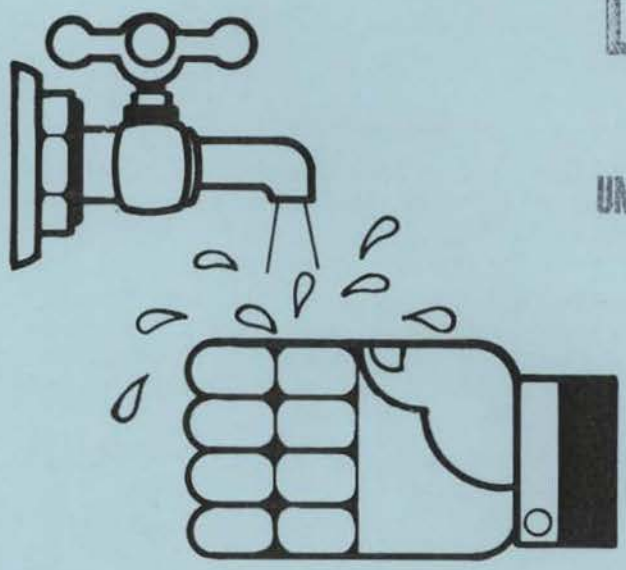
Bulletin No. 610

Cost of Public Service

Water Supply



Cooperative Extension Service
University of Idaho
College of Agriculture

Contents

This is one of eight bulletins supported by Title V of the Rural Development Act of 1972 on estimating costs of public service in Idaho communities of various size. The services covered in the series are:

- Education
- Fire Protection
- Police Protection
- Sewage Collection and Treatment
- Sheriff Protection
- Solid Waste Disposal
- Water Supply

A worksheet for estimating costs for each service area is designed to facilitate citizen use. Relationships are used to derive costs and are expressed in terms of state averages. You may use the standards as given to derive cost estimates for the services or change them to reflect the situation in your community.

Extension Bulletin 602, *Residential Growth: Its Benefits and Costs to the Local Community*, is used as a format for an overall look at what effects increases in the number of residential dwellings and people have on revenues for the public and private sector and on costs in the public sector. The estimation procedure is outlined for cities, counties and school districts.

This publication outlines a method of estimating your community's increased costs in water supply caused by population growth.

About the Authors

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Cost of Public Service: Water Supply

N. R. Rimbey and N. L. Meyer

This publication presents a method of estimating expenditures for water supply and a method for estimating the impact of population growth on these expenditures. The cost estimates derived are based on relationships taken from various sources which approximate the actual situation in communities and counties. The relationships are based on state or national averages and can be changed to reflect the situation in your community. Worksheets are provided to help you in the estimation procedure.

Introduction

Idaho is currently one of the fastest growing states in the nation. This growth brings economic benefits such as increased tax revenue to the public sector, possibly more service-oriented jobs and increased spending in the private sector. This growth may also bring general social benefits such as meeting and interacting with people from different cultural backgrounds, more specialized health care and more cultural programs through schools and civic organizations.

However, this growth does not come without additional costs. Many communities and counties in Idaho are not prepared for this growth. The public sector (present residents) must handle the added costs of providing services to the new residents. For example, growth may create needs for a new sewage treatment plant, school buildings, fire and police facilities and equipment, water wells or reservoirs and garbage collection and disposal equipment. Sizable public expenditures may also be necessary for land acquisition and additional employees.

Areas can accommodate growth more easily if the public service infrastructure already exists. That means having excess capacity in the water supply, sewage treatment facility, school system and police department and that other services can absorb the population increases without the need for major capital expenditures. Excess capacity in public services does not exist in many rural areas.

The increasing of service capability coupled with the movement toward government spending limitations poses a severe problem for many Idaho communities. "How can we accommodate the rapid population growth and additional service demands of residents and finance the services with reduced or 'frozen' revenues?" This is the most perplexing issue facing state and local government officials.

