City of Fort Collins
and Environs

Policy and Criteria
Use of Irrigation Ditches for Storm Runoff
Mr. Paul A. Lanspery, Acting City Manager  
City of Fort Collins  
P. O. Box 580  
Fort Collins, Colorado 80521  

Dear Mr. Lanspery:

At the request and direction of Mr. William Stover and representatives of the southside ditches, together with the Poudre River Water Users Association, we have prepared the attached, "Policy and Criteria: Use of Irrigation Ditches for Storm Runoff." It is a statement of policy and criteria suitable for use by the City of Fort Collins and Larimer County in the environs of the city, if found acceptable by those entities.

The policy and criteria were prepared in conjunction with W. Joseph Shoemaker, a legal expert in drainage and flood control law. Mr. Shoemaker is author of Section 4, entitled, "Legal Principles."

The appendix contains a two page guideline to be used for drainage plan reviews entitled, "Requirements for Drainage Plan Reviews for Subdivisions Tributary to Irrigation Ditches." Following this guideline is an Executive Order signed by Governor Richard D. Lamm, August 1, 1977, regarding flood hazards. Due to its timeliness and relevance to the issue, it is enclosed.

The urban and rural communities have common goals, but sometimes conflicts arise when the rights and interests of the agricultural and rural community are not understood through lack of communication. We hope that the attached policy and criteria for drainage will assist in overcoming the problem of urban runoff discharge to irrigation ditches.

Very truly yours,

WRIGHT-McLAUGHLIN ENGINEERS

Kenneth R. Wright, Principal Engineer  
David J. Love, Project Engineer

Enclosure

752-32.2E
POLICY AND CRITERIA

USE OF IRRIGATION DITCHES FOR STORM RUNOFF

CITY OF FORT COLLINS AND ENVIRONS
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## APPENDIX

- Requirements for Drainage Plan Reviews for Subdivisions Tributary to Irrigation Ditches
- Executive Order: Evaluation of Flood Hazard in Locating State Buildings, Roads, and Other Facilities, and in Reviewing and Approving Sewage and Water Facilities, and Subdivisions
POLICY AND CRITERIA
USE OF IRRIGATION DITCHES FOR STORM RUNOFF
CITY OF FORT COLLINS AND ENVIRONS

1. FOREWORD

Irrigation ditches in the Fort Collins area divert water from the Cache La Poudre to bring water to agricultural land. Most were constructed more than 100 years ago to follow the contour with relatively flat grades, crossing gulches and sloughs generally at right angles.

In the City of Fort Collins and environs land has been urbanized both uphill and downhill of the irrigation ditches. Land which has been urbanized has more runoff than grass land or farm land. That is, residential and commercial development causes more volume and rate of flow of storm runoff than under historic conditions for a given rainfall intensity and duration. If not managed, the storm runoff has the potential of causing more harm than formerly to subservient lands.

1.1 Irrigation Ditches

There are numerous main ditches in the Fort Collins area plus many laterals. This policy and criteria apply to both main ditches which divert from the river and the laterals which carry water to individual water users.

Some of the most affected ditches are tabulated below with typical maximum diversions from the last decade.

<table>
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2. IRRIGATION DITCHES AND STORM RUNOFF

The Fort Collins area is semi-arid with much of the region, particularly along the stream systems, being agriculturally oriented. Over 100 years ago the settlers established an extensive system of irrigation ditches.

These irrigation ditches course through urbanized areas, as well as many areas which will be developed in the future. Irrigation ditches often lie within fully developed residential subdivisions, industrial areas, and commercial areas.

In past years it has been common practice for urbanized areas to discharge storm sewers into irrigation ditches because of their convenience and proximity. Generally, because the irrigation ditches tend to parallel the contours, the major drainage has also flowed into these irrigation ditches. The problems in recent years of overflowing irrigation ditches has made it apparent that the use of irrigation ditches for the collection of storm runoff was sometimes ill-advised. Hardships can be caused by irrigation ditches overflowing at uncontrolled points of discharge.

Irrespective of past practice and court determinations, it is clear from a hydrologic standpoint that the use of irrigation ditches to collect storm runoff must be subjected to close evaluation and review to reduce problems and to prevent additional hazards from being created.

