Resource development of minor drainage basins
by Clarence F Gilfeather

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of Master of Science in Agricultural Economics
Montana State University

Abstract:
Small water projects have attracted increasing Interest In recent years. This interest stems from an apparent need for an intermediate type organization for resource development to serve the area beyond which private investments are feasible and the area which possesses adequate resource potential to justify development as all or a part of a Federally sponsored project. This “gap in between" embraces a vast, spatial sector of the West which includes most of the Western Great Plains and mountain foothill areas.

This thesis embodies an attempt to think through the problems associated with resource development and the implications of these as they may pertain to the development of minor drainage basins, it endeavors to place the various elements in the problem into a cause-effect sequence consistent with the definition of resource development aa defined in the introduction to the study. Due to the extensive nature of the problem this paper is confined to the broader aspects of it. It is intended more to provoke interest in the subject matter than to provide specific problem solutions.

Part I Contains this writer's definition of resource development, a definition of the problem situation, and a general description of the problem.

Part II consists of an attempt to search out and define the various elements in the problem and place these in their proper perspective relative to the problem.

The character of the problem area and the situation studied is described in Part III. It contains a benefit-cost analysis along with a discussion and analysis of the organisational and institutional phases of the problem.

The conclusion contained in Part IV consists of a summary of the problem and suggested means for achieving a more effective project organization.

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Approved:

Head, Major Department

Chairman, Examining Committee

Dean, Graduate Division

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PREFACE AND ACKNOWLEDGEMENTS

The need for an action program on an intermediate level between what Federal reclamation is doing and what can be accomplished by individuals acting alone or in small groups to bring additional resources into production has been the subject of numerous dissertations. It is with appropriate humility that this writer undertakes to set forth what he considers to be the elementary factors in the problem and policy objectives that should define direction for public action.

I wish to thank my thesis committee and other members of the faculty of Montana State College for the stimulation they have given me. All individuals and agencies contacted in connection with this study were kind and cooperative, particularly representatives of the Montana State Water Conservation Board who were very helpful.

ABSTRACT

Small water projects have attracted increasing interest in recent years. This interest stems from an apparent need for an intermediate type organization for resource development to serve the area beyond which private investments are feasible and the area which possesses adequate resource potential to justify development as all or a part of a Federally sponsored project. This "gap in between" embraces a vast, spatial sector of the West which includes most of the Western Great Plains and mountain foothill areas.

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PART I

INTRODUCTION TO THE PROBLEM

This study is concerned with the resource development of minor drainage basins. It is directed particularly to the determination of a method to serve as a guide for the development of the minor basins that make up the drainage network of the foothills and plains areas east of the Continental Divide in Central and Eastern Montana.

Resources and Resource Development Defined

A resource is defined as wealth or a productive capacity. Erick W. Zimmerman states, "Resources are not, they become; they are not static but expand and contract in response to human wants and human actions." 1/ He goes on to describe these not as substances or things, but functions performed by substances and things in a production process to satisfy human wants and aims.

Resource productivity is measured in terms of how well functions fulfill needs and aims, or stated differently, in how fully the resource is employed. The extent to which a resource is employed depends on (1) the need for it, (2) the availability of it, and (3) whether or not people know how to use it. A shift in all or any one of these factors will retard or expand resource productivity. Since the demands of society are not static, the level of resource productivity is the state of flexibility by which substances and things respond to suit demands or needs through time. Resource development can therefore be defined as a secular rate of

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1/ Zimmerman, Erick W., World Resources and Industries, Harper and Brothers, New York, Revised Edition, 1951, p. 15.

growth in resource productivity where the increase in growth as measured at any given time is synonymous with the increase in flexibility by which functions are performed to satisfy demands and needs.

Minor Drainage Basins Defined

Minor drainage basins are construed to mean the tributary drainages that are generally by-passed by government investment policy and are too limited in resources to attract autonomous investments of a sufficiently sustaining type to avoid periodic economic and social maladjustments.

The Problem Situation

The problem stems from the relatively low and variable precipitation pattern of the area. Rainfall is not so limited that it prohibits economic use. In some parts of the area large acreages are cultivated and have been for many years. The grasslands provide a highly palatable forage and in most seasons a sizable amount. The problem arises from the production requirements placed upon the land over a period of years in relation to land capability during periods of drought. A type of use or rate of use to secure an average production for a normal rainfall period is marginal when the precipitation falls below normal.

Forced disinvestments follow drought and the fall in land values that accompanies forced disinvestments invites new investments of the same type when climatic conditions improve. In this manner the problem tends to perpetuate itself.

Agricultural units consist of dryland grain farms and range livestock operations largely dependent upon year around range use, or a combination of both. These units lack operational flexibility. There is seldom a

reserve. Relatively few compensatory measures can be exercised to alleviate the impact of drought and particularly drought of three to four years duration. The "rolling up and unrolling" so commonly described in connection with periodic drought is not confined to the agricultural sector. Whole communities and business centers roll up and unroll right along with the farms and ranches.

Early settlers of the Western Great Plains were not long in discovering water to be the limiting factor in both the agricultural and non-agricultural industries. The more stable settlements developed along streams. Agricultural units became established as irrigated farms or ranches using irrigated lands for winter feed bases. The old low water ditch, however, is a thing of the past. Available water supplies were appropriated early. The cost of developing comparable properties has become progressively greater due to the necessity for storage reservoirs to provide a water supply, the need for sizable carrying systems, and the increased cost of farm improvements. For these reasons there has been little expansion of privately owned irrigation systems beyond the headwater areas.

Federal projects do not take up at the point where private irrigation is no longer feasible. These are generally confined to the major drainage ways, are multiple purpose as to aims, and usually do not provide the stability and other forms of opportunity required in areas tributary to the large drainages.

The situation is one of instability which places a ceiling on growth to the future. The root of the problem lies with the inadequacy of existing devices to bridge the gap between private and public investments.

The Purpose of Study and Area Studied

The State of Montana has a reclamation agency, the Montana State Water Conservation Board. This agency carries on an action program for irrigation, rural electrification, municipal water developments, and can provide a variety of other functions for the State as needs dictate. 2/ The Board 3/ was organized in 1933. The primary task at the time of inception was to direct the spending of Federal relief funds in the State of Montana in order to make the highest possible use of these funds.

The Musselshell River Drainage in Central Montana was the object of considerable expenditure of this type and the developments initiated at that time have been expanded upon as a State Water Board project since the termination of the Federal relief program.

It is hoped that through an examination of this State sponsored project and the area involved, a better understanding can be had of an intermediate type government sponsored program as to its potentialities and limitations for meeting the needs of the problem area.

2/ See Sections 89-101, Laws Pertaining to the State Water Conservation Board, State of Montana, Title 89, Chapters 1 and 4, Revised Codes of Montana, 1947.

3/ The Montana State Water Conservation Board.

PART II

ELEMENTS IN THE PROBLEM

Before one can evaluate a problem it is necessary to gain a perspective of the problem, particularly of the inherent factors which contribute to it. This part is concerned with a search of the account in an attempt to place the events in their proper sequence relative to the problem situation. Writers in the field of resources development involving public programing have thoroughly outlined numerous of the more important elements in the problem of resource development. 1/ For the purpose of this study the various factors will be examined in relation to their natural, economic, and institutional contributions to the situation, as well as the social and public aspects of it.

Natural Factors

M. M. Kelso has stated that if any single problematic feature of the West could be reconciled the one which would receive the most unanimous support of the people who habitate the area would be in the form of measures to counteract the effects of the highly variable climate. 2/ The influence which climate exerts is extended to and never absent from all activities of the society including its economic, institutional, social,

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1/ Huffman, Roy E., "War and Post-War Problems of Irrigation Planning in the Northern Plains", The Journal of Land and Public Utility Economics, Vol. XIX, No. 4, Nov. 1943, p. 455.

Cooke, Morris L., et al, "A Water Policy for the American People", United States Government Printing Office, Washington, D. C., Vol. 1, Dec. 1950, pp. 58-61.

2/ Kelso, M. M., "New Directions in Land Economics Research", Journal of Farm Economics, Proceedings No., Vol. XXXI, No. 4, Part 2, p. 1035.

and political characteristics.

Climatic Aspects

Climate is a predominate factor in the economy of the area. First, it effects the availability of input factors from one production period to another. Land is a fixed quantity only as to its spatial character. Under circumstances of variable climatic conditions an input of a given acreage of land is not a concrete quantity. Generally speaking, the amount of land surface available in the short run is static which brings about a variability in land input in direct relation to the climatic conditions that prevail at any given time. The availability of capital and labor tends to follow the land pattern due to fluctuations in income. Inconsistent production has certain secondary effects on agriculture peculiar to that industry since in many instances production from land is an input factor within a single operation. Production in such an instance differs from that usually observed where the entrepreneur is free to select from among varying amounts and kinds of input factors and to allocate these on the basis of function and price. If the farm or ranch operator in the Great Plains area could organize his production accordingly without interference from climatic variation, his major problem - uncertainty in production - would not exist.

Second, agriculture is a high fixed cost and high risk industry due to necessary investments in machinery, land improvements, and livestock in addition to land in order to control an operating unit. Land is not a fixed input under erratic climatic conditions; however, investment obligations are fixed quantities that must be met periodically regardless of

income from operations. The investment condition is aggravated by the fact that farm and ranch operators tend to build up their inventories of land and equipment during favorable production periods and consequently at or near peak prices. This seems to occur due to optimism created by favorable conditions and the accompanying increase in income which makes the purchase of additional inventories possible. In connection with this same problem Rainer Schickle has pointed to the imperfect nature of the real estate market. 3/ Imprefect prices appear equally evident with regard to all other factors of production. The need for a high fixed income in proportion to high fixed costs creates a rate of resource use in the short run that is in excess of resource capability in the long run. This has the effect of increasing risks as well as bringing about a reduction in inventories of input resources at an abnormal rate.

Third, agricultural units lack operational flexibility. Few compensatory measures are available in the event of a drought. Units generally consist of dryland grain farms or range livestock operations which rely on nine or more months of grazing per season, or a combination of both. Consequently either type or any combination of the two is extremely vulnerable to drought and particularly an extended drought. In such an instance the operator is faced with two alternatives. He can liquidate all or some part of his inventory or purchase additional inventories in an attempt to minimize losses. This generally entails borrowing. The availability of

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3/ Schickle, Rainer, and Engleking, Rueben, "Land Values and the Land Market in North Dakota", Agric. Exp. Stat., North Dakota Agric. College, Fargo, North Dakota, June, 1949.

credit coincides almost perfectly with climatic variations and is usually available in limited amounts when needed the most.

Fourth, the health of local business units in a rural economy typical to the problem area relies heavily on the economic status of the agricultural sector. This accounts for the "rolling and unrolling" so commonly described in connection with small urban business centers as a result of precipitation changes. Institutions which normally carry out credit, educational, and other functions reflects the effects of cyclic climate.

The major social problem stems from population maladjustments. First, educational facilities are generally unstable as well as inadequate. Second, there is a constant displacement of population in both the short and long run. This takes place in the short run in the form of forced liquidations as a result of unstable investments and employment opportunities, and to all ages of the population. In the long run a greater part of the younger population is drained off due to necessity in search of employment opportunity. The aged and less talented remain regardless of employment status due to immobility.

One who will concern himself with means and ends with regard to governmental activities must necessarily become concerned with the political aspects of the situation. Only through legislation can ideas be transformed into action programs. The political atmosphere is tempered to a great extent by the general public welfare. During periods of above normal prosperity people tend to forget past experiences and are less interested in major issues effecting their welfare. During periods of

stress they face up to the issues and take a more active responsibility in government. It has been said, and with little doubt justly, that the erratic climate is outdone only by the fickle political atmosphere that accompanies it. This atmosphere fosters cyclic attitudes which take the form of pressures on government during adverse periods to alleviate emergencies which in the eyes of the community obviates the need for long term corrective measures.

Resource Distribution

Resources vary widely both between and within drainage areas. One drainage may head in a heavy snowfall area whereas another may depend entirely on seasonal run-off for water supply. One may be mineralized and the other not. In almost all cases the critical water need is generally far removed from the headwater area. Interests in water over the basin therefore seldom coincide.

The Economic Problem

Resource Allocation

The economics of resource development is an allocation problem. Resource allocation is the concept of inputs to a production process whereby maximum value product is attained from the allocation of a given resource when the values of marginal products are equated in all uses. 4/ There may

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4/ Allen, Edward D. and Brownlee, O.H., Economics of Public Finance, Prentice-Hall, Inc., 1948, p. 138.

be a multiplicity of goods and services and other forms of remuneration derived from the allocation of a single resource. The possibility for alternative inputs is also important to achieve the goal of maximum product for the reason that one cannot assume that the allocation of a single resource such as water will most nearly fulfill demands and needs (maximize value product). 5/ Due to the possibility for alternative inputs value product may be enhanced by certain combinations of inputs. The decisions involved in the allocation of resources in public programing can be likened to those faced by the agricultural or private entrepreneur. He first chooses from among competing enterprises- possible alternatives - and selects that one which promises to yield the greatest net return from the employment of all of his resources. He then combines with the main enterprise selected complementary enterprises which will contribute most to net returns. Next he adds supplementary enterprises as long as these contribute further to the total value product.

M. M. Kelso has pointed out that the essential objective in resource development is to remove critical obstacles to autonomous adjustments of a sustaining type that will provide for a stable resource use. 6/ The most evident deficiency which characterizes the West stems from the inadequate supply and distribution of water. The central problem therefore is to determine the most effective means for correcting this deficiency

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5/ Huffman, Roy E., "Economics of Irrigation Development", an unpublished paper presented at the Thirty-first Annual Meeting of the Agricultural Institute of Canada, June 27, 1951, p. 5.

6/ Kelso, M. M., op. cit., p. 1036.

along with complementary and supplementary measures that will provide for the full employment of all resources within the drainage area including water. The central obstacle to resource development may vary as to time and place both within and between projects undertaken and proposed. Resource allocation must therefore adhere to a marginal and substitutional analysis. "Best allocation" is resolved as a "benefit-cost" analysis. 7/ Though a benefit-cost analysis is complex, it is in principle no more than a process of adding up all benefits attributable to the project on the one hand and all costs on the other. A project is generally considered feasible if benefits equal costs or the ratio of benefits to costs is 1 to 1. Certain alternatives may afford ratios of 3 or more to 1. If projects proposed and successive injections within projects undertaken are selected on the basis of the most favorable benefit-cost ratio, "best allocation" will be realized. The benefit-cost analysis or allocation process is therefore not merely a procedure for assessing the merits of a given situation but consists of a series of propositions to serve as a guide for the allocation process. It is a continuous process of substitution and selection both between and within projects as to time, place, and function.

Financial Versus Economic Feasibility

By the conventional method of irrigation development the irrigation farmer has paid the cost of the water project through the sale of irrigated farm products. Due to the increasing scarcity of irrigation water supplies

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7/ Huffman, Roy E., Irrigation Development and Public Water Policy, The Ronald Press Company, New York, 1953, p. 199.

and land readily accessible to irrigation use, the irrigation farmer is no longer financially able to absorb the entire burden of water resources development. It has been recognized for a long time that there is a demand for the development of water for purposes other than irrigation. It has also become obvious that important benefits accrue indirectly to non-farm groups as a result of increased agricultural production.

Students in the field of resource development have divided the problem into two broad fields. 8 / One is entirely financial in character and is concerned with the dollar economies of providing project facilities to direct consumers of project services. This is the "micro-economic" aspect of the problem and is wholly concerned with gains and losses to individual firms. If it is determined that project costs can be liquidated by net income derived from the direct sale of agricultural commodities and within the limits perscribed by ordinary investment channels the project is said to be "financially feasible". The other aspect of the economic problem involves gains and losses to the society as a whole, including direct consumers of project services, and is referred to as "macro-economics". This latter constitutes the gains and losses to all micro-units which includes all firms, industries, and individuals in the society. This is the concept of the "external economy". It is explained by the fact that all units, including government, are consuming as well as producing units, and the total of all incomes plus the total of all investments will determine to a great extent the amount that will be spent on any single producer's

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8 / Ibid., p. 192.

product, as well as the products that will be available to him for consumption. The total of all consumption plus the total of all investments is equal to the total product. 9/

Evaluation of Benefits and Costs

The more important benefits generally associated with project developments are:

(1) Net increases in income to consumers of project services such as net increases in income to irrigation farmers.

(2) Net increases in business activity due to more farm income and spending along with the "multiplier effect" of the increased business volume. 10/

(3) More stable agricultural production and firmer purchasing power.

(4) New employment and settlement opportunities.

(5) Improvements in community services and facilities.

(6) Improved conservation use of resources and flood control.

There are some important differences in these effects. Any net increase in farm income as a result of an increase in water consumption for irrigation use is clearly a direct gain to the individual farm firm. This type benefit is referred to as a "direct" or "primary" benefit. Other direct benefits may accrue where industrial or municipal water is made available, or for any purpose where a direct allocation of goods or services is involved. Net increases to business accrues indirectly due to increased spending

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9/ Dillard, Dudley, The Economics of John Maynard Keynes, Prentice-Hall, Inc., New York, August 1949, p. 38.

10/ Ibid., p. 98.

for goods and services by the farm sector or by any other direct beneficiary of the project. These type benefits are referred to as "extended", "secondary", or "indirect". Benefits and costs are also classified as "tangible" or "intangible". Tangible effects are those that adhere to dollar measurements. Intangibles have been so designated for the reason that these defy measurement in any monetary sense. Though there are usually a certain amount of intangible effects in all cases involving benefits and costs, intangible benefits are generally associated with the types of effects enumerated as (2) through (6) on page 22 above.

