Guidelines for

PREVENTION, CONTROL, AND REPORTING OF CHEMICAL SPILLS AT AN INDUSTRIAL FACILITY

Prepared by the
Chemical Industry Advisory Committee
to the
OHIO RIVER VALLEY WATER SANITATION COMMISSION

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GUIDELINES

FOR

PREVENTION, CONTROL, AND REPORTING

OF

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April, 1978

Prepared by the Chemical Industry Advisory Committee

to the

Ohio River Valley Water Sanitation Commission
414 Walnut Street Cincinnati, Ohio

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FOREWORD

The guidelines which follow address a critical area of water quality concern--spills or abnormal discharges of solvents, cutting oils, and other chemcals within an industrial plant or storage facility. Effective prevention, control, and reporting of spills are essential to water pollution programs at all industrial sites.

As an aid to management in evaluating, improving, or developing an effective in-plant spill control program, an outline of the essential components of such a program is provided. Types of potential spills are discussed, along with possible causes and probable impacts of spills and accidental discharges at an industrial site. While it is recognized that transport of hazardous materials is an area of critical concern in the prevention and control of spills, the guidelines presented here do not address that problem.

An effective spill control program requires three key components. First, the plant's management must be sensitized to the importance of spill control and positively committed to developing and maintaining a program to prevent, detect, and control spills and accidental discharges. In addition, a chain of responsibility for in-plant handling of spills must be defined, and effective communication procedures established. Third, employees should be made aware of the seriousness of in-plant spills and informed about remedies and controls on a continuing basis.

These guidelines do not in any way replace or supercede local, state, or federal requirements regarding the development and content of mandated spill contingency plans.

Special thanks go to Charles C. Duffield for his work in preparing this report.

NOTE

Because each plant's arrangement and operational complexities present a unique set of circumstances, there are no easy answers to all potential problems related to in-plant spills. Personnel and procedures used in the development of a spills program will vary with the size and staff capabilities of the individual facility. Effective programs for control, prevention, and reporting of spills must be developed with local considerations in mind; however, the guidelines suggest avenues of approach which will be of assistance in formulating a plan for spill control.

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TYPES AND CAUSES OF SPILLS

Summary and Definition

Spill is defined as the deposit or discharge of any dry, semi-solid, or liquid material--other than the normal process wastewaters from production operations--which might be:

- Transported through plant sewerage (storm, process, or sanitary) or by surface runoff;
- Discharged to plant waste treatment facilities, to sewerage for transport to municipal treatment facilities, to public or private receiving waters, or the groundwater through infiltration.

The sources and types of accidental spills are numerous and variable. Since no two plants are alike, each must be individually reviewed in regard to spill potential and related programs.

The causes of spills are as widely variable as the types which might be encountered. Most are the result of "people failure" and are, therefore, controllable by the actions of people.

In recognizing and assessing spill potential it is essential that all circumstances be considered, in the belief that "anything that can happen will happen." Therefore, recognition, definition, and planning cannot be too comprehensive.

1.1 Abnormal Discharges

Primary causes of abnormal discharges can be classified as either design, maintenance, or operational determinants. Abnormal discharges result principally from overheating, uncontrolled exothermic reactions, over-loading, and leakage into cooling water or other drain lines.

Many errors arise from incomplete instructions and/or insufficient operator training. Where the possibility of an abnormal discharge exists, personnel should be so well indoctrinated that carelessness and over-confidence are avoided.

1.2 Transfer to and from Storage

Overpumping is a cause of spills.

Inadequate personnel training, work-force instructions, maintenance inspections and maintenance corrections may be causative factors, especially where transfers are on an intermittent basis.

Inadvertent damage to facilities, such as valves, piping, and storage tanks, by vehicles or work crews may also lead to accidental discharge.

1.3 Transfer to and from Carriers

Spills occur during transfer to and from transportation vehicles.

Accidents of this type present a more serious situation. Potential damage may involve treatment facilities or receiving waters.

1.4 Storage Facility Leaks and Failures

Structural or other failure of containment facilities, tanks, or lagoons may result in serious spills. Leaks which escape early detection may be serious, in that long periods of time may elapse before the leak is noticed or the loss detected.

