Economic Evaluation of Stockwater Developments[1]

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Highlight

Stockwater development offers a good possibility for favorable returns on investment. By analyzing proposed development projects as described here, a rancher can make sounder economic decisions concerning range improvement practices.

Ranchers and government land agencies have long recognized that good range management requires proper location of livestock watering facilities. Many wells and springs have been developed to improve range utilization. Ranchers contemplating such investments, however, must be able to determine whether the returns resulting from a water-development practice will exceed the costs of initiating and maintaining the practice. This paper is concerned primarily with the economic decision a rancher has to make before he commits his own resources to a water project. It does not consider the many issues a public land administrator may have to face before he invests public funds.

An economic study of spring and well development practices used by ranchers was conducted in Utah during 1962 and 1963. Physical data were obtained from ranchers and government agencies involved in water development. Prices for materials, labor, and other factors as well as for the marketable products were obtained from firms and agencies servicing ranchers. Physical requirements and costs of commonly observed spring and well-development practices were synthesized from all available information for two types of spring and four types of stock-well developments.

The physical features and costs of each practice are described, and the actual and probable benefits and returns resulting from each project are considered. Finally, a method is suggested for deciding whether a proposed project is economically feasible.

Spring Development

Small Springs—The potentials of small springs should not be underestimated. A trickle of water that amounts to no more than two quarts per minute can be harnessed and stored so it will supply enough water for 35 head of cattle (Waller, 1958).

Developing a small spring commonly involves digging it back to a central source where a concrete collection box is constructed. The water is usually directed to the collection box through pipe. Another carries the water from the box directly to a watering trough. Ranchers seem to prefer long, shallow troughs and special precautions are taken to locate the watering trough away from flood danger. Also, the spring area is generally

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fenced to keep stock out. The materials and costs involved in developing a typical small spring in Utah in 1962 are listed in table 1.

Large Springs—Water from large springs is generally developed at the spring site and conveyed some distance to where it is used. A project usually includes the initial development work, construction of a large-capacity storage facility, and a pipe laid from the source to the point of use. The storage tank, placed near the spring site, is often used as a watering facility as well as to feed the pipeline which may have several float-controlled watering troughs. After the desired route is determined, the area is surveyed, and the necessary slope is achieved. The pipeline is installed underground to prevent freezing. Soil Conservation Service personnel sometimes aid in obtaining the right slope and laying the pipe correctly. A tractor and a heavy ditcher are often used to make and cover the pipeline trench. Materials and costs required for a typical large spring development in Utah are shown in table 2.

Table 1. Small spring development costs in dollars, Utah, 1962.

Item	Type	Size	Amount	Cost unit	Total Cost
Machinery					
Truck	pickup		7 hrs	3.00	21.00
Labor					
Man			48 hrs	1.50	72.00
Horses			6 hrs	.75	4.50
Materials					
Pipe	galv.	1.5 in	20 ft	.52	10.40
	tile	4 in	9 ft	.35	3.15
Cement			1 bag	1.50	1.50
Sand & gravel					1.00
Lumber	No. 2	2 in x 12 in	10 ft (2)	.13/bd ft	5.20
Poles			12	1.00 ea	12.00
Posts			8	1.00 ea	8.00
Trough		2 ft x 18 ft			42.00
Misc. supplies					1.00
Total Cost					181.75

Table 2. Large spring development costs in dollars, Utah, 1962.

Item	Type	Size	Amount	Cost unit	Total Cost
Machinery					
Tractor	D-2		55 hr	3.00/hr	165.00
Truck	pickup		15 hr	3.00/hr	45.00
Labor					
Man hours			150 hr	1.50/hr	225.00
Materials					
Pipe	plastic	1 in	5280 ft	.09/ft	475.20
	tile	4 in	12 ft	.35/ft	4.20
	galv.	1.5 in	40 ft	.52/ft	20.80
Cement			2 bags	1.50 ea	3.00
Sand & gravel					2.00
Poles			12	1.00 ea	12.00
Posts			4	1.00 ea	4.00
Trough	steel	395 gal			52.00
Float valve assembly					5.00
Fittings					10.00
Misc. supplies					10.00
Storage facility	concrete	7000 gal			
Concrete			11 yd	15.00/yd	165.00
Rod	reinforcing	.5 in	450 lb	13.30/cwt	60.00
Labor			50 hr	1.50/hr	75.00
Misc.					20.00
Total Cost					1,353.20

Stockwell Development

The physical characteristics of stockwells vary markedly among wells and among ranges. However, costs of construction and operation are related closely to the size of the casing, the depth of the well, the height of lift, and the source of power.

