MELBOURNE AND METROPOLITAN BOARD OF WORKS

A UNIFIED CONCEPTUAL FRAMEWORK FOR FLOOD PLAIN MANAGEMENT

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INTRODUCTION

All waterways lead to Melbourne. Apart from a few exceptions this statement describes the drainage pattern of the metropolitan region. Within this pattern, the major urban investment has been located at the collecting point for the region's floodwaters.

To safeguard the urban investments from flood damages and to protect the general public health, safety and welfare, the region's watercourses must be managed in a comprehensive manner. This suggests that the existing main drainage policy must be replaced with a systematic flood plain management policy. A single purpose approach must be expanded into a multipurpose, multiple-means program.

The watercourses of the region must be managed in a manner that will accommodate floodwaters without causing undue flood losses. These watercourses also have the potential to improve vastly the quality of life in the metropolitan region. The watercourses can serve as green arteries or linear parks extending like spokes radiating from the Melbourne central business district (CBD) into the countryside. Trails for hiking, biking, and horseback riding can be readily incorporated into the green arteries.

These strips of green also will provide visual relief for the urban development pattern by bringing the country into the city. At the same time, they will provide space for urban stormwater runoff and space for active recreation.

The importance of the watercourses as urban amenities has long been recognized in the Melbourne region. Early action taken to preserve green space along the banks of the lower Yarra River

attests to this fact. The Board of Works will continue with its policy of preserving open space along the urban watercourses. This action opens the banks of the rivers to walkers and canoeists. It also reduces the opportunity for unwise development of the flood plain and helps to preserve the natural flood plain storage along the watercourses. Such an approach integrates drainage works with open space and people.

This concept of integrating open space planning with drainage planning recently has been extended into some of the small catchments. Open soft channel projects have been developed for reaches of Steele Creek, Money Ponds Creek (west meadows), and Darebin Creek. These projects have demonstrated a broadened approach to drainage planning by the Board of Works.

For the watercourses to function as urban amenities rather than water hazards, careful planning and engineering must take place to assure the wise use of land subject to periodic inundation. Also, action must be taken to prevent new urban development from increasing the flood runoff. Such efforts, to be successful, must be couched within a clearly presented conceptual framework.

II

A CONCEPTUAL FRAMEWORK

A unified conceptual framework for flood plain management in the Melbourne metropolitan region consists of three basic principles. These principles provide the underlying philosophy of a flood plain management policy.

The Urban Environment is a Single Interacting System

Air, land and water are interrelated and they affect and are affected by the development placed in the system. In this context,

a flood plain management plan must be viewed as a subsystem of a larger and more important urban system. It is a means to an end (a better quality of life) not an end in itself (a demonstration of engineering works). Also, such a plan must be related to the total river and Port Phillip Bay system. The influence of new development must be carefully analyzed and adjustments must be made to prevent the creation of new drainage problems.

The Urban Environmental System for Planning Purposes is Closed

Floodwaters must be someplace. Thus, urban flood plain management is a space allocation problem. Because water cannot be compressed, the space required for floodwaters is the same whether it is in upstream natural flood plain storage, in detention basins, or in downstream storage areas. Flood plain storage space usurped for urban development simply means that an equal volume of space at some other location will be claimed by the floodwaters. Floodwaters have the capability to plan for themselves when sufficient space is not allocated.

Channels simply are means of conveying floodwaters between storage sites. Their ability to function is related to the availability of downstream storage. By preserving and enhancing natural flood plain storage in the upstream tributary basins investments in channels is minimized. Also, the floodwaters are not rushed to the area of major urban investment where discharge could be hindered by unusually high tides and/or a thunderstorm in the lower Yarra.

Floodwaters are Resources Out-of-Place

In this context, a positive approach to flood plain management is taken. Floodwaters are viewed as a resource to be conserved and managed rather than as a common enemy to be gotten rid of as quickly as possible. This approach is in keeping with

Australian legal concepts in which the rights of the downstream riparian landowners have been protected against the actions of an Authority or a Goverment who may wish to discharge additional waters along a watercourse and thereby raise flood levels on a downstream property.

