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PROCEDURAL HANDBOOK FOR VALUE ENGINEERING

DECEMBER 1975

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WATER PROGRAM OPERATIONS
WASHINGTON, D.C. 20460

MCD-18

NOTES

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PROCEDURAL HANDBOOK

FOR

VALUE ENGINEERING

Municipal Construction Division
Office of Water Program Operations
Environmental Protection Agency

December 1975

MCD-18

CONTENTS

I INTRODUCTION

A. Background

The cost-effective approach to wastewater treatment management is directed in the Federal Water Pollution Control Act Amendments of 1972 (the Act). Under Section 212 (2)(B) of the Act, the grant applicant is required to demonstrate that the proposed project is the most cost-effective alternative to meet the goals of the Act. EPA cost-effectiveness guidelines (40 CFR 35, Appendix A) provide guidance to grant applicants for use in making cost-effectiveness studies.

Value Engineering (VE) is a step beyond the traditional engineering analysis. Experiences have shown that application of the VE techniques during the design of a project results in significant cost savings. Reports of the application of VE to municipal wastewater treatment works show that VE is beneficial to increase cost effectiveness in the EPA construction grants program. The billions of dollars required to construct and operate the nation's water pollution control projects indicates that even a small percentage of savings would result in substantial dollar savings.

This handbook is intended to provide the administrative support and management procedures required by grant applicants and design engineers to conduct a voluntary VE program. Grant applicants and designers should be aware of potential benefits provided by VE analysis and are encouraged to use it whenever appropriate.

The VE Job Plan, a detailed description of the VE methodology, is presented only briefly here because is is assumed that either the designer has the personnel with the required qualifications to conduct the VE study or the designer will contract personnel with the required qualifications to do the study.

B. Definition of Value Engineering

Value Engineering is a systematic and creative approach to identify unnecessarily high costs in a project in order to arrive at a cost savings without sacrificing the reliability or efficiency of the project or increasing operating and maintenance costs.

C. The Effect of the VE Study on the Designer-Client Relationship

The client relies upon the designer to design for him a facility that most economically will meet the needs of the municipality. The client should, therefore, encourage the use of new processes and techniques, but he must leave the actions and responsibilities in the hands of the designer. If this idea is combined with the following from the

canons of ethics for engineers, a strong case for the use of VE techniques emerges: "He (the engineer) shall engage, or advise his client or employer to engage, and he will cooperate with other experts and specialists whenever the client's or employers interests are best served by such service." Therefore, it seems reasonable to assume that since VE has been shown to enhance cost effectiveness to the client, the techniques of VE should be an integral part of the design process.

The point sometimes raised by clients is that since they have already contracted a designer for an economical design, any additional engineering such as VE is either superfluous or represents an additional expense. Actually, Value Engineering is an objective second look at a project. EPA is willing to share the cost of the study effort because of the demonstrated savings that result. This extra effort is beyond the scope of the conventional design practice.

D. Design Review by "Other" Designers

The EPA program requires that Value Engineering be conducted by design personnel not involved with the original design team. This is because the Value Engineering study is to be an objective second look at the project design. If the firm has sufficient personnel with the required qualifications (discussed later in this handbook), the firm may be able to conduct its own VE study. On the other hand, if it does not have sufficient design personnel, the VE study will have to be augmented by other personnel, such as from another firm. The reason for this is to have personnel not technically involved in the original design so that an atmosphere conducive to an objective study is created.

Some designers may be reluctant to submit their work for review by other designers. However, past experience has shown that the results of VE studies have been beneficial not only to the owners, but to the original designers as well. Embarrassment to the designers has not materialized; rather, owners have appreciated the efforts of the designers to enhance the value of their facilities.

Design disclosure of information which may be of significant benefit to a potential competitor is largely controllable by the designer. First of all, any proprietary data or other data which the designer feels must be protected, can be withheld from the VE review; however, the designer must justify doing so when submitting his VE program for grant eligibility. Secondly, the designer may also select other design firms to submit proposals to conduct the VE study.

E. The VE Program Outline

This handbook covers the entire VE program and describes the four phases shown below. Where lengthy procedures, techniques or discussions are required, they are referenced in an appendix.

1. Administrative Procedures

   a. Objective
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   f. Scheduling the VE program
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      (1) Drawings
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3. VE Study Procedures

4. Post-VE Study Procedures

   a. Preparation of the preliminary VE study report
   b. Distribution of the preliminary VE study report
   c. Preliminary VE study report review
   d. Distribution of final VE study report
   e. Implementation and followup

II THE VALUE ENGINEERING (VE) PROGRAM

A. Administrative Procedures

1. Objective

The objective of the following administrative procedures is to provide information needed for submittal of the VE proposal for eligibility with the Step II grant application or amendment of an existing Step II grant to include VE. Procedures for submittal of both the VE proposal and the designer's redesign fee for grant eligibility are contained in paragraph II.A.7.

2. Level of VE Effort

The level of effort required to conduct an effective VE study is a function of the complexity of the project and should be decided by the designer after discussion with the VE team coordinator. For instance, the level of effort for a project utilizing the trickling filter process may not require the same level of effort as a project utilizing the activated sludge process and biological nitrification. Therefore, the level of effort as stated below is intended to serve only as a guide. Approval of the actual level of effort proposed lies with the Environmental Protection Agency and the State, and is part of the Step II grant-approval process discussed later in this handbook.

A complex wastewater treatment plant (WWTP) may require multiple team and/or multiple VE studies to adequately review the project. For example, each of the following areas may require one team to assure thorough coverage.

a. All processes

b. Plant layout and structures

c. Interface (electrical and piping) and other related items.

