

# **Statewide River Rehabilitation & Floodplain Management Needs Inventory**

**Prepared For:**

**State of Colorado**

**Department of  
Natural Resources**

**Water  
Conservation  
Board**



McLaughlin Water Engineers, Ltd.  
December 1998

## Acknowledgments

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This report is the summary document for work efforts that extended for over a year on the Inventory and Assessment of River Rehabilitation and Flood Plan Management Needs for the state of Colorado.

The work was performed under the direction of Larry F. Lang, Chief, Flood Protection Section of the Colorado Water Conservation Board (CWCB). His active participation throughout the project was greatly appreciated. In addition, the following CWCB staff members should be recognized for their invaluable cooperation and assistance:

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Mark D. Matulik - State Hazard Mitigation Officer  
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The Mitigation Assistance Corporation - Clancy Philipsborn  
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## **EXECUTIVE SUMMARY FOR THE CWCB STATEWIDE RIVER REHABILITATION & FLOODPLAIN NEEDS INVENTORY**

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The Colorado Water Conservation Board (CWCB) inventory addresses issues regarding the preservation of Colorado's rivers; destroyed habitat; lost land; flood loss reduction measures; funding requirements; multi-objective perspectives; and teamwork. These issues are the focus of the CWCB's recent survey conducted in an effort to provide better guidance in the management of Colorado's rivers and floodplains. The CWCB initiated a survey to solicit the input of Colorado landowners and communities and inventory their needs for dealing with stream corridors, floodplains, and watersheds. The importance of determining these needs cannot be underestimated since it is tied so directly to the better management of the state's stream corridors. The attributes of living and working in Colorado continue to attract new people whose presence in turn affects the state's watersheds and their components: the floodplains and stream corridors.

The Board's consultant, McLaughlin Water Engineers, Ltd. (MWE), was retained by the CWCB to assist with the survey of the state's 321 communities (63 counties and 268 cities and towns), and of 110 flood and water related organizations having an interest in the state's stream corridors. The response rate to the statewide assessment survey has been very high, with 141 (40%) survey questionnaires returned. MWE also assisted the CWCB with the interpretation of the survey results and the development of recommendations for responding to the needs identified.

The completed questionnaires provided a good overview of floodplain issues, planning and implementation needs, and existing environmental and institutional concerns in Colorado. In addition, the needs survey allowed the opportunity for additional input from floodplain administrators, land use coordinators, government entities, landowners, and the water and environmental communities who deal directly with water resources and flood-related issues.

The survey yielded findings that provide an overview of statewide needs for the Board staff and the Project Steering Committee (Committee). The CWCB staff was assisted by a Committee which provided instructions regarding project scoping, task reviews, and drafting of project recommendations. (See Table 1 for the Committee Membership list.) The survey findings offer a basis for understanding needs and formulating recommendations for meeting those needs. The statewide needs for floodplain and stream corridor management have been compiled by the CWCB's consultant. At the January 14, 1998 Committee meeting, the CWCB and the Committee agreed on the following categories of needs: 1) planning assistance; 2) funding for project implementation; 3) public information; and 4) policy and criteria guidelines. The Committee selected a project title of *Statewide River Rehabilitation and Floodplain Management Needs Inventory*.

**Planning Assistance** - Many of the state's watersheds have an absence of an overall plan for addressing the rehabilitation or restoration of the channels and floodplains that have been eroded or flood ravaged. With the implementation of short-term and site specific projects, longer-term problems are created that might have been avoided, or at least minimized, if the initial activities had been undertaken with a broader perspective. In addition to taking a watershed approach, these plans need to consider the full range of interests in the watershed through a multi-objective approach. Funding needs to be provided for multi-objective watershed master plan activities and local floodplain mapping and mitigation planning. Planning assistance is needed for technical evaluations and development of stream corridor management plans.

**Funding for Project Implementation** - The single most common need identified in the questionnaire was the need for a mechanism to fund projects. Nearly every respondent said there are stream corridor and watershed needs that cannot be met with current resources. Many respondents suggested that a Statewide Revolving Fund Loan Program be established that could be used in a variety of ways. In addition to creating one or more funding mechanisms for stream corridor projects, an important component of implementation would be to expand the funding opportunities to allow the CWCB more partnership options with federal agencies, and to facilitate stream restoration and flood emergency response activities.

**Public Information** - There are three very important components to information: 1) data, 2) technical training to interpret the data and make meaningful and wise decisions from that data, and 3) education to implement the data and take advantage of the technical expertise. A lot of the data that contributes to current watershed management decisions, at least in the floodplain portion of the watershed, consists of FEMA Flood Insurance Studies. A substantial portion of the data and maps were developed in the early 1970's and are lacking detail in many ways. The need to update this data is critical to design successfully for current development patterns, plan for future development activities, and prepare for the 21st century. Many communities cited a lack of technical expertise as a key problem in helping to plan and implement stream corridor improvements or stabilization. In addition, the responses indicated a need for educating administrators and landowners on the principles of floodplain management.

**Policy and Criteria** - Several definitions need to be added to the current statutory language for floodplain management activities. These include defining the "base flood" for the state floodplain management activities, as that flood event with a 100-year return frequency (1% chance). This 100-year definition is currently the state's regulatory design criteria. It is recommended that "critical facilities" be protected from losses by a 500-year return frequency (0.2% chance). "Critical facilities" should be defined as facilities necessary to maintain the health and safety of the public in a community, except for public road systems. In addition, a statewide flood detention policy should be proposed, requiring that increased storm runoff from new development activities shall be detained and standards should be provided for how that should be accomplished. This action will require establishment of a "baseline hydrologic condition" for the state's basins/watersheds. There is also a need to create a wetland banking/accounting and replacement program to assist in maintaining existing wetland conditions. The banking system would protect the state's existing level of wetlands and provide opportunities for the better management of future development

activities. A number of Colorado communities have stormwater criteria manuals, which address hydrology, stream mechanics, environmental concerns, and project design and implementation. Many communities expressed a desire for a state model as well.

The results of the CWCB's "Needs Inventory" provided:

1. Four needs categories – Planning, Funding, Public Information, and Policy & Criteria;
2. Basic Hazard Data and requirements for stream rehabilitation and restoration;
3. Problems with existing flood and stormwater drainage programs;
4. Values of Colorado's stream corridors;
5. Funding Mechanisms for flood and drainage projects; and
6. Recommendations for better floodplain management practices, rehabilitation of Colorado's stream corridors, and flood response activities.

**Recommended Implementation Actions** - The study recommendations and findings resulting from the study, which were formulated by the steering committee, CWCB, and McLaughlin Water Engineers are:

- Provide funding for multi-objective planning studies for Colorado's major river basins, stream rehabilitation analysis for selected stream reaches, and community-based mitigation projects;
- Create a statewide revolving loan fund to enable communities to implement flood protection and stream rehabilitation projects;
- Establish a statewide wetlands bank;
- Expand the on-going program for floodplain mapping;
- Prepare a statewide model stormwater criteria manual;
- Set minimum criteria for detention of excess runoff from development;
- Prepare an informational brochure on the theme, *What's the Floodplain Need and the Value of Stream Corridors*;
- Formulate a legislative strategy for the implementation of the study recommendations and findings;
- Improve Colorado's flood emergency preparedness and response activities.

A need exists to provide a planning partnership between landowners and local and state government groups. The programs need to address a funding mechanism to implement watershed planning and protection project activities. The survey provides recommendations to address the inventoried needs, development of new program objectives, and loan fund opportunities. These recommendations were supported by the steering committee.

**TABLE ES - 1**  
**STEERING COMMITTEE MEMBERSHIP**

Name	Affiliation	Phone	Fax
Ernest Gianetti	Agricultural Landowner	(970) 963-2275	(970) 963-4066
Bob Sakata	Agricultural Landowner	(303) 659-1559	(303) 659-7865
Ron Cattany	Dept. of Nat. Res.	(303) 866-3311	(303) 866-2115
Laurie Mathews or Paul Flack	Div. Of Parks & Rec.	(303) 866-3202	(303) 866-3206
John Hamill or Chuck Elliot	US Fish & Wildlife Service	(303) 236-8155 x252 (303) 236-5365 x222	(303) 236-8163 (303) 236-4631
Lt. Col. Lloyd Wagner or Jim Townsend	Army Corps of Engineers, Albuquerque Dist.	(505) 342-3432	(505) 342-3489
John Fischbach or Bob Smith	City of Fort Collins	(970) 221-6500	(970) 224-6107
Kent Mueller	Manager, Town of Basalt	(970) 927-4701	(970) 927-4703
Butch Knowlton	La Plata County	(970) 382-6250	(970) 382-6298
Kathy Hall	Mesa County Commissioner	(970) 244-1604	(970) 244-1639
Barbara Kirkmeyer	Weld County Commissioner	(970) 356-4000	(970) 352-0242
Michael Stevens	Stream Geomorphologist	(303) 444-7120	(303) 444-8471
Eric Wilkinson	N. Colo. Water Cons. Dist.	(970) 667-2437	(970) 663-6907
Steve Prokopiak	Land Development/Real Estate	(303) 573-0066	(303) 573-6916
Jane Bunin	Natural Science Associates	(303) 499-5014	(303) 499-5014
Scott Tucker	Urban Drainage and Flood Control District	(303) 455-6277	(303) 455-7880
Michael Hart	Gravel Pit Mining/Reclamation	(303) 444-6602	(303) 444-6602
Ken Bueche	Colorado Municipal League	(303) 831-6411	(303) 860-8175
Peter King	Colorado Counties, Inc.	(303) 861-4076	(303) 861-2878

# **CHAPTER I**

## **INTRODUCTION AND BACKGROUND**

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The Statewide Needs Inventory was initiated by the Colorado Water Conservation Board (CWCB) in response to the flood losses, channel conveyance, and stream bank stability problems experienced statewide during the flood events of 1993, 1995, and 1997. In the 20th Century, Colorado communities have experienced over \$4.9 billion in direct flood damage to homes, businesses, public buildings and utility infrastructure and suffered unmeasured loss of water supply capacity and environmental quantity.

Between July 28 and August 17, 1997, extreme flooding impacted a thirteen-county area of Colorado as a result of a monsoonal storm system, which stalled over the front range area. Point rainfall amounts of 8.3 inches to 15 inches were recorded. An estimated \$170 million in flood damages resulted in the Fort Collins/Larimer County area, and an additional \$50 million in damages occurred in twelve other counties. Six deaths were attributed to the flooding and the thirteen-county area received a Presidential Disaster Declaration.

Stream and riverine flooding has always been, and remains to be, the greatest natural hazard to life and property in Colorado. Today, flood prone areas have been identified in 268 cities and towns and in all of the 63 counties in Colorado. Based on estimates by the CWCB staff, 250,000 people reside in Colorado's 100-year floodplains, with property valued at over \$16.5 billion. There is a clear need for improved floodplain management efforts to reduce the at-risk population's vulnerability to flooding, prevent further encroachment into flood hazard zones and preserve the natural resources and functions of the floodplain areas.

Floodplain areas in stream corridors have many uses other than conveyance of floodwaters; these include:

- Opportunities for outdoor recreation,
- Open space,
- Preservation of riparian and aquatic wildlife habitat,
- Preservation of wetlands.

Such uses of floodplain areas and stream corridors are becoming increasingly important. Little demand exists for the single purpose flood control project of the past; today, municipalities and other governmental and private entities with responsibility for flood damage reduction and/or stream corridor management are demanding multiple purpose projects, which not only provide for floodplain management, but meet needs for outdoor recreation, open space, wildlife habitat and wetlands preservation.

To meet this need for increased stewardship of Colorado's stream corridors, the Colorado State Legislature in 1997 directed the CWCB to:

*...conduct a statewide inventory of river channel restoration and floodplain management needs. The findings of the needs assessment will be the basis for a proposal to determine the economic feasibility of establishing a statewide floodplain management and river channel rehabilitation program funded separately from the Colorado Water Conservation Board construction fund. The proposed program would represent a comprehensive approach and source of funds for local governments to better manage mitigation measures, streambanks and channel erosion, loss of channel conveyance capacity, and loss of wildlife habitat areas.*

In order to carry out this Legislative directive, the following steps were taken:

- ♦ A steering committee was organized to provide an overview of the project; bring an expanded level of expertise and perspective; provide direction and comment; endorse the study findings; and provide recommendations to the CWCB. Table 1 lists steering committee members.
- ♦ In order to complete the statewide inventory of floodplain management and river rehabilitation needs, a detailed questionnaire was developed and sent to 321 communities and counties and 110 environmental and water related organizations.
- ♦ Extensive follow-up by telephone with the questionnaire recipients was done in order to facilitate a good return rate of questionnaires and to clarify respondents' answers.
- ♦ Information and data from respondents' questionnaires was then entered into a database and analyzed.
- ♦ Based on these data and information, stream corridors program objectives and recommendations were developed in response to the Legislature's directives in Senate Bill 97-008.
- ♦ The Value of Stream Corridors program focuses on four major categories of assistance to Colorado communities: planning assistance, funding implementation, public information/technical assistance, and necessary policy and criteria.

The development of the Value of Stream Corridors program (See Figure I-1) and the details of the recommended program are described in the following report.

**Figure I-1 - Value of Stream Corridors**

Colorado's stream corridors include channels, wetlands, natural floodplains, dams and reservoirs, and man-made water related structures. These corridors are important environmental and economic assets to the state. Healthy and natural corridors assist both in natural and in human processes vital to Colorado's well-being.

must team-up to maintain acceptable standards for human activities in stream corridors and floodplains. The CWCB Multi-Objective Management Studies program is a means to facilitate the wise usage of the state's floodplains and stream corridors.

Since 1995, the CWCB has responded to severe floods with

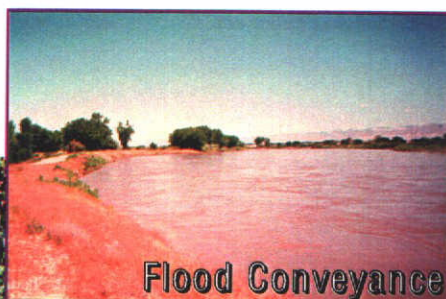
Multi-Objective Management Studies:

- ♦ **Arkansas River**
- ♦ **South Platte River**
- ♦ **Roaring Fork River**
- ♦ **Elk River**
- ♦ **Rio Grande**
- ♦ **Fountain Creek**  
(proposed)
- ♦ **North Fork of the Gunnison River**  
(assisting local study initiative)

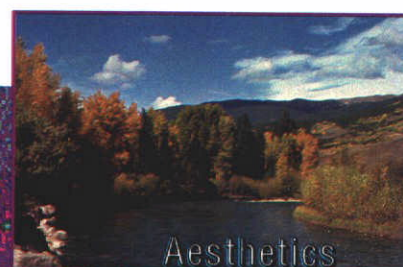
People and natural processes



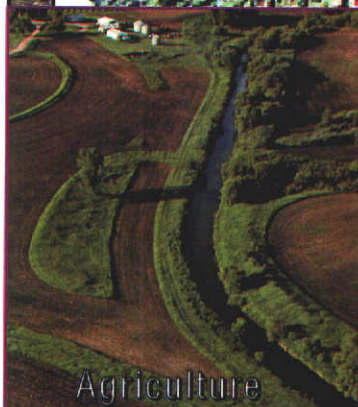
Water Quality



Flood Conveyance

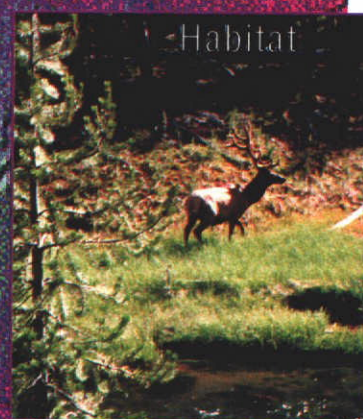


Aesthetics

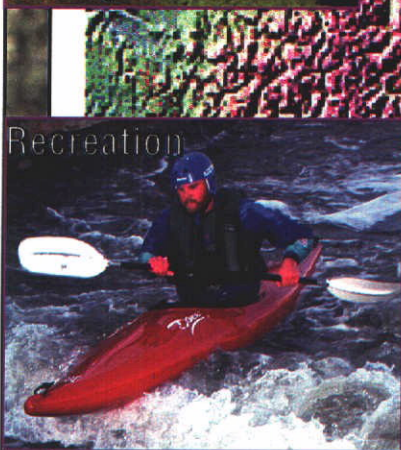


Agriculture

**Multi-Objective Management is the Future**



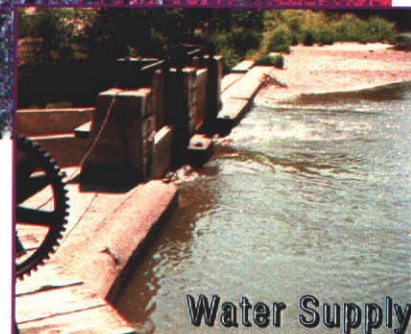
Habitat



Recreation



Open Space



Water Supply

## **CHAPTER II**

# **FLOOD HISTORY AND STREAM DETERIORATION**

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### **FLOOD HISTORY**

Colorado experiences, on average, 20 to 30 flood events annually. Every year, at least one of these events equals or exceeds the 100-year flood level, somewhere in the state. Over the past decade, Colorado has experienced statewide flooding in 1993, 1995, and 1997. Western Colorado experienced major flooding in 1983 and 1984.

Colorado's total direct value flood damages are approaching \$5 billion (in 1998 dollars), and fatalities totaling more than 300 people. Secondary losses have not been quantified, but are estimated to be two to three times greater than the direct damages. Secondary losses include economic development and trade, tourism, agricultural production, and investment capital.

The state of Colorado formally started collecting flood data in 1937, with authorizations and the creation of the CWCB. Prior to 1937, the state's flood data was gathered and documented in individual reports and from federal agencies.

Documented flood information and data are very valuable in the administration of a floodplain management program. Past flood information is valuable in the projection and forecasting of future flood activity for a floodplain or watershed. Nature has demonstrated that it will repeat itself on any given watershed.

The scientific community uses past flood information for:

- Hydrological analysis,
- Hydraulic determinations,
- Economic justification of flood protection measures, and
- Justification for regulatory floodplain mapping and flood insurance requirements.

The management community uses past flood information for:

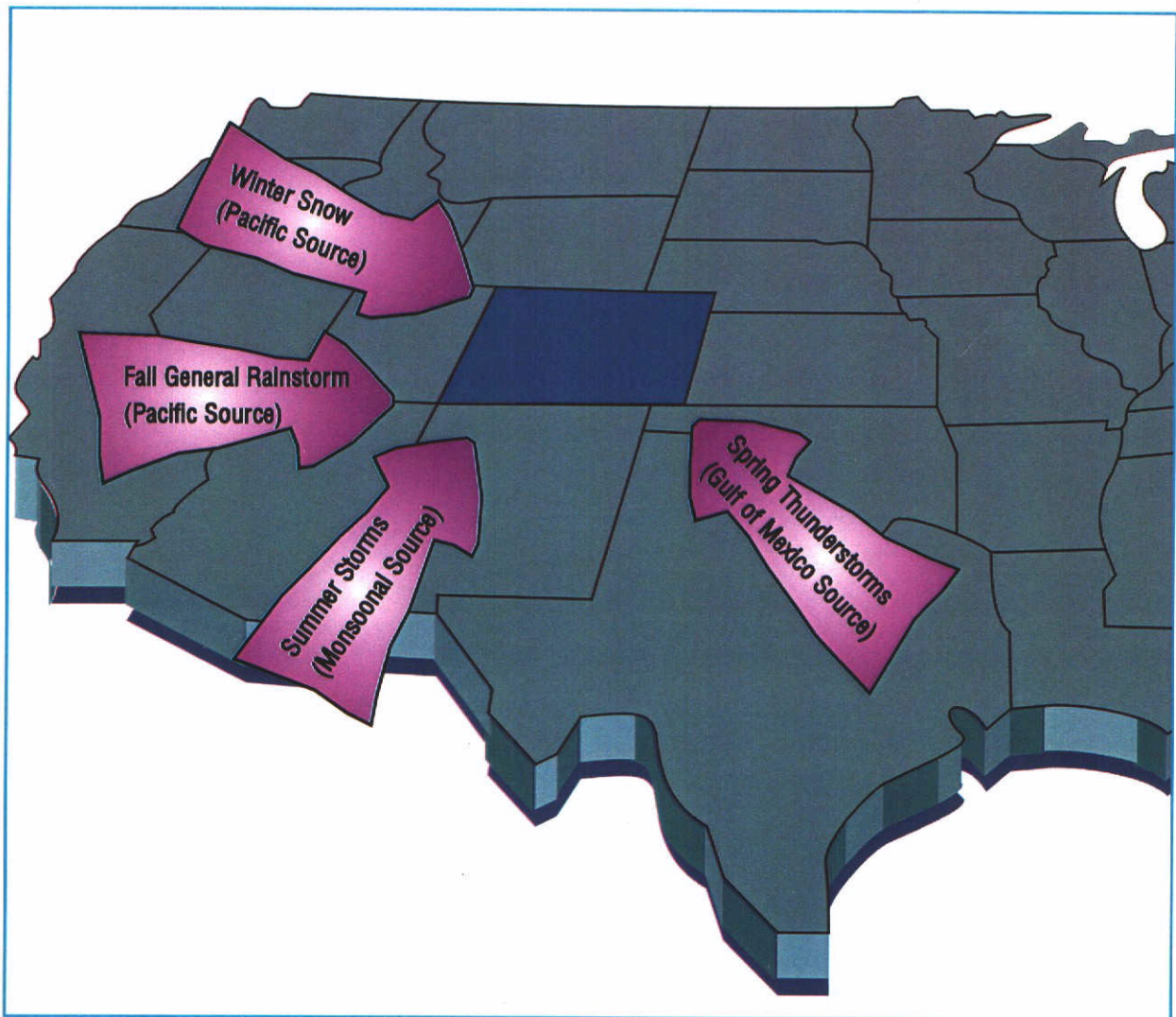
- Community awareness of flood dangers and risks,
- Community implementation of a floodplain management program, and
- Community endorsement of major economic development proposals.

The flood producing weather patterns in Colorado are not homogeneous. There is quite a bit of seasonal variability and geographic variability. Therefore, Colorado experiences several types of natural flood events, including stream specific floods, localized floods, and regional/statewide floods.

The type and location of flood events are somewhat predictable, based on the moisture source and time of year. Colorado's main moisture sources are shown in Figure II-1. Depending on weather patterns, the type of flood events may differ from year to year. For example:

- ♦ In 1983, 1984 and 1995, Colorado experienced high snowpack, due to high levels of moisture from the Pacific Ocean.
- ♦ In 1965 and 1973, major spring floods along the Front Range and Eastern Plains were caused by excessive moisture out of the Gulf of Mexico.
- ♦ In 1911, 1970, 1972 and 1997, Southwestern Colorado experienced area-wide flooding, due to fall Pacific moisture sources.
- ♦ In 1997, monsoonal moisture caused flooding in mountain areas and across the state, with the exception of Northwestern Colorado.

**Figure II-1 - Colorado's Main Moisture Sources**



In researching past flood events, it has been found that the severity of flooding is directly related to the level and intensity of the available moisture and other atmospheric conditions. The causes of floods relate directly to the accumulation of rainfall runoff, rapid snowmelt, the failure of man-made structures, such as dams and levees, or a combination of any of these events. The following table entitled "Major Floods in Colorado" presents the date, stream or location of the flood; the type of event; the number of deaths it caused; and the damage totals in 1998 dollars. The acronyms for the types of events are detailed below:

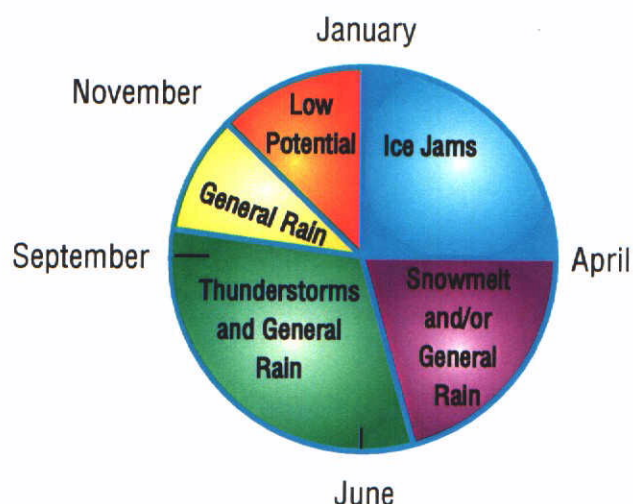
- ♦ General Rain Floods (GR)
- ♦ Thunderstorm Floods (TS)
- ♦ Snowmelt Floods (SM)
- ♦ Rain or Snow Floods (RS)
- ♦ Ice Jam Floods (IJ)
- ♦ Dam/Levee Failure Floods (DF)

**Table II - 1 - Major Floods In Colorado**

Date	Major Stream or Location	Type of Event	Deaths	Damages (in 1998 \$)
May 1864	Cherry Creek at Denver	TS	?	6,000,000
July 1896	Bear Creek at Morrison	TS	27	6,000,000
Oct. 1911	San Juan River near Pagosa Springs	GR	2	6,000,000
July 1912	Cherry Creek at Denver	TS	2	120,000,000
June 1921	Arkansas River at Pueblo	TS	78	760,000,000
May 1935	Monument Creek at Colorado Springs	TS	18	52,000,000
May 1935	Kiowa Creek near Kiowa	TS	9	15,000,000
May 1942	South Platte River Basin	RS	?	8,500,000
May 1955	Purgatorie River at Trinidad	GR	2	36,000,000
June 1957	Western Colorado	SM	?	18,000,000
June 1965	South Platte River at Denver	TS	8	2,200,000,000
June 1965	Arkansas River Basin	TS	16	205,480,000
May 1969	South Platte River Basin	RS	0	21,500,000
Sept. 1970	Southwest Colorado	GR	0	13,200,000
May 1973	South Platte River at Denver	RS	10	388,800,000
July 1976	Big Thompson River in Canyon	TS	144	85,200,000
July 1982	Fall River at Estes Park	DF	3	49,080,000
June 1983	North Central Counties	RS	10	26,250,000
May-June 1984	Western & Northwestern Counties	SM	2	46,500,000
May-June 1993	Western Slope	SM	0	2,140,000
June 1995	Western Slope and South Platte River	SM	21	51,266,000
July 1997	Ft. Collins & 13 Eastern Counties	TS	6	219,367,000
<b>TOTALS</b>			<b>352</b>	<b>\$4,436,577,000</b>

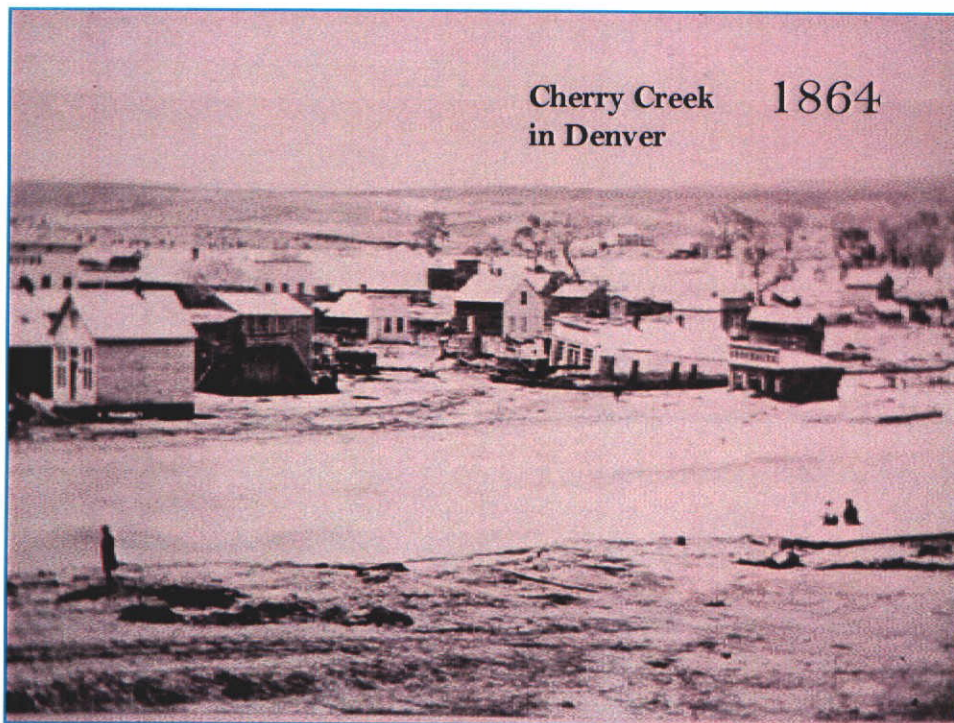
Different types of flooding usually occur during specific times of the year in Colorado, as shown on the annual flood clock below:

**Figure II - 2 - Annual Flood Clock**



Human occupation of the state's streams and floodplains have resulted in the loss of property and lives. There is great diversity, and non-homogeneity in Colorado's flood events. This diversity has a great impact on the magnitude of flood losses. Some of Colorado's most significant types of events are further described in the following paragraphs.

#### Earliest Recorded Event



On May 19 and 20, 1864, heavy rainfall extended over the entire South Platte Basin, from Colorado Springs to Fort Collins. Communities all along the Front Range experienced differing levels of severe flooding. Denver and Fort Collins experienced the most damaging flooding.

### Most Intense Rainfall Event

On May 30-31, 1935, Colorado experienced its most intense recorded rainfall event. At Hale, Colorado, the state recorded 24 inches of rainfall in six hours from an intense thunderstorm. This event caused a flood-of-record on the Republican River in eastern Colorado, on Monument Creek in Colorado Springs, and on Kiowa Creek at Elbert.

**Table II - 2 - Extreme Storm Precipitation Reports**

Storm No.	Storm Name	State	Storm Date	Region	Type	Lat	Long	Maximum Precipitation	Remarks
99	Cherry Creek - Hale	CO	May 30-31, 1935	1	GLC	39 36	102 08	Report of 9" in 2 hrs at Selbert, huge floods Bijou Creek and Republican	24" in 6 hrs (unofficial) near Hale USBR report, 3.00" at Rush

Source: Climatology Report #97-1, Colorado State University, May 1997

### The Killer Flood Event

On July 31, and August 1, 1976, 149 lives were lost in the Big Thompson Canyon flood. This flood event was the state's worst-ever flash flood event on record. The flood hit with little warning, no advanced measures, or alerts.

**1976**



**Big Thompson River in Larimer County**



### The Most Recent Flood Events

The City of Fort Collins' flood-of-record occurred on July 28, 1997. One day later, on July 29, 1997, Pawnee Creek and the City of Sterling were flooded as a result of heavy rain from the same storm system that flooded Fort Collins. This storm system was the largest, high-volume storm recorded in Colorado.



1997



Fort Collins/  
Larimer County

July 28, 1997



Sterling/ Logan  
County

1997



July 30-31, 1997

**Table II - 3 - Colorado Declarations and Flood Facts**

Recent Major Presidential Disaster Declarations			Flood Facts	
Year	Location	Cause	Counties/Towns with Flood Prone Areas	268
1965	Front Range - 33 Counties	Intense (Thunderstorm) Rainfall	Total Flood Insurance Policies	15,203
1969	Front Range - 15 Counties	Sustained Rainfall	Population in the 100-year Floodplain	250,000
1970	Southwest	Sustained Rainfall	Homes in the 100-year Floodplain	65,000
1973	(1) Kersey (2) Front Range - 13 Counties (3) Southwest - 13 counties	Dam Failure Sustained Rainfall Sustained Rainfall	Commercial/Industrial/Businesses in the 100-year Floodplain	15,000
1976	Big Thompson, Front Range - 2 Counties	Flash Flooding, Heavy rainfall over short duration	Total value of the Property in the 100-year Floodplain	16.5 Billion
1982	Lawn Lake, Front Range - 1 County (Larimer)	Dam Failure	Cumulative Flood Losses from the Turn of the Century to 1999	4.5 Billion
1984	Western Slope - 15 Counties	Snowmelt Floods and Mudslides	Miles of Delineated 100-year Floodplains	8000
1997	Front Range - 13 Counties	Intense (Thunderstorm) Rainfall		

### STREAM DETERIORATION

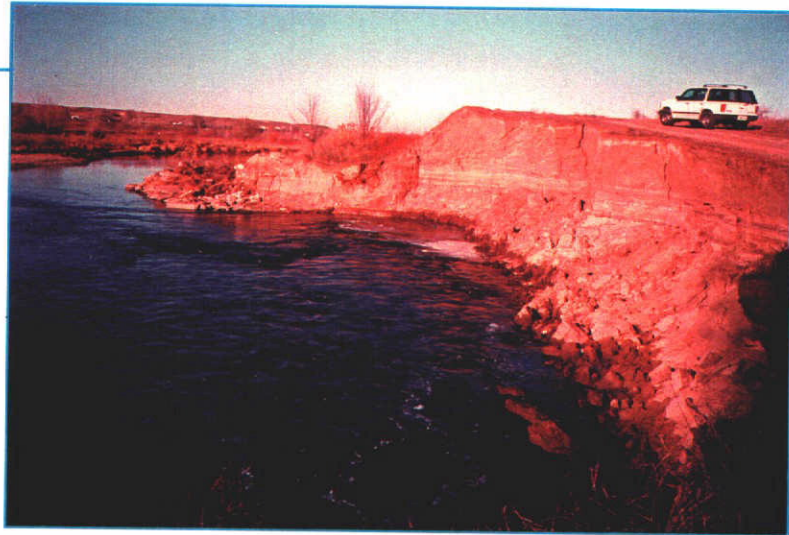
In addition to the severe flooding threat that exists in Colorado on most major streams and watersheds, there is on-going deterioration of streambeds and channels. Some of these channel changes are part of the natural process; however where there is human intervention, significant damage and losses can be experienced. For some stream reaches, the flood loss potential is high.

