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INDIRECT AND INTANGIBLE COSTS AND BENEFITS: AN EXPANDED EVALUATION FORMAT TO AID IN SLUDGE MANAGEMENT

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ABSTRACT

Cost-benefit analysis has proven a useful tool in evaluating public sector ventures. Due to the nuisance value accorded sludges—created to preserve water quality—public sector involvement is necessary.

One sludge disposal/reuse option being tried involves using treated sludges to reclaim strip mined land. The hope is to upgrade the land and make it fit for agricultural pursuits.

Past analyses have concentrated on evaluation of the direct costs and benefits resulting from this venture. This paper extends the tools of analysis to include indirect and intangible items.

INTRODUCTION

Sludges, which are the result of an unalterable biological process and industrial processes, are created in an effort to preserve water quality standards.[1] Negating the creation of sludges implies public health problems of enormous magnitude. Once produced, these sludges must be collected, processed, treated and disposed of or recycled as a product that has beneficial uses for man. Three media are available to receive sludges. Sludges may be dried and incinerated, a portion of the mass is burned away causing air pollution the residual forms an ash that must be disposed of or reused. A second alternative requires pipelines, railcars or

[1] The provisions of the Federal Water Pollution Control Act, Amendments of 1972, (Public Law 92-500) require treatment of wastewater. Given the present technology, this treatment results in the creation of sludges.

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trucks to transport sludges for ocean dumping. The hope in this disposal method relates to an assumption that the ocean has the assimilative capacity to "break down" the components of sludge—benefiting from the nutrient qualities and absorbing the harmful elements. The last medium for disposal or reuse is land based. Sludges may be applied to the land in various consistencies ranging from liquid to a semi solid form of humus.

One form of land based application seeks to merge two "bads" to form a "good." The "bads" in this case are sludges and strip mined land. The "good" that may result from the merger is land with the ability to support agricultural pursuits.

To date, this merger of sludges with strip-mined land has not witnessed widespread acceptance. First, the prime sludge generating areas are usually great distances from strip-mining operations. This necessitates elaborate (and expensive) transport schemes. Second, sludge as a component toward developing agriculturally sound humus meets with poor public acceptance.

Instead of using sludges to reclaim strip-mined land, commercial substances marketed as "Real Earth" and "Super Soil" are frequently used. As an example, in West Virginia, where approximately 20,000 acres of land are striped mined annually, yielding some twenty million tons of coal, the direct cost of land regrading and revegetating using these products ranges from $2,250/acre to $5,450/acre [1].

Nevertheless, one large project merging sludges and strip mined land has been in operation for a number of years. The arrangement whereby Chicago area sludges are applied to Fulton County strip-mined land has existed since 1970.

The analyses of this merger have focused on economic effects that allow relatively easy dollar quantification. Specifically, the authors have addressed such issues as crop yields at prices that generate revenues [2-4], land values and land costs [3-4], leveling and site preparation costs [2-4], sludge transport costs [2-4], local impacts in the form of a multiplier to denote increased county income [2, 3], direct costs at the sludge processing and treatment site such as sludge concentration—capital costs, operation and maintenance costs, sludge digestion—capital costs, operation and maintenance costs [4].

A common theme in these writings stresses consideration of direct costs and benefits. This paper will extend the tools of analysis to include indirect and intangible costs and benefits toward evaluation of sludge management.

COST BENEFIT AS A TOOL[2]

Cost-benefit analysis is used to assess the outcomes of pursuing alternative methods with the intent of achieving some objectives(s). In this case, we wish to

[2] The sequence of the words cost-benefit is illustrative of the phenomenon whereby the costs of a project are usually realized before the benefits. As a general source for issues surrounding cost-benefit analysis, see E. J. Mishan reference [5].

rid ourselves of sludges. It is a useful tool in assessing the likely outcomes of publicly funded projects through its ability to act as a substitute for a market environment. Profit in the cost-benefit sense accrues to society at large, or as is normally the case distributed to members of society based on spatial dimensions or group affiliations.

Cost-benefit is the efficient tool to organize information relevant to sludge management, in that public activity is necessary if sludges are to be created—thus enabling waste water treatment—and disposed of or reused. Private market solutions are lacking because sludges are not products that have value in use or value in exchange. As a product, they are regarded as a nuisance. This only means sludges encounter a marketing problem at the point of collection, processing and treatment.

