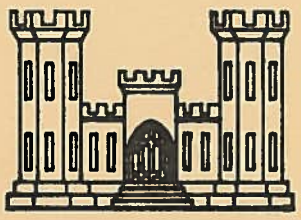
REPORT ON SURVEY

DRY CREEK
FLOOD CONTROL
EPHRATA, WASHINGTON



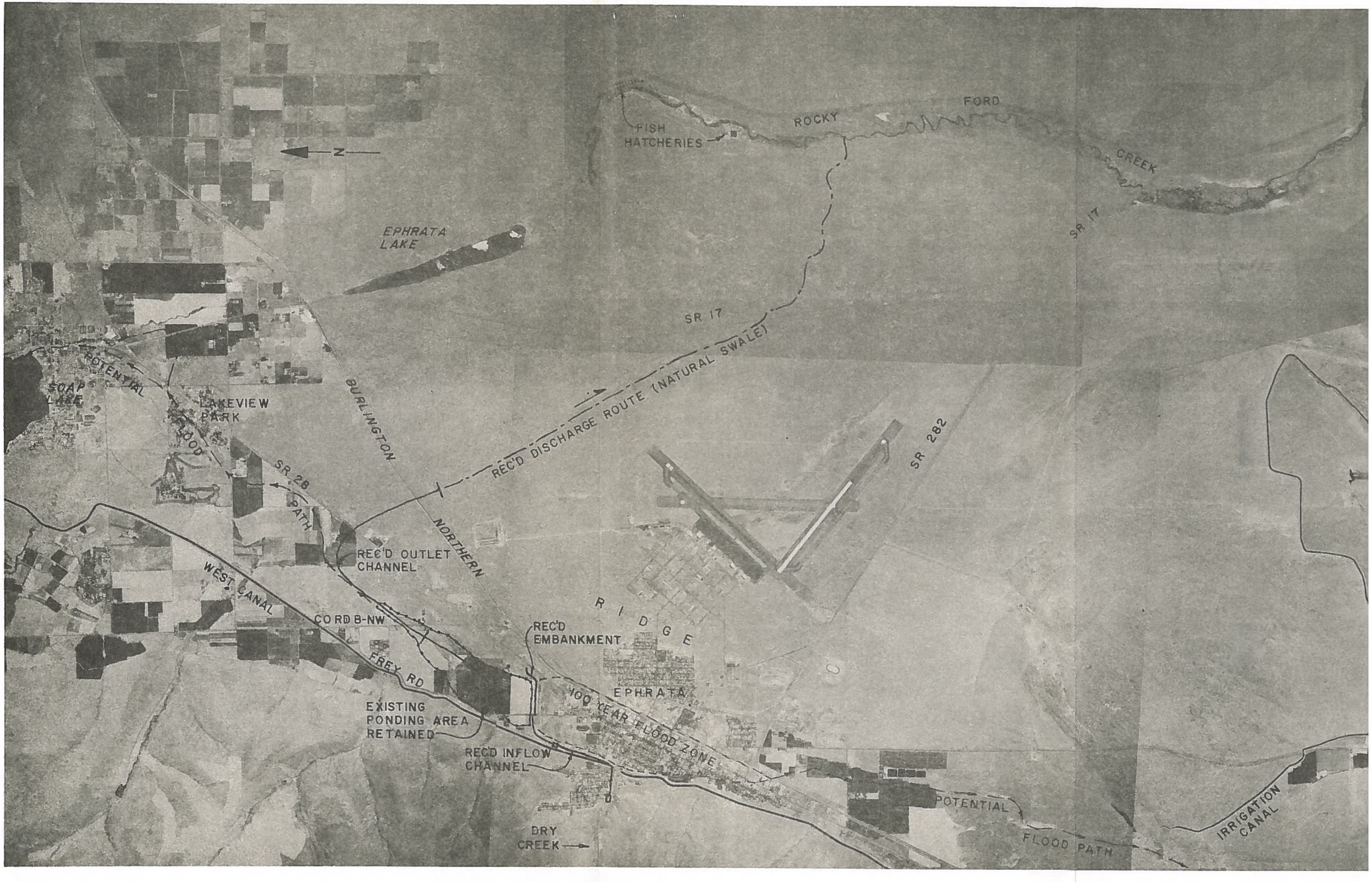
MAY 1973

DEPARTMENT OF THE ARMY

SEATTLE DISTRICT, CORPS OF ENGINEERS

SYLLABUS

The cities of Ephrata and Soap Lake, Washington, intervening crop and grazing lands, and State Highway 28 are subject to damage from flooding of Dry Creek, an intermittent stream which carries snowmelt and rainfall runoff through the city of Ephrata toward Soap Lake, 6 miles away. Normally, runoff is held in a natural ponding area just beyond the limits of Ephrata where it is dissipated by ground infiltration. However, floods greater than a 20-year flood would exceed the capacity of the existing channel and ponding area. A number of alternative measures for reduction of flood damages were investigated and the best alternative is considered to be an improved channel to the ponding area and an outlet channel from the ponding area, discharging into Rocky Ford Creek. This is recommended by the District Engineer. The cost of construction is estimated at $3,070,000 of which $2,630,000 would be the cost to the United States and $440,000 the cost to local governments for road and utility modification and right-of-way acquisition. The ratio of annual benefits to annual charges is 1.7.


N
EPHRATA LAKE
FISH HATCHERIES
ROCKY FORD CREEK
SR 17
SR 17
REC'D DISCHARGE ROUTE (NATURAL SWALE)
SOAP LAKE
POTENTIAL FLOOD PATH
LAKEVIEW PARK
BURLINGTON NORTHERN
SR 282
SR 28
PATH
REC'D OUTLET CHANNEL
WEST CANAL
CORD B-NW
RIDGE
REC'D EMBANKMENT
FREY RD
EPHRATA
100 YEAR FLOOD ZONE
EXISTING PONDING AREA RETAINED
REC'D INFLOW CHANNEL
DRY CREEK
POTENTIAL FLOOD PATH
IRRIGATION CANAL

REPORT ON SURVEY
DRY CREEK
EPHRATA, WASHINGTON

CONTENTS

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
1519 ALASKAN WAY SOUTH
SEATTLE, WASHINGTON 98134

NPSEN-PL-BP 15 May 1973

SUBJECT: Dry Creek, Ephrata, Washington - Report on Survey

Division Engineer, North Pacific

I - INTRODUCTION

AUTHORITY

1. This study was made under authorization conferred by a resolution of the Committee on Public Works of the House of Representatives, as follows:

> "Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the reports of the Chief of Engineers on Columbia River and Tributaries, published as House Document Numbered 403, Eighty-seventh Congress, Second Session, and other pertinent reports, with a view to determining whether improvements for flood control and other purposes along Dry Creek at and in the vicinity of Ephrata, Washington, are advisable at this time."
>
> George H. Fallon, Chairman. Adopted October 19, 1967. (Requested by Representative Catherine May)

PURPOSE AND SCOPE

2. This report is of survey scope and in full response to the authorizing resolution. The study examined needs and possible measures relative to all water and land resources in the study area, with emphasis on flood damage reduction. An investigation was made of past and potential future effects of large magnitude discharges at the mouth of the canyon containing Dry Creek, resulting from snowmelt and rainfall in the Beezley Hills behind Ephrata, Washington. The historical and potential damage area includes a large, intensively developed part of Ephrata, the unincorporated community of Lakeview Park, the town of Soap Lake, and intervening crop and grazing land, all shown on plate 1. A number of possible local flood control measures were evaluated and recommendations made regarding the measure that best

meets engineering, environmental, and economic criteria and the desires of the public. Detailed technical material is contained in the appendices bound at the end of this report.

EXTENT OF INVESTIGATIONS

3. Public involvement in planning. In addition to the public brochure, described in the next paragraph, the public was invited to participate at the following meetings.

a. An initial public meeting was held at Ephrata 9 April 1969. Of 59 persons besides Corps of Engineer personnel who attended, 9 gave testimony. Sixteen statements and several informal written comments were submitted. Representation included Congresswoman Catherine May, 22 Federal, State, county, district, and city officials, 8 businessmen, 4 members of civic organizations, and 24 other individuals.

b. An invitational workshop was conducted in Ephrata 13 May 1971 to review study findings, discuss possible solutions to the flood problem, and make plans for another public meeting. Twenty-six persons met with Corps personnel--16 Federal, State, county, and city officials, 4 business men, 1 member of a civic organization, and 5 other individuals.

c. A formulation-stage public meeting was held by the District Engineer in Ephrata on 1 December 1971. The meeting was attended by 47 persons in addition to Corps of Engineer personnel. These included a representative of the district's Congressman, 23 Federal, State, county, and city officials, 5 members of civic organizations, and 18 other individuals. The consensus of the meeting was that a flood discharge channel should be provided, the location to depend upon the results of detailed studies. All other alternatives were eliminated.

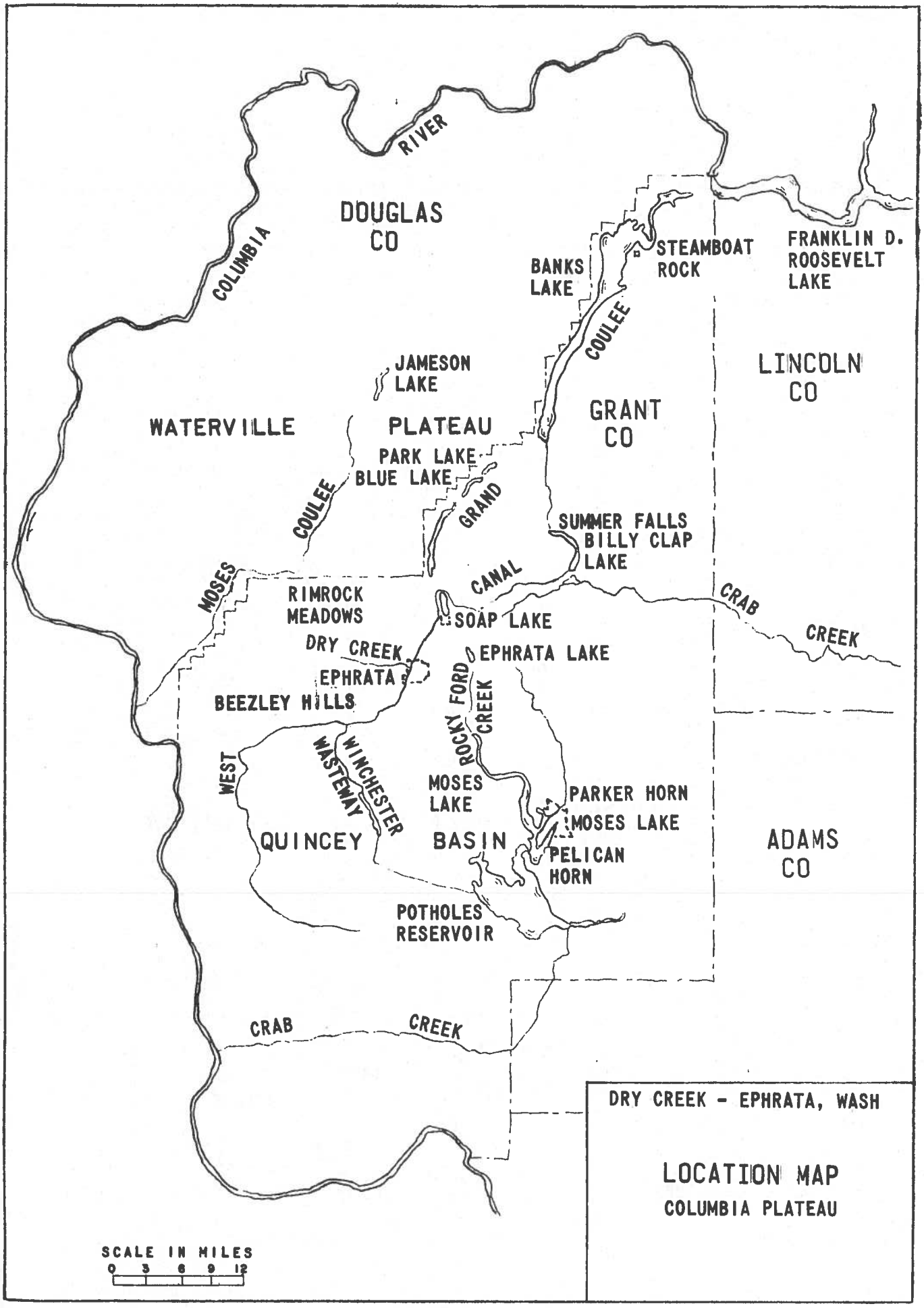
d. The final public meeting was held by the District Engineer in Ephrata on 16 November 1972. In addition to Corps of Engineer personnel, 25 persons were in the audience, representing landowners, sportsmen's groups, the Burlington Northern Railroad, the City of Ephrata, Grant County, Washington Departments of Highways, Natural Resources, Game, and Ecology, the Bureau of Sport Fisheries and Wildlife, and the Soil Conservation Service. The District Engineer announced that detailed studies subsequent to the previous public meeting had led to the conclusion that the most feasible plan would require flood waters to be diverted toward Rocky Ford Creek. This decision was supported by the Washington Department of Game. A suggestion made for another method of diversion to Ephrata Lake instead of Rocky Ford Creek was evaluated after the meeting and found too costly. Study participants were advised by mailed notices of the content of the final meeting and the result of study of the alternative which had been suggested at that meeting.

4. Public brochure. Starting in 1971 public participation in planning was assisted by development of a Public Brochure, displaying data on alternative measures suggested by individuals, groups, and agencies. Space was provided for comments pro and con with regard to each alternative. In addition, the brochure contained a description of the flood situation, a history of the study to date, plans for the remainder of the study, and requirements for Federal and local participation in flood control measures. A preliminary form of the brochure was reviewed at the workshop in May 1971 and the first draft was mailed in duplicate to all interested parties in October 1971 with preaddressed envelopes and a request that one copy be returned, marked with additional comments on the alternatives. Based on the response to this mailing an enlarged second draft of the brochure was available for distribution at the formulation-stage public meeting on 1 December 1971. That draft contained a resume of reasons for eliminating alternatives or retaining them for further study. The availability of the brochure was made known through the local press; copies were kept on hand at the Ephrata City Hall and could be obtained by letter or telephone request from the Seattle District Office. A revised draft, describing results of detailed studies of the selected alternatives, was prepared and mailed out prior to the final public meeting, held 16 November 1972. The most recent edition of the brochure is included with this report as appendix A.

5. Field and office studies. Hydrologic data developed include flow frequency curves, flood hydrographs, and a preliminary Standard Project Flood. Aerial photographs were taken and a photo mosaic made, but topographic surveys were not considered necessary, except for details of the existing flood control system, in view of the availability of excellent Bureau of Reclamation contour maps. Soils investigations included a geological reconnaissance, foundation borings, percolation tests, and exploration for sources of construction materials. Design layouts and cost estimates were made for a debris basin, lined and unlined channels, a stilling basin, and culverts for flows of various frequencies. Studies of storage dams were less detailed and intended to provide reasonable approximations of construction costs. Hydrologic, geologic, and design data are given in appendix B. For purposes of economic analysis, a flood damage appraisal, an economic environment study, and projections of future growth were made and benefits of various alternatives computed. Land values were covered in a real estate appraisal report. Economic data are given in appendix C. Preparation of the Environmental Impact Statement involved coordination with State and Federal fish and wildlife and environmental agencies. Their comments are attached as exhibits at the end of the report. Additional coordination was maintained with State and Federal recreation agencies, the Bureau of Reclamation, and the Soil Conservation Service. A field inspection of the study area was made by the District Engineer 1 December 1971.

RELATED REPORTS

6. The only other report related to this study is a reconnaissance report made by the Corps of Engineers under provisions of section 205 of the Flood Control Act of 1948. On 8 January 1965 the mayor of Ephrata wrote the Corps of Engineers asking for a survey of the annual snowmelt flood situation and advice on the best method to correct the problem. In 1967, studies under section 205 were terminated because estimated Federal construction costs would have exceeded the statutory limitation of $1,000,000. The solution on which the cost estimate was based consisted of replacing the existing channel carrying Dry Creek flows to a ponding area north of Ephrata with concrete and unlined channels, an improved embankment at the south end of the ponding area, and an outlet channel to a natural swale which would direct excess flows toward Rocky Ford Creek. Local interests were not financially able to pay Federal costs in excess of $1,000,000 and in June 1967 asked their Congressional representatives to request the House Committee on Public Works to authorize a review of reports by the Board of Engineers for Rivers and Harbors. The report reviewed, House Document Numbered 403, 87th Congress, 2nd Session, commonly known as the 1958 Columbia River Report, does not deal specifically with Dry Creek.



DRY CREEK - EPHRATA, WASH

LOCATION MAP

COLUMBIA PLATEAU

II - BASIN DESCRIPTION

LOCATION AND EXTENT

7. The study area, shown on plate 1, includes the 27-square-mile drainage basin of Dry Creek; the cities of Ephrata, at the mouth of Dry Creek, and Soap Lake, 6 miles northeast, and the intervening flood plain; Ephrata Lake, 3 miles northeast of Ephrata; and Rocky Ford Creek, a tributary of Crab Creek, 5 miles east of Ephrata. This area is in Grant County on the Columbia Plateau of eastern Washington, 120 road miles west of Spokane. The geographical relationship of the study area to other parts of the Columbia Plateau is shown on the preceding location map.

PHYSIOGRAPHY

8. To the north of the study area is the Waterville Plateau, a large broken expanse of generally high land, with elevations of 2000 to 3000 feet, between the Columbia River and the Grand Coulee. The southern limit of the Waterville Plateau is formed by the Beezley Hills, which drop to the extensive flat plain of the Quincy Basin where elevations are generally 1200 to 1300 feet. The drainage basin of Dry Creek occupies the east end of the Beezley Hills and Ephrata lies at their base, about elevation 1280, where Dry Creek emerges onto the Qunicy Basin. About one-half mile east of the hills is a low north-south ridge about 10 miles long, which forces discharge from Dry Creek either north or south into closed basins. Since 1901 natural flow has been northward. Immediately north of the city is a natural ponding area one and a half miles long and half a mile wide, in which ordinary discharges of Dry Creek may pond up to elevation 1266.5. North of this ponding area the terrain slopes irregularly downward for 3 miles to Soap Lake. East of Ephrata, past the low ridge, the land slopes downward in undulations to Ephrata Lake and Rocky Ford Creek, the latter a southward-flowing tributary of Crab Creek, which is the major drainage for this portion of the Columbia Plateau.

CHARACTERISTICS OF STREAMS AND LAKES

9. The name "Dry Creek" has been arbitrarily assigned to the longest of a network of 10 major ravines draining the 27-square-mile basin within the Beezley Hills. In its 9-mile length the creek bed falls 1,400 feet from elevation 2700 to 1300. The gradient is fairly uniform, averaging about 150 feet per mile. Near its mouth at Ephrata the creek bed is about 20 feet wide, with steep sides.

10. Soap Lake, 6 miles northeast of Ephrata, is a permanent body of mineralized water about 2.5 miles long and 0.5 mile wide, with surface elevation about 1074. The city of Soap Lake is at the south end of the lake.

11. Rocky Ford Creek, the nearest permanent stream, rises at about elevation 1070, 5 miles due east of Ephrata in a picturesque canyon, fed by springs in the canyon wall. Seven air miles south of the springs

it enters the northern extremity of Moses Lake, average elevation about 1046, where it becomes part of the Crab Creek mainstream. For most of its length the gradient of Rocky Ford Creek, as it meanders over the 1000-foot-wide canyon floor, averages about 1.5 feet per mile.

12. Ephrata Lake is a former dry depression, 2 miles long and a fifth of a mile wide, slightly over a mile northwest of the head of Rocky Ford Creek. The lake bottom is about 50 feet higher than the headwaters of Rocky Ford Creek. The lake basin has a maximum depth of 26 feet and a capacity of 3,600 acre-feet. Prior to initiation of large-scale irrigation in the Columbia Basin, only a small pond marked the equilibrium between inflow from springs and evaporation. The subsequent rise in elevation of the local water table resulting from irrigation is reflected by the 11 feet of alkaline water which now occupies the lower 1,000 acre-feet of the lake basin.

GEOLOGY AND SOILS

13. The dominant rock of the area is the Columbia River Basalt, which underlies both the Beezely Hills and the Quincy Basin. Between the Beezley Hills and Rocky Ford Creek the rock is covered by as much as 100 feet of glacial flood gravels mixed with sands and silts. The low north-south ridge just east of Ephrata is a large gravel bar, which, like the other gravels, was deposited by large volumes of water from the Grand Coulee during the closing stages of the ice age. Large scattered boulders are visible on the surface of the gravel plain. Outwash from Dry Creek has formed an alluvial fan on which much of Ephrata is built. The fan consists of 6 to 30 feet of silt, mixed with beds of sand and gravel, lying on top of older partly cemented sands and gravels of the Ringold formation. Dry Creek alluvium extends beyond Ephrata in a narrow strip to the north and south, several miles long.

CLIMATE

14. The study area lies within a climatic region which is dominated through the winter months by modified maritime air and during the summer months by dry continental airmasses. The climate is characterized by cold but not normally severe winters and hot, dry summers. Climatological data is available from records of the National Weather Service station at Ephrata. Average monthly temperatures there vary from 20° F to 33° F in January and from 62° F to 90° F in July. During an average year temperatures fall below freezing on 115 days and below zero on 3 days, and rise above 90° on 44 days. The average growing season is 185 days long. Annual precipitation averages 8 inches. An average of 1 inch falls in January and 0.2 inch in July. Fifty percent of the annual precipitation occurs in October through February, a large part in the form of snow. The 20 percent which falls from May through August results from thunderstorms. In May 1912 a record 1-day rainfall of 1.75 inches took place. Heavy thunderstorm precipitation over part of the Dry Creek basin west of Ephrata occurred in May 1948. Annual snowfall averages 18 inches, but occasional chinook winds usually prevent accumulation of more than a few inches.

VEGETATION AND WILDLIFE

15. Native vegetation within the Dry Creek basin and the adjacent plain to the east is confined largely to sagebrush and grasses. Several varieties of trees have been planted in communities and farmsteads, and wheat is cultivated extensively by dry farming methods on the rolling hills of the drainage basin. The only large game animal in the vicinity of Ephrata is the mule deer. Smaller species include whitetailed and blacktailed jackrabbits, cottontail rabbits, rock chuck, badger, racoon, and skunk. Coyotes and bobcats are trapped for their pelts. Furbearers inhabiting the shores of Rocky Ford Creek include beavers (bank dwellers, lacking the material for dams), muskrat, and mink. Imported ring-necked pheasant, chukar partridge, hungarian partridge, and valley quail share their habitat with native sage grouse and mourning doves. There are 15 species of duck along Rocky Ford Creek. Fish habitat is limited to Rocky Ford Creek, which contains rainbow trout and carp from Moses Lake. Ephrata Lake has been found to be too shallow and warm to support rainbow trout and, because of its mineral content, there are no fish in Soap Lake.

ECONOMIC DEVELOPMENT

16. There are no communities in the Dry Creek basin above Ephrata, only scattered farmsteads. However, the flood plain, north from the mouth of Dry Creek to Soap Lake includes the cities of Ephrata and Soap Lake and the unincorporated community of Lakeview Park. These developed urban areas occupy about half of the total flood plain. Since 1909 Ephrata has been the seat of Grant County and until the 1950's its largest city. Ephrata came into prominence just after 1940 as construction headquarters for the Columbia Basin (irrigation) Project and only since the mid-1950's has Moses Lake in the heart of the irrigated area exceeded it in population. Ephrata remains an important county center with a 1970 population of 5,255. Still the site of county government and Bureau of Reclamation operations, it also is the location of a public utility district office responsible for two major Columbia River dams and power distribution therefrom. Administration is the principle occupation of Ephrata, the three aforementioned activities employing 1,400 out of a work force of 2,000. Ephrata is a prosperous appearing, progressive city with 7 schools, 10 hotels and motels, a 60-bed general hospital, 14 churches, 2 newspapers, and a radio station. For recreation and cultural pursuits there are 4 parks, a swimming pool, 2 theaters, a golf course, library, and historical museum. A municipal recreation complex under construction in the south end will include two lakes, a large picnic area, trailer court, and golf course.

17. Soap Lake is a resort town 6 miles northeast of Ephrata on the body of water called Soap Lake (from the lather formed when the wind whips its mineral waters.) In 1970 its population was 1,064, many involved incatering to tourists. The unincorporated community

of Lakeview Park lies just outside its boundaries to the south. Approximately 2,000 persons live in the unincorporated areas surrounding Ephrata and Soap Lake. Ephrata and Soap Lake together support about 250 business and professional establishments. There are half a dozen small industries in Ephrata based on steel, aluminum, and concrete products, altogether employing about 100 persons. A commercial trout hatchery on Rocky Ford Creek supplies trout eggs to markets throughout the United States and Europe. In recent years two other firms have become established, a box car salvaging operation employing about 50 persons and an indoor hog raising plant. Ephrata and Soap Lake are on State Highway 28, which is 4 lanes wide between the cities, and are connected by State Highway 17 to Moses Lake, 23 miles away. The State's two major east-west arteries, US 2 and Interstate 90 lie a short distance to the north and south respectively. The study area is approximately midway between Seattle (160 miles) and Spokane (120 miles.) It is served by 10 trucking companies, a major bus line, the Burlington Northern railroad (freight only), and a regional airline which utilizes the 7,300-foot-runway municipal airport immediately east of Ephrata.

18. A development which may have a significant bearing on the future growth of the area is the platting and offering for sale of 15,000 one to 20-acre lots at Rimrock Meadows in the Moses Coulee country, 15 miles northwest of Ephrata. Should the 1971-72 sale of 1,450 lots at an average price of $4,000 each be followed by an influx of population and home construction, the demand for services from the Ephrata-Soap Lake urban center would increase considerably. The primary concern of the area at present, however, is agriculture. The main irrigation canal passing through Ephrata divides the dry wheat farming to the north and west from the irrigated farming and sheep-grazing plains to the south and east. Within 15 miles of Ephrata are 150,000 acres of irrigated and dry farm land and pasture, with production valued at $15,000,000 annually. Products consist chiefly of forage such as alfalfa, corn silage, and grass; grains such as wheat, barley, and oats; potatoes, sugar beets, and seed crops; vegetables such as beans, peas, and corn for processing; and wool, cattle, and dairy products. Both sprinkler and gravity flow methods are used on irrigated farms immediately north and south of Ephrata. Construction of another main canal, the East High, resulting in irrigation of additional lands to the north and east, could have some bearing on Ephrata's future growth.

19. A growth rate of 0.8% annually is predicted for the study area, which in 50 years would give a population of about 7,500 for Ephrata and about 1,500 for Soap Lake. This conservative forecast is based on the assumption that the area will grow at least at the average rate forecast by the Office of Business Economics for the surrounding nine-county area in northeastern Washington. Increases in agricultural productivity from technical improvements and extension of irrigation in the service area, steady development of recreational facilities, and a moderate influx of new processing industries support this assumption.

III - WATER AND LAND RESOURCES AVAILABILITY AND MANAGEMENT

SURFACE WATER

20. Dry Creek. Surface water runoff in the Dry Creek drainage basin, shown on plate 1, takes place intermittently when a thunderstorm or rapid snowmelt combined with rainfall occurs. Often the water is absorbed into the hillside soil or streambeds. However, if the ground is frozen or wet, runoff in substantial quantities reaches the mouth of Dry Creek. No records of streamflow have been kept, but from experience in similar nearby areas, peak flow frequencies are estimated as follows:

Peak flow (cfs)	Average recurrence interval (years)
680	5
1,300	10
2,150	20
3,700	50
5,000	100

This is depicted as a flow frequency curve in figure B-1 of appendix B. The most severe combination of weather and runoff conditions reasonably characteristic of the area, such as an intense thunderstorm centered over the drainage basin, could result in a peak flow of 15,000 second-feet, the Standard Project Flood.

21. Before 1940, when the construction of municipal water supply wells in Dry Creek canyon was begun, a small perennial stream called Canyon Creek, fed by springs, was used by early settlers for domestic purposes and stock watering. Eventually a crude timber diversion dam was built and water conveyed to a pond for ice-making in the winter. In 1901 a severe flood destroyed the dam and changed the course of the stream below the canyon mouth from south to north. From then on until construction of the Columbia Basin Project, spring runoff served the purpose of irrigating farm lands north of the town by ponding. Prior to 1958 Dry Creek, in running north from the canyon mouth, passed under 1st Avenue NW by means of a box culvert. In 1958, with State assistance, the box culvert was replaced by a corrugated metal arch culvert 10 feet high, 24 feet wide, and 100 feet long. A steel sheet pile training wall, 250 feet long, turns the creek in the direction of the culvert. Creek waters are thence carried northward in a channel paralleling the adjacent West (irrigation) Canal. The channel has a capacity of 2,200 cfs. which represents a flow having an estimated recurrence interval of 20 years. About 3,500 feet north of 1st Avenue NW the channel turns eastward, releasing discharges into a ponding area north of Ephrata. The ponding area is 1.5 miles long and nearly one-half mile wide and has a capacity for storing about 1,800 acre-feet. A low embankment is intended to prevent the extension of ponding southward into Ephrata,

but has a top elevation 3 feet below the maximum potential ponding elevation. Because of the fine materials used in construction, the embankment is subject to failure from erosion whenever flow exceeds 560 second-feet, which is approximately a 4-year flow.

22. Rocky Ford Creek. Records of Rocky Ford Creek flow, 1.5 miles below its source, have been kept, briefly in 1910-11 and continuously since 1942. Flow varies uniformly from about 50 cfs in late winter to 110 cfs in late summer. Water temperature remains near 52 degrees. The spring-fed headwaters of Rocky Ford Creek became the site of a commercial fish hatchery in 1945, most of the creek flow being routed through rearing ponds before being released downstream. In 1971 the site was purchased by the Washington Department of Game and the commercial facility was reconstructed a mile downstream. The Department of Game plans to construct a State hatchery at the original site. Dikes across the lower reaches of the creek allow land owners to raise the water surface for irrigation by closing culverts.

23. Soap Lake. The outstanding recreational attraction in the study area is Soap Lake. In its stark desert setting under the basalt cliffs of the Grand Coulee it furnishes an unusual swimming experience and its dark sand beaches are popular with visitors from many places. Therapeutic benefits are claimed, accounting for the large town hospital originally constructed by the State of Washington about 1939 for the treatment of Buerger's Disease. Soap Lake residents zealously defend the lake against pollution or dilution. In this regard the Bureau of Reclamation has installed pumps to intercept the additional ground water flow brought about by the Columbia Basin Project. The lake has such a high concentration of mineral salts that it is unusable for irrigation and supports no life except minute crustaceans.

24. Irrigation canals. There is no natural body of surface water in the study area capable of providing for irrigation or water supply. However, as a result of the Columbia Basin Project, irrigation water is available in large quantities from Franklin D. Roosevelt Lake behind Grand Coulee Dam on the Columbia River. Water is pumped from the lake into the Grand Coulee (Banks Lake) and conveyed thence by canal and pipeline to Long Lake and the main canals serving three irrigation districts. The West Canal, capacity 5,200 cfs, runs just west of Soap Lake and Ephrata to the Quincy Irrigation District, which furnishes water to land east of Soap Lake, between Soap Lake and Ephrata, and to large blocks of farmland further south. The canal passes under Dry Creek and 1st Avenue NW in Ephrata by means of an inverted siphon. The Winchester Wasteway, leading from the West Canal at a point 9 miles southwest of Ephrata to the Potholes Reservoir near Moses Lake, provides a 3,400-cfs-capacity relief route for excess water in the system and a collection channel for irrigation return flows. In 1972 516,000 acres of the Columbia Basin Project were under irrigation, with an additional 579,000 acres available

for future development. Most of this future development will depend upon construction of another main canal (East High) along the eastern edge of the Project.

GROUNDWATER

25. The groundwater table at the west edge of Ephrata lies at about elevation 1220, higher in the hills immediately to the west, and falling off to the east until appearing at Ephrata Lake at about elevation 1130 and at Rocky Ford Creek in the form of springs at elevation 1080. The city of Ephrata draws upon this groundwater for its municipal supply, using 7 wells varying in depth from 260 to 1,360 feet with a total capacity of 4,725 gpm. Water quality is good and no treatment is required; chemically it is slightly hard and slightly alkaline. North of Ephrata underground flow is to the northeast; south of Ephrata it is to the southeast. In this area the water table has been rising since 1950 when irrigation began to be practiced north of Ephrata, however it now appears to be stabilizing. In order to maintain Soap Lake at its normal elevation of 1074 seven wells with a total pumping capacity of 17 cfs are used to pump ground water in the vicinity of the lake into the nearest main irrigation canal.

LAND

26. The silty soils on the flatter slopes of the Beezley Hills within the Dry Creek drainage basin are productive and provide good yields of grains, chiefly wheat, under dry farming methods. The alluvial outwash of these silts on the bottom lands at the base of the hills permits good yields of various crops when irrigated. Nearly all of the arable land in the vicinity of Ephrata and Soap Lake is now under cultivation. The gravelly plain between Ephrata and Rocky Ford Creek is suitable primarily for dry sheep pasturage. The Soil Conservation Service for a number of years has encouraged land owners in the drainage basin (watershed) to employ agricultural management methods to reduce runoff and erosion, increase percolation of precipitation into the soil, and conserve soil and moisture. Of the 17,000 acres within the drainage basin, about 7,500 acres are wheat-summer fallow cropland and 9,500 acres are rangeland. "Stubble mulching," the mixing of grain stubble into the surface layer of the soil, is a common practice. Most cropland is treated in the fall by contour "chiseling" or "subsoiling" - dragging a single spike-like tool along contours 3 to 7 feet apart to make furrows 10 to 18 inches deep. This breaks up the soil, permitting infiltration to take place by preventing the formation of a solid layer of frozen earth at the surface. Erosion has been reduced by seeding roadside ditches. Cross-slope seeding now is done on about 25 percent of the cropland.

MINERALS

27. No minerals of value have been reported in the study area except sand and gravel. These commodities are plentiful and support several concrete products firms.

FLOOD CONTROL

28. History of flooding. Severe flooding of Dry Creek has been caused both by rapid snowmelt combined with rainfall and by thunderstorms. The earliest known flood occurred from snowmelt in the spring of 1901 when runoff, forceful enough to uproot 10-inch-diameter trees, cut a new permanent channel to the north, 5 feet lower than the previous southward channel. Thereafter, flow was toward the natural ponding area north of the community. Older residents recall that at one time in 1920 Ephrata, by then a town of 550, was ankle deep in water. By 1948 Ephrata had grown past the 3,000 mark when it was struck by its best remembered flood. On 27 May, of that year a thunderstorm following several weeks of rainy weather caused heavy precipitation over the Dry Creek and Moses Coulee drainage basins. This resulted in an estimated flow of 3,000 cfs in Dry Creek, which broke out of its normal channel and spread water and silt over a 60-block area between the Beezley Hills and the railroad. Basements, streets, lawns, and the storm sewer system were inundated and silted. The last reported high water was in 1956 when filling of the ponding area caused inundation of the grounds and basements of commercial establishments at the north end of Ephrata. Between years of damaging high water, runoff volumes appear to vary in cycles. Water may appear in the ponding area several years in a row, followed by several years in which runoff is too light to reach the ponding area in significant quantities.

29. Potential flooding. The existing flood control channel has a capacity of 2,200 cfs, which would be the peak flow of a 20-year flood. Such a flood would substantially fill the entire ponding area. Any flood in excess of the capacity of the existing flood control system, or resulting from debris blocking the 1st Avenue NW culvert, would inundate a large part of Ephrata between the West Canal and the railroad. This intensively developed area approximately half a mile wide and 2 miles long, includes the commercial and industrial sections. Because the urban topography slopes north and south from the mouth of Dry Creek canyon, depths of flood waters probably would be limited to just over the first floor elevation of buildings. Moderate flooding would be partly relieved by the municipal storm sewer system, which consists of 8 to 21-inch pipelines leading to 4 disposal pits. However, flood-carried silt would tend to reduce the capacity of the system. With larger floods the storm sewers would be ineffective, leaving the flood waters to find their own course across lands to the north and south. In addition to flooding of the central Ephrata area, filling of the ponding area would cause inundation of the north end of Ephrata including commercial buildings and the high school grounds. Eventually, water entering the ponding area would rise above a shallow divide and proceed in the direction of Soap Lake. The route taken is difficult

to define exactly because the irregular nature of the terrain provides several possible courses of flow. In general, discharges would approximately parallel State Highway 28, passing through rangeland, irrigated cropland, the unincorporated community of Lakeview Park, and the town of Soap Lake, ending in the lake itself, 4 miles from the ponding area. Along the route, flood flows would impinge upon State Highway 28, eroding shoulders and crossing the pavement. In the vicinity of the town of Soap Lake both Highway 28 and intersecting State Highway 17 would be inundated. An additional potential source of damage lies in the fact that the channel embankment at the north end of Ephrata is subject to failure from erosion at flows in excess of 560 second-feet, approximately a 4-year flood. Thus the north end of Ephrata has a lower degree of protection than the overall capability of the channel to carry a 20-year flood would indicate.

30. Monetary flood damages. The 33-year flood which occured in 1948 before construction of the existing flood control system caused damages estimated at about $1,500,000 at 1973 prices and conditions. A recurrence of this flood would cause failure of the existing flood control channel, resulting in approximately the same degree of damage. Average annual damages are estimated to be $170,000 at 1973 prices and conditions. Over the next 50 years average annual damages would amount to $325,000, taking into account projected growth and development. Derivation of flood damages is covered in more detail in appendix C.

