MULTIPLE USE CONCEPTS IN FLOODPLAIN MANAGEMENT

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Introduction

A complete floodplain management program must include all activities necessary to reduce future flood hazards (preventive) while correcting past mistakes (remedial). These actions include land use controls; and the planning, design, construction and maintenance of flood control facilities.

Local governments, which are the agencies usually responsible for providing remedial flood control facilities, are being increasingly squeezed between revenues and the demand for services. The public wants relief from flooding problems while also looking for more amenities, including recreational facilities. It therefore makes sense to combine public uses whenever feasible. Flood control facilities, while necessary and useful, are dry most of the time; and are therefore available for other public uses (such as recreation and open space) which are compatible with the flood hazard.

Land developers also face multiple requirements when subdividing or building. These can include floodplain regulation requirements, park and school land dedication requirements, stormwater detention facilities, open space or landscaping requirements and marketing considerations. These requirements can break a project - or make it.

Both public agencies and private developers should look to the concept of multiple use to provide needed facilities and desirable amenities which improve the quality of life. Shared land, shared facilities, and shared construction and maintenance responsibilities can all help meet the needs of society at reasonable cost. Good planning can assure multiple use. Bad planning results in loss of opportunity for multiple use and higher costs to the public.

This is not a new concept but it is too often overlooked or ignored. The purpose of this paper is to focus on concepts of multiple use and examples of public-and private-sector multiple use projects in the Denver area.

Channels

Flood control channels, whether built for remedial purposes or as part of new development, offer the opportunity for greenbelts and trail systems. Maintenance trails can easily double as hiker/biker trails (Figure 1). Pocket parks can be created at intervals along the channels. These are small parks which can consist of play ground equipment, benches, picnic tables, bicycle racks, exercise stations, drinking fountains, trash recepticles, etc.

The type of channel can obviously affect the amenity provided. For example, the Urban Drainage and Flood Control District (UDFCD) and the City of Denver had planned to construct a concrete channel for a section of Weir Gulch at its confluence with the South Platte River to remove a public housing area from the floodplain. A citizen's group called the Platte River Development Committee (PRDC, now the Greenway Foundation), which was revitalizing the South Platte River with parks, trails and other amenities, proposed a joint flood control and recreation project for Weir Gulch. With additional funds provided by the PRDC the three parties were able to acquire additional right-of-way which permitted the construction of a blue grass channel, boat launching lagoon providing access to the river, parking lot with basketball court, and play structure. The end result was a facility that not only provides the desired flood protection, but is a park for the housing area and provides a link to the South Platte River facilities (Figure 2).

Detention

Detention facilities can include every type of facility from major Corps of Engineers' flood control projects to the smallest of "on-site" ponds. Several examples of multiple use detention facilities are given below.

Holly Dam. Holly Dam controls a drainage area of 2.1 square miles. The 100-year flood volume of 252 acre-ft. will be contained in the flood pool which is owned by the South Suburban Recreation and Park District. The park district has

constructed tennis courts in a terraced fashion stepping down into the flood pool. The lowest courts are at the 10-year flood pool elevation. They have been flooded once in the 7 years since they were built (Figure 3). A soccer field was rough graded into the flood pool in the embankment borrow area at the time of construction but has not yet been developed. Maintenance of the facility is shared by the UDFCD and the park district.

Englewood School Detention. The UDFCD and the City of Englewood determined that the best solution to a flood control problem on Little Dry Creek was the construction of a side-channel storage facility to shave the peak from flood hydrographs. Fortunately, the ideal location for such a facility was the 11 acre athletic fields of Englewood High School. The School Board, although originally skeptical of the idea, eventually agreed to the concept. The resulting project provides 89 acre-feet of flood storage. In return for the authorization of the school board to use the land, the project added blue grass sod, one additional soccer field, concrete bleachers, concession stand and an office/press box. The school district maintains the bulk of the facilities, with the flood control maintenance responsibility limited to the inlet and outlet facilities, as well as after storm clean up.

On-Site Detention. Local on-site detention to maintain peak discharges at pre-development levels is required by many Colorado communities. These facilities can be stuck away in a corner where they are neglected, become maintenance problems and/or loose their effectiveness; or, they can be integrated into the overall development plan where they become assets to the development, and, because they are assets the chances of them receiving the needed maintenance are greatly enhanced. Figures 4 and 5 show how these on-site facilities can function as multiple use assets.

