooded with water to dilute waste materials concentration
 - Dilute or neutralize liquids could be absorbed by paper or solid
 absorbent

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Figure 4.1 Emergency Response for Hazard Spill Liquid (Transport of Hazardous Wastes

Manual)

4.2.3 Mercury Spills

- Mercury should be cleaned up by suction through mercury collector, mercury sponge or vacuum flask
- Contaminated area should be powdered with sulfur or flowers and provide a good ventilation to the area
- In the following day the sulfide or the flower should be disposed of

4.2.4 Toxic Solid Spill

- In case the solid in a powder form, breathing equipment should be used and rubber gloves for the cleaning up
- The waste material from the cleaning up should be disposed of

4.3.5 Ignitable or Reactive! here because trafficture grow is entered to all trainings of

- ◆ Wastes should be separated from the reactive materials or the sources that might cause fire such as: smoking, cutting, welding, flames
- ♦ Storage ignifable materials should be away at least 50 ft from the facility property line
 - ◆ Separate the incompatible materials and the incompatible wastes or protected from each other to avoid explosions, firs, container eruption, fumes or toxic gases.
- In case fire or explosion, the coordinator must immediately inform
 the local authority and identify the reasons of the accidents,
 materials involved, total damages and to what extend is going to be

The state of the second section section

- All the equipments must be tested and maintained to ensure proper only of the second order of the operations in the emergency time
 - Testing and maintenance implies and requires a written policy and transposition and keep track record to ensure periodically inspection and process and the pr

- and give addition only above

4.4 Manifest System

The transportation of hazardous wastes has to go through a certain regulations to ensure the full environmental control and safety. The purpose of the waste

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manifest is to provide a very detailed record and tracking of the waste, from the beginning to the end. These regulations legislated by the government with the help of environmental experts. These regulations put it in forms called manifest. Manifest track hazardous wastes from the beginning of the process to the end to ensure safe delivery, the manifest serves both shipping documents and tracking documents and include the following information:

- ♦. Generator's name, address, phone number
 - ♦ Name and the identification of the driver
 - ♦ Name of the facility and the location
- ◆ Description of the types, quantities and the no of containers
- Generators have to provide documents, that the wastes are in a good condition for transportation and the appropriate method of treatment, storage and disposal

The generator complete and sign the manifest and distributed as following:

- ◆ Copy to the designated authority in the province, if the movement is in the same province, the generator should send a copy to the Environment Canada for international shipments
- ◆ Four copies should given to the transporter with the shipment
- - ◆ The transporter fill out section B and ensure that the manifest be with him all the trip time

 **The transporter fill out section B and ensure that the manifest be with him all the trip time
- The consignee should sign the four copies after receiving them and complete section C, he should keep a copy for himself, and give a

copy to the transporter and one copy to the proper authority and the

last one to the consignor.

By these mandatory rules, the government will be able to control the movement

of the hazardous wastes, and offences are going to be punishable by the law, the

offences could be subjected to fines or imprisonment.

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3) OBSCR (Commission) for Engineering Congression and Encyclopenia of Fluxentiuss. Council Commission for Congres of many beneather Movements of Fluxentiuss. Makabas considered for compress operations. (EG3 and an archest and confined to C.).

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Import and Export of Hazardous wastes between Canada and USA

There were many advantages resulted from the cooperation of both countries Canada and USA related to the broader authorities for the export and import of hazardous waste such as improved environmental protection regulations Act, meeting Canada's international obligations and develop Environmental Sound Management. The aim of ESM is to make sure that the hazardous wastes managed controlled in a proper way to protect the environment and human health. Canada involved in three international agreements regarding to trans boundary movements of hazardous waste materials as following:

- 1) Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and the disposal, 1989.
- 2) Canada and USA agreement concerning the Trans boundary Movements of Hazardous Wastes, 1986 and amended in 1992.
- 3) OECD (Organization for Economic Cooperation and Development) Decision of Council Concerning the Control of trans boundary Movements of Hazardous Wastes destined for recovery operations, 1993 and amended and replaced by C (2001)/107/Final.

The primary objective of The Basel Convention is minimizing the hazardous wastes production to enhance environmental sound management and protect the public health. The Basel Convention was comprehensive agreement includes

116 nations in 1987. Canada and USA signed this agreement in 1992. The Basel Convention: produced twenty-nine articles and six annexes that include everything related to the trans boundary movement of hazardous wastes. The agreement sets out the regulations and the conditions for the export and import a right an agraigh gait an direin, greathan i leagantaidh a righ agus aire seil 🐔 🧸 of hazardous wastes. The agreement controls the trans boundary movements of other completely a secure of the control of the sections and the control of the c hazardous wastes. Before setting down any international rules or regulations, a apagetisets na jenjenojan jiroprotomat jarathetan Parcentilern soft seksem tellis e definition of hazardous waste materials have to be identified and classified first. of policy delegated by a block of the first enforcement for some in buffills Due to the difficulties to reach an exact definition of hazardous wastes materials, therefore, it was a consensus that the United Nations Environment Program will come up with the exact definition. The aim of this agreement conforms the fundamental principals and regulations to control the trans boundary movement of hazardous wastes from the origins to the destinations as following:

1) Both counties manage their wastes under its own regulations within its own jurisdiction. For example, in Canada, the federal government has the authority to manage and control her hazardous wastes under its regulations, and regulates the trans boundary movements of hazardous wastes. In other words, it controls the export and import from and into Canada as well as controls the movements between its provinces. The exporter must fill out the form which indicates the manifest reference number provided by exporter authority and that has to be prior to the transportation of the hazardous wastes.

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- 2) Exports and imports allowed only to the countries that are parties in this agreement, the country that export wastes should notify the other country a head of time with a note include the following:
- ◆ The name of authorized career and authorized facility,
- ♦ Type of the used container for example, boxes, tanks or etc.,

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- ◆ Determine the method of recycling, treatment, storage, or disposal
- ♦ The name of transporter and the mode of transportation
- ◆ The quantity in kilograms or liters of the hazardous wastes
- ◆ The port of exit through which the export will take place
- ♦ The customs office at which the hazardous wastes
 - ◆ The notice has to be send in the language that are used in the import country in addition to another copy of English
- ♦ The reference number provided by the Minister
- ◆ The name, civic, mailing and electronic addresses ad telephone of the person who should be contacted in case of problem

For instance, Transport Canada and Environment Canada must receive the notification form, 60 days in advance from the generator in or out Canada for all wastes, and 30 days in advance or the first between the provinces, and 7 days in advance of subsequent shipments of PCB waste out of and into Canada (Waste Hazardous Transport Manual).

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3) Exporting country must permit return of any hazardous waste that the importing country rejects it. In the case of hazardous wastes

exporter and the authorities of that country as soon as possible. If there no respond for 90 days there are two options have to be done whether to make arrangements to dispose the hazardous wastes or to return the hazardous wastes back to the exporter where it is issued.

4) Both countries should cooperate to achieve the implementation of the statement and ensure the full control management on the countries to the statement and ensure the full control management on the hazardous wastes.

5.1 General Obligations of the Parties to the Basel Convention (31)

1. (a) Parties exercising their rights to prohibit the import of hazardous wastes or other wastes for disposal shall inform the other parties of their decision pursuant to Article13

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- (b) Parties shall prohibit or shall not permit the export of hazardous wastes and the other wastes to the parties, which have prohibited the import of such wastes, when notified pursuant to subparagraph above
- (c) Parties shall prohibit or shall not permit the export of hazardous wastes and other wastes if the State of import does not consent in writing to the specific import, in the case where that State of import, in the case where that State of import of import not prohibited the import of such waste
- 2. Each party shall take the appropriate measures to:

- a) Ensure that the generation of hazardous wastes and other wastes within it is reduced to a minimum, taking into account social technological and economic aspects
- b) Ensure the availability of adequate disposal facilities, for the environmentally sound management of hazardous wastes and other wastes, that shall be located to the extent possible, with it whatever the place of their disposal

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- c) Ensure that persons involved in the management of hazardous wastes or other wastes within it take such steps as are necessary to prevent pollution due to hazardous wastes and other wastes arising form such management and, if such pollution occurs, to minimize the consequences thereof for human health and the environment
- d) Ensure that the Tran boundary movement of hazardous wastes and other wastes is reduced to the minimum consistent with the environmentally sound and efficient management of such wastes and is conducted in a manner which will protect human health and the environment against the adverse effects which may result from such movement
- e) Not allow the export of hazardous wastes or other wastes to a State or group of States belonging to an economic and or political integration organization that are parties, particularly developing countries, which have prohibited by their legislation all imports, or if it has reason to believe that the wastes in question will

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not be managed/in/an environmentally/sound/manner according to criteria to/be decided on by the parties at their first meeting as and beday and of the content of the conte

f)::Require that information: about a proposed trans boundary movement of hazardous wastes and other wastes be provided to the States concerned according to Annex VA, to state clearly the effects of the proposed movement on human health and the environment.