COST AND BENEFIT CLASSIFICATIONS

For purposes of this discussion, costs and benefits may be classified as direct, indirect or intangible [6-8]. Direct costs are the dollar outlays to finance development and operation of a sludge treatment/reuse scheme. These dollar outlays may be regarded as opportunity costs in that the resources commanded would seek alternative uses. (Specifically, we are not assuming that labor would otherwise face chronic unemployment and/or land at the treatment site is unsuitable for alternative uses and/or capital development could not foster productivity gains in another sector of the economy.)

Direct benefits would be the dollar proceeds received from the sale of products or services generated as a result of the creation of sludges. The significance of this item is minor at best.[3] Sludge management as a public activity is predicated on the presumption that sludges have little value in use, in terms of the costs incurred to create them, and the same scant value in exchange, due to the nuisance classification applied by potential consumers.

Indirect benefits and costs arise when the property rights of an individual are affected as a result of the exercise of a sludge processing-treatment/reuse option. Indirect benefits might arise when the sludge management decision poses a beneficial impact on productivity or wealth. Indirect costs are generated in the opposite manner—the selection and manifestation of the sludge processing-treatment/reuse option poses a harmful effect on a party's ability to generate income or enjoy a stock of wealth.

Intangible items, both benefits and costs, are regarded as impacts that escape

[3] Direct benefits as cited by the National Research Council would consist of revenues from fertilizer sales, revenues from other reclaimed products, e.g., methane gas, and the proceeds from sales of land reclaimed [9, p. 127]. While the direct costs, concerning sludge management are compared for various cites [8, p. 118], no mention of quantification is extended toward direct benefits. As a consultant to this report, this lack of an estimate on direct benefits arose due to the paucity of case studies, upon which, one could derive economic data.

a pricing mechanism. These impacts upon common property resources (air and water) cannot be properly redressed by a price system, e.g., make or receive payments to offset damage or enhancement of aesthetics, and frequently defy bounding in a spatial and/or temporal sense.

The classes of costs and benefits as well as factors that serve to describe them are summarized in Table 1.

As was noted in the introduction, direct costs (and benefits) of the sludge management/strip mining reclamation scheme have been delineated by other authors. Nevertheless, as shown in Table 1, many items require consideration and evaluation to properly assess the sludge management/strip mining reclamation scheme.

The items examined will consist of indirect costs, indirect benefits, intangible costs, and intangible benefits. These items are not peculiar to the strip mining reclamation option. They are present in different magnitudes for other disposal/reuse options, hence, their delineation forms the basis for generalization.

INDIRECT COSTS

Present understanding of the economics of sludge management does not permit application of dollar values to the indirect costs and benefits. Instead, a series of functional statements are provided that describe how these items might be estimated. This provides the necessary first step towards quantification. The indirect cost items include:

1. downward shifts in the market value of land adjacent to the sludge treatment site reflecting losses in productivity;
2. the costs of government;
3. the potential health hazards created;
4. the added costs to productively use any reclaimed land.

Land Values (adjacent to sludge treatment site)

$$IC_L = f(M_t - M_{t+1})$$

Where:

IC_L = indirect cost imposed on land owners

M_t = market value before installation of sludge facility

M_{t+1} = market value after installation of sludge facility

The indirect cost surfaces under conditions when:

$$M_t = x$$

$$M_{t+1} = r(X)$$

Table 1. Summary of the Characteristics of Costs and Benefits[a]

