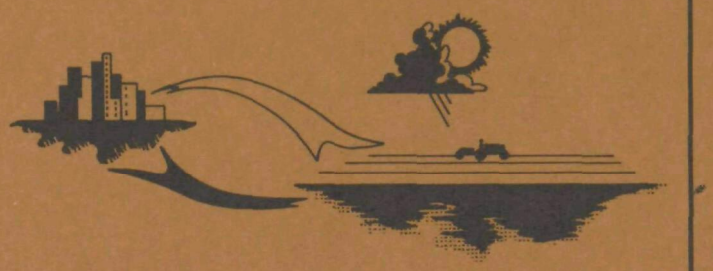
METRO DENVER SLUDGE MANAGEMENT PLAN



DRAFT EIS

MAY 1976

U.S. ENVIRONMENTAL PROTECTION AGENCY

SUMMARY

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DRAFT

ENVIRONMENTAL IMPACT STATEMENT

on

MANAGEMENT PLAN FOR WASTEWATER SLUDGE
BY METROPOLITAN DENVER SEWAGE DISPOSAL DISTRICT NO. 1
DENVER, COLORADO

by

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION VIII, DENVER

May 1976

Approved by: John A. Green
Regional Administrator

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SUMMARY

WHY THIS E.I.S.?

In 1969 a law of far-reaching significance for Federal agencies was passed by Congress. This law, called the National Environmental Policy Act (and referred to as NEPA), requires a Federal agency to take account of and make known the environmental impacts of any major action it is about to undertake. The agency must decide whether a given action is a major one that will have a significant effect on the environment. The document that a Federal agency must prepare on such a major action is called an environmental impact statement (the EIS).

EPA and NEPA--the difference

The Environmental Protection Agency (EPA) is responsible for seeing to it that many of the environmental laws passed by Congress are put into effect; however, it is also one among many Federal agencies which must also comply with NEPA in its own actions. The action EPA could take in this case is the approval of a plan by the Metropolitan Denver Sewage Disposal District No. 1 or 'Metro' to design and construct a sludge processing and disposal system in Adams County.

Under the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500), EPA is responsible for approving such plans for water pollution control improvements of municipal sewage treatment systems. As part of this law, Congress set aside $18 billion for design and construction of facilities, which EPA has the responsibility for distributing. Should this plan be approved for funding, 75 percent of the eligible portion of the project could be paid for with a Federal grant.

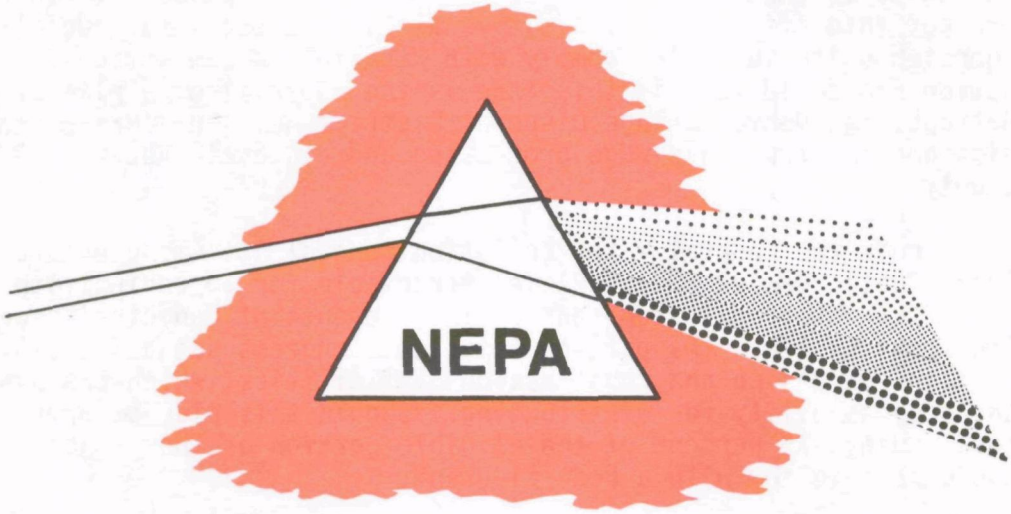
EPA decided that the proposed Metro project involved significant environmental impacts, and therefore has written this environmental impact statement. The National Environmental Policy Act requires a thorough review of the EIS by other Federal agencies, State agencies, local governments and interested citizens. The idea is to get the benefit of expertise both of other agencies and of citizens, as well as to inform the public of what is about to take place. The EPA must carefully weigh the comments it receives before any final action can be taken.

This version of the EIS is a draft for your consideration; a final EIS will be prepared and circulated after comments have been received on the draft. No action will be taken in approving this facility plan until thirty days following the release of the final EIS.

The Draft EIS

The EIS outlines in detail the proposed design of the project. This includes the location, alternatives to the project as a whole or to parts of the project, and the environmental effects of what is planned, as well as the likely impacts of alternative options to the plan.

The discussion of environmental impacts includes both direct and indirect impacts to the extent that they can be predicted. NEPA requires disclosure of impacts of an irreversible or long-lasting nature. A very important feature of the impact statement is its attempt to propose ways to lessen the negative impacts identified. These methods are known as "Mitigative Measures."



It should be made clear that the term "environment," as used

in the National Environmental Policy Act, is very broad; it applies to people and social institutions as well as the biological and physical world.

The Facilities Plan

Because of problems with its present sludge disposal system, the Metro District has developed a plan to dispose of its sludge by recycling it to the land. Formally, the plan is called a facilities plan under Public Law 92-500. A mechanism for parcelling grant monies was developed whereby an applicant such as Metro, after having been given priority standing by the State, would develop and submit a facilities plan. This is known as STEP I. This plan must meet State water quality goals as well as the Congressionally ordered goals (viz., wherever possible, the nation's streams would become fishable and swimmable, maximum recycling of resources, etc.). EPA has also developed, in its construction grant regulations, a fairly lengthy list of what other information must be presented in a facilities plan. Among these requirements is an environmental assessment that helps EPA to decide upon the environmental importance of the project. It is only after EPA has fulfilled its obligation under the National Environmental Policy Act that STEP II funds can be awarded for design. After the State has approved these design plans, a STEP III construction grant can be made.

THE PROBLEM AND THE PLAN

Metropolitan Denver Sewage Disposal District No. 1 (Metro) provides sewage treatment for most of the Denver metropolitan area. It is a District with 52 member sanitation districts in and around Denver. The main treatment plant is located on the South Platte River at Commerce City, as shown on Figure A.

What is Sludge?

The Metro's (wastewater treatment) facility must dispose of on the average over 100 dry tons of sludge per day. Sludge is the mixture of water and solid materials found in sewage that is removed from wastewater in the process of purifying it. Sludge contains water, the organic matter of human wastes, paper, some oils and grease, traces of heavy metals and other elements, and some salts. Sludge also contains those critical nutrients--nitrogen, phosphate and potassium--in quantities similar to commercial fertilizers. Table A below indicates the relative amounts of these three constituents in Metro sludge, other natural fertilizer sources and commercial fertilizer.

