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# MEASURING STATE AND REGIONAL ECONOMIC EFFECTS OF LAND RETIREMENT IN AN IRRIGATED RIVER BASIN

by

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## INTRODUCTION

The Pecos River originates in New Mexico in a region of sparse and diverse rainfall. This river basin also includes a large artesian aquifer that is linked to the surface flows of the basin. The river and the aquifer are heavily used for irrigation in New Mexico accounting for about 200,000 acres of irrigated land. This level of irrigation has a significant influence on the amount of streamflow that eventually enters Texas. The amount of water delivered to Texas by the Pecos River has been in dispute for most of this century. Recently the United States Supreme Court ruled that New Mexico was using excessive amounts of water in the Pecos basin and was in violation of a compact between the two states. As part of the Court decree New Mexico is required to increase flows to the state line. To accomplish this, New Mexico must alter its level of water utilization by reducing the amount of irrigation in the basin.

The history of Pecos River deliveries to the Texas state line indicates a cyclical pattern that ranges from a series of years with major shortfalls to several years that can include over-deliveries. However, accurate long run predictions of anticipated shortfalls or over-deliveries are very difficult. Given the current level of water use in the Pecos River basin of New Mexico, there is a constant risk of New Mexico encountering shortfalls in state line deliveries that now must be quickly replaced. Under decree from the U.S. Supreme Court, annual shortfalls that result in net deficit deliveries to Texas require that New Mexico implement a procedure to erase the deficit within six months. Surplus deliveries can be carried forward indefinitely as credit against future shortfalls.

Under this decree, New Mexico can continue to operate without a permanent solution to the water delivery problem, living with the uncertainty of shortfalls that must be overcome. A "do nothing" strategy involves considerable risk of encountering shortfalls that would impose large and immediate costs on the region and state in order to erase delivery deficits. The state can also implement permanent solutions to the problem that will avoid the risk and uncertainty of possible delivery deficits. Such permanent solutions will involve differing levels of cost and cost distribution for residents of the region and state. The purpose of this report is to generate information about alternative policies that New Mexico may follow in dealing with this problem. The report analyzes economic costs of three choices that were available to New Mexico at the time of the study.

1. Single Year Injunction
   This scenario anticipates operation under present circumstances wherein a permanent solution to the problem is not in place. It requires that sufficient primary and supplemental water rights be curtailed in priority order in a single year to replace current deficits in state line deliveries. No compensation is provided for owners of water rights that are curtailed in this manner. It is

assumed that the water rights would return to use the following year and continue until the next deficit is incurred.

2. Lease/Purchase:
A permanent solution is achieved by purchasing and retiring sufficient strategically located irrigation water rights within the basin to meet a required increase in average deliveries to Texas, and to accrue a sufficient credit to avoid shortfalls during prolonged drought periods. Farmers would willingly sell water rights to the state for a price that would fully compensate the value of all fixed assets associated with irrigation farming.

3. Post 1946 Retirement:
A solution is provided through a permanent retirement of all water rights in the Pecos River basin issued in New Mexico after 1946, the water rights deemed by the Court to be in violation of the river compact. This approach would include no compensation to present owners of post 1946 rights for asset losses involved in the shutdown. The distribution of costs would fall heavily upon local residents.

Each scenario is evaluated for both direct and indirect costs on the regional and state economies.

## PROCEDURE

### Definition of Direct and Indirect Impacts

Farms that are shut-down for lack of water cease to provide income to their owners and farm workers. These effects are as "direct income impacts" to be measured as dollar costs in net present value terms. Note that all direct (primary) costs of non-agriculture water rights curtailment are measured in terms of equivalent irrigated agriculture.

There are off-farm or "indirect income impacts" as well. With the shut-down of farms a host of input expenditures are avoided. In a single-year shutdown the farm avoids normal variable input expenditures, e.g., expenditures for fuels, fertilizer, pesticides, seed, hired labor, custom tillage and harvesting, transportation, and so on. If the curtailment is permanent, as with the Lease/Purchase (L/P) and Post 1946 scenarios, fixed expenditures are also avoided.

To the extent that avoided expenditures represent reduced sales from local firms, there will be a loss in income in these firms. Such firms will in turn reduce their local purchases, causing still further local income losses. These are the off-farm or indirect income impacts, and the sum of these constitutes the total indirect income impact, measured as a dollar cost to the state or region.

### Estimating Regional Economic Impacts

Direct income impacts are determined with the aid of representative 1992 farm income statements, or farm budgets. These budgets also indicate changes in farm input expenditures which are used in the estimation of indirect impacts. The data used to determine the types of crops, methods of irrigation, and sources of water affected by the land retirement are provided by Lansford et al. The costs of production and net farm returns used to estimate agricultural costs of

land retirement are provided by New Mexico State University Cooperative Extension Service (Libbin).

Indirect impacts reflect the action of a regional economic multiplier effect, and estimating this multiplier effect requires a regional economic model. A set of income multipliers was assembled from the U.S. Forest Service IMPLAN regional input-output modeling system, and accompanying 1985 data for New Mexico counties. In constructing the regional economic model, IMPLAN "type III" value added multipliers are utilized. "Type III" refers to IMPLAN's method of generating "induced," or household-inclusive multiplier effects. Value added is simply a broad measure of income that includes all factors of income, including that portion of income set aside for depreciation.

