APPENDIX "A"

Applying to Change the Regulatory Flood Standard Within A Watershed - Procedures

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APPLYING TO CHANGE THE REGULATORY FLOOD STANDARD WITHIN A WATERSHED

For those watersheds with a regulatory flood standard greater than the provincial minimum acceptable standard of the 100 year flood, the option exists for municipalities and planning boards to apply to the Minister of Natural Resources, in accordance with the following procedures, to change the standard, subject to the following overriding conditions: [6]

- changes to the existing regulatory flood standard will only be considered with the support of a significant majority of municipalities and/or planning boards within the watershed, in consultation with the local Conservation Authority or Ministry of Natural Resources, where Conservation Authorities do not exist; and

- the lowering of the existing regulatory flood standard where the past history of flooding reveals a higher level is more appropriate will not be considered.

Costs associated with changes in the regulatory flood standard, i.e. re-mapping, flood studies, etc., will be eligible for funding under the normal provincial grant programs.

It is recognized that complete information may not be available when a municipality comes forward with a request to change the regulatory flood standard. It is suggested however, that reasonable information be provided to assess the impacts of the change.

Conservation Authorities and Ministry of Natural Resources Regional Offices, where Conservation Authorities do not exist, will be responsible for co-ordinating requests for changes.

6

NOTE:

For territories without municipal organization, planning boards, where they exist, will assume the responsibilities identified for "municipalities" within the context of this process. For territories without municipal organization that do not have planning boards, requests to change the regulatory flood standard will be made directly to the Minister of Natural Resources by interested parties.

To facilitate requests for changes in the regulatory flood standard, the following sequence will be followed: (See also Figure 12)

(1) Responsibilities of the Initiating Municipality

- when considering requesting a change in the regulatory flood standard, the initiating municipality will first provide a suitable forum for public input for which prior notice is given to the general public.

  A request made to the Minister of Natural Resources to consider a change will be in the form of a council endorsed resolution. The resolution, accompanied by documentation on the prior notification and opportunities for public input, will be forwarded to the Minister of Natural Resources together with an explanation as to the reasons for the request. The Minister may wish to seek clarification or additional information from the initiating municipality;

(2) Ministry's Action

- main office of the Ministry of Natural Resources will inform the appropriate Conservation Authority or Ministry of Natural Resources Regional office, where no Conservation Authorities exist, and the Ministry of Municipal Affairs, of the request for a change;

(3) Co-ordination/Technical Input by the Conservation Authority or Ministry of Natural Resources

- the Conservation Authority or Ministry of Natural Resources Regional office will provide written notification to each municipality within the watershed. Municipalities will include upper tier (i.e. regions, counties, etc.) and lower tier (i.e. cities, townships, etc.), whether situated totally or partially within the watershed. The transmittal letter will:

  - identify that the Conservation Authority or Ministry of Natural Resources Regional office is acting in a co-ordinating role on behalf of the Minister of Natural Resources

- identify that a request to change the regulatory flood standard has been made and include the actual resolution passed by the initiating municipality

- request that all municipalities make their views known (whether for or against) in the form of a council endorsed resolution

- identify that the resolutions are to be directed to the Minister of Natural Resources but forwarded to the local Conservation Authority or Ministry of Natural Resources Regional office for compilation

- request that documentation of the public notification and the opportunities afforded for public representation also be provided and forwarded in conjunction with the council endorsed resolution

- identify that the comments of the Conservation Authority or Ministry of Natural Resources Regional office will be forwarded to each municipality in the near future

- identify that a change in the regulatory flood standard may result in changes to municipal planning documents (i.e. official plan, zoning by-laws, etc.) and that the municipality may wish to contact the Ministry of Municipal Affairs in this regard;

- under separate cover, the Conservation Authority or Ministry of Natural Resources Regional office will provide comments to the municipalities regarding the water management implications, if any, of a change in the regulatory flood standard. Comments may include specific information on:

    - past history of flooding
    - time required to pass flood flows
    - extent and rate of urbanization
    - changes required to give effect to a change in the regulatory flood standard
    - funding implications
    - etc.;

(4) Responsibilities of the Responding Municipalities

- in considering the request of the initiating municipality to change the regulatory flood standard for the watershed, each municipality will provide opportunities for public input for which prior notice is given to the general public;

(5) Additional Opportunity for Public Input

- if after a municipality has finalized its position through a council endorsed resolution, members of the public still wish to make their views known, they may do so directly to the Minister of Natural Resources;

(6) Minister's Decision

- once obtained, the Conservation Authority or Ministry of Natural Resources Regional office will forward all municipal resolutions, including documentation of public notices and opportunities provided for public input, and its own comments to the Minister of Natural Resources and copies of the submission will be sent to each watershed municipality for information purposes;

- in considering a request to change the regulatory flood standard, the main office of the Ministry of Natural Resources will consult the Ministry of Municipal Affairs and may request the comments and opinions of any other groups and/or individuals, as deemed appropriate;

- upon making a decision, the Minister of Natural Resources will directly inform, in writing, all watershed municipalities, the local Conservation Authority or Ministry of Natural Resources Regional office, and the Ministry of Municipal Affairs;

(7) Communication Plan

- upon formal approval of a change in the regulatory flood standard, the watershed municipalities, in conjunction with the local Conservation Authority or Ministry of Natural Resources Regional office, will jointly prepare a communication plan to inform:
  - the general public
  - interest groups/associations
  - other appropriate public agencies
  - consultants (i.e. planning, engineering, architectural, etc.)
  - developers/builders
  - others

The communication plan will also highlight the major water management changes and changes to municipal planning documents that may be required as a result of the change in the regulatory flood standard.

APPLYING TO CHANGE THE REGULATORY FLOOD STANDARD WITHIN A WATERSHED

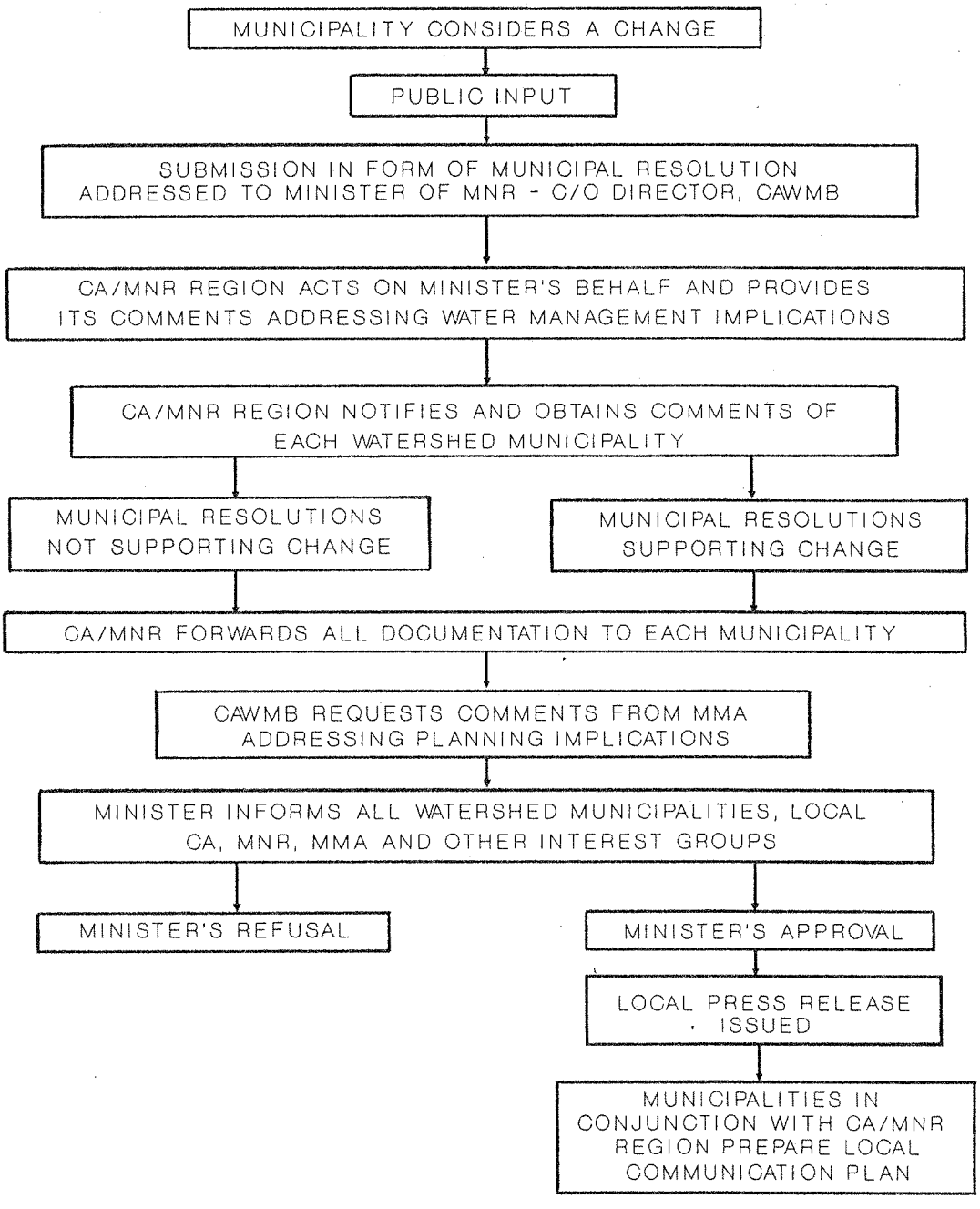

FIGURE 12

APPENDIX B

APPLICATION OF THE TWO-ZONE CONCEPT

FACTORS TO BE CONSIDERED

APPENDIX "B"

Application of the Two-Zone Concept

Factors to be considered

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APPLICATION OF THE TWO-ZONE CONCEPT
FACTORS TO BE CONSIDERED

Evaluation of the following factors will assist in assessing the suitability of applying the two-zone concept.