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- g) Prevent the import of hazardous wastes and other wastes if it has reason to gotherwood much conditional tempter on values and service as telescopic tempters and the service parameters in question will not be managed in an environmentally offer parameters for the declaration of the parameters.
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- h) Cooperate in activities with other parties and interested organizations directly and through the secretariat; including the dissemination of information on the trans boundary movement of hazardous wastes and other wastes, in order to improve the environmentally sound management of such wastes and to achieve the prevention of illegal traffic average bases as a secretariat or achieve.
- the metermany time isological frequencies of the managers and the production in
- 3) The parties consider that illegal traffic in hazardous wastes or other wastes is one seem temperature translations because of the vistophological criminal subject translations are preferable properties.
- 4) Each party shall take appropriate legal, administrative and other measures to implement and enforce the provisions of this convention, including measures to prevent and punish conduct in contravention of the convention.

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- 5) A party shall not permit hazardous wastes at other wastes to be exported to a non-party or to be imported form an non-party of the latest to be exported to a
- 6) The parties agree not to allow the export of hazardous wastes or other wastes for disposal within the areas south of the 60° latitudes, whether or not such wastes are subject to trans boundary movement.

interpreter and to be extensive region unit instruction resolven supplied for the good will trepred by a

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- 7) Furthermore, each party shall:
- a) Prohibit all persons under its national jurisdiction from transporting movement be packaged, labeled, and transported in conformity with generally accepted and recognized international rules and standards in the field of packaging labeling, and transport, and that due account is standards in the field of packaging labeling, and transport, and that due account is standards in the field of packaging labeling, and transport, and that due account is taken or relevant internationally recognized practices.
- b) Require that hazardous wastes and other wastes that are to be the subject of a trans boundary movement be packaged, labeled, and transported in conformity with generally accepted and recognized international rules and standards in the field of packaging labeling, and transport, and that due
- movement document from the point at which a trans boundary movement commences to the point of disposal

- 8)Each party shall require those hazardous wastes on other wastes; to be exported, and managed in an environmentally sound manner in the State of import or elsewhere. The parties at their first meeting shall decide technical guidelines for the environmentally sound management of wastes subject to this explanation and the state of the state o
- 9): Parties shall take the appropriate measures to ensure that the tarns boundary movement of hazardous wastes and other wastes only be allowed if a second and the second
- a) The state of export does not have the technical capacity and the necessary facilities, capacity or suitable disposal sites in order to dispose of the wastes in question in an environmentally sound or efficient manner.
- b) The wastes in question are required as a raw material for recycling or recovery industries in the State of import.

ATT BENTANCE

- c) The trans boundary movement in question is in accordance with other criteria to be decided by the parties, provided those criteria do not differ from the objectives of this convention.
- 10) The obligation under this convention of States in which hazardous wastes and other wastes are generated to require that those wastes are managed in an environmentally sound manner.
- 11) Nothing in this convention shall prevent a party from imposing additions requirements that are consistent with the provisions of this convention, and are in

accordance with the rules of internal law, in order better to protect human health and the environment.

- 12) Nothing in this convention shall affect in any way the sovereignty of States over their territorial sea established in accordance with international law, and the sovereign rights and the jurisdiction, which states have in their exclusive economic zones and their continental shelves in accordance with international law and as reflected in relevant international instructions.
- 13) Parties shall undertake to review periodically the possibilities for the reduction of the amount and or the pollution potential of hazardous wastes and other wastes which are exported to other states in particular to developing countries. (1).

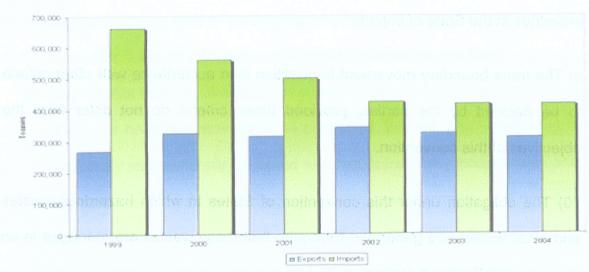


Figure 5.1 (Environment Canada 2004) Statistics on Export and Import Hazardous Waste Material 1999-2004

As shown from the graph, the 2004 Canadian's amount of hazardous waste Import and export is gradually decreasing. For example in 2002 the total quantity of importing was almost 418,000 tons, in 2003 was almost 417,000 tones and in 2004 tones is almost 416,000 tones. Based on the statistics of 2004, 98.8% of all Canadian imports of hazardous wastes came from USA and the rest 1.2% from other countries.

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5.2 Environment Sound Management

Some problems could be created from the poor management and insufficient wal soft or experiences consequence lesson soft other statemanagement of knowledge. For example, leachate, is the mean reason of the ground waster करवार अहर्ते केम्पांट को कि केद्रांत्र ए तके कारान्य माने वर्तान्य प्राप्त कर् contamination or release gases which have a negative impact on the human animana amminativit health and the environment. In response to the public concern to maintain Company of the sone perfection and interest to enterest and a adequate control over the potentially hazardous wastes and maintain toutta esperalegica estas se obras afin air tait ai cráthaigeach utaeta environmental sound, Environmental Sound Management criteria plays a मही स्वयंक्तकार्य पुरस्क संभावकार्य कार्य स्वयंक्तकार पुरस्कार्य स्वयंक्तकार स्वयं स्वयं स्वयंक्रिक significant role to reduce the danger that imposes from the hazardous wastes, by र पर्वात है। वृद्ध के कह बर्गकों कि कुछ एकर अवस्था वर्ष के के के के के के के किए से अवस्था अंगल है। उसके establishing a framework or comprehensive plan. Environmental Sound spitt ethologic reductionary bas and provide politically an food Management's objective is to protect the environment and the human life through ter grane sistembre garangegieri girgasidangan di protesta umb te sedarum management strategies, sophisticated plans and intelligent system as following: puntikh siderica ik almidene eni grenati eneniste grees tin

- Reduction of wastes are one of the most potential useful way to encourage reuse and recycle the waste materials, by exchanging the wastes from one firm to another, which can be used as an inexpensive way of raw materials which present the best way of managing the wastes with the most environmentally sound.
- ◆ Ensure that all the hazardous wastes procedures are according and that an entrance has a management at the conforming the Environmental Sound Management's criteria.