Lagoons, utilized for temporary storage of concentrated wastes or reject materials, for equalization of wastes, or for controlled discharge, present a threat of accidental discharge. Failures in walls, bottom leaks, faulty valves, deterioration of liners, or capacity overload may result in a sudden large volume discharge or a small continuing discharge which remains undetected over a longer period.

1.5 Process Facility Leaks and Failures

Leaks in this category are usually of an intermittent or repetitive nature.

Although there may be a tendency on the part of operators to ignore or "live with" process inadequacies, such leaks add substantial waste load on a cumulative basis. Slugs in sewerage systems may result when an accumulation of waste material is flushed to the sewer.

Mechanical failures of valves, lines, and pumps may directly or indirectly cause spills and varying amounts of chemical loss, with adverse effects on the plant's effluent system. Most failures are sudden and unpredictable.

1.6 Boilout, Washup, and Process Shutdown Wastes

Even relatively small volumes of highly concentrated wastes resulting from periodic clean-up of equipment systems and storage facilities may be serious contributors to pollution.

Although disposal of such wastes may be infrequent, they are often unusual in strength and different in composition than normal process wastes consisting of raw material, intermediate compounds, and end products. Therefore, selection of cleaning materials, control of clean-up procedures, and a system for handling clean-up liquids and residues demand careful attention.

1.7 In-Plant Waste Control (Treatment) System Failures and Inefficiencies

The effectiveness of a plant's pollution abatement and control program is no better than the design and operation of the in-plant waste treatment and control facilities. Those facilities require the same careful attention as process or production operations. Treatment efficiencies must meet regulatory requirements, even when subjected to excessive loads due to spills or abnormal discharges to the wastewater collection system.

1.8 Storm Water Drainage

Storm water is not always recognized as a potential pollution problem and may be overlooked within and without industry. Pollutants which might be carried by storm water are subject to control.

Loading and unloading areas, tank farms, and outdoor storage of raw or waste materials are particularly significant potential sources of pollution through storm water drainage.

1.9 Fire, Flood, and Explosions

Water pollution is usually a relatively minor factor in plant fires, explosions, or other catastrophes. However, protection of water quality should not be overlooked in the preoccupation with other matters, since serious pollution may result if containment and treatment facilities fail or are overloaded during such abnormal conditions. Therefore, personnel responsible for dealing with emergency situations should possess technical expertise in pollution control.

2

EFFECTS OF SPILLS

Summary

Although the effects of a spill may vary widely in type and degree from plant to plant, the potential outcome can be defined for a given set of circumstances. Therefore, specific definition, projection, and assessment of hazard potentials are essential for each plant. Failure to recognize problems and act accordingly may result in serious operational, legal, and economic repercussions.

Thorough knowledge of these and other influencing factors is basic to controlling and minimizing the effects of a spill.

2.1 Fire or Explosion

Some materials themselves or in combination with others may present fire or explosion hazards when spilled on the ground or into sewers. Others may react to emit flammable or explosive fumes which are hazardous when confined in plant or sewers.

The effects and methods of handling such spilled materials vary in accordance with the specific chemical compound and conditions surrounding the accident. Although the hazard is normally confined to the immediate area of the spill and to nearby individuals, negligence or improper action may compound the problem in the immediate area or permit its expansion to other areas.

2.2 Release of Heat, Toxic, or Noxious Vapors

Some compounds react exothermically when diluted with water, combined with other materials, or released from conditions of controlled storage. Others release toxic, noxious, or nauseous fumes. As a result, air pollution or industrial hygiene problems may affect a relatively wide area and persist for extended periods.

2.3 Physical Damage to Sewerage and Treatment Facilities

The possibility of physical damage to sewerage systems by fire or explosion is obvious, as is the potential damage from chemical vapors. Less obvious are the effects of spilled materials high in suspended solids or those which interact to form solids that coat or clog sewers. Monitoring, control, and instrumentation equipment, as well as effluent transfer equipment, may also be damaged by such materials when spilled.

2.4 Upset of In-Plant Wastewater and Waste Treatment Systems

The accidental discharge of concentrated materials into plant sewerage systems may seriously affect physical facilities, recycle and reuse practices, pretreatment processes, or internal wastewater treatment plants.