31. Alternative single-purpose flood control system measures. Possible alternative measures for flood damage prevention are: restrictions on development (flood plain management), watershed land treatment, storage within the drainage basin above Ephrata, diversion channels, and ground infiltration. These measures, with pros and cons, are discussed in the Public Brochure included with this report as appendix A and are summarized in the following paragraphs.

a. Flood plain management. Under this plan Grant County and the cities of Ephrata and Soap Lake would place all lands subject to inundation by a 100-year flood on Dry Creek in a flood plain zone. New development within this zone would be limited to parks, parking lots, golf courses, drive-in theaters, agriculture, and other uses where damage from flooding would be minimal. If desired, building could be permitted with adequate floodproofing by such means as omission of basements, elevating first floors, and avoiding undue obstruction of flowage. Owners of existing property in the flood plain would be encouraged to take flood proofing measures when remodeling and to plan emergency procedures for movement of goods and furnishings. The effectiveness of emergency plans would depend on an adequate local warning system in the event of imminent heavy rainfall, snowmelt, or thundershowers. Flood plain zoning would make the area eligible for Federally guaranteed low-cost flood insurance. This alternative would cost relatively little, but would require constant administrative attention. Existing property, including agricultural

lands, would remain subject to average annual damages which amount to $170,000 at 1973 prices and would gradually increase with time.

b. Watershed land treatment. Runoff from the Dry Creek drainage basin could be reduced to some extent by agricultural measures which would retard flow and induce ground seepage of precipitation and melting snow. The practice of subsoil chiseling, which breaks up the soil, preventing the formation of an impervious frozen surface layer, could be extended. Level terracing consists of forming low berms on hillside contrours to trap runoff on the flatter slopes; about 1,500 acres could be terraced in this way. Additional cross-slope seeding, now being carried out on 25 percent of cropland, also would slow the movement of runoff on slopes. A total of 45 or 50 small earthfill detention dams in draws could store approximately 150 acre-feet of runoff altogether. Seeding of draws and roadside ditches would minimize soil erosion. All of these measures, carried out, would have an effect on reducing peak runoff, about a 10 percent reduction for a 100-year flood. Their greatest value, however, would be in conserving water and abating erosion within the drainage basin. Watershed land treatment also would serve to minimize siltation of downstream flood control facilities.

c. Storage. A storage dam capable of controlling runoff from the entire drainage basin, could be constructed in Dry Creek canyon about 1 mile west of Ephrata. If incoming flows were released gradually into the natural ponding area, using the existing channel, a dam 100 feet high would control a 100-year flood. A dam 120 feet high would store the entire 100-year runoff, which could be released into the West Canal as soon as the stored water had clarified and flow within the canal could be regulated to accept such releases. The ponding area in that case would not be needed and could become available for other types of development. A storage reservoir could serve no purpose other than flood control. A 100-year flood would be required to fill the reservoir, which would have to be emptied as soon as possible to prepare for additional precipitation. Even if not released, the stored water eventually would evaporate or percolate into the ground. Storage would eliminate the need for discharge channels out of the ponding area and would minimize the need for improvement of the inflow channel, but the cost of any storage plan would be several times the average annual flood damages prevented. Construction of several storage dams within the drainage basin for control of a 100-year flood would be more costly than construction of a single large dam.

d. Diversion channels. Control of a 100-year flood by channelization would require 2 major elements--improvement of the existing channel to the ponding area and provision of a discharge route from the ponding area to a receiving point. Two routes appear feasible--one would utilize a natural swale leading to Rocky Ford Creek; the other would require construction of a channel to Ephrata Lake. In either case the ponding area would serve as a balancing reservoir, minimizing flow into the outlet channel. Bypassing the ponding area

is not considered advisable as, in addition to the higher construction cost entailed, this could encourage structural development in the by-passed ponding area which would be jeopardized by floods greater than 100-year and by ground seepage.

e. Ground infiltration. The east edge of the ponding area lies against a gravelly slope which appears to present possibilities for ground percolation. A trench constructed in the gravels would receive overflow from the ponding area, which would be carried into the ground by seepage. However, tests showed that the gravels are not uniformly permeable; they are intermixed with sand and silt and contain relatively impermeable sand and silt layers. Even a mile of trench could not be expected to absorb runoff from a large flood. Permeability would tend to decrease with time as silt was carried into the gravels.

LAND TREATMENT

32. Like all dry farming areas there is a constant need for conservation of precipitation and protection against soil erosion on the 7,500 acres of cropland and 9,500 acres of rangeleand in the Dry Creek drainage basin. In some places the productive silt soil is thinly spread over the underlying basalt and loss would be critical. Improved agricultural methods advocated by the Soil Conservation Service can be placed into effect only be voluntary action on the part of land owners, with financial assistance through such agencies as the Agricultural Stabilization and Conservation Service. Some beneficial practices, such as stubble mulching and contour chiseling, already are widespread. About 25 percent of cropland is cross-slope seeded, several miles of roadside ditches have been seeded, and a start has been made on level terracing. Cross-slope seeding can be carried out by individual farmers with little expenditure except time. However, level terracing and construction of detention dams in draws necessitate a financial investment. Level terracing would consist of creating low berms along contours 200 to 400 feet apart, starting at the top of a hill. These berms would hold back as much as 1.5 inches of runoff during a storm. About 1,500 acres in the watershed would be susceptible to this treatment. Establishment of detention dams in draws is slow in coming about because of the cost to the farmer and the fact that the retained water percolates rapidly without remaining available for such uses as stock watering.

IRRIGATION

33. Irrigation in the study area has reached its ultimate practicable development. Although irrigation of the dry pasture on the gravel plain east of Ephrata is a future possibility, at present this does not appear to be economically feasible.

WATER SUPPLY

34. Municipal and industrial water supply, including rural domestic, is not a problem in the study area for the foreseeable future. All

present and anticipated future supply is from groundwater, quality is good, and drawdown has not become serious. Should a future need arise for large quantities of industrial or even municipal water, this could be provided from the main canals of the irrigation system by purchase from the irrigation district. For domestic use treatment would be necessary to remove odor and taste.

WATER QUALITY

35. Soap Lake and Rocky Ford Creek are the only bodies of water in the study area which would be concerned with water quality and pollution control. There is no known significant pollution problem in either. Sanitary sewage from the town of Soap Lake is treated, and effluent disposed of, in a drain field over half a mile from the lake. Rocky Ford Creek is subject to wastes from the fish hatchery, which could create an oxygen deficiency and algae problems. Occasional monitoring of the stream would indicate the need, if any, for pollution control measures.

OUTDOOR RECREATION

36. Outdoor recreation in the immediate study area is provided by bathing, boating, and water-skiing on Soap Lake, fishing for rainbow trout in the spring and fall at Rocky Ford Creek, and use of the parks and golf courses and Ephrata and Soap Lake. Within a 30-minute drive, are a number of other attractions. The Grand Coulee, in addition to its remarkable scenery, is the site of Blue Lake and Park Lake, much used for swimming and fishing, in the lower coulee, and man-made Banks Lake, offering 25 miles of boating and fishing and Steamboat Rock State Park, in the upper coulee. Between the upper and lower coulees is the unique geological phenomenon known as Dry Falls. Jameson Lake in Moses Coulee west of the Grand Coulee is being incorporated into the Rimrock Meadows recreational home development. Billy Clapp Lake with Summer Falls at its head lies to the east and Moses Lake and the Pothole Reservoir to the south. The latter is unusual in that it contains hundreds of sand dunes forming islands of various shapes and sizes. These recreational features easily accommodate summer visitors as well as the local population. Only Sun Lakes State Park at Park Lake, one of the oldest and most popular in the State park system, is crowded. Nearby Banks Lake provides opportunity for almost unlimited park development as needed. Private recreational developments such as at Blue Lake also serve to meet the demand. Possible means of improving recreation in the immediate study area include modernization of resort facilities at Soap Lake and provision of a large public park and swimming pool in Ephrata. Ephrata Lake now has a cerain desolate charm for hikers which largely derives from its untouched naturalness. This condition should be preserved as it could be an invaluable resource in the future, particularly if urbanization of the Ephrata area is accelerated. Indian artifacts add to the lake's interest.

FISH AND WILDLIFE

37. The immediate study area is not one of the major hunting and fishing areas of the state. Mule deer are taken in the Beezley Hills and small game around Ephrata, Lake, but there is no fishery in Soap Lake and only an intermittent rainbow fishery in Rocky Ford Creek. The most important game species are upland birds and the waterfowl found along Rocky Ford Creek and at Ephrata Lake. Upland game birds are most plentiful in the vicinity of dry-farmed cropland in the Beezley Hills and irrigated farms in the adjacent bottom lands. As nearly all arable land in the area now is being farmed, no increase in the upland game bird population is foreseen. Waterfowl populations on Rocky Ford Creek also are expected to remain stable. The Washington Department of Game, however, anticipates improving the rainbow fishery in Rocky Ford Creek with the objective of making it a blue-ribbon trout fishing stream.

PRESERVATION AND ENHANCEMENT OF THE NATURAL ENVIRONMENT

38. The study area may be scenically described as moderately attractive, varying from the somewhat prosaic surroundings of Ephrata to striking geologic features such as the mouth of the Grand Coulee at Soap Lake, the view, from the cliff overlooking Rocky Ford Creek, and the sagebrush and wheat-covered slopes of the Beezley Hills. State Highway 28 between Ephrata and Soap Lake has the usual roadside signs and castoff materials, but State Highway 17 a few miles east runs through rolling sagebrush plains and basalt outcrops with an austere beauty, occasionally including the sight of a surviving coyote. Without local concern this environment, which still has a clean freshness about it, could be degraded as urban growth takes place. Protection of the natural environment would seem to depend on aggressive action by city and county planning department, strict review of proposed developments, cooperative improvements by commercial interests, and student projects aimed at awakening residents to the value of their local scenic resources. A 1971 act of the Washington State Legislature, stemming from the 1965 Federal Highway Beautification Act, has resulted in the screening or removal of dumps and scrap metal and wrecking yards along the State Highway.

V - PLAN FORMULATION

COMPREHENSIVE BASIN PLANNING

39. The Dry Creek basin is within the Columbia-North Pacific Region, which comes under the planning authority of the Pacific Northwest River Basins Commission. The current draft of the Commission's Columbia-North Pacific Region Framework Study recommends that channel improvements for flood control be carried out at Dry Creek, Ephrata, before 1980.

SUMMARY OF ALTERNATIVE FLOOD CONTROL SOLUTIONS CONSIDERED

40. Alternative single purpose flood control measures, described under "Water and Land Needs and Means," include flood plain management, watershed treatment, storage dams, diversion channels, and ground infiltration. Flood plain management was eliminated because of the extensive urban development already occupying half of the flood plain. Watershed treatment is considered relatively ineffective for control of large floods, but is discussed under "land measures" later in this section. Storage dams were eliminated primarily because of their high cost, which would have been 3 or 5 times flood control benefits, depending on the number of dams and type of outlet works. Retention of water for recreation or fish and wildlife would not have been practicable because of the pervious nature of the soil and the irregular volume of runoff. The ground infiltration alternative was considerd unsatisfactory for absorbing large quantities of water because the underlying gravels are not sufficiently permeable.

SELECTION OF PLAN OF IMPROVEMENT

41. The only economically feasible measure effective against flooding was found to be construction of diversion channels, using the existing ponding area north of Ephrata, with alternative discharge routes to either Ephrata Lake or Rocky Ford Creek. Effectiveness against flooding would require control of a 100-year flood in accord with criteria of the Water Resources Council for urban areas and Federal Housing Administration loan-approval guidelines. The only other alternative which would have provided such control was storage, for which costs would have been far in excess of benefits with no significant advantage over the diversion channel plan. The diversion channel plan, therefore, was selected as the best alternative.

42. The 100-year flood would consist of a flow of 5,000 cfs at the mouth of Dry Creek and a 5-day runoff of 4,000 acre-feet. Consideration was given to providing greater control capability; however, both Ephrata Lake and Rocky Ford Creek are limited in the volume of runoff they can accept without damage to fish hatcheries. Overfilling of the Ephrata Lake basin would cause spilling into the proposed state hatchery site and excessive flow into Rocky Ford Creek would cause backwater endangering the existing commercial hatchery. By limiting channel

capability to control of the 100-year flood, Ephrata Lake and Rocky Ford Creek would be protected from greater floods, while residual flow into Ephrata or overland toward Soap Lake from such greater floods would be relatively moderate. In addition to these considerations, a maximization study described in appendix C showed that protection against the 100-year flood produced the greatest net benefits.

43. There are advantages and disadvantages to each of the alternative points of discharge. Use of the natural swale to Rocky Ford Creek would necessitate severance by a broad flowage easement of tracts now under single ownership. This disadvantage is mimimized by the fact that, as long as the land continues to be used primarily for sheep pasturage, the occasional passage of water would be beneficial to the natural forage. Diversion to Ephrata Lake would avoid the overbank flooding of Rocky Ford Creek which may occur with the larger Dry Creek floods. However, prevention of overflow of Ephrata Lake southward into Rocky Ford Creek with possible damage to fish hatcheries would require cutting off flow to the lake at the outlet stucture on the edge of the Ephrata ponding area. This could be accomplished by the use of stoplogs, containing the remainder of the 100-year flow in the ponding area, but, if for any reason, stoplogs were not placed at the proper time, Ephrata Lake could overflow. This was the basis of objections by the Washington Department of Game and the Bureau of Sport Fisheries and Wildlife to using Ephrata Lake. In addition to simplicity of operation, discharge to Rocky Ford Creek has the important advantage of lesser cost, largely because a constructed channel would not be needed. In view of the safety, simplicity of operation, and lower cost afforded, Rocky Ford Creek was selected as the most desirable point of discharge.

OTHER RESOURCE CONSIDERATIONS

44. In addition to flood control, consideration has been given to meeting needs related to other water and land resources. In the immediate study area there appear to be no major problems connected with irrigation, water supply, or water quality at this time and preservation and enhancement of the natural environment appear to depend primarily upon local control and voluntary cooperation. However there are steps which could be taken in the interest of land treatment, outdoor recreation, and fish and wildlife and these are noted in the following paragraphs.

45. Land treatment. Watershed treatment is desirable to conserve soil and water and, by restriction of erosion and runoff, increase the effectiveness of downstream flood control facilities. Major items of work would include programs for cross-slope seeding, level terracing, and small detention dams. This program should be accelerated, if possible, under existing authorities of the Soil Conservation Service and the Agricultural Stabilization and Conservation Service, with local cooperation organized by the Ephrata and Moses Coulee Soil and Water Conservation District.

46. Outdoor recreation. Other than municipal and private developments, the greatest opportunity for future outdoor recreation in the study area appears to lie in preservation of Ephrata Lake for public use. Acquisition of development and public use rights would be desirable. This might be a cooperative undertaking between for example, the State of Washington and the Bureau of Outdoor Recreation. Ownership of Ephrata Lake now is shared by the state, the city of Ephrata, and at least two private landholders. Stabilization of the lake would appear to be technically possible by delivery of water through existing irrigation systems during periods of low irrigation demand, provided that suitable arrangements with the irrigation districts involved could be made.

47. Fish and wildlife. A program to provide public access the full length of Rocky Ford Creek would help make available excellent fishing in the study area, and would help create an outdoor recreation zone extending from Ephrata Lake through Moses Lake. Acquistion of public use rights along Rocky Ford Creek might be carried out by the Washington Department of Game. Flowage rights in the Rocky Ford Creek Valley to be acquired by the sponsor of the flood control project would not necessarily provide for public access.

Soap Lake

Ephrata Lake

Dry Creek

Culvert under 1st Avenue NW

Inflow channel, ponding area to left

Ponding area

Ephrata, ponding area middle left, State Highway 28
and Burlington Northern railway middle right

Ephrata, facing east, swale forming discharge
route in background

Abandoned fish hatchery, head of Rocky Ford Creek, Ephrata Lake in background

Troutlodge fish hatchery, one mile below head of Rocky Ford Creek

Rocky Fork Creek valley, facing
upstream from State Highway 17

Rocky Fork Creek valley, facing
downstream from State Highway 17

Moses Lake, upper end facing north

Moses Lake, upper end facing south

VI - PLAN OF IMPROVEMENT

DESCRIPTION

48. The flood control plan of improvement, shown on plates 1-4, consists basically of an improved channel of 5,000-cfs capacity from the mouth of Dry Creek canyon to the natural ponding area north of Ephrata and an outlet channel of 700-cfs capacity from the ponding area, discharging toward Rocky Ford Creek.

49. A debris basin about 500 feet long would be created in Dry Creek canyon near its mouth by excavation to rock and construction of an ungated concrete spillway, tied at each end to rock outcrops in the canyon walls. The basin would be designed to retain bedload to the maximum practicable extent. From the debris basin a rectangular reinforced-concrete high-velocity channel would cross over the inverted siphon of the West (irrigation) Canal and turn northward under 1st Avenue NW. replacing the existing corrugated metal arch culvert. It would continue parallel to the irrigation canal to a stilling basin approximately 3,800 feet from the debris basin. The channel would have a width of about 20 feet and a maximum depth of about 10 feet. The stilling basin would be about 55 feet long, about 34 feet wide, and about 21 feet deep. An unlined trapezodial channel, riprapped where required, with a bottom width of about 42 feet, would lead from the stilling basin, turning eastward into the ponding area and crossing under the county's Frey Road by means of an existing culvert. An embankment on the right (south) side of the channel would prevent flow in the direction of Ephrata. To this point the proposed work would follow the alinement of the existing system.

50. Flow from the ponding area would be controlled by a concrete outlet structure having a 7.5-foot-wide opening. The unlined outlet channel beyond the outlet structure would be trapezodial, with a bottom width of about 30 feet. It would run northeast for approximately a mile, crossing under county road B-NW, then turn to the southeast for about another mile, crossing under State Highway 28 and the Burlington Northern railroad track. About one-half mile beyond the railroad the channel would merge with a natural swale running southeastward 4.5 miles to Rocky Ford Creek. Dumped rock detention barriers would be placed across the swale as necessary to reduce erosion and trap debris. A minimum of three barriers has been assumed. Culverts would be required where the swale is crossed by State Highway 17. Excavation for the project generally would be in silty sand and gravel, providing material for embankment and backfill. Rock for riprap is plentiful and there are existing stockpiles of waste rock from irrigation canal construction.

RELOCATIONS

51. No major road, railroad, or utility relocations are involved in the plan of improvement. The proposed channel alinement would avoid displacement of existing homes, commercial establishments, or

other structures. Channel road crossings would have to be provided at 1st Avenue NW. in Ephrata, county road B-NW, and State Highways 28 and 17. Several water and sewer lines near the mouth of Dry Creek canyon might have to be adjusted, depending upon conditions determined during detailed design. Street and road channel crossings and adjustments of utilities would be the responsibility of local interests.

PROVISION FOR RECREATION

52. The plan of improvement does not appear to lend itself to recreational use. The channels and ponding area would be dry except for a few days each year, and in many years flow would percolate into the ground before reaching Rocky Ford Creek. The terrain through which the channels would run is dry, supporting only sagebrush and native grasses. Recreational development of Rocky Ford Creek, which is favorably presented elsewhere in this report, would be a separate undertaking, distinct from the flood control project. However, detailed planning for the flood control project should take into account possible future recreational use of Rocky Ford Creek.

FISH AND WILDLIFE PROVISIONS

53. The only fish in the study area are those in Rocky Ford Creek, chiefly trout and carp, and trout in the fish hatcheries near the head of the creek. Discharge from the ponding area to Rocky Ford Creek would require measures to prevent sedimentation and debris from the natural swale detrimental to fish, being carried into the creek. These measures would consist of dumped rock detention barriers to be placed across the swale as necessary. Flow would pass over and through these barriers, but would be retarded sufficiently to minimize erosion and movement of debris. This retardation also would encourage percolation of water into the ground along the course of flow. Wildlife patterns are not expected to be disturbed by the diversion canals. Channel depths are moderate and side slopes in the unlined sections sufficiently flat to permit unobstructed animal movement, including escape at the onset of flow. The depressed ground level alongside the walls of the rectangular concrete channel would help prevent entry by animals. Occasional large floods on Dry Creek could cause inundation of the valley floor adjacent to Rocky Ford Creek. Should this occur during the spring nesting period, there could be losses of young pheasant and waterfowl.

LAND ACQUISITION

54. Lands across which the project would be constructed are owned by the United States, State of Washington, City of Ephrata, an irrigation district, and several private landholders, including the Burlington Northern railroad. That part of Dry Creek canyon where the debris basin and spillway and the first part of the inflow channel would be constructed is privately owned and would be acquired in fee. Approaching 1st Avenue NW, the inflow channel would enter the Quincy Irrigation District right-of-way along the West Canal and remain within that

right-of-way for about three-quarters of a mile. A construction and maintenance permit from the irrigation district would be required. After turning east the inflow channel would run across several privately owned tracts, following the path of the existing diversion ditch to the ponding area. A right-of-way for the improved channel and a permit to cross the county's Frey Road would be necessary.

55. The ponding area lies across several large privately owned tracts. Flooding occurs here naturally. However, to assure that ponding will continue in the future as part of the operation of the flood control project, a flowage easement would be acquired to the elevation at which flow out of the ponding area occurs naturally. This is approximately elevation 1266.

56. The outlet channel would require right-of-way across several privately owned tracts. In addition, permits would be necessary to cross County Road B-NW, State Highway 28, and the Burlington Northern right-of-way.

57. The discharge route to Rocky Ford Creek would lie across lands which at present are nearly all under a single private ownership. A flowage easement would have to be obtained. A small part of the discharge route would be across state land where a permit would be required. A permit to cross State Highway 17 would be necessary. A flowage easement would have to be obtained on privately owned lands adjacent to Rocky Ford Creek, in view of the possibility of occasional inundation.

58. Real estate requirements are summarized in the following tabulation.

Real estate requirements

Project feature	Approximate area in acres	Ownership	Type of right
Debris basin and spillway	2.3	Private	Fee
Inflow channel	5.8	Private	Right-of-way
"	5.5	Quincy Irrig. District	Permit
Ponding area	272.0	Private	Flowage easement
Outlet channel	28.5	Private	Right-of-way
Discharge route to Rocky Ford Creek	230.0	Private	Flowage easement
"	29.4	State	Permit
Lands adjacent to Rocky Ford Creek	600.0	Private	Flowage easement

NOTE: Permits also would be required for road crossings, as described in the text.

In addition to the permanent real estate rights described above, access easements would be required during construction and for maintenance. Acquisition of all lands, easements, and rights-of-way would be the responsibility of the local sponsor.

CONSTRUCTION COST ESTIMATE

59. The estimated costs of major features of the plan of improvement are given in the following tabulation. Detailed cost estimates are contained in appendix B and are based on price levels in effect 1 January 1973. Non-Federal costs shown are for lands, easements, rights-of-way, utility relocation, and road crossings over channels.

Construction Costs

Feature	Federal	Non-federal
Debris basin and spillway	$ 212,500	$ 3,700
Concrete inflow	1,127,500	33,800
Stilling basin	141,400	0
Unlined inflow channel	179,300	10,700
Outlet channel	466,300	242,600
Discharge route	13,000	91,700
Subtotal	2,140,000	382,500
Engineering and design	300,000	36,500
Supervision and administration	190,000	21,000
TOTAL 1/	2,630,000	440,000

OPERATION

60. The proposed flood control project would be self-operating. Runoff from snowmelt, rainfall, or thunderstorms in the drainage basin would concentrate in Dry Creek canyon, flowing into the debris basin and over the spillway at its downstream end. Most solid material would be left in the debris basin. During moderate flows all settleable solids larger than silt sizes would be retained, but at maximum design flow sands and gravels may be carried over the spillway to the stilling basin. Beyond the spillway water would be carried at high velocity, by means of the rectangular concrete channel, under 1st Avenue NW to the stilling basin. At peak flow of 5,000 cfs, maximum velocity would be about 40 feet per second, reduced to 9 feet per second beyond the stilling basin. Flow would continue at decreasing velocity into the ponding area. When water in the ponding area reached the invert of the outlet channel, flow would begin in the direction of Rocky Ford Creek. If the rate of inflow continued to exceed the rate of outflow, water would rise in the ponding area. The maximum stage water could reach in the ponding area would be elevation 1266.5, occurring in the event of a 100-year flood. Under such conditions the peak outflow from the ponding area would be 755 cfs. Outflow would continue until water in the ponding area had been lowered to the invert of the outlet channel. As a result of ground percolation, discharges into Rocky Ford Creek are expected to be reduced, but this reduction cannot be determined exactly without actual operating experience.

1/ Does not include preauthorization costs of about $115,000.

MAINTENANCE

61. Maintenance of the project would be the responsibility of local interests. It would consist of periodic removal of debris, sediments, and vegetation from the debris basin, channels, culverts, and stilling basin. Sedimentation behind dumped rock detention barriers in the natural swale would be removed as necessary to assure their continued effectiveness. Routine maintenance would be required annually, with major cleanup following larger runoffs. Occasional repair of concrete structures might be required. Most sedimentation would be silt, suitable for use on public grounds; stone and gravel could be used in road fills, and vegetable material burned or mulched. Average annual cost of maintenance, including major replacements, is estimated at $7,000.

DESIGN AND CONSTRUCTION SCHEDULE

62. Subject to project authorization and appropriation of funds, design and construction could proceed according to the following estimated schedule:

1st Year - Start of design memos and model study.

2nd Year - Completion of design memos and model study, start of plans and specifications and real estate action.

3rd Year - Completion of plans and specifications and real estate action.

4th Year - Start of construction.

5th Year - Completion of construction within 18 months of start.

VII - ENVIRONMENTAL CONSIDERATIONS

LAND AND WATER FEATURES

63. The study area is in that portion of eastern Washington known as the Columbia Basin, or "Big Bend Country" - dry, elevated, hot in summer, and lightly populated. Ephrata lies between two geological features of this major geographical segment of the state. Northwestward are the furrowed heights of the Waterville Plateau and in every other direction the lower, undulating plains of the Quincy Basin. Immeditely east of Ephrata the terrain rises in a broad ridge, where residential development has expanded toward the airport, descends through relatively untouched sagebrush land, where sheep browse on the sparse, dry native grasses, and then drops into the basin of Ephrata Lake and the coulee-like valley of Rocky Ford Creek. The alkaline waters of Ephrata Lake support a waterfowl population, but no game fish. A divide, about 15 feet higher than the lake surface, separates Ephrata Lake from Rocky Ford Creek, which rises in a cluster of springs about 50 feet lower than the lake bottom.

64. Near the springs are the abandoned buildings and ponds of a former commercial fish hatchery, now relocated in new quarters a mile downstream. Creek flow is relatively uniform, varying over the year from about 50 to 100 second-feet, but maintaining a nearly constant temperature of about 52° F. From the springs to the new hatchery the creek falls about 10 feet, then for 4 miles meanders at a relatively flat gradient. Here the valley floor is about a quarter-mile wide. Bullrushes border the stream, giving way to tall native grasses on higher ground. Pheasant and several species of duck nest in the valley, which in this reach is undeveloped except for cattle grazing. Near the lower end of this reach the valley is crossed by State Highway 17. The embankment of an earlier, abandoned road crossing is utilized for raising the water table by closing culverts through which the creek normally flows. Below the highway the stream gradient steepens, falling about 14 feet in the last mile to Moses Lake.

65. Moses Lake, which is about one-third mile wide at this end, winds for about 8 miles through largely undeveloped land before reaching the residences of former Larsen air base, now the county airport. From there on the lake is dominated by the urbanization of the city of Moses Lake--five miles past the airport is the mouth of Parker Horn, carrying the inflow of Crab Creek, 2 miles further is Pelican Horn, site of the city's waste treatment plant, and the end of the lake is a mile beyond. The lower half of Moses Lake experiences a considerable growth of algae to which agricultural runoff and urban wastes may contribute. From Moses Lake, water passes into the Potholes Reservoir and thence into irrigation systems or to lower Crab Creek and the Columbia River.

66. Under project plans Dry Creek flow would be routed through the ponding area north of Ephrata, around the low ridge to the east, and overland to Rocky Ford Creek. Flows of sufficient size to exceed the

channel capacity of Rocky Ford Creek would occur about every 10 years. Greater flows would cause inundation of Rocky Ford Creek banks up to an estimated depth of about 2.5 feet once in 100 years. This would not damage the present fish hatchery, but would prohibit the construction of permanent structures on low lands bordering the creek below the hatchery.

APPEARANCE

67. From a visual point of view the plan of improvement may be considered in three sections--the inflow channel from the mouth of Dry Creek canyon to the ponding area, the outlet channel from the ponding area to past the railroad, and the discharge route from the railroad to Rocky Ford Creek. The inflow channel would constitute replacement of an existing system, consisting of a steel sheet pile training wall, a metal culvert, and an earth ditch, by a concrete structure consisting of a spillway, rectangular channel, and stilling basin. The concrete structure, visible from well-traveled 1st Avenue NW, would be more in keeping with the major irrigation canal it parallels. About half a mile from 1st Avenue NW, beyond the stilling basin, the unlined channel would begin, with sloping sides flanked by embankments. Although somewhat similar to the existing ditch and dikes, it would be larger and more uniformly shaped. Side slopes and embankments would be seeded.

68. The unlined trapezoidal outlet channel would be a new addition to the landscape. It would be visible from State Highway 28, but because of the rolling character of the terrain, would not be overly conspicuous except where crossing under the highway. At that point the outlet channel would be approximately 8 feet deep with a bottom width of 30 feet. Beyond the railroad it would be essentially hidden from public view. Side slopes and embankments of the outlet channel also would be seeded. The discharge route to Rocky Ford Creek would follow a natural swale for 4.5 miles. The gradient is generally easy, but to further restrict flow to reduce erosion, trap debris, and induce percolation, about three rock barriers would be placed across the swale. Material would be native basalt rock and the barriers would resemble existing rock outcrops.

WATER QUALITY

69. Of major concern is the effect on water quality of introducing Dry Creek flows to Rocky Ford Creek and Moses Lake. Consideration was given to possible movement of sediments, fertilizers, pesticides, and animal bacteria. Snowmelt or rainfall, flowing down the slopes of the Beezley Hills, would pass through the ponding area north of Ephrata and across 4.5 miles of undisturbed sagebrush land before reaching Rocky Ford Creek. Sedimentation from erosion of the dry wheat farms in the Beezley Hills would depend upon conditions under which snowmelt or thunderstorms occurred. Less soil would be lost from fields of growing wheat than from fallow fields and losses from the latter would be minimized if contour-plowed and stubble-mulched.

Should the ground be frozen, erosion would be negligible. Gravel and rocks eroded in gullies would be trapped in the debris basin and sand particles would tend to settle out in the stilling basin or the inflow channel ahead of the ponding area. If the storm occurred shortly after fertilizer application in late May or June, eroded farm soil could have a high nitrogen content. Pesticides are not regularly applied, their use being limited to occasional grasshopper infestations. As most grazing in the Beezley Hills takes place outside the Dry Creek watershed, animal bacteria would not be a significant factor.

70. A large part of the ponding area is irrigated farm land. No erosion would take place here and, on the contrary, silt would tend to settle out. Some fertilizer might be absorbed and some animal bacteria from pasturage picked up. Absorption of pesticides would be minimal as a result of the current practice of using quick-acting, disintegrating types only as their need is indicated. A 2-mile channel from the ponding area would carry flow to a natural swale extending to Rocky Ford Creek. Because the swale is wide and shallow, with a flat gradient for most of its 4.5-mile length, erosion generally is not expected to take place. As a precaution, dumped rock detention barriers are included in the project plan to reduce velocities further and trap any incidental debris. No fertilizers or pesticides are used in this area, but there could be some animal bacteria from sheep grazing. Dry Creek flows reaching Rocky Ford Creek and Moses Lake would contain little sediment and only moderate amounts of fertilizer, pesticides, and animal bacteria. Because of the infrequent occurrence of flows, these factors would have a negligible impact on the water quality of Rocky Ford Creek and Moses Lake.

FISH AND WILDLIFE

71. Sport fish in Moses Lake include carp, perch, crappies, sunfish, bullheads, whitefish, and rainbow trout. Carp also are seined commercially. Between 25,000 and 50,000 rainbow trout are planted each year. Lake fish move freely into Rocky Ford Creek where they provide about 500 man-days of fishing annually. Above the commercial hatchery, Rocky Ford Creek is open, in season, to barbless fly fishing, with fish under 20 inches required to be returned to the water. There are no fish in Dry Creek, which is an intermittent stream. Mule deer range over the study area and are hunted annually. Infrequently elk winter in the Beezley Hills. Other animals inhabiting the area include coyotes, bobcats, rabbits, rock chucks, badgers, and racoons. Beaver, muskrat, and mink live along Rocky Ford Creek. Upland game birds include pheasant, partridge, chukar, quail, grouse, and doves. Pheasants and several species of ducks nest near Rocky Ford Creek. On an average of one in ten years inflow from Dry Creek would cause some overbank flooding of Rocky Ford Creek, resulting in the loss of any fish which left the creek channel and were unable to return as flow receded. Overbank flooding occurring in March through June could disrupt nesting of ducks and pheasants.

RECREATION

72. The area in which the project would be constructed is not conducive to outdoor recreation because of the lack of water, grass, and trees. Recreationists tend to use parks and swimming pools in Ephrata or to visit Moses Lake, Soap Lake, and lakes in the Grand Coulee. The project would be operated too infrequently to provide water-oriented recreation. However, occasional overbank flow in the Rocky Ford Creek valley, as a result of the project, would tend to limit development and thereby contribute to possible future recreational use.

HISTORICAL AND ARCHEOLOGICAL SITES

73. There are no known sites of historical significance which would be affected by the project plan. However, the vicinity has a potential for aboriginal sites of interest. Prior to detailed design, an archeological survey would be conducted under the supervision of the National Park Service. Comments relative to the existence of historical and archelolgical sites in the study area were requested of the Washington State Parks and Recreation Commission and the Department of Anthropology at Washington State University. The latter affirmed the existence of archeological and paleontological sites in the study area and offered to assist in arranging an archeological survey. A letter from the Corps of Engineers to the Department of Anthropology with copy to the National Park Service, states that upon authorization of the project and appropriation of funds, arrangements will be make for any archeological surveys the National Park Service feels to be necessary.

VIII - ECONOMIC ANALYSIS

ANNUAL CHARGES

74. Annual charges for the flood control project include interest and amortization of the total investment, average annual costs of operation and maintenance, and the equivalent average annual value of major replacement costs. A 1.5-year construction period is assumed. An interest rate of 5.5 percent and an economic life of 50 years have been used in the analysis. Cost estimates, based on January 1973 prices, are given in detail in appendix B and additional details on economic analysis are given in appendix C. The total investment includes the value of lands where an arrangement for use appears likely at no financial cost to the project sponsor, shown as real estate rights donated.

Investment costs

Item	Cost
Federal construction costs	$2,630,000
Non-federal costs	440,000
Value of real estate rights donated	5,000
TOTAL INVESTMENT	3,075,000

Annual charges

Item	Charges
Interest and amortization	$ 182,000
Operation, maintenance, and major replacement	7,000
TOTAL ANNUAL CHARGES	189,000

ANNUAL BENEFITS

75. The derivation of project benefits is given in detail in appendix C. Benefits are credited to the project for flood damage reduction and area redevelopment.

a. Flood damage reduction. Under conditions existing in 1973, flooding would cause damages to urban residential structures, contents, and grounds; commercial enterprises and contents plus loss of business; public buildings, grounds, utilities, streets, and roads; agricultural lands, crops, and buildings; and railroad facilities and motor vehicles. Costs also would be incurred for emergency aid. Average annual flood damages now amount to 170,000. Average annual damages are expected

to increase with time. Historically, the flood plain experienced rapid population and economic growth to 1965, then a slight decline, followed by stabilization. Recent trends indicate a return to moderate long-term growth forecast by the Office of Business Economics for the surrounding nine-county area. The earliest probable year of project completion is 1979, with an economic life of 50 years. Average annual damages without the project for the 50-year period, 1979-2029, is estimated at $325,000. Of this amount the flood control project would prevent damages estimated at $271,000 which thus constitutes the flood damage reduction benefits for the project.

b. Area redevelopment. Under Title IV of the Public Works and Economic Developemtn Act of 1965 (Public Law 89-136), Grant County as of April 1973 continued to be designated an area of substantial and persistent unemployment. Area redevelopment benefits for employment of the locally unemployed in construction and operation, distributed over the 50-year economic life of the project, average $58,300 annually.

Summary of benefits

Purpose served	Average annual benefits
Flood damage reduction	$271,000
Area redevelopment	44,300
TOTAL BENEFITS	315,300

BENEFIT-COST COMPARISON

76. The ratio of benefits to costs is given in the following tabulation.

Benefit-cost comparison

Item	Without Area Redevelopment	With Area Redevelopment
Average annual benefits	$271,000	$315,300
Average annual charges	189,000	189,000
Benefit to cost ratio	1.4	1.7

APPORTIONMENT OF COSTS AMONG INTERESTS

77. All costs are apportioned to the Federal government excepts costs of local cooperation. Details of non-Federal costs are given in the detailed cost estimate in appendix B and are summarized, with an allowance of engineering and supervision, in the following tabulation.