With some variation among scenarios, the formal operation of the model appears as:

$$(1) \qquad II = \sum_{i=1}^{n} b_i(\Delta C_i + \alpha_{ci} \cdot \Delta DI)$$

where $\Delta$(greek delta) denotes change and:

$II$ = indirect income.

$b_i$ = Type III IMPLAN income (value added) multiplier for sector i, indicating total change in regional income per dollar change in expenditures on commodity i.

$C_i$ = change in farm input purchases of commodity i.

$\alpha_{ci}$ = coefficient indicating personal consumption expenditures on commodity i per dollar of regional income.

$DI$ = direct net farm income.

Estimating spillover effects with precision requires a multiregional input-output model, but no such model is available for New Mexico. Hence, the estimate of spillover effects is based on a multiregional input-output model constructed for a multi-state functional economic region centered on Salt Lake City, Utah, which indicates rural to urban spillovers of approximately 20% (Robison et. al., 1993). We assume a similar spillover applies in the case of the rural Pecos drainage economy. There is, however, an additional complicating factor. As suggested by Hamilton et. al., 1991, in terms of economic dominance, the rural Pecos drainage economy is focused in two directions: to Texas (Amarillo, Lubbock, and El Paso) and to greater New Mexico (Albuquerque). Recognizing this two-way multi-state dominance, an equal 10% spillover to both Texas and greater New Mexico is assumed. Accordingly, impacts are estimated for the small-area Pecos drainage economy with a model of the region of the form indicated in (1), and then an additional 10% of this small-area impact is assumed to spillover to greater New Mexico, and another 10% to West-Texas.

## Impacts versus Costs

In choosing among the three policy alternatives, decision-makers are fundamentally interested in their relative *costs*. Costs, specifically indirect costs, and impacts are not the same thing. Impacts are more inclusive. As Hamilton et. al. (1991) have shown, adjustments must be made to "impacts" to arrive at "costs."

In estimating regional economic impacts, models such as IMPLAN (I-O models) make a number of assumptions regarding the functioning of the regional economy. Most notably, these models assume fixed prices and infinitely elastic supplies of all commodities, including labor. If the farm sector reduces its purchases of farm inputs, the I-O model assumes those inputs then stand unsold, and the affected farm labor stands unemployed.

In reality, a myriad of interrelated price effects, or "general equilibrium effects" come into play. Farm-linked labor is part of a larger multiregional labor market, and this labor market will exhibit a degree of price responsiveness in both supply and demand – a price responsiveness not captured by regional I-O models.

Recognition of price-responsive supply and demand relationships means that some of the income lost to unemployment indicated by the regional I-O model in fact will be reemployed in other regional and multiregional industries. In moving from measurement of impacts to measurement of costs, lost income in farm-linked industries must be expressed net of income gained in reemploying industries. The reemployment of farm-impacted productive factors will occur according to some time profile. A portion of the factors will find new employment immediately, while others will take longer. With the passage of time it is reasonable to expect all mobile factors, i.e., labor and mobile capital, to be fully reemployed.

Immobile factors, principally land, buildings and some machinery, cannot respond to next-best opportunities elsewhere. However, this does not necessarily mean a one-to-one correspondence between impacts and costs. Machinery, buildings, and the improvements in land that give rise to income all require periodic expenditures on maintenance and repair. Absent these expenditures, the productivity of immobile factors depreciate to zero over time. It is incorrect to measure as lost income, and therefore as cost, a return to immobile factors that no longer exist due to unchecked depreciation.

Costs are estimated by reducing impacts to reflect the reemployment of mobile factors, particularly labor, and the depreciation of immobile factors. Unfortunately, the economic literature provides little guidance, empirical or otherwise, on the reemployment/depreciation issue. Accordingly, an assumption is used to specify a parameter of unemployment, $\gamma^t$ which is an exponential function of time t with base, $\gamma$ equal to 0.8.

$\gamma^t$ captures the portion of mobile factors unemployed at time t due to the modeled action, and the portion of immobile factors undepreciated, and therefore unemployed, at time t. Indirect impacts estimated in (1) are now transformed to indirect costs by incorporating $\gamma^t$ thus:

$$(2) \qquad IC_t = \gamma^t \sum_{i=1}^{n} b_i(\Delta C_i + \alpha_{ci} \cdot \Delta DI)$$

where IC, is "indirect costs" in year t, and other terms are as defined previously.

Each of the water right retirement scenarios has long run implications. The Single Year injunction scenario has implications for the long run since it can occur repeatedly over time with some known probability. The permanent solutions (2 and 3) clearly have effects extending far into the future. Hence, the direct and indirect costs of each scenario are stated in comparable present value terms to provide policy makers realistic comparisons.

## Components of Cost

The explanation of procedures used to estimate primary and secondary economic costs imposed by each scenario requires the definition of some useful terms.

GR = Gross revenue from farm production

VC = Variable costs of crop production, avoidable in a single year if crop production is eliminated. The farm input items included in this category form the major backward linkages with the regional economy that is affected by reductions in irrigated acreage.