Huffman points out that the question is whether or not it is possible to devise a common yardstick for all instances involving intangibles that can be used alongside the dollar which will be acceptable and free from bias for the measurement of values that cannot be defined in monetary terms and brought within a market value classification. 11/

Direct benefits The measurement of direct benefits is usually developed as a "before and after" or "with or without" analysis by the use of farm budgets for instances involving irrigation. Huffman points out in connection with irrigation that "The residual computed in the budget analysis plus the operation and maintenance cost and increased interest and tax charges resulting from irrigation, which were deducted as a part of farm operating costs, will give a total which is an approximation of the value of water". 12/

The complexity of a farm budget analysis depends on farm unit organization. If it could be assumed that all agricultural units both existing

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11/ Huffman, Roy E., Irrigation and Policy, op. cit., p. 223.

12/ Ibid., p. 197.

and proposed are similar in character as to soils, topography, location, size of unit, and other characteristics, then a common budget would reflect costs and income for the group. Except for isolated instances such circumstances would likely be rare. Water delivery for irrigation purposes might involve a wide variety of circumstances. Some of the more evident considerations that would need to be taken into account in developing budgets are:

(1) Variations in output per unit of input due to differences in the productivity of soils and other physical attributes of the land resource.

(2) Variations in output per unit of input due to differences in size of units. With regard to cattle ranches Kelso states there is little difference in net income per unit capacity within the 150 to 600 animal unit size range which is considered an optimum size range under ordinary operating conditions. 13/

(3) Irrigation in some cases may require pumping systems or new canal systems that will make the cost per unit or per acre higher than for users that can be served by old, established ditch systems.

(4) Irrigation may not increase net income. This especially true of large livestock concerns. The cost of adding unit capacity by means of irrigation may be high in relation to other means for increasing the size of unit.

(5) The addition of an irrigated acreage generally requires additional management and management may already be the limiting factor to higher income.

(6) The financial status of the unit operator may influence income since one who owns all or a substantial equity in his unit is in a more favorable position to improve his unit and bring it into a higher production level.

It is evident that it might be necessary to develop a wide range of types

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13/ Kelso, M.M., "How Much Can A Cattleman Pay per AU For A Cattle Ranch?", unpublished, January, 1949.

of budgets to suit a variety of circumstances to arrive at an approximation of the value of water.

The value of water or other goods and services to municipalities, civic, and other organizations both public and private, is generally based on what is normally spent for such goods and services. The Bureau of Reclamation in connection with their Garrison Division Unit set up municipal rates calculated on the basis of rates of charges typical to the area and for the amount estimated would be consumed annually less annual costs including local installation costs. 14/ This is not a market price but a "determined" price on the basis of prices being paid for the same services elsewhere. Such a method of pricing can be projected to a variety of public services such as flood control programs and state and Federal fish and wildlife programs provided these have specific programs. Benefits to flood control are evaluated in the light of flood damages, frequencies, and sources of flood waters. Game management is closely allied with and commonly includes water shed management out of necessity. Benefits from a cooperative program with other agencies may exceed benefits that can be obtained from an individual project and at less cost.

Indirect benefits Business benefits may vary widely from project to project. First, as Stewart points out the multiplier effect tends to approach zero with successive injections or project expenditures. 15/ Under

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14/ "Interim Information Report, Garrison Division Unit Missouri-Souris Division, Missouri River Basin Project Region 6, United States Department of The Interior, Bureau of Reclamation, October 30, 1953.

15/ Stewart, O.E., "Discussion of The Montana Study of Secondary Benefits From Irrigation Development", Unpublished, September, 1952.

conditions of full employment the multiplier effect ceases to function. Second, business benefits will depend on how much better off direct beneficiaries are as a result of the project. Benefits will not be maximized unless the project provides an opportunity for expansion in incomes to direct beneficiaries. Third, the effect on local non-farm business units will vary with the intensity of the settlement pattern that takes place. A study of two areas having comparable natural resources where the ownership pattern in one consisted of small family operated units and the other of large corporately owned units disclosed the following:

> "There were sixty-two business establishments in the small-farm community compared to thirty-five in the large-farm community. The volume of retail trade was $4,383,000 in the small-farm community as against $2,535,000 in the large-farm community during the twelve months analysed. Expenditures for household supplies and building equipment were more than three times as much in the small-farm community as in the large-farm community."16/

M.E. Marts in a study of local indirect benefits of irrigation, Payette, Idaho, identified and segregated benefits as follows: 17/

Local direct benefits	Local indirect benefits
net farm income	entrepreneurial income
government payments	labor income
farm wages	property income

A summary of the comparative relationships expressed as ratios between the various types of benefits as determined by the study is as follows:

benefits compared	ratio
gross value crop to all	1 to 2.18
direct to indirect	1 to 1.27
direct to all	1 to 2.27

16/ Huffman, Roy E., Irrigation and Policy, op. cit., p. 226.

17/ Marts, M. E., "An Experiment in the Measurement of the Indirect Benefits of Irrigation, Payette, Idaho", United States Department of The Interior, Bureau of Reclamation, Boise, Idaho, June, 1950, pp. 25 - 38.

Marts also found the total value per acre irrigated per capita to be $191 annually, with a total income per capita of $957. The average income for each of the 345 business establishments in the trade area was found to be $30,500.

More community facilities are generally found in a thickly populated community than in a sparsely populated one. The cost of such facilities depends on the tax or consumer base that will support the cost of the facilities. As Stewart has pointed out, increased facilities do not necessarily entail a reduction in the cost of such and may increase costs. 18/ The availability of services obviously has an effect on the consumption of them and accordingly has a direct effect on the level of living within the community. The availability of services may also have an effect on the organization of resources within the community. For example, electricity to the rural may influence the extent of diversification or specialization, and more particularly vertical diversification within and between groups of agricultural units. For these reasons improved facilities can have the effect of increasing the tax and consumption base as well as increasing output of other resource factors and in fact bring about a reduction in the relative costs of facilities.

Production stability is an indirect benefit of significance to all of the society. S. V. Ciriacy-Wantrup 19/ and Arthur C. Bunce 20/ consider

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18/ Stewart, C. E., op. cit.

19/ Ciriacy-Wantrup, S. V., "Private Enterprise and Conservation", Journal of Farm Economics, Vol. XXIV, 1942, pp. 84-86.

20/ Bunce, Arthur C., Economics of Soil Conservation, Iowa State College Press, Ames, Iowa, 1942, p. 81.

insecurity in tenure to be a fundamental reason for the conservation problem. This is explained by the fact that uncertainty to the future causes land users to exploit resources at a rate in excess of long run productivity. Consequently, the value of a water project to conservation use of resources depends on the contribution of the project to the stability of agricultural units. Stabilizing measures may also reduce the need for emergency relief spending. Emergency relief is a contingent liability to the general public which cannot be anticipated either as to time nor amount. It is a high cost means of stabilizing the economy for the reasons that:(1) Too little is usually made available too late to be of any value to small operators or new operators getting started. (2) The public pays for the production they get and at erratic prices due to variations in amounts of production available as well as for production they don't get during short crop periods or during periods of restocking of livestock after a drought period.

Project Organization

The need for and distribution of project facilities such as storage reservoirs and appertinent works depends on what is required to alleviate deficiencies in resource organization. This should be with consideration for existing enterprises and the extent to which a potential can be developed that will attract new settlers, new services, and other forms of investment that will utilize the project. What is believed to be the more important considerations in connection with project organization are as follows:

(1) Multiple-use of resources.

(2) Integration of units of the project on a drainage-wide basis.

(3) Integration of land and water resources.

(4) Analysis of factors effecting sustained resource use.

(5) Analysis of factors effecting the employment of project facilities.

The concept of multiple-use is generally associated with multiple-purpose developments and therefore is of fairly recent origin. It is ancient in actual practice as it represents a natural course of events. people commonly utilize the same land for grazing purposes as for picnicking, and fish from the same stream that water is diverted for irrigation. Forest lands are used for timber production, water production, the grazing of livestock, recreation, and many other purposes.

The watershed is an integral part of the water project since an acre foot of water from the watershed is an input factor the same as an acre of irrigable land or a cubic yard of concrete in the storage installation. To achieve an optimum allocation it may be desirable and necessary to set up a watershed management program as a part of the project at least for the more important water producing areas over the drainage.

The significance of watersheds for water production as compared to other uses was effectively pointed out by the Dairy Farm Manager, Utah State College, during a tour of the College pastures in 1952. He has conducted a series of studies in connection with production from irrigated pastures the past several years. The average production from the pastures has been about 5 tons per acre per year which is the equivalent of 1.67 animal units of feed per acre year long. Less than 2 acre feet of water

per season is used. Total costs including taxes, interest, annual operating expenses, and other costs are approximately $40 per acre per season. The resultant input per animal unit of feed produced is .6 acres of land combined with 1.2 acre feet of water at a total cost of $24 per unit. At an investment cost of $150 per animal unit at 6 percent interest it would cost an additional $9 per year to stock the land. Assuming a cost of $2 per unit for machinery and taxes, the total cost per livestock unit would be $35. Typical costs on a range livestock concern varies from about $40 to $50 per unit capacity per year. Under such circumstances the value of the watershed for water production for irrigation alone exceeds its value for grazing.

Another aspect of multiple-use is the prospect for expanding markets for water along with services allied with water use. There may be many uses for water in addition to irrigation such as municipal, industrial, and livestock water as well as private non-farm organizations and governmental agencies. Since one of the major problems with respect to resource development stems from the cost of installations as compared to returns to the cost of such, allocation to all markets might do much to alleviate the problem of scale.

Water available for use within a drainage basin is dependent upon both the amount and distribution of water run-off. The distribution and operation of project facilities can influence the amount of water available because installations can be made to complement and supplement one another. Downstream storages can recoup return flow water from irrigation. Water can be diverted from a higher to a lower storage when needed. There are a

number of possibilities for improving water distribution, particularly of a complementary nature.

The integration of land and water resources involves the question of the kind of project layout that will best suit the needs of the area. In connection with irrigation Huffman points out that irrigation water may benefit agriculture by increasing the amount of production and stability in production. 21/ He goes on to state that emphasis in the past has been on increased production to limited areas and that only in recent years has much thought been given to stabilizing agriculture as a whole by drainage area. As pointed out above, an integrated project may involve more than the agricultural sector.

Providing supplemental water to deficient areas is one means of integration which has become an established practice. This practice is almost entirely for the purpose of stabilizing production on existing units. This is the ideal solution where the only problem is instability resulting from short water supplies since whatever delivery systems and other improvements needed are generally in and all that is needed is a storage system. Huffman has defined two other types of distribution applicable to basin type projects. 22/ These are "shoe string" and "scattered pattern" projects. The "shoe string" is a long, narrow project the limits of which are usually defined by a natural drainage way. The "scattered pattern" project consists

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21/ Huffman, Roy E., Irrigation and Policy, op. cit., p. 122.

22/ Ibid., p. 132.

of a number of small, isolated irrigation developments all served by the same administrative organization and usually the same source of water supply. Proponents of these type projects say that such organization permits the selection of lands best suited to irrigation, tends to eliminate drainage problems, spreads the benefits of irrigation over a large area, and encourages the adaption of a diversified type of agriculture.23/ What would seem to be the most logical arguments for designing projects along these lines including any combination of "shoe string","scattered pattern", or a supplemental water project on a drainage basis are:

> First, these take advantage of natural factors. The drainage is the water producing unit as well as the natural distribution unit. For these reasons it may be possible to recoup and redivert return flow. The natural channel can also serve as all or some part of the distribution system.
>
> Second, such a pattern will be more likely to provide for a multiple-use of water. It can provide supplemental water to existing units and may be diverted at various points to scattered developments where desired. By virtue of the extensive distribution pattern it is most likely to serve a maximum of water needs such as municipal, recreational, industrial, ect.
>
> Third, multiple demands may afford advantages of scale.
>
> Fourth, Such projects may afford the opportunity for a variety of alternatives. Where the natural stream channel is used for distribution purposes a small pumping plant serving a relatively few users might obviate the need for an elaborate canal system.

Huffman also defines six types of relationships that may result either directly or indirectly from the integration of land and water. These are as follows: 24/

23/ Ibid., p. 132.

24/ Ibid., p. 130.

(1) Irrigated land in combination with an acreage of grazing land.

(2) A ranch operation with an irrigated feed base.

(3) Combination of dryland farming and irrigated production on the same unit.

(4) Exchange of irrigated and dryland feed crops and hay between dryland and irrigation farmers.

(5) Exchange of dryland feeders for irrigation fattening between dryland and irrigation operators.

(6) Exchange of labor between dryland and irrigated units.

A study of 108 farm and ranch operations in Northern Montana in 1949 showed that integration was taking place in the form of autonomous adjustments both within and between units. Of the 108 units studied over four-fifths of these practiced one or more types of integration identified above. 25/

Project planners must recognize a number of cause-effects associated with tenure arrangements that may have a direct bearing on the stability and development of units over the project as well as the conservation use of resources. Heady 26/ attributes the conservation problem to five fundamental factors. These are as follows:

(1) Leasing arrangements where the tenant or landlord does not receive full marginal product from investment.

(2) Capital situations whereby operators must consume now.

25/ Ward, Ralph E., and Kelso, M. M., "Irrigation Farmers Reach Out Into The Dryland", Montana State College Experiment Station Bulletin 464, September, 1949, pp. 35 - 36.

26/ Heady, Earl O., "Principles of Conservation Economics and Policy", Agricultural Experiment Station, Iowa State College, Research Bulletin 382, p. 384.

(3) General economic instability wherein uncertainty about the future discourages conservation.

(4) Situations where benefits are realized in one locality from investments elsewhere.

(5) Situations in which a long period of time intervenes between conservation investments and returns.

It is evident that a project might further the conservation problem rather than alleviate it unless actions taken are with consideration for possible consequences. It is also evident that little progress may take place in many instances unless tenure problems can be satisfactorily resolved.

A review of traditional investments policy with regard to irrigation developments indicates that the underlying assumption has been that returns to the project are maximized at the point of least outlay where autonomous investments in the form of capital and labor are attracted to it. This notion seems to persist among a large segment of the society including some students of resource development even though the history of irrigation development demonstrates that the mere attraction of such investments is not a valid yardstick by which to measure project success. The misconception in connection with this is due in large part to lack of consideration for ripening costs. Ripening costs are defined as the costs of taking land out of one use and placing it to a higher use. 27/ During the period of transition from the old to the new use costs incurred are mainly for the new use and income during the adjustment period is from the old, lower, use. This income lag between the time of investment and any financial remuner-

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27/ Ely, Richard T., and Wehrwein, George S., Land Economics, The Macmillan Company, New York, 1947, p. 149.

ation from the land limits the financial responsibility that can be assumed and accordingly the amount of investment in it. Ripening costs are significant in agriculture because it is a high fixed-cost industry. This is especially critical with regard to the development of raw land for irrigation since the land must be cleared, leveled, and often drained prior to any production from it. An optimum production from irrigation also requires substantial investments in buildings, machinery, and in most instances livestock.

The Wheeler-Case program of 1940 took a revolutionary view of ripening costs. Policy under the program was to carry out such activities as land leveling, drainage, and to provide various other on-farm improvements right along with the development of irrigation storages and delivery systems. A study of factors effecting rates of asset accumulation on irrigated farms in Montana in 1950 shows that considerable more progress is made by settlers on units where substantial amounts of on-farm improvements are made prior to the date of settlement. 28/ It was found by the study that settlers on "pre-developed" units controlled resources valued at $37,500 whereas operators on units developed in the conventional manner controlled resources valued at $18,800 after a similar settlement period.

It is evident that water is only one of several inputs that may be necessary if a project is to achieve an orderly settlement and a substantially

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28/ Stewart, C.E., and Myrick, D.C., "Control and Use of Resources In The Development of Irrigated Farms Buffalo Rapids and Kinsey, Montana", Montana State College Agricultural Experiment Station Bulletin 476, October 1951, p. 70.

high rate of return from the land in less than a 15 or 20 year period.

Land speculation effects the price that must be paid for land prior to settlement. Speculation follows directly in the trough of expenditures on project facilities and is made possible as a result of such expenditures. Any increase in land values due to the potential created by the project investment becomes capitalized in the value of the land and the settler and the project loses the financial advantage created by it. This is true for the reason that unless development affords some investment attraction there is no financial potential and accordingly little or no activity in speculation.

It should be noted that speculation is not confined to persons specifically following that profession. Large land owners commonly fall heir to sizeable acreages of irrigable lands and the land is held at prices in excess of dryland values.

Various anti-speculation measures have been adopted. The Columbia Basin Project of the Bureau of Reclamation provided for the purchase of "excess lands". 29/ Those lands that were not purchased by the Government were sold at Government appraised prices. 30/

It is evident from the foregoing that there are two broad considerations in connection with project layout or the manner in which resources should

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29/ Lands in excess of acreages allowable under Federal reclamation law. Further reference to "excess lands" in connection with this study is construed to mean lands in excess of unit needs or the amount that can be effectively utilized by the owner in connection with his operation.

30/ Lawrence, James E., et al, "Missouri Land And Water", The Report of The Missouri Basin Survey Commission, United States Government Printing Office, Washington, February 1953, p. 205.

be organized. First, it is necessary to determine the most effective types and arrangements of project facilities to provide the kinds and amounts of services needed. Second, supplementary and complementary inputs should then be added to provide for the full employment of all resources. These may be either financial or institutional in nature or both. A project is productive only to the extent that it makes new resources available in amounts and in combinations that will provide for a full employment of all resources under the project.

Benefit-Cost Analysis

The benefit-cost analysis embraces a detailed summary of all effects to be anticipated as a result of the project. It necessitates a "micro-economic" analysis for several reasons.