Non-Federal costs

Item		Cost
Lands		
Within municipal limits	$ 0	
In unincorporated areas	65,900	
Subtotal		65,900
Relocation of utilities		
Municipal utilities	4,000	
County utilities	0	
Subtotal		4,000
Bridges and culverts		
Municipal streets	37,600	
County roads	84,500	
State highways	248,000	
Subtotal		370,100
TOTAL NON-FEDERAL COSTS		440,000

78. Final cost-sharing arrangements amoung the non-Federal interests would be made prior to start of construction. The City of Ephrata has agreed to provide rights-of-way and modifications of roads and utilities in cooperation with Grant County and the State of Washington. Grant County has agreed to modify county roads and share the cost of right-of-way acquistion. After completion of construction the project would be transferred to the City of Ephrata. All subsequent costs for operation and maintenance would be borne by the city, with such assistance from other local entities as might be agreed upon.

IX - LOCAL COOPERATION AND COORDINATION

LOCAL COOPERATION

79. The study was undertaken at the request of the city of Ephrata and the city has remained the principal sponsor. Under provisions of public law and Federal regulations, should the plan of improvement be authorized by Congress, the local sponsoring agency must agree to:

a. Provide, without cost to the United States, all lands, easements, and rights-of-way necessary for construction of the project, at a presently estimated cost of $65,900;

b. Hold and save the United States free from damages due to the construction works;

c. Maintain and operate the project after completion, in accordance with regulations prescribed by the Secretary of the Army;

d. Provide without cost to the United States all relocations of buildings and utilities, highway bridges, sewers, related and special facilities, and local betterments, at a presently estimated cost of $374,100; and

e. Prevent any encroachment of the rights-of-way of the improvement that might reduce the flood-carrying capacity of the stream or interfere with operation and maintenance of the project.

By letter dated 1 November 1973 (exhibit 1), signed by Mayor Robert E. Ping, the City of Ephrata expressed its willingness to enter into an agreement with the Secretary of the Army under which the terms of cooperation would be carried out. Arrangements will be made by the city with Grant County and the State of Washington in regard to sharing the costs of local cooperation. Of the 4 road crossings, 1 involves a county road and 2 involve State highways. By letter dated 6 March 1972 (exhibit 3), the Grant County Board of Commissioners agreed to cooperate with the city of Ephrata in working out an equitable division of local costs. Although the plan of improvement is not known to involve relocations, the City of Ephrata has been advised of the applicability of the Uniform Relocation Assistance and Real Propery Acquisition Policies Act of 1970 (PL 91-646) and the requirement for a Relocation Plan on the part of the city should relocations become involved. The City of Ephrata also has been advised of the applicability of Section 221 of the River and Harbor Act of 1970 (PL 91-611).

COORDINATION WITH GOVERNMENT AGENCIES

80. A number of Federal, state, and local agencies have participated in the study. The Washington Department of Game provided assistance in determining possible effects on the Rocky Ford Creek fish hatchery of diverting flood flows to the creek or to Ephrata Lake. The Soil Conservation Service furnished information on agricultural practices and land treatment measures in the drainage basin. Data on irrigation and ground water were provided by the Bureau of Reclamation. The Washington Department of Highways cooperated in providing highway data. Within the study area both city and county officials, including planners and engineers, helped evaluate alternative proposals.

81. Letters from several agencies have been included as exhibits following the report and are commented upon as follows:

a. Exhibit 4, Environmental Protection Agency. Favors diversion to Ephrata Lake and is concerned with effect of sediment, bacteria, pesticide, and nutrient transport; recommends supplemental watershed land treatment. Comment: If the project is authorized, diversion to Ephrata Lake will be reviewed prior to detailed design. Transport of pollutants is discussed in the report, which also supports watershed land treatment by appropriate agencies.

b. Exhibit 5, Bureau of Outdoor Recreation. Acknowledges information provided on study. Comment: Recreation development is not included in the project plan for reasons stated in the report.

c. Exhibit 6, Washington Department of Natural Resources. Favors diversion to Ephrata Lake to avoid silt and debris deposition in Rocky Ford Creek and to avoid property severance by the flowage easement to Rocky Ford Creek. Comment: If the project is authorized, diversion to Ephrata Lake will be reviewed prior to detailed design. Provisions to prevent significant transport of silt and debris have been included in the project plan. The effect of property severance is discussed in the report.

d. Exhibit 7, Washington Department of Game. Favors diversion to Rocky Ford Creek in view of the possibility of overflow of Ephrata Lake, but is concerned with the possibility of siltation of Rocky Ford Creek. Comment: Provision to prevent significant transport of silt have been included in the project plan.

e. Exhibit 8, Washington Department of Fisheries. States that no commercial fisheries are involved, supports position of Department of Game.

f. Exhibit 9, Bureau of Sport Fisheries and Wildlife. Favors diversion to Rocky Ford Creek in view of possibility of overflow of Ephrata Lake, but recommends check dams to retard erosion and siltation and is concerned with possible backwater effect on the commercial hatchery on Rocky Ford Creek. Comment: Provisions to prevent erosion

and transport of silt have been included in the project plan. Protection of the hatchery from backwater would be provided if found nessary during detailed design.

g. Exhibit 10, Washington Department of Ecology. Agrees with the report recommendation for diversion to Rocky Ford Creek; however, is concerned that sediment and debris would be detrimental to fish and wildlife and to the quality of Moses Lake. Urges incorporation of flood plain management, promotion of watershed treatment, and development of settling basins. Comment: Provisions to control sediment and debris are included in the project plan and the report encourages watershed treatment. If the project is authorized, consideration will be given to providing additional settling facilities.

COORDINATION WITH PRIVATE INTERESTS

82. Residents of the study area, many of them landowners who would be affected by the proposed project, were contacted for comments by means of public meetings, workshops, and telephone. Members of the League of Women Voters of the Columbia Basin were encouraged to observe the planning process and were represented at meetings. Officials of the Burlington Northern railroad attended meetings and provided data relative to proposed channel crossings. Three public meetings and one workshop were held, three drafts of the Public Brochure were mailed out, and an estimated 100 individuals took part in project formulation in addition to Corps of Engineers personnel. The latest draft of the Public Brochure, containing comments by individuals and organizations is included with this report as appendix A.

X - RESULTS OF THE INVESTIGATION

DISCUSSION

83. An area from the center of Ephrata, Washington, to Soap Lake, a distance of 6 miles, which includes the suburban community of Lakeview Park, irrigated cropland, and pasture land, is subject to flooding by Dry Creek flows having a recurrence interval of 20 years or greater. Portions of Ephrata are subject to flooding from lesser flows. Average annual damages are estimated at $170,000. Ephrata, with a population in excess of 5,000, is the seat of Grant County and the headquarters of the Columbia Basin Project and the Grant County Public Utility District. Soap Lake is a well-known health resort with a permanent population of over 1,000. Grant County is designated an area of substantial and persistent unemployment under PL 89-136. Flooding results from rapid snowmelt combined with rainfall in the spring or from thunderstorms in the spring and summer, resulting in a concentration of runoff in Dry Creek canyon at the mouth of which Ephrata is located. Runoff exceeding the capacity of an existing channel and ponding area overflows into Ephrata and, if sufficiently large, would flow overland to Soap Lake.

84. Measures examined for prevention of flood damage included flood plain zoning, storage in Dry Creek canyon, ground infiltration, and diversion channels. Flood plain zoning would not protect existing developments, the cost of storage in Dry Creek canyon would be far in excess of benefits, and subsurface conditions are such as to make large-scale infiltration unreliable. The only economically feasible means for control of floods up to the 100-year recurrence interval would consist of an improved channel to the ponding area and an outlet channel discharging into a natural swale leading to Rocky Ford Creek. Discharge to Ephrata Lake would have a greater initial construction cost and would pose some risk of uncontrolled overflow into Rocky Ford Creek. The additional cost of facilities to control floods of greater than 100-year recurrence interval would not be supported by the additional benefits.

85. The cost of constructing the flood control project is estimated at $3,070,000 with annual economic costs of $189,000. Average annual future flood damages of $271,000 would be prevented. Area redevelopment credits would increase total average annual benefits to $329,300. The benefit to cost ratio is 1.7. Costs for rights-of-way, easements, and road crossings are estimated at $440,000. The average annual cost of operation and maintenance is estimated at $7,000. Under provisions of Federal law these items would be the responsibility of the local sponsors. The City of Ephrata, the principal local sponsor, and Grant County have furnished letters expressing willingness to assume the obligations of local cooperation.

86. Although some members of the public would prefer storage or ground infiltration if those measures were effective and economically justified, there is no significant opposition to the diversion channel plan. In addition to flood control there are other water and land resource measures in the study area which warrant consideration, especially in regard to watershed land treatment, outdoor recreation, and fish and wildlife. Suggested steps are noted in the report, however they cannot practicably by combined directly with the flood control plan. Additional information on recommended and alternative projects called for by Senate Resolution 148, 85th Congress, adopted 28 January 1958, is contained in a supplement at the end of this report.

EFFECT ASSESSMENT

87. Studies of possible adverse economic, social, and environmental effects are summarized as follows:

a. Air pollution. Some dust will be created during construction where surface silts are disturbed, however most work is removed from populated areas and sprinkling would minimize dust elsewhere. On a permanent basis, replacement of part of the existing unlined inflow channel with a concrete channel will reduce blowing dust in the urban area. Seeding side slopes and embankments of unlines channels will minimize dust from that source.

b. Noise pollution. There will be a moderate amount of equipment noise during construction.

c. Water pollution. The project will introduce flows from Dry Creek into Rocky Ford Creek and thence into Moses Lake. Such inflow will occur every few years, persisting for a period of time from a few hours to a day or two under extreme conditions. This water will carry a small amount of sediment too fine to settle out in the ponding area or along the discharge route and may contain traces of fertilizer, pesticides, and animal bacteria.

d. Destruction or disruption of man-made resources. The project will require about 9,000 cubic yards of reinforced concrete made from cement and steel. These commodities are in plentiful supply. The only existing structure removed will be the training wall and culvert at 1st Avenue NW.

e. Destruction or disruption of natural resources. Sand and gravel will be required for making concrete. These commodities are produced in large quantities locally. Rock will be required for protection of portions of unlined channels and to reduce velocities in some parts of the natural swale. Such rock is in plentiful supply locally and large amounts are available from existing stockpiles. About every 10 years on the average, inflow of Dry Creek flows will

cause overbank flooding of Rocky Ford Creek, resulting in possible loss of duck and pheasant hatchings and possible stranding of fish.

f. Esthetic values. The concrete portion of the inflow channel will present a more orderly appearance than the present unlined channel. The new outlet channel, in a partially developed area, will be relatively inconspicuous because of the irregular nature of the terrain. Use of an existing swale for the discharge route will avoid making any structural impact on the relatively undeveloped land between the railroad and Rocky Ford Creek. The few dumped rock detention barriers necessary to reduce velocity of flow in some parts of the swale will blend with existing rock outcrops. Overbank flooding of Rocky Ford Creek is expected to take place about every 10 years on the average. This will persist from a few hours to a day or two under extreme conditions and will have no permanent effect on the creek or valley. The possibility of occasional flooding will serve to retain the lower parts of the valley in their natural state.

g. Community cohesion. Within the urban area of Ephrata the project will follow the existing channel, which lies adjacent to an existing irrigation canal, until reaching the ponding area which is outside the existing community. During construction, the rebuilding of the 1st Avenue NW crossing will cause some inconvenience to drivers and possible detours.

h. Public facilities and services. No public facilities will be displaced or services reduced. The prevention of flooding of central Ephrata will assure the continuance of county and city government and the operation of Federal agencies and the PUD during periods of high runoff. Protection of the north end of Ephrata from flooding would permit expension of school or public recreational facilities in that location.

i. Adverse employment effects. Prevention of flooding of businesses will avert work stoppage during periods of high runoff. Employment in central Ephrata could increase because of the willingness of firms to expand after the flood threat is removed.

j. Tax losses. Tax losses would be minimal. The project will require acquisition of about 3 acres of unproductive land at the mouth of Dry Creek, about 5 acres along the alinement of the existing inflow channel, and about 28 acres for the outlet channel. A small part of the latter would be farmland; the remainder presently useful only for dry pasture. Flowage easements will be required over several hundred acres in the existing ponding area, the swale forming the discharge route, and Rocky Ford Creek valley. The occasional flooding of these areas would not change their present use.

k. Property value losses. The value of the ponding area will not be adversely affected as, except for a 100-year flood, the outlet channel would reduce the amount of ponding currently experienced.

The value of the swale area along the discharge route, with respect to its present use for pasturage, should be somewhat improved by the benefit to forage of occasional passage of water. The value of Rocky Ford Creek valley, with respect to its present use for pasturage, should be somewhat improved by occasional overbank flooding benefiting growth of grasses. Although sedimentation is expected to be negligible, any sediments which did remain in the valley would improve the existing soils.

l. Injurious displacement of people, business, and farms. No existing residence, business, or farm will be displaced or caused to relocate under the project plan.

m. Disruption of desirable community and community and regional growth. Growth of the community into the ponding area presently is restrained by the possibility of inundation. The project will not change this and the area will remain best suited for agriculture. The presence of the outlet channel would not prohibit expansion of the community in that area although provision for crossing the channel would be as necessary as for a natural watercourse. Use of the natural swale for discharge would necessitate that any future commercial development in that area make provision for passage of flow. This should not be a serious deterrent to development in view of the large extent of higher land on both sides of the swale. The infrequency of flow would permit streets or roads to cross the swale if necessary as part of any development. The possibility of overbank flooding of Rocky Ford Creek valley will prohibit intensive commercial or residential development. There is no apparent need for such development, whereas retention of this small, scenically attractive valley in approximately its present state appears desirable.

STATEMENT OF FINDINGS

88. I have reviewed and evaluated, in light of the overall public interest, the documents concerning the proposed action, as well as the stated views of other interested agencies and the concerned public, relative to the various practicable alternatives in accomplishing prevention of damages from flooding of Dry Creek at Ephrata, Washington. The possible consequences of these alternatives have been studied according to environmental, social well-being, and economic effects, including regional and national development and engineering feasibility.

89. In evaluation, the following points were considered pertinent:

a. Air, noise, and water pollution.

b. Destruction or desruption of man-made and natural resources, esthetic values, community cohesion, and the availability of public facilites and services.

c. Adverse employment effects and tax and property value losses.

d. Injurious displacement of people, business, and farms.

e. Disruption of desirable community and regional growth.

90. I find that the proposed action, as developed in the Conclusions and Recommendations, is based on thorough analysis and evaluation of various practicable alternative courses of action for achieving the stated objectives; that wherever adverse effects are found to be involved they cannot be avoided by following reasonable alternative courses of action which would achieve the congressionally specified purposes; that where the proposed action has an adverse effect, this effect is either ameliorated or substantially outweighed by other considerations of national policy; that the recommended action is consonant with national policy, statutes, and administrative directives; and that on balance the total public interest would best be served by the implementation of the recommendation.

CONCLUSIONS

91. An economically justified means is available for substantially reducing any future damages caused by flooding of Dry Creek. This measure would constitute a project capable of controlling up to a 100-year flood and would include a debris basin in Dry Creek canyon near its mouth, a reinforced-concrete channel from the debris dam to a stilling basin, an unlined channel thence to an existing ponding area, an unlined channel from the ponding area to a point east of the Burlington Northern railroad, and discharge by means of a flowage easement along a natural swale to Rocky Ford Creek. The project would help alleviate excess unemployment prevailing in Grant County by providing employment during the construction period.

RECOMMENDATIONS

92. I recommend construction of diversion channels and appurtenances, generally as described in this report, with such modifications as at the discretion of the Chief of Engineers may be advisable, from the mouth of Dry Creek, Ephrata, to Rocky Ford Creek, at an estimated first cost to the United States of $2,630,000 for construction, provided that prior to construction local interests furnish assurances satisfactory to the Secretary of the Army that they will:

a. Provide, without cost to the United States, all lands, easements, and rights-of-way necessary for construction of the project, at a presently estimated cost of $65,900;

b. Hold and save the United States free from damages due to the construction works;

c. Maintain and operate the project after completion, in accordance with regulations prescribed by the Secretary of the Army;

d. Provide without cost to the United States all relocations of buildings and utilities, highway bridges, sewers, related and special facilities, and local betterments, at a presently estimated cost of $374,100; and

e. Prevent any encroachment on the rights-of-way of the improvement that might reduce the flood-carrying capacity of the stream or interfere with operation and maintenance of the project.

93. The net cost to the United States for the plan of improvement is estimated at $2,630,000 for construction, with no costs for operation, maintenance or replacements.

W. O. BACHUS
Colonel, Corps of Engineers
District Engineer

NPDPL-PF (15 May 73) 1st Ind.
SUBJECT: Dry Creek, Ephrata, Washington - Report on Survey

DA, North Pacific Division, Corps of Engineers, 210 Custom House, Portland, Oregon 97209 25 October 1973

TO: Chief of Engineers

I concur in the conclusions and recommendations of the District Engineer.

R. E. McCONNELL
Major General, USA
Division Engineer

EXHIBITS

Note: Several of the following exhibits were letters written as comments on the Public Brochure (appendix A) and make reference to alternatives 6 and 6A. Alternative 6 is the project recommended in this report. Alternative 6A is similar, but with discharge to Ephrata Lake instead of Rocky Ford Creek.

Ephrata

WASHINGTON

November 1, 1973

District Engineer
Seattle District, Corps of Engineers
1519 Alaskan Way South
Seattle, Washington 98134

Dear Sir:

The Mayor and City Council of the City of Ephrata, Washington, have reviewed the proposed plan for control of flooding of Dry Creek, and, based upon the cost estimates therein as of this date, agree that the City will sponsor the project and provide or arrange for the required items of local cooperation; as follows:

a. Provide, without cost to the United States, all lands, easements, and rights-of-way necessary for construction of the project.

b. Hold and save the United States free from damages due to the construction works.

c. Maintain and operate the project after completion, in accordance with regulations prescribed by the Secretary of the Army.

d. Provide without cost to the United States all relocations of buildings and utilities, highway bridges, sewers, related and special facilities, and local betterments.

e. Prevent any encroachment on the rights-of-way of the improvement that might reduce the flood-carrying capacity of the stream or interfere with operation and maintenance of the project.

A formal agreement covering our participation will be entered into prior to the initiation of construction.

Sincerely,

Robert E. Ping

Robert E. Ping
Mayor

EXHIBIT 1

GRANT COUNTY
OFFICE OF
BOARD OF COUNTY COMMISSIONERS

ROBERT A. LUDOLPH
GRAND COULEE, WASH.
(FIRST DISTRICT)

H. E. "MODE" SNEAD
MOSES LAKE, WASH.
(SECOND DISTRICT)

F. D. "FRENCHY" O'DONNELL
QUINCY, WASH.
(THIRD DISTRICT)

POST OFFICE BOX 37
EPHRATA, WASHINGTON 98823

March 6, 1972

Honorable Robert E. Ping
Mayor of Ephrata
City Hall
Ephrata, Washington 98823

Dear Mayor Ping: .

The Board of Commissioners of Grant County have reviewed the proposed plan for control of flooding from Dry Creek and are willing to cooperate with the City of Ephrata in meeting the required local obligations.

If the project is authorized and funded, the county will undertake to replace county road B-NW where it crosses the proposed channel and will enter into discussion with the City of Ephrata regarding a fair cost-sharing arrangement for the acquisition of rights-of-way and easements.

In addition, the County will exercise its regulatory authority to prevent any encroachment on the rights-of-way of the improvement that might reduce the flood-carrying capacity of the stream or interfere with operation and maintenance of the project.

A formal agreement covering the County's participation will be entered into prior to the initiation of construction.

Yours very truly,

BOARD OF COUNTY COMMISSIONERS
GRANT COUNTY, WASHINGTON

H E Snead
Chairman

Robert A. Ludolph

HES:dn

cc: District Engineer
Corps of Engineers

EXHIBIT 3

ENVIRONMENTAL PROTECTION AGENCY

REGION X

1200 SIXTH AVENUE

SEATTLE, WASHINGTON 98101

December 7, 1971

Colonel Howard L. Sargent
District Engineer
Seattle District Corps of Engineers
1519 Alaskan Way South
Seattle, Washington 98134

Attn: NPSEN - PL - BP

Dear Colonel Sargent:

This replies to Mr. Young's letter of November 17, 1971, requesting our comments on the alternatives being considered for flood control on Dry Creek at Ephrata, Washington.

We have reviewed the 2nd Edition of your Public Brochure and agree with your tentative conclusion that alternative 6A, a flood control channel discharging into Ephrata Lake, would be the best measure for the control of flooding with the least environmental impact. However, we are concerned over the effects of sediment transport into the lake, and the effects of bacteria, pesticides and nutrients on the lake and Rocky Ford Creek. Detailed studies would be required to predict the effects of these contaminants on Ephrata Lake and Rocky Ford Creek and to plan for controls to minimize their impacts.

Although watershed treatment alone will not satisfy project objectives, it is a desirable, if not essential, measure which should be incorporated into the overall plan. We recommend that a program of watershed treatment be implemented in the basin, either in conjunction with one of the other alternatives or as a separate program, to maintain ground cover and control runoff. This would be beneficial to quality and quantity of all basin surface waters.

We appreciate the continuing opportunity to participate in your planning efforts.

Sincerely,

Harold E. Geren, Acting Chief,
Program Support Branch

cc: John A. Biggs, Director, Washington State Dept. of Ecology
John Findlay, Regional Director, Bureau of Sport Fisheries & Wildlife
Fred J. Overly, Regional Director, Bureau of Outdoor Recreation

EXHIBIT 4

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF OUTDOOR RECREATION
PACIFIC NORTHWEST REGION
1000 SECOND AVENUE
SEATTLE, WASHINGTON 98104

IN REPLY REFER TO:
D6427CNP

DEC 28 1971

Colonel Howard L. Sargent, Jr.
District Engineer
Seattle District, Corps of Engineers
1519 Alaskan Way South
Seattle, Washington 98134

Dear Colonel Sargent:

Reference is made to your letter of December 17, 1971, regarding the Dry Creek Flood Control Study. I regret to inform you that our situation has not materially changed from that indicated in our letter of November 2, 1971. We continue to be unable to review and comment on the project at this time. We appreciate being advised of the progress of your investigation.

Sincerely yours,

Maurice H. Lundy
Regional Director

E. E. Allen

(for) E. E. Allen
Acting Regional Director

EXHIBIT 5

STATE OF WASHINGTON
Department of
Natural Resources

COMMISSIONER
BERT COLE

DON LEE FRASER
SUPERVISOR

BOX 168
OLYMPIA, WASHINGTON
98501

February 11, 1972

Mr. Sydney Steinborn, Chief
Engineering Division, Seattle District
Department of the Army
1519 Alaskan Way South
Seattle, WA 98134

Dear Mr. Steinborn:

Re: NPSEN-PL-ER

On December 21, 1971 you sent us your revised plans for the flooding of Dry Creek at Ephrata, Washington.

Subsequent examination, however, disclosed that the underlying gravels were not sufficiently permeable to handle large quantities of runoff safely, and you then proposed additional alternates.

Our review of this material indicates the following:

1. Alternative No. 6 would be a good plan, but possibly should be dropped in favor of Alternative No. 6A. Under No. 6 too much silt and debris would be deposited into Rocky Ford Creek which could affect the stream gradient and quality. Also, the five-mile flowage easement needed along the natural line of flow could possibly hinder future land development by the landowners.

2. Alternative No. 6A would mostly eliminate the danger of depositing silt and debris into Rocky Ford Creek. If the holding capacity of Ephrata Lake was exceeded by a large future flood, a bypass channel could probably be constructed through the fish hatchery planned on Rocky Ford Creek by the State Game Department. The three-mile-long channel to Ephrata Lake could follow property lines as far as possible, which would hold down the devaluation of property by severance.

EXHIBIT 6
Page 1 of 2

Mr. Sidney Steinborn, Chief
Engineering Division

February 11, 1972

Thank you for giving us the opportunity to make our suggestions.

Sincerely yours,

BERT L. COLE
Commissioner of Public Lands

By Wallace R. Hoffman
Wallace R. Hoffman
Division Supervisor
Lands Division

WRH:mg

cc: Harold Beeman

DEPARTMENT OF GAME

600 North Capitol Way / Olympia, Washington 98501

February 24, 1972

Corps of Army Engineers
1519 Alaskan Way, South
Seattle, Wash. 98134

Attention: Herb Young

Re: Flood Damage Prevention - Dry Creek at Ephrata, Washington

Gentlemen:

In your letter of December 17, 1971 to the Department of Game, we were asked to give our appraisals of alternates 6 and 6A as stated in the Public Brochure for the above-referenced project.

We understand that alternate 6A (flood control channel discharge into Ephrata Lake) has been selected for further detailed study. We wish to emphasize that Ephrata Lake's location above our Rocky Ford Hatchery site constitutes a constant degree of threat to the future water quality, hatchery facilities, and fish stocks. This threat would also hold for the new commercial hatchery located downstream from our site. Although it is claimed that the Ephrata Lake Basin is adequate to contain expected floods, the overflow possibility remains, and contours indicate this would definitely spill towards the headwaters of Rocky Ford Creek. Therefore the Department of Game will definitely continue to object to alternate 6A.

We feel that we could reasonably agree to alternate 6 (flood control channel discharging toward Rocky Ford Creek). One possible problem with this alternate is siltation of Rocky Ford Creek by flood runoff. This threat could be somewhat reduced by rock dike settling basins or other means.

We appreciate the opportunity to review and comment on this proposed project.

Very truly yours,

Carl N. Crouse, Director
DEPARTMENT OF GAME

CNC/JN/jmr
cc: Fisheries
Ecology
Patzwaldt & Spence

EXHIBIT 7

WASHINGTON
Department of
FISHERIES

DANIEL J. EVANS
GOVERNOR

ROOM 115, GENERAL ADMINISTRATION BUILDING • PHONE 753-6600
OLYMPIA, WASHINGTON 98504

THOR C. TOLLEFSON
DIRECTOR

August 3, 1972

Corps of Engineers
Seattle District
1519 Alaskan Way South
Seattle, Washington 98134

Gentlemen:

Re: Public Brochure - Flood Damage Prevention - Dry Creek WRIA-41

The Department of Fisheries has reviewed the above-referenced brochure attached to your letter of December 17, 1971. We apologize for our delayed response concerning this proposal.

There are no salmon in the Dry Creek drainage basin on Rocky Ford Creek. We have no preferred alternative, but in the development of any alternative it would be important to provide adequate facilities for retention of settleable solids at the project site.

We would suggest your review of the Department of Game's response, dated February 24, 1972, relative to Ephrata Lake basin and future overflow possibilities.

We appreciate the opportunity to review and comment on this project, and look forward to the review of final plans.

Sincerely,

Thor C Tollefson

Thor C. Tollefson
Director

cc: Washington Department of Game

EXHIBIT 8

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

1500 N. E. IRVING STREET
P. O. BOX 3737
PORTLAND, OREGON 97208

Reference: RB

Your reference:
NPSEN-PL-ER
December 17, 1971

September 26, 1972

District Engineer
Seattle District, Corps of Engineers
1519 Alaskan Way South
Seattle, Washington 98134

Attention: Herb Young

Dear Sir:

This letter has been prepared under the authority of and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and constitutes our comments on your proposed Dry Creek Flood Control project, Ephrata, Washington. An onsite inspection was made of the project area May 11, 1972, by representatives from your office, our Spokane Area office, and the Washington Department of Game. Purpose of the trip was to reassess merits of alternatives 6 and 6A as described in the public brochure and April 1972 revised plans showing outlet control structure.

Alternate 6A would discharge flood flows into Ephrata Lake. With this alternate a local agency, possibly the Washington Department of Game, would have the opportunity to remove stoplogs from the outlet structure in the event flood water exceeded Ephrata Lake capacity. Flood waters would then flow northeast from Ephrata to Soap Lake. We do not believe the citizens of Soap Lake would permit the diversion of flood waters toward their community when flows could spill into Rocky Ford Creek.

The Washington Department of Game also objects to alternate 6A since Ephrata Lake is located upstream from their Rocky Ford hatchery and poses a constant threat to hatchery operations in the event overflow of the lake occurs. We believe a similar condition exists for the new commercial hatchery located downstream from the Washington Department

of Game hatchery. The hatchery managers have indicated their raceways are located very near the same elevation as Rocky Ford Creek and floodflows would probably damage both the State and private hatcheries.

Alternate 6 would discharge floodflows into Rocky Ford Creek approximately three-fourths mile downstream from the commercial hatchery. This channel route would require local sponsors to obtain a greater number of easements through private lands than alternate 6A and would also require check dams to retard soil erosion and siltation. The commercial hatchery on Rocky Ford Creek could be damaged by backwaters created by floodflows discharged into the stream. However, this would probably affect only the lower rearing ponds and channel discharge location.

We agree with the Washington Department of Game in that alternate 6 would be less damaging to fish and wildlife than alternate 6A. We generally support their position as stated in their letter to you dated February 24, 1972.

We appreciate the opportunity to review and comment on this proposed project.

Sincerely yours,

John D. Findlay

JOHN D. FINDLAY
Regional Director

April 19, 1973

Colonel W. O. Bachus
District Engineer
Army Corps of Engineers
Seattle District
1519 Alaskan Way South
Seattle, Washington 98134

Re: Flood Damage Prevention Dry Creek at Ephrata, Washington

Dear Colonel Bachus:

This replies to Mr. Herb Young's request for the State of Washington, Department of Ecology's policy statement in regard to the referenced study.

After reviewing the 4th draft - November 1, 1972 of the Public Brochure and the information presented at the public meeting on November 16, 1972, we can reasonably agree with the Corps tentative recommendation, or alternative 6. This is the plan utilizing the physical structures of a debris basin, concrete channel, stilling basin, and unlined channel, and routes the Dry Creek flood flows to Rocky Ford Creek.

This plan has the least environmental impact when compared to alternative 6A, or the plan which routes the flood flows into Ephrata Lake. However, we are still quite concerned that enough sediment and debris would still find its way into Rocky Ford Creek and eventually into Moses Lake to be detrimental to fish and wildlife and add to an already poor water quality situation in Moses Lake.

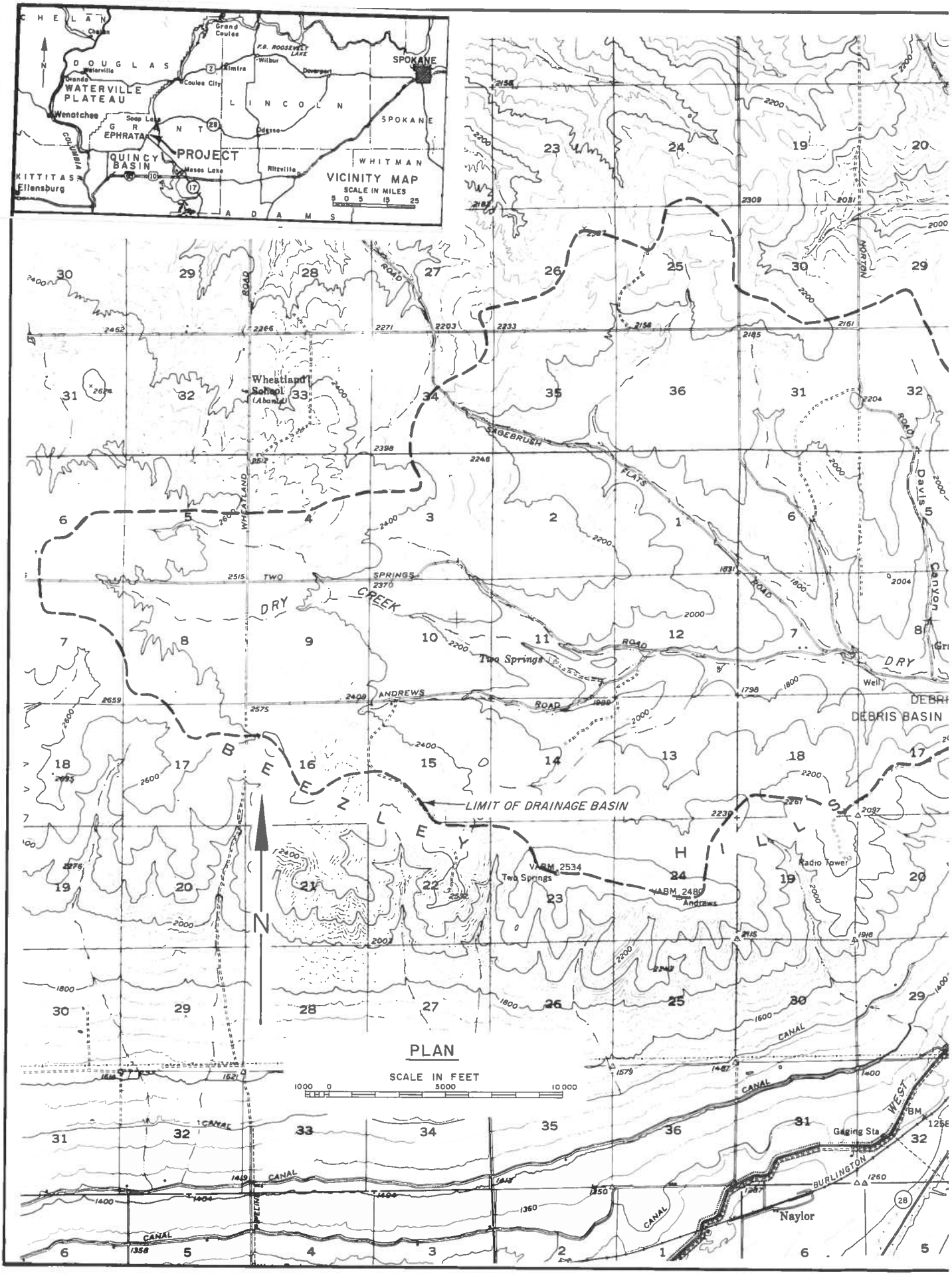
Realizing that the economics of the plan has just enough annual benefits to be feasible, every effort should be made to develop and incorporate into the plan a reasonable and attainable flood plain management program. This would promote watershed treatment and develop additional low-cost settling basins to help reduce the siltation problem, thus maintaining or improving the water quality in Rocky Ford Creek and Moses Lake.