Open Space

Open space, particularly riparian land, is most beneficial to the overall quality of life of an area. In many instances in the Denver area, developers have found that the best way to address the flood hazard potential is to set the floodplain aside as open space area as an integral part of the development plan. With the addition of trails for hikers/bikers and for maintenance activities the

floodplains become linear parks and connecting links between different portions of the community (Figure 6). One caution is that the increased frequency and amount of runoff resulting from urbanization can cause significant erosion problems which should be addressed at the time of development.

Trails

Trails are perhaps the most common example of multiple use. Every flood control facility, whether a channel or an open floodplain, should have a maintenance trail along its entire length. The UDFCD constructs maintenance trails along all of its channelization projects. The fact that these trails can also be used for hiker/biker trails is a bonus to the community.

On the other hand, trails built as hiker/biker facilities can also be used to provide access for flood control maintenance purposes. For example, when the Colorado Greenway proposed a trail along Bear Creek it provided the opportunity for the UDFCD to open up an almost inaccessible reach of Bear Creek by joining with the other trail sponsors to provide a part of the construction costs. The end result of the Greenway project was a recreational trail which also provides flood control maintenance access. Another example is a joint project between the UDFCD and the Greenway Foundation for a trail link along Lakewood Gulch from the South Platte River to a Denver park six blocks away (Figure 7).

Guidelines For Multiple Use

Over the years the UDFCD has developed an informal set of guidelines to assist in the formulation of multiple uses. These guidelines are summarized below:

1. Uses must be compatible with the flood control purposes of the facility. Park, recreation and open space uses offer the greatest opportunity for multiple uses.
2. Public land is expensive to acquire and maintain. Multiple use can result in shared acquisition and maintenance costs. Look for right-of-way already in public ownership, or look for a potential "partner" in the use and maintenance of a project site.

3. Consideration of multiple use possibilities should begin early in the project planning stage. Multiple use should always be foremost in the minds of the planners.
4. Multiple use facilities develop a greater constituency for their continued operation and maintenance than single purpose projects, particularly flood control projects which function only occasionally.
5. Multiple use typically involves more than one agency. Future responsibilities; particularly maintenance, public safety and liability exposure; must be understood and accepted up front.
6. Multiple use can be stimulated by local governments through many avenues, such as the transfer of development rights.

A Final Example

Diligence in the pursuit of multiple use concepts for the Hidden Lake Outlet Channel project resulted in a unique multi-faceted project involving several agencies. The situation at the beginning of the project was this. The Hidden Lake Dam embankment had been declared unsafe by the State Engineer. The lake provided a valuable benefit, however, in reducing downstream flood peaks and the UDFCD wanted to insure the continued existence of the reservoir in order to decrease the required size of downstream channel facilities. The right-of-way needed to construct the required outlet channel, service spillway and emergency spillway consisted of two parcels: the Shattuck parcel, consisting of 9.7 acres; and the Kareus/Sullivan parcel of 6.0 acres.

The following arrangements were developed to secure the acquisition and long term use and maintenance of the two parcels. The Shattuck parcel was acquired through negotiation; with Hyland Hills Metropolitan Recreation and Parks District, Adams County Parks and the Land and Water Conservation Fund providing $197,000 and UDFCD and Adams County Public Works providing $35,000. The Kareus/Sullivan parcel was acquired through eminent domain proceedings by UDFCD and Adams County Public Works at a cost of $222,156.

Title to the Shattuck parcel was vested with Hyland Hills, and the flood control interests were given easements for the outlet channel, service and emergency spillways and embankment. Title to the Kareus/Sullivan parcel rests with UDFCD,

although it will eventually be transferred to Adams County. Hyland Hills has executed a long term lease with UDFCD for the use of the parcel with such uses being consistent with the proposed emergency spillway. Hyland Hills has constructed four ball fields on the two parcels using proceeds from the Colorado Lottery. A major concession facility is also planned.

The end result of this project is a 15.7 acre park and flood control facility. The combined funding (from 6 sources) resulted in facilities which would have been significantly more expensive to implement independently. The UDFCD will maintain the flood control facilities, while Hyland Hills will maintain the ball fields, including the emergency spillway area.

Summary

Multiple use concepts are a viable way in which to combine uses of land and monetary resources to obtain multiple objectives at a lesser cost to each of the individual interests. Flood control uses are particularly suited to be combined with park, recreation and open space uses. Examples of various types of multiple use projects in the Denver area demonstrate the value of this concept.