(1) Frequency of Flooding

Caution should be exercised in applying the two-zone concept for chronic flood problem areas. While development in such areas could adequately be floodproofed, maintenance and upkeep would continuously be required to ensure floodproofing measures and local services remain effective.

(2) Physical Characteristics of the Valley

Steepness of valley slopes, instability of banks and poor soil conditions in flood fringe areas can physically render the flood fringe unsuitable for development. Adopting the two-zone concept would show more promise for areas with a flat overbank and shallow flow. Topography varies, so evaluation is necessary on a local basis in determining suitability. (See Figure 13).

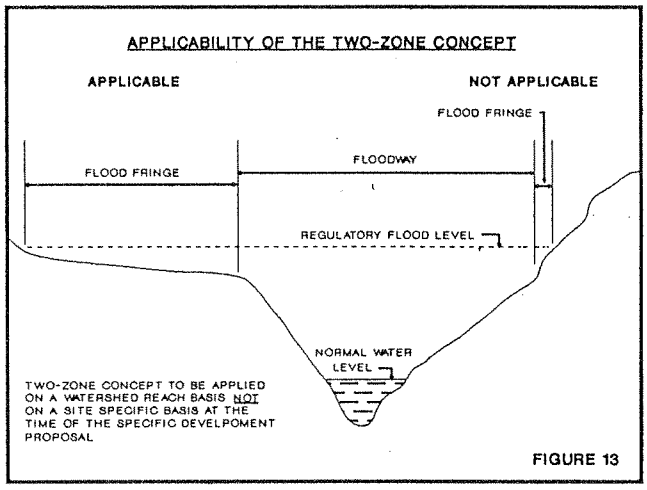

FIGURE 13

(3) Local Need

Suitability of flood fringe areas for development can be influenced by municipal planning considerations including availability of developable land elsewhere in the municipality. In urban areas where land values are high and pressure for development is usually the greatest, the concept shows promise. Lot sizes are usually larger in rural areas, and it is generally possible to locate development outside the flood plain. Therefore proposed application of the two-zone concept in rural/agricultural areas will require detailed rationale/justification.

(4) Impacts of Proposed Development

Encroachment within the flood fringe area usually results in an increase in regulatory flood levels. The extent of potential increases will be dependent on a number of factors in watershed characteristics and the degree to which the two-zone concept is to be applied. As a result, it may be necessary to recalculate the regulatory flood levels for floodproofing purposes and identify and assess the upstream and downstream impacts where the two-zone concept is being considered. This is particularly true where the two-zone concept is to be applied over extensive areas.

(a) Regulatory Flood Levels at the Site and Upstream

Filling and construction within the flood fringe area reduces the cross-sectional area of the waterway, so the corresponding flood level increases at the site and immediately upstream. This increase in the regulatory flood level can be estimated with reasonable accuracy and normally does not require major engineering studies.

(b) Regulatory Flood Levels Downstream

General encroachment within the flood fringe area reduces the storage capacity of the flood plain and results in an increase in flood flows and the regulatory flood levels along the downstream reaches of the river. If undertaken during the initial flood plain mapping process, the revised levels can be computed without major additional expense. Where flood plain mapping was undertaken several years earlier and the data base utilized in preparing the maps is not readily available, the calculation of the revised flood levels may require major engineering studies at substantial cost.

(5) Feasibility of Floodproofing

One of the major factors in determining if a flood fringe area is suitable for development is the feasibility and cost of floodproofing.

(6) Constraints to the Provision of Services

Flood fringe areas are low-lying and it is often difficult and expensive to provide necessary services (watermains, sewers, drainage works, etc.) to serve the developments. Drainage systems should provide protection against the regulatory flood and it may be difficult to provide outlets above the regulatory flood level. In these situations, it may be necessary to provide pumping facilities which could result in some additional expense in new developments.

(7) Ingress/Egress

Major accessways to development potentially located in the flood fringe must be examined. It is not acceptable to have development isolated during the flood conditions because roads and escape routes are not passable.

(8) Changes in Land Use

Land use is a key factor considered in flood plain studies and the calculation of flood lines. Proposed development, not anticipated in these calculations, could create increased flood risks and thus reduce the effectiveness of flood plain management programs.

It is therefore imperative that municipalities discuss proposed changes in land use with the local Conservation Authority or Ministry of Natural Resources, where one does not exist.

(9) Administrative Capability

The feasibility of the two-zone concept requires the examination of a number of factors and implementation requires assurance that various conditions are complied with. Therefore, staff availability and expertise must also be considered.

As well, certain planning tools (e.g. zoning, site plan control, subdivision control) are required to effectively implement the necessary land use controls. Where such tools are not available, e.g. areas without municipal organization, application of the two-zone concept is not a viable option unless supported by detailed methods of implementation.

It is not mandatory that a municipal official plan contain floodway - flood fringe policies prior to utilizing the two-zone concept. It is certainly intended that the municipal documents ultimately outline the basis for utilizing the two-zone concept and the areas of the municipality where it would apply. However, some municipalities in conjunction with the Conservation Authority (Fill, Construction and Alteration to Waterways Regulation) or the Ministry of Natural Resources, may have already been utilizing the two-zone concept. In this regard, it is not the intent of the Provincial Flood Plain Policy that the water management options be applied retroactively, to municipal planning documents.

During the preparation of an official plan update or a major official plan amendment affecting flood plain areas, the municipality in conjunction with the Conservation Authority or Ministry of Natural Resources, should include policies addressing:

- existing areas of the municipality utilizing the two-zone concept and/or

- a framework for analyzing potential areas of two-zone application, including both land use considerations and technical flood plain information and, (See Figure 14)

- the inter-relationship between the official plan, zoning by-law and the Conservation Authority's Fill, Construction and Alteration to Waterways Regulation.

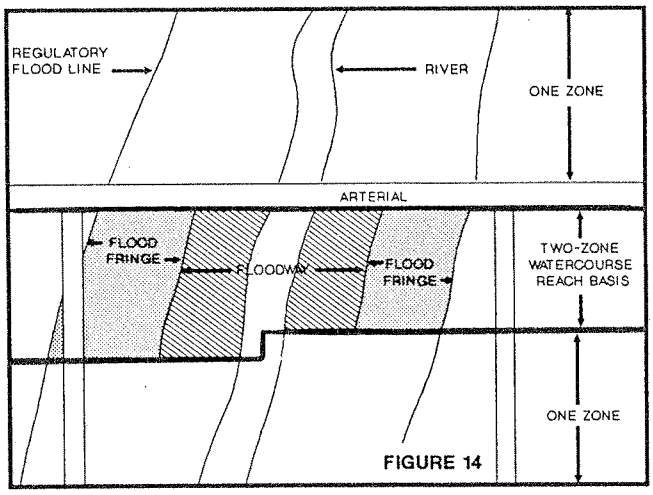

FIGURE 14

APPENDIX C

SPECIAL POLICY AREAS

FACTORS TO BE CONSIDERED
AND
PROCEDURES FOR APPROVAL

APPENDIX "C"

Special Policy Areas - Factors To Be Considered and Procedures for Approval

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B - Procedures for Approval

SPECIAL POLICY AREAS

A - FACTORS TO BE CONSIDERED

In determining whether or not an area potentially qualifies for special policy area status, the factors to be considered can be grouped into two major categories -- community related and technical.

(1) Community Related

The characteristics of the community itself are important considerations in identifying eligibility for special policy area status. To potentially qualify, an area should:

- have a municipal commitment to area maintenance;
- be an area designated in the official plan for continued growth;
- have significant investment in infrastructure, i.e. services;
- limited opportunities for development elsewhere.

(a) Municipal Commitment

To qualify for special policy area status a municipality must have a commitment, reflected in its official plan policies, to the continued upkeep of the area, such as an active program to revitalize.

(b) Designated Growth Centre

To qualify for special policy area status, a community must be recognized as a centre for urban growth and development. This would be reflected in planning documents - regional municipality, county, joint planning area or local municipality plan. This criterion attempts to ensure there is a desire and commitment to further development on the community's part.

(c) Infrastructure Investment

A further measure of commitment to continued growth is the extent of investment in community infrastructure. Practical indicators include the extent of servicing that exists, i.e. water and sewage.

(d) Limited Alternatives

A community with feasible alternatives for expansion or redevelopment outside the flood plain area would not necessarily qualify for special policy area status.

(2) Technical Criteria

To determine if a community qualifies for special policy area status, various technical criteria relating to the flood hazard must also be considered:

- appropriateness of other flood plain management measures, i.e. remedial works, two-zone approach;
- depth of flooding and velocity of flow;
- frequency of flooding;
- feasibility of floodproofing measures;
- upstream and downstream effects;
- frequency of ice jams and other obstructions;
- berms and flood walls;
- reduced regulatory flood standard.

