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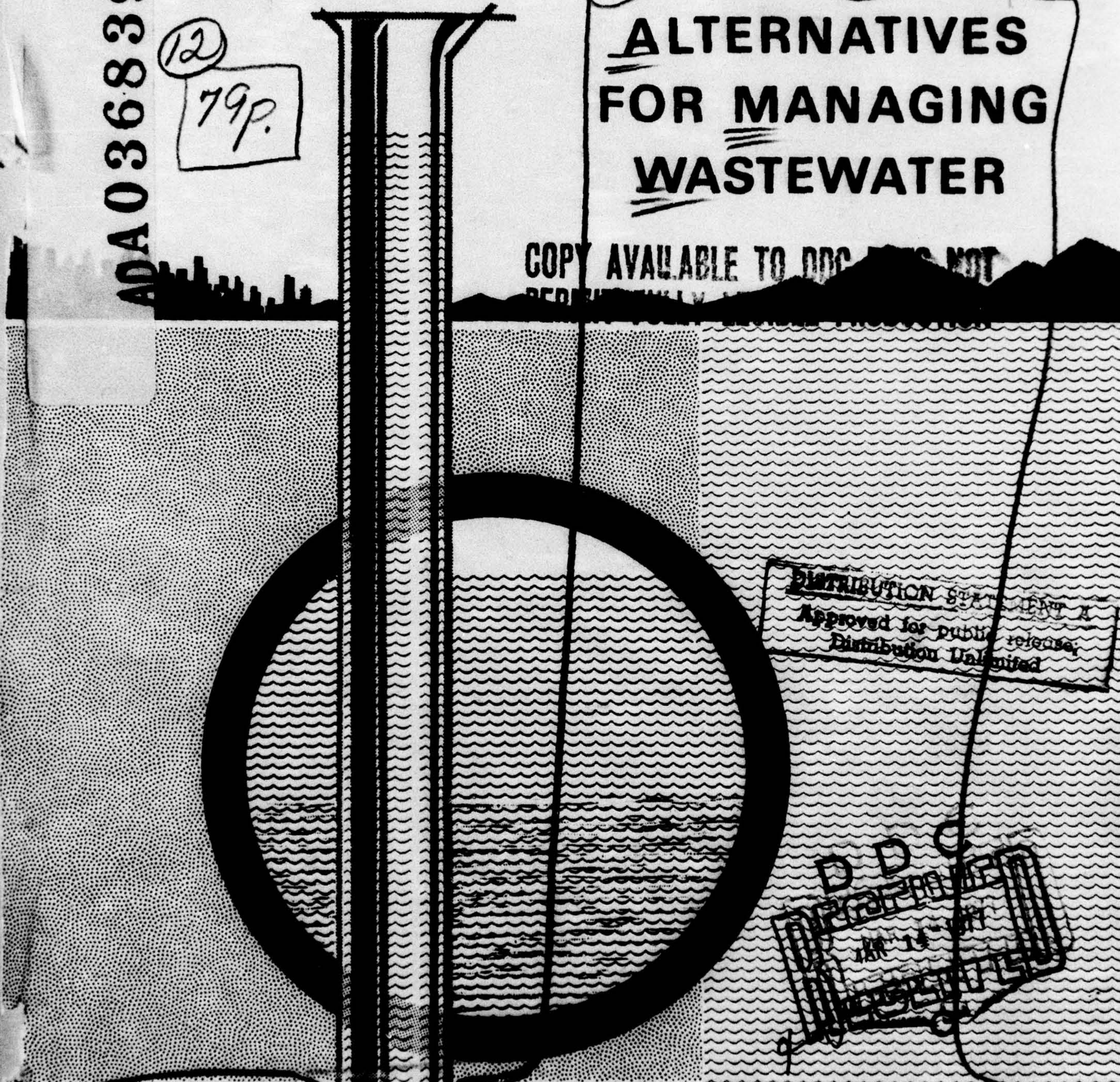





## IN THE SAN FRANCISCO BAY AND SACRAMENTO-SAN JOAQUIN DELTA AREA.

VOLUME III.

APPENDIX D - EVALUATION OF SELECTED ALTERNATIVES.

APPENDIX E - BIBLIOGRAPHY.

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**ALTERNATIVES**

**FOR**

**MANAGING WASTEWATER**

**IN THE**

**SAN FRANCISCO BAY AND SACRAMENTO-SAN JOAQUIN DELTA**

**AREA**

**APPENDIX D**

**EVALUATION OF**
**SELECTED ALTERNATIVES**





**US ARMY ENGINEER DISTRICT, SAN FRANCISCO**
**CORPS OF ENGINEERS**
**SAN FRANCISCO, CALIFORNIA**

**JULY 1971**

APPENDIX D

# EVALUATION OF SELECTED ALTERNATIVES

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## APPENDIX D

## EVALUATION OF SELECTED ALTERNATIVES

### D-1. INTRODUCTION

a. Impact Evaluation. The impact evaluation is the second of a two step process in this study necessary to gain an understanding of the accomplishments, shortcomings, and consequences of the wastewater management alternatives selected in Appendix B. It attempts to measure or place a value on the changes in the characteristics of the study area, identified in Appendix C, which could reasonably be expected to result from each wastewater management alternative. Evaluation procedures are oriented toward four broad objectives of water resources management.

b. Objectives of Water Resources Management. The four broad objectives of water resources management used in this evaluation process are as follows:

ENVIRONMENTAL QUALITY,

SOCIAL WELL-BEING,

NATIONAL ECONOMIC DEVELOPMENT, and

REGIONAL DEVELOPMENT.

It should be noted that these objectives are structured differently than the impact characteristics used in Appendix C, and an impact can be pertinent to one or more of the above water resources objectives.

These objectives form the basis of the impact evaluation and for this purpose are defined as follows:

(1) Environmental Quality. Although social, aesthetic, and public health values are generally considered to be part of environmental quality, they will be discussed under the social well-being objective. Environmental quality is then reduced to its ecological context. As such it is the improvement of the quality in existing ecosystems, in terms of health, diversity, productivity, and stability.

(2) Social Well-Being. Social well-being is concerned with improving the physical quality of life and mental contentment of those influenced by the development of a wastewater management alternative, reinforcing the efforts and programs of various government agencies and groups in alleviating deprivation, and enhancing the opportunity for group and individual fulfillment.

(3) National Economic Development. The national economic development objective is met by increasing the value of the nation's output of goods and services and improving national economic efficiency. National economic development includes:

(a) The value to users of increased output of goods and services resulting from a wastewater management alternative.

(b) Value of output resulting from external economies or the reduction of costs of adverse external economies (e.g., costs of pollution of rivers, bays and estuaries).

(c) Value of output from the use of unemployed or under-employed resources.

(4) Regional Development. Regional objectives include the components of other objectives listed above as they apply to users or resources present in the Bay-Delta area. In addition, the regional objective includes additional net income considerations accruing to the area from the construction or implementation of an alternative and from other economic activities induced by operation of an alternative.

c. Contribution of a Wastewater Management Program to the Four Broad Objectives for Water Resources Management. The first task in the evaluation process is to define specific components of each of the broad objectives to which a wastewater management program could contribute. The changes expected to result from each alternative are then evaluated on the basis of each alternative's contribution to the components. If the change is considered to be desirable, or operates to meet a need, it has a beneficial effect. If the change is generally undesirable or operates in opposition to the attainment of needs, it has an adverse effect. The specific components selected from each of the four broad objectives follow:

(1) Environmental Quality. In formulating specific environmental quality objectives, two schools of thought become evident; one advocates "beneficial use," the other advocates "environmental protection." Close examination of these two philosophies reveal that they more or less converge when beneficial use is at a maximum. This point is known as "maximum sustained yield." For example, if one maintains a Striped Bass fishery as an indicator of environmental protection then all other water dependent beneficial uses would be maintained inadvertently since Striped Bass require high quality environmental conditions to survive. The opposite is true at the other end of the spectrum, maintenance of a Carp fishery would limit beneficial use. Beneficial use then, is a function of how one defines environmental protection.

The following components of the environmental quality objective were used to evaluate the alternatives, and were based on environmental protection.

(a) Hydrosphere.

1. Protect and enhance the fishery resources

2. Minimize eutrophication

3. Maintain the integrity of the salt marsh

4. Rehabilitate the shellfish fishery

5. Preserve marine communities

(b) Land.

1. Create diversity in land use

2. Preserve or create land resources

3. Preserve and enhance quality of ground and surface waters

4. Prevent adverse climatic and atmospheric effects

5. Minimize disease vectors

6. Minimize space requirements

(c) Components Common to Both Hydrosphere and Land.

1. Reduce projected waste loads discharged to the environment

2. Utilize wastewater as a resource

3. Minimize adverse effects of bioaccumulative toxicants

4. Protect rare and endangered species and biotic communities

(2) Social Well-Being.

(a) General Comments on Evaluation. There are several basic conditions requiring consideration concerning the evaluation procedures for the social well-being impacts of the various wastewater management alternatives.

1. Evaluation within a pervasive and often controversial concept such as social well-being involves value judgments; therefore, the more representative the working group is in terms of incorporating a variety of interests such as varied professionals, industries, public agencies, and minority groups, the more meaningful the evaluation in relation to expressing the desires or objective of those most influenced by a proposed alternative. The mechanisms for developing such public participation are inherent in the social well-being objectives incorporated within the feasibility study.

2. The lack of existing general and definitive social objectives and operational programs and mechanisms for accomplishing such objectives within the Bay and Delta study area prohibit the opportunity for utilizing a social well-being document upon which to evaluate many of primary social well-being considerations. Therefore, the general social goals presented in existing governmental agency and planning group programs were used where possible to develop general goals and establish objectives for evaluating the wastewater management alternatives within the feasibility study. These social well-being objectives have several components.

(b) Components of Social Well-Being Objectives.

1. Area Viability - Identify the factors and conditions possibly influenced by the development of wastewater management alternatives on the following social parameters:

a. Employment (levels, stability, diversity, categories influenced)

b. Income (individual, groups, levels, distributive equity, income areas)

c. Growth and development (spatial distribution of industrial, residential, open space and recreation, commercial, agricultural, institutional and community service activities).

2. Public Health - Identify public health and safety factors such as hygienic conditions and human values, attitudes or prejudices.

3. Amenity - Identify amenity factors such as visual and odorous perception, aesthetics, convenience of and access to public facilities and compatibility of activities or uses.

4. Distributive Equity - Help establish mechanisms which relate the development of wastewater management alternatives to the social and economic betterment of the local area and region in terms of:

a. The increased personal and group opportunity for economic sufficiency,

b. An equitable distribution of income, goods and services,

c. A just opportunity for all the area's population, especially the poor and disadvantaged, to equitably share the benefits from environmental enhancement and increases in the national wealth and abundance.

5. Procedural.

a. Develop concepts and plans within established regional and local growth objectives, where those objectives exist or can be established.

b. Identify those groups affected by the development of regional wastewater management alternatives to determine:

those served

those benefited

those physically displaced and those indirectly physically influenced by the system development.

c. Reinforce existing Federal, State and local governmental social programs by close cooperation with agencies such as ABAG, OEO, HUD, county government, in their planning and work programs.

d. Help establish the proper public participatory mechanisms where necessary to establish social and physical development objectives that will respond to local, as well as regional, State and Federal needs and desires. This participation could be accomplished by including in advisory positions persons and groups not normally included from the localized areas influenced by the wastewater management alternatives.

e. In order to recognize the value systems of the various groups possibly affected by the development of wastewater management systems, public participation program should be initiated. In seriously addressing the social well-being impact of alternative wastewater management systems, the Corps can work with other Federal, State, and local agencies as well as with local citizens groups concerned with social planning and development. Corps planning efforts, therefore, can reinforce the social planning and developments of agencies such as HUD, OEO, and HEW by providing definitive avenues to coordinate these social planning efforts with the physical planning programs of the Corps. The Corps efforts therefore would be to reinforce Federal and Federally assisted regional and local social planning programs - not to assume the social planning role. For example, proposals requiring land acquisitions for conveyance system developments, present opportunities for greater control over the apatial distribution and linkages of open space for children's parks, walking trails, or picnicking areas. The site planning and design of treatment plants or other related structures in a community could also include within the same development site, plans and programs for needed community service facilities such as child day-care centers, meeting rooms, or small outdoor game areas. Within such an integrated program, large scale Federal planning and construction efforts could provide an operational vehicle to help reinforce the Federal and local social planning and development programs. Such programs would greatly help toward honestly distributing benefits, not only to large populations as a whole, but to those areas or groups most in need of it. In such a process, the equitable distribution to all of the opportunity to benefit from projects could truly be realized.

(3) National Economic Development.

(a) Direct output increases.

(b) Utilize unemployed and underemployed resources.

(4) Regional Development.

(a) Increase regional income.

(b) Increase regional employment.

(c) Diversify regional economic base.

(d) Enhance environmental and social well-being conditions.

D-2. IMPACT EVALUATION OF ALTERNATIVES FOR MANAGING WASTEWATER

a. Ocean Disposal Alternative - Advanced Treatment. In Appendix C, the impacts of two ocean disposal alternatives, advanced treatment and secondary treatment, were assessed to determine which alternative best represents the ocean disposal concept. Although average annual costs of ocean disposal with secondary treatment would be lower by approximately $55 million, the conclusion of the impact assessment was that advanced treatment best represents the ocean disposal concept. The reasons are that secondary treatment relative to the base condition:

- Would not reduce the buildup of persistent toxicants in the marine environment,

- Could increase the potential for eutrophication in the coastal zone,

- Would not reduce the projected waste loads discharged to the hydrosphere and

- Would not provide a significant potential for reuse of treated wastewater.

Consequently, only the impacts of ocean disposal with advanced treatment will be evaluated in this appendix.

(1) Environmental Quality Objective.