Very truly yours,

John A. Biggs
Director

JAB:gh

EXHIBIT 10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LINCOLN
SPOKANE
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ADAMS
GRANT
KITTITAS
WATERVILLE PLATEAU
QUINCY BASIN
PROJECT
Grand Coulee
Coulee City
Wilbur
Davenport
Odessa
Ritzville
Moses Lake
Ephrata
Soap Lake
Wenatchee
Chelan
Omak
Okanogan
Columbia
Ellensburg
Waterville
Almira
L. ROOSEVELT LAKE
Wheatland School (Abandoned)
SAGEBRUSH FLATS
DRY CREEK
TWO SPRINGS
Two Springs
ANDREWS ROAD
Andrews
WHEATLAND ROAD
DAVIS CANYON
DEBRIS BASIN
LIMIT OF DRAINAGE BASIN
BEEZLEY HILLS
VABM 2534
VABM 2480
Radio Tower
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BM 1256
BURLINGTON
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WEST CANYON
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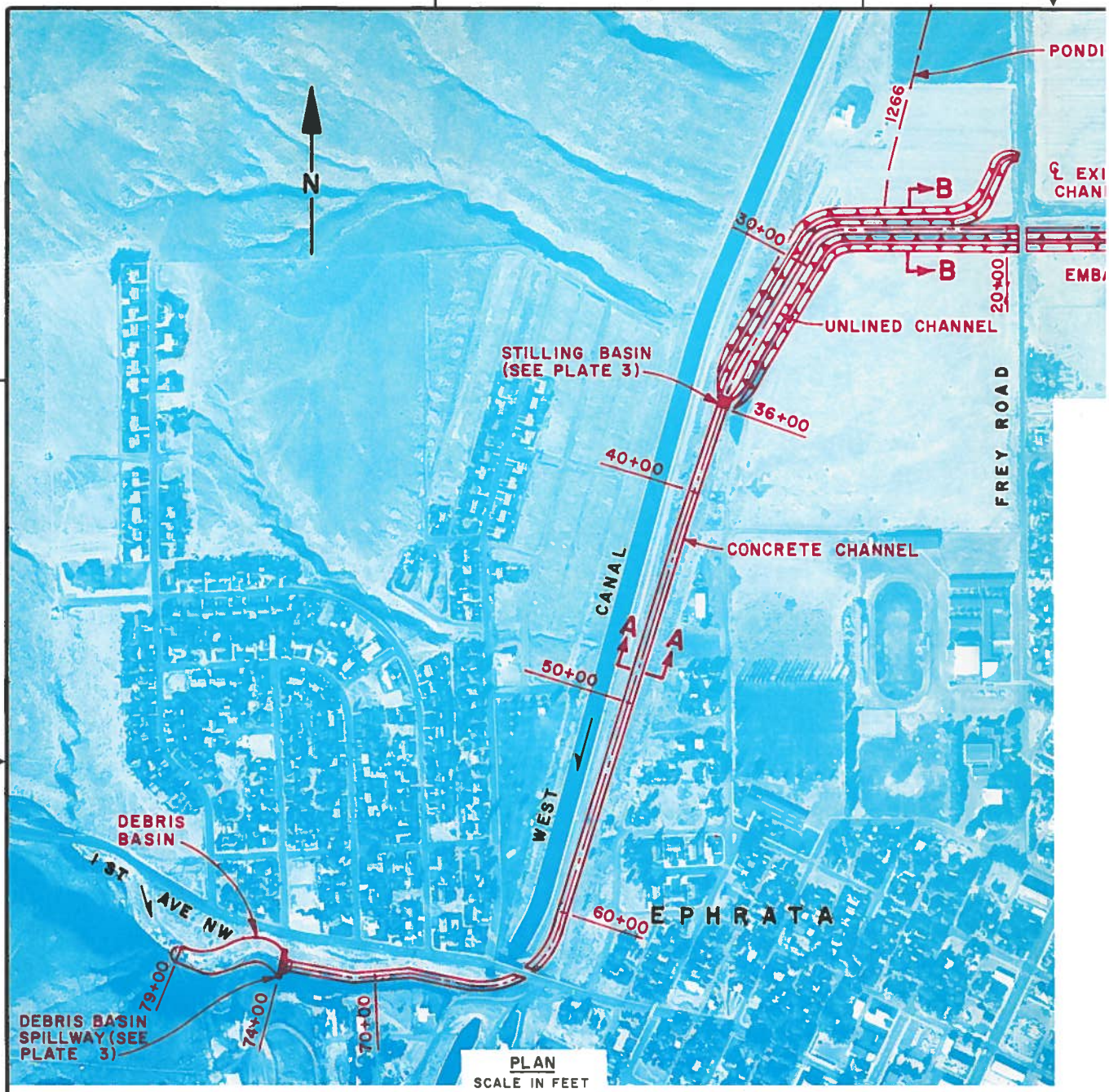

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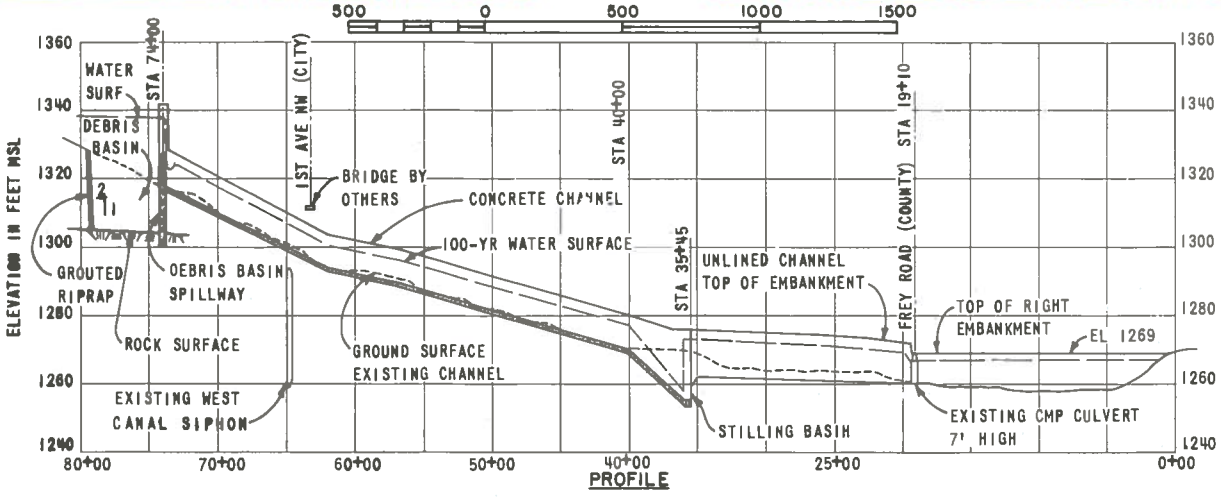

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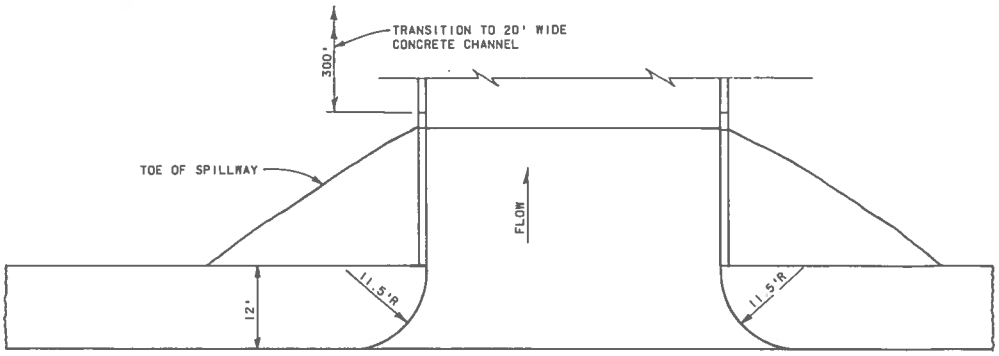

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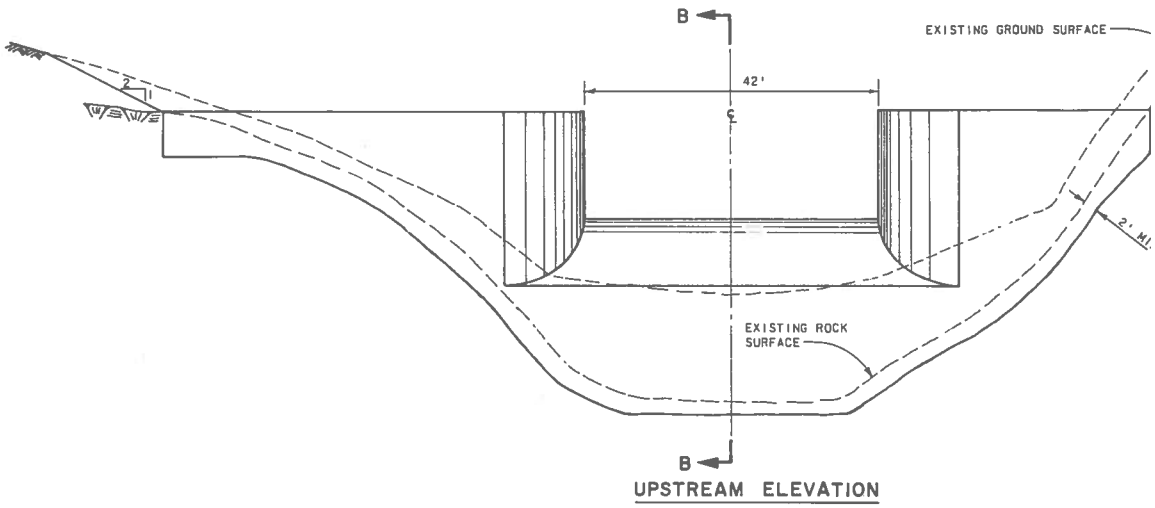

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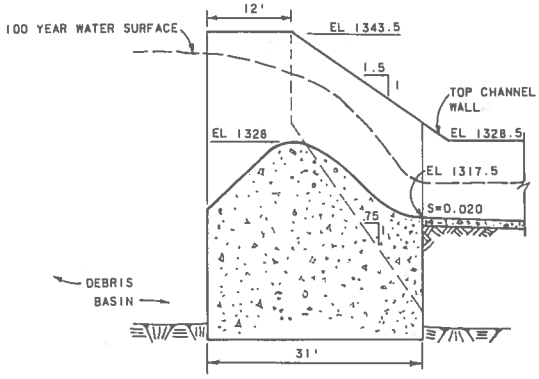
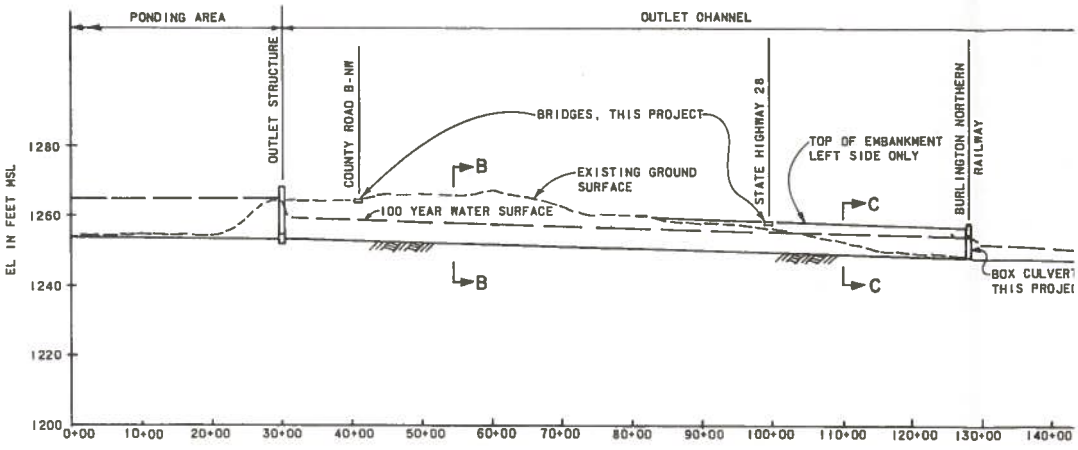


SECTION B-B

DEBRIS BASIN SPILLWAY



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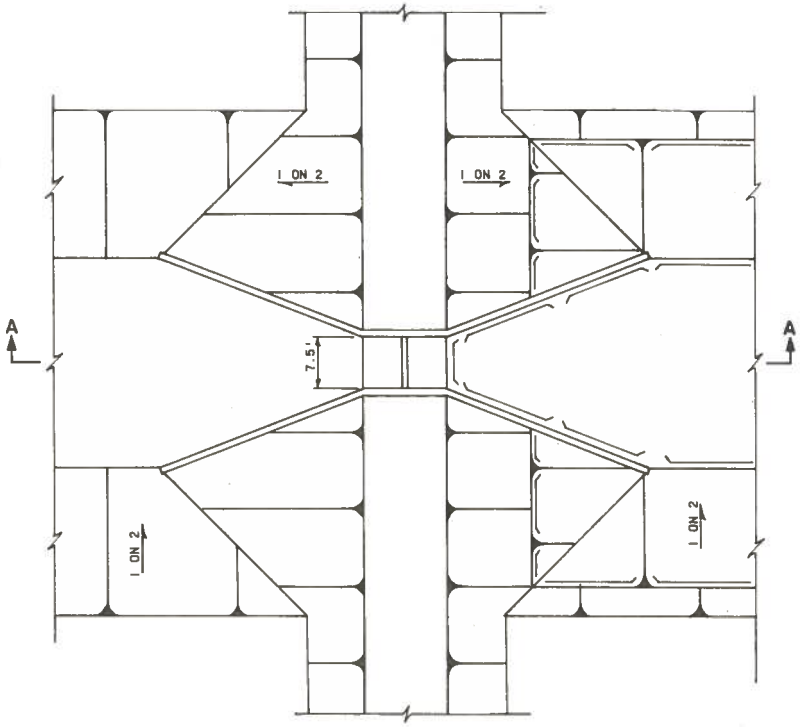

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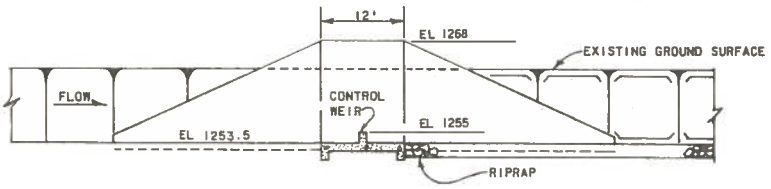
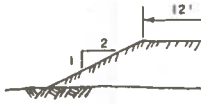


SECTION A-A



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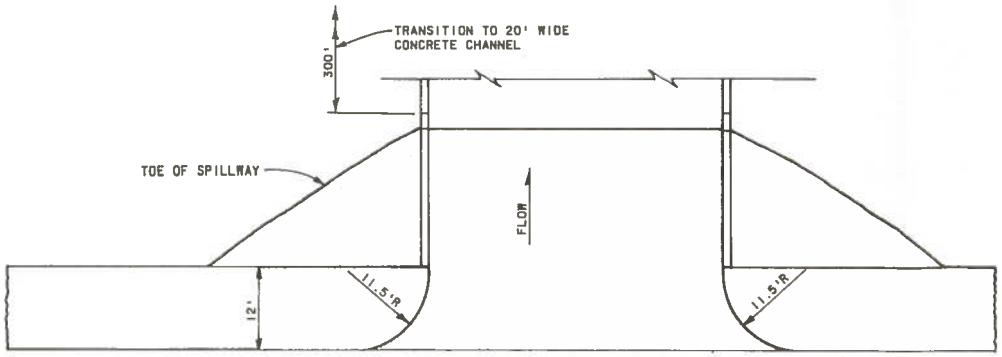

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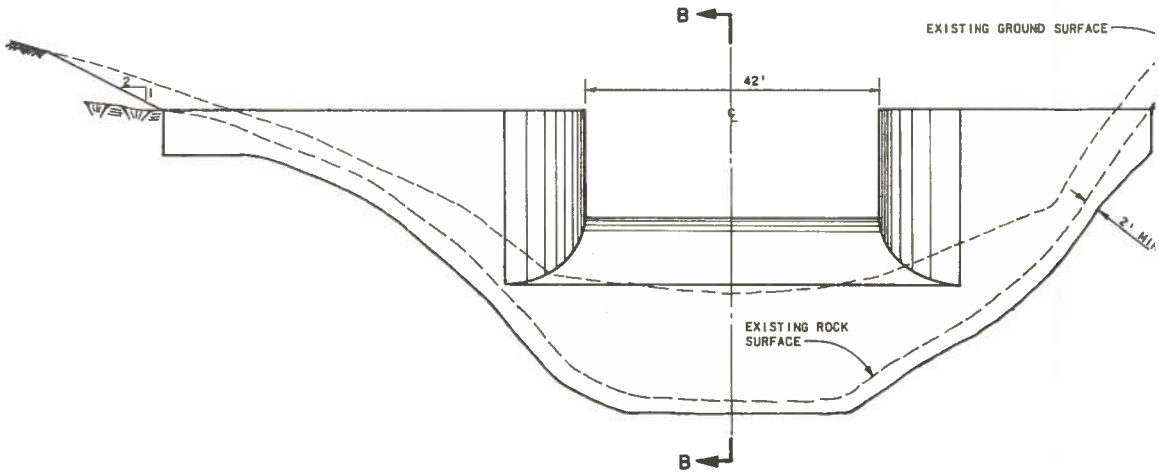
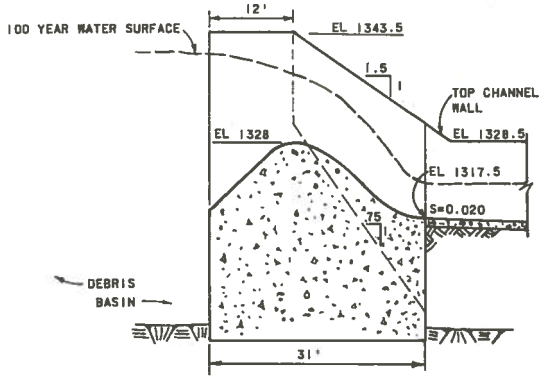


UPSTREAM ELEVATION



SECTION B-B

DEBRIS BASIN SPILLWAY

Appendix A

PUBLIC BROCHURE

PUBLIC BROCHURE

ALTERNATIVES AND THEIR PROS AND CONS

FLOOD DAMAGE PREVENTION
DRY CREEK AT EPHRATA, WASHINGTON

AUTHORITY FOR STUDY: Congress has directed the Corps of Engineers to determine whether improvements for flood control and other purposes along Dry Creek at and in the vicinity of Ephrata are advisable at this time.

PURPOSE OF BROCHURE: This brochure portrays the full range of alternatives available for reducing flood damages in the Ephrata area, as well as the alternative of "doing nothing."

METHOD (FISHBOWL PLANNING): This brochure is available to interested parties on request, and their comments are solicited and incorporated in successive draft brochures.

The alternatives shown were suggested by local people and agency representatives through public meetings, workshops, correspondence, and personal contacts. Interested persons are invited to propose additional alternatives, defending them with advantages (PROS) and describing disadvantages (CONS) of other competing alternatives.

The brochure is revised continually until all meetings and studies have been completed. Changes are made as new comments are received from individuals, agencies, and associations, and as studies reveal new facts about alternatives.

Individuals, groups, and local, State, and Federal agencies are urged to participate now, when their efforts are most effective in guiding the planning process. The brochure is not intended as a device for obtaining votes favoring or rejecting alternatives. Selection of alternatives for final study is based on consideration of all social, economic, and environmental advantages and disadvantages of each alternative.

We would appreciate your examination of alternatives set forth and invite your comments (PRO or CON), suggested additions or modifications of the alternatives, and your appraisal of the impacts - environmental, social, or otherwise - of any one or all of the alternatives.

PRELIMINARY
SUBJECT TO REVISION

HERB YOUNG
Study Manager
206-442-5005

SEATTLE DISTRICT, U. S. ARMY CORPS OF ENGINEERS
1519 ALASKAN WAY SOUTH, SEATTLE, WASHINGTON 98134

4th draft - 1 November 1972

INDEX

*Sources of comments on alternatives are shown by reference numbers identified on page 28

SEATTLE DISTRICT'S TENTATIVE RECOMMENDATION

In view of the findings of detailed studies, the Seattle District, Corps of Engineers, believes that the best alternative flood control plan consists in routing Dry Creek floodflows to Rocky Ford Creek, as described in Alternative 6. This plan would provide protection to Ephrata, Soap Lake, Lakeview Park, and intervening farm and pasture lands against a 100-year flood. It is less costly and, therefore, more economically sound than the Ephrata Lake alternative (Alternative 6A). Unlike Ephrata Lake, Rocky Ford Creek is capable of receiving all discharges from Dry Creek without depending upon the operation of a control structure. Damages to an existing fish hatchery and small irrigation dams, which would be caused by a temporary rise in the surface elevation of Rocky Ford Creek, can be prevented by inexpensive means. However, floods of 10-year frequency or greater would cause a loss of part of the annual production of ducks and pheasants in the Rocky Ford valley.

SUMMARY OF ENVIRONMENTAL CONSIDERATIONS

The tentatively recommended flood control plan (Alternative 6) would require a channel 2 miles long from the existing ponding area, plus a flowage easement 4 miles long to Rocky Ford Creek. The channel, the sides of which would be seeded, would not be a conspicuous feature of the landscape, except at its crossing of State Highway 28. The flowage easement would not necessitate any disturbance of the natural environment, but its existence would prevent any nonagricultural development which would obstruct floodflows. Floodflows normally would occur once during the year, for a period of a day or two. Flows reaching Rocky Ford Creek would raise the creek surface as much as 6 feet for a 100-year flood. This would back water to the fish hatchery, requiring embankments to safeguard any future facilities built on low ground. Existing small irrigation dams downstream also would be endangered and would require protection. Smaller floods would have less effect - a 10-year flood, for example, would cause a 3-foot rise in the water level of the creek.

The flood water is expected to carry fine suspended sediments, part of which would probably be deposited on the grasslands adjoining the creek. As these lands are either marshy or rocky, the deposited soil, as well as any fertilizer brought in, should be agriculturally beneficial. The remainder of the suspended sediments and nutrients would be carried on to Moses Lake, thence to lower Crab Creek and the Columbia River. No large amounts of pesticides or animal bacteria are known to originate in Dry Creek or the ponding area.

As flood inflows would be of short duration and would not create high velocities in Rocky Ford Creek, significant damage to the resident trout population is not anticipated. On the valley floor bordering the creek there are approximately 50 nests of mallard and teal and other species of ducks, and about 25 pheasant nests. Floods of 10-year frequency and greater, occurring during the nesting period, would cause loss of young birds. The outlet channel from the ponding area would have sloping sides, and thus would not present a hazard or obstruction to animal life.

In addition to flood protection to existing developments, the project would have some positive environmental effects. The ponding area north of Ephrata would be drained immediately after floods, unless retention of the water for irrigation purposes was desired. A park planned for the north end of Ephrata would become practicable once the land became flood-free. Land within the flowage easement would receive moisture and incidental nutrients carried by floodflows.

RESULTS OF DETAILED STUDIES

At the formulation-stage public meeting, 1 December 1971, Alternatives 6 (Flood Control Channel Discharging Toward Rocky Ford Creek) and 6A (Flood Control Channel Discharging Into Ephrata Lake) were selected for detailed study. Subsequent study findings are summarized below under the headings of "Flood Control Effectiveness," "Adverse Effects," and "Economic Feasibility."

Flood Control Effectiveness - Both alternatives are designed to protect Ephrata, Lakeview Park, Soap Lake, and intervening lands against a flood having a maximum discharge of 5,000 second-feet. Such a flow has a 1 percent change of occurring in any given year, and thus is referred to as a "100-year flood." This is considered by Federal Government standards to be the minimum adequate level of protection for urban areas. With the Ephrata Lake plan there is a possibility that the level of protection eventually could decline from loss of storage capacity, either due to a rise in the water table or to a gradual reduction in permeability of the lake bed. In contrast, the Rocky Ford Creek alternative is not dependent on storage or seepage. With either plan, discharges of Dry Creek greater than 5,000 second-feet would cause the capacity of the outlet channel to be exceeded, thereby permitting the excess water to follow its natural route northward toward Soap Lake.

Adverse Effects - The Ephrata Lake plan would depend on operation of a control structure to halt further flow to the lake when its capacity had been reached. Should the control not be operating for any reason, any flood equal to or greater than the flood of 1948 could overfill the lake, causing an overflow to the south into Rocky Ford Creek. Erosion, sediment deposit in the creek, and flooding of existing and future fish hatcheries could result. The Department of Game and Bureau of Sport Fisheries and Wildlife oppose the Ephrata Lake alternative for this reason.

With the Rocky Ford Creek plan, large flood inflows would raise the level of the creek, backing water to the existing fish hatchery, overflowing hay and pasture lands on both sides of the creek, and possibly washing out existing small irrigation dams downstream. Pollutants, in the form of suspended sediments and fertilizers, would be contained to some extent in the discharge from the Ephrata ponding area.

Economic Feasibility - Economically, both plans are close to marginal; that is, average annual benefits are only slightly greater than average annual costs. The Rocky Ford Creek alternative is in the better position economically, in that its total cost is about $250,000 less than the Ephrata Lake plan.

RATIONALE FOR ELIMINATION OF ALTERNATIVES

Alternative 1 - No Action - was eliminated because of the great potential for damage to property under existing conditions. The present system for handling runoff is capable of managing flows up to only 2,200 c.f.s., a flow which on a statistical average occurs every 20 years. Larger flows would carry water and debris into the central area of Ephrata, scouring lawns, undermining streets, destroying the contents of basements, damaging vehicles, inundating the ground floors of homes and shops, disrupting traffic, causing electrical failures, and necessitating a massive and costly cleanup. Furthermore, the capacity of the existing natural ponding area could be exceeded and destructive flows take place across rural properties, the community of Lakeview Park, and the town of Soap Lake. Voluntary limitations on future urban development in the flood-susceptible area would not protect the extensive existing developments.

Alternative 2 - Flood Plain Management - was eliminated because of the extensive urban development already occupying the flood plain. Should no flood control measures be constructed, flood plain zoning should be considered for the as yet undeveloped lands in the flood-susceptible area.

Alternative 3 - Watershed Treatment) is not a true flood damage prevention measure, because even complete treatment of the watershed would have only

a minor effect in reducing large floods. One estimate is that the 100-year runoff would be reduced about 10 percent after all possible elements of watershed treatment had been completed. Therefore, alternative 3 in itself would not provide an adequate degree of flood control. However, it can be recognized as a highly desirable program which, in addition to conserving soil and water in the watershed, would reduce the amount of silt and debris carried by Dry Creek, and would have some beneficial effect through diminishing runoff. Alternative 3, therefore, may be considered complementary to other means of flood damage prevention, but would have to be carried out as a separate program.

Alternative 4 - Storage Dam with Outlet into Irrigation Canal - was eliminated primarily on the basis of cost. To be economically feasible, project benefits should exceed costs, and in this case the annual costs would be four times annual benefits. An additional consideration is the possible objection of irrigation-water users to the quality of water which would be introduced into the irrigation system by this alternative.

Alternative 5 - Storage Dam with Existing Outlet - was eliminated because of its high cost. Average annual costs would be three times annual benefits.

Alternative 5A - Multiple Storage Dams - was eliminated as having no advantage over Alternative 5. A given amount of storage capacity can be provided more efficiently by a single large reservoir than by several smaller ones, each with its spillway and outlet works. For this alternative, annual costs would be nearly five times annual benefits.

Alternative 7 - Flood Control Channel with Infiltration Trench - was eliminated after soil borings and percolation tests showed insufficient permeability to carry a 100-year flood to groundwater. The condition would worsen with time, as annual runoff would bring silt into the infiltration trench, further sealing the subsurface gravels.

ALTERNATIVE COMPARISON

	No action 1	Flood plain management 2	Watershed treatment 3	Diversion into irrigation canal 4	Storage dam 5	Multiple storage dams 5A	Channel toward Rocky Ford Creek 6	Channel to Ephrata Lake 6A	Infiltration trench 7
Maximum prevention of flood damages	○	◑	Not an adequate flood control measure in itself, but would be a desirable complement to any of Alternatives 2-7.	●	●	●	●	●	◑
Least disruptive to physical environment	●	●		○	○	○	◑	○	◑
Least harmful to fish and wildlife	●	●		◑	◑	◑	○	○	●
Most favorable benefit-cost ratio	NR	NR		○	○	○	●	◑	○
Minimizes total construction cost.	●	●		○	○	○	◑	◑	◑
Minimizes local construction cost.	●	●		◑	◑	◑	○	○	○

LEGEND - ACHIEVEMENT LEVEL

● High

◑ Intermediate

○ Low

NR Not Rated

FLOOD SITUATION

Little or no flow occurs in Dry Creek for extended periods of time throughout the summer and into the winter. From December through June the maximum flow varies from none in some years to damaging discharge in others. *Flooding can occur from December to March as a result of rainfall and snowmelt, or later as a result of thunderstorms. During the winter the ground may be frozen and covered with snow. The city of Ephrata was flooded in 1920 and 1948. The estimated peak discharge of the 1948 flood was 3,000 c.f.s.

The flood plain of Dry Creek includes Ephrata, Lakeview Park, and Soap Lake, separated by irrigated agricultural areas and dry lands. The 100-year flood plain comprises 720 acres, nearly half of which is agricultural and the rest residential, roads and streets, commercial-industrial,and public facilities, in that order. The most recent severe flood, that of 27 May 1948, was caused by a cloudburst at the upper end of the watershed. An 8-foot wall of water swept down the canyon and over a training dike into the city. Water and silt spread out over the residential area and business district, filling basements, damaging furnishings, and overtaxing the storm sewer system. If the 1948 flood occurred today, it would cause damage estimated at $1,400,000.

The flood control system now consists of an improved training dike, a culvert under 1st Avenue, N.W., and an unlined ditch leading to a natural ponding area of about 200 acres north of Ephrata. The ponding area is partly used for irrigated farming. Much of the water entering the ponding area reaches a gravel pit on the east side, where it permeates into the ground. Water left standing on farmland permeates more slowly. The existing system is capable of handling flows up to 2,200 c.f.s. and of holding about 1,300 acre-feet in the ponding area. Flows exceeding the capacity of the system overflow the bypass ditch into Ephrata or fill the ponding area and flow south into Ephrata or north to Lakeview Park and Soap Lake.

STUDY HISTORY AND PUBLIC INVOLVEMENT

In 1967 the city of Ephrata offered to sponsor a survey investigation. The investigation was authorized that year by resolution of the House Committee on Public Works. Upon funds becoming available, a public hearing was held in Ephrata on 9 April 1969. Comments and data were requested from the city of Ephrata, interested groups and individuals, Grant County, Burlington Northern Railroad, State of Washington, Bureau of Sport Fisheries and Wildlife, Soil Conservation Service, Bureau of Reclamation, and others. Studies were made of flood frequency and runoff, damages, and real estate values.

Following a workshop held in Ephrata in May 1971, preliminary studies were made of storage sites, hydraulic design of flood control channels, and channel

layouts. Soil investigations were carried out during the summer of 1971. In October 1971, the first draft of the public brochure was mailed to each person known to have any interest in the study, two copies being sent so that one could be returned with PROS and CONS. These comments were incorporated in the second draft, mailed in November 1971.

At the formulation stage public meeting held in Ephrata 1 December 1971, the District Engineer proposed that, on the basis of studies and comments to date, Alternative 6A (Channel to Ephrata Lake) be selected for detailed study. However, in view of the substantial support for Alternative 6 (Flowage to Rocky Ford Creek) as well as for 6A, the consensus of the meeting was taken to favor a detailed study of both Alternatives 6 and 6A.

Following the formulation stage public meeting, the final report was prepared in draft form and subjected to detailed review. During this period comments were received from State and Federal conservation agencies, and a field inspection was made with the Department of Game and Bureau of Sport Fisheries and Wildlife. A draft of the environmental impact statement was written and economic feasibility reexamined. Correspondence was carried on with the Department of Highways regarding its willingness to assume responsibility for necessary highway changes. The public brochure was revised for mailing prior to the final public meeting.

FUTURE STUDY

At a final public meeting, scheduled for 16 November 1972, the results of the detailed studies on the alternatives selected will be presented prior to our forwarding our report. A final edition of this brochure and the environmental statement will accompany the Seattle District Engineer's report. The recommendations contained in the report will be reviewed by the Corps of Engineers' Division Engineer in Portland, Oregon, and by the Board of Engineers for Rivers and Harbors and the Chief of Engineers in Washington, D. C. Comments will be requested from other Federal agencies and from the State of Washington. The report will then be submitted to Congress. *If the project is authorized, a review of all alternatives and changed conditions will be made in coordination with the public and other agencies. Final design will proceed on the basis of the findings of that review.

FEDERAL AND LOCAL PARTICIPATION

All alternatives, except Alternative 1 (No Action), are potentially eligible for Federal financial assistance. However, Federal participation in any alternative finally recommended after detailed study would be contingent upon the following criteria:

a. The alternative must provide sufficient benefits, including economic, environmental, and social considerations, to offset the costs.

b. The local sponsoring agency must agree, first in a letter of intent and later in a written agreement, under the terms of Section 221 of the Flood Control Act of 1970, to:

(1) Provide, without cost to the United States, all lands, easements, and rights-of-way necessary for construction of the project.

(2) Hold and save the United States free from damages due to the construction works.

(3) Maintain and operate the project after completion, in accordance with regulations prescribed by the Secretary of the Army.

(4) Provide, without cost to the United States, all relocations of buildings and utilities, highway bridges, sewers, related and special facilities, and local betterments.

(5) Prevent any encroachment on the rights-of-way of the improvement that might reduce the flood-carrying capacity of the stream or interfere with operation and maintenance of the project.

In March 1972, letters were received from the City of Ephrata, agreeing to sponsor the project, and from Grant County, agreeing to cooperate with the City of Ephrata in meeting the required local obligations.

ALTERNATIVE 1

NO ACTION

Physical structures. None. Existing bypass ditch to remain in use.

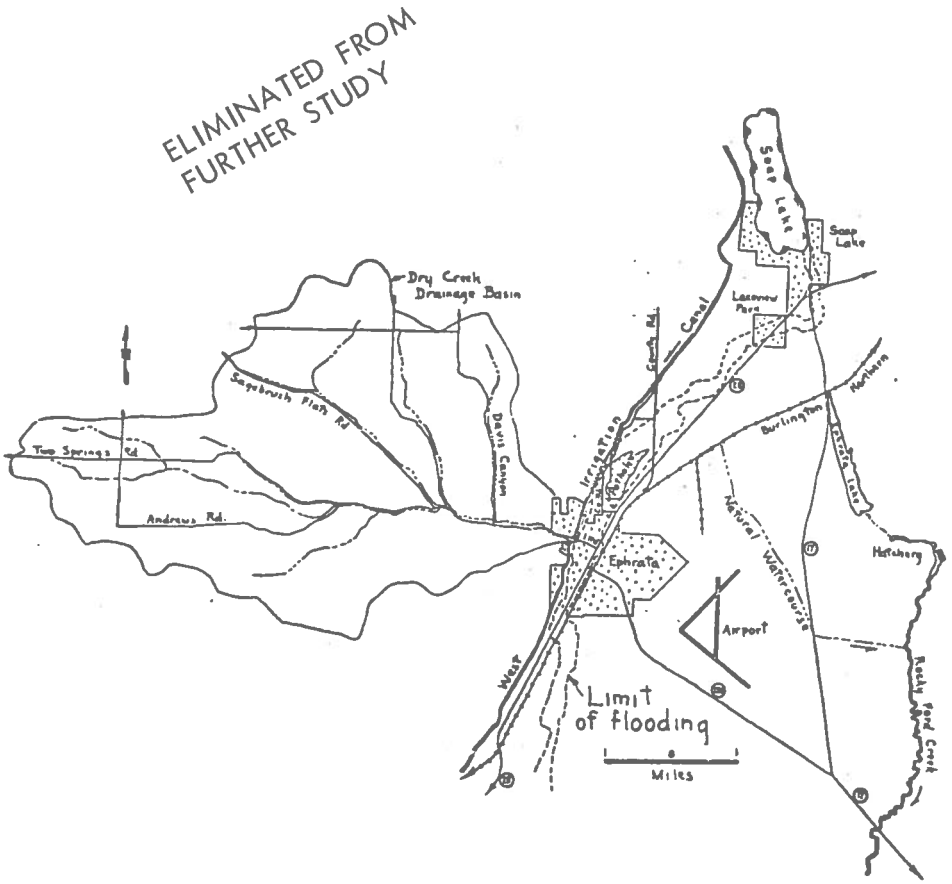
Nonstructural measures. None.

Water and land use. Possible curtailment of urban development in Ephrata, Lakeview Park, and Soap Lake flood plain because of flood hazard or difficulty in obtaining Government loans.

Effects. Recurrent inundation of the flood plain would continue, with damages as described on page 3. Damages would grow as development took place and property values and agricultural production increased.

Federal costs. None except emergency aid.

Local costs. Damage losses and depression of tax base because of flood hazard.



ALTERNATIVE 1

NO ACTION

PROS		CONS
1. A repetition of the 1948 flood would be less damaging because of the present flood diversion canal. (5)	→	1. A fast, large runoff could cause conditions similar to or worse than 1948. The capacity of the storm sewer system could be exceeded, the sanitary sewer system put out of commission, the water system contaminated, and public utilities, communications, businesses, and homes damaged by mud and water. (10,11)
2. Damaging floods are infrequent. (5)	←	2. The potential loss through flood damages cannot be tolerated. A minimum of 100-year flood protection should be considered. (30) Will inevitably result in large future damage. (10,12)
3. Addition of top soil to the flood plain may offset flooding costs. (5)	←	3. Damages incurred on a recurring basis north of Ephrata include loss of crops, repair costs, insect and weed contamination, loss of top soil, and siltation. (1)
4. Not detrimental to present wildlife habitat. (31)		4. _____
5. _____		5. Results in no flood control. (2)
6. _____		6. Prevents full use of flood plain and ponding area. (1)

ALTERNATIVE 2

FLOOD PLAIN MANAGEMENT

Physical structures. No flood control structures. Alterations to buildings and utilities by owners to minimize flood damage. Existing bypass ditch to remain in use.

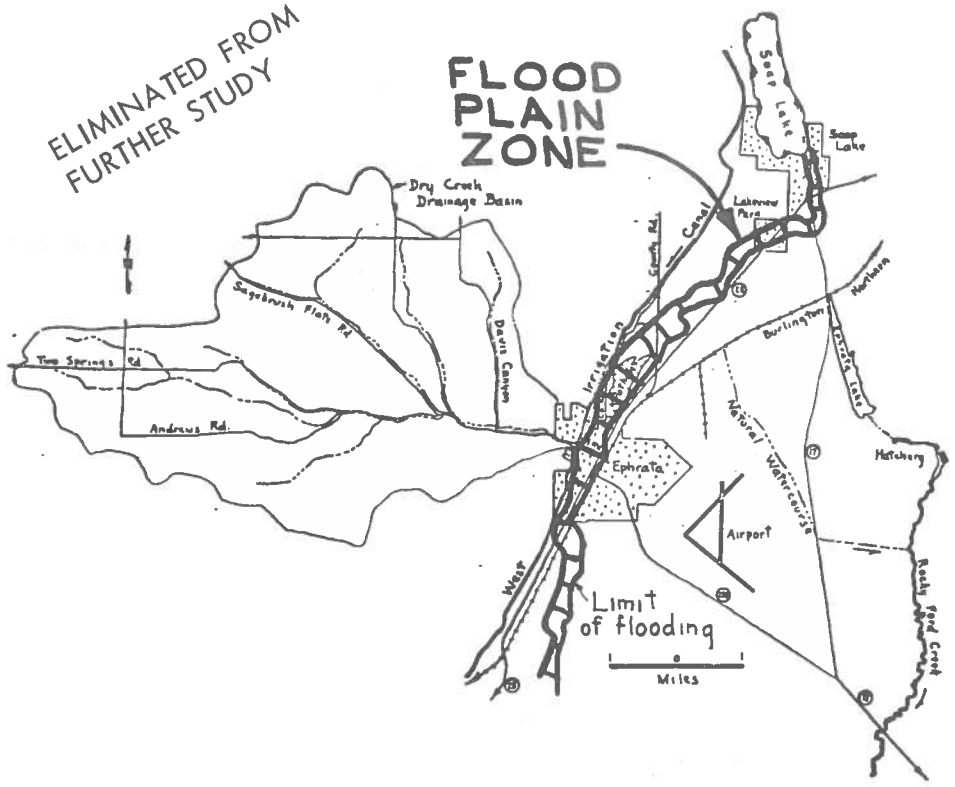
Nonstructural measures. Zoning of flood plain by county and cities to halt further flood-susceptible development and make area eligible for flood insurance. Establishment of a flood warning and evacuation plan.

Water and land use. Further urban development in the flood plain would be halted. Use of flood plain for agriculture and recreation would continue.

