



Agricultural Water Conservation Program Review

Internal Report
South East Kelowna Irrigation District
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South East Kelowna Irrigation District: Agricultural Water Conservation Program Review

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Abstract

In 1994 the South East Kelowna Irrigation District (SEKID) implemented a progressive and often controversial demand management program directed at the agricultural community it serves. This paper looks at the evolution of that program over the past ten years and provides insight to the challenges inherent in managing agricultural water use. Phase 1 of the program used an educational approach for water conservation resulting in a 10% reduction in drought year demand. Phase 2 of the program implemented a conservation strategy using water allotments and a metered rate penalty for excess water use. This resulted in a further 22% reduction in demand under drought year conditions, significantly reducing water use while maintaining adequate supply for agricultural use. Under average demand conditions water use was reduced 27.4% below the 29 year average annual consumption rate.

Introduction

The South East Kelowna Irrigation District (SEKID) encompasses twenty-two percent of the area of the City of Kelowna. It is mainly rural agricultural with about 1,900 domestic connections and over four hundred irrigation connections. The annual average water consumption (1994 – 2003) is 11,713 da m³ (9,500 acre-feet), of which about 85% is used for agricultural purposes. The district watershed is 65km² (25mi²) in area and is supplied by runoff from the annual snow pack.

In 1994 the Board of Trustees of the South East Kelowna Irrigation District implemented a metering program for all irrigation connections in the district. A number of factors contributed to the board's decision to proceed with metering. In addition to the capital and operating cost savings of water conservation, also considered were limited and expensive options to increase the water supply to the district, the unknown implications of climate change, the availability of senior government grants for the metering program and favorable results from a pilot metering program that had been initiated in 1990.

From the beginning the program was highly controversial. The agricultural community believed water meters would result in higher water costs. To allay these fears the trustees made the commitment to the landowners that no metered rate for water would be implemented for a minimum of five years. The meters would be used as a tool to measure, learn and educate landowners about agricultural water use.

The educational approach used in Phase 1 of the program proved to be effective for the majority of landowners with metered irrigation connections. Efforts to collect, analyze and provide water use information and advice to landowners about water use contributed to a ten percent savings in the overall annual water demand of the district (Pike, 1998).

A small percentage of agricultural landowners continued to use a disproportionate amount of water, however, and Phase 2 of the program involves the implementation of water allotments. This allotment system is intended to provide adequate water for irrigation while eliminating excessive water waste and abuse. It has evolved to incorporate a punitive metered rate for water use in excess of the allotment and this has greatly increased the effectiveness of agricultural metering as a conservation and water supply management tool.

This report provides a summary of the metering program to date, including the financial implications of the metering program and looks at the effectiveness of education and metered rate penalties in agricultural water conservation.

Metering Program - Phase 1 Summary

Funding assistance for the metering program was received from the Canada-BC Green Plan for Agriculture. Technical assistance in irrigation scheduling, field day seminars and data collection and management was received from the staff at the B.C. Ministry of Agriculture, Food and Fisheries (MAFF). The Green Plan involved a five year cooperative commitment between staff from senior levels of government and SEKID. Program costs cited relate to the five year period of the formal Green Plan program from 1994 to 1998. A detailed report on the Green Plan project entitled *South East Kelowna Irrigation District Demand Management Project* was prepared by MAFF in 2000 and can be obtained from MAFF or the SEKID office.

Implementation

Over 400 irrigation meters were installed in 1994 and 1995 within the South East Kelowna Irrigation District's distribution area on properties with separate irrigation services. The total cost of installation including materials, equipment and labour amounted to \$606,000.

Irrigation Scheduling

Considerable effort was put into educating growers to use irrigation water efficiently. Each property in the district that was metered was also provided with a set of two tensiometers. These devices indicate soil moisture and help to determine when to irrigate. For many growers in the district irrigation scheduling was a function of convenience or scheduling labour and not a water use efficiency process – the tensiometers were provided as a tool to monitor soil moisture levels to match actual crop requirements. Several field days were held over the course of the program to promote the use of tensiometers and other irrigation scheduling techniques.