FC = Fixed costs of farm production, not avoidable in a single year but avoidable if land is permanently retired. Major items in this category are equipment depreciation, equipment taxes, and land taxes.

WP = Wages and proprietor income earned through farm production.

LR = Land rent or returns to land that are capitalized into current market values of land.

NR = Net Return to fixed capital = GR - VC

These defined measures of cost and revenue from agricultural production are used in the calculation of direct and indirect economic costs. The application of these terms to specific estimates of cost are as shown below.

| | | DRIVERS | |
|---|---|---|---|
| Scenario | Direct Costs | Indirect Region Costs | Indirect State Costs |
| Single Year | NR = GR - VC + LR | VC + WP + LR | VC + WP |
| Lease/Purchase | LR + .5WP = GR - VC - FC - .5WP | VC + WP + FC | VC + WP + FC + LR |
| Post 1946 | LR + WP = GR - VC - FC | VC + WP + FC + LR | VC + WP + FC + LR |

The same 1992 crop production budgets are used in all cases to estimate the defined cost and return measures. Theoretically, the annual returns to land calculated in this manner can be capitalized into the current market value of land. Hence, either short run (annual) or long run (permanent) shifts in primary activity can be evaluated using these values. This process does require some additional explanation.

The Single Year scenario is, as the term implies, a one year curtailment of specified irrigated acreage. Because of the short term nature of the interruption, all measures of direct and

indirect cost are estimates of the changes in revenue and economic activity for that one year. The secondary impact (I/O) model reacts to changes in primary activity to measure the changes in economic flows among sectors of the economy. In this case, the changes in primary activity that affect the secondary economy are the changes in purchased inputs for crop production (VC), the loss of wages and proprietor income (WP) and the loss in land rent (LR). It is assumed that the capital investment in agriculture will not be diminished, though in reality the value of affected water rights would decrease under this policy.

The single year curtailment of water rights can actually occur repeatedly over time. The long run probability of shutdowns of this nature are used to predict the expected annual cost of relying on this approach for meeting compact requirements. These expected annual costs are discounted to form an estimate of present value cost for this scenario.

The L/P scenario shifts the direct costs of water rights curtailment and retirement to the general population of the state. It is assumed that the owners of the water rights purchased for retirement are fully compensated for all investment in irrigated agriculture. Due to the retirement of irrigated land, there is a comparable loss to the state of the annual land rent. There is also an assumed loss of wages for hired labor no longer employed on this irrigated land. The lost land rent is a state level cost while the lost wages are mostly a regional cost. The water rights curtailed through temporary leases will also be a cost to the state with the major regional cost being the lost wages for hired labor.

Costs of secondary impacts for the L/P option will differ for the region and the state. State government revenues are used to purchase assets associated with water rights in the study region. It is assumed that the capital from these purchases does not leave the region but is reinvested into other forms of economic activity in the region. The rent from this capital investment remains in the local economy. However, an equivalent amount of this capital is lost to the state economy outside the region. Hence, the rent from capital used to purchase water rights is a loss to the state economy. Since this is a permanent shift in the agricultural base there is an added component of secondary impact to both the region and state not encountered in the Single Year scenario, that is, the loss of depreciation and taxes on capital equipment (FC).

The Post 1946 water rights shutdown scenario is assumed to be without compensation to the owners of the water rights. The value and productive capacity of the agriculture is eliminated with no opportunity for replacement in the local economy. Hence, there is a loss of returns to capital investment in land and unsalvageable equipment to the primary economy. In this long run shutdown of irrigation, the normal expenditures for purchased inputs (VC) and depreciable capital equipment (FC) are avoidable costs to primary agriculture leaving land rent (LR) as a permanent loss to the regional economy. There is also a loss of wages and proprietor income that will affect local spending. The previous expenditures for purchased inputs (VC), wages and proprietor income (WP), and fixed capital (FC) will be diverted to new uses in a relatively short time to achieve a new equilibrium, leaving the secondary effects of these impacts with a short life.

In summary, the results of direct and indirect costs that are estimated for each scenario are reported in terms of net present value. While the regional agriculture base is retained under the Single Year scenario, it is subject to long run uncertainty of repeated shutdowns over time. The other two scenarios result in permanent changes to the agricultural base and their effects are definitely long term. The rate for displaced capital and labor resources to find new productive uses is estimated to provide the aggregate present value of indirect costs. In all cases, the numerical values provided for evaluation and comparison of alternative scenarios are expressed in terms of direct and indirect cost to individuals, the region, or the state. This report provides none of the

usual measures of "impacts" (employment, trade flows, etc.) which are sometimes found in secondary impact studies. Specific assumptions regarding the impact of and reaction to irrigation curtailment by farmers and the regional economy will not be listed here.

Some general concerns and limitations of the analysis include the following. Each of the land retirement scenarios would have differing effects on the value of water rights throughout the basin. The L/P option, once implemented, will leave all remaining water rights in the basin in a very secure position, at least from threat of shutdown to deliver water to Texas. Hence, the value of these water rights will not be diminished by the L/P option.