(a) Protect and Enhance the Fishery Resources - A limited amount of toxic wastes would still be discharged into the ocean environment. The discharge of toxic wastes into the Gulf of the Farallons would be reduced, which would be expected to improve the fishery in that area. The low salinity discharge in nearshore waters could interfere with the migratory patterns of anadromous fish in the ocean. The removal of wastes from the estuary would improve the status of estuarine and anadromous fisheries in the estuary. However, the absence of wastewater flushing flows could increase existing and projected problems of low flows in the Delta.

(b) Minimize Eutrophication - A small amount of nutrients would still be discharged into the ocean, which could increase the potential eutrophic rate of the ocean. The removal of nutrients from the estuary would reduce the potential for algal blooms and low dissolved oxygen levels. In contrast to that reduction, the absence of wastewater flushing flows could increase eutrophic rates in low flow areas of the estuary.

(c) Maintain the Integrity of the Salt Marsh - Other water sources would be needed to provide freshwater flooding for Suisun Marsh.

(d) Rehabilitate the Shellfish Fishery - Crabbing areas near the proposed discharge sites would be impaired by the fresh-water effluent, as could planktonic forms passing through those sites. Crabbing in the Gulf of the Farallons would be improved by reduced discharges of toxic wastes. The reduction in the coliform level in the estuary would render existing shellfish suitable for human consumption.

(e) Preserve Marine Communities - The northern discharge could alter the salinity levels of the nearshore area and select for species resistant to lower salinities. The adjacent Bodega Bay and Tomales Bay aquatic communities could suffer from disturbed salinity gradients. Changes at the southern discharge site would be less severe due to the greater dispersion potential of that area. The biotic communities in the Gulf would be expected to improve in quality, if their planktonic forms were not damaged while passing through the discharge sites.

(f) Create Diversity in Land Use - Sludge disposal sites, conveyance and treatment facilities would limit diversity of land use. Reclaimed wastewater would provide for a diversity in land use.

(g) Preserve or Create Land Resources - Sludge disposal and treatment facilities would modify land resources. Reclaimed wastewater would be utilized to preserve or create land resources.

(h) Preserve and Enhance Quality of Ground and Surface Waters - Leached pollutants from sludge deposits could threaten ground and surface waters in the vicinity of the disposal areas.

(i) Prevent Adverse Climatic and Atmospheric Effects - Climatic and atmospheric conditions would remain unchanged from the base condition.

(j) Minimize Disease Vectors - The potential for contamination of marine species and coastal zones would be reduced.

(k) Minimize Space Requirements - Space requirements for treatment, disposal, and conveyance facilities would be higher than the base condition.

(l) Reduce Projected Waste Loads Discharged to the Environment - The amount of toxicants, nutrients, degradable organics, and suspended solids discharged to the hydrosphere would be significantly reduced over the base condition.

(m) Utilize Wastewater as a Resource - This alternative provides a higher potential for reuse of wastewater than the base condition.

(n) Minimize Adverse Effects of Bioaccumulative Toxicants - The amount of persistent pesticides and heavy metals introduced to the ocean environment would be reduced. Other pollutant sources from outside of the study area would still contribute to this problem.

(o) Protect Rare and Endangered Species - The absence of fresh-water flooding could further endanger the Suisun marshland community. Fresh-water plumes in the ocean could locally endanger marine species.

(2) Social Well-Being Objective.

(a) Area Viability. With respect to the base condition, long-term enhancement to employment and income related to water-oriented activities, especially ocean fishing, should occur for the coastal localities as well as the region as a whole by advanced treatment.

The opportunities for varied spatial distribution development choices would be greatly enhanced for commercial water-related activities and recreation. Also, as a result of reduced pollutant loads entering the hydrosphere, the traditional water-related character of the region should be greatly benefited over time and result in less restrictions for overall regional and sub-area development.

Due to the reuse potential of reclaimed wastewater, the potential suburban and rural development opportunities could produce long-term benefits to employment diversity and income levels. Also. the benefits of additional sources of water supply for all areas would offer many choices for optimum regional growth dispersion.

(b) Public Health. This alternative contributes to the achievement of public health objectives by significantly lowering the mass-emission of toxic agents and by using the assimilative capacity of the hydrosphere. However, this plan does introduce some increased hygienic risk because larger amounts of more concentrated pollutants in the form of a sludge slurry would be transported to, and disposed on two large land areas.

(c) Amenity. The sludge disposal sites selected in Marin/Sonoma and Santa Clara/San Benito Counties have very high cumulative aesthetic characteristics. Use of such areas for sludge disposal sites could have long-term detrimental effects on larger areas, not only visibly, but for future development potential and overall environmental amenity due to the existing vegetation and undulating land form patterns with their strongly defined sense of place. Ocean disposal places greater requirements for sludge application in these critical locations. The mental prejudices, customs, and phobias associated with treated wastewater for agricultural use and human consumption could still be a detriment to existing value systems of individuals.

(d) Distributive Equity. The matters discussed herein are common to all wastewater management alternatives and are of major concern. Many social concerns regarding the distributive equity of income, employment, recreation, or displacement, and questions of opportunities and benefits from the development of the system are vital to the social well-being evaluation of the alternatives. Therefore, for any alternative to effectively benefit all segments of society, efforts must be made to reinforce the social planning and development programs of agencies such as HUD, OEO, and HEW by providing definitive avenues to coordinate and assist these social planning efforts with the physical planning programs. As a result, groups in greater need would share in the opportunity for human betterment. The role of those agencies responsible for planning physical systems must be to assist agencies responsible for social planning and betterment, not to assume the social planning role themselves. At the very least, the development of any of the alternative wastewater management plans should not make the condition of the poor any worse.

(3) National Economic Development Objective.

(a) Direct Output Increases. Quantified net income factors addressed in this appendix are related to some of the evaluation findings under the Environmental Quality Objective. In addition, a quantified approximation is made of the underemployed resource of treated wastewater. From the evaluation of environmental factors, it is estimated, in magnitude terms, that the ocean disposal alternative will increase net income over the base condition, because of the reduction in discharged pollutants and health factors as follows:

| | |
|---|---|
| General Recreation | $62,000,000 |
| Sport Fisheries | 10,000,000 |
| Commercial Fishing | 5,000,000 |
| | $77,000,000 |

(b) Utilize Unemployed and Underemployed Resources. The ocean alternative presents a reclaimed water potential of 1.2 million acre feet in 1990 and 2.2 million acre-feet in 2020. In close proximity to the treatment plants, a value of $90 per acre-foot would be representative; at more distant locations, inland and closer to other potential water sources, the value would reduce to $40 to $50 per acre-foot. Preliminary cost estimates of first investments for regulation and transport of reclaimed water to the more distant locations reflect about $1,000 per acre-foot of capacity, which when converted to an average annual value per acre-foot would make reclaimed water marginally competitive. Thus, localized delivery is more favorable to utilizing this resource but expected demands would be substantially less than available quantity.

First cost estimates of the ocean alternative indicate an investment of $4.1 billion dollars in 1975 and an additional investment of $3.1 billion dollars in 1990. Estimated average annual charges for interest and amortization, operation and maintenance would be $472 million dollars over a 100-year economic life assuming an interest rate of 5-1/8 percent. Features constructed by 1975 were designed to meet 1990 needs with features added by 1990 of capacity to meet 2020 conditions. The estimated first cost of the ocean alternative is 40 percent higher than the assumed base condition and estimated average annual charges 30 percent higher. More details on costs are presented in Tables D-1 and D-2.

Qualitative economic evaluation factors, pending detailed investigation, are:

1. Sludge disposal areas concentrated in two areas in close proximity to the ocean coast for the ocean disposal versus several at scattered locations for the base condition could have greater adverse economic impact.

2. The ocean alternative land requirements for treatment and interceptor facilities could involve less valuable shoreline areas suitable for many purposes than the base condition.

3. Underemployed human resources might be more readily applied with a comprehensive regional plan.

4. Industrial investment for "source control" of pollutants might be reduced with a comprehensive regional plan.

The above discussion indicates that national economic activity would be in a more favorable position over the long term with the ocean disposal alternative.

(4) Regional Development Objective.

(a) Increase Regional Income and Employment, and Diversify Regional Economic Base. The ocean disposal alternative provides a solution for the expected future problems of the Bay and Delta region for municipal and industrial wastewater dischargers. Economic evaluation for the region would be the same as under the National Economic Development objective. Recreational beneficial effects would be essentially regionally oriented, however, commercial fishery benefits might be only partially shared by the region because ocean enhancement affects a wider area. A portion of the reclaimed wastewater potential could involve areas outside the region and, therefore, the region might have to share such a benefit with other areas. The region would have to participate in larger investments for wastewater management.

(b) Enhance Environmental Conditions. Environmental quality would experience a net enhancement of significant scope. However, such net enhancement would result in certain specific adverse impacts in the environment. The beneficial aspect would be reduced pollutant loads in the estuary and ocean with resultant improvement of their waters and nearshore areas. Increased salinity in the eastern and southern extremity of the estuary would have adverse effects on marine life dependent on specific salinity conditions. Also, resulting changes in salt marsh vegetation would adversely affect wildlife potential. The ocean and shoreline areas in the vicinity of outfalls could be adversely affected by low salinity discharges. The shellfish potential for human consumption would be increased. Reclaimed wastewater could be used to enhance the environment or mitigate adverse effects if desired. Sludge areas for the ocean disposal alternative are of overall higher environmental quality than for the base condition. With the possible exception of changes in ocean resource conditions, all environmental beneficial and adverse effects would be regional in nature.

(c) Enhance Social Well-Being Condition. In the area of social well-being, the ocean disposal alternative would increase employment and income associated with water-oriented activities. Spatial distribution opportunities for development, regional or by sub-area, would be enhanced. Reclaimed water could produce long-term benefits in employment and income levels, the degree depending on use. Ocean disposal is the most favorable of alternatives from a public health viewpoint. Amenities associated with the estuary would be enhanced, in the ocean associated areas a probable change in conditions with an overall minor enhancement; in the sludge disposal areas, because location, there would be an adverse effect. All social well-being considerations, favorable and unfavorable, would be essentially related to the region except that reclaimed water, ocean changes, and sludge area impacts might also affect other areas.

The ocean disposal alternative, relative to the base condition, provides additional regional opportunities in: economic activities; meeting future environmental objectives; and, enhancing social well-being.

b. Estuarine Disposal Alternative.

(1) Environmental Quality Objective.

(a) Protect and Enhance the Fishery Resources.

1. Discharges of toxicants and persistent pollutants to the estuary would be reduced, which should improve the estuarine fishery. Use of wastewater which has received advanced treatment for flow augmentation would improve the habitat of species important in estuarine food chains.

2. The anadromous fishery would benefit from the lengthened salinity gradient, and the positive net flow toward the sea.

3. The fishery in the Gulf of the Farallons would be improved and other coastal areas would be protected.

(b) Minimize Eutrophication. The amount of biostimulants discharged to the estuary would be reduced. The eutrophic rate of the Delta could be reduced by use of treated wastewater for flow augmentation. The discharges could also improve the flushing rate of the South Bay.

(c) Maintain the Integrity of the Salt Marsh. Flooding flows would be provided to preserve Suisun Marsh. Natural salinity concentrations in the Bay would be maintained, thereby protecting the contiguous marshlands.

(d) Rehabilitate the Shellfish Fishery.

1. Crabbing in the Gulf of the Farallons could be improved by reduced discharges of toxic wastes in the estuary. Other coastal crabbing areas would be preserved.

2. The reduction in the coliform level of the estuary would render existing shellfish suitable for human consumption. The augmentation of freshwater flushing could enhance bay shellfish habitat.

(e) Preserve Marine Communities. The pollutant stress on the Gulf of the Farallons would be relieved; its biotic communities would be improved, and other coastal areas would be protected.

(f) Create Diversity in Land Use. Sludge disposal sites and treatment facilities would limit diversity in land use. Use of reclaimed wastewater, other than for flow augmentation, would provide a potential for more diverse land use.

(g) Preserve or Create Land Resources. Sludge disposal sites and treatment facilities would modify land resources. Use of reclaimed wastewater, other than for flow augmentation, would preserve or create land resources.

(h) Preserve and Enhance Quality of Ground and Surface Waters. Leached pollutants from sludge deposits could threaten ground and surface waters in the vicinity of the disposal areas.

(i) Prevent Adverse Climatic and Atmospheric Effects. Climatic and atmospheric conditions would not be changed from the base condition.

(j) Minimize Disease Vectors. The potential for contamination of estuarine species and riparian zones would be reduced.

(k) Minimize Space Requirements. Space requirements for disposal, treatment and conveyance facilities would be higher than the base condition.

(l) Reduce Projected Waste Loads Discharged to the Environment. The amounts of toxicants, nutrients, degradable organics and suspended solids discharged to the estuary would be significantly reduced over the base condition.

(m) Utilize Wastewater as a Resource. This alternative provides a high potential for reuse of treated wastewaters.

(n) Minimize Adverse Effects of Bioaccumulative Toxicants. The discharge of persistent pesticides and heavy metals, into the estuarine and the ocean environments would be reduced.

(o) Protect Rare and Endangered Species. This alternative provides protection for endangered coastal and marshland species.

(2) Social Well-Being Objective.

(a) Area Viability. With respect to the base condition, the Estuarine Disposal Alternative would provide more wastewater with a higher degree of treatment for flow augmentation in the northern part of the estuary and in the Delta. Flow augmentation should benefit water-related commercial and recreational development opportunities in the study area. Under the base condition, there is a threat of long-term accumulations of toxicants in the aquatic environment which might possibly offset the benefits from these opportunities. This alternative would significantly reduce this threat. Sludge disposal in portions of six counties would probably be detrimental to existing and future agricultural developments as well as to the associated employment and income opportunities of groups and individuals dependent upon the maintenance and growth of existing agricultural patterns. In Solano County these possible detriments are amplified by the current decline of agricultural employment in the county.