As a resource, floodwaters will be stored ... on flood plains, in urban developments, in retarding basins, and retention basins ... to the degree practicable and beneficially used. Possible uses of such waters are for irrigation, groundwater recharge, low flow augmentation, and industrial water supplies. In addition, the storage areas can be designed as aesthetic amenities and provide recreational open space.

III

FLOOD PLAIN MANAGEMENT ACTIONS

To implement the unified conceptual framework for flood plain management, two courses of action must be followed concurrently. The one course of action consists of preventive measures designed to prevent the spread of the flood problem. The other consists of corrective actions that are designed to mitigate the effects of the existing flood problem.

Preventive Actions

Floods are acts of God but flood damages are acts of man. This simple fact is well known in the United States. There, after 40 years of concerted national attack on the flood problem, ($10 billion expenditure for flood control works) the exposure to floods has increased. As a result, the costs to the United States are rising for adjustments to floods, and the vulnerability to catastrophe has increased. (Since 1959, floods in excess of the 100-year flood accounted for 61% of the damages.) In recognition of this

situation, all recent flood plain legislation in the United States expresses a general intent to slow the growth of incompatible and unnecessarily hazardous development on flood plains.

Throughout much of the Melbourne region, a preventive approach to flood damage mitigation can be taken. Actions in a preventive approach include flood plain acquisition, flood plain information and education, flood plain zoning, flood warnings, control of water and sewer extensions into flood plains so as to protect the public investment from flood effects, and land runoff control.

The mix of these preventive actions will be site specific for each of the catchments. Thus, a plan must be developed to show the extent to which each of the actions should be applied in a given situation. The Board of Works, by integrating its flood plain management functions with its sewer, water supply, metropolitan parks, and town planning functions has the opportunity to prevent the spread of flood problems in the Melbourne region. The ineffectiveness of the American flood damage reduction program need not be repeated in Australia.

Flood Plain Acquisition

The provision of green arteries in the metropolitan area can be accomplished by either the purchase of flood plain land or the dedication of such lands by developers as permanent open space. Control of the flood plain provides a cost-effective form of flood plain management.

The purchase of the flood plain lands will provide other benefits. Flood plain storage will be preserved. Open space for active and passive recreation will be provided. Trails can be constructed along the green arteries to link major recreational and park areas. Finally, flood plain ecosystems will be preserved. In essence, the purchase of flood plains can result in

synergistic benefits -- the whole will be greater than the sum of its parts. A dollar expended will yield a variety of benefits.

Flood Plain Information and Education

The delineation of the flood hazard in the Melbourne metropolitan area will be undertaken by the Board of Works. Information on the flood hazard is a vital input to any preventive actions. The flood hazard to be delineated will have a recurrence interval of once every 100 years, the 100-year flood. That flood has a one percent chance of recurring every year.

The development of flood plain information must be accompanied with an education effort. The flood hazard maps will be provided to the various Councils. The news media will be contacted and encouraged to disseminate the flood plain information. Small flyers will be published that will contain the mapping so that citizens can understand the areal extent of the flood hazard. Significant educational efforts will help the citizens to become aware of the range of actions which can be taken to mitigate the effects of flooding. Films, video tape, and slides will be used to help communicate this information.

Flood Plain Zoning

The delineation of a flood plain zone will be undertaken for all watercourses. The 100-year flood will be determined using synthetic hydrology based upon basin and regional rainfall-runoff relationships. The runoff will be based upon future development of the basins in accordance with the area-wide plan for the year 2000, and with flood plains in their existing condition. Mapping will be prepared at a large scale, either 1 inch to 1000 feet or 1 inch to 2000 feet.

A model flood plain ordinance will be prepared by the Board of Works and made available to the various Councils. The ordinance will provide for overlay zoning so that existing zoning will in no way be affected. Professional technical staff from the Board will be made available to provide technical assistance to the Councils.