Some chemicals can permanently damage collection systems, piping, pumps, and control equipment. Disturbing normal recycling or reuse of wastewaters may render the best system inoperative and/or seriously overtax in-plant controls. This is especially true when biological treatment systems are "killed" or "poisoned" by the introduction of a slug of acid, alkali, or highly toxic materials. Since the recovery period of biological treatment systems is often lengthy, the intervening polluting load presents a problem and, in some cases, might necessitate temporary shutdown or curtailment of plant production.

2.5 Shock Load to Public Treatment Facilities

Hazards similar to those in-plant exist when a highly concentrated waste is discharged to a publicly owned treatment system, but with even more potentially serious consequences. While production operations may be shut down for a recovery period, community treatment plants cannot cease to function without developing other problems.

2.6 Pollution of Groundwaters

While many spills result in detrimental effects on sewage treatment systems or surface waters, some may affect the quality of groundwaters. Leaks from storage tanks or impoundments with bottoms below soil level may percolate downward or laterally into shallow groundwaters.

The geology of the area is an influencing factor in determining the migration of spills of this type. Sandy soils are particularly subject to percolation of pollutants into groundwaters.

2.7 Pollution of Receiving Waters

Protecting the ultimate receiving water is the primary consideration in dealing with in-plant spills or accidental discharges. Whether the introduction of an unusual pollutant is direct or indirect, the consequences differ only in degree or in duration. The potential effects range from fish kills and destruction of other biota to rendering the water unacceptable as a water resource for downstream users.

3

CRITERIA FOR SPILL PREVENTION AND CONTROL

Summary

Effective spill prevention and control programs depend on pre-emergency recognition of in-plant hazards, along with action and direction commensurate with the hazard potential.

Applying the "if it can happen, it will" theory will assure that accidents are anticipated and steps taken to prevent them. Programs can be designed so that unanticipated spills do not measurably affect discharge effluent characteristics or cause deterioration of receiving water quality.

Since most spills are caused by mechanical failure and/or personnel error, most can be prevented or minimized.

3.1 Responsibility Assignment

Assignments of specific responsibility will vary with organizational structure. It is vital that responsibility for corrective action be established. Someone must be in charge to direct and coordinate the work of others.

Although prevention and control programs require substantial technical input, the assignment of line responsibility normally is retained by operations. This is appropriate, since spills are mostly operational; and control measures should be executed by operating personnel.

Communications, cooperation, and coordinated efforts are essential to a successful program. Timely input by knowledgeable personnel may mean the difference between routine solutions and crisis failures.

If an environmental incident occurs or is imminent, communication begins with an immediate report by the party who recognizes a problem or potential problem. Notification should be given to designated personnel in accordance with established procedures. The person recognizing the problem must know what to do, whom to notify, and how to report promptly and accurately. In turn, speed and quality of response is vital.

3.2 Assessment of Hazards

The hazard potential of each material, the spill problems it poses, and possible in-plant and outside effects must be clearly recognized.

Each plant, therefore, must have the facts on all:

- Raw materials,
- Intermediate process compounds,
- By-products,
- Waste materials, and
- End products.

The potential ill effects of spills must then be projected in relation to situations that can be anticipated.

Specific information about chemical materials--toxicity, biodegradability, reactivity, and odor--is usually available or obtainable. The potentially hazardous effects of such materials then require study, including such factors as types, causes, and effects of spills which might occur. Because of the possibility of run-off to receiving waters, the physical features and terrain surrounding the plant are extremely important.

3.3 Inspections and Materials Control

After surveying the hazard potential of materials used and developing a program for prevention of spills, it is important to audit regularly the effectiveness of the program through inspections and through a control program which reports materials lost.

Reporting of spill incidents and communication of reports to operating management is one means of evaluating and establishing the record. Such reporting also maintains a spill-conscious attitude by operating personnel. Audits of the physical facilities with respect to spill preventive maintenance should be done on a routine basis by review teams who report on their findings, performance records, and loss of materials.

3.4 Containment, Temporary Storage, Equalization, and Controlled Discharge

Spills will occur regardless of preventative measures. Therefore, providing ways to confine the spilled material is the first step to controlling its effects. Such temporary confinement alleviates the need for decisions to be made under emergency conditions. In many cases the spill is best coped with in its concentrated, identifiable form rather than after it has been diluted in plant sewerage. Methods include:

- Diking, similar to that used for tank farms. Dikes can be constructed around storage facilities, loading and unloading areas, and process units. However, diked areas must be constructed so as to preclude percolation to groundwaters.
- Diversion, via pumping or gravity flow to a temporary storage area. Automatic sewer cut-offs with appropriate pumping facilities may be useful.