A large storage capacity is desirable at wells to reduce the number of pumpings and make the project more dependable. Any of various types of storage facilities can be used so long as water evaporation and leakage are minimized. Four examples of common well construction in Utah are detailed here. An individual rancher should generally be able to adapt one of the plans to his special situation.

Example 1—A 6-inch casing is drilled to a 100-foot depth and water is lifted 50 feet to the storage facility by a power pump jack. The pump jack is driven by a 2-hp gasoline engine which gives dependable, shallow-well, pumping service. A 7,000-gallon concrete tank provides adequate storage. The project costs about $1,500 (table 3).

Example 2—A 6-inch casing is drilled to a 250-foot depth and water is lifted 150 feet to a 7,000-gallon concrete storage facility. Electricity is available within ¼ mile of the well and provides the power source, so the well is equipped with a 1-hp submersible type pump. The initial cost for this well is about $3,000 (table 4).

Table 3. Example 1, stockwell development costs in dollars, Utah, 1962.

Item	Type	Size	Amount	Cost/unit	Total cost
Drilling well[1]		6 in	100 ft	6.00	600.00
Equipping well					
Power pump jack					219.00
Cylinder		3.5 in			40.00
Engine		2 hp			45.00
Drop pipe	galv.	2 in	50 ft	.71/ft	35.50
Pump rod	steel	.5 in	50 ft	.25/ft	12.50
Installation[2]					
Storage facility[3]	concrete	7000 gal			320.00
Total Cost					1,492.00

[1] Includes cost of pipe and drilling.
[2] Contract installation cost 50 miles from installer's place of business.
[3] Includes labor, materials, and transportation for constructing facility (table 2).

Table 4. Example 2, stockwell development costs in dollars, Utah, 1962.

Item	Type	Size	Amount	Cost/unit	Total Cost
Drilling well[1]		6 in	250 ft	6.00/ft	1,500.00
Equipping well					
Pumping unit	submersible	1 hp			310.00
Electric wire			150 ft	.24/ft	36.00
Well seal		1 in			9.35
Pipe	galv.	1 in	150 ft	.35/ft	52.50
Pump installation[2]					200.00
Electricity installation			.25 mil.		595.00
Storage facility[3]	concrete	7000 gal			320.00
Total Cost					3,022.85

[1] Includes cost of pipe and drilling.
[2] Contract installation cost 50 miles from installer's place of business.
[3] Includes labor, materials, and transportation for constructing facility (table 2).

Table 5. Example 3, stockwell development costs in dollars, Utah, 1962.

Item	Type	Size	Amount	Cost/unit	Total Cost
Drilling well[1]		6 in	250 ft	6.00/ft	1,500.00
Equipping well					
Pumping unit	reciprocating				186.00
Engine	4 cycle	3 hp			57.00
Pump rod	wood/ galv.	1 ⅛ in	150 ft	.40/ft	60.00
Cylinder		2 ¾ in			44.00
Pipe	galv.	2 in	150 ft	.71/ft	106.50
Installation[2]					200.00
Storage facility[3]	concrete	7000 gal			320.00
Total Cost					2,474.10

[1] Includes cost of pipe and drilling.
[2] Contract installation cost 50 miles from installer's place of business.
[3] Includes labor, materials, and transportation for constructing facility (table 2).

Example 3—Again a 6-inch casing is drilled to a 250-foot depth, and the water is lifted 150 feet to a 7,000-gallon concrete storage tank. However, a 3-hp gasoline engine with a reciprocating type pump is the power source. This combination has proven its reliability as a deep-well unit and can deliver over 400 gallons of water per hour. The total cost is about $2,500 (table 5).

Example 4—A 6-inch casing is drilled to a 300-foot depth and the water is lifted 200 feet. Wind is the source of power. The pumping unit includes a 12-foot diameter windmill on a 27-foot tower. A wooden pump-rod is run to the working barrel through a 2½-inch galvanized drop-pipe. This type of unit can provide economical and durable service for a long time. The water storage facility is a galvanized steel tank with a concrete bottom. The capacity is over 14,000 gallons. Total costs are about $3,700 (table 6).

Benefits From Stockwater Development

Benefits to a rancher from investing in stockwater projects can take several forms. First, a project may result in increased carrying capacity for a range by lengthening the season of use, spreading usage more evenly over the range, or opening up new range to grazing. The added use will be in terms of animal unit months (AUM's) of grazing. AUM's can be priced at whatever a rancher feels a new AUM is worth to him. The AUM price for privately owned range similar to his in the area is a good indication of a market price.

Second, a water project may result in increased marketable livestock products such as greater calf- or cow-weights and reduced death loss. These added products can be converted to value by using applicable livestock market prices.

Table 6. Example 4, stockwell development costs in dollars, Utah, 1962.