(a) Appropriateness of Other Measures

In order to contemplate eligibility for special policy status, other measures such as remedial works and the two-zone approach must be proven to be unworkable.

In situations where remedial measures to permanently reduce flood levels may not be implemented in the immediate future, a special policy area might be considered as a water management option, until the remedial measures have been completed.

(b) Flow Characteristics

The depth of flooding and velocity of flow within a flood plain will have a bearing on the extent and location of a special policy area. No matter how strong the arguments relating to other criteria, an area susceptible to severe flooding may not be appropriate for special consideration.

(c) Frequency of Flooding

The frequency of flooding relative to the depth and velocity criteria also determines if special policy area status is appropriate. Potential special policy areas will be individually evaluated relative to flood frequency, both past and future.

(d) Floodproofing Measures

The feasibility of floodproofing new development, in general, within the special policy area must be examined. Based on flood characteristics, local conditions and type of land use proposed, alternative floodproofing measures can be examined as to their individual feasibility and desirability. Key in examining alternative floodproofing measures is the level of flood protection that can be afforded.

(e) Upstream and Downstream Effects

The effects on upstream and downstream areas caused by increased development in the flood plain must be taken into account. Normally, this is determined through the watershed planning process of the Conservation Authority or other special water management studies co-ordinated by the Province. These effects may be only minor in some instances. In others, because of the land use patterns and topography, the effects, though significant, may be acceptable. To determine upstream and downstream effects, all special policy area proposals will be evaluated on a case by case basis.

(f) Frequency of Ice Jams

Ice jams are a natural phenomena caused by topographic, hydraulic and meteorological factors. Resultant flooding has long been a problem and must be considered in the decision making process regarding development in a flood plain.

It is almost impossible to predict in advance whether an ice jam will form or if any resultant flooding will occur and to what extent it will occur.

With ice generated floods, river flows are generally much below a regional flood (winter conditions), but due to ice constriction, levels may rise above the regulatory flood level. Due to the unpredictable nature of ice jams, a conservative approach to development is needed where ice jams are known to have caused problems.

(g) Berms and Flood Walls

Where a berm or flood wall has been properly designed to the regulatory flood level and constructed, and a suitable maintenance program is in place, the floodway would be considered to be contained within the berm or flood wall area. The area behind the berm or flood wall can be considered flood fringe. As such, a new development would be required to be floodproofed to the regulatory flood level. If new development can not be floodproofed to the regulatory flood level, then special policy area status may be requested.

If there are any openings in the berm or flood wall (e.g. road crossings, watercourse confluence etc.) which would require human intervention to complete the dyke during an impending flood through sand bagging, placing of stop logs etc., the berm or flood wall shall not be considered to contain the floodway.

The establishment of no or limited development zones behind a berm or flood wall will be dependent on local conditions (e.g. flood depth and velocity) and local approaches to flood plain management. As a precaution, certain areas immediately behind a berm or flood wall may be considered too hazardous for any or certain types of uses, if through ice jams, debris jams etc., failure of the berm or flood wall was ever to occur.

(h) Reduced Regulatory Flood Levels

For watersheds where reduced regulatory flood levels have received approval by the Minister of Natural Resources in accordance with the provisions of Appendix "A", the option still exists for a municipality to apply for preliminary approval in principle for Special Policy Area status. However, if for example, the new regulatory flood level for a watershed is the 100 year and a floodway has been defined using the product of depth and velocity, it may be difficult to provide justification for the two-zone concept being too stringent.

Existing Special Policy Area policies may require revision once a reduced regulatory flood level has been approved by the Minister or alternatively, the need for a special policy area may no longer exist.

(i) Evaluation

All criteria must be balanced against one another and a decision reached as to whether the community will qualify for special policy area status. The weighing of these factors will depend on the complexity and relative nature of the criteria. Before such weighing is undertaken, as much factual data as possible should be assembled.

(3) Types of Special Policy Areas

Each special policy area is unique, but there are two identifiable types:

(a) special policy areas where floodproofing to the regulatory flood level is not provided; and

(b) special policy areas where development is proposed in the floodway.

Both types of special policy areas run counter to basic concepts within the provincial policy statement, namely; new development within the flood plain should be protected from flooding to the level of the regulatory flood and new development within the floodway, the more hazardous portion of the flood plain, should be prohibited or restricted to non-structural uses such as open space.

Therefore, great care must be exercised in proposing and approving special policy areas as susceptibility to flooding and damage are much greater in such areas.

B - PROCEDURES FOR APPROVAL

Procedures for seeking approval of a special policy area designation will generally consist of three phases: (See Figure 15, page 128)

Phase

I	identification of need and preliminary approval in principle;
II(a)	data collection and preparation of draft official plan policies;
II(b)	review and formal approval of official plan policies.
III	implementation and review/update

(1) Phase I - Identification of Need and Preliminary Approval as Special Policy Area

(a) Request for Special Policy Area Status

Phase I (preliminary approval in principle) is designed to establish special policy area status in principle, and to lay the framework for further technical evaluation. It will prevent unnecessary expenditures prior to the approval agencies' acceptance of the request as being consistent with the principles of flood plain management. This phase will also identify the nature and extent of further studies necessary to accurately evaluate the limits and/or scope of the special policy area.

A special policy area is a flood plain planning option based on water management principles. It is necessary to consider policies for all land uses within the special policy area as policy decisions regarding one land use may adversely affect or limit the alternatives for other land use policies. Separate special policy area proposals for each land use within an overall special policy area is not appropriate.

It must be noted, approval in principle does not signify final approval of the proposed designated, nor is it an assurance the special policy area will be approved. The latter will depend largely on the conclusions and results of studies under Phase II(a).

The initial request for special policy area status, having regard to the criteria outlined, must come from the municipality. The municipality should be satisfied it meets the criteria and that it has suitable expertise and financial capability to deal with the establishment of a special policy area. The request for special policy area status should be accompanied by a brief report addressing the criteria for special policy area eligibility. In this regard, the municipality should contact the local Conservation Authority where one exists, as an initial step to determine the type of flood related information that may exist. The Conservation Authority or Ministry of Natural Resources shall also provide detailed flood related information in report form indicating the rationale and justification why the provisions of the two-zone concept are too onerous.

The municipality should then approach the Ministry of Municipal Affairs, the local Conservation Authority and the Ministry of Natural Resources to obtain approval in principle of its request for special policy area status. Until it has been notified of approval in principle, the municipality should not proceed with any additional studies.

(b) Provincial Review of Municipal Request for Approval in Principle

The Ministry of Municipal Affairs will co-ordinate the review of material prepared by the municipality to decide whether it meets the criteria and if acceptance in principle can be given. Where the municipality seeking approval in principle for special policy area status is within a 'delegated' regional municipality, the region will be involved in the review. (Ottawa-Carleton, Hamilton-Wentworth and Waterloo). Regional municipal representatives may co-ordinate the review of all materials relating to a special policy area designation once the municipality has been given approval in principle and direction has been provided as to the additional studies required to support an approval of a specific special policy area.

If more information is required, the municipality will be advised what is required in support of its request for approval in principle and the agencies will reconsider the application when the additional material is available.

(c) Approval in Principle to Consider Special Policy Area Status

The municipality will receive written approval in principle jointly issued by representatives of the Ministries of Municipal Affairs, Natural Resources and, where one exists, the local Conservation Authority.

Upon acceptance in principle, the municipality will be advised regarding detailed studies required to support development of official plan policies for the special policy area.

(d) Refusal of Approval in Principle for Special Policy Area Status

If a municipality is ineligible under the criteria outlined, it will be notified and given reasons.

(2) Phase II(a) - Data Collection and Preparation of Draft Official Plan Policies

A municipality granted approval in principle for consideration of special policy area status, will be expected to collect appropriate data according to the approval in principle letter, and to produce policies meeting the guideline requirements. While data collection is the responsibility of the municipality requesting special policy area status, provincial agencies will assist as much as possible in providing information and in endeavoring to provide the municipality with guidance, technical advice, etc. A working group may be established to liaise with the municipality and monitor the study progress.

The municipality should carry out the following steps under the guidance of the working group composed of representatives of the Ministry of Natural Resources, the local Conservation Authority, the Ministry of Municipal Affairs, and possibly other Ministries such as the Ministry of the Environment and the Ministry of Northern Development. Municipal representation should include both planning and engineering staff. If there is a regional municipality, its' representative should also be included.

(a) Municipal Data Collection

Before policies are developed, the municipality should collect data and demonstrate adequate consideration of alternatives. This stage should be monitored by the working group who will provide technical assistance to the municipality as needed and wherever possible.

(b) Evaluation of Alternatives

The municipality should consider alternative approaches to handling the problems of the flood prone area including upstream and downstream effects of the alternatives.

(c) Policy Formation

Once the data collection is completed, the municipality can prepare proposed policies. The policies should include and be supported by, but not necessarily limited to, the following information which shall be subject to the approval of the Conservation Authority, where one exists and the Ministries of Municipal Affairs and Natural Resources:

- an introductory statement containing an explanation of provincial policy, a brief description of the area proposed for a special policy area, and a justification for the proposal (including an evaluation of risk factors involved in permitting development in the flood plain);

- the boundaries of the special policy area shall extend to the regulatory floodlines on each side of the watercourse (if appropriate) and be closed at both the upstream and downstream limits. The policies will then address all land uses, additions, renovations and replacements within these boundaries.