Stream deterioration can be a result of the following activities:

- Streambed Degradation - Lowering of the existing channel level
- Streambank Erosion - Migration of the high bank to the left or right across a floodplain
- Streambed Aggradation - The raising of a streambed or the creation of sandbars within the conveyance areas
- Sediment Loading - Increase in stream turbidity, which impacts the water quality. Turbidity is an accumulation of sediment from watershed development without stormwater detention or from stream erosion activities.
- Floodplain Land Invasion - Stream migration activity results in the loss of value of land to agricultural practices, development activities, natural habitat, and transportation systems.

There are many examples of the need for stream stabilization, rehabilitation, restoration, and reclamation. Some more common examples are:

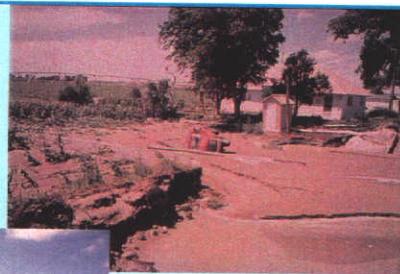
#### Channel Stabilization



#### Channel Conveyance

1997

Weldon/Morgan  
County

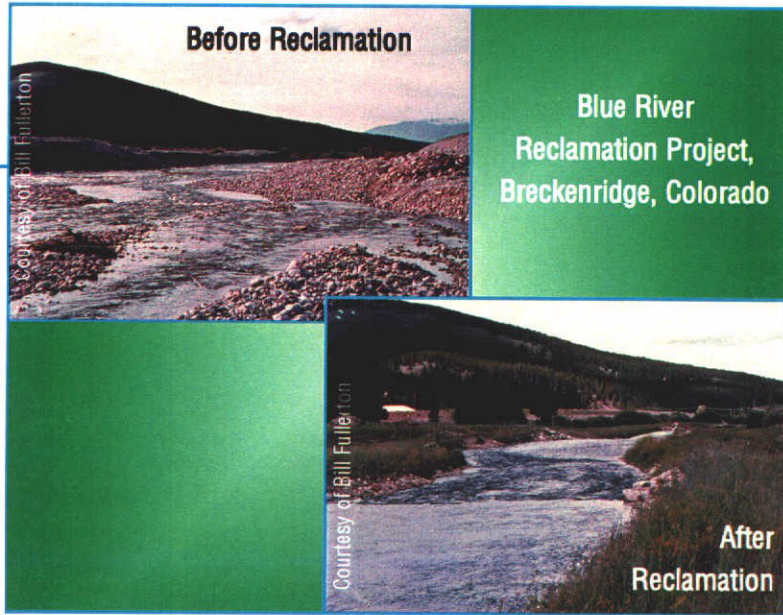


July 29-30, 1997

#### Channel Migration Into Floodplain Lands



Channel Reclamation and  
Rehabilitation



## **CHAPTER III**

### **INVENTORY PROCESS**

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#### **RESEARCH**

The first task completed by the consultant team was basic research to assess the current information available regarding floodplain mapping, existing flood hazards, flood damages and repetitive losses, and structural and nonstructural flood hazard mitigation needs. The primary state/local agencies are the CWCB and the Urban Drainage and Flood Control District.

The CWCB was created by Legislature in 1937. Today the CWCB is part of the Department of Natural Resources for the expressed general purpose "to promote the conservation of the waters of the state of Colorado in order to secure the greatest utilization of such waters and the utmost prevention of floods." Specific legislative charges regarding the floodplain information and management program are:

- To devise and formulate methods, means, and plans for bringing about the greater utilization of the waters of the state and the prevention of flood damages therefrom.
- To designate and approve storm or floodway runoff channels or basins.
- To make such designations available to legislative bodies of cities and incorporated towns; to county planning commissions and to boards of adjustment of cities; and counties of the state.
- To promulgate a model floodplain regulation for floodplain hazard areas.
- To identify mitigation measures to reduce flood risks.
- To assist local governments on a continuing basis in the management of their floodplain hazard areas.
- To assist local governments on a continuing basis in determining what use and occupation may be permitted in designated floodplain hazard areas.

Over the years, CWCB has completed floodplain information studies (which include flood damage histories and floodplain maps) and post-flood assessment reports, which document field inspections and flood damages. The CWCB is also the state agency that administers the flood insurance program for the Federal Emergency Management Agency. The staff at CWCB maintains a library of floodplain information studies, flood insurance maps and other related reports for flood prone communities throughout Colorado.

The Urban Drainage and Flood Control District (UDFCD) was established by the Colorado Legislature in 1969, to assist local governments in the Denver metropolitan area with multi-jurisdictional drainage and flood control problems. The District covers an area of 1,608 square miles, including Denver, parts of five surrounding counties, and all or parts of 33 incorporated cities and towns. A 17-member board comprised of locally elected officials and two registered professional engineers. District funds come from four different property tax mill levies, earmarked for five programs: Master Planning, Design and Construction, Maintenance, Floodplain Management, and the South Platte River. All but a small percentage of the 1,600 miles of major drainageways have been mapped (for 100-year floodplain) by the District, and a complete library of flood hazard delineation studies is maintained at the UDFCD office. The District assists local governments in the development of flood warning plans and maintains a special notification program under which over 23,000 informational brochures are mailed to addresses in or adjacent to identified floodplains.

### **Other State and Federal Programs**

Another research task was to review and summarize existing state and federal programs regarding flood mitigation and floodplain management. This work was assigned to two subconsultants. Robert Kistner of Kistner and Associates researched existing state programs and Clancy Philipsborn of the Mitigation Assistance Corporation investigated existing federal programs. Appendix A of this report lists each state and federal program, its objective, eligibility requirements, and any partnership opportunities available.

## **SURVEY QUESTIONNAIRE**

### **Questionnaire Development**

To assess the floodplain management and stream rehabilitation problems and concerns across Colorado, a detailed questionnaire was developed by MWE, CWCB, and the Steering Committee. The questionnaire solicited data on the following major subjects.

- Community Profile
- Floodplain Management
  - ☐ Floodplain Related Issues
  - ☐ Floodplain Mapping Needs
  - ☐ Existing/Planned Mitigation Measures
- Multi-Objective Use of Stream Corridors
- Institutional Issues

Based on recommendations from CWCB staff and the Steering Committee, a second questionnaire was developed for distribution to special districts, environmental organizations and other water related groups. Complete copies of the original questionnaires sent to Colorado communities and organizations may be found in Appendix D, with copies of the original mailing lists.

### **Distribution**

On October 23, 1997, the questionnaires were mailed to 63 counties and 268 cities and towns, with a request that they be returned by November 14, 1997. Similarly, questionnaires were distributed to 110 water related organizations.

### **Rate of Return**

By the initial November 14 deadline, only 10 percent of the communities had responded. In order to improve the response rate, members of the consultant team made over 200 follow-up phone calls to the non-responding communities. This effort dramatically improved the return rate. By the end of January 1998, approximately forty-four percent (44.4%) of Colorado counties had returned their questionnaires, and approximately (39.9%) of cities and towns had responded. Overall, 135 of the 331 questionnaires (40.8%) have been received. Twenty-four of the 110 organizations (21.8%) also completed questionnaires.

### **Questionnaire Review**

Each questionnaire was reviewed by MWE staff. Completed questionnaires ranged from very brief responses with minimal or incomplete data to extensive documents with detailed responses that included maps, reports, or other supplemental information. Additional follow-up calls were made to fill in blanks on returned questionnaires or to clarify responses. Once all information was verified, the questionnaires were entered into a database model, as discussed in the next chapter.

# CHAPTER IV

## ASSESSMENT RESULTS

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### OVERVIEW

By the initial November 14, 1997 questionnaire return deadline, the project had received a ten percent response to the questionnaire. The consultant input the responses and other information into a database system as described in Chapter V. The initial query from the database system yielded a set of general categories. These categories were presented to the Steering Committee at its December 10, 1997 meeting. The discussion items for the general categories and issues are presented the following outline:

### OUTLINE FOR DISCUSSION ITEMS

#### INFORMATION

- Floodplain Mapping

- ☐ Geomorphic (may alleviate problem of present or future)

#### PLANNING

- Multi-Objective Planning and Projects
- Watershed Master Planning

#### Stormwater Detention Policy

- Regional detention
- Managed releases to prevent surges downstream
- What are the water rights issues?

#### IMPLEMENTATION

- Funding Mechanisms for Floodplain Projects

#### Streambank Stabilization

- Create a yearly, regional 404 permit
- Standard designs
- Why not undertake vegetative measures to prevent erosion?
- Determine causes before fixing
- River and stream classifications should be standardized
- "Show me" the federal interest to obtain funding and permits

#### REGULATORY

- Stormwater Detention Policy
- Statewide Design Standard and Criteria Manuals
- Wetland Detention Policy

#### Multi-Objective Projects and Planning

- Should be value based - based on a consensus of the importance of all issues
- Should include multi-use
- It is a process
- Statewide plan of needs for legislative funding

#### General Categories

##### Floodplain Mapping

- What still needs to be mapped?
- How much will it cost?
- Who will we partner with to complete the mapping?
- Accurate information is needed
- What are our priorities in mapping?
  - ☐ 100-year floodplain?
- Which floodplain do we map, and how detailed should it be?
  - ☐ Present conditions, or future development

### **Funding**

- GOCO (site or project specific)
- Non-tax based
- Re-evaluate current mechanisms and recombine
- Revolving Loan fund
- Needs to be an integrated effort
- Prepare a handbook on available funding and where to get it

### **Design Standards and Criteria Manuals**

Based on minimums  
Mandatory vs. recommended  
Modeling and operations  
Explain the benefits of the standards

### **GIS System**

Used for risk assessment and management  
Information management/sharing

### **Education**

Share information

- ☐ CML and CCI meetings
- ☐ Informational signs at flood sites (high water marks, etc.)

### **Scoping Federal Programs**

- Feds respond to local people (legislature will push for programs if constituents push)
- Need an integrated voice

### **Watershed Master Plan**

- Perceived by Committee to be main focus of possible bill
- Everything fits under master plan
- Questions on how to accomplish with so many watersheds throughout Colorado

### **Additional Categories to Be Considered:**

- Wetlands and wildlife habitat
- Riparian areas
- Recreation
- Endangered species
- Minimum instream flows

All of the additional categories can be considered under a multi-objective plan.

Following the December 10, 1997 committee meeting, the consultant incorporated the recommendations provided by the Steering Committee and CWCB into a concept paper, dated December 16, 1997, that the initial findings of the statewide assessment of floodplain needs and issues. An additional recommendation of the Steering Committee was for the consultant to implement and expand the sampling and data collection process. The findings and discussions in the concept paper are presented in Appendix B-1. It should be understood that this presentation is derived from a ten (10) percent response to the questionnaire. Following is a summary of initial survey findings from the concept paper:

### **STATEWIDE ISSUES**

- The most common issue is the source of funding to conduct studies, implement mitigation activities and build projects.
- The need for engineering and planning assistance to support community leaders in decision making processes and conducting local investigations.
- The National Flood Insurance Program's (NFIP) Flood Insurance Rate Maps are out of date, difficult to relate to local topography, and for many stream reaches do not have elevation information.

- ♦ Generally, there is a lack of understanding of the importance of floodplain rules and regulations and enforcement by local communities.
- ♦ Community officials and the public welcome multi-use approach in the management of the state's stream corridors and floodplain areas.

### REGIONAL ISSUES

- ♦ Communities located in the eastern "high plains" tend to perceive the threat of flooding differently than communities located along a defined drainage, stream or river in the foothills and mountains.
- ♦ Communities located along major streams under the jurisdiction of federal and state regulations expressed frustration in the process for getting some projects or map changes accomplished.
- ♦ Communities with federal agencies as their "partners" expressed frustration with the lack of interest and cooperation in working together to solve problems.

### LOCAL ISSUES

- ♦ A number of communities expressed the problem and difficulty of getting elected officials to "buy-in" to floodplain regulation concepts.
- ♦ The turnover of local governing board members can result in the loss of priorities that had been set for floodplain projects by previous boards and councils.
- ♦ Many communities in Colorado are experiencing significant growth. Associated with this fact is the increase demand for basic data and flood hazard information for wise land use planning and decision making.

### RESPONDENTS' COMMENTS ABOUT THE SURVEY/QUESTIONNAIRE

- ♦ Comments by some respondents related to the "purpose" of the questionnaire. For example, some thought it was a marketing effort by MWE instead of a mechanism to obtain information for CWCB to develop a program for the Colorado legislature.
- ♦ The objective of the questionnaire was somewhat unclear to communities in eastern Colorado who do not have major stream/floodplain problems. Instead they deal with street drainage and localized flooding problems following rainstorms.
- ♦ Another survey! Don't have time to complete.
- ♦ Several "major players" representing communities who regularly deal with flooding and stormwater issues did not respond in spite of several follow-up phone calls from MWE. No time was available for this questionnaire due to large, demanding, daily-workloads.
- ♦ CWCB list of contacts including names, addresses and phone numbers was surprisingly out of date. It appears the contact list was at least three years old, judging by the comments of those who did respond. **This type of information is vital to staying in touch with local communities. Some procedure should be established to keep this current.**
- ♦ Several communities asked if they could receive a copy of the summary of the questionnaire because they had an interest in this project and would like to assist to the extent possible.

## PROPOSED RECOMMENDATIONS

From the initial assessments by the consultant, CWCB, and Steering Committee, it is important that the final project document develops and formulates recommendations for the following areas:

- ♦ Information and educational needs
- ♦ Implementation funding for project needs
- ♦ Planning assistance needs
- ♦ Regulatory and policy provisions for certain floodplain and stream needs

By January 31, 1998, through the consultant's expanded search and discovery processes, the responses to the questionnaire had been increased to forty-four (44) percent of counties, forty (40) percent of cities and towns, and twenty-two (22) percent of federal, state, regional, and interest groups.

At meeting number four on February 18, 1998 of the Steering Committee, the findings and results of the expanded research and discover processes were presented to the Committee. These findings and results are:

**Figure IV-1 - Problems with Floods and/or Drainage**

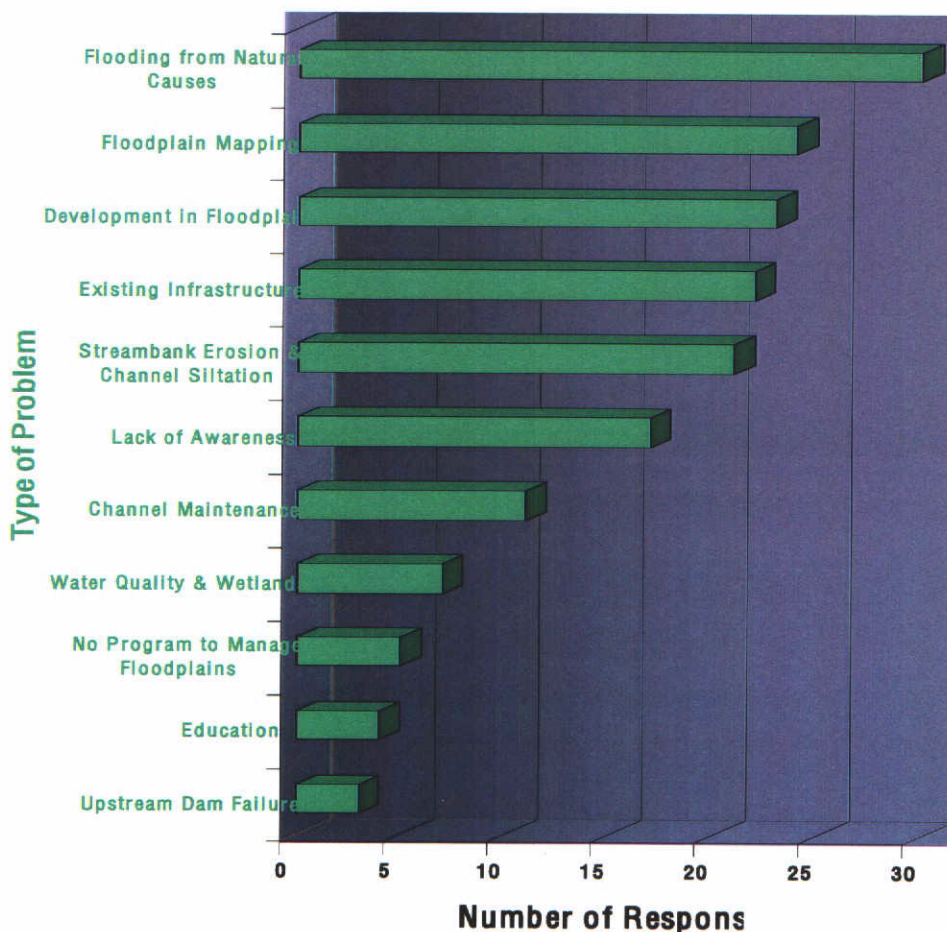


Figure IV-1 - Problems with Floods and/or Drainage, describes the problems identified by the 134 survey respondents in dealing with flooding and/or drainage in their communities. The responses indicated a wide variety of problems are being experienced by these communities, indicating the need for a multi-objective approach to solving these problems.

**Figure IV-2 - Values of Colorado Stream Corridors**

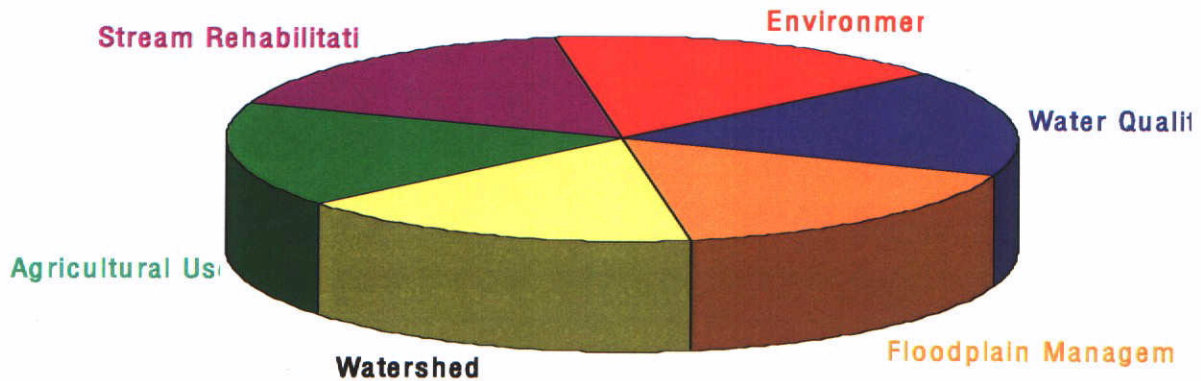


Figure IV-2 - Values of Colorado Stream Corridors, shows the variety of values placed on stream corridors by survey respondents and indicates the need to broaden the factors considered in stream corridor and floodplain management to insure a multi-objective perspective is preserved when making decisions about current and future uses of this portion of the watershed. These values are in addition to the obvious purposes of conveying water as part of the natural hydrologic cycle, including flood water flows from the upper watershed downstream to the lower watershed.

**Figure IV-3 - Funding Implementation Preferences**

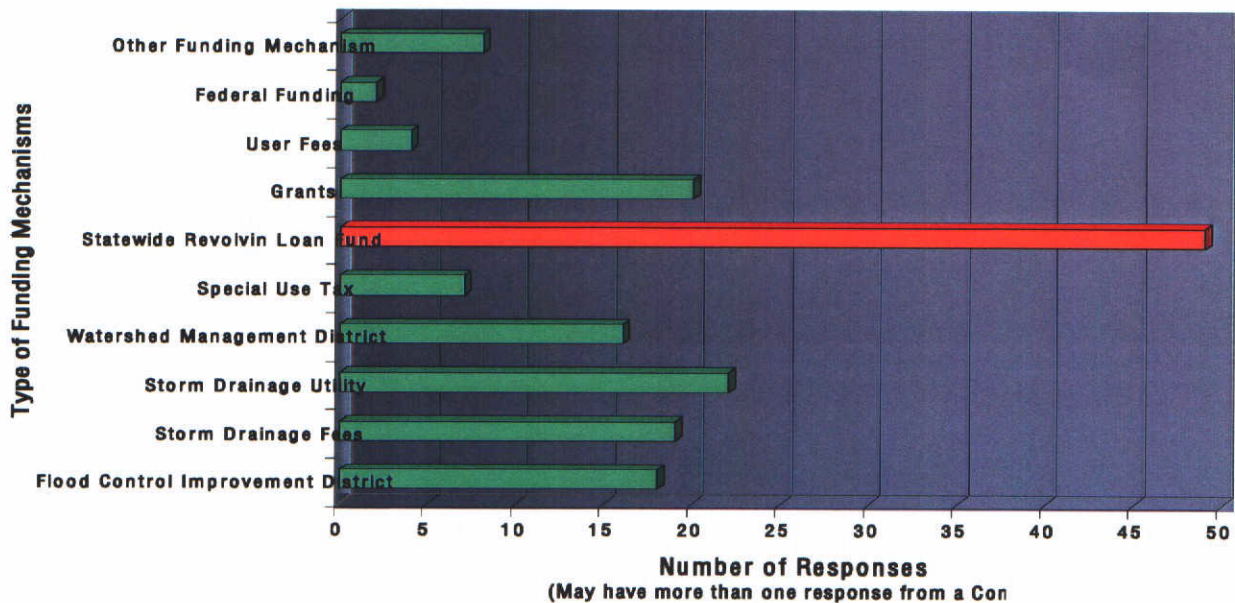


Figure IV-3 - Funding Implementation Preferences, shows the variety of choices identified by the survey respondents and their preferred choice, a statewide revolving fund loan program. There are other options also identified, but reluctance by residents to increase their local tax burden apparently makes other alternatives less attractive.

Organizational responses to the following selected questions are presented in Appendices A - D. These responses were grouped into four categories of responders: environmental organizations, federal, floodplain and special districts, and water organizations. Their responses provided additional comments and perspectives, which were used by the project team to formulate the "Rive Rehabilitation and Stream Corridors" Program:

- Question 1 - What does your organization feel is the most significant floodplain problem relating to stream corridors in Colorado?
- Question 2 - What does you organization value about stream corridors?
- Question 3 - What are the most significant barriers to achieving your organization's goals for stream corridors?
- Question 4 - Does you organization believe Colorado has needs for multi-objective flood hazard mitigation or river rehabilitation projects that incorporate the following uses or benefits?
- Question 5 - Does your organization know of problematic or threatened stream corridors that you feel would benefit from a multi-objective solution strategy?

**Needs Identification.** Four major need categories have been identified based upon the findings from the survey questionnaire: planning assistance, funding implementation, public information/technical assistance, and policy and criteria. The following paragraphs summarize the community responses, identified needs, and recommendations for each of the need categories.

Planning Assistance. Stream corridor and local flooding is a significant problem for communities. Drainage plans need to be based upon a watershed drainage master plan, which provides a broader perspective to planning than has been followed in the past. Planning efforts should include: floodplain delineation, master planning for selected basins, and project planning. Future stream and river rehabilitation projects should be built as multi-objective projects rather than single purpose projects.

The CWCB has recently undertaken multi-objective studies of the Arkansas, South Platte and Roaring Fork River watersheds in response to the 1995 flood events. Presently, there is no state program to deal with watershed planning needs on a pro-active basis. To date, watershed planning at the state level has been a re-active one.

Future Implementation. In order to be effective, stream corridor and floodplain management focused programs need to have additional funding. A funding strategy should be formulated to provide financial assistance for watershed planning and a revolving loan fund for project implementation and construction. The mechanism for such a program would be grants for cost shared planning and loans for project implementation and/or construction. A component of this effort would be to create a statewide revolving

fund loan program to enable communities to address flood mitigation, stream rehabilitation, and watershed improvements.

**Public Information/Technical Assistance.** Respondents identified nearly 500 miles of unmapped, 100-year floodplain. Statewide, CWCB staff and MWE project staff estimate there are at least 1500 miles needing to be studied and mapped. In addition, floodplain mapping completed nearly 20 years ago needs to be updated. The community surveys also identified the need to (1) establish a program of information sharing to disseminate information relating to flood hazards, flood mitigation techniques, and stream corridor values, and (2) provide technical data, training, and education to local decision makers who deal directly with watershed, stream corridor, and floodplain management.

**Policy and Criteria.** Policies should be established concerning: (1) creating a storm water detention policy to control excess runoff from new development limiting the increase of peak flows in the floodplain, (2) establishing a statewide wetlands banking process to allow reallocation of existing and new wetlands resulting from multi-objective stream corridor management. New criteria should be established: (1) defining baseline conditions (100 year event) for stream corridor management activities, (2) defining a higher level of protection (500 year event) than baseline conditions for critical facilities, and (3) creating and adopting a statewide model stormwater criteria manual.

At meeting number five on March 12, 1998, the Committee acted on the following final products for the project. The discussion topics were:

- Prepare a project informational brochure and select an appropriate title
- Discuss the final recommendations for the project needs categories
- Review and discuss on the consultant's draft final project report

The Steering Committee, CWCB, and consultant decisions on March 12th were:

**Project Informational Brochure.** The brochure should be entitled "Stream Rehabilitation and Flood Protection Needs in Colorado." The brochure content should include: "What's the Need?" (survey findings), Requested Funding Mechanisms, Values of Stream Corridors, Goals for Streams Corridors, "How Do We Get There?", and Benefits.

**Final Recommended Project Need Categories.** The Committee agreed on the final need categories that are:

- Planning Assistance - River Basin Multi-Objective Plans and Floodplain Mapping
- Funding Implementation - Revolving Loan Fund and Flood Emergency Account
- Public Information/ Technical Assistance - Floodplain Hazard Awareness and GIS
- Policy and Criteria - Establish Minimum Standards

**Review and Discussion on the Draft Final Project Report.** The Committee members were requested to provide comments on the contents of the draft report by March 19, 1998.

A total of five Steering Committee meetings were conducted for the project, which provided instructions for the scope-of-work, and the planning, reviewing, and commenting process. In addition, the meetings provided key strategies for the overall development and formulation of the project. The Steering Committee was very instrumental in instructing and advising the CWCB and the consultant on the project needs categories and recommendations that were responsive to the project objectives. The respondents' replies to the questionnaire generated the answer to the question - "What's the Need?" This answer is discussed and presented in Chapter VI.

## **CHAPTER V**

### **NEEDS ASSESSMENT DATABASE**

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Once the various communities filled out the questionnaires, a method was needed to categorize and store the information contained in each questionnaire. Microsoft Access97 was used because of the great diversity the database program lends to its users. The database was divided into two main parts, communities and organizations. The questionnaires for the two groups were slightly different, warranting separation in the database.

The database was designed to incorporate all of the answers given on the questionnaires, with the ability to query the entries to produce usable data. A few communities sent additional information, such as maps, and notes were made in the database to indicate their existence and location.

#### **TYPE OF INFORMATION OBTAINED**

The number and quality of the responses was generally very good. There were some responses that were very detailed, and others, due primarily to inexperience or lack of familiarity with floodplain management, did not fully answer particular questions or sections of the questionnaires. There were communities that did not return questionnaires. The reasons for this were varied, with the most common reason being a lack of time.

#### **DATABASE CONTENTS**

Questions were phased differently throughout the questionnaires. In an attempt to get the most use out of the questions, different types of responses were stored in the database. In the Needs Assessment Database, there are four basic types of responses: text, yes/no, listed, and descriptive. Below are descriptions of each type of response, followed by a brief table of contents for the community questionnaire and the organization questionnaire.

#### **Types of Responses**

Text Responses. Text responses are very short and contain exact information. Most text responses allow only 30 characters to be typed. Examples of text responses can be found in most of the community or organization information responses. Items such as the address, telephone number, and respondent's name are not questions that need to be deciphered into smaller ideas.

Yes/No Responses. Yes/no responses were the checked items in the questionnaire. Some of these questions were paired with a descriptive response for explanations or a text response to include a cost, length, or location. All yes/no responses used a list box. Respondents were only able to select from the

list of answers. A good example of this, which is not quite a yes/no response, is the effectiveness of existing or planned mitigation measures. The questionnaire asked for a 'poor', 'fair', or 'good' rating. In the database, however, the rating is not stored as a text but as a number. If a query of this type was planned, the assigned number would have to be looked up in a table showing that relationship. The number is required to properly sort the data.

**Listed Responses.** These questions asked for either a list or were left open-ended so that a community could answer with any number or response. For instance, communities were asked to list watersheds in need of master planning. The answers were so varied that flexibility in entering these lists was given to the data recorder. This was a big factor in the design of the database.

**Descriptive Responses.** Descriptive responses were reserved for explanations and descriptions associated with yes/no responses or with question asking for an opinion (this was used more in the organization questionnaire). There was no limit on how many characters could be typed for a descriptive response. Many times, the response mirrored the answer in the questionnaire, with minor interpretation by the data recorder.

### **Community Questionnaire**

**Community Information.** The community's name, county, address, zip, phone, fax, and e-mail was requested in this section along with the respondent's name, title, address, phone, fax, and e-mail. Other information included population, river basin, hydrologic unit number, and state congressional senate districts.

**Community Profile.** Four questions were asked in this section, all of which are listed responses. The first question addressed significant floodplain problems relating to stream corridors. The second question asked what is valued about stream corridors. The third question asked respondents to discuss barriers in achieving community goals for stream corridors, and the final question asked which person or group is most active with community stream corridors. The type of person or group was also requested.

**Floodplain Management.** The floodplain management section was separated into four subsections. The first subsection explored floodplain information such as the population in the 100-year and 500-year floodplains, structures in the floodplains and the estimated assessed value of structures in the floodplains. This subsection also asked for a list of critical facilities in the 100-year floodplain.

The flood related issues subsection asked about major flood events; the year and magnitude of that flooding and the possible explanation. In addition, erosion damage information was requested, including linear feet of channel and acres lost to stream channel migration. The final question concerned flood problems relating to existing irrigation or other water delivery facilities. Some communities provided supplemental maps to delineate erosion damage.

The third subsection dealt with floodplain mapping needs. For example, "Are there any streams with unmapped 100-year floodplains and are the maps current for those areas already mapped?" The response to the first question may have included a map or a list of reaches and their associated miles that need to be mapped, while the second may have had an explanation of why the maps are not current.

The last subsection asked about the types of flood hazard mitigation measures that the community had used and then rate their effectiveness. Each measure was to be rated with a poor, fair, or good response. An estimate of dollars expended on each mitigation measure was also provided.

**Multi-Objective Use of Stream Corridors.** The first question in this section asked the communities if multi-objective projects have been used and if so, have they been effective. A description was allowed if the multi-objective project was not effective. A supporting inquiry was made to see if there was an interest in multi-objective projects. A list of benefits was provided, with space to give a description of the project, location and cost estimate for each item. The last two questions asked if there was a concern for preserving the loss of agricultural lands and if there would be interest in any other type of flood related project. Both had a space for descriptions.

**Institutional Issues.** This section begins by determining the community's regulations. Next was an inquiry concerning whether there was a need for watershed based drainage master plans, and if so, for which watersheds. The third question determined if communities thought it was beneficial to develop a statewide storm drainage criteria manual. This section also explored community funding mechanisms; do the communities have one and what would they prefer, if a choice was given. Finally, the communities were asked what significant institutional barriers there are to improving their management of stream corridors.

### **Organizational Questionnaire**

**Organizational Information.** Basic information was requested in this section, such as the organization's name, address, zip, phone, fax, e-mail, and respondent's name and title.

**Organizational Profile.** The mission statement or main purpose of the organization was requested along with the primary activities. Both questions had descriptive response boxes.

**Floodplain Management.** The first part of this section addressed: (1) significant floodplain problems relating to stream corridors, (2) the value of stream corridors, and (3) barriers to achieving stream corridor goals. The next subsection was flood related issues, which sought to determine stream erosion and flood problems related to irrigation or water delivery facilities. A description could be included for each question. The last subsection was floodplain mapping needs, with information on floodplain mapping and what reaches may be unmapped or need to be revised.

Multi-Objective Use of Stream Corridors. The use of multi-objective projects was asked effectively with a follow-up question on the need to use these types of projects. If there was an interest in multi-objective projects, a list of benefits was provided with space to give a description of projects incorporating multi-objective elements. Then organizations were asked if they were aware of any threatened stream corridors and to provide a description of the streams. Next, the organization's interest in participating in a multi-objective stream or river project was determined and what type of resources the organization would be willing to commit. The next two questions dealt with interest in other types of flood related projects and the concern for preserving the loss of agricultural lands. Both questions had a description associated with them. The final question was lengthy, divulging information on past and presently used mitigation measures. Each measure was rated as poor, fair or good; some included descriptions.

Institutional Issues. The first question asked whether there was a need for watershed based drainage master plans and the development of a statewide storm drainage criteria manual. Organizations were also asked if they thought Colorado had adequate mechanisms for funding flood control, flood mitigation or stream stabilization project and which new funding mechanisms their organization would support. Requirements in the realm of water resources were determined and programs or funding sources that would address those needs were obtained. The next question inquired about the programs and support the organization receives. Organizations were also asked if there was adequate support for reproducing, communicating and disseminating water resources information and if not, what priorities were higher. Finally, they were asked whether their organization had interacted with the CWCB previously and what suggestions they had for future water resources education.

