



Project Summary

Estimation of Small System Water Treatment Costs

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Construction and operation and maintenance costs are presented for 45 centralized water treatment unit processes and 5 point-of-use water treatment techniques. The cost data apply to flows of up to 3,785 m³/d (1 mgd). The unit processes were selected based on their ability (1) to remove contaminants included in the National Interim Primary Drinking Water Regulations or (2) to treat and dispose of sludges and brines produced by these treatment processes.

This Project Summary was developed by EPA's Water Engineering Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The main purpose of this project was to develop and present cost data for constructing, operating, and maintaining centralized and point-of-use treatment techniques for small water treatment systems. The data presented apply to flows up to 3,785 m³/day (1 mgd).

Another objective was to verify cost data generated in the laboratory with those collected in the field. To accomplish this goal, utilities using a wide variety of the treatment techniques were visited.

Approach to Cost Development

Cost data presented in this report are based on December 1983 costs. They were developed to allow maximum flexibility in their use. Construction costs are plotted versus the design parameter that best accommodates designer preference, raw water quality variations, and regulatory agency loading rates. Though some

construction costs are plotted versus flow, most are plotted versus another design parameter such as pounds or cubic feet per day for chemical feed systems, square feet of surface area for filters, and contractor volume for ion exchange and adsorption processes. This approach gives the cost data much greater flexibility than if costs for all processes were plotted versus flow.

Construction costs were developed and are presented in eight categories: Excavation and sitework, manufactured equipment, concrete, steel, labor (installation), pipe and valves, electrical instrumentation, and housing. To convert the construction cost into capital cost for an entire plant, the data must be aggregated for the individual processes included in the plant, and adjustments must be added for the following:

- Sitework, interface piping, roads, and standby power
- General contractor's overhead and profit
- Engineering
- Land
- Legal, fiscal, and administrative costs
- Interest during construction

The capital cost for a treatment system is the sum of the costs for these items (where applicable).

Operation and maintenance requirements were developed for energy, maintenance material, and labor. The energy category includes process electrical energy, building electrical energy, and diesel fuel. Electrical energy requirements are presented in kWh/year, and diesel fuel requirements are presented in gal/year. Annual energy costs are determined using unit costs of \$0.07/kWh

of electricity and \$0.29/L (\$1.10/gal) of diesel fuel.

Maintenance material costs include those for periodic replacement of component parts needed to keep the process operable and functioning. Examples of maintenance materials are valves, motors, instrumentation, and other similar process items. The maintenance materials do not include the cost of chemicals required for process operation.

Labor requirements include both operation and maintenance labor, and they are presented in terms of hours per year. The process operating parameter should be used to determine the labor requirement. The labor requirements were converted to an annual cost using an hourly labor rate of \$11.00/hr, which includes salary and fringe benefits.

Computer Program

A computer program and users manual is included in the report. The WATER program is a FORTRAN program that can retrieve and update cost data for the 45 unit processes. Examples of the input files are included along with output sheets for three hypothetical plants. The user need not be an experienced programmer to use the WATER program, but a familiarity with programming is recommended.

Cost Updating

Two approaches are presented for updating construction costs: One is to use a single index such as the Engineering News Record (ENR) Construction Cost Index, and the second (and more accurate) approach is to use a separate index for each of the eight construction cost components. An approach is presented using five different Bureau of Labor Statistic indices and two ENR indices. The latter approach is difficult to perform manually, but it is well suited to a computer program.

The total operation and maintenance costs can be updated by updating the three individual components: energy, labor, and maintenance material. Energy and labor can be updated by applying the current unit costs to the kilowatt-hour, diesel fuel, and labor requirements obtained from the energy and labor curves. Maintenance material costs, which are presented in terms of dollars per year, can be updated using the Producer Price Index for Finished Goods.

Treatment Techniques

The 45 centralized treatment techniques included in this report are:

Complete treatment techniques

1. Package complete water treatment systems
 - Conventional package complete treatment
 - Culligan Multi-Tech System
 - Neptune Microfloc Trident System
2. Package lime softening

Filtration techniques

3. Package pressure filtration plants
4. Package gravity filtration plants
5. Diatomite filtration
 - Package vacuum diatomite filters
 - Package pressure diatomite filters
6. Slow sand filters

Membrane treatment techniques

7. Reverse osmosis
8. Electrodialysis
9. Package ultrafiltration

Ion exchange and adsorption techniques

10. Cation exchange softening
11. Anion exchange nitrate removal
12. Activated alumina fluoride removal
13. Granular activated carbon adsorption
 - Package pressure granular activated carbon contactors
 - Package gravity granular activated carbon contactors

Aeration

14. Diffused air aeration
15. Countercurrent packed tower aeration
16. Spray aeration systems
17. Cascade tray aerators

Chemical feed systems

18. Gas feed chlorination systems
19. Hypochlorite solution chlorination systems
20. Pellet feed chlorinators
21. Erosion feed chlorinators
22. On-site hypochlorite generation systems
23. Chlorine dioxide generation and feed systems
24. Ozone generation, feed, and contacting systems
25. Basic chemical feed systems
26. Dry chemical feed systems
27. Polymer feed systems
28. Powdered activated carbon feed systems

29. Sulfuric acid and sodium hydroxide feed systems
30. Potassium permanganate feed systems
31. Ferric chloride feed systems

Sludge and brine handling techniques

32. Sludge dewatering lagoons
33. Sludge disposal to sanitary sewers
34. Sand drying beds
35. Liquid sludge hauling by truck
36. Dewatering sludge hauling by truck
37. Brine evaporation lagoons

Miscellaneous techniques

38. Water wells
39. Package raw water pumping facilities
40. Package high-service pumping facilities
41. Filter media
42. Package flocculator clarifier
43. Contact basins—direct filtration applications
44. Ultraviolet light disinfection
45. Clearwell storage

The five point-of-use treatment techniques are:

1. Reverse osmosis
2. Activated alumina
3. Granular activated carbon
4. Cation exchange
5. Anion exchange

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Richard G. Eilers is the EPA Project Officer (see below).

The complete report consists of two parts, entitled:

"Estimation of Small System Water Treatment Costs (Text)," (Order No. PB 85-161 644; Cost: \$43.00)

"Estimation of Small System Water Treatment Costs (Computer Tape)" (Order No. PB 85-161 651; Cost: \$400.00)

The above items will be available only from: (costs subject to change)

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