- ♦ Ensure compliance with the regulations and existing rules in the manifest to protect the environment of 2002 to be access to be a beginning to
- Reduce or prevent the unexpected hazardous wastes resulted from unforeseen accidents might happens due to spill or contaminations that happened during recycling, treatment, transportation or the military also between two many closes of the disposal process the first of the first seeks that the second of the first institution and the second of the second of
- ◆ Arrangements with the local emergency authorities to the fire e selection de la comitation de la comite del comite de la comite del la comite del la comite del la comite de la comite de la comite de la comite del la comite de la comite del la comite de la comite de la comite de la comite del la c department and to the police department for the areas that have grander and engligeright and and grander grander alphilic engrand deviations, an engliger made and hazardous wastes angging to the processor information of the performance of the perform
- ♦ Arrangements to familiarize local hospitals with the hazardous and the configuration of the c waste properties in the facility and the consequences effect

- Safety and emergency response are particularly very important in skill gestagt, in jorg jar kissin rogel at antere knon generale sett produke hiller harrellereke the heavily urbanized area in a wide variety of different application main greathle regard a mainmart a chaitiliaire such as planning infrastructure and transportation projects. The graphs) give notice of any languagements are gain to other module or anticipal and transcours will number of fire stations is significantly influencing the efficiency of randon and will rente a his garders to reproved a lateral pales e professionale transportension emergency response during fire accidents. A suitable distance of the filter for the food were all to revoke puters to entire the file. between fire stations and maximizing the area that can be served Britaniews III - Richelier Binade Right (webst in de de 1981 beste versier by these fire stations is very important issue; this could be gas na aspare ao mais mais e caregras on an inter-inoninagrasam sai effectively by using geographic information systems technology to a serious consistence for explicit higher and finding the best state that the consistence is a separate with (GIS). The efficiency of the current fire station locations and reduce า กรุ ซึ่ง เกิดสุดพาพอสร้างกรุ ทั้งหลายเล่าสำเหมหมาย คู่เร็ว เสียหมาย เ the hazard transport impact on the routes.
- il de la completa de Provide a list of prohibitions and conditions relating to the estrance at a comparable temporal commencion traditional and and comtransportation, recycling, treatment or disposal process

Canada's first priority is to protect the environment and human health. There are a strict regulations imposed on the export and import hazardous wastes in Canada in order to protect the environment and the public health from any Short operated benefitted in Canal damage might occur through trans boundary movements of hazardous wastes. o transposito i especiel so e pertugiar o piratrologica de proposito de la francia de la filosofia de la filosofia. The main purpose of the proposed regulations is to enhance safety and etry), yrang a region i i koko tetener brin mandalet iyal to at tail in act terleteand abesit Co environmental protection. Canada has issued a new manifest form shows the on wealth are necessary required regulations for the trans boundary movement and the E.A. CHARLES MARKSHAME AS AS ARCHARD CHARLE difference between the international and the domestic regulations for the Bergerater and english Green deplets and Control of the Control hazardous wastes transportation also provides a list of the prohibited and on the California against the country of the contract of the California (California) is the contract of the California (California California C permitted materials to export or import. The manifest shows the regulations England (PAZ, grantal), and transmall contribit to the should be followed from the very beginning of shipment to the final destination to principal Section of the property of the contract of the section of enhance environment management sound.

In 1999, CEPA gained power to enforce some regulations on hazardous wastes materials trans boundary movements as following

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- Prohibit exports, imports of hazardous wastes movements where required

 DEMONDATION OF THE PROPERTY OF THE PRO
- 2) Develop criteria to assess the Environmental Sound Management of Tran boundary wastes and refuse permits for exports and import
- 3) Prepare plan to reduce phase out exports of waste hazardous movements destined for final disposal

In 2002 there were some changes in control authorities in Canada related to the hazardous wastes trans boundary movements. For example, Transportation of

Dangerous Goods Regulations controlled the tracking requirements of hazardous wastes materials according to Transportation of Dangerous Good Act, 2001.

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5.3 Environmental Legislation In Canada

Waste Hazardous Materials Process includes handling, shipping, disposal in Canada controlled by a Varity of legislations and regulations through many Acts as following:

- ➤ Transportation of Dangerous Goods Act
- ➤ Environmental Protection Act includes
 - (Waste Management General Regulations 347 Ontario)
 - (Air Pollution General Regulations 346 Ontario)
 - (Waste Management PCB Regulation 362 Ontario)
- > Environmental Contamination Act
- > Pest Control Products Act
- ➤ Pesticides and Regulations Act
- > Nuclear Safety and Control Act includes
 - Canadian Nuclear Safety Commission (CNSC)
- Packaging and Transport of Nuclear Substances Regulations

5.4 Hazardous Waste Management in Ontario

Ontario government has established a master plan that has achieved tremendous implementations of reducing the hazardous waste. Ontario hazardous waste is managed under the General Waste Management of Environmental Protection Act. Regulation 347. The Environmental Protection Act

enacts rules and regulation to protect the environment, and the human health. It is therefore, responsible for the approval of constructing landfills and the control of generating hazardous waste in Ontario in addition to, the initiative of applying registrations the electronic hazardous waste information network program to coordinate all the hazardous waste activities in Ontario and provide a better service for generators, which made Ontario waste hazardous plan is the most competitive plan in North Americas and provide as a competitive plan in North Americas and provide and provide and provide and provide as a competitive plan in No

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5.5 Hazardous Waste Regulations in Ontario comboned the

There was amendments toke place in Ontario regulations in 2002. The modified regulations require annual renewal of the registration of the hazardous waste generators with the Environmental Protection Act, and provide detailed information about the amount of hazardous waste that being produced and disposed on and off site every year. Furthermore, these amendments on the regulations included the improving the leaching tests method and updating the classification lists of hazardous wastes. The modified regulations are legislated in a very tough way to ensure and enhance environmental sound in Ontario, and whoever breaks the law or abuse the system will expose to fines and probably to imprisonment (3).

Regulations of the hazardous waste management

Complete a training hazardous waste course or seminar at least once

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Determine the recycle materials and the waste hazardous materials

- The Hard Determine whether the waste may be legally disposed of in the seweros contact exsystem of landfill the severos to so whose tell but of the research as
- Treat:wasteras hazardous wasterif it cannot be recycled, detoxified as to the predictributed or disposed of in the sewer or landfillusing the continues as
- Follow the policies for containing, storing, labeling and inspecting the policies for containing and inspecting the policies and t
- Notify the Environmental/Safety officials when hazardous waste needs to be disposed of. Indicate where the waste is, what kind and how much hazardous waste there is, as well as whom the contact person in the contact person is the contact person in the contact person in the contact person is the contact person in the contact person in the contact person is the contact person in the contact person in the contact person is the contact person in the contact person in the contact person in the contact person in the contact person is the contact person in the contact pers
- Review procedures producing hazardous waste to see if they can be minimized.
- Recognize a problem, or potential problem, with hazardous waste and take steps to correct the problem (25).

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5.6 Liability requirements

Hazardous wastes have a huge potential of causing injuries, permanent disability or even death to human and damages to the environment, if such an accident occurs, the question arise, who is going to cover that damage. Financial responsibility includes insurance coverage and compensation for any injury or incidents during transportation or even during storage, treatment or disposal operation should be designated. Insurance is very important, it helps owner and the operator to be clear and have peace in mind toward any incident might face

them. The transport of hazardous waste as any transport operation could be subjected to collisions. In addition to the danger might happen from the hazardous wastes itself. It is therefore, an urgent need to cover the unforeseen losses and legislate national laws to protect anyone involves in the operation. The law should help the victim to get compensation for the harm that already happened and also provides protection rules against future harms. Reliability of staff play a very important role in the transportation operation, because experience shows that a proper training to the staff and special licenses are very essential and should be mandatory for both the carrier and handling agencies.

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5.7 Inspection

Inspectors who are authorized to ensure and enhance the Transportation of Dangerous Goods Act and regulation, they appointed by the Minister and issued a certificate to practice the inspection on any wastes are ready for transportation, inspector can perform inspection on every thing related to handling, packing, documents and authority. The inspection could be at the port, places where the wastes produced or at the facility. The inspector has the right to refuse the wastes and not allowed to enter the board. The carrier also has the right to check the shipment before he transports. The Carrier he shouldn't accept to receive the shipment for these following reasons

- If there is any discrepancy and not in compliance with
 - Incomplete documentations

- Misinformation on the waste manifest → Misinformation on the waste manifest
- ♦ Improper signs, unsafe or damaged packing
- ♦ Vehicle mechanical problem (Waste Transportation Manual)

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5.8 Transportation System Attributes

Transportation System attributes could be fall into six categories

- > Traffic
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 - in secondary, coefficient in an agreement of the highest fines and the color two by the gree Freight
 - > Operation and maintenance
 - > Financial perspectives
- 1. Physical: And Agram as the Construction of the Construction.