Additionally, eight growers in the district participated in a pilot project managed by MAFF designed to track water requirement versus water use. This program showed there was considerable opportunity for water savings during the spring and fall (Van der Gulik, 2000). Irrigation systems are designed to provide for water requirements during the peak season and many systems are operated at full capacity regardless of seasonal demand. This, of course, results in over-watering.

The total costs of materials, equipment and labour for the irrigation scheduling amounted to \$118,500.

Data Management

The basic data management aspect of the program involved reading meters and tracking water use. This information was collected monthly and determined the irrigation water demand of the district.

Concurrent with this was an initiative to determine the actual water use requirement of the district. This was done by collecting data from each property on crop, irrigated area, soil type and irrigation system. Climate information was collected from a weather station at the district yard. From this information the estimated water requirement of the irrigated acreage in the district could be calculated for a given period of time.

Monthly water use reports were generated using the information described above. Each property in the district was provided with a report indicating water use, estimated water use requirement and average water use of the comparable peer group. In most cases water use was higher than the calculated requirement, but in some cases water use was lower. These detailed water use reports were provided monthly each year through to the end of the irrigation season in 2000.

The cost of collecting and analyzing data and sending out water use reports was \$60,000.

Cost Summary

The project cost summary for the period 1994 to 1998 was as follows:

1. Meter Installation	\$606,000
2. Irrigation scheduling	118,500
3. Data management	<u>60,000</u>
Total:	\$784,000

Results

A new drought year requirement

Phase 1 of the metering program provided the district with the unique opportunity to do a detailed review and analysis of the water demand of the district. The year 1998 was the highest demand year in recent memory with a net moisture deficit for the May 1 to October 15 irrigation period of 777.8mm (30.62 inches) (Farmwest, 2004). These high demand conditions provided the opportunity to update the drought year water requirement of the district.

The original distribution system was designed in the late 1960's to deliver 7.62 da m³/ha of land (2.50 acre-feet/acre) (Doughty-Davies, 1970). The 1998 analysis showed the actual demand figure was 6.86 da m³/ha (2.25 acre-feet/acre) (Pike, 1998) – a savings of 10% from original design demand. The metering program was likely responsible for a large portion of this water savings. Advances in irrigation system efficiency, high density orchard plantings and other horticultural practices also have contributed to greater water use efficiency.

The surplus water supply resulting from this 10% savings is shown in the supply/demand calculation presented in Table 1.

Table 1: Water Supply and Demand 1970/1998				
	Original drought year demand, 1970		New drought year demand, 1998	
	7.62 da m ³ /ha	2.50 acre-feet/acre	6.86 da m ³ /ha	2.25 acre-feet/acre
Supply and demand budget:				
Dependable water supply (MOE, 1979)	16,428	13,324	16,428	13,324
Drought year requirement for 2,153 ha (5,322 acres)	<u>16,405</u>	<u>13,305</u>	<u>14,769</u>	<u>11,975</u>
Surplus/(deficit) da m ³ (acre-feet)	23	19	1,659	1,349

Under the old demand figure the district had a surplus of 23 da m³ (19 acre-feet) of water, which would be adequate to provide water for an additional 3.07 ha (7.6 acres) of land at 7.62 da m³/ha (2.5 acre-feet/acre). Under the new demand figure the district had a surplus of 1,659 da m³ (1,349 acre-feet) of water, which is adequate to supply water to an additional 242 ha (600 acres) of land at 6.86 da m³/ha (2.25 acre-feet/acre).

Cost benefit analysis

Phase 1 of the program resulted in a net financial gain for the district based on the value of the water surplus identified.