In some circumstances spills may be routinely diverted to a holding or equalization facility for wastes and subsequently handled or combined with normal waste discharges.

Solid materials, pastes, or heavy slurries should be removed by physical means rather than by flushing into the sewer or drainage system.

3.5 Process Controls, Alarm Systems, and Fail-Safe Procedures

As with all accidents, spills are caused; they do not just happen. Therefore, their causes as well as their effects may be minimized through controls, alarms, and fail-safe procedures. Control equipment and warning systems should be coordinated with predetermined personnel response.

Use of controls and alarms varies widely from plant to plant. The sophistication required is determined by a logical assessment of a spill's potential seriousness and the probability that a spill might occur.

3.6 Countermeasure Actions

In some cases, the effect of a spilled material may be negated or minimized by countermeasures.

Preliminary steps may be containment, temporary storage, or diversion to equalization facilities.

All countermeasure actions must be predetermined; materials, equipment, and facilities must be readily available; responsible personnel must be assigned.

3.7 Removal, Cleanup, and Proper Disposal of Spilled Materials

Eventually, spilled material must be removed, the site of the spill cleaned, and the waste disposed of without continuing or recurring ill effects.

Potential pollution of water, air, or soil and possible translation from one to the other must be considered.

Normally, disposal can be accomplished by:

- Material recovery for reprocessing,
- Biological or chemical treatment, or
- Incineration, landfill.

In some cases it may be economically desirable to recover the spilled material through product processing or to sell it as raw material for another use. In others, contract disposal by a qualified firm may be preferable.

3.8 Personnel Training, Review Teams, and Check Lists

A successful spill prevention and control program is entirely dependent on the attitudes of plant personnel. Awareness and alertness are essential. Employees must be aware that virtually anyone can cause, contribute to, or be involved in a spill and that their action or inaction influences the level of control that is attained. Ongoing training should be conducted by review teams.

4

REPORTING

4.1 In-Plant Reporting

Minimizing the effect of a spill depends on awareness. Someone must recognize that there is a problem or potential problem and must know what to do, whom to notify, and how to report accurately.

In turn, the speed and quality of the response is vital. Evaluation and the implementation of countermeasures can be carried out effectively only by those who are thoroughly familiar with the situation, the materials involved, and the potential effects. Procedures must be established in advance; the program must be operable at all times and fit all conceivable incidents.

4.2 Reporting within the Company

Depending upon the case, notification within the company logically may come before or after reporting outside the company. If the situation is critical and the person in charge is fully qualified, immediate reporting to the appropriate public agency may be more important than timely transmittal of information up the internal management line. The objective is to minimize deleterious effects, and early communication should be with those who may best serve in achieving it.

4.3 External Reporting

Communicating with the appropriate public agency or agencies might be the first step in minimizing the effects of a spill.

Responsible officials (see section 3.1) at the plant should know what agency the spill affects and the degree of importance to that agency. Those to be contacted vary from plant to plant and state to state, but include:

- Water and/or sewage treatment management;
- Fire, health, and emergency services;
- State, federal, and local water pollution control agencies;
- Local and state air pollution control agencies; and
- Fish and wildlife agencies.

Federal and state laws, regulations, and permits require immediate reporting of most spills or abnormal discharges which may enter surface waters, infiltrate through the soil to the groundwaters, or pass through wastewater treatment facilities (either on-site or publicly owned).

5

SPILL CONTROL REVIEWS

5.1 Reasons for Spill Prevention Review

The purpose of a spill prevention review is to foresee hazards and to attack them before accidents occur.

5.2 Kinds of Review

Spill prevention review should cover:

. Process development,

. Plant modifications,

. Pre-startup, and

. Periodic spills.

5.2.1 Process Development Review

The group responsible for developing a process should be concerned also with anticipating spill potential and the impact of process hazards on the ultimate design of the plant. The choice of solvents and reactants, as well as operating conditions, is of prime importance. The spill prevention review should be made prior to initiation of the bench scale model, pilot plant, or other development work.