In the above situation, it may be advisable to conduct the study on the processes first and then follow with studies on the remaining areas.

If more than one study is to be conducted, the studies may be conducted at different times during Step II either by different teams or by the same team(s). In any event, close coordination between the teams is important.

3. Qualification Requirements of the VE Study Team(s)

The qualification requirements which follow apply whether the VE study is conducted by the designer, or is subcontracted to an outside firm. The VE study shall be conducted by teams composed of experienced technical staff personnel, experienced in the design of WWTP projects. The size of the team would be approximately five active members. If it is desired to have more than five men on the team(s), justification shall be given in the VE program application for grant eligibility with the Step II grant.

The VE study shall be directed by either a qualified VE specialist or an experienced engineer who has completed a construction-oriented 40-hour VE workshop. This director will be called the VE team coordinator. For workshops commencing July 1, 1976, or later, the VE team coordinator must have participated in a minimum of two actual VE studies on construction projects, preferably WWTP projects. For workshops commencing before that date, less experience may be acceptable, depending on the complexity of the project. The VE team coordinator shall not be a member of any one VE study team except when only one team is conducting the VE study. No active member of the team(s) nor the team coordinator may be a member of the original design team of the project being studied (except the cost estimator).

The VE study shall be primarily project oriented. This means that every effort should be made to ensure that the VE study of the project is effectively and thoroughly executed. A training program may be made a part of the VE study provided it is approved by the State and EPA. In this case, costs associated with the training program will not be grant eligible, but costs for VE study of the project are eligible.

4. Where to Find Qualified VE Specialists

Information concerning qualified VE specialists may be obtained from the regional office of EPA or regional offices of the General Services Administration.

5. Estimating the Cost of a VE Program

The cost of a VE program is a function of the level of effort which, in turn, is a function of the complexity of the project. Therefore, the level of effort must first be determined considering the number of teams and the number of workshops. The cost estimate should then be made based on the entire program, from the administrative phase through to the post-VE study phase. (Use EPA Form 5700-41, February 1976).

6. Scheduling the VE Program

The VE program comprises pre-VE study activities, the VE study itself, and all post-VE study activities including report preparation, proposal review and completion of the implementation or redesign. Therefore, the entire VE program should be scheduled for completion no later than 70 to 80 percent completion of Step II, to ensure the project schedule will not be delayed. Since the VE program schedule will be conducted simultaneously with the design schedule, it may be advantageous to time the actual study to coincide with design reviews.

The actual time required for VE change proposal review and acceptance or rejection, plus redesign and implementation, is difficult to estimate; therefore, estimates should be based on estimated maximum amount of post-VE study effort.

The above guidelines stress the latest date of initiation of the VE program. However, the earliest date should be a function of several variables such as availability of data required for the VE study and the type of system being designed. A decision should be made between starting a VE program with minimum data, and waiting so long that extensive redesign would be necessary. This decision lies with the designer.

7. Submitting the VE Program Proposal

The cost of the VE program is grant eligible; the proposal should be submitted as a part of the application for Step II grant for preparation of plans and specifications. Payment for the VE program, if approved, is intended to be flexible and consistent with the payment schedule for the main Step II grant. The following guidelines may be applied when appropriate:

First payment:	Completion of the VE study
Second payment:	Completion of VE report from the designer (see post-VE study procedures and report distribution)
Final payment:	Completion of redesign and implementation and followup process including submittal of a report by the designer stating actual savings

The VE program proposal, when it is submitted as a supplement to an existing Step II grant, should be submitted between the start and 40 percent completion of the Step II grant for plans and specifications.

The designer's redesign fee and implementation cost resulting from the accepted and implemented VE proposed changes are also grant eligible. Application for the redesign fee and implementation costs should be submitted with the final report from the designer.

In addition to the standard grant information, the application for a VE program shall include:

a. Pertinent information on the project to be studied, including size, treatment process, current estimated construction cost, et cetera.

b. Cost to accomplish the VE program

c. Schedule of proposed VE program. The application shall indicate the schedule in relation to the project design schedule to show that undue delay will be avoided. The schedule shall also show when the recommendations will be available to the original designer and when the VE report will be submitted to EPA by the designer.

d. Identification of the VE team. The name, professional background, and VE experience (if any) of each member of the VE study team(s) shall be given.

e. Level of effort. The level of effort shall be stated and shall be in accordance with the guidelines established in this handbook.

B. Pre-VE Study Procedures

The success of a VE study is greatly dependent on timely and efficient prestudy preparations. Certain information and documents should be distributed to the team members as soon as possible before the study to prepare the study teams for their particular area of study, and to help the teams determine what reference material to bring.

1. Documents Required

Copies of drawings, detailed cost data, specifications, reports, and pertinent regulations are required in sufficient numbers to permit team members to investigate various areas simultaneously. Documents needed by each team are as follows:

a. Drawings: One complete set of team's area of study. If the total number of drawings in the entire set is relatively small (for example, between 50 and 100), it may be desirable to have one complete set of drawings per team. If it is decided that each team will have a copy of drawings pertinent to only their particular study area, then it is highly desirable to have one or more complete reference sets for use by all teams. The actual number of reference drawing sets would be dependent on the project size.

b. Detailed Cost Data: The cost data should be as complete and as detailed as practicable.

c. Copies of the specifications, design criteria, regulations, and reports.