The most important advantage of GIS in transportation is its potential for data integration. GIS application in Transportation includes land use, environmental, demographic, utility and hazardous materials databases. The hazardous materials represented by travel demand by using the origin and the destination of the trip. Utility systems, such as sewers and water, which represented as networks by using, nods and links for the appropriate attributes. Transportation includes the interaction of supply (physical attributes) and demand (Traffic attribute), the interaction between supply and demand is emphasized by travel attributes. Financial attributes cover the variety of costs such as maintenance, construction operation and vehicles operation. To classify the GIS application seven function are used as follows:

- Basic functions (editing, display, measurements). The editing function allows the user to add or delete lines, points and change the attributes.
 The display function generates thematic maps. The measurements function is used to determine the area and any measurements.
- > Dynamic segmentation, which divides the network, links into homogenous segments. The dynamic segmentation would create new homogenous segments groups.
 - Surface modeling function creates a three dimension model and create a model for the digital topographic map.
 - ➤ Raster display and analysis function permits photographs to involve in GIS, this function used to add new links or new features.
 - ➤ Routing based on minimum time bath available in travel distance in the perference of the personal travel of the software.
 - > Transportation modeling packages.
 - > Overlay function allow two or more base maps to displayed gration egonometrics is simultaneously.

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Potential application of GIS in transportation

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Several application of GIS have implemented in the transportation field such as management of urban of infrastructure, traffic operation management, road safety and the assessment of road accidents and the impact on the environment many application such as the following:

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- ➤ Pavement management system

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 - > Bridge management
 - > Maintenance management
 - > Road safety management
 - Transportation system management
 - > Travel demand forecasting
 - > Corridor preservation and right of way
 - > Construction management
 - > Hazardous cargo routing
 - > Land side economic impact
 - > Environmental impact
 - Accident analysis
 - > Oversize vehicles permit routing

GIS is a powerful tool in the analysis and design of transport routing networks. Its graphical display capabilities allow not only visualization of the different routes but also the design of the network.

6.1 Risk management in Hazardous waste transport

GIS capabilities allow the risk analyst, decision makers, and general visualization of the potential transportation accident involving the release of the radioactive material into the atmosphere. There are different formulas describe the concept of hazardous wastes. The damages resulted of the uncontrolled release of the hazard wastes such as flammability, toxicity, and chemicals are based on where and when the accident occurs. Obviously, in order to reduce the risk of transportation hazardous waste is reducing the probability of transportation accidents frequency (28).

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6.2 GIS to minimize Hazardous Waste

Geographic information systems (GIS) represent a technology with considerable o dage (kalendar saan) potential for important applications in transportation engineering. One of the most important applications of the GIS is to utilize GIS to minimize the potential impact of hazardous waste transport shipment accidents. The interaction between the and the great that the first of the state of transportation system and the environment makes GIS technology very effective รมี เรนิดเกรเลี้ยงก็หนึ่งการการความ เดียวระบุ รายการ์ด การตา สูงกำลุด เรนาวาม พาร์ก ดัง สายการคลดพิพยาก in hazardous waste. The purpose of using Arc View GIS software store roadway signification section is a section of the section o information to make an assessment to choose the optimal route for shipments, which minimizes the travel distance and also the exposure of the hazardous waste to population. Some studies have shown that, GIS can develop a route The said the colour of the colour of the said of the s that minimizes the impact of hazardous waste incidents occurring along the REPORTED RESORTINGS roadway network. The ultimate goal of using GIS is to reduce the hazardous waste transportation risk, and provide the tools for reducing uncertainty in decision making to ensure that the decision is made wisely. Developed computerized model, which local jurisdictions can manage the risks related to hazardous waste transportation. The model was developed as a part of the risk assessment. The model is used to assess the risk associated with various transportation modes. The main purpose of developing and predicting models is to assess the safety of the community through which hazardous material will be transported. The risk measurements based on many factors such as roadway design, characteristics of drivers, vehicles, and the exposure of hazardous to the population. This model developed by Chung-kuo (29). The model developed with two sub-models as following.

$$CR=R_{L}(HMV)^{*}(P_{D}+P_{V}+N_{E}+N_{S})^{*}T_{F}$$
(6.2)

Where, in the fact to that the first of the fact that the

CR denotes to the community risk such as spillage, fire, etc. and the consequences of that such as the rate of injury, death, and property damage. In other word, it focus on the roadway transportation

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CP denotes to the community preparation such as emergency response

 $R_L(HMV)$ = risk level index of an incident involving a motor vehicle carrying hazardous materials

 P_D = population density factor f(x) = f(x) + f

Pv= property value factor? (IA in apopular papile evention in automobile Monaida Monai N_S = type and numbers of the facilities which is close to the roadway (schools, hospitals, etc.) RESPONDED THE PERSON A STATE OF T_F= forms of threat resulting from an incident such as spillage, explosion, fire, sealing to and microscop to At etc. R_L(HMV) is separately modeled as sub-model as following nelari kupel depara siriliny maara 6 m il $R_L(HMV) = R_L(MV) * (P_{EX} + P_{CG} + P_{FL} + P_{FS} + P_O + P_P + P_C + P_M)$ (6.3)Tallie volance is in construction Where. Afterpresents with representative becomes not seems lover and at expression (200) P_{EX} = %explosive vehicles in ADT registration of HO are (1946) aster encapes programmed (1946), excentioning in P_{CG} = % compressed gas vehicles in ADT PFL = % flammable liquid vehicles in ADT SERVER DESCRIPTION

Presidential model consequences and organic peroxides vehicles in ADT. The value one of the property of the vehicles in ADT and present of the vehicles in ADT and the

P_M = % miscellaneous or unknown class vehicles in ADT with a charge of the contract of the c

 $R_L(MV)$ = risk level of index of a motor vehicle incident = $T_L * (D_L + V_L + R_L) * S_L (6.4)$

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 T_L =traffic volume level index as a state of state and for a section x and x and x

D_L = driver level index

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 R_L = roadway geometry

S_L = average vehicle speed level index

Traffic volume T_L is rated 1 to 10

(CP) denotes to the level index for second sub-model for community preparedness, (ER) is emergency response index (0-50), and CR is regulation compliance index (0-50). Then

respect of the second control of the policy of the present of the second of the second

6.3 Case study #1. The objective of this study is to minimize the hazardous waste that exposed to the population during the transportation trips. Based on the study of Dr. Michael Anderson (21), about the use of GIS in the Birmingham, Alabama, and metropolitan area to reduce the hazardous waste transport shipment incidents. In the U.S. statistics there are over than 500,000 shipments of hazardous materials every day. Trucks on highways transport more than 90 %

of these shipments, and 5 to 15 percent of the trucks are carrying hazardous materials. Almost 50 percent of these materials are flammable petroleum products, gasoline, and other corrosive, and 13 % are chemical materials. The remaining shipments represent any of the 2,700 chemicals considered hazardous when transported in interstate commerce. This research develops GIS application in transportation to obtain an effective ways to reduce the haulage cost and reduce hazardous waste as well. In addition to, minimizing the potential impacts of incidents resulting in the possible spill of hazardous (21).

6.3.1 Study Area: The roadways for Birmingham, Alabama (Jefferson County) are from the 1995 TIGER files. The point locations for schools are taken from a directory of Jefferson County Schools and show differences in type of school, elementary, junior high, and high school as shown in the figure below.



Figure 6.1 School Locations in Birmingham, AL. "Development of GIS Based Hazardous Waste Transportation System (HWTS)"

6.3.2 Methodology

The methodology that adopted for this study is, using Dykstra's Algorithm or Moore's Algorithm to developed and produces a new short routs based on the network road travel characteristics. The study based on obtaining the relationship between the population of the facility and the distance from the road segment. For instance, using schools as the facility. Accordingly, The higher the risk associated with the facility, the shorter the distance from the facility to the road segment.

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The relative reciprocal function that is recommended is listed below.

Impact = sum
$$(f(p,d))$$
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Where, p is the population of the facility,

d is the distance from the road to the facility,

1/250 is the risk constant.

In this case, they used a path is 10.54 miles across town as shown in the figure below. By investigating the route, there are nine elementary schools, two junior high schools, and two senior high schools located within one half mile of the route.