One possible alternative for local government officials is a program which would require new development to pay its "fair share" of the added service costs. Although this may seem to be a simple policy move, this action will require certain kinds of information. For example, information should be collected and analyzed to determine: the present costs of various services, the estimated costs for new residents, when expansion of which capital facilities will be needed (based on capacities of existing systems and projected growth rates), and what the existing policy of the governmental unit is concerning who should pay the additional costs.

Present costs of services are available in the annual audit report or annual budget of the unit of government. The policy aspect may require investigation of zoning regulations, building permit procedures or conversations with a city or county administrator.

The cost estimates presented here are based on relationships or standards that typify state or national averages. Standards for each service are

presented with the intention that you will change or modify them to fit the situation in your municipality. Worksheets, an abbreviated interest table and sources of information within the municipality are also given to help you in the estimation process.

A word of caution should be injected at this point. The cost figures presented here are **estimates** of actual costs and should be analyzed carefully before basing policies upon them. To help you critically evaluate costs, remember that the standards given should be changed when they prove inaccurate. Variations between actual and estimated costs may result from using average figures, topography of the area, the time lag between estimation and construction and a variety of other circumstances. Be advised, then, to use care in using the cost figures presented.

This publication was designed to give you, as a concerned citizen or government official, a **framework** for estimating the current costs of a public service. A method to estimate the added costs of population growth is also given. The service covered is water supply.

Methods of Estimating Expenditures

You can estimate costs several ways. The procedure used most often in fiscal impact studies is known as the average cost method. This involves:

1. Using the existing budget or audit report to derive current costs of services.
2. Dividing these costs by number of people or households served to determine a per capita or per household cost for each service.
3. Projecting this cost to new residents by multiplying the per capita or household costs by the number of new residents or houses.

This technique may be adequate for projecting the operation and maintenance costs of services but will severely underestimate the impact if capital expansion is needed. The problem lies in basing the estimates on past costs.

A more reliable method is using average cost figures and adding estimated capital costs. In other words, you can use average cost figures from the budgets as well as the estimated increases in capital costs to derive estimates of the impact on expenditures.

The most reliable (and costly) estimation method is conducting a detailed audit of each department within the municipality to determine the actual costs per household (or resident) and determining the anticipated date and cost of needed facilities expansion. This would involve a detailed study of each employee's duties, the anticipated equipment and personnel needs and the municipality's projected growth rates. This procedure is obviously very time consuming and expensive. However, it is the most reliable method to support local policies which require new development to pay for added service cost.

The following section outlines standards and procedures for estimating existing costs and added costs of development for community water supply. This material should be used together with the information in Ext. Bull. 602, **Residential Growth: Its Benefits and Costs to the Local Community**, to derive estimates of the public benefits and costs of community growth.

Water Supply

Idaho communities generally rely upon three different sources for their water supply. A system of well(s) and storage tanks is the most common source. This system is followed in importance by surface systems (reservoirs, rivers, springs, etc.) and the third, the purchase of water from existing water systems in adjacent municipalities.

This publication will help you determine the costs of a water system using wells and storage facilities. Costs considered include well drilling, pump and accessories, water lines, land, storage facilities and other related facilities.

Treatment costs have not been included here because of the assumption that the water from well sources does not need treatment. Another study mentions that treatment costs can be estimated by taking 6 percent of the total annual cost of the water system (1).

You can use the following standards to derive cost estimates for a community water system:

Standard 1 — The length of water main per capita decreases as population increases; the size of water main increases with population. Apply the following formula:

$$Y = 114.54x^{-.19}$$ where Y = length of main (feet capita) and X = community population.

Table 1 gives the water main length and size per capita for various community sizes (3).

Standard 2 — PVC pipe is used for water mains. The costs are $4.59 per foot for 6-inch pipe and $7.59 per foot for 8-inch pipe (2).

Table 1. Length and size of water main by community size.

