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Impacts of Western Coal, Oil Shale, and Tar Sands Development on Aquatic Environmental Quality: A Technical Information Matrix; Volume 1 Introduction and Instructions

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IMPACTS OF WESTERN COAL, OIL SHALE, AND TAR SANDS DEVELOPMENT ON AQUATIC ENVIRONMENTAL QUALITY: A TECHNICAL INFORMATION MATRIX

Volume 1

INTRODUCTION AND INSTRUCTIONS

Jay J. Messer and Frederick J. Post

Editors

Utah Water Research Laboratory
Utah State University
Logan, Utah 84322

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COAL

I.A. Exploration		1	Surveying
		2	Test Drilling
		3	Test Pit Mining
I.B. Extraction Activities		1	Operation of Equipment
		2	Removal of Surface Features
		3	Topsoil Storage
		4	Dewatering
		5	Blasting
		6	Overburden Disposal
		7	Mineral Extraction
I.C. Ancillary Activities		1	Mineral Storage
		2	Mineral Cleaning
		3	Mineral Loading
		4	Railroad
		5	Access Roads
		6	Haul Roads
		7	Conveyor Pipelines
		8	Fuel and Chemical Storage
		9	Yards and Lots
		10	Sewage
		11	Electric Transmission
		12	Water Supply
		13	Sediment Pond/Strip Lakes
		14	Waste Rock (Refuse)
		15	
I.D. Reclamation Activities		1	Runoff Controls
		2	Backfilling and Grading
		3	Topsoiling and Revegetation
		4	Irrigation
		5	Treatment Facilities
		6	
I.E. Power Production		1	Cooling Systems
		2	Scrubber Effluent
		3	Scrubber Sludge
		4	Ash Disposal
		5	Ash Ponds
		6	Cooling Lakes
I.F. Gasification	Surface	1	Gas Quench and Cooling Waters
		2	Waste Streams
		3	Ash/Slag Disposal
		4	Ash Ponds
	In Situ	5	Explosive Fracturing
		6	In-Situ Gasification
		7	
I.G. Liquefaction		1	Cooling Systems
		2	Waste Streams
		3	Solid Wastes
		4	

1. Surface Water Quality

a	Temperature
b	Salinity
c	Nutrients
d	pH
e	Dissolved Solids
f	Suspended Solids
g	Toxicants
h	Carcinogens
i	Heavy Metals
j	Sulfates
k	Radionuclides
l	Pathogens
m	Organics

2. Subsurface Water Quality

a	Temperature
b	Salinity
c	Nutrients
d	pH
e	Dissolved Solids
f	Suspended Solids
g	Toxicants
h	Carcinogens
i	Heavy Metals
j	Sulfates
k	Radionuclides
l	Pathogens
m	Organics

3. Aquatic Ecology

a	Algae
b	Micro-Invertebrates
c	Macro-Invertebrates
d	Vertebrates
e	Aerobic Decomposers
f	Anaerobic Decomposers
g	Macrophytes
h	Biomass
i	Species Diversity
j	Key Species
k	Population Size
l	Ecosystem Functions

4. Aquifer Modification

a	Water Table Alteration
b	Transmissivity
c	Recharge and Discharge
d	Hydrologic Regime
e	Storage Coefficient

IMPACTS OF WESTERN COAL, OIL SHALE, AND TAR SANDS DEVELOPMENT ON AQUATIC ENVIRONMENTAL QUALITY: A TECHNICAL INFORMATION MATRIX

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INTRODUCTION

The Upper Colorado River Basin contains vast deposits of coal, oil shale, and tar sands, which could undergo extensive development should oil prices rise or an international situation restrict oil imports. Naturally, the prospect of development of these alternative fossil fuel resources has led to concern over how extraction and conversion activities will impact environmental quality. A thorough understanding of the nature and magnitude of the resulting environmental impacts is a necessary prerequisite, if the costs and risks of such activities are to be weighed against the economic benefits. When we set out to evaluate these costs and risks, it soon became obvious that the voluminous literature in this area is difficult to access, often repetitive, and not well integrated into state-of-the-art reviews. This led us to realize the need to categorize and collate the results of such energy-related impact research in a way that would go beyond the compilation of a bibliography, or even keywording relevant citations. The form of presentation that we eventually selected was the technical information matrix presented in this report.

This matrix consists of information on the impacts of coal mining and conversion, oil shale mining and retorting, and tar sands development on four aspects of aquatic environmental quality: surface water and groundwater chemistry, aquatic ecology, and aquifer modification. The report consists of three parts. This introductory volume contains instruction for use of the technical information matrix, a glossary, and sources of data on energy development and environmental impacts. Two additional looseleaf volumes contain the coal (II), and oil shale and tar sands matrices (III), respectively, along with the corresponding matrix references and a bibliography of general (summary or overview) references. Each matrix volume also includes a list of symbols and abbreviations used in the matrix.

Qualitatively, information on the three categories of fossil fuel development differs principally in amount, type, and geographical specificity. Coal extraction is a well-studied process in the East, where acid mine drainage and metal toxicity are well documented. In the West, surface mining of vast arid and semiarid tracts, as well as generally more alkaline mine drainage, has been less thoroughly studied. Nonetheless, commercial scale operations have been in place for a sufficiently long period, even in the West, to have produced a reasonably large data base. Coal conversion processes, although new, have also reached the commercial scale, and information is becoming relatively abundant.

Conversely, environmental information is not generally available for the Scottish and Russian oil shale industries, or for the primitive industry in the Colorado Basin earlier in the century, and the present day oil shale industry in the west is insufficiently developed to have produced commercial scale case studies. Most information at present comes from pilot or semi-works facilities, and the impacts of a full-scale development over a 20-30 year project life are difficult to predict. Although Alberta, Canada, has a well developed tar sands industry, site specific information on tar sands

development in the Colorado Basin is lacking.

There are several areas of omission in the coverage of sources of fossil fuel impact on aquatic environmental quality. Petroleum drilling, whose principal impacts in the Colorado Basin are related to interconnection of saline with good quality aquifers, creation of saline surface springs during exploration and illegal brine disposal practices has been omitted. Also, we have not pursued the effects of acid (e.g., SO_2) base (e.g., NH_3) or volatile metal (e.g., Hg) emissions to the atmosphere and their subsequent effects on downwind ecosystems when they are returned by precipitation or dry deposition. We have generally omitted the toxicological literature relating to occupational exposure (e.g., skin painting tests, etc.), as well as the impacts of water withdrawals on fish habitat through reduction of natural instream flows. In the latter case such impacts require site specific consideration of hydrology and channel morphology.

The more than 1300 citations in these matrices were gathered from a wide variety of refereed journals, symposium proceedings, government documents, abstracting services, and personal communications with researchers. The papers cited emphasize the period 1970-1981. Greatest emphasis was placed on the more recent literature, but late 1981 papers are probably underrepresented. There is also little doubt that we have failed to include some valuable material found in project reports, oral presentations, masters theses, dissertations, and similar sources. Certainly some citations were not optimally summarized or categorized, particularly when it was necessary to work from an abstract or summary. Hopefully, such exclusions or poor representations will not result in loss of excessive information or unduly mislead the user.

We plan to update the matrix periodically, supplementing new information found with the searching techniques developed thus far and especially with information supplied by users. Updates will be in the form of looseleaf pages to be added to or substituted in Volumes I and II, and will be published as frequently as deemed necessary to cover developments in the subject areas. We would very much appreciate receiving copies (or summaries) of pertinent reports from the users of this matrix, together with corrections or improvements in the content or categorization of material presently in the matrix. These should be sent to:

F. J. Post (coal) or Jay Messer
(oil shale and tar sands)
Utah Water Research Laboratory
UMC 82
Utah State University
Logan, UT 84322

They will be gratefully included in the next update.

USING THE TECHNICAL INFORMATION MATRIX

The technical information matrix is similar in some respects to the environmental information matrix popularized by Leopold et al. (1971). Figure 1 displays an overview of the matrix in which a variety of energy related activities on the horizontal axis are juxtaposed against four categories of aquatic environmental impacts along the vertical axis. The content of the matrix elements, however, is different than that of the Leopold matrix, in that each matrix node or address is not occupied by an ordinal estimate of the severity and importance of the impact, but by a brief summary of the relevant information in a corresponding literature citation. The activity categories are expanded in Figures 2, 3, and 4, and the impact categories in Figure 5. A summary of the entire matrix is printed on the inside cover of each volume of this report as an aid to searching the matrix.

Activity categories

Activity categories are broadly divided into three fossil fuel types: coal (I), oil shale (II), and tar sands (III). Activity subcategories A-D are the same for all fossil fuel types (Figure 2) and include exploration and extraction, ancillary activities associated with ore preparation, supporting facilities for the work force and site reclamation. Other coal related processes include mine mouth power generation (E) and synfuels conversions (F and G) performed on site (Figure 3). In addition to categories A-D, the oil shale and tar sands categories include the on site retorting operations (E and F) necessary to convert the fuel to an economically transportable crude. Distillation and cracking operations have not been specifically considered, as these will likely occur offsite, and impacts will be similar to those associated with petroleum refining.

Specifically, the impact categories and typical effects are:

A. Exploration

1. Surveying: seizmic testing, including blasting and operation of heavy equipment (e.g., Thumpers) may affect soils, vegetation, and erosion potential.

2. Test drilling: e.g., shot holes may connect aquifers of different quality.

3. Test pit mining: small scale excavations may have effects similar to, but less extensive than, those associated with full scale operations.

B. Extraction Activities

1. Operation of equipment: includes soil compression by heavy trucks and tracked vehicles, air pollution from exhausts and dust, and effects of fuel and lubricant leaks.

2. Removal of surface features: relates principally to effects of soil and vegetation removal on erosion, biogeochemical weathering and transport, aesthetic impacts, and alteration of shallow aquifers.

3. Topsoil storage: storage of topsoil for subsequent revegetation may result in nutrient, salinity, and acid transport to nearby streams.

	I Coal							II Oil Shale					III Tar Sands				
Activities / Impacts	A Exploration	B Extraction	C Ancillary Activities	D Reclamation	E Power Production	F Gasification	G Liquefaction	A Exploration	B Extraction	C Ancillary Activities	D Reclamation	E Retorting Operations	A Exploration	B Extraction	C Ancillary Activities	D Reclamation	E Retorting Operations
1. Surface Water Quality																	
2. Subsurface Water Quality																	
3. Aquatic Ecology																	
4. Aquifer Modification																	

Figure 1. General matrix showing broad activity and impact categories.

I.A. Exploration	1	Surveying
	2	Test Drilling
	3	Test Pit Mining
I.B. Extraction Activities	1	Operation of Equipment
	2	Removal of Surface Features
	3	Topsoil Storage
	4	Dewatering
	5	Blasting
	6	Overburden Disposal
	7	Mineral Extraction
I.C. Ancillary Activities	1	Mineral Storage
	2	Mineral Cleaning
	3	Mineral Loading
	4	Railroad
	5	Access Roads
	6	Haul Roads
	7	Conveyor Pipelines
	8	Fuel and Chemical Storage
	9	Yards and Lots
	10	Sewage
	11	Electric Transmission
	12	Water Supply
	13	Sediment Pond/Strip Lakes
	14	Waste Rock (Refuse)
	15	
I.D. Reclamation Activities	1	Runoff Controls
	2	Backfilling and Grading
	3	Topsoiling and Revegetation
	4	Irrigation
	5	Treatment Facilities
	6	

Figure 2. Expanded activity categories A-D as used for coal mining, oil shale, and tar sands.

I.E. Power Production						I.F. Gasification							I.G. Liquefaction			
						Surface				In Situ						
1	2	3	4	5	6	1	2	3	4	5	6	7	1	2	3	4
Cooling Streams	Scrubber Effluent	Scrubber Sludge	Ash Disposal	Ash Ponds	Cooling Lakes	Gas Quench and Cooling Waters	Waste Streams	Ash/Slag Disposal	Ash Ponds	Explosive Fracturing	In-Situ Gasification		Cooling Systems	Waste Streams	Solid Wastes	

Figure 3. Expanded activity categories for coal mining (I) categories E-G.

II.E Retorting Operations									III.E Retorting Operations								
Surface						In Situ			Surface						In Situ		
1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
Cooling Systems		Waste Streams	Retort Water	Retention Ponds		Explosive Fracturing	Residual Matter	Retort and Condensate Water	Cooling Systems		Waste Streams	Retort Water	Retention Pond		Explosive Fracturing	Residual Matter	Retort and Condensate Water

Figure 4. Expanded activity categories for oil shale (II) and tar sands (III) categories E.

1. SURFACE WATER QUALITY

a.	Temperature
b.	Salinity
c.	Nutrients
d.	pH
e.	Dissolved Solids
f.	Suspended Solids
g.	Toxicants
h.	Carcinogens
i.	Heavy Metals
j.	Sulfates
k.	Radionuclides
l.	Pathogens
m.	Organics

2. SUBSURFACE WATER QUALITY

a.	Temperature
b.	Salinity
c.	Nutrients
d.	pH
e.	Dissolved Solids
f.	Suspended Solids
g.	Toxicants
h.	Carcinogens
i.	Heavy Metals
j.	Sulfates
k.	Radionuclides
l.	Pathogens
m.	Organics

3. AQUATIC ECOLOGY

a.	Algae
b.	Micro-Invertebrates
c.	Macro-Invertebrates
d.	Vertebrates
e.	Aerobic Decomposers
f.	Anaerobic Decomposers
g.	Macrophytes
h.	Biomass
i.	Species Diversity
j.	Key Species
k.	Population Size
l.	Ecosystem Functions

4. AQUIFER MODIFICATION

a.	Water Table Alteration
b.	Transmissivity
c.	Recharge and Discharge
d.	Hydrologic Regime
e.	Storage Coefficient

Figure 5. Expanded impact categories 1-4.