- the regulatory flood levels must be defined by flood plain mapping studies for the area(s) under consideration. Such studies should consider both pre and post-development situations;

- the minimum acceptable level of protection (floodproofing) for development within the special policy area; [7]

- the land use policies and designations for the proposed special policy area;

- detailed implementation policies identifying the mechanisms (i.e. zoning, site plan control) and means to be applied to ensure flood susceptibility and floodproofing are addressed by new development;

- policies for new buildings, additions, renovations, infilling and replacements within the proposed special policy area;

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7 A minimum acceptable level of protection has not been included in the Provincial Policy for Flood Plain Planning due to the extent of variation in flood plain characteristics which exists province-wide. However, the 100 year flood has been used almost exclusively as the minimum acceptable regulatory flood standard and the CMHC lending policy is also based on this level. (See Section 5.4, Federal Legislation). SPAs which include a minimum acceptable level of protection which is less than the 100 year flood will require substantial justification. In this regard it should not be interpreted as either the regulatory flood elevation or the 100 year flood elevation. In all situations as much of floodproofing as possible should be incorporated in the policies.

- the roles of council, Conservation Authority(ies) and the Ministries of Municipal Affairs, Natural Resources and any other appropriate agency with respect to the circulation and review of development proposals including subdivision plans, consents, minor variances, and building permits;

- the delineation of the boundaries of the special policy area, as an overlay, on the land use schedule;

- an appendix which includes background reports and studies supporting the policies proposed.

The municipality in preparing an appendix to its official plan document would include background papers addressing the special policy area guidelines and how the draft official plan policies reflect them. It would outline various alternatives considered and studies carried out to support the proposed policies. Exceptions to the provincial policy statement on flood plain planning are considered on their own merits, and the Province will want to ensure there is a clear outline of the basis of these exceptions for the benefit of the public and others.

Agreement to the general policy proposals should be given in writing by representatives of Ministries of Municipal Affairs, Natural Resources and the local Conservation Authority, preferably before any public meeting, so as to avoid raising false expectations.

(3) Phase II(b) - Review and Formal Approval of Official Plan Policies

Processing the documentation for review and approval would comply with the requirements of the Planning Act, and the standard procedures established by the Ministry of Municipal Affairs for the review of all official plans and amendments would be followed.

(a) Public Involvement

The municipality has a responsibility to involve the public in considering proposed policies as they will form a component of the official plan. The municipality may request technical backup and support from the provincial ministries for presentation purposes at any public meetings.

(b) Review of Draft Official Plan Policies

Following public meetings, the official plan policies, including appendix material, should be finalized in draft form by the municipality and copies forwarded to the Ministry of Municipal Affairs, whose responsibility is to co-ordinate a response from the provincial agencies and the local Conservation Authority on all draft documents. This response should be received by the municipality within 30 days or other agreed to period. If necessary, meetings may be held to discuss the response.

(c) Municipal Adoption

Based on comments received, the municipality would make appropriate modifications and formally adopt the official plan policies.

(d) Conservation Authority Adoption

The special policy area provisions will determine the basis by which a Conservation Authority will administer applications pursuant to their Fill, Construction and Alteration to Waterways Regulation. Therefore, the agreed upon policies require a resolution of acceptance by either the Executive Committee or the Full Authority, whichever has been vested with the decision making authority.

(e) Formal Submission for Approval

Once finalized at the local level, the municipality would then submit the policies to the Ministry of Municipal Affairs for approval, unless a regional municipality has the authority to receive them.

As the draft official plan policies request approval for special policy area status, they will also be forwarded to the appropriate Regional Office of the Ministry of Natural Resources to initiate the approval process by the Minister of Natural Resources. The Minister would then inform the Minister of Municipal Affairs of his/her support or objection to the official plan policies.

In all other respects, normal official plan policy circulation and approval procedures would be followed, as specified under the Planning Act, 1983 or by the Ministry of Municipal Affairs.

(4) Phase III - Implementation and Review/Update

(a) Implementation

The official plan/official plan amendment policies for a special policy area are implemented by a municipality and the Ministry of Natural Resources outside the area of Conservation Authority jurisdiction through the zoning by-law process. (See Section 5, Implementation Guidelines).

The policies developed for the special policy area will have no legislative basis for enforcement under the Planning Act unless they are addressed in the zoning by-law. It is therefore important that close ongoing liaison among the agencies that developed the policies, be maintained after the approval of the official plan/official plan amendment to ensure that the proposed zoning by-law provisions adequately address all of the special policy area policies.

Ideally, the alternative implementation mechanisms will have been previously discussed or outlined in the implementation section of the official plan/official plan amendment. However, if additional information is required or unforeseen problems arise at the time the implementing zoning by-law is being prepared, it may be necessary to reconvene the special policy area technical committee. As a minimum, the implementing zoning by-law should be circulated in draft form to the agencies represented on the technical committee prior to public meetings and/or prior to the by-law receiving three readings by council.

Special policy area policies are also implemented by Conservation Authorities where they exist, through the issuance of permits under Section 28(1) of the Conservation Authorities Act where such regulations have been adopted. It is therefore important to establish and maintain a close working relationship between the Conservation Authority and the municipality to ensure that any necessary approvals under the Planning Act and the Conservation Authorities Act are coordinated and mutually supportive.

(b) Review and Update

As flood plain information/works or reduced regulatory flood levels are approved and/or completed the Special Policy Area policies should be reviewed by the respective participants and the municipal documents amended as necessary.

Where no changes to the Special Policy Area policies, land use designations or boundaries are necessary and the policies/schedules are being transferred to another municipal document, further approvals of the Minister of Natural Resources are not required.

SPA FLOWCHART PROCESS

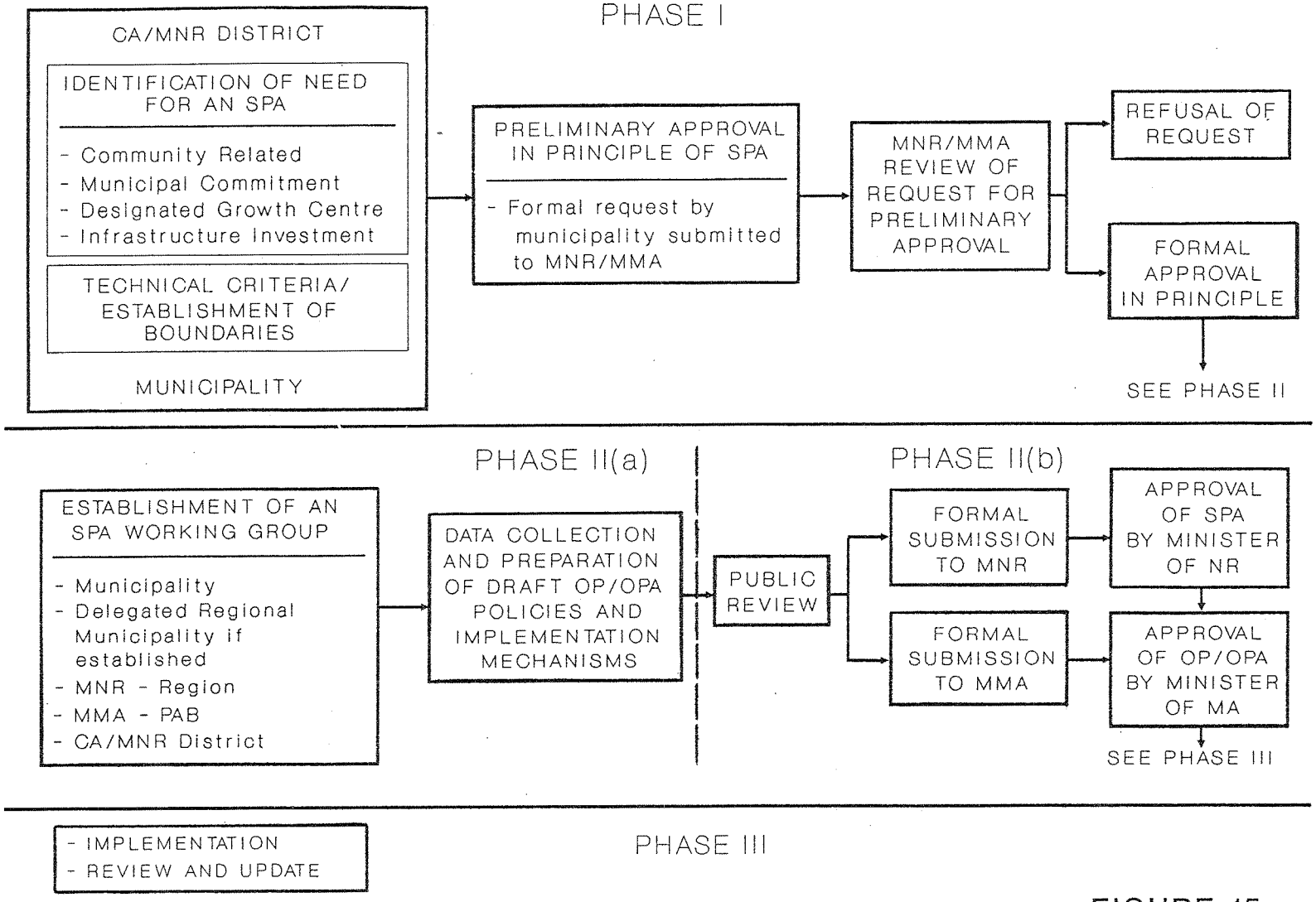

FIGURE 15

APPENDIX D

FLOODPROOFING IN ONTARIO

APPENDIX D

FLOODPROOFING
IN ONTARIO

APPENDIX "D"

Floodproofing in Ontario

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FLOODPROOFING IN ONTARIO

INTRODUCTION

Floodproofing is defined as a combination of structural changes and/or adjustments incorporated into the basic design and/or construction or alteration of individual buildings, structures or properties subject to flooding so as to reduce or eliminate flood damages. It is acknowledged that this term is somewhat misleading, since total protection from flood damage cannot always be assured. However, if applied effectively, floodproofing can play a significant role in comprehensive flood plain management.