In contrast, the Single Year injunction policy casts a shadow of uncertainty over all water rights with affected priority dates. The uncertainty of potential curtailment will drive down the market value of these water rights. It will also likely increase the value of water rights known to be secure from the curtailment process. The Post 1946 option, will eliminate the total market value of all affected water rights, but will probably have a bullish effect on the value of those unaffected.

Finally, the appropriate measure of direct and indirect costs for comparison among policy options is the net present value of costs over time. In this analysis the real discount rate chosen for all present value calculations is 4 percent.
It was assumed that each policy option would commence on the same date in calculating present value costs.

## RESULTS

### Single Year Injunction

The Single Year scenario is based on the assumption that New Mexico state is forced to react to delivery deficits through a temporary injunction on use of water rights sufficient to restore deficit deliveries within the calendar year in which the injunction occurs. The expected value of long term deficits is 15,000 acre feet (15 KAF). In the short term, due to current water conditions at the time of this study, this level of deficit would be expected to occur with a probability of about 1.0. In the longer term, over a 20 or 25 year period, this probability would decrease, because once an injunction has occurred, the probability or magnitude of another will decrease considerably due to the carry over effect of water savings in the initial injunction. State line accruals from a single year injunction will continue for more than 50 years following the initial year, with most of the effects being felt within the first two decades. Within a wide range around the 15 KAF deficit level, the acreage affected and costs of an injunction would be relatively proportional to the level of deficit.

All water rights with priority date subsequent to June 1920 are potentially included in the injunction, with retirement to occur in priority order. To meet a 15 KAF deficit would require approximately 89,000 of full curtailment along with an additional 29,000 acres losing supplemental water rights. Clearly, the distribution of affected acreage is not uniform throughout the basin.

Direct Costs

The direct costs for a single year of a water rights curtailment are summarized in Table 1. These costs are calculated in terms of forgone net farm income (NR) that would be lost in the year of water rights curtailment. All costs of production avoided by not irrigating and producing crops for the single year are deducted from potential gross farm income to provide an estimate of loss to operator labor and management and all fixed capital. For example, the Roswell-Hagerman flood irrigated farm would incur a loss of $457 per acre for complete curtailment. The same farm type

losing supplemental water accounting for one-third of crop application would lose $88 per affected acre. Total lost net farm income for the entire region through this scenario is estimated to be $35.8 million for each year of the injunction. This value includes the loss to wages and proprietor income affected by reduced farm production.

The single year injunction will occur repeatedly over time as the need arises. The exact frequency and magnitude of such injunctions cannot be predicted but the average occurrence based on long term weather records are estimated. The average accretion effects at the state line were evaluated for a 20 year period. Approximately 7.9%, or 15 KAF, of long run total accretions to state line river flows would occur in the first year. The percentage of accretions would increase to 10.3% in year two and then decline in a nonlinear fashion out to year 20 and beyond. Thus, for each year of required curtailment, additional accretions to the river would occur in the future. This information was used to evaluate 20 year traces of curtailment amounts and additional accrual at the state line resulting from these curtailments, assuming an initial accrued credit of 0 AF in 1992. Simulation of potential river flows and delivery departures was based on a 40 year period of record (1952 to 1991). Forty sequences of simulated delivery departures were then averaged to obtain both the curtailment amounts and the annual expected accruals.

The center column of Table 2 shows the expected accruals from acreage curtailment that would be realized under this policy. On average, in year 1 the requirement would be for curtailment of acreage equivalent to provide 12,800 KAF of water at the state line. Subsequent years would require smaller acreage curtailments until year 8 when the expected acreage would stabilize at a level required to produce about 1,800 KAF, with further declines beginning in year 18. Recall that actual acreage curtailments would be quite variable over time, ranging from zero in many years to amounts that could exceed those shown in Table 1. The NPV of direct costs for the single year policy is estimated to be approximately $150 million.

Indirect Costs

Overall reductions in agricultural input purchases, labor payments, and returns to land and fixed factors with the single year injunction policy are shown in Table 3 for the full acreage reductions from Table 1. Reductions in economic activity indicated in Table 3 have an effect on the local economy, most notably a reduction in local income. The reduction in income, corrected for reemployed and depreciated factors, constitutes the indirect cost of the single year injunction policy.

Indirect costs are expressed as the present discounted value of future income losses using a real discount rate of 4%. Indirect costs have two components, lost income in the small-region five-county Pecos economy, and lost income throughout the remaining New Mexico economy. Indirect costs in the form of lost income in the small-region economy, for any year t, are estimated for the single year injunction policy according to the following expression:

$$(3) \qquad IC_t = \gamma \sum_{i=1}^{n} b_i(\Delta VC_i + \alpha_{ei} \cdot \Delta DI)$$

where:

$IC_t$ = Indirect costs in year t.

DI = WP + LR + FC (direct income one year-injunction).

$VC_i$ = Variable costs mapped to industries i=1,n of the economic model.