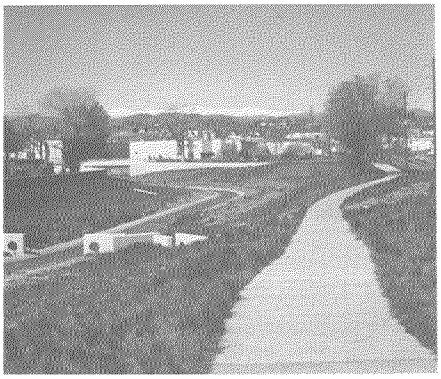

Figure 1 - Little Dry Creek Channel and Trail

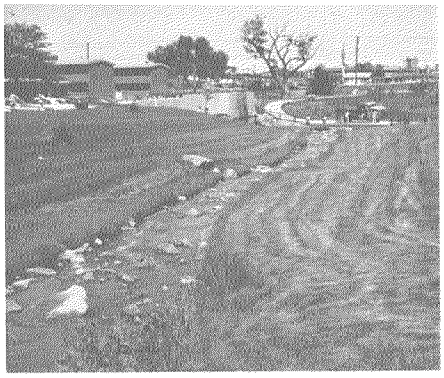

Figure 2 - Weir Gulch Channel and Park

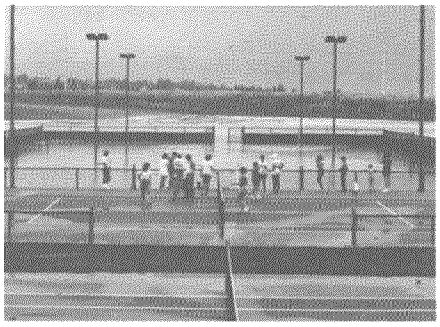

Figure 3 - Holly Dam tennis courts flooded

Figure 4 - Detention in a park

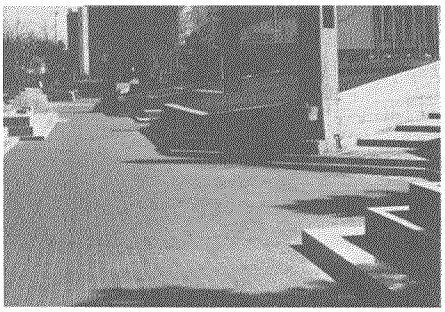

Figure 5 - Skyline Park in downtown Denver

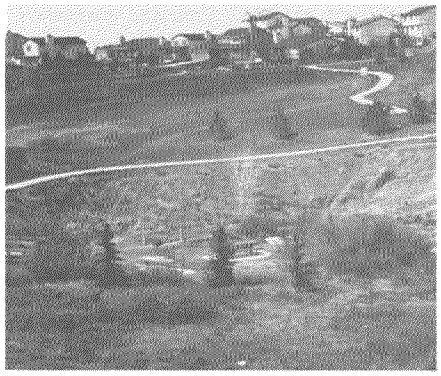

Figure 6 - Open space trails and picnic area

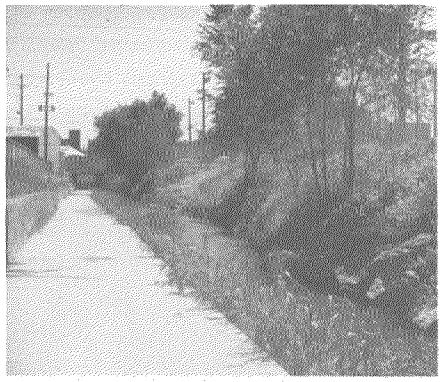

Figure 7 - Lakewood Gulch Trail

DENSITY DEVELOPMENT CRITERIA FOR FLOODWATER CONVEYANCE

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The concept of limiting development density has been used for such planning purposes as 1) maintaining agricultural and forest uses, 2) discouraging certain types of development, and 3) restricting development in order not to overstress existing services. Typically, specifications for lot size, volume of structural development, and configuration are components of density criteria. This same concept has numerous applications in flood-prone areas where maintaining adequate floodwater conveyance area is the objective. This presentation will explain these applications and will illustrate mechanics and case studies.