Item	Type	Size	Amount	Cost/unit	Total cost
Drilling well[1]		6 in	300 ft	6.00/ft	1,800.00
Equipping well					
Windmill		12 ft			476.00
Tower		27 ft			254.00
Working barrel		2¼" x 25"			40.80
Drop pipe	galv.	2.5 in	200 ft	1.00/ft	200.00
Pump rod	wood	1⅛ in	230 ft	.42/ft	96.60
Misc. equipment[2]					50.00
Installation[3]					300.00
Storage facility	galv. steel concrete	14,000 gal			
Tank		31' x 3'			223.00
Freight					40.00
Concrete			10 yd	15.00/yd	150.00
Labor			40 hr	1.50/hr	60.00
Total Cost					3,690.40

[1] Includes cost of pipe and drilling.
[2] Additional materials for equipping well: stuffing box, pump standard, etc.
[3] Contract installation cost 50 miles from installer's place of business.

Third, a project may result in a labor- and machine-use savings, especially if water had to be hauled to the animals before the project was completed. The wages and machine costs saved should be considered benefits derived from the project.

Fourth, a water project may reduce the non-range feed needed by a rancher. This would release capital for other uses. The savings made should thus be considered a benefit resulting from the project.

Ranchers need to determine the economic benefits that they can expect as a result of investing in a stockwater project; then with cost information available as well as reasonable benefit expectations, they can make economically rational decisions concerning the initiation of water development projects.

Return on the Investment—In deciding whether to invest in a water development practice, a rancher needs to determine what economic yield he is likely to realize on his investment (Gardner, 1962). This yield or rate of return on the investment can be used as a guide in decision making. If the rate of return on the investment is expected to be greater than would result from any other use for the money and also greater than the rate of interest paid for money he might have to borrow, then the rational decision is to invest in the project. If, on the other hand, the money is expected to return more if invested in some other use or if the expected rate of return is below the interest rate on money he may have to borrow, then the rational decision is not to invest in the project.

The rate of return on the project investment can be calculated if the initial project cost, the expected life time of the project, and the increase in the annual flow of net ranch returns over the life of the project can be estimated. Sometimes the increase in the annual flow of net ranch returns cannot be estimated adequately. In that case the rate of interest associated with credit sources in the area can be used as a criterion and the increased annual net ranch returns required to yield that rate are calculated. If the expected increase in annual net ranch returns exceed those calculated, then the project is at least economically feasible. If the expected increase in annual net ranch returns is less than those calculated, then the project is not economically feasible since the money invested costs more to borrow than it returns in the project.

To illustrate the usefulness of the rate of return concept as a decision making guide, some sample calculations are given using data from typical stockwater development practices in Utah.

Required Returns — Suppose that it costs $182 to develop a small spring for a 48-cow ranch, and that these costs are all incurred the first year of the project which is expected to last 20 years. Also, suppose that annual ranch operating costs increase $19.00 over the life of the project, and that money could be borrowed at an interest rate of 7 percent. The annual increase in net ranch returns necessary to yield a 7 percent rate of return on the investment can be closely approximated by using the following formula and a table showing the present value of an annuity of one dollar over the life of the project (Burington, 1947).

(1) $$AX = Y$$

Where:

A = the present value of a dollar received annually for 20 years at 7 percent (to be read from a present value of an annuity table).

X = the increase in net ranch returns received annually as a result of the project.

Y = the initial investment in the project.

From the information above,

$A = 10.594$

$Y = \$182$

Therefore,

$$X = \frac{\$182}{10.594} = \$17.18$$

and $17.18 + $19 = $36.18 which is the increase in gross returns necessary each year for 20 years

Table 7. Costs and annual increased returns in dollars, necessary to make stockwater developments feasible for 20-year projects and a 7 percent interest rate, selected Utah Cattle ranches, 1962.

			Ranch size[1]			
			48 cows		150 cows	
Project	Initial investment	Annual net returns required to repay initial investment[2]	Expected change in annual operating costs	Total returns required to cover investment and increased operating costs	Expected change in annual operating costs	Total return required to cover investment and increased operating cost
Small spring	182	17.18	19	36.18	19	36.18
Large spring	1,353	127.71	89	216.71	89	216.71
Wells						
Example 1	1,492	140.83	243	383.83	295	523.83
Example 2	3,023	285.35	291	576.35	300	585.35
Example 3	2,474	233.53	309	542.53	382	615.53
Example 4	3,690	348.31	195	543.31	195	543.31

[1]The ranches used here are representative of ranches using Forest Service ranges in the summer and privately owned feed sources for the balance of the year.
[2]Calculated by using formula 1. Net returns might be increased by reducing ranch operating costs rather than by increasing total returns. In either case the analysis is valid.

to cover the initial investment plus the annual increase in ranch operating costs because of the project.