Floodproofing is generally most appropriate in situations where moderate flooding with low velocity and short duration is experienced and where traditional structural flood protection, such as dams and channels are not considered to be feasible. Although measures can be applied to both existing and new developments, it is usually impractical, expensive and extremely difficult to floodproof existing buildings.

Since floodproofing is best incorporated into the initial planning and design stages, new development has the greatest potential for permanent structural adjustment. In general, floodproofing can be applied most economically and effectively in the design of new buildings in developing areas. It can also be applied to infilling situations and proposed additions in developed areas. However, as well as providing adequate flood protection, new development within developed areas will have to take into account special considerations such as the aesthetic blend with neighbouring properties.

NOTE: Certain information/data in this appendix was obtained or generated by MacLaren Plansearch Inc.

TYPES OF FLOODPROOFING

All floodproofing measures can be described as active or passive and providing wet or dry protection.

Active vs Passive

Active floodproofing requires some action, i.e. closing water tight doors or sandbagging for the measure to be effective. Advance flood warning is almost always required in order to make the flood protection operational.

Passive floodproofing measures are defined as those that are in place and do not require flood warning or any other action to put the flood protection into effect. These include construction of development at or above the regulatory flood level, or the use of continuous berms or floodwalls.

Dry vs Wet Protection

The object of dry floodproofing is to keep a development and its contents completely dry. Such can be carried out by elevating the development above the level of the regulatory flood or by designing walls to be watertight and installing watertight doors and seals to withstand the forces of flood waters. The benefit of elevated floodproofing is that it is passive and advance warning of an impending flood is not required. Temporary watertight closures, on the other hand, are considered to be active floodproofing usually requiring advance warning for operation.

Wet floodproofing is undertaken in expectation of possible flooding. Its use is generally limited to certain specific non-residential/non-habitable structures (e.g. arena, stadium, parking garage), but many of the techniques of wet floodproofing can be used with certain dry floodproofing approaches. The intent of wet floodproofing is to maintain structural integrity by avoiding external unbalanced forces from acting on buildings during and after a flood, to reduce flood damage to contents, and to reduce the cost of post flood clean up. As such, wet floodproofing requires that the interior space below the level of the regulatory flood remain unfinished, be non-habitable, and be free of service

units and panels, thereby ensuring minimal damage. Also, this space must not be used for storage of immovable or hazardous materials that are buoyant, flammable, explosive or toxic. Furthermore, access ways into and from a wet floodproofed building must allow for safe pedestrian movement.

For new development, dry floodproofing above the level of the regulatory flood can generally be economically and easily achieved in the design and early construction phase. However, dry floodproofing of structures which will have portions below the level of the regulatory flood will require additional special design attention so that the structure will resist all loads including hydrostatic pressures.

TECHNICAL CONSIDERATIONS

Once flood waters enter a development, the risk of loss of life and flood damage will be determined by the location of the habitable portion of the buildings. The habitable portion of a structure is defined as living space intended for use by the occupant with the key concern being overnight occupancy. This includes buildings used for residential, commercial, recreational, and institutional purposes. In considering appropriate floodproofing measures, the habitable portion of the building should be designed to eliminate or minimize the risk of flood damage and loss of life.

As a rule, damages increase rapidly with the depth of flooding. Major structural damage occurs when a structure is weakened, totally collapses or is displaced. Damage to contents, such as finishes, trimwork, furniture, appliances, equipment and storage materials, also represents a substantial portion of the total loss. In addition, it is difficult to assign a dollar value to compensate for human suffering caused by a flood.

Thus, protection to at least the level of the regulatory flood is significant in reducing human suffering and property damage. In selecting between wet or dry flood protection, consideration must be given to the type of development, need for floodproofing and cost effectiveness. Further, selection of active or passive measures will depend on location of the habitable portion of the development below or above the level of the regulatory flood, local flood warning, and accessways.

As well, all mechanical and electrical systems should be designed and installed so that the heating, lighting, ventilation, air conditioning and other systems are not vulnerable to flood damage during the regulatory flood. Where flooding could interrupt key power supplies, it may be necessary to provide stand-by or backup systems, with power and controls located above the level of the regulatory flood.

In order to determine the most appropriate floodproofing measure, the full extent of the flood hazard must be evaluated. This section outlines technical considerations which can assist in determining the most suitable floodproofing measure.

(1) Flooding as a Threat to Life

Hazard to life is linked to the frequency of flooding, and to depth of flood waters and the velocity of flow in the flood plain. Depth increases buoyancy and velocity increases instability, so that each of depth and velocity should be studied independently or as a combined function.

(a) Depth

Any person in the midst of a flooded area will be acted upon by a buoyant force equal to the weight of water displaced by that person. The volume of displaced water and this force increases with depth until neutral equilibrium is reached and the person begins to float.

Average adults and teenage children remain stable when standing in flood depths up to about 1.37 m (4.5 ft.). The average school child 6 - 10 years old would float at about 1.1 m (3.5 ft.), although smaller, younger children in this range would be unstable at a depth of about 0.98 m (3.2 ft.).

Hence, in terms of depth and individuals who could be present in the flood plain during a flood:

- depths in excess of about 0.99 m (3.2 ft.) would be sufficient to float young school children

- a depth of about 1.37 m (4.5 ft.) is the threshold of stability for teenage children and most adults.

(b) Velocity

Moving water in the flood plain exerts a lateral force resulting from momentum thrust of the flood flow. This force acts to displace objects in a downstream direction. The shear force of friction of a person on the wet surface of the flood plain resists this force. However, even relatively low velocities of flow in the flood plain can pose possible flood hazards.

The force exerted by various flow velocities can be developed for different age and size groups, but because its effect is tied to depth, a better appreciation of velocity effects can be gained by looking at both depth and velocity in combination.

(c) Combination of Depth and Velocity

As a guide for personnel involved in stream flow/depth monitoring, the "3 x 3 rule" was developed in the U.S. The rule suggests that field staff would be at risk if the product (multiple) of the velocity and the depth exceeded 0.8 m^2/s (9 $ft.^2/s$).

The Water Survey of Canada has the same rule of thumb and the Hydrometric Field Manual (1981) states, "a general rule of thumb which has been used in the past is arrived at through the product of the depth and velocity. Generally speaking, if the bed is firm and provides good footing, the product of these two factors should be slightly less than 1 m2/s, or roughly 9 ft.2/s".

It should be noted that this rule of thumb applies to trained professionals (usually men) whose regular work accustoms them to the dynamic forces of river flows, buoyant forces from partial submergence and recognition of potential hazards, e.g. rocks, depressions, etc. They also enter the stream with equipment which will assist them in maintaining stability, e.g. tag line, wading rod, strap-on cleats for greater stability.

It is considered highly unlikely that such equipment would be available to most occupants of floodproofed buildings in the flood plain. It seems equally unlikely that these occupants would have the same level of experience as water survey staff in dealing with high depths, current speeds, unsteady footing, or cold weather/water conditions.

As a result, it is likely that a 3 x 3 product (1 m2/s or 9 ft.2/s) represents an upper limit for adult male occupants in the flood plain and that it would be reasonable to consider something lower as being more representative of a safe upper limit for most flood plain occupants.

As noted earlier, any person on foot during a flood may be subject to a number of forces in the flood plain. Excluding impact by ice and/or other debris, these forces include:

- an upward buoyant force, equal to the weight of the fluid displaced
- a lateral force exerted by the moving water (linear momentum)
- unbalanced hydrostatic forces

Resisting these forces are:

- the shear force of friction acting through the weight of the person standing on a wet surface in the flood plain.

Figure 16 provides a graphical representation of depth and velocity hazards in the flood plain to show the limits of stability. Unit weights of 976,1464 and 1952 kg/m2 (200, 300 and 400 lb/ft2) are used. Adults of average size would fall into the range between 976 - 1952 kg/m2 (200 - 400 lb/ft2) but young children would more appropriately fall into a range of 732 - 1464 kg/m2 (150 - 300 lb/ft2). Only 7% of Ontario's population is within the 6 - 10 year age range, i.e. young children (Statistics Canada, 1981).