Such a review may eliminate problems during construction and operation. The results of the review should be incorporated in an environmental impact section of the process report.

5.2.2 Preliminary Review

As process development progresses and the final project is initiated, opinions should be obtained from the manager of environmental control, as well as from plant and corporate engineers. The project manager should consider each recommendation and comment on appropriate action.

These recommendations are important in determining possible alternative solutions and resolving differences in judgment.

5.2.3 Project Design Review

During the design stage, all phases of spill prevention--electrical precautions, fire protection, instrumentation, mechanical processes, and personnel safety--should be reviewed to assure they are provided for at appropriate stages.

5.2.4 Pre-Startup Review (Manufacturing)

A spill prevention review should be held prior to completion of the plant operating manual and before plant startup in order to:

- . Confirm that operating personnel are thoroughly familiar with the hazards involved and the controls that have been engineered into the process;
- . Determine whether any additional process hazards are involved, including those which could develop under abnormal conditions; and
- . Check the adequacy of operating procedures, emergency procedures, and startup plans.

Participants should include research, engineering, and plant pollution abatement personnel, as well as others who can advise operation supervisors of hazard potentials and spill prevention provisions.

5.2.5 Periodic Plant Review (Manufacturing)

Since minor changes in operating details, equipment, piping connections, temperatures, pressures, operating rates, and raw materials inevitably occur during operation, periodic reviews are essential to:

- . Keep operating personnel alert to hazards,
- . Determine whether operating procedures require revision,
- . Screen the operation for changes which may have introduced new hazards,
- . Identify changes which should be made to reduce existing hazards, and
- . Reveal through new experiences or information potential hazards not previously recognized.

The review should look particularly for changes that have been introduced with or without the benefit of process amendments or alteration projects.

5.2.6 Review Reports

Reports on spill prevention review should be sent to the corporate or plant environmental control group. They enable the company to:

- . Compile suggestions for spill prevention and control in other facilities, and
- . Develop a file of information to aid engineers in designing new plants.

5.3 Organization of Spill Prevention Reviews

5.3.1 Team Approach

Spill-occurrence-probability analyses can best be obtained through a review-team approach, utilizing the knowledge and experience of qualified individuals, with technical backgrounds of team members varying according to the type of spill prevention under consideration.

To secure an objective review, personnel from a unit not concerned with the success or failure of the new project should be included in the review team.

Company size may affect the formation of a technically competent team. In some circumstances, the services of qualified consultants or insurance company specialists may be required.

5.3.2 Composition of Review Team

The review team should be composed of individuals who participate in reviews of all units in the plant and others appointed for the particular review at hand. A representative from the pollution abatement or environmental control department should always be a member of the group.

A group appointed for a particular review should include a representative from each of the functions concerned with the operation: manufacturing, maintenance, technical, and possibly research, engineering, or other special categories--selected on the basis of applicable expertise.

5.3.3 Special Value of Central Review Group

Although the central group will generally be the most experienced, all groups should work as one team. Central members should see that the proper questions are asked, while participating on a basis of equality with the other members.

The central group's primary role is to provide the experience derived from prior review along with a broad knowledge of interdependency of hazards among various internal and external operations.

5.3.4 Scheduling of Spill Prevention Reviews

Spill prevention reviews for the different operations in a plant should be routinely scheduled. Crash review programs are seldom beneficial, due to their shallowness.

5.3.5 Review in Depth

The spill prevention review should be a comprehensive step-by-step examination of the operation, to uncover unsuspected hazards which could lead to serious incidents, including:

- Process chemistry;
- Hazardous properties of all materials; and
- Physical operations, including flow charts, utilities, and plant layout.

5.3.6 Recommendation by Team

The review team should develop recommendations for attacking recognized hazards, but not engineering solutions. Its function is to analyze in depth, not to design.

5.3.7 Review Team Report

The activity of the review team should culminate in a concise, definite report with two primary sections:

- A listing of spill exposures, and
- A listing of hazards with recommendations for action.

6

SPILL PREVENTION AND CONTROL CHECK LISTS

6.1 Definition and Assessment of Hazards of Material Handled

6.1.1 Raw Materials

- Have all raw materials been considered?
- Have the potential consequences of each raw material been defined?
- Is the inventory control of raw materials adequate?