(b) Public Health. This alternative contributes to the achievement of public health objectives by significantly lowering the mass-emission of toxic agents and by using the assimilative capacity of the hydrosphere. However, this plan does introduce some hygienic risk because larger amounts of more concentrated pollutants in the form of sludge slurry transported to and disposed on land areas.

(c) Amenity. This alternative should benefit the overall aesthetic perception of the estuary due to increased flow augumentation and decreased pollutant loads discharged to the estuary. Although recreational opportunities are not expected to be greatly impaired under the base condition, the Estuarine Alternative should allow more opportunities for a variety of developments throughout the Bay and Delta region.

Sludge disposal would be detrimental to the aesthetic character of the disposal areas in terms of visual and possibly odorous perception. Although the sludge disposal areas would be visually prominent in all the areas, the highly visual character of the valley enclosures in Marin/Sonoma would be greatly detrimented. Also, the amount of available open space for future recreation or other development opportunities in all the areas could be greatly restricted.

(3) National Economic Development Objective.

(a) Direct Output Increase. Quantified net income in this report is related to some of the evaluation findings under the environmental quality objectives. In addition, a quantified approximation is made of the value of reclaimed wastewater.

From the evaluation of environmental quality objectives, it is estimated that the estuarine disposal alternative, by reducing the pollutant loads discharged to the aquatic environment and providing more favorable health factors, would increase the annual net income over the base condition. The estimated increase in annual net income is as follows:

| | |
|---|---|
| General Recreation | $62,000,000 |
| Sport Fishing | 10,000,000 |
| Commercial Fishing | 5,000,000 |
| Total | $77,000,000 |

(b) Utilize Unemployed and Underemployed Resources. This alternative presents the potential for reclaiming 1.2 million acre-feet of wastewater in 1990 and 2.2 million acre-feet in 2020. Since three of the seven advanced treatment plants are located near the coast, $90 per acre-foot would be a representative value of this reclaimed wastewater. Representative values of reclaimed wastewater from the four inland treatment plants would be around $40 to $50 per acre-foot.

If reclaimed wastewater is conveyed away from the immediate areas of the treatment plants to more distant areas for reuse, preliminary first costs of conveyance and regulatory storage facilities would be $1,300 per acre-foot of capacity. When this cost is converted to an average annual value, reclaimed wastewater would be marginally competitive with other water supply sources. Thus, reuse in the vicinity of the treatment facilities is more favorable, but projected demands are expected to be less than the available supply.

Estimated first cost of the Estuarine Disposal Alternative would be $2.8 billion dollars in 1975 to handle projected 1990 waste flows, and an additional $1.9 billion dollars in 1990 to handle projected 2020 waste flows. Total estimated average annual charges for interest and amortization; and operation, maintenance and replacement would be $331 million dollars over a 100-year economic life, assuming an interest rate of 5-1/8 percent. The total estimated first cost of estuarine disposal is approximately 90 percent of that of the assumed base condition. The total estimated average annual charges are approximately 90 percent of those of the base condition. More details on costs are presented in Tables D-1 and D-2.

Other economic factors are qualitatively assessed as follows:

1. Sludge disposal is concentrated in five areas for estuarine disposal versus disposal in several scattered areas for the base condition, thus could have greater adverse economic impact.

2. Land requirements of the estuarine disposal alternative for treatment and conveyance facilities could involve less use of valuable shoreline areas suitable for many purposes than under the base condition.

3. Underemployed human resources might be more readily applied with a comprehensive regional plan.

4. Industrial investment for "source control" of pollutants might be reduced with a comprehensive regional plan.

The above discussion indicates that national economic development would be in a more favorable position over the long term with the estuarine disposal alternative.

(4) Regional Development Objective.

(a) Increase Regional Income and Employment. The Estuarine Disposal Alternative would produce similar, but not identical, accomplishments to the ocean disposal alternative with respect to economic development. Some additional benefits to the region may be incurred due to repulsion of salinity which low salinity estuarine discharges may provide. Commercial fishery aspects, recreational potential, and benefits from wastewater reuse would not be significantly different from the ocean disposal alternative.

(b) Enhance Environmental Conditions. The estuarine disposal alternative would have a net beneficial impact on environmental quality considerations. The main changes over the base condition would be an upgrading of water quality in the Bay-Delta estuary and the Gulf of the Farallons due to the lower amount of wastes discharged. Such improvement in water quality would benefit the aquatic and marine organisms in these areas by reducing both acute and chronic environmental stresses. Furthermore, as long as highly treated low salinity wastewater is discharged to the Bay-Delta estuary, possible salinity changes due to removal of this flow (as in the other alternatives) would be avoided. Shellfish consumption by humans would probably increase. Sludge disposal areas for this alternative would not differ appreciably from the base condition since the areas affected are the same. All environmental benefits and detriments would be related to the region with the exception of possible benefits resulting outside the region due to increased anadromous fish runs.

(c) Enhance Social Well-Being Conditions. Social well-being changes would be generally beneficial for this alternative. Water-oriented activities in the Bay-Delta estuary would show a net increase due to improved water quality. However, relative to the other alternatives, this increase may not be as large since complete elimination of all discharges from the Bay-Delta waters (as under the other alternatives) may provide slightly higher social benefits. From consideration of public health factors, this alternative would be an improvement over the base condition but would not provide the degree of protection to humans that the ocean disposal alternative would. The same is true of general amenities. In fact, this alternative would provide improvement for most social well-being categories such as employment, income, and development, but may not reach the level of accomplishment as the ocean disposal alternative.

The main regional benefits expected from this alternative could be categorized as increased economic activities and environmental quality and enhancement of social well being. While improvements in all would be accomplished, relative to the base condition, the absolute level of accomplishments relative to other alternatives is related to trade-offs.

No significant differences from the Ocean Alternative would occur outside the region.

c. Land Disposal Alternative.

(1) Environmental Quality Objective.

(a) Protect and Enhance the Fishery Resources. This alternative would eliminate the direct discharge of treated urban wastes to the hydrosphere. The coastal fisheries would be protected and the status of estuarine and freshwater fisheries would be improved.

(b) Minimize Eutrophication. If biostimulants are retained on the land, the overall threat of increased eutrophication would be minimized. However, by eliminating discharge of treated wastewaters to the estuary, the residence time of biostimulants in the estuary could be increased. Flushing of South Bay would not be improved over the base condition.

(c) Maintain the Integrity of the Salt Marsh. By reducing pollutants entering the hydrosphere and possibly by enabling water-using industries to locate away from the perimetry of the estuary, preservation of salt marshes would be aided. The use of treated wastewater to flood Suisun Marsh would protect that marshland community, provided that land filtration would remove toxicants.

(d) Rehabilitate the Shellfish Fishery. Crabbing in the Gulf of the Farallons would be improved by the elimination of urban waste discharges to the estuary. Other coastal crabbing areas would be protected. Shellfish in the estuary would be rendered suitable for human consumption. Shellfish beds in San Pablo Bay could continue to be contaminated, depending on quality of treated wastewater used to flood Suisun Marsh. Beneficial fresh water flooding of shellfish areas would be reduced.

(e) Preserve Marine Communities. The pollutant stress on the Gulf of the Farallons would be alleviated which would be expected to improve its biotic communities. Other coastal areas would be protected.

(f) Create Diversity in Land Use. A wetlands biome will be created in the disposal areas at the expense of the existing biotic communities.

(g) Preserve or Create Land Resources. Land resources would be modified. Whether the modification would be beneficial or detrimental needs further study. Sludge could be used as a soil conditioner, particularly in land areas which now have marginal soils for crop production. Reclaimed wastewater could be utilized to preserve or create land resources.

(h) Preserve and Enhance Quality of Ground and Surface Waters. Depending on the removal efficiencies of land filtration, there may be a potential for polluting ground and surface waters in the vicinity of the disposal areas. Leached pollutants from sludge deposits could threaten ground and surface waters.

(i) Prevent Adverse Climatic and Atmospheric Effect. This alternative could result in higher humidity and increased fog frequency in the disposal areas.

(j) Minimize Disease Vectors. The habitat for pest and disease carrying organisms (mosquitos) would be enhanced over the base condition. The potential for contamination of domestic and wild animals needs further study.

(k) Minimize Space and Land Requirements. Land disposal would involve an area of 335,000 acres by the year 2020. Depending on whether the disposal areas have multiple use, this alternative may be competitive with urban, agricultural and recreational demands for use of the land areas.

(l) Reduce Projected Waste Loads Discharged to the Environment. The amount of toxicants, nutrients, degradable organics, and suspended solids discharged to the hydrosphere would be reduced over the base condition. The capability of land to remove specific pollutants needs further evaluation. Land filtered wastewater would be high in TDS.

(m) Utilize Wastewater as a Resource. Assuming marketable crops can be grown in the disposal areas and that the capability of land to remove certain pollutants can be substantiated, this alternative provides a high potential for reuse of treated wastewater. However, 50 percent of the treated wastewater applied to the land would be lost to evapotranspiration.

(n) Minimize Adverse Effects of Bioaccumulative Toxicants. Biological magnification of toxicants in the hydrosphere would be reduced. Biological magnification of toxicants by land species needs further evaluation.

(o) Protect Rare and Endangered Species and Communities. The threat to rare and endangered aquatic species would be reduced. The effect on rare and endangered terresterial species needs further evaluation.

(2) Social Well-Being Objective.

(a) Area Viability. By eliminating discharges of urban wastes to the estuary, the Land Disposal Alternative would significantly reduce pollutant levels in the estuary which should have a substantial long-term effect on benefiting the underlying structure of the region. Specifically, the water-oriented activities of commercial fishing and recreation should be greatly benefited in relation to employment stability, diversity and long term growth. The region as a whole, especially the coastal counties in Sub-areas A and B, should experience long term benefits from income increases in water-oriented activities.

Increases in the overall long-term water quality of the ocean and estuary should enhance the region's water-related character, thus greatly sustaining as well as improving one of the region's most important industries, tourism. The increased opportunities for existing recreational facilities as well as the potential for developing new ones is of primary benefit toward enhancing the overall quality of life of the regional population. However, to maximize the benefits possible from significant pollution abatement and recreation development, efforts must be made to increase not only the quality and level of recreation facilities, but also their access and convenience in relation to the concentrated urban population. Locational factors of recreation are of primary importance in evaluating their overall and specific benefits to the region. In relation to this alternative, reduced pollutant levels in the estuary and coastal waters should offer opportunities for optimum location and for maximum benefits from recreational improvements and developments. Also, these developments in dense urban areas could greatly benefit lower income groups and result in greater distributive equity of benefits resulting from the overall system development and the resulting environmental improvements.

As a result of this alternative, the possibility of a high reuse of wastewater and residuals would greatly benefit the long-term diversity, growth, and stability of agriculture, industry, or any other activities dependent upon an abundant, readily accessible water source. The resulting employment and income gains could greatly contribute to the distributive equity of opportunity to share in resultant project benefits provided the proper social programs are initiated to reinforce these opportunities.

The physical facilities for developing this alternative include large land areas for spraying, sludge disposal, storage ponds, aeration lagoons, and reuse reservoirs. Since the land areas are in a variety of locations throughout the Bay and Delta region, a variety of beneficial and detrimental impacts could be produced. Employment from implementing this alternative should benefit certain categories of employment but for a relatively short time. Also, the new or increased agricultural production associated with applying treated wastewater to land could stimulate the agricultural economy with resultant benefits to many related employment and income groups. These possible benefits, combined with the benefits previously discussed resulting from improved water quality, could greatly help to diversify, stabilize and stimulate the overall growth and development of the Bay and Delta region. However, the great land use conversion necessary for the development of the total system (335,000 acres by 2020), and the long-term impacts on the many localities directly influenced by these land conversions, may be detrimental to opportunities for diversified development.

Large land use alterations in the suburban and rural areas of Contra Costa, Sacramento, Solano, and San Benito Counties could greatly limit the future development and spatial distribution choices of these areas. Even should these land areas continue in new types of agricultural production under the system, persons or groups dependent upon existing employment types and income from existing agricultural use could be greatly detrimented.

(b) Public Health. This alternative presents certain hygienic risks that must be recognized as potentially influential upon society. The land disposal alternative, however, does contribute to the achievement of certain public health objectives by removing biological agents, reducing the mass-emission of all toxic agents through reuse, and by somewhat limiting the possibility of biological magnification in the human food web.

Chemical agents such as gasoline and phenols, however, are ineffectively removed by percolation and the fate of heavy metals when percolated through soil is not completely known. Based upon preliminary present knowledge, these agents could filter their way into the groundwater or into drainage water and as a result, introduce a significant hygienic risk to the area population.

(c) Amenity. In relation to aesthetic changes, alterations of crop patterns in certain areas may be detrimental. In Marin County the dominant visual pattern is pasturage for beef and dairy cattle. Fields of feed crops, which are among the primary crop choices for potential land disposal cultivation, are only occasionally seen and, therefore, a conversion to these crops would greatly alter the area. The actual long term benefit or detriment of these changes would be a matter of local resident preference in addition to economic and other factors. Unlike the large geometric field patterns in Solano County which could readily accommodate the large tracts needed for land disposal, existing cultivation patterns in Sacramento, San Joaquin, Contra Costa and San Benito Counties are small and less geometric. Great alteration of these areas could be a detriment to the existing scale of agriculture development. Also, the humidity increases in the valley inclosures of the Marin/Sonoma and Santa Clara/San Benito areas could be detrimental to existing climatology values. Other value factors concerning existing development patterns and prejudices against converting prime valley lands into "waste" treatment areas could be very important to local residents and considered as a detriment to their areas.

The beneficial or detrimental impact of the development and construction of the land disposal alternative will be largely dependent upon careful site selections and overall planning and design criteria enforcement throughout the total design and construction processes.