The flood plain delineation and zoning will recognize Nature's prescribed and natural easement along each of the watercourses.

Flood Warnings

An early flood warning system will be established based upon radar scanning from an established installation in the Melbourne area plus telemetry gages in the various drainage basins.

Responsibility for the early warning system rests with the State. However, the Board will provide technical assistance and gaging to the program. Flood advisories and/or flood forecasts will be disseminated to defense agencies, the police, home guard, and the television and radio stations.

Control of Water and Sewer Extensions

The Board of Works is in the unique position of controlling, not only drainage, but the water and sewer utilities.

To protect the public health, safety and welfare, as well as the public investments in the utility lines, permits will not be issued for water and sewer taps in the designated flood plain.

Further as a pollution control step, installation of sewer lines in flood prone areas will not be allowed. This will mitigate the infiltration and inflow of floodwater into the sewer lines. This, in turn, will reduce the probability of sewer overflows

which has the potential to cause the discharge of raw sewage into the watercourses and the Bay.

Control of water and sewer extensions, coupled with the town planning functions, allows the Board to actively discourage the unwise use of flood plains in the Melbourne metropolitan region.

Land Runoff Control

One of the primary factors in the urban flood management is detention storage near where the precipitation occurs. Such storage can take a great number of forms -- on roof tops, in planned depressions, on yards, on driveways and on parking lots. It will reduce peak runoff rates; aid in providing water supply; provide an attenuation mechanism if stormwater is to be treated; lessen the possibility of downstream flooding, stream erosion and sedimentation; and can be used in the urban development of upstream areas while avoiding the increasing of runoff peaks which impact on existing downstream facilities.

Detention storage can be aided by designing grassed depressions in residential subdivisions. The drainage from roofs and driveways can be kept dispersed so that the runoff is sheet runoff rather than concentrated or channeled runoff. By extending the time of concentration, the design capacity of pipes and channels will be reduced. Where temporary storage is provided, outlets will be designed to attenuate peak outflow.

Temporary storage in "dry ponds" is an effective drainage measure. After a storm, the site can be drained slowly and the "field" would become available for recreational purposes. Playing fields and tennis courts can be designed to be compatible with the temporary storage of waters. Temporary storage can also be obtained in parking lots, on rooftops, or when suitable conditions exist in underground seepage pits. A three-inch water depth stored

temporarily on a roof top is equivalent to a load of 15.6 lbs/sq.ft. This is less than most requirements for live loads. Generally, a roof drain ring is used which permits a constant outflow of ¼ to ½ inch per hour, with the excess being detained.

The development policies of the Board will limit storm runoff to historic predevelopment rates or less, so as to protect those living downstream. By limiting runoff from new development, it will be possible to maintain natural-type channels which will not subject downstream areas to increased and more frequent peak runoff rates. Thus, natural channels tend to be adequate to carry the urbanized flow in the manner they carried the rural flows.

Corrective Actions

To address the backlog of flood problems which have been inherited and to not pass them to future generations, corrective actions must be taken. These actions fall under the general headings of flood control, flood proofing and land use adjustments. In a comprehensive program the preventive actions need to be integrated with the corrective actions. This allows a dynamic interaction between program elements to achieve the most cost-effective design.

Flood Control

The correction of existing flood problems normally deals with either channelization or storage under traditional engineering solutions of a structural nature. However, both can be counter productive to catchment-wide flood control if over emphasized or used imprudently.

A channel with high velocities and limited channel and flood plain storage tends to transfer the flood problem downstream, often to areas of higher investment such as the CBD of Melbourne.

Retarding basins have the effect of reducing downstream flows for the range of flood frequencies within the basin design criteria. In-filling of the valley below the retarding basin with development sets the stage for increased damage when the emergency spillway comes into operation.

Thus, corrective actions to solve existing flood problems can set the stage for larger future damages when the actions are not made a part of an overall strategy.