Note that in contrast to the general indirect cost estimating expression (2), the parameter measuring unemployment $\gamma$ appears in (3) without time-period denoting exponent t. Curtailments with the single year injunction policy are assumed to occur as independent events. Accordingly, each is treated in isolation, with the parameter of unemployment implicitly set at $t=1$. Note that only changes in variable costs, VC, are included in the indirect cost estimating expression (3). With the single-year injunction, farm owners expect to reopen the following year and thus continue paying fixed expenditures, or fixed costs, on repair and maintenance. Only variable costs, VC, are avoidable in the single-year curtailment.

The indirect cost estimation is driven by changes in direct income, namely land rent, LR, and wages and proprietary income, WP, and an amount of income equal to the fixed costs. It will be recalled that fixed expenditures themselves are maintained with the single-year injunction. Importantly, this continuation of expenditures in the face of lost farm revenues is assumed to be made from other income sources, at the expense of consumer spending on the part of the farm owner.

Expression (3) provides the indirect cost in terms of lost income in the small-region economy of the Pecos River basin. A 10% income spillover to the greater New Mexico economy is assumed. Table 4 shows the present discounted value of indirect costs for the single year injunction to be $68.6 million to the five-county Pecos River economy, and $6.9 million in the New Mexico economy outside the Pecos River drainage. The total state-wide indirect cost of the single year injunction is therefore $80.8 million. Also indicated in Table 4 is the estimate of indirect cost spillovers to Texas equal to $6.9 million.

Additional Impacts of an Injunction Policy

A statistical model by Mittlehammer has shown that five year average shortfalls can exceed 26,000 acre feet with a probability greater than 20%. Hence, there is no guarantee that the temporary land retirement scenario would not have to be continued consecutively for more than one year, resulting in regional costs greater than those anticipated for a single year. Even if deficits are not occurring to require the temporary shutdown of local agriculture, the uncertainty created by the threat of doing so is a detriment to the viability of local agriculture and the surrounding economy. Some important impacts caused by such a policy would include: inability of farmers to remain current on capital debt service; irrigation facilities may become unserviceable through nonuse; idle farm lands will require continued maintenance such as weed control to reduce long term problems of land productivity; the continued threat of temporary land retirements will make lenders reluctant to provide capital to farmers for operating costs or capital purchases; and despite reduced long term income and asset values, current tax obligations will have to be met to maintain state and local governments.

## Lease/Purchase Scenario

The L/P scenario reflects a policy wherein sufficient irrigated land and associated water rights would be purchased from current owners for permanent retirement from irrigation to permanently solve the state line water delivery problem. However, since the land purchases must be extended over several years and the water accruals to these land purchases will occur slowly over time, it will be necessary to supplement the process by leasing some water rights for temporary retirement in the early years. The total acres to be purchased over a period of nine years are 17,594. Leased acreage begins in the first year at 7,271 and decreases to zero in year 14.

Direct Costs

No direct costs are incurred by current owners of the purchased water rights since they

are fully compensated for all vested interest in these assets. The average purchase value of land under this scenario is $2000 per acre, bringing the total cost of the land purchase to approximately $35 million. However, the actual direct cost of lost land value to the state from this policy is assumed to be the average market value of land in each affected region. The difference between the purchase value
of the retired land and the actual payments by the state is assumed to be a transfer payment from the state to the local region, but not a net cost to the state. Table 5 shows that present value of the state loss in land value from this L/P policy is estimated to be $23 million. The direct costs of land purchase should be considered as a cost to the state, rather than a regional cost.

The payment for land purchased in the L/P scenario is assumed to compensate farm operators for their share of lost wages and proprietor income. However, the hired labor displaced by land purchase and lease, assumed to be one-half of total costs of labor and management, will incur a direct cost. Each increment of land purchase results in a displacement of farm employment that will decrease over time at an exponential rate.

A third source of direct cost is payment for leasing water rights. This cost is shown in Table 5 to have a present value of $5.2 million, reflecting payments from the state to owners of water rights in the region. It is a cost largely imposed on the state rather than the Pecos River basin economy.

Adding all of the estimated direct costs of the L/P scenario results in a total present value cost of $32.0 million. The portions due to land purchase and leasing fall on the entire state and those flowing from lost wages will be largely
concentrated in the local economy. The present value of the income transfer from the state to persons in the Pecos River basin region (for land payments exceeding average market value) is estimated to be $6.63 million and is an additional drain on available state revenues.

Indirect Costs

Changes in purchases of agricultural inputs and labor payments with the L/P policy are relatively complex. For both leased and purchased water rights, variable costs are avoided. In addition, all fixed costs are avoided in the case of purchased water rights. We assume avoidance of one-half of fixed costs in the case of leased water rights, since in the long run this land will be returned to production.

In terms of indirect effects, all wage and proprietary income, WP, is lost with both lease and purchase. However, much of the previous spending will continue, now funded by lease or outright purchase payments. Continued spending is assumed to equal the annual land rent, LR.

The expenditures by New Mexico for the L/P policy is about $40 million, extended over a period of 13 years from beginning of land purchase to end of land lease. The state is assumed to finance most water right purchases through borrowing and most lease costs from current revenues. Borrowed capital is assumed to carry a real interest rate of 4%. Further the burden of these amortized payments is assumed to fall equally on all New Mexico taxpayers and are therefore distributed between the small-area
Pecos and non-Pecos regions in proportion to their respective populations.