(3) National Economic Development Objective.

(a) Direct Output Increases. Quantified net income in this report is related to some of the evaluation findings under the environmental quality objectives. In addition, a quantified approximation is made of the value of reclaimed wastewater.

From the evaluation of environmental factors, it is estimated, in gross terms, that the land disposal alternative, by eliminating discharges of urban wastewaters to the estuary and by providing favorable health factors, would increase the annual net income over the base condition. The estimated increase is as follows:

| | |
|---|---|
| General Recreation | $62,000,000 |
| Sport Fisheries | 10,000,000 |
| Commercial Fishing | 5,000,000 |
| Total | $77,000,000 |

(b) Utilize Unemployed and Underemployed Resources. Assuming evapotranspiration losses do not exceed 50 percent of the treated wastewater applied to the land, this alternative presents the potential for reclaiming approximately 600,000 acre-feet of wastewater in 1990 and 1.1 million acre-feet in 2020. In addition there is a potential agricultural benefit from applying treated wastewater to land upon which crops would be grown.

Wastewater and sludge are applied to six separate land areas. Since most of these areas are located in proximity to other existing or proposed water supply sources, a representative value of the reclaimed wastewater would be in the range of $40 to $50 per acre-foot. This reclaimed wastewater would have the character of secondary effluent which has been filtered through a soil column of approximately 8 feet.

If reclaimed wastewater is conveyed away from the disposal areas to more distant areas for reuse, preliminary first costs of conveyance and regulatory storage facilities would be approximately $650 per acre-foot of capacity. When this cost is converted to an average annual value, reclaimed wastewater would be competitive with other water supply sources, depending on the degree of any further treatment needed prior to reuse.

Agricultural benefits of applying treated wastewater to land could be used to offset the average annual charges of this alternative. Approximately 170,000 acres of land would be irrigated during the period 1975-1990, and up to 310,000 acres after 1990. The ecological impacts of land disposal of wastewater and sludge, discussed in Appendix C, pointed to the possibility of creating redwood forests in the disposal areas. If redwood trees were grown and harvested at 20 year intervals, the average annual benefits over a 100-year period would be approximately $13 million dollars. If the disposal areas were instead used for irrigated pasture the average annual benefits would be approximately $6 million dollars. Benefits from these two rather diverse uses of the disposal areas are presented to give a range of the benefits which could be used to offset the average annual charges of this alternative.

Estimated first costs of the Land Disposal Alternative would be $6.5 billion dollars in 1975 to handle projected 1990 waste flows, and an additional $3.4 billion dollars in 1990 to handle projected 2020 waste flows. Total estimated average annual charges for interest and amortization; and for operation, maintenance and replacement would be $699 million dollars over a 100-year economic life, assuming an interest rate of 5 1/8 percent. The total estimated first cost of this alternative is approximately two times that of the assumed base condition. The total estimated average annual charges are approximately 1.9 times that of the base condition. More details on costs are presented in Tables D-1 and D-2.

Other economic factors are qualitatively assessed as follows:

1. Although this alternative would involve less use of valuable shoreline areas than the base condition, this alternative requires 335,000 acres of land by 2020 for treatment and disposal. This amount of land would possibly conflict with existing and proposed land use patterns which could adversely affect existing uses and/or be detrimental to diversified development of the areas.

2. With the exception of the effects of sludge disposal, the qualitative assessment of other economics factors is generally the same as for the ocean and estuarine alternatives. Assuming that sludge is disposed on land under the base condition, sludge disposal under this alternative is not expected to have a greater adverse economic impact.

The above discussion indicates that over the long term, the national economic development could be in a more favorable position with the land disposal alternative.

(4) Regional Development Objective.

(a) Increase Regional Income and Employment. The land disposal alternative, by eliminating wastewater discharges to the estuary and ocean, would enhance the fisheries in both areas. Benefits realized from an increase in commercial fisheries would be shared both by the region and by surrounding areas. Increases in water oriented recreation due to improved water quality would be strictly regional. Depending upon the use for reclaimed water, benefits from this item could be shared with other regions. The total magnitude of these benefits would be less than for the other alternatives because of the lesser amount of water available for reuse. Increases in agricultural production could produce monetary benefits which may partially offset the high cost of this alternative. These benefits would be related both to the region and to surrounding areas.

Possible adverse economic developments could occur with respect to land use patterns, future development and spatial distribution. Such effects would relate both to the region and to surrounding regions.

(b) Enhance Environmental Conditions. Under this alternative, a net environmental quality benefit could be credited to the hydrosphere, through elimination of municipal and industrial discharges. Possible adverse effects in the estuary may result through localized salinity changes due to elimination of these discharges. These net benefits to the hydrosphere could be offset either in whole or in part by possible adverse changes to land areas. These changes would be limited to the region, although possible climatic changes could be more extensive.

(c) Enhance Social Well-Being Conditions. With respect to social well-being, this alternative would have the greatest impact. Employment and income associated with water oriented activities would increase. Additional benefits in employment and income could be projected for the land disposal areas, through crop production.

Possible adverse changes could result from hygienic problems, especially from disease vectors, and from the heavy metal and chemical constituents in the filtered water. Large land use alterations in the disposal areas could greatly limit future development and spatial distribution, by restricting land use alternatives. Some adverse changes could be expected with respect to existing agricultural employment. This alternative could be detrimental to existing agricultural development in counties where cultivation patterns are small. Benefits from reclaimed water usage could offset some of these potential adverse changes, although the possible increased employment and income from such usage would be less than for the other alternatives. Social well being changes would not be limited to the region alone, but could produce effects outside the region.

Relative to the base condition this alternative would provide the greatest regional opportunities in economic activities.

d. Combination Disposal Alternative

(1) Environmental Quality Objective:

(a) Protect and Enhance the Fishery Resources. This alternative would limit the discharge of pollutants to the estuary and ocean. The coastal fisheries would be protected and status of estuarine and freshwater fisheries would be improved. Use of wastewater which has received advanced treatment for flow augmentation would improve the habitat of species important in estuarine food chains and would benefit the anadromous fishery.

(b) Minimize Eutrophication. If biostimulants are retained on the land, the threat of increased eutrophication would be reduced. The eutrophic rate of the Delta would be reduced by a higher level of treatment and by the use of treated wastewater for flow augmentation. The discharges could also improve the flushing of the South Bay. The absence of waste discharges into the ocean would reduce the eutrophic potential of coastal waters.

(c) Maintain the Integrity of the Salt Marsh. By reducing pollutants entering the hydrosphere and possibly by enabling water using industries to locate away from the perimetry of the estuary, preservation of salt marshes would be aided. Use of treated wastewater to flood Suisun Marsh would protect the existing marshland community provided land filtration removes detrimental toxicants.

(d) Rehabilitate the Shellfish Fishery. Crabbing in the Gulf of the Farallons could be improved by the reduction of toxic discharges from the estuary. Other coastal crabbing areas would be protected. The reduced coliform level would render estuarine shellfish suitable for public consumption. Flow augmentation would provide beneficial freshwater flooding of north bay shellfish beds.

(e) Preserve Marine Communities. The pollutant stress on the Gulf of Farallons would be relieved, which would be expected to improve its biotic communities. Other coastal areas would be preserved.

(f) Create Diversity in Land Use. A wetlands biome will be created in the land disposal areas at the expense of the existing biotic communities. Land disposal of sludge from the advanced treatment plants would limit land use diversity.

(g) Preserve or Create Land Resources. Sludge deposits and treatment facilities would modify land resources. Reclaimed wastewater would be utilized to preserve or create land resources. Sludge could be used as a soil conditioner.

(h) Preserve and Enhance Quality of Ground and Surface Waters. Sludge deposits would threaten ground and surface waters. The effects of the land treatment process on ground waters needs further study.

(i) Prevent Adverse Climatic and Atmospheric Effect. This alternative could result in higher humidity and increased fog in the land disposal areas.

(j) Minimize Disease Vectors. In the land disposal areas, the habitat for pest and disease carrying organisms would be enhanced. The potential contamination of domestic and wild animals needs further study.

(k) Minimize Space and Land Requirements. The combination alternative would involve an area of 172,000 acres by 2020 for land disposal of wastewater and sludge. Depending on whether these disposal areas can have multiple use, this alternative may compete with urban, agricultural and recreational demands for use of the land area. It should be noted that this alternative requires for fewer acres of land for disposal than the land disposal alternative.

(l) Reduce Projected Waste Load Discharged to the Environment. Pollutants discharged to the hydrosphere would be greatly reduced. The capability of land to remove specific pollutants needs further evaluation. The land filtered wastewater will be high in TDS.

(m) Utilize Wastewater as a Resource. Assuming marketable crops can be grown in the disposal area and that the capability of land to remove certain pollutants can be substantiated, this alternative provides a high potential for reuse of wastewater. However 50 percent of the treated wastewater applied to land would be lost to evapotranspiration.

(n) Minimize Adverse Effects of Bioaccumulative Toxicants. The discharge of persistent pesticides and toxicants to the estuarine and ocean environments would be reduced. Biological magnification of toxicants by land species needs further evaluation.

(o) Protect Rare and Endangered Species and Communities. The threat to rare and endangered aquatic species would be reduced. If not removed in the land treatment process, toxic components, including persistent pesticides, would threaten the rare and endangered species of Suisun Marsh. The effect on rare and endangered terresterial species needs further evaluation.

(2) Social Well-Being Objective.

(a) Area Viability. Evaluation of the estuarine disposal and the land disposal portions of the Combination Disposal Alternative is essentially the same as the Estuarine and Land Disposal Alternatives, respectively. Estuarine disposal of urban wastewaters from Sub-areas A and C should help to relieve pollution problems and benefit overall water-related activities. Possible long-term pollution accumulations in the estuary, which under the base condition could negate these benefits, would be reduced.

Land disposal of urban wastewaters from Sub-areas B and D would benefit water-oriented commercial and recreation activities by eliminating discharge of urban wastewaters to the estuary and by making use of wastewater and residuals as a resource. However, the large land areas required by 2020 (172,000 acres) for land disposal of wastewater and sludge (from land and advanced treatment processes) would restrict opportunities for diversified developments in the disposal areas, especially existing agriculture and its associated employment and income considerations. Although much of the land areas could remain in agricultural production, the alterations of crop patterns and the possible shifts in employment opportunities could be detrimental to the existing area markets. Further detailed studies would be needed to ascertain these relationships.

(b) Public Health. This alternative contributes to the public health objectives by lowering the mass-emission of toxic agents and reducing the possibility of biological magnification in the human food web. However, the estuarine portion of this alternative does introduce some hygienic risk in that larger amounts of more concentrated pollutants in the form of a sludge slurry from the advanced treatment process would be transported and applied to lands in eastern Contra Costa and western San Joaquin Counties.

The land disposal portion introduces significant hygienic risk in that the capability and effectiveness of the soil column in removing phenols and heavy metals is not completely known. A possibility exists that these agents could percolate into the ground water where they would be collected by the underdrain system for reuse.

(c) Amenity. In relation to aesthetic changes, alternations of crop patterns in certain areas may be detrimental. In Marin County the dominant visual pattern is pasturage for beef and dairy cattle. Fields of feed crops, which are among the primary crop choices for potential land disposal cultivation, are only occasionally seen and, therefore, a change to these crops would greatly alter the area. The actual long term benefit or detriment of these changes would be a matter of local resident preference in addition to economic and other factors. Unlike the large geometric field patterns in Solano County which could readily accommodate the large tracts needed for land disposal of wastewater and sludge, existing cultivation patterns in Sacramento, San Joaquin, and Contra Costa Counties are small and less geometric. Alteration of these areas could be a detriment to the existing "scale of agriculture development." Also, the humidity increases in the valley inclosures of the Marin/Sonoma area could be detrimental to the existing climatology values. Other value factors concerning existing development patterns and prejudices against converting prime valley lands into "waste" treatment areas could be very important to local residents and considered as a detriment to their areas.

(3) National Economic Development Objective.

(a) Direct Output Increases. Quantified net income in this report is related to some of the evaluation findings under the environmental quality objectives. In addition, a quantified approximation is made of the value of reclaimed wastewater.

From the evaluation of environmental factors, it is estimated, in gross terms, that the combination disposal alternative, by eliminating discharges of urban wastewaters to the estuary from Sub-areas B and D, by reducing pollutant loads discharged to the estuary from Sub-areas A and C, and by providing favorable health factors, would increase the annual net income over the base condition. The estimated increase is as follows:

| | |
|---|---|
| General Recreation | $62,000,000 |
| Sport Fisheries | 10,000,000 |
| Commercial Fishing | 5,000,000 |
| TOTAL | $77,000,000 |

(b) Utilize Unemployed and Underemployed Resources. Assuming evapotranspiration losses do not exceed 50 percent of that portion of the total wasteflows applied to the land, this alternative presents the potential for reclaiming approximately 1.0 million acre-feet of wastewater in 1990 and 1.8 million acre-feet in 2020. In addition, there is a potential agricultural benefit from applying treated wastewater to land upon which crops would be grown.

Under the land portion of this alternative, wastewater and sludge are applied to five separate land areas. Since most of these areas are located in proximity to other existing or proposed water supply sources, a representative value of the reclaimed wastewater would be in the range of $40 to $50 per acre-foot. This reclaimed wastewater has the character of secondary effluent which has been filtered through a soil column of approximately 8 feet.

Under the estuarine portion two of the three advanced treatment plants are located near the coast. A representative value of reclaimed wastewater from the two coastal plants would be about $90 per acre-foot. A representative value of reclaimed wastewater from the inland treatment plant would be in the range of $40 - $50 per acre-foot, since it is located closer to other potential water supply sources.