	Direct costs/benefits	*Indirect costs/benefits*	*Intangible costs/benefits*
Valuation Standard	$ expended = opportunities foregone	$ estimates = opportunities foregone (or captured)	Physic; Amenity; Environmental; Aesthetic
Other Terms Used to Classify Items	Abatement Costs [10]	Avoidance Costs [10]; Transactions Costs [10]; Relevant Externality [11, 13]; Spillovers [9, 10]; Secondary [6]	Non-quantifiable
Method of Exchange	Two party transaction, e.g., municipality → private contractor(s)	Two party transaction induced by the parties generating direct costs/benefits, e.g., (municipality)-farmers → produce buyers	Non-Market Spillover
Unit(s) of Analysis	Tons Processed	Many; land values, crop yield, morbidity indices, etc.	Indivisible, dependent on subjective judgement, e.g., aesthetics
Items Impacting on Costs (Benefits)	State of Technology; Scale of Plant; Nature of Wastewater and Wastewater Treatment Processes; Disposal/Reuse Option Selected; Access (transport routes); Interest Rate	State of Technology; Density of Human Activities; Resource Use with "Slack" in Economy	State of Technology; Aesthetic Perceptions
Spatial Area Involved	Local Political Jurisdictions; National by Virture of Federal Construction Grants	Largely Regional—in proximity to sludge treatment, disposal/reuse site; Regional impacts not necessarily defined by political jurisdiction; National by virture of government monitoring, research, etc.; Potentially global (for example, food chain effects on health)	Most apparent in proximity to sludge treatment, disposal or reuse site; But, potentially global

[a] An earlier version of this table prepared by the author appears in *Multimedium Management of Municipal Sludge* [9].

with, $o < r < 1$ in that r expresses the extent of depreciation, where x measures constant dollar values.

In cases where market value (M_t) is "low" on a per acre basis, the value of r will approach 1; thus, the market value (M_{t+1}) will be similar to market value (M_t). This occurs when the land is not in demand or, stated another way doesn't invite bidders. The coefficient, r, becomes a smaller and smaller fraction when nuisance or neighborhood effects annoy a greater number of activities thus hindering productivity. In these cases, the market value of properties (site and improvements) adjacent to the sludge facility could be expected to plummet. This cost may be similar for any sludge disposal/reuse option. If that is the case, it would *not* effect the rankings of options on a net benefit or minimum cost basis.

Government[4]

$$IC_G = f(P,R,B,F)$$

Where:

IC_G = costs of government involvement

P = costs of policy development (information)

R = regulation costs stemming from a policy stance (enforcement)

B = administration, which includes intra and inter agency e.g., management of EPA and added costs to IRS towards support of EPA. (costs of bureaucracy)

F = capsule of other functions generating costs, such as, monitoring, research, etc. not included in P, R, or B.

The costs of government would presumably persist, in some form, regardless of the sludge disposal/reuse option selected. Nevertheless, the ends related to these costs may produce drastically different consequences. Probably, government costs most often are incurred to gain the end of compliance. Where a selected option joined sludge management to a current public "bad," the government costs would aid in producing a different end. In the case of sludge management joined to strip-mining activities, a favorable joint product—improved land value—results.

Health Hazards

$$IC_H = f(N, p_i, D_i, S_i, W)$$

Where:

IC_H = indirect costs posed by health hazards

[4] R. C. D'Arge provides a definition of policy costs relevant to water quality issues [14].

N = number of people exposed

p_i = probability of contracting illness

D_i = dollars expended for corrective treatment

S_i = severity of illness expressed as average duration, i.e., time

W = an average wage rate

The health hazard cost would be solved as follows:

$$IC_H = p_i (N) (D_i) + p_i (N) (S_i) (W)$$

Depending on the type of health complication involved, the number of individuals exposed would be a function of the population density in the sludge disposal area and/or the extent of disease transmission through food chains. Further, the indirect cost of health hazards is the sum of the costs attributable to the various illnesses arising from the infectious or toxic substances present in sludges. In the case of diseases caused by chemical toxics in sludge, grave intergenerational implications could be involved. Depending on the penetration and persistence of the toxics released in the soil, the indirect cost conceivably could arise several generations in the future when the debased land resource is cultivated. The potential for health hazard costs forces examination of the issues concerning intense application of sludges, as well as the health danger potential at the processing-treatment site.

Added Inputs to Land

$$IC_I = f(A,C,L,O,P)$$

Where:

IC_I = indirect cost of added inputs to land

A = number of acres reclaimed

C = capital costs, e.g., tractor

L = labor costs, e.g., tractor operator

O = operating costs, e.g., gasoline for tractor

P = planting costs, e.g., seed

One could reasonably expect that the variables C, L, O, and P would respond directly to the magnitude of A. Hence, the cost estimate requires a two part solution; determining first the number of acres to be reclaimed, second the resources needed to cultivate this acreage.