(1) The primary purpose of the project is to afford greater economic opportunity to potential consumers of project services. Resources must therefore be allocated in such a manner that users can establish themselves on productive units and on a sustained basis.

(2) The "multiplier effect" on the external economy as a result of a project investment hinges on the premise that an increase in direct income from the sale of goods produced by the project will create a money injection into the economy as a whole.

(3) Supply does not create its own demand. Unless the public can and will utilize services and goods in amounts to be provided by the project the project will create no useful potential.

Project analysis entails a "macro-analysis" since the summation of all individual losses and gains including direct beneficiaries is the net public effect and by which project feasibility is determined.

And finally, by an analysis of net public effects it is possible to set up a series of propositions in the form of benefit-cost ratios to

guide the allocation process and determine what actions are most nearly in the public interest.

Cost Allocation

Cost allocation involves the problem of who pays and how much toward the retirement of project costs. The more prominent theories are based on the notions that (1) joint costs should be allocated on the basis of facilities used for each purpose the project serves, and (2) joint costs should be allocated in accordance with amounts of benefits accruing to each purpose. 31/ The first would be the most convenient method particularly where a single resource such as water would be allocated to a relatively few purposes. One writer has pointed out that such a method could be likened to a department store where items are priced in relation to the floor or counter space occupied by them. 32/

The distinction between local and non-local benefits is important from a public viewpoint since a project selected for development may offer little or no more from a general public standpoint than certain other alternatives.

Due to the difficulty of identifying project effects of an intangible nature and the extensive distribution of benefits, cost allocation is far from an exact science. Some writers hold the view that all projects should be entirely self liquidating and should therefore involve the expenditure of little or no public funds. 33/ Others maintain that the public should

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31/ Huffman, Roy E., Irrigation and Policy, op. cit., p. 208.

32/ Ibid.

33/ "Task Force Report on Water Resources Projects", Appendix K, prepared for the Commission on Organization of the Executive Branch of the Government, January 1949, p. 28.

contribute 50 percent or more to repayment of project costs. 34/

Information indicates that returns to the Federal treasury from water resources development may be sizeable in proportion to public funds that have been spent in the past. According to Bureau of Reclamation reports a fully developed and equipped farm unit will support a farm family of four which will in turn support eight families of four. Each of the nine families spends $4550 through retail channels and contributes $1250 in Federal taxes per annum. 35/ This is a total annual income to the Federal treasury of $11,250 attributable to a single irrigated farm unit. This amount if amortized for 20 years at 4 percent interest would justify a Federal expenditure of slightly over $150,000 per irrigated farm unit from tax returns alone. This same amount amortized for 40 years would provide for an expenditure of about $225,000.

Conservancy district laws have been adopted by a number of states for the purpose of facilitating repayment to project costs from local sources. The principal criticism of conservancy districts as they have been used to date is that revenues raised in this manner have been negligible compared to benefits received. This is evident with regard to the Bureau of Reclamation's Garrison Project in North Dakota where approximately one and one-half percent of the annual cost of the project is to be supported by the district. 36/ Such a contribution by the district would imply that the

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34/ H. R. 2646, 82nd Congress, 1st Session, February 14, 1951

35/ Hansen, Robert R., "Prairie Dogs Vs. Prosperity", Roundup Edition, The Denver Post, January 16, 1955.

36/ "Interim Information", Bureau of Reclamation, op. cit., pp. 134 - 139.

ratio of direct farm benefits to local non-farm benefits is 1 to .045 which represents a relatively insignificant amount of secondary benefits.

Cost allocation to irrigation users would be expected to be a problem in many instances due to the variability in the value of water over the project. The value of water might be expected to range from a low of $3 or $4 per acre foot to a high of $12 or $15. To be equitable the assessment would need to reflect such differences. A variable assessment rate might be applicable between units of the over-all drainage project if undertaken at various stages of the development as to time and place. It is doubtful if a separate assessment could be set up among farm units of a single project unit. In order to establish an equitable assessment in such instances it would appear that the most effective approach both from the viewpoint of maximizing benefits as well as cost allocation would be to initiate measures to equate the value of water from unit to unit rather than to set up a variable water charge. This might be accomplished by adjustments in acreages of units in so far is possible and through such acts as the extension of credit or by direct expenditures to improve soil productivity, technical assistance, or any combination of these.

Public Aspects of Resource Development

If public programing is to be carried out in the public interest it is necessary to identify the public and its aims. Identification of public and private interests involves a "micro" (private) and "macro" (public) analysis similar to the delineation employed in economic theory. Individual gains and losses are private in effect, whereas gains and losses to all individuals combined is a public concern.

Identification of the public and its aims is a difficult task for several reasons:

(1) The public is not made up of a single group of individuals. The public is more readily identified as a large number of groups that are highly variable as to size, distribution, and interest. These special interest groups are generally of a state, regional, industrial, or of other special nature.

(2) A private interest group may assert itself in such a way and in such amounts that it appears to represent a general public effort. If such is effectively organized it may in fact carry with it a sizeable public support even though it is essentially private in effect.

(3) The public interest is difficult to define because it is usually of an intangible character. Most private interests can be defined in monetary terms. For instance, a tract of land that commands a certain monetary value for grazing purposes may be of critical value and of a character which lends itself to administration for water production. The latter is hard to evaluate in monetary terms and though it may be by far the highest use, emphasis is generally placed on the more tangible value as it represents an effective dollar demand as to time, place, and amount.

Accordingly, the formulation of program objectives must be guided by judgments based on more or less established value premises as evidenced by the society through time. The more generally accepted criteria identified with the public welfare are: economic efficiency, opportunity, freedom, economic progress, and equality of distribution and income. Though there is obviously considerable conflict among and between these aims, a problem situation must be defined in terms of them and consequently actions must be guided by them.

Institutional Aspects of the Problem

The institutions of a society prescribe the means by which it can act to carry out its numerous activities. Resource organization and product-

ivity depend on how effectively institutions provide for resource use to satisfy the aims of the society. Institutions are the organizational framework within which functions are performed in the development process and are therefore in themselves resources. Notions about how to accomplish given tasks become established by law and custom. Since the demands and needs of a society are constantly undergoing change there is a continual need for new notions and ideas and a revision of those that have become established through practice in the past. There are consequently two broad aspects of an institutional nature. First, it is necessary to continually search out and advance new ways of doing things as conditions change. Second, old laws and customs need to be discarded to the extent that these have become obsolete and to be replaced by techniques that satisfy existing needs.

Existing Organization

Except for Federal multiple-purpose projects, water resources development has been confined to irrigation and carried out on an individual or small group basis financed primarily by private capital. This type organization has failed to meet needs in recent years for several reasons.

> First, the development of small, isolated irrigation projects is seldom financially feasible. This condition stems mainly from water scarcity. The cost of facilities necessary to control and divert new water supplies is high compared to the value of production from irrigation.
>
> Second, the appropriation doctrine by which rights to the use of water developed no longer serves as a vehicle to expand water use. So long as water was available the idea of prior rights served to establish property rights in water to insure the right to continued use of it. This encouraged an early expansion in water use. The present problem, however, is not one of dividing a scarce good but one of creating a scarce good.

> Third, there is an increased demand for water for purposes other than for irrigation. The need for municipal and industrial water has become an acute problem in many areas. There is also an increased demand for water for other purposes. Due to population growth, increased population mobility, and demands for more leisure, there is an apparent need for additional recreational facilities.
>
> Fourth, water producing areas have become far removed from water consuming areas in most instances. This condition has given rise to the need for such organization as inter-state water compacts in order to apportion the scarce water supply.
>
> Fifth, due to technological changes that have taken place in both the farm and non-farm sectors of the society more emphasis is being placed on the need for the development of resources allied with water use such as electrical services.

The Federal Government has initiated programs in recent years to facilitate water conservation and use on an extensive basis. These are limited in scope as they are confined to individual and small group actions. Though their contributions to water production and conservation are widely recognized these can exert very little influence over stream flow and water distribution beyond the limits of individual ownership boundaries. The problem of water development and distribution as it exists today is a water management task on a drainage wide basis.

The Problem of Functions

Functions are executed by institutions both public and private. These are generally carried out for a single purpose. They are initiated in the development process as input factors and are accomplished by engineers, credit agencies and concerns, and hydrological, soil, and economic analysts, to name a few. The emphasis in the past has been on engineering functions due to the apparent need for sound engineering layout. The result has been that institutions and particularly engineering concerns and agencies

have defined resource development problems in terms of institutional capabilities rather than in terms of the problem itself. Consequently, the action has too often defined the problem, whereas, the problem should define the action or actions required to achieve desired adjustments. This condition carries with it all of the implications of economic and social mal-allocation and mal-adjustment.

It is common knowledge that agencies overlap to some extent in their abilities to accomplish certain tasks. It is also known that institutions both public and private vie with one another for public funds and the opportunity to administer these. The situation is not usually one of determining what function is needed. The concern is that of integrating a group of tasks many of which are highly technical in function and which embraces a number of specialized institutions.

Outdated Institutions

A law or custom becomes an antiquity when it no longer serves the purpose for which it was intended. Such institutions tend to persist through time and are difficult to discard for several reasons.

> First, as M. L. Wilson points out, generalized ideas of right and wrong become associated with established laws and customs. One who would strive for institutional change is considered to impinge directly upon a whole array of established concepts ranging from the physical to the economic and moral. 37/

> Second, obsolete institutions generally do serve some purpose even though they do not serve the purpose for which they were originally adopted. For example, considerable land is being

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37/ Wilson, M. L., "Beyond Economics", Year Book of Agriculture, United States Printing Office, 1940, p.927.

irrigated by private companies and state irrigation districts though these no longer serve the purpose of expanding water use to any significant extent. There is therefore a continuous conflict between those that have been served in the past and are yet being served by existing institutions and those needs the institutions are no longer suitable to satisfy.

Third, institutional changes are generally accomplished by legislative action. Except during periods of strife such as periods of extended drought whereby established institutions disintegrate, legislators tend to adhere to a conservative view in harmony with old, established practices. 38/ This condition is agravated by legislative actions during short run emergencies which takes the form of emergency relief payments to minimize losses to established concerns. It seems to require a national emergency to awaken the society to the fact that certain cause-effects adverse to the welfare of the society may be wholly or partially due to the inadequacy of existing institutions.

Laws and customs provide the framework by which ends can be realized. One writer has pointed out, "It is the process that counts. If the means are faulty, the objective will not be satisfying even if reached". 39/ Actions rarely achieve ends in a dynamic society as these are reformulated from time to time. Actions taken in the interim prescribe the rules by ~~rules by~~ which the society lives and are therefore, in themselves, important ends.

Public Action Agencies

There are a number of public agencies and institutions concerned with resource development in Montana. The more important of the agencies are the Montana State Water Conservation Board, the Farmers Home Administration of the Farm Credit Administration, and the Soil Conservation Service.

38/ Schlesinger, Arthur M. Jr., The Age of Jackson, New American Library, New York, Abridged Edition, 1953, p. 141.

39/ Huffman, Roy E., Irrigation and Policy, op. cit., p. 187.

The Montana State Water Conservation Board

The purpose of the Act as set forth by section 89 - 105 is to meet, in so far as possible, a state-wide need for the conservation and use of water, through the construction and operation of projects designed for such purposes. The Board is impowered to make such investigations as may be necessary to plan and carry out a comprehensive state-wide program as may be required. 40/ The objectives of the Act as contained in section 89 - 130 of the Act are to (1) enhance the welfare of agriculture, (2) facilitate trade and industry, (3) promote the conservation development of resources including electrification, (4) resuscate and revive the mineral industry, and (5) generally promote the welfare of the State and Nation. 41/ Section 89 - 128 provides that, "This act, being necessary for the welfare of the state and its citizens, shall be liberally construed to effect the purposes hereof". 42/

The Act provides that the Board shall make estimates of the costs of projects including operation and maintenance costs and that revenues from the project shall be sufficient to pay the cost of maintaining, repairing and operating the project. Construction is financed through the maintenance of a revolving fund and by the sale of bonds. The revolving fund is

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40/ "Laws Pertaining To The State Water Conservation Board, State of Montana, Title 89", revised codes of Montana of 1947, issued by the State Water Conservation Board, Helena, Montana, undated, p. 6.

41/ Ibid., p. 20.

42/ Ibid.

maintained by state appropriations, proceeds from sales, grants, interest earned on securities, and income from associations 43/ in excess of operating and maintenance charges. The Board is a body corporate and may buy, sell, or otherwise dispose of any property owned by it. Such property may also be used as collateral for bonds.

The Board is authorized to carry on a variety of kinds and types of functions. The Act is very comprehensive in this respect. Functions that may be executed persuant to the provisions of the Act are inumerated as parts (a) through (y) section 89 - 132 of the Act. 44/ These provide among other things that the Board can negotiate and enter into contracts and agreements with other agencies, governmental units, and private concerns in order to affect the aims of a program.

The Soil Conservation Service

The program of the Soil Conservation Service is organized by districts under state law. This service is concerned with water shed management which includes water production and utilization. The latter may and commonly does involve land development for irrigation purposes. The water shed management aspect of the work is very essential to any water development program to maintain and possibly improve water production on the water sheds. Their contribution is mainly of a technical or advisory nature which is badly needed in connection with irrigation developments during both the planning and settlement periods of the project. The program also supplies incentive payments to cooperators which helps to reduce the burden of ripening costs.

43/ Water users associations.

44/ "Laws Pertaining to Water Conservation Board", op. cit., p. 21.

The Farmers Home Administration

The Farmers Home Administration makes loans to farm and ranch operators. These loans are of three types namely; operating, realestate, and water facilities loans.

A single individual can hold both an operating and realestate loan in the amount of about $23,000 provided the security and personal risk involved warrants such an amount. Loans by the Agency are usually for 100 percent of security value. Due to this reason loans usually require close supervision as well as managerial assistance in some instances.

Water facilities loans are available in amounts up to 100 thousand dollars. These are made to both individuals and small groups. The Agency is in a good position to bargain with regard to project 45/ organization and controversies between water users such as water rights since the Agency can withhold loan funds until a solution satisfactory to the Agency has been reached. The major problem of the Agency is their dependance on Federal appropriations. The Agency can insure loan funds extended by private individuals and concerns which gives it some latitude provided such individuals or concerns are interested in this type investment or wish to participate in the development of the water resources of the area.

45/ Meaning water facilities loan project.

PART III

RESOURCES AND RESOURCE DEVELOPMENT OF THE MUSSELSHELL RIVER DRAINAGE

Surveys and Reports

There have been several reports completed on all or some part of the Musselshell River drainage. Two cover the entire drainage. 1/ There are a number of reports confined to particular sections, the most recent and notable being the detailed water resources surveys prepared by the Montana State Engineer's Office. 2/

Characteristics of Area

Location

The Musselshell River is located in Central Montana. The drainage area includes Wheatland, Golden Valley, Musselshell, and Petroleum Counties in addition to portions of Meagher, Fergus, Garfield, Park, Stillwater, Sweet Grass, and Rosebud Counties. It covers a total of approximately 9,400 square miles. The river rises in the Little Belt Mountains in

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1/ See (1) Iakisch, J. R., "Report of Investigation of Irrigation Projects, Musselshell River, Montana", Dept. of Interior, U.S.B.R., 1932.
(2) "Proposals For a Water Facilities Area on Musselshell River Drainage Basin in Central Montana", Water Utilization Section, Division of Land Economics, Nov. 1941.

2/ See (1) "State Engineer's Water Resources Report", reports by county for Meagher, Wheatland, Golden Valley, Musselshell, Rosebud and Stillwater Counties.
(2) LU-MT reports available at Montana State College Library.
(3) Geisker, L. F., "Soils Survey By Counties", Montana State College Experiment Station Bulletins.
(4) Munns, F. K., "Soils Survey of the Upper Musselshell Valley Area, Montana", U. S. Dept. of Agriculture in cooperation with Montana State College Experiment Station, Series 1939, No. 1, November 1942.

Meagher County and flows approximately 185 miles east to a point near Melstone in Musselshell County where it turns north for 90 miles to its confluence with the Missouri River. It drains from a total of seven mountain ranges.

Climate

This area falls within the rain shadow of the Rocky Mountains. The climate is continental in character with light rain showers and heavy "gully washers" coming largely in the growing season. For climatic summary see Table I.

Population

This was one of the last areas in the State to be settled. Livestock operations were extended into the valley from 1860 to 1880. Dryland farming reached a zenith in 1918. The bulk of the settlement was undertaken during a period of unusually favorable rainfall and mass liquidations came with the change in prices and climate following World War I. 3/ Population numbers derived from Bureau of the Census data for the past four decades are as follows:

1920	33,000
1930	22,500
1940	18,500
1950	14,500

The principal towns, county in which each is located, and the 1950 populations are:

3/ Archer, E. H., and Lingo, S. M., "Institutional Adjustments Survey, Central Montana Land Utilization Projects, Musselshell and Petroleum Counties", LA-MT-3 and LU-MT-38-3, Roundup, Montana, January, 1940, p. 1.

Table I - Climatic Summary for Various Stations in the Musselshell River Drainage

Station	Elev. (ft.)	Precipitation (inches)			Temperature (F°)					Killing Frost (average)		Growing Season
		Ave. ann.	Max. ann.	Min. ann.	Mean ann.	Jan. ave.	July ave.	Max. record-ed	Min. record-ed	Last	First	Ave. Days
Findan	6000	17.55	21.54	11.86	40.4	22.4	62.4	96	-37	5/22	9/22	123
Martins-dale	4820	15.57	21.89	10.71	42.1	22.4	64.6	104	-52	6/1	9/5	96
Harlow-town	4240	11.57	16.31	6.22	40.8			100	-46	6/6	9/5	91
Rye-gate	3640	14.82				28.1	59.8	109	-49	5/22	9/12	97
Roundup	3236	14.96			59.1	32.1	45.6			5/9	9/29	143
Mel-stone	2897	12.53			46.2	32.4	60.1			5/6	9/22	139
*Flat-willow	2950	11.88				21.1	70.2	107	-48	5/18	9/25	130

Source: "Water Resources Survey", Musselshell, Golden Valley, Wheatland, and Meagher Counties, 1949.
* Year Book of Agriculture, United States Government Printing Office, 1941, pp. 956-58.