If reclaimed wastewater from both the advanced treatment plants and the land area is conveyed away from the treatment and disposal areas to more distant areas for reuse, preliminary first costs of conveyance and regulatory storage facilities would be approximately $1,200 per acre-foot of capacity. When this cost is converted to an average annual value, reclaimed wastewater would be marginally competitive with other water supply sources.

Agricultural benefits of applying treated wastewater to land could be used to offset the average annual charges of the land portion of this alternative. Approximately 55,000 acres of land would be irrigated during the period 1975-1990, and up to 120,000 acres after 1990. The ecological impacts of land disposal of wastewater and sludge, discussed in Appendix C, pointed to the possibility of creating redwood forests in the disposal areas. If redwood trees were grown and harvested at 20 year intervals, the average annual benefits over a 100-year period would be approximately $4.6 million dollars. If the disposal areas were instead used for irrigated pasture the average annual benefits would be approximately $2.2 million dollars. Benefits from these two rather diverse uses of the disposal areas are presented to give a range of the benefits which could be used to offset the average annual charges of this alternative.

Estimated first costs of the Combination Disposal Alternative would be $4.2 billion dollars in 1975 to handle projected 1990 wasteflows, and an additional $2.6 billion dollars in 1990 to handle projected 2020 wasteflows. Total estimated average annual charges for interest and amortization; and for operation, maintenance and replacement would be $464 million dollars over a 100-year economic life, assuming an interest rate of 5-1/8 percent. The total estimated first cost of this alternative is approximately 1.3 times that of the assumed base condition. The total estimated average annual charges are approximately 1.3 times that of the base condition. More details on costs are presented in Tables D-1 and D-2.

Subject to detailed investigation, other economic factors are qualitatively assessed as follows:

1. Although this alternative would involve less use of valuable shoreline areas than the base condition, this alternative requires 130,000 acres of land by 2020 for treatment and disposal. This amount of land would possibly conflict with existing and proposed land use patterns which would adversely affect existing uses and/or be detrimental to diversified development of the areas.

2. Sludge disposal, concentrated in five areas for this alternative, when compared to sludge disposal in several scattered areas under the base condition could have greater adverse economic impact.

3. The qualitative assessment of other economic factors is generally the same as for the ocean and estuarine alternatives.

The above discussion indicates that over the long term, the national economic development could be in a more favorable position with the combination disposal alternative.

(4) Regional Development Objective.

(a) Increase Regional Income and Employment. Regional development changes pertaining to this alternative would be a synthesis of those changes resulting from the land disposal alternative and the estuarine disposal alternative.

With respect to economic considerations, the region would benefit from increased employment and income related to commercial fisheries, water oriented recreation activities, agricultural production, salinity repulsion and reuse of wastewaters. All of these benefits would be limited to the region with the exception of fisheries and reuse of wastewaters. Economic increases could be expected outside of the region from these two aspects, although the magnitude is unknown.

Some adverse economic consequences related to land use patterns could be expected although the extent of this change would not be as great as for the land disposal alternative.

(b) Enhance Environmental Conditions. In regard to environmental quality, the hydrosphere would benefit from the elimination of major wastewater discharges. Resulting changes on land areas would be similar to the changes occurring from the land disposal alternative, although they would not be as extensive.

(c) Enhance Social Well-Being Conditions. Social well-being changes would be a combination of the effects resulting from both the estuarine and the land disposal alternatives. The greatest changes would be associated with those areas where land disposal would be practiced, since land disposal has a relatively high social well-being impact. Hygienic problems and future development and spatial distributions would be the areas of greatest concern.

The changes resulting from this alternative would be largely restricted to the region, whereas the land disposal alternative would produce more extensive changes, since part of one land disposal area is outside the region. Possible changes outside the region would be related to climatic changes and reuse of wastewaters. However, these changes would be of a lesser magnitude than for the land or estuarine alternatives.

D-3. DESIGN AND COST DATA

a. Basis for First Cost of Improvements.

(1) Pipeline and Outfall.

(a) Pipeline costs were based on using precast concrete pipe. The in-placed costs were obtained from cost curves developed by Kaiser Engineers for a Final Report to the State of California titled "San Francisco Bay-Delta Water Quality Control Program" dated March 1969 and updated using the ENR Index.

(b) Outfall costs were developed using a combination of cost curves developed by Kaiser Engineers for diffuser structures, onshore and underwater pipelines.

(2) Pump station costs were based on curves developed for total installed horsepower of pumping plant as developed by Kaiser Engineers and updated as stated in 1a above.

(3) Sewage Treatment Facilities. Sewage Treatment Plant costs were based on Flow and Solids Content cost curves as developed by Kaiser Engineers in the above referenced report, updated as appropriate.

(4) Land Disposal Facilities. Costs were developed on a per/acre basis from a material and quantity breakdown and a preliminary installation costs.

(5) Recreation and Environmental Development costs were taken as follows:

(a) Conveyance Facilities - $20,000 per mile of route for year 1990 which includes cost for landscaping, administration facilities and $10,000 per mile of route for the 2020 expansion;

(b) Sewage Treatment - 3 percent of the first cost;

(c) Sewage Lift Stations - 3 percent of the first costs;

(d) $24,000 per square mile for Land Disposal Facilities;

(e) $30,000 per square mile for sludge disposal areas.

(6) All costs are based on current price level - June 1971.

b. <u>Basis for Rights-of-Way and Land Costs</u>. Rights-of-way and land costs were estimated on a fee basis for land surface only. No improvements were valued, nor any severance damages considered.

Justification for this simplification is as follows: Pipelines are such that they can be routed to avoid intensive development; disposal areas which are acceptable contain sufficient excess acreage such that intensive development can be avoided.

Land and rights-of-way were assumed purchased in the first phase for both phases of the project. Costs are based on current price levels and were compiled by the Sacramento District.

c. Storage Reservoirs.

(1) The following procedure was followed in developing estimates for regulation storage reservoirs for alternatives involving reuse.

(a) Storage requirements were determined.

(b) At a typical site, 4 diked ponds capable of holding the required storage at a depth of 50 feet with 5 feet of freeboard were assumed.

(c) The cost per acre-foot of storage was then determined based on dike quantities and appurtenances.

(d) This cost was used at all remaining sites and, further, applied to all plans.

(2) A search for "natural" reservoir sites should be made at survey stage and the decision to use either "natural" or "diked" reservoirs made on the basis of more complete investigations carried out at that time. However, for preliminary and comparative estimating purposes, it is felt that the procedure described above is reasonable for the following reasons:

(a) Based on a limited investigation, evaporative losses for the reservoir size range under study would be roughly the same for either type. The average depth of reservoirs which have been constructed in similar terrain is approximately 50 feet. The loss, then, due to evaporation using either the artificial (diked) reservoirs or the "natural" reservoirs would be approximately 4 acre-feet per acre of surface per year. Under the land disposal alternative this is a loss of 20 percent of potentially reusable water. Thought should be given at survey stage to an evapo-retardant film if losses become too great.

(b) It is probable that "natural" sites could be found in the size range necessary (20,000 to 50,000 acre-feet) for the various alternatives, although the selection should involve detailed costs for environmental mitigation and site-by-site investigation of geologic conditions.

(c) Based on an investigation of first costs for a number of reservoirs in this size range, it would appear that there may be some advantage in using "natural" type storage. However, the choice should involve more detailed analyses including first costs for conveyance, operation costs for conveyance, and possible use of pumped storage power to partially offset the higher operating expenses. It is probable that operation costs during the life of the project would be the deciding economic factor.

(d) Flood Control in Land Disposal Areas.

Flood control in the land disposal areas is of very great importance due both to possible contamination of surface waters by overland flow from disposal areas and from flooding by major streams which run through the disposal areas.

(1) With respect to overland flow, the type of soil which will be necessary for the land disposal method should be reflected in reduced or, possibly, eliminated surface runoff. As a part of distribution and collection system costs, an allowance was made for contour checks and minor grading.

(2) With respect to flooding caused by the upstream watersheds, it should be possible to locate all reservoirs and disposal sites on ground above the flood elevation. Where this is not possible, the reservoirs themselves may be utilized as levees for flood protection with the possible addition of riprap to the stream side of the dikes. Some other minor channel improvements may be required.

(3) A more intensive study of the entire problem is necessary at survey stage, but it is roughly estimated that the following is representative of the amount of money which would be devoted to flood control under the four alternatives.

| | 1990 | 2020 EXPANSION |
|---|---|---|
| Ocean | 10,000,000 | 10,000,000 |
| Estuarine | 10,000,000 | 10,000,000 |
| Land | 20,000,000 | 20,000,000 |
| Combination | 12,000,000 | 12,000,000 |

When compared with the totals of the alternatives, the magnitude of the flood control costs are such that, within the precision of the estimates, they may be regarded as subsidiary items already covered by the previously presented estimates.

D-4. DERIVATION OF AVERAGE ANNUAL BENEFITS

a. General. For purposes of preliminary analysis each plan contains an evaluation of certain quantifiable benefits for which physical and economic data are presently available. Tangible water use benefits were grouped into three categories: recreation, commercial fishing and wastewater reuse. No benefits were estimated for changes induced on the land by any of the alternatives. Benefits which were estimated are preliminary and are intended to indicate an order of magnitude for each category.

b. Recreation Water Uses. Recreation benefits were derived using annual incremental participation days from 1975 to 2075 for the following activities: sightseeing, swimming, picnicking, boating, nature walks, camping and water skiing. Participation day estimates for these recreation activities in the study were initially made by the U.S. Corps of Engineers, San Francisco District, in 1965. Dollar benefits of $.90 to $2.50 per participation day for the various activities were held constant over the study period. Applying these dollar values to the projected recreation days resulted in the gross annual incremental benefits shown below in thousands of dollars:

| 1975 | 1985 | 1995 | 2005 | 2015 | 2025 |
|---|---|---|---|---|---|
| $32,000 | $46,000 | $60,000 | $84,000 | $98,000 | $123,000 |

These benefits are "gross" in that they do not reflect the costs of facilities that would be required for some of the activities to take place (e.g., boating).

The benefits by decade shown above were then changed to an average annual equivalent for values given by decades. Thus, for the recreation activities discussed above, average annual benefits through 2025 amount to $62,000,000.

The above annual benefits do not include sport fishing and clamming, two important Bay-Delta water uses. It is estimated that if Bay-Delta waters were improved by a comprehensive wastewater plan with at least secondary treatment, there would be an increase of 200,000 angler days per year for clam digging. Using methods from the Delaware Estuary Comprehensive Study 1/ a monetary value can be estimated for activity days as follows:

Maximum - 25% of usage @ $5.00 per day

Minimum - 25% of usage @ $3.00 per day

1/ "Delaware Estuary Comprehensive Study," Federal Water Pollution Control Administration," July 1966, pps. 76-77.

A range of benefits is computed to be from $150,000 to $250,000. The average of these two figures is $200,000 which was used to estimate clam digging recreation benefits on an average annual basis.

In 1958, Dr. Max Katz, fisheries bioligist for the U.S. Public Health Service, estimated annual expenditures for sport fisheries in San Francisco Bay to be in excess of $32 million annually. 1/ With proper control of wastes, it was estimated that this could increase to $37 million per year.

This annual one-sixth increase in expenditures was multiplied by estimates of sports fishing participation days. An average annual equivalent value of $10.4 million was derived from these estimates. Gross annual incremental benefits for 1975-1025 are shown below in thousands of dollars.

| 1975 | 1985 | 1995 | 2005 | 2015 | 2025 |
|---|---|---|---|---|---|
| $8,000 | $9,000 | $11,000 | $13,000 | $14,000 | $16,000 |

These estimates include only recreational benefits of cleaner water in the Bay and Delta. No benefits were estimated for recreational use of reservoirs or ponding areas which would be developed with each plan. Such recreational uses could be substantial, especially in relation to the Land Disposal and Combination alternatives, inasmuch as facilities would be located near populous areas. Recreational use of alternative facilities would have to be evaluated in the survey scope investigation.

c. Commercial Fishing. Benefits to Bay-Delta commercial fishermen from improved Bay-Delta water quality would accrue from an enhancement of various species of fish life. Oysters, crabs and bay shrimp would all benefit from improved water quality, and these would in turn benefit commercial fishermen. Many of these benefits are contingent upon physical changes which require investigation. Moreover, the time element for improvements is at present unclear. To rejuvenate certain species could take as long as a decade.

1/ Max Katz, "The Fishery Resources," in Erman A. Pearson, "Reduced Area Investigation of San Francisco Bay," (State Water Pollution Control Board), Pg. 188.

Quantifiable benefits have been estimated in detail for Bay-Delta oysters and these values were used in the benefit analysis. The California State Department of Fish and Game estimates that Bay-Delta commercial fishermen would reap average annual benefits of about $2 million soon after water quality is improved. 1/ This may be a very conservative estimate. 2/

d. Water Reuse Benefits. Benefits are assumed to accrue from reuse of wastewater for irrigation and for municipal and industrial supplemental water supply, primarily industrial cooling. Average annual benefits are estimated on the basis of assuming a value of $30 - $50 per acre foot of wastewater reused, before a cost of conveyance is added.

e. Proposed Investigations. In the survey scope of the investigation more detailed economic analyses are required. Studies to be conducted are shown in Figure D-1. The required research falls into four categories.

(1) The economics of recycling has not been studied extensively to date. If water is to be recycled throughout the San Francisco Bay-Delta economy, a study is required of how water is priced for the first consumptive use.

Related to this is the problem of financing the alternative proposed sewage treatment works. How are costs to be allocated among purposes? Can any by-products of the treatment process be sold in order to defray costs?

(2) Regional vs. national economic growth is the second topic which requires additional study. The relationship between wastewater management and growth patterns requires investigation. An additional conceptual problem in the analysis of alternative disposal systems concerns the relationship between economic impact and social well-being impact. The desirability of the San Francisco Bay-Delta region as a place to live has many economic repercussions. Were the social well-being aspects of life in the area to be seriously imperiled, the economic impacts would soon be felt. Interrelationships between social well-being and economic effects should be investigated.