In regard to legal aspects of utilizing irrigation ditches for carrying either the initial or major storm runoff, the developer or planner is referred to competent legal counsel. If there is any doubt about liability involved, it would be prudent to proceed in a manner which would leave the storm runoff in its natural watercourse, and furthermore, to proceed in a manner which will result in the minimal hazard to those parties potentially affected.
3. CHARACTERISTICS OF IRRIGATION DITCHES

Irrigation ditches were usually constructed to carry a specific amount of water, generally the amount permitted by the decree issued for the water right under the appropriation doctrine. Usual ditch grades range from 1 foot to 5 feet per 1,000 feet. The ditch is generally constructed on the side of a hill, with an outside bank formed from the excavated material. The top of this bank is usually at varying heights above the ditch flowline in a random fashion. The nature of an irrigation ditch is such that it collects surface storm runoff from those lands above the ditch.

A characteristic of agricultural irrigation ditches is such that when they overflow, one generally cannot tell ahead of time where they will overflow. Often, overtopping of the outside bank is associated with a breach of the bank.

Historically, and prior to urbanization, the farmer or ditch company was not concerned about surface runoff into the ditch. Because of the high percolation rates from the native grassed land above the ditch, there was not much storm runoff. Furthermore, if the ditch did overflow and breach, it was just a matter of repairing the ditch after the storm to get the ditch back into operation. Urbanization causes increased runoff and results in the construction of buildings below the ditch, and for this reason a close review of the adequacy of irrigation ditches in urban areas is needed.

The urbanization of an area may result in the abandonment of an irrigation ditch by an irrigator. With the abandonment of a ditch a municipality has the opportunity to acquire the right of way. However, this also brings about the responsibility for maintaining the right-of-way and probably accepting the responsibility for damage which might occur from the flooding from the ditch.
Engineering studies can readily be performed to determine the ditch capacities in a reliable manner. The slow velocities are related to low gradients. Usually, the capacity of a ditch is small when compared with urban storm discharge rates.

The investigation of an existing ditch flood hazard, or the study to determine whether or not a new storm sewer can be discharged into an irrigation ditch, requires a detailed hydraulic analysis of the ditch carrying capacity. This will often include a determination of bridge and culvert restrictions, and a survey of the ditch flowline and outside bank profile coupled with cross sections at control points. A review and analysis should also be made of any emergency spillways already existing. These are generally located at gulches and streams which may be crossed by the ditch.

The analysis of the carrying capacity of a ditch should be undertaken using the standard step method for backwater curves. The engineer may find it desirable to utilize computer programs already developed for this purpose. The analysis of the capacity and the water surface profile can generally pinpoint the ditch limitations for carrying storm runoff. However, it will also provide the needed information for determining the location of emergency overflows, and it should indicate the locations of uncontrollable overflow which should be corrected.

Ditches in the Fort Collins area are subject to a trash and debris accumulation, which will often plug small bridges and culverts. Consideration must be given to such blockages.
4. **LEGAL PRINCIPLES**

1. The owner of the dominant estate has a legal and natural easement or servitude in the lower or servient estate for the drainage of surface water flowing in its natural course and manner.

   City of Boulder vs. Boulder & White Rock Ditch and Reservoir Co., 73 Colo. 426, 216 P. 553 ( )


2. When an interruption in the natural flow or passage of surface waters is caused by the servient owner to the detriment or injury of the estate of the dominant owner, a mandatory injunction for the opening of the easement which has been blocked will be issued.

   Hoff vs. Ehrlich
   City of Englewood vs. Miller, 155 Colo. 47, 392 P. 2d 591 ( ).

3. But a dominant owner may not send waters downhill in a manner or quantity causing more harm than formerly.


4. These and other principles relating to the legal and engineering considerations of urban drainage problems are contained in:


   b. "What Constitutes Benefits for Drainage Improvements" also by W. J. Shoemaker in

5. Laying those surface water principles on top of the physical characteristics of an irrigation ditch traversing an urban area allows the following matters to be considered:

   a. Does the irrigation ditch interrupt the natural flow of surface water from the drainage basin(s)?

   b. Is more water than would naturally flow being sent downhill?
6. In most cases involving irrigation ditches in urban settings, the legal principles applying to surface water cases come into play and, as here, result in a third party (a local government) involvement. This adds, of course, another legal principle:

A municipality has no duty to resolve a surface water dispute between two private property owners, but if it chooses to do so, it will be held responsible for its negligence.