Town	County	1950 Population
Roundup	Musselshell	2,760
Harlowtown	Wheatland	1,740
Winnett	Petroleum	400
Ryegate	Golden Valley	350

Resources of the Drainage Area

Agricultural Resources

Land-use disposition by type, ownership, and county is shown by Table II.

Dryland wheat is by far the most important crop and is exceeded only occasionally in some areas by grain hay. Wheat acreages and the general pattern of production for the years 1920 through 1950 for the four counties falling entirely within the basin are shown by Table III. Production has varied widely from year to year as acres planted have expanded and contracted over a period of years. Acres harvested vary annually.

Dryland hay production along with total hay production in tons for four consecutive five-year periods for these same four counties is shown by Table XII below. In spite of the fact that much of the wheat acreage is cut or salvaged by clipping for hay during the low production periods, hay tonnage has varied greatly. It can also be noted by reference to Table IV that livestock numbers were sharply on the increase at times when there was very little hay for wintering. Dryland hay acreages are again on the increase as can be seen by Table XII.

The rangeland capacity of the drainage is estimated at 1,375,000 animal unit months of feed, 4/ or an average of about 3 3/4 acres per anim-

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4/ 1/12 the requirement for 1 animal unit (AU) on a year-long basis. An AU is 1 wet cow, 1.2 two year old steers, 1.4 yearlings, .8 bulls, or 5 sheep.

Table II - Acres, Ownerships, and Land Use Types, by County, Musselshell River Drainage

County	(1) Irrigated Reg.	(1) Irrigated All	(2) Dry Farm	GRAZING (3) Private	GRAZING (4) Natl.For.	GRAZING (5) Federal	All Grazing	TOTAL ALL
Meagher	12,250	13,060	2,000	218,714	162,033	18,263	399,010	414,070
Wheatland	23,900	36,610	60,000	731,257	80,640	3,493	815,390	912,000
Golden Valley	2,680	5,140	90,000	619,926	26,877	11,977	658,780	753,920
Park					6,400		6,400	6,400
Sweet Grass			300	114,900	10,200		125,100	125,400
Sweet Water				69,760			69,760	69,760
Mussel-shell	5,750	7,850	85,000	952,864		126,686	1,079,550	1,172,400
Rosebud		200	1,197	138,863			138,863	140,260
Garfield		400	19,150	415,550			415,550	435,100
Petroleum	5,300	9,000	55,000	584,973		416,237	1,001,210	1,065,210
Fergus	2,500	5,000	91,555	661,646	34,300	99,419	795,365	891,920
	52,380	77,260	404,202	4,508,453	320,450	676,075	5,504,978	5,986,440

Source: (1) State Engineer's Reports where these are available. Petroleum County taken from assessment records; Fergus County estimated by Extension Service Representative.
(2) Estimated from data of acres harvested and planted for past several years.
(3) Includes county lands which are at present negligible.
(4) Obtained from Stations at Martinsdale and Lewistown.
(5) "Proposal for Water Facilities Area on Musselshell River Basin in Central Montana", Water Utilities Section of Land Economics, Nov. 1941.

Table III - Wheat Acreages (thousands of acres) and Wheat Yields (bushels) for Four Counties in the Musselshell River Drainage, 1925 through 1949.

19-	WHEATLAND				GOLDEN VALLEY				MUSSELSHELL				PETROLEUM			
			Yield				Yield				Yield				Yield	
	A.P.*	A.H.**	A.P.	A.H.	A.P.	A.H.	A.P.	A.H.	A.P.	A.H.	A.P.	A.H.	A.P.	A.H.	A.P.	A.H.
25	37.5	36	8.7	9	48.2	40	6.9	8.4	44.8	40	7.5	8.4	11.9	10.5	8	9
26	35	35	11.2	11.2	49.7	48	8	8.3	50.7	50	7.2	7.3	11	11	7.5	7.5
27	36	36	13.2	13.2	34	34	17.9	17.9	49	49	19.3	19.3	10	10	16.4	16.4
28	25.1	24.9	12.9	13	42.6	42.2	10.2	10.3	46	45.6	11	11.1	27.8	27.7	12	12
29	21.5	20.8	5.2	5.4	33	31.9	4.9	5.1	40	38.8	5.7	5.9	25.5	24.9	5.3	5.4
30	22.1	18.1	4.8	5.8	31.5	27.6	4.5	5.2	47.2	42.5	3.5	3.8	23.8	20.9	3.9	4.4
31	23.4	14.7	3.1	5	25.5	15.6	4.4	7.2	41.8	26.2	4	6.4	23.5	14.4	2.4	3.7
32	22	21.1	6.4	6.6	39.5	38.4	12	12.3	48.7	46.3	10.6	11.1	27.2	25.9	11.6	12.2
33	18.6	14.3	3.8	4.9	27.4	23.6	3.9	4.6	21.9	18.3	5.6	5.8	23.5	20.2	6	7
34	9.6	7	4.8	6.6	16.2	16	5	5.1	24.1	20.5	2.8	3.3	10.9	9.4	4.7	5.5
35	17.4	13.4	6.1	7.9	18.2	15.1	4.4	5.3	27.5	16.6	3.4	5.6	14.1	11.1	3.9	4.9
36	22.8	7.5	1.9	5.8	25.9	11	2.1	5	32.4	9.9	1.1	3.6	20.3	6.5	.7	2.1
37	14.1	11.1	6.5	8.2	21.1	17.2	4	4.9	24	15.9	3.4	5.2	14.6	7.2	2.7	5.5
38	14.9	14.6	14	14.3	29.5	28.7	20.5	21.1	28.1	27.3	16.4	16.8	13.4	13.2	9.4	9.6
39	10.7	9.6	8	8.9	20.2	19.9	11.3	11.5	23.7	22.1	10.1	10.9	9.8	5.9	6.9	11.5
40	12.9	9.7	5.3	7	22.7	19.6	7	8.1	24	22.5	9	9.6	9.6	6.3	4	6.1
41	9.7	9.3	13.2	13.7	21.5	20.8	17	17.6	22.4	21.6	13.7	14.2	7.3	6.3	8.1	9.4
42	9.6	9.5	17.2	17.3	19.5	19.3	16.9	17.1	20.6	20.3	19.6	19.9	6.9	6.8	19.7	20
43	10	9.9	12.4	12.5	21.5	20.5	15.1	15.8	22	21.6	15.7	16	7	6.8	11.7	12
44	10.2	9.5	12.6	13.5	25.5	23	13.9	15.4	23.7	22	14.5	15.6	8.4	7.6	11.3	12.5
45	10.1	9.4	12.2	13.1	25.1	23.5	15.9	17.1	18.5	17.6	14.3	14.9	9.3	8.6	10.4	11.3
46	7	6.7	11.3	11.8	23.7	19.9	13.8	16.3	27.9	26.2	14.8	15.7	7.2	6.7	12.7	13.4
47	7.1	5.9	11.2	13.6	22.9	20.9	11.3	13.6	21.5	19.6	11.8	13	13.2	7.8	5.4	9.1
48	5.6	5.1	18.1	20	24.6	23.5	19.3	20.7	24.3	23.3	15	15.5	11.3	10.5	16.7	18
49	8.7	5.9	11.6	17.1	27	23.8	9.7	10.8	25.8	22.8	8.7	10	13	10	6	7.7

SOURCE: Acres planted and harvested and yields taken from Handbook of Wheat Statistics, Montana Wheat Acreage and Production 1915 - 1945, U.S.D.A., Bureau of Agricultural Economics, Helena, Montana. Data for 1945 - 1949 from Agricultural Statistics for Montana, Bureau of Agricultural Economics, Helena, Montana.

* Acres Planted ** Acres Harvested

al unit month for the 9400 square miles. 5/ It is believed to vary from about 2½ for the higher producing parts of Meagher, Wheatland, and Fergus Counties to about 5 for most of Petroleum, Garfield, Rosebud, and Musselshell Counties. Studies indicate that the potential of the grassland may be 1/5 to 1/4 greater than the above estimates of present capacity. 6/

Livestock numbers for the years 1921 through 1950 are shown by Table IV. Dairy and dairy products have been of very minor importance to date. The percent of total agricultural income derived from these for Wheatland, Golden Valley, Musselshell, and Petroleum Counties for the year 1949 was .024, .028, .034, and .019 respectively.

Irrigated production is confined almost entirely to hay with alfalfa seed as a complementary crop. Irrigated acreages cropped have varied considerably from year to year. Acres reported irrigated over the Musselshell drainage by the Irrigation Census for four ten year periods are as follows:

year	acres
1919	45,559
1929	59,286
1939	56,460
1949	78,560

It can be noted that the 78,560 acres reported irrigated in 1949 by the Bureau of the Census corresponds very closely with the total shown as irrigated by Table II. Of the 77,260 acres shown as irrigated by the table only 52,380 acres are classified as "regular irrigation" or acres consistently irrigated. The balance are "flood irrigated" or acres that do not have

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5/ "Similar Vegetative Range Types in Montana", 359, Montana State College, 1949.

6/ Ibid.

Table IV - Cattle and Sheep Numbers for a 29-Year Period for Four Counties in Thousands of Head and Total Units. *

Year	WHEATLAND (1000)			GOLDEN VALLEY (1000)			MUSSELSHELL (1000)			PETROLEUM (1000)		
19-	Cattle	Sheep	Units	Cattle	Sheep	Units	Cattle	Sheep	Units	Cattle	Sheep	Units
21	20.5	52.6	31	11.1	8.2	12.7	13.2	9.2	15			
22	24.5	56	35.7	12.8	8.9	14.6	14.5	9.9	16.5			
23												
24												
25	17	59.4	29	10.2	12.4	12.7	12.8	8.9	14.3	12.8	26.3	18.1
26	14.7	73	29.3	9.7	14.7	12.6	13	9.8	15	11.2	29	17
27	12.7	87	30.1	8.4	18.3	11.9	8.4	11	10.6	6.5	19.5	10.4
28	11.9	94.7	30.9	9.3	24.5	14.2	9.8	16.9	13.6	7.1	34.9	14
29	12.9	94.5	31.8	9	22	13.4	10.9	26.2	16.1	7.7	43	16.3
30	12.5	84	27.5	9	22	13.4	10.4	23.5	15.1	8.6	44.8	17.6
31	12.7	90.1	30.7	9.5	27.3	15	11.4	24.2	16.2	9.2	49.2	19
32	12.7	94.4	31.6	8.7	27.5	14.2	10.7	22.8	15.3	7.9	32.8	14.5
33	12.9	84	29.9	9.4	23.9	14.2	12.8	25	17.8	9.6	51.7	22.2
34	14.8	84.1	31.6	11.6	29.5	17.5	16.7	36.4	24	12.8	56.1	24
35	14	83.6	30.7	11.6	28.5	17.3	17.1	35.9	24.3	13.9	39.9	21.9
36	10.7	59.2	32.5	9.4	24.5	15.3	13.9	29.3	19.8	6.7	23	11.3
37	9	80.9	25.3	4.8	23	9.4	5	13.6	7.7	2.2	10.3	4.2
38	7.6	74.2	22.4	4.9	26.5	10.2	4.8	20	8.8	1.7	14.1	4.5
39	9.6	83.9	26.4	5.8	38.2	15.1	5.8	26.9	11.2	2.9	26.5	8.2
40	10.3	104.8	31.2	7.5	41.1	15.7	6.9	33.9	13.7	4.5	31.9	10.9
41	11.5	95.5	30.6	7.8	38.5	15.5	8.5	40.6	16.6	5.3	38.4	12.8
42	13.8	105.3	34.9	8.7	45.5	17.8	11	42	19.4	6.4	40.8	14.6
43												
44												
45	18.8	79	34.8	15.8	31.6	22.1	17.2	30.2	22.2	14.5	27.5	20
46	19.7	68.5	35.4	16.4	31.9	22.8	17.7	26	22.9	16.4	24.3	21.3
47	22.8	49.7	32.7	14.7	22.2	19.1	16.7	19.6	20.6	17.9	16.1	21.1
48	23.9	48.7	33.6	16.2	17.4	19.7	18.4	16.7	21.7	19.4	13.8	22.1
49	22.9	48.6	28.6	17	17	20.4	18.8	15.1	21.8	20.4	12.8	23
50	23.2	42.6	31.7	16.6	15.1	19.6	15.9	13.2	18.5	16.9	8	18.5

* These are not segregated by age group, but totals of head (excluding calves and lambs). Ratio cattle to sheep 1 : 5.

SOURCE: Biennial Reports Montana State Board of Equalization.

either a permanent or adequate irrigation water supply. J. R. Iakisch estimated 35,026 acres to be irrigated in 1931. 7/ In his report for the Bureau of Reclamation in 1932 Iakisch shows the water supply for irrigation at Harlowtown for the years 1916 through 1931 to be as follows:

extent of shortage	no. of years	year or years
throughout the season	1	1931
June to end of season	3	1919, 1926, 1930
July to end of season	8	- - - - - - - -
August to end of season	5	- - - - - - - -

The water resources survey by the State Engineers Office of Wheatland County in 1948 classes the Musselshell River as an intermittent stream.

Mineral Resources

There are only two important developed minerals in the drainage basin. 8/ These are coal and crude petroleum. The largest coal deposits are in the Bull Mountains south from Roundup. The Bull Mountain Field covers 600 square miles and is reported to contain a reserve of 407 billion tons of coal. 9/ There are also numerous coal deposits lying east and south from Roundup. Minor production is reported for Golden Valley County. Coal output for a series of years is shown by Table V.

Some crude petroleum is produced in all counties in the basin located north and east from Roundup. Crude petroleum production by county is shown by Table V. As can be seen by reference to the table there has been a marked increase in crude oil production accompanied by a decline in coal output.

7/ Iakisch, J. R., op. cit., p. 13.

8/ Biennial Reports of the Montana State Board of Equalization.

9/ "The Shift is West", undated, Montana Chamber of Commerce.

Table V - Crude Petroleum and Coal Production by Counties, 1925 through 1950:

	COAL (1000's Tons)			:	CRUDE PETROLEUM (1000's Bbls.)			
19-	Mussel-shell	Golden Valley	Total Prod.	:	Petrol-eum	Mussel-shell	Rose-bud	Total Prod.
25	951		951					
26	935		935		1001			1001
27	1168		1168		773			773
28	x		x		x			x
29	1055	1	1056		597			597
30	1100	1	1101		463			463
31	800	1	801		416			416
32	662	1	663		355			355
33	654	2	656		311			311
34	601	2	603		264			264
35	646	2	648		235	.23		235.23
36	804	2	806		292			292
37	917	2	919		253			253
38	791	1	792		224			224
39	710	1	711		213			213
40	691	1	692		194			194
41	750	1	751		175			175
42	799	1	800		170			170
43	x	x	x		x			x
44	x	x	x		x			x
45	1101		1101		112	97.4		209.4
46	1078		1078		127	80		207
47	840		840		380	105		485
48	900		900		414	52		466
49	700		700		312	131		443
50	556		556		244	410	.4	654.4

X - Information not obtained.

SOURCE: Biennial Reports of the Montana State Board of Equalization.

Community Facilities

The location of railroads is shown by the map on page 65. There are three surfaced highways through the basin. There is a scarcity of all-weather secondary roads, particularly in the lower extremities of the drainage area.

Electrical power has been extended to all of the more densely settled parts of the area in the past few years.

Property Tax Values

The assessed valuation of all real and personal properties in millions of dollars for the years 1925 through 1950 for Wheatland, Golden Valley, Musselshell, and Petroleum Counties can be seen by reference to Table VI.

Income and Employment

Major sources of income and employment for the four counties lying entirely within the basin are shown by Table VII.

Private Irrigation Development

Irrigation along the Musselshell River is reported to have begun in about 1860 or 1865. By 1935 there were between 55,000 and 60,000 acres irrigated except for seasonal variations in water runoff. This irrigation was dependent wholly upon natural stream flow of the river and its tributaries with the exception of a water supply obtained from a reservoir on Lebo Creek in Wheatland County which supplied supplemental water for a small and variable acreage of land.

In addition to the Lebo Lake storage several others were attempted. Data concerning these are as follows:

Table VI - Taxable Valuations Agricultural Properties and All Properties, 1925 through 1950, for Four Counties in the Musselshell River Basin. (Millions of dollars)

19-	WHEATLAND		GOLDEN VALLEY		MUSSELSHELL		PETROLEUM	
	Agric.	All	Agric.	All	Agric.	All	Agric.	All
50	6	13.8	3.7	7.5	4.5	11.5	2.8	4.6
49	5.9	13	3.7	7.4	4.5	11.4	3.2	4.9
48	6.1	12.8	3.8	6.8	4.4	10.2	3	4.1
47	6	12	3.2	6.6	3.8	9.3	2.7	3.6
46	5.9	11.3	3.3	6.5	4	9.2	2.6	3.4
45	5.8	10.8	3.3	6.5	4	9	2.5	3
44								
43								
42	4.9	10.5	3.2	5.5	3.3	8.2	1.9	2.5
41	4.5	9.9	2.8	5.3	3.1	8	1.9	2.5
40	4.4	9.6	2.6	5.1	2.9	7.8	1.6	2.4
39	4.3	9.9	2.7	5.2	3	8.2	1.4	2.3
38	4.2	10.3	2.8	5.2	2.8	8.4	1.5	2.2
37	4.5	11.3	2.8	5.3	3	8.6	1.6	2.7
36	5.6	11.5	2.8	5.4	2.8	9.8	1.7	2.7
35	5.5	11.7	2.8	5.5	3	10	2.6	4.8
34	5.9	11.8	2.8	5.6	4.4	9.8	2.9	4.9
33	5.6	12	2.8	5.4	4.5	10	2.6	5
32	7	13.8	3.8	7.5	4.5	11.7	2.7	4.9
31	8.5	16	4.3	8.2	4.5	12.8	5.9	6.3
30	11	17.9	5.8	9.8	5.2	14.3	6.9	8.8
29	10.8	18.3	5.9	10	5.7	14.3	7	8.9
28	10.6	18	6.7	10.6	6.8	14.4	7.7	10
27	10.5	17.8	6.7	10.6	6.6	13.4	7.6	10.8
26	11.6	18.5	6.8	10.9	7.5	14.4	7.8	11.3
25	11.8	19.3	6.8	11	7.2	14.3	6.6	10.3

SOURCE: Biennial Reports, Montana State Board of Equalization.