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1/ J.E. Skinner, "A Review of Fish and Wildlife Resources of San Francisco Bay Area," June 1962, Water Projects Branch Report, California Department of Fish and Game, pps 103-105.

2/ Interview with Dr. Harold Orcutt, California Department of Fish and Game, Menlo Park, California, July 19, 1971.

## RESEARCH REQUIRED IN SURVEY SCOPE STUDY TO MEASURE ECONOMIC IMPACTS

**ECONOMIC IMPACT CRITERIA**

| ANTICIPATED CHANGE IN PHYSICAL RESOURCE | PROBABLE IMPACT | RECOMMENDED MEASURE | PROPOSED INVESTIGATIONS |
|---|---|---|---|
| **OCEAN WATERS** | | | |
| Change in quality | Change in quantity of commercially valuable fish life. | Value of catch. | Detrimental effect of ocean disposal on all forms of acquatic life. |
| | Effect on other species of marine life and aquatic growth. | Potential economic effects of breakdown in ecologic chain. | |
| **BAY & DELTA WATERS** | | | |
| Change in quality | Change in desirable species of fish and wildlife. | Visitor or recreation days, and value of commercial catch. | Economic effects of various disposal plans on all forms of acquatic life in and around the Bay. |
| | Changes in public access, and change in other water-related recreation. | Visitor-days. | |
| | Change in commercial establishments based on "enjoyment" of Bay. | Income from services. | |
| | Change in property values near Bay because of aesthetics. | Changes in value. | Degree to which visual appearance of water will change; and whether this influences desirability of waterfront locations. |
| | Change in water temperatures. | Changed pumping costs for industrial cooling. | |
| **LAND RESOURCE** | | | |
| Re-use of water | Agricultural and forestry production. | Value of output. | Types of crops or trees which can be grown; and their commercial values. |
| | Soil erosion control. | Reduced maintenance dredging costs. | |
| | Change in "green" municipal parks and golf courses. | Visitor days. | Marketing studies to find as many uses as possible for treated wastewater. |
| | Change in demands in other sources of irrigation water. | Cost savings. | |
| | Groundwater replenishment. | Pumping costs; Alternative surface water costs. | Potential acquifer recharge and re-use where tertiary and advanced treatment is envisioned. |
| | Change in salt water incursion. | Differing "life" of fresh water wells and associated costs. | |
| | Change in land subsidence. | Cost of surface repairs, or of protection from flooding. | |
| | Water available for cooling. | Price at which it could be sold. | |
| Re-use of residual solids | Potential increased agricultural production. | Value of products. | Marketing studies to find us. for reclaimed solids. |
| | Fertilizer, land-fill, mulch-compost or fill; recycling of waste constituents. | Price at which it could be sold. | |
| **INSTITUTIONAL CHANGES** | | | |
| **CHANGE IN LAND-USE PATTERNS** | | | |
| | Control over patterns of settlement. | Costs of providing government services. | |
| | Change in cost/revenue patterns of local governments. | Ability of government to provide necessary services. | Impact of land-disposal system on financial structure of local governments. |
| **IMPEDIMENTS TO POLLUTERS** | | | |
| | Costs to users of sewage system. | Change in value of industrial production. | Alternative methods of paying for the systems; how costs will be allocated to users. |
| | | Change in rate of regional growth. | Inter-industry impact of alternative plans on economic base of sub-regions. |
| | Restrictions on bypassing public system, i.e., against direct dumping. | Change in value of industrial production. | Complementary regulations needed to control polluters who presently discharge directly into hydrosphere. |

Fig. D - 1

(3) A "marketing" study for sewage effluents describes the third topic which requires additional analysis. Conventional markets do not exist for many waste products and by-products. Can new markets be developed for treated wastewaters, treated effluents, sludge and reclaimed minerals? How and where can they be used in the regional economy? Can treated effluent be used for industrial purposes? Economically, how important is groundwater recharge?

(4) The optimum scale of the proposed facilities must also be examined. Presently over 160 municipal and 70 industrial plants treat sewage generated in the Bay and Delta area. Alternatively, disposal plans considered herein envision regional systems. Sizing the alternative disposal systems requires analysis of such factors as long range land development patterns in the sub-areas; first costs; operation, maintenance and replacement costs.

Each alternative developed in this feasibility study has certain advantages and disadvantages. The preferred alternative is probably some combination. In part, that answer can be determined by simulating various size combinations of plant and collector systems and varying practices of effluent disposal, and selecting that variant which approaches an optimal condition.

D-5. ESTIMATED INVESTMENTS

Previous paragraphs have indicated the results of preliminary first cost estimates and related average annual cost estimates for the base condition and selected regional disposal alternatives. Tables D-1 and D-2 summarize the results of these estimates.

First costs reflect 1971 price levels. Average annual costs reflect: a 100-year economic life; annual interest rate of 5 1/8 percent; construction for 1990 waste loads in the first year (1975); and, construction of additional increments in the 15th year (1990) to meet 2020 waste loads. Replacement analyses depends on the type of material or equipment involved assuming normal maintenance and operation.

All first cost estimates assume for purposes of computation that wastewater treatment facilities for the region came into existence in the first year. Existing facilities and those planned in the near future are not given credit toward meeting future needs because the degree of potential integration of these facilities into the different systems analyzed is beyond the scope of this investigation. Evaluation of the cost data presented here should be limited to comparisons of the magnitude or sensitivity of the estimates because of the preliminary nature of the analysis and because substantial favorable feature modification could result from more detailed investigation.

SUMMARY OF FIRST COSTS AND

DISPO

| ITEMS | | | BASE CONDITION | | | OCEAN (ADVANCED TREATMENT) | |
|---|---|---|---|---|---|---|---|
| FIRST COSTS | UNIT | QUANTITY | AVG. UNIT PRICE ($1,000's) | AMOUNT ($1,000's) | QUANTITY | AVG. UNIT PRICE ($1,000's) | A ($1 |
| 1. Major Interceptors and Outfalls | | | | | | | |
| a. Pipeline | Mile | 200 | 3,500 | $ 700,000 | 400 | 2,500 | $ 1 |
| b. Pump Stations | H.P. | 35,000 | 1 | 35,000 | 629,000 | 0.56 | |
| c. Land Cost | Acre | 1,350 | 38 | 51,000 | 4,100 | 32 | |
| Subtotal | | | | 786,000 | | | 1 |
| Contingencies 25% (±) | | | | 194,000 | | | |
| Subtotal - MAJOR INTERCEPTOR | | | | $ 980,000 | | | $ 1 |
| 2. Treatment Facilities | | | | | | | |
| a. Secondary Treatment Plants (incl. digestion) | Each | 17 | 18,500 | 315,000 | | | |
| b. Advanced Treatment Plants (incl. digestion) | Each | - | - | - | 2 | 260,000 | |
| c. Oxidation Lagoons | Each | 7 | 1,400 | 10,000 | - | - | |
| d. Land Disposal Areas | | | | | | | |
| (1) Application System | Job | 1 | L.S. | 100 | - | - | |
| (2) Collection System | Job | 1 | L.S. | 400 | - | - | |
| e. Sludge Disposal | | | | | | | |
| (1) Digester | Job | 1 | L.S. | 3,000 | - | - | |
| (2) Land Disposal Areas | | | | | | | |
| (a) Application System | Job | 1 | L.S. | 55,000 | 1 | L.S. | |
| (b) Collection System | Job | 1 | L.S. | 250,000 | 1 | L.S. | |
| (3) Conveyance System | | | | | | | |
| (a) Pipeline | Mile | 525 | 790 | 415,000 | 150 | 740 | |
| (b) Pump Stations | H.P. | 1,700 | 0.9 | 1,500 | 1,300 | 0.8 | |
| (4) Wet Weather Storage Reservoirs | Ac.Ft. | 2,000 | 0.5 | 1,000 | 2,200 | 0.5 | |
| f. Wet Weather Storage Reservoirs | Ac.Ft. | 10,000 | 0.5 | 5,000 | - | - | |
| g. Land Cost | Acre | 66,500 | 4.5 | 300,000 | 65,000 | 5 | |
| Subtotal | | | | 1,356,000 | | | 1 |
| Contingencies 25% (±) | | | | 344,000 | | | |
| Subtotal - TREATMENT FACILITIES | | | | $1,700,000 | | | $1 |
| 3. Recreational and Environmental Treatment | | | | | | | |
| a. Major Interceptors Lines | R.O.W. Miles | 200 | 20 | 4,000 | 410 | 20 | |
| b. Sludge Conveyance Lines | R.O.W. Miles | 340 | 10 | 3,400 | 140 | 10 | |
| c. Treatment Plants and Digester | Job | 1 | L.S. | 12,000 | 1 | L.S. | |
| d. Pump Stations | Job | 1 | L.S. | 1,500 | 1 | L.S. | |
| e. Oxidation Lagoons | Job | 1 | L.S. | 400 | - | - | |
| f. Wet Weather Storage Reservoirs | Job | 1 | L.S. | 200 | 1 | L.S. | |
| g. Sludge Disposal Area | Sq. Mi. | 45 | 21 | 1,000 | 50 | 21 | |
| h. Land Disposal Area | Sq. Mi. | 5 | 17 | 100 | - | - | |
| i. Flood Control | Job | 1 | L.S. | 5,000 | 1 | L.S. | |
| Subtotal | | | | 27,600 | | | |
| Contingencies 25% (±) | | | | 7,400 | | | |
| Subtotal - RECREATIONAL AND ENVIRONMENTAL TREATMENT | | | | $ 35,000 | | | $ |
| Subtotal Estimate First Cost | | | | 2,715,000 | | | 3 |
| Engineering and Design 7% (±) | | | | 180,000 | | | |
| Supervision, Administration and Inspection 8% (±) | | | | 205,000 | | | |
| TOTAL PROJECT COST | | | | $3,100,000 | | | $ 4 |
| AVERAGE ANNUAL COSTS | | | | AMOUNT | | | |
| 1. Annual Cost and Interest | | | | 209,000,000 | | | 27 |
| 2. Operation and Maintenance | | | | 73,000,000 | | | 7 |
| TOTAL AVERAGE ANNUAL COST | | | | $ 282,000,000 | | | $ 34 |

TABLE D-1

SUMMARY OF FIRST COSTS AND AVERAGE ANNUAL COSTS TO TREAT 1990 LOADS

DISPOSAL ALTERNATIVE

| BASE CONDITION | | | OCEAN (ADVANCED TREATMENT) | | | ESTUARINE | | | LAND | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ANTITY | AVG. UNIT PRICE ($1,000's) | AMOUNT ($1,000's) | QUANTITY | AVG. UNIT PRICE ($1,000's) | AMOUNT ($1,000's) | QUANTITY | AVG. UNIT PRICE ($1,000's) | AMOUNT ($1,000's) | QUANTITY | AVG. UNIT PRICE ($1,000's) | AMOUNT ($1,000's) |
| 200 | 3,500 | $ 700,000 | 400 | 2,500 | $ 1,000,000 | 240 | 1,750 | $ 420,000 | 400 | 2,000 | $ 800,00 |
| 35,000 | 1 | 35,000 | 629,000 | 0.56 | 352,000 | 37,000 | 1 | 37,000 | 181,000 | 0.75 | 136,00 |
| 1,350 | 38 | 51,000 | 4,100 | 32 | 131,000 | 1,560 | 45 | 70,000 | 3,300 | 25 | 83,00 |
| | | 786,000 | | | 1,483,000 | | | 527,000 | | | 1,019,00 |
| | | 194,000 | | | 367,000 | | | 133,000 | | | 281,00 |
| | | $ 980,000 | | | $ 1,850,000 | | | $ 660,000 | | | $1,300,00 |
| 17 | 18,500 | 315,000 | | | | | | | | | |
| - | - | - | 2 | 260,000 | 520,000 | 7 | 80,000 | 560,000 | - | - | - |
| 7 | 1,400 | 10,000 | - | - | - | - | - | - | 210 | 1,400 | 294,00 |
| 1 | L.S. | 100 | - | - | - | - | - | - | 1 | L.S. | 300,00 |
| 1 | L.S. | 400 | - | - | - | - | - | - | 1 | L.S. | 1,250,00 |
| 1 | L.S. | 3,000 | - | - | - | - | - | - | 1 | L.S. | 70,00 |
| 1 | L.S. | 55,000 | 1 | L.S. | 60,000 | 1 | L.S. | 60,000 | - | - | - |
| 1 | L.S. | 250,000 | 1 | L.S. | 260,000 | 1 | L.S. | 260,000 | - | - | - |
| 525 | 790 | 415,000 | 150 | 740 | 111,000 | 360 | 700 | 252,000 | - | - | - |
| 1,700 | 0.9 | 1,500 | 1,300 | 0.8 | 1,000 | 3,800 | 0.8 | 3,000 | - | - | - |
| 2,000 | 0.5 | 1,000 | 2,200 | 0.5 | 1,000 | 2,200 | 0.5 | 1,000 | - | - | - |
| 0,000 | 0.5 | 5,000 | - | - | - | - | - | - | 445,000 | 0.45 | 200,00 |
| 6,500 | 4.5 | 300,000 | 65,000 | 5 | 325,000 | 67,000 | 4 | 268,000 | 335,000 | 3.9 | 1,307,00 |
| | | 1,356,000 | | | 1,278,000 | | | 1,404,000 | | | 3,421,00 |
| | | 344,000 | | | 322,000 | | | 346,000 | | | 859,00 |
| | | $1,700,000 | | | $1,600,000 | | | $1,750,000 | | | $ 4,280,00 |
| 200 | 20 | 4,000 | 410 | 20 | 8,200 | 160 | 20 | 3,200 | 340 | 20 | 6,80 |
| 340 | 10 | 3,400 | 140 | 10 | 1,400 | 360 | 10 | 3,600 | - | - | - |
| 1 | L.S. | 12,000 | 1 | L.S. | 20,000 | 1 | L.S. | 21,000 | 1 | L.S. | 3,00 |
| 1 | L.S. | 1,500 | 1 | L.S. | 13,000 | 1 | L.S. | 2,000 | 1 | L.S. | 5,00 |
| 1 | L.S. | 400 | - | - | - | - | - | - | 1 | L.S. | 11,00 |
| 1 | L.S. | 200 | 1 | L.S. | 400 | 1 | L.S. | 100 | 1 | L.S. | 8,00 |
| 45 | 21 | 1,000 | 50 | 21 | 1,000 | 50 | 21 | 1,000 | - | - | - |
| 5 | 17 | 100 | - | - | - | - | - | - | 250 | 17 | 4,0 |
| 1 | L.S. | 5,000 | 1 | L.S. | 10,000 | 1 | L.S. | 10,000 | 1 | L.S. | 20,0 |
| | | 27,600 | | | 54,000 | | | 40,900 | | | 57,8 |
| | | 7,400 | | | 16,000 | | | 9,100 | | | 12,2 |
| | | $ 35,000 | | | $ 70,000 | | | $ 50,000 | | | $ 70,0 |
| | | 2,715,000 | | | 3,520,000 | | | 2,460,000 | | | 5,650,0 |
| | | 180,000 | | | 270,000 | | | 160,000 | | | 400,0 |
| | | 205,000 | | | 310,000 | | | 180,000 | | | 450,0 |
| | | $3,100,000 | | | $ 4,100,000 | | | $ 2,800,000 | | | $ 6,500,0 |
| | | AMOUNT | | | AMOUNT | | | AMOUNT | | | AMOUN |
| | | 209,000,000 | | | 271,000,000 | | | 186,000,000 | | | 420,000,0 |
| | | 73,000,000 | | | 70,000,000 | | | 60,000,000 | | | 126,000,0 |
| | | $ 282,000,000 | | | $ 341,000,000 | | | $ 246,000,000 | | | $ 546,000,0 |