Channelization works should provide a maximum of valley storage coupled with slow flow characteristics to lengthen the time of concentration and thus relieve downstream flooding. Channels should be made as wide, shallow and with a rough surface and on as flat a grade as topography and required capacity will permit.

Bank slopes should be no steeper than 3:1 and flatter where possible, to reduce erosional tendencies and to mitigate safety hazards. This also reduces maintenance cost.

When retarding basins are constructed, flood plain management must be practiced along the downstream outlet channel to prevent urban encroachment on the flood plain. Experience has shown that urban growth downstream from retarding reservoirs can reach a magnitude which will result in flood damage which may be equal or exceed the flood damages prevented by the retarding basin. This points out the need to integrate the preventive and corrective actions in a given situation. In the U.S., there is a growing body of data which shows that problems can be made more quickly than they can be solved.

A flood control plan can, in one respect, be considered as a blue-green phenomena. The permanent water features,or the blue elements, would be of modest dimensions and would convey the run-

off from the frequent storms. The green features, which may be parks, recreational areas, or other open spaces, are designed to carry or store the runoff from the relatively infrequent flood.

Flood Proofing

Flood proofing consits of those adjustments to structures and building contents which are designed or adapted primarily to reduce flood damages. This concept allows private property managers to take actions to reduce their flood risks. Flood proofing is a viable and practical means for reducing flood losses as evidenced by the accomplishment at the Containers Ltd. The 1974 flood on the Merri Creek caused over $1,000,000 to the building. Since the flood, adjustments have been made to the building which will prevent the entry of water from future floods of the 1974 magnitude.

The Board of Works will provide technical assistance to private building owners and to consultants on matters relating to flood proofing. Engineers from the Board will assist Councils, public property managers and private property managers with flood proofing technology.

Flood Insurance

The implementation of the non-structural flood control strategy can be enhanced by creation of a State or Federal flood insurance program.

Existing flood prone properties would obtain subsidized insurance. New buildings would be subject to actuarial rates. The U.S. program has shown that actuarial rates virtually rule out any further development of flood plains. Experience has shown that the benefits derived from a flood plain site are not able to offset the costs associated with the flood risk if the owner must absorb the losses.

Once an existing building was damaged to 50 percent or more from flooding, fire, or other loss, subsidized insurance would no longer be available to the building owner.

Through mortgage institutions, flood insurance would be required on all buildings for which new mortgages were to be made following the publishing of the actuarial rate making maps.

IV
DESIGN CRITERIA

In shifting from a main drainage policy to a flood plain management policy, adjustment in approach and design criteria must be made. Under the main drainage program emphasis was placed upon providing physical hydraulic drainage outlets to Port Phillip Bay. These outlets are usually underground pipes or concrete and earth channels. Where sites are available, reservoirs are sometimes built to detain floodwaters so that downstream channels would not be as large as otherwise.

An urban flood plain management program goes beyond main drains and reservoirs and makes full use of the range of land use planning and control opportunities available. In such a program an urban watercourse and its catchment basin are to be considered as an overall and single unit. The separation of planning for main drains from the drainage planning of the small local basin is not a proper or cost-effective procedure; it separates the cause from the effect. The drainage planner must deal with both and make use of the full range of available planning, engineering, and land use tools.

Criteria that require adjustments are the design flood frequency and the approach to channel improvements.

Flood Frequency

The frequency of occurrence of floods for planning and design purposes, i.e., the magnitude of discharge of floodwaters, should provide a reasonable level of freedom from damage or threat to life and health, but not as high as to be unnecessarily restrictive.

The magnitude of flood discharge used for planning and design should be in the intermediate range of possible floods.

Melbourne's flood planning should be based on the 100-year flood. This is the flood which has a 1 percent chance of being equalled or exceed in any one year. If the 1 percent flood occurs in a given year, statistically it will again have a 1 percent chance of occurring the next year.

The 1 percent flood has a 20 to 30 percent chance of occurring during a typical home mortgage period.