Table VII - Agricultural Income and Major Sources of Non-agricultural Income and Employment for Four Counties in the Musselshell River Basin, 1939 and 1949.

County	Year	NON-AGRICULTURAL							AGRICULTURAL			WAGES PAID and AGRIC. INCOME	
		Wholesale, Retail,& Service:				Payroll ($000)			Crop	Live-stock	Total		
		No. Estbs.	No. Emp'd.	Sales ($000)	Payroll ($000)	Mfg. & Mining	Other	Total	Sales ($000)	Sales ($000)	Sales ($000)	Total ($000)	Percent Agric.
Wheat-land	1939	99	116	1635.	98.	80.	347.4	524.4	124.3	765.9	890.2	1415.6	62.8
	1939(a)	99	116	2800.	102.	160.	556.3	816.	201.	2350.	2551.	3367.	54.
	1949	113	174	4210.	254.	127.	838.5	1219.5	299.1	2383.5	2682.5	3902.	70.
Golden Valley	1939	41	10	345.	7.	-	21.5	28.5	175.9	349.7	525.6	554.1	94.8
	1939(a)	41	10	508.	9.	1.	34.5	41.1	396.	1056.	1452.	1493.1	92.
	1949	37	32	972.	47.1	1.6	36.	84.7	493.1	1415.3	1908.4	1993.1	96.4
Mussel-shell	1939	131	153	2214.	144.	768. 7	74.7	1005.4	266.9	220.9	487.8	1493.3	32.
	1939(a)	131	153	3541.	208.	1225.	119.4	1960.	562.	660.	1202.	3162.	48.3
	1949	116	281	6607.	465.	1406.4	145.	2016.4	515.4	2107.2	2662.6	4639.	56.5
Petrol-eum	1939	27	22	278.	16.	9.6	36.	47.	110.8	136.7	247.5	294.5	84.
	1939(a)	27	22	442.4	32.8	15.3	57.	81.5	265.3	411.3	676.5	774.	84.
	1949	26	37	869.	147.7	7.	71.	225.3	491.6	1287.7	1779.3	2004.6	78.3

(a) 1939 adjusted to 1949 price level. See Statistical Abstract of U. S. for 1939 and 1950; Index of Wages, 1950, p. 203, 1939, p. 329. Retail prices on basis of Consumer Index for Denver, 1950, p. 287.

SOURCE: Census of Agriculture, 1949 and 1950; all non-agricultural for 1939 from "County Data Book", Dept. of Commerce, 1947; service, wholesale, and retail for 1949 from the following census publications: Service Trade, Vol. 1; Wholesale Trade, Vol. 1; and Retail Trade, Vol. 5. Payroll for 1949 for manufacturing and income designated under caption "Other" reported as "covered" industries by Unemployment Compensation Commission and railroad payroll as reported by representative of Milwaukee Railroad; wages paid by oil companies 1949 from Continental Oil Company.

County	Year	Name of Storage	Acres Irrigable	Estimated Cost
Wheatland	1913	Musselshell Valley Irrig. District	19,000	$ 218,139
Golden Valley	1907	Franklin Bench	22,800	Not known
Golden Valley	1922	Fish Creek	31,000	1,519,000
Petroleum	1910	Flatwillow	25,000	55,000
Petroleum	1911	North Winnett	25,000	150,000

Construction on the Flatwillow project was initiated but it was abandoned at an early date. About 3000 acres or less are irrigated to some extent when water is available on the North Winnett project. The other three storage projects were proposed only.

Investments in irrigation works for four of the counties in the Musselshell Drainage are shown by Table VIII. The right hand caption

Table VIII - Total Present Investments and Increase or Decrease in Total Investments Over Previous 10-Year Periods for Wheatland, Golden Valley, Musselshell, and Petroleum Counties for Three 10-Year Periods:

COUNTY	YEAR	TOTAL INVESTMENT ($1000)	% INCREASE OR DECREASE OVER Previous Period	1920	AVERAGE ACRE INVESTMENT 1940
Wheatland	1920	234.8			
	1930	162.1	-65		
	1940	161.1		-65	6.51
Golden Valley	1920				
	1930	49.3			
	1940	19.3		-40	4.93
Musselshell	1920	155.3			
	1930	75.4	-48.5		
	1940	69.4	- 9.2	-57.7	13.58
Petroleum	1920				
	1930	266.			
	1940	266.9			30.17

SOURCE: Census of Irrigation.

shows the average acre investment in 1940. It would appear evident from the table that there has been considerable disinvestment over the 20-year period. These data should not reflect much distortion resulting from changing price levels. The rate of new investments in irrigation works from 1920 to 1940 is not known and consequently neither is the actual rate of disinvestments known. However, assuming no investments after 1920 the acre investment in 1940 would be as follows:

Wheatland County	$20.83
Golden Valley County	16.30
Musselshell County	35.05
Petroleum County	50.20

In April of 1931 an investigation of the entire drainage was carried out by the Bureau of Reclamation. This was done at the request of a group known as "The Musselshell Basin Flood Control Association". The enthusiasm for this investigation was described in the report as an unusual interest in irrigation actuated by the complete failure of dry farming on the uplands, with depopulation of much of the dry farmed area, together with an extremely deficient supply of water for irrigation in 1931. 10/ A Federal irrigation development was not carried out. The report of recommendation advised that a more comprehensive investigation should be made prior to the time that any construction is undertaken.

Public Developments in the Musselshell River Basin

Types and Distribution of Project Facilities

Public investments in water developments commenced in 1935 when work was initiated on Deadman's Basin Storage Reservoir as a work relief project

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10/ Iakisch, J. R., op. cit., p. 1.

under W.P.A. This was followed by the construction of the Durand and Martinsdale reservoirs and canal systems. At about the same time construction was started on the Valentine and Yellow Water Dams and an attempt was made to rehabilitate the North Winnett Company's irrigation system and the Lebo Lake Reservoir. A number of other small water retention reservoirs and water systems were constructed or rehabilitated. These latter are widely scattered over the basin and the numbers are not known. All of these works were completed and for the most part constructed under the supervision of the Montana State Water Conservation Board. Since that time the Water Board has completed an irrigation works on Flatwillow Creek in Petroleum County known as the Petrolia Bench project, and a network of canals below Roundup along the main drainage way of the river known as the Lower Musselshell Canals all of which were completed in 1951. The Delphia-Gage Canals a few miles below the Town of Roundup were proposed for construction in 1952.

Works completed and proposed by 1951 are shown by Table IX. The distribution of these works can be seen by reference to the map on page 65.

Three of the storages either lie across or divert water from the main channel of the Musselshell River. These are the Durand, Martinsdale, and Deadman's Basin Reservoirs. These three storages provide a supplemental water supply for approximately 22,700 acres of irrigated land located between the Durand Reservoir site in Meagher County and the Musselshell-Petroleum County line about 18 miles below the Town of Melstone. 11/

11/ Taken from field notes compiled by the State Engineer's Office in 1939.

MAP

MUSSELSHELL RIVER WATERSHED - MONTANA

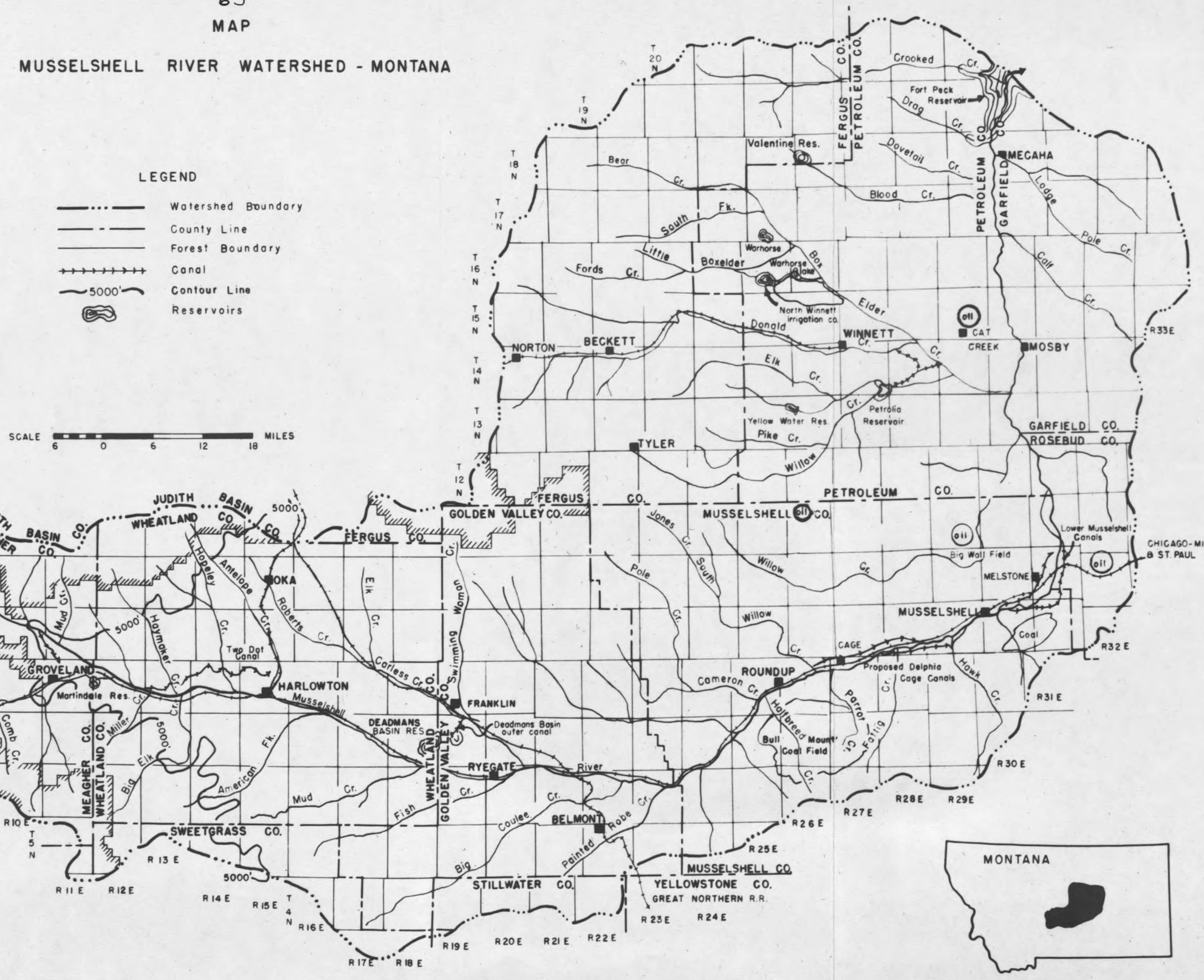

Table IX - Montana State Water Conservation Board Installations in the Musselshell River Drainage

Item No.	Name of Installation	County or Counties	Date completed	Acres Irrigated or Irrigable						Storage Capacity (acre feet)	Other Commercial Use
				Irrigated (1951)			Irrigable				
				Primary	Supplemental	All	Primary	Supplemental	All		
(1)	Durand & Martinsdale Reservoirs	Meagher & Wheatland	1938	4360	14,580	18,940	7068	14,580	21,648	30,000	None
(2)	Deadman's Basin Res.	Golden Valley & Musselshell	1940	1170	10,800	11,970	8400	10,800	19,200	52,000	500 1/
(3)	Lower Musselshell Canals	Musselshell	1951	0	0	0	14,500	0	14,500	0	None
(4)	Delphia-Gage Canals	Musselshell	1952	0	0	0	2565	0	2,565	0	None
(5)	North Winnett Co.	Petroleum	1936	3000	0	3,000	3000	0	3,000	19,000	None
(6)	Lebo Lake Reservoir	Wheatland	1936	0	2,000	2,000	0	2,000	2,000	2,719	None
(7)	Petrolia Bench Res.	Petroleum	1951	0	0	0	5300	-	5,300	8,500	None
(8)	Yellow Water Res.	Petroleum	1936	2400	-	2,400	-	-	-	3,700	None
(9)	Valentine Reservoir	Fergus	1936	0	-	0	-	-	-	2,000	None

1/ City of Roundup for municipal purposes.

Source: Montana State Water Conservation Board data.

There are also an estimated 2500 acres of land irrigated between the Musselshell-Petroleum County line and the mouth of the river which obtain some supplemental water benefits as a result of the storages. The balance of the lands irrigated are dependent entirely on storage supplies. These latter are new lands irrigated or made irrigable by Water Board canals or by the extension of private systems. A summary of water use by type of water supply and ownership of delivery systems, numbers of water users, and the potential irrigable acreages under these systems as of 1951 as nearly as these data could be determined is as follows:

Irrigation Systems	No. Users	Acres Irrigated	Acres Irrigable	Acre Feet Storage
Private				
Supplemental water users	143	22,700		
Primary water users 12/	-	4,885 13/	33,900	
Water Board Canals (All primary)				
Diversion - Durand to Martinsdale				
Martinsdale Turnout				
Two Dot Canal	21	4,360	7,018	
Deadman's Basin Intake				
Deadman's Basin Outlet (Franklin Bench)	6	1,170	8,100	
Lower Musselshell Canals	18	14/	14,500	
Delphia-Gage Canals	9	15/	3,940	
City of Roundup	500 acre feet for municipal use			82,000

12/ "Primary" irrigation is where total supply is from storage water.

13/ Acreage reported irrigated by the Irrigation Census, Department of Commerce, 1949, minus amount reported for 1939, minus the amount irrigated by State Water Board Canals by 1949.

14/ Not constructed until 1951.

15/ Proposed for construction 1952.

Works along creeks tributary to the main river channel are shown as items (5) through (9) on Table IX. A summary of types and amounts of water use by these as of 1951 is as follows:

Water System or Works	No. Users	Acres Irrigated	Acres Irrigable	Acre Feet Storage
Petrolia Bench (Primary) (Water Board Canals)	19	None	5,300	4,960
Yellow Water Dam (80 to 85% Primary)	4	2,400	Not known	3,700
Valentine Dam (Primary)		20 or less	Not known	2,000
North Winnett Company (Primary)	14	3,000	Not known	19,000
Lebo Lake (Supplemental)	2	2,000	16/Not known	2,720

Acreages irrigable are not known in most instances as the water from any of these works can be diverted to the main river channel.

Direct Benefits

Agricultural benefits. The circumstances of water use are highly variable over the drainage. The project provides a full primary water supply to some users, a supplemental supply to others, and in many cases both. This occurs in highly variable amounts from farm unit to farm unit. Units also differ in size as to acres irrigated and in total acres per unit. No attempt has been made to develop budgets to determine the value of water. Insight to direct farm benefits is evident, however, due to increase in water use per acre, increase in acres irrigated, and the increase in acres made irrigable over the area.

A general estimate of value product from irrigation as a result of public developments in this case can be determined by calculating the

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16/ Estimated.

annual increase in production due to supplemental water supplies and the annual value of production from new lands brought under irrigation. Lands not irrigated but made irrigable by the State Project are also a direct benefit to land owners. Direct agricultural benefits are therefore a summation of the increase in income as a result of supplemental water supplies plus the value of production from new lands irrigated, plus the net increase in market value of non-irrigated lands made irrigable by the project.

As nearly as could be determined, there are 143 supplemental water users along the main channel of the Musselshell Drainage between the Durand Reservoir site and Fort Peck Lake at the mouth of the river. Of these, 52 were interviewed. These water users were asked what the irrigation supply had been from natural flow prior to the installation of the storage reservoirs. Information so obtained by sector of the drainage is as follows:

Sector of Drainage	No. of Cases	Date of last water for irrig.	Average number of irrigations
Harlowtown and above	14	7/1 to 8/1	1½
Harlowtown to Roundup	17	4/1 to 7/15	1 or less
Roundup and below	16	4/1 to 8/1	Usually 1

Supplemental water users were also asked how many times they had irrigated in 1950 and what their crop yields from irrigation had been. Irrigated hay yields in relation to numbers of irrigation coverages reported are as follows:

No. of Cases	No. of Irrigations	Average Yield (Tons)
14	1	1
19	2	1.9
6	3	2.8

Eleven of the water users had irrigated pastures which were reported irrigated once in two cases and up to five times in four cases. Slightly over 50 percent of the acres irrigated were reported to be irrigated two or more times.

There is no way to predict how many times an operator will irrigate his land. However, there is no excess irrigated production in this area as can be seen by reference to Table XII. It would seem fair to presume that an operator will irrigate his land at least twice each season if water supplies are available which has been the case since 1940. On the basis of yields reported for two irrigations and the availability of water for irrigation use prior to 1940, an increase of 25 percent would be expected for the Harlowtown area (Wheatland County), and about 90 percent for Golden Valley, Musselshell, and Petroleum Counties. A part of this increase stems from factors other than water; nevertheless, it is evident from the foregoing data obtained from farm and ranch operators that there was no water available for irrigation in some seasons prior to the storage developments.