These costs, as stated, are in terms of the added productive inputs employed. Where excess capacity exists, in terms of available farm machinery or under and/or unemployment of unskilled and semi-skilled workers, this cost could be quite small. In certain cases, one could argue this cost arises only in terms of (O) and (P).

INDIRECT BENEFITS

The indirect benefit items include:

1. added outputs—chiefly agricultural—from reclaimed land;
2. added productivity resulting from substitution effects involving the commercial fertilizer industry;
3. appreciation of land values of parcels adjacent to the reclamation project.

Added Outputs from Reclaimed Land

$IB_L = f\,(A, Y, \$)$

Where:

IB_L = indirect benefits emanating from reclaimed land

A = size of parcel, i.e., acreage

Y = type of crop and yield per acre

\$ = prices of crops

During the early stages of the reclamation scheme the type of crops produced normally will be grain for animal feed. The value of the benefit would be found through estimating $IB_L = \Sigma\ [(Y)\ (\$_y)]$ when y applies to the varieties of crops produced and $\$_y$ corresponds to the relevant prices. The benefit becomes most attractive in that its fruition permits inclusion of strip-mining as a joint product. Because of this, the public's attitude toward strip-mining might be altered. The benefits of capturing coal as an energy source are realized, with reclamation activities acting to cancel some of the undesirable side-effects caused by the strip-mining process. This benefit is indirect in the sense that sludge collection, processing and treatment is a given and the disposal/reuse option is evaluated.

Fertilizer

$IB_F = f\,(L, C, E, A)$

Where:

IB_F = indirect benefit stemming from substituting processed sludges for manufactured fertilizers.

L = labor available for other productive pursuits

C = capital available for other productive pursuits

E = energy savings

A = land, (acreage) available for other productive pursuits

Gaining an estimate of this benefit would involve summing the four distinct benefit categories. The labor component would be solved by determining the number of workers displaced from the fertilizer industry, subtracting those which remain unemployed and multiplying that difference by the appropriate wage rate(s). The capital and land components would seek a similar solution—the focus being on *added* productivity, or more formally real gains to output.

The energy benefit component would not need to reflect resource unemployment since storage or easy transfer is possible. Hence, the benefit statement would seek to evaluate the quantity and quality of energy sources saved, forming the product via the relevant prices.

This benefit is interwoven with political overtones in that private market activity is displaced, the resources involved seeking other employment. Sludges would take the place of some commercial fertilizers, e.g., "Super Soil," "Real Earth," in aiding the reclamation of strip-mined lands. The potential political problems relate to the fact that fertilizer concerns operate in the private sector and do not have the benefit of a law-making and enforcing body as government to "push" the sludge-reclamation option.

Land values (adjacent to reclamation site)

IB_L = indirect benefit gained by landowners

M_t = market value before reclamation

M_{t+1} = market value after reclamation

The indirect benefit surfaces under conditions when:

$$M_t = X$$

$$M_{t+1} = r(X)$$

with, $r > 1$ in that r expresses the extent of appreciation—the land upgraded to a higher use in terms of productivity—X being the pecuniary measure expressed in constant dollars.

This land value argument is the converse to the condition where sludge management policies generated indirect costs. In this case, the neighborhood effects are presumed to be positive. This would occur when the results of sludge management generated an amenity. The improvement of low quality land—such as strip-mined land—through controlled application of sludges serves as the best example. This transition would presumably pose a positive neighborhood effect.

INTANGIBLE COSTS AND BENEFITS

To complete an accounting format for evaluating sludge management, recognition should be given to a group of items that are regarded as non-market. These intangible costs and benefits relate to notions of the quality of life and are non-priced. Shadow pricing will not be attempted in that these items have been conceptualized as non-market items of well-being. Imputation of money prices implies that market values can be approximated for a class of public well-being measures that are not exchanged and cannot be exchanged because they frequently are intangible, relate to common ownership (as opposed to private property rights), and/or are non-allocable in terms of a bounded spatial unit [15, pp. 302-303].