The magnitude of the 100-year flood (1 percent flood) will be computed from known critical rainfall patterns in the Melbourne area. One or more synthetic hydrograph methods or programs will be used which will taken into consideration future land use and land runoff controls but will not estimate the effects of proposed retarding basins which may or may not be built.

Some floods of record in the Melbourne area could be expected to have exceeded the 100-year flood while others have been less. The use of the 100-year flood will provide a common basis for assessing flood problems throughout the Melbourne metropolitan region.

There are numerous engineering and economic measures for selecting the 100-year flood for land use planning and design

purposes. The most important is knowledge of the damage potential and impact upon public health and safety so that presently unwary citizens living along the watercourse can make needed adjustments and understand risks involved. There is a tendency for many flood plain residents to think of the Board of Works design flood as being the largest which is likely to occur. If the 5, 10 or 20-year channel is overtopped and homes are flooded, the normal reaction is that the design of the channel was a failure. Thus, the 100-year flood plain delineation is an important public information item. Studies in the United States indicate that 61 percent of the nations annual flood damage is caused by floods larger than the 1 percent flood. To plan for the 20-year flood sets the stage for future disasters.

Planning for the 100-year flood leads to preserving flood plain storage upstream from Melbourne which is very important to the economic well being of the central city where major capital investments are made such as subways and large office and commercial buildings. Subways for instance need to be planned to avert flooding via stations and other openings to the ground surface.

This flood management policy is based upon time phased space allocation of drainage water within a catchment basin. This includes managing the floodwaters on an entire catchment basin. The old policy of accepting the storm runoff at whatever flow rates it is deposited in the main drain and speedily carrying it downstream to the central business area of Melbourne is a method of planning no longer acceptable.

Runoff from urbanized areas must be limited to historic levels or less. To accomplish this, the maximum allowable rates of discharge from the 100-year,and more frequent storms, should be established on a unit-area-basis for each drainage catchment. This is achieved by prudent land use development practices in the

the upper portion of the basin along with space allocation of floodwaters throughout the whole basin.

The policy is aimed at maximizing the time of concentration of runoff water. The problems arise with early concentration of runoff water because the shorter the time of concentration the longer the peak flow is at any given point.

The entire range of flood management action must be utilized in each catchment basin, whether they be large or small. This results in the most flood protection for the least cost. It also helps to guard against the major disaster which would be caused by unprecedented storms.

Design Alternatives for Channels

Under the current main drainage policy, the Board of Works is a receiver of water. The quantity of water discharged during a storm was determined by others. In this position, the Board reacted with a policy of carrying away the water that was discharged upon it by others. Because of space constraints and ever-increasing quantities of water associated with expanding urbanization as currently planned, the Board constructed many high velocity concrete channels on the limited land that was available to it as a means of performing its main drainage responsibilities. Where possible, the sizes of the channels were reduced with storage provided in retarding basins.

If the region cooperates in a policy shift from main drainage to comprehensive flood plain management, the Board will be in a position to revert back to soft or "natural" channels.

The ideal channel is a natural one carved by nature over a long period of time. A natural channel provides benefits such as:

1. Low velocities which result in longer concentration times and smaller downstream peak flows.
2. Channel and flood plain storage which helps to decrease peak flow.
3. Low maintenance need because of channel stability in its natural state with the channel in a state of equilibrium.
4. Open space and recreational amenities.

Channel stability is a well recognized problem in urban hydrology. A natural urban channel usually will need erosion control measures, and these can be designed to preserve the natural appearance.

Sometimes a natural channel has its greatest stress as a result of new sewer line construction, filling, and adjacent road construction. Slashing of vegetation in the valley bottom can expose soil to erosion forces.

When an engineered channel is required in an urban area to mitigate a flood problem, there is a range of channel design choices; providing that adequate land is available. The basic choice is whether it should be concrete lined, grassed, or left in a natural appearance. Grassed channels have a wide variety of shapes, depth, width, slopes and uses. A grassed channel can be made to suit a particular neighborhood aesthetically and be safe without dependence on fences to keep people out.