The coefficient of friction between foot apparel and wet grass, gravel bare soils, pavements or other wet surfaces under flood conditions is not well known. A standard table of friction coefficients suggests that friction factors in the order of 0.3 to 0.6 could be characteristic of the ratio of the force to body weight required to initiate movement over unlubricated, dry surfaces. It is assumed that a lower friction factor range would be representative of the same state for a person standing on wet grass or pavement under flood conditions. The sensitivity of the stability calculation to friction factors of 0.15 and 0.3 is shown on Figure 16.

Any flood plain situation giving velocity and depth conditions lower than the appropriate curve for that individual is one where that person would be in a stable condition in the flood plain. Conditions of velocity or depth exceeding the appropriate stability curve would be unstable conditions for the same individual.

It is also appropriate to note that this analysis is based on a person standing still in the flood plain. Once a person begins to move to install floodproofing measures or leave the flood-prone area, stability is reduced further.

Figure 17 presents the same chart with overlays of different "product rules" (products of depth x velocity in m and m/s (ft. and ft./s). The 3 x 3, 3 x 2 and 2 x 2 rules are shown on the figure with the use of 0.3 friction factor to represent wet conditions. The cross hatched area defines a region of depth and velocity combinations which are stable, low risk combinations for most individuals likely to be present in the flood plain during a flood.

The 3 x 3 line encloses a large area of depth and velocity conditions which would lead to instability for most individuals. The 3 x 2 line represents a general average, but it too encompasses areas of instability for many individuals.

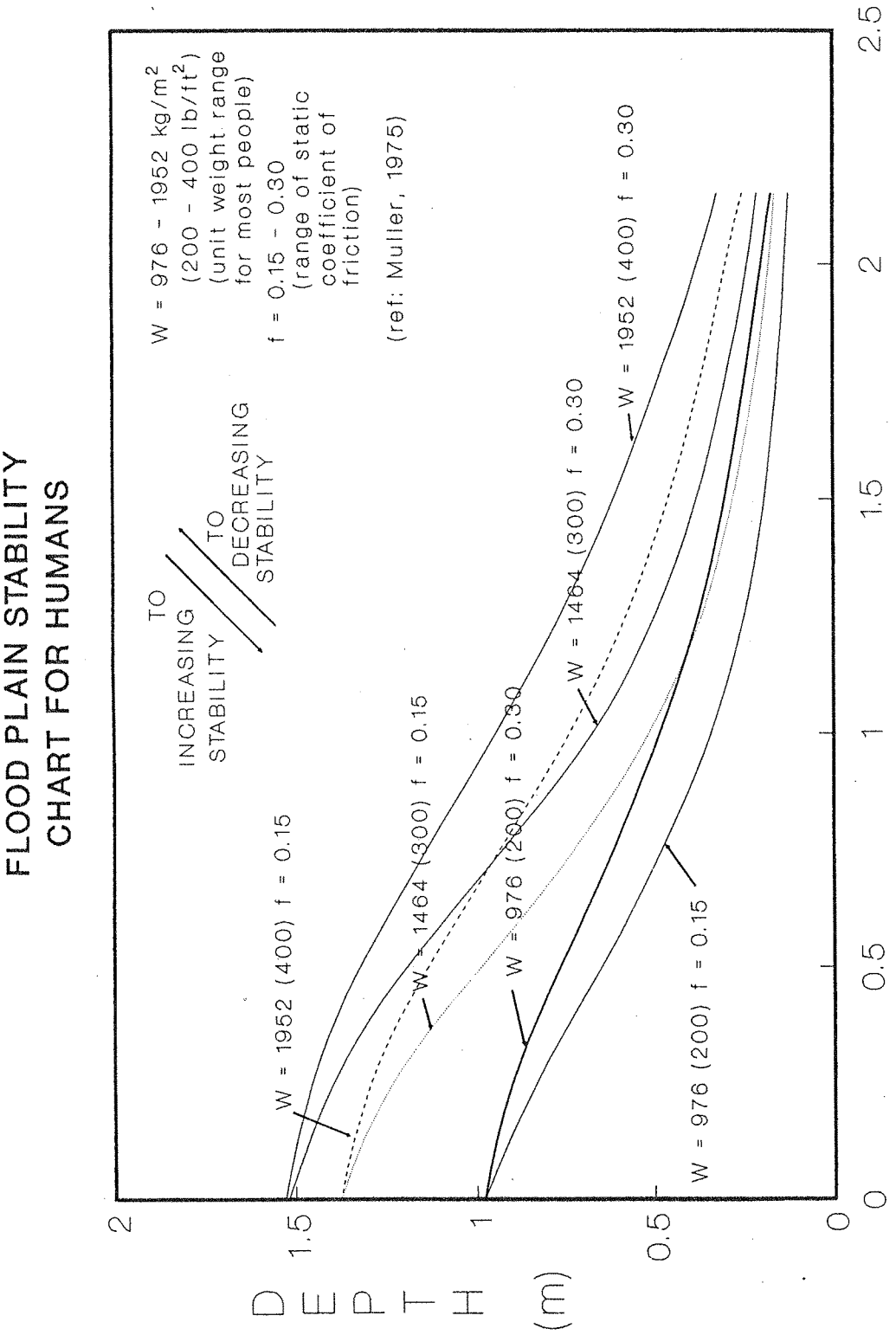
FLOOD PLAIN STABILITY
CHART FOR HUMANS
W = 976 - 1952 kg/m2
(200 - 400 lb/ft2)
(unit weight range
for most people)
f = 0.15 - 0.30
(range of static
coefficient of
friction)
(ref: Muller, 1975)
TO
INCREASING
STABILITY
TO
DECREASING
STABILITY
W = 1952 (400) f = 0.15
W = 1464 (300) f = 0.15
W = 976 (200) f = 0.30
W = 1464 (300) f = 0.30
W = 1952 (400) f = 0.30
W = 976 (200) f = 0.15
DEPTH (m)
VELOCITY (m/s)
0
0.5
1
1.5
2
2.5

FIGURE 16

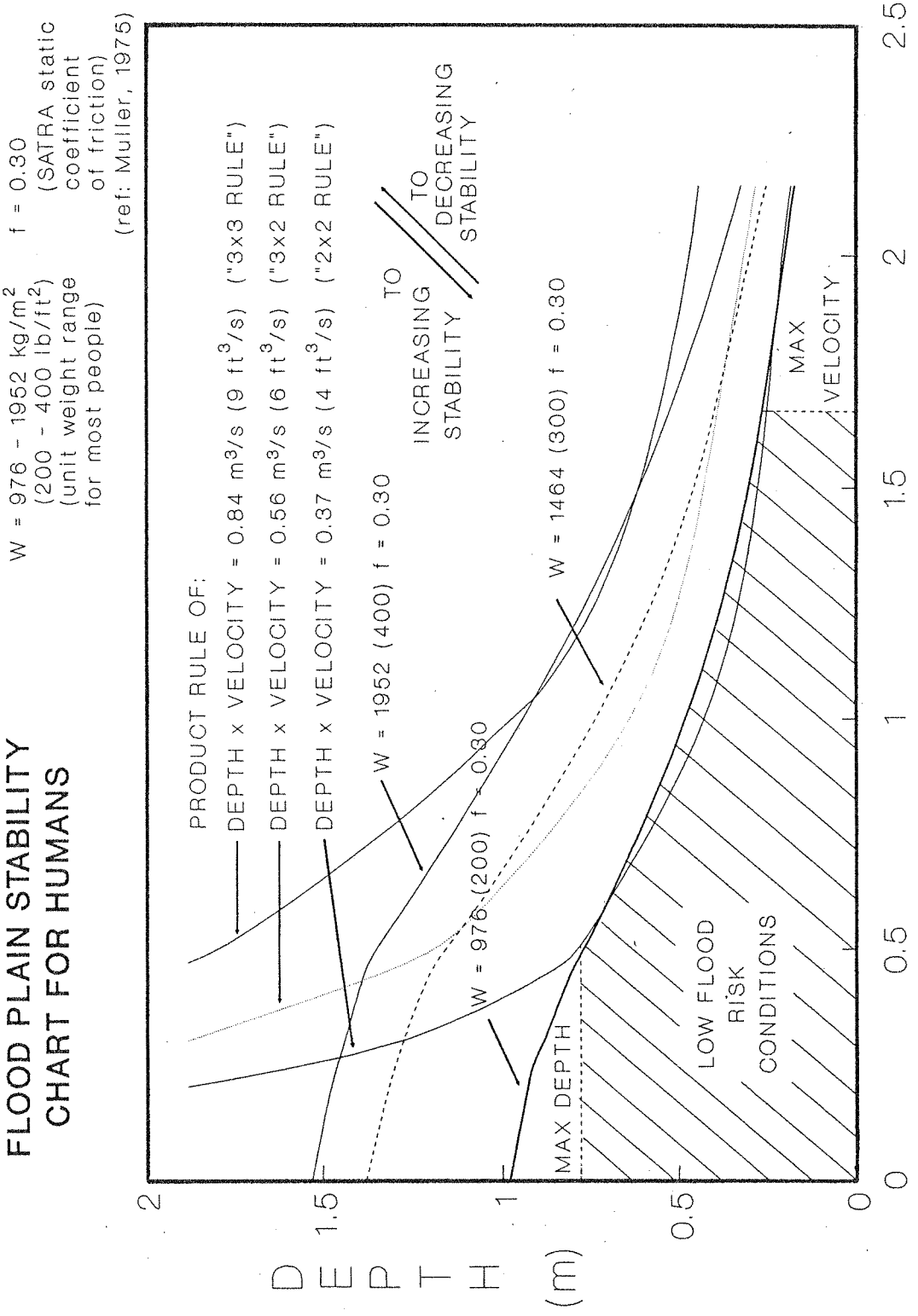
FLOOD PLAIN STABILITY
CHART FOR HUMANS
W = 976 - 1952 kg/m²
(200 - 400 lb/ft²)
(unit weight range
for most people)
f = 0.30
(SATRA static
coefficient
of friction)
(ref: Muller, 1975)
PRODUCT RULE OF:
DEPTH x VELOCITY = 0.84 m³/s (9 ft³/s) ("3x3 RULE")
DEPTH x VELOCITY = 0.56 m³/s (6 ft³/s) ("3x2 RULE")
DEPTH x VELOCITY = 0.37 m³/s (4 ft³/s) ("2x2 RULE")
W = 1952 (400) f = 0.30
W = 1464 (300) f = 0.30
W = 976 (200) f = 0.30
TO INCREASING STABILITY
TO DECREASING STABILITY
MAX DEPTH
MAX VELOCITY
LOW FLOOD RISK CONDITIONS
DEPTH (m)
VELOCITY (m/s)
0
0.5
1
1.5
2
2.5