In summary, the compilation of the community responses and organization responses produced a database with significant information embedded in each table. As a result of the database's design, the tables, except for the Community Information or Organization Information, tables contain only responses from a questionnaire (e.g., if a community did not return a questionnaire, there is no information in these tables for that community). This helps simplify querying, which is discussed in the next chapter.

## THE FUTURE OF THE DATABASE

The Steering Committee wanted the Needs Database to be available to the public and local governments. This was to be accomplished through a link to the Internet. Although the Needs Database was designed to fully incorporate the data from the community and organizational questionnaires, some modifications need to be done so that it can be linked to the internet and used by the general public.

**At the time of this report, the database is being modified, and the logistics of linking it to the Internet, via the CWCB website, are still being worked out.** There has been some question as to the true value of having this database available to the public at large, due to its complexity, and the lack of complete information for all of Colorado's communities. The information on the database is currently available to local communities and to other interested parties by contacting the CWCB.

There is also a possibility, in the future, of linking the database to a geographic information system or GIS. Having this information linked to a GIS will allow users to query the data by simply clicking on a county or community on a map. This may be a better tool to link to the Internet than just the database itself, since some of the information can then be displayed graphically.

The Steering Committee and the CWCB hope that data will eventually be gathered for all of Colorado's communities. Some of the basic data: number of homes and businesses in the floodplain, total area in floodplains, etc. can be gathered during Community Assistance Visits, which are conducted by CWCB staff. As this data is collected, it will be added to the Needs Database.

Although the response to the questionnaires has produced a relatively comprehensive database for floodplain information and future needs for Colorado's communities, the lack of complete data for every community in Colorado must be taken into account when examining the results of queries applied to the data.

The staff of the CWCB and the consultant used the database information to project values for mitigation needs, floodplain mapping needs, and stream rehabilitation needs for all Colorado counties. Table V-I presents the results of the statewide needs inventory extrapolation.

**Figure V-1 - Survey Results Extrapolated for Colorado Counties**

<b>Counties</b>	<b>Mitigation (millions of \$)</b>	<b>Floodplain Map Mileage</b>	<b>Stream Rehabilitation Mileage</b>
Adams	25	100	60
Alamosa	13	50	50
Arapahoe	25	115	30
Archuleta	10	40	20
Baca	1	3	1
Bent	10	50	50
Boulder	20	100	60
Chaffee	5	2	10
Cheyenne	1	2	1
Clear Creek	10	15	15
Conejos	5	40	40
Costilla	2	0	5
Crowley	4	2	2
Custer	5	30	10
Delta	20	23	50
Denver	17	0	15
Dolores	5	10	10
Douglas	20	100	50
Eagle	40	66	20
El Paso	300	150	150
Elbert	5	100	10
Fremont	15	60	10
Garfield	27	100	30
Gilpin	10	35	35
Grand	2	105	20
Gunnison	15	90	60
Hinsdale	3	15	10
Huerfano	5	50	10
Jackson	1	10	10
Jefferson	35	100	50
Kiowa	1	100	10
Kit Carson	1	2	0
La Plata	20	80	55
Lake	10	30	15
Larimer	75	50	50
Las Animas	10	10	50
Lincoln	5	15	1
Logan	25	15	55
Mesa	40	100	50
Mineral	15	50	16
Moffatt	5	10	8
Montezuma	2	20	4
Montrose	10	15	25
Morgan	15	50	10
Otero	25	100	30
Ouray	15	30	30
Park	10	25	3
Phillips	5	10	10
Pitkin	45	5	25
Prowers	20	45	35
Pueblo	20	100	75
Rio Blanco	2	20	2
Rio Grande	8	20	10
Routt	15	80	27
Saguache	2	15	2
San Juan	2	5	10
San Miguel	20	28	14
Sedgwick	2	35	15
Summit	10	50	8
Teller	30	23	20
Washington	2	8	2
Weld	25	150	50
Yuma	12	4	2
<b>Totals:</b>	<b>1160</b>	<b>2863</b>	<b>1613</b>

## CHAPTER VI

# NEEDS CATEGORIES

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### BACKGROUND

Through the administration of the project entitled "Statewide River Rehabilitation and Floodplain Management Needs Inventory" by the Steering Committee, CWCB, and McLaughlin Water Engineers, Colorado's floodplain management needs were assessed. The project theme was: *What is the need?*

In search of the answer to the above question, the following process was used:

- ♦ Research and discover facts and needs through the project questionnaire process
- ♦ Develop an inventory database for compilation of the facts and needs
- ♦ Assessment of collected information for project findings
- ♦ List the statewide problems, based on the findings

### PROCESS

A specific process was developed and followed in order to carry out the mission of answering the question, *What is the need?* Briefly, the process consisted of:

**Research and Discover** – To assess the floodplain management and stream rehabilitation problems and concerns across Colorado, a detailed questionnaire was developed by McLaughlin Water Engineers, CWCB, and the Steering Committee. The questionnaire solicited data on subjects such as community profile, floodplain management issues, floodplain mapping needs, mitigation measures, multi-objective use of stream corridors, and institutional issues.

**Inventory Database** – Once the questionnaires were completed by various entities and returned to the McLaughlin Water Engineers, a method was needed to categorize and store the submitted information. Microsoft Access 97 was selected as the tool of choice to build an adequate database for the project. The database was constructed to handle community information as well as interest group input. The database contains all of the information from the questionnaires along with additional information as submitted by the respondents. The database can be accessed by users to find out pertinent floodplain management information and needs of communities and interest groups.

**Assessment of Collected Information** - The questionnaires and database allowed the consultant to more easily assess the collected information and determine project findings. The general categories of needs as determined from the process and the database are: floodplain mapping, stormwater detention policy, streambank stabilization, multi-objective planning and projects, funding mechanisms for floodplain projects, authorization for local funding and implementation powers, statewide design standards and

criteria manuals, statewide GIS system with internet access/interface, education program, participation in scoping of new/improved federal programs, wetland detention policy, and watershed master planning.

**Statewide Problems** – Once the general needs were categorized, then it was necessary to further refine the assessment in order to make sense of the information and come up with common, statewide problem areas. This last step permits the development of concise recommendations to address the problem areas.

**The top five flood-related problems that surfaced as a result of the process are:**

- 1) Lack of funding mechanism,
- 2) Damages caused by flood events,
- 3) Mapping needs and development in floodplains,
- 4) Channel erosion, and
- 5) Lack of education and watershed management.

### FINAL NEEDS DETERMINATION

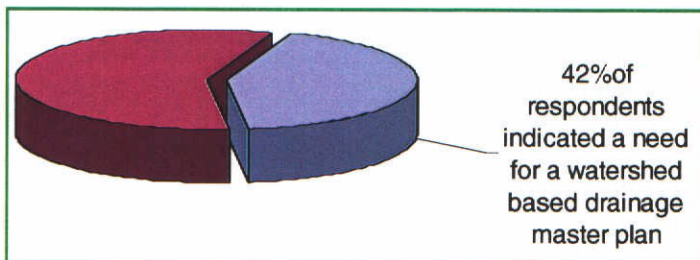
The survey findings offer a basis for understanding needs and formulating recommendations for meeting those needs. The CWCB's consultant has compiled needs for floodplain and stream corridor management. The CWCB and the Steering Committee agreed on the following specific categories of needs that were pared down from the general needs stated above. These needs should also help to address the statewide flood-related problems as well.

**Planning Assistance** - Many of the state's watersheds have an absence of an overall master drainage plan and mitigation plan for a rehabilitation or restoration plan for the flood ravaged channels and floodplains. With the implementation of short-term and site specific projects, longer-term problems are created, which might have been avoided, or at least minimized, if the initial activities had been undertaken with a broader perspective. In addition to taking a watershed approach, these plans need to consider the full range of interests in the watershed through a multi-objective approach. Planning assistance options that the respondents identified are:

Community Master Plan: Community growth patterns are adversely affecting natural stream corridor functions. ***Forty-two percent of the respondents indicated the need to include a watershed based drainage master plan to enable present decision makers to create a plan that addresses the watershed***

***and how individual projects would fit into the overall plan, rather than only looking at individual projects.***

This master plan would also provide future decision makers with insight concerning what was envisioned for the watershed, and provide a basis for sound decision making based upon hydrological and environmental concepts that take into account the watershed's unique geomorphology, soils, climate, vegetation, wildlife, and human characteristics.



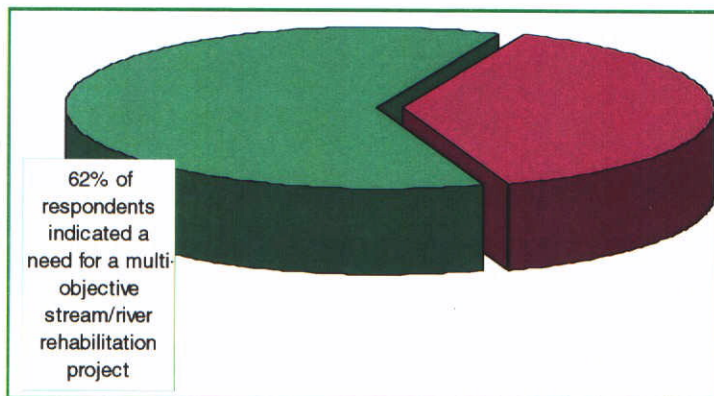
Community Floodplain Information Maps: Community 100-year floodplain maps needed to be reviewed and updated on a five year interval. These reviews and map updates will provide the communities with more accurate designation of their flood hazard areas.

Multi-Objective Management Perspective:

Specific, single-purpose solutions are generally inadequate; multi-objective stewardship perspective should be applied to management of watershed and stream corridors. Multi-objective planning solutions are needed for most Colorado watersheds.

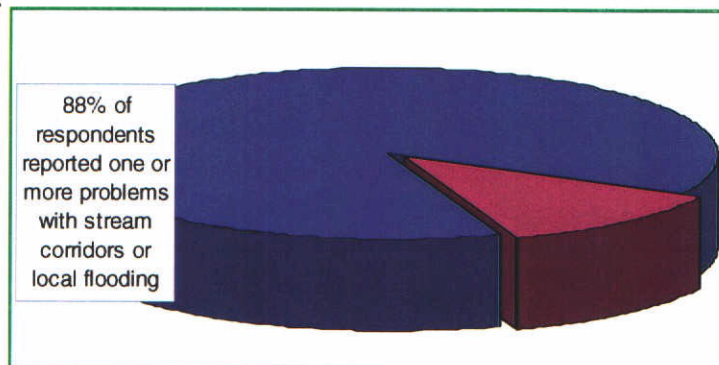
***Sixty-two percent of the respondents expressed a need for a multi-objective stream/river rehabilitation project.*** This

indicates recognition that floodplains and stream corridors have important functions within the watershed that can be managed to benefit more than one single purpose. Due to the general arid climate in the West, the presence of water in these portions of the watershed often contain some of the more unique and valuable habitat attributes within the watershed, which can be enjoyed by all residents if properly managed.



Technical Assistance for Stream Rehabilitation: Community and landowners need assistance in formulating and planning their river or stream rehabilitation projects. Floodplain management must be expanded to include stream rehabilitation/stabilization, habitat and riparian zone preservation/enhancement, and flood hazard mitigation.


***Eighty-eight percent of the respondents cited one or more problems related to stream corridors or local flooding.*** This high percentage indicates recognition that flooding is a natural function of this portion of the watershed. Natural recovery may be very slow and man's influences have placed constraints on the recovery process.



Post-Flood Local Recovery Plans: Communities and landowners who have experienced a major flood event usually respond at various levels in some manner by the 7th to 14th day following the flood event. Emergency operations begin during or immediately following a natural disaster, but long-term mitigation is a key for preventing future disasters in the same location. The common question after a disaster is, "What is government going to do for me?" Presently, federal and state flood mitigation programs do not have an instrument to begin preparing a specific flood recovery plan by the 14th day after the event (with

completion in 60 to 90 days after the event). An opportunity exists to implement successful mitigation projects, if a rapid response can be provided to flood victims.

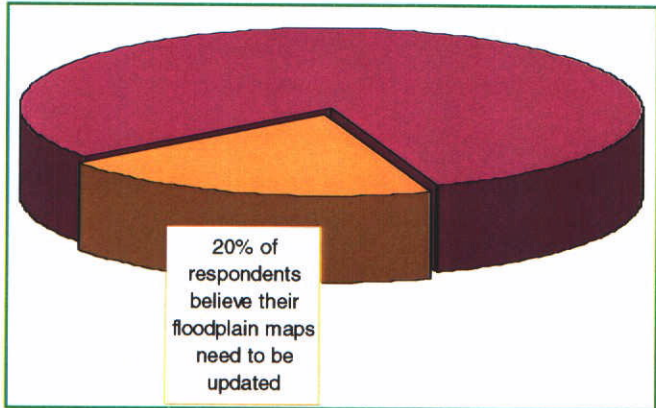
Funding for Project Implementation: The single most common need identified in the questionnaire was the need for a mechanism to fund projects. Nearly every respondent said there are stream corridor and watershed needs that cannot be met with current resources. Thirty-six percent of the respondents indicated lack of funding was the primary obstacle to planning and implementing improvements. Economic factors have affected many communities, due to the rapid influx of new residents who want daily life sustaining needs to be provided, including water supply, water treatment, streets, and other utilities.



70% of respondents indicated their funding mechanisms were nonexistent or inadequate

These demands frequently consume all the fiscal and staff resources of communities. As a result, floodplain and stream corridor planning and management is pushed to a lower priority until natural flooding occurs, which leaves no alternative but to deal with floodplain survival rather than management. Unfortunately, when such events have passed, the need to prepare for the next event is often forgotten, as evidenced by ***seventy percent of the respondents stating they do not have a funding mechanism or if they do, it is inadequate to deal with current conditions.*** Many respondents suggested that a statewide revolving fund loan program be established, which could be used in a variety of ways. In addition to creating one or more funding mechanisms for stream corridor projects, an important component of implementation would be to expand the funding opportunities to allow the CWCB more partnership options with federal agencies, and to facilitate stream restoration and flood emergency response activities. There is also a need for fiscal resources to assist in flood related emergency response and post-flood land acquisition, to assist in relocating property owners from the floodplain to alternate locations.

Public Information: There are three very important components to information: 1) data, 2) technical training to interpret the data and make meaningful and wise decisions from that data, and 3) education to implement the data and take advantage of the technical expertise. The respondents indicate an immediate need for mapping 460 miles of unmapped 100-year floodplain area. This has been conservatively projected (for all areas of the state) to be



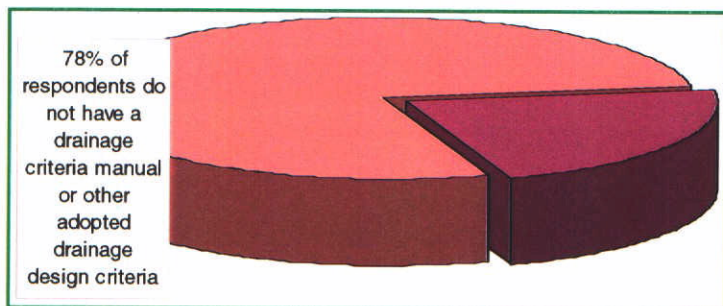
20% of respondents believe their floodplain maps need to be updated

approximately 2800 miles, within the total 8,000 miles of unmapped floodplains statewide. ***Twenty percent of the respondents believe that their floodplain maps need to be updated.*** Much of the data and maps were developed in the early 1970's and are lacking detail in many ways. The need to update this data is critical to successfully design for current development patterns, plan for future development activities and prepare for the 21st century. Many communities cited a lack of technical expertise as a key problem in helping to plan and implement stream corridor improvements or stabilization. With man's increased pressure to utilize floodplains and stream corridors for other uses, the need to accurately predict where certain levels of flow will reach becomes imperative to insure human and natural uses do not conflict. Man's presence must accommodate the stream's need to also occupy portions of the floodplain, since flood waters exercise a very real presence with no opportunity for negotiation. In addition, the responses indicated a need for educating administrators and landowners on the principles of floodplain management.

**Policy and Criteria:** Several definitions need to be added to the current statutory language for floodplain management activities. These include defining the "base flood" for the state floodplain management activities as that flood event with a 100-year return frequency (1% chance). This 100-year definition is currently the state's regulatory design criteria. It is recommended that "critical facilities" be protected from losses by a 500-year return frequency (0.2% chance). "Critical facilities" should be defined as facilities necessary to maintain the health and safety of the public in a community, except for public road systems. In addition, a statewide flood detention policy should be proposed, requiring that increased storm runoff from new development activities shall be detained and standards should be provided for how that should be accomplished. This action will require establishment of a "baseline hydrologic condition" for the state's basins/watersheds. There is also a need to create a wetland banking/accounting and replacement program to assist in maintaining existing wetland conditions. The banking system would protect the state's existing level of wetlands and provide opportunities for the better management of future development activities.

***Seventy-eight percent of the respondents do not have a drainage criteria manual or other adopted drainage design criteria.***

In addition, seventy-four percent of the respondents stated that they do not have a stormwater detention policy.



## THE BOTTOM LINE?

### Flood Protection

There is a clear need for improved floodplain management to reduce the at-risk human population's vulnerability to flooding and prevent further encroachment into flood hazard zones by man. There is also a need to improve stream maintenance and implement flood protection measures to reduce annual flood losses.

Stream flooding remains the greatest hazard to life and property in Colorado. Today, flood-prone areas have been identified in 268 cities and towns and in all of the 63 counties in Colorado. As many as 250,000 people are estimated to reside in Colorado's 100-year floodplains, with property valued at more than \$16.5 billion.

**Flood Protection Measures Can Include:**

- ♦ Structural Measures
  - Levee Systems
  - Detention and Flood Storage
  - Structural Floodproofing
  - Channel Conveyance Systems
  - Designed Open Space and Wetland Areas
- ♦ Nonstructural Measures
  - Flood Insurance Coverage
  - Floodproofing
  - Natural Open Space Areas
  - Preservation of Wetlands
  - Land and Property Acquisition
  - Building Codes and Floodplain Regulations

**Stream Rehabilitation**

Many streams throughout Colorado are experiencing erosion from natural processes and human activities and practices. Streambank erosion and channel degradation can harm fish habitat, destroy agricultural land and damage private property. Rehabilitation measures are needed to stabilize threatened stream corridors, preserve the natural resources and functions of floodplain areas, and increase flood capacity.

**Stream Rehabilitation Measures Can Include:**

- ♦ Channel Stabilization Measures
- ♦ Riparian Habitat Improvements
- ♦ Wetland Area Enhancement
- ♦ Eroded Streambanks Repair
- ♦ Open Space Preservation

## **CHAPTER VII**

### **STREAM CLASSIFICATION NEED**

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#### **BACKGROUND AND PURPOSE**

Classification can be defined as the ordering of objects into sets on the basis of their similarities or their relationships (Platts 1980). Classification enables us to infer attributes of individual streams on the basis of their characteristics as they relate to the classification categories. The most effective classification systems are those that are based on objective, quantifiable criteria that permit consistent use of the classification system (Rosgen 1996). The attempt to classify streams has been occurring for many decades.

The purposes of stream classification, especially as it relates to Colorado stream rehabilitation projects, are to: 1) serve as an indicator of the dominant physical processes in the stream of interest; 2) aid in the evaluation of potential restoration projects that are competing for project funds; and 3) allow for clear communication between all parties involved in rehabilitation projects. One of the major benefits of this approach is to ensure that rehabilitation measures are in harmony with a stream's inherent characteristics. The objective of classifying streams is to set categories of discrete stream types so that consistent, reproducible descriptions and assessments of condition and potential can be developed. Examples of specific objectives of a stream classification system are presented in the table below.

**Table VII - 1 - Specific Objectives of Stream Classification**

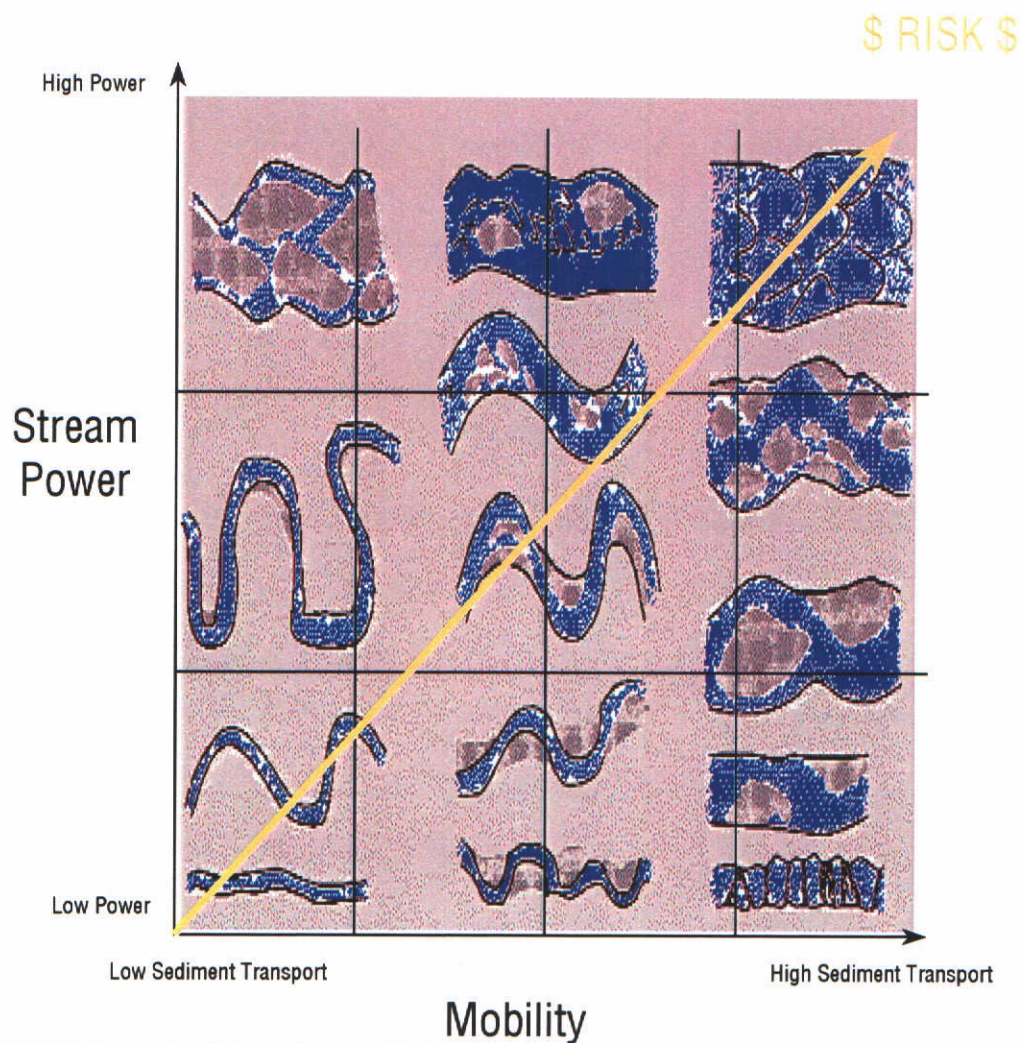
♦	Predict a stream's behavior from its appearance
♦	Develop specific hydraulic and sediment relationships for a given stream type and its state
♦	Provide a mechanism to extrapolate site-specific data to stream reaches having similar characteristics
♦	Provide a consistent frame of reference for communicating stream morphology and condition among a variety of disciplines and interested parties.

## DYNAMIC SYSTEMS

Streams are dynamic features of the earth's surface that change over time. A basic understanding of the physical processes that are responsible for stream form is needed in order to work within the stream environment. Unlike static features on the earth's surface, such as a road, there is no template for the construction of a stream. The geometry of a stream is self-adjusting in response to the flow velocity, flow rate, and volume of water & sediment loading that is supplied to the system. Over time, changes in water and sediment supply result in channel adjustments that may include erosion of the streambed or bank, or channel aggradation and the creation of sandbars.

As a stream increases in power and mobility it becomes less predictable. Figure VII-1 illustrates the increasing uncertainty and risk that occurs with increasing power and mobility. It is important in the rehabilitation of stream channels that the physical difficulty and uncertainty associated with the work be understood and suitable design criteria developed. Therefore, the classification method takes various combinations of mobility and stream power and establishes class identification.

**Figure VII-1 - The River Environment**



## GEOMORPHOLOGY

Understanding the processes and characteristics of fluvial systems requires knowledge of their inherent hierarchical structure. The modern stream reflects the effects of current climate, lithology, depositional and erosional history, and the mediating effects of broad vegetation zones (Rosgen 1996). The morphology of a stream is shaped by the sediment regime and streamflow determined by climate and landform, and it reflects events of the past. The basic elements of stream morphology are its dimension, pattern, and profile, which combine to allow a balanced stream response to specific energy gradients, sediment supplies, and transport characteristics. Figure VII-2 provides an example of stream properties that have been used for stream classification (based on work by Brice and Blodgett 1978).





















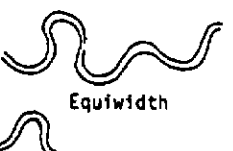
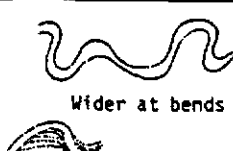
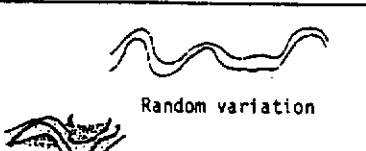
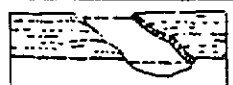

## CHANNEL STABILITY AND SEDIMENT TRANSPORT

Technical parameters that relate to channel stability include flow velocity, shear stress, stream power, hydraulic geometry relationships, sediment transport functions, and bank slope stability. Channel stability plays an important role in determining how a stream responds to various flow regimes over time. Depending on a channel's ability to resist erosion and the amount of sediment available for deposition, a large or rare flood event can have a major impact on the physical characteristics (geometry, form, etc.) of the stream itself. Table VII-2 below provides general guidance on channel stability in terms of flow velocities and channel material.

**Table VII-2**  
**Example of Flow Velocities to Maintain Channel Stability**

<i>Channel Material</i>	<i>Mean Channel Velocity (ft/s)</i>
Fine sand	2
Coarse sand	4
Fine gravel	6
Sandy silt	2
Silty clay	3
Clay	6
Grass-lined (slopes <5%)	5 – 8
Poor rock	10
Soft sandstone	8
Soft shale	3.5
Solid rock	20

**Figure VII-2**  
**Stream Properties for Stream Classification**

CHANNEL WIDTH	Small ( $<100$ ft or 30 m wide)	Medium (100-500 ft or 30-150 m)	Wide ( $>500$ ft or 150 m)		
FLOW HABIT	Ephemeral	(Intermittent)	Perennial but flashy	Perennial	
CHANNEL BOUNDARIES	 Alluvial	 Semi-alluvial	 Non-alluvial		
BED MATERIAL	Silt-clay	Silt	Sand	Gravel	Cobble or boulder
VALLEY; OR OTHER SETTING	 Low relief valley ( $<100$ ft or 30 m deep)	 Moderate relief (100-1000 ft or 30-300 m)	 High relief ( $>1000$ ft or 300 m)	 No valley; alluvial fan	
FLOOD PLAIN	 Little or none ( $<2\times$ channel width)	 Narrow ( $2-10\times$ channel width)	 Wide ( $>10\times$ channel width)		
DEGREE OF SINUOSITY	 Straight (Sinuosity 1-1.05)	 Sinuous (1.06-1.25)	 Meandering (1.26-2.0)	 Highly meandering ( $>2$ )	
DEGREE OF BRAIDING	 Not braided ( $<5$ percent)	 Locally braided (5-35 percent)	 Generally braided ( $>35$ percent)		
DEGREE OF ANABRANCHING	 Not anabranching ( $<5$ percent)	 Locally anabranching (5-35 percent)	 Generally anabranching ( $>35$ percent)		
VARIABILITY OF WIDTH AND DEVELOPMENT OF BARS	 Equiwidth Narrow point bars	 Wider at bends Wide point bars	 Random variation Irregular point and lateral bars		
APPARENT INCISION	 Not incised	 Probably incised			
CUT BANKS	Rare	Local	General		
BANK MATERIAL	Coherent Resistant bedrock Non-resistant bedrock Alluvium		Non-coherent Silt; sand gravel; cobble; boulder		
TREE COVER ON BANKS	$<50$ percent of bankline	50-90 percent	$>90$ percent		

(Federal Highway Administration, NHI #13010, 1990)

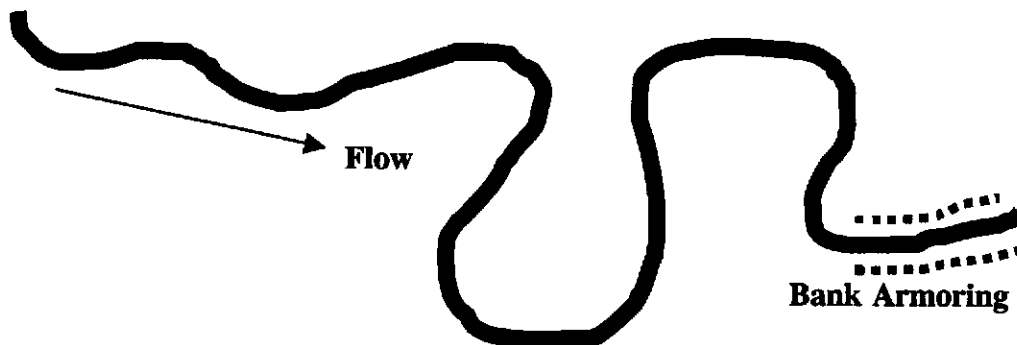
Adequate resistance to erosion does not necessarily produce stability, if the channel has substantial inflows of bed sediment. Basic hydrologic input to the stream and the associated hydraulic parameters of the flow (velocity, depth, slope, etc.) will dictate erosion patterns in the simple scenario. More complex analyses are required when an abundance of sediment inflows may lead to severe sediment deposition or a combination of erosion and aggradation of a stream channel.

### HYDRAULIC GEOMETRY

Hydraulic geometry relationships involve three independent associations for: 1) width or wetted perimeter, 2) depth or hydraulic radius, and 3) slope or velocity, all vs. discharge. They indicate the preferred cross-section and slope of a channel for a given channel-forming discharge and given boundary materials. In the design of a channel project, the preferred channel is supposed to be stable, with respect to cross-section and slope, but is not necessarily free from lateral shifting and meandering.

Meander geometry is an interesting phenomenon in river mechanics. Meander dimensions in natural systems tend to scale with channel width. Stream projects that tend to alter or fix channel width also tend to alter the meander patterns of the natural system over time. Meander wavelength, like channel width, will vary roughly as the square root of channel-forming discharge. The figure below depicts an example of a distorted meander pattern.

**Figure VII-3**  
**Example of Distorted Meander Pattern of an Armored Channel Reach**



### BIOLOGICAL CONDITIONS

Classification is an important component of many of the scientific disciplines relevant to stream corridors such as hydrology, geomorphology, limnology, and plant & animal ecology. When a classification system is used as a measure of biological condition of a stream, there are several factors to consider for restoration planning. These factors may include geographic domain, variables considered, incorporation of temporal relations, focus on structural or functional behavior, and the extent to which management alternatives or human actions are explicitly considered as classification variables.

Habitat evaluation procedures (HEP) can be used for several different types of habitat studies, including impact assessment, mitigation, and habitat management (Federal Interagency Stream Restoration Working Group, 1998). HEP provides information for two general types of habitat comparisons. The first is the relative value of different areas at the same point in time, and the second is the relative value of the same area at different points in time. Potential changes in wildlife (both aquatic and terrestrial) habitat due to proposed projects are characterized by combining these two types of comparisons (FISRWG, 1998).

#### **WHY A STREAM CLASSIFICATION SYSTEM FOR PROJECT DESIGN?**

A stream classification procedure or system will assist the scientific and environmental communities' understanding of stream reach characteristics. The basic understanding will assist in the design of flood mitigation programs and projects that will be cost-effective and sustainable for various flow scenarios. This approach can also assist planners and designers for the purpose of achieving multi-objective benefits to stream corridor mitigation projects. Appendix C presents a simplified classification system to serve as a screening method for Colorado streams.

## CHAPTER VIII

# CONCLUSIONS AND RECOMMENDATIONS

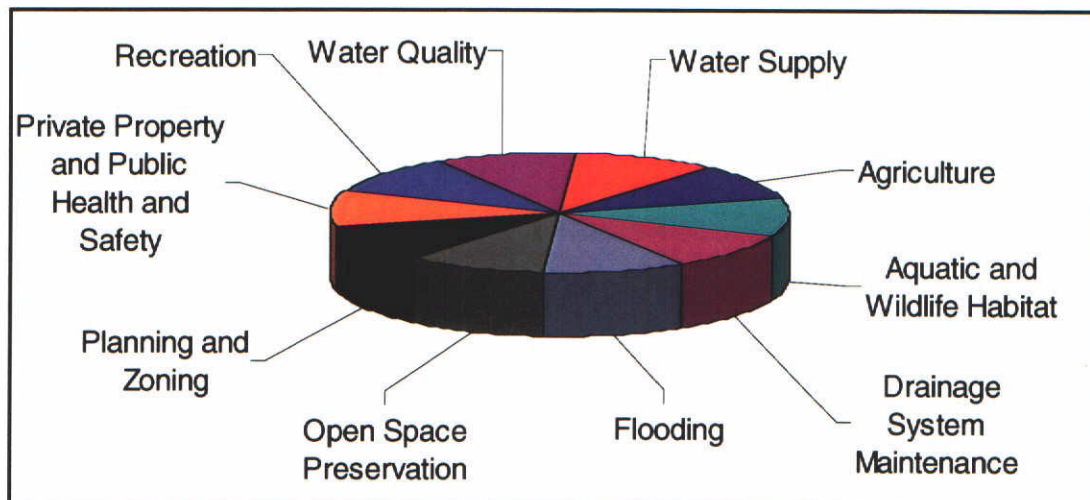
### INTRODUCTION

This chapter presents the results of 176 communities, counties and water organizations, representing forty percent of those polled by the CWCB's inventory of floodplain and stream corridor issues. The responses have been grouped into four general categories: planning assistance, funding implementation responses, public information/technical assistance, and policy and criteria. The needs of the respondents in each of the four categories are presented in Chapter VI. The conclusions from the responses and instruction from the Steering Committee are summarized to provide direction and confirmation of the need for additional involvement with local stakeholders by the CWCB, in floodplain and stream corridor management. The Statewide Inventory and Assessment Process by the Steering Committee, CWCB and McLaughlin Water Engineers, Ltd. determined the answer to: "What's The Need?" The answers are stream rehabilitation and flood protection.