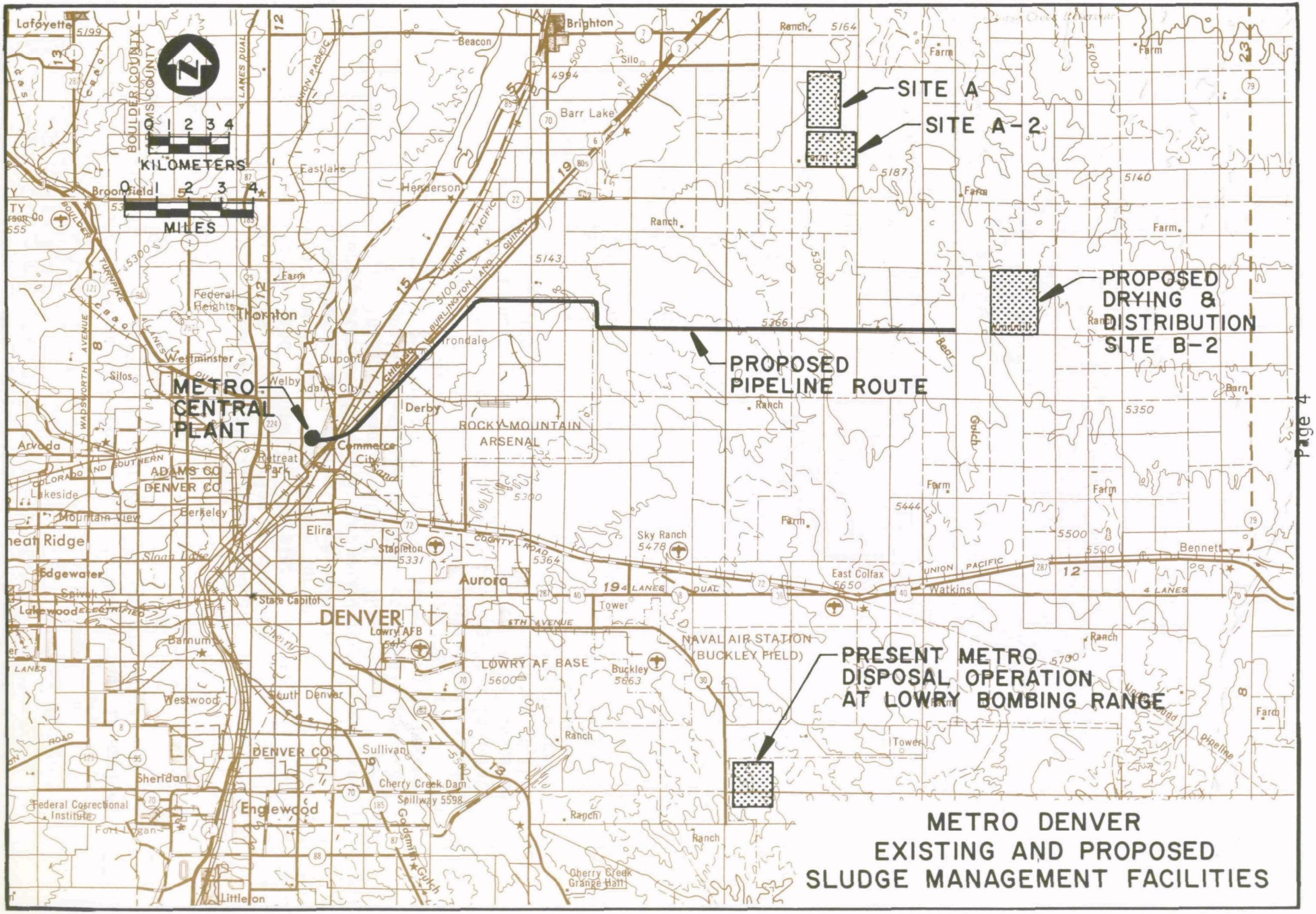


FIGURE A

METRO DENVER
EXISTING AND PROPOSED
SLUDGE MANAGEMENT FACILITIES

Table A. CONCENTRATIONS OF MAJOR PLANT NUTRIENTS IN SLUDGE AND OTHER FERTILIZER SOURCES

(percent of dry weight)

Fertilizer	Total nitrogen (N)	Total phosphoric acid (P_2O_5)	Acid-soluble potassium (K_2O)
Metro digested sludge	3.0 to 4.0	2.3 to 3.4	0.7 to 1.4
Ammonium sulfate	20.5	-	-
Anhydrous ammonia	82.0		
Urea	38.0		
Farm manure	1.2	1.2	1.2
Chicken manure	4.1	3.7	2.3
Cottonseed meal	7.0	2.5	1.5

Source: Metro Denver District Sludge Management, Volume III, Table 7-2.

Sludge produced in the course of the wastewater treatment processes is collected in primary and secondary settling tanks (clarifiers). At the present time, Metro sludge is a mixture of primary sludge (30 percent of the total) and secondary, waste-activated sludge (58 percent of the total) from the Central Plant plus primary digested sludge (12 percent of the total) from the City of Denver's North Side plant. Thus, the currently produced sludge is composed of 88 percent undigested sludge.

Raw primary sludge is that sludge which settles out when sewage is first brought into settling tanks at the Central Plant. Waste-activated sludge is produced when the sewage is brought into contact with air and microorganisms. Much of the original material in the sewage is converted into a living cell mass by this process. These two types of sludge are highly odorous and have a high energy content. In both types of sludge it is extremely difficult to separate the solid matter from the water in the sludge.

Anaerobically digested sludge is produced in large, covered tanks using self-sustaining, slow microbial combustion process that reduces the energy content of primary and secondary waste-activated sludge, as well as to break down the more complex, odorous compounds in the sludge. What is left is a relatively inert, dark

material, rich in nitrogen, phosphate, and trace elements. Anaerobic digestion generally performs in short time the natural breakdown of complicated organic material that is continually occurring in nature.

Metro's Current Sludge Operation

The District now handles the sludge produced at the two plants by first chemically treating it to reduce possible harmful bacteria and other organisms and to make it possible to remove greater amounts of water from the sludge. The sludge is "de-watered" and then hauled by truck to a part of the Lowry Bombing Range area that is leased by the City and County of Denver for solid waste disposal, shown on Figure A. There, it is spread over the surface of the land and disc-plowed into the topsoil after some air drying has taken place.

Although this method of disposal has shown some positive benefits (such as improved forage for cattle), there are a number of outstanding problems with the present system:

First, the present sludge mixture is not of the proper type for land recycling. Metro must use large doses of lime and ferric chloride to disinfect the raw and primary sludge, to control odors, and to dewater the sludge. This is expensive and adds large amounts of chemicals (up to 30 percent of the dry weight of the sludge) to the soil, with no benefit. Furthermore, odors from these sludges are difficult to control.

Second, the amounts of sludge now spread on the Lowry Bombing Range are great enough to cause concern about eventual effects on the groundwater. The loading rates are excessive for the purpose of using the sludge's nutrients on this kind of land in Denver's semi-arid climate, given the limited area where sludge can now be spread.