4. Dewatering: removal of mine accrual water may affect surface water quality, aquifer transmissivity and storage, and land subsidence.

5. Blasting: effects of explosions may affect suspended sediment and chemical inputs to streams due to the rubble or the chemicals in the explosives, as well as cause changes in aquifers and surface stream morphology.

6. Overburden disposal: disposal and piling of overburden may have effects similar in kind to topsoil storage.

7. Mineral extraction: the removal of the mineral itself, as opposed to topsoil or overburden, may have different biogeochemical effects due to its particular geochemistry (e.g., reducing, organic, radiochemistry).

C. Ancillary Activities

1. Mineral storage: The reducing nature of many organic minerals may contribute acids or metals to leachates, as well as various organics.

2. Mineral cleaning: removal of ash impurities may result in air and water pollution.

3. Mineral loading: transfer of minerals to unit trains may result in atmospheric dusts that could impact nearby streams.

4. Railroads: roadbeds and train operations may result in physical and chemical effects on streams and groundwater.

5. Access roads: roads providing site access may impact streams near crossings or through deicing procedures.

6. Haul roads: Haul roads are frequently temporary and subject to erosion and dust generation.

7. Conveyer pipelines: pipelines may affect streams through chronic or catastrophic leaks, or may affect shallow groundwater aquifers, if buried.

8. Fuel and chemical storage: fuel and chemical tanks and bunkers may contaminate streams and groundwater from leaks or spills.

9. Yards and lots: maintenance yards and parking lots may affect aquifer recharge and contribute oil, grease, and salt from deicing to percolation and runoff.

10. Sewage: package plants and septic tanks may contribute BOD, nutrients, or toxicants to streams or groundwater.

11. Electric transmission: right-of-ways may contribute to erosion, weathering, and mineral transport.

12. Water supply: impoundments may affect chemical and other habitat changes in existing streams.

13. Sediment ponds/strip lakes: artificial ponds created for sediment control, and lakes resulting from flooding of mining cuts provide their own aquatic habitat, as well as affect groundwater quality and hydrology.

14. Waste rock (refuse): disposal of waste rock, including spent oil shale and tar sands may contribute different minerals or toxicants than the corresponding topsoils, overburden, or raw minerals.

15. Left blank for future categories.

D. Reclamation

1. Runoff controls: dams and terracing can isolate contaminated leachate and control soil erosion on piled spoils or overburden.

2. Backfilling and grading: covering or isolation of acidic minerals, and controlling accessibility of water to potentially dangerous overburden, can alter biogeochemical weathering and leaching.

3. Topsoiling and revegetation: replacing soils and encouraging plant growth affects erosion and leaching rates.

4. Irrigation: providing sufficient water to allow for plant growth may lead to undesirable or unnecessary leaching of piled spoils or overburden.

5. Treatment facilities: biological and chemical treatment of process streams may considerably ameliorate adverse chemical inputs to surface or groundwater. This category refers to treatment and treatability only, as opposed to the waste streams impacts if untreated or minimally treated (e.g., E-F).

6. Left blank.

E. Coal Power Plant Production - Mine Mouth Plants Only

1. Cooling systems: heat dissipation may result in undesirable thermal inputs to receiving streams or adverse geochemical changes in groundwater aquifers.

2. Scrubber effluents: wet scrubber effluents contain toxic metals that must be disposed of.

3. Scrubber sludge: removing SO_2 from stacks results in a concentrated sludge that could pollute streams or groundwater, if not properly disposed of.

4. Ash disposal: bottom and fly ashes are rich in heavy metals.

5. Ash ponds: creation of ponds for treating ashes provides their own ecosystem, as well as affecting surface and groundwater.

6. Cooling lakes: heated effluents are often discharged into cooling lakes to prevent stream impacts. The lakes constitute their own aquatic ecosystem.

F. Gasification (Surface and In Situ)

1. Gas quench and cooling waters: these product streams include soluble ash components, mutagenic organics, and various toxicants, which must be treated prior to release.

2. Waste streams: this category is used when several waste streams converge to create a point source of impact, e.g., as when retort water and boiler blowdown are combined before treatment or ponding.

3. Ash/slag disposal: bottom and fly ashes are rich in heavy metals.

4. Ash ponds: creation of ponds for treating ashes provides their own ecosystem, as well as affecting surface and groundwater.

5. Explosive fracturing: in situ gasification involves rubblizing a coal seam, which can alter the quality and flow paths of surrounding groundwater.

6. In-situ gasification: many of the problems in F1 occur, but underground, where isolation and treatment are more difficult.

7. Left blank

G. Liquefaction

1. Blowdown and cooling waters: these product streams include soluble ash components, mutagenic organics, and various toxicants, which must be treated prior to release.

2. Waste streams: this category is used when several waste streams converge to create a point source of impact,

e.g., as when retort water and boiler blowdown are combined before treatment or ponding.

3. Solid wastes: bottom and fly ashes are rich in heavy metals.

Oil Shale and Tar Sands

E. Retorting Operations

1. Cooling systems: heat dissipation may result in undesirable thermal inputs to receiving streams or adverse geochemical changes in groundwater aquifers.

2. Left blank

3. Waste streams: this category is used when several waste streams converge to create a point source of impact, e.g., as when retort water and boiler blowdown are combined before treatment or ponding.

4. Retort water: the water produced during retorting is rich in inorganic and organic toxicants, ammonia, and dissolved solids.

5. Retention ponds: retort waters may be combined with other waste streams in retention ponds, which have the potential of polluting ground or surface waters.

6. Left blank

7. Explosive fracturing: in situ gasification involves rubblizing a coal seam, which can alter the quality and flow paths of surrounding groundwater.

8. Residual matter: this category is similar to IID16, but the spent shale remains underground, and so is not amenable to controlled disposal.

9. Retort and condensate water: similar to IIE4, the water in an in situ retort may not be easily treated, and contains a higher proportion of groundwater.

Because the activity categories had to be chosen a priori, some overlap was inevitable. When in doubt, we recommend that all categories related to an activity of interest be searched. In order to facilitate addition of new activity categories, several of the addresses have been left blank.

Impact categories

Impact categories are expanded in Figure 5. The same water quality parameters are used for both surface and groundwater. In addition to water in stream channels, overland flow and waters traveling short distances through the soil from raw and spent material storage were included in the surface water category. Groundwater was taken to be waters that remain in the ground longer than one year. The lines of demarcation between categories 1 and 2 are necessarily vague.

The aquatic ecology categories are broadly divided into taxonomic (3a-g) and ecosystems (3h-l) categories, depending on the goals and expertise of the individual investigators. Aquifer modification (4) includes hydraulic parameters that might affect surface or groundwater quality through effects on geochemistry or removal or augmentation of instream flows or lentic habitats (lakes, ponds, and wetlands).

Within the major impact categories, the subcategories are treated as follows:

1, 2 Water quality

(a) temperature: data relating to thermal effects

(b) salinity: data relating to osmotic effects on plants or corrosion of pipelines, e.g., total dissolved solids (TDS), electrical conductivity (EC) (EC)

(c) nutrients: data relating to eutrophication potential; e.g., N and P species

(d) pH: data on acidity or basicity

(e) dissolved solids: data on chemical concentrations of individual species; e.g., major ions as opposed to TDS or EC

(f) suspended solids: e.g., suspended solids (SS) and turbidity

(g) toxicants: dissolved species concentrations that are toxic but are not metals or organics, e.g., arsenic, fluoride, boron; also relates to nonanalyzed toxicants causing effects in bioassay studies using standard, nonaquatic test organisms, e.g., mice

(h) carcinogens: relates to a positive response to the Ames Salmonella test for mutagens or carcinogenic assays with test animals

(i) heavy metals: transition elements toxic at low concentrations; e.g., copper, cadmium, mercury

(j) sulfates: particularly relates to sulfur and its involvement in pH and/or redox chemistry, rather than mere presence as one of a number of other constituents, as in (e)

(k) radionuclides: e.g., strontium or uranium

(l) pathogens: e.g., virus, bacterial pathogens, or indicators of fecal contamination coliforms

(m) organics: data on nonspecific oxygen demanding organics (e.g., biochemical oxygen demand (BOD), total organic carbon (TOC)) as well as specific toxic or carcinogenic species (chemical analyses must have been performed in the latter case, e.g., benzo-(a)pyrene)

The water quality categories generally describe constituent concentrations related to standards or criteria values.

Aquatic ecological categories deal with utilization of aquatic organisms, organism assemblages, and community metabolic rates to assess aquatic environmental quality. These include:

(a) algae: effects on growth/revegetation (either in bottle or microcosm bioassays or in nature) of phytoplankton or periphyton.

(b) micro-invertebrates: those eucaryotic, heterotrophic organisms passing through a standard sieve or drift net (30-50 mesh).

(c) macro-invertebrates: as in (b) but retained by such a net or sieve.

(d) vertebrates: e.g., fish, amphibians, and reptiles but not wading birds or riparian mammals.

(e) aerobic decomposers: aerobic bacteria and fungi.

(f) anaerobic decomposers: nitrate and sulfate reducing bacteria and methanogens.

(g) macrophytes: aquatic vascular plants, mosses and liverworts.

(h) biomass: refers to community or population measurements

but not to weight gain in test animals; includes surrogate measures such as chlorophyll a, ATP, etc.

(i) species diversity: e.g., diversity indices which are thought to describe a community's general health and resilience.

(j) key species: single species important in an ecological (e.g., rare, endangered, or necessary) or economic (e.g., sport or commercial species) context.

(k) population size: enumerated by counting (rather than biomass) in a community study.

(l) ecosystem function: relates to community respiration, photosynthesis, mineral cycling, predation, etc.

Aquifer modification (4) subcategories include:

(a) water table alteration: lowering or raising groundwater levels in shallow aquifers; important for stock wells, wetlands, etc.

(b) transmissivity: affecting ability of an aquifer to transmit water horizontally.

(c) recharge and discharge: affecting vertical patterns of water movement, including lateral discharge to surface waters.

(d) hydrologic regime: a catchall category relating to changes in overall groundwater movement.

(e) storage coefficient: effects on abilities of aquifers to store groundwater.

Again, when in doubt, it is best to pursue as many categories as seem potentially relevant.

Suggestions for using the matrix

A sample page is presented in Figure 6 to illustrate use of the technical information matrix. Matrix addresses have four components and appear at the top of the page as the heading: Main activity on the left, I = coal, E = power production; Secondary activity on the upper right, 6 = cooling lakes; Impact category on the lower right, 3 = aquatic ecology. Although there is redundance in the three matrix addresses appearing at the top of each page, we find that this design is useful when rapidly thumbing through the matrix looking for a particular address or category of addresses.

Impact subcategories appear in the box headings with lower case letters. Below the impact boxes are three columns titled Impact, Description, and Source. Lower case letters in the column under Impact refer to the impact categories in the heading box on the page. For example, the g and i in the first citation indicate that the reference contains information on macrophytes and species diversity. The Description is a brief summary of one or more papers dealing with those two impacts. Two or more references are included in one citation if they contain mostly subsets of the same informnation, e.g., an oral presentation and a technical report. The information in parenthesis following the summary gives the geographical location (if specific) or a G meaning "General Paper." For example, the Hendrey study occurred at Atitokan, Ontario. Other abbreviations and symbols can be found in the appendices of each matrix volume. The Source is the citation(s) from which the description is derived and these are cited in

	Algae	Micro-Invertebrates	Macro-Inverbebrates	Vertebrates	Aerobic Decomposers	Anaerobic Decomposers	Macrophytes	Biomass	Species Diversity	Key Species	Population Size	Ecosystem Functions
	a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	k.	l.

Impact	Description	Source
g,i	Rapid and dramatic changes in vegetation within the thermally altered zone have occurred as a result of changes in both water temperature and water levels. (WI)	(Willard et al. 1976)
a,b,c,d h,i,j,k	An 800 MW power plant will damage fish populations, primary production, and decomposition in the aquatic ecosystem will be impaired. Salemanders, frogs, and other organisms may be eliminated. (Atikokan, OT)	(Hendrey 1978)
g,h,i j,k	Changes in plant community characteristics were monitored biannually from 1974-77 in a freshwater wetland adjacent to the cooling lake. Plant phenology and growth were altered, annuals rapidly invaded newly opened habitat, and tolerant, more hydrophytic perennial species spread. (WI)	(Bedford 1977)
d,k,l	Data on water quality, fish communities, pesticide and heavy metal concentrations as well as largemouth bass blood components and sexual development were analyzed from a 547 ha power plant cooling reservoir. The exact cause of the spawning repression was not identified. (Bexar Co. TX)	(Dean and Bailey 1977)

Figure 6. Sample page from the technical information matrix.

full in the References for each matrix volume.

As an example of the use of the matrix, a user interested principally in impacts on macrophytes would search the left hand columns for citations marked with a "g", i.e., the first and third citation in Figure 5. As can be seen from the letters to the left of the citation, the third reference contains information on biomass, while the first does not. The second citation is noticeably different than the others, inasmuch as it appears to refer to expected, rather than observed impacts. This introduces an important point regarding the variety in type of citations included in the matrix.