The floodway concept is one of the two major floodplain management tools used in the United States. The other tool is the elevation criteria for new structures. The floodway is specifically required in the regulations of the National Flood Insurance Program for most participating communities, and is a component of the floodplain programs of virtually every other governmental program which deals with floodplains. Under the floodway provision, a designated area within the floodplain won't be encroached upon, thereby assuring that floodwaters of the 100-year magnitude will pass with no more than a one-foot rise. This rise is caused by, and allows for, encroachment in the fringe area up to a total filling. In the "standard" floodplain configuration consisting of a defined channel and a floodplain where topography gradually rises away from the channel, the conventional floodway is, indeed, appropriate. In most cases, the central portion of the floodplain will contain waters of the greatest depth and velocity.

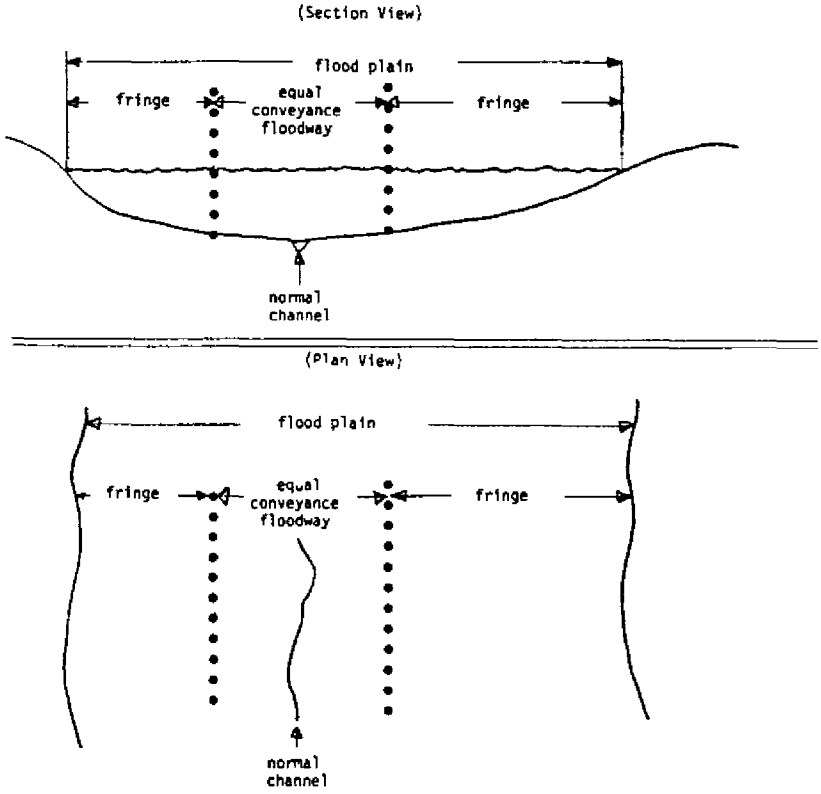
Therefore, the "conventional" floodway located by the equal conveyance principal will usually coincide with this central area of greatest hazard, though another hydraulically feasible location may be adopted. In any case, the location chosen, in order to be hydraulically efficient, would generally coincide with the area of greatest depth and velocity.

This fairly central location of the floodway can be justified , then, not only on the basis that conveyance must be reserved, but that this area, because of its relatively high hazards, should be most severely restricted regarding habitable development. Because of this additional supporting fact, the "conventional" floodway, located by the equal conveyance displacement principal, is normally understood and accepted by the public.

Where the floodplain is not typical, however, the applicability decreases. The following figures illustrate a "typical" floodplain and two that are atypical. It may be somewhat misleading in parts of this country to call these two atypical since, though they are rarely seen in standard documents or literature illustrating the floodway concept, their occurrence is fairly frequent.

FIGURE I

"Typical" equal conveyance floodway located between dashed lines. Floodway contains deepest and fastest waters It covers the most efficient conveyance area.