Effects. Recurrent inundation of the flood plain would continue, with damages as described on page 3. Urban damages might decrease as floodproofing alterations were made. Greater use of the flood plain for agriculture would result in an increase in agricultural flood damages.

Federal costs. Flood plain information study, flood insurance payments, and emergency aid.

Local costs. Administrative costs for flood plain management. Cost of flood alarm equipment. Individual costs for floodproofing alterations. Flood insurance premiums.



ALTERNATIVE 2

FLOOD PLAIN MANAGEMENT

PROS	CONS
1. Would not be detrimental to the wildlife habitat. (31)	1. _____
2. _____	2. Impractical to expect voluntary structural protection. Flood plain zoning contrary to existing and proposed land use. (10,12)
3. _____	3. Prevents full use of flood plain and ponding area. Damages would continue to recur as with alternative 1.(1)
4. _____	4. Results in no flood control. (2)
5. _____	5. _____

ALTERNATIVE 3

WATERSHED TREATMENT

Physical structures. Detention dams in watershed (about 45 sites, less than 5 acre-feet of storage at each).

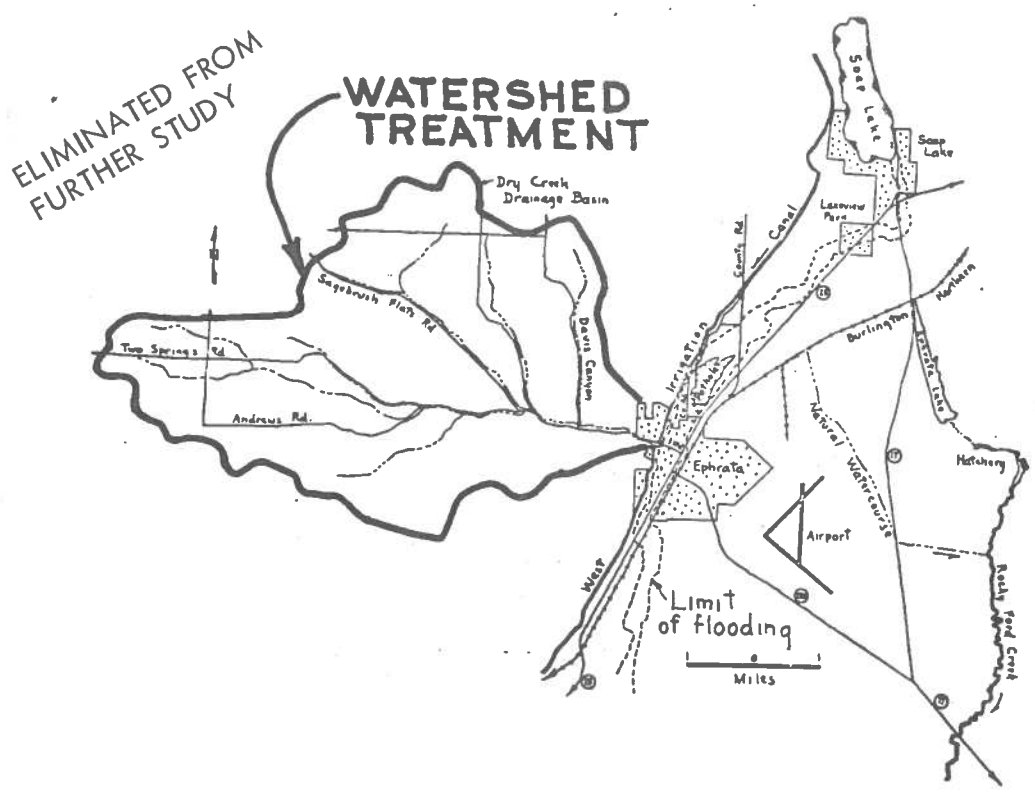
Nonstructural measures. Terracing, conversion of some cropland to permanent vegetation, mulching, chiseling, grazing control.

Water and land use. Possible curtailment of urban development in Ephrata, Lakeview Park, and Soap Lake flood plain because of remaining flood hazard. Use of flood plain for agriculture and recreation would continue. Agricultural use of water and land in upper watershed would be more efficient and productive and probably would expand.

Effects. Recurrent inundation of the flood plain would continue, but with reduced runoff and damages. (Soil Conservation Service estimates approximately 10 percent reduction in flood runoff with full watershed treatment.) Damages would grow as development took place and property values and production increased. This alternative is not a complete flood control plan in itself, but would be complementary to any of the other alternatives.

Federal costs. Watershed treatment costs not determined. Emergency aid.

Local costs. Local share for watershed treatment. Damage losses and some depression of tax base because of remaining flood hazard.



ALTERNATIVE 3

WATERSHED TREATMENT

PROS	CONS
1. Contour subsoiling, stubble mulching, cross-slope seeding, and proper grazing reduce soil erosion, sedimentation, and water loss. These practices must be supplemented with terraces, strip-cropping and dams. (20)	1.
2. Keeps water where it can be used. (5)	2.
3. Not a complete flood control plan, but a desirable complement to any downstream plan. (2,5, 10,12,32)	3.
4. Approximately 20 percent of the 7,500 acres of cropland is suitable for level terraces. (42)	4.
5. Would improve wildlife habitat. (31)	5.
6.	6. Financing of physical structures may be difficult. (2)
7.	7. Would not reduce runoff sufficiently to provide adequate flood control. (6)
8.	8. Prevents full use of flood plain and ponding area. (1)

ALTERNATIVE 4

STORAGE DAM WITH OUTLET INTO IRRIGATION CANAL

Physical structures. Storage dam 120 feet high with spillway and outlet works on Dry Creek about one mile upstream from Ephrata, diversion structure, and intake structure on West Canal. Road relocations.

Nonstructural measures. None.

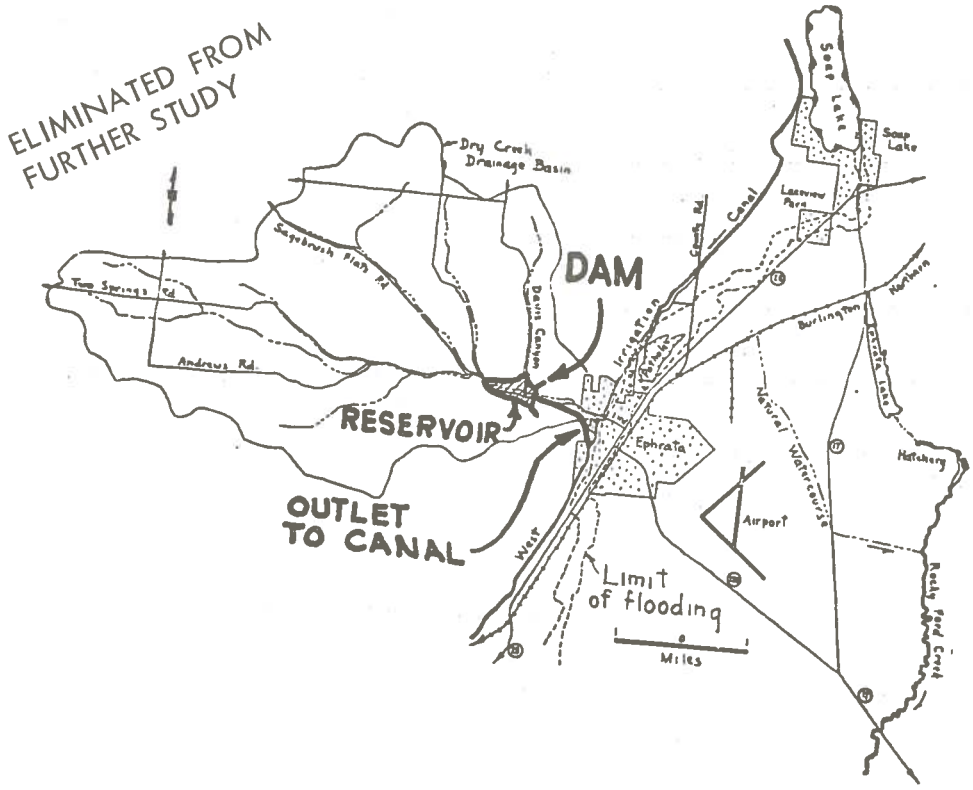
Water and land use. Urban development could take place within the flood plain.

Effects. Complete protection would be provided against the 100-year flood. As the irrigation canal may be full when flooding occurs, the storage dam would have to be large enough to contain all runoff until flow in the canal could be reduced to accommodate the discharge of floodwaters. During the period of discharge the canal upstream from Dry Creek would be carrying less than the normal quantity of irrigation water.

	Construction cost	Annual O.& M.
Federal	$16,000,000	$80,000
Local 1/	0	0
Total	$16,000,000	$80,000

1/Cost sharing not determined. Local interests might operate and maintain dam, as well as share land and road costs.

Economic analysis. Average annual benefit - $250,000
Average annual cost - $1,010,000.



ALTERNATIVE 4

STORAGE DAM WITH OUTLET INTO IRRIGATION CANAL

PROS	CONS
1. An impounding basin from which water could be pumped into the West Canal would obviate the need for costly construction of an outlet channel. (3)	1a. Costs are high. (5, 6, 30, 41) 1b. Problems with Bureau of Reclamation would be too great. (2)
2. Retains water close to source. (4)	2. Could interfere with water rights north of Ephrata. (5)
3. Permanent protection for Ephrata, Lakeview Park, Soap Lake, flood plain, Ephrata Lake, fish hatchery, and Rocky Ford Creek. Eliminates need for permanent flood control channels through present and future urban areas. (1)	3. _____
4. Avoids disposal of silt and debris on previously unaffected areas. (5)	4. _____
5. _____	5. Discharges into canal must be free of silt and debris. (43)
6. _____	6. Irrigation District will expect reimbursement for regulating canal flows in coordination with flood discharges. (43)
7, _____	7. The irregularity of flood flows eliminates their value for irrigation. (43)

ALTERNATIVE 5

STORAGE DAM WITH EXISTING OUTLET

Physical structures. Storage dam 100 feet high, with spillway and outlet works on Dry Creek about one mile upstream from Ephrata. Road relocations. Existing bypass ditch to remain for carrying gradual releases to ponding area north of Ephrata.

Nonstructural measures. None.

Water and land use. Urban development could take place within the flood plain outside the ponding area.

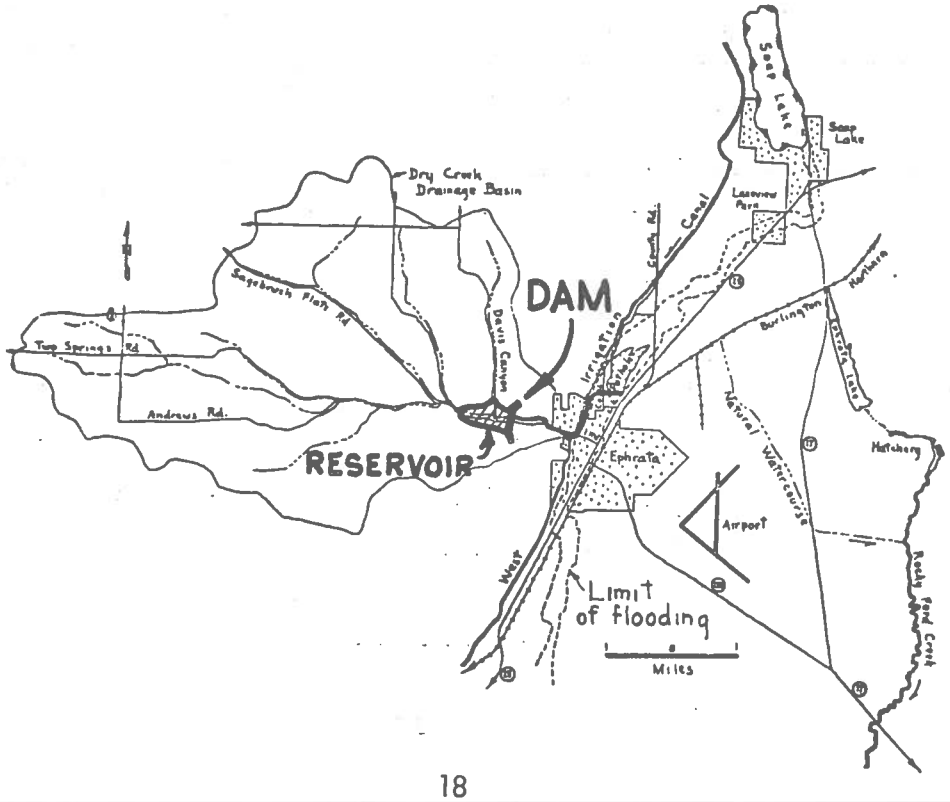
Effects. Complete protection would be provided against the 100-year flood. Greater floods would be passed directly to the ponding area; if capacity of the ponding area or bypass ditch was exceeded, some flooding would take place.

	Construction cost	Annual O. & M.
Federal	$12,500,000	$62,000
Local 1/	0	0
Total	$12,500,000	$62,000

1/ Cost-sharing not determined. Local interests might operate and maintain dam, as well as share land and road costs.

Economic analysis. Average annual benefit - $250,000
Average annual cost - 737,000

ELIMINATED FROM FURTHER STUDY



ALTERNATIVE 5

STORAGE DAM WITH EXISTING OUTLETS

PROS	CONS
1. Would save cost of connection to irrigation canal and eliminate need for discharge channel. (2)	1. Costs are high. (6, 31)
2. Protects existing water rights north of Ephrata. (5)	2. Prevents full use of ponding area. (1)
3. Retains water close to source rather than diverting to presently unaffected areas. (4,5)	3. _____

ALTERNATIVE 5A

MULTIPLE STORAGE DAMS

Physical structures. Several storage dams, each with spillway and outlet works, on Dry Creek and tributaries. Existing bypass ditch to remain for carrying gradual releases to ponding area north of Ephrata. The cost estimate is based on four dams.

Nonstructural measures. None.

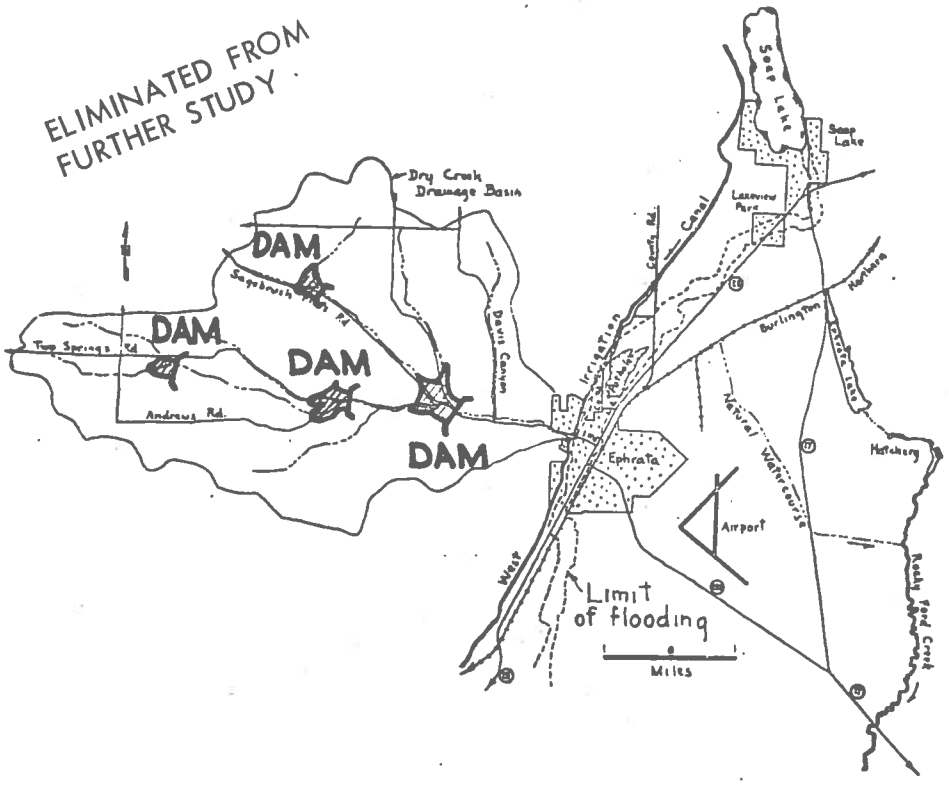
Water and land use. Urban development could take place within the flood plain outside the ponding area.

Effects. Complete protection would be provided against the 100-year flood. Greater floods would be passed directly to the ponding area, and if the capacity of the ponding area or bypass ditch was exceeded, some flooding would take place.

	Construction cost	Annual O. & M.
Federal	$20,000,000	$100,000
Local 1/	0	0
Total	$20,000,000	$100,000

1/Cost sharing not determined. Local interests might operate and maintain dams, as well as share land and road costs.

Economic analysis. Average annual benefit - $ 250,000
Average annual cost - $1,180,000



ALTERNATIVE 5A

MULTIPLE STORAGE DAMS

PROS	CONS
1. Protects existing water rights in area. (5)	1. Prevents full use of the ponding area. (1)
2. Storage for approximately 2,800 acre-feet of runoff could be provided by earthfill dams on tributaries. (42)	2. _____
3. Retains water close to source rather than diverting to presently unaffected areas. (4,5)	3. _____
4. _____	4. Costs exceed benefits. (2,5,6)

ALTERNATIVE 6

FLOOD CONTROL CHANNEL DISCHARGING TOWARD ROCKY FORD CREEK

Physical structures. Debris basin, high-velocity concrete channel passing under 1st Ave., N.W., stilling basin, and unlined channel passing under two county roads to existing ponding area and continuing under SH-28 and Burlington Northern Railway. Flows then carried by natural water courses in direction of Rocky Ford Creek.

Nonstructural measures. Flowage easements along natural water courses from railroad to Rocky Ford Creek.

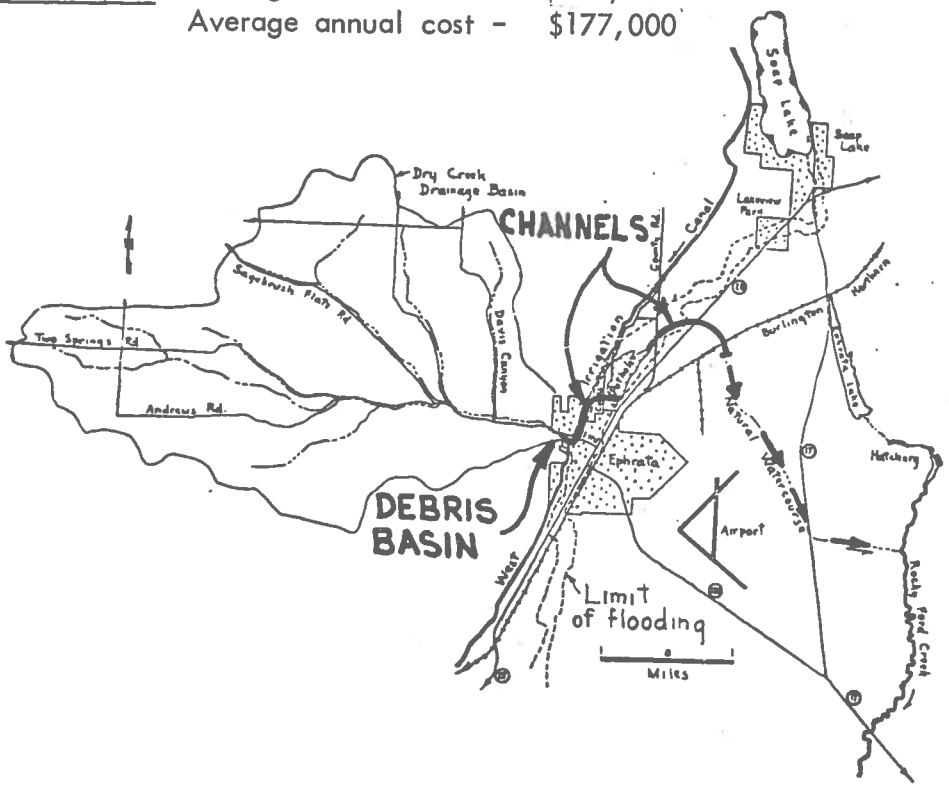
Water and land use. Urban development could take place within the flood plain outside the ponding area.

Effects. Complete protection would be provided against the 100-year flood. Greater floods would exceed the capacity of the system and cause some flooding of parts of Ephrata and lands to the north.

	Construction cost	Annual O. & M.
Federal	$2,500,000	$ 0
Local 1/	400,000	7,000
Total	$2,900,000	$ 7,000

1/ Local costs are for road crossings, rights-of-way, and flowage easements.

Economic analysis. Average annual benefit $262,000
Average annual cost - $177,000



ALTERNATIVE 6

FLOOD CONTROL CHANNEL DISCHARGING TOWARD ROCKY FORD CREEK

PROS		CONS
1. Most feasible considering construction and operating costs. (32)	→	1. Net benefit is small. (5)
2. Lowest cost and least effect on future land development. (10, 12)	←	2. Would lower value of property along path of flow and interfere with economic development of area. (2)
3. Flows probably would not reach Rocky Ford Creek, especially if detention ponds provided. (6)	←	3. Heavy loads of silt and debris could be discharged into Rocky Ford Creek, with detrimental effects on fish and wildlife. (31, 40)
4. Flood water could be safely diverted into the natural flood plain north of the city. Backup into the city could be prevented with an improved dike. Water could be carried by ditch into Rocky Ford Creek; due to the natural gravel soil, a great amount of the flood could be absorbed within the ditch itself. (10,11)	→	4a. Would cause erosion along flow path and sedimentation in Rocky Ford Creek unless settling basins provided along path of discharge. (41) 4b. Prevents full use of the ponding area. (1) 4c. Diverts water to areas not previously affected. (5)
5. A practical, low-cost means of flood control. (30)	→	5a. A flood channel entering Rocky Ford Creek, bringing silt and debris, would cause a reduction in the stream gradient below the hatchery, adversely affecting its operation. (3) 5b. Lack of debris detention facilities could result in depositions in Rocky Ford Creek (20)

ALTERNATIVE 6A

FLOOD CONTROL CHANNEL DISCHARGING INTO EPHRATA LAKE

Physical structures. Debris basin, high-velocity concrete channel passing under 1st Ave., N.W., stilling basin, and unlined channel passing under two county roads to existing ponding area, thence by extension of unlined channel under SH 28 and Burlington Northern Railway to Ephrata Lake. Flows which would exceed capacity of Ephrata Lake would be retained in ponding area.

Nonstructural measures. None.

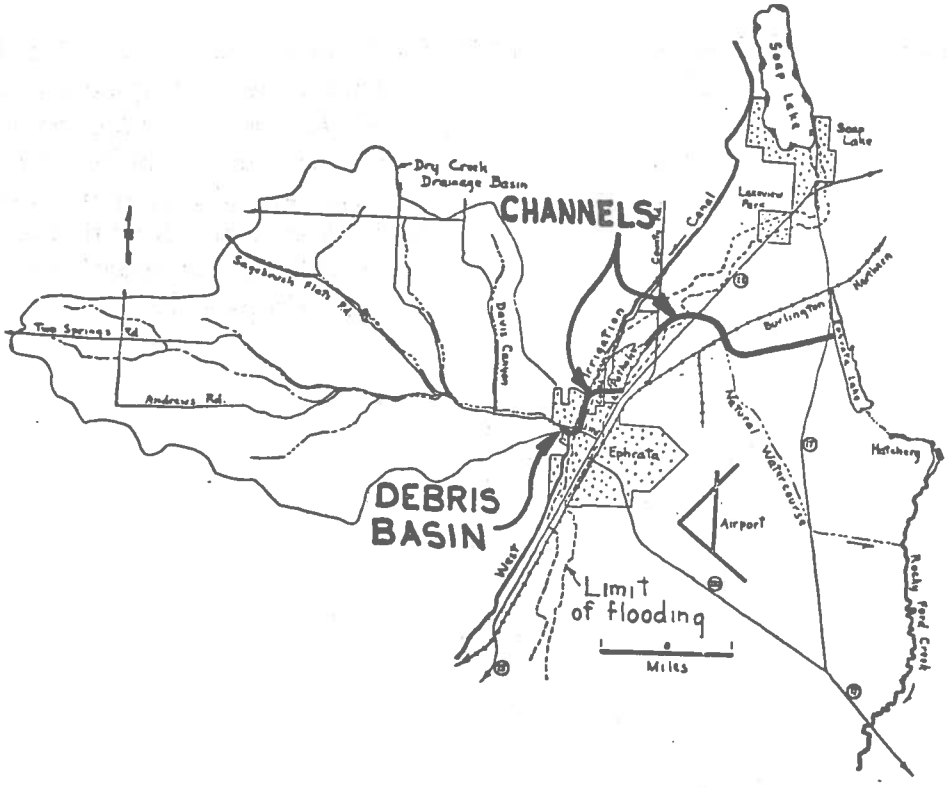
Water and land use. Urban development could take place within the flood plain outside the ponding area.

Effects. Complete protection would be provided against the 100-year flood. Greater floods would exceed the capacity of the system and cause some flooding of parts of Ephrata and lands to the north.

	Construction cost.	Annual O. & M.
Federal	$2,800,000	$ 0
Local 1/	400,000	5,000
Total	$3,200,000	$ 5,000

1/ Local costs are for road crossings and rights-of-way.

Economic analysis. Average annual benefit - $266,000
Average annual cost - 189,000



ALTERNATIVE 6A

FLOOD CONTROL CHANNEL DISCHARGING INTO EPHRATA LAKE

PROS		CONS
1. A practical, low-cost means of flood control, especially if sub-surface infiltration could be added. (30)	→	1. Net benefit is small. (5)
2. Outlet channel location would cause little interference with future economic development of area. (2)	←	2. Diverts water to areas not previously affected. (5)
3. A reasonable cost solution if flows would not exceed capacity of lake. (6)	→	3. Overflow of Ephrata Lake would severely threaten the hatchery facilities. (31)
4. _____		4. Possible damage to roads and railroad because of seepage from channel. (5)
5. _____		5. Prevents full use of the ponding area. (1)
6. Avoids risk of damage to fish hatchery. (7)		6. _____
7. Best flood control measure with least environmental impact. (41)		7. _____

ALTERNATIVE 7

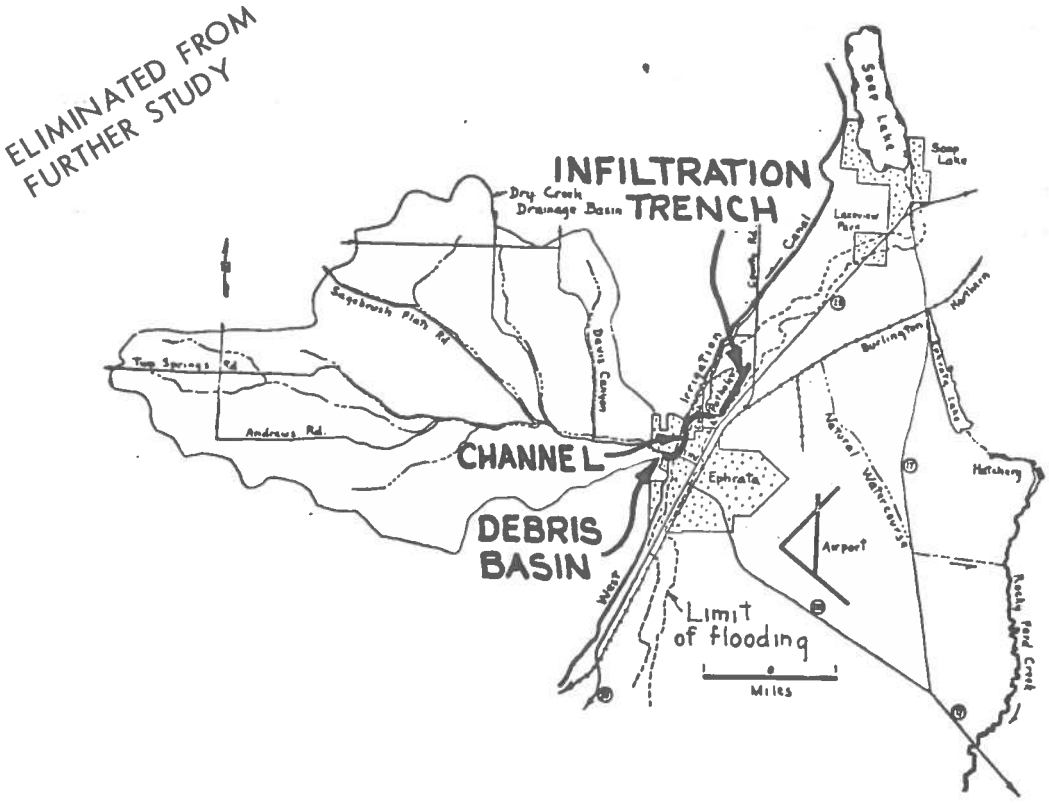
FLOOD CONTROL CHANNEL WITH INFILTRATION TRENCH

Physical structures. Debris basin, high-velocity concrete channel passing under 1st Ave., N.W., stilling basin, unlined channel passing under county road to ponding area, and infiltration trench.

Nonstructural measures. None.

Water and land use. Restricted urban development in view of remaining hazard from large floods.

Effects. Soil borings and percolation tests indicate that gravels typical of the area are not permeable enough to pass sufficient quantities of water into the ground during a large flood. This condition would worsen with time as each runoff would bring silt into the trench, further reducing the permeability of the subsurface gravels.



ALTERNATIVE 7

FLOOD CONTROL CHANNEL WITH INFILTRATION TRENCH

PROS	CONS
1. Practicable if combined with watershed treatment and flood plain zoning. (5)	1. Does not provide adequate degree of flood control. (6)
2. Does not divert water to areas previously unaffected. (5)	2. Prevents full use of the flood plain and ponding area. (1)
3. Seepage channel (infiltration trench) would not adversely affect quality of surface waters. (41)	3. _____
4. Costs are low. (5)	4. _____
5. Avoids adverse effects on fish and wildlife. (40)	5. _____
6. Least disruption of environment, least maintenance cost. (21)	6. _____

CONTRIBUTORS TO BROCHURE

Reference No.*	Name	Contact	Contributed to brochure dated 15 Oct.	17 Nov.
	INDIVIDUALS			
1	Sam Billingsley	Kennewick, 586-1202	X	X
2	Tom Drumheller	754-4120		X
3	Margaret Nasburg	754-4476	X	
4	H.A. Nessen	754-3266		X
5	Lavere Peters	754-4181		X
6	Robert Ping	754-4511		X
7	Edward McLeary	754-3597		X
	MUNICIPAL			
10	Mayor	Harry Drittenbas,[1] 754-4601	X	X
11	City Council	" "	X	
12	City Engineer	John Gonseth, 754-2561	X	X
	COUNTY			
20	Ephrata and Moses Coulee SWCD	George Pheasant, 754-3012	X	
21	Board of Commissioners	Peder Hemstead, 754-3501		X
	STATE			
30	Dept. of Ecology	Fred Hahn, Olympia, 206-753-6878	X	X
31	Dept. of Game	Merrill Spence, 754-4624	X	X
32	Dept. of Natural Resources	Norbert Bochsler, 754-46 21		X
	FEDERAL			
40	Bureau of Sport Fisheries and Wildlife	Norvell Brown, Spokane, 838-4577	X	
41	Environmental Protection Agency	Harold Geren Seattle, 206-442-1285	X	X
42	Soil Conservation Service	D.H. Lewis, 754-4611	X	
43	Bu. of Reclamation	H. R. Gray, 754-4611		X

*This number used to identify the contributor of a PRO or CON suggestion.

1/ Robert Ping became mayor of Ephrata in 1972

Appendix B

DESIGN

Report on Survey

Dry Creek Flood Control

Ephrata, Washington

APPENDIX B

DESIGN

Table of Contents

DESIGN

1. INTRODUCTION. The Dry Creek drainage basin is located in central Washington and drains approximately 27 square miles to the west of Ephrata, Washington. The creek flows easterly out of the hills and towards the city. At the west edge of the city the creek has been diverted to discharge into a ponding area north of the city. Dry Creek is subject to floods which could exceed the capacity of the existing channel and ponding area, inundating parts of Ephrata and lands to the north. The proposed flood control project is designed to control flows up to a 100-year recurrence interval, Q = 5,000 c.f.s. - see frequency curve on figure B-1. The damage potential would be alleviated by constructing flood control improvements shown on plates 1-4.

2. SCOPE OF APPENDIX. This appendix presents engineering considerations, design criteria, construction details, project schedule, and project cost estimate.

3. RECOMMENDED PROJECT. The recommended flood control project consists of a debris basin, debris basin spillway, high-velocity concrete channel, stilling basin, low-velocity trapezoidal channel into and out of the ponding area, and use of a natural swale to convey flows to Rocky Ford Creek.

4. EXTENT OF FIELD STUDIES. Survey data used in the studies included 1" = 50' topographic maps with 2' contour interval made by the Seattle District from surveys taken in 1965, aerial photography at 1" = 3000' and 1" = 500' flown in October of 1969; USGS quadrangle maps and Bureau of Reclamation 1" - 1000' township maps. Subsurface explorations included 5 borings drilled with a 42-inch bucket auger and 7 exploratory holes excavated with a backhoe. A field reconnaissance was made of the site area to determine the most favorable channel improvements and alinement. The study area is covered by the following USGS 1:24,000 quadrangle maps:

a. Ephrata, Wash.

b. Ephrata S.W., Wash.

c. Grant Orchards, Wash.

d. Soap Lake, Wash.

5. DESIGN STANDARDS AND REFERENCES. The project was designed in accordance with the following standards and references:

a. 100-year flood discharge of 5,000 c.f.s.

b. Mannings equation for sizing the channels with 'n' value of .012 for concrete high velocity channel and .035 for the unlined channels.

c. Freeboard on concrete high velocity channel a minimum of 3.0 feet based on F = 2.0 + .025 VD1/3 where v = mean velocity and D = depth. Freeboard on unlined channels 2.0 feet.

d. Debris basin - based on a discussion by Tatum titled, "A Method of Estimating Debris Storage Requirements for Debris Basins."

e. Debris basin spillway and stilling basin - Corps of Engineers EM-1110-2-1602, EM-1110-2-1603 and Hydraulic Design Criteria (WES).

f. Channels - Corps of Engineers EM-1110-2-1601.

6. DESIGN. The recommended channel improvement project, shown on plates 1-4 of the main report, is designed to accommodate a 100-year frequency discharge from Dry Creek basin. Portions of this channel system may require model verification. A description of the various design features follows:

a. Debris Basin. The debris basin, shown on plate 2, near the mouth of Dry Creek canyon would prevent debris such as sand, gravel, and boulders from entering the channel. The basin, sized to hold in excess of 20,000 cubic yards, is approximately 80 feet wide, 500 feet long, and 15 feet deep. The debris basin was sized on the basis of expected sediment and debris yield associated with the design flood condition.

b. Debris Basin Spillway. This structure, shown on plate 4, forms the outlet of the debris basin and includes a 45-feet-wide low ogee spillway with a design head of 10 feet. The spillway chute transitions from the 42 feet spillway width to the channel width of 20 feet in 100 feet of horizontal distance.

c. Rectangular Concrete Channel. This high velocity channel, shown on plate 2, has a rectangular cross section with a 20-foot bottom width, the wall height varying between 11.2 feet and 9.4 feet. The concrete floor has a shallow v-section to facilitate low flow. Gradient of the concrete channel varies from 0.9 percent to 3.75 percent, producing supercritical velocities for all flows. The maximum velocity would be approximately 43 f.p.s. Details of horizontal and vertical curves and superelevation requirements would be considered during detailed design. Model testing of portions or all of this high velocity channel and related structures may be required.

d. Stilling Basin. The concrete high-velocity channel transitions from a 20-foot bottom width to the 34-feet-wide stilling basin as shown on plates 2 and 4. The stilling basin would dissipate the energy of the high velocity flow. The stilling basin is sufficiently long to contain the hydraulic jump, and would be set at an elevation to assure formation of a hydraulic jump within the stilling basin for all discharges up to the design discharge. Consideration would be given to means of draining the stilling basin.

e. Unlined Inflow Channel and Embankment. The unlined inflow channel would convey flow from the stilling basin to the ponding area as shown on plate 2. The channel from the stilling basin to Frey Road is trapezoidal with a bottom width of approximately 42 feet and 1 on 2 side slopes, stabilized with riprap. The design discharge would flow approximately 11 feet deep. Downstream from Frey Road the existing channel has been retained, the embankment continuing on the right side only. Floodflows would overflow the left bank into the ponding area.

f. Ponding Area. The ponding area with discharge release would provide storage for up to the 100-year event. The net effective storage of 1,340 acre-feet in the ponding area would be available at elevation 1266.

g. Outlet Control Structure and Channel. In order to efficiently utilize the ponding area as a reservoir, a control structure is required. This structure was sized to allow 700 c.f.s. flow with the ponding area filled to elevation 1266. The structure consists of a normally uncontrolled, restriction located at the entrance to the outlet channel. The unlined outlet channel is trapezoidal with approximately a 30 foot bottom width and 1 on 2 side slopes. The maximum velocity in this channel would be approximately 9 f.p.s. This channel crosses under a county road (B-NW), State Highway 28 and the Burlington Northern railroad. Crossings at the county road and state highway are assumed to require bridges. The crossings at the Burlington Northern railroad is assumed to be by means of a reinforced concrete box culvert, during construction of which a shoofly would be necessary. Beyond the railroad discharge would follow a flowage easement along a natural swale southeast to Rocky Ford Creek. A culvert would be required under State Highway 17.