7. Although irrigation ditches carry surface runoff waters, they were not designed to do so. Municipalities should avoid planning which incorporates irrigation ditches as a part of a storm drainage system. (Streets, under the control of municipalities, are just the opposite. See: Drainage Criteria Manual of the Urban Drainage and Flood Control District).

8. A master plan for storm drainage in an urban area containing irrigation ditches should consider the following:


b. Does more water now flow downhill in these basins than formerly? How much?

c. Does this surface water overflow into the irrigation ditch? Does it infiltrate it at bridge crossings from streets? Does this surface water back up on the uphill side of the ditch?

d. Is the surface water causing more harm to the ditch than formerly? Is there a way to keep the "excess" storm water out of the ditch? How? Where would it go?

e. Could a storm sewer or culvert be built under the ditch but perpendicular to the ditch to allow the surface water to continue downhill from the ditch? Is there a "safe" outlet at next drainage basin?

f. What benefits (damage alleviation, use of surface water) would accrue by making any of the above "improvements"?
9. Not to be overlooked are the following statutory considerations
   a. §106-2-34 (4)(C) (County drainage planning duties)
   b. §106-2-34 (3)(D) (ix) (Subdivider planning duties)
   c. §118-7-1 (1) and (2) (Statutes of Limitation on actions affecting real property)(and exceptions)
   d. S.B. 116, (1973), relating to storm water detention facilities.

CONCLUSION:

Any lawsuit determination will be made based on the most dependable, detailed and clear set of facts in relation to the above questions.

CONCERNING THE REQUIREMENTS OF SUBDIVISION REGULATIONS RELATING TO STORM WATER DETENTION FACILITIES.

Be it enacted by the General Assembly of the State of Colorado:

SECTION 1. 106-2-34 (3) (d), Colorado Revised Statutes 1963, as amended by section 7 of chapter 81, Session Laws of Colorado 1972, is amended BY THE ADDITION OF A NEW SUBPARAGRAPH to read:

106-2-34. Subdivision regulations. (3) (d) (ix) Maps and plans for facilities to prevent storm waters in excess of historic runoff, caused by the proposed subdivision, from entering, damaging, or being carried by conduits, water supply ditches and appurtenant structures, and other storm drainage facilities;

SECTION 2. 106-2-34 (4) (c), Colorado Revised Statutes 1963, as amended by section 7 of chapter 81, Session Laws of Colorado 1972, is amended to read:

106-2-34. Subdivision regulations. (4) (c) Standards and technical procedures applicable to storm drainage plans and related designs, in order to insure proper drainage ways, WHICH MAY REQUIRE, IN THE OPINION OF THE BOARD OF COUNTY COMMISSIONERS, DETENTION FACILITIES WHICH MAY BE DEDICATED TO THE COUNTY OR THE PUBLIC, AS ARE DEEMED NECESSARY TO CONTROL, AS NEARLY AS POSSIBLE, STORM WATERS GENERATED EXCLUSIVELY WITHIN A SUBDIVISION FROM A ONE HUNDRED YEAR STORM WHICH ARE IN EXCESS OF THE HISTORIC

Capital Letters indicate new material added to existing statutes; dashes through words indicate deletions from existing statutes and such material not part of act.
RUNOFF VOLUME OF STORM WATER FROM THE SAME LAND AREA IN ITS UNDEVELOPED AND UNIMPROVED CONDITION;

SECTION 3. Safety clause. The general assembly hereby finds, determines, and declares that this act is necessary for the immediate preservation of the public peace, health, and safety.

John D. Vanderhoof  
PRESIDENT  
OF THE SENATE

John D. Fuhr  
SPEAKER OF THE HOUSE  
OF REPRESENTATIVES

Comfort W. Shaw  
SECRETARY OF  
THE SENATE

Lorraine F. Lombardi  
CHIEF CLERK OF THE HOUSE  
OF REPRESENTATIVES

APPROVED

John A. Love  
GOVERNOR OF THE STATE OF COLORADO

PAGE 2-SENATE BILL NO. 116
5. CONCEPT OF STORAGE

The essence of managing runoff is the realization that storm runoff is a space allocation problem. That is, at any given place and time, there is a fixed volume of water in storage or transit for any given rainfall event.