Third, Metro's existing sludge treatment and disposal system is nearing its capacity in some units. Funds will have to be granted either to expand the present system or to find another alternative.

Finally, the system is expensive and highly energy-consuming. Metro would like to cut operating costs while at the same time trying to find a way to use the nutrients and soil-building potential of the sludge.

Metro's Sludge Recycling Plans

With the above problems in mind, Metro began searching for a method of disposing of its sludge in a way that it could be of use on agricultural lands. Metro originally proposed a system of spraying sludge on dryland farming areas to the northeast of Denver in Adams County. The lands would have either been owned outright and farmed by Metro or leased back to local farmers. This system, however, was highly criticized by the local farming community because of the high loading rates suggested for dryland farming. Farmers were also not happy with the prospect of having Metro as a governmental competitor in the farming business. Fears were also expressed about odors and the loss of land values around the site.

The Metro District then reviewed its original plans with its engineering consultant, Cornell, Howland, Hayes, and Merryfield and Hill (CH2M-Hill for short), and came up with a more flexible plan for recycling sludge to the land. Instead of getting into the farming business itself, Metro now proposes in their facilities plan to build a drying, storage and distributing center in the same general area it had proposed for the spraying/farming operation. After the sludge has been pumped and dried at the site, the sludge could then be sold at some reasonable charge to metropolitan area users. The system would take advantage of plentiful solar heat to dry the sludge.

Features of the Metro Proposal--

Anaerobic Digesters--At the Metro Central Plant, the system would make use of new anaerobic digesters. These digesters are an essential part of any land application plan for sludge. They allow sewage solid material to be fermented in an air-free environment for a period of 22 days on the average, resulting in a stabilized, and relatively odor-free sludge.

This product then, is the material that would be pumped some 22 miles by pipeline to the drying/storage site. At this time, the only operating digesters in the Metro system are at the Denver Northside Plant about a mile upstream of the Central Plant. Its sludge accounts for only a small percentage of Metro's total sludge to be disposed of. Metro is responsible for further processing and disposal of this sludge. It may be of interest to note that at present, Metro is dewatering this sludge separately from the rest of Metro's sludge. The Denver Parks Department wishes to use this sludge on parklands, and Metro is storing and drying this sludge in a small area of the Lowry Bombing Range for use by the Parks Department.

Recently, EPA gave the Metro District a construction grant to build enough anaerobic digesters to handle all of Metro's present and projected sludge loads to 1985. The grant was given with the understanding that EPA would not be committed to approval of any final method of disposal of the sludge. It was expected that the anaerobic digesters would be beneficial to the Metro system no matter what type of final disposal was selected. Some disposal alternatives (such as incineration) might operate better without digestion, but enough options would still remain available for disposal to permit such a grant. Thus, for all practical purposes, anaerobic digestion of sludge must be considered a part of any future sludge handling plans.

Sludge Transport--The liquid digested sludge would be pumped from the Central Plant through two pipelines, using two pumping stations (at the Plant and midway), to the sludge drying, storage and distribution center 22 miles east of the Central Plant in Adams County.

Sludge Drying, Storage and Distribution--Metro's proposed system calls for a site in western Adams County in Range 64 West, Township 2 South, comprising Sections 16 and 21 and the western halves of Sections 15 and 22. This site is known as B-2, as shown on Figure A. Sludge would be air dried in unlined earthen basins for about six months. Then it would be scraped and stockpiled for another six months prior to shipment for reuse.

The site would include 600 acres of drying basins within its total 2,000-acre area. Two impoundments are planned for capturing all surface runoff from the site. A smaller area would be used to stockpile the dried sludge on the land surface. A variety of research and demonstration plots would surround the drying area, as shown on Figure 3 in the body of the EIS. Metro also plans to use the site for emergency disposal of the dried or liquid sludge, if necessary.

Land Application of Sludge--The heart of the proposal is to provide Metro dried sludge to willing users in the entire metropolitan area. Metro has indicated that potential areas of use include irrigated farms, dryland farms, sod farms, Denver parks and other metropolitan parks, and mine spoil areas. Metro has also received a considerable number of letters from individual home owners who would like to use the sludge on home gardens and lawns. Other possible candidates include a company interested in bagging and marketing dried sludge fortified with additional fertilizer nutrients. Another company proposes to utilize sludge and garbage as a fuel source for a coal gasification plant. To a great extent, the success of Metro's proposal will depend on the ability to develop a market for the sludge.

AREA IN FOREGROUND RECEIVED SLUDGE

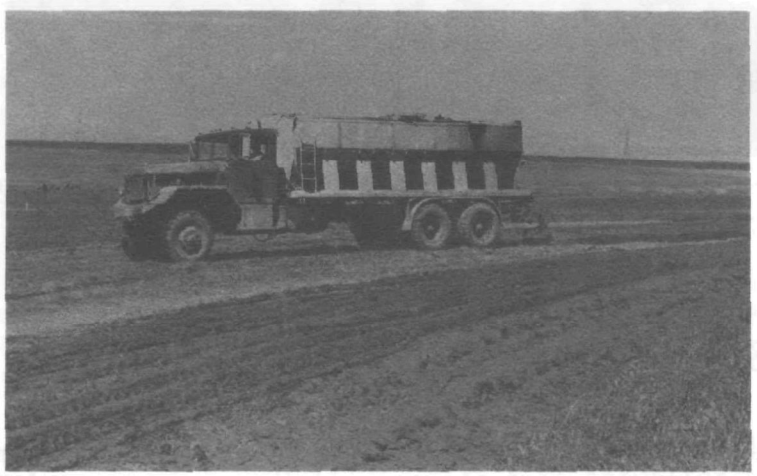
THE ANALYSIS IN THIS E.I.S.

The National Environmental Policy Act requires that an EIS evaluate the following five items: (1) the environmental impact of the action, (2) alternatives, (3) adverse impacts that cannot be mitigated, (4) irreversible and irretrievable committments and (5) short-range versus long-term resource tradeoffs. Because EPA has been given the responsibility by Congress to develop overall pollution control approaches to wastewater treatment (including sludge treatment and disposal), EPA is also very much interested in seeing that the best possible methods are incorporated into sludge processing and disposal projects. EPA has generally endorsed the idea of recycling waste materials wherever it is cost-effective and environmentally suitable. This includes making use of the nutrient and soil-building benefits in municipal sludge.

EPA is also aware of the myriad problem areas in applying this general concept to a particular situation. Denver's case, for example, requires a close look at the peculiarities of climate, soils, water availability, the groundwater situation, health effects, system design and a host of other factors. All environmental areas--biological, cultural and physical--must be considered and protected

in evaluating such a proposed system. EPA considers impacts occurring "offsite," that is, where the sludge will ultimately be applied, to be of critical importance. Factors such as loading rates, the condition of the sludge, what the uses of the land are and how well control will be exercised over areas receiving the sludge are important in deciding the overall merit of the proposal. The EIS is EPA'S tool for evaluating these areas of concern on a site-specific level.

In preparing this draft environmental impact statement, EPA hired an environmental consultant to help evaluate the project.