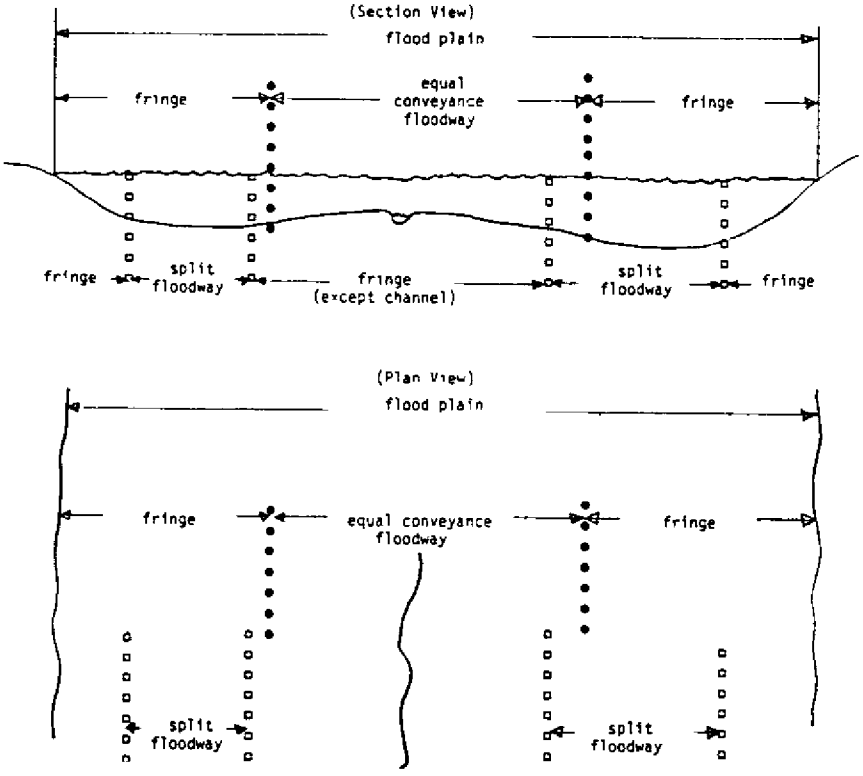
As can be seen in Figure 1, the conventional floodway location is both administratively and hydraulically "clean." It can readily be calculated with standard methods by any flood insurance study contractor and is easily delineated on maps and within zoning ordinances. The figure indicates that the two fringe areas could be completely filled and the floodway area could still pass the flood flows without exceeding the allowable predetermined surcharge. In FEMA's case, this is a maximum of one foot. It is this type of floodplain around which most regulatory criteria, including those of the NFIP, are written and to which the standard floodway hydraulic computer program is adapted.

It should be noted that a hydraulic reason for the floodway location coinciding with the fastest and deepest water is that more water passes through more quickly in this area than in the fringe. Therefore, it is the most efficient area in terms of conveyance. An area of equal linear size in the fringe would not pass as much floodwater during the same time interval.

A second type of flood plain is one that is "non-typical" in the sense that the most hazardous waters are not centrally located in the floodplain. This is shown in Figure 2.

FIGURE II

Standard equal conveyance floodway (between dotted lines) does not coincide with the most hazardous area. Split floodway (designated by□□) contains the most hazardous waters and covers the most effective flow area. Normal channel would also be designated as floodway



Because the channel is not lower than all the surrounding floodplain (i.e., the topography does not slope up from the channel), the most hazardous floodwaters are not located centrally , but in the two deep areas outboard of the channel.

The standard equal conveyance calculations would delineate a floodway shown by the dotted lines (• • • • •). However, common sense and good engineering judgement would indicate that such a central location is inappropriate. Such a location, though acceptable by the standard hydraulic computer model, would encompass neither the most hazardous area nor the most efficient flow area.

The two locations encompassed by (□ □ □ □ □) indicate two areas through which portions of the floodwaters could logically be passed. This would represent a split floodway configuration that would encompass the most effective flow areas. In addition, it would seem logical that these areas should come under the most severe regulations, the floodway development constraints.

As one can imagine, it would be very difficult to sell the idea that the area between the dotted lines (the equal conveyance location) should not be encroached upon, while the fringe could be completely filled. This would not only run contrary to sound environmental practice, but would be much more expensive to develop than would be the high ground area closer to the channel. The split floodway, with its fringe areas located where there is the least flood hazard, would be more economically developed while also being supported by common sense.

The split floodway concept was adopted for use several years after floodway regulations were generally accepted. Though it was the target of some resistance from FEMA, the Corps of Engineers, and other engineering staff, it was applied in a limited number of cases and has now become a frequently accepted method of floodway location. Since in those cases where it has been appropriately applied it has appeared to be the most logical choice, this location alternative has been much easier to "sell" to the public.