5.1 Natural Versus Man-Made Storage

Runoff storage exists in all natural settings. This storage occurs in many forms, a few of which are:

- Water held by vegetation.
- Water infiltrated and held in the soil and other substrata.
- Water held in shallow small surface depressions.
- Water held in large surface depressions or ponds and lakes.
- Water dynamically stored in streams and floodplains.

This storage is referred to as natural storage. Urbanization, agricultural and forestry practices can modify the natural storage and the stream network. Compensation for these effects, or the desire to modify the drainage system, often leads to man-made storage to replace and/or augment natural storage.

An effect of urbanization is generally to increase the rate of runoff response due to faster hydraulic conditions that exist in paved areas versus vegetated areas. An objective of storage is to slow this rate of response of the development area. By using slow-flow channels, revegetation, and planned storage, the effects of urbanization are minimized, and in many cases, planned positive results can occur.

5.2 Man-Made Storage Potential

Construction of man-made storage is a valuable means to achieving well-managed runoff systems. Such storage can vary in scale from large retarding (detention) basins on principal rivers and creeks which regulate flood flows, to rooftop ponding systems which would control a wide range of runoff flows to help reduce local storm drainage works.
Storage facilities can be managed to provide multiple benefits. Such benefits include water quality improvement, sediment control, water supply, and recreational opportunities. In some instances, valley configurations are conducive to the development of storage sites. Such storage can be achieved by a road fill across a valley. Excavations for aggregate or fill can also provide storage opportunities.

Man-made storage must be viewed as only one of the possible measures to be considered in a drainage program. It must be coordinated with efforts to maintain and possibly enhance the natural storage.

Man-made storage should be planned initially in terms of drainage requirements. Aesthetics and/or recreational considerations must be subordinated to that purpose. Such storage should be evaluated in regard to economic feasibility and physical practicability.

When provision of storage is being considered, the designer must verify that the attenuation of the peak runoff will not undesirably aggravate any potential downstream peaking conditions for a range of flood frequencies. Consideration must also be given to the effect of the prolongation of flows. Assessment of these aspects must not be limited to the immediate watercourse or watercourses under consideration, but must extend to any other watercourse along which the floodwaters are conveyed on their way to the receiving stream. In some instances, this may necessitate routing of storms of durations critical for each reach of the watercourses under consideration through the whole of the drainage system upstream of the reach. In other instances, only a superficial assessment based on experienced judgment may suffice.

The greater the number of storages in a system, the more complex is the analysis of the interaction of the various outflows. Also for such storages to function in accordance with their design intent during a given event, they must be regularly and effectively maintained. This factor must be taken into account by the designer.
5.3 Location of Man-Made Storage

Man-made storage can be located throughout a catchment. To be effective, the storage must be related to the area to be protected. With respect to location, man-made storage can be located upstream of the area to be protected, within (dispersed) the areas to be protected, and downstream from the area to be protected. The location selected will be determined by the nature and source of the flood problem.

5.3.1 Upstream Storage. This storage takes place upstream from the area to be protected. Its purpose is to store runoff which originates upstream or beyond the area to be protected.

5.3.2 Within Area Storage. This storage takes place within the area to be protected. It can be dispersed throughout the area. Its primary purpose is to provide storage for the increased runoff which results from the urban development. Frequently such storage is provided at the development sites.

5.3.3 Downstream Storage. This storage takes place downstream from the area to be protected. Its purpose is to provide acceptable outlets for discharges from a storm sewerage system. In general, downstream storage manages the runoff from the protected area and mitigates any downstream effects that may be associated with development in the protected area.

5.4 Types of Storage

Storage facilities can be classified into three basic types. These types provide a range of management opportunities to the designer. Within a given catchment, a plan may use a mix of the three types of storage.