7. UTILITY RELOCATION. Utility relocations consist of lowering a 4-inch waterline and minor adjustment to sanitary sewer manholes near where the channel crosses under 1st Avenue N.W. The road to the well pumphouse in Dry Creek canyon may have to be relocated because of debris basin excavation.

8. CONSTRUCTION MATERIAL. The embankment and backfill material would be obtained from required excavation. Excess excavation would be stockpiled for use by local interests or wasted in disposal areas. The backfill along the high velocity channel and structures would be shaped

to harmonize with the environment. Rock riprap is available from an existing stockpile of excavation waste from the irrigation canal about 1 mile south of Ephrata. About 9,200 cubic yards of concrete would be required for the project and would be available from a commercial source within 5 miles.

9. DESIGN AND CONSTRUCTION SCHEDULE. The preconstruction planning and construction schedule is given on figure B-2. Preconstruction planning, in accordance with ER 1110-2-1150, would consist of a two-phase Design Memorandum followed by plans and specifications for the project. Model studies for the high-velocity channel would be scheduled during design memorandum studies. Real estate acquisition by local interests would be accomplished during preparation of plans and specifications. A 16-month construction period is assumed. The project could be completed in the fifth fiscal year after project authorization.

10. COST ESTIMATE. The cost estimate is based on unit prices determined by considering the location of the project, accessibility to the construction area, estimated cost of local supplies and prices in recent contracts for similar work. Unit prices are based on January 1973 price levels. To the cost estimate has been added a contingency allowance for conditions not susceptible of complete evaluation at this time. The contingency allowance is 25 percent for Federal costs and 15 percent for non-Federal. The detailed cost estimates are shown on table B-1.

TABLE B-1

Dry Creek, Ephrata, Flood Control Project

DETAILED COST ESTIMATE

Feature or Item	Unit	Quantity	Price	Cost
DEBRIS BASIN AND SPILLWAY				
Federal costs				
Common excavation	CY	13,000	1.00	13,000
Rock excavation	CY	6,000	5.00	30,000
Structural excavation	CY	550	4.00	2,200
Mass concrete	CY	1,500	50.00	75,000
Cement	Bbl	1,100	9.00	9,900
Reinforcing steel	lb	44,500	0.20	8,900
Grouted riprap	CY	1,000	28.00	28,000
Environmental treatment	Job	1	LS	3,000
Subtotal				170,000
Contingency allowance - 25%				42,500
Total Federal cost				212,500
Non-Federal costs				
Lands	Ac	2.3	500.00	1,200
Relocation, city well road	Job	1	LS	2,000
Subtotal				3,200
Contingency allowance - 15%				500
Total non-Federal cost				3,700
CONCRETE INFLOW CHANNEL				
Federal costs				
Common excavation	CY	25,000	1.00	25,000
Excavation, existing road fill	CY	3,300	0.80	2,600
Structural excavation	CY	5,200	4.00	20,800
Removal of existing culvert	Job	1	LS	1,500
Fine grading	SY	11,000	0.30	3,300
Structural concrete	CY	6,700	90.00	603,000
Cement	Bbl	7,400	9.00	66,600
Reinforceing steel	Lb	565,000	0.20	113,200
Backfill	CY	45,000	1.00	45,000
Drainage inlets	Job	1	LS	1,000
Environmental treatment	Job	1	LS	20,000
Subtotal				902,000
Contingency allowance - 25%				225,500
Total Federal cost				1,127,500

Table B-1 (Cont'd)

Feature of Item	Unit	Quantity	Price	Cost
Concrete Inflow Channel (Cont'd)				
Non-Federal costs				
Lands and rights-of-way	Ac	0.8	500.00	400
Relocation of utilities	Job	1	LS	1,500
Concrete bridge deck and abutments	Job	1	LS	24,000
Bridge approches	Job	1	LS	3,500
Subtotal				29,400
Contingency allowance - 15%				4,400
Total non-Federal costs				33,800
STILLING BASIN				
Federal costs				
Structural excavation	CY	1,900	4.00	7,600
Structural concrete	CY	850	90.00	76,500
Cement	Bbl	1,100	9.00	9,900
Reinforcing steel	Lb	73,000	0.20	14,600
Backfill	CY	2,000	1.00	2,000
Environmental treatment	Job	1	LS	2,500
Subtotal				113,100
Contingency allowance - 25%				28,300
Total Federal cost				141,400
UNLINED INFLOW CHANNEL				
Federal costs				
Common excavation	CY	23,000	0.80	18,400
Stripping under embankment	SY	27,000	0.35	9,500
Compacted embankment	CY	33,000	0.40	13,200
Filter under riprap	CY	3,600	4.25	15,300
Rock riprap	Ton	14,000	6.00	84,000
Environmental treatment	Job	1	LS	3,000
Subtotal				143,400
Contingency allowance - 25%				35,900
Total Federal cost				179,300
Non-Federal costs				
Rights-of-way for channel	Ac	5	500.00	2,500
Flowage easement for ponding area	Ac	272	25.00	6,800
Subtotal				9,300
Contingency allowance - 15%				1,400
Total non-Federal cost				10,700

Table B-1 (Cont'd)

Feature of Item	Unit	Quantity	Price	Cost
OUTLET CHANNEL				
Federal costs				
Common excavation	CY	181,000	0.80	145,000
Excavation, existing road fills	CY	4,500	0.80	3,600
Structural excavation	CY	1,500	4.00	6,000
Stripping under embankment	SY	15,000	0.35	5,300
Structural concrete	CY	120	90.00	10,800
Cement	Bbl	140	9.00	1,300
Reinforcing steel	Lb	10,000	0.20	2,000
Compacted embankment	CY	16,000	0.40	6,400
Box culverts under railroad	Job	1	LS	56,500
Filter under riprap	CY	2,000	4.25	8,500
Rock riprap	Ton	3,600	6.00	21,600
Environmental treatment	Job	1	LS	10,000
Railroad shoofly	Job	1	LS	96,000
Subtotal				373,000
Contingency allowance - 25%				93,300
Total Federal cost				466,300
Non-Federal costs				
Rights-of-way	Ac	28.5	350.00	10,000
County road bridge	Job	1	LS	60,000
County road bridge approaches	Job	1	LS	3,500
State highway bridge	Job	1	LS	130,000
State highway bridge approaches	Job	1	LS	7,500
Subtotal				211,000
Contingency allowance - 15%				31,600
Total non-Federal cost				242,600
DISCHARGE ROUTE				
Federal costs				
Common excavation	CY	500	0.80	400
Dumped rock flow barriers	Ton	1,500	6.00	9,000
Environmental treatment	Job	1	LS	1,000
Subtotal				10,400
Contingency allowance - 25%				2,600
Total Federal cost				13,000
Non-Federal costs				
Flowage easement (swale)	Ac	230	62.50	14,400
Culverts under state highway	LF	160	300.00	48,000
State highway reconstruction	Job	1	LS	2,300
Flowage easement (Rocky Ford Creek)	Ac	600	25.00	15,000
Subtotal				79,700
Contingency allowance - 15%				12,000
Total non-Federal cost				91,700

Table B-1 (Cont'd)

Feature of Item	Unit	Quantity	Price	Cost
OUTLET CHANNEL				
Federal costs				
Common excavation	CY	181,000	0.80	145,000
Excavation, existing road fills	CY	4,500	0.80	3,600
Structural excavation	CY	1,500	4.00	6,000
Stripping under embankment	SY	15,000	0.35	5,300
Structural concrete	CY	120	90.00	10,800
Cement	Bbl	140	9.00	1,300
Reinforcing steel	Lb	10,000	0.20	2,000
Compacted embankment	CY	16,000	0.40	6,400
Box culverts under railroad	Job	1	LS	56,500
Filter under riprap	CY	2,000	4.25	8,500
Rock riprap	Ton	3,600	6.00	21,600
Environmental treatment	Job	1	LS	10,000
Railroad Agency	Job	1	LS	96,000
Subtotal				373,000
Contingency allowance - 25%				93,300
Total Federal cost				466,300
Non-Federal costs				
Rights-of-way	Ac	28.5	350.00	10,000
County road bridge	Job	1	LS	60,000
County road bridge approaches	Job	1	LS	3,500
State highway bridge	Job	1	LS	130,000
State highway bridge approaches	Job	1	LS	7,500
Subtotal				211,000
Contingency allowance - 15%				31,600
Total non-Federal cost				242,600
DISCHARGE ROUTE				
Federal costs				
Common excavation	CY	500	0.80	400
Dumped rock flow deflectors	Ton	1,500	6.00	9,000
Environmental treatment	Job	1	LS	1,000
Subtotal				10,400
Contingency allowance - 25%				2,600
Total Federal cost				13,000
Non-Federal costs				
Flowage easement (Hewle)	Ac	230	62.50	14,400
Culverts under state highway	LF	160	300.00	48,000
State highway reconstruction	Job	1	LS	2,300
Flowage easement (Rocky Ford Creek)	Ac	600	25.00	15,000
Subtotal				79,700
Contingency allowance - 15%				12,000
Total non-Federal cost				91,700

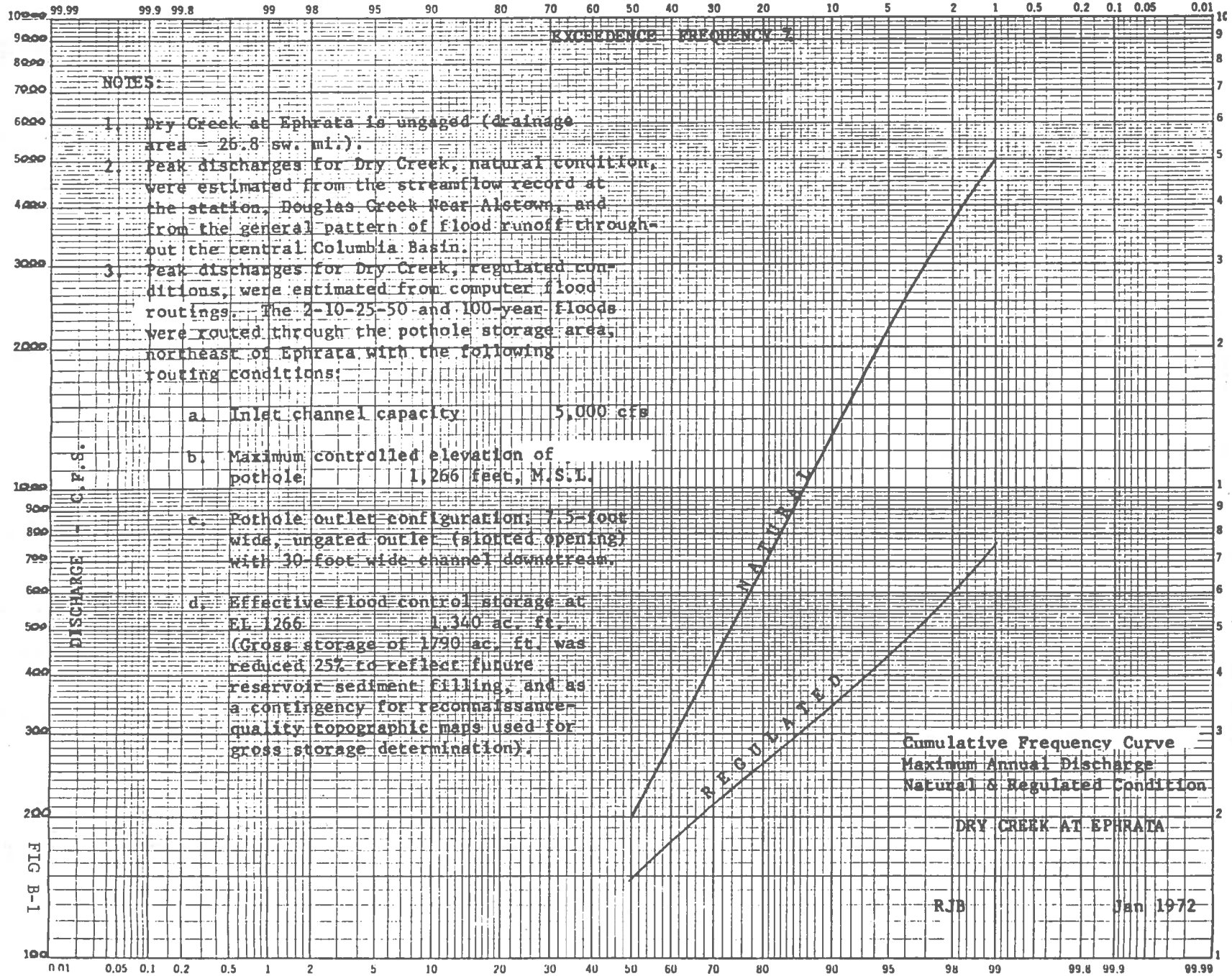
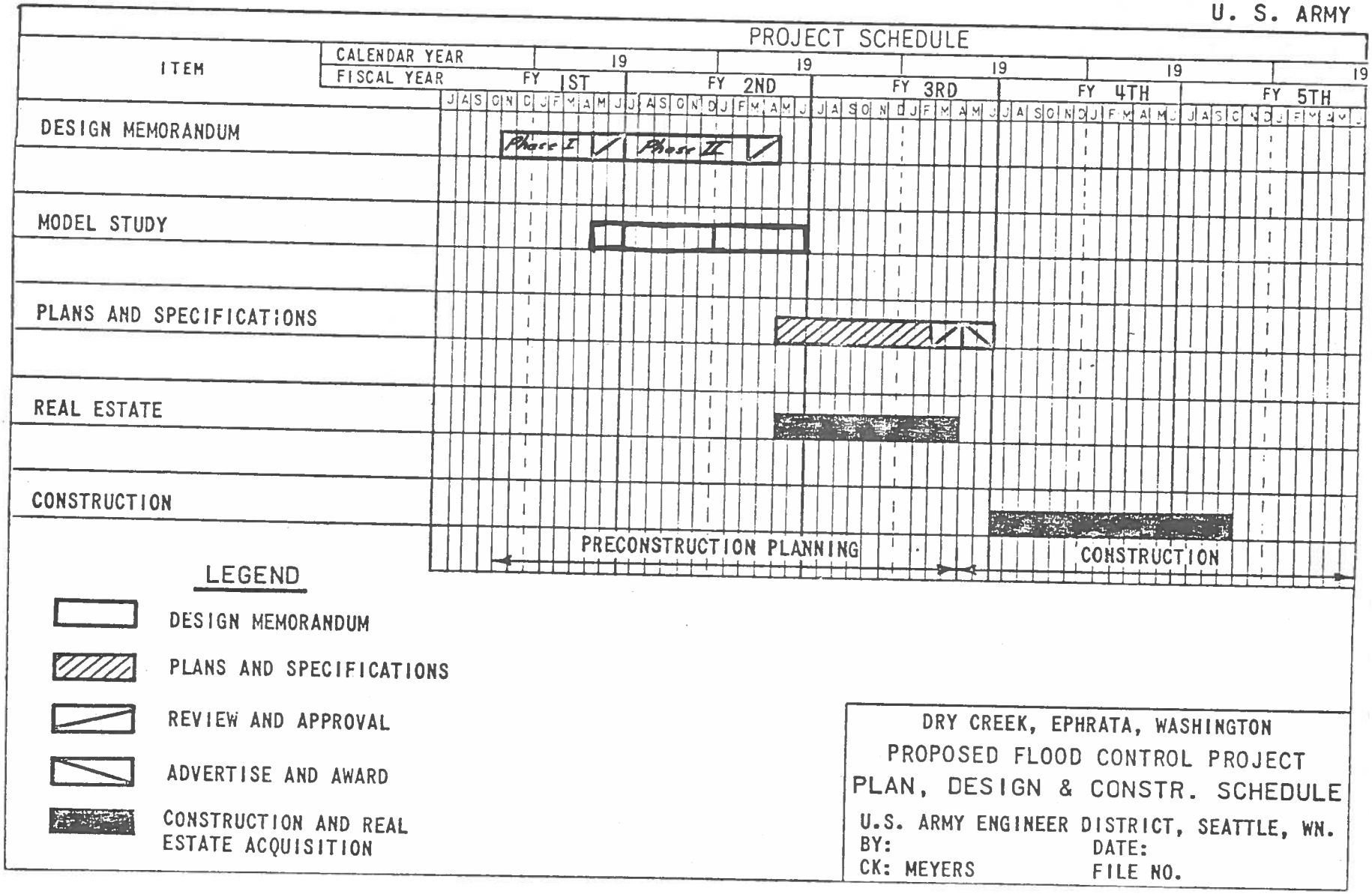

EXCEEDENCE FREQUENCY %
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
DISCHARGE, c.f.s.
NATURAL
REGULATED
NOTES:
1. Dry Creek at Ephrata is ungaged (drainage area = 26.8 sw. mi.).
2. Peak discharges for Dry Creek, natural condition, were estimated from the streamflow record at the station, Douglas Creek Near Alotown, and from the general pattern of flood runoff throughout the central Columbia Basin.
3. Peak discharges for Dry Creek, regulated conditions, were estimated from computer flood routings. The 2-10-25-50 and 100-year floods were routed through the pothole storage area, northeast of Ephrata with the following routing conditions:
a. Inlet channel capacity 5,000 cfs
b. Maximum controlled elevation of pothole 1,266 feet, M.S.L.
c. Pothole outlet configuration; 7.5-foot wide, ungated outlet (slotted opening) with 30-foot wide channel downstream.
d. Effective flood control storage at EL 1266 1,340 ac. ft. (Gross storage of 1790 ac. ft. was reduced 25% to reflect future reservoir sediment filling, and as a contingency for reconnaissance-quality topographic maps used for gross storage determination).
Cumulative Frequency Curve
Maximum Annual Discharge
Natural & Regulated Condition
DRY CREEK AT EPHRATA
RJB
Jan 1972
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99

FIG B-1

CORPS OF ENGINEERS

U. S. ARMY



LEGEND

- DESIGN MEMORANDUM
- PLANS AND SPECIFICATIONS
- REVIEW AND APPROVAL
- ADVERTISE AND AWARD
- CONSTRUCTION AND REAL ESTATE ACQUISITION

DRY CREEK, EPHRATA, WASHINGTON
PROPOSED FLOOD CONTROL PROJECT
PLAN, DESIGN & CONSTR. SCHEDULE
U.S. ARMY ENGINEER DISTRICT, SEATTLE, WN.
BY: DATE:
CK: MEYERS FILE NO.

FIG B-2

GEOLOGY - SOILS AND EXPLORATION

1. Geologic Setting: Dry Creek is an intermittent stream which, during periods of heavy rainfall and spring snow melting, drains the southeastern corner of the Waterville Plateau. The stream has cut a deep channel into the Columbia Basalt down the face of the Beezley Hills across the scarp of the Coulee Monocline. The stream discharges into a long, north-south depression between the basalt scarp and a low ridge, 10 miles long, 2 to 3 miles wide and nearly 100 feet high. Dry Creek has built an alluvial fan across this depression and the central part of Ephrata lies on this fan. Detritus from Dry Creek has spread northward and southward within the depression. A man-made channel now diverts normal discharge to the north, however, when the flow exceeds channel capacity, water and detritus spread in a fashion characteristic of an alluvial fan. All discharge to date has ultimately disappeared into the fan or into the glacial flood gravels. The portion of the depression which now receives creek discharge is underlain by an estimated 6 to 30 feet of silt with some intercalated sand and gravel which is part of the detritus from Dry Creek. These deposits are underlain by partly cemented sands and gravels with intercalated silts and clays, all part of the Ringold Formation which in turn rests on the basalt surface at elevations just above 1200 feet. Eastward from the depression the low ridge is underlain by 40 to 60 feet of sand, gravel and large boulders deposited during the closing stages of the ice age by large volumes of water discharging from the Lower Grand Coulee. These deposits thicken northward towards Soap Lake and rapidly thin eastward to the scabland channels in basalt (Ephrata Lake and Rocky Ford Creek) which represent the ancient outlet of the Coulee. Beneath the low ridge these deposits rest on Ringold Formation which in turn rests on the basalt surface at about elevation 1200 feet. The phreatic surface slopes gently eastward and southeastward at about 30 feet per mile, dropping from an elevation of 1220 in the vicinty of Ephrata to 1130 at Ephrata Lake 3-1/2 miles to the east. Contours on the phreatic surface and a geologic section are shown on Plate B-3.

2. Investigations: Reconnaissance geologic mapping was done in the summer of 1970 and refined in the summer of 1971. Exploration was conducted in the summer of 1971 with major emphasis on investigating the feasibility of an infiltration trench in the gravel on the east side of the north-south depression. The proposed inflow channel and the proposed debris basin spillway were also investigated. Five borings were drilled with a 42-inch bucket auger and 7 exploratory holes were excavated by backhoe. The location and logs of this exploration are shown on Plates B-4 and B-5.

3. Foundation and Excavation Conditions:

a. Debris Basin Spillway. Exploration hole 71-BH-11 in the bottom of Dry Creek Canyon at the site of the proposed debris basin spillway encountered refusal on possible bedrock at a depth of 16.5

feet. Bedrock under the canyon floor is overlain by large gravel and boulders. Bedrock is locally exposed on both sides of the canyon in this reach, but the debris basin can and should be located so that rock excavation is not required. Further design investigations should include rotary drill holes to confirm rock elevation in the canyon bottom.

b. Inflow Channel: The route of the proposed inflow channel closely follows the existing channel. Beginning near the apex of the alluvial fan just below where the natural channel of Dry Creek leaves the rock, the channel would cross the siphon of the West Canal and swing abruptly northward down the north slope of the fan to the ponding area. Foundation and excavated materials in this reach will be mostly silty sandy gravel alluvium, portions of which are spoil from the West Canal and the adjacent existing Dry Creek flood channel. The proposed channel swings eastward near the fan's northern limits and the materials in this reach are silt with intercalated sand and gravel characteristic of the depression. Exploration holes 71-BH-5 and 6, dug in the vicinity of the proposed stilling basin, encountered silty sands, sandy gravel and cemented gravels within the depth of proposed excavation. The upper portions of these materials represent the unconsolidated slope wash with spoil from excavation of the West Canal. Cemented or partly cemented materials are probably part of the Ringold Formation.

c. Embankment: The embankment proposed to restrict floodwater to the ponding area without permitting water to back up into north Ephrata would be founded on alluvial silt. The silt cap is about 15 feet thick in this area and intercalated sand and gravel exposed in the existing channel may permit minor under-seepage under anticipated head conditions. Hole 71-BH-7 was dug in the floor of the existing channel in the vicinity of both the proposed embankment and the Frey Road county bridge.

d. Ponding Area: The east side of the ponding area is composed entirely of sand and gravel. Existing flood and waste irrigation water presently enters a channel along the periphery of the cultivated area and terminates in an old gravel pit. The Ephrata City Engineer occasionally cleans the silt from this pit and the excess water sinks into the ground. An unknown amount of water will be discharged into the ground in this area, depending on the permeability of the gravels and as discussed in paragraph 7. The floor of the depression is impervious silt.

e. Outlet Channel: Foundation materials in the vicinity of the proposed outlet channel consist of sand and gravel in which large boulders and blocks up to 10 feet in diameter might be encountered. Bridge or culvert structures will be founded on such materials. Exploration holes 71-BH-8, 9, and 10 were located near the proposed channel crossing of the county road, the state highway, and the Burlington Northern railroad, respectively. These borings encountered sandy gravels and silty sandy gravels with numerous cobbles and boulders. The alternate channel route to Ephrata Lake, while not investigated, is expected to encounter similar materials. As the present water table

or bedrock surface is estimated to be about 60 feet below the surface, considerable quantities of water would be lost to the gravels, both in the constructed outlet channel and in the southeast trending draw into which the excavated channel would discharge. Because the estimates of gravel permeability could vary by a factor of possibly 100, the percentage of flow reduction along the east edge of the storage depression and along the proposed outlet route cannot be realistically estimated without extensive field testing.

4. Construction Materials:

a. Embankment Materials: Embankment materials can generally be obtained from channel excavation provided that selective use is make of materials. Extremely clean gravels should be mixed with silty materials or used for embankment only in areas where embankment seepage can be tolerated. Impervious material may be obtained from the floor of the depression.

b. Riprap: Rock for riprap can be obtained from an existing stockpile of excavation waste from the irrigation canal located about 1 mile south of Ephrata.

5. Embankment and Channel Design: Embankment and channel slopes of 1 vertical on 2 horizontal will generally be suitable except that slopes of 1 on 3 are recommended for embankments founded on silts and fine sands adjacent to the ponding area.

6. Downstream Effects: Any water not lost to the ground west of Highway 17 would cross under the highway and find its way across the basalt scablands, eventually reaching Rocky Ford Creek which is tributary to Moses Lake. Loss of water to temporary ground storage or ground storage or ground seepage is expected to reduce the rate of inflow to Rocky Ford Creek such that no flooding or damage by Rocky Ford Creek would occur. The water table has been rising in this area and since 1949 has risen about 25 feet resulting in the formation of Ephrata Lake. The rising trend is gradually abating according to the Bureau of Reclamation. Any waters added to the ground water circuit should not permanently influence Ephrata Lake nor should any short term ground water effects be damaging elsewhere.

7. Infiltration Trench: An alternative method of disposing of floodwater by ground seepage into an infiltration trench along the east side of the ponding area was considered. Bucket auger borings 71-BA-1, 2, 3, 4, and 8 were drilled to investigate the permeability of the glacial flood gravels and thus the feasibility of this scheme. Approximately 100 gallons per minute were pumped into boring BA-3, near the southern end of the proposed trench, for a period of approximately 8 hours. Water levels were recorded in adjacent borings BA-1 and BA-2. An average gravel permeability of approximately 1.0 foot per minute was computed from the pumping test data. This value is considered marginal for feasibility of the infiltration trench scheme. Using such a value, a drainage trench 10,000 feet long, 15 to 20 feet deep with 1

on 3 side slopes and a 10-foot bottom width, would still require a reservoir storage area for about 3,000 acre-feet for a 5-day, 100-year frequency flood. Borings BA-4 and BA-8 were drilled to further investigate the gravels near the northern end of the proposed trench. These borings encountered relatively impervious silts and silty sands at depths of 17.5 feet and 22 feet respectively and the overlying gravels did not appear to be as free draining as was anticipated. Because of the marginal permeability of the gravels and the presence of the silts, the infiltration trench scheme is not considered feasible for present design floodflows.

BASALT HILLS MANTLED WITH SILT, SAND AND GRAVEL
SLOPEWASH
DRY CREEK ALLUVIUM
EPHRATA
EPHRATA MUNICIPAL AIRPORT
AREA OF FLOOD GRAVELS FROM THE GRAND COULEE
1220
1200
1180
SLOPEWASH

DRY CREEK PROJECT EPHRATA ~~RIVER~~

DEPTH OF HOLE 38.0' DIAMETER OF HOLE 42"
DEPTH OF O.B. 38.0' DATE STARTED 29 June 1971
ROCK DRILLED DATE COMPLETED 6 July 1971
% CORE RECOVERED CONTRACTOR USAED, Seattle

SURFACE EL HOLE NO 71-BA-1 N NE1/4 Sec 10 E T21N R26E

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
		GM		SILTY SANDY GRAVEL	0800 29 June 1971
	5	GP GM		SANDY GRAVEL w silt, numerous cobbles and boulders, gray, 2" x 1-1/2" x 1", dry to 5' depth, cemented 5.0 to 5.5, w silt and moist below 5.5	1630 29 June 1971 0630 30 June 1971 Drilled and shot six times between 4' and 6' Drive casing each foot of hole dug 1630 30 June
	10	GP-GM		SANDY GRAVEL (3") w silt, moist, gray	0600 1 July 1971
	15	GP		SANDY GRAVEL w cobbles (5") moist, gray	
	20				
	25				
	30	SM		SILTY SAND moist, yellow-brown	1430 1 July 1971 0600 2 July 1971
	35	GP		SANDY GRAVEL w silt and cobbles (8"), brown Hard sandstone zone	Set 4" Casing
				Water Level	2 July 1971
				Bottom of Hole 39.0	6 July 1971 2" plastic piezometer Permeability Test performed 15 July 1971

DRY CREEK PROJECT EPHRATA ~~RIVER~~

DEPTH OF HOLE 35.0' DIAMETER OF HOLE 42"
DEPTH OF O.B. 35.0' DATE STARTED 6 July 1971
ROCK DRILLED DATE COMPLETED 9 July 1971
% CORE RECOVERED CONTRACTOR USAED, Seattle

SURFACE EL HOLE NO 71-BA-2 N NE1/4 Sec 10 E T21N R26E

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
		ML		GRAVELLY SILT	1030 6 July 1971
		GM		SILTY SANDY GRAVEL, tan	Drilled and shot six times between 1.0 and 4.5
	5	GP GM	A	SANDY GRAVEL w silt, numerous cobbles and boulders, gray, cemented w caliche 4.5 to 5.0, increasing amount of silt below 5.0	1530 6 July 1971 0700 7 July 1971
	10	GP-GM	B	SANDY GRAVEL (3"), w silt, occ cobble, moist, gray	1530 7 July 1971
	15	GP	C	SANDY GRAVEL w cobbles (8"), gray	0700 8 July 1971
	20		D	Nest of cobbles and boulders 22.0 to 24.0, sand is coarse, moist	42" casing to 22.0 Open hole to 35.0 Nobody went down hole below 24.0
	25		E	Cobbles 10" below 25.0	
	30	SM	F	SILTY SAND brown	1530 8 July 1971 0700 9 July 1971
		GP		SANDY GRAVEL moist, brown	
	35		G	Water Level Bottom of Hole 35.0	1130 9 July 1971 Permeability Test performed 15 July 1971 NOTE Samples A-G 2 socks each

DRY CREEK PROJECT EPHRATA ~~RIVER~~

DEPTH OF HOLE 28.0' DIAMETER OF HOLE 42"
DEPTH OF O.B. 28.0' DATE STARTED 9 July 1971
ROCK DRILLED DATE COMPLETED 14 July 1971
% CORE RECOVERED CONTRACTOR USAED, Seattle

SURFACE EL HOLE NO 71-BA-3 N NE1/4 Sec 10 E T21N R26E

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
		ML		SILT, dry, tan	1230 9 July 1971
		GM		SILTY GRAVEL, dry, tan	
	5	GP-GM	A	SANDY GRAVEL w silt, cobbles (5" dry, gray, w boulders (20" below 4.0	1530 9 July 1971 0700 12 July 1971 1530 12 July 1971
	10	GP-GM	B	SANDY GRAVEL (3" w silt, moist, gray	0700 13 July 1971
	15	GP	C	SANDY GRAVEL w cobbles (8"), gray	1530 13 July 1971 0700 14 July 1971
	20		D		
	25		E		Casing to 23.5'
		SM		SILTY SAND, brown	NOTE Sample A-1 sack, Samples B, C, D, and E-2 socks each Permeability Test performed 15 July 1971
				Bottom of Hole 28.0	

DRY CREEK PROJECT EPHRATA ~~RIVER~~

DEPTH OF HOLE 21.5' DIAMETER OF HOLE 42"
DEPTH OF O.B. 21.5' DATE STARTED 19 July 1971
ROCK DRILLED DATE COMPLETED 20 July 1971
% CORE RECOVERED CONTRACTOR USAED, Seattle

SURFACE EL HOLE NO 71-BA-4 N SE1/4 Sec 3 E T21N R26E

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
				SANDY GRAVEL w cobbles and boulder (30") w some cementation	0400 19 July 1971
	5	GP	A	Nest of boulder (7.0 to 9.0	
	10		B	Numerous boulders 11.0 to 13.0	1430 19 July 0600 20 July
	15		C		
		ML	D	SANDY SILT moist, brown	W.L. 19.0' 1330
	20	SM	E F	SILTY SAND moist, brown, cemented	W.L. 18.5' 1
					1330 20 July 1971
				Bottom of Hole 21.5	NOTE Samples A and B 2 socks each Samples C, D, and E 1 sack each

DRY CREEK PROJECT EPHRATA ~~RIVER~~

DEPTH OF HOLE 12.0' DIAMETER OF HOLE --
DEPTH OF O.B. 12.0' DATE STARTED 12 July 1971
ROCK DRILLED -- DATE COMPLETED 12 July 1971
% CORE RECOVERED -- CONTRACTOR Pete Winter Exc

SURFACE EL 1276± HOLE NO 71-BH-5 N SW1/4 Sec 10 E T21N R26E

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
		GM		SILTY SANDY GRAVEL w/cobbles and boulders (15") gray	Stilling bas'n for 100 yr. flood
		SM		SANDY SILT, dark brown	
	5	SM		SILTY SAND, brown	Traverse Sta 51+00 Left 80', Sht 4 Dwg E-36-1-35
		SM		SILTY SAND, gray-white (alkaline)	
	10	GP		SANDY GRAVEL, brown	Sides stand vertical Very hard to dig
				Bottom of Hole 12.0 Refusal to backhoe on cemented gravels	Design bottom elevation of basin 1256 Bottom of hole elevation 1255

DRY CREEK PROJECT EPHRATA ~~RIVER~~

DEPTH OF HOLE 16.0' DIAMETER OF HOLE --
DEPTH OF O.B. 16.0' DATE STARTED 12 July 1971
ROCK DRILLED -- DATE COMPLETED 12 July 1971
% CORE RECOVERED -- CONTRACTOR Pete Winter Exc

SURFACE EL 1264.5 HOLE NO 71-BH-6 N SW1/4 Sec 10 E T21N R26E

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
		GM		SILTY SANDY GRAVEL, tan	200 yr flood stilling basin. Traverse Sta 56+00 Left 50', Sht 5 Dwg E-36-1-35 Top 3' sloughing to 1 on 1 slope, remainder standing vertical
		GP		SANDY GRAVEL, gray	
	5	GP		SANDY GRAVEL, brown w/cobbles (10")	
		SM		SILTY SAND, brown	
		GP		SANDY GRAVEL, brown, cemented w/caliche	
	10	SM		SILTY GRAVELLY SAND, brown	
		SM		SILTY SAND, brown	
	15			Bottom of Hole 16.0	Design bottom elevation 1248 Bottom of hole elevation 1248.5

DRY CREEK PROJECT EPHRATA ~~RIVER~~

DEPTH OF HOLE 14.0' DIAMETER OF HOLE --
DEPTH OF O.B. 14.0' DATE STARTED 12 July 1971
ROCK DRILLED -- DATE COMPLETED 13 July 1971
% CORE RECOVERED -- CONTRACTOR Pete Winter Exc

SURFACE EL HOLE NO 71-BH-8 N SE1/4 Sec 3 E T21N R26E

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
		ML		SANDY SILT, tan	
		GM		SILTY SANDY GRAVEL, tan, w/cobbles (12")	Adjacent to 71-BA-6
	5	GP		SANDY GRAVEL, gray, w/cobbles and boulders (48")	
	10	GP-GM		SANDY GRAVEL, w/silt, cobbles (10"), very hard to dig, boulders (14" below 12.0, brown	Sides standing vertical
				Bottom of Hole 14.0	

DRY CREEK PROJECT EPHRATA ~~RIVER~~

DEPTH OF HOLE 13.0 DIAMETER OF HOLE --
DEPTH OF O.B. 13.0 DATE STARTED 13 July 1971
ROCK DRILLED -- DATE COMPLETED 13 July 1971
% CORE RECOVERED -- CONTRACTOR Pete Winter Exc

SURFACE EL 1275± HOLE NO 71-BH-9 N SW1/4 Sec 2 E T21N R26E

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
		ML		GRAVELLY SILT, tan	Low velocity channel
		GM		SILTY SANDY GRAVEL, tan w/cobbles and boulders (15")	
	5	GP		SANDY GRAVEL, gray, w/cobbles and boulders (36")	
	10	GM		SILTY SANDY GRAVEL, gray, w/cobble (8")	Sides standing vertical
				Bottom of Hole 13.0	

Appendix C

ECONOMIC EVALUATION

Report on Survey
Dry Creek Flood Control
Ephrata, Washington

APPENDIX C

ECONOMIC EVALUATION

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REPORT ON SURVEY
DRY CREEK FLOOD CONTROL
EPHRATA, WASHINGTON

APPENDIX C

ECONOMIC EVALUATION

CHAPTER I - INTRODUCTION

1. Purpose and Scope.

This Appendix presents the procedures and the projections used in determining benefits for a flood control channel project on Dry Creek at Ephrata, Washington. Benefits considered for this project were prevention of flood damage, land enhancement and employment of labor for project construction and operation. Included also are details of the economic environment of the study area, a description of present flood control improvements, and a discussion of historical flood damages as the basis of forecasting future average annual benefits which would result from construction of planned improvements. For the purpose of this analysis, the first year the project is expected to be in operation, project year one, has been estimated as the year 1979. The period of economic analysis and project life has been designated as a 50-year period starting in 1979.

2. Basin Description

Dry Creek Basin, as shown on plate C-1, is located in Grant County near the geographic center of the State of Washington. Dry Creek is an intermittently flowing stream with a drainage area of 26.8 square miles located northwesterly from the incorporated city of Ephrata, Washington. The upland areas above the canyons are rolling and used almost exclusively for dryland farming of grain-type crops. The side slopes of the canyons, through which Dry Creek and tributary streams flow, rise abruptly from the narrow canyon floors and land use is confined to pasture and grazing. Downstream of the mouth of the main canyon, Dry Creek flows through an artificial channel to a point of low elevation north of Ephrata where the water ponds and percolates into the ground or evaporates. The 100-year flood plain of Dry Creek downstream from the mouth of the canyon is about 1.1 square miles in area and includes portions of the cities of Ephrata and Soap Lake, which is about six miles northeast of Ephrata, as well as a strip of land between the two cities. The city of Ephrata is situated on the alluvial fan at the mouth of the canyon. The area subject to inundation from discharges of Dry Creek in excess of the capacity of the artificial channel is predominately urban land use in the city of Ephrata. The city of Soap Lake is situated in a physiographic bowl at the southern end of Soap Lake. A natural

channel meanders from Ephrata through residential and commercial areas in the city of Soap Lake and into the lake. The natural channel is the area of inundation in the city of Soap Lake. Major transportation facilities are a blacktop state highway (No. 28) which passes through both Ephrata and Soap Lake and railroad lines of the Burlington Northern that traverse the basin at Ephrata. County roads provide access to homes and farms in the upper part of the basin.