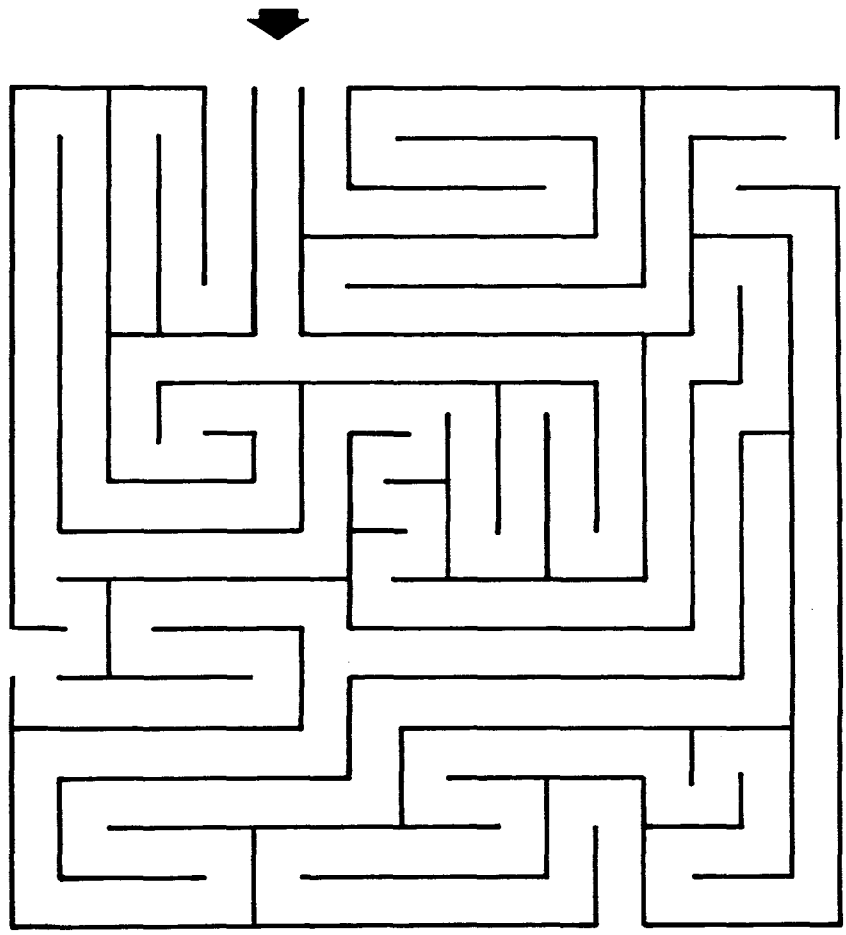


The work of the consultant, Engineering-Science, was closely managed by the EPA Region VIII staff in the preparation of the EIS. The consultant was charged with the following tasks: (1) to review and evaluate the work done by the Metro District and its engineering consultant, CH2M-Hill, (2) to evaluate Metro's tentative proposals for use of the sludge in six areas--irrigated farms, dryland farms, sod farms, mine-spoil areas, parklands and home gardens and (3) to develop its recommendations for any measures it felt were needed to protect any and all environmental areas. The environmental consultant evaluated the costs of 17 different sludge treatment and disposal systems and compared them for environmental and engineering tradeoffs.

EPA specifically asked the consultant to evaluate the two most likely alternatives to Metro's proposal: continuation of the existing system at Lowry and the combination of Metro's sludge

with a Denver solid waste recycling system under study by the Denver Regional Council of Governments (DRCOG). The latter involved possible use of sludge with solid waste in the Denver area for supplementary fuel or for production of synthetic gas.

THE ALTERNATIVES



The EIS considers both entirely new sludge treatment and disposal systems as well as options within the basic Metro plan, as alternatives. These subsystem options include changes in site location, sizing, and drying-basin design.

Alternatives to the Overall Metro Plan

EPA first reviewed the work that had been done by others in developing overall system alternatives. Metro had considered three basic options in its 1972 Predesign Study: the present disposal system at Lowry, incineration, and a form of land recycling using sludge spraying equipment. CH2M-Hill performed a more detailed evaulation of sludge processing and disposal alternatives in Volume II of the facilities plan. Eight systems were selected for detailed comparison, including the present system, the proposed drying/distribution method, composting, the use of heat treatment technology and incineration. Engineering-Science was asked to evaluate combined solid waste-sludge systems, the eight facilities plan alternatives and additional feasible systems.

The solid waste-sludge combination seemed promising at first, but the recent defeat in the State legislature of a bill to provide funding for such a system has made this option much less realistic. To a great extent, the compatibility of the two wastes would depend on the system eventually selected by DRCOG. For example, sludge would not fit well with the use of solid wastes for supplemental fuel; however, a combination composting system could use sludge fairly well.

CH2M-Hill and Engineering-Science both concluded that the Metro overall proposal was probably the most economical for Metro and likely the best overall system. Engineering-Science's cost evaluation is found in Appendix A of the EIS.

EPA prepared its own general comparative evaluation, using environmental, engineering and economic criteria, for this EIS. This evaluation, presented in Section II and summarized in Table 2, includes general sludge disposal options; EPA feels that the ultimate disposal choice in the overall sludge processing system has the most important environmental implications. EPA likewise concludes from an overall standpoint that the land recycling approach is generally preferable to other alternatives, for the Metro situation.

EPA decided that two basic alternatives should be considered further and evaluated in detail: Metro's proposed system and the existing Lowry system. The latter must be considered further because it is an ongoing system, and future changes to the system might make it more economical and environmentally less damaging. At present, there are no Federal funds available for construction of the proposed Metro system. Therefore, Metro might have to continue to use the Lowry area for a number of years.

Alternatives to Portions of the Metro Plan

The EIS evaluates possible alternatives within these two systems. In the Metro proposal, alternative sites for the sludge drying and distribution center were evaluated. EPA reviewed the comparisons of 11 sites in a 1973 study developing the agricultural reuse program. EPA also reviewed the evaluation of three sites selected by Metro for more intensive consideration in the facilities plan. In Section II, a discussion of other suggested sites is presented, including areas at the Lowry Bombing Range, the Rocky Mountain Arsenal and areas to the north of the South Platte River. Part of the assignment of Engineering-Science was to evaluate the site location from the standpoint of costs and energy requirements for hauling sludge by truck to possible sludge reuse areas.

It appears that the proposed site B-2 shown in Figure A is a reasonable choice for a sludge drying and distribution center. No one site appears to be completely favorable when all factors (such as nearness to markets, elevation, soils, nearness of human habitation, land values, etc.) are considered. It is perhaps more important, from an environmental viewpoint, to design correctly for the site-specific conditions, whatever the site chosen. It is somewhat distressing, however, that little soils and groundwater information is available for proper evaluation of site differences and impacts.

Other subsystem alternatives considered for the Metro system are: digestion, conditioning, transportation of the sludge, drying basin design, controls at land application sites and the sizing of the system. Anaerobic, mesophilic digestion appears to be the only realistic conditioning alternative at this point. Furthermore, there appears to be little problem with the choice of pipeline route or pipeline design selected.