5.4.1 Retention Storage. Retention storage is provided in a basin in which the runoff from a given flood event is stored and is not discharged into the downstream drainage system during the flood event. This type of stored water may be used for beneficial purposes such as irrigation or low-flow augmentation or be allowed to evaporate or seep into the ground. To
be totally effective, the stored water in the flood control part of the basin must be used or lost before the next flood event occurs. A permanent conservation pool can be designed into a retention storage facility. When this is done, the facility may be referred to as wet storage.

5.4.2 Retardation (Detention) Storage. Retardation storage is short-term storage which attenuates the peak flow by reducing the peak outflow to a rate less than the peak inflow and thereby lengthens the time base of the hydrograph. The total volume of water discharged is the same, it is simply distributed over a longer duration. The retarding basin usually drains completely in less than a day. The area is normally dry and can be used for recreational purposes. On rare occasions, the storage of runoff may conflict with the planned recreational use of the site.

5.4.3 Conveyance Storage. During the period that channels, floodplains, drains, and storm sewers are filling with runoff, the waters are being stored in a transient form. This type of storage is known as conveyance storage. Construction of slow velocity channels with large cross sectional areas assists in the accomplishment of such storage.
6. GOALS

Drainage or flood control will be viewed as an integral part of the comprehensive planning process. It is a subsystem of a larger and more comprehensive urban system. Proper management of irrigation ditches in the urban environs is part of the planning process.

It is a goal of Fort Collins to have a unified conceptual program for drainage and flood control. This program will seek to mitigate future flood damages while systematically reducing existing flood damage through comprehensive flood plain management. Where undeveloped flood plains exist, land uses will be controlled to prevent development that would result in increased flood losses. Existing flood problems will be mitigated by applying the proper combination of nonstructural and structural measures.
7. OBJECTIVES IN REGARD TO IRRIGATION DITCHES

The objectives of drainage systems as they relate to irrigation ditches are:

- To convey irrigation water to users in both the urban and rural areas.
- To convey drainage waters to receiving streams in a manner acceptable by both City and ditch company at the minimum cost to public.
- To reduce the exposure of people and property to flood hazard from overtopping ditches.
- To insure that drainage policies of ditches are consistent with overall goals and objectives of region.
- To minimize erosion and sedimentation problems.
- To protect environmental quality and social well-being.
8. PRINCIPLES

The basic principles underlying the goals and objectives for drainage and flood control include:

8.1 The Drainage System is Part of a Larger Environmental System
The drainage system is a part of a larger interrelated comprehensive urban system. The drainage system can be managed as simply a support system for an urban area or it can be managed in a way that will assist efforts to achieve a broad range of goals and objectives. In the latter sense, it is a means to an end, not an end in itself.

Urbanization has the potential to increase both the volume and rate of stormwater runoff. The influence of planned new development within a drainage basin must be analyzed and adjustments made to minimize the creation of flood problems. Local and regional goals help to define the drainage works prescribed for a watercourse.

8.2 Flood plains are Natural Storage Areas
The flood plain is nature's prescribed and natural easement along a watercourse. The primary natural function of each watercourse and its associated flood plain is the collection, storage, and transmission of stormwater runoff. This function cannot be subordinated to any other use of the flood plain without costly compensatory control measures. Within these constraints, the flood plains have the potential to help improve water quality and air quality, provide open space, preserve important ecosystems, and accommodate properly planned urban network systems.

8.3 Stormwaters Require Space
Stormwater management is a time related space allocation problem. Water cannot be compressed, and if natural storage is reduced by urban or other land use practices without appropriate compensatory measures, then additional space will be claimed by the floodwaters at some other location(s).
8.4 Stormwaters Have Potential Uses
Stormwater is often a resource out of place. In such cases, storage of stormwater is the first step in a program to make use of the resource. These storage areas can be designed and operated to provide aesthetic amenities and recreational space. The stored water may have the potential to be used for irrigation, groundwater recharge, low-flow augmentation and industrial water supplies.

8.5 Irrigation Ditches
Irrigation ditches are the lifeblood of the agricultural economy in the Fort Collins area. Rights of the irrigators must be protected from adverse urban impacts and potential increased liability due to urban storm runoff.