In terms of the sludge disposal/reuse options, these intangible costs surface in the form of health hazards, insults to aesthetic sensibilities, and the acquisition "costs" of the air, land and water as media for receiving sludges. Intangible benefits may arise upon exercising an option that enhances aesthetics. A major benefit to society, which is only superficially developed in this paper, results from the creation of sludges which manifests a flow of treated wastewater.

In addition to the indirect costs termed health hazards, an added health-related intangible cost may be created as a result of sludge management practices. The indirect cost was expressed as the cost of corrective treatment plus any losses in productivity. Unfortunately, corrective treatment is not applied instantaneously, and the probability of correction is not 100 per cent. In these instances, an intangible cost arises due to deficient health. It may be expressed as the non-market cost of the individual not feeling well.

The aesthetic costs arise through disruption of a natural environment. Further, these are costs only in cases where the disruption is perceived as a nuisance. Because of the difficulty in achieving public acceptance of sludge disposal, regardless of the media involved, most options are regarded as generating some sort of nuisance factor and intangible costs are incurred. It may be argued that aesthetic benefits arise from the reclamation of strip-mined land with sludge, because the reclaimed land is more appealing to the senses than the disturbances wrought by strip-mining.

Along with the aesthetic values insulted or enhanced, the acquisition costs of the air and water media may surface as intangible costs. These costs may be cumulative and intergenerational. They escape market valuations in that the media are owned in common by the nation and the world.

These quality-of-life items are summarized below in functional format to clarify their inclusion in an accounting framework that facilitates an evaluative process.

Health Hazards

$$C_{IH} = f(N, p_i, 1 - p_e, S_i, I_i)$$

Where:

C_{IH} = intangible costs of poor health

N = number of individuals exposed to the contaminant

p_i = probability of contracting illness

p_e = probability corrective treatment is effective

S_i = severity/duration of the illness, i.e., length of time in days, months, etc.

I_i = intensity of discomfort

The valuation of this cost relies on the ill persons' subjective judgements to determine S_i and I_i. The "same" discomfort would presumably be perceived differently by different people as would the length of the illness. This is in keeping with Bishop and Cicchetti, where cost is viewed in terms of the inability to allocate time in the most preferred manner [16].

In cases where corrective treatment is 100 per cent effective, the cost would then be related to the speed of medical treatment. In cases where the contaminant entered the food chain, the number of people exposed would increase.

These psychic or intangible health costs may predominate at the processing site and the reclamation site, but the entry of contaminants to the food chain could generate costs of a wider scale. By the same token, the reclamation activity may act as a health benefit in that the potential for acid seepage into waterways is prevented when the strip-mined lands are converted to crop producing acreage.

Aesthetic Costs and Benefits

$$C_{IA}\ (B_{IA}) = f\ (N, d_o, i_o, 1_o)$$

Where:

C_{IA} (B_{IA}) = intangible cost or benefit resulting from the nuisance or aesthetic enhancement

N = number of people effected

d_o = direction of opinion

i_o = intensity of opinion

1_o = length of time opinion is held, e.g., stability

Again, subjective judgements, from those benefiting or incurring costs, are necessary for any attempt at estimation. Further, direction and intensity of opinion are subject to change.

The aesthetic valuations may be either a cost or a benefit. As long as sludge is regarded as a public "bad" (nuisance), individuals subjected visually, and/or olfactorily to the nuisance are impacted unfavorably in terms of aesthetics. Frequently, a nuisance is regarded as such due to cultural transmissions. Possibilities for altering perceptions in an effort to minimize intangible costs would seem to be an important component of sludge management programs. In the strip-mining reclamation example, the benefit of upgrading the land, most certainly, (over time) outweighs the transitory nuisance of sludge applications.

Acquisition Costs and Benefits

$$C_{IE}\ (B_{IE}) = f\ (S * M)$$

$C_{IE}\ (B_{IE})$ = environmental impact

$S * M$ = interactions of sludges with receiving media determining environmental outcome.

Acquisition costs depend on the degree of impact of sludge management options on air, land, and water quality. The environmental impact could range from trivial to catastrophic. Similarily, the impact(s) could be felt for but a brief period of time, or at the other extreme persist in perpetuity.

A major social benefit, of the acquisition variety, associated with sludge management is the improvement in water quality due to wastewater treatment. The magnitude of this benefit is a function of direct expenditures. In terms of reclaiming strip-mined land the acquisition benefit may be quite "large" in that the entire environmental quality of the land is changed, and this change is perpetuated through time.