Operators interviewed were also asked the numbers of acres which they irrigated in 1940 and in 1950. Most of them reported some increase. The percent increase in acres reported by district for three sectors of the drainage is as follows:

Sector of Drainage	Percent Increase Reported
Harlowtown and above	16.5
Harlowtown to Roundup	30
Roundup and below	45

The acreages irrigated by Water Board Canals are shown above on page

67. The increase in value of agricultural production due to the increased water use per acre and additional acres irrigated can be seen by reference to Table X. The net agricultural value as shown by the right hand caption of the table is computed as 25 percent of the gross increase. Historically, the net turnoff from mixed irrigated and livestock units is about 35 percent of gross. A conservative estimate is considered more realistic in this instance because of the underdeveloped state of a major part of the land. Much of the land has been brought into production in the last three to four years and is not fully developed for irrigation.

There are a total of 68,758 acres irrigable of which 35,515 are irrigated. This leaves 33,243 acres of irrigable, non-irrigated land. These acreages by county or counties in which located are as follows:

Meagher and Wheatland	2,658 acres
Golden Valley	7,745 "
Musselshell and Rosebud	19,940 "
Petroleum	5,300 "

Raw lands under the Two Dot Canal in Wheatland County have sold for from $20 to $60 per acre when settled during the period 1944 through 1949. The average price paid was $26.40. The same land would be expected to sell for 20 to 30 percent more at this time. Lands on Franklin Bench under the Deadman's Basin Reservoir sold for a low of $13.50 in 1946 to a high of $60 per acre in 1951. Two tracts of raw irrigable land on the Petrolia Bench in Petroleum County sold for $55 to $58 per acre in 1951. No irrigable land under the Lower Musselshell Canals had sold by 1951. Irrigable lands along the Musselshell River below Roundup are highly variable in character; however, they would be expected to sell for about the same price as those on Franklin Bench. By capitalizing the value of these

Table X - Net Value of Agricultural Production from Public Developments in Four Counties, Musselshell River Basin

COUNTY	SUPPLEMENTAL Acres (000)	SUPPLEMENTAL Tons (000)	SUPPLEMENTAL Increase %	SUPPLEMENTAL Increase Tons (000)	SUPPLEMENTAL 1/ AUM's (000)	PRIMARY Acres (000)	PRIMARY Tons (000)	PRIMARY AUM's (000)	Total AUM's (000)	TURNOFF IN DOLLARS Per AUM	TURNOFF IN DOLLARS Per Acre	TURNOFF IN DOLLARS Total ($)	NET AGRIC. VALUE 2/ ($000)
Wheatland	12.4	24.8	25	6.2	18.6	5.16	10.32	30.96	49.56	4.	48.	198.24	49.56
Golden Valley	3.6	7.2	90	6.5	19.5	2.37	4.74	14.22	33.72	4.	48.	134.00	33.72
Musselshell	4.7	9.4	90	8.46	25.38	2.5	6.25	18.75	44.13	4.	48.	176.52	44.13
Petroleum	-	-	-	-	-	2.4	6.	18.	20.4	4.	48.	81.60	20.40

1/ Computed on basis of 3 AUM's per ton.
2/ Computed as 25 percent total net.

irrigable lands at 5 percent the windfall gain to landowners can be estimated as follows:

County	Acres	Acre Value ($) 17/	Total Value ($)	Annual Value ($) (5 percent total)
Meagher and Wheatland	2,658	20.	53,160.	2,658.
Golden Valley	7,745	35.	271,075.	13,553.75
Musselshell and Rosebud	19,940	35.	697,900.	34,895.
Petroleum	5,300	35.	185,500.	9,275.

Total direct benefits to agriculture in thousands of dollars by county are as follows:

County	Annual Net Value of production	Municipal 18/	Annual Net value of non-irrigated land	Total Annual net value
	(values in thousands of dollars)			
Meagher and Wheatland	49.56		2.66	52.22
Golden Valley	33.72		13.55	47.27
Musselshell and Rosebud	44.13	8.1	34.90	87.13
Petroleum	20.40		9.28	29.68
Total all				216.30

Indirect Benefits

Agricultural stability In view of the highly unstable production history of agriculture in the Musselshell Drainage, one of the major objectives of this study was to analyze the effect of the irrigation developments on production stability. The effect on winter feed production to supplemental water users along the main channel of the river from the Harlowtown area to the mouth of the river can be seen by reference to

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17/ Assuming a raw land value of 15 dollars per acre.

18/ Computed as 1 percent of annual retail value.

Table XI – Acres per Ranch Unit, Animal Units Run, Acres Irrigated Before and After Storage, and Increase in Total Feed Production for 39 Supplemental Water Users, by Area, Musselshell River Drainage.

Area	No. Cases	Ave. Total Acres	Ave. A.U. Run 1950	Irrigation Use: Acres 1940	Irrigation Use: Acres 1950	Production Before Storage: Total Prod.	Production Before Storage: Feed Per AU (1950)	Production After Storage: Total Prod.	Production After Storage: Feed Per AU (1950)	Percent Increase over Previous Period
Harlowtown and above	10	5,733	254	465	560	452	1.27	597	1.45	35 %
Harlowtown to Roundup	13	4,797	148	94	105	98	.75	178	.93	155 %
Roundup and below	16	12,010	215	71	131	78	.37	244	.75	86 %

Table XII - Animal Units Run, Feed Produced, Feed in Tons from Irrigation, and Assured Feed in Tons per A.U. for 4 Counties in the Musselshell River Basin for 5 Consecutive 5-Year Periods.

County	Year	A.U.'s (000)	Hay Production Dry Acres (000)	Dry Tons (000)	Irrigated Acres (000)	Irrigated Tons (000)	Total Tons (000)	Total Tons Per A.U.	Irrig. Hay Per A.U. (tons)	Assured Feed Total Acres (000)	Assured Feed Total Tons (000)	Assured Feed 1/ Per A.U. (1950)	Percent Increase (Tons)
Wheatland	1929	39.2	9.9	4.9	20.3	23.5	28.4	.7	.6	18.3	20.1	.51	
	1934	37.7	8.3	6.1	17.3	17.5	20.5	.5	.46	—	—		
	1939	41.4	7.8	6.1	15.3	16.3	22.4	.54	.4	—	—		
	1944	38.4	12.7	10.3	14.8	17.5	27.8	.7	.45	—	—		
	1949	43.5	22.2	15.6	19.	30.	45.6	1.	.7	22.8	29.7	.68	47.8 %
Golden Valley	1929	18.3	15.5	8.9	3.6	4.7	13.6	.74	.25	3.6	3.7	.2	
	1934	26.3	5.6	3.2	3.3	3.4	6.6	.3	.16	3.6	3.7		
	1939	18.3	6.2	7.1	3.3	5.3	12.4	.67	.28	3.6	3.7		
	1944	22.9	10.5	10.3	4.2	7.3	17.6	.76	.32	—	—		
	1949	26.7	13.1	11.9	4.5	8.9	20.8	.78	.33	4.4	8.8	.33	138 %
Musselshell	1929	25.	11.4	6.	4.1	4.7	10.7	.4	.19	3.8	4.3	.17	
	1934	27.2	10.1	3.9	2.7	2.9	6.8	.25	.1	3.8	4.3		
	1939	19.8	10.4	10.7	3.8	5.1	15.8	.8	.26	3.8	4.3		
	1944	28.	12.1	9.2	4.7	6.7	15.9	.57	.24	—	—		
	1949	33.7	13.4	9.3	5.5	9.5	18.8	.56	.28	5.8	9.6	.28	123 %
Petroleum	1929	24.2	15.9	11.6	5.2	6.6	18.2	.75	.27	5.3	4.5	.18	
	1934	26.8	12.	5.6	6.2	5.3	10.9	.4	.2	—	—		
	1939	14.9	11.	8.7	4.1	3.4	12.1	.8	.24	—	4.5		
	1944	20.5	12.7	10.3	5.	6.	16.3	.8	.3	—	4.5		
	1949	30.5	12.2	6.6	8.1	12.2	18.8	.6	.4	7.	6.	.2	25 %

1/ Assured Feed is construed to mean feed production from lands having a permanent water supply. The assured acreage base is the average for 1929 and 1939 plus any addition in irrigated acres due to storage water.

SOURCE: Census of Agriculture.

Table XI. These farm units are all irrigated and the major part or all of the feed is consumed on the unit on which it is produced. It can be seen by the table that there has been a substantial increase in feed production. The effect of the increased production on the availability of feed county-wide for Wheatland, Golden Valley, Musselshell, and Petroleum Counties can be seen by reference to Table XII. Livestock numbers have varied over the years but they have been on the increase in recent years as can be noted by the table. It can be noted further by reference to Table XII that this drainage area has relied heavily on the production of dryland feeds and still does so at this time. However, all counties have gained substantially with the exception of Petroleum County.

There have been a number of other significant effects upon the stability of the area. As can be seen by Table XIII, 15 of 58 operators reported new irrigated feed bases. A number of these reported local hay sales and feed purchases, and 16 reported irrigated pastures.

Table XIII - Integration of Irrigated with Other Land Uses by Areas in the Musselshell River Basin, 1950.

Area	No. Cases	Range Land	Dryland Crop	Hay Sales	Hay Purch.	New Feed Bases	Irrig. Pastures
Harlowtown and above	21	15	1	8	2	3	3
Harlowtown to Roundup	17	16	2	8	3	3	9
Roundup and below	20	19	8	2	2	9	4

New and rehabilitated farm units There are far more rehabilitated units than new ones in the drainage area for the reason that almost every unit existing prior to the storage was rehabilitated to one extent or another by virtue of the supplemental water supply made available by the

project.

There were 7 new farms in the vicinity of the Town of Harlowtown in Wheatland County by 1951. Five of the operators were interviewed. The progress made by them can be seen by reference to items 1 through 5 on Table XIV. It can be noted by the table that these vary widely as to purchase prices paid, acres per farm, improvements placed upon the land to date, and building and chattel investments controlled by the operator. While these operators appear to have made fair progress, settlement of the land has been very slow. These lands have been available since early 1940 and only slightly over half of the land considered irrigable has been settled by irrigation farmers. The owners of the land do not make it available at prices which attract settlement or development. In fact, they compete with new subscribers for additional acreages. Several local ranch operators who own a considerable acreage of irrigated land along the river bottom have bought up small acreages under the Two Dot Canal. One purchased 750 acres in a single block.

The operator designated as item 2 on Table XIV is a dryland wheat farmer who has resettled under the canal. He owned approximately 50 percent of the assets shown by the table as owned in 1951. Items 6 through 9 comprise the total of all farm developments on Franklin Bench as of 1951. Franklin Bench lies immediately below the Deadman's Basin Reservoir and includes a total of 8100 acres of irrigable land. These lands were subject to settlement under irrigation as early as 1940. As can be noted by reference to the table, the first tract of land purchased for settlement was in 1946. Total acres as well as irrigable acreages of the units

Table XIV - Investments in Land and Land Improvements, Acres Irrigated and Acres Irrigable, on New Farm Units under the Two Dot Canal and Deadman's Basin Reservoir, 1951.

	PURCHASE DATA						IMPROVEMENTS					PRESENT INVESTMENTS						
No.	Date Acquired	Total Acres	Acres Irrigated	Dry Crop	Building Value	Total Price	Acres Leveled	Cost	Other Costs	Acres (1951) Irrigated	Acres (1951) Irrigable	Building Value 1/	Land and Land Improvements	Machinery 2/	Livestock Value 3/	Total Machinery & Livestock	Other Value	Total Investment
1.	1945	160	135	0	0	9,600	20	500	0	135	135	0	10,100	9,520	0	9,520	0	19,620
2.	1946-47	480	30	0	0	10,200	255	2500	800	205	230	4,700	18,250	14,760	9,720	24,480	600	43,330
3.	1944-46	310	30	0	1000	6,400	150	4500	750	150	190	11,000	12,750	8,313	4,568	12,881	80	24,711
4.	1949	335	205	0	0	8,750	0	0	800	205	240	3,000	12,550	1,935	0	1,935	0	14,485
5.	1944	620	0	0	200	6,500	30	750	150	270	300	600	8,000	6,985	6,186	13,171	175	21,346
6.	1946-48	293	0	0	0	3,265	0	0	0	0	290	3,500	6,765	700	0	700	0	7,465
7.	1950-51	240	0	0	0	12,000	0	0	300	100	200	250	12,550	4,600	130	4,730	0	17,280
8.	1950	160	0	0	0	2,000	80	1200	900	80	120	1,100	5,200	5,178	1,480	6,658	500	12,358
9.	1949	160	0	0	100	2,000	50	400	220	85	135	200	2,720	3,282	0	3,282	0	6,002

1/ Estimated on basis of 1949 replacement costs.
2/ 1950 prices depreciated to 1947.
3/ Milch cows $200; range cattle, including yearlings, $160; hogs $50; sheep $13; chickens $1 per head.

shown by the table are quite variable. Assets owned as of 1951 are limited in all cases.

There are two basic obstacles to the settlement and development of the lands under the Two Dot Canal and on Franklin Bench as well as in similar circumstances over the entire drainage area. These are ripening costs and land speculation. In almost all cases encountered operators expressed the need for credit to bring the land into production. This need is not confined to small operators. The raw land does not attract money investments except for isolated instances where very productive land can be brought readily into irrigated production. Because of this, lands which have been developed to date have been in general the more productive lands and those that require the least investment.

As noted above, there is an excess land problem under the Two Dot Canal. This is generally true of the entire area. As near as can be determined from a cursory check of land ownership records of Golden Valley County, there were about forty land owners on the Franklin Bench under the Deadman's Basin Reservoir in 1951. As can be noted by reference to Table XIV four farms were in the process of development at that time. It can also be seen from the table that the lands sold up to and including 1950 sold at from $12 to $15 per total acre, a large portion of which were irrigable. The last tract purchased which comprises a part of item 7 as designated by Table XIV consisted of an 80 acre tract and sold for $100 per acre in 1951. A local realtor was acting as agent for the disposal of the unsettled land on this bench in 1951. As near as could be learned the asking price for the more level lands on the bench was $80 to

$100 per acre. Two tracts of irrigable land on Petrolia Bench sold for $55 and $58 per acre in 1951 and at the time when the project was still under construction. One of these purchases was made by the owner of a sizable acreage of land who stated he purchased the land for speculative purposes. The intent of the other buyer is not known.

Local business benefits It can be seen by reference to Table VII that there have been considerable gains to local business units during the period 1939 to 1949. In order to determine the net effect of the project it is necessary to obtain an estimate of the net income to the area by county that is attributable to the project. An estimate of the increase in annual net income on the basis of the increase in livestock feed supplies and the value of net annual turnoff from livestock as a result of increased feed supplies is shown in terms of thousands of dollars by Table X. These data are used as a basis for determining the percent increase in agricultural production attributable to the project for each of the four counties, a summary of which is shown by Table XV.

No attempt was made in this study to delineate trade areas, consequently there may be a small amount of double counting. There is also an appreciable amount of trading carried on outside the drainage area that is not accounted for. It is therefore not possible to project a reasonable estimate of total benefits from the drainage project. An estimate of the effect of the project on local business units can be made by comparing the net increase in production as shown on Table VII with the total income from agriculture and total income from non-agricultural industries. A comparison between these can be seen by reference to Table XV. In order

to interpolate these data accurately it would be necessary to determine total annual earnings for each industrial group, the number of individuals in each group, and the amount spent by each group by types of sales and purchases and by market areas in order to isolate the agricultural sector. About 65 percent of the payroll in Wheatland County is derived from the railroad and the flour mills. Most of the wheat processed there comes from Judith Basin and Fergus Counties. It can be noted by the table that the relative importance of agricultural income has declined by 9 percent during the 10 year period. The Bureau of the Census shows a decline in the number of farms from 229 to 192. Golden Valley County affords a better opportunity to see the effects of the change in agricultural production on local business activity since 92 percent of the total income for 1939 and 96.4 percent for 1949 was derived from agriculture. There is, however, no indication of total benefits since the amount of trading carried on outside the county is not known. It can be noted in this case that the volume of sales has increased from $508,000 to $972,000 and the number of persons employed in retail sales and service businesses has increased from 10 to 32. The ratio of increase between 1939 and 1949 both in total income and volume of sales corresponds closely to the same ratios for Wheatland and Musselshell Counties where there are substantial amounts of income not attributable to agriculture. The number of farms in Golden Valley County declined from 268 to 225 during the 10 year period.

Table XV shows the ratio of total income to gross sales for Musselshell County as 1:1.4 for both 1939 and 1949. Roundup is the most highly developed trading center in the drainage area; however, there is no reason

Table XV - Income in Thousands of Dollars and Ratios of Income to Spending on Retail and Wholesale Goods and Services for Wheatland, Golden Valley, Musselshell, and Petroleum Counties, 1939 and 1949.

County	Year	(1) ($000)	Percent Agric.	Urban employed in Wholesale Retail & Service	(2) ($000)	Ratio of Increase 1939 to 1949 (1)	Ratio of Increase 1939 to 1949 (2)	Ratio of (1) to (2)	Ratio Agric. to Local Sales	Estimated Net Business Benefits from Agricultural Production ($ 000)
Wheatland	1939	3556.	63	116	2800.			1: .78		
	1949	4160.	54	174	4210.	1:1.2	1:1.5	1:1.01	1: .65	64.24
Golden Valley	1939	1466.1	92	10	508.			1: .35		
	1949	1993.1	96.4	32	972.	1:1.36	1:1.9	1: .48	1: .40	32.5
Musselshell	1939	3102.	48.3	153	3541.			1:1.4		
	1949	4639.	56.5	281	6607.	1:1.5	1:1.9	1:1.4	1: .80	64.0
Petroleum	1939	780.	84.	22	442.4			1: .56		
	1949	2270.9	78.3	57	869.	1:2.8	1:2	1: .38	1: .40	15.98

(1) Value of agricultural products sold plus wages paid.
(2) Sales, wholesale, retail, and service.