Individual articles run the gamut from detailed in situ studies or monitoring programs, through somewhat speculative environmental impact statements, to luncheon addresses and program summaries. If a reference in the latter categories was found to contain useful data or described well-developed sampling or analytical protocols, it was included at the appropriate matrix address. More general treatments were included in the General Bibliography of each matrix, which follows the matrix References. The General Bibliography also references some good descriptions of process engineering, other useful background information, and useful bibliographies, periodical publications, and symposia proceedings relating to energy and environmental quality. We recommend the user scan this section for information that may meet specific needs.

The index can be visually scanned by impact, by activity, or by general categories. The serendipitous discovery of relevant information through the scanning process will hopefully compensate for the extra time required over computerized search techniques based on keywords. The advantages to be gained were demonstrated when Gernerd (1982) found that keyword searches in the energy area generally lead to the loss of significant amounts of information because of nonuniformity in the keywords (e.g., surface vs strip mining) used to describe a particular action or impact.

The Glossary chapter at the end of this volume should be consulted for unfamiliar terms.

Information sources

Information sources used for the matrix and General Bibliography are shown in Table 1. The period covered focused on the years 1970-1981, although late 1981 publications are undoubtedly incompletely covered. The lag time to publication in refereed journals, and to a lesser extent project completion reports, generally make symposium and workshop proceedings and abstracts particularly timely, although quality control is less rigorous.

One should also be aware of the amount of parallel publication in this area. It is not unusual to find two or three symposium papers, a project completion report, and a refereed journal article describing the same bioassay or leaching study. It was also noted that high quality discussions are often printed in some symposium proceeding. These frequently refer to ongoing research or disclose important shortcomings of researchers' understanding of technologies or proper application of results.

On-line searching of computer data bases through the Lockheed Dialog system was found to be particularly useful. The more useful data bases are described briefly in the Data Base chapter of this volume for those users interested in receiving rapid service in obtaining abstracts or textual material. It is hoped that this publication will substitute the need for expensive comprehensive searching.

Table 1. Information sources.

1. Computer Databases Accessed
   a. NTIS-National Technical Information Service
   b. Water Resources Abstracts
   c Enviroline
   d. Energyline
   e. Compendex
   f. Agricola
   g. Seaminfo
   h. Scisearch
   i. Pollution Abstracts
   j. Conference Papers Index
   k. Dissertation Abstracts

2. Bibliographies and Published Searches
   a U.S. Fish & Wildlife Service
   b. National Technical Information Service
   c Western Energy & Land Use Team
   d. National Science Foundation
   e Bituminous Coal Research, Inc.
   f. U.S. Department of Agriculture
   g. National Coal Association
   h. U.S. Geological Survey
   i. Energy & Mineral Resources Res. Inst.
   j. Bureau of Mines
   k. Oil Shale Task Force
   l. Environmental Protection Agency
   m. Various Colleges and Universities

3. Department of Energy - Technical Information Center
   a. Fossil Energy Update (monthly publication)
   b. Laramie Energy Technology Center
   c. Environmental Development Plans, Workshops, and Environmental Impact Statements

4. Hard Bound Abstract Series
   a ERDA - Energy Research and Development Administration
   b. Biological Abstracts
   c. Chemical Abstracts
   d. Pollution Abstracts

5. Environmental Protection Agency Research Report Series
   a. Environmental Health Effects Research
   b. Environmental Protection Technology
   c. Ecological Research
   d. Environmental Monitoring
   e. Scientific and Technical Assessment Reports
   f. Interagency Energy - Environmental Research and Development
   g. Special and Miscellaneous Reports

6. Conference and Symposium Proceedings
   a. >100 referenced in the technical matrix

Table 1. Continued.

7. Prominent Research Laboratories
a. Battelle Columbus Laboratories
b. Brookhaven National Laboratory
c. Los Alamos Scientific Laboratory
d. Argonne National Laboratory
e. Oak Ridge National Laboratory
8. Private Corporations and Consulting Firms

Concluding comments

Present plans are to update this matrix periodically by providing looseleaf supplements. It is hoped that the looseleaf format will encourage users to pencil in their own references as well as those of colleagues and professional organizations. Receipt of any such information will be gratefully acknowledged by the editors and included in the next update (see Introduction).

References

Leopold, L., Clark, F., Hansaw, B. and Balsley, J. 1971. A procedure for evaluating environmental impact. U.S. Geol. Surv., U.S. Govt. Printing Office, Washington, D.C.

Gernerd, K. 1982. Construction of a matrix to facilitate data acquisition on the aquatic environmental impacts of western fossil fuel development. M.S. Thesis. College of Engineering, Utah State University, Logan.

DESCRIPTION OF ONLINE DATA BASES

The following pages provide brief descriptions of the individual databases used in this study (DIALOG 1982, Calkins 1978). The meaning of database names, number of citations or records and years covered will accompany the descriptions along with online connect time rates and offline print rates for each respective database. All databases listed can be accessed through the DIALOG Information Retrieval Service.

AGRICOLA (AGRICultural On-Line Access)

1970-present, 1,476,000 records, monthly updates.

Technical Information Systems, Science and Education Administration, USDA, Beltsville, MD. Covers worldwide literature in agriculture and allied sciences, including general agriuclture and rural sociology, agricultural economics, animal science, forestry, plant science, pesticides, entomology, natural resources, and pollution. This file represents the holdings of the National Agricultural Library and cites journal articles, monographs, government reports and special reports, and conference proceedings.

$35 per online connect hour, $.10 per full record printed offline.

BIOSIS PREVIEWS (BioSciences Information Service Previews)

1969-present, 3,169,540 records, semimonthly updates.

Biosciences Information Service, Philadelphia, PA. Worldwide coverage of research in the life sciences. Nearly 8,000 primary journals as well as symposia, reviews, preliminary reports, semipopular journals, selected institutional and government reports, research communications, and other secondary sources provide citations on all aspects of the biosciences and medical research. Subjects include agriculture, microbiology, plant and animal sciences, biochemistry, environmental biology, environmental medicine, public health, ecology, toxicology, and virology.

$58 per online connect hour, $.15 per full record printed offline.

COMPENDEX (COMputerized ENgineering InDEX)

January 1970-present, 1,001,000 records, monthly updates.

Engineering Index, Inc., New York, NY. Provides worldwide coverage of engineering and technological literature, including civil-environmental-geological engineering, mechanical-automotive-nuclear-aerospace engineering, chemical-agricultural-food engineering, and industrial engineering, management, mathematics, physics, and instruments. 3500 journals are indexed, as well as publications of engineering societies and organizations, conference proceedings, and books.

$80 per online connect hour, $.30 per full record printed offline, $.20 per full record typed or displayed online.

CPI (Conference Papers Index)

1973-present, 895,700 records, monthly updates.

Cambridge Scientific Abstracts, Bethesda, MD. Provides access to records of more than 100,000 scientific and technical papers presented at over 1,000 major regional, national, and international meetings each year. Primary subject areas covered include the life sciencies, chemistry, physical sciences, geosciences, and engineering. Announcements of any publications issued from the meetings, available preprints, reprints, abstract booklets, and proceedings volumes, including dates of availability, costs and ordering information are also included in this database.

$73 per online connect hour, $.20 per full record printed offline.

DOE (Department of Energy)

1974-present, 640,000 records, biweekly updates.

U.S. Department of Energy, Technical Information Center, Oak Ridge, TN. International coverage of energy-related scientific and technical literature, including nuclear energy, petroleum, natural gas, coal (gasification, liquefaction and desulfurization), solar energy, and geothermal energy. Sources are journal articles, government reports, patents, monographs, conference proceedings, dissertations, and translations.

$35 per online connect hour, $.15 per full record printed offline.

ENERGYLINE (Energy Online)

1971-present, 34,900 citations, bimonthly updates.

Environment Information Center, Inc., New York, NY. Subjects covered include: energy economics, U.S. policy and planning, international economic and political issues, research and development, resources and reserves, environmental impact, electrical power transmission and storage, fuel production, fuel transport, nuclear power, and industrial, transportation, and residential consumption. Sources include journals, books, congressional publications, conference proceedings, speeches, and statistics.

$78 per online connect hour, $.15 per full record printed offline.

ENVIROLINE (ENVIRonment On-LINE)

1971-present, 91,200 citations, monthly updates

Environment Information Center, Inc., New York, NY. Indexes information in all areas of environmental studies. Subject areas include air pollution, chemical and biological contamination, environmental education, environmental design and urban ecology, food and drugs, international affairs, land use and misuse, noise pollution, natural resources, oceans and estuaries, solid wastes, transportation, water pollution, weather modification, and wildlife. Sources include more than 3,000 periodicals, as well as government documents, industry reports, conference proceedings, newspaper articles, films, monographs and books.

$78 per online connect hour, $.15 per full record printed offline.

NTIS (National Technical Information Service Bibliographic Data File)

1964-present, 863,500 citations, biweekly updates.

National Technical Information Service, Springfield, VA. Broad, multidisciplinary file which indexes technical reports of U.S. government-sponsored research. It is the means through which unclassified, publicly available, unlimited distribution reports are made available

for sale from such agencies as NASA, DDC, DOE, HEW, HUD, DOT, Department of Commerce, and some 240 other units. State and local government agencies are now beginning to contribute their reports to the file. Some subjects included are: aeronautics, agriculture, biological and medical sciences, chemistry, each sciences, electronics, engineering, energy, environmental pollution and control, technology transfer, and urban and regional planning. The file includes some reprints and translations of technical reports.

$40 per online connect hour, $.10 per full record printed offline.

POLLUTION (Pollution Abstracts)

1970-present, 83,216 citations, bimonthly updates.

Cambridge Scientific Abstracts, Bethesda, MD. Indexes environmentally related literature on pollution, its sources, and its control. Journal articles, reports, contracts and symposia are covered. Subjects include air pollution, pesticides, radiation, environmental quality, noise pollution, solid wastes, and water pollution.

$73 per online connect hour, $.20 per full record printed offline.

SCISEARCH (Science Citation Index)

1965-present, 7.2 million records, monthly updates.

Institute for Scientific Information, Philadelphia, PA. Multidisciplinary index to the most significant journal literature of science and technology. Subjects include agriculture, biology, chemistry, engineering, electronics, energy, environmental sciences, medicine, and nuclear science. More than 3,000 journals are covered. Its unique feature is indexing by the author's cited references.

$65 per online connect hour, $.15 per full record printed offline.

SSIE (Smithsonian Scientific Information Exchange)

Previous two years; 170,000 citations; monthly updates. Smithsonian Science Information Exchange, Washington, D.C. Contains reports of both government and privately funded scientific research projects. Data are collected from more than 1,300 organizations, with 90 percent of the information coming from agencies of the federal government. The remainder is furnished by state and local government agencies, nonprofit associations and foundations, and colleges and universities. A small amount of material comes from private industry and foreign research organizations. Encompasses all fields of basic and applied research in the life, physical, social and engineering sciences. Subject areas include agricultural, behavioral and biological sciences, chemistry and chemical engineering, electronics, physics, and materials science, engineering, mathematics, medical sciences, and the social sciences and economics.

$78 per online connect hour, $.20 per full record printed offline.

WRA (Water Resources Abstracts)

1968-present, 130,000 records, monthly updates.

U.S. Department of Interior, Washington, D.C. Indexes a wide range of water resource topics including water resources economics, ground and surface water hydrology, metropolitan water resources planning and management, environmental effects of energy development, water quality, and sewage and water treatment. Covers predominantly

English-language materials and includes monographs, journal articles, reports, patents, and conference proceedings.	$45 per online connect hour, $.15 per full record printed offline.

GLOSSARY

Abandoned - An operation that is not producing any mineral and is not expected to continue or resume.

Abatement - The controlled reduction of pollutant emissions.

Absorption - The penetration of one substance into or through another. For example, in air pollution control absorption is the dissolving of a soluble gas from an emission into a liquid as a means of removing that gas from the air stream.

Abundance, (species) - An estimate of the total number of individuals of species in a defined area, volume, population, or community.

Access Road - Any haul road or other road that is constructed, improved, maintained, or used by the operator and that ends at the pit or bench and is located within the area of land affected.

Acid Mine Drainage - Any acidic water draining or flowing on, or having drained or flowed off, any area of land affected by mining.

Acid Rain - Rain that contains acidic substances such as sulfuric, hydrochloric, and nitric acids, in addition to the normal carbonic acid component. Acidity of the rain can be as low as pH 3. "Normal" rain is typically pH 6-8.

Acid Soil - A soil that is deficient in available bases, particularly calcium, and gives an acid reaction when tested by standard methods. There is no unanimous agreement on what constitutes an acid soil. The term is usually applied to the surface layer or to the root zone unless specified otherwise.

Activated Carbon - Carbon which is treated by high-temperature heating with steam or carbon dioxide producing an internal porous particle structure; has the property of absorbing large quantities of gases, solvent vapors; used also for clarifying liquids.

Active Surface Mine Operation - An operation where land is being disturbed or mineral is being removed.

Adaptation - A change in the structure, physiology or behavior of an organism that increases the overall compatibility of the organism with its environment. Adaptions are generally thought of in two time frames: 1) long-term evolutionary

adjustment of a population to environmental changes, or 2) short-term physiological or behavioral responses.

Additive Effects - The combined effects of more than one pollutant acting simultaneously or in succession to give a total effect equal to the sum of the independent effects.

Adsorption - The adherence of the atoms, ions, or molecules of a gas or liquid to the surface of another substance (the adsorbent). Adsorption is often used to extract pollutants by causing them to be attached to adsorbents such as activated carbon or silica gel.