The above documents are required at least one week (preferably two depending on the size of the project) prior to the first day of the VE study because the VE team coordinator must:

a. Construct the cost model

b. Determine high-cost areas with the greatest potential for savings

c. Determine the discipline composition of team members and assign teams to corresponding study areas

d. Review the drawings, specifications, cost data, and reports to be thoroughly familiar with the project

e. Distribute information to the team members as soon as possible before the first day of the workshop

The VE team coordinator should request assistance from the designer during project familiarization. When appropriate, a project description may be prepared by the VE team coordinator and distributed to each team member as early as possible before the start of the VE study.

The VE team coordinator should obtain for each team member reference material on VE methodology. Finally, the VE team coordinator should prepare an itemized list of equipment and material which each team member should bring to the study.

2. VE Team Composition

It is not intended that this handbook establish rigid rules for the composition of VE study teams; rather, it is intended that sufficiently flexible guidelines be presented to assist in the selection of personnel for the various study areas and projects.

Composition of the teams is a function of the study area; only the disciplines involved in the study area should be represented on the team. For instance, the following table illustrates team composition for different areas of study.

	NUMBER OF MEN			
DISCIPLINE	PROCESS	SITE	BLDGS	INTERFACE (PIPING, ELEC)
SANITARY	1			1
STRUCTURAL		1	1	1
ME (PIPING)	1	1		1
ME (HVAC)			1	
ELEC	1	1	1	1
COST EST.	1	1	1	1
ARCHITECT		1	1	

For study teams of fewer than five men, the disciplines should be selected according to the significance of the study areas. For instance, a three-man study team for an underground pumping station might best be composed of structural, mechanical, and electrical engineers. However, a three-man study team for an above-ground pumping station near a residential area might be composed of structural and mechanical engineers and an architect.

3. Liaison with Design Engineer and Federal, State, and Local Authorities

It is imperative that some form of liaison be established with the designer to provide the VE study teams with a constant source of answers to questions which may arise during the study. This liaison may be accomplished in any manner suitable to the VE team coordinator and designer.

In addition, some form of liaison should be established with Federal, State, and local authorities, by the designer at his option, or by the VE team coordinator. This liaison might best be accomplished by having one or more of the State and local authorities attend the VE study as consultants or observers.

4. Selection of Study Areas

The selection of study areas should be accomplished without regard to EPA design guidelines criteria since these criteria may be challenged if the VE study presents substantial cause. Note, however, the legal or regulatory requirements (such as permit discharge limitations) are not to be modified by the VE process. There are other mechanisms for this purpose and these issues should be resolved before the design is started. Exceptions to design criteria will take more time for EPA review and this should be considered. The selection should be based on:

a. The results of the cost model (and any additional cost analysis conducted prior to the study)

b. The number of teams available versus the number of study areas available

c. Information known about the system beforehand which may influence the selection of study areas

d. Timing of the VE program, or other factors which may prohibit or emphasize the study of certain areas.

Study areas should be selected only after careful consideration of all factors involved. The study areas should be well defined and known to all teams so that ideas may be coordinated between the teams during the study.

As soon as the study areas have been selected, specific teams should be composed and assigned to the study areas. The VE team coordinator should then contact all team members as soon as possible and inform them of the area(s) which they will be studying, so that they can bring appropriate reference books, catalogs, and other necessary documents.

C. VE Study Procedures

The VE Job Plan

Several authors have described the VE Job Plan using various phases and titles of phases. Appendix B shows the principal phases of the VE Job Plan which must be incorporated into the VE study. Sample forms for the VE Job Plan workbook are also shown in Appendix A. This handbook does not present the VE Job Plan in detail since VE-trained personnel will be directing the study.

The VE study may be conducted either by meeting 5 consecutive days, or by conducting the information phase in the first day and then waiting for several days before continuing the VE study. In the latter case, the team and VE team coordinator would have ample time to find answers to questions raised during the information phase. Also, it is sometimes advantageous to expose the team to the project and then let the team dwell on it for several days.

1. Information Phase

A project briefing should be presented by the study team coordinator. Drawings, reports, cost data, specifications, and other documents should be distributed and the teams permitted sufficient time for familiarization.

Project constraints and other design criteria should be discussed during this phase.

2. Speculation Phase

The team should generate numerous alternative means of accomplishing the function(s) of the item under study. No attempt should be made to evaluate the alternatives at this time regardless of how "far-out" they may appear since these alternatives often lead to development of the final alternative proposed for implementation. It is interesting to note that, in many cases, the alternatives generated during the last half of the creative session were those which were developed and proposed for implementation.

3. Analytical Phase

This process eliminates those alternatives generated during the creative phase session which are not considered feasible. Only those ideas which, after team discussion, appear most promising should be retained and closely examined for overall advantages and disadvantages. Consideration must be given to all the design criteria, including cost, needed performance, efficiency, reliability, quality, maintainability, desired esthetics, safety, fire protection, environmental and ecological effects, replacement and future expansion plans, and the probability and cost of implementation. Emphasis should be placed not only on instant savings cost, but also on maintenance, operating, and replacement costs.

4. Development Phase

The alternatives remaining from the analytical phase should be developed to a point where they can be compared with the original design from the points of view of both feasibility and costs.

This is the phase in which the techniques of Life-Cycle Costing (LCC) should be used. Those components of LCC which comprise operation, maintenance and replacement (OMR) cost, and those which comprise the capital cost segment of the LCC, should be evaluated and reported separately so that subsequent review of the proposal can identify these components of the LCC analysis.

A very important function of the development phase is the development of the cost data for both the as-designed system and the proposed system. The cost data must be developed systematically and references shown to which the cost data may be traced. Where possible, the cost estimates should be prepared by the cost estimators who prepared the original estimates.