As referenced above, one hectare of land has a drought year water requirement of 6.86 da m³ (2.25 acre-feet/acre) of water. In 1998 water rights for one hectare of land could be purchased from the district for \$4,942 (\$2,000 per acre). The water surplus created through metering and other water use efficiencies is adequate to supply 242 hectares (600 acres) of land and the total revenue potential from the sale of these water rights amounts to \$1,200,000. The total cost of the metering program amounted to \$784,000. The benefit to cost ratio through Phase 1 of the program can be calculated as follows:

Description	Amount
Program Benefit (value of water rights freed up)	\$1,200,000
Program Cost	\$784,000
Benefit/Cost Ratio	1.53

This calculation does not consider the savings associated with the lower capital and operating costs inherent with greater water use efficiencies.

Metering Program Phase 2

The formal Canada-BC Green Plan agreement concluded in 2000. In addition to saving water, the meters provided many side benefits. These included the ability to detect leaks in private irrigation systems, to insure individuals stay within the flow allotment for their property and to fairly allocate water during shortages, insuring equitable distribution of the resource.

There was general agreement among board members that the benefits of water conservation combined with these additional benefits made it worthwhile to continue with the program. The wisdom of this decision became apparent the following 2001 irrigation season, which provided the district with a new approach to the program. It was at this stage that the main focus of the metering program evolved from an educational to a regulatory approach to water conservation.

Metered Irrigation Service Allotments

2001

Allotment with disconnection for excess water use

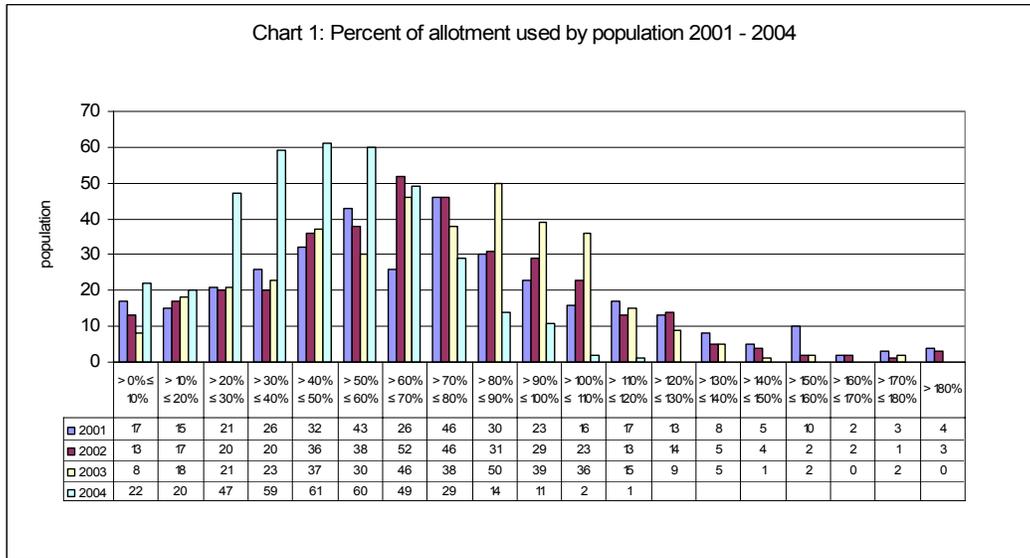
The snow pack, stream flows and groundwater levels in the spring of 2001 were at or below record levels. It was soon apparent the district could be facing water shortages for the coming season. In April the board implemented water restrictions on all irrigation and domestic connections in the district. Domestic connections had sprinkling restrictions imposed and irrigation connections were provided with an allotment of 5.49 da m³/ha (1.8 acre-feet/acre), which was 80% of the estimated drought year requirement of 6.86 da m³/ha (2.25 acre-feet /acre).

Notices of the restrictions were mailed to all agricultural landowners in the district and the spring newsletter featured extensive coverage of the issue. Landowners were also advised that failure to remain within the allotment would result in disconnection. In June of 2001 the district's main reservoir did not fill for the first time in over thirty years. The district wells were operated to supplement the surface water supply.