8.6 Water Pollution Control Measures are an Essential Feature
Water pollution control is essential to a realization of the potential benefits to be derived from watercourses and floodplains. Pollution control measures, which deal with both point and nonpoint discharges, are an integral part of a drainage and flood control program. Low flows to irrigation ditches from controlled storm runoff releases can aid in the management of nonpoint pollution from urban areas. Such pollution management is consistent with PL 92-500 goals.
9. POLICIES

The City of Fort Collins has adopted these policies and criteria as they relate to the use of irrigation ditches for drainage and flood control. These policies and criteria will be incorporated into the development of master drainage plans based on the projected development for the year 2000. Once prepared, the plans should be periodically reviewed and updated. Individual developers would incorporate the features of the master drainage plan into future development.

In general, proposals for both structural and nonstructural drainage and flood control measures should be evaluated on the likely discharge arising from the appropriate critical duration rainfalls of 1 percent probability. (The 1 percent probability rainfall—or one in 100-year event—is that which has a 1 percent chance of being equaled or exceeded in any given year.) Lesser storms will also be evaluated to arrive at a more complete assessment of effects.

The strategies that are to be incorporated into the master drainage plans include:

- The determination of the most likely points of ditch overflow, including uncontrolled and emerging spillways.
- The delineation of potential flooding from ditch overflows and flood plain zoning of these areas.
- The determination of the general extent of flooding from the ditch to the receiving stream.
- The development of flood forecasting systems and emergency measures.
- The utilization of detention and retention ponds.
- The enlargement of ditch capacity.
- The utilization of spilling structures at creeks, gulches, and artificial channels.
The urban drainage policy for Fort Collins and environs shall include all of the seven strategies listed in the preceding paragraph. However, detention and retention of storm runoff shall be utilized by all land developments when the runoff from the land discharges to irrigation ditches.

Under no case, however, can approval be given to an urban drainage plan for a new residential or commercial development by the City or Larimer County which would cause new discharges to an irrigation ditch when such discharge would cause predictable flood hazard to either life or property.
10. CRITERIA FOR IRRIGATION DITCH DISCHARGE

The following procedures and criteria shall be followed for the discharge of runoff into irrigation ditches.

1. Meet with ditch owners to discuss plan and obtain factual data, including maps and drawings.
2. Determine ditch capacity for pertinent downstream reaches.
3. Determine most likely points of overflow, including uncontrolled and emergency spillways.
4. Evaluate maximum river diversion rates and existing inflow characteristics from rural and urban lands. Determine excess capacity available.
5. Evaluate effectiveness of ability and willingness of ditch owners to shut down river headgate diversions during storm occurrence, including nighttime and holidays. Evaluate ditch reaction time to headgate shutdown.
6. Determine historic storm runoff contribution (volume and rate) from a design storm of 2 hours duration for 2, 10, 25, and 100 year return frequency. Base infiltration and retention on field tests and observation, or from aerial photos prior to urbanization.
   - The City of Fort Collins Rainfall Intensity Duration Curve shall be used in all cases (attached).
   - The Rational Method is not adequate for these determinations because:
     - This method cannot take into account the initial and long-term infiltration rates,
     - This method does not result in runoff volumes,
     - The "C" coefficient is difficult to define and it is not well suited for use with multi-basins.
   - Acceptable methods of calculating historic storm runoff contributions include:
RAINFALL INTENSITY DURATION CURVE
NOVEMBER, 1975

BASED ON DATA AND PROCEDURES FROM
NOAA ATLAS 2 — PRECIPITATION - FREQUENCY
ATLAS OF THE WESTERN UNITED STATES
VOLUME III - COLORADO
• CUHP, a procedure that is primarily used in urban areas, where the calculated hydrograph is based upon local factors (coefficients); this method cannot account for routing of flows within the basin,
• Computer Models, various models are appropriate for particular engineering investigations; see Comparison of Major Model Categories (attached).

7. Determine post-development runoff characteristics (volume and rate) for tributary basins. A master planning approach will be used. City and County zoning and planning data for the year 2000 will be used. Runoff amounts will be based on the 2, 10, 25, and 100-year storm return frequencies. The same rainfall intensity duration curve is to be used as was presented in Item 6.

8. Determine if it is practical to utilize the irrigation ditch as a storm drainage outfall by determining available ditch capacity against the urban storm runoff rate and volume.