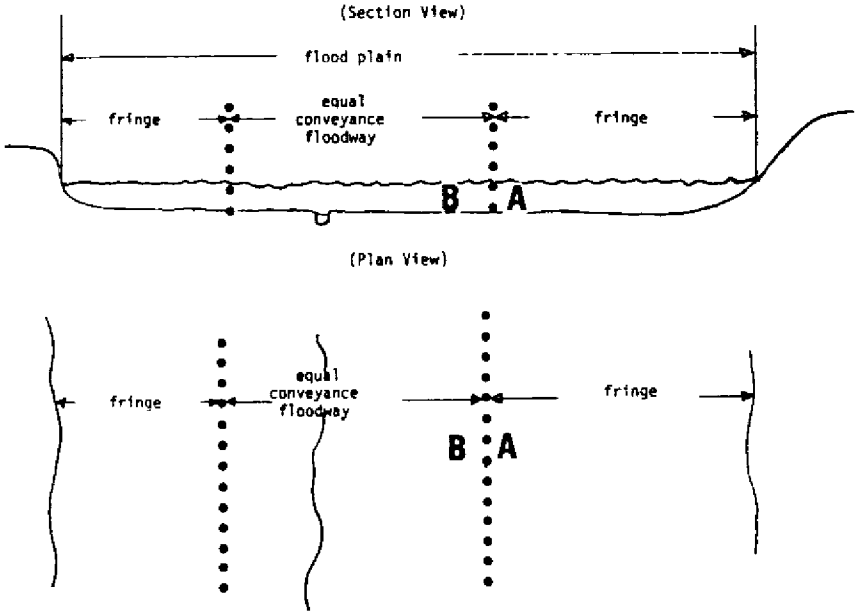
To the layperson, it appears to encourage development away from the worst areas, and into the "safer" areas. Though not presented on Figure 2 for reasons of visual clarity, the natural channel itself would also be designated as a floodway area. This would be the case in any type of floodplain configurations.

The second type of "non-typical" floodplain is shown in Figure 3. In this

type, the hazard, with its components of depth and velocity, is generally constant from one edge of the floodplain to the other. In other words, the hazard at A is equal to the hazard at B. The standard equal conveyance floodway can be easily computed and delineated. It is also as easy to describe on a map and in an ordinance as was the example shown in Figure 1.

FIGURE III

Hazards (in depth and velocity) generally constant in flood plain.



The paramount difference is that though the hazards are equal, the floodway regulations, particularly those of FEMA, treat A and B far differently. A, being in a fringe, has the ability to completely fill the property. Of course, any structure would have to meet applicable elevation requirements, but the owner could fill the areas with earth, concrete, or any other encroachment up to a total fill and still be within FEMA criteria. There could be as many habitable structures as the owner pleased on the property. B, however, could not, for most practical purposes, fill any of the property and could only build a structure if there was a detailed engineering analysis to demonstrate this the structure, along with all future anticipated possible developments, would not cause any rise in water surface elevation. Though the regulations envisioned no development in a floodway, it has been found that some very limited types of structures can be placed in a floodway without causing any measurable rise in water surface elevation. However, this kind of effort is both time-

consuming and costly and, very often, not really practical.

The reason B, and others inside the floodway, cannot cause any rise is that the allowable surcharge (e.g., FEMA's one foot) has been "used up" by the designation of the fringe as an area where unregulated encroachment can take place. Though, in reality, the fringe in most cases would not be totally filled, only by making this assumption is a community able to allow any measure of development without having to make a detailed case-by-case analysis to measure the encroachment potential of each development.

The inequity of the situation becomes apparent. The only significant difference between A and B is that B is unfortunate enough to be on the wrong side of the floodway line. B and other neighbors within the floodway are shouldering the entire burden of conveyance assurance, while A and neighbors are enjoying full use of their properties at the expense of B.

The density criteria are is designed to alleviate this inequity while at the same time assuring that an adequate conveyance area is provided. The density concept is based on the principal that the burden of assuring adequate conveyance can be shared among all floodplain occupants who are subjected to similar hazards.

Figure 4 shows a floodplain configuration onto which no standard floodway has been drawn. The plan view shows, approximately to scale, what would be developed when density criteria have been imposed. The criteria for this example are those currently used by the City of Richland, Washington.