In each year for which a loan-amortizing or lease payment is due, these payments are assumed to absorb an equal amount of New Mexico consumer spending. Reduced consumer spending has a regional economic effect. The lost regional economic income as a result of reduced consumer spending is included as part of the indirect cost of the L/P policy. Formally, the indirect

cost to the five-county Pecos economy in any year t is estimated for the L/P scenario according to the following expression:

$$(4) \qquad IC_t = \gamma^t \sum_{i=1}^{n} b_i(\Delta VC_i + \Delta FC_i + \alpha_{ci}(\mu B_i + \Delta WP))$$

where:

$IC_t$ = Indirect costs in year t.

$\mu$ = Pecos drainage-area's portion of all-New Mexico's population.

$FC_i$ = Fixed expenses.

$B_i$ = Sum of year t loan-amortizing and lease payments.

As before, spillover income effects to the remaining portion of the state are estimated to be 10%. The remaining portion of the loan-amortizing and lease payments, $(1 - \mu)B_t$ is applied to a New Mexico-wide model to indicate the indirect cost in terms of lost income to the remainder of the state.

Table 6 presents the indirect costs of the L/P policy. Indirect costs expressed as a discounted present value are $20.2 million in the five-county Pecos economy, $6.4 million in the New Mexico economy outside the Pecos drainage and, therefore, approximately $26.6 million state-wide. Spillover indirect costs to Texas in this case are estimated to be $2.0 million.

## Post 1946 Rights Scenario

Acreage Affected

The third scenario is the permanent retirement of all water rights in the basin dated after 1946, without compensation or opportunity for later use. The acreage affected would be approximately one-half that involved in the temporary injunction policy of scenario 1. Total acreage involved would be about 43,000 of complete retirement with an additional 16,000 losing supplemental water rights.

Direct Costs

The direct costs in this scenario are losses of asset value to current property owners plus losses of wages and proprietor income. Owners of capital assets would have no opportunity to sell or move them to other productive uses. The assets are effectively removed from any subsequent use in New Mexico.

The present value of lost wages and proprietor income due to the retirement of all post 1946 water rights is shown in Table 7 to be approximately $13.8 million using the 4% real discount rate. In addition, the full market value of irrigated land is lost in cases of complete retirement. Loss of supplemental water rights is assumed to reduce the market value of land by one-third. The result is a total loss in asset value of $69.1 million bringing total direct costs to $82.9 million. All of these direct costs would fall on local owners of irrigation assets and labor with no capital transfers from state tax revenues as in the L/P scenario.

Indirect Costs

Formally, the indirect cost calculation in this case appears very much like the L/P policy

except spending associated with land rent, LR, is now lost, and there is no loan-amortizing or lease payments. Accordingly, the indirect income cost to the five-county Pecos economy in any year t is estimated according to the following expression:

$$(5) \qquad IC_t = \gamma^t \sum_{i=1}^{n} b_i(\Delta VC_i + \Delta FC_i + \alpha_{ci} \cdot \Delta DI)$$

where:

$IC_t$ = Indirect costs in year t.

DI = WP + LR (direct income with complete shut-down)

A 10% spillover income effect to the non-Pecos portion of the New Mexico economy is followed. The discounted present value of indirect costs associated with the post-1946 retirement policy appears in Table 8, $42.7 million in the five-county Pecos economy, $4.3 million in the New Mexico economy outside the Pecos drainage, and a total state-wide indirect cost of $46.9 million. Spillover of indirect costs to Texas are estimated to be $4.3 million.

## SUMMARY

Total direct and indirect costs of each scenario are summarized in Table 9. The L/P scenario, costing about $58.6 million, is far cheaper than either of the alternatives, about one-half the total cost of the next best alternative. The L/P scenario does impose a much larger share of total costs on state-wide residents than the alternative policies. In fact, there is a $6.63 million transfer payment from the state to residents of the Pecos Basin not included as a measure of direct cost to the state. Including that factor as a cost to the state would increase the state share to $41 million and the total scenario cost to $65.2 million. A major feature of this policy is that it would be least disruptive to the regional or state economies. There would be little noticeable effect on any elements of either economy.

The lower costs of the L/P policy derives from its relative hydrologic efficiency. By targeting those rights with the greatest direct effect on state line flows, it is possible to minimize the affected acreage to be curtailed or retired. Because the priority enforcement options must curtail irrigation based on water right priorities, they are less efficient in augmenting state line flows.

The Post-1946 shutdown policy imposes a cost on the state of New Mexico about $130 million, but concentrates most of the cost in the Pecos Basin. This policy would require no revenue support from the state. It would eliminate about 25% of total irrigated acreage in the Pecos Basin, a major shock to the local economy, but does have the major advantage of providing a permanent solution to the state line delivery problem.

The Single Year scenario is much more costly than the other two alternatives. It also has the disadvantage of providing no permanent solution to the problem of required water deliveries to Texas. Uncertainties about potential shutdowns would create a shadow over the local economy as long as the policy persists. It must be emphasized this policy is based on an uncertain future. Actual costs could be much lower or much higher than those estimated, depending upon the long run weather patterns that may occur.