Design of the drying basins may need to be changed if a danger to groundwater quality exists. The design could also be modified if salts are a problem or if longer drying times are needed. Metro will have to demonstrate that there will be no groundwater problem with its proposal.

In order to control the amounts of some heavy metals in the sludge, Metro might be required to institute some control over discharges into the sewer system. The most critical need for control would likely involve discharges of cadmium into the system.

The question of who should be allowed to use the sludge will be an important one from a public health standpoint. Either restrictions could be placed on the types of users, or the system design

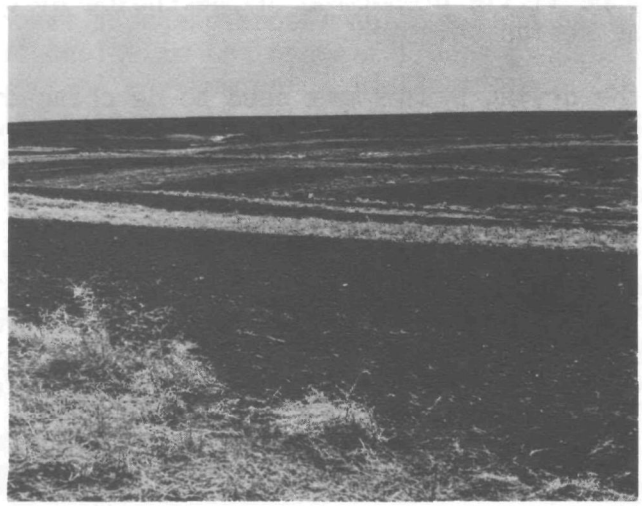
could be changed to produce a sludge so benign as to allow for the whole range of possible users, without any potential health hazard.

System Capacity--

EPA considered a change in the design capacity of the project. The project was originally designed for a growth rate considerably greater than the present rate. Furthermore, the sizing appears to be out of line with DRCOG desirable population growth limits for the metropolitan Denver region. However, EPA has decided not to require a change in the system capacity at this point, for two reasons: (1) the greater capacity would be useful for a longer period of time and might be needed if longer drying and storage times became necessary for pathogen reduction, and (2) the effect on secondary impacts (air pollution and land use from new populations) is only very distantly related to sludge handling subsystems. A more definite control can be put on the wastewater treatment facilities in their drainage basin population sizing.

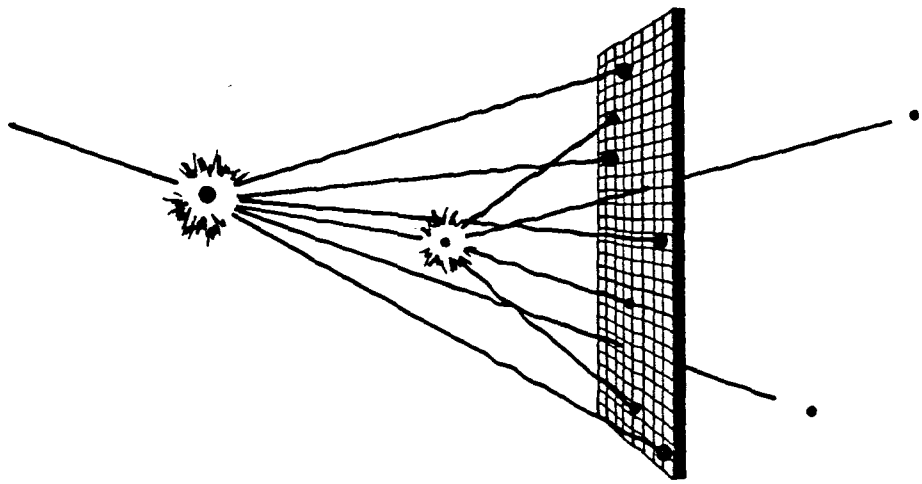
Lowry Disposal System Modification

Alternatives to the present Lowry system are described in the EIS. Metro's new anaerobic digesters will change the type of sludge being applied to the Bombing Range. Some form of composting/drying and storage could be instituted at Lowry to allow eventual reuse of some or all of the sludge. It is possible that more land could be acquired at the Bombing Range to improve the soils and vegetation without accumulating excess metals in the soils or nitrates in the groundwater reservoir.



SLUDGE APPLIED TO LOWRY BOMBING RANGE

POTENTIAL IMPACTS, MITIGATING MEASURES, UNAVOIDABLE EFFECTS AND LONG-TERM IMPLICATIONS



The evaluation of environmental impacts is carried out in this EIS in the following way. A description of potential positive and negative impacts from the proposed Metro system is provided. Wherever possible, impacts are quantified with reasonable basic assumptions regarding the system and prevailing conditions. Where quantification is difficult due to lack of basic data or an imprecise state of knowledge, ranges of possible impacts or qualitative statements of impacts are made. In all cases, thresholds of significance for impacts are determined from the experience of the professionals on the environmental team and from knowledge of local conditions.

Mitigative measures are developed for reducing the severity of impacts. Section VII is devoted to a listing of negative or adverse effects that cannot be avoided and of the long-term implications of the proposal.

The EIS looks at three basic areas in analyzing the environmental impacts: Metro's proposed system, including digesters, pipeline, site and drying/processing/storage facilities; off-site areas where the sludge is likely to be applied; and the part of the Lowry Bombing Range containing the existing Metro sludge processing system. Schematic representations of impacts in these three basic areas of concern are presented in Figures 16, 17 and 18 in the main text.

Table B provides a rough summary of the major impacts expected from the proposed Metro system and the existing Lowry operation, divided into the same three basic areas. This table also summarizes possible mitigating measures and those adverse effects that cannot be lessened.

Table B. SUMMARY OF MAJOR POTENTIAL IMPACTS, MITIGATION MEASURES AND UNAVOIDABLE EFFECTS

Environmental parameter	Impact	Importance	Severity of impact	Mitigation[a] Feasibility	Mitigation[a] Methods	Unavoidable effects[a]
			Sludge Drying, Storage and Distribution Site			
Soil/land	Destruction of profile	moderate	Confined to site, severe	-	NA	Elimination of agriculture in the site; destruction of wildlife habitat
Groundwater	Nitrate and salt contamination	high	Potentially severe	+	(1) Line basins; (2) Remove decant; (3) Collect drainage; (4) Promote anaerobic conditions	Mitigation will increase project cost
Water quantities	Removal from South Platte	minor	moderate	P	(1) Avoid irrigation; (2) Return water	
Air quality	Odor generation; particulates	negligible	Negligible except with digester upset; particulates in severe wind	P	(1) Bury sour digester contents elsewhere; (2) Keep stockpiles moist	Minor odors on calm days; some particulate dispersal in severe winds
Public health	Pathogen survival and vector proliferation; airborne particles	high	Low, except with loss of control	+	(1) Medical attention; (2) Insect control	none
Energy use	beneficial	moderate		NA	NA	NA
Nutrient resources	beneficial	high		NA	NA	NA
			Sludge Application Areas			
Food chain	Magnification of heavy metals, especially cadmium	high	Low under strict controls	+	(1) Limit sites, crops, users, rates; (2) Control heavy metals at source	Heavy metals contamination in soils; exposure of burrowing animals to toxic elements
Public health	Pathogen survival, especially *Ascaris*	high	Low on sod farms, high on home gardens	+	(1) Restrict use of sludge; (2) Longer drying, storage; (3) Medical attention	Possible mismanagement of the sludge reuse
Water quality	Nitrate and salt concentration	high	Minor on drylands, severe on others	-	NA	Long-term cumulative effect in entire region
Soil productivity	beneficial	high		NA	NA	NA
Soil salinity	adverse	moderate	High on dryland farms only	-	NA	Long-term cumulative effect in dry farms