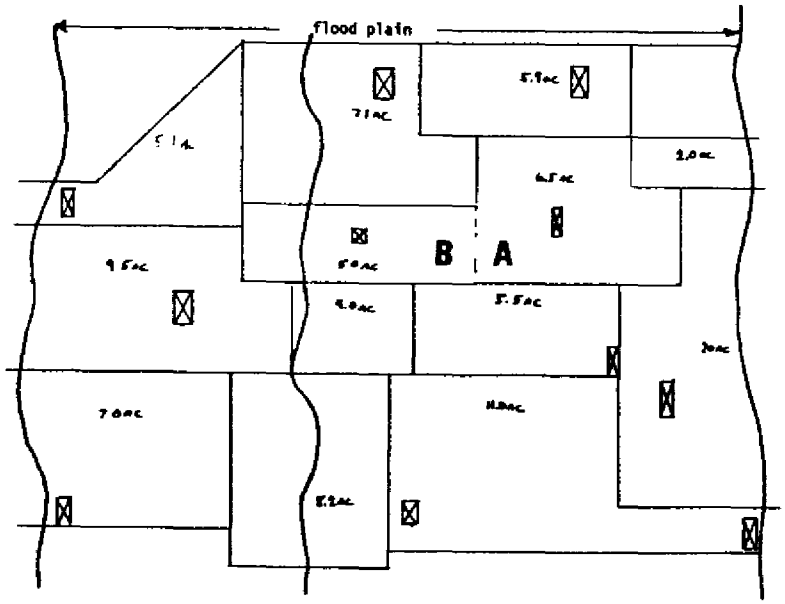
By applying the development criteria shown across the entire floodplain, the imposition of a designated floodway was avoided. Every property owner had to bear some of the burden of conveyance assurance, but these constraints allowed an economically reasonable use of the land for all. Not every parcel in the floodplain was exactly five acres in size when the criteria were imposed. Those that were smaller than five acres could not be built upon, and those smaller than ten acres could accommodate only one habitable structure which had to meet the rest of the criteria. Since existing structures are taken into consideration during the calculation of the base flood elevations (BFE) for the area, encroachments (structures, fills) were already considered in determining the flooded area and elevations need not be included when calculating maximum density allowable by the one-foot surcharge regulation.

The density criteria are only an option for floodplain configurations shown in Figures 3 and 4 because an argument for density criteria should be

FIGURE IV

CRITERIA	MAXIMUM
Density - maximum number of structures allowed	: 1 per 5 acres
Density - maximum area of fill allowed	: 10% of lot
Maximum cross-sectional blockage allowed:	30%, not to exceed 200'
Stucture Placement	: only parallel to flow
Other constraints	: no blockage of defined overflow channels

NOTE: Land area less than 10 acres can only contain one "structure" due to 5 acre minimum lot size



made only when the hazard components of depth and velocity are generally constant. It can further be shown that if the product of these two components is constant, it makes little difference how great that product is since the equal conveyance floodway fringe regulations would allow habitable structures to be built anyway. In other words, even if the depth or velocity or both are great, the greatest restriction FEMA could place on new development is that only the floodway area could be preserved, while the fringe, with this same magnitude of hazard, could be completely developed.

The technology for analyzing density criteria for conveyance maintenance is now available, as is documented in a study done by the Army Corps of Engineers Hydrologic Engineering Center (HEC) for FEMA. While the method produced by this study has not been widely applied, those who have used the

method seem to be pleased with the results. Any engineering firm capable of using the HEC programs and/or producing a flood insurance study would also be capable of running a density criteria analysis. FEMA Region X has recently funded Corps sponsorship of a training session for all Corps' Districts within the region on the use of the method.

In conclusion, the advantages of a density criteria are: 1) the burden of development restriction is spread to all property owners in the area, 2) properties of equal risk are regulated equally, and 3) no arbitrary placement of varying restrictions (i.e., floodway/fringe) is necessary. These advantages can make administration of floodplain regulations much more acceptable to local property owners. The approach can be utilized in areas with various degrees of mapping accuracy (approximate to very detailed), and be made to comply with various government regulations (Section 60.3(c)(10), NFIP). Its most obvious application is in areas where detailed floodplain data are available, but a regulatory floodway has not been provided. It can also be used in shallow flow areas and as a supplement to a regulatory floodway.

Cases in which density criteria have been adopted demonstrate that it is a workable concept and one that achieves conveyance assurance while providing a high degree of equity. These cases include Richland, Washington; Scio, Oregon; and Tualatin, Oregon.