Advanced Waste Treatment - Any treatment method or process employed following biological treatment (1) to increase the removal of pollution load, (2) to remove substances which may be deleterious to receiving waters or the environment, (3) to produce a high-quality effluent suitable for reuse in any specific manner or for discharge under critical conditions. The term tertiary treatment is commonly used to denote advanced waste treatment methods.

Aeration - The process of being supplied or impregnated with air; to mix or charge with air.

Aerobic - Able to live and grow only if free oxygen is present.

Aerosol - A suspension of liquid or solid particles (in a gas) of such size that they tend to remain suspended for an indefinite period.

Agglomeration - The coalescence of dispersed suspended matter into larger flocs or particles which settle more rapidly.

Algae - Simple plants, many microscopic, containing chlorophyll.

Algal Bloom - A proliferation of algae on the surface of lakes, streams, or ponds, which is stimulated by nutrient enrichment.

Algicide - Chemicals used to kill or otherwise control phytoplankton (algae) in water.

Aliphatic - One of the major groups of organic compounds characterized by straight-chain or branched arrangement of the constituent carbon atoms. Aliphatic hydrocarbons include three subgroups: (1) paraffins (alkanes), (2) olefins (alkenes or alkadienes), (3) acetylenes (alkynes).

Alkaline - The condition of a water solution having a pH concentration greater than 7.0 and having the properties of a base.

Alkalinity - The capacity of water to neutralize acids, a property imparted by the water's content of carbonates, bicarbonates, hydroxides, and occasionally borates, silicates, and phosphates. It is expressed in milligrams per liter or equivalent calcium carbonate.

Alluvium - Material such as earth, sand, gravel, or other rock or mineral materials transported by and deposited by flowing water.

Anaerobic - Able to live and grow where there is no air or free oxygen.

Angle of Repose - The greatest angle from the horizontal at which any loose or fragmented solid material will stand without sliding after coming to rest when poured or dumped in a pile or on a slope (approximately 37^{o}).

Angle of Slide - The degree of slope at which loose or fragmented materials will start to slide. A slightly greater angle than the angle of repose.

Anion - A negatively charged ion (e.g. OH^{-}, $SO_4^{=}$, $CO_3^{=}$).

Anthracite - Generally, a hard, black, lustrous coal containing a high percentage of fixed carbon and a low percentage of volatile matter.

Aquifer - A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield quantities of water to wells and springs.

Area of Land Affected - The area of land from which overburden is to be or has been removed and upon which the overburden is to be or has been deposited. Included are all lands affected by the construction of new roads or the improvement or use of existing roads other than public roads, to gain access and to haul the mineral.

Area Surface Mining - A type of strip mining that is generally practiced on gently rolling to relatively flat terrain; it is commonly found in the midwest and far west. Mineral is removed by digging a series of parallel trenches with spoil material being placed in the cut made during the previous pass.

Aromatic Hydrocarbon - An unsaturated cyclic hydrocarbon containing one or more six-carbon rings.

Ash - Theoretically, the inorganic salts contained in coal; practically, the solid residue remaining after coal is burned.

Auger Mining - Mining of coal from an exposed vertical coal face by means of a mechanically driven boring machine that employs an auger to cut and bring the coal out of the bore hole.

Auxiliary Process - Processes associated with a technology which are used for purposes that are in some way incidental to the main functions involved in transformation of raw materials into end products. Auxiliary processes are used for recovery of byproducts from waste streams, to furnish necessary utilities, and to furnish feed materials; e.g. the auxillary processes for low- and meadium Btu gasification technology include: (1) oxygen plant which is used only for medium-Btu gas; (2) the Stretford plant used to recover sulfur compounds from gaseous waste streams.

Available Water-Holding Capacity - The capacity to store water available for use by plants, usually expressed in linear depths of water per unit depth of soil. Commonly defined as the difference between the percentage of soil water at field capacity and the percentage at wilting point.

Backfill - To place soil, overburden, or waste rock into a surface mine excavation and return the area to a predetermined configuration; the material so placed.

Bench Plant Stage - A small-scale laboratory unit for testing process concepts and operating parameters as a first step in the evaluation of a process.

Beneficiation - The process of upgrading an ore or mineral for further use.

Benthos - Aquatic bottom-dwelling organisms. These include: (1) Sessile animals, such as the sponges, barnacles, mussels, some of the worms, and many attached algae; (2) creeping forms, such as insects, snails, and certain clams; and (3) burrowing forms, which include most clams and worms.

Berm - A bench of soil or rock built on an earthen structure to break the continuity of an otherwise long slope, usually for the purpose of reducing erosion, or to increase the thickness or width of cross section of an embankment. It may serve various purposes such as a dike, as an encasement for a drainage system, as weight for structural stabilization of an embankment, or as erosion control.

Bioassay - A determination of the concentration of a given material by comparison with a standard preparation; or the determination of the quantity necessary to affect a test animal under stated laboratory conditions.

Baffles - Deflector vanes, guides, grids, grating, or similar devices constructed or placed in flowing water or sewage to (1) check or effect a more uniform distribution of velocities; (2) absorb energy; (3) divert, guide, or agitate the liquids, and (4) check eddy currents.

Barrier - Portions of the mineral and/or overburden that are left in place during mining. Function is to provide a natural seal along the outcrop.

Base - A compound which dissolves in water to yield hydroxyl ions (OH^-).

Baseline Information (Studies) - Environmental information collected (or studies conducted) prior to initiation of mining operations. The scope of study may range widely, from qualitative inventories conducted by natural resource managers to exhaustive quantitative studies of specific development sites undertaken by industry in compliance with federal and state regulations.

Bedrock - Any solid rock in place either on or beneath soil, sand, clay, silt, etc.

Bench - The surface of an excavated area located at some point between the material being mined and the original surface of the ground on which equipment can be set, move or operate. The working road or base, ledge, shelf, table or terraces formed in the contour method of strip mining.

Biological Wastewater Treatment - Forms of wastewater treatment in which bacterial or biochemical action is intensified to stabilize, oxidize, and nitrify the unstable organic matter present. Intermittent sand filters, contact beds, trickling filters, and activated sludge process are examples.

Biomass - The weight of all life in a specified unit of environment or an expression of the total mass or weight of a given population, both plant and animal.

Biota - All living organisms of a region.

Biotic Potential - The intrinsic rate of population increase. The inherent ability of a population to grow in the absence of external controlling factors.

Bitumen - A general name for various solid and semi-solid hydrocarbons; a native substance of dark color that is comparatively hard and nonvolatile and is composed principally of hydrocarbon.

Bituminous Coal - A broad class of coals containing 46 to 86 percent fixed carbon and 20 to 40 percent volatile matter.

Block Cut Method - A variation of contour strip mining in which overburden is removed and placed around the periphery of a box-shaped cut. After coal is removed the spoil is pushed back into the cut and the surface is blended into the topography.

Blow Down - The process whereby five to ten percent of the water within a wet-type cooling tower is continually drained off and replenished with a fresh supply to prevent the excessive concentration of certain salts, minerals, and other constituents within the system.

Boiler - A device in which a liquid is converted into its vapor state by action of heat. In the steam electric generating industry, the equipment which converts water into steam.

Boiling Fluidized Bed - A fluidized bed through which part of the fluidizing medium passes in the form of bubbles of a size approximately equal to the size of the solid particles, but very small relative to the dimensions of the containing vessel.

Bottom Ash - The solid residue left from the combustion of a fuel which falls to the bottom of the combustion chamber. Also called cinders.

Box Cut - In surface mining, the initial cut made at a mining site that results in a highwall on the upslope side and a low wall barrier on the downslope side.

Brine - Water saturated with salt.

BTX - Benzene, toluene, xylene; aromatic hydrocarbons.

Bucket Wheel Excavator - A continuous digging machine composed of a boom on which is mounted a rotating vertical wheel having buckets on its periphery. As the rotating wheel is pressed into the material to be excavated, the buckets scoop material and discharge it onto a conveyor belt system for transport to loading or dumping sites.

Buffering Capacity - A measure of the tendency of a soil or water to resist large changes in pH.

By-Product (Residuals) - Secondary products (possibly of commercial value) that are obtained from the processing of raw material. By-products may be the residues of the gas production process (such as coke, tar, and ammonia) or they may be the result of further processing of such residues (such as ammonium sulfate).

By-Product (Streams) - Discharge streams from which useful materials are recovered to: (1) eliminate undesirable environmental discharges; or (2) recover valuable materials which are most economically isolated from process input stream after it has been physically or chemically transformed.

Caking - The softening and agglomeration of coal as a result of the application of heat.

Calcareous - A material containing calcium or calcium carbonate, usually found in limestone or in spoil impregnated with lime.

Capacity (Power Plant) - Rated capacity is the design output (MWe) or size of a power plant. Operating capacity is the actual output (MWe) of a power plant, averaged over a year. Typically, it is around 70% of the rated capacity.

$$\text{Capacity factor} = \frac{\text{Operating Capacity}}{\text{Rated Capacity}} \times 100$$

Carbon Steam Reaction - Water gas reaction whereby the passage of steam over carbon results in the formation of carbon monoxide and hydrogen.

Carcinogen - A substance or agent that produces or incites cancerous growth.

Carrying Capacity - The maximum density (or biomass) of a given species in a given area beyond which no significant increase can occur without damage occurring to the resources upon which the population depends.

Catalytic Hydrogenation Process - A method for adding hydrogen to substances using a catalyst to promote the reaction. It can be used to convert coal to a liquid and/or to remove sulfur from residual ore, coal, crude coal liquids, and coal extracts.

Cation - A positively charged ion (e.g. Na^{+}, Fe^{+2}, Al^{+3}).

Char - The solid residue remaining after the removal of moisture and volatile matter from coal.

Characteristic Species - Species that are found predominantly in one community or found completely, or almost so, in only one community.

Clay Liner (Waste Disposal) - A liner consisting of a compacted layer of a clay with a low hydraulic conductivity.

Clinker - A term used to identify the material overlying a burned coal bed, sometimes referred to as "scoria." Clinkers usually

consist of baked clay, shale, or sandstone. They weather to gravel-sized particles that are generally red in color and are used extensively as a road-surfacing material.

Clinker Bed - That which is left after a major coal seam is burned. A hard mass of fused stoney material (matter) formed in a furnace from impurities in the coal.

Closed-Cycle Cooling System - Condenser cooling water is passed through the condensers; cooled in cooling towers, cooling ponds, or cooling sprays; and returned to the condensers. Withdrawal of water (makeup) from a natural water source is required to replace evaporative and other losses.

Coal - A solid, combustible material consisting of amorphous elemental carbon with various amounts of organic and inorganic compounds.

Coal Conversion - The conversion of coal to a gas suitable for use as a fuel.

Coal Gas - The gas that comes from retorts, mufflers, or ovens during the distillation of coal. Coal gas has a high illuminating value and is a relatively suitable engine fuel. Large quantities of coal gas are produced when coal is used to make coke, coal tar, benzoil, toluene, ammonia, and other products.

Coal Gasification - The conversion of coal to a gas suitable for use as a fuel (HYGAS, CO_2, Acceptor, Bi-Gas, methanation, Lurgi, ATGAS processes).

Coal Gasification (High-Btu Gas) - The combustion of coal at high temperatures (+1000°F) in an atmosphere deficient in oxygen (reducing) to produce a combustible gas.

Coal Liquefaction (Hydrogenation) - The conversion of coal into liquid hydrocarbons and related compounds by hydrogenation.

Coal Oil - Oil obtained by the destructive distillation of bituminous coal; also an archaic term for kerosene made from petroleum.

Coal Pile Drainage - Runoff from the coal pile as a result of rainfall.

Coal Seam - A bed of coal that is usually thick enough to be profitably mined.

Coal Slurry - A mixture of crushed or pulverized coal suspended in a liquid, which can be pumped.

Coal Slurry Pipeline - A pipeline that transports coal slurry.

Coal Tar - A gummy, black substance produced as a by-product of distillation of bitiminous coal.

Coalification - Metamorphosis of plant debris into coal.

Coke - Strong porous residue consisting of carbon and mineral ash formed when bituminous coal is heated in a limited air supply or in the absence of air.

Community - An assemblage of biotic components that occupy a particular habitat or ecosystem.

Compaction - The decreasing of void space among the particles of soil and rock, generally caused by running heavy equipment over the area.

Condensate - Liquid hydrocarbon obtained by the combustion of a vapor or gas produced from oil or gas wells and ordinarily separated at a field separator and run as crude oil. Or any liquid converted from its gaseous phase.

Consumptive Use (Water) - That portion of water taken into a power plant that is not directly returned to the surface water body. The water is lost through evaporation and seepage.

Contour Mining - A type of strip mining that is practiced in areas of steep topography where the mineral seam crops out or approaches the surface at approximately the same elevation along a hillside.

Cooling Canal - A canal in which warm water enters at one end, is cooled by contact with air, and is discharged at the other end.

Cooling Tower - A device used to remove excess heat from water. It is used in industrial operations, notably in electric power generation.

Cooling Tower (Dry-Type) - Cooling towers in which waste heat is dissipated to the air by conduction and convection rather than evaporation.

Cooling Tower (Mechanical Draft) - A cooling tower that uses fans to move ambient air through the tower.

Cooling Tower (Natural Draft) - A cooling tower that depends upon a chimney or stack to induce air movement through the tower.

Cooling Tower (Wet-Type) - A cooling tower in which cooling water is brought in direct contact with a flow of air and the heat is dissipated mainly by evaporation.

Core Drilling - The process by which a cylindrical sample of rock and other strata is obtained through the use of a hollow drilling bit that cuts and retains a section of the rock or other strata penetrated.

