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Case Report

Benefits of Safe Drinking Water Mni Wiconi Rural Water System, Oglala Lakota County, SD, USA

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Abstract

This report assesses the economic efficiency of the Mni Wiconi water supply system overall and the on-going home connections program using a benefit-cost approach with results expressed as a B/C ratio. This study demonstrates that provision of safe drinking water has many benefits that exceed costs and warrants investments made and anticipated.

Keywords: Benefits, Costs, B/C Ratio, Safe Drinking Water, Health

Abbreviations: B/C: Benefit/Cost ratio; BRC: Boulder Rotary Club; MW: Mni Wiconi; NGO: Non-Governmental Organization; OLC: Oglala Lakota County; O&M: Operation and Maintenance; PRR: Pine Ridge Reservation; RS: Running Strong; SD: South Dakota; UN: United Nations, WHO: World Health Organization

Introduction

Provision of safe drinking water on the Lakota Sioux Nation on the Pine Ridge Reservation has been a concern for several decades. Shallow groundwater often used for domestic supply has been determined to have high concentrations of arsenic and uranium (Heakin 1992) [1]. The levels of these contaminants are a concern for health and longevity (EPA 2009). Powers, et al (2019) [3] found that 32% of adults ages 45 to 74 years have airflow obstruction or restriction that was associated with low-moderate arsenic exposure, independent of smoking and other lung disease risk factors.

To address economic and health issues of southwest South Dakota the federal government designed and built the Mni Wiconi (Water is Life) water supply system (https://www.mni-wiconi.org/). The Mni Wiconi water supply system involved 200 miles of main line delivery and a total system cost of approximately $400M of which about $160M was directed to the OLC portion to serve a design population of 21,000 persons. Connections of homes to the MW water mains are proceeding through a collaboration of the NGO Running Strong for American Indian Youth and the Boulder Rotary Club, CO. Part of this RS/BRC program involves assessment of the effectiveness of such water supply interventions.

Materials and Methods

Provision of safe drinking water to OLC was expected to yield a variety of beneficial health and community outcomes. The economic evaluation compares the value of quantifiable benefits gained from the water supply intervention with the costs of implementing the intervention. Benefits and costs are expressed in US dollars. The cost-benefit approach is based on work conducted by the WHO and UNICEF (Hutton et al 2007) [2] and measures efficiency expressed as a benefit-cost ratio (B/C). A B/C ratio exceeding 1.0 indicates

that benefits exceed costs thus providing a metric for judging project worthiness.

Benefits of the MW water supply intervention include time savings due to easier access to safe water, gains in productive time, reduced health care costs saved due to less illness, and prevented deaths. The approach estimates annual cost and time savings on a per home basis. Direct costs involve travel expenses and medical costs. Indirect costs relate to opportunity costs of lost earnings associated with time for travel and treatment. Another opportunity cost is the lost wages due to shorter life span. These avoided annual cost savings are taken as recurring over a service life (10 years) and discounted at 6% to a present value. The collection of present values of cost savings are compared to the present value of costs for construction and operations of the water supply system, including the household connections to the main MW water lines. A Base-Case scenario assumes a pre-MW situation where the centralized system does not exist, and homeowners travel to obtain safe water from a community source. Due to the uncertainty of estimates a range of values are adopted to reflect low and high estimates of the B/C ratio. The Base-Case represents the best estimate, a Low-Case represents pessimistic estimates, and a High-Case represents optimistic estimates.

Description of the benefit and cost estimation categories follow. Overall results are tabulated in Table 1. Data and information supporting the various factors for estimation of benefits and costs were obtained through extensive literature search and communications with involved professionals. Most of that background is too detailed and extensive to include here.

Estimation of Benefits: Water procurement costs and time savings include a) avoided travel costs for water procurement and b) time savings yielding either increased production or more leisure time ($21,600). Direct economic benefits of avoiding disease include a) value of avoided outpatient visits and in-patient days ($103,900) and b) non-health direct cost savings related to visits such as transport costs and other visit expenses ($17,500). Indirect economic benefits related to health improvement which include lower morbidity and longer life span ($17,700).

Estimation of Costs: Costs include the MW 1st cost $160M investment for the OLC portion of the project assigned to 5420 homes plus 600 commercial connections (per home cost $27,000). Annual operation and maintenance (O&M) costs were estimated by a survey of O&M for similar sized systems ($6,400 per home). Per home connections was approximately $6000. Total present value cost per home sums to $39,100.

Results

Results, presented (Table 1), are tabulated for the categories of benefits and costs.

Table 1: Oglala Lakota County - Benefits of Safe Drinking Water.

	Base-Case	Low-Case	High-Case
Benefits*	**$/Home**	**$/Home**	**$/Home**
Water procurement Costs & Time Savings	$21,572	$15,135	$25,225
Value of Visits Avoided	$103,866	$41,216	$197,839
Non-health Direct Savings	$17,468	$9,060	$27,563
Value of Longer Life	$17,685	$10,469	$23,301
Total Per-Home Costs	$139,019	$60,745	$248,703
Cost*	$/Home	$/Home	$/Home
MW 1st Costs/Connect	$26,667	$30,000	$23,333
O&M PV (r%, T yrs.)/Connect	$6,440	$7,728	$5,152
Home Connection Cost	$6,000	$8,000	$6,000
Total Per-Home Costs	$39,107	$45,728	$34,485
Benefits/Cost Ratio	3.6	1.3	7.2

*All per-home present values (r%=6%, T= 10 yrs.)

Discussion and Conclusions

The Base-Case analysis indicates that the MW investments are worthwhile with a B/C ratio of 3.6, meaning that for every dollar invested for safe drinking water yields returns of $3.6. The value of clinic and hospital visits avoided constitute the largest percentages ranging from 68% to 80% of total benefits. Depending on assumptions for various factors used for the analysis, the B/C ratio ranges from 1.3 to 7.2. The analysis is considered conservative as other benefits for economic and community well-being are not addressed.

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