When land is available, natural channels are preferable for urban flood plain management. This is true even when consideration is given to the need for a modest amount of periodic maintenance to aid in readjustment to the urbanized hydraulic regime. When artificial channels are required, they should incorporate as many natural hydraulic characteristics as is practicable.

V

TOWARD IMPLEMENTATION

To achieve a basic change in policy, a strategy must be developed to implement the change. Elements of the strategy are presented in a preliminary manner.

No New Legislation

With its sewerage, water supply, drainage, metropolitan park and town planning functions, the Board has an adequate legislative base to pursue an urban flood plain management program.

Under recent amendments, the Board has been given the power to control the quantity of water discharged into the drainage system and the point of discharge.

Rather than seek extensive institutional reorganization or more legislation, the time has come to implement the legislation the Board now has and to better coordinate existing efforts.

Adoption of Policy

This change in policy will require action at several levels. First, the Board must adopt the policy as their approach to flood plain management. Next, the policy changes must be submitted to the 54 councils which comprise the metropolitan region. These councils should adopt the policy so a unified effort can be achieved.

After the metropolitan region has achieved unity, the policy should be submitted to the State for guidance of programs which influence the region.

As the municipal entities adopt the policy, their engineers, in conjunction with the Board's planners and engineers, will begin to apply the policy in both preventive and corrective efforts. In the Anderson Creek catchment, the councils involved have expressed a desire to launch such a cooperative effort.

Throughout this process, the many private interest groups which have expressed a concern for the quality of life will be appraised of the policy change. This will provide them with the opportunity to support the new policy and to assist efforts to implement it.

Demonstration Program by the Board.

To expedite the policy change, the Board will prepare a drainage manual for the Melbourne Metropolitan Region. The manual will address in detail, the type of flood problems that exists, and lay out design criteria to be applied in their solutions. The manual will be, in essence, a handbook for the city engineers, drainage engineers, and developers. The manual will be prepared in two phases. They are outlined as follows:

Interim Drainage Criteria Manual

1) Analyze immediate needs for a drainage criteria manual by the Board of Works to complement the Urban Flood Plain Management Policy. The range of criteria for early action use would be developed.

2) Prepare an Interim Drainage Criteria Manual with appropriate drawings, tables, figures and narrative description covering the following subjects, plus others deemed necessary by the Engineer-in-Chief.

   a) Statement of policy, goals, and objectives for drainage and flood control
   b) Brief summary of Victoria drainage law
   c) Planning

d) Rainfall

e) Runoff and flood magnitudes, including hydrologic model description

f) Flood plain delineation

g) Flood plain regulation

h) Upstream detention planning
   1. new developments
   2. existing developments
   3. retarding basin planning

i) Non-structural flood plain management planning

Final Urban Drainage and Flood Control Criteria Manual

1) Determine overall needs for a final drainage criteria manual in conjunction with the Board of Works personnel.

2) Prepare a final Urban Drainage and Flood Control Manual with appropriate drawings, tables, figures and narrative.

   a) Include criteria developed in Part A, but refined and expanded as necessary

   b) Major drain planning

   c) Major drain design

   d) Hydraulic structures

   e) Inlets and culverts

   f) Roads and streets drainage criteria

   g) Floodproofing

   h) Synergistic uses

   i) Sediment control

Concurrent with the development of the drainage manual will be the formulation of an urban catchment flood plain management plan. This plan will set forth, in a conceptual manner, how the policy would be applied.

In the basin plan, an early action pilot project will be identified, planned, engineered and constructed to demonstrate in real life how the policy will be implemented.

Integrated Funding

Flood plain management is a multipurpose, multi-means program. As such, it cannot be funded adequately with single purpose drainage funds. Because of the wide range of benefits that will accrue, funds from several sources ... drainage, metropolitan parks, sewage and open space ... should be blended together.

The National, State, and local significance of the Melbourne metropolitan region suggests that both public and private funds should be used. The public funds should be a blend of Commonwealth, State, Board and Council funds.