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Figure 6.2 Shortest Path through the Network." Development of GIS Based Hazardous Waste

Transportation System (HWTS)"

GIS technology application in transportation is very profound. GIS is used to provide information for roadway segments within the specified distances of the study area. This information included the roadway segment distance, to develop a new potential reduction for the hazardous waste on the road segment. For the case study example, the student population of each elementary school is 200, each junior high school is 500, and each high school is 2,000. The area around each school shows the hazardous waste routing and each roadway segment the falls into this zone as shown in the figure below.

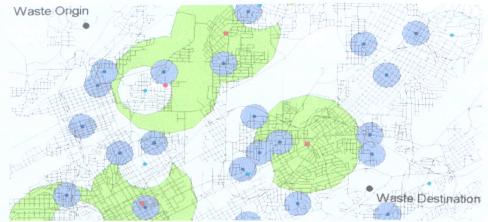


Figure 6.3 School Zones of Influence. " Development of GIS Based Hazardous Waste Transportation

System (HWTS)"

The shortest route compared to the school zones of influence show that there are significant areas where this route passes close to schools as shown in the figure below.



Figure 6.4 Schools Impacted by Shortest Route. " Development of GIS Based Hazardous Waste

Transportation System (HWTS)"

By using the roadway distance and impact area, a new route is developed that minimizes potential impact associated with a hazardous waste shipment.



Figure 6.5 Safest Route through the Network. "Development of GIS Based Hazardous Waste Transportation System (HWTS)"

By testing the two routes, the shortest path route has a distance of 10.54 miles compared to the minimized impact route of 11.68 miles. However, with the distance and impact level, the route that initially had the shortest path is scored as 38.91 and the route that minimizes potential impact is scored as 32.40. Therefore, providing a shortest transport route for a hazardous waste shipment that reduces the potential impact of an incident.

6.3.3 Conclusions for the case study

This study presented the development of a geographic information system based hazardous waste transport system (HWTS) that is intended to reduce the impact of potential incidents regarding hazardous waste shipments. The methodology included in the Hazardous waste transportation system provides for the determination of transportation routes that attempt to minimize the impact of potential incidents by incorporating socio-economic considerations into the routing process. The case study shown for Birmingham, Alabama is provided to

demonstrate the use of the HWTS using school locations as the socio-economic consideration. As demonstrated in the case study, the shortest route for the shipment, only 10.54 miles, passes by several city of Birmingham and Jefferson County schools. When the location of each school is considered into the routing equation, there is a small increase in total distance of travel, however, there is a larger increase in potential safety associated with the longer route". (21)

6.4 Case Study #2

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This study obtained form "Transportation Safety and Risk Analysis, along Rural Southwest Roads" Douglas Filler, 2002"(22). This study aimed at developing a set of methods designed to assist road departments in rural jurisdictions (local, county, state) improve the traffic safety of the roads under their management by addressing different risk factors and assigning different weights to these factors e.g. road curvature, side slopes, intersections etc by using GIS techniques. The authors developed and tested these methods in the U.S. Southwest, where thousands of kilometers of unimproved and graded dirt roads cross Native American reservations. This generally arid region is nevertheless subject to periodic summer rainstorms and winter snow and ice, creating hazardous conditions for the region's transportation lifelines.

By using GIS, the methods can lead to less expensive means of analyzing the risks and hazards along paved and unpaved roads of the American Southwest and are also transferable to international settings, particularly in similarly arid climates (22).

6.4.1 Study Area: and abusing land and sold account allows as beginning the sold and allowed the sold allowed the so

The site under consideration is Hopi Reservation is located on western edge of the Colorado Plateau within the northern half of the State of Arizona, and is surrounded by the much larger Navajo Reservation as shown in the Figure below.

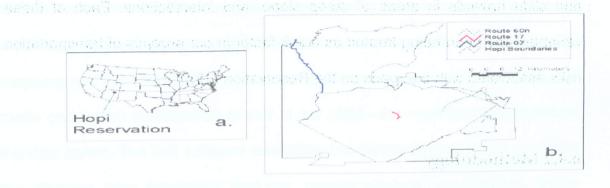


Figure 6.6 Maps of the Hopi Reservation "An Application of Lidar Technology to Highway Safety"

The climate is continental / temperate with hot summers and cold winters. Average daily high and low temperatures range from 5o/-6oC in winter and 32o/15o in summer. Soil scientists have recognized some 40 different soil classes on the Hopi Reservation. The soil distribution is complex and governed mainly by the extensive sedimentary parent materials (principally sandstones and shales) and topography. Three classes of roads cut across the Hopi Nation; paved highways maintained by the state of Arizona; graded dirt roads, which are maintained by the Bureau of Indian Affairs, an agency of the U.S. Department of the Interior; and a large network of informal roads, some of which receive occasional grading. Dirt roads are readily passable for much of the year although moderate to heavy rainfall in areas of clay soil greatly reduces tire traction, thus

rendering many dirt roads impassable for brief periods (usually several hours). As mentioned above, sudden downpours can also wash away road surfaces, thus cutting off important transportation lifelines on the Reservation. Other notable hazards include variations in road width due to the placement of drainage structures (culverts) and cattle guards, high curvature (i.e., sinuosity), rock-fall and slide hazards in areas of steep slope, and intersections. Each of these variables has been being treated as a risk factor in our analysis of transportation risks associated with the roads on the Reservation (22).

6.4.2 Methodology

The Hopi Nation has made significant investments in remote sensing, GIS, and GPS technologies. Further, the Nation has a federal requirement to develop a long-term plan for its road system. The data set consisted of geo-referenced data layers, including a set of digital orthohotos (1 meter spatial resolution), and a moderate resolution (10-meter) digital elevation model (DEM). Although Ikonos panchromatic and multispectral data would have been better for the first phase of this research, the relatively high cost of these data has prevented their use. Instead, the digital orthophotos of the area prepared by the U.S. Geological Survey were used. These data have the distinct advantage that they cost less than \$10 per 3.75-minute quadrangle. However, the digital orthophoto quarter quads (DOQQ), as they are called, have the distinct disadvantage that because they are derived from periodic aerial surveys, they do not reflect the most recent changes in the road network. In fast growing areas like many of the U.S. suburbs

they very quickly fall out of date. Thus, for many applications, recently acquired high-resolution satellite data are preferable. Nevertheless, for research purposes, they are excellent substitutes for the more expensive satellite data. Table 1 lists the baseline data sets used in analysis thus far (22).

From the DOQQs, washes and intersections were digitized using raster-based GIS software (Idrisi32). The main advantage to using this particular software is its advanced decision-support capabilities for use in land allocation, suitability mapping, and risk assessment. Linear and point features were rasterized to a 10-meter grid, which corresponds to that of the DEM—the most spatially coarse of the data layers. The GIS software was utilized to create derived layers depicting the distance from hazardous features, namely washes, intersections, steep slopes, and culverts.

operations gave applied in the common at all regal edition can be dulingly element. 6.4.3 Evaluation of digitized features

The accuracy of features digitized from the DOQQs was evaluated with a GPS in the field during an August 2001 visit to the Reservation. Both a hand-held Garmin GPS as well as a RedHen Video Mapping System were used, which provided post-processing differential correction for position and elevation. Thus, it was possible to evaluate the accuracy of the DEM, which is one of the most important layers given the highly variable, steep topography of the Reservation.