Corrosion Inhibitor - A chemical agent which slows down or prohibits a corrosion reaction.

Cracking - The partial decomposition of high-molecular-weight organic compounds into lower-molecular-weight compounds, generally as a result of high temperatures.

Cut - Longitudinal excavation made by a strip-mining machine to remove overburden in a single progressive line from one side or end of the property being mined to the other side or end.

Cut and Fill - Process of earth moving by excavating part of an area and using the excavated material for adjacent embankments or for filling adjacent, previously excavated areas.

Deep Chiseling - Deep chiseling is a surface treatment that loosens compacted soils. The process involves digging a series of parallel slots along the contours of the soil surface. The slots impede water flow and markedly increase infiltration.

Deep Mining - The exploitation of coal or mineral deposits at depths exceeding about 1,000 feet.

Degradation - A type of decomposition characteristic of high-molecular-weight substances such as proteins, polymers, and branched-chain sulfonates, resulting from oxidation, heat, solvents, and bacterial action.

Detention Time - The time allowed for solids to collect in a settling tank. Theoretically, detention time is equal to the volume of the tank divided by the flow rate. The actual detention time is determined by the purpose of the tank. Also, the design resident time in a tank or reaction vessel which allows a chemical reaction to go to completion, such as the reduction of chromium $^{+}6$ or the destruction of cyanide.

Detrimental Environmental Impact - Any substance, procedure or energy produced by any operation that adversely affects any form of life or creates a condition offensive to the aesthetic sense.

Dewatering (Construction) - Removal of water from an excavation, usually by pumping.

Dewatering (Slurry) - The process of removing water from a slurry. Processes include natural evaporation, centrifugation, decantation, and filtration.

Discharge (Flow) - Rate of flow; a volume of fluid passing a specific point per unit time commonly expressed as cubic feet per second, million gallons per day, gallons per minute, or cubic meters per second.

Discharge (Thermal) - A discharge of heat energy from an industrial facility as a by-product of operation, usually in the form of heated air or water.

Dispersion - A suspension of particles in a medium; the opposite of flocculation; a scattering process.

Dissolved Solids - Theoretically, the anhydrous residues of the dissolved constituents in water. Actually, it is the difference between the total and suspended solids in water.

Distillation - A process of vaporizing a liquid and condensing the vapor by cooling; used for separating liquids into various fractions according to their boiling points or boiling ranges.

Disturbed Land - Land that has been altered physically, biologically, or chemically by the action of man (e.g. land on which excavation has occurred or upon which overburden has been deposited).

Diversion - Channel constructed across a slope to intercept surface runoff; changing the course of all or part of a stream or runoff.

Diversity (Biological) - The number of species of organisms or the variety of communities or associations per unit area or volume.

Diversity (Ecological) - The total range in kinds and frequencies of species interactions in a defined area and time period; the greater number of species, the higher the diversity.

Diversity (Species) - The number and abundance of species in a biotic community.

Dolomite - A mineral having the chemical formula $Ca\ Mg(CO_3)_2$ (i.e., a carbonate of calcium and magnesium).

Dominant Species - The conspicuous species of a particular community. Generally, those which are highly successful ecologically and which determine to a considerable extent the conditions under which the associated species must grow.

Dragline - An excavating machine that utilizes a bucket which is operated and suspended by means of lines or cables, one of which hoists or lowers the bucket from a boom; the other cable, from which the name is derived, allows the bucket to swing out from the machine or to be dragged toward the machine for loading. The machine is usually operated from a highwall.

Drainage Basin (Catchment Area, Watershed) - All land and water within the confines of a drainage divide.

Drift - The entrained solids and liquids carried from a cooling tower by the exhaust air.

Dry Bottom Furnace - A furnace in which the ash leaves the boiler bottom as a solid (as opposed to a molten slag).

Dry Gas - A gas that does not contain the heavier fractions, which may not easily condense under normal atmospheric conditions (e.g., methane and ethane).

Dust - A general term used to describe solid particles that are in the micron-size range (e.g., fly ash, coarse dirt, and mechanically produced particles).

Ecology - The science of the interrelations between living organisms and their environment.

Ecology (Systems) - The application of techniques of systems analysis to ecological problems.

Economizer - A heat exchanger which uses the heat of combustion gases to raise the boiler feedwater temperatures before the feedwater enters the boiler.

Ecoregion - A geographical area over which the environmental complex, produced by the climate, topography, and soil, is sufficiently uniform to permit development of characteristic types of ecological associations.

Ecosystem - A community and its environment treated together as a functional system of relationships and transfer and circulation of energy and matter.

Ecosystem (Dynamics) - Characteristic and measurable processes within an ecosystem such as (1) succession; (2) energy flow and nutrient cycling; (3) community and metabolism.

Efficiency (Power Plant) - The electrical energy output achieved by a power plant per unit of coal energy put into the plant.

Effluent - A liquid which flows out of a containing space. A discharge of pollutants into the environment partially or completely treated or in its natural state (generally used in regard to discharges into waters).

Electrostatic Precipitator - A device used to remove particles from flue gases, by charging the particles electrically and collecting them on appropriate electrodes.

Elutriation - The preferential removal of the small constituents of a mixture of solid particles by a stream of high-velocity gas.

Emergent Properties - New characteristics arising unexpectedly through the interaction of several variables, such characteristics not being evident in the separate variables.

Emission - A discharge of pollutants into the environment, generally used in regard to releases into the atmosphere.

Emission Standards - Standards based on the concentration of pollutants that cannot legally be exceeded during fixed time intervals within specified geographic areas and coming from an identified source.

Empirical - Relying or based solely on experiment and observation.

Emulsion - A stable mixture of two or more immiscible liquids held in suspension by small percentages of substances called emulsifiers.

Endangered Species - Those species of animal or plant in danger of extinction throughout all or a significant portion of their ranges. Species or subspecies from very limited areas or from restricted, fragile habitats usually are considered "endangered."

Entrain - To draw in and transport (as solid particles or gas) by the flow of a fluid.

Entrainment - Biological usage refers to the passage of organisms through the cooling system of, for example, power plants; engineers use it in terms of ambient water being brought into the cooling plumes as the effluents are discharged from power plants.

Entrained Bed (Flow) - A bed in which solid particles are suspended in a moving fluid and are continuously carried over in the effluent stream.

Environment - The sum total of all the external conditions that may act upon an organisms or community to influence its development or existence.

Environmental Analysis Report (E.A.R.) - A report on environmental effects of proposed federal actions that may require an Environmental Impact Statement (EIS) under Section 102 of the National Environmental Policy Act (NEPA). The EAR is an "in-house" document of various degrees of formality that becomes the final document on environmental impacts for those projects that because their effects are minor, do not require a formal EIS.

Environmental Impact Assessment - An evaluation and objective prediction of the environmental impacts of a proposed action using a systematic, interdisciplinary approach that integrates social and natural sciences and environmental design arts.

Environmental Impact Statement (EIS) - A document prepared by a federal agency in which anticipated environmental effects of a planned federal course of action or development are evaluated. An impact statement includes the following points:

1. the environmental impact of proposed action,
2. any adverse impacts that cannot be avoided by the action,
3. the alternative courses of action,
4. the relationships between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity,
5. a description of the irreversible and irretrievable commitment of resources that would occur if the action were accomplished.

Ephemeral Stream - A stream which flows only in direct response to precipitation in the immediate watershed or in response to the melting of a cover of snow and ice, and which has a channel bottom that is always above the local water table.

Erodibility - The relative ease with which a specific soil type erodes under specified conditions of slope as compared with other soils under the same conditions.

Erosion - 1) The wearing away of the land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep. 2) Detachment and movement of soil or rock fragments by water, wind, ice, or gravity.

Eutrophication - The normally slow aging process by which a lake evolves into a bog or marsh. During eutrophication the lake becomes so rich in nutritive compounds, especially nitrogen and phosphorus, that algae become superabundant. Eutrophication may be accelerated by enrichment from human activities.

Evaporation - The process by which a liquid becomes a vapor or gas.

Evapotranspiration - The process by which soil water is depleted through the combined effects of direct evaporation from the soil and transpiration through living plant tissue.

Fabric Filter - A material to remove particles from an air steam, similar to a vacuum cleaner bag.

Facultative Aerobe - An organism that although fundamentally an anaerobe can grow in the absence of free oxygen.

Facultative Anaerobe - An organism that although fundamentally an aerobe can grow in the absence of free oxygen.

Fauna - The entire animal life of a region.

Feeder - A device used to transfer coal at a controlled rate.

Feedwater Heater -- Heat exchangers in which boiler feedwater is pre-heated by steam extracted from the turbine.

Fertility - The quality of a soil that enables it to provide nutrients in adequate amounts and in proper balance for the growth of specified plants when other growth factors, such as light, moisture, temperature, and the physical condition of the soil are favorable.

FGD (Flue-Gas Desulfurization) - Any process used to remove sulfur (largely sulfur oxides) from flue gases.

Field Capacity - The quantity of water that can be permanently retained in the soil in oposition to the downward pull of gravity.

Fill - (1) Depth to which material is to be placed (filled) to bring the surface to a predetermined grade. (2) The volume of material to be added. (3) An embankment.

Fill Area - Natural or man-made excavations used for the disposal of unwanted solid material.

Fill Bench - That portion of a bench formed by spoil that has been deposited on the original slope (contour mining).

Filter - A device or structure for removing solid or collodial material, usually of a type that cannot be removed by sedimentation from water, sewage, or other liquid. The liquid is passed through a filtering medium, which may consist of a granular material such as sand, infusorial, or diatomaceous earth anthracite coal, etc., finely woven cloth, unglazed porcelain, or specially prepared paper. Filters may be of the type - high rate, intermittent, low-rate, rapid sand, vacuum, etc.

Filter Bed - A device for removing suspended solids from water, consisting of granular material placed in a layer(s) and capable of being cleaned hydraulically by reversing the direction of the flow.

Filter Cake - The moist residue remaining from the filtration of a slurry to produce a clean filtrate.

Filter Strip - Strip of undisturbed vegetation that retards the flow of runoff water, causing deposition of transported material and thereby reducing sediment flow.

Final Contour - The contour existing in a surface mined area after overburden is replaced and graded.

Final Cut - In area mining, the last linear excavation; if left unfilled, a highwall remains.

Fines - In general, the smallest particle of coal or mineral in any classification, process, or sample of material. Those particles less than 0.074 mm (#200 sieve) in diameter.

Fireflooding - The process of igniting the hydrocarbons in the formation at the site of an injection well; this is followed by propagation of the combustion front through the reservoir to producing wells.

Fireside Cleaning - Cleaning of the outside surface of boiler tubes and combustion chamber refractories to remove deposits formed during the combustions.

Fischer Assay - Standardized method of determining the yield of oil from oil shale (gallons of oil/ton of shale).

Fixative (for FGD Sludge) - A chemical additive that is mixed with FGD sludge to give it more desirable properties for disposal. Commonly, a fixative is used to lessen the thixotropic characteristics of the sludge.

Fixed Bed - A bed in which the individual particles or granules of a solid are motionless and supported by contact with each other (in contrast with moving bed).

Floc - A very fine, fluffy mass formed by the aggregation of fine suspended particles.

Flocculator - An apparatus designed for the formation of floc in water or sewage.

Flocculation - The agglomeration of colloidal and finely divided suspended matter after coagulation by gently stirring by either mechanical or hydraulic means. In biological waste-water treatment where coagulation is not used, agglomeration may be accomplished biologically.

Flora - The entire plant life of a region.

Flotation - A process for separating minerals from waste rock or solids of different kinds by agitating the pulverized mixture of solids with water, oil, or special chemicals, which causes preferential wetting of solid particles of certain types by the oil. (The unwetted particles are carried to the surface by the air bubbles and thus are separated from the wetted particles.) A frothing agent is also used to stabilize the bubbles in the form of a froth, which can easily be separated from the body of the liquid (froth flotation).

Flow Net - A graphical representation of second-order differential equations used to determine quantity of flow and water pressures.

Flow Rate - Usually expressed as liters/minute (gallons/minute) or liter/day (million gallons/day). Design flow rate is that used to size a process capacity.

Flue Gas (Stack Gas) - The gases resulting from combustion of a fuel.

Fluidization (Dense Phase) - The turbulent motion of solid particles in a fluid stream; the particles are close enough to interact and give the appearance of a boiling liquid.

Fluidization (Entrained) - Solid particles transported by a high-velocity fluid stream with little or no solid interaction.

Fluidized Bed - A bed of suitably sized solid particles through which a fluid (usually a gas) flows at a velocity high enough to buoy the particles, to overcome the influence of gravity, and to impart to them an appearance of great turbulence.

Fluidized Bed Combustion (Coal) - Burning coal along with ground limestone ($CaCO_3$) or dolomite ($MgCO_3$). This is one method to reduce emissions of sulfur dioxide from coal-fired power plants. The calcium (or magnesium) combines with sulfur dioxide during the burning process to form solid calcium sulfate (or magnesium sulfate).

Flume - An open channel or conduit on a prepared grade.

Fly Ash - All solids, ash, cinders, dust, soot, or other partially incinerated matter that is carried in or removed from a gas stream. Fly ash is usually associated with electric generating plants.

Fossil Fuel - Naturally occurring substances derived from plants and animals that lived in ages past. Fossil fuels include lignite, coal, oil, and natural gas.

Foul Water - Coal conversion wastewaters which consist of the following items - process condensate, decanter wastewater (hydro-treating), gas purification wastewater, and cryogenic separation wastewater.

Forward Combustion - The combustion zone advances in the same direction as the air flow.