### CONCLUSIONS

The inventory results indicate the following:

1. A watershed master planning program should be created addressing management of floodplains and stream corridors, which includes the following interest groups:



2.



Communities are keenly interested in addressing floodplain and stream corridor management issues. However, they do not believe they can afford the cost of such activities on their own. Repeated efforts by some communities to obtain funding through property taxes have been defeated. Therefore, another source of funding, such as the statewide revolving fund loan is needed.

3.

Development within floodplains has occurred without consideration of the effects on floodplain natural resources functions. There must be a balance between a need for man's activities in the floodplain and the tremendous benefits to be gained from maintaining naturally functioning floodplains. Multi-objective management is the key.

4.

A statewide model stormwater criteria manual would be of benefit in assisting local government officials and developers to devise viable mitigation measures. Balancing future development with the natural function of the floodplain will reduce loss of nature floodplain values and annual flood damages.



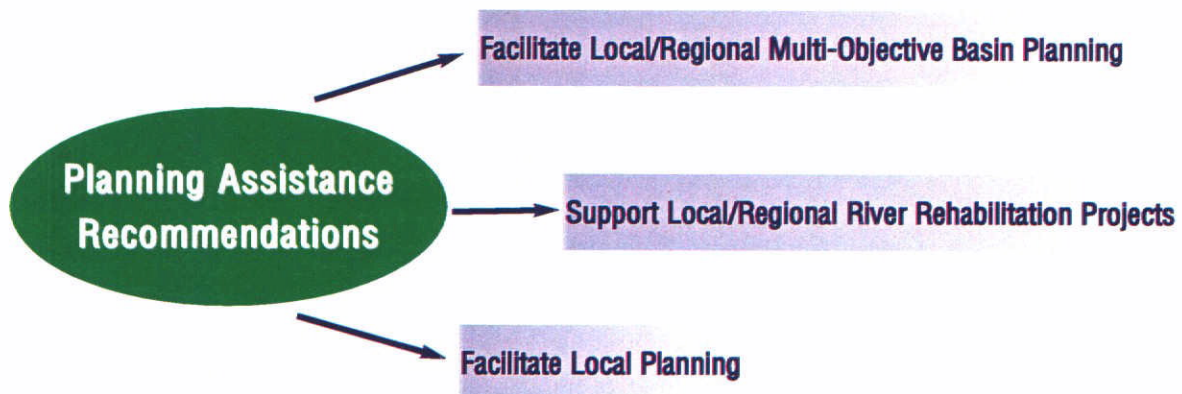
5.

With Colorado's expanding economic and rapid growth, there is need to expand the state's on-going program for floodplain mapping.

6.

Rivers are dynamic features of the earth's surface that change over time. A basic understanding of the physical processes responsible for river form is needed to effectively work within the river environment. A classification system for Colorado's streams and floodplains will assist with understanding the physical characteristics of the state's water courses and storm runoff channels.

## RECOMMENDATIONS



### **Planning Assistance Recommendations**

Facilitate Local/Regional Multi-Objective Basin Planning. The CWCB should facilitate local/regional multi-objective basin planning for Colorado's major river basins in cooperation with local stakeholders. Previous experience with floodplain management in Colorado, and nationally, indicates the most effective long term method of dealing with floodplains is a comprehensive holistic approach, which considers the entire watershed as an interrelated environment and attempts to satisfy numerous needs, while utilizing long range vision. Membership in this planning effort needs to use a participatory approach that involves all stakeholders and allows for as much participation as possible within the various planning tasks.

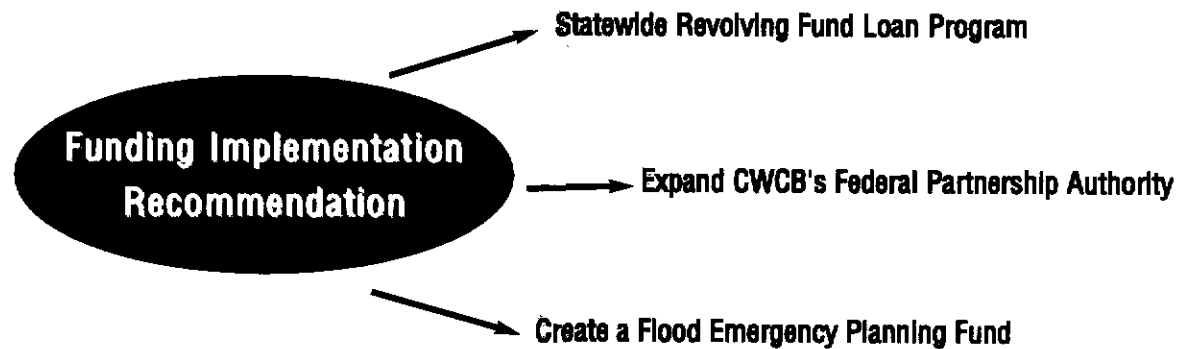
Support Local/Regional River Rehabilitation Projects. The CWCB needs to establish a program to support local/regional river rehabilitation project planning for selected stream reaches. This effort would serve several important purposes including:

1. By selecting the more significant reaches of streams, which are in need of assistance, problems can be addressed before they become any worse, and solutions become even more challenging and expensive.
2. The program would serve as a model to others in the subject basins to exemplify a stakeholder driven, watershed approach to problem solving.
3. As in any new endeavor, the prototype can consume more time and effort than the next version. This would serve to add to CWCB's overall knowledge of approaches to problems, which can be transferred to other locations, and also approaches that may need to be carefully considered due to past experience.
4. Successful endeavors are encouraging to others who may want to address flooding problems, but have become frustrated with a lack of success. The stakeholder approach to stream corridor stewardship would encourage others to join the process.

Facilitate Local Planning. The program should be designed to facilitate local planning for community based multi-objective flood hazard mitigation projects and preparation of post-flood recovery plans. The traditional single purpose approach to flood control has not meet the needs of communities and most are dependent on federal funding. This is due, in part, to single purpose issues competing with other local interests and being unable to compete with those interests. By coordinating flood loss reduction with other community needs and goals, a stronger and more comprehensive program results. Community representatives who understand that floodplain management can also improve opportunities for open space, recreation, fish and wildlife habitat, urban redevelopment, housing improvement, agriculture, water supply and water quality improvement are more willing to support such use of public funding and resources, which include floodplain management efforts. Further, obtaining local involvement in the multi-objective flood hazard mitigation process can result in cost savings by leveraging and building upon the financial resources and the willingness of the people with interests in the watershed to take action.

This local acceptance creates a sense of stewardship, which provides a healthy long term relationship.

Following the 1997 flood events, there was no program at the state or federal agencies to commence with a recovery plans 7 days after the disaster. Experience has demonstrated in flood impact communities that the helping hand turns to finger pointing around the 7th day.



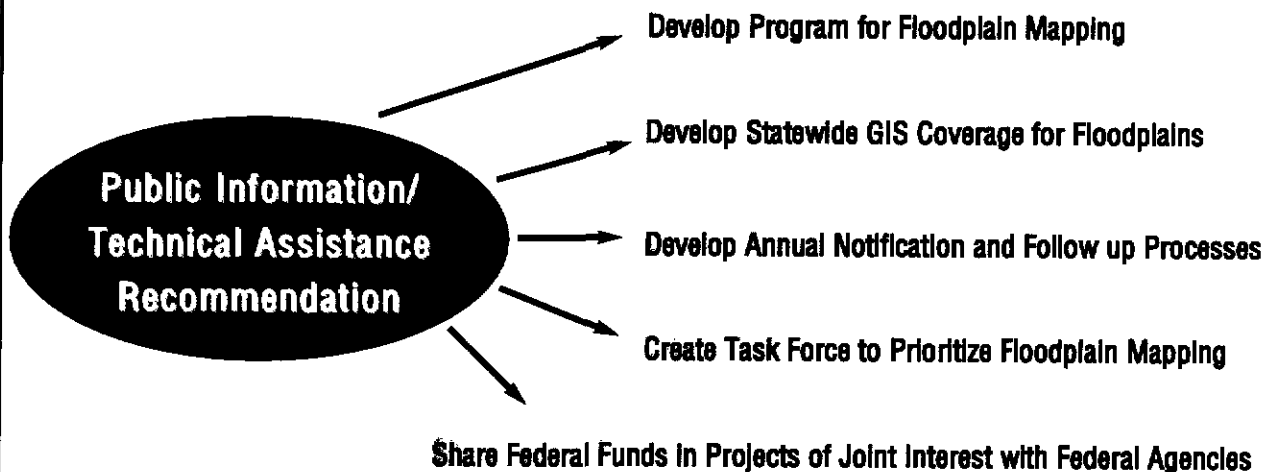
#### **Funding Implementation Recommendation.**

Statewide Revolving Fund Loan Program. The program needs to have a statewide revolving fund loan program created to enable communities to address flood mitigation, watershed, and stream corridor management issues. The single, most pressing issue to enable communities to deal with identified floodplain issues is a reliable accessible source of funding. CWCB already has a very favorable reputation for being such a source in other areas of water management and conservation issues through its construction loan program. The statewide revolving fund loan program would add to the options CWCB could utilize to assist communities in addressing one more water resource management issue.

Expand CWCB's Federal Partnership Authority. The existing statutory authority, which directs the CWCB's daily activities, needs to be expanded to enable the CWCB to sponsor projects with federal agencies in addition to existing authority with the Corps of Engineers. There are other federal agencies in Colorado, such as the Bureau of Reclamation, U.S. Fish and Wildlife Service, and Bureau of Land Management, that also have major interests in watershed management. These federal agencies frequently are looking for a sponsor at the state level who would participate with them in projects. By expanding the current authority, the CWCB could fulfill that role and enter into programs that benefit Colorado residents in dealing with stream corridor and floodplain issues.

Create a Flood Emergency Planning Fund. A fund should be established that would enable the CWCB to provide advance flood preparedness activities, immediate flood response recovery planning, flood documentation and reconnaissance following a flood event. After the 1997 disastrous flood event, no program was available to assist flood ravaged communities to develop a flood recovery and operational plan to assist in rebuilding their communities. There is a need for a *Recovery Plan* to be completed in 60-90 days following a flood event.

**Develop Broad Based Stakeholder Support.** The CWCB flood protection program should support projects/planning that include diverse stakeholders in multipurpose projects to maximize opportunities and benefits to stream corridor and watershed projects. Building consensus among all affected stakeholders, however diverse, best provides an opportunity to establish mutually supportive partnerships and offers the obvious benefits of commitment to basic goals and objectives and more meaningful implementation. A community approach is needed that involves various, diverse stakeholders in planning floodplain use and management (e.g., land owners, resource managers, local government, environmental advocates, and agricultural and business interests). Under current federal, state, and local authority, most if not all of these stakeholders already have some kind of input, approval or permitting authority. This allows their involvement and input in the initial stages of a program to be more effective than involvement towards the end of the planning or implementation phase of a project.



#### **Public Information/Technical Assistance Recommendation**

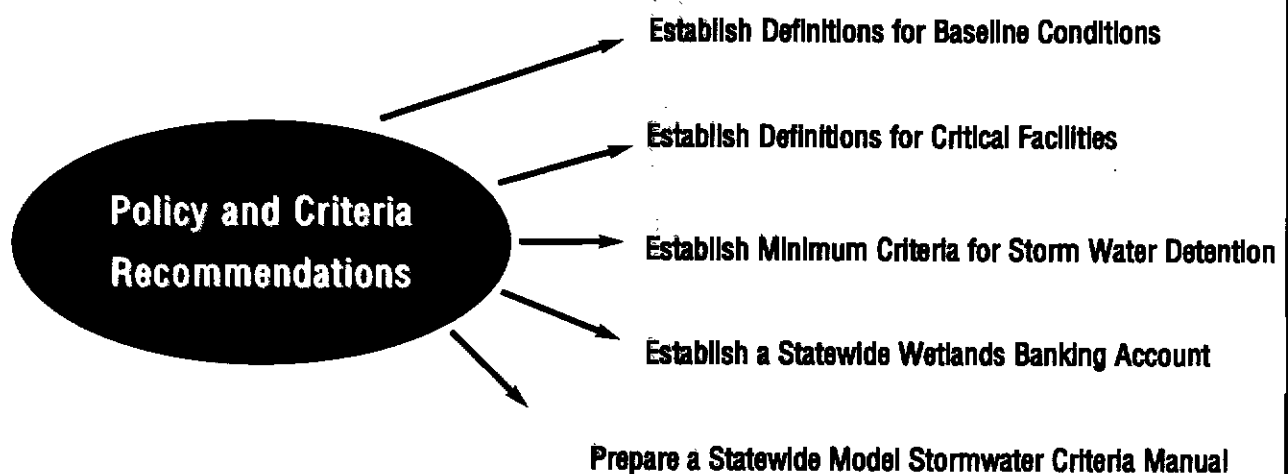
**Develop Program for Floodplain Mapping.** The CWCB should establish an ongoing program for floodplain mapping. The first step in watershed management is to identify the physical features of the watershed. While some Colorado watersheds have had mapping completed in the early 1970's, and others are still awaiting floodplain mapping to be completed, nearly every watershed, or portion thereof, is experiencing increased development pressure. Population growth led by a very positive perception to life in Colorado has created development pressures on existing infrastructure, which seriously affects the ability of local communities to properly manage their floodplain areas. One vital component in this effort is to have accurate, up-to-date floodplain mapping information available to communities, developers, and interested parties. Such information can be effectively used to assist in decision making efforts to direct man's activities in combination with, rather than in opposition to, the functions of the floodplain and stream corridor. This investment will pay huge dividends by preserving the natural resource function of stream corridors.

Develop Statewide GIS Coverage for Floodplains. The CWCB, in cooperation with private and other local, state, and federal entities should establish a statewide GIS coverage for elements of floodplain management and stream rehabilitation. New technology in the form of GPS coverage, as well as the more traditional mapping coverage, which is being digitized for use in GIS applications, can be very useful in evaluating subtle but significant changes as streams and floodplains respond to flooding events and man's efforts to protect his investment in the floodplain and stream corridor. By making GIS coverage available to the public and applying current and new hydrologic modeling efforts to this data, a new level of information can be made available to local decision makers and stakeholders to facilitate their efforts in wise stewardship of the floodplain and stream corridor portions of the watershed.

Develop Annual Notification and Follow up Processes. The CWCB should establish an annual notification process for communities securing flood insurance coverage and implementing flood mitigation programs. This effort would ensure that proper attention is being given at the local level to perform the necessary activities to maintain flood insurance programs. In addition, this effort would also ensure that opportunities are acted upon in a timely manner following flooding events to acquire flood prone property within the floodplain or stream corridor.

Create Task Force to Prioritize Floodplain Mapping. The CWCB should create a task force of local, state, and federal agencies to establish priorities and criteria for floodplain mapping through pooling common sources of relevant data. The use of public funds to address floodplain activities demands those funds be used as efficiently and effectively as possible. Therefore, the assessment of current information to establish priorities and criteria for floodplain mapping would not only be good stewardship of public funds, but would serve as positive indicators to other stakeholders of the sincere interest by the public sector.

Share Federal Funds in Projects of Joint Interest with Federal Agencies. The CWCB should share as much federal funds as possible by including multiple purpose functions of common interest to federal agencies. Colorado has a significant public interest since a portion of the state is owned by federal agencies. These agencies are also faced with very limited financial resources and are looking for partners who can enter into mutually agreeable relationships where joint ventures can accommodate multiple objective projects for the benefit of all involved.



### **Policy and Criteria Recommendations**

Establish Definitions for Baseline Conditions. The CWCB should establish definitions for baseline conditions for stream corridor management activities. Currently, the CWCB operates its program based upon federal guidelines of the *base flood* being a flood event that has a probability of one chance in a hundred of occurring in any given year. The area that would be inundated by this event is the area shown on the Flood Insurance Rate Map (FIRM) as the 100-year floodplain. This definition should be incorporated into Colorado law to provide a reference for further actions, which maybe necessary as part of the stewardship of Colorado streams.

Establish Definitions for Critical Facilities. The CWCB should also establish definitions for critical facilities and an appropriate level of protection higher than the baseline conditions. Recent flooding events in Colorado and the response by Colorado communities to the inventory indicate too frequently many critical facilities, such as law enforcement facilities, hospitals, fire stations, and water treatment facilities are located in the 100 year floodplain. The ability of these critical facilities to perform their intended functions during periods of flooding should not be compromised. Therefore, it is suggested these critical facilities, which would be defined to include facilities necessary to maintain the health and safety of the public in a community, except for public road systems, be designed to withstand a 500 year flood event to insure they are capable of performing their intended functions during even some of the most extreme flooding events experienced in Colorado.

Establish Minimum Criteria for Storm Water Detention. The CWCB should establish minimum criteria for detention of excess runoff from development. One of the key factors to live in harmony within stream corridors, particularly within the floodplain, is to insure that historic events, which are used to predict future events and are used to design and located facilities in proximity to the floodplain, do not change significantly. Unfortunately, development in a watershed, which changes the historic runoff pattern, both in time and duration, causes adverse impacts to downstream residents. Therefore, the CWCB believes it is in the public interest to propose that a minimum statewide criteria for detention of excess of runoff from future development be established. This would require that increased storm runoff from new development

activities shall be detained and standards should be provided for how that should be accomplished. This action will require establishment of a *baseline hydrologic condition* for the state's basins/watersheds.

Establish a Statewide Wetlands Banking Account. The CWCB should establish a statewide wetlands banking/accounting and replacement program to assist in maintaining existing wetland conditions. The banking system would protect the state's existing level of wetlands and provide opportunities for the better management of future development activities. Currently, Colorado does not have such an account and it cannot take credit for activities such as groundwater recharge projects, which have as another benefit, creation of a wetlands. As Colorado enters a new area of stewardship of its streams, a method of accounting such activity would be very valuable.

Prepare a Statewide Model Stormwater Criteria Manual. The CWCB should prepare a statewide model stormwater criteria manual. Currently, there is no such manual for Colorado. Each community is left to its own devices and resources to address stormwater management. A model-criteria model would insure that all the important factors of stormwater management were addressed, provide minimum standards based upon data from storms in Colorado, and allow local communities to exercise latitude in determining what additional criteria should be considered for their local communities. Many communities lack criteria to guide the planning and design of storm drainage infrastructure.

## **APPENDIX A**

# **HAZARD MITIGATION INFORMATION**

## Appendix A - Hazard Mitigation Information

A variety of local, state, federal, and private agencies can provide assistance to a community in planning and implementing a mitigation program. Some agencies provide advice and guidance, some can help find the program, and some provide both technical and financial assistance.

**Chapter 3** identified which agencies can help on specific mitigation measures. This appendix provides a brief summary of the agencies' programs and notes where to contact the agency.

### A.1 Local and Private Agencies

#### A.1.1 International Conference of Building Officials (ICBO) Colorado Chapter

**Types of Assistance:** Provide assessments for disaster locations, and advice, development and improvement for building codes

**Eligibility:** Benefactors of building code information

Colorado Chapter ICBO  
950 South Birch Street  
Glendale, CO 80246  
303-639-3601 Fax 303-759-0561

#### A.1.2 Colorado Association of Stormwater and Floodplain Managers

**Types of Assistance:** Provide assessments for disaster locations, and advice, development and improvement for floodplain and stormwater management

**Eligibility:** All

Colorado Association of Stormwater  
and Floodplain Managers  
P.O. Box 22673  
Denver, CO 80222-0673  
c/o Susan Hayes (City of Fort Collins)  
970-221-6589 Fax 970-221-6239

### Other Local Governments

Other local governments are offer agreeable to cooperative efforts where a flood mitigation project can further their objectives. In addition to their primary concerns, river conservancy districts and drainage districts can construct drainage or flood control improvements. School districts initiate cooperative education and public information programs. Counties, cities, towns and fire districts often enter into mutual aid agreements to support each other during emergencies. These agreements can include loaning building officials and other staff to help with heavy workloads during recovery.

#### A.1.3 Urban Drainage and Flood Control District (UDFCD)

**Types of Assistance:** The Urban Drainage and Flood Control District was established by the Colorado legislature in 1969, for the purpose of assisting local governments in the Denver metropolitan area with multi-jurisdictional drainage and flood control problems. The District covers an area of 1608 square miles and includes Denver, parts of the 5 surrounding counties, and all or parts of 33 incorporated cities and towns. There are about 1600 miles of "major drainageways" which are defined as draining at least 1000 acres. The present population of the District is approximately two million people.

The District can help by documenting flood levels and the effectiveness of in-place structures. It can review or help prepare flood protection plans, master drainage plans, and flood control project designs. The UDFCD has emergency contingency funds that may be available for certain activities. For example, a recent project with the City of Arvada included the acquisition of approximately 100 mobile homes located in the Ralston Creek floodplain. The mobile homes have all been re-located and the floodplain and creek will be restored.

**Eligibility:** Participating communities in the UDFCD

Urban Drainage and Flood Control District  
2480 West 26th Avenue, Suite 156 B  
Denver, CO 80211  
303-455-6277 Fax 303-455-7880  
<http://www.udfcd.org>

#### A.1.4 City of Fort Collins Stormwater Utility

**Types of Assistance:** The Utility can help by documenting flood levels and the effectiveness of in-place structures. It can review or help prepare flood protection plans, master drainage plans, and flood control project designs. The Utility has emergency contingency funds that may be available for certain activities.

**Eligibility:** City of Fort Collins

City of Fort Collins Stormwater Utility  
235 Mathews  
P.O. Box 580  
Fort Collins, CO 80522-0580  
303-573-0444 Fax 970-221-6239

#### A.1.5 Association of State Floodplain Managers Floodplain Management Resource Center

**Type of Assistance:** The Association of State Flood-

plain Managers has established a Floodplain Management Resource Center located at the Natural Hazards Research and Applications Information Center. Documents are summarized and entered into a computerized bibliographic database. Topics include flood-proofing, arid west issues, stormwater management, and guidance for local officials. Most inquiries are handled by phone or by the Internet.

Floodplain Management Resource Center  
Natural Hazards Research & Applications Center  
Information Institute of Behavioral Science #6,  
Campus Box 482, University of Colorado  
Boulder, CO 80309-0482  
(303) 492-6818 Fax: 303-492-2151  
<http://www.Colorado.EDU/hazards>

#### **A.1.6 The Association of State Floodplain Managers**

**Types of Assistance:** The Association of State Floodplain Managers also publishes flood hazard reduction planning and implementation documents. In addition to proceedings from their annual conference. Members receive News and Views, their bi-monthly newsletter. For a list of publications, contact:

ASFTM Publications  
P.O. Box 2051  
Madison, WI 53701-2051  
608-249-0649

### **A.2 State Agencies**

#### **A.2.1 Department of Natural Resources, Colorado Water Conservation Board**

**Types of assistance:** Prepare flood documentation reports, mitigation recommendations. River rehabilitation and floodplain management. Advice and assistance on floodplain regulations, state floodplain permit requirements, and local responsibilities under the National Flood Insurance Program. Operate construction fund with 5% of total revenue available as low interest loans for floodplain management activities.

**Eligibility:** Local jurisdictions, agencies, boards, organizations and private sector.

Department of Natural Resources  
Colorado Water Conservation Board  
1313 Sherman Street, Room 721  
Denver, CO 80203  
303-866-3441 Fax 303-866-4474  
<http://www.dnr.state.co.us/water/flood>

#### **A.2.2 Department of Natural Resources Division of Water Resources**

**Types of Assistance:** Technical assistance for dams, flood control structures, water rights, and funding for emergency construction.

**Eligibility:** Local and regional jurisdictions, State agencies

Department of Natural Resources  
Division of Water Resources  
1313 Sherman Street, Room 818  
Denver, CO 80203  
303-866-3581 Fax 303-866-3589  
<http://www.dnr.state.co.us>

#### **A.2.3 Department of Natural Resources Colorado Geological Survey**

**Types of Assistance:** Cooperative program for natural hazard mitigation planning including GIS resources.

**Eligibility:** Local and regional jurisdictions, State agencies

Department of Natural Resources  
Colorado Geologic Survey  
1313 Sherman Street, Room 715  
Denver, CO 80203  
303-866-2611 Fax 303-866-2461  
<http://www.dnr.state.co.us>

#### **A.2.4 Department of Natural Resources Division of Wildlife**

**Types of Assistance:** Grants and technical assistance for impacts on wildlife and wetlands.

**Eligibility:** Local and regional jurisdictions, State agencies, individuals, and private sector

Department of Natural Resources  
Division of Wildlife  
6060 North Broadway  
Denver, CO 80216  
303-297-1192 Fax 303-294-0874  
<http://www.dnr.state.co.us>

#### **A.2.5 Department of Local Affairs Office of Emergency Management**

**Types of Assistance:** Offers financial and technical assistance as well as emergency training, planning and exercises services. Provides a coordinated state response and recovery program.

**Eligibility:** Local and regional jurisdictions, State agencies, organizations, boards and the private sector

Department of Local Affairs  
Office of Emergency Management  
15075 South Golden Road  
Golden, CO 80401  
303-273-1622 Fax 303-273-1795  
[www.state.co.us/gov\\_dir/Loc\\_Affairs](http://www.state.co.us/gov_dir/Loc_Affairs)

#### A.2.6 Department of Local Affairs Division of Local Government

**Types of Assistance:** Provides technical assistance for planning, land use, GIS service, resource coordination with universities and colleges, and packaging of grants for rural development

**Eligibility:** Local governments

Department of Local Affairs  
Division of Local Government  
1313 Sherman Street, Room 521  
Denver, CO 80203  
303-866-2156 Fax 303-866-4819  
[www.state.co.us/gov\\_dir/Loc\\_Affairs](http://www.state.co.us/gov_dir/Loc_Affairs)

#### A.2.7 Department of Local Affairs Field Services

**Types of Assistance:** Manages Community Development Block (non-entitlement) Grants, Energy/Mineral Impact Assistance Program, and Contiguous County Limited Gaming Impact funds

**Eligibility:** Local governments

Department of Local Affairs - Field Services  
1313 Sherman Street, Room 323  
Denver, CO 80203  
303-866-2771 Fax 303-866-2751  
[www.state.co.us/gov\\_dir/Loc\\_Affairs](http://www.state.co.us/gov_dir/Loc_Affairs)

#### A.2.8 Department of Local Affairs Division of Housing

**Types of Assistance:** Coordinates low to moderate housing grants

**Eligibility:** Local governments and non-profits

Department of Local Affairs - Division of Housing  
1313 Sherman Street, Room 521  
Denver, CO 80203  
303-866-2033 Fax 303-866-4077  
[www.state.co.us/gov\\_dir/Loc\\_Affairs](http://www.state.co.us/gov_dir/Loc_Affairs)

#### A.2.9 Department of Transportation

**Types of Assistance:** Response and repairs to emergencies plus damage reimbursement to federal-aid road systems

**Eligibility:** Jurisdictions with federal-aid road systems

Department of Transportation  
1325 South Colorado Blvd., Suite 770B  
Denver, CO 80222  
303-757-9536 Fax 303-757-9719

#### A.2.10 Colorado Department of Public Health and Environment

**Types of Assistance:** Manages State Revolving Fund for loans and grants to restore waste and wastewater facilities and drinking water projects. Provides damage and costs estimates for storm sewers, advise on

household waste issues, testing of water quality in landfills, mosquito spraying (if warranted), and activates the Crisis Management Center

**Eligibility:** Local and jurisdictions

Colorado Department of Public Health  
and Environment  
4300 Cherry Creek Drive South  
Denver, CO 80246  
303-692-3024 Fax 303-782-4969

#### A.2.11 Colorado Historical Society State Historical Preservation Office

**Types of Assistance:** Provides consultation on historical structures and archeological sites, technical advice on preservation methods and resources, and administers the State Historical Fund Grants, including Emergency Grants.

**Eligibility:** Local jurisdictions and non-profits, federal and state agencies

Colorado Historical Society  
State Historical Preservation Office  
1300 Broadway  
Denver, CO 80203  
303-866-3398 Fax 303-866-4464

#### A.2.12 Colorado Natural Hazards Mitigation Council (CNHMC)

**Types of Assistance:** Technical assistance for evaluation of projects and information on reducing and managing impacts from natural hazards

**Eligibility:** Local and regional jurisdictions, State agencies, organizations, boards and the private sector

Colorado Natural Hazards Mitigation Council  
C/o Office of Emergency Management  
15075 South Golden Road  
Golden, CO 80401  
303-273-1622 Fax 303-273-1795

#### A.2.13 The Natural Hazards Center, located at the University of Colorado, Boulder

**Types of Assistance:** The Natural Hazards Center, located at the University of Colorado, Boulder, Colorado, USA, is a national and international USA, is a national and international clearinghouse for information on natural hazards and human adjustments to hazards and disasters. This center can help by conducting literature searches, research projects, and quick response post-disaster studies or documentation. The Natural Hazards Center carries out its mission in four principal areas: information dissemination, an annual workshop, research, and library services. The Natural Hazards Center has a variety of resources available from the Internet, including:

- Introduction to the Hazards Center, its Services, and its Staff

- The Natural Hazards Center On-line Library Database
- Latest issues of the Natural Hazards Observer - their printed newsletter and Information on how to subscribe

**Eligibility:** Individuals, agencies, and organizations that are actively working to reduce disaster damage and suffering.

The Natural Hazards Center  
University of Colorado at Boulder  
Campus Box 482  
Boulder, CO 80309-0482  
303-492-6818 Fax: 303-492-2151  
<http://www.Colorado.EDU/hazards>

#### A.2.13 Colorado Soil Conservation Board

**Types of Assistance:** Acts as a state board of appeals for the districts. Administers and disburses funds for the purpose of assisting soil conservation districts. Acts in an advisory capacity with the districts. Coordinates the programs of all districts. Undertakes studies of watershed planning. Develops, implements and administers watershed flood prevention and underground water storage projects. Accepts grants, services and materials for conservation purposes.