Community population	Length of main per capita	Total length of main	Size of main
	(feet)	(feet)	(inches)
500	35.17	17,585	6
1,000	30.83	30,830	6
1,500	28.54	42,810	6
2,000	27.02	54,040	6
2,500	25.90	64,750	6
5,000	22.71	113,550	8
10,000	19.90	199,000	8
15,000	18.43	276,450	8
30,000	16.15	484,500	8

Table 2. Component costs of water systems as percentages of total investment (1).

Component	% of total investment
Land	2
Water source and facilities	45
Distribution (water mains and construction)	36
Storage	14
Site improvements	3
Total	100

Standard 3 — Total water main costs can be divided into two components. Pipe at the site is 64 percent of the cost, and construction costs account for the remainder (1).

Standard 4 — Table 2 gives component costs of water systems as percentages of total investment.

Standard 5 — Annual operation and maintenance cost is 3 percent of the total investment cost (1).

Standard 6 — The ratio of population to hookup is 3.2:1 (4).

Standard 7 — The average length of house connection is 60 feet, and ¾-inch pipe is used at a cost of 60 cents per foot (2,3). Therefore, total hookup cost is $180.

Standard 8 — Financing for the system is available at 10 percent interest for 20 years. Table 3 gives other amortization rates for different time periods and interest rates.

Estimating the Cost of Water Supply

Using the eight standards, you can estimate the current cost of providing water to a community of a given size. For example, consider a community with a population of 1,000 people.

Step 1 — Estimate the number of feet of water pipe necessary to serve this community (Standard 1):

1,000 population × 30.83 feet capita = **30,830 feet** of water line

Step 2 — Determine the pipe cost (Standard 2):

30,830 feet × $4.59 foot = **$141,510** total pipe cost

Step 3 — Determine the total water main cost (Standard 3):

$141,510 total pipe cost ÷ 0.64 = **$221,109** total water main cost

Step 4 — Estimate the total investment of the system (waterlines, well and storage facilities, Standard 4):

$221,109 water main cost ÷ 0.36 = **$614,192** total investment

The component costs of the system are:

Land	$ 12,284
Water source and facilities	276,386
Storage	85,987
Site improvements	18,426
Distribution	221,109
Total	$614,192

Table 3. Amortization rates for different interest rates and loan periods.

Interest rate	Years					
	3	5	10	15	20	30
7	.381052	.243891	.142378	.109795	.094393	.080586
8	.388034	.250456	.149029	.116830	.101852	.088827
9	.395055	.257092	.155820	.124059	.109546	.097336
10	.402115	.263797	.162745	.131474	.117460	.106079
11	.409213	.270570	.169801	.139065	.125576	.115025
12	.416349	.277410	.176984	.146824	.133879	.124144
13	.423522	.284315	.184290	.154742	.142354	.133411
14	.430700	.291200	.191700	.162800	.150900	.142800
15	.437900	.298300	.199200	.171000	.159700	.152300

This table will help you calculate the annual payments on investments for community services. For example, the annual payments for a $40,000 loan at 10 percent interest rate for 15 years can be calculated:

Loan amount × amortization rate = annual payment
($40,000) (.131474) ($5,259)

An annual payment of $5,259 would pay the principal and interest on this loan and retire the debt in 15 years. If an interest rate and the time period for a loan are not listed in this table, your local bank can provide the figures.

Step 5 — Estimate the annual cost of financing the system by amortizing the total investment for 20 years at 10 percent (Standard 8):

$614,192 × 0.117460 (amortization rate, Table 3) =
$72,143 annual cost of financing system

Step 6 — Estimate the annual operation and maintenance of the water system as follows (Standard 5):

$614,192 total investment × 0.03=
$18,426 annual operation and maintenance cost

Step 7 — The total annual cost of the system is the sum of the annual cost of financing the system and the annual operation and maintenance cost:

$72,143 + $18,426 =
$90,569 total annual cost

This estimate can also be expressed in cost per capita or household:

$90,569 ÷ 1,000 population =
$90.57 annual cost per capita
$90,569 ÷ 313 household (Standard 6) =
$289.36 annual cost per household

Cost estimates for other populations are presented in Table 2.