5. Proposal Phase

The proposal phase concludes the VE Job Plan workbook but not the VE program. The alternatives developed should be presented briefly and concisely. The items which should be presented are:

a. Total costs and cost savings

b. Brief description and sketches of as-designed versus as-proposed alternatives

c. The rationale of the proposed alternatives

d. Implementation costs and a brief description of how implementation is to be accomplished

6. Adjournment of VE Study

Before or immediately after adjournment of the VE study, it may be desirable to make a copy of each team's workbook for immediate distribution to all team members, depending on whether teams require any additional input to the VE team coordinator or for the VE Job Plan workbook.

D. Post-VE Study Procedures

1. Preparation of the Preliminary VE Study Report

This report is prepared by the VE team coordinator from the information contained in the VE Job Plan Workbook generated during the VE study. The report should contain a brief description of the project and a summary of findings. The VE Job Plan Workbook, calculations, and other detailed data should be included in an appendix.

The report should include:

a. Overall project description, including project estimated construction cost

b. Present design, showing cost and sketch

c. Proposed design, showing cost and sketch

d. Implementation costs

e. Implementation procedures and problems, if any

f. Instant contract savings

g. Operations, maintenance, and replacement cost savings

h. Total life-cycle costs

The method of expressing cost savings should be presented in both present-worth amounts and in annual savings amounts, in accordance with the cost effectiveness analysis guidelines (See Appendix A). In addition, the savings should be presented as percent of system and percent of entire construction costs or total annual costs.

2. Distribution of the Preliminary VE Study Report

Distribution of the report shall be the responsibility of the VE team coordinator and shall be in accordance with the following:

Recipient	Number of Copies
Designer	2
Owner	2
State Pollution Control Agency	2
EPA, Regional Office (See Appendix B)	2

3. Preliminary VE Study Report Review

The designer and the owner shall review the preliminary VE study report submitted by the VE team coordinator. It shall be their responsibility to accept or reject the proposals of the report. The designer shall then prepare a final VE study report describing those VE proposals accepted and those rejected.

For those proposals accepted, an implementation plan and schedule shall be shown. In addition, the resultant savings shall be presented in present worth amount and in amortized form, and shall include the following:

a. Initial cost savings

b. Operating, maintenance and replacement costs savings

c. Implementation costs

For those proposals rejected, justification for rejection shall be included in the report. Rejection may be based on cost effectiveness, reliability, project delay, unusual operating and maintenance problems, and other factors that may be critical to the treatment process or to the environmental assessment.

The designer shall include in this report his redesign fee associated with the accepted proposed changes.

4. Distribution of the Final VE Study Report

The final VE study report shall be distributed by the designer as follows:

Recipient	Number of Copies
Owner	Owner's Choice
EPA, Regional Office (See Appendix C)	1
State Pollution Control Agency	As agreed

5. Implementation and Followup

The designer should report any deviations from anticipated results or any problems associated with implementation to the State and regional EPA authorities. These offices should maintain historical records of all such reports as reference data for future VE studies.

APPENDIX A

PHASES OF THE VE JOB PLAN

VE JOB PLAN WORKBOOK FORMS

COST EFFECTIVENESS GUIDELINES

PHASES OF THE VE JOB PLAN

I Information Phase

A. Objectives

1. Provide an Information Base
2. Select Areas of Detailed Study

B. Questions

1. What Is It?
2. What Must It Do?
3. What Does It Cost?
4. What Is It Worth?

C. Techniques

1. Functional Analysis
2. Cost Worth Concept
3. Graphics
4. Cost Modeling
5. Project Briefing

II Speculative Phase

A. Objective

Generate Alternates for Meeting Requirements

B. Questions

What Else Will Perform the Required Function?

C. Techniques

Creative Thinking Processes (e.g., Brainstorming)

III Analytical Phase

A. Objective

Evaluation and Selection of Best Cost-Savings Alternates

B. Questions

1. What Will the Alternates Cost?
2. Will the Alternates Meet the Required Functions?
3. What Proposals Have Greatest Cost Savings?

IV Development Phase

A. Objectives

1. To develop cost data in a systematic manner and which is traceable to reference
2. To define costs of all components of the system being proposed versus the as-designed system

B. Techniques

Use standard reference documents and available cost data. Show reference bibliography in footnotes