**Eligibility:** Farmers and ranchers. Colorado's 78-soil conservation districts.

Colorado State Soil Conservation Board  
1313 Sherman Street, Room 219  
Denver, CO 80203  
303-866-3351 Fax 303-832-8106  
[Http://www.dnr.state.co.us/edo/soil.html](http://www.dnr.state.co.us/edo/soil.html)

### A.3 Federal Agencies

#### A.3.1 Consolidated Farm Services Agency (CFSA) under USDA U.S. Department of Agriculture

**Types of Assistance:** Emergency Conservation Program for rehab of farmland, debris removal, water conservation (CFSA will provide up to 64% cost share of project, balance to be funded by farmers or ranchers)

**Eligibility:** Eligible agricultural producers

Releasing commodities for shelter residents' meals, initiating disaster food stamps and providing school lunches for displaced students

**Eligibility:** Shelter residents and disaster victims

U.S. Department of Agriculture  
655 Parfet, Suite 301  
Lakewood, CO 80215  
303-236-2866 Fax 303-236-2879  
[Http://www.usda.gov](http://www.usda.gov)

#### A.3.2 Department of Interior (DOI) including Bureau of Indian Affairs (BIA) and U.S.

#### Geological Survey (USGS)

**Types of Assistance:** Repair and restore wildlife refuges. BIA welfare assistance to meet food and fuel needs of affected Tribes, and also snow removal, school repairs, and other assistance. Replacement and repair of USGS stream gauges and other damaged equipment (assistance varies with types of services)

**Eligibility:** Local and State governments and Indian tribes

U.S. Department of Interior (DOI)  
1849 "C" Street, N.W.  
Washington, D.C. 20240  
202-208-6416  
[Http://www.doi.gov](http://www.doi.gov)

Bureau of Indian Affairs (BIA)  
500 Gold S.W., 6th Floor  
Albuquerque, NM 87103  
505-248-7243 Fax 505-248-7210  
[Http://www.bia.gov](http://www.bia.gov)

U.S. Geological Survey (USGS)  
Building 53, Denver Federal Center  
P.O. Box 25046  
Denver, CO 80225  
303-236-4882 Fax 303-236-4912  
[Http://www.usgs.gov](http://www.usgs.gov)

#### A.3.3 Department of Labor (DOL)

**Types of Assistance:** Fund temporary jobs and provide cleanup assistance (assistance varies with type of services)

**Eligibility:** Dislocated workers, homeowners under Federal Weatherization Program and public entities

U.S. Department of Labor (DOL)  
1999 Broadway, Suite 1660  
Denver, CO 80202-5716  
303-844-1700 Fax 303-844-1615  
[Http://www.dol.gov](http://www.dol.gov)

#### A.3.4 Economic Development Districts (EDDs) under Department of Commerce (DOC)

**Types of Assistance:** Grants for preparing disaster mitigation plans, identifying potential projects, coordinating long term needs and projects (assistance 75% federal/ 25% sponsor cost share)

**Eligibility:** Local and State Governments

Economic Development Administration (EDA)  
1244 Speer Blvd.  
Denver, CO 80204  
303-844-4403 Fax 303-844-3968

#### A.3.5 Environmental Protection Agency (EPA)

**Types of Assistance:** EPA State Revolving Fund/

CWA low interest loans for restoring wastewater facilities and for drinking water projects. CBEP scientific analysis, monitoring systems, environmental information. EPA also offers technical assistance on wetlands, household waste and removal of tanks and drums. (CBEP - Technical assistance limited funding)

**Eligibility:** Cities and Towns

US EPA, Region 8 (EPR-PS)  
999 18th Street, Suite 500  
Denver, CO 80202-2466  
1-800-227-8917  
<http://www.epa.gov>

**A.3.6 Federal Highway Administration (FHWA)**

**Types of Assistance:** Reimbursement for repair of damaged federal-aid roads (assistance state match generally varies from 10% to 20%)

**Eligibility:** Local and State governments

U.S. Federal Highway Administration (FHWA)  
Region 8 (HRA-08)  
555 Zang Street, Room 400  
Lakewood, CO 80228  
303-969-6722  
<http://www.fhwa.dot.gov>

**A.3.7 Federal Emergency Management Agency (FEMA)**

**Types of Assistance:** (HMGP or 404) grants for Hazard Mitigation Assistance designed for long term mitigation projects (assistance up to 75% federal/25% sponsor cost share)

**Eligibility:** Local and State governments, nonprofit organizations and Indian Tribes

**Public Assistance PA** - Public Assistance grants designed to restore public infrastructure. Also funds cost-effective mitigation measures (assistance up to 75% federal/25% sponsor cost share)

**Eligibility:** Local and State governments, nonprofit organizations and Indian Tribes

**(FMAP) Grants** - Flood Map Assistance Program (assistance limited to planning and technical assistance)

**Eligibility:** NFIP jurisdictions in good standing

Federal Emergency Management Agency (FEMA)  
Region 8, Denver Federal Center  
P.O. Box 25267, Building 710  
Denver, CO 80225-0267  
303-235-4900 Fax 303-235-4894  
<http://www.fema.gov>

Federal Emergency Management Agency (FEMA)  
500 C Street, SW  
Washington, DC 20472  
<http://www.fema.gov>

**A.3.8 Health and Human Services (HHS)**

**Types of Assistance:** Serve and enroll children affected by floods

**Eligibility:** Head Start children

U.S. Health and Human Services (HHS)  
1961 Stout Street  
Denver, CO 80294-3538  
303-844-3372 Fax 303-844-4545  
<http://www.hhs.gov>

**A.3.9 Housing & Urban Development (HUD)**

**Types of Assistance:** Community Development Block Grant (CDBG) (assistance provides grants for a variety of projects)

**Eligibility:** Cities and counties

U.S. Housing and Urban Development (HUD)  
633 17th Street  
Denver, CO 80202  
303-672-5285 303-672-5028  
<http://www.hud.gov>

**A.3.10 Natural Resources Conservation Service (NRCS) - (formerly SCS) under U. S. Department of Agriculture (USDA)**

**Types of Assistance:** Emergency Watershed Protection - emergency repair of levees and structures, channel clearance and protection of eroding stream banks (assistance up to 75% federal/25% sponsor cost share)

**Eligibility:** Public and private landowners represented by a project sponsor (public agency)

**PL 566 - Small Watershed Protection Program** - construct flood protection projects and land treatment (assistance - 100% grants for structural projects, 75% for non-structural projects)

**Eligibility:** Local, regional, and State and governments

**Cooperative River Basin Program** - appraises water sheds and land resources for conservation planning (assistance limited to technical assistance)

**Eligibility:** Local, regional, and state and federal governments

U.S. Natural Resources Conservation Services (NRCS)  
U.S. Department of Agriculture (USDA)  
655 Parfet Street  
Lakewood, CO  
303-236-2903 Fax 303-236-2896

### A.3.11 Rural Economic & Community Development Services (formerly FmHA)

**Types of Assistance:** Soil and water loans to develop wells, terraces, waterways, control erosion and build dikes (assistance - 1% loans)

**Eligibility:** Owners and operators of farms and ranches

**HR 2667** - Emergency Farm Loans to assist where physical damage affects farming, ranching or aquaculture (assistance - 4.5% loans)

**Eligibility:** Farmers, ranchers, and aquaculture operators

Rural Economic & Community Development Services  
655 Parfet, Suite 301  
Lakewood, CO 80215  
303-236-2866 Fax 303-236-2879  
[Http://www.usda.gov](http://www.usda.gov)

### A.3.12 U.S. Army Corps of Engineers

**Types of Assistance: Section 206** - Floodplain management services for floodplain mapping, flood warning & preparedness planning and technical assistance (Cost share varies with types of services)

**Section 22** - Planning assistance to support any water resource issue analysis related to state water plan (50% federal/50% sponsor cost share)

**PL 84-99** - Rehabilitation of flood control structures damaged by flooding (Repair to pre-flood conditions; cost share may apply)

**Section 205** - Small flood control projects for flood prevention (projects up to \$5 million per project, 65% federal/35% sponsor cost share)

**Section 14** - Emergency stream bank and shoreline protection to prevent erosion from damage to public and nonprofit facilities (projects up to \$500,000; 65% federal/ 35% sponsor cost share)

**Eligibility:** Local and State governments, Indian Tribes, and water districts (in some cases)

U.S. Army Corps of Engineers  
Albuquerque District  
4101 Jefferson Plaza NE  
Albuquerque, New Mexico 87109-3435  
505-342-3283 Fax 505-342-3498  
<http://www.swa-wc.usace.army>

U.S. Army Corps of Engineers  
Albuquerque District  
Southern Colorado Project Office  
720 North Main Street, Suite 205  
Pueblo, CO 81003-3046  
719-543-9459 Fax 719-543-9475  
<http://www.swa-wc.usace.army>

U.S. Army Corps of Engineers  
Omaha District

215 North 17th Street  
Omaha, NE 68102  
404-221-4897 402-221-4856  
<http://www.swa-wc.usace.army>

U.S. Army Corps of Engineers  
Omaha District - Tri Lakes Project Office  
9307 State Highway 121  
Littleton, CO 80123-6901  
303-979-4120 Fax 303-979-0602  
<http://www.swa-wc.usace.army>

### A.3.13 U.S. Fish and Wildlife (USF&W)

**Types of Assistance:** Partners for Wildlife - provides funds for improvement, protection of fish and wildlife habitat on private lands (approximately 50% federal/50% sponsor cost share with USF&W providing supplies and landowner will to actual restoration) The Service administers Federal Aid grants to States for fish and wildlife restoration. The money for these programs does not come from general taxes, but from Federal excise taxes paid by hunters, anglers, and boaters on hunting and fishing equipment and motorboat fuels. In 1995, Colorado received \$4.9 million for sport fish restoration and \$5.2 million for wildlife restoration and hunter education from the Fish and Wildlife Service's Federal Aid program

**Eligibility:** Private citizens and corporations

U.S. Fish and Wildlife  
Region 8 Office  
134 Union Blvd.  
Lakewood, CO 80225  
303-236-7904  
[Http://www.fws.gov](http://www.fws.gov)

### A.3.14 U.S. Small Business Administration (SBA)

**Types of Assistance:** SBA disaster loans to help rebuild and recover after a disaster - assists in damaged real and personal property (low-interest, long-term loans at various terms Up to 20% additional loan for mitigation measures)

**Eligibility:** Homeowners, renters, businesses of all sizes and private nonprofit organizations

U.S. Small Business Administration (SBA)  
4400 Armos Carter Blvd. #102  
Fort Worth, TX 76155  
970-207-4588 970-207-4584  
<http://www.sba.gov>

## Additional Hazard Mitigation Information

### AMERICAN ACADEMY OF VETERINARY DISASTER MEDICINE

3910 Morehouse Road, West Lafayette, IN 47906. E-mail: seh@vet.purdue.edu.

### AMERICAN ENGINEERS FOR DISASTER RELIEF, INC.

P.O. Box 684, Princeton Junction, NJ 08550-0684. James Cohen, Trustee; (609) 730-0510; fax: (609) 730-0511 or 737-3714; e-mail: jccpc@msm.com.

### AMERICAN INSTITUTE OF ARCHITECTS

1735 New York Avenue, N.W., Washington, DC 20006. Kerry Lord; (202) 626-7383; fax: (202) 626-7365; e-mail: 47334@t-mail.telescan.com.

### AMERICAN METEOROLOGICAL SOCIETY

45 Beacon Street, Boston, MA 02108. Richard Hallgren, Executive Director; (617) 227-2425; fax: (617) 742-8718; e-mail: hallgren@ametsoc.org; WWW: <http://www.ametsoc.org/AMS>.

### AMERICAN PLANNING ASSOCIATION

122 South Michigan Avenue, Suite 1600, Chicago, IL 60603. William Klein, Director of Research; (312) 431-9100; fax: (312) 431-9985; e-mail: research@planning.org; WWW: <http://www.planning.org>.

### AMERICAN PSYCHOLOGICAL ASSOCIATION, DISASTER RESPONSE NETWORK

APA Practice Directorate, 750 First Street, N.E., Washington, DC 20002. Jan Peterson; (202) 336-5898; fax: (202) 336-5797; e-mail: jlp.apa@email.apa.org; WWW: <http://www.apa.org>.

### AMERICAN PUBLIC WORKS ASSOCIATION, EMERGENCY MANAGEMENT COMMITTEE

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### AMERICAN RED CROSS

National Headquarters, Disaster Services Department, 8111 Gatehouse Road, Second Floor, Falls Church, VA 22042. John Clizbe, Vice President; (703) 206-8672; fax: (703) 206-8835; 24-Hour Disaster Operations Center: (703) 206-8822; e-mail: infor@usa.redcross.org; WWW: <http://www.redcross.org>. [Note: Disaster information is provided by local Red Cross chapters. Requests sent to the national headquarters are referred to local chapters.]

### AMERICAN SOCIETY FOR PUBLIC ADMINISTRATION, SECTION ON EMERGENCY AND CRISIS MANAGEMENT

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### AMERICAN SOCIETY OF CIVIL ENGINEERS

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### AMERICAN WATER RESOURCES ASSOCIATION

950 Herndon Parkway, Suite 300, Herndon, VA 20170-5531. Kenneth D. Reid, Executive Vice President; (703) 904-1225; fax: (703) 904-1228; e-mail: awrahq@aol.com; WWW: <http://www.uwin.siu.edu/~awra>.

### APPLIED TECHNOLOGY COUNCIL

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### ARGONNE NATIONAL LABORATORY, EMERGENCY SYSTEMS GROUP

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### ASSOCIATION OF CONTINGENCY PLANNERS

National Headquarters, 421 North Rodeo Drive, Suite 15-565, Beverly Hills, CA 92010; (800) 445-4223. Charlie Fox, National Chairperson and CEO; (801) 246-2802. Mary Carido, National President, Regional Business Recovery and Mitigation; fax: (801) 246-2810; e-mail: mlc2resq@ix.netcom.com.

### ASSOCIATION OF ENGINEERING GEOLOGISTS

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### ASSOCIATION OF STATE DAM SAFETY OFFICIALS

450 Old East Vine, Second Floor, Lexington, KY 40507. Lori Spragens, Executive Director; (606) 257-5140; fax: (606) 323-1958; e-mail: damsafety@aol.com; WWW: <http://members.aol.com/damsafety/homepage.htm>.

### ASSOCIATION OF STATE FLOODPLAIN MANAGERS

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### ASSOCIATION OF STATE WETLAND MANAGERS

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1090 Vermont Avenue, N.W. Suite 700, Washington, DC 20005-4905. James R. Smith; (202) 289-7800; fax: (202) 289-1092; e-mail: [bssc@nibs.org](mailto:bssc@nibs.org); WWW: <http://www.nibs.org/bssc1.htm>.

#### **BUSINESS AND INDUSTRY COUNCIL FOR EMERGENCY PLANNING AND PREPAREDNESS**

P.O. Box 1020, Northridge, CA 91328. (213) 386-4524; fax: (818) 775-4879.

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c/o Emergency Management Agency, 125 North Main, Room 2B49, Memphis, TN 38103. James L. Johnson; (901) 528-2780; fax: (901) 576-6547 or 528-3711.

#### **CALIFORNIA SPECIALIZED TRAINING INSTITUTE**

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#### **CENTER FOR THE STUDY OF EMERGENCY MANAGEMENT**

1241 Johnson Avenue, Department 160, San Luis Obispo, CA 93401; (805) 782-6787; fax: (805) 782-6730; e-mail: [wbalda@simeon.org](mailto:wbalda@simeon.org); WWW: <http://www.simeon.org/msm.html>.

#### **DISASTER EMERGENCY RESPONSE ASSOCIATION INTERNATIONAL**

P.O. Box 37324, Milwaukee, WI 53237-0324. (970) 532-3362; fax: (970) 532-2979; e-mail: [disasters@delphi.com](mailto:disasters@delphi.com); WWW: <http://www.disasters.org/dera.html>.

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#### **INSTITUTE FOR BUSINESS AND HOME SAFETY (Formerly Insurance Institute for Property Loss Reduction)**

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#### **INSURANCE INFORMATION INSTITUTE**

110 William Street, New York, NY 10038. Jeanne Salvatore, Manager of Public Relations and Consumers; (212) 669-9200; fax: (212) 791-1807; e-mail: [IIIConsumer@aol.com](mailto:IIIConsumer@aol.com); WWW: <http://www.iii.org>.

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#### **INTERNATIONAL ASSOCIATION OF FIRE CHIEFS**

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#### **INTERNATIONAL CITY/COUNTY MANAGEMENT ASSOCIATION**

777 North Capitol Street, N.E., Suite 500, Washington, DC 20002-4201. (202) 962-3610; fax: (202) 962-3500; WWW: <http://www.icma.org>.

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1225 Eye Street, N.W., Suite 300, Washington, DC 20005. Susan Gilson, Executive Director; (202) 682-3761, ext. 239; fax: (202) 842-0621.

#### **NATIONAL CENTER FOR ATMOSPHERIC RESEARCH, ENVIRONMENTAL AND SOCIETAL IMPACTS GROUP**

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#### **NATIONAL CONFERENCE OF STATES ON BUILDING CODES AND STANDARDS**

505 Huntmar Park Drive, Suite 210, Herndon, VA 20170. Jill Moreschi, Communications Specialist; (703) 437-0100; fax: (703) 481-3596.

#### **NATIONAL COORDINATING COUNCIL ON EMERGENCY MANAGEMENT**

111 Park Place, Falls Church, VA 22046-4513. Elizabeth Armstrong, Executive Director; (703) 538-1795; fax: (703) 241-5603; e-mail: [nccem@aol.com](mailto:nccem@aol.com); WWW: <http://www.nccem.org>.

#### **NATIONAL EMERGENCY MANAGEMENT ASSOCIATION**

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#### **NATIONAL FIRE PROTECTION ASSOCIATION**

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#### **NATIONAL GOVERNORS ASSOCIATION, NATURAL RESOURCES GROUP**

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#### **NATIONAL INSTITUTE OF BUILDING SCIENCES**

1201 L Street, N.W., Suite 400, Washington, DC 20005. Philip J. Schneider, AIA Director, Earthquake Loss Estimation Methodology Study; (202) 289-7800; fax: (202) 289-1092; e-mail: [pschneider@nibs.org](mailto:pschneider@nibs.org); WWW: <http://www.nibs.org>.

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607 North Avenue, Suite 16, Wakefield, MA 01880. (617) 224-9876; fax: (617) 224-4350; e-mail: [nesec@serve.com](mailto:nesec@serve.com); WWW: <http://www.serve.com/NESEC>.

#### **OAK RIDGE NATIONAL LABORATORY, DISASTER MANAGEMENT AND MITIGATION GROUP**

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**PUBLIC ENTITY RISK INSTITUTE**

11350 Random Hills Road, #800, Fairfax, VA 22030.  
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**PUBLIC RISK MANAGEMENT ASSOCIATION**

1815 North Fort Myer Drive, Suite 1020, Arlington, VA  
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**SOCIETY FOR RISK ANALYSIS**

1313 Dolley Madison Boulevard, Suite 402, McLean, VA  
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com.

**STATE AND LOCAL EMERGENCY MANAGEMENT DATA  
USERS GROUP**

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65049. Mike McNeill, President; (573) 365-7373; fax: (573)  
365-2163 or 365-2581; e-mail: mmcneill@mail.  
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**URBAN AND REGIONAL INFORMATION SYSTEMS AS-  
SOCIATION**

900 Second Street, N.E., Suite 304, Washington, DC  
20002. Tom Palmerlee, Executive Director; (202) 289-  
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**VOLUNTEERS IN TECHNICAL ASSISTANCE, DISASTER  
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**CLARK UNIVERSITY, GEORGE PERKINS MARSH INSTI-  
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**CLEMSON UNIVERSITY, COASTAL HAZARDS ASSES-  
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**COLORADO STATE UNIVERSITY**

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**GEORGE WASHINGTON UNIVERSITY, INSTITUTE FOR  
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**NEW YORK MEDICAL COLLEGE, CENTER FOR PSY-  
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**SOUTHWEST TEXAS STATE UNIVERSITY, CENTER FOR  
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**TEXAS A&M UNIVERSITY, HAZARD REDUCTION AND  
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<http://ag.arizona.edu/OALS/oals/oals.html>.

**UNIVERSITY OF CALIFORNIA - BERKELEY**

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CA 94704-4704. Diane Wolcott; (510) 642-7537; fax: (510)  
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#### UNIVERSITY OF COLORADO - BOULDER

Natural Hazards Research and Applications Information Center, Campus Box 482, Boulder, CO 80309-0482. (303) 492-6818; fax: (303) 492-2151; e-mail: hazctr@colorado.edu; WWW: <http://www.colorado.edu/hazards>. Floodplain Management Resource Center, Natural Hazards Center, Campus Box 482, Boulder, CO 80309-0482. Dave Morton, Librarian; (303) 492-5787; fax: (303) 492-2151; e-mail: david.morton@colorado.edu; WWW: <http://www.colorado.edu/hazards>.

#### UNIVERSITY OF DELAWARE, DISASTER RESEARCH CENTER

Newark, DE 19716. Joanne Nigg and Kathleen Tierney, Co-Directors; (302) 831-6618; fax: (302) 831-2091; e-mail: joanne.nigg@mvs.udel.edu or tierney@udel.edu. Librarian: Susan Castelli; e-mail: Susan.Castelli@mvs.udel.edu; WWW: <http://www.udel.edu/DRC/homepage.htm>.

#### UNIVERSITY OF LOUISVILLE, CENTER FOR HAZARDS RESEARCH AND POLICY DEVELOPMENT

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#### UNIVERSITY OF NEBRASKA - LINCOLN, NATIONAL DROUGHT MITIGATION CENTER

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#### UNIVERSITY OF NEW ORLEANS, ENVIRONMENTAL SOCIAL SCIENCE RESEARCH INSTITUTE

Department of Sociology, New Orleans, LA 70148. Steve Kroll-Smith, Director; (504) 286-7390; fax: (504) 286-6468.

#### UNIVERSITY OF NORTH CAROLINA - CHAPEL HILL, CENTER FOR URBAN AND REGIONAL STUDIES

Campus Box 3410, Chapel Hill, NC 27599. William M. Rohe, Director; Mary Beth Powell, Associate Director; (919) 962-3076; fax: (919) 962-2518; e-mail: powell.curs@mhs.unc.edu; WWW: <http://www.unc.edu/depts/curs>.

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#### UNIVERSITY OF SOUTH CAROLINA, HAZARDS RESEARCH LABORATORY

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#### UNIVERSITY OF WISCONSIN, DISASTER MANAGEMENT CENTER

Department of Engineering Professional Development, 432 North Lake Street, Madison, WI 53706. Don Schramm, Director; (608) 262-5441; fax: (608) 263-3160; e-mail: dmc@enr.wisc.edu; WWW: <http://epdwww.enr.wisc.edu/dmcd/>.

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National Climatic Data Center, 151 Patton Avenue, Asheville, NC 28801. Primary public contact point and climatic data ordering service; (704) 271-4682; fax: (704) 271-4876; e-mail: ncdc@noaa.gov; WWW: <http://www.ncdc.noaa.gov>.

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National Centers for Environmental Prediction, Climate Prediction Center, W/NMC53, Room 805, World Weather Building, Washington, DC 20223. Richard Tinker, Editor, Weekly Climate Bulletin; (301) 763-4670; fax: (301) 763-8125; e-mail: [tinker@climon.wwb.noaa.gov](mailto:tinker@climon.wwb.noaa.gov); WWW: <http://nic.sb4.noaa.gov>.

High Plains Regional Climate Center, 242 L.W. Chase Hall, University of Nebraska-Lincoln, Lincoln, NE 68583-0728. Kenneth Hubbard, Director; (402) 472-6706; fax: (402) 472-6614; e-mail: [khubbard@hpcsun.unl.edu](mailto:khubbard@hpcsun.unl.edu).

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Northeast Regional Climate Center, 11th floor, 1123 Bradfield Hall, Cornell University, Ithaca, NY 14853. Warren Knapp, Director; (607) 255-1751; fax: (607) 255-2106; e-mail: [nrccl@cornell.edu](mailto:nrccl@cornell.edu); WWW: <http://met-www.cit.cornell.edu/>.

Southeastern Regional Climate Center, South Carolina Department of Natural Resources, 1201 Main Street, Suite 1100, Columbia, SC 29201. Michael R. Helfert, Director; (803) 737-0849; fax: (803) 765-9080; e-mail: [helfert@water.dnr.state.sc.us](mailto:helfert@water.dnr.state.sc.us); WWW: <http://water.dnr.state.sc.us/climate.sercc>.

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Office of Hydrology, Hydrologic Operations Division, Hydrologic Services Branch, Station 8144, W/OH22, 1325 East West Highway, Silver Spring, MD 20910. Edward R. Johnson or Glenn Austin; (301) 713-0006; fax: (301) 713-0963; e-mail: [edward.johnson@noaa.gov](mailto:edward.johnson@noaa.gov).

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[www.sbaonline.sba.gov/disaster/](http://www.sbaonline.sba.gov/disaster/).

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Directorate of Civil Works, Readiness Branch, CECW-OE, 20 Massachusetts Avenue, N.W., Washington, DC 20314. Edward Hecker, Chief; (202) 761-0409; e-mail: [hecker@inet.hq.usace.army.mil](mailto:hecker@inet.hq.usace.army.mil); WWW: <http://www.hq.usace.army.mil>.

Flood Plain Management Services and Coastal Resources Branch, 20 Massachusetts Avenue, N.W., Washington, DC 20314. (202) 272-0169; fax: (202) 272-1972; WWW: <http://www.hq.usace.army.mil/cecw/planni ng/main.htm>.

Hydrologic Engineering Center, 609 Second Street, Davis, CA 95616. Vern Bonner, Publications and Training; (916) 756-1104; fax: (916) 756-8250; e-mail: [bonner@hec61.wrc-ec.usace.army.mil](mailto:bonner@hec61.wrc-ec.usace.army.mil); WWW: <http://wrc-hec.usace.army.mil>.

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Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199. Office of Public Affairs; (601) 634-2502; WWW: <http://www.wes.army.mil/Welcome2.html>.

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Natural Resources Conservation Service (formerly Soil Conservation Service), P.O. Box 2890, Washington, DC 20013.

Community Assistance and Resource Development Division; (202) 720-2847; fax: (202) 690-0639.

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Earth Science Information Center, 507 National Center, Reston, VA 20192; (703) 648-6045; fax: (703) 648-5948; e-mail: [esicmail@usgs.gov](mailto:esicmail@usgs.gov); WWW: <http://mapping.usgs.gov/esic/esic.html>.

Earth Resources Observation Systems Data Center, 1608 Mountain View Road, Rapid City, SD 57702. (605) 594-6151; fax: (605) 594-6589; e-mail: [custserv@edcserver1.cr.usgs.gov](mailto:custserv@edcserver1.cr.usgs.gov); WWW: <http://edcwww.cr.usgs.gov/>.

Library, USGS National Center, MS-950, Reston, VA 20192. Information Desk: (703) 648-4302 or 648-4303; e-mail: [library@usgs.gov](mailto:library@usgs.gov); WWW: <http://www.usgs.gov/education/library.html>.

Library, Special Video Collections, MS-955, 345 Middlefield Road, Menlo Park, CA 94025. Michael Moore; (415) 329-5009.

National Landslide Information Center, MS-966, P.O. Box 25046, Federal Center, Denver, CO 80225-0046. Lynn M. Highland, Director; (800) 654-4966; fax: (303) 273-8600; e-mail: [nlic@usgs.gov](mailto:nlic@usgs.gov); WWW: [http://gldage.cr.usgs.gov/html\\_files/nlicsun.html](http://gldage.cr.usgs.gov/html_files/nlicsun.html).

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Photographic Library, MS-914, P.O. Box 25046, Federal Center, Denver, CO 80225-0046. Joe McGregor, Librarian; (303) 236-1010.

Public Affairs Office, MS-119, National Center, Reston, VA 20192. Don Kelly; (703) 648-4460.

Public Affairs Office, Western Region, 345 Middlefield Road, MS-144, Menlo Park, CA 94025. Pat Jorgenson; (415) 329-4011; fax: (415) 329-4013; e-mail: [pjorgenson@isdmal.wr.usgs.gov](mailto:pjorgenson@isdmal.wr.usgs.gov).

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USGS Information Services (Maps, Professional Papers, and Circulars), Box 25286, MS-306, Federal Center, Denver, CO 80225. (303) 202-4700 or (800) 435-7627; fax: (303) 202-4693.

USGS Information Services (Open-File Reports Section),

P.O. Box 25286, MS 517, Federal Center, Denver, CO 80225; (303) 202-4210; fax: (303) 202-4695.

U.S. Public Health Service, Office of Emergency Preparedness, National Disaster Medical System, Room 4-81, 5600 Fishers Lane, Rockville, MD 20857. Robert Knouss; (301) 443-1167 or (800) 872-6367; fax: (800) 872-5945.

**APPENDIX B-1**

**SUMMARY OF CWCB COMMUNITY  
QUESTIONNAIRE COMMENTS**

# **Appendix B-1**

## **SUMMARY OF CWCB COMMUNITY QUESTIONNAIRE COMMENTS**

### **December 16, 1997**

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#### **INTRODUCTION**

This paper summarizes comments contained in the Community Questionnaires and makes recommendations to be considered by the CWCB and Steering Committee.

#### **STATEWIDE ISSUES**

- The most common issue is the source of funding to conduct studies, for mitigation, and building projects. Generally, staff members of local units of government believe their constituents are not interested in or financially capable of supporting any more taxes, mill levees, etc. Low interest loans were given mixed review but are generally more desirable than any local source of funding.
- The need for engineering and planning assistance to support community leaders in decision making processes and conducting local investigations was the second highest issue of concern. Several communities spoke of the impacts of down sizing of staff and budgets while simultaneously being asked to provide even more services. Some communities have been severely affected by this action. One county's assessed valuation has been reduced 5 fold. Needless to say, there is no local support for any increased taxes.
- The National Flood Insurance Program's Flood Insurance Rate Maps are out of date, difficult to relate to local topography, and do not have elevation information. A related issues has to do with the lack of any mapping in areas that are experiencing urban growth. This kind of information needs to be updated making it more relevant for communities to use in assisting and informing the public. There exists confusion on this purchase and benefits of the NFIP.
- Generally, there is a lack of understanding of the importance of floodplains, rules and regulations, and enforcement by local communities. This tends to be in direct relationship to the size of the community. However, there are exceptions. This may relate to a lack of understanding of CWCB role to provide support to local communities.
- Community officials and the public welcome a multi-use approach in the management of the state's stream corridors and floodplain areas.

## REGIONAL ISSUES

- Communities located in the eastern "high plains" area tend to perceive the threat of flooding differently than communities located along a defined drainage, stream, or river. To eastern communities, their major problem is dealing with local drainage from spring and summer thunderstorms. Most of their concerns were regarding installing and maintaining their storm drainage infrastructure, whereas communities located in the foothills and mountain regions are concerned with spring snowmelt and flash flood events.
- Communities located along major streams under the jurisdiction of federal and state regulations expressed frustration about the amount of "red tape" required to address even the smallest problem on such a stream. For large communities having knowledgeable staff, this can be addressed much more effectively than a small community with little staff resources to focus on such permit requests. In short, don't tell us what we can do, but help us!
- Communities with federal agencies as their neighbors expressed frustration with the lack of interest by the federal government in working together to solve problems. The term "unfunded mandate" was used more frequently by representatives in this category than any other.

## LOCAL ISSUES

- Several community representatives said they did not believe some of their elected officials really had 'bought in' to the concept of regulating development in the floodplain, especially enforcement of rules and regulations. This maybe an example where private property rights and regulating for the public good "collide" without better communication and understanding at the local level. A well planned and functional steam corridor management program will actually help protect private property from flooding and enhance its value within the environmental community.
- The turnover of local board members can result in priorities being changed every time there is an election. The lack of continuity, particularly in dealing storm water management and flood control measures, can leave communities very vulnerable during times of need. The same level of commitment by most communities to provide fresh, potable water to residents and collect "used" water for subsequent treatment, is needed to deal with storm water and floodplain management.
- Many communities in Colorado are experiencing significant growth. Associated with this are demands upon local government resources to provide information and make decisions affecting that development. Most local government resources are unable to meet this demand at the level expected. As a result, decisions maybe made and actions taken that are not in the best interest of the residents of the community for the long term in providing for a safe community.

## RECOMMENDATIONS

### Information

1. The data base containing a list of contact persons needs to be maintained. A letter, with a post card enclosed, should be sent out annually to the current address list. The post card could request any updated information be indicated on the card and returned to CWCB to update the data base.
2. Form a task force of local, state, and federal agencies to share relevant information, such as GIS data bases to create "layers of data" which can be used by local communities to update current stream corridor information.

### Planning

1. Challenge communities to view stream corridor management as an important part of their local government responsibility. Provide examples of Colorado communities who have successfully used nontraditional approaches to stream corridor management. This may need to be done at workshops held around the state where "scholarships" to the workshops are provided to all communities to enable everyone in appropriate positions to attend.
2. Purchase GPS equipment which can be used to determine elevations at a level of accuracy to be useful in determining 100 yr. flood elevations. Enter into contracts with college students who are in surveying classes at the colleges and universities to do the field work during the summer months. Develop a common data base, and methodology of how this data is collected so it can be accessed by the public.
3. Evaluate steam corridors on a watershed basin approach. Development in the upper portion of a watershed contributes to management problems to down stream residents. Local remedies to problems, unless done in a coordinated fashion with an understanding of the entire watershed, may create more problems than are solved.

### Implementation

1. Utilize private sector resources including manpower, technical resources, and "community spirit" to implement well thought out steam corridor management solutions. Corporate sponsorship of certain stream reaches may be considered, similar to the highway R-O-W trash clean up sponsorship programs, with a tax reduction incentive added.

2. The statewide revolving loan fund received the greatest level of interest other than federal or state grants. It is recommended that a statewide revolving loan fund mechanism be established with an initial amount money to indicate a viable program for the purposes of formulating and/or implementing multi-objective inspections and creating solutions to reduce flood damage and stream rehabilitation. Priorities should be given to those communities which have the greatest need. A needs rating program should be established to enable those communities to be selected.
3. Develop a statewide drainage handbook, including hydrology for varied Colorado conditions, to assist communities.
4. Utilize private property ownership along stream corridors to establish long term multi-objective projects. Obtain easements for such projects through a financial package attractive to the land owner.
5. Select one a watershed in each of the seven major river basins, and develop a pilot program to showcase what can be done through watershed level, multi-objective approaches to stream corridor management. Selections should consider the more critical stream reaches so solutions that produce the most results to watershed residents are clearly evident. Examples of watersheds to be considered could include Fountain Creek in the Arkansas River Basin, and North Fork of the Gunnison, Mainstem of the South Platte River, Animas River, Elk River, and Roaring Fork River.

#### Regulatory

1. Need definitions in the appropriate language such as defining the "base flood" and "critical facilities". The "base flood" for all floodplains/stormwater regulatory management activities shall be 100 year return frequency. For "critical facilities", the 500 year return frequency shall be used. "Critical facilities" shall include all facilities, except for public roads, necessary to maintain the health and safety of the community's intra systems. Examples are: public water supply and waste water treatment facilities, law enforcement and fire protection facilities, hospitals, etc.
2. A statewide flood detention policy should be instituted. This policy would establish a statewide requirement that all **increased** storm runoff shall be detained. The legislative provisions shall include:
  - a. CWCB will draft a model storm water detention ordinance by December 31, 1998.
  - b. Local jurisdictions and quasi-governmental organizations shall adopt ordinances, based upon the model ordinance, by June 30, 1999.
  - c. Baseline hydrologic conditions shall be defined as those site hydrologic conditions existing as December 31, 1998.

- d. Local city and county governments shall adopt a hydrology procedure by July 1, 2000. CWCB should approve all hydrology procedures for consistency and uniformity, prior to their adoption by the community.
3. Obtain legislative authority to establish a Colorado State Wetland Bank, with membership from all state agencies. This bank would create wetland accounts and groundwater recharge accounts to assist development of wetlands within stream corridors. These accounts would be confined with in specific major river basins.
4. Amend state and local government statutes regarding the formulation of improvement districts for floodplain project and stream corridor projects.