There are other scenarios that could be evaluated. For example, it is probable that if either the Single Year or Post-1946 policies were implemented, a local market for water rights

would be created out of necessity to reduce cost burdens on the regional economy. Farmers threatened with shutdown should be willing to purchase other water rights for retirement, essentially implementing the L/P scenario on their own.

This analysis did provide a basis for decision makers to choose among alternative policies. A post script will show that the market approach (L/P policy) was chosen by New Mexico. The state has appropriated funds to move forward with the lease and purchase of lands for policy implementation. Finally, the methods developed in this study for estimating direct and indirect costs of alternative regional impact policies should be useful and instructive to other researchers and policy makers with similar problems in the future.

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ABLE 1 Estimated direct cost of lost farm income for each year of curtailment under a Single Year injunctio
licy

| AREA | FARM BUDGET | Full Retirement ACREAGE | COST/AC | Supp Retirement ACREAGE | COST/AC | TOTAL COST $1000 |
|---|---|---|---|---|---|---|
| North Roswell | Flood | 33,589 | $457 | 3,103 | $88 | $15,625 |
| | Sprinkler | 10,033 | $362 | 927 | $18 | $3,650 |
| South Roswell | Flood | 10,935 | $417 | 2,673 | $93 | $4,808 |
| | Sprinkler | 3,266 | $352 | 798 | $76 | $1,210 |
| Carlsbad Basin | Flood | 12,970 | $318 | 12,840 | $18 | $4,362 |
| | Sprinkler | 6,984 | $352 | 6,914 | $76 | $2,985 |
| Fort Sumner | Flood-large | 5,658 | $371 | 0 | $42 | $2,097 |
| | Flood-small | | $189 | 0 | b | $550 |
| Penasco-Hondo | Flood | 2,754 | $185 | 1,835 | b | $509 |
| TOTAL | | 89,105 | | 29,089 | | $35,795 |

The distribution of farm types was taken from Lansford, et al.
Cost of supplemental water retirement estimated to equal zero after accounting for low returns to operator labor and management.

TABLE 2 Present value of total direct cost of land retirement under a Single Year injunction, land returns plus wages

| YEAR | Stateline Accruals-b Acre Feet | Expected Direct Cost $1000 a |
|---|---|---|
| 1 | 12,800 | $30,545 |
| 2 | 12,300 | $29,352 |
| 3 | 12,000 | $28,636 |
| 4 | 8,100 | $19,329 |
| 5 | 5,400 | $12,886 |
| 6 | 3,300 | $7,875 |
| 7 | 2,200 | $5,250 |
| 8 | 1,800 | $4,295 |
| 9 | 1,800 | $4,295 |
| 10 | 1,800 | $4,295 |
| 11 | 1,800 | $4,295 |
| 12 | 1,800 | $4,295 |
| 13 | 1,800 | $4,295 |
| 14 | 1,800 | $4,295 |
| 15 | 1,800 | $4,295 |
| 16 | 1,800 | $4,295 |
| 17 | 1,800 | $4,295 |
| 18 | 1,100 | $2,625 |
| 19 | 400 | $955 |
| 20 | 400 | $955 |
| 21 | 400 | $955 |
| 22 | 400 | $955 |
| 23 | 400 | $955 |
| 24 | 400 | $955 |
| 25 | 400 | $955 |
| NET PRESENT VALUE OF LAND COST @ 4% DR | | $149,892 |

a: Based on estimated primary cost of the single year injunction equaling $35,795 million for a 15 KAF accrual requirement.

b: Accrual requirements provided by State Engineer personnel.

TABLE 3 Changes in economic activity due to Single Year injunction to meet a 15 KAF deficit, Pecos River basin

| Item | Complete Retirement acres | Supplement Retirement acres | Dollars (1000) |
|---|---|---|---|
| | 89,105 | 29,089 | |
| Seed | | | $1,602 |
| Fertilizer | | | $2,871 |
| Chemicals | | | $3,585 |
| Crop Insurance | | | $383 |
| Other purchased inputs | | | $1,294 |
| Canal Water | | | $812 |
| Fuel, oil & lubricants-Equipment | | | $1,244 |
| Fuel-Irrigation | | | $4,063 |
| Repairs | | | $2,079 |
| Custom charges | | | $4,509 |
| Land taxes | | | $114 |
| Other expenses | | | $4,004 |
| Labor and Management costs | | | $8,787 |
| Interest on Operating Capital | | | $695 |
| Land rent | | | $11,203 |
| Fixed expenses (excluding land) | | | $6,916 |
| Interest on Equipment | | | $2,982 |

TABLE 4 Indirect costs associated with Single Year injunction policy, Pecos Basin and State-wide

| ITEM | DOLLARS $1000 |
|---|---|
| Pecos-Area Economy | $68,591 |
| NM Outside Pecos-Area | $6,859 |
| STATE WIDE TOTAL | $75,451 |
| Texas Spillover | $6,859 |