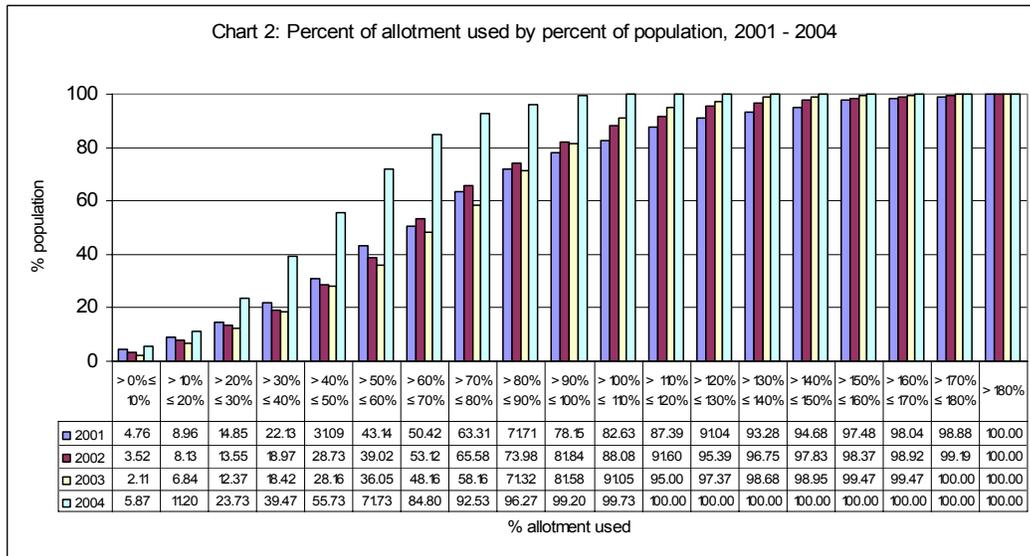
Results

Fortunately, 2001 proved to be a low demand year for irrigation with timely rainfall over the early summer and fall months. The net moisture deficit in the region for the period May 1, 2001 to October 15, 2001 was 720.7mm (28.37 inches) (Farmwest.com, 2004). By early August surface water reservoir supplies had returned to normal levels and the water allotment restrictions on irrigation services were lifted.

The distribution of annual water use as a percentage of the allotment used for the years 2001 to 2004 is presented in Chart 1.



The annual percent of allotment used by percent of population for the years 2001 to 2004 is presented in Chart 2. At the end of the irrigation season in 2001 78.15% of metered irrigation services were within the water allotment for the property. This was somewhat surprising given that the allotment was only 80% of the drought year requirement, the water restrictions had been lifted in early August and the last half of the irrigation season saw relatively high demand.



2002

Allotment with \$100 penalty for excess water use

The fall and winter of 2001/2002 provided sufficient snow pack to replenish surface water supplies and the board determined the normal drought year requirement of 6.86 da m³/ha (2.25 acre-feet/acre) of water rights would be a suitable allotment for the coming year. Notices of the restrictions were again mailed to each landowner and the spring newsletter featured similar coverage to the previous year. Landowners were also advised that to exceed the allotment was

a violation of district bylaws and to do so could result in disconnection of service and a \$100 fine.

Results

The net moisture deficit in the region for the period for the May 1 to October 15 2002 was 733.5mm (28.88 inches) (Farmwest.com, 2004). The water use percentage by allotment and population for 2002 is presented in Chart 2. At the end of the season 81.84% of services remained within the allotment. Sixty-seven landowners exceeded their allotment and were fined \$100.

The fairness of applying a standard rate penalty came under scrutiny because it applies the same penalty regardless of whether the excess use is one or one million gallons. In light of this inequity, the board requested staff provide options for applying a metered rate for water use in excess of the allotment.