V Proposal Phase

A. Objective

Presentation of Best Alternates to the Decision Maker

B. Question

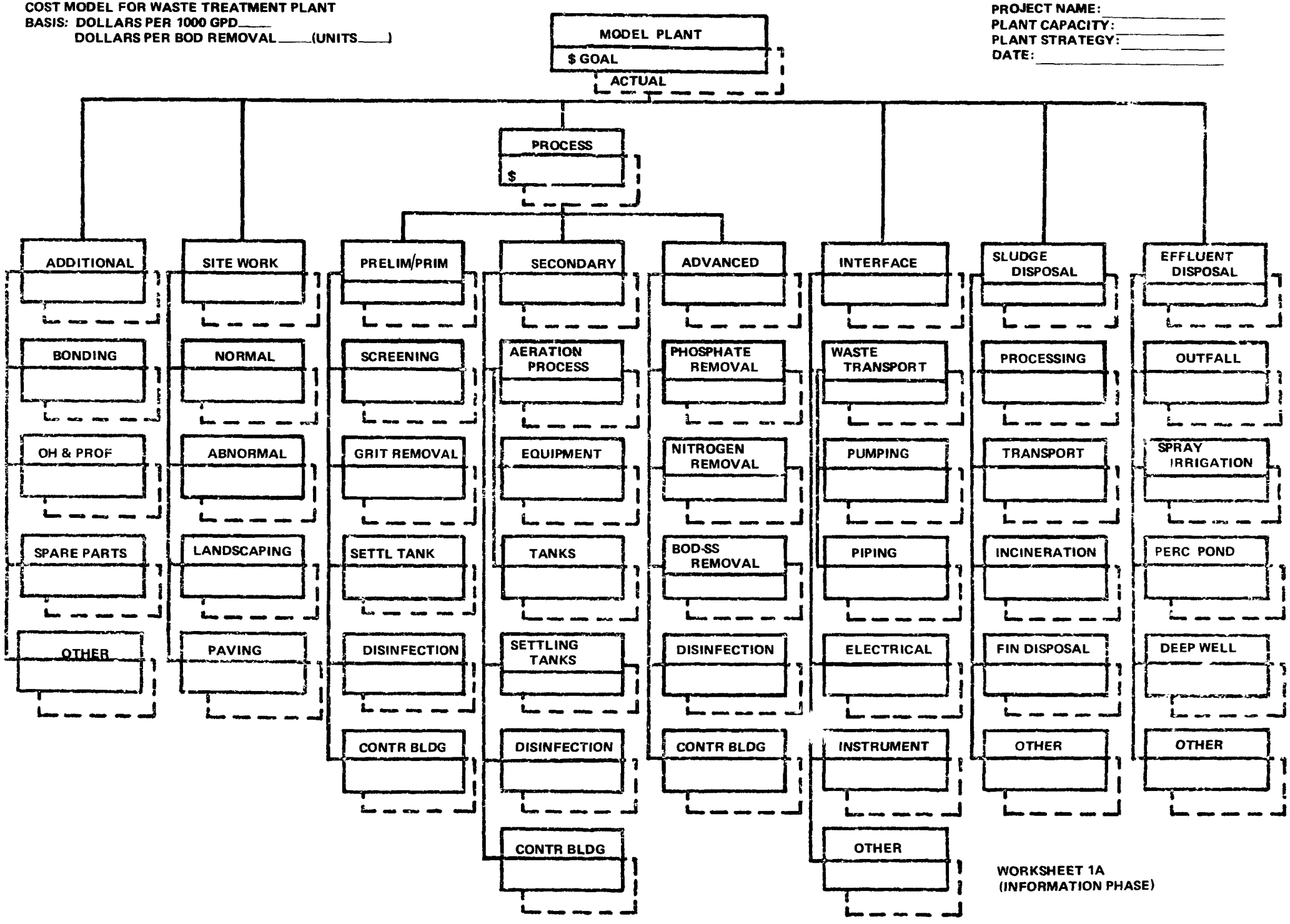
How Best to Present Proposals?

C. Techniques

1. Narrative Report
2. Schematic Overlay
3. Graphics

COST MODEL FOR WASTE TREATMENT PLANT
BASIS: DOLLARS PER 1000 GPD____
DOLLARS PER BOD REMOVAL____(UNITS____)

PROJECT NAME: _____
PLANT CAPACITY: _____
PLANT STRATEGY: _____
DATE: _____



WORKSHEET 1A
(INFORMATION PHASE)

Worksheet 2
(Information Phase)

VALUE ENGINEERING TEAM STUDY

INFORMATION

PROJECT _____

ITEM _____ TEAM NO. ___

BASIC FUNCTION _____ DATE _____

DESIGN CRITERIA:

DESIGN HISTORY & BACKGROUND:

TEAM MEMBERS:

NAME	TITLE	TELE. NO.
1.		
2.		
3.		
4.		
5.		