Fracturing (Drilling, Blasting) - Process of breaking up overburden or mineral for ease of removal.

Frothing - Vapor escaping from rapidly boiling liquid carries liquid with it causing bubbles to form, which impedes the reaction taking place.

Fuel - A substance used to produce heat energy, chemical energy by combustion, or nuclear energy by nuclear fission.

Fugitive Dust - Particles of dust removed from a surface by the wind.

Functional Group - The grouping of biota according to their role or activity in the system of interest.

Fungi (Fungus) - Simple or complex organisms without chlorophyll. The simpler forms are one-celled; the higher forms have branched filaments and complicated life cycles. Examples of fungi are models, yeasts, and mushrooms.

Generation - The conversion of chemical or mechanical energy into electrical energy.

Gas (Natural) - A naturally occurring mixture of hydrocarbon gases found in porous geologic formations beneath the earth's surface, often in association with petroleum. (The principal constituent of natural gas is methane.)

Gas (Synthesis) - A method of developing liquid fuels from coal by oxidation.

Gas Chromatography - The process in which the components of a mixture are separated from one another by volatilizing the sample into a carrier gas stream that is passing through and over a bed of packing consisting of a 20- to 200-mesh solid support.

Gases - Materials that can be condensed to liquids only by pressure or at temperatures below ambient (such as oxygen, methane, hydrogen).

Gas Liquor (Sour Water) - The aqueous streams condensed from the coal conversion and processing areas by scrubbing and cooling of the crude gas stream.

Gasification - The conversion of coal to the high-Btu synthetic natural gas under conditions of high temperatures and pressures; in a more general sense, conversion of coal into a usable gas.

Gob - Waste coal, rock pyrites, slate or other unmerchantable material of relatively large size that is extracted during underground mining and deposited either underground or on the surface in gob piles. Gob (sometimes used synomously with

refuse) may also refer to the solid fragments in waste material from coal washing that do not remain suspended in the cleaning water.

Gouging - The process of making numerous small basins in the soil for the purpose of capturing precipitation for increased soil moisture and reduction of erosion.

Grade - 1. The inclination or slope of a stream channel or ground surface, usually expressed in terms of the ratio or percentage of number of units of vertical rise or fall per unit of horizontal distance. 2. To establish a profile by backfilling.

Grading - The shaping of the area of land surface affected by mining with earth moving equipment.

Grain Size - Physical size of soil particle, usually determined by either sieve or hydrometer analysis.

Grey Literature - Publications that are not distributed or accessible through regular channels (i.e., libraries, repositories). Included in this literature are Environmental Impact Statements, environmental reports, monitoring reports, and others.

Groundwater - Phreatic water or subsurface water occupying the zone of saturation.

Habitat - The environment in which the life needs of a plant or animal are supplied.

Hardness (Water) - A characteristic of water, imparted by salts of calcium, magnesium, and iron, such as bicarbonates, carbonates, sulfates, chlorides, and nitrates, that causes curdling of soap, deposition of scale in boilers, damage in some industrial process, and sometimes objectionable taste.

Haul Road - Road from pit to loading dock, ramp, or preparation plant used for transporting mined material by truck.

Haul Truck - Generally an off-road vehicle designed to transport ore and, in some cases, overburden from an extraction site. The trucks may be a rear dump or bottom dump type with capacities from 35 to 150 tons.

Head of the Hollow (Valley Fill Method) - A valley fill method for surface-mined land in which overburden material from adjacent contour or mountain top mines is placed in compacted layers in narrow, steep-sided hollows so that surface drainage is possible.

Heat Content (Coal) - The heat per pound (usually expressed as Btu/lb) that is released from coal during combustion.

Heat Reservoir (Sink) - Anything that absorbs heat, usually part of the environment (such as air, a river, or outer space).

Heavy Metals - Metallic elements of high molecular weight, generally toxic to plant and animal life in low concentrations. Such metals are often residual in the environment and exhibit biological accumulation. Examples include mercury, chromium, cadmium, arsenic, and lead.

Heterocyclic - A cyclic or ring structure in which one or more of the atoms in the ring is an element other than carbon.

High-Btu Gas - Fuel gas having heating value of about 1000 Btu/scf or more.

High-Sulfur Coal - In general, coal that contains over 1% sulfur.

Highwall - The unexcavated face of exposed overburden coal in a surface mine or the face or bank on the uphill side of a contour strip mine excavation.

Holism - The doctrine that the universe, including life in all its forms and the inorganic environment, is correctly seen in terms of interacting wholes that are more than the mere sum of elementary parts.

Hot - Refers to material in the overburden, refuse, or gob piles that is highly acid producing or difficult to revegetate because of its acid nature.

Hydraulic Conductivity - The rate at which water can flow through a permeable material.

Hydraulic Gradient - The change in hydraulic head over a distance. Nearly horizontal flow has a very small gradient.

Hydraulic Head - The energy which allows water to flow. It consists of a pressure and a height component. Water flows from areas of higher to lower head.

Hydrocarbon - An organic compound consisting exclusively of the elements carbon and hydrogen. The principal types are aliphatic (straight-chain) and cyclic (closed ring).

Hydrocracking - An oil-refining process in which the large molecules of crude oil are broken into smaller molecules through reaction with hydrogen. (The process is used to convert heavy oil into lighter fractions such as gasoline.

Hydrogasification - Gasification that involves the direct reaction of fuels with hydrogen to optimize formation of methane.

Hydrogenation - Chemical reactions involving the addition of gaseous hydrogen to a substance under temperatures and pressures.

Hydrologic Balance - The relationship between the quality and quantity of water inflow to, water outflow from, and water storage in a hydrologic unit such as a drainage basin, aquifer, soil zone, lake or reservoir. It encompasses the dynamic relationship amoung precipitation, runoff, evaporation, and changes in ground and surface water storage.

Hydrologic Regime - The entire state of water movement in a given area. It is a function of the climate and includes the phenomena by which water first occurs as atmospheric water vapor, passes into a liquid or solid form, falls as precipitation, moves along or into the ground surface, and returns to the atmosphere as vapor by means of evaporation and transpiration.

Hydrology - The science of water, its properties, laws, distribution and behavior from both a physical and chemical standpoint.

Hydroseeding - Dissemination of seed, mulch and soil amendments, hydraulically in a water medium.

Impact - An observed effect that occurs in an ecosystem as the result of an environmental perturbation.

Impact (Direct and Indirect) - Direct or primary impacts are those in which the causative agent impinges directly upon the responding ecological components. Indirect or secondary effects are those in which man-caused change in the environment creates one or more intermediary effects in a chain of events leading to the observation of the impact.

Impingement - The term used by aquatic biologists to refer to incidents in which aquatic organisms become caught and held by water flow against intake screens such as those utilized in power plant cooling systems.

Impoundment - A body of water formed by collection and confinement of stream flow (as in a reservoir).

Incineration - The combustion (by burning), for example of organic matter in wastewater sludge solids after water evaporation from the solids.

Indicator

. Biological - An organisms that exhibits identifiable responses to a pollutant at low levels; ideally, the responses can be quantified and used to predict what may happen to other, less sensitive, associated organisms at higher stress levels.

. Chemical - A parameter, component, or element that is relatively easily measured and that provides a broad amount of information about the state of an aquatic system.

Inert Gas - A gas that does not react with other substances under ordinary conditions.

Infiltration - The act or process of the movement of water into soil.

Inorganic - Being or composed of matter other than plant or animal.

Intake - The place where water enters a conduit or other structure.

Intermittent Stream - A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and is dry for a large part of the year.

Inversion - A thermally stable atmospheric condition wherein surface air is prevented from rising by a layer of warmer air above.

Invertebrates - Animals without backbones.

Kerogen - A resinous hydrocarbon material that is the chief organic constituent of oil shale. When heated to 450 to 600°C, Kerogen releases vapors that can be converted to raw shale oil, a black, viscous mixture of hydrocarbons.

Key Species - A species that plays an important ecological role in determining the overall structure and dynamic relationships within a biotic community. A component species of a biotic community whose presence is essential to the integrity and stability of a particular ecosystem.

Lacustrine Deposits - Deposits which have been laid down in freshwater lakes or marshes.

Lagoon - (1) A shallow body of water as a pond or lake which usually has a shallow, restricted inlet from the sea.
(2) A pond containing raw or partially treated wastewater in which aerobic or anaerobic stabilization occurs.

Launder - (1) A trough, channel, or gutter, by which water is conveyed. (2) In mining, a chute or trough for conveying powdered ore, or for carrying water to or from the crushing apparatus.

Lay-Down Area (Construction) - An area used for temporary storage of construction material.

Leachate - Liquid that has percolated through a medium and has extracted dissolved or suspended materials from it.

Leaching - Extraction of dissolved or suspended materials from a solid by a liquid.

Legume - A plant member of the legume family, leguminossae, which is one of the most important and widely distributed plant families. Legumes include food and forage species such as peas, beans, peanuts, clovers, alfalfas, sweet clovers, lespedezas, vetches, and kudzu. Practically all legumes are nitrogen-fixing plants.

Levee - An embankment to confine or control water, especially one built along the banks of a river to prevent overflow of lowlands.

Lignite - Brownish-black coal containing 65 to 72 percent carbon on a mineral-matter free basis, with a rank between peat and sub-bituminous coal.

Lime - Any of a family of chemicals consisting essentially of calcium hydroxide made from limestone (calcite) which is composed almost wholly of calcium carbonate or a mixture of calcium and magnesium carbonates.

Limnology - The study of the physical, chemical, and biological aspects of inland waters.

Liquefaction - Conversion of a solid to a liquid; with coal, this appears to involve the thermal fracture of carbon-carbon and carbon-oxygen bonds, forming free radical. The radicals abstract hydrogen atoms yielding low-molecular-weight gases and condensed aromatic liquids.

Low-Btu Gas - A gas having a heating value of up to 350 Btu per standard cubic foot.

Lockhopper - A mechanical device that permits the introduction of a solid into an environment of different pressure.

Macro-Organisms - Plants, animals, or fungal organisms visible to the unaided eye.

Macrophyte - Any plant that can be seen with the unaided eye e.g., mosses, ferns, liverworts, rooted plants.

Makeup Water - Water to replace that lost by evaporation, seepage, and blowdown.

Marcasite - White iron pyrites, FeS_2.

Matrix - (1) A rectangular array of rows and columns of mathematical elements that can be combined to form sums and products. (2) A figure resembling a mathematical matrix, such as a list of categories along vertical and horizontal axes with a designation of the interactions of any two components at the point of intersection.

Mean Velocity - The average velocity of a stream flowing in a channel or conduit at a given cross section or in a given reach. It is equal to the discharge divided by the cross sectional area of the reach. Also called average velocity.

Mechanical Draft Tower - A cooling tower in which the air flow through the tower is maintained by fans. In forced draft towers, the air is forced through the tower by fans located at its base; whereas in induced draft towers, the air is pulled through the tower by fans mounted on top of the tower.

Methanation - The catalytic combination of carbon monoxide and hydrogen to produce methane and by-product water. (About 60% of the end-product methane is produced in the methanation step.)

Method of Operation - The manner by which the cut or open pit is made, the overburden is placed or handled, water is controlled, and other acts are performed by the operator in the process of uncovering and removing the mineral. The method of operation affects the reclamation of the area of land affected.

Microflora - A term used in general reference to four groups of microorganisms: bacteria, actinomycetes, fungi, and algae.

Microhabitat (Microenvironment) - A small or restricted set of distinctive environmental conditions that constitute a small habitat, such as a tree stump, a dead animal, or a space between clumps of grass.

Microorganism - Any minute organisms invisible or barely visible to the unaided eye.

Milling - Grinding and crushing ore, often to remove waste constituents.

Mine Drainage - Any water discharged from a mine-affected area, including runoff, seepage, and underground mine water.

Mine-Mouth - A steam electric power plant located within a short distance of an extraction operation and to which the mineral is transported from the mine by a conveyor system, slurry pipeline, or truck.

Mineral Seam - Layer of strata in which a mineral is contained (e.g., coal seam, oil shale seam, etc.).

Mitigation - Specific procedure to reduce, avoid, or alleviate negative impacts of development on the environment.

Model - A representation or abstraction of a real system; an attempt to present some of the important features of the real system in a simplified way to aid understanding. Models may use words, pictures, or mathematics to present the abstractions.

Monitoring Program (Environmental) - A program for measuring anticipated disturbances in environmental systems. The program often includes certain aspects of the baseline study program selected for their ability to detect alterations in local ecosystems caused by the project of interest.

Mountain Top Removal - An adaptation of area mining to contour mining in which 100 percent of the overburden covering a coal seam is removed in order to recover 100 percent of the mineral.

Moving Bed - A body of solids in which the particles or granules of a solid remain in mutual contact, but in which the entire bed moves in piston-like fashion with respect to the containing walls (in contrast with fixed beds).

Mottled - Soil horizons irregularly marked with spots of color. A common cause of mottling is impeded drainage, although there are other causes, such as soil development from an unevenly weathered rock.

Mulching - The addition of materials (usually organic) to the land surface to curtail erosion or retain soil moisture.

Multiple Seam Stripping (Mining) - Process of surface mining more than one (usually parallel) mineral seam in the same pit.

Necrosis - Localized or general death of plant or animal tissue, often characterized by a brownish or black discoloration.

Nekton - Macroscopic organisms swimming actively in water; e.g., fishes.

Neoplasm - A new and abnormal formation of tissue, as a tumor or growth that serves no useful function but grows at the expense of the health organism.