CHAPTER II - ECONOMIC ENVIRONMENT

3. General

Evaluation of flood damage prevention activities is related to present and projected economic activity of the region, basin and areas subject to flooding. To determine the need for remedying the flood problem in the cities of Ephrata and Soap Lake vicinity and to evaluate the feasibility of any plan of improvement involves information concerning present land use, damages suffered, and probable future changes in intensity and use of land in the affected area. These future changes are determined by the type and magnitude of economic activities and accompanying intensity of urban development. Another consideration is the extent to which new residences and business establishments will locate or expand within the area influenced by the project. This chapter presents data and information which describes the economic activity in the Upper Columbia Subregion 1/ of the Columbia-North Pacific Region, Grant County, the Dry Creek Basin, and the cities of Ephrata and Soap Lake in which the flood plain is located. The economic boundaries of the Upper Columbia Subregion encompass nine counties (listed in table C-1) in north central Washington. In addition, the data in this chapter provides the basis for estimating probable future growth in damages in the flood plain (See Chapter III, paragraph 26, Future Growth in the Flood Plain).

4. Resources.

a. Land. The land resource of the subregion is devoted almost entirely to forest, agriculture and mineral production. Small areas in urban land use are scattered throughout the subregion. The subregion consists of 22,890 square miles of land area. As of 1970, land utilization was classified as follows: 2/

Forest land, 40 percent
Rangeland, 33 percent
Cropland, 23 percent
Barren land, 2 percent
Urban, 2 percent

Land in Dry Creek Basin is devoted almost exclusively to agriculture. Rangeland represents 60 percent of the total basin land area, 30 percent is cropland and the remaining 10 percent is classified as barren.

1/Corresponds to Water Resources Council Subregion 1709 and Columbia-North Pacific Region Comprehensive Framework Study Subregion 2.

2/Appendix IV, Land and Mineral Resources, Columbia-North Pacific Region Comprehensive Famework Study.

TABLE C-1

LAND AREA AND POPULATION BY COUNTY

UPPER COLUMBIA SUBREGION

County	Land Area (square miles)	Population 1940	1950	1960	1970
Adams	1,894	6,209	6,584	9,929	12,014
Chelan	2,926	34,412	39,301	40,744	41,355
Douglas	1,839	8,651	10,817	14,890	16,787
Ferry	2,202	4,701	4,096	3,889	3,655
Franklin	1,260	6,307	13,563	23,342	25,816
Grant1/	2,681	14,668	24,346	46,477	41,881
Lincoln	2,306	11,361	10,970	10,919	9,572
Okanogan	5,301	24,546	29,131	25,520	25,867
Stevens	2,481	19,275	18,580	17,884	17,405
Total	22,890	130,130	157,388	193,594	194,352

1/Location of Dry Creek Basin

SOURCE: U.S. Department of Commerce, Census of Population

An urban area composed of the city of Ephrata, occupies 2.8 square miles at the mouth of Dry Creek, on the perimeter of the basin. The city of Soap Lake lies about 6 miles northeast of Ephrata and comprises about 0.8 square mile in urban area, a portion of which is subject to flooding from Dry Creek.

b. Forests. The subregion contains 5.7 million acres of forest land of which more than 4.6 million acres are classified as commercial timber. 1/ The major species are Douglas fir and ponderosa pine with lesser quantities of white and lodgepole pine. In 1964 over 520 million board feet were harvested, or about 2.5 percent of the total for the entire Columbia-North Pacific Region. The forests also provide recreation opportunities by furnishing areas for hunting, fishing, and other outdoor activities. Grant County does not have commercial timber resources; however, harvested logs from other parts of the subregion are brought into the county for processing.

c. Minerals. The subregion contains both metallic and nonmetallic mineral deposits. Important metals found in the area are gold, silver, copper, lead, and zinc. Among nonmetals, the subregion contains deposits of magnesite, high grade silica sand, limestone, dolomite, sand, gravel, pumice, and diatomite. Diatomite is the leading mineral resource in Grant County with commercial application as a filtering aid, as a filler, and for insulation purposes. Sand, gravel, lime, and stone are also mined from various locations in the county. In 1968 Grant County produced $2.1 million in mineral output, ninth in value among Washington's 39 counties. 2/

d. Water. The major water resource of the subregion is the Columbia River. The Methow, Chelan, and Wenatchee Rivers contribute most of the flow generated within the subregion. Other large streams such as the Spokane, Okanogan, and Kettle Rivers contribute a large quantity of water to the Columbia River but they are entirely outside the subregion or originate outside the subregion. Annual rainfall in the subregion ranges from 100 inches at the crest of the Cascades to 7 inches in the Columbia Basin. The discharge generated within the subregion is principally due to spring runoff caused by snowmelt. In winter, heavy rainfall accompanied by warming trends cause snowmelt, which occasionally results in heavy runoff. Utilization of water resources in the subregion has grown rapidly. At the present time irrigation is the largest use through diversions to the Bureau of Reclamation Columbia Basin Project. Water diversions began in 1951 and now serve approximately 516,000 acres utilized

1/ Ibid
2/ U.S. Department of Interior, Minerals Yearbook 1968.

for agricultural production. 1/ Dry Creek Basin is located in the Columbia Plateau, the driest section of the subregion. Annual precipitation at Ephrata is only 8 inches. The major stream in the Columbia Plateau is Crab Creek with an average flow of less than 100 c.f.s. at Irby. Dry Creek itself contains little or no flow for extended periods throughout the summer and into the winter. Since there is an absence of an adequate local source of water in Grant County, it has been imported through water diversion projects. The 1969 Census of Agriculture shows that importation of water into Grant County has been substantial, with 241,000 acres classified as irrigated land in farms. This represented 23 percent of all land in farms in the county.

5. Transportation.

Grant County, near the geographic center of Washington, is served by two major highways, Interstate 90 and U.S. Highway 2. These two highways plus additional all-weather roads provide access to all points in the State of Washington. Regularly scheduled motor freight service is provided to all communities in Grant County. Interstate and intrastate bus service is available in the larger communities and in rural areas along scheduled routes. One transcontinental railroad, the Burlington Northern, serves Grant County with freight service. Currently, no railroad passenger service is available. A regional airline serves the county through Ephrata Municipal Airport with connections to Spokane, Yakima, Seattle, and Portland. A charter air service is available at Grant County Airport. Ephrata is located on State Highway 28 at the intersection of State Highways 282 and 283. It is approximately 160 miles east of Seattle and 120 miles west of Spokane. The city of Soap Lake is on State Highway 28, about 5 miles northeast of Ephrata.

6. Population

Population and land area of the nine counties of the subregion are presented in table C-1. The subregion gained population steadily between 1940 and 1960, but experienced a less than 1 percent increase between 1960 and 1970, according to Census of Population data. Subregion population is primarily rural in character. In 1970, 65 percent of total population was classified as rural farm or rural nonfarm with the remaining 35 percent urban. However, this was a marked change from 1940, when the ratio was 83 percent rural and 17 percent urban. In 1970, Grant County had the largest population among counties in the subregion. The historic population of Grant County and the incorporated cities of the county are shown in table C-2. The urban population of Grant County has increased from 25 percent of total population in 1940

1/ Appendix V, Water Resource, Columbia-North Pacific Region Comprehensive Framework study.

TABLE C-2

HISTORICAL POPULATION

GRANT COUNTY

1940-1970

	1940	1950	1960	1970
Coulee City	744	977	654	558
Electric City	-	1,484	404	651
Ephrata	951	4,589	6,548	5,255
George	-	-	-	273
Grand Coulee	3,659	2,741	1,058	1,302
Hartline	168	205	206	189
Krupp	94	98	99	52
Matawa	-	-	394	180
Moses Lake	326	2,679	11,299	10,310
Quincy	318	804	3,269	3,237
Royal City	-	-	-	477
Soap Lake	662	2,091	1,591	1,064
Warden	78	322	949	1,254
Westlake	-	-	298	258
Wilson Creek	210	337	252	184
Unincorporated	7,458	8,019	19,456	16,637
Total	14,668	24,346	46,477	41,881

SOURCE: U.S. Department of Commerce, Census of Population

to 45 percent in 1970. The number of inhabitants in Grant County declined 10 percent between 1960 and 1970, after nearly doubling between 1950 and 1960. Consistent with the decline of population in the county, the cities of Ephrata and Soap Lake also lost population between 1960 and 1970. There has been population growth in the Ephrata suburban area outside the city limits, although data are not available to measure the extent of expansion. The cities of Ephrata and Soap Lake developed as trade and service centers for cattle ranches in the area in the late 1800's. By the early 1900's Ephrata was an established railway distribution center, but remained small with less than 1,000 people in 1940. Growth in Grant County and the cities of Ephrata and Soap Lake after 1940 was correlated with the Columbia Basin Project, with expansion of county, state, and Federal employment, and with growth of military facilities, specifically, Larson Air Force Base and missile site north of Moses Lake. Population decline in the cities of Ephrata and Soap Lake is attributable to past demographic trends which included the loss of jobs caused in part by movement of young people to metropolitan areas in search of jobs unavailable in Grant County, closing of Larson Air Force Base in 1965, and increasing agricultural productivity and better technology in farming methods. The population has now stabilized and Ephrata is showing signs of rebounding.

7. Employment

Total historical employment in the subregion by county is shown in table C-3. The data show that the subregion experienced a steady increase in employment between 1940 and 1970. Table C-4 presents percentage distribution of total employment by industry group. The most notable trends are the sharp decline in agriculture's share of total employment from 37 percent in 1940 to 19 percent in 1970 and the offsetting increases in manufacturing, trade, services, and government; all prime employment sectors in Ephrata. In 1940, the latter three represented 33 percent of the total employment and by 1970 they increased to 56 percent of the total. Analysis of average monthly covered employment1/ in Grant County for 1960 and 1970 revealed that contract construction dropped 1,600 but this was offset by manufacturing, trade, and services increasing 1,500. This decline in construction was due primarily to the completion of Priest Rapids and Wanapum Dams on the Columbia River. In manufacturing, the largest increases occurred in food processing. In the Ephrata area, employment is concentrated in local, state, and Federal Government offices, in trade and services, and in the manufacture of lumber and fabricated metal and concrete products. The city of Soap Lake is a trade and service center for the surrounding farming community and recreation oriented activities. Both cities are a base for persons visiting the area for recreational pursuits, primarily hunting, fishing, boating, and sightseeing.

1/Employees covered by unemployment insurance under the Washington State Employment Security Act. This classification generally excludes agricultural, government, railroad, self-employed and casual labor.

TABLE C-3

TOTAL EMPLOYMENT BY COUNTY

UPPER COLUMBIA SUBREGION

1940-1970

County	1940	1950	1960	1970
Adams	2,366	2,725	3,665	4,701
Chelan	11,408	14,292	15,020	15,348
Douglas	3,019	3,936	5,462	6,349
Ferry	1,541	1,365	1,247	1,240
Franklin	2,421	5,303	8,500	9,936
Grant	5,867	9,328	14,540	15,558
Lincoln	4,099	4,090	3,910	3,567
Okanogan	8,422	10,122	8,852	9,024
Stevens	6,101	6,422	5,890	5,121
Total	45,244	57,583	67,086	70,844

NOTE: Excludes armed forces.

SOURCE: U.S. Department of Commerce, Census of Population.

TABLE C-4

EMPLOYMENT DISTRIBUTION BY INDUSTRY

UPPER COLUMBIA SUBREGION

1940-1970

Industry	Percent			
	1940	1950	1960	1970
Agriculture, forestry and fisheries	37	26	21	19
Mining	3	1	1/	1/
Construction	14	16	10	7
Manufacturing	7	8	12	13
Food and kindred products	(1)	(1)	(2)	(5)
Lumber and wood products	(4)	(4)	(5)	(3)
Primary metals	(1/)	(1/)	(1)	(2)
Transportation equipment	(1/)	(1/)	(1)	(1/)
Other	(2)	(3)	(3)	(3)
Transportation & communication	6	7	5	5
Trade	13	16	18	22
Services	17	19	24	22
Government	3	7	10	12
Total	100	100	100	100

1/Less than .5 percent

SOURCE: Appendix VI, Economic Base and Projections, Columbia-North Pacific Comprehensive Framework Study and U.S. Department of Commerce, 1970 Census of Population.

8. Income

Total personal income, an indicator of the magnitude of economic activity of an area, rose from $37.2 million in 1950 to $143.9 million in 1969 in Grant County (current price levels); a 287 percent increase which was significantly above the 165 percent increase for the subregion over the same 19-year period (table C-5). Per capita personal income in Grant County climbed from $1,519 in 1950 to $3,436 in 1969 or about 126 percent. However, county per capita income as a percent of the subregion's per capita income has declined since 1959. This was caused in part to the closing of Larson Air Force Base in 1956 and the associated loss of military and civilian payrolls. Recent developments in recreation and manufacturing, broadening the economic base of the area, indicate this trend will not continue.

9. Agriculture

The subregion supports three types of farming: the apple producing area of Chelan and Okanogan Counties, the dry-land wheat producing areas scattered throughout the subregion and the diversified farming area of the Columbia Basin Project, most of which is in Grant County. In 1969 the subregion produced $248 million in agricultural products. The leading cash crop in the subregion is wheat, with fruit crops second, and beef and veal third.[1/] Other important crops were hay and potatoes. Table C-6 presents land in farms and value of farm products for each county in the subregion in 1969. Grant County is one of Washington's leading agricultural areas. In 1969 the county produced $80.6 million in agricultural output, second among the counties in Washington with 10 percent of total state output. Of the total, crops composed $44 million and livestock and livestock products $36 million. The Columbia Basin Project is the primary factor in the county's prominent position in agriculture. The leading irrigated crops are alfalfa, wheat, potatoes, sugar beets, irrigated pasture, pea, seed, and corn. In 1967 these crops were grown on 373,000 irrigated acres and accounted for 82 percent of the irrigated acreage of the Columbia Basin Project, and 78 percent of the total gross crop value on irrigated land in the project area.[2/] Livestock output has also expanded steadily along with irrigation development. Dry-land farming, with wheat and barley the prominent crops, remains an important segment of Grant County's agricultural base. Farmlands in the Dry Creek flood plain are irrigated and highly productive, supporting corn, beets, alfalfa hay, oats, and pasture grasses.

10. Manufacturing

Manufacturing industries in the subregion in order of importance based on employment, are food and kindred products, lumber and wood products, primary metals (aluminum), and transportation equipment. Lumber manufacturing accounts for almost all forest products output. Food

1/Appendix IV, Economic Base and Projections, Columbia - North Pacific Region Comprehensive Framework Study.
2/Grant County Public Utility District.

TABLE C-5

PERSONAL INCOME

UPPER COLUMBIA SUBREGION AND GRANT COUNTY

1950 - 1969

	1950	1959	1969
Total Personal Income ($1,000's)			
Subregion	$266,000	$404,000	$705,000
Grant County	$ 37,174	$101,423	$143,900[1/]
Per Capita Personal Income			
Subregion	$ 1,690	$ 2,087	$ 3,626
Grant County	$ 1,519	$ 2,199	$ 3,436[1/]

NOTE: Current dollars.

1/Census data adjusted to fit OBE methodology.

SOURCE: U.S. Department of Commerce, Office of Business Economics (OBE), and Census of Population.

TABLE C-6

LAND IN FARMS AND VALUE OF FARM PRODUCTS SOLD

UPPER COLUMBIA SUBREGION

1969

County	Land in Farms (1,000 acres)	Value of Farms Products Sold ($1,000's)
Adams	1,249	$30,687
Chelan	139	24,171
Douglas	1,027	19,287
Ferry	770	1,480
Franklin	618	32,332
Grant[1/]	1,043	80,655
Lincoln	1,450	22,221
Okanogan	1,434	26,294
Stevens	710	10,765
TOTAL	8,440	$247,892

1/Location of Dry Creek Basin

SOURCE: U.S. Department of Commerce, Census of Agriculture, 1969.

processing includes a broad spectrum of fresh, refined, canned, dried, and frozen products. In terms of value added among foodstuffs, sugar refining ranks first with fruit and vegetable canning and preserving second.[1] These two groups account for over three-fourths of the total value added for food products. Value added by manufacturing for the subregion is shown in table C-7. Processing of agricultural output is Grant County's primary manufacturing activity. Sugar beets, potatoes, corn, and beans are the leading processed commodities. Since 1965 six new food processing plants have been constructed. Five of these produce potato products such as dehydrated potato granuals, frozen french fries, and hash browns. Other crop processing operations include spearmint and peppermint stills, a potato starch plant and alfalfa pelleting mills. Among nonagricultural industries there are manufacturers of lumber, concrete products, plastic pipe, prefab houses, fabricated steel and aluminum products and diatomaceous earth products. The city of Ephrata has a limited amount of manufacturing composed of concrete products, publishing, metal fabrication, and lumber products. However, some new manufacturing is beginning to move into the area. In the city of Soap Lake, printing is the only manufacturing activity.

11. Trade and Services

Retail sales in the nine counties of the subregion for 1963 and 1967 are shown in table C-8. Trade and service outlets in Grant County derive most of their income from the agricultural base and its related manufacturing. The normal complement of community services such as a community college, medical facilities, retail outlets, churches, and schools are available in Grant County. The city of Ephrata serves the nearby farming community and contains branch offices of the U.S. Bureau of Reclamation and Washington State Employment Security Department, as well as the main office of the Grant County Public Utility District and the Grant County office building. The County Building contains offices and service departments for such county agencies as tax assessor, auditor, sheriff, and engineering. The Bureau of Reclamation acts as a base industry since it brings Federal funds into the county. Table C-9 presents retail sales for Grant County and the cities of Ephrata, Moses Lake, and Quincy for 1963 and 1967. Data are not available for the city of Soap Lake.

12. Recreation

Grant County has a wide variety of recreation opportunities including hunting, fishing, boating, and sightseeing. Climatic conditions are characterized by low humidity, low precipitation, and an abundance of sunshine. With the establishment of irrigation, wildlife, especially upland birds and waterfowl, has increased significantly. Approximately 225 lakes (172,500 acres of water) are in Grant County, the majority of which are either manmade or formed by seepage from irrigation waters.[2] These lakes provide excellent fishing, boating, water skiing, swimming, and camping. Banks Lake, the equalizing reservoir for Grand

1/Appendix VI, Economic Base and Projections, Columbia - North Pacific Region Comprehensive Framework Study.
2/Grant County Public Utility District

TABLE C-7

VALUE ADDED BY MANUFACTURING

UPPER COLUMBIA SUBREGION

1958 - 1967

County	Millions of Dollars 1958	1963	1967
Adams	0.2	0.7	4.7
Chelan	27.7	37.1	17.7
Douglas	2/	2/	2/
Ferry	2.5	2.2	1.6
Franklin	1.5	1.5	5.7
Grant 1/	7.8	17.6	57.4
Lincoln	2/	2/	2/
Okanogan	9.0	9.5	13.8
Stevens	6.3	5.7	9.1
Total	55.0	74.3	110.0

1/Location of Dry Creek Basin

2/Withheld to avoid disclosing figures for individual companies.

SOURCE: U.S. Department of Commerce, Census of Manufactures, 1967

TABLE C-8

RETAIL SALES

UPPER COLUMBIA SUBREGION

1963 - 1967

County	1963 ($1,000's)	1967 ($1,000's)
Adams	$18,878	$27,871
Chelan	64,571	91,461
Douglas	7,571	12,145
Ferry	1,899	2,198
Franklin	47,734	60,941
Grant[1/]	67,092	76,222
Lincoln	14,340	17,245
Okanogan	29,111	36,709
Stevens	16,716	20,594
Total	$267,912	$345,386

1/Location of Dry Creek Basin

NOTE: Current dollars

SOURCE: U.S. Department of Commerce, Census of Business

TABLE C-9

RETAIL SALES

GRANT COUNTY

1963 - 1967

CITIES	1963 ($1,000's)	1967 ($1,000's)
Ephrata	$11,274	$14,487
Moses Lake	29,377	35,248
Quincy	11,228	10,460
Other	15,213	16,027
Total Grant County	$67,092	$76,222
Ephrata as a percent of Grant County	16.8%	19%

NOTE: Current dollars

SOURCE: U.S. Department of Commerce, Census of Business

Coulee Dam, Potholes Reservoir behind O'Sullivan Dam, and the Sun Lakes in the Grand Coulee are among the lakes available for recreation. The principle natural feature in the county is Grand Coulee, which extends southward from Grand Coulee Dam. This 50-mile gorge was carved from the earth's crust by meltwaters of the Ice Age. For professional and amateur geologists, archaelogists, and "rockhounds," Grant County offers a profusion of exposed geology. Recent recreation investments and developments within the service area of Ephrata and Soap Lake indicate a positive growth potential for the area.

13. Projections and Trends of Development

The potential for long range growth in Grant County is favorable. Analysis of historic growth in population, employment, and income has a positive long range trend. The recent slowdowns are seen as only temporary. In the past, the county has held a strong position in Upper Columbia subregion economic activity and has equaled or exceeded historical growth rates of most subregion indicators. Therefore, the use of OBERS[1/] subregion projections to estimate growth in pertinent county indicators appears reasonable. These trends and projections have also been used to develop growth factors for the Dry Creek flood plain in chapter III. Projections of population, employment and income for the period 1969 through 2030 for both Grant County and the subregion are shown in table C-10. Grant County and Dry Creek study area should continue to derive the largest share of income from agriculture and related food processing. Expansion of acres under irrigation, combined with advanced agricultural technology and increased productivity, will assist in assuring future expansion of agricultural output. Additional nonfood related manufacturing and recreation should supplement agriculture and assist in broadening the industrial base of the county.

1/Volume 4, OBERS Projections, U.S. Water Resources Council.

TABLE C-10

PROJECTIONS

UPPER COLUMBIA SUBREGION AND GRANT COUNTY

1969 - 2030

	1969	2000	2030[1]	Average annual growth rate 1969-2000	2000-2030	1969-2030
Population[2]						
Subregion	193,900	237,400	311,000	0.6%	0.9%	0.8%
Grant County	41,800[3]	51,200	67,100	0.6%	0.9%	0.8%
Employment						
Subregion	73,000	92,000	121,400	0.6%	0.9%	0.8%
Grant County	15,600[2]	19,600	25,900	0.75%	0.9%	0.8%
Total Personal Income[3]						
Subregion	$651,300	$1,914,200	$5,781,000	3.5%	3.8%	3.6%
Grant County	132,900[1]	390,600	1,180,000	3.5%	3.8%	3.6%
Per Capita Income[4]						
Subregion	$3,359	$8,063	$18,588	2.9%	2.8%	2.8%
Grant County	3,180[1]	7,629	17,586	2.9%	2.8%	2.8%

1/Estimated by U.S. Army Corps of Engineers, using OBE and census data.
2/Estimated for midyear.
3/From 1970 census data, $1,000's.
4/1967 price level.

SOURCE: U.S. Department of Commerce, Office of Business Economics (OBE), except as noted.

CHAPTER III - FLOOD DAMAGES

14. General

This chapter describes historical, present, and projected future flood damages in the Dry Creek flood plain located in the city of Ephrata, Washington, and vicinity. Included is a description of the flood plain, existing economic development and a description of procedures and rationale used to determine average annual damages under present and future conditions. Monetary damage to such items as land, improvements, personal property, public property, interruption of business, and other expenditures directly attributable to a flood are evaluated. Floods also cause damages which are not subject to an easily defined market value. These intangible damages include loss of human life, impairment of health, human suffering, loss of esthetic values and impact of any disruption of the flow of commodities on the economies of the region, state, and nation.

15. Extent and Character of the Flood Plain

The area inundated by water from Dry Creek is shown on plate C-1, Dry Creek Basin and Flood Plain. The flood plain of Dry Creek Basin includes portions of the urban areas of the cities of Ephrata and Soap Lake, and rural farm areas between Ephrata and Soap Lake. Most of the city of Ephrata has been developed on an alluvial fan extending east from the mouth of Dry Creek Canyon. The city of Soap Lake is located on terrain shaped in the form of a bowl at the south end of Soap Lake. The central residential and business districts of Ephrata and the central business district of Soap Lake are in the flood plain. Development in the urban flood plain includes dwellings, office buildings, commercial establishments, motels, and appurtenant structures. Most buildings are of good construction. Farmlands in the flood plain are irrigated and highly productive, supporting corn, beets, alfalfa hay, oats, and pasture grasses. Farm structures are generally of good construction and well maintained. The 100-year flood plain contains a total of 720 acres and is shown on plate C-1. Table C-11 presents acreage for various urban and rural land-use categories.

16. Value of Land Improvements in the Flood Plain

The assessed value of the city of Ephrata was $6,730,000 in 1970. The Dry Creek flood plain portion of Ephrata was assessed at $4,048,000 or about 60 percent of total assessed value of the city. The current market value of lands, improvements, and personal property located in the flood plain in the city of Ephrata is about $16,200,000. Flood plain portions of the city of Soap Lake and nearby suburban developments are estimated to have a land, improvement, and personal property market value of $8,000,000. The market value of rural flood plain lands, improvements, and personal property is estimated at $600,000. Total market value of all lands, improvements, and personal property in the entire area subject to inundation by Dry Creek is estimated to be about $24,800,000. Total values in the area subject to a flood of a frequency of 100 years is estimated at $20,000,000.

TABLE C-11

LAND USE

DRY CREEK FLOOD PLAIN

Discharge in c.f.s.	3,700	5,000	6,200
Frequency of occurrence in years	50	100	200
Land use in acres			
Agricultural	248	318	372
Commercial and industrial	80	105	111
Public	40	47	49
Residential	92	134	156
Roads and streets	80	116	132
Total	540	720	820

17. Ownership of Flood Plain Lands

The flood plain affected by the proposed Dry Creek flood control project contains several hundred ownerships. Only portions of the larger rural-agricultural ownerships are in the flood plain. Flood plain portions of ownerships are generally smaller than 20 acres.

18. Description of Flood Plain by Reaches

For the purpose of flood damage appraisal study the entire flood plain of Dry Creek was divided into the following reaches:

a. Reach I. Reach I is composed of the portion of the city of Ephrata located on the Dry Creek flood plain. The flood plain in this reach is about 2.3 miles long and 0.3 miles wide. Commercial buildings and dwellings are mostly well maintained good construction and are closely spaced in a high density urban setting. Streets and walks are paved. Yards contain well kept lawns, shrubbery and shade trees.

b. Reach II. Reach II is composed of the area north of Ephrata including the city of Soap Lake, and the rural area south of Soap Lake. The flood plain of the town of Soap Lake is about 0.6 miles long and 0.1 mile wide. Commercial buildings and dwellings vary from well maintained, good construction to poorly constructed buildings in a moderately close spaced setting. Streets and walks are paved. Lakeview Park, a suburban residential community, is located about 0.5 miles south of Soap Lake and is about 0.4 mile wide and 0.6 mile long. Dwellings and other buildings in the flood plain of this development range in type of construction from good to poor. Some streets and walks are paved. Yards contain lawns, shrubbery, and shade trees.

The rural flood plain from Ephrata to Soap Lake averages 0.2 mile in width and is about 6.3 miles long. Rural agricultural land is planted in corn, oats, beets, alfalfa hay, mixed hay, and pasture grasses. All crop land and good pasture land is irrigated. Some of the area is rocky and contains poor soil and provides a limited amount of pasture. Beef and dairy cattle and some sheep are pastured in the flood plain. Rural flood area improvements include farm buildings, dwellings, county roads, and state highways.

19. Existing Flood Protection

At the mouth of Dry Creek canyon a steel sheet pile training wall turns flow into a constructed channel running north, parallel to a major irrigation canal. Beyond the north end of the city, the channel, formed by an embankment on each side, turns eastward, leading into a natural ponding area. The channel generally has a capacity of 2200 cubic feet per second, which represents a 20-year flow. However, the embankments of the eastward running portion are constructed of fine material subject to failure beyond a flow of 560 cubic

feet per second. This failure would permit water to fill that part of the ponding area which extends into the north end of Ephrata. A 20-year flood would fill the entire ponding area after which an additional inflow would tend to follow natural channels in the direction of Lakeview Park and Soap Lake. The Dry Creek flood plain is not currently subject to flood plain development restrictions in the form of zoning, floodway easements, or building codes.

20. Historical Floods and Damages

The most severe historical floods occurred in 1920 and 1948. The discharge and frequency of the 1920 flood are not available. The 1948 flood had an estimated discharge of 3,000 c.f.s. and frequency of occurrence of once in 33 years. A large portion of the residential and commercial sections of Ephrata were flooded. An estimated $1,500,000 damage would occur in the town of Ephrata by a recurrence of the 1948 flood under January 1973 prices and conditions.

21. Survey of Flood Damages

During 1969-70, a flood damage appraisal was made based on the depth of water for floods having a frequency of occurrence of once in 30 years, 50 years, 100 years, and 200 years. This appraisal was based upon existing land use, density of improvements, and value of improvements subject to damage. Present land use of the flood plain, including crop patterns, was determined. Entire residential and commercial areas subject to flooding were evaluated. Damages to crops were estimated by applying the unit values of damages per acre to the acreage of the corresponding crop. Damage to each large commercial and public facility was appraised independently. Value of damages for other items such as roads, railroads, fences, and some utilities were appraised on the basis of miles inundated. The appraisal process for the determination of emergency aid utilized information on historical expenditures and the severity and duration of floods. These expenditures included costs to perform emergency levee or dike repairs at the flood channel, flood fight and evacuation costs, and the cost of additional police and fire department activities. A flood of the magnitude of a 30-year frequency flood occurring in January 1973 would cause an estimated $1,412,000 damage in the Dry Creek flood plain, a 50-year frequency flood $2,031,000, a 100-year frequency flood $2,933,000, and a 200-year flood $3,602,000. Table C-12 shows the value of flood damages by categories for each of these flood events.

22. Types of Flood Damages

Flood losses or damages were designated by class and category of damage. The following tangible damages were considered: (1) physical damages caused by inundation; (2) emergency losses or costs incurred in fighting or in anticipation of the flood; (3) business financial losses resulting in decreased profits and wages; and (4) increased

TABLE C-12

FLOOD DAMAGES

DRY CREEK FLOOD PLAIN

(January 1973 Prices and Conditions)

Frequency of flood occurrence in years	30	50	100	200
Discharge in c.f.s.	2,800	3,700	5,000	6,200
Category of damage	Value of damages ($1,000's)			
Residential	$740	$1,090	$1,580	$1,850
Commercial	360	510	750	1,000
Public facilities utilities, roads and bridges	260	360	510	620
Other	45	57	62	89
Agricultural	7	14	31	43
Total	$1,412	$2,031	$2,933	$3,602

cost of normal operations and living expenses. Tangible damages were determined for the following categories of flood losses:

a. Residential. Residential damages include inundation losses to nonfarm residences and contents, appurtenant buildings and grounds and represent 52 percent of total average annual damages.

b. Commercial. Commercial damages include losses to all properties used in wholesale or retail business, trade, services, or entertainment as distinguished from other properties used in industry, public administration, utility production and service, and transportation. Physical flood damages to commercial property and facilities include damages to land, buildings, equipment, supplies, merchandise and other items used in the conduct of the business. Loss of business sustained by commercial activities as a consequence of floods results in loss of net profits to the owner of a business. Loss of wages to employees of a commercial establishment were considered when such losses were not compensated for by employment in emergency activities during the flood and rehabilitation period. Commercial damages represent 28 percent of total average annual damages.

c. Public Facilities, Utilities, Roads, and Bridges. Damages to public facilities include inundation losses to public buildings, grounds, parks, and all other publicly-owned facilities, including equipment and furnishings owned or operated by Federal, state, county, and municipal government agencies. Public business losses include losses in wages, and increased cost of normal operations. Included in this category are inundation and destruction losses to utilities, roads, bridges, streets, pavement, sidewalks, and highway structures, supplies and equipment, traffic delays, and interruptions. Average annual damages in the category are 16 percent of the total.

d. Agricultural. Agricultural damages include destruction of growing crops, siltation, loss of soil fertility, and cost of removal of debris and weed seed. The value of all agricultural damages is less than 1 percent of total annual damages.

e. Other. The following categories of damages, representing 4 percent of the total, are included under "other."

(1) Railroad losses include damage to tracks, roadbed rights-of-way, supplies, and equipment directly attributable to overflow of flood waters. Loss due to bank erosion and monetary losses due to traffic delays are also included in this category. The value of railroad losses and damages is less than 1 percent of all damages.

(2) The cost of emergency aid includes expenditures essential for the preservation of life and property, such as clearance of debris and wreckage, emergency repair, or temporary replacement of private and public facilities, evacuation assistance, Federal aid for flood fighting, flood emergency preparation, rescue operations, police

protection, and repair and restoration of damaged flood-control works. Aid and relief activities include two general categories: (a) that furnished to the individuals and family units directly affected by a flood, and (b) that furnished for emergency rehabilitation of communities and cities. The value of emergency aid is less 2 percent of the total.

(3) Additional items include damages to motor vehicles, irrigation and flood control facilities which represent about 1 percent of the total.

23. Derivation of Average Annual Damages

The average annual value of flood damages was derived graphically in the following manner:

a. Discharge-frequency relationship. Curves showing discharge frequencies were developed for the flood plain that will be affected by the proposed project. The curves were developed from existing records, historical reports, comparison of areas and runoff characteristics, and correlation of recorded discharges. Basic data for this relationship was obtained from discharge frequency curves shown in Appendix B, Design.

b. Discharge-damage relationship. A discharge for zero damage was determined from a field investigation of the existing channel. Discharge-damage curves for each category of damage were prepared by plotting the value of damages from 30, 50, 100, and 200-year frequency floods at 1971 conditions and prices against the corresponding flood discharges and fitting curves to these points and zero damage.

c. Damage-frequency relationship. Curves showing damage-frequency relationship were prepared by graphical correlation by quadrant plotting of the discharge-damage and discharge-frequency curves for existing conditions.

d. Average annual damage. The area above the damage-frequency curve, converted to its equivalent value in dollars, is the average annual damage in terms of 1971 prices and conditions. These figures were converted to January 1973 prices and conditions to be comparable with the cost data.

24. Flood Damages Under Existing Conditions and Prices

Plates C-2 and C-3 (Flood Damage Relationship) show the curves from which recurring flood damage values were derived. Plate C-2 is for the city of Ephrata (Reach I). Plate C-3 is for the city of Soap Lake, the suburban development south of the town of Soap Lake, and the rural farm area between Soap Lake and Ephrata. (Reach II) The curves are based on 1971 prices and conditions. Plate C-4 is an example of a more precise statistical technique utilized to determine

average annual damages under preproject conditions for Reach I, where the majority of the damages occur. The average annual damage at January 1973 prices and conditions for the entire Dry Creek flood plain is $170,400. The average annual damage by category for Reaches I and II, is shown on table C-13.

25. Land Value Check

The reliability of the estimated flood prevention benefits can be checked by comparing the difference in the value of agricultural flood-prone lands with agricultural flood-free lands. Market value of land is based on the estimated net income potential of the land. Since flood damage reduces net income, the value of flood-prone land should be less by an amount which reflects its reduced net earning potential. Therefore, the expected rate of net return multiplied by the difference in price of flood-prone compared to flood-free lands should correspond to the estimated annual flood prevention benefits. The estimated value of the agricultural lands in the flood plain is is $510 per acre compared to $570 for comparable flood-free lands. The difference in value, $60, represents the capitalized value of expected reduced earnings resulting from flood damages and higher operating costs associated with flood hazards. At a normal expected rate of return of 8 percent, the average annual net loss in income anticipated from floods is $5 per acre or $1,600 for the 318 acres. This compares with the estimated flood prevention benefits of $300. The large difference between the two figures is caused by inflated land values. The agricultural flood plain is between the city of Ephrata and unincorporated community of Lakeview Park and the location has resulted in speculative land values.