Plant nutrition	beneficial	moderate		NA	NA	NA
Energy use	Fuel requirement for trucking	moderate	Lower than present operations	+	Develop markets in vicinity of site	Moderate fuel consumption
			Lowry Bombing Range Existing Operations			
Food chain	Domestic animals grazing on sludge-amended fields	high	potentially severe	+	(1) Restrict grazing; (2) Control heavy metals at source	Heavy metals accumulation in soils
Public health	Exposure of people in parks and home gardens to pathogens	very high	potentially severe	+	(1) Longer drying time; (2) Medical attention	
Soil productivity	beneficial	low		NA	NA	NA
Soil salinity	Salt buildup in root zone	moderate	moderate	P	(1) Remove decant, (2) Spread over larger areas and lower the loading rates	Gradual salt buildup in the region
Groundwater quality	Nitrate pollution, salt increase	high	Low to potentially severe	-	NA	Groundwater pollution in irrigated farms
Air quality	Odors	low	Low except with digester upsets	+	(1) Source control of toxic materials; (2) Optimal operation of digesters; (3) Burial of sour digester sludge	Complaints from neighboring areas
Energy	Use of large amounts of fuel for transport	moderate	high	+	(1) Use of anaerobic sludge reduces total load, produces gas	Loss of energy; resources wasted
Chemicals resources	Use of conditioning chemicals (ferric chloride and lime)	moderate	high	+	Use of anaerobic digesters	

[a]The symbol + indicates totally feasible; - indicates infeasible; P indicates feasible in part; NA indicates not applicable.

Sludge Drying and Distribution Site

The most serious negative environmental impacts at the sludge drying and distribution center are on soil properties, groundwater quality and the public health through nitrate pollution of groundwater and pathogen problems. Positive impacts are energy and resource conservation. Other impacts will occur to downstream water users because of increased consumption of water; minor impacts will also be felt from occasional odors. Very little mitigation of the soil destruction is possible; groundwater effects and exposure of the public to pathogens can be controlled with proper measures as shown in Table B.

Land application Areas

Land application areas hold both the greatest promise for benefits as well as the greatest amount of potential detrimental impact from sludge application. On the positive side, the Metro proposal would lessen overall energy use--in comparison with commercial fertilizers, which require energy for their production--by taking advantage of solar heat in the drying process. A beneficial effect is expected on the soil structure and moisture-holding capacity of the soil as a result of sludge application. Properly applied, the nutrients in sludge can replace commercial fertilizers. Sludge nitrogen is also of the slow-release form that would be available to plants over a number of years, somewhat in harmony with plant needs.

The principal negative features of the application of sludge on farms and gardens are keyed to the specific kind of land use involved. Dryland farms have different (lower) requirements for amounts of nutrients and sludge from those of irrigated areas. Exposure to pathogens will differ greatly, depending on whether sludge is applied to farmland or to city parks and home gardens.

The principal areas of concern in applying sludge to lands on which various kinds of crops for human use are grown would be: nutrient loadings, toxic or plant-inhibiting effects of heavy metals, salt accumulation in the soil profile and food-chain effects (the gradual buildup of trace elements in plants and animals or in humans consuming the plants and specific organs of the animals). Other concerns involve effects on groundwater and runoff effects on water quality. The latter are not considered very significant overall because of the projected recommended loading rates considered for this semi-arid area.

Each of the above problem areas can be mitigated to a large extent, either by controlling how much sludge is applied and where it is applied or by source control of heavy metals and greater treat-

ment at the Metro facility. Such measures will require greater managerial control by the Metro District as to the final disposition of sludge. Currently, legislation is pending in the State of Colorado to remove sewage sludge from the category of solid waste and, presumably, to set up a new statute or bring sludge application into closer harmony with existing public health laws. This, in turn, would mean that the State Health Department could establish regulations defining where and how sludge could be applied to the land.

In the present EIS, EPA has provided recommended measures for minimizing the environmental impacts of the use of sludge on land areas. A set of recommendations is presented in Section VI of the EIS.

Disposal Operations at Lowry Bombing Range

The impacts associated with the continued use of the existing system, including final disposal of sludge at the Lowry Bombing Range, must be considered generally negative at this point. The existing system uses considerably more energy and chemicals than would be required with the Metro proposal. Little agricultural productivity, except for grazing forage, is now derived from Lowry rangelands. At the present rates of application, there could be discernible effects on groundwater quality around the landspreading area in the future, and heavy metals will accumulate in the soils. Since cattle grazing is the chief use of Lowry lands, possible toxic chemical buildup in cattle tissues will have to be monitored. A study is underway at present, funded by the U.S. Food and Drug Administration, to determine what heavy metals buildups are taking place in cattle now grazing on the sludge application areas. Cattle are known to ingest a substantial amount of soil as part of their diet.

Mitigation of some of these impacts at Lowry could be achieved by spreading the sludge over larger areas of the Bombing Range. The use of anaerobic digesters could also produce a better sludge, which could be stockpiled at Lowry and distributed to farmers, thus lessening the burden on the soil of the Bombing Range.

Long-Term Implications

The Metro proposal offers an opportunity to increase the use of renewable resources as well as to lessen the use of non-renewable materials. The extensive use of chemicals can be eliminated. The sludge drying and distribution proposal will lessen Metro's consumption of dwindling fossil fuels; reuse of nutrients would also lessen the amount of fossil fuel needed to produce these fertilizers. Soil productivity could be improved by recycling carbonaceous material to the soil. Solar energy would replace the fossil

fuel energy needed to dry the sludge. Additional gas from the anaerobic digestion process would also substitute for commercial fuels at the Metro plant.

Long-term uses of heavy metals in sludge on soils are not expected to significantly deteriorate soil quality if the conservative application rates are followed. Some metals could be beneficial as micro-nutrients to crops.

THE IMPORTANT ISSUES

This section of the Summary Document is an attempt to bring into focus what EPA considers to be the most important issues surrounding the Metro project at the time of the writing of the draft EIS. Some of the issues have arisen from people's reactions to the Metro agricultural reuse proposal; other issues were identified in the course of the analytical process in the EIS. Some are technical issues while others represent potential value judgments in the political process.

The EIS process has thus far served to sharpen the focus and put into perspective the relative severity of impacts that give rise to these issues. The Draft EIS points out where additional basic data are needed and where the need for intensive monitoring is most critical for continuous safeguarding of the environment. The continuous need for specialized expertise in the various disciplines of soil science, entomology, public health medicine, engineering, etc., in the proposed project cannot be overemphasized.