INCORPORATING INTANGIBLES IN A DISPLAY FORMAT

Admittedly, the inclusion of intangible items causes counting problems. One solution calls for reference to intangibles as social factors and applying subjective weights corresponding to the magnitude of environmental/aesthetic disruption [17, pp. 98-99].

A second opinion describes four ways of valuing intangibles [18, pp. 173-175]:

1. dollar values applied by experts,
2. opinion polling of laymen,
3. formulate a range of dollar values,
4. disregard.

The problem is similar to the equity issue, which for some time was dismissed as an area upon which cost-benefit analysis is silent. The equity issue was accommodated in cost-benefit analysis via a display format [19]. Specifically,

Table 2. Decision-Matrix

Alternatives	*Direct benefits*	*Direct costs*	*Indirect benefits*	*Indirect costs*	*Intangible benefits*	*Intangible costs*
I	DB_I	DC_I	IB_I	IC_I	$B_{i,I}$	$C_{i,I}$
II	DB_{II}	DC_{II}	IB_{II}	IC_{II}	$B_{i,II}$	$C_{i,II}$
III	DB_{III}	DC_{III}	IB_{III}	IC_{III}	$B_{i,III}$	$C_{i,III}$

the analyst need not define equity, instead the analyst should provide a cost-benefit format capable of displaying equity concerns.

This type of strategy works well in displaying intangible items. The various alternatives may be ranked using dollar values, with the intangibles receiving implicit weight in the decision making process. The matrix shown in Table 2 may help to clarify this point.

Alternatives would correspond to the sludge disposal/reuse options available, e.g., application to strip-mined land, ocean dumping, drying and incineration, etc. The DB, DC, IB, IC, would correspond to the direct and indirect benefits and costs arising from exercising the various options. These items would have money values. Intangibles (B_i, C_i) would be described. The implicit values accorded intangibles would be determined through comparisons. For example, if $\Sigma[(DB_I + IB_I) - (DC_I + IC_I)] > \Sigma[(DB_{II} + IB_{II}) - (DC_{II} + IC_{II})]$ but option II is preferred: it follows the difference in intangible items, emanating from the exercise of the options under consideration, is weighted enough to, at the least, equate the benefit minus cost comparisons.

In terms of equations: If,

$$\Sigma[(DB_I + IB_I) - (DC_I + IC_I)] > \Sigma[(DB_{II} + IB_{II}) - (DC_{II} + IC_{II})].$$

and alternative II is preferred.

Then,

$$\Sigma[(B_{i,I} - C_{i,I}) - (B_{i,II} - C_{i,II})] < 0$$

And,

$$\Sigma[(DB_I + IB_I + B_{i,I}) - (DC_I + IC_I + C_{i,I})] < \Sigma[(DB_{II} + IB_{II} + B_{i,II}) - (DC_{II} + IC_{II} + C_{i,II})]$$

The equations depict the situation where the alternatives yield positive net benefits. A cost minimization procedure would use the same information with the appropriate sign changes.

The point of this format exercise is to show how intangibles may be integrated in a cost-benefit analysis. It does little good to state cost-benefit, with its genesis in welfare economics, speaks to efficiency concerns and all else may go by the boards. The public economy contains a raft of issues debated across criteria lines, e.g., efficiency, equity, effectiveness, etc., with trade-offs apparent toward meeting these diverse standards. Admittedly, cost-benefit is best suited for efficiency concerns. Nevertheless, through format adaptation variables that cannot be valued at efficiency standards (i.e., money values), may be included in the analysis. This forms a more complete management information system.

CONCLUSION

The Chicago-Fulton County project has been in operation since 1970, this appears to be a sufficient time for direct benefits and costs to take on a stable character and for some indirect and intangibles to have surfaced. At the least, such items as land values, added inputs and outputs from (to) the land, substitution effects resulting from displacing commercial fertilizers, could be "priced-out;" albeit only in terms of the single case study. These items would be merged with the data on direct benefits and costs. Should this preliminary analysis signal a net benefit advantage with imposition of some target discount rate other ventures should be initiated.