FUNCTIONAL ANALYSIS

PROJECT _____ ITEM _____

BASIC FUNCTION _____ DATE _____

QUANTITY	UNIT	COMPONENT	FUNCTION		BASIC/ SEC.	EXPLANATION	ORIGINAL COST	WORTH
			VERB	NOUN				

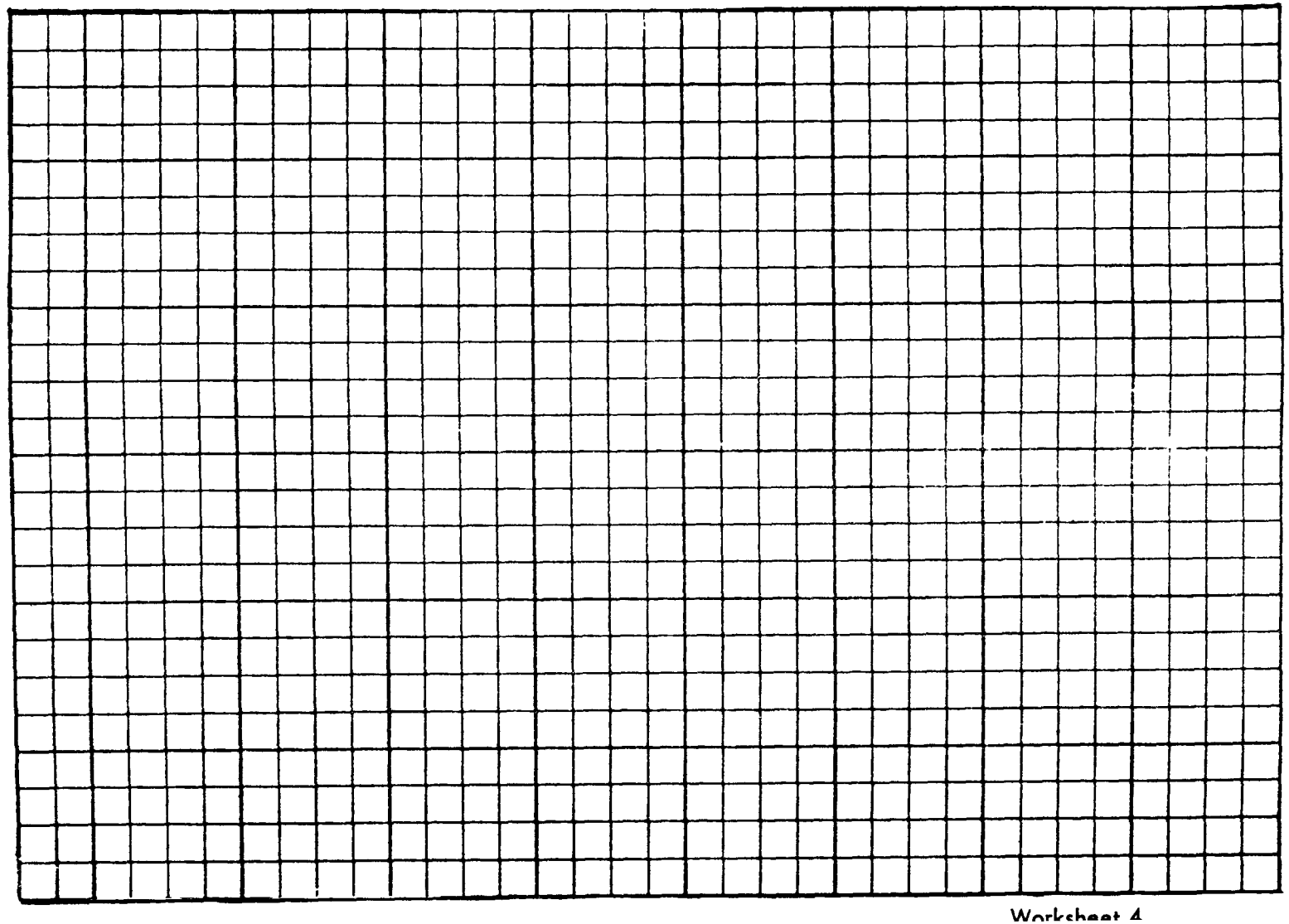
Worksheet 3
(Information Phase)

Project _____
Basic Function _____

GRAPHICAL FUNCTIONAL ANALYSIS

(Prepare bar graph showing cost of each component.

Item _____
Date _____



Worksheet 4

Worksheet 5
(Creative Phase)

VALUE ENGINEERING TEAM STUDY
CREATIVE IDEA LISTING

PROJECT _____
ITEM _____ TEAM NO. _____
BASIC FUNCTION _____

Uninhibited Creativity Date

Don't Evaluate Idea - - - - Idea Refinement is Later

1.	21.
2.	22.
3.	23.
4.	24.
5.	25.
6.	26.
7.	27.
8.	28.
9.	29.
10.	30.
11.	31.
12.	32.
13.	33.
14.	34.
15.	35.
16.	36.
17.	37.
18.	38.
19.	39.
20.	40.

Worksheet 6
(Judgment Phase)

EVALUATION CHART

PROJECT _____ DATE _____

ITEM _____ TEAM NO. _____

BASIC FUNCTION _____

Ideas Selected from Worksheet 5	Potential Advantages	Potential Disadvantages	Idea Rating

Worksheet 7
(Judgment Phase)

Weighted Constraints Chart

WEIGHT / Constraints / IDEAS								TOTAL	RANK

4 ---Excellent
3 ---Good
2 ---Fair
1 ---Poor

Project _____
Date _____

Worksheet 8
(Development Phase)

COST BREAKDOWN WORKSHEET

NOTE: SHOW COST BREAKDOWN OF ORIGINAL DESIGN AND YOUR ALTERNATIVES - INDICATE REFERENCES USED TO OBTAIN COSTS

SYSTEM: SUBSYSTEM: UNIT:	UNIT		TOTAL COST
	QUANITY	COST	

Life Cycle Cost Analysis

Worksheet 9
(Development Phase)

Project _____ Date _____

System or Item _____ TEAM NO. _____

			ORIGINAL	ALT. #1	ALT. #2
INITIAL COSTS	INSTANT CONTRACT	1. Base Cost			
		2. Interface Costs			
		(a)			
		(b)			
	COLLATERAL COSTS	3. Other Initial Costs			
		(a)			
		(b)			
		4. TOTAL INITIAL COST			
REPLACEMENT COSTS		LIFE-CYCLE EXPENDITURES			
		5. Year ____ @ ____ % Amount ____			
		Present Worth of Future Replacement Cost ____			
		6. Year ____ @ ____ % Amount ____			
		Present Worth of Future Replacement Cost ____			
		7. Year ____ @ ____ % Amount ____			
		Present Worth of Future Replacement Cost			
SALVAGE VALUE		SALVAGE VALUE			
		8. Year ____ @ ____ % Amount ____			
		Present Worth of Salvage Value ____			
		9. Year ____ @ ____ % Amount ____			
		Present Worth of Salvage Value			
TOTAL COST OF OWNERSHIP (LIFE CYCLE COST)		ANNUAL OWNING & OPERATING COSTS			
		CAPITAL RECOVERY OF THE TOTAL COSTS			
		10. Amortized Initial Cost @ ____ % ____ Year ____			
		Initial Factor ( )			
		11. Capital Recovery of the Present Worth of the Replacement Cost			
		(a) Year ____			
		(b) Year ____			
		(c) Year			
		12. Annual Costs			
		(a) Maintenance ____			
		(b) Operations ____			
		(c)			
		13. TOTAL ANNUAL OWNING & OPERATING			
		14. Annual Salvage Value Credit (Amortized)			
		(a) ____			
		(b)			
		15. Net Annual Owning & Operating Cost			
		16. Annual Difference			
		17. PRESENT WORTH OF ANNUAL DIFFERENCE			
		18. Present Worth of line 15			