SOURCE: Taken from Table VII.

to believe that more than a minor amount of trade comes from outside the county. The main reasons for the difference in the ratio in this case seem to be due to the fact that a higher proportion of the trading for the county is retained in Roundup and within the county and because of the industrial income from sources other than agriculture. Wheatland County more nearly resembles Musselshell County with respect to trading facilities and non-agricultural income than do either of the other counties as can be noted by the table.

Property tax base As can be seen by reference to Table VI the county tax base has been highly variable, particularly the agricultural base. Irrigated lands are evaluated at from $15 to $40 per acre by county governments. Irrigated lands under the Two Dot Canal in Wheatland County are evaluated at $30 per acre for assessment purposes. Assuming a valuation of $30 per acre for all lands brought under irrigation by the project the increase in agricultural tax base in thousands of dollars for the following counties would be:

Wheatland	263.55
Golden Valley	168.3
Musselshell	202.35
Petroleum	72.0

The volume of sales per business establishment for the years 1939 and 1949 is shown by Table XVI. The table also shows the percent and net increase in dollars per business establishment attributable to the drainage project for Wheatland, Golden Valley, Musselshell, and Petroleum Counties. The percent of the total assessed valuation that these establishments represent is not known. It is evident from the table, however, that significant increases in value would be expected as a result of increased bus-

iness volume.

Table XVI - Value of Gross Sales per Retail Establishment in Thousands of Dollars and Net Increase Attributable to the Project in Percent of Total and Thousands of Dollars for Four Counties in the Musselshell River Basin.

County	Sales per Est.: 1939 ($ 000)	1949 ($ 000)	Net 1939 Over 1949: Attrib. to Project ($000)	% Vol. Sales: Ratio value to $ value local sales	Ratio value agric. prod. to $ value local sales	Inc. in Volume of Sales Attrib. to Project 1949 %	Dollars
Wheatland	28.3	38.1	9.8	2.3	1:.65	1.5	571.50
Golden Valley	12.4	26.3	13.9	4.1	1:.4	1.64	431.32
Musselshell	27.	57.	30.	2.3	1:.8	1.8	1026.00
Petroleum	16.4	33.4	17.	1.6	1:.4	.64	213.76

Source: Tables VII and XVIII

Recreational benefits The Montana State Fish and Game Department has planted some fish in storage reservoirs along with cold water fish in streams in the headwaters of the drainage basin. Such activity, however, has been of a very general nature. There has been no specific public recreational program. Local residents report that trout have been caught as far downstream as the town of Ryegate in recent years which is about 35 miles farther down the river then this type fish was ordinarily found prior to the installation of the Durand and Martinsdale Reservoirs.

There is some fishing in all of the Water Board Reservoirs, most of which is local except for Deadman's Basin which attracts fisherman from all of the central part of the State. The storage reservoirs have made the Musselshell River Drainage an attractive lake fishing area. Due to the demand for fishing areas in Central Montana any action taken to firm up the cold water flow along the river channel and its tributaries would undoubtedly attract considerably more sportsmen and other recreational

traffic.

There is a conflict between persons on recreational pursuits and local land owners because of trespass on privately owned lands, as well as conflict between the vacationing public and the Water Conservation Board. A representative of the Water Board advised that fishermen and picnicking parties congregate on installations and in certain instances have done damage to rip rap on the face of earth fills and have committed other irresponsible acts.

Flood control The Musselshell Drainage covers approximately 9400 square miles. The combined drainage areas above the main channel storages - Durand, Martinsdale, and Deadman's Basin Reservoirs - cover only about 2700 square miles. Other reservoirs are all small and there are no storages over a large sector of the drainage. The reservoirs are designed for the storage of irrigation water and to supplement stream flow throughout the season, particularly during drought seasons. Most of the water is stored during late fall, winter, and early spring months. Reservoirs must be filled during this period if water is available due to uncertainty of runoff in late spring and summer months. There has been some flexibility with regard to the filling of Deadman's Basin Reservoir to date as it will hold up to 52,000 acre feet of water. However, this flexibility will be reduced with increased demands for storage water for irrigation and other purposes. Water Board facilities therefore can be expected to exercise little control over floods.

Project Benefits vs. Costs

Only the older parts of the project were in operation by 1951. Works

shown by Table IX as constructed in 1951 were under construction at that time. The Delphia-Gage Canals were proposed for construction in 1952. For the purpose of this study the benefits from development and costs incurred are confined to those works shown by the table which were constructed from 1936 through 1940.

In evaluating benefits and costs there is a price level problem since costs incurred in construction were from 1935 through 1940, whereas returns to the project by 1951 have occurred over the period from 1936 to 1951. Project costs for all projects constructed by 1940 are shown by Table XVII. The expenditures on construction shown by the table were incurred in large part as public works projects. Much of the work was done by pick and shovel and with obsolescent construction equipment. An engineer of the Water Board stated that he believed the same work could be done for as little or possibly at less cost at the present time.

Table XVII - Cost of Water Board Works Constructed Prior to and Including 1940, by County, and Date Constructed.

Name of Works	Cost ($)	County or Counties	Date
Durand and Martinsdale Reservoirs and Two Dot Canal	884,577.	Wheatland, Meagher	1938
Deadman's Basin Reservoir	1,016,675.	Wheatland, Golden Valley	1940
Lebo Lake Reservoir	28,000.	Wheatland	1936
North Winnett Irrigation Co.	162,000.	Petroleum	1936
Yellow Water Dam	101,678.	Petroleum	1936
Valentine Dam	73,615.	Fergus	1936
Total	2,266,545.		

Source: Montana State Water Conservation Board.

The Bureau of Reclamation used a long term projected price level of 215 (1910-14 equals 100) for determining total net benefits for their

Missouri-Souris Project in North Dakota. 19/ This is approximately the 1946 price level. Net income computed above on page 73 is derived from the average of 1948-49 prices which averaged about 275(1910-14 equals 100). The selection of a price level that will most nearly represent actual costs and returns during the life of a project is an estimate at best. The average for 1948-49 is used in this study.

A summary of benefits and costs as determined by this study can be seen by reference to Table XVIII. These data are actual costs amortized annually for a 50 year period with the exception of operation and maintenance costs which are estimated, plus an assumed interest on construction indebtedness of 2½ percent. It can be noted by the table that the

Table XVIII - Summary of Benefits and Costs, Water Board Project, Musselshell River Basin

(thousands of dollars)

Item	Annual Benefits ($000)	Item	Annual Cost ($000)
Net farm income	147.81	Operation and maintenance	38.65 (1)
Value non-irrigated land	60.40	Construction	45.33 (2)
Municipal	8.10	Interest	32.38 (3)
Indirect farm	- -		
Local business	96.07		
Public	- -		
Flood control	- -		
Recreation	- -		
Total	312.38		116.56
Ratio	2.7		1.

(1) Estimated at 1/3 total annual cost.
(2) Computed as 1/50 construction cost.
(3) Computed as 2½ percent amortized for 50 years.

19/ "Interim Information Report", Garrison Diversion Unit Missouri-Souris Division, Missouri River Basin Project Region 6, United States Department of The Interior, Bureau of Reclamation, October 30, 1953, p. 133.

ratio of benefits to costs is calculated at 2.7: 1. No estimates are made as to indirect farm benefits even though it is evident that there have been considerable amounts of these type benefits from improved operational stability alone. Neither does the ratio include any benefits from flood control, wild life, or public benefits other than those accruing to local business units.

The analysis to this point indicates that the ratio of benefits to costs is 2.7: 1. Assuming that a project is feasible as long as the ratio of benefits to costs is 1: 1 or more, the project in this case is feasible. Such a determination, however, does not indicate that the allocation pattern is the "most feasible". It is possible that the same benefits or possibly more might have been obtained by some other organization of resources and at less cost. Neither does it demonstrate that benefits are maximized at this point.

A summary of possible alternatives is shown by Table XIX. This is not a complete analysis since there may be a number of possible storage sites, irrigable areas, and uses for water not known to this writer. It is therefore confined to works undertaken or proposed by the Montana Water Board. It is assumed that the "value of water" per acre for irrigation purposes is the same in all instances. The potential value is computed on the basis of 2 ton hay production at 3 AUM's per ton valued at $4. per AUM. Net farm income is calculated at 35 percent of gross. Therefore, net value is computed as $\frac{2 \times \text{acres} \times 3 \times 4}{.35}$.

It was not possible in this study to account for variations in productivity per acre although considerable variation is know to exist in

Table XIX - Benefit-Cost Comparison, Montana Water Board Works Undertaken and Proposed, Musselshell River Basin

No.	Structures	Total Cost ($ 000)	Acres (000) Irrigated 1/	Acres (000) Irrigable	Annual Costs & Benefits ($ 000)					Potential Benefits				Acre Ft. Storage per Acre 6/	
					Costs 2/	Direct Benefits	Indirect Benefits 3/	Other 4/	Ratio Benefits to Costs	Direct ($000)	Indirect ($000)	Other 5/	Ratio Potential Benefits to Costs	Irrigated	Irrigable
1	Durand & Martinsdale Storages	776.37	20.7	33.9	40.	43.68	28.39	8.1	2:1	154.56	100.46	NK	6.4:1	1.85	1.1
2	Deadman's Basin Reservoir	1016.68	8.3	25.6	51.85	68.89	44.78	8.1	2.3:1	214.21	139.24	"	7 :1	6.6	2.
3	(1) plus (2)	1793.05	20.7	42.	91.85	43.68	28.39	8.1	.87:1	222.46	144.60	"	4 :1	6.6	2.1
4	Lower Musselshell Canals plus (2)	1366.68	8.3	33.75	69.7	68.89	44.78	8.1	1.7:1	282.67	183.74	"	7 :1	6.6	1.5
5	Delphia-Gage Canals plus (4)	1666.68	8.3	36.32	85.	68.89	44.78	8.1	1.4:1	302.09	196.36	"	5.8:1	6.6	1.4
6	Two Dot Canal plus (1)	884.58	20.7	40.9	45.11	43.68	28.39	8.1	1.6:1	212.52	138.14	"	7.8:1	1.85	.9
7	(1) through (6)	2551.25	20.7	59.8	130.11	43.68	28.39	8.1	.61:1	371.28	241.33	"	4.7:1	4.2	1.45
8	Yellow Water Dam	101.68	-	4.	5.19	-	-	-	-	33.20	21.58	"	10:1	-	-
9	Petrolia Bench	350.	-	5.3	17.8	-	-	-	-	44.52	28.93	"	4.1:1	-	-

1/ Estimated from plain table data, Montana State Water Conservation Board and State Engineer's reports.
2/ Computed at 2½ percent interest amortized for 50 years, plus O. & M. costs computed at 1/3 total.
3/ Taken as 65 percent of direct benefits.
4/ Municipal water.
5/ Data as to potential other than irrigation not known.
6/ Total supply available taken from reports by State Engineer's office.

many instances. Indirect benefits are computed at 65 percent of net farm income.

Table XIX shows the various benefit-cost ratios for a number of works completed and proposed. Costs of proposed projects are based on estimates by the Water Board. The table sets forth four important considerations. First, it shows the relationship of benefits and costs for individual works and combinations of works. Second, it incorporates one essential physical aspect of the problem into the analysis, that being the water supply available under the various organizational arrangements. For example, items 2 and 4 show the highest potential benefit-cost ratios except for item 6. There is, however, only .9 acre foot of water per acre available in the case of item 6. This is likely not an adequate water supply in the long run at least. If the Deadman's Basin storage is constructed, irrigable areas below Deadman's Basin can be served in all or by some part from that supply. In such case there is no longer any question as to the water supply in connection with items 1 and 6. This same analogy can be followed through with regard to any of the works shown by the table. Third, a drainage basin of this type where irrigation has been practiced for a long time, even though intermittently, serves as an immediate outlet for storage water and provides for benefits from irrigation at an early date. Fourth, the table also shows the immediate benefits which will accrue in each instance, and the potential of the various works and combinations of works. The potential is projected on the assumption that new lands made available for new farms including "excess" irrigable lands will be brought into production. If

lands are held off the market or if the value of water becomes capitalized in the value of the raw land, any expansion that takes place is very slow. The rate of settlement and development will also depend on whether or not there is an organized effort to reduce the effects of ripening costs. If there is a responsible organization to facilitate an orderly settlement of the land benefits would be expected to exceed costs by a very significant amount in instances similar to the Musselshell River drainage as can be seen by reference to Table XIX. If an organized effort is not forthcoming benefits may not exceed costs for many years to come for the reason that there may be little or no real potential created by the project due to the capatalization of water in the value of the irrigable lands and because of ripening costs. Accordingly, in choosing between projects and works within projects proposed for development the organizational aspects of the problem are as important and possibly more important than the economic considerations.

There are also possibilities for still other types of substitution. For irrigation purposes small pumping plants may obviate the need for canals. Such possibilities have considerable merit in instances where the areas under canals might not be developed for a considerable period of time.

The status of the Musselshell River Project as shown by Table XVIII corresponds closely to the combination of possibilities shown as items 2, 6, and 8 by Table XIX. By 1951 and 11 to 13 years after the completion of the project works an estimated 12,500 new irrigated acres had been brought into production in addition to the supplemental water supplies provided by the works. As can be seen by reference to Table XVIII the ratio of benefits

to costs is estimated to be 2.7 : I.

Cost Allocation

A summary of all investment costs including projects in the process of construction by 1951 and proposed for 1952 by source of investment funds and income from water sales can be seen by reference to Table XX. As can be seen by the table all projects completed by 1940 were financed in some part by Federal grants, State funds - identified by the table as "revolving funds" - and bond sales. The Federal grants were the Federal Government's direct financial contribution to the project. The "revolving fund" is the State of Montana's appropriation for reclamation works. The bonds were issued by the State Water Board. These were purchased by the Federal Government. Collateral for the bonds are water purchase contracts entered into between the Water Board and "water users associations". The amount of the bonds are therefore the local water users or local community responsibility. The bond and interest charge (B & I) as shown by the table is the investment charge per acre foot of water sold. The schedule of repayment to principal and interest can therefore be computed by multiplying the B & I per acre foot times the number of acre feet of water under contract. The Federal, State and local responsibilities to repayment in percent of total costs for works in operation by 1951 under this arrangement are:

works	Federal	State	Local
Durand and Martinsdale Reservoirs	32.5	12.5	55
Deadman's Basin	72.2	13	14.8
Lebo Lake	100		
North Winnett	80	20	
Yellow Water Dam	68	32	
Valentine Dam	80	20	
Average all	72.1	16.25	11.63

There has been some re-alignment of financial responsibilities to repay-

Table XX - Montana State Water Conservation Board Works in The Musselshell River Drainage

NAME	Date Completed	Acre Feet Storage	U. S. Grant ($)	FINANCE								Acre Feet Sold	Acre Feet Not Sold	Acres Irrigated	Acres Irrigable
				Revolving Fund ($)	Bonds ($)	Total Cost ($)	Per Acre Irrigable	Per Acre Irrigated	O. & M.	B. & I.					
Durand & Martinsdale Reservoirs and Two Dot Canal	1938	37,243	349,364	108,213	427,000	884,577	24.83	47.18	.18	1.10		11,081	26,162	18,942	35,630
Deadman's Basin	1940	52,000	736,651	145,024	135,000	1016,675	54.73	128.50	.25	.75		8,269	43,731	7,912	18,578
Lebo Lake Storage	1936	2,720	-	-	-	28,000	-	14.00	-	-		-	-	2,000	-
Lower Musselshell Canals	1951	1/	-	-	-	350,000	24.10	-	.50	2.00		-	-	-	14,500
Delphia-Gage Canals	1952	1/	-	-	-	250,000	63.50	-	-	-		-	-	-	3,940
Petrolia Bench Works	1951	4,960	-	-	-	350,000	66.04	-	.50	2.00		4,000	960	-	5,300
North Winnett Irrigation Co.	1936	19,250	125,000	37,000	-	162,000	32.40	-	-	1.00		2,340	-	3,000	5,000
Yellow Water Dam	1936	4,400	75,000	26,678	-	101,678	NK	-	-	1.00		2,000	-	2,400	-
Valentine Dam	1936	2,500	28,202	15,413	-	73,615	NK	-	-	-		-	-	-	-

SOURCE: Montana State Water Conservation Board.

1/ Deadman's Basin Storage.

ment as the State has recovered some costs through the direct sale of water. The State has also been forced to bear costs in excess of those shown above due to delinquent water contracts. It has encountered difficulty in enforcing water contracts since the water contracts comprised the collateral for bonds held by the Federal Government and therefore payment on water contracts could not be enforced by threat of cancellation of contracts by the State. In 1951 the State purchased the bonds held by the Federal Government for about 50 percent of the outstanding amount of the bonds. The Federal Government has therefore actually contributed about 80 percent of the total cost and the State and local water users associations about 20 percent.

It can be seen by reference to Table XX that the works constructed in 1951 and proposed for construction in 1952 are to be financed by State appropriation to the revolving fund the amount of which will be retired in all or some part by the sale of water. According to bond and interest charges for water sold to date on these projects construction charges are to be paid by the water users at the rate of $2.00 per acre foot of water used. The Petrolia Bench works cost $350,000 and has an estimated storage capacity of 5,000 acre feet. This cost amortized over a 50 year period at 2½ percent interest would be an annual cost of $9,000. Five thousand acre feet at $2.00 per acre foot would provide a gross payment toward indebtedness of $10,000 per annum. The intent evidently is that water users will carry the cost of the project or at least to the extent that irrigation users are willing and able to support water contracts.