COSTS TO TREAT 1990 LOADS

E

| ESTUARINE | | | LAND | | | COMBINATION | | |
|---|---|---|---|---|---|---|---|---|
| UANTITY | AVG. UNIT PRICE ($1,000's) | AMOUNT ($1,000's) | QUANTITY | AVG. UNIT PRICE ($1,000's) | AMOUNT ($1,000's) | QUANTITY | AVG. UNIT PRICE ($1,000's) | AMOUNT ($1,000's) |
| 240 | 1,750 | $ 420,000 | 400 | 2,000 | $ 800,000 | 325 | 1,600 | $ 520,000 |
| 37,000 | 1 | 37,000 | 181,000 | 0.75 | 136,000 | 64,400 | 0.9 | 58,000 |
| 1,560 | 45 | 70,000 | 3,300 | 25 | 83,000 | 2,200 | 35 | 77,000 |
| | | 527,000 | | | 1,019,000 | | | 655,000 |
| | | 133,000 | | | 281,000 | | | 165,000 |
| | | $ 660,000 | | | $1,300,000 | | | $ 820,000 |
| 7 | 80,000 | 560,000 | - | - | - | 3 | 125,000 | 375,000 |
| - | - | - | 210 | 1,400 | 294,000 | 65 | 1,400 | 91,000 |
| - | - | - | 1 | L.S. | 300,000 | 1 | L.S. | 95,000 |
| - | - | - | 1 | L.S. | 1,250,000 | 1 | L.S. | 420,000 |
| - | - | - | 1 | L.S. | 70,000 | 1 | L.S. | 25,000 |
| 1 | L.S. | 60,000 | - | - | - | 1 | L.S. | 45,000 |
| 1 | L.S. | 260,000 | - | - | - | 1 | L.S. | 190,000 |
| 360 | 700 | 252,000 | - | - | - | 140 | 860 | 120,000 |
| 3,800 | 0.8 | 3,000 | - | - | - | 3,000 | 1 | 3,000 |
| 2,200 | 0.5 | 1,000 | - | - | - | 1,550 | 0.5 | 1,000 |
| - | - | - | 445,000 | 0.45 | 200,000 | 135,000 | 0.45 | 61,000 |
| 67,000 | 4 | 268,000 | 335,000 | 3.9 | 1,307,000 | 170,000 | 4.5 | 765,000 |
| | | 1,404,000 | | | 3,421,000 | | | 2,191,000 |
| | | 346,000 | | | 859,000 | | | 559,000 |
| | | $1,750,000 | | | $ 4,280,000 | | | $2,750,000 |
| 160 | 20 | 3,200 | 340 | 20 | 6,800 | 260 | 20 | 5,200 |
| 360 | 10 | 3,600 | - | - | - | 140 | 10 | 1,400 |
| 1 | L.S. | 21,000 | 1 | L.S. | 3,000 | 1 | L.S. | 19,000 |
| 1 | L.S. | 2,000 | 1 | L.S. | 5,000 | 1 | L.S. | 2,000 |
| - | - | - | 1 | L.S. | 11,000 | 1 | L.S. | 4,000 |
| 1 | L.S. | 100 | 1 | L.S. | 8,000 | 1 | L.S. | 2,000 |
| 50 | 21 | 1,000 | - | - | - | 50 | 21 | 1,000 |
| - | - | - | 250 | 17 | 4,000 | 100 | 17 | 1,700 |
| 1 | L.S. | 10,000 | 1 | L.S. | 20,000 | 1 | L.S. | 12,000 |
| | | 40,900 | | | 57,800 | | | 48,300 |
| | | 9,100 | | | 12,200 | | | 11,700 |
| | | $ 50,000 | | | $ 70,000 | | | $ 60,000 |
| | | 2,460,000 | | | 5,650,000 | | | 3,630,000 |
| | | 160,000 | | | 400,000 | | | 260,000 |
| | | 180,000 | | | 450,000 | | | 310,000 |
| | | $ 2,800,000 | | | $ 6,500,000 | | | $ 4,200,000 |
| | | AMOUNT | | | AMOUNT | | | AMOUNT |
| | | 186,000,000 | | | 420,000,000 | | | 270,000,000 |
| | | 60,000,000 | | | 126,000,000 | | | 78,000,000 |
| | | $ 246,000,000 | | | $ 546,000,000 | | | $ 348,000,000 |



3

SUMMARY OF ADDITIONAL FIRST

| ITEMS | UNIT | BASE CONDITION QUANTITY | AVG. UNIT PRICE ($1,000's) | AMOUNT ($1,000's) | OCEAN (ADVANCED T QUANTITY | AVG. UNIT PRI ($1,000's) |
|---|---|---|---|---|---|---|
| **FIRST COSTS** | | | | | | |
| 1. Major Interceptors and Outfalls | | | | | | |
| a. Pipeline | Mile | 140 | 2,310 | $ 323,000 | 450 | 2,210 |
| b. Pump Stations | H.P. | 40,950 | 1 | 41,000 | 468,000 | 0. |
| c. Land Cost | Acre | - | - | - | - | - |
| Subtotal | | | | 364,000 | | |
| Contingencies 25% (±) | | | | 91,000 | | |
| Subtotal - MAJOR INTERCEPTORS | | | | $ 455,000 | | |
| 2. Treatment Facilities | | | | | | |
| a. Secondary Treatment Plants (incl. digestion) | Each | 17 | 15,550 | 264,000 | | |
| b. Advanced Treatment Plants (incl. digestion) | Each | - | - | - | 2 | 217,500 |
| c. Oxidation Lagoons | Each | 15 | 1,400 | 21,000 | - | - |
| d. Land Disposal Areas | | | | | | |
| (1) Application System | Job | 1 | L.S. | 200 | - | - |
| (2) Collection System | Job | 1 | L.S. | 1,000 | - | - |
| e. Sludge Disposal | | | | | | |
| (1) Digester | Job | 1 | L.S. | 7,000 | - | - |
| (2) Land Disposal Areas | | | | | | |
| (a) Application System | Job | 1 | L.S. | 60,000 | 1 | L.S. |
| (b) Collection System | Job | 1 | L.S. | 220,000 | 1 | L.S. |
| (3) Conveyance System | | | | | | |
| (a) Pipeline | Mile | 525 | 790 | 415,000 | 150 | 740 |
| (b) Pump Stations | H.P. | 1,700 | 0.9 | 1,500 | 1,300 | 0.8 |
| (4) Wet Weather Storage Reservoirs | Ac.Ft. | 2,000 | 0.5 | 1,000 | 1,950 | 0.5 |
| f. Wet Weather Storage Reservoirs | Ac.Ft. | 22,000 | 0.5 | 11,000 | 2,200 | 0.4 |
| g. Land Cost | Acre | - | - | -- | - | - |
| Subtotal | | | | 1,001,700 | | |
| Contingencies 25% (±) | | | | 248,300 | | |
| Subtotal - TREATMENT FACILITIES | | | | $ 1,250,000 | | |
| 3. Recreational and Environmental Treatment | | | | | | |
| a. Major Interceptor line | R.O.W. Mile | 200 | 10 | 2,000 | 450 | 10 |
| b. Sludge Conveyance line | R.O.W. Mile | 340 | 10 | 3,400 | 140 | 10 |
| c. Treatment Plants and Digester | Job | 1 | L.S. | 10,000 | 1 | L.S. |
| d. Pump Station | Job | 1 | L.S. | 1,600 | 1 | L.S. |
| e. Oxidation Lagoons | Job | 1 | L.S. | 1,000 | 0 | - |
| f. Wet Weather Storage Reservoir | Job | 1 | L.S. | 400 | 1 | L.S. |
| g. Sludge Disposal Area | Sq. Mi. | 35 | 21 | 700 | 50 | 21 |
| h. Land Disposal Area | Sq. Mi. | 5 | 17 | 100 | 0 | - |
| i. Flood Control | Job | 1 | L.S. | 5,000 | 1 | L.S. |
| Subtotal | | | | 24,200 | | |
| Contingencies 25% (±) | | | | 5,800 | | |
| Subtotal - RECREATIONAL AND ENVIRONMENTAL TREATMENT | | | | $ 30,000 | | |
| Subtotal Estimated First Cost | | | | 1,735,000 | | |
| Engineering and Design 7% (±) | | | | 124,000 | | |
| Supervision, Administration and Inspection 8% (±) | | | | 141,000 | | |
| **TOTAL PROJECT COST** | | | | $ 2,000,000 | | |

| AVERAGE ANNUAL COSTS | AMOUNT |
|---|---|
| 1. Annual Cost and Interest | 65.000.000 |
| 2. Operation and Maintenance | 20,000,000 |
| **TOTAL AVERAGE ANNUAL COST** | $ 85,000,000 |

TABLE D-2

SUMMARY OF ADDITIONAL FIRST COSTS AND AVERAGE ANNUAL COSTS AFTER 1990 TO TREAT 2020 LOADS

DISPOSAL ALTERNATIVE

| BASE CONDITION | | | OCEAN (ADVANCED TREATMENT) | | | ESTUARINE | | | LAND | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| UANTITY | AVG. UNIT PRICE ($1,000's) | AMOUNT ($1,000's) | QUANTITY | AVG. UNIT PRICE ($1,000's) | AMOUNT ($1,000's) | QUANTITY | AVG. UNIT PRICE ($1,000's) | AMOUNT ($1,000's) | QUANTITY | AVG. UNIT PRICE ($1,000's) | AMOU ($1,00 |
| 140 | 2,310 | $ 323,000 | 450 | 2,210 | $ 995,000 | 180 | 1,610 | $ 290,000 | 420 | 1,570 | $ 659 |
| 40,950 | 1 | 41,000 | 468,000 | 0.6 | 281,000 | 33,300 | 0.9 | 30,000 | 84,900 | 0.8 | 68 |
| - | - | - | - | - | - | - | - | - | - | - | |
| | | 364,000 | | | 1,276,000 | | | 320,000 | | | 727, |
| | | 91,000 | | | 324,000 | | | 80,000 | | | 173, |
| | | $ 455,000 | | | $ 1,600,000 | | | $ 400,000 | | | $ 900, |
| 17 | 15,550 | 264,000 | | | | | | | | | |
| - | - | - | 2 | 217,500 | 435,000 | 7 | 65,400 | 458,000 | - | - | - |
| 15 | 1,400 | 21,000 | - | - | - | - | - | - | 176 | 1,420 | 250, |
| 1 | L.S. | 200 | - | - | - | - | - | - | 1 | L.S. | 202, |
| 1 | L.S. | 1,000 | - | - | - | - | - | - | 1 | L.S. | 884, |
| 1 | L.S. | 7,000 | - | - | - | - | - | - | 1 | L.S. | 65, |
| 1 | L.S. | 60,000 | 1 | L.S. | 59,000 | 1 | L.S. | 48,000 | - | - | - |
| 1 | L.S. | 220,000 | 1 | L.S. | 210,000 | 1 | L.S. | 210,000 | - | - | - |
| 525 | 790 | 415,000 | 150 | 740 | 111,000 | 360 | 700 | 252,000 | - | - | - |
| 1,700 | 0.9 | 1,500 | 1,300 | 0.8 | 1,000 | 3,800 | 0.8 | 3,000 | - | - | - |
| 2,000 | 0.5 | 1,000 | 1,950 | 0.5 | 1,000 | 2,000 | 0.5 | 1,000 | - | - | - |
| 22,000 | 0.5 | 11,000 | 2,200 | 0.45 | 1,000 | - | - | - | 360,000 | 0.45 | 162, |
| - | - | -- | - | - | - | - | - | - | - | - | - |
| | | 1,001,700 | | | 818,000 | | | 972,000 | | | 1,563, |
| | | 248,300 | | | 202,000 | | | 248,000 | | | 387, |
| | | $ 1,250,000 | | | $1,020,000 | | | $ 1,220,000 | | | $1,950, |
| 200 | 10 | 2,000 | 450 | 10 | 4,500 | 160 | 10 | 1,600 | 390 | 10 | 3,9 |
| 340 | 10 | 3,400 | 140 | 10 | 1,400 | 360 | 10 | 3,600 | 0 | - | |
| 1 | L.S. | 10,000 | 1 | L.S. | 16,000 | 1 | L.S. | 17,000 | 1 | L.S. | 2,0 |
| 1 | L.S. | 1,600 | 1 | L.S. | 11,000 | 1 | L.S. | 1,000 | 1 | L.S. | 3,0 |
| 1 | L.S. | 1,000 | 0 | - | 0 | 0 | - | 0 | 1 | L.S. | 9,0 |
| 1 | L.S. | 400 | 1 | L.S. | 300 | 1 | L.S. | [illegible] | 1 | L.S. | 6,0 |
| 35 | 21 | 700 | 50 | 21 | 1,000 | 50 | 21 | 1,000 | 0 | - | |
| 5 | 17 | 100 | 0 | - | 0 | 0 | - | 0 | 270 | 17 | 4,6 |
| 1 | L.S. | 5,000 | 1 | L.S. | 10,000 | 1 | L.S. | 10,000 | 1 | L.S. | 20,0 |
| | | 24,200 | | | 44,200 | | | 34,300 | | | 48,5 |
| | | 5,800 | | | 10,800 | | | 8,700 | | | 1[illegible],5 |
| | | $ 30,000 | | | $ 55,000 | | | $ 43,000 | | | $ 60,0 |
| | | 1,735,000 | | | 2,675,000 | | | 1,663,000 | | | 2,910,0 |
| | | 124,000 | | | 200,000 | | | 110,000 | | | 229,0 |
| | | 141,000 | | | 225,000 | | | 127,000 | | | 261,0 |
| | | $ 2,000,000 | | | $3,100,000 | | | $1,900,000 | | | $3,400,0 |
| | | AMOUNT | | | AMOUNT | | | AMOUNT | | | AMOUNT |
| | | 65,000,000 | | | 100,000,000 | | | 61,000,000 | | | 109,000,00 |
| | | 20,000,000 | | | 31,000,000 | | | 24,000,000 | | | 44,000,00 |
| | | $ 85,000,000 | | | $131,000,000 | | | $ 85,000,000 | | | $153,000,00 |