Estimating Population Growth's Impact on Water Supply Costs

The assumptions can also be used to estimate the impact of population growth on water system expenditures. As an example, consider a community of 1,000 people which expects to have 500 new residents moving into a development. The impact on community water expenditures can be estimated in two ways. The method used here compares average cost figures for the two population sizes. The other uses actual data on number of feet of new water line and the estimated cost, estimates for increases in operation and maintenance, storage facilities and so on. (Similar to the approach used for University of Idaho Extension Bulletin 607, *Sewage Collection and Treatment.*) The second approach yields more reliable estimates on a case-by-case basis than the average cost approach used here. However, the second approach is more involved and better suited to individual communities concerned with specific growth problems.

Comparing the cost figures for the two populations yields the following:

Step 1 — Estimate the number of feet of water pipe necessary to serve the new residents of the community (Standard 1):

1,500 population × 28.54 feet per capita =	42,810 ft
1,000 population × 30.83 feet per capita =	30,830 ft
Additional feet water main	11,980 ft

Step 2 — Determine the pipe cost (Standard 2):

11,980 ft × $4.59/ft = $54,988 cost additional pipe

Step 3 — Determine the total water main cost (Standard 3):

$54,988 total additional pipe cost ÷ .64 =
$85,919 total additional water main cost

Step 4 — Estimate the total additional investment cost of the system (waterlines, well and storage facilities, Standard 4):

$85,919 total additional water main cost ÷ .36 =
$238,664 total additional investment

Component costs of the system are:

Land	$ 4,773
Water source and facilities	107,399
Storage	33,413
Site improvements	7,160
Distribution (water mains and construction)	85,919
Total additional investment	$238,664

Table 4. Water supply costs by community population.

Population	A Length of main per capita	B Price per foot of pipe	C Total pipe cost	D Total water main construction	E Total investment	F Annual financing cost	G Annual operation and maintenance	H Total annual cost	I Annual cost per household
500	35.17	$4.59	$ 80,715	$ 126,117	$ 350,326	$ 49,149	$ 10,510	$ 59,659	$381.82
1,000	30.83	4.59	141,510	221,109	614,192	72,137	18,426	90,563	289.34
1,500	28.54	4.59	196,498	307,028	852,855	100,176	25,586	125,762	268.29
2,000	27.02	4.59	248,044	387,568	1,076,578	126,455	32,297	158,752	254.00
2,500	25.90	4.59	297,203	464,379	1,289,941	151,517	38,698	190,215	243.48
5,000	22.71	7.59	861,845	1,346,632	3,740,645	439,376	112,219	551,595	353.02
10,000	19.90	7.59	1,510,410	2,360,016	6,555,599	770,021	196,668	966,689	309.34
15,000	18.43	7.59	2,098,256	3,278,524	9,107,011	1,069,710	273,210	1,342,920	286.49
30,000	16.15	7.59	3,677,355	5,745,867	15,960,742	1,874,749	478,822	2,353,571	251.05

A. Standard 1
B. Standard 1 and 2
C. Population × A × B
D. Standard 3 (C ÷ 64%)
E. Standard 4 (D ÷ 36%)
F. Standard 8
G. Standard 5 (E × 3.00%)
H. F ÷ G
I. H ÷ number of households

Step 5 — Estimate the annual cost of financing the additional investment for 20 years at 10 percent (Standard 8):

$238,664 × .117460 (amortization rate, Table 3) =
$28,034 annual cost of financing additional investment

Step 6 — Estimate the annual additional operation and maintenance of the water system as follows (Standard 5):

$238,664 additional investment × .03 =
$7,160 additional operation and maintenance

Step 7 — The total additional annual cost of the system is the sum of the annual cost of additional financing and operation and maintenance:

$28,034 + $7,160 =
$35,194 total annual additional cost

This estimate can be expressed in cost per capita or household:

$35,194 ÷ 500 additional population = $70.39/capita
$35,194 ÷ 156 additional households = $225.60/household

If the increase is paid by all residents in the community (1,500 population), the new costs are:

$90,569 previous total cost + $35,194 additional total cost =
$125,163 total cost

$125,163 total cost ÷ 1,500 population = $83.84/capita
$125,163 total cost ÷ 468 households = $267.44/household

Community Sources

- The city engineer and city manager will be able to provide valuable information on the existing water system and possible areas of future growth.
- The city budget may contain useful information concerning existing costs of the water system.
- Local plumbing supply outlets will be able to provide information concerning water pipe costs.
- Local banks and financial institutions will be able to provide information on existing financial arrangements. The Farmer's Home Administration will also be able to supply information concerning federal water programs concerning your community.

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5. City-County Data Book. 1977. Boise Center for Urban Research, Assn. of Idaho Cities, Idaho Assn. of Counties.

WORKSHEET
Estimating Water Supply System Costs

A. _____
Community population

B. _____ = (_____ × _____)
Number feet water pipe — (A) Population — Table 1 value

C. _____ = (_____ × _____)
Water pipe cost — (B) Number feet water pipe — (Price per foot (Standards 1 and 2)

D. _____ = (_____ ÷ .64)
Total distribution cost — (C) Water pipe cost — Standard 3

E. _____ = (_____ ÷ .36)
Total investment — (D) Total distribution cost — Standard 4

F. _____ = (_____ × _____)
Annual investment cost — (E) Total investment — Amortization rate (Table 3)

G. _____ = (_____ × .03)
Annual operation and maintenance cost — (E) Total investment — Standard 5

H. _____ = _____ + _____
Total annual cost — (F) Annual investment cost — (G) Annual operation and maintenance cost

I. _____ = (_____ ÷ _____)
Annual cost per person — (H) Total annual cost — (A) Community population

J. _____ = (_____ ÷ _____)
Annual cost per household — (H) Total annual cost — Number households

WORKSHEET
Estimating Population Growth's Impact On Water Supply Expenditures

A. _____
Number new residents

B. _____ = (_____ × _____)
Feet additional water main — Total population (including new) — Standard 1, Table 1

- (_____ × _____)
Total previous population — Standard 1, Table 1

C. _____ = (_____ × _____)
Cost additional water pipe — (B) Additional water main — Price per foot (Standards 1 and 2)

D. _____ = (_____ ÷ .64)
Total additional distribution cost — (C) Cost additional water pipe — Standard 3

E. _____ = (_____ ÷ .36)
Total additional investment — (D) Total distribution cost — Standard 4

F. _____ = (_____ × _____)
Annual additional investment cost — (E) Total additional investment — Amortization rate (Table 3)

G. _____ = (_____ × .03)
Annual additional operation and maintenance cost — (F) Total additional investment — Standard 5

H. _____ = _____ + _____
Total annual additional cost — (F) Annual additional investment cost — (G) Annual additional operation and maintenance cost

I. _____ = (_____ ÷ _____)
Annual cost per new resident — (H) Total annual additional cost — (A) Number new residents

J. _____ = (_____ ÷ _____)
Annual cost per new household — (H) Total annual additional cost — Number of new households

K. _____ = (_____ ÷ _____)
Annual cost per resident — (H) Total annual additional cost — Total number community residents (new and previous)

Cost of Public Service: Water Supply is the eighth in a series of bulletins on estimating costs of public service in various size Idaho communities. Other bulletins in that series available from the University of Idaho Agricultural Information Department are as follows:

EXT 602	Residential Growth: Its Benefits and Costs to the Local Community	50 cents
EXT 604	Cost of Public Service: Education	25 cents
EXT 605	Cost of Public Service: Fire Protection	25 cents
EXT 606	Cost of Public Service: Police Protection	25 cents
EXT 607	Cost of Public Service: Sewage Collection and Treatment	25 cents
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