Weighted Constraints Chart

Worksheet 1
(Development Phc

WEIGHT									
Constraints / IDEAS								TOTAL	RANK

4---Excellent
3---Good
2---Fair
1---Poor

Project _____
Date _____

Worksheet 11
(Presentation Phase)

VALUE ENGINEERING PROPOSAL

PROJECT _____ DATE _____

ITEM _____ TEAM NO. _____

Summary of Change (Brief Description of "before" and "after".)

ESTIMATED COST SUMMARY (ATTACH COST ESTIMATES IF NECESSARY).

LINE NUMBERS REFER TO WORKSHEET 9	No. of Units	Unit Cost	Total
A. Original . . . (Total Initial Line 4)			
B. Proposed . . . (Total Initial Line 4)			
C. Initial Savings . . . A-B			
D. Life Cycle Costs Annual Savings Line (16) . . .			
E. Present Worth of LCC Annual Savings (Line 17)			

Percent Savings Instant (C ÷ A) _____

Percent Savings LCC, Annual (D ÷ line 15 of original design) _____

VALUE ENGINEERING REVIEW

Worksheet 12

Idea Listing

(Use this worksheet to list ideas which have potential but which you do not have time to pursue during this workshop.)

Description	Est. Potential Saving		Remarks
	Initial	Life Cycle	

federal register

Title 40—Protection of the Environment

CHAPTER I—ENVIRONMENTAL PROTECTION AGENCY

SUBCHAPTER D—GRANTS

PART 35—STATE AND LOCAL ASSISTANCE

Appendix A—Cost-Effectiveness Analysis

On July 3, 1973, notice was published in the FEDERAL REGISTER that the Environmental Protection Agency was proposing guidelines on cost-effectiveness analysis pursuant to section 212(2)(c) of the Federal Water Pollution Act Amendments of 1972 (the Act) to be published as appendix A to 40 CFR part 35.

Written comments on the proposed rulemaking were invited and received from interested parties. The Environmental Protection Agency has carefully considered all comments received. No changes were made in the guidelines as earlier proposed. All written comments are on file with the agency.

Effective date.—These regulations shall become effective October 10, 1973.

Dated September 4, 1973.

JOHN QUARLES,
Acting Administrator.

APPENDIX A

COST EFFECTIVENESS ANALYSIS GUIDELINES

a. *Purpose.*—These guidelines provide a basic methodology for determining the most cost-effective waste treatment management system or the most cost-effective component part of any waste treatment management system.

b. *Authority.*—The guidelines contained herein are provided pursuant to section 212(2)(C) of the Federal Water Pollution Control Act Amendments of 1972 (the Act).

c. *Applicability.*—These guidelines apply to the development of plans for and the selection of component parts of a waste treatment management system for which a Federal grant is awarded under 40 CFR, Part 35.

d. *Definitions.*—Definitions of terms used in these guidelines are as follows:

(1) *Waste treatment management system.*—A system used to restore the integrity of the Nation's waters. Waste treatment management system is used synonymously with "treatment works" as defined in 40 CFR, Part 35.905-15.

(2) *Cost-effectiveness analysis.*—An analysis performed to determine which waste treatment management system or component part thereof will result in the minimum total resources costs over time to meet the Federal, State or local requirements.

(3) *Planning period.*—The period over which a waste treatment management system is evaluated for cost-effectiveness. The planning period commences with the initial operation of the system.

(4) *Service life.*—The period of time during which a component of a waste treatment management system will be capable of performing a function.

(5) *Useful life.*—The period of time during which a component of a waste treatment management system will be required to perform a function which is necessary to the system's operation.

e. *Identification, selection and screening of alternatives*—(1) *Identification of alternatives.*—All feasible alternative waste management systems shall be initially identified. These alternatives should include systems discharging to receiving waters, systems using land or subsurface disposal techniques, and systems employing the reuse of wastewater. In identifying alternatives, the possibility of staged development of the system shall be considered.

(2) *Screening of alternatives.*—The identified alternatives shall be systematically screened to define those capable of meeting the applicable Federal, State, and local criteria.

(3) *Selection of alternatives.*—The screened alternatives shall be initially analyzed to determine which systems have cost-effective potential and which should be fully evaluated according to the cost-effectiveness analysis procedures established in these guidelines.

(4) *Extent of effort.*—The extent of effort and the level of sophistication used in the cost-effectiveness analysis should reflect the size and importance of the project.

f. *Cost-Effective analysis procedures*—(1) *Method of Analysis.*—The resources costs shall be evaluated through the use of opportunity costs. For those resources that can be expressed in monetary terms, the interest (discount) rate established in section (f)(5) will be used. Monetary costs shall be calculated in terms of present worth values or equivalent annual values over the planning period as defined in section (f)(2). Nonmonetary factors (e.g., social and environmental) shall be accounted for descriptively in the analysis in order to determine their significance and impact.

The most cost-effective alternative shall be the waste treatment management system determined from the analysis to have the lowest present worth and/or equivalent annual value without overriding adverse nonmonetary costs and to realize at least identical minimum benefits in terms of applicable Federal, State, and local standards for effluent quality, water quality, water reuse and/or land and subsurface disposal.