FIGURE 17

The 2 x 2 line excludes most of the unstable conditions for most individuals and would appear adequate at first glance. However, the 2 x 2 rule also has limitations as shown on the graph. At low velocity but depths greater than 0.9 - 1.2 m (3 - 4 ft.), most individuals would become buoyant. Similarly in areas where flood plain depths may be less than 0.3 m (1 ft.) but where velocities exceed 1.5 - 1.8 m/s (5 - 6 ft./s) (encountered on roadways or bridge crossings, for example), stability conditions would be exceeded and some individuals would be swept off their feet.

Although no product rule exactly defines this region, a reasonable approximation of the low risk area can be made with a product rule that includes some constraints on the domain of depth and velocity. For example, a product depth and velocity less than or equal to 0.4 m2/s (4 ft.2/s) defines the low risk area providing that depth does not exceed 0.8 m (2.6 ft.) and that the velocity does not exceed 1.7 m/s (5.5 ft./s). These two constraints are marked by bold dashed lines in Figure D-2. By contrast, in a situation where the depth and velocity are 1.1 m (3.5 ft.) and 0.3 m/s (1 ft./s) respectively, the product is less than 0.4 m2/s (4 ft.2/s) but the depth limit is exceeded. Hence, these conditions define a high risk area for some individuals.

It is evident that this approximate classification is somewhat conservative; but until further research is undertaken, it provides a reasonable factor of safety for all individuals - young and old - who may be present in the flood plain.

(2) Duration of Flood

The duration of a flood or the length of time a river overflows its banks, reaches its crest and recedes to within its banks depends on the efficiency of the river to transport the flood waters. Since the size of the watershed, time of concentration and duration of a flood affects the type of impact and pressure on the development, floodproofing measures must be designed to withstand these forces for the required period of time.

(3) Rate of Rise and Fall

The rate of rise and fall of a flood to and from its crest can affect the type and extent of floodproofing. For example, where the rise and fall are very sudden, there may not be time to implement active floodproofing measures, such as watertight seals and doors and thus these approaches would be deemed unacceptable. The rate should also be considered in investigations of slope stability for certain types of soils where a quick drawdown of flood waters may pose problems.

(4) Flood Warning System

The availability of advance warning can play an important role in determining the most appropriate measure. Where active floodproofing procedures are contemplated, lead time for implementation of appropriate protective measures and devices must be related to the amount of advance warning.

(5) Structural Integrity

When buildings and structures are surrounded by flood waters, they cause unbalanced pressures and loadings on all wetted surfaces, which increase rapidly with depth. Unbalanced pressures can cause structural and sub-structural damages which can completely collapse or displace the development. In order to design the most appropriate floodproofing measures, it is important to determine the effect of stresses on the proposed building.

The stresses imposed on a building are due to hydrostatic, hydrodynamic and impact loadings, depending on its location. Hydrostatic loads are developed by water that is either still or moving at a low velocity. These loads may be defined as acting vertically downward (i.e., on floors), or vertically upward (i.e., uplift), or laterally when acting horizontally on walls. Hydrodynamic loads result from the flow of water against or around a structure at moderate or higher velocities. These loads are directly dependent on the velocity of flow, and can also

adversely affect the floodproofing measures by causing erosion and scour. Impact loads are caused by water-borne objects, debris and ice. Their effects become greater and more crucial as the velocity and weight of objects increase. Impact loads are difficult to predict and define accurately. However, a reasonable allowance can be made with the knowledge of the conditions of the site.

(a) Superstructures (Above Ground)

Hydrostatic Loading Effects

Until the mid-1970s, it was assumed that standard design and construction practices - without modification - would be adequate to ensure that floodproofing by closures and seals could be conducted to moderate depth/hydrostatic loading without threatening the structural integrity of the above ground/superstructure of most buildings. However, various research by the U.S. Corps of Engineers over the years, has suggested otherwise.

Studies on structures of conventional design have determined that:

- brick veneer, frame structures (such as a typical home) would resist hydrostatic loading up to about 0.8 m (2.5 ft.) without damage

- concrete block structures with limited or no reinforcement (such as the small warehouse building) displayed similar resistance characteristics and would not be damaged by hydrostatic loadings up to 0.8 m (2.5 ft.). Above this at 0.9 and 1.2 m (3 and 4 ft.) depths deflection and cracking became significant

- solid brick structures responded in a similar manner. Tests with these also included end and side walls and walls with and without door openings. Walls with ceiling joists (with and without door openings) were found adequate to resist loadings to about 0.8 m (2.5 ft.). Walls with ceiling joists proved much stronger, but failed explosively when 2 x 4 supports were snapped.

- poured concrete walls were not tested, but from experience with other structural designs it was presumed that conventional design techniques would prove adequate against hydrostatic loads to at least 0.9 m (3 ft.).

Therefore, 0.8 m (2.5 ft.) would appear to be the upper limit of effective flood depth (static plus equivalent hydrodynamic head) which can be resisted by conventionally designed structures without affecting structural integrity.

Studies on structural integrity during flood conditions have also given an appreciation of the permeability of conventional structures, in that:

- brick structures of conventional design begin to leak almost immediately and badly, when in contact with flood waters;

- concrete block structures of conventional design also leak badly at a rate that exceeds that of brick structures.

Tests also conducted to determine if materials or surface coatings would enhance water tightness found:

- no clear sealants (e.g. epoxy) were completely effective

- no asphaltic material was completely effective

- embedded roofing felts with polyethylene sheeting laid between a second brick course were found effective - but exceptionally stringent quality control of workmanship was required (particularly at joints)

- flood shields/bulkheads also presented difficulties and were for the most part ineffective unless designed especially with gaskets smooth surfaces and locking bolts

- certain thick, non-tear materials can be used as external "wrappings" to effectively seal buildings against infiltration. These are very special materials and fall into the category of "active" measures vs "passive", permanent measures.

In summary then:

- conventional designs are not water resistant/waterproof for even low depths of flooding

- new structures should be designed from scratch for complete water tightness (or if not completely water tight must incorporate an internal system to collect and remove water seepage)

- new structures using conventional designs can be made water tight (without re-design) but the only proven approach so far uses external "wrapping".

Erosion

Flow velocities which will cause erosion of grass covered slopes or erosion around foundations are difficult to determine. Factors such as type of cover, slope and soil conditions must be taken into account. For most common situations, the range lies between 0.8 m/s and 1.2 m/s (2.5 ft./s and 4 ft./s) for easily eroded soils and 1.1 m/s to 1.5 m/s (3.5 ft./s to 5 ft./s) for more erosion resistant soils.

Impact Loading and Debris Accumulation

This aspect of structural integrity has not been studies in the field because it is practically impossible to establish velocity/depth limits associated with loadings caused by debris accumulation and the impact of floating objects on the flood plain. The nature of debris accumulations and size and shape of floatables simply varies too significantly.

Ice, debris and other floating materials can result in significant impact lading on buildings within the flood plain or increase the loads on buildings as a result of blockage. Although these loads are difficult to estimate a reasonable allowance must be made in design. Sites where the potential for such lading is high should simply be avoided or buildings should be designed/landscaped to intercept/deflect materials before the building is affected.

In cases where floodproofing is achieved by elevation on columns or piles, the clearing space between the columns or piles should measure perpendicular to the general direction of flood flow and should be adequately designed to minimize possible debris blockage. The open space created below the level of the regulatory flood should remain essentially free of more buoyant or hazardous materials.

(b) Substructures/Basements (Below Ground)

Based on normal (conventional) struction methods, any hydrostatic head in excess of 0.2 m (0.7 ft.) may result in damage to basement floors (i.e. the upward force of groundwater on the basement floor).

Even where the basement of a single storey brick or masonry structure has been structurally reinforced and/or made watertight, structural integrity or buoyancy may pose problems when groundwater (saturated soil) levels are 1.2 - 1.5 m (4 - 5 ft.) above the level of the basement floor. Much depends on the duration of the flooding, type of soil and the presence/effectiveness of the drainage system.

(6) Vehicular Access

Little or no information exists in the literature regarding ingress/egress criteria for vehicles.