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6.6.4 Mapping areas of high risk:

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Since the initial goal was to map areas of high risk along roads, a set of procedures was used to standardize and combine data layers to create composite risk maps as following:

Methodology Flow chart

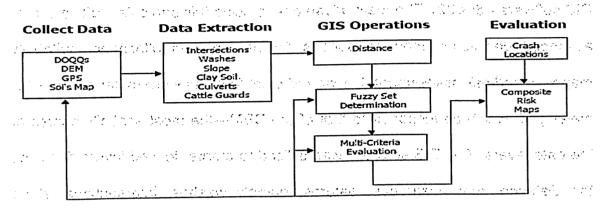


Figure 6.7 Different Steps for creating composite risk maps "An Application of Lidar Technology to Highway Safety"

Standardization of each data layer to a common set of values was performed were making to be a first to the first training of the first using the Fuzzy module in the software. This module is designed to assign each en grang er en er legten gan mar dit 2000 fatt met met in dem in de grane fatt fan de pixel in an image to a fuzzy set by evaluating any of a series of fuzzy set County hard on rooms and tap mental last relations of the second of membership functions. The main advantage to this approach for the current work party from the transfer of the second of is that it avoids setting hard or arbitrarily established thresholds between different The agreement in the property of the property of the property of the property of levels of risk. It also facilitates subsequent integration of data layers in the Description of the property of the property of the State of the sectors generation of composite risk maps, which take into account the major risk factors gregare compared to a first confinence or the confinence of the configuration of the configuration of the confinence of the configuration of the configurati for which we have data(i.e. slope, clay content, washes, culverts, intersections, and cattle guards).

Both linear fuzzy functions and J-shaped fuzzy functions were used (these can be further specified to be either monotonically increasing or decreasing functions), which are controlled by four breakpoints ordered from low to high on the measurement scale. A: J-shaped function sets point a sand d where the function is 0.5 and in the process, makes the J-shape function asymptotic to 0: and 1; points of absolute minimum and maximum risk. In the case of a monotonically increasing function, the first point marks the location where the membership function begins to rise above 0. The second point indicates where it reaches 1 (i.e., 100 percent probability of class membership). Output was scaled from 0 (zero probability of class membership) to 255 (100 percent probability of class membership) for each layer in our analyses. In the case of slope, for example, steepness was evaluated using a monotonically increasing function with the first breakpoint set at 10% (slopes are beginning to become "steep") and u mai percelument grands dem metro fra saltant dare get (Taras Dustino Amatric Ellista med b, c and d set at 25% (slope has become a full member of the class "steep ight what is an except that is dispersion to be slopes").

6.4.5 Creation of composite risk maps

Integration of the data to create composite risk maps along roads was carried out using the Multi-Criteria Evaluation (MCE) module, also in Idrisi32. Like the Fuzzy module, the MCE procedure allows for the combination factors using a variety of functions. The linear-weighted function was used, which is analogous to a weighted mean, with factor weights determined arbitrarily. Factor weights are very important because they determine how individual factors will tradeoff relative

to each other. In the case of a linear weighted combination, the higher the factor weight the more influence that factor has on the final composite risk map. A factor weight sensitivity analysis was carried by varying both the factor weights and the type of fuzzy function used for each risk factor thus creating a final set of twenty or so MCE composite risk maps. Once this step was completed, each CE composite risk map was then compared to a set of accident data points from the same road networks used in the analysis. These accident points were collected by the Hopi Tribal police and converted into a GPS/GIS database at the Hopi Tribal Office. T-tests were used to assess the statistical significance of risk values at crash versus non-crash locations.

6.4.6 Results (Findings)

The MCE output ("MCE test") layers, factor weights and fuzzy functions have been shown in the figure as following.

MCE test	Layers involved	Fuzzy Functions	Factor weights
1J 1L 2J 3J 3L 4J 4L 6J 11 14	1; 2; 3; 4; 5 1; 2; 3; 4; 6 1; 2; 3; 4; 5 1; 2; 3; 4; 6 1; 2; 3; 4; 6 1; 2; 3; 4; 6 1; 2; 3; 4; 6 1; 2; 3; 4; 5 1; 3; 4; 5 1; 3; 4; 5 1; 3; 4; 5 1; 3; 4; 5	L,L,L,L,J L,L,L,L,L L,L,L,L,J L,L,L,L,J L,L,L,L,	0.2; 0.2; 0.2; 0.2; 0.2 0.2; 0.2; 0.2; 0.2; 0.2 0.25; 0.15; 0.1; 0.2; 0.3 0.3; 0.2; 0.15, 0.25; 0.1 0.3; 0.2; 0.15, 0.25; 0.1 0.1; 0.25; 0.2; 0.3; 0.15 0.1; 0.25; 0.2; 0.3; 0.15 0.2; 0.1; 0.3; 0.15; 0.25 0.25; 0.25, 0.25, 0.25 0.2; 0.3; 0.3; 0.2 0.1; 0.4; 0.4; 0.1

Figure 6.8 MCE composite risk maps with normally distributed scores (values from 0-255). "An Application of Lidar Technology to Highway Safety"

Figure 11 shows the results of analysis for Route 17, which is one of three road segments that have been analyzed. As in all risk maps generated, this particular example produces data scaled from zero (no risk) to 255 (maximum risk). This composite risk map along with several others depicts good correspondence between crash locations (white dots) and areas of high risk, although in some instances crash location was displaced somewhat from the areas of highest risk, which coincide with the location of several risk features such as intersections, curves, etc. Several factors may explain this displacement including error associated with the crash site data (obtained through interviews with emergency personnel), post-collision momentum, or other hazards unaccounted for in analysis (e.g., temporary obstructions in the roadway).

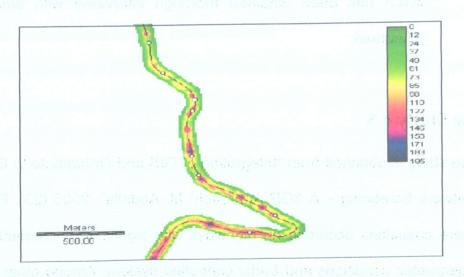


Figure 6.9 Results of MCE-based risk map (Test 4J, input parameters in table 1)

Blue to Black Tunes: Areas of high risk Green tune: Areas of low risk "An Application of Lidar Technology to Highway Safety"

Shortcomings of the study

The following shortcomings of this study have been observed:

- The digital orthophotos used have the distinct disadvantage that as they are derived from periodic aerial surveys, they do not reflect the most recent changes in the road network. These can quickly fall out of data in fast growing areas such as in U.S suburbs. Thus recently acquired high-resolution satellite data are preferable.
- Driver error is important part of collisions so it should also be taken into account while addressing different risk factors and collision history.
- There is possibility of error associated with the crash site data, which has been obtained thorough interviews with emergency personnel.

6.5 Case Study # 3

This case study is obtained from "Integration of GIS and Orthophoto to Enhance Road-Network Screening – A 3GR Approach" M. Abdalla", 2005 (23). Fatalities and severe casualties occurring on highways with significant increment due to unsafe geometric conditions and traffic controlled system. Among other factors, good visibility is essential to the safe operations of motor vehicles. Driving at nighttime can be more challenging than daytime driving, as the distance that a driver can see clearly is reduced at night. Therefore, most of the accidents occur at nighttime due to less visible environment, which is due to illuminated and un-

illuminated highways. However, there is a clear need to improve the analysis for nighttime collisions and to identify the lighting conditions accurately, but little evaluation has been done in this area because the collections process is costly and time consuming.

In this research paper, a new road-safety analysis technique is used for verifying and enhancing light database records in a road-network. Semi-Automatic method is based on the integration of data obtained from a Geographic Information System (GIS), orthophotos and a road-networks database, A semi-automatic method was developed to recognize illuminated and un-illuminated road segments by using a specific group of filters and the cross correlation technique. Validation of the procedure showed that the new technique improved the light database, and the semi-automatic method successfully identified street segment types and extracted the streets' poles positions.

The objective of this paper will improve the quality of the data, road safety analysis, and network screening.

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6.5.1 Data set sperie contribution true species sould too propositive to bookle.

Three different sources of data were used in this study:

- (1) Digital orthophoto images for target area
- (2) Roads database records (e.g. collisions records, traffic volume, etc)
- (3) Single Line Road Network (SLRN) in GIS, ArcView Format.

The data and images used in this study were obtained from the Regional Municipality of Durham.