2003

Allotment with inclining block rate for excess water use

The staff recommendation to the board for a rate structure to promote agricultural water conservation was based on the assumption that the drought year requirement of the district would be an adequate supply for agricultural use under drought conditions. The metered rate would be used to determine the penalty charged for water use in excess of the allotment and was meant to deter waste.

Fundamental to this approach is the recognition that the agricultural sector requires the allotted volume of water under drought conditions for irrigation. There would be no metered charge for the initial allotment and a metered rate would only be calculated and charged for properties exceeding the allotment.

The inclined block rate was chosen because the incremental increase in each block rate provided the flexibility to develop an effective rate structure suited to the application. A rate structure was needed that would recognize that a uniform allotment is difficult to apply fairly over diverse demand (soil) conditions. The rate structure must also provide a strong deterrent against excessive water use.

The 6.86 da m³/ha (2.25 acre-feet /acre) allotment is a weighted average drought year requirement covering a variety of soil types spread out over the 3,642 ha (9,000 acre) distribution area of the district. During drought years the actual water requirement of the highest demand soils in the district would exceed the weighted average drought year requirement. The inclined block rate was developed to recognize that some land should slightly exceed the allotment in a drought year and the penalty for doing so would be minimal. For example, excess water use within ten percent of the allotment would be charged a nominal rate and the penalty would increase incrementally with each ten percent block in recognition that increasing water use above that level is increasingly wasteful.

Rate options

The development of rate options for the Board of Trustees to consider was arbitrary (Pike, 2003). The options provided would generally be considered low for non-agricultural water use. The rates were intended as a deterrent and were not

required as a source of revenue for the utility. Significantly, the board also maintained the discretion to discontinue water service to any lands in excess of the allotment. Table 2 provides the three rate options originally provided to the board. The board chose Option 3 and these rates were brought into effect with the passage of Bylaw No. 579, the *Irrigation Water Distribution and Regulation Bylaw, 2003*.

All landowners were advised of the new metered rate penalty through the district newsletter and special mailings. Those properties that had been over their allotment in 2002 were also mailed a notice of the penalty amount that would apply under the new rate structure if the same volume of water was used in 2003.

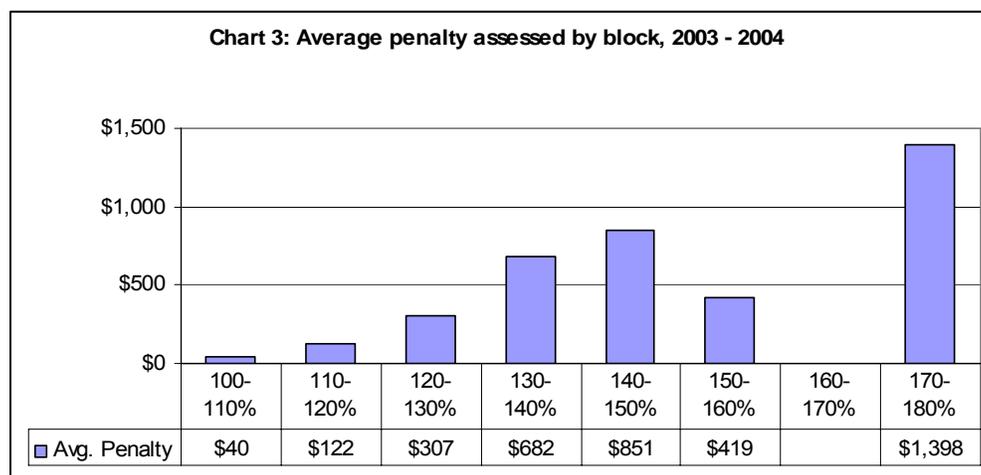
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Option 1 (rate per 1,000 USG)	\$0.01	\$0.02	\$0.03	\$0.04	\$0.05	\$0.06	\$0.07	\$0.08	\$0.09	\$0.10
Option 2 (rate per 1,000 USG)	\$0.10	\$0.12	\$0.14	\$0.16	\$0.18	\$0.20	\$0.22	\$0.24	\$0.26	\$0.28
Option 3 (rate per 1,000 USG)	\$0.10	\$0.13	\$0.16	\$0.20	\$0.25	\$0.31	\$0.38	\$0.46	\$0.55	\$0.65

Results

Snow packs, stream flows and groundwater levels were much lower than average over the winter of 2002/2003. Consequently, the district's main storage reservoir failed to fill for the second time in over thirty years. This low supply situation was followed by the fourth driest summer in the southern interior of B.C. since 1948 (Dobson, 2004).