#### **CATEGORIZE THE SURVEY RESPONSE ON THE QUESTIONNAIRE EFFECTIVENESS**

- Comments by some responders of the purpose for the questionnaire. Some thought it was a marketing effort by MWE instead of a mechanism to obtain information for CWCB to develop a program for the Colorado legislature.
- Questionnaire was somewhat unclear to communities in eastern Colorado who do not have stream/floodplain problem. Instead they deal with local flooding problems from thunderstorms.
- Another survey! Don't have time to complete.
- Several "major players" representing communities who regularly deal with flooding and storm water issues have not responded, in spite of several follow up phone calls from MWE. Due to large, demanding daily workloads no time was available for this questionnaire.
- CWCB list of contacts, including names, addresses and phone numbers was surprisingly out of date. It appears the contact list was at least three years old, judging by the comments of those who did respond. **This type of information is vital to staying in touch with local communities. Some procedure should be established to keeping this current.**
- Several communities asked if they could receive a copy of the summary of the questionnaire because they had an interest in this project and want to assist.

**APPENDIX B-2**

**TABLE B2-1**  
**FIELD SURVEY RESULTS**

## Appendix B-2

Table B2-1  
FIELD SURVEY RESULTS

ITEM	SURVEY RESULTS FROM QUESTIONNAIRES
<b>COMMUNITY PROFILE</b>	
Enforcement of Floodplain Regulations (Includes Encroachment into Floodplains)	26 communities and 13 organizations indicated there was a problem with development in the floodplain or floodplain regulation enforcement.
Desire for Public Education	3 organizations indicated there was a need for public education concerning flooding problems.
Need/Desire for Technical Assistance	21 communities and 7 organizations indicated there was a need for technical assistance.
<b>FLOODPLAIN MANAGEMENT</b>	
Mitigation Losses - Up to Present	Community respondents cited a total of 1,856,000 ft (350 miles) and 1250 acres of stream erosion damage. See Figure V-1 for a statewide extrapolation.
Flood Damage - Historical	Communities indicated a total of \$185 million in historical flood damage.
Floodplain Mapping Needs	493 miles - mixture of new, revised, and updated miles. 11 organizations stated there were unmapped reaches, but did not quantify them. See Figure V-1 for a statewide extrapolation.
<b>SINGLE PURPOSE PROJECTS</b>	
Need for Flood Damage Reduction Project (Single Purpose Projects)	81 communities said yes there was a need for flood damage reduction projects while 16 said there was no need.

ITEM	SURVEY RESULTS FROM QUESTIONNAIRES
<b>MULTI-OBJECTIVE PROJECTS</b>	
Wetlands Management Needs/Opportunities for Development, Enhancement, Preservation	45 communities thought there were needs/opportunities and 18 organizations indicated the needs/opportunities.
Needs/Opportunities for Open Space Enhancement	54 communities though there were needs/opportunities, while 19 organizations did.
Needs/Opportunities for Multi-Objective Projects	Communities - 70 said yes 34 said no Organizations -20 said yes 1 said no
<b>INSTITUTIONAL ISSUES</b>	
Watershed Planning Needs Master Framework Planning for Basins	19 communities indicated a need for, or update of, drainage master plans.
Need for Drainage Criteria Manual & Detention Policy with Uniform Criteria for Flood - Critical Facilities, Detention	55 communities indicated a need for a drainage criteria manual and 52 indicated there was no need.
Existing Funding Mechanism	30 communities stated they an existing funding mechanism and 85 said they did not have a funding mechanism or it was inadequate.
Type of Existing Funding Mechanism	See Table IV-3 for a listing of funding implementation preferences.
Future Funding Sources (Top Three Funding Sources Preferred)	The numbers below indicate how many communities preferred these funding sources 49 - Statewide Revolving Fund 24 - Storm Drainage Utilities 21 - Storm Drainage Fees
Need for Statewide Storm Drainage Criteria Manual	68 communities indicated a need for a statewide storm drainage criteria manual and 35 communities did not.

# STREAM CLASSIFICATION

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A SCREENING METHOD  
FOR COLORADO STREAMS

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# STREAM CLASSIFICATION

## A SCREENING METHOD FOR COLORADO STREAMS

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### INTRODUCTION

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River and stream corridors in Colorado occur in some of the most diverse terrain of the North American continent. From mountains to high plains, nearly the full range of river process are evident in the Colorado landscape. Likewise, Colorado's river and stream corridors are heavily utilized providing botanical, wildlife, and recreation environments.

Often the backdoor of many communities in the past, river environments are now integrated into new development and being upgraded to higher land values. In many cases, an improved river environment is a direct economic stimulus to community development. At the same time, the natural environment of river has been recognized as a limited resource with a complex ecology.

Rivers are also one of the great natural hazards to residents of Colorado. Floods routinely inflict significant damage to property and result in death and injury. Erosion of stream banks can degrade the environment of a stream channel, reducing the quality of the corridor as well as causing property damage. Control of flood damage continues to be a significant challenge for communities throughout Colorado.

So it is clear that rivers and streams in Colorado are both an opportunity and a hazard. By their nature, rivers are dynamic accomplishing the work of wearing away the earth's surface and transporting it to the sea. The landscape we see in Colorado today is testimony to the diversity of erosion processes. It is important in managing rivers to appreciate that change is essential over time, and that planning needs to anticipate such change.

It is often difficult to make decisions regarding the resources of a community or the State when significant uncertainty is present. The management of rivers is such a case. Not only do rivers flood, but they may change course (either gradually or suddenly). To invest wisely in the long-term management of rivers means balancing the risks against the potential improvements to river resources.

The following stream classification presents a simple method to identify risk in river management projects. Once the risk associated with a project is identified then it can be compared to potential benefits. The comparison of risk to benefits is subjective since quantification of project benefits typically does not tell the whole story. It is not the purpose of this method to elaborate on the many and various benefits that can be obtained in a river corridor, but simply to identify risk.

It is expected that the primary uses of the classification method will be in early screening of projects to determine feasibility, and for prioritization of funding.

## STREAM CLASSIFICATION

There are three general patterns of streams in nature: straight, meandering, and braided. These pattern names are hydrologic shorthand used to describe what is in reality a continuum of channel form. ~~So~~ there are many variations on each pattern, and patterns that are in between. What is known is that meandering streams occur as part of landscapes that are low gradient with low bed-load transport, and that braided streams occur in steep gradient, high bed-load transport landscapes. Schumm and Meyer (1979) used the relationship of grade and bed-load transport to identify five types of stream forms (Figure 1). Streams become less predictable as they transition from straight to meandering to a braided pattern.

The bed-load transport is a function of channel velocity and bed material size. The mode of bed material transport changes from mostly bed material transport to mostly suspended material transport as velocity increases. Laursen (1960) identifies the limits of each mode of transport as follows:

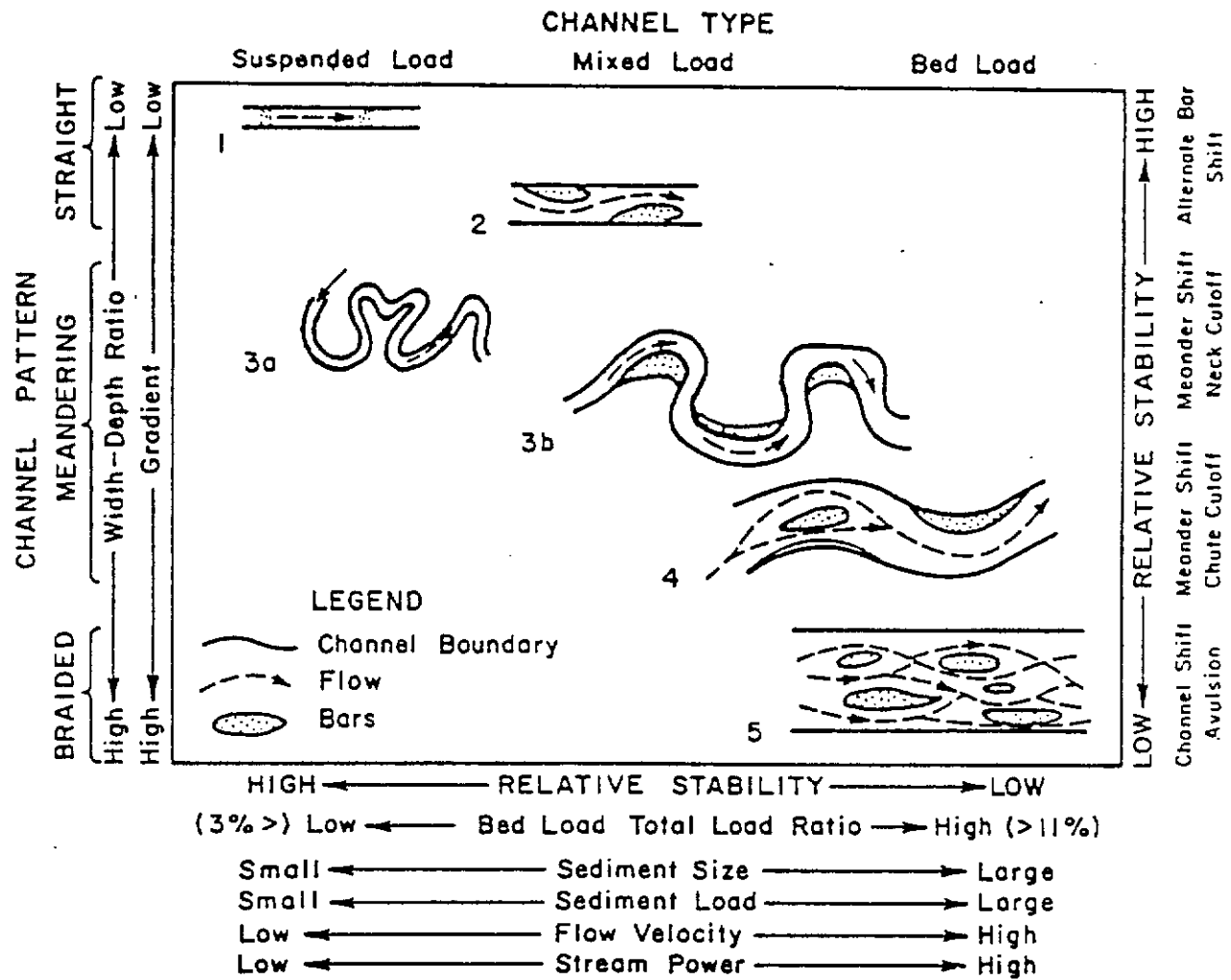
Table 1. Modes of Bed Material Transport

U./w	Transport Mode
< 0.50	mostly contact bed-load transport
0.50 to 2.0	mix of suspended and contact bed-load transport
> 2.0	mostly suspended bed-load transport

where U. is the shear velocity ( $= (g d S)^{0.5}$  where g is the acceleration of gravity, 32.2 ft/s<sup>2</sup>; d is the mean depth of flow, ft; and S is the slope of the energy grade), and w is the fall velocity, ft/s. The shear velocity can be thought of as the near bed velocity in a channel and is logarithmically proportional to the mean velocity of the flow. The fall velocity of bed material in the range of fine sand to gravel is given in Appendix 1. For stream classification, the shear velocity is based on estimation of a dominant discharge. Methods for determination of dominant discharge are given in Appendix 2.

$$U = \frac{R^{1/6}}{\sqrt{g n}}$$

Figure 1. Channel Classification showing relative stability and types of uncertainty encountered with each pattern.



## STREAM TYPES

The stream types shown in Figure 1 constitute the five base classifications (referred to by the notation ST-1 to ST-5). The classification relates the fundamental variables of alluvial channel dynamics: water discharge, sediment transport, bed-material size, and stream grade to relative channel stability. The following are brief descriptions of each stream type.

### Stream Type ST-1

**General Description:** Straight channel pattern with mostly suspended bed-material sediment transport. The stream bed profile has riffle-pool sequences. These are low-power streams that are easily diverted from a straight alignment by topographic constraints.

**Comment:** In natural channels, a straight channel pattern indicates a stream with a meander wavelength much larger than the normal 10 to 14 times stream width (see EQ.4, Stream Channel Geometry). Straight streams show distinct oscillation in the channel bed in the form of riffle-pool sequences. A straight channel will contain a succession of riffles and pools (at about 5 to 7 time the channel width) around each bend. Bends occur because the stream is confined between valley bluffs which divert the stream back and forth across the valley floor. In this case, the sinuosity of the stream should be estimated as the sum of riffle to riffle distances.

Relative Stability: Stable

Uncertainty: Slight, shifting of riffle-pools within channel

Sinuosity, P: 1.0 - 1.05

### Stream Type ST-2

**General Description:** Straight channel pattern with a mixed sediment transport mode (contact and suspended bed-material sediment transport). This stream type is slightly more powerful compared to ST-1 and possesses pre-meandering features such as longitudinal and medial bars. These streams ~~that~~ are easily diverted from a straight alignment by topographic constraints.

**Comment:** Straight channels with a mixed sediment transport show some lateral as well as vertical oscillation in the channel bed. Lateral features are in the form of alternate bars or dissected riffles indicating an increase in the organization and power of secondary currents. However, these channels are still too low-powered to produce a lateral oscillation in the stream bank.

Relative Stability: Stable

Uncertainty: Slight, shifting of alternate bars within channel

Sinuosity, P: 1.0 - 1.05

#### Stream Type ST-3a

General Description: Meandering channel pattern with mostly suspended sediment transport. Characteristics of this stream type is a uniform width channel with regular meanders that are well incised. Point bars are small and uniform.

Comment: River meanders are the result of secondary currents that exist in channels and are most pronounced at bends. Meanders are the result of higher power, and meandering streams actively migrate as the result of selective bank erosion and point bar formation. Irregularities in the natural terrain and sedimentation (formation of bars) strongly affect the meandering course. Meander sinuosity and section depth increase with high silt-clay contents in the perimeter sediments.

Relative Stability: Stable to Moderately Unstable

Uncertainty: Moderate, meander migration and neck cutoff

Sinuosity, P:  $> 1.25$

#### Stream Type ST-3b

General Description: Meandering channel pattern with mixed contact and suspended sediment transport. This stream type has a lower silt-clay content, resulting in a shallower channel section and a additional width at channel bends.

Comment: This stream type is the lower silt-clay content variation of stream type ST-3a. Point bars are distinct features of the stream pattern, but chute development is rare.

Relative Stability: Stable to Moderately Unstable

Uncertainty: Moderate, meander migration and neck cutoff

Sinuosity, P: 1.05 - 1.26

#### Stream Type ST-4

General Description: Meandering channel pattern with mostly contact sediment transport. This stream type is more irregular in its width, islands and chutes are more likely to occur. Two meandering frequencies may occur together leading to a different sinuosity at low water.

Comment: This stream type is the near limit of stability for the meandering channel form. Medial bars and chutes are more frequent. Channel incisement increases with higher silt-clay content, channels are wider and shallower at lower silt-clay content. Two meander wavelengths can occur in the same channel with a low-flow meander occurring within main channel. Point bars are the primary feature of the stream pattern, and chute development is common.

Relative Stability: Moderate to Low

Uncertainty: Moderate, meander migration and chute cutoff

Sinuosity, P:  $> 1.25$

#### Stream Type ST-5

General Description: Braiding channel pattern with mostly contact sediment transport. This stream type consists of multi-threaded channels. As the power of the stream increases the complexity of the braiding pattern increases.

Comment: Braided streams occur as the result of large or significant changes in slope, stream flow, or sediment load. Multiple flow paths exist in braided streams and individual paths are uncertain and often change in a response to major flows. There is continual spatial variation in braided streams with bars and islands being formed and destroyed at a high frequency. During major floods old channels can be suddenly reoccupied or new channels formed resulting in a channel avulsion. At high stream power, a transition from a meandering, single-thread stream (ST-4) to braided stream can occur.

Relative Stability: Low

Uncertainty: High, channel movement and channel avulsion

Sinuosity, P: 1.05 - 1.25

## CONSTRAINTS

There are several types of natural constraints on stream form including: geologic, topographic, sedimentologic, and botanical. The degree to which a constraint affects a stream type depends on the relative power of the stream, and the time scale involved. In the short-term, there are many constraints on stream form, while on a geologic time scale stream erosion and sedimentation eventually surpasses nearly every control. The time frame pertinent to river management is 50 to 100 years which is short on a geologic time scale. Many controls are affective for less powerful streams and diminish in importance as stream power increases.

### GEOLOGIC

Geologic controls can occur in two types: incisement into bedrock, or control of channel grade by a protrusion of bedrock across the valley. Bedrock channels are typically found in steep valleys where sediment transport significantly exceeds sources of sediment. Geologic grade controls can be found in nearly any type of terrain and can often be identified by other bedrock outcrops in the valley floor. The influence of geologic controls varies with the durability of the rock formation ranging from hard granites to more erodible sandstone and shale.

### TOPOGRAPHIC

Narrow, well defined valleys are capable of confining stream flow to within the limits of the valley walls. For less powerful streams, confinement may occur due to smaller features that are the remnants of large flood, debris flow, or land slide events. The more powerful the stream the deeper the valley that is needed to confine the stream.

### SEDIMENTOLOGIC

Streams may be confined to boulder bed channels that are the remnants of post-glacial wash outs or catastrophic flood events. The stream occurs within stable boulder beds that have a threshold for movement that exceeds the present flood hydrology. This constraint is similar to bed rock incisement of the stream. In a related case, a cobble bed channel may overfit the larger boulder-bed channel.

Stream sediments may become exhausted in denuded watershed. That shows as altered grade and sediment size in a reach that is uncharacteristic for steeper terrain. This is most common in mountain streams where the geology of the watershed is very resistant to erosion or catastrophic erosion has taken place.

### BOTANICAL

Large vegetation can locally effect the channel alignment and influence stream pattern. In particular, large trees either as a mass of debris, or as individual spars or root wads can redirect flow in bends. The regularity of stream meanders varies with relative stream power and vegetative debris size. For low stream power, vegetation may dominate the channel section and bank, increasing the stability of the bed and banks over the stability of the perimeter soils.

Channels with vegetated banks tend to be deeper and narrower. An effect that is similar to an increase in the silt-clay content of the channel perimeter soils.

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## STREAM FORM

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Channel pattern can be predicted based on the channel grade, discharge, and bed-material size. The thresholds in channel pattern are slightly different between streams with sand versus gravel bed-material. Sand-bed streams have bed-material gradations that are predominantly in the range of particle sizes from 0.062 mm to 2.00 mm (greater than a No. 200 sieve and less than a No. 10 sieve). The gradation of gravel-bed streams is in the range of 2.00 mm to 64 mm (greater than a No. 10 sieve and less than 2.5 inches).

Estimation of channel grade and discharge are extremely important issues in channel pattern prediction. Methods for estimation channel grade and discharge are discussed in detail in separate appendices. It is also important to keep in mind that these relationships are empirical and that there is significant scatter

### SAND-BED CHANNEL

Lane (1957) studied the characteristics of braiding and meandering streams. He conducted his analysis on sand-bed streams with meandering and braiding pattern, and derived two equations that partition the entire range of channel pattern. For meandering channels, Lane concluded, based on regression analysis, that a threshold relationship between slope and discharge was defined:

$$S = 0.0017 Q^{-0.25}$$

*Handwritten note:*  $Q^{1/4}$  ~ ~ ~

EQ.1

where S is the channel slope, Q is the mean annual discharge in cfs. Streams plotting below this equation should be meandering.

For braided streams, the threshold relationship between slope and discharge was:

$$S = 0.010 Q^{-0.25}$$

EQ.2

Streams plotting above this curve should be braided. The area between these two curves is characterized as a zone of transition between braiding and meandering.

### GRAVEL-BED CHANNEL

Leopold and Wolman (1957) found a similar relationship for meandering and braided gravel-bed streams as that of Lane for sand-bed channel. Their fit of the threshold between meandering and braided streams was given by the equation:

$$S = 0.060 Q^{-0.44}$$

EQ.3

Streams plotting below the curve are considered meandering, and those above the curve braided.

## STREAM CHANNEL GEOMETRY

The geometry of a stream channel is described by its alignment (sinuosity), width (distance between stream banks), and depth (distance from top of bank to stream bed). Stream geometry is determined by the sediment and water moving through the channel. As with stream pattern, there are empirical relationships that have been developed that relate water and sediment discharge to stream geometry.

### SINUOSITY

Schumm (1968) found that meander wavelength ( $L$  in feet) is related to mean annual discharge ( $Q_m$  in cfs) and the mean percentage of silt and clay (particle sizes smaller than the No. 200 sieve, 0.074 mm) forming the channel perimeter,  $M$ .

$$L = 1890 Q_m^{0.34} M^{-0.74} \quad \text{EQ.4}$$

The relationship of channel width to meander wavelength (Leopold and Wolman, 1960) is approximately:

$$L = 4 \pi W \quad \text{EQ.5}$$

This is closely related to riffle-pool wavelength ( $2\pi W$ ), because in a regular meander bend there are two riffle-pool cycles to one bend with pools at the apices and riffles at the inflections. Meander wavelength and radius,  $r_c$ , are also related:

$$L = 4.70 r_c^{0.98} \quad \text{EQ.6}$$

(Leopold and Wolman, 1960), and therefore  $r_c = 2 - 3 W$ .

The general alignment of meandering channels is a complex succession of irregular and compound bends. There are usually numerous topographic and geologic effects on the alignment.

### WIDTH AND DEPTH

All available evidence indicates that the greater the quantity of water that moves through a channel, the larger the cross section of that channel. Schumm (1968) produced the following relationships for channel width and depth (in feet):

$$W = 37 Q_{ma}^{0.38} M^{-0.39} \quad \text{EQ.7}$$

$$d = 0.60 Q_{ma}^{0.29} M^{0.34} \quad \text{EQ.8}$$

At a given discharge, channels with a high silt-content in the banks are narrow and deep in cross-section, while those with sandy, erodible banks are wide and shallow. The ratio of channel width to depth is called the channel form ratio,  $F$ . From EQ. 7 and 8, the form ratio is given by the following relationship:

$$F = 61.6 Q_{ma}^{0.09} M^{-0.73}$$

EQ.9

This relationship indicates that the form ratio increases slightly downstream, but that the major control of channel shape is due to sediment transport. Channels that are stable (Schumm, 1960) will plot close to form factor relationship, while aggrading channels are relatively wider and shallower (plotting above the curve) and degrading channels are relatively narrower and deeper (plotting below the curve).

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## GEOMORPHIC RISK

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Stream instability, either as lateral migration, deposition, or scour, is the prevailing geomorphic hazard for river corridors. The following procedure uses geomorphic relationships for stream form and channel geometry to determine the type and condition of the stream. The approach is to evaluate a river corridor at several scales, beginning with an assessment of large scale features and then focusing on local conditions.

### METHODOLOGY

The methodology consists of three steps:

- 1) Identify the geomorphically active area;
- 2) Determine the chance of instability hazards; and
- 3) Assess the damages in the stream corridor.

### GEOMORPHICALLY ACTIVE AREA.

Data on the lateral extent of the geomorphically active stream environment can be gathered from published topographic, soils, and geology maps and other sources of earth surface data. Field inspection by a qualified professional with experience and technical knowledge of geomorphology, flood hydrology, and sedimentation is recommended. The stream form relationships presented in the previous section provide tools for estimating the lateral extent of the geomorphically active area.

The longitudinal extent of the area must include significant changes in any of the following important variables: stream grade, water discharge, sediment load, channel bed and bank material, and geologic influences. The importance of stream grade is strongly emphasized. In most case, changes in water discharge, sediment load, bed and bank material, and geology are manifest in the stream grade.

Changes in longitudinal grade should be carefully evaluated. Lane's basic relationship for channel stability aids in the interpretation of longitudinal variation in a stream.

$$Q S \sim Q, D_{50} \qquad \text{EQ.10}$$

where  $Q$  is the water discharge,  $Q_s$  is sediment transport,  $S$  is stream grade, and  $D_{50}$  is mean bed material size. The following table summarizes some of the possible causes for stream grade changes.

$S^+$	$Q^-$	$Q_s^0$	$D_{50}^0$	Water diversion from stream
	$Q^0$	$Q_s^+$	$D_{50}^0$	Increased watershed sediment yield
	$Q^0$	$Q_s^{0/+}$	$D_{50}^+$	Debris loading to stream
$S^-$	$Q^+$	$Q_s^0$	$D_{50}^0$	Water diversion to stream
	$Q^0$	$Q_s^-$	$D_{50}^0$	Reservoir sedimentation with clear water releases.
	$Q^+$	$Q_s^{-/0}$	$D_{50}^-$	Urbanization of watershed

#### INSTABILITY HAZARDS.

The method identifies three groups of geomorphic hazards within a stream corridor. Hazard groups 1 and 2 (see table 1) are reach scale geomorphic processes that characterize a particular stream environment. These processes create the chance that over the long-term a river instability may result from natural events or man-caused activities. Hazard group 3 results from hydraulic conditions occurring locally such as at a particular property or stream channel feature.

HAZARD GROUP 1.	Existing river instability	Reach Scale
HAZARD GROUP 2.	Potential for induced instability	
HAZARD GROUP 3.	Local scour or sedimentation	At-Site

The method deals with reach scale effects in a different manner than local effects. First, we assume that given an unaltered stream environment the general channel pattern and average geometry can be predicted using the empirical geomorphic relationships and associated constraints. These relationships then define the geomorphically active portion of the river valley. We also assume that the river corridor could be managed to have zero geomorphic hazard. This becomes the theoretical baseline condition.

Second, we recognize that the probability of damage from a geomorphic hazard is due to encroachment into the geomorphically active portion of the river valley. Encroachment can occur in one of two ways: either as intrusion into the active area, or due to an alteration of the baseline that induces instability. Induced instability is caused by the alteration of sediment or water discharge to the reach, or the alteration of channel geometry or gradient.

Local stream stability is based on observation of site-specific conditions in the stream. Local disturbances are major alterations in channel geometry and alignment at a site that fall beyond the normal baseline for a stream classification. Local disturbances due to natural causes such as tributary debris flows, floating debris accumulations can create risk. Many modern infrastructure or development projects (transportation routes, hardening of stream banks at select locations, in-stream mining) can also pose a similar risk. Since most stream types are dynamic, local stream stability must always be taken in context of the baseline stability of the geomorphically active area.

## PROBABILITY OF FAILURE

Risk is simply the probability of failure multiplied by the associated damages. Risk is then integrated over the entire distribution of probabilities. The integration is simplified by the fact that stream failures tend to occur once a threshold event is surpassed. So, below the threshold event the probability of failure is near zero (giving zero risk) and above the threshold the damages are fairly constant having mostly occurred once the threshold was exceeded. So the probability of failure can be defined by the probability of the threshold event. To account for existing, induced, and local hazards a factor (hazard weighting factor, HWF) is used to adjust the probability of the threshold event, resulting in the following equation:

$$\text{Risk} = \text{Probability}_{\text{failure}} * \text{HWF} * \text{Losses} \quad \text{EQ.11}$$

The hazard weighting factor (HWF) is the product of reach scale factors (RHWF) and local scale factors (LHWF). The reach stability factor is a function of stream classification, and the ratio of encroachment to the base active channel width, where:

$$\text{RHWF} = \left( \frac{1}{\sigma} \right)^b \quad \text{where } \sigma \leq 1 \quad \text{EQ.12}$$

$$\sigma = \frac{\text{Base Width} - \text{Encroachment}}{\text{Base Width}}$$

The weighting factor increases as the encroachment factor decreases (as encroachment increases). This relationship shows that slight encroachments with little effect on the geomorphically active area have little effect on reach stability, while a large encroachment decreases reach stability. The exponent "b" depends on stream classification with the exponent increasing as uncertainty in the stream form increases. Table 2 provides the recommended exponent values:

Table 2. Reach Stability, HWF Exponent

Channel Classification	Exponent, b
ST-1	0.08
ST-2	0.34
ST-3a	0.68
ST-3b	0.77
ST-4	0.86
ST-5	1.10

The weighting factors for local hazards are available for selected conditions. Cotton (1995) compiles lateral and vertical weighting factors for local scour at bridges, and for river countermeasures including spurs, guide bank, grade control, and bank revetments.

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## REFERENCES

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- Cotton, G.K., 1995, "Effect of geomorphic hazards on bridge reliability," First International Conference, Water Resources Engineering, ASCE, ed. Espey, W.H., and Combs, P.G.
- Lane, E.W., 1957, "A study of the shape of channels formed by natural streams flowing in erodible material," M.R.D. Sediment Series No. 9, U.S. Army Engineer Division, Missouri River, Corps of Engineers.
- Leopold, L.B., and Wolman, M.G., 1957, "River channel patterns: braided, meandering, and straight," U.S. Geological Survey Professional Paper 282-B.
- Leopold, L.B., and Wolman, M.G., 1960, "River meanders," Bulletin of the Geologic Society of America 71, pp. 769-94.
- Laursen, E.M., 1960, "Scour at bridge crossings," Journal of the Hydraulics Division, ASCE, v89 no. HY3.
- Schumm, S.A., 1960, "The shape of alluvial channels in relation to sediment type," U.S. Geological Survey Professional Paper 352-B, pp. 17-30.
- Schumm, S.A., 1968, "River adjustment to altered hydrologic regimen - Murrumbidgee River and paleochannels, Australia," U.S. Geological Survey Professional Paper 598.
- Schumm, S.A., and Meyer, D.F., 1979, "Morphology of alluvial rivers of the Great Plains," Riparian and Wetlands Habitats of the Great Plains, Great Plains Agricultural Council Publication, 92.

# Appendix 1.

## Fall velocity for Bed-Material Classes

Ds, mm	w, ft/s	Bed-Material Class
0.0625	0.0108	Very fine sand
0.125	0.0394	Fine sand
0.25	0.115	Medium sand
0.5	0.246	Coarse sand
1	0.459	Very coarse sand
2	0.919	Very fine gravel
4	1.41	Fine gravel
8	2.16	Medium gravel
16	3.05	Coarse gravel
32	3.86	Very coarse gravel
64	5.45	Small cobbles
128	7.71	Large cobbles
256	17.2	Small boulders
512	24.4	Medium boulders

# Geomorphic, Environmental and Engineering Analysis

A. Utilize Hydrologic Data, Real or Synthetic  
Flood Frequency Analysis  
 $Q_2 \rightarrow Q_{100}$  as objectives dictate



B. Hydrologic Conditions  
HEC-2 and HEC-RAS  
Water Surface  
Profile  
Depths  
Average Velocities



C. Watershed Stability and  
Supply of Sediment to Reach  
Characteristics of Sediment Supply

Subject  
to Change



D. Determine Hydraulic Conditions  
for Incipient Motion  
Shields  
Meyer-Peter, Mueller  
Observations

Indications  
of Instability



E. Armoring Potential

Little Armoring  
Potential



F. Aggradation/Alluvial Fans

Fans - Actual  
or Possible



G. Analysis of Rating Curves  
Specific Stage  
Shifts in Rating Curve

Potential for  
Scour/Aggradation



H. Potential For:  
General Scour  
Contraction Scour  
Local Scour (Bridges, etc.)

Infrastructural  
Analysis (Bridges, etc)

Proceed With  
Physical and  
Mathematical Model  
Analysis

No

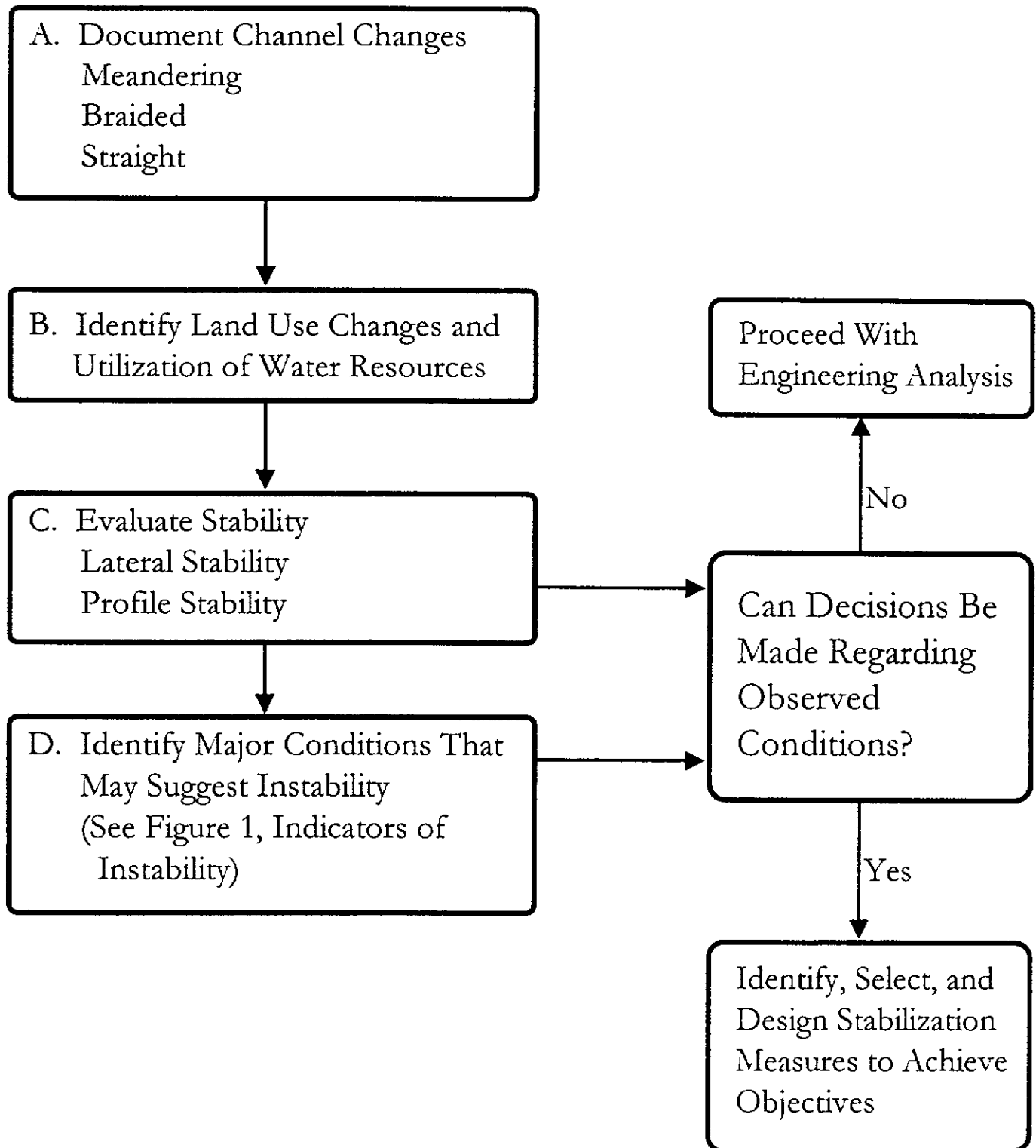
Can Decisions Be  
Made Regarding  
Stability and/or  
Instabilities?