6.5.1.1 Methodology of bean apple to an overall anythmethology of beautimps.

The main objective is to extract the street poles (illuminated or un-illuminated) from the streets to identify its location. Since the poles are vertical objects and have very limited width in orthophoto images. Direct extraction method is not applicable; however, indirect method is developed to extract the streetlight poles. Semi-automatic method has been developed to help users to recognize the streetlight poles types and location. The method is based on observing the streetlight pole and their shadow as the shadow makes the streetlight pole easier to recognize. Filters are used to make the streetlight poles' shadow more clear. The following major steps are considered in the semi-automatic method.

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6.5.2 Identifying Poles' location

- Link of orthophotos with SLRN by using ArcView
 - Template windows for streetlight poles are assigned.
 - To enhance the shadow of the streetlight poles, Minimum filter is used. It replaces the current brightness value of pixels. Minimum filter has the effect of spreading out black areas and shrinking while areas.
 - To enhance the objects in the image, 'Find Edges' filter is applied. It makes the object image more recognizable visually and mathematically when cross correlation is applied.
- Cross correlation technique to identify streetlight pole types and locations.

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- Supervised selection is made by selecting the best results from cross correlation

 Supervised selection is made by selecting the best results from cross correlation.
- Merging of results with GIS system

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6.5.3 Identifying Road Segment Types

different types of dataset are used. Digital orthophotos, road network records and SLNR. The Arc View GIS system was used to link the digital images, network screening database, collision database and SLRN.

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The linking procedure was used to identify which proad segments are stilluminated (Type 1) and un-illuminated (Type 2).

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6.5.3 Validation Method

In order to validate the test results from semi-automatic method, the technique was applied to the route, which consists of 62 different road segments with a total length of 39;886 meters. The site images and images taken by semi-automatic method were recorded in GIS. The results were verified on a site trip for the target route, which found that:

- wello to ten Fifty-seven out of sixty-two segments (91%) verified, ∌
- Five segments cannot be identified clearly. The reasons may be of the continuous core and are obstructed by the reason shadows of high buildings, according a sleep and the reasons.

6.5.3.1 Findings of the study:

 The semi-automatic method successfully extracted the position of streetlight poles and identified whether road segment types were illuminated or not. The procedure resolved 90% authenticity in the results obtained for illuminated, hence, improving the data for illumination in the road database.

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- The integration method presented offers a new tool to check and improve illumination data in the databases of road safety agencies.
- This method is ideal for rural and semi-urban areas as high-rise building and other factors may affect the imagery collected in urban areas.
 - The integration of GIS, GPS and remote sensing can help road safety analysts to improve the quality and accuracy of their findings.

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6.5.3.2 Shortcomings of the study:

- This technique could be used to check and examine intersections
 to identify which intersections are controlled by traffic signals. Semiautomatic technique may not be feasible if high buildings or other
 obstructions cover the pole's shadow.
- Orthophoto images with 0.2m spatial resolutions were used to extract the pole type/positions and to identify the segment types

and locations. However, high-resolution remote sensing images

(1.0m resolution) are recommended to identify road segment types.

6.5.3.3 Conclusion remarks of the study

The integration of GIS, orthophotos and databases can play a key role in improving the road network-screening database.

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- Recent advances in Geographic Information Science and decision support have resulted in a set of new techniques for efficient integration of different GIS and remotely sensed data layers to map composite risk along certain sections of roadway.
- Airborne platforms and satellite can provide information, not possible by conventional means, at the same time, these are inexpensive and rapid.

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- Orthophoto images can play a key role in extracting illumination data from the street network. Road agencies should give more attention to orthophoto images because the mages have considerable potential for supplying additional data about the road.
 - More Efforts should be done close the gap between research and application with consideration of cost to benefit ratio and cost comparisons.
 - > There should be more interaction of transportation and remote sensing researchers and subsequently the technologies.

6.6 Case Study # 4 https://doi.org/10.1000/10.1000/10.100/10.1000/10.100/10.100/10.100/10.100

This case study is obtained from "Application of Lidar and GIS Technology to improve Highway Safety and reduce hazardous waste transportation" A.J. Khatak et al 2003 (24). The objective of this study was to utilize GIS and LiDAR elevation data to obtain information that can lead geometric safety improvements at highway intersections. Intersection safety was analyzed by working on intersection sight triangles, which are critical characteristics for safe intersection operation. Intersection sight triangles are triangular areas needed at each intersection leg for visibility. Any obstructions coming within these sight triangles will lead to unsafe travel conditions. Intersections are designed with recommended design consideration to provide sufficient sight triangles. However, subsequent changes in traffic control (e.g. all way stop controlled, 2-way stop controlled), erection of utility poles, growth of trees, shrubs and hedges, and installation of street furniture can result in obstructed sight triangles.

To improvise the safety on highway and reduce the hazardous transportation, an application of Light Detection And Ranging (LiDAR) technology is used. LiDAR elevation data were utilized in line of sight analysis to obtain information on sight line obstructions at six selected intersections located on the IA1 corridor in lowa. The results were further verified by the field validation method of the existence of obstructions detected during the analysis.

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6.6.1 Methodology and data characteristic

The basic methodology adapted for this research work is shown in the figure below. It consists of acquiring data from several sources and then combining those data in geographic information system (GIS). The acquired data constituted such as geocoded crashes, study area orthophotos, and Lidar elevation data, which were combined in ArcView (ESRI) GIS software. Utilizing the combined data, sight lines were evaluated to obtain information on obstructions located within sight triangles at selected intersections. Results of the analysis were then field-validated by visiting the analyzed intersections. The study area and various data acquired for this research along with the processing procedures are described next.

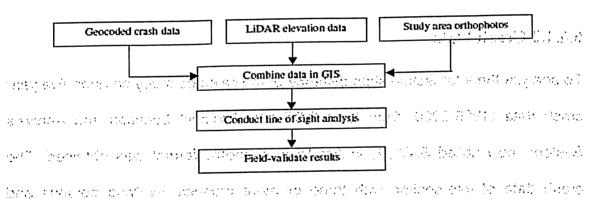


Figure 6.10 Schematic Diagram of Methodology of Research "An Application of Lidar
Technology to Highway Safety"

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6.6.1.1 Study Area

The study corridor selected for this research passing through Linn, and Johnson Counties, IA, consisted of the Northern section of IA 1 Solon Bypass as shown in Figure below. The study corridor has 72 intersections (include 43 highways). It

receives significant traffic during morning and evening because of its proximity to the University of Iowa.

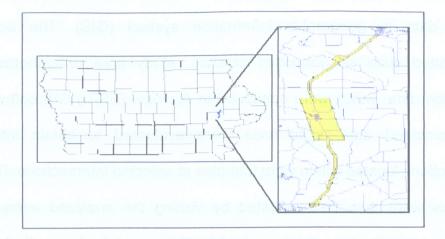


Figure 6.11 Study area corridor, IA 1Solon Bypass, IOWA "An Application of Lidar Technology to Highway Safety"

6.6.1.2 Crash Data

To analyze the intersection sight distance of the selected study corridor, five year crash data (1996-2000) from Iowa DOT GIS Accident Location and Analysis System (now called SAVER) in Arc View shapefile format was obtained. The crash data of intersection with three or more crashes involving persons and vehicles were extracted. This can narrows the research to the most critical intersections, which has more accidents.

6.6.1.3 Data analysis

Out of the 72 intersections selected in the corridor, six intersections in the City of Solon were selected for the line of sight analysis. The selection based on

intersection crash frequency (three or more during the study period), older driver involvement. Lidar data coverage. The crashes at these selected six intersections appear to be off-the road but this is due to minor discrepancies in overlaying the crash layer on the aerial imagery. All six selected intersections had stop control on the minor intersecting road. IA 1 running North-South through the City of Solon is named Market St. and it is the major road through the six intersections. Its intersections with East Third St. and East Rock St. are 3-legged while the other four intersections are 4-legged as shown in Figure below. Line of sight analysis was carried out utilizing both the LiDAR first return and last-return elevation data.