D-2

**GE ANNUAL COSTS AFTER 1990 TO TREAT 2020 LOADS**

**ERNATIVE**

| ESTUARINE | | | LAND | | | COMBINATION | | |
|---|---|---|---|---|---|---|---|---|
| QUANTITY | AVG. UNIT PRICE ($1,000's) | AMOUNT ($1,000's) | QUANTITY | AVG. UNIT PRICE ($1,000's) | AMOUNT ($1,000's) | QUANTITY | AVG. UNIT PRICE ($1,000's) | AMOUNT ($1,000's) |
| 180 | 1,610 | $ 290,000 | 420 | 1,570 | $ 659,000 | 280 | 1,420 | $ 398,000 |
| 33,300 | 0.9 | 30,000 | 84,900 | 0.8 | 68,000 | 61,000 | 0.9 | 55,000 |
| - | - | - | - | - | - | - | - | - |
| | | 320,000 | | | 727,000 | | | 453,000 |
| | | 80,000 | | | 173,000 | | | 117,000 |
| | | $ 400,000 | | | $ 900,000 | | | $ 570,000 |
| 7 | 65,400 | 458,000 | - | - | - | 3 | 83,300 | 250,000 |
| - | - | - | 176 | 1,420 | 250,000 | 80 | 1,420 | 115,000 |
| - | - | - | 1 | L.S. | 202,000 | 1 | L.S. | 100,000 |
| - | - | - | 1 | L.S. | 884,000 | 1 | L.S. | 448,000 |
| - | - | - | 1 | L.S. | 65,000 | 1 | L.S. | 31,000 |
| 1 | L.S. | 48,000 | - | - | - | 1 | L.S. | 28,000 |
| 1 | L.S. | 210,000 | - | - | - | 1 | L.S. | 122,000 |
| 360 | 700 | 252,000 | - | - | - | 140 | 860 | 120,000 |
| 3,800 | 0.8 | 3,000 | - | - | - | 3,000 | 0.9 | 3,000 |
| 2,000 | 0.5 | 1,000 | - | - | - | 1,100 | 0.5 | 1,000 |
| - | - | - | 360,000 | 0.45 | 162,000 | 160,000 | 0.45 | 72,000 |
| - | - | - | - | - | - | - | - | - |
| | | 972,000 | | | 1,563,000 | | | 1,290,000 |
| | | 248,000 | | | 387,000 | | | 320,000 |
| | | $ 1,220,000 | | | $1,950,000 | | | $ 1,610,000 |
| 160 | 10 | 1,600 | 390 | 10 | 3,900 | 260 | 10 | 2,600 |
| 360 | 10 | 3,600 | 0 | - | 0 | 140 | 10 | 1,400 |
| 1 | L.S. | 17,000 | 1 | L.S. | 2,000 | 1 | L.S. | 11,000 |
| 1 | L.S. | 1,000 | 1 | L.S. | 3,000 | 1 | L.S. | 2,000 |
| 0 | - | 0 | 1 | L.S. | 9,000 | 1 | L.S. | 4,000 |
| 1 | L.S. | [illegible] | 1 | L.S. | 6,000 | 1 | L.S. | 3,000 |
| 50 | 21 | 1,000 | 0 | - | 0 | 20 | 21 | 400 |
| 0 | - | 0 | 270 | 17 | 4,600 | 93 | 17 | 1,600 |
| 1 | [illegible] | 10,000 | 1 | L.S. | 20,000 | 1 | L.S. | 12,000 |
| | | 34,300 | | | 48,500 | | | 38,000 |
| | | 8,700 | | | 11,500 | | | 12,000 |
| | | $ 43,000 | | | $ 60,000 | | | $ 50,000 |
| | | 1,663,000 | | | 2,910,000 | | | 2,230,000 |
| | | 110,000 | | | 229,000 | | | 170,000 |
| | | 127,000 | | | 261,000 | | | 200,000 |
| | | $1,900,000 | | | $3,400,000 | | | $2,600,000 |
| | | AMOUNT | | | AMOUNT | | | AMOUNT |
| | | 61,000,000 | | | 109,000,000 | | | 83,000,000 |
| | | 24,000,000 | | | 44,000,000 | | | 33,000,000 |
| | | $ 85,000,000 | | | $153,000,000 | | | $116,000,000 |



3

It appears that an expenditure of three to five billion dollars will be required for municipal and industrial wastewater management in the Bay and Delta region to correct present deficiencies, provide for increased preservation and enhancement of the environment, and accommodate the present population plus a projected additional three and one-half million residents by 1990. These expenditures are exclusive of the sewerage collection systems from individual users to logical connection points with interceptors or treatment plants, and also exclusive of "source control" measures for industries. Average annual costs are about 490 million dollars per year over a 100-year economic life.

A review of major interceptor costs indicates that ocean disposal concepts are not suited to the eastern portion of study area. Similarly, the combination of interceptor costs and treatment costs for land disposal, involving large blocks of highly valued land, indicates that the most likely areas where the land alternative would be considered as desirable would be the northern and eastern portion of the study area. The estuarine alternative shows favorable aspects, either alone or in combination with other alternatives. All of these considerations are pertinent if environmental, social well-being and public health accomplishments are to be held essentially equal.

## D-6. RECLAIMED WATER INVESTMENTS

Evaluations in previous portions of this chapter have indicated costs associated with reclaimed water. Tables D-1 and D-2 do not include the costs of facilities required to develop reuse potential for treated wastewater. These facilities include the conveyance systems needed to move the treated water to reuse locations and the regulating reservoirs needed for system efficiency. Regulating reservoirs provide temporary storage of treated water to cope with seasonal imbalance between generation of treated water and reuse demand. To provide for meeting any of the potential demands, the capacity of regulating reservoirs associated with the chemical/biological advanced treatment facilities used in ocean or estuarine disposal alternatives would be controlled by seasonal demand factors for agricultural reuse; capacity of reservoirs associated with the land disposal alternative would be controlled by demand factors for municipal and industrial reuse. Costs of developing these facilities are not included because they depend on specific demands and locations for reclaimed water; more detailed study would be needed to identify these factors.

A recent State of California publication, Department of Water Resources Bulletin No. 160-70, indicated in gross terms and general locations the expected future water demands of the State to year 2020. Based on this information, preliminary estimates of the first costs of major transport and regulations facilities for reuse were prepared. Results are presented in the following tabulation:

| ALTERNATIVE | FIRST COST ($1,000 per Acre-Foot of Capacity) |
|---|---|
| OCEAN DISPOSAL | $1,000 |
| ESTUARINE DISPOSAL | 1,300 |
| LAND DISPOSAL | 650 |
| COMBINED DISPOSAL | 1,200 |

A sensitivity analysis of these costs indicated that the land disposal alternative should be considered in any further investigation of regional systems when reuse of treated wastewater is an objective.

D-7. POTENTIAL SYSTEM MODIFICATIONS

During the latter portion of the investigations associated with this report, it became apparent that two major modifications to the features of selected alternatives should be considered in the evaluation. First, since the base condition assumed secondary level treatment with discharge into the estuary, and the ocean aquatic environment is different than the estuarine, the ocean disposal alternative was reevaluated for sensitivity to secondary level treatment instead of advanced treatment. Although estimated average annual costs for a regional system with secondary treatment facilities to handle 2020 projected waste flows would be lower by approximately $55 million, the conclusion of the evaluation was that advanced treatment best represents a viable ocean disposal concept. The reasons are that secondary treatment:

a. Would not reduce the buildup of persistent toxicants in the marine environment,

b. Could increase the potential for eutrophication in the coastal zone,

c. Would not reduce the projected waste loads discharged to the hydrosphere over that of the base condition, and

d. Would not provide a significant potential for reuse of treated wastewater.

Second, the assumed rate of application of sludge on land disposal areas appears to be low based on recent information. Careful review of this matter through further investigation could confirm indications that the extent of required land areas would be about 50 percent less than those used in this report. A brief investigation of the impact of such a development on the selected regional alternatives and the base condition indicates that the comparative analysis of investments shown in the report remains essentially unaffected. Sludge loads from the base condition (secondary treatment) would be less than from the selective regional alternatives (advanced treatment) but equal disposal areas are assumed for all systems. The impact of this feature on investments varies with the selected alternative; i.e., eliminating the investment differential between the base condition and estuarine disposal, increasing the differential with ocean disposal by about 20 percent and increasing differentials with other regional alternatives about ten percent. The main conclusion with regard to sludge disposal is that a controlled and monitored physical solution to the disposal problem is an expensive item, but it appears warranted for environmental and public health reasons. Also, the magnitude of the public investment required for any alternative indicates that consideration of regional solutions rather than incremental solutions is warranted.

## D-8. INSTITUTIONAL ASPECTS

The selected regional alternatives and the assumed base condition considered in this report present different potential problems in the matter of institutional arrangements. Those institutional matters pertinent to the evaluation procedure are discussed in following paragraphs.

a. <u>Incremental Approach</u>.

Current Federal, State and local institutional structures for wastewater management would permit incremental development of facilities to reach the assumed base condition; essentially a continuation into the future of ongoing programs. If local interests are not to be required to assume the entire investment in the future, then some form of current Federal and State funding programs for cost sharing will have to be extended. Consolidation into larger units of less than fully regional extent can be accomplished by Joint Powers Agreements among local governments. To date, the critical aspect of implementation of a satisfactory incremental development has, on several occasions, required the State to issue "cease and desist" orders against industries or local governments. In some cases, such orders included stopping of further connections to existing municipal systems. Usually these court orders are withdrawn upon firm establishment of planning, design and construction schedules extending over a two or three year period. Some industries faced with a similar situation have ceased operations in the study area, usually if local operations are of marginal efficiency and excess production capacity is available at other locations in the nation. Undefined social well-being problems are cited by communities facing either of these situations. The State has recognized and is approaching through regulation the observed problems of education, training and experience associated with responsibilities for operation and maintenance of wastewater systems.

b. **Regional Approach**.

Existing Federal authorities would be applicable to regional wastewater systems, however, as more information is developed some modifications to the authorities might be appropriate. Subjects that might require further consideration are the national interest, Federal areas of participation and the Federal authorities that should be associated with different beneficial uses of reclaimed water. The State, acting alone, would be faced with the same problems. However, in programs involving Federal participation, the State would have additional problems of coordinating local participation. Future Federal, State and local funding programs would have to be considered. An optimized regional approach might also require participation of an area not directly incurring primary benefits. A strong State participation in all aspects of a regional system should reduce or eliminate the occasions when State and local agencies find it necessary to resort to the courts for resolution of divergent views. Opportunities to resolve problems with industries should be enhanced and adverse social well-being impacts, therefore, reduced. Assuring qualified and trained personnel to operate and maintain a regional wastewater system should present no problem. The public would have maximum advance awareness of their future program and investments in wastewater management reflecting staged construction when appropriate. This would assist participating local governmental agencies in formulating actions toward their overall responsibilities.

c. **Public Investment**.

Because of the numerous priority problems facing communities, premature abandonment of existing public investments in wastewater management must be avoided. Regional management plans must critically consider this matter. Because of rapidly changing environmental objectives, it appears that a regional approach to wastewater management provides maximum opportunities to avoid premature abandonment of the facilities for which long term committments of public investment have been made.

# ALTERNATIVES

# FOR

# MANAGING WASTEWATER

# IN THE

# SAN FRANCISCO BAY AND SACRAMENTO-SAN JOAQUIN DELTA AREA

## APPENDIX E

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JULY 1971

## APPENDIX E

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