Similar cost-benefit data could be gathered for other sludge disposal options, i.e., air and water as the receiving media. Comparisons could be made with use of a series of discount rates to promote sensitivity analysis. Intangible items would be entered into the comparison framework at the decision making point.

The object is to form a sludge management strategy. Assessment of total costs and benefits acts to guide choice. This methodology allows for the analysis of activities at the margin whereby a decision point is reached regarding the disposition of the n, n + 1, n + 2. . . . n + k ton of sludges. This strategy focuses actions toward maximization of benefits or minimization of costs through a systems framework.

REFERENCES

1. J. Strum, unpublished data, West Virginia Surface Mining and Reclamation Association, Charleston, West Virginia, 1976.
2. W. D. Seitz and E. R. Swanson, Economic Aspects of Application of Municipal Wastes to Agricultural Land, *Recycling Municipal Sludges and Effluents on Land,* National Association of State Universities and Land Grant Colleges, Washington, D.C., 1973.
3. M. Hogan, An Economic Simulation Analysis of the Use of Digested Sludge to Reclaim Strip-Mined Land, unpublished M.S. thesis, University of Illinois, Urbana, Illinois, 1972.
4. F. E. Dalton and R. R. Murphy, Land Disposal IV: Reclamation and Recycle, *Journal WPCF, 45:*7, pp. 1489-1507, 1973.
5. E. J. Mishan, *Cost-Benefit Analysis,* Praeger, New York, 1971.

6. A. R. Prest and R. Turvey, Cost-Benefit Analysis: A Survey, *The Economic Journal, 75:*300, pp. 683-735, 1965.
7. H. M. Peskin and E. Seskin, Introduction and Overview, *Cost-Benefit Analysis and Water Pollution Policy,* H. M. Peskin and E. Seskin, (Eds.), The Urban Institute, Washington, D.C., 1975.
8. R. H. Haveman and B. A. Weisbord, The Concept of Benefits in Cost-Benefit Analysis: With Emphasis on Water Pollution Control Activities, *Cost-Benefit Analysis and Water Pollution Policy,* H. M. Peskin and E. Seskin, (Eds.), The Urban Institute, Washington, D.C., 1975.
9. National Research Council, *Multimedium Management of Municipal Sludge,* National Academy of Science, Washington, D.C., p. 127, 1977.
10. Council on Environmental Quality, *Environmental Quality: The Sixth Report of the Council on Environmental Quality,* U.S. Government Printing Office, Washington, D.C., 1975.
11. R. Bish, *The Public Economy of Metropolitan Areas,* Markham Publishing Co., Chicago, Illinois, 1971.
12. R. N. McKean, *Efficiency in Government Through Systems Analysis: With Emphasis on Water Resources Development,* John Wiley, New York, 1958.
13. J. M. Buchanan and W. C. Stubblebine, Externality, *Economica, 29:*Nov., pp. 371-384, 1962.
14. R. C. D'Arge, Environmental Policy Costs: Definition, Measurement, and Conjecture, *Cost-Benefit Analysis and Water Pollution Policy,* H. M. Peskin and E. Seskin, (Eds.), The Urban Institute, Washington, D.C., 1975.
15. F. G. Muller, Benefit Cost Analysis: A Questionable Part of Environmental Decisioning, *Journal of Environmental Systems, 4:*4, pp. 299-307, 1974.
16. J. Bishop and C. Cicchetti, Some Institutional and Conceptual Thoughts on the Measurement of Indirect and Intangible Benefits and Costs, *Cost Benefit Analysis and Water Pollution Policy,* H. M. Peskin and E. Seskin, (Eds.), The Urban Institute, Washington, D.C., 1975.
17. R. B. Wenger and C. R. Rhyner, Evaluation of Alternatives for Solid Waste Systems, *Journal of Environmental Systems, 2:*2, pp. 89-108, 1972.
18. D. Hill, Cost Benefit Analysis of Alaskan Development and Conservation, *Journal of Environmental Systems, 1:*2, pp. 161-181, 1971.
19. M. C. McGuire and H. A. Garn, The Integration of Equity and Efficiency Criteria in Public Project Selection, *The Economic Journal, 79:*316, pp. 882-893, 1969.

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