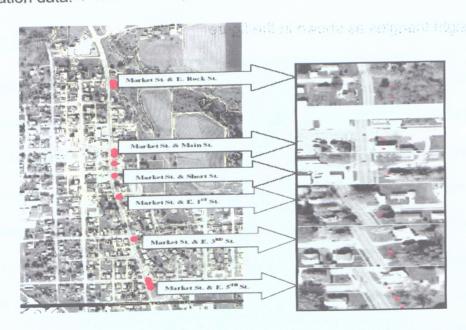


Figure 6.12 Selected Six Intersections and Crash locations "An Application of Lidar Technology to Highway Safety"

6.6.1.4 Line of Sight Analysis

Line of sight of an observer is determined by a 3-D Analyst extension using a TIN. An analyst specifies the location of an observer, the observer's eye height,

the location of a target, and the height of the target. Utilizing this input, ArcView calculates if the observer has a clear line of sight to the target. If not, ArcView identifies the location where the sight line is blocked. Line of sight analysis capabilities of ArcView were utilized to locate obstructions within sight triangles using TINs created from the first-return and last-return data.

Multiple sight lines were drawn in ArcView to identify obstructions within sight triangles at the six selected intersections. A distance of 100 ft along the major road was maintained between successive sight lines. Sight lines were drawn over TIN themes starting at the stopped driver's position and ending at the marked target position at 445 ft, and then at every 100 ft intervals along major road of the sight triangles as shown in the figure

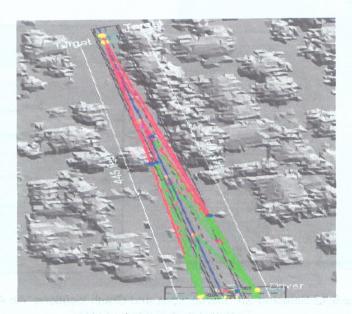


Figure 6.13 Multiple lines of sight at 100-ft interval along the major road "An Application of Lidar Technology to Highway Safety"

The light gray and dark gray portions of a sight line indicate the visible and non-visible portions of the driver's field of view. A dark gray point marks blockages of

sight lines. The distances between the dark gray points and the location of the driver stopped on the minor road were measured.

The results of line of sight analysis indicated 66 points where sight line was blocked while sight lines through three intersection sight triangles were not blocked. Since it is possible that a single object will result in the blocking of multiple sight lines therefore, the 66 points do not necessarily indicate the presence of 66 individual obstructions. To validate blocking of sight lines, the City of Solon, IA was visited and intersection sight triangles verified using video equipment.

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6.6.1.5 Field Validation

A digital video camera mounted 3.5 ft on a tripod and a passenger car with 3.5 ft marked on both sides was used to verify sight line obstructions within intersection sight triangles. The camera was placed at the location of the stopped driver on the minor road and its height (3.5 ft) represented the driver's eye level. The ender als Grauchssteine et all merke strategeten with hat da brainer freigheit out flacen that methers 🖎 🖰 passenger car was driven at a constant speed of 25 mph in each direction on the main road and its motion recorded by the video camera. The 3.5 ft high marked sides of the car represented a target of that height. Driving the car at a constant The Bridge Marie Target and the contraction of the contraction of the contraction of the contraction and the contraction of the 25 mph speed ensured that distances could be calculated during video analysis Topol profest on the mention toward receiving frame and reside by noting travel time of the passenger car. After video capture, it was transferred di diregioù bige marena se rare arri dent pertra delsea delsearar to a desktop computer for a frame-by-frame analysis. MGI's Video Wave 3 (Roxio, Inc.) video editing software was used to keep an accurate account of time elapsed during the video capture.

Objects located within 445 ft of the camera that blocked the passenger car were noted and their distance from the camera calculated. This calculation was based on the time it took the passenger car to travel between the object and the camera. If the blocking object was found to be in the approximate vicinity of the dark gray points in the line of sight analysis, then it was assumed that the line of sight analysis had correctly identified an obstruction in the intersection sighttriangle: Acadim dia managadi managadi managadi managadi managadi managadi managadi managadi managadi managadi

Most of the sight line blockings identified by the line of sight analysis were validated either as obstructions or as potential obstructions. Some of the actual included tree trunks. utility poles. validated obstructions appurtenances. Potential obstructions primarily consisted of overhanging tree branches as shown in Figure below The Community of the manager of the community of the comm

			Video validation	
material control establishment of control seed		Confirmed	Unconfirmed	
		Identified	62	4
	Line of sight analysis	Not identified	3	0

Figure 6.14 confirmed and Non-confirmed sight line obstructions "An Application of Lidar grant of the control of the second of the chology to Highway. Safety" of the grant of the second of the control of the control

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6.6.1.6 Findings of the study

The objective of this study was to illustrate the use of Lidar elevation data to was and restrict making perfoliosking and introduced as according to the reason theory of the obtain highway safety-related information by taking into consideration the entire rational in the first of the problem of Wilman in the contract of the first the state of the conintersection safety. Using Lidar data on potential sight distance obstructions at E agrafiji ganije pilatij gigaja igratija pilatnija a ali mit agam navalas a ak six selected intersections and then validating the results by videotaping in the on il 1939 il partin patin paggina naggi kalipe kaj tre kija kaj transka kant bio aktiva i skali okcide. field conducted line of sight analysis. Results verified that about 90% of the anagang sigu is mala na ing magalas

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potential and actual obstructions: were correctly: identified by: the line of sight analysis.

Line of sight analysis is useful for detecting intersections where drivers might have trouble due to potential sight obstruction (overhanging tree branches) in the intersection sight triangles.

Lidar is beneficial finding in safety analysis and other applications like flooding mapping, vehicle-collision prevention systems, speed enforcement, and area wide vehicle emission estimation and railroading route location. It can also create a false color imagery to identify features of varying degree of quality.

6.6.1.7 Shortcoming of the study

- Cost-benefit analysis could be a significant factor while evaluating the benefits of Lidar technology, in the presence of other alternative methods like video/photo log analysis, safety audits.
- Obtaining Lidar data and aerial images simultaneously would enable analysts to detect obstructions such as on-road vehicles in the analysis thereby reducing the detection of false obstructions.
- The impact of positional inaccuracies of Lidar (up to one meter, horizontally) is important on the identification of sight triangle intersection. The effect such inaccuracy has on the triangle depends greatly on the overall size, density and location of the obstruction with respect to the driver's eye. The closer the object to

more difference a positional inaccuracy will create.

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Conclusions

Hazardous waste is a real threat to human life. It has negative impact on the Statementalistics for exemple fight of the new en 1900s in outside the period of common actienvironment and the human health if it is not properly controlled and managed. recent will be weekly the to have been considerable and to wisconstitution and the telephone The effects of hazardous wastes have a different dangerous effect. The togene bounder of premate e. 270 militar of a 270 militar to another bound of hazardous waste generally contains different substances such as metal, tong at most horsewood as as \$11\$). Americans remanded the commit sales in medical sales chemical, pesticides, organics, inorganic, solid, liquid, and gaseous and visitionals becomes an entry when products transfer on approach from the passes. sometimes combination of some of them, but the biggest threat comes from the moved and take had arrayor formeritic rain to our our covery your currently and interests chemical wastes evolved from the contaminated ground water. Hazardous wastes have the most important potential environmental impact. In the past few decades, throughout the country, the concern for hazardous waste has grown tremendously due to the danger that threatens public health and the environment. In response to this concern, many legislatives and potentials have designated to control the wastes hazard problems. Generators, transporters, and handlers of the hazardous waste are playing the most important roles of reducing the hazardous wastes problems. Generator, are the institutions which produce the wastes whether manufactures or non manufacturing, which known as on-site wastes hazardous waste management which present 80 - 95 percent of hazardous waste volume, about 5-20 percent of hazardous waste are transported to off site waste hazardous facilities. There are different modes of hazardous waste transportion (highway, railway, air, water) and each mode has its own regulation and specifications.

There are 25% of people in the emergency response have adequate training to meet a hazardous materials emergency (30).

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Geographic information systems (GIS) represent a technology with considerable potential for important applications in transportation engineering. One of the most important applications of the GIS is to utilize GIS to minimize the potential impact of hazardous waste transport shipment accidents. GIS is a powerful tool in the analysis and design of transport routing networks. Its graphical display capabilities allow not only visualization of the different routes but also the design of the road network.

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