Neutralization - Reaction of acid or alkaline solutions with the opposite reagent until the concentrations of hydrogen and hydroxyl ions are about equal.

Niche (Ecological) - The functional role of an organism within its community and ecosystem, resulting from the organism's structural adaptations, physiological responses, and specific behavior, (inherited and/or learned).

Nonpoint Source - Any nonconfined area from which pollutants are discharged into a body of water, i.e., agriculture runoff, urban runoff, and sedimentation from construction sites.

Once-Through Cooling System - A circulating water system which draws water from a natural source, passes it through the main condensers, and returns it to a natural body of water.

On-Stream Operating Time - The time during which the entire pilot plant is actually working at preset conditions, as opposed to the time in which it is shot down for repairs, is starting up, etc.

Open Cut - Longitudinal excavation made by strip mining to expose a mineral seam.

Operation - All of the premises, facilities, railroad loops, roads, and equipment used in the process of producing and removing a mineral from a designated mine area or prospecting for the purpose of determining the location, quality or quantity of a natural coal deposit.

Organic - Of, relating to, or containing carbon compounds.

Orphan Land (Bank, Pile) - Disturbed surfaces resulting from surface mines that were inadequately reclaimed or not treated at all, usually mined before the enactment of comprehensive reclamation laws.

Outcrop - To come to or be exposed on the surface. That area of land where the mineral seam is naturally exposed or near the surface.

Outslope - The face of the fill spoil extending downslope from the outer point of the bench to the toe of the fill section.

Overburden - Material of any nature, consolidated or unconsolidated, that overlies a deposit of useful materials, ores, or coal, and are removed in surface mining.

Oxidation - Originally meant a reaction in which oxygen combines chemically with another substance, but term now includes any reaction in which electrons are transferred.

Oxidation Halo - The zone of oxidized minerals surrounding a body of reduced material (e.g., FeS_2).

Oxygen Demand (BOD; Biological Oxygen Demand) - A measure of the demand on a water body's dissolved oxygen supply that will be generated, over a specified time period, by the biological decomposition of organic material. A high BOD may temporarily or permanently so deplete the oxygen in water than aquatic life is killed.

Oxygen Demand (COD; Chemical Oxygen Demand) - A measure of the amount of a water body's dissolved oxygen supply that will be used up in completely oxidizing added inorganic oxidizable compounds - such as in the oxidation of ammonia to nitrate.

Ozone - A form of oxygen (O_3) produced by reactions in photochemical smog and in electrical discharges. It is a powerful oxidizing agent that is toxic to both plants and animals at relatively low concentrations.

Packing - A media providing large surface area for the purpose of enhancing mass and heat transfer, usually between a gas vapor and a liquid.

PAN - Peroxyacetyl nitrate, a pollutant created by the action of sunlight on hydrocarbons and nitrogen oxides in the air. PAN's are an integral part of photochemical smog.

Parameter - (1) A quantity that characterizes or describes a statistical population (e.g., a population mean). (2) A quantified estimate or measure of the value of an attribute of a component of an ecological system (e.g., gm/m^2 provides a mesure of biomass for some species or groups of species of organisms for a given site).

Particulate Fluidized Bed - A bed in such a condition of fluidization that the individual particles are discretely separated from each other and the volumetric concentration of solid particles is uniform throughout the bed.

Particulate Matter - Small particles of solid material such as ash, that are released in exhaust gases from the combustion process at fossil fuel plants.

Peak-Load Plant - A generating facility operated only during periods at maximum demand.

Peat - One of the earliest stages of coal in which the remains of plants and ferns that have been preserved may be clearly seen. (Peat contains a very high percentage of water and has been used as a fuel for hundreds of years in Ireland, England, and Germany.)

Percolation - Downward movement of water through soils or parent materials.

Periphyton - A community of aquatic organisms (usually small but densely set) closely attached to stems and leaves of rooted aquatic plants or other surfaces projecting above the bottom.

Permeability - The property of a material which permits appreciable movement of water through it when saturated and actuated by hydrostatic pressure of the magnitude normally encountered in natural subsurface water. The rate of permeability is measured by the quantity of water passing through a unit cross section in a unit time when the gradient of the energy head is unity.

pH value - A numerical measure of the acidity or hydrogen ion activity of a soil. The neutral point is pH 7.0. All pH values below 7.0 are acid and all above 7.0 are alkaline. Mathematically, it is the logarithm of the reciprocal of the gram ionic hydrogen equivalents per liter.

Phenology - The study of the periodic phenomena of animal and plant life and their relations to weather and climate, e.g., the annual time of flowering in plants.

Photochemical Oxidants - Secondary pollutants formed by the action of sunlight on nitrogen oxides and hydrocarbons in the air; they are the primary constituents of photochemical smog.

Photoperiod - The duration of light during a 24-hour period.

Photosensitize - To make sensitive to the influence of radiant energy and especially light.

Phreatophyte - A desert plant with a tap root capable of reaching the water table.

Phytoplankton - The plant (algal) portion of plankton.

Pilot Column Leaching Test - Adding and percolating a known type and quantity of water through residue and subsurface strata materials, in order to collect leachate samples at various points in the column for analysis of constituents.

Pilot Plant - A small-scale industrial process unit operated to test the application of a chemical or other manufacturing process under conditions that will yield information useful in design and operation of full-scale manufacturing equipment.

Pipeline Gas - A methane-rich gas that conforms to certain standards and has a higher heating value between 950 and 1,050 Btu per standard cubic foot.

Piping - The action of water through or under a dam, dike or embankment and carrying with it to the surface at the downstream toe some of the finer material. Such action may result in excessive leakage or even failure, as with the increased porosity of the material due to removal of the fines, the velocity of the water increases and in turn more and larger-sized material is removed.

Pit (Strip Pit) - That part of the operation from which coal is being or has been removed from its natural state.

Pitch of Tar - A black or dark brown solid or semisolid residue obtained by partial evaporation or fractional distillation of tars and tar products.

Plankton - Aquatic plants and animals, mostly microscopic, that drift with water currents.

Plant Monitors - Plant biological indicators maintained to obtain or approximate a measure of the concentration of pollutants.

Plume (Atmospheric) - A continuous definable volume of pollutant in the atmosphere. Can be visible or invisible.

Plume (Water) - A stream of water that enters an existing body of water and is still distinguishable because of differences such as velocity, chemistry, or temperature between the influent water and that of the receiving water. A plume dissipates with dilution and dispersion.

Pneumoconiosis - A chronic fibrous reaction in the lungs to the inhalation of dust.

Point Source - A stationary emitting point of a pollutant, e.g., a stack or a discharge pipe; in contrast to an area source or a nonpoint source.

Pollutant - Any contaminant that, when present in the air or water, detracts from or interferes with the desired use or natural state of that air or water.

Pollution - An undesirable change in the physical, chemical, or biological characteristics of air, land, and water that may or will harmfully affect human, plants, or animal life, industrial processes, living conditions, or cultural assets; or that may or will waste or deteriorate raw material resources.

Polynuclear - Chemically polycyclic especially with respect to the benzene ring, used chiefly of aromatic hydrocarbons that are important as pollutants and possibly as carcinogens.

Pond - (1) A body of water of limited size either naturally or artificially confined and usually smaller than a lake. (2) To gather together into a pond.

Population Dynamics - Changes in population size or structure.

Population Pressure - The combined effects exerted by the individuals of a population upon each other, upon the other organisms in a community, and upon their physical environment.

Population (Statistical) - In a statistical sense, a population refers to the complete set of data that is under study.

Porosity - (1) The state of being porous or containing interstices. (2) An index of the void characteristics of a soil or stratum as pertaining to percolation; degree of perviousness.

Potamology - The study of the physical, chemical, geological, and biological aspects of rivers.

Powerplant - Equipment that produces electrical energy generally by conversion from heat energy produced by chemical or nuclear reaction.

Power Shovel - A large machine for digging, which employs a bucket as the terminal member of an articulated boom. When digging, the bucket moves outward and upward so that the machine usually does not excavate below the level at which it stands.

Process Pond Water - Wastewater stored in the pond that was used in some way during the gasification process.

Process Stream - Any material stream within the coal conversion processing area.

Productivity - (1) The rate of production of organic matter produced by biological activity in an area of volume (e.g., grams per square meter per day).
(2) The capacity of a soil to produce a certain kind of crop under a defined set of management conditions.
(3) The rate of storage of organic matter or energy in tissue by organisms, including the matter or energy used by the organisms in maintaining themselves.

Product Stream - Streams within the coal conversion plant that contain the material which the plant was built to produce (e.g., oil, SNG, SRC).

Prospecting (Exploration) - Core drilling, removal of overburden, or any other surface disturbance for the purpose of determining location, quality, or extent of a mineral.

Pulverized Coal - Coal that has been ground to a powder, usually of a size where 80 percent passes through a #200 U.S.S. sieve.

Pyrite - Iron disulfide, FeS_2, generally metallic appearing, yellow in color; also known as "fool's gold."

Pyrolysis - Thermal decomposition of organic compounds in the absence of oxygen. As for example the extraction of kerogen from crushed oil shale by the application of heat.

Quenching - Cooling by immersion in oil, water bath, or water spray.

Rank - Those differences in the pure coal material due to geological processes designated as metamorphic, whereby the coal material changes from peat through lignite and bituminous coal to antracite or even to graphite; the degree of coal metamorphism.

Raw Gas - Impure gas produced in a gasifier.

Reactive Char - Char that is capable of spontaneously catching on fire while in strategic piles.

Reactor - Vessel in which coal-conversion reactions take place.

Reclamation - The process of converting mined land to its former or other productive uses; includes backfilling, grading, highwall reduction, top-soiling, planting, revegetation and other work to restore an area of land affected by mining.

Red Dog - General term applied to ash-like residue remaining after a coal waste dump has burned. The material is red color and is often used for road surfacing.

Refuse - All solid waste from coal mining, preparation, or cleaning including tailings and slurry. Other synonyms are: dirt, gob, shale, slate, etc.

Regrading - The movement of earth over a surface or depression to change the shape of the land surface.

Reheater - A heat exchange device for adding superheat to steam which has been partially expanded in the turbine.

Reinjection - To return a flow, or portion of flow, in a process.

Residence Time - The period of time during which a substance resides in a designated area.

Respiration - The process of extracting energy from organic material by catabolic (breakdown) metabolism.

Restoration - The process of restoring site conditions to the way they were before occurrence of land disturbances.

Retorting - Process of extracting and converting oil from oil shale and tar sands, involving various steps, most requiring heat.

Revegetation - Reestablishment and maintenance of vegetation on disturbed land.

Reverse Combustion - The combustion front advances in the direction opposite to the flow of air.

Runoff - All rainfall (and snowmelt) that does not soak into the ground, evaporate immediately, or is used by vegetation becomes runoff. This flows down slopes and forms streams.

Salinity - (1) The relative concentration of salts, usually sodium chloride, in a given water. (2) A measure of the concentration of dissolved mineral substances in water.

Sample - The part of a population that is collected or measured, usually through a deliberate selection procedure, for the purpose of drawing conclusions about the properties of the parent population.

Scale - Generally insoluble deposits on equipment and heat transfer surfaces which are created when the solubility of a salt is exceeded. Common scaling agents are calcium carbonate and calcium sulfate.

Scarification - Loosening or stirring the surface soil without turning it over, as with a disc.

Scoria - An irregular, rough, slaglike, more or less vesicular fragment of lava, baked clay, shale or sandstone, often a result of past coalbed fires.

Scraper - A rubber-tired excavation vehicle which can load, transport, and dump its own load via a centrally mounted "pan" equipped with a bottom cutting blade. Capacities range from 4.5 to 30 cubic meters.

Scraper - Dozer Operation - A type of area strip mining where scrapers and bull-dozers are used to remove soft or unconsolidated overburden.

Scrubber - A device for removing particles or objectionable gases from a stream of vapor or gas.

Sediment - Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice, and has come to rest on the earth's surface.

Sedimentation - The process of subsidence and deposition of suspended matter by a liquid.

Sediment Trap (Basin) - A small temporary basin formed by an excavation and/or embankment to intercept sediment-laden runoff and to trap and retain the sediment.

Seepage - Movement of water through soil without forming definite channels. This term is often used to refer to the liquid lost through the bottom of a waste pond.

Semi-works - A processing plant of intermediate size between a pilot plant and a commercial operation.

Sequestering Agents - Chemical compounds which are added to water systems to prevent the formation of scale by holding the insoluble compounds in suspension.

Sere - A developmental series of communities, each replacing the previous one during ecological succession.

Silt - Finely divided particles of soil or rock that are often carried in cloudy suspension in water and eventually deposited in sediment.

Siltation - Small sized sedimentary particles of soil carried by surface runoff into lower levels.

Simulation - The imitative representation of the function of one system of process by examination of the function of another. Essentially, simulation consists of a representation of a system or organization by means of a model. The behavior of the system under various possible conditions is then analyzed through repeated manipulations of the model.

Sink - An infinite receptacle outside the system of interest for flows of matter or energy.

Sintering - The agglomeration of solids at temperatures below their melting point, usually as a consequence of heat and pressure.

Slag - That portion of the coal ash that melts to a viscous fluid at boiler operating temperatures, and cools to a glassy, angular material.

Slag Tap Furnace - Furnace in which the temperature is high enough to maintain ash (slag) in a molten state until it leaves the furnace through a tap at the bottom. The slag falls into the sluicing water where it cools, disintegrates, and is carried away.

Slip (Slide or Slump) - A mass of overburden, soil, or spoil material that moves downward and outward to a lower elevation because of the force of gravity.