Yes

Identify, Select, and  
Design Stabilization  
Measures to Achieve  
Objectives

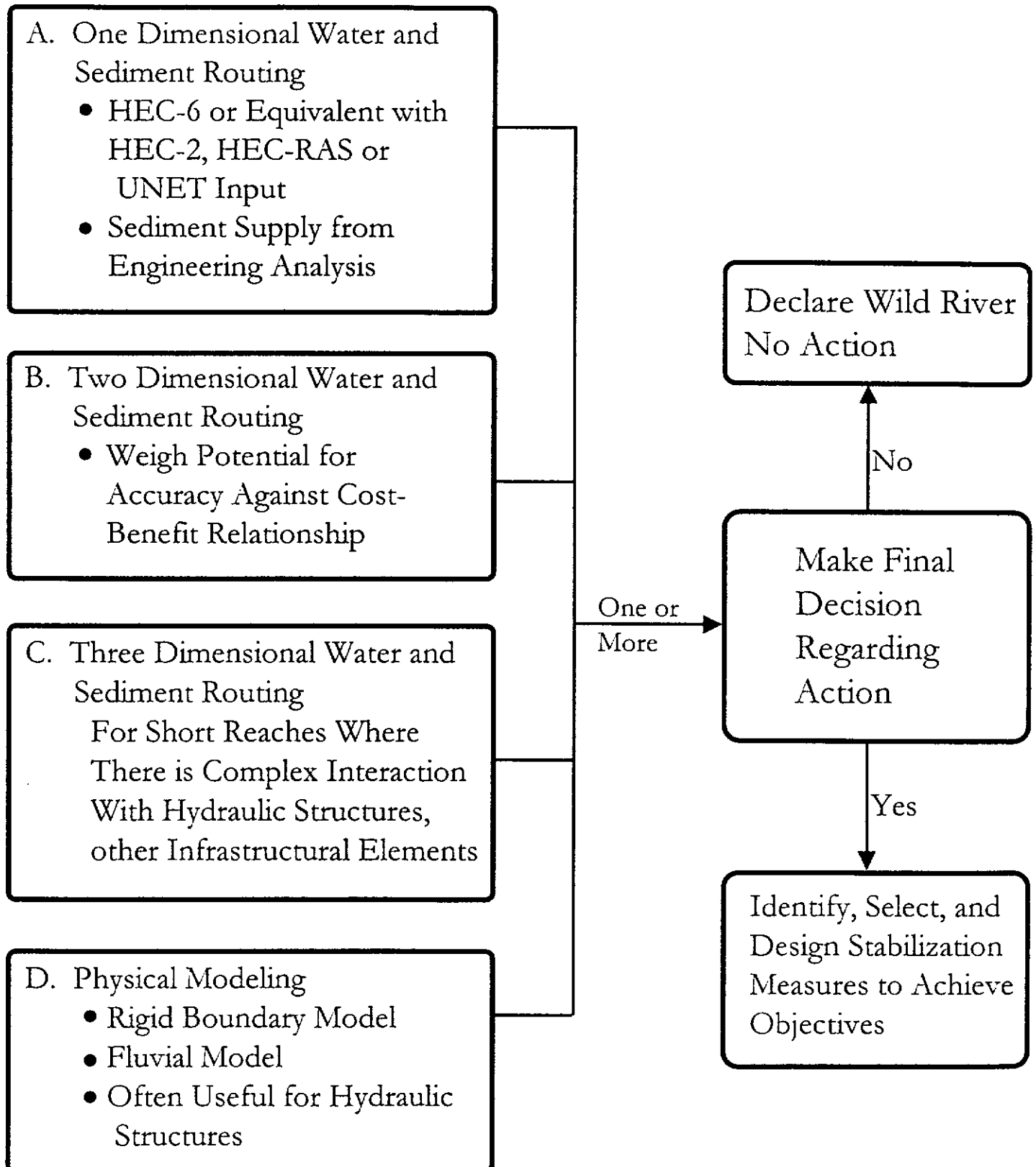
# Geomorphic and Environmental Analysis

Utilize Existing Data Base



# Geomorphic, Engineering and Modeling Analysis

## Possible Levels of Water and Sediment Routing



## **APPENDIX D**

# **THE MAILING LISTS AND QUESTIONNAIRES**

## APPENDIX D

### THE MAILING LISTS AND QUESTIONNAIRES

Below is a list of most of the communities and organizations who were sent a questionnaire. An original copy of both the community and organization questionnaire can be found following the tables. There are a few communities who did not receive a questionnaire for reasons to be explained. A few weeks after the questionnaires were sent out, it was noticed that not many responses were returned which lead to follow-up calls. MWE discovered that many questionnaires were sent to people who may not deal administratively with the floodplains. MWE felt this was a major contribution to the lack of response. Thus several more questionnaires were sent out based on these follow-up calls.

In addition, some communities are considered to be in more than one county. This only causes problems when trying to determine how many questionnaires were received. These duplicates are indicated in the "Respondent's Name & Title" block with a "See Aurora in Adams County" type of comment.

TABLE D-1: LIST OF COMMUNITIES

Community	County	Returned Questionnaire
Arvada	Adams	<input checked="" type="checkbox"/>
Aurora	Adams	<input checked="" type="checkbox"/>
Bennett	Adams	<input type="checkbox"/>
Brighton	Adams	<input checked="" type="checkbox"/>
Broomfield	Adams	<input checked="" type="checkbox"/>
Commerce City	Adams	<input type="checkbox"/>
Federal Heights	Adams	<input checked="" type="checkbox"/>
Hazeltine Heights	Adams	<input type="checkbox"/>
Northglenn	Adams	<input type="checkbox"/>
Thornton	Adams	<input type="checkbox"/>
Unincorporated	Adams	<input type="checkbox"/>
Westminster	Adams	<input checked="" type="checkbox"/>
Alamosa	Alamosa	<input checked="" type="checkbox"/>
Hooper	Alamosa	<input type="checkbox"/>
Unincorporated	Alamosa	<input checked="" type="checkbox"/>
Aurora	Arapahoe	<input checked="" type="checkbox"/>
Bow Mar	Arapahoe	<input type="checkbox"/>
Cherry Hills Village	Arapahoe	<input type="checkbox"/>
Columbine Valley	Arapahoe	<input type="checkbox"/>
Deer Trail	Arapahoe	<input type="checkbox"/>
Englewood	Arapahoe	<input type="checkbox"/>
Foxfield, Co.	Arapahoe	<input checked="" type="checkbox"/>
Glendale	Arapahoe	<input checked="" type="checkbox"/>
Greenwood Village	Arapahoe	<input checked="" type="checkbox"/>
Littleton	Arapahoe	<input checked="" type="checkbox"/>
Sheridan	Arapahoe	<input checked="" type="checkbox"/>
Unincorporated	Arapahoe	<input checked="" type="checkbox"/>
Pagosa Springs	Archuleta	<input checked="" type="checkbox"/>
Unincorporated	Archuleta	<input checked="" type="checkbox"/>

Community	County	
Campo	Baca	<input type="checkbox"/>
Pritchett	Baca	<input type="checkbox"/>
Springfield	Baca	<input checked="" type="checkbox"/>
Two Buttes	Baca	<input type="checkbox"/>
Unincorporated	Baca	<input type="checkbox"/>
Vilas	Baca	<input type="checkbox"/>
Walsh	Baca	<input type="checkbox"/>
Las Animas	Bent	<input type="checkbox"/>
Unincorporated	Bent	<input type="checkbox"/>
Boulder	Boulder	<input checked="" type="checkbox"/>
Broomfield	Boulder	<input checked="" type="checkbox"/>
Eldorado Springs	Boulder	<input type="checkbox"/>
Erie	Boulder	<input checked="" type="checkbox"/>
Jamestown	Boulder	<input checked="" type="checkbox"/>
Lafayette	Boulder	<input type="checkbox"/>
Longmont	Boulder	<input checked="" type="checkbox"/>
Louisville	Boulder	<input checked="" type="checkbox"/>
Lyons	Boulder	<input checked="" type="checkbox"/>
Nederland	Boulder	<input type="checkbox"/>
Orodell	Boulder	<input type="checkbox"/>
Sunnyside	Boulder	<input type="checkbox"/>
Sunset	Boulder	<input type="checkbox"/>
Superior	Boulder	<input type="checkbox"/>
Tungsten	Boulder	<input type="checkbox"/>
Unincorporated	Boulder	<input type="checkbox"/>
Wallstreet	Boulder	<input type="checkbox"/>
Ward	Boulder	<input type="checkbox"/>
Wheelman	Boulder	<input type="checkbox"/>
Buena Vista	Chaffee	<input type="checkbox"/>
Poncha Springs	Chaffee	<input type="checkbox"/>
Salida	Chaffee	<input type="checkbox"/>
Unincorporated	Chaffee	<input type="checkbox"/>
Cheyenne Wells	Cheyenne	<input checked="" type="checkbox"/>
Kit Carson	Cheyenne	<input checked="" type="checkbox"/>
Unincorporated	Cheyenne	<input checked="" type="checkbox"/>
Empire	Clear Creek	<input type="checkbox"/>
Georgetown	Clear Creek	<input checked="" type="checkbox"/>
Idaho Springs	Clear Creek	<input checked="" type="checkbox"/>
Silver Plume	Clear Creek	<input checked="" type="checkbox"/>
Unincorporated	Clear Creek	<input type="checkbox"/>
Antonito	Conejos	<input type="checkbox"/>
La Jara	Conejos	<input type="checkbox"/>
Manassa	Conejos	<input type="checkbox"/>
Romeo	Conejos	<input type="checkbox"/>
Sanford	Conejos	<input checked="" type="checkbox"/>
Unincorporated	Conejos	<input type="checkbox"/>

Community	County	
Blanca	Costilla	<input type="checkbox"/>
San Luis	Costilla	<input type="checkbox"/>
Unincorporated	Costilla	<input type="checkbox"/>
Crowley	Crowley	<input checked="" type="checkbox"/>
Olney Springs	Crowley	<input checked="" type="checkbox"/>
Ordway	Crowley	<input type="checkbox"/>
Sugar City	Crowley	<input type="checkbox"/>
Unincorporated	Crowley	<input type="checkbox"/>
Silver Cliff	Custer	<input type="checkbox"/>
Unincorporated	Custer	<input type="checkbox"/>
Westcliffe	Custer	<input type="checkbox"/>
Cedaridge	Delta	<input type="checkbox"/>
Crawford	Delta	<input type="checkbox"/>
Delta	Delta	<input checked="" type="checkbox"/>
Hotchkiss	Delta	<input type="checkbox"/>
Orchard City	Delta	<input type="checkbox"/>
Paonia	Delta	<input checked="" type="checkbox"/>
Unincorporated	Delta	<input checked="" type="checkbox"/>
Denver	Denver	<input checked="" type="checkbox"/>
Unincorporated	Denver	<input type="checkbox"/>
Dove Creek	Dolores	<input type="checkbox"/>
Rico	Dolores	<input type="checkbox"/>
Unincorporated	Dolores	<input type="checkbox"/>
Aurora	Douglas	<input checked="" type="checkbox"/>
Castle Rock	Douglas	<input checked="" type="checkbox"/>
Franktown	Douglas	<input type="checkbox"/>
Larkspur	Douglas	<input type="checkbox"/>
Littleton	Douglas	<input checked="" type="checkbox"/>
Lone Tree	Douglas	<input checked="" type="checkbox"/>
Parker	Douglas	<input type="checkbox"/>
Unincorporated	Douglas	<input checked="" type="checkbox"/>
Avon	Eagle	<input checked="" type="checkbox"/>
Basalt	Eagle	<input type="checkbox"/>
Eagle	Eagle	<input type="checkbox"/>
Edwards	Eagle	<input type="checkbox"/>
Emma	Eagle	<input type="checkbox"/>
Gilman	Eagle	<input type="checkbox"/>
Gypsum	Eagle	<input type="checkbox"/>
Minturn	Eagle	<input checked="" type="checkbox"/>
Red Cliff	Eagle	<input type="checkbox"/>
Unincorporated	Eagle	<input checked="" type="checkbox"/>
Vail	Eagle	<input type="checkbox"/>
West Vail	Eagle	<input type="checkbox"/>
Wolcott	Eagle	<input type="checkbox"/>
Calhan	El Paso	<input checked="" type="checkbox"/>
Colorado Springs	El Paso	<input checked="" type="checkbox"/>

Community	County	
Fountain	El Paso	<input checked="" type="checkbox"/>
Green Mountain Falls	El Paso	<input type="checkbox"/>
Manitou Springs	El Paso	<input type="checkbox"/>
Monument	El Paso	<input checked="" type="checkbox"/>
Palmer Lake	El Paso	<input checked="" type="checkbox"/>
Ramah	El Paso	<input type="checkbox"/>
Unincorporated	El Paso	<input checked="" type="checkbox"/>
Elizabeth	Elbert	<input checked="" type="checkbox"/>
Kiowa	Elbert	<input checked="" type="checkbox"/>
Simla	Elbert	<input type="checkbox"/>
Unincorporated	Elbert	<input type="checkbox"/>
Brookside	Fremont	<input type="checkbox"/>
Canon City	Fremont	<input checked="" type="checkbox"/>
Coal Creek	Fremont	<input checked="" type="checkbox"/>
Florence	Fremont	<input checked="" type="checkbox"/>
Prospect Heights	Fremont	<input type="checkbox"/>
Rockvale	Fremont	<input checked="" type="checkbox"/>
Unincorporated	Fremont	<input checked="" type="checkbox"/>
Williamsburg	Fremont	<input type="checkbox"/>
Carbondale	Garfield	<input type="checkbox"/>
Glenwood Springs	Garfield	<input checked="" type="checkbox"/>
New Castle	Garfield	<input type="checkbox"/>
Parachute	Garfield	<input checked="" type="checkbox"/>
Rifle	Garfield	<input type="checkbox"/>
Silt	Garfield	<input type="checkbox"/>
Unincorporated	Garfield	<input checked="" type="checkbox"/>
Black Hawk	Gilpin	<input checked="" type="checkbox"/>
Central City	Gilpin	<input type="checkbox"/>
Unincorporated	Gilpin	<input checked="" type="checkbox"/>
Fraser	Grand	<input checked="" type="checkbox"/>
Granby	Grand	<input type="checkbox"/>
Grand Lake	Grand	<input type="checkbox"/>
Hot Sulphur Springs	Grand	<input type="checkbox"/>
Kremmling	Grand	<input type="checkbox"/>
Unincorporated	Grand	<input type="checkbox"/>
Winter Park	Grand	<input type="checkbox"/>
Crested Butte	Gunnison	<input checked="" type="checkbox"/>
Gunnison	Gunnison	<input checked="" type="checkbox"/>
Marble	Gunnison	<input type="checkbox"/>
Mount Crested Butte	Gunnison	<input checked="" type="checkbox"/>
Pitkin	Gunnison	<input type="checkbox"/>
Unincorporated	Gunnison	<input checked="" type="checkbox"/>
Lake City	Hinsdale	<input type="checkbox"/>
Unincorporated	Hinsdale	<input checked="" type="checkbox"/>
La Veta	Huerfano	<input type="checkbox"/>

Community	County	
Unincorporated	Huerfano	<input checked="" type="checkbox"/>
Walsenburg	Huerfano	<input type="checkbox"/>
Unincorporated	Jackson	<input type="checkbox"/>
Walden	Jackson	<input type="checkbox"/>
Arvada	Jefferson	<input checked="" type="checkbox"/>
Bow Mar	Jefferson	<input type="checkbox"/>
Broomfield	Jefferson	<input type="checkbox"/>
Edgewater	Jefferson	<input type="checkbox"/>
Golden	Jefferson	<input checked="" type="checkbox"/>
Lakeside	Jefferson	<input type="checkbox"/>
Lakewood	Jefferson	<input checked="" type="checkbox"/>
Littleton	Jefferson	<input checked="" type="checkbox"/>
Morrison	Jefferson	<input checked="" type="checkbox"/>
Mountain View	Jefferson	<input type="checkbox"/>
Superior	Jefferson	<input type="checkbox"/>
Unincorporated	Jefferson	<input checked="" type="checkbox"/>
Westminster	Jefferson	<input checked="" type="checkbox"/>
Wheat Ridge	Jefferson	<input type="checkbox"/>
Eads	Kiowa	<input checked="" type="checkbox"/>
Haswell	Kiowa	<input type="checkbox"/>
Sheridan Lake	Kiowa	<input type="checkbox"/>
Unincorporated	Kiowa	<input type="checkbox"/>
Bethune	Kit Carson	<input checked="" type="checkbox"/>
Burlington	Kit Carson	<input checked="" type="checkbox"/>
Flager	Kit Carson	<input type="checkbox"/>
Seibert	Kit Carson	<input checked="" type="checkbox"/>
Stratton	Kit Carson	<input checked="" type="checkbox"/>
Unincorporated	Kit Carson	<input type="checkbox"/>
Vona	Kit Carson	<input type="checkbox"/>
Bayfield	La Plata	<input type="checkbox"/>
Durango	La Plata	<input checked="" type="checkbox"/>
Hermosa	La Plata	<input type="checkbox"/>
Ignacio	La Plata	<input type="checkbox"/>
Unincorporated	La Plata	<input type="checkbox"/>
Leadville	Lake	<input type="checkbox"/>
Unincorporated	Lake	<input checked="" type="checkbox"/>
Berthoud	Larimer	<input type="checkbox"/>
Estes Park	Larimer	<input checked="" type="checkbox"/>
Fort Collins	Larimer	<input checked="" type="checkbox"/>
Loveland	Larimer	<input type="checkbox"/>
Timnath	Larimer	<input type="checkbox"/>
Unincorporated	Larimer	<input checked="" type="checkbox"/>
Wellington	Larimer	<input checked="" type="checkbox"/>
Windsor	Larimer	<input type="checkbox"/>
Aguilar	Las Animas	<input checked="" type="checkbox"/>
Branson	Las Animas	<input type="checkbox"/>

Community	County	
Cokedale	Las Animas	<input type="checkbox"/>
Kim	Las Animas	<input type="checkbox"/>
Starkville	Las Animas	<input type="checkbox"/>
Trinidad	Las Animas	<input checked="" type="checkbox"/>
Unincorporated	Las Animas	<input checked="" type="checkbox"/>
Arriba	Lincoln	<input type="checkbox"/>
Genoa	Lincoln	<input type="checkbox"/>
Hugo	Lincoln	<input type="checkbox"/>
Limon	Lincoln	<input checked="" type="checkbox"/>
Unincorporated	Lincoln	<input type="checkbox"/>
Atwood	Logan	<input type="checkbox"/>
Crook	Logan	<input type="checkbox"/>
Fleming	Logan	<input type="checkbox"/>
Iiff	Logan	<input type="checkbox"/>
Merino	Logan	<input type="checkbox"/>
Peetz	Logan	<input checked="" type="checkbox"/>
Sterling	Logan	<input checked="" type="checkbox"/>
Unincorporated	Logan	<input checked="" type="checkbox"/>
Collbran	Mesa	<input type="checkbox"/>
De Beque	Mesa	<input type="checkbox"/>
Fruita	Mesa	<input checked="" type="checkbox"/>
Grand Junction	Mesa	<input checked="" type="checkbox"/>
Palisade	Mesa	<input checked="" type="checkbox"/>
Unincorporated	Mesa	<input checked="" type="checkbox"/>
Creede	Mineral	<input type="checkbox"/>
Unincorporated	Mineral	<input type="checkbox"/>
Craig	Moffat	<input type="checkbox"/>
Dinosaur	Moffat	<input checked="" type="checkbox"/>
Unincorporated	Moffatt	<input type="checkbox"/>
Cortez	Montezuma	<input checked="" type="checkbox"/>
Dolores	Montezuma	<input checked="" type="checkbox"/>
Mancos	Montezuma	<input type="checkbox"/>
Unincorporated	Montezuma	<input type="checkbox"/>
Montrose	Montrose	<input type="checkbox"/>
Naturita	Montrose	<input checked="" type="checkbox"/>
Nucla	Montrose	<input checked="" type="checkbox"/>
Olathe	Montrose	<input type="checkbox"/>
Unincorporated	Montrose	<input checked="" type="checkbox"/>
Brush	Morgan	<input checked="" type="checkbox"/>
Fort Morgan	Morgan	<input checked="" type="checkbox"/>
Hillrose	Morgan	<input type="checkbox"/>
Log Lane Village	Morgan	<input type="checkbox"/>
Unincorporated	Morgan	<input type="checkbox"/>
Wiggins	Morgan	<input checked="" type="checkbox"/>
Cheraw	Otero	<input type="checkbox"/>
Fowler	Otero	<input checked="" type="checkbox"/>

Community	County	
La Junta	Otero	<input checked="" type="checkbox"/>
Manzanola	Otero	<input checked="" type="checkbox"/>
Rocky Ford	Otero	<input checked="" type="checkbox"/>
Swink	Otero	<input type="checkbox"/>
Unincorporated	Otero	<input checked="" type="checkbox"/>
Ouray	Ouray	<input checked="" type="checkbox"/>
Ridgway	Ouray	<input type="checkbox"/>
Unincorporated	Ouray	<input type="checkbox"/>
Alma	Park	<input type="checkbox"/>
Fairplay	Park	<input checked="" type="checkbox"/>
Unincorporated	Park	<input type="checkbox"/>
Haxtun	Phillips	<input type="checkbox"/>
Holyoke	Phillips	<input type="checkbox"/>
Paoli	Phillips	<input type="checkbox"/>
Unincorporated	Phillips	<input type="checkbox"/>
Aspen	Pitkin	<input type="checkbox"/>
Basalt	Pitkin	<input checked="" type="checkbox"/>
Snowmass Village	Pitkin	<input checked="" type="checkbox"/>
Unincorporated	Pitkin	<input type="checkbox"/>
Granada	Prowers	<input checked="" type="checkbox"/>
Hartman	Prowers	<input checked="" type="checkbox"/>
Holly	Prowers	<input type="checkbox"/>
Lamar	Prowers	<input checked="" type="checkbox"/>
Unincorporated	Prowers	<input checked="" type="checkbox"/>
Wiley	Prowers	<input type="checkbox"/>
Boone	Pueblo	<input type="checkbox"/>
Pueblo	Pueblo	<input checked="" type="checkbox"/>
Rye	Pueblo	<input type="checkbox"/>
Unincorporated	Pueblo	<input checked="" type="checkbox"/>
Meeker	Rio Blanco	<input checked="" type="checkbox"/>
Rangely	Rio Blanco	<input checked="" type="checkbox"/>
Unincorporated	Rio Blanco	<input checked="" type="checkbox"/>
Baxterville	Rio Grande	<input type="checkbox"/>
Center	Rio Grande	<input type="checkbox"/>
Del Norte	Rio Grande	<input checked="" type="checkbox"/>
Masonic Park	Rio Grande	<input type="checkbox"/>
Monte Vista	Rio Grande	<input type="checkbox"/>
South Fork	Rio Grande	<input type="checkbox"/>
Unincorporated	Rio Grande	<input checked="" type="checkbox"/>
Hayden	Routt	<input checked="" type="checkbox"/>
Oak Creek	Routt	<input type="checkbox"/>
Steamboat Springs	Routt	<input checked="" type="checkbox"/>
Unincorporated	Routt	<input type="checkbox"/>
Yampa	Routt	<input type="checkbox"/>
Bonanza	Saguache	<input type="checkbox"/>
Center	Saguache	<input type="checkbox"/>

Community	County	
Crestone	Saguache	<input type="checkbox"/>
Moffat	Saguache	<input type="checkbox"/>
Saguache	Saguache	<input checked="" type="checkbox"/>
Unincorporated	Saguache	<input type="checkbox"/>
Silverton	San Juan	<input checked="" type="checkbox"/>
Unincorporated	San Juan	<input checked="" type="checkbox"/>
Mountain Village	San Miguel	<input type="checkbox"/>
Norwood	San Miguel	<input checked="" type="checkbox"/>
Ophir	San Miguel	<input type="checkbox"/>
Sawpit	San Miguel	<input type="checkbox"/>
Telluride	San Miguel	<input checked="" type="checkbox"/>
Unincorporated	San Miguel	<input checked="" type="checkbox"/>
Julesburg	Sedgwick	<input type="checkbox"/>
Ovid	Sedgwick	<input type="checkbox"/>
Sedgwick	Sedgwick	<input type="checkbox"/>
Unincorporated	Sedgwick	<input type="checkbox"/>
Blue River	Summit	<input type="checkbox"/>
Breckenridge	Summit	<input type="checkbox"/>
Dillon	Summit	<input type="checkbox"/>
Frisco	Summit	<input checked="" type="checkbox"/>
Montezuma	Summit	<input checked="" type="checkbox"/>
Silverthorne	Summit	<input type="checkbox"/>
Unincorporated	Summit	<input checked="" type="checkbox"/>
Cripple Creek	Teller	<input checked="" type="checkbox"/>
Green Mountain Falls	Teller	<input type="checkbox"/>
Unincorporated	Teller	<input checked="" type="checkbox"/>
Victor	Teller	<input type="checkbox"/>
Woodland Park	Teller	<input type="checkbox"/>
Akron	Washington	<input checked="" type="checkbox"/>
Otis	Washington	<input type="checkbox"/>
Unincorporated	Washington	<input type="checkbox"/>
Ault	Weld	<input type="checkbox"/>
Dacono	Weld	<input type="checkbox"/>
Eaton	Weld	<input type="checkbox"/>
Erie	Weld	<input type="checkbox"/>
Evans	Weld	<input type="checkbox"/>
Evanston	Weld	<input type="checkbox"/>
Firestone	Weld	<input type="checkbox"/>
Fort Lupton	Weld	<input type="checkbox"/>
Fort St. Vrain Nucle	Weld	<input type="checkbox"/>
Frederick	Weld	<input checked="" type="checkbox"/>
Garden City	Weld	<input checked="" type="checkbox"/>
Gilcrest	Weld	<input checked="" type="checkbox"/>
Greeley	Weld	<input checked="" type="checkbox"/>
Grover	Weld	<input type="checkbox"/>

Community	County	
Hudson	Weld	<input checked="" type="checkbox"/>
Johnstown	Weld	<input type="checkbox"/>
Keenesburg	Weld	<input type="checkbox"/>
Kersey	Weld	<input type="checkbox"/>
La Salle	Weld	<input type="checkbox"/>
Lochbuie	Weld	<input checked="" type="checkbox"/>
Mead	Weld	<input type="checkbox"/>
Milliken	Weld	<input checked="" type="checkbox"/>
Nunn	Weld	<input type="checkbox"/>
Pierce	Weld	<input type="checkbox"/>
Platteville	Weld	<input type="checkbox"/>
Raymer	Weld	<input type="checkbox"/>
Severance	Weld	<input type="checkbox"/>
Unincorporated	Weld	<input type="checkbox"/>
Vollmer	Weld	<input type="checkbox"/>
Wattenberg	Weld	<input type="checkbox"/>
Windsor	Weld	<input type="checkbox"/>
Eckley	Yuma	<input checked="" type="checkbox"/>
Unincorporated	Yuma	<input type="checkbox"/>
Wray	Yuma	<input type="checkbox"/>
Yuma	Yuma	<input checked="" type="checkbox"/>

TABLE D-2: LIST OF ORGANIZATIONS

Organization	Returned Questionnaire
Alamosa River Watershed Project	<input checked="" type="checkbox"/>
Andrew Wallach	<input type="checkbox"/>
Assoc. of State Floodplain Managers	<input type="checkbox"/>
Basalt WCD	<input type="checkbox"/>
Battlement Mesa WCD	<input checked="" type="checkbox"/>
Black Canyon Audubon Society	<input type="checkbox"/>
Boulder Creek Watershed Initiative	<input checked="" type="checkbox"/>
Bureau of Land Management	<input type="checkbox"/>
Bureau of Reclamation	<input type="checkbox"/>
Carl Norbeck	<input type="checkbox"/>
Centennial Water & Sanitation Dist.	<input type="checkbox"/>
Central Colorado WCD	<input type="checkbox"/>
Chair, Metro Water Conservation Inc.	<input type="checkbox"/>
CIRES	<input type="checkbox"/>
CO Water Conservation Alliance	<input checked="" type="checkbox"/>
Colorado Alliance for Environmental Education	<input type="checkbox"/>
Colorado Cattleman's Assoc.	<input type="checkbox"/>

## Organization

Colorado Division of Wildlife - Haggerty	<input type="checkbox"/>
Colorado Division of Wildlife - Kochman	<input type="checkbox"/>
Colorado Division of Wildlife - McNeill	<input type="checkbox"/>
Colorado Division of Wildlife - Puttman	<input checked="" type="checkbox"/>
Colorado Farm Bureau	<input type="checkbox"/>
Colorado Municipal League - Mamet	<input type="checkbox"/>
Colorado Municipal League - Wilson	<input type="checkbox"/>
Colorado Outdoor Education Center	<input type="checkbox"/>
Colorado Riparian Assoc.	<input type="checkbox"/>
Colorado River Headwaters Forum	<input type="checkbox"/>
Colorado River WCD - Merritt	<input checked="" type="checkbox"/>
Colorado River WCD - Tenney	<input checked="" type="checkbox"/>
Colorado Trout Unlimited	<input type="checkbox"/>
Colorado Water Congress	<input type="checkbox"/>
Colorado Wildlife Federation	<input type="checkbox"/>
Conejos WCD	<input type="checkbox"/>
CSU Cooperative Extension	<input type="checkbox"/>
CWC ISF Subcomm.	<input type="checkbox"/>
Denver Water (CWC)	<input type="checkbox"/>
Dir. Of Colo. River Rehab. Program	<input type="checkbox"/>
Director, CIFRES	<input type="checkbox"/>
E. Bruce Jones	<input type="checkbox"/>
E. S. Program Watershed Project	<input type="checkbox"/>
Eagle County River Assembly	<input type="checkbox"/>
Ed Nielson	<input type="checkbox"/>
El Paso County SCD	<input checked="" type="checkbox"/>
Environmental Defense Fund - Flynn	<input type="checkbox"/>
Environmental Defense Fund - Luecke	<input type="checkbox"/>
Environmental Protection Agency - Hamilton	<input checked="" type="checkbox"/>
Environmental Protection Agency - Ruitter	<input checked="" type="checkbox"/>
Fountain Creek Watershed Project	<input checked="" type="checkbox"/>
Fruitland Mesa WCD	<input type="checkbox"/>
Gnd Jct/ Mesa Co. Riverfront Comm.	<input type="checkbox"/>
Gore Range Anglers/Trout Unlimited	<input type="checkbox"/>
Grand Junction Drainage Dist.	<input checked="" type="checkbox"/>
Grand Mesa WCD	<input type="checkbox"/>
GREEN	<input type="checkbox"/>
High County Citizen's Alliance - Glazier	<input type="checkbox"/>
High County Citizen's Alliance - Sprung	<input type="checkbox"/>
High County News	<input type="checkbox"/>
Huerfano County WCD	<input type="checkbox"/>
Jackson County WCD (CWC)	<input type="checkbox"/>
JBC-GA	<input type="checkbox"/>
KGNU Radio	<input type="checkbox"/>
La Plata WCD	<input type="checkbox"/>

## Organization

Laura Backus	<input type="checkbox"/>
League of Women Voters	<input type="checkbox"/>
Lower South Platte WCD	<input type="checkbox"/>
Mancos WCD	<input type="checkbox"/>
Mesa County Land Conservancy	<input type="checkbox"/>
Middle Park WCD	<input type="checkbox"/>
National Organization for River Sports	<input type="checkbox"/>
Natural Resources Group, LWV	<input type="checkbox"/>
Natural Resources Law Center	<input type="checkbox"/>
North Fork River Improvement Assoc.	<input type="checkbox"/>
Northern Colorado WCD	<input checked="" type="checkbox"/>
Northwest Colorado COG	<input checked="" type="checkbox"/>
Northwest Colorado COG - Water	<input checked="" type="checkbox"/>
Quality/Quantity	
Peregrine River Outfitters	<input type="checkbox"/>
Pueblo Board of Water Works	<input type="checkbox"/>
Ralph Clark III	<input type="checkbox"/>
Rio Grande Canal Water Users Assoc.	<input type="checkbox"/>
Rio Grande WCD	<input type="checkbox"/>
Roaring Fork Environmental Education	<input checked="" type="checkbox"/>
Association	
Rocky Mountain Farmers Union	<input type="checkbox"/>
Rocky Mountain News	<input type="checkbox"/>
San Miguel Watershed Coalition	<input checked="" type="checkbox"/>
Sierra Club, Rocky Mtn. Chapter -	<input checked="" type="checkbox"/>
Cunningham	
Sierra Club, Southwest Office - Arapikes	<input type="checkbox"/>
Sierra Club, Southwest Office - Fox	<input type="checkbox"/>
Southeastern Colo. WCD (CWC)	<input type="checkbox"/>
Southwestern WCD	<input type="checkbox"/>
The Daily Sentinel - Buchanan	<input type="checkbox"/>
The Daily Sentinel - McGregor	<input type="checkbox"/>
The Nature Conservancy	<input type="checkbox"/>
The Riparian Task Force	<input type="checkbox"/>
Tri-State Generation & Trans. Assoc.	<input type="checkbox"/>
UDFCD	<input checked="" type="checkbox"/>
Uncompahgre Valley Water Users Assoc.	<input type="checkbox"/>
University of Colorado	<input type="checkbox"/>
Upper Animas Coordinator	<input type="checkbox"/>
Upper Arkansas River Restoration Project	<input checked="" type="checkbox"/>
Upper Arkansas WCD	<input type="checkbox"/>
Upper Colorado River Commission	<input type="checkbox"/>
Upper Gunnison WCD	<input checked="" type="checkbox"/>
Upper Yampa WCD	<input type="checkbox"/>
US Army Corps of Engineers	<input type="checkbox"/>

Organization	
US Geological Survey	<input type="checkbox"/>
US Geological Survey - Lystrom	<input checked="" type="checkbox"/>
US Soil Cons. Service	<input type="checkbox"/>
USDA - Natural Resources Conservation Service	<input checked="" type="checkbox"/>
USDA Forest Service	<input type="checkbox"/>
USFWS	<input checked="" type="checkbox"/>
Valley Land Conservancy	<input checked="" type="checkbox"/>
Water Resources Research Institute	<input type="checkbox"/>
Wright Water Engineers	<input type="checkbox"/>
Yampa River Basin Partnership	<input type="checkbox"/>
Yampa River Legacy System	<input type="checkbox"/>
Yampa River Parnership	<input type="checkbox"/>

October 23, 1997



Dear Community Representative:

McLaughlin Water Engineers, Ltd. and representatives of the Colorado Water Conservation Board (CWCB) have prepared the enclosed Community Inventory Questionnaire. In addition to the floodplain management issues, the CWCB will survey other water resources organizations to receive their comments regarding related issues and common interests on the state's stream corridors. We strongly solicit your comments. By completing the questionnaire, you will assist us in collecting information on floodplain management and river rehabilitation needs for your community as well as other communities throughout Colorado. Statewide data will be compiled and analyzed to provide recommendations for the establishment of new measures and means to address flood-related and associated water interests and environmental concerns and to better manage the state's floodplains and waterways. A summary of the results will be provided to all participants.