The question of safety for the passage of vehicles can be subdivided into:

. flood depth and velocity considerations affecting egress of private vehicles from floodproofed areas

. flood depth and velocity affecting access of private and emergency vehicles to floodproofed areas.

(a) Private Vehicles

In general, water contact is one critical issue in terms of its effect on the ignition/electrical system and the exhaust system. In the former, the distributor and/or spark plugs are the main items of concern and those which are typical problem areas for most motorists.

Private vehicles come in all shapes and sizes and it is practically impossible to identify a "typical" vehicle for assessing the elevation of key electrical components from the road surface. It appears likely that a depth of about 0.4 m - 0.6 m (1.5 - 2 ft.) would be sufficient to reach the distributor or plugs of most private

vehicles. They would fail to start at this depth and hence vehicular egress will be halted. Cars may start at lower depths but then "splash" from driving on wet pavement or from the radiator fan would become a concern.

The issue of the exhaust system and the effect that flooding can play on engine back pressures/expulsion of exhaust gases appears to be the controlling factor. Difficulty would probably be experienced in starting most vehicles if the vehicle is standing in water at a depth that covers the muffler. The vehicle may start and continue to run if it is quickly removed from the water but if it remains at that depth, there is a strong possibility that it will fail soon after.

Again, it is practically impossible to generalize this depth but for most family automobiles something in the range of about 0.3 m - 0.4 m (1 - 1.5 ft.) would be the maximum depth of flooding before potential egress problems would result.

A hazard diagram such as Figure D-2 may also be derived to evaluate the significance of flood velocity (and depth) on vehicles. Such a diagram would indicate that a "typical" North American car would not be significantly affected by velocities up to about 4.5 m/s (15 ft./s) or more at flood depths at less then 0.3 m (1 ft.). At running board depth or slightly above 0.3 m (1 ft.) the maximum velocity for stability drops to about 3 m/s (10 ft./s) and at about 0.4 m (1.5 ft.) depth an average vehicle may be displaced by velocities as low as 0.3 - 0.6 m/s (1 - 2 ft./s), with smaller vehicles becoming buoyant.

(b) Emergency Vehicles

Emergency vehicles operate under the same constraints relating to the electrical/exhaust system. Most police vehicles and ambulances would be limited by exhaust considerations, although emergency vans are better equipped to avoid splash problems since the key electrical components are higher above the road surface.

Diesel fire vehicles with top exhausts appear best suited for flood conditions. Their road clearance is high and it is suggested that 0.9 m - 1.2 m (3 - 4 ft.) of flood depth would not present a problem. These vehicles are about 10 times heavier than most automobiles and hence are resistant to displacement by higher velocity flood flows. Operations at velocities in excess of 4.5 m (15 ft./s) would probably not pose a problem when these vehicles are moving over a good/non-eroding base.

(7) Portable or Mobile Buildings and Structures

A portable or mobile building is one that is not permanently tied or anchored to a foundation and can be transported by means of a hauler. Portable or mobile buildings can be located on individual sites or in a park or subdivision. They can be used for temporary purposes, such as for construction crews or as full-time residences/seasonal homes with overnight occupancy.

When located in flood plains, portable or mobile buildings are highly susceptible to flood damage. Since they are not affixed to a permanent foundation, flood waters may easily sweep such buildings off their sites. Without advance warning, residents can be entrapped in the building. In addition, portable or mobile buildings can increase the flood hazard as they collide with other structures or block bridge openings or culverts. Despite this, portable or mobile buildings often are located in flood plains because:

- flood plain land acquisition costs may be lower;
- swamp conditions and higher water table which prevail in flood plain areas may preclude construction of permanent homes with basements; and
- potential recreational access by locating close to the water's edge.

Ideally, portable or mobile buildings should not be located in the flood plain. However, when located in the flood fringe, they should be properly floodproofed to the regulatory flood level, in order to prevent flotation, collapse and lateral movement. Due to the inherent hazard of remaining in a mobile building during a flood, contingency plans indicating escape routes and alternative vehicular accessways should be prepared.

Where the portable or mobile building is on site temporarily, it may not be feasible to meet all the requirements for floodproofing. In such cases, temporary location of portable and mobile buildings in the flood fringe may be considered where the time frame is very short and sufficient flood warning would allow the structure to be hauled away in advance of the flood.

(8) Floodproofing Complexity

The complexity of floodproofing techniques (and to a degree the cost) is best related to depth and type of floodproofing considered.

(a) Closures and Seals

It appears that external walls can be floodproofed by closures and seals to a flood depth of about 0.8 m (2.5 ft.). Beyond this depth, structural integrity is threatened and special reinforcing or revised designs (with poured concrete walls for example) are required.

Dry floodproofing to this depth can be completed with the use of impervious external "wrappings". These contingency wrappings are anchored beneath the ground surface along the foundation and rolled upward and hung into place along the walls of buildings prior to flooding. Equivalent dry floodproofing using internal sealants, doubled walls, etc. with flood shields at openings is more complex, expensive and uncertain as to effectiveness.

Basements can be closed and sealed to levels of about 1.2 - 1.5 m (4 - 5 ft.) above the floor slab with poured concrete designs employing additional reinforcement and special attention to monolithic construction. Beyond this level, the procedure becomes complicated as buoyancy/uplift must be addressed through anchors and/or added wall and slab thickness.

Overall, closures and seals is fraught with possible problems and is considerably more complicated than other floodproofing approaches.

(b) Elevated Structures

Structures on Fill

Elevation floodproofing on fill is generally considered for slab on grade construction. It is not a complex procedure and conventional building techniques are employed once the pad is down. The principal concern is fill compaction which must usually be done in 0.2 - 0.3 m (0.5 - 1 ft.) lifts. Beyond 0.6 - 0.9 m (2 - 3 ft.), however, pad sizes increase, compaction requirements become more important and an engineer or soils consultant should be employed for design review and inspection. Increased elevation may also lead to requirements for pad sizes in excess of lot size and, hence, additional requirements for erosion protection, etc.

Houses with conventional basements can also be placed in fill to elevate the first floor to a level about 2.1 - 2.4 m (7 - 8 ft.) above grade (i.e. the basement is founded on grade and the basement walls are surrounded by fill). At 1.2 - 1.5 m (4 - 5 ft.) above grade, the procedure is complicated by the need for wall and slab reinforcement, and anchors to prevent buoyancy.

Elevation on Columns, Piles, Piers and Extended Foundation Walls

Elevated structures using these techniques must be designed with consideration for debris loading, orientation of supports, effective submergence on foundation soil conditions and anchorage, bracing and connection details, availability of mechanical equipment, etc. In most instances, an engineer should be consulted to ensure that the possible effects of flooding are considered in the design. There are more factors to consider than conventional house construction on fill and, hence, these approaches could be considered more complex.

The majority of elevated buildings use posts for support (steel or timber). Installation becomes more complex at lengths in the range of 3.6 - 4.8 m (12 - 16 ft.) since machinery is needed for installation. A range of 3 - 3.6 m (10 - 12 ft.) seems typical for most homes which use extended posts.

Mechanically-driven piles are reported to be the best solution if severe erosion is anticipated. Pile driving equipment and skilled operators are at a premium and, because of the initial expense, this technique may be too complex/unnecessary for flood depths less than 1.5 - 1.8 m (5 - 6 ft.).

Piers/columns are generally constructed with brick, concrete block or poured concrete. The common elevation range for each of these approaches is as follows, beyond which increasing complexity is assumed:

- 0.4 - 1.8 m (1.5 - 6 ft.) for brick piers
- 0.4 - 2.4 m (1.5 - 8 ft.) for reinforced concrete masonry piers
- 0.4 - 3.6 m (1.5 - 12 ft.) (or more) for poured in place, reinforced concrete piers

Extended foundation walls make a relatively simple and effective foundation for elevated structures but again must be designed with consideration for loads and pressures anticipated in the flood plain.

Berms and Floodwalls

Berms (or levees) and floodwalls used for floodproofing are low structures built around single homes or individual industrial complexes. Proper design is more complex since material and construction practices must be closely monitored, they must be regularly maintained (in the case of berms), and they usually require adequate pumping facilities to handle interior drainage and seepage. Both berms and floodwalls usually have some opening for access and consideration must be given to closure.

In many instances, berms and floodwalls should be designed by qualified professional engineers.

Intentionally Flooding a Building (Wet Floodproofing)

Intentionally flooding a building for the purpose of balancing internal and external pressures so as to maintain structural integrity is in itself not complex. To ensure minimal damage and quick clean up, a number of conditions have been placed on the use of wet floodproofing by agencies such as Canada Mortgage and Housing Corporation. Requirements include:

- at least two openable windows located on opposite sides of the building
- tops of window sills to be not less than 150 mm below grade (to allow flood water into the basement)
- basements to remain unfurnished and contain non-habitable space only
- mechanical and electrical equipment, heating units and duct work to be located above the regulatory flood level
- sump pump required
- etc.

While wet floodproofing may be designed and provided for in a building, there is no guarantee over time that the requirements will be maintained. In particular, it is difficult to control the "finishing off" of basements which would then result in damages when wet floodproofing measures were put into effect. Therefore, while wet floodproofing may appear desirable initially, the ability to ensure the principles and requirements of wet floodproofing are maintained in the future must also be considered.