6.1.2 Intermediate Process Compounds

- Have all intermediates been identified?
- What are the possible consequences of spillage of intermediate compounds?
- Do you have means for detecting and measuring the losses of intermediate materials and compounds?

6.1.3 End Products

- Have all end products been considered?
- Have the potential consequences of spills of each end product been defined?
- Is the inventory control of end products adequate?

6.1.4 By-Products and Waste Products

- Have all by-products and waste products been considered?
- Have the potential consequences of spills of each by-product and waste product been defined?
- Is the inventory control of by-products and waste products adequate?

6.1.5 Rating Guide

- Has the rating guide been prepared or considered for use in spill situations?
- Have the frequency, detectability, consequences, toxicity, and local condition factors been considered?
- Have all raw materials, intermediates, by-products, waste products, and end products been rated?
- Who has access to and uses the rating guide?

6.2 Assessment of the Potential of Spill Occurrence

6.2.1 Receiving and Unloading

- Has the "anything that can happen, will" philosophy been applied?
- Are the losses monitored?

6.2.2 Storage and Transfer

- Are all materials inventoried and controlled?
- Are small spills reported and handled properly and promptly?
- Has the probability of a major spill incident been established?

6.2.3 Process Operations

- What is the practice of controlling and reporting emergency discharges?
- Are process upsets and equipment failures repetitive? If so, why?
- Are process errors recognized and reported?
- Do the operating personnel know and recognize the detrimental effects of spills and accidental discharges?

6.2.4 In-Process Transfer

- What are the practices of controlling and reporting emergency discharges?
- Are in-process transfer failures repetitive? If so, why?
- Are transfer errors recognized and reported?
- Do the operating personnel know and recognize the detrimental effects of spills and accidental discharges?

6.2.5 Laboratory Operations

- Are the potential ill effects of accidental or unusual discharges recognized?
- Is waste control practiced in laboratory procedures, sampling, handling, disposal operations?

6.2.6 Shut-Down and Clean-Up

- Are procedures developed with spill prevention and control in mind?
- Can the unusual be isolated and handled as a special case?
- Are personnel aware that the problem can't be flushed down the drain?
- Have personnel been alerted to the unusual hazards involved in start-up and shut-down, especially emergency shut-downs?

6.2.7 Maintenance Procedures

- Are maintenance personnel aware of spill prevention and control problems?
- Do production, technical, and waste personnel coordinate with maintenance?

6.3 Evaluation of Influencing Physical Factors

6.3.1 Plant Site

- . Are physical factors such as terrain and proximity to receiving waters considered in planning, prevention, and control of spills?
- . Are dikes and other containment devices influenced by physical factors of slope, runoff, flooding, soil conditions?

6.3.2 Machinery and Equipment

- . Is the design of plant machinery and equipment a significant factor in spill prevention?
- . Is related auxiliary and support equipment properly maintained?
- . Does spill prevention and control equipment receive adequate inspection and preventive maintenance?

6.3.3 Buildings, Structures, and Grounds

- . Are roof deposits potential spill hazards?
- . Are ground deposits potential spill hazards?

6.3.4 Operating Areas

- . Are spilled materials handled promptly and properly?
- . Does accumulation of small spills present a problem?

6.3.5 Sewerage Systems

- . Are sewers segregated or combined?
- . Can spills be diverted to minimize effects?
- . Is the plant sewerage system maintained properly?
- . Are blockage and back-up flooding a problem?

6.3.6 Storm Water Runoff and Collections

- . Has the effect of storm water been considered?
- . Can storm water be diverted away from spill areas?
- . Are roofs and ground a source of "Act-of-God"-spill effects?
- . Are storm water effluents measured, sampled, and evaluated?

6.3.7 Utilities and Utilities Transmission

- . Do spill prevention and control devices have adequate uninterrupted power?
- . What is the effect of power interruption on alarms, control systems, pumping, etc.?
- . Does the interruption of power to the wastewater treatment plant contribute to potential for spills?

6.3.8 Potential and Natural Disasters

- Has the probability of natural disasters been determined or considered?
- What areas could be affected by natural disasters?
- Is sewerage back-up a problem?
- Can waste impoundment ponds be influenced?