TABLE 5 Direct cost for Lease/Purchase scenario, net present value at 4% RDR

| Year | Lease Labor-a ($1000) | Purchase Labor-b ($1000) | Land Lease Cost-c ($1000) | Land Purchase Cost-d ($1000) |
|---|---|---|---|---|
| 1 | $295 | $159 | $1,713 | $6,494 |
| 2 | $236 | $175 | $800 | $2,008 |
| 3 | $189 | $198 | $560 | $1,950 |
| 4 | $151 | $216 | $560 | $2,490 |
| 5 | $121 | $262 | $560 | $3,501 |
| 6 | $97 | $303 | $560 | $3,300 |
| 7 | $77 | $340 | $455 | $3,450 |
| 8 | $62 | $336 | $316 | $2,250 |
| 9 | $50 | $320 | $234 | $1,800 |
| 10 | $40 | $256 | $166 | $0 |
| 11 | $32 | $205 | $112 | $0 |
| 12 | $25 | $164 | $66 | $0 |
| 13 | $20 | $131 | $25 | $0 |
| 14 | $0 | $105 | $0 | $0 |
| 15 | $0 | $84 | $0 | $0 |
| 16 | $0 | $67 | $0 | $0 |
| 17 | $0 | $54 | $0 | $0 |
| 18 | $0 | $43 | $0 | $0 |
| 19 | $0 | $34 | $0 | $0 |
| 20 | $0 | $27 | $0 | $0 |
| 21 | $0 | $22 | $0 | $0 |
| 22 | $0 | $18 | $0 | $0 |
| 23 | $0 | $14 | $0 | $0 |
| 24 | $0 | $11 | $0 | $0 |
| 25 | $0 | $9 | $0 | $0 |
| NPV (25 yrs @ 4%) | $1,189 | $2,596 | $5,248 | $22,978 |
| | | TOTAL NPV DIRECT COST | | $32,012 |

a: One-half labor cost for least land decayed at $(0.8)^t$. (Local cost)
b: One-half annual labor cost decayed at $(0.8)^t$ into future and summed over years of buyout. (Local cost)
c: Lease apyment from state to water right owners. (State cost)
d: Purchase cost based on land value. (State cost)

TABLE 6 Indirect costs associated with Lease/Purchase policy, Pecos Basin and State-wide

| ITEM | DOLLARS $1000 |
|---|---|
| Pecos-Area Economy | $20,213 |
| NM Outside Pecos-Area | $6,364 |
| STATE WIDE TOTAL | $26,577 |
| Texas Spillover | $2,021 |

TABLE 7 Estimated direct cost from lost wages and lost land value from permanent retirement of post-1946 water rights

| YEAR | % Labour Remaining Unemployed | Expected Value $1000 a |
|---|---|---|
| 1 | 0.8000 | $3,323 |
| 2 | 0.6400 | $2,659 |
| 3 | 0.5120 | $2,127 |
| 4 | 0.4096 | $1,701 |
| 5 | 0.3277 | $1,361 |
| 6 | 0.2621 | $1,089 |
| 7 | 0.2097 | $871 |
| 8 | 0.1678 | $697 |
| 9 | 0.1342 | $558 |
| 10 | 0.1074 | $446 |
| 11 | 0.0859 | $357 |
| 12 | 0.0687 | $285 |
| 13 | 0.0550 | $228 |
| 14 | 0.0440 | $183 |
| 15 | 0.0352 | $146 |
| 16 | 0.0281 | $117 |
| 17 | 0.0225 | $94 |
| 18 | 0.0180 | $75 |
| 19 | 0.0144 | $60 |
| 20 | 0.0115 | $48 |
| 21 | 0.0092 | $38 |
| 22 | 0.0074 | $31 |
| 23 | 0.0059 | $25 |
| 24 | 0.0047 | $20 |
| 25 | 0.0038 | $16 |
| NET PRESENT VALUE OF LAND COST @ 4% DR | | $13,827 |
| LAND VALUE LOST | | $69,136 |
| TOTAL DIRECT COST | | $82,963 |

a: Based on lost labor and management returns.

TABLE 8 Indirect costs associated with retirement of Post-1946 water rights, Pecos Basin and State-wide

| ITEM | DOLLARS $1000 |
|---|---|
| Pecos-Area Economy | $42,652 |
| NM Outside Pecos-Area | $4,265 |
| STATE WIDE TOTAL | $46,918 |
| Texas Spillover | $4,265 |

TABLE 9 Summary of direct and indirect costs of alternative scenarios for meeting required state line flows in the Pecos River, total present value lost

| SCENARIO | DIRECT COSTS $1000 | INDIRECT COSTS $1000 | TOTAL COSTS $1000 |
|---|---|---|---|
| SINGLE YEAR | | | |
| Pecos Basin | $160,614 | $68,591 | $229,205 |
| State | | $6,859 | $6,859 |
| TOTAL | $160,614 | $75,450 | $236,064 |
| LEASE/PURCHASE | | | |
| Pecos Basin | $3,785 | $20,213 | $23,998 |
| State | $28,226 | $6,364 | $34,590 |
| TOTAL | $32,011 | $26,577 | $58,588 |
| POST-1946 | | | |
| Pecos Basin | $82,963 | $42,652 | $125,615 |
| State | | $4,265 | $4,265 |
| TOTAL | $82,963 | $46,917 | $129,880 |