Over the life of the project, the increase in annual returns must not only pay back the initial investment but must also cover any increase in annual ranch operating costs. The 48- and 150-cow ranches studied in Utah typically had annual operating costs of $6,483 and $12,149 per year (Nielson, 1964).[2] Using these ranches as examples, their expected changes in operating costs, the net returns required to cover the initial investments and increased annual operating costs over 20 years at 7 percent are given relative to the six model projects discussed earlier (table 7). The two ranches have different return requirements because some costs are necessarily related to the number of animals served by the project. The increase in pounds of livestock products that would be required to provide the indicated needed returns can be estimated. Simply divide the total return requirements by the price received per pound of products produced.

The above analysis applies regardless of the source of increased net ranch income. The project may result in reduced labor costs but also increased maintenance, power, and depreciation costs. The expected annual net savings will also be the increase in annual net return available to pay off the initial investment at the specified interest rate.

Rate of Return for Selected Cases.—Present value of annuity tables may also be used to calculate the rates of return from actual stockwater developments, provided an estimate of the increase in annual returns is available. In this case formula 1 still applies except (A) is unknown and (X) is known.

As an example, consider one rancher who invested in two large springs. His initial investment for developing the springs was $2,210. The physical features of the springs were similar to those in table 2, although their average development costs were about $250 less per spring because of the difference in length of pipeline and size of storage facilities. It cost $160 annually to maintain the springs over the 20-year life of the project. The rancher estimated that the carrying capacity of his range increased by 147 AUM's as a result of the project. If an AUM can be leased for $3.50, the total annual increased returns equaled about $515. Subtracting the annual operating costs of $160 from the increased returns left a net cash flow of $355 per year. The determination of the rate of return is as follows:

From formula 1

A is unknown for 20-year project life

$X = \$355$

$Y = \$2,210$

Therefore,

$$A = \frac{\$2,210}{\$355} = 6.225$$

and, 6.225 is the 20-year discount factor found in the present value of an annuity table that will equate the net annual flow and

[2] *Nielson, Robert Max. 1964. Economic evaluation of stockwater development practices on mountain cattle ranges in Utah. Utah State University. M. S. Thesis (unpublished), pp. 56-78.*

$2,210 at about 15 percent. This return can now be compared to the rate of interest on borrowed money to determine if the project is feasible.

Three ranchers interviewed had reliable estimates of increased AUM's of grazing resulting from water development projects. One rancher realized a gain of 147 AUM's of grazing and was described in detail in the previous example. The second developed five small springs at a cost per spring equivalent to that in table 1. He estimated an annual increase of 270 AUM's. The third developed an example-2 stockwell at about the cost indicated in table 4. His gain was 225 AUM's of grazing. Rates of return for these cases were calculated for 20 and 15-year project lifes and grazing values of $5, $3.50, and $2 per AUM (table 8).

Table 8. Rates of return for three actual water development projects applied to a 150 cow ranch, Utah, 1962.

	Project life					
	15 years			20 years		
	Price $ per AUM			Price $ per AUM		
	2.00	3.50	5.00	2.00	3.50	5.00
	(Percent)					
Large spring, (2 springs)	*	14	24.5	2	15	25
Small spring, (5 springs)	48.5	**	**	49	**	**
Example 2 well, (1 well)	*	14	26.5	*	15	27

* Less than ¼ percent.
** Over 50 percent.

The returns listed in table 8 are generally high. All projects of these types could not be expected to be equally productive. Much depends upon the relative efficiency of range use at the time projects are initiated. If lack of stockwater has been limiting the use of the range, extremely high rates of return are possible. The cases of stockwater development used in the rate of return analyses presented here, are examples in which development has been vital to gaining use of the range.

The analyses above have assumed that all development costs are paid by the rancher. In reality, however, these practices are eligible for federal (ACP) cost-sharing payments. Rancher utilization of these federal programs greatly reduces the investment cost to him thus increasing the rate of return on his investment.

Conclusions

Stockwater development is a range improvement practice that offers a good possibility for favorable returns on investment. Sample rate of return calculations have been limited to actual cases because generalized statements as to expected rates of return must be based on reliable benefit data. Such data are virtually unavailable in the literature or from ranchers. The rates of return calculated from our severely limited observations were favorable; however, this does not indicate that such returns are inevitable from water development projects. Results obviously depend upon the individual situation. When lack of stockwater seriously limits the usefulness of a range, high rates of return are reasonable expectations.

By analyzing proposed development projects in the manner described herein, a rancher can make more rational economic decisions concerning range improvement practices. More research on the impact of range improvement practices on the physical and economic organization of ranches would provide more reliable estimates of changes in costs and returns resulting from the introduction of these practices.

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