The net moisture deficit in the region for the period May 1 to October 15, 2003 was 783.7mm (30.85 inches) (Farmwest.com, 2004). Water use as a percentage of allotment and population for 2003 is presented in Chart 2. At the end of the 2003 season 81.58% of properties remained within the allotment for the property.

Chart 3 provides a breakdown of the average penalty assessed to the 70 properties that exceeded the allotment in 2003. Over half of these properties (36) were within 10% of the allotment. The average penalty for this group amounted to \$40. At the other extreme, two properties used between 70% and 80% over the allotment and the average penalty amounted to almost \$1,400.



The average annual water use for the nine years 1995 – 2003 is 11,659 da m³ (9,456 acre-feet). The total water used for 2003 was 11,975 da m³ (9,712 acre-feet), about 2.7% above average. By way of comparison, the water use for 1998 totaled 14,229 da m³ (11,540 acre-feet), which is 22% above the nine year average. Both years were similar in terms of demand, with the irrigation period May 1 to October 15 showing a net moisture deficit of 777.8mm (30.62 inches) in 1998 and 783.7mm (30.85 inches) in 2003 (Farmwest, 2004). The main storage reservoir in 2003 was at 36.9% of capacity at the beginning of the year and at 41.5% at the end of the year. This indicates the district would be able to sustain water supplies through similar drought years in succession.

2004

Allotment with inclining block rate for excess water use

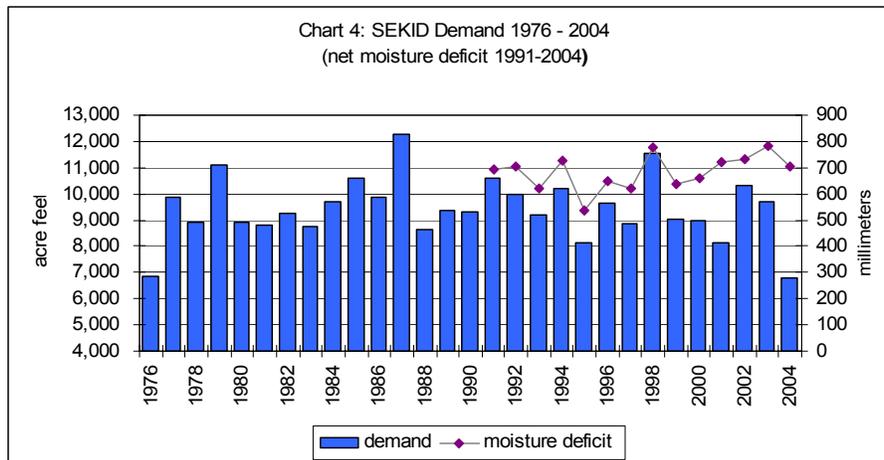
Given the effectiveness of the conservation strategy for the previous year, the decision was made to again implement water allotments with an inclined block rate for excess water use for the 2004 irrigation season. The snow pack over the 2003/2004 winter was adequate to replenish the surface water supply and the board determined the normal drought year requirement of 6.86 da m³/ha (2.25 acre-feet/acre) of water rights would be a suitable allotment for the year.

All properties with metered irrigation services were notified by mail of the annual allotment in April and four water use reports updating water use information were provided over the course of the irrigation season.