9. Normally, the ditch capacity will not be adequate. Detention or retention storage planned for the 100-year (1 percent) storm runoff event will usually be required. General planning criteria is presented below for storage.

• Facilities should be coordinated with the development goals and objectives and the existing land use.
• Facilities should be designed to protect against failure that would increase the potential for downstream flood loss.
• Facilities should be evaluated with consideration of normal flow conditions, frequent events, less frequent intense events such as the 100-year frequency rainfall event, and maximum probable events. The evaluation of such considerations will assure that the storage does not worsen downstream flood conditions.
• Facilities should be designed with careful attention to a particular design event. A design rainfall probability of 1 percent should normally be used unless specific minor facilities are being evaluated.

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• Facilities should be planned with respect to the topography, soil, and geology.
• Facilities should be planned to reduce to the degree practicable operation, maintenance, and administrative needs.
• Provisions should be made to assure the maintenance of the facilities over their design life.
• Floodplains should be regulated downstream of new storage facilities to prevent new encroachment into the area protected by the storage. A storage facility should not encourage creation of new flood hazards or set the stage for larger disasters than formerly.

10. The planned storage shall be tested for adequacy for the full range of return frequencies, not merely the 1 percent frequency.

11. In those cases where total retention is required, operating regulations will be presented which are reasonable to the governmental unit and the ditch company. These regulations would cover release procedures.

12. For a small subdivision covering only a portion of the tributary basin, the total basin must be considered for total inflow and ditch capability, however, storage constructed would relate only to the specific subdivision unless the master plan approved by the governmental unit expressly designated a basin wide storage plan. In this latter case the developer may be required to contribute to the master planned storage in lieu of constructing individual subdivision storage.
Subdivider shall submit a storm drainage report certified by a registered engineer competent in storm drainage. Said report to include the following:

1. A topographical map showing the subdivision, the irrigation ditch, and all lands tributary to the irrigation ditch through the subdivision.

2. A topographical map of the subdivision showing the historic lay of the land, the extent and type of vegetation, and historic drainage patterns.

3. A verbal description of the drainage basin and historic drainage patterns.

4. A table listing the historic drainage flows at locations where thalwegs enter or exit the subdivision for the mean annual and the 100-year storm events. Flow location points should be referenced to the subdivision topographical map.

5. A table listing the historic drainage flows produced within the subdivision for the mean annual and the 100-year storm events.

6. A topographical map of the subdivision showing the proposed drainage system. The map shall show the location, size, and capacity of all culverts, cross pans, gutters, catch basins, channels, detention ponds, and other facilities.

7. A table listing the proposed drainage flows generated within the subdivision for total development for the mean annual and the 100-year storm events.

8. A description of the subdivision including building types, impervious areas, grass and vegetated areas, and proposed grading.

9. A description of the hydrological method used to calculate runoff, including source of rainfall and infiltration data.

10. A description of how drainage waters are to be conveyed over, under, or into the irrigation ditch and safety measures to be provided to the system. Hydraulic calculations to be furnished under separate cover.

11. A description of the hydraulic structures within the subdivision. Hydraulic calculations for structures to be furnished under separate cover.
12. A discussion of flooding potential caused by upstream drainage flowing into the subdivision.

13. Detention pond(s) are encouraged to be used to minimize flashing of runoff and to help catch and settle sediment, particularly during the construction period. These ponds should be sized to retain or detain the increased runoff within the subdivision due to development based on a 100-year, 24-hour event. Calculations for sizing of the ponds should be furnished under separate cover.

14. A description of the erosion protection measures to be incorporated into the drainage plan.

15. A description of the proposed maintenance program for drainage facilities. The scheme of carrying out the maintenance program should be defined.

16. A description of any additional information necessary for the evaluation of the drainage plan.

In the event it shall become necessary for the ditch company to retain independent engineers to assist the ditch company in rendering the decisions and opinions required for the review of the drainage plan, the subdivision shall be liable for and pay the cost thereof. A $500 deposit shall be paid to the ditch company at the time of request for drainage plan review to cover the independent engineers fee. The $500 amount is to be considered as the maximum fee to be paid to the independent engineer for the review of a single drainage plan for a normal subdivision. Multiple reviews of a single drainage plan or complex drainage studies may require an additional deposit.