Slope - The inclination or gradient from the horizontal of a cline or surface. The degree of inclination is usually expressed as a ratio, such as 1:25, indicating one unit rise in 25 units of horizontal distance; or in a decimal fraction (0.04); degree ($2^{o}18'$); or percent (4 percent).

Sludge - A soft mud, slush, or mire; accumulated solids separated from a liquid during processing; (e.g., the solid product of a filtration process before drying.

Slurry - Any mixture of water and finely divided solids. Can refer to mixtures of coal and water (coal slurry), ash and water (ash slurry) desulfurization sludge and water (scrubber sludge), or coal refuse and water (refuse slurry).

Smog - In general, a term broadly used to mean polluted air; more specifically, a mixture of smoke and fog.

Soil - The unconsolidated natural surface material present above bedrock ranging from a few inches to several feet thick. It is composed of finely divided rock debris mixed with decomposing vegetation and animal matter and is capable of supporting plant growth.

Soot - Agglomeration of tar-impregnated carbon particles that form when carbonaceous material does not undergo complete combustion.

Sour Gas - A gas containing hydrogen sulfide.

Sour Water - The aqueous streams condensed from the fossil fuel conversion and processing areas by scrubbing and cooling of the crude gas stream.

Species (Biological) - A unit of classification of organisms, consisting of those individuals actually or potentially sharing a common gene pool.

Species (Composition) - The kinds and numbers of species jointly occupying a specified area.

Species (Richness) - The number of species in a given area.

Spoil - All overburden material removed, disturbed, or displaced from over the coal by excavating equipment, blasting, augering, or any other means. Spoil is the soil and rock that has been removed from its original location.

Spoil (Toxic) - Includes acid spoil with pH below 4.0. Also refers to spoil having amounts of minerals such as aluminum, manganese, and iron that adversely affect plant growth.

Spray Canal - A heat dissipation system used in electric power generation. Heated water is sprayed in the air where some of it evaporates, thereby cooling the rest. Sprayed water is collected in canals that recirculate the water, repeating the process until the water is cool enough for discharge.

Stabilization Lagoon - A shallow pond for storage of wastewater before discharge. Such lagoons may serve only to detain and equalize wastewater composition before regulated discharge to a stream, but often they are used for biological oxidation.

Stabilization Pond - A type of oxidation pond in which biological oxidation of organic matter is affected by natural or artificially accelerated transfer of oxygen to the water from air.

Stack (Power Plant) - A chimney associated with a power plant for the purpose of discharging gases into the atmosphere.

Stacking Tube - A concrete or metal tube with outward opening doors at different heights along the tube. Coal dumped down the tube discharges at ascending elevations.

Standing Crop - The total number or the total biomass of one or more species in an area at a given time. An instantaneous measure of numbers or biomass.

Stockpiling - Process of storing removed topsoil, overburden, or mineral.

Stream (Intermittent, Temporary) - A stream that flows only part of the year.

Stream (Interrupted, Discontinuous) - A stream in which part of the flow is underground.

Stream (Perennial, Permanent) - A stream that flows throughout the year with water covering the substratum over its entire course.

Strike-Off - Removing the peak of a spoil ridge by mechanical means to provide a truncated condition.

Strip Mining - Refers to a procedure of mining that entails the complete removal of all material from over the coal to be mined in a series of rows or strips; also referred to as open-cut, open-pit, or surface mining.

Stripping Ratio - The ratio of removed overburden to extractable mineral resource.

SRC System - A noncatalytic direct-hydrogenation coal liquefaction process for converting high-sulfur and ash coal into clean burning gaseous, liquid or solid fuels.

SRC-I Product - A solid coal like produce of less than one (1) percent sulfur and 0.2 percent ash.

SRC-II Product - A low-sulfur fuel oil of 0.2 to 0.5 percent sulfur, and naphtha product.

Sub-Bituminous Coal - Coal of intermediate rank (between lignite and bituminous); weathering and nonagglomerating coal having calorific values in the range of 8,300 to 13,000 Btu, calculated on a moist, mineral-matter free basis.

Subsidence - The settling or sinking of the land surface because of drainage or because of collapse of underground cavities such as those resulting from underground mining.

Succession - The natural replacement of one kind of plant community by another kind in response to gradual changes in the biotic and abiotic environment.

Surface Mining - A mining method whereby the overlying minerals are removed to expose the mineral for extraction.

Surface Mining (Blockcut Method) - A method of surface mining in which overburden is removed and placed around the periphery of a box-shaped cut. After coal is removed the spoil is pushed back into the cut and the surface is blended into the topography.

Surface Mining (Extendedbench Method) - A method of surface mining in deep overburden that employs a large-capacity walking dragline operating from machinesupporting bench that is formed by filling the pit between the partially stripped highwall and the last cut spoil bank.

Surface Mining (Lateral Movement Method) - A method of surface mining in which coal is removed by stripping and augering with no material being placed on the downslope. Lateral movement reduces disturbed acreage by nearly two-thirds when compared with conventional surface mining because the overburden is hauled by truck laterally along the bench and then backfilled against the highwall.

Surface Mining (Modified Blockout Method) - This method of surface mining adapts the block cut method to steeply sloped areas. The modification essentially is backfilling with spoil from succeeding blocks rather than from the spoil-producing block.

Surface Mining (Open Pit Method) - A type of surface mining in which the overburden is removed from the product being mined and is dumped back after mining; or an area from which the overburden has been removed and not replaced.

Surface Mining (Strip) - Surface mining in which the overburden is removed in narrow strips and placed in adjacent pits producing an uneven surface of ridges resembling a plowed field.

Suspended Solids - Small particles of solid pollutants that resist separation by conventional means. S.S. (along with BOD) is used as a measurement of water quality and an indicator of waste-treatment-plant efficiency.

Sweet - Refers to the lime content or calcareous conditions of spoil that indicates a neutral or slightly alkaline material capable of supporting certain calcium-demanding plants; the term "sweet" indicates a pH of 7.0 or above.

Synergistic Effects - Effects that together form impacts "greater than the sum of their parts." e.g., timber-harvesting practices may increase water temperatures, which make fish more susceptible to disease, while also decreasing the dissolved oxygen content of the water, creating conditions of severe stress for fish.

Synthetic Natural Gas (SNG) - Substitute natural gas; a manufactured gaseous fuel generally produced from naphtha or coal that contains 95% to 98% methane and has an energy content of 980 to 1,035 Btu/scf (about the same as that of natural gas).

Tacking (Mulch) - The process of binding mulch fibers together by the addition of a sprayed chemical compound.

Tailings - Waste material derived when the raw mineral or ore is processed to improve its quality or liberate other components. Tailings are usually associated with hard rock mining.

Tar (Coal) - A dark brown or black, viscous, combustible liquid formed by the destructive distillation of coal.

Tar Fog - Submicron aerosol of condensed tar particles.

Tar Sands - Naturally occurring deposits of very viscous or semi-solid hydrocarbons in the pore space of consolidated rock or unconsolidated sand. The hydrocarbon, or bitumen, is a heavy asphalt-like material similar in composition to the heavy ends of cruel oil.

Telescoping Chute - A sectionalized chute that can be raised and lowered so that the discharge spout stays close to the top of the pile.

Terracing - Process of cutting contour benches into a hillside for the purpose of cultivation or to control surface runoff and minimize soil erosion.

Thermocline - The shallow layer of water lying between the epilimnion and the hypolimnion in a lake. The temperature of the thermocline exhibits the abrupt transition between the two layers.

Threshold Sensitivity Level - The minimum level of exposure to a specific pollutant that results in a detectable effect. It is important to note that threshold levels are defined relative to the applied technology's ability to detect an effect.

Tilth - The physical condition of a soil in respect to its fitness for the growth of a specified plant.

Topsoil - The unconsolidated earthy material that exists in its natural state above the rock strata and that is or can be made favorable to the growth of desirable vegetation.

Topsoiling - The placement of topsoil on areas backfilled with overburden.

Total Solids - The total amount of solids in a wastewater in both solution and suspension.

Total Suspended Solids (TSS) - The amount of solids, both organic and inorganic, in suspension in the water. Includes such things as silt, suspended oil, and animal wastes.

Toxicant - A substance that kills or injures living organisms by its chemical or physical actions, or by altering the environment of the organisms.

Toxin - A poison of organic origin.

Trace Elements - Chemical elements that normally are present in minute (trace) quantities. Includes metals such as chromium, zinc, cadmium, copper, and nonmetals such as selenium, boron, and arsenic.

Transpiration - The normal loss of water vapor from a plant, mostly through the stomata of the leaves and the lenticles of the stems and twigs.

Truck-and-Shovel Operation - A mineral removal operation in which a power shovel located in the pit loads blasted or unconsolidated mineral and overburden into large trucks for removal.

Turbidity - A measure of water clarity. Light penetration is reduced in turbid waters. High turbidity indicates high suspended solids.

Turbine - A device used to convert the energy of steam or gas into rotational mechanical energy and used as prime mover to drive electrical generators.

Underground Mining (Deep Mining) - Removal of coal being mined without the disturbance of the surface.

Unit Train - A train composed only of coal cars and locomotives which runs between a mine loading site and the coal discharge point. There are usually no intermediate stops and the empty train returns to the coalfields.

Vacuum Disk Filter - A continuous rotary vacuum filter made up of filter disks mounted at regular intervals around a hollow center shaft covered with a cloth filter. The device is used for dewatering sludge or solids by application of a vacuum inside the disks.

Venturi Scrubber - A gas-cleaning device that involves the injection of water into a stream of dust-laden gas flowing at a high velocity through a contracted portion of a duct, thus transferring the dust particles to the water droplets, which are subsequently removed.

Volatile Combustion Matter - The relatively light components in a fuel which readily vaporize at a relatively low temperature and which when combined or reacted with oxygen, giving out light and heat.

Wash Out - The removal of a pollutant by precipitation.

Washery Refuse - The refuse removed from newly mined coal at preparation plants.

Water Bar - Any device or structure placed in or upon a haul or access road for the purpose of channeling or diverting the flow of water off the road.

Water-Holding Capacity (Soil) - The total amount of water capable of being held in a soil by capillary forces. Usually expressed as percent by weight of dry soil.

Water Quality - A term used to describe the chemical, physical, and biological characteristics of water in respect to its suitability for a particular use.

Water-Quality Criteria - The types and concentration of pollutants that affect the suitability of water for a given use.

Water-Quality Standard - A plan for water-quality management specifying: the use to be made of the water (recreation, fish and wildlife, drinking water, industrial or agricultural); criteria with which to measure and protect these uses; implementation and enforcement plans; and an autodegradation statement to protect existing water quality.

Watershed - An area, usually a valley or collection of valleys, surrounded by surface water divides that drains water, sediment, and dissolved materials to a common outlet at some point along a stream channel.

Water Table - The upper surface of the groundwater or that depth below which the soil is saturated with water.

Weathering - Action of the weather elements in altering the color, texture, composition, or form of exposed objects.

Wheel Excavator - A machine for excavating unconsolidated material. It consists of a digging wheel, rotating on a horizontal axle and carrying large buckets on its rim.

Wet Scrubber - A device for the collection of particulate matter from a gas stream of adsorption of certain gases from the stream.

Yellow Boy - Insoluble iron hydrate produced as a result of acid mine drainage and hydrolysis.

Zooplankton - The animal portion of the plankton. Protozoa and other animal microorganisms living unattached in water.

II/ III.A. Explor- ation			II/III.B. Extraction Activities							II/III.C. Ancillary Activities																	II/III.D. Reclamation Activities						II/III.E. Retorting Operations								
																																		Surface						In Situ		
1	2	3	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	1	2	3	4	5	6	1	2	3	4	5	6	7	8	9
Surveying	Test Drilling	Test Pit Mining	Operation of Equipment	Removal of Surface Features	Topsoil Storage	Dewatering	Blasting	Overburden Disposal	Mineral Extraction	Mineral Storage	Mineral Cleaning	Mineral Loading	Railroad	Access Roads	Haul Roads	Conveyor Pipelines	Fuel and Chemical Storage	Yards and Lots	Sewage	Electric Transmission	Water Supply	Sediment Pond/Strip Lakes	Waste Rock (Refuse)		Runoff Controls	Backfilling and Grading	Topsoiling and Revegetation	Irrigation	Treatment Facilities		Cooling Systems			Waste Streams	Retort Water	Retention Ponds		Explosive Fracturing	Residual Matter	Retort and Condensate Water

OIL SHALE AND TAR SANDS

1. Surface Water Quality

- a Temperature
- b Salinity
- c Nutrients
- d pH
- e Dissolved Solids
- f Suspended Solids
- g Toxicants
- h Carcinogens
- i Heavy Metals
- j Sulfates
- k Radionuclides
- l Pathogens
- m Organics

2. Subsurface Water Quality

- a Temperature
- b Salinity
- c Nutrients
- d pH
- e Dissolved Solids
- f Suspended Solids
- g Toxicants
- h Carcinogens
- i Heavy Metals
- j Sulfates
- k Radionuclides
- l Pathogens
- m Organics

3. Aquatic Ecology

- a Algae
- b Micro-Invertebrates
- c Macro-Invertebrates
- d Vertebrates
- e Aerobic Decomposers
- f Anaerobic Decomposers
- g Macrophytes
- h Biomass
- i Species Diversity
- j Key Species
- k Population Size
- l Ecosystem Functions

4. Aquifer Modification

- a Water Table Alteration
- b Transmissivity
- c Recharge and Discharge
- d Hydrologic Regime
- e Storage Coefficient