26. Future Growth in the Flood Plain

a. General. Determination of growth factors to represent the increase in damageable items in the flood plain, assuming no additional flood protection, was based on selection of pertinent economic indicators and correlating them with the economic environmment in the flood plain. The purpose of this paragraph is to (1) project the growth of the Ephrata-Soap Lake area to determine increase in future development and associated changes in land use in the overall urban area, and (2) to estimate the extent to which these changes will affect the development and use of the specific flood plain area (without flood protection). Indicators for the Ephrata and Soap Lake flood plain were derived after extensive office studies, field surveys and discussions with local planners, county public officials, and state officials. From the selection of proper indicators, projected annual growth rates were derived and translated into average annual discounted growth factors. When applied to average annual damages under present conditions, these factors yield average annual damages including future growth over the study period, assuming no additional flood protection. Growth factors were developed for the following three categories of damages: (1) Residential (2) Commercial, and (3) Public Facilities, Utilities, Roads, and Bridges. These three categories account for

TABLE C-13

AVERAGE ANNUAL DAMAGES

DRY CREEK FLOOD PLAIN

(January 1973 Prices and Conditions)

Category	Reach I	Reach II	Total
Residential	$85,600	$2,200	$87,800
Commercial	44,000	3,100	47,100
Public facilities utilities, roads and bridges	27,000	700	27,700
Other	6,600	200	6,800
Agricultural	———	1,000	1,000
Total	$163,200	$7,200	$170,400

96 percent of average annual flood damages. The indicators used in the flood plain analysis included numbers of dwelling units, vacant land, population, per capita income, total personal income, retail sales, and receipts from selected services. Table C-14 presents annual growth rates and discounted growth factors for the three categories.

b. Residential. Residential flood losses include damages to homes and their contents, associated structures, and other related damages. The residential flood plain under study consists predominantly of the urban core areas of Ephrata and Soap Lake. The majority of structures are of good quality and are well maintained. There is some vacant land available for expansion in the flood plain, consisting of vacant lots between buildings within city limits. The magnitude of residential flood damages can be expected to increase in the future. This increase is related to two factors: (1) Construction of new buildings and addition of new contents: and, (2) increased values due to renovational maintenance and improvement of existing structures and replacement and upgrading of contents. New construction is related to population increases in the flood plain. Historically, the area experienced rapid increase in population after World War II followed by a decline in the 1960 to 70 decade. The decline was closely associated with the closing of military bases in the area and the phasing out of other Federal construction programs. Currently, the population has stabilized due to a more diversified economic base. New building permits for the city show a moderate growth trend. Over the long range, population growth of the cities and flood plain are expected to approach that of Grant County, which is projected to average 0.8 percent annually. However, the land available in the urban flood plain for new residential construction will accommodate approximately 75 new single family housing units. It was assumed this construction would take place over the life of the project which results in a growth in damageable structures of 0.3 percent annually. Data on new electrical hook-ups tends to substantiate this rate. Additional population would be absorbed through greater density per acre. The growth in value of existing and new development can be measured by growth in per capita income. Relevance of such an indicator has been supported nationally by studies by Resources for the Future, which found a constant ratio between income and expenditures for construction of dwellings during the period from 1936 to 1960 and projected the same relationship to continue to their terminal year of 2000. This trend is especially evident in the city of Ephrata. A survey of local building permits shows a minimum of new dwelling permits but a substantial number of permits for alterations and additions to dwellings being granted yearly as well as permits for new garages. The per capita income growth in the flood plain was assumed to be similar to that projected for Grant County or an average of 2.8 percent annually. This assumption is supported by several factors. Ephrata is one of the major trade centers of Grant County and it is expected to increase as the service area around it expands. New recreation and industrial development is taking place within the area serviced by Ephrata and Soap Lake. The generally well maintained condition

TABLE C-14

GROWTH RATES AND FACTORS

DRY CREEK FLOOD PLAIN

Damage Category	Annual Growth Rates in Percent 1972-1979	1979-2029	1979-2079
Residential	3.1	3.1	1.5
Commercial	1.6	1.6	0.8
Public facilities utilities, roads and bridges	3.1	3.1	1.5

Damage Category	Growth Factor to 1979	Average Annual Equivalent Discount Factors 1/ 50 Years	100 Years
Residential	1.24	1.73	2.01
Commercial	1.12	1.30	1.38
Public facilities, utilities, roads and bridges	1.24	1.73	2.01

1/Equivalent average annual factors discounted at 5.5 percent.

and constant improvement of the flood plain development indicate income growth. Combining the rate for per capita income and the estimated rate of new construction gives a combined growth of 3.1 percent annually to be applied as growth in residential damages to 2029. After 2029 one half this rate or 1.5 percent is used. Table C-14 shows conversion to 50 and 100 year growth factors.

c. Commercial. Indicators used for measuring growth in flood damage to commercial property were retail sales and receipts from service industries. Commercial activity in the flood plain is in the form of retail trade and service outlets in the cities of Ephrata and Soap Lake for the residents of the two cities, surrounding farm communities, and other county residents and businesses. As total personal incomes increase, sales at these outlets are expected to expand. Between 1954 and 1967, receipts from selected services in constant dollars, increased 3.25 percent annually in Grant County and 4.5 percent in Ephrata. Retail sales for the county over the same period rose 2.6 percent annually and in Ephrata it rose at 1.1 percent annually. The lower historical growth of retail trade in Ephrata indicates some travel by service area populace to other trade centers for purchases. Thus, greatest weight was given to historical trends of Ephrata in estimating growth in retail sales and selected services. These trends were weighted by dollar magnitude and combined yielding an estimated growth rate of 1.6 percent annually to 2029 and one-half that rate beyond 2029. Table C-14 presents the growth factors for these rates.

d. Public Facilities, Utilities, Roads, and Bridges. Flood damages in this category consist of repair and replacement of roads, bridges, utilities, and public facilities. Nationally, resources for the future has projected investments in highways and utilities to increase at a rate which approximated growth in total economic activity as measured by the gross national product. A comparable indicator locally would be total personal income. Local data on street maintenance and improvement shows substantial continuing investments in streets and utilities. The same rate is used for these damages as was derived for residential damages, 3.1 percent annually. This rate is slightly under expected total personal income but is more representative of flood plain conditions. The growth rate beyond 2029 is estimated to 1.5 percent. The 50 and 100-year growth factors are shown in Table C-14.

27. Future Growth of Flood Damages

With existing flood protection and more intensive economic development in the flood plain, flood damages may be expected to increase in the future. Projections have been made for various study periods, (i.e.: 1972-1979, 1979-2029, and 1979-2079) based on estimate of first year of project operation and an assumed 50 or 100-year economic project life. Table C-15 shows average annual damages at project year one (1979) and for 50 and 100-year analysis periods after application of appropriate factors in Table C-14.

TABLE C-15

GROWTH IN AVERAGE ANNUAL DAMAGES

DRY CREEK FLOOD PLAIN

(January 1973 Prices and Future Conditions)

Category	Project Year One 1979	50 Years 1979-2029	100 Years 1979-2079
Residential	$108,800	$188,000	$219,000
Commercial	52,800	69,000	73,000
Public facilities utilities, roads and bridges	34,400	60,000	69,000
Agricultural	1,000	1,000	1,000
Other	6,800	6,800	6,800
Total	$203,800	$324,800	$368,800

CHAPTER IV - ECONOMIC JUSTIFICATION

28. General

The Dry Creek project consists of flood channel improvements combined with a natural flood storage area. The channel carries flood discharges from the mouth of Dry Creek canyon west of Ephrata to a natural ponding and drainage area north of the city of Ephrata. Design capacity of the channel will be equal to the discharge of a flood having a one percent probability of occurring in any year (100 year flood). Direct primary benefits are from flood damage prevention. Area redevelopment benefits for the employment of local labor which would normally be unemployed are also computed. For the purpose of this evaluation, 1979 has been selected as the year the project could be expected to be operable.

29. Summary of Investment Costs and Annual Charges

Detailed information on construction costs is contained in Appendix B, Design. Costs are based on January 1973 prices and amortized at 5-1/2 percent rate of interest. To provide protection against a flood with a probability of occurrence of once in 100 years requires an investment cost of $3,075,000. Table C-16 shows the average annual costs for 50 and 100-year study periods.

30. Project Accomplishment - Existing Conditions

Plates 2 and 3 show the relationship between flood flows and chance of occurrence for both preproject and postproject conditions. Table C-17 shows that average annual flood control benefits under existing conditions and at present prices are $141,400 with residual annual damage of $29,000.

31. Flood Damage Prevention Benefits - Future Conditions

Future growth in the flood plain without the project has been previously discussed in Chapter III, Flood Damages. Application of growth factors from Table C-14 indicates that by the first year of project operation (1979), average annual benefits will be $170,000. For a 50-year study period (1979-2029) including projected economic growth, the average annual benefits are $271,000 and for the 100-year period (1979-2079), including projected economic growth, $308,000 as shown in table C-18.

TABLE C-16

AVERAGE ANNUAL COSTS

(January 1973 Prices and 5-1/2% Interest Rate)

	50 Years	100 Years
Interest & Amortization	$182,000	$170,000
Operation & Maintenance	7,000	7,000
Total	$189,000	$177,000

TABLE C-17

AVERAGE ANNUAL FLOOD REDUCTION BENEFITS

(January 1973 Prices and Conditions)

Category	Existing Damages	Residual Damages 1/	Benefits
Residential	$87,800	$14,000	$73,800
Commercial	47,100	8,900	38,200
Public facilities, utilities, roads and bridges	27,700	4,300	23,400
Agricultural	1,000	700	300
Other	6,800	1,100	5,700
Total	$170,400	$29,000	$141,400

1/Damages caused by floods greater than 100-year frequency.

TABLE C-18

AVERAGE ANNUAL FLOOD DAMAGE PREVENTION BENEFITS

(January 1973 Prices and Future Conditions)

Category	Project Year One 1979	50 Years 1979-2029	100 Years 1979-2079
Residential	$93,000	$159,000	$185,000
Commercial	43,000	56,000	59,000
Public	29,000	50,000	58,000
Agricultural	300	300	300
Other	5,700	5,700	5,700
Total	$170,000	$271,000	$308,000

32. Land Enhancement Benefits

Analysis of the land area subject to inundation indicates that project influence on changes in land use would be minimal. A majority of the land area is projected to develop for residential use without the project. Therefore, no benefit for increased land values has been estimated and the small amount that might occur would be widespread to all owners of land in the flood plain.

33. Area Redevelopment Benefits

Grant County in which the proposed project is located, has been designated by the Economic Development Administration, U.S. Department of Commerce, as an area of persistent unemployment and is thus eligible for consideration in the award of Federal contracts under Title IV of the Public Works and Economic Development Act of 1965, Public Law 89-136, Senate Document 97, 87th Congress. The average annual unemployment rate as of 1972 was 10.6 percent of the labor force. Area redevelopment benefits from project construction are based on labor data from records of the Bureau of Reclamation and Corps of Engineers. The Bureau of Reclamation has constructed numerous irrigation facilities in the Columbia Basin similar in physical characteristics to the proposed Dry Creek flood control project. Their records show that, of total construction costs, 45 percent typically would be labor, with 38 percent of the labor skilled, 20 percent semiskilled (operators), and 42 percent unskilled. Available evidence indicates that most of the labor requirements for the Dry Creek project could be hired locally (within Grant County). Because of the long-term irrigation construction activity in the area, a number of heavy construction firms have become established at communities in the county, including Ephrata and Moses Lake. However, as a result of the intermittent nature of construction work, there are many experienced workers unemployed at any given time. The Washington Employment Security Department reported that in October 1973 there were 133 construction workers unemployed in the county; skill categories were not available. On the basis of Corps of Engineers contract experience and the large potential for local hiring in Grant County, the assumption has been made that 60 percent of the skilled labor and 100 percent of the semiskilled and unskilled would be hired locally from among the unemployed. Applied to the labor categories given above, this results in the assumption that 85 percent of labor would be hired locally. Area redevelopment benefits from this hiring are computed as follows:

Total Construction Cost 1/	$3,012,000
Less EDS&A	548,000
Total Contract Cost	$2,464,000

1/Does not include real estate.

Total Labor Cost (45%)	$1,109,000
Less Contractor Overhead and Indirect Costs 2/	277,000
Remaining Labor Cost	$832,000
Labor Cost to Local Unemployed (85%)	$707,000
50-year Project Life Average Annual Construction Benefit	$42,000
100-year Project Life Average Annual Construction Benefit	$39,000

Unemployment would be further relieved by hiring local residents to maintain and operate the proposed project. Determination of this benefit is based on estimates that (a) labor costs represent about 75 percent of total maintenance and operation costs, and (b) the labor force will be local residents. In accordance with ER 1165-2-6 "Resource Policies and Authorities, Evaluation of Redevelopment Effects," 1 February 1966, the employment benefits from project operation and maintenance were based on a straight line reduction in potential project employables for maintenance to a zero level at the end of 20 years from the date of project evaluation. The average annual cost for maintenance and operation is $7,000. With a 5-1/2 percent rate of interest, the average annual benefits are $2,300 for the 50-year and $2,100 for the 100-year study period respectively. Total employment benefits are shown in the following tabulation:

Employment Benefits	50-year Project Life	100-year Project Life
Construction	$42,000	$39,000
Operation & Maintenance	2,300	2,100
Total Employment Benefits	$44,300	$41,100

34. Summary of Benefits

Primary benefits attributable to the proposed flood control project for the Dry Creek flood plain are flood damage prevention. Area redevelopment benefits are also included. These have been analyzed for the 50- and 100- year project lives in terms of January 1973 prices and 5-1/2 percent discount rate. Table C-19 summarizes these benefits.

2/Includes wages for supervisors and key personnel at approximately 25 percent of total labor costs.

TABLE C-19

SUMMARY OF BENEFITS

Type of Benefit	50-years	100-years
Flood Prevention	$271,000	$308,000
Area Redevelopment	44,300	41,100
Total Benefits	$315,300	$349,100

35. Distribution of Benefits

The project benefits are widespread due to the large number of ownerships on relatively small parcels. In addition, any land enhancement which might occur would be minimal and was not entered as a project benefit. There are no windfall benefits due to flood damage prevention of such a magnitude as to constitute the basis for additional requirements of local cooperation.

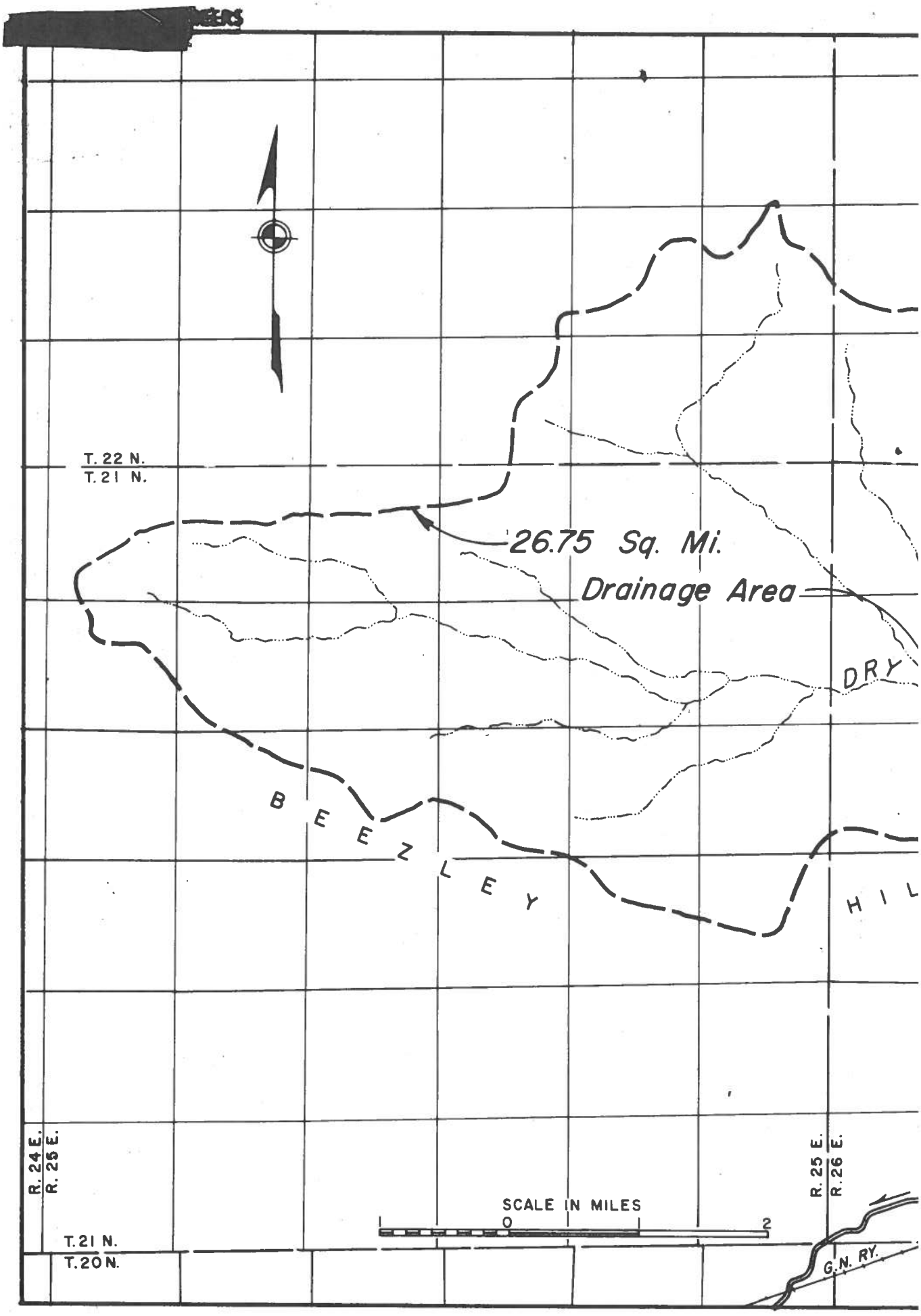
36. Benefit-Cost Analysis

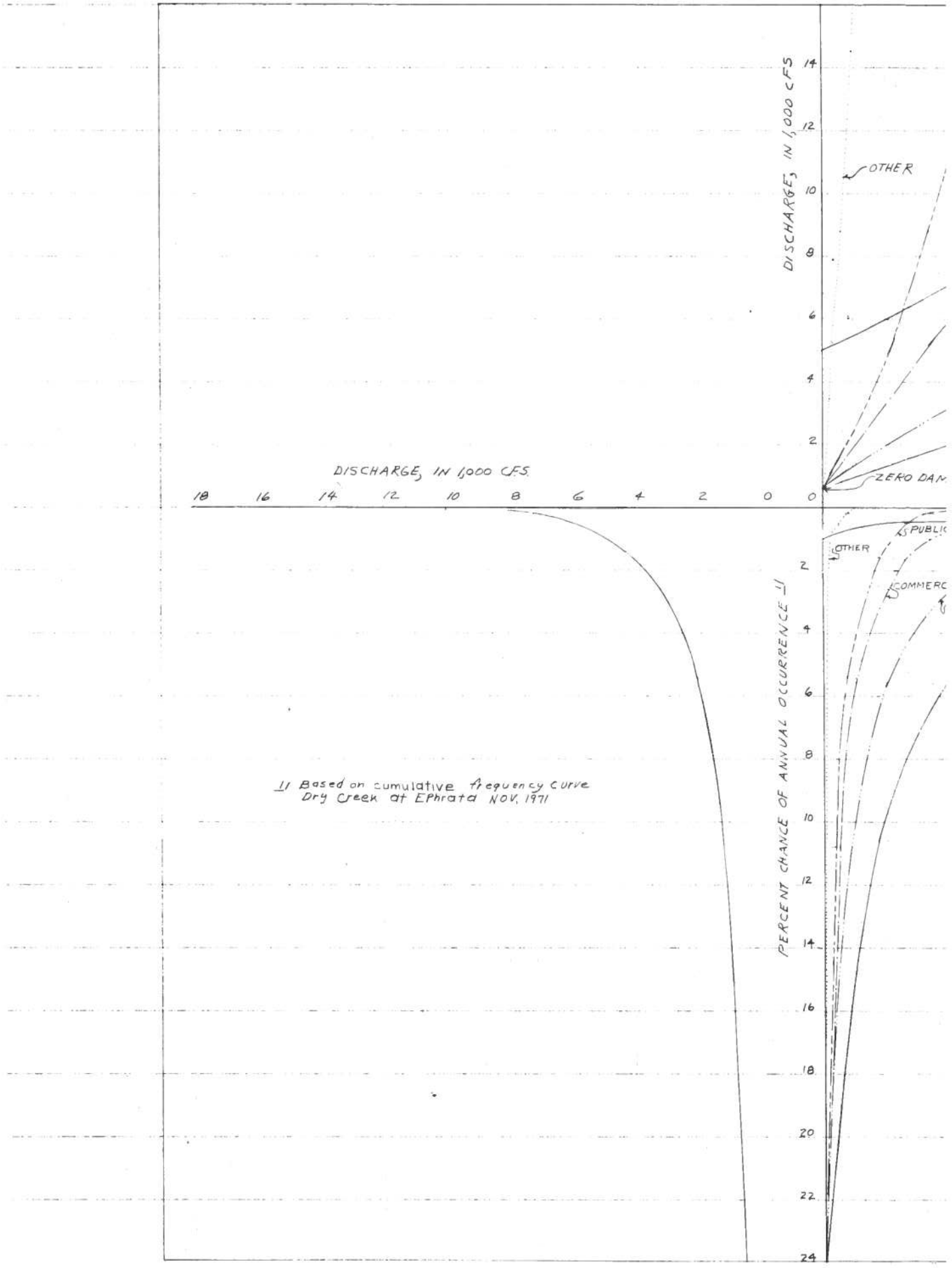
A comparison of project benefits (table C-19) and costs (table C-16) yields the following benefit-to-cost ratios for 50 and 100-year study periods.

	50-year		100-year	
	Primary Benefits	With ARA Benefits	Primary Benefits	With ARA Benefits
Benefit/Cost Ratio	1.4	1.7	1.7	2.0

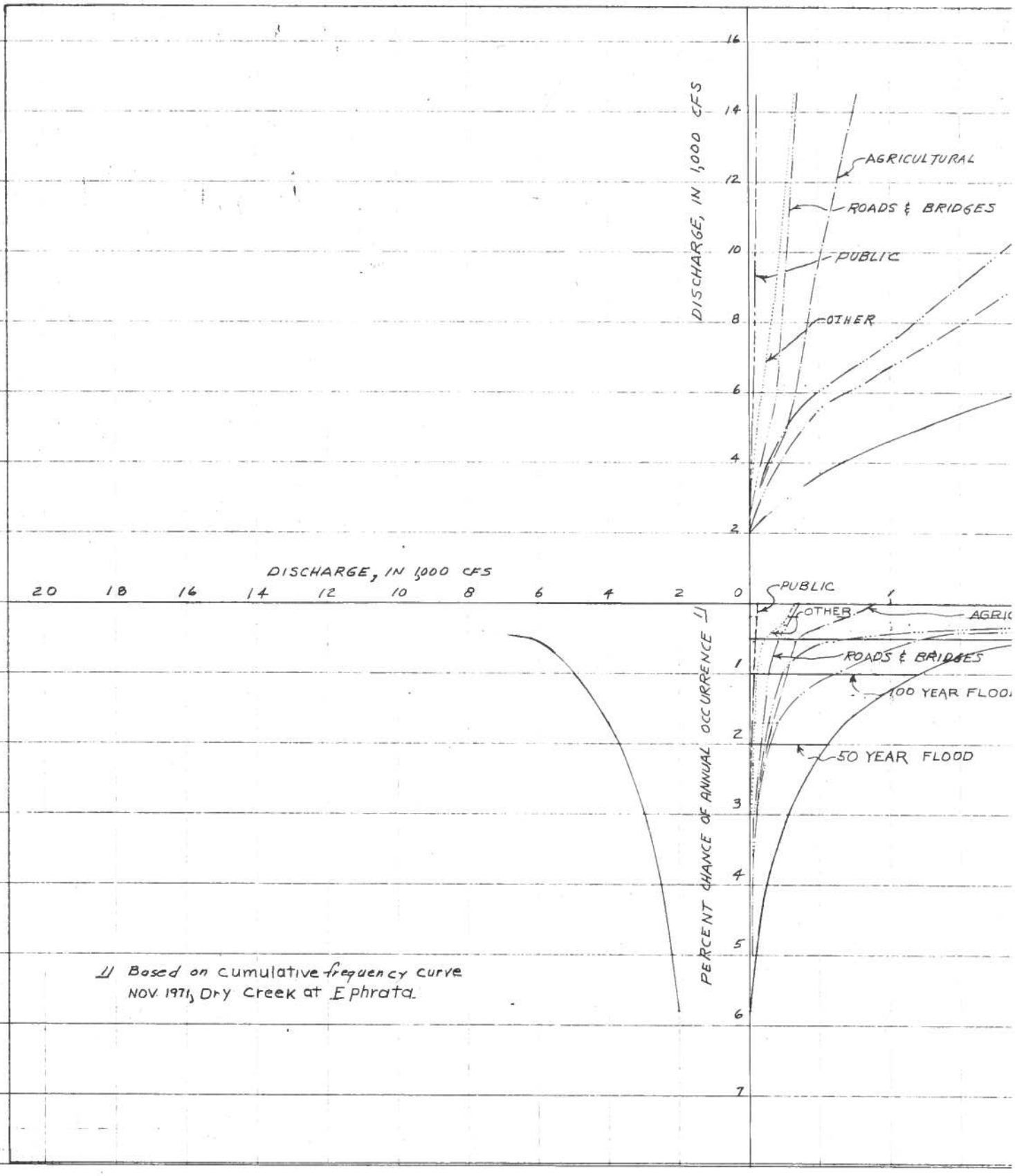
37. Project Maximization

The project providing maximum net benefits for the Ephrata and vicinity flood plain was that providing 100-year protection. Plate C-6 graphically depicts the annual benefit, cost, and net benefit curves for various discharges. The selected project would provide $82,000 in net benefits.


T. 22 N.
T. 21 N.
26.75 Sq. Mi.
Drainage Area
DRY
B E E Z L E Y
H I L
R. 24 E.
R. 25 E.
R. 25 E.
R. 26 E.
SCALE IN MILES
0
2
T. 21 N.
T. 20 N.
G.N. RY.



1/ Based on cumulative frequency curve
Dry Creek at Ephrata NOV. 1971



// Based on cumulative frequency curve NOV. 1971, Dry Creek at Ephrata

REACH I
DRY CREEK @ EPHRATA
AVERAGE ANNUAL DAMAGE AND DAMAGES PREVENTED
1971 PRICES AND CONDITIONS

Damages Preproject Conditions							Damages Prevented By Proposed Levee Project						
1/Discharge (1,000 c.f.s.)	1/Frequency of annual occurrence	1/Damages (000)	Avg. damage for interval (000)	Frequency of interval	Annual damage (000)	Accumulated damage (000)	1/Discharge (1,000 c.f.s.)	1/Frequency of annual occurrence	1/Damages (000)	Avg.damage for interval (000)	Frequency of interval	Annual damage (000)	Accumultd. damage (000)
5.6	.240	0.0					5.6	.240	0.0				
			100.0	.105	10.5					100.0	.105	10.5	
10.0	.135	200.0				10.5	10.0	.135	200.0				10.5
			360.0	.050	18.0					360.0	.050	18.0	
15.0	.085	520.0				28.5	15.0	.085	520.0				28.5
			660.0	.023	15.2					660.0	.027	15.2	
20.0	.058	800.0				43.7	20.0	.058	800.0				43.7
			950.0	.018	17.1					950.0	.018	17.1	
25.0	.040	1100.0				60.8	25.0	.040	1100.0				60.8
			1170.0	.007	8.2					1170.0	.007	8.2	
28.0	.033	1240.0				69.0	28.0	.033	1240.0				69.0
			1455.0	.010	14.6					1455.0	.010	14.6	
35.0	.023	1670.0				83.6	35.0	.023	1670.0				83.6
			1735.0	.003	5.2					1735.0	.003	5.2	
37.0	.020	1800.0				88.8	37.0	.020	1800.0				88.8
			1870.0	.004	7.5					1870.0	.004	7.5	
40.0	.016	1940.0				96.3	40.0	.016	1940.0				96.3
			2120.0	.002	4.3					2120.0	.002	4.3	
45.0	.014	2300.0				100.6	45.0	.014	2300.0				100.6
			2430.0	.004	9.7					2430.0	.004	9.7	
50.0	.010	2560.0				110.3	50.0	.010	2560.0				110.3
			2825.0	.005	14.1					1530.0	.005	7.7	
62.0	.005	3090.0				124.4	62.0	.005	500.0				118.0
			5045.0	.005	25.2					2010.0	.005	10.7	
	.000	7000.0				149.6		.000	3520.0				128.1

1/SOURCE PLATE C-2 & 3.

USE 149.6 (1971 Prices & Conditions)

163.2 (Jan. 1973 Prices & Conditions)

USE 128.1 (1971 Prices & Conditions)

139.7 (Jan. 1973 Prices & Conditions)

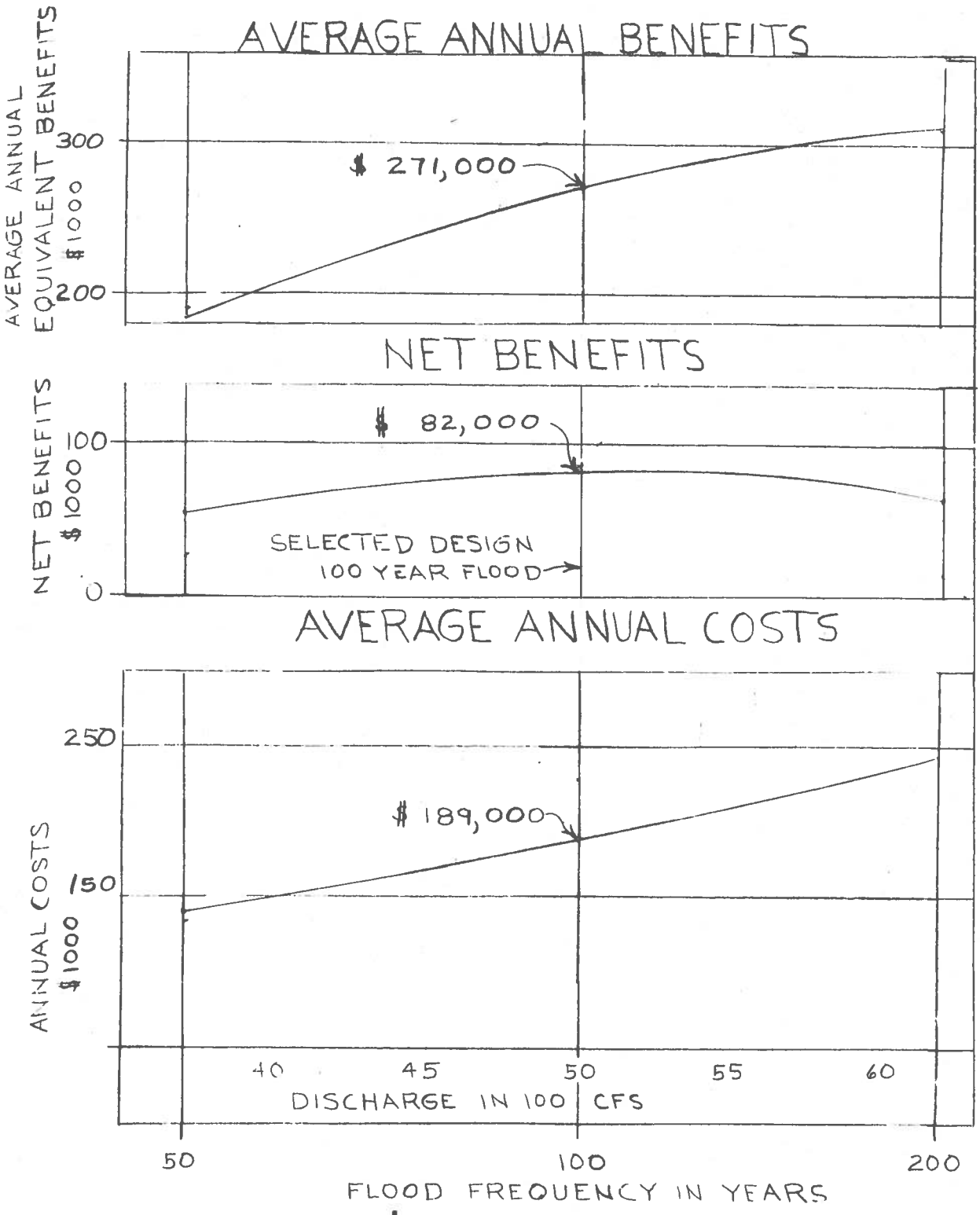
Plate C-4

UPDATE FACTORS FROM DEC 1971 TO JAN 1973

Dry Creek @ Ephrata

Benefit Category	Price Level Index	% In Category	Weighted Index Dec. 1971 to Jan. 1973	Estimated Growth For 1 Year	Aggregate Update Factor
Residential	Consumer Prices-All	80	0.83		
	Bldg Cost-ENR	20	0.22		
			1.05	1.03	1.08
Commercial	Wholesale Prices Finished Goods	75	0.80		
	Bldg Cost-ENR	25	0.27		
			1.07	1.02	1.09
Public Facil Util, Rds, Bridges	Const Cost-ENR	70	0.77		
	Bldg Cost-ENR	30	0.33		
			1.10	1.03	1.13
Agricultural	Prices Paid by Farmers-All	50	0.56		
	Common Labor	50	0.55		
			1.11	---	1.11
Other	Common Labor	60	0.66		
	Constr Cost-ENR	40	0.44		
			1.10	---	1.10

Plate C-5



DRY CREEK
AT EPHRATA, WASHINGTON

MAXIMIZATION CURVES

Sheet 1 of 1 Scale: As shown

U. S. Army Engr. District, Seattle, Wash.

Dr:

Tr:

Ck:

File No.

E-36-1-67

R 12 JUL 73

PLATE C-6

Supplement

DRY CREEK

EPHRATA, WASHINGTON

Information Called for by
Senate Resolution 148, 85th Congress
Adopted 28 January 1958

1. Project description. The recommended plan for protection of the Ephrata-Soap Lake area from flooding of Dry Creek consists of an improved channel from the mouth of Dry Creek canyon to an existing ponding area north of Ephrata plus an outlet channel about two miles long, leading east to a natural swale draining into Rocky Ford Creek. An economic life of 50 years was used for project feasibility analysis.

2. Project costs. First costs and annual costs of the project are shown in the following tabulation.

First costs	
Federal costs	$ 2,630,000
Nonfederal costs	440,000
Total first cost	$ 3,070,000
Annual costs	
Operation, maintenance, and replacements	$ 7,000

These amounts are based on a detailed cost estimate, shown in appendix B of the report, using 1973 price levels and including an allowance for contingencies.

3. Benefit-cost ratios. Economic analyses of project costs and benefits are given in the following tabulation.

	50-year life	100-year life
Economic investment		
Construction costs	$ 3,070,000	$ 3,070,000
Value of real estate donated	5,000	5,000
Total investment	$ 3,075,000	$ 3,075,000

	50-year life	100-year life
Annual charges		
Interest & amortization, 5-1/2%	$ 182,000	$ 170,000
Operation, maintenance, and replacements	7,000	7,000
Total annual charges	$ 189,000	$ 177,000
Annual benefits		
Flood damage reduction	$ 271,000	$ 308,000
Area redevelopment	44,300	41,100
Total annual benefits	$ 315,300	$ 349,100
Benefit-cost ratio	1.7	2.0

4. Intangible project effects. An assessment of project effects is given in the report in section X, "Results of the Investigation." Major intangible beneficial and adverse effects are (a) removal of the flood hazard will create elegibility for Federally-insured loans for improvements in the Ephrata central area, (b) the possibility of occasional, though infrequent, overflow of Rocky Ford Creek banks would serve to keep this environmentally attractive small valley in its presently undeveloped state, and (c) such overbank flow could result in loss of a portion of the duck and pheasant hatch for that year.

5. Provision for future needs. The project constitutes a permanent means for preventing damages from flows up to a 100-year flood regardless of community growth. Flows in excess of a 100-year flood could cause damages in the central Ephrata area, but the degree of damage would be greatly reduced because of the project. A greater degree of protection was not economically justified or desired by local interests and no provision has been made for increasing the degree of protection in the future. The normal margin of safety in the project design probably would allow it to carry in excess of a 100-year flood.

6. Allocation of costs. As the project serves only the purpose of flood control, no cost allocation is necessary. Nonfederal costs consist of the usual local cooperation requirements for provision of lands, easements, and rights-of-way, relocation of utilities, and relocation of streets and roads.

7. Extent of interest in project. The Federal government has an interest in the project from the standpoint of flood damage reduction. The State government, primarily represented by the Department of Game, has taken an interest in helping determine the most desirable point of discharge of flood waters. Local governments, who are sponsoring the project, have offered to meet required local obligations. Letters to this effect from the Mayor of Ephrata and Grant County Commissioners

are included as exhibits at the end of the report. Appendix A, the Public Brochure, depicts the attitudes of numerous concerned individuals and agencies.

8. Repayment schedules. There are no reimbursable costs connected with the project. All nonfederal first costs would be incurred prior to start of construction.

9. Effect of project on State and local governments. No increases in government services would be required as a result of the project other than maintenance of the project itself. The project alone would have little or no influence on local population growth; it is intended to protect and permit full utilization of the Ephrata central area, portions of Soap Lake and intervening lands. No public facilities would be displaced or services reduced by the project. Tax revenue reductions would be negligible. Land to be acquired for the project is nearly all low-yield dry pasture. Flowage easements required are for infrequent inundation of the ponding area, discharge swale, and Rocky Ford Creek valley and would not affect present use of those areas.

10. Alternative projects. Proposals for other means of flood control are described in the report in section IV, "Water and Land Needs and Means," and Section V, "Plan Formulation" and in greater detail in appendix A, the Public Brochure. These proposals comprise flood plain management, watershed land treatment (improved agricultural practices), storage dams in the watershed, and ground infiltration. Those measures are not true alternatives because they either would not be adequate to protect against a 100-year flood or would cost several times as much as the resulting benefits. The only real alternative is a modification of the recommended project in which discharge would be routed to Ephrata Lake instead of Rocky Ford Creek. This alternative was eliminated because of the possibility of overfilling the lake and damaging fishery facilities below its outlet. Use of Ephrata Lake as the point of discharge would add about 10 percent to the cost of the project, chiefly for construction of a channel to the lake. The Washington Department of Game urged use of Rocky Ford Creek in preference to Ephrata Lake.

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