(2) *Planning period.*—The planning period for the cost-effectiveness analysis shall be 20 years.

(3) *Elements of cost.*—The costs to be considered shall include the total values of the resources attributable to the waste treatment management system or to one of its component parts. To determine these values, all monies necessary for capital construction costs and operation and maintenance costs shall be identified.

Capital construction costs used in a cost-effectiveness analysis shall include all contractors' costs of construction including overhead and profit; costs of land, relocation, and right-of-way and easement acquisition; design engineering, field exploration, and engineering services during construction; administrative and legal services including costs of bond sales; startup costs such as operator training; and interest during construction. Contingency allowances consistent with the level of complexity and detail of the cost estimates shall be included.

Annual costs for operation and maintenance (including routine replacement of equipment and equipment parts) shall be included in the cost-effectiveness analysis. These costs shall be adequate to ensure effective and dependable operation during the planning period for the system. Annual costs shall be divided between fixed annual costs and costs which would be dependent on the annual quantity of wastewater collected and treated.

(4) *Prices.*—The various components of cost shall be calculated on the basis of market prices prevailing at the time of the cost-effectiveness analysis. Inflation of wages and prices shall not be considered in the analysis. The implied assumption is that all prices involved will tend to change over time by approximately the same percentage. Thus, the results of the cost effectiveness analysis will not be affected by changes in the general level of prices.

Exceptions to the foregoing can be made if their is justification for expecting significant changes in the relative prices of certain items during the planning period. If such cases are identified, the expected change in these prices should be made to reflect their future relative deviation from the general price level.

(5) *Interest (discount) rate.*—A rate of 7 percent per year will be used for the cost-effectiveness analysis until the promulgation of the Water Resources Council's "Proposed Principles and Standards for Planning Water and Related Land Resources." After promulgation of the above regulation, the rate established for water resource projects shall be used for the cost-effectiveness analysis.

(6) *Interest during construction.*—In cases where capital expenditures can be expected to be fairly uniform during the construction period, interest during construction may be calculated as $I \times \frac{1}{2} P \times C$ where:

I=the interest (discount) rate in Section f(5).
P=the construction period in years.
C=the total capital expenditures.

In cases when expenditures will not be uniform, or when the construction period will be greater than three years, interest during construction shall be calculated on a year-by-year basis.

(7) *Service life.*—The service life of treatment works for a cost-effectiveness analysis shall be as follows:

Land	Permanent
Structures (includes plant buildings, concrete process tankage, basins, etc.; sewage collection and conveyance pipelines; lift station structures; tunnels; outfalls)	30–50 years
Process equipment (includes major process equipment such as clarifier mechanism, vacuum filters, etc.; steel process tankage and chemical storage facilities; electrical generating facilities on standby service only).	15–30 years
Auxiliary equipment (includes instruments and control facilities; sewage pumps and electric motors; mechanical equipment such as compressors, aeration systems, centrifuges, chlorinators, etc.; electrical generating facilities on regular service).	10–15 years

Other service life periods will be acceptable when sufficient justification can be provided.

Where a system or a component is for interim service and the anticipated useful life is less than the service life, the useful life shall be substituted for the service life of the facility in the analysis.

(8) *Salvage value.*—Land for treatment works, including land used as part of the treatment process or for ultimate disposal of residues, shall be assumed to have a salvage value at the end of the planning period equal to its prevailing market value at the time of the analysis. Right-of-way easements shall be considered to have a salvage value not greater than the prevailing market value at the time of the analysis.

Structures will be assumed to have a salvage value if there is a use for such structures at the end of the planning period. In this case, salvage value shall be estimated using straightline depreciation during the service life of the treatment works.

For phased additions of process equipment and auxiliary equipment, salvage value at the end of the planning period may be estimated under the same conditions and on the same basis as described above for structures.

When the anticipated useful life of a facility is less than 20 years (for analysis of interim facilities), salvage value can be claimed for equipment where it can be clearly demonstrated that a specific market or reuse opportunity will exist.

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APPENDIX B

ADDRESSES OF THE REGIONAL OFFICES OF THE ENVIRONMENTAL PROTECTION AGENCY

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APPENDIX C

GLOSSARY OF VE TERMS

Glossary of VE Terms

Value Engineering (VE)

A specialized cost control technique which is based on a systematic and creative approach to identify unnecessarily high cost in a project in order to arrive at a cost saving without sacrificing the reliability or efficiency of a project.

VE Team Coordinator

A person who is qualified to direct and conduct a VE study on a waste treatment project. The VE team coordinator must have sufficient VE background to meet the qualifications specified by the Environmental Protection Agency.

VE Study or VE Workshop

A project study or review session where the objective is to review an actual project to propose cost saving alternatives to the designer. The workshop is performed by a VE team or teams chaired by a VE team coordinator. Each team session may take 40 hours or less depending on the size and the complexity of the project. Sometimes, a review session may be divided into 2 or 3 sub-sessions of 8 to 24 hours each.

VE Training Workshop

A workshop where the major objective is to provide at least 40 hours of academic training in VE methodology with application of the methodology to example or actual projects.

Life Cycle Costs

Ownership costs for the functional life of the project. It includes cost for design, construction, operation, maintenance and replacement.

Implementation Cost

Costs incurred for implementing the VE recommended changes. This normally includes costs for reviewing the VE change proposal, final report writing and project redesign (if required).

Cost Effectiveness

The economy and effectiveness of performing a required function in terms of life cycle cost.

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