Results

The net moisture deficit in the region for the period May 1 to October 15, 2004 was 701.7mm (27.62 inches) (Farmwest.com, 2004). Water use as a percentage of allotment and population for 2004 is presented in Chart 2. At the end of the 2004 season 99.20% of properties remained within the allotment for the property. McCulloch Reservoir ended the year at 64% of capacity.

Chart 4 provides a summary of district demand from 1976 to 2004 (Mould, 1997; SEKID.ca, 2004) and the net moisture deficit for the May 1 to October 15 irrigation period for the years 1991 to 2004 (Farmwest.com, 2004).



The water rights assessment area of the district has increased from 1,755 ha (4,337 acres) in 1974, to 2,291 ha (5,661 acres) in 2004, a 30.5% increase in water rights area over the past 30 years. The average net moisture deficit for the past fourteen years is 683.1 mm. The 2004 figure of 701.7 mm is higher than average, indicating irrigation demand for the year was above average for the period.

The total water use for 2004 was 8,380 da m³ (6,792AF). This is the lowest level of annual water use in at least the past 29 years. The average annual use for this period is 11,550 da m³ (9,364 acre-feet). Water use for 2004 was 27.4% below the 29 year average.

Discussion

The allotment system with an inclining block rate under Phase 2 of the program allocates water according to need. Careful consideration has been given to determining what the demand requirements are for agriculture under drought conditions. Once this demand plan is established, each property is provided with an allotment of water to meet these conditions. The punitive metered rate and trustee discretion to discontinue service for exceeding the allotment are effective deterrents to water waste and promote efficient use and conservation of a limited water supply. The demand plan must be flexible enough to allow for changes in water use requirements over time.

A comparison of the effectiveness of the educational approach of Phase 1 and the regulatory approach of Phase 2 of the program shows significantly greater water savings under drought year conditions were realized under Phase 2.

The allotment system is an effective method for managing agricultural water demand from several perspectives. The allotment provides an adequate volume of water for agricultural use under drought year conditions and the inclined block rate for water use in excess of the allotment deters significant excess water use, without severely penalizing those who exceed their allotment by a minor amount. The system is designed to eliminate water waste, not beneficial use.

Clearly the regulatory approach of Phase 2 was more effective in conserving water than the educational method used in Phase 1. It is doubtful, however, that Phase 2 of the program could have been as successful had it not followed the educational efforts of Phase 1. The drought conditions of 2003 created very high demand conditions and the regulations required that users stay within the drought year allotment. The ability of landowners to comply with the regulations can, in part, be attributed to knowledge gained through Phase 1 of the program.

The 2004 water use indicates the allotment system with an inclining block rate is also an effective conservation strategy under non-drought conditions. 2004 water use under above-average demand conditions was 27.4% below the twenty-nine year average. This is an impressive reduction and indicates the allotment system motivates users to regulate water use to match actual demand, regardless of what those demand conditions are.

This is significant because it indicates the program is capable of being an effective demand management tool under diverse conditions. The water resource is managed so that the needs of the user are provided for and waste is eliminated. This reduces overall use of the resource.

Building a consensus within the Okanagan Basin on agricultural water management is a significant challenge. Each water system presents a unique geopolitical entity with its own adaptive capacity for water conservation. Political will, capital costs, droughts, regulation and other influences allow (or prevent) adaptation to occur (Shepherd, 2004). An agricultural conservation program premised on delivering the required demand and only penalizing waste is, presumably, more acceptable to the agriculture industry than a program that charges by the volume of water used.

This approach establishes a demand plan based on a detailed analysis of the water demands of the service area. Greater control over demand provides greater certainty for management of supply. This allows rate structures to be established that meet the financial goals of the utility independently from water use. This provides revenue certainty that is not tied to consumption.

Significantly, this approach of analyzing water needs and eliminating waste could be applied to other water use sectors. The allocation of water resources then becomes a function of assessing demand and developing public policy for water allocation to reflect community and regional values. This method can recognize and allow for values that are not easily measured in economic terms and may be an alternative to using systems that provide access to the resource based on highest dollar value and ability to pay.

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