EPA expects to resolve these issues in the course of the EIS process. The final EIS will make specific recommendations on the following issues (or any other issues raised in public and agency review and comment) that will become a part of the grant requirements. The issues below are listed as they appear in the evaluation of environmental impacts; the order in which they are listed does not necessarily reflect the importance of the issues.

Source Control of Trace Elements in Sludge

> Will heavy metals affect crop growth, soil productivity and/or the food chain? Should Metro institute source control of cadmium, since the cadmium/zinc concentration ratio is in excess of the recommended 0.01?

The general heavy metals effect at the recommended sludge application rates for dryland and irrigated croplands is expected to be small. A comprehensive discussion of this issue is provided in Appendix D of the EIS.

Cadmium has been identified as a special problem because of its known toxic effects in humans (kidney damage and hypertension). Although the absolute concentrations of cadmium are lower than in many large metropolitan area municipal sludges, the Cd:Zn concentration ratio is relatively high (0.017) compared with recommended levels variously set at 0.005 and 0.01. The calcareous nature of soils in the Denver region makes heavy metals less available for plant uptake and may somewhat compensate for this high concentration ratio.

A very effective method of control of the heavy metals (cadmium in particular) would be for Metro and its member districts to survey industrial sources of cadmium, such as electroplating firms, and to impose pre-treatment requirements on their discharges.

Sludge Drying and Distribution Site Selection

Should Metro look for another site for its drying/distribution site?

This is an extremely controversial issue that cannot be decided solely upon technical grounds. CH2M-Hill has established that the present site is a reasonable choice, although it is not an optimum site by any means. Metro has stated that its overwhelming concern is to place the site as far away as possible from human habitation. This site was selected even though it had obvious disadvantages, one being its distance from potential irrigated farm markets and the Central Plant.

EPA has experienced in its construction grants program that site locations are always controversial. All other things being equal, no one wants a sewage treatment plant located close to them.

EPA further evaluated through its consultant the relative benefits and costs of having the site located so far from its potential markets. Using the nitrogen fertilizer value in the sludge as a sole criterion, it appears that up to distances of 50 to 70 miles, the value of the nutrients in the sludge exceeds the cost of truck-hauling the sludge. Whether a potential sludge user would realize the same economics is another matter.

EPA has raised other site possibilities such as the Rocky Mountain Arsenal or the Lowry Bombing Range, because some people have expressed interest in knowing whether these sites would be better. At this point in time, this issue is still unresolved.

Lining of the Drying Basins

Will nitrate concentration and salt buildup in the groundwater below the drying site be a problem? Should Metro be required to line the drying basins or use some other technique to prevent groundwater contamination?

Indications are that a substantial part of the total nitrogen available in the sludge may be converted to nitrate. In this highly soluble form, nitrates could move easily toward the groundwater.

The exact amount of nitrate reaching the groundwater must be considered an unknown at this point. In an anaerobic environment as could occur at the bottom of the drying basins, nitrate is converted to nitrogen gas, which is itself harmless. Nitrate in groundwater is a public health hazard, since high concentrations of nitrate are linked to methemoglobinemia in infants.

Metro liquid sludge presently contains a high concentration of soluble salts. Under present design conditions, a highly concentrated salt solution would move unrestrained toward the groundwater table.

Mitigation for nitrates and other salts could easily be accomplished by lining the 600 acres of drying basins, but this would be very expensive. A system of vacuum filtration and decanting liquid from the pumped sludge could be installed at the drying site that would also be very expensive. The decant would have to be stored and treated. Metro has suggested pumping the groundwater if a problem were discovered, but this will not be a reliable way of handling the problem. The pumped water would in turn need proper disposal.

For the present, EPA will require Metro to develop a research site under conditions similar to the operation expected at the site. Nitrate and other salts concentrations will then be monitored to determine the seriousness of the problem. Only if Metro can conclusively demonstrate that the nitrate has been converted to nitrogen gas and that other salts do not pose a serious problem under all operating conditions will the original proposal be approved.

Reduction of Pathogenic Organisms

Should Metro dry and store the sludge for longer periods of time (than the six months drying, one year total storage now stipulated) to adequately overcome pathogen survival?

Although many pathogenic organisms have fairly short life-spans in dried sludge, some organisms such as *Ascaris* can live for two years or more. To a great extent, this issue should be decided by the type of land to which sludge is applied. If individual homeowners are to be allowed to use the sludge, a longer storage time (up to three years) may be needed.

Use Restriction of the Sludge

Should Metro place restrictions on the use of the dried sludge, especially where parklands and individual home users are concerned? What crops should be restricted?

This EIS argues that environmental impacts will be felt differentially from the use of sludge at different application sites. Given Metro's proposal for sludge drying and storage, pathogens can be reduced but cannot be eliminated entirely. Home gardens growing leafy vegetables will be particularly vulnerable to contamination by pathogens. People eating these vegetables would run the risk of disease. Direct contamination could occur in parklands if people were to use grass areas that had been treated with sludge.

Depending on the results of the study underway to determine the amounts of heavy metals uptake by cattle at Lowry, it may become advisable to restrict sludge applications or restrict cattle grazing where sludge is applied. Certain crops are also susceptible to heavy metal uptake. Swiss chard, lettuce, spinach and sugar beets are among the most efficient accumulators of heavy metals. By contrast, the use of sludge on sod farms and certain irrigated and dry farm lands may pose fewer problems.

EPA feels that these differences should be taken into account in developing markets for future use of the sludge. Eventually, the State of Colorado will have to set such limits through its regulations on sludge use. The final EIS will develop recommendations and require Metro to develop its own guidelines as to best areas for sludge use as well as what areas should be restricted.

Control and Surveillance over Sludge Users

Once sludge has been sold to the ultimate user, should Metro or another responsible agency control the manner and rate of application?

Application of sludge to various soils and crops, under different management conditions, requires a sophistication of approach that is somewhat more than that required for use of commercial fertilizers and farm manures. Furthermore, some of the negative impacts transcend the boundaries of the farm area on which the sludge is applied. Hence, land application of sludge by individuals becomes a public concern and may need to be regulated by appropriate public agencies, such as public health departments. It may be necessary to obtain binding agreements with users, delineating precise manners of use, annual rate limitations, time of cessation of use, field re-entry periods, crop use limitations in succeeding years, etc. Such agreement would best include provisions for field inspection, monitoring, additional management practices and amendments, and termination conditions.

Present State of Colorado statutory and regulatory provisions may not be adequate to ensure good control over the sludge applications. There are changes being proposed to the State Solid Waste Act and new regulations being initiated dealing with sludge applications that may improve State control over this area.

Control of Salt Accumulation

Will soluble salt loadings from the sludge buildup in the soil inhibit plant growth in the sludge application areas?

Salt contamination of western soils is a common problem. Gradual buildups of salts in the soil profile can inhibit plant growth. Sensitivity to salts varies with the kind of crop grown. Sugar beets and citrus crops are especially sensitive, corn moderately so and grasses very salt-resistent.