Organizational and Institutional Aspects

Water users associations The Water Board operates similar to a public utility in that the Board organizes finance for the construction of facilities and sells services on a unit price basis. The State enters into contracts to deliver water to "users associations" who in turn sells water to individual water users. The users associations assume all responsibility for administration and management of water use. Four water users associations were organized in the Musselshell River basin by 1951. The names of these, approximate dates organized, and the general sectors of the basin served by each are as follows:

Name	date	area served
Upper Musselshell	1938	Durand Reservoir site to the town of Ryegate
Deadman's Basin	1950	Ryegate to Musselshell
Lower Musselshell	1951	Town of Musselshell to Musselshell-Petroleum County line
Petrolia Bench	1951	immediate vicinity of installation

The North Winnett Irrigation Company also holds a contract with the Water Board as a result of storage capacity created by re-habilitation works. There is no association of water users under the Yellow Water Dam. There are only four users and these contract as individuals directly with the State. There is no commercial use made of the water from the Valentine Dam and accordingly no users association. Organization of water use from Lebo Lake is not known.

Under the project organization in this drainage area the users associations are the functional hubs of the organization. First, the association is the grass roots organization of citizens that promotes interest in the

construction of the project. Second, in accordance with policy to date, the association is responsible for the administration and use of services provided by the project after it is constructed. The users association therefore organizes the local demand and administers the project or works. The extent to which the users association represents the public interest and the responsibility it assumes in the administration of services provided by the project or works is therefore a very important aspect of the over-all organization.

The Upper Musselshell Water Users Association was formed in 1938. This association was responsible for the distribution and use of all water along the main channel of the River until 1950 when the Deadman's Basin Water Users Association was organized. Since that time the Upper Musselshell Association has been responsible for the distribution of water between the Durand Reservoir site to a point about four miles above the town of Ryegate. The operation of the Association is confined to the administration of water use under the Water Board Canals most of which is limited to the Two Dot Canal and supplemental water use along the main River channel to the vicinity of Ryegate with the exception of some expansion in irrigated acreages under privately owned irrigation systems. The Association does not seem to assume much responsibility for the distribution of the water. A ditch rider distributes irrigation water under the Water Board canals. He also turns water loose from storage to users under private ditch systems; however, except for water use under the Water Board canals he has no jurisdiction over the distribution of water among users. Therefore, one person may call for water and some other user under the same ditch or possibly some other ditch system

may divert the water to his land. The ditch rider attempts to resolve disputes when they arise however, if he cannot settle differences among water users he must call in a representative of the Water Board to act as an arbitrator or mediator. Consequently, an engineer employed by the Board often finds himself acting as a roustabout trouble shooter for a water users association. This puts the Water Board in a bad position since it is continually becoming involved in disputes many of which are of relatively insignificant importance simply because the association will not assume the responsibility.

The Upper Musselshell Water Users Association is represented by eight or ten individuals primarily interested in irrigation farming who reside in the Harlowtown and Two Dot Communities. They are not interested in programs for purposes other than for irrigation, nor are they interested in a basin wide distribution of the storage water.

The Deadman's Basin Water Users Association represents the irrigation users in the vicinity of the Town of Ryegate and between Ryegate and the Town of Roundup. In 1951 it was contemplated that another association would be formed at Musselshell and possibly another at Gage. There has been no organization formed to date that represents the interests of persons more than a few miles below the Musselshell-Petroleum County line. It is about 80 miles from this point to the south of the river. Persons from this lower area reported that groups from that vicinity have contacted officials of the Upper Musselshell Water Users Association as well as the Deadman's Basin Association to work out a means for water distribution to the lower extremities of the basin. They were discouraged in such instances by the associations who stated that the distance was to great to insure water delivery.

The problem of water distribution to the lower part of the basin is a real problem since it is about 135 miles from the Deadman's Reservoir site to the mouth of the river.

In view of the discouragements from the existing water users associations and the distribution problem some of the residents of the lower part of the drainage have entertained the notion of another storage reservoir in the vicinity of Mosby. In view of present Water Board policy these new users would have to bear all or a substantial part of the construction costs for such a works.

The physical problem of water distribution does not appear to be the only problem. Water users in the lower part of the basin have been reluctant to organize because they would then have to bear part of the cost of the project. In most seasons they have water anyway even though it may not be timely or adequate. Neither is the position of the associations presently organized difficult to understand. It can be noted by reference to Table XX that there is very little outstanding debt against the Durand, Martinsdale, and Deadman's Basin storages. Federal grants and aids have absorbed a large part of the construction costs. It can also be noted by reference to the table that the major part of the storage capacity of these reservoirs was not under contract as of 1951. There would seem little reason to believe that the associations administering these would be in favor of a wider distribution of the storage water supply. In view of the foregoing it appears evident that if a wider distribution of the public storage water is to be had it will be necessary to organize still more users associations.

Private ditch systems Much of the land area served by the Water Board storages is accomplished by means of privately owned irrigation delivery systems. Of particular interest to this study therefore is the cooperation and integration achieved between the State or water users associations and the owners of the private ditch systems. There are 14 sizable systems of this type along the main river channel which serves a large proportion of the water users. Six of the larger ditch associations were contacted. Data as to the number of users per ditch, acres irrigated, and acres irrigable are shown by table XXI. Two of the users under ditch number 1 said it is not in condition for use. When asked why they did not clean and repair the

Table XXI - Six Private Ditch Associations, Numbers of Users, Acres Irrigated and Acres Irrigable.

Ditch no.	No. users	Acres irrigated	Acres irrigable
1	4	1279	2709
2	26	500	644
3	5	387	427
4	13	1047	1221
5	7	700	730
6	5	1180	1541

Source: "Water Resources Survey", State Engineer's Reports for Wheatland, Golden Valley, and Musselshell Countries.

ditch they stated that it would do no good because users farther up the ditch would take all the water anyway. Ditch no. 2 is the Sims Ditch at Ryegate. This ditch was abandoned except for two users until the spring of 1951. At that time the ditch was cleaned and repaired and considerable abandoned irrigated land has been reclaimed under it as well as new acres brought into production. Ditch no. 3 was reported to have been in continuous use, however, the water supply was reported very short at times prior to 1940. The history of ditch no. 4 was very similar to no. 2. The water supply to ditch no. 5

was very erratic until 1940. Use has been continuous since that time. Very little new irrigated land has been brought into production under ditch no. 6. It is evident that water users under private ditch systems must be required to iron out their differences and organize for water use prior to the time that storage systems are undertaken.

Water rights Water rights along the Musselshell River have not been adjudicated. Every water user claims an appropriators right of one sort or another. The Water Board has storage rights and one of the last rights in the basin. It has the right to store flood water which is water that would not be put to beneficial use by any user who holds a prior water right. Water deliveries are complicated by the lack of measuring devices for private ditch systems. The Board can "require" that all water users construct and maintain such structures; however, this cannot be enforced short of court litigation of water rights or through easement by condemnation.

Early water right holders tend to "take over" the management and distribution of water under many of the ditch systems. This hinders water distribution and acts as a resistance to irrigation development.

Old antiquated water rights have been revived as well as enlarged upon in many instances. One operator in the vicinity of the Town of Shawmut stated that he considered he had a water right for the irrigation of about 550 acres of land by virtue of the fact that there is an early water right filing describing the lands he intends to irrigate. The contingent problem of these old water rights was recognized by Iakisch in his examination of

the Musselshell drainage area in 1932. 20/

Users associations have assumed little or no responsibility with regard to water rights problems. They have evidently made no effort to alleviate problems steming from eroneous water right claims. In view of the fact that any measures to enforce a more effective distribution of storage water would necessarily require considerable local support from water users the Water Board has been reluctant to take any action. In view of these circumstances as soon as a storage is completed all or some part of the water users claim an "old" water right which may in fact be an early filing for a limited acreage of land. By virtue of this they immediately claim an immunity to all or some part of their responsibilities to the project.

Integration among agencies Since the Water Board limits its activities to the engineering phases of the problem, particular interest to this study was the cooperation and amount of integration practiced between the Water Board and other agencies and individuals performing technical, credit, and other functions. The Water Board is represented on the Federal Interagency Committees. It also has working agreements with the Soil Conservation Service, the Farmers Home Administration, and other agencies. The actual amount of integration practiced between the Water Board and other agencies appears negligible. Soil surveys were being made of the land on Petrolia Bench by the Soil Conservation Service during the summer of 1951 after the Water Board installations were about completed. There was no evidence of soil surveys in other instances except as individual farm

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20/ Iakisch, J. H., Op. cit., p 42.

or ranch operators requested. It was also found that the Soil Conservation Service was carrying out irrigation development programs with cooperators who were either delinquent in their water contracts with the State or in some instances operators who had no contracts at all.

The operation of the Farmers Home Administration is similar to the Soil Conservation Service. Either come into the development process when called upon to do so by individual farm or ranch operators, provided funds and personnel are available to do so.

The problem of agency cooperation was effectively pointed out by a student of resource economics when he said, "Agencies get together to cooperate in a joint program after their budgets are set up to provide for their own individual programs". Accordingly, there are seldom either funds or personnel that can be diverted to a cooperative effort. The integration that takes place is of a very indirect nature. Agencies plan their activities in accordance with the effects of past programs of other agencies - not in anticipation of what other agencies plan to do.

PART IV

CONCLUSION

Summary

The public development program in the Musselshell River Basin was initiated at a time when underemployment and general instability both in and out of agriculture was the focal problem. The act creating the Montana State Water Conservation Board was primarily for the purpose of guiding an emergency program of a vast magnitude and which required expedient action. Works were therefore commenced and completed with a minimum consideration for details except for those involving engineering techniques. In view of this fact the program got off to a start with a minimum of organization of any kind including committments as to areas of responsibility to the program.

The enabling act of the Montana State Water Conservation Board is a very comprehensive act. It extends to the Board adequate authority to enter into firm contracts with any qualified person, concern, or governmental unit. By virtue of this fact it can function in a very versitile and comprehensive manner. The Board can therefore negotiate and otherwise organize a program at any level including individuals, local government units, and the Federal Government.

It appears evident that the Water Board has made a direct effort to integrate the various works within the Musselshell River drainage on a drainage wide basis. The Durand, Martinsdale, and Deadman's Basin Reservoirs can be operated in unison as a single unit. The Yellow Water and Petrolia reservoirs can be operated jointly and all can be coordinated at the lower extremities of the drainage including the Valentine Dam. It is also evident

that the Board has not sold their storages short in any instance as near as can be determined from available information on storage capacities. This provides for considerable flexibility in the use of water in both the short and long run.

There has been some agitation from water users and other persons to purchase the storage reservoirs and other installations and turn these over to the users associations. The Board has refrained from selling any of the storage systems to date. Sale would be adverse to the public interest for several reasons. First, no storage unit is a distinct project in itself. All are coordinate and can most nearly serve the needs of the drainage area if operated accordingly. Second, local interests to limited sectors of the drainage are not in harmony with interests over the drainage as a whole or with the State and Nation. Water distribution and control is a state and national interest and accordingly a state and national responsibility. Third, public ownership of the works affords flexibility to the future since demands and needs change through time. Public ownership makes it possible for such changes to be made readily when needed. Fourth, it is very doubtful if local users associations could or would assume the responsibility of upkeep and maintenance or the liability involved in the ownership of the major storages and works.

The policy of the Board with regard to water contracts between the Board and water users has placed a minimum burden on the water users during the land development period. Unlike the obligation created under the conventional irrigation district organization, the Board requires payment only for the amount of water used without regard to irrigable acreages under the

project. The water user can therefore assume a minimum obligation during the early stages of unit development when he can least afford to carry a heavy debt burden. The real advantage of this feature to a new settler is neutralized to a large extent because the value of water along with advantages offered by the program becomes capitalized in land prices.

Suggested Improvements

The most apparent weaknesses of the program of the Water Board results from (1) the limited interests of users associations, (2) the evasion of responsibility to the project by users associations, and (3) the lack of a set of principles to serve as a guide for project selections and development.

Under present policy a group of persons or representatives for a group contact the Water Board with regard to the construction of a certain project or works. The basis for project determination therefore depends on the interests of a limited group. In the event a project is deemed feasible by the Board and funds are available for construction the works is completed. It is then administered by the interest group that originally promoted it. Though such evidence of demand is highly important it is apparent in the case of the Musselshell River developments that such evidence of demand may fall far short of the over-all demands and needs of the drainage area. It is therefore believed that the task of contacting the Board should be that of the county commissioners who represent the interests of the entire county. In instances where the proposal involves more than one county, commissioners from all counties effected should be called in by the Board. Since the Board represents the over-all state interest it should provide for represent-

ation from the various governmental agencies concerned with State and Federal programs such as for fish and wildlife and flood control. In order to facilitate a determination in each case that would most nearly suit the public interest, all interested persons and agencies should be required to furnish detailed reports or explanations as to the interests they represent and plans for executing a program. Some such organization of demand is necessary to more clearly express the public interest.

There is a need for firm committments from the various interest groups and agencies as to the contribution each will make and the responsibilities each will assume. This is not to say that an intricate organization is always needed. It may be that two or three ranchers or farmers request the construction of a storage system. The purpose of the Board is to satisfy any feasible need. However, there should be firm committments as to what is to be accomplished and whom is to be responsible for it. These should be negotiated prior to any other action. Negotiations should be between the Board and the county or counties and other agencies involved and not between the Board and any group of individuals. Though it is believed that local groups should be left relatively free to operate their organization as they see fit they must be held responsible to the program in relation to local benefits derived from it. It is evident from experiences in the Musselshell River Basin that organization by the local group will determine in large part the benefits that can be expected and accordingly the feasibility of the project.

Under present policy the Board is extremely vulnerable to special interest pressures. These pressures are brought to bear on the Board through

legislative channels by actions effecting appropriations. Such tactics can not be entirely eliminated. They can, nevertheless, be appreciably reduced provided information about resources is developed to serve as a factual basis for decision making and such information is made available to the general public. An inventory and analysis of resources and resource potentials is a highly complex problem. It calls for analysis and judgements by the most competent personnel available from a wide variety of specialized fields. Since the justification for public participation in resource development is the public interest involved, the inventory and analysis should be the responsibility of the public. The most qualified organization of personnel on a state wide basis is the state experiment stations. Such a responsibility suite the objectives of the experiment stations since they were created for the purpose of furthering industrial technology and the social welfare. It would be necessary for the legislature to appropriate funds for the experiments stations to carry out this work. This might be expected to meet with considerable resistance as a number of groups in the society in the past have evidenced objections to government paid educators and researchers becoming involved in studies other than for the compilation of purely statistical data. A statistical report, however, would be far better than no information. The public is becoming more capable of disseminating technical data. These data should be made available to both the general public and the legislature somewhat in advance of the time that the legislature is to meet. The availability of such data would alleviate and possibly eliminate circumstances that have occurred in the past where the most objective and effective data available to legislators and the public

has been the utter lack of any information regarding kinds and amounts of resources.

Limitations of The Study

Data used in this study are derived from the most complete information available. Though it is considered to be reasonably accurate it is in most instances estimated or derived from estimates. It should also be evident to the reader that parts of the paper are not fully developed and accordingly is in some respects incomplete.

As pointed out throughout the text of this thesis the solution or solutions to the problems involves study into a number of highly specialized fields. A study of this type is therefore not one that can be resolved in detail either by a generalist or by any particular type of specialist.

Conclusion

The purpose of this study was to determine the type of organization required to satisfy the needs of the problem area. To serve any real purpose the organization must accomplish one of two things. First, it would have to accomplish ends desired by the public that are not being satisfied in the absence of the organization, or second, do a better job of satisfying public needs than other agencies or concerns are now doing.

It is evident from the study that private investors acting alone or in small groups can accomplish very little. It would appear evident that a large concern having considerable financial resources could develope a drainage that has the resource potential of the Musselshell River to the extent that this has been accomplished to date since it appears from this study that the financial considerations have been much less significant than the

organizational elements in the problem. This is not to suggest that such organization would be more nearly in the public interest since much of the public interest in resource development is not financial in nature or in some cases even economic.

It has been stated that an intermediate - State organization - has an advantage over a Federal organization due to lower overhead costs. 1/ This may be true, however, any advantage enjoyed by such organization should not be at the expense of costs to be incurred at some future date. Defered costs that result from poor soils, ripening costs, land speculation, or resource depletion are all a part of the cost to the public. Stated differently, there is nothing to be gained by bypassing sound organization and economic principles.

What appears to be the major objection to Federal Reclamation in the problem area is not economic at all but rather an institutional problem. The main resistance to the Federal Agency is due to acreage limitation and anti speculation measures imposed by Federal law which are objectionable to large land owners. There are some advantages to the absence of such laws since such regulations are many times too inflexible and consequently in some instances defeat the purpose for which they are intended. It should be born in mind however, that the problem of excess lands and the leakage that results from land speculation is just as real and equally significant from a

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1/ Lawrence, James E., et al., "Missouri Land And Water", The Report of The Missouri Basin Survey Commission, United States Government Printing Office, Washington, 1953, p 247.

public interest viewpoint without acreage limitation and anti speculation laws as with them.

As the more select opportunities for development are completed and costs of projects increase the problem of resource development will become increasingly more difficult. It would seem only fair to conclude that if the State sponsored program is to make any significant contribution to resource development in the future it will have to (1) adhere much more closely to sound economic principles than it has done in the past, and (2) adapt a sounder policy by which responsibilities are distributed in accordance with interests and benefits recieved.

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