*Personal Incentive!* Everyone responding before November 14, 1997 will be entered in a raffle for a pair of Avalanche tickets and an overnight stay at a Denver hotel!

The tickets are for the Saturday, December 6th, game against Vancouver. The tickets were donated by **McLaughlin Water Engineers**.

We can help! If you have questions regarding the completion or use of this Questionnaire, please contact:

Larry Lang, Program Manager



Colorado Water Conservation Board

1313 Sherman Street

Denver, Colorado 80203

(303) 866-3441

John Pflaum, Project Manager/

Wayland Anderson, Project Engineer



McLaughlin Water Engineers, Ltd.

2420 Alcott Street

Denver, CO 80211

(303) 458-5550

# Statewide River Rehabilitation and Floodplain Management Needs Assessment



## COMMUNITY INVENTORY QUESTIONNAIRE

### Objective

The Colorado Legislature has authorized the **Colorado Water Conservation Board (CWCB)** to perform a statewide needs assessment to better manage and address flood-related and multi-objective river issues within the known and unknown floodplains. Known floodplains are commonly referred to as 100 and 500-year floodplains. One of the key steps in completing a needs inventory is to assess the floodplain management and stream rehabilitation problems/concerns across the state. To complete the statewide needs assessment, CWCB will be relying on a survey of all flood prone communities and water resource-related interests in the state. This **Questionnaire** is the primary means of completing this survey. **The purpose of the questionnaire is to:** 1) evaluate existing programs, 2) determine future needs, 3) formulate recommendations for consideration by the CWCB.

**Your answers to the questions in this Questionnaire will be critical** to CWCB's ability to formulate an action plan. Questions are grouped to obtain information from your community relating to the following subjects:

- Floodplain Management (mapping/regulation, flood insurance, mitigation measures)
- Multi-Objective Use of Stream Corridors (wetlands, recreation, fisheries, irrigation, etc.)
- Institutional Issues (study criteria, legislative barriers, fiscal & legal problems)

### Instructions

Please fill out this **Questionnaire as completely as possible and return it in the envelope provided by November 14, 1997.** If certain information has not been previously developed, please make your best estimate. We believe information provided by community officials and water managers, based upon local experience and preferences, better identifies your needs. **If you do not, or cannot provide the information, more general estimates for your community may have to be made, which could overlook problems unique to your community.**

### Community Map

Responses to certain questions may be more clearly or easily shown on a map. Use of a map is encouraged, but not required. If you choose to show information on a map (for example, stream reaches with unmapped floodplains) please indicate the map's scale and distinguish between different subjects with different line colors or line types. For example, you might indicate eroding or unstable stream reaches with a colored or solid line and high flood hazard reaches with a different color or a dashed line. Please include a legend or other explanatory notes to aid in compiling the information.



## Community Information

Community Name \_\_\_\_\_ Address \_\_\_\_\_

Zip \_\_\_\_\_ Phone \_\_\_\_\_ Fax \_\_\_\_\_ E-mail \_\_\_\_\_

Respondent's Name & Title \_\_\_\_\_ Phone \_\_\_\_\_

Fax \_\_\_\_\_ E-Mail \_\_\_\_\_ Address \_\_\_\_\_

## Community Profile

- What is the community's most significant floodplain problem relating to stream corridors in your community? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- What does your community value about stream corridors? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- What are the barriers (technical, financial, political, or others) to achieving your community's goals for stream corridors? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- What person or group is most active/involved in your community's stream corridors? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

# Floodplain Management

## Floodplain Information

### ● Population in 100-year Floodplain

☐ 0-50      ☐ 50-300      ☐ 300-1000      ☐ 1000-5000      ☐ >5,000

### ● Population in 500-year Floodplain

☐ 0-50      ☐ 50-300      ☐ 300-1000      ☐ 1000-5000      ☐ >5,000

### ● Number of homes, businesses, industry, and farm structures in the 100-year floodplain

☐ 0-5      ☐ 5-20      ☐ 20-50      ☐ 50-100      ☐ 100-500      ☐ >500

### ● Number of homes, businesses, industry, and farm structures in the 500-year floodplain

☐ 0-5      ☐ 5-20      ☐ 20-50      ☐ 50-100      ☐ 100-500      ☐ >500

### ● Estimated assessed value of structures in 100-year floodplain

☐ <\$500,000      ☐ \$500,000      ☐ \$1 Million      ☐ \$10 Million      ☐ \$100 Million      ☐ >\$500 Million  
to      to      to      to  
\$1 Million      \$10 Million      \$100 Million      \$500 Million

### ● Estimated assessed value of structures in 500-year floodplain

☐ <\$500,000      ☐ \$500,000      ☐ \$1 Million      ☐ \$10 Million      ☐ \$100 Million      ☐ >\$500 Million  
to      to      to      to  
\$1 Million      \$10 Million      \$100 Million      \$500 Million

### ● List any critical facilities in the 100-year floodplain: (e.g., hospitals, nursing homes, police and fire stations, schools, water and sewer plants.)

\_\_\_\_\_

## Flood Related Issues

- Please list your community's major flood events that most nearly approximated a 100-year event or larger. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- Has the stream(s)/river(s) in your community suffered erosion damage related to the following (check applicable boxes).

☐

Stream Bank Erosion

☐

Channel Meandering

☐

Vertical Movement (deposition, degradation/headcutting)

If you have checked one or more of the above, please estimate the following or illustrate this information on a community map.

Linear feet of channel with instability problems \_\_\_\_\_

Acres lost to stream channel migration \_\_\_\_\_

- Does your community have a flood problem related to existing irrigation or other water delivery facilities such as canals, ditches, reservoirs, etc.?

YES NO

If yes, please illustrate on your community map or describe below. \_\_\_\_\_  
\_\_\_\_\_

## Floodplain Mapping Needs

- Do you have any stream/river reaches with unmapped (by federal, state, or local agencies) 100-year floodplains? YES NO

If yes, please show on your community map or answer in the space provided approximately how many miles of unmapped 100-year floodplains exist, and on what streams and rivers.

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- For stream/river reaches that are mapped, are they current? YES NO NOT SURE

If No, or Not Sure, Explain \_\_\_\_\_

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### Existing/Planned Mitigation Measures

- Indicate types of flood hazard mitigation measures that you use or have used and rate their effectiveness in your community.

Mitigation Measure	Currently Used in Community?		Effectiveness			Est. Dollars Expended
	YES	NO	POOR	FAIR	GOOD	
Channelization						
Levees/Dikes						
Detention/Retention						
Bridges/Culverts						
Zoning/Setbacks						
Structure Relocation						
Flood Proofing						
Floodplain Acquisition						
Flood Warning						
Stream Erosion Control						
Watershed Erosion Control						
Public Awareness						
Educational Activities						

### Single Purpose Flood Control/Stabilization Projects

- Does your community have a need for any of the following structural measures for the sole purpose of flood control or channel stabilization?

☐ Channels

☐ Bank Protection

☐ Levees

☐ Grade Control (Drop) Structures

☐ Dams

☐ Other (Specify) \_\_\_\_\_

If yes, describe the proposed measure, stream/river location and estimated cost. \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### **M**ulti-Objective Use of Stream Corridors

- Have multi-objective flood control projects (e.g., combined parks and detention basins, greenway corridors, riparian and fish habitat, etc.) been used in your community? YES NO

If yes, have the projects been effective for all purposes? YES NO

If no, explain how the project did not meet all objectives \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

- Does your community have a need for a multi-objective flood hazard mitigation, stream stabilization, or river rehabilitation project that incorporates the following uses or benefits?

YES NO If yes, check the uses or benefits that apply.

☐ Recreation (parks, trails, boating)

☐ Restoration of Natural Stream Form

☐ Open Space

☐ Wetland Protection/Enhancement

☐ Wildlife and Aquatic Habitat Enhancement

☐ Protection of Roadway & Utility Systems

☐ Improved Water Diversion/Delivery System

☐ Other (explain) \_\_\_\_\_

Operation

- If you have checked one or more of the above, describe your multi-objective project(s), location and estimated cost. \_\_\_\_\_

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- Is there a need/concern for preserving and/or mitigating the loss of agricultural lands?

YES      NO      If yes, indicate on a map where this need exists, or describe below.

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- Is your community participating in or interested in any other type of flood related project or study (for example, changes in operation of reservoirs and canal systems)? YES      NO

If yes, describe. \_\_\_\_\_

## Institutional Issues

- Does your community have:

FEMA Floodplain Regulations?	YES	NO
Additional More Restrictive Floodplain Regulations?	YES	NO
Drainage Criteria Manual or Other Adopted Drainage Design Criteria?	YES	NO
Policy for Stormwater Detention (Peak Flow Control)?	YES	NO
Drainage/Watershed Master Plan(s)?	YES	NO

- Does your community have a need for a watershed based Drainage Master Plan? YES      NO

If yes, please indicate on your community map or list below what watersheds need master planning. \_\_\_\_\_

- Would your community benefit from the development of a statewide storm drainage criteria manual that would provide uniform criteria regarding hydrology, hydraulics, detention, etc.?

YES

NO

- Does your community have a mechanism for funding flood control, flood mitigation or stream stabilization projects? YES NO If yes, describe \_\_\_\_\_

- Which of the following would interest your community as a funding mechanism?

- ☐ Flood Control Improvement District (funded by a tax base)
- ☐ Storm Drainage Fees (funded property assessment, mil levy)
- ☐ Storm Drainage Utility (funded by local revenue source)
- ☐ Special Use Tax (funded by sales tax, mil levy)
- ☐ Statewide Revolving Loan Fund
- ☐ Watershed Management District (funded by a tax base)
- ☐ Other Funding Mechanism (explain) \_\_\_\_\_

Please describe what you feel is the most significant institutional barrier to improving your community's management of its stream corridors. \_\_\_\_\_

Thank You for Taking the Time to Complete this Questionnaire!  
Good Luck in the Drawing.

November 10, 1997

Dear Organization  
Representative:



The enclosed Questionnaire was prepared by McLaughlin Water Engineers, Ltd and representatives of the Colorado Water Conservation Board (CWCB). A similar questionnaire was sent out to over 330 communities in Colorado. In the interest of broadening our perspective on floodplain and stream corridor management, we would like to solicit your comments as an important water resources or environmental organization. Please review the enclosed questionnaire and provide us with your responses to the attached questions. Your input is valued and will assist the CWCB in development of new measures and means to address flood related problems and environmental concerns on stream corridors throughout Colorado. Please return your completed questionnaire in the envelope provided by November 24, 1997. A summary of the results will be provided to all participants.

We can help! If you have questions regarding the completion or use of this *Questionnaire*, please contact:

Larry Lang, Program Manager

● Colorado Water Conservation Board  
1313 Sherman Street  
Denver, Colorado 80203  
(303)866-3441

John Pflaum, Project Manager/

Wayland Anderson, Project Engineer

● McLaughlin Water Engineers, Ltd.  
2420 Alcott Street  
Denver, CO 80211  
(303) 458-5550

## Organization Information

Organization Name \_\_\_\_\_ Address \_\_\_\_\_

Zip \_\_\_\_\_ Phone \_\_\_\_\_ Fax \_\_\_\_\_ E-mail \_\_\_\_\_

Respondent's Name & Title \_\_\_\_\_

## Organization Profile

- What is the the mission statement or main purpose of your organization? \_\_\_\_\_

\_\_\_\_\_

- What are the primary activities of your organization? \_\_\_\_\_

\_\_\_\_\_

## Floodplain Management

- What does your organization feel is the most significant floodplain problem relating to stream corridors in Colorado? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

- What does your organization value about stream corridors? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

- What are the most significant barriers (technical, financial, political, or others) to achieving your organization's goals for stream corridors? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### **Flood Related Issues**

- Does your organization believe Colorado streams/rivers have suffered excessive erosion damage related to the following (Stream Bank Erosion, Channel Meandering, Vertical Movement)?

YES      NO      If yes, describe \_\_\_\_\_

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- Does your organization believe Colorado has flood problems related to existing irrigation or other water delivery facilities such as canals, ditches, reservoirs, etc.?      YES      NO

If yes, please describe \_\_\_\_\_

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### **Floodplain Mapping Needs**

- Does your organization believe there are significant stream reaches in Colorado which need floodplain mapping or revisions to existing floodplain mapping?      YES      NO

If yes, which ones? \_\_\_\_\_

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## **M**ulti-Objective Use of Stream Corridors

- Does your organization believe multi-objective flood control projects (e.g., combined parks and detention basins, greenway corridors, riparian and fish habitat, etc.) have been used effectively in Colorado?      YES      NO

- Does your organization believe Colorado has needs for multi-objective flood hazard mitigation, stream stabilization, or river rehabilitation projects that incorporate the following uses or benefits?      YES      NO      If yes, check the uses or benefits that apply.

( ) Recreation (parks, trails, boating)

( ) Restoration of Natural Stream Form

( ) Open Space

( ) Wetland Protection/Enhancement

( ) Wildlife and Aquatic Habitat Enhancement

( ) Protection of Roadway & Utility Systems

( ) Improved Water Diversion/Delivery System

( ) Other (explain)\_\_\_\_\_

Operation

- Does your organization know of problematic or threatened stream corridors that you feel would benefit from a multi-objective solution strategy?      YES      NO      If yes, please describe

\_\_\_\_\_  
\_\_\_\_\_

- Would your organization actively participate in a multi-objective stream or river project?

YES      NO      If yes, what resources (i.e., funding, manpower, or other) would your organization be willing to commit?\_\_\_\_\_

\_\_\_\_\_

- Is your organization participating in or interested in any other type of flood related project or study (for example, changes in operation of reservoirs and canal systems)?      YES      NO

If yes, describe.\_\_\_\_\_

\_\_\_\_\_

- Does your organization believe there is a need/concern for preserving and/or mitigating the loss of agricultural lands?      YES      NO

## Existing/Planned Mitigation Measures

Provide your organization's rating of the effectiveness of the following flood hazard mitigation measures in Colorado.

Mitigation Measure	Currently Used in Organization?		Effectiveness		
	YES	NO	POOR	FAIR	GOOD
Channelization					
Levees/Dikes					
Detention/Retention					
Bridges/Culverts					
Zoning/Setbacks					
Structure Relocation					
Flood Proofing					
Floodplain Acquisition					
Flood Warning					
Stream Erosion Control					
Watershed Erosion Control					
Public Awareness					
Educational Activities					

## Institutional Issues

- Does your organization believe that Colorado has a need for watershed based Drainage Master Plans? YES NO
- Does your organization believe that Colorado would benefit from the development of a statewide storm drainage criteria manual that would provide uniform criteria regarding hydrology, hydraulics, detention, etc.? YES NO

- Does your organization believe Colorado currently has adequate mechanisms for funding flood control, flood mitigation or stream stabilization projects?    YES    NO

- Which of the following funding mechanisms would be supported by your organization?

- ☐ Flood Control Improvement District (funded by a tax base)
- ☐ Storm Drainage Fees (funded property assessment, mil levy)
- ☐ Storm Drainage Utility (funded by local revenue source)
- ☐ Special Use Tax (funded by sales tax, mil levy)
- ☐ Statewide Revolving Loan Fund
- ☐ Watershed Management District (funded by a tax base)
- ☐ Other Funding Mechanism (explain)\_\_\_\_\_

- What kinds of problems or needs (e.g., public awareness and education needs) do you see in the realm of water resources - including floodplains, waterways, stream rehabilitation, fish and wildlife habitat and watersheds? Needs could be in schools, government agencies, the public generally, or specific groups).\_\_\_\_\_

\_\_\_\_\_

- What programs or funding sources address the needs that you identified above (e.g., to develop educational materials)?\_\_\_\_\_

\_\_\_\_\_

- What programs and supports does your organization receive?\_\_\_\_\_

\_\_\_\_\_

- Is there adequate support for reproducing, communicating and disseminating water resources information?    YES                      NO                      If not, what are high priorities?\_\_\_\_\_

\_\_\_\_\_

- Have you interacted with the CWCB Office of Water Conservation? YES    NO

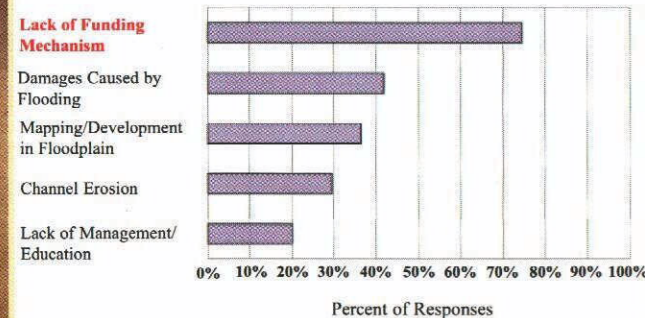
What suggestions do you have for its future role in water resources education?\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

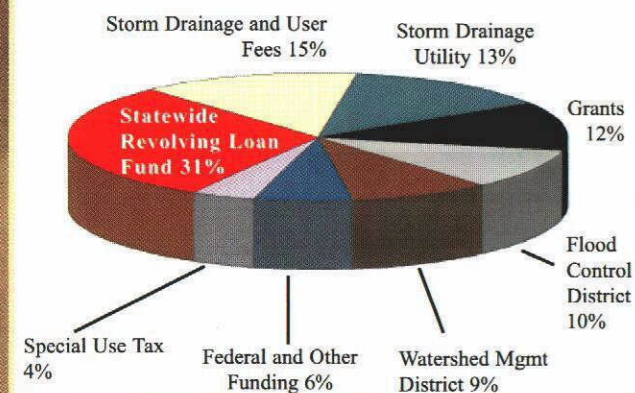
## Survey Findings

### Problems Identified with Flooding

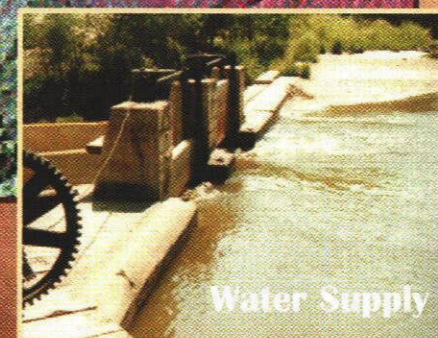
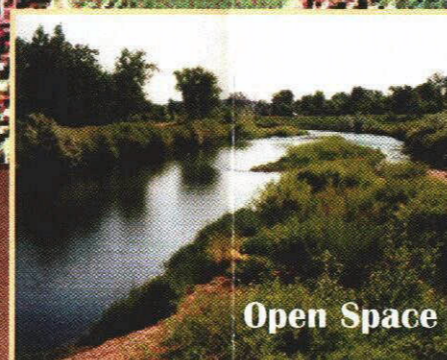
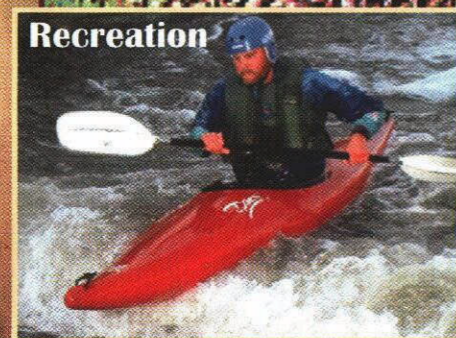
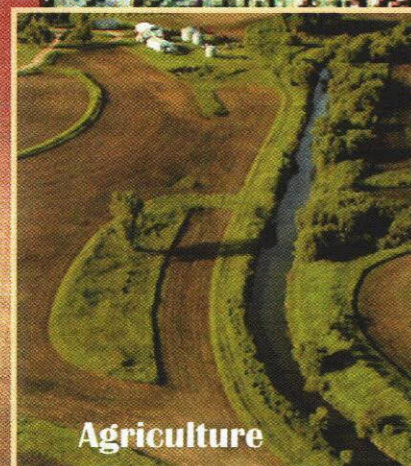
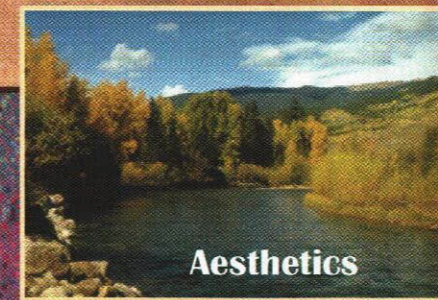
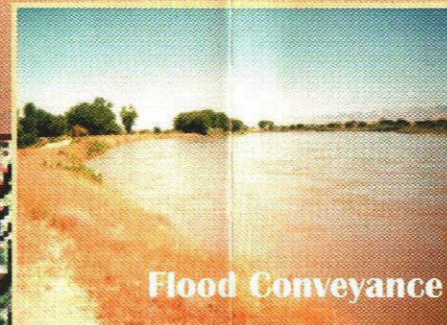
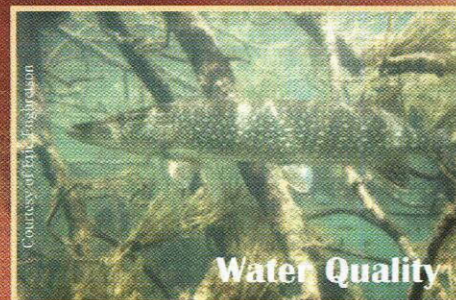


To assess the floodplain management and stream rehabilitation problems and concerns across the state, the CWCB in cooperation with its steering committee, contracted McLaughlin Water Engineers, Ltd., Denver, Colorado, to conduct a statewide needs inventory. A detailed questionnaire was distributed to more than 400 communities, special districts, environmental organizations and other water related groups. The questionnaire solicited data regarding flood hazards, floodplain management, multiple use of stream corridors and institutional issues such as regulations, criteria, and fiscal and legal problems.

### Requested Funding Mechanisms



## Values of Stream Corridors



**Multi-Objective Management is the Key**

## Goals for Stream Corridors

- ❖ To reduce the loss of life, disruption, and damage caused by floods
- ❖ To preserve and restore the natural resources and functions of floodplains

## How Do We Get There?

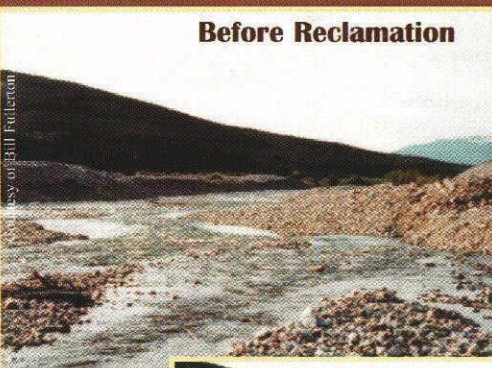
The Steering Committee, in cooperation with CWCB staff and McLaughlin Water Engineers, recommend a program to address the following actions:

- ❖ Provide funding for multi-objective watershed planning studies for Colorado's major river basins, stream rehabilitation analysis for selected stream reaches, and community-based mitigation projects.
- ❖ Create a statewide revolving loan fund to enable communities to implement flood protection and stream rehabilitation projects.
- ❖ Establish a statewide wetlands bank.
- ❖ Expand the ongoing program for floodplain mapping.
- ❖ Prepare a statewide model stormwater criteria manual.
- ❖ Set minimum criteria for detention of excess runoff from development.

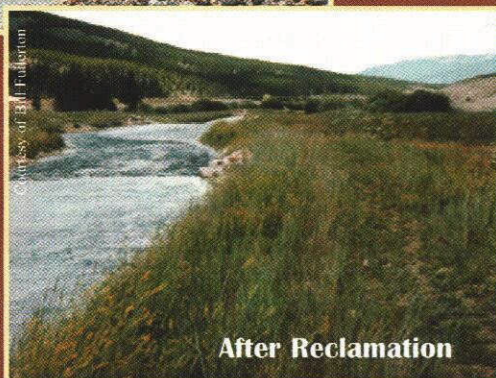
## Benefits

Before Reclamation

Blue River  
Reclamation  
Project,  
Breckenridge,  
Colorado



After Reclamation



With adequate funding Colorado can:

- ❖ Reduce Flood Losses and Save Lives
- ❖ Preserve Stream Characteristics and Water Quality
- ❖ Repair Degraded Stream Channels
- ❖ Maintain Agricultural Uses
- ❖ Promote Open Space Uses
- ❖ Enhance Wildlife Habitat

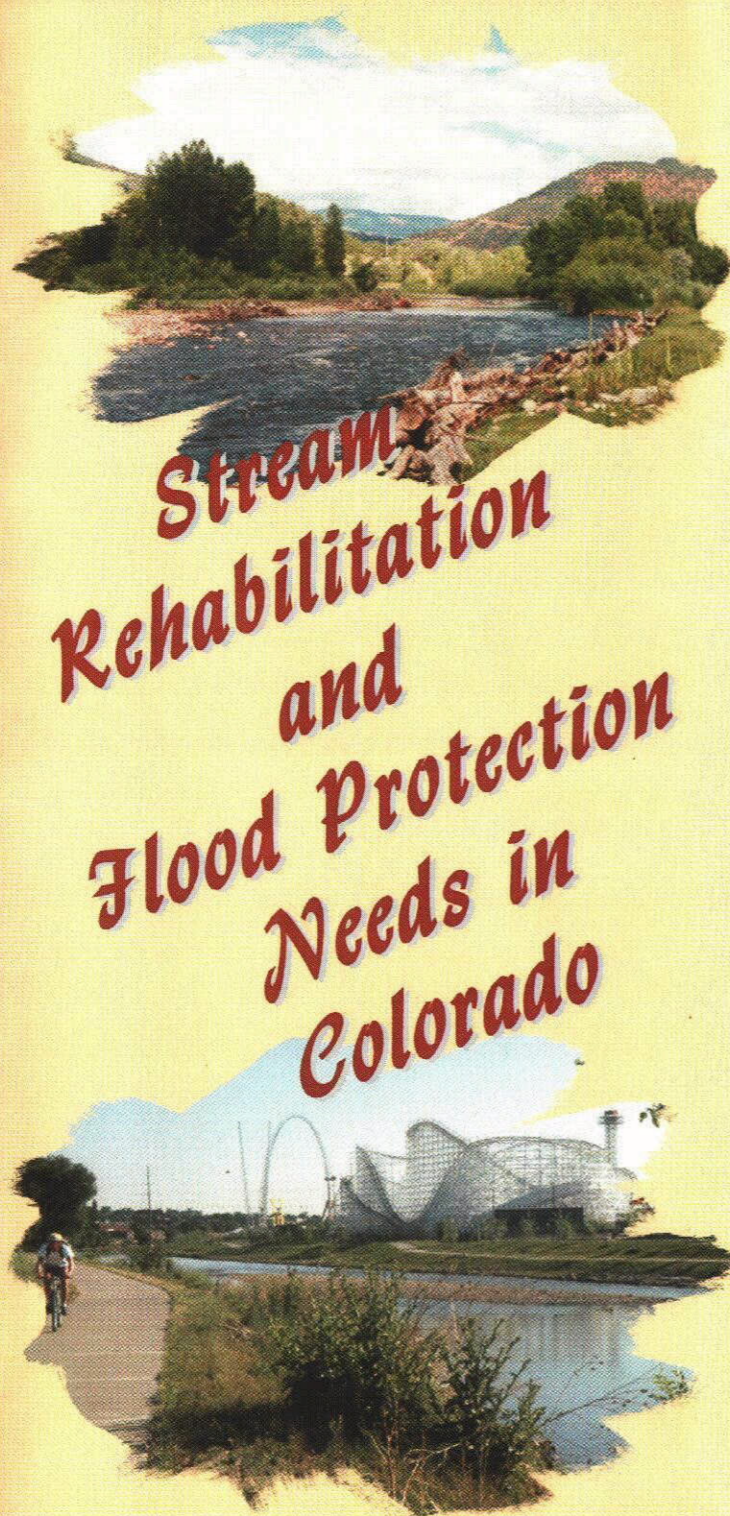
Department of Natural Resources



**Colorado Water  
Conservation Board**

721 Centennial Bldg. ♦ 1313 Sherman Street  
Denver, CO 80201 ♦ (303) 866-3441

## Stream Rehabilitation and Flood Protection Needs in Colorado

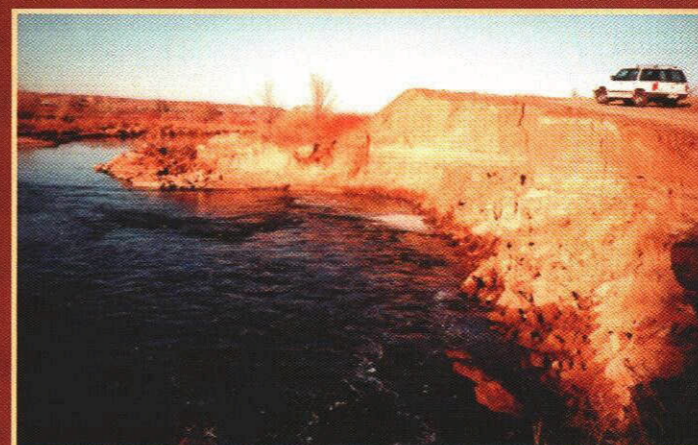


**Colorado Water  
Conservation Board**

## What's the Need?

### Stream Rehabilitation

**NEED** - Many streams throughout Colorado are experiencing erosion from natural processes and human activities and practices. Streambank erosion and channel degradation can harm fish habitat, destroy agricultural land and damage private property. Rehabilitation measures are needed to stabilize threatened stream corridors, preserve the natural resources and functions of floodplain areas, and increase flood capacity.



**Fact** - 80 % of Colorado's wildlife species use floodplains and stream riparian corridors as their habitat.

Stream Rehabilitation measures can include:

- ❖ Channel Stabilization Measures
- ❖ Riparian Habitat Improvements
- ❖ Wetland Area Enhancement
- ❖ Eroded Streambanks Repair
- ❖ Open Space Preservation

### Flood Protection

**NEED** - There is a clear need for improved floodplain management to reduce the at-risk human population's vulnerability to flooding and prevent further encroachment into flood hazard zones by man. There is also a need to improve stream maintenance and implement flood protection measures to reduce annual flood losses.

Stream flooding remains the greatest hazard to life and property in Colorado. Today, flood-prone areas have been identified in 268 cities and towns and in all of the 63 counties in Colorado. As many as 250,000 people are estimated to reside in Colorado's 100-year floodplains, with property valued at more than \$11 billion.

**HISTORY** - Seventy-five percent of Colorado's disasters are flood disasters! Selected major events include:

1896	Bear Creek at Morrison
1921	Arkansas River at Pueblo
1935	Monument Creek at Colorado Springs
1955	Purgatoire River at Trinidad
1965	South Platte River at Denver
1969	South Platte River Basin
1970	Southwest Colorado
1973	South Platte River at Denver
1976	Big Thompson River in Canyon
1982	Fall River at Estes Park
1984	Western and Northwestern Counties
1993	Western Slope Communities
1995	Statewide Colorado
1997	Fort Collins and 13 Eastern CO Counties