Metro has reported that the salt content of the sludge was measured at about 6,000 ppm. However, the most critical constituents, sodium and chloride, accounted for only about five percent of the total dissolved salts (TDS). Data on concentrations of other cations and anions is lacking; however, it would not be unreasonable to expect that much of the salts are of the calcareous, alkaline earth kind, with some sulfate. These salts are generally less of a problem than sodium and chloride. EPA will require Metro to provide a more complete cation and anion analysis for the sludge stream expected at the drying site.

Mitigation would be best accomplished for soluble salt removal by separating the decant from the heavier sludge, if necessary. Irrigated land application of sludge might not be a problem if sufficient water is applied to flush the salts through the soil profile.

Air Pollution Abatement

Could airborne sludge from the sludge drying and distribution center create health problems around the site?

The possibility exists that pathogens could be transmitted through the air. This statement is made mostly because of the lack of any definite evidence to the contrary. The studies that have been performed on workers at sewage treatment plants does not indicate any greater health risk than for the general population. Metro's sludge will also have undergone anaerobic digestion that greatly reduces the number of pathogens in sludge. The distance from human habitation is also a factor that would minimize this problem. However, the exposed nature of the proposed stockpile windrows makes aerosol and particulate matter blowing a problem during the more severe windy conditions. Metro will be required to develop a contingency plan to protect against fugitive dust leaving the stockpile areas during high wind conditions.

Odor Problems and Land Values

Will the proposed Metro system of drying sludge at Site B-2 create odor problems? What effect will it have on the value of adjacent lands?

This is a controversial issue that cannot be decided solely on technical grounds. Sludge has been processed by anaerobic digestion for most of this century and is known to be much less odorous than raw or activated sludge from municipal treatment plants. This is not to say that some persons might not find the odor undesirable. The B-2 site location offers a buffer from human habitation that would make any odors difficult to detect. Calm inversion conditions might occasionally allow odors to carry offsite, but this would occur infrequently. Upset of the anaerobic digesters that can happen occasionally would create a much more odorous sludge. Metro will have to develop a contingency plan before the final EIS is issued, showing how they will handle this situation. A comparison is fortunately available from actually operating digesters at the Denver Northside Plant that could tell how often such a situation might occur and what is done under these conditions. The Northside plant is an exceptionally good example

because it receives the bulk of the industrial discharges in the metropolitan Denver system. Slugs of heavy metal discharges are generally the cause of disruption of the anaerobic digestion process.

The effect on land values is unclear. Since the lands around the B-2 site are mostly dryland farms, little or no change would be expected in their present farm value. Such land would be less valuable for sale for housing developments or other urban uses. If County, Regional, local or state planners are interested in preserving areas around the metropolitan region for open space, this use would be quite compatible with such goals. Adams County is considering the development of a regional airport in the future, possibly located near the B-2 site in Range 65 West. The large open space afforded by this drying site could be useful as a safe "clear zone" for airplanes landing and taking off at such an airport.

Finally, if the Metro distribution center were to become a financial success and if sludge application on dryland farms proves feasible, nearness of such farms to the distribution center could be an advantage.

Continuation of Landspreading of Sludge at Lowry

Could Metro use the existing sludge treatment and disposal system at Lowry without having to develop a new system?

EPA has presented briefly some possibilities for an improved sludge disposal and perhaps utilization approach that could be developed at Lowry. This will depend on a number of very uncertain factors: how the treatment system will operate with the new anaerobic digesters, whether more land could be acquired at Lowry, and whether Federal construction grant funds become available for the proposed Metro project.

The EIS has tentatively concluded that the overall Lowry system is not as environmentally desirable a system as the agricultural reuse plan, especially as the Lowry system is now operated. Whether it is worth the investment of some $18 to $22 million of Federal funds to achieve this improvement is a difficult question to answer, especially where Federal funding for water quality improvements is limited.

Metro will have to explore further other possible ways to make use of the present Lowry-based system, at least for the near future. The present system may be needed for a number of years if Federal funds are not available, if litigation holds up the funding process, or if EPA does not approve the proposal.

Should EPA even consider approval of the Metro land recycling proposal in the event that Metro is not able to demonstrate that a users market will be available for the dried sludge? Could Metro use site B-2 for disposal?

This is an extremely complex question to answer that depends upon many factors. With a pioneering project of this kind, it may not be completely possible to evaluate the full market potential for the use of sludge until some time after the project has been in existence. Strictly from an economic perspective, the value of sludge will depend on how farmers and other potential users perceive the value of the sludge, efforts by the Metro District to familiarize and convince potential users about the benefits of the sludge, and the rates Metro will charge for the product. State regulations could also affect the extent to which various users could apply the sludge. Research and demonstration efforts, which can only be done over an extended period of time, may be necessary to convince potential users about the value of sludge.

EPA recognizes that there is a certain amount of risk involved in terms of the "success" of the project. The Agency can evaluate the technical merits of the proposal as it has done in this EIS, make recommendations, and see to it that certain procedures are followed. It cannot, however, guarantee that the project will be a success. Many other public institutions and private individuals will have a hand in its success or failure.

It is possible for Metro to operate the drying/distribution operation for some period of time before any distribution will be required. The size of the proposed site offers a great deal of flexibility in storing stockpiled sludge for greater amounts of time than currently proposed (six months). Metro has indicated in its facility plan that some sludge could be buried on-site if necessary for disposal purposes. Metro could also itself haul dried sludge to a landfill, if no other market were available for recycling. The cost evaluations by both CH2M-Hill and Engineering-Science considered the relative economics of the "worst-case" condition of no market for the sludge and showed that even under this condition the drying/distribution was competitive with other alternatives.

It does not appear then, that the fact of an immediate lack of a market for the sludge product would necessarily preclude EPA from approval of the proposed project. EPA will require Metro to become more specific about the most likely markets for sludge use in the final EIS. In addition, Metro will have to spell out exactly how the sludge would be disposed of and where, both on-site and off-site, in the eventuality that for at least the short-term, no users market were available for the dried sludge.

Regarding the second question, EPA would be strongly opposed to having Metro use the drying/processing site for any ultimate disposal of sludge other than for research and demonstration purposes. The evaluation of sludge injection for a secondary disposal system at site B-2 (page 166 of the EIS) indicates that severe effects on plant life, the soil profile, and groundwater would be expected at the application rates proposed. The site is not large enough to effectively dispose of the sludge either liquid or dried. Therefore, as mentioned above, Metro will have to develop a contingency plan of some form of off-site disposal to handle all excess sludge that cannot be marketed or used in the research and demonstration plots, for the final EIS.

Readers of this document and of the EIS it summarizes are requested to comment with respect to contents, conclusions and the project evaluated. All comments may be addressed to:

Regional Administrator
U.S. Environmental Protection Agency
Rocky Mountain-Prairie Region VIII
Suite 900
1860 Lincoln Street
Denver, Colorado 80203

Copies of the full EIS may be reviewed at public libraries and the libraries of Colorado State University and the University of Colorado as well as at the address shown above. A public hearing will be held to receive additional written or oral comments from the general public.

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