The planning, engineering, and facility installation shall be in accordance with, and meet the intent of, the attached Policy and Criteria: Use of Irrigation Ditches for Storm Runoff, City of Fort Collins and Environs.
EVALUATION OF FLOOD HAZARD IN LOCATING STATE BUILDINGS, ROADS, AND OTHER FACILITIES, AND IN REVIEWING AND APPROVING SEWAGE AND WATER FACILITIES, AND SUBDIVISIONS

WHEREAS, hazardous uses of Colorado flood plains are occurring and potential flood losses and loss of life are increasing despite substantial efforts to control floods; and

WHEREAS, economic losses due to floods in Colorado during the last twelve years place Colorado near the top of the Nation's list for per capita losses; and

WHEREAS, past inadequate land use policy and controls led to the major disaster in the Big Thompson Canyon on July 31, 1976; and

WHEREAS, minimum flood plain and floodway regulation criteria have been promulgated by the Colorado Water Conservation Board and the Colorado Land Use Commission on the premise that wise use of our State's flood plains is the key to controlling and minimizing future economic losses and suffering of our citizens; and

WHEREAS, wise use of our flood plains will promote public health, safety and welfare, reduce future public costs for relief and rehabilitation and contribute to the State's economy; and

WHEREAS, the State of Colorado has extensive and continuing programs for the construction of buildings, roads, and other facilities and further, State Agencies are involved in the review and approval of water and sewer treatment plants, subdivisions, trailer parks, campgrounds, and many other facilities throughout the State of Colorado; and

WHEREAS, both Federal and State Agencies have compiled significant data and studies concerning the frequency of floods and the location of flood plains and are expert at estimating flood hazards;

NOW, THEREFORE, by virtue of the authority vested in me as Governor of Colorado, it is hereby ordered as follows:
1. The heads of State agencies shall provide leadership in encouraging a broad and unified effort to prevent uneconomic uses and development of Colorado flood plains and in particular, to promote the public health, safety and welfare and to reduce the risk of flood losses in connection with Colorado lands and installations and State financed or supported improvements.

2. All State agencies directly responsible for the construction of State buildings, structures, roads, overnight campgrounds, or other facilities shall evaluate flood hazards when planning the location for new facilities and as far as practicable shall preclude the uneconomic, hazardous, or unnecessary use of flood plains in connection with such facilities.

3. Whenever practical and economically feasible, flood proofing measures shall be applied to existing facilities to reduce flood damage potential.

4. The Colorado Water Conservation Board and the Land Use Commission in cooperation with the appropriate state and federal agencies shall continue to undertake the evaluation of hazardous flood plain uses in the State of Colorado, proceed with the identification of flood plains, and prepare suitable flood disaster preparedness plans in cooperation with affected cities and counties, including an effective flood insurance information program, early warning system, and related steps to protect against future loss of life and unnecessary economic losses. Priority shall be given to the numerous hazardous canyons in the State of Colorado.

5. All State agencies responsible for the review and/or approval of sewage treatment plants, water treatment plants, interceptor sewers, subdivisions, trailer parks, and other facilities within the State of Colorado shall evaluate flood hazards in writing in connection with such review and approval of facilities and take measures to minimize the exposure of facilities, and development which they may induce, to potential flood damage and the need for future State expenditures for flood protection and flood disaster relief.

6. All State agencies responsible for programs which entail land use planning shall take flood hazards into account when evaluating applications for planning grants, when reviewing water and wastewater facility plans, and area-wide wastewater management plans.

7. Requests for flood hazard information and hazard assessment may be addressed to the Colorado Water Conservation Board or the Land Use Commission.

8. Any requests for appropriations for State construction of new buildings, structures, roads, or other facilities by State agencies shall be accompanied by a statement on the findings of the agency's evaluation and consideration of flood hazards in development of such requests.

9. As used in this Order, the term "State agency" includes any department, commission, division, or other organizational entity of the executive branch of State Government.
10. The State agencies shall proceed immediately to develop such procedures, regulations, and information as are provided for in, or may be necessary to carry out, the provisions of this Executive Order.

GIVEN under my hand and the Executive Seal of the State of Colorado, this first day of August, A.D., 1977.

Richard D. Lamm
Governor